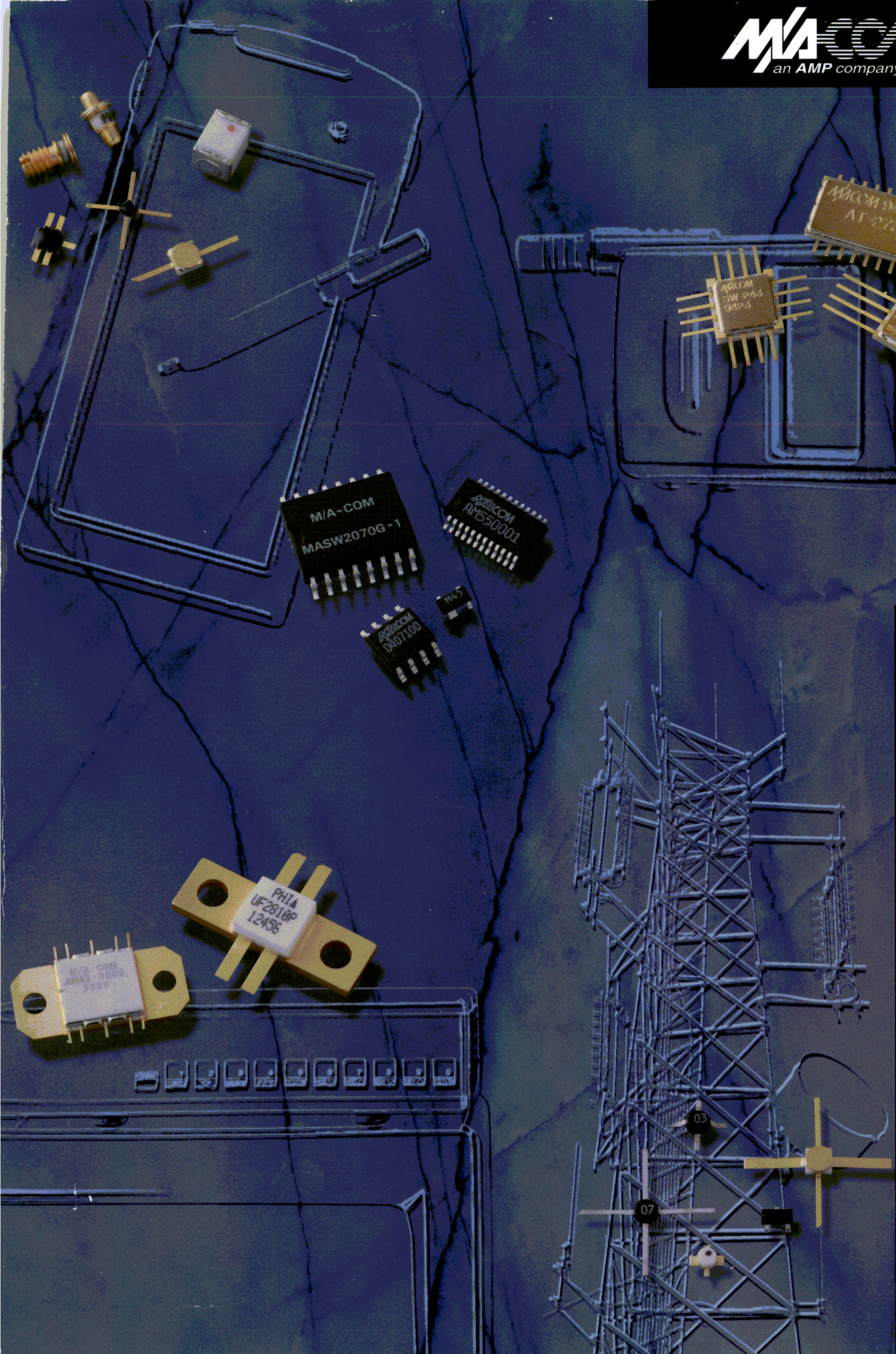
M/A-COM
an AMP company



RF AND MICROWAVE SEMICONDUCTORS

Discrete, Monolithic and Multi-function

M/A-COM's Expertise spans the spectrum... dc through millimeter wave

At M/A-COM, core technologies include material fabrication and processing, circuit design and high volume production.

Materials expertise includes silicon and gallium arsenide. Circuit design capability encompasses passive transmission line circuits through complex integrated circuits in monolithics and hybrid technologies. The latest high volume production techniques are applied to wafers, chips and integrated circuits. This combined with our extensive packaging experience in ceramics and plastics, provides dramatic cost efficiencies.

You'll find our products in commercial applications like cellular telephones, wireless LANs, advanced automotive electronics, and satellite and navigation systems. You'll find us in defense applications too, like radars, missile systems, EW and surveillance. You'll find M/A-COM wherever RF, microwave or millimeter wave expertise and quality manufacturing is critical.

Semiconductors
- Diodes
- Bipolar and MOSFET Transistors
- MMICs

Control Components
- PIN Diode/GaAsFET
  - Switches
  - Attenuators
  - Phase Shifters
  - Limiters
- E/M Switches
- Receiver Protectors

Sources
- Gunn Diode
- Transistor DRO
- PLO
- Synthesizers
- VCO - Diode and YIG Tuned
- Transceivers

Amplifiers
- Low Noise
- Small Signal
- Power
- Gain Blocks
- Linear Power

Receiver Components
- Mixers
- LNAs
- Discriminators
- Detectors
- DLVAs
- Converters

Antennas
- Horns
- Slot
- GPS
- CNI
- Feeds
- Spirals
- ECM
- Wireless

Passive Components
- Isolators
- Circulators
- Filter Assemblies
- Waveguide Ferrite
- Couplers
- Splitters/Combiners
- Transformers
- Attenuators
- Terminations
- Rotary Joint

Integrated Assemblies
- RF, Microwave and Millimeter Wave

Cable Assemblies
- High Performance
- CNI
- EW
- Delay Lines
- Test/Instrument
- Fiber Optic

Connectors
- Standard
- Miniature
- Microminiature
- Blind Mate
- Surface Mount
- Millimeter Wave
- Fiber Optic

GaAs Materials - Semi-insulating
- Substrates
- Wafers
- Bulk

Epitaxial Materials
- Silicon Wafers

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How to Order:

Specify by M/A-COM part number. If special features are required, describe them completely.

Your local M/A-COM Sales office or nearest representative is your contact for Sales and Service assistance for the products listed in this catalog.

In addition, many of these products are available directly from stocking distributors. For the mane of your locally authorized stocking distributor call your local M/A-COM Sales Office or representative. A listing of M/A-COM sales offices and distributors is located at the back of this catalog.

Terms:

F.O.B. Origin, Net 30, days if credit gas been extended; otherwise shipments will be made on a prepaid or C.O.D. basis at M/A-COM's discretion. Prices are subject to change without notice.

Warranty:

M/A-COM warrants the products listed in this publication to be free from defects in materials and workmanship under conditions of normal use. All M/A-COM products are warranted for a minimum period of 12 months. If within the warranty period to the original owner and after prepaid return by the original owner, any M/A-COM product listed in this publication is found to be defective, M/A-COM shall, at its option, repair or replace said defective product. This warranty does not apply to products which have been disassembled, modified or subjected to conditions exceeding the application specifications or ratings.

M/A-COM reserves the right to make design changes without notice on any of its products without any obligations to make some or similar changes to products previously purchased. In no event does M/A-COM assume liability for installation labor or for consequential damages. This warranty is the extent of the obligation or liability assumed by M/A-COM with respect to its products, and no other warranty or guarantee is either expressed or implied.

Notice:

The information in this catalog has been carefully reviewed; no responsibility, however, is assumed for any inaccuracies or errors. This information does not convey to the purchaser or user of any product listed in this catalog any license under any patent, copyright, mask work, trade secret, or other intellectual property. M/A-COM, Inc., and its affiliates reserve the right to change any specification, designs, models and other information contained herein without notice.

Contents

Introduction

M/A-COM and the Microelectronics Division

As of July 1995, M/A-COM became a wholly owned subsidiary of AMP, Inc. As a result, M/A-COM now forms the cornerstone of AMP's Wireless Group. The combination of AMP's strong manufacturing technology and market position with M/A-COM's leading position in RF technology now brings a powerful set of products and solutions to today's wireless markets.

The Microelectronics Division, largest of the M/A-COM divisions, produces all of the semiconductor and most of the semiconductor-based products within M/A-COM. While our roots go back to the emergence of the microwave industry in the 1950s, our technology and product base puts us at the leading edge in today's wireless marketplace.

Facilities

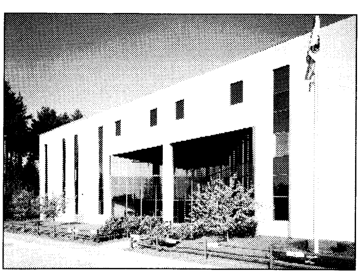
M/A-COM's Microelectronics Division designs and produces semiconductor products at six locations: Lowell, Massachusetts (two facilities); Torrance, California; Burlington, Massachusetts; Arecibo, Puerto Rico; and Cork, Ireland. These facilities contain over 63,000 square feet of clean room space to support our semiconductor production.

This catalog represents our complete line of semiconductor products, including materials, discrete diodes and transistors, power devices, single-function MMICs and ASIC chip sets. This broad offering of semiconductor products serves the RF, microwave and millimeter frequency markets in a multitude of commercial and government applications.

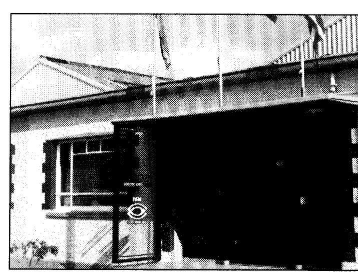
To help you select the most suitable M/A-COM solution, this catalog contains capability overviews, product specific selection guides, application notes and appendices.

43 South Avenue
Burlington,
Massachusetts 01803
U.S.A.
617-564-3000

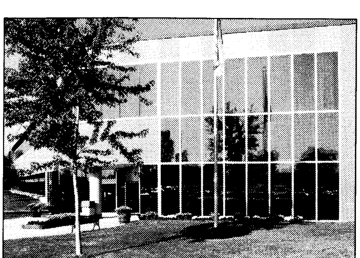
1742 Crenshaw
Boulevard
Torrance, California
90501 U.S.A.
310-320-6160



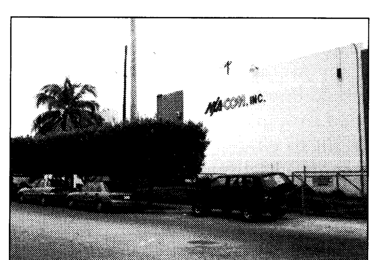
1011 Pawtucket
Boulevard
Lowell,
Massachusetts 01853
U.S.A.
508-442-5000



Youngline Centre.
Casey's Cross
Pouladuff Road -
Cork, Ireland
353-21-311 266



100 Chelmsford Street
Lowell, Massachusetts
01854 U.S.A.
508-442-5000



Arecibo, Puerto Rico
00613
809-878-9000

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Fax (800) 618-8883 Fax +81 (03) 3226-1451 Fax +44 (1344) 300 020

A Continuing Tradition

M/A-COM Microelectronics Division has over four decades of technical accomplishments and experience in the development and manufacture of RF, microwave and millimeter wave products, assuring you access to the widest range of product and technical capability in the industry.

The ensure continued growth, we are aggressively pursuing wireless applications for our technologies, ranging from our RF ICs for portable telephones to our millimeter wave transceivers for automotive sensors. Our ongoing success in these markets also provides benefits to our government customers through continued improvements in production technology.

We are the leader in the industry in offering "dual use" technologies that allow us to participate successfully in both government and commercial markets through the following capabilities:

- **GaAs and Silicon MMIC products**
- **In-house IC design and FAB capabilities**
- **Glass Microwave Integrated Circuits (GMIC)**
- **Heterolithic Microwave Integrated Circuits (HMIC)**
- **Largest domestic producer of semi-insulating GaAs materials**
- **Extensive product experience in both semiconductor-based and passive technologies**
- **Wide spectrum coverage producing semiconductor components and assemblies from RF to millimeter wave frequencies.**

These capabilities, combined with our experience, guarantee continued growth through technology leadership and innovative design solutions.

GMIC is a trademark of M/A-COM, Inc., The GMIC process is the subject of U.S. patent 4,737,236, owned by M/A-COM, Inc.

HMIC is a trademark of M/A-COM, Inc. Patent pending.

Commitment to Total Customer Satisfaction

As the demands of the electronics industry have changed, so has M/A-COM. We have always led the RF/microwave industry in product performance. Now, at the Microelectronics Division, every employee recognizes the role they play in providing you with total satisfaction. Total customer satisfaction means total process improvement.

Through the implementation of Continuous Flow Manufacturing, Process Re-engineering and ISO 9001, we are striving to continuously improve quality, cost and delivery. Business, design, procurement and manufacturing processes have been optimized and documented to reduce cycle time and eliminate waste. Training, documentation, measurement and audit is then added to assure the process responds to changing demands. Decisions are made based upon data, using statistical tools such as control charts, run charts and design of experiments. Widespread use of integrated design, manufacturing, order management and quality data systems have reduced time-to-market, while enhancing manufacturability.

The effectiveness of this total system is evaluated through employee teams and regular management reviews. Always open to opportunities for learning, M/A-COM Quality's signature is listening: to our customers, to our suppliers and to each other. The result? M/A-COM has certified operations to ISO 9001, received awards for our quality and delivery performance and earned the right to be recognized as a partner in excellence.

DNV

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THE DUTCH COUNCIL
FOR CERTIFICATION
Reg. No 24

ISO-9001 CERTIFICATED FIRM

DET NORSKE VERITAS INDUSTRY B.V., THE NETHERLANDS

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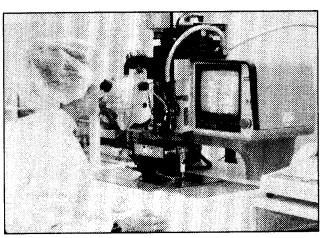
Quality Is What We Do

Quality is what we do. We have organized our design, assembly, inspection and test functions into product lines that allow for flexible continuous flow manufacturing and real-time data analysis covering a wide range of product families from attenuators to multi-function assemblies. While the products differ, the approach to quality is the same. We communicate our customers' needs to our employees and listen to the employees' suggestions for improvement. We train our operators to inspect their own work and cross-train them to understand the responsibilities of their fellow employees. Quality data is used within the cell to take action to improve customer satisfaction through design improvement, better work instructions and more efficient processes.

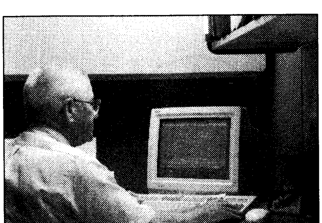
Quality Systems Management

Our operations have been certified to ISO 9001, the International Standard for Quality Excellence. Our success in achieving total customer satisfaction comes with our success in incorporating these steps into our daily work. We manage their effectiveness through periodic audits and management reviews of the audit results with employees.

Our quality system includes more than product test and inspection. It extends to each link in the chain of customers within our business.



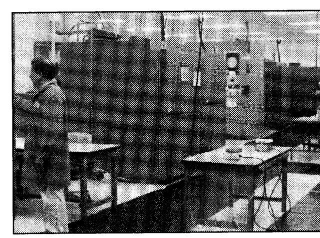
Controlling processes in-line.



Preventing defects with on-line systems.

We are dedicated to achieving *total customer satisfaction* by empowering our employees to continuously improve the quality, cost and delivery of their products and services.

To improve, we must recognize *the value of learning* from our customers, our competition, our suppliers and each other.



Assuring product performance in all environments.

Discovering opportunities in real-time.

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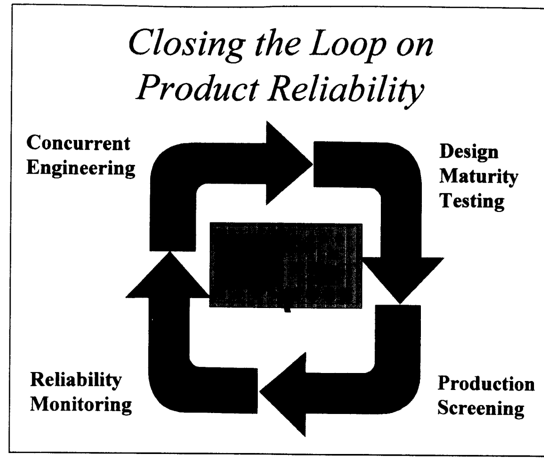
Reliability

M/A-COM uses failure modes and effects analysis, combined with reliability modeling, in-house qualification testing and reliability monitoring to assure that new technology designs meet the demands of high-volume applications. We work with our customers and suppliers during the design and development phase to translate these requirements into workable solutions that assure billions of hours of worry-free operation. Reliability monitoring provides the feedback on the ongoing performance of these technologies. Our on-site environmental and reliability test facilities provide the tools needed for real-time analysis of critical product and process characteristics, including:

- Scanning electron microscopy and EDS
- Real-time X-ray
- Mount and cross-section
- High-power photography
- Electrostatic discharge sensitivity
- Temperature/humidity testing
- Burn-in
- Temperature extreme operating tests
- Temperature cycling
- Thermal shock
- Vibration
- Mechanical shock
- Constant acceleration
- Hermeticity
- Accelerated life testing



Engineers use state-of-the-art technology to maximize the reliability of new processes and products during the initial design phase.

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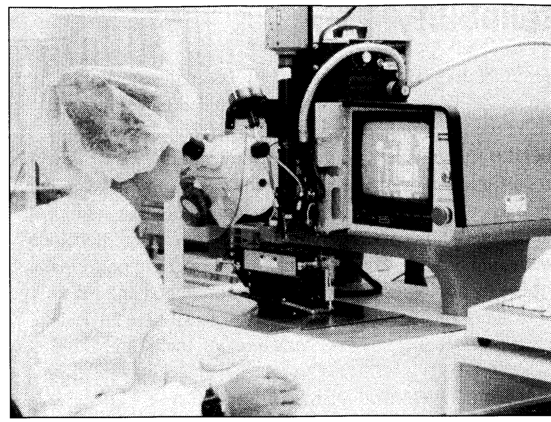
Automated Assembly Capabilities



"MRSI 170" – Fully automatic epoxy dispenser

The VAP and AMC Flexible Manufacturing capabilities allow for quick set up and conversion from one product to another, as well as adaptation to smaller production volumes. Cycle time reductions are achieved by incorporating common fixtures and software-configurable assembly equipment. These capabilities include:

- Batch eutectic die attach with DAP programmable sealers and MEI 703 and 709 machines.
- Fully automatic programmable epoxy dispensing using full pattern recognition MRSI-170 dispensers, cassette to cassette.
- Stencil printer, Transition ASP-1000
- Automatic pick-and-place with one MRSI 505 and one KME DM22M
- Semi-automatic assembly pick-and-place using the Laurier HA225
- Fully automatic wire bond capability using three Hughes model 2470-3 bonders--one running a 1-mil gold wire process and the other running a 0.8-mil gold wire process; one Hughes 2460-3 ball bonder and one KME HW22 ball bonder.
- Benchmark, seam sealer SST DAP2200
- Marking, Lumonics laser marking, engraving
- Visual inspection using a voice recognition system tied directly to the data base to capture and store visual inspection data.

These capabilities allow for trend and pareto type analysis that facilitates process line optimization, minimizes paper recordings and provides real-time data retrieval.

The integration of more automated equipment and the philosophy of flexible manufacturing into the work flow has allowed VAP to optimize and generate a very consistent product. This consistency in assembly leads to predictable RF performance. Once RF performance can be consistently established, optimizing yields and truly impacting cost are realized.

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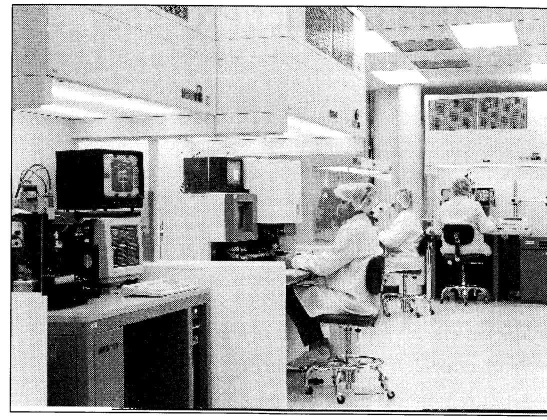
Volume Automated Production Capabilities


Volume Automated Production (VAP) — Work cell based assembly

M/A-COM's Volume Automated Production (VAP) assembly line, located in Lowell, MA, offers a complete foundry of RF and microwave IC, hybrid and module products. VAP's major strengths and capabilities include fully automated on-wafer and "fixtureless" RF test, state-of-the-art automated assembly and a vast linking database network.

Our broad based synergy, with microwave device design, wafer fabrication, flexible VAP and test of subassemblies, is based on Concurrent Engineering practices. Standard production design guidelines and processes, along with customer and supplier involvement ensure the product is Designed For Manufacturability (DFM), yielding cost reduction benefits.

The realization of our Process Oriented Microwave Manufacturing Technologies (PROMPT), based on leveraging M/A-COM's Glass Microwave Integrated Circuits (GMIC), Monolithic (MMIC) and Heterolithic (HMIC) technologies for commercial and government applications, is focused to provide more effective product solutions.

With our dedicated employee workforce, M/A-COM is positioned to be first with our customers by continuously striving for total quality management (TQM) and courteous, timely service.

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Integrated Product/Process Development

Responding to competitive pressures in commercial and government markets demands more systematic methods in product design and processes for quality manufacturing with higher product reliability and lower cost.

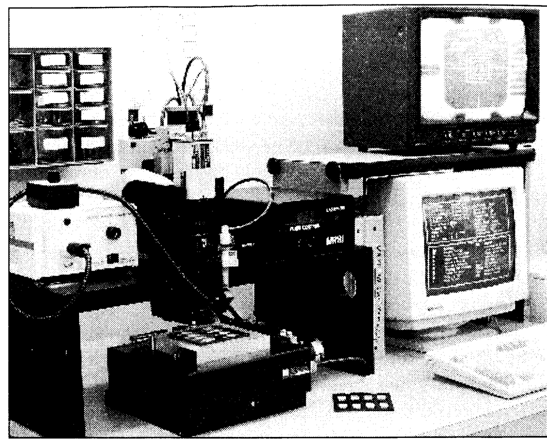
Traditionally, product development in many US companies has evolved in a progression of steps. They are:

- **Market research or applied research**
- **Product design and engineering**
- **Procurement of materials, components and services**
- **Process development**
- **Manufacturing engineering**
- **Production and quality assurance**

These steps, identified as largely independent, cause changes during the manufacturing process, promote rework due to non-optimal design, introduce delays in development schedule and production delivery and result in cost over-runs.

M/A-COM's approach is that of a Concurrent Engineering philosophy, where an integrated multi-discipline team is communicating on all aspects of product development. Product development is achieved through a field of concurrent contributing forces—not isolated, but integrated.

To dispel a common misconception, Concurrent Engineering is not simultaneous or overlapping design and production. Concurrent Engineering involves the simultaneous design of the product and the downstream processes. It does not include the simultaneous design of the product and the execution of the production process, that is the beginning high-rate production of an item that has not completed its test, evaluation and fix phases. On the contrary, Concurrent Engineering emphasizes completion of all contributing tasks prior to the initiation of production.



Automatic Wire Bonding — Two automatic systems with COGNEX pattern recognition

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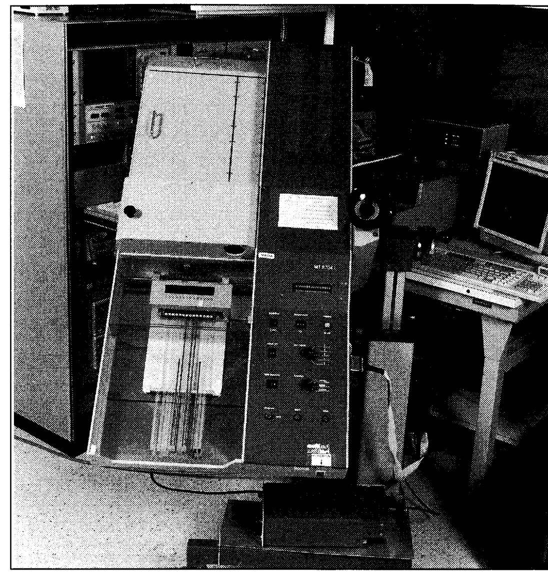
Assuring Product Quality in a High-Volume, High-Mix Environment



M/A-COM has developed extensive RF test capabilities over the past several years for use in a production GaAs MMIC environment. These capabilities have been instrumental in all aspects of our business, as they allow us to accurately and cost-effectively quantify the electrical success of design, process and assembly activities in terms of actual device use conditions and performance requirements.

Tests are performed both at the wafer level (as appropriate) and after assembly of the die onto carriers or into packages. For those products which are assembled into relatively expensive mental and ceramic-based packages, wafer-level testing assures that only known good die are used in these assemblies, resulting in improved yields and a reduction of cycle time and cost. Devices which are sold in plastic packages are only tested after packaging, as the yields are typically very high (>85%) and the cost of test is similar to the cost of packaging.

The production test facility consists of eight automated test stands. Table 1 summarizes the capabilities of these stands. Automated measurement capabilities include S-parameters, noise figure, vector pulsed power and harmonic content, as well as concomitant DC parameters. These capabilities allow us the fully characterize the products we manufacture, including: switches, attenuators, phase shifters, amplifiers, mixers and multi-function MMICs that combine several of these functions onto a single device. Furthermore, most of the test systems are configured with RF switch matrices, so that multi-port products (such as switches) can be fully tested with a single insertion to the test system.

All production test stands are computer controlled using HP9000 series 380 workstations. A single generic Test Executive (software) written in HP BASIC and running on a UNIX operating system (RMB/UX) is used for automatic testing, test stand calibration, data analysis and test facility management. These eight computers are networked together with additional HP workstations used as analysis platforms. This network is also linked to a VAX cluster on which the process and test databases reside. Furthermore, the HP network is accessible from PCs through an X-window protocol.

To accommodate the rapidly growing commercial market for GaAs MMICs, M/A-COM has added a number of automated handlers used for DC and RF final test of plastic packaged devices. Handlers are currently employed to test products in SOIC, SSOP and SOT style packages. These machines have a dramatic impact on test throughput; manual insertion and removal of parts from a test fixture may require as much as 30 seconds per device, compared with 1.5 seconds or less for a handler.

Other common techniques used to interface between the test stands and the device under test (DUT) include device probing and manual fixture measurements. Four of the test stands are connected to automatic probe stations configured for RF measurements. The use of probe stations to measure the RF performance of MMICs in wafer form is well established and provides distinct advantages in test speed, measurement reliability and calibration accuracy.

M/A-COM has developed techniques to increase the test throughput of MMIC carrier assemblies using multi-position assembly/test fixtures, which hold several devices simultaneously, and probe stations. In this way, the advantages of probe testing wafers are extended to carrier testing. RF measurements can also be made on packaged parts using these test stands and an appropriate fixture.

Following test, a copy of all measured data is routed to the test database for statistical analysis. The raw data remains on the HP network as well for review and analysis of individual device performance. When required, test reports are generated automatically upon completion of a test. The test report can be delivered to the customer either on paper or as an element of a data file on magnetic media (3.5-inch floppy disc, 8-mm DAT cartridge or 9-track tape).

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M/A-COM believes there is a significant cost advantage to our products resulting from our extensive test capabilities, ready to integrate and satisfy both commercial and military requirements. The cost advantage due to automation is obvious in reduced set-up and test time, increased calibration and measurement accuracy and diminished requirements for operator interaction. For assembled products (such as hermetically packaged devices, carrier assemblies or multi-chip modules) an even greater cost savings is realized from the ability to test the MMIC to the full set of final product performance specifications at the wafer level. This results in only known good die being submitted into the assembly activity, greatly enhancing the final electrical yield of the assembled devices. Over ten years of experience testing GaAs products can be applied to meet the demanding cost and performance requirements of today's customers.

Stand	Frequency Range (GHz)	RF Ports	S-Parameters	Noise Figure	Power	Harmonics	Interface: Probe, Fixture, Handler
1	0.05 - 26.5	6	X	X			P, F, H
2	0.05 - 50.0	6	X	X			P, F
3	2.0 - 20.0	16	X		X	X	P, F
4	1.0 - 18.0	16	X		X	X	P, F, H
5	0.05 - 26.5	3			X	X	H
6	0.05 - 26.5	10	X				F
7	0.0001 - 1.8	7			X	X	H
8	0.5 - 18.0	2	X	X			H

Table 1: Summary of Production RF Test Stand Capabilities

Burn-in and Life Test Capabilities

M/A-COM has developed state-of-the-art burn-in and life test capabilities for MMIC-based hybrids and carrier assemblies. Our DC biased burn-in systems provide a total capacity of over 1500 devices simultaneously in an inert (nitrogen gas) atmosphere. In situ monitoring of gate and drain voltages and currents can be performed automatically using HP3852 data acquisition units controlled by HP series 320 computers.

A product specification file is created and stored in the computer for each type of device subjected to burn-in. This file defines both the conditions for the burn—in (bias, duration and temperature) and the acceptance limits for the monitored electrical parameters. A summary report is automatically printed upon completion of the burn-in, identifying the pass/fail status of each part. This system has been used to burn-in over 30,000 high-power amplifier and driver amplifier carrier assemblies on the Cobra program.

Both DC biased and RF biased life test capabilities also exist at M/A-COM. As with the burn-in system, both the DC and RF life test stands incorporate automated data acquisition to monitor the status of each part during the life test. Capacity for testing up to 32 devices under RF drive conditions and over 120 devices with DC bias conditions is currently available. Over 250,000 device-hours of reliability testing at temperatures between 150°C and 250°C have been logged during the past three years. These capabilities can be easily configured to meet customer's product qualification needs.

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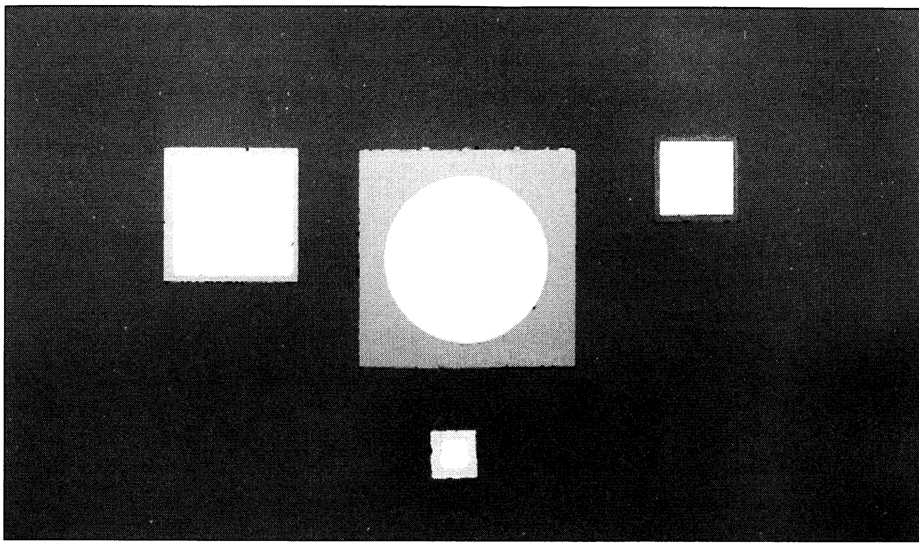
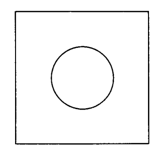
Chip Capacitors



Chip Capacitors

Capacitance (pF)	Maximum Standoff Voltage Rating Volts	Part No.	Page No.
Round Bonding Pads			
2	200	MA4M2002	2 - 2
5	200	MA4M2005	2 - 2
10	100	MA4M1010	2 - 2
20	100	MA4M1020	2 - 2
20	200	MA4M2020	2 - 2
30	100	MA4M1030	2 - 2
50	100	MA4M1050	2 - 2
80	100	MA4M1080	2 - 2
100	100	MA4M1100	2 - 2
100	200	MA4M2100	2 - 2
200	100	MA4M1200	2 - 2
250	100	MA4M1250	2 - 2
250	200	MA4M2250	2 - 2
300	100	MA4M1300	2 - 2
300	200	MA4M2300	2 - 2
600	100	MA4M1600	2 - 2



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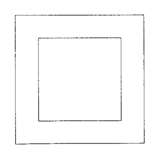

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Capacitance (pF)	Maximum Standoff Voltage Rating Volts	Part No.	Page No.
Square Bonding Pads			
10	200	MA4M3010	2 - 2
20	200	MA4M3020	2 - 2
30	200	MA4M3030	2 - 2
50	200	MA4M3050	2 - 2
100	50	MA4M3100	2 - 2
150	50	MA4M3150	2 - 2

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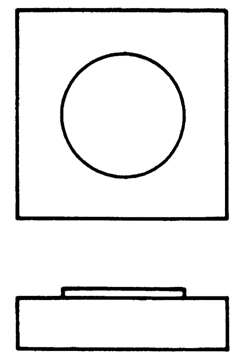
MNS Microwave Chip Capacitors

MA4M Series

V 2.00

Features

- Excellent Repeatability (Wafer to Wafer and Lot to Lot)
- Small Size
- Low Loss
- Available with Round and Square Bonding Pads



Case Style 350

Description

The MA4M series of MNS (metal-nitride-silicon) silicon chip capacitors is designed specifically for high reliability and repeatable performance in microwave circuit applications. These capacitors are made using a low pressure chemical vapor deposition (LPCVD) that results in dense uniform nitride layers. These capacitors exhibit higher capacitance per unit area (resulting in smaller chip size) than over similar MOS, MIS and ceramic capacitors. Sputtered gold contacts are used to provide an easily bondable metal pad on the capacitor chip. M/A-COM MNS capacitors have shown no measurable capacitance change when subjected to the rated standoff voltage at 150°C.

The MA4M series of chip capacitors is an excellent choice for use in hybrid microwave circuits up through Ku-band, where low loss, high reliability, small size and temperature stability are prime concerns.

These chip capacitors are suited for applications requiring dc blocks, coupling capacitors, bypass capacitors, capacitive loads and tuning elements of oscillators, multipliers and filters.

Comparison of M/A-COM MNS Capacitors to Ceramic Chip Capacitors

Characteristics Compared	MNS	Ceramic
Operating Temperature Range	-55 to + +200°C	-55 to +125°C
Temperature Coefficient	180 PPM	1000 PPM
Insertion Loss of a 20 pF Capacitor in a 50Ω line at 15 GHz	0.1 dB	0.2 dB
Chip Size 200 pF, 100V 20 pF, 100V	 40 x 40 mils 22 x 22 mils	 70 x 70 mils 50 x 50 mils

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Specifications

Chip Capacitors with Round Bonding Pads				
Model Number	Capacitance (pF)1,2,3,4 ± 10%	Maximum Standoff Voltage Rating2,3 (Volts)	Chip Style	Nominal Top Contact Diameter (mils)
MA4M2002	2	200	132	3.5
MA4M2005	5	200	132	6.0
MA4M1010	10	100	132	6.0
MA4M1020	20	100	132	9.0
MA4M2020	20	200	132	11.5
MA4M1030	30	100	132	11.0
MA4M1050	50	100	132	14.0
MA4M1080	80	100	199	18.0
MA4M1100	100	100	199	20.0
MA4M2100	100	200	200	26.0
MA4M1200	200	100	200	28.0
MA4M1250	250	100	200	32.0
MA4M1300	300	100	201	35.0
MA4M2300	300	200	263	45.0
MA4M1600	600	100	263	48.0

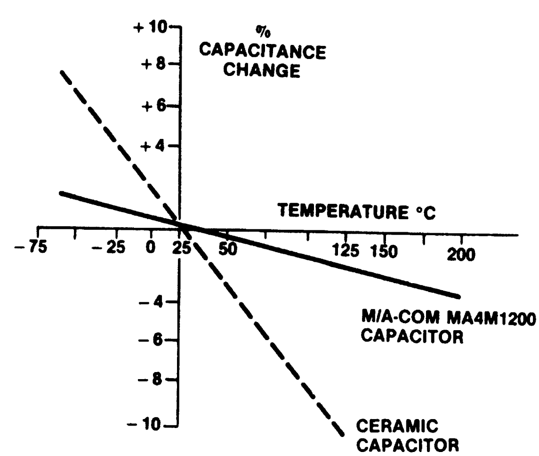
Chip Capacitors with Square Bonding Pads			
Model Number	Capacitance (pF)1,2,3,4 ± 10%	Maximum Standoff Voltage Rating2,5 (Volts)	Chip Style
MA4M3010	10	200	350
MA4M3020	20	200	351
MA4M3030	30	200	352
MA4M3050	50	200	354
MA4M3100	100	50	358
MA4M3150	150	50	359

Notes:
1. 5% capacitance tolerance is available on request.
2. Other capacitance and standoff voltage values are available on request.
3. Capacitance is measured at 1 MHz.
4. Temperature coefficient of capacitance is nominally 180 PPM/°C.
5. Device failure may occur if standoff voltage ratio is exceeded.

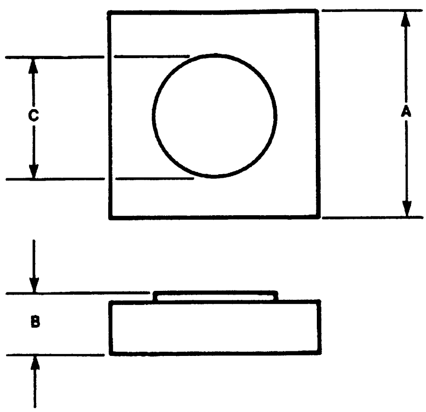
Maximum Ratings

Applied Voltage	Specified standoff voltage
Operating Temperature	-55°C to +200°C
Storage Temperature	-55°C to +225°C

TYPICAL CAPACITANCE CHANGE FOR MNS vs CERAMIC CAPACITOR WITH TEMPERATURE (200 PF CAPACITOR)

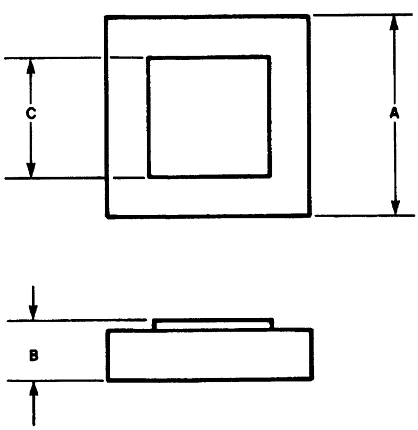


Chip Styles



Chip Style	DIM.	INCHES		MILLIMETERS	
		MIN.	MAX.	MIN.	MAX.
132	A	0.020	0.024	0,51	0,61
	B	0.003	0.006	0,08	0,15
199	A	0.027	0.031	0,69	0,79
	B	0.004	0.005	0,10	0,13
200	A	0.037	0.041	0,94	1,04
	B	0.004	0.005	0,10	0,13
201	A	0.047	0.051	1,19	1,30
	B	0.004	0.005	0,10	0,13
263	A	—	0.060	—	1,52
	B	0.004	0.005	0,10	0,13

Note:
For "C" dimension on above case styles, see specifications.



Chip Style	DIM.	INCHES		MILLIMETERS	
		MIN.	MAX.	MIN.	MAX.
350	A	0.018	0.021	0,46	0,53
	B	—	0.005	—	0,13
	C	—	0.009	—	0,23
351	A	0.018	0.021	0,46	0,53
	B	—	0.005	—	0,13
	C	—	0.012	—	0,30
352	A	0.018	0.021	0,46	0,53
	B	—	0.005	—	0,13
	C	—	0.015	—	0,38
354	A	0.020	0.023	0,51	0,58
	B	—	0.005	—	0,13
	C	—	0.018	—	0,46
358	A	0.018	0.021	0,46	0,53
	B	—	0.005	—	0,13
	C	—	0.013	—	0,33
359	A	0.018	0.021	0,46	0,53
	B	—	0.005	—	0,13
	C	—	0.016	—	0,41

Bonding and Handling Considerations for MNS Chip Capacitors

Handling

Normal precautions that are common to the handling of hybrid semiconductors also apply to MNS chip capacitors. Removal of chips from waffle packs and subsequent handling should be done with a vacuum pencil. Pencils equipped with either metallic or nonmetallic tips are acceptable.

Surface Preparation

Each MNS chip and substrate should be free of oils and other surface contamination. Such contaminants may result in poor solder wetting. Cleansing can be done with acetone, alcohol, freon, TMS or other common microelectronic solvents. Burnishing of MNS capacitor chips is not necessary or recommended.

Solder

Soldering temperatures up to 300°C are acceptable for a duration not greater than 5 seconds for MNS chip capacitors. Any of the common tin-lead-silver, lead-indium, or higher temperature gold alloy solders are acceptable provided that the 300°C temperature is not exceeded. Pure tin or tin-antimony solders are not recommended. Cleaning of residual flux is required and can be accomplished with a fluorinated or chlorinated solvent.

Conductive Epoxy

Any of the conductive epoxies that are available for semiconductor die attachment are acceptable for MNS chip capacitor attachment. Follow the manufacturer's recommendations for mixing and application carefully. Take care to seat the capacitor on the substrate using a soft implement.

Lead Bonding

Ball, ultrasonic, TC or pulse bonding of the wire or ribbon leads are all acceptable methods. Temperature for the pulse bonder should not exceed 300°C. Maximum pressure applied to the MNS capacitor chips should not exceed 25 grams for any of the methods used. Proper procedure will result in bond strength that exceeds MIL-STD-883B Method 2011.2 for gold wire or gold ribbon.

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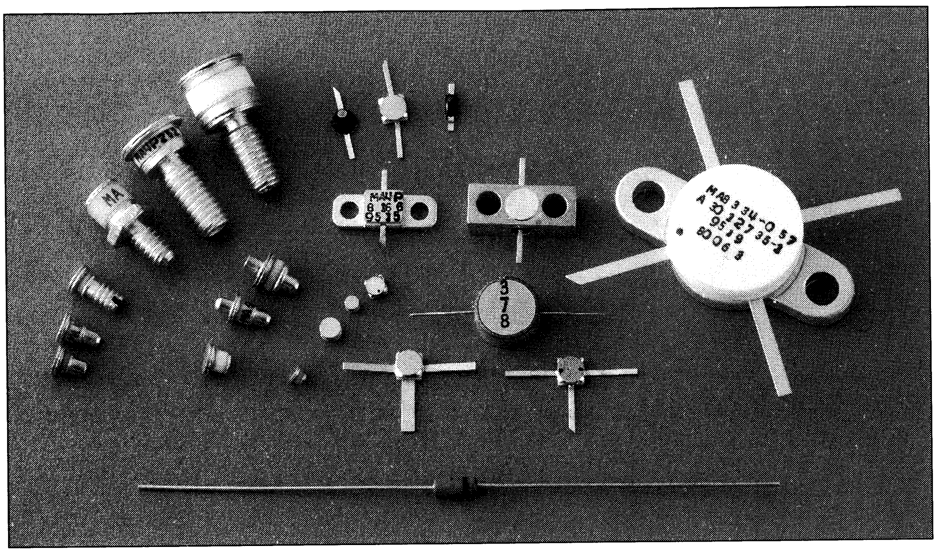
PIN Diodes



Title **Page**

PIN Diode Selection Guide Table of Contents

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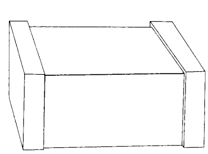
M/A-COM an AMP company

SMQ Square Surface Mount PIN Diodes 10 MHz - 2 GHz

V 2.00

Voltage Rating (V)	Power Dissipation (W)	Capacitance Max. (pF)	R_S (Ω)	Lifetime (μsec)	Part No.	Page No.
High Power Standard Diodes						
50	3.0	1.2	0.75 Max. @ 50 mA	2	MA4P1250	3-1
50	7.5	2.5	0.75 Max. @ 50 mA	4	MA4P1450	3-1
Small Signal Diodes						
35	1.0	1.2	0.5 Max. @ 10 mA	0.3	MA4PH235	3-49
200	1.0	0.5	3.0 Max. @ 10 mA	1.5	MA4PH236	3-49
200	2.0	1.5	0.6 Max. @ 10 mA	3.0	MA4PH237	3-49
High Voltage Cermachip™ Diodes						
500	1.5	0.5	0.6 Max. @ 100 mA	2	MA4P504-1072	3-50
500	1.5	0.65	0.45 Max. @ 100 mA	2	MA4P505-1072	3-50
500	1.5	1.0	0.30 Max. @ 100 mA	2	MA4P506-107	3-50
Other SMQ™ Diodes						
100	2.0	1.0	0.5 Max. @ 100 mA	2.5	MA4P7101F	3-11
100	3.0	0.7	0.8 Max. @ 100 mA	3	MA4P7001F	3-11
200	3.0	0.7	0.8 Max. @ 100 mA	3	MA4P7002F	3-11
200	3.0	1.0	0.5 Max. @ 100 mA	2.5	MA4P7102F	3-11
600	3.0	0.7	0.8 Max. @ 100 mA	3	MA4P7006F	3-11
100	5.0	2.0	1.0 Max. @ 100 mA	8	MA4P4301F	3-11
200	5.0	2.0	1.0 Max. @ 100 mA	8	MA4P4302F	3-11
100	7.5	2.2	0.5 Max. @ 100 mA	6	MA4P4001F	3-11
200	7.5	2.2	0.5 Max. @ 100 mA	6	MA4P4002F	3-11
600	7.5	2.2	0.5 Max. @ 100 mA	6	MA4P4006F	3-11
Attenuator Diodes						
200	1.0	0.5	75 Typ. @ 0.3 - 0.6 mA	1	MA4PH238	3-49
200	2.0	0.8	75 Typ. @ 1.2 - 2.0 mA	3	MA4PH239	3-49

Stocked at your local distributor.



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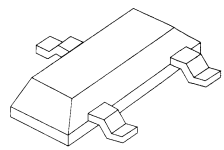
M/A-COM
an AMP company

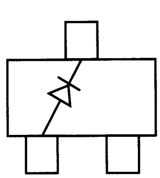
Surface Mount PIN Diodes

V 2.00

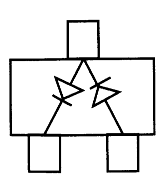


Voltage Rating Min. (V)	Total Cap. Max. (pF)	Series Resistance R_S @ 10 mA (Ω)	Typical Forward Current @ R_S = 75Ω (mA)	Package Wiring Diagrams: Single	Reverse Series Tee	Common Cathode	Page No.
General Purpose Switching Diodes							
35	1.0	0.6	-	MA4CP101A	-	-	3 - 4
35	1.0	0.5	-	MA4P275	MA4P275ST	MA4P275CK	3 - 7
50	0.35	1.5	-	MA4P789	MA4P789ST	MA4P789CK	3 - 7
100	0.35	1.2	-	MA4P282	-	-	3 - 7
Attenuator PIN Diodes							
100	0.35		0.1 - 0.3	MA4P274	MA4P274ST	MA4P274CK	3 - 7
200	0.35		0.5 - 1.0	MA4P278	-	-	3 - 7
200	0.35		0.3 - 0.6	MA4P277	-	MA4P277CK	3 - 7

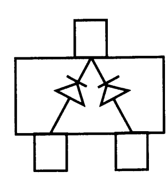
Stocked at your local distributor.



SINGLE



REVERSE SERIES TEE



COMMON CATHODE

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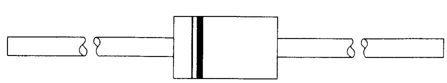
V 2.00

HIPAX™ High Power Axial Lead PIN Diodes

Voltage Rating (V)	Capacitance Max. (pF)	RS @ 100 mA (Ω)	Parallel Resistance @ 100 V, 100 MHz (K-Ω)	Power Dissipation (W)	Part No.	Page No.
Standard HIPAX™ Diodes						
50V	1.2	0.75	10k	5.0	MA4P1200	3 - 12
50V	2.5	0.75	20k	12.0	MA4P1400B	3 - 12
Other HIPAX™ Diodes						
100	0.7	0.8	200k	5	MA4P7001B	3 - 11
100	1.0	0.5	100k	6	MA4P7101B	3 - 11
100	2.0	1.0	50k	10	MA4P4301B	3 - 11
100	2.2	0.5	20k	12	MA4P4001B	3 - 11
200	0.7	0.8	200k	5	MA4P7002B	3 - 11
200	1.0	0.5	100k	6	MA4P7102B	3 - 11
200	2.0	1.0	50k	10	MA4P4302B	3 - 11
200	2.2	0.5	20k	12	MA4P4002B	3 - 11
400	1.0	0.5	100k	6	MA4P7104B	3 - 11
600	2.0	0.8	200k	5	MA4P7006B	3 - 11
600	2.2	0.5	20k	10	MA4P4006B	3 - 11

Stocked at your local distributor.



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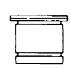
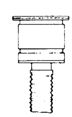
2 and 3 Kilo Volt PIN Diodes

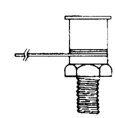
Series Resistance Maximum (Ohms)	Minimum Power Dissipation (W)	Pill	Stud	Stud (No Solder Lug)	Isolated Stud	Isolated Stud (No Solder Lug)	Page No.
2000 Volt Diodes							
0.20	35-50	MA4PK2000	MA4PK2001	MA4PK2002	MA4PK2003	MA4PK2004	3 - 17
3000 Volt Diodes							
0.25	50-75	MA4PK3000	MA4PK3001	MA4PK3002	MA4PK3003	MA4PK3004	3 - 17



Pill



Stud



Isolated Stud

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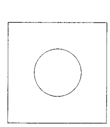
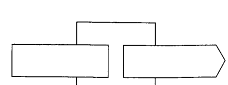
Beam-Lead and Chip PIN Diodes

V 2.00

Suggested Frequency Range (GHz)	Voltage Rating (V)	Capacitance Maximum C_T @ 10 V (pF)	Resistance Maximum @ mA (Ohms)	Nominal Carrier Lifetime (ns)	Nominal Reverse Recovery Time (ns)	Part No.	Page No.
Beam Lead Diodes							
1-18	100	0.025	3.5 @ 50 mA	100	10	MA4P800	3 - 20
1-18	100	0.030	3.3 @ 50 mA	100	10	MA4P801	3 - 20
1-8	50	0.070	2.2 @ 10 mA	50	3	MA4P461	3 - 20
1-6	30	0.120	1.7 @ 10 mA	20	2	MA4P462	3 - 20

Voltage Rating (V)	Capacitance Maximum C_T @ 10 V (pF)	Resistance Maximum @ 10m A (Ohms)	Nominal Chip Size (mils)	Nominal Carrier Lifetime (ns)	Part No.	Page No.
Low Capacitance Diodes						
20	0.10	1.5	15 x 15	10	MA4P150	3 - 28
30	0.05	2.0	15 x 15	10	MA4P151	3 - 28
30	0.10	1.5	15 x 15	10	MA4P152	3 - 28
30	0.15	1.2	15 x 15	10	MA4P153	3 - 28
30	0.20	1.0	15 x 15	10	MA4P154	3 - 28
40	0.05	2.0	15 x 15	15	MA4P155	3 - 28
40	0.10	1.5	15 x 15	15	MA4P156	3 - 28
60	0.10	1.5	15 x 15	50	MA4P157	3 - 28
60	0.20	1.0	15 x 15	65	MA4P159	3 - 28
100	0.05	1.9	15 x 15	80	MA4P160	3 - 28
100	0.10	1.5	15 x 15	90	MA4P161	3 - 28
100	0.15	2.0	15 x 15	100	MA4P162	3 - 28
200	0.05	2.5	15 x 15	170	MA4P165	3 - 28
200	0.10	2.0	15 x 15	190	MA4P166	3 - 28





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M/A-COM an AMP company

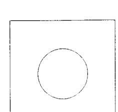
V 2.00

General Purpose, Attenuator and High Voltage Chip PIN Diodes

Voltage Rating (V)	Capacitance Maximum C_T @ V (pF)	Resistance Maximum @ 10 mA (Ω)	Nominal Chip Size (mils)	Carrier Lifetime (ns)	Part No.	Page No.
General Purpose Diodes						
35	0.85 @ 20	0.5	20 x 20	300	MA47420-132	3 - 29
50	0.05 @ 10	2.5	15 x 15	50	MA4P102-134	3 - 29
100	0.05 @ 10	2.0	15 x 15	100	MA4P202-134	3 - 29
100	0.15 @ 10	1.5	15 x 15	100	MA4P203-134	3 - 29
200	0.15 @ 10	1.5	15 x 15	200	MA4P303-134	3 - 29
250	0.60 @ 50	0.6	20 x 20	1000	MA4P404-132	3 - 29

Voltage Rating (V)	Capacitance Maximum C_T @ V (pF)	Resistance Maximum @ 10 mA (Ω)	Nominal Chip Size (mils)	Carrier Lifetime (ns)	Part No.	Page No.
Diodes for Attenuator Circuits						
200	0.15	3	20 x 20	1.0	MA47418	3 - 28
200	0.15	6	20 x 20	2.0	MA47416	3 - 28
200	0.15	8	20 x 20	2.5	MA47406	3 - 28

Voltage Rating (V)	Capacitance Maximum C_T @ 100 V (pF)	Resistance Maximum @ 100 mA (Ω)	Nominal Chip SIze (mils) (ns)	Carrier Lifetime No.	Part No.	Page No.
High Voltage CERMACHIP™ Diodes						
500	0.20	0.60	20 x 20	1	MA4P504-132	3 - 29
500	0.35	0.45	30 x 30	2	MA4P505-131	3 - 29
500	0.70	0.30	30 x 30	3	MA4P506-131	3 - 29
1000	0.30	1.00	30 x 30	3	MA4P604-131	3 - 29
1000	0.60	0.70	30 x 30	4	MA4P606-131	3 - 29
1000	1.30	0.40	65 x 65	5	MA4P607-210	3 - 29
1000	2.50	0.35	85 x 85	5	MA4P608-130	3 - 29



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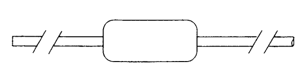
Axial Lead PIN Diodes

V 2.00

Voltage Rating (V)	Capacitance Max. (pF)	R_S Max. 10 mA (Ω)	Part No.	Page No.
General Purpose Switching Diodes				
35	1.0	0.5	MA47120	3 - 44
35	1.2	0.5	MA47270	3 - 44
50	0.3	1.5	MA4PH401	3 - 44
100	1.2	0.6	MA4PH151	3 - 44
100	0.25	1.5	1N5719	3 - 44
200	0.30	3.0	MA47047	3 - 44
200	0.50	3.0	MA47123	3 - 44
200	1.50	0.6	MA47266	3 - 44

Voltage Rating (V)	Capacitance Max. (pF)	Typical R_S @ 1 mA (Ω)	R_S Max. @ 10 mA (Ω)	Typical Lifetime (μS)	Part No.	Page No.
Low Distortion Attenuator Diodes						
200	0.3	30	6	2	MA47600	3 - 44
200	0.5	30	6	2	MA47110	3 - 44
200	0.3	50	8	2.5	MA47100	3 - 44
200	0.8	75	25	4	MA47111	3 - 44

Stocked at your local distributor.



Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

Silicon PIN Diodes

V 2.00

Voltage Rating (V)	Capacitance Max. (pF) @ V	R_S Max. @ mA (Ω)	Lifetime @ 10 mA (μsec)	Thermal Resistance Max. (°C/W)	Part No.	Page No.
50	0.30 @ 10	2.50 @ 10	20	60	MA4P102	3-49
100	0.25 @ 10	2.00 @ 10	100	60	MA4P202	3-49
100	0.35 @ 10	1.50 @ 10	200	30	MA4P203	3-49
200	0.35 @ 10	1.50 @ 10	1000	30	MA4P303	3-49
250	0.40 @ 10	0.60 @ 50	1.0	20	MA4P404	3-49
500	0.40 @ 100	0.60 @ 100	1.0	20	MA4P504	3-50
500	0.55 @ 100	0.45 @ 100	2.0	15	MA4P505	3-50
500	0.90 @ 100	0.30 @ 100	3.0	20	MA5P506	3-50
1000	0.50 @ 100	1.00 @ 100	3.0	20	MA4P604	3-51
1000	0.80 @ 100	0.70 @ 100	4.0	10	MA4P606	3-51
1000	2.00 @ 100	0.40 @ 100	5.0	7	MA4P607	3-51
1000	3.20 @ 100	0.35 @ 150	5.0	5	MA4P608	3-51
1500	3.30 @ 100	0.25 @ 200	10	2	MA4P709	3-51

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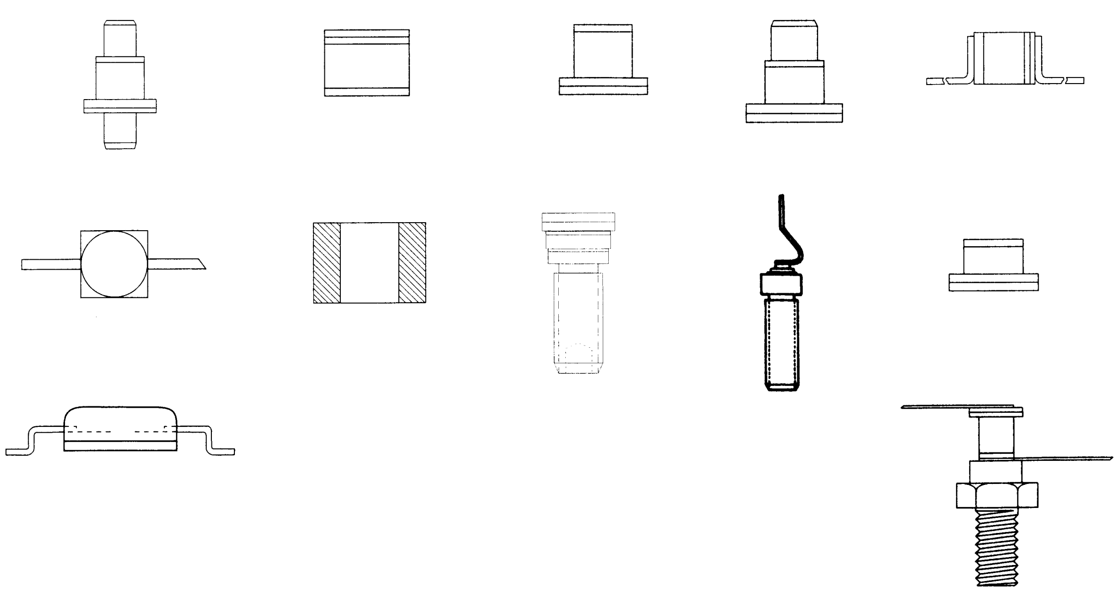

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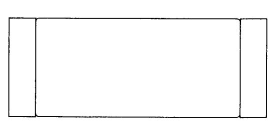
Melf™ Surface Mount PIN Diodes

V 2.00

Voltage Rating (V)	Capacitance Max. (pF)	R_S Max. @ 10 mA (Ω)	I Region Thickness (mils)	Part No.	Page No.
General Purpose Switching Diodes					
35	1.2	0.5	0.4	MA47058	3-61
50	0.5	1.5	0.4	MA4PH101	3-61
100	1.4	0.6	0.8	MA4PH152	3-61
200	0.5	3.0	2.0	MA47055	3-61
200	1.5	0.6 at 50 mA	3.0	MA47059	3-61

			Nominal Attenuator Characteristics				
Voltage Rating (V)	Capacitance Max. (pF)	R_S Max. @ 10 mA (Ω)	Typical I_f for 75 Ω (mA)	Lifetime (μsec)	I Region Thickness (mils)	Part No.	Page No.
Low Distortion Attenuator Diodes							
200	0.5	6.0	0.3 - 0.6	2	4	MA47057	3-61
200	0.5	8.0	0.5 - 1.0	3	7	MA47056	3-61
200	0.5	25.0	1.2 - 2.4	6	14.0	MA4PH601	3-61

Stocked at your local distributor.



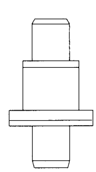
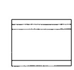
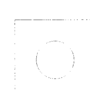
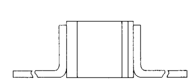
M/A-COM an AMP company

GaAs PIN Diodes

V 2.00

Suggested Frequency Range (GHz)	Voltage Rating (V)	Capacitance Maximum @ -10 V (pF)	Forward Resistance Maximum @ 20 mA (Ω)	Nominal Carrier Lifetime (ns)	Nominal Switching Speed (ns)	Part No.	Page No.
Beam Lead PIN Diodes							
4-18	50	0.07	2	5	5	MA4GP901	3-23
4-18	50	0.025	4.5	2	2	MA4GP932	3-23

Suggested Frequency Range (GHz)	Voltage Rating (V)	Total Capacitance Maximum C_T (pF)	Forward Resistance Maximum @ 20 mA (Ω)	Nominal Carrier Lifetime (ns)	Nominal Switching Speed (ns)	Part No.	Page No.
Chip and Packaged PIN Diodes							
2-8	75	0.35	0.85	10.0	4.0	MA4GP025	3-40
4-10	50	0.15	1.00	5.0	4.0	MA4GP022	3-40
4-12	100	0.12	1.50	25.0	10.0	MA4GP032	3-40
4-18	100	0.06	2.00	20.0	10.0	MA4GP030	3-40

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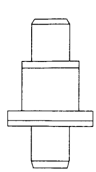
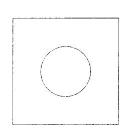
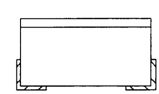
Limiter Diodes

Incident Peak Power at 1 dB Limiting (dBm)	Incident Peak Power Maximum (W)	Carrier Lifetime (ns)	Voltage Rating (V)	Junction Capacitance Max. (pF)	Part No.	Page No.
7	100	7	20	0.20	MA4L011	3-66
10	400	10	30	0.20	MA4L021	3-66
10	200	10	30	0.15	MA4L022	3-66
16	800	15	40	0.20	MA4L031	3-66
16	600	15	40	0.15	MA4L032	3-66
19	900	90	100	0.15	MA4L101	3-66
23	1000	200	200	0.20	MA4L301	3-66
23	1500	250	200	0.25	MA4L302	3-66
29	2000	800	250	0.30	MA4L401	3-66

Note: Pulse length 1 microsecond (1% duty)







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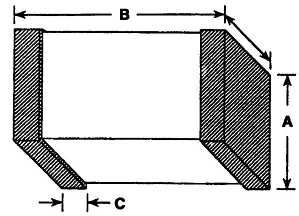
Surface Mount PIN Diodes

MA4P1250, MA4P1450 SMQ™

V 2.00



		Size, Inches (mm)		
Model No.	Case Style	A(sq.) Min./Max.	B Min./Max.	C Min./Max.
MA4P1250	1072	0.080/0.095 (2.03/2.41)	0.115/0.135 (2.92/3.43)	0.008/0.030 (0.203/0.762)
MA4P1450	1091	0.138/0.155 (3.51/3.94)	0.180/0.200 (4.57/5/08)	

Features

- Non-Rollable MELF Design
- Hermetically Sealed
- Low Loss, Low Distortion
- Passivated PIN Diode Chips
- Full Face Chip Bonds
- Non-Magnetic Package
- Pick and Place Compatibility

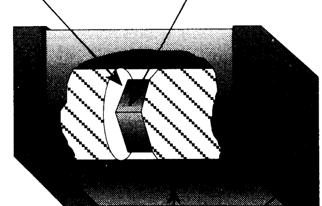
Description

The MA4P1250 and MA4P1450 are square surface mountable PIN diodes in a non-rollable, metal electrode leadless faced (MELF) package. They incorporate passivated PIN diode chips that are full face bonded to refractory metal pins. These parts utilize M/A-COM's HIPAX technology in a low inductance ceramic package with no ribbons or whisker wires. The package is hermetically sealed at temperatures exceeding 300°C.

Applications

The MA4P1250 is designed for use as a low loss switching element from HF through UHF. Its high power rating allows performance in antenna switch elements at RF power levels greater than 100 watts CW. It is designed to meet the low distortion requirements of mobile radios.

The MA4P1450 is a higher power diode. It has lower distortion at RF CW power greater than 10 watts and can dissipate 7.5 watts.



Designed for Automated Assembly

These surface mount PIN diodes are designed for high volume tape and reel assembly. The square package eases automatic pick and place indexing and assembly. The parallel flat surfaces are suitable for key jaw or vacuum pickup techniques. All solderable surfaces are tin plated and compatible with reflow and vapor phase soldering methods.

Environmental Capability

These HIPAX diodes are applicable for use in industrial and military applications. They can meet the environmental requirements of MIL-STD-750 and MIL-STD-202 or be screened to JAN-TX and other high reliability standards.

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Electrical Specifications @ +25°C (MA4P1250)

Parameter	Minimum	Typical	Maximum	Unit	Condition
Series Resistance	—	0.5	0.75	Ω	F = 100 MHz I = 50 mA
Capacitance	—	0.9	1.2	pF	F = 1 MHz V = 50 V
Parallel Resistance	5 K	10 K	—	Ω	F = 100 MHz V = 0 V
Carrier Lifetime	2.0	4.0	—	µs	I = 10 mA
Forward Bias Harmonic Distortion ($R\frac{2a}{a}$, $R\frac{3a}{a}$)	80	90	—	dBc	F = 100 MHz P = 30W I = 50 mA
Reverse Bias Harmonic Distortion ($R\frac{2a}{a}$, $R\frac{3a}{a}$)	60	70	dBc	—	F = 100 MHz P = 0 dBm V = 0 V
Voltage Rating	50	—	—	V	I = 10 µA
Forward Voltage	—	1.0	—	V	I = 50 mA

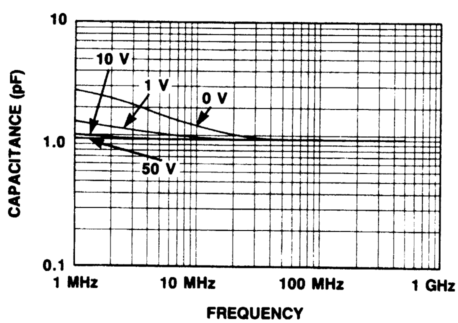
* Available only in case style 1072.

Maximum Ratings

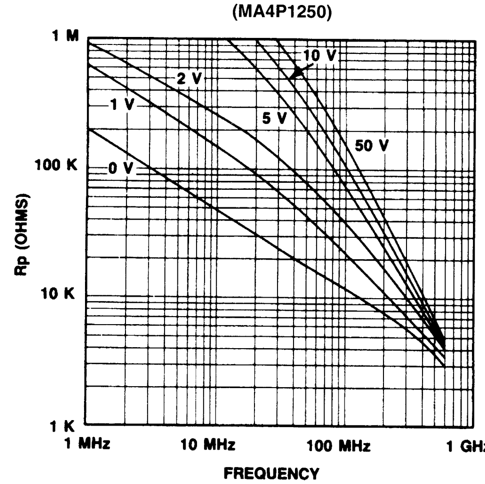
Parameters	Absolute Maximum
Voltage	50 Volts
Operating Temperature	-65°C to + 175°C
Storage Temperature	-65°C to +175°C
Power Dissipation Free Air Contact Surfaces @ +25°C	 1.5 Watts 4.0 Watts

Typical Performance Curves

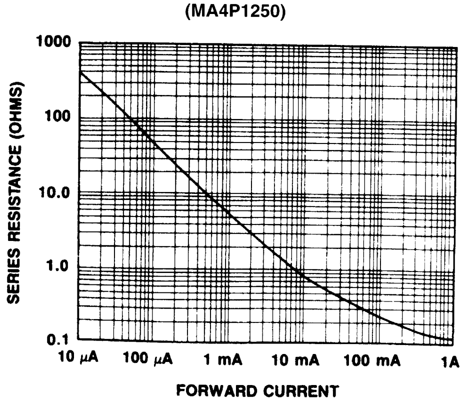
CAPACITANCE vs FREQUENCY (MA4P1250)



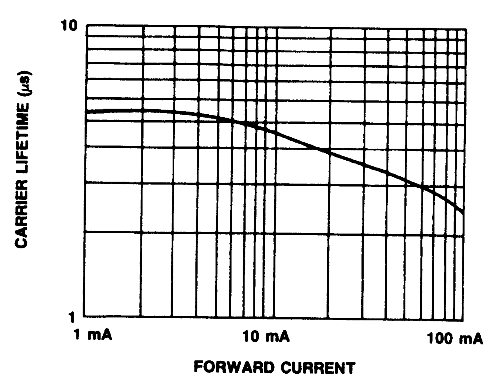
CARRIER LIFETIME vs FORWARD CURRENT (MA4P1250)



SERIES RESISTANCE AT 100 MHZ vs FORWARD CURRENT (MA4P1250)



PARALLEL RESISTANCE vs FREQUENCY AND REVERSE BIAS (MA4P1250)



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MA4P1450 PIN Diodes for High Volume Applications
Electrical Specifications @ +25°C

Parameter	Minimum	Typical	Maximum	Unit	Condition
Series Resistance	—	0.5	0.75	Ohms	I_F = 50 mA F = 100 MHz
Capacitance	—	1.8	2.5	pF	F = 1 MHz V_R = 0
Parallel Resistance	5 K	10 K	—	ø	F = 100 MHz V_R = 0
Carrier Lifetime	4	6	—	µS	I_F = 10 mA
Forward Bias Harmonic Distortion ($R\frac{2a}{a}$, $R\frac{3a}{a}$)	80	90	—	dBc	F = 100 MHz P = 30W I_F = 100 mA
Reverse Bias Harmonic Distortion ($R\frac{2a}{a}$, $R\frac{3a}{a}$)	60	70	—	dBc	F = 100 MHz P = 0 dBm V = 0 Volts
Voltage Rating	50	—	—	Volts	I_V = 10 mA
Forward Voltage	1.0	—	—	—	100 mA
Thermal Resistance Junction Case $R_{TH(I-C)}$	—	12.5	15	°C/Watt	—

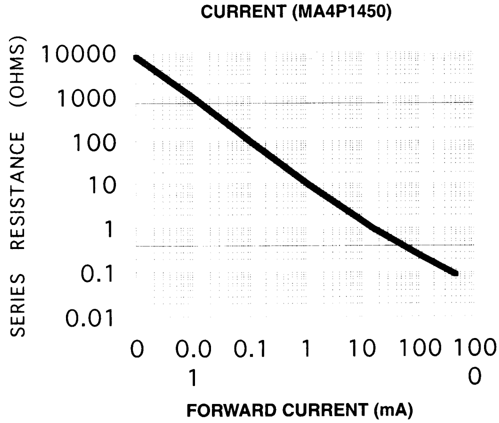
Note: Available only in case style 1091.

Maximum Ratings

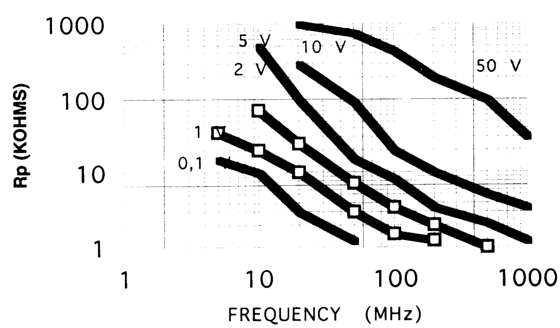
Parameters	Absolute Maximum
Operating Temperature	-65°C to + 175°C
Storage Temperature	-65°C to +175°C
DC Reverse Voltage	50 Volts
Power Dissipation Free Air Contact Surfaces @ +25°C	 1.5 Watts 4.0 Watts

Typical Performance Curves

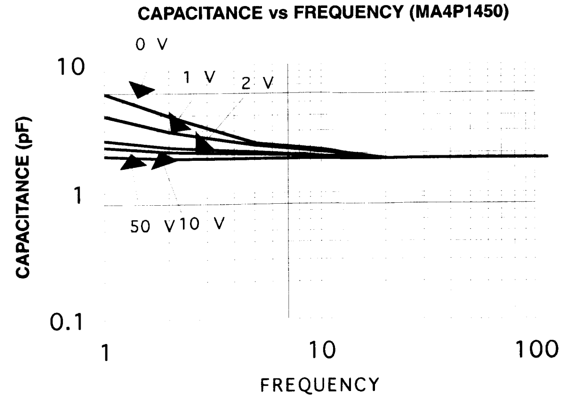
SERIES RESISTANCE AT 100 MHZ vs FORWARD CURRENT (MA4P1450)



PARALLEL RESISTANCE vs FREQUENCY AND REVERSE BIAS (MA4P1450)



CAPACITANCE vs FREQUENCY (MA4P1450)



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an AMP company

Surface Mount PIN Diode

MA4CP101A High Sigma™

V 2.00

Features

- High Performance PIN Diode
- Designed for High Volume Pick and Place Assembly
- Low Profile Surface Mount Package
- High Quality Products (Defect Rate Less Than 50 PPM)
- Aggressively Priced for High Volume, Commercial Applications

Description

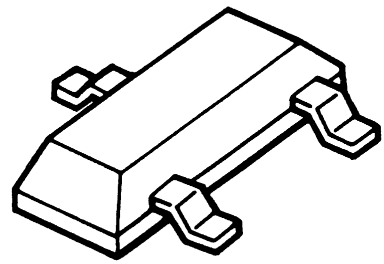
A surface mount PIN diode is available from M/A-COM for high volume, pick and place assembly applications. It is packaged in low profile SOT-23 package.

This diode is suitable for a wide range of RF and microwave switch applications.

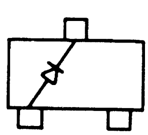
These diodes are manufactured using Statistical Process Control (SPC) procedures ensuring high reliability and demonstrated defect levels less than 50 parts per million.

This product line is delivered in industry standard 8 mm tape and reel format. Standard reels contain 3,000 devices.

SOT-23



Configuration (Top View)



SINGLE (A)

Electrical Specifications @ +25°C PIN Switching Diode

Model Number	Configuration	Marking	Minimum Reverse Voltage V_R	Maximum Capacitance	Maximum Resistance	Typical Carrier Lifetime
			I_R = 10 µA	V_R = 20 V, f = 1 MHz	I_F = 10 mA, f = 100 MHz	I_F = 10 mA
MA4CP101A	Single	A2	35 V	1 pF	0.6 ohms	100 ns

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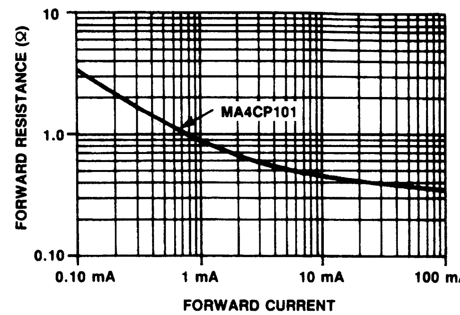
Absolute Maximum Ratings

Parameter	Absolute Maximum
Reverse Voltage	Voltage Rating
Forward Current	100 mA
Total Power Dissipation[1]	250 mW
Operating Temperature	-65°C to +125°C
Storage Temperature	-65°C to +125°C

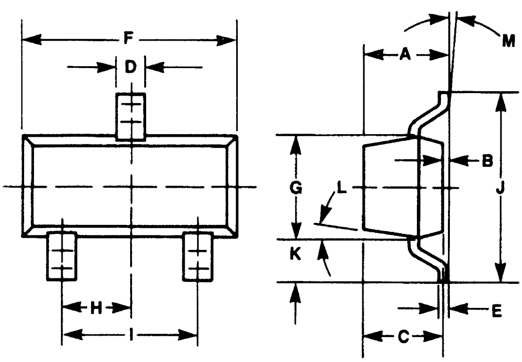
Note:
1. At +25°C case temperature. Derate linearly to +125°C.

Typical Performance Curve

FORWARD RESISTANCE vs FORWARD CURRENT (MA4CP101)



SOT-23 (Low Profile)

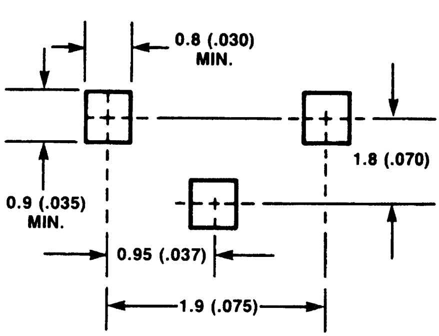


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.044	—	1.10
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
I	0.075 typical		1.90 typical	
J	—	0.103	—	2.60
K	—	0.024	—	0.60

DIM.	GRADIENT
L	10° max.[1]
M	2°...30°

Note:
1. Applicable on all sides

Mounting Pad Diagrams



Dimensions: MILLIMETERS (INCHES)

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Surface Mount PIN Diodes

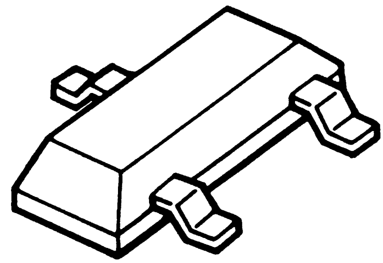
MA4P Series

V 2.00

Features

- Surface Mount Package
- Low Capacitance Diodes
- Low Loss Switch Diodes
- Low Distortion Attenuator Diodes
- Fast Switching Diodes
- Single and Dual Diode Configurations
- Tape and Reel Packaging Available

SOT-23

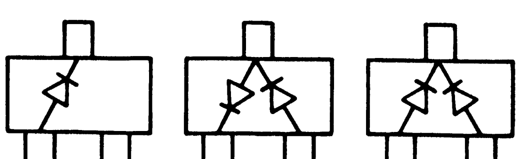


Description

The SOT-23 is a widely used low cost semiconductor package that may be supplied in tape and reel for automated pick and place assembly on surface mount circuit boards. The semiconductor chips in the SOT-23 package are completely encapsulated with molded silicone plastic. This results in a rugged package offering protection from corrosive agents and extreme environmental conditions. The need for special care to protect bond wires in chip and wire hybrid circuit assemblies is also eliminated using SOT-23 packaged PIN diodes.

M/A-COM's series of SOT-23 PIN diodes is designed to cover a broad range of RF and microwave applications. Devices are available with low resistance and short carrier lifetime (MA4P275) for low loss, fast speed switches; with low capacitance (MA4P789) for high isolation UHF and S-band switches; and with thick intrinsic width (MA4P278) for low distortion attenuator circuits. SOT-23 PIN diodes from M/A-COM are also available incorporating dual chips in one package (series Tees and common cathode) for compound switch and attenuator applications.

Configurations (Top View)



SINGLES   SERIES TEE (REVERSE)   COMMON CATHODE TEES

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Specifications @ T_A= +25°C
Single Diodes[5]

Model Number	Minimum[1] Reverse Voltage V_R (Volts)	Maximum Total[2] Capacitance (pF)	Maximum[3] R_S @ 10 mA (Ohms)	Nominal Characteristics	
				Carrier Lifetime[4] (µs)	I-Region Thickness (mils)
MA4P275	35	1.00 @ 20V	0.5	0.2	0.4
MA4P789	50	0.35 @ 20V	1.5	0.2	0.4
MA4P282	100	1.20 @ 20V	0.6	1.0	0.8
MA4P274	100	0.35 @ 50V	3.0	1.0	2.0
MA4P277	200	0.35 @ 50V	6.0*	2.0	4.0
MA4P278	200	0.35 @ 50V	10.0**	3.0	7.0

*Rs = 75 ohms at I_F -0.3-0.6 mA **Rs - 75 ohms at I_F -0.5-1.0 mA

Model Number	Single Chip[1] Minimum Reverse Voltage V_R (Volts)	Single Chip[2] Maximum Total Capacitance (pF)	Single Chip[3] Maximum R_S @ 10 mA (Ohms)	Nominal Characteristics	
				Single Chip[4] Carrier Lifetime (µs)	Single Chip I-Region Thickness (mils)
MA4P275ST	35	1.00 @ 20V	0.5	0.2	0.4
MA4P789ST	50	0.35 @ 20V	1.5	0.2	0.4
MA4P274ST	100	0.35 @ 50V	3.0	1.0	2.0

Series Tees (Reverse)[5]

Model Number	Single Chip[1] Minimum Reverse Voltage V_R (Volts)	Single Chips[2] Maximum Total Capacitance (pF)	Single Chips[3] Maximum R_S @ 10 mA (Ohms)	Nominal Characteristics	
				Chip[4] Carrier LIfetime (µs)	Single Chip I-Region Thickness (mils)
MA4P275CK	35	1.00 @ 20V	0.5	0.2	0.4
MA4P789CK	50	0.35 @ 20V	1.5	0.2	0.4
MA4P274CK	100	0.35 @ 50V	3.0	1.0	2.0
MA4P277CK	200	0.35 @ 50V	6.0*	2.0	4.0

Common Cathode Tees

*R_S = 75 Ohms at I_F - 0.3-0.6 mA

Notes:
1. Voltage rating is measured at a reverse bias current of 10 µA.
2. Maximum total capacitance is measured at 1 MHz at the indicated voltage.
3. Maximum series resistance is measured at the specified current and a frequency of 100 MHz.
4. Nominal minority lifetime is measured at I_F = 10 mA.
5. See previous page for configurations.

Maximum Ratings

Parameter	Absolute Maximum
Operating Temperature	-65°C to +125°C
Storage Temperature	-65°C to +125°C
Power Dissipation at +25°C ambient	250 mW
Reverse Voltage	Voltage Rating
Forward Current	100 mAdc

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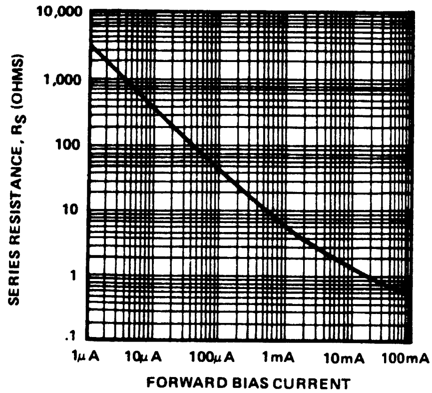
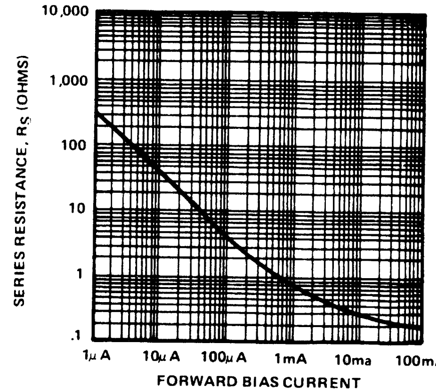
Typical Resistance Curves at 100 MHz

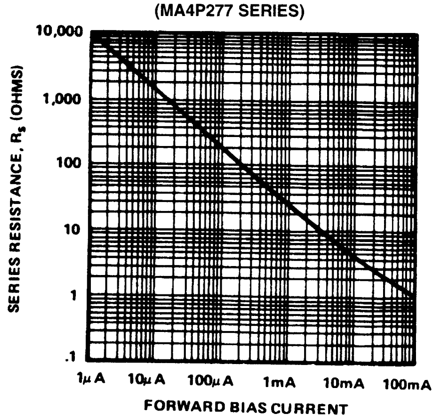
RESISTANCE vs FORWARD CURRENT
(MA4P274 SERIES)



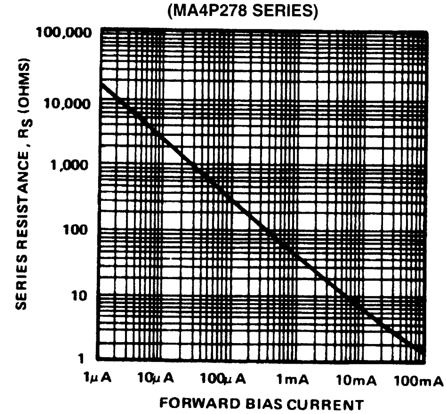
RESISTANCE vs FORWARD CURRENT
(MA4P275 SERIES)



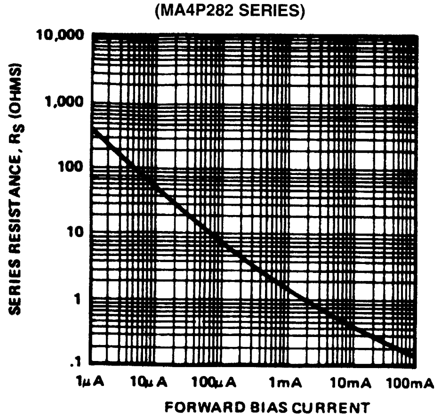
RESISTANCE vs FORWARD CURRENT
(MA4P277 SERIES)



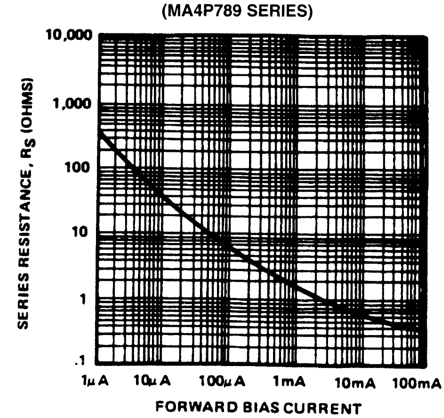
RESISTANCE vs FORWARD CURRENT
(MA4P278 SERIES)



RESISTANCE vs FORWARD CURRENT
(MA4P282 SERIES)



RESISTANCE vs FORWARD CURRENT
(MA4P789 SERIES)



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PIN Diode Cross Reference

Many of M/A-COM's glass axial lead hermetic surface mount and SOT-23 PIN diodes use similar chips and, therefore, have the same electrical characteristics, except for package parasitics.

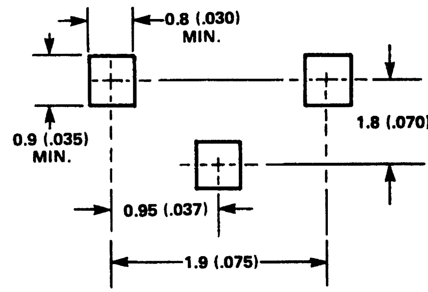
The following table lists the SOT-23 PIN diodes by model number and standard axial lead PIN diode and the equivalent square surface mount (SMQ) PIN diodes.

SOT-23 Diodes	Axial Lead Glass Diodes	SMQ Diodes
MA4P274	MA47123	MA4PH236
MA4P275	MA4P270	MA4PH235
MA4P277	MA47110	MA4PH238
MA4P278	MA47100	—
MA4P282	MA4PH151	—
MA4P789	MA4PH401	—

Mounting Information

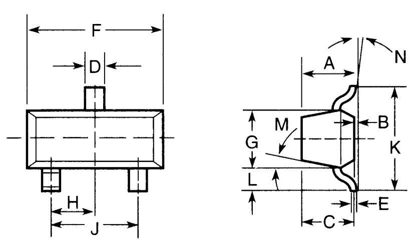
The illustration indicates the recommended mounting pad configuration for the SOT-23 package. Solder paste containing flux should be screened onto the pads to a thickness of 0.005 inches. The SOT-23 device is placed in position firmly adhering to the solder paste.

Permanent attachment is performed by a reflow soldering procedure that the tab temperature does not exceed +275°C and the body temperature does not exceed +250°C.



Dimensions Millimeters (inches)

SOT-23 (High Profile)



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.048	—	1,22
B	—	0.008	—	0,20
C	—	0.040	—	1,00
D	0.013	0.020	0,35	0,50
E	0.003	0.006	0,08	0,15
F	0.110	0.119	2,80	3,00
G	0.047	0.056	1,20	1,40
H	0.037 typical		0,95 typical	
J	0.075 typical		1,90 typical	
K	—	0.103	—	2,60
L	—	0.024	—	0,60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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M/A-COM an AMP company

High Power PIN Diodes

MA4P HIPAX™ Series

V 2.00

Features

- High Power Handling
- Low Loss, Low Distortion
- Voltage Ratings to 1000 Volts
- Passivated PIN Chip – Full Face Bonded
- Hermetically Sealed
- Low Inductance Axial Lead, and SMQ Surface Mount Package Options
- Available as Chips

Description

M/A-COM's HIPAX PIN diodes are designed for service in switch and attenuator applications requiring high power handling and low distortion. HIPAX PIN diodes incorporate a fully passivated PIN diode chip resulting in extremely low reverse leakage current. ALL HIGH VOLTAGE HIPAX PIN DIODES ARE SPECIFIED AT 1 μA REVERSE CURRENT AT THE VOLTAGE RATING. The chip is full face bonded to refractory metal pins on both anode and cathode. The result is a low loss PIN diode with low thermal resistance due to symmetrical thermal paths.

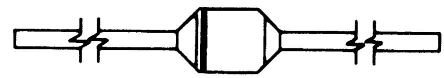
HIPAX PIN diodes are packaged in hermetically sealed ceramic enclosures at temperatures exceeding 300°C. Package options include: axial leaded and surface mount packages that have a square, nonrollable outline.

The semiconductor technology utilized in the HIPAX family draws on M/A-COM's substantial experience in PIN diode design. This results in thick intrinsic region PIN diodes specified with low resistance, low capacitance and long carrier lifetime parameters.

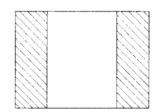
SMQ Square Outline Surface Mount

The surface mount HIPAX PIN diode is available in M/A-COM's unique, square outline, non-rollable SMQ package design. The SMQ package eases automatic pick and place indexing and assembly.

Case Styles



401



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Applications

HIPAX PIN diodes are designed for use in a wide variety of switch and attenuator applications from HF through UHF at power levels beyond 1 kW CW. These diodes have been comprehensively characterized to ensure predictable performance.

Design Recommendations

1. Low Distortion Attenuators: MA4P4301B
2. Surface Mount Switches: MA4P7101F
3. Cellular Radio Antenna Switches: MA4P1200, MA4P1250

Environmental Capability

HIPAX PIN diodes are appropriate for use in military, industrial and commercial applications. They are capable of meeting the environmental requirements of MIL-STD-750 and MIL-STD-202. HIPAX PIN DIODES ARE CAPABLE OF HTRB SCREENING AT 80% OF VOLTAGE RATING AT 150°C.

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Voltage Ratings and Model Numbers

Voltage Rating	MA4P4000 Series	MA4P4300 Series	MA4P7000 Series	MA4P7100 Series
100 Volts	MA4P4001	MA4P4301	MA4P7001	MA4P7101
200 Volts	MA4P4002	MA4P4302	MA4P7002	MA4P7102
400 Volts	—	—	—	MA4P7104
600 Volts	MA4P4006	—	MA4P7006	—

Maximum Ratings

Parameter	Absolute Maximum
DC Reverse Voltage	Voltage Rating
Operating and Storage Temperature	-65°C to +175°C
Installation Temperature	+250°C, 30 Seconds

Electrical Specifications @ +25°C

Parameter	Symbol	Condition	MA4P4000 Series	MA4P4300 Series	MA4P7000 Series	MA4P7100 Series
Series Resistance (Max)	R_S	100 mA, 100 MHz	0.5 Ω	1.0 Ω	0.8 Ω	0.5 Ω
Total Capacitance (Max)	C_T	100 V, 1 MHz	2.2 pF	2.0 pF	0.7 pF	1.0 pF
Parallel Resistance (Min)	R_P	100 V, 100 MHz	20 kΩ	50 kΩ	200 kΩ	100 kΩ
Carrier Lifetime (Min)	T_L	10 mA	6 µs	8 µs	3 µs	2.5 µs
Forward Voltage (Max)	V_F	100 mA	1.0 V	1.2 V	1.0 V	1.0 V
Reverse Current (Max)	I_R	Voltage Rating	1 µA	1 µA	1 µA	1 µA
I-Region Width (Nominal)	W	—	175 µm	300 µm	175 µm	100 µm

Power Dissipation and Thermal Resistance Ratings

Package Style	Condition	MA4P4000		MA4P4300		MA4P7000		MA4P7100	
		P_D	$ø_{JC}$	P_D	$ø_{JC}$	P_D	$ø_{JC}$	P_D	$ø_{JC}$
B (Axial Leaded)	1/4 Inch Total Length	12 W	12.5°C/W	10 W	15°C/W	5 W	30°C/W	6 W	25°C/W
	to 25°C Free Air Rating	2.5 W	—	2.5 W	—	1.5 W	—	1.5 W	—
F (SMQ Surface Mount)	25°C Contacts	7.5 W	20°C/W	5 W	30°C/W	3 W	50°C/W	3 W	50°C/W
Both B and F	Single 1 µs pulse	100 kW	—	100 kW	—	15 kW	—	15 kW	—
Both B and F	Single 100 µs pulse	5 kW	.03°C/W	5 kW	03°C/W	300 W	0.5°C/W	300 W	0.5°C/W

Environmental Ratings

HIPAX PIN diodes may be supplied with JAN TX level screening. The table lists some of the MIL-STD-750 environmental tests HIPAX PIN diodes are designed to meet.

Test	MIL-STD-750 Method	Description
High Temperature Storage	1031	+175°C, 250 Hours
Temperature Shock	1051	-65°C to +175°C, 20 Cycles
HTRB	1038	809b VR, +150°C, 96 Hours
Moisture Resistance	1021	
Fine Leak	1071 Cond. H	1 x 10^{-7} CC/Sec
Constant Acceleration	2006	20,000 G's
Vibration Fatigue	2046	20,000 G's
Solderability	2026	
Lead Fatigue	2036.3 Cond. E	3 cycles, 8 oz., 90°, Bent at Body
Tension	2036.3 Cond. A	2 lbs., 30 seconds

Ordering Information

HIPAX PIN diodes are designated by MA4P followed by four digits which indicate the voltage rating and series. A package style letter suffix follows:

To purchase:
MA4P4000 Series, 600V, SMQ package (F)

Order Model No.: MA4P4006F

The same unit in an axial lead package (B) is: MA4P4006B.

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Electrical

Parameter	Minimum	Typical	Maximum	Unit	Condition
Voltage Rating	50	—	—	V	I = 10 μA
Series Resistance	—	0.5	075	Ω	F = 100 MHz I = 50 mA
Capacitance: MA4P1200	—	1.2	1.5	pF	F = 1 MHz V = 50 V
Parallel Resistance	5 K	10 K	—	Ω	F = 100 MHz V = 0 V
Carrier Lifetime	2.0	4.0	—	μs	I = 10 mA
Forward Bias Harmonic Distortion ($R\frac{2a}{a}$ $R\frac{3a}{a}$)	80	90	—	dBc	F = 100 MHz P = 30 WA I = 50 mA
Reverse Bias Harmonic Distortion ($R\frac{2a}{a}$ – $R\frac{3a}{a}$)	60	70	—	dBc	F = 100 MHz P = 0 dBm V = 0 V
Forward Voltage	—	—	1.0	V	I = 50 mA

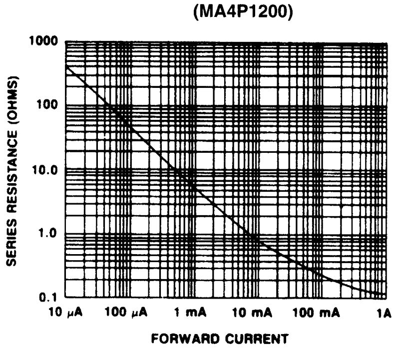
Note: MA4P1200 available in axial leaded case style.

Maximum Ratings

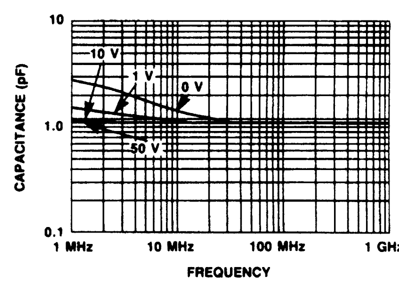
Parameter	Absolute Max.
Operating and Storage Temp.	-65°C to +175°C
DC Reverse Voltage	50 Volts
Power Dissipation: Free Air 1/4 inch spaced to +25°C Contacts	 1.5 Watts 5.5 Watts

Typical Performance Curves

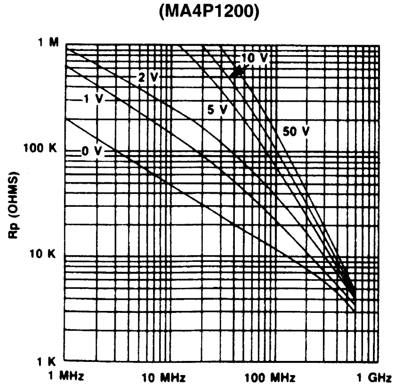
SERIES RESISTANCE AT 100 MHz vs FORWARD CURRENT (MA4P1200)



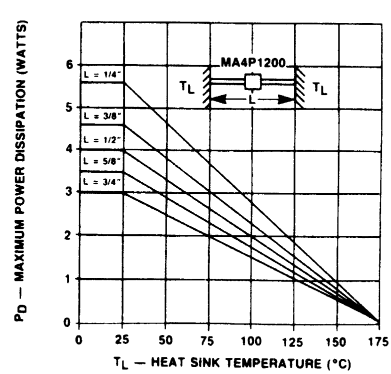
CAPACITANCE vs FREQUENCY (MA4P1200)



PARALLEL RESISTANCE vs FREQUENCY AND REVERSE BIAS (MA4P1200)



HEAT SINK TEMPERATURE vs MAXIMUM POWER DISSIPATION (MA4P1200)



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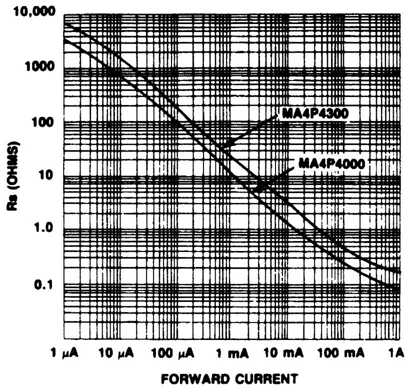
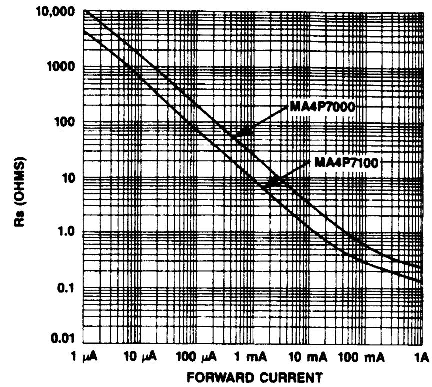
Typical Performance Curves

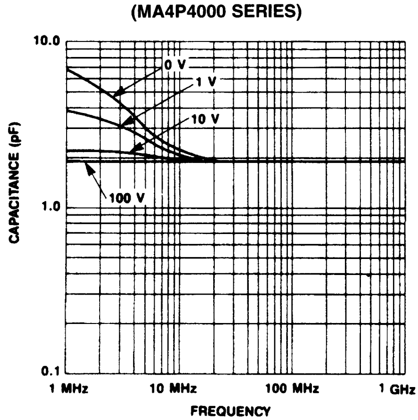
SERIES RESISTANCE AT 100 MHz vs FORWARD CURRENT (MA4P4000, MA4P4300 SERIES)



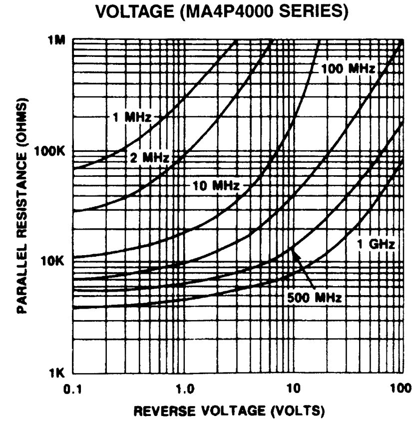
SERIES RESISTANCE AT 100 MHz vs FORWARD CURRENT (MA4P7000, MA4P7100 SERIES)



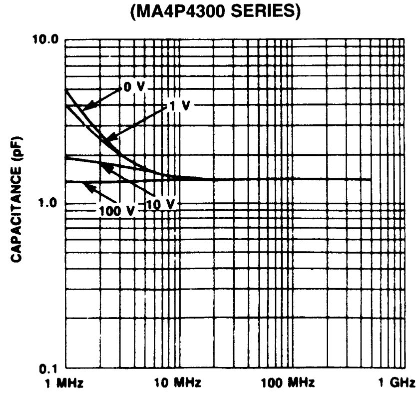
CAPACITANCE vs FREQUENCY AND REVERSE BIAS (MA4P4000 SERIES)



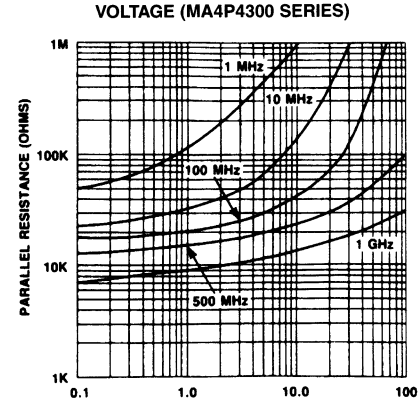
PARALLEL RESISTANCE vs FREQUENCY AND REVERSE VOLTAGE (MA4P4000 SERIES)



CAPACITANCE vs FREQUENCY AND REVERSE BIAS (MA4P4300 SERIES)



PARALLEL RESISTANCE vs FREQUENCY AND REVERSE VOLTAGE (MA4P4300 SERIES)



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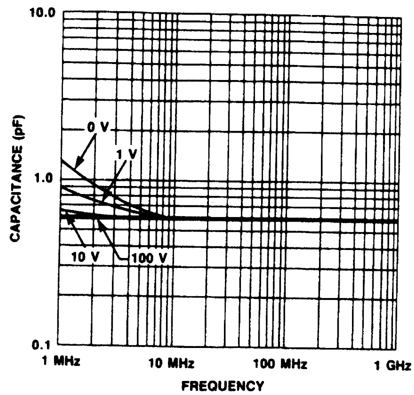
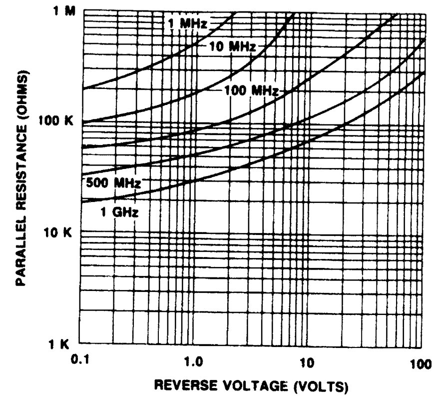
Typical Performance Curves (Cont'd)

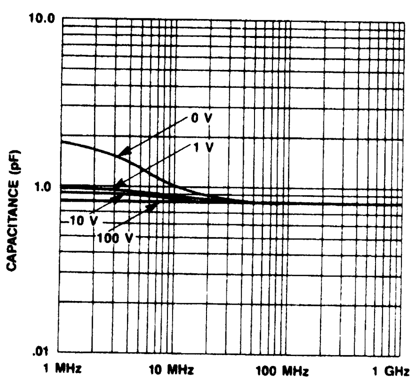
CAPACITANCE vs FREQUENCY AND REVERSE BIAS
(MA4P7000 SERIES)



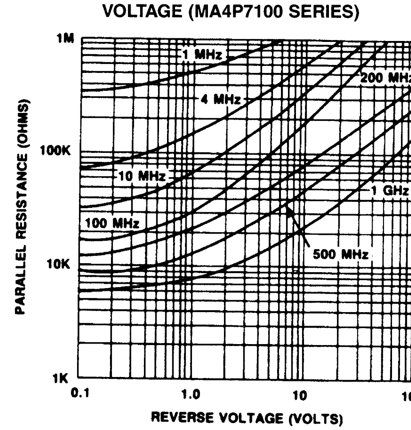
PARALLEL RESISTANCE vs REVERSE VOLTAGE
(MA4P7000 SERIES)



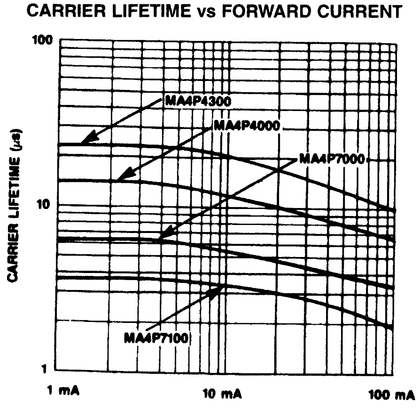
CAPACITANCE vs FREQUENCY AND REVERSE BIAS
(MA4P7100 SERIES)



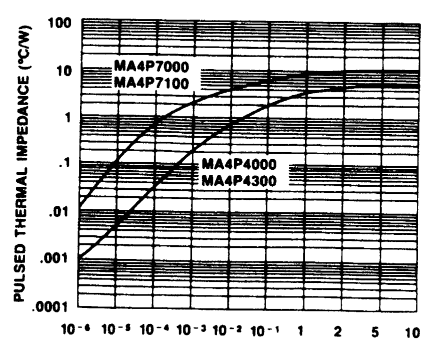
PARALLEL RESISTANCE vs FREQUENCY AND REVERSE
VOLTAGE (MA4P7100 SERIES)



CARRIER LIFETIME vs FORWARD CURRENT



PULSED THERMAL IMPEDANCE vs PULSE WIDTH



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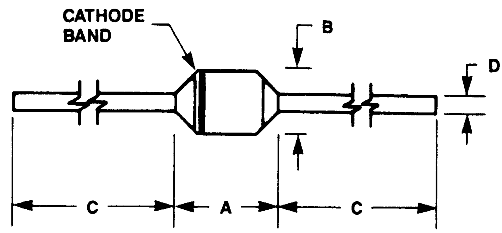
Case Styles

Style B - Axial Leaded

Case Style 401 — MA4P7000B, MA4P7100B, MA4P1200

	INCHES		MILLIMETERS	
DIM.	**MIN.**	**MAX.**	**MIN.**	**MAX.**
A	—	0.190	—	4,83
B	—	0.090	—	2,29
C	0.975	—	24,8	—
D	0.027	0.029	0,69	0,74



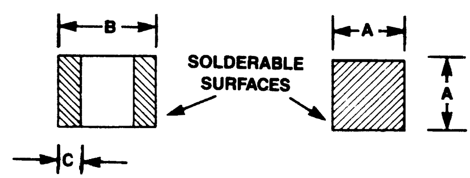
Case Style 402 — MA4P4000B, MA4P4300B

	INCHES		MILLIMETERS	
DIM.	**MIN.**	**MAX.**	**MIN.**	**MAX.**
A	—	0.230	—	5,842
B	—	0.140	—	3,556
C	0.975	—	24,765	—
D	0.039	0.041	0,991	1,041

Style F- SMQ Surface Mount

Case Style 1072 — MA4P7000F, MA4P7100F

	INCHES		MILLIMETERS	
DIM.	**MIN.**	**MAX.**	**MIN.**	**MAX.**
A	0.080	0.095	2,032	2,413
B	0.115	0.135	2,921	3,429
C	0.008	0.030	0,203	0,762

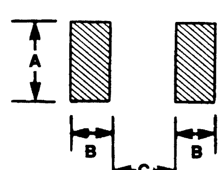


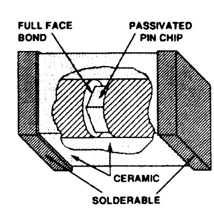
Case Style 1091 — MA4P4000F, MA4P4300F

	INCHES		MILLIMETERS	
DIM.	**MIN.**	**MAX.**	**MIN.**	**MAX.**
A	0.138	0.155	3,51	3,94
B	0.180	0.200	4,57	5,08
C	0.008	0.030	0,203	0,762

Bonding Pad for SMQ Diodes

	Case Styles 1072		Case Styles 1091	
DIM.	**IN.**	**MM**	**IN.**	**MM**
A	0.093	2,36	0.150	3,81
B	0.050	1,27	0.050	1,27
C	0.060	1,52	0.100	2,54





M/A-COM an AMP company

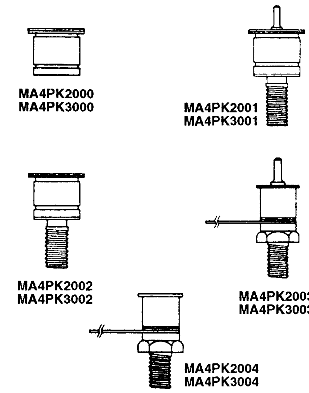
2000 Volt and 3000 Volt PIN Diodes

MA4PK2000, 3000 KILOVOLT™ Series

V 2.00

Features

- Voltage Ratings to 3000 Volts
- 25 Ampere Current Rating
- Designed for HF, Multi-Kilowatt Switches
- Low Loss, Low Distortion Design
- Rugged, Hermetically Sealed Packaging
- Convenient Solder Lug Attachment
- Low Magnetic Parts for MRI



Description

M/A-COM's KILOVOLT PIN diodes utilize modern semiconductor and packaging technology that assures low loss, low distortion, and reliable performance in multi-kilowatt switch applications at frequencies as low as 1 MHz. The semiconductor chips employed have low resistance, high power dissipation and very high stand-off voltage capability.

KILOVOLT PIN diodes employ ultra high resistivity, long carrier lifetime, float zone silicon intrinsic material onto which P+ and N+ regions are deposited using an epitaxial process specifically designed at M/A-COM for high voltage PIN diodes. This process results in better preservation of the intrinsic carrier lifetime and superior junctions in comparison to the conventional double diffused process. The processing of the I-region width is tightly controlled using modern lapping techniques.

KILOVOLT PIN diode chips utilize M/A-COM s proprietary cermachip glass passivation. The hard glass covers all exposed junction and intrinsic region surfaces. This results in a hermetically sealed, passivated chip that has been accepted in many hi-rel military programs.

Packaging

New metal-ceramic packages were developed for the KILOVOLT PIN diode series. They were designed to withstand extremely high voltages and currents and to be compatible with the semiconductor chip and RF circuitry. These packages meet the environmental requirements of MIL-STD-202 and MIL-STD750.

The PIN diode chip is bonded to the package and the anode strap is bonded to the chip at temperatures exceeding 300°C. The anode strap is a unique, large cross-section area design allowing for high current capability. The packages are sealed using a projection welding technique in an inert environment.

KILOVOLT PIN diodes are available with a solder lug on the anode electrode to allow a convenient and reliable wrap-around wire connection.

Applications

M/A-COM's KILOVOLT PIN diodes are designed for use as high power switching elements in multi-kilowatt HF and VHF applications. These PIN diodes have been extensively characterized for their electrical and thermal properties to assure predictable low loss, high power handling, and low distortion performance. Some typical applications are as follows:

1. Filter Switches
2. Antenna Couplers
3. Power Amplifier By-pass Switches
4. MRI Switches

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M/A-COM KILOVOLT PIN Diodes

Part Numbers

2000 Volt Rating	3000 Volt Rating	Package Type
MA4PK2000	MA4PK3000	Pill
MA4PK2001	MA4PK3001	Stud - Solder Lug
MA4PK2002	MA4PK3002	Stud - No Solder Lug
MA4PK2003	MA4PK3003	Insulated Stud-Solder Lug
MA4PK2004	MA4PK3004	Insulated Stud-No Solder Lug

Note:
Cathode heat sink is standard on all parts. Reverse polarity, NIP diodes are available on request.

Maximum Ratings

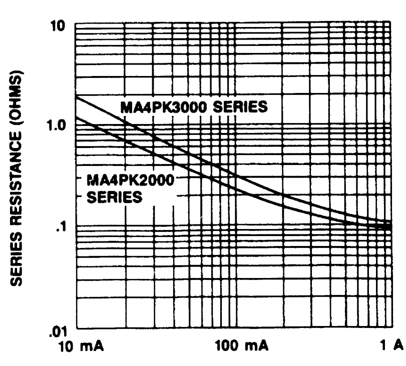
Parameter	Absolute Max.
Operating and Storage Temp.	-65°C to +175°C
Installation Temperature	250°C, 30 Seconds
Instantaneous Reverse Voltage	Voltage Rating
Forward Current (RF and DC)	25 Amperes
Power Dissipation at 25°C Case Temperature	
MA4PK2001, MA4PK2002	50 Watts
MA4PK2003, MA4PK2004	37.5 Watts
MA4PK3001, MA4PK3002	75 Watts
MA4PK3003, MMPK3004	50 Watts

Electrical Specifications @ +25°C

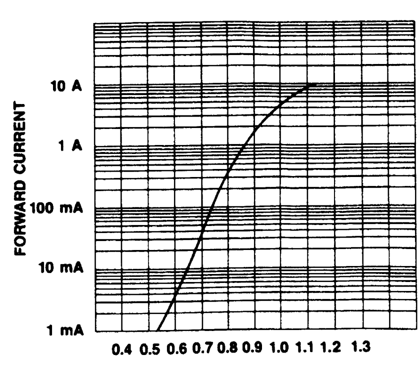
Parameter	Condition	MA4PK2000 Series	MA4PK3000 Series
Reverse Voltage Rating	10 μA	2000 Volts	3000 Volts
Series Resistance (Max)	F = 4 MHz, I = 0.5 A	0.20 Ω	0.25 Ω
Series Resistance (Typ)	F = 1.0 -100 MHz, I = 0.5 A	0.10 Ω	0.15 Ω
Total Capacitance (Max)	F = 1 MHz, V = 100 V	3.2 pF	4.0 pF
Reverse Bias	F =10 MHz, V = 100 V	1 μS	1 μS
Carrier Lifetime (Min)	I_F = 10 mA	10 μs	20 μs
Forward Voltage (Max)	I_F = 1 A	1.2 V	1.2 V
Thermal Resistance (Max)	—	3°C/W (Stud) 4°C/W (Ins Stud)	2°C/W (Stud) 3°C/W (Ins Stud)
I-Region Width (Nom)	—	200 μm	325 μm

Typical Characteristics

SERIES RESISTANCE vs CURRENT FREQUENCY AT 100 MHz



DC FORWARD VOLTAGE vs FORWARD CURRENT (MA4PK2000, MA4PK3000 SERIES)



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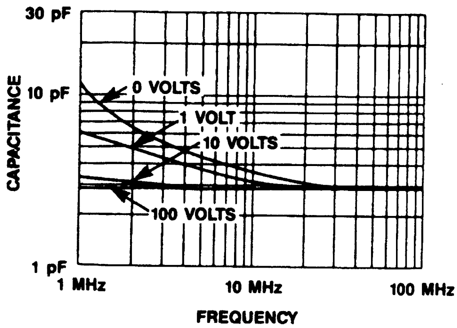
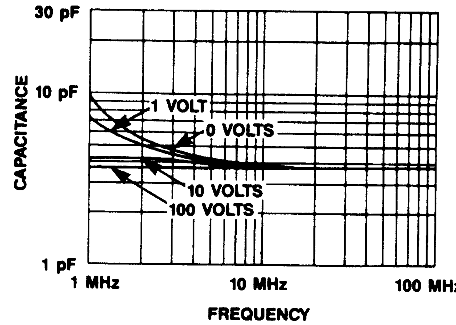
Typical Characteristics (Cont'd)

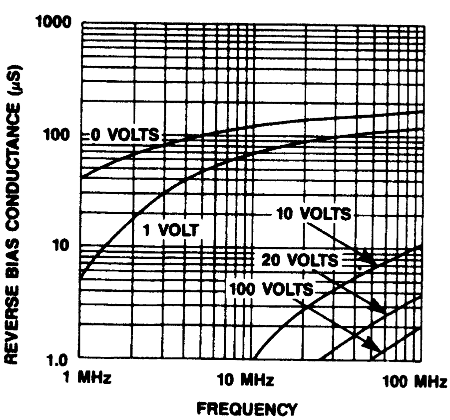
REVERSE BIAS CAPACITANCE vs FREQUENCY AND REVERSE VOLTAGE (MA4PK2000 SERIES)



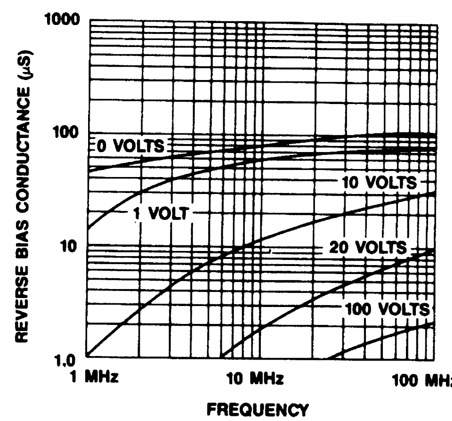
REVERSE BIAS CAPACITANCE vs FREQUENCY AND REVERSE VOLTAGE (MA4PK3000 SERIES)



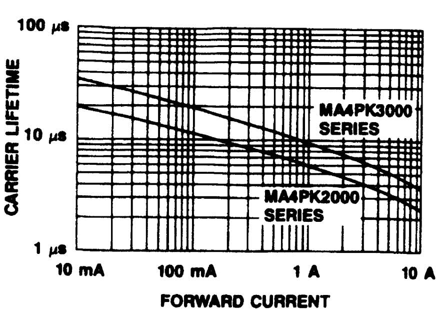
REVERSE BIAS CONDUCTANCE vs FREQUENCY AND REVERSE VOLTAGE (MA4PK2000 SERIES)



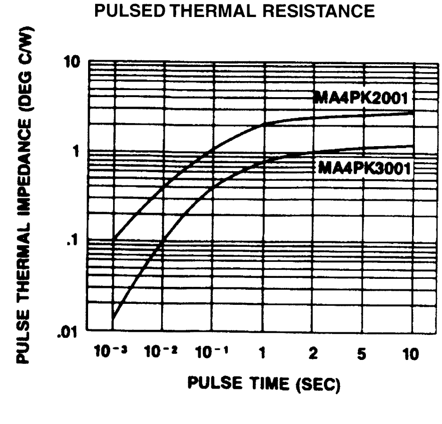
REVERSE BIAS CONDUCTANCE vs FREQUENCY AND REVERSE VOLTAGE (MA4PK3000 SERIES)



CARRIER LIFETIME vs FORWARD CURRENT



PULSED THERMAL RESISTANCE



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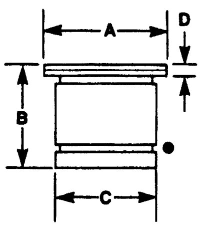
Case Styles

● Denotes Cathode

Pill



MA4PK2000 Case Style 1027

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.304	0.316	7.72	8.02
B	0.254	0.270	6.45	6.86
C	0.245	0.255	6.22	6.48
D	0.023	0.031	0.58	0.79

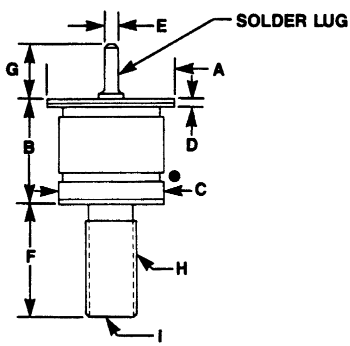
C_p - .45 pF
L_S = 2 nH

MAPK3000 Case Style 1073

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.468	0.485	11,9	12,3
B	0.373	0.395	9,45	10,0
C	0.390	0.400	9,91	10,2
D	0.028	0.042	0,71	1,06

C_p = .75 pF
L_S = 3 nH

Stud



MA4PK2001 Case Style 1082 (Solder Lug)

MA4PK2002 Case Style 1048 (No Solder Lug)

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.304	0.316	7,72	8,02
B	0.266	0.292	6,45	6,86
C	0.245	0.255	6,22	6,48
D	0.023	0.031	0,58	0,79
E	0.060	0.065	1,52	1,65
F	0.281	0.305	7,14	7,75
G	0.190	0.205	4,83	5,21
H	6-40 UNF-3A			
I	.072 SPLINE x .07 DP			

C_p - .45 pF
L_S - 2 nH

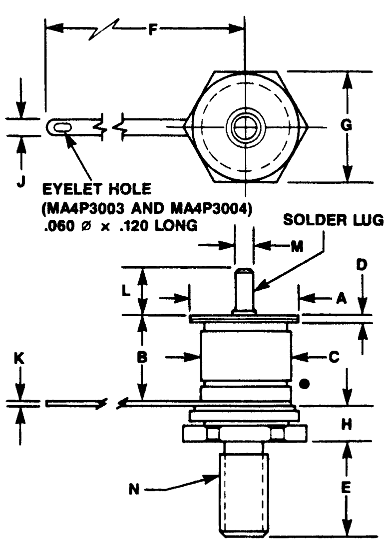
MA4PK3001 Case Style 11084 (Solder Lug)

MA4PK3002 Case Style 1074 (No Solder Lug)

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.468	0.485	11,9	12,3
B	0.387	0.411	9,83	10,4
C	0.390	0.400	9,90	10,1
D	0.028	0.042	0,71	1,06
E	0.060	0.065	1,52	1,65
F	0.425	0.445	10,8	11,3
G	0.190	0.205	4,83	5,21
H	10-32 UNF-2A			
I	.050 SLOT x .06 DP			

C_p = .75 pF
L_S = 3 nH

Insulated Stud



MA4PK2003 Case Style 1080 (Solder Lug)

MA4PK2004 Case Style 1038 (No Solder Lug)

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.304	0.316	7,72	8,02
B	0.254	0.270	6,45	6,86
C	0.245	0.255	6,22	6,48
D	0.023	0.031	0,58	0,79
E	0.221	0.252	5,61	6,40
F	0.780	0.790	19,8	20,1
G	0.245	0.255	6,22	6,48
H	0.128	0.137	3,25	3,48
J	0.120	0.130	3,05	3,30
K	0.007	0.009	0,18	0,23
L	0.190	0.205	4,83	5,21
M	0.060	0.065	1,52	1,65
N	6-32 UNC-3A			

C_p = .45 pF
L_S = 2 nH
C_{GRD} = 1.1 pF

MA4PK3003 Case Style 1085 (Solder Lug)

MA4PK3004 Case Style 1075 (No Solder Lug)

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.468	0.485	11,9	12,3
B	0.373	0.395	9,47	10,0
C	0.390	0.400	9,91	10,2
D	0.028	0.042	0,71	1,07
E	0.422	0.452	10,7	11,5
F	0.805	0.820	20,4	20,8
G	0.490	0.500	12,4	12,7
H	0.148	0.170	3,76	4,32
J	0.120	0.130	3,05	3,30
K	0.022	0.026	0,559	0,660
L	0.190	0.205	4,83	5,21
M	0.060	0.065	1,52	1,65
N	10-32 UNF-2A			

C_p = .75 pF
L_S = 3 nH
C_{GRD} = 4.2 pF

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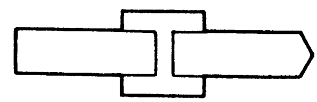
Beam-Lead PIN Diodes

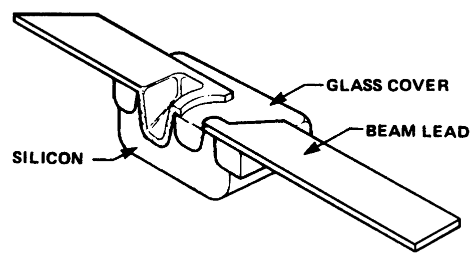
MA4P461, MA4P462, MA4P800, MA4P801

V 2.00

Features

- High Performance Microwave Characteristics
- Fast Switching Speeds
- Glass Encapsulated Construction
- Hermetically Sealed
- Mechanically Rugged – 6 Grams Minimum Beam Strength





Description

M/A-COM's series of silicon beam lead PIN diodes are designed for low loss high isolation microwave switch and attenuator circuits. These diodes are fabricated with a glass layer completely encapsulating the semiconductor junction resulting in a hermetic structure. This construction also offers a high degree of ruggedness with a beam pull strength in excess of 6 grams and mechanical strength and uniformity unique to silicon beam lead diodes. These characteristics result in a diode well suited for high performance series mounted microstrip circuits.

The microwave performance of M/A-COM's silicon beam lead PIN diodes is derived from their resistance capacitance characteristics. Insertion loss approaching 0.3 dB and isolation greater than 20 dB at 10 GHz in a SP2T switch can be obtained employing the MA4P800 as series connected elements. For applications requiring switching speeds faster than 5 nanoseconds the MA4P461 and MA4P462 are recommended.

Specifications @ T_A = +25°C

Model Number	Maximum Capacitance @ 10 Volts 1 MHz (pF)	Maximum R_S @ 500 MHz (Ohms)	Minimum[1] Reverse Voltage V_R (Volts)	Nominal[2] Carrier Lifetime (ns)	Nominal[3] Reverse Recovery Time (ns)
MA4P800	0.025	3.5 @ 50 mA	100	100	10
MA4P801	0.030	3.3 @ 50 mA	100	100	10
MA4P461	0.070	2.2 @ 10 mA	50	30	3
MA4P462	0.120	1.7 @ 10 mA	30	20	2

Notes:
1. The reverse current will not exceed 10 µA at the minimum voltage rating.
2. Nominal carrier lifetime measured at 10 mA.
3. Nominal reverse recovery time measured at I_F = 20 mA, I_R = 200 mA.

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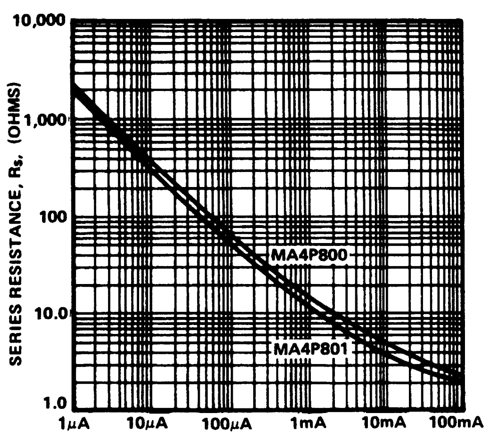
Maximum Ratings

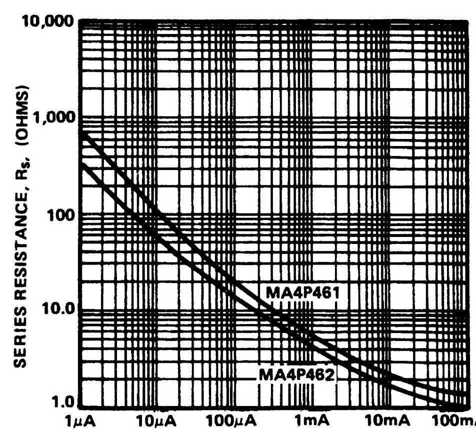
Parameter	Absolute Maximum
Voltage	Voltage Rating
Operating Temperature	-65°C to +150°C
Storage Temperature	-65°C to +175°C
Power Dissipation at +25°C	250 mW
Beam Strength	6 grams

Typical Performance Curves

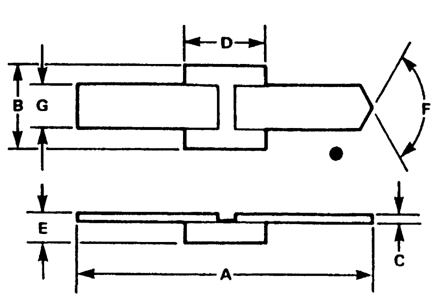
TYPICAL RESISTANCE AT 500 MHz



TYPICAL RESISTANCE AT 500 MHz



Case Style 129



• Cathode

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.030	0.034	0,76	0,86
B	0.007	0.011	0,18	0,28
C	0.0004	0.0006	0,010	0,015
D	0.007	0.011	0,18	0,28
E	0.002	0.004	0,05	0,10
F	110°	130°	110°	130°
G	0.0045	0.0055	0,114	0,140

Bonding Procedures

Bonding Beam Lead Diodes

The preferred methods for bonding a beam lead diode are thermal compression bonding and parallel gap welding. For thermal compression bonding the beam lead diode is placed down (gold beam to gold plated substrate) with the leads resting flat on the pad and bond made by using a heated wedge. Heat and pressure form a metallurgical bond. A minimum of 100 microinches of gold on the substrate is recommended for optimum bonding .

In the parallel gap technique current is first passed through the substrate metallization then through the device lead. Most of the heat is generated at the interface. Care must be taken to see that the step welder does not discharge through the diode junction or the diode will be destroyed. The bonding pressure should be approximately 900 gms/mm2.

The major advantage of the parallel gap technique is that a cold ambient may be used. Heat is only generated in the vicinity of the bond itself. Caution must be taken when making the second bond because if the diode is placed in tension the lead may break.

The following precautions will ensure better results when bonding beam leads:

To minimize the lead inductance the wedge or heated tips should be placed as close as possible to the edge of the chip without touching it. The chip is very easily damaged and care must be taken that the bonding tip does not contact the chip at any time during the bonding process.

The bonding tip must be perpendicular to the beam during bonding to prevent a torsional force which will pull the beams apart. This is particularly important when bonding the second lead.

Bonding to Soft Circuits

PIN beam leads can be soft soldered epoxied or parallel gap welded to Teflon fiberglass or soft circuit boards if low bond pressure is used. Bonding pressure must be reduced to a minimum to prevent diode breakage by forcing the beam into the board.

In general soft soldering or reflow soldering is the preferable technique. The circuit board should be pretinned with solder or a solder plating to obtain the best wetting. Solder melting temperatures of 225–300°C are most satisfactory. Usually the circuit board manufacturer's solder recommendations should be followed.

Conductive solder paste such as high conducting silver filled epoxy will also result in good low loss bonds. Care should be taken to ensure that the wet paste does not run up the beam lead and short it.

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GaAs Beam-Lead PIN Diodes

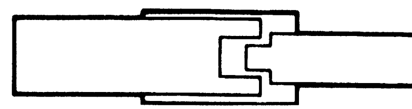
MA4GP900 Series

V 2.00

Features

- Superior High Speed Microwave Switching Diode
- 2-3 Nanosecond Switching When Driven From TTL Logic
- Capacitance as Low as 0.025 pF Specified at 10 GHz
- Series Resistance as Low as 2 Ohms Specified at 10 GHz
- Mechanically Rugged Construction— 10 Gram Beam Strength

Case Style



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Description

The MA4GP900 family of Gallium Arsenide beam lead PIN diodes offers superior performance for high speed microwave switching applications. The high carrier mobility of Gallium Arsenide results in low series resistance and fast switching. The low carrier density in the intrinsic region results in zero bias punch through and high off impedance at zero bias.

Air bridge technology reduces the beam parasitic capacitance and helps to achieve very small total capacitance. The use of a semi-insulating Gallium Arsenide substrate allows larger, stronger beam leads. Beam strength is in excess of 10 grams.

Specifications @ T_A = +25°C

Electrical Specifications					Nominal Characteristics	
Model Number	Maximum[1] Capacitance at 10 GHz and 0 Volts (pF)	Forward[2] Resistance at 20 mA and 10 GHz (Ohms)		Voltage[3] Rating (Volts)	Switching[4] Speed (ns)	Carriers Lifetime[5] (ns)
		Max.	Nom.			
MA4GP901	0.07	2.0	1.5	50	3	5
MA4GP902	0.025	4.5	3.0	50	2	2

Notes:
1. Capacitance is determined by measuring isolation in a 50 Ohm line at 10 GHz.
2. Forward series resistance is measured at 20 mA in a 50 Ohm line at 10 GHz.
3. Reverse current will not exceed 10 microamperes at the voltage rating.
4. Switching speed is measured between 10% and 90% points in a series mounted switch.
5. Carrier lifetime is measured at 10 mA.

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Maximum Ratings

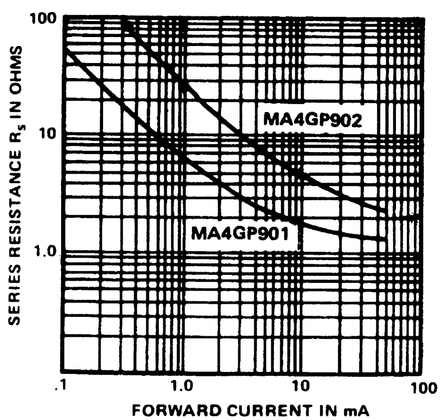
Parameter	Absolute Maximum
Operating Temp.	-65°C to +175°C
Storage Temp.	-65°C to +175°C
Voltage	Voltage Rating
Power Dissipation	0.10W at 25°C – MA4GP901 0.05W at 25°C – MA4GP902
Beam Strength	10 grams

Environmental Ratings Per MIL STD 750

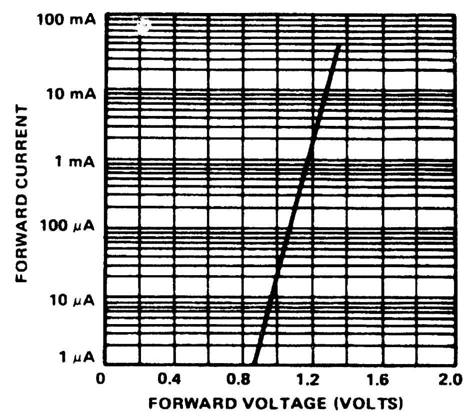
	Method	Level
Temperature Cycling	1051	5 cycles, -65°C to +150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's

Typical Performance Curves

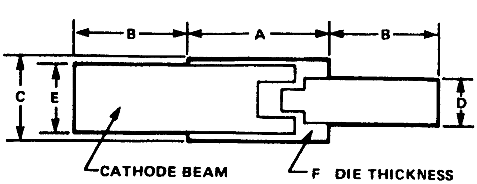
TYPICAL FORWARD R_S vs FORWARD CURRENT AT 10 GHz



TYPICAL CHARACTERISTICS AT +25°C FORWARD CURRENT vs FORWARD VOLTAGE @ +25°C



Case Style 992



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.012	0.014	0.305	0.356
B	0.010	—	0.254	—
C	0.006	0.008	0.152	0.203
D	0.004	0.006	0.102	0.152
E	0.007	0.009	0.178	0.229
F	—	0.004	—	0.102

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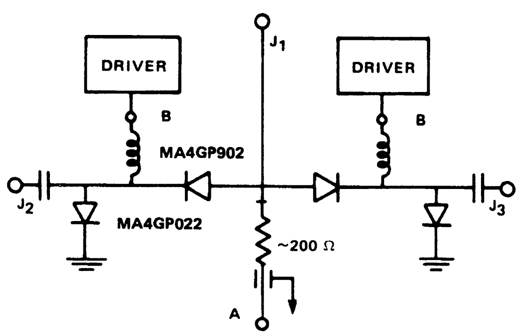
GaAs PIN Diode Driver Circuit

GaAs PIN diodes have high RF impedance at zero bias. They can be driven to low impedance by 5-20 mA of forward current. This current can normally be supplied directly from TTL line drivers, such as the 74F240 family.

The following figures illustrate the use of simple, inexpensive driver circuits employing low cost commercial logic gates. Both driver circuits are quite fast and can achieve RF switching speeds of 2–4 nanoseconds. It appears that the actual switching times of GaAs PINs are at present somewhat "faster" than these logic drivers.

Figure 1 shows the schematic of a simple broadband SPDT using a MA4GP902 diode in series and a MA4GP022 in shunt in each arm of the switch.

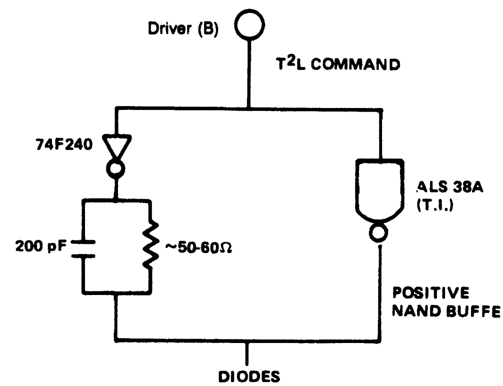
FIGURE 1: SPDT DRIVER



A common (+5) volt supply is used to forward bias one of the series diodes. The current is limited to 5-20 mA with an appropriate series resistance. When the command logic is high (1) the selected arm will be set in low insertion loss state because the driver (figure 2) will provide a current return to ground through the positive Nand buffer (ALS38A). The selected arm of the switch may be turned off by a low logic state (0).

The low logic state will cause the positive Nand buffer to have high DC impedance. The state will also cause positive current to flow from the 74F240 logic gate through the shunt diode. This shorts out the diode and causes a voltage drop across the series diode, turning it to high impedance. We use an approximate 60 ohm resistor to limit current to 15-20 mA. The capacitor in parallel to the resistor produces a current or voltage spike to speed switching.

FIGURE 2. DRIVER CIRCUIT



The 74F240 logic buffer can also be used to directly drive a SPST switch with a single series or shunt diode. We use this driver in a 50 ohm series test circuit to RF test beam lead diodes for wafer approval. The typical switching time is approximately 2 nanoseconds.

To achieve the fastest speed, hybrid chip drivers, careful, small layouts and very short lead lengths are required.

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Bonding Procedures for Beam Lead Diodes

The preferred methods for bonding a beam lead diode are thermal compression bonding and parallel gap welding. For thermal compression bonding, the beam lead diode is placed down (gold beam to gold plated substrate) with the leads resting flat on the pad and the bond is made by using a heated wedge. Heat and pressure form a metallurgical bond. A minimum of 100 microinches of gold on the substrate is recommended for optimum bonding.

In the parallel gap technique, current is first passed through the substrate metallization, then through the device lead. Most of the heat is generated at the interface. Care must be taken to see that the step welder does not discharge through the diode junction or the diode will be destroyed. The bonding pressure should be approximately 900 gms/mm^2.

The major advantage of the parallel gap technique is that a cold ambient may be used. Heat is only generated in the vicinity of the bond itself. Caution must be taken when making the second bond because if the diode is placed in tension, the lead may break.

The following precautions will ensure better results when bonding beam leads:

To minimize the lead inductance, the wedge, or heated tips should be placed as close as possible to the edge of the chip without touching it. The chip is very easily damaged, and care must be taken that the bonding tip does not contact the chip at any time during the bonding process.

The bonding tip must be perpendicular to the beam during bonding, to prevent a torsional force which will pull the beams apart. This is particularly important when bonding the second lead.

Bonding Proceedures to (Soft) Substrates

PIN beam leads can be soft soldered, epoxied or parallel gap welded to Teflon fiberglass or soft circuit boards if low bond pressure is used. Bonding pressure must be reduced to a minimum to prevent diode breakage by forcing the beam into the board.

In general, soft soldering or reflow soldering is the preferable technique. The circuit board should be pretinned with solder or a solder plating to obtain the best wetting. Solder melting temperatures of 225-300°C are most satisfactory. Usually, the circuit board manufacturer's solder recommendations should be followed.

Conductive solder paste such as high conducting silver filled epoxy will also result in good low loss bonds. Care should be taken to ensure that the wet paste does not run up the beam lead and short it.

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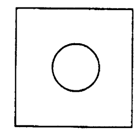
PIN Diode Chips

V 2.00

Features



- CERMACHIP™ (glass) or Silicon Dioxide Passivation
- Hermetically Sealed CERMACHIP Design
- Fast Speed, Low Loss Microwave Chips
- Attenuator Chips
- Voltage Ratings to 1500 Volts
- Wide Range of PIN Characteristics

Description

M/A-COM offers a comprehensive product line of silicon PIN diode chips covering a wide range of performance characteristics for use in hybrid integrated circuits. PIN diode chips designed for fast switching speed, low loss microwave applications and for high power, high voltage RF applications are available.

The small size and low parasitics of PIN diode chips allow for the design of miniature, broadband microwave circuits particularly useful in microstrip assemblies. These devices combine M/A-COM's latest design technology and long experience as a manufacturer of PIN diodes.

M/A-COM's PIN diode chips have gold contact surfaces, with the cathode surface as the bottom contact.

The low capacitance PIN diode chips have a mesa construction and are passivated with silicon dioxide. Capacitance values range from 0.05 pF. These devices are designed with thin I region widths and short carrier lifetime for fast switching speed microwave circuits.

The attenuator PIN diode chips have a mesa construction and are passivated with CERMACHIP glass. Because of their thick intrinsic region and well controlled resistance current characteristics, these devices are well suited for low distortion attenuator circuits.

The general purpose PIN diode chips are silicon dioxide passivated mesa structures. They are also available in hermetically sealed packages as described in the packaged PIN diode section. These diodes encompass a wide range of characteristics with voltage ratings from 50 to 250 volts.

M/A-COM's CERMACHIP PIN diode chips employ M/A-COM's unique hard glass passivation, covering the entire active surface of the PIN diode junction. This results in an hermetically sealed chip that has been qualified for many high reliability military and space programs. The CERMACHIP PIN chips are available with voltage ratings up to 1,500 volts and are capable of controlling kilowatts of power.

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Low Capacitance PIN Diode Chips
Specifications @ T_A = +25°C

Model[1] Number	Voltage[2] Rating (Volts)	Maximum[3] Cj @ 10V (pF)	Maximum[4] R_S @ 10 mA (Ohms)	Nominal Characteristics		
				Carrier[5] Lifetime (ns)	Reverse[6] Recovery Time (ns)	Contact Diameter (mils)
MA4P150	20	0.10	1.5	10	2	1.5
MA4P151	30	0.05	2.0	10	2	1.5
MA4P152	30	0.10	1.5	10	2	2.0
MA4P153	30	0.15	1.2	10	2	2.0
MA4P154	30	0.20	1.0	10	2	2.0
MA4P155	40	0.05	2.0	15	4	1.5
MA4P156	40	0.10	1.5	15	4	1.5
MA4P157	60	0.10	1.5	50	6	2.0
MA4P159	60	0.20	1.0	65	7	2.5
MA4P160	100	0.05	1.9	80	8	2.0
MA4P161	100	0.10	1.5	90	9	2.5
MA4P162	100	0.15	1.2	100	10	3.0
MA4P165	200	0.05	2.5	170	20	2.0
MA4P166	200	0.10	2.0	190	20	3.0

Notes:
1. Nominal chip size is 15 X 15 mil, case style 134. See Appendix for full dimensions.
2. Maximum reverse current is 10 µA at the specified voltage rating.
3. Maximum capacitance is specified at 1 MHz at the indicated voltage.
4. Maximum series resistance is at the specified current and a frequency of 500 MHz.
5. Nominal carrier lifetime is specified at I_F = 10 mA.
6. Nominal reverse recovery time is specified at I_F - 20 mA, I_R = 200 mA.

Attenuator PIN Diode Chips
Specifications @ T_A = +25°C

Model[1] Number	Voltage[2] Rating (Volts)	Maximum[4] R_S @ 10 mA (Ohms)	Maximum[3] Cj @ 100V @ 100 V (pF)	Nominal Characteristics				
				Rs for I_F = 1 mA (Ohms)	Rs for I_F = 10 µA (Ohms)	Carrier Lifetime (µS)	I-Region Width (mils)	Equivalent[4] M/A-COM Axial Lead PIN Diode
MA47418	200	3	0.15	8	500	1.0	2	MA47047
MA47416	200	6	0.15	30	2000	2.0	4	MA47600
MA47406	200	8	0.15	50	3000	2.5	7	MA47100

Notes:
1. Nominal chip size for the MA47418 and MA47416 is 30 x 30 mil (case style 131), MA47406 is 20 x 20 mil (case style 132). See Appendix for full dimensions
2. Maximum reverse current is 10 µA at specified voltage rating.
3. Capacitance is specified at 1 MHz.
4. Resistance is specified at 100 MHz.
5. Carrier Lifetime is specified at 10 mA.

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General Purpose PIN Chips Specifications @ T_A = +25° C

Model[1] Number	Voltage[2] Rating (Volts)	Maximum R_S @ 10 mA (Ohms)	Maximum[3] Cj @ V_R (pF)	Nominal Characteristics				
				Carrier[4] Lifetime (ns)	I-Region Width (µm)	Contact Diameter (mils)	Thermal Resistance (°C/W)	Chip Size[5] (mils X mils)
MA4P420-132	35	0.5	0.85 @ 20	300	10	6.0	60	20 X 20
MA4P102-134	50	2.0	0.05 @ 10	20	7	1.5	60	15 X 15
MA4P202-134	100	2.5	0.05 @ 10	60	12	1.5	60	15 X 15
MA4P203-134	100	1.5	0.15 @ 10	100	12	2.5	30	15 X 15
MA4P303-134	200	1.5	0.15 @ 10	200	20	4.0	30	15 X 15
MA4P404-132	250	0.6*	0.20 @ 50	1000	30	4.0	20	20 X 20

*At 50 mA, 100 MHz

Notes:
1. Maximum reverse current is 10 µA at specified voltage rating.
2. Resistance is specified at 500 MHz unless indicated.
3. Capacitance is specified at 1 MHz at the indicated voltage.
4. Nominal carrier lifetime is specified at 10 mA.
5. Case style is indicated by model number suffix. See Appendix for full dimensions.

PIN CERMACHIPS Specifications @ T_A = +25°C

Model[1] Number	Voltage[2] Rating (Volts)	Maximum R_S @ 100 mA (Ohms)	Maximum[3] Cj @ 100V (pF)	Nominal Characteristics				
				Carrier[4] Lifetime (µs)	I-Region Width (mils)	Chip Size[5] (mils X mils)	Contact Diameter (mils)	Thermal Resistance (°C/W)
MA4P504-132	500	0.60	0.20	1	2	20 X 20	5	20
MA4P505-131	500	0.45	0.35	2	2	30 X 30	8	15
MA4P506-131	500	0.30	0.70	3	2	30 X 30	12	10
MA4P604-131	1000	1.00	0.30	3	4	30 X 30	12	15
MA4P606-131	1000	0.70	0.60	4	4	30 X 30	18	10
MA4P607-210	1000	0.40	1.30	5	4	65 X 65	28	7
MA4P608-130	1000	0.35*	2.50	5	4	80 X 80	38	5
MA4P709-223	1500	0.25**	3.30	10	7	110 X 110	50	2

* At 150 mA
** At 300 mA

Notes:
1. Maximum reverse current is 10 µA at specified voltage ratings.
2. Capacitance is specified at 1 MHz.
3. Resistance is specified at 100 MHz.
4. Nominal Carrier Lifetime is specified at 10 mA.
5. Case style is indicated by model number suffix. See Appendix for full dimensions.

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Maximum Ratings

Parameters	Absolute Maximum
Storage Temperature	-65°C to +200°C
Operating Temperature	-65°C to +175°
Voltage	Voltage Rating

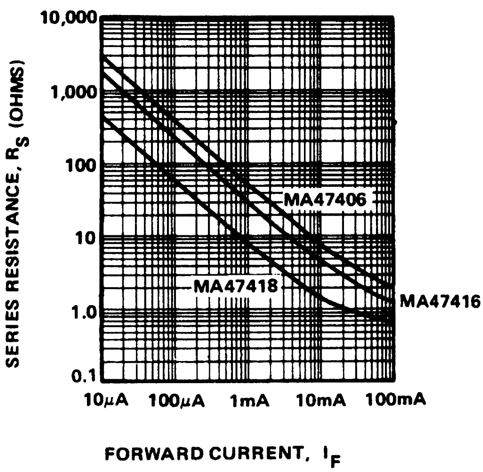
Power Dissipation

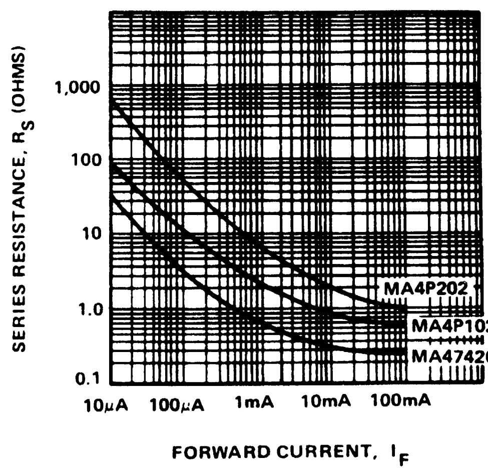
Low Capacitance and Attenuator Chips — 0.5 Watts @ 25°C (derate to zero watts at 175°C)

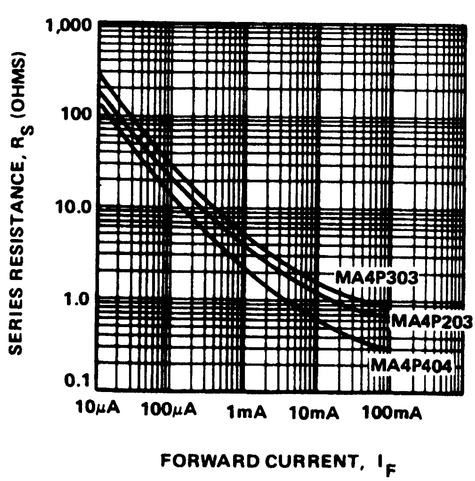
General Purpose Chips and CERMACHIPS

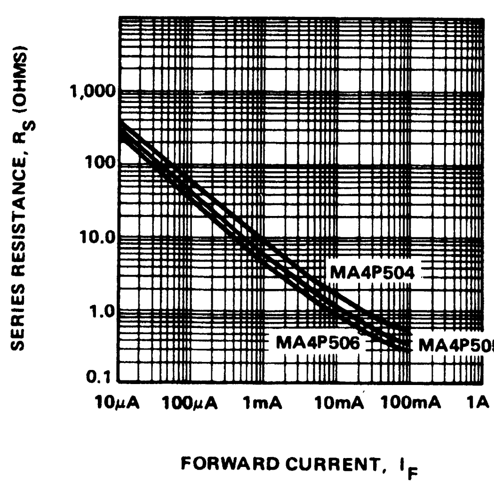
$$P\ diss = \frac{175°C - T\ ambient}{Thermal\ Resistance}$$

Typical Series Resistance vs Current Performance Curves









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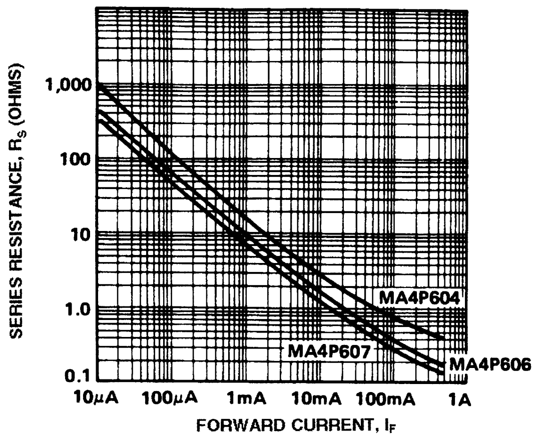
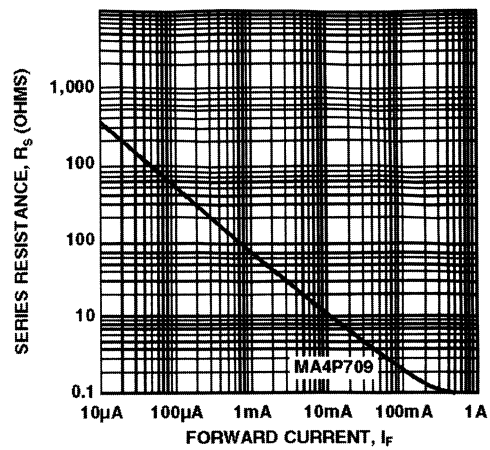
Typical Series Resistance vs Current Performance Curves





Bonding and Handling Considerations for Silicon PIN Diode Chips

The normal handling precautions used on semiconductors in hybrid microelectronic circuits are appropriate to silicon PIN diode chips. PIN diode chips are packaged in waffle packs that should be stored in a dry, clean environment. It is recommended that the chips be removed and subsequently handled using a vacuum pencil.

Die Bonding

Hot gas bonding is recommended for the passivated chips and the smaller CERMACHIP (less than 60 X 60 mils) PIN diodes. The preferred mating substrate surface is plated with gold or tin over a nickel flash. A gold tin preform (80%/20%, 280°C melting temperature) should be used. The substrate is heated to 250°C and the hot gas (forming gas) is injected at 350°C. The collet pressure should be about 70 grams during bonding.

For the larger CERMACHIP PIN diodes, it is recommended that softer solder preform such as lead-tin-silver (90%/5%/5%, 308°C melting temperature) be used. Bonding should take place in a belt furnace using a hydrogen cover gas.

It is also possible to solder these chips directly on a heat transfer platform using a solder preform or solder cream. If flux is required, it should be used sparingly and its residue removed immediately after bonding. Flux should not be used with CERMACHIP diodes since it will damage the passivation surface. The platform temperature should be raised to 30°C above the solder liquid state temperature.

Bonding with conductive epoxy is also acceptable. The manufacturers recommendations for mixing, applying and curing must be followed. The curing should take place in a circulating air chamber dedicated to inorganic epoxies.

Lead Bonding

Thermocompression and thermocompression ultrasonic lead bonding techniques may be employed for PIN diode chips. Wire bonds using 0.7 mil and 1 mil gold wire may be ball or wedge bonded; ribbons from 0.25 mil X 3.0 mil to 1 mil X 10 mil maybe wedge bonded. The choice depends on the application and the contact size. During lead bonding, it is preferable that the substrate be raised to approximately 150°C. The bonding tip temperature and pressure depends on the wire or ribbon size and contact area. The resulting bond strength should exceed the specification in MIL-STD883, Method 2011.3 for gold wire or ribbon leads.

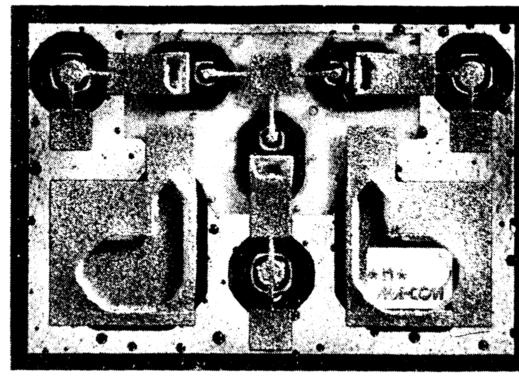
Monolithic PIN Diode Switches

MA4SW100, 200, 300

V 2.00

Features

- Broadband Performance:
  Specified 1-18 GHz
  Usable 1-26 GHz (SPST, SPDT)
  Usable 1-20 GHz (SP3T)
- Insertion Loss 1.2 dB to 18 GHz
  Isolation 40 dB to 18 GHz
- Single Chip Replaces up to Six Diodes and Twelve Bonds
- Rugged, Monolithic, Glass Encapsulated, Junction Construction

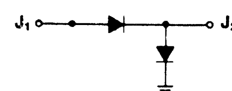


Description

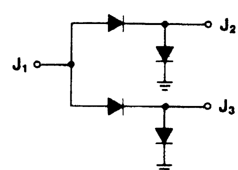
The MA4SW100-300 series are broadband monolithic switches using M/A-COM's patented HMIC technology. They utilize a series and shunt connected PIN diode in each arm. The close spacing of these series/shunt diodes results in low loss and high isolation. They are available as SPST, SPDT and SP3T switches. These monolithic switches are specifically designed as easy to use replacements for beam lead and chip PIN diodes in MIC circuits.

The MA4SW100 SPST and MA4SW200 SPDT are usable through 26 GHz. The MA4SW300 SP3T is usable through 20 GHz. Each of the chips has 5 mil square (0.13 mm) gold plated bonding pads at each RF port. Gold backside plating allows conventional chip bonding techniques using solder, thermal compression bonding or conductive epoxy. The large pads facilitate convenient low inductance ribbon bonds to adjacent circuit elements. The PIN diodes are fully encapsulated in a hermetic low loss glass and the RF connection is deposited on this glass to reduce line losses.

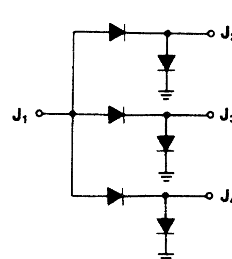
SPST



SPDT



SP3T



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Electrical Specifications at +25°C

MA4SW100 (SPST)[1]

Parameters	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	0.6 1.0 1.5	0.8 1.5 —	dB dB dB
Isolation[2]	1-8 GHz 8-18 GHz 18-26 GHz	42 35 —	45 40 35	— — —	dB dB dB
Input Return Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	15 10 10	— — —	dB dB dB
Signal Compression @ 500 mW	1 GHz	—	0.2	—	dB
Switching Speed[3]	—	—	20	—	nS
Voltage Rating[4]	—	50	—	—	V

MA4SW200 (SPDT)[1]

Parameters	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	0.6 1.0 1.5	0.8 1.5 —	dB dB dB
Isolation[2]	1-8 GHz 8-18 GHz 18-26 GHz	42 35 —	45 40 35	— — —	dB dB dB
Input Return Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	15 10 10	— — —	dB dB dB
Signal Compression @ 500 mW	1 GHz	—	0.2	—	dB
Switching Speed[3]	—	—	20	—	nS
Voltage Rating[4]	—	50	—	—	V

Notes:
1. Standard case styles are: 1053 for part number MA4SW100; 1052 for part number MA4SW200; 1051 for part number MA4SW300.
2 Switching parameters specified with ±20 mA current applied to J_2, J_3 and J_4. Specifications are verified by measurement in a 50 Ohm test mount and 3 mil ribbons bonded to the RF pads.
3. Typical switching speed measured from 10% to 90% of detected RF signal.
4. Reverse current specified not to exceed 10 μA at voltage rating.

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Electrical Specifications (Cont'd.)

MA4SW300 (SP3T)[1]

Parameters	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss[2]	1-8 GHz 8-18 GHz	— —	1.0 1.2	1.5 1.5	dB dB
Isolation[2]	1-8 GHz 8-18 GHz	35 30	37 32	— —	dB dB
Input Return Loss[2]	1-8 GHz 8-18 GHz	10 10	15 12	— —	dB dB
Signal Compression @ 500 mW	1 GHz	—	0.20	—	dB
Switching Speed[3]	—	—	20	—	nS
Voltage Rating[4]	—	50	—	—	V

Notes:
1. Standard case styles are: 1053 for part number MA4SW100; 1052 for part number MA4SW200; 1051 for part number MA4SW 300.
2. Switching parameters specified with ±20 mA current applied to J_2, J_3 and J_4. Specifications are verified by measurement in a 50 Ohm test mount and 3 mil ribbons bonded to the RF pads.
3. Typical switching speed measured from 10% to 90% of detected RF signal.
4. Reverse current specified not to exceed 10 μA at voltage rating.

Absolute Maximum Ratings

Operating Temperature	-65°C to +150°C
Storage Temperature	-65°C to +175°C
Power Dissipation at 25°C	100 mW
Incident CW RF Power at 25°C	1 Watt
Applied Voltage	50 Volts

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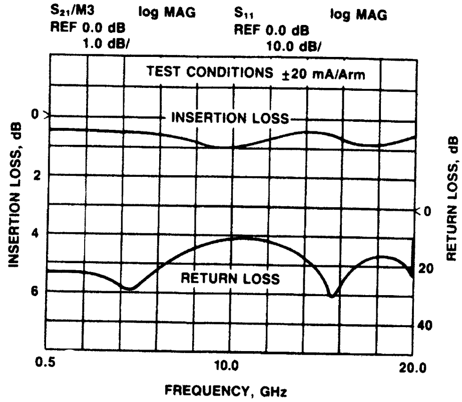
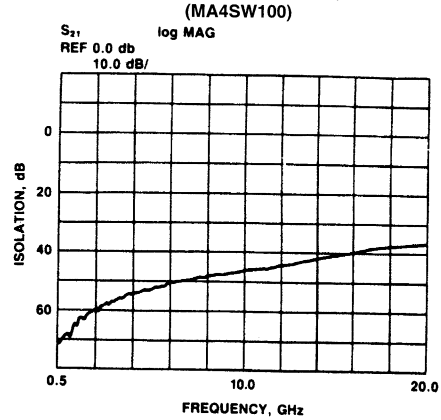
Typical Performance Curves

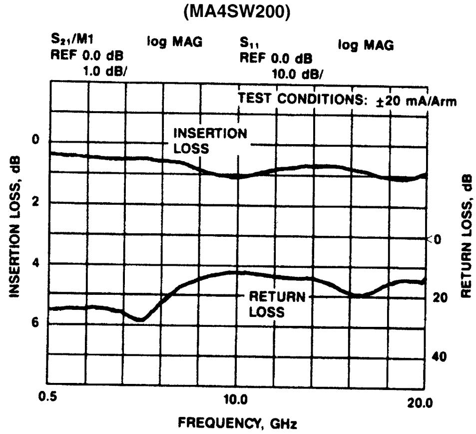
INSERTION LOSS AND RETURN LOSS vs FREQUENCY (MA4SW100)



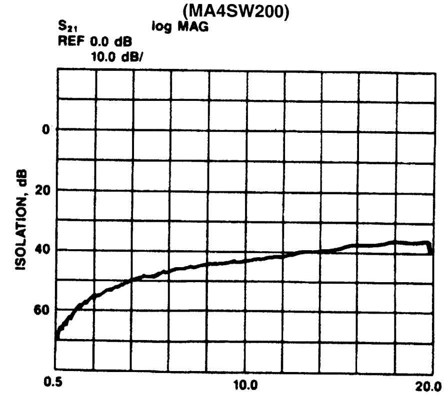
ISOLATION vs FREQUENCY (MA4SW100)



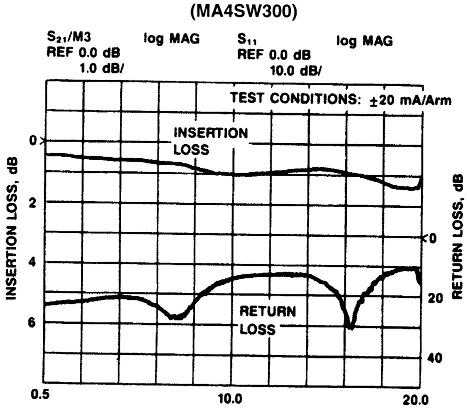
INSERTION LOSS AND RETURN LOSS vs FREQUENCY (MA4SW200)



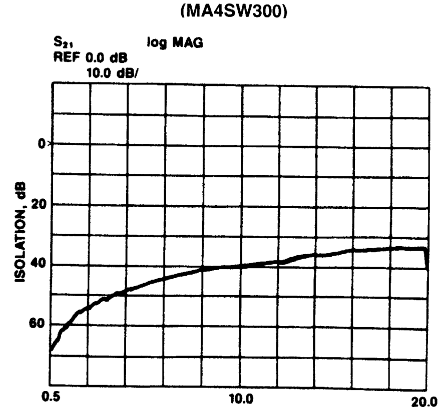
ISOLATION vs FREQUENCY (MA4SW200)



INSERTION LOSS AND RETURN LOSS vs FREQUENCY (MA4SW300)



ISOLATION vs FREQUENCY (MA4SW300)



Specifications Subject to Change Without Notice.

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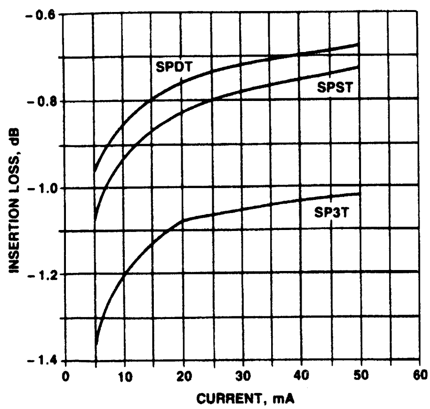
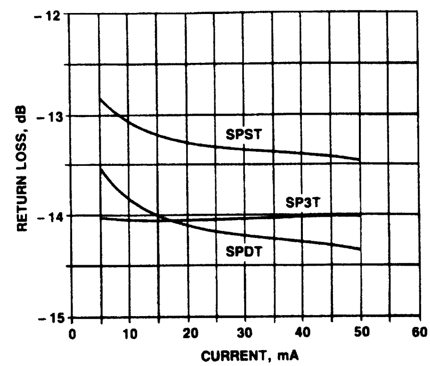
Typical Performance Curves (Cont'd)

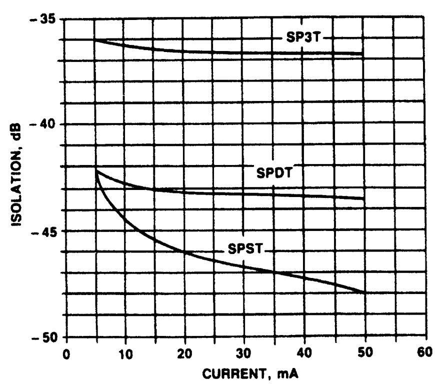
INSERTION LOSS vs CURRENT AT 10 GHZ



RETURN LOSS vs CURRENT AT 10 GHZ



ISOLATION vs CURRENT AT 10 GHZ



S-Parameters

The following files are abstracted "real" S-parameters calculated for the MA4SW series from "Touchstone" by EESOF. Only the chip is simulated with port 1 being the "RF in" and ports 2, 3 and 4 being the output for various configurations. Bias circuit design should include parasitic elements from ribbons, wires, etc.

M/A-COM can supply the Touchstone file on a 5 1/2 inch disk (DOS format) on special order. Contact Factory for details.

MA4SW100 **SPST**

Frequency (GHz)	Off (S21) dB	On (S21) dB	Off (S11) dB	On (S11) dB
2.00000	56.786	0.300	0.026	31.140
4.00000	50.757	0.334	0.052	32.395
6.00000	47.206	0.370	0.078	32.219
8.00000	44.658	0.406	0.105	31.343
10.0000	42.650	0.444	0.133	29.327
12.0000	40.976	0.484	0.161	26.884
14.0000	39.526	0.527	0.189	24.498
16.0000	38.234	0.574	0.218	22.325
18.0000	37.056	0.626	0.248	20.380
20.0000	35.965	0.684	0.279	18.638
22.0000	34.937	0.749	0.311	17.072
24.0000	33.956	0.822	0.344	15.656
26.0000	33.011	0.905	0.379	14.368

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S-Parameters (Cont'd)

MA4SW200 SPDT

Frequency (GHz)	Off (S31) dB	On (S21) dB	Off (S11) dB	On (S11) dB
0.0000	88.560	0.264	89.081	29.266
2.0000	62.142	0.314	62.675	26.950
4.0000	56.390	0.382	56.885	20.999
6.0000	53.011	0.465	53.435	17.647
8.0000	50.617	0.557	50.943	15.468
10.000	48.766	0.656	48.969	13.855
12.000	47.250	0.760	47.307	12.627
14.000	45.951	0.864	45.847	11.683
16.000	44.791	0.964	44.518	10.961
18.000	43.713	1.058	43.272	10.421
20.000	42.670	1.143	42.075	10.038
22.000	41.620	1.217	40.902	9.791
24.000	40.526	1.282	39.733	9.661
26.000	39.417	1.337	38.615	9.620

MA4SW300 SP3T

Frequency (GHz)	Off (S21) dB	On (S31) dB	Off (S14) dB	On (S11) dB
2.00000	62.572	0.327	62.572	25.976
4.00000	56.624	0.415	56.624	19.786
6.00000	53.188	0 522	53.188	16.404
8.00000	50.769	0.641	50.769	14.228
10.0000	48.897	0.768	48.897	12.655
12.0000	47.352	0.897	47.352	11.481
14.0000	46.008	1.025	46.008	10.593
16.0000	44.780	1.149	44.780	9.915
18.0000	43.608	1.267	43.608	9.390
20.0000	42.443	1.383	42.443	8.964
22.0000	41.252	1.505	41.252	8.575
24.0000	40.013	1.649	40.013	8.146
26.0000	38.722	1.839	38.722	7.592

Driver Connections

SPST (MA4SW100)

Control Level (DC Current) at	Condition of RF Output
J_2	J_1–J_2
-20 mA	Low Loss
+20 mA	Isolation

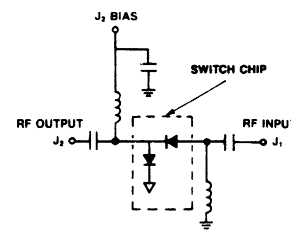
SPDT (MA4SW200)

Control Level (DC Current) at		Condition of RF Output	Condition of RF Output
J_2	J_3	J_1–J_2	J_1–J_3
-20 mA	+20 mA	Low Loss	Isolation
+20 mA	-20 mA	Isolation	Low Loss

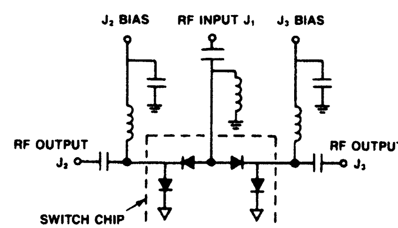
SP3T (MA4SW300)

Control Level (DC Current) at			Condition of RF Output	Condition of RF Output	Condition of RF Output
J_2	J_3	J_4	J_1–J_2	J_1–J_3	J_1–J_4
-20 mA	+20 mA	+20 mA	Low Loss	Isolation	Isolation
+20 mA	-20 mA	+20 mA	Isolation	Low Loss	Isolation
+20 mA	+20 mA	-20 mA	Isolation	Isolation	Low Loss

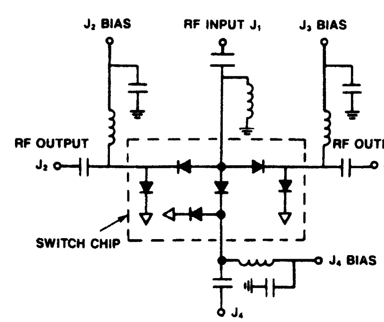
SPST AND BIAS CONNECTION



SPDT AND BIAS CONNECTION



SP3T AND BIAS CONNECTION



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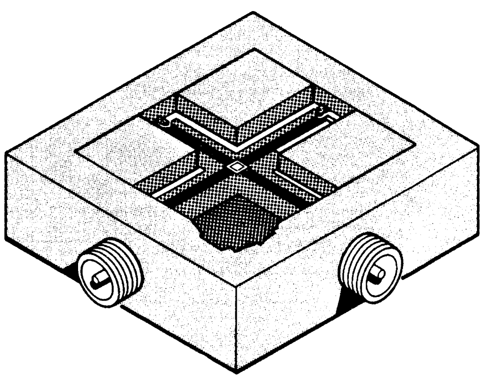
General Information

Testing the MA4SW Series

The MA4SW series of switches are tested in stripline test fixtures. They contain 5 mil duroid microstrip circuit boards in a channelized housing. The lines are approximately 15 mils wide. K connectors are used to make contact to the circuit boards. The channel width is 120 mils (3 mm). Connections to the RF ports are made with ribbons approximately 3 mils wide.

Bias is supplied through broadband bias tees connected to each port. Reference data is first established using a straight through microstrip board connecting the input port J_1 to the output port.

TYPICAL SP3T TEST FIXTURE



Operation of the MA4SW Series

Operation of the MA4SW series of switches is achieved by simultaneous application of positive and negative DC currents to ports J_2–J_4 as required (see bias connections). A DC return is required at J_1. The driver currents should be supplied by a constant current source. The voltage at these points will not exceed ±1.5 volts at currents up to ±50 mA. In the low loss state, the series diode must be forward biased and the shunt diode reverse biased. In the isolated arm the shunt diode is forward biased and the series diode reverse biased. The switch is specified with ±20 mA diode currents.

Bonding and Handling Considerations

for the MA4SW Series

The normal handling precautions used with silicon chips in microelectronic circuits are appropriate to the MA4SW series of monolithic switches. The MA4SW series of switches are packaged for delivery in waffle packs and should be stored in a dry, clean environment until used. The chips should be removed from the waffle pack and handled with a vacuum pencil; tweezers should not be used.

Die Metallization

Gold metallization is used on both the back and all bonding pads. All die attach and bonding methods should be compatible with gold contacts.

Die Bonding

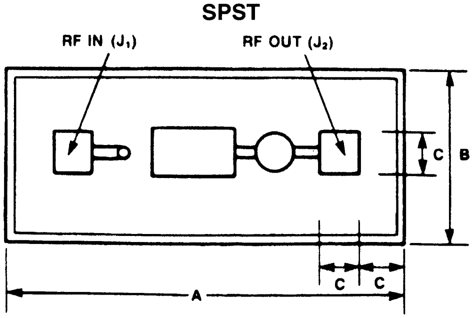
Hot gas bonding is preferred. The surfaces should have a nickel flash under gold or tin plating. The use of gold-tin solder (80%-20%, melting point ~280°C)is recommended. During the bonding operation, the mating surfaces should be heated to approximately 250°C. A collet pressure of 55 to 85 grams is satisfactory. The hot gas should be applied only until the solder flows (less than 5 seconds). Conductive epoxies can also be used.

Ribbon Bonding

Wedge thermocompression bonding may be used to attach ribbons to the bonding pads. The gold ribbons should be between 3-5 mils wide and 0.50-1.0 mils thick. The bonding pressure should be between 600 and 900 grams/mm2 and the force should be adjusted according to the size of the tip. Aluminum leads are not recommended.

Case Style 1053

SPST



MA4SW100

DIM.	NOMINAL DIMENSIONS INCHES	NOMINAL DIMENSIONS MILLIMETERS
A	0.070	1,780
B	0.050	1,270
C	0.005	0,127
Thickness	0.008 Max.	0,20 Max.

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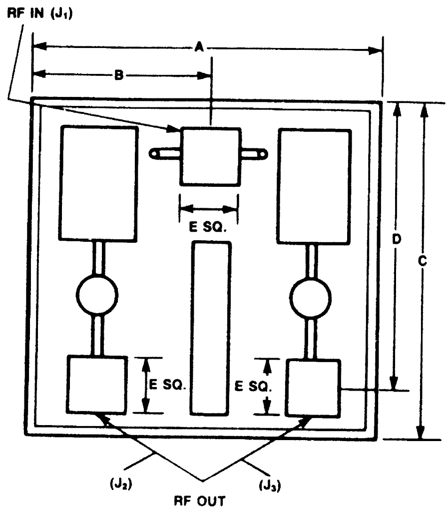
Case Styles (Cont'd)

1052

SPDT

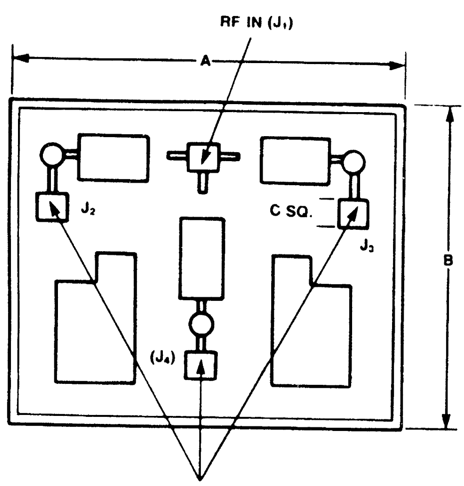


MA4SW200

DIM.	NOMINAL DIMENSIONS	
	INCHES	MILLIMETERS
A	0.041	1,04
B	0.020	0,508
C	0.040	1,01
D	0.029	0,74
E	0.005	0,127
Thickness	0.008 Max.	0,20 Max.

1051

SP3T



MA4SW300

DIM.	NOMINAL DIMENSIONS	
	INCHES	MILLIMETERS
A	0.070	1,780
B	0.050	1,270
C	0.005	0,127
Thickness	0.008 Max.	0,20 Max.

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an AMP company

GaAs PIN Diodes

MA4GP Series

V 2.00

Features

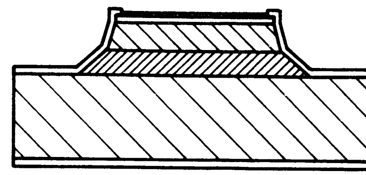
- May be Driven Directly from TTL Signals
- Low Series Resistance
- Fast Switching Speed
- No Reverse Bias Required
- Available as Passivated Chips

Description

Gallium Arsenide PIN diodes offer improved performance characteristics in many microwave semiconductor applications. These benefits result from the inherent semiconductor material properties of GaAs including high carrier mobility resulting in low resistance and fast switching speed. Low I-region carrier concentration results in near zero bias punch through. Gallium Arsenide's higher band gap also assures higher temperature capability.

Switching speeds in the low nanosecond range using inexpensive TTL buffer logic are achievable with GaAs PIN diodes. This performance is achieved because GaAs PIN diodes can exhibit high impedance at positive bias (up to 0.5 volts). Reverse bias is not required for many GaAs PIN diode applications. Low loss in switch and phase shifter circuits (up to 40 GHz) is achievable as a result of low parasitic series resistance in the conducting and non-conducting state.

Case Style 277



Specifications T_A= +25°C Electrical Specifications

Model[1] Number	Maximum[2] Forward Rs @ 20 mA, 1 GHz (Ohms)	Capacitance 1 MHz @ - 10 volts Maximum (pF)	Minimum Reverse Voltage V_B @ 10 µA (Volts)	Nominal Switching[3] Speed (ns)	Nominal Carrier[4] Lifetime (ns)
MA4GP022	1.0	0.15	50	4.0	5.0
MA4GP025	0.85	0.35	75	4.0	10.0
MA4GP030	2.0	0.06	100	10.0	20.0
MA4GP032	1.5	0.12	100	10.0	25.0

Notes:
1. The passivated chip (case style 277) is the standard case style for the MA4GP series. Minimum bonding pad diameter is 2 mils. The other available case styles are 30, 31, 94 and 120. To specify the case style desired, add the case style number as a suffix to the model number when ordering. See Appendix for full dimensions.
2. Forward R_S is measured by terminating a transmission line with the diode in the case style 30 package.
3. Switching speed is measured between 1 dB and 20 dB loss in a shunt mounted 7.0 GHz switch.
4. Carrier lifetime is measured at 10 mA derived from stored charge measurements.

Specifications Subject to Change Without Notice.

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Maximum Ratings

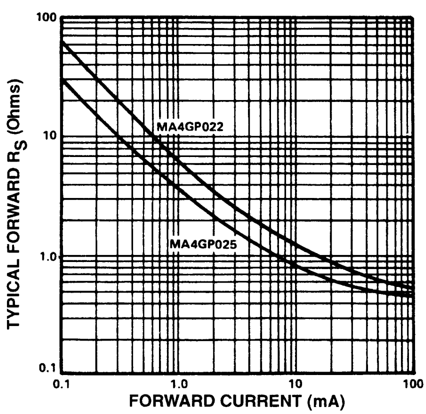
Parameter	Absolute Maximum
Temperature	
Operating	-65° C to +175°C
Storage	-65° C to +175°C
Voltage	Breakdown Voltage
Power Dissipation	250 mW @ +25°C

Environmental Rating PER MIL-STD-750

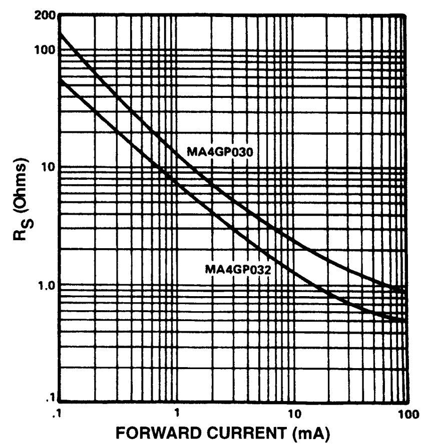
	Method	Level
Temperature, Cycling	1051	5 cycles, - 65° C to +150° C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Moisture Resistance (Packaged diodes)	1021	10 days

Typical Performance Curves

TYPICAL FORWARD RESISTANCE vs FORWARD CURRENT AT 1 GHz

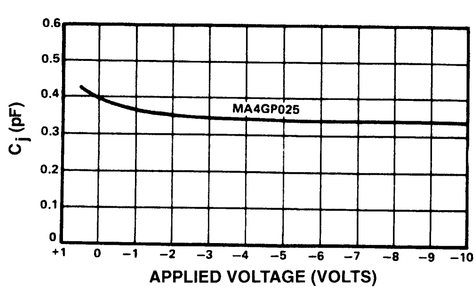


TYPICAL FORWARD RESISTANCE vs FORWARD CURRENT AT 1 GHz

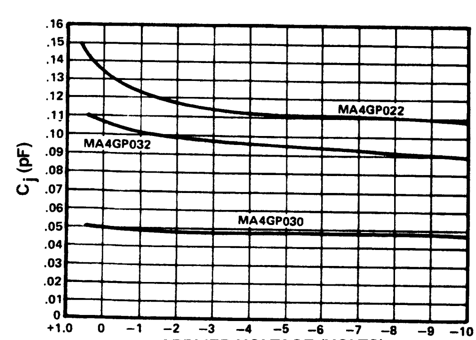


Typical Performance Curves

CAPACITANCE VOLTAGE CHARACTERISTICS AT 1 GHz



CAPACITANCE VOLTAGE CHARACTERISTICS AT 1 GHz



Specifications Subject to Change Without Notice. *— Contiunued next page —*

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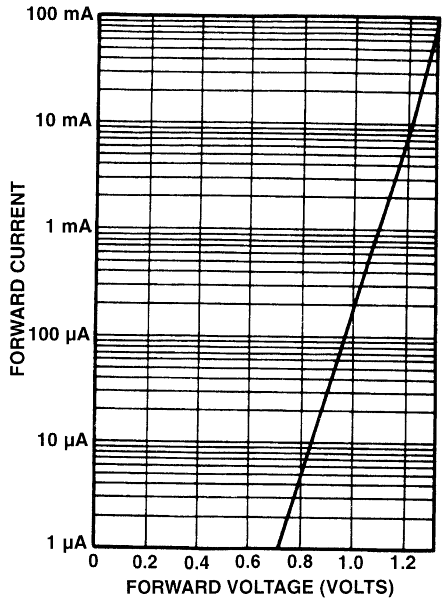
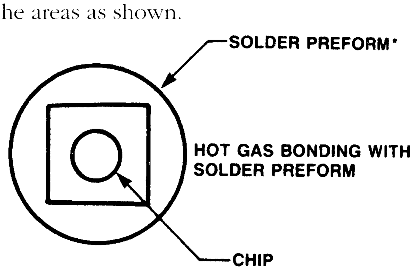
TYPICAL FORWARD CURRENT vs FORWARD VOLTAGE @ +25°C (MA4GP SERIES)



Die Bonding

GaAs is softer and more brittle than Silicon. The use of gold tin solder preform (80% Au 20% Sn) with an eutectic melting point of 280° C is recommended. A clean gold plated surface is required to insure good wetting. The preform should be large enough to insure that the die fits within the areas as shown.



*Recommended thickness of preform is 1 mil (.025 mm)

The heating stage should be set at 240° C. An 80% N_2, 20% H_2 forming gas is effective as the hot gas jet. The temperature at the tip should be approximately 400° C.

Ribbon and Wire Attachment

It is recommended that thermo-compression bonding be used. The bonding tip should be smaller than the anode contact. The exact conditions will depend on the tool types used. It is recommended that a half hard gold wire or strap be used. The wire or strap diameter should be smaller than the diameter of the anode contact. Typical bonding force should be between 20 and 25 grams and should not exceed 30 grams. When wire bonding a thermal compression wedge bonding is recommended using a heated stage and heated tip. The stage temperature should be approximately 240° C and the recommended temperature for the tip is 120° C. Ultrasonic scrubbing is not recommended.

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Axial Lead PIN Diodes

V 2.00

Features

- Glass Hermetic Sealed Packages
- Screenable to JAN-TXV and Military Specifications
- General Purpose Switch Diodes
- Low Distortion Attenuator Diodes
- Tape and Reel Packaging Available

Description

M/A-COM's series of glass, hermetically sealed axial lead PIN diodes are designed for switch and attenuator applications from HF through S-Band. The manufacturing methods employed to construct these devices are suitable to meet high volume production requirements.

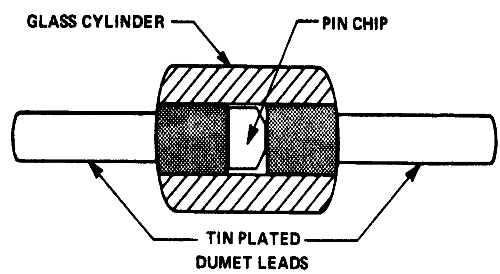
These PIN diodes are applicable for use in industrial and military applications. Their inherent ruggedness and reliability allows them to be screened to JAN-TX level and to meet other military standards.

Applications for M/A-COM's axial lead PIN diode products include electrically tuned digital filter circuits, AGC attenuators, antenna switches as well as general purpose PIN diode applications. These PIN diodes are particularly useful in distortion sensitive circuit environments.

This series of PIN diodes are available in three glass packages. The case style 54 is the most suitable to meet low total capacitance requirements for high isolation in series connected switches at VHF frequencies. The case style 139 and case style 146 are most suitable for moderate power applications requiring lower package inductance.

Case Style 54

Case Styles 139, 146*



* Enlarged to show detail.

Specifications @ T_A = +25°C
General Purpose PIN Diodes

Model Number	Case[1] Style	Minimum Reverse Voltage V_R (Volts)	Maximum Series Resistance R_s @ I_F (mA) (Ohms)	Maximum Total Capacitance C_T @ V_R (Volts) (pF)	Nominal Characteristics	
					Carrier Lifetime (μs)	I-Region Thickness (mils)
MA47120	54	35	0.5 @ 10	1.00 @ 20	0.3	0.4
MA4P270	139	35	0.5 @ 10	1.20 @ 20	0.3	0.4
MA4PH401	54	50	1.5 @ 10	0.30 @ 20	0.2	0.4
MA4PH151	139	100	0.6 @ 10	1.20 @ 50	1.0	0.8
1N5719	54	100	1.5 @ 50	0.25 @ 50	1.0	2.0
MA47047	54	200	3.0 @ 10	0.30 @ 50	1.0	2.0
MA47123	139	200	3.0 @ 10	0.50 @ 50	1.0	2.0
MA47266	146	200	0.6 @ 50	1.50 @ 50	3.0	3.0

Note: 1. See Appendix for full dimensions.

Low Distortion Attenuator PIN Diodes

Model Number	Case[1] Style	Minimum Reverse Voltage V_R (Volts)	Maximum Series Resistance R_s @ I_F - 10 mA (Ohms)	Maximum Total Capacitance C_T @ 50V (pF)	Nominal Characteristics			
					R_s		Carrier Lifetime (μs)	I-Region Thickness (mils)
					I_F = 1 mA (Ohms)	I_F = 10 μA (Ohms)		
MA47600	54	200	6	0.30	30	2,000	2	4
MA47110	139	200	6	0.50	30	2,000	2	4
MA47100	54	200	8	0.30	50	3,000	2.5	7
MA4P208	139	100	20	0.35	100	6,500	1.5	9
MA47111	146	200	25	0.80	75*	4,000	4.0	14

*75 Ohms @ I_F = 1.5 to 2.5 mA.

Note: 1. See Appendix for full dimensions.

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Maximum Ratings

Parameter	Absolute Maximum
Operating Temp.	- 65°C to +175°C
Storage Temp.	- 65°C to +175°C
Voltage	Voltage Rating
Power Dissipation	(derate linearly to zero at +175°C)
Case Style 54	250 mW (Free Air)
Case Style 139	500 mW (Free Air)
Case Style 146	1.0 W (Free Air) 1.5 W (0.5 inch total length to +25°C contact)

Environmental Capability (Per MIL-STD-750 and MIL-S-202)

	Method	Level
Storage Temperature	1031	See Maximum Ratings
Operating Temperature	—	See Maximum Ratings
Temperature Cycling	1051	5 cycles, - 65°C to 150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Screened Diodes

Typical 100% Preconditioning and Screening Program for TX Level Screening Per MIL-S-202

Inspections	Method	Conditioning
Internal Visual and/or X-ray	2072/2076	See note 1
High Temperature Life	1032	48 hours minimum at maximum storage temperature
Thermal Shock	1051	10 cycles
Constant Acceleration	2006	20,000 g's, Y1
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical	— —	See note 2
Burn-In	1038	See note 2

Notes:
1. Internal visual on TXV screening programs only. X-ray is optional for any screening plan.
2. Conditions and details of test depend on specific part number. Information available on request.

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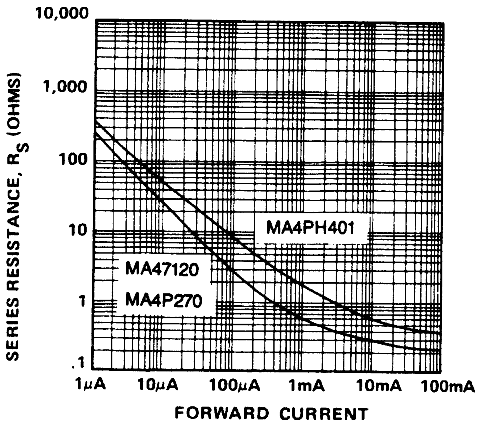
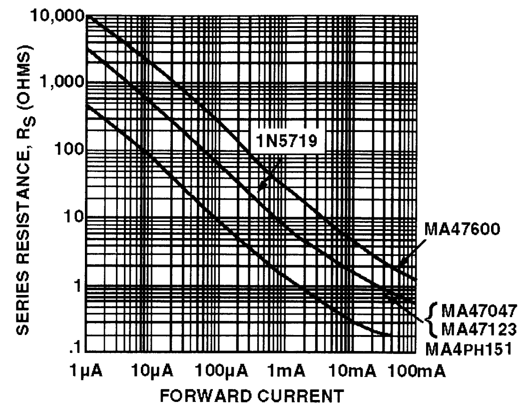
Typical Resistance Curves at 100 MHz

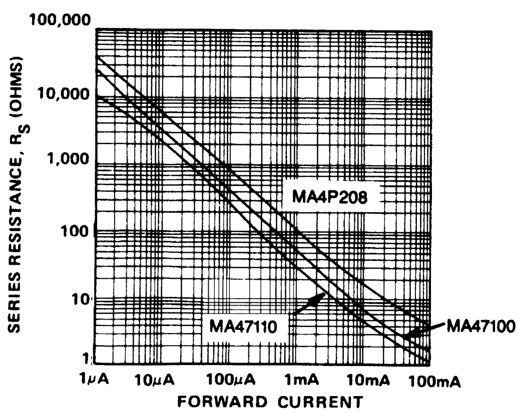
SERIES RESISTANCE vs FORWARD CURRENT FOR GENERAL PURPOSE PIN DIODES



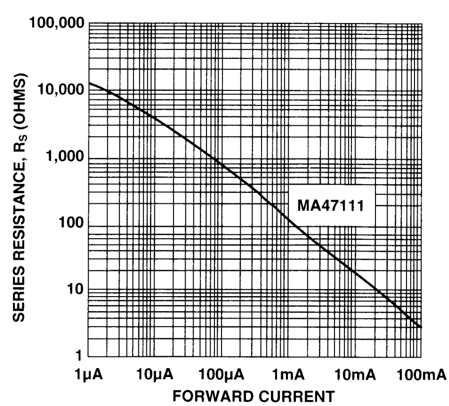
SERIES RESISTANCE vs FORWARD CURRENT FOR GENERAL PURPOSE PIN DIODES



SERIES RESISTANCE vs FORWARD CURRENT FOR LOW DISTORTION ATTENUATOR PIN DIODES



SERIES RESISTANCE vs FORWARD CURRENT FOR LOW DISTORTION ATTENUATOR PIN DIODES



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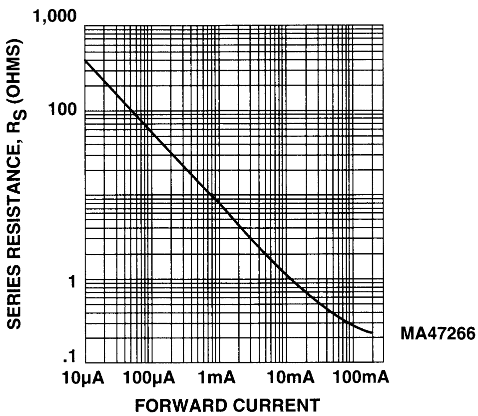
Typical Resistance Curves at 100 MHz

SERIES RESISTANCE vs FORWARD CURRENT FOR LARGE SIGNAL SWITCH PIN DIODES



Cross Reference

Many of M/A-COM's axial lead, hermetic surface mount (SMQ) and SOT-23 PIN diodes use similar chips and, therefore, have the same electrical characteristics except for package parasitics.

The following table lists the axial lead PIN diode by model number and the equivalent square surface mount (SMQ) PIN and SOT-23 PIN diodes.

Axial Lead PIN Diodes	SMQ PIN Diodes	SOT-23 Diodes
MA47100	—	MA4P278
MA47110	MA4PH238	MA4P277
MA47111	MA4PH239	—
MA47123	MA4PH236	MA4P274
MA47266	MA4PH237	—
MA4P270	MA4PH235	MA4P275
MA4PH151	—	MA4P282
MA4PH401	—	MA4P789

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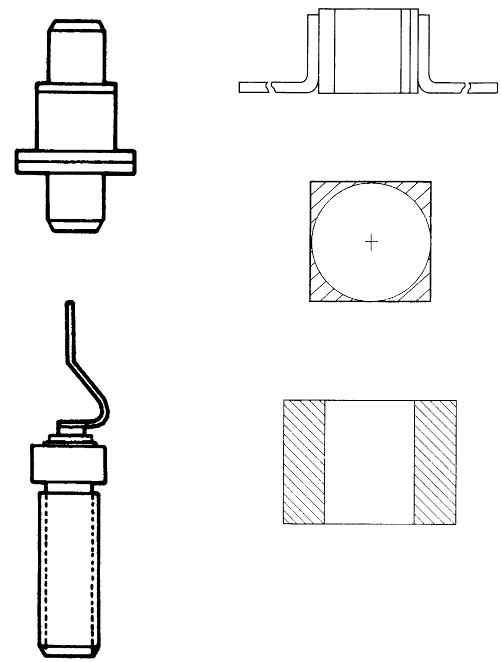
Packaged PIN Diodes

MA4P100 thru 600 Series

V 2.00

Features

- High Power PIN Diodes
- Fast Speed PIN Diodes
- Voltage Ratings to 1500 Volts
- Long Carrier Lifetime Designs
- Wide Variety of Hermetic Packages
- High Reliability for Space/Military Applications



Description

M/A-COM's product line of packaged PIN diodes represents a comprehensive combination of PIN diode electrical characteristics and package outlines. This union of semiconductor and packaging technology gives considerable design flexibility to the PIN diode circuit designer.

The fast switching speed PIN diodes utilize thin I-region silicon dioxide passivated chips that incorporate careful control of semiconductor processing. These diodes achieve consistent performance in control circuit applications. The packaged CERMACHIP PIN diodes employ M/A-COM's unique hard glass passivated, hermetically sealed PIN diode chip. The packaged CERMACHIP PIN diodes are designed for use in high power and high RF voltage applications. The PIN diode chips are bonded into hermetically sealed ceramic or glass packages that are designed for high volume, close tolerance utilization. Packages are available which are suitable for mounting in a variety of microwave and RF circuit media.

The packaged silicon PIN diode series has high inherent reliability and is capable of meeting stringent environmental tests. These diodes may be ordered with testing to selected reliability levels.

Ordering Information

Packaged PIN diode specifications are listed in the appropriate tables. The standard package style is indicated as part of the model number; i.e., MA4P506-30. Alternative package styles for the diodes are also indicated. To order, indicate the desired model number by indicating the chip model number and desired package style; i.e., MA4P506-258. Note that the specification tables lists total diode capacitance in the standard case style only. The total capacitance for the diode in an alternative package are computed from the difference in package capacitance. Parts are available only in the case styles as indicated in each product table.

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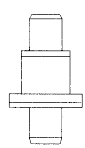
50 to 250 Volt, Fast Switching PIN Diodes Specifications $T_A = +25°C$

Model[1] Number	Mimimum[2] Reverse Voltage V_R (Volts)	Maximum[3] Capacitance C_T @ 10V (pF)	Maximum[4] R_S @ 10 mA 500 MHz (ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics		
					Carrier[5] Lifetime (ns)	T_{rr}[6] (ns)	I-Region Width (microns)
MA4P102-30	50	0.30	2.0	60	20	3	7
MA4P202-30	100	0.25	2.5	60	60	5	12
MA4P203-30	100	0.35	1.5	30	100	20	12
MA4P303-30	200	0.35	1.5	30	200	60	20
MA4P404-30	250	0.40*	0.6**	20	1000	100	30

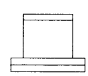
* At 50 Volts
** At 50mA, 100 MHz

The standard case style is 30. Also available in the following packages:
31, 32, 36, 94, 111, 120, 186, 255, 276, 1056 and 1088. See Appendix for full dimensions and nominal parasitic values.

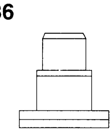
30



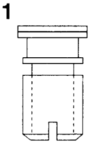
31, 32, 94



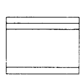
36



111

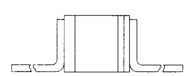


120, 255

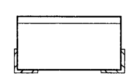


186

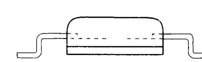
276



1056



1088



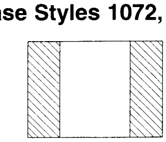
SMQ General Purpose Switching Diodes Specifications $T_A = +25°C$

Model Number	Case* Style	Minimum[2] Reverse Voltage V_R (Volts)	Maximum Capacitance C_T @ 50V (pF)	Maximum[3] Resistance I_F @ 10 mA (Ohms)	Typical Current for $R_S = 75\Omega$ (mA)	Typical[5] Carrier Lifetime (µs)	Typical I-Region Thickness (mils)	Power Dissipation Rating (watts)
MA4PH235	1072	35	1.2	0.5	—	0.3	0.4	1.0
MA4PH236	1072	200	0.5	3.0	—	1.5	2.0	1.0
MA4PH237	1079	200	1.5	0.6	—	3.0	3.0	2.0
MA4PH238	1072	200	0.5	6.0	0.3 - 0.6	2.0	4.0	1.0
MA4PH239	1079	200	0.8	25.0	1.2 - 2.4	6.0	14.0	2.0

*Available only in case styles indicated. See Appendix for full dimensions.

Notes:
1. The diodes are available in chip form for integrated circuits.
2. The maximum reverse current is 10 µA at voltage rating.
3. Capacitance is specified at 1 MHz.
4. Resistance is specified at 100 MHz unless otherwise indicated.
5. Nominal carrier lifetime is specified at 10 mA.

Case Styles 1072, 1079



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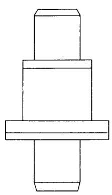
500 Volt CERMACHIP PIN Diodes
Specifications T_A = +25°C

Model[1] Number	Minimum[2] Reverse Voltage V_R (Volts)	Maximum[3] Capacitance C_T @ 100V (pF)	Maximum[4] R_S @ 100 mA (Ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics	
					Carrier[5] Lifetime (us)	I-Region Width (mils)
MA4P504-30	500	0.40	0.60	20	1.0	2
MA4P505-30	500	0.55	0.45	15	2.0	2
MA4P506-30	500	0.90	0.30	10	3.0	2

The standard case style is 30. Also available in the following packages:
31, 32, 36, 111, 255, 258 (isolated Heatsink), 1056, 1088. See Appendix for full dimensions and nominal parasitic values.

30



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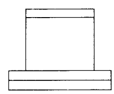

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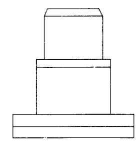

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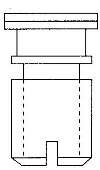
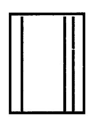
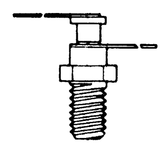


255



258

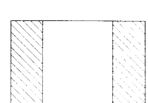


SMQ CERMACHIP High Voltage PIN Diodes
Specifications T_A = +25°C

Model Number	Case* Style	Minimum[2] Reverse Voltage V_R (Volts)	Maximum[3] Capacitance C_T @ V_R = 100 V (pF)	Maximum[4] R_S @ 100 mA (Ohms)	Typical[5] Carrier Lifetime (μs)	Typical I-Region Thickness (mils)	Power Dissipation Rating (Watts)
MA4P504-1072	1072	500	0.5	0.6	1.0	2.0	1.5
MA4P505-1072	1072	500	0.65	0.45	2.0	2.0	1.5
MA4P506-1072	1072	500	1.0	0.3	3.0	2.0	1.5

*See Appendix for full dimensions.

1072



Notes:
1. The diodes are available in chip form for integrated circuits.
2. The maximum reverse current is 10 μA at voltage rating.
3. Capacitance is specified at 1 MHz.
4. Resistance is specified at 100 MHz unless otherwise indicated.
5. Nominal carrier lifetime is specified at 10 mA.

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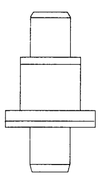
1000 Volt CERMACHIP PIN Diodes
Specifications T_A = +25°C

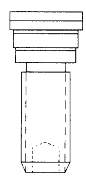
Model[1] Number	Minimum[2] Reverse Voltage V_R (Volts)	Maximum[3] Capacitance C_T @ 100V (pF)	Maximum[4] R_S @ Forward Current (Ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics	
					Carrier[5] Lifetime (µs)	I-Region Width (mils)
MA4P604-30	1000	0.50	1.00 @ 100	20	3.0	4
MA4P606-30	1000	0.80	0.70 @ 100	10	4.0	4
MA4P607	1000	2.00	0.40 @ 100	7	5.0	4
MA4P608-43	1000	3.20	0.35 @ 150	5	5.0	4

The standard case styles are indicated as a suffix to the model number. See Appendix for full dimensions.
The MA4P604 and MA4P606 are available only in case style 30.
The MA4P607 is available only in case styles 43 and 296. Add case style suffix to model number.
The MA4P608 is available only in case style 43.

30, 296



43



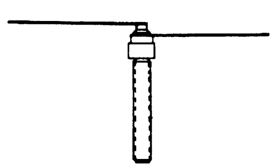
1500 Volt CERMACHIP PIN Diode
Specifications T_A = +25°C

Model Number	Minimum[2] Reverse Voltage V_R (Volts)	Maximum[3] Capacitance C_T @ 100V (pF)	Maximum[4] R_S @ Forward Current (Ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics	
					Carrier[5] Lifetime (µS)	I-Region Width (mils)
MA4P709-150	1500	3.3	0.25 @ 200	2	10	7

The standard case style is 150. Also available in 985 (Isolated heatsink). See Appendix for full dimensions.

150

985



Notes:
1. The diodes are available in chip form for integrated circuits.
2. The maximum reverse current is 10 µA at voltage rating.
3. Capacitance is specified at 1 MHz.
4. Resistance is specified at 100 MHz unless otherwise indicated.
5. Nominal carrier lifetime is specified at 10 mA.

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Maximum Ratings

Parameter	Absolution Max.
Voltage	Voltage Rating
Operating Temperature	- 65°C to +175°C
Storage Temperature	- 65°C to +200°C
Operating & Storage Temp. Case Sty. 1088 (Plastic)	- 65°C to +125°C

Power Dissipation

Cathode Heat Sinked Packages (Case Styles 30, 31, 32, 36, 94, 111, 120, 150, 258, 985, 1072, 1079)	$P_{diss} = \frac{T_{(max. operating)} - 25°C}{\text{Thermal Resistance}}$
Leaded Packages @ +25°C (Case Styles 186, 276, 1088)	P_{diss} = 250mW
Surface Mount Package (Case Style 1056)	P_{diss} = 300mW

Environmental Ratings
Per MIL-STD 750
The following table is recommended for Group B and C testing for TX, TXV level screening.

	Method	Level
Storage Temperature	1031	See maximum ratings
Operating Temperature	—	See maximum ratings
Temperature Cycling	1051	5 cycles -65° to + 150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Maximum Soldering Temperature

Case Style 150, 186, 258, 985, 188: 200°C maximum for 5 seconds.

Case Style 120, 255, 276: 200°C maximum for 5 seconds — cathode only.

Case Style 30, 31, 32, 36, 43, 94, 111, 296: 225°C maximum for 5 seconds.

Case Style 1088: 150°C maximum for 5 seconds, 1mm from the case.

Screened Diodes (MIL-STD 750)

Suggested 100% preconditioning and screening program for TX level and TXV level screening.

Inspection	Method	Condition
Internal Visual and/or Xray	2072/2076	See note
High Temp. Storage	1032	48 hours minimum @ max. storage temp.
Thermal Shock	1051	10 Cycles
Constant Acceleration	2006	20,000 g's, Y1
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical	—	See note
Burn-In	1038	See note

Note:
Conditions and details of test depend on specific model number. Information available upon request. The case styles 1056 and 1088 are not military (MIL-STD-750 rated packages).

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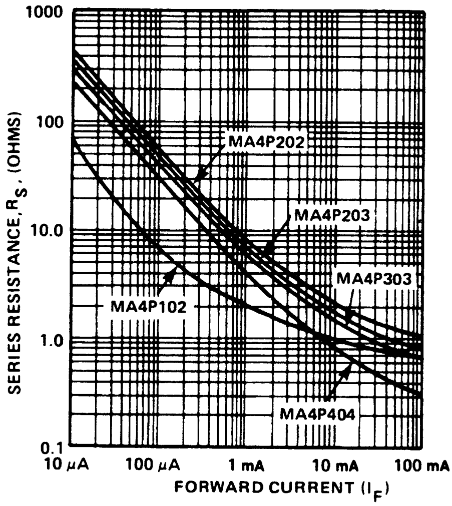
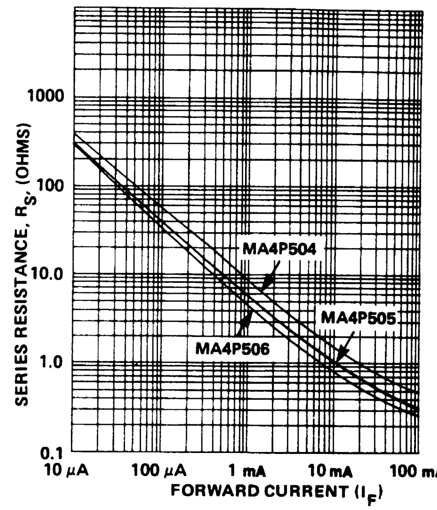
Typical Resistance Curves

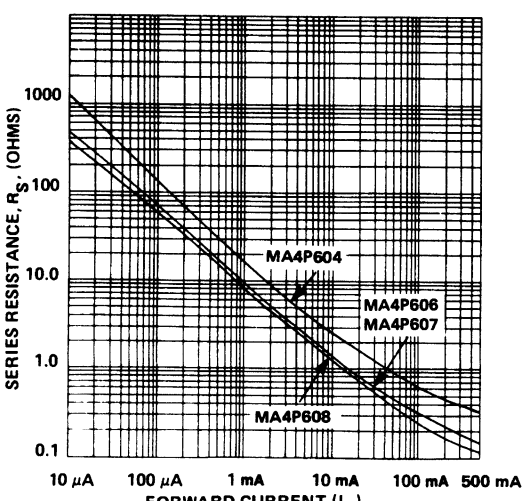
FORWARD CURRENT vs SERIES RESISTANCE
(MA4P202, MA4P203, MA4P303, MA4P404 AND MA4P102)



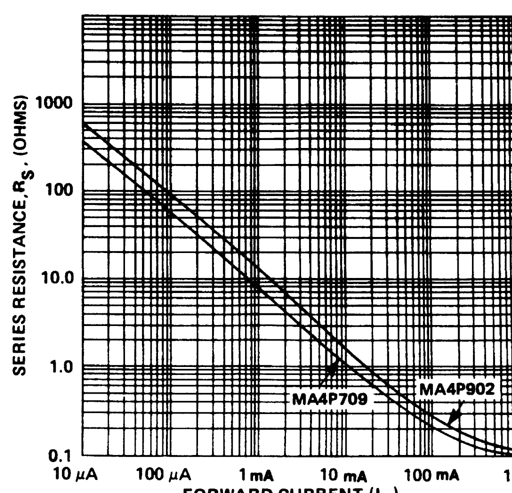
FORWARD CURRENT vs SERIES RESISTANCE
(MA4P504, MA4P505, MA4P506)



FORWARD CURRENT vs SERIES RESISTANCE
(MA4P604, MA4P606, MA4P607, MA4P608)



FORWARD CURRENT vs SERIES RESISTANCE
(MA4P709, MA4P902)



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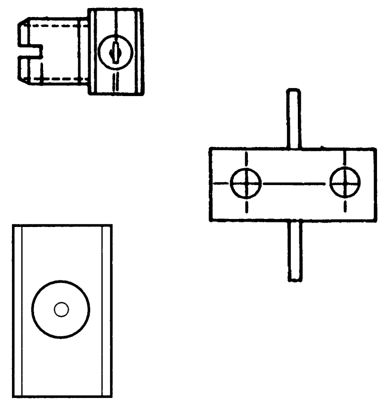
Stripline PIN Diode Switch Modules

MA47200 Series

V 2.00

Features

- Broadband 50 Ohm Designs Through X Band
- Circuit Characterized
- High Power Capacity
- Voltage Ratings to 1000 Volts
- Fast Switching Speed to 10 Nanoseconds
- Hermetically Sealed Packages



Description

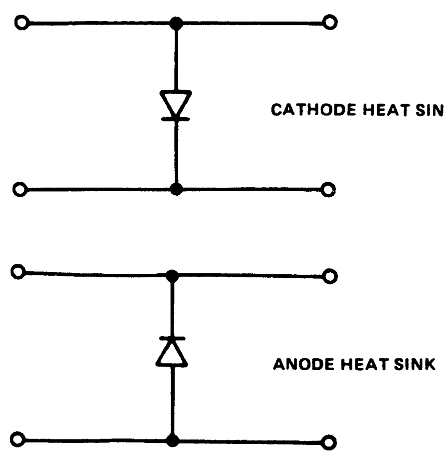
This series of M/A-COM semiconductor products is hermetically sealed stripline package PIN diodes designed to drop into a 50 ohm stripline circuit without external matching. The MA47200 series can be used as SPST reflective switches and are useful in applications from VHF through X band. Several models are provided with different power and switching speed capability.

This series of stripline switch modules consists of shunt-mounted passivated PIN diodes in hermetic stripline packages. These modules are optimized for 50 ohm microstrip and stripline circuits. The MA47200 series modules may be operated as a switch by applying the appropriate forward and reverse DC excitation. They can also be used as attenuators by varying the forward DC current.

Applications

The MA47200 series of broadband shunt-mounted PIN diodes features a shunt-mounted PIN chip with an appropriate series inductance to produce a matched low-pass filter structure at zero or reverse bias. By applying +10 mA to +100 mA to the center conductor the diode's impedance changes to a low-impedance inductive short causing the diode to reflect RF power (+10 mA to +100 mA) must be supplied to the center conductor of the MA47200 to provide high isolation.

Internal Wiring Diagram



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Specifications @ T_A = +25°C

Model[1] Number	Case[4] Style	Test Frequency (GHz)	Maximum[2] insertion Loss (dB) @ V_R	Minimum Isolation (dB) @ I_F	Minimum[3] Reverse Voltage V_R (Volts)	Maximum Thermal Resistance (C/W°)	Nominal Switching Speed (ns)	
							RF Off to RF On	RF On to RF Off
MA47208	114	1.0	0.25 @ 20V	30 @ 25 mA	1000	10	300	150
MA47200	114	1.0	0.25 @ 20V	30 @ 25 mA	500	10	200	60
MA47201	115	1.0	0.25 @ 20V	30 @ 25 mA	500	10	200	60
MA47203	115	6.0	0.50 @ 20V	25 @ 25 mA	500	15	150	30
MA47223	144	4-8**	0.50 @ 0V	20 @ 100 mA	500	20	150	30
MA47222	144	8.0	0.50 @ 0V	20 @ 100 mA	150	20	100	30
MA47220*	144	10.0	0.50 @ 0V	20 @ - 100 mA	150	30	100	30
MA47221	144	4-8**	1.00 @ 0V	20 @ 20 mA	70	20	10	10

* Anode heat sink
** Swept frequency measurement

Notes:
1. All models have a cathode heatsink, except MA47220.
2. Maximum SWR is 1.5 at specified insertion loss condition.
3. Maximum reverse current is 10 microamperes at specified voltage rating.
4. These parts are available only in the indicated case style.

Environmental Performance

The MA47200 series of diodes is capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500 MIL-STD-202 and MIL-STD-750 which specify mechanical electrical thermal and other environmental test common to semiconductor products.

Environmental Ratings (PER MIL-STD-750)

	Method	Level
Storage Temperature	1031	See maximum ratings
Operating Temperature	—	See maximum ratings
Temperature Cycling	1051	5 cycles -65°C to +150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Maximum Ratings

Parameter	Absolute Maximum
Storage Temp.	-65°C to +175°C
Operating Temp.	-65°C to +150°C
Voltage	Voltage Rating
Power Dissipation	$P_{diss} = \frac{150°C - T\ ambient}{Thermal\ Resistance}$

Specifications Subject to Change Without Notice.

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Screened Diodes

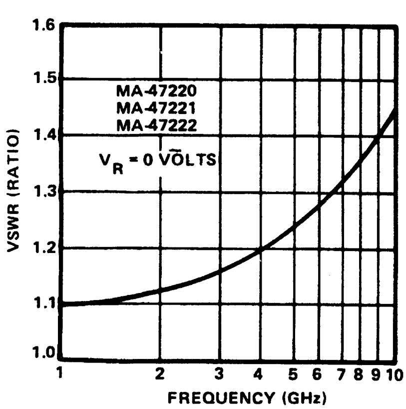
Table 1. Typical 100% Preconditioning and Screening Program for TX Level Screening

Inspections	Method	Condition
Internal Visual and/or X-ray	2072/2076	See note 1
High Temperature Life	1032	48 hours minimum at maximum storage temperature
Thermal Shock	1051	10 cycles
Constant Acceleration	2006	20 000 g s Y1
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical	——	See note 2
Burn-In	1038	See note 2

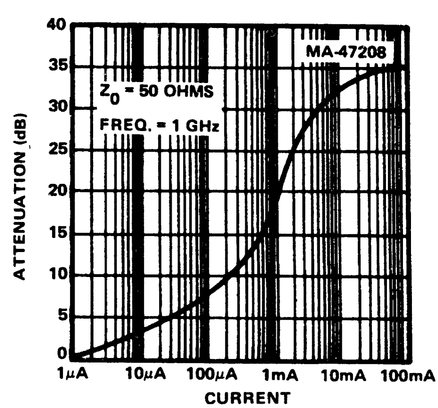
Notes:
1. Internal visual on TXV screening programs only. X-ray is optional for any screening plan.
2. Conditions and details of test depend on specific part number. Information available on request.

Typical Performance Curves

VSWR vs FREQUENCY



ATTENUATION vs FORWARD CURRENT



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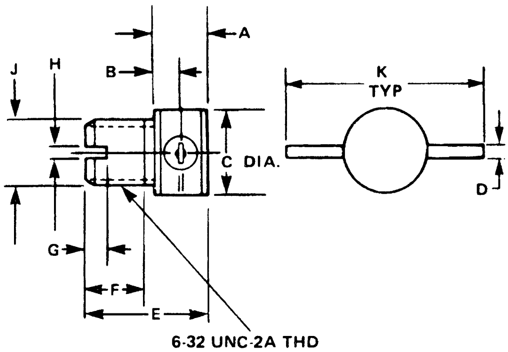
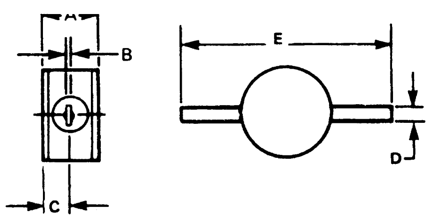
Case Style 114



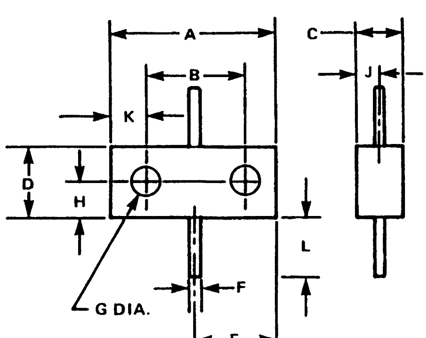
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.120	0.140	3.04	3.55
B	0.058	0.072	1.47	1.82
C	—	0.255	—	6.47
D	0.011	0.013	0.76	1.52
E	0.380	0.400	9.65	10.16
F	0.205	—	5.20	—
G	—	—	—	—
H	—	—	—	—
J	0.1312	0.1372	3.33	3.48
K	—	—	—	—

Case Style 115



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.118	0.140	3.00	3.55
B	0.002	0.006	0.051	0.152
C	0.058	0.072	1.47	1.82
D	0.011	0.013	1.76	1.52
E	—	—	—	—

Case Style 144



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.405	0.415	10.16	10.67
B	0.240	0.260	6.10	6.60
C	0.120	0.130	3.05	3.30
D	0.155	0.165	3.94	4.19
E	0.195	0.215	4.95	5.46
F	0.015	0.035	0.38	0.89
G	0.092	0.100	2.34	2.54
H	0.075	0.085	1.91	2.16
J	0.056	0.066	1.42	1.68
K	0.075	0.085	1.91	2.16
L	0.120	—	3.05	—

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RF Multi-throw PIN Diode Switch Modules

MA8334 Series

V 2.00

Features

- SPDT and SP3T Designs
- Low Distortion
- High Reliability
- Usable from 10 MHz to 1 GHz
- Low Insertion Loss
- High Isolation

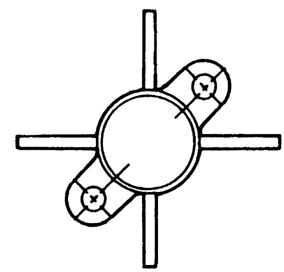
Description

M/A-COM's MA8334 series Multi-throw Switch Modules are SPDT and SP3T switches designed for use from 20 MHz to 1000 MHz. They are rated to handle 100 watts CW RF power.

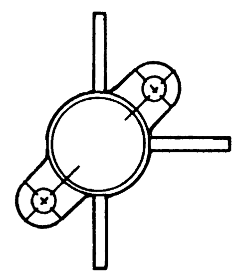
These switch modules are constructed using advanced hybrid technology and utilize PIN diode chips distinguished by their low loss and high reliability. These switch modules employ M/A-COM's high voltage CERMACHIP PIN diodes.

Applications of the MA8334 switch modules include 100 watt TR antenna and diversity switches. The semiconductor elements have been selected for low distortion performance.

Case Styles



844-004



844-001

Specifications @ T_A = +25°C

Model Number	Case Style	Maximum[3] CW Input Power (Watts)	Switch Type	Frequency Range (MHz)	Minimum[1,2] Isolation (dB)	Maximum[1,2] Insertion Loss (dB)	Diode Voltage Rating (Volts)
MA8334-001	844-001	100	SPDT	10-1000	24	0.35	900
MA8334-004	844-004	100	SP3T	10-1000	24	0.35	900

Notes:
1. For the MA8334-001 and the MA8334-004 the isolation and insertion loss at small signals is specified at 450 MHz with the "ON" branch forward biased at 50 mA and the "OFF" branch at zero bias. For "high power" reverse bias will be required on the off arm.
2. Maximum SWR for all switches is 1.35 at specified frequency.
3. Nominal thermal resistance is 20° C/W, per diode.

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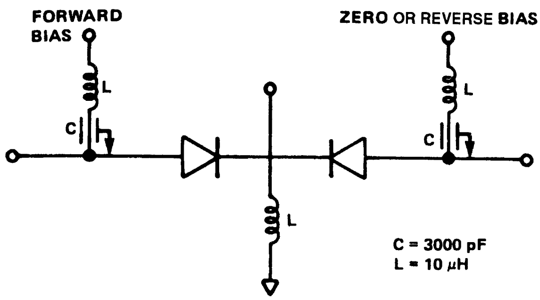
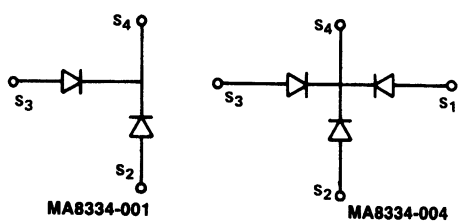
Applications Circuits

SUGGESTED BIAS CIRCUIT FOR SPDT



Internal Wiring Diagrams

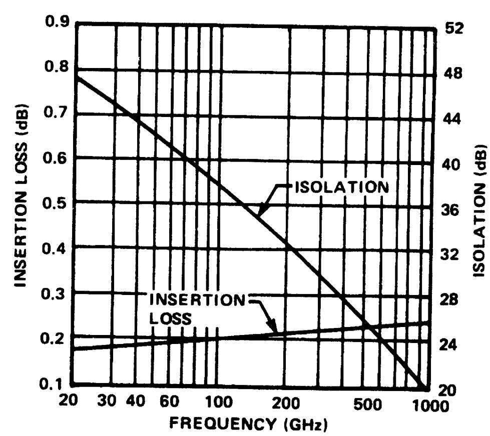


Maximum Ratings

Parameters	Absolute Maximum
Storage Temperature	-65°C to +125°C
Operating Temperature	-65°C to +125°C
Power Dissipation	5 watts derated to 0 watts at max. operating temperature
Voltage	Voltage Rating

Typical Performance Curves

INSERTION LOSS AND ISOLATION vs FREQUENCY



Hermetic Surface Mount PIN Diodes

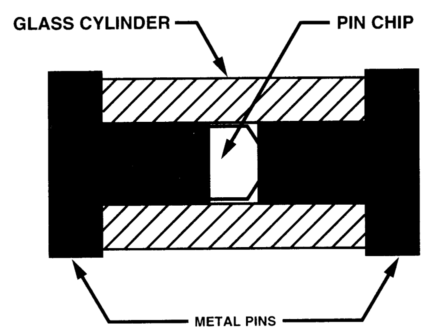
V 2.00

Features

- Power Dissipation to 1 Watt
- Low Loss Switching Diodes
- Low Distortion Attentuator Diodes

Description

This series of PIN diodes is encapsulated in metal electrode faced (MELF) bond packages resulting in hermetically sealed devices suitable for surface mount applications. The metallic contact surfaces are tin plated for good solder wetting and are designed for adhesion to circuit boards using wave solder or solder reflow techniques. MELF PIN diodes contain no small ribbons or whisker wires, resulting in lower parasitic inductance and capacitance. M/A-COM's MELF PIN diodes are designed for switch and attenuator circuits from HF through S-Band. A wide range of PIN chips are available including diodes with 1 watt power rating, long carrier lifetime, and low resistance for high power antenna and filter switches (MA47059). Thick I-region PIN diodes suitable for low distortion VHF attenuators are also offered (MA4PH601).



Maximum Ratings

Parameter	Absolute Maximum
Voltage	Voltage Rating
Operating Temp.	-65˚C to +150˚C
Storage Temp.	- 65°C to +175°C
Power Dissipation at 25˚ ambient	(derate linearly to zero at +175°C) Case 983 = 500 mW Case 984 = 1.0 mW
Maximum Soldering Temperature	275˚C for 10 seconds

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V 2.00

General Purpose and Switch PIN Diodes Specifications @ T_A = +25°C

Model Number	Case Style	Minimum[1] Reverse Voltage V_R (Volts)	Maximum R_S @ 10 mA 100 MHz (Ohms)	Maximum[2] Total Capacitance @ Volts (pF)	Nominal Characteristics	
					Carrier[3] Lifetime (μsec)	I-Region Thickness (mils)
MA47058	983	35	0.5	1.2 @ 20V	0.3	0.4
MA4PH101	983	50	1.5	0.5 @ 20V	0.3	0.4
MA4PH152	983	100	0.6	1.4 @ 20V	1.0	0.8
MA47055	983	200	3.0	0.5 @ 20V	1.5	2.0
MA47059	984	200	0.6 @ +50mA	1.5 @ 20V	3.0	3.0

Low Distortion Attenuator PIN Diodes Specifications @ T_A = +25°C

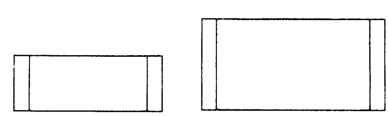
Model Number	Case Style	Minimum[1] Reverse Voltage V_R (Volts)	Maximum R_S @ 10 mA 100 MHz (Ohms)	Maximum[2] Total Capacitance @ 50 Volts (pF)	Nominal Characteristics		
					I_F for R_S = 75Ω (mA)	Carrier[3] Lifetime (μsec)	I-Region Thickness (mils)
MA47057	983	200	6.0	0.5 @ 50V	.3–.6	2.0	4.0
MA47056	983	200	8.0	0.5 @ 50V	.5–1.0	3.0	7.0
MA4PH601	983	200	25.0	0.5 @ 50V	1.2–2.4	6.0	14.0

Notes:
1. The reverse current will not exceed 10 microamperes at the minimum voltage rating.
2. Maximum total capacitance is measured at 1 MHz.
3. Nominal minority lifetime is measured at I_F = 10 mA.

Screened Diodes (MIL-STD-750)

Suggested 100% Preconditioning and Screening Program for TX Level Screening

Inspection	Method	Condition
Internal Visual and/or X-ray	2072/2076	See Note
High Temperature Life	1032	48 hours minimum at maximum storage temp.
Thermal Shock	1051	10 cycles
Constant Acceleration	2006	20 000 G1 Y1
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical	—	See Note
Burn-In	1038	See Note
Stability Verification	—	See Note



983 984

See appendix for full dimensions.

NOTE:
Conditions and details of test depend on specific model number. Information available on request.

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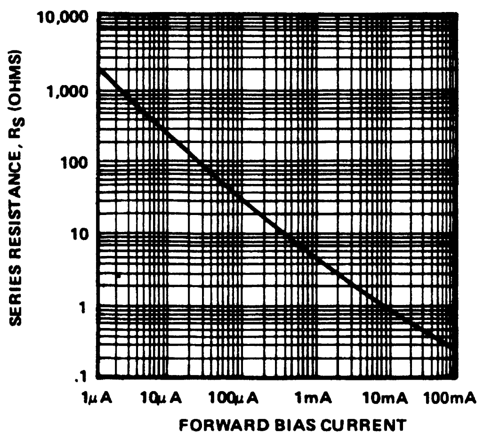
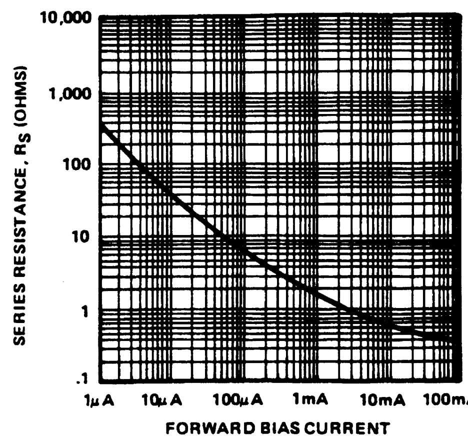
Typical Resistance Curves at 100 MHz

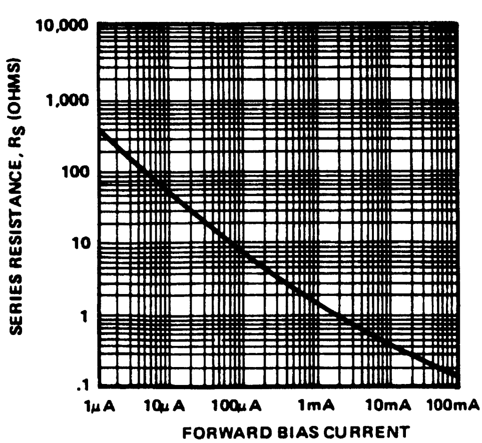
MA47059 SERIES
RESISTANCE vs FORWARD CURRENT



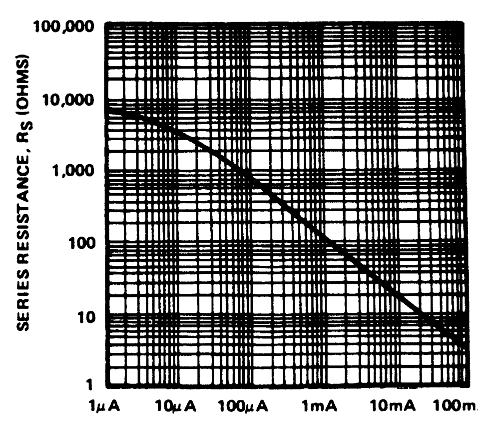
MA4PH101 SERIES
RESISTANCE vs FORWARD CURRENT



MA4PH152 SERIES
RESISTANCE vs FORWARD CURRENT



MA4PH601 SERIES
RESISTANCE vs FORWARD CURRENT



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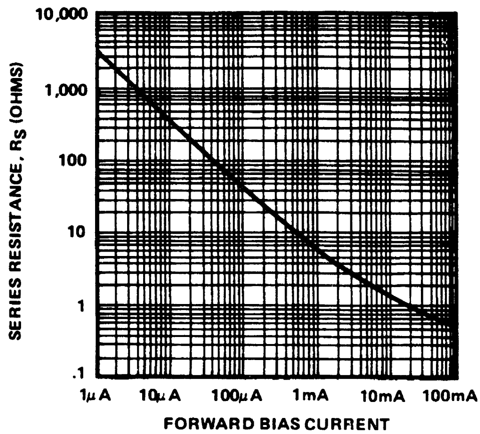
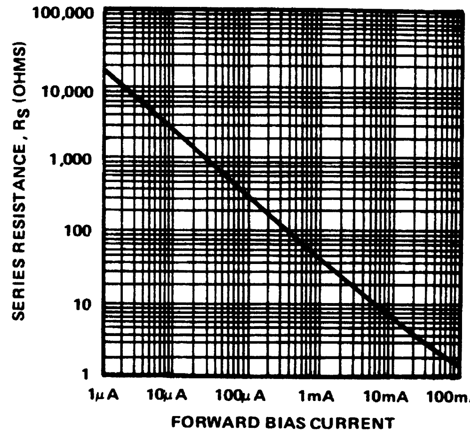
Typical Resistance Curves at 100 MHz

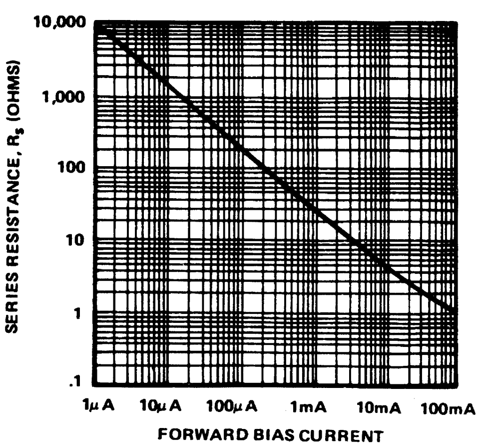
MA47055 SERIES
RESISTANCE vs FORWARD CURRENT



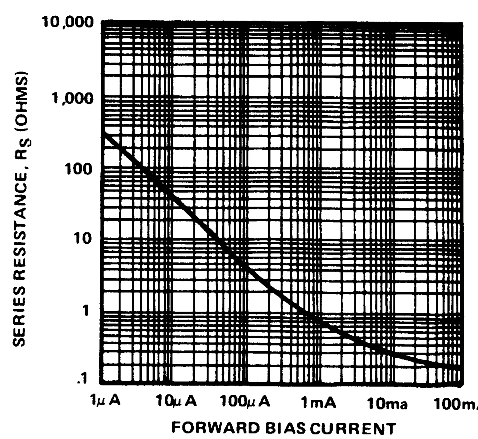
MA47056 SERIES
RESISTANCE vs FORWARD CURRENT



MA47057 SERIES
RESISTANCE vs FORWARD CURRENT



MA47058 SERIES
RESISTANCE vs FORWARD CURRENT



The following table is recommended for Group B and C testing for TX level screening.

ENVIRONMENTAL RATINGS PER MIL-STD 750

	Method	Level
Storage Temperature	1031	See maximum ratings
Operating Temperature	—	See maximum ratings
Temperature Cycling	1051	5 Cycles -65°C to +150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Cross Reference

Many of M/A-COM's MELF, SMQ and SOT-23 diodes use similar chips and therefore have the same electrical characteristics except for package parasitics. The following table lists the MELF PIN diode by model number and SOT-23 diodes.

MELF Surface Mount Diodes	SMQ Square Surface Mount Diodes	SOT-23 Diodes
MA47055	MA4PH236	MA4P274
MA47056	—	MA4P278
MA47057	MA4PH238	MA4P277
MA47058	MA4PH235	MA4P275
MA47059	MA4PH237	—
MA4PH101	—	MA4P789
MA4PH152	—	MA4P282
MA4PH601	MA4PH239	—

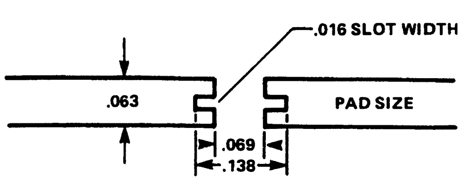
M/A-COM recommends, where applicable, that the SMQ equivalent be chosen.

Mounting Information

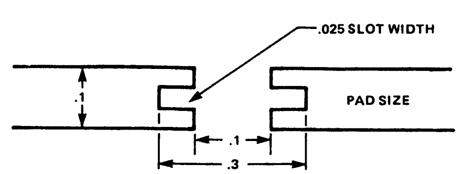
Mounting MELF PIN Diodes to Circuit Boards Wave soldering or reflow soldering techniques may be used to mount M/ACOM's MELF PIN diodes to circuit boards. The MELF construction, due to its size, cylindrical shape and mass has shown less tendency to lift up on end (tombstone) or skew than lighter, four sided surface mount components. Wave soldering requires that the MELF devices be mechanically affixed to the circuit board with an epoxy adhesive prior to inverting the board. The subsequent solder wave will result in electrical adhesion of the devices to the circuit board. Reflow soldering requires the MELF diode to be temporarily secured to the circuit board by the solder paste. It is very important to apply equal amounts of solder paste to each bonding pad to prevent diode movement, which would result from unequal surface tension on the contacts of the diode. The solder reflow operation is then performed in a belt furnace or by vapor phase. The adhesion provided by solder paste is usually adequate to hold the MELF package in piace for solder reflow. If additional resistance to rolling or skewing is desired, the pad patterns shown in the illustrations below are recommended.

Recommended Pad Drawings

PAD FOR CASE STYLE 983



PAD FOR CASE STYLE 984



Dimensions in Inches

an AMP company

Limiter PIN Diodes

MA4L Series

V 2.00

Features

- Low Turn On Power
- High Peak Power Diodes
- Chips and Packaged Diodes

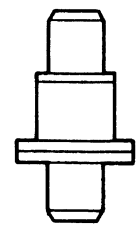
Description

M/A-COM produces a series of PIN diodes specifically designed for limiter applications. Each of these diodes is designed for low insertion loss at zero bias, rapid turn on and high isolation. This series of diodes is available as passivated chips and in hermetic ceramic packages such as M/A-COM's style 30.

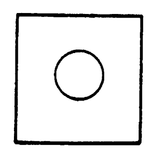
Applications

The MA4L series of PIN limiter diodes is designed for use as passive limiters to protect sensitive receiver components such as low noise amplifiers mixers and detectors.

Case Styles



30



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Electrical Specifications @ T_A = +25°C[1]

Model[1] Number	Minimum[2] Reverse Voltage V_R (Volts)	Maximum[3] Cj @ 0 Volts (pF)	Maximum[4] Rs @ 10 mA (Ohms)	Nominal Characteristics			
				Carrier Lifetime @ 10 mA (ns)	I-Region Width (μm)	Contact Diameter (mils)	Thermal[5] Resistance (°C/W)
MA4L011-134	20	0.20	2.0	7	2	1.5	70
MA4L021-134	30	0.20	1.5	10	3	2.0	60
MA4L022-134	30	0.15	2.0	10	3	2.0	60
MA4L031-134	40	0.20	1.5	15	5	1.5	40
MA4L032-134	40	0.15	2.0	15	5	1.5	40
MA4L101-134	100	0.15	2.0	90	10	2.5	30
MA4L301-134	200	0.20	2.0	200	20	3.0	30
MA4L302-134	200	0.25	1.5	250	20	5.0	30
MA4L401-132	250	0.30	1.2	800	25	4.0	25

Notes:
1. The passivated chips, case style 134, (15X15 mils) or case style 132 (20X20 mils) are the standard case style for the MA4L series. The devices are also available in case style 30 (i.e., model number MA4L011-30) and other ceramic packages. Consult the factory.
2. Breakdown voltage is specified at 10 microamperes reverse current.
3. Capacitance is specified at 1 MHz. For diodes in case style 30, add 0.20 pF.
4. Resistance is specified at 500 MHz.
5. Nominal thermal resistance is derived from diode geometry and is equivalent to case style 30 diode mounted to a heat sink.

Nominal Limiting Characteristics[6]

Model Number	Incident[6] Peak Power 1 dB Limiting @ 6 GHz (dBm)	Incident[6] Peak Power For 10 dB Limiting 6 GHz (dBm)	Incident[6] Peak Power For 20 dB Limiting @ 6 GHz (dBm)	Recovery[8] Time (ns)	Maximum[7] Incident Peak Power (Watts)	Maximum CW Input Power (Watts)
MA4L011-134	7	25	40	10	100	2
MA4L021-134	10	30	43	10	400	4
MA4L022-134	10	30	43	10	200	3
MA4L031-134	16	36	49	20	800	5
MA4L032-134	16	36	49	20	600	3
MA4L101-134	19	42	52	10	900	4
MA4L301-134	23	46	59	50	1000	5
MA4L302-134	23	46	59	50	1500	7
MA4L401-132	29	52	65	100	2000	10

Notes:
6. Nominal microwave performance is the expected performance of the MA4L series shunt connected in a 6 GHz, 50 ohm transmission line.
7. The nominal maximum incident peak power is the suggested maximum safe operation peak power for a 1 microsecond pulse width and at 1% duty cycle.
8. The nominal recovery time is from isolation to within 3 dB of the insertion loss state.

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Maximum Ratings

Parameter	Absolute Maximum
Temperature Range **Storage** **Operating**	 -65°C to +200°C -65°C to +125°C
Power Dissipation	$Pdiss = \frac{175°C - T\ ambient}{Thermal\ Resistance}$

Environmental Performance

The MA4L series of diodes is capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500 MIL-STD-202 and MIL-STD-750 which specify mechanical electrical thermal and other environmental tests common to semiconductor products.

Environmental Ratings (Packaged Diodes) (PER MIL-STD-750)

	Method	Level
Storage Temperature	1031	See maximum ratings
Operating Temperature	—	See maximum ratings
Temperature Cycling	1051	5 cycles -65°C to 150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Screened Diodes (Packaged Diodes)

Table 1. Typical 100% Preconditioning and Screening Program for TX Level Screening

Inspection	Method	Condition
Internal Visual and/or X-ray	2072/2076	See Note 1
High Temperature Life	1032	48 hours minimum at maximum storage temperature
Thermal Shock	1051	10 cycles
Constant Acceleration	2006	20 000 g's Y1
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical	—	See Note 2
Burn-In	1038	See Note 2

Notes:
1. Internal visual on TXV screening programs only. X-ray is optional for any screening plan.
2. Conditions and details of test depend on specific part number. Information available upon request.

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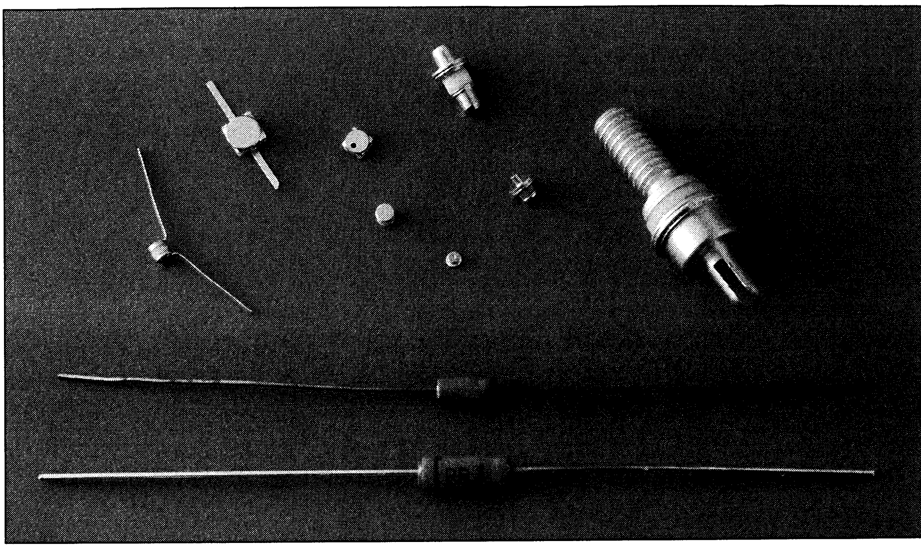
Tuning Varactors

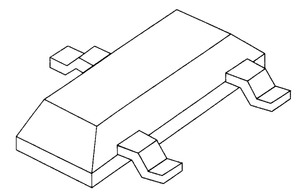


Title	Page

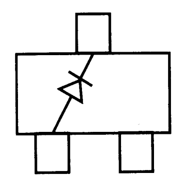
Surface Mount (SOT-23) Tuning Varactors

Nominal Capacitance @ 4 V (pF)	Capacitance Ratio (C_{T0}/C_{T30})	Single	Common Cathode	Page No.
Abrupt Varactors, B_V = 30 V				
4.7	4.5	MA45436	MA45436CK	4-2
5.6	4.5	MA45437	MA45437CK	4-2
6.8	4.5	MA45438	MA45438CK	4-2
8.2	4.5	MA45439	MA45439CK	4-2
10	4.5	MA45440	MA45440CK	4-2
12	4.6	MA45441	MA45441CK	4-2
22	4.6	MA45444	-	4-2
27	4.7	MA45445	-	4-2
33	4.7	MA45446	-	4-2
47	4.7	MA45448	-	4-2
Hyperabrupt Varactors, B_V = 22 V				
10	6.0	MA4ST401	MA4ST401CK	4-4
15	7.0	MA4ST403	MA4ST403CK	4-4
18	7.0	MA4ST404	MA4ST404CK	4-4
22	7.5	MA4ST405	MA4ST405CK	4-4
27	8.0	MA4ST406	MA4ST406CK	4-4
33	9.0	MA4ST407	MA4ST407CK	4-4
39	9.5	MA4ST408	MA4ST408CK	4-4
47	9.5	MA4ST409	MA4ST409CK	4-4
Wide Band, Low Voltage Varactors, B_V = 12 V				
5.0	7.8	MA4ST083	MA4ST083CK	4-6
7.3	8.2	MA4ST082	MA4ST082CK	4-6
10	8.5	MA4ST081	MA4ST081CK	4-6
25	8.9	MA4ST080	MA4ST080CK	4-6
54	9.1	MA4ST079	MA4ST079CK	4-6

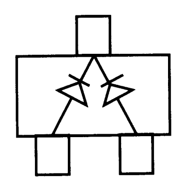
Stocked at your local distributor.



Configurations (Top View)



Single



Common Cathode

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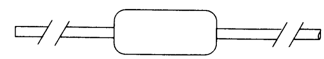
Axial Lead Tuning Varactors

Capacitance @ 4 V (pF)	Capacitance Ratio (C_{T0}/C_{T30})	Part No.	Page No.
Abrupt Junction Tuning Varactors, Nominal B_V = 30 V			
4.7	4.3	MA45330	4 - 8
5.6	4.5	MA45331	4 - 8
10	4.6	MA45334	4 - 8
13	4.6	MA45336	4 - 8
18	4.6	MA45337	4 - 8
22	4.6	MA45338	4 - 8



Capacitance @ 4 V (pF)	Capacitance Ratio ($C_{T2.5}/C_{T20}$)	Capacitance Ratio ($C_{T1.5}/C_{T20}$)	Part No.	Page No.
Hyperabrupt Junction Tuning Varactors, Nominal B_V = 22 V				
11 @ 3V	-	8	MA4ST533	4 - 19
20	7.5	-	MA4ST520	4 - 13
27 @ 3V	-	8	MA4ST534	4 - 13
50	7.5	8	MA4ST522	4 - 13
110	7.5	-	MA4ST523	4 - 13
155	7.5	-	MA4ST524	4 - 13

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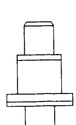
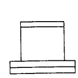
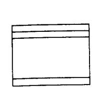
Microwave Tuning Varactors

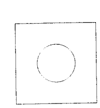
Nominal Total Capacitance @ 4 V (Case Style 30) (pF)	Capacitance Ratio (Case Style 30) (C_{T0}/C_{T30})	Packaged Part No.	Chip Part No.	Page No.
Abrupt Varactors, Nominal B_V = 30 V				
0.5	2.7	MA45225	MA45225-134	4-10
0.6	2.9	MA45226	MA45226-134	4-10
0.8	2.9	MA45227	MA45227-134	4-10
1.0	3.0	MA45228	MA45228-134	4-10
1.2	3.2	MA45227	MA45227-134	4-10
1.5	3.3	MA45230	MA45230-134	4-10
1.8	3.5	MA45231	MA45231-134	4-10
2.2	3.6	MA45232	MA45232-134	4-10
2.7	3.7	MA45233	MA45233-134	4-10
3.3	3.7	MA45234	MA45234-134	4-10
4.7	3.8	MA45236	MA45236-134	4-10
8.2	4.0	MA45239	MA45235-134	4-10
10	4.0	MA45240	MA45240-134	4-10
12	4.0	MA45241	MA45241-134	4-10

Nominal Total Capacitance @ 4 V (Case Style 30) (pF)	Capacitance Ratio (Case Style 30) (C_{T0}/C_{T20})	Packaged Part No.	Chip Part No.	Page No.
Hyperabrupt Varactors, Nominal B_V = 22 V				
0.8	3.2	MA4ST551	MA4ST551-134	4-19
1.0	3.4	MA4ST552	MA4ST552-134	4-19
1.2	3.8	MA4ST553	MA4ST553-134	4-19
1.5	4.3	MA4ST554	MA4ST554-134	4-19
1.8	4.6	MA4ST555	MA4ST555-134	4-19
2.2	5.0	MA4ST556	MA4ST556-134	4-19
2.7	5.2	MA4ST557	MA4ST557-134	4-19
3.3	5.5	MA4ST558	MA4ST558-134	4-19
3.9	5.9	MA4ST559	MA4ST559-134	4-19
4.7	6.0	MA4ST560	MA4ST560-134	4-19
5.6	6.7	MA4ST561	MA4ST561-134	4-19
6.8	7.0	MA4ST562	MA4ST562-134	4-19
8.2	7.2	MA4ST563	MA4ST563-134	4-19









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High Q, Surface Mount, GaAs Tuning Varactors

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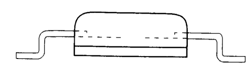
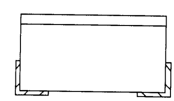
Abrupt Varactors, B_V= 30 V

Nominal Total Capacitance @ 4 V (pF)	Capacitance Ratio C_{T0} / C_{T30}	Ceramic Case Style 1056	Plastic Case Style 1088	Page No.
0.6	2.1	MA46504-1056	MA46504-1088	4 - 22
1.0	2.8	MA46505-1056	MA46505-1088	4 - 22
3.0	3.4	MA46506-1056	MA46506-1088	4 - 22



1088



1056

Constant Gamma = 0.75, Varactors, B_V = 20 V

Nominal Total Capacitance @ 4 V (pF)	Capacitance Ratio C_{T0} / C_{T20}	Ceramic Case Style 1056	Plastic Case Style 1088	Page No.
0.6	5.5	MA46H070-1056	MA46H070-1088	4 - 22
1.0	6.4	MA46H071-1056	MA46H071-1088	4 - 22
3.0	7.5	MA46H072-1056	MA46H072-1088	4 - 22
5.0	7.5	MA46H073-1056	MA46H073-1088	4 - 22

Constant Gamma = 1.25, Varactors, B_V = 22 V

Nominal Total Capacitance @ 4 V (pF)	Capacitance Ratio C_{T0} / C_{T20}	Ceramic Case Style 1056	Plastic Case Style 1088	Page No.
0.6	3.0	MA46H200-1056	MA46H200-1088	4 - 23
1.0	4.1	MA46H201-1056	MA46H201-1088	4 - 23
3.0	5.6	MA46H202-1056	MA46H202-1088	4 - 23
5.0	10	MA46H203-1056	MA46H203-1088	4 - 23
10	10	MA46H204-1056	MA46H204-1088	4 - 23
12	10	MA46H205-1056	MA46H205-1088	4 - 23
15	10	MA46H206-1056	MA46H206-1088	4 - 23

Constant Gamma = 1.5, Varactors, B_V = 18 V

Nominal Total Capacitance @ 4 V (pF)	Capacitance Ratio C_{T0} / C_{T12}	Ceramic Case Style 1056	Plastic Case Style 1088	Page No.
0.6	2.8	MA46H500-1056	MA46H500-1088	4 - 23
1.0	3.9	MA46H501-1056	MA46H501-1088	4 - 23
3.0	5.0	MA46H502-1056	MA46H502-1088	4 - 23
5.0	8.0	MA46H503-1056	MA46H503-1088	4 - 23

Specifications Subject to Change Without Notice.

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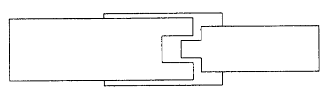
GaAs Beam Lead Tuning Varactors

Nominal Capacitance @ 4 V (pF)	Capacitance Ratio (C_{T2}/C_{T12})	Part No.	Page No.
Constant Gamma = 1.0, Varactors, B_V = 18 V			
0.5	3.2 - 5.2	MA46583	4-26
0.7	3.2 - 5.2	MA46586	4-26
1.0	3.2 - 5.2	MA46587	4-26
1.5	3.2 - 5.2	MA46588	4-26
2.0	3.2 - 5.2	MA46589	4-26

Nominal Capacitance c 4V (pF)	Capacitance Ratio (C_{T2}/C_{T12})	Part No.	Page No.
Constant Gamma = 1.25, Varactors, B_V = 18 V			
0.5	4.5 - 6.5	MA46580	4-26
0.7	4.5 - 6.5	MA46581	4-26
1.0	4.5 - 6.5	MA46582	4-26
1.5	4.5 - 6.5	MA46583	4-26
2.0	4.5 - 6.5	MA46584	4-26



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High Q, GaAs Tuning Varactors

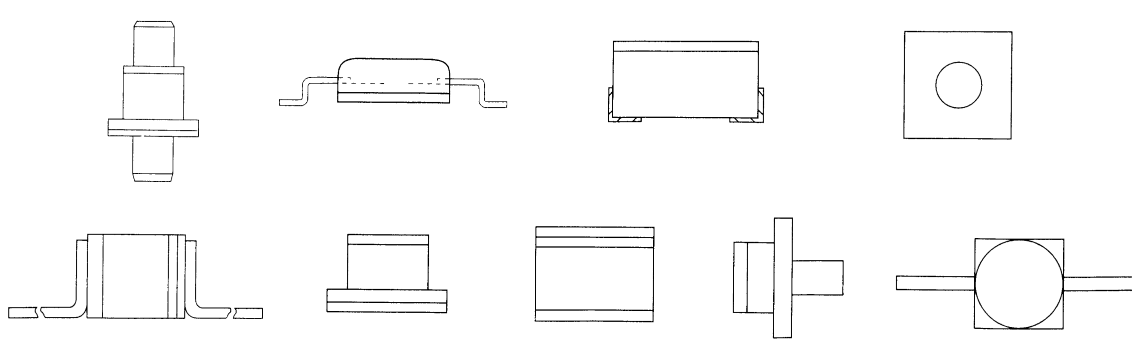
V 2.00

Capacitance @ 4 V (Case Style 30) (pF)	Capacitance Ratio (Case Style 30) C_{T0} / C_{T30}	Part No.	Page No.
Abrupt Varactors, B_V= 30 V			
0.3	1.9	MA46600	4 - 29
0.4	2.1	MA46601	4 - 29
0.5	2.5	MA46602	4 - 29
0.7	2.8	MA46603	4 - 29
1.0	3.2	MA46604	4 - 29

Capacitance @ 4 V (Case Style 30) (pF)	Capacitance Ratio C_{T2} / C_{T20}	Part No.	Page No.
Constant Gamma = 1.25, Varactors, B_V = 22 V			
0.5	2.9 - 4.1	MA46470	4 - 32
0.7	3.6 - 5.6	MA46471	4 - 32
1.0	4.8 - 7.4	MA46472	4 - 32
1.2	4.8 - 7.4	MA46473	4 - 32
1.5	5.0 - 7.4	MA46474	4 - 32
1.8	6.6 - 8.7	MA46474	4 - 32
2.0	6.6 - 8.7	MA46474	4 - 32
2.2	6.6 - 8.7	MA46474	4 - 32
2.7	6.9 - 10	MA46474	4 - 32
3.3	6.9 - 10	MA46479	4 - 32
3.8	6.9 - 10	MA46480	4 - 32
4.7	6.9 - 11	MA46481	4 - 32
5.6	7.2 - 11.5	MA46482	4 - 32
6.8	7.2 - 11.5	MA46483	4 - 32
8.2	7.2 - 11.5	MA46484	4 - 32
10	7.2 - 11.5	MA46485	4 - 32

Capacitance @ 4 V (Case Style 30) (pF)	Capacitance Ratio (Case Style 30) C_{T2} / C_{T20}	Part No.	Page No.
Constant Gamma = 1.0, Varactors, B_V = 22 V			
0.5	2.0 - 3.8	MA46450	4 - 32
0.7	2.9 - 4.4	MA46451	4 - 32
1.0	3.6 - 5.2	MA46452	4 - 32
1.5	3.8 - 5.5	MA46454	4 - 32
1.8	4.1 - 6.1	MA46455	4 - 32
2.2	4.1 - 6.1	MA46457	4 - 32
3.3	4.5 - 6.7	MA46459	4 - 32
4.7	4.8 - 7.2	MA46461	4 - 32

Capacitance @ 4 V (Case Style 30) (pF)	Capacitance Ratio C_{T2} / C_{T12}	Part No.	Page No.
Constant Gamma = 1.5, Varactors, B_V = 22 V			
0.5	2.7 - 4.3	MA46410	4 - 32
1.0	4.2 - 5.7	MA46413	4 - 32
1.8	5.2 - 6.9	MA46416	4 - 32
2.7	5.7 - 7.6	MA46418	4 - 32
3.8	6.0 - 8.1	MA46420	4 - 32
4.7	6.2 - 8.3	MA46421	4 - 32
5.6	6.3 - 8.4	MA46422	4 - 32
10	6.6 - 8.8	MA46425	4 - 32



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Surface Mount Abrupt Tuning Varactors

MA45430 Series

V 2.00

Features

- Surface Mount Package
- Low Cost
- High Quality Factor
- Tape and Reel Packaging Available
- SPC Controlled Process for Superior C-V Repeatability
- Available as Singles and Common Cathode Pairs

Description

The MA45430 series are abrupt junction silicon tuning varactors in the SOT-23 surface mount package. These thermal oxide passivated diodes feature high capacitance ratio and quality factor. They are well suited for tuning in the HF to UHF frequency bands. The standard capacitance tolerance is ±10%, with tighter tolerances available. Capacitance matching at one or more bias voltages is also available.

Applications

The MA45430 series tuning varactor is useful for tuning applications in the HF through UHF ranges. Applications include VCOs and voltage tuned filters in radios, cable TV tuners and test instruments where low cost and excellent lot-to-lot repeatability are critical.

Ordering Information

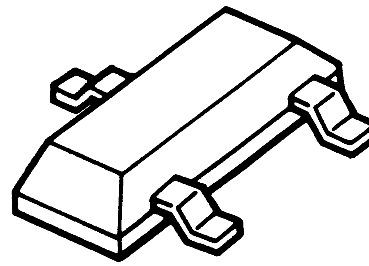
The part numbers shown are for single diodes. When ordering diodes in common cathode pairs add suffix "CK." For example, MA45436CK specifies model number MA45436 as a common cathode pair. To order parts on tape and reel add suffix T/R to the end of the part number. i.e. MA45436CK - T/R.

Mounting Information

The diagram below indicates the recommended mounting pad configuration for the SOT-23 package. Solder paste containing flux should be screened onto the pads to a thickness of 0.005 inches. The SOT-23 device is placed in position, firmly adhering to the solder paste.

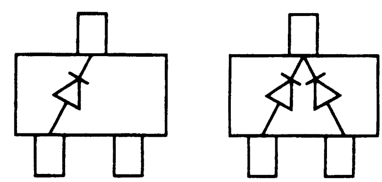
Permanent attachment is performed by a reflow soldering procedure. The tab temperature must not exceed 275°C and the body temperature must not exceed 250°C.

SOT-23



Configurations

TOP VIEW



(SINGLE) (COMMON CATHODE PAIR)

Maximum Ratings

Reverse Voltage	30 V
Forward Current	50 mA
Total Power Dissipation[1]	250 mW
Junction Operating Temperature	-55°C to +150°C
Storage Temperature	-55°C to +150°C

Note:
1. At 25°C case temperature. Derate linearly to 0 mW at 150°C.

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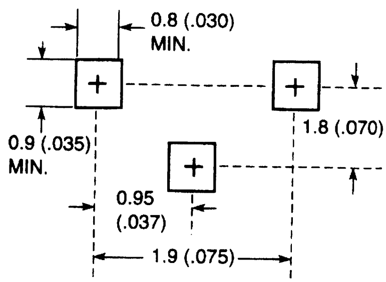
DIMENSIONS MILLIMETERS (INCHES)



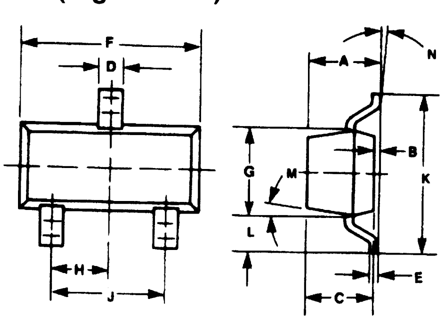
Electrical Specifications @ +25°C

Minimum Breakdown Voltage (V_B) = 30 Volts at 10μA
Maximum Reverse Current (I_R) = 100 nA at 24 Volts
Lower capacitance values available upon request

Model Number	Total Capacitance C_{T4} ± 10% (pF)	Minimum Capacitance Ratio C_{T0}/C_{T30}	Minimum Q
MA45436	4.7	4.5	1800
MA45437	5.6	4.5	1700
MA45438	6.8	4.5	1600
MA45439	8.2	4.5	1500
MA45440	10.0	4.5	1300
MA45441	12.0	4.6	1200
MA45444*	22.0	4.6	1000
MA45445*	27.0	4.7	900
MA45446*	33.0	4.7	750
MA45448*	47.0	4.7	400
Test Conditions	V_R = 4 V f = 1 MHz	V_R = 0/30 V f = 1 MHz	V_R = 4 V f = 50 MHz

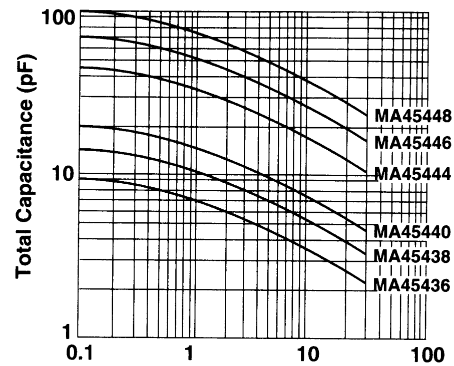
* Available as single diodes only.

Case Style
SOT-23 (High Profile)



Typical Performance

CAPACITANCE vs REVERSE VOLTAGE



Reverse Voltage (Volts)
Capacitance vs. Reverse Voltage

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.048	—	1.22
B	—	0.008	—	0.20
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K		0.103		2.60
L		0.024		0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30º

Note:
1. Applicable on all sides

Specifications Subject to Change Without Notice.

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Surface Mount Hyperabrupt Varactors

MA4ST400 Series

V 2.00

Features

- Surface Mount Package
- High Quality Factor
- Capacitance Ratio to 9.5:1
- Tape and Reel Packaging Available
- SPC Monitored Ion Implantation for Excellent C-V Repeatability
- Singles and Common Cathode Pairs

Description

The MA4ST400 series are ion-implanted, hyperabrupt junction, silicon tuning varactors in the SOT-23 surface mount package. These thermal oxide passivated diodes feature high capacitance ratio and quality factor. They are well suited for octave bandwidth tuning in the HF to UHF frequency bands. The standard capacitance tolerance is ±10%, with tighter tolerances available. Capacitance matching at one or more bias voltages is also available.

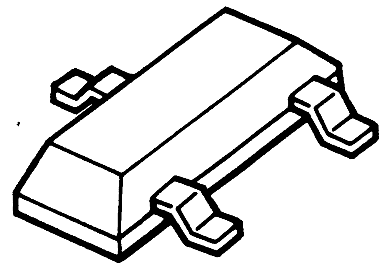
Applications

The MA4ST400 series tuning varactor is useful for octave bandwidth tuning applications in the HF through UHF ranges. Applications include VCOs and voltage tuned filters in radios, cable TV tuners and test instruments where low cost and excellent lot-to-lot repeatability are critical. Linear tuning performance is available from 3 to 8 volts.

Ordering Information

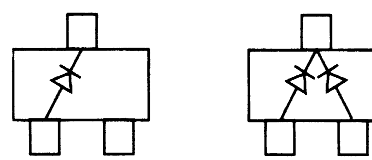
The model number indicated is for a single varactor. When ordering diodes in common cathode pairs add suffix "CK." For example, MA4ST401CK specifies model number MA4ST401 in common cathode pairs. To order parts on tape and reel add suffix T/R to the end of the part number. i.e. MA4ST401CK - T/R.

SOT-23



Configurations

TOP VIEW



(SINGLE) (COMMON CATHODE PAIR)

Maximum Ratings

Reverse Voltage	22 Volts
Forward Current	50 mA
Total Power Dissipation[1]	250mW
Junction Operating Temperature	-55°C to +125°C
Storage Temperature	-55°C to +125°C

Note:
1. At 25°C case temperature. Derate linearly to zero at 150°C.

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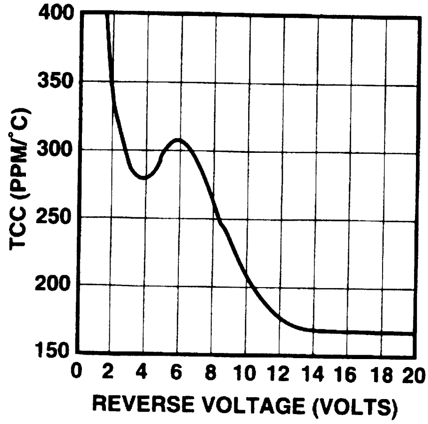
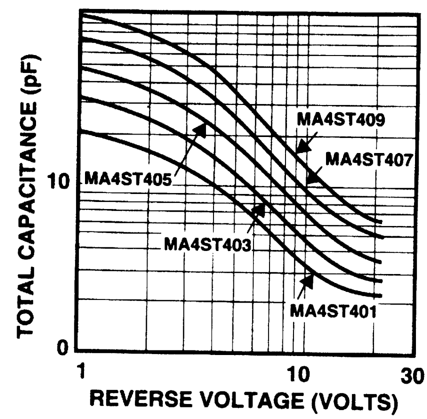
Typical Performance Curves

TYPICAL TEMPERATURE COEFFICIENT OF CAPACITANCE vs REVERSE VOLTAGE



REVERSE VOLTAGE CAPACITANCE (PF) vs REVERSE VOLTAGE

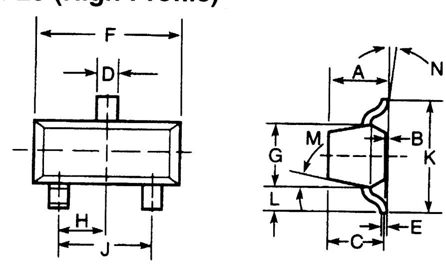


Electrical Specifications @ +25°C

Minimum Breakdown Voltage (V_B)= 22 Volts at 10 µA
Maximum Reverse Current (Ir)= 100 nA at 20 Volts

Model Number	Total Capacitance C_{T4} ± 10%	Minimum Capacitance Ratio C_{T2}/C_{T20}	Maximum Q
MA4ST401	10 pF	6.0	250
MA4ST402	12 pF	6.5	250
MA4ST403	15 pF	7.0	250
MA4ST404	18 pF	7.0	175
MA4ST405	22 pF	7.5	175
MA4ST406	27 pF	8.0	150
MA4ST407	33 pF	9.0	150
MA4ST408	39 pF	9.5	150
MA4ST409	47 pF	9.5	150
Test Conditions	F=1 MHz V_R=4 Volts	F=1 MHz	F=50 MHz V_R=4 Volts

Case Style
SOT-23 (High Profile)



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.048	—	1.22
B	—	0.008	—	0.20
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K		0.103		2.60
L		0.024		0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30º

Note:
1. Applicable on all sides

Specifications Subject to Change Without Notice.

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an AMP company

Surface Mount Hyperabrupt Wide-Band Tuning Varactors

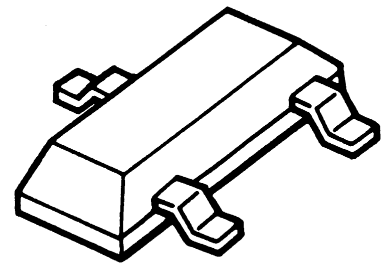
MA4ST079 thru 083

V 2.00

Features

- Low Cost
- Very High Capacitance Ratio from 1 to 8 Volts
- Surface Mount Package
- High Quality Factor
- Useful for Battery Applications
- SPC Monitored Ion Implantation for Excellent C-V Repeatability
- Singles and Common Cathode Pairs
- Available in Tape and Reel

SOT-23



Description

The MA4ST079 through MA4ST083 series of silicon hyperabrupt junction tuning varactors is produced with ion implantation and advanced epitaxial growth techniques. These diodes have thermal oxide passivation, and feature very high capacitance ratio and quality factor. They are well suited for use from the sub-HF through UHF frequency range. The standard capacitance tolerance is ±10%, with tighter tolerances available. Capacitance matching at one or more bias voltages is also available.

Applications

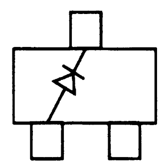
The MA4ST079 through MA4ST083 series of hyperabrupt junction tuning varactors is suggested for usage where a large frequency change is required with only a small change in tuning voltage.

This series is appropriate for usage in wide band voltage controlled oscillators and voltage controlled filters which require the largest rate of change of capacitance with voltage. The large change in capacitance from 1 to 8 volts makes them very attractive for battery operated or other systems with limited available control voltage.

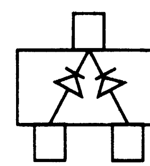
The MA4ST079 through MA4ST083 family can be used in VCOs and VTFs from approximately 100 KHz through the UHF frequency band.

Configurations

TOP VIEW



(SINGLE)



(COMMON CATHODE PAIR)

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Specifications @ T_A = +25°C

Breakdown Voltage @ I_R = 10 µA, VB = 12 Volts Minimum
Reverse Leakage Current @ V_R = 10 Volts, I_R = 100 nA Maximum
Temperature Coefficient ot Capacitance @ V_R = 8 Volts, TCC = 400 ppm/°C Typical

Model Number	Minimum Total Capacitance (pF)	Total Capacitance (pF)		Maximum Total Capacitance (pF)	Maximum Total Capacitance (pF)	Typical Total Capacitance Ratio C_{T1}/C_{T8}	Typical Q
	f = 1 MHz V_R = 1 Volt	f = 1 MHz V_R = 2.5 Volts min.	max.	f = 1 MHz V_R = 4 Volts	f = 1 MHz V_R = 8 Volts	f = 1 MHz V_R = 1/ V_R=8	f = 50 MHz V_R = 4 Volts
MA4ST079	87.4	48.7	59.5	27.3	11.8	9.1	80
MA4ST080	40.0	22.3	27.3	13.1	5.5	8.9	150
MA4ST081	16.2	9.1	11.1	5.2	2.4	8.5	300
MA4ST082	11.5	6.6	8.0	3.8	1.8	8.2	350
MA4ST083	7.9	4.5	5.5	2.6	1.3	7.8	450

Absolute Maximum Ratings

Reverse Voltage	12 Volts
Junction Temperature	-65°C to +125°C
StorageTemperature	-65°C to +125°C
Forward Current	50 mA
Power Dissipation	50 mW @ 25°C

Ordering Information

The part numbers shown are for single diodes. When ordering diodes in common cathode pairs add suffix "CK." For example, MA4ST079CK specifies model number MA4ST079 as a common cathode pair. To order parts on tape and reel add suffix T/R to the end of the part number. i.e. MA4ST079-T/R

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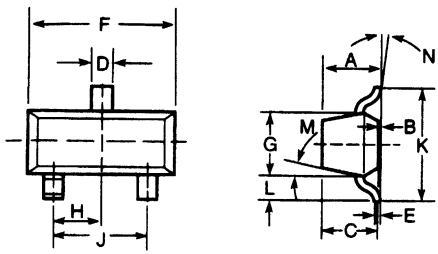
Case Style
SOT-23 (High Profile)

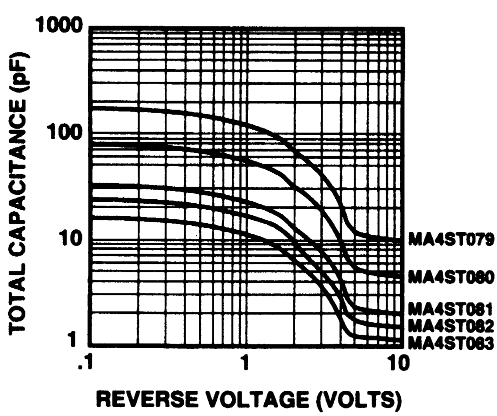


Package Capacitance = 0.15 pF typical
Package Inductance = 2 nH typical

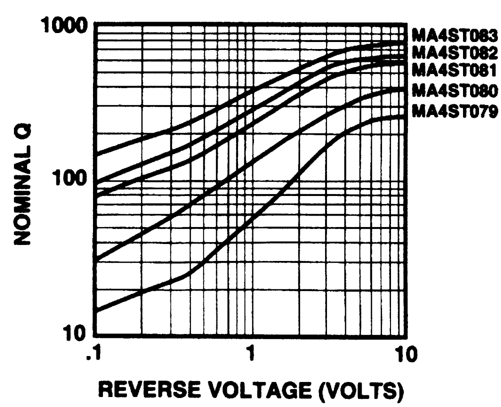
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.110	0.120	2.80	3.05
B	0.047	0.055	1.20	1.40
C	0.034	0.047	0.86	1.20
D	0.014	0.017	0.35	0.43
E	0.003	0.005	0.08	0.13
F	0.070	0.081	1.78	2.06
G	0.083	0.098	2.11	2.49
H	0.035	0.043	0.89	1.09
J	0.018	0.024	0.46	0.61
K	0.005	0.009	0.13	0.23
L	0.018	0.022	0.46	0.56

Typical Performance Curves

TOTAL CAPACITANCE vs REVERSE VOLTAGE



NOMINAL Q vs REVERSE VOLTAGE



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Axial Lead Abrupt Tuning Varactors

MA45300 Series

V 2.00

Features

- High Q
- Low Leakage
- Low Post Tuning Drift
- Frequency Range Through X-band
- Can Be Screened to TX, TXV Specifications

Description

The MA45300 series of silicon abrupt junction tuning varactors has been designed to obtain the highest Q possible. All diodes in this series have a high density silicon dioxide passivation which results in low leakage currents, low phase noise and low post tuning drift. These diodes are available in axial lead glass packages.

Applications

This series of silicon abrupt tuning varactors is designed for applications through S-band. Silicon abrupt junction tuning varactors are useful for transistor VCOs and tunable filters, phase shifters or pre-selectors.

Environmental Performance

All tuning varactors in the MA45300 series are capable of meeting the performance tests dictated by the methods and procedures of the latest revisions of MIL-S-19500 MIL-STD-202 and MIL-STD-750 which specifies mechanical, electrical, thermal and other environmental tests common to semiconductor products.

High Reliability Parts

All diodes in the MA45300 series may be screened to TX or TX-V specifications.

Maximum Ratings

Reverse Voltage	30 V
Operating Temperature	-65°C to + 150°C
Storage Temperature	-65°C to + 150°C
Temperature Coefficient	300ppm/°C at - 4 Volts
Power Dissipation (Derate linearly to zero at 150°C)	200mW

Case Style 54

Specifications @ T_A = +25°C

30 Volt Axial Lead Silicon Tuning Varactors

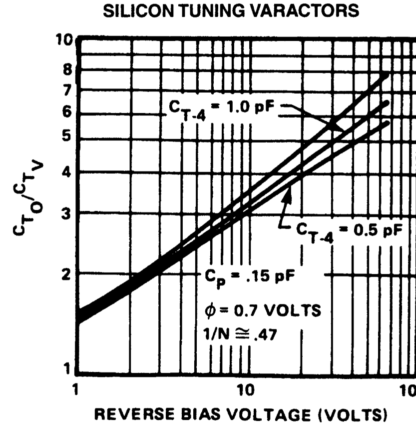
Model[1] Number	Total[2] Capacitance (pF)	Minimum Capacitance Ratio C_{to}/C_{tVb}	Typical[3] "Q" (@ - 4 Volts)
MA45330	4.7	4.5	1800
MA45331	5.6	4.5	1700
MA45334	10	4.6	1300
MA45336	15	4.6	1200
MA45337	18	4.6	1100
MA45338	22	4.6	1000

Notes:

1. All silicon abrupt junction varactors in this series are available as standard products in the axial lead glass package, case style 54. See appendix for complete dimensions.
2. Standard capacitance tolerances are ± 10%. A tighter tolerance (± 5%) may be obtained by adding the suffix "A" to the diode model number.
3. Diode Q is calculated at - 4 volts and 50 MHz using values of R_S measured at 500 MHz and values of junction capacitance measured at 1 MHz.

Typical Performance Curves

TYPICAL CAPACITANCE CHANGE RATIO FOR SILICON TUNING VARACTORS



Specifications Subject to Change Without Notice.

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Abrupt Tuning Varactors

MA45200 Series

V 2.00

Features

- High Q
- Low Leakage
- Available in Chip Form
- Available in Ceramic Packages
- Low Post Tuning Drift
- Frequency Range VHF – Ku-Band
- Can be Screened to TX, TX-V Specifications

Description

The MA45200 series of silicon abrupt junction tuning varactors has been designed to obtain the highest Q possible. Each diode in this series has a high density silicon dioxide passivation which results in exceptionally low leakage currents and low post tuning drift. These silicon abrupt junction tuning varactors, which have a high Q, exhibit large capacitance changes with bias voltages. The capacitance change is approximately equal to the square root of the voltage. The MA45200 series diodes are available in a number of ceramic packages as well as in chip form.

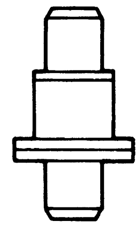
Applications

The MA45200 series of silicon tuning diodes are useful for frequency tuning applications through Ku band, including electronic tuning of transistor, Gunn and IMPATT oscillators.

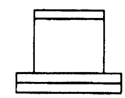
High Reliability Parts

All diodes in the MA45200 series may be screened to TX, TX-V specification.

Case Styles



30



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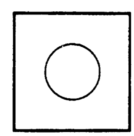

132

Maximum Ratings

Reverse Voltage	Same as rated breakdown V_B
Operating Temperature	-65°C to + 150°C
Storage Temperature	-65°C to + 200°C
Temperature Coefficient	+300 ppm/°C @ 4 Volts
Power Dissipation	Cj ≤ 1.0 pF @ 100 mW Cj ≥ 1.0 pF @ 200 mW
Storage Temperature (derate linearly to zero at 150°C)	-35°C to + 200°C

Environmental Performance

All tuning varactors in the MA45200 series are capable of meeting the performance tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

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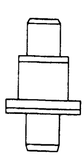
Specifications @ T_A= +25°C

Model[1] Number	Minimum[5,6] V_B (Volts)	Total[2,7] Capacitance (pF)	Minimum[2,3,7] Capacitance Ratio C_{TO}/C_{TVB}	Typical[4] Q at 50 MHz	Suggested Frequency Range (GHz)
MA45225	30	0.5	2.7	5500	10-12
MA45226	30	0.6	2.9	5500	9-11
MA45227	30	0.8	2.9	5000	8-10
MA45228	30	1.0	3.0	4800	7-9
MA45229	30	1.2	3.2	4800	6-8
MA45230	30	1.5	3.3	4500	6-8
MA45231	30	1.8	3.5	4000	5-7
MA45232	30	2.2	3.6	4000	5-7
MA45233	30	2.7	3.7	4000	4-6
MA45234	30	3.3	3.7	3500	4-6
MA45236	30	4.7	3.8	3000	2-4
MA45239	30	8.2	3.9	2700	1-2
MA45240	30	10.0	4.0	2500	1-2
MA45241	30	12.0	4.0	2200	.5-1.0

Notes:

1. Case style 30 is the standard enclosure tor this series. On special order, these devices are also available in other case styles including 31, 94, 96, 108, and in chip form (132). To order the MA45200 series in chip form or other case styles, add the designated available case number as a suffix to the model number, i.e., MA5229-132 is a chip or MA45229-96 is in the 96 case style.
2. Total capacitance is measured at 1 MHz.
3. The total capacitance ratio will vary with different packages due to differences in package parasitic capacitance.
4. Diode Q at -4 volts is determined at 1 GHz and extrapolated to 50 MHz by:
   $$Q_{-4} = \frac{1}{2xf\,C_{j-4}} R_S$$
5. Reverse leakage current is 20 nanoamperes maximum at 24 volts.
6. Reverse leakage is 10 microamperes maximum at breakdown voltage.
7. The total capacitance and capacitance ratios shown are for diodes housed in case style 30. Other cases and chip styles will result in slightly different values.

Case Styles (See appendix for complete dimensions)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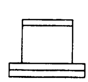
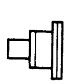

31


94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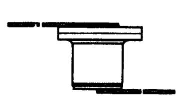
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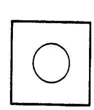
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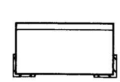
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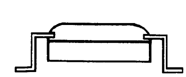
1088

Specifications Subject to Change Without Notice.

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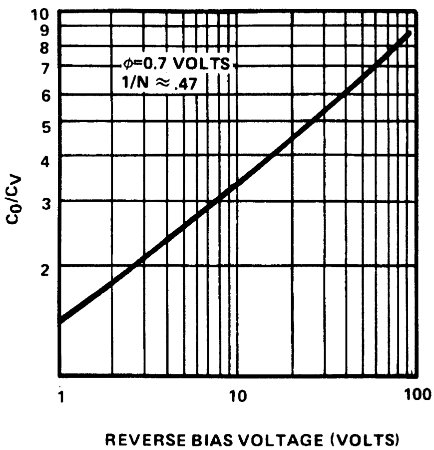
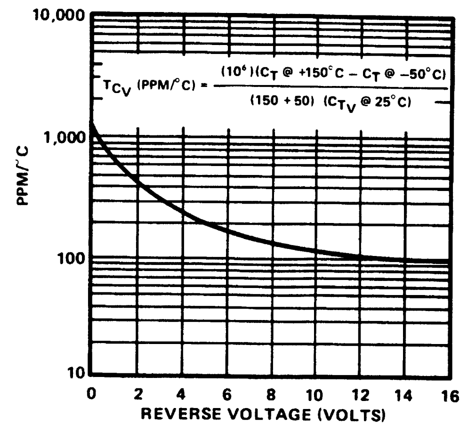
Typical Performance Curves

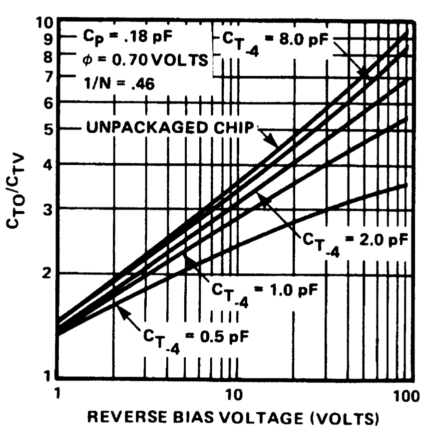
TYPICAL CAPACITANCE CHANGE RATIOS FOR SILICON TUNING VARACTOR CHIPS



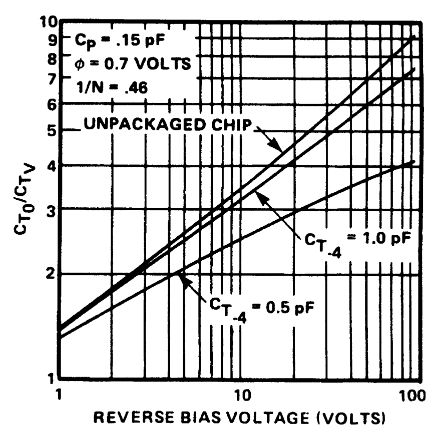
TYPICAL TEMPERATURE COEFFICIENT OF SILICON VARACTORS



TYPICAL CAPACITANCE CHANGE RATIOS FOR SILICON TUNING VARACTORS IN CASE STYLES 30, 31 & 108



TYPICAL CAPACITANCE CHANGE RATIOS FOR SILICON TUNING VARACTORS IN CASE STYLES 94 AND 96



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UHF, VHF Hyperabrupt Tuning Varactors

MA4ST520, MA4ST530 Series

V 2.00

Features

- A Superior Ion Implantation Process Results in More Repeatable C-V Characteristics Within Specified Capacitance Tolerances
- High Q
- Usable Capacitance Change Ratios as High as 8:1. (MA4ST520 Series)

Description

M/A-COM's silicon hyperabrupt tuning varactors combine advantages of a repeatable ion-implant process with excellent passivation and low series resistance. The resulting diodes exhibit a C-V characteristic that is consistent from lot to lot and stable within close tolerances, over time and temperature.

Applications

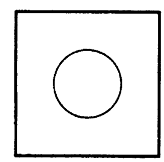
The MA4ST520 series was developed for VCO tuning in the VHF through UHF ranges. Applications are high volume fixed tuned and frequency hopping military radios where low cost and lot-to-lot C-V repeatability are critical. The MA4ST530 family has a faster change of capacitance with voltage.

Ordering Information

When ordering diodes, use the appropriate M/A-COM model number and add case style suffix where appropriate. (For example, MA4ST520B is an 18-22 pF (@ 4V) varactor in the standard glass package (case style 4). The MA4ST520B-132 is the unpackaged chip version.

Case Style (See appendix for complete dimensions)

4



132

Maximum Ratings

Temperature Range Operating	-65°C to +125°C
Storage	-65°C to +150°C
Power Dissipation (Max.)	(derate linearly to zero at 150°C) 250 mW (Case Style 4)
Max. Reverse Voltage	Same as V_B
Forward Current	50 mAdc
Max. Leakage Current	@ 80% V_B = 100 nA max. @ +25°C

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High Tuning Ratio
Specifications @ T_A = +25°C

Min. Reverse Voltage V_R 22 V @ 10 μA   Max. Reverse Leakage Current I_R @ 18 V = 100 nAmps

Parameter	Diode Capacitance[1] (pF)				Tuning Ratio		Figure of Merit	
Test Conditions	F = 1 MHz				F = 1 MHz		F = 50 MHz	
	V_R = 2.5 Vdc	V_R = 4.0 Vdc	V_R = 8.0 Vdc	V_R = 20 Vdc	C (4V)/C (8V)	C (4V)/C (20V)	V_R = 4 Vdc	
Part Number	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Typ.	Chip Style[2]
MA4ST520	25/29	18/22	—	—	—	—	150	132
MA4ST520B	—	18/22	7.5/10.5	3.1/3.9	—	4.6/7.1	300	132
MA4ST520D	—	19/21	7.8/9.2	3.1/3.9	2.0/2.7	4.8/6.8	300	132
MA4ST522	62/72	45/55	—	—	—	—	100	132
MA4ST522C	—	47.5/52.5	18.4/21.6	—	2.2/2.8	—	200	132
MA4ST522D	—	47.5/52.5	18.4/21.6	7.3/9.2	2.2/2.8	5.2/6.9	200	132
MA4ST523	135/160	100/120	—	—	—	—	65	200
MA4ST523C	—	104.5/115.5	41.4/48.6	—	2.15/2.8	—	125	200
MA4ST523D	—	104.5/115.5	41.4/48.6	16/20	2.15/2.8	5.2/7.3	125	200
MA4ST524	195/225	140/170	—	—	—	—	50	200
MA4ST524C	—	147/163	59.8/70.2	—	2.1/2.8	—	100	200
MA4ST524D	147/163	147/163	59.8/70.2	22.5/28	2.1/2.8	5.2/7.2	100	200

Note:
1. The capacitance values and tuning ratios are given for diodes in case style 4. Chip diodes may have slightly different values.

Specifications @ T_A = +25°C

Parameter	Reverse Breakdown Volage (Vdc)	Diode Capacitance[1] (pF)				Tuning Ratio		Figure of Merit
Test Conditions		F = 1 MHz				F = 1 MHz		F = 50 MHz
	@ 10 μAdc	V_R = 1.25 Vdc	V_R = 3.0 Vdc	V_R = 8.0 Vdc	V_R = 20 Vdc	C (3V)/C (8V)	C (3V)/C (20V)	V_R = 3 Vdc
Part Number	MIn.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Typ.
MA4ST533	15	14/17.5	10.5/12.5	—	—	—	—	200
MA4ST533B	22	—	10.5/12.5	4.3/4.7	2.0/2.4	—	4.4/6.3	300
MA4ST533C	22	—	10.5/12.5	4.3/4.7	2.0/2.3	—	4.6/6.3	450
MA4ST534B	22	—	25/31	10/13.5	4.5/5.3	—	4.7/6.9	200
MA4ST534C	22	—	25/31	10/13.5	4.5/5.1	—	4.9/6.9	300

Notes:
1. For all model numbers listed above the reverse leakage current at 80% of related V_B Max. is 100 nAmps Max.
2. All model numbers listed above are available in axial lead Case Style 4 and Chip Style 132. To order chip style 132, add the case style suffix to the part number, ie: MA4ST533-132.

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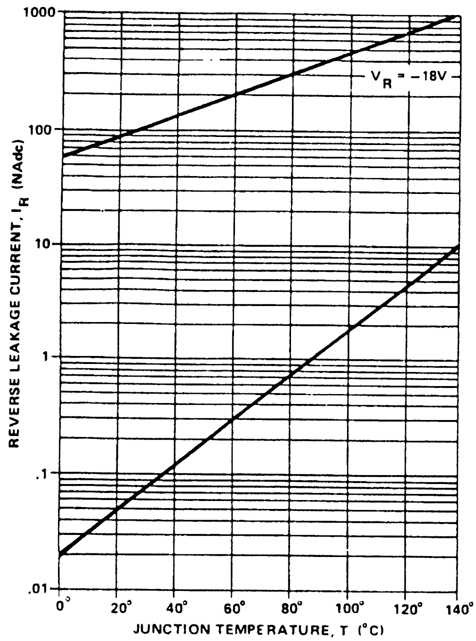
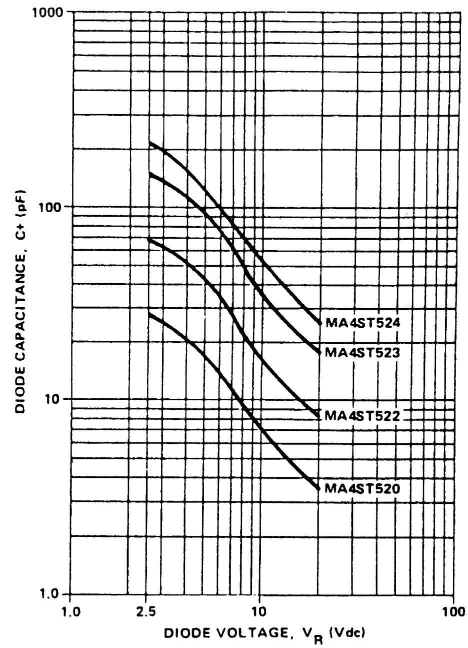
Typical Performance Curves MA4ST520 Series

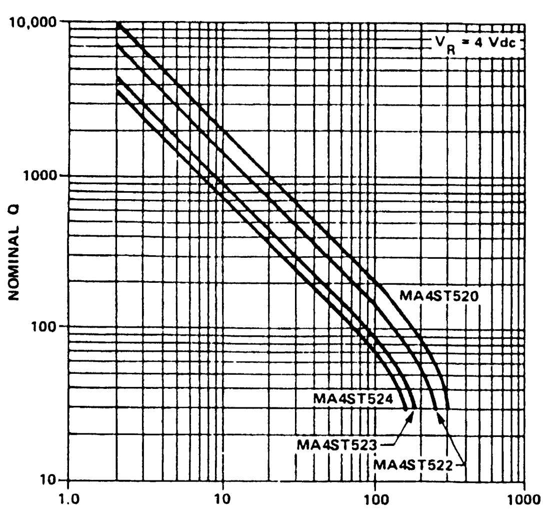
REVERSE LEAKAGE CURRENT @ - 18V vs JUNCTION TEMPERATURE



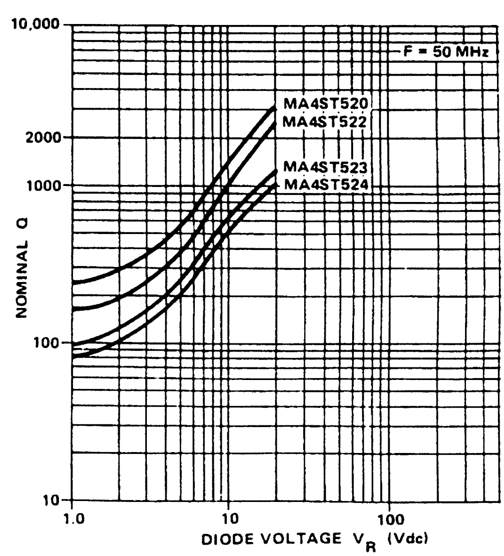
NOMINAL CAPACITANCE vs TUNING VOLTAGE T_A = +25°C



NOMINAL Q vs FREQUENCY



NOMINAL Q vs TUNING VOLTAGE



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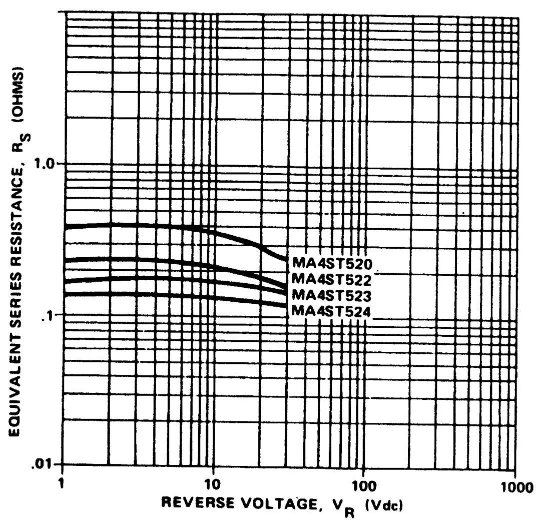
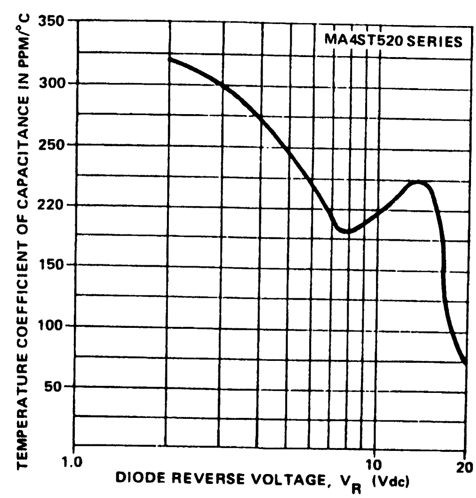
Typical Performance Curves MA4ST520 Series (Cont'd)

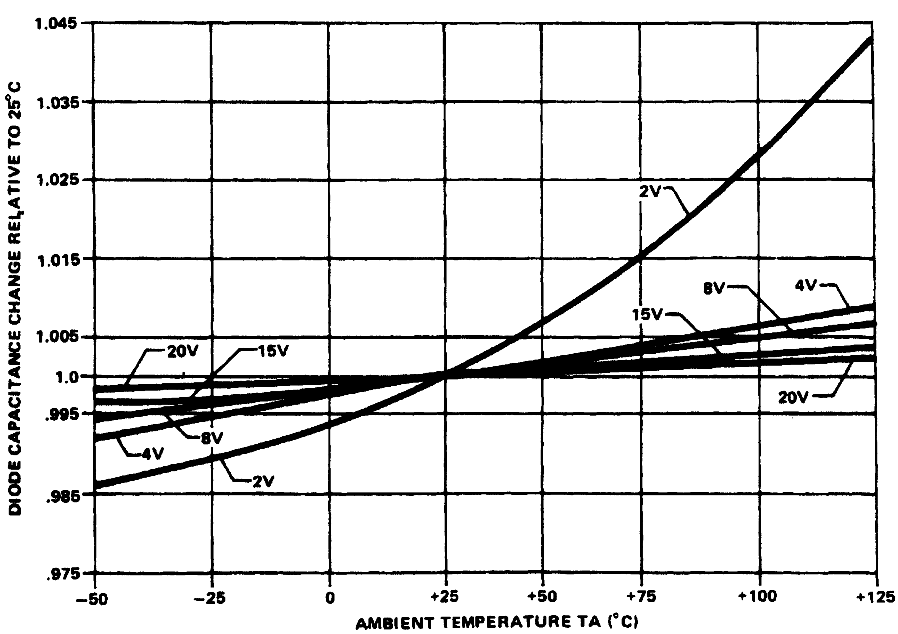
EQUIVALENT SERIES RESISTANCE vs VARACTOR VOLTAGE (T_A = +25°C)



TEMPERATURE COEFFICIENT OF CAPACITANCE IN PPM/°C vs TUNING VOLTAGE



CAPACITANCE CHANGE vs AMBIENT TEMPERATURE



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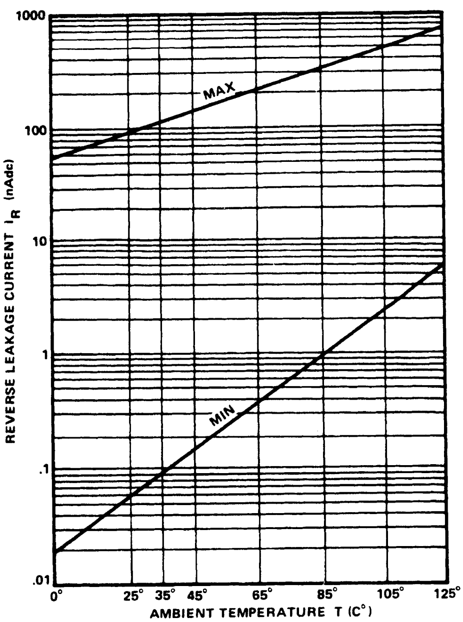
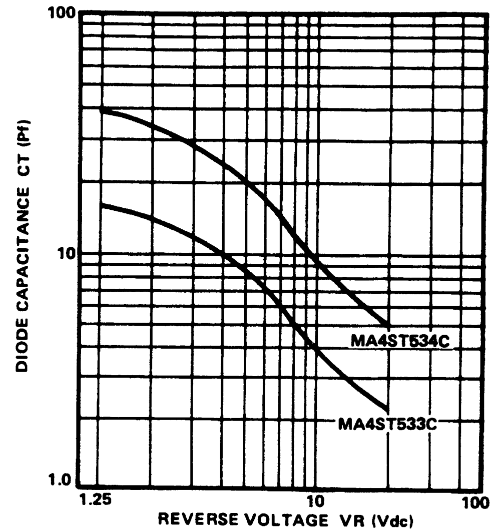
Typical Performance Curves MA4ST530 Series

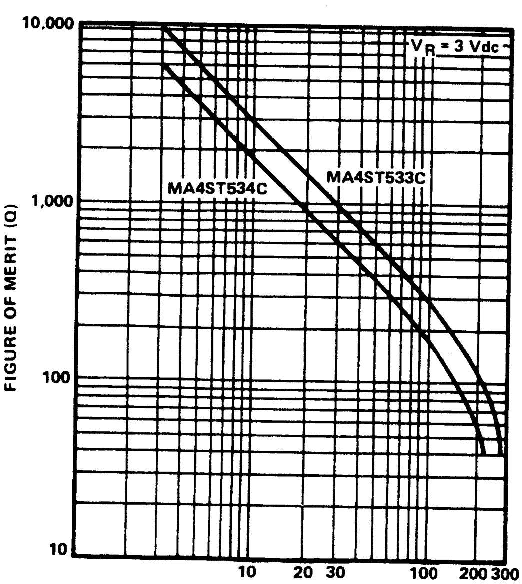
REVERSE LEAKAGE CURRENT @ 80% V_B vs AMBIENT TEMPERATURE



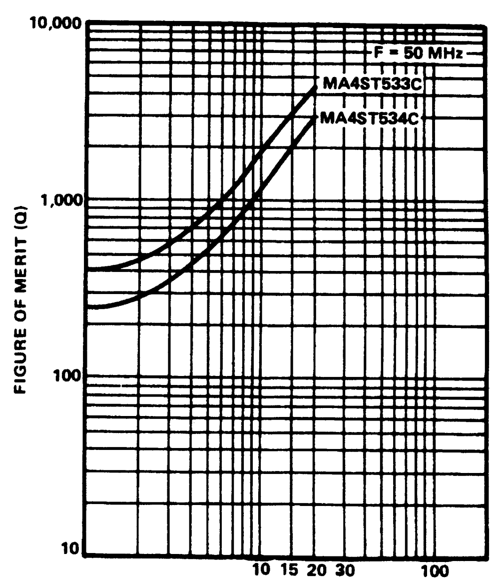
NOMINAL CAPACITANCE vs TUNING VOLTAGE T_A = +25°C



NOMINAL Q vs FREQUENCY



NOMINAL Q vs TUNING VOLTAGE



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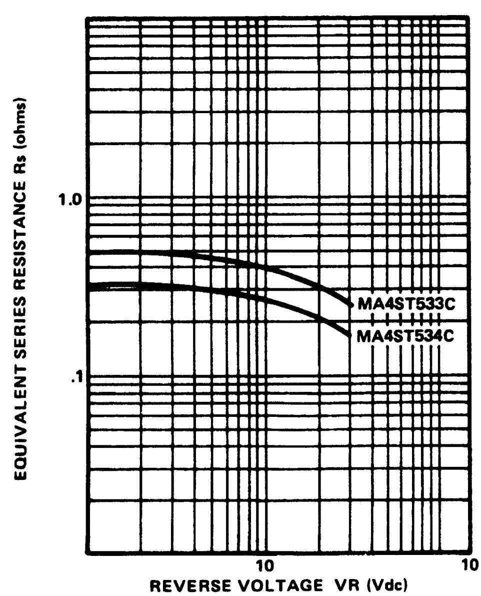
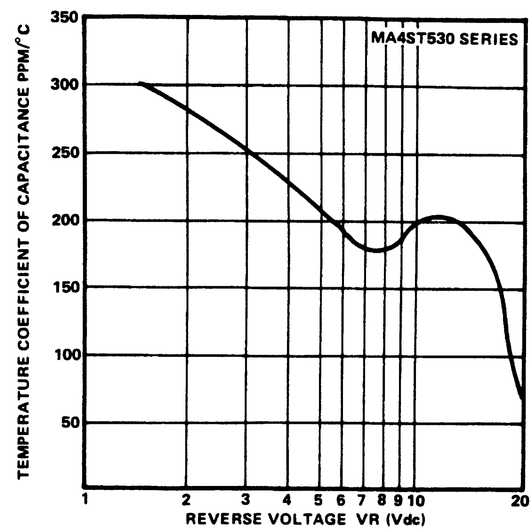
Typical Performance Curves MA4ST530 Series (Cont'd)

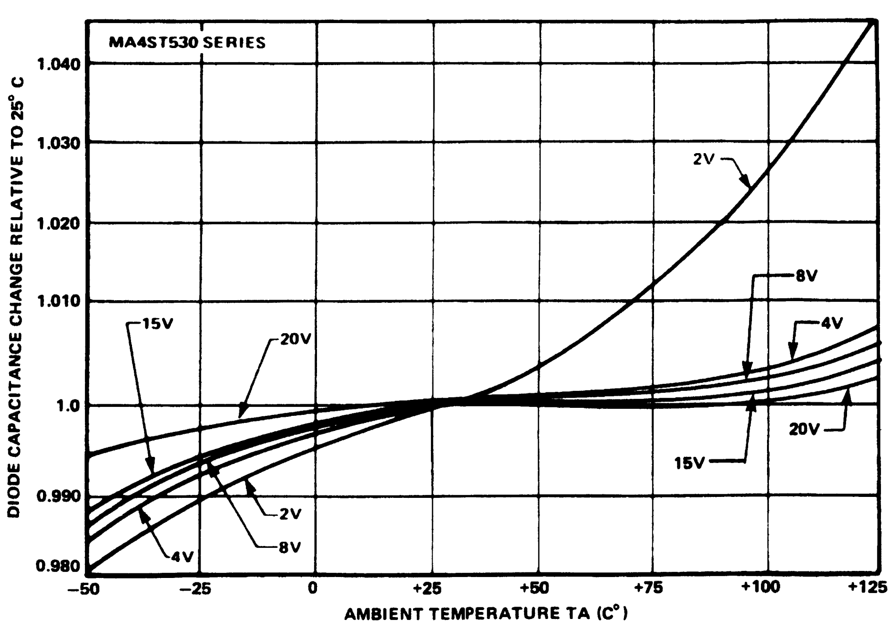
EQUIVALENT SERIES RESISTANCE vs VARACTOR VOLTAGE (T_A = 25°C)



TEMPERATURE COEFFICIENT OF CAPACITANCE IN PPM/°C vs TUNING VOLTAGE



CAPACITANCE CHANGE vs AMBIENT TEMPERATURE



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High Q Hyperabrupt Tuning Varactors

MA4ST550 Series

V 2.00

Features

- High Q
- Usable Capacitance Change of 7:1
- Low Reverse Leakage for Good Post Tuning Drift Characteristics
- Reproducible C-V Curves

Description

The MA4ST550 family of high Q Silicon Hyperabrupt Tuning Varactors is available in a series of low parasitic capacitance microwave packages or in chip form. The MA4ST550 series of diodes is available with junction capacitances of approximately 0.8 pF to 8.2 pF at -4 volts. These diodes have capacitance change ratios as high as 7:1.

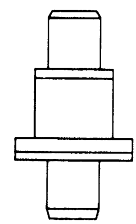
Applications

The MA4ST550 series is appropriate for use in VCOs with frequencies within the range of approximately 1-14 GHz where a large capacitance change is required. These diodes are suited for VCOs in missile seekers, telecommunication systems and electronic warfare systems with critical post tuning drift specifications.

Environmental Performance

All tuning varactors in ceramic packages are capable of meeting the performance tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

Case Styles



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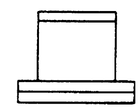

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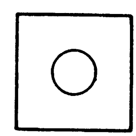

134

Maximum Ratings

Reverse Voltage	Same as Breakdown Voltage
Operating Temperature	- 65°C to +150°C
Storage Temperature	- 65°C to +200°C
Temperature Coefficient	400 ppm/°C at -4 Volts

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Specifications @ T_A= +25°C

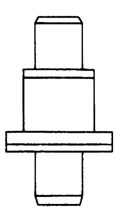
Breakdown Voltage = 22 Volts Minimum @ 10 Microamps

Reverse Current = 50 nAmps Maximum @ 20 Volts and 25°C

Model Number	Case[1] Style	Total Capacitance[2,3] @ - 4V (pF) Min./Max.	Total Capacitance[2,3] @ - 20V (pF) Min./Max.	Typical @ - 4 Volts 50 MHz
MA4ST551	30	0.72-0.88	0.30-0.38	650
MA4ST552	30	0.90-1.10	0.34-0.42	650
MA4ST553	30	1.08-1.32	0.38-0.48	600
MA4ST554	30	1.35-1.65	0.43-0.58	600
MA4ST555	30	1.62-1.98	0.51-0.68	550
MA4ST556	30	1.98-2.42	0.58-0.78	550
MA4ST557	30	2.43-2.97	0.68-0.88	500
MA4ST558	30	2.97-3.63	0.82-1.02	500
MA4ST559	30	3.51-4.29	0.93-1.18	450
MA4ST560	30	4.23-5.16	1.13-1.43	450
MA4ST561	30	5.04-6.16	1.33-1.63	450
MA4ST562	30	6.12-7.48	1.58-1.98	400
MA4ST563	30	7.38-9.02	1.88-2.38	400

Notes:
1. The standard case style is 30. Other packages and chips shown at the bottom of this page are available. When ordering, specify the desired case style by adding the case designation as a suffix to the model number, i.e. MA4ST552-134 is a 15 X 15 mil chip diode. See appendix for complete dimensions.
2. Capacitance is measured at 1 MHz.
3. The total capacitance values shown are for devices housed in case style 30. Other case styles will result in different values due to different case parsasitics. Case parasitics (C_P and L_S) are given for available case styles along with the outline drawings in the appendix.

Case Styles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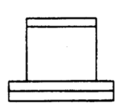
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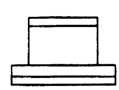
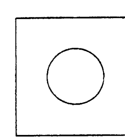

94


120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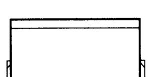
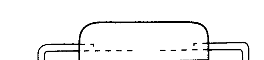

1056


1088

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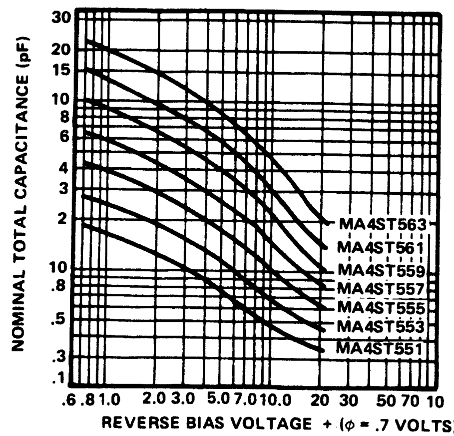
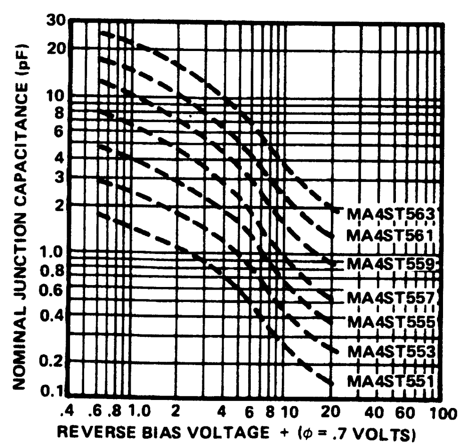
Typical Performance Curves

CAPACITANCE vs REVERSE BIAS VOLTAGE
(CASE STYLE 30)



CAPACITANCE vs REVERSE BIAS VOLTAGE
(CASE STYLE 30)



an AMP company

Surface Mount GaAs Tuning Varactors

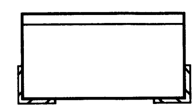
MA46 Series

V 2.00

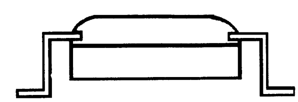
Features

- Low Cost
- Surface Mount Packages
- Very High Quality Factor
- Constant Gamma Abrupt Junction: 0.5
  Hyperabrupt Junctions: 0.75, 1.25 and 1.5
- Capacitance Ratio to 10:1
- Case Style 1056 is Hermetic and may be Screened to JANTX levels
- Tape and Reel Packaging Available

Case Styles



1056



1088

Description

M/A-COM offers four families of low cost surface mount gallium arsenide tuning varactors. All families have silicon nitride protected junctions for low leakage current and high reliability.

The **MA46H500 through MA46H504** family has hyperabrupt junctions with constant gamma of 1.5 from 2 to 12 volts and high quality factor.

The **MA46H200 through MA46H206** family has hyperabrupt junctions with constant gamma of 1.25 from 2 to 20 volts and higher quality factor.

The **MA46H070 through MA46H073** family has hyperabrupt junctions with constant gamma of 0.75 from 0 to 20 volts and very high quality factor.

The **MA46504 through MA46506** family has abrupt junctions with constant gamma of 0.5 from 0 to 30 volts and the highest quality factor.

Applications

The **MA46H500 through MA46H504 (gamma 1.5)** family of constant gamma hyperabrupt GaAs tuning varactors is designed for wide bandwidth VCOs and voltage tuned filters where limited bias voltage is available. These varactors have greatest capacitance change versus voltage at the cost of slightly lower quality factor than the other families of GaAs varactors.

The **MA46H200 through MA46H206 (gamma 1.25)** family of constant gamma hyperabrupt GaAs tuning varactors has the largest capacitance ratio of the families of GaAs varactors and high quality factor. These diodes are very well suited for wide bandwidth VCOs and VTFs where the optimum combination of very wide tuning range and high quality factor is required.

The **MA46H070 through MA46H073 (gamma 0.75)** family of constant gamma hyperabrupt GaAs tuning varactors has quality factor approaching that of abrupt junction varactors, but higher capacitance change versus tuning voltage. These diodes are very well suited for narrower bandwidth VCOs and VTFs where wide tuning range and very high quality factor are required.

The **MA46504 through MA46506 (gamma 0.5)** family of constant gamma abrupt GaAs tuning varactors has the highest quality factor. These diodes are very well suited for narrower bandwidth VCOs and VTFs where highest quality factor is of paramount concern.

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Absolute Maximum Ratings

	Case 1056	Case 1088
Operating Temperature	-65°C to +150°C	-65°C to +125°C
Storage Temperature	-65°C to +200°C	-65°C to +125°C
Reverse Voltage	Breakdown Voltage	
Forward Current	50 mA @ 25°C	
Power Dissipation	50 mW @ +25°C, derate linearly to 0 mW at maximum operating temperature	

Electrical Specifications @ +25°C

Gamma 0.5 Abrupt Tuning Varactors

Breakdown Voltage @ 10 µA = 30 V minimum
Reverse Current @ 24 V = 100 nA maximum
Gamma = 0.48 - 0.50, V_R = 0 to 30 V

Model Number	Total Capacitance (pF)	Nominal Total Capacitance Ratio (C_{T0}/C_{T30})	Typical Q
	f=1 MHz V_R=4 Volts	f=1 MHz V_R=0/V_R=30	f=50 MHz V_R=4 Volts
MA46504	0.5 - 0.7	2.1	6000
MA46505	0.9 - 1.1	2.8	5700
MA46506	2.7 - 3.3	3.4	4500

Electrical Specifications @ +25°C

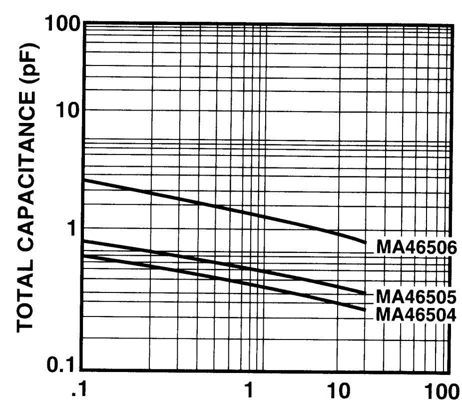
Gamma 0.75 Hyperabrupt Tuning Varactors

Breakdown Voltage @ 10 µA = 20 V minimum
Reverse Current @ 16 V = 100 nA maximum
Gamma = 0.68 - 0.83, V_R = 0 to 20 V

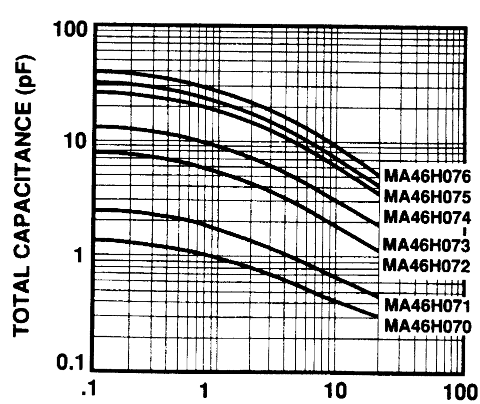
Model Number	Total Capacitance (pF)	Nominal Total Capacitance Ratio (C_{T0}/C_{T20})	Typical Q
	f = 1 MHz V_R = 4 Volts	f = 1 MHz V_R = 0/V_R=20	f = 50 MHz V_R = 4 Volts
MA46H070	0.5 - 0.7	5.5	4500
MA46H071	0.9 - 1.1	6.4	4500
MA46H072	2.7 - 3.3	7.5	3000
MA46H073	4.5 - 5.5	7.5	2200

Typical Performance Curves

CAPACITANCE vs REVERSE VOLTAGE



CAPACITANCE vs REVERSE VOLTAGE



Specifications Subject to Change Without Notice.

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Electrical Specifications @ +25°C

Gamma 1.25 Hyperabrupt Tuning Varactors

Breakdown Voltage @ 10 μA = 22 V minimum
Reverse Current @ 16 V = 100 nA maximum
Gamma = 1.13 - 1.38, V_R = 2 to 20 V

Model Number	Total Capacitance (pF)	Nominal Total Capacitance Ratio (C_{T2}/C_{T20})	Typical Q
	f = 1 MHz V_R = 4 Volts	f = 1 MHz V_R = 2/V_R=20	f=50 MHz V_R = 4 Volts
MA46H200	0.5 - 0.7	3.0	3000
MA46H201	0.9 - 1.1	4.1	3000
MA46H202	2.7 - 3.3	5.6	2000
MA46H203	4.5 - 5.5	10.0	1500
MA46H204	9.0 - 11.0	10.0	1500
MA46H205	10.8 - 13.2	10.0	1500
MA46H206	13.5 - 16.5	10.0	1500

Electrical Specifications @ +25°C

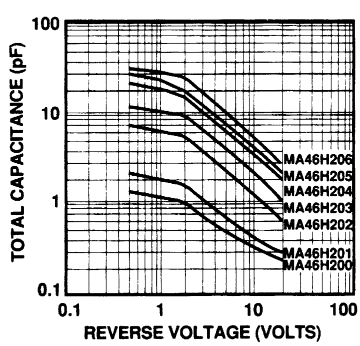
Gamma 1.5 Hyperabrupt Tuning Varactors

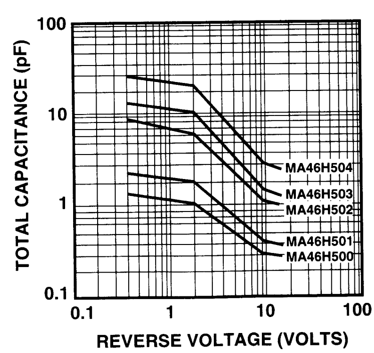
Breakdown Voltage @ 10μA = 18 V minimum
Reverse Current @ 14 V = 100 nA maximum
Gamma = 1.4 - 1.6, V_R = 2 to 12 V

Model Number	Total Capacitance (pF)	Nominal Total Capacitance Ratio (C_{T2}/C_{T12})	Typical Q
	f = 1 MHz V_R = 4 Volts	f = 1 MHz V_R = 2/V_R = 12	f = 50 MHz V_R = 4 Volts
MA46H500	0.5 - 0.7	2.8	2500
MA46H501	0.9 - 1.1	3.9	2500
MA46H502	2.7 - 3.3	5.0	1800
MA46H503	4.5 - 5.5	8.1	1200
MA46H504	9.0 - 11.0	8.1	1200

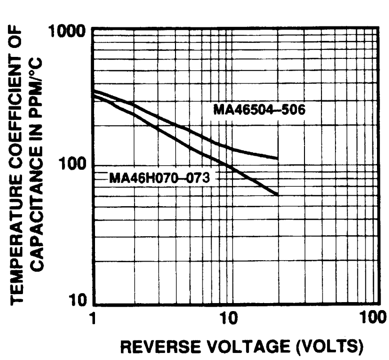
Typical Performance Curves

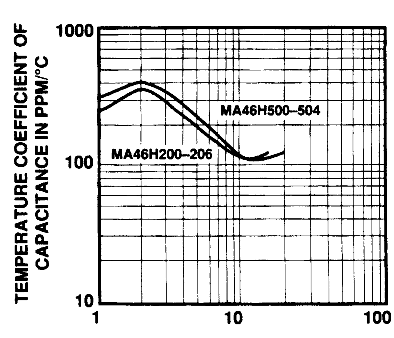
Capacitance vs Reverse Voltage





Temperature Coefficient of Capacitance vs Reverse Voltage





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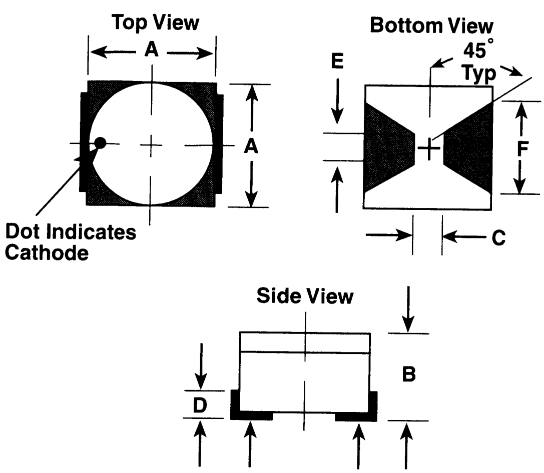
Ordering Information

These GaAs tuning varactors are available in either case style as shown. When ordering, specify the desired case style by adding the case designation as a suffix to the model number. For example, a MA46H200-1088 specifies a 1.25 gamma hyperabrupt tuning diode in case style 1088.

Case Styles

1056

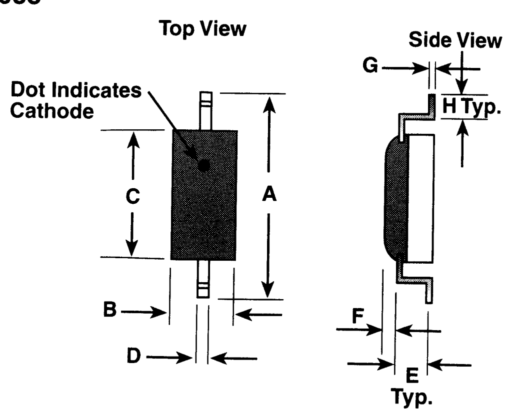


Not to Scale

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.065	0.075	1.72	1.90
B	0.034	0.041	0.86	1.04
C	0.030	0.036	0.76	0.91
D	0.013	0.017	0.33	0.44
E	0.010	0.014	0.25	0.36
F	0.043	0.053	1.09	1.35

Package Capacitance: 0.15 pF Typical
Package Inductance: 0.45 nH Typical

1088



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.175	0.195	4.44	4.95
B	0.040	0.050	1.02	1.27
C	0.085	0.095	2.16	2.41
D	0.015	0.025	0.38	0.64
E	0.010	0.015	0.25	0.38
F	0.015	0.020	0.38	0.51
G	0.004	0.006	0.10	0.15
H	0.020	0.030	0.51	0.76
J	0.013	0.033	0.33	0.84
K	0.003	0.005	0.08	0.13

Package Capacitance: 0.13 pF Typical
Package Inductance: 0.50 nH Typical

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Beam Lead Constant Gamma GaAs Tuning Varactors

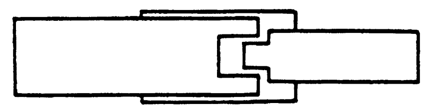
MA46580 thru 589 Series

V 2.00

Features

- Gamma of 1.0 and 1.25 Available
- Constant Gamma for Linear Tuning
- Strong Beam Construction
- Low Parasitic Capacitance
- High Q
- Close Capacitance Tracking
- Minimum 10 Gram Beam Strength

Case Style 992



Description

The MA46580 through 589 series of beam lead constant gamma tuning varactors are hyperabrupt junction gallium arsenide diodes with a constant gamma of 1.0 or 1.25. The high Q values and elimination of package parasitics make these varactors very attractive for voltage controlled oscillators that require linear tuning. These tuning diodes are useful at frequencies as high as 40 GHz.

The beam lead design eliminates almost all package parasitics resulting in improved linearity of the junction capacitance change with voltage. This improves tracking between diodes and can improve VCO linearity.

The standard capacitance tolerances is ±20%. Tighter tolerances of ±10% and ±5% are available. Matched pairs or sets are also available with the above tolerances.

Applications

These beam lead constant gamma tuning varactors are particularly useful in broadband VCOs, where linear frequency tuning is an important feature. They are also very useful for FM modulating a source for telecommunication transmitters and in many cases such circuits can be designed without a linearization circuit.

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Specifications @ T_A = +25°C

Minimum Voltage Rating 18 Vdc[2,4] Gamma = 1.25 ± 10% From 2-12 Volts						
Model Number	MA46580	MA46581	MA46582	MA46583	MA46584	Units
Q at 4 Volts[3]	3000	3000	2500	2000	2000	(Typ.)
C_T at 4 Volts[1]	0.5	0.7	1.0	1.5	2.0	pF (± 20%)
$\frac{CT_2}{CT_{12}}$	4.5:1 / 6.5:1	4.5:1 / 6.5:1	4.5:1 / 6.5:1	4.5:1 / 6.5:1	4.5:1 / 6.5:1	Min. / Max.

Minimum Voltage Rating 18 Vdc[2,4] Gamma = 1.0 ± 10% from 2-12 Volts						
Model Number	MA46585	MA46586	MA46587	MA46588	MA46589	Units
Q at 4 Volts[3]	3000	3000	2500	2000	2000	(Typ.)
C_T at 4 Volts[1]	0.5	0.7	1.0	1.5	2.0	pF (± 20%)
$\frac{CT_2}{CT_{12}}$	3.2:1 / 5.2:1	3.2:1 / 5.2:1	3.2:1 / 5.2:1	3.2:1 / 5.2:1	3.2:1 / 5.2:1	Min. / Max.

Notes:
1. Capacitance is measured at 1 MHz.
2. All junctions are hyperabrupt with nominal y = 1.0 or 1.25.
3. Diode Q is measured at 3 GHz and at -4 volts and extrapolated to 50 MHz. Tested in M/A-COM's microstrip test fixture.
4. Maximum leakage current: I_R - 20 nA max. at -14V and 25°C
   I_R - 10 μA max. at -18V and 25°C

Ordering Information

Units available only in case style 992. See appendix for complete dimensions.

Maximum Ratings

Operating Temperature	-65° to 150°C
Storage Temperature	-65° to 200°C
Reverse Voltage	18 Volts
Power Dissipation	25 mW at 25°C
Beam Strength	10 grams min.

Environmental Ratings PER MIL-STD-750

	MIL Method	Level
Storage Temp.	1031	See maximum ratings
Temperature Cycle	1051	10 cycles, -65° to +175°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

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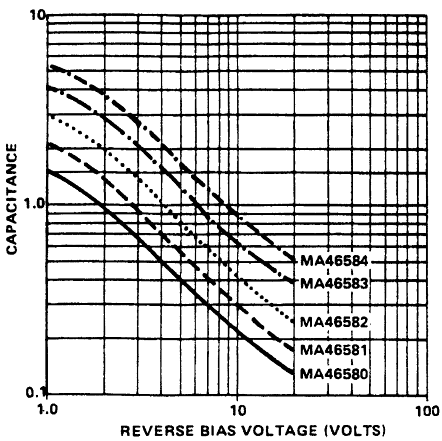
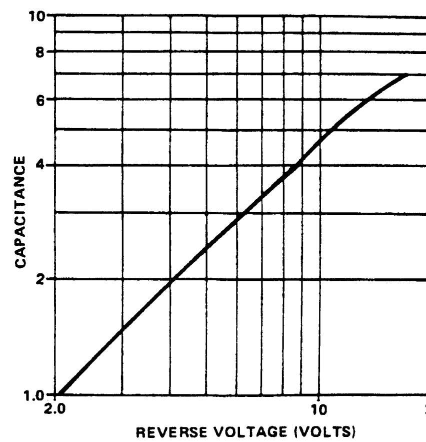
Typical Performance Curves

CAPACITANCE vs VOLTAGE

GAMMA = 1.25 ± 10% FROM 2-12 VOLTS

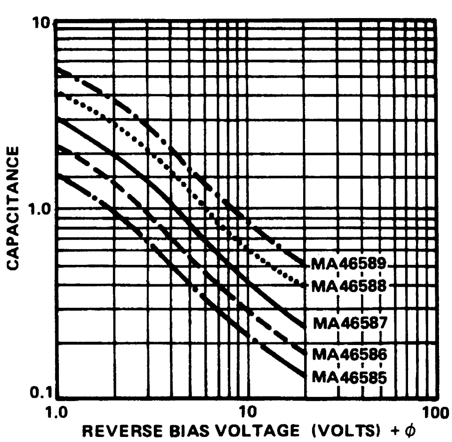


CAPACITANCE RATIO C_{T-2}/C_{TV} (MA46580 THRU 589)

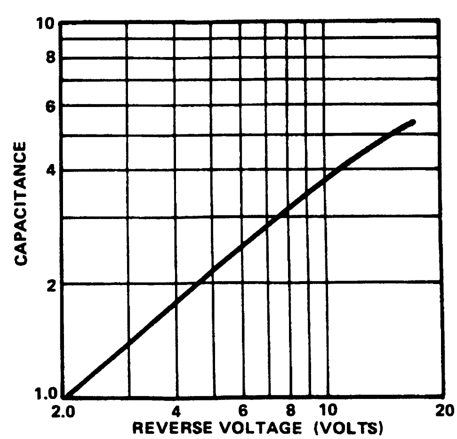


CAPACITANCE vs VOLTAGE

Gamma = 1.0 ± 10% from 2-12 Volts



CAPACITANCE RATIO C_{T-2}/C_{TV} (MA46580 THRU 589)



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GaAs Abrupt Tuning Varactors

MA46600 Series

V 2.00

Features

- Highest Q
- Large Capacitance Variation with Voltage
- Custom Tailored Designs Available on Request

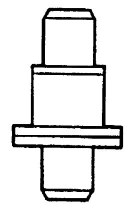
Description

The MA46600 series of microwave tuning varactors is a family of abrupt junction gallium arsenide devices featuring Q factors in excess of 8000. This series is specifically designed for broadband high Q tuning performance (up to 8000 at -4 volts and 50 MHz) from L through Ka band. Characteristics such as high reliability, low leakage and close capacitance tracking between diodes are typical of these devices. Standard capacitance matching is ± 10%, but closer matching is available upon request. All diode types are available in a wide selection of ceramic packages as well as in chip form.

Applications

The MA46600 series of tuning varactors can be used for both broad and narrow band tuning through Ka-band. Typical applications include solid state tuning of VCOs using transistors or Gunns as well as voltage tunable filters and amplifier circuits. The GaAs abrupt junction tuning varactors offer the highest Q of any tuning varactors and are utilized in high frequency applications where Q is premium.

Case Styles



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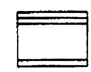

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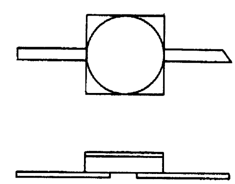

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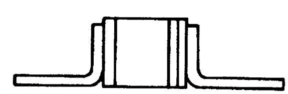

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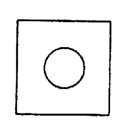

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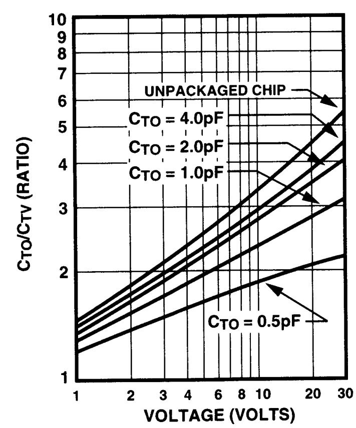
Specifications @ T_A= +25°C

Model Number	Reverse[6] Voltage (Volts)	C_{T4}[1,2] ± 10% (pF)	Q @ -4 Volts (Typical)	Ratio[1, 2] C_{T0}/C_{TV_B} (pF) (Typical)
MA46600	30	0.3	8000	1.9
MA46601	30	0.4	7500	2.1
MA46602	30	0.5	7000	2.5
MA46603	30	0.6	6500	2.8
MA46604	30	0.8	6000	3.2
MA46605	30	1.0	5700	3.4
MA46607	30	1.5	5000	3.8
MA46609	30	2.2	4000	4.0

Notes:
1. Capacitance is measured at 1 MHz on a bridge which has been balanced with shielded test holders connected in place but open circuited.
2. All GaAs tuning varactors are available in any case style shown in this bulletin as well as in chip form. When ordering, specify the desired case by adding the case designation as a suffix to the model number, i.e., MA46601-30. For example, a MA46601-30 specifies a 30 volt tuning diode in a case style 30 with a C_{T14} between .36 and .44 pF and a Q at -4 volts and 50 MHz ≥7500. The capacitance values and capacitance ratios are for case style 30. Other case styles or chips will have slightly different values.
3. All junctions are abrupt i.e., y = 0.50 ± .03.
4. Total capacitance ratios will vary with case choice due to differences in case capacitance (Cp). Figure 1 shows the ratio for the 30 case style.
5. Case parasitics (C_p and L_S) are given for most case styles.
6. Breakdown voltage (V_B) is specified at -10 µA.

Typical Performance Curve

CAPACITANCE CHANGE RATIOS FOR GaAs TUNING VARACTORS IN CASE STYLE 30



Maximum Ratings

Temperature: **Operating** **Storage**	 -65°C to + 175°C -65°C to + 200°C
Voltage	See Breakdown Voltage
Power Dissipation **(derate linearly to zero at 200°C)**	Cj < 1.0 pF max. @ 50 mW Cj ≥ 1.0 pF min. @ 100 mW

Environmental Ratings

	Method	Levels
Temperature, Storage	1031	See Maximum Ratings
Temperature, Cycling	1051	5 cycles, -65 to + 150 C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Moisture Resistance	1021	10 days

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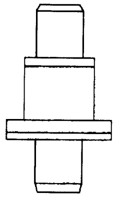
Case Styles (See appendix for complete dimensions)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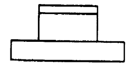
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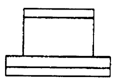
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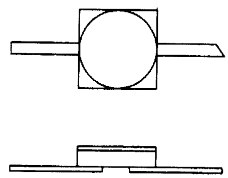
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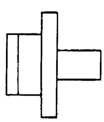
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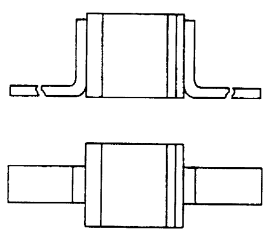
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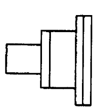
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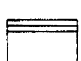
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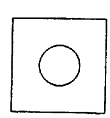
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Specifications Subject to Change Without Notice.

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GaAs Constant Gamma Hyperabrupt Tuning Varactors MA46410 thru 480 Series

V 2.00

Features

- Constant Gamma = 1.0, 1.25 or 1.5
- High Q (up to 4000 at -4 Volts)
- Larger Capacitance Change with Voltage
- More Linear Frequency Tuning
- High and Nearly Constant Modulation Sensitivity

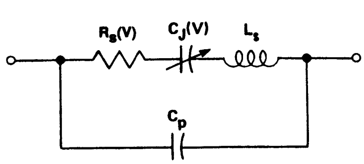
Description

The MA46450, MA46470 and MA46410 series of tuning varactors are hyperabrupt junction Gallium Arsenide diodes featuring constant gamma 1.0 (MA46450 series), 1.25 (MA46470 series) or 1.5 (MA46410 series). These diodes offer high Q (up to 4000) permitting excellent tuning performance from VHF through Ka band. Each part in this series exhibits the large change in capacitance versus bias voltage characteristic of hyperabrupt junctions. The standard capacitance tolerance is ±10%, with tighter tolerances available. Capacitance matching at one or more bias voltages is also available. All diode types are available in a wide selection of ceramic packages and in chip form.

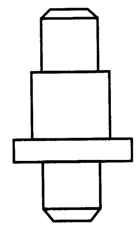
Applications

The constant gamma value of 1.0, 1.25 or 1.5 available with these diodes enables the circuit designer to produce significant improvements in circuit performance. Constant gamma tuning varactors permit more linear VCO frequency tuning than do conventional hyperabrupt tuning varactors. These varactors are particularly well suited for use in voltage tuned filters, analog phase shifters, and modulator circuits.

PACKAGED TUNING VARACTOR EQUIVALENT CIRCUIT



Case Styles



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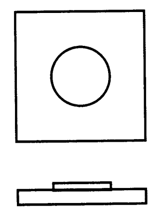

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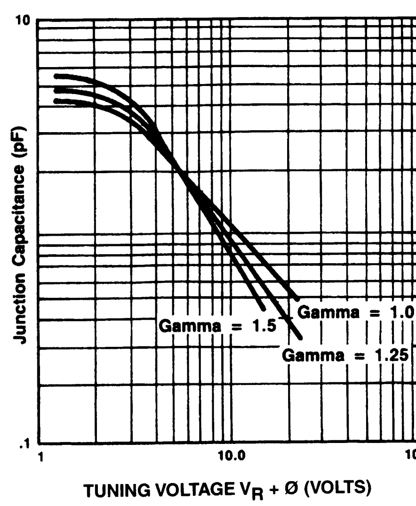
TYPICAL JUNCTION CAPACITANCE vs TUNING VOLTAGE



Specifications @ T_A = +25°C

MA46450 Series Gamma = 1.0

Reverse Voltage[6] = 22 Volts minimum
Gamma[4] = 0.9 - 1.1, V_R = 2 - 20 Volts
Junction Capacitance Ratio (C_{J2}/C_{J20}) = 5.0 - 8.0

Model Number	Cases[1] Style	Total[2, 3, 5, 7] Capacitance @ -4 Volts Min./Max. (pF)	Total Capacitance[7] Ratio (2/20) Min./Max.	50 MHz Q at -4 Volts Typical
MA46450	30	0.5	2.0-3.8	4000
MA46451	30	0.7	2.9-4.4	4000
MA46452	30	1.0	3.6-5.2	3000
MA46454	30	1.5	3.8-5.5	3000
MA46455	30	1.8	4.1-6.1	3000
MA46457	30	2.2	4.1-6.1	3000
MA46459	30	3.3	4.5-6.7	2000
MA46461	30	4.7	4.8-7.2	1500

MA46410 Series Gamma = 1.5

Breakdown Voltage[6] = 18 Volts minimum
Gamma[4] = 1.4 - 1.6, V_R = 2 - 12 Volts
Junction Capacitance Ratio (C_{J2}/C_{J12}) = 6.2 - 10.8[4]

Model Number	Case[1] Style	Total[2, 6, 7] Capacitance @ -4 Volts Min./Max. (pF)	Total Capacitance[7] Ratio (2/12) Min./Max.	50 MHz Q at -4 Volts Typical
MA46410	30	0.45-0.60	2.7-4.3	3000
MA46413	30	0.90-1.10	4.2-5.7	2500
MA46416	30	1.62-1.98	5.2-4.9	2500
MA46418	30	2.42-2.97	5.7-7.6	1800
MA46420	30	3.33-4.22	6.0-8.1	1800
MA46421	30	4.22-5.17	6.2-8.3	1200
MA46422	30	5.04-6.16	6.3-8.4	1200
MA46425	30	9.00-11.00	6.6-8.8	1200

Maximum Ratings

Operating Temperature*	-65°C to +175°C
Storage Temperature	-65°C to +200°C
Reverse Voltage	Breakdown Voltage

* The maximum storage and operating temperature of the plastic 1088 case style is 125°C.

Environmental Ratings PER MIL-STD-750

	MIL Method	Level
Storage Temperature	1031	See maximum ratings
Temperature Cycle	1051	10 cycles, -65°C to +175°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Specifications Subject to Change Without Notice.

MA46470 Series Gamma = 1.25

Reverse Voltage[6] = 22 Volts minimum
Gamma[4] = 1.13 - 1.38, V_R = 2 - 20 Volts
Junction Capacitance Ratio (C_{J2}/C_{J20}) = 8.15 - 12.99

Model Number	Case[1] Style	Total[2, 3, 5, 7] Capacitance @ -4 Volts Min./Max. (pF)	Total Capacitance[7] Ratio (2/20) Min./Max.	50 MHz Q at -4 Volts Minimum
MA46470	30	0.5	2.2/4.1	4000
MA46471	30	0.7	3.6/5.6	4000
MA46472	30	1.0	4.8/7.4	3000
MA46473	30	1.2	4.8/7.4	3000
MA46474	30	1.5	5.0/7.4	3000
MA46475	30	1.8	6.6/8.7	3000
MA46476	30	2.0	6.6/8.7	3000
MA46477	30	2.2	6.6/8.7	3000
MA46478	30	2.7	6.4/10.0	2000
MA46479	30	3.3	6.4/10.0	2000
MA46480	30	3.7	6.8/11.0	2000
MA46481	30	4.7	6.9/11.1	1500
MA46482	30	5.6	7.2/11.5	1500
MA46483	30	6.8	7.2/11.5	1500
MA46484	30	8.2	7.2/11.5	1500
MA46485	30	10.0	7.5/12.0	1500

Notes:
1. All GaAs tuning varactors are available in chip form as well as the case styles shown on the following page. When ordering, specify the desired case by adding the case designation as a suffix to the type number.
2. Case parasitics (C_p and L_s) are given for most case styles along with case outlines in the appendix. The Cp values listed typically have tolerances of ±0.02 pF.
3. The nominal tolerance at -4 Volts is ± 10%. Closer tolerances are available upon request. By adding the suffix A to the part number, a tolerance of ± 5% at -4 Volts is guaranteed.
4. The values guaranteed for gamma are measured on unpackaged chips. The total capacitance versus bias voltage curve will deviate slightly from the chip capacitance versus bias voltage curve due to the package parasitic capacitance (Cp).
5. Capacitance is measured at 1 MHz.
6. Reverse voltage (V_B) is measured at 10 microamps.
7. The total capacitance and capacitance ratios shown are for diodes housed in case style 30. Other case styles will result in different values.

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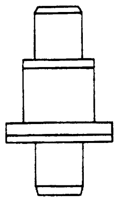
Case Styles (See appendix for complete dimensions)



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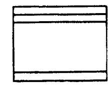

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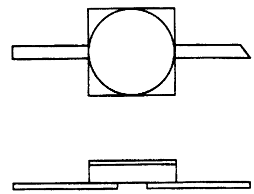

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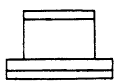

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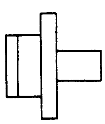

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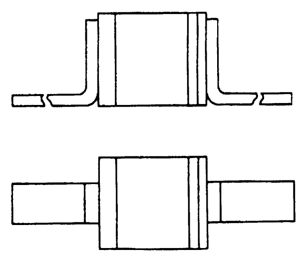

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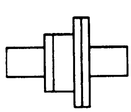

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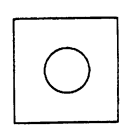

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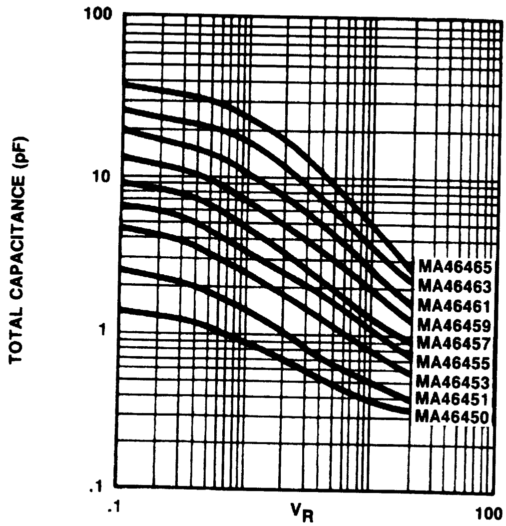
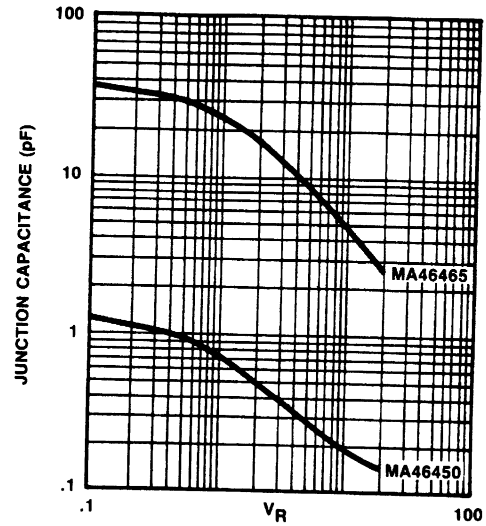
Typical Performance Curves

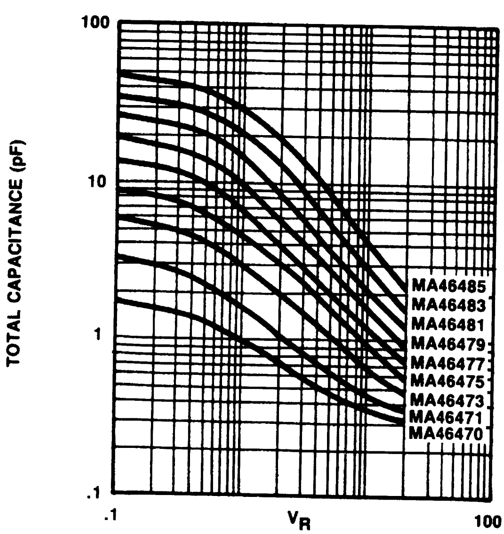
TOTAL CAPACITANCE vs REVERSE BIAS VOLTAGE (γ = 1.0)
(CASE STYLE 30)



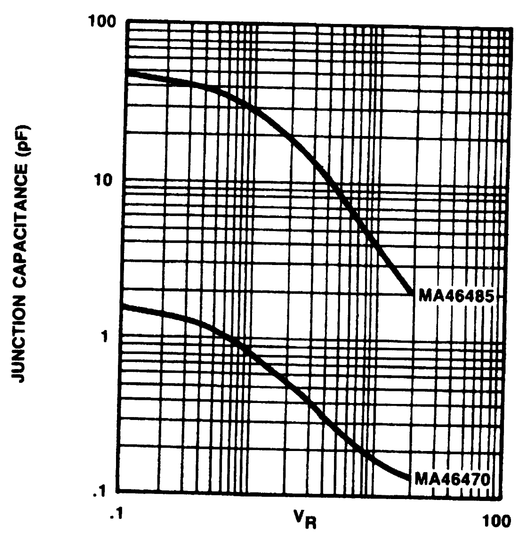
JUNCTION CAPACITANCE vs REVERSE BIAS VOLTAGE (γ = 1.0)
(MA46450)



TOTAL CAPACITANCE vs REVERSE BIAS VOLTAGE (γ = 1.25)
(CASE STYLE 30)



JUNCTION CAPACITANCE vs REVERSE BIAS VOLTAGE
(γ = 1.25)



Specifications Subject to Change Without Notice.

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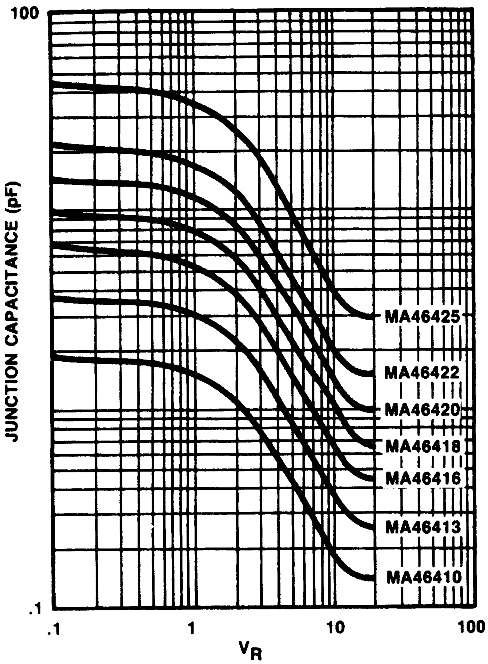
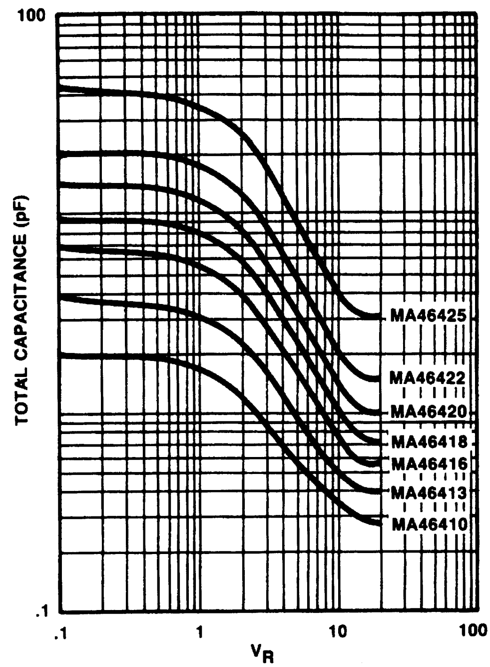
Typical Performance Curves (Con't)

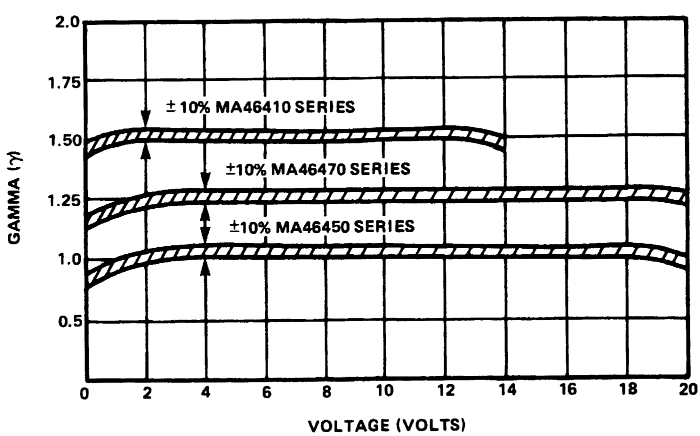
JUNCTION CAPACITANCE vs REVERSE BIAS VOLTAGE ($\gamma = 1.5$)



TOTAL CAPACITANCE vs REVERSE BIAS VOLTAGE ($\gamma = 1.5$) (CASE STYLE 30)



GAMMA vs VOLTAGE



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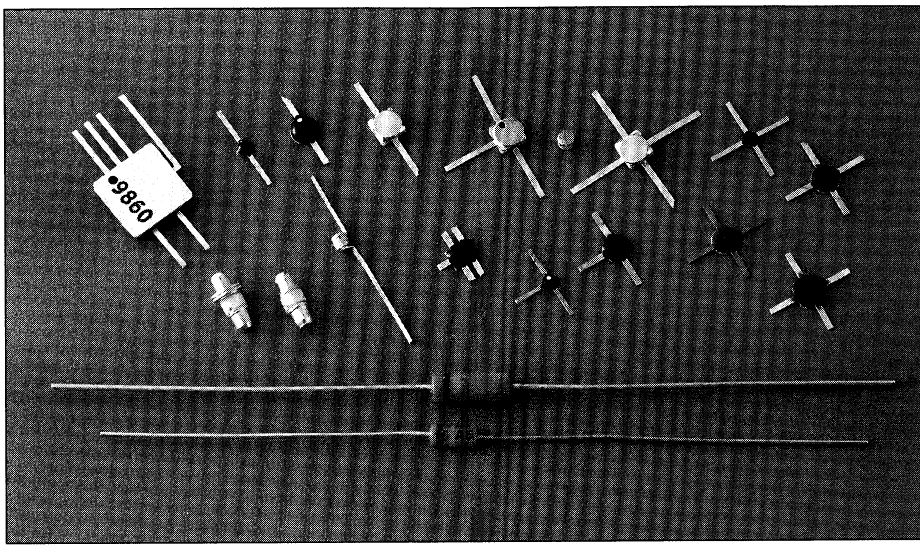
Schottky Diodes



Schottky Diodes Selection Guide Table of Contents

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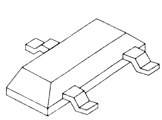
Surface Mount Schottky Diodes

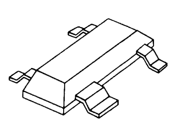
Suggested Frequency Range (GHz)	Voltage Rating (V)	Capacitance Maximum C_T (pF)	Forward Voltage @ 1 mA (V)	Single SOT-23	Series Pairs SOT-23	Common Cathode SOT-23	Unconnected Pair SOT-143	Page No.
Chip Electrical Characteristics				Wiring Diagrams				
General Purpose Schottky Diodes								
DC - 1.5	70	2.0	0.410	MA4CS101A	-	-	MA4CS101E	5-6
DC - 1.5	20	1.2	0.410	MA4CS103A	MA4CS103B	-	-	5-6
DC - 1.5	8	1.0	0.36	MA4CS102A	MA4CS102B	MA4CS102C	MA4CS102E	5-6

Suggested Frequency Range (GHz)	Voltage Rating (V)	Capacitance Maximum CT (pF)	Forward Voltage @ 1 mA (V)	Single	Series Pair (KB)	Series Pair (KC)	Page No.
Chip Electrical Characteristics				Wiring Diagrams			
X-Band Low Barrier Mixer/Detector Diodes							
2-12	3	0.25	0.250	MA4E1245KA	MA4E1245KB	MA4E1245KE	5-1

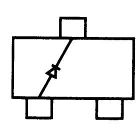
Stocked at your local distributor.



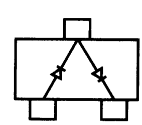
SOT-23



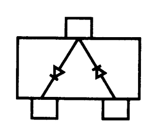
SOT-143



Single



Series Pair



Series Pair MA4E1245KE

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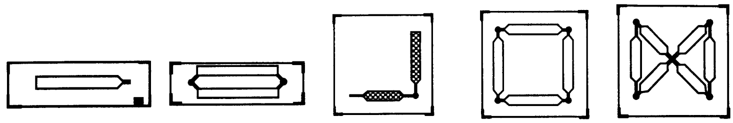
Schottky Mixer Diodes



Suggested Frequency Range (GHz)	Barrier Height	Single Diode	Anti-Parallel	Series Tee	Ring Quad	Crossover Quad	Page No.
Surmount™ (Beamless Beam Leads)							
0 - 3	Low	-	-	-	MA4E2532L	MA4E2544L	5 - 11
3 - 6	Low	MA4E2502L	-	-	MA4E2532L	MA4E2544L	5 - 11
6 - 12	Low	MA4E2502L	-	MA4E2515L	MA4E2532L	MA4E2544L	5 - 11
12 - 18	Low	MA4E2503L	MA4E2508L	MA4E2515L	MA4E2533L	MA4E2545L	5 - 11
18 - 26	Low	MA4E2503L	MA4E2508L	-	-	-	5 - 11

Beam Leads				Chips			
Suggested Frequency Range (GHz)	Barrier Height	Single Beam Lead	Page No.	Suggested Frequency Range (GHz)	5 Junction Bondable	Single Junction	Page No.
Surmount™ Beam Lead and Chip Diodes							
0 - 3	Low	-	-	0 - 3	-	MA4E968	5 - 17
0 - 3	Medium	-	-	0 - 3	-	MA4E969	5 - 17
3 - 6	Low	MA40132	5 - 19	3 - 6	MA40437	-	5 - 35
3 - 6	Medium	MA40133	5 - 19	3 - 6	MA40438	-	5 - 35
6 - 12	Low	MA40132	5 - 19	6 - 12	MA40120	-	5 - 17
6 - 12	Medium	MA40133	5 - 19	6 - 12	MA40438	-	5 - 35
12 - 18	Low	MA40131	5 - 19	12 - 18	MA40120	-	5 - 17
12 - 18	Medium	MA40133	5 - 19	12 - 18	MA40170	-	5 - 17

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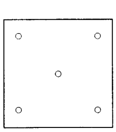

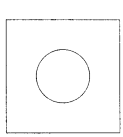

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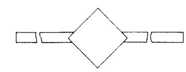
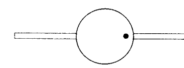
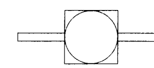
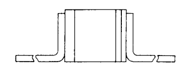
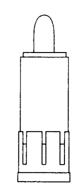
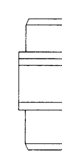
Schottky Mixer Diodes

Suggested Frequency Range (GHz)	Diode Barrier Height	Case Style 137	Case Style 186	Case Style 213	Case Style 276	Page No.
Stripline Mixer Diodes						
2 - 4	Low	MA40433	MA40126	-	-	Section 5
2 - 4	Medium	MA40032	MA40176	MA40048	-	5-46
2 - 4	High	MA40045	-	MA40060	-	5-47
4 - 8	Low	MA40133	MA40126	-	MA40105-276	Section 5
4 - 8	Medium	-	MA40176	-	MA40155-276	Section 5
4 - 8	High	-	MA4E197	-	MA4E185-276	Section 5
8 - 12	Low	MA40180	MA40126	MA40183	MA40105-276	Section 5
8 - 12	Medium	-	MA40176	-	MA40155-276	Section 5
8 - 12	High	-	MA4E197	-	MA4E185-276	Section 5
12-18	Low	-	-	-	MA40115-276	5-46
12-18	Medium	-	-	-	MA40166-276	5-46
12-18	High	-	-	-	MA4E190-276	5-47
18-26	Low	-	-	-	MA4E914-276	5-46
18-26	Medium	-	-	-	MA4E920-276	5-46
18-26	High	-	-	-	MA4E926-276	5-47

Frequency Range (GHz)	Diode Barrier Height	Waveguide	Ceramic	Pill	Page No.
Waveguide Mixer Diodes					
2 - 4	Low	-	MA40418	-	5-24
2 - 4	Medium	MA40051G	MA40021	-	5-50
2 - 4	High	-	MA40055	-	5-50
4 - 8	Low	-	MA40100	MA40105	5-49
4 - 8	Medium	MA40071G	MA40150	MA40155	5-50
4 - 8	High	-	MA4E180	MA4E185	5-50
8 - 12	Low	-	MA40100	MA40105	5-49
8 - 12	Medium	MA40071E	MA40150	MA40155	5-50
8 - 12	High	-	MA4E180	MA4E185	5-50
12-18	Low	-	MA40110	MA40115	5-49
12-18	Medium	-	MA40160	MA40165	5-50
12-18	High	-	MA4E188	MA4E190	5-50
18-26	Low	-	MA4E913	MA4E914	5-49
18-26	Medium	-	MA4E919	MA4E920	5-50
18-26	High	-	MA4E925	MA4E926	5-50

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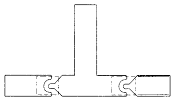
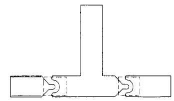
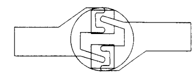
Beam Lead Schottky Diodes



Forward Tee



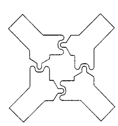
Reverse Tee



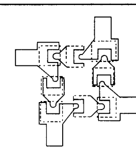
Anti-Parallel Pair

Tees and Anti-Parallel Pair Diodes

Suggested Frequency Range (GHz)	Barrier Height	Forward Tees	Reverse Tees	Page No.	Anti-Parallel Pairs	Page No.
2 - 6	Low	MA4E201L	MA4E974L	5 - 30	-	-
2 - 6	Medium	MA4E201M	MA4E974M	5 - 30	-	-
2 - 6	High	MA4E201H	MA4E974H	5 - 30	-	-
6 - 12	Low	MA4E204L	MA4E975L	5 - 30	MA40279L	5 - 28
6 - 12	Medium	MA4E204M	MA4E975M	5 - 30	MA40279M	5 - 28
6 - 12	High	MA4E204H	MA4E975H	5 - 30	MA40279H	5 - 28
12 - 18	Low	MA4E207L	MA4E976L	5 - 30	MA40278L	5 - 28
12 - 18	Medium	MA4E207M	MA4E976M	5 - 30	MA40278M	5 - 28
12 - 18	High	MA4E207H	MA4E976H	5 - 30	MA40278H	5 - 28



Ring and Bridge Quads



Dual Ring Quads

Ring and Bridge Quad Diodes

Suggested Frequency Range (GHz)	Barrier Height	Ring Quads	Page No.	Dual Ring Quads	Page No.	Bridge Quads	Page No.
0.1 - 2	Low	-	-	-	-	MA4E402L	5 - 32
0.1 - 2	Medium	-	-	-	-	MA4E402M	5 - 32
0.1 - 2	High	-	-	MA40482-905	5 - 36	MA4E402H	5 - 32
2 - 6	Low	MA40437	5 - 35	-	-	MA4E402L	5 - 32
2 - 6	Medium	-	-	-	-	MA4E402M	5 - 32
2 - 6	High	-	-	MA40483-905	5 - 36	MA4E402H	5 - 32
6 - 12	Low	MA40284	5 - 35	-	-	MA4E401L	5 - 32
6 - 12	Medium	MA40450	5 - 35	-	-	MA4E401M	5 - 32
6 - 12	High	-	-	MA40483-905	5 - 36	MA4E401H	5 - 32
12 - 18	Low	MA40284	5 - 35	-	-	MA4E400L	5 - 32
12 - 18	Medium	MA40450	5 - 35	-	-	MA4E400M	5 - 32
12 - 18	High	-	-	-	-	MA4E400H	5 - 32

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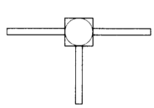
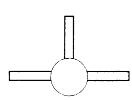
Schottky Diode Tees

Suggested Frequency Range (GHz)	Barrier Height	Hermetic	Plastic	Mini Tee	Page No.
Forward Tee Diodes					
0.1 - 2	Low	MA4E201L-270	MA4E201L-272	MA4E201L-1000	5-30
0.1 - 2	Medium	MA4E201M-270	MA4E201M-272	MA4E201M-1000	5-30
0.1 - 2	High	MA4E201H-270	MA4E201H-272	MA4E201H-1000	5-30
2 - 6	Low	MA4E204L-270	MA4E204L-272	MA4E204L-1000	5-30
2 - 6	Medium	MA4E204M-270	MA4E204M-272	MA4E204M-1000	5-30
2 - 6	High	MA4E204H-270	MA4E204H-272	MA4E204H-1000	5-30
6 - 12	Low	MA4E204L-270	MA4E204L-272	MA4E204L-1000	5-30
6 - 12	Medium	MA4E204M-270	MA4E204M-272	MA4E204M-1000	5-30
6 - 12	High	MA4E204H-270	MA4E204H-272	MA4E204H-1000	5-30
12 - 18	Low	MA4E207L-270	MA4E207L-272	MA4E207L-1000	5-30
12 - 18	Medium	MA4E207M-270	MA4E207M-272	MA4E207M-1000	5-30
12 - 18	High	MA4E207H-270	MA4E207H-272	MA4E207H-1000	5-30
Reverse Tee Diodes					
0.1 - 2	Low	MA4E974L-270	MA4E974L-272	MA4E974L-1000	5-30
0.1 - 2	Medium	MA4E974M-270	MA4E974M-272	MA4E974M-1000	5-30
0.1 - 2	High	MA4E974H-270	MA4E974H-272	MA4E974H-1000	5-30
2 - 6	Low	MA4E975L-270	MA4E975L-272	MA4E975L-1000	5-30
2 - 6	Medium	MA4E975M-270	MA4E975M-272	MA4E975M-1000	5-30
2 - 6	High	MA4E975H-270	MA4E975H-272	MA4E975H-1000	5-30
6 - 12	Low	MA4E975L-270	MA4E975L-272	MA4E975L-1000	5-30
6 - 12	Medium	MA4E975M-270	MA4E975M-272	MA4E975M-1000	5-30
6 - 12	High	MA4E975H-270	MA4E975H-272	MA4E975H-1000	5-30
12 - 18	Low	MA4E976L-270	MA4E976L-272	MA4E976L-1000	5-30
12 - 18	Medium	MA4E976M-270	MA4E976M-272	MA4E976M-1000	5-30

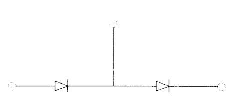


Hermetic

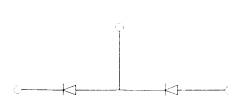


Plastic

Mini Tee



Forward Tee



ReverseTee

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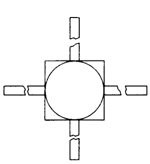
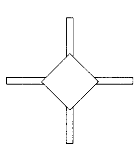
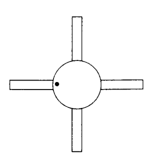
Schottky Ring Quad Diodes

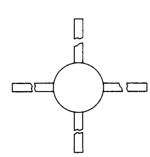
Suggested Frequency Range (GHz)	Barrier Height	Hermetic	Plastic Encapsulated	Plastic	Broadband	Low Cost	Page No.
Single Ring Quad Diodes							
0.1 - 2	Low	MA40430	MA40431	MA40432	-	MA40430-1008	5 - 35
0.1 - 2	Medium	MA40440	-	MA40442	-	MA40446-1008	5 - 35
0.1 - 2	High	MA40490	-	MA40449	-	MA40490-1008	5 - 35
2 - 6	Low	MA40433	MA40434	-	-	MA40433-1008	5 - 35
2 - 6	Medium	MA40443	MA40444	-	-	MA40443-1008	5 - 35
2 - 6	High	MA40493	-	-	-	MA40493-1008	5 - 35
6 - 12	Low	-	MA40436	-	MA40284	-	5 - 35
6 - 12	Medium	-	MA40446	-	MA40285	-	5 - 35
6 - 12	High	-	MA40496	-	MA40286	-	5 - 35
12 - 18	Low	-	-	-	MA40284	-	5 - 35
12 - 18	Medium	-	-	-	MA40285	-	5 - 35
12 - 18	High	-	-	-	MA40286	-	5 - 35

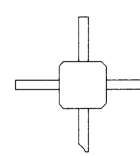
Suggested Frequency Range (GHz)	Barrier Height	Crossover Quad	Hermetic	Plastic Encapsulated	Plastic	Broadband	Low Cost	Page No.
Crossover and Dual High Barrier Ring Quad Diodes								
0.1 - 2	Medium	MA40472	-	-	-	-	-	5 - 36
0.1 - 2	High	-	-	MA40482	MA40482	-	MA40482	5 - 36
2 - 6	Medium	MA40471	-	-	-	-	-	5 - 36
2 - 6	High	-	MA40482	MA40482	MA40482	-	-	5 - 36
6 - 12	High	-	-	-	-	MA40483	-	5 - 36

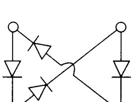

Hermetic

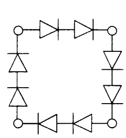

Plastic Encapsulated

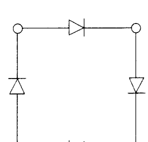

Plastic


Broadband


Crossover Quad and Low Cost


Crossover Quad


Dual, High Barrier Quad


Single Ring Quad

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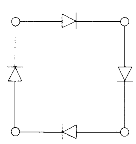
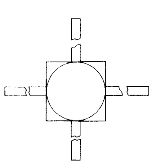
Schottky Bridge Quad Diodes

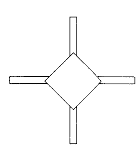
Suggested Frequency Range (GHz)	Barrier Height	Hermetic	Plastic Encapsulated	Plastic	Broadband	Page No.
0.1 - 2	Low	MA402L-226	MA402L-227	MA402L-228	-	5 - 32
0.1 - 2	Medium	MA402M-226	MA402M-227	MA402M-228	-	5 - 32
0.1 - 2	High	MA402H-226	MA402H-227	MA402H-228	-	5 - 32
2 - 6	Low	MA402L-226	MA402L-227	MA402L-228	-	5 - 32
2 - 6	Medium	MA402M-226	MA402M-227	MA402M-228	-	5 - 32
2 - 6	High	MA402H-226	MA402H-227	MA402H-228	-	5 - 32
6 - 12	Low	-	MA401L-227	-	MA4E401L-963	5 - 32
6 - 12	Medium	-	MA401M-227	-	MA4E401M-963	5 - 32
6 - 12	High	-	MA401H-227	-	MA4E401H-963	5 - 32
12 - 18	Low	-	MA400L-227	-	MA4E400L-963	5 - 32
12 - 18	Medium	-	MA400M-227	-	MA4E400M-963	5 - 32
12 - 18	High	-	MA400H-227	-	MA4E400H-963	5 - 32



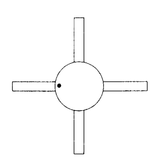
Single Ring Quad



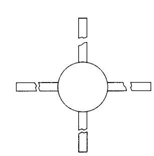
Hermetic



Plastic Encapsulated



Plastic



Broadband

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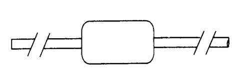
Axial Lead Schottky Diodes

Voltage Rating (V)	Capacitance Max. (pF)	V_F @ 1 mA (V)	Current Max. (mA)	M/A-COM Part No.	JEDEC Part No.	Page No.
General Purpose (Switching) Schottky Diodes						
70	2.0	0.41	15	-	1N5711	5 - 39
30	1.0	0.40	75	MA4E2812	1N5712	5 - 39
20	1.0	0.40	35	MA4E2303	1N5767	5 - 39
15	1.2	0.41	20	MA4E2811	1N5713	5 - 39
8	1.0	0.34	30	MA4E2835	-	5 - 39

Suggested Frequency Range (GHz)	Barrier Height	Noise Figure (dB)	Part No.	Page No.
Axial Lead Mixer Diodes				
DC - 1.5	Low	5.5	MA40103	5 - 43
DC - 1.5	Medium	5.5	MA4882	5 - 43
1.5 - 4	Medium	6.5	MA4853	5 - 43
4 - 10	Medium	6.5	MA40153	5 - 43

Suggested Frequency Range (GHz)	Nominal Tss (dBm)	Part No.	Page No.
Axial Lead P Type Detector Diodes			
DC - 3	-55	MA40053	5 - 60

Stocked at your local distributor.



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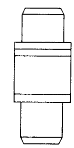
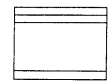
GaAs Schottky Mixer Diodes

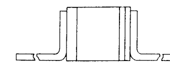
Suggested Frequency Range (GHz)	Ceramic	Pill	Stripline	Page No.
Hermetic Single Diodes				
12 - 26	MA40403	MA40407	MA40411	5-23
26 - 40	MA40404	MA40408	MA40412	5-23



Ceramic



Pill

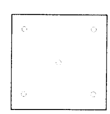


Stripline

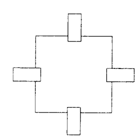
Suggested Frequency Range (GHz)	Chips	Single	Page No.	Anti-Parallel	Ring Quads	Page No.
Beam Leads						
12 - 18	MA40414	MA40415	5-23	-	MA40419-1108	5-23
18 - 26	MA40414	MA40415	5-23	MA40422	MA40419-1108	5-23
26 - 40	MA40414	MA40416	5-23	MA40422	-	5-23
40 - 100	-	MA40417	5-23	-	-	5-23

Anti-Parallel

Single

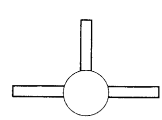


Chip

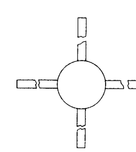


1108

Suggested Frequency Range (GHz)	Tees Non Hermetic	Ring Quads Hermetic Miniquad	Bridge Quads Hermetic Miniquad	Page No.
Tees and Quads				
8 - 18	MA40421	MA40419	MA40418	5-24
18 - 26	-	MA40419	-	5-24



Tee



Quad

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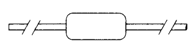
Packaged Schottky Diodes
Detector & Power Monitor Diodes

Suggested Frequency Band (GHz)	Typical Tss (dBm)	Axial Lead Case Style 54	Coaxial Case Style 119	Pill Case Style 120	Page No.
Packaged Diodes					
0.1 - 3	-55	MA40053	-	-	5-60
3 - 6	-55	MA40053	MA40064	-	5-60
6 - 12	-52	MA40202	MA40201	MA40207	5-60
12 - 18	-50	-	MA40205	MA40215	5-60
18 - 26	-48	-	MA40205	MA40268	5-60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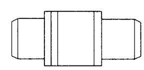
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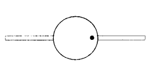
120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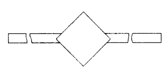
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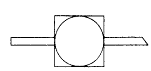
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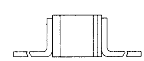
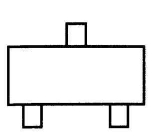
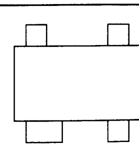

276

Suggested Frequency Band (GHz)	Typical Tss (dBm)	Plastic Case Style 137	Plastic Case Style 213	Hermetic Case Style 186	Hermetic Case Style 276	Page No.
Stripline Packaged Diodes						
0.1 - 3	-55	-	MA40143	MA40261	-	5-61
3 - 6	-55	MA40108	MA40147	MA40261	MA40207-276	5-61
6 - 12	-52	MA40108	MA40147	MA40264	MA40207-276	5-61
12 - 18	-50	-	-	MA40264	MA40215-276	5-61
18 - 26	-48	-	-	-	MA40215-276	5-61

Suggested Frequency Band (GHz)	Typical Tss (dBm)	Single (SOT-23)	Series Pair (SOT-23)	Unconnected Pair (SOT-143)	Page No.
SOT-23 and SOT-143 Packaged Diodes					
0.1 - 3	-55	MA4CS102A	MA4CS102B	MA4CS102E	5 - 6
3 - 6	-55	MA4E1245KA	MA4E1245KB	-	5 - 1
6 - 12	-52	MA4E1245KA	MA4E1245KB	-	5 - 1


SOT-23


SOT-143

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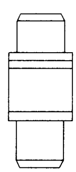
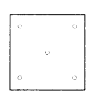
Zero Bias and Low 1/f Noise P-Type Schottky Detector Diodes

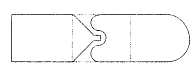
Nominal Frequency Band (GHz)	Nominal Tss (dBm)	Nominal (Rv) (k Ohms)	Ceramic	Chip	Beam Lead	Page No.
Zero Bias Diodes						
0.1 - 10	-50 to 55	0.5 - 1	MA4E929	-	MA40186	5-57
0.1 - 10	-50 to 55	1 - 2	MA4E929A	MA4E931A	-	5-57
0.1 - 10	-50 to 55	2 - 5	MA4E929B	-	MA40186B	5-57
0.1 - 10	-50 to 55	5 - 10	MA4E929C	MA4E931C	MA40187D	5-57
0.1 - 10	-50 to 55	10 - 20	MA4E929D	-	MA40187D	5-57
10 - 18	-50	0.5 - 1	MA4E929	-	MA40186	5-57
10 - 18	-50	1 - 2	MA4E929A	MA4E931A	-	5-57
10 - 18	-50	2 - 5	MA4E929B	-	MA40186B	5-57
10 - 18	-50	5 - 10	MA4E929C	MA4E931C	MA40186C	5-57
10 - 18	-50	10 - 20	MA4E929D	-	MA40186D	5-57



Ceramic

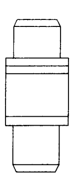


Chip

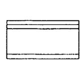


Beam Lead

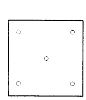
Nominal Frequency Band (GHz)	Nominal Tss (dBm)	Axial Lead	Pill	Hermetic Stripline	Ceramic	Page No.
0.1 - 10	-50 to 55	MA40252	MA40257	MA40257-276	MA40251	5-61



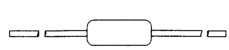
Ceramic



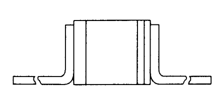
Pill



Chip



Axial Lead



Hermetic Stripline

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Surface Mount Low Barrier X-Band Schottky Diodes

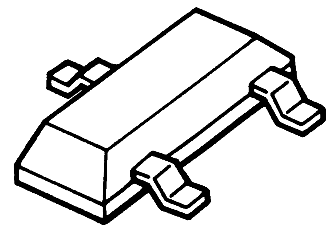
MA4E1245 Series

V 2.00

Features

- Designed for High Volume Low Cost Detector and Mixer Applications
- Low Noise Figure: 5.7 dB (SSB) at X-Band
- High Detector Sensitivity: -55 dBm TSS
- Low Capacitance: 0.25 pF
- Fully Characterized Performance
- Single and Series Pair Configurations
- Available on Tape and Reel

SOT-23



Description

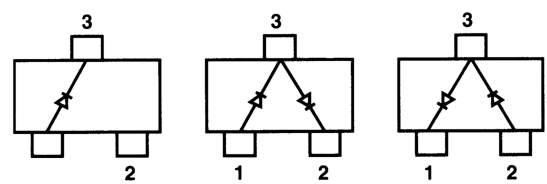
The MA4E1245 series is a low barrier n-type silicon Schottky diode assembled in a low cost surface mount plastic package. It is designed for service as a high performance mixer and detector diode at frequencies from VHF through X-band.

M/A-COM incorporated its HMIC technology in the MA4E1245 series allowing the use of pure glass in conjunction with an offset bond pad, to manufacture a low capacitance, low series resistance, Schottky diode chip. M/A-COM's high volume plastic packaging facility which is capable of manufacturing high quality microwave diode and transistor products is utilized in the production of these components. SPC controls are used during processing to ensure high quality.

The MA4E1245KA is a single element Schottky diode characterized for use as a single ended mixer and detector. The MA4E1245KB and MA4E1245KE incorporate two Schottky chips in the SOT-23 package in series pair configurations. These devices are useful in balanced mixers and detector voltage doubler circuits. Applications for the MA4E1245 series include VSAT and DBS mixers and other frequency converters. Their small size and low cost make them attractive for use in RF tag applications for identification and toll collection.

Configurations

TOP VIEW



SINGLE MA4E1245KA | SERIES PAIR MA4E1245KB | SERIES PAIR MA4E1245KE

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Maximum Ratings

Parameter	Unit	Values
Operating Temperature	°C	-65 to +125
Storage Temperature	°C	-65 to +125
Incident RF Power (CW)	mW	75*
Reverse Voltage @ 25°C	V	3
Soldering Temperature	°C	+260 for 5 sec.

* At 25°C case temperature. Derate linearly to zero watts at 125°C case temperature.

Electrical Specifications @ +25°C

Parameter	Condition	Symbol	Specification
Breakdown Voltage	I_R = 10 µA	V_B	3.0 V min.
Total Capacitance	V_R = 0 F = 1 MHz	C_T	0.25 pF max.
Capacitance Difference*	V_R = 0	ΔC_T	0.04 pF max.
Dynamic Resistance	I_F = 10 mA	R_D	14 Ohms max.
Dynamic Resistance Difference*	I_F = 10 mA	ΔR_D	2 Ohms max.
Forward Voltage	I_F =1 mA	V_F	250 mV min. 350 mV max.
Forward Voltage Difference*	I_F = 1 mA	ΔV_F	20 mV max.

* Applies to MA4E1245KB and MA4E1245KE.

Typical RF Performance @ 25°C

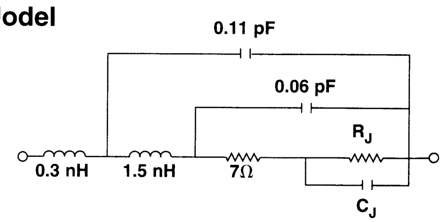
Parameter	Typical Value	Conditions
Mixer Noise Figure[1] IF Impedance	5.7 dB (SSB) 200 ohms	f = 9.375 GHz LO = 0 dBm I_F = 30 MHz
Tangential Signal Sensitivity[2]	-55 dBm	I_F = 20 µA BW = 2 MHz Video NF = 1.5 dB
Detector Output Voltage at -30 dBm[2]	20 mV	R_L = 100K Ohms I_F = 20 µA
Detector Output Voltage at -30 dBm[2]	20 mV	R_L = 1M Ohm Zero Bias

Notes:
1. Fixture tuned to 9.375 GHz.
2. Fixture tuned to 2.5 GHz. See Figure 3 through Figure 6 for untuned fixture performance.

Typical Scattering Parameters

Frequency (GHz)	0 dBm (Zero Bias) S11 Mag.	0 dBm (Zero Bias) S11 Ang.	-30 dBm (Zero Bias) S11 Mag.	-30 dBm (Zero Bias) S11 Ang.	-30 dBm (20 µA Bias) S11 Mag.	-30 dBm (20 µA Bias) S11 Ang.
1.00	0.56	-3.31	0.99	-9.88	0.97	-10.59
1.50	0.54	-13.76	0.99	-15.13	0.97	-15.91
2.00	0.52	-14.54	0.98	-19.94	0.96	-21.32
2.50	0.54	-17.80	0.98	-24.70	0.95	-27.12
3.00	0.50	-28.60	0.98	-29.79	0.95	-32.55
3.50	0.48	-35.04	0.98	-35.58	0.95	-39.21
4.00	0.48	-38.71	0.99	-41.97	0.95	-45.97
5.00	0.41	-54.30	0.97	-54.95	0.94	-60.45
6.00	0.33	-68.19	0.96	-69.62	0.92	-76.48
7.00	0.13	-103.79	0.95	-89.11	0.90	-97.46
8.00	0.07	148.85	0.91	-125.67	0.87	-123.48
9.00	0.20	89.00	0.90	-141.97	0.84	-157.67
10.00	0.29	63.62	0.88	178.71	0.81	158.60
11.00	0.41	51.93	0.87	140.49	0.83	120.07
12.00	0.48	38.25	0.86	99.44	0.82	81.04

Circuit Model



Circuit Model Values

RF Power	R_J (Ω)	C_J (pF)
-30 dBm*	2500	0.090
-3 dBm	300	0.125
0 dBm	170	0.140
3 dBm	100	0.200

* I_F= 20 µA at -30 dBm; I_F= 0 at other power levels.

Spice Model Parameters

IS = 3×10^{-8} A	M = 0.50
RS = 7Ω	EG = 0.69 eV
N = 1.05	BV = 5.0 V
TT = 0 S	IBV = 1×10^{-5} A
CC = 0.08×10^{-12} F	
VJ = 0.85 V	

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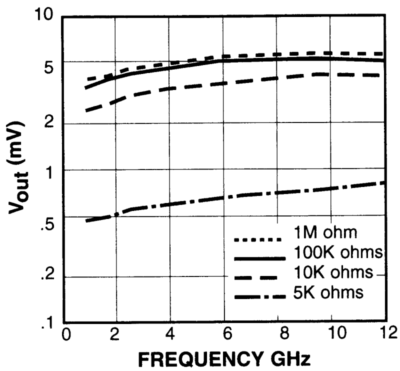
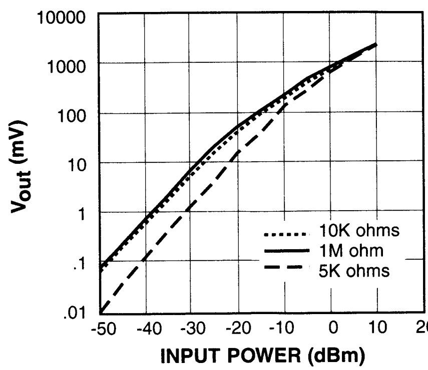
Typical Performance Curves @ 25°C
(MA4E1245KE)

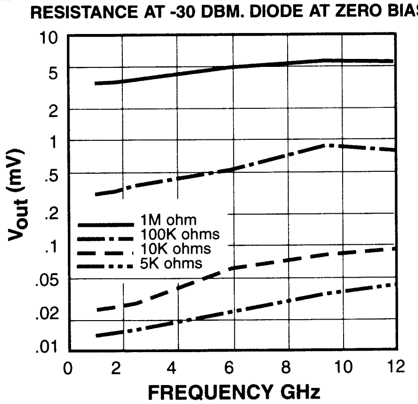
DETECTOR OUTPUT VOLTAGE vs FREQUENCY AND LOAD RESISTANCE AT -30 DBM. DIODE FORWARD BIASED AT 20 μA. UNTUNED FIXTURE.



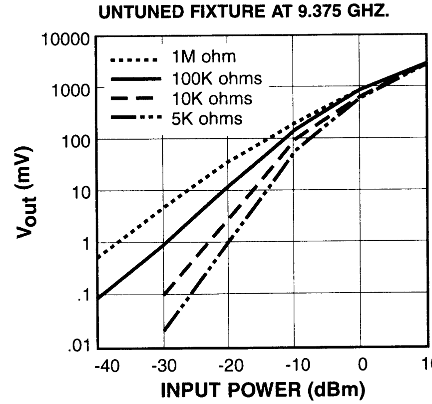
DETECTOR OUTPUT VOLTAGE vs INPUT POWER AND LOAD RESISTANCE. DIODE FORWARD BIASED AT 20 μA. UNTUNED FIXTURE AT 9.375 GHZ.



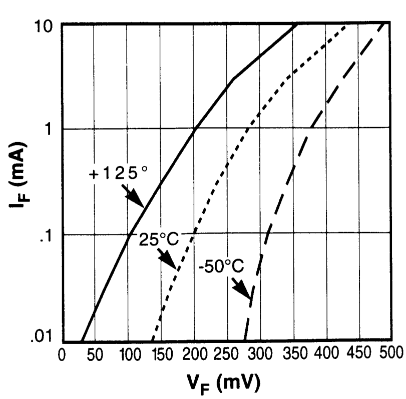
DETECTOR OUTPUT VOLTAGE vs FREQUENCY AND LOAD RESISTANCE AT -30 DBM. DIODE AT ZERO BIAS.



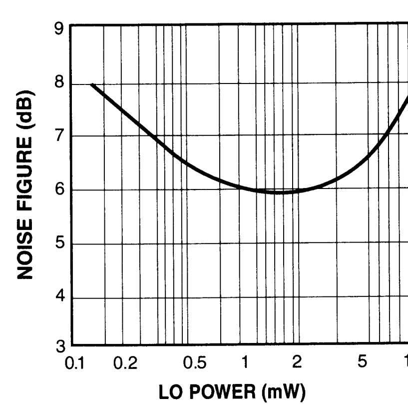
DETECTOR OUTPUT VOLTAGE vs INPUT POWER AND LOAD RESISTANCE. DIODE AT ZERO BIAS. UNTUNED FIXTURE AT 9.375 GHZ.



FORWARD CURRENT vs FORWARD VOLTAGE AND TEMPERATURE.



NOISE FIGURE vs LO POWER AT 9.375 GHZ.



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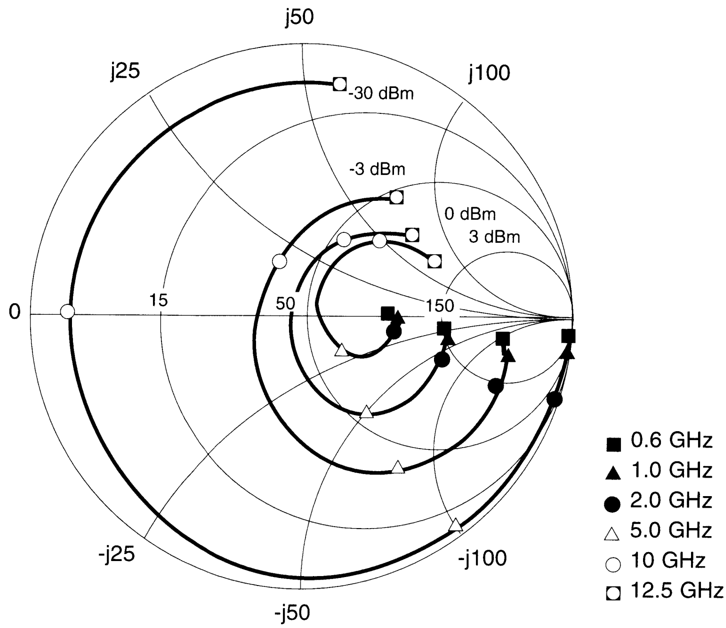
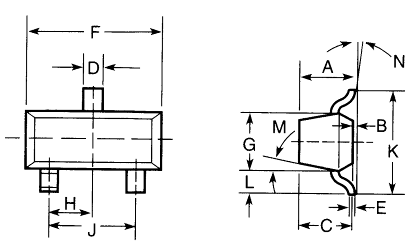
RF Impedance of the MA4E1245KA



SOT-23



SOT-23

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.048	—	1,22
B	—	0.008	—	0,20
C	—	0.040	—	1,00
D	0.013	0.020	0,35	0,50
E	0.003	0.006	0,08	0,15
F	0.110	0.119	2,80	3,00
G	0.047	0.056	1,20	1,40
H	0.037 typical		0,95 typical	
J	0.075 typical		1,90 typical	
K	—	0.103	—	2,60
L	—	0.024	—	0,60

DIM.	GRADIENT
M	10° max.1
N	2°...30°

Note:
1. Applicable on all sides

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Surface Mount Schottky Diodes

MA4CS101, 102, 103 Series

V 2.00

Features

- High Performance Schottky Diodes
- Designed for High Volume Pick and Place Assembly
- Low Profile Surface Mount Packages - Single and Pair Configurations
- High Quality Products (Defect Rate Less Than 50 PPM)
- Aggressively Priced for High Volume, Commercial Applications

Description

Surface mount Schottky diodes are available from M/A-COM for high volume, pick and place assembly applications. They are packaged in low profile SOT-23 and SOT-143 packages. A variety of wiring configurations is offered, including singles, series pairs, common cathode pairs and unconnected pairs.

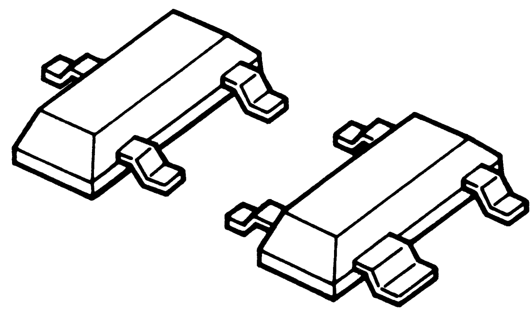
These diodes are suitable for a wide range of RF and microwave switching, attenuator and receiver applications. The product types offered include the following:

- General Purpose 20 and 70 Volt Schottky Diodes
- Low Forward Voltage Schottky Diodes

These products are manufactured using Statistical Process Control (SPC) procedures ensuring high reliability and demonstrated defect levels less than 50 parts per million.

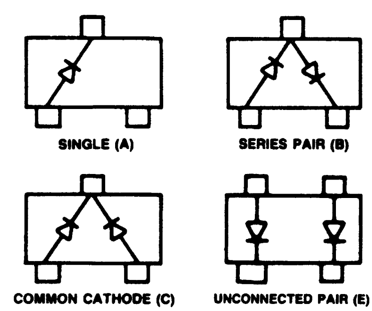
These units are delivered in industry standard 8 mm tape and reel format. Standard reels contain 3,000 devices.

SOT-23



SOT-143

Configurations (Top View)



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Electrical Specifications @ +25°C

Model[1] Number	Configuration	Marking	Minimum Reverse Voltage V_R IR = 10 aA	Maximum Reverse Current	Maximum Forward Voltage	Maximum Capacitance V_R = 0 V f = 1 MHz	Typical Dynamic Resistance
MA4CS101A	Single	73	70 V	200 nA	410 mV @ I_F = 1 mA	2.0 pF	35 Ω @ I_F = 5 mA
MA4CS101B	Series Pair	74		@ V_R = 50 V	1 V @ I_F = 15 mA		
MA4CS101E	Unconnected Pair	77					
MA4CS102A	Single	83	8 V	100 nA	360 mV @ I_F = 1 mA	1.0 pF	8 Ω @ I_F = 5 mA
MA4CS102B	Series Pair	84		@ V_R = 1 V	500 mV @ I_F = 10 mA		
MA4CS102C	Common Cathode	85					
MA4CS102E	Unconnected Pair	87					
MA4CS103A	Single	13	20 V	200 nA @ V_R = 15 V	410 mV @ I_F = 1 mA 1 V @ I_F = 35 mA	1.2 pF	15 Ω @ I_F = 5 mA

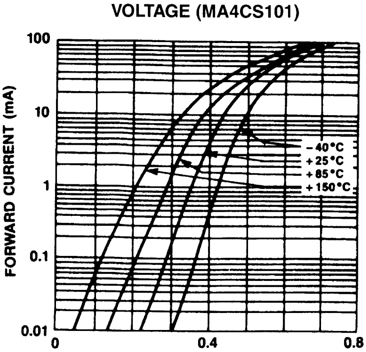
Note:
1. Model numbers A-D available in SOT-23 (low profile) only. Model number E available in SOT-143 (low profile) only.

Absolute Maximum Ratings

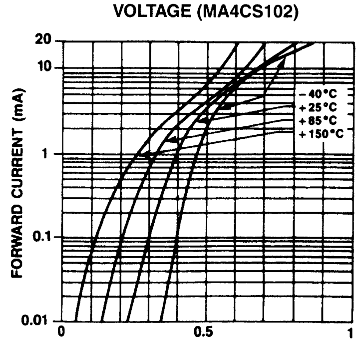
Parameter	Values
Reverse Voltage	Breakdown Voltage Rating
Forward Current: MA4CS101 MA4CS102 MA4CS103	 15 mA 30 mA 100 mA
Surge Forward Current, t ≤ 10 ms MA4CS101, 102 MA4CS103	 100 mA 500 mA
Total Power Dissipation2	250 mW
Operating Temperature	- 55°C to + 150°C
Storage Temperature	- 55°C to + 150°C

Typical Performance Curves

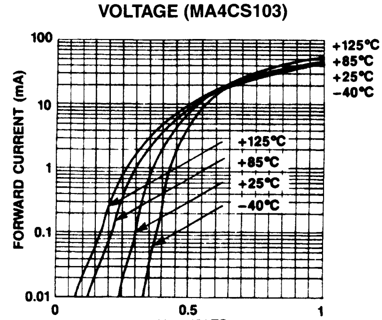
FORWARD CURRENT vs FORWARD VOLTAGE (MA4CS101)



FORWARD CURRENT vs FORWARD VOLTAGE (MA4CS102)



FORWARD CURRENT vs FORWARD VOLTAGE (MA4CS103)



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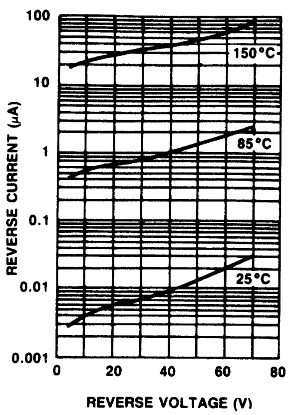
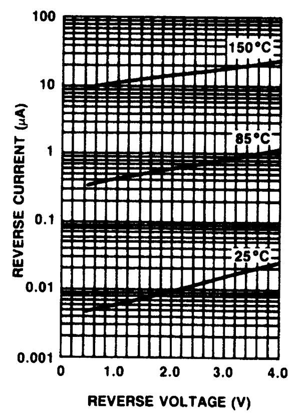
Typical Performance Curves (Cont'd)

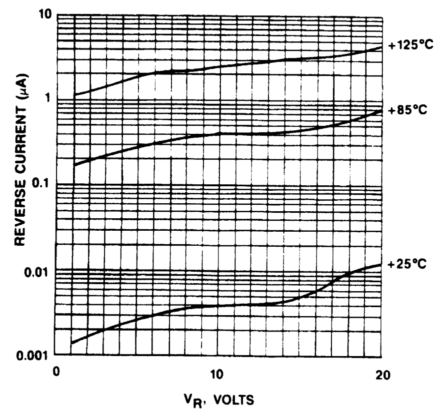
REVERSE CURRENT vs REVERSE VOLTAGE (MA4CS101)



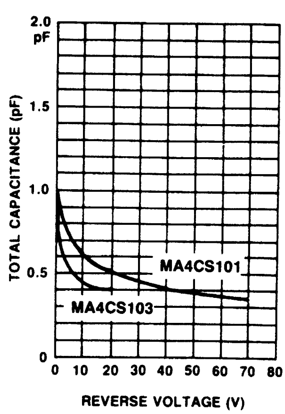
REVERSE CURRENT vs REVERSE VOLTAGE (MA4CS102)



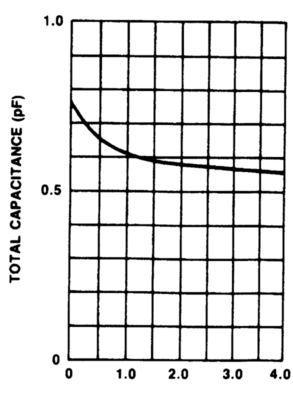
REVERSE CURRENT vs REVERSE VOLTAGE (MA4CS103)



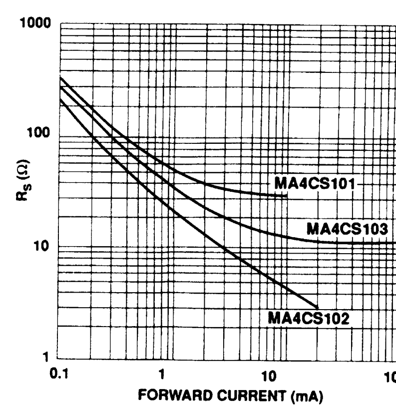
TOTAL CAPACITANCE vs REVERSE VOLTAGE



TOTAL CAPACITANCE vs REVERSE VOLTAGE (MA4CS102)



DYNAMIC RESISTANCE vs FORWARD CURRENT



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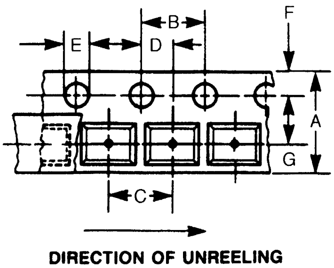
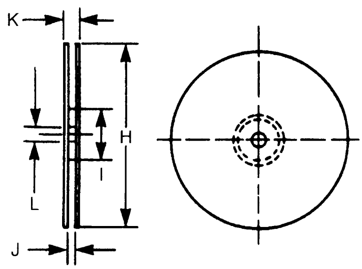
Tape and Reel Packaging

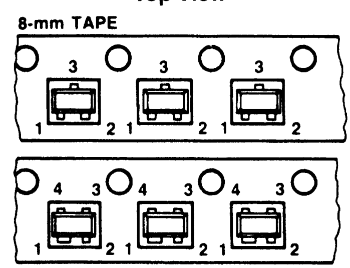




DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.303	0.327	7,7	8,3
B	0.153	0.161	3,9	4,1
C	0.153	0.161	3,9	4,1
D	0.077	0.081	1,95	2,05
E	0.059	0.063	1,5	1,6
F	0.065	0.073	1,65	1,85
G	0.136	0.140	3,45	3,55
H	6.8	7.2	173	183
I	2.382	2.50	60,5	63,5
J	0.331	0.390	8,4	9,9
K	—	0.567	—	14,4
L	0.502	0.562	12,75	12,9

Polarity and Orientation of Taped Components

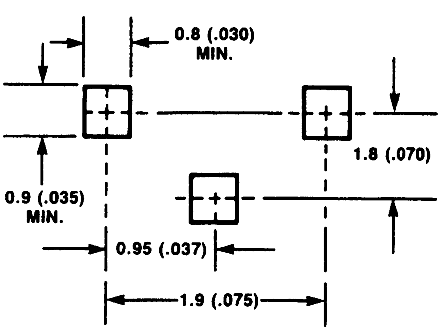
Top View



SOT-23

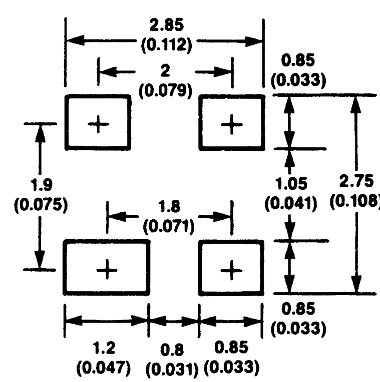
SOT-143

Mounting Pad Diagrams



DIMENSIONS: MILLIMETERS (INCHES)

SOT-23



DIMENSIONS: MILLIMETERS (INCHES)

SOT-143

Specifications Subject to Change Without Notice.

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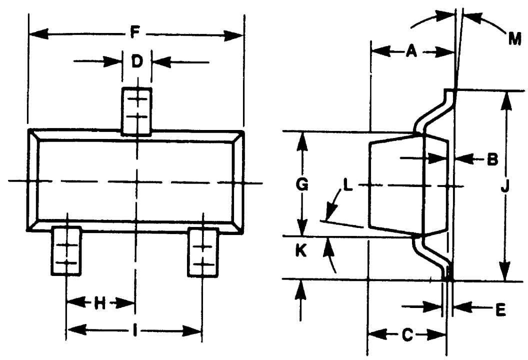
Case Styles

SOT-23 (Low Profile)

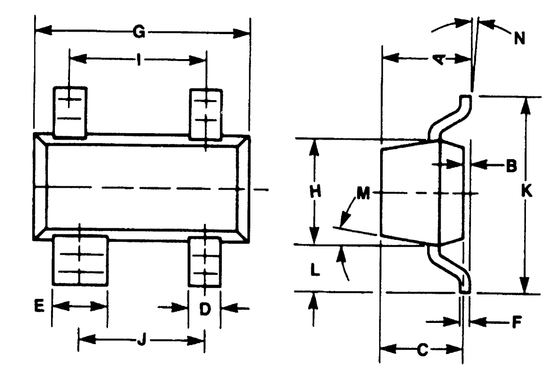


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.044	—	1,10
B	—	0.004	—	0,10
C	—	0.040	—	1,00
D	0.013	0.020	0,35	0,50
E	0.003	0.006	0,08	0,15
F	0.110	0.119	2,80	3,00
G	0.047	0.056	1,20	1,40
H	0.037 typical		0,95 typical	
I	0.075 typical		1,90 typical	
J		0.103		2,60
K		0.024		0,60

DIM.	GRADIENT
L	10° max1
M	2° . . .30°

Note:
1. Applicable on all sides

SOT-143 (Low Profile)



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.044	—	1,10
B	—	0.004	—	0,10
C	—	0.040	—	1,00
D	0.013	0.020	0,35	0,50
E	0.030	0.035	0,75	0,90
F	0.003	0.006	0,08	0,15
G	0.110	0.119	2,80	3,00
H	0.047	0.056	1,20	1,40
I	0.075 typical		1,90 typical	
J	0.040 typical		1,70 typical	
K	—	0.103	—	2,60
L	—	0.024	—	0,60

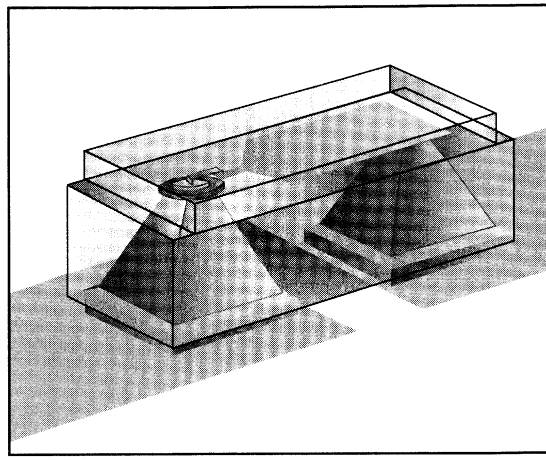
DIM.	GRADIENT
M	10° max1
N	2° . . .30°

Note:
1. Applicable on all sides

Surface Mount Chip Monolithic Low Barrier Schottky Diodes

MA4E2500 Surmount™ Series

V 2.00



Features

- Singles, Pairs, Tees, Ring and Cross-over Quads
- Reliable, Multilayer Metalization with a Diffusion Barrier, 100% Stabilization Bake (300°C, 16 hours)
- Lower Susceptibility to ESD Damage
- Very Low Parasitic Capacitance and Inductance
- Rugged HMIC Construction
- Surface Mountable in Hybrid Circuits
- No Wirebonds Required
- JANTX or MIL-S-883 Element 5008 Equivalent Screening Available

Description

The MA4E2500L SurMount™ series diodes are silicon low barrier Schottky monolithic chip devices fabricated with the Heterolithic Microwave Integrated Circuit (HMIC) process. HMIC circuits consist of silicon pedestals, which may form diodes or conductors, embedded in a glass dielectric, which is used as the microstrip medium. The combination of silicon and glass allows HMIC devices to have excellent power handling and electrical performance in a small rugged chip.

The SurMount Schottky devices are excellent choices for circuits where the minimal parasitics of a beam lead structure are required, but the mechanical fragility of a beam lead is a liability. The SurMount chip structure employs very low resistance silicon vias to connect the Schottky contacts to the metalized mounting pads on the bottom surface of the chip without using wirebonds. These devices are low cost, rugged and reliable. They have lower susceptibility to electrostatic discharge than beam lead Schottky diodes. They are optionally available with JANTX or MIL-S-883 Element 5008 equivalent screening, and are suitable for space applications.

The multi-layer metalization employed in the fabrication of the SurMount chip Schottky junctions includes a platinum diffusion barrier, which permits all devices to be subjected to a 16 hour non-operating stabilization bake at 300°C.

The available configurations for the MA4E2500L series of silicon low barrier SurMount chip Schottky devices include single diodes, anti-parallel pairs, ring quads, cross-over ring quads and series tees.

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Applications

The MA4E2500L family of SurMount chip Schottky diodes are recommended for use in hybrid circuits through X-band frequencies for low power applications such as mixers, limiters, sub-harmonic mixers, sampling or detector circuits. The HMIC construction facilitates the direct replacement of fragile beam lead diodes with the corresponding SurMount chip structure, which can be connected to a hard or soft substrate circuit with solder or conductive epoxy.

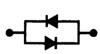
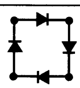
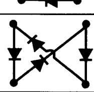
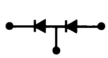
Absolute Maximum Ratings

Operating Temperature		-65°C to + 175°C
Storage Temperature		-65°C to + 200°C
Forward DC Current	**0.10 pF** **0.20 pF**	20 mA per junction 25 mA per junction
Reverse Voltage	**3V**	
Incident CW **RF Power**	**0.10 pF** **0.20 pF**	50 mW per junction 75 mW per junction

Electrical Specifications @ 25°C

For all Parts:
Maximum V_F @ 1.0 mA = 0.35 Volts
Minimum V_R @ 10 µA = 3 Volts

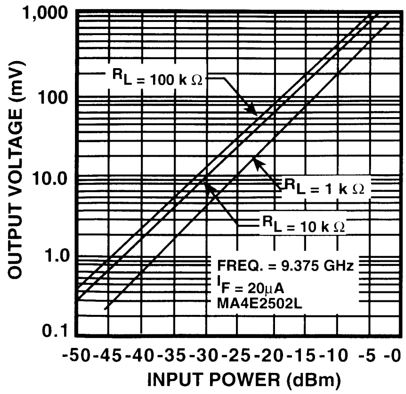
For Pairs, Tees and Quads:
Delta V_F = 15 mV maximum
Delta C_j= 0.03 pF maximum

Configuration	Model Number	Device Type	Recommended Frequency Range	Max. C_j @ 0 Volts and 1 MHz (pF)	Max. R_S[1] @ 10 mA (Ohms)
	MA4E2502L	Single	Through Ku-Band	0.10	14
	MA4E2503L		Through X-Band	0.20	10
	MA4E2508L	Anti-Parallel Pair	Through Ku-Band	0.10	14
	MA4E2532L	Ring Quad	Through Ku-Band	0.10	14
	MA4E2533L		Through X-Band	0.20	10
	MA4E2544L	Cross-Over Ring Quad	Through Ku-Band	0.10	14
	MA4E2545L		Through X-Band	0.20	10
	MA4E2514L	Series Tee	Through Ku-Band	0.10	14
	MA4E2515L		Through X-Band	0.20	10

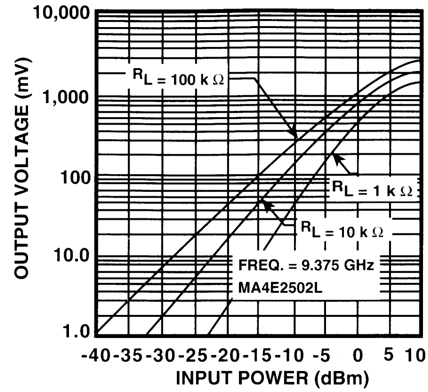
1. R_T is the dynamic resistance at 10mA and $R_S = R_T - R_j$ where $R_j = \frac{26}{I_f}$)IF in mA).

Typical Performance Curves @ +25°C

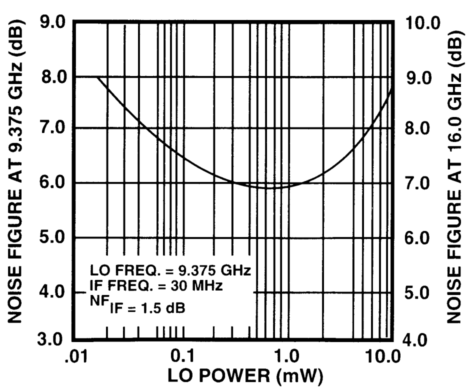
MA4E2500L SERIES NOMINAL OUTPUT VOLTAGE AT X-BAND (WITH FORWARD BIAS)



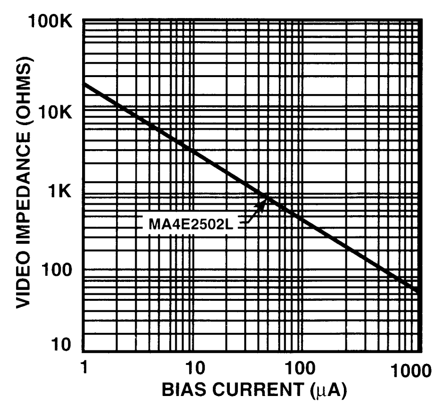
MA4E2500L SERIES NOMINAL OUTPUT VOLTAGE AT X-BAND (WITH ZERO BIAS)



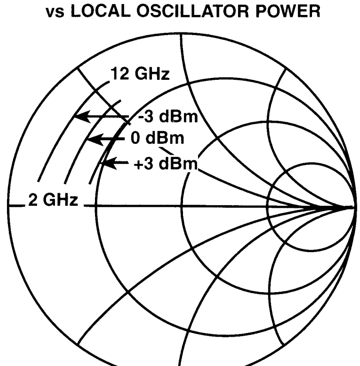
MA4E2500L SERIES NOMINAL NOISE FIGURE vs LOCAL OSCILLATOR POWER



MA4E2500L SERIES NOMINAL VIDEO IMPEDANCE vs BIAS CURRENT

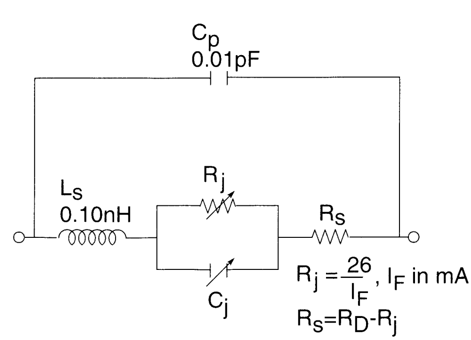


NOMINAL ADMITTANCE OF A SINGLE JUNCTION vs LOCAL OSCILLATOR POWER



Typical Admittance Plot

SINGLE JUNCTION EQUIVALENT CIRCUIT



Specifications Subject to Change Without Notice.

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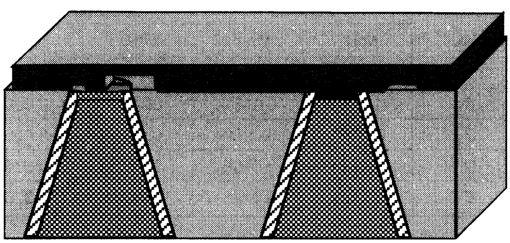
Handling and Bonding

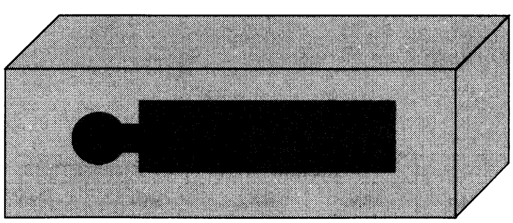
The rugged construction of these SurMount chip devices allows the use of standard handling and die attach techniques. It is important to note that industry standard electrostatic discharge (ESD) control is required at all times, due to the nature of Schottky junctions.

Handling

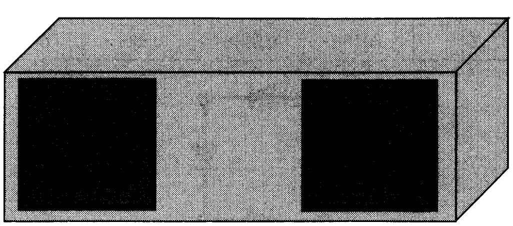
The devices can be handled with # 3c tweezers for manual placement. The top surface of the die has a protective coating to minimize damage. These devices are compatible with vacuum pencil or automatic pick and place installation.



Cross Section



Top View



Bottom View

Bonding

Die attach for these devices is made simple through the use of surface mount die attach technology. Mounting pads are conveniently located on the bottom surface of these devices, and are removed from the active junction locations. The devices are well suited for high temperature solder attachment onto hard substrates. The use of 80% gold 20% tin solder is recommended, but lead tin solders are acceptable. Conductive epoxy may also be used for die attach.

When soldering these devices to a hard substrate, hot gas die bonding is preferred. We recommend utilizing vacuum tip and force of 60 to 100 grams applied normal to the top surface of the device. When soldering to soft substrates, it is recommended to use a lead-tin interface at the circuit board mounting pads. Position the die so that its mounting pads are aligned with the circuit board mounting pads, and reflow the solder by heating the circuit trace near the mounting pad while applying 60 to 100 grams force perpendicular to the top surface of the die. Solder reflow must not be accomplished by causing heat to flow through the die. Consequently, the solder joints must be made one at a time, or a multi-tip soldering iron could be used to simultaneously reflow all the solder joints.

Since the HMIC glass is transparent, the edges of the mounting pads closest to each other can be visually inspected through the die after die attach is completed.

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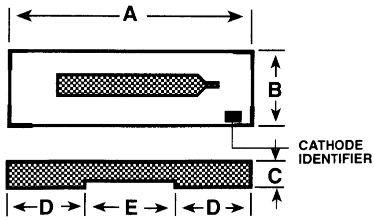
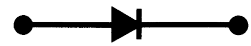
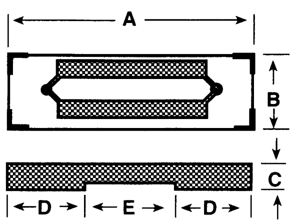
Single - MA4E2502L
MA4E2503L



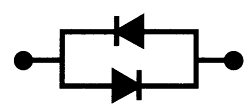
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0394	0.0433	1,009	1,100
B	0.0118	0.0157	0,300	0,399
C	0.0040	0.0080	0,102	0,203
D	0.0128	0.0148	0,325	0,376
E	0.0128	0.0148	0,325	0,376



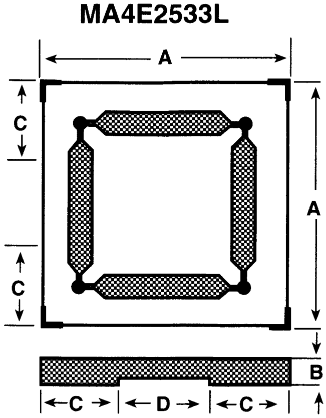
Anti-Parallel Pair- MA4E2508L



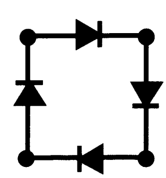
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0394	0.0433	1,009	1,100
B	0.0118	0.0157	0,300	0,399
C	0.0040	0.0080	0,102	0,203
D	0.0128	0.0148	0,325	0,376
E	0.0128	0.0148	0,325	0,376



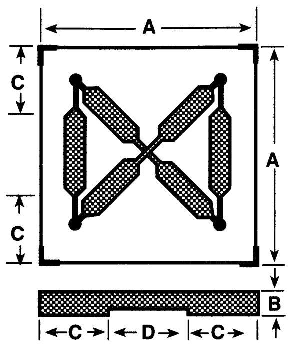
Ring Quad - MA4E2532L
MA4E2533L



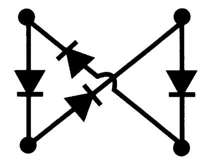
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0394	0.0433	1,009	1,100
B	0.0040	0.0080	0,102	0,203
C	0.0128	0.0148	0,325	0,376
D	0.0128	0.0148	0,325	0,376



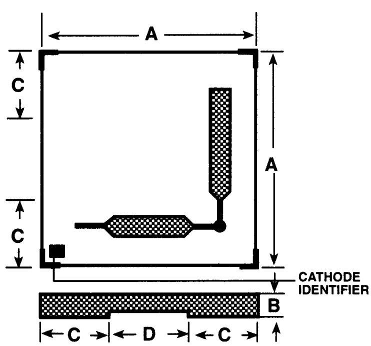
Cross-Over Ring Quad - MA4E2544L MA4E2545L



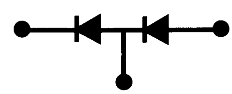
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0394	0.0433	1.009	1,100
B	0.0040	0.0080	0,102	0,203
C	0.0128	0.0148	0,325	0,376
D	0.0128	0.0148	0,325	0,376



Series Tee - MA4E2514L MA4E2515L



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0394	0.0433	1,009	1,100
B	0.0040	0.0080	0,102	0,203
C	0.0128	0.0148	0,325	0,376
D	0.0128	0.0148	0,325	0,376



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Silicon Schottky Mixer Diode Chips

V 2.00

Features

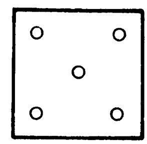
- Multi-Junction Chip for Higher Yield
- Low Noise Figure Through 26 GHz
- Small Junction Capacitance
- Low and Medium Barrier Diodes

Description

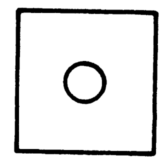
This series of chip silicon Schottky mixer diodes have gold anode and cathode metallization and are designed for easy assembly in microstrip mixer circuits through 26 GHz.

Two chips are offered, a chip with five individual junctions (Case Style 135) and a larger capacitance single junction (Case Style 1009) chip.

Case Styles



135



1009

Maximum Ratings

Temperature Range	
Storage Temperature	- 65°C to + 150°C
Operating Temperature	- 65°C to + 150°C
Power Ratings	
Maximum Peak Incident RF Power	C-X Band 1 Watt for 1 microsecond Ku-K Band 0.5 Watt for 1 microsecond
Maximum CW Incident RF Power	C-X Band 150 mW Ku-X Band 100 mW

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Specifications @ T_A = 25°C

RF characteristics are tested on a sample basis.

Low Barrier Chip Mixer Diodes

Low barrier diodes are most suitable for applications where the local oscillator drive level is between -3 and + 3 dBM per diode.

Model Number	Case Style[5]	Test Frequency (GHz)	Nominal[1] Noise Figure (dB)	Maximum[2] Junction Capacitance (pF)	Minimum[3] Reverse Voltage V_R	Nominal[4] Forward Voltage (V)
MA4E968	1009	3.000	5.5	0.60	2	0.24
MA4E971	1009	6.000	5.5	0.45	2	0.26
MA40137	135	9.375	6.0	0.18	2	0.30
MA40120	135	16.000	6.5	0.15	2	0.30
MA4E915	135	24.000	7.5	0.10	2	0.31

Medium Barrier Chip Mixer Diodes

Medium barrier diodes are most suitable for applications where the local oscillator drive level is between 0 dBm and +10 dBm per diode.

Model Number	Case Style[5]	Test Frequency (GHz)	Nominal[1] Noise Figure (dB)	Maximum[2] Junction Capacitance (pF)	Minimum[3] Reverse Voltage V_R	Nominal[4] Forward Voltage (V)
MA4E969	1009	3.000	5.5	0.60	3	0.34
MA40138	135	9.375	6.0	0.18	3	0.40
MA40170	135	16.000	6.5	0.15	3	0.40
MA4E921	135	24.000	7.5	0.10	3	0.41

Notes:

1. Test Conditions: (Chips are packaged for NF testing). Water lots are approved on a sample basis.
   P_{LO} = 1.0 mW (for low and medium barrier)
   F_{IF} = 30.0 MHz
   N_{IF} = 1.5 dBM
   R_L = 22 Ohms
2. Measurement frequency = 1 MHz; Voltage = 0 volts
3. Reverse voltage is measured at 10 microamps.
4. Measured at forward current of 10 milliamps.
5. See appendix for complete dimensions.

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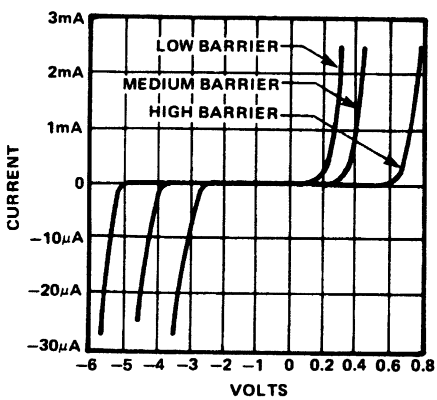
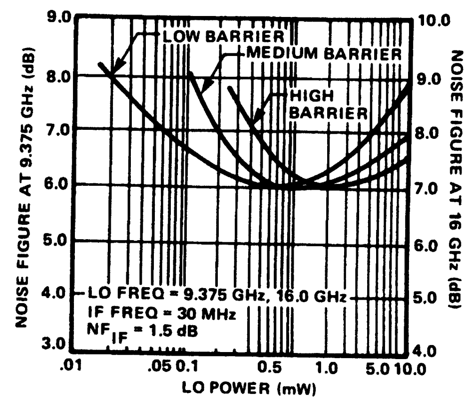
Typical Performance Curves[1]

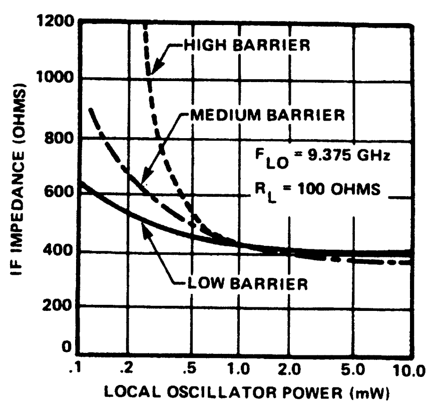
NOMINAL I-V CHARACTERISTICS AND BARRIER HEIGHT FOR SCHOTTKY MIXER DIODES



NOMINAL SCHOTTKY BARRIER NOISE FIGURE vs LO POWER



NOMINAL IF IMPEDANCE vs LOCAL OSCILLATOR DRIVE



Note:
1. High barrier diodes are not offered as chips.

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M/A-COM an AMP company

Silicon Beam Lead Schottky Barrier Diodes

MA40130 Series

V 2.00

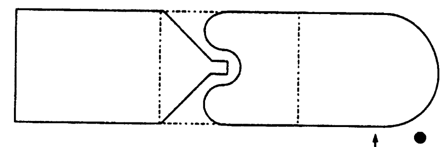
Features

- Planar Construction (Surface Oriented Diode)
- Strong Beam Construction
- Low Noise Figure (Mixer Diodes)
- Low, Medium and High Barrier Diodes Available

Description

The MA40130 series of beam lead Schottky diodes has both the Schottky junction and ohmic contact in the same plane. This makes them convenient for bonding into microstrip circuits. The Schottky junction is passivated with silicon oxide and silicon nitride to give stable reliable performance.

Case Style 965



Maximum Ratings

Operating Temperature	-65°C to + 150°C
Storage Temperature	-65°C to + 150°C
Incident CW RF Power	75 mW
Incident RF Pulse Power (3ns pulse width, .001 duty cycle)	1W
Beam Strength	2g

Specifications @ T_A = +25°C

Model Number	Barrier Height	Frequency Band	Maximum[1] Junction Capacitance C_j (pF)	Typical[2] Forward Voltage V_F (Volts)	Minimum[5] Reverse Voltage V_R	Maximum[3] Resistance R_S (Ohms)	Nominal[4] Noise Figure NF (dB)
MA40132	Low	X	0.2	0.28	2	10	6.5
MA40131	Low	Ku	0.1	0.31	2	15	7.5
MA40133	Medium	Ku	0.1	0.41	3	15	7.5
MA40135	High	Ku	0.1	0.61	5	15	7.5

Notes:

1. C_j is measured at V_R = 0V and F = 1.0 MHz.
2. V_F is measured at I_F = 1.0 mA.
3. Series resistance, R_S, is determined by subtracting the junction resistance, R_j from the measured value of 10 mA dynamic (slope) resistance, R_T:
   $R_S = R_T - R_j$ Ohms
   Junction resistance is computed from:
   $R_J = 26/I_F$
   I_F = 10 mA
   I_F is the forward current in mA.
4. Noise figure measurements are performed on single diodes sampled from every wafer lot. The noise figure specified is the maximum limit for lot approval. The test conditions are as follows:
   LO Power = 1.0 mW low and medium barrier, 2.0 mW for high barrier
   LO Frequency — 9.375 GHz (X-Band)
   16 GHz (Ku-Band)
   I_F = 30 MHz
   NF_{IF} = 1.5 dB
5. V_R is measured at I_R = 10µA

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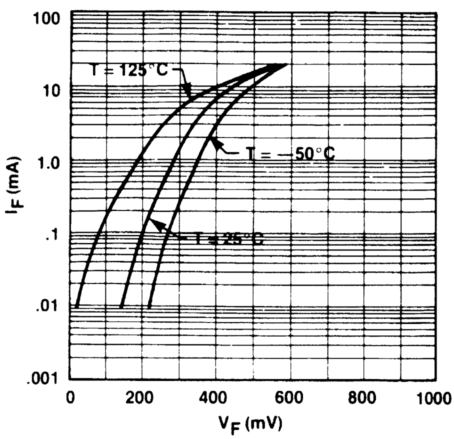
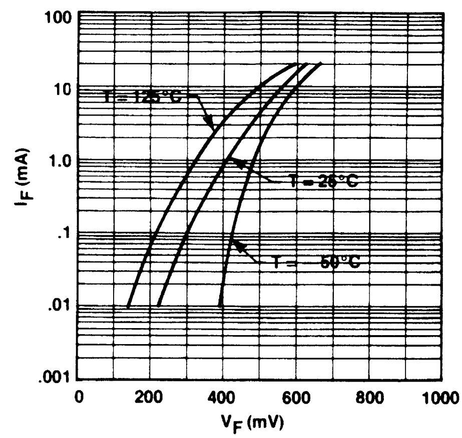
Typical Performance Curves

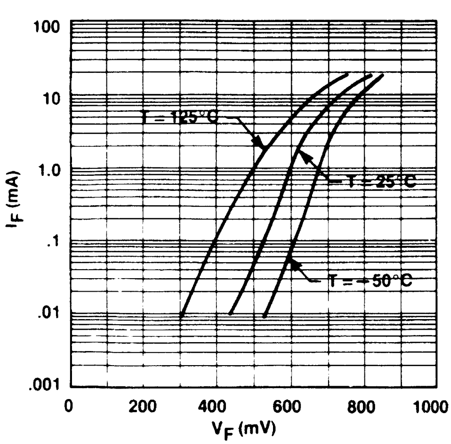
LOW BARRIER SCHOTTKY DIODE FORWARD CHARACTERISTICS vs TEMPERATURE



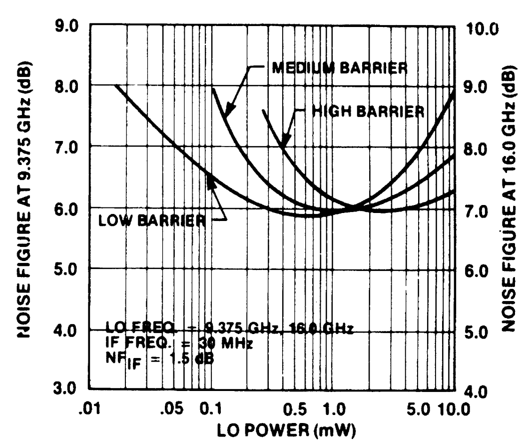
MEDIUM BARRIER SCHOTTKY DIODE FORWARD CHARACTERISTICS vs TEMPERATURE



HIGH BARRIER SCHOTTKY DIODE FORWARD CHARACTERISTICS vs TEMPERATURE



NOISE FIGURE vs LOCAL OSCILLATOR POWER



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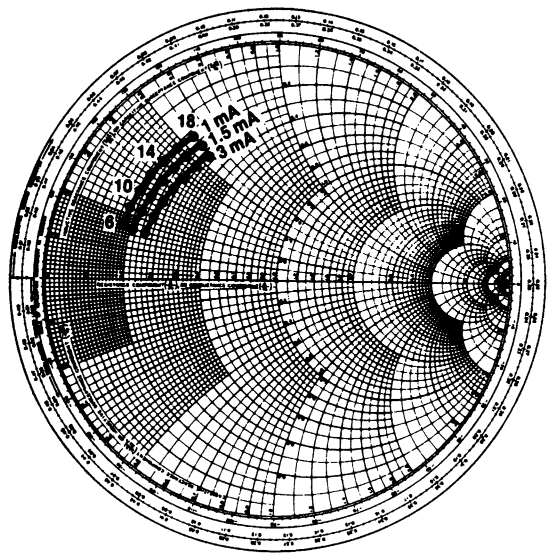
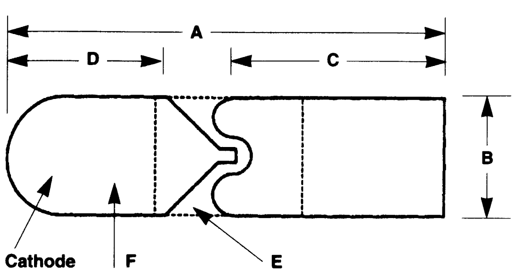
Typical Admittance Characteristics With Self Bias

MEDIUM BARRIER AND HIGH BARRIER DIODES
MA40133 AND MA40135



Case Style 965



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0270	0.0290	0,686	0,737
B	0.0050	0.0060	0,127	0,152
C	0.0130	0.0140	0,330	0,356
D	0.0122	0.0132	0,310	0,335
E	0.0010	0.0015	0,0254	0,038
F	0.00025	0.0003	0,00635	0,00762

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GaAs Schottky Mixer Diodes

MA40400 Series

V 2.00

Features

- Very Low Noise Figure from X through W-Band
- Low Junction Capacitance
- Low Series Resistance
- Wide Range of Available Product
  - Packaged Diodes
  - Chips
  - Beam Leads
  - Anti-Parallel Beam Leads
  - Bridge Quads
  - Ring Quads
  - Tees
- Superior Dynamic Range to Silicon Diodes
- Minimum Breakdown Voltage is 5 Volts
- Minimum 5 Gram Beam Strength For Beam Leads

Description

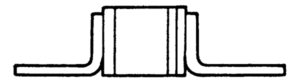
This family of Gallium Arsenide Schottky diodes is fabricated with noble metal metallization and silicon nitride passivation to assure good reliability and low series resistance.

These diodes are designed to give superior noise figure from X- through W-band. They are available in a wide range of packages, chip and beam lead configurations. The beam lead types include single beam leads, tees, anti-parallel pairs, ring and bridge quads.

These diodes have lower series resistance than equivalent junction capacitance silicon schottky diodes. This low series resistance results in superior conversion loss and noise figure.

The higher reverse voltage and low series resistance of Gallium Arsenide Bridge Quads make them particularly attractive for use in AM modulation and/or sampling circuits for signal processing and frequency generation.

Case Styles



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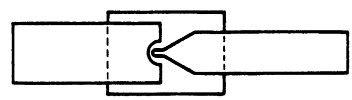

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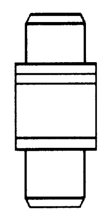

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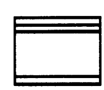

120

272

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Maximum Ratings

Operating and Storage Temperature Range of Junctions	-65° to +150°C
Maximum Power Dissipation (Derate Linearity to 0 at 150°C)	at 25°C 75 mW/Junction
Soldering Temperature (Packaged Diodes)	235°C for 10 seconds
Beam Lead Strength	5 grams Min.

Specifications @ T_A = +25°C

Packaged Diodes

Specifications						Typical Characteristics	
Model Number	Case Style	LO Test Frequency (GHz)	Maximum[4] Noise Figure NF (dB)	I_F[4] Impedance Min./Max. (Ohms)	Minimum[5] Reverse Voltage V_B	Nominal[1, 3] Junction Capacitance Cj (pF)	Series Resistance R_S Min./Max. (Ohms)
MA40403	119	24	6.5	250 / 500	5	0.07	3 / 6
MA40404	119	36	6.5	250 / 500	5	0.06	3 / 6
MA40407	120	24	6.5	250 / 500	5	0.07	3 / 6
MA40408	120	36	6.5	250 / 500	5	0.06	3 / 6
MA40411	276	24	6.5	250 / 500	5	0.07	3 / 6
MA40412	276	36	6.5	250 / 500	5	0.06	3 / 6

Beam Leads and Chips

Specifications						Typical Characteristics	
Model Number	Case Style	Frequency Band	Series[3] Resistance Min./Max. (Ohms)	Junction[1] Capacitance Min./Max. (pF)	Minimum[5] Reverse Voltage V_R	I_F Impedance MIn./Max. (Ohms)	Nominal Noise Figure (dB)
MA40414	135	Ka	3 / 6	0.050 / 0.060	5	250 / 500	6.5
MA40415	1010	K	3 / 6	0.055 / 0.075	5	250 / 500	6.5
MA40416	1010	Ka	3 / 6	0.050 / 0.070	5	250 / 500	6.5
MA40417	1010	W	4 / 10	0.030 / 0.055	5	250 / 500	7.010

Anti-Parallel Beam Leads

Specifications								Typical Character-istics
Model Number	Case Style	Frequency Band	Series[3] Resistance Min./Max. R_S (Ohms)	Junction[6] Capacitance Min./Max. C_j (pF)	Maximum[5] Junction Capacitance Difference ΔC_j (pF)	Minimum[5] Reverse Voltage V_R	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)
MA40422	1013	K-Ka	3 / 6	0.10 / 0.20	0.025	5.0	0.015	0.700

Specifications Subject to Change Without Notice.

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Specifications @ T_A = +25°C

Specifications								Typical Characteristics
Model[10] Number	Case Style	Frequency Band	Maximum[3] Series Resistance Min./Max. R_S (Ohms)	Junction[7, 8] Capacitance Min./Max Cj (pF)	Maximum[7, 8] Junction Capacitance Difference ΔCj (pF)	Minimum[5] Reverse Voltage V_R	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)
MA40418	963	L-K	3 / 6	0.05 / 0.10	0.025	5	0.02	0.7

Bridge Quad

Specifications								Typical Characteristics
Model[10] Number	Case Style	Frequency Band	Maximum[3] Series Resistance Min./Max. R_S (Ohms)	Junction[7, 8] Capacitance Min./Max Cj (pF)	Maximum[7, 8] Junction Capacitance Difference ΔCj (pF)	Minimum[5] Reverse Voltage V_R	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)
MA40419	963	L-K	3 / 6	0.05 / 0.10	0.025	5.0	0.02	0.7
MA40419	1108	L-K	3 / 6	0.05 / 0.10	0.025	5.0	0.02	0.7

Ring Quads

Specifications							Typical Characteristics		
Model[10] Number	Case Style	Frequency Band	Maximum[3] Series Resistance Min./Max. R_S (Ohms)	Junction[7, 8] Capacitance Min./Max. Cj (pF)	Maximum[7, 8] Junction Capacitance Difference ΔCj (pF)	Maximum[2] Forward Voltage Difference ΔV_F	Nominal[2] Forward Voltage V_F (Volts)	Nominal[5] Reverse Voltage V_R (Ohms)	Nominal[4] Noise Figure NF (dB)
MA40421	272	C-Ku	3 / 6	0.05 / 0.10	0.025	0.02	0.7	5	6

Tees

Notes:

1. C_j is measured at V_R = 0V and f = 1.0 MHz.
2. V_F is measured at I_F = 1.0 mA.
3. Series Resistance, R_s, is determined by subtracting the junction resistance Rj, from the measured value of 10 mA dynamic (slope) resistance, R_T:
   $R_s = R_T$ - Rj ohms
   Junction resistance is computed from:
   $Rj = 26/I_F$
   I_F = 10 mA
   I_F is the forward current in mA
4. Noise figure measurements are single sideband noise figure with N_{IF} = 1.5 dB minimum. The noise figure of chips and beam lead types are performed on a sample of the lot. Chips are tested in a package.

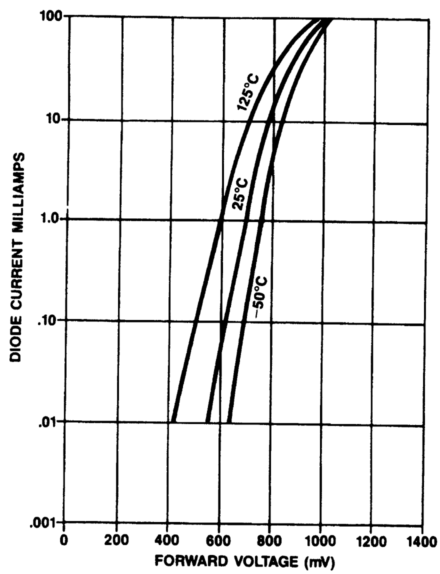
   Beam leads are tested in a stripline holder The test conditions are as follows:

LO Power	6.0 dBm
LO Frequency	16.0 GHz
	24.0 GHz
	35.0 GHz

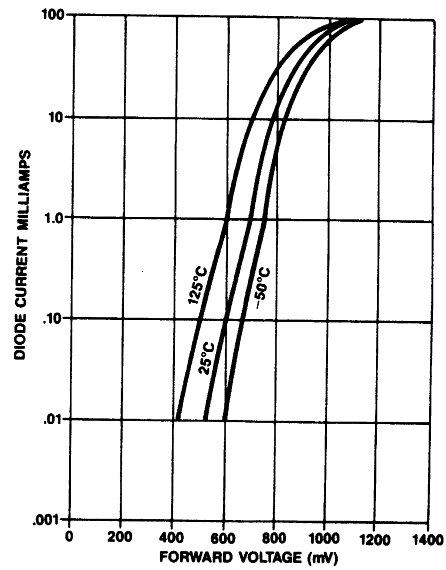
   f_{if} = 30 MHz
   R^j = 22 Ohms
5. V_R is measured at I_R = 10 µA.
6. C_j is measured at V_R = 0V and f = 1.0 MHz. C_j of anti-parallel diodes is comprised of the capacitance of two diode junctions in parallel.
7. C_j is measured between adjacent leads of device at V_R = 0V and f = 1 MHz.
8. $C_T = C_j + C_P$
   C_T is total capacitance
   C_j is junction capacitance
   C_P is packaged capacitance
9. Conversion loss at 94 GHz with LO power ~ 8-12 dBm.
10. The part number includes the case style as a suffix. i.e. MA40418 - 1169 is a beam-lead Tee; MA40418-963 is the part in the case style 963.

Typical Performance Curves

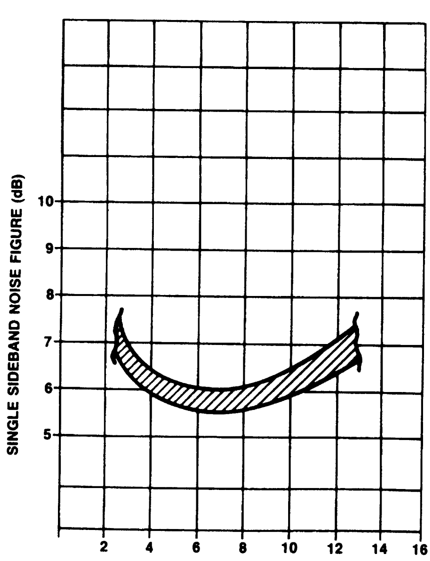
DIODE CURRENT vs FORWARD VOLTAGE
(MA40403 - 40412 PACKAGED GAAS CHIPS)



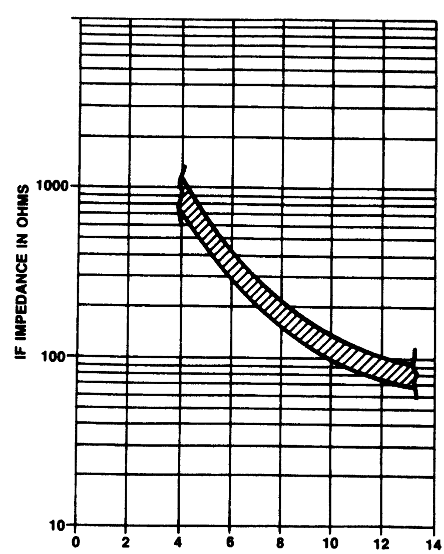
DIODE CURRENT vs FORWARD VOLTAGE
(MA40415, 40416 GAAS BEAM LEAD)



NOISE FIGURE vs LOCAL OSCILLATOR POWER
(MA40400 SERIES)



I_F IMPEDENCE vs LOCAL OSCILLATOR DRIVE
WITH R_L = 10 OHMS (MA40400 SERIES)



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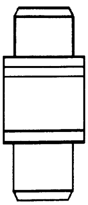
Case Styles (See appendix for complete styles)



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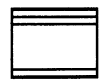

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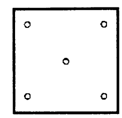

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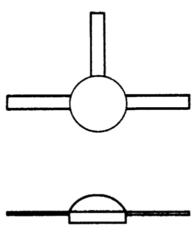

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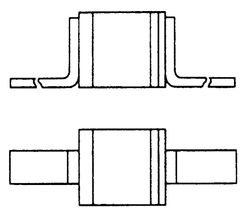

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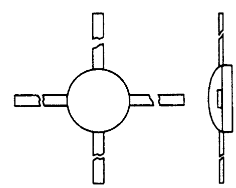

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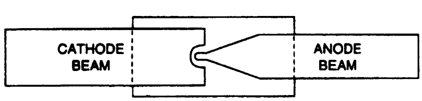

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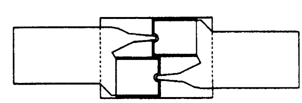

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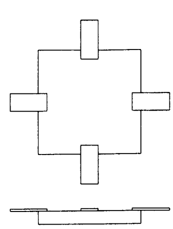

1108

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Schottky Barrier Beam Lead Anti-Parallel Pairs

MA40278, MA40279 Series

V 2.00

Features

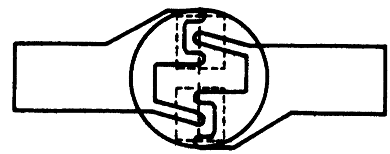
- Small Physical Size for Microstrip Mounting
- High Reliability
- Closely Matched Junctions
- Three Diode Barrier Heights are Available
- Minimum Parasitics for Broadband Designs
- Suited for Subharmonically Pumped Mixers

Description

Each Schottky barrier diode pair consists of two closely matched diodes connected in an anti-parallel pair configuration. The diodes are formed monolithically to assure close matching of electrical characteristics such as capacitance, forward voltage and series resistance. The silicon that originally connected the diodes in the wafer is removed to isolate each diode. The beam lead construction minimizes parasitic capacitance and lead inductance. It enables interconnection of the diodes in anti-parallel pairs at the wafer level.

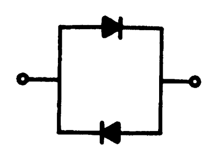
Three barrier height levels are available for different local oscillator drive power. The MA40278L and MA40279L devices feature a low barrier for applications which have low available local oscillator power. Both medium barrier (MA40278M and MA40279M) and high barrier (MA40278H and MA40279H) devices are available for applications with higher drive levels. The higher LO price can improve dynamic range.

Case Style 942



Applications

These diodes are intended primarily for use in subharmonic mixers. The minimal electrical parasitics are well-suited for miniature broadband components. The low barrier devices should be used whenever optimum noise figure is required with +3 dBm or less of local oscillator drive power. Medium barrier devices should be used where minimum noise figures are desired at LO drive levels between +3 dBm and +6 dBm. Minimum noise figures can be obtained at LO drive levels in excess of +6 dBm by using high barrier devices. The diode configuration is shown below.



Diode Configuration

Specifications @ T_A = +25°C

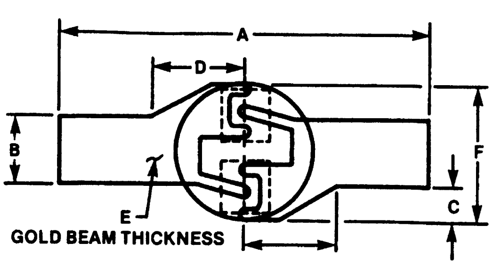
Model Number	Barrier Height	Suggested Local Oscillator Frequency	Junction[1] Capacitance C_J (pF) Min.	Max.	Maximum[2] Resistance R_S (Ohms)	Typical[3] Forward Voltage VF (Volts)	Maximum[3] Forward Voltage Difference ΔV_F (Volts)
MA40279L	Low	S-X	0.30	0.60	12	0.27	0.010
MA40278L	Low	Ku-K	0.10	0.30	15	0.30	0.010
MA40279M	Medium	S-X	0.30	0.60	12	0.30	0.010
MA40278M	Medium	Ku-K	0.10	0.30	15	0.40	0.010
MA40279H	High	S-X	0.30	0.60	12	0.57	0.010
MA40278H	High	Ku-K	0.10	0.30	15	0.60	0.010

Notes:
1. C_j is measured at V_R = 0V and f = 1.0 MHz. C_j is comprised of the capacitance of two diode junctions in parallel.
2. Series resistance, R_S, is detemined by subtracting the junction resistance, R_j, from the measured value of 10 mA dynamic (slope) resistance, R_T:
   $R_s = R_T - R_j$ Ohms
   Junction resistance is computed from the following equation:
   $R_j = 26/I_F$
   I_F = 10 mA
   I_F is the forward current in mA.
3. V_F and ΔV_F are measured at I_F = 1.0 mA.

Maximum Ratings

Operating and Storage Temperature Range of Junctions	-65°C to + 150°C
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/junction
Beam Strength	2g

Case Style 942



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0260	0.0280	0,6600	0,7110
B	0.0045	0.0055	0,1140	0,1400
C	0.0019	0.0029	0,0480	0,0740
D	0.0060	0.0070	0,1520	0,1780
E	0.0002	0.0005	0,0051	0,0127
F	0.0085	0.0100	0,2160	0,2540

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Schottky Barrier Packaged and Beam Lead Tees

MA4E20, MA4E970 Series

V 2.00

Features

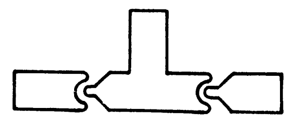
- Small Physical Size for Microstrip Mounting
- High Reliability
- Closely Matched Junctions for High Isolation
- Three Diode Barrier Heights are Available
- Minimum Parasitics for Broadband Designs

Description

Each Schottky barrier beam lead Tee consists of two closely matched diodes connected in the classic Tee configuration. The diodes are formed monolithically to assure close matching of electrical characteristics such as capacitance, forward voltage and series resistance. The silicon that originally connected the diodes on the wafer is removed. The beam lead construction assures minimum parasitic capacitance, connecting lead inductance and permits the interconnection of the diodes into Tees at the wafer level.

Three barrier levels are available allowing different levels of local oscillator drive power. The L series features a low barrier for applications which have low available local oscillator power. Both medium barrier (M series) and high barrier (H series) devices are available for applications with higher drive levels. The RF and local oscillator frequencies can range up to 18 GHz with selection of an appropriate junction capacitance. Each series is available in three case styles which are compatible with microstrip or stripline assembly techniques. The 270 case style is hermetically sealed and is suggested for harsh environments or for military or high reliability circuits. The 272 case style is a low cost plastic enclosure similar in case style. The beam lead case styles 271 and 1012 are designed for maximum bandwidth. The case style 271 is a forward tee and the 1012 is a reverse tee. The case style 1000 is the smallest stripline package and has the lowest parasitic capacitance and inductance.

Case Styles



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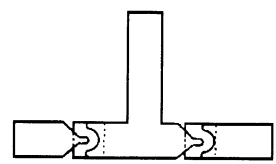
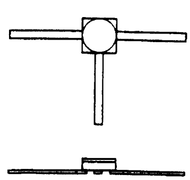


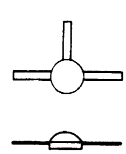
1012

Maximum Ratings

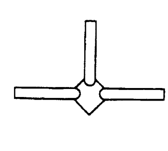
Operating and Storage Temperature Range	-65°C to +150°C (Case Style 270, 271 and 1012) -65°C to +125°C (Case Styles 272, 1000)
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/junction
Soldering Temperature	235°C for 10 sec. (Case Style 270) 150°C for 5 sec. (Case Styles 271, 272)
Beam Strength	2g (Case Style 271, 1012)



270



272



1000

Specifications @ T_A = 25°C

Schottky Beam Lead Tees

Model[5,7] Number	Barrier Height	Suggested Frequency (Hz)	Maximum[1] Junction Capacitance Cj (pF)	Maximum[1] Junction Capacitance Difference ΔCj (pF)	Maximum[3] Resistance R_S (Ohms)	Nominal[2] Forward Voltage V_F (Volts)	Maximum[2] Forward Voltage Match V_F (Volts)	Nominal Noise Figure NF (dB)	Minimum[4] Reverse Voltage V_R
MA4E201L	Low	S	0.50	0.10	7	0.25	0.015	6.0	2
MA4E204L	Low	C-X	0.35	0.10	10	0.27	0.015	6.5	2
MA4E207L	Low	Ku	0.20	0.05	12	0.30	0.015	7.5	2
MA4E201M	Medium	S	0.50	0.10	7	0.35	0.015	6.0	3
MA4E204M	Medium	C-X	0.35	0.10	10	0.37	0.015	6.5	3
MA4E207M	Medium	Ku	0.20	0.05	12	0.40	0.015	7.5	3
MA4E201H	High	S	0.50	0.10	7	0.55	0.015	6.0	5
MA4E204H	High	C-X	0.35	0.10	10	0.57	0.015	6.5	5
MA4E207H	High	Ku	0.20	0.05	12	0.60	0.015	7.5	5

Schottky Beam Lead Reverse Tees

Model[6,7] Number	Barrier Height	Frequency (H_Z)	Maximum[1] Junction Capacitance C_j (pF)	Maximum[1] Junction Capacitance Difference ΔC_j (pF)	Maximum[3] Resistance R_S (Ohms)	Nominal[2] Forward Voltage V_F (Volts)	Maximum[2] Forward Voltage Match V_F (Volts)	Nominal Noise Figure NF (dB)	Minimum[4] Reverse Voltage V_R
MA4E974L	Low	S	0.50	0.10	7	0.25	0.015	6.0	2
MA4E975L	Low	C-X	0.35	0.10	10	0.27	0.015	6.5	2
MA4E976L	Low	Ku	0.20	0.05	12	0.30	0.015	7.5	2
MA4E974M	Medium	S	0.50	0.10	7	0.25	0.015	6.0	3
MA4E975M	Medium	C-X	0.35	0.10	10	0.27	0.015	6.5	3
MA4E976M	Medium	Ku	0.20	0.05	12	0.30	0.015	7.5	3
MA4E974H	High	S	0.50	0.10	7	0.25	0.015	6.0	4
MA4E975H	High	C-X	0.35	0.10	10	0.27	0.015	6.5	4
MA4E976H	High	Ku	0.20	0.05	12	0.30	0.015	7.5	4

Notes:

1. C_j and ΔC_j are measured at V_R = 0 volts and f = 1.0 MHz.
2. V_F is measured at I_F = 1.0 mA.
3. Series resistance, R_S, is determined by subtracting the junction resistance, R_j, from the measured value of 10 mA dynamic (slope) resistance, R_T:
   $R_S = R_T - R_j$ Ohms
   Junction resistance is computed from the following equation:
   R_j - 26/I_F Ohms
   I_F = 10 mA
   I_F is the forward bias current in mA.
4. Reverse voltage is measured at I_R = 10 µA.
5. The standard case styles for the forward tee series is 271, and the Schottky beam lead tees are 270, 271, 272 and 1000.
6. The standard case style for the reverse tee series of diodes is case style 1012. Tees are available in case styles 270, 272 and 1000.
7. To order parts specify the package as a suffix, i.e., MA4E201L-270 is a low barrier tee in case style 270.

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M/A-COM an AMP company

Schottky Barrier Beam Lead and Packaged Bridge Quads

MA4E400 Series

V 2.00

Features

- Small Physical Size for Microstrip Mounting
- High Reliability
- Closely Matched Junctions for High Isolation
- Low, Medium and High Barrier Diodes Available to Match RF Power
- Minimum Parasitics for Broadband Designs

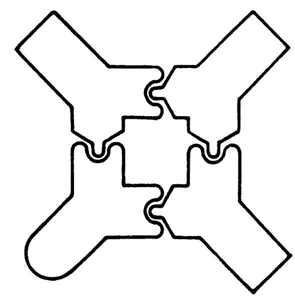
Description

Each Schottky barrier diode quad consists of four closely matched diodes connected in a bridge configuration. The four diodes are formed monolithically to assure close matching of electrical characteristics, namely capacitance, forward voltage and series resistance. The silicon which originally connected the diodes in slice form is etched away so that each individual diode is in beam lead form. The beam lead construction assures minimum junction capacitance, minimum connection lead inductance and permits the interconnection of the diodes into the bridge configuration at the wafer level.

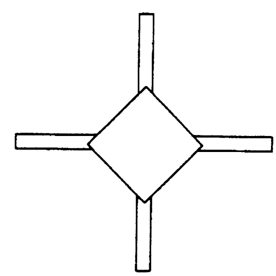
Three barrier height levels are available. The MA4E400L series features a low barrier for lower power applications. The MA4E400M and MA4E400H series feature medium and high barriers respectively. The RF frequencies can range up to 18.0 GHz with selection of an appropriate junction capacitance.

These parts are available as beam leads or in four stripline packages.

Case Styles



906



227

Specifications @ T_A = +25°C

Model* Number	Barrier Height	Frequency Band	Junction[1,2] Capacitance C_j (pF) Min.	Max.	Maximum[4] Junction Capacitance Difference ΔC_j (pF)	Maximum[2] Resistance R_T (Ohms)	Typical[4] Forward Voltage V_F (Volts)	Maximum Forward Voltage Difference ΔV_F (Volts)	Minimum[5] Reverse Voltage V_R (Volts)
MA4E402L	Low	S	0.30	0.60	0.10	7	0.250	0.020	2.0
MA4E401L	Low	C X	0.15	0.40	0.10	10	0.270	0.020	2.0
MA4E400L	Low	Ku	0.05	0.25	0.05	12	0.300	0.020	2.0
MA4E402M	Medium	S	0.30	0.60	0.10	7	0.350	0.020	3.0
MA4E401M	Medium	C-X	0.15	0.40	0.10	10	0.370	0.020	3.0
MA4E400M	Medium	Ku	0.05	0.25	0.05	12	0.410	0.020	3.0
MA4E402H	High	S	0.30	0.60	0.10	7	0.550	0.020	5.0
MA4E401H	High	C-X	0.15	0.40	0.10	10	0.570	0.020	5.0
MA4E400H	High	Ku	0.05	0.25	0.05	12	0.610	0.020	5.0

* Case styles are specified by adding the case style number as a suffix to the basic part number. For example, an MA4E402L-228 is a low barrier bridge quad housed in the 228 case style. The available packages are 226, 227, 228 or 963.

Notes:
1. C_j is measured across diagonal leads at V_R = 0V and f = 1 MHz.
2. $C_T = C_j + C_P$ is the package capacitance.
3. Series resistance, R_S, is determined by subtracting the junction resistance, Rj, from the measured value of 10 mA dynamic (slope) resistance, RT:
   $R_S = R_T - R_j$ Ohms

Junction resistance is computed from the following equation:
   $R_j = 26/1_F$ Ohms
   I_F is the forward bias current in mA.

4. ΔC_j is measured across adjacent quad leads at V_R = 0V and f = 1 MHz.
5. V_R is measured at I_R = 10 µA

Maximum Ratings

Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/ junction
Operating and Storage Temperature Range of Junctions	- 65°C to + 150°C
Plastic Packages	-65°C to +125°C (Case Styles 227, 228, 963)
Ceramic Package	-65°C to +150°C (Case Style 226)
Beam Strength	2g (Case Style 906)

Applications

These beam lead Schottky bridge quads are commonly used in sampling and modulator applications. The small case sizes and minimal electrical parasitics are well suited for miniature broadband components.

High speed switching, a necessary sampling requirement, is accomplished with the Schottky diode. Schottky diodes have switching speeds in the picosecond range. The four closely matched junctions assure high inherent isolation between the signal and sampler pulse circuits.

The different barrier heights enable the designer to select a diode with an appropriate barrier such that the RF signal input to the sampler will not cause the diodes in the bridge to conduct. The diode circuit configuration is shown on the next page.

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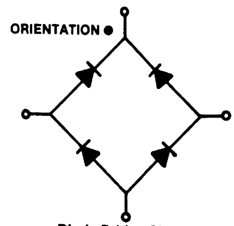
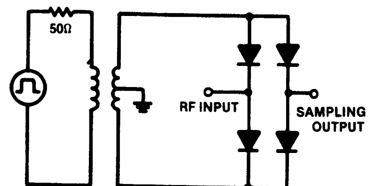
Diode Circuit Configuration

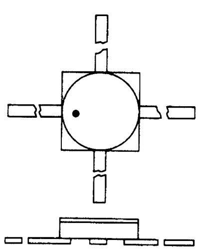


Diode Bridge Circuit

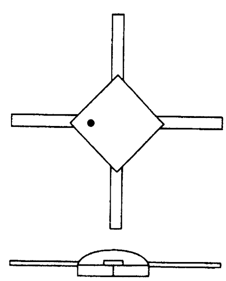


Sampling Circuit Bridge Quad

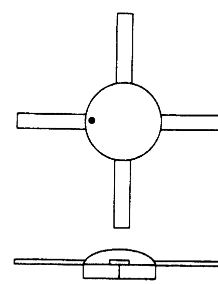
Case Styles (See appendix for complete dimensions)



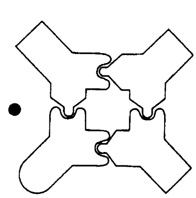
226
(Hermetic Ceramic Package)



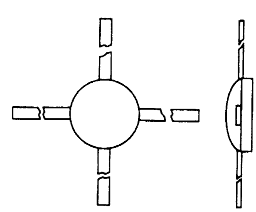
227
(Plastic Encapsulation)



228
(Plastic Encapsulation)



906
(Beam Lead)



963
(Plastic Encapsulation)

● Orientation Mark

an AMP company

Schottky Barrier Beam Lead and Packaged Ring Quads

V 2.00

Features

- Small Physical Size for Microstrip Mounting
- High Reliability
- Closely Matched Junctions for High Isolation
- High Barriers for LO Power Levels up to +27 dBm
- Minimum Parasitics for Broadband Designs

Description

Single Barrier Ring Quads

Each Schottky barrier diode quad consists of four closely matched diodes connected in a ring configuration. The four diodes are formed monolithically to assure close matching of electrical characteristics: capacitance, forward voltage and series resistance. The beam lead construction assures minimum junction capacitance, minimum connection lead inductance and permits the interconnection of the diodes into rings at the wafer level.

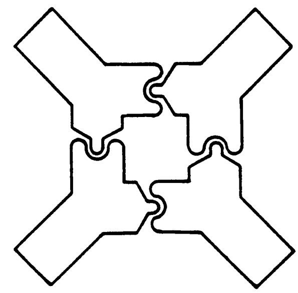
Dual Barrier Ring Quads

Each dual barrier ring quad consists of eight Schottky diodes connected in a ring configuration. Each arm of the quad consists of two high barrier Schottky diodes. The structure is formed monolithically to assure close matching of electrical characteristics. They are available in the low cost 1008 package.

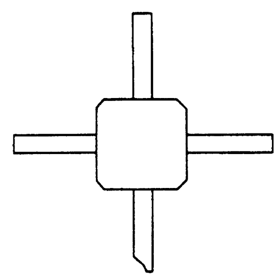
Medium Barrier Cross-Over Quads

M/A-COM's ring quads are available in beam lead form and five stripline case styles which are compatible with microstrip assembly techniques. The 226 case style is hermetically sealed and should be used in either harsh environments or high reliability military systems. The 228 case style is a low-cost package of similar size to the 226 case style. Case style 227 is suggested for either high frequency or wide bandwidth applications. Case style 963 has the lowest parasitics and is suggested for widest bandwidth applications. Case style 1008 is a low cost moderate frequency package used in many double balanced mixers through 2 GHz.

Case Styles



264



1008

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Specifications @ T_A = +25°C

Model[4] Number	Frequency Band	Maximum Capacitance C_j (pF)	Maximum[1] Capacitance Difference ΔC_T (pF)	Typical[2] Forward Voltage V_F (Volts)	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Maximum[3] Series Resistance R_S (Ohms)
Low Barrier Ring Quads						
MA40430	L-S	0.55	0.10	0.25	0.02	7
MA40431	L-S	0.40	0.10	0.25	0.02	7
MA40432	L-S	0.50	0.10	0.25	0.02	7
MA40439	L-S	0.50	0.20	0.25	0.02	7
MA40433	C	0.30	0.05	0.27	0.02	10
MA40437	C-X	0.25	0.10	0.27	0.02	10
MA40435	X	0.20	0.05	0.30	0.02	12
MA40284	X-Ku	0.10	0.05	0.31	0.02	18
Medium Barrier Ring Quads						
MA40440	L-S	0.50	0.10	0.35	0.02	7
MA40442	L-S	0.50	0.10	0.35	0.02	7
MA40449	L-S	0.50	0.20	0.35	0.02	7
MA40443	C	0.30	0.05	0.37	0.02	10
MA40444	C	0.30	0.10	0.37	0.02	10
MA40446	X	0.20	0.05	0.41	0.02	12
MA40447	Ku	0.15	0.05	0.41	0.02	12
MA40450	X-Ku	0.15	0.05	0.41	0.02	12
MA40285	X-Ku	0.10	0.05	0.41	0.02	18
High Barrier Ring Quads						
MA40490	L-S	0.50	0.10	0.55	0.02	7
MA40499	L-S	0.50	0.20	0.55	0.02	7
MA40493	C	0.30	0.05	0.57	0.02	10
MA40496	X	0.20	0.05	0.61	0.02	12
MA40497	Ku	0.15	0.05	0.61	0.02	12
MA40286	X-Ku	0.10	0.05	0.61	0.02	18

Notes:

1. C_T is measured across diagonal contacts. ΔC_T is measured across adjacent contacts. Capacitance is measured at zero bias and 1 MHz.
2. V_F and ΔV_F are measured across adjacent contacts at I_F = 1 mA.
3. Series resistance, R_S, is determined by subtracting the junction resistance, R_j, from the measured value of dynamic (slope) resistance, R_T:
   $R_S = R_T - R_j$ Ohms
   Junction resistance is computed from:
   $R_j = 26/I_F$ Ohms
   I_F is the forward current in mA.
4. All of these parts are available in case styles 226, 227, 228, 264, 963 and 1008. To order add case style as suffix i.e., MA40430-1008.

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Specifications @ T_A = +25°C (Cont'd)

Dual High Barrier Beam Lead Ring Quads

Model[5] Number	Frequency Band	Junction Capacitance C_j (pF) Min.	Max.	Maximum[3] Junction Capacitance Difference ΔC_j (pF)	Typical[2] Resistance R_T (Ω)	Typical[4] Forward Voltage V_F (V)	Maximum[4] Forward Voltage Difference ΔV_F (V)
MA40482	S	0.20	0.30	0.10	14	1.10	0.020
MA40483	X	0.12	0.20	0.10	20	1.14	0.020

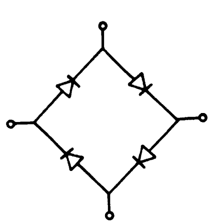
Notes:
1. CJ is measured across diagonal leads at V_R = 0V and f = 1 MHz. C_j is comprised of the capacitance of two diode junctions in series.
2. R_S is the diode series resistance which is the dynamic resistance, R_T, minus the junction resistance, R_j. The junction resistance is $R_j = 26/I_F$ is the DC bias current expressed in milliamperes. R_T is measured for I_F = 10 mA and the junction resistance, R_j, is subtracted from R_T to determine R_S. R_S is measured across adjacent quad leads and it is comprised of the series resistance of two diode junctions in series.
3. ΔC_j is measured across adjacent quad leads at V_R = 0V and f = 1 MHz.
4. V_F and ΔV_F are measured across adjacent quad leads at I_F = 1.0 mA. V_F is comprised of the forward voltage of two diode junctions in series.
5. All of these parts are available in case styles 226, 228, 264, 963 and 1008. To order add case style as suffix to the part number, i.e., MA40482-1008.

Medium Barrier Crossover Quads

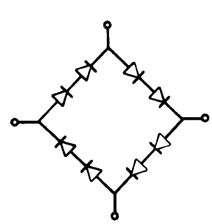
Model Number	Case Style	Frequency Band	Total[1] Capacitance C_T (pF)	Maximum[1] Total Capacitance Difference ΔC_T (pF)	Maximum[2] Series Resistance R_S (Ohms)	Typical[3] Forward Voltage V_F (Volts)	Maximum[3] Forward Voltage Difference ΔV_F (Volts)
MA40472	1008	L	1.20	0.10	7	0.330	0.020
MA40471	1008	S	0.60	0.10	7	0.350	0.020

Notes:
1. C_T and ΔC_T are measured across adjacent leads 1-4 and 2-3 at V_R = 0V and f = 1 MHz.
2. R_S is the diode series resistance which is the dynamic resistance R_T minus the junction resistance R_j. The junction resistance is $R_j = 26/I_F$ where I_F is the DC bias current expressed in milliamperes. R_T is measured for I_F = 10 mA and the junction resistance, R_j, is subtracted form R_T to determine R_S. R_S is calculated across leads 1-2, 2-4, 3-4 and 1-3. ($R_S = R_T - R_j$)
3. V_F and ΔV_F are measured across adjacent leads at I_F = 1 mA.

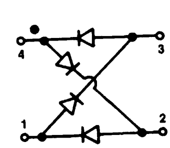
SINGLE BARRIER RING QUAD CIRCUIT TOP VIEW PACKAGED



DUAL BARRIER RING QUAD CIRCUIT TOP VIEW



CROSS-OVER QWUAD CIRCUIT TOP VIEW PACKAGED



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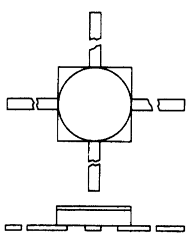
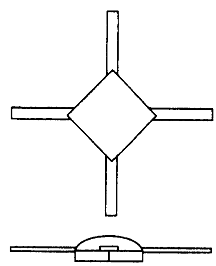
Maximum Ratings

Operating and Storage Temperature Range of Junctions	-65°C to +150°C (Case Style 226) -65°C to +125°C (Case Style 227, 228, 963, 1008)
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/junction
Soldering Temperature (Plastic Packages)	235°C for 10 sec. (Case Style 226) 150°C for 5 sec. (Case Styles 227, 228, 963, 1008)
Beam Strength	2g (Case Styles 264 and 905)

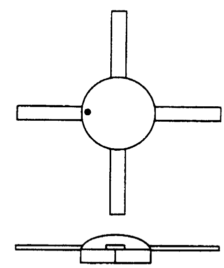
Case Styles (See appendix for complete dimensions)



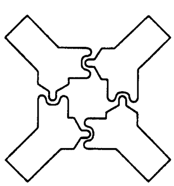
226
(Hermetic Ceramic Package)



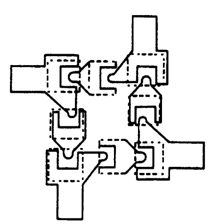
227
(Plastic Encapsulation)



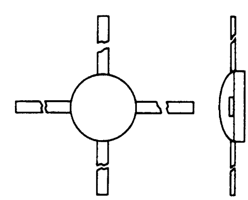
228
(Plastic Encapsulation)



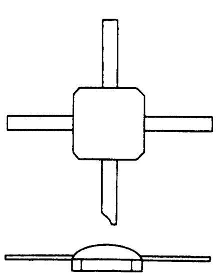
264
(Beam Lead)



905
(Dual Barrier Beam Lead)



963
(Plastic Encapsulation)



1008
(Plastic Encapsulation)

General Purpose Axial Lead Glass Packaged Schottky Diodes

V 2.00

Features

- Picosecond Switching
- JANTX/JANTXV Screening Available
- Low Forward Voltage Drop
- Low Reverse Leakage

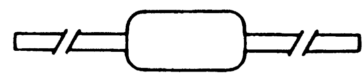
Description

This family of Schottky diodes have "picosecond" switching speed. These diodes are housed in a hermetic axial lead glass package and can be screened to JANTX and JANTXV levels. Breakdown voltage of up to 70 volts is available. The MA4E2835 is designed to have very low forward drop.

Applications

This family of axial lead glass packaged Schottky diodes is useful for high level mixers, detectors, upconverters and fast switching and gating circuits. These diodes are also used in fast sampling circuits such as bridge quads and/or limiters, for pulse shaping circuits and for gates in frequency discriminators.

Case Style 54



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Specifications @ T_A = +25°C

General Purpose Diodes

These silicon diodes are packaged in an axial lead glass package. Various uses include detecting, mixing and switching at low power levels. This series of diodes can also be used in the UHF and VHF frequency bands for pulse shaping, sampling and as fast logic gates.

Model[1,2] Number	JEDEC Equivalent Part Number	Minimum[3] Reverse Voltage V_R (Volts)	Maximum Forward Voltage V_F @ 1 mA (Volts)	Minimum Forward Current V_F @ 1 V (mA)	Maximum Reverse Leakage Current, I_R (nA)	Maximum[4] Total Capacitance, C_T (pF)
1N5711	1N5711	70	0.410	75	200 @ -50V	1.0
MA4E2303	1N5167	20	0.400	35	500 @ -15V	1.0
MA4E2810	—	20	0.410	35	100 @ -15V	1.2
MA4E2812	1N5712	20	0.550	35	150 @ -15V	1.2
MA4E2811	1N5713	15	0.410	20	100 @ -8V	1.2
MA4E2835	—	8[6]	0.340	10	100 @ -1V	1.0

Notes:
1. Effective minority carrier lifetime (TL) is 100 ps maximum measured with the Krakauer method at 20 mA, for all diodes except MA4E2835, MA4E2812 and MA4E2811 which are measured at 5 mA.
2. All diodes in this series are housed in case style 54, a miniature axial lead glass package.
3. Reverse voltage is measured at 10 µA current, except where noted.
4. Capacitance is measured at 0 V and 1 MHz.
5. JANTX and JANTXV level screening are available upon request. Contact factory.
6. The reverse voltage of MA4E2835 is measured at 100 µA reverse current.

Maximum Ratings

Storage Temperature	-65°C to +200°C
Operating Temperature	-65°C to +150°C
Reverse Voltage	See voltage ratings
Power Dissipation	250 mW Derate linearly to zero at 135°C
Soldering Temperature	230°C for 5 seconds 1 mm from glass

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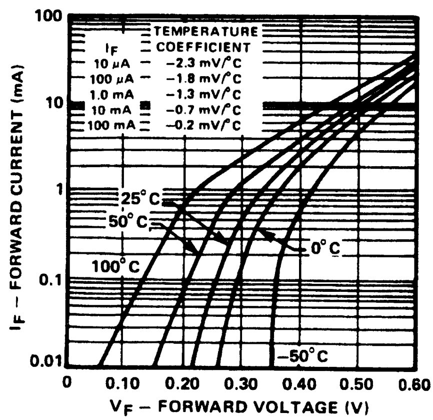
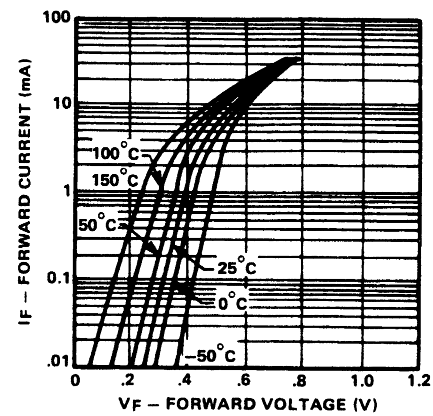
Typical Performance Curves

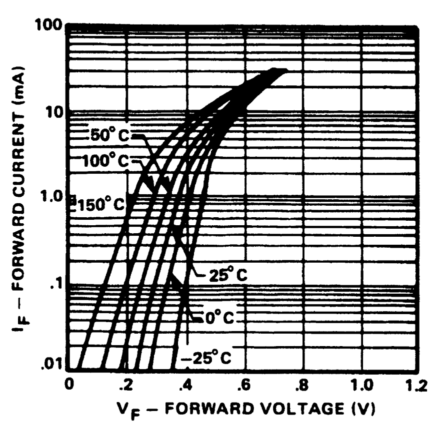
I-V CURVE SHOWING TYPICAL TEMPERATURE VARIATIONS FOR THE MA4E2303 SERIES SCHOTTKY DIODES.



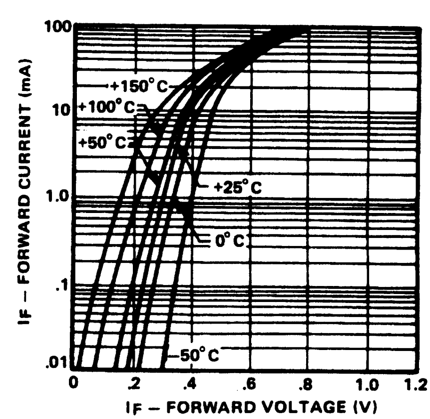
1-V CURVE SHOWING TYPICAL TEMPERATURE VARIATIONS FOR THE MA4E2810, 2812 SERIES SCHOTTKY DIODES.



I-V CURVE SHOWING TYPICAL TEMPERATURE VARIATIONS FOR THE MA4E2811 SERIES SCHOTTKY DIODES.

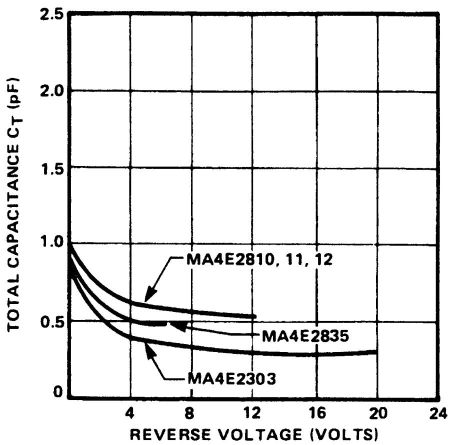


1-V CURVE SHOWING TYPICAL TEMPERATURE VARIATIONS FOR THE MA4E2835 SERIES SCHOTTKY DIODES.

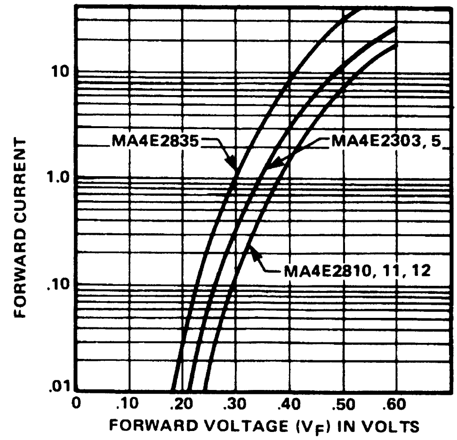


Typical Performance Curves (Con't)

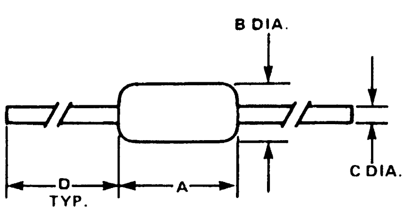
NOMINAL TOTAL CAPACITANCE vs REVERSE VOLTAGE



NOMINAL FORWARD CURRENT vs FORWARD VOLTAGE (AT 25°C)



Case Style 54



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.145	0.165	3,68	4,19
B	0.068	0.075	1,72	1,91
C	0.014	0.016	0,35	0,41
D	1.000	1.500	25,40	38,10

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

M/A-COM an AMP company

Axial Lead Glass Packaged Schottky Mixer Diodes

V 2.00

Features

- High Reliability
- Screening to Jantxv Level Available
- Low and Medium Barrier Diodes Available
- Low Noise Figure Through 10 GHz

Description

Two families of axial lead Schottky diodes are offered with diodes optimized for 100 MHz through 10 GHz.

Low barrier diodes require the smallest local oscillator drive.

Medium barrier diodes give good noise figure with normal local oscillator drive.

Case Style 54

(See appendix for complete dimensions)

M/A-COM, Inc.

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Specifications @ T_A = +25°C

This series of axial lead Schottky mixer diodes is designed for use in stripline or lumped element mixers from VHF through X-band. Each diode is listed by barrier height, test frequency and noise figure.

Low Barrier Mixer Diodes

Model Number	Case Style	Test Frequency (GHz)	Maximum[1] Noise Figure (dB)	Maximum[2] SWR	Z_{IF} Range[3] Min./Max. (Ohms)
MA40103	54	9.375	6.5	1.5	250/450

Medium Barrier Mixer Diodes

Model Number	Case Style	Test Frequency (GHz)	Maximum[1] Noise Figure (dB)	Maximum[2] SWR	Z_{IF} Range[3] Min./Max. (Ohms)
MA4882	54	1.000	5.5	1.5	125/250
MA4853	54	3.000	5.5	1.5	125/250
MA40153	54	9.375	6.5	1.5	250/450

Notes:

1. Test conditions for noise figure:
   P_{LO} = 1 mW (for low and medium barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB
   R_L = 22 Ohms
2. SWR for low and medium barrier diodes is tested at LO power of 1.0 mW.
3. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal. R_L = 22 Ohms. Low and medium barrier diodes are tested at an incident power level of 1 mW.

Maximum Ratings

Temperature Ratings	
Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +150°C
Power Ratings	
Maximum Peak RF Power	L-S band, 1 watt at 1 µs maximum C-X band, 0.5 watt at 1 µs maximum
Maximum CW RF Power	(L-S Band) 250 mW (C-X Band) 150 mW
Solder Temperature Ratings	
Soldering Temperature	230°C for 5 seconds within 1 mm of package

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Screened Diodes MIL-STD19500

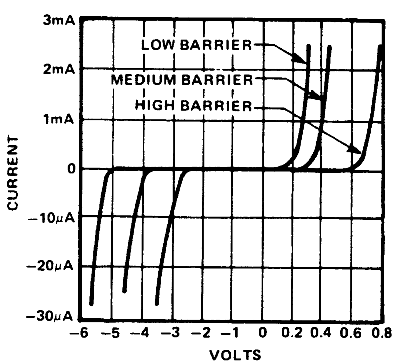
All Glass Axial Leaded Silicon Schottky mixer diodes can be screened to TX or TXV levels.

Inspection	Method	Condition
Internal Visual	2074	See Note 1
High Temperature Life (Stabilization Bake)	1032	T = 24 Hours, T_A = +150°C
Thermal Shock	1056	20 cycles -65°C to +125°C, T extreme > 10 minutes
Constant Acceleration	2006	20,000 g's, Y1 direction
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical		See Note
HTRB	1038	T_A = +150°C
		V_R = 80% V_B
		T = 48 Hours Minimum
Pre-Burn-In Electrical		See Note
Burn-In	1038	Condition B
		T_A = +25°C
		I_{pk} = 10 mA
		T = 96 Hours Minimum
Final Electricals and Delta		See Note

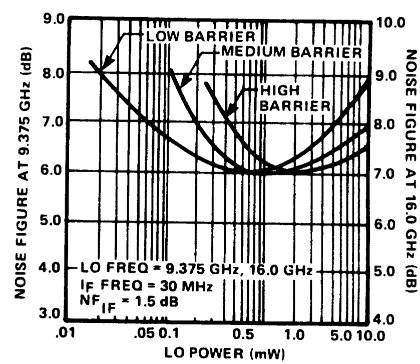
Note:
Conditions and details of test depend on the specific model number. Information is available from the factory upon request.

Typical Performance Curves

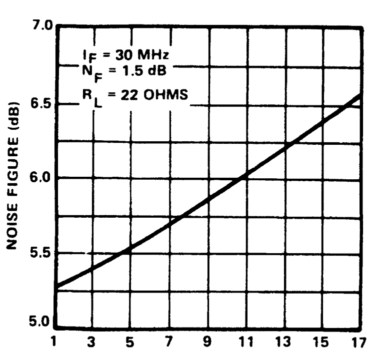
1-V CHARACTERISTICS AND BARRIER HEIGHTS FOR SCHOTTKY MIXER DIODES



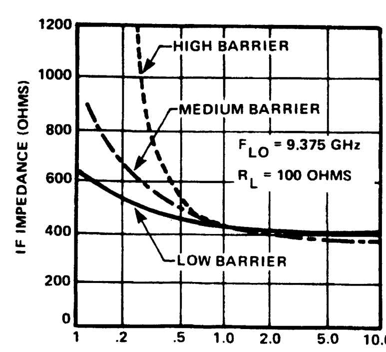
SCHOTTKY BARRIER NOISE FIGURE vs LO POWER



NOMINAL NOISE FIGURE vs FREQUENCY



NOMINAL IF IMPEDANCE vs LOCAL OSCILLATOR DRIVE



Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

Stripline Packaged Schottky Mixer Diodes

V 2.00

Features

- Large Choice of Available Packages
- Uniform RF Characteristics
- Screening to JANTXV Level Available
- Low, Medium and High Barrier Diodes

Description

Three families of stripline packaged mixer diodes are offered in a wide range of packages. These diodes have low noise figure through 26 GHz. The three families are:

- Low Barrier diodes for minimum LO drive.
- Medium Barrier diodes for normal LO drive.
- High Barrier diodes for maximum dynamic range and upconverters.

Applications

Stripline and microstrip mixers from 100 MHz Upconverters.

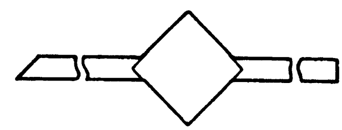
Stripline Packaged Schottky Mixer Diodes

These stripline packaged Schottky barrier mixer diodes are suitable for use in stripline and microstrip mixers. Each family of diodes is listed by barrier height, increasing frequency capability, and grouped according to package style and noise figure.

The forward I-V characteristics of Schottky diodes are dependent on the barrier voltage of the metal. The barrier voltage affects the local oscillator requirement for optimum RF performances. M/A-COM offers low, medium and high barrier Schottky mixer diodes.

Electrical characteristics and packaging other than the standard specifications listed, may be available upon request. For more information, contact the factory.

Case Style 213



Maximum Ratings

Temperature Range	
Operating (case style 186, 276)	-65°C to +150°C
(case style 137, 213)	-65°C to +125°C
Storage (case style186,276)	-65°C to +150°C
(case style 137, 213)	-65°C to +125°C
Incident Power Ratings	
Maximum Peak RF Incident Power	C-X Band 1 Watt for 1 microsecond maximum Ku-K Band 0.5 Watt for 1 microsecond maximum
Maximum CW RF Incident Power	C-X Band 150 mW Ku-K Band 100 mW
Solder Temperature Ratings	
(case style 137, 213)	200°C for 5 seconds, 1 mm from package
(case style 186, 276)	225°C for 5 seconds, 1 mm from package

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Specifications @ T_A = +25°C

Low Barrier Stripline Packaged Schottky Diodes

Low barrier diodes normally are most satisfactory for use in balanced mixers where the local oscillator drive level is between 0.5 dBM and +3 dBM per diode.

Model Number	Case Style	Test Frequency (GHz)	Maximum[1] Noise Figure (dB)	Maximum[2] SWR (Volts)	Z_{IF} Range[3] Min./Max. (Ohms)
MA40033	137	6.000	5.5	1.5	200/500
MA40036	213	6.000	5.5	1.5	200/500
MA40126	186	9.375	6.0	1.5	250/450
MA40083	213	9.375	6.0	1.5	250/450
MA40105-276	276	9.375	6.0	1.5	250/450
MA40115-276	276	16.000	6.5	2.0	250/450
MA4E914-276	276	24.000	7.5	1.5	200/500

Medium Barrier Stripline Schottky Diodes

Medium barrier diodes are normally most satisfactory for use in balanced mixers where the local oscillator drive level is between +0 dBM and +10 dBM per diode.

Model Number	Case Style	Test Frequency (GHz)	Maximum[1] Noise Figure (dB)	Maximum[2] SWR (Volts)	Z_{IF} Range[3] Min./Max. (Ohms)
MA40030	137	6.000	7.0	1.5	200/500
MA40032	137	6.000	5.5	1.5	200/500
MA40048	213	6.000	5.5	1.5	200/500
MA40088	137	9.375	6.0	1.5	200/500
MA40089	213	9.375	6.0	1.5	200/500
MA40176	186	9.375	6.0	1.5	250/450
MA40155-276	276	9.375	6.0	1.5	250/450
MA40166-276	276	16.000	7.0	2.0	250/450
MA4E920-276	276	24.000	7.5	1.5	200/500

Notes:

1. Test conditions for noise figure:
   P_{LO} = 1 mW (for low and medium barrier)
   P_{LO} = 2 mW (for high barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB (minimum)
   R_L = 22 ohms
2 SWR for low and medium barrier diodes is tested at LO power of 1.0 mW. High barrier diodes are tested at a LO power level of 2 mW. R_L = 22 Ohms.

3. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal. R_L = 22 Ohms. Low and medium barrier diodes are tested at an incident power level of 1 mW. High barrier diodes are tested at an incident power level of 2 mW.

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Specifications (Cont'd)

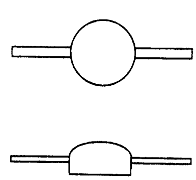
High Barrier Stripline Schottky Diodes

High barrier diodes are normally most satisfactory for use in balanced mixers where the local oscillator drive level is between + 6 dBM and + 15 dBM per diode.

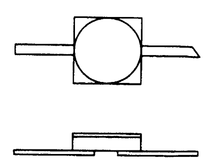
Model Number	Case Style	Test Frequency (GHz)	Maximum[1] Noise Figure (dB)	Maximum[2] SWR (Volts)	Z_{IF} Range[3] Min./Max. (Ohms)
MA40045	137	6.000	5.5	1.5	200/500
MA40060	213	6.000	5.5	1.5	200/500
MA40095	137	9.375	6.0	1.5	250/450
MA4E197	186	9.375	6.0	1.5	250/450
MA4E199	186	9.375	7.0	2.0	250/450
MA40094	213	9.375	6.5	1.5	250/450
MA4E185-276	276	9.375	6.0	1.5	250/450
MA4E190-276	276	16.000	6.5	1.5	250/450
MA4E926-276	276	24.000	7.5	1.5	200/500

Notes:
1. Test conditions for noise figure:
   P_{LO} = 1 mW (for low and medium barrier)
   P_{LO} = 2 mW (for high barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB (minimum)
   R_L = 22 ohms
2 SWR for low and medium barrier diodes is tested at LO power of 1.0 mW. High barrier diodes are tested at a LO power level of 2 mW. R_L = 22 Ohms.
3. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal. R_L = 22 Ohms. Low and medium barrier diodes are tested at an incident power level of 1 mW. High barrier diodes are tested at an incident power level of 2 mW.

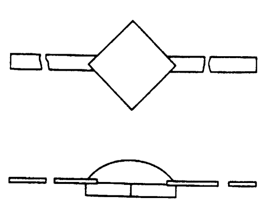
Case Styles (See appendix for complete dimensions)



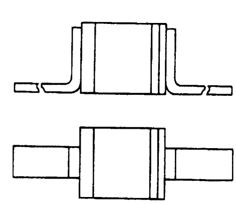
137
(Plastic Encapsulation)



186
(Hermetic Ceramic package)



213
(Plastic Encapsulation)



276
(Hermetic Ceramic package)

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Specifications (Cont'd)

All stripline ceramic packaged Schottky mixer diodes can be screened to TX or TXV levels.

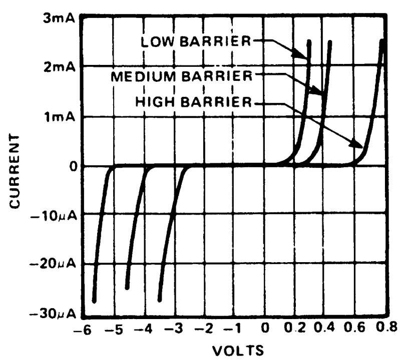
Screened Diodes MIL-STD19500 (Case Style 186, 276)

Inspection	Method (MIL-STD-750)	Condition
Internal Visual	2073	See note
High Temperature Life (stabilization bake)	1032	T = 24 hours, T_A = +150°C
Thermal Shock	1051	20 cycles -65°C to +125°C, T extreme >10 minutes
Constant Acceleration	2006	20,000 g's, Y1 direction
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical		See note
HTRB	1038	T_A = +150°C, V_R = 80% V_B, T = 48 hours minimum
Pre Burn-In Electrical		See note
Burn-in	1038	Condition B, T_A = +25°C, Ipk = 10 mA, T= 96 hours minimum
Final Electricals and Delta		See note

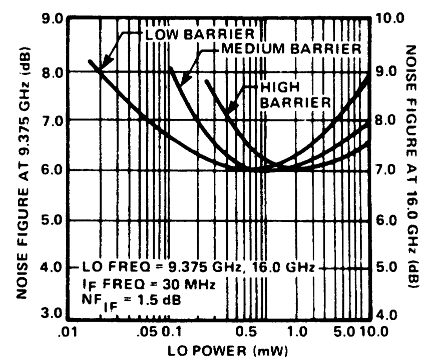
Note:
1. Conditions and details of test depend on the specific model number. Information available from the factory on request.

Typical Performance Curves

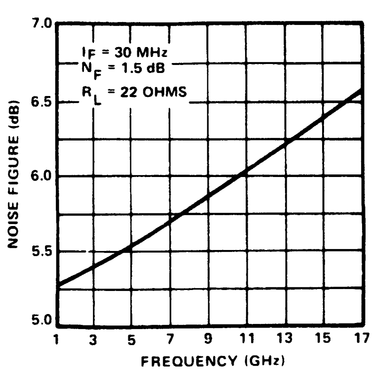
NOMINAL 1-V CHARACTERISTIC AND BARRIER HEIGHTS FOR SCHOTTKY MIXER DIODES



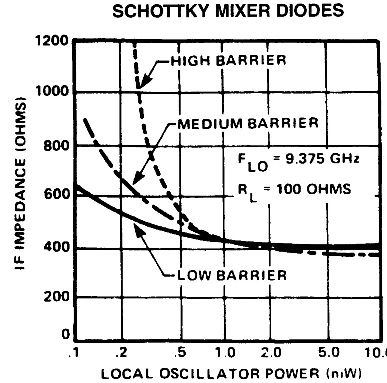
NOMINAL SCHOTTKY BARRIER NOISE FIGURE vs LO POWER



NOMINAL NOISE FIGURE vs FREQUENCY



NOMINAL L-V CHARACTERISTICS AND BARRIER HEIGHTS FOR SCHOTTKY MIXER DIODES



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M/A-COM an AMP company

Ceramic Packaged Schottky Mixer Diodes

V 2.00

Features

- Choice of Three Available Packages
- Can Be Screened to JANTXV Levels

Description

Three families of ceramic packaged Schottky diodes are offered. All pans are thermal compression bonded. The low barrier diodes require the least local oscillator drive. Medium barrier diodes are best for normal L.O. drive. High barrier diodes are most useful for high dynamic range mixers and/or upconverters.

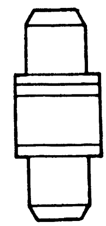
Applications

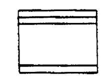
Waveguide and coaxial mixers and upconverters from 100 MHz to 26 GHz.

Ceramic Packaged Schottky Barrier Mixer Diodes

These ceramic packaged Schottky Barrier Mixer Diodes are intended for use in waveguide and coaxial mixers. Each of these diodes is listed by barrier height, test frequency, and grouped by packaged style and noise figure. Other electrical specifications or custom packaging are available upon request at a nominal charge.

Case Styles


119


120

Specifications @ T_A = +25°C

Low Barrier Mixer Diodes

Low barrier mixer diodes are the best choice for applications where the local oscillator drive level is between -3 dBM and +3 dBM per diode.

Model Number	Case Style[1]	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum[3] SWR	Z_{IF} Range[4] Min./Max. (Ohms)
MA40018	119	3.000	5.5	1.5	125/250
MA40100	119	9.375	6.0	1.5	250/450
MA40105	120	9.375	6.0	1.5	250/450
MA40110	119	16.000	6.5	1.5	250/450
MA40115	120	16.000	6.5	1.5	250/450
MA4E913	119	24.000	7.5	1.5	200/500
MA4E914	120	24.000	7.5	1.5	200/500

Notes:
1. The standard case style is given for each model number.
2. Test conditions are as follows:
   P_{LO} = 10 mW (Low or Medium Barrier)
   P_{LO} = 2 mW (High Barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB (minimum)
   R_L = 22 Ohms
3. SWR is tested at a peak power of 1 mW for low and medium barrier and 2 mW for high barrier R_L = 22 Ohms.
4. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal. R_L = 22 Ohms and an incident power level of 1.0 mW for low and medium barrier diodes, and 2 mW for high barrier diodes.

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Medium Barrier Mixer Diodes

Medium barrier diodes are the best choice for applications where the local oscillator drive level is between 0 dBm and +6 dBm per diode.

Specifications @ T_A = +25°C

Model Number	Case Style[1]	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum[3] SWR	Z_{IF} Range[4] Min./Max. (Ohms)
MA40051G	3	3.000	5.5	1.5	350/450
MA40021	119	3.000	5.5	1.5	125/250
MA40071E	3	9.375	7.5	2.0	300/500
MA40150	119	9.375	6.0	1.5	250/450
MA40155	120	9.375	6.0	1.5	250/450
MA40160	119	16.000	6.5	1.5	250/450
MA40165	120	16.000	6.5	1.5	250/450
MA4E919	119	24.000	7.5	1.5	200/500
MA4E920	120	24.000	7.5	1.5	200/500

High Barrier Mixer Diodes

High barrier diodes are the best choice for applications where the local oscillator drive level is between +6 dBm and +15 dBm per diode.

Specifications @ T_A = +25°C

Model Number	Case Style[1]	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum[3] SWR	Z_{IF} Range[4] Min./Max. (Ohms)
MA40055	119	3.000	5.5	1.5	125/250
MA4E180	119	9.375	6.0	1.5	250/450
MA4E185	120	9.375	6.0	1.5	250/450
MA4E188	119	16.000	6.5	1.5	250/450
MA4E190	120	16.000	6.5	1.5	250/450
MA4E925	119	24.000	7.5	1.5	200/500
MA4E926	120	24.000	7.5	1.5	200/500

Notes:

1. The standard case style is given for each model number.
2. Test conditions are as follows:
   P_{LO} = 10 mW (Low or Medium Barrier)
   P_{LO} = 2 mW (High Barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB (minimum)
   R_L = 22 Ohms
3. SWR is tested at a peak power of 1 mW for low and medium barrier and 2 mW for high barrier R_L = 22 Ohms.
4. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal. R_L = 22 Ohms and an incident power level of 1.0 mW for low and medium barrier diodes, and 2 mW for high barrier diodes.

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Environmental Ratings

All ceramic packaged Schottky mixer diodes in case 119 and 120 can be screened to TX or TXV levels.

Screened Diodes MIL-STD19500

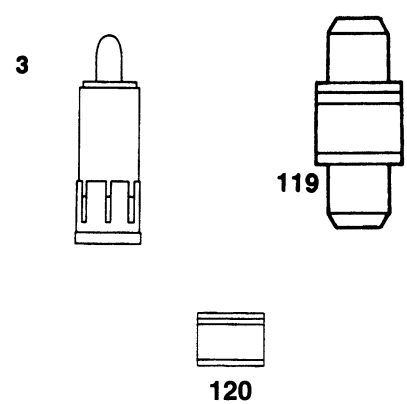
Inspection	Method (MIL-STD-750)	Condition
Internal Visual	2073	See note
High Temperature Life		
(Stabilization Bake)	1032	T = 24 hours, T_A = +150°C
Thermal Shock	1051	20 cycles -65°C to +125°C T extreme > 10 minutes
Constant Acceleration	2006	20,000 G's, Y1 direction
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical		See note
HTRB	1038	T_A = +150°C
		V_R- 80% V_B
		T-48 hours minimum
Pre-Burn-In Electrical		See note
Burn-In		1038 Condition B
		T_A = +25°C
		I_{pk} = 10 mA
		T = 96 hours minimum
Final Electricals and Delta		See note

Note:
Conditions and details of test depend on the specific model number. Information available from the factory on request.

Maximum Ratings

Temperature Ratings	
Storage Temperature	-65°C to +150°C
Operating Temperature	-65°C to +150°C
Power Ratings	
Maximum Incident Peak RF Power	S-X Band 1 Watt for 1 μs maximum Ku - K Band 0.5 Watt for 1 μs maximum
Maximum CW RF Power	S Band 200 mW C-X Band 150 mW Ku-K Band 100 mW
Maximum Solder Temperature	235°C for 5 seconds (Case Style 119) 200°C for 5 seconds (Case Style 120)

Case Styles (See appendix for complete dimensions)



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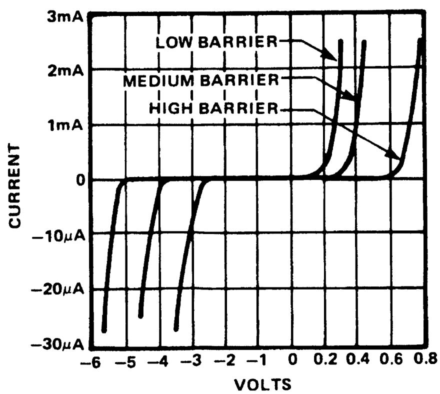
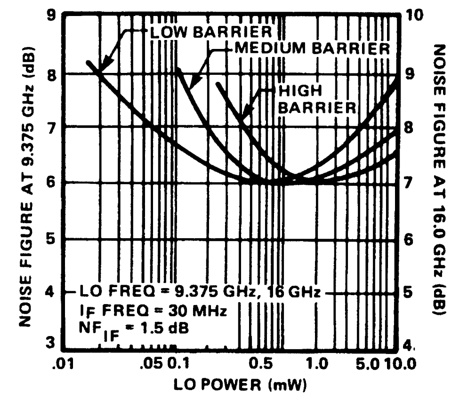
Typical Performance Curves

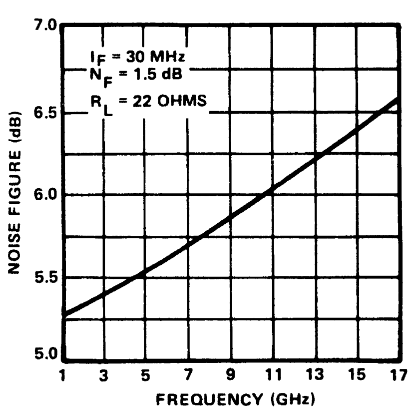
1-V CHARACTERISTICS vs BARRIER HEIGHTS FOR SCHOTTKY MIXER DIODES



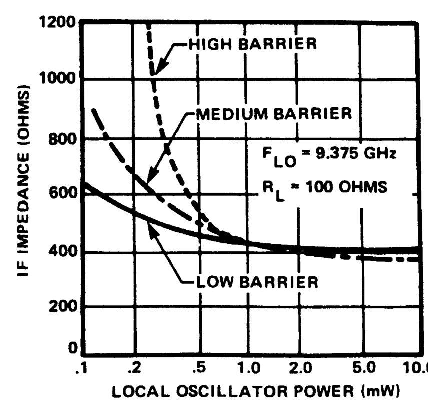
SCHOTTKY BARRIER NOISE FIGURE vs LO POWER



NOMINAL NOISE FIGURE vs FREQUENCY



NOMINAL IF IMPEDANCE vs LOCAL OSCILLATOR DRIVE



an AMP company

Low 1/f Noise, Low Barrier Schottky Doppler Mixer Diodes

V 2.00

Features

- Low Guaranteed 1/f Noise At 10 KHz
- Low Local Oscillator Requirements
- Wide Range Of Available Packages
- Useful For Starved Lo Mixers

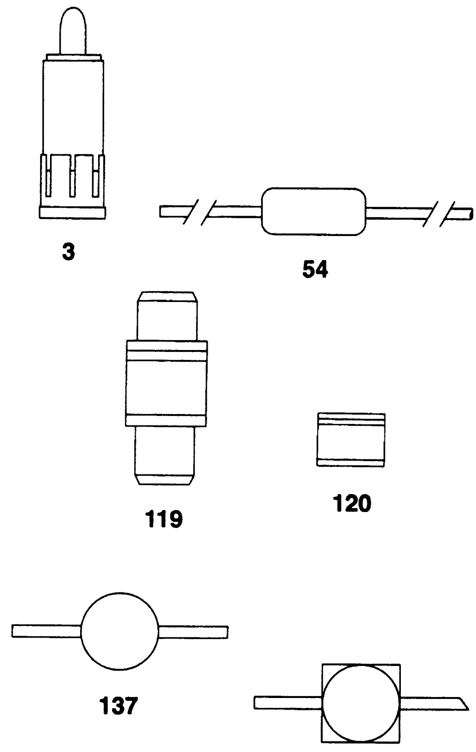
Description

This family of low barrier Schottky diodes is designed to operate under low local oscillator drive or with starved local oscillator drive (-6 dBm). These diodes are particularly useful for doppler systems and the noise figure is specified at an IF frequency of 10 KHz. These low barrier Schottky doppler mixer diodes are offered in a wide range of packages including ceramic packages for coaxial and waveguide circuits, axial lead glass packages and stripline packages.

Applications

Mixers using low frequency IF such as doppler radars, altimeters and motion detection devices. These diodes are also useful for systems where the local oscillator drive is limited or a starved local oscillator is required.

Case Styles (See appendix for complete dimensions)



3, 54, 119, 120, 137, 186

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Specifications @ T_A = +25°C

Low IF/Low LO Drive Schottky Doppler Mixer Diodes

These low level Schottky doppler mixer diodes are suitable for use in waveguide, coaxial and stripline mixers. These diodes are intended for mixers using starved LO conditions (-6 dBm). This family of diodes exhibits the

Model Number	Case Style[1]	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Nominal[3] Z_{IF} (Ohms)
MA40194	3	9.375	12	250
MA40192	54	9.375	12	250
MA40196	137	9.375	12	250
MA40197	186	9.375	12	250
MA40190	120	9.375	12	250
MA40183	119	16.000	12	250
MA40182	120	16.000	12	250
MA40181	119	24.000	12	350
MA40180	120	24.000	12	350

Notes:
1. The standard case style is listed for each model number.
2. Test conditions are as follows:
   P_{LO} = -10 dBm
   F_{IF} = 10 KHz
   R_L = 22 Ohms
   N_{IF} = 1.5 dB
3. The input impedance of the 10 KHz amplifier is approximately 10 K Ohms. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal, R_L = 22 Ohms.

Maximum Ratings

Temperature Range	
Storage Temperature	
(case style 3, 54, 119, 120 186)	-65°C to +150°C
(case style 137)	-65°C to +125°C
Operating Temperature	
(case style 3, 54, 119, 120, 186)	-65°C to +150°C
(case style 137)	-65°C to +125°C
Power Ratings	
Maximum Incident Peak RF Power	0.5 watt for 1 µs maximum
Maximum Incident CW RF Power	X Band 100mW
	Ku-K Band 75 mW
Solder Temperature Ratings	
For case style 54, 119, 186	230°C for 5 seconds 1 mm from case
For case style 120	200°C for 5 seconds
For case style 137	200°C for 5 seconds 1 mm from case

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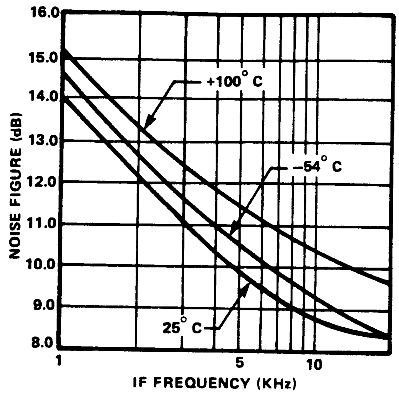
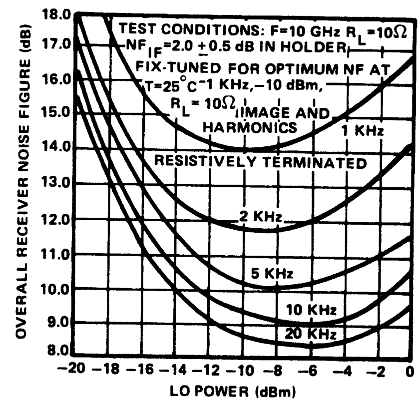
Typical Performance Curves

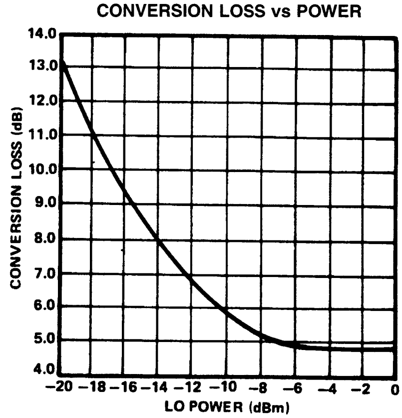
NOISE FIGURE vs I_F FREQUENCY OVER TEMPERATURE



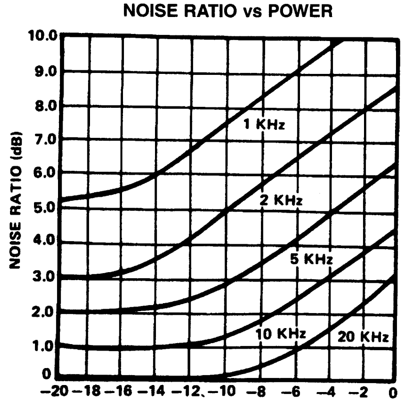
SINGLE SIDEBAND NOISE FIGURE vs POWER



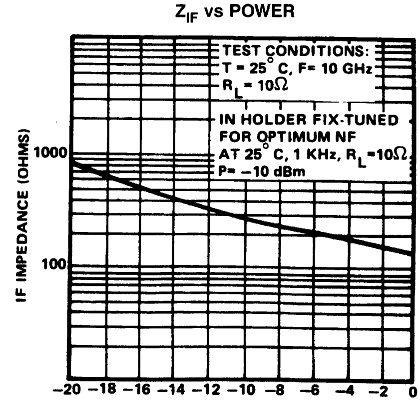
CONVERSION LOSS vs POWER



NOISE RATIO vs POWER



Z_{IF} vs POWER



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Zero Bias Detector Diodes

V 2.00

Features

- Can Be Used Without External DC Bias
- Exhibit Uniform Rv Characteristics
- High Voltage Sensitivity
- Available in Packages, Chips and Beam Leads

Description

This family of Zero Bias Detector (ZBD) diodes is designed for use in video detectors and power monitors eliminating the need to provide external DC bias to the diode.

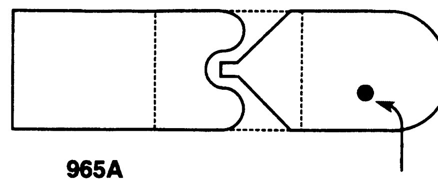
These diodes offer good output sensitivity and low junction capacitance.

M/A-COM's Zero Bias Detector diodes are available in two hermetic packages, and as bondable chips and beam leads. This series of diodes are offered with video impedances of 0.5 to 15 k Ohms at zero bias.

Applications

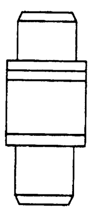
This series of diodes is useful as video detectors and power monitors through K-band and do not require external DC bias.

Case Styles (See appendix for complete dimensions)

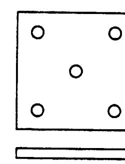


965A

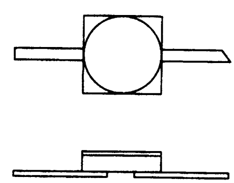
CATHODE



119



135A



186

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Schottky ZBD Beam Lead Diodes (Case Style 965A)

Model Number	Test Frequency Band	Minimum[2] T_{SS} (-dBm)	Minimum[2] Eo, mV	Rv[3,4,5] (k Ohms) (Minimum)	(Maximum)
MA40186	X	48	2	0.5	1.0
MA40186B	X	50	8	2.0	5.0
MA40186C	X	52	10	5.0	10.0
MA40187D	Ku	49	8	10.0	15.0

Silicon Packaged and Chip ZBD Diodes

Model[1] Number	Case Style	Minimum[2,6] T_{SS} (-dBm)	Minimum[2,6] Eo, mV	Rv[3,4,5] (k Ohms) (Minimum)	(Maximum)
MA4E929	119	46	2	0.5	1.0
MA4E929A	119	48	5	1.0	2.0
MA4E929B	119	50	8	2.0	5.0
MA4E929C	119	50	10	5.0	10.0
MA4E929D	119	50	10	10.0	15.0
MA4E931A	135A	52	8	1.0	2.0
MA4E931C	135A	56	15	5.0	10.0
MA4E932	186	47	3	0.5	1.0
MA4E932A	186	48	5	1.0	2.0
MA4E932B	186	50	8	2.0	5.0
MA4E932C	186	50	10	5.0	10.0
MA4E932D	186	50	10	10.0	15.0

Specifications @ T_A = +25°C

Maximum Ratings	
Temperature Ratings: Operating and Storage Temperature	-65°C to +150°C
Power Ratings: Maximum Peak Incident RF Power	0.5 Watts for 1 µsec maximum
Maximum Peak CW RF Power Both ratings at 25°C. Derate linearly to zero at maximum operating temperature.	100 mW
Solder Temperature Ratings: For case style 54, 186	230°C for 5 sec (1mm from package)
For case style 119	200°C for 5 sec (maximum)

Notes:

1. Schottky barrier diodes are thermocompression bonded in case styles 119 and 186. Case style 135A is a bondable chip. Other case styles may be available. For additional information, contact the factory. To order chip parts add 135A as the suffix to the part number, i.e., MA4E929A-135A. Only the MA4E929 series is available as a chip.
2. Test conditions:
   For T_{SS}: Video Bandwidth = 1 MHz
   Noise Amplifier = 3.5 dB
   Test Frequency: X-Band = 10 GHz
   Ku-Band = 16 GHz
   Voltage Sensitivity: PIN = -30 dBm
   R_L = 1 M (Ohms)
   Test Frequency = as stated
3. Higher Rv values are available on request. Contact the factory.
4. The nominal junction capacitance values are as follows:
   Diodes with Rv ~0.5 to 2.0 k Ohms, Cj ~0.30 pF (maximum)
   Diodes with Rv ~2.0 to 5.0 k Ohms, Cj ~0.25 pF (maximum)
   Diodes with Rv ~5.0 to 15.0 k Ohms, Cj ~0.20 pF (maximum)
5. The nominal R_s is ~30 Ohms maximum.
6. Test frequency band is X-Band.

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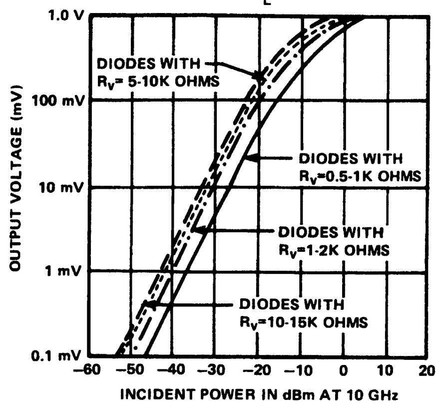
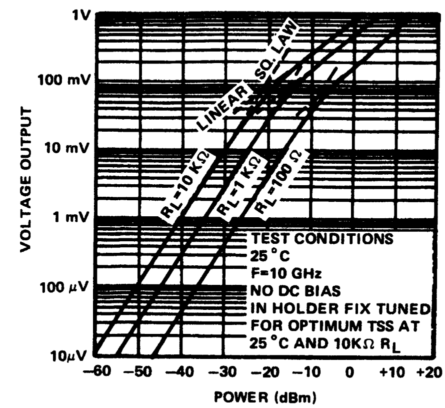
Typical Performance Curves

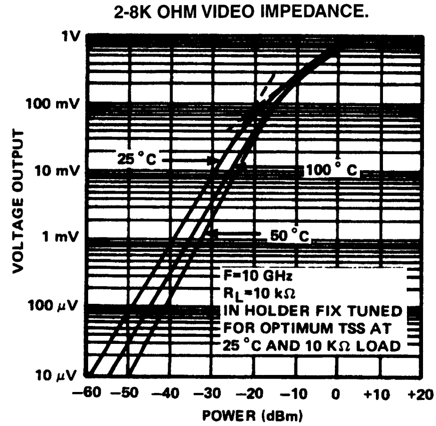
ZERO BIAS SCHOTTKY DETECTOR DIODE NOMINAL OUTPUT VOLTAGE AT 25°C AND 10 GHZ WITH A FIXED TUNED HOLDER AN R_L = 10K OHMS.



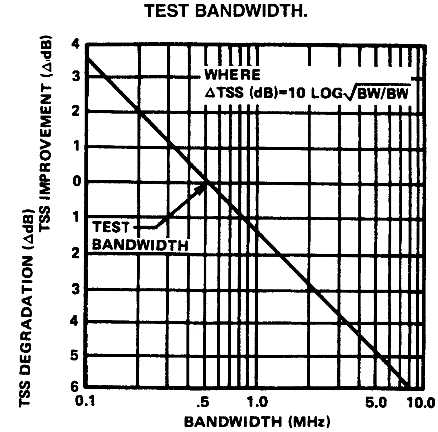
ZERO BIAS SCHOTTKY DETECTOR VOLTAGE SENSITIVITY FOR DIODES WITH 2-8K OHM VIDEO IMPEDANCE.



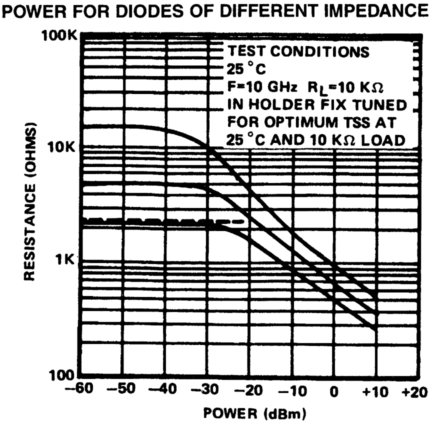
ZERO BIAS SCHOTTKY DETECTOR VOLTAGE SENSITIVITY CHARACTERISTICS UNDER TEMP FOR DIODE WITH 2-8K OHM VIDEO IMPEDANCE.



TSS CONVERSION FOR BANDWIDTHS OTHER THAN TEST BANDWIDTH.



ZERO BIAS SCHOTTKY DETECTOR DYNAMIC RESISTANCE (RV) vs POWER FOR DIODES OF DIFFERENT IMPEDANCE RANGES.



Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

Schottky Detector Diodes

V 2.00

Features

- Wide Selection of Packages for Stripline, Coaxial and Waveguide Detectors
- Chip Diodes Available
- Both P and N Type Diodes
- Excellent Sensitivity Through Ka-Band
- Low 1/F Noise

Description

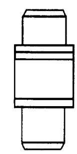
This family of low capacitance Schottky diodes is designed to give superior performance in video detectors and power monitors from 100 MHz through 40 GHz. They have low junction capacitance and repeatable video impedance. These diodes are available in a wide range of ceramic, stripline and axial lead packages and as bondable chips. Both P and N type diodes are offered.

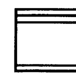
Applications

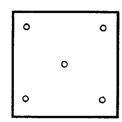
Detectors and power monitors in stripline, coaxial and waveguide circuits through 40 GHz.

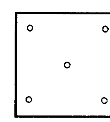
Case Styles (See appendix for complete dimensions)

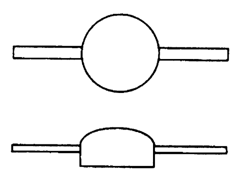

54

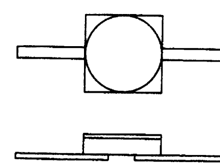

119

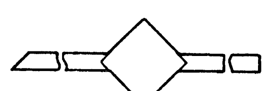

120

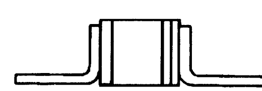

135


135A


137


186


213


276

Maximum Ratings

Temperature Ratings **Storage Operating Temperature**	-65°C to +150°C (Case styles 54, 119, 120, 135, 135A, 186, 276) -65°C to +125°C (Case styles 137, 213)
Power Ratings at 25°C **Maximum Peak Incident RF Power**	S-X Band 1 Watt-1 microsecond maximum pulse length Ku-K Band 0.5W-1 microsecond maximum pulse length
Maximum CW RF Power **Derate Linearly to Zero at 150°C**	S-X Band 150 mW (maximum) Ku-K band 100 mW (maximum)
Solder Temperature Ratings	
For case styles 54, 119, 186, 276	230°C for 5 seconds, 1 mm from package
For case style 120	200°C for 5 seconds
For case style 137 and 213	150°C for 5 seconds, 1 mm from package

Packaged N Type Silicon Schottky Detector Diodes

These low barrier packaged detector diodes are suitable for use in stripline, waveguide and coaxial detectors. They feature high sensitivity and low l/f noise. These diodes are listed by increasing test frequency, grouped by packaged style and decreasing Tss. Other case styles than those specified may be available.

Specifications @ T_A = +25°C

Model[1] Number	Case Style	Test Frequency (GHz)	Maximum[2,3] Tang. Signal Sensitivity T_{SS} (dBm)	Video Impedence[3,4] Range Min./Max. (k Ohms)
MA40053	54	3	- 55	1/2
MA40064	119	3	- 55	1/2
MA40202	54	10	- 55	1/2
MA40201	119	10	- 55	1/2
MA40207	120	10	- 55	1/2
MA40205	119	16	- 52	1/2
MA40215	120	16	- 52	1/2
MA40268	120	36	- 49	1/2

Notes:

1. Schottky barrier junction diodes are thermocompression bonded in case style 119 and 120. Case style 54 uses pressure contacts. The standard case style is given for each model number. Other case styles may be available.
2. The video amplifier bandwidth is 1 MHz and the nominal amplifier noise figure is 3 dB. DC impedance is 10 k Ohms. The DC bias is 20 μA.
3. RF Power = 30 dBM. The dc forward bias is + 20 μA.
4. Measured at the indicated test frequency and at -30 dBm RF power

N Type Silicon Schottky Detector Diodes

These low barrier packaged detector diodes are suitable for use in striping applications. They feature high sensitivity, and low 1/f noise. These diodes are listed by increasing frequency, and grouped by package style and Tss. Case styles other than those specified may be available. For additional information, contact the factory.

Model Number	Case Style	Test Frequency (GHz)	Minimum[1] Tang. Signal Sensitivity T_{SS} (dBm)	Video Impedence[2] Range Min./Max. (K Ohms)
MA40261	186	3	- 55	1/2
MA40143	213	3	- 50	1/2
MA40108	137	10	- 52	1/2
MA40070	137	10	- 50	1/2
MA40264	186	10	- 55	1/2
MA40147	213	10	- 55	1/2
MA40207-276	276	10	- 55	1/2
MA40215-276	276	16	- 52	1/2

Packaged P Type Silicon Schottky Detector Diodes

This series of low barrier P type detector diodes has good voltage sensitivity and lower 1/f noise than similar capacitance N type Schottky diodes. They are listed by case style.

Specifications @ T_A = +25°C

Model Number	Case Style	Test Frequency (GHz)	Minimum[1] Tang. Sig. Sens. T_{SS} (dBm)	Video Impedance[2] Range Min./Max. (Ohms)	Minimum[2] Sensitivity (mV/mW)
MA40252	54	10	- 55	1.2/1.8	5000
MA40251	119	10	- 55	1.2/1.8	5000
MA40257	120	10	- 55	1.2/1.8	5000
MA40257-276	276	10	- 55	1.2/1.8	5000

Notes:
1. The video amplifier bandwidth is 1 MHz and the noise figure is 3 dB. The input impedance is 10 k Ohms and DC bias is 20 μA.
2. Pinc = -30 dBM. The DC forward bias is +20 μA.

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N Type Silicon Schottky Chip Detector Diodes

These low barrier N type chip detector diodes are suitable for use in microstrip applications. They feature sensitivity, and low 1/f noise. These diodes are listed by increasing frequency.

Model Number	Case Style	Test Frequency (GHz)	Nominal[1,5] T_{SS} (dBM)	Minimum Reverse Voltage V_R (Volts)	Nominal[3] Forward Voltage (Volts)	Nominal[4] Total Capacitance (pF)
MA40220	135	10.0	- 52	2.0	0.3	0.12
MA40222	135	16.0	- 52	2.0	0.3	0.09

P Type Silicon Schottky Chip Detector Diodes

These low barrier P type chip detector diodes are suitable for use in microstrip or stripline circuits. These diodes are listed by increasing test frequency.

Specifications @ T_A = 25°C

Model Number	Case Style	Test Frequency (GHz)	Minimum[2] Reverse Voltage V_R (Volts)	Nominal[1,5] T_{SS} (dBM)	Nominal[3] Forward Voltage (Volts)	Nominal[4] Total Capacitance (pF)
MA40270	135A	10.0	4.0	- 52	0.4	0.12
MA40272	135A	16.0	4.0	- 52	0.4	0.09

Notes:
1. The video amplifier bandwidth is 1 MHz and the noise figure is 3 dB. Impedance is 10 k Ohms and DC bias is +20 µA. Wafers are evaluated on a sample basis for T_{SS}.
2. Voltage rating is measured at 10 µA reverse bias current.
3. Forward voltage is measured at a forward current of 1 mA.
4. Capacitance is measured at 0 V and 1 MHz.
5. RF power = -30 dBm. The DC forward bias is +20 µA. Measured at the indicated test frequency and at -30 dBm RF power with R_L = 10 k Ohms and DC forward bias +20 µA.

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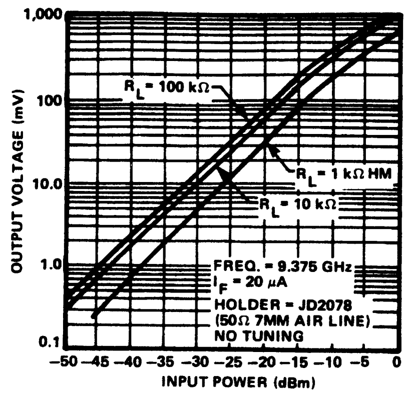
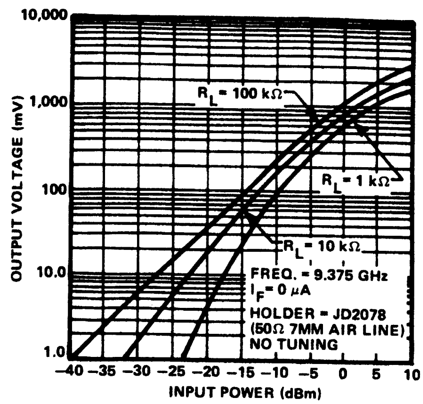
Typical Performance Curves

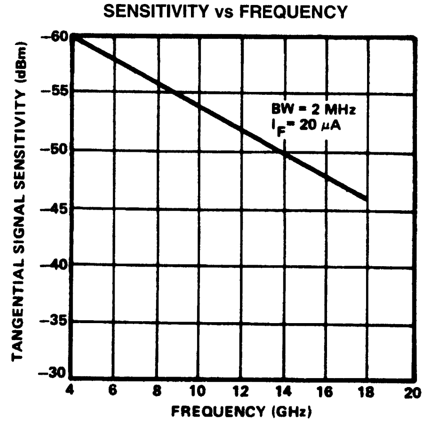
NOMINAL OUTPUT VOLTAGE AT X-BAND
(WITH FORWARD BIAS)



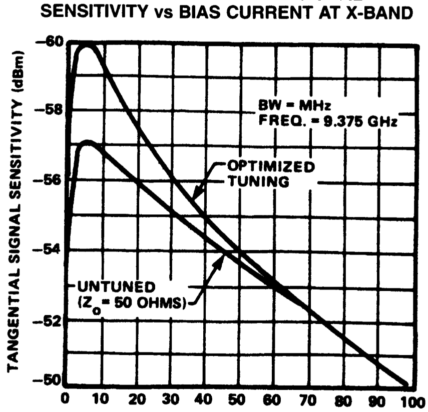
NOMINAL OUTPUT VOLTAGE AT X-BAND
(WITH ZERO BIAS)



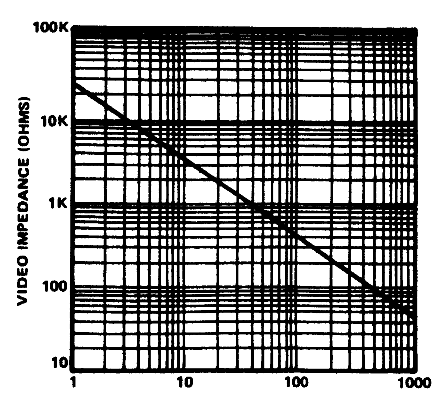
NOMINAL TANGENTIAL SIGNAL
SENSITIVITY vs FREQUENCY



NOMINAL TANGENTIAL SIGNAL
SENSITIVITY vs BIAS CURRENT AT X-BAND



NOMINAL VIDEO IMPEDANCE vs BIAS CURRENT



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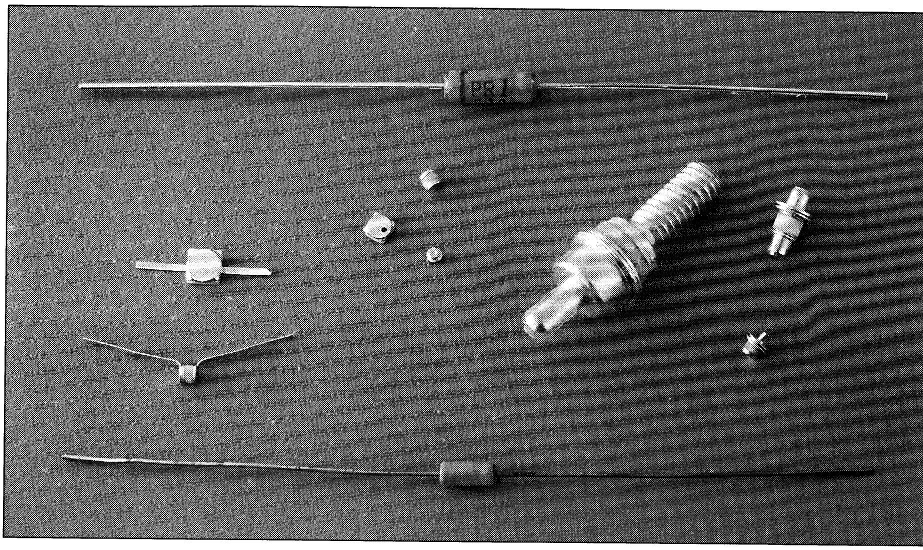
Multiplier Diodes



Title **Page**

Multiplier Varactors

Suggested Frequency Range (GHz)	Reverse Voltage Minimum (V)	Junction Capacitance Min./Max. (pF)	Lifetime Minimum (nsec)	Transition Time (Psec)	Part No.	Page No.
Snap Varactors[1]						
10 - 20	20	0.2 - 0.5	7	50	MA44621	6-2
7 - 12	20	0.5 - 1.5	7	50	MA44622	6-2
6 - 12	30	0.3 - 1.1	8	70	MA44631	6-2
5 - 10	30	0.5 - 1.5	8	70	MA44631	6-2
2 - 10	40	0.4 - 1.5	12	90	MA44641	6-2
2 - 8	40	0.5 - 1.5	12	150	MA44642	6-2
1 - 5	50	0.5 - 1.5	15	150	MA44652	6-2
1 - 4	60	0.7 - 2.0	20	250	MA44663	6-2

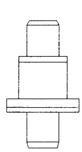
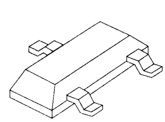
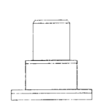
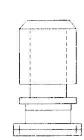
1. Available in Packaged or Chip form.

High Order Step Recovery Diodes For Comb Generators						
1 - 12	25 - 40	0.2 - 0.3	9 - 27	90	MA43592	6-4
2 - 20	20 - 50	0.2 - 0.55	10 - 25	60	MA43543	6-4

Suggested Frequency Range (GHz)	Output Frequency (GHz)	Typical Output Power (W)	Capacitance Min./Max. (pF)	Reverse Voltage Min./Max. (V)	Lifetime Min./Max. (nsec)	Transition Time Maximum (Psec)	Family Part No.	Page No.
High Power Step Recovery Diodes								
1 - 3	2	4.0	3 - 4.5	85 - 105	250 - 500	600	MA43000	6-3
1 - 6	6	1.5	1.6 - 2.4	45 - 70	75 - 225	250	MA43002	6-3
3 - 13	12	0.3	0.95 - 8.5	30 - 45	20 - 50	150	MA43004	6-3

Suggested Frequency Range (GHz)	Reverse Voltage Minimum (V)	Junction Capacitance Min./Max. (pF)	Lifetime Minimum (nsec)	Transition Time (Psec)	Part No.	Page No.
Surface Mount (SOT-23) Packaged Step Recovery Diodes						
1 - 4	30	0.8 - 1.2	20 - 50	150	MA44769	6-3
0.5 - 2.5	30	1.6 - 2.4	75 - 225	250	MA44768	6-3
0.5 - 1.5	30	3 - 4.5	250 - 500	600	MA44767	6-3

SOT-23 applies to bottom table only

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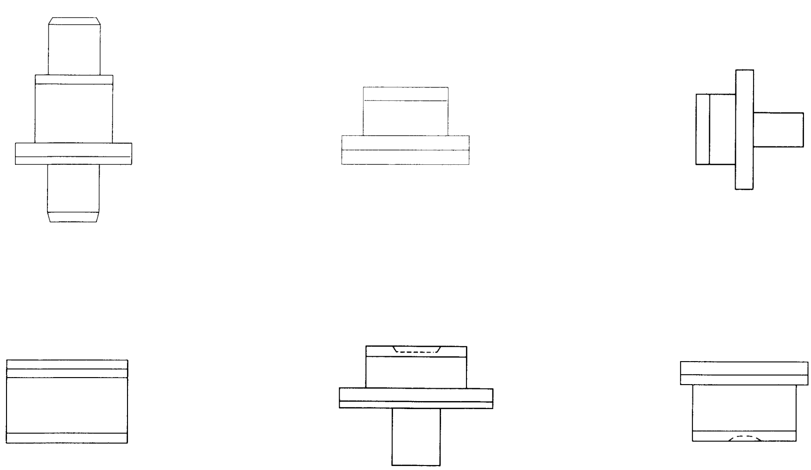
M/A-COM an AMP company

GaAs Multiplier Diodes

V 2.00

Suggested Frequency Range (GHz)	Nominal Cut-off Frequency (GHz)	Zero Bias Reverse Junction Capacitance (pF)	Voltage Minimum (V)	Part No.	Page No.
Voltage Variable (Single-Bias Control)					
20 - 50	550	0.15 - 0.25	15	MA48701E	6 - 6
20 - 40	500	0.25 - 0.35	15	MA48702E	6 - 6
15 - 30	450	0.35 - 0.45	15	MA48703E	6 - 6
15 - 30	400	0.45 - 0.55	15	MA48704E	6 - 6
10 - 20	400	0.55 - 0.65	15	MA48705E	6 - 6
20 - 40	400	0.15 - 0.25	25	MA48706C	6 - 6
15 - 35	350	0.25 - 0.35	25	MA48707C	6 - 6
15 - 30	300	0.35 - 0.45	25	MA48708C	6 - 6



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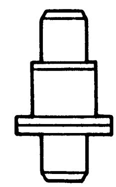
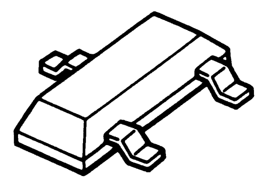
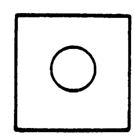
Step Recovery Diodes

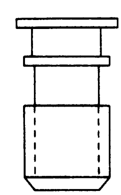
MA43000, MA44600, MA44700 Series

V 2.00









Features

- Low Transition Times
- Tight Capacitance Ranges
- High Voltage and Low Thermal Resistance for Higher Input Power
- Surface Mount Package Available (SOT-23)

Description

The MA44600 series of Step Recovery diodes is designed for use in low and moderate power multipliers with output frequencies of up to 20 GHz. These Step Recovery diodes generate harmonics by storing a charge as the diode is driven to forward conductance by the positive voltage of the input signal. When the signal reverses polarity, this charge is extracted. The Step Recovery diode will appear as a low impedance current source until all the charge is extracted, then it will “snap” to a higher impedance. This causes a voltage pulse to form in the impulse circuit of the multiplier. Step Recovery diodes make excellent high order multipliers such as comb generators. They are also useful as efficient moderate power X2- X4 multipliers.

Applications

High Order Narrow Band Moderate Power Multipliers (MA44600 series)

Comb Generators (MA43592, MA43543)

High Power Circuit Tested Multiplier (MA43000 Series)

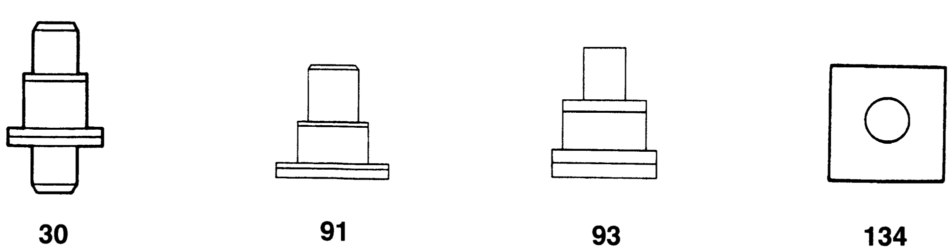
Surface Mount Low Power Multipliers (MA44700 Series)

Snap Varactors
Specifications @ T_A = +25°C

Model[1] Number	Minimum[2] Reverse Voltage V_R (Volts)	Junction[3] Capacitance Range (C_j) Min./Max. (pF)	Minimum Lifetime 10 mA/6 mA TI (ns)	Transition Time T_S[4] (ps)	
				Nominal	Max.
MA44621A	20	0.2 / 0.3	7	50	100
MA44621B	20	0.3 / 0.4	7	50	100
MA44621C	20	0.4 / 0.5	7	50	100
MA44622A	20	0.5 / 0.7	7	50	100
MA44622B	20	0.7 / 0.9	7	50	100
MA44631A	30	0.3 / 0.5	8	70	100
MA44631B	30	0.5 / 0.7	8	70	100
MA44631C	30	0.7 / 0.9	8	70	100
MA44641A	40	0.4 / 0.6	12	90	150
MA44641B	40	0.6 / 0.8	12	90	150
MA44641C	40	0.8 / 1.1	12	90	150
MA44652A	50	0.5 / 0.7	15	150	200
MA44652B	50	0.7 / 0.9	15	150	200
MA44652C	50	0.9 / 1.1	15	150	200
MA44663A	60	0.7 / 0.9	20	250	300
MA44663B	60	0.9 / 1.1	20	250	300
MA44663C	60	1.1 / 1.5	20	250	300
MA44663D	60	1.5 / 2.0	20	250	300

Notes:
1. When ordering, specify the desired case style by adding the case designation as a suffix to the model number. Case styles for the MA44600 series are 30, 91 and 93. To order in chip form, add the suffix "134" to the model number. The nominal chip size for the MA44600 series is 15 mils.
2. Reverse voltage (V_R) is measured at a reverse bias current of 10 μA.
3. Junction capacitance is measured at a reverse voltage of 6 volts and a frequency of 1 MHz.
4. Transition time is measured between 20% and 80% points on the voltage recovery trace. Test conditions are +10 mA and -10 volts.

Case Styles (See appendix for complete dimensions)



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Specifications @ $+T_A = +25°$ C (Cont'd)

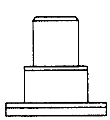
High Power Circuit Tested Step Recovery Diodes

Model Number	Case[1] Style	Minimum Output Power (Watts)	Input Frequency (GHz)	Output Frequency (GHz)	Maximum Input Power (Watts)	Min./Max.[2] Reverse Voltage V_R (Volts)
MA43000	103	4.0	0.333	2.0	15	85 - 105
MA43002	91	1.5	2.000	6.0	5	45 - 70
MA43004	91	0.3	3.300	13.0	2	30 - 45

Model Number	Min./Max.[3] Junction Capacitance C_j (pF)	Min./Max. Lifetime, T_L 10 mA/6 mA (ns)	Maximum Snap Time, T_S -10V/10 mA (ps)	Maximum Thermal Resistance, jc (C/W)
MA43000	3 - 4.50	250 - 500	600	12
MA43002	1.60 - 2.40	75 - 225	250	25
MA43004	0.45 - 0.85	20 - 50	150	45

Notes:
1. The standard case styles are indicated for each model number. Other case styles are available. Consult the factory for information.
2. Reverse voltage is measured at reverse bias current of 10 µA.
3. Junction capacitance is measured at a reverse bias of 6 volts and a frequency of 1 MHz.

Case styles (See appendix for complete dimensions)



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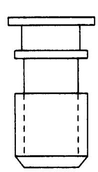

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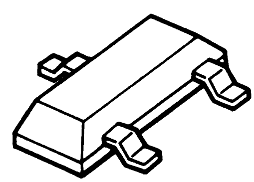

SOT-23 (High Profile)

Surface Mount Step Recovery Diodes (SOT-23)

Model Number	Min./Max. Total Capacitance (pF) f = 1 MHz V_R = 6 V	Minimum Reverse Voltage V_R (Volts) I_R = 10µA	Nominal Carrier Lifetime T_L (ns)	Maximum Transition Time T_S (psec)	Suggested Nominal Input Frequency (GHz)	Suggested Nominal Output Frequency (GHz)
MA44767	3 - 4.5	30V	250 - 500	600	0.05 - 0.5	0.5 - 1.5
MA44768	1.6 - 2.4		75 - 225	250	0.1 - 1	0.5 - 2.5
MA44769	0.8 -1.2		20 - 50	150	0.1 - 1	1 - 5

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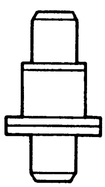
Specifications @ T_A = 25° C (Cont'd)

High Order Step Recovery Diode Varactors for Use in Comb Generation

Model Number	Case[1] Style	Maximum[2] Input Power (Watts)	Min./Max.[3] Reverse Voltage V_R (Volts)	Min./Max.[4] Junction Capacitance Cj (pF)	Min./Max. Carrier Lifetime, T_L (ps)	Maximum Snap Time, T_S -10V/10 mA (ps)	Maximum Thermal Resistance jc(C/W)	Nominal[2] Output Frequency (GHz)
MA43592	30	1.0	25 - 40	0.2 - 0.30	9 - 27	90	70	1 - 12
MA43543	93	1.5	20 - 50	0.2 - 0.55	10 - 25	60	125	2 - 20

Notes:
1. The standard case styles are indicated for each model number. For other available case styles, consult the factory.
2. This is an operable output frequency range and does not imply instantaneous bandwidth.
3. Breakdown voltage is measured at a reverse bias voltage of 10 µA.
4. Junction capacitance is measured at a reverse bias voltage of 6 volts and a frequency of 1 MHz.

Case Styles (See appendix for complete dimensions)



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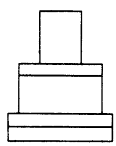

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Maximum Ratings

Temperature Range	
Operating Range	-65°C to +200°C -65°C to +125°C (SOT-23 only)
Storage Range	-65°C to +200°C -65°C to +125°C (SOT-23 only)

Environmental Performance

The MA44600 and MA43000 series of diodes in ceramic packages are capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to military semiconductor products.

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GaAs Multiplier Varactors

MA48700 Series

V 2.00

Features

- High Cutoff Frequency
- Operating Temperatures From -65°C to +200°C

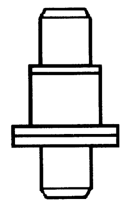
Description

The MA48700 series of Gallium Arsenide Abrupt Junction Multiplier Varactors is specifically designed to provide single state, high order multiplication at output frequencies extending to approximately 100 GHz. All varactors in this series are available in either package or chip form. The cathode is the heat sink end of the package.

Applications

This series of Gallium Arsenide Multiplier Varactors is intended for medium power harmonic generation with high conversion efficiency. These diodes may be used to double or triple the frequency output of a phase locked source for millimeter wave radar and communication systems for local oscillators and transmitters.

Case Styles (See appendix for complete dimensions)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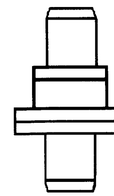
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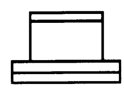
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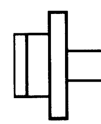
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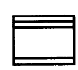
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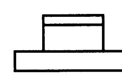
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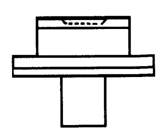
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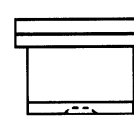
166

Specifications @ T_A = +25°C

Model[3] Number	Minimum Voltage Rating (Volts)	Zero Bias[1] Junction Capacitance (pF)	Cut-off Frequency[2] (fc) at -6 Volts (GHz)	Suggested Output Frequency Range (GHz)
MA48701E	15	0.150 - 0.250	550	20 - 50
MA48702E	15	0.250 - 0.350	500	20 - 40
MA48703E	15	0.350 - 0.450	450	15 - 30
MA48704E	15	0.450 - 0.550	400	15 - 30
MA48705E	15	0.550 - 0.650	400	10 - 20
MA48706C	25	0.150 - 0.250	400	20 - 40
MA48707C	25	0.250 - 0.350	350	15 - 35
MA48708C	25	0.350 - 0.450	300	15 - 30

Electrical Characteristics

Notes:

1. Junction capacitance (C_{j0}) is measured at 1 MHz and 0 volts on a bridge which has been balanced with a shielded test holder connected in place, but open circuited.
2. Cutoff frequency measurements (F_{C0}) are made at 0 volts and then extrapolated to -6 volts. See curve of Figure 1 showing typical F_{C-6} (cutoff at - 6 volts) versus F_{C0} (cutoff at 0 volts) performance curve.
3. Available in the case styles 30, 92, 94, 95, 120, 126, 128 and 166. When ordering, specify the case style by adding the case style number as a suffix to the basic part number.
4. Nominal package parasitics (Cp and Ls) are given for each case style with the outline drawing in the appendix section.

Maximum Ratings @ 25°C

Temperature **Storage** **Operating**	 -65°C to +250°C -65°C to +200°C
Voltage	Voltage Rating

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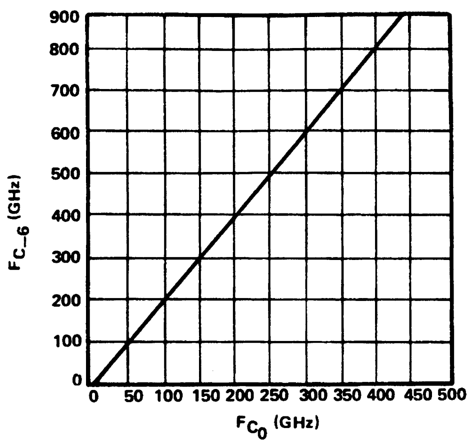
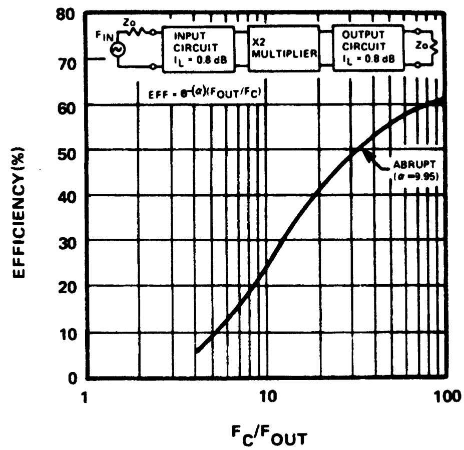
Typical Performance Curves

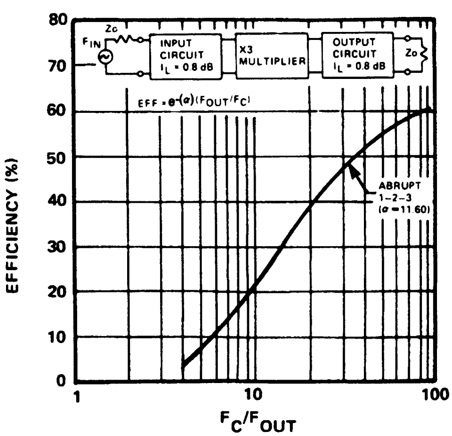
RELATIONSHIP BETWEEN CUTOFF FREQUENCY AT ZERO AND SIX VOLTS IN GaAs VARACTOR DIODES



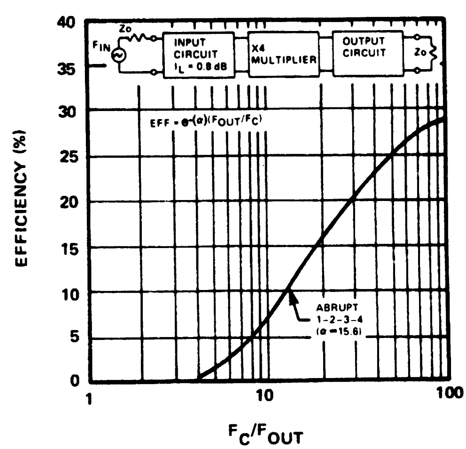
THEORETICAL EFFICIENCY OF X2 GaAs VARACTOR MULTIPLIERS



THEORETICAL EFFICIENCY OF X3 GaAs VARACTOR MULTIPLIERS



THEORETICAL EFFICIENCY OF X4 GaAs VARACTOR MULTIPLIERS



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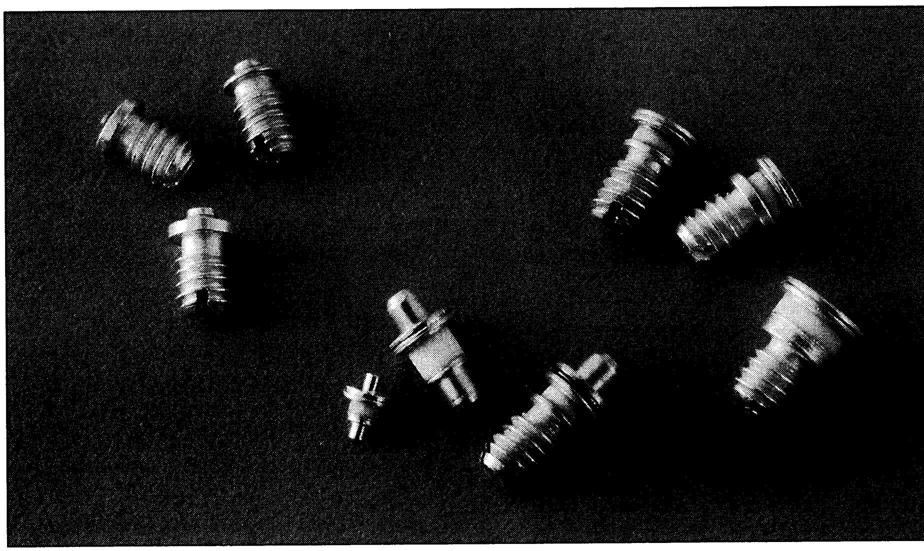
Gunn Diodes



Title	Page

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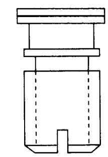
Gunn Diodes

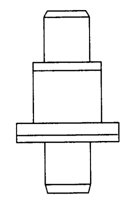
V 2.00

Frequency	Suggested Range (GHz)	Case Style	Part Number P_{OUT} 5 mW	P_{OUT} 10 mW	Page No.
Anode Heat Sink Diodes					
	8 - 12	30	MA49618	MA49508	7 - 4
	12 - 18	30	-	-	-
	18 - 26	30	MA49499	MA49628	7 - 4
	26 - 40	138	-	MA49191	7 - 3



111

	Suggested Frequency Range (GHz)	Case Style	Part Number Anode Heat Sink Pulse 10 mW	Broadband Cathode Heat Sink 100 mW	Page No.
Anode Heat Sink Pulse and Broadband Diodes					
	8 - 12	30	MA49870	-	7 - 5
	8 - 12	148	-	MA49117	7 - 3
	12 - 18	138	-	MA49126	7 - 3



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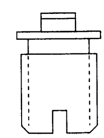

138/148

	Suggested Frequency Range (GHz)	Case Style	Part Number P_{OUT} 10 mW	P_{OUT} 25 mW	P_{OUT} 50 mW	P_{OUT} 100 mW	P_{OUT} 250 mW	Page No.
Cathode Heat Sink Diodes								
	5 - 8	30	-	MA49151	MA49152	MA49153	MA49154	7 - 2
	5 - 8	111	-	MA49135	MA49136	MA49137	MA49138	7 - 2
	8 - 12	30	-	MA49156	MA49157	MA49158	MA49159	7 - 2
	8 - 12	111	-	MA49104	MA49106	MA49107	MA49109	7 - 2
	12 - 18	30	-	MA49161	MA49162	MA49163	MA49164	7 - 2
	12 - 18	111	-	MA49121	MA49122	MA49123	MA49124	7 - 2
	18 - 26	30	-	-	MA49179	MA49180	-	7 - 3
	18 - 26	138	-	-	MA49179-138	MA49180-138	-	7 - 3
	18 - 26	148	-	-	MA49179-148	MA49180-148	MA49178	7 - 3
	26 - 40	138	-	-	MA49172	MA49173	MA49837	7 - 3
	26 - 40	138	-	-	-	MA49177[1]	-	7 - 3
	40 - 50	138	-	-	MA49181	MA49838	-	7 - 3
	40 - 50	138	-	-	MA49182	MA49839	-	7 - 3
	50 - 60	138	-	-	-	MA49193	-	7 - 3
	94	138	MA49840	MA49149	MA49498	-	-	7 - 3

1. Power = 150 mW

Stocked at your local distributor.

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an AMP company

GaAs Gunn Diodes

MA49000

V 2.00

Features

- Low Noise Characteristics From 5 to 100 GHz
- Catalog or Custom Tailored Diodes
- Pulse or CW Operation

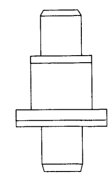
Description

The MA49000 series of Gallium Arsenide Gunn diodes is designed to operate at a fixed frequency under pulsed or CW conditions within a specified band. These diodes feature low FM and AM noise and provide a one step conversion from dc to microwave oscillators using low voltage power supply. Gunn diodes have cathode heat sinks unless otherwise specified.

Applications

Gunn diodes are useful for low FM noise moderate power oscillators used for microwave links, commercial marine and weather radar, local oscillators, microwave door openers, motion and speed detectors, and ground speed and distance sensors at frequencies from 10-90 GHz.

Case Styles (See appendix for complete dimensions)



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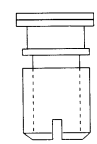

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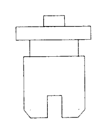

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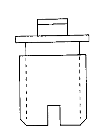

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Fixed Frequency CW Gunn Diodes (5-18 GHz)[7]
Specifications @ T_A = +25°C

Model Number	Case Style	Operating[2,3] Frequency Min./Max. (GHz)	Min. CW[1,3,5] Output Power (mW)	Operating Voltage Min./Max. (Volts)	Operating[5] Current Min./Max. (mA)	Maximum Thermal Resistance (°C/W)
MA49135	111	5.0/8.0	25	10.0/14.0	150/250	45
MA49151	30	5.0/8.0	25	10.0/14.0	150/250	45
MA49136	111	5.0/8.0	50	10.0/14.0	250/350	35
MA49152	30	5.0/8.0	50	10.0/14.0	250/350	35
MA49153	30	5.0/8.0	100	10.0/14.0	350/500	17
MA49137	111	5.0/8.0	100	10.0/14.0	350/500	25
MA49138	111	5.0/8.0	250	10.0/14.0	500/700	24
MA49154	30	5.0/8.0	250	10.0/14.0	500/700	17
MA49104	111	8.0/12.4	25	8.0/12.0	200/300	45
MA49156	30	8.0/12.4	25	8.0/12.0	200/300	45
MA49157	30	8.0/12.4	50	8.0/12.0	300/450	35
MA49106	111	8.0/12.4	50	8.0/12.0	300/450	35
MA49107	111	8.0/12.4	100	8.0/12.0	450/650	24
MA49158	30	8.0/12.4	100	8.0/12.0	450/650	24
MA49159	30	8.0/12.4	250	8.0/12.0	750/1050	15
MA49109	111	8.0/12.4	250	8.0/12.0	750/1050	15
MA49161	30	12.4/18.0	25	6.0/10.0	200/300	45
MA49121	111	12.4/18.0	25	6.0/10.0	200/300	45
MA49162	30	12.4/18.0	50	6.0/10.0	300/500	35
MA49122	111	12.4/18.0	50	6.0/10.0	300/500	35
MA49123	111	12.4/18.0	100	6.0/10.0	500/750	24
MA49163	30	12.4/18.0	100	6.0/10.0	500/750	24
MA49124	111	12.4/18.0	250	6.0/10.0	850/1150	15
MA49164	30	12.4/18.0	250	6.0/10.0	850/1150	15

Notes:
1. This power is delivered at a specified single frequency in the specified band .
2. The customer MUST species the desired operating frequency within the indicated range.
3. Power is measured into a critically coupled load at a customer specified single frequency in the indicated range. Typical bandwidth is ±5%. The minimum indicated output power is guaranteed into a critically coupled load over the indicated bandwidth centered around the frequency specified by the customer. Higher power diodes are available on special request.
4. These diodes are designed to operate within a heat sink temperature -30°C to +70°C. However, for higher operating temperatures, please contact the factory.
5. The maximum threshold current is approximately 1.3 times the maximum operating current.

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Fixed Frequency CW Gunn Diodes (18-94 GHz)[7]
Specifications @ T_A = +25°C

Model Number	Case Style	Operating[2] Frequency Min./Max. (GHz)	Min. CW[1,2,3,4] Output Power (mW)	Operating Voltage Min./Max. (Volts)	Maximum[5] Operating Current (mA)
MA49190*	148	18.0/26.5	10	4.0/7.0	250
MA49179	138	18.0/26.0	50	5.0/8.0	600
MA49179	148	18.0/26.5	50	5.0/8.0	600
MA49180	138	18.0/26.5	100	5.0/8.0	1000
MA49180	148	18.0/26.5	100	5.0/8.0	1000
MA49178	148	18.0/26.5	250	5.0/8.0	1600
MA49191*	138	26.5/40.0	10	3.0/6.0	250
MA49172	138	26.5/40.0	50	3.5/6.0	800
MA49173	138	26.5/40.0	100	3.5/6.0	1200
MA49177	138	26.5/35.0	150	4.0/8.0	1400
MA49837	138	26.5/35.0	250	4.0/8.0	1600
MA49838	138	40.0/50.0	100	2.5/4.5	1600
MA49181	138	40.0/50.0	50	2.5/4.5	1200
MA49193	138	40.0/50.0	75	2.5/4.5	1400
MA49182	138	50.0/60.0	50	2.5/4.5	1200
MA49839	138	50.0/60.0	100	2.5/4.5	1600
MA49840	138	94.0	10	2.5/4.5	1400
MA49149	138	94.0	30	2.5/4.5	1400
MA49148	138	94.0	50	2.5/4.5	1400

* These diodes are flip chip devices. The heat sink (threaded end) is the anode.

CW Broadband Gunn Diodes[7]

These Gunn diodes are useful for use in low power, fast tuning oscillators such as an ECM local oscillator or a broadband tunable source for an instrument. These diodes will deliver full rated power over the specified bandwidth.

Model Number	Case Style	Frequency[9] Min./Max. (GHz)	Min. CW[9] Output Power (mW)	Maximum Operating Voltage (Volts)	Operating[5] Current Min./Max. (mA)	Nominal Operating Voltage (Volts)
MA49117	148	8.0/12.4	100	12.0	450/60	8.0
MA49126	148	12.4/18.0	100	10.0	500/750	6.0

Notes:
1. This power is delivered at a specified single frequency in the specified band .
2. The customer MUST species the desired operating frequency within the indicated range.
3. Power is measured into a critically coupled load at a customer specified single frequency in the indicated range. Typical bandwidth is ±5%. The minimum indicated output power is guaranteed into a critically coupled load over the indicated bandwidth centered around the frequency specified by the customer. Higher power diodes are available on special request.
4. These diodes are designed to operate within a heat sink temperature -30°C to +70°C. However, for higher operating temperatures, please contact the factory.
5. The maximum threshold current is approximately 1.3 times the maximum operating current.
6. All diodes are burned in for a minimum period of 8 hours at diode case temperature (Tc) of 70 ± 5°C and a dc bias voltage of (Vop + 1.0 volts). upon request and for an additional charge, these diodes can be burned in for longer periods.
7. The polarity is cathode heat sink, unless otherwise specified.
8. M/A-COM, will provide technical assistance in specification, interpretation and selection of Gunn diodes.
9. These diodes will deliver the specified Output power over the full frequency range, i e., the MA49117 will deliver 100 mW minimum at 25°C ambient from 5-8 GHz.

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Commercial Fixed Frequency CW Gunn Diodes

These Gunn diodes are useful for low power transmitters and local oscillators used in the detection of moving targets in such applications as speed control radars, radar detectors, intrusion alarm systems, door openers and commercial marine navigational radar. These low power diodes can also be used in control applications such as near object direction for vehicles, traffic light control, anti-skid braking systems for vehicles, and door openers.

Specifications @ T_A = +25°C

Model Number	Case Style	Frequency[2,3] Min./Max. (GHz)	Min. CW[1,3] Output Power (mW)	Maximum[5] Operating Current (mA)	Nominal Operating Voltage (Volts)
MA49618*	30	9.0/12.0	5.0	80	8.0
MA49508*	30	9.0/12.0	10.0	160	8.0
MA49628*	30	18.0/26.0	10.0	200	5.0
MA49499*	30	18.0/26.0	5.0	100	5.0

* The heat sink is the anode.

Notes:

1. This power is delivered at a specified single frequency in the specified band .
2. The customer MUST species the desired operating frequency within the Indicated range.
3. Power is measured into a critically coupled load at a customer specified single frequency in the indicated range. Typical bandwidth is ±5%. The minimum indicated output power is guaranteed into a critically coupled load over the indicated bandwidth centered around the frequency specified by the customer. Higher power diodes are available on special request.
4. These diodes are designed to operate within a heat sink temperature -30°C to +70°C. However, for higher operating temperatures, please contact the factory.
5. The maximum threshold current is approximately 1.3 times the maximum operating current.
6. All diodes are burned in for a minimum period of 8 hours at diode case temperature (Tc) of 70 ± 5°C and a dc bias voltage of (Vop + 1.0 volts). upon request and for an additional charge, these diodes can be burned in for longer periods.

Screening of Gunn Diodes for High Reliability

M/A-COM's Gunn diodes have proven to have a high reliability when operated properly in oscillator systems at junction temperatures not exceeding 260°C. The following prescreening procedure is suggested as a means of further guaranteeing Gunn diode reliability over long periods of time.

Environmental and Lot Sampling Tests

M/A-COM's Environmental Laboratory has complete capability for all Group B and C test requirements including life test as required by MIL-STD19500 and MIL-STD-750.

Available Procedures for JANTX Equivalency

100% Screening	MIL-STD-750 Method	Conditions/Comments
High Temperature Storage	1032	200°C for 24 hours
Temperature Cycle	1051	-65°C to +200°C, 20 Cycles for 30 minutes
Acceleration	2006	20,000 g's
Fine Leak	1071	5 x 10^{-8} cm^3/sec
Gross Leak	1071	Fluorocarbon or penetrative dye
Burn-In	1038	70°C heat sink temp. and V_{OP} + 1 volt (or 10%) for 96 hours

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Commercial Pulsed Gunn Diodes

This series of pulsed Gunn diodes have very low average current drain and are used in motion detection systems, burglar alarms and door openers.

Specifications @ T_A = +25°C

Model Number	Case Style	Frequency[2,3,8] Min./Max. (GHz)	Minimum[1,3,8] Peak Power (mW)	Maximum Operating Voltage (Volts)	Maximum[5] Operating Current (mA)
MA49870*	30	9.0/11.0	10.0	8.5	120

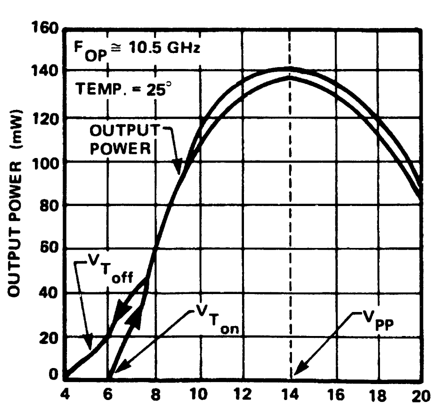
* Heat sink is anode.

Notes:

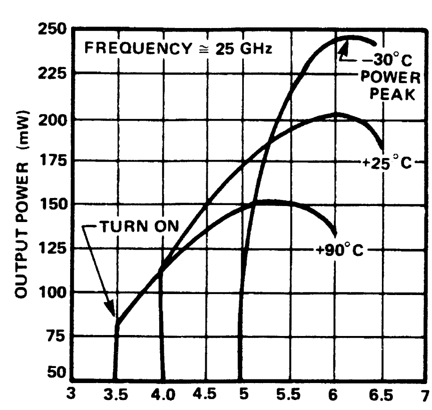
1. This power is delivered at a specified single frequency in the specified band .
2. The customer MUST specify the desired operating frequency within the indicated range.
3. Power is measured into a critically coupled load at a customer specified single frequency in the indicated range. Typical bandwidth is ± 5%. The minimum indicated output power is guaranteed into a critically coupled load over the indicated bandwidth centered around the frequency specified by the customer. Higher power diodes are available upon special request.
4. These diodes are designed to operate within a heat sink temperature -30°C to +70°C. However, for higher operating temperatures, please contact the factory.
5. The minimum threshold current is approximately 1.3 times the maximum operating current.
6. All diodes are burned in for a minimum period of 8 hours at diode case temperature (T_c) of 70 ± 5°C and with CW dc bias.
7. Frequency chirp during 0.5 (µs) is typically less than 10 MHz in a waveguide cavity.
8. Maximum duty cycle is 1%. Maximum pulse width is 1 (µs).

Typical Performance Curves

OUTPUT POWER vs BIAS VOLTAGE OF A TYPICAL X-BAND GUNN DIODE



OUTPUT POWER vs BIAS VOLTAGE AND TEMPERATURE OF TYPICAL K-BAND GUNN DIODE



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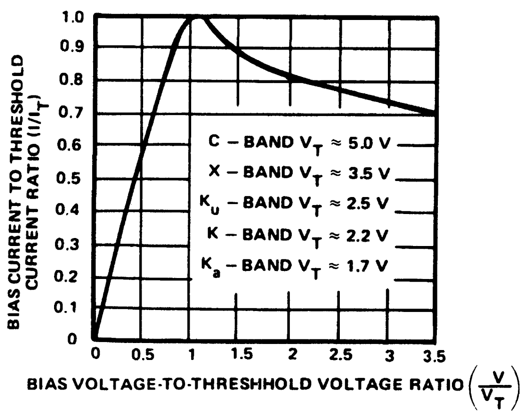
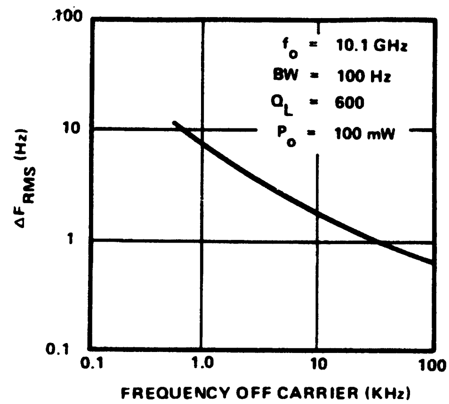
Typical Performance Curves (Con't)

CURRENT vs VOLTAGE CHARACTERISTICS



FM NOISE SPECTRUM



Gunn Diode Mounting and Heat Sink Considerations

The rise in temperature between the diode case and the active region is defined by AT - Rq, (Pin—Pout) In actual use the thermal drop between the ambient and the diode case must be taken into account in order to avoid exceeding the maximum active temperature of 260°C. The maximum active region temperature may be computed as follows:

Maximum active region temperature:

$$T_{AL} = T_A + \Delta T_{CA} + (P_{in} - P_{out}) R\varnothing$$

where:

T_A = Ambient temperature

ΔT_{CA} = Temperature difference between the diode case and the ambient at operating power.

$R\varnothing$ = Thermal resistance

T_{AL} = Active region temperature

In well designed heat sinks, the thermal difference ΔT_{CA} is usually less than 30°C for a power input of about 15 watts. This is an important factor in the design of Gunn oscillators and must be carefully considered.

Our technique for measuring thermal resistance is available upon request.

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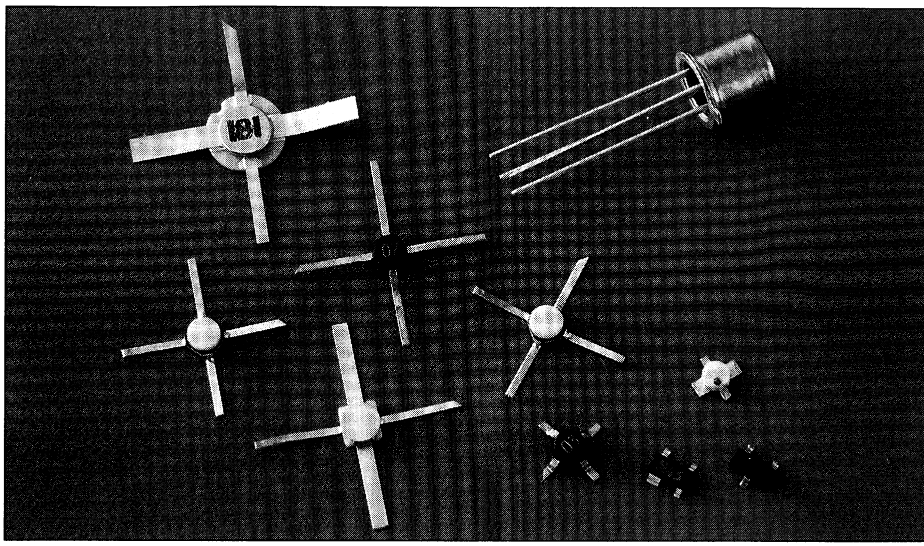
Low Noise Small Signal Transistors



M/A-COM an AMP company

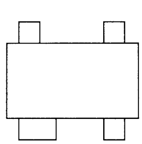
3 V, Low Noise, Small Signal, Bipolar Transistors for Portable (Battery Operated) RF Systems

V 2.00

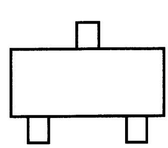
	Nominal f_T (GHz)	Nominal Noise Figure (NF) @ f = 1 GHz (dB)	NF Conditions Bias @ 3 V (mA)	Insertion Associated Gain @ NF Conditions (dB)	Power Gain $\|S_{21E}\|$ @ 1 GHz (dB)	1 (dB) Gain Compression (P1dB) @ 2 GHz (dBm)	Maximum Collector Current (mA)	Part No.	Page No.
New	12	1.5	0.4	12	11	-7	5	MA4T630533	8-2
New	13	1.5	0.5	12	12	1.5	10	MA4T631033	8-10
New	12	1.5	2	10	11	7	25	MA4T632533	8-18
	10	1.4	5	12.5	13.5	17	65	MA4T636533	8-37
	9	1.6	7	12	9.5	18	80	MA4T638033	8-26
New	6	2.2	10	8	7.5	22	110	MA4T324333	8-53
SOT-143 Package									
New	12	1.5	0.4	12	11	-7	5	MA4T630539	8-2
New	13	1.5	0.5	12	12	1.5	10	MA4T631039	8-10
New	11	1.5	2	10	11	7	25	MA4T632539	8-18
	10	1.4	5	12.5	13.5	17	65	MA4T636539	8-37
New	9	1.6	7	12	9.5	18	80	MA4T638039	8-26
	6	2.2	10	8	7.5	22	110	MA4T324339	8-53
Micro-X Package									
New	12	1.5	0.4	13	11.5	-7	5	MA4T630535	8-2
New	14	1.5	0.5	13	12.5	1.5	10	MA4T631035	8-10
New	11	1.5	2	10	11.5	7	25	MA4T632535	8-18
	11	1.3	5	13	15	17	65	MA4T636535	8-37
New	9.5	1.5	7	12.5	10	18	80	MA4T638035	8-26
	7	2.2	10	8.5	7.5	22	110	MA4T324335	8-53

Note: All units are rated for operation from 2.5 to 5V.

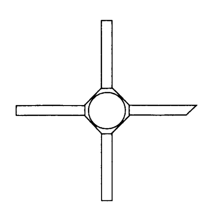
Stocked at your local distributor.



SOT-143



SOT-23



MICRO-X

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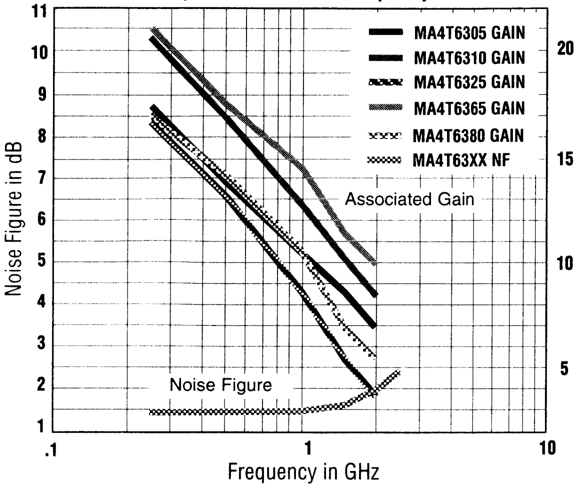
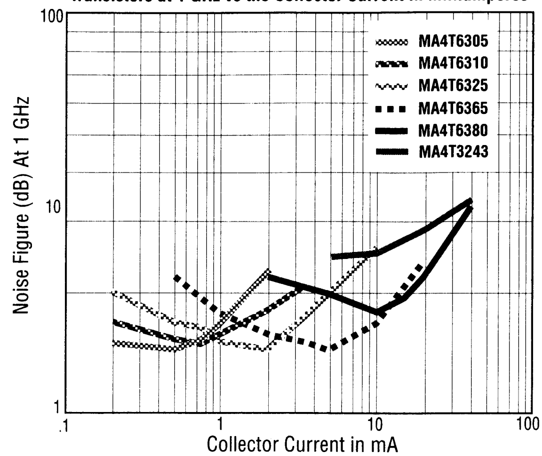
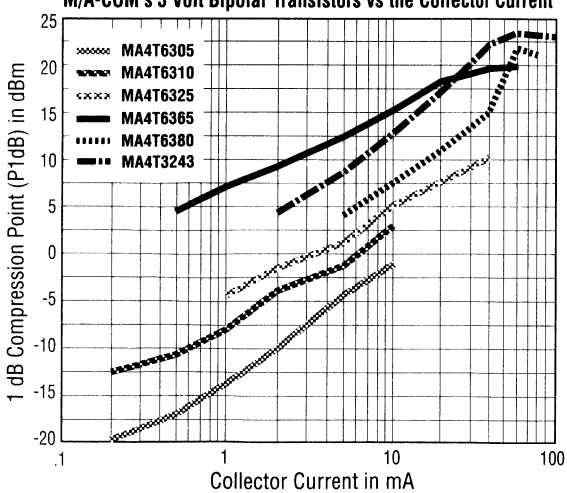
Noise Figure and Associated Gain Performance of M/A-COM's 3 Volt Silicon Bipolar Transistors vs Frequency in GHz



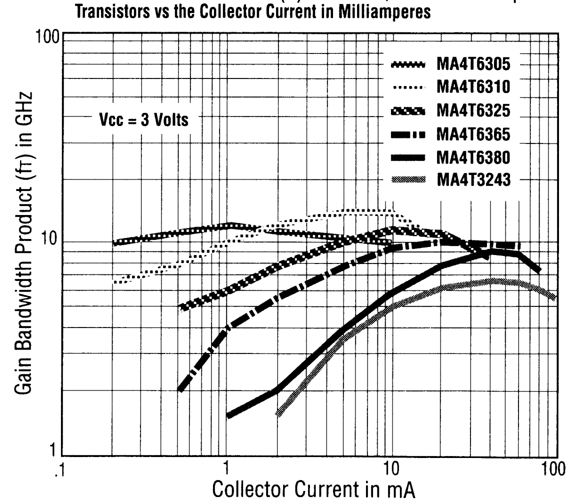
Noise Figure Performance of M/A-COM's 3 Volt Bipolar Transistors at 1 GHz vs the Collector Current in Milliamperes



Graph of the 1 dB Compression Performance at 1 GHz of M/A-COM's 3 Volt Bipolar Transistors vs the Collector Current



Gain Bandwidth Performance (f_T) In GHz of M/A-COM's 3 Volt Bipolar Transistors vs the Collector Current in Milliamperes



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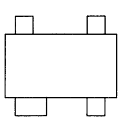
M/A-COM an AMP company

6 - 12 V, General Purpose, Small Signal, Bipolar Transistors

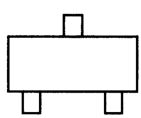
V 2.00

	Nominal f_T (GHz)	Nominal Noise Figure (NF) @ 1 GHz (dB)	NF Conditions Bias (mA @ V)	Associated Gain @ NF Conditions (dB)	Insertion Power Gain $\lvert S_{21E} \rvert$ (dB @ GHz)	1 dB Gain Compression (P1dB) (dBm @ GHz)	Max. Collector Current (mA)	Package	Part No.	Page No.
New	4.5	-	60 @ 12	15	11 @ 1	25 @ 2	150	Chip	MA4T56800	8-32
	7	2.5	20 @ 12	16	12 @ 1	25 @ 2	110	Micro-X	MA4T24335	8-61
	7	2.5	20 @ 12	16	12 @ 1	27 @ 1	110	Chip	MA4T24300	8-61
	10	1.5	0.5 @ 8	12	16 @ 1	20 @ 1	65	SOT-23	MA4T64533	8-45
	10	1.5	7 @ 8	13	20 @ 1	1.5 @ 1	65	SOT-143	MA4T64539	8-45
	10	1.5	7 @ 8	12	12.5 @ 2	20 @ 1	65	Micro-X	MA4T64535	8-45

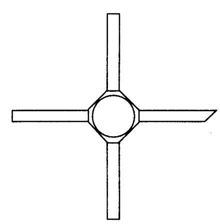
Stocked at your local distributor.



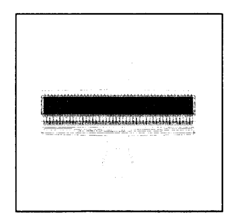
SOT-143



SOT-23

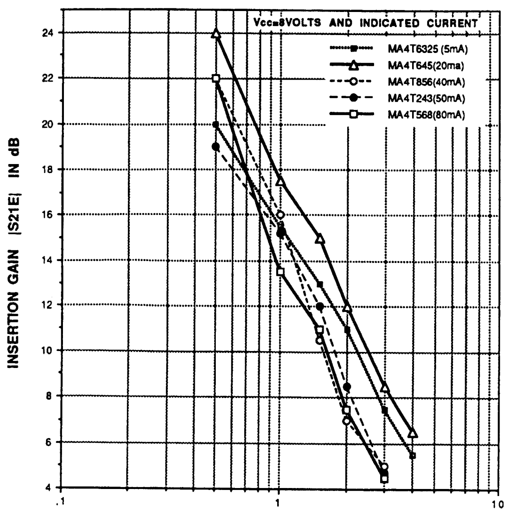


MICRO-X

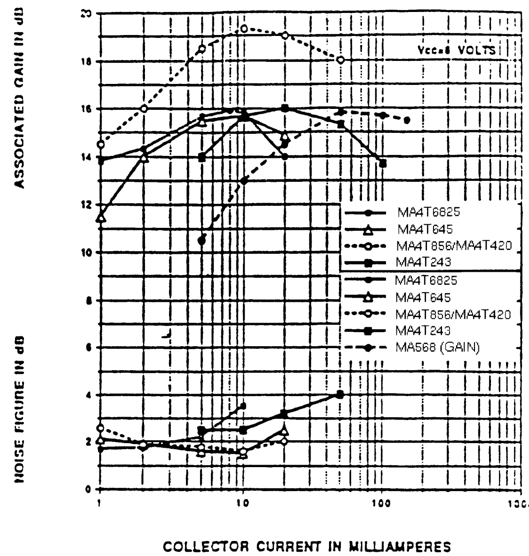


Chip

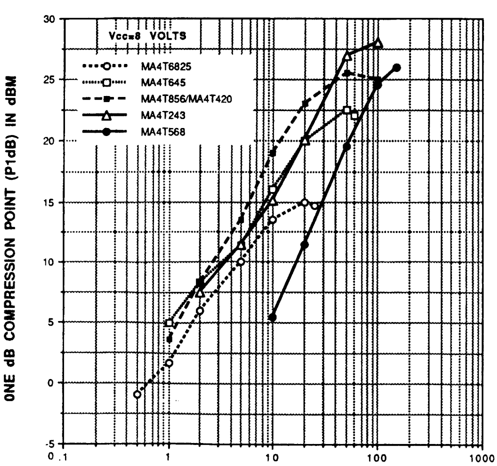
TYPICAL INSERTION GAIN |S21E| ²PERFORMANCE FOR M/A COM'S 8-12 VOLT BIPOLAR TRANSISTORS VS FREQUENCY IN GHZ



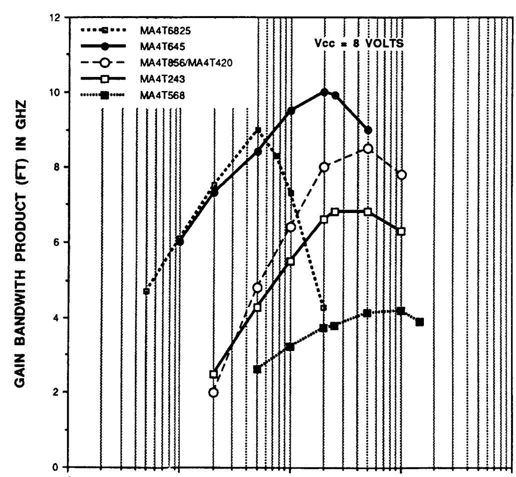
NOISE FIGURE AND ASSOCIATED GAIN PERFORMANCE OF M/A COM'S 8-12 VOLT BIPOLAR TRANSISTORS AT ONE GHZ VS. COLLECTOR CURRENT



GRAPH OF THE ONE dB COMPRESSION PERFORMANCE AT 1 GHZ OF M/A COM'S 8-12 VOLT BIPOLAR TRANSISTORS VS. THE COLLECTOR CURRENT IN MILLIAMPERES



GAIN BANDWITH PERFORMANCE (FT) IN GHZ OF M/A COM'S 8-12 VOLT BIPOLAR TRANSISTORS VS THE COLLECTOR CURRENT IN MILLIAMPERES

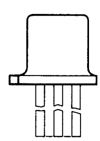


Other RF Low Noise, Small Signal, Bipolar Transistors

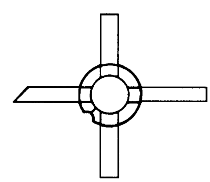
V 2.00

Nominal (GHz)	Nominal Noise Figure (NF) (dB @ GHz)	NF Conditions Bias @ 10 V (mA)	Associated Gain @ NF Conditions (dB)	Insertion Power Gain $\|S_{21E}\|$ (dB @ GHz)	Maximum Collector Current (mA)	Maximum Collector Voltage (V)	Package	Part No.	Page No.
1.5	3.5 @ 0.45	20	13	8 @ 0.45	80	30	TO	MA42121	8-67
1.8	4.5 @ 0.45	1.5 @ 6 V	10	8 @ 1.0	50	30	TO	2N2857	8-67
2.5	1.0 @ 0.06	5	25	20 @ 0.06	125	20	TO	MA42001	8-67
2.8	OSC.TRANS.	-	-	7 @ 1.0	300	30	Ceramic	MA42181	8-67
4.5	2.5 @ 1.0	5	13	10 @ 1.0	50	27	TO	MA42141	8-67
5.5	1.5 @ 0.45	5	15	13 @ 0.45	125	20	Ceramic	MA42111	8-67
7	1.5 @ 1.0	3	11	9 @ 0.45	25	20	Ceramic	MA42161	8-67

Stocked at your local distributor.

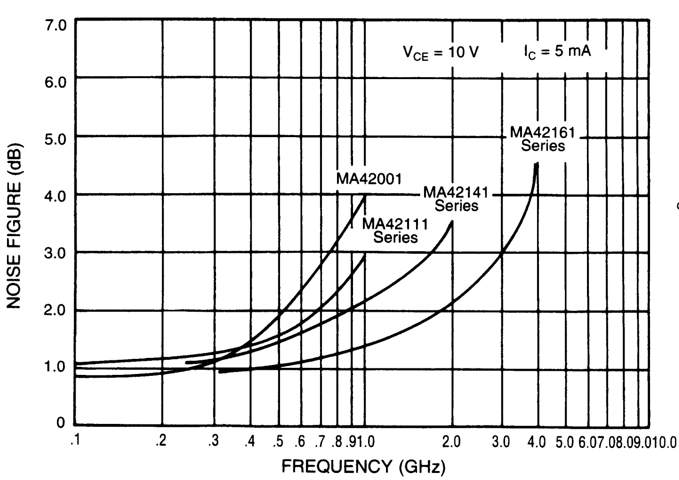


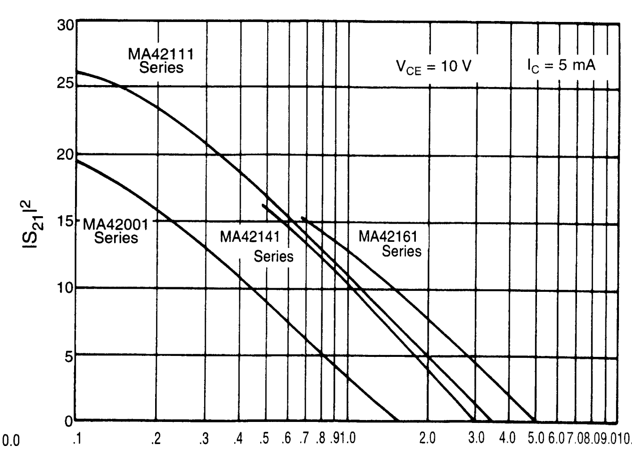
TO



Ceramic

Typical Performance Curves





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3 Volt, Low Current, Low Noise High f_T Silicon Transistor

MA4T6305 Series

V 2.00

Features

- Low Current and Low Voltage Operation
- 1.5 dB Noise Figure at 0.3 - 0.6 mA
- 11 GHz f_T
- Low Cost Plastic Packaging
- Available on Tape and Reel
- Available as Chips

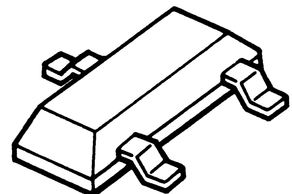
Description

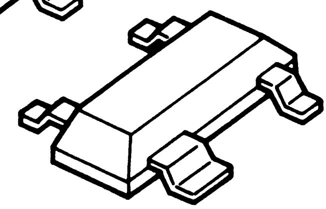
The MA4T6305 series of silicon bipolar NPN transistors provide low noise figure at a bias of 3 volts and very small collector current. These low cost surface mount transistors are well suited for usage in battery operated systems from approximately 500 MHz through 2.5 GHz where good noise figure at the minimum collector current is an important criteria. These transistors will provide good noise figure using only one to two milliwatts DC power.

The MA4T6305 series has high f_T (11 GHz) and provides low noise figure at a bias of 3 volts and 0.2 to 1 milliamperes current. Associated gain is 12 dB at 1 GHz. The MA4T6305 also has low phase noise while operating at a low power 3-5 volt battery operated VCO.

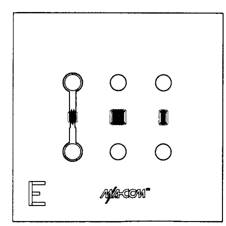
The MA4T6305 series is available as a chip (MA4T630500), in the SOT-23 (MA4T630533), the SOT-143 (MA4T630539) and the Micro-X (MA4T630535) package. The surface mount packages are available on tape and reel.

SOT-23

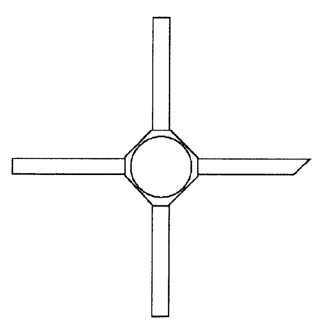




SOT-143



Chip



Micro-X

Maximum Ratings @ +25°C

Parameter	Symbol	Maximum
Collector-Base Voltage	V_{CBO}	8 V
Collector-Emitter Voltage	V_{CEO}	6 V
Emitter-Base Voltage	V_{EBO}	3 V
Collector Current	I_C	5 mA
Junction Temperature	T_j	200 °C
Storage Temperature Chips or Ceramic Packages Plastic Packages	T_{STG}	 -65°C to +200°C -65°C to +125°C
Power Dissipation	P_D	30 mW[1]

Note: 1. See power derating curves. The thermal resistance of the MA4T630500 chip is 80°C/watt maximum.

Electrical Specifications @ +25°C
MA4T6305 Series

Parameter	Condition	Symbol	Units	MA4T630535 Micro-X	MA4T630533 SOT-23	MA4T630539 SOT-143	MA4T630500 Chip
Gain Bandwidth Product	V_{CE} = 3 V I_C = 1 mA	f_T	GHz	11 typ.	11 typ.	11 typ.	11 typ.
Insertion Power Gain	V_{CE} = 3 V I_C = 3 mA f = 1 GHz f = 2 GHz	$\|S_{21E}\|^2$	dB	 11 min. 7 typ.	 10 min. 6 typ.	 10 min. 6 typ.	 11 min. 7 typ.
Noise Figure	V_{CE} = 3 V I_C = 0.5 mA f = 1 GHz f = 2 GHz	NF	dB	 1.5 max. 2.2 max.	 1.7 max. 2.2 max.	 1.7 max. 2.2 max.	 1.5 max. 2.2 max.
Unilateral Gain	V_{CE} = 3 V I_C = 0.5 mA f = 1 GHz f = 2 GHz	GTU (max)	dB	 14 typ. 9 typ.	 13 typ. 8 typ.	 13 typ. 8 typ.	 14 typ. 9 typ.
Maximum Available Gain	V_{CE} = 3 V I_C = 3 mA f = 1 GHz f = 2 GHz	MAG	dB	 10 typ.	 9 typ.	 9 typ.	 10 typ.
Power Out at 1 dB Compression	V_{CE} = 3 V I_C = 3 mA f = 1 GHz	P_{1dB}	dBm	 -7 typ.	 -7 typ.	 -7 typ.	 -7 typ.
Thermal Resistance	Junction/ Ambient	$R_{TH(J-A)}$	°C/W	600 max.[2]	700 max.[2]	700 max.[2]	80 max.[1]

Notes: 1. Junction/Heat Sink RTH(J-C)
2. Free Air

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Electrical Specifications @ +25°C
MA4T6305 Series

Parameter	Condition	Symbol	Min	Typical	Max	Unit
Collector Cut-off Current	V_{CB} = 3 V I_E = 0	I_{CBO}	—	—	100	nA
Emitter Cut-off Current	V_{EB} = 1 V I_C = 0	I_{EBO}	—	—	1	µA
Forward Current Gain	V_{CE} = 3 V I_C = 3 mA	h_{FE}	30	100	200	—
Collector-Base Junction Capacitance	V_{CB} = 3 V I_E = 0 f = 1 MHz	C_{OB}	—	0.33	0.45	pF

Typical Noise Parameters in the Micro-X Package
MA4T630535

Frequency GHz	I_C (mA)	NFo (dB)	GA (dB)	Γ_{OPT}		Rn
				Mag	Angle	
2.00	0.2	1.85	2.7	0.76	43.3	82.1
2.00	0.5	1.95	3.6	0.78	43.2	80.3
2.00	1.0	2.17	5.0	0.75	46.7	71.7

Typical Scattering Parameters in the Micro-X Package
MA4T630535
V_{CE} = 3 Volts, I_C = 0.5 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.920	-18.2	1.262	150.9	0.078	74.3	0.973	-16.7
1000	0.836	-34.9	1.202	128.9	0.143	60.6	0.902	-31.7
1500	0.734	-49.8	1.154	110.1	0.189	49.3	0.821	-44.1
2000	0.630	-64.4	1.133	93.9	0.228	41.3	0.750	-55.0
2500	0.527	-77.1	1.090	78.9	0.254	33.9	0.684	-65.7
3000	0.423	-85.8	1.042	65.0	0.276	28.8	0.629	-74.1
3500	0.363	-97.1	1.038	54.1	0.294	21.4	0.585	-82.8
4000	0.309	-110.1	1.010	44.9	0.306	18.2	0.551	-90.8
4500	0.243	-122.0	0.971	33.3	0.317	13.2	0.514	-98.4
5000	0.199	-135.1	0.951	25.2	0.324	9.4	0.487	-105.5
5500	0.159	-151.2	0.934	17.5	0.330	6.4	0.467	-113.0
6000	0.135	-163.5	0.920	9.3	0.341	3.3	0.451	-120.6

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Typical Scattering Parameters in the Micro-X Package (Con't)

MA4T630535
V_{CE} = 3 Volts, I_C = 1 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.860	-23.1	2.450	147.1	0.075	71.4	0.941	-20.7
1000	0.730	-43.5	2.223	123.8	0.130	57.6	0.823	-36.8
1500	0.589	-60.9	2.017	104.7	0.166	48.1	0.721	-48.4
2000	0.465	-76.7	1.831	88.6	0.198	42.1	0.645	-59.0
2500	0.358	-89.7	1.662	74.1	0.222	36.6	0.584	-67.7
3000	0.260	-98.2	1.492	61.5	0.244	32.6	0.538	-75.3
3500	0.214	-107.8	1.410	51.3	0.264	26.9	0.504	-83.8
4000	0.173	-122.4	1.320	42.2	0.282	24.1	0.480	-91.8
4500	0.121	-137.4	1.238	31.3	0.297	19.7	0.450	-99.7
5000	0.091	-157.9	1.184	23.4	0.311	16.0	0.429	-107.1
5500	0.067	164.0	1.137	15.8	0.323	12.8	0.414	-114.9
6000	0.065	138.5	1.950	7.7	0.337	9.7	0.402	-123.2

MA4T630535
V_{CE} = 3 Volts, I_C = 3 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.637	-39.0	5.402	135.5	0.062	66.8	0.841	-26.9
1000	0.421	-67.6	4.140	107.6	0.101	57.3	0.672	-39.8
1500	0.282	-86.2	3.161	89.2	0.130	52.5	0.583	-47.2
2000	0.196	-105.3	2.562	75.5	0.160	48.4	0.534	-55.7
2500	0.134	-125.3	2.159	63.6	0.186	44.2	0.496	-62.8
3000	0.081	-151.7	1.843	53.3	0.209	40.4	0.469	-69.5
3500	0.069	164.7	1.676	44.6	0.232	35.4	0.449	-77.8
4000	0.076	150.3	1.532	36.2	0.252	32.4	0.439	-85.5
4500	0.092	118.6	1.422	26.3	0.270	28.3	0.419	-93.6
5000	0.119	99.9	1.339	19.0	0.286	24.4	0.403	-100.9
5500	0.149	84.2	1.272	11.7	0.303	20.9	0.393	-108.7
6000	0.176	74.3	1.220	3.9	0.318	17.9	0.386	-116.9

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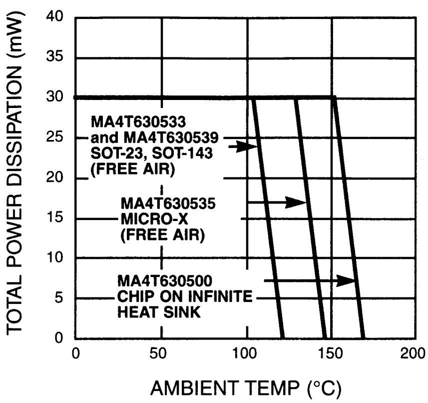
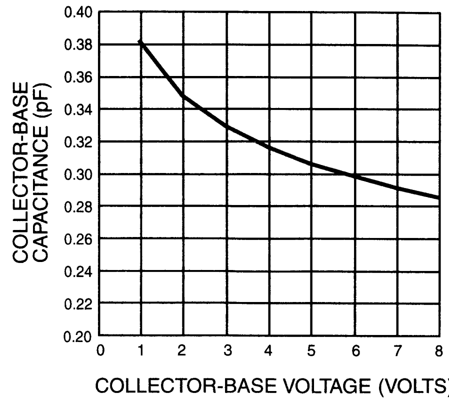
Typical Performance Curves

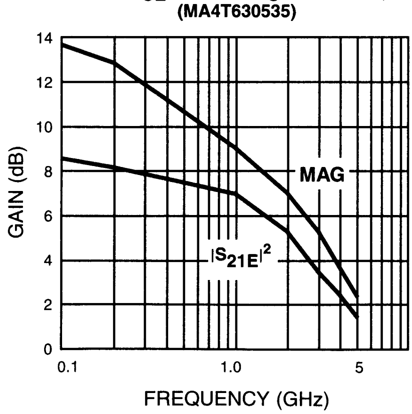
POWER DERATING CURVES



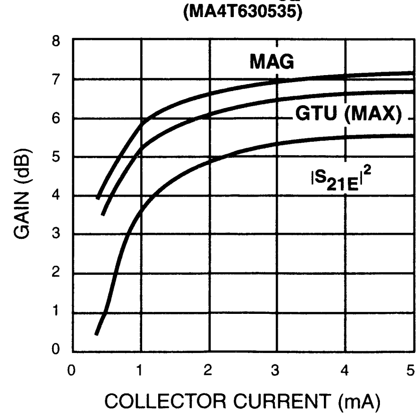
COLLECTOR-BASE CAPACITANCE (C_{OB}) vs
COLLECTOR-BASE VOLTAGE
(MA4T630535)



GAIN vs FREQUENCY AT
V_{CE} = 3 V AND I_C = 1 MA
(MA4T630535)



GAIN VS COLLECTOR CURRENT
AT 3 GHz AND V_{CE} = 3 V
(MA4T630535)



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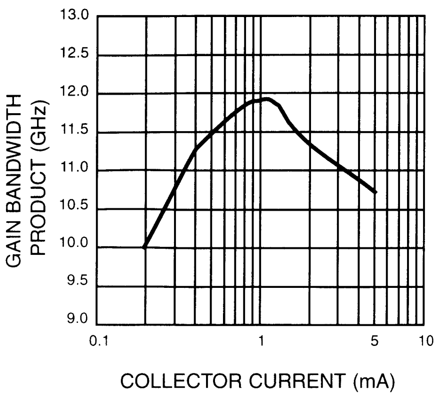
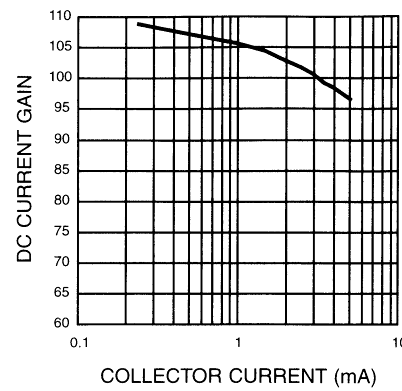
Typical Performance Curves (Con't)

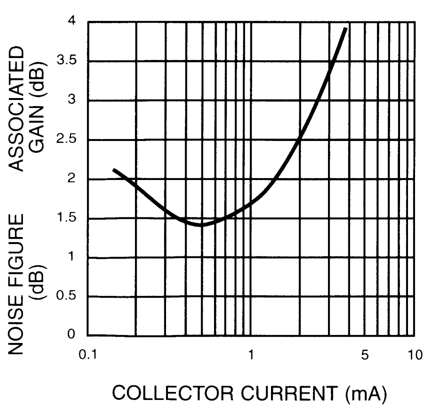
GAIN BANDWIDTH PRODUCT (f_T) vs COLLECTOR CURRENT AT V_{CE} = 3 V (MA4T630535)



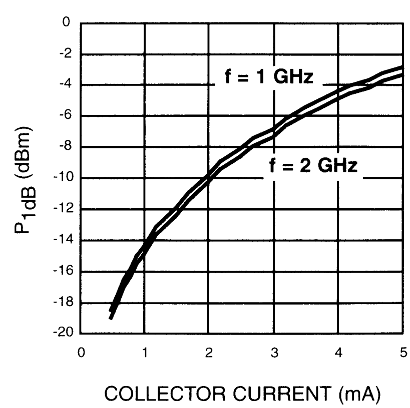
DC CURRENT GAIN (h_{FE}) vs COLLECTOR CURRENT AT V_{CE} = 3 V (MA4T630535)



NOISE FIGURE AND ASSOCIATED GAIN AT 1 GHz AT V_{CE} = 3 V vs COLLECTOR CURRENT (MA4T630535)



NOMINAL OUTPUT POWER AT THE 1 dB COMPRESSION POINT vs COLLECTOR CURRENT, V_{CE} = 3 V (MA4T630535)



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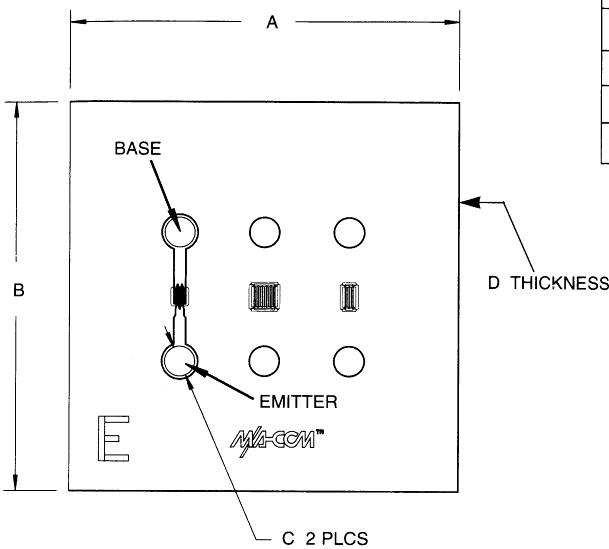
Case Styles

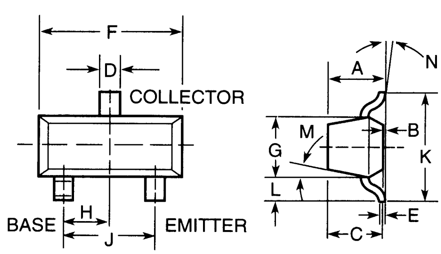
Chip — MA4T630500
Case Style 1166



MA4T630500

DIM.	INCHES (Nominal)	MM (Nominal)
A	0.013	0.35
B	0.013	0.35
C	0.0012	0.030
D	0.0045	0.11

SOT-23 – MA4T630533



MA4T630533

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K		0.103		2.60
L		0.024		0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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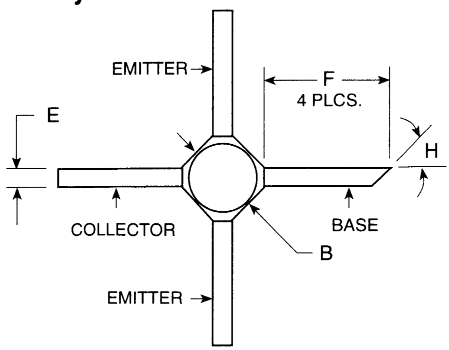
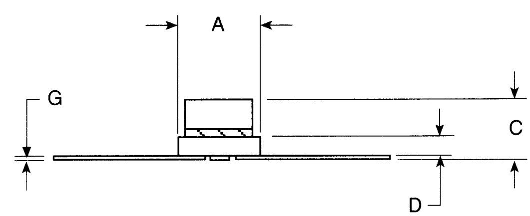
Case Styles (Con't)

Micro-X — MA4T630535 Case Style 1139

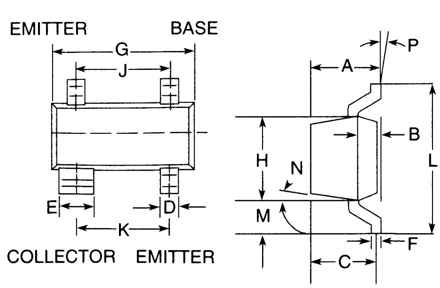




MA4T630535

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.046	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

SOT-143 — MA4T630539



MA4T630539

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	—	0.044	—	1.10
B	—	0.044	—	1.10
C	—	0.040	—	1.00
D	0.030	0.035	0.75	0.90
E	0.013	0.020	0.35	0.50
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 TYPICAL		1.90 TYPICAL	
K	0.075 TYPICAL		1.90 TYPICAL	
L	—	0.103	—	2.6
M	—	0.024	—	0.6

DIM.	GRADIENT
N	10° max.1
P	2°...30°

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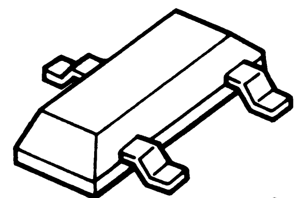
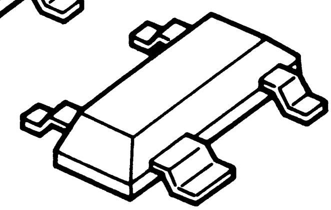
3 Volt, Low Noise High f_T Silicon Transistor

MA4T6310 Series

V 2.00

SOT-23





SOT-143

Features

- 1.5 dB Noise Figure at 0.5 mA
- 13 dB Gain at 1 GHz
- 14 GHz f_T
- Low Cost Plastic Package
- Available on Tape and Reel

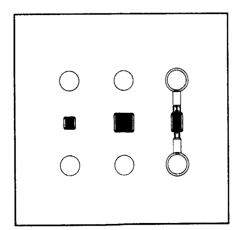
Description

The MA4T6310 series of low current, high f_T silicon NPN bipolar transistors provides low noise figure at a bias of 3 volts and small collector current. These inexpensive surface mount NPN transistors are well suited for usage in portable battery operated wireless systems from 500 MHz through 2.5 GHz where low noise figure at small current is important.

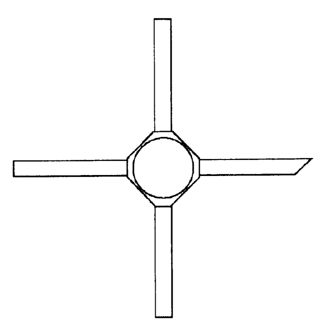
The MA4T6310 transistor series has high f_T and low noise when operated with 0.3 to 2.0 milliamperes current, and 3 volt bias. The associated gain is approximately 14 dB at 1 GHz with 1 mA collector current. The MA4T6310 also has low phase noise while operating in a low power 3-5 volt battery operated VCO in the frequency range of 0.5 to 3 GHz.

The MA4T6310 transistor is useful for wireless communication systems from VHF through L-band where good noise figure and high gain at 3 volt bias and low DC current are key system requirements. Suggested uses include, 900 MHz portable phones, pagers, PCN subscriber phones and 2.4 GHz cordless and cellular hand held receivers.

The MA4T6310 is available as a chip (MA4T631000), in the SOT-23 (MA4T631033), the SOT-143 (MA4T631039), and in the Micro-X (MA4T631035) packages. Surface mount packages are available on tape and reel.



Chip



Micro-X

Maximum Ratings @ +25°C

Parameter	Symbol	Maximum Rating
Collector-Base Voltage	V_{CBO}	8 V
Collector-Emitter Voltage	V_{CEO}	6 V
Emitter-Base Voltage	V_{EBO}	1.5 V
Collector Current	I_C	10 mA
Junction Temperature	T_j	200 °C
Storage Temperature Chips or Ceramic Packages Plastic Packages	T_{STG}	 -65°C to +200°C -65°C to +125°C
Power Dissipation	P_D	-60mW[1]

Note: 1. See power derating curve.

Electrical Specifications @ +25°C
MA4T6310 Series

Parameter	Condition	Symbol	Units	MA4T631035 Micro-X	MA4T631033 SOT-23	MA4T631039 SOT-143	MA4T631000 Chip
Gain Bandwidth Product	V_{CE} = 3 V I_C = 6 mA	f_T	GHz	14 typ.	12 typ.	12 typ.	14 typ.
Insertion Power Gain	V_{CE} = 3 V I_C = 4 mA f = 1 GHz f = 2 GHz	$\lvert S_{21E}\rvert^2$	dB	 12 typ. 8 typ.	 11 typ. 7 typ.	 11 typ. 7 typ.	 12 typ. 8 typ.
Noise Figure	V_{CE} = 3 V I_C = 0.5 mA I_C = 1 mA f = 1 GHz	NF	dB	1.5 typ.	1.5 typ.	1.5 typ.	1.5 typ.
Unilateral Gain	V_{CE} = 3 V I_C = 4 mA f = 1 GHz f = 2 GHz	GTU (max)	dB	 14.5 typ. 9 typ.	 13 typ. 8 typ.	 13 typ. 8 typ.	 14.5 typ. 9 typ.
Maximum Available Gain	V_{CE} = 3 V I_C = 4 mA f = 2 GHz	MAG	dB	10 typ.	10 typ.	10 typ.	10 typ.
Power Out at 1 dB Compression	V_{CE} = 3 V I_C = 8 mA f = 1 GHz	P_{1dB}	dBm	1.5 typ.	1.5 typ.	1.5 typ.	1.5 typ.
Thermal Resistance	Junction/ Ambient	$R_{TH(J-A)}$	°C/W	600 typ.[2]	700 typ.[2]	700 typ.[2]	75 max.[1]

Notes:
1. Junction/Heat Sink R_{TH} (J-C)
2. Free Air

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Electrical Specifications @ +25°C

MA4T6310 Series

Parameter	Condition	Symbol	Min	Typical	Max	Unit
Collector Cut-off Current	V_{CB} = 3 V I_E = 0	I_{CBO}	—	—	100	nA
Emitter Cut-off Current	V_{EB} = 1 V I_C = 0	I_{EBO}	—	—	1	μA
Forward Current Gain	V_{CE} = 3 V I_C = 3 mA	h_{FE}	20	100	200	—
Collector-Base Junction Capacitance	V_{CB} = 3 V I_E = 0 f = 1 MHz	C_{OB}	—	0.42	0.55	pF

Typical Noise Parameters in the Micro-X Package

MA4T631035

Frequency GHz	I_C (mA)	NFo (dB)	GA (dB)	Γ_{OPT}		Rn
				(Mag)	(Angle)	
2.00	0.5	1.96	3.4	0.66	59.6	45.0
2.00	1.0	2.37	5.1	0.58	63.1	39.2
2.00	2.0	2.88	6.9	0.44	72.0	32.4
3.00	0.5	2.22	2.1	0.55	88.2	28.8
3.00	1.0	2.53	3.3	0.48	91.8	25.5
3.00	2.0	3.05	4.5	0.37	100.8	22.1

Typical Scattering Parameters in the Micro-X Package

MA4T631035

V_{CE} = 3 Volts, I_C = 2 mA

Frequency (MHz)	S_{11E}		S_{21E}		S_{12E}		S_{22E}	
	Mag	Angle	Mag	Angle	Mag	Angle	Mag	Angle
500	0.744	-37.9	4.174	137.0	0.088	63.8	0.841	-31.2
1000	0.524	-69.7	3.435	109.7	0.136	51.4	0.645	-48.2
1500	0.357	-94.3	2.771	89.9	0.169	45.5	0.531	-57.9
2000	0.255	-118.6	2.308	75.0	0.201	41.2	0.463	-67.5
2500	0.188	-142.6	1.977	62.3	0.228	37.3	0.415	-75.2
3000	0.139	-171.1	1.719	51.5	0.254	33.8	0.383	-81.9
3500	0.130	168.9	1.587	41.9	0.281	29.1	0.360	91.2
4000	0.133	140.6	1.448	33.1	0.299	25.8	0.342	-97.9
4500	0.156	122.4	1.369	23.1	0.323	21.8	0.324	-107.8
5000	0.180	105.0	1.296	15.5	0.342	17.9	0.308	-115.4
5500	0.204	89.7	1.239	7.9	0.362	14.3	0.299	-123.5
6000	0.228	78.9	1.194	0.7	0.379	10.7	0.292	-132.8

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Typical Scattering Parameters in the Micro-X (Con't)

MA4T631035

V_{CE} = 3 Volts, I_C = 4 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.558	-54.5	6.582	127.1	0.074	61.9	0.727	-37.0
1000	0.324	-92.2	4.537	98.8	0.114	54.8	0.523	-49.9
1500	0.217	-119.0	3.299	82.1	0.149	51.4	0.437	-56.5
2000	0.169	-150.7	2.635	69.2	0.184	47.4	0.387	-65.3
2500	0.147	172.8	2.204	58.0	0.215	43.3	0.353	-72.2
3000	0.141	148.6	1.888	48.1	0.244	39.4	0.330	-78.6
3500	0.145	134.2	1.719	39.3	0.274	34.5	0.315	-88.4
4000	0.167	115.0	1.562	30.9	0.296	30.7	0.305	-95.7
4500	0.196	103.5	1.465	21.3	0.322	26.2	0.288	-106.1
5000	0.223	90.9	1.381	13.9	0.343	22.0	0.275	-114.0
5500	0.251	79.0	1.314	6.4	0.365	17.8	0.267	-122.7
6000	0.275	69.7	1.260	-1.4	0.383	14.1	0.262	-132.5

MA4T631035

V_{CE} = 3 Volts, I_C = 6 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.429	-67.5	7.855	120.2	0.067	62.5	0.656	-39.5
1000	0.244	-107.3	4.871	93.9	0.107	57.9	0.466	-49.4
1500	0.178	-136.4	3.445	78.8	0.144	54.7	0.397	-54.9
2000	0.160	-168.7	2.722	66.7	0.179	50.3	0.354	-63.5
2500	0.158	163.5	2.264	56.0	0.212	45.9	0.326	-70.3
3000	0.166	138.7	1.933	46.4	0.241	41.5	0.306	-76.9
3500	0.170	126.8	1.753	37.9	0.273	36.5	0.295	-87.3
4000	0.192	109.9	1.584	29.8	0.294	32.8	0.289	-94.3
4500	0.221	100.9	1.490	20.2	0.322	28.1	0.275	-106.0
5000	0.250	89.2	1.403	13.0	0.344	23.8	0.263	-114.7
5500	0.280	77.8	1.333	5.3	0.367	19.4	0.255	-124.2
6000	0.304	68.6	1.276	-2.4	0.385	15.7	0.254	-134.7

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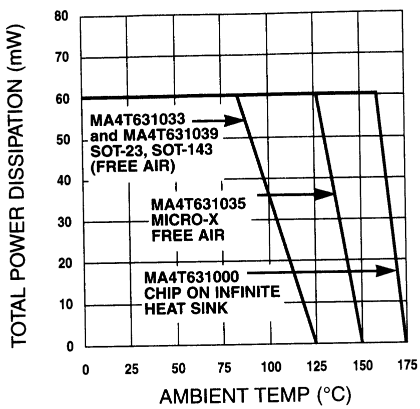
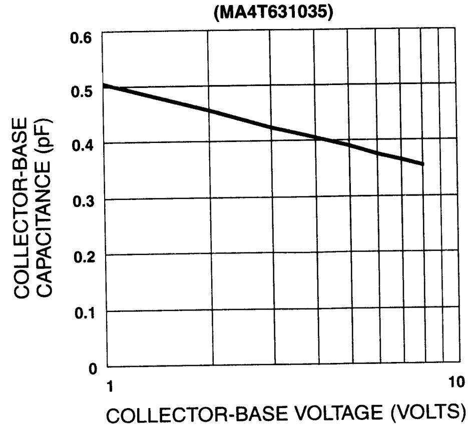
Typical Performance Curves

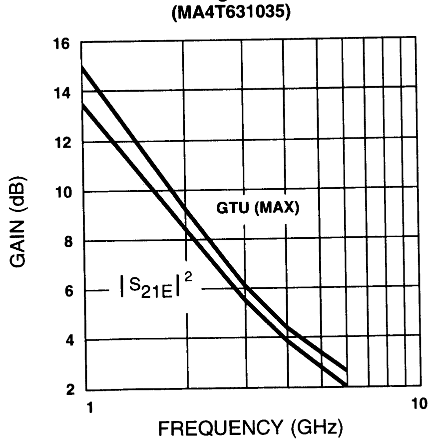
POWER DERATING CURVES



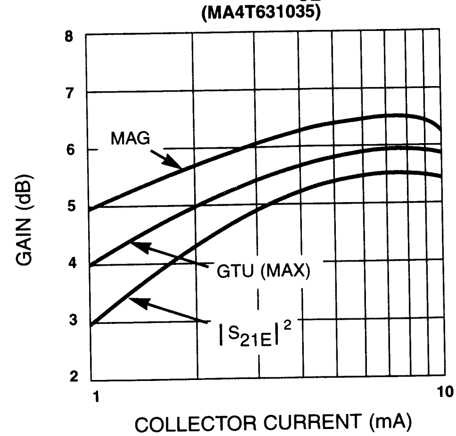
COLLECTOR-BASE CAPACITANCE (C_{OB}) vs COLLECTOR-BASE VOLTAGE (MA4T631035)



GAIN vs FREQUENCY AT V_{CE} = 3 V AND I_C = 4 mA (MA4T631035)



GAIN vs COLLECTOR CURRENT AT 3 GHz AND V_{CE} = 3 V (MA4T631035)



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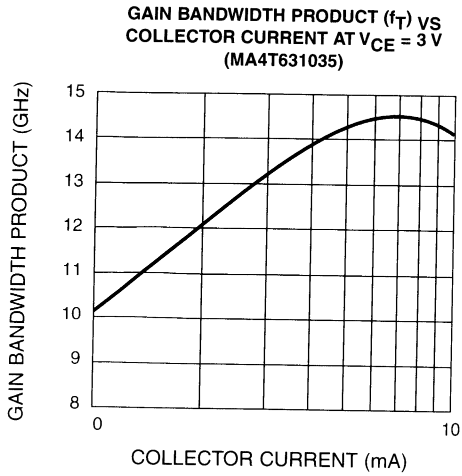
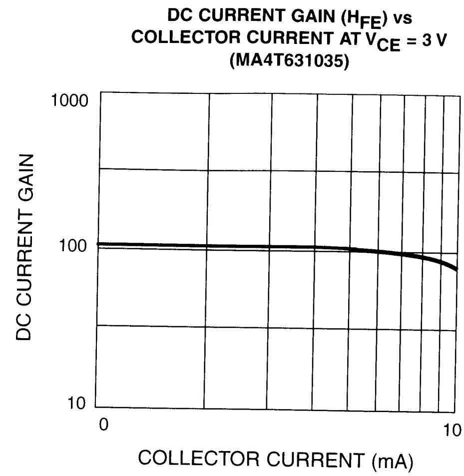
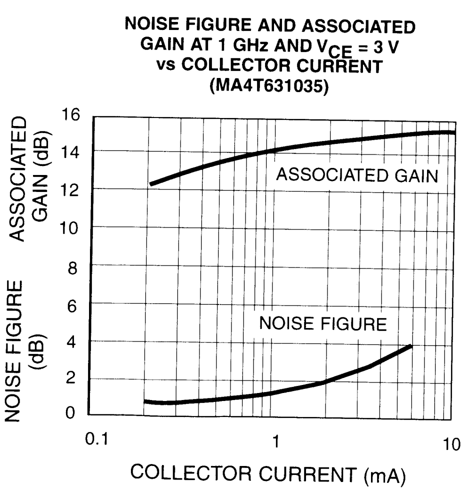
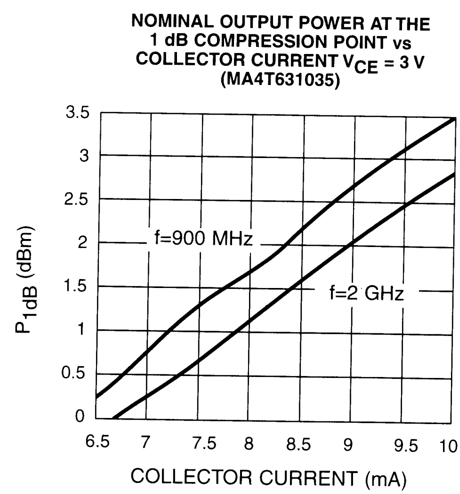
Typical Performance Curves (Con't)









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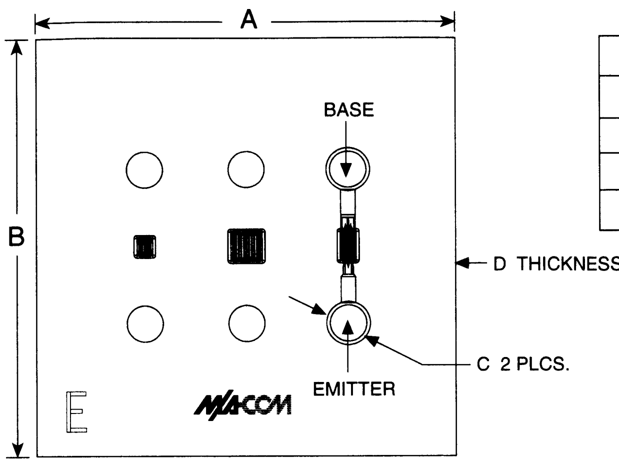
Case Styles

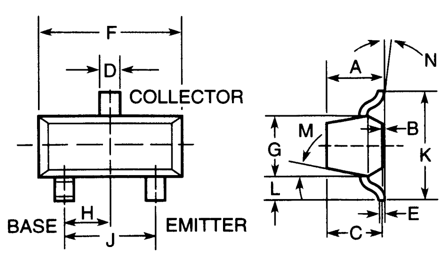
Chip — MA4T631000
Case Style 1165



MA4T631000

DIM.	INCHES (Nominal)	MM (Nominal)
A	0.013	0.35
B	0.013	0.35
C	0.0012	0.030
D	0.0045	0.11

SOT-23 — MA4T631033
(High Profile)



MA4T631033

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K	—	0.103	—	2.60
L	—	0.024	—	0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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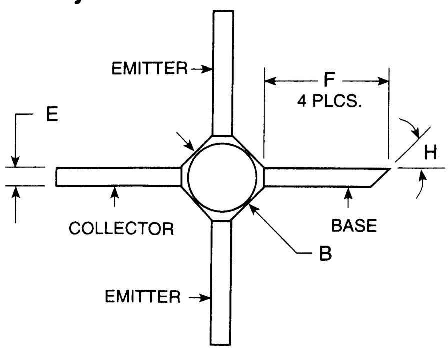
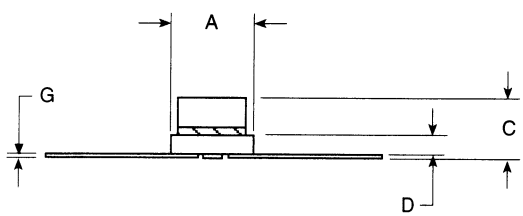
Case Styles (Con't)

Micro-X — MA4T630535
Case Style 1139

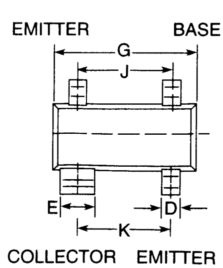


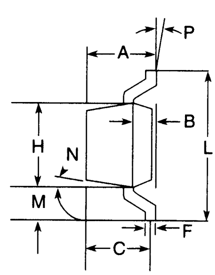


MA4T630535

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.046	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

SOT-143 — MA4T630539





MA4T630539

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	—	0.044	—	1.10
B	—	0.044	—	1.10
C	—	0.040	—	1.00
D	0.030	0.035	0.75	0.90
E	0.013	0.020	0.35	0.50
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 TYPICAL		1.90 TYPICAL	
K	0.075 TYPICAL		1.90 TYPICAL	
L	—	0.103	—	2.6
M	—	0.024	—	0.6

DIM.	GRADIENT
N	10° max.[1]
P	2°...30°

3 Volt, General Purpose Low Noise High f_T Silicon Transistor

MA4T6325 Series

V 2.00

Features

- Low Voltage Operation (3 - 5 V)
- High f_T (11 GHz)
- Low Noise Figure with 1-5 mA Current
- Inexpensive
- Available on Tape and Reel

Description

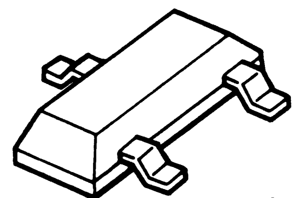
The MA4T6325 series of low voltage silicon bipolar transistors provide low noise figure at a bias of 3-5 volts and collector current of 1 to 5 mA. These inexpensive surface mount transistors are useful for low noise amplifiers and VCOs in portable battery-operated RF systems from VHF through 2.5 GHz.

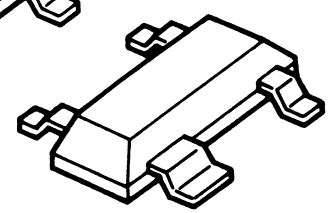
The MA4T6325 series has high f_T (11 GHz) and provides 1.5 dB noise figure with 1-5 mA current and 3 volts bias at 1 GHz. These transistors also have low phase noise when used in 3-5 volt low power battery-operated VCOs through 2.5 GHz.

The MA4T6325 series are inexpensive transistors useful for portable battery operated RF systems that require low current drain from 3-5 volt DC supplies.

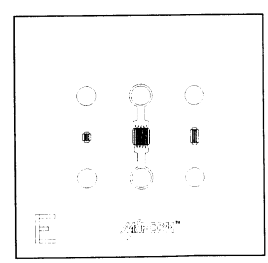
This family is available as chips (MA4T632500), in the SOT-23 (MA4T632533), the SOT-143 (MA4T63259) and in the Micro-X (MA4T632535) packages. Surface mount packages are available on tape and reel.

SOT-23

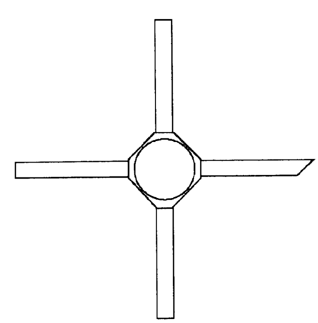




SOT-143



Chip



Micro-X

M/A-COM, Inc.

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

Maximum Ratings @ 25°C

Parameter	Symbol	Maximum
Collector-Base Voltage	V_{CBO}	8 V
Collector-Emitter Voltage	V_{CEO}	6 V
Emitter-Base Voltage	V_{EBO}	1.5 V
Collector Current	I_C	25 mA
Junction Temperature	T_j	200 °C
Storage Temperature Chips or Ceramic Packages Plastic Packages	T_{STG}	 -65°C to +200°C -65°C to +125°C
Power Dissipation	P_D	150 mW[1]

Note: 1. See power derating curves.

Electrical Specifications @ 25°C
MA4T6325 Series

Parameter	Condition	Symbol	Units	MA4T632500 Chip	MA4T632533 SOT-23	MA4T632535 Micro-X	MA4T632539 SOT-143
Gain Bandwidth Product	V_{CE} = 3 V I_C = 10 mA	f_T	GHz	11 typ.	10 typ.	11 typ.	11 typ.
Insertion Power Gain	V_{CE} = 3 V I_C = 10 mA f = 1 GHz f = 2 GHz	$\|S_{21E}\|^2$	dB	 12 min. 8 typ.	 11 min. 7 typ.	 12 typ. 8 typ.	 11 min. 7 typ.
Noise Figure	V_{CE} = 3 V I_C = 2 mA f = 1 GHz	NF	dB	1.5 typ.	1.6 typ.	1.5 typ.	1.6 typ.
Unilateral Gain	V_{CE} = 3 V I_C = 10 mA f = 1 GHz f = 2 GHz	GTU (max)	dB	 14.5 typ. 9.5 typ.	 13 typ. 8 typ.	 14.5 typ. 9.5 typ.	 13 typ. 8 typ.
Maximum Available Gain	V_{CE} = 3 V I_C = 10 mA f = 2 GHz	MAG	dB	10 typ.	9 typ.	10 typ.	9 typ.
Power Out at 1 dB Compression	V_{CE} = 3 V I_C = 15 mA f = 900 MHz	P_{1dB}	dBm	8 typ.	8 typ.	8 typ.	8 typ.
Thermal Resistance	Junction/ Ambient (Free Air)	$R_{TH(J-A)}$	°C/W	—	650 typ.	500 typ.	625 typ.
Thermal Resistance	Junction/Case	$R_{TH\ (J-C)}$	°C/W	70 max.[1]	200 typ.	200 typ.	200 typ.

Note: 1. Junction to infinite heat sink.

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Electrical Specifications @ +25°C
MA4T6325 Series

Parameter	Condition	Symbol	Min	Typical	Max	Unit
Collector Cut-off Current	V_{CB} = 5 V I_E = 0	I_{CBO}	—	—	100	nA
Emitter Cut-off Current	V_{EB} = 1 V I_C = 0	I_{EBO}	—	—	1	μA
Forward Current Gain	V_{CE} = 3 V I_C = 3 mA	h_{FE}	20	90	200	—
Collector-Base Junction Capacitance	V_{CB} = 3 V I_E = 0 f = 1 MHz	C_{OB}	—	0.52	0.70	pF

Typical Scattering Parameters in the Micro-X Package
MA4T632535
V_{CE} = 3 Volts, I_C = 5 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.486	-80.5	7.164	119.8	0.077	56.6	0.628	-45.8
1000	0.338	-128.0	4.508	93.4	0.112	51.9	0.424	-58.8
1500	0.294	-156.3	3.219	78.1	0.144	50.2	0.345	-65.9
2000	0.284	169.8	2.533	66.1	0.179	47.8	0.305	-74.9
2500	0.283	160.9	2.123	55.5	0.210	44.7	0.280	-83.1
3000	0.281	144.6	1.835	46.3	0.240	41.8	0.266	-90.8
3500	0.290	132.5	1.678	36.8	0.272	36.7	0.256	-103.7
4000	0.320	119.4	1.546	28.3	0.301	33.2	0.254	-113.8
4500	0.333	106.6	1.434	18.9	0.323	29.0	0.245	-125.4
5000	0.358	94.9	1.354	11.5	0.349	25.1	0.241	-135.9
5500	0.382	82.7	1.290	4.0	0.375	21.4	0.246	-146.1
6000	0.405	72.7	1.238	-4.0	0.397	17.7	0.255	-157.0

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Typical Scattering Parameters in the Micro-X Package (Cont'd)

MA4T632535

V_{CE} = 3 Volts, I_C = 10 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.326	-116.9	8.628	108.6	0.060	60.9	0.505	-48.5
1000	0.288	-158.6	4.808	86.7	0.098	60.0	0.351	-56.2
1500	0.288	174.6	3.337	73.4	0.135	57.7	0.302	-61.8
2000	0.305	160.8	2.608	62.3	0.170	53.7	0.275	-71.7
2500	0.319	145.8	2.172	52.2	0.204	49.7	0.256	-80.2
3000	0.330	131.0	1.863	43.2	0.234	45.8	0.245	-88.1
3500	0.335	121.4	1.696	35.5	0.268	41.0	0.245	-101.8
4000	0.372	110.2	1.559	25.9	0.299	36.8	0.245	-112.9
4500	0.385	99.4	1.444	16.9	0.322	32.7	0.240	-125.3
5000	0.417	88.6	1.361	9.4	0.350	28.3	0.237	-136.8
5500	0.445	77.1	1.294	3.2	0.379	24.1	0.242	-148.0
6000	0.468	67.4	1.236	-6.0	0.401	20.3	0.253	-160.2

MA4T632535

V_{CE} = 3 Volts, I_C = 15 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	0.288	-136.7	9.912	104.1	0.053	65.0	0.428	-50.5
1000	0.278	-173.6	5.355	84.5	0.092	64.6	0.295	-55.5
1500	0.287	168.5	3.679	72.6	0.132	60.8	0.263	-60.3
2000	0.317	149.8	2.875	61.7	0.165	56.6	0.236	-70.3
2500	0.334	135.8	2.377	52.0	0.200	52.2	0.222	-77.5
3000	0.354	121.6	2.029	43.0	0.230	47.7	0.215	-84.3
3500	0.355	112.4	1.834	34.6	0.265	42.7	0.218	-97.2
4000	0.382	100.2	1.653	26.7	0.290	38.9	0.220	-103.8
4500	0.408	92.3	1.552	17.3	0.317	34.1	0.218	-117.6
5000	0.440	82.1	1.456	10.0	0.344	29.7	0.213	-127.1
5500	0.471	71.3	1.377	2.2	0.372	25.2	0.212	-137.0
6000	0.492	62.2	1.312	-5.5	0.392	21.3	0.218	-147.9

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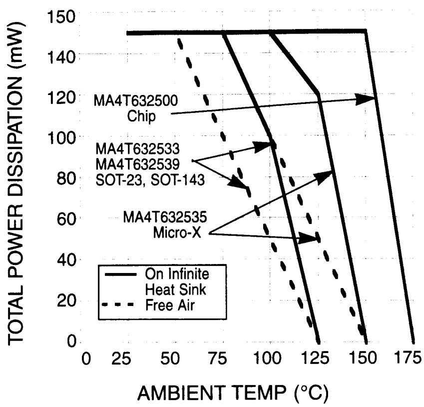
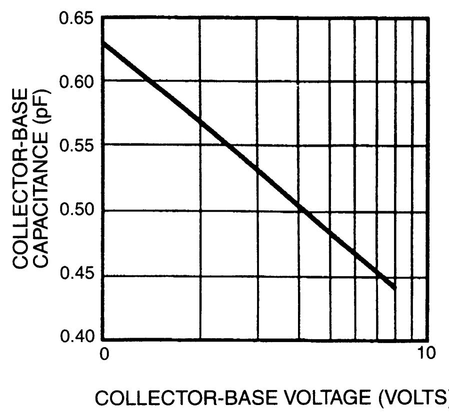
Typical Performance Curves

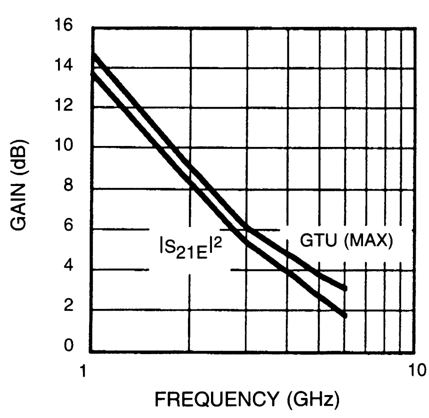
POWER DERATING CURVES



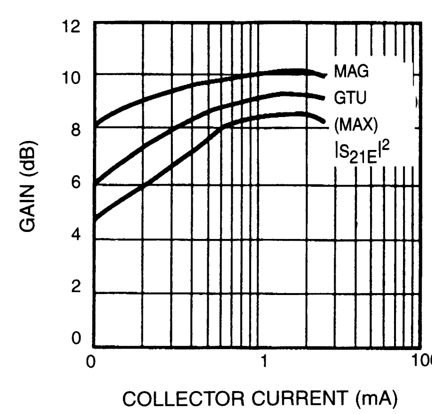
COLLECTOR-BASE CAPACITANCE (C_{OB}) vs COLLECTOR-BASE VOLTAGE (MA4T632535)



GAIN vs FREQUENCY AT V_{CE} = 3 V AND I_C = 10 mA (MA4T632535)



GAIN vs COLLECTOR CURRENT AT 2 GHz AND V_{CE} = 3 V (MA4T632535)



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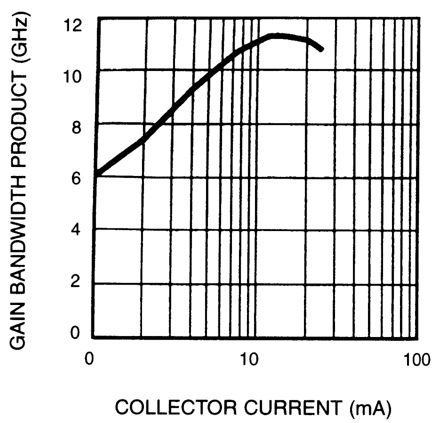
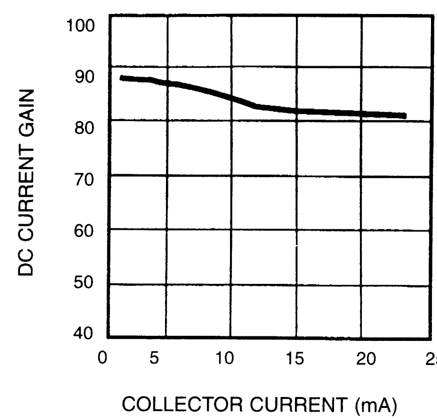
Typical Performance Curves (Cont'd)

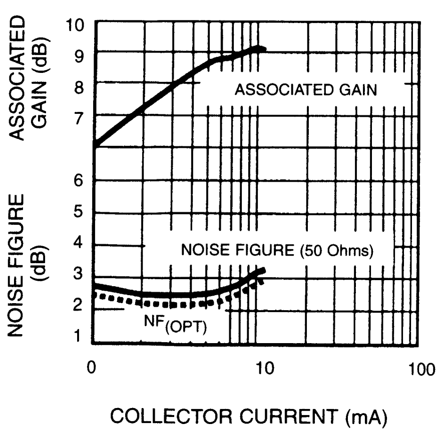
GAIN BANDWIDTH PRODUCT (f_T) vs COLLECTOR CURRENT AT V_{CE} = 3 V (MA4T632535)



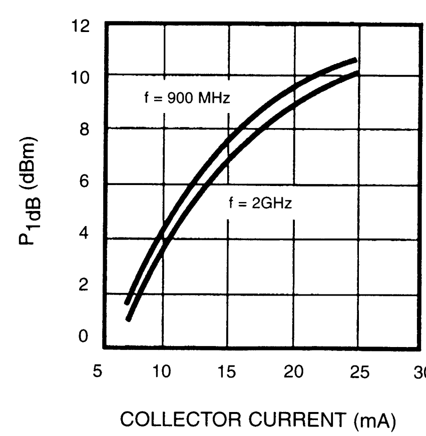
DC CURRENT GAIN (H_{FE}) vs COLLECTOR CURRENT AT V_{CE} = 3 V (MA4T632535)



NOISE FIGURE AND ASSOCIATED GAIN AT V_{CE} = 3 V AND 1 GHz vs COLLECTOR CURRENT (MA4T632535)

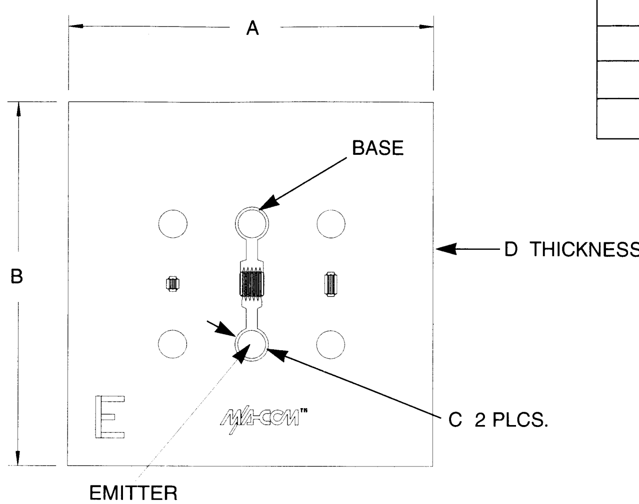


NOMINAL OUTPUT POWER AT THE 1 dB COMPRESSION POINT vs COLLECTOR CURRENT, V_{CE} = 3 V (MA4T632535)



Case Styles

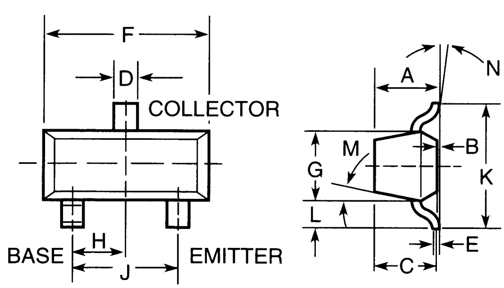
Chip — MA4T632500
Case Style 1167



MA4T632500

DIM.	INCHES (Nominal)	MM (Nominal)
A	0.013	0.35
B	0.013	0.35
C	0.0016	0.040
D	0.0045	0.11

SOT-23 – MA4T632533



MA4T632533

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K	—	0.103	—	2.60
L	—	0.024	—	0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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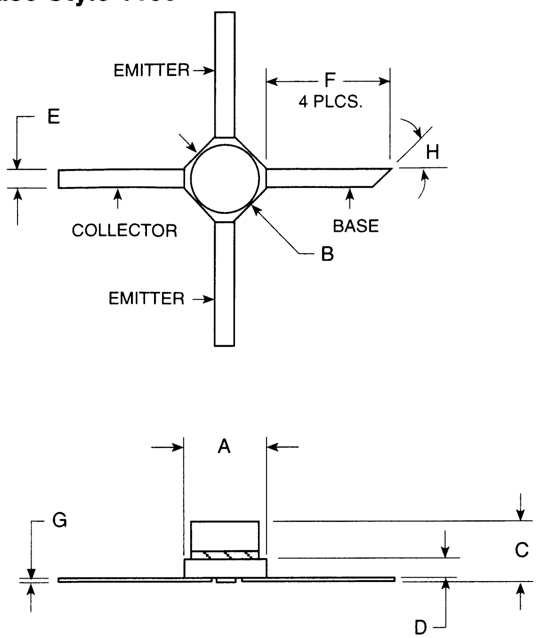
Case Styles (Con't)

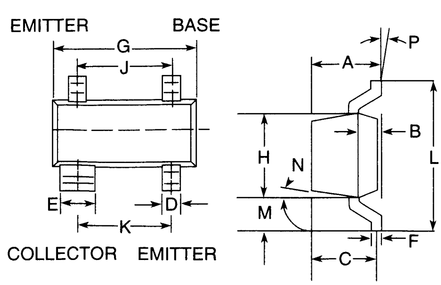
Micro-X — MA4T630535
Case Style 1139



MA4T630535

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.046	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

SOT-143 — MA4T630539



MA4T630539

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0.044	—	1.10
B	—	0.044	—	1.10
C	—	0.040	—	1.00
D	0.030	0.035	0.75	0.90
E	0.013	0.020	0.35	0.50
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 TYPICAL		1.90 TYPICAL	
K	0.075 TYPICAL		1.90 TYPICAL	
L	—	0.103	—	2.6
M	—	0.024	—	0.6

DIM.	GRADIENT
N	10° max.[1]
P	2°...30°

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an AMP company

Coming Attractions

Moderate Power, 3 Volt, High f_T NPN Silicon Transistor

MA4T6380 Series

V 2.00

Features

- Low Voltage Operation (3-5 Volts)
- High Output Power
  +21 dBm P_{1dB} at 1 GHz
  16 dBm at 2 GHz
- High f_T 10 GHz
- Low Noise Figure (1.5 dB)
- Low Noise Oscillator
  Low Phase Noise with 3-5 Volt V_{CE}

Description

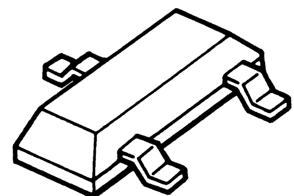
The MA4T6380 series of moderate power low voltage NPN transistors provide low noise at 3-5 volts operating voltage. These transistors are designed to optimize at moderate collector currents (20-60 mA) and low voltage.

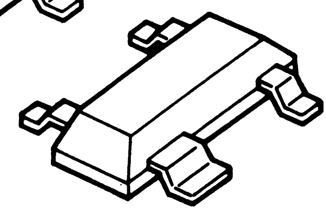
They are useful as moderate power (+15 to +20 dBm) low noise amplifiers at 0.5-2 GHz or as a low noise VCO transistor in portable battery operated RF systems from 100 MHz to 3.0 GHz.

These inexpensive transistors are available in the SOT-23 (MA4T638033), the SOT-143 (MA4T638039), and the Micro-X (MA4T638035) packages. They are also available as chips (M4T638000) for hybrid circuits. The plastic packages SOT-23 and SOT-143 are normally supplied on tape and reel.

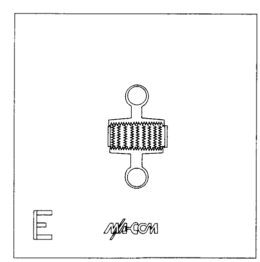
The MA4T6380 series are useful for moderate power low noise amplifiers or oscillators from VHF to approximately 3.0 GHz.

SOT-23

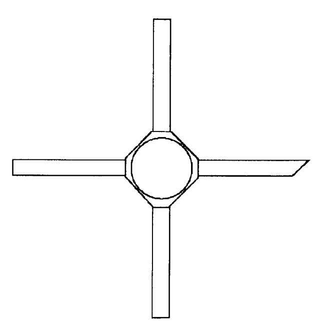




SOT-143



Chip



Micro-X

Maximum Ratings @ 25°C

Parameter	Symbol	Maximum
Collector-Base Voltage	V_{CBO}	8 V
Collector-Emitter Voltage	V_{CEO}	6 V
Emitter-Base Voltage	V_{EBO}	1.5 V
Collector Current	mA	80 mA
Junction Temperature	T_j	200 °C
Storage Temperature Chips or Ceramic Packages Plastic Packages	T_{STG}	 -65°C to +200°C -65°C to +125°C
Power Dissipation	P_D	500 mW[1]

Note: 1. See power derating curves.

Electrical Specifications @ +25°C
MA4T6380 Series

Parameter	Condition	Symbol	Units	MA4T638000 Chip	MA4T638033 SOT-23	MA4T638035 Micro-X	MA4T638039 SOT-143
Gain Bandwidth Product	V_{CE} = 3 V I_C = 50 mA	f_T	GHz	9 typ.	9 typ.	9 typ.	9 typ.
Insertion Power Gain	V_{CE} = 3 V I_C = 20 mA f = 1 GHz	$\|S_{21E}\|^2$	dB	10 typ.	9 typ.	10 typ.	9 typ.
Noise Figure	V_{CE} = 3 V I_C = 10 mA f= 1 GHz	NF	dB	1.6 typ.	1.6 typ.	1.5 typ.	1.6 typ.
Collector Capacitance	V_{CE} = 3 V	C_{OB}	pF	1.0 typ.	1.15 typ.	1.1 typ.	1.15 typ.
Associated Gain	V_{CE} = 3 V I_C = 20 mA f = 1 GHz	GA	dB	11.5 typ.	11 typ.	11.5 typ.	11 typ.
Output Power at 1 dB Compression	V_{CE} = 3 V I_C = 60 mA f = 1 GHz	P_{1dB}	dBm	21 typ.	20 typ.	21 typ.	20 typ.
Thermal Resistance	Junction/ Ambient (Free Air)	$R_{TH(J-A)}$	˚C/W	—	600 max.	550 max.	600 max.
Thermal Resistance	Junction/Case	$R_{TH(J-C)}$	˚C/W	60 max.[1]	200 typ.	200 typ.	200 typ.

Note: 1. Junction to infinite heat sink.

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Electrical Specifications @ +25°C
MA4T6380 Series

Parameter	Condition	Symbol	Min	Typical	Max	Unit
Collector Cut-off Current	V_{CB} = 3 V I_E = 0	I_{CBO}	—	—	100	μA
Emitter Cut-off Current	V_{EB} = 1 V I_C = 0	I_{EBO}	—	—	1	μA
Forward Current Gain	V_{CE} = 3 V I_C = 10 mA	h_{FE}	20	100	250	—
Collector-Base Junction Capacitance	V_{CB} = 3 V f = 1 MHz	C_{OB}	—	1.0	1.2	pF

Typical Scattering Parameters in the Micro-X Package
MA4T638035
V_{CE} = 3 Volts, I_C = 5 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
400	0.642	-159.5	5.80	80.2	0.110	12.4	0.436	-115.3
800	0.630	147.3	3.16	36.0	0.132	11.9	0.304	-167.4
1200	0.626	109.6	2.20	-0.4	0.153	32.4	0.275	154.5
1600	0.623	75.8	1.72	-34.6	0.179	53.9	0.269	120.7
2000	0.621	43.7	1.43	-67.3	0.208	76.4	0.274	90.8
2400	0.618	12.6	1.25	-99.1	0.238	100.2	0.280	59.9
2800	0.611	-18.2	1.12	-129.9	0.270	124.9	0.289	32.5
3200	0.606	-49.3	1.04	-160.1	0.304	150.3	0.301	2.7
3600	0.602	-80.1	.97	170.3	0.337	176.3	0.311	-26.2
4000	0.599	-110.3	.91	141.4	0.373	157.1	0.327	-56.6

MA4T638035
V_{CE} = 3 Volts, I_C = 10 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
400	0.627	179.2	6.87	73.6	0.079	19.5	0.377	-144.6
800	0.629	135.9	3.61	33.8	0.111	2.1	0.313	163.8
1200	0.626	101.4	2.48	-0.6	0.147	18.7	0.301	127.8
1600	0.621	69.0	1.93	-33.5	0.185	42.6	0.299	96.0
2000	0.616	37.8	1.61	-65.3	0.223	67.8	0.298	67.1
2400	0.611	7.4	1.40	-96.5	0.261	94.0	0.300	37.6
2800	0.601	-23.0	1.26	-127.1	0.299	120.8	0.300	10.9
3200	0.593	-53.7	1.16	-157.2	0.335	148.0	0.305	-18.3
3600	0.586	-84.1	1.08	173.1	0.369	175.4	0.305	-45.7
4000	0.580	-113.9	1.02	144.0	0.404	157.0	0.313	-74.1

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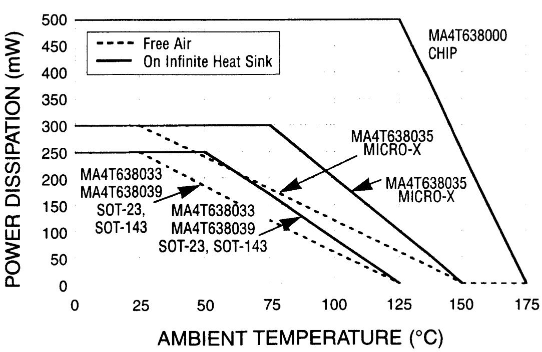
Typical Scattering Parameters in the Micro-X Package (Con't)
MA4T638035
V_{CE} = 3 Volts, I_C = 20 mA

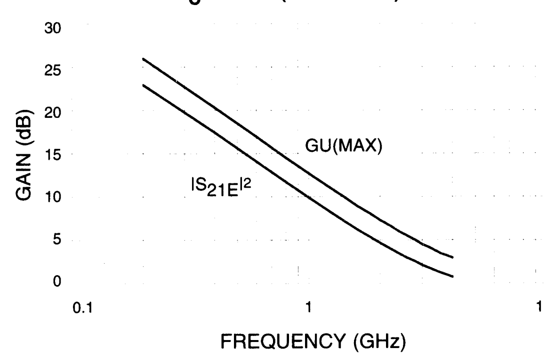
Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
400	0.634	167.5	7.43	69.4	0.063	30.8	0.378	-166.6
800	0.638	129.4	3.84	32.4	0.105	13.3	0.352	147.4
1200	0.634	96.8	2.64	-.8	0.148	10.2	0.346	113.9
1600	0.628	65.5	2.05	-32.9	0.192	36.3	0.343	83.0
2000	0.621	34.9	1.70	-64.3	0.235	63.3	0.339	54.4
2400	0.613	4.9	1.48	-95.2	0.276	90.7	0.339	25.0
2800	0.602	-25.1	1.33	-125.5	0.316	118.6	0.332	-4.3
3200	0.592	-55.5	1.22	-155.5	0.354	146.6	0.333	-31.0
3600	0.583	-85.7	1.14	174.9	0.389	174.7	0.328	-58.5
4000	0.575	-115.2	1.08	145.7	0.424	157.2	0.330	-86.6

Typical Performance Curves

POWER DISSIPATION vs TEMPERATURE (MA4T6380 SERIES)



GAIN vs FREQUENCY AT V_{CE} = 3 V AND I_C = 20 MA (MA4T638035)



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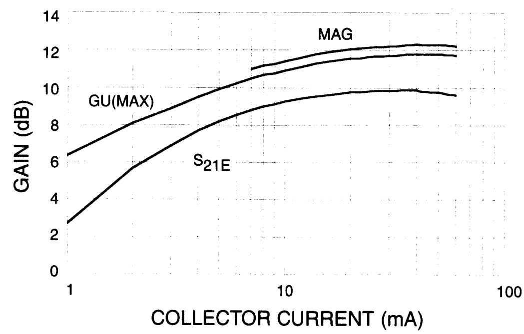
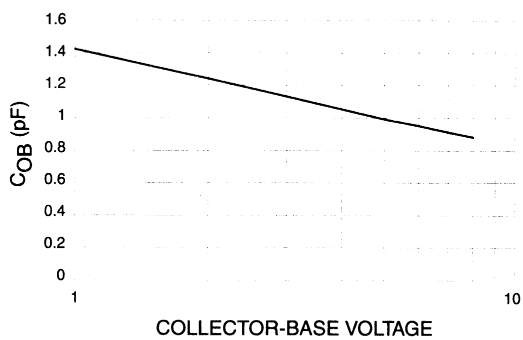
Typical Performance Curves (Con't)

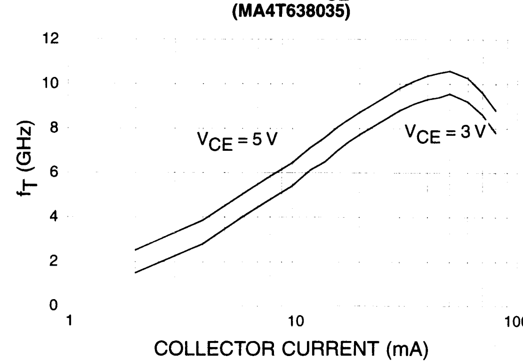
GAIN vs COLLECTOR CURRENT f = 1 GHz, V_{CE} = 3 V (MA4T638035)



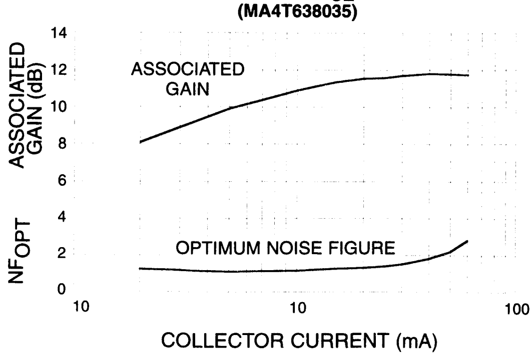
COLLECTOR BASE CAPACITANCE vs COLLECTOR-BASE VOLTAGE (MA4T638000)



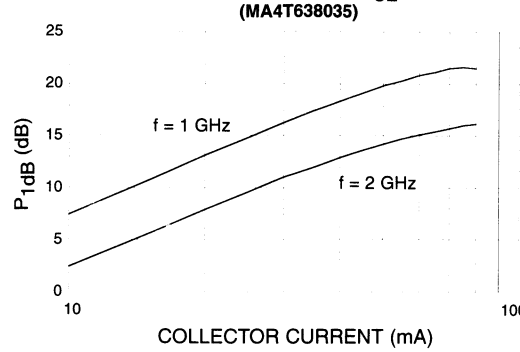
GAIN BANDWIDTH PRODUCT (f_T) vs COLLECTOR CURRENT, V_{CE} = 3V, f = 1 GHz (MA4T638035)



NOISE FIGURE & ASSOCIATED GAIN vs COLLECTOR CURRENT, V_{CE} = 3 V, f = 1 GHz (MA4T638035)



NOMINAL OUTPUT POWER @ 1 dB COMPRESSION vs COLLECTOR CURRENT, V_{CE} = 3 V (MA4T638035)



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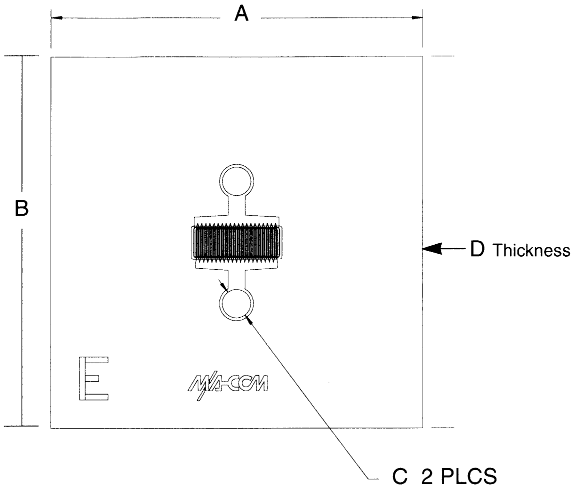
Case Styles

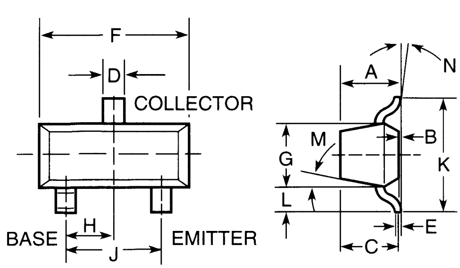
Chip — MA4T638000
Case Style 1169



MA4T638000

DIM.	INCHES (Nominal)	MM (Nominal)
A	0.013	0.35
B	0.013	0.35
C	0.0012	0.03
D	0.0045	0.11

SOT-23 — MA4T638033



MA4T638033

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K	—	0.103	—	2.60
L	—	0.024	—	0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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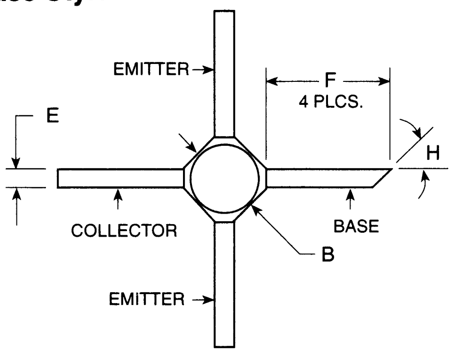
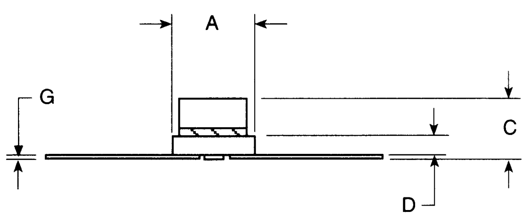
Case Styles (Con't)

Micro-X — MA4T630535
Case Style 1139

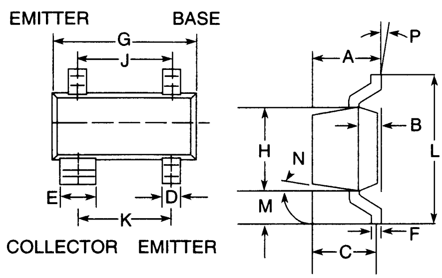




MA4T630535

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.046	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

SOT-143 — MA4T630539



MA4T630539

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	—	0.044	—	1.10
B	—	0.044	—	1.10
C	—	0.040	—	1.00
D	0.030	0.035	0.75	0.90
E	0.013	0.020	0.35	0.50
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 TYPICAL		1.90 TYPICAL	
K	0.075 TYPICAL		1.90 TYPICAL	
L	—	0.103	—	2.6
M	—	0.024	—	0.6

DIM.	GRADIENT
N	10° max.[1]
P	2°...30°

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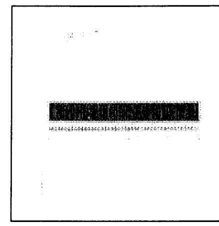
Medium Power, 12 Volt, High f_T NPN Silicon Bipolar Transistor

MA4T56800

V 2.00



Features

- High Output Power, 23 dBm P1dB @ 1 GHz
- High Gain-Bandwidth Product, 4 GHz fT
- High Power Gain, $|S_{21E}|^2$ = 12 dB @ 1 GHz
  GTU (max.) = 11 dB @ 2 GHz

Description

The MA4T568 is a medium power, high f_T silicon NPN transistor designed to work at 8 - 12 volts V_{CC} and with collector currents up to 150 mA.

It is offered as a chip, MA4T56800, for use in hybrid applications as an amplifier or moderate power oscillator. It can also be supplied in a common collector ceramic package.

This chip transistor is designed for use in medium power amplifiers through 3 GHz and oscillators operating from VHF through 5 GHz. A M/A-COM proprietary refractory barrier/gold metallization system utilized to provide maximum device reliability and ease of chip and wire assembly. This transistor series is also manufactured with M/A-COM's silicon oxide and silicon nitride passivation to assure reliability and low 1/f noise.

Electrical Specifications @ 25°C

Parameter of Test	Condition	Symbol	Units	MA4T56800 Chip
Gain Bandwidth Product	V_{CE} = 10 V I_C = 60 mA	f_T	GHz	4.2 typ.
Insertion Power Gain	V_{CE} = 10 V I_C = 60 mA f= 1 GHz	$\|S_{21E}\|^2$	dB	12 typ.
Unilateral Gain	V_{CE} = 10 V I_C = 60 mA f = 1 GHz	GTU (max.)	dB	16 typ.
Power Out @ 1dB Compression	V_{CE} = 10 V I_C = 100 mA f = 1 GHz	P_{1dB}	dBm	22.5 typ.

Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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Maximum Ratings @ +25°C

Parameter	Symbol	Maximum
Collector-Base Voltage	V_{CBO}	25 V
Collector-Emitter Voltage	V_{CEO}	15 V
Emitter-Base Voltage	V_{EBO}	3 V
Collector Current	I_C	150 mA
Junction Temperature	T_j	200 °C
Storage Temperature	T_S	-65°C to 200°C
Power Dissipation[1]	P_D	1500 mW
Thermal Resistance	$R_{TH\ (J-C)}$	40°C/W

Note: 1. See figure 1 for power derating.

Typical Scattering Parameters, V_{CE} = 10 Volts, I_C = 40 mA
MA4T56800

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
400	0.794	-141.2	8.75	104.8	0.081	24.3	0.478	-106.0
600	0.795	-157.1	6.08	94.4	0.085	19.6	0.417	-122.0
800	0.796	-166.5	4.64	87.2	0.087	17.8	0.392	-131.1
1000	0.796	-173.2	3.76	81.3	0.089	16.7	0.383	-136.6
1500	0.794	174.3	2.55	69.7	0.094	17.5	0.382	-142.6
2000	0.794	166.7	1.93	59.5	0.098	17.9	0.396	-144.7
2500	0.793	159.4	1.58	50.6	0.102	19.6	0.408	-145.6
3000	0.794	153.0	1.32	42.0	0.108	20.7	0.421	-144.8
3500	0.791	146.5	1.15	33.7	0.115	21.5	0.437	-143.3
4000	0.789	141.2	1.02	26.7	0.123	20.6	0.460	-141.7

Typical Scattering Parameters, V_{CE} = 10 Volts, I_C = 80 mA
MA4T56800

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
400	0.798	-144.6	8.94	103.2	0.077	23.3	0.476	-113.3
600	0.800	-159.6	6.17	93.2	0.080	19.4	0.425	-128.9
800	0.800	-168.5	4.70	86.4	0.082	18.3	0.403	-137.4
1000	0.800	-175.0	3.80	80.7	0.084	17.7	0.395	-142.5
1500	0.798	174.1	2.58	69.5	0.090	19.0	0.394	-147.9
2000	0.797	165.8	1.95	59.7	0.095	20.1	0.405	-149.6
2500	0.796	158.7	1.70	50.9	0.099	21.7	0.415	-150.0
3000	0.797	152.3	1.34	42.4	0.107	22.8	0.425	-149.0
3500	0.794	146.3	1.16	34.6	0.115	23.3	0.437	-147.2
4000	0.791	140.6	1.03	27.3	0.122	22.5	0.456	-145.2

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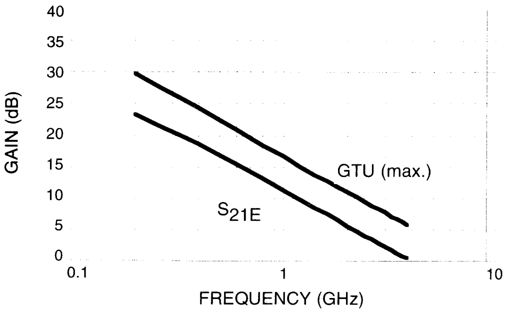
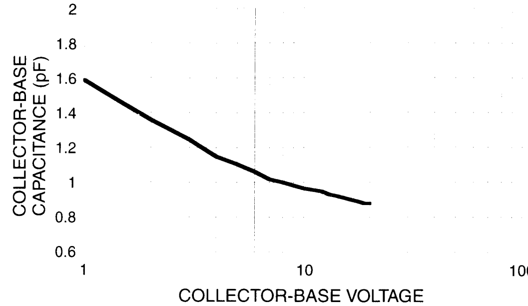
Typical Performance @ +25°C

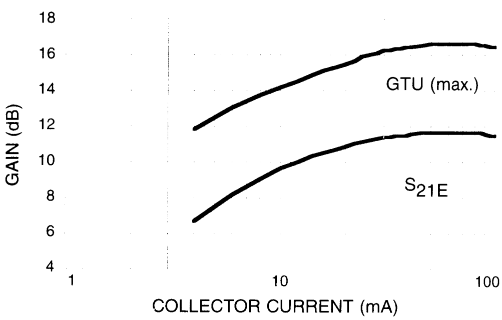
GAIN vs FREQUENCY
V_{CE} = 10 V, I_C = 80 mA



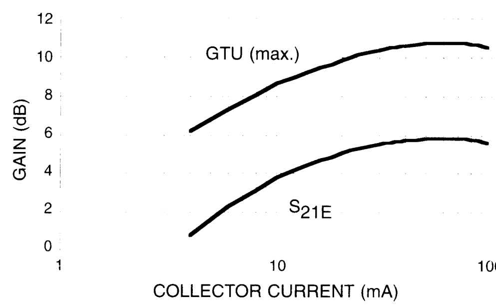
CAPACITANCE vs COLLECTOR-BASE VOLTAGE



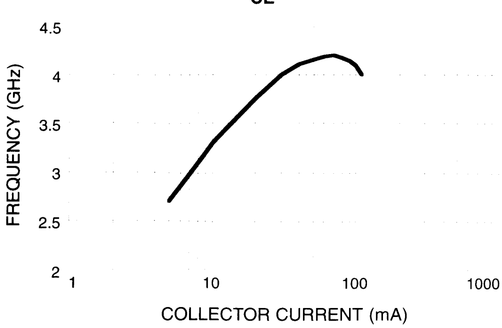
GAIN vs COLLECTOR CURRENT
V_{CE} = 10 V, f = 1GHz



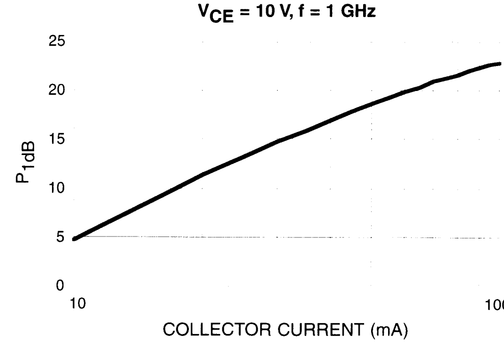
GAIN vs COLLECTOR CURRENT
V_{CE} = 10 V, f = 2 GHz



FREQUENCY WHERE S_{21} = 0 (F_S)
V_{CE} = 10 V



POWER OUTPUT @ 1 dB COMPRESSION
V_{CE} = 10 V, f = 1 GHz



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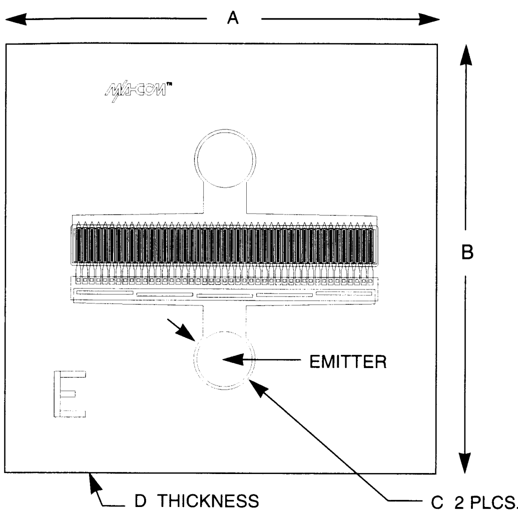
Case Style

Chip — MA4T56800
Case Style 1170



MA4T568000

DIM.	INCHES (Nominal)	MM (Nominal)
A	0.013	0.35
B	0.013	0.35
C	0.0020	0.05
D	0.0045	0.11

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Low Operating Voltage, High f_T Bipolar Microwave Transistors

MA4T6365 Series

V 2.00

Features

- Designed for Battery Operation
- f_T to 10 GHz
- Low Voltage Oscillator and Amplifier
- Low Phase Noise and Noise Figure
- Hermetic and Surface Mount Packages and Chips Available
- Can be Screened to JANTX, JANTXV Equivalent Levels

Description

The MA4T6365 family of low voltage, high gain bandwidth silicon NPN bipolar transistors provides low noise figure and high gain at low bias voltages. These transistors are especially attractive for low operating voltage low noise amplifiers or driver amplifiers at frequencies to 4 GHz. They are also useful for low phase noise local oscillators and VCOs in battery operated equipment to 10 GHz.

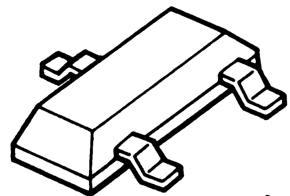
The MA4T6365 family was designed to have low noise figure at operating voltages as low as 3 volts. These transistors also exhibit low phase noise in VCOs operating at 5 volts or less.

Because this transistor family was specifically designed to operate from low bias voltage, it has superior phase noise in comparison to similar current bipolar transistors with higher collector breakdown voltage when operating under the same low voltage conditions.

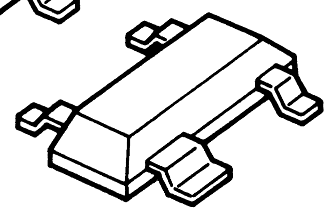
The MA4T6365 series transistors are available in hermetic Micro-X packages, the SOT-23, the SOT-143, and in chip form (MA4T636500). Other stripline and hermetic packages are available. The chip and hermetic packages can be screened to JANTX, JANTXV equivalent levels. The plastic parts can be supplied on tape and reel.

All of M/A-COM's silicon bipolar transistor families use silicon dioxide and silicon nitride passivation to assure low 1/F noise for amplifier and oscillator applications.

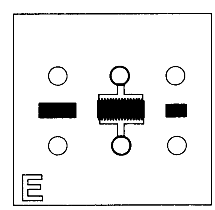
Case Styles



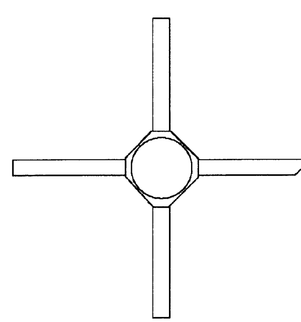
SOT-23



SOT-143



Chip



Micro-X

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Maximum Ratings (T_A = 25°C)
MA4T6365 Series

Collector-Base Voltage	V_{CBO}	10 V
Collector-Emitter Voltage	V_{CE}	6 V
Emitter-Base Voltage	V_{EB}	1.5 V
Collector Current	I_C	65 mA
Junction Operating Temperature	T_j	200°C
Storage Temperature Chip or Ceramic Packages Plastic Packages	T_S	-65°C to + 200°C -65°C to +125°C
Power Dissipation		
Package Type	Maximum Dissipation @ 25°C	Maximum Operating Temperature
Chip (MA4T636500)	400 mW	175°C
SOT-23 (MA4T636533)	200 mW	125°C
Micro-X Package (MA4T636535)	300 mW	150°C
SOT-143 (MA4T636539)	225 mW	125°C

Electrical Specifications @ 25°C
MA4T6365 Series

Parameter of Test	Condition	Symbol	Units	MA4T636500 Chip	MA4T636535 Micro-X	MA4T636539 SOT-143	MA4T636533 SOT-23
Gain Bandwidth Product	V_{CE} = 3 V I_C = 20 mA	f_T	GHz	10 typ	10 typ	10 typ	10 typ
Insertion Power Gain	V_{CE} = 3 V I_C = 10 mA f = 1 GHz f = 2 GHz	$\|S_{21E}\|^2$	dB	14 typ 7.0 min	13 typ 7.0 min	13 typ 7.0 min	13 typ 7.0 min
Noise Figure	V_{CE} = 3 V I_C = 5 mA f = 1 GHz f = 2 GHz	NF	dB	1.3 max 1.6 typ	1.3 max 1.6 typ	1.4 max 1.7 typ	1.4 max 1.7 typ
Unilateral Gain	V_{CE} = 3 V I_C = 5 mA f = 1 GHz f = 2 GHz	GTU (max)	dB	15 typ 10 typ	15 typ 10 typ	14 typ 9 typ	14 typ 9 typ
Maximum Available Gain	V_{CE} = 3 V I_C = 20 mA f = 1 GHz f = 2 GHz	MAG	dB	16 typ 12 typ	16 typ 11 typ	16 typ 10 typ	16 typ 10 typ
Output Power at 1 dB Compression	V_{CE} = 3 V I_C = 20 mA f = 2 GHz f = 4 GHz	P_{1dB}	dBm	16 typ 12 typ	17 typ 13 typ	16 typ 12 typ	16 typ 12 typ

Specifications Subject to Change Without Notice.

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Electrical Specifications @ 25°C

Parameter	Condition	Symbol	Min	Typical	Max	Unit
Collector Cut-off Current	V_{CB} = 3 volts I_E = 0 µA	I_{CBO}	—	—	100	nA
Emitter Cut-off Current	V_{EB} = 1 volt I_C = 0 µA	I_{EBO}	—	—	1	µA
Forward Current Gain	V_{CE} = 3 volts I_C = 5 mA	h_{FE}	30	75	200	—
Collector-Base Junction Capacitance	V_{CB} = 5 volts I_E = 0 µA f = 1 MHz	C_{OB}	—	0.50	0.70	pF

Typical Common Emitter Scattering Parameters in the Micro-X Package

MA4T636535

V_{CE} = 3 Volts, I_C = 5 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.640	-103	6.343	116.9	.103	38.7	.534	-75.2
1000	.580	-153	3.984	91.5	.123	29.0	.346	-103.0
1500	.571	-175	2.813	77.9	.135	27.7	.250	-124.9
2000	.590	168	2.214	67.0	.146	26.8	.242	-140.4
2500	.597	155	1.853	579	.159	27.3	.211	-150.2
3000	.622	144	1.632	48.2	.174	27.3	.227	-164.1
3500	.646	134	1.460	40.1	.190	26.8	.229	-168.0
4000	.676	124	1.341	31.7	.205	25.6	.238	170.7
4500	.712	115	1.241	23.7	.218	24.1	.255	167.9
5000	750	106	1.191	16.4	.238	22.2	.277	157.8
5500	.793	96	1.130	8.4	.257	20.2	.310	153.0
6000	.833	88	1.081	2.5	.272	17.3	.323	145.0

V_{CE} = 3 Volts, I_C = 10 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.580	-142	8.562	104.6	.066	39.1	.389	-102.8
1000	.589	-175	4.641	85.8	.086	40.5	.274	-132.0
1500	.592	170	3.200	75.1	.106	42.9	.228	-158.1
2000	.617	157	2.480	65.9	.125	43.0	.243	-169.4
2500	.625	146	2.069	57.9	.150	42.7	.220	171.9
3000	.652	136	1.811	48.9	.172	40.8	.250	166.9
3500	.676	127	1.613	41.3	.195	38.3	.251	161.4
4000	.707	118	1.479	33.3	.218	35.1	.270	150.2
4500	.741	109	1.366	25.6	.234	31.9	.281	146.1
5000	.776	100	1.311	18.5	.259	28.1	.311	135.9
5500	.817	91	1.240	10.6	.281	24.9	.342	132.5
6000	.855	82	1.188	3.0	.298	20.5	.351	125.1

Typical Common Emitter Scattering Parameters in the Micro-X Package

MA4T636535

V_{CE} = 3 Volts, I_C = 20 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.551	-160	9.374	99.1	.048	46.7	.321	-111.2
1000	.567	177	4.916	84.2	.071	52.5	.238	-139.5
1500	.577	164	3.373	74.7	.094	54.2	.217	-161.0
2000	.599	153	2.613	66.4	.117	53.2	.223	-171.4
2500	.611	143	2.174	58.9	.144	52.0	.214	168.4
3000	.633	133	1.898	50.6	.169	49.2	.232	163.6
3500	.659	125	1.690	43.4	.194	45.9	.242	159.3
4000	.689	116	1.552	35.8	.219	42.1	.256	149.4
4500	.724	107	1.444	28.4	.238	38.3	.274	144.3
5000	.758	99	1.378	21.4	.263	33.9	.294	135.8
5500	.800	90	1.309	13.5	.287	30.0	.319	130.4
6000	.840	82	1.252	6.0	.304	25.3	.333	124.2

V_{CE} = 3 Volts, I_C = 40 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.589	-173	9.150	93.6	.044	55.7	.275	-120.0
1000	.604	171	5.202	80.8	.067	59.2	.220	-147.2
1500	.620	159	3.505	70.8	.094	58.6	.210	- 164.0
2000	.642	149	2.685	62.2	.119	56.4	.210	174.3
2500	.666	138	2.218	54.1	.145	53.8	.212	171.8
3000	.681	128	1.935	45.9	.172	50.0	.220	168.3
3500	.704	119	1.710	37.6	.195	46.0	.234	161.2
4000	.738	110	1.560	29.8	.218	41.9	.248	153.7
4500	.777	101	1.445	22.3	.240	37.8	.265	147.0
5000	.819	92	1.365	14.5	.262	33 7	.283	140.6
5500	.858	82	1.290	6.7	.284	29.9	.301	134.8
6000	.896	73	1.228	-1.4	.305	25.5	.328	128.3

V_{CE} = 3 Volts, I_C = 60 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.604	-179	8.203	92.9	.040	60.9	.242	-112.0
1000	.614	167	4.730	80.5	.084	63.6	.189	-139.1
1500	.631	156	3.220	69.9	.091	61.8	.182	-155.9
2000	.655	146	2.480	60.6	.116	59.0	.181	-168.3
2500	.681	135	2.048	51.8	.141	55.8	.182	-172.5
3000	.697	125	1.778	43.3	.166	51.9	.190	-174.3
3500	.721	116	1.573	34.8	.189	47.9	.204	170.8
4000	.758	107	1.430	26.8	.211	43.9	.217	164.7
4500	.798	97	1.325	19.3	.232	40 0	.234	158.5
5000	.843	88	1.255	11.4	.254	36.2	.253	152.9
5500	.883	79	1.190	3.3	.279	32.4	.278	146.6
6000	.922	69	1.125	-5.2	.298	27.6	.300	138.4

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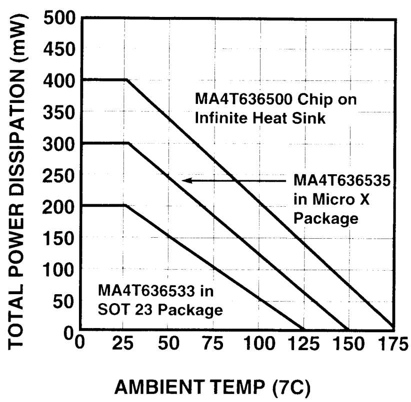
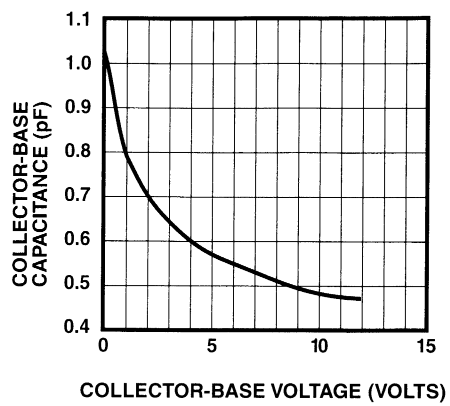
MA4T6365
Typical Performance Curves

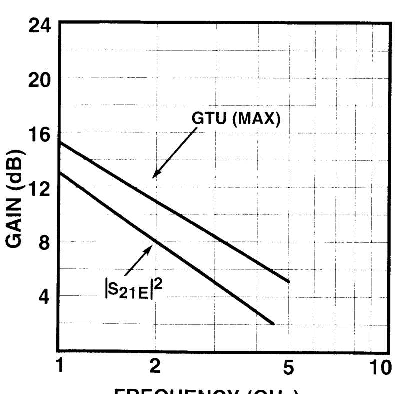
POWER DERATING CURVES



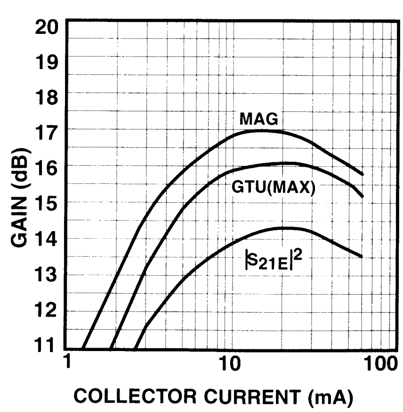
NOMINAL COLLECTOR-BASE CAPACITANCE (C_{OB})
COLLECTOR-BASE VOLTAGE (MA4T636535)



NOMINAL GAIN vs FREQUENCY AT
V_{CE} = 3 VOLTS, I_C = 10 mA (MA4T6356535)



NOMINAL GAIN vs COLLECTOR CURRENT AT
F = 1.0 GHz, V_{CE} = 3 VOLTS (MA4T636535)



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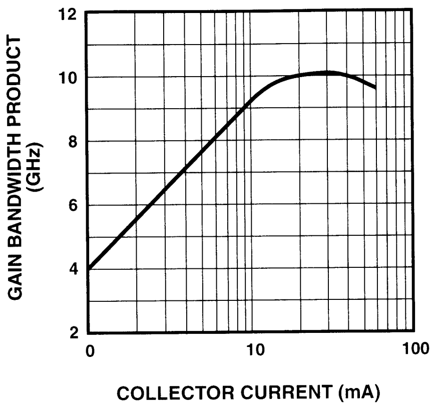
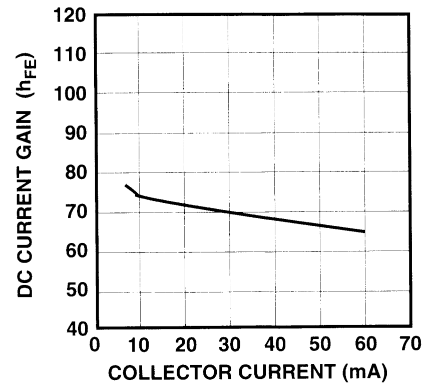
Typical Performance Curves

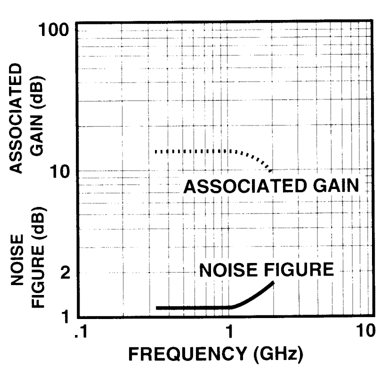
NOMINAL GAIN BANDWIDTH PRODUCT (f_T) vs COLLECTOR CURRENT AT V_{CE} = 3 VOLTS (MA4T636535)



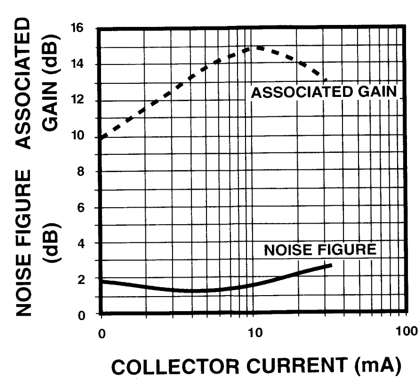
NOMINAL DC CURRENT GAIN (h_{FE}) vs COLLECTOR CURRENT AT V_{CE} = 3 VOLTS (MA4T636535)



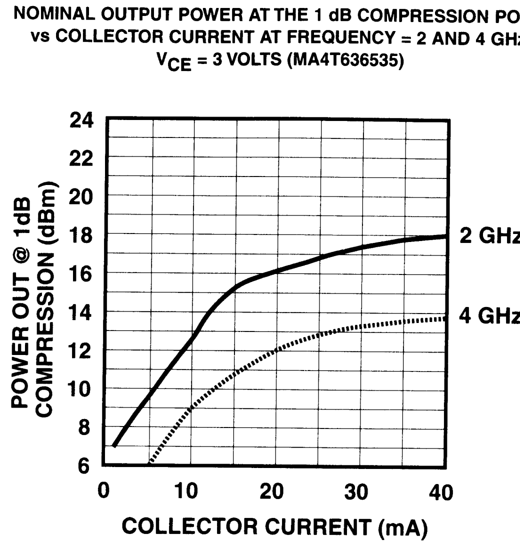
NOMINAL NOISE FIGURE AND ASSOCIATED GAIN vs FREQUENCY AT V_{CE} = 3 VOLTS, COLLECTOR CURRENT = 5 mA (MA4T636535)



NOMINAL NOISE FIGURE AND ASSOCIATED GAIN AT V_{CE} = 3 VOLTS, AND 1 GHz vs THE COLLECTOR CURRENT (MA4T636535)

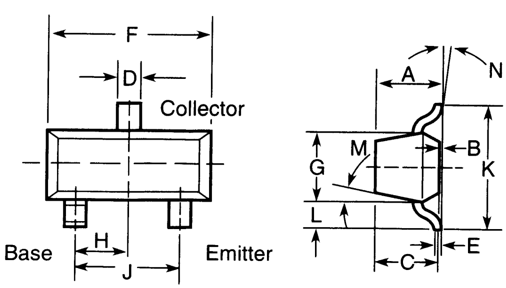


Typical Performance Curves (Con't)



Case Styles

SOT-23 - MA4T636533



MA4T636533

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K		0.103		2.60
L		0.024		0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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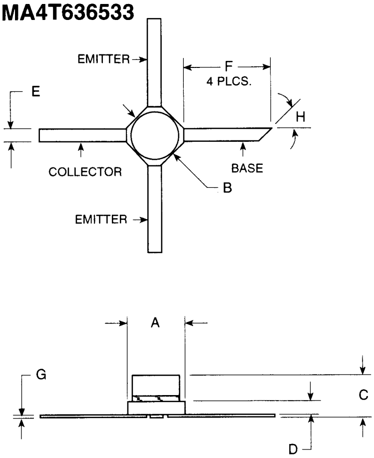
Case Styles (Con't)

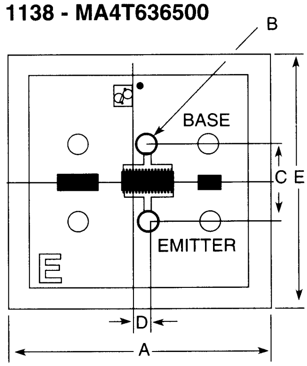
Micro-X - MA4T636533



MA4T636535

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.46	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

Case Style 1138 - MA4T636500

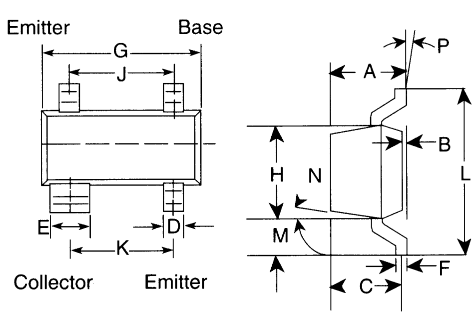


F = chip thickness

MA4T636500

DIM.	INCHES	MILLIMETERS
A	0.013	0.325
B (Dia.) 2 plcs.	0.0012	0.030
C	0.004	0.110
D	0.0005	0.013
E	0.013	0.325
F	0.0045	0.114

Case Style SOT-143 - MA4T636539



MA4T636539

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0.044	—	1.10
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.030	0.035	0.75	0.90
E	0.013	0.020	0.35	0.50
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 typical		1.90 typical	
K	0.040 typical		1.70 typical	
L		0.103		2.60
M		0.024		0.60

DIM.	GRADIENT
N	10° max.[1]
P	2°...30°

Note:
1. Applicable on all sides

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an AMP company

Silicon Bipolar High f_T Low Noise Microwave Transistors

MA4T645 Series

V 2.00

Features

- f_T to 9 GHz
- Low Noise Figure
- High Associated Gain
- Hermetic and Surface Mount Packages Available
- Can be Screened to JANTX, JANTXV Equivalent Levels
- Industry Standard

Description

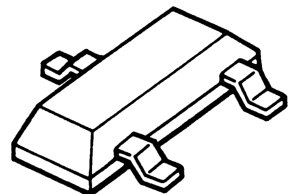
The MA4T645 family of high gain-bandwidth, small signal silicon bipolar transistors is well suited for use in amplifiers to approximately 4 GHz, and in oscillators to approximately 10 GHz. These industry standard transistors feature low noise figure at high collector current, which produces very good associated gain and wide dynamic range. The MA4T645 series transistors are available in a hermetic microstrip package (MA4T64535), in the plastic SOT-23 package (MA4T64533), in chip form (MA4T64500), and in the SOT-143 package (MA4T64539). The MA4T645 series is available in other plastic and hermetic packages as well. The chip and hermetically packaged transistors can be screened to a JANTXV equivalent level.

Applications

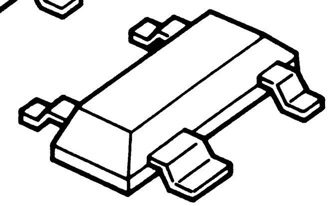
The MA4T645 family of bipolar NPN transistors can be used for low noise, high associated gain, large dynamic range amplifiers up to approximately 4 GHz. These transistors can also be used as preamplifier or driver stages in the same frequency range.

The MA4T645 family of bipolar NPN transistors can also be used for oscillators or VCOs up to approximately 10 GHz. The passivation consists of silicon dioxide, commonly known as thermal oxide, and silicon nitride to produce very low 1/f noise in both amplifiers and oscillators.

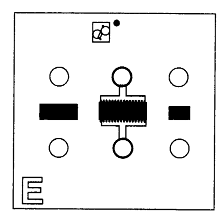
Case Styles



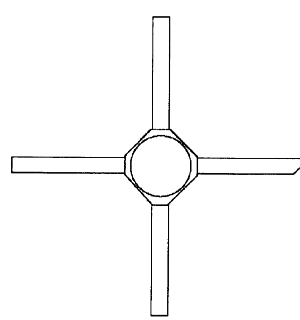
SOT-23



SOT-143



Chip



Micro-X

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Absolute Maximum Ratings
MA4T645 Series

Collector-Base Voltage	V_{CBO}	25 V
Collector-Emitter Voltage	V_{CEO}	12 V
Emitter-Base Voltage	V_{EBO}	1.5 V
Collector Current	I_C	65 mA
Junction Operating Temperature	T_j	200°C
Storage Temperature Chip or ceramic packages Plastic packages		 -65 to +200°C -65 to +125°C
Total Power Dissipation at 25°C Derate Linearly to: +150°C Chip +125°C Plastic Package (SOT-23) +150°C Ceramic Package (Micro-X)		 400 mW 200 mW 300 mW

Electrical Specifications @ 25°C
MA4T645 Series

Parameter of Test	Condition	Symbol	Units	MA4T64500 Chip	MA4T64533 SOT-23	MA4T64535 Micro-X
Gain Band Width Product	V_{CE} = 8 volts I_C = 20mA	f_T	GHz	10 typ	8 typ	9 typ
Insertion Power Gain	V_{CE} = 8 volts I_C = 20 mA f = 1 GHz f = 2 GHz f = 4 GHz	$\|S_{21E}\|^2$	dB	 18 typ 11 min 7 typ	 16 typ 10 min	 17 typ 10 min 6.5 typ
Noise Figure	V_{CE} = 8 volts I_C = 7 mA f = 1 GHz f = 2 GHz	NF	dB	 1.7 max 2.0 typ	 1.7 max 2.5 typ	 1.7 max 2.0 typ
Unilateral Gain	V_{CE} = 8 volts I_C = 7mA f = 1 GHz f = 2 GHz	GTU (max)	dB	 18 typ 11 typ	 16 typ 10 typ	 17 typ 11 typ
Maximum Available Gain	V_{CE} = 8 volts I_C = 10 mA f = 2 GHz f = 4 GHz	MAG	dB	 14 typ 12 typ	 13 typ 10 typ	 14 typ 11.5 typ
Power Out at 1 dB Compression	V_{CE} = 8 volts I_C = 10 mA f = 1 GHz f = 4 GHz	P_{1dB}	dBm	 16 typ 11 typ	 16 typ 11 typ	 16 typ 11 typ

Note:
The electrical characteristics of the MA4T64539 (SOT-143) are very similar to those of the MA4T64533 (SOT-23).

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Electrical Specifications @ 25°C

MA4T645 Series

Parameter	Condition	Symbol	Min	Typical	Max	Unit
Collector Cut-off Current	V_{CB} = 8 volts I_E = 0 µA	I_{CBO}	—	—	100	nA
Emitter Cut-off Current	V_{EB} = 1 volt I_C = 0 µA	I_{EBO}	—	—	1	µA
Forward Current Gain	V_{CE} = 8 volts I_C = 7 mA	h_{FE}	30	125	250	—
Collector-Base Junction Capacitance	V_{CB} = 10 volts I_E = 0 µA f = 1 MHz	C_{CO}	—	0.3	0.6	pF

Typical Scattering Parameters in the Micro-X Package

MA4T64535

V_{CE} = 8 Volts, I_C = 7 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.583	-114	9.315	116.1	.052	43.6	.573	-42.6
1000	.569	-153	5.399	94.7	.063	39.0	.406	-53.0
1500	.573	-173	3.807	82.0	.072	40.0	.357	-57.1
2000	.587	170	2.980	72.0	.082	42.5	.313	-61.8
2500	.598	159	2.479	62.7	.092	44.0	.299	-71.7
3000	.616	150	2.132	54.8	.103	45.2	.304	-78.5
3500	.645	142	1.935	47.0	.118	45.5	.289	-86.5
4000	.675	132	1.782	38.5	.130	45.7	.281	-96.6
4500	.705	124	1.631	29.6	.143	45.5	.292	-105.5
5000	.749	115	1.538	22.0	.159	44.5	.281	-114.1
5500	.791	106	1.445	14.4	.176	43.6	.283	-125.7
6000	.832	96	1.395	6.1	.188	42.3	.306	-135.0

MA4T64535

V_{CE} = 8 Volts, I_C = 10 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.562	-128	10.477	111.9	.044	44.5	.515	-46.2
1000	.564	-161	5.845	92.1	.056	44.0	.358	-53.8
1500	.575	176	4.088	80.5	.068	46.5	.313	-57.2
2000	.592	166	3.185	70.9	.080	49.0	.276	-62.3
2500	.601	156	2.638	62.0	.092	49.7	.268	-71.7
3000	.618	148	2.266	54.5	.105	50.1	.272	-78.3
3500	.648	139	2.053	46.9	.122	49.4	.259	-87.0
4000	.677	130	1.892	38.6	.136	48.7	.253	-96.9
4500	.706	122	1.734	29.8	.150	47.9	.264	-106.0
5000	.749	113	1.634	22.3	.167	46.1	.257	-115.1
5500	.790	104	1.532	14.8	.184	44.4	.259	-126.3
6000	.831	95	1.482	6.4	.196	42.6	.278	-136.0

Specifications Subject to Change Without Notice.

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Typical Scattering Parameters in the Micro-X Package (Con't)
MA4T64535 Series
V_{CE} = 8 Volts, I_C = 20 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.536	-154	11.788	104.0	.033	49.8	.390	-46.8
1000	.565	-177	6.309	87.5	.046	55.7	.284	-53.2
1500	.579	170	4.350	77.0	.062	57.7	.270	-54.6
2000	.592	160	3.368	68.6	.077	59.3	.237	-57.5
2500	.612	151	2.798	60.1	.093	58.0	.226	-70.0
3000	.630	142	2.390	52.6	.108	56.5	.243	-77.2
3500	.660	134	2.156	45.4	.126	54.4	.231	-84.4
4000	.691	125	1.984	37.2	.141	52.6	.223	-95.8
4500	.719	117	1.809	28.4	.155	50.9	.240	-105.2
5000	.760	109	1.697	21.3	.173	48.5	.229	-112.6
5500	.803	101	1.594	13.8	.192	46.0	.229	-112.6
6000	.844	92	1.540	6.0	.210	44.2	.258	-136.2

Typical Scattering Parameters in the SOT-23 Package
MA4T64533
V_{CE} = 8 Volts, I_C = 7 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.421	-95	7.378	126.4	.062	77.9	.519	-36.3
1000	.257	-149	4.384	118.9	.100	97.9	.402	-36.9
1500	.232	-176	3.082	123.3	.140	116.2	.368	-39.6
2000	.238	157	2.408	129.2	.183	130.9	.354	-44.7
2500	.256	140	2.005	136.3	.224	145.7	.346	-51.6
3000	.279	126	1.734	143.2	.274	160.8	.339	-58.8
3500	.310	116	1.498	153.3	.308	172.0	.331	-68.5
4000	.338	106	1.367	163.5	.350	173.6	.320	-80.1
4500	.359	97	1.284	173.8	.402	161.0	.327	-90.6

MA4T64533
V_{CE} = 8 Volts, I_C = 10 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
500	.299	-116	8.385	119.4	.057	82.1	.451	-33.9
1000	.216	-161	4.558	116.9	.099	102.3	.354	-33.2
1500	.215	172	3.185	122.7	.142	119.5	.332	-37.7
2000	.230	151	2.487	129.0	.188	132.9	.332	-44.0
2500	.247	134	2.064	136.4	.230	146.9	.332	-50.1
3000	.267	123	1.783	143.8	.281	161.5	.322	-56.1
3500	.299	114	1.548	153.9	.315	172.5	.310	-66.4
4000	.328	104	1.410	164.0	.357	173.6	.299	-79.2
4500	.352	96	1.320	174.5	.408	161.3	.310	-90.1

Note: The electrical characteristics of the MA4T64539 (SOT-143) are very similar to those of the MA4T64533 (SOT-23).

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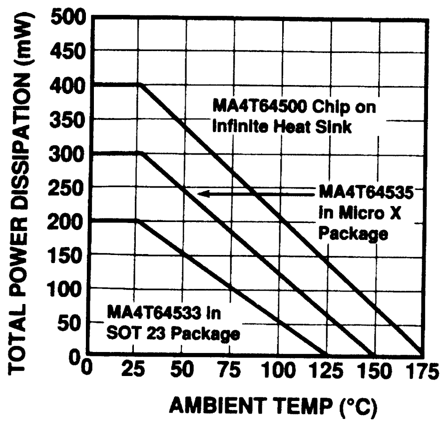
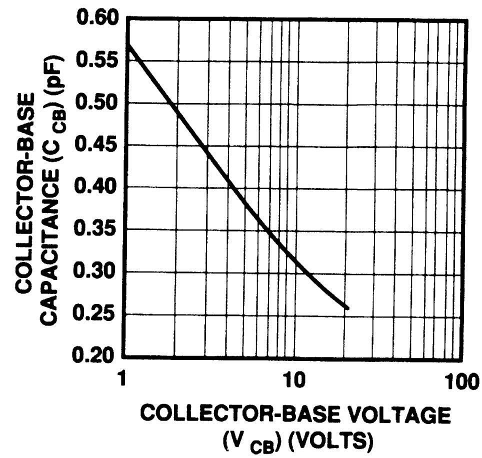
MA4T645 Series
Typical Performance Curves

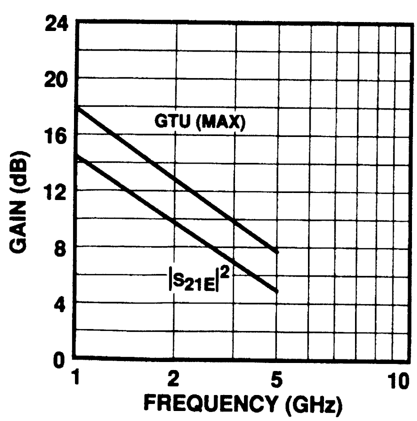
NOMINAL POWER DERATING CURVES



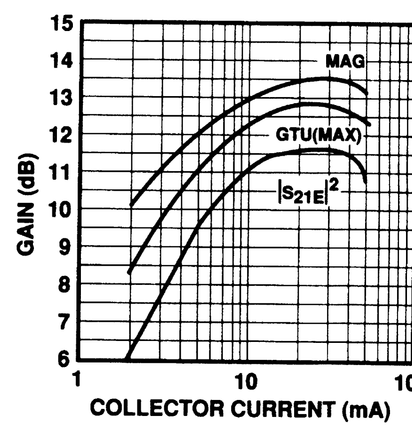
NOMINAL COLLECTOR-BASE CAPACITANCE vs COLLECTOR-BASE VOLTAGE (MA4T64535)



NOMINAL GAIN vs FREQUENCY AT V_{CE} = 8 VOLTS AND I_C = 10 mA (MA4T64535)



NOMINAL GAIN vs COLLECTOR CURRENT AT F = 1.5 GHz AND V_{CE} = 8 VOLTS (MA4T64535)



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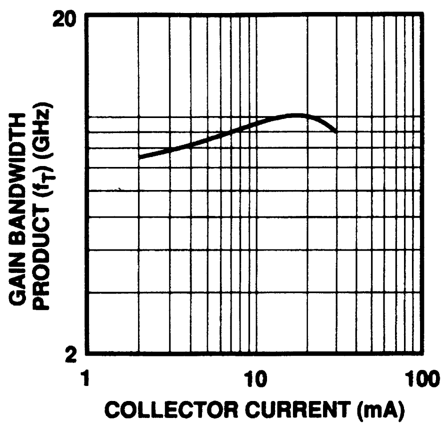
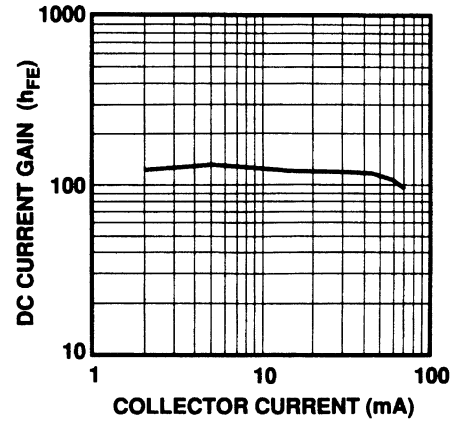
Typical Performance Curves (Con't)

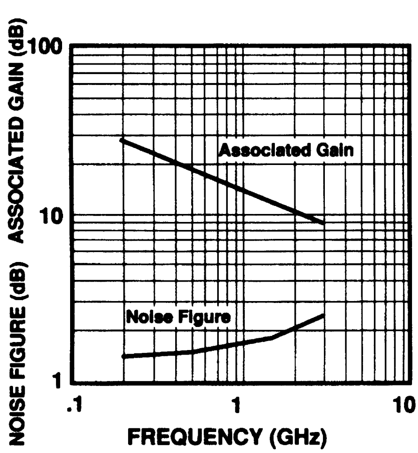
NOMINAL GAIN BANDWIDTH PRODUCT vs COLLECTOR CURRENT (MA4T64535)



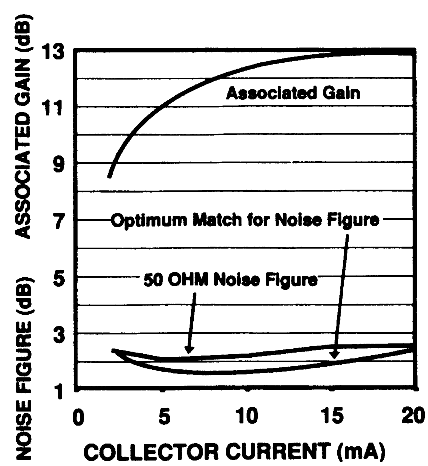
NOMINAL DC CURRENT GAIN vs COLLECTOR CURRENT AT V_{CE} = 8 VOLTS (MA4T64535)



NOMINAL NOISE FIGURE AND ASSOCIATED GAIN vs FREQUENCY AT V_{CE} = 8 VOLTS AND COLLECTOR CURRENT = 7 mA (MA4T64535)

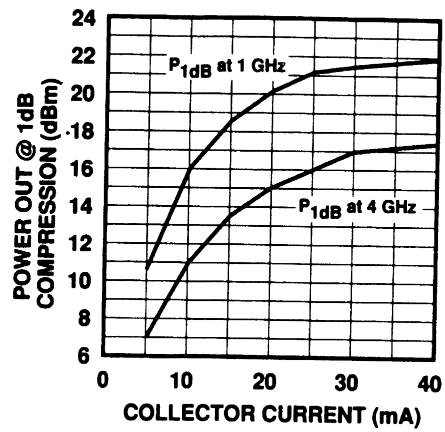


NOMINAL NOISE FIGURE AND ASSOCIATED GAIN vs COLLECTOR CURRENT AT F = 1 GHz AND V_{CE} = 8 VOLTS (MA4T64535)



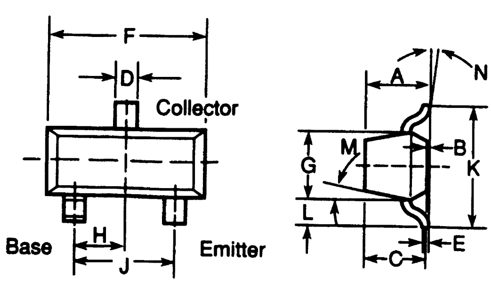
Typical Performance Curves (Con't)

NOMINAL OUTPUT POWER AT THE 1 dB COMPRESSION POINT vs COLLECTOR CURRENT AT FREQUENCY = 1 AND 4 GHz AND V_{CE} = 8 VOLTS (MA4T64535)



Case Styles

MA4T64533
SOT-23



MA4T64533

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K		0.103		2.60
L		0.024		0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

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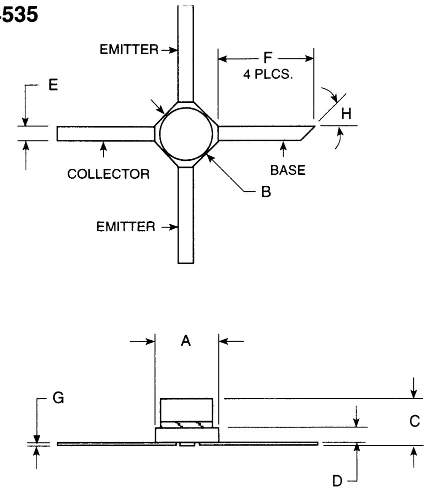
Case Styles (Con't)

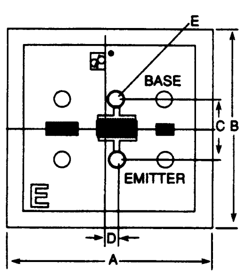
MA4T64535
Micro-X



MA4T64535

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.46	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

MA4T64500
Case Style 1138

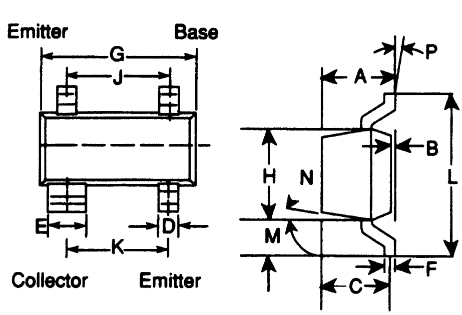


F = chip thickness

MA4T64500

DIM.	INCHES	MILLIMETERS
A	0.013	0.325
B	0.013	0.325
C	0.004	0.110
D	0.0005	0.013
E (Dia.)	0.0012	0.030
F	0.0045	0.114

MA4T64539
SOT-143



MA4T64539

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0 044	—	1.10
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.030	0.035	0.75	0.90
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 typical		1.90 typical	
K	0.040 typical		1.70 typical	
L		0.103		2.6
M		0.024		0.6

DIM.	GRADIENT
N	10º max.[1]
P	2º…30º

Note:
1. Applicable on all sides

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Bipolar High f_T Low Voltage NPN Silicon Transistors

MA4T3243 Series

V 2.00

Features

- Designed for 3-5 Volt Operation
- Useable to 6 GHz in Oscillators
- Useable for Low Noise, Low Voltage Driver Amplifiers Through 3 GHz
- Useful for Class C Amplifiers
- Available as Chips, and in Hermetic and Surface Mount Packages
- Can be Screened to JANTX, JANTXV Equivalent Levels
- Tape and Reel Packaging Available

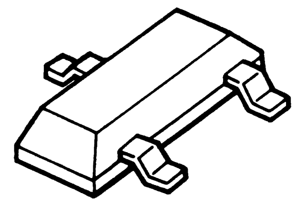
Description

The MA4T3243 series of high fT low voltage NPN medium power silicon bipolar transistors are designed for usage in battery operated systems with 3-5 volt collector bias. They are useful as low phase noise oscillator transistors through 6 GHz and as moderate power driver amplifiers through 3 GHz.

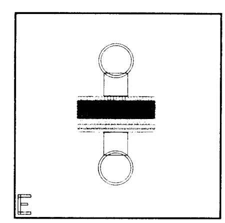
These transistors are available as a chip for hybrid oscillators or in ceramic packages for military or commercial usage. Both the chip and hermetic packages can be screened to JANTXV equivalent levels.

These transistors use M/A-COM's high temperature gold. platinum, titanium metalization with silicon dioxide and silicon nitride passivation. The chip is emitter balasted with polysilicon resistors to prevent current concentration at high current operation.

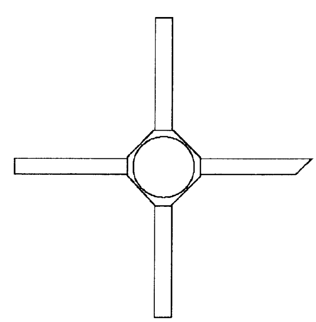
Case Styles



SOT-23



Chip



Micro-X

Maximum Ratings

Parameter	Symbol	Unit	MA4T324300 Chip	MA4T324333 SOT-23	MA4T324335 Micro-X
Collector-Base Voltage[1]	V_{CBO}	Volts	8	8	8
Collector-Emitter Voltage[1]	V_{CE}	Volts	6	6	6
Emitter-Base Voltage[1]	V_{EB}	Volts	1.5	1.5	1.5
Collector Current[1]	I_C	mA	110	110	110
Junction Temperature	T_j	°C	200	125	200
Storage Temperature	T_{STG}	°C	-65 to +175°C	-65 to +125°C	-65 to +175°C
Power Dissipation[1,3]	P_T	mW	600	250	400
Operating Temperature[2]	T_{cp}	°C	150	125	150

Note:
1. At 25°C case temperature (packaged transistors) or 25°C mounting surface temperature (chip transistors).
2. Case or bonding surface temperature. Derate maximum power dissipation rating to zero watts at maximum operating temperature.
3. The thermal resistance of the MA4T324300 junction/case is 50°C/watt nominal.

Electrical Specifications @ 25°C

Parameter	Condition	Symbol	Units	MA4T324300 Chip	MA4T324333 SOT-23	MA4T324335 Micro-X
Gain Bandwidth Product	V_{CE} = 3 volts I_C = 50 mA	f_T	GHz	6 typ	6 typ	6 typ
Insertion Power Gain	V_{CE} = 3 volts I_C = 40 mA f = 1 GHz f = 2 GHz	$\|S_{21E}\|^2$	dB	7 min 3 typ	6 min 2.5 typ	7 min 3 typ
Noise Figure	V_{CE} = 3 volts I_C = 10 mA f = 1 GHz	NF	dB	2.2 max	2.4 max	2.2 max
Unilateral Gain	V_{CE} = 3 volts I_C = 40 mA f = 1 GHz f = 2 GHz	GTU (max)	dB	10 typ 6 typ	9 typ 4 typ	10 typ 6 typ
Maximum Available Gain	V_{CE} = 3 volts I_C = 40 mA f = 2 GHz	MAG	dB	8.5 typ	7 typ	8.5 typ
Power Out at 1 dB Compression	V_{CE} = 3 volts I_C = 50 mA f = 2 GHz f = 3 GHz	P_{1dB}	dBm	20 typ 15 typ	19 typ 15 typ	20 typ 15 typ

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Electrical Specifications @ 25°C
MA4T243 Series

Parameter	Condition	Symbol	Min	Typical	Max	Units
Collector Cut-off Current	V_{CB} = 4 Volts I_E = 0 µA	I_{CBO}	—	—	10	µA
Emitter Cut-off Current	V_{EB} = 1 Volt I_C = 0 µA	I_{EBO}	—	—	1	µA
Forward Current Gain	V_{CE} = 3 Volts I_C = 20 mA	h_{FE}	20	125	250	—
Collector Base Junction Capacitance	V_{CB} = 3 Volts I_E = 0 µA f = 1 MHz	C_{OB}	—	0.8	1.0	pF

Typical Scattering Parameters in the Micro-X Package
MA4T324335
V_{CE} = 3 Volts, I_C = 10 mA

Frequency	S_{11E}		S_{21E}		S_{12E}		S_{22E}	
(MHz)	Mag	Angle	Mag	Angle	Mag	Angle	Mag	Angle
1000	0.647	172	2.480	73.2	0.137	51.4	0.311	-165.8
2000	0.666	149	1.408	51.2	0.225	49.0	0.365	172.5
3000	0.694	128	1.135	34.1	0.336	43.8	0.366	156.0
4000	0.714	109	1.005	17.3	0.427	32.1	0.412	142.1
5000	0.748	90	0.948	4.0	0 507	22.8	0.453	127.2
6000	0.772	70	0.930	-9.1	0.605	11.8	0.499	111.9

MA4T324335
V_{CE} = 3 Volts, I_C = 20 mA

Frequency	S_{11E}		S_{21E}		S_{12E}		S_{22E}	
(MHz)	Mag	Angle	Mag	Angle	Mag	Angle	Mag	Angle
1000	0.661	168	2.632	73.3	1 0.137	60.8	0.373	178.5
2000	0.677	146	1.493	53.1	0.238	53.0	0.421	161.3
3000	0.697	125	1.210	36.5	0.359	44.8	0.415	144.6
4000	0.715	107	1.067	19.3	0.451	31.0	0.450	130.3
5000	0.744	89	1.007	5.4	0.525	20.7	0.480	115.5
6000	0.762	69	0.990	-8.5	0.619	9.1	0.510	101.6

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Typical Scattering Parameters in the Micro-X Package (Con't)

MA4T324335

V_{CE} = 3 Volts, I_C = 40 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
1000	0.675	164	2.678	73.3	0.139	66.2	0.424	176.6
2000	0.692	143	1.528	54.1	0.244	55.0	0.470	158.6
3000	0.707	121	1.230	37.7	0.368	45 9	0.455	141.6
4000	0.719	104	1.095	20.8	0.463	31.5	0.481	128.1
5000	0.749	86	1.035	6.5	0.537	20.4	0.504	113.3
6000	0.763	66	1.017	-7.8	0.629	8.4	0.523	99.2

MA4T324335

V_{CE} = 3 Volts, I_C = 60 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
1000	0.685	164	2.678	73.1	0.140	68.1	0.446	173.9
2000	0.698	143	1.528	54.2	0.251	56.1	0.492	156.8
3000	0.719	122	1.245	37.7	0.380	45.6	0.480	139.4
4000	0.727	104	1.103	20.7	0.474	31.0	0.502	125.4
5000	0.754	86	1.045	6.5	0.549	19.8	0.520	110.6
6000	0.767	67	1.025	-7.9	0.641	7.4	0.540	96.0

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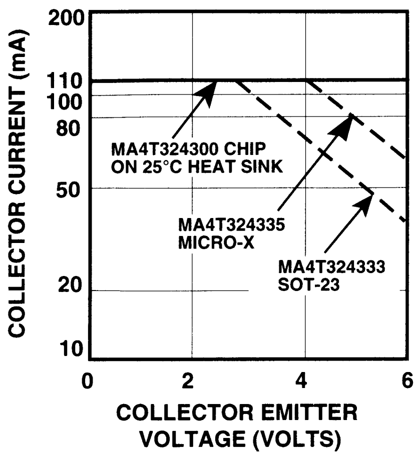
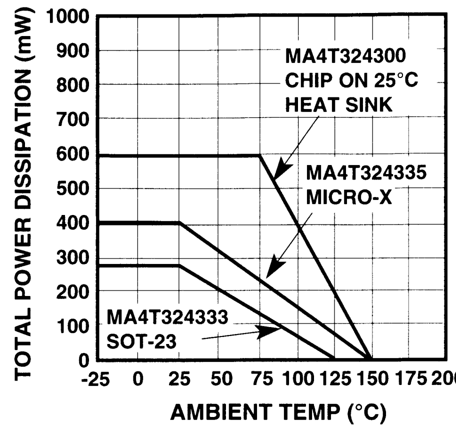
MA4T3243 Series
Typical Performance Curves

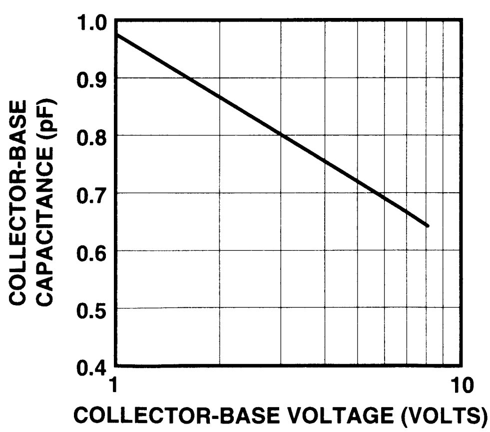
DC SAFE OPERATING RANGE AT 25°C



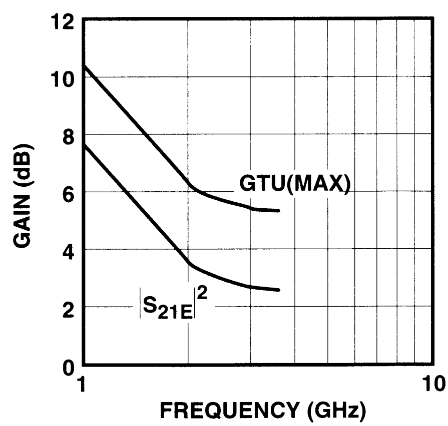
NOMINAL POWER DERATING CURVES



NOMINAL COLLECTOR-BASE CAPACITANCE (C_{OB}) vs COLLECTOR-BASE VOLTAGE (MA4T324335)



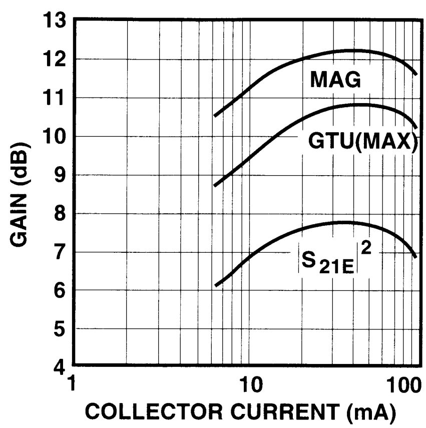
NOMINAL GAIN vs FREQUENCY AT V_{CE} = 3 VOLTS AND I_C = 20 mA (MA4T324335)



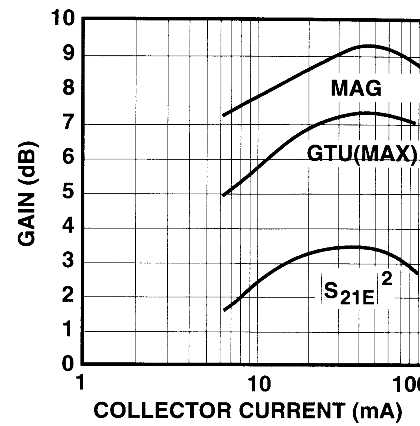
V 2.00

Typical Performance Curves (Con't)

NOMINAL GAIN vs COLLECTOR CURRENT AT F = 1 GHz AND V_{CE} = 3 VOLTS (MA4T32433)

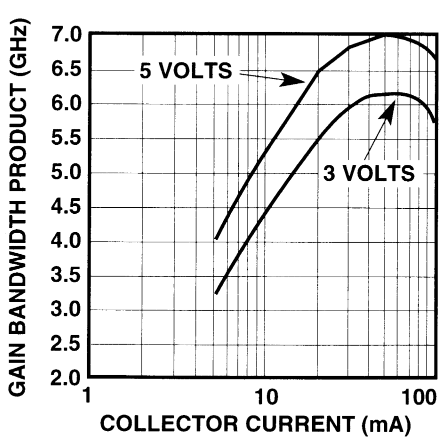


NOMINAL GAIN vs COLLECTOR CURRENT AT F = 2 GHz AND V_{CE} = 3 VOLTS (MA4T324335)

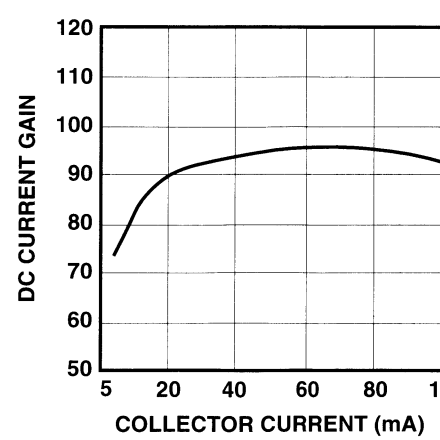


CE

NOMINAL GAIN BANDWIDTH PRODUCT (f_T) vs THE COLLECTOR CURRENT AT V_{CE} = 3 AND 5 VOLTS (MA4T324335)



NOMINAL DC CURRENT GAIN (h_{FE}) vs COLLECTOR CURRENT AT V_{CE} = 3 VOLTS (MA4T324335)



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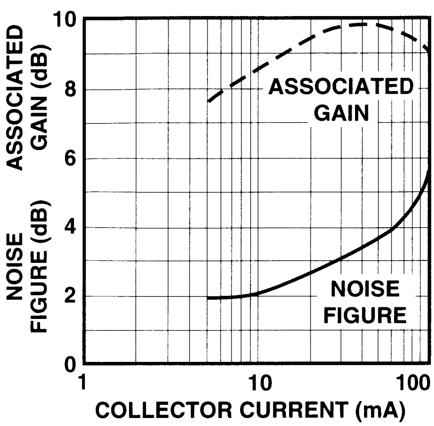
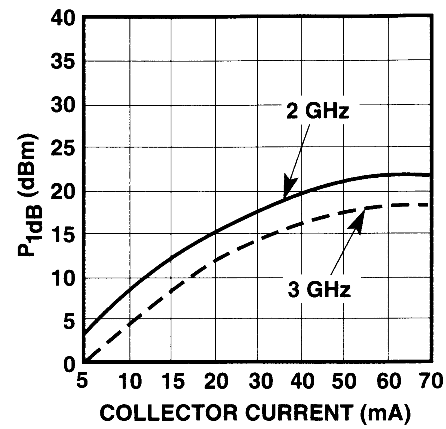
Typical Performance Curves (Con't)

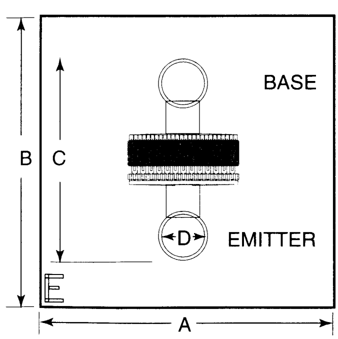
NOMINAL NOISE FIGURE AND ASSOCIATED GAIN AT 1 GHz AT V_{CE} = 3 VOLTS AND COLLECTOR CURRENT IN mA (MA4T324335)



NOMINAL OUTPUT POWER AT THE 1 dB COMPRESSION POINT vs COLLECTOR CURRENT AT FREQUENCY = 2 AND 3 GHZ, V_{CE} = 3 VOLTS (MA4T324335)



Case Style
MA4T324300
Case Style 1168

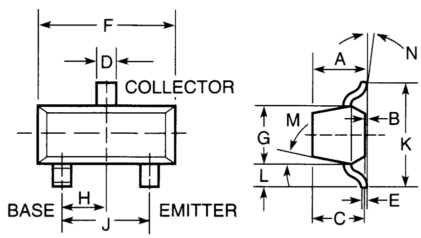


MA4T324300

NOMINAL DIM.	INCHES	MILLIMETERS
A	0.013	0.325
B	0.013	0.325
C	0.005	0.25
D (Dia.)	0.002	0.030
E (Chip Thickness)	0.0045	0.114

Case Styles (Con't)

MA4T324333
SOT-23



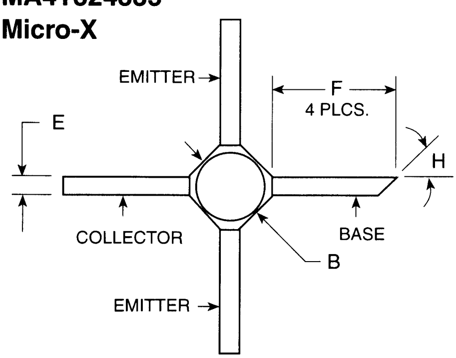
MA4T324333

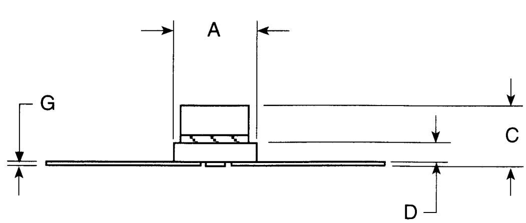
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1 00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 typical		0.95 typical	
J	0.075 typical		1.90 typical	
K		0.103		2.60
L		0.024		0.60

DIM.	GRADIENT
M	10° max.[1]
N	2°...30°

Note:
1. Applicable on all sides

MA4T324335
Micro-X





MA4T324335

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.46	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

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Silicon Bipolar High f_T Low Noise Medium Power 12 Volt Transistors

MA4T243 Series

V 2.00

Features

- Low Phase Noise Oscillator Transistor
- 200 mW Driver Amplifier Transistor
- Operation to 8 GHz
- Available as Chip
- Available in Hermetic Surface Mount Packages

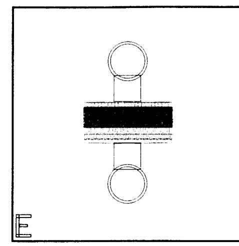
Description

The MA4T24300 series of high f_T NPN medium power bipolar transistors are designed for usage in oscillators to 8 GHz and for moderate power driver amplifiers through 3 GHz with noise figure below 4 dB.

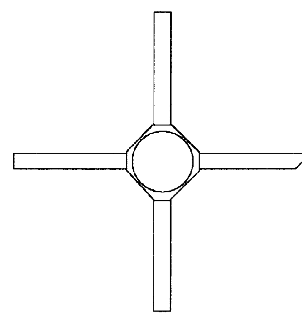
This industry standard transistor is available as a chip for hybrid oscillator circuits or in hermetic ceramic packages for military usage. The chip and hermetic packages may be screened to JANTXV equivalent levels.

The MA4T243 transistors utilize sub-micron photolithography and locos oxidation techniques to minimize parasitic capacitances. It also reduces shot noise enabling improved low noise characteristics. These transistors use a M/A-COM proprietary high temperature refractory barrier/gold metalization process. The MA4T243 transistor is emitter ballasted using ion implanted polysilicon resistors to prevent emitter current hot spots at high current operation.

Case Styles



Chip



Micro-X

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Maximum Ratings

Parameter	Symbol	Unit	MA4T24300 Chip	MA4T2435 Micro-X
Collector-Base Voltage[1]	V_{CBO}	Volts	25	25
Collector-Emitter Voltage[1]	V_{CEO}	Volts	12	12
Emitter-Base Voltage[1]	V_{EBO}	Volts	1.5	1.5
Collector Current[1]	I_C	mA	110	110
Junction Temperature	T_j	°C	200	200
Storage Temperature	T_{STG}	°C	-65 to +200	-65 to +200
Power Dissipation [1,3]	P_T	mW	1000	400
Operating Temperature[2]	T_{cp}	°C	150	150

Note:
1. At 25°C case temperature (packaged transistors) or 25°C mounting surface temperature (chip transistors).
2. Case or bonding surface temperature. Derate maximum power dissipation rating to zero watts at maximum operating temperature.
3. The thermal resistance of the MA4T24300 junction/case is 50°C/watt nominal.

Electrical Specifications @ 25°C

Parameter	Condition	Symbol	Units	MA4T24300 Chip	MA4T24335 Micro-X
Gain Bandwidth Product	V_{CE} = 12 volts I_C = 40 mA	f_T	GHz	7 typ	7 typ
Insertion Power Gain	V_{CE} = 12 volts I_C = 40 mA f = 1 GHz f = 2 GHz	$\|S_{21E}\|^2$	dB	12 min 8 typ	11 min 8 typ
Noise Figure	V_{CE} = 12 volts I_C = 20 mA f = 1 GHz	NF	dB	3 typ	3 typ
Unilateral Gain	V_{CE} = 12 volts I_C = 40 mA f = 2 GHz	GTU (max)	aB	11 typ	10.5 typ
Maximum Available Gain	V_{CE} = 12 volts I_C = 40 mA f = 2 GHz	MAG	dB	15 typ	15 typ
Power Out at 1 dB Compression	V_{CE} = 12 volts I_C = 40 mA f = 1 GHz f = 2 GHz	P_{1dB}	dBm	24 typ 22 typ	24 typ 22 typ

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MA4T243 Series
Electrical Specifications @ 25°C

Parameter	Condition	Symbol	Min	Typical	Max	Units
Collector Cut-off Current	V_{CB} = 15 Volts I_E = 0 μA	I_{CBO}	—	—	10	μA
Emitter Cut-off Current	V_{EB} = 1 Volt I_C = 0 μA	I_{EBO}	—	—	1	μA
Forward Current Gain	V_{CE} = 8 Volts I_C = 50 mA	h_{FE}	20	90	250	—
Collector Base Junction Capacitance	V_{CB} = 10 Volts I_E = 0 μA f = 1 MHZ	C_{CB}	—	0.60	0.08	pF

MA4T24335
Typical Scattering Parameters in the Micro-X Package
V_{CE} = 12 Volts, I_C = 10 mA

Frequency	S_{11E}		S_{21E}		S_{12E}		S_{22E}	
(MHz)	Mag	Angle	Mag	Angle	Mag	Angle	Mag	Angle
1000	0.598	-157	3.610	84.4	0.114	27.6	0.378	-73.4
2000	0.612	177	2.373	64.6	0.127	27.3	0.286	-90.7
3000	0.549	153	1.658	44.2	0.146	29.4	0.253	-113.2
4000	0.709	133	1.355	26.1	0.173	30.9	0.269	-138.5
5000	0.794	115	1.182	9.1	0.207	30.2	0.314	-162.2
6000	0.899	96	1.063	-7.4	0.246	27.1	0.367	170.8
7000	1.013	75	0.973	-24.0	0.296	21.5	0.439	157.0
8000	1.108	53	0.878	-41.0	0.360	13.4	0.559	135.6
9000	1.161	30	0.773	-58.8	0.438	2.5	0.757	116.4
10000	1.161	13	0.677	-73.2	0.500	9.2	0.949	103.4
11000	1.161	13	0.677	-73.2	0.500	9.4	0.949	103.6

MA4T24335
V_{CE} = 12 Volts, I_C = 20 mA

Frequency	S_{11E}		S_{21E}		S_{12E}		S_{22E}	
(MHz)	Mag	Angle	Mag	Angle	Mag	Angle	Mag	Angle
1000	0.574	-153	4.51	90.3	0.103	32.1	0.33	-78.0
2000	0.591	170	2.433	64.3	0.126	30.1	0.239	-100.4
3000	0.635	147	1.777	45.3	0.15	32.9	0.205	-126.2
4000	0.696	128	1.465	27.5	0.181	32.1	0.217	-151.3
5000	0.788	110	1.298	11.1	0.215	29.4	0.262	-169.0
6000	0.89	51	1.18	-5.3	0.246	25.8	0.301	-167.7
7000	1.018	72	1.09	-23.1	0.285	19.6	0.366	156.2
8000	1.106	50	1.00	-40.9	0.347	12.1	0.457	134.3
9000	1.165	27	0.875	-60.0	0.399	6.3	0.625	115.1
10000	1.147	6	0.723	-79.5	0.485	13.5	0.847	101.7
11000	1.147	6	0.723	-79.5	0.485	13.5	0.847	101.7

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Typical Scattering Parameters in the Micro-X Package (Con't)
MA4T24335
V_{CE} = 12 Volts, I_C = 40 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
1000	0.571	-164	4.410	88.2	0.092	35.3	0.282	-83.2
2000	0.603	166	2.533	65.6	0.118	35.2	0.196	-105.6
3000	0.650	141	1.875	44.5	0.146	35.2	0.176	-127.1
4000	0.701	123	1.485	27.0	0.178	33.4	0.183	-147.4
5000	0.788	104	1.305	10.2	0.210	31.2	0.216	-169.0
6000	0.879	86	1.163	-6.0	0.247	26.3	0.255	171.8
7000	0.982	66	1.065	-23.1	0.290	21.4	0.317	153.6
8000	1.057	46	0.932	-40.8	0.333	14.6	0.391	135.8
9000	1.101	25	0.815	-57.8	0.389	5.8	0.502	116.6
10000	1.097	5	0.675	-76.6	0.450	-8.5	0.656	96.7

MA4T24335
V_{CE} = 12 Volts, I_C = 60 mA

Frequency (MHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
1000	0.577	-168	4.055	86.4	0.084	35.1	0.268	-72.9
2000	0.608	165	2.330	64.7	0.111	37.7	0.200	-88.8
3000	0.652	140	1.728	44.4	0.140	38.0	0.185	-108.3
4000	0.701	123	1.382	27.1	0.171	36.5	0.192	-127.9
5000	0.786	105	1.215	10.6	0.204	34.6	0.218	-147.4
6000	0.874	86	1.085	-5.6	0.242	29.8	0.254	-160.4
7000	0.972	67	0.990	-22.0	0.288	5.0	0.320	-161.7
8000	1.045	46	0.873	-39 4	0.334	18.1	0.396	145.7
9000	1.086	25	0.760	-55.6	0.394	9.7	0.508	125.8
10000	1.084	7	0.638	-73.3	0.462	-4.7	0.668	105.7

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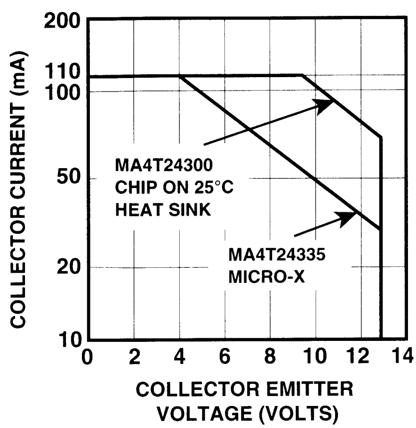
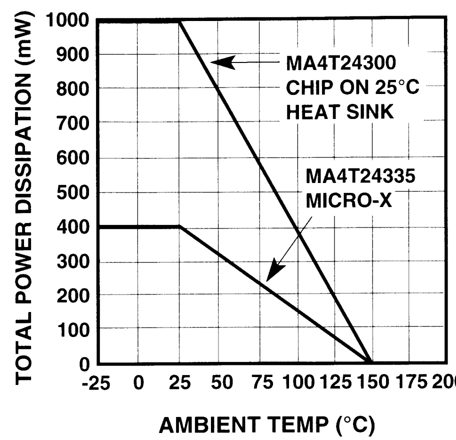
Typical Performance Curves

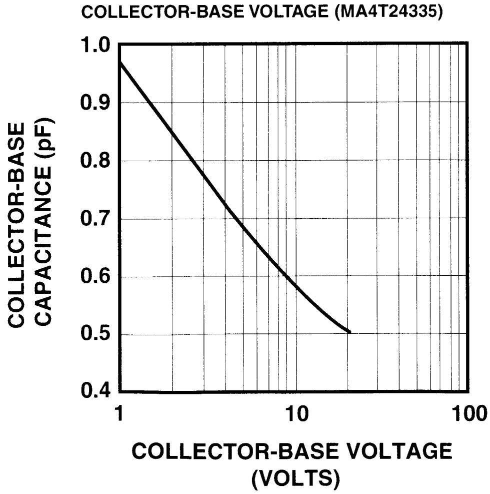
DC SAFE OPERATING RANGE AT 25°C



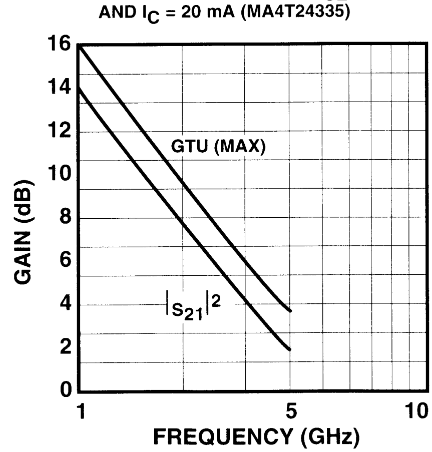
POWER DERATING CURVES



NOMINAL COLLECTOR-BASE CAPACITANCE vs COLLECTOR-BASE VOLTAGE (MA4T24335)



NOMINAL GAIN vs FREQUENCY AT V_{CE} = 12 VOLTS AND I_C = 20 mA (MA4T24335)



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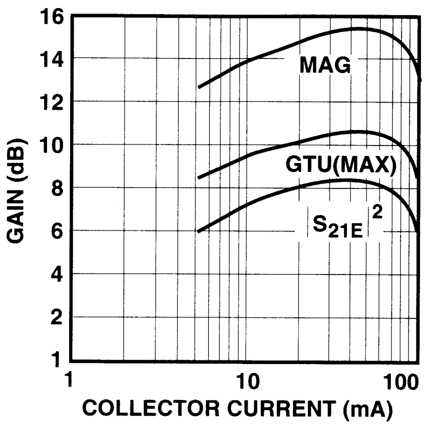
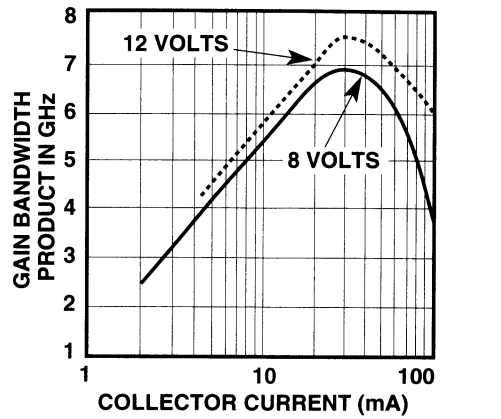
Typical Performance Curves (Con't)

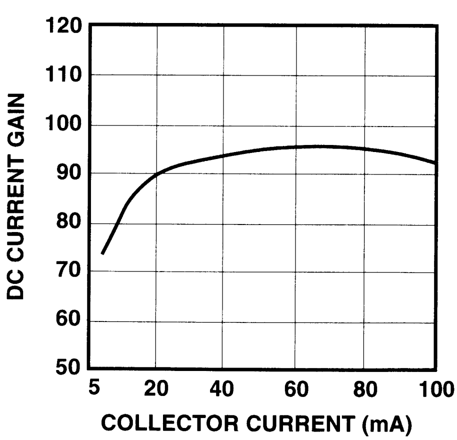
NOMINAL GAIN vs COLLECTOR CURRENT AT F = 2 GHz AND V_{CE} = 12 VOLTS (MA4T24335)



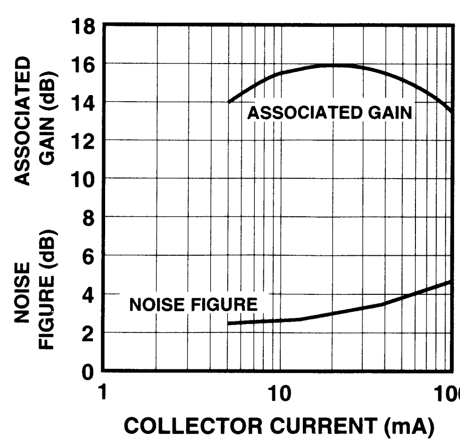
NOMINAL GAIN BANDWIDTH PRODUCT (f_T) vs COLLECTOR CURRENT AT V_{CE} = 8 AND 12 VOLTS (MA4T24335)



NOMINAL DC CURRENT GAIN (h_{FE}) vs COLLECTOR CURRENT AT V_{CE} = 8 VOLTS (MA4T24335)



NOMINAL NOISE FIGURE AND ASSOCIATED GAIN vs COLLECTOR CURRENT AT 1 GHz AND V_{CE} = 12 VOLTS (MA4T24335)



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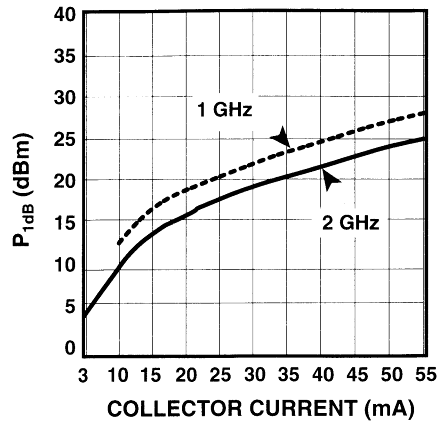
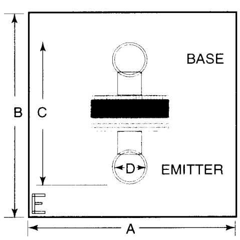
Typical Performance Curves (Con't)

NOMINAL OUTPUT POWER AT THE 1 dB COMPRESSION POINT
vs COLLECTOR CURRENT AT
F = 1 AND 2 GHz, V_{CE} = 8 VOLTS (MA4T24335)



Case Styles

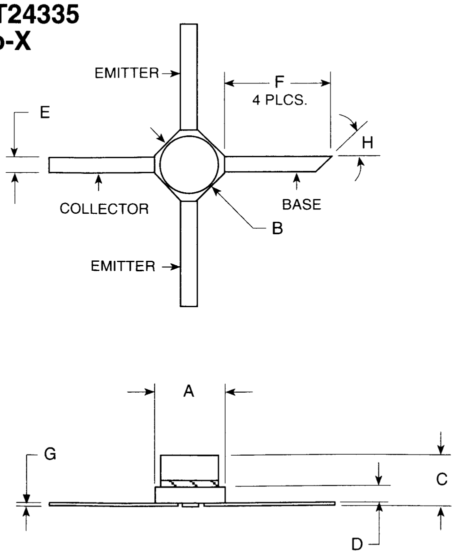
MA4T24300
Case Style 1168



MA4T24300

NOMINAL DIM.	INCHES	MILLIMETERS
A	0.013	0.325
B	0.013	0.325
C	0.007	0.18
D (Dia.)	0.002	0.030
E (Chip Thickness)	0.0045	0.114

MA4T24335
Micro-X



MA4T24335

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.092	0.108	2.34	2.74
B	0.079	0.087	2.01	2.21
C	—	0.070	—	1.78
D	0.019	0.025	0.48	0.64
E	0.018	0.022	0.46	0.56
F	0.150	—	3.81	—
G	0.003	0.006	0.08	0.15
H	45°		45°	

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M/A-COM
an AMP company

General Purpose Low Noise Bipolar Transistors

V 2.00

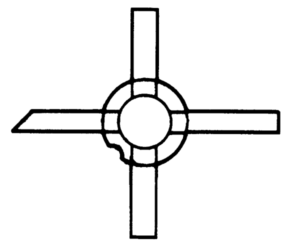
Features

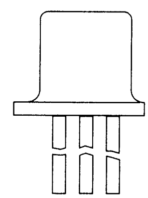
- Low Noise Through 1.5 GHz
- Hermetic Package
- Can Be Screened to JAN, JANTX, JANTXV Levels

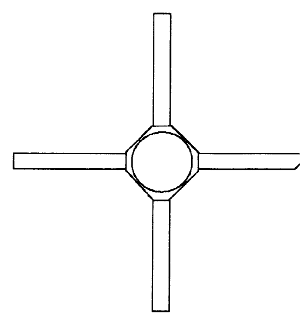
Description

The series of Silicon NPN bipolar transistors are designed for low noise amplifiers in the frequency range of 60 MHz through 2 GHz. These devices are offered in several different families with different f_T, gain and dynamic range characteristics. They are offered in hermetic, RF packages and as chips. Also offered are a family of low power, high f_T oscillator transistors useful in applications up to 3 GHz.

Case Styles



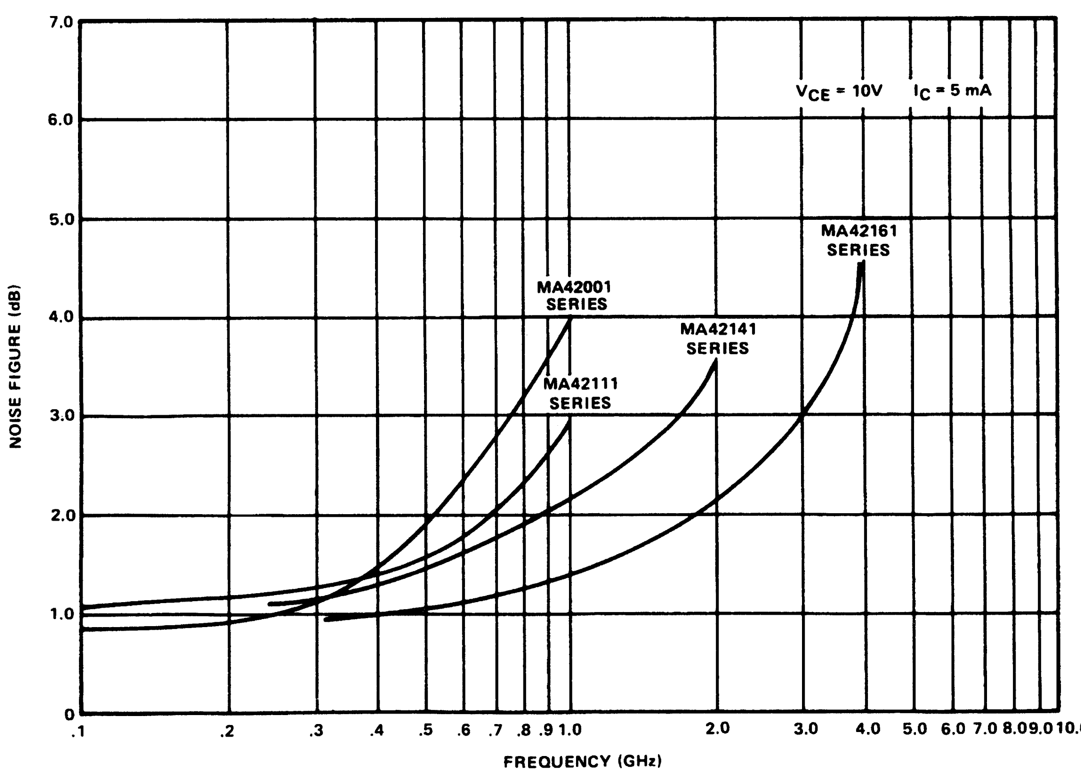




Selection Guide

Model No. Series	Geometry	Nominal f_T (GHz)	Nominal Optimum Noise Figure at Current (mA)	Nominal Current Range	I_C (Max.) (mA)	Useful Frequency Range (MHz)
MA42161	72	7.0	3	0.5 - 7.0	20	500 - 2500
MA42111	60	5.5	5	3.0 - 20.0	125	100 - 1500
MA42141	63	4.5	3	1.0 - 10.0	50	300 - 2000
MA42151	63	4.5	3	1.0 - 10.0	50	300 - 2000
MA42001	60	2.5	5	5.0 - 40.0	125	10 - 750
MA42021	20	1.8	1	1.0 - 3.0	40	10 - 600
MA42051	55	1.8	2	1.0 - 5.0	50	10 - 600
MA42121	70	1.5	1	0.9 - 3.0	80	10 - 600
MA42181	02	2.8	20	10.0 - 60.0	300	10 - 1600

Typical Performance Curves



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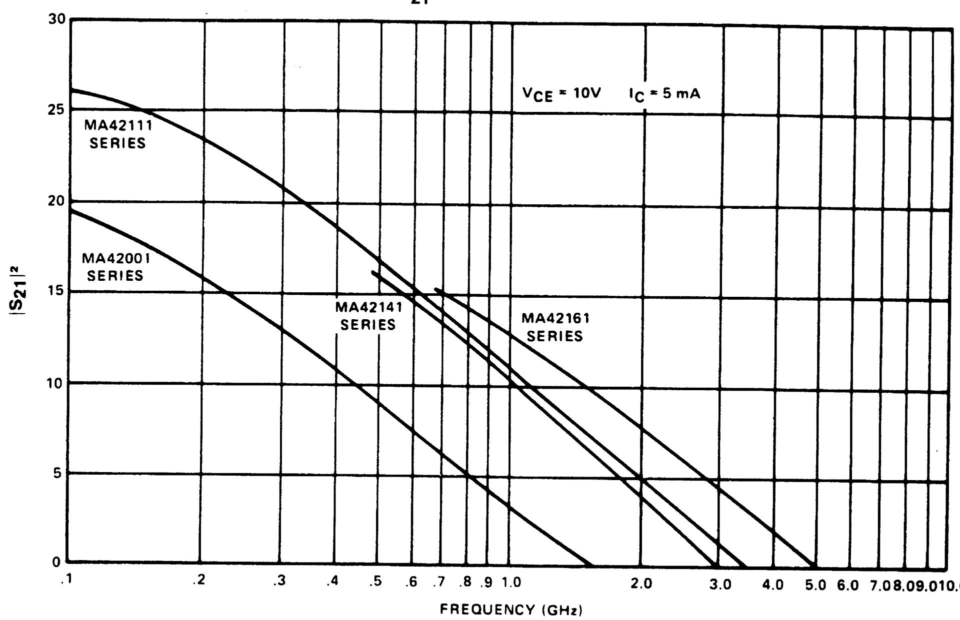
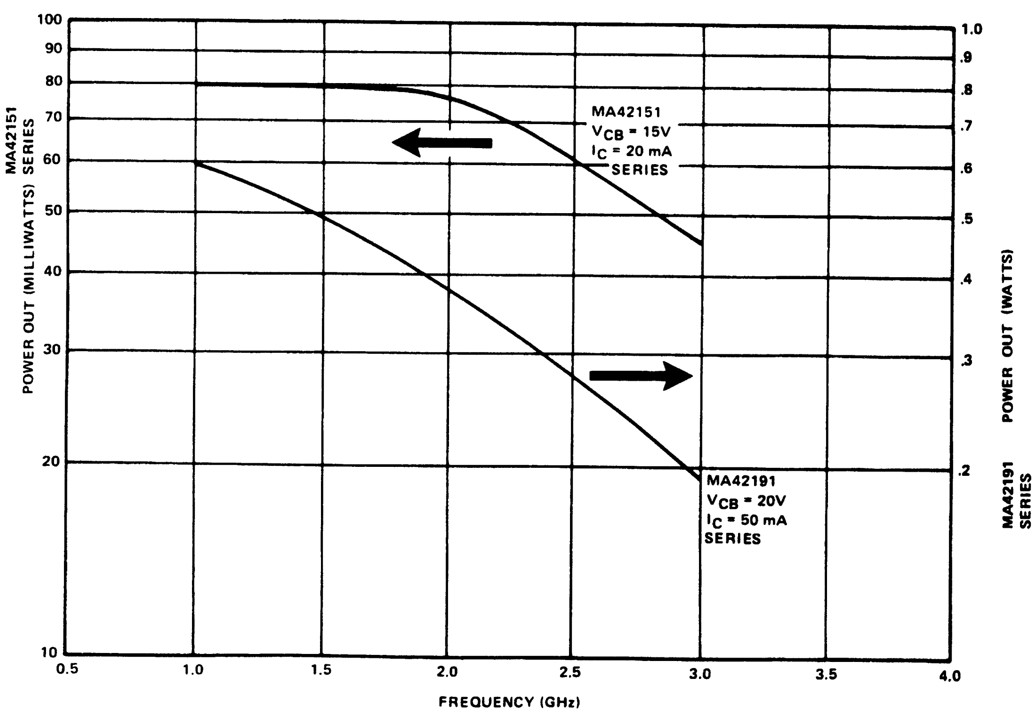
Typical Performance Curves (Cont'd)

$|S_{21}|^2$ VS. FREQUENCY



COMMON-BASE POWER OUT VS. FREQUENCY



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MA42161 Series

Description

- Nominal f_T = 7 GHz
- Nominal Current Range = 0.5 to 7 mA
- I_C Max. = 20 mA
- Frequency Range = 500 MHz to 2 GHz

The MA42161 is a low noise silicon planar epitaxial transistor for 0.5 to 2.0 GHz amplifiers. These transistors have typically 14.0 dB gain at 2.0 GHz and nominal noise figure of 2.3 dB at 2.0 GHz. These transistors when housed in case style 511, are useful in low level oscillators from 1-5 GHz.

Maximum Ratings @ 25° C

MA42161 Series

Parameter	Symbol	Unit	MA42161
Collector-Base Voltage	V_{CBO}	Volts	20
Collector-Emitter Voltage	V_{CEO}	Volts	12
Emitter-Base Voltage	V_{EBO}	Volts	1.5
Collector Current	I_C	mA	20
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation (Case Style 511)	P_D	mW	250

Specifications @ T_A =25°C

Model[1,4] Number	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum[2] Unilateral Gain (dB)	Nominal[2] $\lvert S_{21E}\rvert^2$ (dB)	Nominal[2] Gain @ Optimum Noise Figure (dB)
MA42161	2.0	2.5	12	8.0	11.0
MA42161	1.0	1.5	18	12.5	15.0

Notes:
1. 1 dB compression point is -5 dBM.
2. Test conditions I_C = 3 mA, V_{CE} = 10 volts.
3. The nominal collector to emitter sustaining voltage is 12 volts; I_C = 1.0 mA.
4. Available in case styles 511 and Micro-X. To order, add package as suffix to the model number i.e., MA42161-511.

Electrical Specifications @ 25° C

MA42161 Series

Parameter	Condition	Symbol	Min.	Typical	Max.	Unit
Collector Cut-off Current	V_{CB} = 10 V I_E = 0 µA	I_{CBO}	—	—	200	nA
Emitter Cut-off Current	V_{EB} = 1 V I_C = 0 µA	I_{EBO}	—	—	1.0	µA
Forward Current Gain	V_{CE} = 10 V I_C = 5 mA	H_{FE}	50	80	250	—
Collector-Base Junction Capacitance	V_{CB} = 5 V f = 1 MHz	C_{OB}	—	1.0	1.2	pF

Specifications Subject to Change Without Notice.

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MA42141 Series

Description

- Nominal f_T = 4.5 GHz
- Nominal Current Range = 1 to 10 mA
- I_C Max. = 50 mA
- Frequency Range = 300 MHz to 2.0 GHz
- Geometry = 63

The MA42141 NPN silicon planar transistor features excellent high frequency current gain at medium current levels.

The MA42141 series has low noise figures from the frequency range of 0.5 to 2 GHz. These transistors are useful in RF amplifiers and low level oscillators from 100 MHz to 2 GHz.

Maximum Ratings @ 25° C

MA42141 Series

Parameter	Symbol	Unit	MA42141
Collector-Base Voltage	V_{CBO}	Volts	27
Collector-Emitter Voltage	V_{CEO}	Volts	20
Emitter-Base Voltage	V_{EBO}	Volts	3
Collector Current	I_C	mA	50
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation	P_D	mW	
Case Style 509			400
Case Style 510			700
Case Style 511			700

Specifications @ T_A = 25°C

Model[1] Number	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum Unilateral Gain (dB)	Nominal BV_{ebo} (Volts)
MA42141	1.00	2.5	17	1.5

Notes:
1. MA42141 is available in case styles 509, 510 and 511. To order, add the case style as a suffix to the basic model number, i.e.: MA42141-510.
2. The collector current = 5 mA.

Electrical Specifications @ 25° C

Parameter	Condition	Symbol	Min.	Typical	Max.	Unit
Collector Cut-off Current	V_{CB} = 10 V I_E = 0 µA	I_{CBO}	—	—	200	nA
Emitter Cut-off Current	V_{EB} = 1 V I_C = 0 µA	I_{EBO}	—	—	1.0	µA
Forward Current Gain	V_{CE} = 10 V I_C = 5 mA	H_{FE}	20	80	200	—
Collector-Base Junction Capacitance	V_{CB} = 5 V f = 1 MHz	C_{OB}	—	0.8	1.0	pF

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MA42111 Series
Description

- Nominal f_T = 5.5 GHz
- Nominal Current Range = 3 to 20 mA
- I_C Max. = 125 mA
- Frequency Range = 100 MHz to 1.5 GHz

The MA42111 series of silicon NPN bipolar transistors is designed to give low noise figure and wide dynamic range. They can be used as low power oscillators to 4 GHz.

Maximum Ratings @ 25° C
MA42111 Series

Parameter	Symbol	Unit	MA42111
Collector-Base Voltage	V_{CBO}	Volts	20
Collector-Emitter Voltage	V_{CEO}	Volts	15
Emitter-Base Voltage	V_{EBO}	Volts	2.5
Collector Current	I_C	mA	125
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation	P_D	mW	
Case Style 509			450
Case Style 510			1200
Case Style 511			750

Specifications @ T_A = 25°C

Model Number	Case Style	Test Frequency (MHz)	Maximum[1] Noise Figure (dB @ mA)	Maximum[2] Unilateral Gain (dB)	Minimum[3] $\lvert S_{21E}\rvert^2$	Nominal Gain @ Opt. NF (dB)
MA42111-509	509	450	1.5	14	13.0	13
MA42111-510	510	450	1.5	17	15.5	15
MA42111-511	511	450	1.5	19	16.0	15

Notes:
1. The maximum noise figure is measured as follows:
   V_{CE} = 10 volts
   I_C = 5 mA
   Frequency = 450 MHz.
2. For the maximum unilateral gain, 1 dB compression point is equal to 0 dBm.
3. Minimum $\lvert S_{21E}\rvert^2$ is: V_{CE} = 10 volts, I_C = 20 mA, and the frequency = 450 MHz.
4. The maximum collector cutoff current is 10 µA, where V_{CB} = 10 volts.

Electrical Specifications @ 25° C
MA42111 Series

Parameter	Condition	Symbol	Min.	Typical	Max.	Unit
Collector Cut-off Current	V_{CB} = 10 V, I_E = 0 µA	I_{CBO}	—	10	100	nA
Emitter Cut-off Current	V_{EB} = 1 V, I_C = 0 µA	I_{EBO}	—	—	1.0	µA
Forward Current Gain	V_{CE} = 15 V, I_C = 5 mA	H_{FE}	20	120	300	—
Collector-Base Junction Capacitance	V_{CB} = 5 V, f = 1 MHz	C_{OB}	—	1.0	1.2	pF

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V 2.00

MA42001-509 and 2N6665-509

Description

- Nominal f_T = 2.5 GHz
- Nominal Current Range = 5 to 40 mA
- I_C Max. = 125 mA
- Frequency Range = 10 MHz to 750 GHz

This series of NPN silicon bipolar transistors is designed to provide low noise figures at frequencies from 10 to 750 MHz. These transistors have flat noise figures from ~2 to 20 mA collector current. This series is recommended for applications such as IF and RF amplifiers from 10 to 750 MHz where wider dynamic range is required.

Maximum Ratings @ 25° C MA42001 Series

Parameter	Symbol	Unit	MA42001
Collector-Base Voltage	V_{CBO}	Volts	20
Collector-Emitter Voltage	V_{CEO}	Volts	15
Emitter-Base Voltage	V_{EBO}	Volts	2.5
Collector Current	I_C	mA	125
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation	P_D	mW	
Case Style 509			450
Case Style 510			1200
Case Style 511			750

Specifications @ T_A = 25°C

Model Number	Case Style	Test Frequency (MHz)	Maximum[1] Noise Figure (dB @ mA)	Maximum[2] Unilateral Gain (dB)	Maximum[4] cbo (nA)	Minimum[2] BV_{cbo} (Volts)	Minimum[3] BV_{ebo} (Volts)
2N6665-509	509	60	1.0 @ 5.0	28	10	20	2.5
MA42001-509	509	60	1.0 @ 5.0	28	10	20	2.5

Notes:
1. V_{CE} = 10 Volts.
2. Collector current = 10 µA.
3. Emitter current = 10 A.

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MA42021 and 2N Series

Description

- Nominal f_T = 1.8 GHz
- Nominal Current Range = 1 to 5 mA
- I_C Max = 50 mA
- Frequency = 10 MHz to 600 MHz

This series of NPN silicon planar transistors, packaged in the 509 case style are useful for low noise, high gain amplifiers from 10 to 600 MHz. All these transistors have gold metallization resulting in a rugged, highly reliable transistor.

Specifications @ T_A = 25°C

Model[1] Number	Test Frequency (MHz)	Maximum[4] Noise Figure (dB @ mA)	Maximum Unilateral Gain (dB)	Minimum[5] BV_{cbo} (Volts)	Minimum[6] BV_{ebo} (Volts)
MA42021	60	1.6 @ 1.5	23	30	2.5
2N5031	450	2.5 @ 1.0	10	30	2.5
2N3570	450	2.5 @ 1.5	10	30	2.5
2N3953	450	3.0 @ 1.0	10	30	2.5
2N5032	450	3.0 @ 1.0	10	30	2.5
2N3880	450	3.5 @ 1.5	10	30	2.5
2N3839	450	3.9 @ 1.5	10	30	2.5
2N3571	450	4.0 @ 2.0	10	30	2.5
2N5054	450	4.0 @ 2.0	10	30	2.5
2N3683	450	4.5 @ 1.5	10	30	2.5
2N2857*	450	4.5 @ 1.5	10	30	2.5
2N5179	450	4.5 @ 2.0	10	30	2.5
2N5053	450	5.0 @ 2.0	10	30	2.5
2N3572	450	6.0 @ 2.0	10	30	2.5

* This transistor can be screened to JAN level screening.

Notes:
1. This series of NPN silicon planar transistors is packaged in case style 509.
2. Maximum collector cutoff current is 10 µA, where V_{CB} = 15 volts.
3. The nominal current transfer ratio is 120 where V_{CE} = 1 volt, and I_C = 3 mA.
4. V_{CE} = 6 volts.
5. I_C = 1 µA.
6. I_E = 10 µA.

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MA42051 Series
Description

- Nominal f_T = 1.8 GHz
- Nominal Current Range = 1 to 5 mA
- I_C Max. = 40 mA
- Frequency Range = 10 MHz to 600 GHz

The MA42051 series of NPN silicon planar transistors will give high gain and low noise figure characteristics in VHF amplifier applications. This transistor is recommended for low power oscillators from 100 MHz to 1 GHz.

Maximum Ratings @ 25° C
MA42051 Series

Parameter	Symbol	Unit	MA42051
Collector-Base Voltage	V_{CBO}	Volts	20
Collector-Emitter Voltage	V_{CEO}	Volts	15
Emitter-Base Voltage	V_{EBO}	Volts	2.5
Collector Current	I_C	mA	40
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation	P_D	mW	
Case Style 509			300
Case Style 510			450
Case Style 511			350

Specifications @ T_A = 25°C

Model[1] Number	Test Frequency (MHz)	Maximum[3] Noise Figure (dB @ mA)	Maximum[4] Unilateral Gain (dB)	Minimum[5] BV_{cbo} (Volts)	Minimum BV_{ebo} (Volts)
MA42051	450	2.2 @ 3.0	18	20	2.5

Notes:
1. MA42051 is available in the 509, 510, 511 case styles. When ordering, specify the desired case style as a suffix to the basic mode number, i.e., MA42051-510.
2. I_C = 10 μA.
3. I_E = 10 μA.
4. V_{CE} = 1 Volt; I_C = 3 mA; Nominal current transfer ratio = 75.
5. V_{CB} = 10 Volts; Maximum collector current = 40 mA.

MA42121 Series

Description

- Nominal f_T = 1.5 GHz
- Nominal Current Range = 0.4 to 3 mA
- I_C Max. = 80 mA
- Frequency = 100 to 600 MHz

This series of NPN epitaxial silicon planar transistors is designed for 100 MHz to 1 GHz amplifiers and low power oscillators up to 4 GHz. The MA42121 has the maximum frequency of oscillation of 4.2 GHz. Two case styles are offered, case style 508 for low power oscillator applications and case style 509 for small signal IF and RF amplifiers.

Maximum Ratings @ 25° C

MA42121 Series

Parameter	Symbol	Unit	MA42121
Collector-Base Voltage	V_{CBO}	Volts	30
Collector-Emitter Voltage	V_{CEO}	Volts	30
Emitter-Base Voltage	V_{EBO}	Volts	4.0
Collector Current	I_C	mA	80
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation	P_D	W	
Case Style 508			1.0
Case Style 509			0.5

Specifications @ TA = 25°C

Model[1] Number	Case[1] Style	Maximum[2] Unilateral Gain Gu(dB)	Minimum[4] Gain Bandwidth f_T (GHz)	Maximum[4] Available Gain GA(dB)	Maximum[3,5] Frequency Oscillation (GHz)
MA42121	508	13	1.3	12.8	4.2

Notes:

1. Available in case styles 508 and 509. When ordering, specify the package, by adding the case style as a suffix to the basic model number, i.e MA42121-508.
2. The test frequency is 450 MHz.
3. V_{CE} = 10 volts, I_C = 20 mA, Frequency = 500 MHz.
4. V_{CE} = 10 volts, I_C = 20 mA, Frequency = 1 GHz.
5. The maximum frequency of oscillation is calculated from S-parameters, Fmax is the frequency at which the extrapolated Ga (max) is 0 dB.
6. I_C = 10 μA, I_E = 0.

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MA42151 and MA42191 Series

Description

- Nominal f_T = 4.5 GHz
- Nominal Current Range = 1 to 10 mA
- I_C Max. = 100 mA
- Frequency = 300 MHz to 2.0 GHz

These NPN planar transistors are characterized for local oscillator use in to 1.0 to 3.0 GHz range. The MA42151 when mounted in a common base package (case style 510) exhibits a typical Fmax of 9.5 GHz at 20 mA collector current. The MA42191 in case style 510 exhibits a typical Fmax of 6.0 GHz at 50 mA collector current. This transistor is also available in the hermetically sealed case style 511 stripline package.

Maximum Ratings @ 25° C
MA42151 and MA42191 Series

Parameter	Symbol	Unit	MA42151	MA42191
Collector-Base Voltage	V_{CBO}	Volts	27	30
Collector-Emitter Voltage	V_{CEO}	Volts	25	20
Emitter-Base Voltage	V_{EBO}	Volts	1.5	3.5
Collector Current	I_C	mA	50	300
Junction Operating Temperature	T_j	°C	-65 to +150	-65 to +150
Storage Temperature	T_S	°C	-65 to +200	-65 to +200
Power Dissipation (Case Style 510)	P_D	mW	700	30

Specifications @ T_A = 25°C

Model[1] Number	Minimum[2] BV_{cbo} (Volts)	Minimum[3] BV_{ebo} (Volts)	Minimum[4] BV_{ceo} (Volts)	Minimum[5] Oscillator Power (mW)	Collector Current (mA)	Nominal Current Transfer Ratio (hFe)
MA42151	27	1.5	20	20	50	60
MA42191	30	3.5	25	350	300	40

Notes:
1. The standard case style for the MA42151 and MA42191 is case style 510. The MA42151 is also available in the hermetically sealed 511 stripline package; to order, add the case style as a suffix to the basic model number, i.e. MA42151-511.
2. I_C = 10 µA for MA42151; I_C = 100 µA for MA42191.
3. I_E = 10 µA.
4. I_C = 500 µA.
5. I_C = 100 µA.

Maximum Ratings @ 25° C
MA42151 and MA42191 Series

Parameter	Symbol	Unit	MA42151	MA42191
Collector-Base Voltage	V_{CBO}	Volts	27	30
Collector-Emitter Voltage	V_{CEO}	Volts	25	20
Emitter-Base Voltage	V_{EBO}	Volts	1.5	3.5
Collector Current	I_C	mA	50	300
Junction Operating Temperature	T_j	°C	-65 to +150	-65 to +150
Storage Temperature	T_S	°C	-65 to +200	-65 to +200
Power Dissipation (Case Style 510)	P_D	mW	700	30

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MA42181-510

Description

- Nominal fT = 2.8 GHz
- Nominal Current Range = 10 to 60 mA
- IC Max. = 300 mA
- Frequency Range = 10 MHz to 1 GHz

The MA42181 transistor is designed for wide dynamic range amplifier applications from 100 MHz to 1 GHz. Other applications include second stage high dynamic range amplifiers and low level oscillators.

Maximum Ratings @ 25° C

MA42181-510

Parameter	Symbol	Unit	MA42181
Collector-Base Voltage	V_{CBO}	Volts	30
Collector-Emitter Voltage	V_{CEO}	Volts	25
Emitter-Base Voltage	V_{EBO}	Volts	35
Collector Current	I_C	mA	300
Junction Operating Temperature	T_j	°C	-65 to +150
Storage Temperature	T_S	°C	-65 to +200
Power Dissipation Case Style 510	P_D	W	 3.0

Specifications @ T_A = 25°C

Model Number	Case Style	Minimum[1] BV_{cbo} (Volts)	Minimum[2] BV_{EBO} (Volts)	Minimum[3] BV_{CEO} (Volts)	1dB[5] Compression Point (P_{1dB})	Maximum[8] Unilateral Gain(dB) (GHz)
MA42181-510	510	30	3.5	25	+25	8.4

Notes:
1. I_C = 100 µA
2. I_E = 10 µA.
3. I_C = 100 µA.
4. Nominal current transfer ratio is 60; V_{CE} = 15 Volts; I_C = 100 mA.
5. V_{CE} = 15 Volts; I_C = 60 mA; ZG = ZL = 500 Ohms; Frequency = 1 GHz.
6. The nominal $|S_{21E}|^2$ is 2.0 dB; V_{CE} = 15 Volts; I_C = 60 mA; Frequency = 2 GHz.
7. The nominal gain at optimum noise figure is 14.5 dB; V_{CE} = 15 Volts; I_C = 60 mA; Frequency = 1 GHz.
8. V_{CE} = 15 Volts; I_C = 60 mA; Frequency = 1 GHz.

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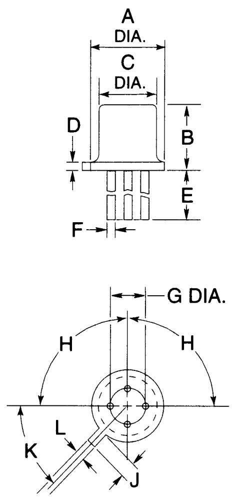
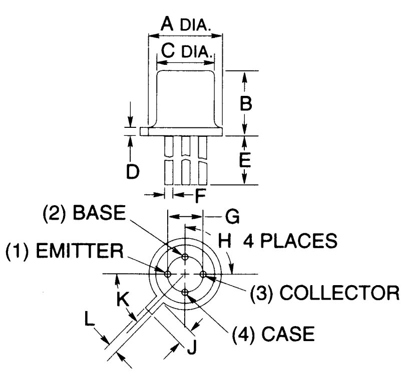
Case Style 508



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.209	0.230	5,31	5,84
B	0.065	0.085	1,65	2,16
C	0.178	0.195	4,52	4,95
D	—	0.030	—	0,76
E	0.500	—	12,70	—
F	0.016	0.021	0,41	0,53
G	0.090	0.110	2,29	2,75
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

Case Style 509



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.209	0.230	5.31	5,84
B	0.170	0.210	4,32	5.33
C	0.178	0.195	4,52	4,95
D	—	0.020	—	0,51
E	0.500	—	12,70	—
F	0.016	0.019	0,41	0,48
G	0.090	0.110	2,29	2,79
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

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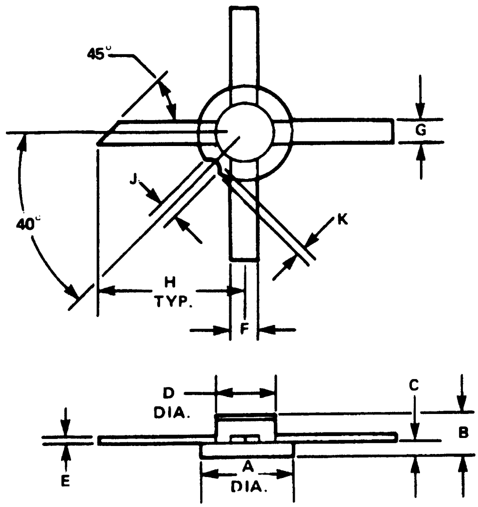
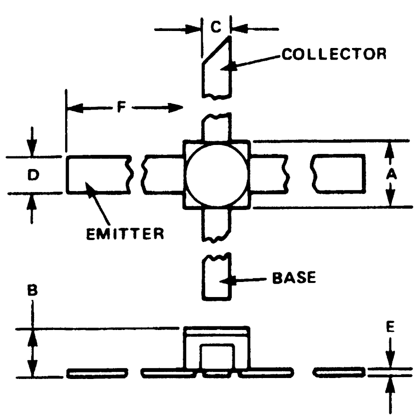
Case Style 510



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.195	0.215	4 95	5 46
B	0.043	0.063	1,09	1,60
C	0.016	0.024	0,41	0,61
D	0.129	0.141	3,28	3,58
E	0.0015	0.0045	0,04	0,11
F	0.054	0.066	1,37	1,68
G	0.024	0.036	0,61	0,91
H	0.279	0.321	7,09	8,15
J	0.030 REF.		0,76 REF.	
K	0.150 REF.		0,38 REF.	

Case Style 511



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.095	0.105	2,41	2,68
B	—	0.050	—	1,27
C	0.016	0.024	0,41	0,61
D	0.036	0.044	0,91	1,12
E	0.002	0.006	0,05	0,15
F	0 190	0.260	4,83	6,60

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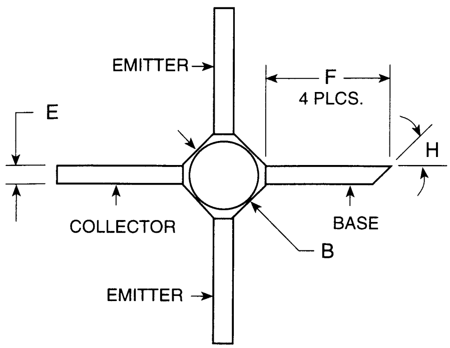
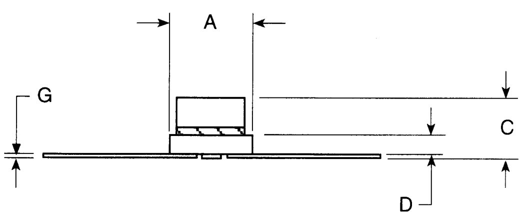
Micro-X



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.092	0.108	2,34	2,74
B	0.079	0.087	2,01	2,21
C	—	0.070	—	1,78
D	0.019	0.025	0.48	0,64
E	0.018	0.022	0,46	0,56
F	0.150	—	3,81	—
G	0.003	0.006	0,08	0,15
H	45°		45°	



an AMP company

General Purpose 0.5 µm N-Type GaAs MESFET Transistors

MA4TF50 Series

V 2.00

Features

- Low Noise Figure
- High Associated Gain
- High Maximum Available Gain
- Designed for Battery Operation
- Useful to Ku-Band

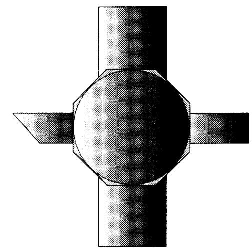
Description

The MA4TF50 is an n-type GaAs depletion mode Metal Semiconductor Field Effect Transistor (MESFET) series with a 0.5 micron gate length and a periphery of 300 microns. The device is available in the ceramic surface mount package, MA4TF5005, and in other hermetically sealed packages. It is also available as a chip, MA4TF5000, with the active region protected by a scratch resistant silicon nitride passivation layer.

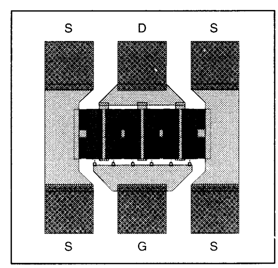
Applications

The MA4TF50 series is intended for low cost commercial applications including low noise microwave amplifiers up to X-band and oscillators up to Ku-band. The low voltage and low current biasing requirement is attractive for battery operation.

Case Styles



1105



Chip

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MA4TF50 Series
Maximum Ratings
(Case Temperature 25°C Unless Otherwise Noted)

Parameter	Symbol	Maximum
Total Power Dissipation of Chip	P_d	300 mW
Total Power Dissipation Ceramic Surface Mount Package	P_d	250 mW
Drain to Source Voltage	V_{DS}	10 V
Gate to Drain Voltage	V_{GDO}	-16 V
Gate to Source Voltage	V_{GSO}	-16 V
Drain Current	I_{DS}	125 mA
Gate Current	I_{GS}	1 mA
Storage Temperature Range	T_S	-65°C to +175°C
Channel Temperature	T_{CH}	+175°C
Lead Temperature	T_L	230°C for 10 seconds

MA4TF5005 (Ceramic Surface Mount Package)
Electrical Specifications @ 25°C

Parameter	Condition	Symbol	Min	Typical	Max	Units
Saturated Drain to Source Current	V_{DS} = 3 V V_{GS} = 0 V	I_{DSS}	30	50	—	mA
Pinch-off Voltage	I_{DS} = 1% I_{DSS}	Vp	-0.5	-1.6	-2.5	V
Transconductance	V_{DS} = 3 V V_{GS} = 0 V	G_m	—	45	—	mS
Gate-Drain Breakdown Voltage	I_G = 10 µA	BV_{GDO}	-7	-14	—	V
Gate-Source Breakdown Voltage	I_G = 10 µA	BV_{GSO}	-7	-14	—	V
Gate-Source Leakage Current	V_{GS} = -5 V	I_{GSO}	—	—	10	µA
Thermal Resistance (Channel to Ambient)	—	R_{TH}	—	200	—	°C/W
Maximum Frequency of Oscillation	V_{DS} = 3 V I_{DS} = 10 mA	f_{MAX}	—	>60	—	GHz
Maximum Available Gain	V_{DS} = 3 V I_{DS} = 30 mA f = 4 GHz	MAG	—	16	—	dB
Optimum Noise Figure	V_{DS} = 3 V I_{DS} = 10 mA f = 4 GHz	NF_O	—	1.0	1.5	dB
Associated Gain	V_{DS} = 3 V I_{DS} = 10 mA f = 4 GHz	G_A	—	11.5	—	dB
Transducer Gain	V_{DS} = 3 V I_{DS} = 30 mA f = 4 GHz	$\|S_{21}\|^2$	4	8	—	dB
Power Output at 1 dB Compression	V_{DS} = 3 V I_{DS} = 30 mA f = 4 GHz	P_{1dB}	—	+16.0	—	dBm

Specifications Subject to Change Without Notice.

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MA4TF5005
Typical Common Source Scattering Parameters in the Ceramic Surface Mount Package
V_{DS} = 3 V, I_{DS} = 10 mA

Frequency (GHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
0.50	1.02	-9.4	2.20	171.2	0.01	83.5	0.73	-6.2
1.00	1.02	-19.0	2.21	162.3	0.02	77.4	0.73	-12.5
1.50	1.01	-28.6	2.26	153.2	0.03	70.4	0.74	-19.5
2.00	0.97	-37.3	2.19	142.8	0.05	62.6	0.74	-25.5
2.50	0.95	-47.6	2.20	133.0	0.06	55.1	0.72	-32.3
3.00	0.93	-57.9	2.19	123.4	0.07	47.8	0.71	-39.1
3.50	0.91	-67.9	2.16	113.7	0.08	40.5	0.69	-45.9
4.00	0.88	-77.7	2.12	104.6	0.08	33.2	0.68	-52.0
4.50	0.86	-87.5	2.08	95.9	0.09	26.0	0.66	-57.8
5.00	0.83	-96.8	2.06	87.4	0.10	19.3	0.64	-63.3
5.50	0.81	-106.2	2.05	79.0	0.10	12.7	0.63	-69.0
6.00	0.78	-115.7	2.04	70.6	0.10	6.3	0.60	-74.7
6.50	0.75	-126.3	2.02	61.8	0.11	-0.3	0.58	-81.2
7.00	0.72	-136.8	2.00	52.7	0.11	-8.0	0.55	-87.6
7.50	0.70	-146.9	1.96	44.5	0.11	-13.6	0.53	-93.2
8.00	0.68	-157.1	1.94	36.4	0.11	-17.6	0.51	-99.1
8.50	0.68	-167.4	1.93	28.0	0.11	-20.9	0.50	-105.8
9.00	0.68	- 177.8	1.90	19.5	0.11	-25.3	0.49	-113.4
9.50	0.67	172.1	1.86	11.2	0.11	-30.2	0.48	-120.8
10.00	0.67	163.2	1.82	3.3	0.11	-34.5	0.47	-128.1
10.50	0.67	153.6	1.78	-4.5	0.11	-38.9	0.46	-136.0
11.00	0.68	144.1	1.75	- 12.6	0.11	-43.4	0.46	-143.8
11.50	0.68	134.5	1.70	-20.8	0.11	47.9	0.45	-152.1
12.00	0.69	125.4	1.66	-29.1	0.11	-52.0	0.44	-160.6
12.50	0.70	116.2	1.61	-37.4	0.10	-55.8	0.44	-169.9
13.00	0.70	107.7	1.55	-45.7	0.10	-59.1	0.43	-179.7
13.50	0.71	99.5	1.49	-53.7	0.10	-61.9	0.43	170.2
14.00	0.72	91.6	1.43	-61.5	0.09	-64.7	0.44	160.6
14.50	0.74	84.5	1.38	-69.0	0.09	-66.1	0.45	151.8
15.00	0.75	77.8	1.33	-76.3	0.09	-67.6	0.47	142.9
15.50	0.76	71.9	1.29	-83.5	0.09	-69.3	0.48	135.0
16.00	0.76	66.4	1.25	-90.6	0.09	-70.4	0.51	126.8
16.50	0.77	60.9	1.22	-97.9	0.09	-72.3	0.54	119.2
17.00	0.78	55.5	1.18	-105.2	0.09	-75.0	0.56	111.7
17.50	0.78	49.5	1.13	-112.6	0.09	-77.6	0.58	104.2
18.00	0.78	44.0	1.07	-119.8	0.09	-80.1	0.60	96.7
18.50	0.78	38.9	1.00	-126.3	0.09	-82.3	0.62	89.7
19.00	0.79	34.6	0.94	-132.5	0.09	-83.8	0.65	83.0
19.50	0.79	30.4	0.88	-138.1	0.09	-85.6	0.67	77.2
20.00	0.80	25.9	0.84	-143.7	0.09	-88.6	0.70	72.4

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MA4TF5005
Typical Common Source Scattering Parameters in the Ceramic Surface Mount Package
V_{DS} = 3 V, I_{DS} = 30 mA

Frequency (GHz)	S_{11E} Mag	S_{11E} Angle	S_{21E} Mag	S_{21E} Angle	S_{12E} Mag	S_{12E} Angle	S_{22E} Mag	S_{22E} Angle
0.50	1.02	-10.9	3.12	170.4	0.01	83.0	0.73	-6.3
1.00	1.01	-22.1	3.15	160.6	0.02	76.3	0.73	-12.7
1.50	1.01	-33.3	3.18	150.6	0.03	69.2	0.73	-19.8
2.00	0.95	-43.4	3.06	139.7	0.04	61.1	0.73	-25.7
2.50	0.93	-55.1	3.04	129.2	0.05	53.4	0.71	-32.3
3.00	0.90	-66.6	2.98	119.1	0.05	46.0	0.69	-39.0
3.50	0.88	-77.7	2.91	109.2	0.06	38.7	0.68	-45.5
4.00	0.85	-88.5	2.82	99.8	0.07	31.8	0.66	-51.3
4.50	0.82	-99.1	2.75	90.8	0.07	24.9	0.64	-56.8
5.00	0.79	-109.4	2.68	82.3	0.07	18.5	0.62	-61.8
5.50	0.76	-119.7	2.63	73.6	0.07	12.5	0.605	-67.0
6.00	0.74	-130.1	2.59	65.2	0.07	6.8	0.58	-72.0
6.50	0.71	-141.5	2.54	56.4	0.08	0.9	0.56	-78.0
7.00	0.68	-152.8	2.47	47.4	0.07	-5.7	0.53	-83.7
7.50	0.66	-163.3	2.40	39.3	0.07	-9.2	0.51	-88.6
8.00	0.65	-173.5	2.36	31.5	0.07	-10.3	0.50	-94.1
8.50	0.65	176.2	2.32	23.3	0.07	-10.7	0.49	-100.4
9.00	0.66	166.0	2.27	15.0	0.07	-13.5	0.48	-107.6
9.50	0.66	156.5	2.21	7.0	0.07	-16.1	0.47	-114.7
10.00	0.66	147.9	2.15	-0.6	0.07	-18.4	0.47	-121.8
10.50	0.67	138.9	2.09	-8.2	0.07	-20.9	0.46	-129.5
11.00	0.68	130.0	2.04	-16.0	0.08	-23.3	0.46	-137.2
11.50	0.69	121.1	1.98	-23.9	0.08	-25.3	0.45	-145.2
12.00	0.70	112.6	1.92	-31.9	0.08	-27.1	0.45	-153.6
12.50	0.71	104.3	1.85	-39.9	0.08	-28.8	0.44	-162.9
13.00	0.72	96.6	1.78	-47.8	0.08	-30.4	0.44	-172.6
13.50	0.74	89.1	1.71	-55.5	0.08	-31.7	0.44	177.3
14.00	0.75	82.0	1.64	-63.1	0.08	-33.7	0.44	167.4
14.50	0.76	75.5	1.58	-70.4	0.09	-35.2	0.45	158.4
15.00	0.77	69.1	1.52	-77.6	0.09	-37.4	0.47	149.2
15.50	0.79	63.5	1.48	-84.7	0.09	-40.0	0.49	141.0
16.00	0.79	58.4	1.44	-91.8	0.10	-43.0	0.52	132.5
16.50	0.80	53.0	1.40	-99.2	0.10	-46.1	0.54	124.6
17.00	0.81	47.7	1.35	-106.5	0.11	-49.8	0.56	116.7
17.50	0.81	41.9	1.30	-113.8	0.11	-53.6	0.59	109.0
18.00	0.81	36.6	1.23	-120.9	0.11	-57.7	0.61	101.0
18.50	0.81	31.8	1.15	-127.5	0.11	-61.0	0.63	93.6
19.00	0.81	27.7	1.08	-133.6	0.11	-63.9	0.65	86.6
19.50	0.82	23.7	1.02	-139.1	0.11	-67.3	0.68	80.4
20.00	0.82	19.5	0.97	-144.8	0.11	-71.1	0.070	75.2

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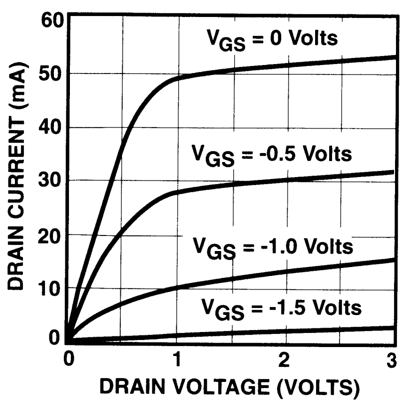
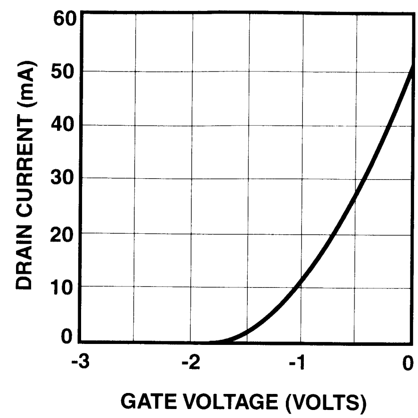
MA4TF50 Series
Typical Performance Curves @ 25°C

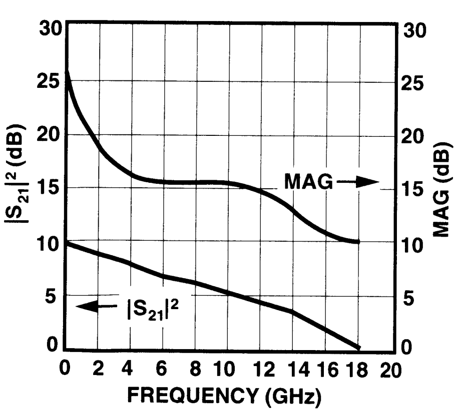
DRAIN CURRENT vs DRAIN VOLTAGE AND V_{GS}



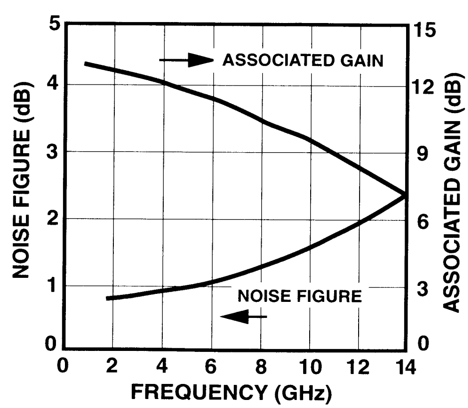
DRAIN CURRENT vs GATE VOLTAGE AT V_{DS} = 3 V



MAXIMUM AVAILABLE GAIN AND TRANSDUCER GAIN
V_{DS} = 3 V, I_{DS} = 30 mA



ASSOCIATED GAIN AND NOISE FIGURE vs FREQUENCY
V_{DS} = 3 V, IDS = 30 mA



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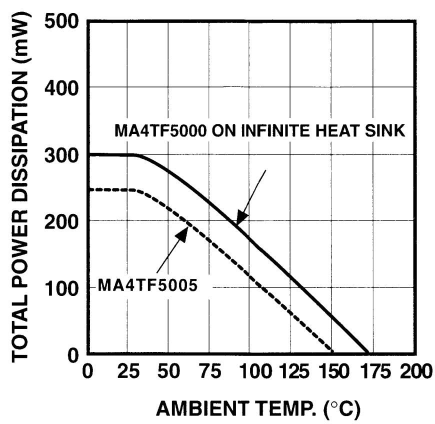
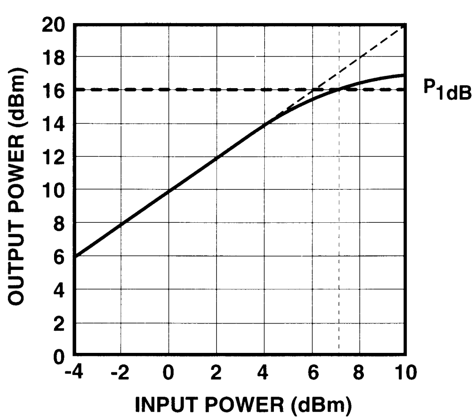
MA4TF50 SERIES
Typical Performance Curves (Con't)

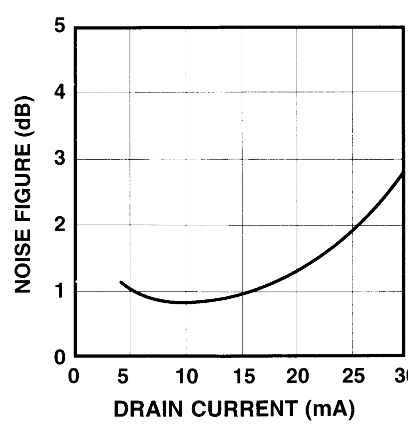
POWER DISSIPATION



OUTPUT POWER vs INPUT POWER
(P_{1DB} = 16 dBM)
V_{DS} = 3 V, I_{DS} = 30 mA, F = 4 GHz



NOISE FIGURE vs DRAIN CURRENT
V_{DS} = 3 V, F = 4 GHz



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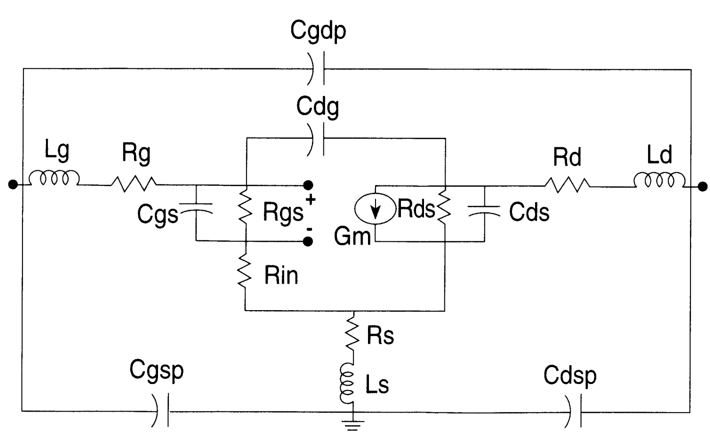
MA4TF5005 in the Ceramic Surface Mount Package Typical Noise Parameters

V_{DS} = 3V, I_{DS} = 10 mA

Frequency (GHz)	NF_O (dB)	G_A (dB)	Γ_{OPT}		R_η
			Mag	Angle	
2.00	0.68	14.41	0.73	28.1	22.29
3.00	0.84	12.88	0.71	43.3	25.24
4.00	1.00	11.55	0.69	60.8	25.74
5.00	1.16	10.41	0.67	80.3	23.48
6.00	1.32	9.43	0.65	101.4	18.77
7.00	1.48	8.62	0.63	123.5	12.74
8.00	1.64	7.96	0.62	146.4	7.16
9.00	1.81	7.44	0.60	169.5	3.93
10.00	1.97	7.06	0.60	-167.5	4.61
11.00	2.13	6.81	0.60	-145.1	9.94
12.00	2.29	6.67	0.60	-123.7	19.75
13.00	2.45	6.65	0.61	-103.7	33.12
14.00	2.61	6.71	0.63	-85.6	48.79

MA4TF5005 in the Ceramic Surface Mount Package Small Signal Model

V_{DS} = 3V, I_{DS} = 10 mA



Element	Value
Rg	0.18 Ω
Rd	0.0015 Ω
Rs	5.5 Ω
Rin	5.0 Ω
Rgs	1481 Ω
Rds	406 Ω
Cgs	0.35 pF
Cds	0.16 pF
Cdg	0.055 pF

Element	Value
Gm	32 mS
Tau	8.62 ps
Lg	0.60 nH
Ld	0.59 nH
Ls	0.045 nH
Cgsp	0.065 pF
Cgdp	0.019 pF
Cdsp	0.039 pF

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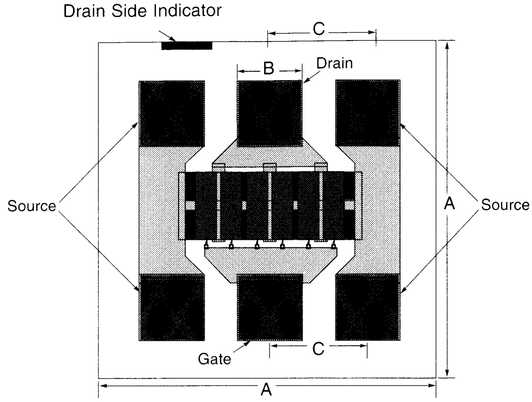
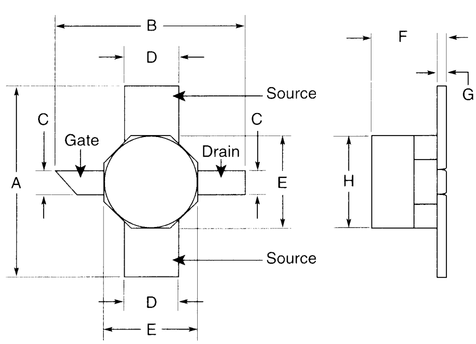
Chip – MA4TF5000
Case Style 1161



MA4TF5000

DIM.	INCHES (NOM.)	MILLIMETERS (NOM.)
A	0.016	0.406
B	0.002	0.050
C	0.003	0.075

MA4TF5005
Ceramic Surface Mount Package
Case Style 1105



MA4TF5005

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.150	0.165	3.80	4.20
B	0.150	0.165	3.80	4.20
C	0.014	0.026	0.35	0.65
D	0.032	0.047	0.80	1.20
E	0.063	0.079	1.60	2.00
F	—	0.057	—	1.45
G	0.002	0.008	0.05	0.20
H	0.063	0.079	1.60	2.00

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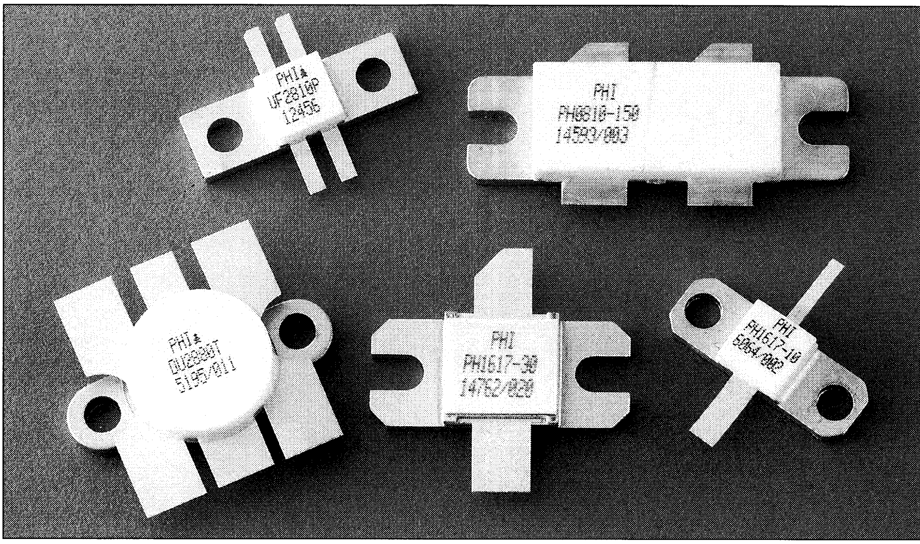
Power Transistors



Title	Page

M/A-COM
an AMP company

Bipolar Power Transistors

V 2.00

	Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Package PP = Push Pull (Inches)	Part No.	Page No.
	30 - 400	CE	AB	16	27	9.0	40	0.25 x 0.32	PH0104-16	9-85
	30 - 400	CE	AB	85	27	7.3	45	0.25 x 0.32	PH0104-85	9-86
	850 - 900	CE	AB	60	26	10.0	35	0.40 x 0.425	PH0810-60A	9-95
	850 - 960	CE	A/AB	35	24	10.0	55	0.23 x 0.36	PH0810-35	9-92
	850 - 960	CE	AB	4	24	14.0	45	0.23 x 0.36	PH0810-4	9-87
	850 - 960	CE	AB	15	24	12.0	50	0.23 x 0.36	PH0810-15	9-90
	850 - 960	CE	AB	75 PEP	26	10.0	35	0.40 x 0.425	PH0810-75	9-99
	850 - 960	CE	AB	150 PEP	26	10.0	35	0.40 x 0.85 PP	PH0810-150	9-100
	850 - 1450	CE	AB	42	28	6.8	40	0.40 x 0.50	PH0814-40	9-102
	900 - 960	CE	AB	60	26	10.0	35	0.40 x 0.425	PH08190-60B	9-97
New	960 - 1215	CB	C	35	37	7.0	35	0.40 x 0.40	PH0912-35	9-1
	960 - 1215	CB	C	120	37	8.0	44	0.40 x 0.50	PH0912-120	9-103
New	960 - 1215	CE	C	100	38	6.0	40	0.40 x 0.40	PH0912-100	9-2
New	960 - 1215	CE	C	107	24	3.3	35	0.40 x 0.40	PH0912-107	9-3
New	1025 - 1150	CB	C	70	49	7.0	35	0.40 x 0.40	PH1012-70	9-4
New	1025 - 1150	CB	C	282	45	6.5	38	0.40 x 0.80 PP	PH1012-282	9-6
New	1025 - 1150	CE	C	190	33	4.8	30	0.40 x 0.80 PP	PH1012-190	9-5
	1030 - 1090	CB	C	175	45	8.3	55	0.40 x 0.50	PH1090-175L	9-104
	1030 - 1090	CB	C	350	45	8.0	55	0.40 x 0.50	PH1090-350L	9-106
	1030 - 1090	CB	C	550	50	7.5	55	0.40 x 0.50	PH1090-550S	9-108
	1100 - 1300	CB	C	100	32	8.0	52	0.40 x 0.50	PH1113-100	9-110
	1200 - 1400	CB	C	2	28	7.0	40	0.25 x 0.25	PH1214-2M	9-114
	1200 - 1400	CB	C	3	16.5	5.7	40	0.25 x 0.25	PH1214-3L	9-116
	1200 - 1400	CB	C	4	28	7.0	45	0.25 x 0.25	PH1214-4M	9-118
	1200 - 1400	CB	C	6	28	7.0	45	0.25 x 0.25	PH1214-6M	9-120
	1200 - 1400	CB	C	8	28	7.0	45	0.25 x 0.25	PH1214-8M	9-121
	1200 - 1400	CB	C	12	28	9.0	45	0.25 x 0.25	PH1214-12M	9-122
	1200 - 1400	CB	C	20	28	9.5	50	0.25 x 0.25	PH1214-20EL	9-124
	1200 - 1400	CB	C	25	28	9.5	50	0.25 x 0.25	PH1214-25S	9-130
	1200 - 1400	CB	C	25	28	9.5	50	0.25 x 0.25	PH1214-25M	9-128
	1200 - 1400	CB	C	25	28	9.5	50	0.25 x 0.25	PH1214-25L	9-126
	1200 - 1400	CB	C	30	28	7.8	50	0.25 x 0.25	PH1214-30EL	9-132

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Power Transistors Selection Guides

Specifications Subject to Change Without Notice.

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V 2.00

	Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Package PP = Push Pull (Inches)	Part No.	Page No.
	1200 - 1400	CB	C	40	40	8.5	50	0.25 x 0.25	PH1214-40M	9-134
	1200 - 1400	CB	C	55	28	6.6	50	0.40 x 0.40	PH1214-55EL	9-136
	1200 - 1400	CB	C	80	40	7.5	50	0.40 x 0.40	PH1214-80M	9-138
	1200 - 1400	CB	C	100	28	6.0	52	0.40 x 0.40	PH1214-100EL	9-140
	1200 - 1400	CB	C	110	40	7.4	50	0.40 x 0.50	PH1214-110M	9-142
	1200 - 1400	CB	C	220	40	7.4	50	0.40 x 0.50	PH1214-220M	9-144
	1200 - 1400	CE	A	0.85	11.5	9.3	30	0.25 x 0.25	PH1214-0.85L	9-112
	1450 - 1550	CE	AB	60-PEP	26	8.0	30	0.40 x 0.425	PH1516-60	9-157
	1450 - 1550	CE	AB	100-PEP	26	10.0	30	0.40 x 0.40 PP	PH1516-100	9-160
	1450 - 1600	CE	A/AB	2	25	10.0	35	0.25 x 0.25	PH1516-2	9-146
	1450 - 1600	CE	A/AB	10	25	10.0	40	0.25 x 0.25	PH1516-10	9-150
	1450 - 1600	CE	AB	30	25	10.0	40	0.40 x 0.40	PH1516-30	9-154
	1600 - 1700	CE	A	4-PEP	26	12.0	35	0.23 x 0.36	PH1617-4N	9-167
	1600 - 1700	CE	A/AB	2	25	10.0	35	0.25 x 0.25	PH1617-2	9-163
	1600 - 1700	CE	A/AB	10	25	10.0	40	0.25 x 0.25	PH1617-10	9-170
	1600 - 1700	CE	AB	30	25	10.0	40	0.40 x 0.40	PH1617-30	9-176
	1600 - 1700	CE	AB	13.5-PEP	26	8.5	25	0.23 x 0.36	PH1617-12N	9-174
	1780 - 1900	CE	A/AB	2	25	10.0	35	0.25 x 0.25	PH1819-2	9-179
	1780 - 1900	CE	A/AB	4	26	10.0	25	0.23 x 0.36	PH1819-4N	9-183
	1780 - 1900	CE	A/AB	10	25	9.0	40	0.25 x 0.25	PH1819-10	9-186
	1780 - 1900	CE	A/AB	15	26	7.0	25	0.23 x 0.36	PH1819-15N	9-189
	1805 - 1880	CE	AB	33	25.0	7.0	40	0.25 x 0.32	PH1819-33	9-192
New	1805 - 1880	CE	AB	45	25.0	8.0	40	0.40 x 0.50	PH1819-45	9-7
	1930 - 1990	CE	AB	33	25.0	7.0	40	0.25 x 0.32	PH1920-33	9-194
New	1930 - 1990	CE	AB	45	25.0	8.0	40	0.40 x 0.50	PH1920-45	9-9
	2000 - 2300	CB	C	1	28	8.0	30	0.230 Dia.	PH2323-1	9-198
	2000 - 2300	CB	C	3	28	8.0	30	0.230 Dia.	PH2323-3	9-200
	2000 - 2300	CB	C	5	28	8.0	35	0.230 Dia.	PH2323-5	9-202
	2000 - 2300	CB	C	14	28	7.6	35	0.29 x 0.32	PH2323-14	9-204
	2200 - 2600	CB	C	50	36	8.0	45	0.40 x 0.40	PH2226-50M	9-196
	2200 - 2600	CB	C	110	36	8.0	45	0.40 x 0.50	PH2226-110M	9-197
New	2300	CB	C	4	28	8.0	35	0.23 x 0.82	PH2323-4	9-11
	2700 - 2900	CB	C	5	36	7.0	30	0.40 x 0.40	PH2729-5M	9-206
	2700 - 2900	CB	C	8.5	36	8.1	35	0.40 x 0.40	PH2729-8.5M	9-208
	2700 - 2900	CB	C	25	36	9.2	45	0.40 x 0.40	PH2729-25M	9-210
	2700 - 2900	CB	C	65	36	8.5	40	0.40 x 0.40	PH2729-65M	9-212
	2700 - 2900	CB	C	110	36	6.8	35	0.40 x 0.50	PH2729-110M	9-214
New	2700 - 2900	CB	C	130	36	7.0	40	0.40 x 0.40	PH2729-130M	9-12
	2700 - 3100	CB	C	5	36	7.0	30	0.40 x 0.40	PH2731-5M	9-216
	2700 - 3100	CB	C	20	36	8.2	45	0.40 x 0.40	PH2731-20M	9-218
	2700 - 3100	CB	C	75	36	7.0	38	0.40 x 0.40	PH2731-75L	9-220

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V 2.00

Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Package PP = Push Pull (Inches)	Part No.	Page No.
2856	CB	C	160	40	7.5	40	0.40 x 0.50	PH2856-160	9-222
2900 - 3100	CB	C	5	36	7.0	30	0.40 x 0.40	PH2931-5M	9-224
2900 - 3100	CB	C	20	36	8.2	45	0.40 x 0.40	PH2931-20M	9-226
2900 - 3100	CB	C	135	42	7.5	40	0.40 x 0.50	PH2931-135S	9-228
3100 - 3400	CB	C	9	36	8.0	35	0.25 x 0.25	PH3134-9L	9-230
3100 - 3400	CB	C	10	36	8.0	35	0.25 x 0.25	PH3134-10M	9-232
3100 - 3400	CB	C	11	36	8.0	35	0.25 x 0.25	PH3134-11S	9-234
3100 - 3400	CB	C	20	36	7.5	35	0.40 x 0.40	PH3134-20L	9-236
3100 - 3400	CB	C	25	36	7.5	35	0.40 x 0.40	PH3134-25M	9-238
3100 - 3400	CB	C	30	36	7.5	35	0.40 x 0.40	PH3134-30S	9-240
3100 - 3400	CB	C	55	36	7.5	35	0.40 x 0.40	PH3134-55L	9-242
3100 - 3400	CB	C	65	36	7.5	35	0.40 x 0.40	PH3134-65M	9-244
3100 - 3400	CB	C	75	36	7.5	35	0.40 x 0.40	PH3134-75S	9-246
3100 - 3500	CB	C	5	33	8.5	30	0.40 x 0.40	PH3135-5M	9-248
3100 - 3500	CB	C	5	33	8.5	30	0.40 x 0.40	PH3135-5S	9-250
3100 - 3500	CB	C	20	36	7.5	35	0.40 x 0.40	PH3135-20M	9-252
3100 - 3500	CB	C	25	36	7.5	35	0.40 x 0.40	PH3135-25S	9-254
3100 - 3500	CB	C	30	36	7.0	35	0.40 x 0.40	PH3135-30M	9-256
3100 - 3500	CB	C	65	36	7.5	35	0.40 x 0.40	PH3135-65M	9-258
3100 - 3500	CB	C	90	36	7.5	35	0.40 x 0.40	PH3135-90S	9-260

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MOSFET Power Transistors

V 2.00

Operating Frequency Range (MHz)	Test Frequency (MHz)	Pout (W)	V_{DS} (V)	Gain (dB)	Package PP = Push Pull (Inches)	Part No.	Page No.
30 - 90	88	8	12	13.0	0.25 x 0.25	FH2164	9-66
30 - 90	88	2	12	10.0	0.25 x 0.25	FH2165	9-67
30 - 90	88	75	24	13.0	0.50 Dia.	FH2114	9-65
2 - 175	175	15	12	9.5	0.38 Dia.	DU1215S	9-15
2 - 175	175	30	12	10.0	0.38 Dia.	DU1230S	9-18
2 - 175	175	60	12	8.0	0.50 Dia.	DU1260T	9-21
2 - 175	175	5	28	11.0	0.38 Dia.	DU2805S	9-24
2 - 175	175	10	28	13.0	0.38 Dia.	DU2810S	9-27
2 - 175	175	20	28	13.0	0.38 Dia.	DU2820S	9-29
2 - 175	175	40	28	13.0	0.38 Dia.	DU2840S	9-32
2 - 175	175	40	28	13.0	0.40 x 0.425	DU2840V	9-35
2 - 175	175	60	28	13.0	0.50 Dia.	DU2860U	9-41
2 - 175	175	60	28	13.0	0.50 Dia.	DU2860T	9-38
2 - 175	175	80	28	13.0	0.50 Dia.	DU2880T	9-44
2 - 175	175	80	28	13.0	0.50 Dia.	DU2880U	9-47
2 - 175	175	80	28	13.0	0.40 x 0.425	DU2880V	9-50
2 - 175	175	120	28	13.0	0.50 Dia.	DU28120T	9-53
2 - 175	175	120	28	13.0	0.50 Dia.	DU28120U	9-56
2 - 175	175	120	28	13.0	0.40 x 0.425	DU28120V	9-59
2 - 175	175	200	28	13.0	0.38 x 0.75	DU28200M	9-62
100 - 500	500	1	28	10.0	TO-39/Isolated	UF2801K1	9-262
100 - 500	500	5	28	10.0	0.25 x 0.25	UF2805B	9-267
100 - 500	500	10	28	10.0	0.25 x 0.25	UF2810P	9-270
100 - 500	500	15	28	10.0	0.25 x 0.25	UF2815B	9-272
100 - 500	500	20	28	10.0	0.25 x 0.25	UF2820P	9-275
100 - 500	500	20	28	10.0	0.38 Dia.	UF2820R	9-278
100 - 500	500	40	28	10.0	0.25 x 0.50PP	UF2840G	9-281
100 - 500	500	40	28	10.0	0.25 x 0.25	UF2840P	9-284
100 - 500	500	100	28	10.0	0.40 x 0.425	UF28100H	9-287
100 - 500	500	100	28	10.0	0.38 x 0.75PP	UF28100M	9-290
100 - 500	500	100	28	10.0	0.40 x 0.50	UF28100V	9-293
100 - 500	500	150	28	8.0	0.40 x 0.425PP	UF28150J	9-296
500 - 1000	1000	2	28	10.0	0.25 x 0.25	LF2802A	9-68
500 - 1000	1000	5	28	10.0	0.25 x 0.25	LF2805A	9-71
500 - 1000	1000	10	28	10.0	0.25 x 0.25	LF2810A	9-74
500 - 1000	1000	30	40	10.0	0.40 x 0.40PP	LF4030C	9-79
500 - 1000	1000	40	28	7.0	0.25 x 0.50PP	LF2840G	9-77
500 - 1000	1000	100	40	10.0	0.40 x 0.40PP	LF40100M	9-82
925 - 960	960	80	26	10.0	0.38 x 0.75PP	CR2480M	9-13

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Avionics Pulsed Bipolar Power Transistors

	Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Pulse Effcy (%)	Width (µs)	Duty (%)	Package PP = Push Pull (Inches)	Part No.	Page No.
New	960 - 1215	CB	C	35	36.6	7.0	35	7	50	0.40 x 0.40	PH0912-35	9-1
New	960 - 1215	CE	C	100	38	6.0	40	7	50	0.40 x 0.40	PH0912-100	9-2
New	960 - 1215	CE	C	107	23.5	3.3	35	7	50	0.40 x 0.40	PH0912-107	9-3
	960 - 1215	CB	C	120	36.6	8.0	44	7	50	0.40 x 0.50	PH0912-120	9-103
New	1025 - 1150	CB	C	70	48.6	7.0	35	TACAN		0.40 x 0.40	PH1012-70	9-4
New	1025 - 1150	CE	C	190	33	4.8	30	TACAN		0.40 x 0.80 PP	PH1012-190	9-5
New	1025 - 1150	CB	C	282	45	6.5	38	TACAN		0.40 x 0.80 PP	PH1012-282	9-6
	1030 - 1090	CB	C	175	45	8.3	55	250	10	0.40 x 0.50	PH1090-175L	9-104
	1030 - 1090	CB	C	350	45	8.0	55	250	10	0.40 x 0.50	PH1090-350L	9-106
	1030 - 1090	CB	C	550	50	7.5	55	10	1	0.40 x 0.50	PH1090-550S	9-108

CW Bipolar Power Transistors

	Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Package (inches)	Part No.	Page No.
	30-400	CE	AB	16	27	9.0	40	0.25 x 0.32	PH0104-16	9-85
	30-400	CE	AB	85	27	7.3	45	0.25 x 0.32	PH0104-85	9-86
	2000 - 2300	CB	C	1	28	8.0	30	0.230 Dia.	PH2323-1	9-198
	2000 - 2300	CB	C	3	28	8.0	30	0.230 Dia.	PH2323-3	9-200
	2000 - 2300	CB	C	5	28	8.0	35	0.230 Dia.	PH2323-5	9-202
	2000 - 2300	CB	C	14	28	7.6	35	0.29 x 0.32	PH2323-14	9-204
New	2300	CB	C	4	28	8.0	35	0.23 x 0.82	PH2323-4	9-11

Linear Accelerator Pulsed Bipolar

Frequency (MHz)	Config.	Class	Vcc (V)	Pout (W)	Gain (dB)	Effcy (%)	Pulse Width (µs)	Duty (%)	Package (inches)	Part No.	Page No.
2856	CB	C	40	160	7.5	40	12	10	0.40 x 0.50	PH2856-160	9-222

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Radar Pulsed Transistors

	Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Pulse Width (μs)	Duty (%)	Package (Inches)	Part No.	Page No.
	1100 - 1300	CB	C	100	32	8.0	52	3	30	0.40 x 0.50	PH1113-100	9-110
	1200 - 1400	CB	C	2	28	7.0	40	100	10	0.25 x 0.25	PH1214-2M	9-114
	1200 - 1400	CB	C	3	16.5	5.7	40	2000	20	0.25 x 0.25	PH1214-3L	9-116
	1200 - 1400	CB	C	4	28	7.0	45	100	10	0.25 x 0.25	PH1214-4M	9-118
	1200 - 1400	CB	C	6	28	7.0	45	100	10	0.25 x 0.25	PH1214-6M	9-120
	1200 - 1400	CB	C	8	28	7.0	45	100	10	0.25 x 0.25	PH1214-8M	9-121
	1200 - 1400	CB	C	12	28	9.0	45	150	10	0.25 x 0.25	PH1214-12M	9-122
	1200 - 1400	CB	C	20	28	9.5	50	2000	10	0.25 x 0.25	PH1214-20EL	9-124
	1200 - 1400	CB	C	25	28	9.5	50	1	10	0.25 x 0.25	PH1214-25S	9-130
	1200 - 1400	CB	C	25	28	9.5	50	150	10	0.25 x 0.25	PH1214-25M	9-128
	1200 - 1400	CB	C	25	28	9.5	50	300	10	0.25 x 0.25	PH1214-25L	9-126
	1200 - 1400	CB	C	30	28	7.8	50	1000	10	0.25 x 0.25	PH1214-30EL	9-132
	1200 - 1400	CB	C	40	40	8.5	50	150	10	0.25 x 0.25	PH1214-40M	9-134
	1200 - 1400	CB	C	55	28	6.6	50	1000	10	0.40 x 0.40	PH1214-55EL	9-136
	1200 - 1400	CB	C	80	40	7.5	50	150	10	0.40 x 0.40	PH1214-80M	9-138
	1200 - 1400	CB	C	100	28	6.0	52	2000	20	0.40 x 0.40	PH1214-100EL	9-140
	1200 - 1400	CB	C	110	40	7.4	50	150	10	0.40 x 0.50	PH1214-110M	9-142
	1200 - 1400	CB	C	220	40	7.4	50	150	10	0.40 x 0.50	PH1214-220M	9-144
	1200 - 1400	CE	A	0.85	11.5	9.3	30	2000	20	0.25 x 0.25	PH1214-0.85L	9-112
	2200 - 2600	CB	C	50	36	8.0	45	100	10	0.40 x 0.40	PH2226-50M	9-196
	2200 - 2600	CB	C	110	36	8.0	45	100	10	0.40 x 0.50	PH2226-110M	9-197
	2700 - 2900	CB	C	5	36	7.0	30	100	10	0.40 x 0.40	PH2729-5M	9-206
	2700 - 2900	CB	C	8.5	36	8.1	35	100	10	0.40 x 0.40	PH2729-8.5M	9-208
	2700 - 2900	CB	C	25	36	9.2	45	100	10	0.40 x 0.40	PH2729-25M	9-210
	2700 - 2900	CB	C	65	36	8.5	40	100	10	0.40 x 0.40	PH2729-65M	9-212
	2700 - 2900	CB	C	110	36	6.8	35	100	10	0.40 x 0.50	PH2729-110M	9-214
New	2700 - 2900	CB	C	130	36	7.0	40	100	10	0.40 x 0.40	PH2729-130M	9-11
	2700 - 3100	CB	C	5	36	7.0	30	100	10	0.40 x 0.40	PH2731-5M	9-216
	2700 - 3100	CB	C	20	36	8.2	45	100	10	0.40 x 0.40	PH2731-20M	9-218
	2700 - 3100	CB	C	75	36	7.0	38	300	10	0.40 x 0.40	PH2731-75L	9-220
	2900 - 3100	CB	C	5	36	7.0	30	100	10	0.40 x 0.40	PH2931-5M	9-224
	2900 - 3100	CB	C	20	36	8.2	45	100	10	0.40 x 0.40	PH2931-20M	9-226
	2900 - 3100	CB	C	135	42	7.5	40	20	1	0.40 x 0.50	PH2931-135S	9-228

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V 2.00

Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Pulse Width (µs)	Duty (%)	Package (Inches)	Part No.	Page No.
3100 - 3400	CB	C	9	36	8.0	35	300	10	0.25 x 0.25	PH3134-9L	9-230
3100 - 3400	CB	C	10	36	8.0	35	100	10	0.25 x 0.25	PH3134-10M	9-232
3100 - 3400	CB	C	11	36	8.0	35	1	10	0.25 x 0.25	PH3134-11S	9-234
3100 - 3400	CB	C	20	36	7.5	35	300	10	0.40 x 0.40	PH3134-20L	9-236
3100 - 3400	CB	C	25	36	7.5	35	100	10	0.40 x 0.40	PH3134-25M	9-238
3100 - 3400	CB	C	30	36	7.5	35	1	10	0.40 x 0.40	PH3134-30S	9-240
3100 - 3400	CB	C	55	36	7.5	35	300	10	0.40 x 0.40	PH3134-55L	9-242
3100 - 3400	CB	C	65	36	7.5	35	100	10	0.40 x 0.40	PH3134-65M	9-244
3100 - 3400	CB	C	75	36	7.5	35	1	10	0.40 x 0.40	PH3134-75S	9-246
3100 - 3500	CB	C	5	33	8.5	30	100	10	0.40 x 0.40	PH3135-5M	9-248
3100 - 3500	CB	C	5	33	8.5	30	2	10	0.40 x 0.40	PH3135-5S	9-250
3100 - 3500	CB	C	20	36	7.5	35	100	10	0.40 x 0.40	PH3135-20M	9-252
3100 - 3500	CB	C	25	36	7.5	35	2	10	0.40 x 0.40	PH3135-25S	9-254
3100 - 3500	CB	C	30	36	7.0	35	100	10	0.40 x 0.40	PH3135-30M	9-256
3100 - 3500	CB	C	65	36	7.5	35	100	10	0.40 x 0.40	PH3135-65M	9-258
3100 - 3500	CB	C	90	36	7.5	35	2	10	0.40 x 0.40	PH3135-90S	9-260

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Wireless Bipolar Power Transistors

	Frequency (MHz)	Config.	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	IMD3	VSWR	Package PP = Push Pull (Inches)	Part No.	Page No.
	850 - 900	CE	AB	60	26	10	35	-28	5:1	0.40 x 0.425	PH0810-60A	9-95
	850 - 960	CE	A/AB	35	24	10	55	30	3:1	0.23x 0.36	PH0810-35	9-92
	850 - 900	CE	AB	4	24	14	45	-30	10:1	0.23 x 0.38	PH0810-4	9-87
	850 - 900	CE	AB	15	24	12	50	-30	10:1	0.23x 0.36	PH0810-15	9-90
	850 - 900	CE	AB	75 PEP	26	10	35	-28	5:1	0.40 x 0.425	PH0810-75	9-99
	850 - 900	CE	AB	150 PEP	26	10	35	-28	5:1	0.40 x 0.85PP	PH0810-150	9-100
	900 - 960	CE	AB	60	26	10	35	-28	3:1	0.40 x 0.425	PH0810-60B	9-97
	1450 - 1550	CE	AB	60 PEP	26	8	30	-28	5:1	0.40 x 0.425	PH1516-60	9-157
	1450 - 1550	CE	AB	100 PEP	26	10	30	-30	5:1	0.40 x 0.40PP	PH1516-100	9-160
	1450 - 1600	CE	A/AB	2	25	10	35	-32	5:1	0.25 x 0.25	PH1516-2	9-146
	1450 - 1600	CE	A/AB	10	25	10	40	-30	3:1	0.25 x 0.25	PH1516-10	9-150
	1450 - 1600	CE	AB	30	25	10	40	-28	3:1	0.40 x 0.40	PH1516-30	9-154
	1600 - 1700	CE	A	4 PEP	26	12	35	-30	10:1	0.23 x 0.36	PH1617-4N	9-167
	1600 - 1700	CE	A/AB	2	25	10	35	-32	5:1	0.25 x 0.25	PH1617-2	9-163
	1600 - 1700	CE	A/AB	10	25	10	40	-30	3:1	0.25 x 0.25	PH1617-10	9-170
	1600 - 1700	CE	AB	30	25	10	40	-28	3:1	0.40 x 0.40	PH1617-30	9-176
	1600 - 1700	CE	AB	13.5 PEP	26	8.5	25	-28	10:1	0.23 x 0.36	PH1617-12	9-174
	1780 - 1900	CE	A/AB	2	25	10	35	-32	5:1	0.25 x 0.25	PH1819-2	9-179
	1780 - 1900	CE	A/AB	4	26	10	25	-30	10:1	0.23 x 0.36	PH1819-4N	9-183
	1780 - 1900	CE	A/AB	10	25	9	40	-28	3:1	0.25 x 0.25	PH1819-10	9-186
	1780 - 1900	CE	A/AB	15	26	7	25	-30	10:1	0.23 x 0.36	PH1819-15N	9-189
	1805- 1880	CE	AB	33	25.0	7	40	-28	2:1	0.25 x 0.32	PH1819-33	9-192
New	1805- 1880	CE	AB	45	25.0	8	40	-	3:1	0.40 x 0.50	PH1819-45	9-7
	1930 - 1990	CE	AB	33	25.0	7	40	-	2:1	0.25 x 0.32	PH1920-33	9-194
New	1930 - 1990	CE	AB	45	25.0	8	40	-	3:1	0.40 x 0.50	PH1920-45	9-19

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V 2.00

Wireless Linear MOSFET Power Transistors

Operating Freq. Range (MHz)	Test Frequency (MHz)	Pout (W)	VDS (V)	Gain (dB)	Effcy (%)	VSWR	Package PP = Push Pull (Inches)	Part No.	Page No.
500 - 1000	1000	30	40	10	50	3:1	0.40 x 0.40	LF4030C	9-79
500 - 1000	1000	40	28	7	50	3:1	0.25 x 0.50 PP	LF2840G	9-77
500 - 1000	1000	100	40	10	45	3:1	0.40 x 0.40 PP	LF40100M	9-82
500 - 1400	1000	2	28	10	40	20:1	0.25 x 0.25	LF2802A	9-68
500 - 1400	1000	5	28	10	50	20:1	0.25 x 0.25	LF2805A	9-71
500 - 1400	1000	10	28	10	50	20:1	0.25 x 0.25	LF2810A	9-74
925 - 960	960	80	28	10	50	3:1	0.38 x 0.75 PP	CR2480M	9-13

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Power Transistors Selection Guides

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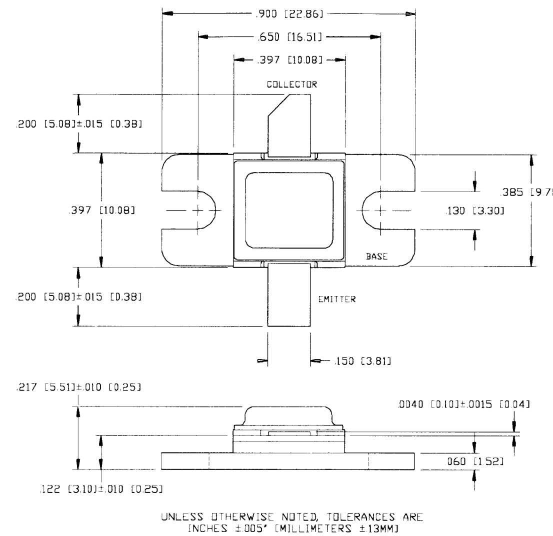
Avionics Pulsed Power Transistor, 35W, TDMA Format
960 - 1215 MHz
PH0912-35

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	30	mA	V_{CE}=65 V
Input Power	P_{IN}	3.5	7.0	W	V_{CC}=36.6 V, P_{OUT}=35 W, F=960, 1090, 1215 MHz, N1
Power Gain	G_P	7.0	10	dB	V_{CC}=36.6 V, P_{OUT}=35 W, F=960, 1090, 1215 MHz, N1
Collector Efficiency	η_C	35	-	%	V_{CC}=36.6 V, P_{OUT}=35 W, F=960, 1090, 1215 MHz, N1
Input Return Loss	RL	8	-	dB	V_{CC}=36.6 V, P_{OUT}=35 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36.6 V, P_{OUT}=35 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Stability	VSWR-S	-	5:1	-	V_{CC}=36.6 V, P_{OUT}=35 W, F=1090 MHz, N1

N1: TDMA pulse format consists of 6.4us ON, 6.6us OFF pulses which repeat for 3.354ms which is then OFF for 4.4585ms

This Data Sheet Contains Typical Electrical Specifications Which May Change Prior to Final Introduction.

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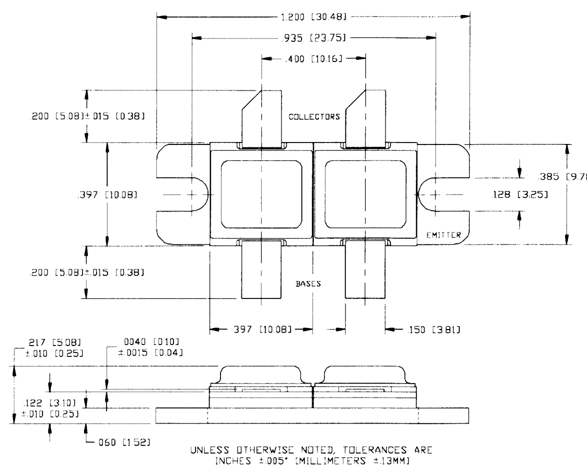
Avionics Pulsed Power Transistor, 100W, TDMA Format
960 - 1215 MHz
PH0912-100

V1.00

Features

- Designed for JTIDS Application
- NPN Silicon Microwave Power Transistor
- Common Emiter Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	90	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	90	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	20	mA	V_{CE}=40 V
Input Power	P_{IN}	-	25	W	V_{CC}=38 V, P_{OUT}=100 W, F=960, 1090, 1215 MHz, N1
Power Gain	G_P	6.0	-	dB	V_{CC}=38 V, P_{OUT}=100 W, F=960, 1090, 1215 MHz, N1
Collector Efficiency	η_C	40	-	%	V_{CC}=38 V, P_{OUT}=100 W, F=960, 1090, 1215 MHz, N1
Input Return Loss	RL	10	-	dB	V_{CC}=38 V, P_{OUT}=100 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Stability	VSWR-S	-	1.5:1	-	V_{CC}=38 V, P_{OUT}=100 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	5:1	-	V_{CC}=38 V, P_{OUT}=100 W, F=1090 MHz, N1

N1: TDMA pulse format consists of 6.4us ON, 6.6us OFF pulses which repeat for 3.354ms which is then OFF for 4.4585ms.

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Coming Attractions

Avionics Pulsed Power Transistor, 107W, TDMA Format

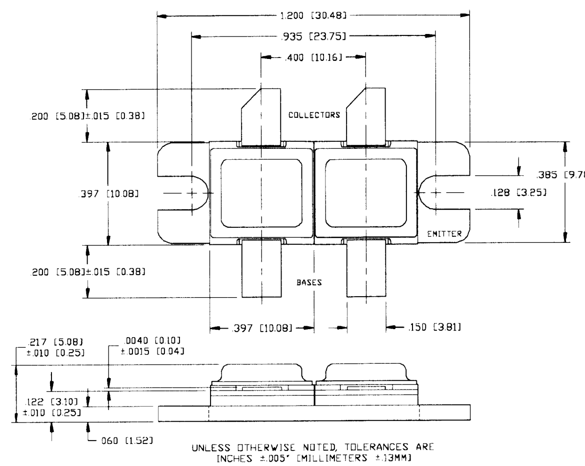
960 - 1215 MHz

PH0912-107

V1.00

Features

- Designed for JTIDS Applications
- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	20	mA	V_{CE}=40 V
Input Power	P_{IN}	-	50	W	V_{CC}=23.5 V, P_{OUT}=107 W, F=960, 1090, 1215 MHz, N1
Power Gain	G_P	3.3	-	dB	V_{CC}=23.5 V, P_{OUT}=107 W, F=960, 1090, 1215 MHz, N1
Collector Efficiency	η_C	35	-	%	V_{CC}=23.5 V, P_{OUT}=107 W, F=960, 1090, 1215 MHz, N1
Input Return Loss	RL	10	-	dB	V_{CC}=23.5 V, P_{OUT}=107 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Stability	VSWR-S	-	1.5:1	-	V_{CC}=23.5 V, P_{OUT}=107 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	5:1	-	V_{CC}=23.5 V, P_{OUT}=107 W, F=1090 MHz, N1

N1: TDMA pulse format consists of 6.4us ON, 6.6us OFF pulses which repeat for 3.354ms which is then OFF for 4.4585ms

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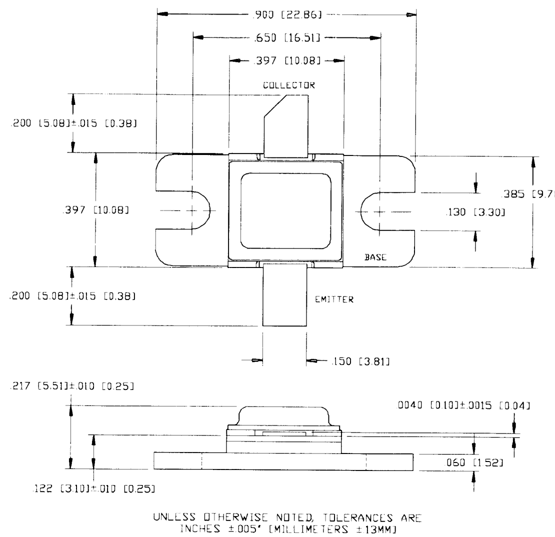
Avionics Pulsed Power Transistor, 70W, TACAN Format 1025-1150 MHz

PH1012-70

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	30	mA	V_{CE}=65 V
Input Power	P_{IN}	4.4	14	W	V_{CC}=48.6 V, P_{OUT}=70 W, F=1025, 1090, 1150 MHz, N1
Power Gain	G_P	7.0	12	dB	V_{CC}=48.6 V, P_{OUT}=70 W, F=1025, 1090, 1150 MHz, N1
Collector Efficiency	η_C	35	-	%	V_{CC}=48.6 V, P_{OUT}=70 W, F=1025, 1090, 1150 MHz, N1
Input Return Loss	RL	8	-	dB	V_{CC}=48.6 V, P_{OUT}=70 W, F=1025, 1090, 1150 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	1.5:1	-	V_{CC}=48.6 V, P_{OUT}=70 W, F=1025, 1090, 1150 MHz, N1
Load Mismatch Stability	VSWR-S	-	5:1	-	V_{CC}=48.6 V, P_{OUT}=70 W, F=1090 MHz, N1

N1: TACAN pulse format consists of two, 4.0 usec pulses separated by 11.5 usec for 150 pairs per second. Duty Factor=0.12%

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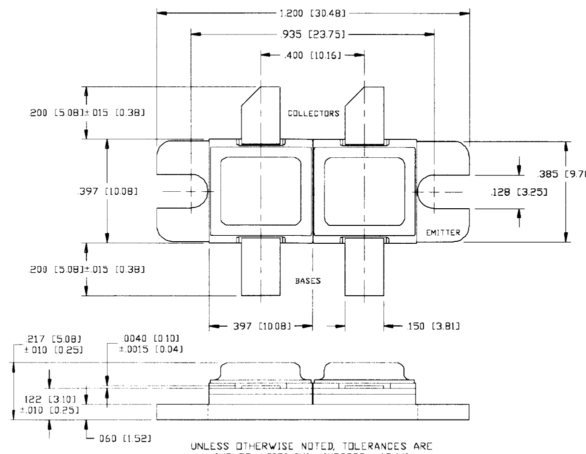
Avionics Pulsed Power Transistor, 190W, TACAN Format
1025 - 1150 MHz PH1012-190

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Emitter Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	20	mA	V_{CE}=40 V
Input Power	P_{IN}	-	63	W	V_{CC}=33 V, P_{OUT}=190 W, F=1025, 1090, 1150 MHz, N1
Power Gain	G_P	4.8	-	dB	V_{CC}=33 V, P_{OUT}=190 W, F=1025, 1090, 1150 MHz, N1
Collector Efficiency	η_C	30	-	%	V_{CC}=33 V, P_{OUT}=190 W, F=1025, 1090, 1150 MHz, N1
Input Return Loss	RL	10	-	dB	V_{CC}=33 V, P_{OUT}=190 W, F=1025, 1090, 1150 MHz, N1
Load Mismatch Stability	VSWR-S	-	1.5:1	-	V_{CC}=33 V, P_{OUT}=190 W, F=1025, 1090, 1150 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	5:1	-	V_{CC}=33 V, P_{OUT}=190 W, F=1090 MHz, N1

N1: TACAN pulse format consists of two, 4.0 usec pulses separated by 11.5 usec for 150 pairs per second. Duty Factor=0.12%

This Data Sheet Contains Typical Electrical Specifications Which May Change Prior to Final Introduction.

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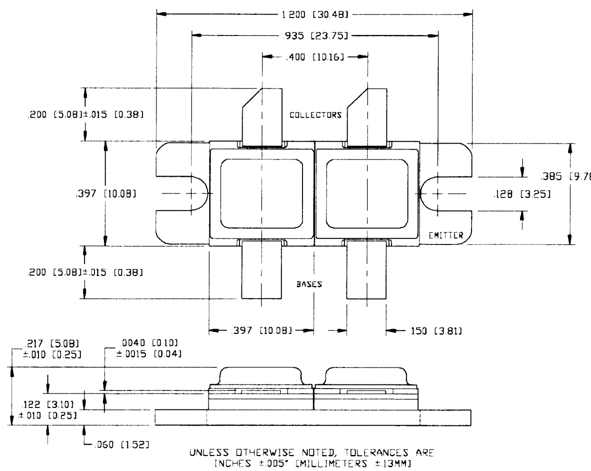
Coming Attractions

Avionics Pulsed Power Transistor, 282W, TACAN Format
1025 - 1150 MHz
PH1012-282

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	90	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	90	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	20	mA	V_{CE}=40 V
Input Power	P_{IN}	-	63	W	V_{CC}=45 V, P_{OUT}=282 W, F=1025, 1090, 1150 MHz, N1
Power Gain	G_P	6.5	-	dB	V_{CC}=45 V, P_{OUT}=282 W, F=1025, 1090, 1150 MHz, N1
Collector Efficiency	η_C	38	-	%	V_{CC}=45 V, P_{OUT}=282 W, F=1025, 1090, 1150 MHz, N1
Input Return Loss	RL	10	-	dB	V_{CC}=45 V, P_{OUT}=282 W, F=1025, 1090, 1150 MHz, N1
Load Mismatch Stability	VSWR-S	-	1.5:1	-	V_{CC}=45 V, P_{OUT}=282 W, F=1025, 1090, 1150 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	5:1	-	V_{CC}=45 V, P_{OUT}=282 W, F=1090 MHz, N1

N1: TACAN pulse format consists of two, 4.0 usec pulses separated by 11.5 usec for 150 pairs per second. Duty Factor=0.12%

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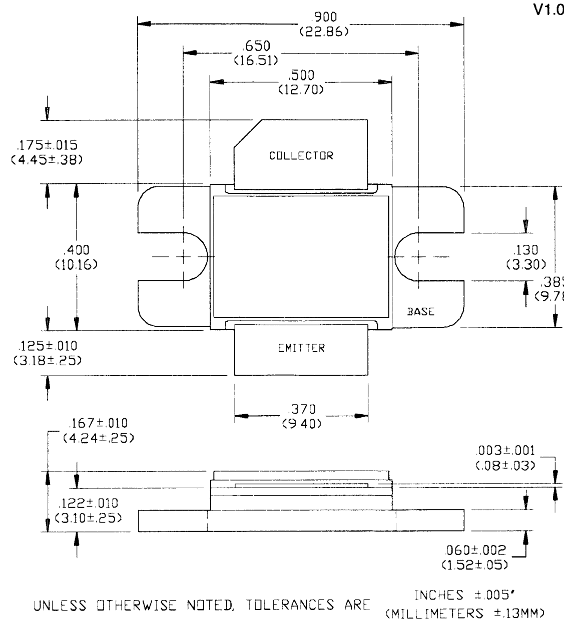
Wireless Bipolar Power Transistor, 45W 1805 - 1880 MHz

PH1819-45

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Emitter Class AB Operation
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting
- Gold Metalization System



Absolute Maximum Ratings at 25°C

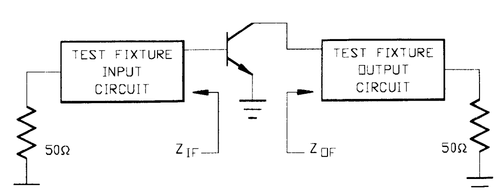
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	25	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	5.5	A
Power Dissipation	P_D	100	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	1.3	°C/W

Electrical Characteristics at 25°C

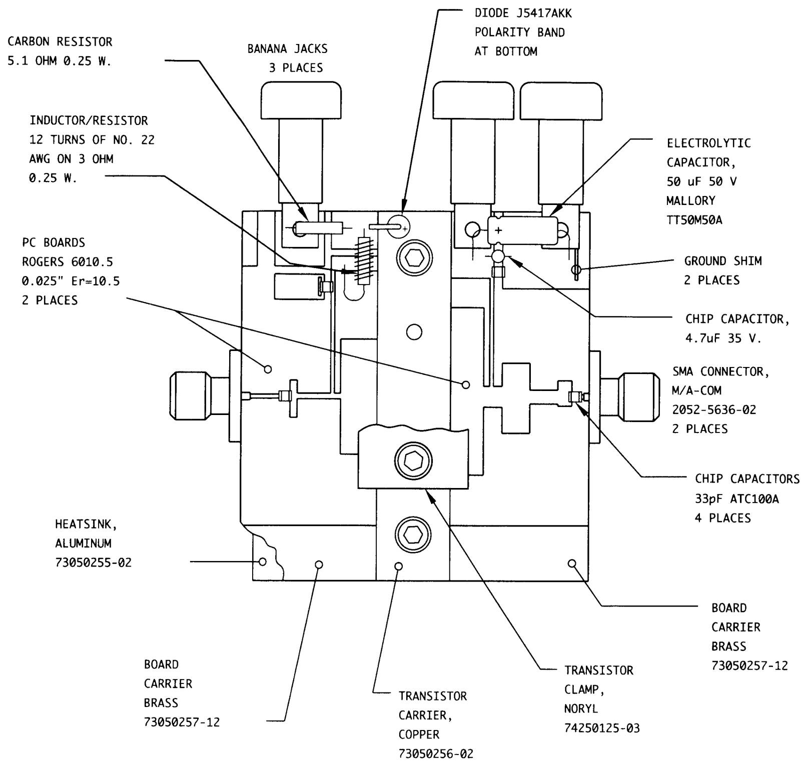
Parameter	Symbol	Min	Max	Units	Test Conditions
Power Gain	G_P	8	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1805, 1880 MHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1805, 1880 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1805, 1880 MHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1805, 1880 MHz

Broadband Test Fixture Impedances

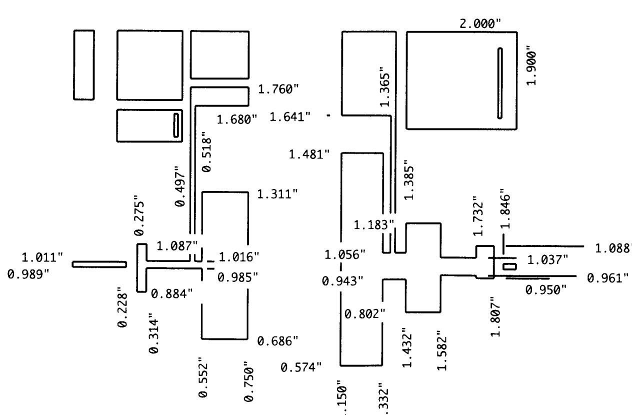
F(MHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1805	2.0 - j3.8	3.7 - j1.4
1850	2.0 - j3.8	3.9 - j1.8
1880	2.0 - j3.7	3.9 - j2.1



RF Test Fixture



Test Fixture PC Board Dimensions



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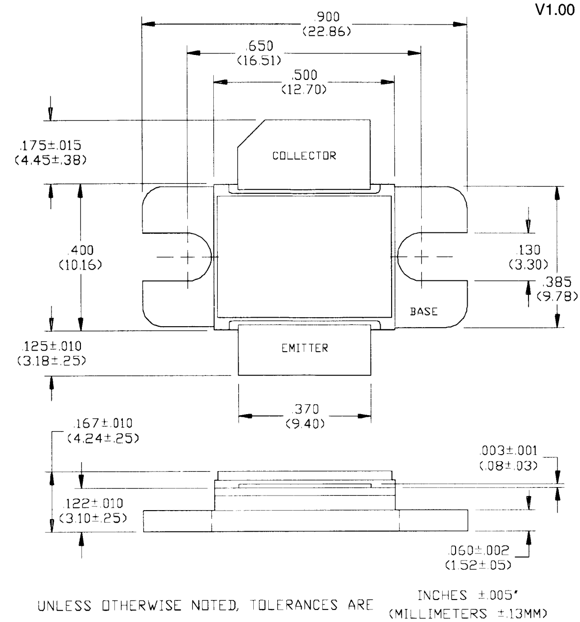
Wireless Bipolar Power Transistor, 45W
1930 - 1990 MHz

PH1920-45

V1.00

Features

- NPN Silicon Power Transistor
- Common Emitter Class AB Operation
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting
- Gold Metalization System



Absolute Maximum Ratings at 25°C

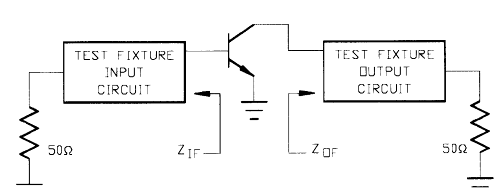
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CEO}	20	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	5.5	A
Power Dissipation	P_D	100	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	1.3	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Power Gain	G_P	8	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1930, 1990 MHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1930, 1990 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1930, 1990 MHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=45 W, F=1930, 1990 MHz

Broadband Test Fixture Impedances

F(MHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1930	2.8 - j5.5	4.8 - j1.1
1960	2.7 - j5.4	5.0 - j1.3
1990	2.6 - j5.3	5.2 - j1.5



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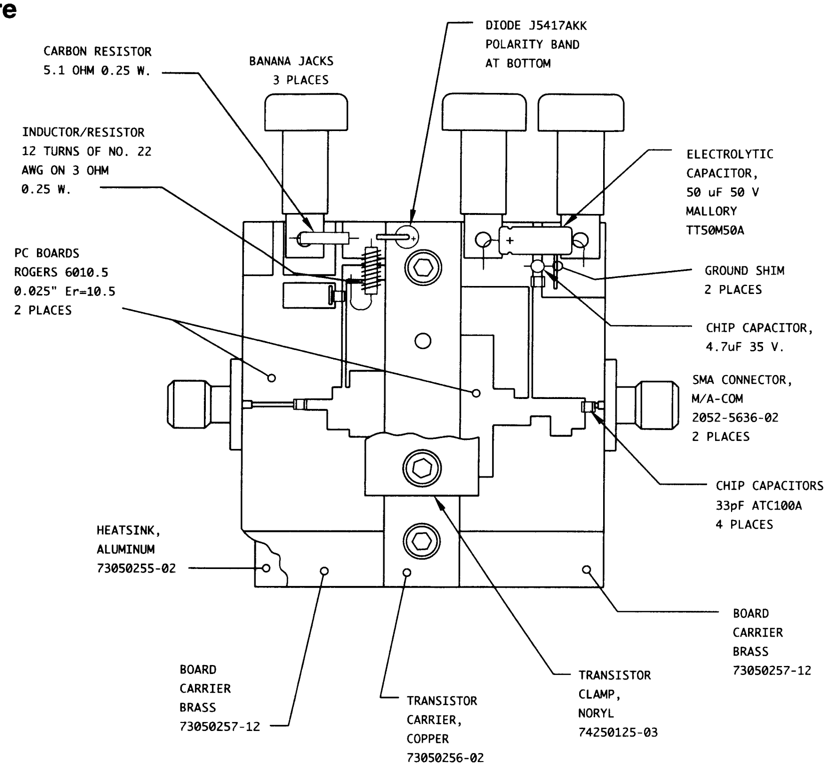
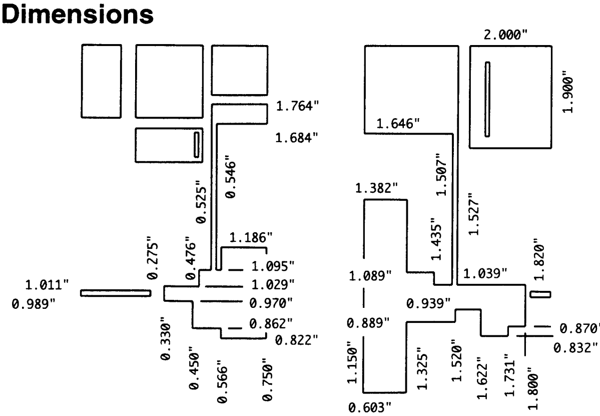
RF Test Fixture



Test Fixture PC Board Dimensions



an AMP company

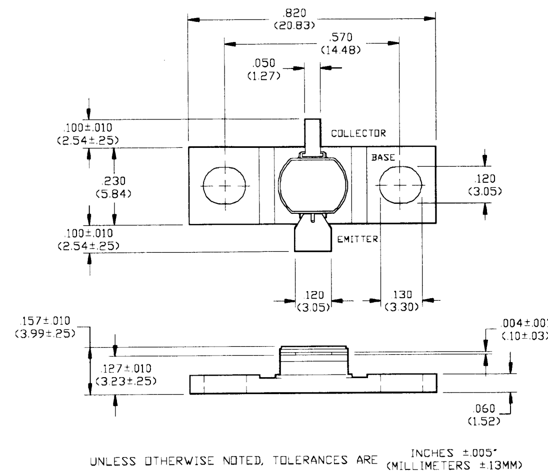
CW Bipolar Power Transistor, 4W 2.3 GHz

PH2323-4

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.6	A
Total Power Dissipation	P_{TOT}	22	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	8.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=7.5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=28 V
Input Power	P_{IN}	-	0.63	W	V_{CC}=28 V, P_{OUT}=4.0 W, F=2.3 GHz
Power Gain	G_P	8	-	dB	V_{CC}=28 V, P_{OUT}=4.0 W, F=2.3 GHz
Collector Efficiency	η_C	353	-	%	V_{CC}=28 V, P_{OUT}=4.0 W, F=2.3 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=4.0 W, F=2.3 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=4.0 W, F=2.3 GHz

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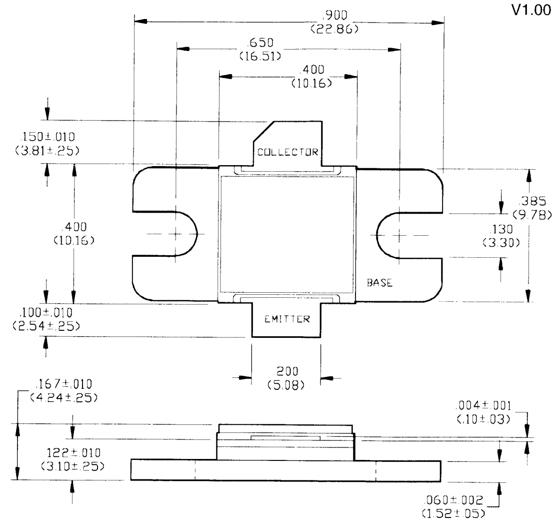
Radar Pulsed Power Transistor, 130W, 100µs Pulse, 10% Duty 2.7 - 2.9 GHz

PH2729-130M

V1.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- New Power Dense Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005' (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	63	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	12.5	A
Total Power Dissipation	P_{TOT}	575	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.3	°C/W	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Output Power	P_{OUT}	130	-	W	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Overdrive Stability	OD-S	-	1.0	dB	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz
Load Mismatch Stablility	VSWR-S	-	2:1	-	V_{CC}=36 V, P_{IN}=26 W, F=2.7, 2.9 GHz

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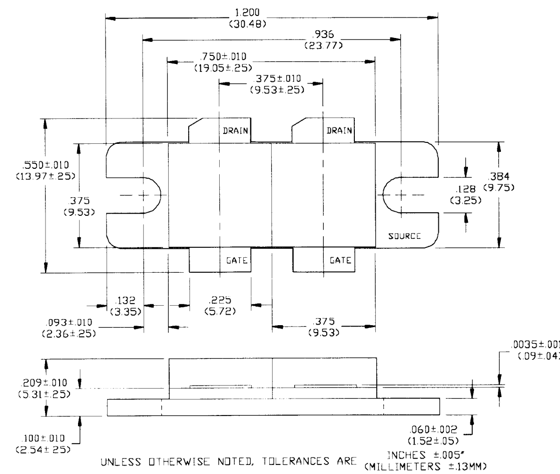
an AMP company

MOSFET Power Transistor, 80W, 26V
925 - 960 MHz CR2480M

V2.00

Features

- N-Channel Enhancement Mode Device
- Cellular Base Station Applications
- 80 Watts CW
- Common Source Gemini Configuration
- RESFET Structure
- Internal Input Impedance Matching
- Gold Metallization



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	60	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	28	A
Power Dissipation	P_D	233	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.75	°C/W

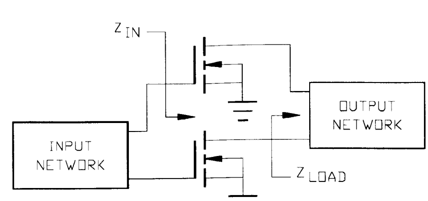
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	60	-	V	I_D=40 mA, V_{GS}=0.0 V*
Drain-Source Leakage Current	I_{DSS}	-	4.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=200 mA*
Forward Transconductance	G_M	1.0	-	S	V_{DS}=10.0 V, I_{DS}=2000 mA (pulsed)*
Input Capacitance	C_{ISS}	-	200	pF	V_{DS}=28.0 V, F=1.0 MHz (Reference Only)*
Output Capacitance	C_{OSS}	-	50	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	14	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=26.0 V, I_{DQ}=400 mA, P_{OUT}=80 W, F=960 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=26.0 V, I_{DQ}=400 mA, P_{OUT}=80 W, F=960 MHz
Load Mismatch Tolerance	VSWR-T	-	3.0:1	-	V_{DD}=26.0 V, I_{DQ}=400 mA, P_{OUT}=80 W, F=960 MHz

* Per Side

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
935	4.6 + j8.0	2.3 + j3.1
960	4.7 +j7.8	2.4 + j3.1



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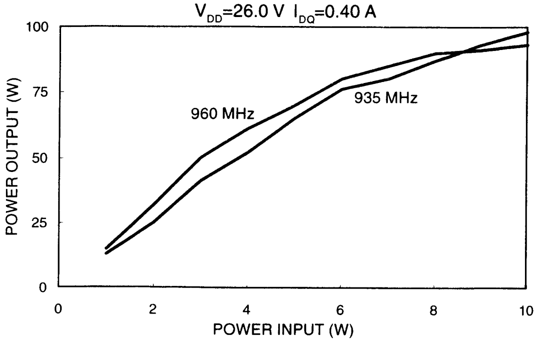
Typical Broadband Performance Curves

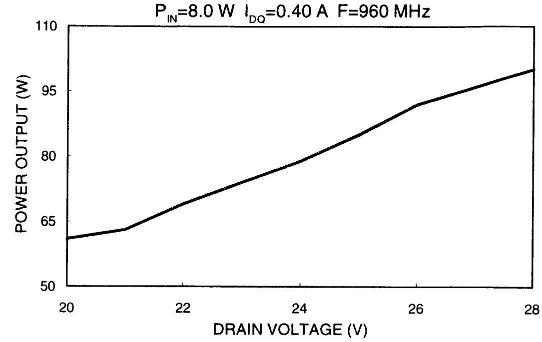
OUTPUT POWER vs INPUT POWER

V_{DD}=26.0 V I_{DQ}=0.40 A

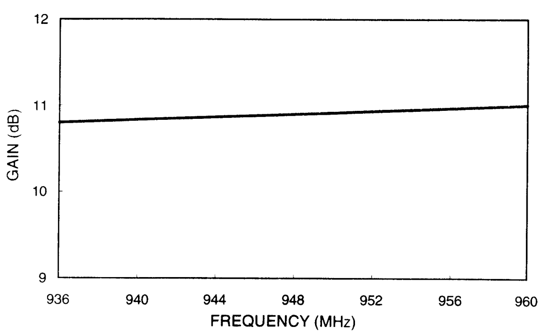


OUTPUT vs DRAIN VOLTAGE

P_{IN}=8.0 W I_{DQ}=0.40 A F=960 MHz

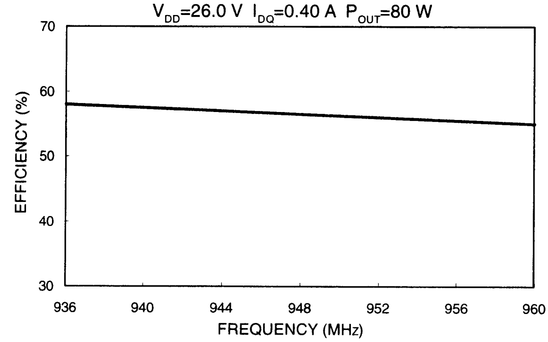


GAIN vs FREQUENCY



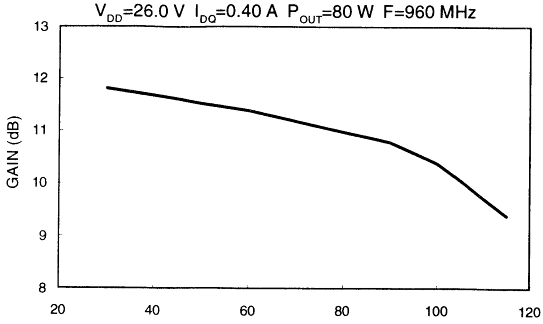
EFFICIENCY vs FREQUENCY

V_{DD}=26.0 V I_{DQ}=0.40 A P_{OUT}=80 W



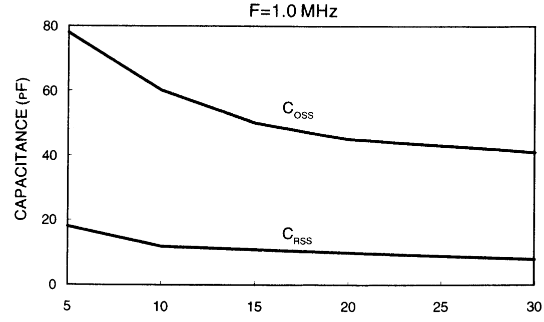
GAIN vs TEMPERATURE

V_{DD}=26.0 V I_{DQ}=0.40 A P_{OUT}=80 W F=960 MHz



CAPACITANCE vs VOLTAGE

F=1.0 MHz



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an AMP company

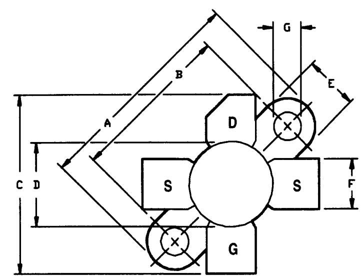
RF MOSFET Power Transistor, 15W, 12V
2 - 175 MHz

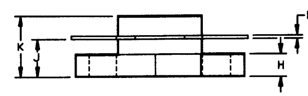
DU1215S

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices
- Specifically Designed for 12 Volt Applications





LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	20.07	20.83	.790	.820
D	9.47	9.73	.373	.383
E	6.22	6.48	.245	.255
F	5.64	5.79	.222	.228
G	2.92	3.30	.115	.130
H	2.29	2.67	.090	.105
J	4.04	4.55	.159	.179
K	6.58	7.39	.259	.291
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	40	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4	A
Power Dissipation	P_D	87.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	2	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	40	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=15.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100 mA
Forward Transconductance	G_M	0.5	-	S	V_{DS}=10.0 V, I_{DS}=1000 mA, ΔV_{GS}=1.0 V
Input Capacitance	C_{ISS}	-	50	pF	V_{DS}=12.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	60	pF	V_{DS}=12.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	12	pF	V_{DS}=12.0 V, F=1.0 MHz
Power Gain	G_P	9.5	-	dB	V_{DD}=12.0 V, I_{DQ}=100 mA, P_{OUT}=15 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=12.0 V, I_{DQ}=100 mA, P_{OUT}=15 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=12.0 V, I_{DQ}=100 mA, P_{OUT}=15 W, F=175 MHz

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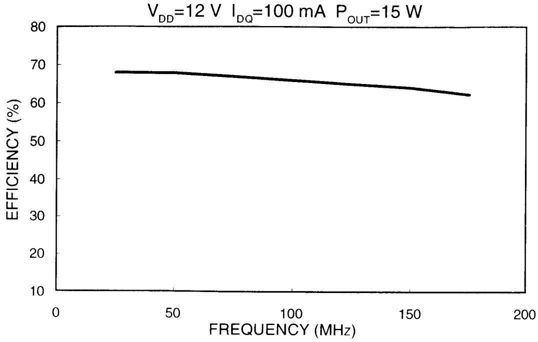
Typical Broadband Performance Curves

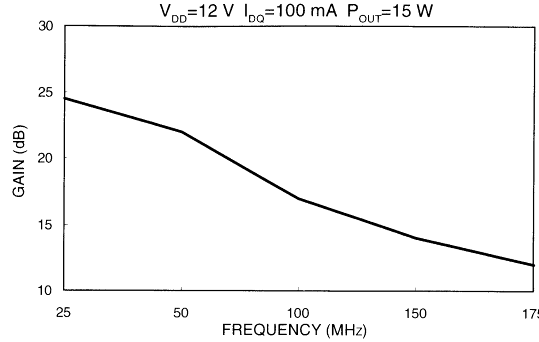
EFFICIENCY vs FREQUENCY

V_{DD}=12 V I_{DQ}=100 mA P_{OUT}=15 W



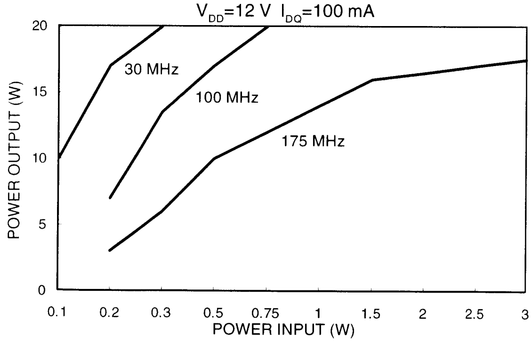
GAIN vs FREQUENCY

V_{DD}=12 V I_{DQ}=100 mA P_{OUT}=15 W



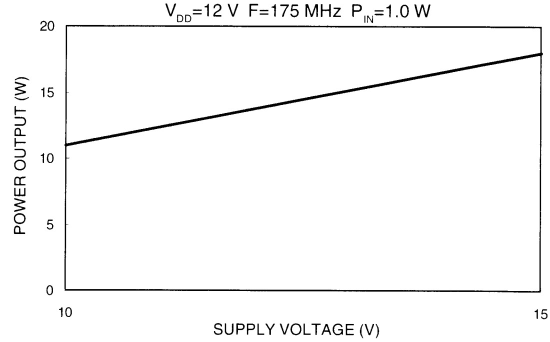
POWER OUTPUT vs POWER INPUT

V_{DD}=12 V I_{DQ}=100 mA



POWER OUTPUT vs SUPPLY VOLTAGE

V_{DD}=12 V F=175 MHz P_{IN}=1.0 W



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Typical Device Impedance

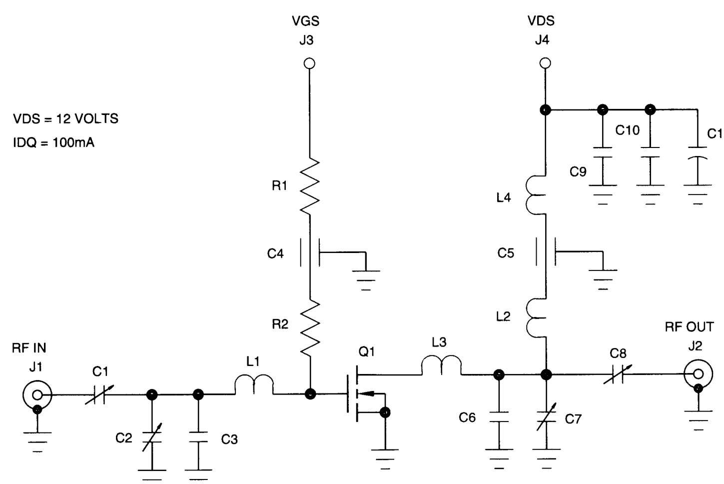
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	3.0 - j 25	4.0 - j 3.0
100	3.0 - j 15	3.5 - j 1.5
175	5.0 - j 8	4.0 + j 0.0

V_{DD}=12 V, I_{DQ}=100 mA, P_{OUT}=15 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C8	TRIMMER CAPACITOR 5-80pF
C2,C7	TRIMMER CAPACITOR 4-40pF
C3,C6	SEMCO CAPACITOR 30pF
C4,C5	FEEDTHROUGH CAPACITOR 0.001uF
C9	SEMCO CAPACITOR 1000pF
C10	MONOLITHIC CERAMIC CAPACITOR 0.01uF
C11	ELECTROLYTIC CAPACITOR 50uF 50 V.
L1,L3	NO. 12 AWG COPPER WIRE X 1"
L2	8 TURNS OF NO. 20 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
L4	12 TURNS OF NO. 20 AWG ON '0.25", CLOSE WOUND
R1,R2	RESISTOR 100K OHMS
Q1	DU1215S
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

M/A-COM an AMP company

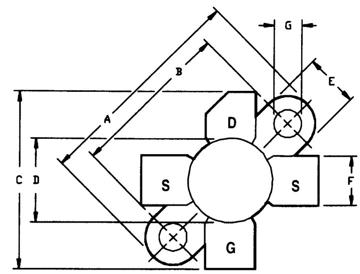
RF MOSFET Power Transistor, 30W, 12V
2 - 175 MHz

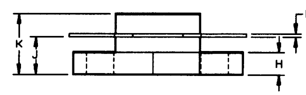
DU1230S

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices
- Specifically Designed for 12 Volt Applications





LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	20.07	20.83	.790	.820
D	9.47	9.73	.373	.383
E	6.22	6.48	.245	.255
F	5.64	5.79	.222	.228
G	2.92	3.30	.115	.130
H	2.29	2.67	.090	.105
J	4.04	4.55	.159	.179
K	6.58	7.39	.259	.291
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	40	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	8	A
Power Dissipation	P_D	175	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	40	-	V	V_{GS}=0.0 V, I_{DS}=10.0 mA
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=15.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=200 mA
Forward Transconductance	G_M	1.0	-	S	V_{DS}=10.0 V, I_{DS}=2000 mA, ΔV_{GS}=1.0 V
Input Capacitance	C_{ISS}	-	100	pF	V_{DS}=12.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	120	pF	V_{DS}=12.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	24	pF	V_{DS}=12.0 V, F=1.0 MHz
Power Gain	G_P	9.0	-	dB	V_{DD}=12.0 V, I_{DQ}=200 mA, P_{OUT}=30 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=12.0 V, I_{DQ}=200 mA, P_{OUT}=30 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=12.0 V, I_{DQ}=200 mA, P_{OUT}=30 W, F=175 MHz

Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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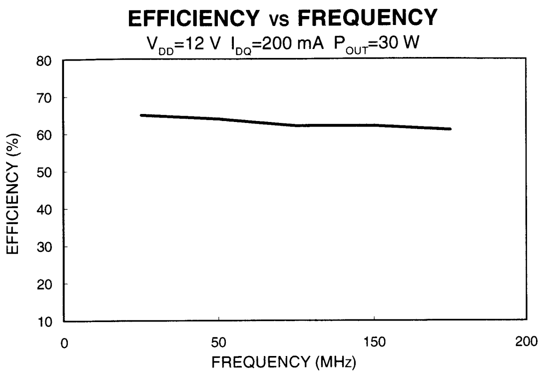
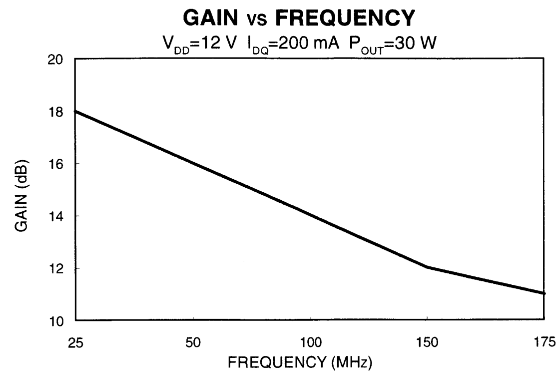
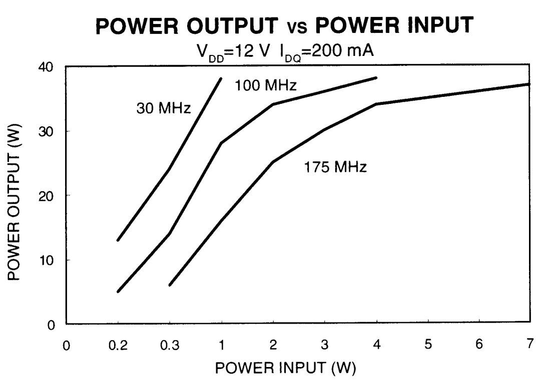
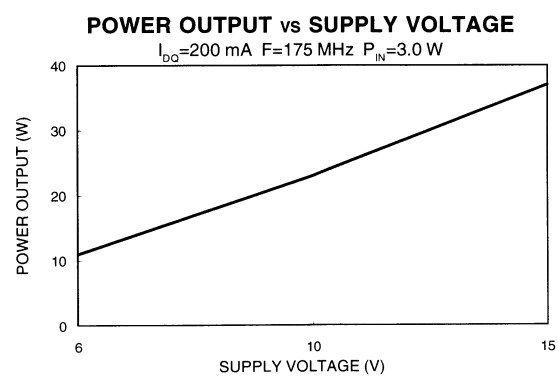
Typical Broadband Performance Curves









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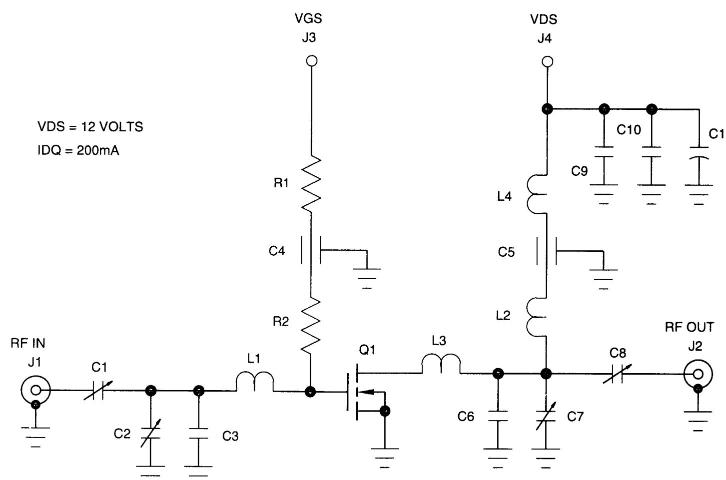
Typical Device Impedance

Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	12.0 - j 14.0	2.5 + j 3.0
100	4.0 - j 8.0	2.5 - j 1.0
175	2.0 - j 2.5	2.5 - j 0.5

V_{DD}=12 V, I_{DQ}=200 mA, P_{OUT}=30 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.
Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C8	ARCO NO. 462 TRIMMER CAPACITOR 5-80pF
C2,C7	ARCO NO. 422 TRIMMER CAPACITOR 4-40pF
C3	SEMCO CAPACITOR 50pF
C4,C5	FEEDTHROUGH CAPACITOR 0.001uF
C6	SEMCO CAPACITOR 30pF
C9	SEMCO CAPACITOR 1000pF
C10	MONOLITHIC CERAMIC CAPACITOR 0.01uF
C11	ELECTROLYTIC CAPACITOR 50uF 50 V.
L1,L3	NO. 12 AWG COPPER WIRE X 1"
L2	8 TURNS OF NO. 20 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
L4	12 TURNS OF NO. 20 AWG ON '0.25", CLOSE WOUND
R1,R2	RESISTOR 100K OHMS
Q1	DU1230S
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

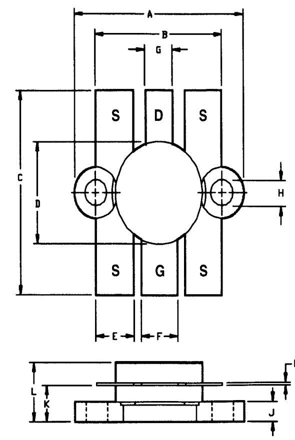
![M/A-COM an AMP company]

RF MOSFET Power Transistor, 60W, 12V
2 - 175 MHz
DU1260T

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices
- Specifically Designed for 12 Volt Applications



LETTER DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.15	.960	.990
B	18.29	18.54	.720	.730
C	21.36	21.74	.841	.856
D	12.60	12.85	.496	.506
E	5.33	5.59	.210	.220
F	5.08	5.33	.200	.210
G	3.81	4.06	.150	.160
H	3.10	3.15	.122	.128
J	2.51	2.67	.099	.105
K	4.06	4.57	.160	.180
L	6.68	7.49	.263	.295
M	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	40	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	24	A
Power Dissipation	P_D	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	40	-	V	V_{GS}=0.0 V, I_{DS}=30.0 mA
Drain-Source Leakage Current	I_{DSS}	-	6.0	mA	V_{DS}=15.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	6.0	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=600 mA
Forward Transconductance	G_M	3.0	-	S	V_{DS}=10.0 V, I_{DS}=6000 mA, ΔV_{GS}=1.0 V
Input Capacitance	C_{ISS}	-	200	pF	V_{DS}=12.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	240	pF	V_{DS}=12.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	48	pF	V_{DS}=12.0 V, F=1.0 MHz
Power Gain	G_P	8.0	-	dB	V_{DD}=12.0 V, I_{DQ}=600 mA, P_{OUT}=60 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=12.0 V, I_{DQ}=600 mA, P_{OUT}=60 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=12.0 V, I_{DQ}=600 mA, P_{OUT}=60 W, F=175 MHz

Specifications Subject to Change Without Notice.

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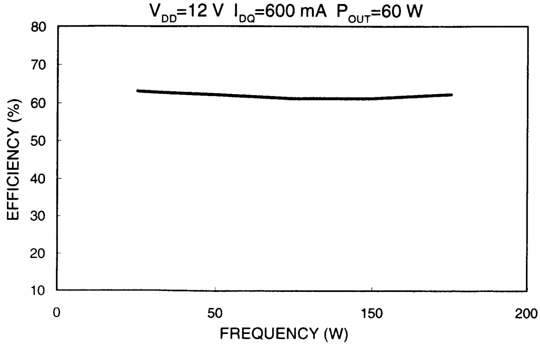
Typical Broadband Performance Curves

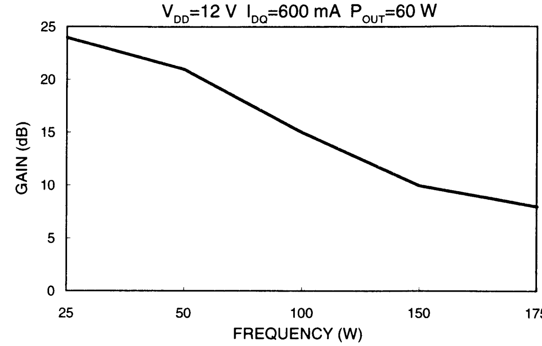
DRAIN EFFICIENCY vs FREQUENCY

V_{DD}=12 V I_{DQ}=600 mA P_{OUT}=60 W



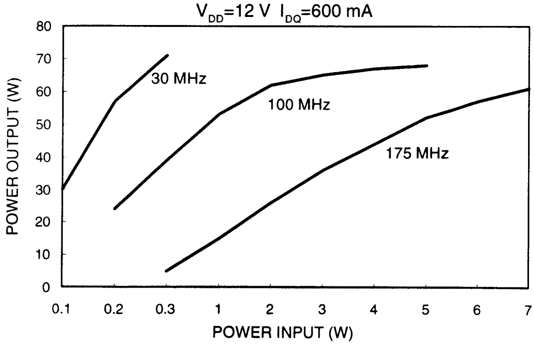
GAIN vs FREQUENCY

V_{DD}=12 V I_{DQ}=600 mA P_{OUT}=60 W



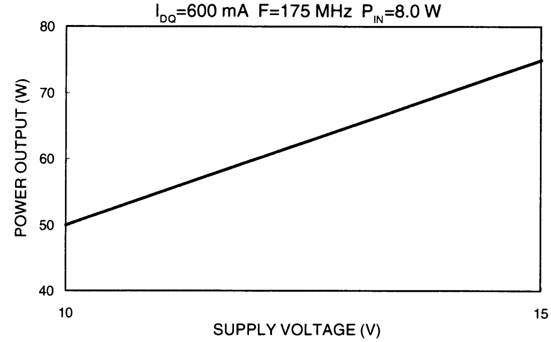
POWER OUTPUT vs POWER INPUT

V_{DD}=12 V I_{DQ}=600 mA



POWER OUTPUT vs SUPPLY VOLTAGE

I_{DQ}=600 mA F=175 MHz P_{IN}=8.0 W



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Typical Device Impedance

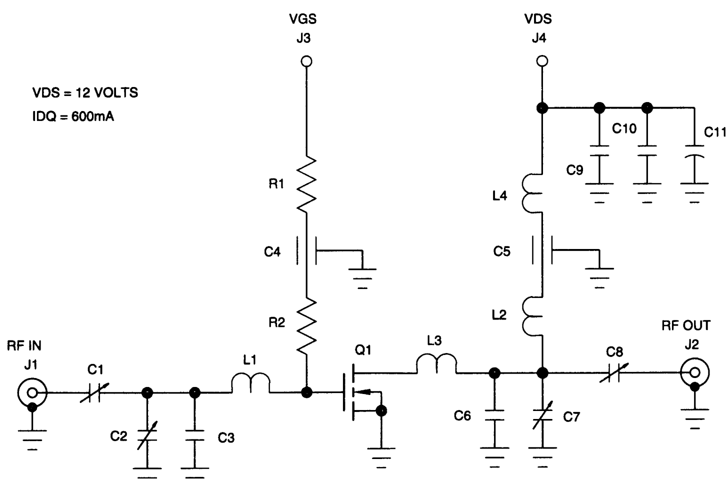
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	4.5 - j 8.0	4.6 - j 7.9
100	1.4 - j 4.0	1.4 - j 8.0
175	1.0 - j 0.5	1.0 - j 0.5

V_{DD}=12 V, I_{DQ}=600 mA, P_{OUT}=60 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C8	ARCO NO. 462 TRIMMER CAPACITOR 5-80pF
C2,C7	ARCO NO. 422 TRIMMER CAPACITOR 4-40pF
C3	SEMCO CAPACITOR 50pF
C4,C5	FEEDTHROUGH CAPACITOR 0.001uF
C6	SEMCO CAPACITOR 30pF
C9	SEMCO CAPACITOR 1000pF
C10	MONOLITHIC CERAMIC CAPACITOR 0.01uF
C11	ELECTROLYTIC CAPACITOR 50uF 50 V.
L1,L3	NO. 12 AWG COPPER WIRE X 1"
L2	8 TURNS OF NO. 20 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
L4	12 TURNS OF NO. 20 AWG ON '0.25", CLOSE WOUND
R1,R2	RESISTOR 100K OHMS
Q1	DU1260T
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

M/A-COM
an AMP company

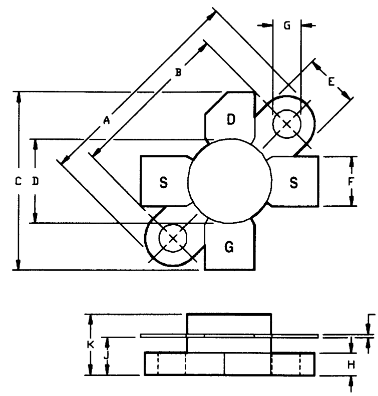
RF MOSFET Power Transistor, 5W, 28V
2 - 175 MHz

DU2805S

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	1.4	A
Power Dissipation	P_D	15.8	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	11.1	°C/W

LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	20.07	20.83	.790	.820
D	9.47	9.73	.373	.383
E	6.22	6.48	.245	.255
F	5.64	5.79	.222	.228
G	2.92	3.30	.115	.130
H	2.29	2.67	.090	.105
J	4.04	4.55	.159	.179
K	6.58	7.39	.259	.291
L	.10	.15	.004	.006

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=2.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=10 mA
Forward Transconductance	G_M	80	-	mS	V_{DS}=10.0 V, I_{DS}=10 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	7	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	5	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	2.4	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	11	-	dB	V_{DD}=28.0 V, I_{DQ}=50 mA, P_{OUT}=5.0 W, F=175 MHz
Drain Efficiency	η_D	55	-	%	V_{DD}=28.0 V, I_{DQ}=50 mA, P_{OUT}=5.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=50 mA, P_{OUT}=5.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

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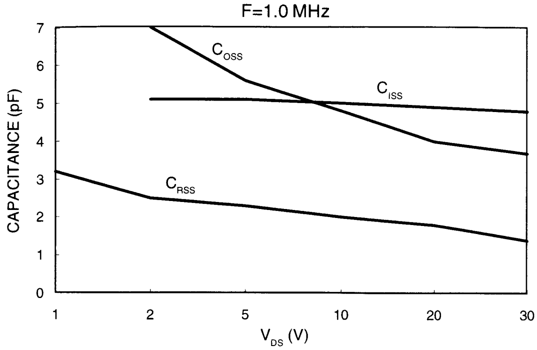
Typical Broadband Performance Curves

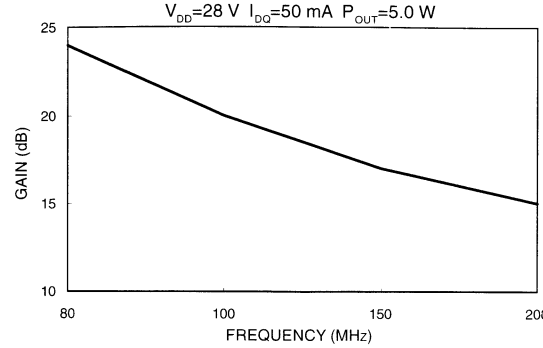
CAPACITANCES vs VOLTAGE

F=1.0 MHz



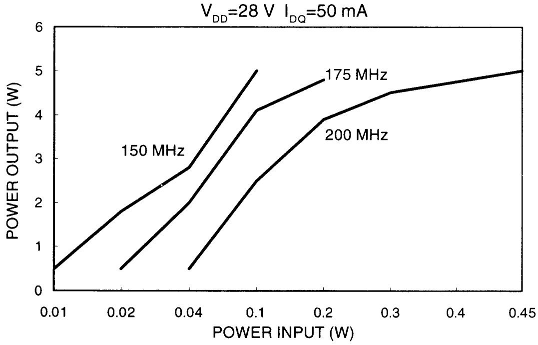
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=50 mA P_{OUT}=5.0 W



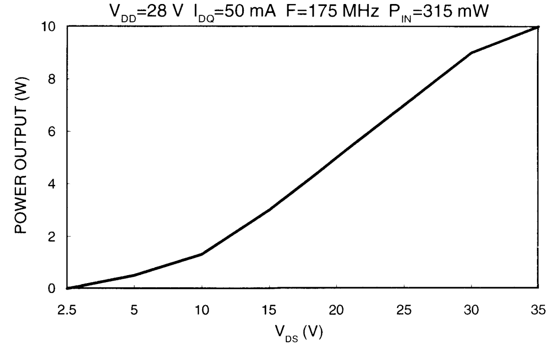
POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=50 mA



POWER OUTPUT vs VOLTAGE

V_{DD}=28 V I_{DQ}=50 mA F=175 MHz P_{IN}=315 mW



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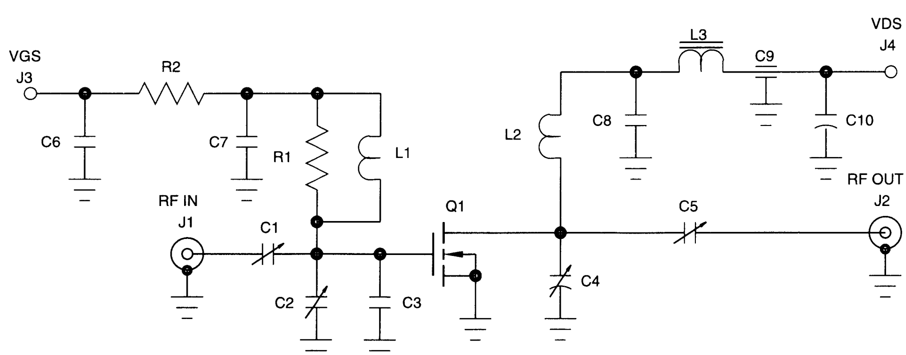
Typical Device Impedance

Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	15.0 - j 121.0	57.0 + j 23.0
150	39.0 - j 77.0	55.0 + j 23.0
175	41.0 - j 38.0	56.0 + j 19.0
200	34.0 - j 14.0	56.0 + j 20.0

V_{DD}=28 V, I_{DQ}=50 mA, P_{OUT}=5 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.
Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1	TRIMMER CAPACITOR 5-80pF
C2	TRIMMER CAPACITOR 7-100pF
C3	CAPACITOR 15pF
C4,C5	TRIMMER CAPACITOR 9-180pF
C6,C8	CAPACITOR 1000pF
C7	CAPACITOR 500pF
C9	FEEDTHROUGH CAPACITOR 1000pF
C10	ELECTROLYTIC CAPACITOR 25uF 50 VOLTS
L1	2 TURNS OF NO. 12 AWG ON '0.25"
L2	8 TURNS OF NO. 12 AWG ON '0.25"
L3	1 TURN OF NO. 12 AWG W/ SIEMENS DOUBLE APERTURE CORE B62152-A0001-X001
Q1	DU2805S
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

an AMP company

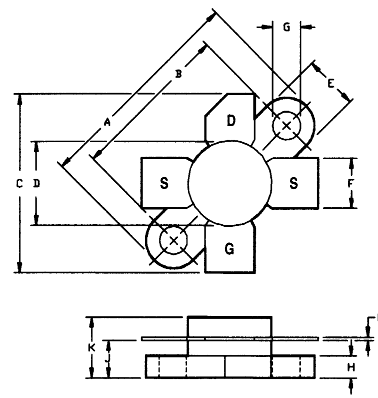
RF MOSFET Power Transistor, 10W, 28V
2 - 175 MHz

DU2810S

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Low Noise Floor



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	20.07	20.83	.790	.820
D	9.47	9.73	.373	.383
E	6.22	6.48	.245	.255
F	5.64	5.79	.222	.228
G	2.92	3.30	.115	.130
H	2.29	2.67	.090	.105
J	4.04	4.55	.159	.179
K	6.58	7.39	.259	.291
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	2.8	A
Power Dissipation	P_D	35	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	2	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=4.0 mA
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=20 mA
Forward Transconductance	G_M	160	-	mS	V_{DS}=10.0 V, I_{DS}=200 mA, Pulsed 80-300 µs
Input Capacitance	C_{ISS}	-	14	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	10	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	4.6	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=10 W, F=175 MHz
Drain Efficiency	η_D	55	-	%	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=10 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=10 W, F=175 MHz

Specifications Subject to Change Without Notice.

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Typical Device Impedance

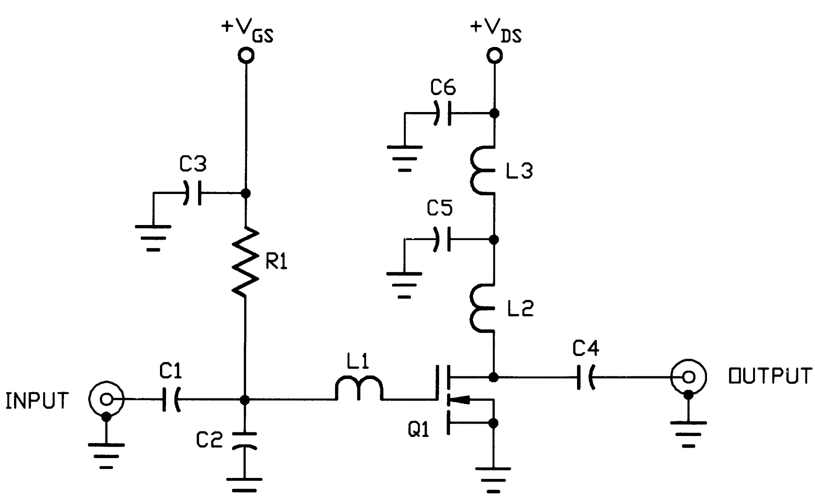
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	27.0 - j 11.0	23.0 - j 3.0
50	24.0 - j 15.0	19.0 - j 5.0
100	18.0 - j 18.0	14.0 - j 6.0
200	12.0 - j 19.0	9.0 - j 5.0

V_{DD}=28 V, I_{DQ}=100 mA, P_{OUT}=10.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the series equivalent load impedance as measured from drain to ground.

RF Test Fixture



C2	20 pF, UNELCO
C1 C3	500 pF, UNELCO
C4 C5	1000 pF, UNELCO
C6	5 uF ELECTROLYTIC
R1	12K OHM
L2	4 TURNS OF NO. 16 AWG ON .10' ID
L1	2 TURNS OF NO. 16 AWG ON .35' ID
L3	5 TURNS OF NO. 16 AWG ON .35' ID
Q1	DU2810S

an AMP company

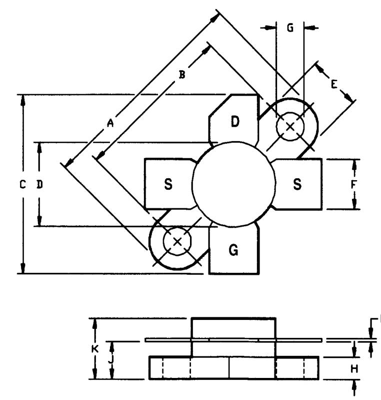
RF MOSFET Power Transistor, 20W, 28V
2 - 175 MHz

DU2820S

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	20.07	20.83	.790	.820
D	9.47	9.73	.373	.383
E	6.22	6.48	.245	.255
F	5.64	5.79	.222	.228
G	2.92	3.30	.115	.130
H	2.29	2.67	.090	.105
J	4.04	4.55	.159	.179
K	6.58	7.39	.259	.291
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	24	A
Power Dissipation	P_D	62.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	2.8	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	μA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA
Forward Transconductance	G_M	500	-	mS	V_{DS}=10.0 V, I_{DS}=100.0 mA, ΔV_{GS}=1.0 V, 80 μs Pulse
Input Capacitance	C_{ISS}	-	45	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	40	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	8	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=20 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=20 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=20 W, F=175 MHz

Specifications Subject to Change Without Notice.

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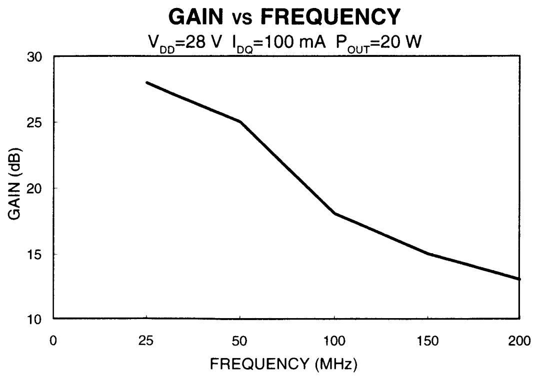
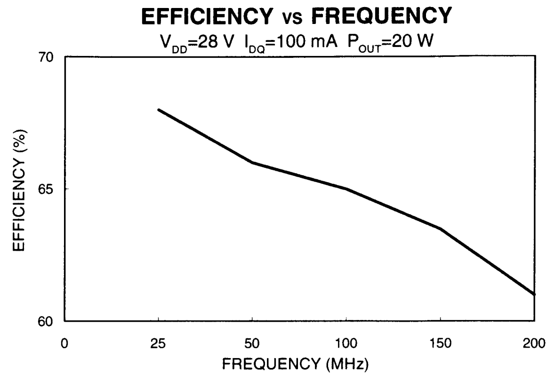
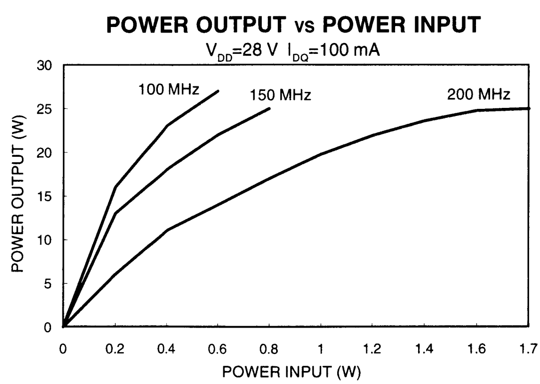
Typical Broadband Performance Curves







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Typical Device Impedance

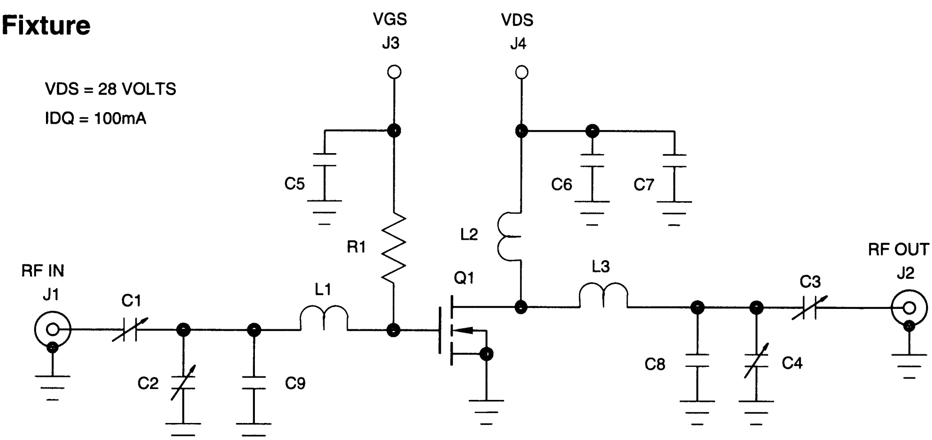
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	17.5 - j 13.0	16.0 + j 2.5
50	15.0 - j 15.5	15.0 + j 4.0
100	8.0 - j 14.0	12.0 + j 6.0
200	5.5 - j 8.0	9.25 + j 6.0

V_{DD}=28 V, I_{DQ}=100 mA, P_{OUT}=20 Watts

Z_{IN} is the series equivalent input impedance of the device.

Z_{LOAD} is the series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C3	TRIMMER CAPACITOR 5-80pF
C2,C4	TRIMMER CAPACITOR 3-30pF
C5,C6	CAPACITOR 0.01uF
C7	CAPACITOR 0.001uF
C8	CAPACITOR 5.6pF
C9	CAPACITOR 10pF
L1,L3	2 TURNS OF NO. 20 ENAMEL WIRE ON '0.25" CLOSE WOUND
L2	7 TURNS OF NO. 20 ENAMEL WIRE ON '0.25" CLOSE WOUND
R1	RESISTOR 100K OHMS
Q1	DU2820S
BOARD	FR4 0.062"

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M/A-COM
an AMP company

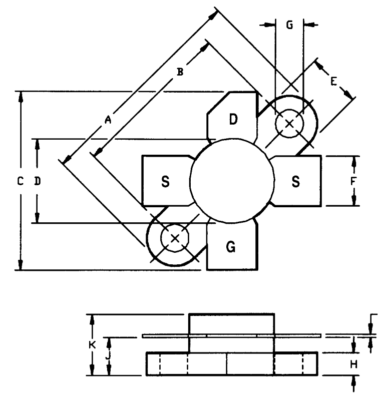
RF MOSFET Power Transistor, 40W, 28V
2 - 175 MHz

DU2840S

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	20.07	20.83	.790	.820
D	9.47	9.73	.373	.383
E	6.22	6.48	.245	.255
F	5.64	5.79	.222	.228
G	2.92	3.30	.115	.130
H	2.29	2.67	.090	.105
J	4.04	4.55	.159	.179
K	6.58	7.39	.259	.291
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	8	A
Power Dissipation	P_D	125	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.4	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=10.0 mA
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=200.0 mA
Forward Transconductance	G_M	1	-	S	V_{DS}=10.0 V, I_{DS}=2000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	90	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	80	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	16	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=200 mA, P_{OUT}=40.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=200 mA, P_{OUT}=40.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=200 mA, P_{OUT}=40.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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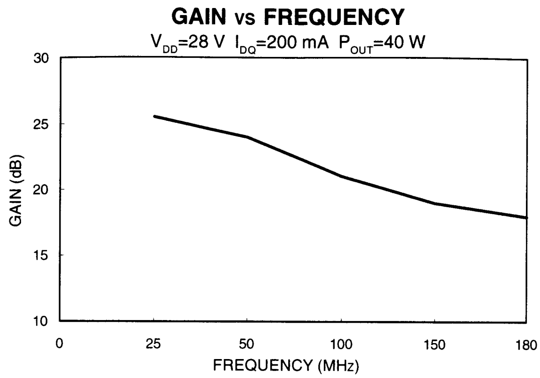
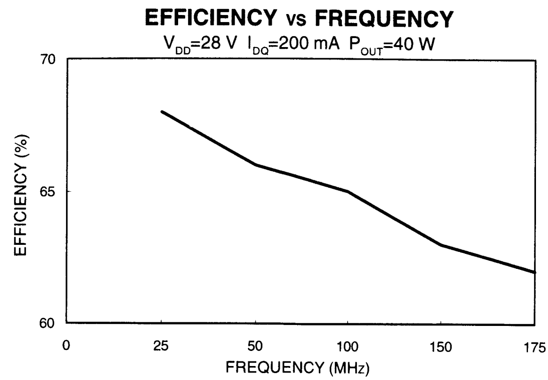
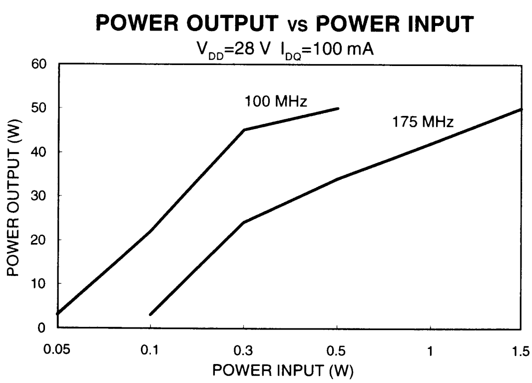
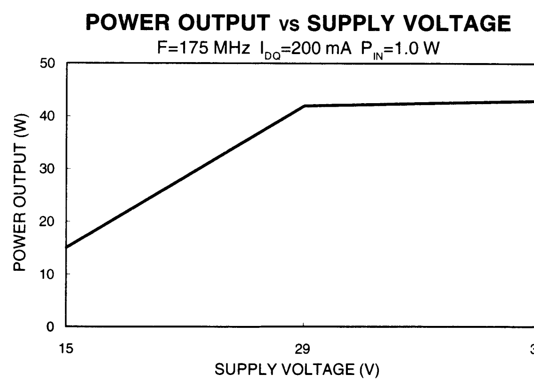
Typical Broadband Performance Curves









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Fax (800) 618-8883 Fax +81 (03) 3226-1451 Fax +44 (1344) 300 020

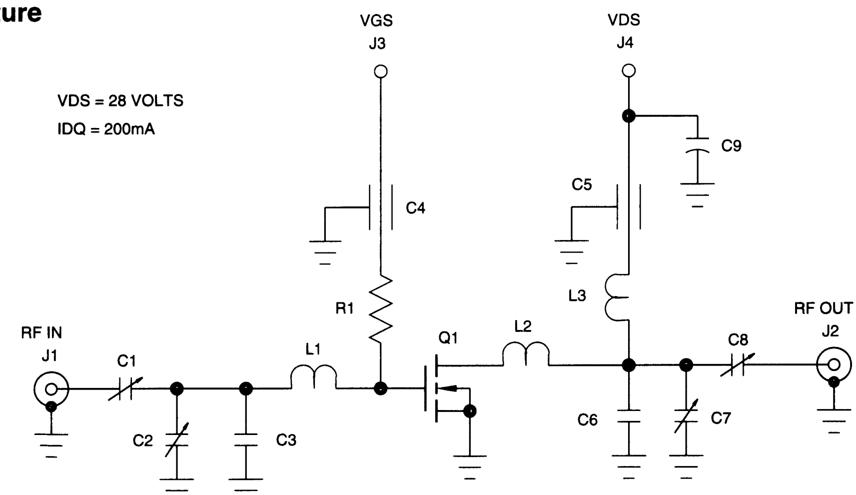
Typical Device Impedance

Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	12.0 - j 6.8	6.5 - j 1.5
50	10.0 - j 6.5	6.0 - j 1.8
100	6.0 - j 5.5	5.5 - j 1.8
200	1.1 - j 3.0	3.5 - j 1.8

V_{DD}=28 V, I_{DQ}=200 mA, P_{OUT}=40 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.
Z_{LOAD} is the series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C7,C8	TRIMMER CAPACITOR 4-40pF
C2	TRIMMER CAPACITOR 9-180pF
C3,C6	CAPACITOR 50pF
C4,C5	FEEDTHROUGH CAPACITOR 0.004uF
C9	ELECTROLYTIC CAPACITOR 50uF 50 VOLT
L1	NO. 12 AWG COPPER WIRE X 1.25"
L2	NO. 12 AWG COPPER WIRE X 1.50"
L3	8 TURNS OF NO. 22 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1	RESISTOR 100K OHMS
Q1	DU2840S
BOARD	FR4 0.062"

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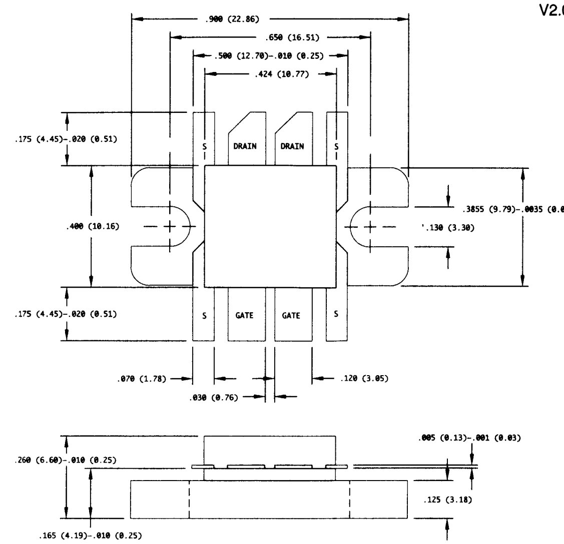
M/A-COM an AMP company

RF MOSFET Power Transistor, 40W, 28V
2 - 175 MHz

DU2840V

V2.00



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±0.13MM)

Features

- N-Channel Enhancement Mode Device
- HF to VHF Applications
- 40 Watts CW
- Common Source Push-Pull Configuration
- DMOS Structure
- Aluminum Metallization

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	8	A
Power Dissipation	P_D	125	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.4	°C/W

Electrical Characteristics at 25°C

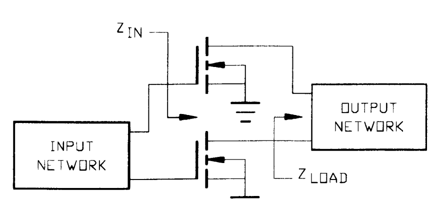
Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	I_D=5.0 mA, V_{GS}=0.0 V*
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100 mA*
Forward Transconductance	G_M	500	-	mS	V_{DS}=10.0 V, I_{DS}=1000 mA (pulsed)*
Input Capacitance	C_{ISS}		45	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}		40	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}		8	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	13	-	dB	V_{DD}=26.0 V, I_{DQ}=200 mA, P_{OUT}=40 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=26.0 V, I_{DQ}=200 mA, P_{OUT}=40 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=26.0 V, I_{DQ}=200 mA, P_{OUT}=40 W, F=175 MHz

* Per Side

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
30	30 - j23	30 + j5.0
50	25 - j28	29 + j6.0
100	15 - j25	22 + j10
200	10 - j13	18 + j11

V_{DD}=28 V, I_{DQ}=200 mA, P_{OUT}=40 W



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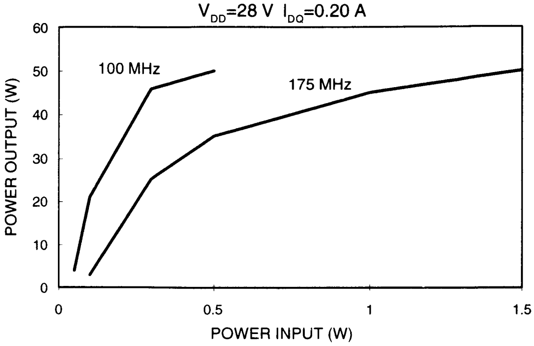
Typical Broadband Performance Curves

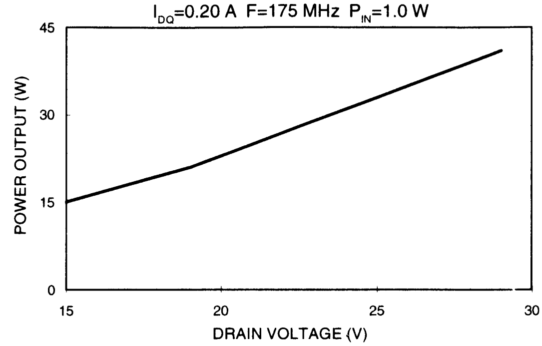
OUTPUT POWER vs INPUT POWER

V_{DD}=28 V I_{DQ}=0.20 A



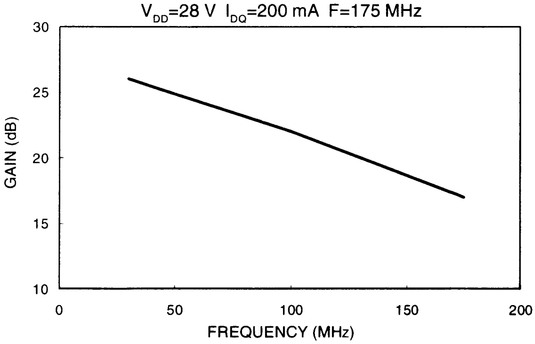
OUTPUT POWER vs DRAIN VOLTAGE

I_{DQ}=0.20 A F=175 MHz P_{IN}=1.0 W



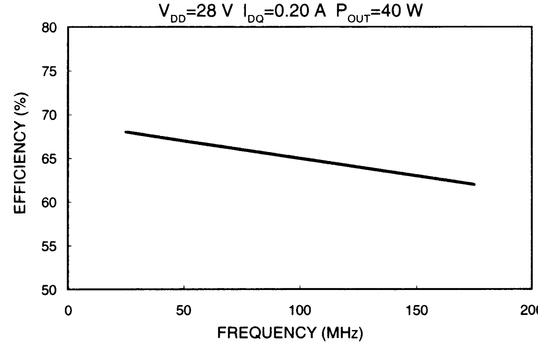
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=200 mA F=175 MHz



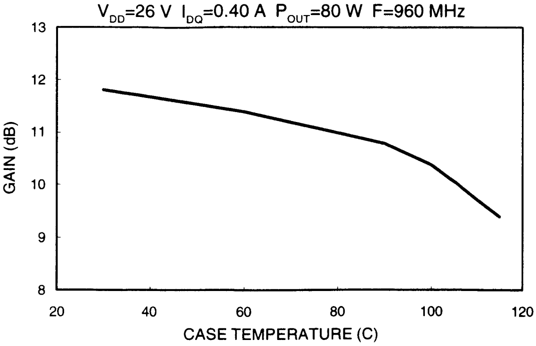
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=0.20 A P_{OUT}=40 W



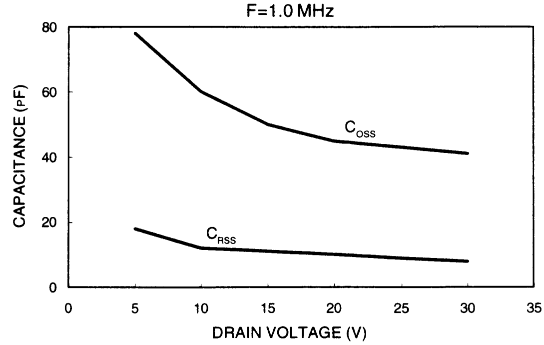
GAIN vs TEMPERATURE

V_{DD}=26 V I_{DQ}=0.40 A P_{OUT}=80 W F=960 MHz



CAPACITANCE vs VOLTAGE

F=1.0 MHz



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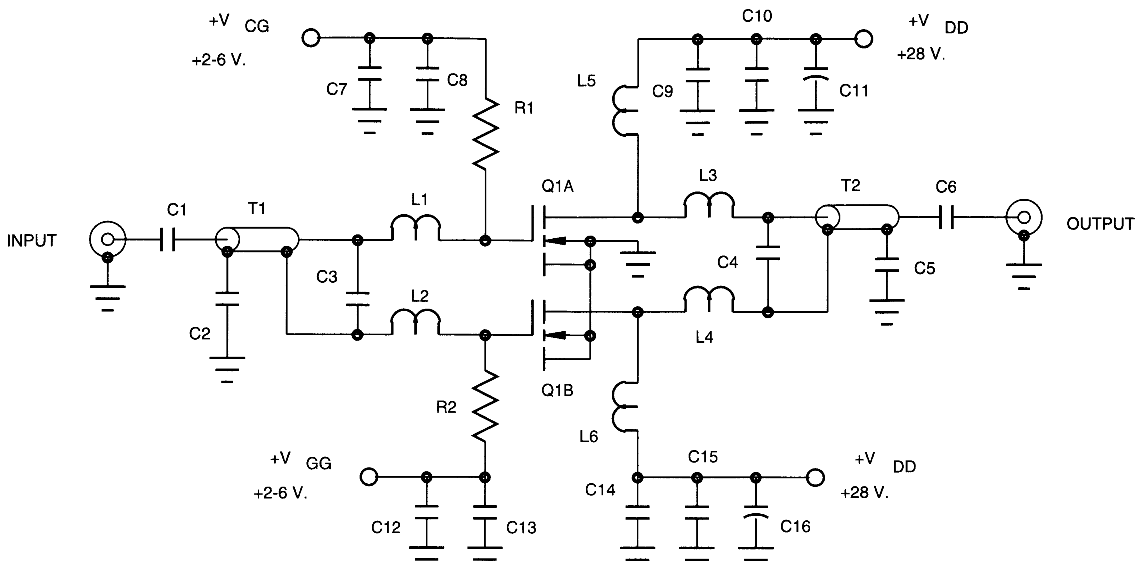
RF Test Fixture



PARTS LIST

C1 C6	ATC 300 pF
C2 C5	ATV 820 pF
C3	ATC 55 pF
C4	ATC 12 pF
C7 C9 C12 C14	ATC 5000 pF
C8 C10 C13 C15	CERAMIC .01 uF
C11 C16	ELECTROYLTIC 47 uF
R1 R2	470 OHMS .25 W
L1 L2 L3 L4	NO. 18 AWG 1.0" LONG X .75" HIGH
L5 L6	9 TURNS OF NO. 18 AWG ON .25" ID
T1 T2	50 OHM .085" OD X 3.0" LONG
Q1	DU2840V

28 VOLT 40 WATT

I_{DQ} = .2 AMP

175 MHZ

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

RF MOSFET Power Transistor, 60W, 28V

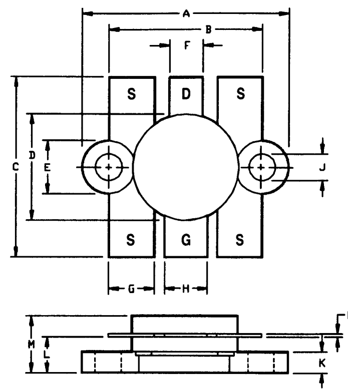
2 - 175 MHz

DU2860T

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	21.21	21.97	.835	.865
D	12.60	12.85	.496	.506
E	6.22	6.48	.245	.255
F	3.81	4.06	.150	.160
G	5.33	5.59	.210	.220
H	5.08	5.33	.200	.210
J	3.05	3.30	.120	.130
K	2.29	2.54	.090	.100
L	4.06	4.57	.160	.180
M	6.68	7.49	.263	.295
N	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	12	A
Power Dissipation	P_D	159	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	1.1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=15.0 mA
Drain-Source Leakage Current	I_{DSS}	-	3.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	3.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=300.0 mA
Forward Transconductance	G_M	1.5	-	S	V_{DS}=10.0 V, I_{DS}=3.0 A, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	135	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	120	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	24	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=300 mA, P_{OUT}=60.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=300 mA, P_{OUT}=60.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=300 mA, P_{OUT}=60.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

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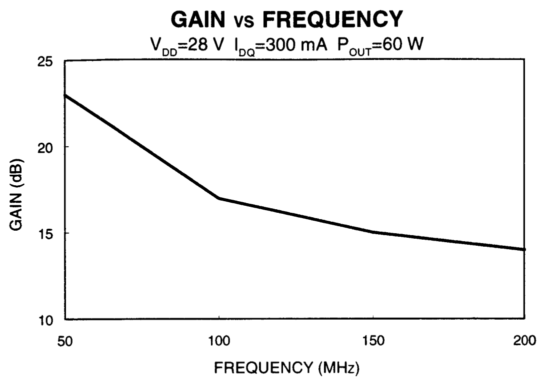
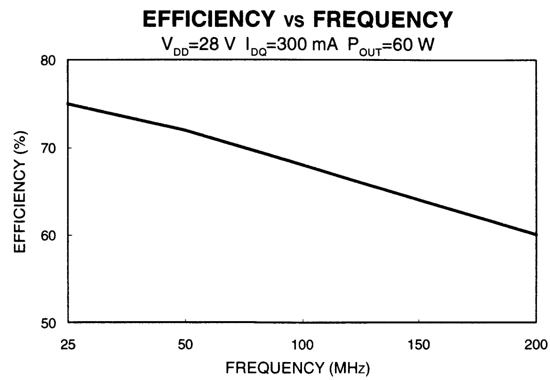
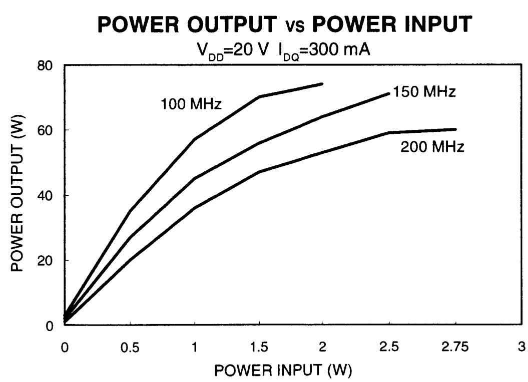
North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

Typical Broadband Performance Curves







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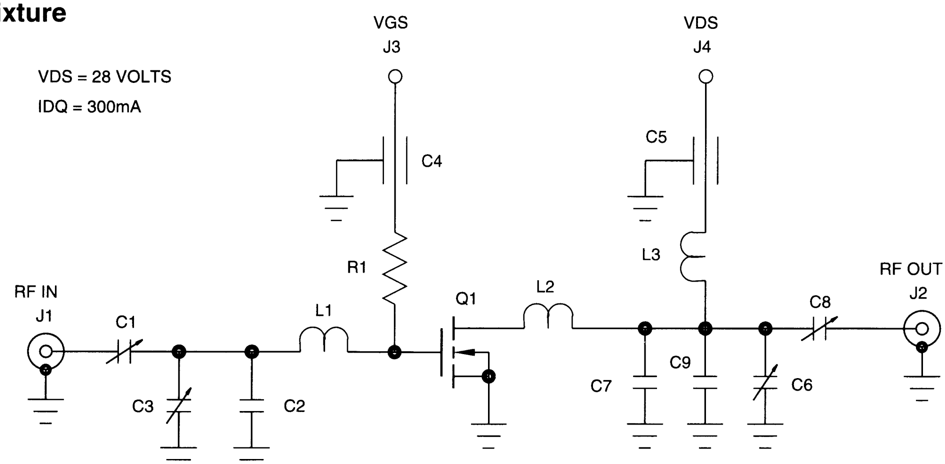
Typical Device Impedance

Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	9.0 - j 4.0	6.0 + j 0.0
50	6.0 - j 5.8	5.0 + j 2.0
100	4.0 - j 4.2	4.0 + j 3.0
200	1.0 - j 1.0	2.0 + j 1.9

V_{DD}=28 V, I_{DQ}=300 mA, P_{OUT}=60 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.
Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C3	TRIMMER CAPACITOR 4-40pF
C2,C9	CAPACITOR 50pF
C4,C5	FEEDTHROUGH CAPACITOR 0.001uF
C6,C8	TRIMMER CAPACITOR 9-180pF
C7	CAPACITOR 15pF
L1	NO. 12 AWG COPPER WIRE X 1.18" (LOOP 0.5")
L2	NO. 12 AWG COPPER WIRE X 1" (LOOP 0.4")
L3	8 TURNS OF NO. 22 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1	RESISTOR 300 OHMS 0.5 WATT
Q1	DU2860T
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

M/A-COM
an AMP company

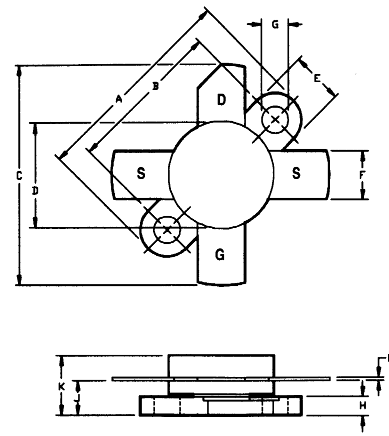
RF MOSFET Power Transistor, 60W, 28V
2 - 175 MHz

DU2860U

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	25.91	26.42	1.020	1.040
D	12.60	12.85	.496	.506
E	6.22	6.48	.245	.255
F	5.59	5.84	.220	.230
G	3.05	3.30	.120	.130
H	2.21	2.59	.087	.102
J	3.91	4.42	.154	.174
K	6.53	7.34	.257	.289
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	12	A
Power Dissipation	P_D	159	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=15.0 mA
Drain-Source Leakage Current	I_{DSS}	-	3.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	3.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=300.0 mA
Forward Transconductance	G_M	1.5	-	S	V_{DS}=10.0 V, I_{DS}=3.0 A, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	135	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	120	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	24	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=300 mA, P_{OUT}=60.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=300 mA, P_{OUT}=60.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=300 mA, P_{OUT}=60.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

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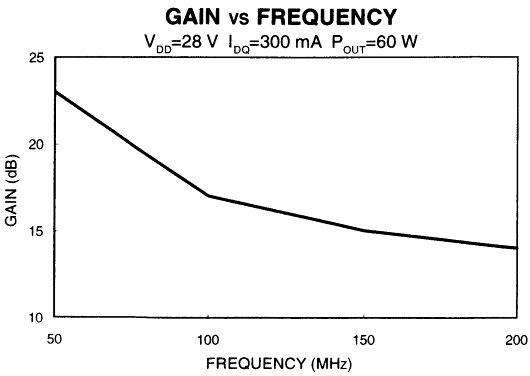
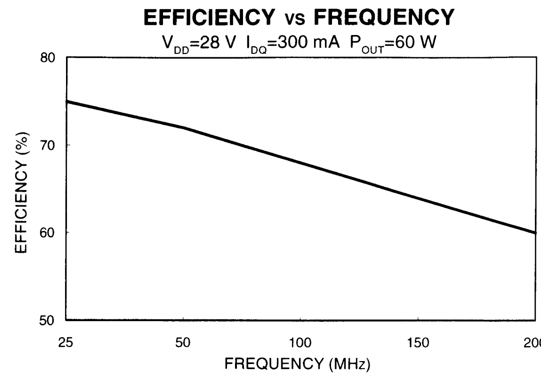
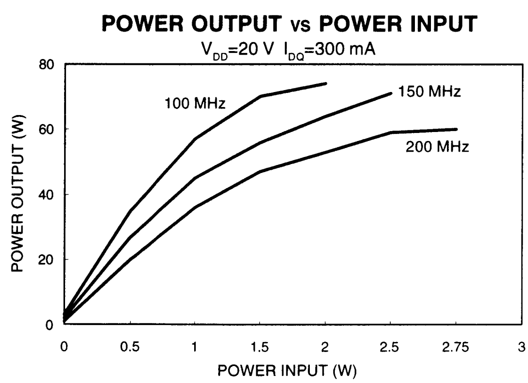
Typical Broadband Performance Curves







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Typical Device Impedance

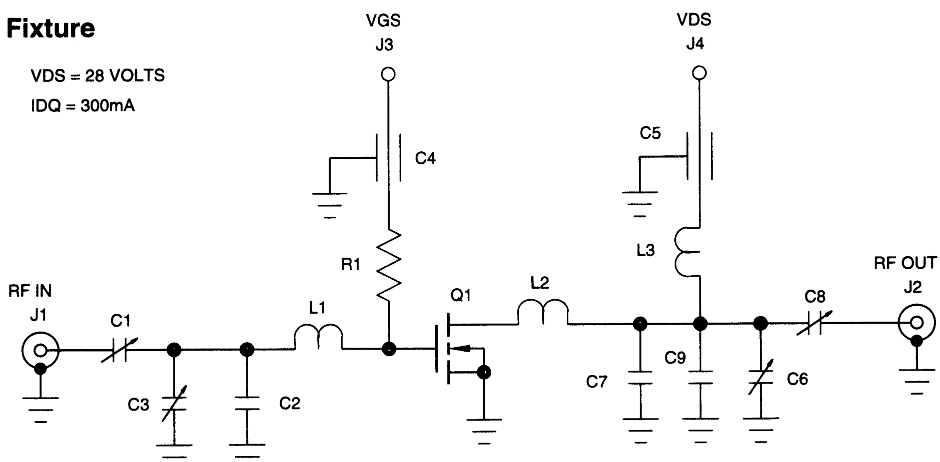
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	9.0 - j 4.0	6.0 + j 0.0
50	6.0 - j 5.8	5.0 + j 2.0
100	4.0 - j 4.2	4.0 + j 3.0
200	1.0 - j 1.0	2.0 + j 1.9

V_{DD}=28 V, I_{DQ}=300 mA, P_{OUT}=60 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C3	TRIMMER CAPACITOR 4-40pF
C2,C9	CAPACITOR 50pF
C4,C5	FEEDTHROUGH CAPACITOR 0.001uF
C6,C8	TRIMMER CAPACITOR 9-180pF
C7	CAPACITOR 15pF
L1	NO. 12 AWG COPPER WIRE X 1.18" (LOOP 0.5")
L2	NO. 12 AWG COPPER WIRE X 1" (LOOP 0.4")
L3	8 TURNS OF NO. 18 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1	RESISTOR 300 OHMS 0.5 WATT
Q1	DU2860U
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

M/A-COM
an AMP company

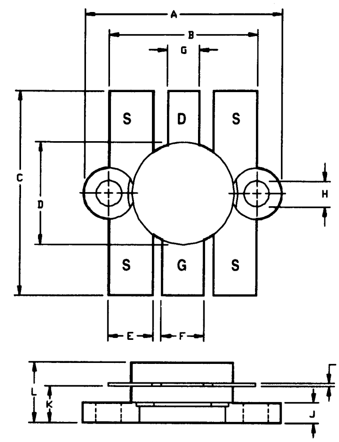
RF MOSFET Power Transistor, 80W, 28V
2 - 175 MHz

DU2880T

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.15	.960	.990
B	18.29	18.54	.720	.730
C	21.36	21.74	.841	.856
D	12.60	12.85	.496	.506
E	5.33	5.59	.210	.220
F	5.08	5.33	.200	.210
G	3.81	4.06	.150	.160
H	3.10	3.15	.122	.128
J	2.51	2.67	.099	.105
K	4.06	4.57	.160	.180
L	6.68	7.49	.263	.295
M	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	16	A
Power Dissipation	P_D	206	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	0.85	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=20.0 mA
Drain-Source Leakage Current	I_{DSS}	-	4.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	4.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=400.0 mA
Forward Transconductance	G_M	2.0	-	S	V_{DS}=10.0 V, I_{DS}=4.0 A, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	180	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	160	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	32	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

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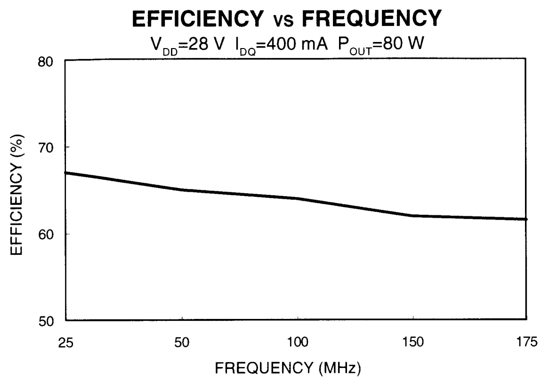
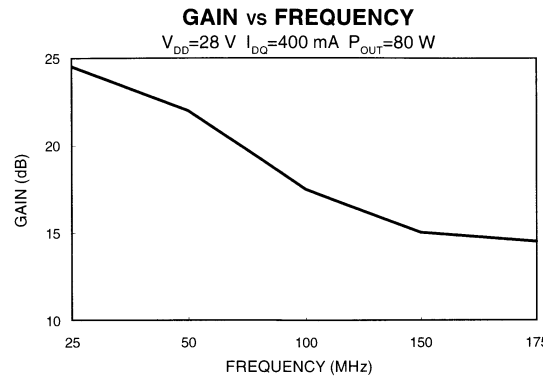
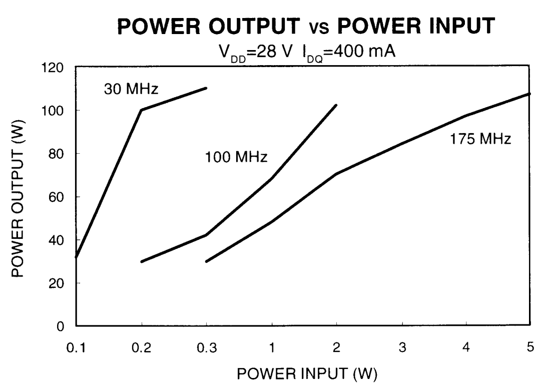
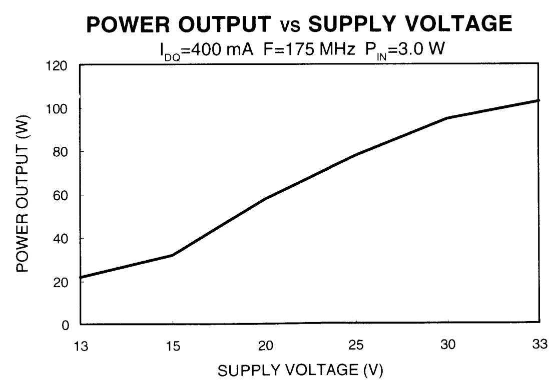
Typical Broadband Performance Curves









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Typical Device Impedance

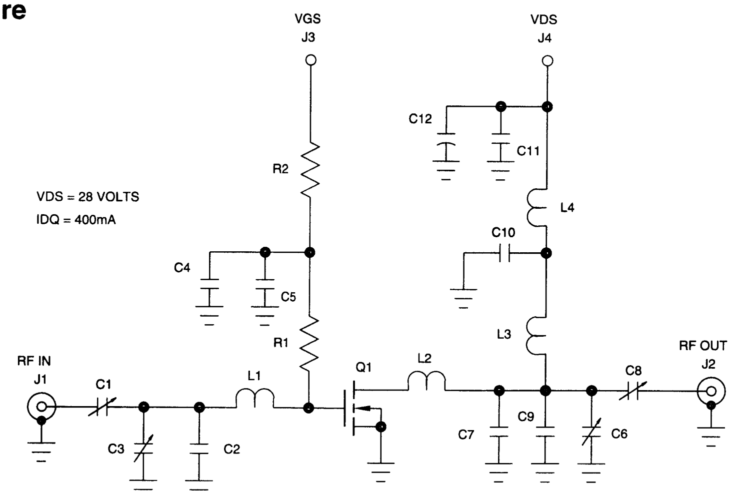
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	5.4 - j 4.4	5.7 + j 4.7
50	2.5 - j 4.4	3.4 + j 3.5
100	1.6 - j 3.4	2.4 + j 2.4
175	0.7 - j 1.2	1.7 + j 0.8

V_{DD}=28 V, I_{DQ}=400 mA, P_{OUT}=80 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C3	TRIMMER CAPACITOR 4-40pF
C2,C9,C10	CAPACITOR 50pF
C4,C11	CAPACITOR 1000pF
C5	MONOLITHIC CIRCUIT CAPACITOR 0.01uF
C6,C8	TRIMMER CAPACITOR 9-180pF
C7	CAPACITOR 15pF
C12	ELECTROLYTIC CAPACITOR 50uF 50 VOLT
L1	NO. 12 AWG COPPER WIRE X 1.18" (LOOP 0.5")
L2	NO. 12 AWG COPPER WIRE X 1" (LOOP 0.4")
L3,L4	8 TURNS OF NO. 18 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1	RESISTOR 300 OHMS 0.5 WATT
R2	RESISTOR 2.7K OHMS 0.25 WATT
Q1	DU2880T
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

an AMP company

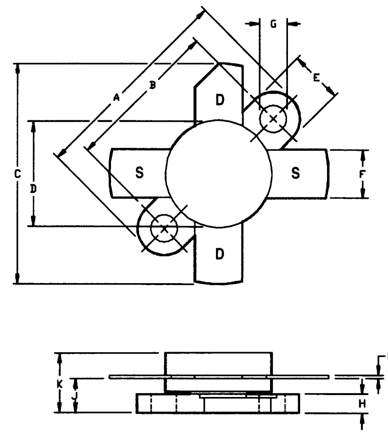
RF MOSFET Power Transistor, 80W, 28V
2 - 175 MHz

DU2880U

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	25.91	26.42	1.020	1.040
D	12.60	12.85	.496	.506
E	6.22	6.48	.245	.255
F	5.59	5.84	.220	.230
G	3.05	3.30	.120	.130
H	2.21	2.59	.087	.102
J	3.91	4.42	.154	.174
K	6.53	7.34	.257	.289
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	16	A
Power Dissipation	P_D	206	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	0.85	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=20.0 mA
Drain-Source Leakage Current	I_{DSS}	-	4.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	4.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=400.0 mA
Forward Transconductance	G_M	2.0	-	S	V_{DS}=10.0 V, I_{DS}=4.0 A, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	180	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	160	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	32	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

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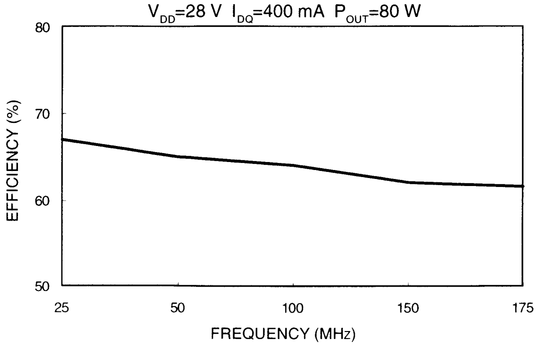
Typical Broadband Performance Curves

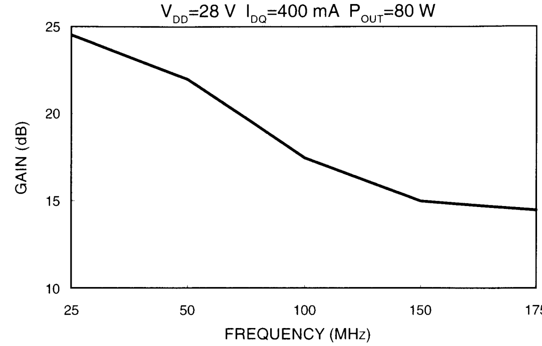
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=400 mA P_{OUT}=80 W



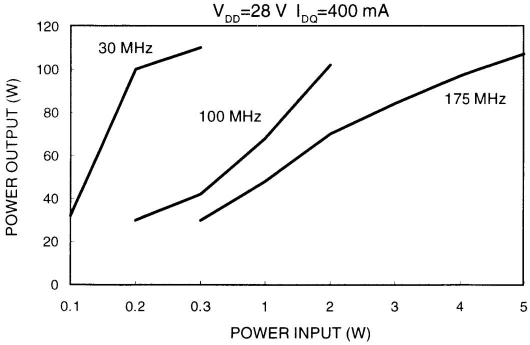
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=400 mA P_{OUT}=80 W



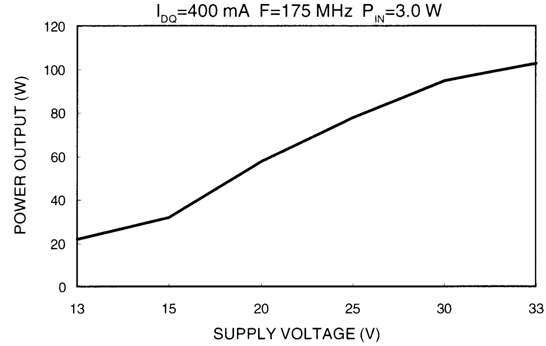
POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=400 mA



POWER OUTPUT vs SUPPLY VOLTAGE

I_{DQ}=400 mA F=175 MHz P_{IN}=3.0 W



Typical Device Impedance

Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	5.4 - j 4.4	5.7 + j 4.7
50	2.5 - j 4.4	3.4 + j 3.5
100	1.6 - j 3.4	2.4 + j 2.4
175	0.7 - j 1.2	1.7 + j 0.8

V_{DD}=28 V, I_{DQ}=400 mA, P_{OUT}=80 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

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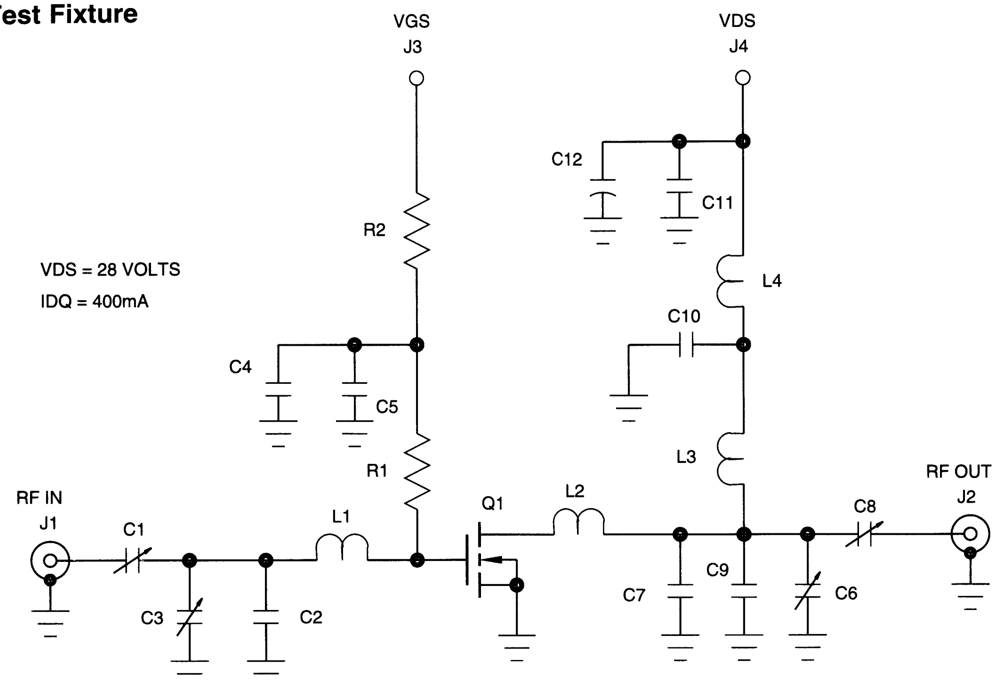
RF Test Fixture



PARTS LIST

C1,C3	TRIMMER CAPACITOR 4-40pF
C2,C9,C10	CAPACITOR 50pF
C4,C11	CAPACITOR 1000pF
C5	MONOLITHIC CIRCUIT CAPACITOR 0.01uF
C6,C8	TRIMMER CAPACITOR 9-180pF
C7	CAPACITOR 15pF
C12	ELECTROLYTIC CAPACITOR 50uF 50 VOLT
L1	NO. 12 AWG COPPER WIRE X 1.18" (LOOP 0.5")
L2	NO. 12 AWG COPPER WIRE X 1" (LOOP 0.4")
L3,L4	8 TURNS OF NO. 18 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1	RESISTOR 300 OHMS 0.5 WATT
R2	RESISTOR 2.7K OHMS 0.25 WATT
Q1	DU2880U
BOARD	FR4 0.062"

an AMP company

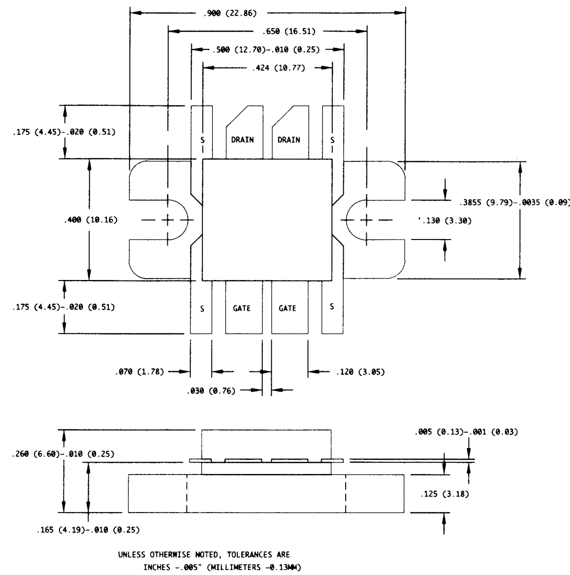
RF MOSFET Power Transistor, 80W, 28V
2 - 175 MHz

DU2880V

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	8*	A
Power Dissipation	P_D	206	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.85	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=10.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=200.0 mA*
Forward Transconductance	G_M	1.0	-	S	V_{DS}=10.0 V, I_{DS}=2000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	90	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	80	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	16	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=400 mA, P_{OUT}=80.0 W, F=175 MHz

* Per Side

Specifications Subject to Change Without Notice.

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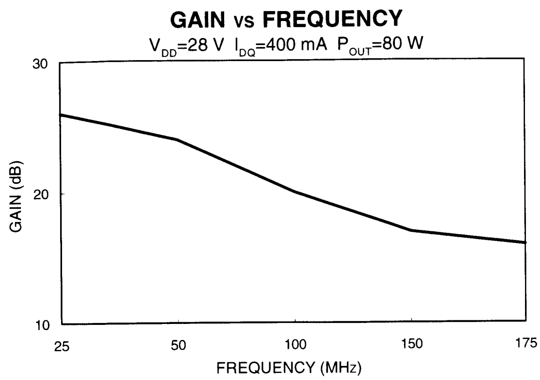
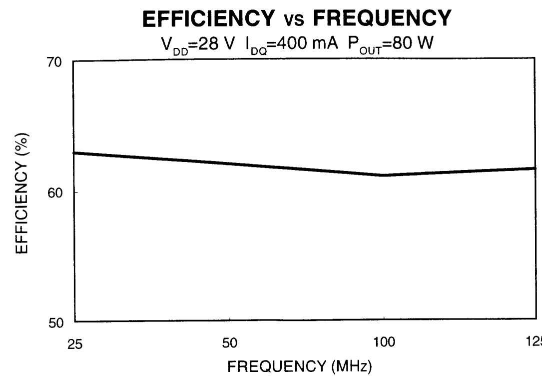
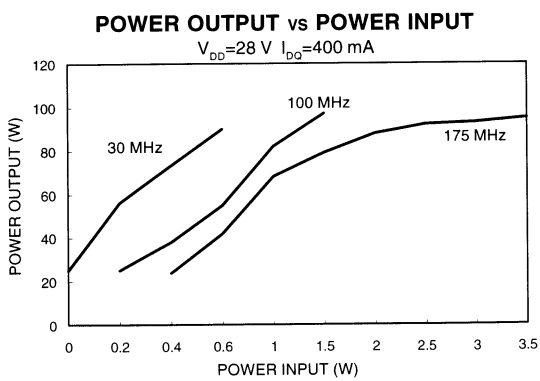
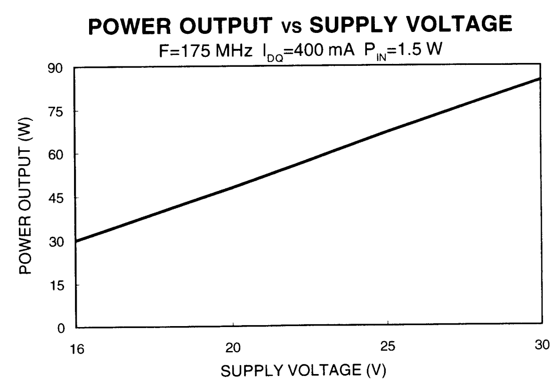
Typical Broadband Performance Curves









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Typical Device Impedance

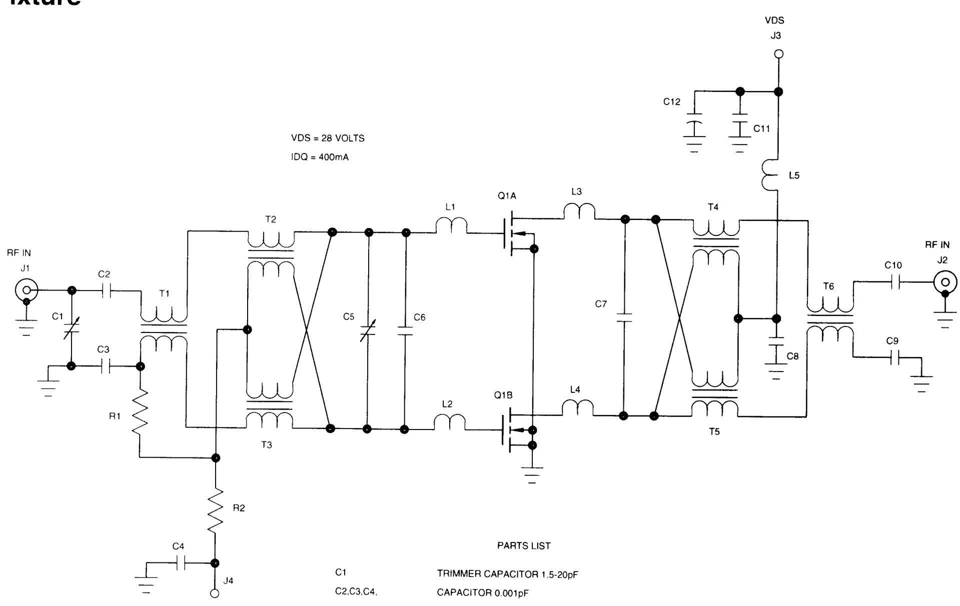
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	4.5 - j 14.5	13.5 + j 4.5
100	3.0 - j 10.5	13.5 + j 6.0
175	2.0 - j 7.5	12.0 + j 4.5

V_{DD}=28 V, I_{DQ}=400 mA, P_{OUT}=80 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C1	TRIMMER CAPACITOR 1.5-20pF
C2,C3,C4, C8,C9,C10 C11	CAPACITOR 0.001pF
C5	TRIMMER CAPACITOR 5-80pF
C6	CAPACITOR 68pF
C7	CAPACITOR 50pF
C12	ELECTROLYTYIC CAPACITOR 100uF 50 VOLTS
L1,L2	0.50" X 0.10" TRACE ON BOARD + ©0.125" X ©0.25" LOOP
L3,L4	0.87" X 0.10" TRACE ON BOARD
L5	7.5 TURNS OF NO. 20 AWG COPPER WIRE X ©0.31"
R1	RESISTOR 18 OHMS 2 WATTS
R2	RESISTOR 10K OHMS
T1,T6	50 OHM BALUN CORES, 2 TURNS OF 50 OHM COAX THRU 2 STACKPOLE 57-1522
T2,T3,T4 T5	4:1 TRANSFORMER 1 TURN OF 2 50 OHM COAX IN PARALLEL THRU 2 STACKPOLE 57-1522 BALUN CORES
Q1	DU2880V
BOARD	FR4 0.062"

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M/A-COM an AMP company

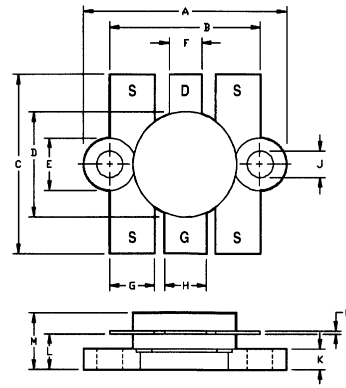
RF MOSFET Power Transistor, 120W, 28V 2 - 175 MHz

DU28120T

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	21.21	21.97	.835	.865
D	12.60	12.85	.496	.506
E	6.22	6.48	.245	.255
F	3.81	4.06	.150	.160
G	5.33	5.59	.210	.220
H	5.08	5.33	.200	.210
J	3.05	3.30	.120	.130
K	2.29	2.54	.090	.100
L	4.06	4.57	.160	.180
M	6.68	7.49	.263	.295
N	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	24	A
Power Dissipation	P_D	269	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.65	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=30.0 mA
Drain-Source Leakage Current	I_{DSS}	-	6.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	6.0	μA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=600.0 mA
Forward Transconductance	G_M	3.0	-	S	V_{DS}=10.0 V, I_{DS}=6000.0 A, ΔV_{GS}=1.0 V, 80 μs Pulse
Input Capacitance	C_{ISS}	-	270	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	240	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	48	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz

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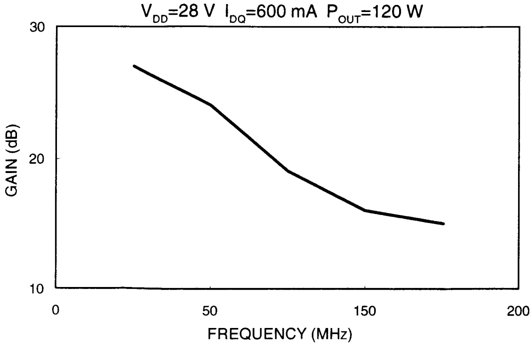
Typical Broadband Performance Curves

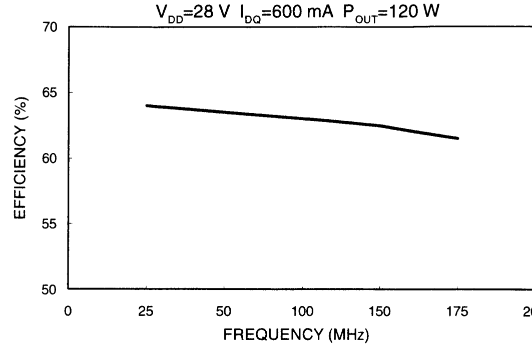
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=600 mA P_{OUT}=120 W



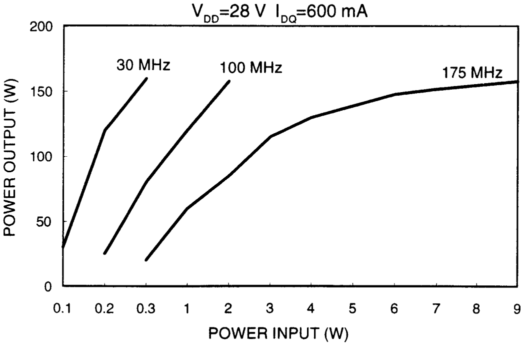
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=600 mA P_{OUT}=120 W



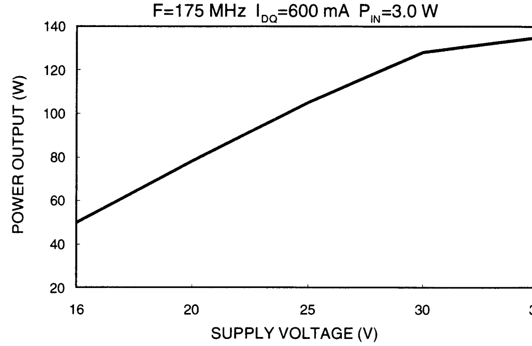
POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=600 mA



POWER OUTPUT vs SUPPLY VOLTAGE

F=175 MHz I_{DQ}=600 mA P_{IN}=3.0 W



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Typical Device Impedance

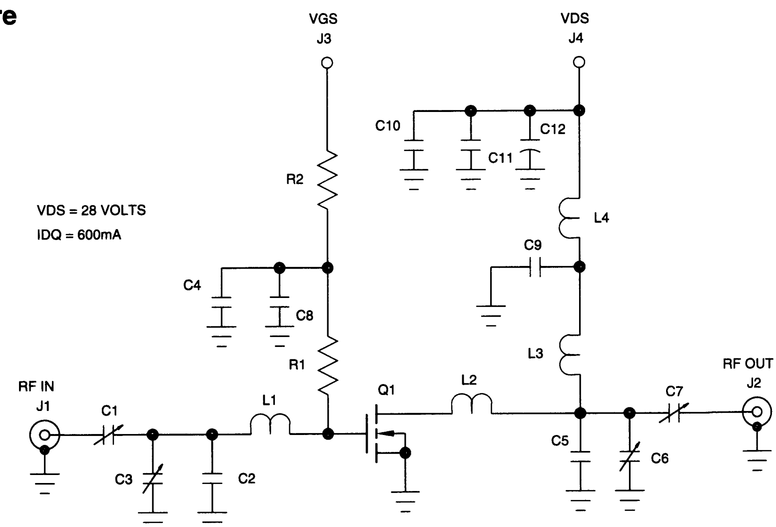
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	4.0 - j 8.0	3.4 + j 2.4
100	1.0 - j 2.5	2.2 + j 1.3
175	1.0 - j 0.5	2.2 + j 0.0

V_{DD}=28 V, I_{DQ}=600 mA, P_{OUT}=120 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C6	TRIMMER CAPACITOR 5-80pF
C2,C5	CAPACITOR 50pF
C3	TRIMMER CAPACITOR 4-40pF
C4,C11	MONOLITHIC CIRCUIT CAPACITOR 0.01uF
C7	TRIMMER CAPACITOR 9-180pF
C8,C9	CAPACITOR 500pF
C10	CAPACITOR 1000pF
C12	ELECTROLYTIC CAPACITOR 50uF 50 VOLT
L1,L2	NO. 12 AWG COPPER WIRE X 0.87" (LOOP 0.4")
L3,L4	8 TURNS OF NO. 16 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1,R2	RESISTOR 2.7K OHMS 0.25 WATT
Q1	DU28120T
BOARD	FR4 0.062"

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

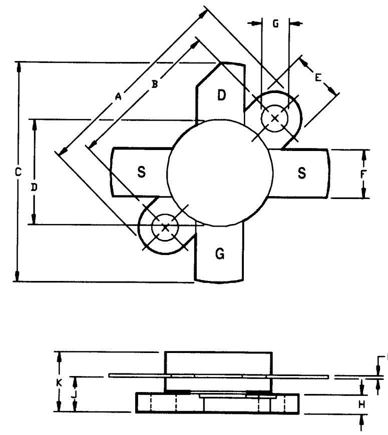
RF MOSFET Power Transistor, 120W, 28V
2 - 175 MHz

DU28120U

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	25.91	26.42	1.020	1.040
D	12.60	12.85	.496	.506
E	6.22	6.48	.245	.255
F	5.59	5.84	.220	.230
G	3.05	3.30	.120	.130
H	2.21	2.59	.087	.102
J	3.91	4.42	.154	.174
K	6.53	7.34	.257	.289
L	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	24	A
Power Dissipation	P_D	269	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.65	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=30.0 mA
Drain-Source Leakage Current	I_{DSS}	-	6.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	6.0	μA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=600.0 mA
Forward Transconductance	G_M	3.0	-	S	V_{DS}=10.0 V, I_{DS}=6.0 A, ΔV_{GS}=1.0 V, 80 μs Pulse
Input Capacitance	C_{ISS}	-	270	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	240	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	48	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz

Specifications Subject to Change Without Notice.

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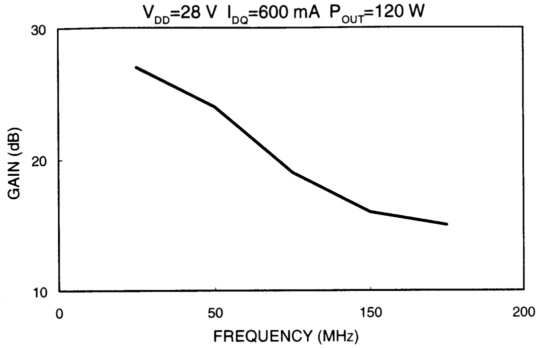
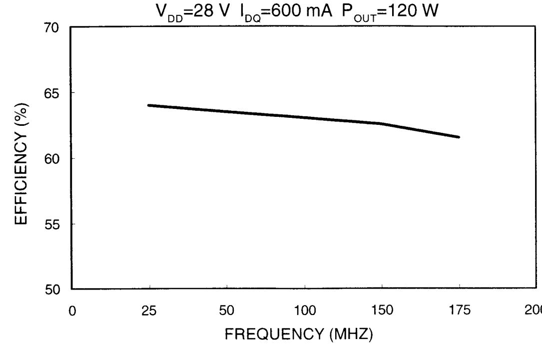
Typical Broadband Performance Curves

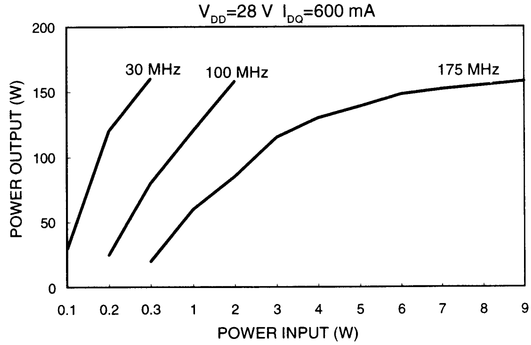
GAIN vs FREQUENCY
V_{DD}=28 V I_{DQ}=600 mA P_{OUT}=120 W



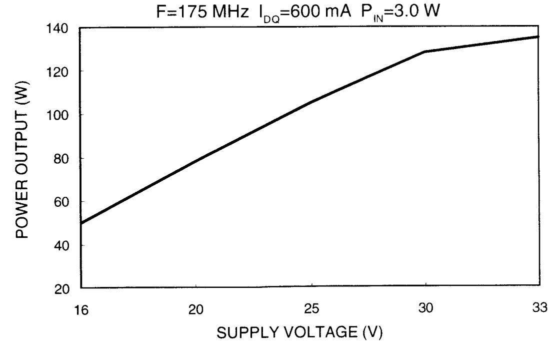
EFFICIENCY vs FREQUENCY
V_{DD}=28 V I_{DQ}=600 mA P_{OUT}=120 W



POWER OUTPUT vs POWER INPUT
V_{DD}=28 V I_{DQ}=600 mA



POWER OUTPUT vs SUPPLY VOLTAGE
F=175 MHz I_{DQ}=600 mA P_{IN}=3.0 W



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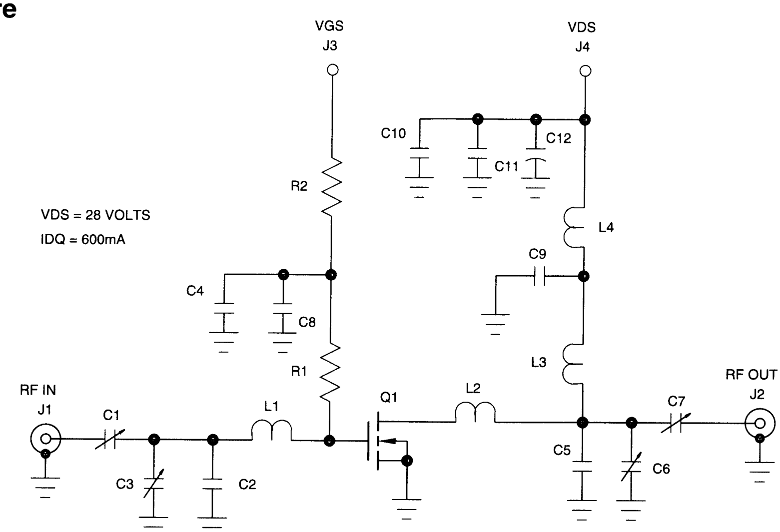
Typical Device Impedance

Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	4.0 - j 8.0	3.4 + j 2.4
100	1.0 - j 2.5	2.2 + j 1.3
175	1.0 - j 0.5	2.2 + j 0.0

V_{DD}=28 V, I_{DQ}=600 mA, P_{OUT}=120 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.
Z_{LOAD} is the series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C6	TRIMMER CAPACITOR 5-80pF
C2,C5	CAPACITOR 50pF
C3	TRIMMER CAPACITOR 4-40pF
C4,C11	MONOLITHIC CIRCUIT CAPACITOR 0.01uF
C7	TRIMMER CAPACITOR 9-180pF
C8,C9	CAPACITOR 500pF
C10	CAPACITOR 1000pF
C12	ELECTROLYTIC CAPACITOR 50uF 50 VOLT
L1,L2	NO. 12 AWG COPPER WIRE X 0.87" (LOOP 0.4")
L3,L4	8 TURNS OF NO. 16 AWG ENAMEL WIRE ON '0.25", CLOSE WOUND
R1,R2	RESISTOR 2.7K OHMS 0.25 WATT
Q1	DU28120U
BOARD	FR4 0.062"

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an AMP company

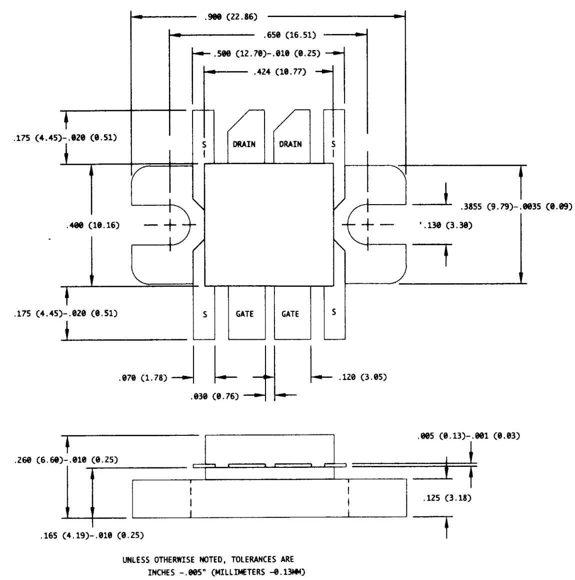
RF MOSFET Power Transistor, 120W, 28V
2 - 175 MHz

DU28120V

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	12*	A
Power Dissipation	P_D	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STJ}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=30.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	6.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	6.0	μA	V_{GS}=20.0 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=600.0 mA*
Forward Transconductance	G_M	3.0	-	S	V_{DS}=10.0 V, I_{DS}=6000.0 A, ΔV_{GS}=1.0 V, 80 μs Pulse*
Input Capacitance	C_{ISS}	-	270	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	240	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	48	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Drain Efficiency	η_D	60	-	%	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Return Loss	R_L	10	-	%	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=600 mA, P_{OUT}=120.0 W, F=175 MHz

* Per side

Specifications Subject to Change Without Notice.

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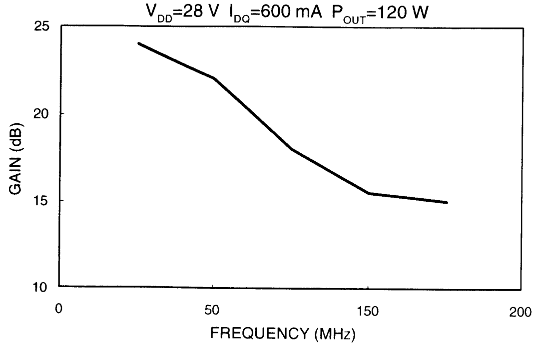
Typical Broadband Performance Curves

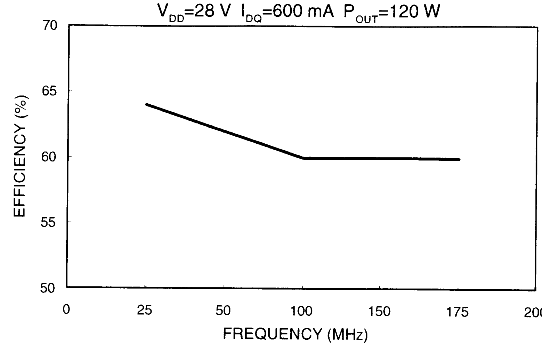
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=600 mA P_{OUT}=120 W



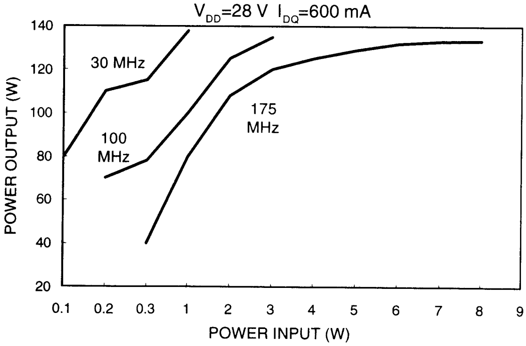
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=600 mA P_{OUT}=120 W



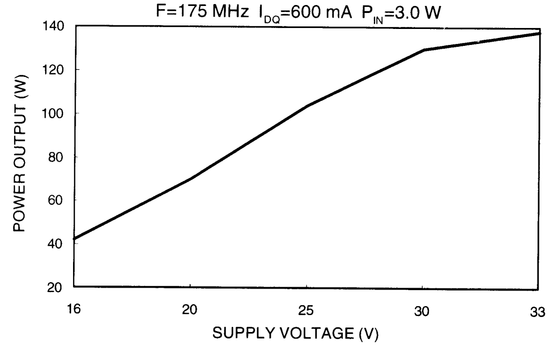
POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=600 mA



POWER OUTPUT vs SUPPLY VOLTAGE

F=175 MHz I_{DQ}=600 mA P_{IN}=3.0 W



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Typical Device Impedance

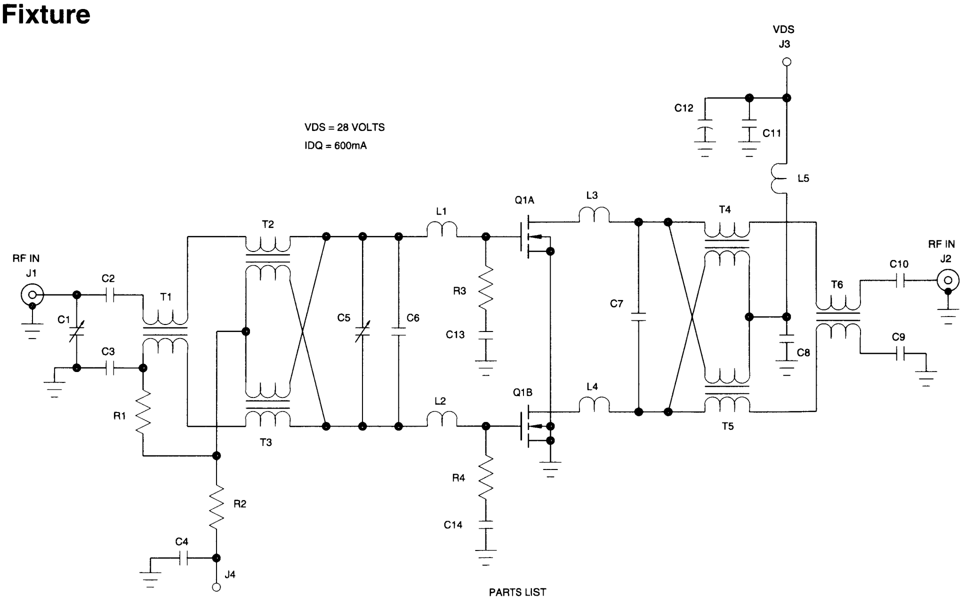
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	3.0 - j 12.5	8.0 + j 6.0
100	1.5 - j 8.5	7.0 + j 6.5
175	1.0 - j 6.0	6.5 + j 5.0

V_{DD}=28 V, I_{DQ}=600 mA, P_{OUT}=120 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C1	TRIMMER CAPACITOR 4-40pF
C2,C3,C4, C8,C9,C10 C11,C13,C14	CAPACITOR 0.001pF
C5	TRIMMER CAPACITOR 5-80pF
C6	CAPACITOR 68pF
C7	CAPACITOR 50pF
C12	ELECTROLYTYIC CAPACITOR 100uF 50 VOLTS
L1,L2	0.50" X 0.10" TRACE ON BOARD + '0.125" X '0.25" LOOP
L3,L4	0.87" X 0.10" TRACE ON BOARD
L5	7.5 TURNS OF NO. 20 AWG COPPER WIRE X '0.31"
R1,R3,R4	RESISTOR 18 OHMS 2 WATTS
R2	RESISTOR 10K OHMS
T1,T6	50 OHM BALUN CORES, 2 TURNS OF 50 OHM COAX THRU 2 STACKPOLE 57-1522
T2,T3,T4, T5	4:1 TRANSFORMER 2 TURNS OF 2 50 OHM COAX THRU 2 STACKPOLE 57-1522 BALUN CORES
Q1	DU28120V
BOARD	FR4 0.062"

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M/A-COM
an AMP company

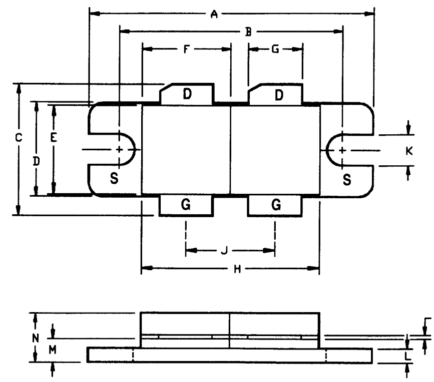
RF MOSFET Power Transistor, 200W, 28V
2 - 175 MHz

DU28200M

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	30.35	30.61	1.195	1.205
B	23.65	23.90	.931	.941
C	13.72	14.22	.540	.560
D	9.63	9.88	.379	.389
E	9.40	9.65	.370	.380
F	9.40	9.65	.370	.380
G	5.59	5.84	.220	.230
H	18.80	19.30	.740	.760
J	9.40	9.65	.370	.380
K	3.12	3.38	.123	.133
L	1.47	1.57	.058	.062
M	2.39	2.74	.094	.108
N	5.03	5.69	.198	.224
P	.05	.13	.002	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	20	A
Power Dissipation	P_D	389	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	0.45	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=25.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	5.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	5.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=500.0 mA*
Forward Transconductance	G_M	2.5	-	S	V_{DS}=10.0 V, I_{DS}=5.0 A, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	225	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	200	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	40	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	13	-	dB	V_{DD}=28.0 V, I_{DQ}=1000 mA, P_{OUT}=200.0 W, F=175 MHz
Drain Efficiency	η_D	55	-	%	V_{DD}=28.0 V, I_{DQ}=1000 mA, P_{OUT}=200.0 W, F=175 MHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{DD}=28.0 V, I_{DQ}=1000 mA, P_{OUT}=200.0 W, F=175 MHz

* Per Side

Specifications Subject to Change Without Notice.

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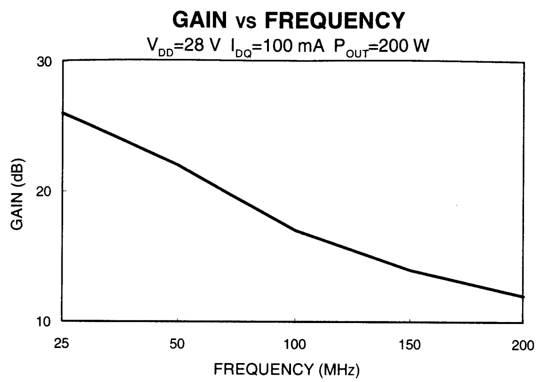
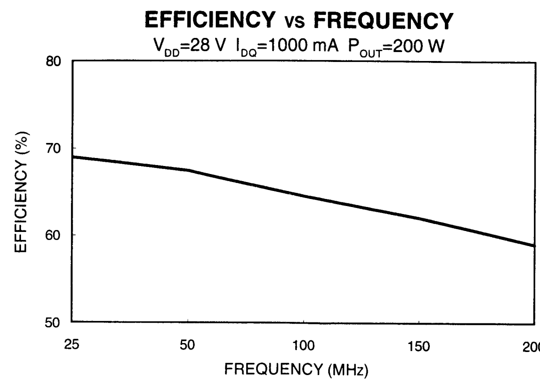
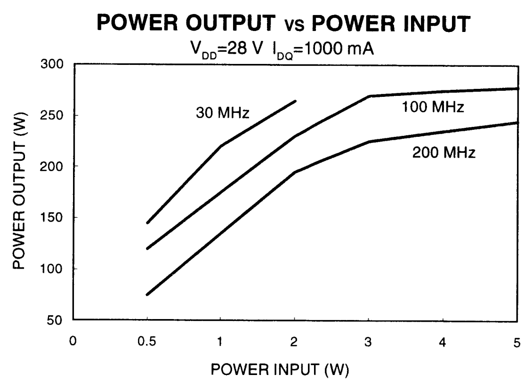
Typical Broadband Performance Curves







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Typical Device Impedance

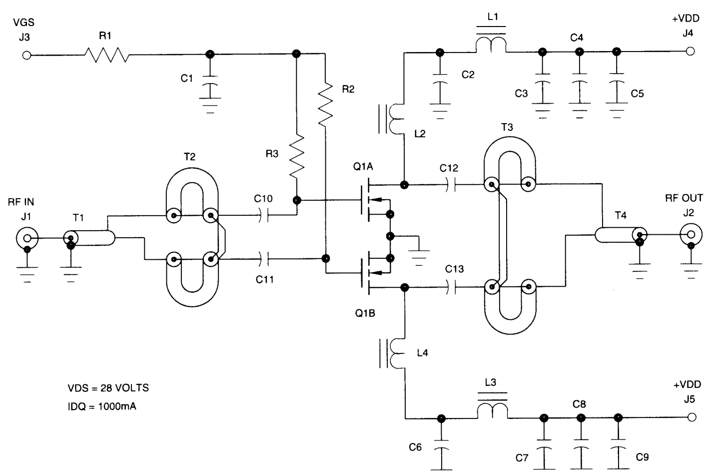
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
30	2.7 - j 4.8	7.2 - j 1.9
100	1.6 - j 3.0	5.25 - j 1.4
150	1.5 - j 2.0	5.0 - j 0.7
175	1.6 - j 1.0	5.2 - j 0.6
200	1.8 - j 0.5	5.5 - j 0.5

V_{DD}=28 V, I_{DQ}=1000 mA, P_{OUT}=200 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the series optimum equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C1,C2,C5, C6,C9	UNELCO CAPACITOR 1000pF
C3	CAPACITOR 50uF
C4,C8	CAPACITOR 0.1uF
C7	ELECTROLYTIC CAPACITOR 50uF 50 V.
C10,C11	CAPACITOR ATC 500pF
C12,C13	CAPACITOR 2X ATC 500pF
L1,L3	1 TURN OF NO. 14 AWG THROUGH BINOCULAR CORE
L2,L4	4 TURNS OF NO. 14 AWG THROUGH BINOCULAR CORE
R1	RESISTOR 6800 OHM 0.5 WATT
R2,R3	RESISTOR 2700 OHM 0.5 WATT
T1,T4	1:1 BALUN 50 OHM COAX X 4"
T2,T3	TWO SECTIONS, 4" EACH OF 25 OHM COAX, CONNECTED IN A 9:1 CONFIGURATION
Q1	DU28200M
BOARD	FR4 0.062"

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an AMP company

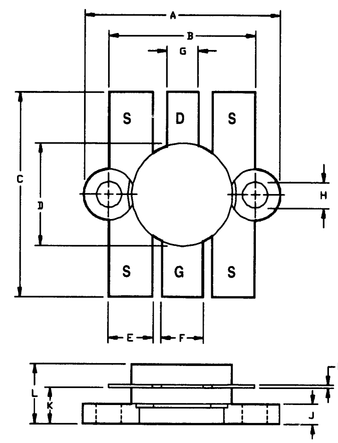
RF MOSFET Power Transistor, 75W, 24V
30 - 90 MHz

FH2114

V2.00

Features

- N-Channel Enhancement Mode Device
- Meets CECOM Drawing A3012711
- Designed for Frequency Hopping Systems
- 30-90 MHz
- Lower Capacitances for Broadband Operation
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.15	.960	.990
B	18.29	18.54	.720	.730
C	21.36	21.74	.841	.856
D	12.60	12.85	.496	.506
E	5.33	5.59	.210	.220
F	5.08	5.33	.200	.210
G	3.81	4.06	.150	.160
H	3.10	3.15	.122	.128
J	2.51	2.67	.099	.105
K	4.06	4.57	.160	.180
L	6.68	7.49	.263	.295
M	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	16	A
Power Dissipation	P_D	159	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=100.0 mA
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=24.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	4.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	7.2	V	V_{DS}=27.0 V, I_{DS}=1000.0 mA
Forward Transconductance	G_M	1.6	-	S	V_{DS}=24.0 V, I_{DS}=1000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	210	pF	V_{DS}=30.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	160	pF	V_{DS}=30.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	25	pF	V_{DS}=30.0 V, F=1.0 MHz
Power Gain	G_P	13	-	dB	V_{DD}=24.0 V, I_{DQ}=1000 mA, P_{OUT}=75.0 W, F=88 MHz
Drain Efficiency	η_D	65	-	%	V_{DD}=24.0 V, I_{DQ}=1000 mA, P_{OUT}=75.0 W, F=88 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=24.0 V, I_{DQ}=1000 mA, P_{OUT}=75.0 W, F=88 MHz

Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

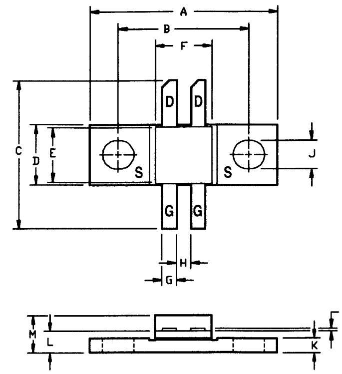
RF MOSFET Power Transistor, 8W, 12V
30 - 90 MHz

FH2164

V2.00

Features

- N-Channel Enhancement Mode Device
- Meets CECOM Drawing A3012715
- Designed for Frequency Hopping Systems
- 30-90 MHz
- Lower Capacitances for Broadband Operation
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	15.67	17.45	.617	.687
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.40	1.65	.055	.065
H	1.40	1.65	.055	.065
J	2.92	3.18	.115	.125
K	1.40	1.65	.055	.065
L	1.96	2.46	.077	.097
M	3.61	4.37	.142	.172
N	.08	.13	.003	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4*	A
Power Dissipation	P_D	61*	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA*
Forward Transconductance	G_M	500	-	mS	V_{DS}=28.0 V, I_{DS}=1000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	45	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	40	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	8	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	13	-	dB	V_{DD}=12.0 V, I_{DQ}=600 mA, P_{OUT}=8.0 W, F=88 MHz
Drain Efficiency	η_D	55	-	%	V_{DD}=12.0 V, I_{DQ}=600 mA, P_{OUT}=8.0 W, F=88 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=12.0 V, I_{DQ}=600 mA, P_{OUT}=8.0 W, F=88 MHz

* Per side

M/A-COM an AMP company

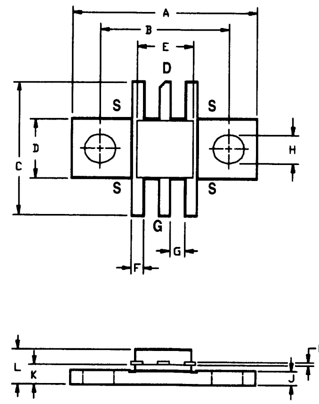
RF MOSFET Power Transistor, 2W, 12V 30 - 90 MHz

FH2165

V2.00

Features

- N-Channel Enhancement Mode Device
- Meets CECOM Drawing A3012716
- Designed for Frequency Hopping Systems
- 30-90 MHz
- Lower Capacitances for Broadband Operation
- Lower Noise Figure Than Bipolar Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	14.73	15.24	.580	.600
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	1.14	1.40	.045	.055
G	1.52	1.78	.060	.070
H	2.92	3.17	.115	.125
J	1.40	1.65	.055	.065
K	2.03	2.39	.080	.094
L	3.66	4.32	.144	.170
M	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4	A
Power Dissipation	P_D	61	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	2.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA
Forward Transconductance	G_M	500	-	mS	V_{DS}=28.0 V, I_{DS}=1000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	45	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	40	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	8	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=12.0 V, I_{DQ}=300 mA, P_{OUT}=2.0 W, F=88 MHz
Drain Efficiency	η_D	55	-	%	V_{DD}=12.0 V, I_{DQ}=300 mA, P_{OUT}=2.0 W, F=88 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=12.0 V, I_{DQ}=300 mA, P_{OUT}=2.0 W, F=88 MHz

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an AMP company

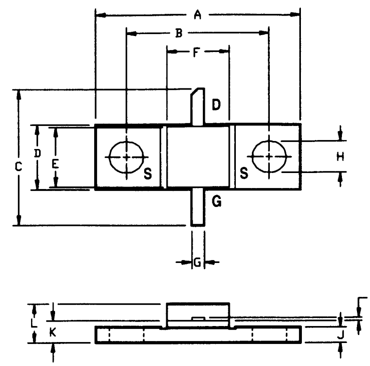
RF MOSFETPower Transistor, 2W, 28V 500 - 1000 MHz

LF2802A

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor
- Applications
  Broadband Linear Operation
  500 MHz to 1400 MHz



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	13.72	14.22	.540	.560
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.14	1.40	.045	.055
H	2.92	3.18	.115	.125
J	1.40	1.65	.055	.065
K	1.96	2.46	.077	.097
L	3.61	4.37	.142	.172
M	.08	.15	.003	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	0.7	A
Power Dissipation	P_D	8	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	21.8	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=1.0 mA
Drain-Source Leakage Current	I_{DSS}	-	0.5	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	0.5	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=5.0 mA
Forward Transconductance	G_M	40	-	mS	V_{DS}=10.0 V, I_{DS}=50.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	3.5	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	3.75	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	1.2	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=25 mA, P_{OUT}=2.0 W, F=1.0 GHz
Drain Efficiency	η_D	40	-	%	V_{DD}=28.0 V, I_{DQ}=25 mA, P_{OUT}=2.0 W, F=1.0 GHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=25 mA, P_{OUT}=2.0 W, F=1.0 GHz

Specifications Subject to Change Without Notice.

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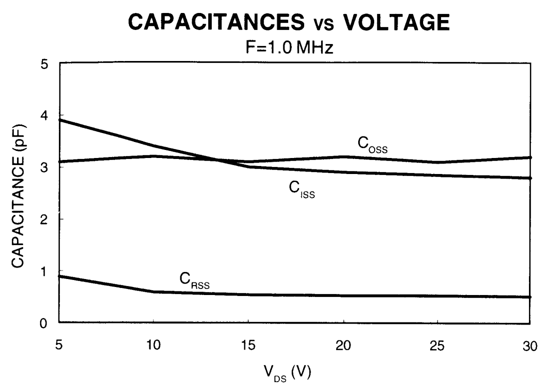
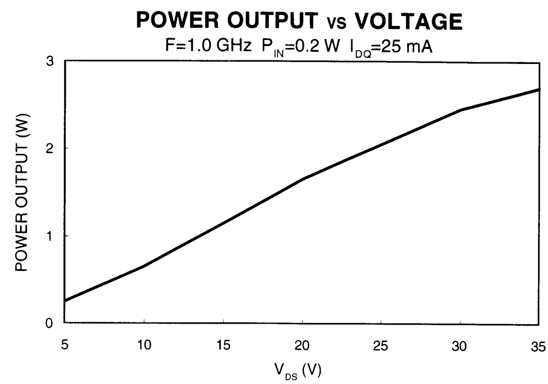
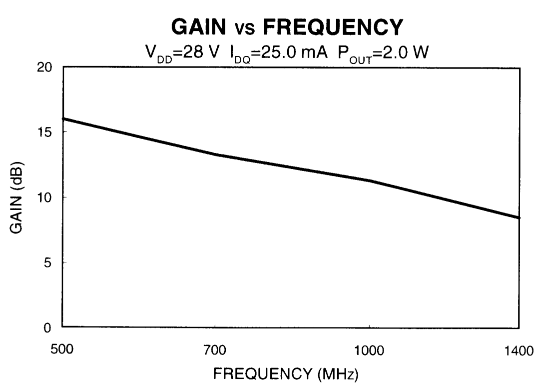
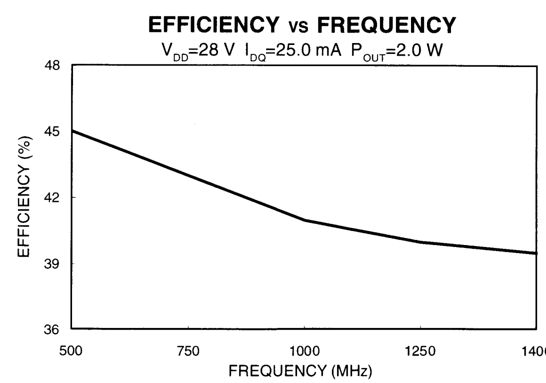
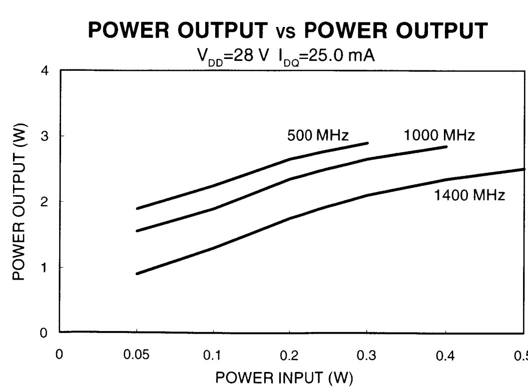
Typical Broadband Performance Curves











- Continued next page -

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Typical Device Impedance

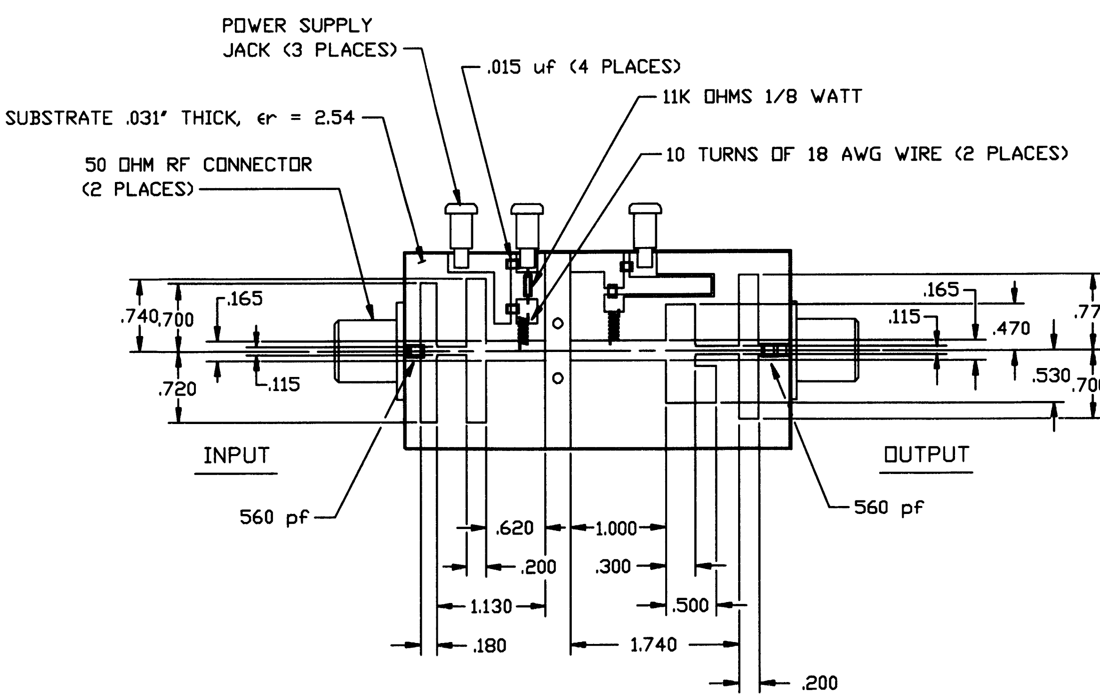
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
500	10.0 - j 41.5	40.0 + j 53.0
1000	4.2 - j 12.0	11.85 + j 33.0
1400	3.5 - j 1.0	7.5 + j 23.3

V_{DD}=28 V, I_{DQ}=25 mA, P_{OUT}=2.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



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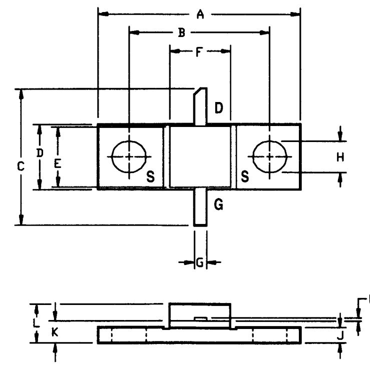
RF MOSFET Power Transistor, 5W, 28V
500 - 1000 MHz

LF2805A

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor
- Applications
  Broadband Linear Operation
  500 MHz to 1400 MHz



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	13.72	14.22	.540	.560
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.14	1.40	.045	.055
H	2.92	3.18	.115	.125
J	1.40	1.65	.055	.065
K	1.96	2.46	.077	.097
L	3.61	4.37	.142	.172
M	.08	.15	.003	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	1.4	A
Power Dissipation	P_D	14.4	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	12.1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=2.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=10.0 mA
Forward Transconductance	G_M	80	-	mS	V_{DS}=10.0 V, I_{DS}=100.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	7	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	5	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	2.4	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=50 mA, P_{OUT}=5.0 W, F=1.0 GHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=50 mA, P_{OUT}=5.0 W, F=1.0 GHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=50 mA, P_{OUT}=5.0 W, F=1.0 GHz

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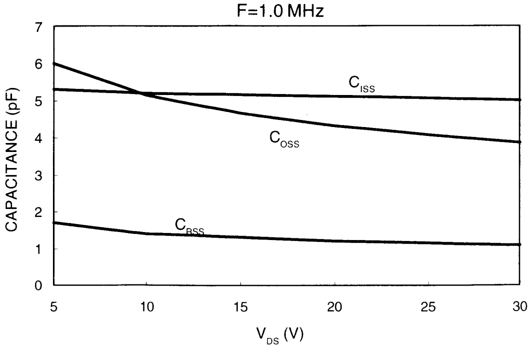
Typical Broadband Performance Curves

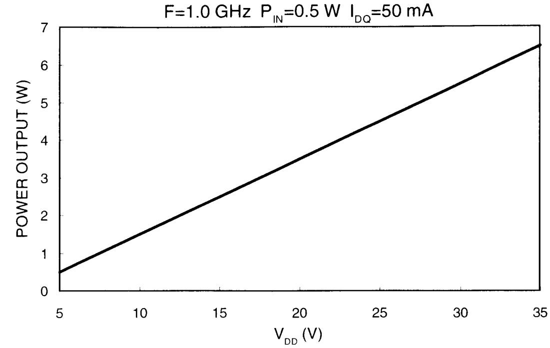
CAPACITANCES vs VOLTAGE

F=1.0 MHz



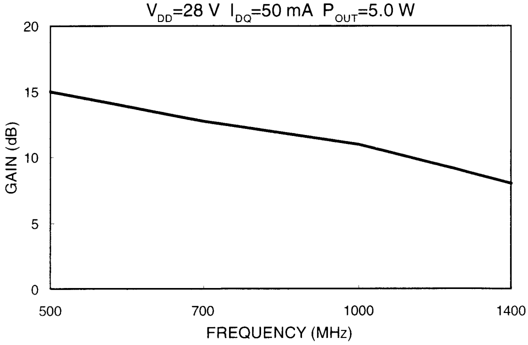
POWER OUTPUT vs VOLTAGE

F=1.0 GHz P_{IN}=0.5 W I_{DQ}=50 mA



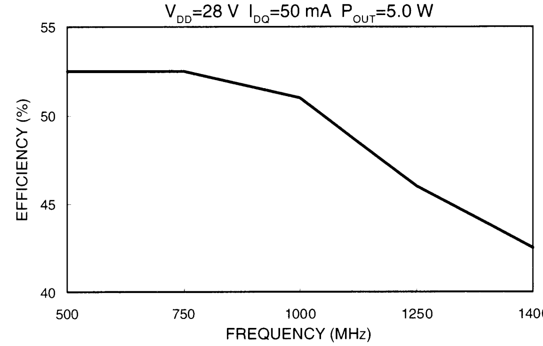
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=50 mA P_{OUT}=5.0 W



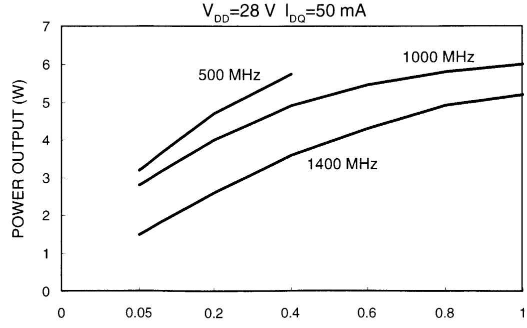
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=50 mA P_{OUT}=5.0 W



POWER OUTPUT vs POWER OUTPUT

V_{DD}=28 V I_{DQ}=50 mA



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Typical Device Impedance

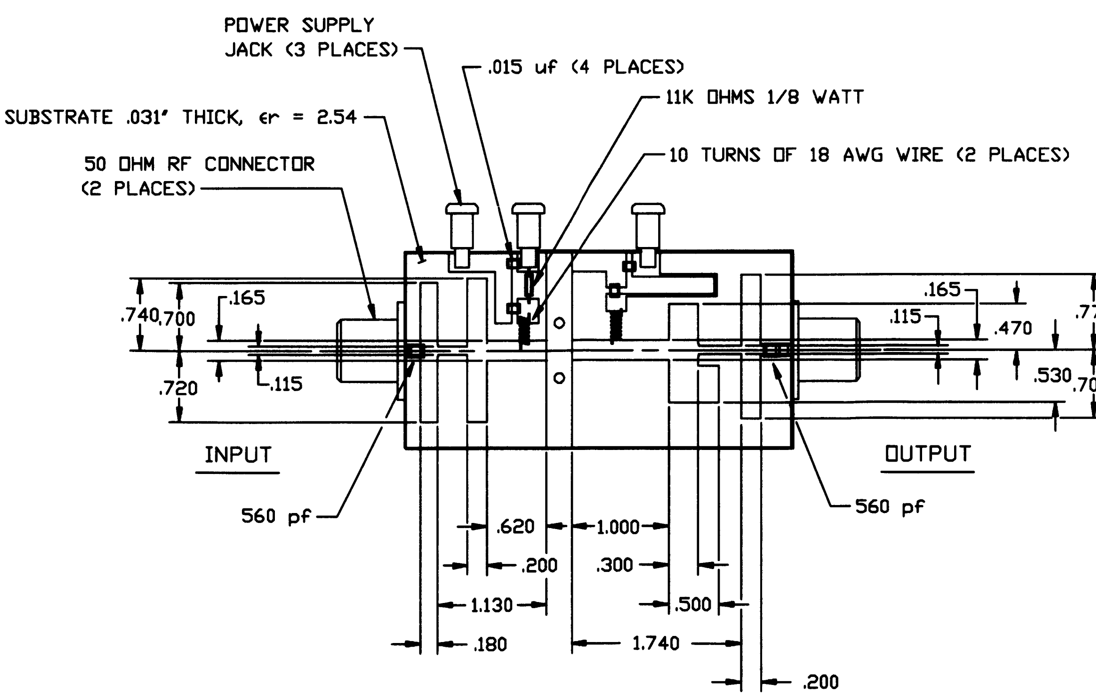
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
500	4.3 - j 29.0	27.3 + j 28.6
1000	2.2 - j 2.75	8.0 + j 16.0
1400	2.8 + j 3.0	9.4 + j 10.6

V_{DD}=28 V, I_{DQ}=50 mA, P_{OUT}=5.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



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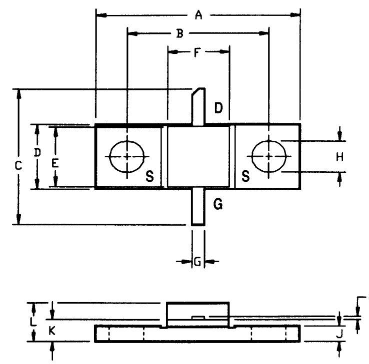
an AMP company

RF MOSFET Power Transistor, 10W, 28V
500 - 1000 MHz LF2810A

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor
- Applications
  Broadband Linear Operation
  500 MHz to 1200 MHz



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	13.72	14.22	.540	.560
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.14	1.40	.045	.055
H	2.92	3.18	.115	.125
J	1.40	1.65	.055	.065
K	1.96	2.46	.077	.097
L	3.61	4.37	.142	.172
M	.08	.15	.003	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	2.8	A
Power Dissipation	P_D	26.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	6.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=4.0 mA
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=20.0 mA
Forward Transconductance	G_M	160	-	mS	V_{DS}=10.0 V, I_{DS}=200.0 mA, 80-30 µs Pulse
Input Capacitance	C_{ISS}	-	14	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	10	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	4.8	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=10.0 W, F=1.0 GHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=10.0 W, F=1.0 GHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=100 mA, P_{OUT}=10.0 W, F=1.0 GHz

Specifications Subject to Change Without Notice.

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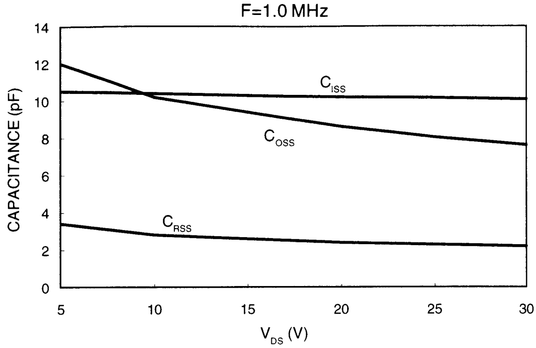
Typical Broadband Performance Curves

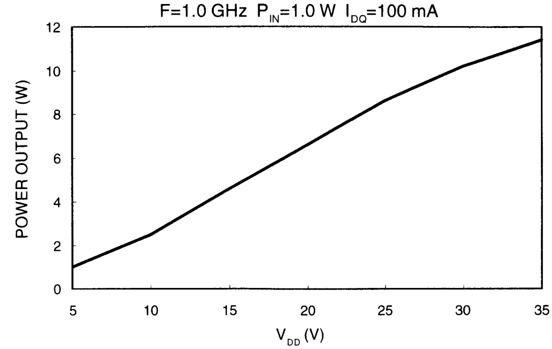
CAPACITANCES vs VOLTAGE

F=1.0 MHz



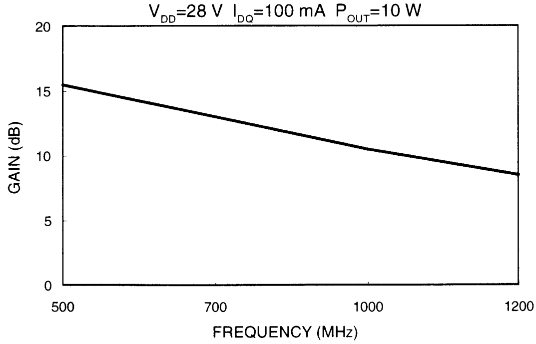
POWER OUTPUT vs VOLTAGE

F=1.0 GHz P_{IN}=1.0 W I_{DQ}=100 mA



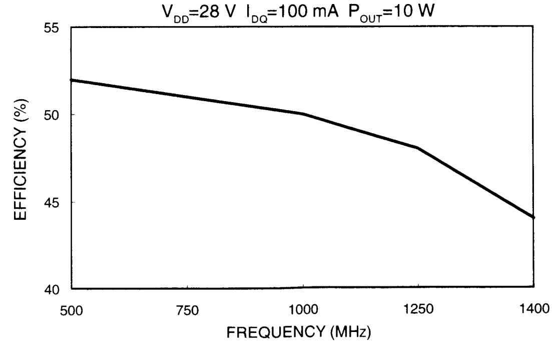
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=100 mA P_{OUT}=10 W



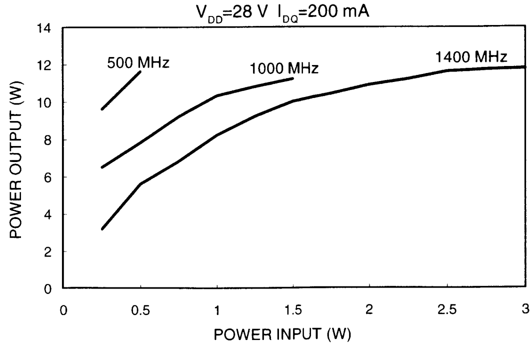
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=100 mA P_{OUT}=10 W



POWER OUTPUT vs POWER OUTPUT

V_{DD}=28 V I_{DQ}=200 mA



Typical Device Impedance

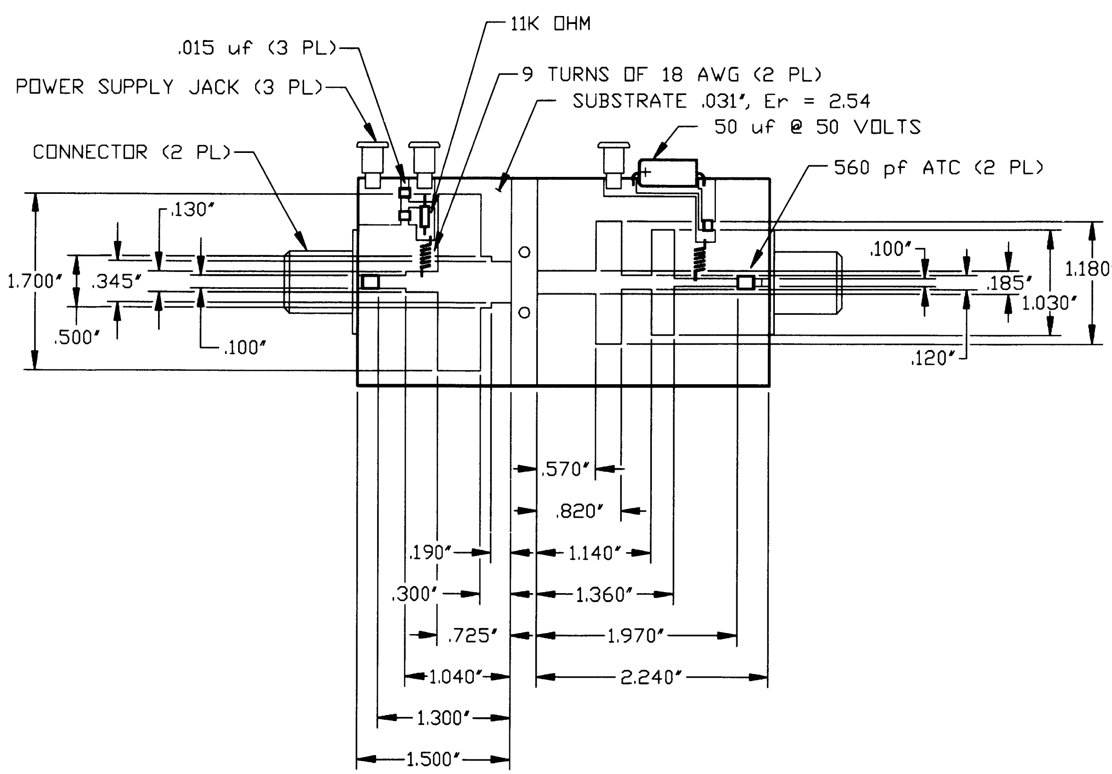
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
500	0.60 - j 9.5	10.0 + j 17.0
1000	1.4 + j 1.0	4.85 + j 7.9
1200	1.5 + j 3.5	5.7 + j 5.7

V_{DD}=28 V, I_{DQ}=100 mA, P_{OUT}=10 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



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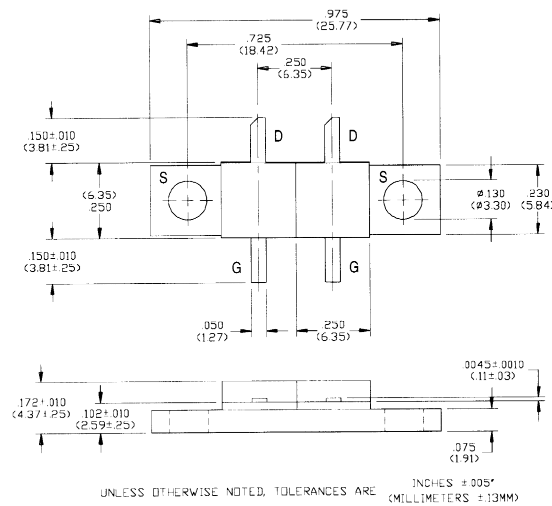
RF MOSFET Power Transistor, 40W, 26V
500 - 1000 MHz LF2840G

V2.00

Features

- N-Channel Enhancement Mode Device
- 40 Watts CW
- Common Source Gemini Configuration
- RESFET Structure
- Gold Metallization



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	60	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	10	A
Power Dissipation	P_D	109	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	60	-	V	I_D=20.0 mA, V_{GS}=0.0 V*
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20.0 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100 mA*
Forward Transconductance	G_M	0.5	-	S	V_{DS}=10.0 V, I_{DS}=1000 mA (pulsed)*
Input Capacitance	C_{ISS}		300	pF	V_{DS}=28.0 V, F=1.0 MHz (Reference Only)*
Output Capacitance	C_{OSS}		90	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}		30	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=26.0 V, I_{DQ}=400 mA, P_{OUT}=40 W, F=1000 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=26.0 V, I_{DQ}=400 mA, P_{OUT}=40 W, F=1000 MHz
Load Mismatch Tolerance	VSWR-T	-	3.0:1	-	V_{DD}=26.0 V, I_{DQ}=400 mA, P_{OUT}=40 W, F=1000 MHz

* Per Side

Typical Optimum Device Impedance

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
1000	6.8 + j18	4.2 - j1.6

Specifications Subject to Change Without Notice.

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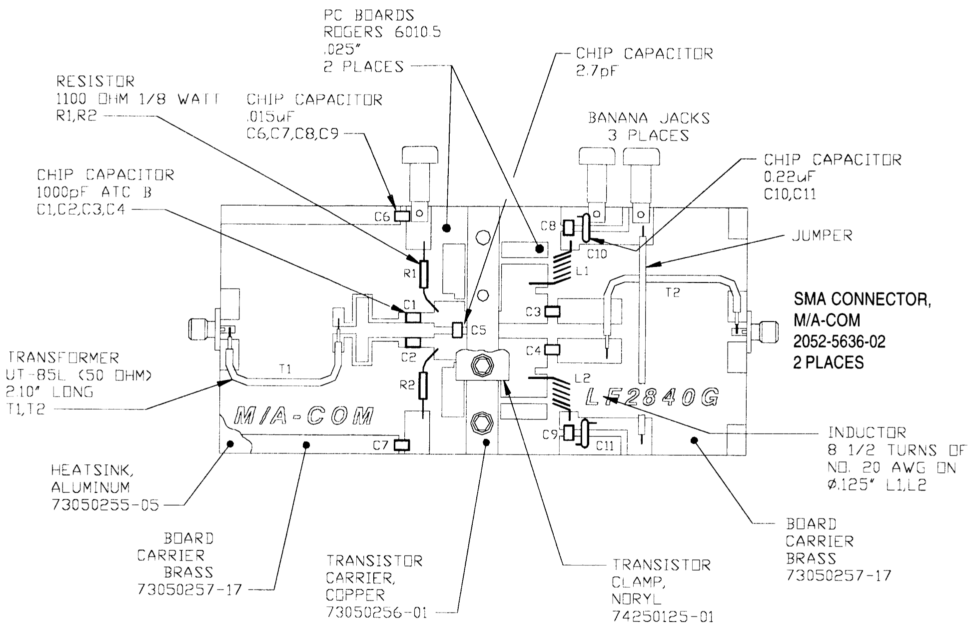
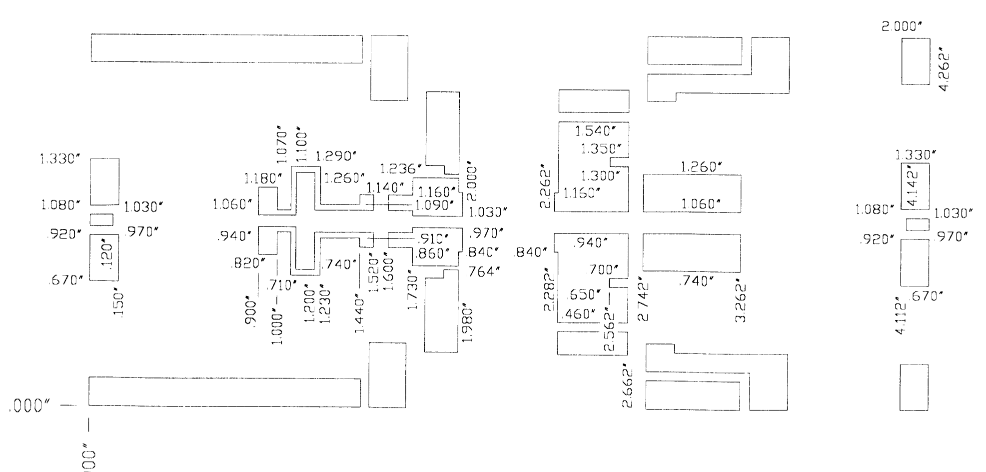
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

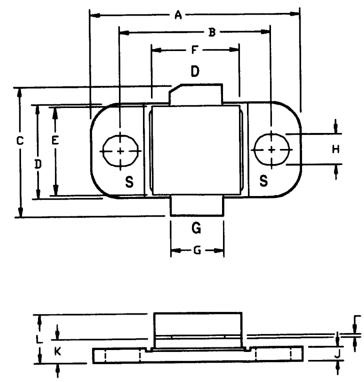
RF MOSFET Power Transistor, 30W, 40V
500 - 1000 MHz

LF4030C

V2.00

Features

- N-Channel Enhancement Mode Device
- Gold Metallized
- Resfet Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Applications
  Broadband Linear Operation
  500 MHz to 1200 MHz



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.73	22.99	.895	.905
B	16.38	16.64	.645	.655
C	13.72	14.22	.540	.560
D	10.03	10.29	.395	.405
E	9.40	9.65	.370	.380
F	9.40	9.65	.370	.380
G	5.59	5.84	.220	.230
H	3.12	3.38	.123	.133
J	1.40	1.65	.055	.065
K	2.34	2.84	.092	.112
L	4.90	5.72	.193	.225
M	.05	.13	.002	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	80	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	5	A
Power Dissipation	P_D	58	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	80	-	V	V_{GS}=0.0 V, I_{DS}=20.0 mA
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=40.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	10	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	1.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA
Forward Transconductance	G_M	500	-	mS	V_{DS}=10.0 V, I_{DS}=1.0 mA, 300 µs Pulse
Input Capacitance	C_{ISS}	-	55	pF	V_{DS}=40.0 V, F=1.0 MHz, Reference only.*
Output Capacitance	C_{OSS}	-	25	pF	V_{DS}=40.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	7	pF	V_{DS}=40.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=40.0 V, I_{DQ}=100 mA, P_{OUT}=30.0 W, F=1.0 GHz
Drain Efficiency	η_D	50	-	%	V_{DD}=40.0 V, I_{DQ}=100 mA, P_{OUT}=30.0 W, F=1.0 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{DD}=40.0 V, I_{DQ}=100 mA, P_{OUT}=30.0 W, F=1.0 GHz

* Note: Due to the internal matching network, this parameter cannot be measured.

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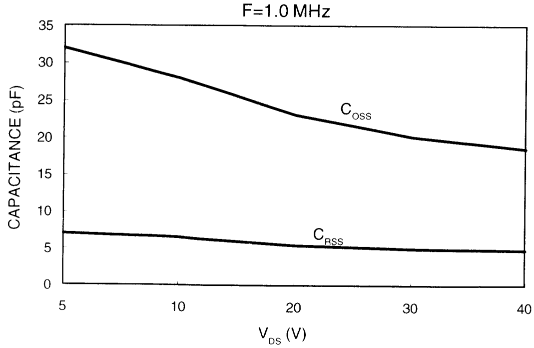
Typical Broadband Performance Curves

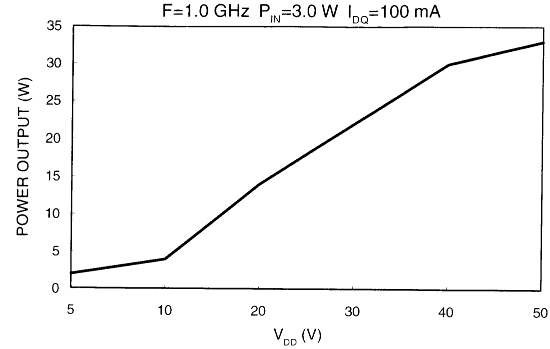
CAPACITANCES vs VOLTAGE

F=1.0 MHz



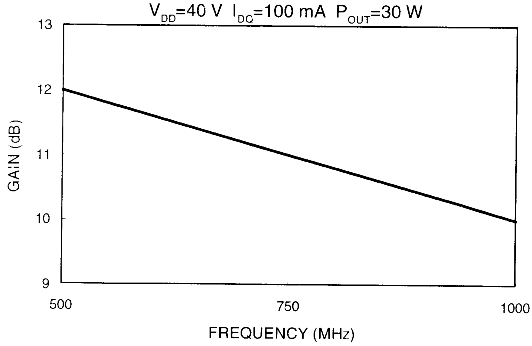
POWER OUTPUT vs VOLTAGE

F=1.0 GHz P_{IN}=3.0 W I_{DQ}=100 mA



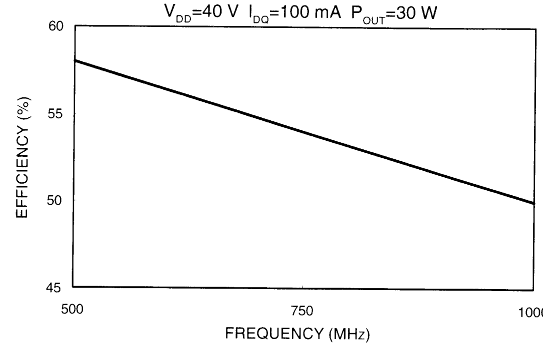
GAIN vs FREQUENCY

V_{DD}=40 V I_{DQ}=100 mA P_{OUT}=30 W



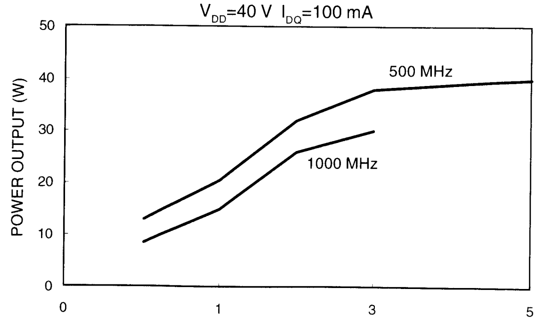
EFFICIENCY vs FREQUENCY

V_{DD}=40 V I_{DQ}=100 mA P_{OUT}=30 W



POWER OUTPUT vs POWER OUTPUT

V_{DD}=40 V I_{DQ}=100 mA



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Typical Device Impedance

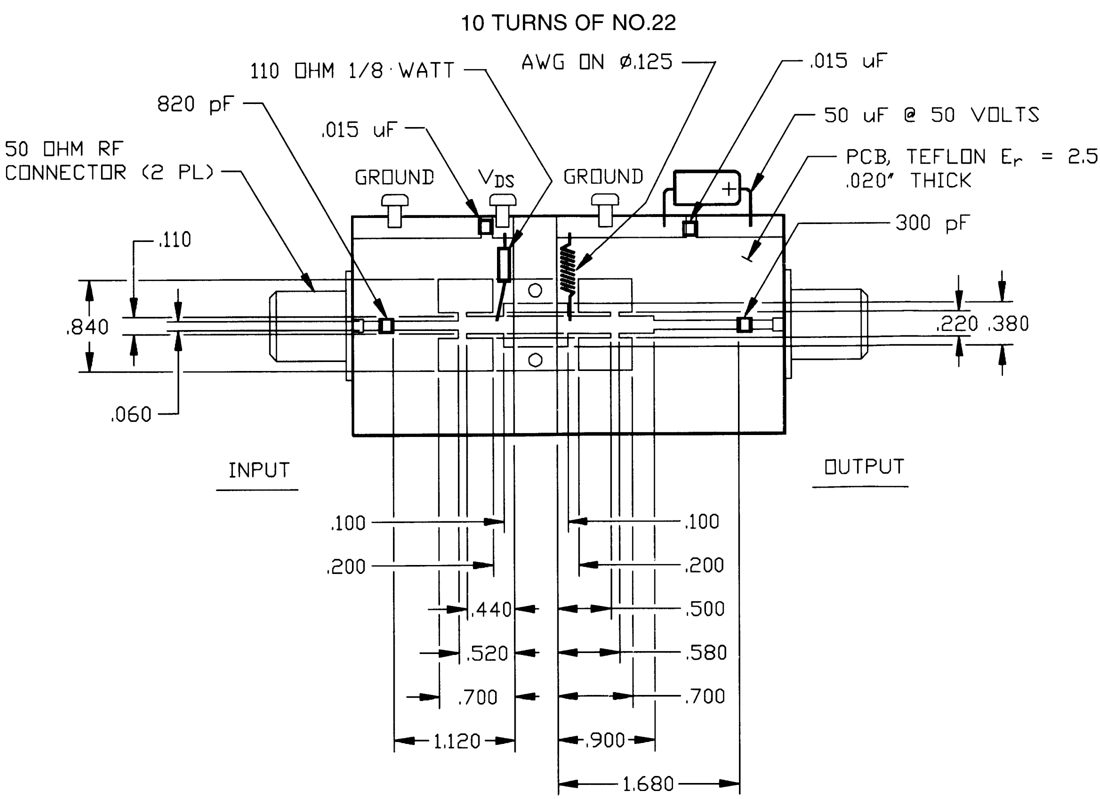
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
500	1.3 + j 1.6	5.5 + j 6.5
640	2.0 + j 4.0	4.0 + j 5.5
850	4.5 + j 3.0	3.2 + j 3.0
1000	3.5 + j 2.0	3.0 + j 2.0

V_{DD}=40 V, I_{DQ}=100 mA, P_{OUT}=30.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



All Dimensions are in inches

an AMP company

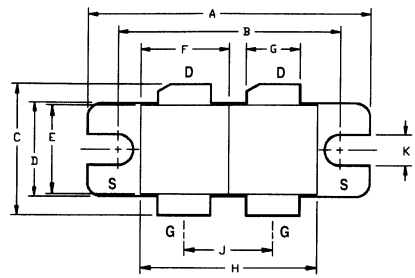
RF MOSFET Power Transistor, 100W, 40V 500 - 1000 MHz

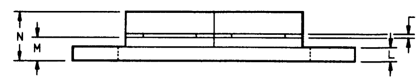
LF40100M

V2.00

Features

- Gold Metallized
- Input Matched
- Resfet Structure
- Lower Capacitances for Broadband Operation
- N-Channel Enhancement Mode Devicec
- Common Source Configuration
- Push-Pull
- Applications
  Broadband Linear Operation
  500 MHz to 1000 MHz





LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	30.35	30.61	1.195	1.205
B	23.65	23.90	.931	.941
C	13.72	14.22	.540	.560
D	9.63	9.88	.379	.389
E	9.40	9.65	.370	.380
F	9.40	9.65	.370	.380
G	5.59	5.84	.220	.230
H	18.80	19.30	.740	.760
J	9.40	9.65	.370	.380
K	3.12	3.38	.123	.133
L	1.47	1.57	.058	.062
M	2.39	2.74	.094	.108
N	5.03	5.69	.198	.224
P	.05	.13	.002	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	80	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	20	A
Power Dissipation	P_D	233	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.75	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	80	-	V	V_{GS}=0.0 V, I_{DS}=40.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	4.0	mA	V_{DS}=40.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	20	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	1.0	6.0	V	V_{DS}=10.0 V, I_{DS}=200.0 mA*
Forward Transconductance	G_M	1.0	-	S	V_{DS}=10.0 V, I_{DS}=2.0 mA, 300 µs Pulse*
Input Capacitance	C_{ISS}	-	110	pF	V_{DS}=40.0 V, F=1.0 MHz, Reference only.**
Output Capacitance	C_{OSS}	-	50	pF	V_{DS}=40.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	14	pF	V_{DS}=40.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=40.0 V, I_{DQ}=400 mA, P_{OUT}=100.0 W, F=1.0 GHz
Drain Efficiency	η_D	45	-	%	V_{DD}=40.0 V, I_{DQ}=400 mA, P_{OUT}=100.0 W, F=1.0 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{DD}=40.0 V, I_{DQ}=400 mA, P_{OUT}=100.0 W, F=1.0 GHz

* Per side
** Note: Due to the internal matching network, this parameter cannot be measured.

Specifications Subject to Change Without Notice.

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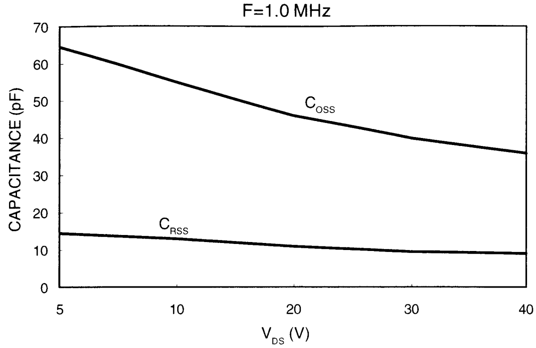
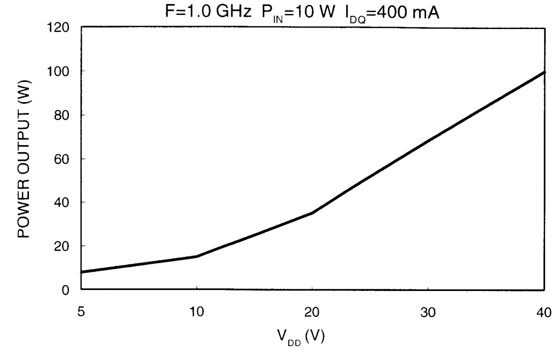
Typical Broadband Performance Curves

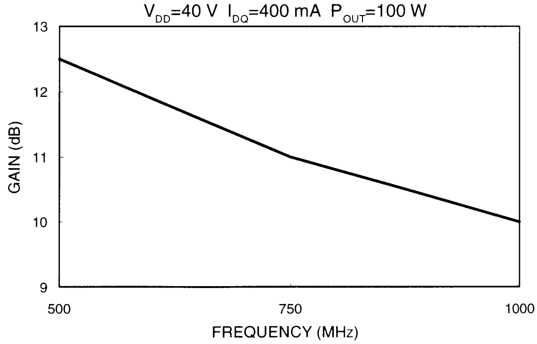
CAPACITANCES vs VOLTAGE
F=1.0 MHz



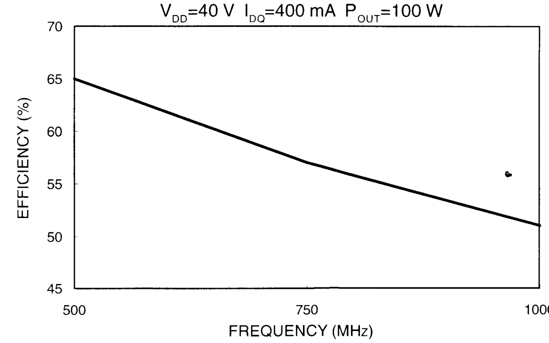
POWER OUTPUT vs VOLTAGE
F=1.0 GHz P_{IN}=10 W I_{DQ}=400 mA



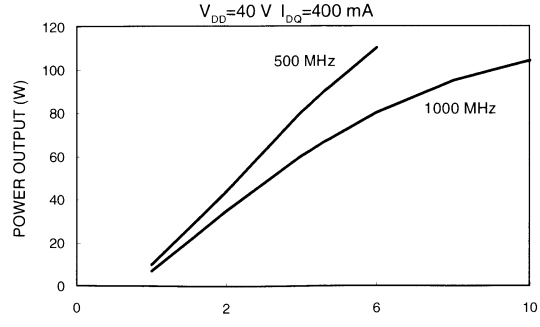
GAIN vs FREQUENCY
V_{DD}=40 V I_{DQ}=400 mA P_{OUT}=100 W



EFFICIENCY vs FREQUENCY
V_{DD}=40 V I_{DQ}=400 mA P_{OUT}=100 W



POWER OUTPUT vs POWER OUTPUT
V_{DD}=40 V I_{DQ}=400 mA



- Continued next page -

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Typical Device Impedance

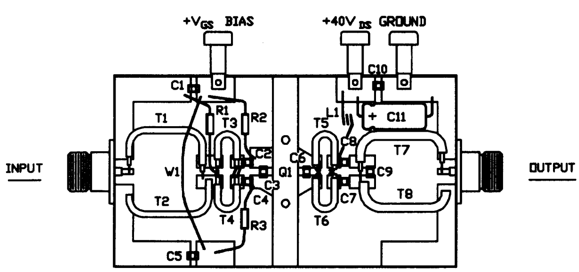
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
500	1.3 + j 5.5	5.2 + j 5.0
640	1.0 + j 6.5	3.3 - j 0.5
850	2.4 + j 9.4	2.2 - j 3.7
1000	3.5 + j 10.5	2.2 - j 5.5

V_{DD}=40 V, I_{DQ}=400 mA, P_{OUT}=100 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

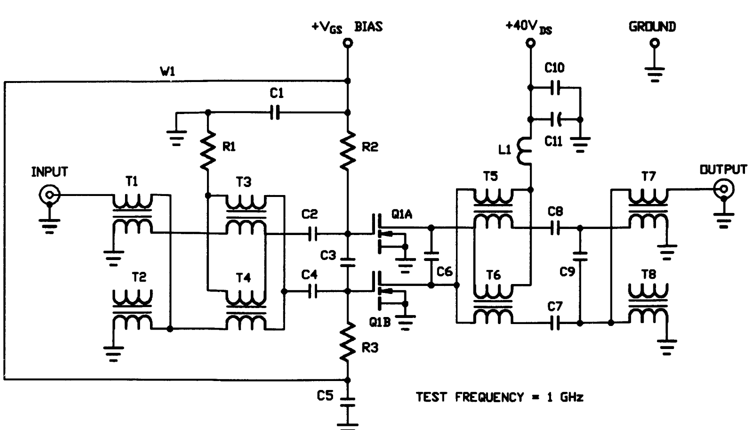
RF Test Fixture



FIXTURE TOP VIEW

PARTS LIST

C1 C5 C10	560 pF
C2 C4 C7 C8	33 pF
C3	8.2 pF
C6	11 pF
C9	2.2 pF
C11	50 uF @ 50 V.
T1 T2 T7 T8	1.50" OF 50 OHM COAX
T3 T4 T5 T6	.70" OF 25 OHM COAX
L1	3 TURNS OF NO. 18 AWG ON .125" DIAMETER
R1	10 OHM .50 WATT
R2 R3	56 OHM .50 WATT
W1	2.70" OF NO. 18 AWG
Q1	LF40100M



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an AMP company

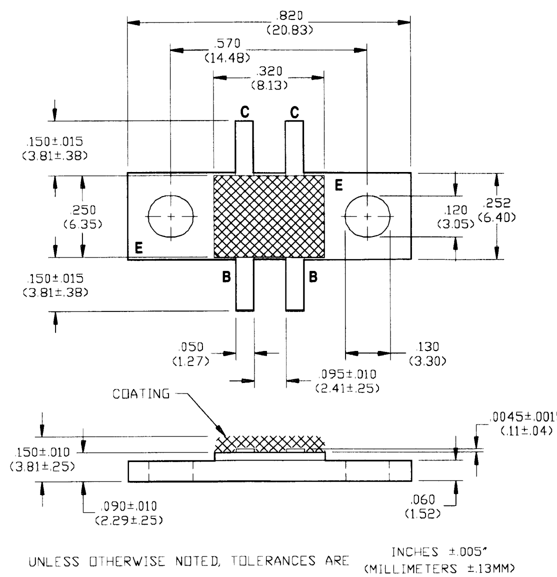
CW Power Transistor, 16W
30 - 400 MHz

PH0104-16

V2.00

Features

- NPN Silicon Power Transistor
- Common Emitter Configuration
- Class AB Broadband Operation
- 16 Watt PEP Output
- Diffused Emitter Ballasting Resistors
- Gold Metallization System
- Proven in Thousands of ARC-182 Airborne Radios



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current (Peak)	I_C	2	A
Power Dissipation	P_D	83	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Thermal Resistance	θ_{JC}	2.1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=5 mA, V_{BE}=0.0 V
Base-Emitter Breakdown Voltage	BV_{EBO}	4.0		V	I_B=2.5 mA, I_C=0.0 A
Collector-Emitter Leakage Current	I_{CES}	-	1	mA	V_{CE}=30 V
DC Forward Current Gain	h_{FE}	20	80	-	V_{CE}=5.0 V, I_C=500 mA
Input Power	P_{IN}	-	2.0	W	V_{CC}=27 V, I_{CQ}=10 mA, P_{OUT}=16 W, F=400 MHz
Power Gain	G_P	9.0	-	dB	V_{CC}=27 V, I_{CQ}=10 mA, P_{OUT}=16 W, F=400 MHz
Collector Efficiency	η_C	40	-	%	V_{CC}=27 V, I_{CQ}=10 mA, P_{OUT}=16 W, F=400 MHz
Input Return Loss	RL	9	-	dB	V_{CC}=27 V, I_{CQ}=10 mA, P_{OUT}=16 W, F=400 MHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=27 V, I_{CQ}=10 mA, P_{OUT}=16 W, F=400 MHz

Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

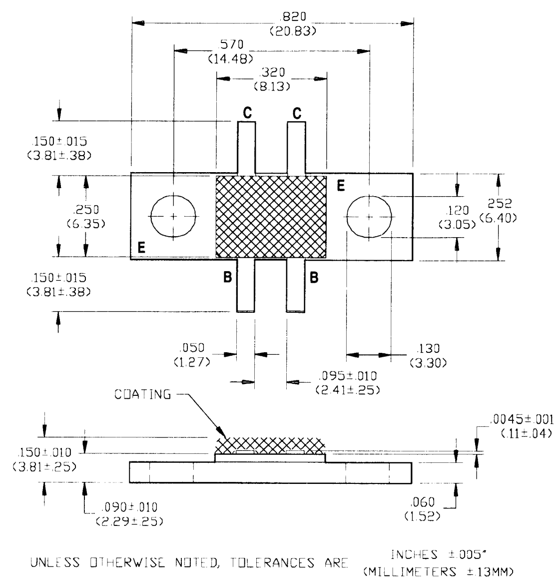
CW Power Transistor, 85W
30 - 400 MHz

PH0104-85

V2.00

Features

- NPN Silicon Power Transistor
- Common Emitter Configuration
- Class AB Broadband Operation
- 85 Watt PEP Output
- Diffused Emitter Ballasting Resistors
- Gold Metallization System
- Proven in Thousands of ARC-182 Airborne Radios



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	4.0	V
Collector Current (Peak)	I_C	10	A
Power Dissipation	P_D	194	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Thermal Resistance	θ_{JC}	0.9	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA, V_{BE}=0.0 V
Base-Emitter Breakdown Voltage	BV_{EBO}	4.0		V	I_B=10 mA, I_C=0.0 A
Collector-Emitter Leakage Current	I_{CES}	-	4	mA	V_{CE}=30 V
DC Forward Current Gain	h_{FE}	20	80	-	V_{CE}=5.0 V, I_C=2.0 A
Input Power	P_{IN}	-	16	W	V_{CC}=27 V, I_{CQ}=50 mA, P_{OUT}=85 W, F=400 MHz
Power Gain	G_P	7.3	-	dB	V_{CC}=27 V, I_{CQ}=50 mA, P_{OUT}=85 W, F=400 MHz
Collector Efficiency	η_C	45	-	%	V_{CC}=27 V, I_{CQ}=50 mA, P_{OUT}=85 W, F=400 MHz
Input Return Loss	RL	9	-	dB	V_{CC}=27 V, I_{CQ}=50 mA, P_{OUT}=85 W, F=400 MHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=27 V, I_{CQ}=50 mA, P_{OUT}=85 W, F=400 MHz

Specifications Subject to Change Without Notice.

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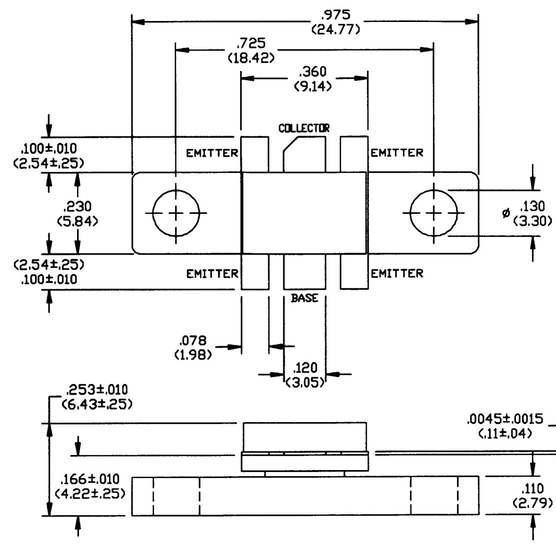
an AMP company

Wireless Bipolar Power Transistor, 4W
850 - 960 MHz
PH0810-4

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Designed for Linear Amplifier Applications
- Class AB: -30dBc Typ 3rd IMD at 4 Watts PEP
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting Resistors
- Gold Metallization System



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

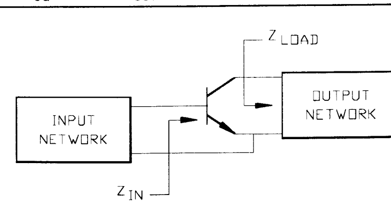
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.7	A
Total Power Dissipation	P_{TOT}	19.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	7.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=24.0 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	22	-	V	I_C=5 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=2.5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=0.1 A
Power Gain	G_P	14	-	dB	V_{CC}=24 V, I_{CQ}=30 mA, P_{OUT}=4 W, F=900 MHz
Collector Efficiency	η_C	45	-	%	V_{CC}=24 V, I_{CQ}=30 mA, P_{OUT}=4 W, F=900 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=24 V, I_{CQ}=30 mA, P_{OUT}=4 W, F=900 MHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=24 V, I_{CQ}=30 mA, P_{OUT}=4 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=24 V, I_{CQ}=30 mA, P_{OUT}=4 W PEP, F=900 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
850	3.0 + j3.5	10.6 + j15.9
900	4.0 + j2.4	11.2 + j16.9
960	3.0 + j1.0	11.3 + j17.5



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Typical S-Parameters

V_{CC}=25 V, I_{CQ}=200 mA

f(MHz)	S11 Mag	S11 Phase	S21 Mag	S21 Phase	S12 Mag	S12 Phase	S22 Mag	S22 Phase
50	0.771	-153.4	21.6	122.4	0.265	-102.1	0.016	20.3
150	0.868	-172.4	8.3	91.5	0.243	-134.1	0.016	11.2
250	0.871	-177.8	5.1	78.2	0.277	-135.4	0.017	2.7
350	0.868	179.3	3.9	67.2	0.302	-130.6	0.016	7.4
450	0.858	177.6	3.2	55.5	0.368	-124.1	0.018	-8.0
550	0.846	176.6	2.8	42.0	0.491	-118.9	0.019	-16.8
650	0.834	176.4	2.6	24.7	0.672	-118.9	0.020	-34.1
750	0.828	177.5	2.3	2.2	0.865	-126.1	0.016	-54.9
850	0.849	178.4	1.8	-23.8	1.0	-141.2	0.010	-89.4
950	0.882	177.6	1.2	-47.7	1.0	-153.6	0.009	-161.3
1050	0.905	175.6	0.817	-65.9	1.0	-165.1	0.009	132.8
1150	0.915	173.6	0.505	-78.5	0.869	-170.1	0.015	108.4
1250	0.918	171.8	0.306	-87.6	0.834	-174.6	0.018	93.5
1350	0.918	170.1	0.176	-92.9	0.79	-175.5	0.022	89.5
1450	0.917	168.1	0.087	-94.3	0.767	-175.2	0.027	83.6
1550	0.912	165.7	0.036	-76.9	0.793	-175.4	0.032	80.5

V_{CC}=25 V, I_{CQ}=300 mA

f(MHz)	S11 Mag	S11 Phase	S21 Mag	S21 Phase	S12 Mag	S12 Phase	S22 Mag	S22 Phase
50	0.777	-153.3	22.1	121.7	0.294	-105.2	0.014	17.9
150	0.868	-172.6	8.4	91.2	0.253	-142.9	0.017	18.9
250	0.870	-177.9	5.2	78.2	0.258	-137.9	0.015	7.8
350	0.865	179.2	3.9	67.2	0.309	-134.1	0.018	-1.0
450	0.856	177.4	3.2	55.4	0.362	-129.4	0.017	-3.4
550	0.844	176.5	2.9	42.1	0.485	-119.3	0.020	-14.3
650	0.829	176.4	2.6	24.7	0.680	-120.2	0.018	-33.4
750	0.824	177.5	2.3	1.7	0.887	-126.8	0.016	-49.4
850	0.847	178.5	1.9	-24.9	1.0	-141.2	0.009	-93.9
950	0.880	177.7	1.3	-48.8	1.0	-155.3	0.006	-165.9
1050	0.904	175.7	0.820	-66.6	0.968	-164.8	0.012	141.8
1150	0.914	173.6	0.508	-79.1	0.864	-170.6	0.015	115.1
1250	0.919	171.8	0.304	-87.4	0.828	-174.9	0.019	96.5
1350	0.917	170.0	0.178	-92.4	0.805	-176.5	0.022	86.2
1450	0.916	168.0	0.090	-93.3	0.769	-174.3	0.025	83.6
1550	0.912	165.7	0.032	-71.5	0.782	-177.6	0.032	78.5

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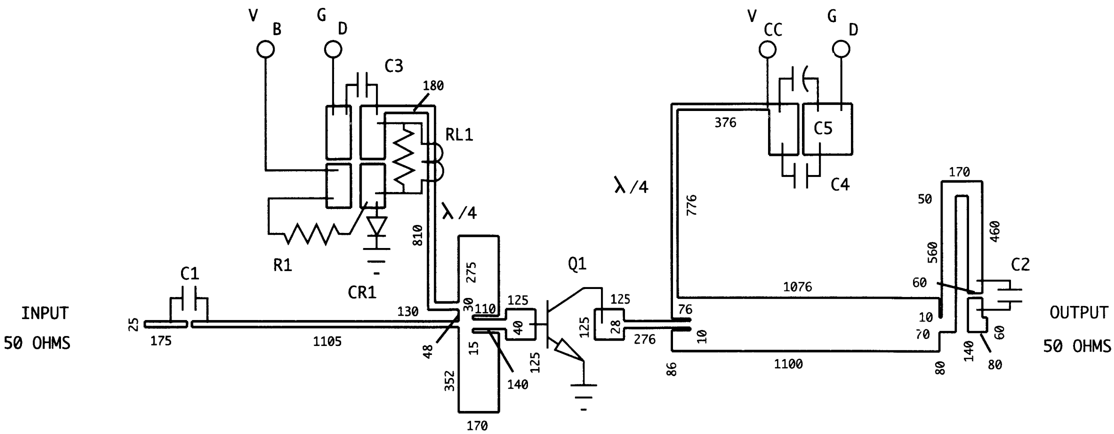
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	100 pF ATC SIZE A
C4	5000 pF ATC SIZE B
C5	50 uF 50 VOLTS
CR1	DIODE CATHODE MECHANICALLY ATTACHED TO FLANGE (HARRIS 1N4245)
Q1	PH0810-4
R1	5 OHMS 1/4 WATT
RL1	10T/NO. 22 AWG ON 3.1 OHM 1/4 WATT
BOARD TYPE	ROGERS 6010.5 .025" THICK, E_R = 10.5

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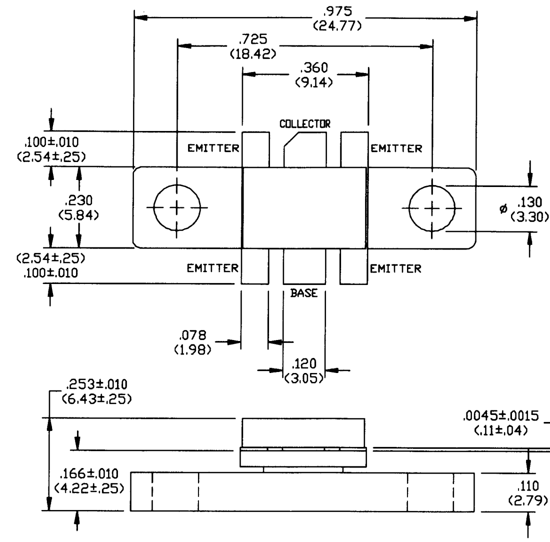
Wireless Bipolar Power Transistor, 15W
850 - 960 MHz

PH0810-15

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -30dBc Typ 3rd IMD at 15 Watts PEP
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting Resistors



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

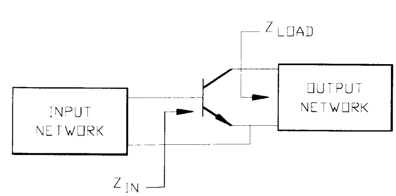
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	1.8	A
Total Power Dissipation	P_{TOT}	43	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=15 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=24.0 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=40 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=2.5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=0.5 A
Power Gain	G_P	12	-	dB	V_{CC}=24 V, I_{CQ}=100 mA, P_{OUT}=15 W, F=900 MHz
Collector Efficiency	η_C	50	-	%	V_{CC}=24 V, I_{CQ}=100 mA, P_{OUT}=15 W, F=900 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=24 V, I_{CQ}=100 mA, P_{OUT}=15 W, F=900 MHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=24 V, I_{CQ}=100 mA, P_{OUT}=15 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=24 V, I_{CQ}=100 mA, P_{OUT}=15 W PEP, F=900 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
850	2.5 + j3.6	4.3 + j2.6
900	2.9 + j2.4	4.4 + j3.4
960	1.5 + j2.0	4.3 + j3.9



Specifications Subject to Change Without Notice.

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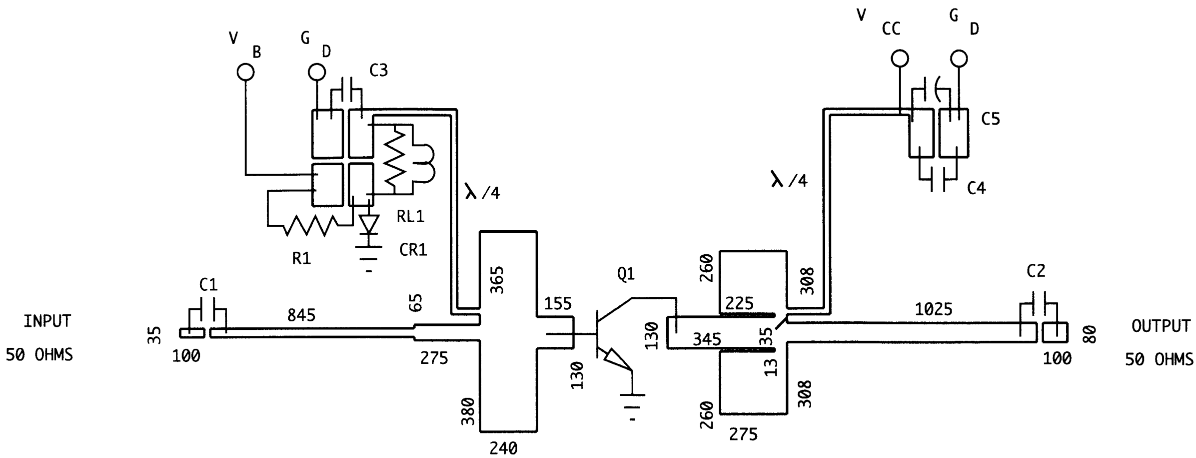
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	100 pF ATC SIZE A
C4	5000 pF ATC SIZE B
C5	50 uF 50 VOLTS
CR1	DIODE CATHODE MECHANICALLY ATTACHED TO FLANGE (HARRIS 1N4245)
Q1	PH0810-15
R1	5 OHMS 1/4 WATT
RL1	10T/NO. 22 AWG ON 3.1 OHM 1/4 WATT
BOARD TYPE	ROGERS 6010.5 .025" THICK, E_R = 10.5

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an AMP company

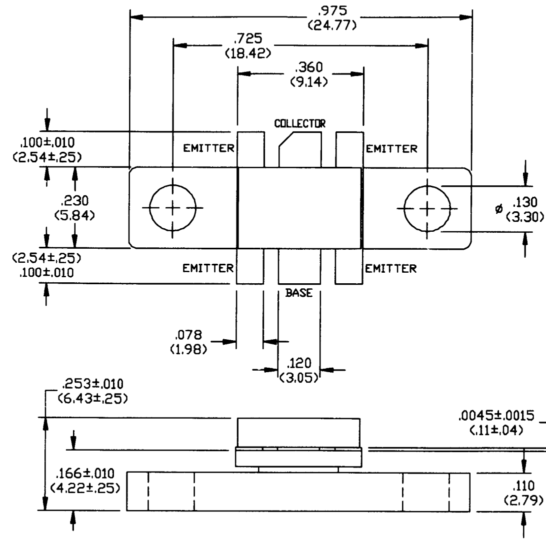
Wireless Bipolar Power Transistor, 35W
850 - 960 MHz

PH0810-35

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -30dBc Typ 3rd IMD at 15 Watts PEP
- Class A: +53dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

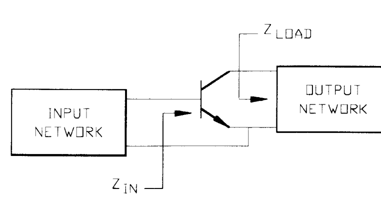
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	1.0	A
Total Power Dissipation	P_{TOT}	116	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=20 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=24.0 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=40 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=20 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=1.0 A
Power Gain	G_P	10	-	dB	V_{CC}=24 V, I_{CQ}=200 mA, P_{OUT}=35 W, F=900 MHz
Collector Efficiency	η_C	55	-	%	V_{CC}=24 V, I_{CQ}=200 mA, P_{OUT}=35 W, F=900 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=24 V, I_{CQ}=200 mA, P_{OUT}=35 W, F=900 MHz
Load Mismatch Tolerance	VSWR-T	-	3.0:1	-	V_{CC}=24 V, I_{CQ}=200 mA, P_{OUT}=35 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=24 V, I_{CQ}=200 mA, P_{OUT}=35 W PEP, F=900 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
800	1.0 + j3.7	2.1 + j0.9
850	1.3 + j4.0	1.6 + j0.7
900	1.9 + j4.3	1.6 + j0.4
960	3.0 + j2.7	1.7 + j0.1



Specifications Subject to Change Without Notice.

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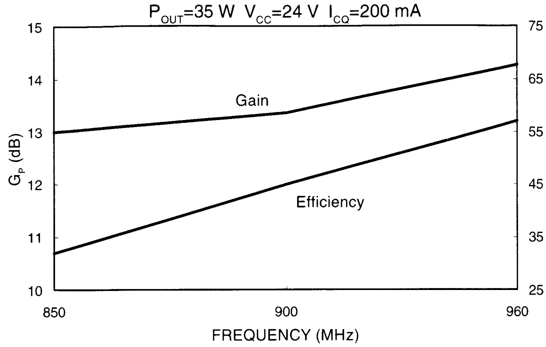
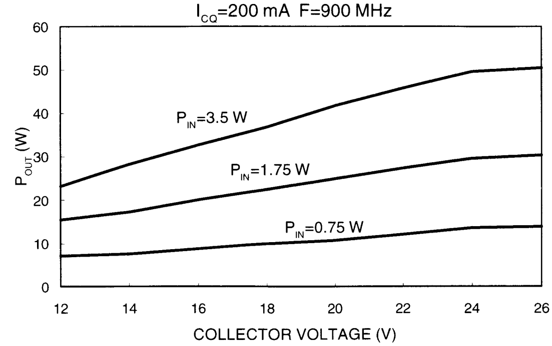
Typical Broadband Performance Curves

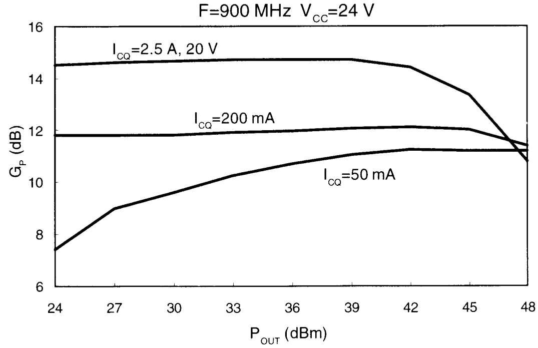
GAIN-EFFICIENCY vs FREQUENCY
P_{OUT}=35 W V_{CC}=24 V I_{CQ}=200 mA



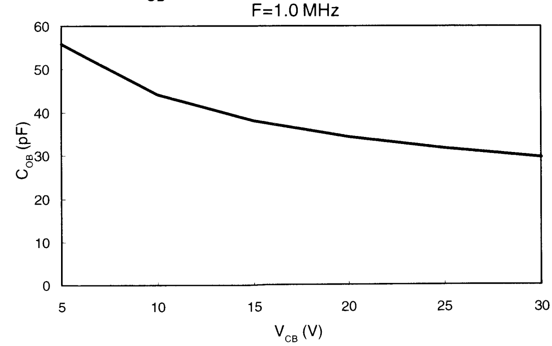
OUTPUT POWER vs COLLECTOR VOLTAGE
I_{CQ}=200 mA F=900 MHz



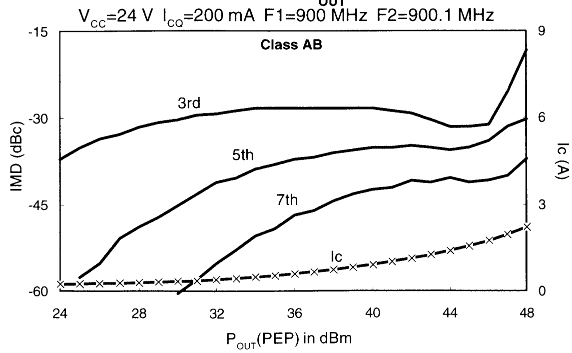
GAIN vs POWER OUTPUT
F=900 MHz V_{CC}=24 V



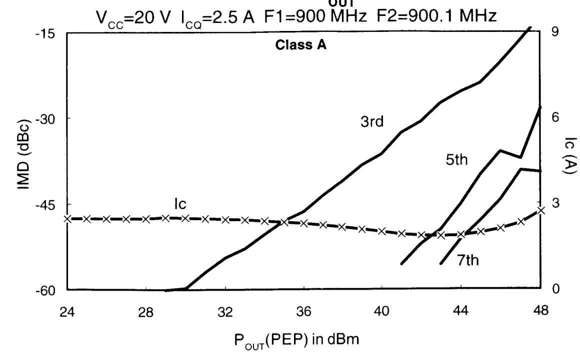
C_{OB} vs COLLECTOR VOLTAGE
F=1.0 MHz



IMD vs P_{OUT}
V_{CC}=24 V I_{CQ}=200 mA F1=900 MHz F2=900.1 MHz



IMD vs P_{OUT}
V_{CC}=20 V I_{CQ}=2.5 A F1=900 MHz F2=900.1 MHz



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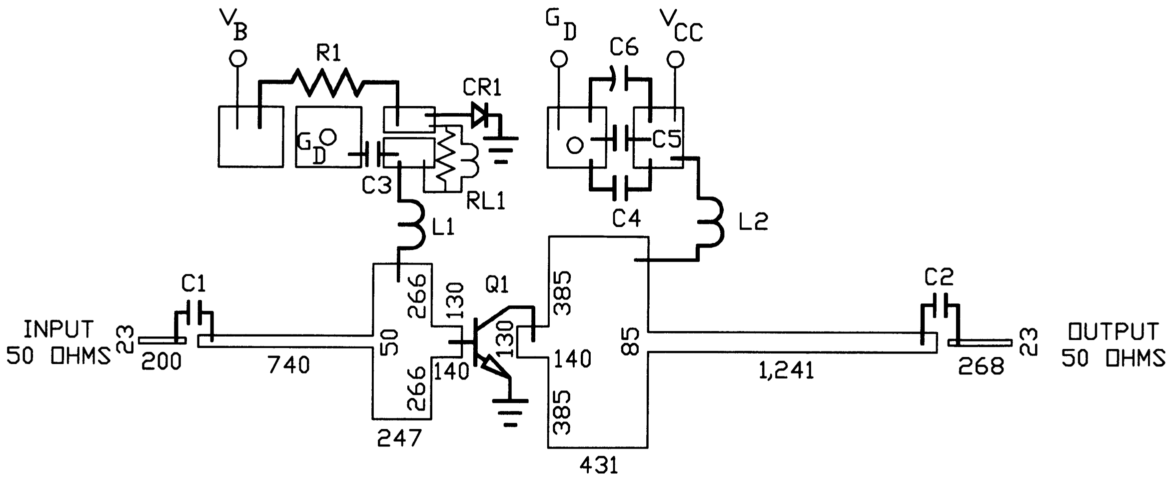
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3 C4	100 pF ATC SIZE B
C5	5000 pF
C6	50 uF 50 VOLTS
CR1	1N4245 DIODE
L1 L2	10T/NO. 20 AWG ON 1/8" DIAMETER
Q1	PH0810-35
R1	5 OHMS 1/4 WATT
RL1	10T/NO. 22 AWG ON 3.1 OHM 1/4 WATT
BOARD TYPE	ROGERS 6010.5 .025" THICK, E_R = 10.5

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an AMP company

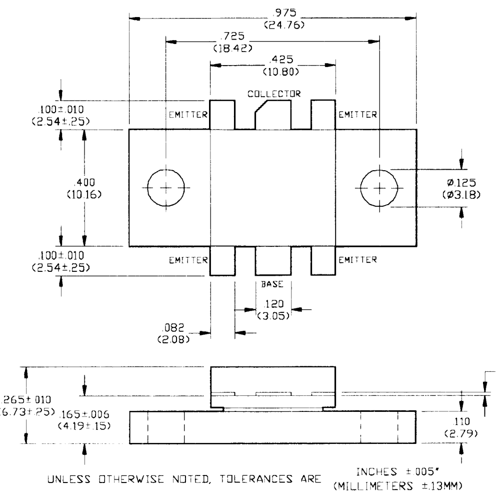
Wireless Bipolar Power Transistor, 60W
850 - 900 MHz

PH0810-60A

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -30 dBc Typ 3rd IMD at 60 Watts PEP
- Common Emitter Configuration
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

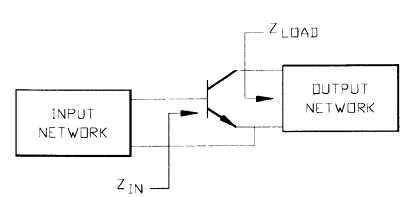
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	10	A
Total Power Dissipation	P_{TOT}	100	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=26.0 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=80 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=50 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=1.0 A
Power Gain	G_P	10	-	dB	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
Collector Efficiency	η_C	35	-	%	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
850	3.0 + j3.0	2.5 + j4.0
875	4.0 + j2.8	2.3 + j5.4
900	4.5 + j2.7	2.2 + j6.5



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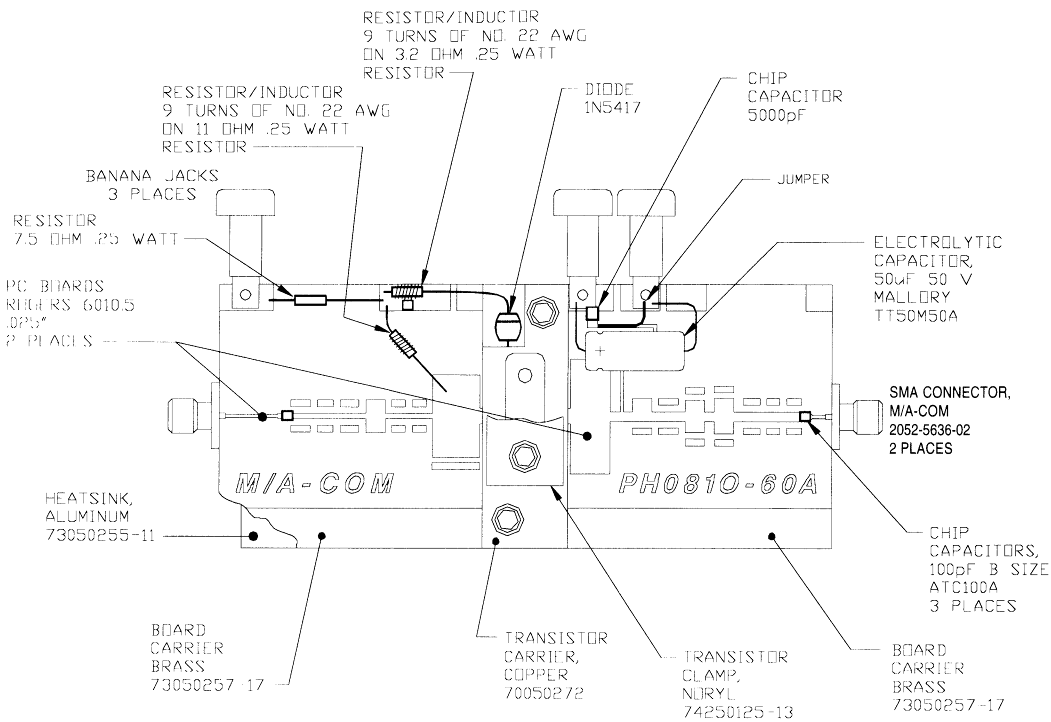
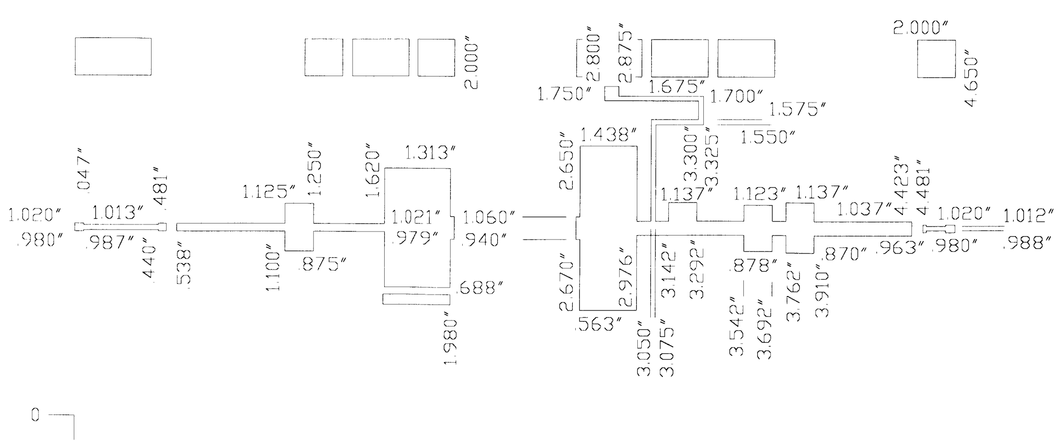
RF Test Fixture



Test Fixture PC Board Dimensions



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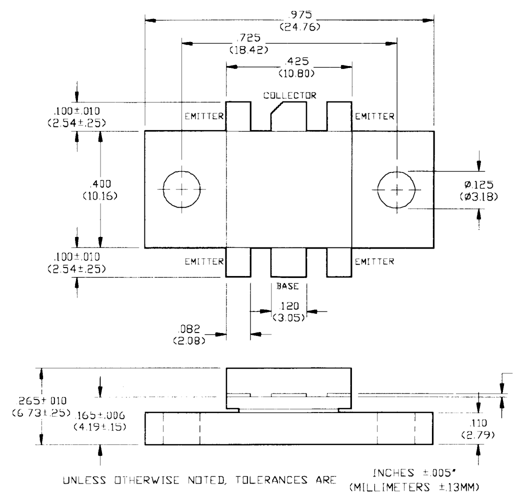
an AMP company

Wireless Bipolar Power Transistor, 60W
900 - 960 MHz PH0810-60B

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -30 dBc Typ 3rd IMD at 60 Watts PEP
- Common Emitter Configuration
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

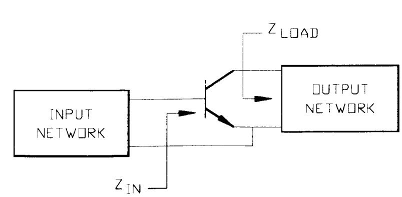
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	10	A
Total Power Dissipation	P_{TOT}	100	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	8.0	mA	V_{CE}=26.0 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=80 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=50 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=1.0 A
Power Gain	G_P	10	-	dB	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
Collector Efficiency	η_C	35	-	%	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=60 W PEP, F=900 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
900	1.5 + j1.8	2.8 - j1.1
960	1.5 + j1.3	2.2 - j1.3



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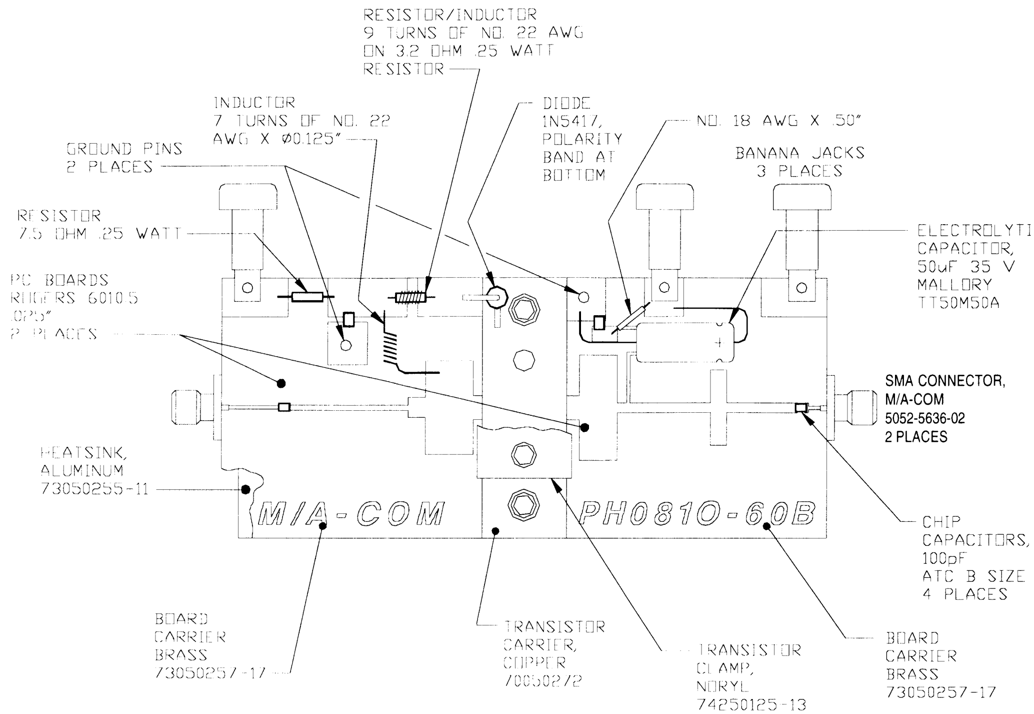
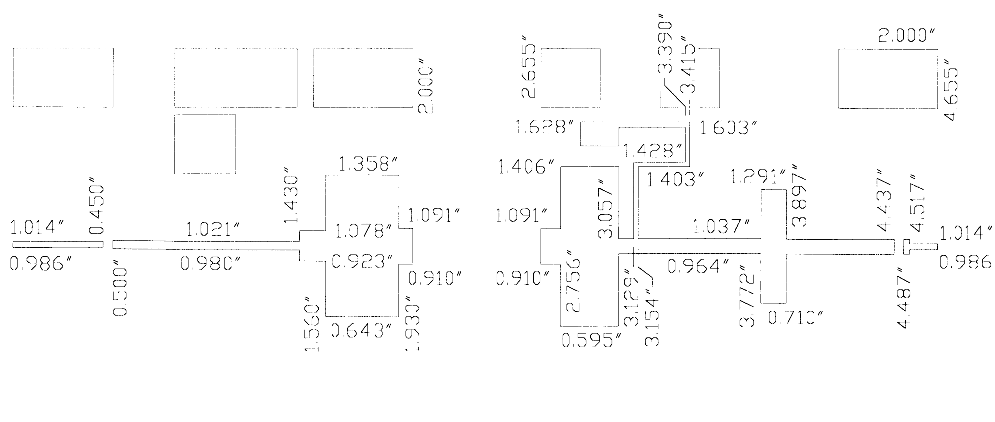
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

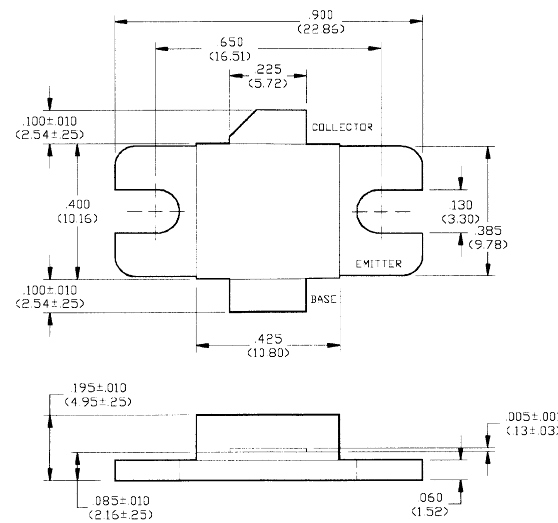
Wireless Bipolar Power Transistor, 75W
850 - 960 MHz

PH0810-75

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -32 dBc Typ 3rd IMD at 75 Watts PEP
- Common Emitter Configuration
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

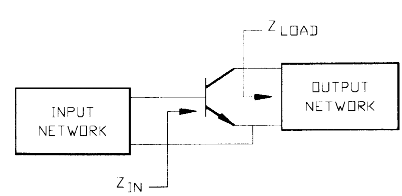
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	12	A
Total Power Dissipation	P_{TOT}	125	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.4	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	8.0	mA	V_{CE}=26.0 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=100 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=50 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=1.0 A
Power Gain	G_P	10	-	dB	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=75 W PEP, F=900 MHz, ΔF=100 kHz
Collector Efficiency	η_C	35	-	%	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=75 W PEP, F=900 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=75 W PEP, F=900 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	5.0:1	-	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=75 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=26 V, I_{CQ}=150 mA, P_{OUT}=75 W PEP, F=900 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
850	1.1 + j3.5	1.7 - j3.0
900	1.7 + j3.1	1.7 - j2.8
960	1.7 + j2.5	1.2 - j2.9



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M/A-COM
an AMP company

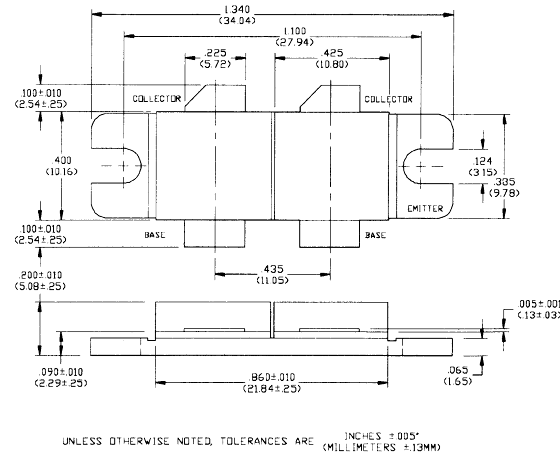
Wireless Bipolar Power Transistor, 150W
850 - 960 MHz

PH0810-150

V2.01

Features

- Designed for Linear Amplifier Applications
- Class AB: -32 dBc Typ 3rd IMD at 150 Watts PEP
- Common Emitter Configuration
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	25	A
Total Power Dissipation	P_{TOT}	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.7	°C/W

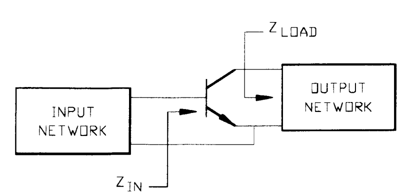
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=50 mA*
Collector-Emitter Leakage Current	I_{CES}	-	10.0	mA	V_{CE}=26.0 V*
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=100 mA*
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=50 mA*
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5.0 V, IC=1.0 A*
Power Gain	G_P	10	-	dB	V_{CC}=26 V, I_{CQ}=300 mA, P_{OUT}=150 W PEP, F=900 MHz, ΔF=100 kHz
Collector Efficiency	η_C	35	-	%	V_{CC}=26 V, I_{CQ}=300 mA, P_{OUT}=150 W PEP, F=900 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=300 mA, P_{OUT}=150 W PEP, F=900 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	5.0:1	-	V_{CC}=26 V, I_{CQ}=300 mA, P_{OUT}=150 W PEP, F=900 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=26 V, I_{CQ}=300 mA, P_{OUT}=150 W PEP, F=900 MHz, ΔF=100 kHz

* Per Side

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
850	2.2 + j6.0	3.3 - j5.4
900	3.5 + j5.6	3.4 - j5.0
960	3.6 + j4.0	2.3 - j5.2



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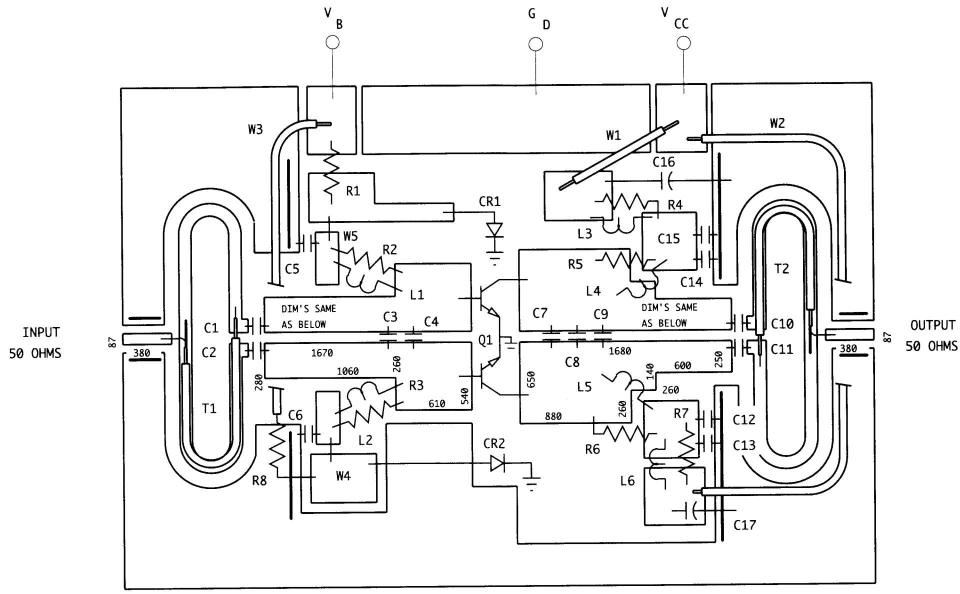
RF Test Fixture



PARTS LIST

C9	.7pF 100 VDC CHIP ATC TYPE B
C7 C8	3.6pF 100 VDC CHIP ATC TYPE B
C4	6.2pF 100 VDC CHIP ATC TYPE B
C3	26pF 100 VDC CHIP ATC TYPE B
C1 C2 C10 C11	43pF 100 VDC CHIP ATC TYPE B
C5 C6 C12 C14	100pF 100 VDC CHIP ATC TYPE B
C13 C15	5000pF 100 VDC CHIP ATC TYPE B
C16 C17	50uF 50 VOLTS
CR1 CR2	DIODE JX5417
L3 L6	7 TURNS OF NO. 18 AWG ON .150" DIA
L1 L2	11 TURNS OF NO. 18 AWG ON .150" DIA
L4 L5	11 TURNS OF NO. 18 AWG ON .100" DIA
Q1	PH0810-150
R2 R3 R4 R7	.47 OHM .5 WATT
R1 R5 R6 R8	47 OHM 1 WATT
T1 T2	50 OHM SEMI RIGID COAX 2.20" X .088" OD
W1 W2 W3	NO. 16 AWG TEFLON WIRE
W4, W5	NO. 16 AWG JUMPER
BOARD MATERIAL	TEFLON GLASS, .031" THICK, Er = 2.54

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an AMP company

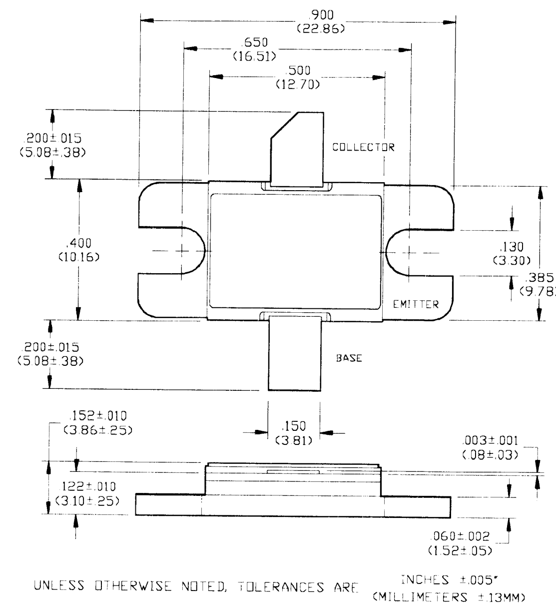
Linear Power Transistor, 40W
850 - 1450 MHz

PH0814-40

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Emitter Configuration
- Broadband Class AB Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

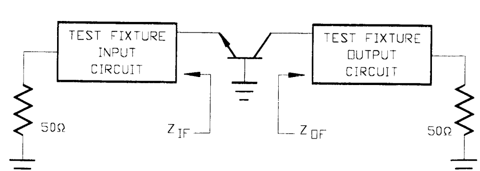
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	56	V
Collector-Emitter Voltage	V_{CES}	56	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	5.6	A
Total Power Dissipation	P_{TOT}	175	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +200	°C
Thermal Resistance	θ_{JC}	1.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	56	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	5.0	mA	V_{CE}=28 V
Collector-Base Breakdown Voltage	BV_{CBO}	56	-	V	I_C=50 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=10 mA
DC Forward Current Gain	h_{FE}	15	100	-	V_{CE}=5.0 V, I_C=0.5 A
Input Power	P_{IN}	5.5	8.8	W	V_{CC}=28 V, I_{CQ}=12 mA, P_{OUT}=42 W, F=1450 MHz
Collector Current	I_C	-	3.75	A	V_{CC}=28 V, I_{CQ}=12 mA, P_{OUT}=42 W, F=1450 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=28 V, I_{CQ}=12 mA, P_{OUT}=42 W, F=1450 MHz
Saturated Output Power	P_{SAT}	50	-	W	V_{CC}=28 V, I_{CQ}=12 mA, F=1450 MHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, I_{CQ}=12 mA, P_{OUT}=42 W, F=1450 MHz
Load Mismatch Tolerance	VSWR-T	-	1.5:1	-	V_{CC}=28 V, I_{CQ}=12 mA, P_{OUT}=42 W, F=850 MHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{OF}(\Omega)$
850	2.0 - j3.6	3.0 - j4.9
950	2.4 - j2.5	2.3 - j3.1
1050	3.1 - j1.8	2.0 - j2.0
1150	3.5 - j1.9	1.8 - j1.4
1250	3.3 - j2.4	1.7 - j0.9
1350	2.5 - j2.4	1.4 - j0.5
1450	1.7 - j1.8	1.2 - j0.1



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an AMP company

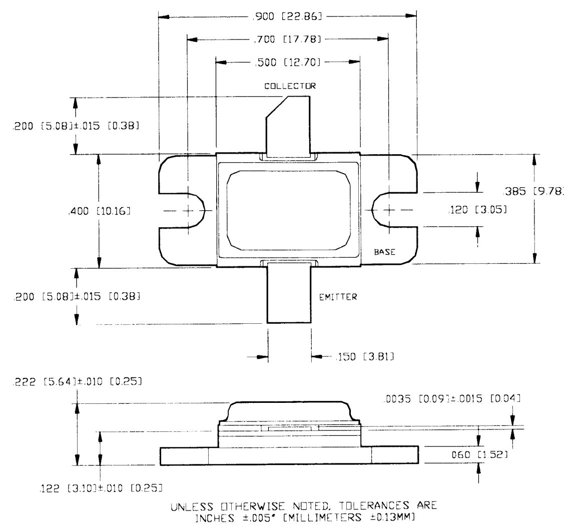
Avionics Pulsed Power Transistor, 120W, TDMA Format

960 - 1215 MHz PH0912-120

V2.00

Features

- Designed for JTIDS Applications
- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	15	A
Power Dissipation	P_D	380	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

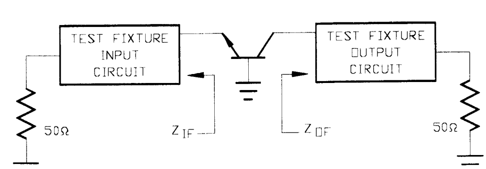
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	55	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	25	mA	V_{CE}=35.0 V
Thermal Resistance	$R_{TH(JC)}$	-	.46	°C/W	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1
Input Power	P_{IN}	-	19	W	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1
Power Gain	G_P	8	-	dB	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1
Collector Efficiency	η_C	44	-	%	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1
Input Return Loss	RL	12	-	dB	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Stablility	VSWR-S	-	2:1	-	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36.6 V, P_{OUT}=120 W, F=960, 1090, 1215 MHz, N1

N1: TDMA pulse format consists of 6.4us ON, 6.6us OFF pulses which repeat for 3.354ms which is then OFF for 4.4585ms

Broadband Test Fixture Impedances

F(MHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
960	1.8 - j4.1	3.4 - j1.6
1090	2.0 - j3.5	2.9 - j1.5
1215	1.2 - j3.5	2.3 - j1.0



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an AMP company

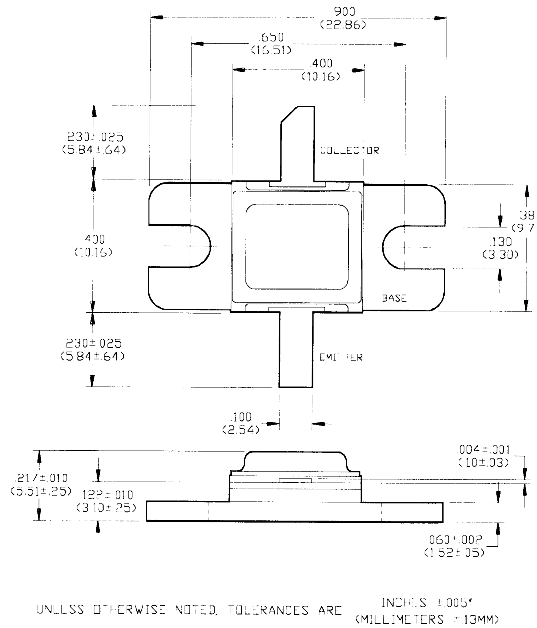
Avionics Pulsed Power Transistor, 175W, 250μs Pulse, 10% Duty 1030 - 1090 MHz

PH1090-175L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

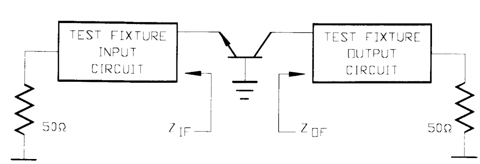
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	80	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	10.5	A
Total Power Dissipation	P_{TOT}	375	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	80	-	V	I_C=125 mA
Collector-Emitter Leakage Current	I_{CES}	-	12.5	mA	V_{CE}=45 V
Thermal Resistance	$R_{TH(JC)}$	-	0.4	°C/W	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz
Output Power	P_{OUT}	175	-	W	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz
Power Gain	G_P	8.3	-	dB	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz
Collector Efficiency	η_C	55	-	%	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz
Input Return Loss	RL	9	-	dB	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=45 V, P_{IN}=26 W, F=1090 MHz

Broadband Test Fixture Impedances

F(MHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1030	3.4 - j5.6	2.3 - j2.2
1090	3.2 - j5.1	2.3 - j1.7



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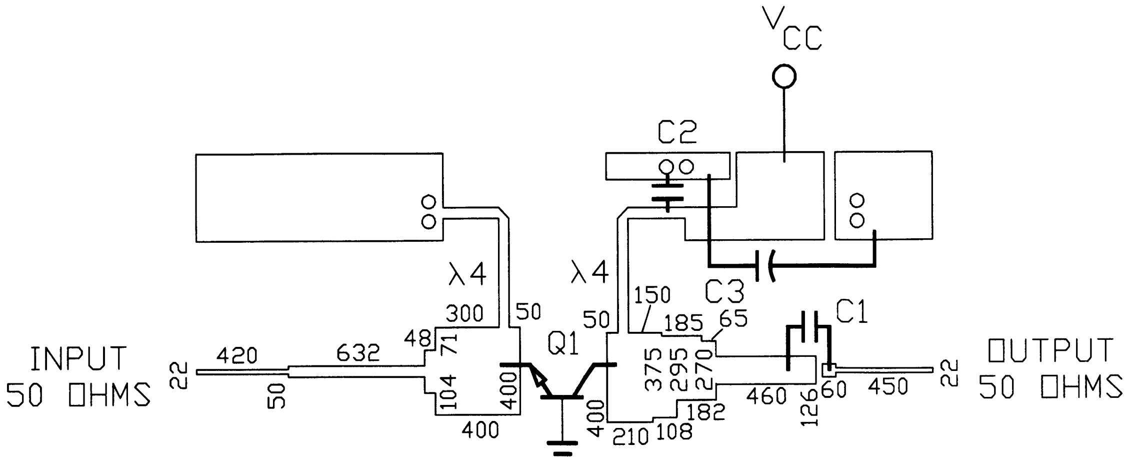
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	10 pF ATC SIZE A
C3	68 uF 63 VOLTS
Q1	PH1090-175L
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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an AMP company

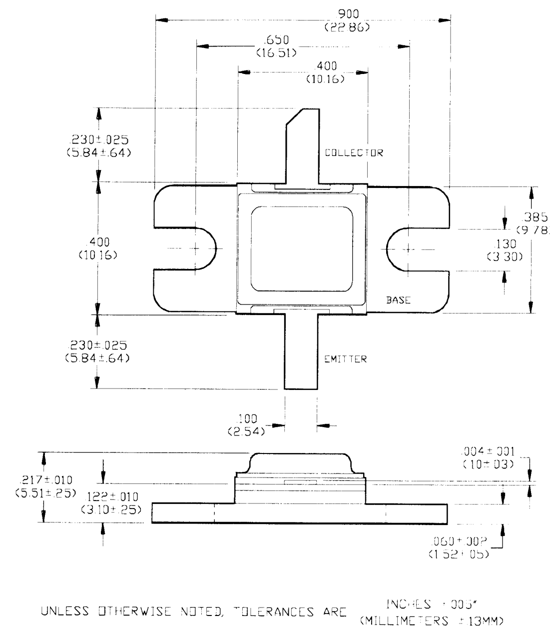
Avionics Pulsed Power Transistor, 350W, 250µs Pulse, 10% Duty 1030 - 1090 MHz

PH1090-350L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

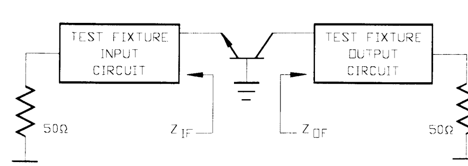
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	80	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	17	A
Total Power Dissipation	P_{TOT}	750	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	80	-	V	I_C=250 mA
Collector-Emitter Leakage Current	I_{CES}	-	25	mA	V_{CE}=45 V
Thermal Resistance	$R_{TH(JC)}$	-	0.2	°C/W	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz
Input Power	P_{IN}	-	55	W	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz
Power Gain	G_P	8.0	-	dB	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz
Collector Efficiency	η_C	55	-	%	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz
Input Return Loss	RL	9	-	dB	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=45 V, P_{OUT}=350 W, F=1090 MHz

Narrowband Test Fixture Impedances

F(MHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1090	2.5 - j1.5	1.1 - j0.9



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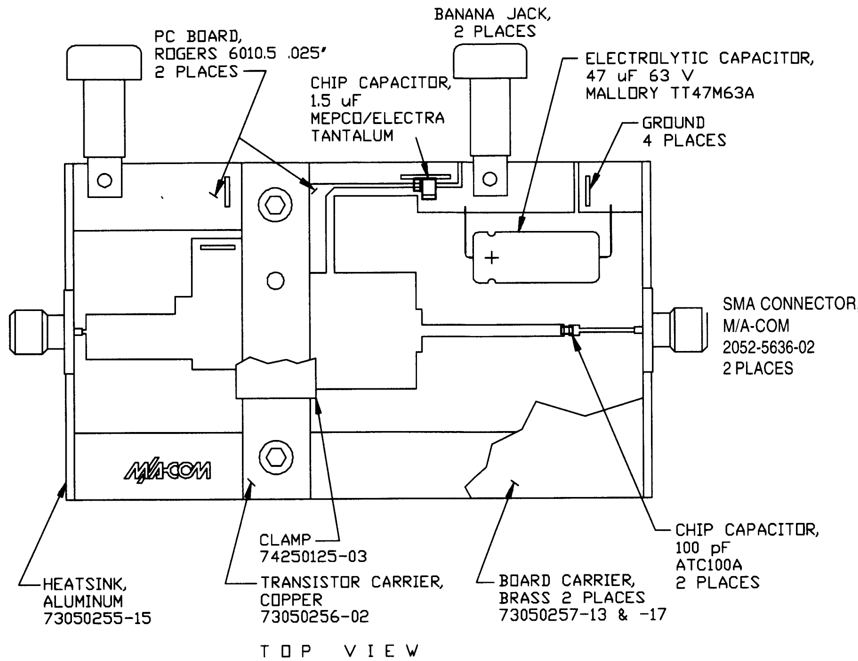
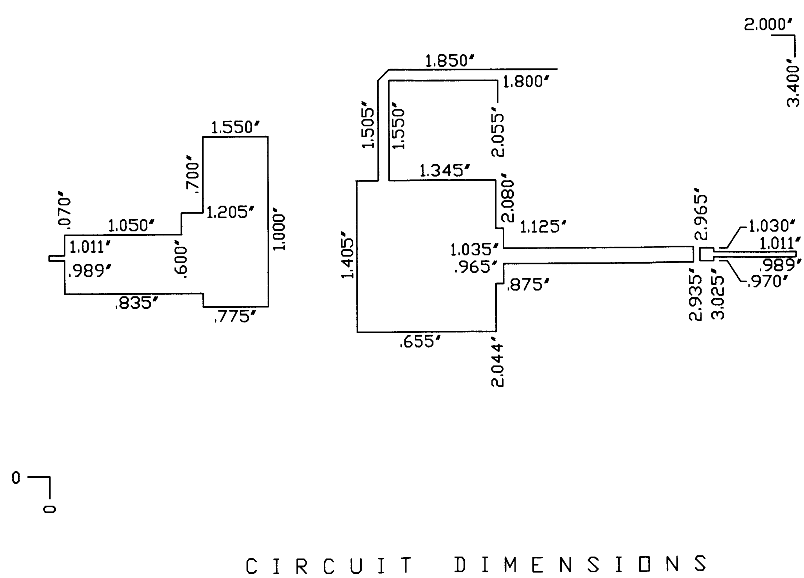
RF Test Fixture





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M/A-COM
an AMP company

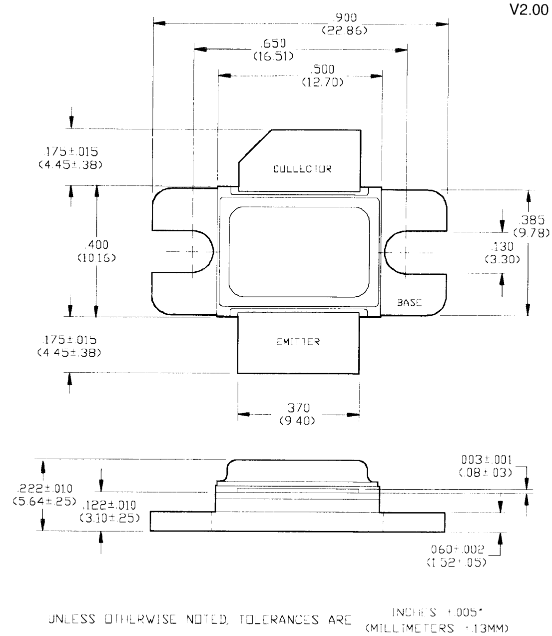
Avionics Pulsed Power Transistor, 550W, 10μs Pulse, 1% Duty 1030 - 1090 MHz

PH1090-550S

V2.00

Features

- Designed for Short Pulse IFF Applications
- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

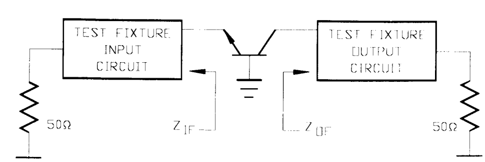
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	80	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	28	A
Total Power Dissipation	P_{TOT}	1.8	kW
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	80	-	V	I_C=250 mA
Collector-Emitter Leakage Current	I_{CES}	-	25	mA	V_{CE}=45 V
Thermal Resistance	$R_{TH(JC)}$	-	0.05	°C/W	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz
Input Power	P_{IN}	-	100	W	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz
Power Gain	G_P	7.5	-	dB	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz
Collector Efficiency	η_C	55	-	%	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz
Input Return Loss	RL	9	-	dB	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=50 V, P_{OUT}=550 W, F=1090 MHz

Broadband Test Fixture Impedances

F(MHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1030	4.0 - j3.5	1.4 - j1.6
1090	3.6 - j2.7	1.1 - j1.9



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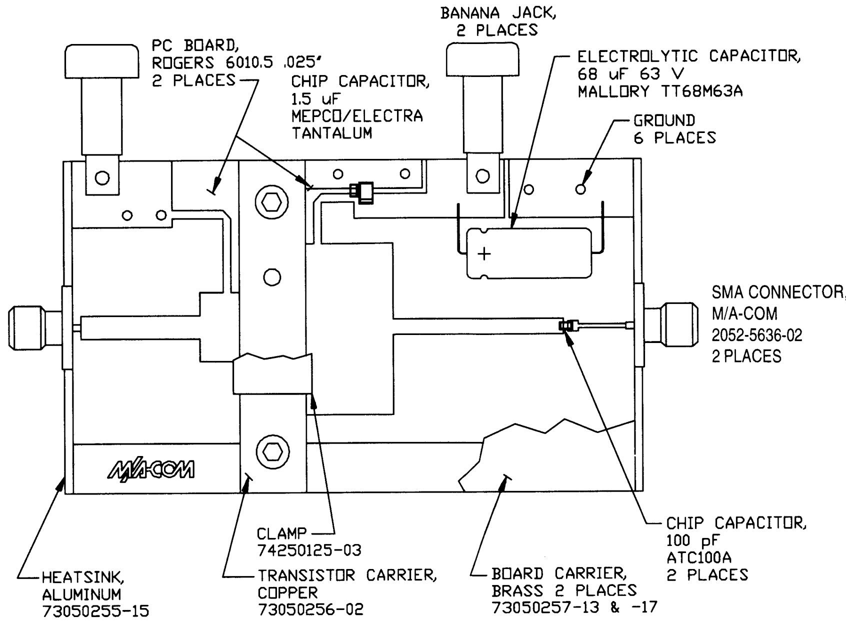
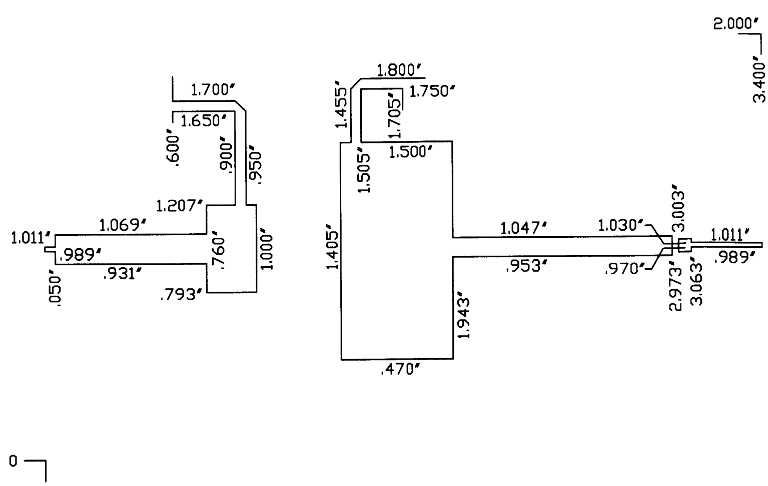
RF Test Fixture



TOP VIEW



CIRCUIT DIMENSIONS

M/A-COM
an AMP company

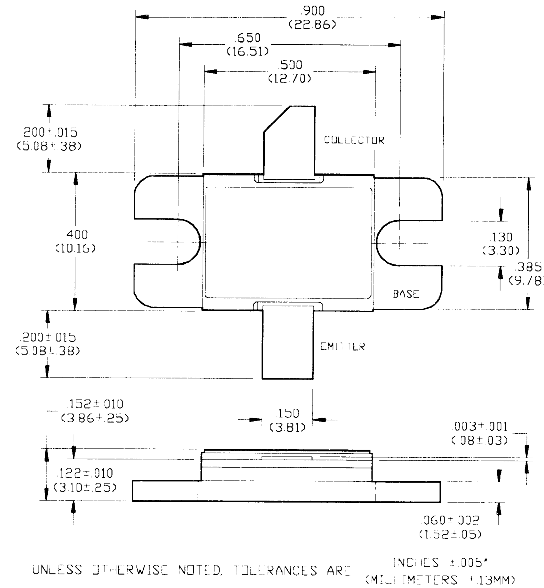
Radar Pulsed Power Transistor, 100W, 3µs Pulse, 30% Duty 1.1 - 1.3 GHz

PH1113-100

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

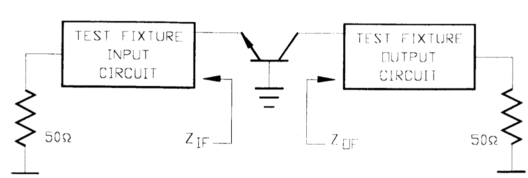
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	9.0	A
Total Power Dissipation	P_{TOT}	350	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	10	mA	V_{CE}=32 V
Thermal Resistance	$R_{TH(JC)}$	-	0.5	°C/W	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz
Input Power	P_{IN}	-	16	W	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz
Power Gain	G_P	8.0	-	dB	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz
Collector Efficiency	η_C	52	-	%	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=32 V, P_{OUT}=100 W, F=1.10, 1.20, 1.30 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.10	5.8 - j3.4	3.0 - j1.7
1.20	5.6 - j1.8	3.0 - j1.5
1.30	5.9 - j0.4	2.8 - j1.3



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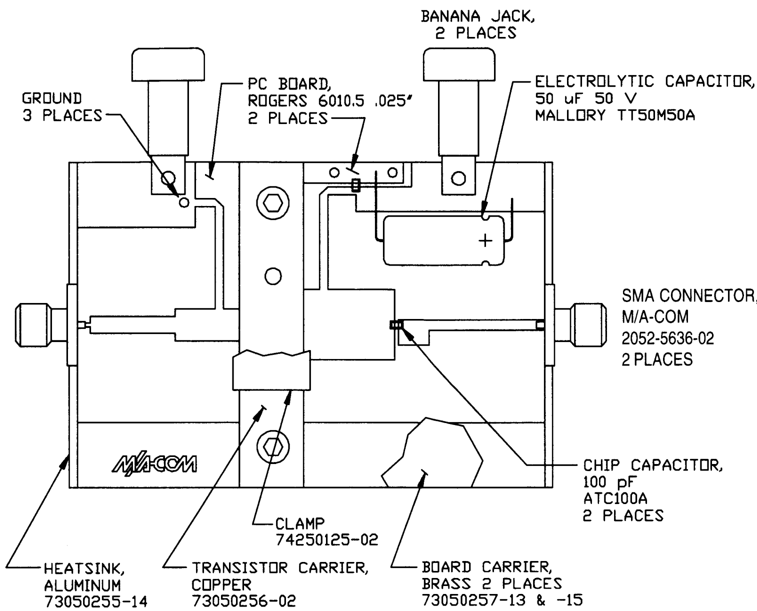
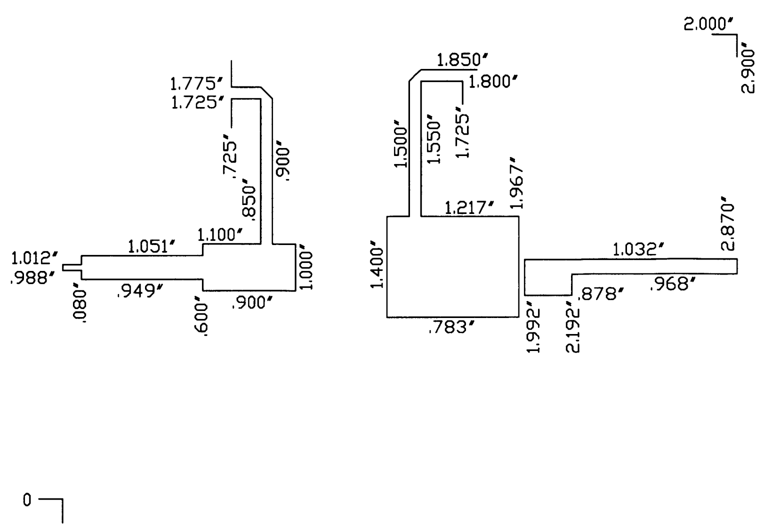
V2.00

RF Test Fixture



TOP VIEW



CIRCUIT DIMENSIONS

M/A-COM
an AMP company

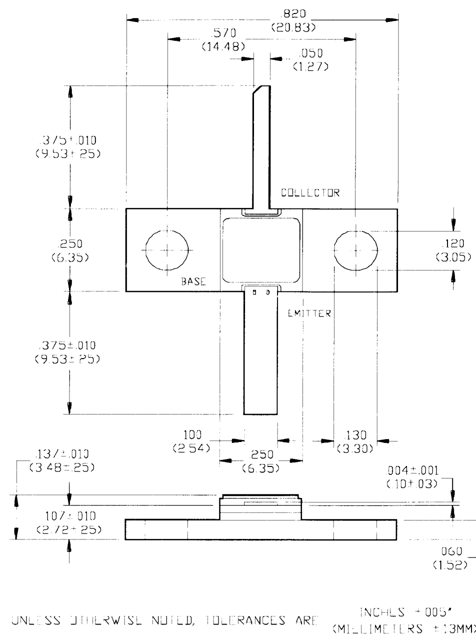
Radar Pulsed Power Transistor, 0.85W, 2ms Pulse, 20% Duty 1.2 - 1.4 GHz

PH1214-0.85L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Emitter Configuration
- Broadband Class A Operation
- Matrix Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

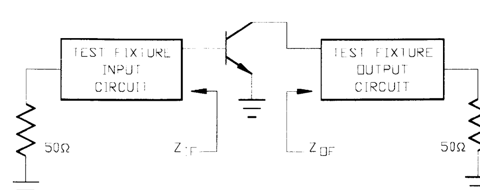
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	27	V
Collector-Emitter Voltage	V_{CEO}	20	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current (Peak)	I_C	710	mA
Total Power Dissipation	P_{TOT}	7.8	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	27	-	V	I_C=4 mA
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=15 V
DC Forward Current Gain	h_{FE}	60	250	-	V_{CE}=5 V, I_C=100 mA
Thermal Resistance	$R_{TH(JC)}$	-	19	°C/W	V_{FIXT}=22, V_{CE}(typ)=11.5, I_{CQ}(typ)=200 mA P_{IN}=100 mW, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	0.85	-	W	
Power Gain	G_P	9.3	-	dB	
Collector Efficiency	η_C	30	-	%	
Input Return Loss	RL	9	-	dB	
Load Mismatch Tolerance	VSWR-T	-	2:1	-	
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	5.9 - j4.5	7.4 + j6.3
1.30	6.4 - j4.0	7.5 + j7.7
1.40	7.1 - j4.4	7.4 + j8.9



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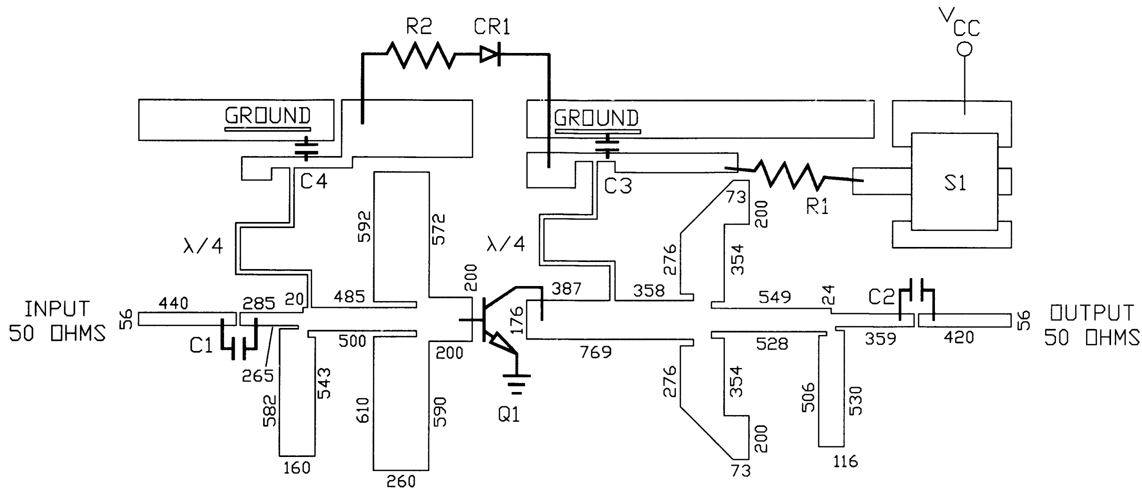
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3 C4	.68 uF 35 VOLTS
CR1	DIODE ECG5016A
Q1	PH1214-.85L
R1	52 OHMS 2 WATTS
R2	830 OHMS 1/4 WATT
S1	DPDT
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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M/A-COM
an AMP company

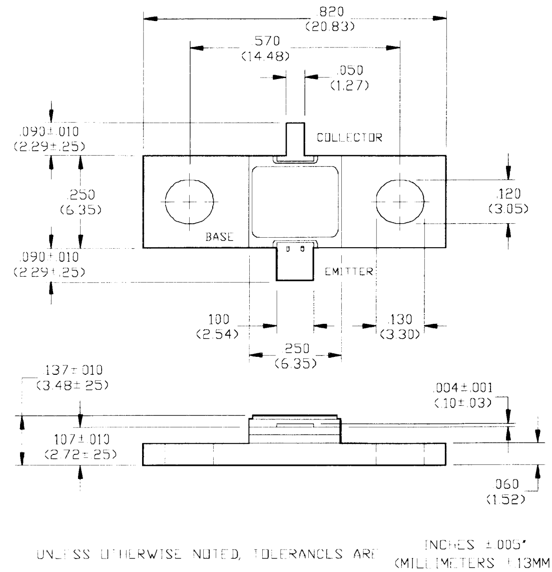
Radar Pulsed Power Transistor, 2W, 100μs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-2M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

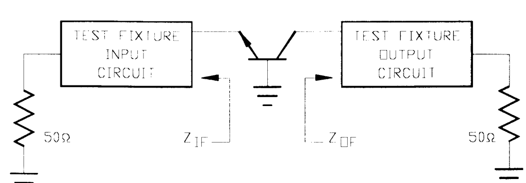
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	450	A
Total Power Dissipation	P_{TOT}	8.8	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=4 mA
Collector-Emitter Leakage Current	I_{CES}	-	500	μA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	17	°C/W	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	2.0	-	W	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{IN}=400 mW, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	9.5 - j6.3	11.6 + j33
1.30	8.6 - j4.9	12.0 + j34
1.40	8.1 - j3.6	11.4 + j37



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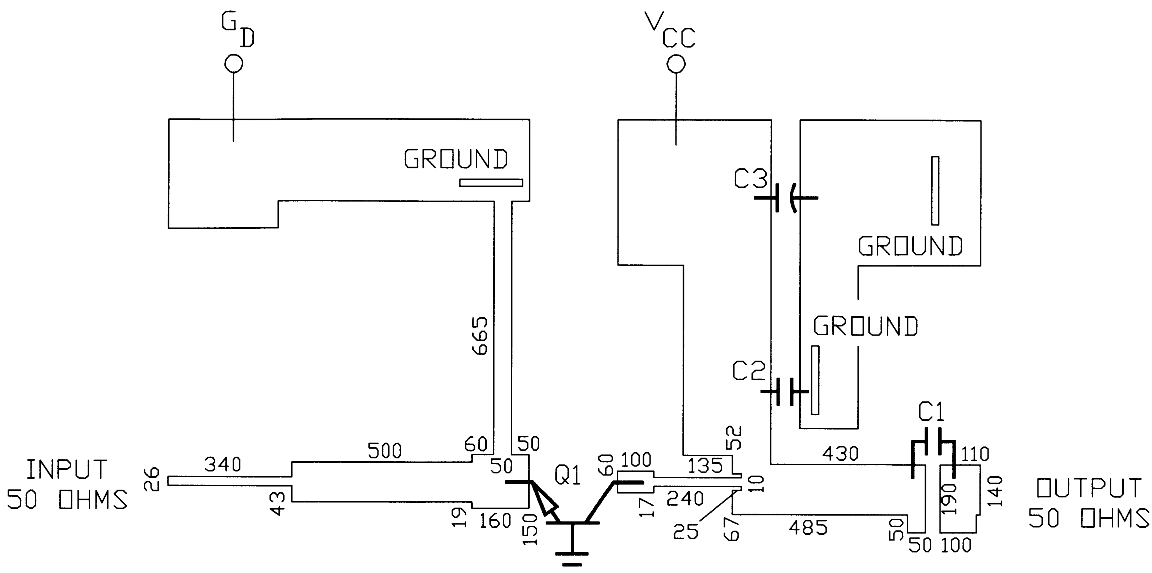
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-2M
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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M/A-COM an AMP company

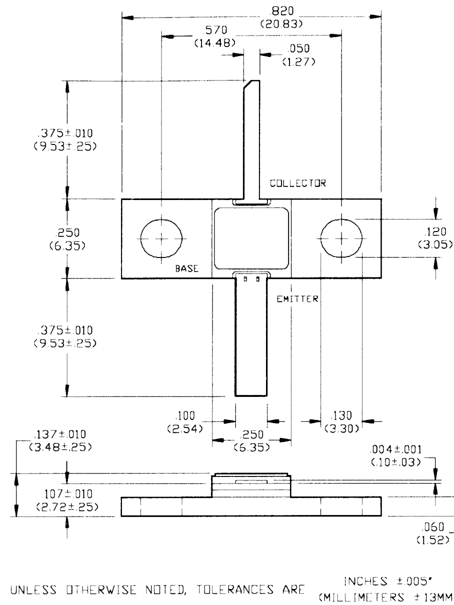
Radar Pulsed Power Transistor, 3W, 2ms Pulse, 20% Duty 1.2 - 1.4 GHz

PH1214-3L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Matrix Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

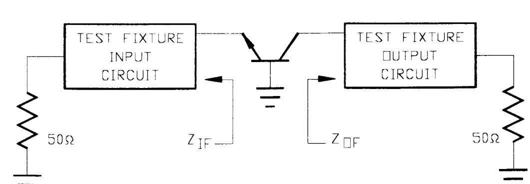
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	50	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current (Peak)	I_C	1.1	A
Total Power Dissipation	P_{TOT}	15.8	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	50	-	V	I_C=20 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	9.4	°C/W	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	3.0	-	W	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	5.7	-	dB	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=16.5 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
1.20	9.4 - j7.8	8.5 + j6.9
1.30	8.8 - j7.3	9.2 + j4.9
1.40	8.1 - j7.2	5.3 + j4.7



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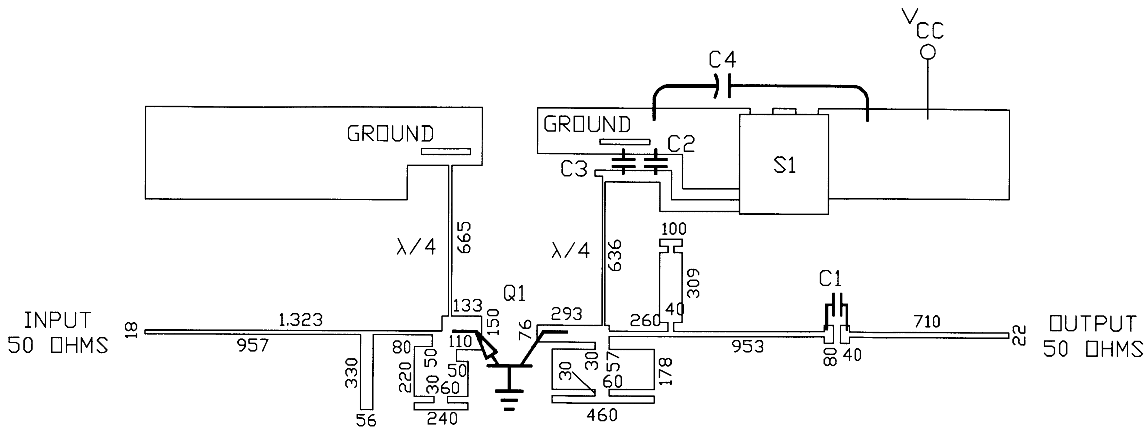
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	470 pF ATC SIZE A
C4	50 uF 50 VOLTS
Q1	PH1214-3L
S1	DPDT
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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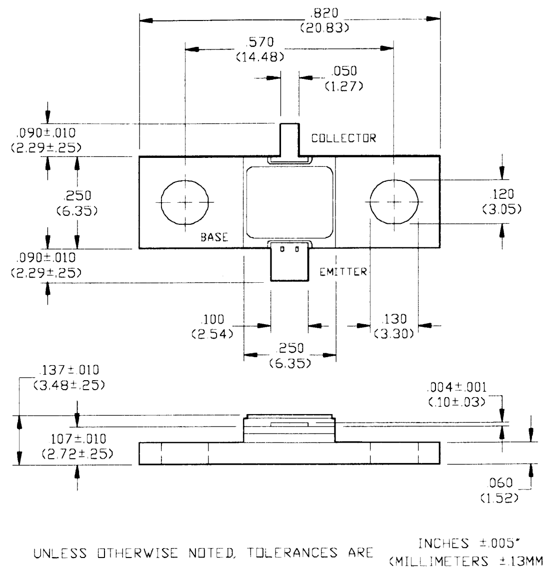
Radar Pulsed Power Transistor, 4W, 100µs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-4M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

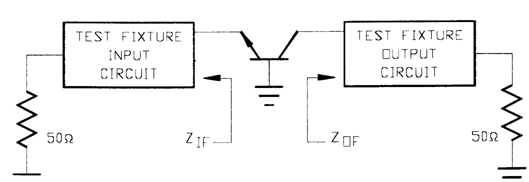
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	875	mA
Total Power Dissipation	P_{TOT}	17	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=8 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	8.6	°C/W	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	4.0	-	W	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{IN}=800 mW, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	7.0 - j4.5	12.0 + j24
1.30	6.4 - j3.0	12.5 + j21
1.40	6.0 - j1.5	10.5 + j24



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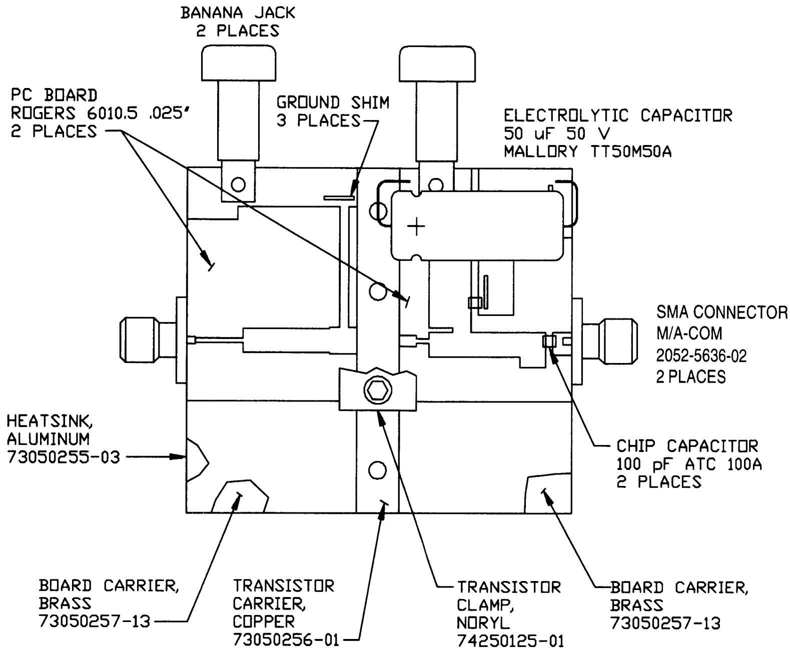
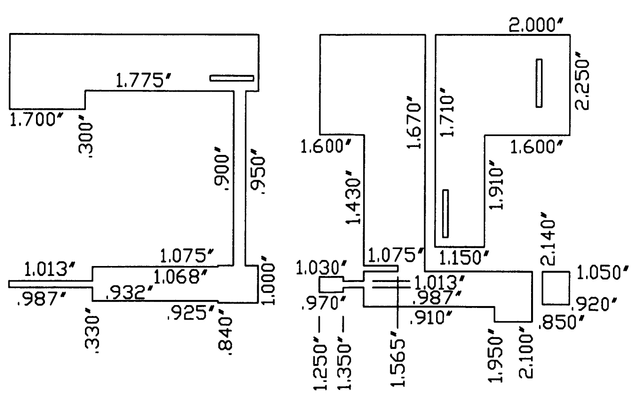
RF Test Fixture



TOP VIEW



CIRCUIT DIMENSIONS

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M/A-COM an AMP company

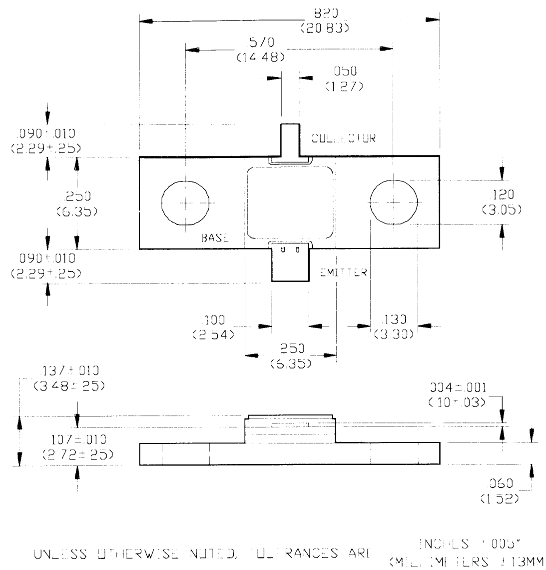
Radar Pulsed Power Transistor, 6W, 100µs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-6M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

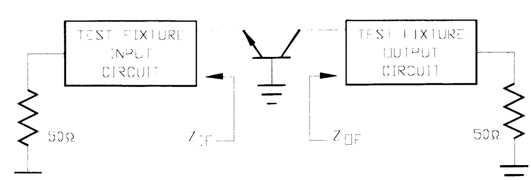
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.3	A
Total Power Dissipation	P_{TOT}	25	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=12 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	5.8	°C/W	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	6.0	-	W	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{IN}=1.2 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	TBD	TBD
1.30	TBD	TBD
1.40	TBD	TBD



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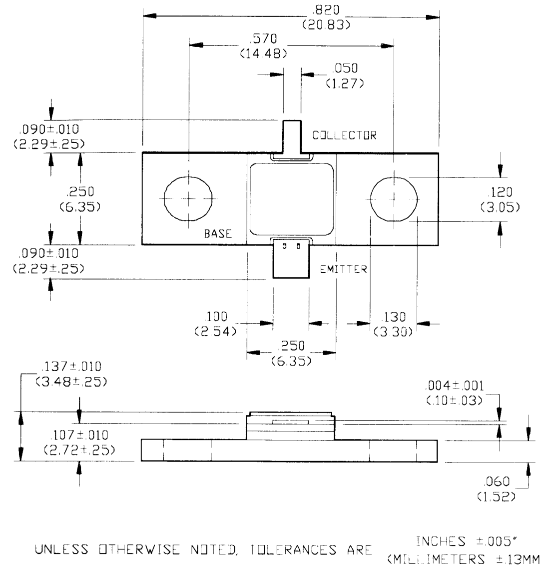
Radar Pulsed Power Transistor, 8W, 100µs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-8M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

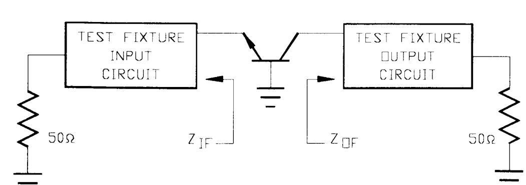
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.5	A
Total Power Dissipation	P_{TOT}	30	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=16 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	4.9	°C/W	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	8.0	-	W	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{IN}=1.6 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	TBD	TBD
1.30	TBD	TBD
1.40	TBD	TBD



Specifications Subject to Change Without Notice.

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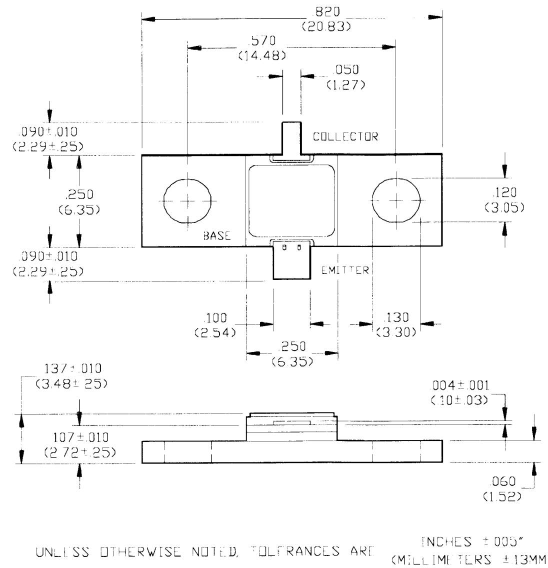
an AMP company

Radar Pulsed Power Transistor, 12W, 150μs Pulse, 10% Duty
1.2 - 1.4 GHz PH1214-12M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

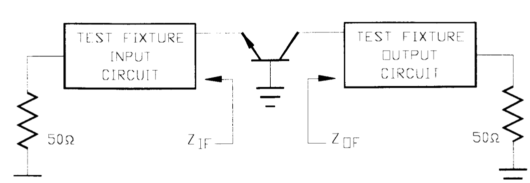
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.3	A
Total Power Dissipation	P_{TOT}	40	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=12.5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	3.7	°C/W	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz
Input Power	P_{IN}	-	1.5	W	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	9.0	-	dB	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{OUT}=12 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
1.20	3.7 - j5.3	5.0 + j6.0
1.30	3.5 - j4.4	7.1 + j5.1
1.40	3.4 - j3.8	7.7 + j3.6



Specifications Subject to Change Without Notice.

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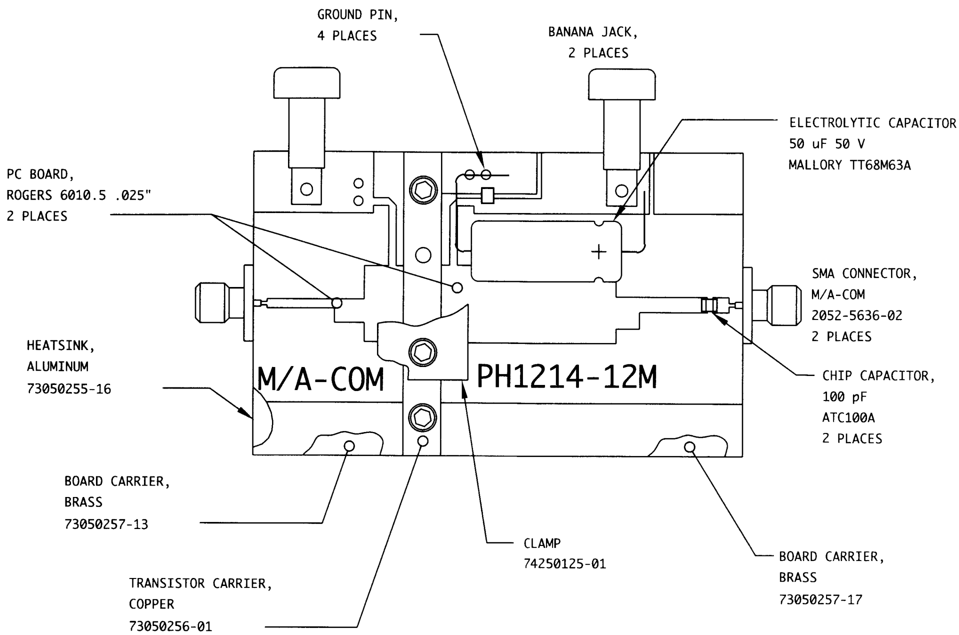
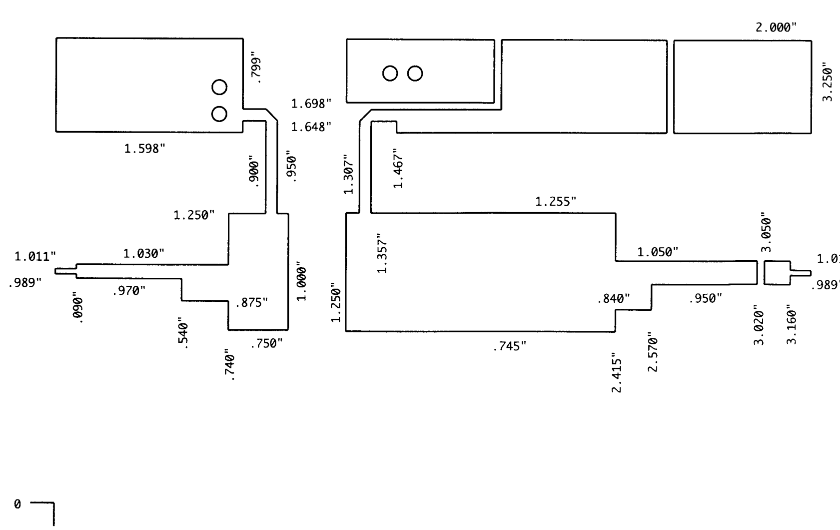
RF Test Fixture



TOP VIEW



CIRCUIT DIMENSIONS

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M/A-COM an AMP company

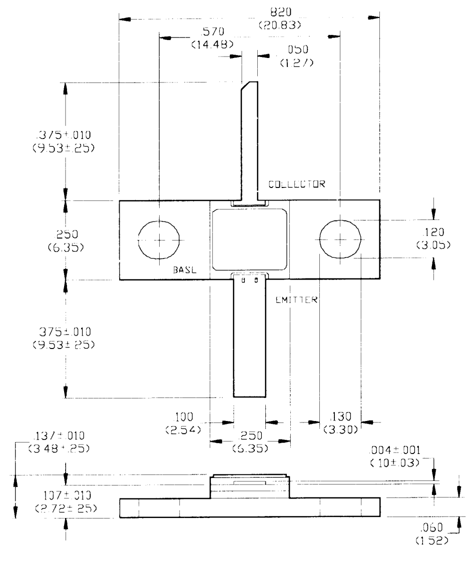
Radar Pulsed Power Transistor, 20W, 2ms Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-20EL

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

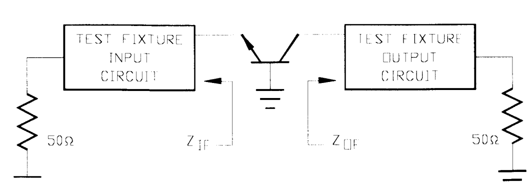
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.5	A
Total Power Dissipation	P_{TOT}	25	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	5.8	°C/W	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz
Input Power	P_{IN}	-	2.3	W	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	9.5	-	dB	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{OUT}=20 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
1.20	2.1 - j4.5	3.7 + j0.9
1.30	2.1 - j3.9	3.6 + j0.4
1.40	2.2 - j3.4	3.0 + j0.2



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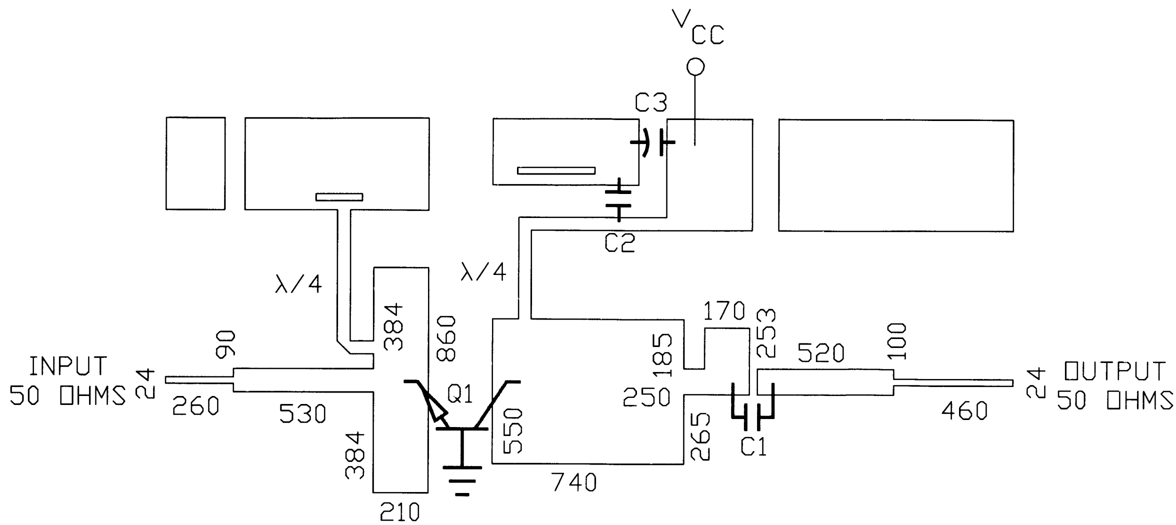
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-25M
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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an AMP company

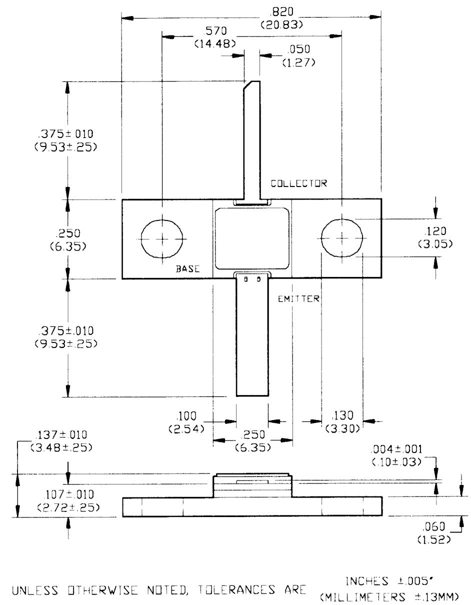
Radar Pulsed Power Transistor, 25W, 300μs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-25L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

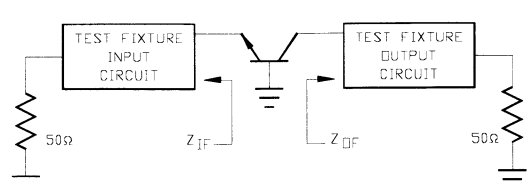
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.6	A
Total Power Dissipation	P_{TOT}	40	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	3.6	°C/W	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Input Power	P_{IN}	-	2.8	W	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	9.5	-	dB	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
1.20	2.1 - j4.5	3.7 + j0.9
1.30	2.1 - j3.9	3.6 + j0.4
1.40	2.2 - j3.4	3.0 + j0.2



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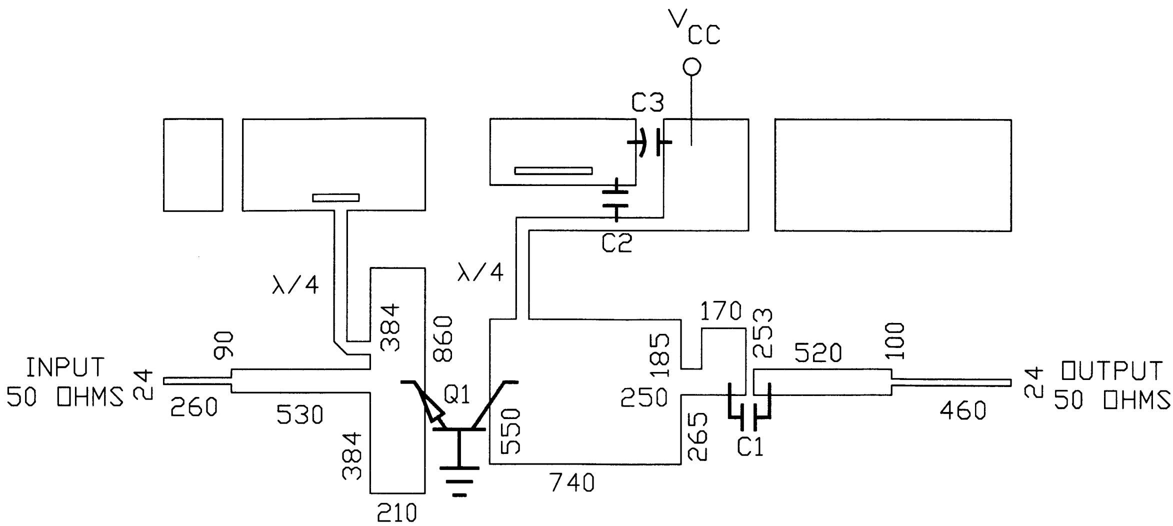
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-25M
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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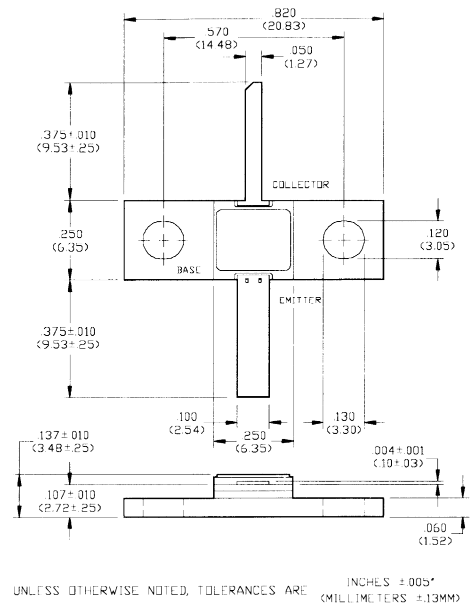
an AMP company

Radar Pulsed Power Transistor, 25W, 150μs Pulse, 10% Duty
1.2 - 1.4 GHz PH1214-25M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

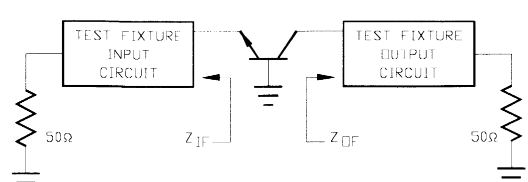
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	2.8	A
Total Power Dissipation	P_{TOT}	58	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	2.6	°C/W	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Input Power	P_{IN}	-	2.8	W	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	9.5	-	dB	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
1.20	2.1 - j4.5	3.7 + j0.9
1.30	2.1 - j3.9	3.6 + j0.4
1.40	2.2 - j3.4	3.0 + j0.2



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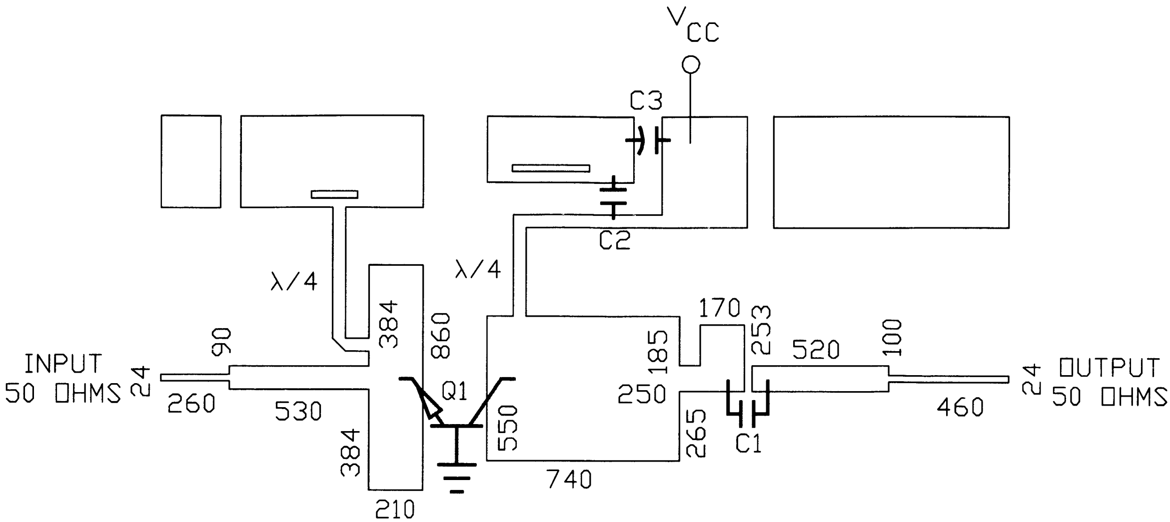
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-25M
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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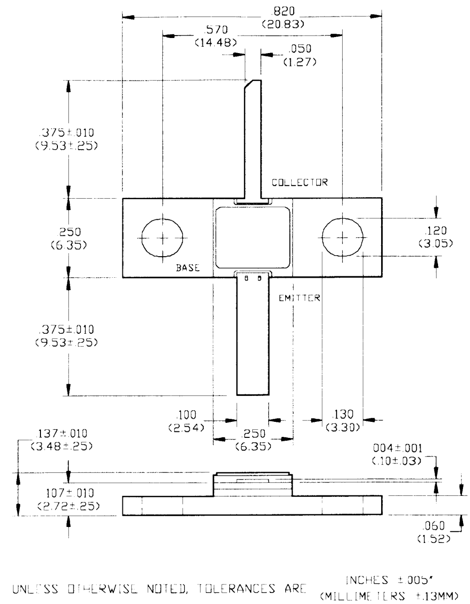
Radar Pulsed Power Transistor, 25W, 1μs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-25S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

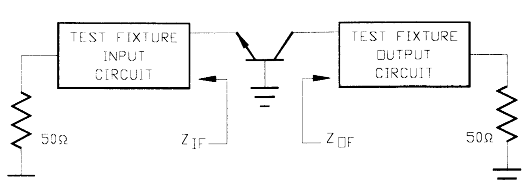
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.5	A
Total Power Dissipation	P_{TOT}	90	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.0	°C/W	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Input Power	P_{IN}	-	2.8	W	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	9.5	-	dB	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{OUT}=25 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	2.1 - j4.5	3.7 + j0.9
1.30	2.1 - j3.9	3.6 + j0.4
1.40	2.2 - j3.4	3.0 + j0.2



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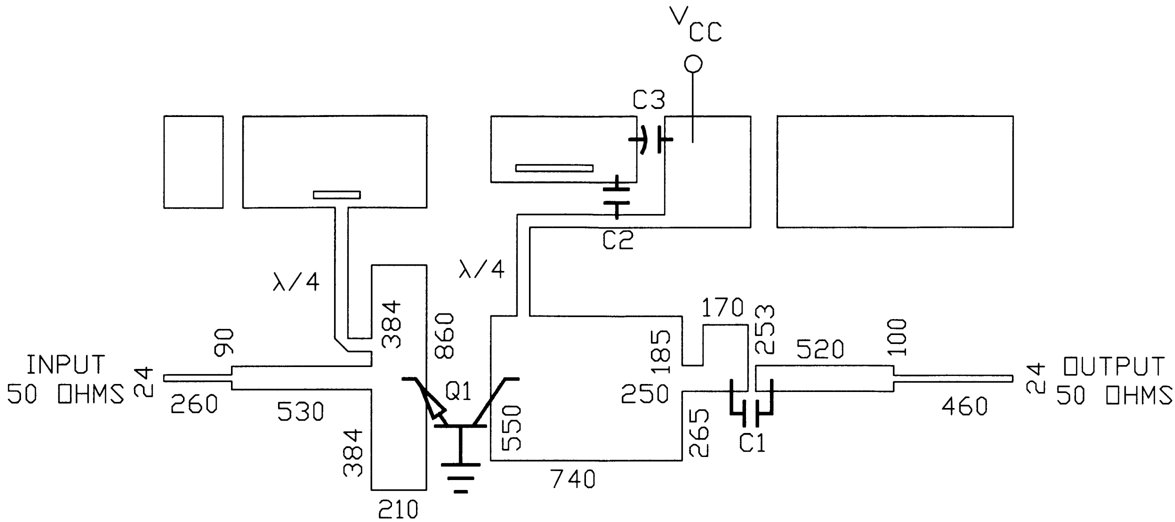
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-25M
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

an AMP company

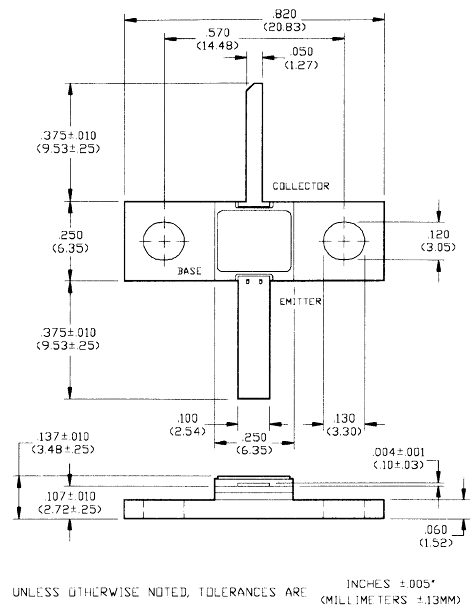
Radar Pulsed Power Transistor, 30W, 1.0ms Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-30EL

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Matrix Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

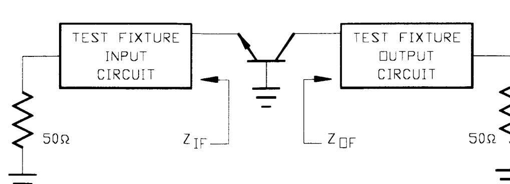
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	56	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.0	A
Total Power Dissipation	P_{TOT}	50	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	56	-	V	I_C=60 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=28 V
Thermal Resistance	$R_{TH(JC)}$	-	1.5	°C/W	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz
Input Power	P_{IN}	-	4.9	W	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.8	-	dB	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{OUT}=30 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	2.5 - j3.5	10.5 + j2.0
1.30	2.7 - j2.7	6.3 + j2.0
1.40	3.5 - j3.5	5.3 + j1.5



Specifications Subject to Change Without Notice.

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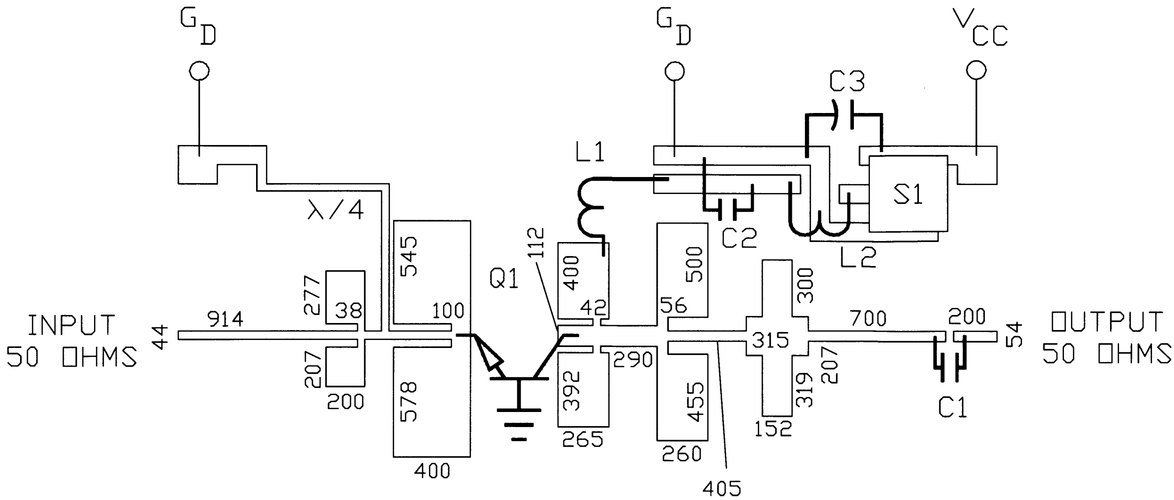
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
L1	4 TURNS OF NO. 18 AWG ON .15″ ID
L2	NO. 18 AWG THRU FERRITE BEAD
S1	SPDT SWITCH
Q1	PH1214-30EL
BOARD TYPE:	ROGERS 5870 .015″ THICK, E_R = 2.35

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

M/A-COM an AMP company

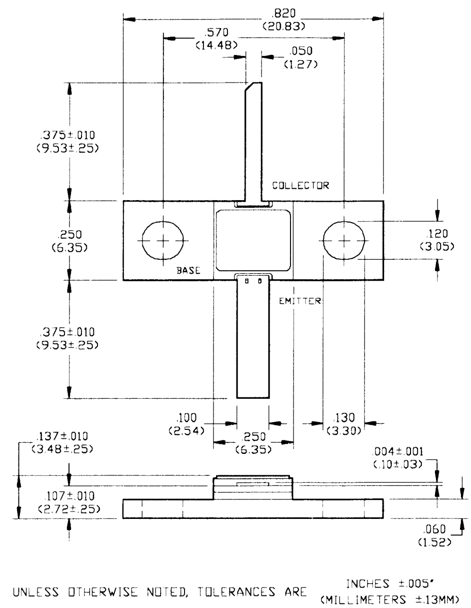
Radar Pulsed Power Transistor, 40W, 150μs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-40M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.0	A
Total Power Dissipation	P_{TOT}	88	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

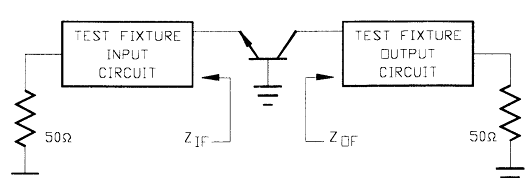
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=15 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.7	°C/W	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1
Output Power	P_{OUT}	40	-	W	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1
Power Gain	G_P	8.5	-	dB	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1
Collector Efficiency	η_C	50	-	%	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1
Input Return Loss	RL	6	-	dB	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=40 V, P_{IN}=5.0 -5.6 W, F=1.20, 1.30, 1.40 GHz, N1

N1: P_{IN} is set for minimum spec. compliant P_{OUT}

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	2.6 - j4.7	2.8 - j0.7
1.30	2.5 - j4.1	3.3 - j0.2
1.40	2.3 - j3.7	3.0 + j0.4



Specifications Subject to Change Without Notice.

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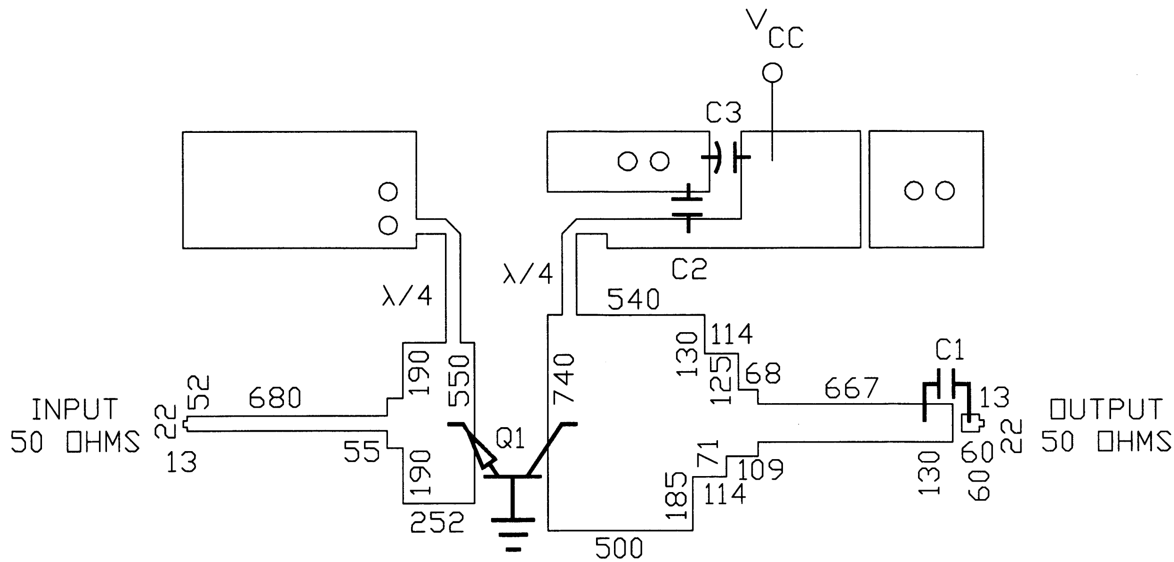
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	47 uF 63 VOLTS
Q1	PH1214-40M
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

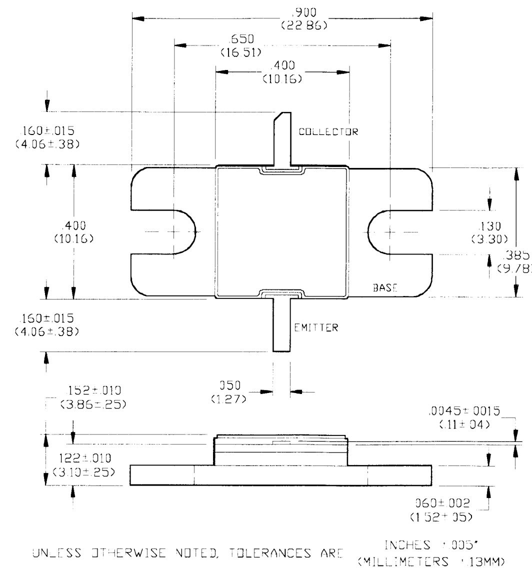
Radar Pulsed Power Transistor, 55W, 1.0ms Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-55EL

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Matrix Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

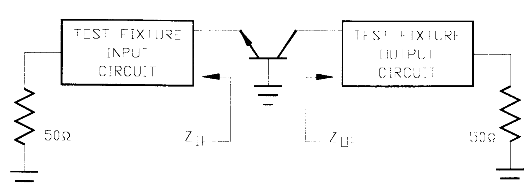
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	58	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	7.0	A
Total Power Dissipation	P_{TOT}	100	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	58	-	V	I_C=120 mA
Collector-Emitter Leakage Current	I_{CES}	-	6.0	mA	V_{CE}=28 V
Thermal Resistance	$R_{TH(JC)}$	-	0.8	°C/W	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	55	-	W	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	6.6	-	dB	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{IN}=12 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	5.7 + j1.8	5.5 - j3.4
1.30	2.4 + j1.3	3.3 - j2.3
1.40	2.4 + j0.6	2.0 - j2.3



Specifications Subject to Change Without Notice.

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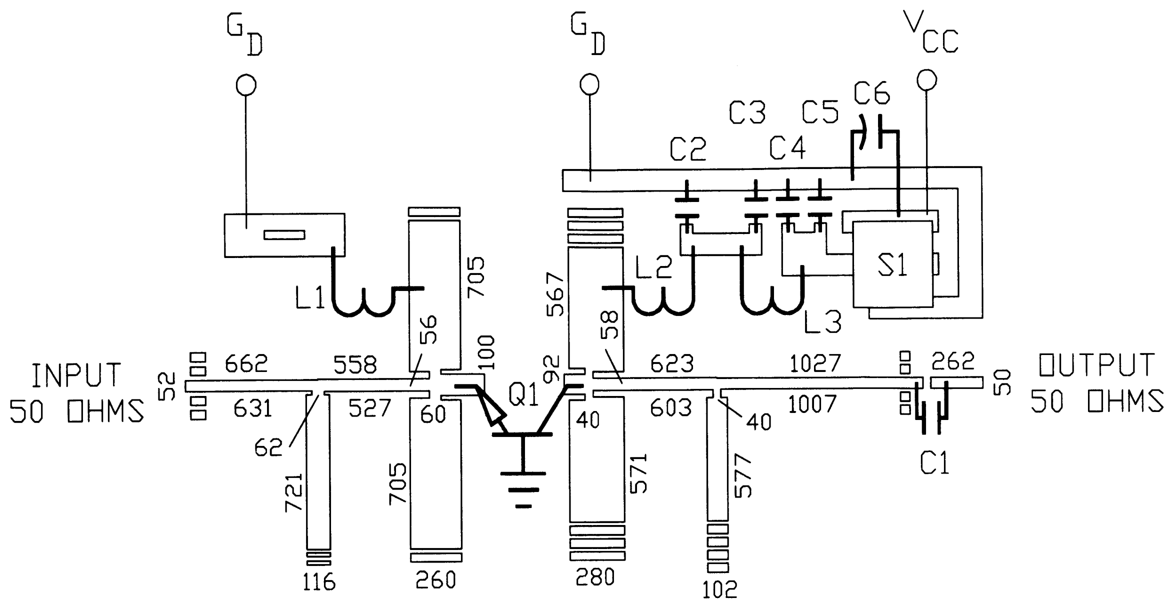
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C4	100 pF ATC SIZE A
C3 C5	470 pF ATC SIZE A
C6	50 uF 50 VOLTS
L1 L2	4 TURNS OF NO. 18 AWG ON .15″ DIAMETER
L3	NO. 18 AWG THRU FERRONICS 11-032-B
S1	SPDT SWITCH
Q1	PH1214-55EL
BOARD TYPE:	TEFLON FIBERGLASS .020″ THICK, E_R = 2.55

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

an AMP company

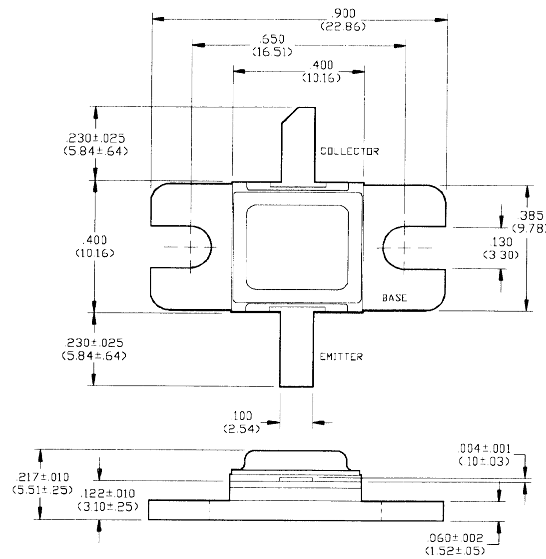
Radar Pulsed Power Transistor, 80W, 150μs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-80M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

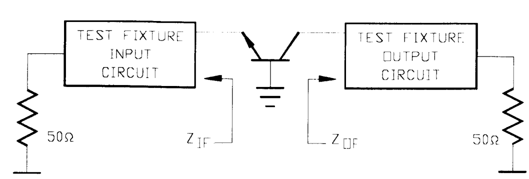
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	6.4	A
Total Power Dissipation	P_{TOT}	185	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=35 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.8	°C/W	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	80	-	W	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=40 V, P_{IN}=13 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	9.4 - j4.5	7.0 - j2.8
1.30	8.3 - j2.8	4.5 - j3.2
1.40	7.9 - j1.3	3.0 + j2.1



Specifications Subject to Change Without Notice.

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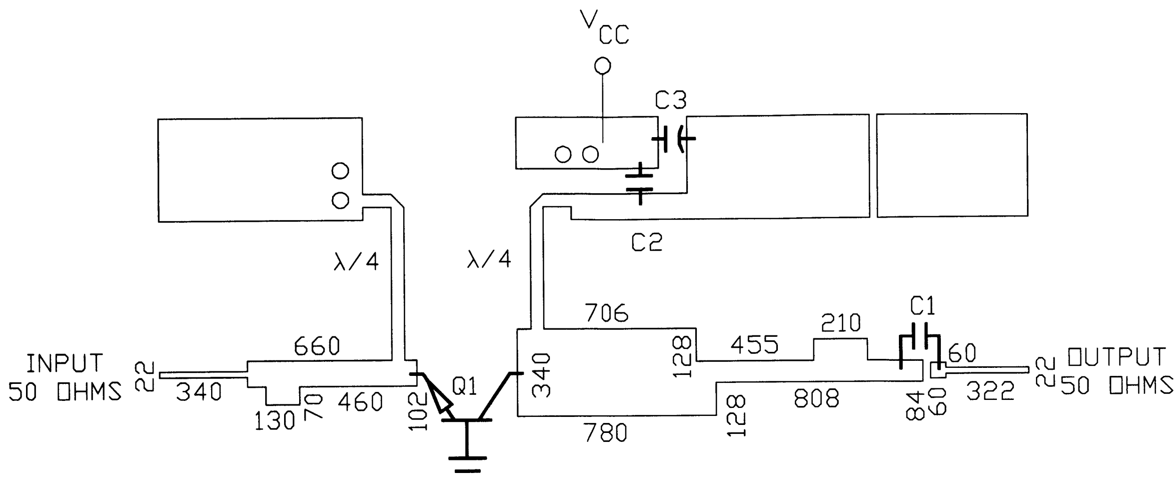
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-80M
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

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an AMP company

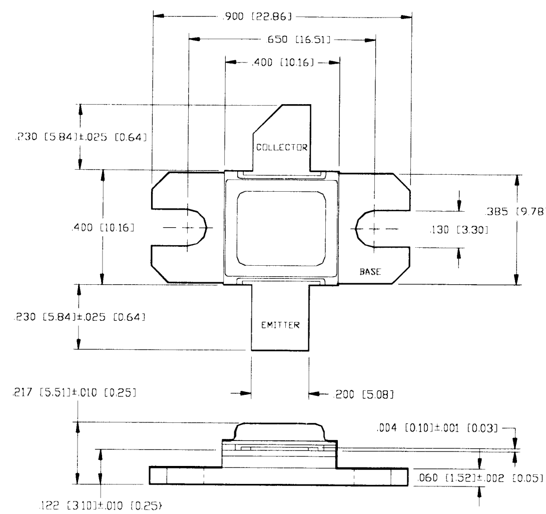
Radar Pulsed Power Transistor, 100W, 2ms Pulse, 20% Duty 1.2 - 1.4 GHz

PH1214-100EL

V2.01

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" [MILLIMETERS ±0.13MM]

Absolute Maximum Ratings at 25°C

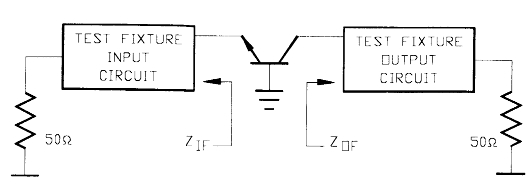
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	75	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	14.1	A
Total Power Dissipation	P_{TOT}	214	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	75	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	10	mA	V_{CE}=28 V
Thermal Resistance	$R_{TH(JC)}$	-	0.7	°C/W	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	100	-	W	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	6.0	-	dB	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	52	-	%	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	8	-	dB	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Overdrive Stability	OD-S	-	+1.0	dB	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=28 V, P_{IN}=25 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	2.6 - j3.8	3.0 - j2.7
1.30	3.0 - j3.4	2.4 - j2.6
1.40	3.4 - j3.1	1.9 - j2.5



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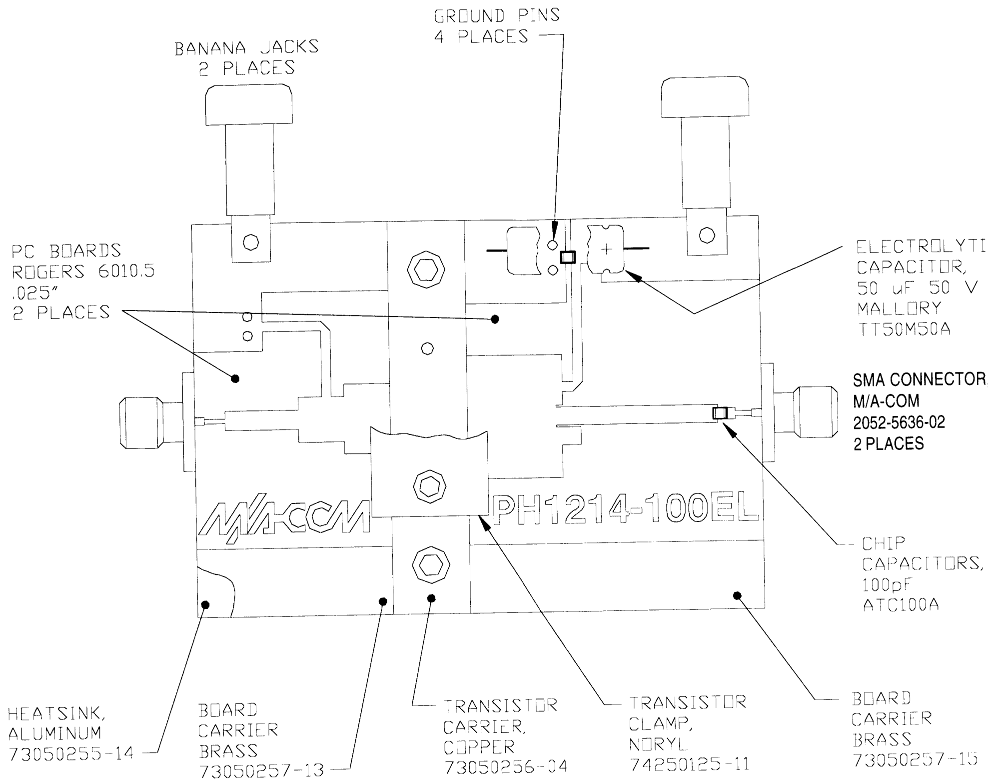
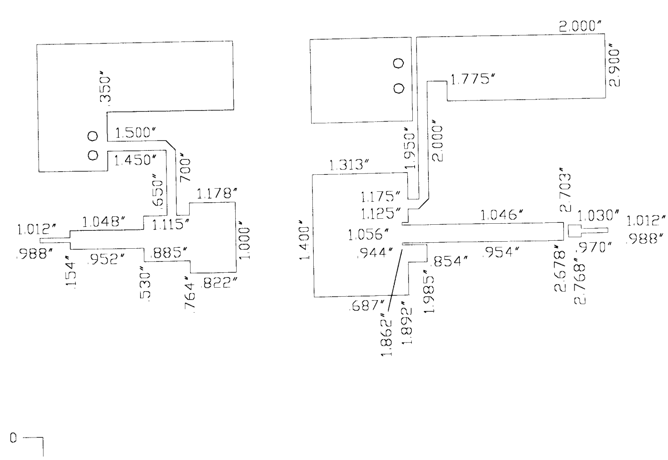
RF Test Fixture





CIRCUIT DIMENSIONS

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an AMP company

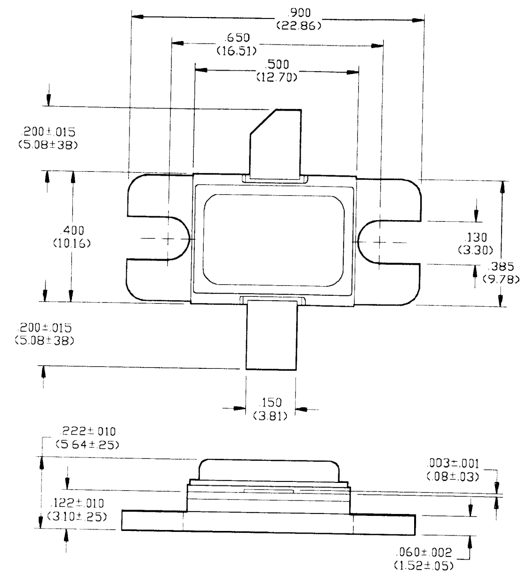
Radar Pulsed Power Transistor, 110W, 150µs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-110M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

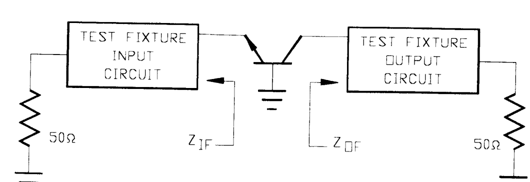
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	10.5	A
Total Power Dissipation	P_{TOT}	300	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	5.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.5	°C/W	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	110	-	W	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.4	-	dB	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=40 V, P_{IN}=20 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	4.7 - j4.4	4.4 - j3.3
1.30	4.5 - j3.3	3.0 - j2.8
1.40	4.5 - j2.3	2.3 - j1.8



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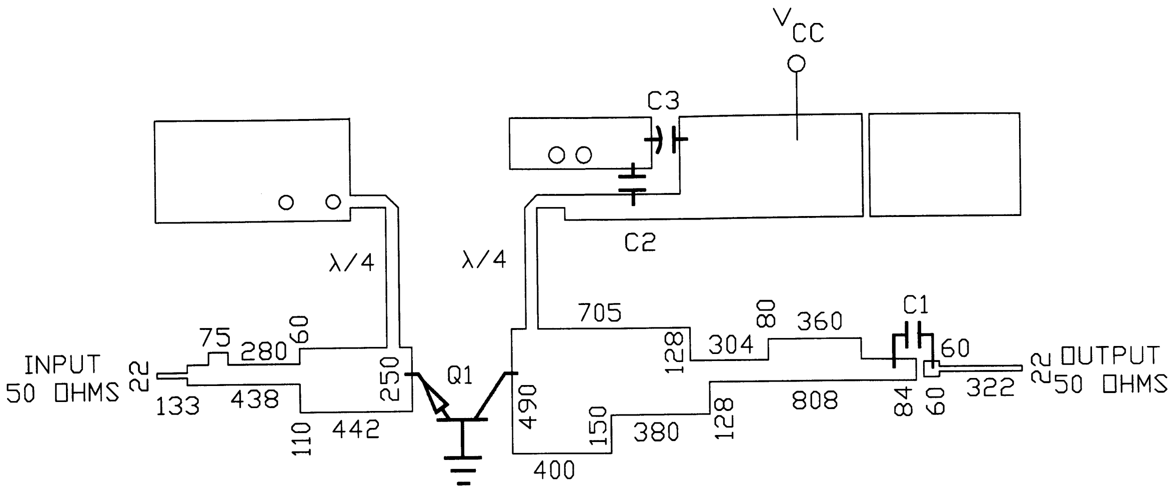
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-110M
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

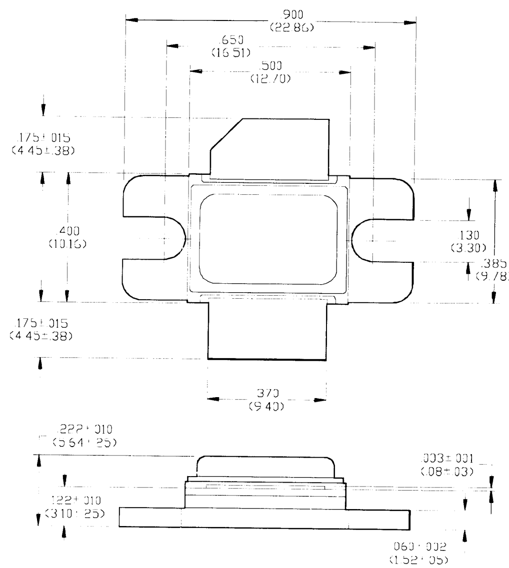
Radar Pulsed Power Transistor, 220W, 150µs Pulse, 10% Duty 1.2 - 1.4 GHz

PH1214-220M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

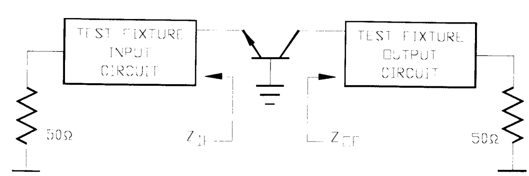
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	70	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	21.0	A
Total Power Dissipation	P_{TOT}	600	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	70	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	10	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.25	°C/W	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz
Output Power	P_{OUT}	220	-	W	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz
Power Gain	G_P	7.4	-	dB	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz
Collector Efficiency	η_C	50	-	%	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=40 V, P_{IN}=40 W, F=1.20, 1.30, 1.40 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1.20	3.3 - j2.7	2.0 - j1.5
1.30	3.4 - j2.1	1.9 - j1.6
1.40	3.6 - j1.3	1.7 - j1.4



Specifications Subject to Change Without Notice.

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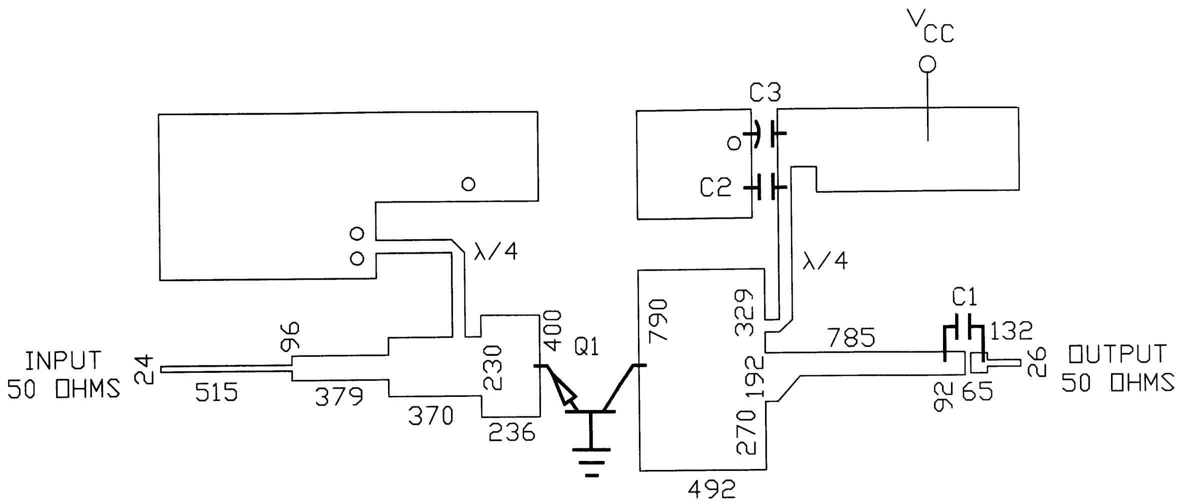
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	100 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH1214-220M
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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an AMP company

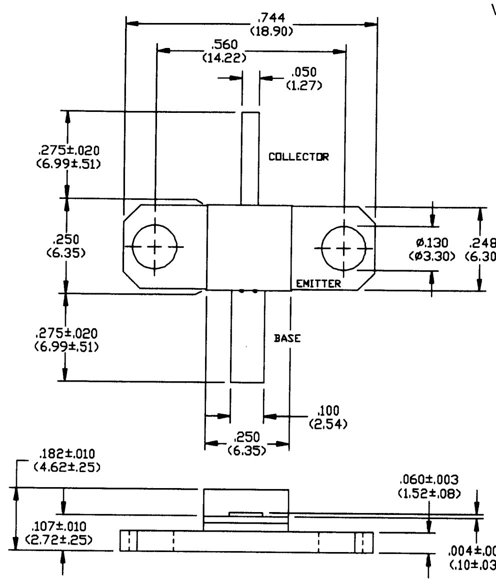
Wireless Bipolar Power Transistor, 2W
1.45 - 1.60 GHz

PH1516-2

V2.00

Features

- Designed for Cellular Base Station Applications
- Class AB: -33 dBc Typ 3rd IMD at 2 Watts PEP
- Class A: +44 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

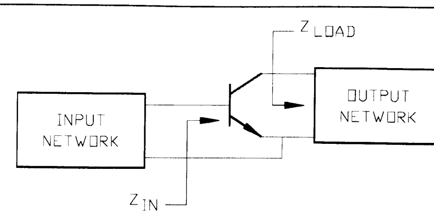
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Total Power Dissipation	P_{TOT}	13.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	13	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	22	-	V	I_C=5 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=5 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=200 mA
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.50 - 1.60 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.50 - 1.60 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.50 - 1.60 GHz
Load Mismatch Tolerance	VSWR	-	5.0:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.50 - 1.60 GHz
3rd Order IMD	IMD_3	-	-32	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W PEP F=1.5 MHz, ΔF=100 kHz

Typical Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.45	2.5 + j7.3	7.3 + j15.0
1.50	2.7 + j7.6	7.0 + j14.2
1.60	3.5 + j8.2	6.6 + j13.5



Specifications Subject to Change Without Notice.

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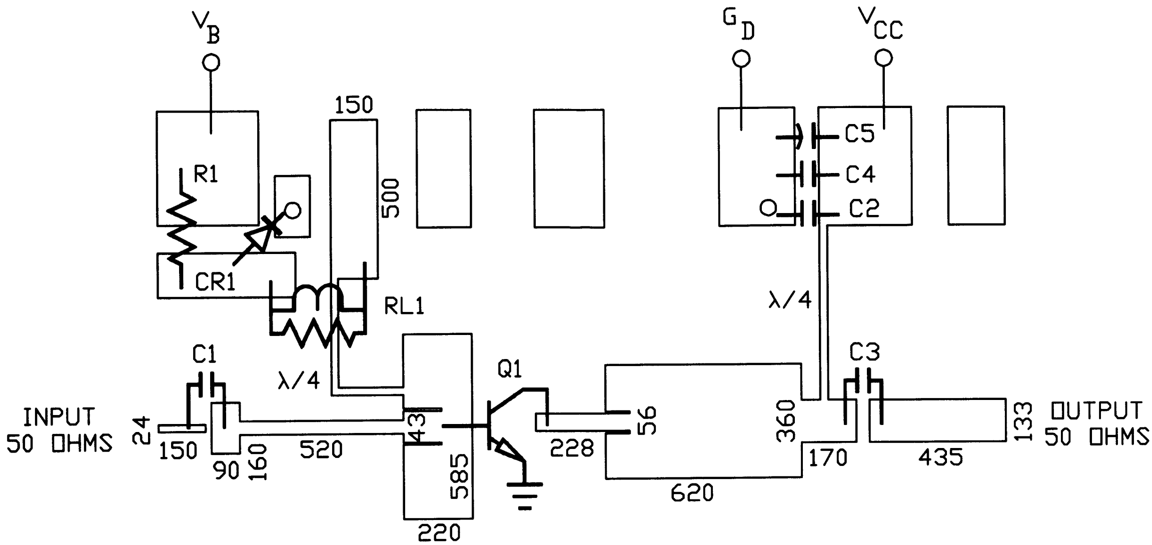
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	5000 pF
C5	4.7 uF 63 VOLTS
CR1	1N914B DIODE
Q1	PH1516-2
R1	5 OHMS 1/4 WATT
RL1	6T/NO. 24 AWG ON 3 OHM 1/4 WATT
BOARD TYPE:	ROGERS 6010.5 25 THICK, E_R = 10.5

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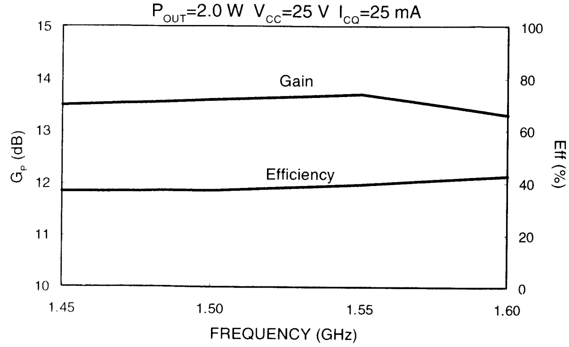
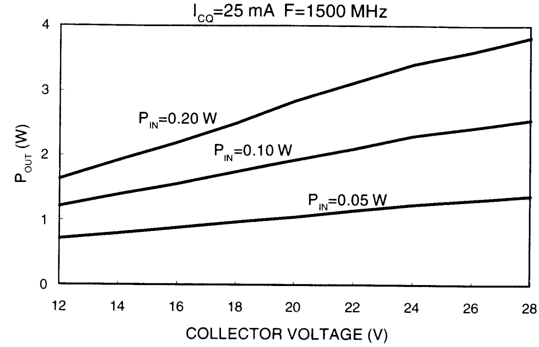
Typical Broadband Performance Curves

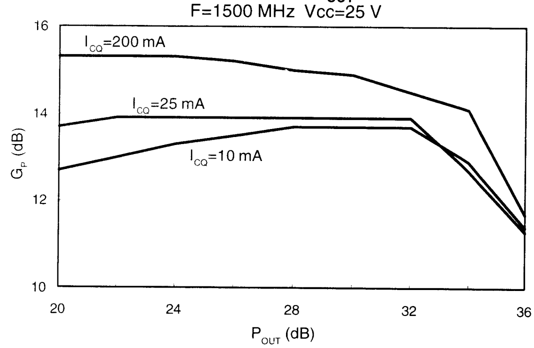
GAIN-EFFICIENCY vs FREQUENCY
P_{OUT}=2.0 W V_{CC}=25 V I_{CQ}=25 mA



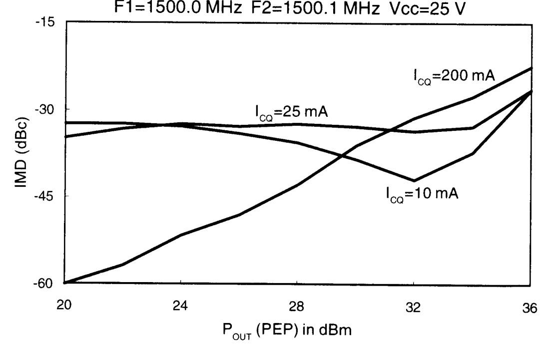
OUTPUT POWER vs COLLECTOR VOLTAGE
I_{CQ}=25 mA F=1500 MHz



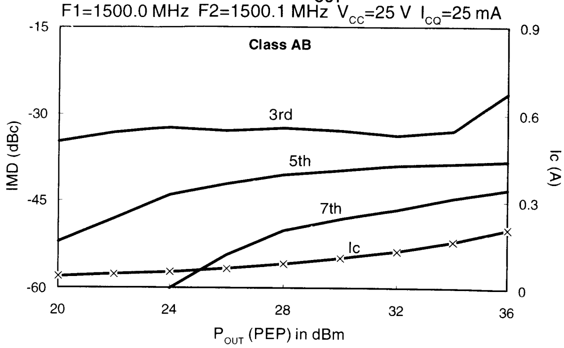
GAIN vs P_{OUT}
F=1500 MHz Vcc=25 V



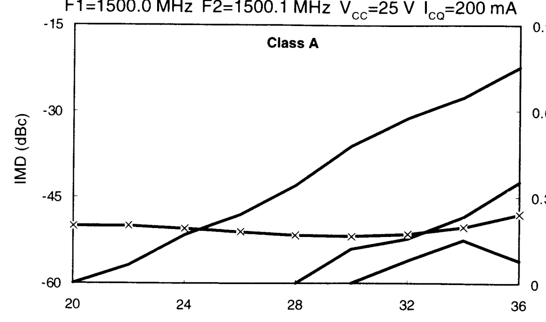
3RD ORDER IMD vs P_{OUT}
F1=1500.0 MHz F2=1500.1 MHz Vcc=25 V



IMD vs P_{OUT}
F1=1500.0 MHz F2=1500.1 MHz V_{CC}=25 V I_{CQ}=25 mA



IMD vs P_{OUT}
F1=1500.0 MHz F2=1500.1 MHz V_{CC}=25 V I_{CQ}=200 mA



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Typical S-Parameters

V_{CC}=25 V, I_{CQ}=200 mA

	S11		S21		S12		S22	
f(MHz)	Mag	Phase	Mag	Phase	Mag	Phase	Mag	Phase
100	1.10	171.5	23.80	120.3	0.012	- 7.4	0.32	-74.5
200	0.75	175.1	12.15	92.1	0.014	- 4.7	0.22	-89.6
300	0.79	-177.9	7.79	81.2	0.016	- 4.5	0.20	-95.7
400	0.84	-177.4	5.77	74.4	0.016	- 9.8	0.23	- 98.7
500	0.87	-178.5	4.65	68.4	0.017	- 3.7	0.26	-100.5
600	0.89	179.8	3.96	62.6	0.018	- 5.9	0.27	-101.4
700	0.89	178.3	3.49	56.7	0.018	- 0.7	0.29	-104.4
800	0.91	177.4	3.08	51.1	0.019	- 2.7	0.33	-103.3
900	0.91	175.4	2.89	45.4	0.017	- 3.4	0.36	-111.0
1000	0.91	174.1	2.74	38.9	0.019	- 0.9	0.40	-114.6
1100	0.89	171.5	2.64	28.9	0.024	- 6.1	0.46	-117.3
1200	0.87	171.7	2.45	22.8	0.024	- 13.6	0.53	-120.8
1300	0.86	170.8	2.35	15.7	0.023	- 18.3	0.57	-122.3
1400	0.86	170.3	2.32	7.6	0.026	- 21.1	0.63	-145.5
1450	0.85	170.1	2.30	3.4	0.026	- 22.9	0.65	-126.2
1500	0.84	169.9	2.27	-1.2	0.025	- 22.3	0.66	-127.6
1550	0.83	169.7	2.26	-6.4	0.026	- 31.0	0.68	-129.1
1600	0.82	169.7	2.24	-11.5	0.030	- 37.3	0.71	-131.9
1650	0.82	170.0	2.22	-16.6	0.029	- 43.2	0.72	-133.6
1700	0.81	170.5	2.19	-22.4	0.027	- 48.5	0.73	-137.6
1750	0.80	171.1	2.14	-28.4	0.025	- 52.2	0.76	-140.1
1800	0.80	171.5	2.11	-35.5	0.026	- 60.2	0.76	-143.9
1850	0.80	171.9	2.05	-40.7	0.027	- 60.1	0.81	-147.5
1900	0.81	172.6	1.99	-47.4	0.024	- 67.1	0.81	-150.1
2000	0.82	173.6	1.83	-60.7	0.024	- 80.8	0.86	-155.5
2100	0.84	174.5	1.61	-74.0	0.020	- 94.0	0.88	-160.0
2200	0.88	174.2	1.40	-84.6	0.019	-104.7	0.87	-164.5
2300	0.90	173.6	1.21	-94.7	0.016	-128.7	0.86	-168.1

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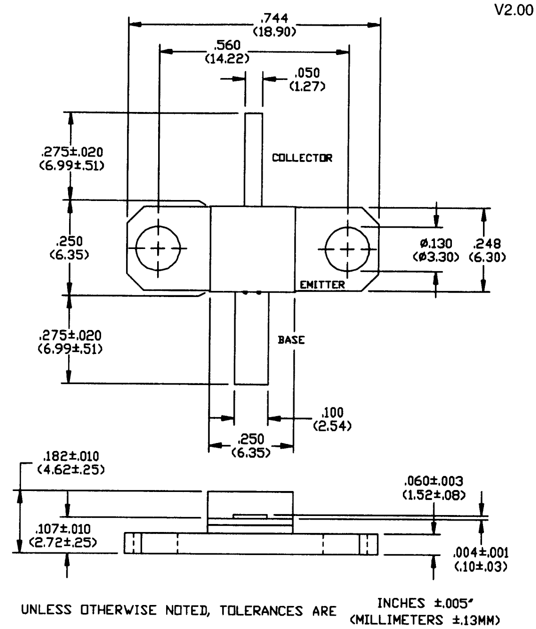
Wireless Bipolar Power Transistor, 10W
1.45 - 1.60 GHz

PH1516-10

V2.00

Features

- Designed for Cellular Base Station Applications
- Class AB: -33 dBc Typ 3rd IMD at 10 Watts PEP
- Class A: +49 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

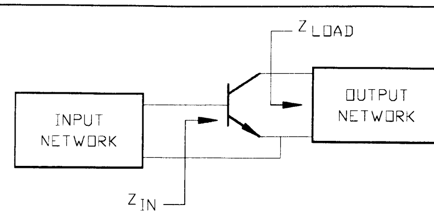
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Total Power Dissipation	P_{TOT}	58	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=20 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=20 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=20 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=20 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=1 A
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50 - 1.60 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50 - 1.60 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50 - 1.60 GHz
Load Mismatch Tolerance	VSWR	-	3.0:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50 - 1.60 GHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W PEP F=1500 MHz, ΔF=100 kHz

Typical Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.50	1.4 + j4.8	2.1 - j0.3
1.55	2.0 + j5.0	2.0 - j0.4
1.60	2.5 + j4.9	2.0 - j0.5



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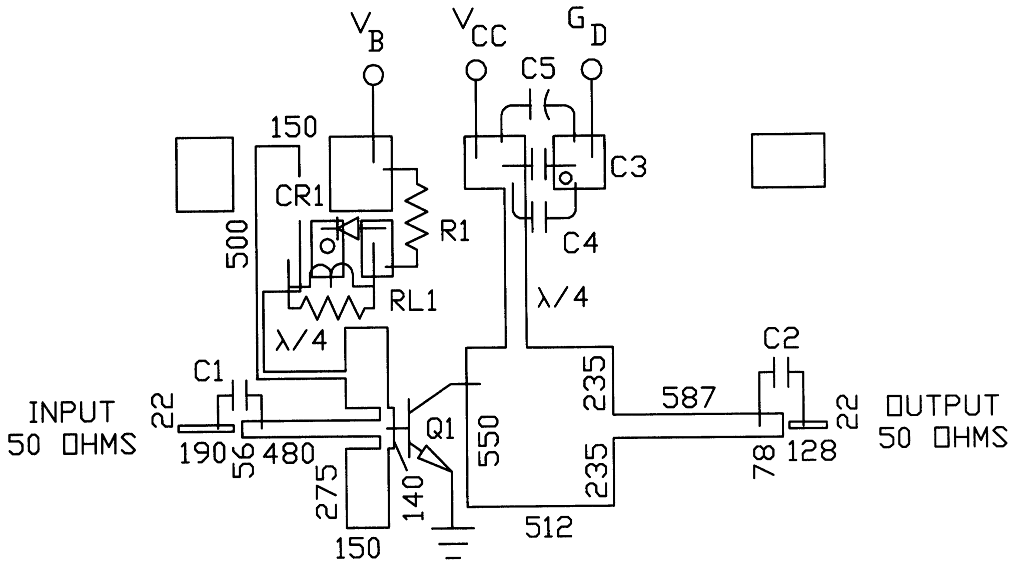
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	4.7 uF 35 VOLT CHIP
C5	50 uF 50 VOLTS
CR1	1N4245 DIODE
Q1	PH1516-10
R1	5 OHMS 1/4 WATT
RL1	6T/NO. 24 AWG ON 3 OHM 1/4 WATT
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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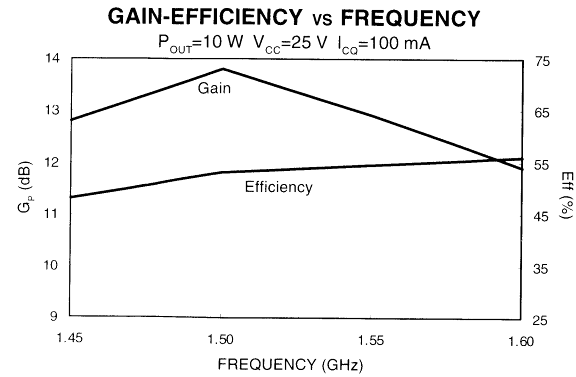
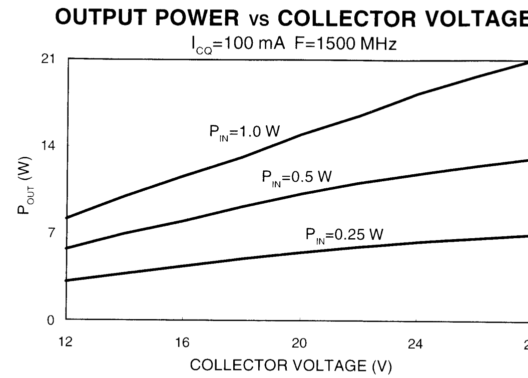
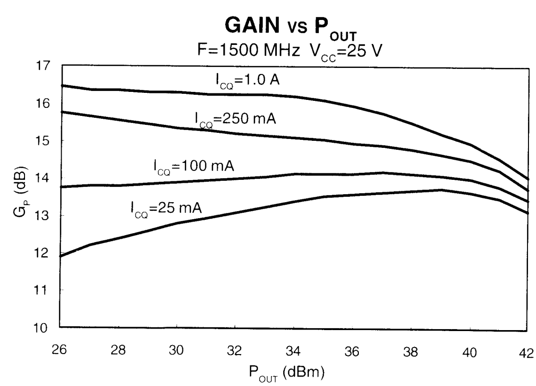
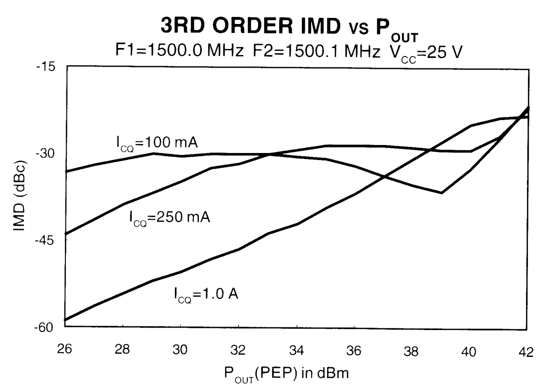
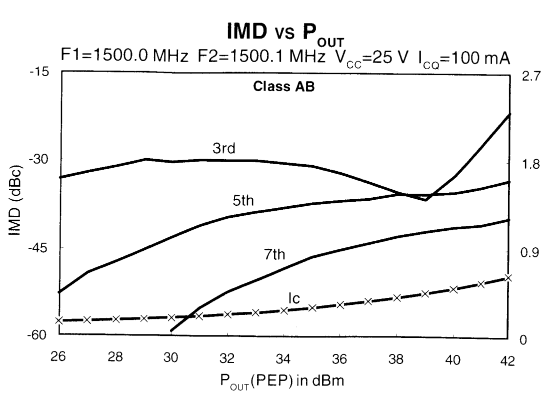
Typical Broadband Performance Curves

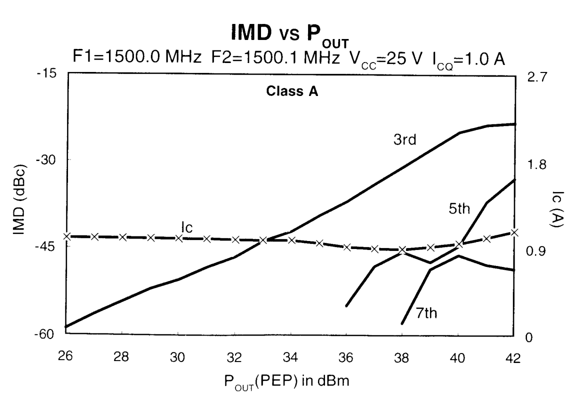












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Typical S-Parameters

V_{CC}=25 V, I_{CQ}=1.0 A

f(MHz)	S11 Mag	S11 Phase	S21 Mag	S21 Phase	S12 Mag	S12 Phase	S22 Mag	S22 Phase
100	0.85	177.3	6.57	92.2	0.0066	6.74	0.73	-179.3
200	0.94	179.4	2.96	79.9	0.0073	4.33	0.73	-179.0
300	0.96	-179.4	1.95	75.5	0.0075	4.04	0.72	-178.8
400	0.97	-170.0	1.51	70.6	0.0077	0.91	0.72	-178.2
500	0.97	178.5	1.27	65.2	0.0081	-0.99	0.72	-177.6
600	0.97	178.1	1.12	59.5	0.0085	-2.6	0.73	-177.1
700	0.96	177.7	1.09	52.7	0.0088	- 6.8	0.72	-176.1
800	0.97	178.0	0.93	39.5	0.0094	-12.0	0.73	-174.5
900	0.96	177.3	0.88	34.6	0.0093	-13.3	0.75	-173.4
1000	0.97	176.7	0.87	27.8	0.0102	-17.8	0.76	-172.3
1100	0.95	175.9	0.96	20.7	0.0126	-24.5	0.76	-170.1
1200	0.93	176.0	0.93	4.1	0.0118	-40.0	0.81	-169.0
1300	0.92	176.3	0.96	-9.2	0.0118	-51.4	0.86	-168.9
1400	0.91	176.9	0.98	-25.3	0.0120	- 68.5	0.91	-169.8
1450	0.91	177.1	0.97	-34.4	0.0118	- 79.3	0.94	-171.1
1500	0.91	177.6	0.95	-43.8	0.0117	- 91.4	0.97	-172.7
1550	0.91	177.9	0.91	-53.8	0.0114	-104.9	0.98	-174.6
1600	0.92	178.1	0.87	-63.4	0.0107	-119.8	0.99	-176.7
1650	0.92	178.3	0.81	-72.7	0.0094	-135.3	0.99	-178.9
1700	0.93	178.1	0.74	-81.2	0.0094	-146.9	0.01	179.0
1750	0.94	178.0	0.67	-89.1	0.0084	-161.9	0.99	177.4
1800	0.95	177.6	0.61	-96.7	0.0080	-174.5	0.98	175.8
1850	0.95	177.1	0.55	-103.2	0.0079	-172.2	0.96	174.7
1900	0.95	176.7	0.49	-108.6	0.0077	-155.4	0.95	173.8
1950	0.96	176.1	0.44	-113.4	0.0071	145.8	0.94	173.1
2000	0.96	175.6	0.40	-117.3	0.0070	134.9	0.92	172.2
2100	0.96	174.3	0.34	-125.5	0.0081	123.6	0.91	171.0
2200	0.96	173.1	0.28	-133.5	0.0087	104.9	0.84	169.3
2300	0.96	171.7	0.23	-140.0	0.0092	89.0	0.88	168.7
2400	0.96	170.5	0.20	-144.5	0.0075	80.1	0.86	168.0

an AMP company

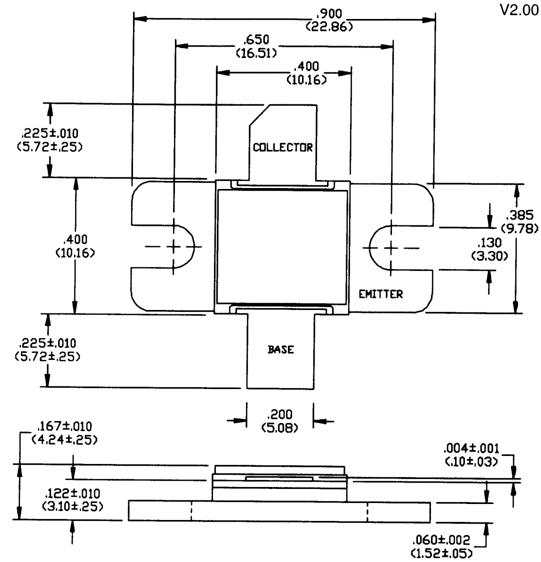
Wireless Bipolar Power Transistor, 30W
1.45 - 1.60 GHz

PH1516-30

V2.00

Features

- Designed for Cellular Base Station Applications
- -30 dBc Typical 3rd IMD at 30 Watts PEP
- Common Emitter Class AB Operation
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

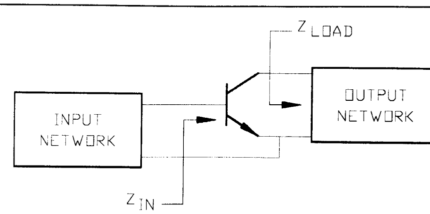
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	10	A
Total Power Dissipation	P_{TOT}	109	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	4.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=40 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=40 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=40 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=2 A
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50 - 1.60 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50 - 1.60 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50 - 1.60 GHz
Load Mismatch Tolerance	VSWR	-	3.0:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50 - 1.60 GHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP F=1500 MHz, ΔF=100 kHz

Typical Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.45	1.7 + j4.8	1.4 + j0.2
1.50	1.9 + j5.0	1.4 + j0.1
1.60	2.1 + j4.9	1.3 - j0.1



Specifications Subject to Change Without Notice.

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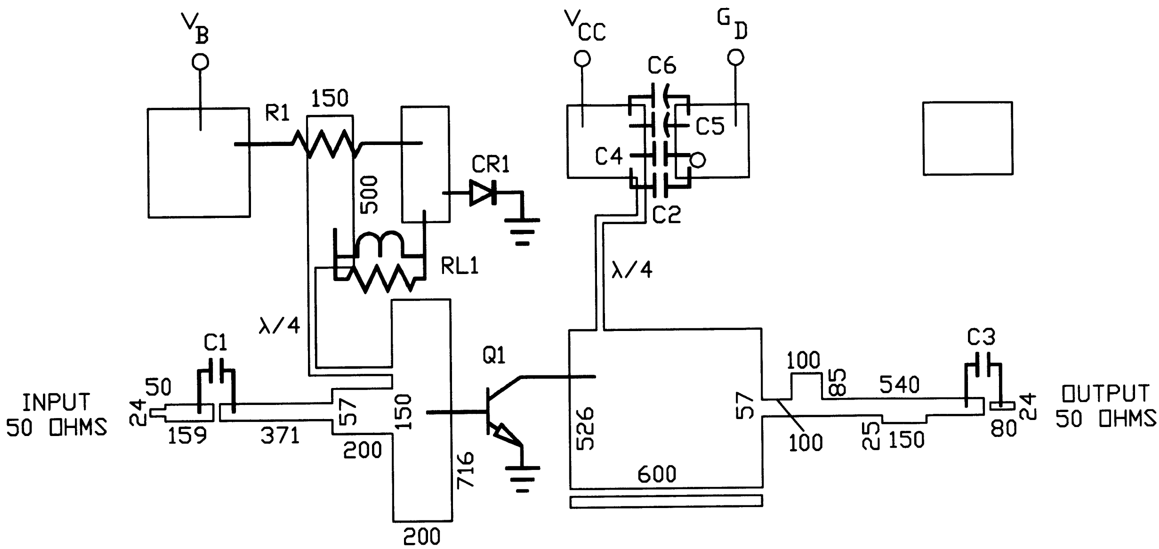
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

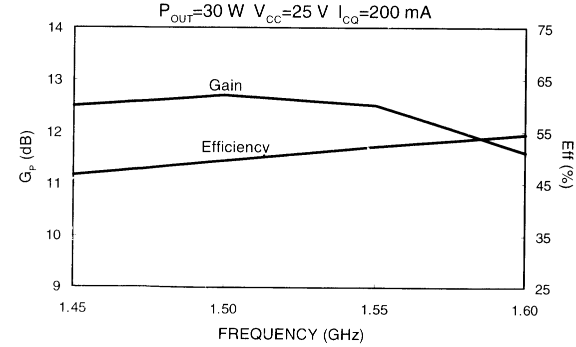
PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	5000 pF
C5	4.7 uF 63 VOLTS
C6	50 uF 50 VOLTS
CR1	1N4245 DIODE
Q1	PH1516-30
R1	5 OHMS 1/4 WATT
RL1	6T/NO. 24 AWG ON 3 OHM 1/4 WATT
BOARD TYPE:	ROGERS 6010.5 25 THICK, E_R = 10.5

Typical Broadband Performance Curves

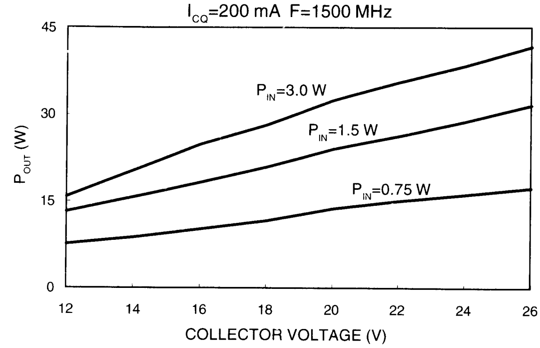
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=30 W V_{CC}=25 V I_{CQ}=200 mA



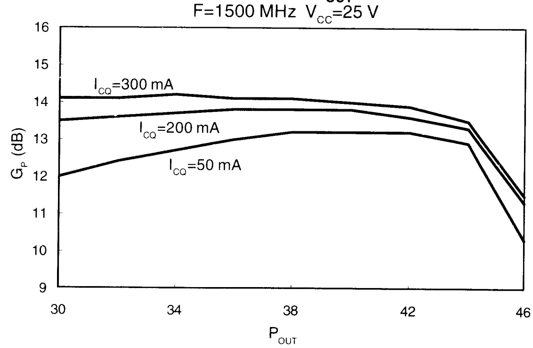
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=200 mA F=1500 MHz



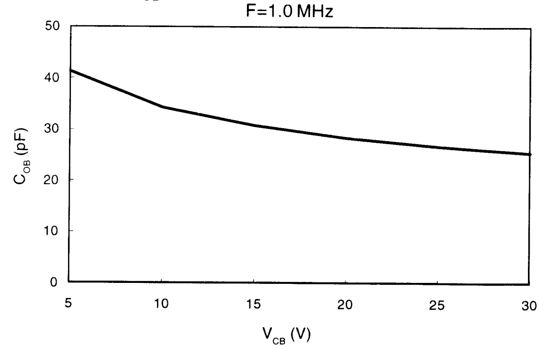
GAIN vs P_{OUT}

F=1500 MHz V_{CC}=25 V



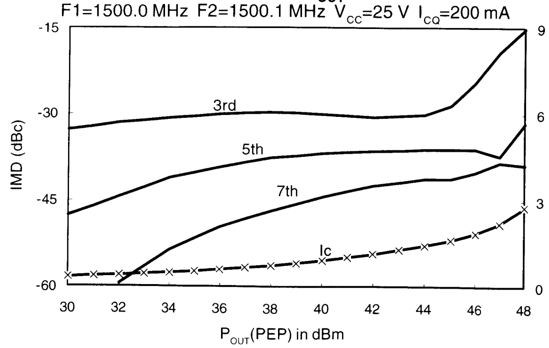
C_{OB} vs COLLECTOR VOLTAGE

F=1.0 MHz



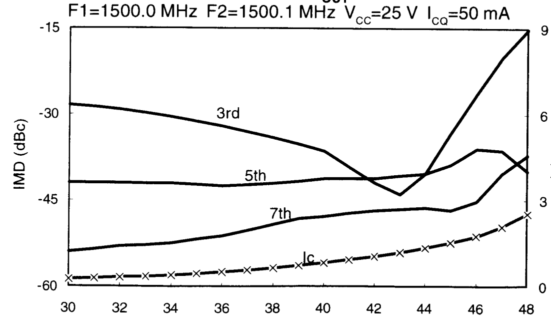
IMD vs P_{OUT}

F1=1500.0 MHz F2=1500.1 MHz V_{CC}=25 V I_{CQ}=200 mA



IMD vs P_{OUT}

F1=1500.0 MHz F2=1500.1 MHz V_{CC}=25 V I_{CQ}=50 mA



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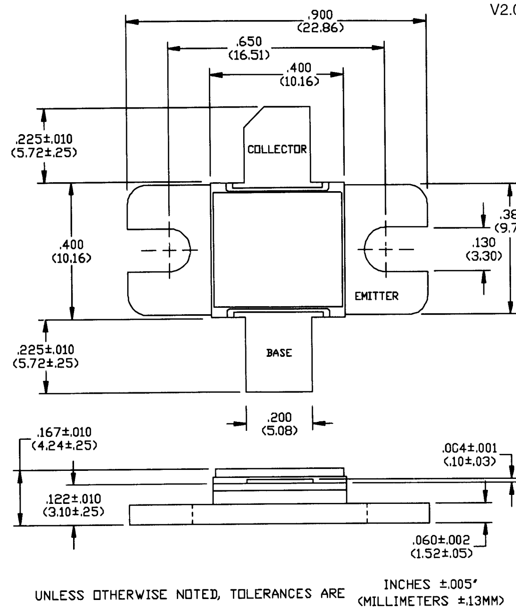
an AMP company

Wireless Bipolar Power Transistor, 60W 1450 - 1550 MHz

PH1516-60

V2.00



Features

- Designed for Linear Amplifier Applications
- Class AB: -30 dBc Typ 3rd IMD at 60 Watts PEP
- Class A: +53 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting

Absolute Maximum Ratings at 25°C

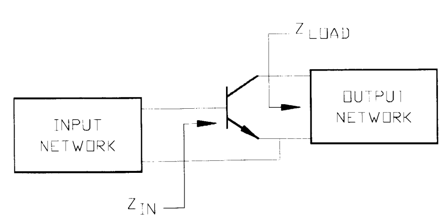
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	10	A
Power Dissipation	P_D	116	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	10	mA	V_{CE}=26 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=40 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=40 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=1 A
Power Gain	G_P	8	-	dB	V_{CC}=26 V, I_{CQ}=50 mA, P_{OUT}=60 W PEP F=1500 MHz, ΔF=100 kHz
Collector Efficiency	η_C	30	-	%	V_{CC}=26 V, I_{CQ}=50 mA, P_{OUT}=60 W PEP F=1500 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=50 mA, P_{OUT}=60 W PEP F=1500 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	5.0:1	-	V_{CC}=26 V, I_{CQ}=50 mA, P_{OUT}=60 W PEP F=1500 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=26 V, I_{CQ}=50 mA, P_{OUT}=60 W PEP F=1500 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1450	2.2 + j5.0	3.0 - j3.8
1500	2.7 + j4.5	2.2 - j4.0
1550	2.1 + j3.7	1.5 - j4.1



Specifications Subject to Change Without Notice.

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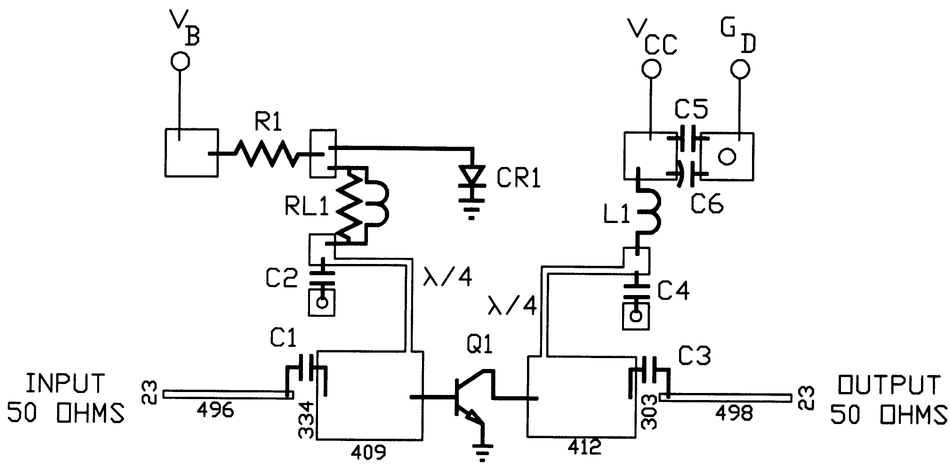
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3 C4	18pF ATC SIZE B CAPACITOR
C5	5000pF CHIP CAPACITOR
C6	50 VOLT 50uF ELECTROLYTIC CAPACITOR
CR1	1N5417 DIODE
L1	7 TURNS OF NO. 22 AWG ON .125″ DIA
Q1	PH1516-60
R1	4.7 OHM 1/2 WATT RESISTOR
RL1	10 TURNS OF NO. 26 AWG ON 3 OHM 1/4 WATT RESISTOR
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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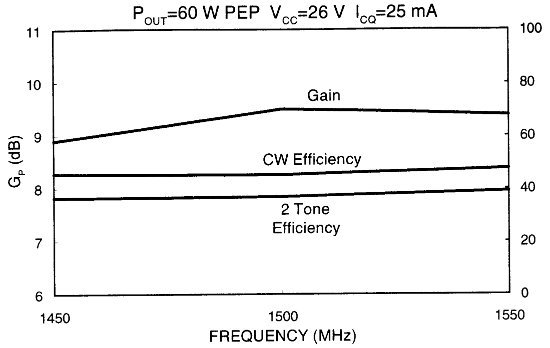
Typical Broadband Performance Curves

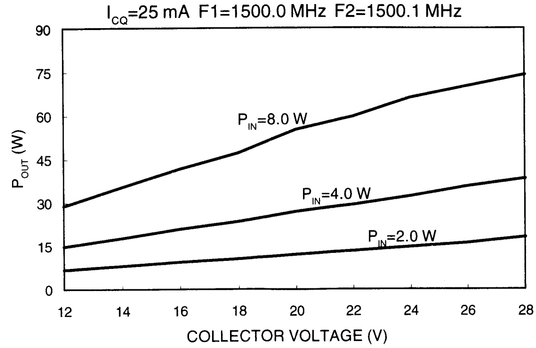
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=60 W PEP V_{CC}=26 V I_{CQ}=25 mA



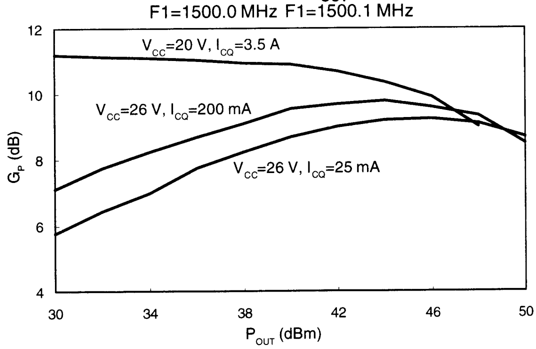
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=25 mA F1=1500.0 MHz F2=1500.1 MHz



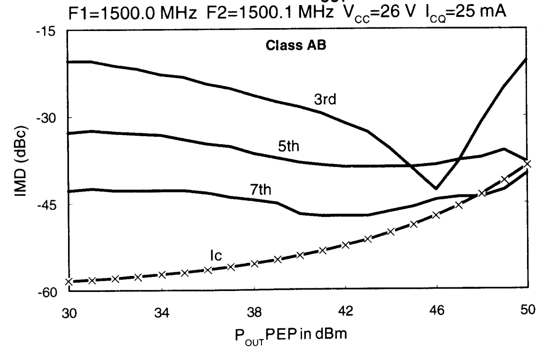
GAIN vs P_{OUT}

F1=1500.0 MHz F1=1500.1 MHz



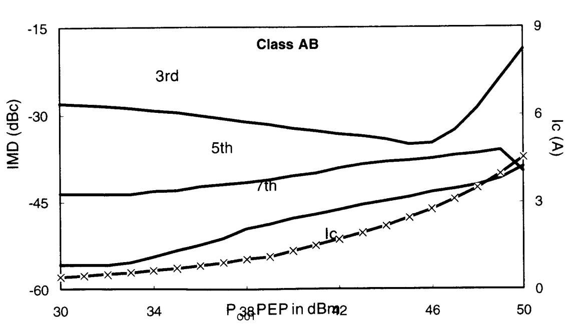
IMD vs P_{OUT}

F1=1500.0 MHz F2=1500.1 MHz V_{CC}=26 V I_{CQ}=25 mA



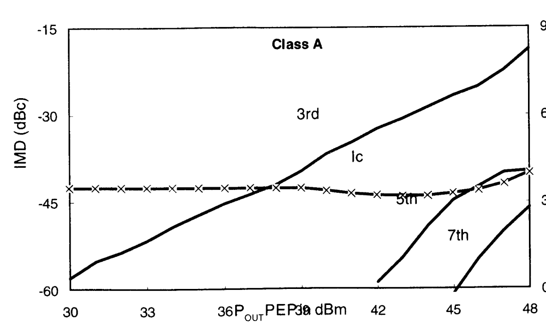
IMD vs P_{OUT}

F1=1500.0 MHz F2=1500.1 MHz V_{CC}=26 V I_{CQ}=200 mA



IMD vs P_{OUT}

F1=1500.0 MHz F2=1500.1 MHz V_{CC}=20 V I_{CQ}=3.5 A



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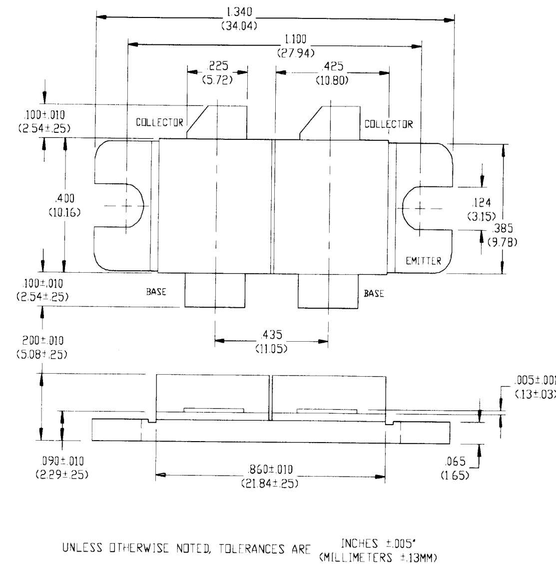
Wireless Bipolar Power Transistor, 100W
1450 - 1550 MHz

PH1516-100

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -32 dBc Typ 3rd IMD at 100 Watts PEP
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	63	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	20	A
Power Dissipation	P_D	233	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	.75	°C/W

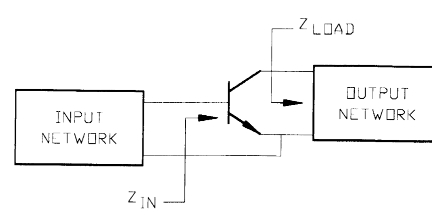
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=60 mA*
Collector-Emitter Leakage Current	I_{CES}	-	4.0	mA	V_{CE}=30 V*
Collector-Emitter Breakdown Voltage	BV_{CEO}	22	-	V	I_C=60 mA*
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=8 mA*
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=1 A*
Power Gain	G_P	10	-	dB	V_{CC}=26 V, I_{CQ}=100mA, P_{OUT}=100W PEP F=1500 MHz, ΔF=100 kHz
Collector Efficiency	η_C	30	-	%	V_{CC}=26 V, I_{CQ}=100mA, P_{OUT}=100W PEP F=1500 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=100mA, P_{OUT}=100W PEP F=1500 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	5.0:1	-	V_{CC}=26 V, I_{CQ}=100mA, P_{OUT}=100W PEP F=1500 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=26 V, I_{CQ}=100mA, P_{OUT}=100W PEP F=1500 MHz, ΔF=100 kHz

* Per Side

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
1450	4.4 + j10.0	6.0 - j7.6
1500	5.4 + j9.0	4.4 - j8.0
1550	4.2 + j7.4	3.0 - j8.2



Specifications Subject to Change Without Notice.

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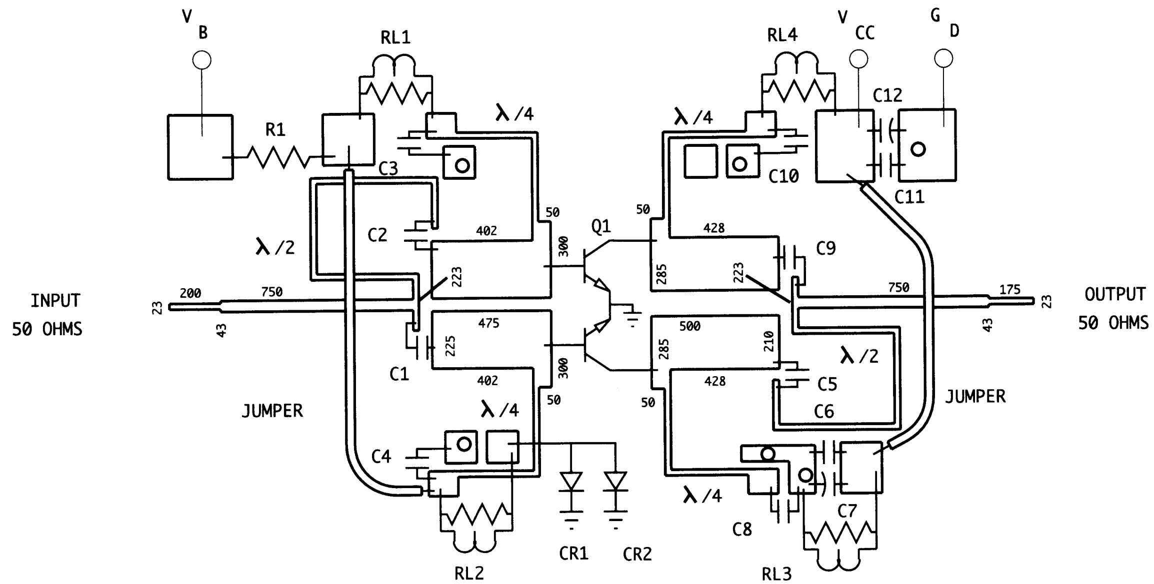
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3 C4 C5 C8 C9 C10	18pF ATC SIZE B CAPACITOR
C6 C11	5000pF CHIP CAPACITOR
C7 C12	50 VOLT 50uF ELECTOLYTIC CAPACITOR
CR1 CR2	1N5417 DIODE
Q1	PH1516-100
R1	4.7 OHM 1/2 WATT METAL FILM RESISTOR
RL1 RL2	12 TURNS OF NO. 22 AWG ON 4.7 OHM 1/2 WATT METAL FILM RESISTOR
RL3 RL4	6 TURNS OF NO. 22 AWG ON 4.7 OHM 1/2 WATT METAL FILM RESISTOR
BOARD TYPE	ROGERS 6010.5 .025" THICK, E_R = 10.5

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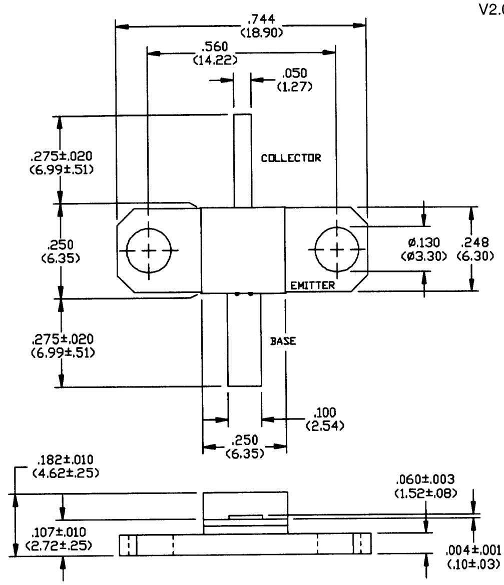
Wireless Bipolar Power Transistor, 2W
1.6 - 1.7 GHz

PH1617-2

V2.00



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Features

- Designed for Linear Amplifier Applications
- Class AB: -33 dBc Typ 3rd IMD at 2 Watts PEP
- Class A: +44 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting

Absolute Maximum Ratings at 25°C

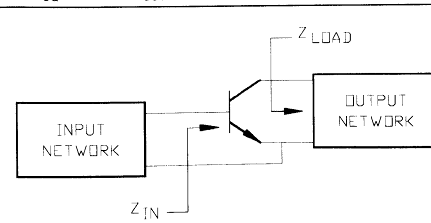
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Power Dissipation	P_D	13.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	13	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	22	-	V	I_C=5 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=5 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=200 mA
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.60, 1.65, 1.70 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.60, 1.65, 1.70 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.60, 1.65, 1.70 GHz
Load Mismatch Tolerance	VSWR-T	-	5:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.60, 1.65, 1.70 GHz
3rd Order IMD	IMD_3	-	-32	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, PEP F=1650 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.60	3.5 + j8.2	6.6 + j13.5
1.65	3.9 + j8.5	6.4 + j13.1
1.70	4.2 + j8.7	6.3 + j12.8



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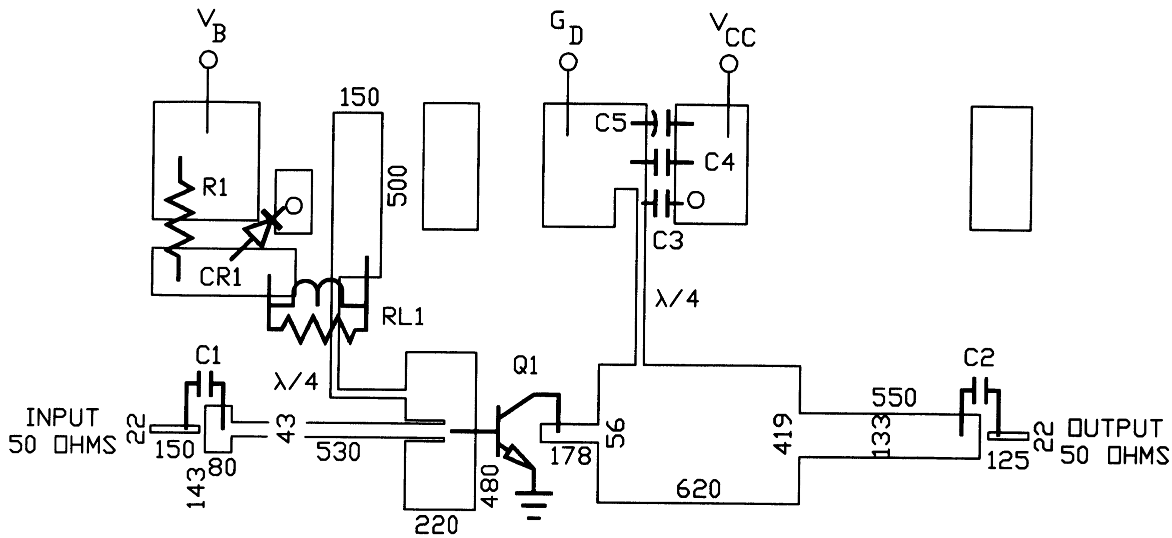
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	4.7 uF 35 VOLTS CHIP
C5	50 uF 50 VOLTS
CR1	1N914B DIODE
Q1	PH1617-2
R1	5Ω 1/4 WATT
RL1	6T/NO. 24 AWG ON 3Ω 1/4WATT
BOARD TYPE:	ROGERS 6010.5 25 MILS THICK, E_R = 10.5

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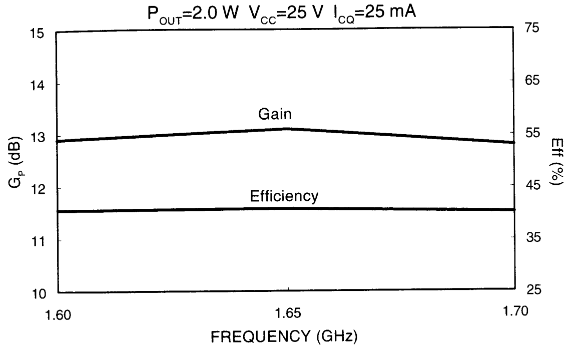
Typical Broadband Performance Curves

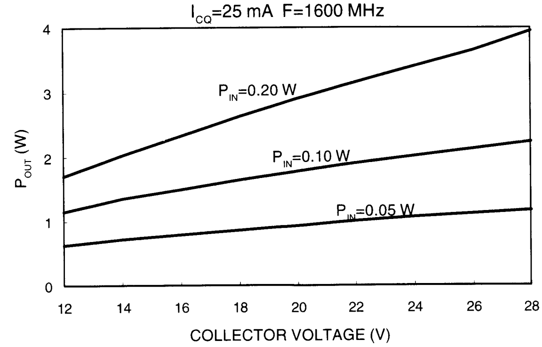
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=2.0 W V_{CC}=25 V I_{CQ}=25 mA



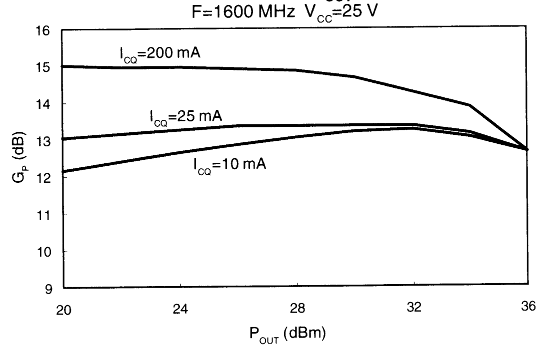
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=25 mA F=1600 MHz



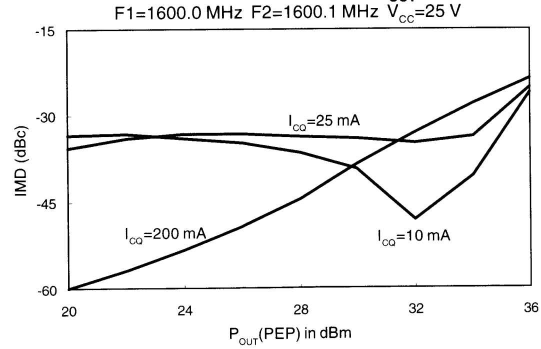
GAIN vs P_{OUT}

F=1600 MHz V_{CC}=25 V



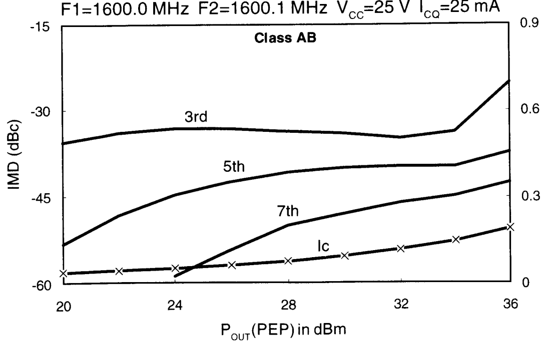
3RD ORDER IMD vs P_{OUT}

F1=1600.0 MHz F2=1600.1 MHz V_{CC}=25 V



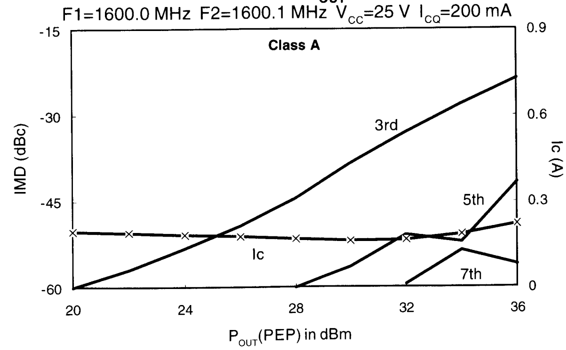
IMD vs P_{OUT}

F1=1600.0 MHz F2=1600.1 MHz V_{CC}=25 V I_{CQ}=25 mA



IMD vs P_{OUT}

F1=1600.0 MHz F2=1600.1 MHz V_{CC}=25 V I_{CQ}=200 mA



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Typical S-Parameters

V_{CC}=25 V, I_{CQ}=200 mA

f(MHz)	S11 Mag	S11 Phase	S21 Mag	S21 Phase	S12 Mag	S12 Phase	S22 Mag	S22 Phase
100	1.10	171.5	23.80	120.3	0.012	- 7.4	0.32	-74.5
200	0.75	175.1	12.15	92.1	0.014	- 4.7	0.22	-89.6
300	0.79	-177.9	7.79	81.2	0.016	- 4.5	0.20	-95.7
400	0.84	-177.4	5.77	74.4	0.016	- 9.8	0.23	- 98.7
500	0.87	-178.5	4.65	68.4	0.017	- 3.7	0.26	-100.5
600	0.89	179.8	3.96	62.6	0.018	- 5.9	0.27	-101.4
700	0.89	178.3	3.49	56.7	0.018	- 0.7	0.29	-104.4
800	0.91	177.4	3.08	51.1	0.019	- 2.7	0.33	-103.3
900	0.91	175.4	2.89	45.4	0.017	- 3.4	0.36	-111.0
1000	0.91	174.1	2.74	38.9	0.019	- 0.9	0.40	-114.6
1100	0.89	171.5	2.64	28.9	0.024	- 6.1	0.46	-117.3
1200	0.87	171.7	2.45	22.8	0.024	- 13.6	0.53	-120.8
1300	0.86	170.8	2.35	15.7	0.023	- 18.3	0.57	-122.3
1400	0.86	170.3	2.32	7.6	0.026	- 21.1	0.63	-145.5
1450	0.85	170.1	2.30	3.4	0.026	- 22.9	0.65	-126.2
1500	0.84	169.9	2.27	-1.2	0.025	- 22.3	0.66	-127.6
1550	0.83	169.7	2.26	-6.4	0.026	- 31.0	0.68	-129.1
1600	0.82	169.7	2.24	-11.5	0.030	- 37.3	0.71	-131.9
1650	0.82	170.0	2.22	-16.6	0.029	- 43.2	0.72	-133.6
1700	0.81	170.5	2.19	-22.4	0.027	- 48.5	0.73	-137.6
1750	0.80	171.1	2.14	-28.4	0.025	- 52.2	0.76	-140.1
1800	0.80	171.5	2.11	-35.5	0.026	- 60.2	0.76	-143.9
1850	0.80	171.9	2.05	-40.7	0.027	- 60.1	0.81	-147.5
1900	0.81	172.6	1.99	-47.4	0.024	- 67.1	0.81	-150.1
2000	0.82	173.6	1.83	-60.7	0.024	- 80.8	0.86	-155.5
2100	0.84	174.5	1.61	-74.0	0.020	- 94.0	0.88	-160.0
2200	0.88	174.2	1.40	-84.6	0.019	-104.7	0.87	-164.5
2300	0.90	173.6	1.21	-94.7	0.016	-128.7	0.86	-168.1

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M/A-COM an AMP company

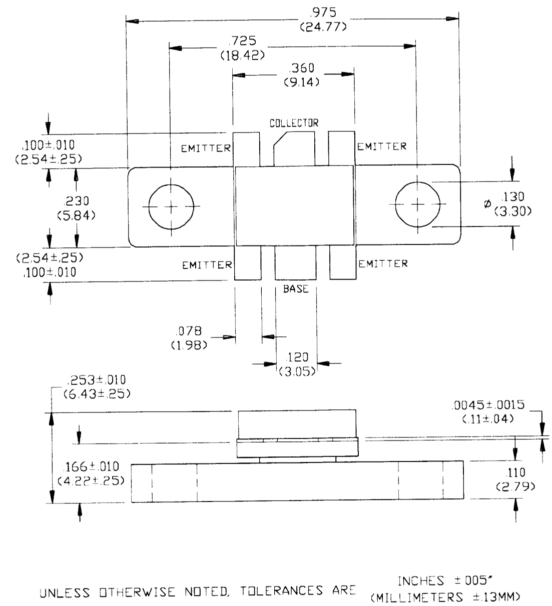
Wireless Bipolar Power Transistor, 4W
1.6 - 1.7 GHz

PH1617-4N

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Designed for Linear Amplifier Applications
- Class AB: -33 dBc Typ 3rd IMD at 4 Watts PEP
- Class A: +44 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting Resistors
- Gold Metalization System



Absolute Maximum Ratings at 25°C

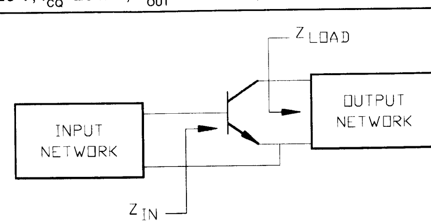
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.7	A
Power Dissipation	P_D	19.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	7.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=24 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=5 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=2.5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=0.1 A
Power Gain	G_P	12	-	dB	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1650 MHz, ΔF=100 kHz
Collector Efficiency	η_C	35	-	%	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1650 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1650 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1650 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1650 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
1600	2.5 + j8.7	4.2 + j9.3
1650	3.2 + j6.6	4.3 + j9.1
1700	3.5 + j8.5	4.4 + j9.0



Specifications Subject to Change Without Notice.

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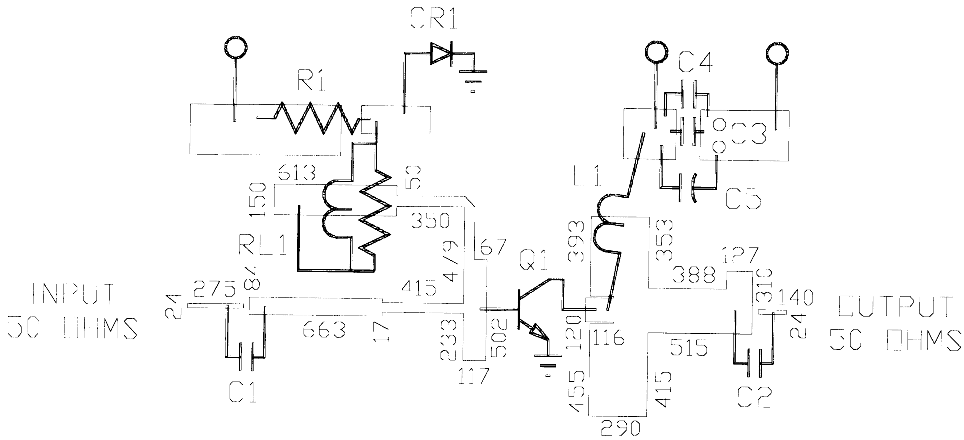
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33pF ATC SIZE A
C4	5000pF CHIP
C5	50uF 50 VOLTS
CR1	1N4245
L1	5 TURNS OF NO. 24 AWG ON Ø.160"
R1	4.7 OHMS .25 WATT
RL1	7 TURNS OF NO. 24 AWG ON 3 OHM .25 WATT
Q1	PH1617-4N
BOARD TYPE	ROGERS 6010.5 .025" THICK, E_R=10.5

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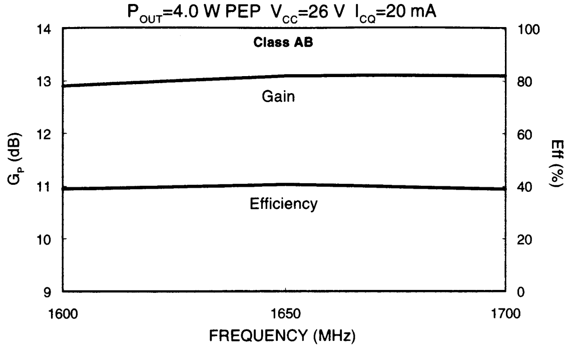
Typical Broadband Performance Curves

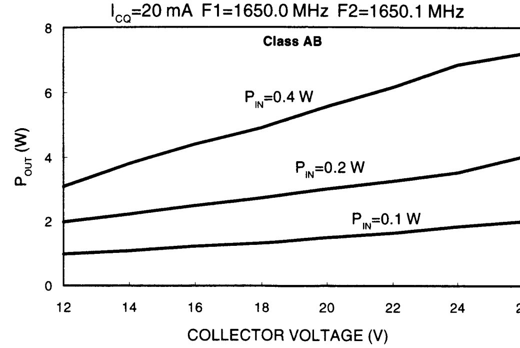
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=4.0 W PEP V_{CC}=26 V I_{CQ}=20 mA



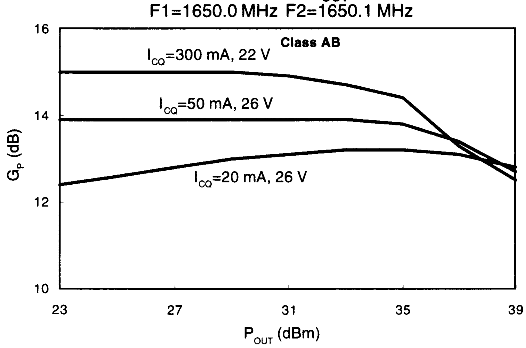
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=20 mA F1=1650.0 MHz F2=1650.1 MHz



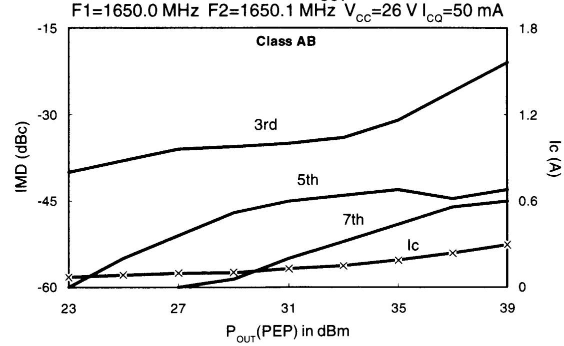
GAIN vs P_{OUT}

F1=1650.0 MHz F2=1650.1 MHz



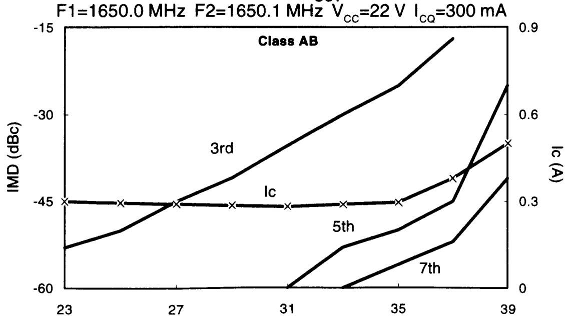
IMD vs P_{OUT}

F1=1650.0 MHz F2=1650.1 MHz V_{CC}=26 V I_{CQ}=50 mA



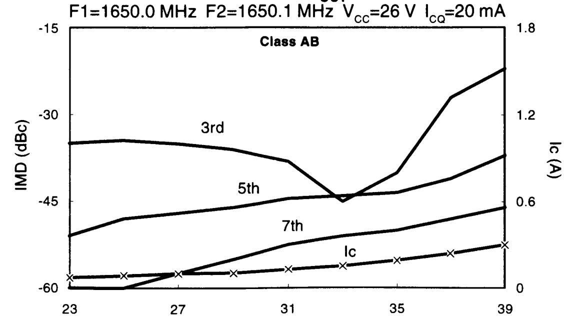
IMD vs P_{OUT}

F1=1650.0 MHz F2=1650.1 MHz V_{CC}=22 V I_{CQ}=300 mA



IMD vs P_{OUT}

F1=1650.0 MHz F2=1650.1 MHz V_{CC}=26 V I_{CQ}=20 mA



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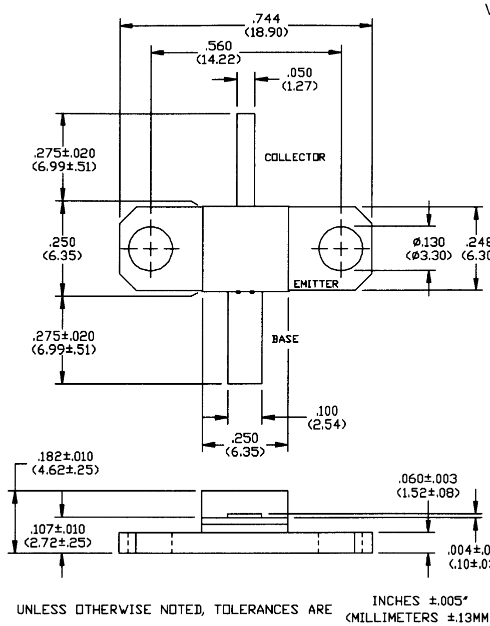
M/A-COM an AMP company

Wireless Bipolar Power Transistor, 10W
1.6 - 1.7 GHz PH1617-10

V2.00

Features

- Designed for Linear Amplifier Applications
- Class AB: -33 dBc Typ 3rd IMD at 10 Watts PEP
- Class A: +49 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

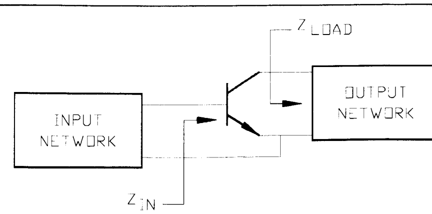
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Power Dissipation	P_D	58	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=20 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=20 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=20 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=20 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=1 A
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60, 1.65, 1.70 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60, 1.65, 1.70 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60, 1.65, 1.70 GHz
Load Mismatch Tolerance	VSWR-T	-	3.0:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60, 1.65, 1.70 GHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W PEP, F=1650 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.60	2.6 + j4.9	2.0 + j0.5
1.65	3.5 + j3.7	1.95 - j0.6
1.70	3.3 + j2.3	1.9 - j0.7



Specifications Subject to Change Without Notice.

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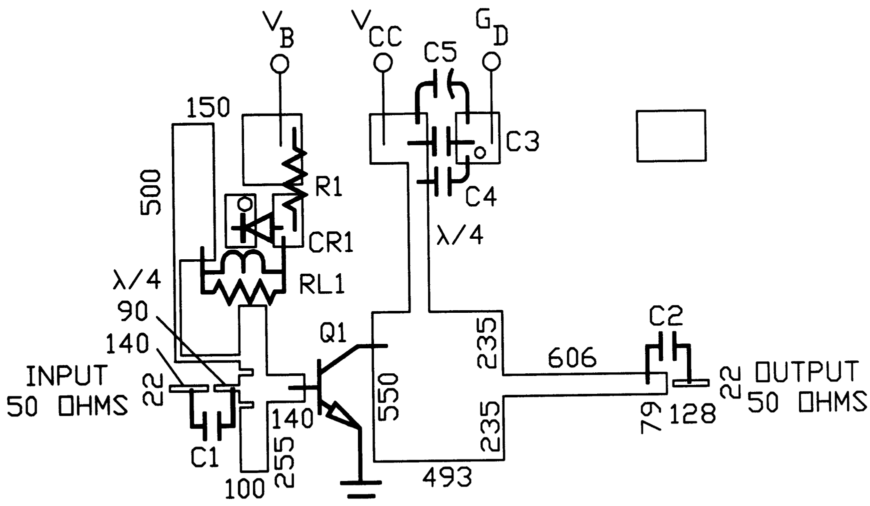
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	4.7 uF 35 VOLTS CHIP
C5	50 uF 50 VOLTS
CR1	1N4245 DIODE
Q1	PH1617-10
R1	5 OHMS 1/4 WATT
RL1	6T/NO. 24 AWG ON 3 OHM 1/4 WATT
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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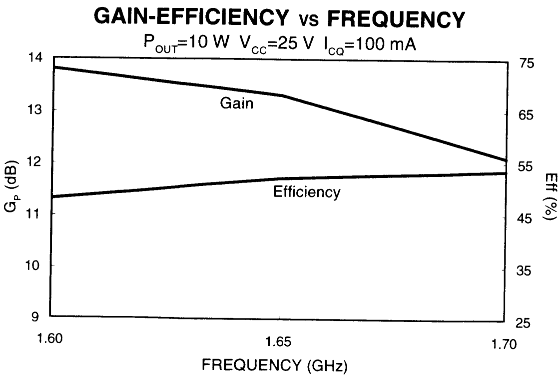
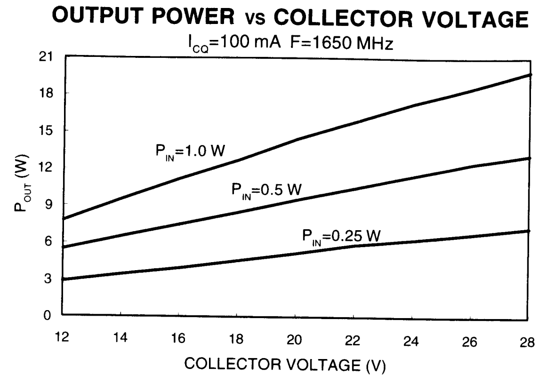
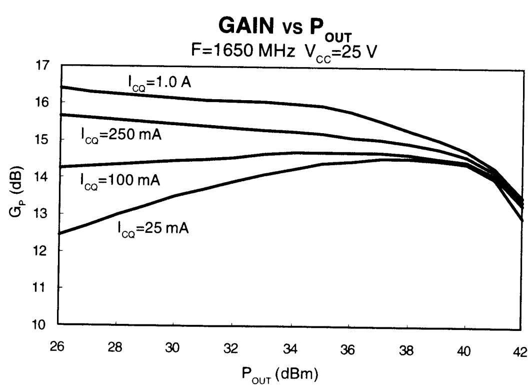
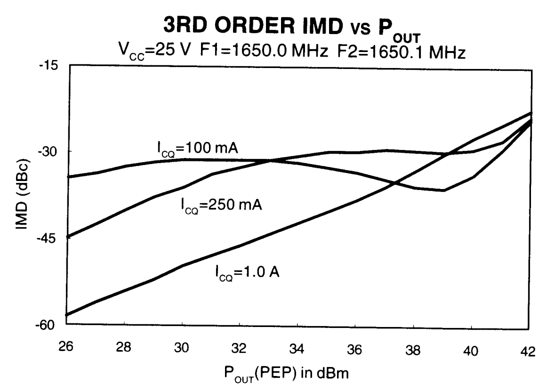
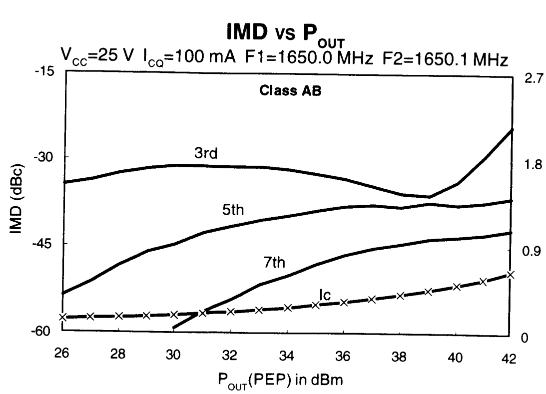
Typical Broadband Performance Curves

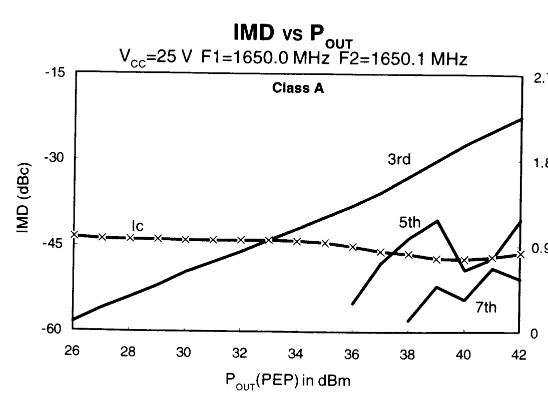












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Typical S-Parameters

V_{CC}=25 V, I_{CQ}=1.0 A

f(MHz)	S11 Mag	S11 Phase	S21 Mag	S21 Phase	S12 Mag	S12 Phase	S22 Mag	S22 Phase
100	0.85	177.3	6.57	92.2	0.0066	6.74	0.73	-179.3
200	0.94	179.4	2.96	79.9	0.0073	4.33	0.73	-179.0
300	0.96	-179.4	1.95	75.5	0.0075	4.04	0.72	-178.8
400	0.97	-170.0	1.51	70.6	0.0077	0.91	0.72	-178.2
500	0.97	178.5	1.27	65.2	0.0081	-0.99	0.72	-177.6
600	0.97	178.1	1.12	59.5	0.0085	-2.6	0.73	-177.1
700	0.96	177.7	1.09	52.7	0.0088	- 6.8	0.72	-176.1
800	0.97	178.0	0.93	39.5	0.0094	-12.0	0.73	-174.5
900	0.96	177.3	0.88	34.6	0.0093	-13.3	0.75	-173.4
1000	0.97	176.7	0.87	27.8	0.0102	-17.8	0.76	-172.3
1100	0.95	175.9	0.96	20.7	0.0126	-24.5	0.76	-170.1
1200	0.93	176.0	0.93	4.1	0.0118	-40.0	0.81	-169.0
1300	0.92	176.3	0.96	-9.2	0.0118	- 51.4	0.86	-168.9
1400	0.91	176.9	0.98	-25.3	0.0120	- 68.5	0.91	-169.8
1450	0.91	177.1	0.97	-34.4	0.0118	- 79.3	0.94	-171.1
1500	0.91	177.6	0.95	-43.8	0.0117	- 91.4	0.97	-172.7
1550	0.91	177.9	0.91	-53.8	0.0114	-104.9	0.98	-174.6
1600	0.92	178.1	0.87	-63.4	0.0107	-119.8	0.99	-176.7
1650	0.92	178.3	0.81	-72.7	0.0094	-135.3	0.01	-178.9
1700	0.93	178.1	0.74	-81.2	0.0094	-146.9	0.01	179.0
1750	0.94	178.0	0.67	-89.1	0.0084	-161.9	0.99	177.4
1800	0.95	177.6	0.61	-96.7	0.0080	-174.5	0.98	175.8
1850	0.95	177.1	0.55	-103.2	0.0079	-172.2	0.96	174.7
1900	0.95	176.7	0.49	-108.6	0.0077	-155.4	0.95	173.8
1950	0.96	176.1	0.44	-113.4	0.0071	145.8	0.94	173.1
2000	0.96	175.6	0.40	-117.3	0.0070	134.9	0.92	172.2
2100	0.96	174.3	0.34	-125.5	0.0081	123.6	0.91	171.0
2200	0.96	173.1	0.28	-133.5	0.0087	104.9	0.84	169.3
2300	0.96	171.7	0.23	-140.0	0.0092	89.0	0.88	168.7
2400	0.96	170.5	0.20	-144.5	0.0075	80.1	0.86	168.0

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M/A-COM
an AMP company

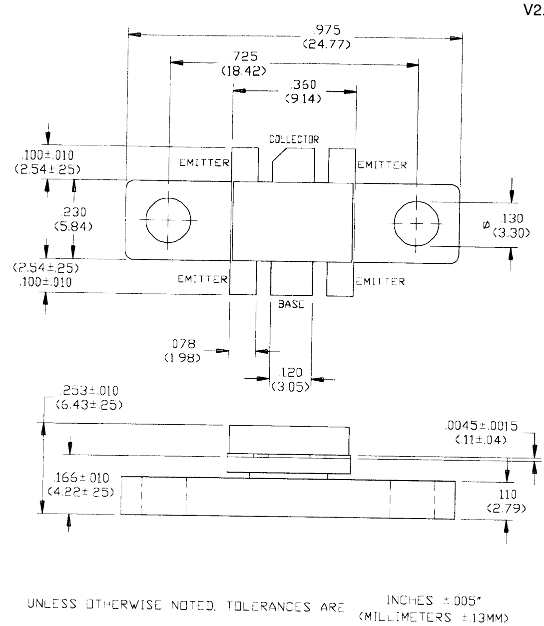
Wireless Bipolar Power Transistor, 12W
1.6 - 1.7 GHz

PH1617-12N

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Designed for Linear Amplifier Applications
- Class AB: -30 dBc Typ 3rd IMD at 12 Watts PEP
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting Resistors
- Gold Metalization System



Absolute Maximum Ratings at 25°C

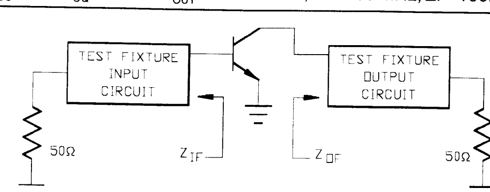
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Power Dissipation	P_D	58	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=15 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.25	mA	V_{CE}=26 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=10 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=10 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=0.5 A
Power Gain	G_P	8.5	-	dB	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=13.5 W PEP, F=1660 MHz, ΔF=100kHz
Collector Efficiency	η_C	25	-	%	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=13.5 W PEP, F=1660 MHz, ΔF=100kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=13.5 W PEP, F=1660 MHz, ΔF=100kHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=13.5 W PEP, F=1660 MHz, ΔF=100kHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=13.5 W PEP, F=1660 MHz, ΔF=100kHz

Broadband Test Fixture Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
1600	9.2 - j5.1	0.76 - j2.3
1650	7.7 - j3.1	0.82 - j1.7
1700	6.9 - j1.6	0.84 - j1.3



Specifications Subject to Change Without Notice.

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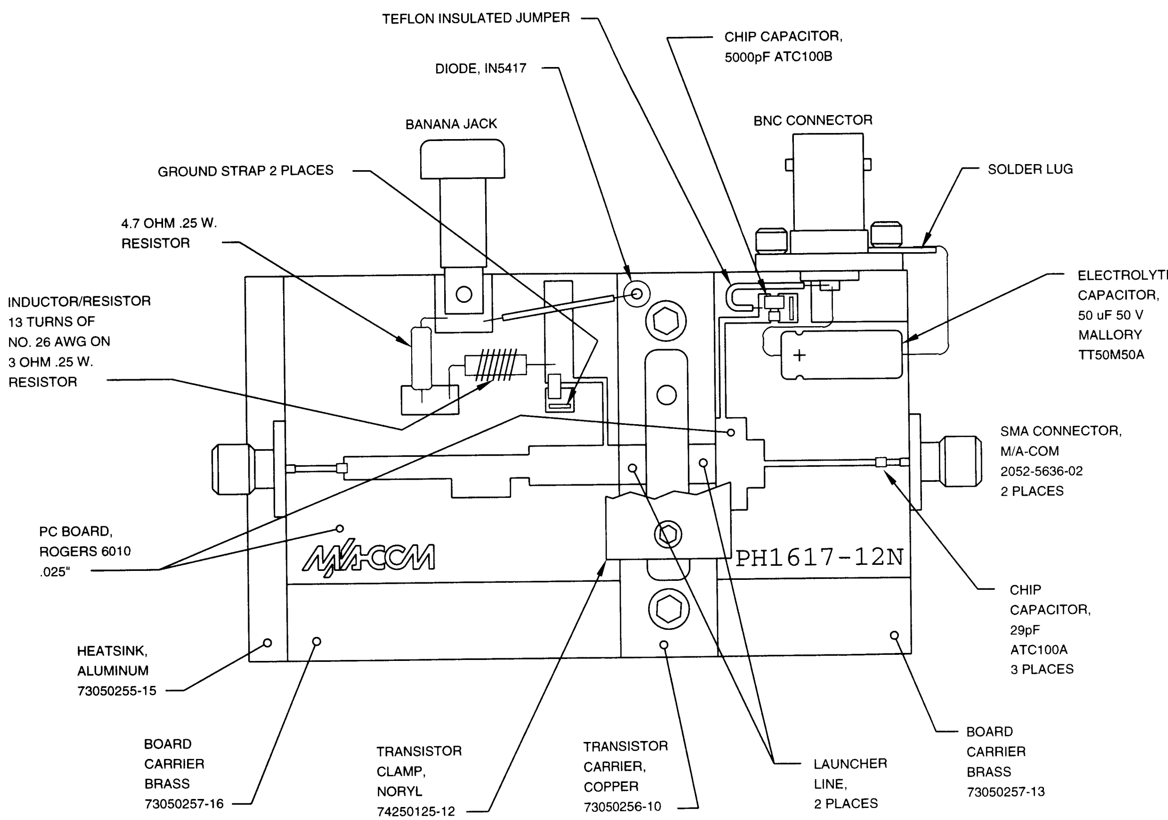
RF Test Fixture

V2.00



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M/A-COM an AMP company

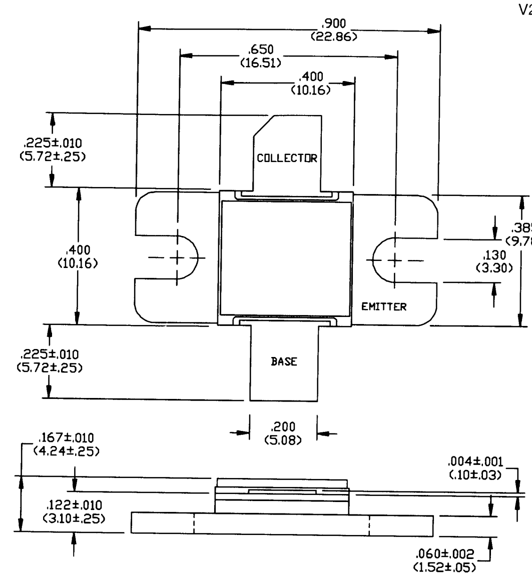
Wireless Bipolar Power Transistor, 30W 1.6 - 1.7 GHz

PH1617-30

V2.00

Features

- Designed for Linear Amplifier Applications
- -30 dBc Typ 3rd IMD at 30 Watts PEP
- Common Emitter Class AB Operation
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

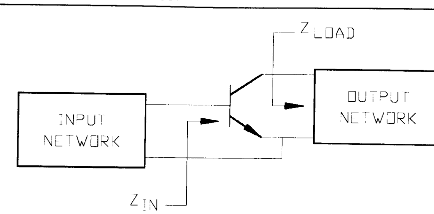
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	10	A
Power Dissipation	P_D	109	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	4.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=40 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=40 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=40 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=2 A
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP, F=1.6, 1.65, 1.70 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP, F=1.6, 1.65, 1.70 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP, F=1.6, 1.65, 1.70 GHz
Load Mismatch Tolerance	VSWR-T	-	3.0:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP, F=1.6, 1.65, 1.70 GHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=25 V, I_{CQ}=020 mA, P_{OUT}=30 W PEP, F=1650 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.60	2.1 + j4.9	1.3 - j0.7
1.65	3.1 + j3.8	1.2 - j0.8
1.70	2.1 + j3.5	1.2 - j0.9



Specifications Subject to Change Without Notice.

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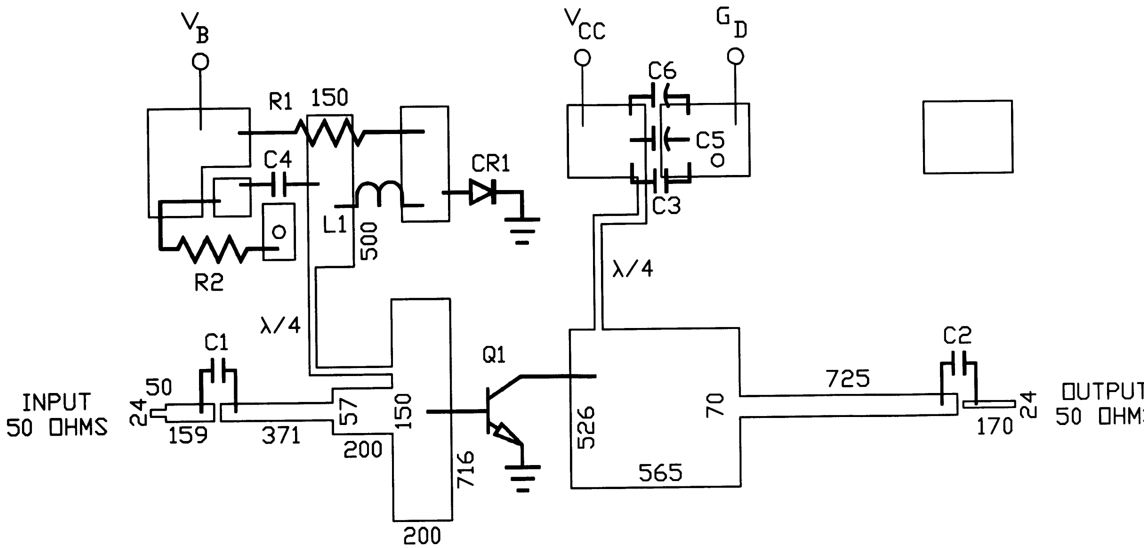
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	6.8 uF 35 VOLTS CHIP
C5	4.7 uF 35 VOLTS CHIP
C6	50 uF 50 VOLTS
CR1	1N4245 DIODE
Q1	PH1617-30
R1	5Ω 1/4 WATT
R2	2.2Ω 1/8 WATT CHIP
L1	10 T/NO. 24 AWG ON 1/8' DIAMETER
BOARD TYPE:	ROGERS 6010.5 25 MILS THICK, E_R = 10.5

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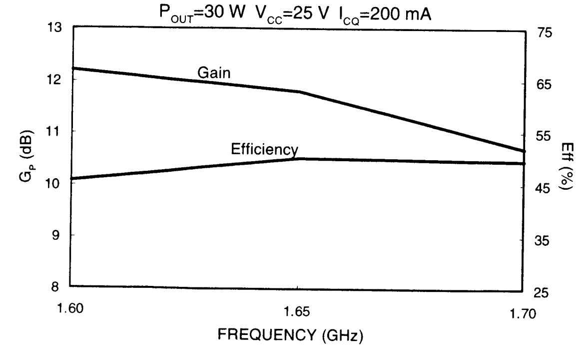
Typical Broadband Performance Curves

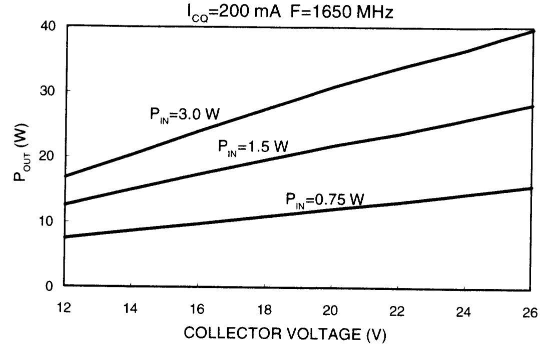
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=30 W V_{CC}=25 V I_{CQ}=200 mA



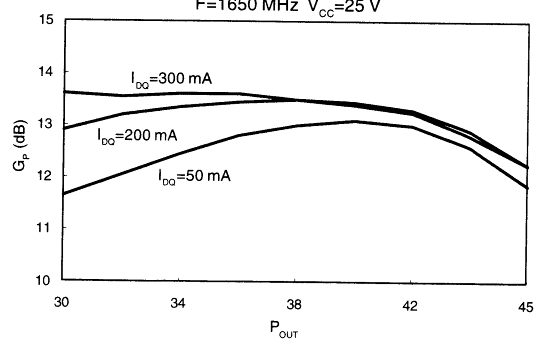
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=200 mA F=1650 MHz



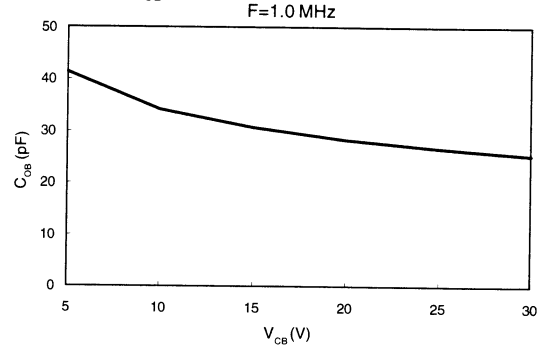
GAIN vs P_{OUT}

F=1650 MHz V_{CC}=25 V



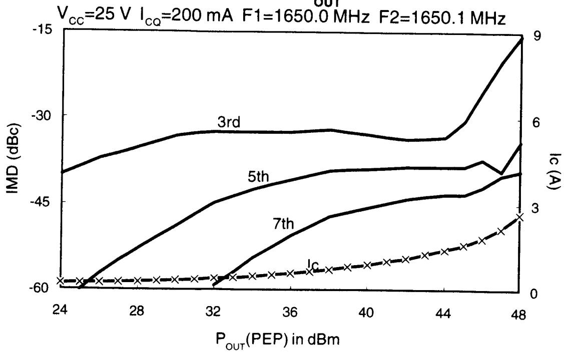
C_{OB} vs COLLECTOR VOLTAGE

F=1.0 MHz



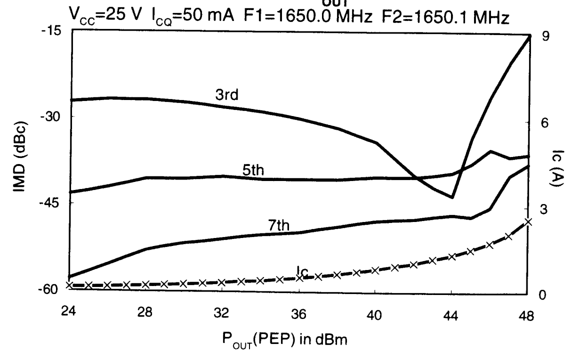
IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=200 mA F1=1650.0 MHz F2=1650.1 MHz



IMD vs P_{OUT}

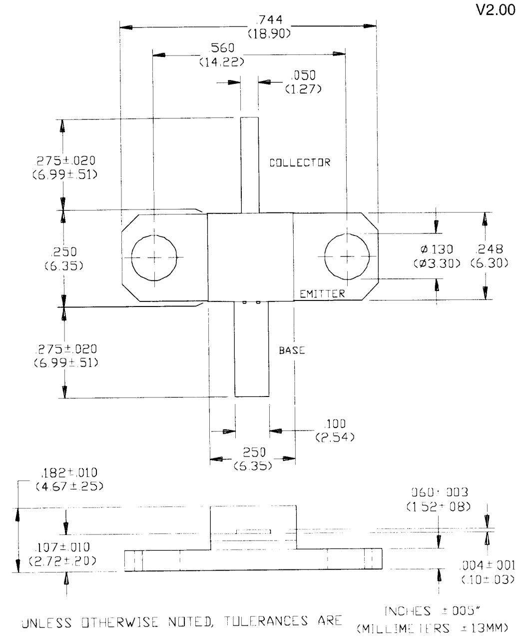
V_{CC}=25 V I_{CQ}=50 mA F1=1650.0 MHz F2=1650.1 MHz



Wireless Bipolar Power Transistor, 2W
1.78 - 1.90 GHz

PH1819-2

V2.00



Features

- Designed for Cellular Base Station Applications
- Class AB: -34 dBc Typ 3rd IMD at 2 Watts PEP
- Class A: +43 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting

Absolute Maximum Ratings at 25°C

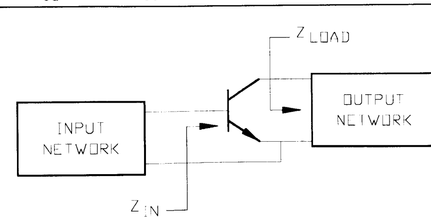
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Power Dissipation	P_D	13.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	13	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	22	-	V	I_C=5 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=5 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=200 mA
Power Gain	G_P	10	-	dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.78, 1.85, 1.90 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.78, 1.85, 1.90 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.78, 1.85, 1.90 GHz
Load Mismatch Tolerance	VSWR-T	-	5:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W, F=1.78, 1.85, 1.90 GHz
3rd Order IMD	IMD_3	-	-32	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2.0 W PEP, F=1850 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.78	6.6 + j10.0	6.0 + j12.0
1.85	8.4 + j10.1	5.7 + j11.0
1.90	9.5 + j9.9	5.0 + j9.0



Specifications Subject to Change Without Notice.

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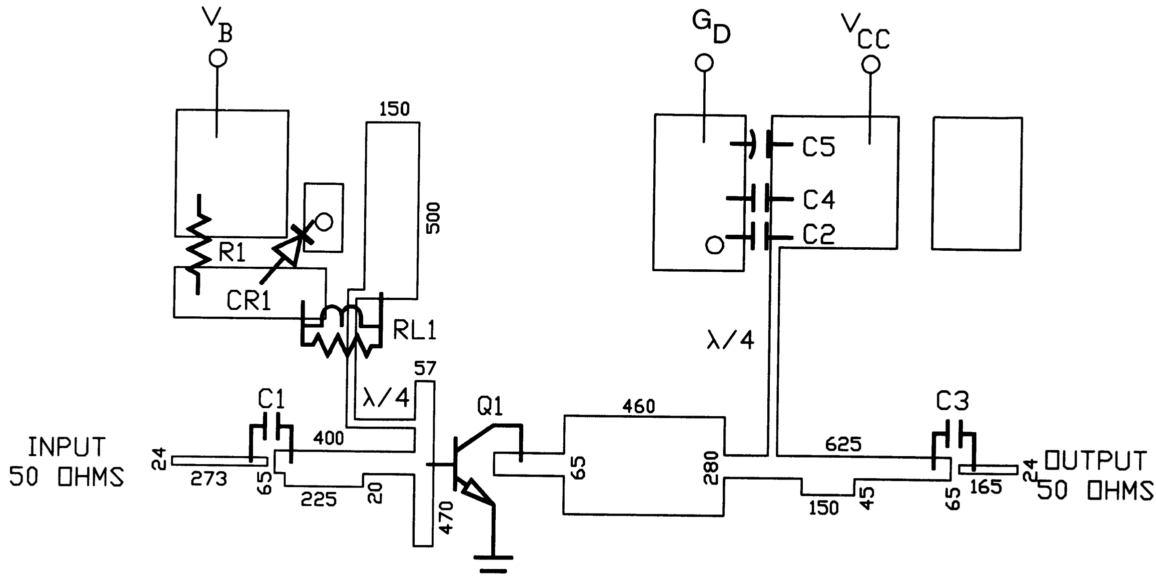
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	5000 pF
C5	4.7 uF 63 VOLTS
CR1	1N914B DIODE
Q1	PH1819-2
R1	5 OHMS 1/4 WATT
RL1	6T/NO. 24 AWG ON 3 OHM 1/4 WATT
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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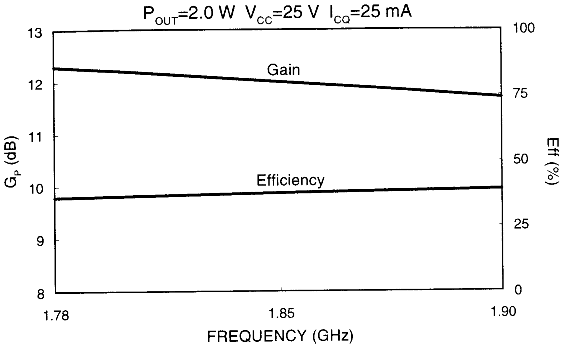
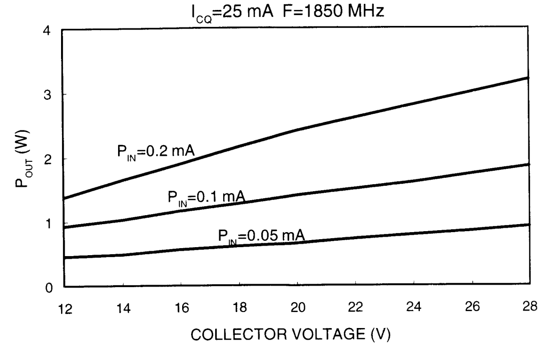
Typical Performance Curves

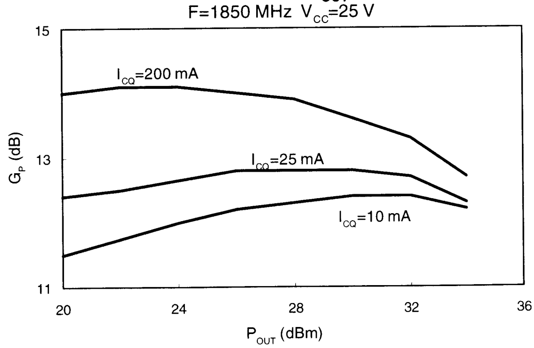
GAIN-EFFICIENCY vs FREQUENCY
P_{OUT}=2.0 W V_{CC}=25 V I_{CQ}=25 mA



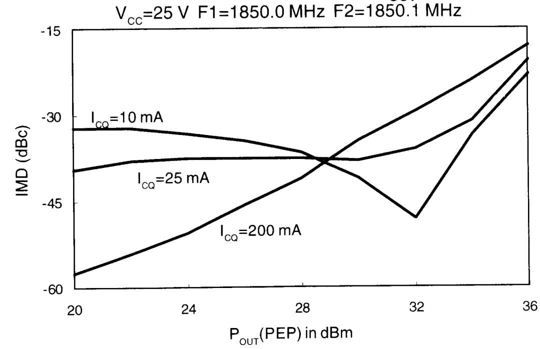
OUTPUT POWER vs COLLECTOR VOLTAGE
I_{CQ}=25 mA F=1850 MHz



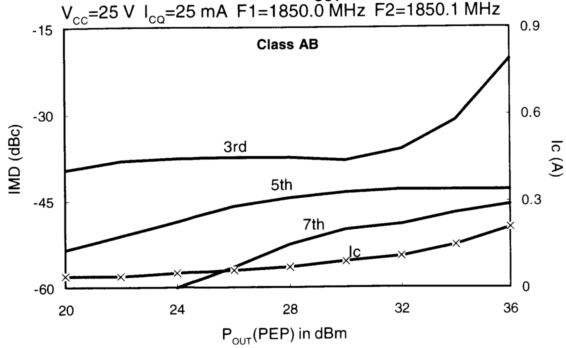
GAIN vs P_{OUT}
F=1850 MHz V_{CC}=25 V



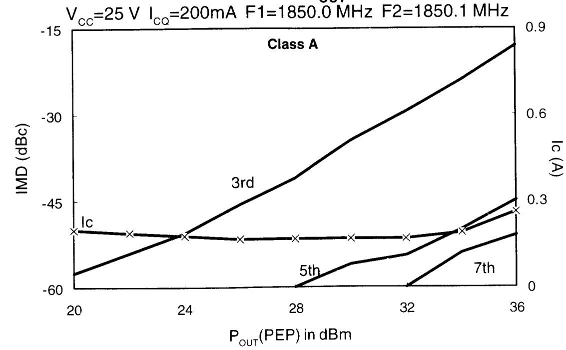
3RD ORDER IMD vs P_{OUT}
V_{CC}=25 V F1=1850.0 MHz F2=1850.1 MHz



IMD vs P_{OUT}
V_{CC}=25 V I_{CQ}=25 mA F1=1850.0 MHz F2=1850.1 MHz



IMD vs P_{OUT}
V_{CC}=25 V I_{CQ}=200mA F1=1850.0 MHz F2=1850.1 MHz



Typical S-Parameters

V_{CC}=25 V, I_{CQ}=200 mA

f(MHz)	S11 Mag	S11 Phase	S21 Mag	S21 Phase	S12 Mag	S12 Phase	S22 Mag	S22 Phase
100	1.10	171.5	23.80	120.3	0.012	- 7.4	0.32	-74.5
200	0.75	175.1	12.15	92.1	0.014	- 4.7	0.22	-89.6
300	0.79	-177.9	7.79	81.2	0.016	- 4.5	0.20	-95.7
400	0.84	-177.4	5.77	74.4	0.016	- 9.8	0.23	- 98.7
500	0.87	-178.5	4.65	68.4	0.017	- 3.7	0.26	-100.5
600	0.89	179.8	3.96	62.6	0.018	- 5.9	0.27	-101.4
700	0.89	178.3	3.49	56.7	0.018	- 0.7	0.29	-104.4
800	0.91	177.4	3.08	51.1	0.019	- 2.7	0.33	-103.3
900	0.91	175.4	2.89	45.4	0.017	- 3.4	0.36	-111.0
1000	0.91	174.1	2.74	38.9	0.019	- 0.9	0.40	-114.6
1100	0.89	171.5	2.64	28.9	0.024	- 6.1	0.46	-117.3
1200	0.87	171.7	2.45	22.8	0.024	- 13.6	0.53	-120.8
1300	0.86	170.8	2.35	15.7	0.023	- 18.3	0.57	-122.3
1400	0.86	170.3	2.32	7.6	0.026	- 21.1	0.63	-145.5
1450	0.85	170.1	2.30	3.4	0.026	- 22.9	0.65	-126.2
1500	0.84	169.9	2.27	-1.2	0.025	- 22.3	0.66	-127.6
1550	0.83	169.7	2.26	-6.4	0.026	- 31.0	0.68-	129.1
1600	0.82	169.7	2.24	-11.5	0.030	- 37.3	0.71	-131.9
1650	0.82	170.0	2.22	-16.6	0.029	- 43.2	0.72	-133.6
1700	0.81	170.5	2.19	-22.4	0.027	- 48.5	0.73	-137.6
1750	0.80	171.1	2.14	-28.4	0.025	- 52.2	0.76	-140.1
1800	0.80	171.5	2.11	-35.5	0.026	- 60.2	0.76	-143.9
1850	0.80	171.9	2.05	-40.7	0.027	- 60.1	0.81	-147.5
1900	0.81	172.6	1.99	-47.4	0.024	- 67.1	0.81	-150.1
2000	0.82	173.6	1.83	-60.7	0.024	- 80.8	0.86	-155.5
2100	0.84	174.5	1.61	-74.0	0.020	- 94.0	0.88	-160.0
2200	0.88	174.2	1.40	-84.6	0.019	-104.7	0.87	-164.5
2300	0.90	173.6	1.21	-94.7	0.016	-128.7	0.86	-168.1

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an AMP company

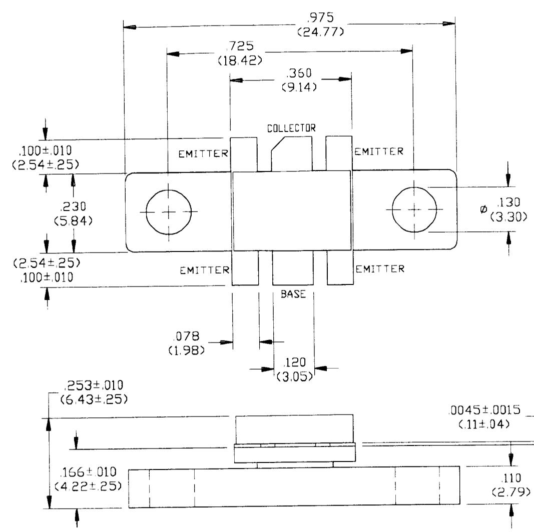
Wireless Bipolar Power Transistor, 4W
1.78 - 1.90 GHz

PH1819-4N

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Designed for Linear Amplifier Applications
- Class AB: -34 dBc Typ 3rd IMD at 4 Watts PEP
- Class A: +44 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting
- Gold Metallization System



Absolute Maximum Ratings at 25°C

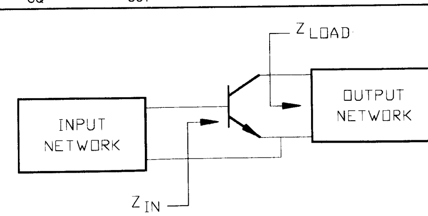
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.7	A
Power Dissipation	P_D	19.5	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	7.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=24 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=5 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=2.5 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=0.1 A
Power Gain	G_P	10	-	dB	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1850 MHz, ΔF=100 kHz
Collector Efficiency	η_C	25	-	%	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1850 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1850 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1850 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=26 V, I_{CQ}=20 mA, P_{OUT}=4 W PEP, F=1850 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
1780	3.5 + j9.3	3.5 + j5.6
1850	3.1 + j9.2	4.5 + j5.2
1900	3.3 + j8.9	4.8 + j5.5



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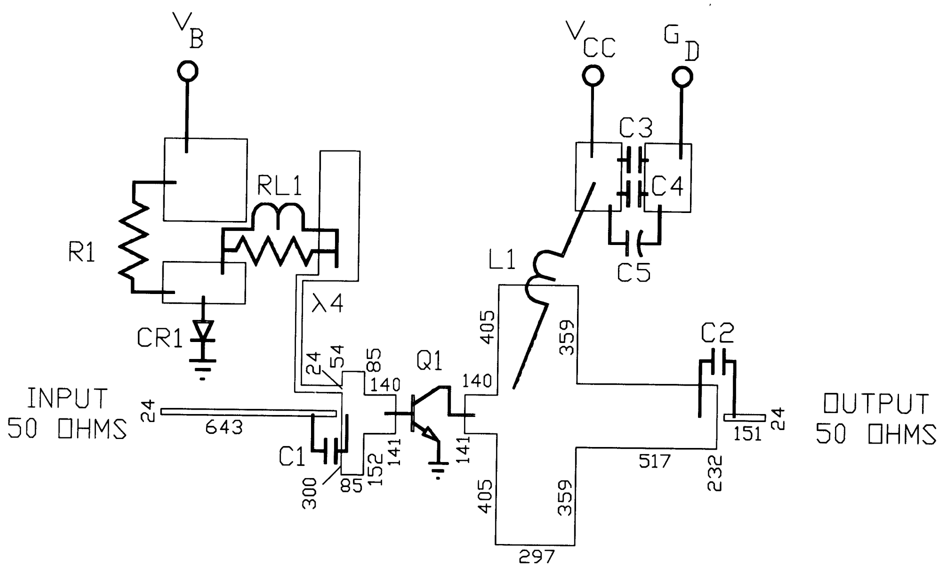
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3	33 pF ATC SIZE A
C4	5000 pF CHIP
C5	50 uF 50 VOLTS
CR1	1N4245 DIODE
L1	5 TURNS OF NO. 20 AWG ON .160″ DIA
R1	4.7 OHMS 1/4 WATT
RL1	7 TURNS OF NO. 24 AWG ON 3 OHM 1/4 WATT
Q1	PH1819-4N
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

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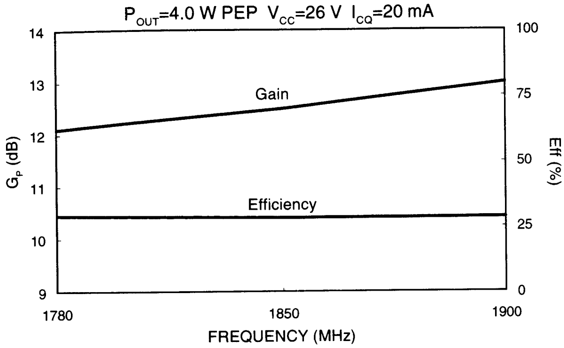
Typical Broadband Performance Curves

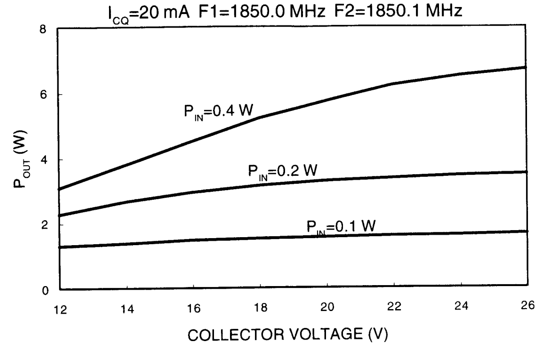
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=4.0 W PEP V_{CC}=26 V I_{CQ}=20 mA



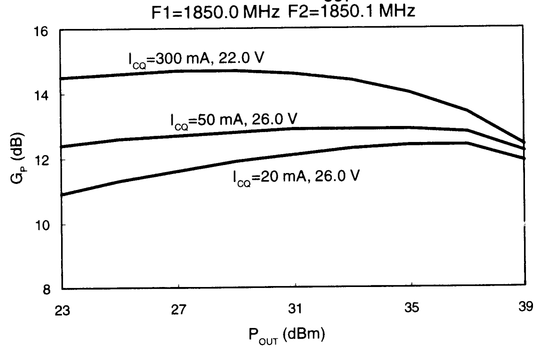
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=20 mA F1=1850.0 MHz F2=1850.1 MHz



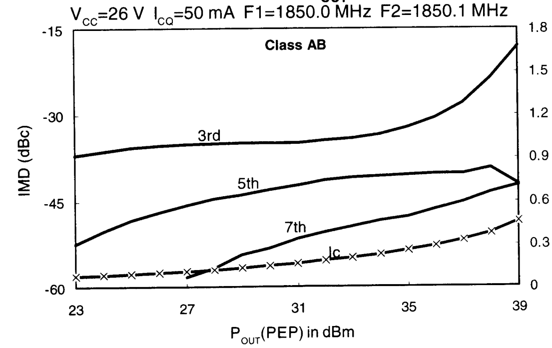
GAIN vs P_{OUT}

F1=1850.0 MHz F2=1850.1 MHz



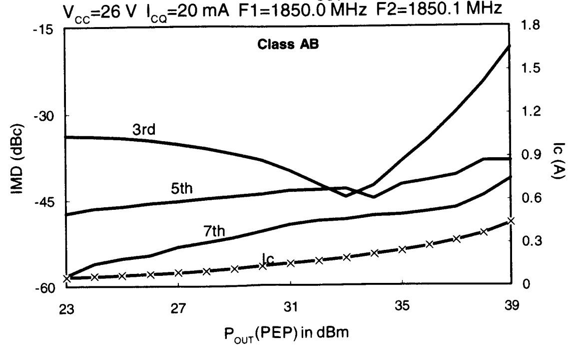
IMD vs P_{OUT}

V_{CC}=26 V I_{CQ}=50 mA F1=1850.0 MHz F2=1850.1 MHz



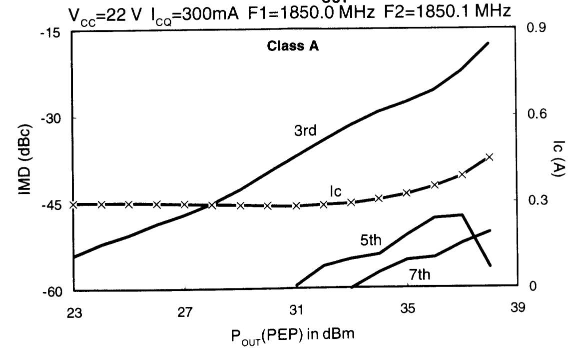
IMD vs P_{OUT}

V_{CC}=26 V I_{CQ}=20 mA F1=1850.0 MHz F2=1850.1 MHz



IMD vs P_{OUT}

V_{CC}=22 V I_{CQ}=300mA F1=1850.0 MHz F2=1850.1 MHz



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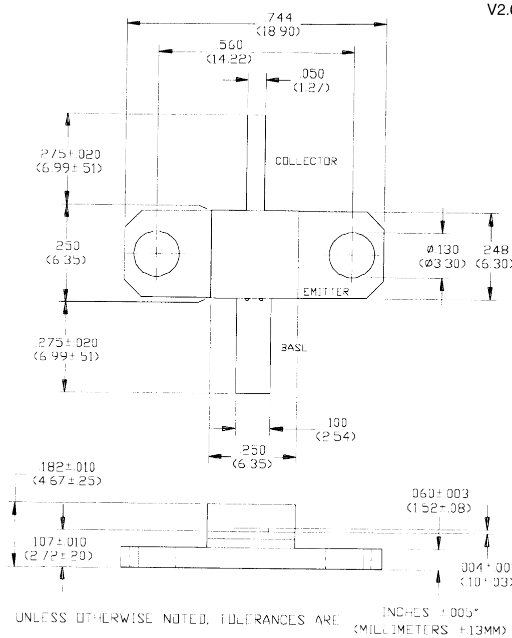
Wireless Bipolar Power Transistor, 10W
1.78 - 1.90 GHz

PH1819-10

V2.00

Features

- Designed for Cellular Base Station Applications
- -30 dBc Typ 3rd IMD at 10 Watts PEP
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting



Absolute Maximum Ratings at 25°C

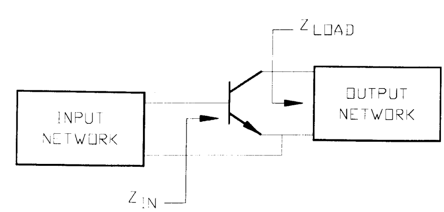
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	65	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	3.0	A
Power Dissipation	P_D	44	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	4.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=25 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	20	-	V	I_C=10 mA
Collector-Emitter Breakdown Voltage	BV_{CER}	30	-	V	I_C=10 mA, R_{BE}=220 Ω
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=10 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=250 mA
Power Gain	G_P	9.0	-	dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78 - 1.90 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78 - 1.90 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78 - 1.90 GHz
Load Mismatch Tolerance	VSWR	-	3.0:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78 - 1.90 GHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W PEP, F=1850 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(GHz)	Z_{IN}(Ω)	Z_{LOAD}(Ω)
1.78	4.5 + j7.0	2.5 + j0.2
1.85	5.0 + j7.3	2.5 + j0
1.90	6.0 + j6.1	2.6 + 0.2



Specifications Subject to Change Without Notice.

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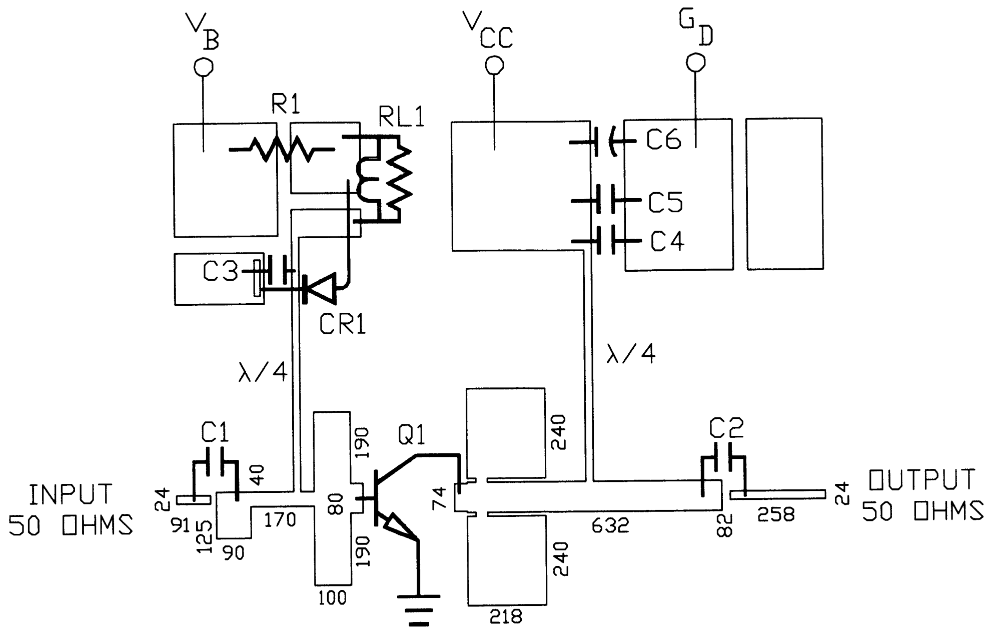
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2 C3 C4	33 pF ATC SIZE A
C5	5000 pF
C6	50 uF 50 VOLTS
CR1	1N4245 DIODE
Q1	PH1819-10
R1	5.1 OHMS 1/4 WATT
RL1	6T/NO. 24 AWG ON 3 OHM 1/4 WATT
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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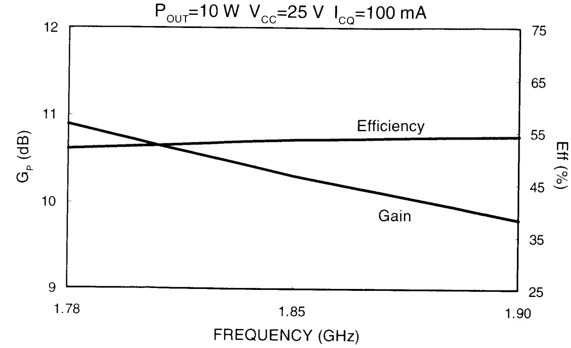
Typical Broadband Performance Curves

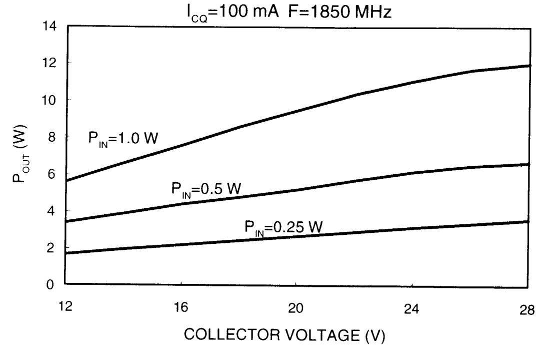
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=10 W V_{CC}=25 V I_{CQ}=100 mA



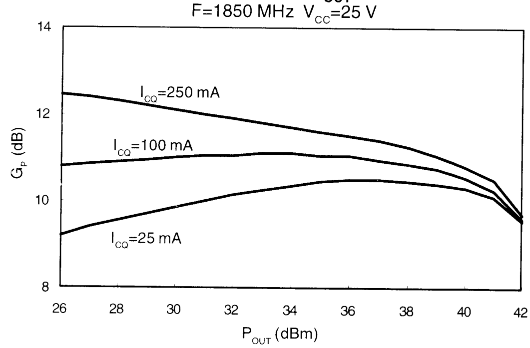
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=100 mA F=1850 MHz



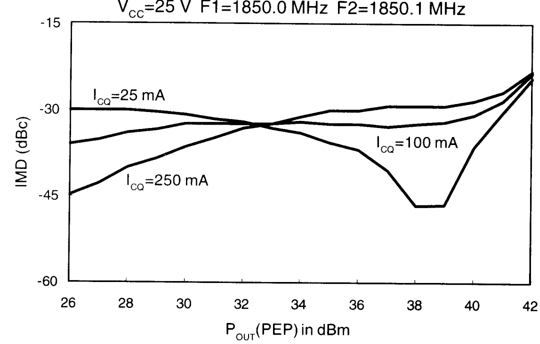
GAIN vs P_{OUT}

F=1850 MHz V_{CC}=25 V



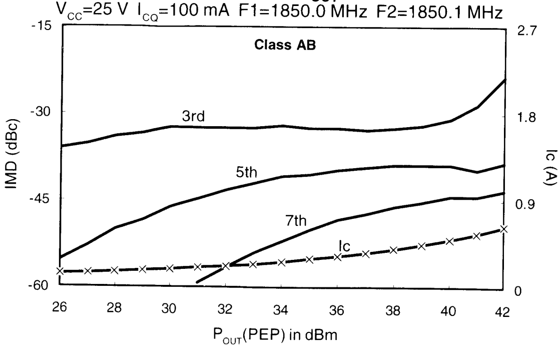
3RD ORDER IMD vs P_{OUT}

V_{CC}=25 V F1=1850.0 MHz F2=1850.1 MHz



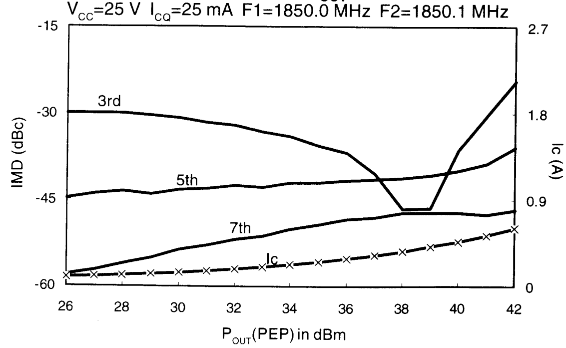
IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=100 mA F1=1850.0 MHz F2=1850.1 MHz



IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=25 mA F1=1850.0 MHz F2=1850.1 MHz



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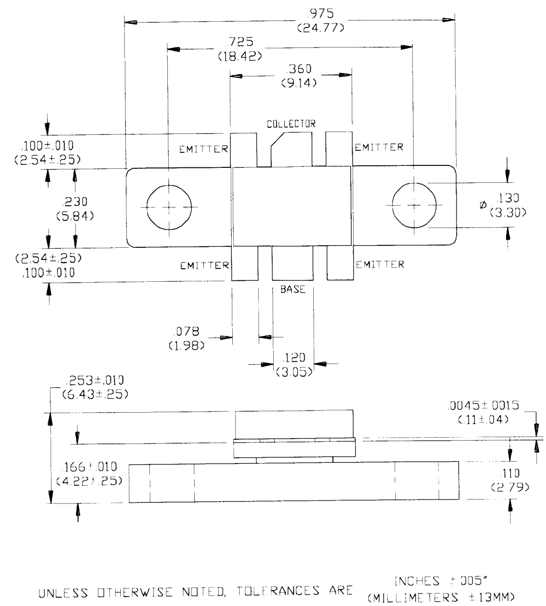
M/A-COM
an AMP company

Wireless Bipolar Power Transistor, 15W
1.78 - 1.90 GHz
PH1819-15N

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Designed for Linear Amplifier Applications
- Class AB: -34 dBc Typ 3rd IMD at 15 Watts PEP
- Class A: +48 dBm Typ 3rd Order Intercept Point
- Common Emitter Configuration
- Internal Input Impedance Matching
- Diffused Emitter Ballasting
- Gold Metallization System



Absolute Maximum Ratings at 25°C

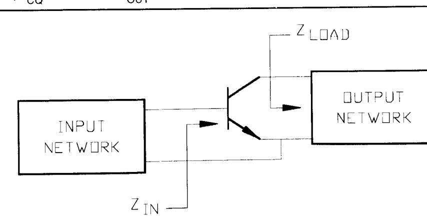
Parameter	Symbol	Rating	Units
Collector-Base Voltage	V_{CBO}	60	V
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	2.0	A
Power Dissipation	P_D	58	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=24 V
Collector-Emitter Breakdown Voltage	BV_{CEO}	24	-	V	I_C=10 mA
Emitter-Base Breakdown Voltage	BV_{EBO}	3.0	-	V	I_B=10 mA
DC Forward Current Gain	h_{FE}	15	120	-	V_{CE}=5 V, I_C=0.5 A
Power Gain	G_P	7.0	-	dB	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=15 W PEP, F=1880 MHz, ΔF=100 kHz
Collector Efficiency	η_C	25	-	%	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=15 W PEP, F=1880 MHz, ΔF=100 kHz
Input Return Loss	RL	10	-	dB	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=15 W PEP, F=1880 MHz, ΔF=100 kHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=15 W PEP, F=1880 MHz, ΔF=100 kHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=26 V, I_{CQ}=25 mA, P_{OUT}=15 W PEP, F=1880 MHz, ΔF=100 kHz

Typical Optimum Device Impedances

F(MHz)	$Z_{IN}(\Omega)$	$Z_{LOAD}(\Omega)$
1780	10.5 + j12.3	1.6 - j1.9
1850	11.4 + j11	1.6 - j2.2
1880	11.9 + j6.2	1.6 - j2.5
1880	9.9 + j3.6	1.6 - j2.7
1900	8.8 + j1.9	1.4 - j2.7



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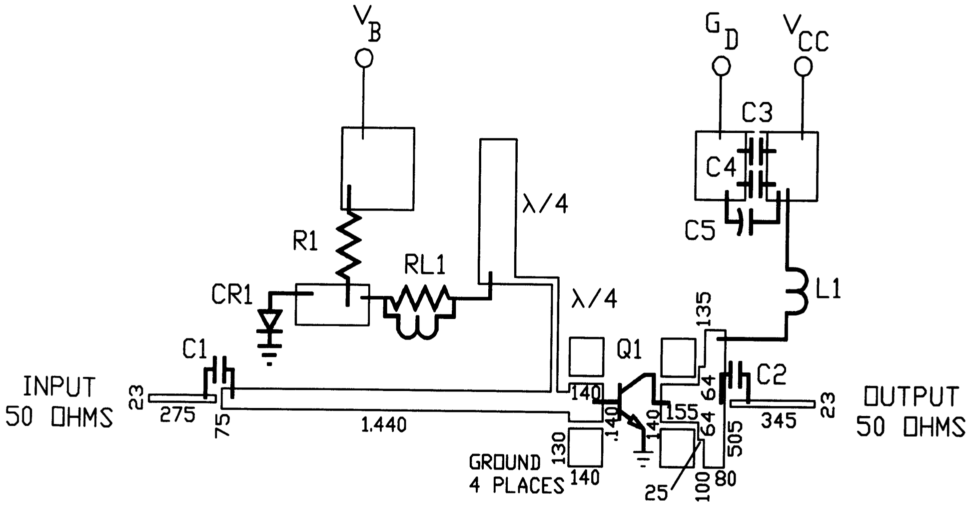
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C4	20pF ATC SIZE A CAPACITOR
C2	2.2pF ATC SIZE A CAPACITOR
C3	5000pF CHIP CAPACITOR
C5	50 VOLT 50uF ELECTROLYTIC CAPACITOR
CR1	1N5417 DIODE
L1	10 TURNS OF NO. 22 AWG ON .125' DIA
Q1	PH1819-15N
R1	4.7 OHM 1/4 WATT RESISTOR
RL1	13 TURNS OF NO. 26 AWG ON 3 OHM 1/4 WATT RESISTOR
BOARD TYPE	ROGERS 6010.5 .025' THICK, E_R = 10.5

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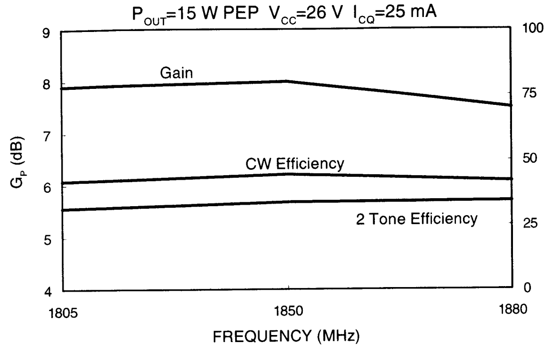
Typical Broadband Performance Curves

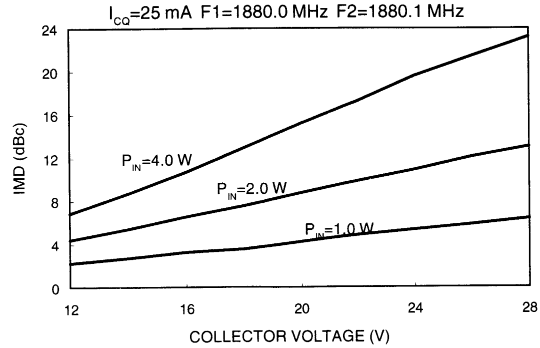
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=15 W PEP V_{CC}=26 V I_{CQ}=25 mA



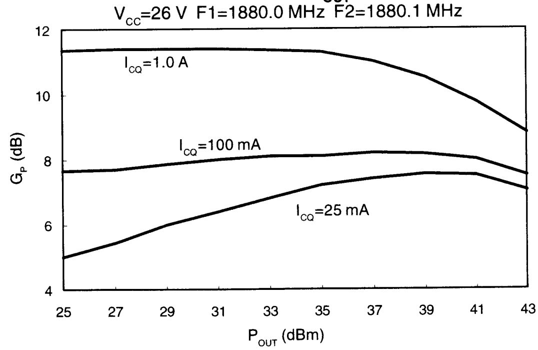
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=25 mA F1=1880.0 MHz F2=1880.1 MHz



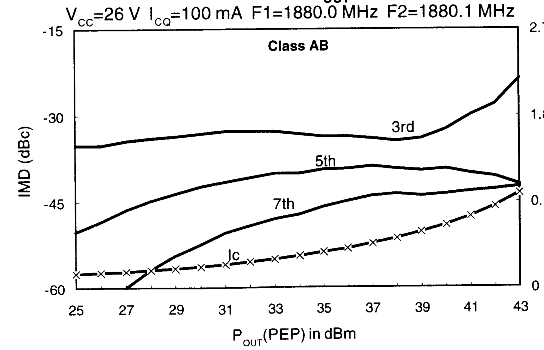
GAIN vs P_{OUT}

V_{CC}=26 V F1=1880.0 MHz F2=1880.1 MHz



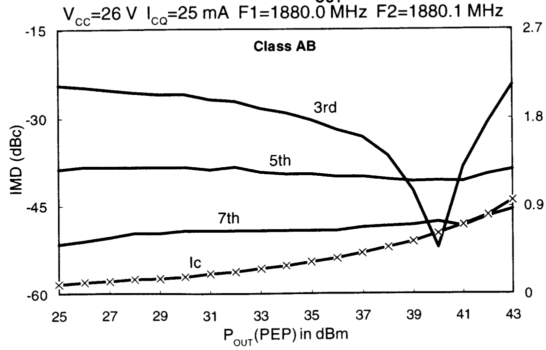
IMD vs P_{OUT}

V_{CC}=26 V I_{CQ}=100 mA F1=1880.0 MHz F2=1880.1 MHz



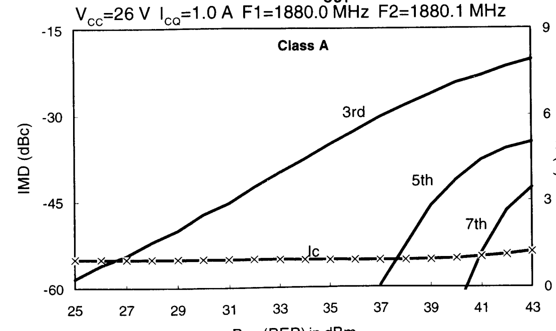
IMD vs P_{OUT}

V_{CC}=26 V I_{CQ}=25 mA F1=1880.0 MHz F2=1880.1 MHz



IMD vs P_{OUT}

V_{CC}=26 V I_{CQ}=1.0 A F1=1880.0 MHz F2=1880.1 MHz



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an AMP company

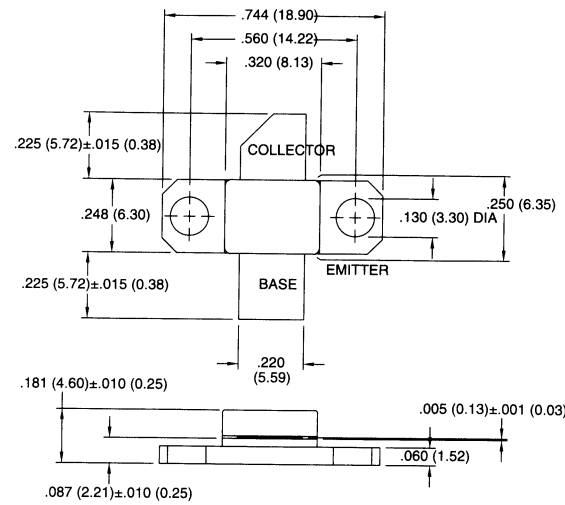
Wireless Power Transistor, 33W
1805 - 1880 MHz

PH1819-33

V2.01

Features

- NPN Silicon Microwave Power Transistor
- Common Emitter Class AB Operation
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting
- Gold Metallization System



Absolute Maximum Ratings at 25°C

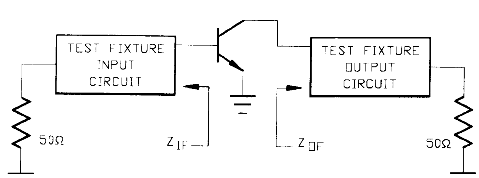
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CEO}	25	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	4.7	A
Power Dissipation	P_D	91	W
Storage Temperature	T_{STG}	-55 to +150	°C
Junction Temperature	T_J	200	°C
Thermal Resistance	θ_{JC}	3.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Power Gain	G_P	7.0	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805, 1880 MHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805, 1880 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805, 1880 MHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805, 1880 MHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1805	1.8 - j5.5	4.0 - j1.4
1850	1.6 - j5.1	3.9 - j1.4
1880	1.7 - j4.8	4.0 - j0.9



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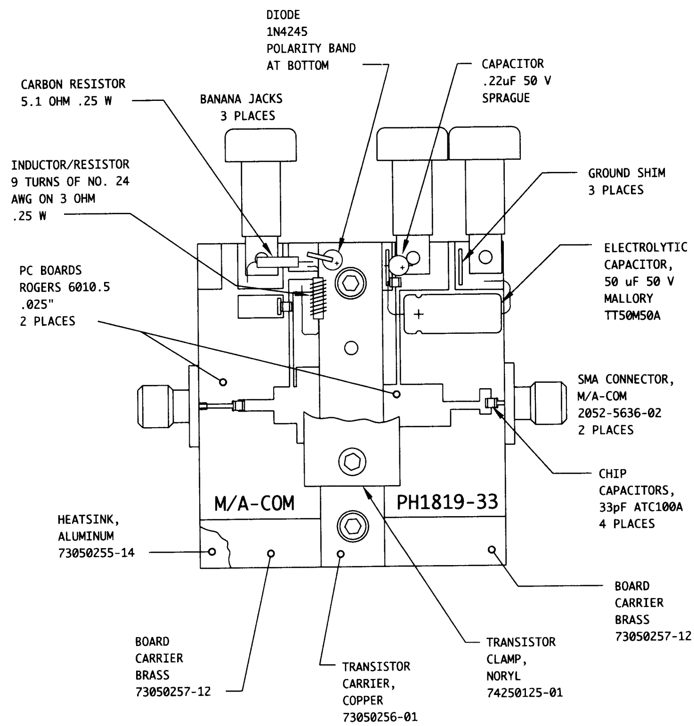
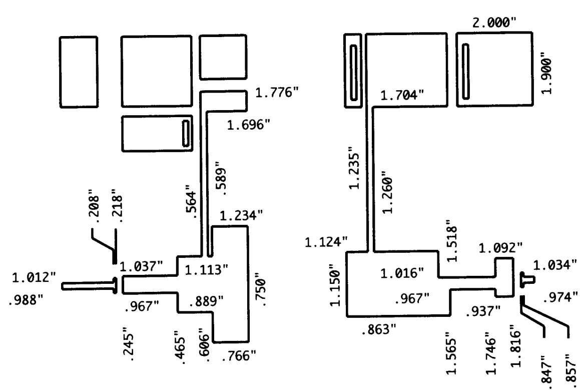
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM
an AMP company

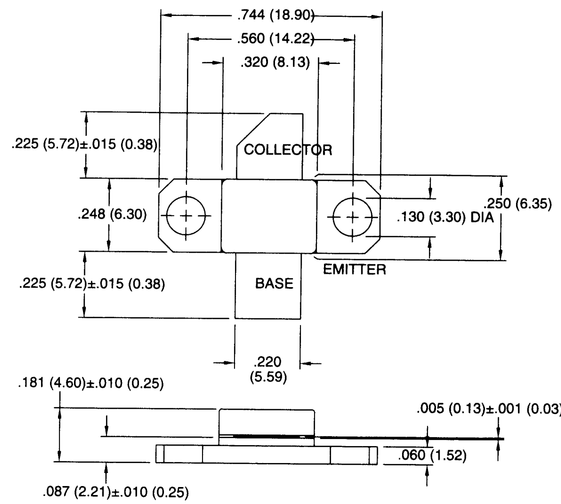
Wireless Bipolar Power Transistor, 33W
1930 - 1990 MHz

PH1920-33

V2.01

Features

- NPN Silicon Microwave Power Transistor
- Common Emitter Class AB Operation
- Internal Input and Output Impedance Matching
- Diffused Emitter Ballasting
- Gold Metallization System



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±0.13MM)

Absolute Maximum Ratings at 25°C

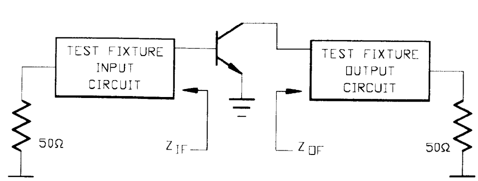
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CEO}	25	V
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	4.7	A
Power Dissipation	P_D	91	W
Storage Temperature	T_{STG}	-55 to +150	°C
Junction Temperature	T_J	200	°C
Thermal Resistance	θ_{JC}	1.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Power Gain	G_P	7.0	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1930, 1990 MHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1930, 1990 MHz
Input Return Loss	RL	10	-	dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1930, 1990 MHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1930, 1990 MHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
1930	2.6 - j2.6	3.3 - j1.1
1960	2.5 - j2.5	3.8 - j1.0
1990	2.4 - j2.3	4.1 - j0.8



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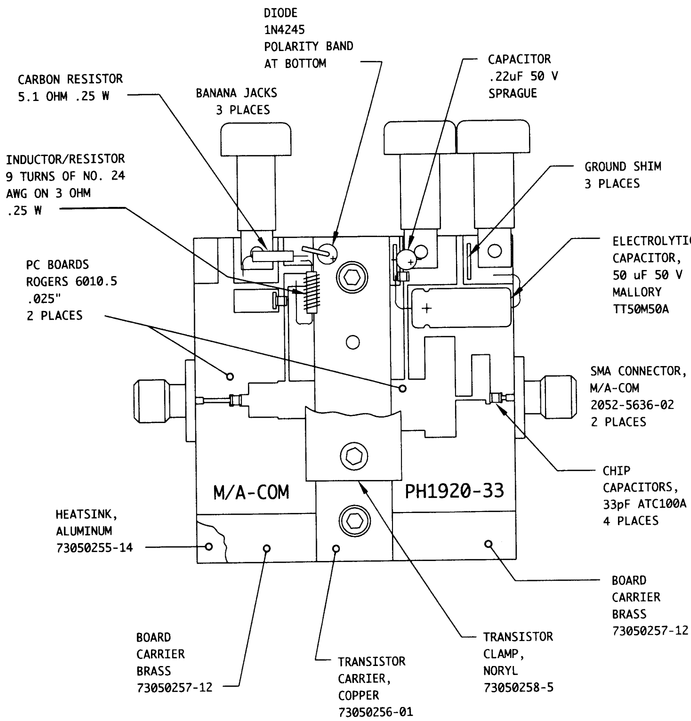
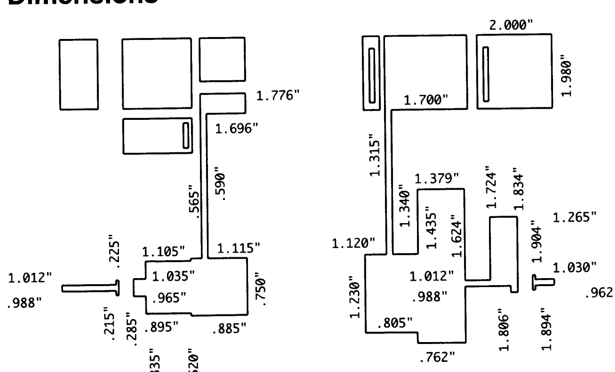
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

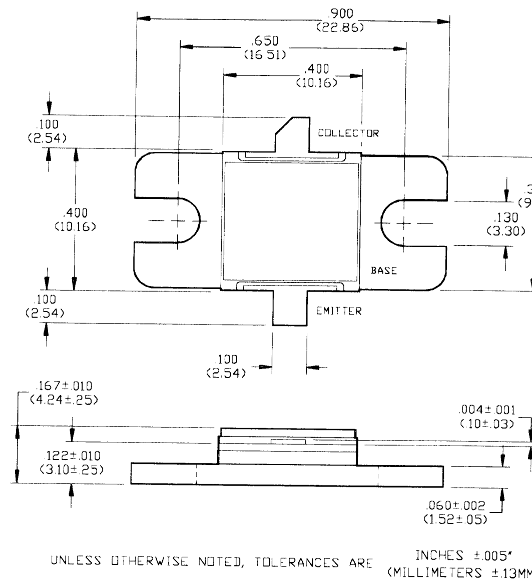
Radar Pulsed Power Transistor, 50W, 100µs Pulse, 10% Duty 2.2 - 2.6 GHz

PH2226-50M

V2.00

Features

- NPN Silicon Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

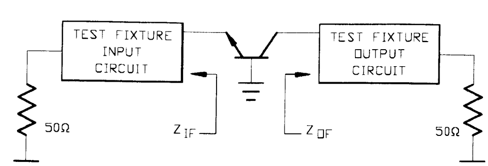
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	63	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	6	A
Total Power Dissipation	P_{TOT}	159	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	63	-	V	I_C=15 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	1.1	°C/W	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz
Output Power	P_{OUT}	50	-	W	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz
Power Gain	G_P	8	-	dB	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=8 W, F=2.2, 2.4, 2.6 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
2.25	15.0 - j7.0	12.8 - j3.0
2.40	14.0 - j5.5	12.0 - j1.6
2.55	13.7 - j4.0	11.8 - j0.4



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an AMP company

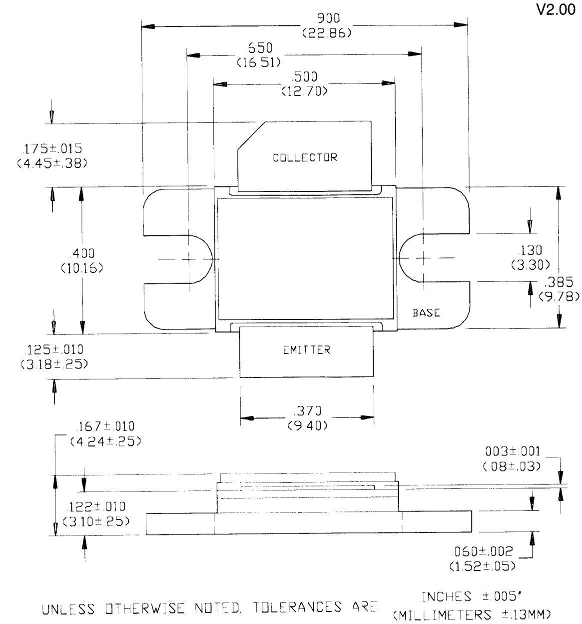
Radar Pulsed Power Transistor, 110W, 100μs Pulse, 10% Duty 2.25 - 2.55 GHz

PH2226-110M

V2.00

Features

- NPN Silicon Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

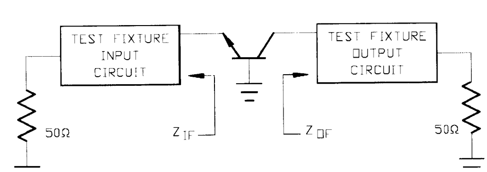
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	63	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	15	A
Total Power Dissipation	P_{TOT}	583	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	63	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.3	°C/W	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz
Output Power	P_{OUT}	110	-	W	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz
Power Gain	G_P	8	-	dB	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=18 W, F=2.2, 2.4, 2.6 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
2.25	2.8 - j3.4	4.1 - j2.9
2.40	2.9 - j3.0	3.8 - j2.9
2.55	3.1 - j2.6	3.3 - j2.7



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M/A-COM an AMP company

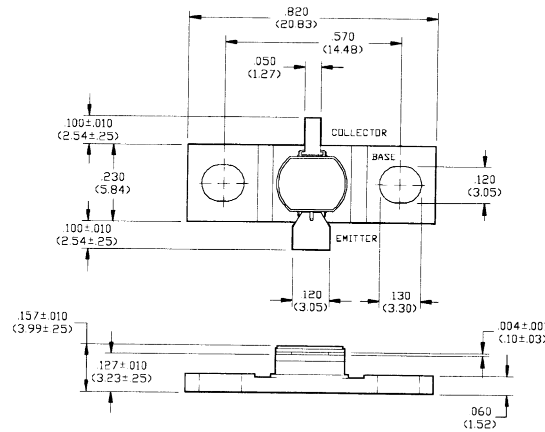
CW Power Transistor, 1W
2.3 GHz

PH2323-1

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

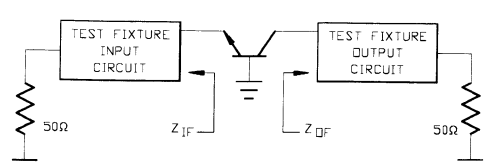
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.2	A
Power Dissipation	P_D	7.0	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	25	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=2.5 mA
Collector-Emitter Leakage Current	I_{CES}	-	0.5	mA	V_{CE}=28 V
Input Power	P_{IN}	-	0.158	W	V_{CC}=28 V, P_{OUT}=1.0 W, F=2.3 GHz
Power Gain	G_P	8	-	dB	V_{CC}=28 V, P_{OUT}=1.0 W, F=2.3 GHz
Collector Efficiency	η_C	30	-	%	V_{CC}=28 V, P_{OUT}=1.0 W, F=2.3 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=1.0 W, F=2.3 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=1.0 W, F=2.3 GHz

Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.30	12.5 - j26.0	3.7 + j10.4



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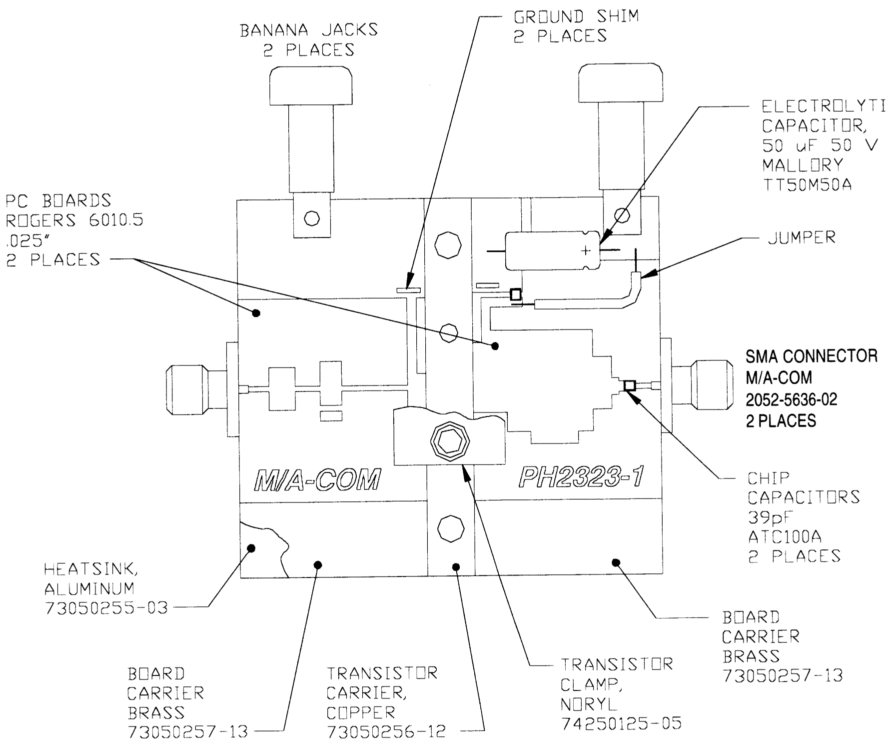
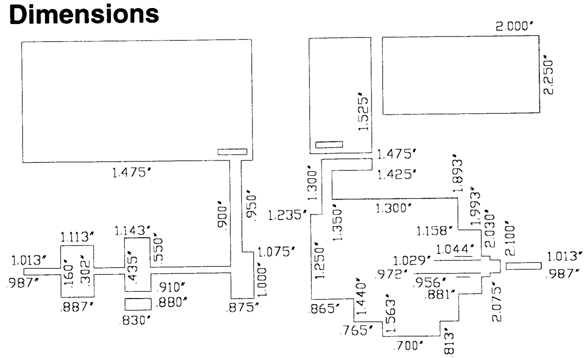
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

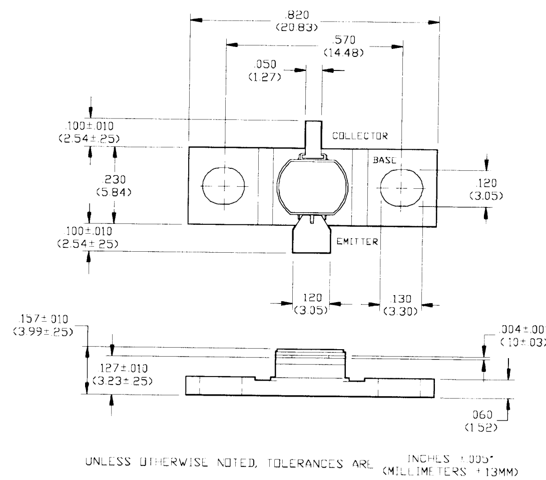
CW Power Transistor, 3.5W
2.3 GHz

PH2323-3

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

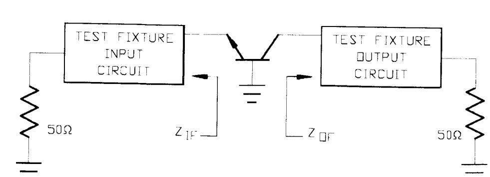
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.4	A
Power Dissipation	P_D	11	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	15	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=28 V
Input Power	P_{IN}	-	0.48	W	V_{CC}=28 V, P_{OUT}=3.0 W, F=2.3 GHz
Power Gain	G_P	8	-	dB	V_{CC}=28 V, P_{OUT}=3.0 W, F=2.3 GHz
Collector Efficiency	η_C	30	-	%	V_{CC}=28 V, P_{OUT}=3.0 W, F=2.3 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=3.0 W, F=2.3 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=3.0 W, F=2.3 GHz

Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.30	6.5 - j23.0	6.3 + j5.4



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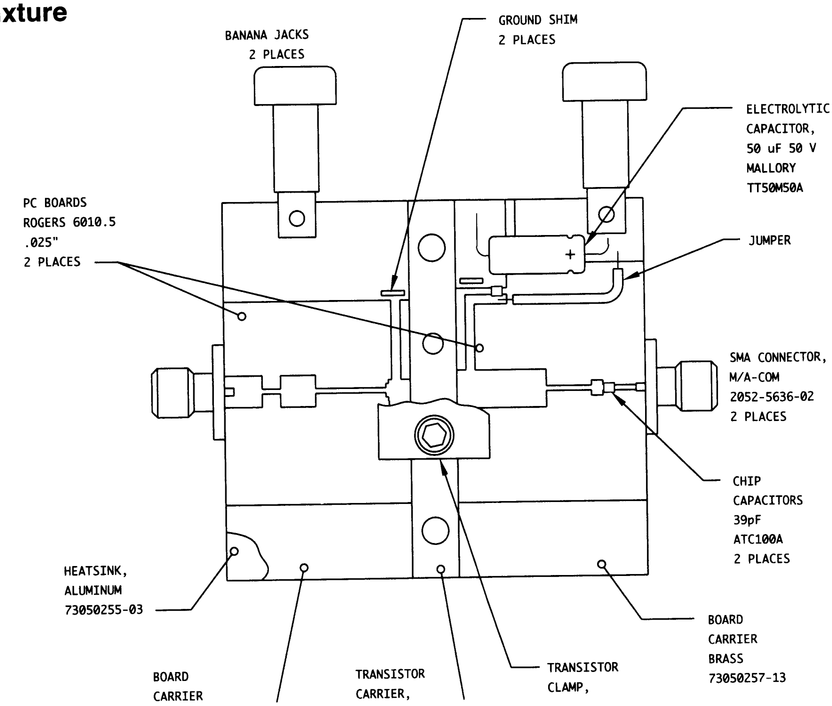
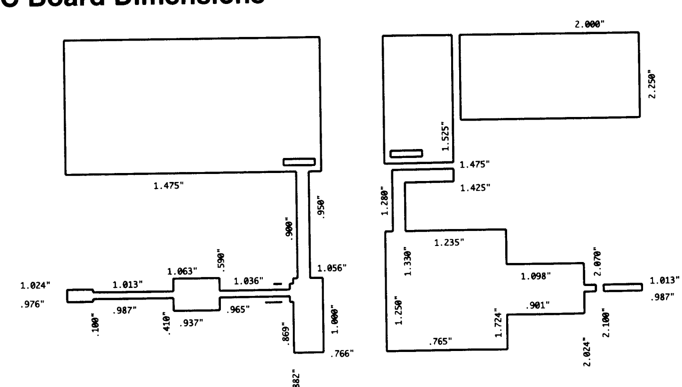
RF vTest Fixture



Test Fixture PC Board Dimensions



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an AMP company

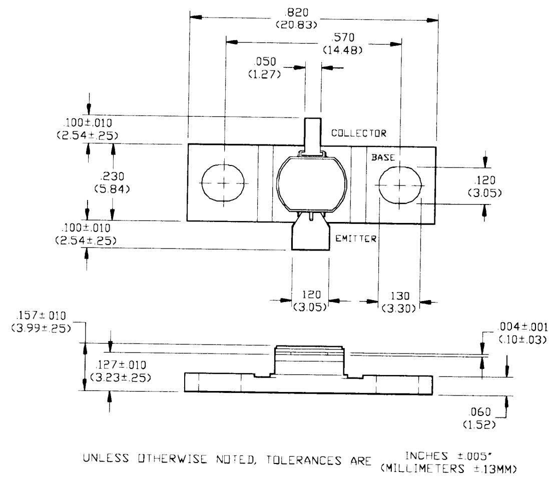
CW Power Transistor, 5W 2.3 GHz

PH2323-5

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Class C Operation
- Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

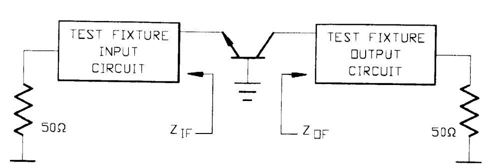
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.8	A
Power Dissipation	P_D	25	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	7.0	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=28 V
Input Power	P_{IN}	-	0.79	W	V_{CC}=28 V, P_{OUT}=5.0 W, F=2.3 GHz
Power Gain	G_P	8	-	dB	V_{CC}=28 V, P_{OUT}=5.0 W, F=2.3 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=28 V, P_{OUT}=5.0 W, F=2.3 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=28 V, P_{OUT}=5.0 W, F=2.3 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=28 V, P_{OUT}=5.0 W, F=2.3 GHz

Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.30	3.5 - j17.0	4.0 + j0.3



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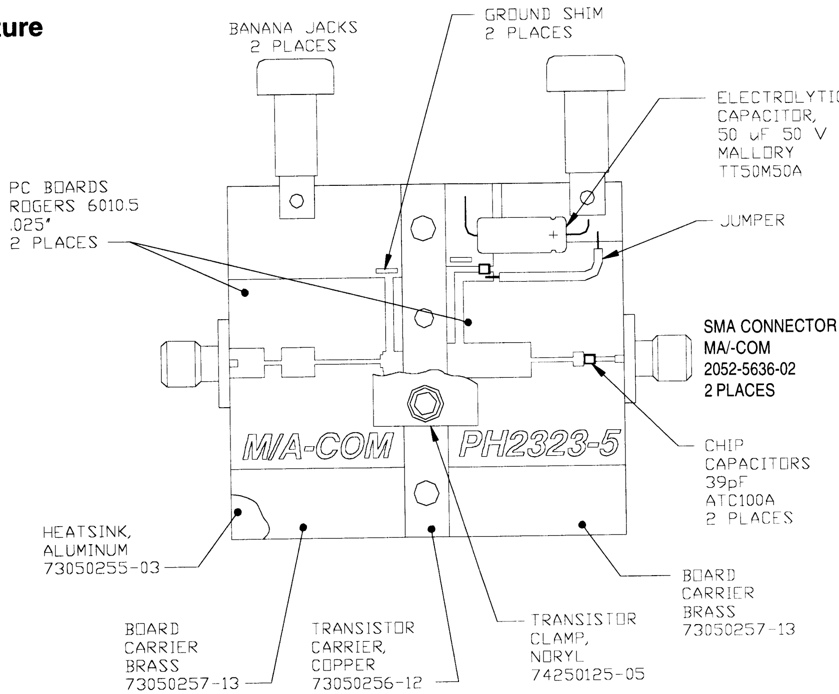
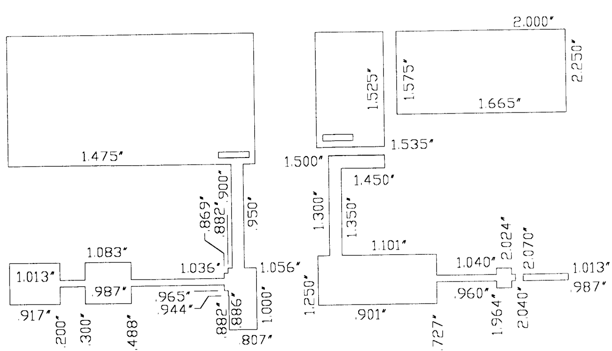
RF Test Fixture



Test Fixture PC Board Dimensions



M/A-COM an AMP company

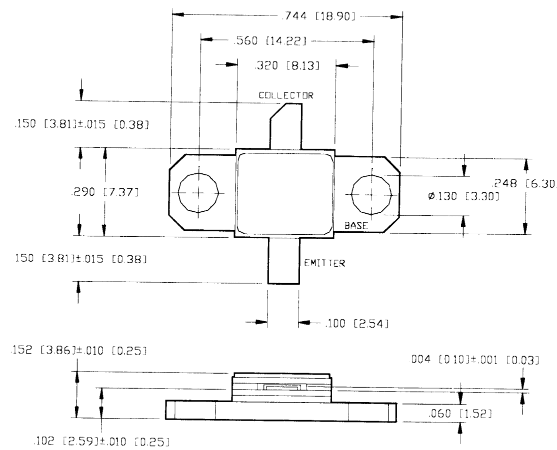
CW Power Transistor, 14W 2.3 GHz

PH2323-14

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Class C Operation
- Interdigitated Geometry
- Gold Metalization System
- Hermetic Metal/Ceramic Package
- Diffused Emitter Ballasting Resistors
- Internal Input and Output Impedance Matching



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Absolute Maximum Ratings at 25°C

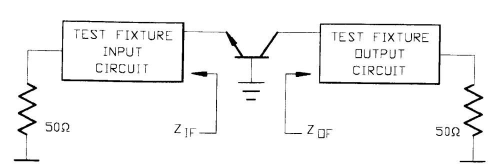
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current	I_C	0.8	A
Power Dissipation	P_D	25	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C
Thermal Resistance	θ_{JC}	4.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	2.0	mA	V_{CE}=28 V
Output Power	P_{OUT}	14	-	W	V_{CC}=28 V, P_{IN}=2.5 W, F=2.3 GHz
Power Gain	G_P	7.6	-	dB	V_{CC}=28 V, P_{IN}=2.5 W, F=2.3 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=28 V, P_{IN}=2.5 W, F=2.3 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=28 V, P_{IN}=2.5 W, F=2.3 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=28 V, P_{IN}=2.5 W, F=2.3 GHz

Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.30	4.1 - j8.5	11.0 + j4.0



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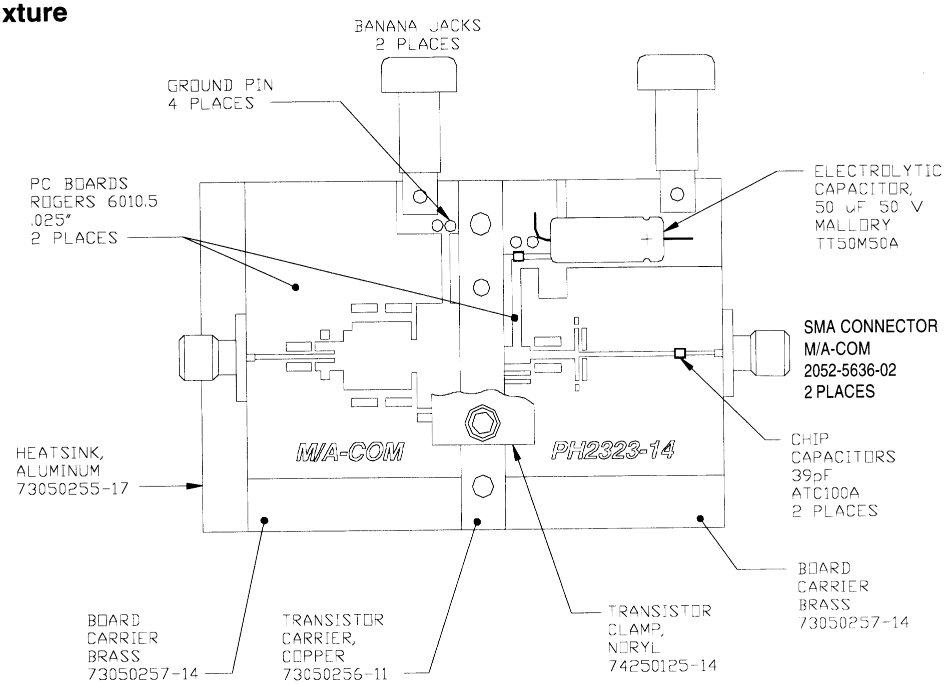
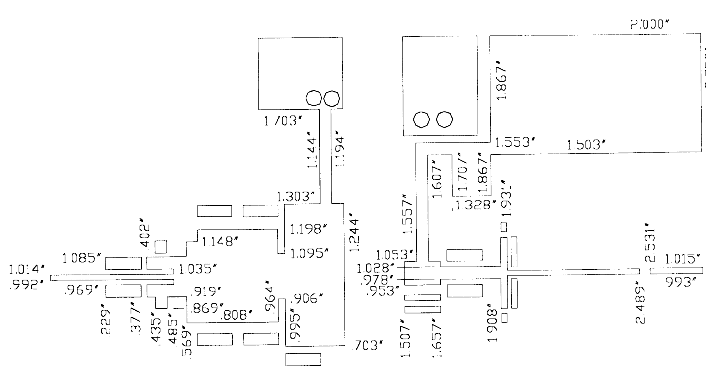
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

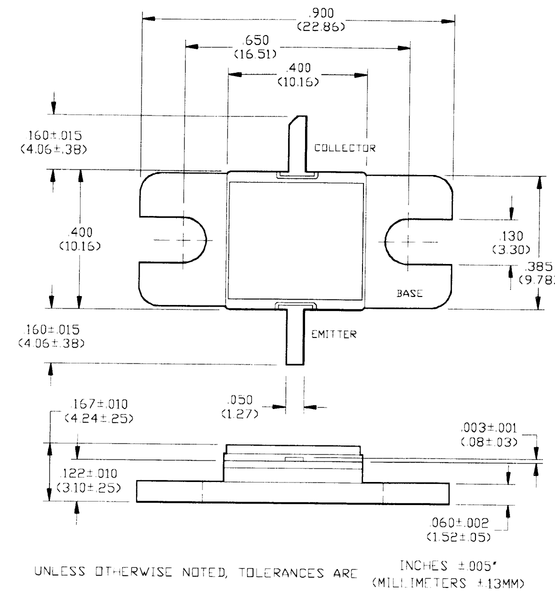
Radar Pulsed Power Transistor, 25W, 100µs Pulse, 10% Duty 2.7 - 2.9 GHz

PH2729-25M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

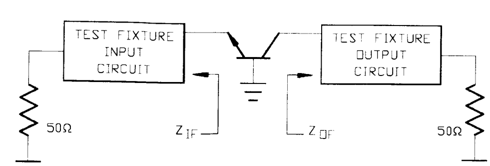
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	4.0	A
Total Power Dissipation	P_{TOT}	120	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.25	°C/W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Output Power	P_{OUT}	25	-	W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Power Gain	G_P	9.2	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
2.70	38 - j14.4	17 + j8.7
2.80	35 - j16.3	15 + j8.7
2.90	33 - j17.8	13.3 + j8.3



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M/A-COM, Inc.

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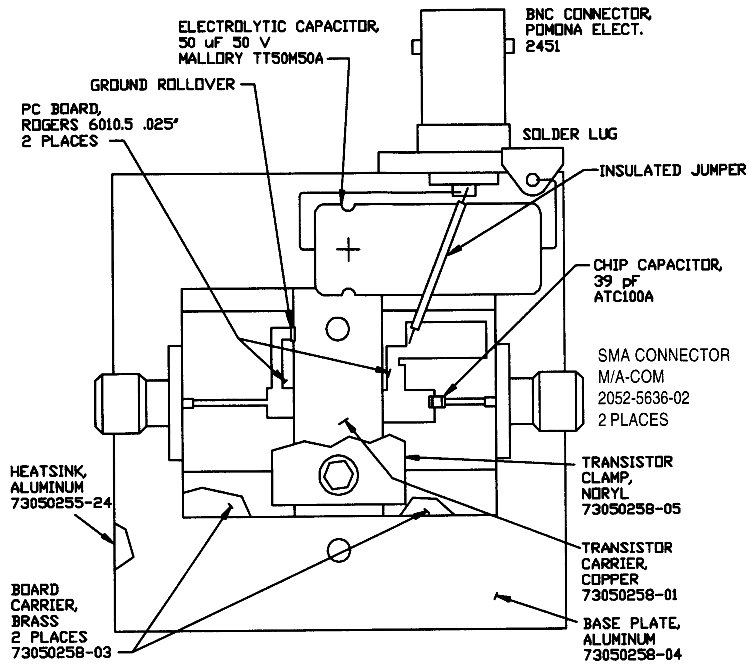
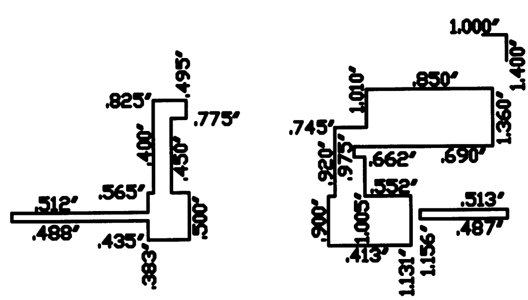
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

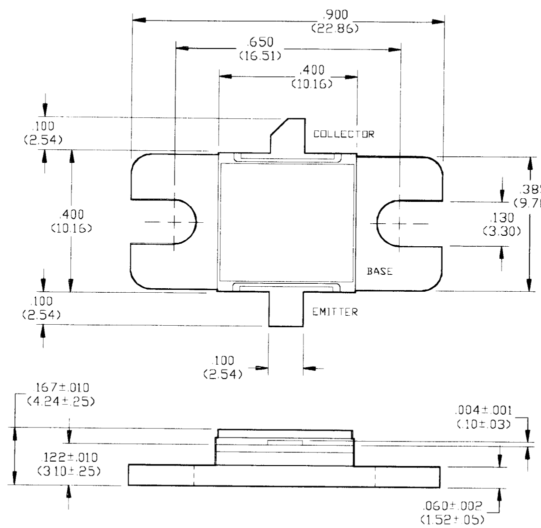
Radar Pulsed Power Transistor, 8.5W, 100μs Pulse, 10% Duty 2.7 - 2.9 GHz

PH2729-8.5M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

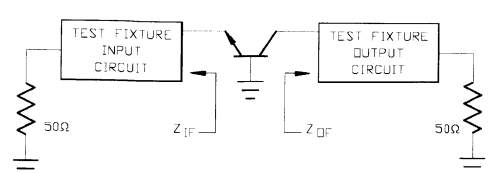
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.8	A
Total Power Dissipation	P_{TOT}	65	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	2.2	°C/W	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz
Output Power	P_{OUT}	8.5	-	W	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz
Power Gain	G_P	8.1	-	dB	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=1.3 W, F=2.7, 2.8, 2.9 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.70	40 - j12	25 + j3.5
2.80	38 - j14	20 + j2.0
2.90	35 - j16	16 + j2.4



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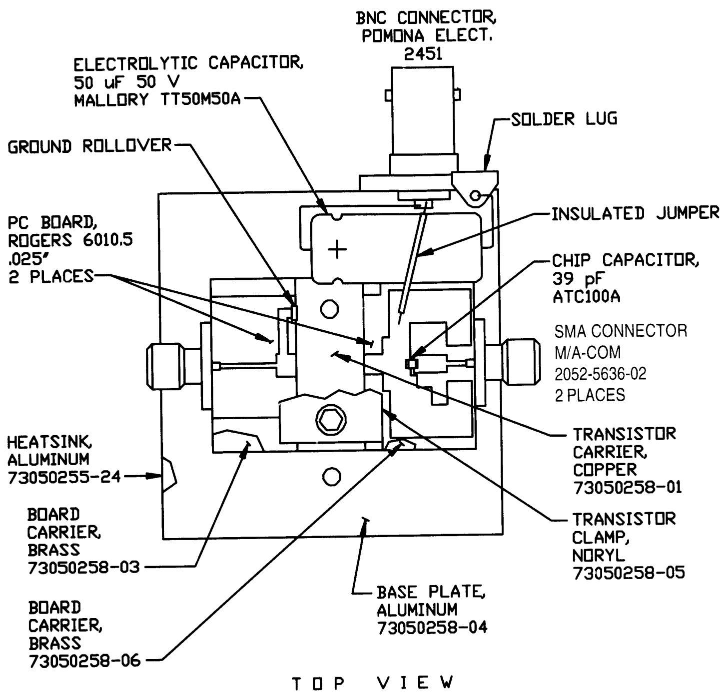
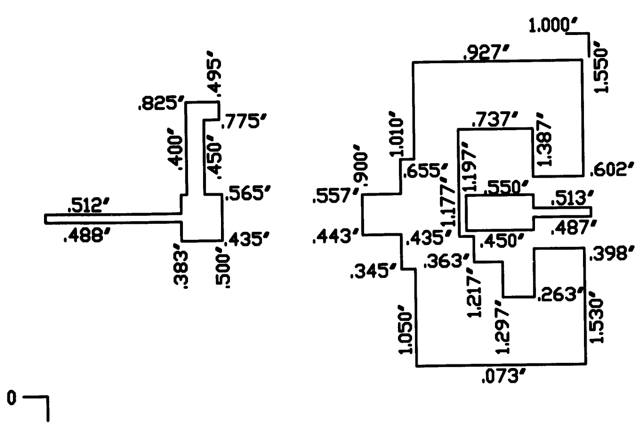
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

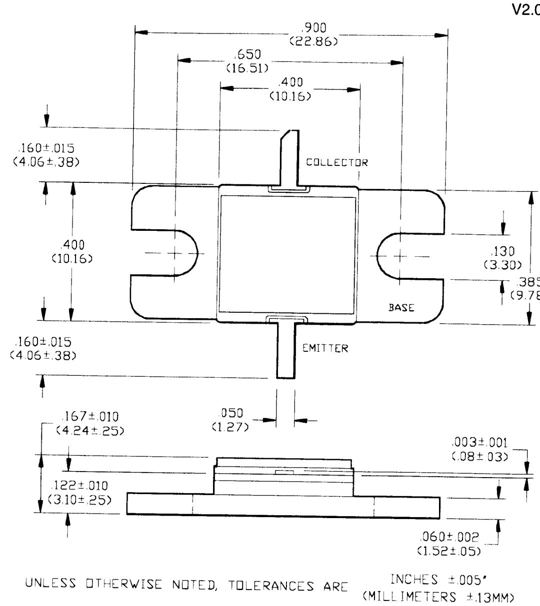
Radar Pulsed Power Transistor, 25W, 100μs Pulse, 10% Duty 2.7 - 2.9 GHz

PH2729-25M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

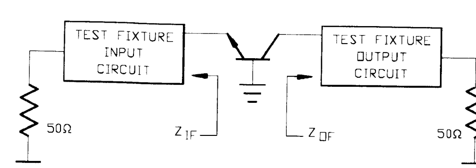
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	4.0	A
Total Power Dissipation	P_{TOT}	120	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.25	°C/W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Output Power	P_{OUT}	25	-	W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Power Gain	G_P	9.2	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.8, 2.9 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.70	38 - j14.4	17 + j8.7
2.80	35 - j16.3	15 + j8.7
2.90	33 - j17.8	13.3 + j8.3



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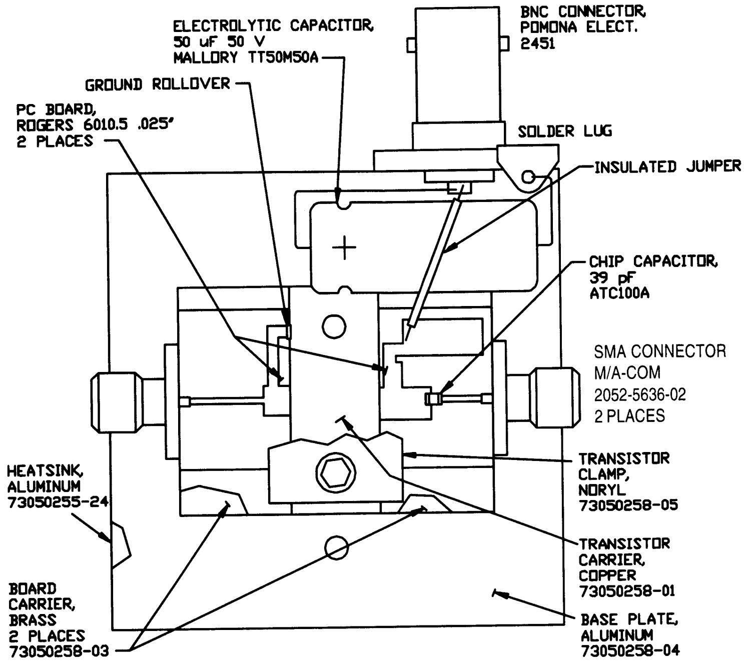
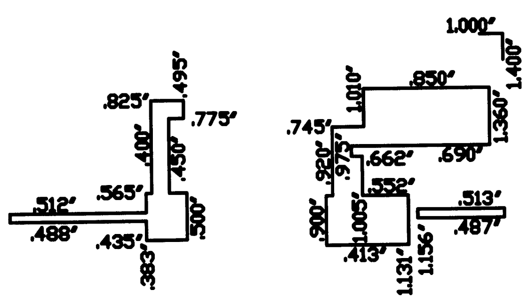
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM
an AMP company

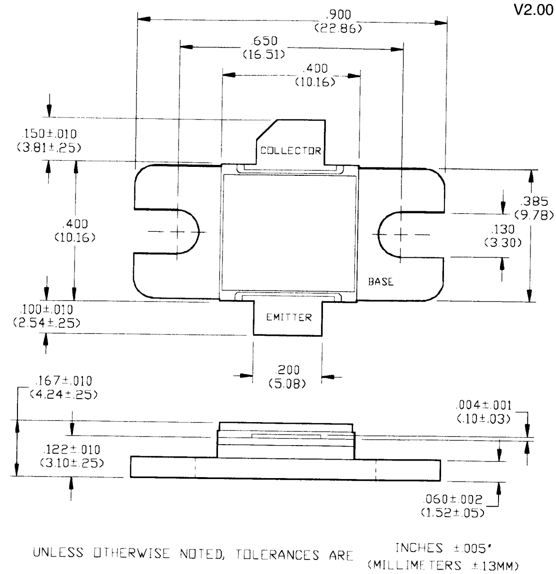
Radar Pulsed Power Transistor, 65W, 100μs Pulse, 10% Duty 2.7 - 2.9 GHz

PH2729-65M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

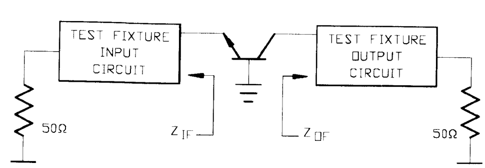
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	8.0	A
Total Power Dissipation	P_{TOT}	330	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.45	°C/W	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz
Input Power	P_{IN}	-	9.0	W	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz
Power Gain	G_P	8.5	-	dB	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{OUT}=65 W, F=2.7, 2.8, 2.9 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.70	7.8 - j8.3	9.3 - j8.9
2.80	7.3 - j6.7	9.0 - j8.4
2.90	7.2 - j5.0	8.6 - j8.0



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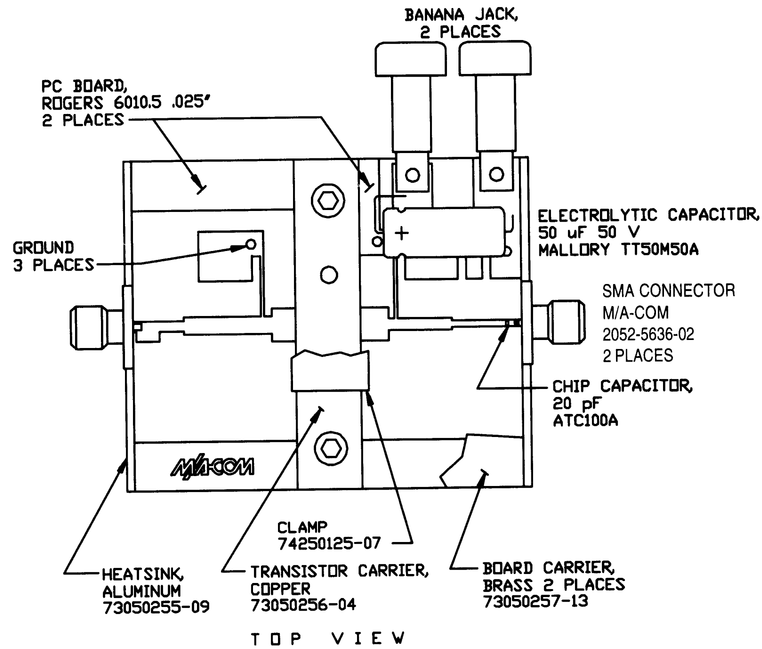
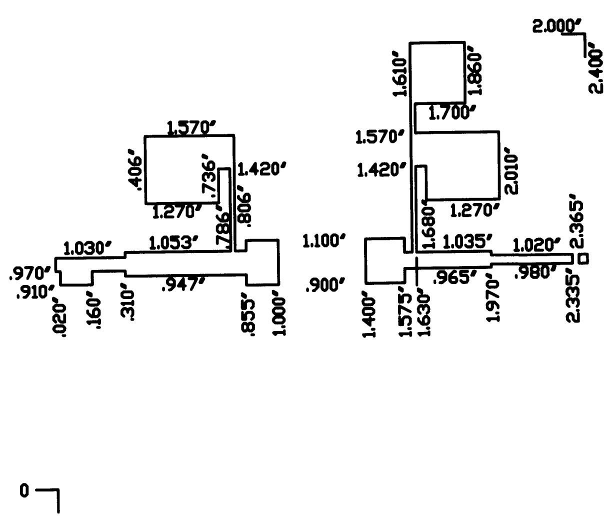
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

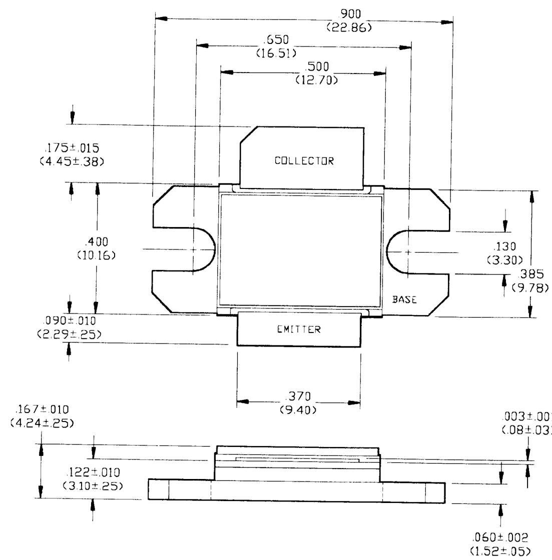
Radar Pulsed Power Transistor, 110W, 100μs Pulse, 10% Duty 2.7 - 2.9 GHz

PH2729-110M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

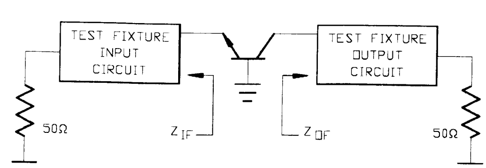
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	15.0	A
Total Power Dissipation	P_{TOT}	500	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.3	°C/W	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Output Power	P_{OUT}	110	-	W	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Power Gain	G_P	6.8	-	dB	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Overdrive Stability	OD-S	-	1.0	dB	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=23 W, F=2.7, 2.8, 2.9 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.70	4.3 - j7.0	2.6 - j3.9
2.80	4.4 - j6.4	2.8 - j3.5
2.90	4.6 - j5.8	2.9 - j3.1



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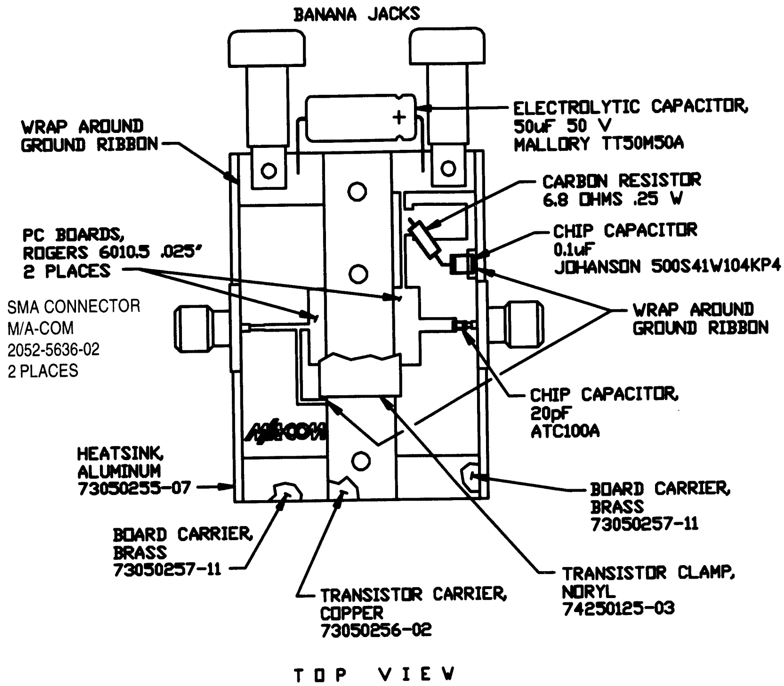
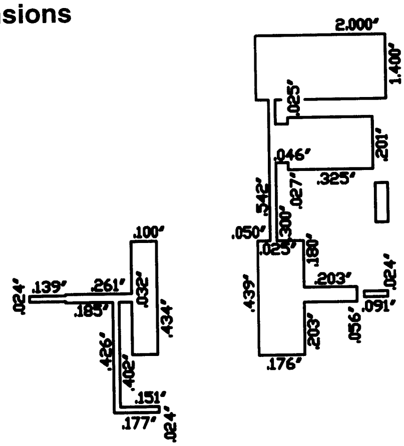
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

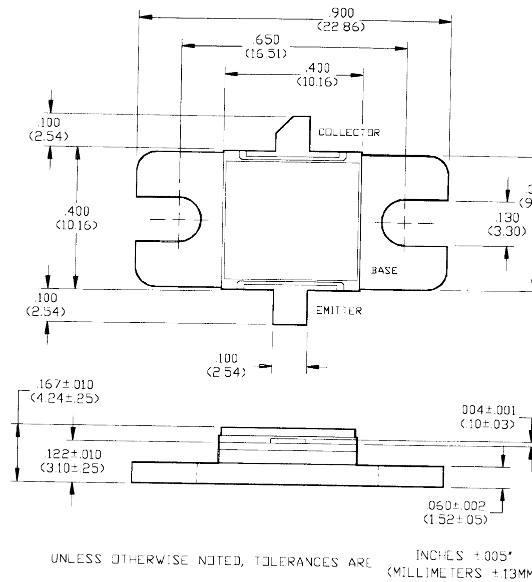
Radar Pulsed Power Transistor, 5W, 100μs Pulse, 10% Duty 2.7 - 3.1 GHz

PH2731-5M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

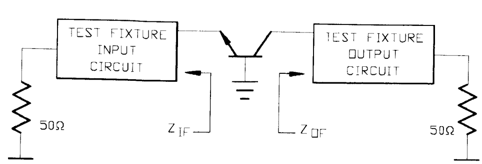
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	0.7	A
Total Power Dissipation	P_{TOT}	50	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	3.5	°C/W	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz
Output Power	P_{OUT}	5.0	-	W	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz
Collector Efficiency	η_C	30	-	%	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=1.0 W, F=2.7, 2.9, 3.1 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.70	40 - j12	25 + j3.5
2.90	35 - j16	16 + j2.4
3.10	30 - j18	12 + j4.0



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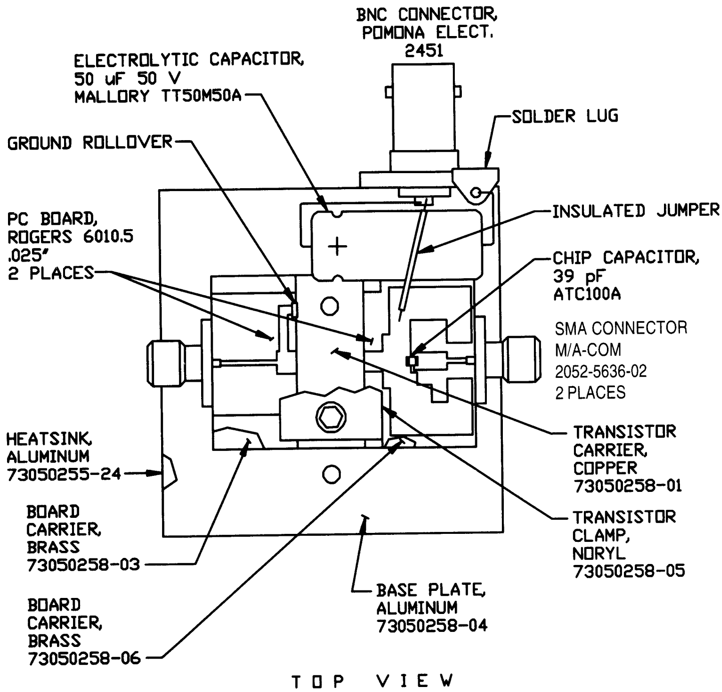
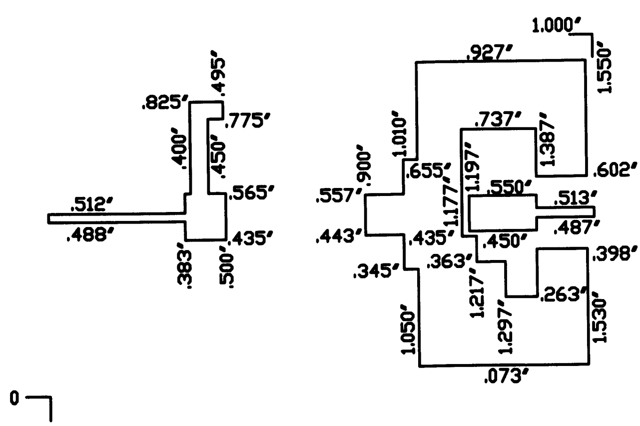
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

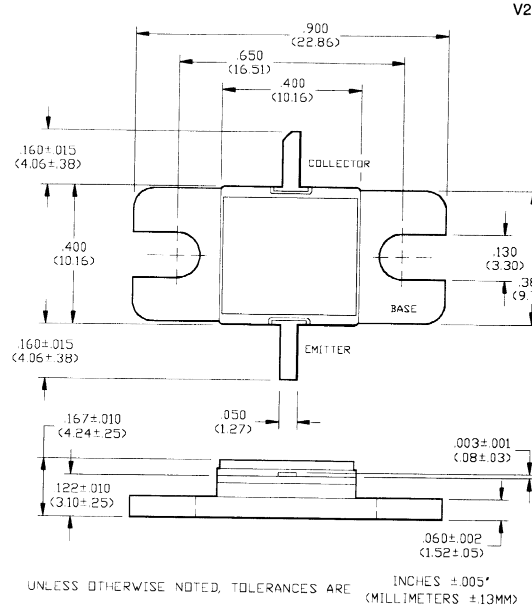
Radar Pulsed Power Transistor, 20W, 100µs Pulse, 10% Duty 2.7 - 3.1 GHz

PH2731-20M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

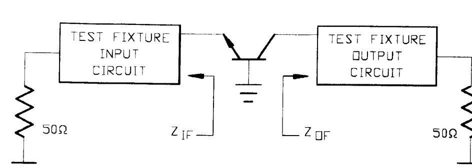
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.85	A
Total Power Dissipation	P_{TOT}	70	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	2.5	°C/W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz
Output Power	P_{OUT}	20	-	W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz
Power Gain	G_P	8.2	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.7, 2.9, 3.1 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.70	38 - j14.4	17.1 - j8.7
2.90	33 - j17.8	13.3 - j8.3
3.10	27 - j19.4	10.9 - j7.4



Specifications Subject to Change Without Notice.

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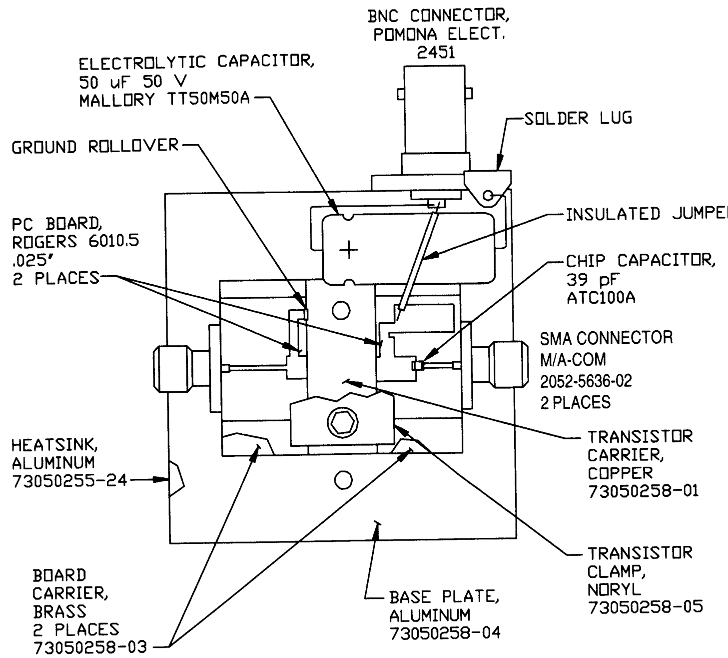
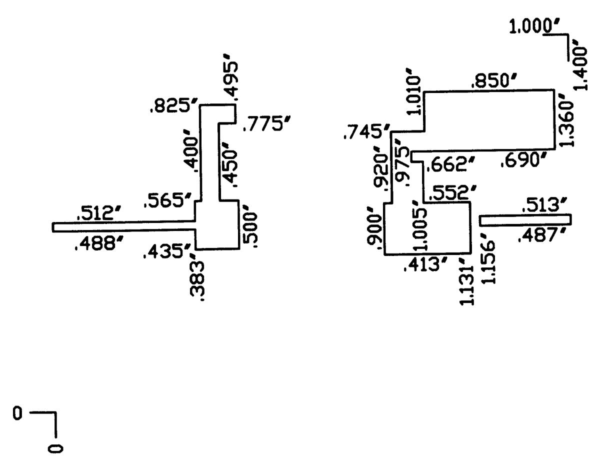
RF Test Fixture



TOP VIEW

Test Fixture PC Board Dimensions



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M/A-COM
an AMP company

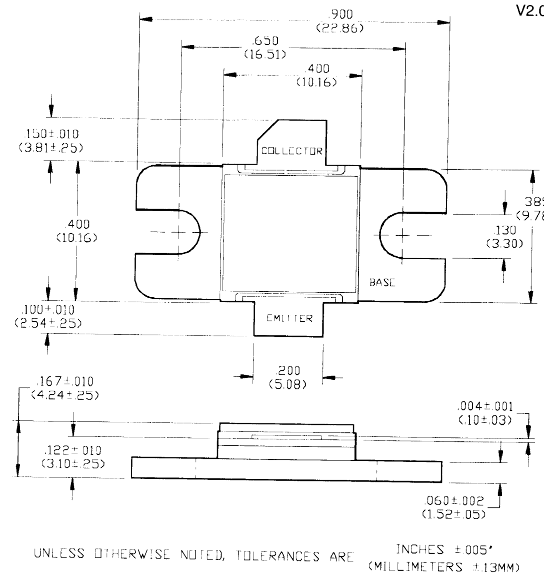
Radar Pulsed Power Transistor, 75W, 300µs Pulse, 10% Duty 2.7 - 3.1 GHz

PH2731-75L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

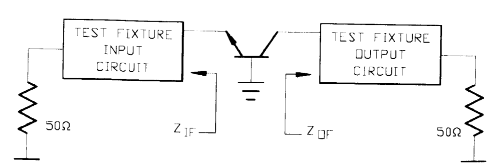
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	7.0	A
Total Power Dissipation	P_{TOT}	190	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=50 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.80	°C/W	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz
Output Power	P_{OUT}	75	-	W	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz
Input Return Loss	RL	-	-6	dB	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz
Collector Efficiency	η_C	38	-	%	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{OUT}=75 W, F=2.7, 2.9, 3.1 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
2.70	6.9 - j12.2	4.5 - j6.8
2.90	6.0 - j11.7	3.9 - j6.1
3.10	5.2 - j10.0	3.4 - j4.8



Specifications Subject to Change Without Notice.

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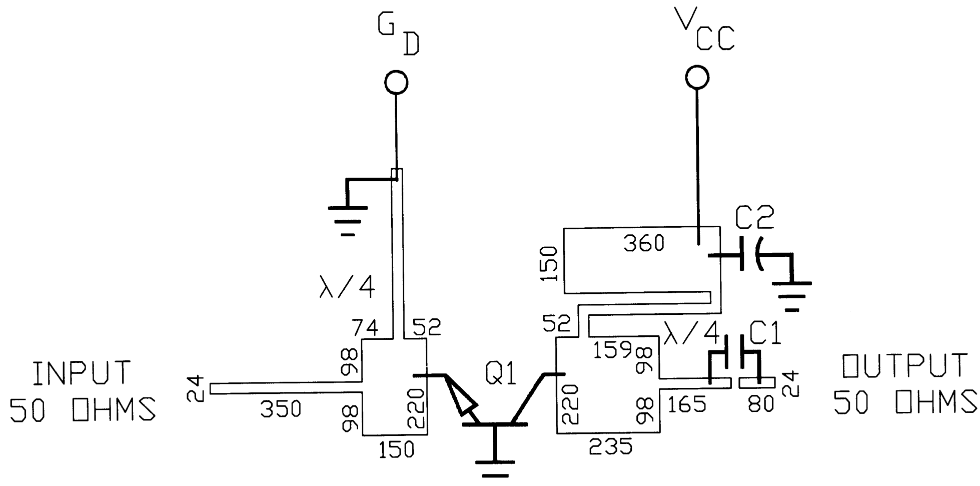
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1	36 pF ATC SIZE A
C2	50 uF 50 VOLTS
Q1	PH2731-75L
BOARD TYPE:	ROGERS 6010.5 .025″ THICK, E_R = 10.5

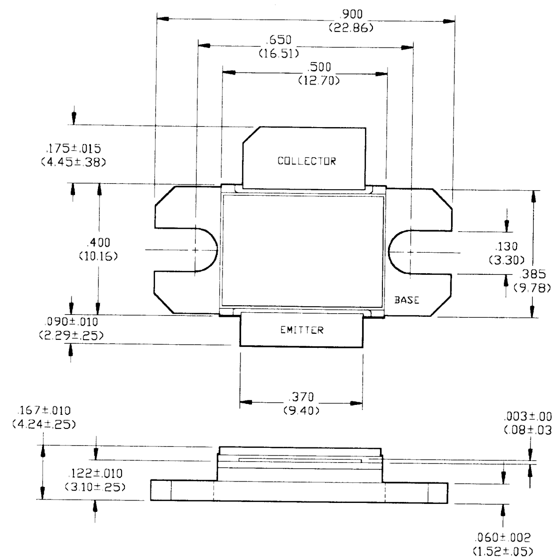
Linear Accelerator Pulsed Power Transistor, 160W, 12μs Pulse, 10% Duty 2.856 GHz

PH2856-160

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

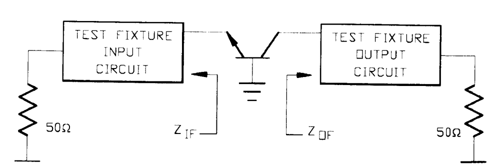
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	15.0	A
Total Power Dissipation	P_{TOT}	700	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.25	°C/W	V_{CC}=40 V, P_{OUT}=160 W, F=2.856 GHz
Input Power	P_{IN}	-	28.5	W	V_{CC}=40 V, P_{OUT}=160 W, F=2.856 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=40 V, P_{OUT}=160 W, F=2.856 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=40 V, P_{OUT}=160 W, F=2.856 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=40 V, P_{OUT}=160 W, F=2.856 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=40 V, P_{OUT}=160 W, F=2.856 GHz

Test Fixture Impedance

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.856	4.4 - j4.9	4.6 - j1.6



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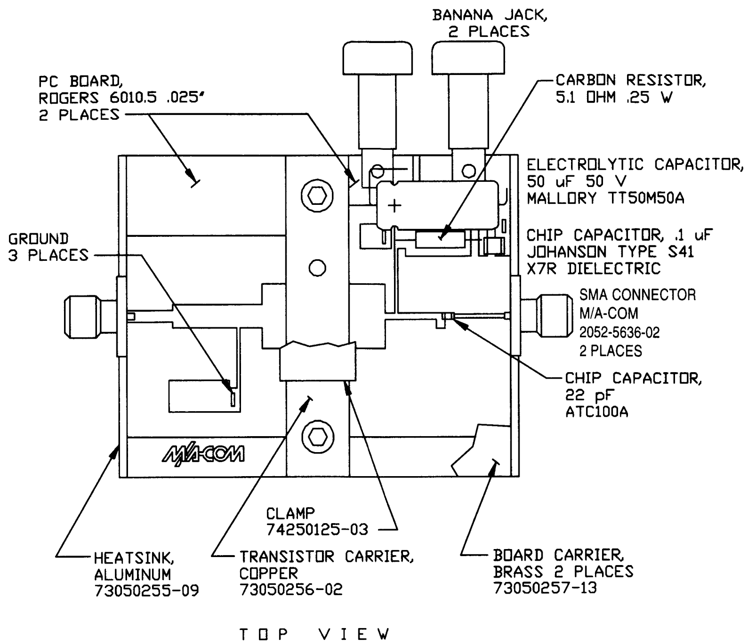
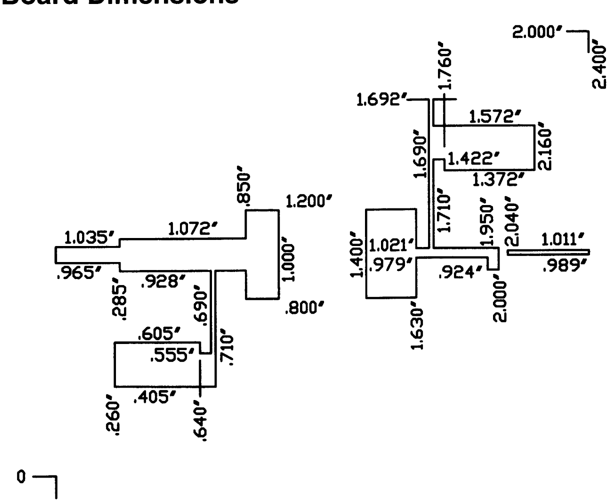
RF Test Fixture



Test Fixture PC Board Dimensions



M/A-COM an AMP company

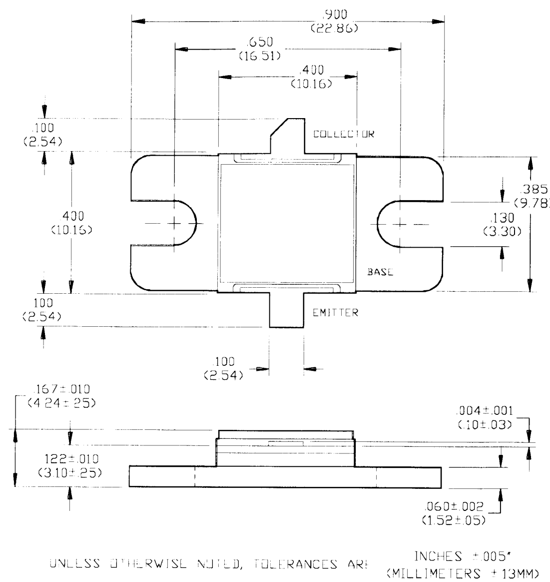
Radar Pulsed Power Transistor, 5W, 100µs Pulse, 10% Duty 2.9 - 3.1 GHz

PH2931-5M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

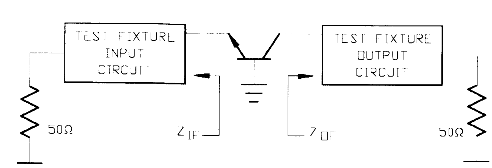
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	0.7	A
Total Power Dissipation	P_{TOT}	55	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	3.5	°C/W	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz
Output Power	P_{OUT}	5.0	-	W	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz
Collector Efficiency	η_C	30	-	%	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=1.0 W, F=2.9, 3.0, 3.1 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
2.90	35 - j16	16 + j2.4
3.00	33 - j17	14 + j3.0
3.10	30 - j18	12 + j4.0



Specifications Subject to Change Without Notice.

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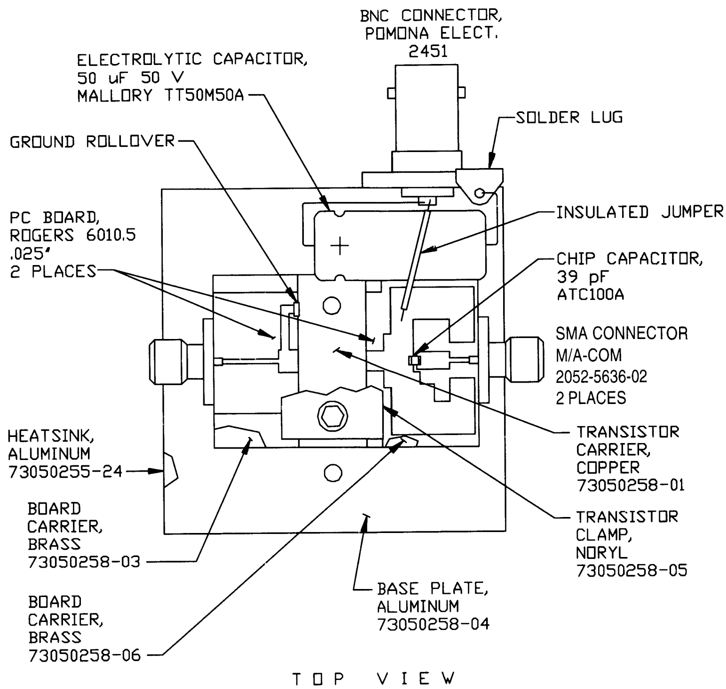
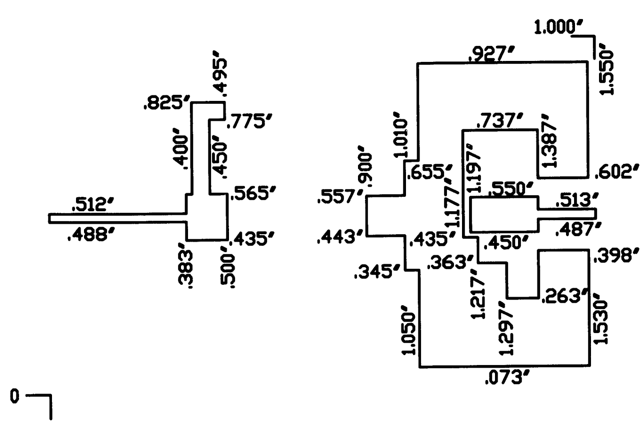
RF Test Fixture



Test Fixture PC Board Dimensions



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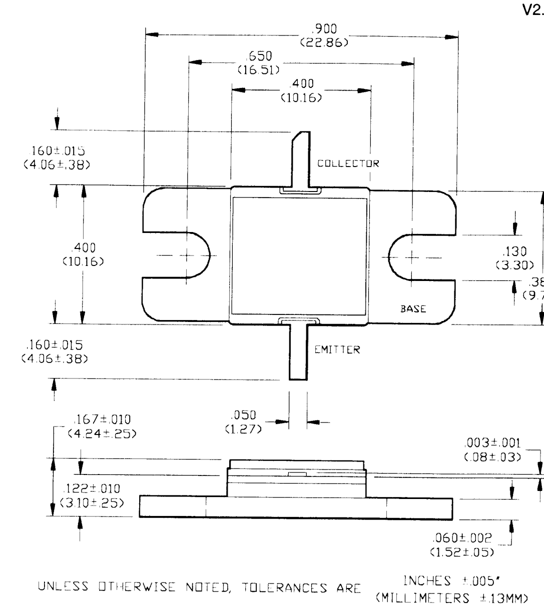
an AMP company

Radar Pulsed Power Transistor, 20W, 100µs Pulse, 10% Duty
2.9 - 3.1 GHz
PH2931-20M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

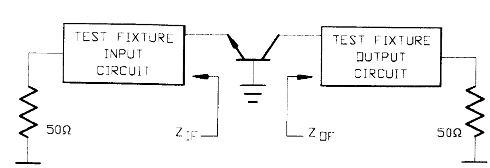
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.85	A
Total Power Dissipation	P_{TOT}	115	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.5	°C/W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz
Output Power	P_{OUT}	20	-	W	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz
Power Gain	G_P	8.2	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz
Collector Efficiency	η_C	45	-	%	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz
Load Mismatch Stablility	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{IN}=3.0 W, F=2.9, 3.0, 3.1 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.90	33 - j18.0	13.3 - j8.3
3.00	30 - j19.0	12.0 - j7.9
3.10	27 - j19.4	10.9 - j7.4



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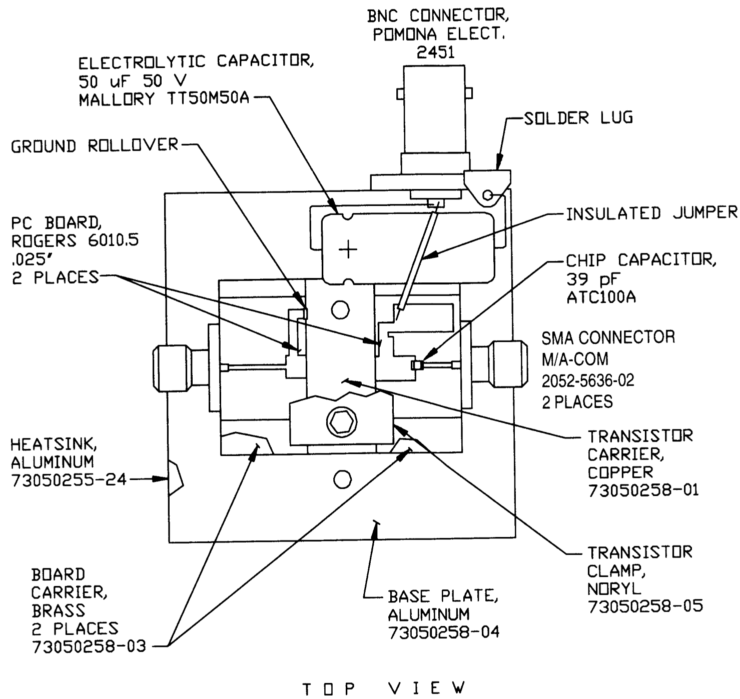
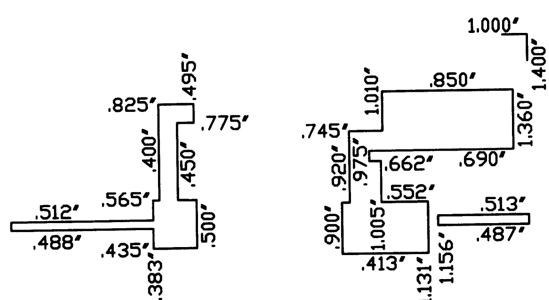
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM
an AMP company

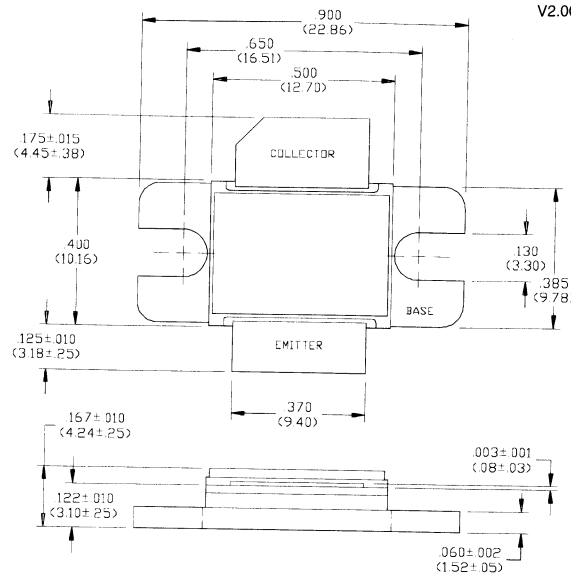
Radar Pulsed Power Transistor, 135W, 20µs Pulse, 1% Duty 2.9 - 3.1 GHz

PH2931-135S

V2.00

Features

- NPN Silicon Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency InterdigitatedGeometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

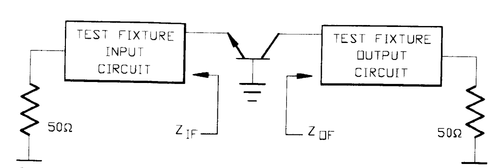
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	80	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	12	A
Total Power Dissipation	P_{TOT}	580	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	80	-	V	I_C=100 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.3	°C/W	V_{CC}=42 V, P_{IN}=24 W, F=2.9, 3.0, 3.1 GHz
Output Power	P_{OUT}	135	-	W	V_{CC}=42 V, P_{IN}=24 W, F=2.9, 3.0, 3.1 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=42 V, P_{IN}=24 W, F=2.9, 3.0, 3.1 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=42 V, P_{IN}=24 W, F=2.9, 3.0, 3.1 GHz
Input Return Loss	RL	9	-	dB	V_{CC}=42 V, P_{IN}=24 W, F=2.9, 3.0, 3.1 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=42 V, P_{IN}=24 W, F=2.9, 3.0, 3.1 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
2.90	4.0 - j6.0	2.3 - j4.3
3.00	4.2 - j5.9	2.5 - j3.9
3.10	4.1 - j5.9	2.4 - j3.8



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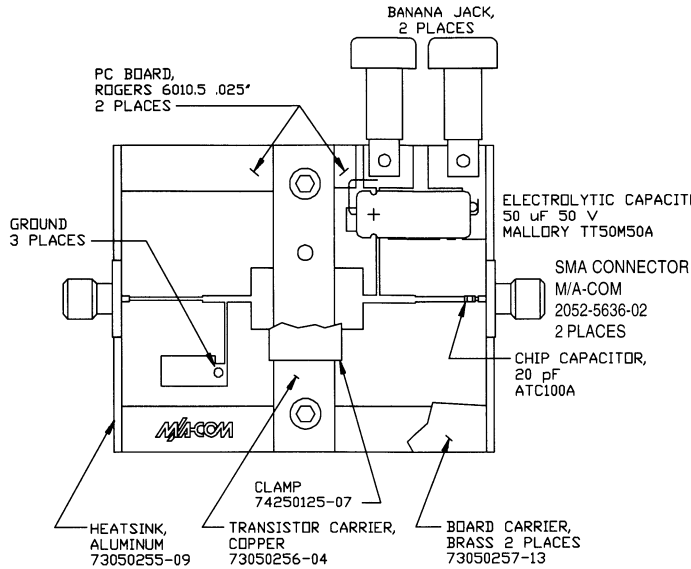
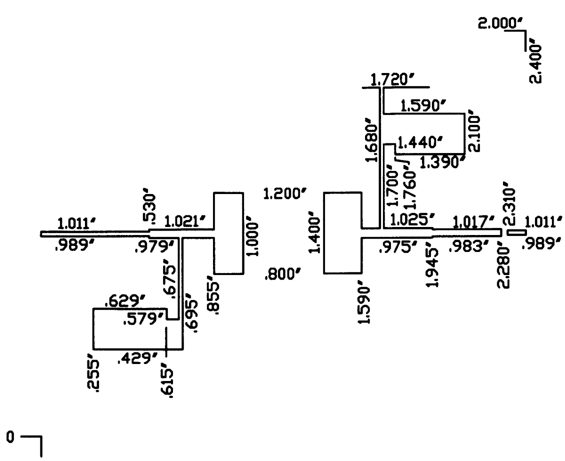
RF Test Fixture



TOP VIEW

Test Fixture PC Board Dimensions



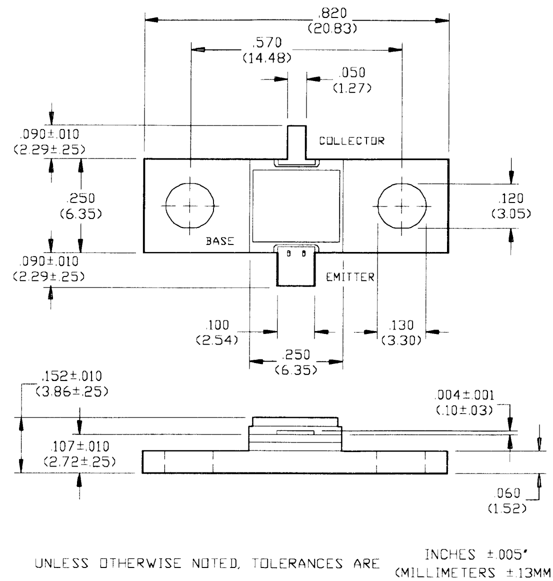
an AMP company

Radar Pulsed Power Transistor, 9W, 300μs Pulse, 10% Duty
3.1 - 3.4 GHz PH3134-9L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency InterdigitatedGeometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

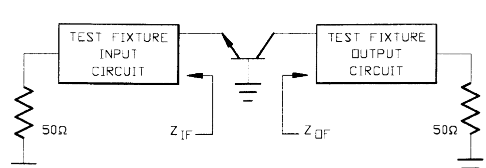
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.1	A
Total Power Dissipation	P_{TOT}	65	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=12.5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.25	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	2.7	°C/W	V_{CC}=36 V, P_{OUT}=9 W, F=3.1, 3.25, 3.4 GHz
Input Power	P_{IN}	-	1.43	W	V_{CC}=36 V, P_{OUT}=9 W, F=3.1, 3.25, 3.4 GHz
Power Gain	G_P	8.0	-	dB	V_{CC}=36 V, P_{OUT}=9 W, F=3.1, 3.25, 3.4 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=9 W, F=3.1, 3.25, 3.4 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=9 W, F=3.1, 3.25, 3.4 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=9 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	17.5 - j8.5	90.0 + j37.0
3.25	15.0 - j8.2	58.0 + j7.0
3.40	13.0 - j8.0	36.0 + j14.5



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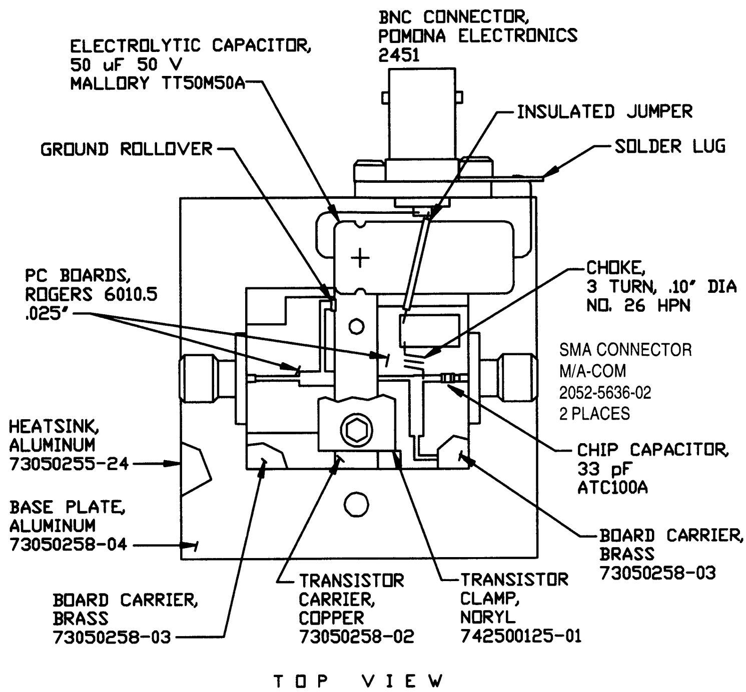
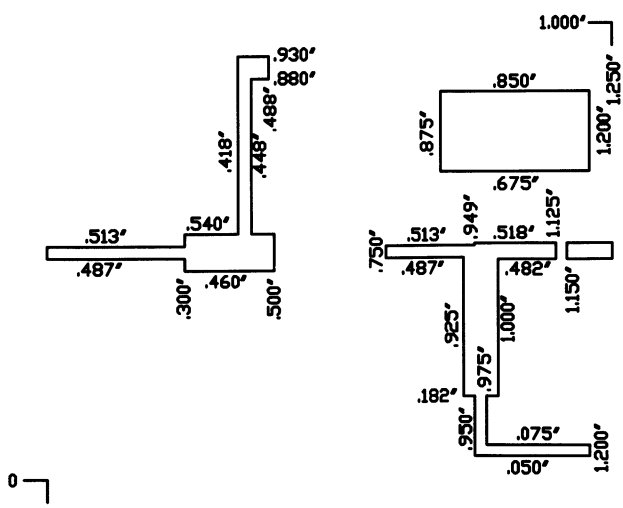
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

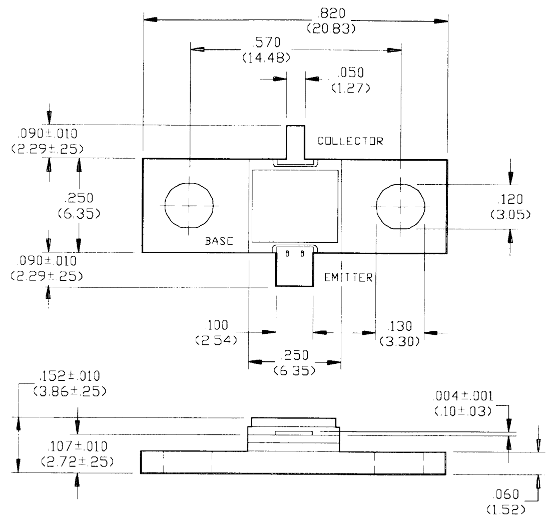
Radar Pulsed Power Transistor, 10W, 100μs Pulse, 10% Duty 3.1 - 3.4 GHz

PH3134-10M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

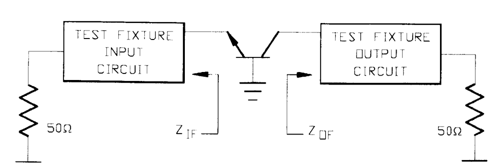
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.2	A
Total Power Dissipation	P_{TOT}	70	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=12.5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.25	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	2.5	°C/W	V_{CC}=36 V, P_{OUT}=10 W, F=3.1, 3.25, 3.4 GHz
Input Power	P_{IN}	-	1.6	W	V_{CC}=36 V, P_{OUT}=10 W, F=3.1, 3.25, 3.4 GHz
Power Gain	G_P	8.0	-	dB	V_{CC}=36 V, P_{OUT}=10 W, F=3.1, 3.25, 3.4 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=10 W, F=3.1, 3.25, 3.4 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=10 W, F=3.1, 3.25, 3.4 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=10 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	17.5 - j8.5	90.0 + j37.0
3.25	15.0 - j8.2	58.0 + j7.0
3.40	13.0 - j8.0	36.0 + j14.5



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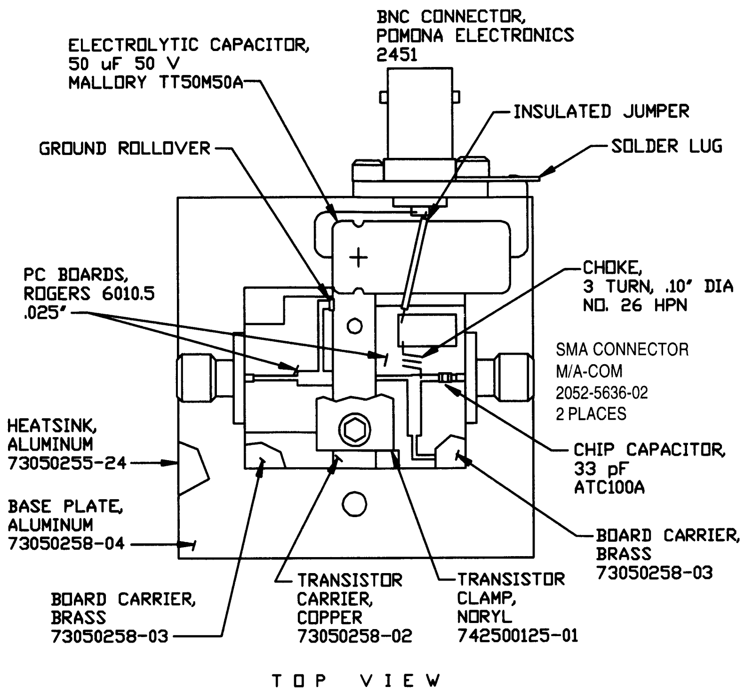
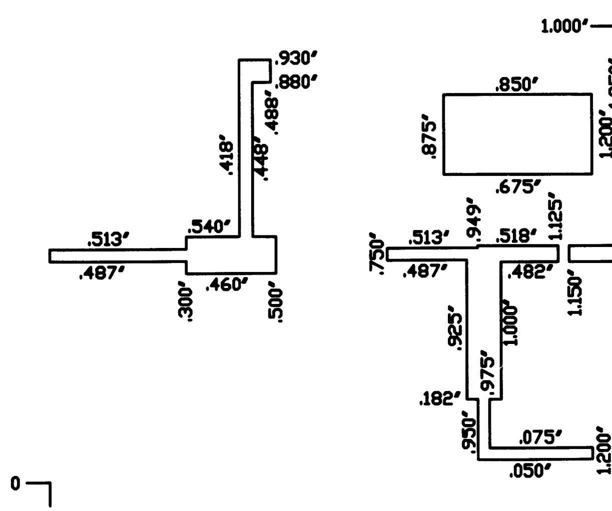
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

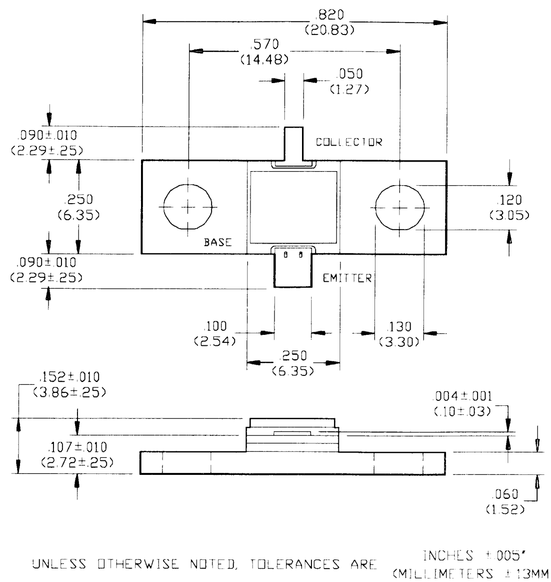
Radar Pulsed Power Transistor, 11W, 1μs Pulse, 10% Duty 3.1 - 3.4 GHz

PH3134-11S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

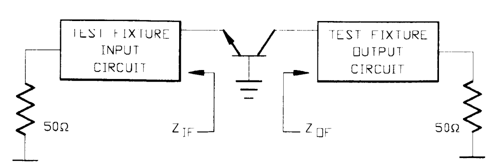
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	1.3	A
Total Power Dissipation	P_{TOT}	125	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=12.5 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.25	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	1.4	°C/W	V_{CC}=36 V, P_{OUT}=11 W, F=3.1, 3.25, 3.4 GHz
Input Power	P_{IN}	-	1.74	W	V_{CC}=36 V, P_{OUT}=11 W, F=3.1, 3.25, 3.4 GHz
Power Gain	G_P	8.0	-	dB	V_{CC}=36 V, P_{OUT}=11 W, F=3.1, 3.25, 3.4 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=11 W, F=3.1, 3.25, 3.4 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=11 W, F=3.1, 3.25, 3.4 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=11 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
3.10	17.5 - j8.5	90.0 + j37.0
3.25	15.0 - j8.2	58.0 + j7.0
3.40	13.0 - j8.0	36.0 + j14.5



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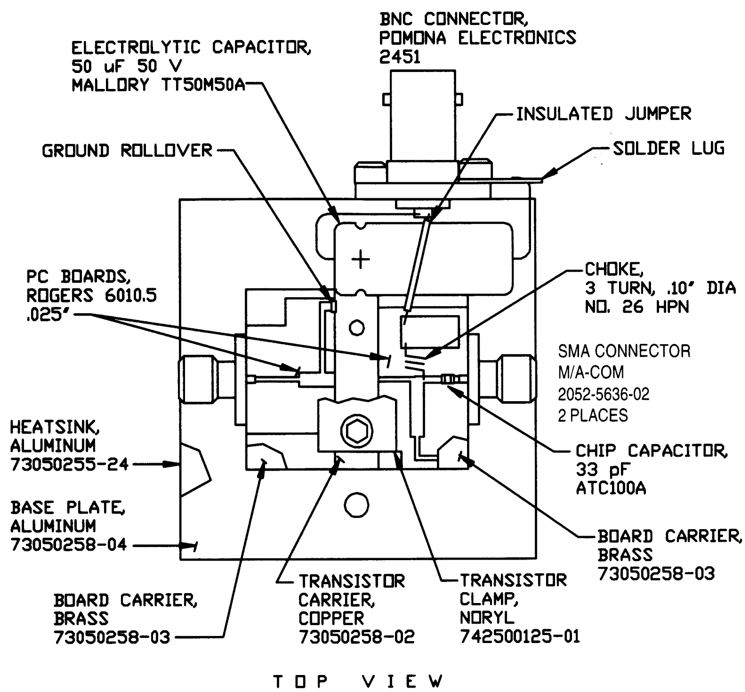
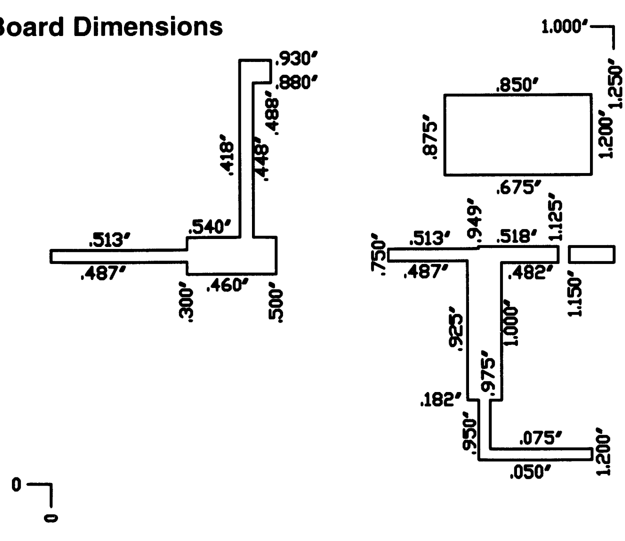
RF Test Fixture



Test Fixture PC Board Dimensions



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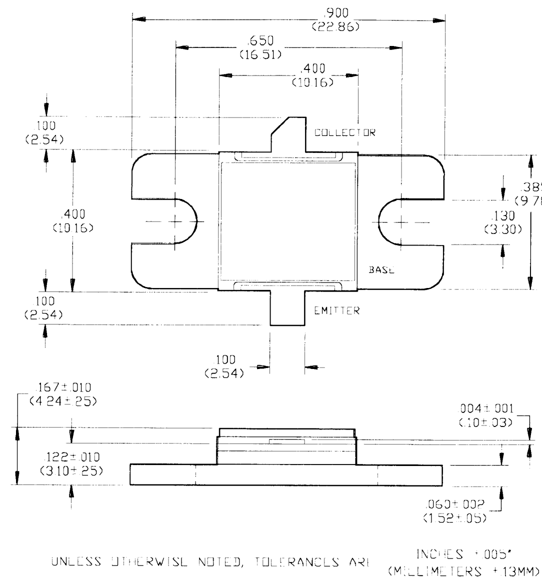
M/A-COM
an AMP company

Radar Pulsed Power Transistor, 20W, 300μs Pulse, 10% Duty
3.1 - 3.4 GHz PH3134-20L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

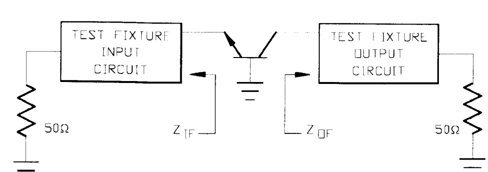
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	2.4	A
Total Power Dissipation	P_{TOT}	146	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.2	°C/W	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.25, 3.4 GHz
Input Power	P_{IN}	-	3.56	W	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.25, 3.4 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.25, 3.4 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.25, 3.4 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.25, 3.4 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=20 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
3.10	16.0 + j5.0	19.0 + j3.0
3.25	14.5 + j2.0	15.5 - j2.0
3.40	11.5 + j0.0	10.0 - j3.5



Specifications Subject to Change Without Notice.

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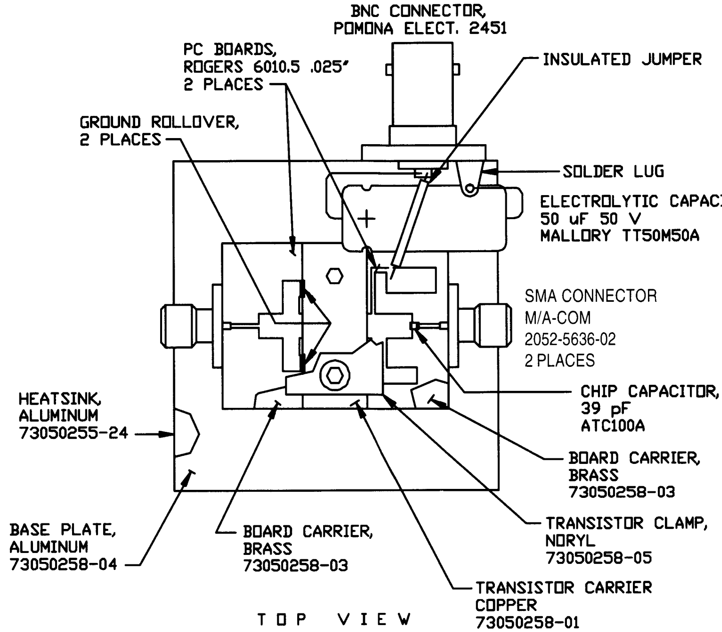
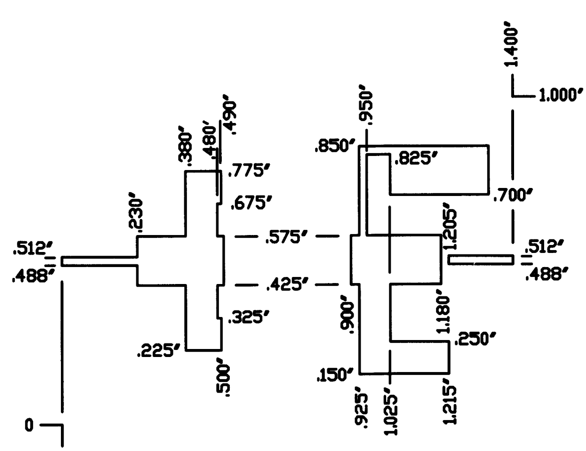
RF Test Fixture



Test Fixture PC Board Dimensions



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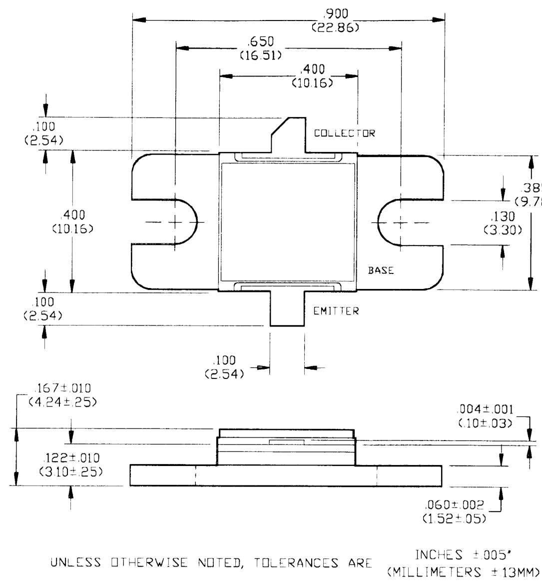
Radar Pulsed Power Transistor, 25W, 100μs Pulse, 10% Duty 3.1 - 3.4 GHz

PH3134-25M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

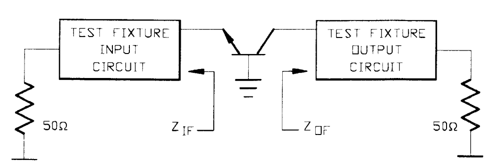
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.0	A
Total Power Dissipation	P_{TOT}	159	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.1	°C/W	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.25, 3.4 GHz
Input Power	P_{IN}	-	4.45	W	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.25, 3.4 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.25, 3.4 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.25, 3.4 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.25, 3.4 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=25 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	16.0 + j5.0	19.0 + j3.0
3.25	14.5 + j2.0	15.5 - j2.0
3.40	11.5 + j0.0	10.0 - j3.5



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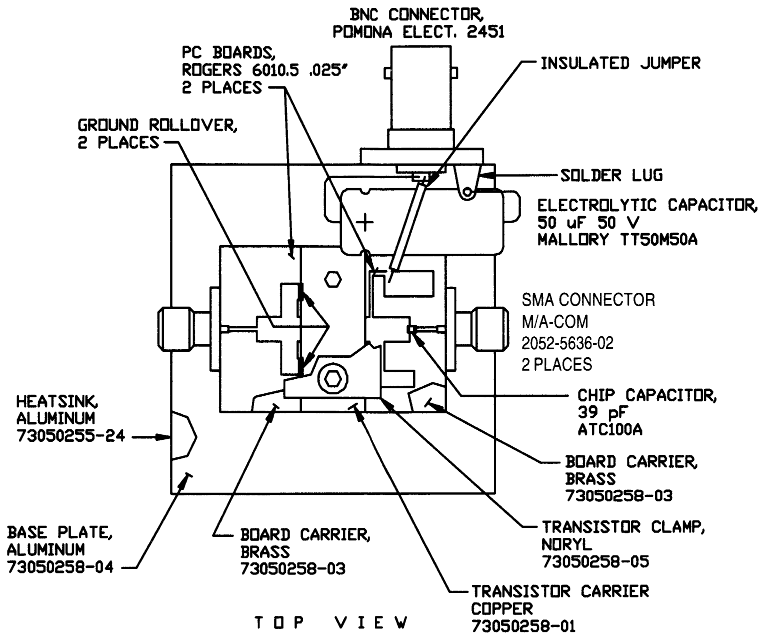
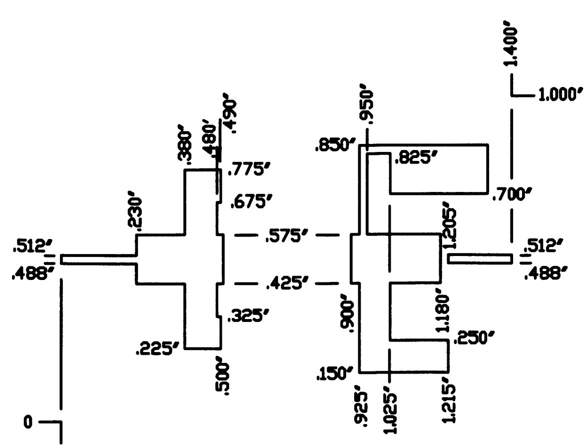
RF Test Fixture



Test Fixture PC Board Dimensions



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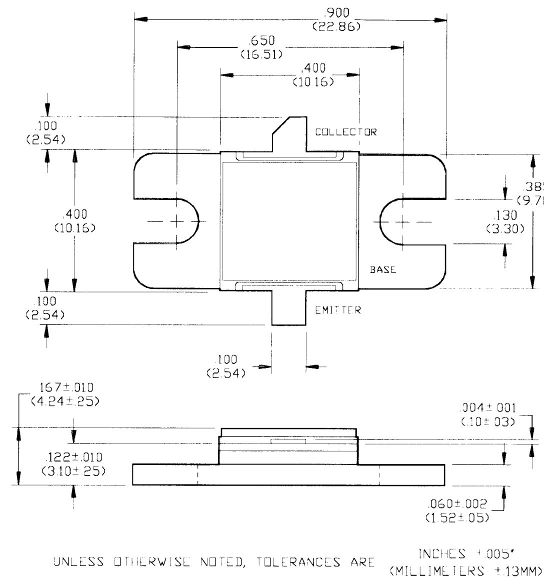
Radar Pulsed Power Transistor, 30W, 1μs Pulse, 10% Duty 3.1 - 3.4 GHz

PH3134-30S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

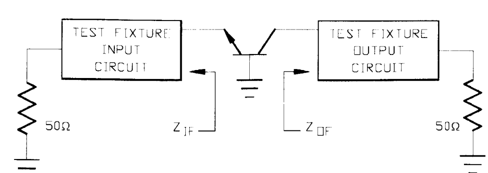
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.6	A
Total Power Dissipation	P_{TOT}	350	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.5	°C/W	V_{CC}=36 V, P_{OUT}=30 W, F=3.10, 3.25, 3.40 GHz
Input Power	P_{IN}	-	5.33	W	V_{CC}=36 V, P_{OUT}=30 W, F=3.10, 3.25, 3.40 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=30 W, F=3.10, 3.25, 3.40 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=30 W, F=3.10, 3.25, 3.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=30 W, F=3.10, 3.25, 3.40 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=30 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	16.0 + j5.0	19.0 + j3.0
3.25	14.5 + j2.0	15.5 - j2.0
3.40	11.5 + j0.0	10.0 - j3.5



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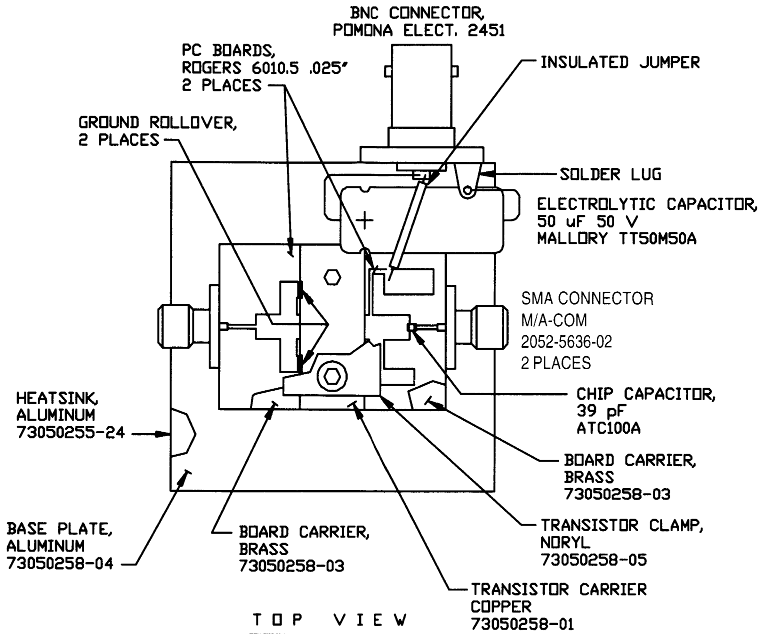
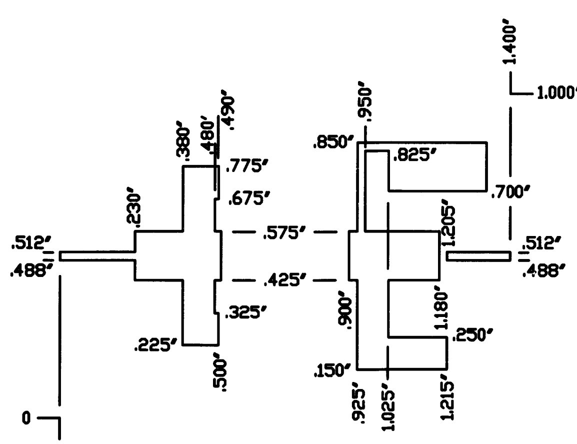
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

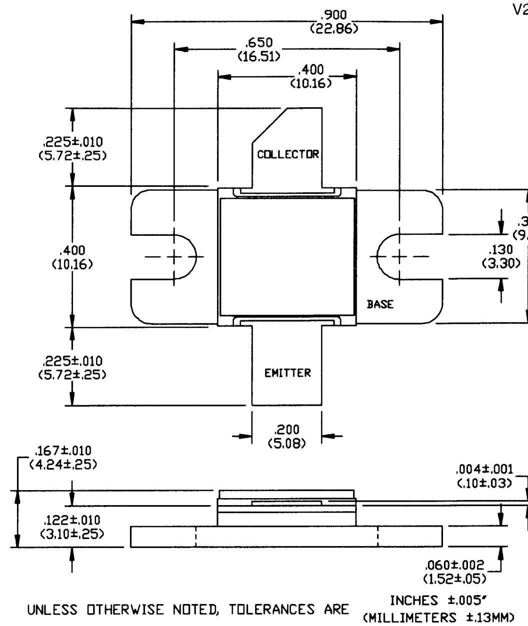
Radar Pulsed Power Transistor, 55W, 300μs Pulse, 10% Duty 3.1 - 3.4 GHz

PH3134-55L

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

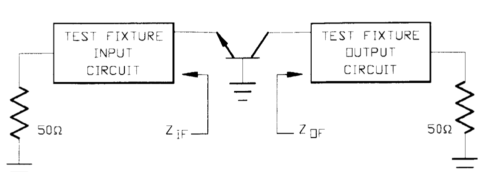
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	6.5	A
Total Power Dissipation	P_{TOT}	350	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	5.0	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.5	°C/W	V_{CC}=36 V, P_{OUT}=55 W, F=3.10, 3.25, 3.40 GHz
Input Power	P_{IN}	-	9.8	W	V_{CC}=36 V, P_{OUT}=55 W, F=3.10, 3.25, 3.40 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=55 W, F=3.10, 3.25, 3.40 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=55 W, F=3.10, 3.25, 3.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=55 W, F=3.10, 3.25, 3.40 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=55 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	11.2 - j11.7	8.1 - j5.3
3.25	11.5 - j9.5	7.1 - j4.3
3.40	12.7 - j7.6	6.4 - j3.3



Specifications Subject to Change Without Notice.

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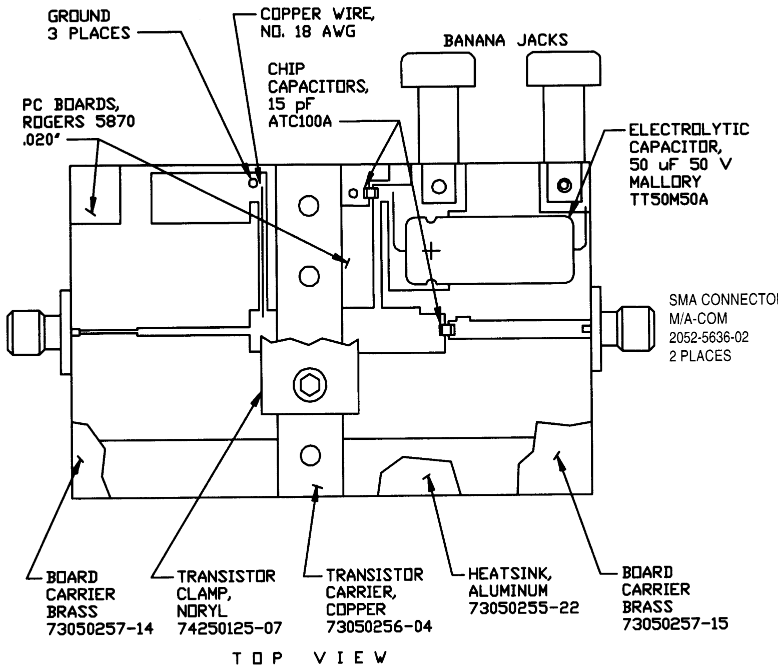
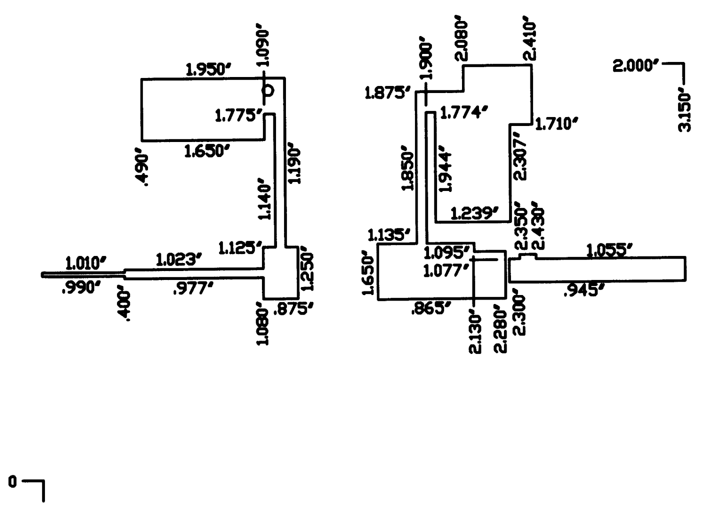
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

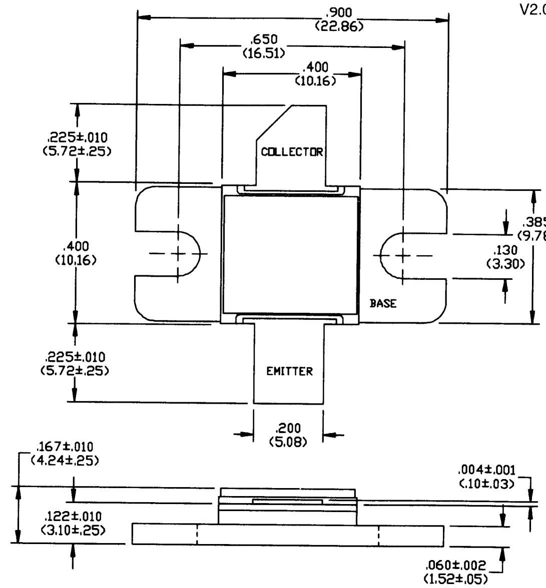
Radar Pulsed Power Transistor, 65W, 100μs Pulse, 10% Duty 3.1 - 3.4 GHz

PH3134-65M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

Absolute Maximum Ratings at 25°C

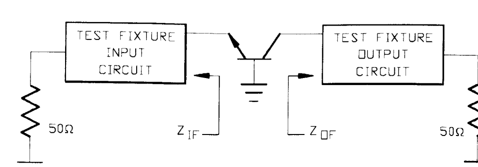
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	7.7	A
Total Power Dissipation	P_{TOT}	350	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	5.0	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.5	°C/W	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Input Power	P_{IN}	-	11.6	W	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=65 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	11.2 - j11.7	8.1 - j5.3
3.25	11.5 - j9.5	7.1 - j4.3
3.40	12.7 - j7.6	6.4 - j3.3



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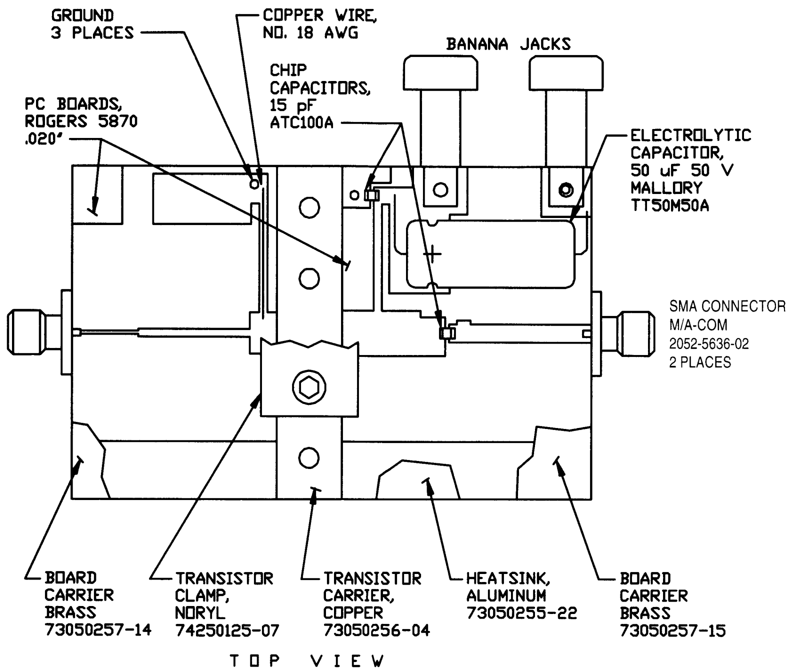
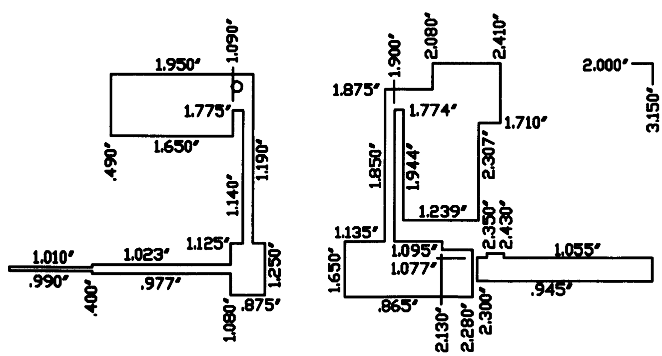
RF Test Fixture



Test Fixture PC Board Dimensions



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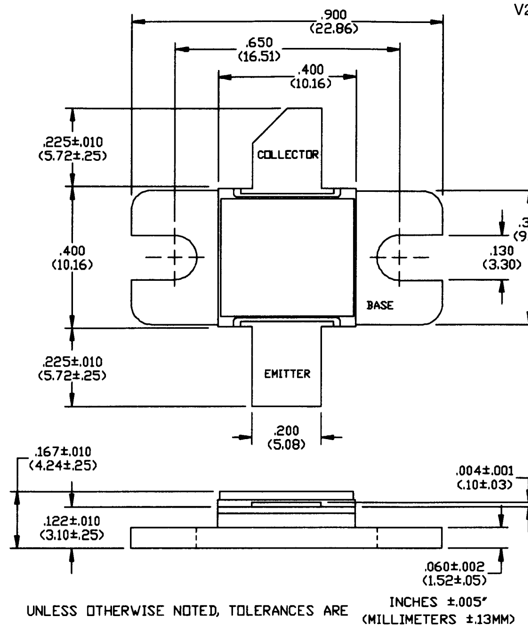
an AMP company

Radar Pulsed Power Transistor, 75W, 1μs Pulse, 10% Duty
3.1 - 3.4 GHz   PH3134-75S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

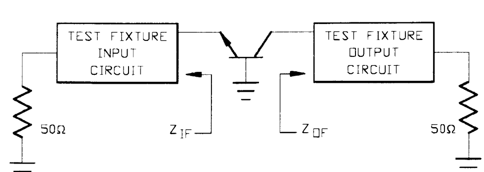
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	8.9	A
Total Power Dissipation	P_{TOT}	700	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	5.0	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.25	°C/W	V_{CC}=36 V, P_{OUT}=75 W, F=3.10, 3.25, 3.40 GHz
Input Power	P_{IN}	-	13.3	W	V_{CC}=36 V, P_{OUT}=75 W, F=3.10, 3.25, 3.40 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=75 W, F=3.10, 3.25, 3.40 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=75 W, F=3.10, 3.25, 3.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=75 W, F=3.10, 3.25, 3.40 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=75 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	11.2 - j11.7	8.1 - j5.3
3.25	11.5 - j9.5	7.1 - j4.3
3.40	12.7 - j7.6	6.4 - j3.3



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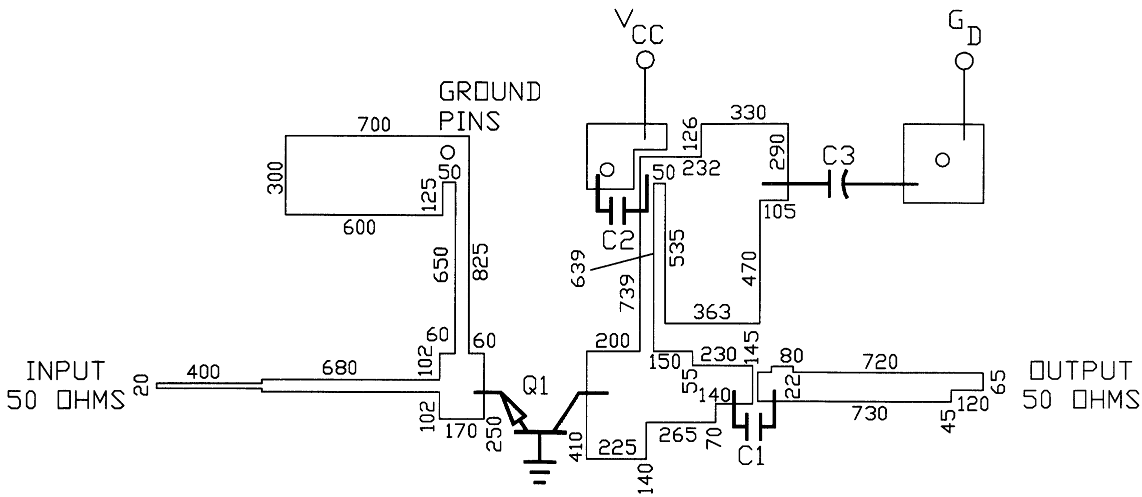
RF Test Fixture



ARTWORK DIMENSIONS IN MILS

PARTS LIST

C1 C2	15 pF ATC SIZE A
C3	50 uF 50 VOLTS
Q1	PH3134-75S
BOARD TYPE:	ROGERS 6010.5 .025" THICK, E_R = 10.5

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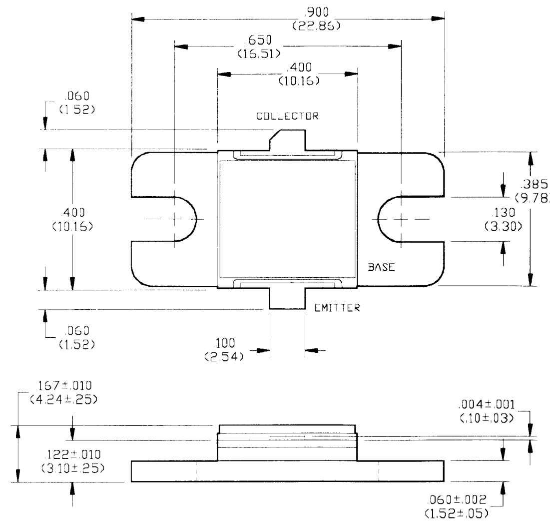
Radar Pulsed Power Transistor, 5W, 100μs Pulse, 10% Duty 3.1 - 3.5 GHz

PH3135-5M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



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Absolute Maximum Ratings at 25°C

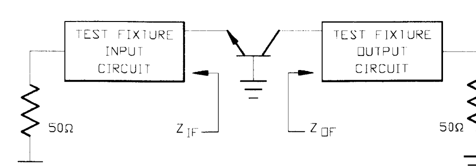
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	0.75	A
Total Power Dissipation	P_{TOT}	50	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	3.5	°C/W	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Input Power	P_{OUT}	5.0	-	W	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Power Gain	G_P	8.5	-	dB	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Collector Efficiency	η_C	30	-	%	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
3.10	24 - j4.4	24 - j20
3.30	20 - j0.7	18 - j11
3.50	17 + j3.9	15 - j3.0



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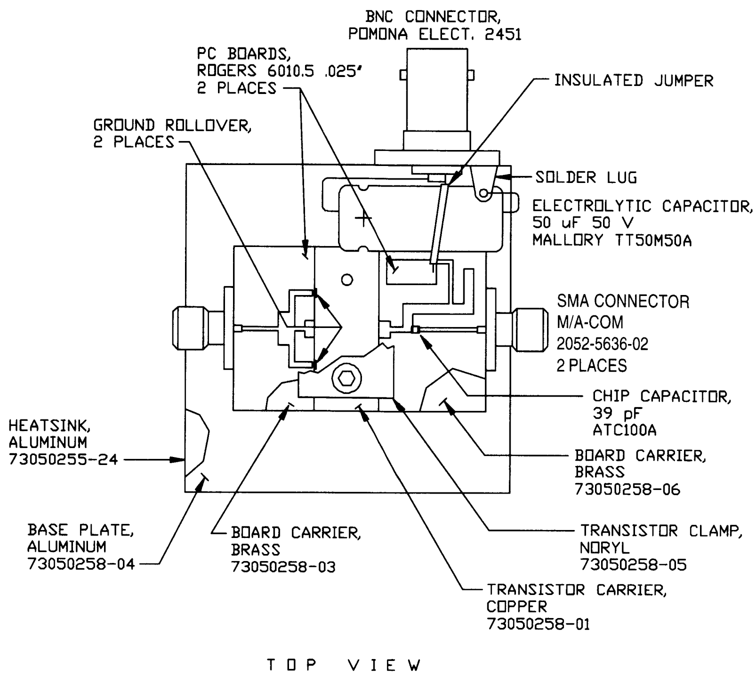
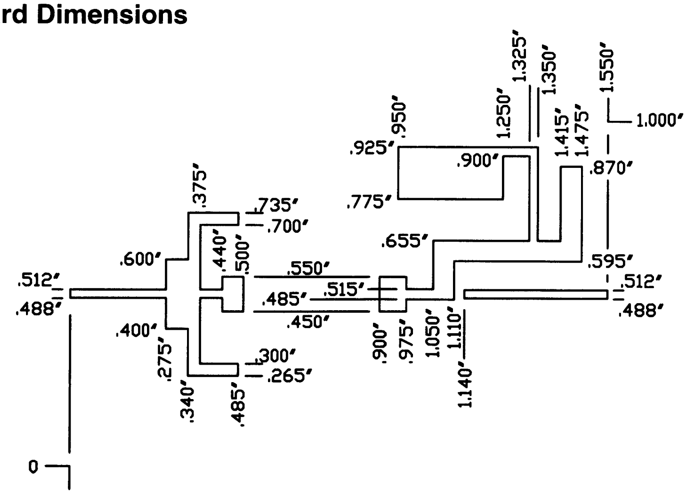
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

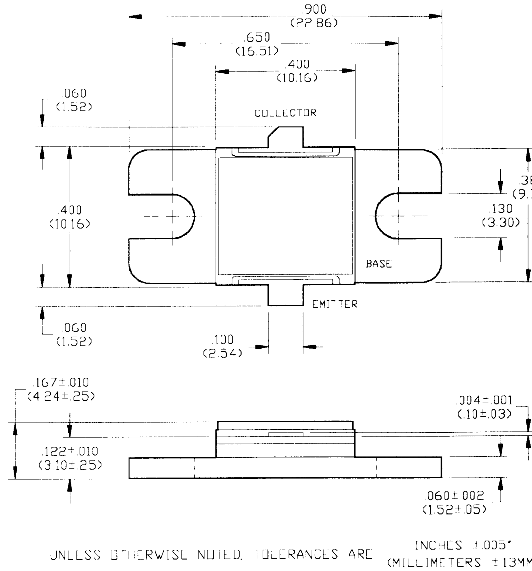
Radar Pulsed Power Transistor, 5W, 2μs Pulse, 10% Duty 3.1 - 3.5 GHz

PH3135-5S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

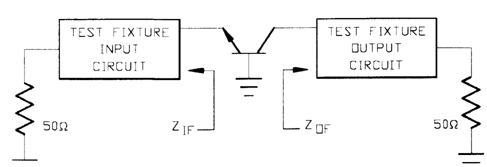
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	60	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	0.75	A
Total Power Dissipation	P_{TOT}	60	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	60	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	3.5	°C/W	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Output Power	P_{OUT}	5.0	-	W	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Power Gain	G_P	8.5	-	dB	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Collector Efficiency	η_C	30	-	%	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=33 V, P_{IN}=0.7 W, F=3.1, 3.3, 3.5 GHz

Broadband Test Fixture Impedances

F(GHz)	Z_{IF}(Ω)	Z_{OF}(Ω)
3.10	24 - j4.4	24 - j20
3.30	20 - j0.7	18 - j11
3.50	17 + j3.9	15 - j3.0



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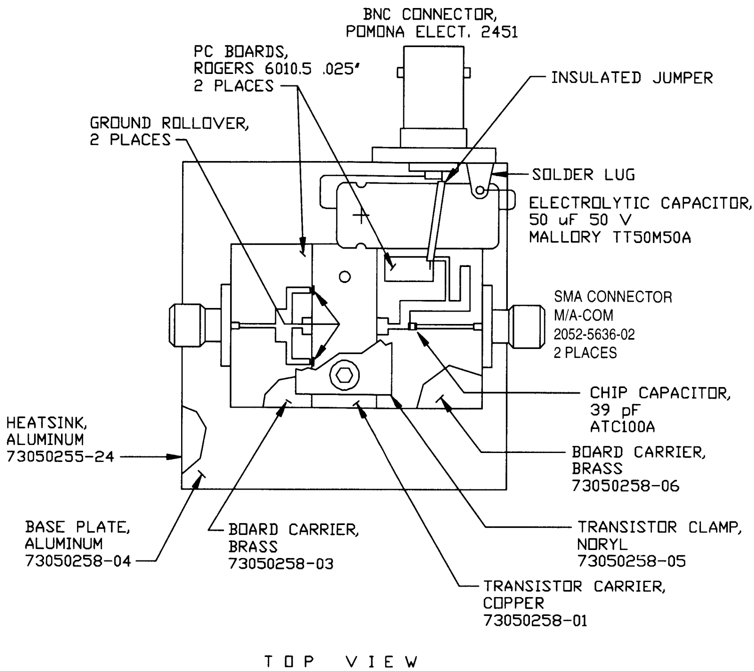
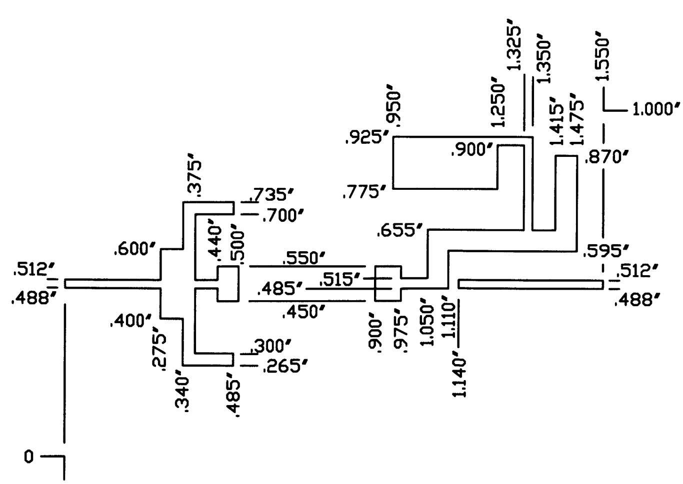
RF Test Fixture



Test Fixture PC Board Dimensions



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M/A-COM an AMP company

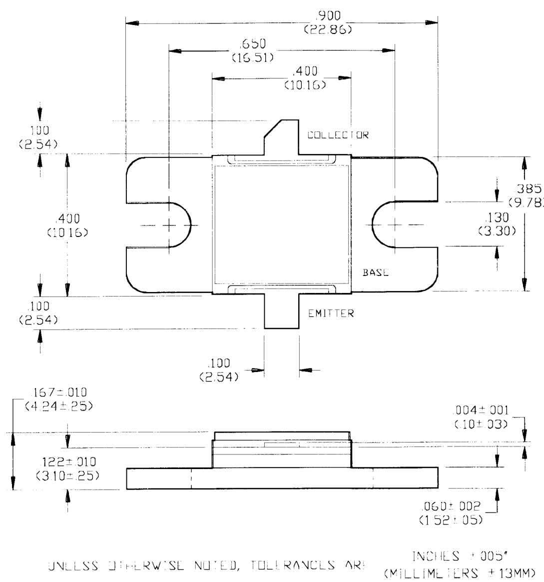
Radar Pulsed Power Transistor, 20W, 100µs Pulse, 10% Duty 3.1 - 3.5 GHz

PH3135-20M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

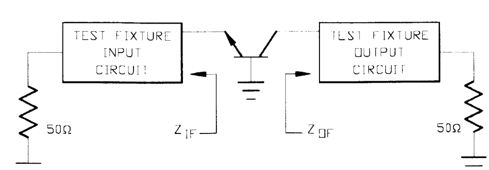
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	2.4	A
Total Power Dissipation	P_{TOT}	160	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	1.10	°C/W	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.3, 3.5 GHz
Input Power	P_{IN}	-	3.6	W	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.3, 3.5 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.3, 3.5 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=20 W, F=3.1, 3.3, 3.5 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	16.0 + j5.5	19.0 + j3.4
3.30	14.5 + j1.6	14.2 - j2.8
3.50	11.3 + j0.0	10.7 - j3.3



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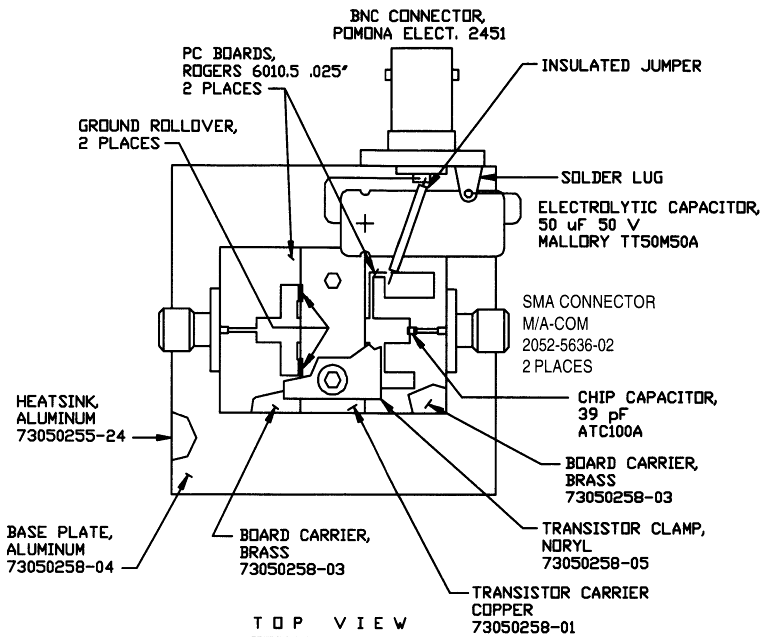
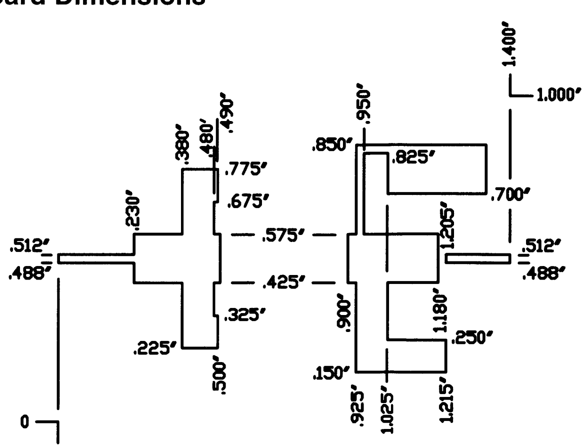
RF Test Fixture



Test Fixture PC Board Dimensions



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an AMP company

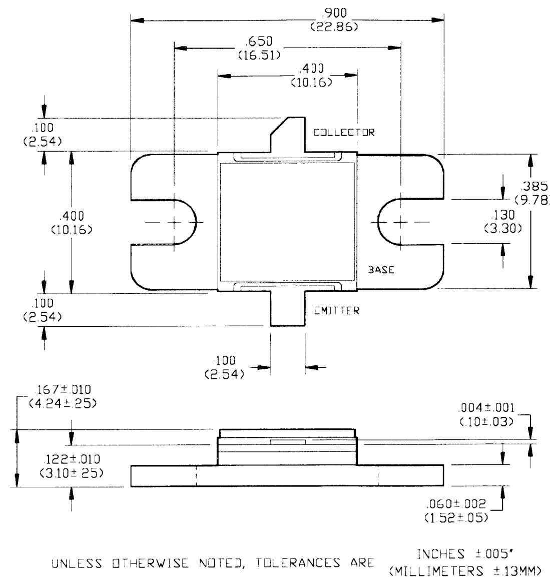
Radar Pulsed Power Transistor, 25W, 2µs Pulse, 10% Duty 3.1 - 3.5 GHz

PH3135-25S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

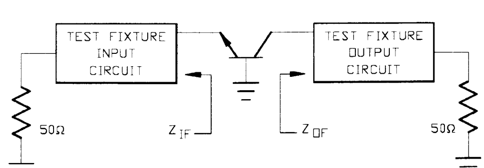
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.0	A
Total Power Dissipation	P_{TOT}	195	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=10 mA
Collector-Emitter Leakage Current	I_{CES}	-	1.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.9	°C/W	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.3, 3.5 GHz
Input Power	P_{IN}	-	4.5	W	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.3, 3.5 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.3, 3.5 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=25 W, F=3.1, 3.3, 3.5 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	16.0 + j5.5	19.0 + j3.4
3.30	14.5 + j1.6	14.2 - j2.8
3.50	11.3 + j0.0	10.7 - j3.3



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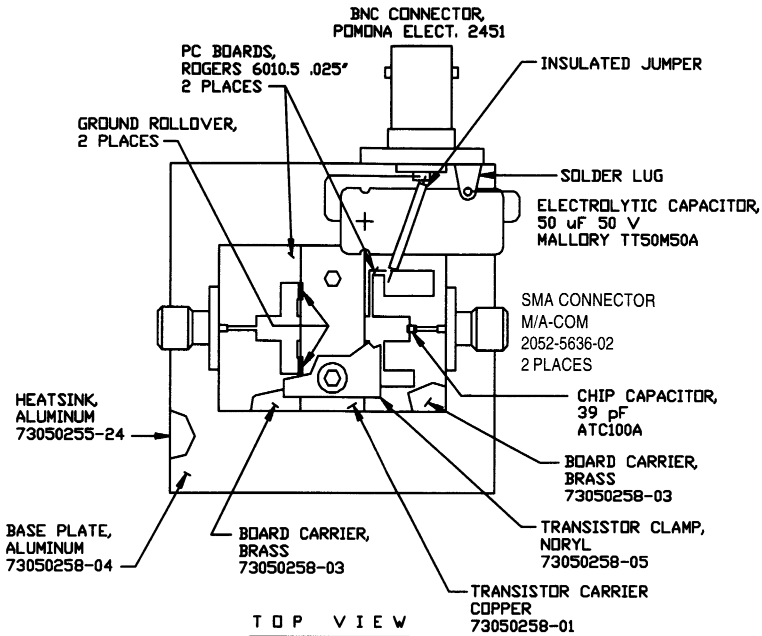
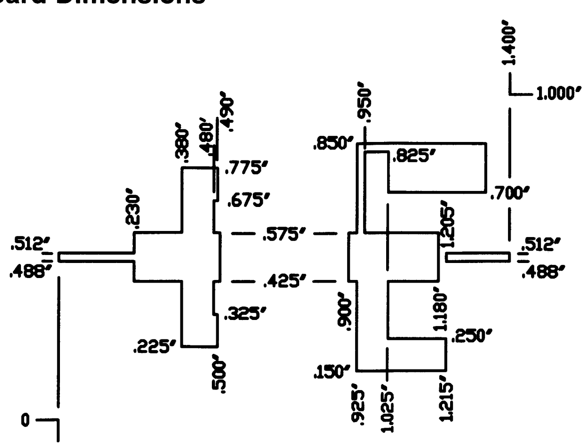
RF Test Fixture



Test Fixture PC Board Dimensions



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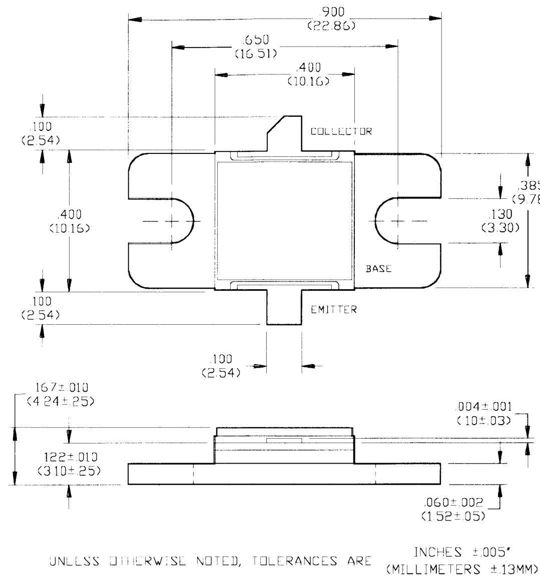
an AMP company

Radar Pulsed Power Transistor, 30W, 100µs Pulse, 10% Duty
3.1 - 3.5 GHz PH3135-30M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

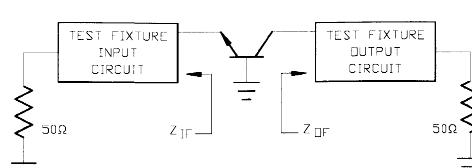
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	3.6	A
Total Power Dissipation	P_{TOT}	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=20 mA
Collector-Emitter Leakage Current	I_{CES}	-	3.0	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.7	°C/W	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz
Output Power	P_{OUT}	30	-	W	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz
Power Gain	G_P	7.0	-	dB	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Stability	VSWR-S	-	2:1	-	V_{CC}=36 V, P_{IN}=6.0 W, F=3.1, 3.3, 3.5 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	21 + j2.0	13.8 - j11.7
3.30	19 - j2.4	7.7 - j8.2
3.50	16 - j5.1	5.3 - j5.3



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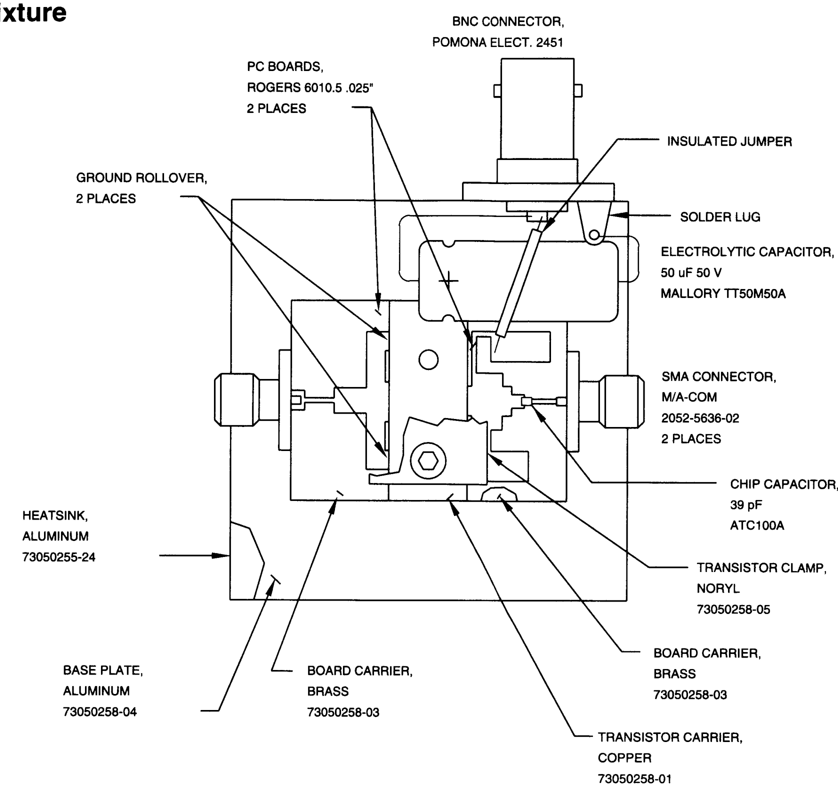
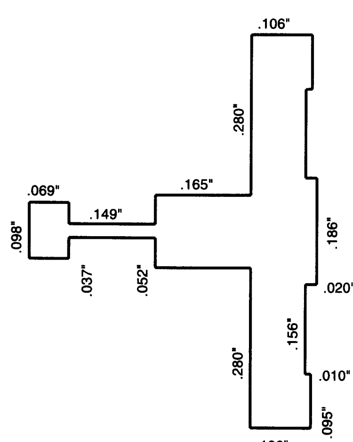
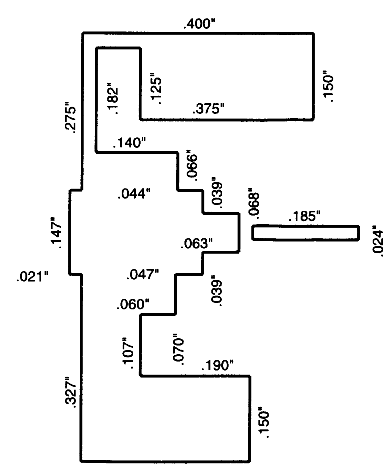
RF Test Fixture



Test Fixture PC Board Dimensions





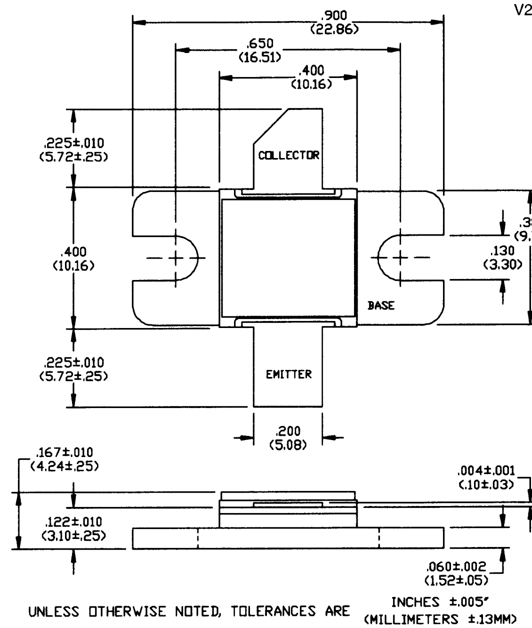
M/A-COM an AMP company

Radar Pulsed Power Transistor, 65W, 100μs Pulse, 10% Duty
3.1 - 3.4 GHz PH3134-65M

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

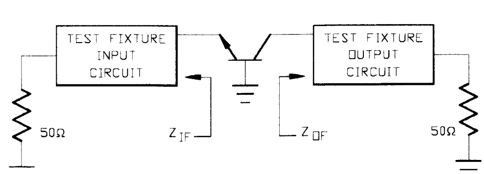
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	7.7	A
Total Power Dissipation	P_{TOT}	350	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=25 mA
Collector-Emitter Leakage Current	I_{CES}	-	5.0	mA	V_{CE}=36 V
Thermal Resistance	$R_{TH(JC)}$	-	0.5	°C/W	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Input Power	P_{IN}	-	11.6	W	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=65 W, F=3.10, 3.25, 3.40 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=65 W, F=3.25 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	11.2 - j11.7	8.1 - j5.3
3.25	11.5 - j9.5	7.1 - j4.3
3.40	12.7 - j7.6	6.4 - j3.3



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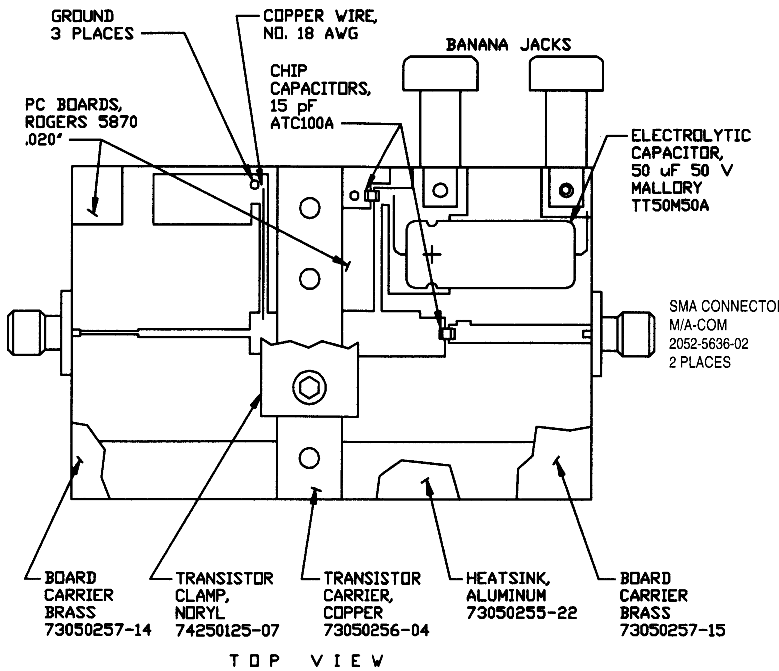
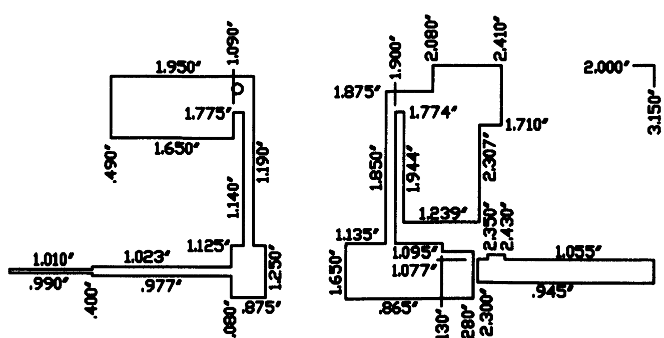
RF Test Fixture



Test Fixture PC Board Dimensions



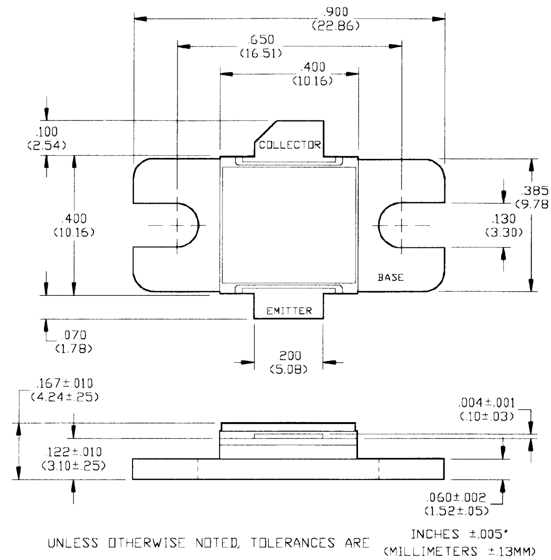
M/A-COM an AMP company

Radar Pulsed Power Transistor, 90W, 2μs Pulse, 10% Duty
3.1 - 3.5 GHz PH3135-90S

V2.00

Features

- NPN Silicon Microwave Power Transistor
- Common Base Configuration
- Broadband Class C Operation
- High Efficiency Interdigitated Geometry
- Diffused Emitter Ballasting Resistors
- Gold Metalization System
- Internal Input and Output Impedance Matching
- Hermetic Metal/Ceramic Package



Absolute Maximum Ratings at 25°C

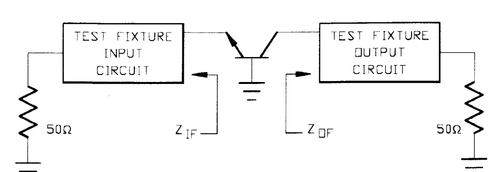
Parameter	Symbol	Rating	Units
Collector-Emitter Voltage	V_{CES}	65	V
Emitter-Base Voltage	V_{EBO}	3.0	V
Collector Current (Peak)	I_C	10.7	A
Total Power Dissipation	P_{TOT}	580	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +200	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Collector-Emitter Breakdown Voltage	BV_{CES}	65	-	V	I_C=40 mA
Collector-Emitter Leakage Current	I_{CES}	-	7.5	mA	V_{CE}=40 V
Thermal Resistance	$R_{TH(JC)}$	-	0.30	°C/W	V_{CC}=36 V, P_{OUT}=90 W, F=3.1, 3.3, 3.5 GHz
Input Power	P_{IN}	-	16.0	W	V_{CC}=36 V, P_{OUT}=90 W, F=3.1, 3.3, 3.5 GHz
Power Gain	G_P	7.5	-	dB	V_{CC}=36 V, P_{OUT}=90 W, F=3.1, 3.3, 3.5 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=90 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{OUT}=90 W, F=3.1, 3.3, 3.5 GHz
Load Mismatch Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=90 W, F=3.1, 3.3, 3.5 GHz

Broadband Test Fixture Impedances

F(GHz)	$Z_{IF}(\Omega)$	$Z_{OF}(\Omega)$
3.10	8.9 - j11.2	5.2 - j11.0
3.30	8.7 - j8.6	4.2 - j8.8
3.50	8.6 - j6.0	4.7 - j7.0



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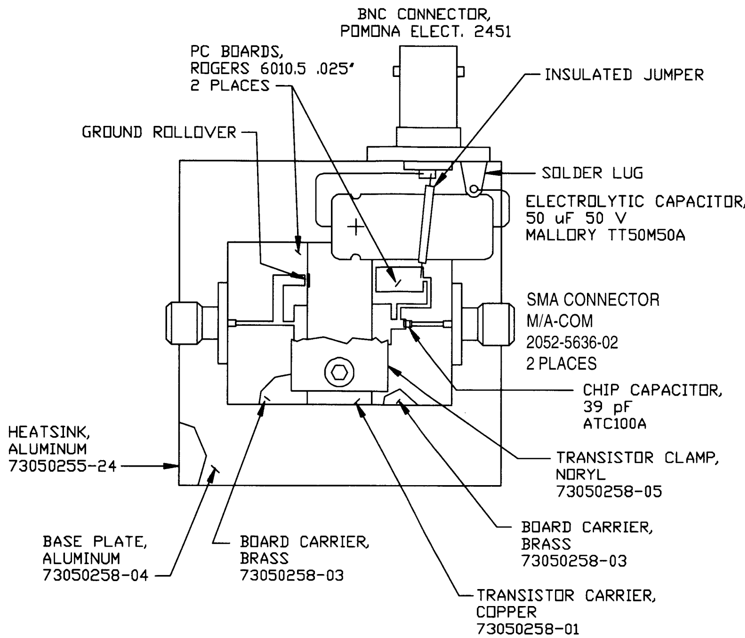
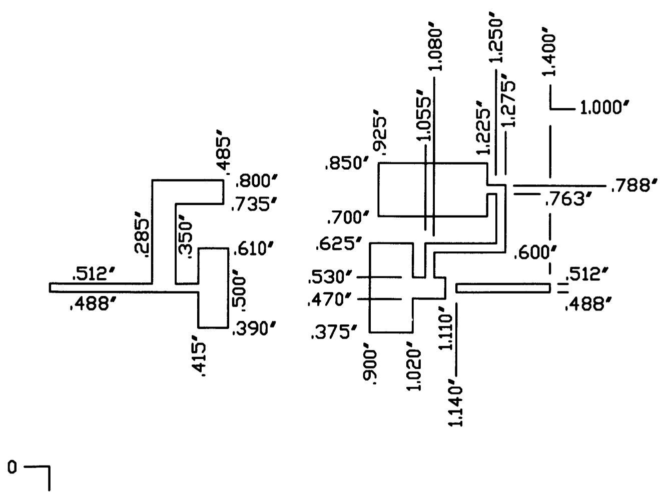
RF Test Fixture



TOP VIEW

Test Fixture PC Board Dimensions



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an AMP company

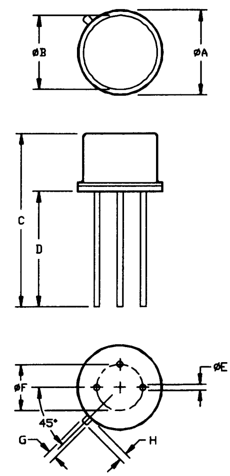
RF MOSFET Power Transistor, 1W, 28V
100 - 500 MHz

UF2801KI

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Lower Noise Floor
- 100 MHz to 500 MHz Operation
- Common Source TO39 Package Configuration



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.07	9.19	.357	.362
B	8.15	8.33	.321	.328
C	19.05	44.45	.750	1.750
D	12.70	38.10	.500	1.500
E	.41	.48	.016	.019
F	4.95	5.21	.195	.205
G	.71	.86	.028	.034
H	.74	1.14	.029	.045

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	0.7	A
Power Dissipation	P_D	5.1	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	34	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=1.0 mA
Drain-Source Leakage Current	I_{DSS}	-	0.5	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	0.5	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=5.0 mA
Forward Transconductance	G_M	40	-	mS	V_{DS}=10.0 V, I_{DS}=50.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	3.5	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	3.75	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	1.2	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=5.0 mA, P_{OUT}=1.0 W, F=500 MHz
Drain Efficiency	η_D	45	-	%	V_{DD}=28.0 V, I_{DQ}=5.0 mA, P_{OUT}=1.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=5.0 mA, P_{OUT}=1.0 W, F=500 MHz

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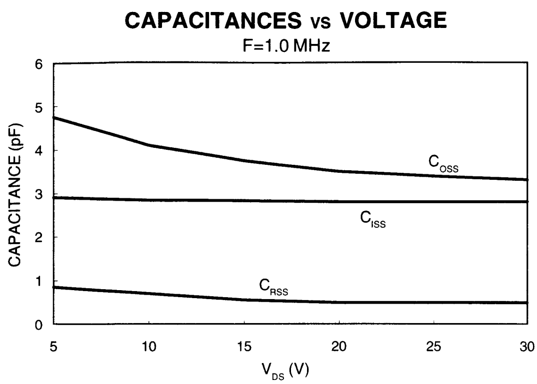
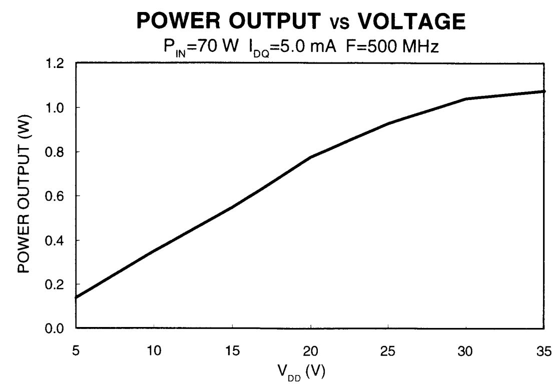
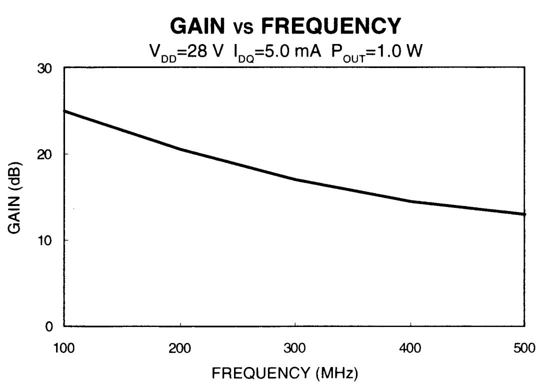
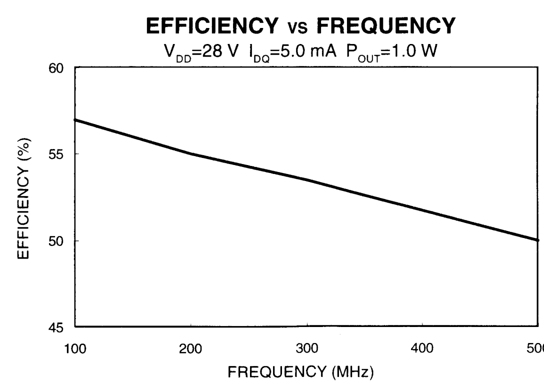
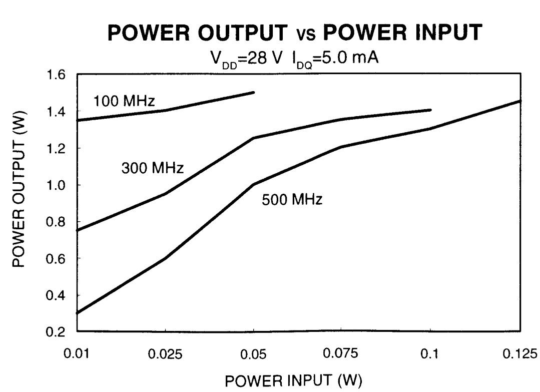
Typical Broadband Performance Curves











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Typical Device Impedance

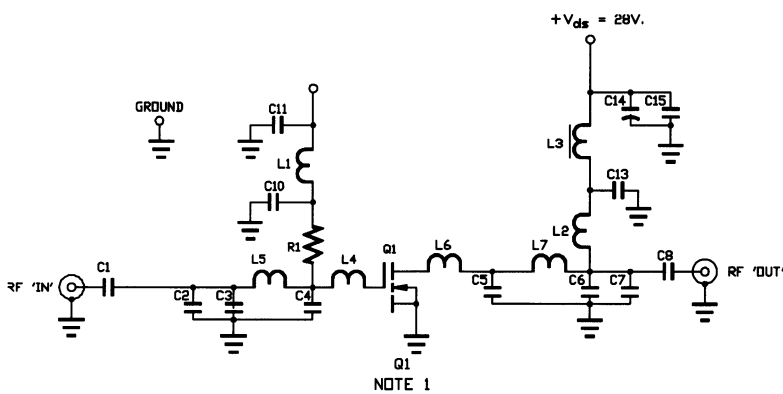
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	53.2 - j 336.0	13.5 + j 246.0
300	50.8 - j 113.0	12.55 + j 84.0
500	46.9 - j 66.0	11.0 + j 54.0

V_{DD}=28 V, I_{DQ}=5.0 mA, P_{OUT}=1.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C5	3.0pf
C4	5.1pf
C6	9.1pf
C3	6.8pf
C2	8.2pf
C7	11pf
C1, 8, 10, 11, 13, 15	.015uf
C14	50uf 50V.
R1	11K OHM
Q1	UF2801KI
L1, 2, 3	10 TURNS OF NO. 22 AWG
L4	1.50" OF 50 OHM TRANSMISSION LINE
L5	.50" OF 50 OHM TRANSMISSION LINE
L6	.30" OF 50 OHM TRANSMISSION LINE
L7	2.00" OF 50 OHM TRANSMISSION LINE

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Typical S-Parameters

V_{DD}=28 V, I_{DS}=25 mA

FREQUENCY MHz	INP. REFL S11		FORW. TRAN S21		REV. TRAN S12		OUTPL. REFL S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.00	1.00	-1.5	1.96	178.6	0.01	82.6	1.00	-1.4
20.00	1.00	-3.0	1.97	177.4	0.02	82.9	1.00	-2.7
30.00	1.00	-4.5	1.97	175.5	0.02	81.6	1.00	-4.2
40.00	1.00	-6.0	1.97	173.6	0.03	82.3	1.00	-5.5
50.00	1.00	-7.5	1.97	171.7	0.04	81.5	1.00	-6.9
60.00	1.00	-8.9	1.96	169.7	0.05	80.0	0.99	-8.3
70.00	0.99	-10.5	1.96	168.0	0.05	79.0	0.99	-9.7
80.00	0.99	-12.0	1.95	166.2	0.06	77.8	0.99	-10.7
90.00	0.99	-13.5	1.96	164.4	0.07	77.2	0.99	-12.5
100.00	0.99	-14.9	1.96	162.4	0.08	76.2	0.99	-13.8
110.00	0.99	-16.3	1.95	160.2	0.08	73.6	0.98	-15.3
120.00	0.99	-17.8	1.94	158.4	0.09	72.8	0.98	-16.6
130.00	0.98	-19.3	1.94	156.5	0.10	71.1	0.98	-17.8
140.00	0.98	-20.8	1.93	154.7	0.10	70.2	0.98	-19.0
150.00	0.98	-22.3	1.92	152.9	0.11	69.5	0.97	-20.5
160.00	0.98	-22.4	1.92	152.8	0.11	69.2	0.97	-20.4
175.00	0.97	-26.1	1.90	148.8	0.13	66.4	0.96	-23.6
200.00	0.96	-29.5	1.88	144.8	0.14	63.0	0.95	-27.0
225.00	0.95	-33.0	1.85	140.2	0.16	60.1	0.94	-30.1
250.00	0.94	-36.1	1.81	135.9	0.17	56.8	0.92	-33.1
275.00	0.93	-39.7	1.78	132.3	0.18	54.6	0.91	-36.1
300.00	0.92	-42.8	1.75	128.6	0.19	52.0	0.89	-39.0
325.00	0.91	-45.8	1.71	124.7	0.20	49.1	0.88	-41.6
350.00	0.90	-48.5	1.69	121.7	0.21	47.9	0.87	-44.3
375.00	0.89	-50.9	1.67	119.2	0.22	45.8	0.85	-46.5
400.00	0.88	-54.2	1.65	115.9	0.22	44.0	0.84	-48.2
425.00	0.87	-56.9	1.64	112.3	0.23	41.5	0.83	-51.0
450.00	0.87	-59.9	1.64	108.5	0.24	38.7	0.82	-53.1
475.00	0.86	-62.7	1.61	104.9	0.25	36.3	0.81	-54.9
500.00	0.85	-65.3	1.51	101.4	0.25	33.8	0.79	-57.0

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M/A-COM an AMP company

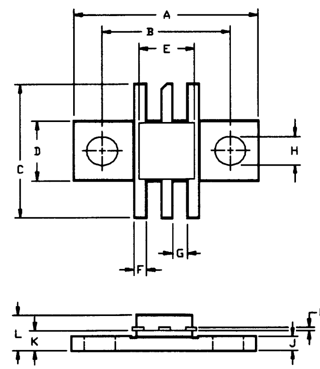
RF MOSFET Power Transistor, 5W, 28V
100 - 500 MHz

UF2805B

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor
- 100 MHz to 500 MHz Operation



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	14.73	15.24	.580	.600
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	1.14	1.40	.045	.055
G	1.52	1.78	.060	.070
H	2.92	3.17	.115	.125
J	1.40	1.65	.055	.065
K	2.03	2.39	.080	.094
L	3.66	4.32	.144	.170
M	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	1.4	A
Power Dissipation	P_D	14.4	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	12.1	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=2.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=10.0 mA
Forward Transconductance	G_M	80	-	mS	V_{DS}=10.0 V, I_{DS}=100.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	7	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	5	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	2.4	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=50.0 mA, P_{OUT}=5.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=50.0 mA, P_{OUT}=5.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=50.0 mA, P_{OUT}=5.0 W, F=500 MHz

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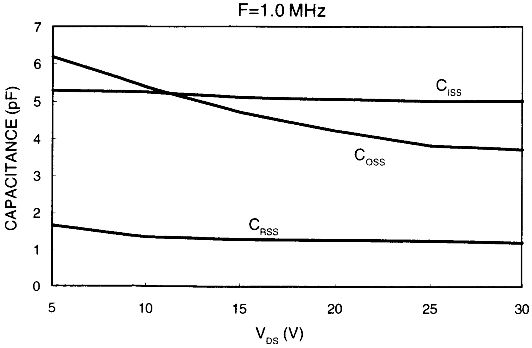
Typical Broadband Performance Curves

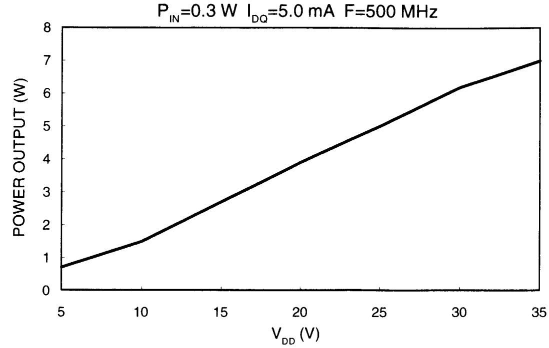
CAPACITANCES vs VOLTAGE

F=1.0 MHz



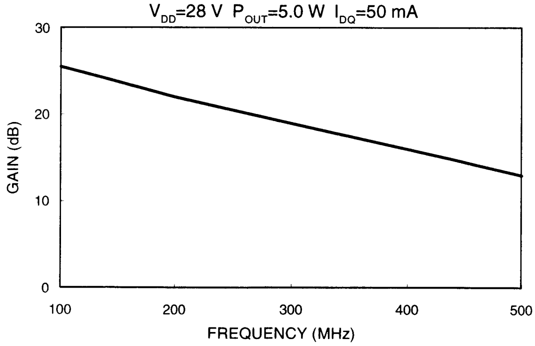
POWER OUTPUT vs VOLTAGE

P_{IN}=0.3 W I_{DQ}=5.0 mA F=500 MHz



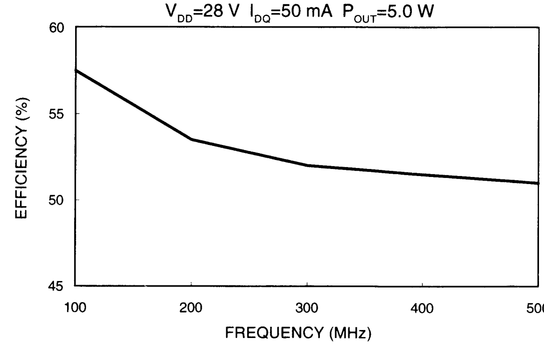
GAIN vs FREQUENCY

V_{DD}=28 V P_{OUT}=5.0 W I_{DQ}=50 mA



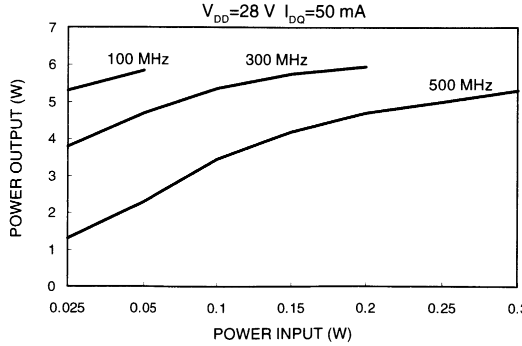
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=50 mA P_{OUT}=5.0 W



POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=50 mA



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Typical Device Impedance

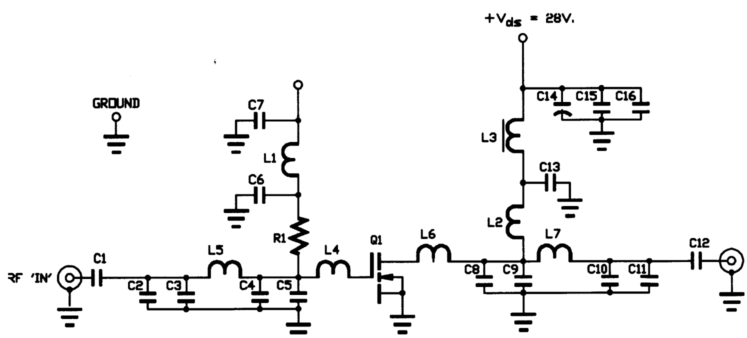
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	15.0 - j 80.0	35.0 + j 55.0
300	8.0 - j 43.0	29.0 + j 40.0
500	4.0 - j 29.0	28.0 + j 29.0

V_{DD}=28 V, I_{DQ}=50 mA, P_{OUT}=5.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C8	1.0pf
C9	3.9pf
C4, 10, 11	4.7pf
C2	5.6pf
C3	8.2pf
C5	15pf
C6, 7, 13, 16	680pf
C1, 12	820pf
C15	.01uf
C14	50uf 50V.
R1	10K OHM
Q1	UF2805B
L1	9 TURNS OF NO. 24 AWG
L2	7 TURNS OF NO. 22 AWG
L3	3 TURNS OF NO. 24 AWG ON FERRITE BEAD
L4	1.30" OF 50 OHM TRANSMISSION LINE
L5	.70" OF 50 OHM TRANSMISSION LINE
L6	.20" OF 50 OHM TRANSMISSION LINE
L7	1.85" OF 50 OHM TRANSMISSION LINE

an AMP company

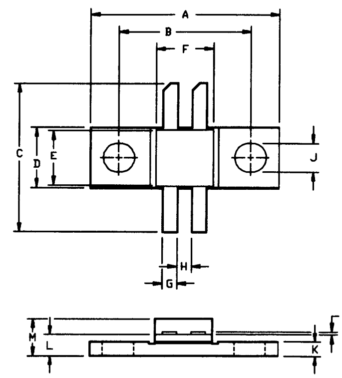
RF MOSFET Power Transistor, 10W, 28V
100 - 500 MHz

UF2810P

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor
- 100 MHz to 500 MHz Operation



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	15.67	17.45	.617	.687
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.40	1.65	.055	.065
H	1.40	1.65	.055	.065
J	2.92	3.18	.115	.125
K	1.40	1.65	.055	.065
L	1.96	2.46	.077	.097
M	3.61	4.37	.142	.172
N	.08	.13	.003	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	1.4*	A
Power Dissipation	P_D	26.9	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	6.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=2.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=10.0 mA*
Forward Transconductance	G_M	80	-	mS	V_{DS}=10.0 V, I_{DS}=100.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	7	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	5	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	2.4	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=100.0 mA, P_{OUT}=10.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=100.0 mA, P_{OUT}=10.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=100.0 mA, P_{OUT}=10.0 W, F=500 MHz

* Per Side

Specifications Subject to Change Without Notice.

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Typical Device Impedance

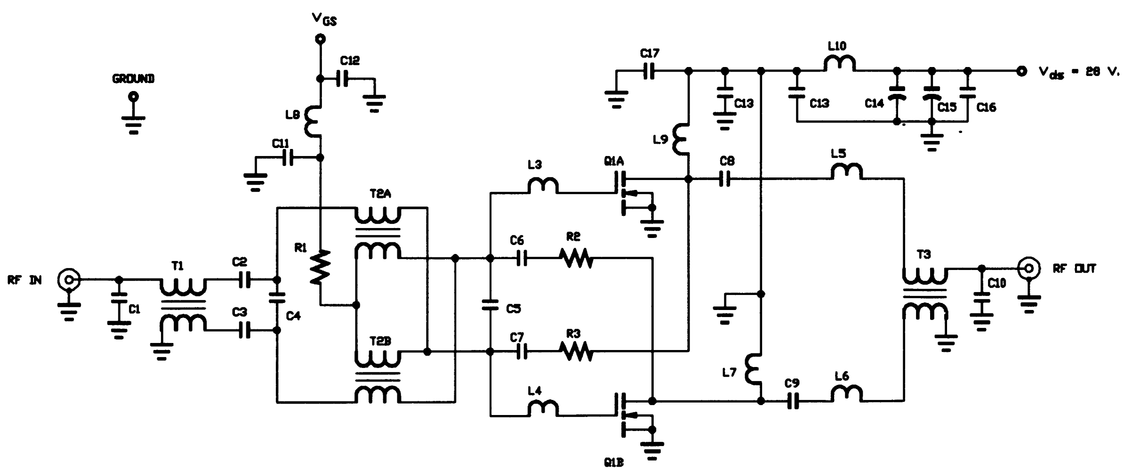
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	30.0 - j 150.0	70.0 + j 110.0
300	15.0 - j 90.0	55.0 + j 80.0
500	4.2 - j 46.0	48.0 + j 50.0

V_{DD}=28 V, I_{DQ}=100 mA, P_{OUT}=10.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



P A R T S   L I S T

C10	2.7 pf
C5	3.0 PF
C1	6.8 pf
C4	15 pf
C2, 3, 6, 7, 8, 9	500 pf
C11, 12, 13, 14, 17	.015 uf
C15	.10 uf
C16	50 uf 50 V.
R1	100 OHM .25 W.
R2, 3	1.1K OHM .25 W.
T1, 2, 3	2.50' OF 50 OHM SEMI-RIGID COAX
L8, 10	7 TURNS OF NO. 22 AWG WIRE
L7, 9	15 TURNS OF NO. 22 AWG WIRE
L1, 2	.35' OF 50 OHM TRANSMISSION LINE
L3, 4	.70' OF 50 OHM TRANSMISSION LINE
L5, 6	1.0' OF 50 OHM TRANSMISSION LINE
Q1	UF2810P

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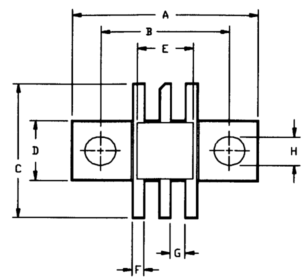
RF MOSFET Power Transistor, 15W, 28V
100 - 500 MHz

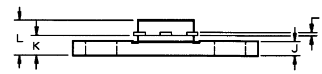
UF2815B

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor
- 100 MHz to 500 MHz Operation





LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	14.73	15.24	.580	.600
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	1.14	1.40	.045	.055
G	1.52	1.78	.060	.070
H	2.92	3.17	.115	.125
J	1.40	1.65	.055	.065
K	2.03	2.39	.080	.094
L	3.66	4.32	.144	.170
M	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4.2	A
Power Dissipation	P_D	48.6	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.6	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=6.0 mA
Drain-Source Leakage Current	I_{DSS}	-	3.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	3.0	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=30.0 mA
Forward Transconductance	G_M	.240	-	S	V_{DS}=10.0 V, I_{DS}=300.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	21	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	15	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	7.2	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=150.0 mA, P_{OUT}=15.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=150.0 mA, P_{OUT}=15.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=150.0 mA, P_{OUT}=15.0 W, F=500 MHz

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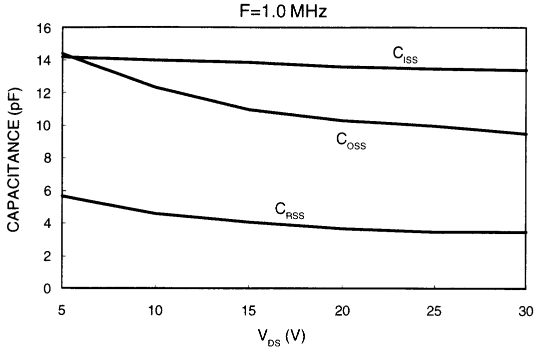
Typical Broadband Performance Curves

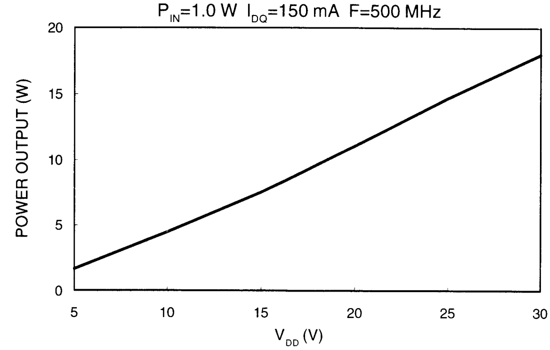
CAPACITANCES vs VOLTAGE

F=1.0 MHz



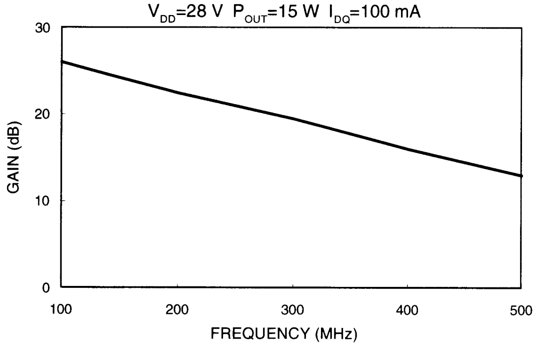
POWER OUTPUT vs VOLTAGE

P_{IN}=1.0 W I_{DQ}=150 mA F=500 MHz



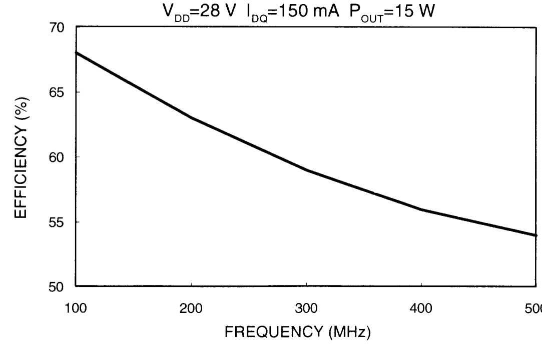
GAIN vs FREQUENCY

V_{DD}=28 V P_{OUT}=15 W I_{DQ}=100 mA



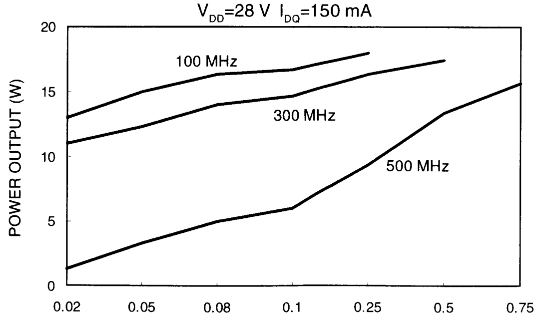
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=150 mA P_{OUT}=15 W



POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=150 mA



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Typical Device Impedance

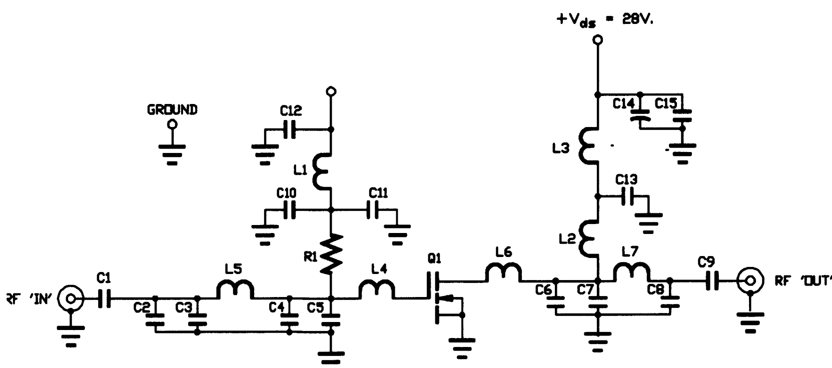
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	6.4 - j 25.0	22.0 + j 16.0
300	6.5 - j 12.0	15.0 + j 14.0
500	1.7 - j 10.5	8.0 + j 10.5

V_{DD}=28 V, I_{DQ}=150 mA, P_{OUT}=15.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C7	2.0 pf
C4	3.0pf
C6	3.6pf
C5, 8	5.6pf
C3	9.1pf
C2	13pf
C9	270pf
C1	820pf
C11, 12, 13, 15	.015uf
C10	.10uf
C14	50uf 50V.
R1	10K OHM
Q1	UF2815B
L1, 3	9 TURNS OF NO. 22 AWG
L2	20 TURNS OF NO. 22 AWG
L4	.55' OF 50 OHM TRANSMISSION LINE
L5	.25' OF 50 OHM TRANSMISSION LINE
L6	1.20' OF 50 OHM TRANSMISSION LINE
L7	.10' OF 50 OHM TRANSMISSION LINE

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M/A-COM an AMP company

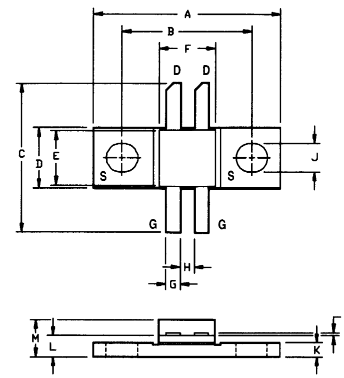
RF MOSFET Power Transistor, 20W, 28V 100 - 500 MHz

UF2820P

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	15.67	17.45	.617	.687
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.40	1.65	.055	.065
H	1.40	1.65	.055	.065
J	2.92	3.18	.115	.125
K	1.40	1.65	.055	.065
L	1.96	2.46	.077	.097
M	3.61	4.37	.142	.172
N	.08	.13	.003	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	2.8*	A
Power Dissipation	P_D	53	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	3.3	°C/W

Electrical Characteristics at 25°C

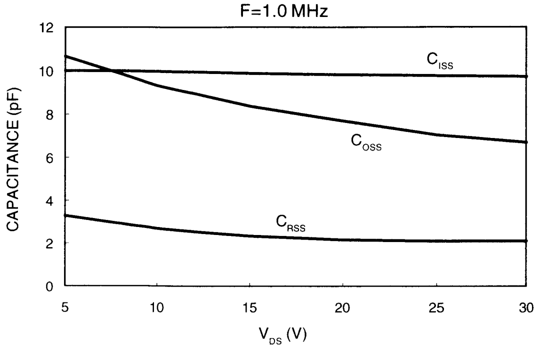
Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=4.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	2.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	2.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=200.0 mA*
Forward Transconductance	G_M	.160	-	S	V_{DS}=10.0 V, I_{DS}=200.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	14	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	10	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	4.8	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=200.0 mA, P_{OUT}=20.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=200.0 mA, P_{OUT}=20.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=200.0 mA, P_{OUT}=20.0 W, F=500 MHz

* Per Side

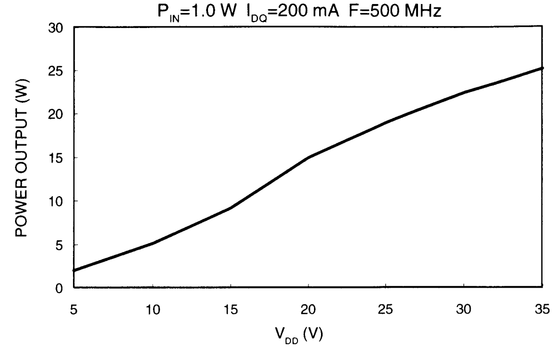
Specifications Subject to Change Without Notice.

Typical Broadband Performance Curves

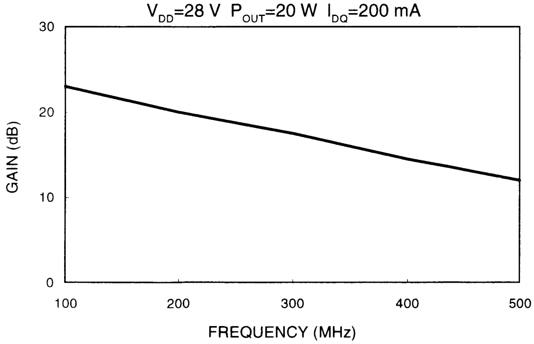
CAPACITANCES vs VOLTAGE
F=1.0 MHz



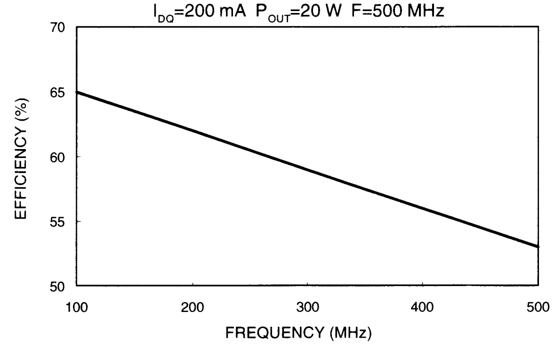
POWER OUTPUT vs VOLTAGE
P_{IN}=1.0 W I_{DQ}=200 mA F=500 MHz



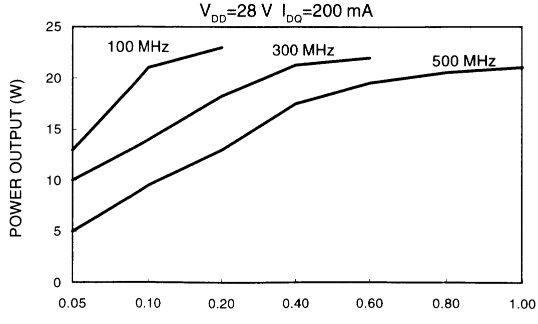
GAIN vs FREQUENCY
V_{DD}=28 V P_{OUT}=20 W I_{DQ}=200 mA



EFFICIENCY vs FREQUENCY
I_{DQ}=200 mA P_{OUT}=20 W F=500 MHz



POWER OUTPUT vs POWER INPUT
V_{DD}=28 V I_{DQ}=200 mA



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Typical Device Impedance

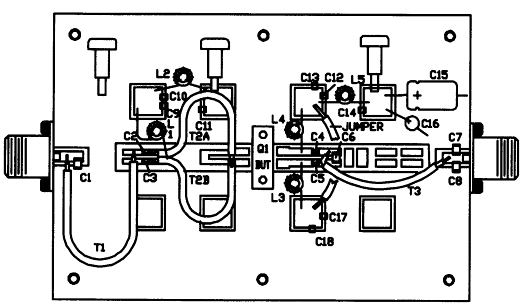
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	9.5 - j 60.0	4.0 + j 68.0
300	5.0 - j 35.0	40.0 + j 48.0
500	2.0 - j 22.0	36.0 + j 34.0

V_{DD}=28 V, I_{DQ}=200 mA, P_{OUT}=20.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

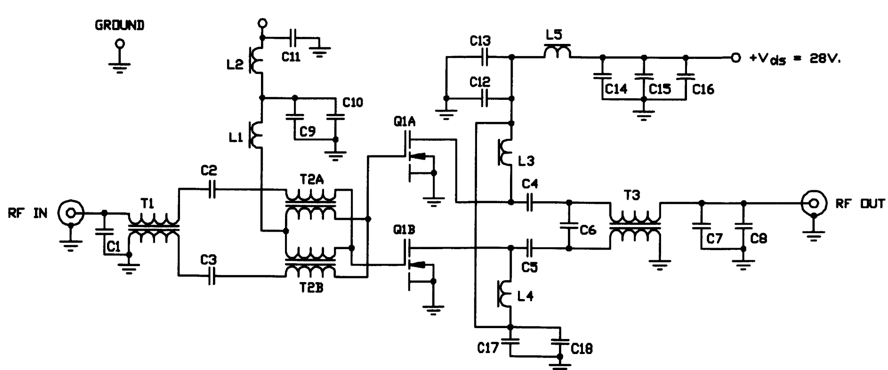
Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



P A R T S L I S T

C1	11pf
C2, 3, 4, 5	560pf
C6	6.8pf
C7	0.6pf
c8	2.0PF
C10, 11, 12, 14, 17	.015uf
C9, 13, 18	680pf
C15	50uf 50V.
C16	0.1uf
T1	2.50' OF 50 OHM (.085' OD) SEMI RIGID COAX
T2A, 2B	2.50' OF 25 OHM (.070' OD) SEMI RIGID COAX
T3	2.10' OF 50 OHM (.085' OD) SEMI RIGID COAX
L1, 2, 3, 4, 5	14 TURNS OF NO. 28 AWG ON TOROID CORE



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an AMP company

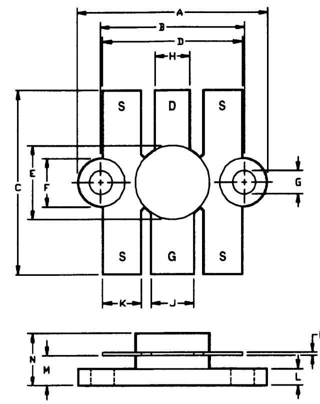
RF MOSFET Power Transistor, 20W, 28V
100 - 500 MHz

UF2820R

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	23.88	24.38	.940	.960
D	18.16	18.42	.715	.725
E	9.47	9.73	.373	.383
F	6.22	6.48	.245	.255
G	2.92	3.18	.115	.125
H	4.45	4.69	.175	.185
J	5.46	5.72	.215	.225
K	4.95	5.21	.195	.205
L	2.41	2.67	.095	.105
M	4.06	4.57	.160	.180
N	6.58	7.39	.259	.291
P	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4	A
Power Dissipation	P_D	61	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	2.86	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA
Forward Transconductance	G_M	.500	-	S	V_{DS}=10.0 V, I_{DS}=1000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse
Input Capacitance	C_{ISS}	-	45	pF	V_{DS}=28.0 V, F=1.0 MHz
Output Capacitance	C_{OSS}	-	30	pF	V_{DS}=28.0 V, F=1.0 MHz
Reverse Capacitance	C_{RSS}	-	8	pF	V_{DS}=28.0 V, F=1.0 MHz
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=100.0 mA, P_{OUT}=20.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=100.0 mA, P_{OUT}=20.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=100.0 mA, P_{OUT}=20.0 W, F=500 MHz

Specifications Subject to Change Without Notice.

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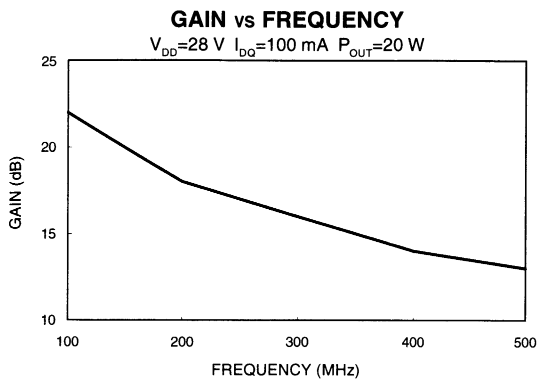
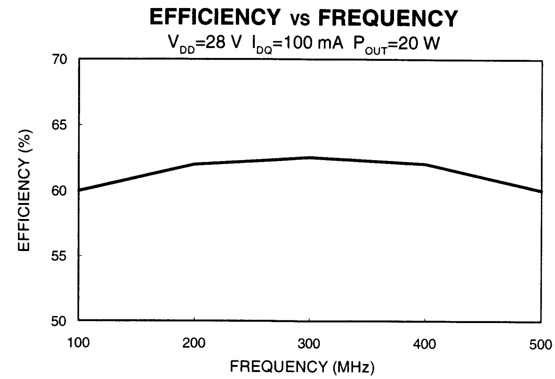
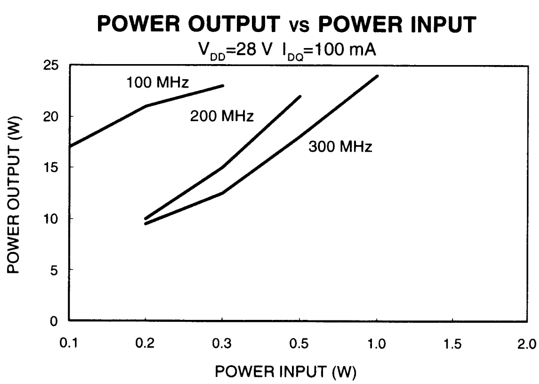
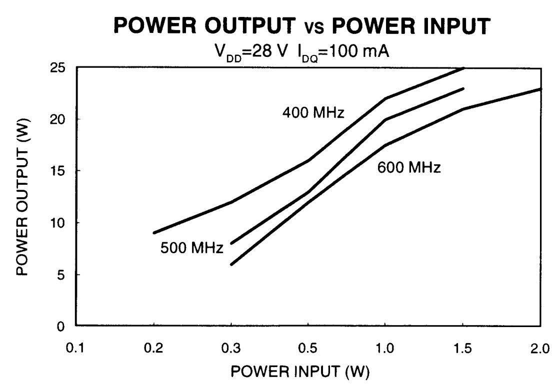
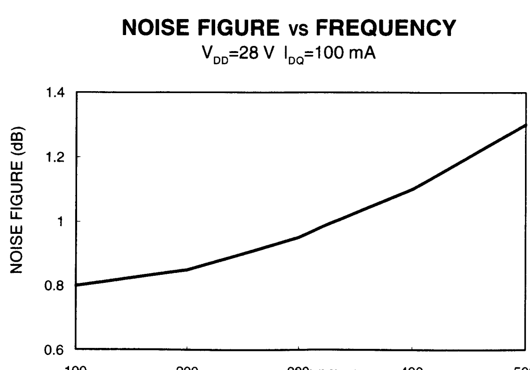
Typical Broadband Performance Curves











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Typical Device Impedance

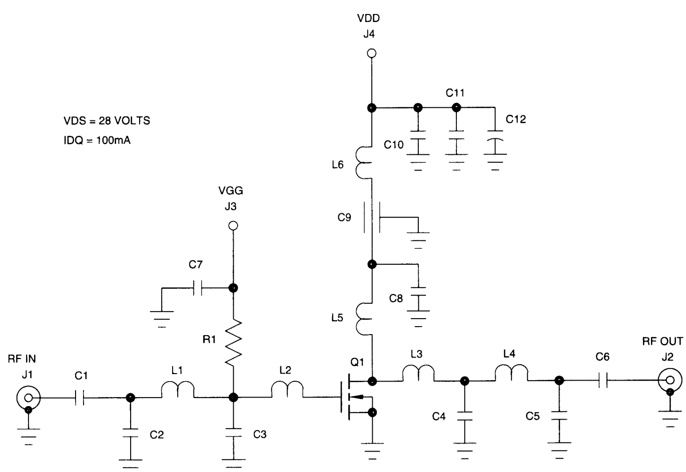
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	8.0 - j 16.0	12.0 + j 6.0
200	5.5 - j 8.0	9.3 + j 6.0
300	4.0 - j 3.8	6.8 + j 5.5
400	3.0 - j 2.0	4.5 + J 4.5
500	2.0 + J 1.0	3.0 + j 3.0

V_{DD}=28 V, I_{DQ}=100 mA, P_{OUT}=20.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to source.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to source.

RF Test Fixture



PARTS LIST

C1,C6,C10	CAPACITOR 1000pF
C7	
C2,C5	CAPACITOR 10pF
C3	CAPACITOR 30pF
C4	CAPACITOR 25pF
C8	CAPACITOR 500pF
C9	FEEDTHROUGH CAPACITOR 500pF
C11	MONOLITHIC CERAMIC CAPACITOR 0.1uF
C12	ELECTROLYTIC CAPACITOR 50uF 50 VOLTS
L1	0.25" X 0.63" HAIRPIN, NO. 22 AWG
L2	0.25" X 0.20" MICROSTRIP LINE
L3	0.25' X 0.40" MICROSTRIP LINE
L4	0.30" X 0.06" HAIRPIN, NO. 18 AWG
L5	6 TURNS OF NO. 20 AWG ON '0.30", CLOSE WOUND
L6	12 TURNS OF NO. 20 AWG ON '0.30", CLOSE WOUND
R1	RESISTOR 12K OHMS 0.25 WATT
Q1	UF2820R
BOARD	FR4 0.062"

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an AMP company

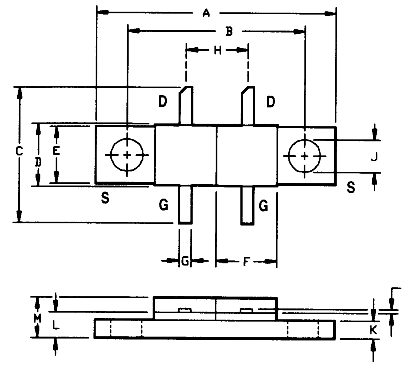
RF MOSFET Power Transistor, 40W, 28V
100 - 500 MHz

UF2840G

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	.970	.980
B	18.29	18.54	.720	.730
C	13.72	14.22	.540	.560
D	6.22	6.48	.245	.255
E	5.72	5.97	.225	.235
F	6.22	6.48	.245	.255
G	1.14	1.40	.045	.055
H	6.22	6.48	.245	.255
J	3.18	3.43	.125	.135
K	1.78	2.03	.070	.080
L	2.34	2.84	.092	.112
M	3.99	4.75	.157	.187
N	.08	.15	.003	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4*	A
Power Dissipation	P_D	116	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.52	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA*
Forward Transconductance	G_M	.500	-	S	V_{DS}=10.0 V, I_{DS}=1.0 A, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	45	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	30	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	8	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=500.0 mA, P_{OUT}=40.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=500.0 mA, P_{OUT}=40.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=500.0 mA, P_{OUT}=40.0 W, F=500 MHz

* Per Side

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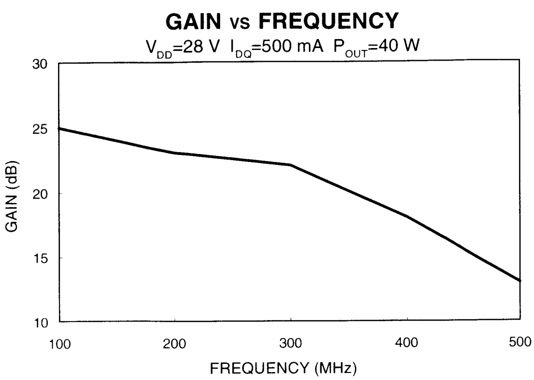
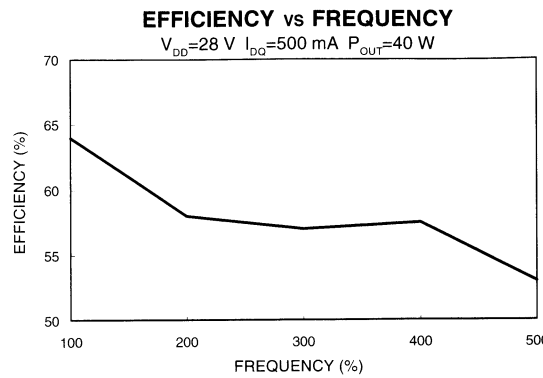
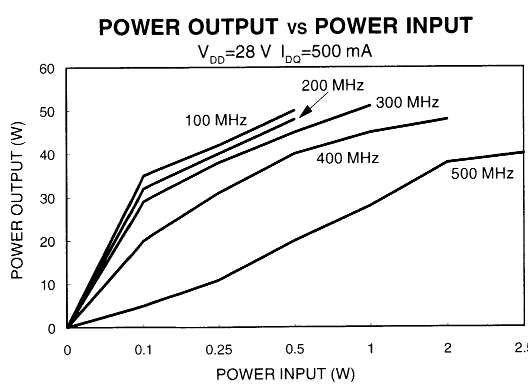
Typical Broadband Performance Curves







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Typical Device Impedance

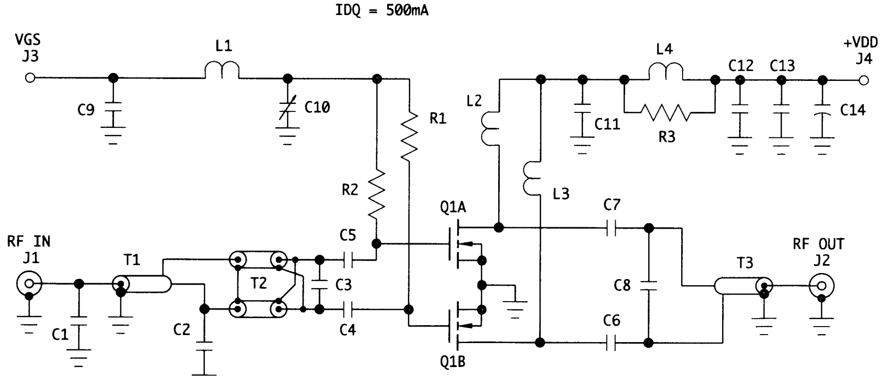
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	6.0 - j 20.0	25.0 + j 27.0
200	3.5 - j 11.5	16.5 + j 19.5
300	2.5 - j 5.5	13.0 + j 13.0
400	3.0 + j 0.0	12.0 + j 9.0
500	4.0 + j 3.0	12.0 + j 5.0

V_{DD}=28 V, I_{DQ}=500 mA, P_{OUT}=40.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to ground.

RF Test Fixture



PARTS LIST

C1,C3	CAPACITOR 15pF
C2	CAPACITOR 7pF
C4,C5,C6, C7	CHIP CAPACITOR 620pF ATC
C8	CHIP CAPACITOR 9.1pF ATC
C9,C12	CAPACITOR 1000pF
C10	TRIMMER CAPACITOR 2-500pF
C11	CAPACITOR ATC 500pF
C13	MONOLITHIC CERAMIC CAPACITOR 0.1uF
C14	ELECTROLYTIC CAPACITOR 50uF 50 V.
L1	4 TURNS OF NO. 22 AWG ON '0.35"
L2,L3	6 TURNS OF NO. 22 AWG ON '0.35"
L4	8 TURNS OF NO. 22 AWG ON R3
R1,R2	RESISTOR 12K OHMS 0.25 WATT
R3	RESISTOR 33 OHMS 3 WATTS
T1	50 OHM SEMI-RIGID COAX 2.1" X '0.085"
T2	25 OHM SEMI-RIGID COAX 2X 2.3" X '0.070"
T3	25 OHM SEMI-RIGID COAX 3.3" X '0.070"
Q1	UF2840G
BOARD	FR4 0.062"

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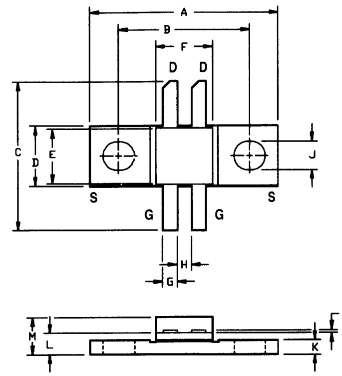
RF MOSFET Power Transistor, 40W, 28V 100 - 500 MHz

UF2840P

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.70	20.96	.815	.825
B	14.35	14.61	.565	.575
C	15.67	17.45	.617	.687
D	6.27	6.53	.247	.257
E	6.22	6.48	.245	.255
F	6.22	6.48	.245	.255
G	1.40	1.65	.055	.065
H	1.40	1.65	.055	.065
J	2.92	3.18	.115	.125
K	1.40	1.65	.055	.065
L	1.96	2.46	.077	.097
M	3.61	4.37	.142	.172
N	.08	.13	.003	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	4*	A
Power Dissipation	P_D	116	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	1.5	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=5.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	1.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	1.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=100.0 mA*
Forward Transconductance	G_M	.5	-	S	V_{DS}=10.0 V, I_{DS}=1000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	45	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	30	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	8	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=500.0 mA, P_{OUT}=40.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=500.0 mA, P_{OUT}=40.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	20:1	-	V_{DD}=28.0 V, I_{DQ}=500.0 mA, P_{OUT}=40.0 W, F=500 MHz

* Per Side

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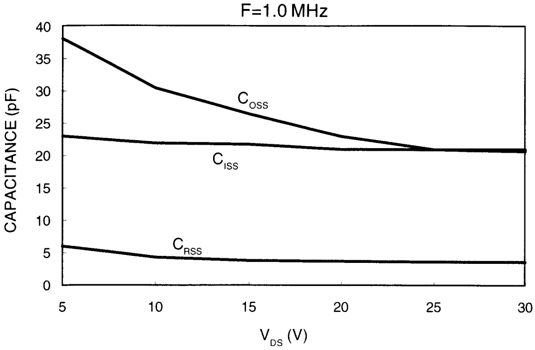
Typical Broadband Performance Curves

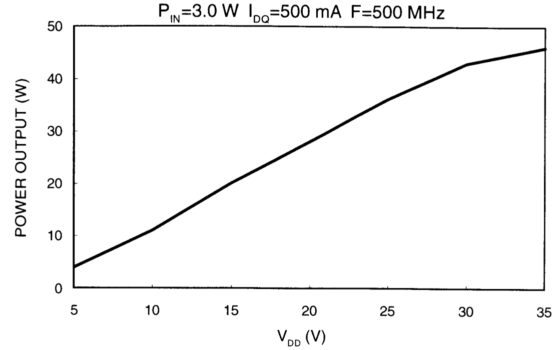
CAPACITANCES vs VOLTAGE

F=1.0 MHz



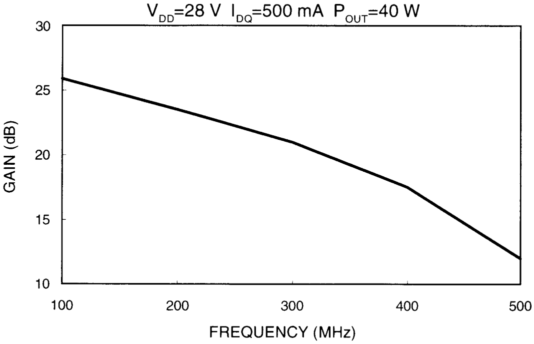
POWER OUTPUT vs VOLTAGE

P_{IN}=3.0 W I_{DQ}=500 mA F=500 MHz



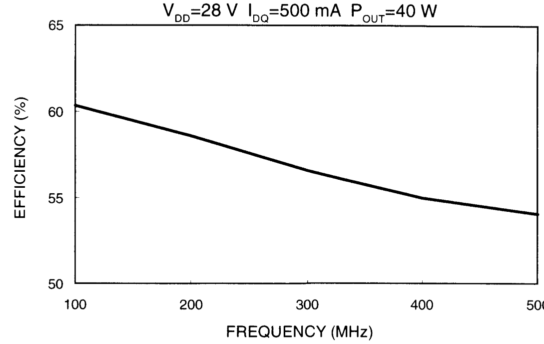
GAIN vs FREQUENCY

V_{DD}=28 V I_{DQ}=500 mA P_{OUT}=40 W



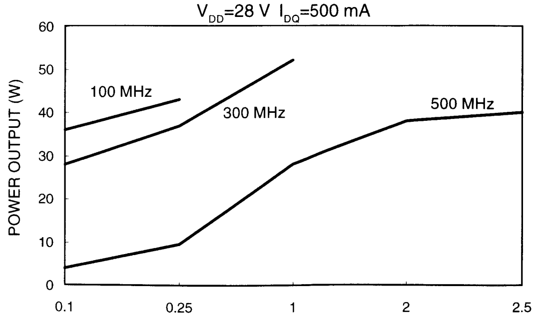
EFFICIENCY vs FREQUENCY

V_{DD}=28 V I_{DQ}=500 mA P_{OUT}=40 W



POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=500 mA



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Typical Device Impedance

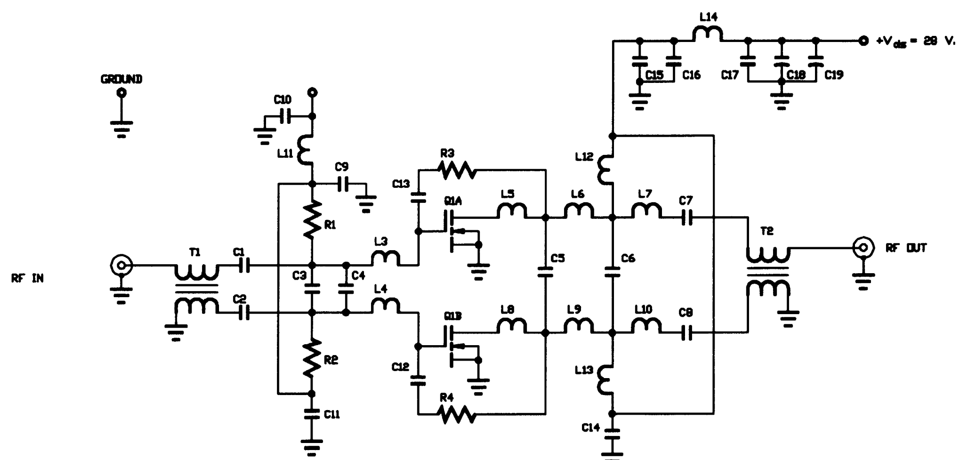
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	6.0 - j 20.0	25.0 + j 27.0
300	2.5 - j 5.5	13.0 + j 13.0
500	4.0 + j 3.0	12.0 + j 5.0

V_{DD}=28 V, I_{DQ}=500 mA, P_{OUT}=40.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



P A R T S L I S T

C3, 5	10.0 pf
C6	11.0 pf
C4	18 pf
C1, 2, 7, 8, 12, 13	470 pf
C7, 9, 10, 11, 14, 15	.015 uf
C18	.10 uf
C16	1.0 uf
C19	50 uf 50 V.
R1, 2	100 OHM .25 W.
R3, 4	270 OHM .25 W.
T1, 2	2.50" OF 25 OHM SEMI-RIGID COAX
L11, 14	7 TURNS OF NO. 22 AWG WIRE
L12, 13	15 TURNS OF NO. 22 AWG WIRE
L7, 10	.15" OF 50 OHM TRANSMISSION LINE
L6, 9	.25" OF 50 OHM TRANSMISSION LINE
L5, 8	.30" OF 50 OHM TRANSMISSION LINE
L4	.35" OF 50 OHM TRANSMISSION LINE
L1, 2	.50" OF 50 OHM TRANSMISSION LINE
Q1	UF2840P

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an AMP company

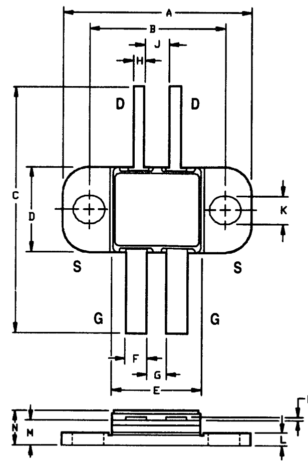
RF MOSFET Power Transistor, 100W, 28V
100 - 500 MHz

UF28100H

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.73	22.99	.895	.905
B	16.38	16.64	.645	.655
C	29.08	29.85	1.145	1.175
D	10.03	10.29	.395	.405
E	10.64	10.90	.419	.429
F	2.41	2.67	.095	.105
G	2.03	2.54	.080	.100
H	1.14	1.40	.045	.055
J	2.79	3.30	.110	.130
K	3.12	3.38	.123	.133
L	1.40	1.65	.055	.065
M	2.87	3.38	.113	.133
N	3.66	4.27	.144	.168
P	.10	.15	.004	.006

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	12*	A
Power Dissipation	P_D	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=15.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	3.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	3.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=300.0 mA*
Forward Transconductance	G_M	1.5	-	S	V_{DS}=10.0 V, I_{DS}=3000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	135	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	90	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	24	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Return Loss	R_L	10	-	dB	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz

* Per Side

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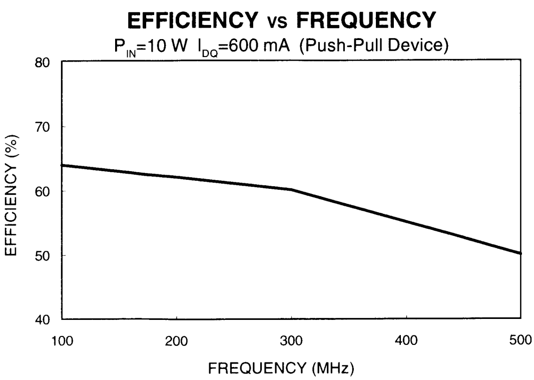
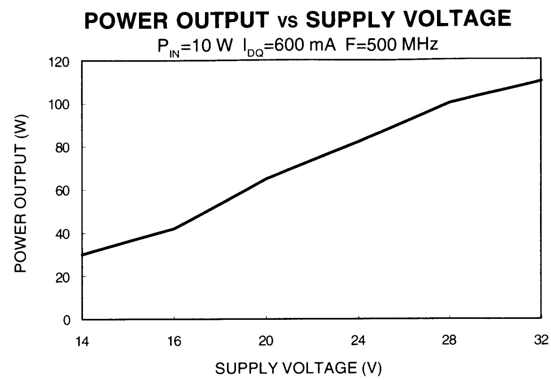
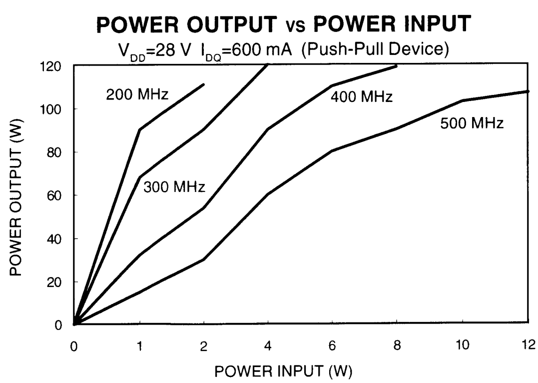
Typical Broadband Performance Curves







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Typical Device Impedance

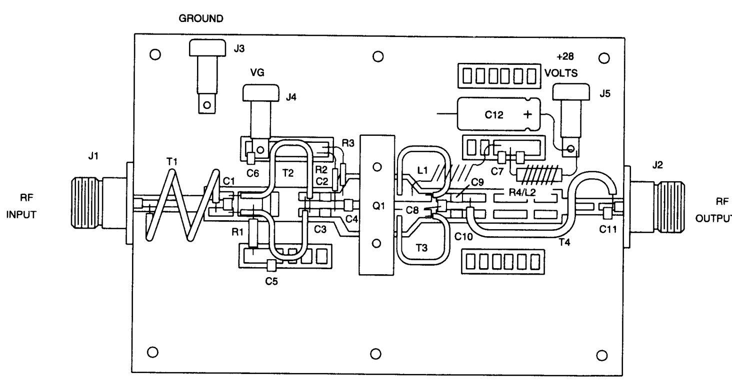
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	4.5 - j 6.0	14.5 + j 0.5
300	2.25 - j 1.75	7.5 + j 1.0
500	1.5 + j 5.5	3.5 - j 3.5

V_{DD}=28 V, I_{DQ}=600 mA, P_{OUT}=100.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C1,C8	CHIP CAPACITOR, 2.0pF ATC B
C2,C3	CHIP CAPACITOR, 5000pF
C4	CHIP CAPACITOR, 37pF ATC B
C5	CHIP CAPACITOR, 260pF ATC B
C6,C7	CHIP CAPACITOR, .015uF
C9,C10	CHIP CAPACITOR, 560pF ATC B
C11	CHIP CAPACITOR, 0.6pF ATC B
C12	ELECTROLYTIC CAPACITOR, 50uF 50 VOLTS
R1,R4	RESISTOR, 27 OHM .25 WATT
R2,R3	RESISTOR, 22K OHM .25 WATT
L1	INDUCTOR, 5 TURNS OF NO. 18 AWG ON '.10"
L2	INDUCTOR, 10 TURNS OF NO. 22 AWG ON R4
T1	1:1 BALUN TRANSFORMER, 50 OHM SEMI-RIGID COAX '.085" X 3" LONG
T2	4:1 BALUN TRANSFORMER, 25 OHM SEMI-RIGID COAX '.070" X 2.5" LONG
T3	1:9 BALUN TRANSFORMER, 10 OHM SEMI-RIGIG COAX '.070" X 2.5" LONG
T4	1:1 BALUN TRANSFORMER, 50 OHM SEMI-RIGID COAX '.085" X 4" LONG
Q1	UF28100H
BOARD	ROGERS 5870, .031" THICK
J1,J2	CONNECTOR, TYPE 'N'
J3,J4,J5	BANANA JACK
HEATSINK	FINNED ALUMINUM, D/N 73050182-03

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an AMP company

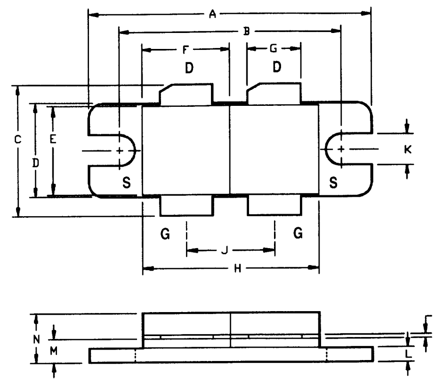
RF MOSFET Power Transistor, 100W, 28V 100 - 500 MHz

UF28100M

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	30.35	30.61	1.195	1.205
B	23.65	23.90	.931	.941
C	13.72	14.22	.540	.560
D	9.63	9.88	.379	.389
E	9.40	9.65	.370	.380
F	9.40	9.65	.370	.380
G	5.59	5.84	.220	.230
H	18.80	19.30	.740	.760
J	9.40	9.65	.370	.380
K	3.12	3.38	.123	.133
L	1.47	1.57	.058	.062
M	2.39	2.74	.094	.108
N	5.03	5.69	.198	.224
P	.05	.13	.002	.005

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	12*	A
Power Dissipation	P_D	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=15.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	3.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	3.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=300.0 mA*
Forward Transconductance	G_M	1.5	-	S	V_{DS}=10.0 V, I_{DS}=3000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	135	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	90	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	24	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Return Loss	R_L	10	-	dB	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz

* Per Side

Specifications Subject to Change Without Notice.

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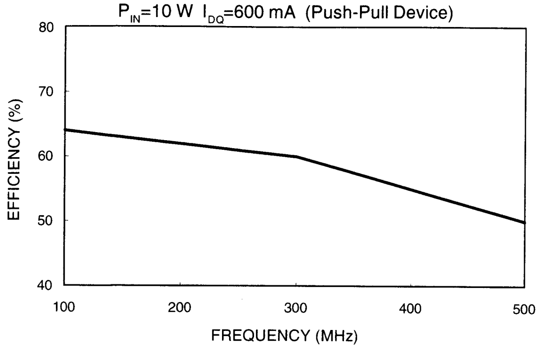
Typical Broadband Performance Curves

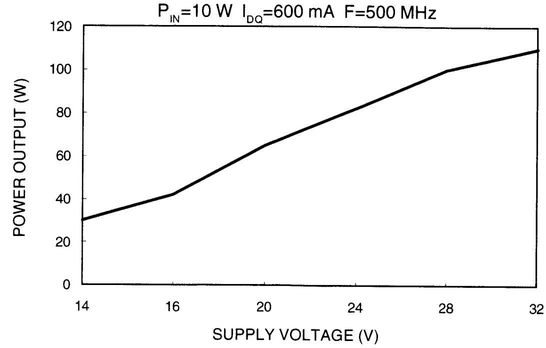
EFFICIENCY vs FREQUENCY

P_{IN}=10 W I_{DQ}=600 mA (Push-Pull Device)



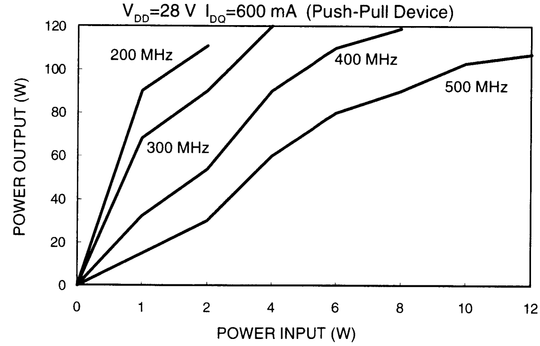
POWER OUTPUT vs SUPPLY VOLTAGE

P_{IN}=10 W I_{DQ}=600 mA F=500 MHz



POWER OUTPUT vs POWER INPUT

V_{DD}=28 V I_{DQ}=600 mA (Push-Pull Device)



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Typical Device Impedance

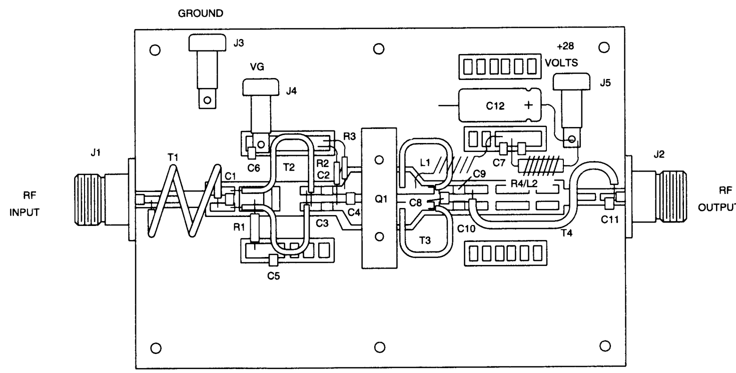
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	4.5 - j 6.0	14.5 + j 0.5
300	2.25 - j 1.75	7.5 + j 1.0
500	1.5 + j 5.5	3.5 - j 3.5

V_{DD}=28 V, I_{DQ}=600 mA, P_{OUT}=100.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C1,C8	CHIP CAPACITOR, 2.0pF ATC B
C2,C3	CHIP CAPACITOR, 5000pF
C4	CHIP CAPACITOR, 37pF ATC B
C5	CHIP CAPACITOR, 260pF ATC B
C6,C7	CHIP CAPACITOR, .015uF
C9,C10	CHIP CAPACITOR, 560pF ATC B
C11	CHIP CAPACITOR, 0.6pF ATC B
C12	ELECTROLYTIC CAPACITOR, 50uF 50 VOLTS
R1,R4	RESISTOR, 27 OHM .25 WATT
R2,R3	RESISTOR, 22K OHM .25 WATT
L1	INDUCTOR, 5 TURNS OF NO. 18 AWG ON '.10"
L2	INDUCTOR, 10 TURNS OF NO. 22 AWG ON R4
T1	1:1 BALUN TRANSFORMER, 50 OHM SEMI-RIGID COAX '.085" X 3" LONG
T2	4:1 BALUN TRANSFORMER, 25 OHM SEMI-RIGID COAX '.070" X 2.5" LONG
T3	1:9 BALUN TRANSFORMER, 10 OHM SEMI-RIGIG COAX '.070" X 2.5" LONG
T4	1:1 BALUN TRANSFORMER, 50 OHM SEMI-RIGID COAX '.085" X 4" LONG
Q1	UF28100M
BOARD	ROGERS 5870, .031" THICK
J1,J2	CONNECTOR, TYPE 'N'
J3,J4,J5	BANANA JACK
HEATSINK	FINNED ALUMINUM, D/N 73050182-03

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an AMP company

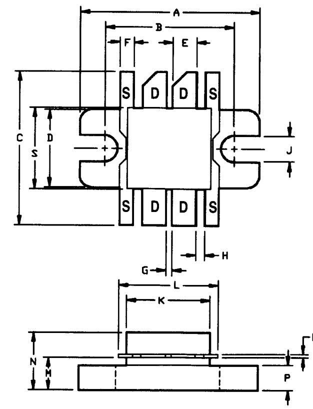
RF MOSFET Power Transistor, 100W, 28V
100 - 500 MHz

UF28100V

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- High Saturated Output Power
- Lower Noise Figure Than Competitive Devices



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.73	22.99	.895	.905
B	16.38	16.64	.645	.655
C	19.05	19.56	.750	.770
D	.382	.389	.382	.389
E	2.92	3.18	.115	.125
F	1.65	1.91	.065	.075
G	.64	.89	.025	.035
H	1.02	1.27	.040	.050
J	3.12	3.38	.123	.133
K	10.67	10.87	.420	.428
L	12.45	12.95	.490	.510
M	4.06	4.57	.160	.180
N	6.71	7.52	.264	.296
P	3.05	3.30	.120	.130
R	.10	.15	.004	.006
S	10.06	10.26	.396	.404

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	12*	A
Power Dissipation	P_D	250	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-55 to +150	°C
Thermal Resistance	θ_{JC}	0.7	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=15.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	3.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	3.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=300.0 mA*
Forward Transconductance	G_M	1.5	-	S	V_{DS}=10.0 V, I_{DS}=3000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	135	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	90	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	24	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	10	-	dB	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Drain Efficiency	η_D	50	-	%	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	30:1	-	V_{DD}=28.0 V, I_{DQ}=600.0 mA, P_{OUT}=100.0 W, F=500 MHz

* Per Side

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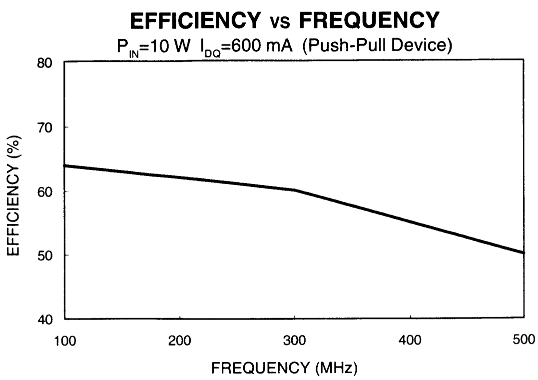
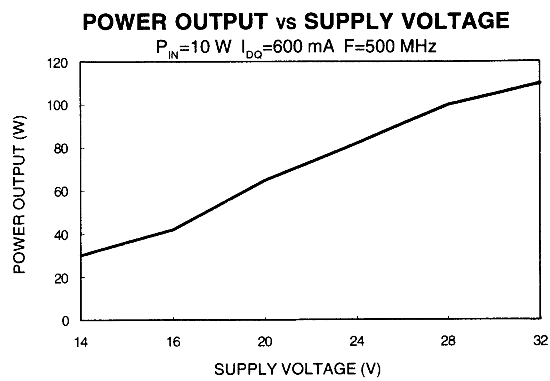
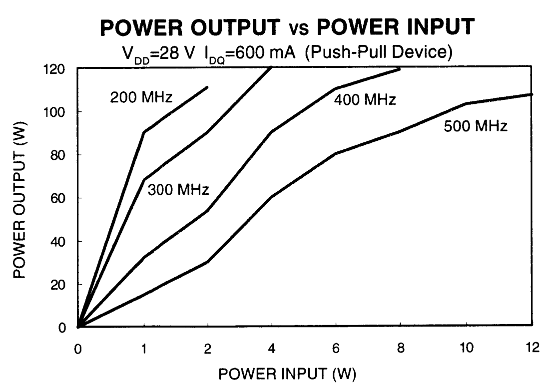
Typical Broadband Performance Curves







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Typical Device Impedance

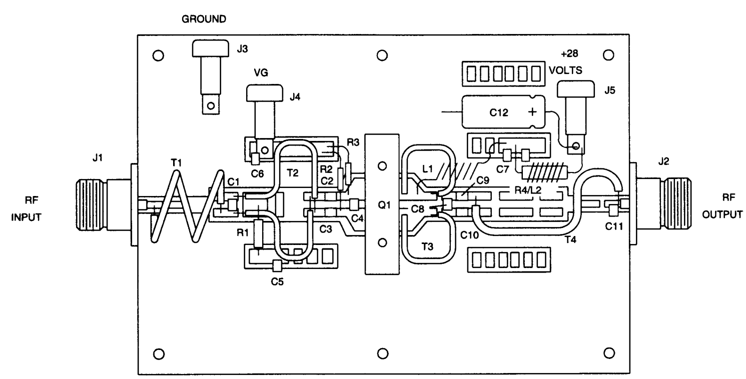
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	4.5 - j 6.0	14.5 + j 0.5
300	2.25 - j 1.75	7.5 + j 1.0
500	1.5 + j 5.5	3.5 - j 3.5

V_{DD}=28 V, I_{DQ}=600 mA, P_{OUT}=100.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C1,C8	CHIP CAPACITOR, 2.0pF ATC B
C2,C3	CHIP CAPACITOR, 5000pF
C4	CHIP CAPACITOR, 37pF ATC B
C5	CHIP CAPACITOR, 260pF ATC B
C6,C7	CHIP CAPACITOR, .015uF
C9,C10	CHIP CAPACITOR, 560pF ATC B
C11	CHIP CAPACITOR, 0.6pF ATC B
C12	ELECTROLYTIC CAPACITOR, 50uF 50 VOLTS
R1,R4	RESISTOR, 27 OHM .25 WATT
R2,R3	RESISTOR, 22K OHM .25 WATT
L1	INDUCTOR, 5 TURNS OF NO. 18 AWG ON '.10"
L2	INDUCTOR, 10 TURNS OF NO. 22 AWG ON R4
T1	1:1 BALUN TRANSFORMER, 50 OHM SEMI-RIGID COAX '.085" X 3" LONG
T2	4:1 BALUN TRANSFORMER, 25 OHM SEMI-RIGID COAX '.070" X 2.5" LONG
T3	1:9 BALUN TRANSFORMER, 10 OHM SEMI-RIGIG COAX '.070" X 2.5" LONG
T4	1:1 BALUN TRANSFORMER, 50 OHM SEMI-RIGID COAX '.085" X 4" LONG
Q1	UF28100V
BOARD	ROGERS 5870, .031" THICK
J1,J2	CONNECTOR, TYPE 'N'
J3,J4,J5	BANANA JACK
HEATSINK	FINNED ALUMINUM, D/N 73050182-03

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M/A-COM
an AMP company

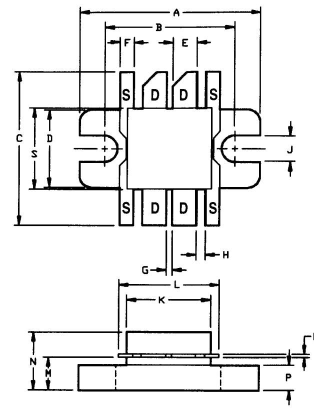
RF MOSFET Power Transistor, 150W, 28V
100 - 500 MHz

UF28150J

V2.00

Features

- N-Channel Enhancement Mode Device
- DMOS Structure
- Lower Capacitances for Broadband Operation
- Common Source Configuration
- Lower Noise Floor



LETTER DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.73	22.99	.895	.905
B	16.38	16.64	.645	.655
C	19.05	19.56	.750	.770
D	.382	.389	.382	.389
E	2.92	3.18	.115	.125
F	1.65	1.91	.065	.075
G	.64	.89	.025	.035
H	1.02	1.27	.040	.050
J	3.12	3.38	.123	.133
K	10.67	10.87	.420	.428
L	12.45	12.95	.490	.510
M	4.06	4.57	.160	.180
N	6.71	7.52	.264	.296
P	3.05	3.30	.120	.130
R	.10	.15	.004	.006
S	10.06	10.26	.396	.404

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Drain-Source Voltage	V_{DS}	65	V
Gate-Source Voltage	V_{GS}	20	V
Drain-Source Current	I_{DS}	16*	A
Power Dissipation	P_D	389	W
Junction Temperature	T_J	200	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Thermal Resistance	θ_{JC}	0.45	°C/W

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Drain-Source Breakdown Voltage	BV_{DSS}	65	-	V	V_{GS}=0.0 V, I_{DS}=25.0 mA*
Drain-Source Leakage Current	I_{DSS}	-	4.0	mA	V_{DS}=28.0 V, V_{GS}=0.0 V*
Gate-Source Leakage Current	I_{GSS}	-	4.0	µA	V_{GS}=20 V, V_{DS}=0.0 V*
Gate Threshold Voltage	$V_{GS(TH)}$	2.0	6.0	V	V_{DS}=10.0 V, I_{DS}=400.0 mA*
Forward Transconductance	G_M	2.0	-	S	V_{DS}=10.0 V, I_{DS}=4000.0 mA, ΔV_{GS}=1.0 V, 80 µs Pulse*
Input Capacitance	C_{ISS}	-	180	pF	V_{DS}=28.0 V, F=1.0 MHz*
Output Capacitance	C_{OSS}	-	120	pF	V_{DS}=28.0 V, F=1.0 MHz*
Reverse Capacitance	C_{RSS}	-	32	pF	V_{DS}=28.0 V, F=1.0 MHz*
Power Gain	G_P	8	-	dB	V_{DD}=28.0 V, I_{DQ}=400.0 mA, P_{OUT}=150.0 W, F=500 MHz
Drain Efficiency	η_D	55	-	%	V_{DD}=28.0 V, I_{DQ}=400.0 mA, P_{OUT}=150.0 W, F=500 MHz
Load Mismatch Tolerance	VSWR-T	-	10:1	-	V_{DD}=28.0 V, I_{DQ}=400.0 mA, P_{OUT}=150.0 W, F=500 MHz

* Per Side

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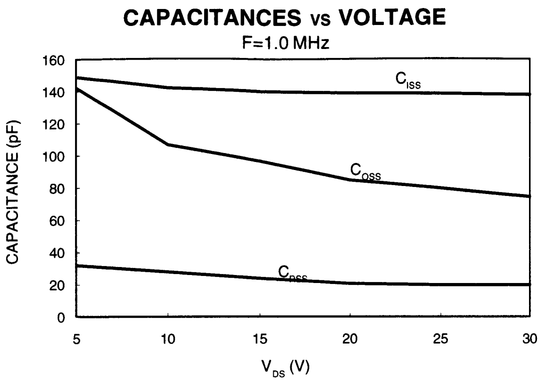
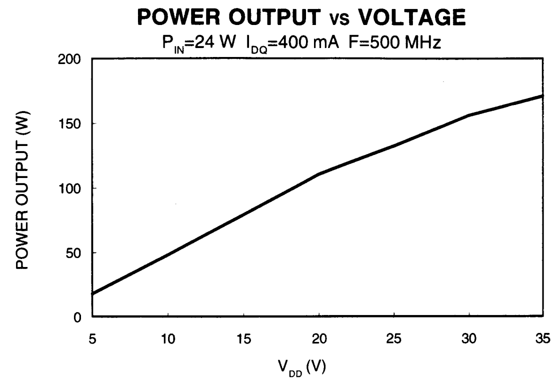
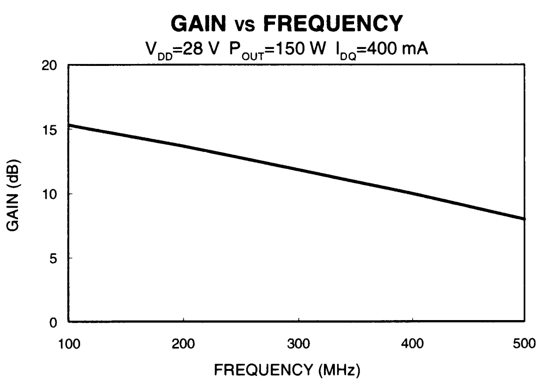
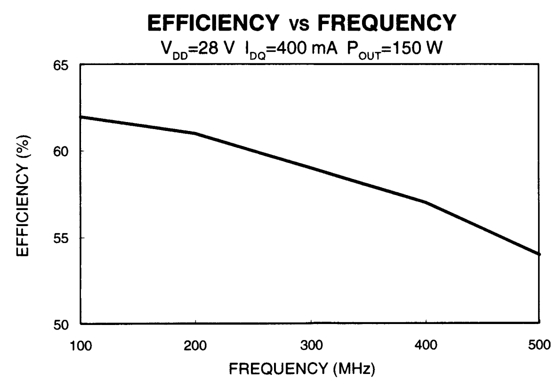
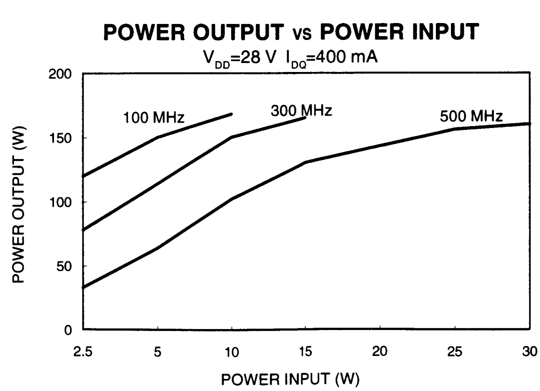
Typical Broadband Performance Curves











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Typical Device Impedance

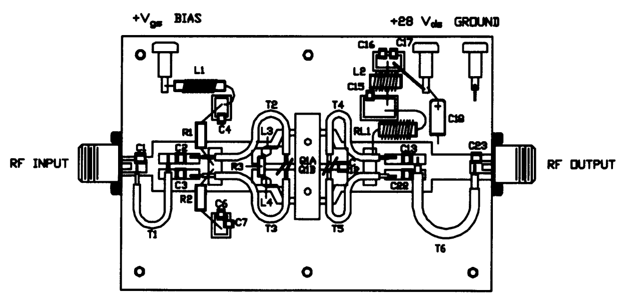
Frequency (MHz)	Z_{IN} (OHMS)	Z_{LOAD} (OHMS)
100	3.7 - j 5.9	3.0 - j 0.7
300	2.7 - j 5.8	2.6 - j 0.55
500	2.5 + j 2.9	2.5 - j 0.5

V_{DD}=28 V, I_{DQ}=400 mA, P_{OUT}=150.0 Watts

Z_{IN} is the series equivalent input impedance of the device from gate to gate.

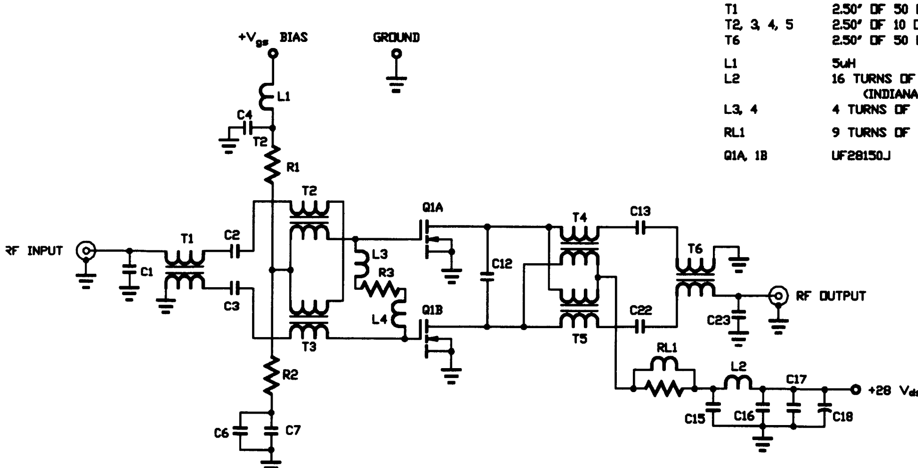
Z_{LOAD} is the optimum series equivalent load impedance as measured from drain to drain.

RF Test Fixture



PARTS LIST

C23	1.0pF
C1	9.1pF
C12	11pF
C2, 3, 13, 22	270pF
C7, 16	680pF
C4, 6, 15, 17	.015uF
C18	50uF 50 V.
R1	11K OHM .25 W. 10%
R2	47 OHM .50 W. 10%
R3	12 OHM .25 W. 10%
T1	2.50" OF 50 OHM (.085" OD) SEMI-RIGID CABLE
T2, 3, 4, 5	2.50" OF 10 OHM (.070" OD) SEMI-RIGID CABLE
T6	2.50" OF 50 OHM (.141" OD) SEMI-RIGID CABLE
L1	5uH
L2	16 TURNS OF NO. 18 AWG ON TORID CORE (INDIANA GENERAL F6278-Q1)
L3, 4	4 TURNS OF NO. 18 AWG ON .125" DIAMETER
RL1	9 TURNS OF NO. 18 AWG ON 15 OHM 2 W. 10% RESISTOR
Q1A, 1B	UF28150J



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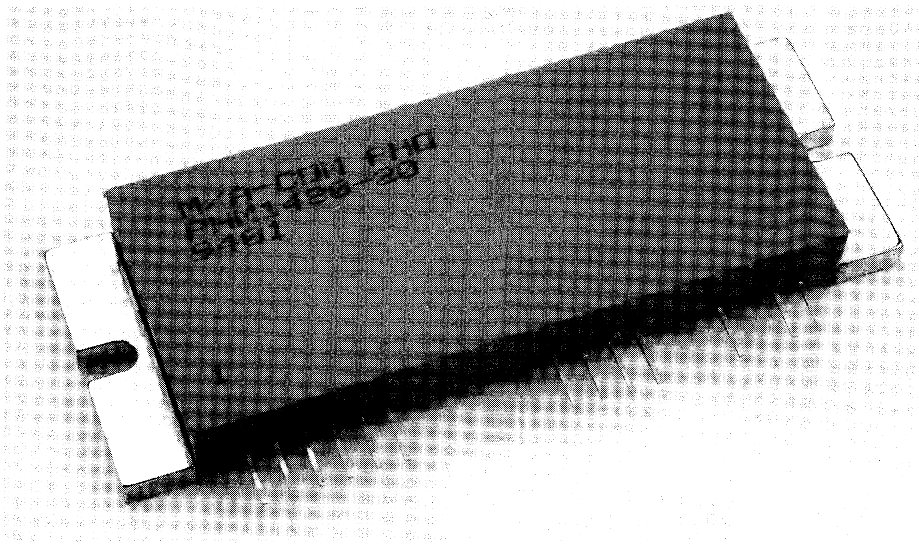
Power Modules



Title	Page

Bipolar Power Modules

V 2.00

	Frequency (MHz)	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	Pulse Width (μs)	Duty (%)	Package (Inches)	Part No.	Page No.
	30 - 400	AB	13	27	28.0	25	CW	-	2.10 x 1.00	PHA4000-1	10-25
	30 - 400	AB	64	27	7.0	35	CW	-	2.10 x 1.00	PHA4000-2	10-26
	1453 - 1477	AB	20	26	40	25	CW	-	1.00 x 2.84	PHM1480-20	10-27
	1500 - 1600	AB	2	25	10.0	35	CW	-	0.80 x 1.25	PHA1516-2	10-7
	1500 - 1600	AB	10	25	10.0	40	CW	-	0.80 x 1.25	PHA1516-10	10-9
	1500 - 1600	AB	30	25	9.5	40	CW	-	0.80 x 1.70	PHA1516-30	10-10
	1600 - 1700	AB	2	25	10.0	35	CW	-	0.80 x 1.25	PHA1617-2	10-12
	1600 - 1700	AB	10	25	10.0	40	CW	-	0.80 x 1.25	PHA1617-10	10-14
	1600 - 1700	AB	30	25	9.5	40	CW	-	0.80 x 1.70	PHA1617-30	10-15
	1780 - 1900	AB	2	25	10.0	35	CW	-	0.80 x 1.25	PHA1819-2	10-17
	1780 - 1900	AB	10	25	10.0	40	CW	-	0.80 x 1.25	PHA1819-10	10-19
New	1805 - 1880	AB	15	26	30.0	25	CW	-	0.81 x 2.65	PHM1880-15	10-2
	1805 - 1880	AB	33	25	7.0	40	CW	-	1.00 x 1.40	PHA1819-30	10-21
New	1930 - 1970	AB	15	26	30.0	25	CW	-	0.81 x 2.65	PHM1990-15	10-4
	2700 - 3100	C	140	36	7.0	35	300	10	1.00 x 1.55	PHA2731-140L	10-23
New	3100 - 3500	C	130	36	7.0	35	100	10	1.00 x 2.00	PHA3135-130M	10-1
	3100 - 3500	C	150	36	7.0	35	100	10	1.00 x 2.00	PHA3135-150M	10-24

Power Module Selection Guides

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M/A-COM an AMP company

V 2.00

Linear Bipolar Power Modules

Frequency (MHz)	Class	Pout (W)	V_{CC} (V)	Gain (dB)	Effcy (%)	Pulse Width (µs)	Package (Inches)	Part No.	Page No.
30 - 400	AB	13	27	28.0	25	CW	2.10 x 1.00	PHA4000-1	10-25
30 - 400	AB	64	27	7.0	35	CW	2.10 x 1.00	PHA4000-2	10-26
1453 - 1477	AB	20	26	40.0	25	CW	1.00 x 2.84	PHM1480-20	10-27
1500 - 1600	AB	2	25	10.0	35	CW	0.80x1.25	PHA1516-2	10-7
1500 - 1600	AB	10	25	10.0	40	CW	0.80x1.25	PHA1516-10	10-9
1500 - 1600	AB	30	25	9.5	40	CW	0.80x1.70	PHA1516-30	10-10
1600 - 1700	AB	2	25	10.0	35	CW	0.80x1.25	PHA1617-2	10-12
1600 - 1700	AB	10	25	10.0	40	CW	0.80x1.25	PHA1617-10	10-14
1600 - 1700	AB	30	25	9.5	40	CW	0.80x1.70	PHA1617-30	10-15
1780 - 1900	AB	2	25	10.0	35	CW	0.80x1.25	PHA1819-2	10-17
1780 - 1900	AB	10	25	9.0	40	CW	0.80x1.25	PHA1819-10	10-19
1805 - 1880	AB	33	25	7.0	40	CW	1.00x1.40	PHA1819-30	10-21

Radar Pulsed Bipolar Power Modules

	Frequency (MHz)	Class	Pout (W)	V_{CC} (V)	Gain (dB)	Effcy (%)	Pulse Width (µs)	Duty (%)	Package (Inches)	Part No.	Page No.
	2700 - 3100	C	140	36	7.0	35	300	10	1.00 x 1.55	PHA2731-140L	10-23
New	3100 - 3500	C	130	36	7.0	35	100	10	1.00 x 2.00	PHA3135-130M	10-1
	3100 - 3500	C	150	36	7.0	35	100	10	1.00 x 2.00	PHA3135-150M	10-24

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Wireless Bipolar Power Modules

V 2.00

	Frequency (MHz)	Class	Pout (W)	Vcc (V)	Gain (dB)	Effcy (%)	IMD3 (dBc)	VSWR	Package (Inches)	Part No.	Page No.
	1500 - 1600	AB	2	25	10.0	35	-32	5:1	0.80 x 1.25	PHA1516-2	10-7
	1500 - 1600	AB	10	25	10.0	40	-30	3:1	0.80 x 1.25	PHA1516-10	10-9
	1500 - 1600	AB	30	25	9.5	40	-27	3:1	0.80 x 1.70	PHA1516-30	10-10
	1600 - 1700	AB	2	25	10.0	35	-30	5:1	0.80 x 1.25	PHA1617-2	10-12
	1600 - 1700	AB	10	25	10.0	40	-30	3:1	0.80 x 1.25	PHA1617-10	10-14
	1600 - 1700	AB	30	25	9.5	40	-27	3:1	0.80 x 1.70	PHA1617-30	10-15
	1780 - 1900	AB	2	25	10.0	35	-32	5:1	0.80 x 1.25	PHA1819-2	10-17
	1780 - 1900	AB	10	25	9.0	40	-28	3:1	0.80 x 1.25	PHA1819-10	10-19
	1805 - 1880	AB	33	25	7.0	40	-28	2:1	1.00 x 1.40	PHA1819-30	10-21
New	1805 - 1880	AB	26	15	30.0	25	-	3:1	0.81 x 2.65	PHM1880-15	10-2
New	1930 - 1970	AB	26	15	30.0	25	-	3:1	0.81 x 2.65	PHM1990-15	10-4

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M/A-COM an AMP company

Coming Attractions

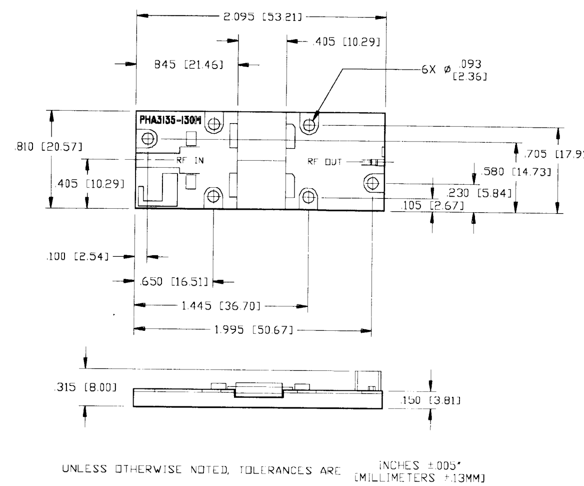
Radar Pulsed Power Module, 115, 130, 145W, 100μs Pulse 3.1 - 3.5 GHz

PHA3135-130M

V1.00

Features

- NPN Silicon Power Transistor
- Input and Output Matched to 50Ω
- Duroid Circuit Board
- Easily Combined for High Power Transmitters
- Plated Copper Flange



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Suppy Voltage	V_{CC}	40	V
Input Power	P_{IN}	26.5	V
Output Power @ 3.3 GHz	P_{OUT}	200	A
Thermal Resistance / Per Transistor	θ_{JC}	0.24	A
Power Dissipation	P_D	400	W
Operating Case Temp.	T_C	-30 to 1200	°C
Storage Temperature	T_{STG}	-40 to +125	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	145	-	W	V_{CC}=36 V, P_{IN}=21 W, F=3.1 GHz
Output Power	P_{OUT}	130	-	W	V_{CC}=36 V, P_{IN}=21 W, F=3.3 GHz
Output Power	P_{OUT}	115	-	W	V_{CC}=36 V, P_{IN}=21 W, F=3.5 GHz
Power Gain	G_P	8.4	-	dB	V_{CC}=36 V, P_{IN}=21 W, F=3.1 GHz
Power Gain	G_P	7.9	-	dB	V_{CC}=36 V, P_{IN}=21 W, F=3.3 GHz
Power Gain	G_P	7.4	-	dB	V_{CC}=36 V, P_{IN}=21 W, F=3.5 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{IN}=21 W, F=3.1, 3.3, 3.5 GHz
Input Return Loss	RL	6	-	dB	V_{CC}=36 V, P_{IN}=21 W, F=3.1, 3.3, 3.5 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=21 W, F=3.1, 3.3, 3.5 GHz
Load VSWR Stablility	VSWR-S	-	2:1	-	V_{CC}=36 V, P_{IN}=21 W, F=3.1, 3.3, 3.5 GHz

Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

Coming Attractions

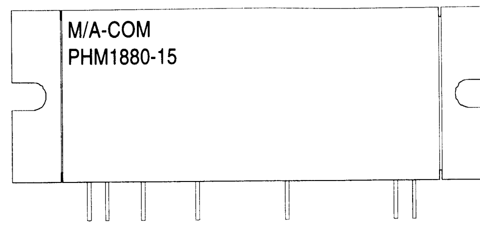
Wireless Power Module, 15W
1805 - 1880 MHz

PHM1880-15

V1.01

Features

- Linear Bipolar Wireless Hybrid Module
- GSM Base Station Applications
- Input and Output Matched to 50 Ω
- Common Emitter Configuration
- Internal TemperatureCompensated Bias Networks
- 30 dB min Gain
- Operating Voltage 24-26V



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage, Collector	V_{CC}	27	V
Supply Voltage, Base	V_{BB}	6	V
Input Power	P_{IN}	5	dBm
Output Power	P_{CUT}	20	W
Power Dissipation	P_D	60	W
Operating Case Temp.	T_C	-10 to +85	°C
Storage Temperature	T_{STG}	-40 to +125	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Output Power Compression	P1dB	-	15	-	W	V_{CC}=26 V, V_{BB}=5 V, F=1805, 1880 MHz
Power Gain	G_P	30	35	-	dB	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1805, 1880 MHz
Power Gain Flatness	ΔG_P	-	1.5	-	dB	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1805, 1880 MHz
Overall Efficiency	η	25	30	-	%	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1805, 1880 MHz
Input Return Loss	RL	10	12	-	dB	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1805, 1880 MHz
Load Mismatch Stability	VSWR-S	-	-	2:1	-	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1805, 1880 MHz
Load Mismatch Tolerance	VSWR-T	-	-	3:1	-	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1805, 1880 MHz

Specifications Subject to Change Without Notice.

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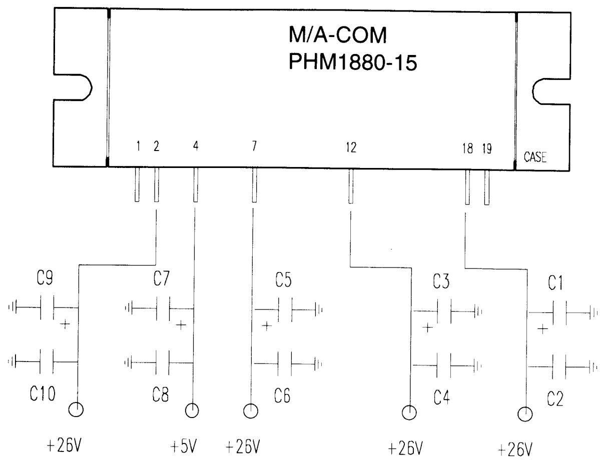
Recommended Bias Decoupling Scheme for Module

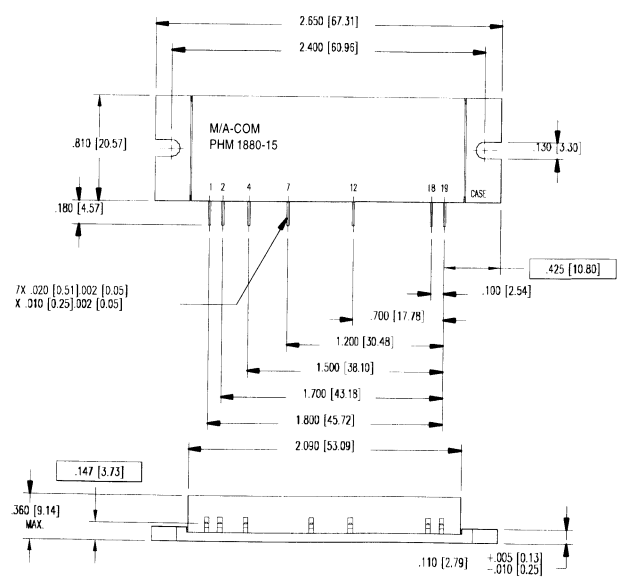


C1,C3,C5,C7,C9 = 1.0uF Tantalum Capacitors
C2,C4,C6,C8,10 = 1800pF Capacitors

Pin Configuration

Pin	Description
1	RE Input
2	VC1
4	VC2
7	V_{BB}
12	VC3
18	VC4
19	RF Output
Case	Ground

Outline Dimensions



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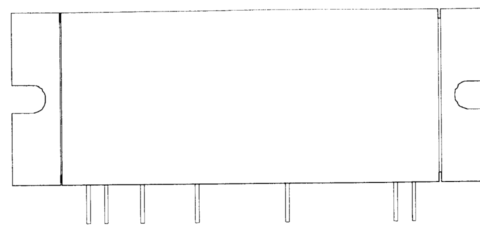
Wireless Power Module, 15W 1930 - 1990 MHz

PHM1990-15

V1.00

Features

- Linear Bipolar Wireless Hybrid Module
- PCN/PCS Base Station Applications
- Input and Output Matched to 50 Ω
- Common Emitter Configuration
- Internal Temperature Compensated Bias Networks
- 30 dB min Gain
- Operating Voltage 24-26V



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage, Collector	V_{CC}	27	V
Supply Voltage, Base	V_{BB}	6	V
Input Power	P_{IN}	5	dBm
Output Power	P_{CUT}	20	W
Power Dissipation	P_D	60	W
Operating Case Temp.	T_C	-10 to +85	°C
Storage Temperature	T_{STG}	-40 to +125	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Output Power Compression	P1dB	-	15	-	W	V_{CC}=26 V, V_{BB}=5 V, F=1930, 1990 MHz
Power Gain	G_P	30	35	-	dB	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1930, 1990 MHz
Power Gain Flatness	ΔG_P	-	1.5	-	dB	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1930, 1990 MHz
Overall Efficiency	η	25	30	-	%	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1930, 1990 MHz
Input Return Loss	RL	10	12	-	dB	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1930, 1990 MHz
Load Mismatch Stability	VSWR-S	-	-	2:1	-	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1930, 1990 MHz
Load Mismatch Tolerance	VSWR-T	-	-	3:1	-	V_{CC}=26 V, V_{BB}=5 V, P_{OUT}=15 W, F=1930, 1990 MHz

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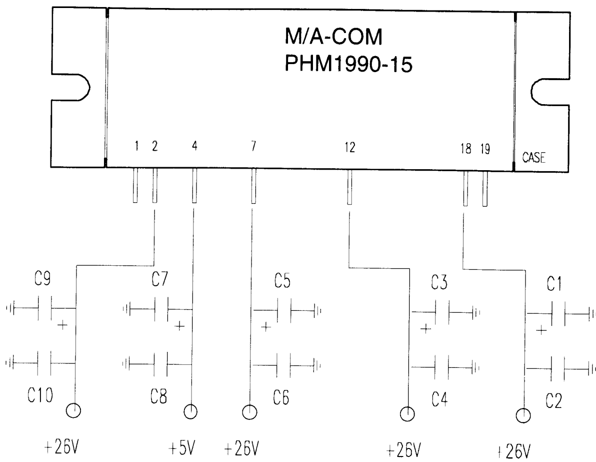
Recommended Bias Decoupling Scheme for Module

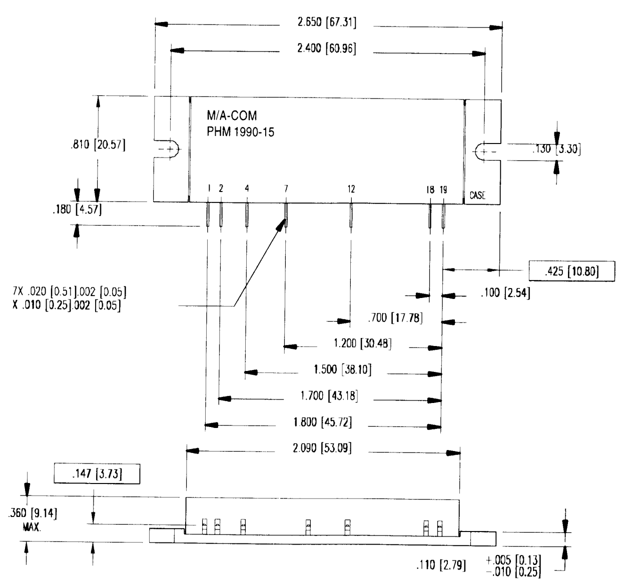


C1,C3,C5,C7,C9 = 1.0uF Tantalum Capacitors
C2,C4,C6,C8,10 = 1800pF Capacitors

Pin Configuration

Pin	Description
1	RF Input
2	VC1
4	VC2
7	V_{BB}
12	VC3
18	VC4
19	RF Output
Case	Ground

Outline Dimensions



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M/A-COM an AMP company

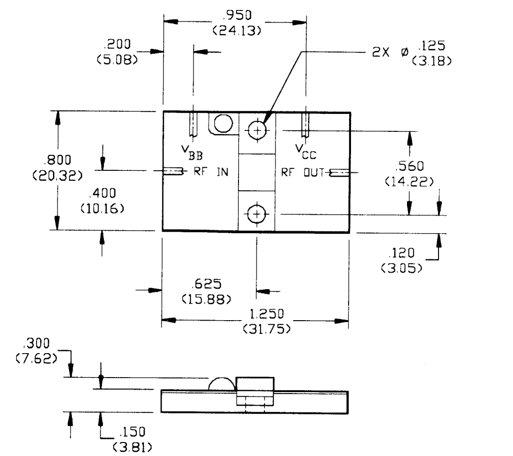
Wireless Power Module, 2W
1.5 - 1.6 GHz

PHA1516-2

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -33 dBc Typ 3rd IMD at 2 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

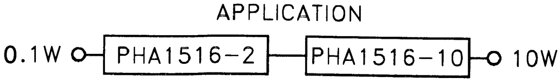
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{in}	0.3	W
Output Power	P_{OUT}	3.0	W
Thermal Resistance	θ_{JC}	13	°C/W
Power Dissipation	P_D	13.5	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	100	mA

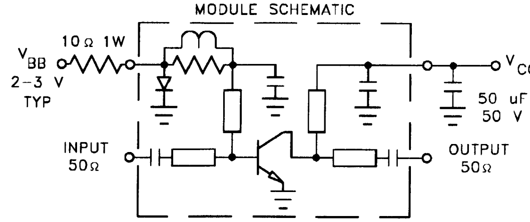
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	2	-	W	V_{CC}=25 V, I_{CQ}=25 mA, P_{IN}=0.2 W, F=1.50-1.60 GHz
Power Gain	G_P	10		dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.50-1.60 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.50-1.60 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.50-1.60 GHz
Load VSWR Tolerance	VSWR-T	-	5:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.50-1.60 GHz
3rd Order IMD	IMD_3	-	-32	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W PEP, F=1600, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.50-1.60 GHz

APPLICATION



MODULE SCHEMATIC



Specifications Subject to Change Without Notice.

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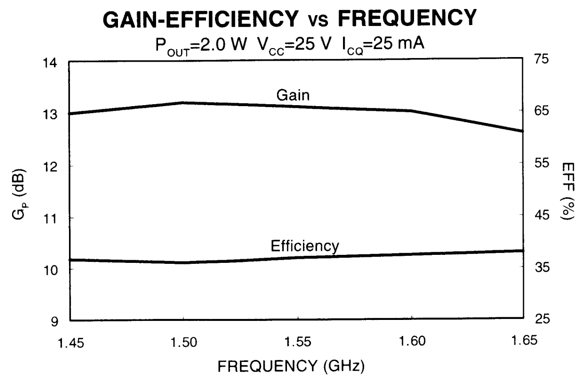
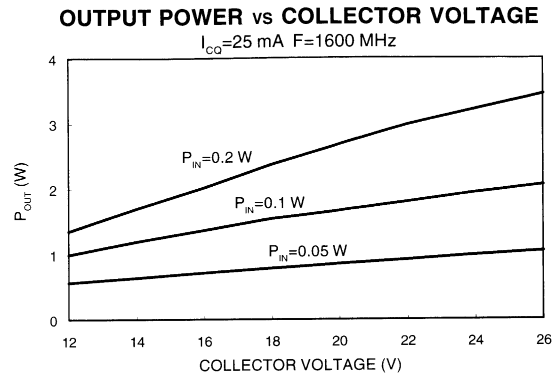
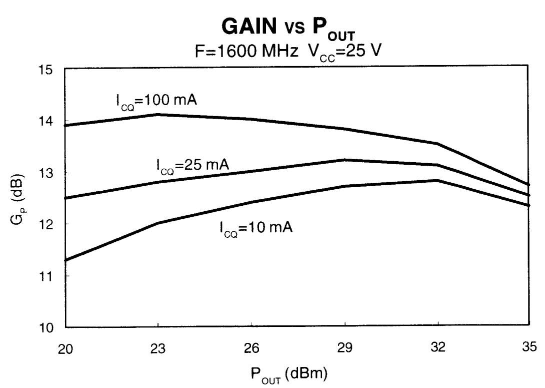
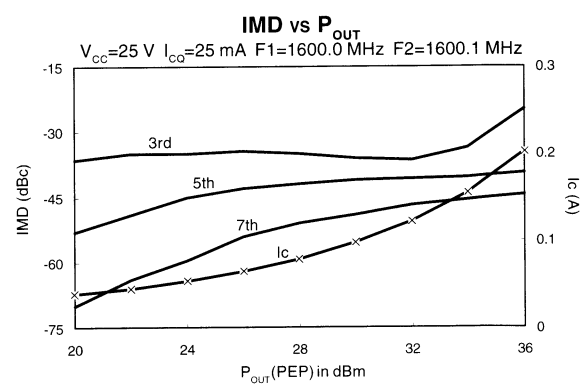
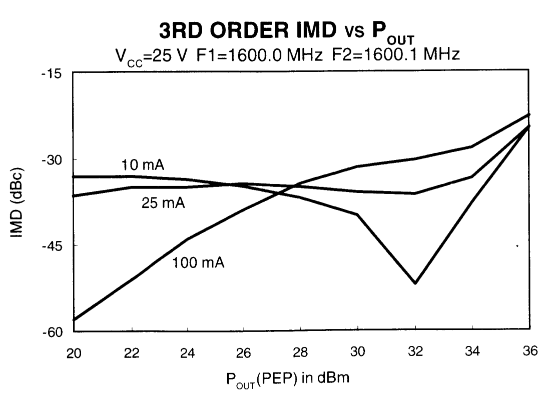
Typical Broadband Performance Curves











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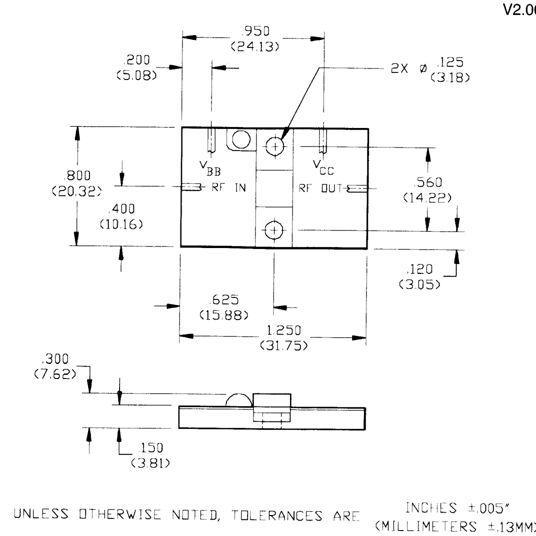
Wireless Power Module, 10W
1.5 - 1.6 GHz

PHA1516-10

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -33 dBc Typ 3rd IMD at 10 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



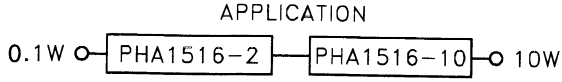
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	2	W
Output Power	P_{OUT}	12	W
Thermal Resistance	θ_{JC}	3	°C/W
Power Dissipation	P_D	58	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C

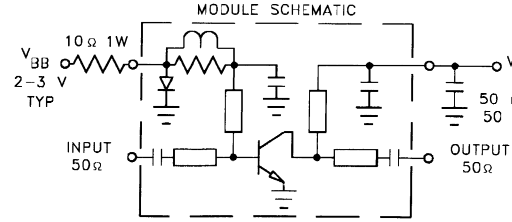
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	10	-	W	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50-1.60 GHz
Power Gain	G_P	10		dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50-1.60 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50-1.60 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50-1.60 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.50-1.60 GHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W PEP, F=1550, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{IN}=1.0 W, F=1.50-1.60 GHz

APPLICATION



MODULE SCHEMATIC



Specifications Subject to Change Without Notice.

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an AMP company

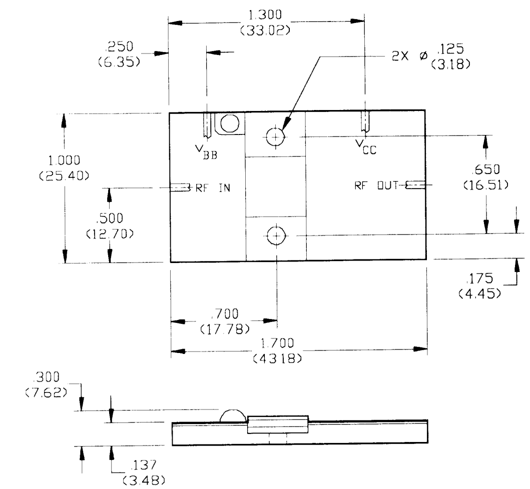
Wireless Power Module, 30W
1.5 - 1.6 GHz

PHA1516-30

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -30 dBc Typ 3rd IMD at 30 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

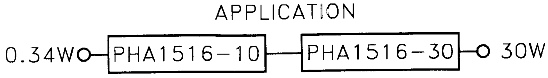
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	4	W
Output Power	P_{OUT}	35	W
Thermal Resistance	θ_{JC}	1.6	°C/W
Power Dissipation	P_D	109	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	300	mA

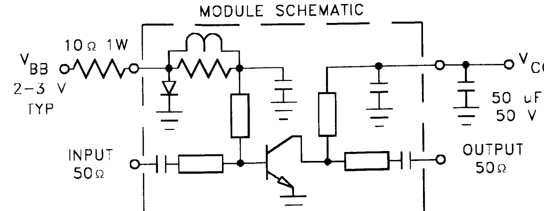
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	30	-	W	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz
Power Gain	G_P	9.5		dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz
3rd Order IMD	IMD_3	-	-27	dBc	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP, F=1600, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz

APPLICATION



MODULE SCHEMATIC



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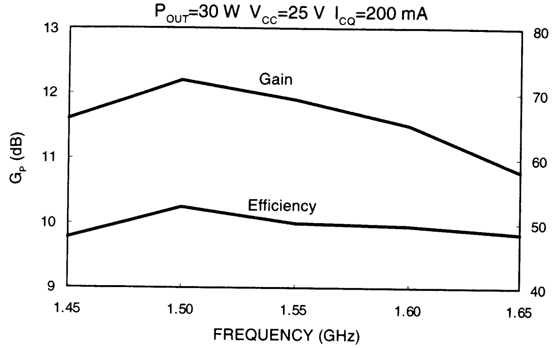
Typical Broadband Performance Curves

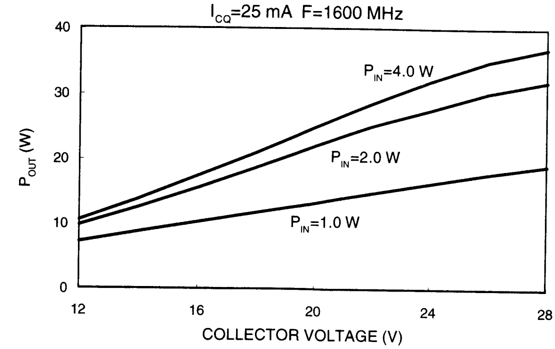
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=30 W V_{CC}=25 V I_{CQ}=200 mA



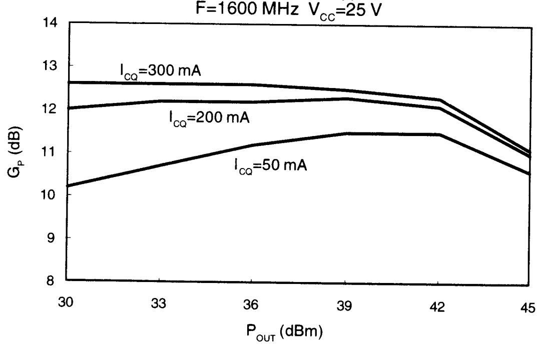
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=25 mA F=1600 MHz



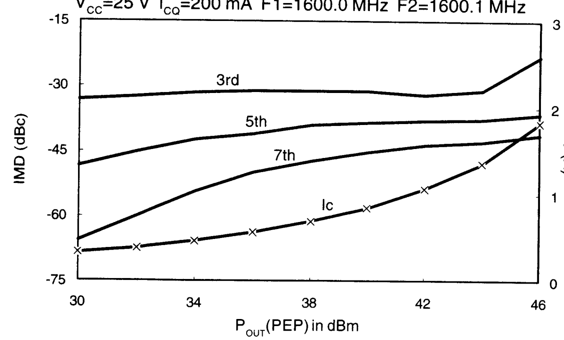
GAIN vs P_{OUT}

F=1600 MHz V_{CC}=25 V



IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=200 mA F1=1600.0 MHz F2=1600.1 MHz



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M/A-COM
an AMP company

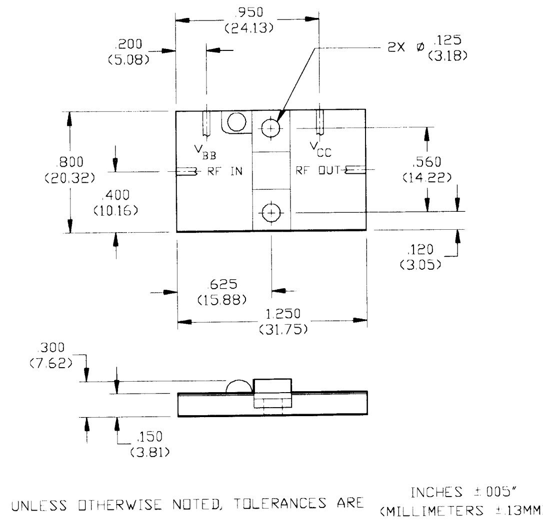
Wireless Power Module, 2W
1.6 - 1.7 GHz

PHA1617-2

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -33 dBc Typ 3rd IMD at 2 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



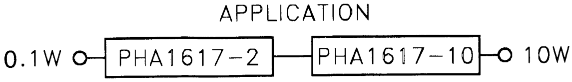
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	0.3	W
Output Power	P_{OUT}	3.0	W
Thermal Resistance	θ_{JC}	13	°C/W
Power Dissipation	P_D	13.5	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	100	mA

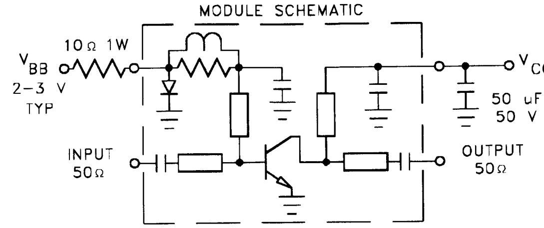
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	2	-	W	V_{CC}=25 V, I_{CQ}=25 mA, P_{IN}=0.2 W, F=1.60-1.70 GHz
Power Gain	G_P	10		dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.60-1.70 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.60-1.70 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.60-1.70 GHz
Load VSWR Tolerance	VSWR-T	-	5:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.60-1.70 GHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W PEP, F=1600, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.60-1.70 GHz

APPLICATION



MODULE SCHEMATIC



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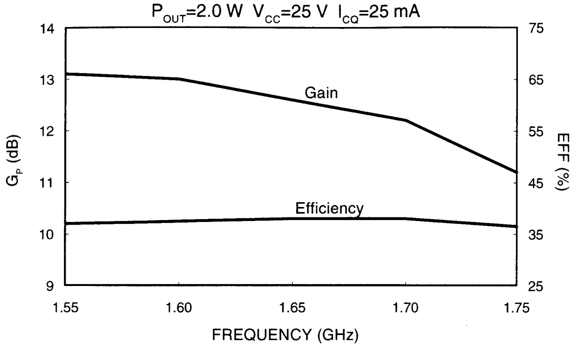
Typical Broadband Performance Curves

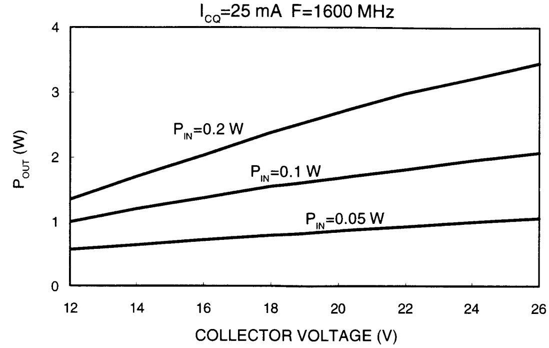
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=2.0 W V_{CC}=25 V I_{CQ}=25 mA



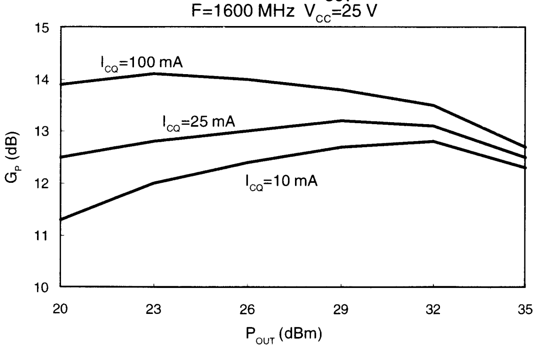
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=25 mA F=1600 MHz



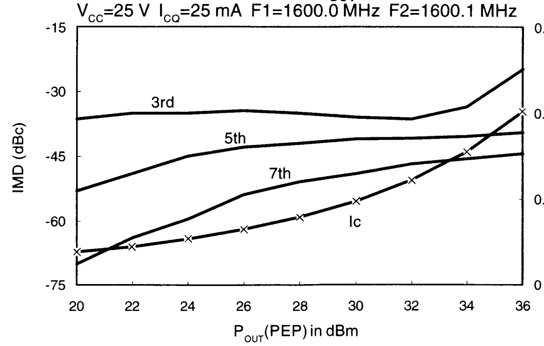
GAIN vs P_{OUT}

F=1600 MHz V_{CC}=25 V



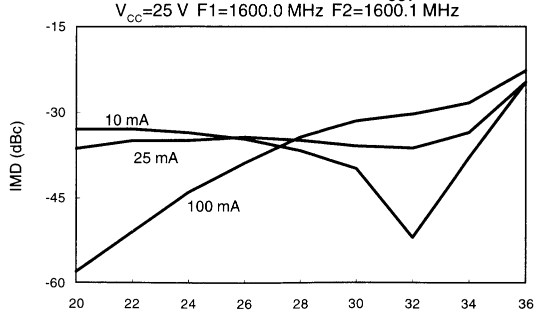
IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=25 mA F1=1600.0 MHz F2=1600.1 MHz



3RD ORDER IMD vs P_{OUT}

V_{CC}=25 V F1=1600.0 MHz F2=1600.1 MHz



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M/A-COM
an AMP company

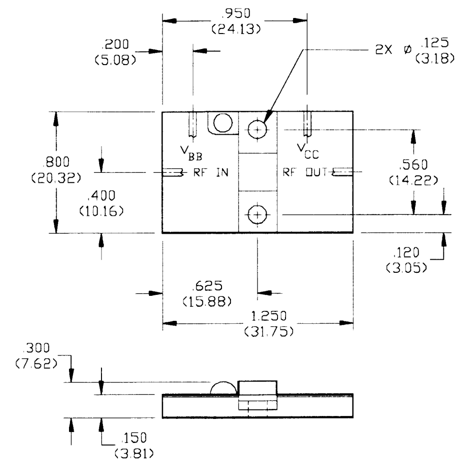
Wireless Power Module, 10W
1.6 - 1.7 GHz

PHA1617-10

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -33 dBc Typ 3rd IMD at 10 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

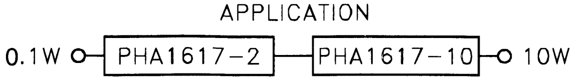
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	2	W
Output Power	P_{OUT}	12	W
Thermal Resistance	θ_{JC}	3	°C/W
Power Dissipation	P_D	58	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C

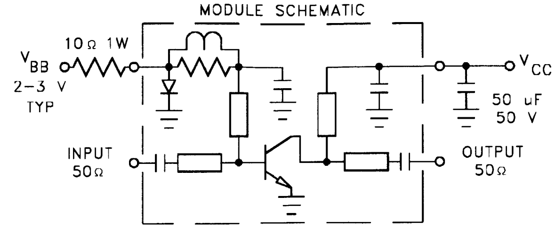
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	10	-	W	V_{CC}=25 V, I_{CQ}=100 mA, P_{IN}=1.0 W, F=1.60-1.70 GHz
Power Gain	G_P	10		dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60-1.70 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60-1.70 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60-1.70 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.60-1.70 GHz
3rd Order IMD	IMD_3	-	-30	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W PEP, F=1650, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{IN}=1.0 W, F=1.60-1.70 GHz

APPLICATION



MODULE SCHEMATIC



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an AMP company

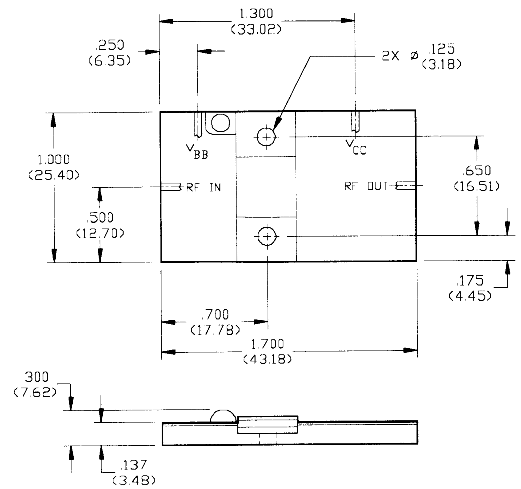
Wireless Power Module, 30W
1.6 - 1.7 GHz

PHA1617-30

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -30 dBc Typ 3rd IMD at 30 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES ±.005" (MILLIMETERS ±.13MM)

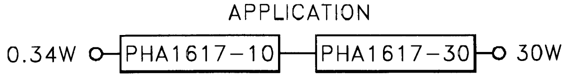
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	4	W
Output Power	P_{OUT}	35	W
Thermal Resistance	θ_{JC}	1.6	°C/W
Power Dissipation	P_D	109	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	300	mA

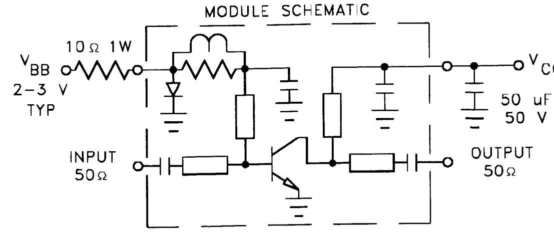
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	30	-	W	V_{CC}=25 V, I_{CQ}=200 mA, P_{IN}=3.4 W, F=1.60-1.70 GHz
Power Gain	G_P	9.5		dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.60-1.70 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.60-1.70 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.60-1.70 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.60-1.70 GHz
3rd Order IMD	IMD_3	-	-27	dBc	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W PEP, F=1600, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=30 W, F=1.50-1.60 GHz

APPLICATION



MODULE SCHEMATIC



Specifications Subject to Change Without Notice.

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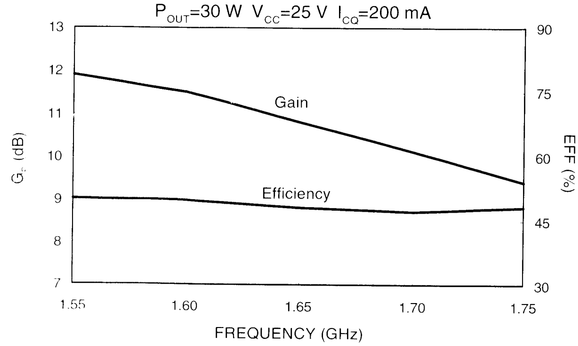
Typical Broadband Performance Curves

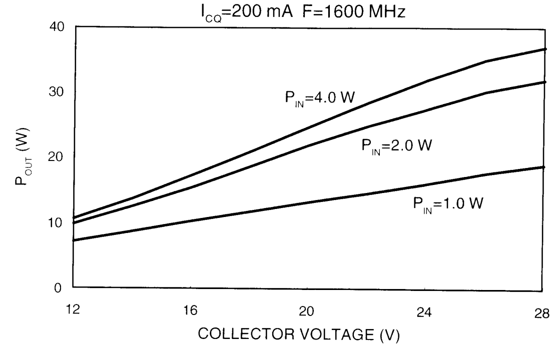
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=30 W V_{CC}=25 V I_{CQ}=200 mA



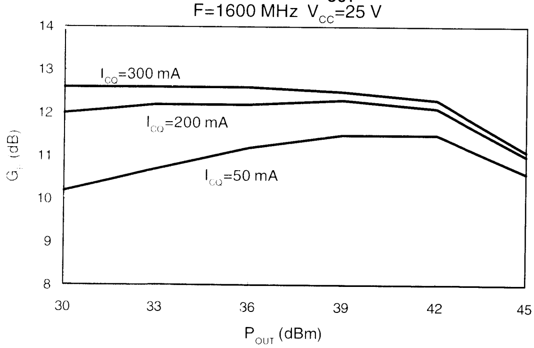
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=200 mA F=1600 MHz



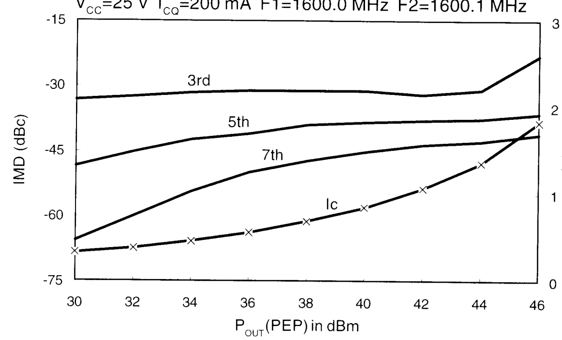
GAIN vs P_{OUT}

F=1600 MHz V_{CC}=25 V



IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=200 mA F1=1600.0 MHz F2=1600.1 MHz



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an AMP company

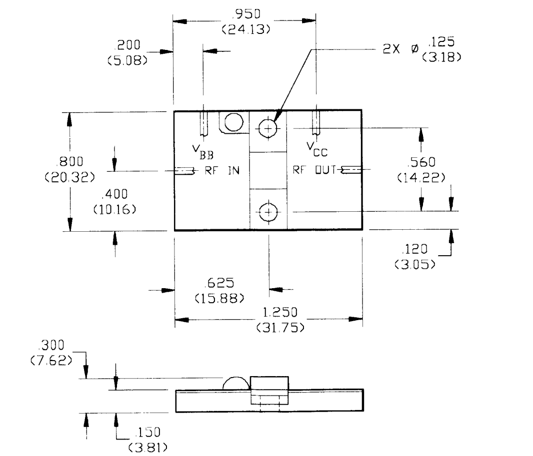
Wireless Power Module, 2W
1.78 - 1.90 GHz

PHA1819-2

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -34 dBc Typ 3rd IMD at 2 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange

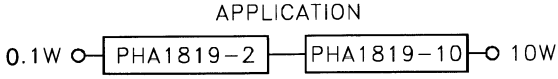


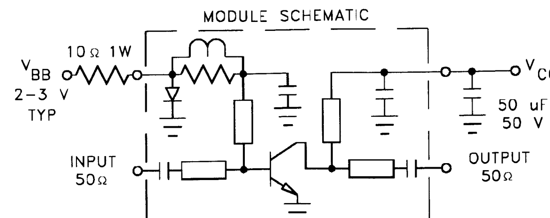
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	0.3	W
Output Power	P_{OUT}	2.5	W
Thermal Resistance	θ_{JC}	13	°C/W
Power Dissipation	P_D	13.5	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	100	mA

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	2	-	W	V_{CC}=25 V, I_{CQ}=25 mA, P_{IN}=0.2 W, F=1.78-1.90 GHz
Power Gain	G_P	10		dB	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.78-1.90 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.78-1.90 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.78-1.90 GHz
Load VSWR Tolerance	VSWR-T	-	5:1	-	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.78-1.90 GHz
3rd Order IMD	IMD_3	-	-32	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W PEP, F=1850, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=25 mA, P_{OUT}=2 W, F=1.78-1.90 GHz





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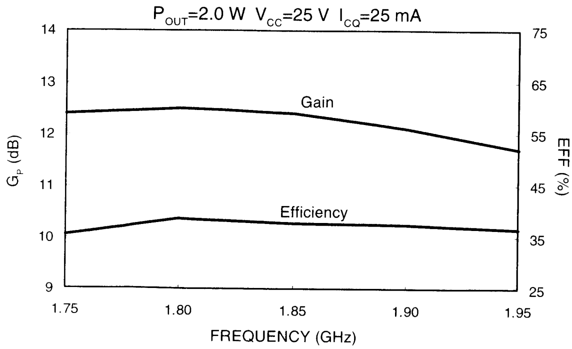
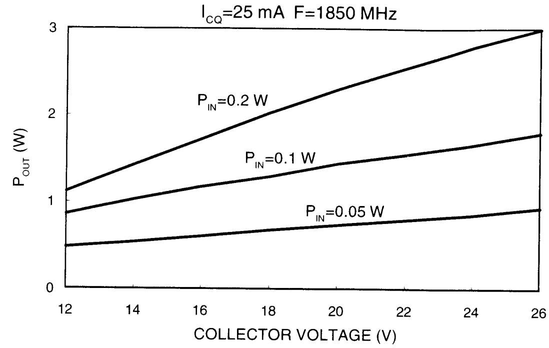
Typical Broadband Performance Curves

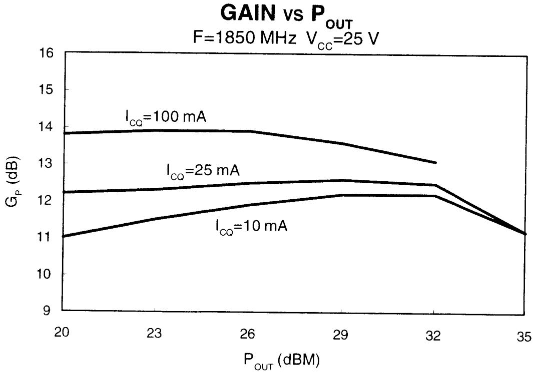
GAIN-EFFICIENCY vs FREQUENCY



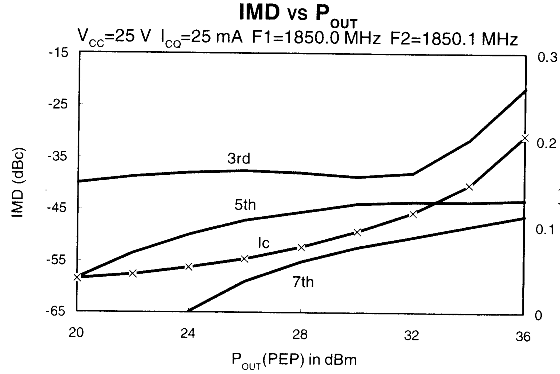
OUTPUT POWER vs COLLECTOR VOLTAGE



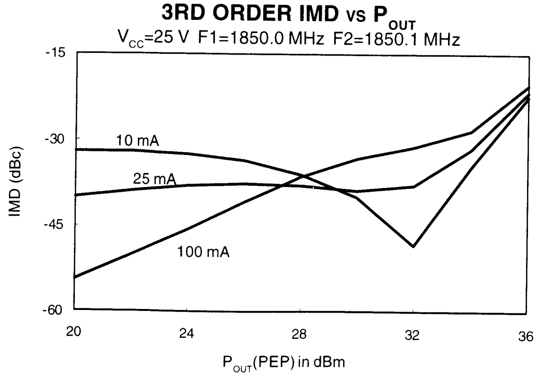
GAIN vs P_{OUT}



IMD vs P_{OUT}



3RD ORDER IMD vs P_{OUT}



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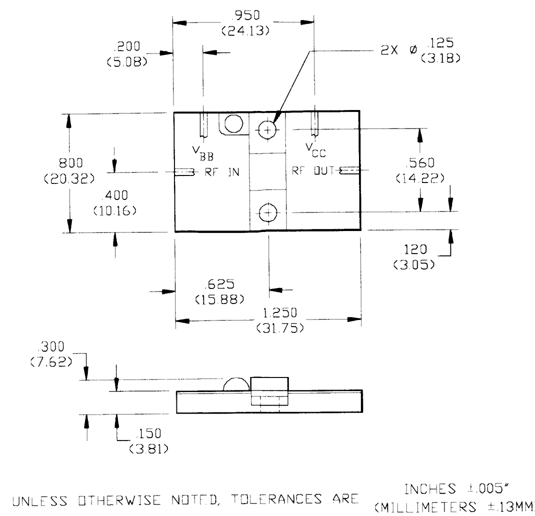
an AMP company

Wireless Power Module, 10W
1.78 - 1.90 GHz

PHA1819-10

V2.00



Features

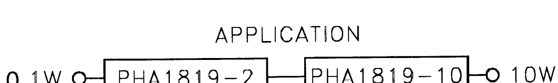
- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: -30 dBc Typ 3rd IMD at 10 Watts PEP
- Thermally Tracking Bias Diode Included
- Plated Copper Flange

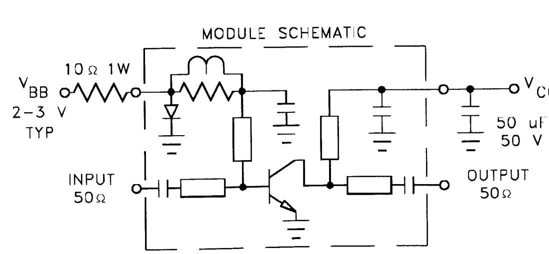
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	28	V
Input Power	P_{IN}	2	W
Output Power	P_{OUT}	12	W
Thermal Resistance	θ_{JC}	4	°C/W
Power Dissipation	P_D	44	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	200	mA

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	10	-	W	V_{CC}=25 V, I_{CQ}=100 mA, P_{IN}=1.25 W, F=1.78-1.90 GHz
Power Gain	G_P	9		dB	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78-1.90 GHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78-1.90 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78-1.90 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W, F=1.78-1.90 GHz
3rd Order IMD	IMD_3	-	-28	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{OUT}=10 W PEP, F=1850, ΔF=100 kHz
2nd Harmonic	2fc	-	-20	dBc	V_{CC}=25 V, I_{CQ}=100 mA, P_{IN}=1.25 W, F=1.78-1.90 GHz





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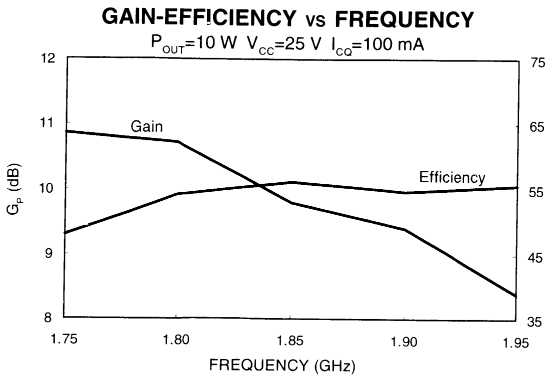
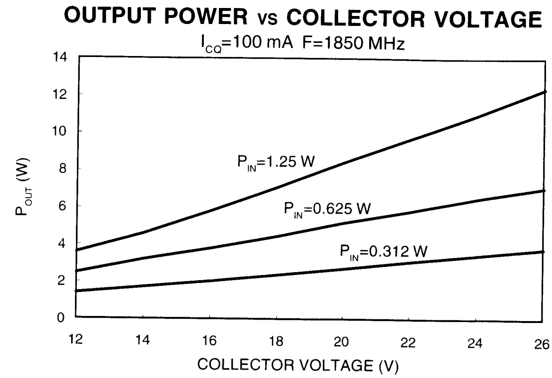
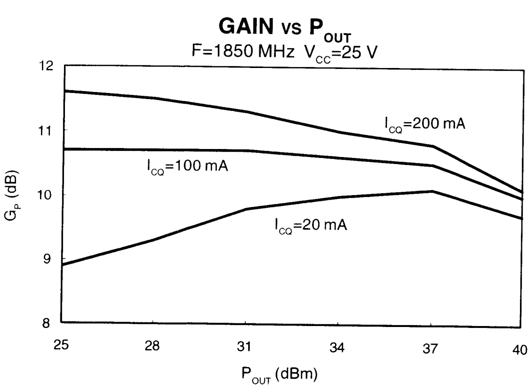
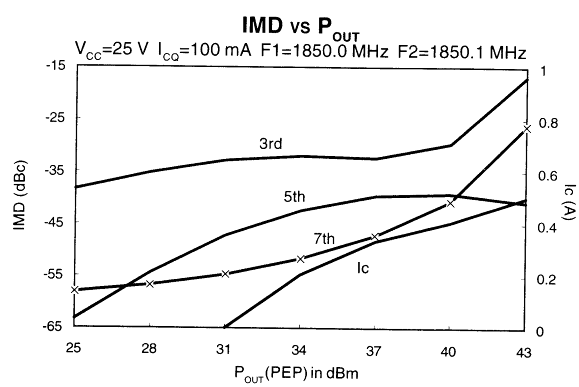
Typical Broadband Performance Curves









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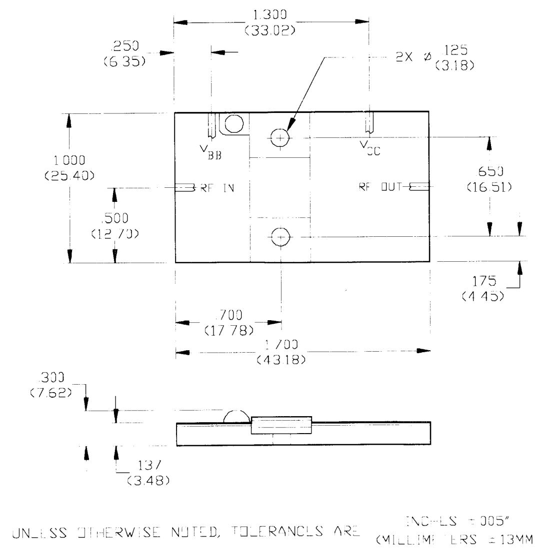
Wireless Power Module, 30W
1805 - 1880 MHz

PHA1819-30

V2.00

Features

- Designed for Cellular Base Station Applications
- Input and Output Matched to 50Ω
- Class AB: Linear Performance
- Thermally Tracking Bias Diode Included
- Plated Copper Flange



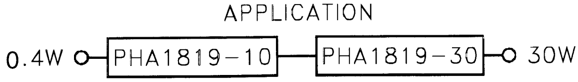
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	26	V
Input Power	P_{IN}	7	W
Output Power	P_{OUT}	35	W
Thermal Resistance	θ_{JC}	2.2	°C/W
Power Dissipation	P_D	80	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C
Collector Quiescent Current	I_{CQ}	300	mA

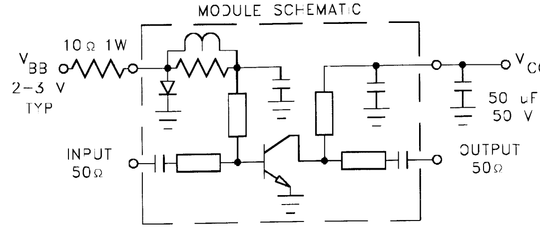
Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	33	-	W	V_{CC}=25 V, I_{CQ}=200 mA, P_{IN}=6.6 W, F=1805-1880 MHz
Power Gain	G_P	7		dB	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805-1880 MHz
Collector Efficiency	η_C	40	-	%	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805-1880 MHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805-1880 MHz
Load VSWR Tolerance	VSWR-T	-	2:1	-	V_{CC}=25 V, I_{CQ}=200 mA, P_{OUT}=33 W, F=1805-1880 MHz

APPLICATION



MODULE SCHEMATIC



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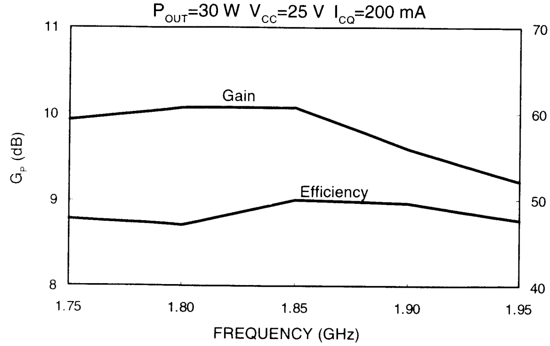
Typical Broadband Performance Curves

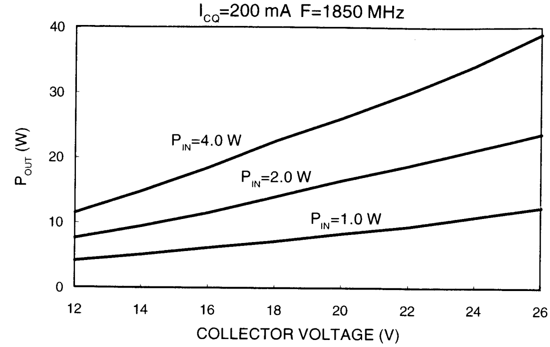
GAIN-EFFICIENCY vs FREQUENCY

P_{OUT}=30 W V_{CC}=25 V I_{CQ}=200 mA



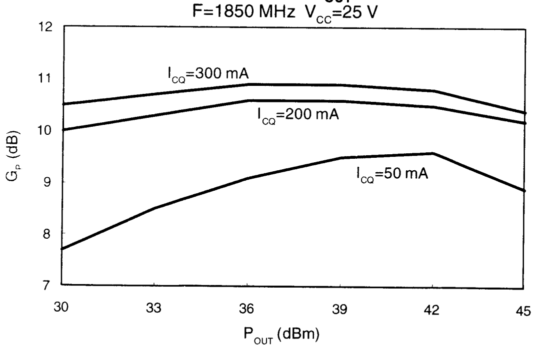
OUTPUT POWER vs COLLECTOR VOLTAGE

I_{CQ}=200 mA F=1850 MHz



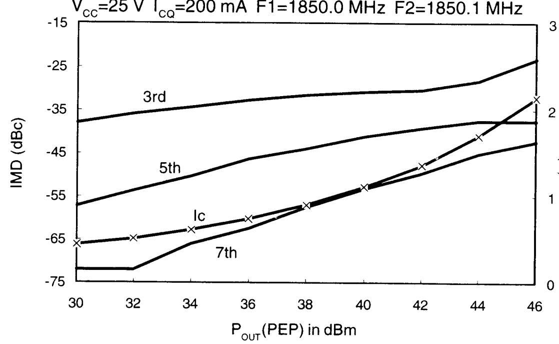
GAIN vs P_{OUT}

F=1850 MHz V_{CC}=25 V



IMD vs P_{OUT}

V_{CC}=25 V I_{CQ}=200 mA F1=1850.0 MHz F2=1850.1 MHz



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an AMP company

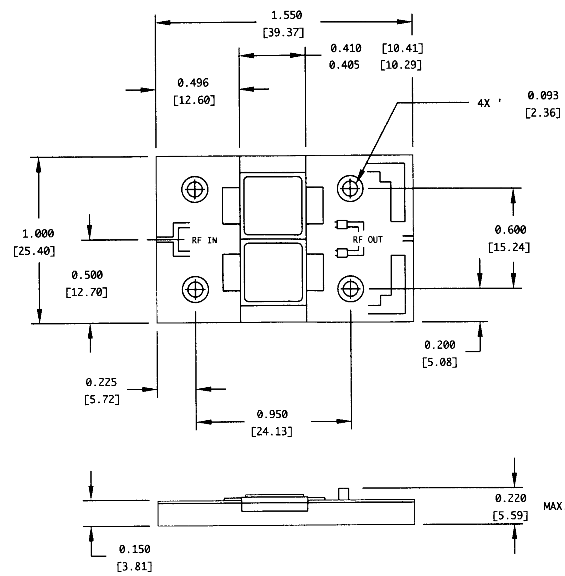
Radar Pulsed Power Module, 140W, 300μs, 10% Duty 2.7 - 3.1 GHz

PHA2731-140L

V2.00

Features

- NPN Silicon Power Transistors
- Input and Output Matched to 50Ω
- Duroid Circuit Board
- Easily Combined For High Power Transmitters
- Plated Copper Flange



UNLESS OTHERWISE NOTED, TOLERANCES ARE INCHES -0.005" [MILLIMETERS -0.13MM]

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	40	V
Input Power	P_{IN}	35	W
Output Power	P_{OUT}	200	W
Thermal Resistance	θ_{JC}	0.8	°C/W
Power Dissipation	P_D	380	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	140	-	W	V_{CC}=36 V, P_{IN}=28 W, F=2.70, 2.90, 3.10 GHz
Power Gain	G_P	7	-	dB	V_{CC}=36 V, P_{OUT}=140 W, F=2.70, 2.90, 3.10 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{OUT}=140 W, F=2.70, 2.90, 3.10 GHz
Input VSWR	VSWR	-	2:1	-	V_{CC}=36 V, P_{OUT}=140 W, F=2.70, 2.90, 3.10 GHz
Load VSWR Tolerance	VSWR-T	-	2:1	-	V_{CC}=36 V, P_{OUT}=140 W, F=2.70, 2.90, 3.10 GHz
Load VSWR for Stability	VSWR-S	-	1.5:1	-	V_{CC}=36 V, P_{OUT}=140 W, F=2.70, 2.90, 3.10 GHz
Pulse Droop	Dp	-	1	dB	V_{CC}=36 V, P_{OUT}=140 W, F=2.70, 2.90, 3.10 GHz

Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

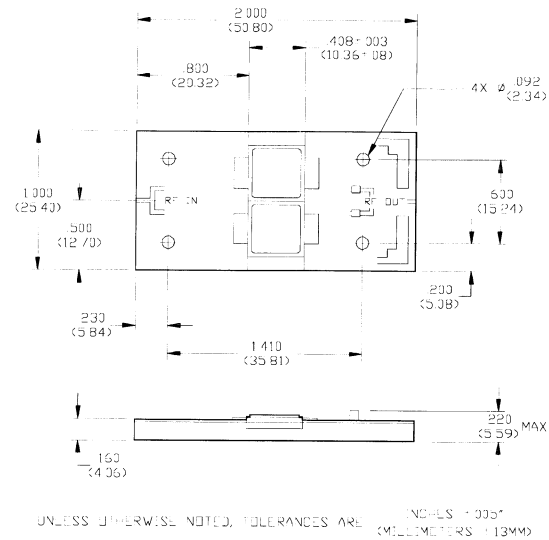
Radar Pulsed Power Module, 150W, 100µs, 10% Duty 3.1 - 3.5 GHz

PHA3135-150M

V2.00

Features

- NPN Silicon Power Transistors
- Input and Output Matched to 50Ω
- Duroid Circuit Board
- Easily Combined For High Power Transmitters
- Plated Copper Flange



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	40	V
Input Power	P_{IN}	47.5	W
Output Power	P_{OUT}	200	W
Thermal Resistance	θ_{JC}	0.35	°C/W
Power Dissipation	P_D	1000	W
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +120	°C

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	150	-	W	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz
Power Gain	G_P	7	-	dB	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz
Collector Efficiency	η_C	35	-	%	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz
Input Return Loss	RL	10	-	dB	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz
Overdrive Stability	OD-S	-	1.0	dB	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz
Load VSWR Tolerance	VSWR-T	-	3:1	-	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz
Load VSWR for Stability	VSWR-S	-	2:1	-	V_{CC}=36 V, P_{IN}=30 W, F=3.10, 3.30, 3.50 GHz

Specifications Subject to Change Without Notice.

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an AMP company

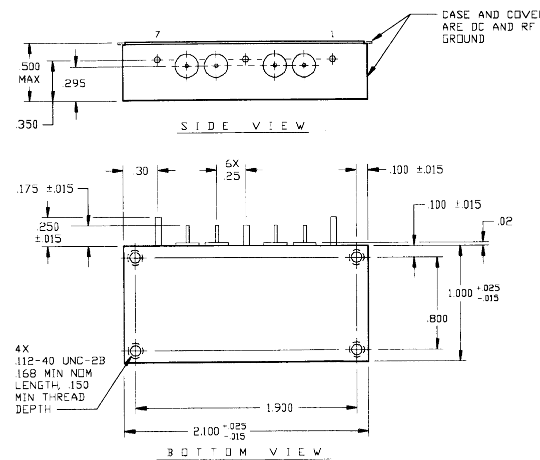
Broadband VHF Power Module, 13W
30 - 400 MHz

PHA4000-1

V2.00

Features

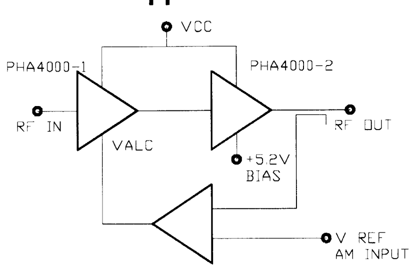
- Broadband Operation 30 to 400 MHz
- 60 dB Gain Control Range
- Thousands of Sets in Use Worldwide
- Optimized for Airborne Environment
- Built to MIL Standards



Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	30	V
Input Power	P_{IN}	0.025	W
Output Power	P_{OUT}	16	W
ALC Voltage	V_{ALC}	-4.0 to +10	V
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C

Application



Pin Configuration

Pin	Description
1	Ground (GP3)
2	RF Input (FT4)
3	V Gain Control (FT3)
4	Ground (GP2)
5	+27 Volts (FT2)
6	RF Output (FT1)
7	Ground (GP1)

Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	13	-	W	V_{CC}=27 V, P_{IN}=0.02 W, F=30-88, 116-174, 225-400 MHz
Power Gain	G_P	28		dB	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz
Collector Efficiency	η_C	25	-	%	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz
Input VSWR	VSWR	-	3:1	-	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz
Load VSWR Tolerance	VSWR-T	-	2.5:1	-	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz
Gain Variation With Freq	G_{VAR}	-	+/-3	dB	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz
Harmonic Output	-	-	-15	dBc	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz
Spurious Output	S	-	-80	dBc	V_{CC}=27 V, P_{OUT}=13 W, F=30-88, 116-174, 225-400 MHz

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an AMP company

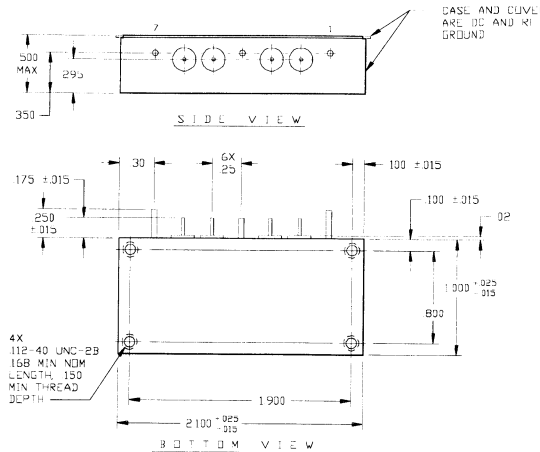
Broadband VHF Power Module, 64W
30 - 400 MHz

PHA4000-2

V2.00

Features

- Broadband Operation 30 to 400 MHz
- High Saturated Output Power - Greater than 54 Watts
- Thousands of Sets in Use Worldwide
- Optimized for Airborne Environment
- Built to MIL Standards



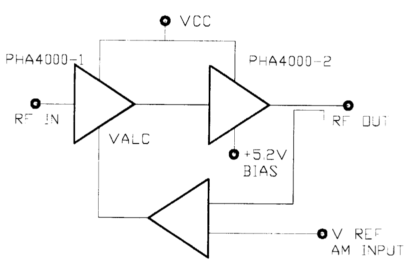
Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	30	V
Input Power	P_{IN}	16	W
Output Power	P_{OUT}	80	W
Bias Voltage	V_B	150	mA
Operating Case Temp.	T_C	-30 to +100	°C
Storage Temperature	T_{STG}	-40 to +125	°C

Pin Configuration

Pin	Description
1	Ground (GP1)
2	RF Input (FT1)
3	+5.2 Volts (FT2)
4	Ground (GP2)
5	+27 Volts (FT3)
6	RF Output (FT4)
7	Ground (GP3)

Application



Electrical Characteristics at 25°C

Parameter	Symbol	Min	Max	Units	Test Conditions
Output Power	P_{OUT}	64	-	W	V_{CC}=27 V, P_{IN}=13 W, F=30-88, 116-174, 225-400 MHz
Power Gain	G_P	7		dB	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz
Collector Efficiency	η_C	35	-	%	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz
Input VSWR	VSWR	-	4:1	-	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz
Load VSWR Tolerance	VSWR-T	-	2.5:1	-	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz
Gain Variation With Freq	G_{VAR}	-	+/-1.5	dB	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz
Harmonic Output	-	-	-15	dBc	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz
Spurious Output	S	-	-80	dBc	V_{CC}=27 V, P_{OUT}=64 W, F=30-88, 116-174, 225-400 MHz

Specifications Subject to Change Without Notice.

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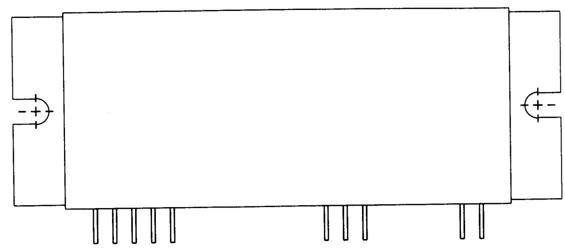
Hybrid Power Module, 20W
1453 - 1477 MHz

PHM1480-20

V2.01

Features

- Linear Bipolar Hybrid Module
- Base Station Applications
- Input and Output Matched to 50 Ω
- High Linearity: -24 dBc 3rd Order IMD
- 43 dB min Gain
- Operating Voltage 24-26V



Electrical Characteristics at 25°C

Parameter	Symbol	Min	Typ	Max	Units	Test Conditions
Output Power	P_{OUT}	20	15	-	W	V_{CC}=24 V, P_{OUT}=20 W, F=1453-1477 MHz
Power Gain	G_P	40	35	-	dB	V_{CC}=24 V, P_{OUT}=20 W, F=1453-1477 MHz
Collector Efficiency	η_C	25	30	-	%	V_{CC}=24 V, P_{OUT}=20 W, F=1453-1477 MHz
3rd Order IMD	IMD_3	-	12	-24	dBc-TT	V_{CC}=24 V, P_{OUT}=8 W PEP, F=1453-1477 MHz
Input VSWR	VSWR	-	-	2.5:1	-	V_{CC}=24 V, P_{OUT}=20 W, F=1453-1477 MHz
Load Mismatch Tolerance	VSWR-T	-	-	3:1	-	V_{CC}=24 V, P_{OUT}=20 W, F=1453-1477 MHz

Absolute Maximum Ratings at 25°C

Parameter	Symbol	Rating	Units
Supply Voltage	V_{CC}	26	V
Input Power	P_{IN}	10	dBm
Output Power	P_{CUT}	32	W
Power Dissipation	P_D	70	W
Operating Case Temp.	T_C	-30 to +80	°C
Storage Temperature	T_{STG}	-40 to +100	°C

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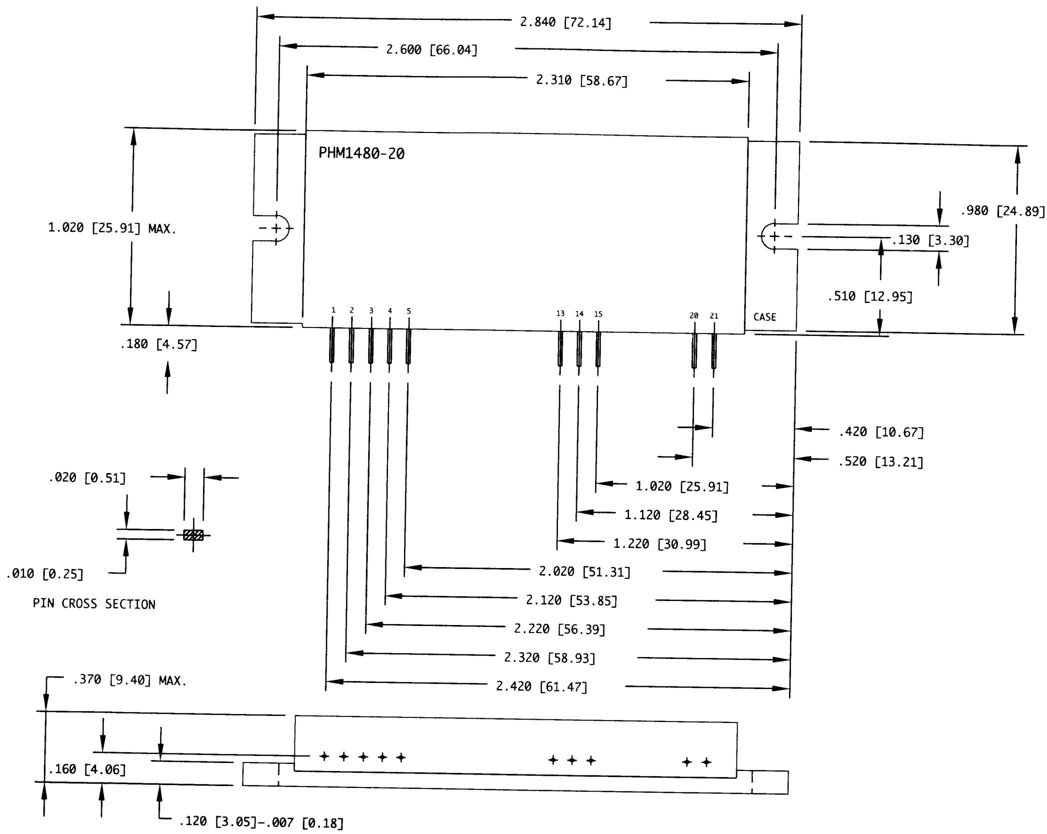

UNLESS OTHERWISE NOTED, TOLERANCES ARE
INCHES -.005" [MILLIMETERS -.13MM]

Pin Configuration

Pin	Description
1	RF Input
2	V_{BB} Q1, Q2
3	V_{CC} Q1, Q2
4	V_{BB} Q3
5	V_{CC} Q3
6	Ground
12	Ground
13	V_{BB} Q4
14	V_{CC} Q4
15	V_{BB} Q5
18	Ground
20	V_{CC} Q5
21	RF Output
Case	Ground

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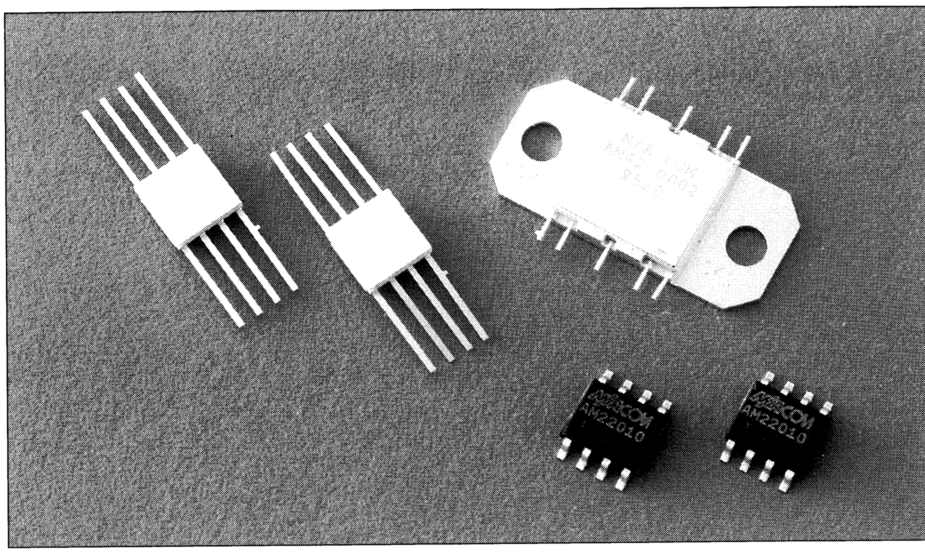
Amplifiers



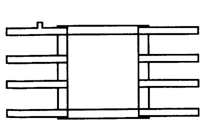
Title	Page

M/A-COM an AMP company

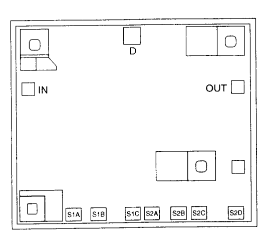
Low Noise Amplifiers

	Frequency (GHz)	Gain (dB)	Noise Figure (dB)	1 dB Comp. Point (dBm)	IP_3 (dBm)	Package	Part No.	Page No.
High Volume, Plastic Package								
New	.815 - .915	14.5	1.5	16.5	+15	SO-8	AM50-0001	11-12
	1.5 - 1.6	14	1.9	2	+14	SO-8	MAAM12022	11-33
	1.5 - 1.6	21	1.6	6	+19	SO-8	MAAM12021	11-30
	1.575	27	1.2	1	+13	SO-8	AM50-0002	11-19
	1.7 - 2.0	13	1.8	2.0	+13	SO-8	MAAM12032	11-39
	1.7 - 2.0	20	1.65	7.0	+19	SO-8	MAAM12031	11-36
	2.4 - 2.5	14	1.9	3.0	+15	SO-8	MAAM22010	11-43
MIL Screened, Ceramic Package								
	1.2 - 1.75	26	1.4	14	+29	CR-3	MAAM12000-A1	11-28
	2 - 3	26	1.25	14	+24	CR-3	MAAM23000-A1	11-48
	3.5 - 7.0	17	2.2	14	+25	CR-3	MAAM37000-A1	11-60
	7.5 - 12	15.5	2.7	11	+21	CR-16	MAAM71200-H1	11-66
Chip								
	1.2 - 1.75	26	1.3	14	+24	Chip	MAAM12000	11-26
	2 - 3	26	1.1	14	+24	Chip	MAAM23000	11-46
	3.5 - 7.0	17	1.8	14	+24	Chip	MAAM37000	11-58
	7.5 - 12	16.5	2.3	14	+24	Chip	MAAM71200	11-64

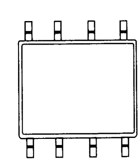
Stocked at your local distributor.



CR-3



CR-16



SO-8

Specifications Subject to Change Without Notice.

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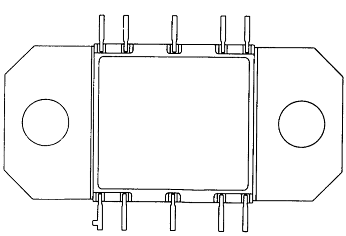
Power Amplifiers

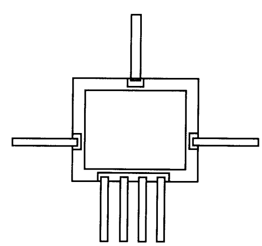
V 2.00

	Frequency (GHz)	Gain (dB)	Output Power (dB)	1 dB Comp. Point (dBm)	IP_3 dBm	Package	Part No.	Page No.
	2-6	18	29.0	27.0	39	CR-2	MAAM26100-B1	11-52
New	2-6	18	30.0	-	40	CR-15	MAAM26100-P1	11-14
	2-6.5	19	30.0	28.0	39	Chip	MAAM26100	11-50
	7-11	18	31.0	28.0	38	Chip	MAAM7100	11-63
New	14-14.5	22	31.5	30.5	40	CR-15	AM42-0002	11-16
New	14-14.5	22	31.5	30.5	40	Chip	AM42-0002-DIE	11-2
New	14-14.5	22	33.0	32.0	41	CR-15	AM42-0007	11-4
New	14-14.5	22	33.0	32.0	41	Chip	AM42-0007-DIE	11-6

Stocked at your local distributor.



CR-15



CR-2

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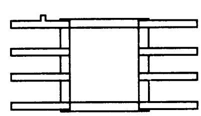
M/A-COM an AMP company

Wideband Amplifiers

	Frequency (GHz)	Noise Gain (dB)	1 dB Comp. Figure (dB)	Point (dBm)	IP_3 (dBm)	Package	Part No.	Page No.
	0.2 - 3	18	4	14	24	CR-3	MAAM02350-A2	11-24
	0.2 - 3	19	3.7	14	24	Chip	MAAM02350	11-22
	2 - 8	17	5.5	14	24	CR-3	MAAM28000-A1	11-56
	2 - 8	18	6	14	24	Chip	MAAM28000	11-58
New	6 - 18	11	5	16	26	Chip	AM46-0006	11-9
New	6 - 18	11	5	16	26	Chip	AM46-0007	11-9

Stocked at your local distributor.



CR-3

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Coming Attractions

GaAs MMIC Power Amplifier, 1.4 W 14.0-14.5 GHz

AM42-0002-DIE

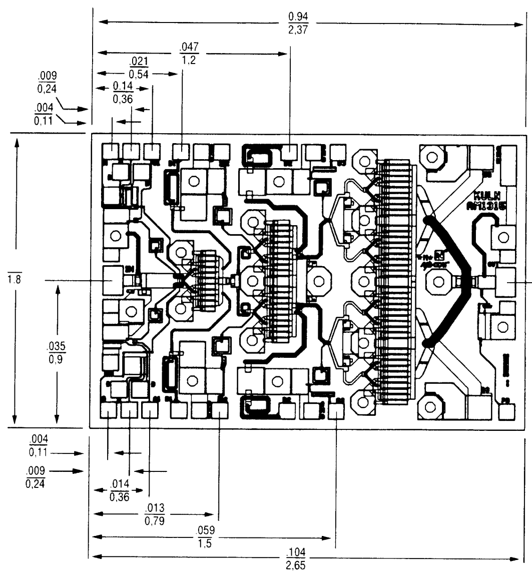
V 2.00

Features

- High Linear Gain: 22 dB Typ.
- High Saturated Output Power: 31.5 dBm Typ.
- High Power Added Efficiency: 22% Typ.
- 50Ω Input/Output Broadband Matched
- Integrated Output Power Detector
- High Performance Ceramic Bolt Down Package

Description

M/A-COM's AM42-0002-DIE is a three-stage MMIC power amplifier fabricated on a mature 0.5-micron MBE based GaAs process. The AM42-0002-DIE employs a fully matched chip with integral bias networks and output power detector. This GaAs MMIC power amplifier is ideally suited for use as an output stage or driver in applications for VSAT systems.



1. Dimensions are inches/mm.

Ordering Information

Part Number	Package
AM42-0002-DIE	MMIC

Electrical Specifications[1], T_B= +25°C, V_{DD} = +9 V, V_{GG} = -1.2 V, Z_0 = 50Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Linear Gain	$P_{IN} \leq 0$ dBm 14.0 - 14.5 GHz	dB		22	
Input VSWR	14.0 - 14.5 GHz			2.5:1	
Output VSWR	14.0 - 14.5 GHz			2.7:1	
Saturated Output Power	P_{IN} = +14 dBm 14.0 - 14.5 GHz	dBm	30.5	31.5	
Output Power @ 1 dB Compression	14.0 - 14.5 GHz	dBm		30.5	
Output IP_3	14.0 - 14.5 GHz	dBm		40	
Power Added Efficiency (PAE)	P_{IN} = +14 dBm 14.0 - 14.5 GHz	%		22	
Bias Current	I_{DD} (No RF) I_{GG} (No RF)	mA mA		800 0.1	
Thermal Resistance	θ_{CB}[2]	°C/W		7.5	
Detector Output Voltage (Vdet)	RL = 10 KΩ, P_{OUT} = +31 dBm 14.0 - 14.5 GHz	V		+3.5	

1. 100% on-wafer tested (50-µs pulse width, 20% duty factor) without resistor network on gates.
2. Channel to die backside.

Specifications Subject to Change Without Notice.

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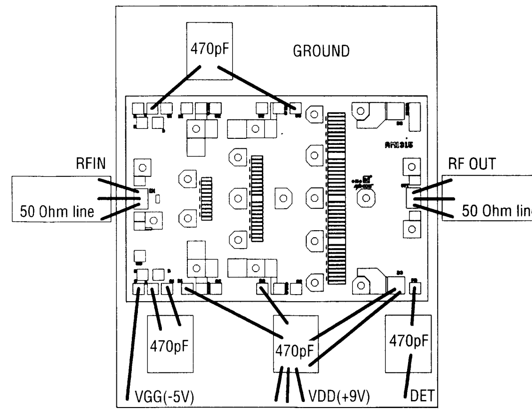
Absolute Maximum Ratings[1,2]

Parameter	Absolute Maximum
V_{DD}	12 Volts
V_{GG}	-10 Volts
Power Dissipation	16.7 W
RF Input Power	+23 dBm
Channel Temperature	150°C
Storage Temperature	-65°C to +150°C

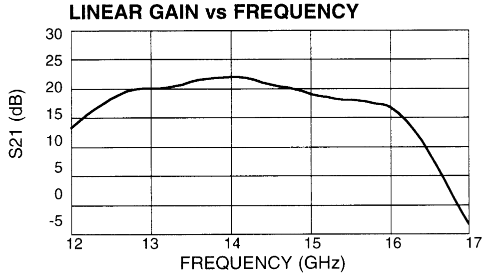
1. Operation of this device outside any one of these limits may cause permanent damage.
2. Back of die temperature (T_B) = +25°C
3. Nominal bias is obtained by first connecting -5 volts to pin V_{GG} (resistor network used) followed by connecting +9 volts to pin V_{DD}. Note sequence.
4. It is recommended that the die be mounted with Au/Sn eutectic preforms for good RF ground and thermal interface.

Typical Bias Configuration [3, 4]

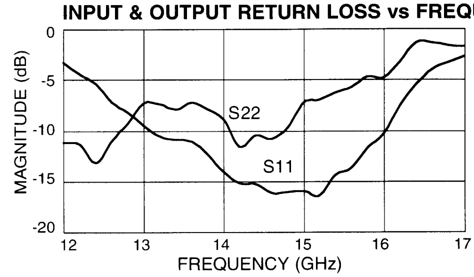


Typical Performance @ +25°C

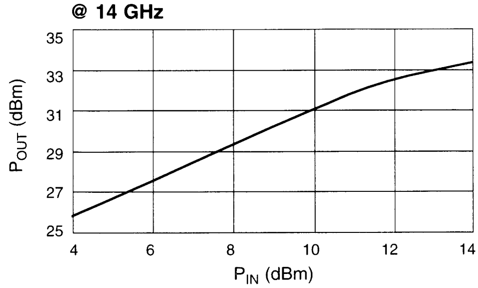
LINEAR GAIN vs FREQUENCY



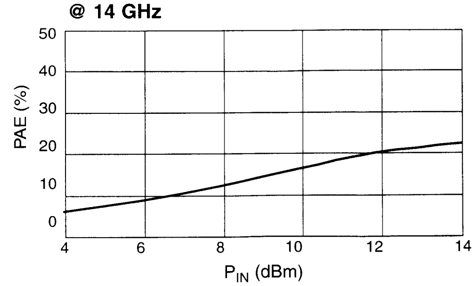
INPUT & OUTPUT RETURN LOSS vs FREQUENCY



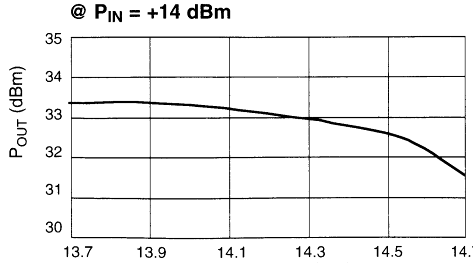
OUTPUT POWER vs INPUT POWER @ 14 GHz



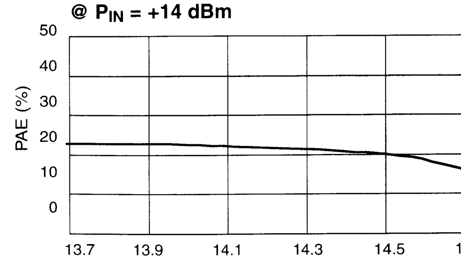
POWER ADDED EFFICIENCY vs INPUT POWER @ 14 GHz



OUTPUT POWER vs FREQUENCY @ P_{IN} = +14 dBm



POWER ADDED EFFICIENCY vs FREQUENCY @ P_{IN} = +14 dBm



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GaAs MMIC Power Amplifier, 2 W 14.0-14.5 GHz

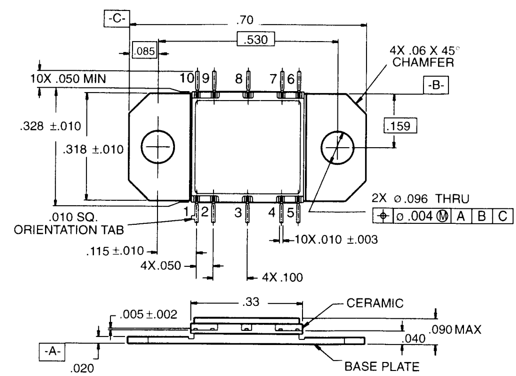
AM42-0007

V 2.00

Features

- High Linear Gain: 22 dB Typ.
- High Saturated Output Power: 33 dBm Typ.
- High Power Added Efficiency: 22% Typ.
- High P_{1dB}: 32 dBm Typ.
- 50Ω Input/Output Broadband Matched
- Integrated Output Power Detector
- High Performance Ceramic Bolt Down Package

CR-15



Notes: (unless otherwise specified)
1. Dimensions are inches.
2. Tolerance: in .xxx = ±.010

Description

M/A-COM's AM42-0007 is a three-stage MMIC linear power amplifier fabricated on a mature 0.5-micron MBE based GaAs process. The AM42-0007 employs a fully matched chip with integral bias networks and output power detector. This GaAs MMIC power amplifier is ideally suited for use as an output stage or driver in applications for VSAT systems.

Ordering Information

Part Number	Package
AM42-0007	Ceramic Bolt Down

Electrical Specifications1, T_C = +25°C, V_{DD} = +9 V, V_{GG} = -1.2 V, Z_0 = 50Ω

Parameter	Test Conditions		Units	Min.	Typ.	Max.
Linear Gain	P_{IN} ≤ 0 dBm	14.0 - 14.5 GHz	dB		22	
Input VSWR		14.0 - 14.5 GHz			2.5:1	2.7:1
Output VSWR		14.0 - 14.5 GHz			2.7:1	
Saturated Output Power	P_{IN} = +14 dBm	14.0 - 14.5 GHz	dBm		33	
Output Power @ 1 dB Compression		14.0 - 14.5 GHz	dBm	31	32	
Output IP_3		14.0 - 14.5 GHz	dBm		41	
Power Added Efficiency (PAE)	P_{IN} = +14 dBm	14.0 - 14.5 GHz	%		22	
Bias Current	I_{DD} (No RF) I_{GG} (No RF)		mA mA		850 18	 25
Thermal Resistance	θ_{CB}		°C/W		9.5	
Detector Output Voltage (Vdet)	RL = 10 KΩ, P_{OUT} = +31 dBm	14.0 - 14.5 GHz	V		+3.5	

Specifications Subject to Change Without Notice.

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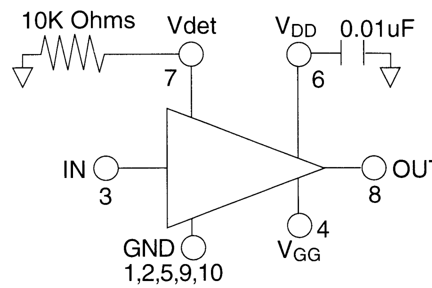
Absolute Maximum Ratings[1,2]

Parameter	Absolute Maximum
V_{DD}	12 Volts
V_{GG}	-10 Volts
Power Dissipation	13.2 W
RF Input Power	+23 dBm
Channel Temperature	150°C
Storage Temperature	-65°C to +150°C

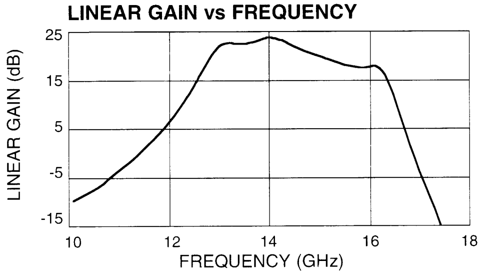
1. Operation of this device outside any of these limits may cause permanent damage.
2. Case Temperature (T_C) = +25°C.
3. Nominal bias is obtained by first connecting -5 volts to pin 4 (V_{GG}), followed by connecting +9 volts to pin 6 (V_{DD}). Note sequence.
4. RF ground and thermal interface is the flange (case bottom). Adequate heat sinking is required.

Typical Bias Configuration [3, 4]

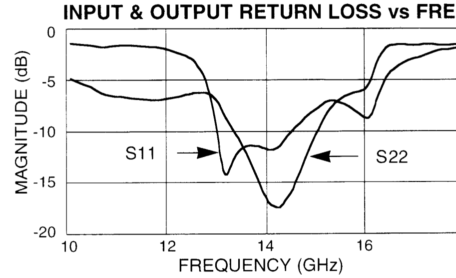


Typical Performance @ +25°C

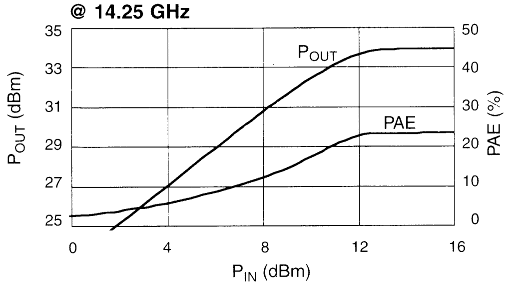
LINEAR GAIN vs FREQUENCY



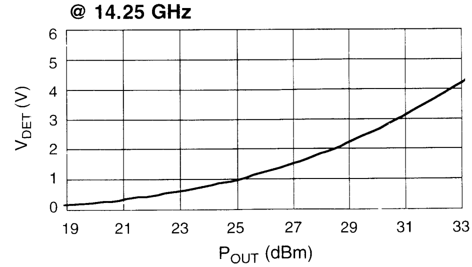
INPUT & OUTPUT RETURN LOSS vs FREQUENCY



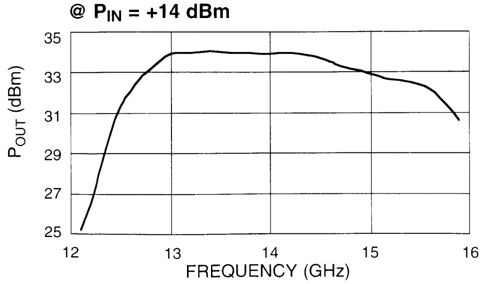
OUTPUT POWER & PAE vs INPUT POWER @ 14.25 GHz



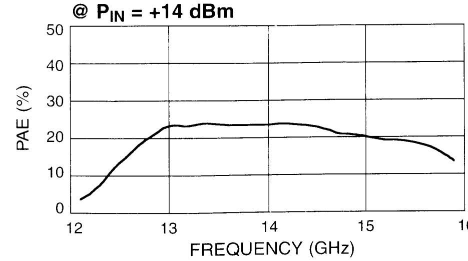
DETECTOR VOLTAGE vs OUTPUT POWER @ 14.25 GHz



OUTPUT POWER vs FREQUENCY @ P_{IN} = +14 dBm



POWER ADDED EFFICIENCY vs FREQUENCY @ P_{IN} = +14 dBm



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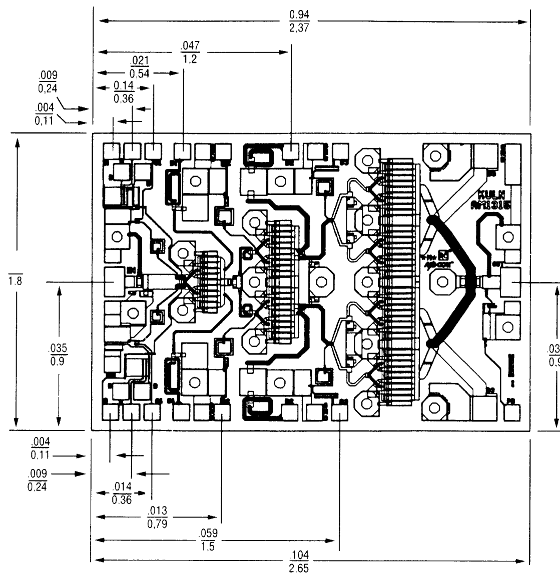
GaAs MMIC Power Amplifier, 2 W 14.0-14.5 GHz

AM42-0007-DIE

V 2.00

Features

- High Linear Gain: 22 dB Typ.
- High Saturated Output Power: 33 dBm Typ.
- High Power Added Efficiency: 22% Typ.
- High P_{1dB}: 32 dBm Typ.
- 50Ω Input/Output Broadband Matched
- Integrated Output Power Detector
- High Performance Ceramic Bolt Down Package



Notes: (unless otherwise specified)
1. Dimensions are inches.
2. Tolerance: in .xxx = ±.010

Description

M/A-COM's AM42-0007-DIE is a three-stage MMIC linear power amplifier fabricated on a mature 0.5-micron MBE based GaAs process. The AM42-0007-DIE employs a fully matched chip with integral bias networks and output power detector. This GaAs MMIC power amplifier is ideally suited for use as an output stage or driver in applications for VSAT systems.

Ordering Information

Part Number	Package
AM42-0007-DIE	MMIC

Electrical Specifications1, T_B= +25°C, V_{DD} = +9 V, V_{GG} = -1.2 V, Z_0 = 50Ω

Parameter	Test Conditions		Units	Min.	Typ.	Max.
Linear Gain	$P_{IN} \leq 0$ dBm	14.0 - 14.5 GHz	dB		22	
Input VSWR		14.0 - 14.5 GHz			2.5:1	
Output VSWR		14.0 - 14.5 GHz			2.7:1	
Saturated Output Power	P_{IN} = +14 dBm	14.0 - 14.5 GHz	dBm		33	
Output Power @ 1 dB Compression		14.0 - 14.5 GHz	dBm	31	32	
Output IP_3		14.0 - 14.5 GHz	dBm		41	
Power Added Efficiency (PAE)	P_{IN} = +14 dBm	14.0 - 14.5 GHz	%		22	
Bias Current	I_{DD} (No RF) I_{GG} (No RF)		mA mA		850 0.1	
Thermal Resistance	θ_{CB}2		°C/W		7	
Detector Output Voltage (Vdet)	RL = 10 KΩ, P_{OUT} = +31 dBm	14.0 - 14.5 GHz	V		+3.5	

1. 100% on-wafer tested (50-µs pulse width, 20% duty factor) without resistor network on gates.
2. Channel to die backside.

Specifications Subject to Change Without Notice.

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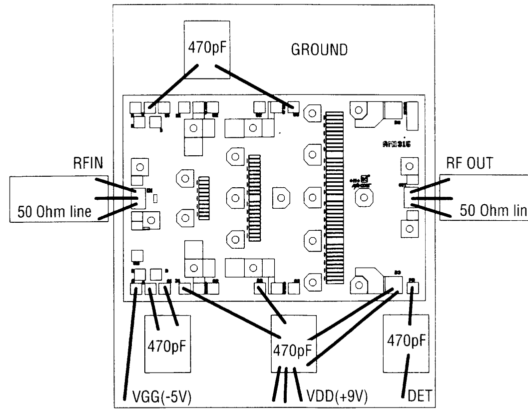
Absolute Maximum Ratings[1,2]

Parameter	Absolute Maximum
V_{DD}	12 Volts
V_{GG}	-10 Volts
Power Dissipation	17.9 W
RF Input Power	+23 dBm
Channel Temperature	150°C
Storage Temperature	-65°C to +150°C

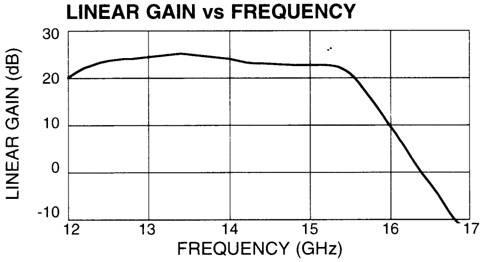
1. Operation of this device outside any of these limits may cause permanent damage.
2. Back of die temperature (T_B) = +25°C
3. Nominal bias is obtained by first connecting -5 volts to pin V_{GG}. (resistor network used) followed by connecting +9 volts to pin V_{DD}. Note sequence.
4. It is recommended that the die be mounted with Au/Sn eutectic preforms for good RF ground and thermal interface.

Typical Bias Configuration [3,4]

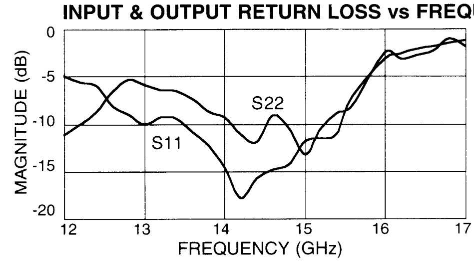


Typical Performance @ +25°C

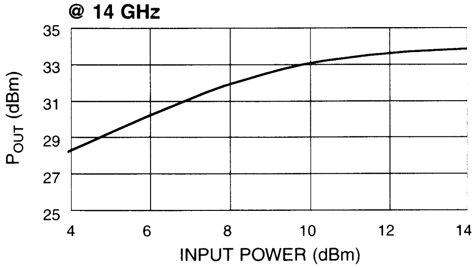
LINEAR GAIN vs FREQUENCY



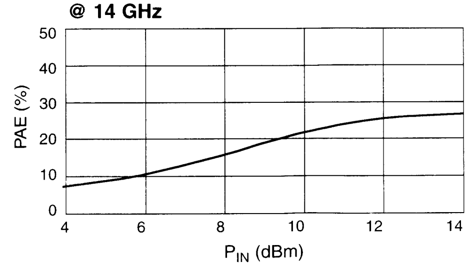
INPUT & OUTPUT RETURN LOSS vs FREQUENCY



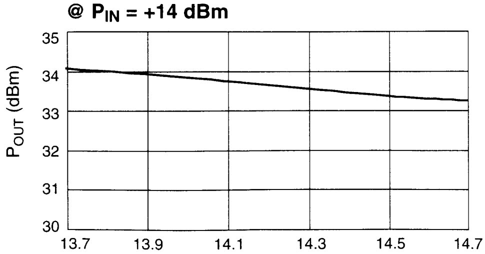
OUTPUT POWER vs INPUT POWER @ 14 GHz



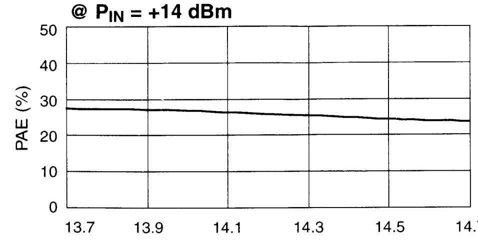
POWER ADDED EFFICIENCY vs INPUT POWER @ 14 GHz



OUTPUT POWER vs FREQUENCY @ P_{IN} = +14 dBm



POWER ADDED EFFICIENCY vs FREQUENCY @ P_{IN} = +14 dBm



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Wide Band GaAs MMIC Amplifier 6 - 18 GHz

AM46-0006/AM46-0007

V 2.00

Features

- 11 dB Typical Gain[1]
- ±0.5 dB Typical Broadband Gain Flatness
- 0.4 dB Positive Gain Slope
- Single Bias Supply
- Low, Medium and High Bias Options
- DC Decoupled RF Input and Output

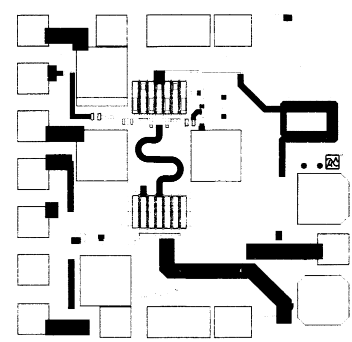
Description

M/A-COM's AM46-0006 and AM46-0007 are versatile broadband GaAs MMIC amplifier chips. The AM46-0006 and AM46-0007 are mirror images of each other. The design matches a cascode FET for flat gain from 6 GHz to 18 GHz. On-chip bias options enable the user to optimize gain and dynamic range.

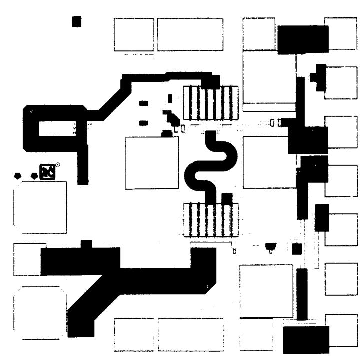
The AM46-0006 and AM46-0007 are ideally suited for use in single or multi-stage EW amplifier modules. Insertion of two devices between lange couplers creates a balanced amplifier. Multi-stage amplifier modules are easily created by cascading single stages. Although the AM46-0006 and AM46-0007 are not matched for VSWR, an external matching circuit can be used for specific narrow band applications.

The AM46-0006 and AM46-0007 are fabricated using a mature 0.5-micron gate length GaAs process for increased reliability and performance repeatability.

AM46-0006



AM46-0007



Electrical Specifications[1]

T_A= +25°C, V_{DD} = +6 V[2], I_{DD} = 50% I_{DSS}, f = 6 - 18 GHz

Parameter	Units	Min.	Typ.	Max.
Gain[1]	dB	9	11	
Noise Figure[1]	dB		5	
Output 1 dB Compression	dBm		16	
IP_3	dBm		26	
Reverse Isolation	dB		33	
Bias Current[1] (I_{DD})	mA		52	70

1. 100% on-wafer tested.
2. See following pages for 8-volt data.

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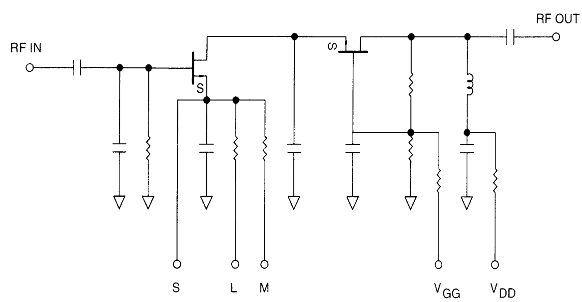
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+15 VDC
Input Power	+20 dBm
Junction Temperature	+150°C
Storage Temperature	-65°C to +150°C
Thermal Resistance	
0.002-Inch Conductive Epoxy Attach	90°C/W
0.002-Inch AuSn 80/20 Solder Attach	83°C/W

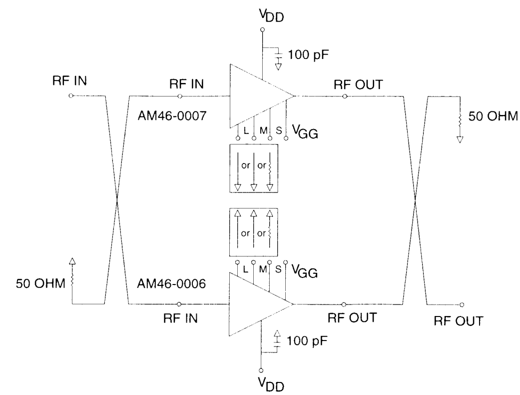
1. Operation of this device outside these limits may cause permanent damage.

Schematic



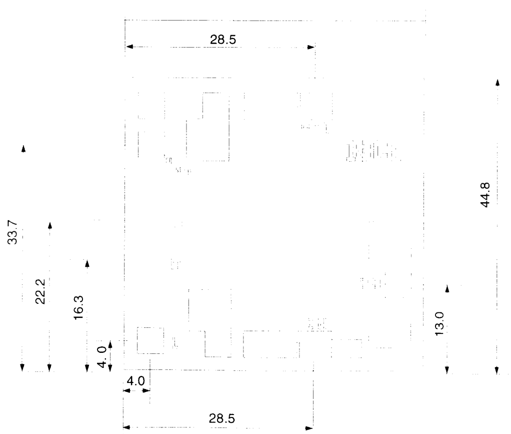
Recommended Circuit Configuration

The AM46-0006 and AM46-0007 are designed to be integrated between two lange or quadrature couplers as shown. The RF bond inductance is assumed to be 0.15 nH. Variations in bond inductance will result in variations in gain slope. A small capacitive stub may be needed depending on the inductance realized in the final assembly.

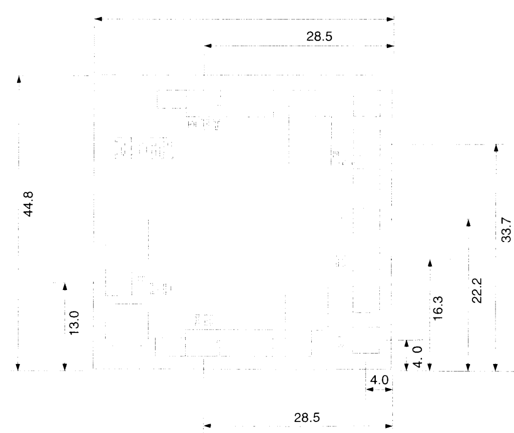


Outline

AM46-0006



AM46-0007



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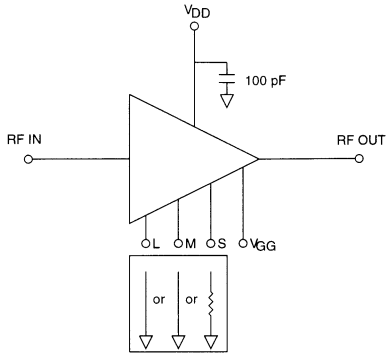
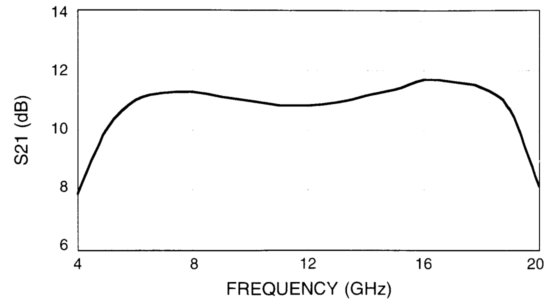
Typical Bias Configuration



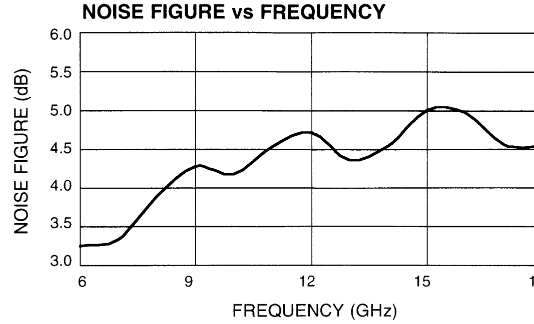
1. Nominal bias is obtained by grounding pad "M" and setting V_{DD} = 6 volts. This sets I_{DD} to 50% I_{DSS}.
2. For I_{DD} = 25% I_{DSS}, ground pad "L" instead of pad "M."
3. For I_{DD} = 60% I_{DSS}, ground both pads "L" and "M."
4. For a finer adjustment of I_{DD}, connect an external resistor in the range of 5 to 20 ohms from pad "S" to ground.
5. Increase V_{DD} to 8 volts for higher gain or output power.
6. Pad "V_{GG}" allows access to the gate of the cascode FET. An internal voltage divider sets this voltage to 0.4 V_{DD}. Since the divider uses large resistor values, this voltage can be forced from an external supply. Varying V_{GG} below 0.4 V_{DD} will reduce gain and available output power. This is sometimes used for gain adjustment or for limiting amplifiers. The device can also be switched off by reducing V_{GG} below -2.0 volts. Varying V_{GG} above 0.5 V_{DD} typically has little effect.

Typical Performance @ +25°C

LINEAR GAIN vs FREQUENCY



NOISE FIGURE vs FREQUENCY



Typical S-Parameters
Bias = 6 volts @ 50 mA

Freq. (GHz)	S11 Mag	S11 Ang	S21 Mag	S21 Ang	S12 Mag	S12 Ang	S22 Mag	S22 Ang
1.0	1.077	-22.08	0.258	-155.39	0.001	-1.95	0.983	-37.45
2.0	1.085	-48.03	0.399	-90.21	0.001	-65.75	0.956	-77.24
3.0	1.098	-72.92	1.450	-119.51	0.003	129.13	0.913	-122.07
4.0	1.075	-95.68	2.532	-164.53	0.005	93.82	0.820	-170.86
5.0	1.029	-115.60	3.232	153.54	0.011	72.75	0.733	140.87
6.0	0.998	-133.33	3.598	116.48	0.012	42.24	0.665	97.98
7.0	0.958	-149.80	3.677	83.93	0.013	14.52	0.627	62.03
8.0	0.923	-164.67	3.686	54.90	0.014	-3.48	0.599	32.09
9.0	0.893	-178.67	3.631	27.71	0.017	-23.40	0.577	7.02
10.0	0.849	167.50	3.569	2.15	0.017	-45.39	0.560	-14.73
11.0	0.817	155.38	3.528	-22.25	0.017	-66.80	0.541	-33.72
12.0	0.787	141.58	3.552	-46.81	0.019	-90.27	0.527	-50.99
13.0	0.767	127.62	3.610	-72.17	0.018	-116.90	0.527	-67.17
14.0	0.751	113.16	3.703	-97.32	0.019	-134.80	0.540	-83.88
15.0	0.730	95.68	3.824	-125.51	0.021	-169.99	0.585	-100.21
16.0	0.697	75.00	3.981	-156.44	0.022	158.21	0.642	-118.83
17.0	0.668	49.24	3.945	171.20	0.019	126.44	0.746	-140.13
18.0	0.623	20.83	3.855	131.92	0.017	88.03	0.859	-166.37
19.0	0.584	-8.26	3.528	93.94	0.019	60.22	0.969	166.94
20.0	0.536	-40.58	2.594	56.14	0.012	18.82	1.048	140.74

High Dynamic Range Low Noise Amplifier 815-915 MHz

AM50-0001

V 2.00

Features

- Low Noise Figure, 1.5 dB
- High Dynamic Range, 15 dBm Input IP_3
- High Gain, 14.5 dB
- Single Supply +5 VDC
- DC Decoupled RF Input and Output
- No External RF Tuning Elements Necessary
- Low Cost SOIC-8 Plastic Package

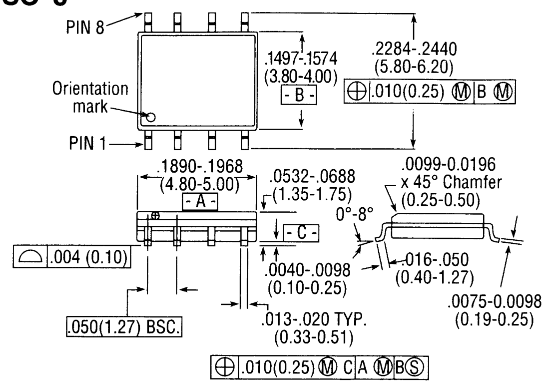
Description

M/A-COM's AM50-0001 is a high dynamic range GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The AM50-0001 employs a fully monolithic design which eliminates the need for external tuning networks. It is biased using a single 5-V supply.

The AM50-0001 is ideally suited for use where low noise figure, high gain, high dynamic range, and low power consumption are required. Typical applications include receiver front ends in AMPS, JTACS, NTACS and NTT base stations as well as ISM receivers. They are also useful as standard gain blocks, buffer amps, driver amps, and IF amps in both fixed and portable systems.

The AM50-0001 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA,Issue C)
Dimensions in () are in mm. Unless Otherwise Noted: .xxx =+/- 0.010 (.xx = +/-0.25)
.xx = +/-0.02 (.x = +/-0.5)

Ordering Information

Part Number	Package
AM50-0001	SOIC 8-Lead Plastic
AM50-0001TR	Forward Tape and Reel*
AM50-0001RTR	Reverse Tape and Reel*
AM50-0001SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications

T_A= +25°C, Z_0 = 50Ω, V_{DD} = 5 V, f = 815 - 915 MHz, P_{IN} = -30 dBm

Parameter	Units	Min.	Typ.	Max.
Gain	dB	13.0	14.5	
Noise Figure	dB		1.5	1.8
Input VSWR			1.5:1	
Output VSWR			1.3:1	
Output 1 dB Compression Point	dBm		16.5	
Input IP_3	dBm		15	
Reverse Isolation	dB		23	
Bias Current	mA		50	80

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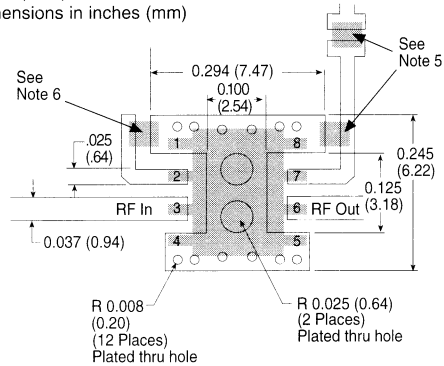
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
V_{DD}	+10 VDC
Input Power	+17 dBm
Current[2]	150 mA
Channel Temperature[3]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

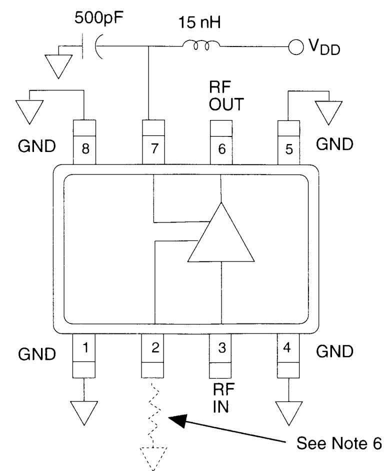
1. Operation of this device outside these limits may cause permanent damage.
2. Only if pin #2 is used to increase current. (See note 6.)
3. Typical thermal resistance (θjc) = +125°C/W.

Recommended PCB Configuration

0.020 (0.51) FR-4 Circuit Board
Dimensions in inches (mm)



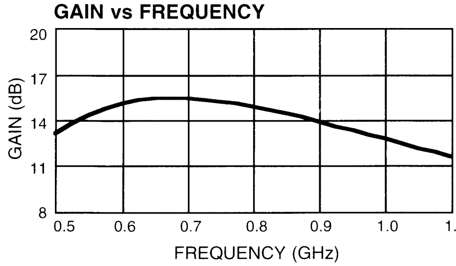
Functional Diagram



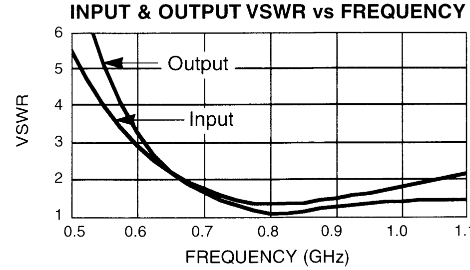
4. Pins 1,4,5, and 8 must be RF and DC grounded as shown.
5. Pin 3 is the RF input; pin 6 is the RF output. V_{DD} is applied on pin 7. This pin must be bypassed with a 500 pF surface mount MLC capacitor mounted as close as possible to pin 7, and RF decoupled with a chip inductor, minimum value 15 nH (as shown in the Recommended PCB Configuration).
6. Pin 2 allows use of an external resistor to ground for optional, higher current bias. For nominal current operation no resistor is used. For increased current operation, connect a 10-40 ohm chip resistor (as shown in the Recommended PCB Configuration).

Typical Performance @ +25°C, V_{DD} = +5 V

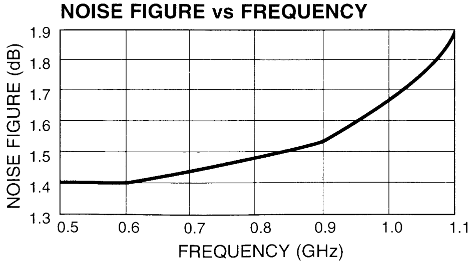
GAIN vs FREQUENCY



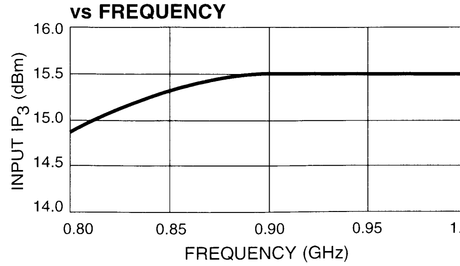
INPUT & OUTPUT VSWR vs FREQUENCY



NOISE FIGURE vs FREQUENCY



INPUT THIRD ORDER INTERCEPT vs FREQUENCY



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GaAs MMIC Power Amplifier 2-6 GHz

MAAM26100-P1

V 2.00

Features

- +30 dBm Saturated Output Power
- 18 dB Typical Gain
- 30% Power Added Efficiency
- On-Chip Bias Network
- DC Decoupled RF Input and Output
- High Performance Ceramic Bolt Down Package

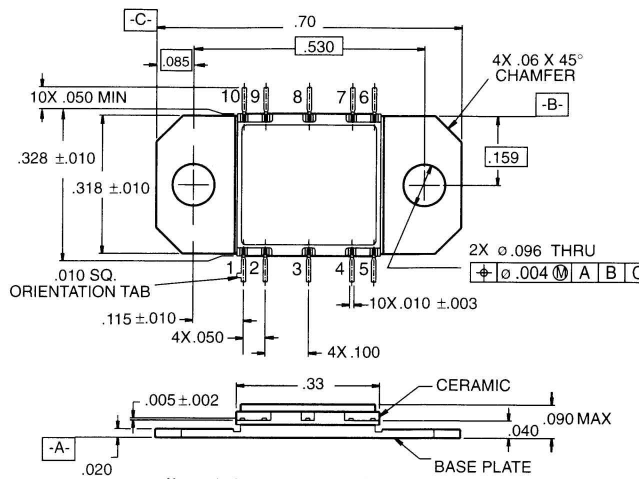
Description

M/A-COM's MAAM26100-P1 is a GaAs MMIC two stage high efficiency power amplifier in a high performance bolt down ceramic package. The MAAM26100-P1 is a fully monolithic design for operation in 50-ohm systems, with an on-chip negative bias network which eliminates the need for external bias circuitry.

The MAAM26100-P1 is ideally suited for driver amplifiers and transmitter outputs in Electronic Warfare Jammers, Missile Subsystems and Phased Array Radars.

M/A-COM's MAAM26100-P1 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

CR-15



Notes: (unless otherwise specified)
1. Dimensions are inches.
2. Tolerance: in .xxx = ±.010

Ordering Information

Part Number	Package
MAAM26100-P1	Ceramic Bolt Down

Typical Electrical Specifications, T_A= +25°C, V_{DD} = +8 V, V_{GG} = -5 V

Parameter	Test Conditions		Units	Min.	Typ.	Max.
Small Signal Gain	$P_{IN} \leq$ -10 dBm	2 - 6 GHz	dB		18	
Input VSWR	$P_{IN} \leq$ -10 dBm	2 - 6 GHz			2.0:1	
Output VSWR	$P_{IN} \leq$ -10 dBm	2 - 6 GHz			2.2:1	
Output Power	P_{IN} = +15 dBm	2 - 6 GHz	dBm		+30	
Power Added Efficiency	P_{IN} = +15 dBm	2 - 6 GHz	%		30	
Output IP_3		2, 5 & 6 GHz	dBm		40	

Specifications Subject to Change Without Notice.

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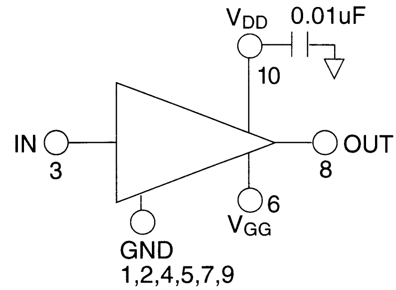
Absolute Maximum Ratings[1, 2]

Parameter	Absolute Maximum
V_{DD}	10 Volts
V_{GG}	-10 Volts
Power Dissipation	8.4 W
RF Input Power	+23 dBm
Channel Temperature	150°C
Storage Temperature	-65°C to +150°C
Thermal Resistance (Channel to Case)	15°C/W

1. Exceeding these limits may cause permanent damage.
2. Case Temperature (Tc) = +25°C

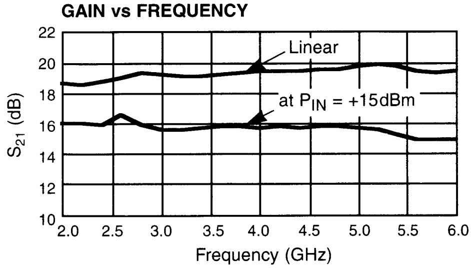
Functional Diagram[3,4]



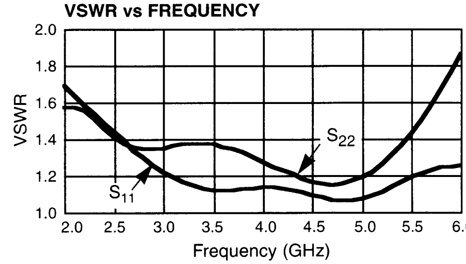
3. Nominal bias is obtained by first connecting -5 volts to pin 6 (V_{GG}), followed by connecting +9 volts to pin 10 (V_{DD}). Note sequence.
4. RF ground and thermal interface is the flange (case bottom). Adequate heat sinking is required.

Typical Performance @+25°C

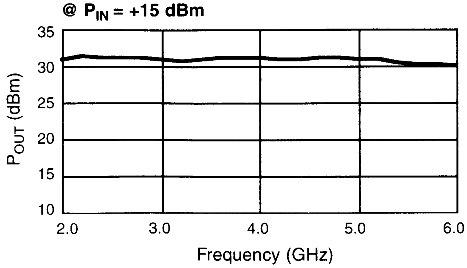
GAIN vs FREQUENCY



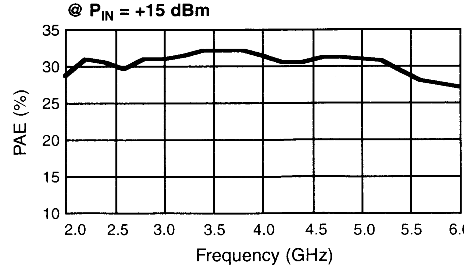
VSWR vs FREQUENCY



OUTPUT POWER vs FREQUENCY
@ P_{IN} = +15 dBm



POWER ADDED EFFICIENCY vs FREQUENCY
@ P_{IN} = +15 dBm



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an AMP company

GaAs MMIC Power Amplifier, 1.4 W 14.0-14.5 GHz

AM42-0002

V 2.00

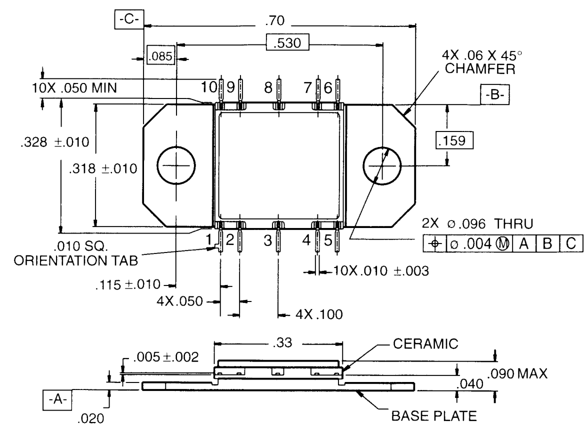
Features

- High Linear Gain: 22 dB Typ.
- High Saturated Output Power: 31.5 dBm Typ.
- High Power Added Efficiency: 22% Typ.
- 50Ω Input/Output Broadband Matched
- Integrated Output Power Detector
- High Performance Ceramic Bolt Down Package

Description

M/A-COM's AM42-0002 is a three-stage MMIC power amplifier fabricated on a mature 0.5-micron MBE based GaAs process employing a high performance ceramic package. The AM42-0002 employs a fully matched chip with integral bias networks and output power detector. This GaAs MMIC power amplifier is ideally suited for use as an output stage or driver in applications for VSAT systems.

CR-15



Notes: (unless otherwise specified)
1. Dimensions are inches.
2. Tolerance: in .xxx = ±.010

Ordering Information

Part Number	Package
AM42-0002	Ceramic Bolt Down

Electrical Specifications, T_C= +25°C, V_{DD} = +9 V, V_{GG} = -5 V, Z_0 = 50Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Linear Gain	$P_{IN} \leq 0$ dBm 14.0 - 14.5 GHz	dB	19	22	
Input VSWR	14.0 - 14.5 GHz			2.5:1	2.7:1
Output VSWR	14.0 - 14.5 GHz			2.7:1	
Saturated Output Power	P_{IN} = +14 dBm 14.0 - 14.5 GHz	dBm	30.5	31.5	
Output Power @ 1 dB Compression	14.0 - 14.5 GHz	dBm		29.5	
Output IP_3	14.0 - 14.5 GHz	dBm		39	
Power Added Efficiency (PAE)	P_{IN} = +14 dBm 14.0 - 14.5 GHz	%		22	
Bias Current	I_{DD} (No RF) I_{GG} (No RF)	mA mA		800 18	1400 25
Thermal Resistance	θ_{JC}	°C/W		10	
Detector Output Voltage (Vdet)	RL = 10 KΩ, P_{OUT} = +31 dBm 14.0 - 14.5 GHz	V		+3.5	

Specifications Subject to Change Without Notice.

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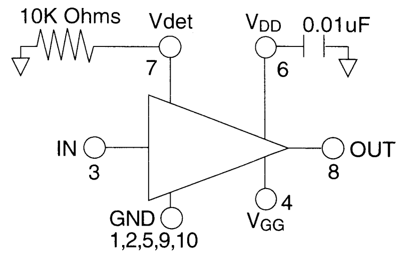
Absolute Maximum Ratings[1,2]

Parameter	Absolute Maximum
V_{DD}	12 Volts
V_{GG}	-10 Volts
Power Dissipation	12.5 W
RF Input Power	+23 dBm
Channel Temperature	150°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside any one of these limits may cause permanent damage.
2. Case Temperature (T_C) = +25°C

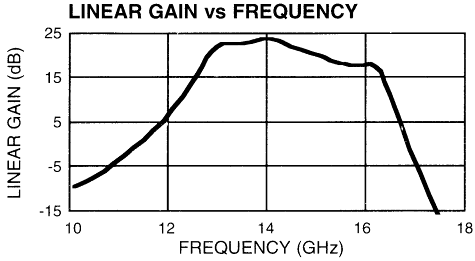
Typical Bias Configuration [3, 4]



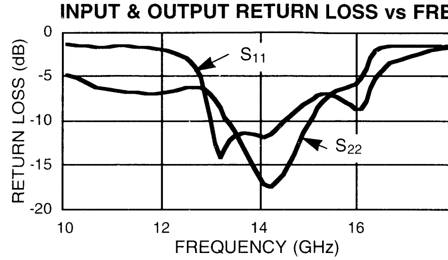
3. Nominal bias is obtained by first connecting -5 volts to pin 4 (V_{GG}), followed by connecting +9 volts to pin 6 (V_{DD}). Note sequence.
4. RF ground and thermal interface is the flange (case bottom). Adequate heat sinking is required.

Typical Performance @ +25°C

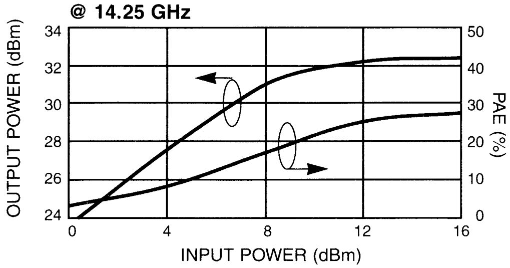
LINEAR GAIN vs FREQUENCY



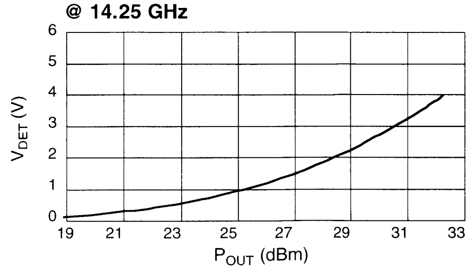
INPUT & OUTPUT RETURN LOSS vs FREQUENCY



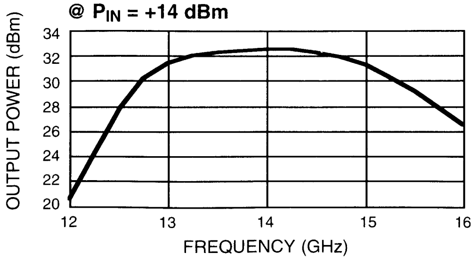
OUTPUT POWER & PAE vs INPUT POWER @ 14.25 GHz



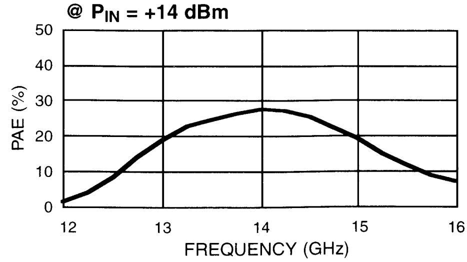
DETECTOR VOLTAGE vs OUTPUT POWER @ 14.25 GHz



OUTPUT POWER vs FREQUENCY @ P_{IN} = +14 dBm



POWER ADDED EFFICIENCY vs FREQUENCY @ P_{IN} = +14 dBm



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an AMP company

Low Noise Amplifier
1.575 GHz

AM50-0002

V 2.00

Features

- Low Noise Figure: 1.15 dB
- High Gain: 27 dB
- Low Power Consumption: 3 to 5 V, 20 mA
- High Dynamic Range
- Low Cost SOIC 8 Plastic Package

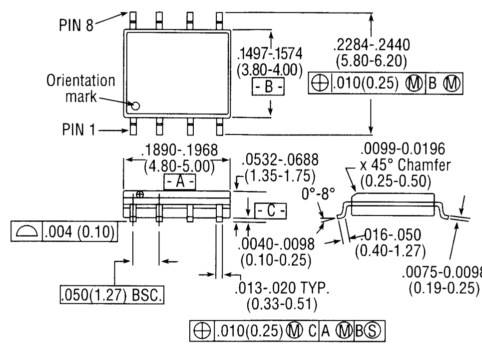
Description

M/A-COM's AM50-0002 is a high performance GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The AM50-0002 employs a monolithic 3-stage self-bias design and a simple external matching network to obtain minimum noise figure. It can be biased using 3- or 5-volt supplies.

The AM50-0002 is ideally suited for use where low noise figure, high gain, high dynamic range and low power consumption are required. Typical applications include receiver front ends in the Global Positioning System (GPS) market, as well as standard gain blocks, buffer amps, driver amps and IF amps in both fixed and portable systems.

M/A-COM's AM50-0002 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AM50-0002	SOIC 8-Lead Plastic
AM50-0002TR	Forward Tape and Reel*
AM50-0002RTR	Reverse Tape and Reel*
AM50-0002SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1]

T_A= +25°C, Z_0=50Ω, V_{DD}=+5V, P_{IN}=-35 dBm, f=1.575 GHz

Parameter	Units	Min.	Typ.	Max.
Gain	dB	25	27	29
Noise Figure	dB		1.15	1.4
Input VSWR			2.0:1	
Output VSWR			1.5:1	
Output1 dB Compression	dBm		1	
Input IP_3	dBm		-14	
Reverse Isolation	dB		48	
Bias Current	mA	15	20	25

1. See following pages for 3-volt data.

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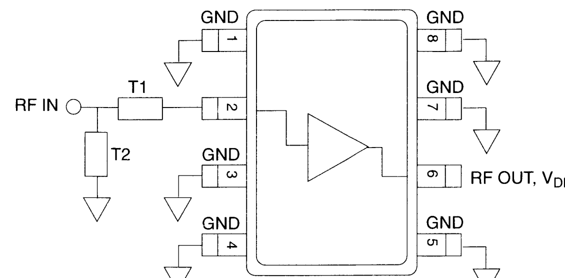
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+10 VDC
Input Power	+17 dBm
Channel Temperature[2]	+150°C
Operating Temperature	-40°C to 85°C
Storage Temperature	-65°C to 150°C

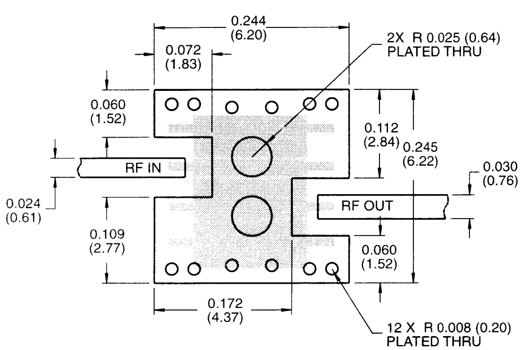
1. Operation of this device outside these limits may cause permanent damage.
2. Typical thermal resistance (θjc) = +165°C/W

Functional Diagram



Recommended PCB Configuration

Dimensions in inches (mm)



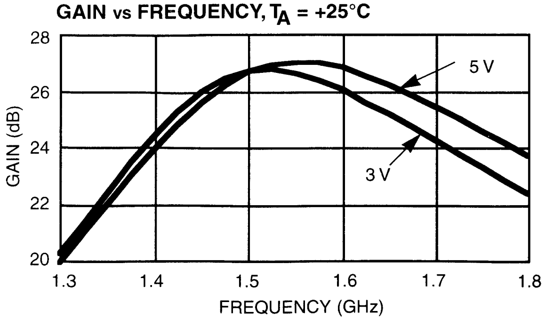
FR-4 circuit board, thickness = 0.016 inches (0.41)

	Frequency = 1.575 GHz	
	Impedance	Electrical Length
T1	57.2 Ω	36.0°
T2	82.7 Ω	16.2°

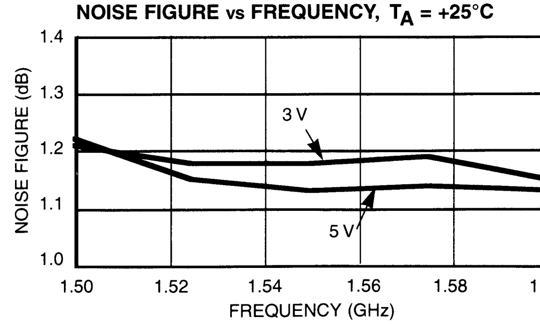
3. Pins 1, 3, 4, 5, 7 and 8 must be RF and DC grounded as shown.
4. Pin 2 is the RF input and must be connected to the simple matching network shown.
5. Pin 6 is the RF output. V_{DD} is also applied on pin 6.

Typical Performance

GAIN vs FREQUENCY, T_A = +25°C



NOISE FIGURE vs FREQUENCY, T_A = +25°C



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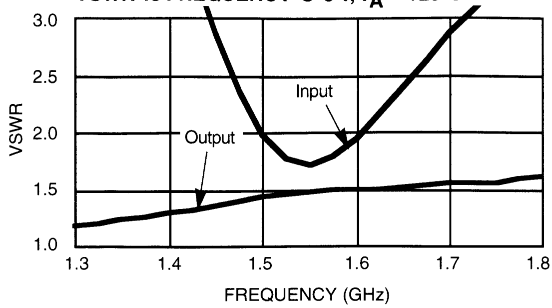
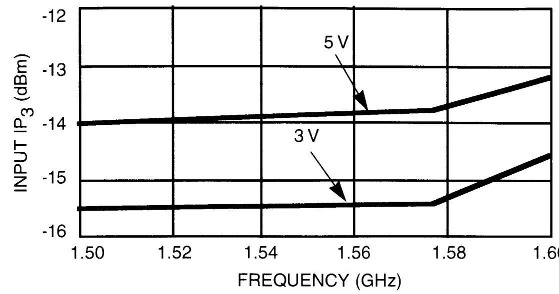
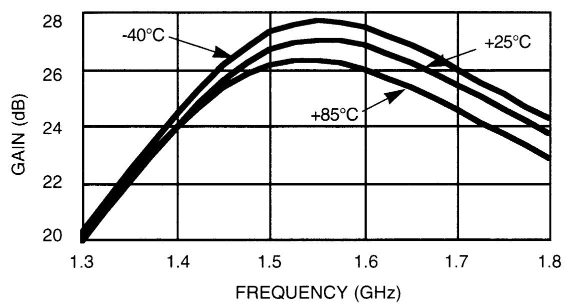
VSWR vs FREQUENCY @ 5 V, T_A = +25°C



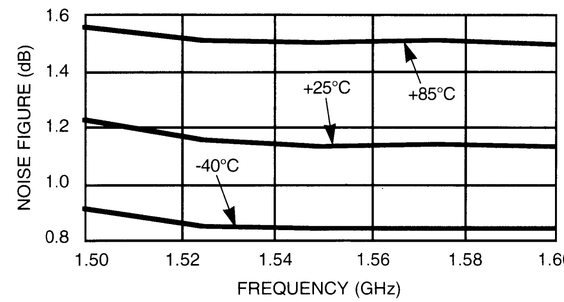
INPUT IP_3 vs FREQUENCY, T_A = +25°C



GAIN vs FREQUENCY @ 5 V



NOISE FIGURE vs FREQUENCY @ 5 V



Additional information is available in Application Note M540, "M/A-COM GaAs MMIC LNA SOIC-8 Platform."

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Wide Band GaAs MMIC Amplifier 0.2 - 3.0 GHz

MAAM02350

V 2.00

Features

- 19 dB Typical Gain[1]
- +14 dBm Typical Output Power
- 3.7 dB Typical Noise Figure[1]

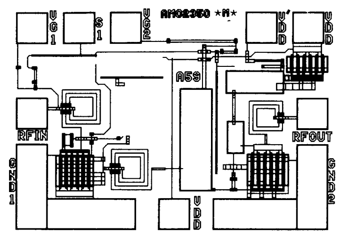
Electrical Specifications @ T_A = +25°C

Frequency Range		0.2 – 3.0 GHz
Gain[1]	19.0 dB Typ	17.0 dB Min
Gain Flatness		±0.5 dB Typ
Noise Figure[1]	4.1 dB Max	3.7 dB Typ
VSWR[1] Input Output		1.8:1 Typ 1.5:1 Typ
Ouput Power at 1 dB Gain Compression		+14 dBm Typ
Third Order Intercept		+24 dBm Typ
Reverse Isolation		+35 dB Typ
Impedance		50 Ω Typ
Bias Voltage Bias Current		Vdd = +6 Vdc Idd = 65mA Typ, 100mA Max

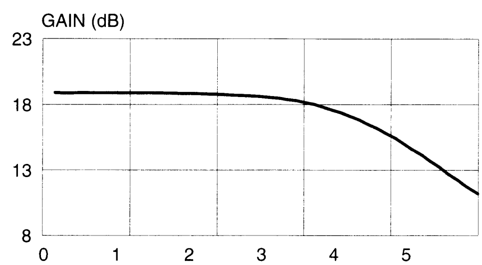
Maximum Ratings

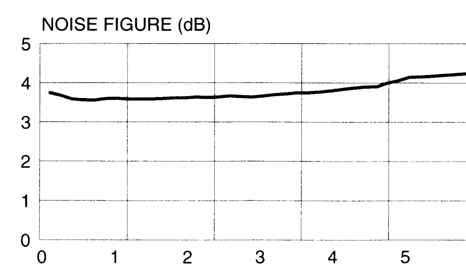
Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

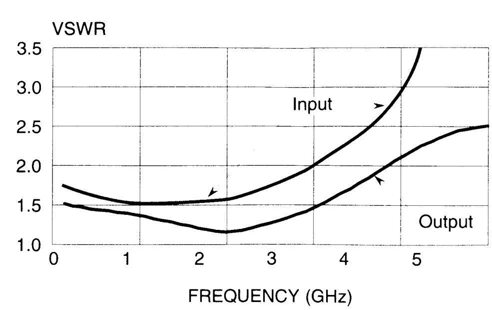
1. 100% on-wafer tested.



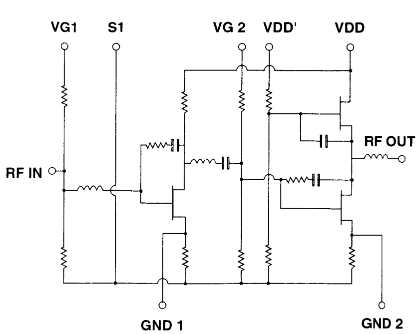
Typical Performance







Schematic



Specifications Subject to Change Without Notice.

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Handling

Permanent damage to the MAAM02350 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM02350 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM02350 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM02350. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM02350 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM02350 is back-metallized with Pd/Ni/Au(100/1,000/30,000Å) metallization. It can be die-mounted using Au/Sn eutectic preforms or epoxy.The attachment surface should be clean and flat.

Eutectic Die Attach:

A. An 80/20 Au/Sn preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 95/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM02350 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MAAM02350 into position. A thin epoxy fillet should be visible around the perimeter of the die.

B. Cure epoxy per manufacturer's recommended schedule.

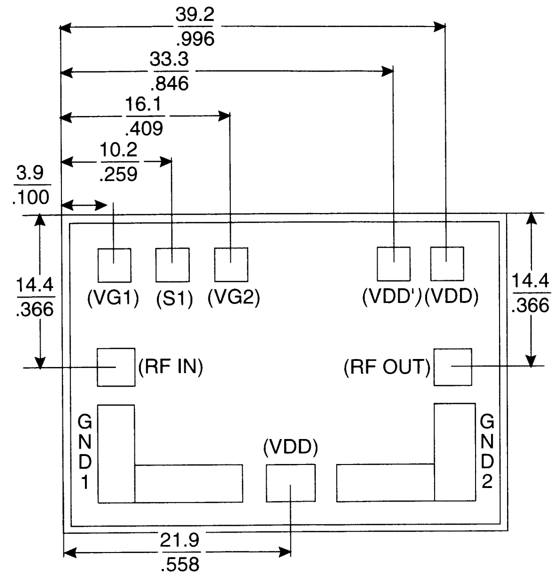
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package. RF bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

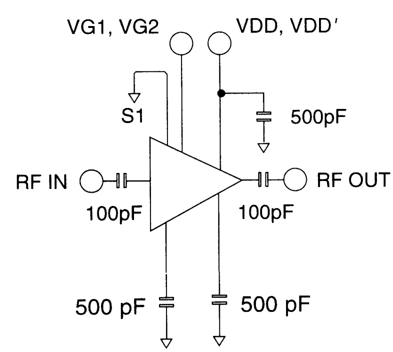
C. Bonding Pads are 4.0 x 4.0 mils.

Outline



0.044 in. x 0.032 in. x 0.004 in. All dimensions are mils/mm.

Typical Bias Configuration



1. Self-bias operation is obtained by connecting +6 volts to both VDD and VDD pads, grounding pad S1, and connecting pads GND1 and GND2 to separate bypass 500pF MOS capacitors.

![M/A-COM an AMP company]

an AMP company

Wide Band GaAs MMIC Amplifier 0.2 - 3.0 GHz

MAAM02350-A2

V 2.00

Features

- High Gain: 18 dB
- Output Power: +14 dBm
- Good Noise Figure: 4 dB
- Single Supply: +6 V
- Gain Flatness: ±0.75 dB
- Small, Low Cost 8-Lead Ceramic Package

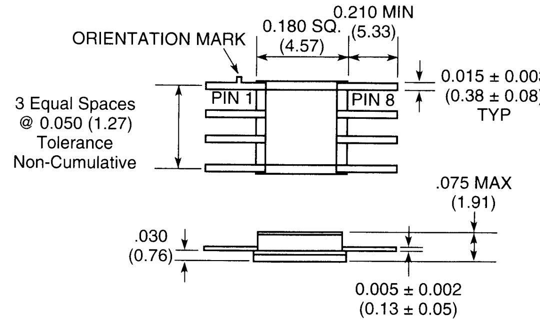
Description

M/A-COM's MAAM02350-A2 is a wide band, MMIC amplifier housed in a small 8-lead ceramic package. It includes two integrated gain stages and employs resistive feedback to obtain flat gain and a good, 50-ohm, input and output impedance match over a very wide bandwidth. The MAAM02350-A2 operates from a single +6 V supply. It is fully monolithic, requires no external components, and is provided in a low-cost, user-friendly, microwave package.

The MAAM02350-A2 functions well as a generic IF, driver or buffer amplifier where high gain, low noise figure, excellent linearity and low power consumption are important. Because of its wide bandwidth, the MAAM02350-A2 can be used in numerous commercial and government system applications, such as wireless communications, EW and radar.

The MAAM02350-A2 is manufactured in-house using a reliable, 0.5-micron, GaAs MESFET process. This product is 100% RF tested to ensure compliance to performance specifications.

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
MAAM02350-A2	8-Lead Ceramic
MAAM02350-A2G	Gull Wing

Electrical Specifications

Test Conditions: T_A = +25°C, Z_0 = 50 Ω, V_{DD} = +6 V, P_{IN} = -30 dBm

Parameter	Units	Min.	Typ.	Max.
Gain	dB	16	18	
Noise Figure	dB		4.0	4.5
Gain Flatness	dB		± 0.5	
Input VSWR			1.7:1	
Output VSWR			1.3:1	
Output 1 dB Compression	dBm		+14	
Input IP_3	dBm		+6	
Reverse Isolation	dB		30	
Bias Current	mA		65	100

Specifications Subject to Change Without Notice.

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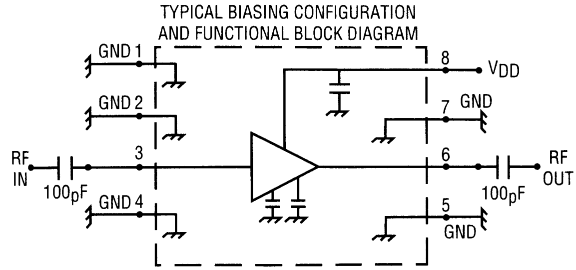
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+10 volts
Input Power	+20 dBm
Current	150 mA
Channel Temperature	+150°C
Operating Temperature[2]	-55°C to +100°C
Storage Temperature	-65°C to +150°C

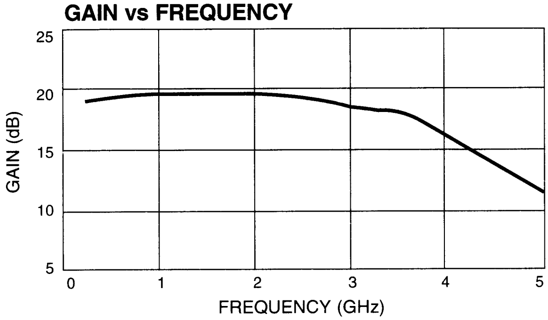
1. Operation of this device outside these limits may cause permanent damage.
2. Typical thermal resistance (θjc) = +80°C/W

Schematic

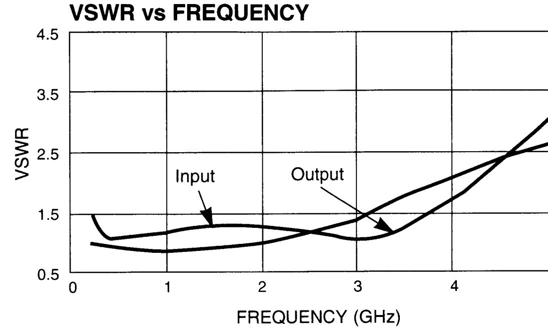


Typical Performance @ +25°C

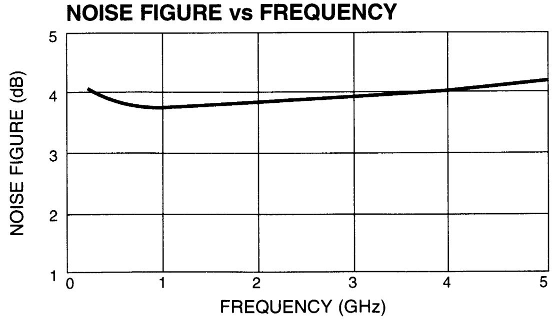
GAIN vs FREQUENCY



VSWR vs FREQUENCY



NOISE FIGURE vs FREQUENCY



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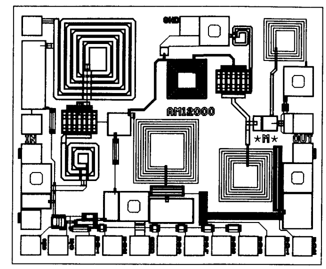
Low Noise GaAs MMIC Amplifier 1.2 - 1.75 GHz

MAAM12000

V 2.00

Features

- 1.25 dB Typical Noise Figure[1]
- 26 dB Typical Gain[1]
- On-Chip Bias Network
- DC Decoupled RF Input and Output



Electrical Specifications @ T_A = +25°C

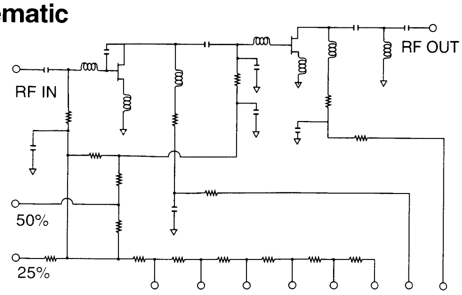
Frequency Range			1.20 - 1.75 GHz
Gain[1]		26 dB Typ	23 dB Min
Gain Flatness			±0.8 dB Typ
Noise Figure[1]		1.6 dB Max	1.25 dB Typ
VSWR[1]	Input Output		1.4:1 Typ 1.5:1 Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			40 dB Typ
Impedance			50 Ω Typ
Bias Voltage			Vdd = +5 Vdc,Vgg = -5 Vdc
Bias Current			Idd = 80 mA Typ, 110 mA Max Igg = 1 mA Typ, 1.5 mA Max

Maximum Ratings

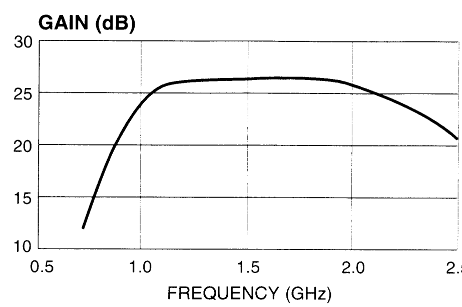
Voltage	+7 V @ Vdd, -10 V @ Vgg
Input Power	+20 dBm
Storage Temperature	-65°C to +150°C
Operating Temperature	-55°C to +125°C

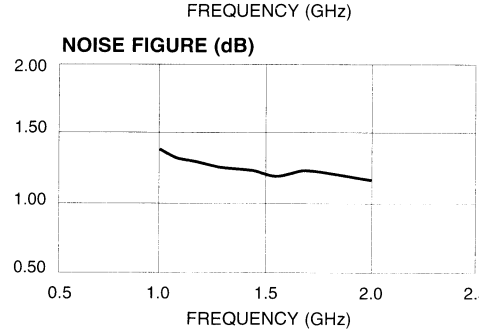
1. 100% on-wafer tested.

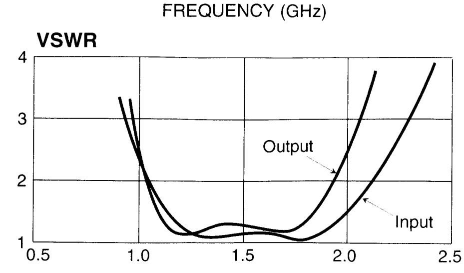
Schematic



Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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Handling

Permanent damage to the MAAM12000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM12000 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM12000 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM12000. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM12000 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM12000 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It can be die-mounted using Au/Sn eutectic preforms or a thermally and electrically conductive epoxy. The attachment surface should be clean and flat.

Eutectic Die Attach:

A. An 80/20 Au/Sn preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 95/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM12000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy is required.

B. Apply a minimum amount of epoxy and place the MAAM12000 into position. A thin epoxy fillet should be visible around the perimeter of the die.

C. Cure epoxy per manufacturer's recommended schedule.

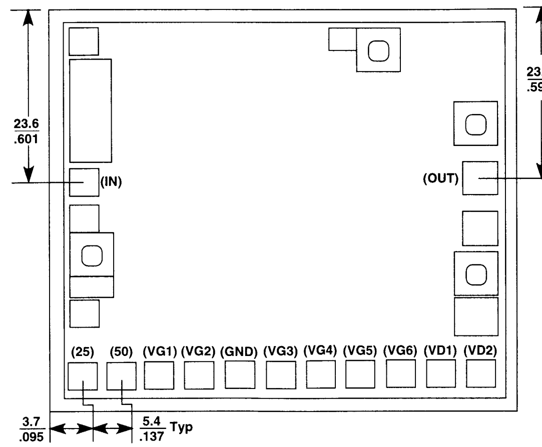
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

C. Bonding pads are 4.0 x 4.0 mils.

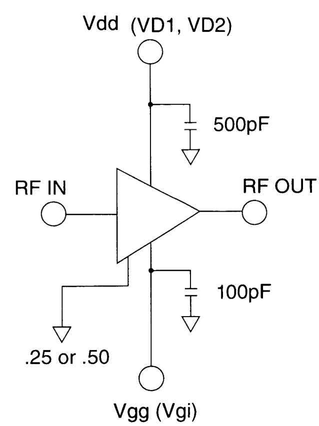
Outline



All dimensions are $\frac{\text{mils}}{\text{mm.}}$

Die Size 0.061" x 0.052" x 0.004" (1.560 mm x 1.308 mm x 0.102 mm)

Typical Bias Configuration



1. Nominal bias is obtained by grounding pad .50 and connecting Vgg to pad VG3.
2. Grounding pad .25, instead of pad .50, will decrease second stage current.
3. Optional biasing can be obtained by connecting Vgg to pads VG1, VG2, VG4, VG5, or VG6, instead of VG3. Connecting to VG1 results in the lowest current; VG6 will yield the highest current. Adjusting the bias can customize performance to suit special requirements.

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an AMP company

Low Noise GaAs MMIC Amplifier

1.2 - 1.75 GHz

MAAM12000-A1

V 2.00

Features

- Low Noise Figure: 1.35 dB
- High Gain: 26 dB
- No External Components Required
- DC Decoupled RF Input and Output
- Small, Low Cost 8-Lead Ceramic Package

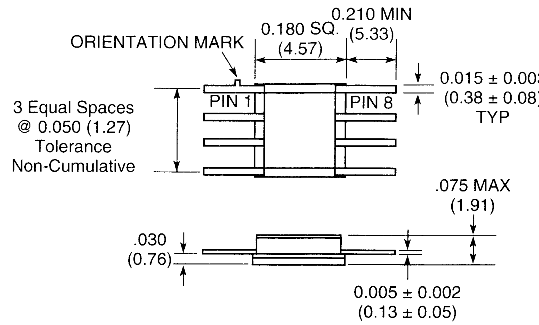
Description

M/A-COM's MAAM12000-A1 is a wide band, low noise, MMIC amplifier housed in a small 8-lead ceramic package. It includes two integrated gain stages and employs series inductive feedback to obtain excellent noise figure and a good, 50-ohm, input and output impedance match over the 1.2 to 1.75 GHz band. The MAAM12000-A1 is fully monolithic, requires no external components, and is provided in a low-cost, user-friendly, microwave package.

The MAAM12000-A1 is ideally suited to receivers in GPS and DGPS applications and operates over both the L1 and L2 frequency bands. Because of its wide bandwidth, the MAAM12000-A1 can also be used as a driver, buffer or IF amplifier in numerous commercial and government system applications that require high gain, excellent linearity and low power consumption.

The MAAM12000-A1 is manufactured in-house using a reliable, 0.5-micron, GaAs MESFET process. This product is 100% RF tested to ensure compliance to performance specifications.

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
MAAM12000-A1	8-Lead Ceramic
MAAM12000-A1G	Gull Wing

Electrical Specifications

Test Conditions: T_A = +25°C, Z_0 = 50Ω , V_{DD} = +5 V, V_{GG} = -5 V, P_{IN} = -30 dBm

Parameter	Units	Min.	Typ.	Max.
Gain	dB	23	26	
Noise Figure	dB		1.35	1.8
Input VSWR			1.4:1	
Output VSWR			1.4:1	
Output 1 dB Compression	dBm		+14	
Input IP_3	dBm		-2	
Reverse Isolation	dB		35	
Bias Current	mA		80	110

Specifications Subject to Change Without Notice.

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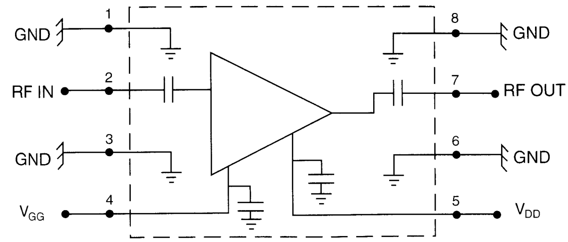
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+7 volts
V_{GG}	-10 volts
Input Power	+20 dBm
Current	150 mA
Channel Temperature	+150°C
Operating Temperature[2]	-55°C to +100°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside these limits may cause permanent damage.
2. Typical thermal resistance (θjc) = +110°C/W

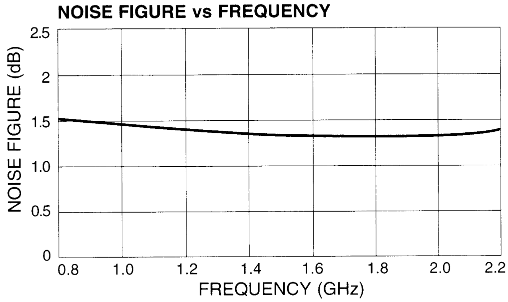
Schematic

TYPICAL BIASING CONFIGURATION AND FUNCTIONAL BLOCK DIAGRAM

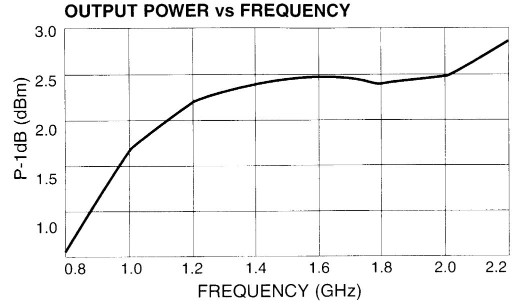


Typical Performance @ +25°C

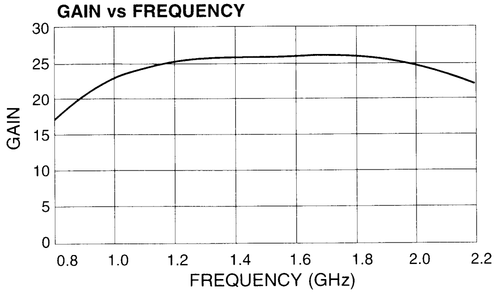
NOISE FIGURE vs FREQUENCY



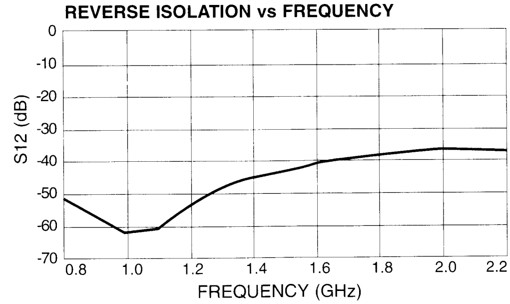
OUTPUT POWER vs FREQUENCY



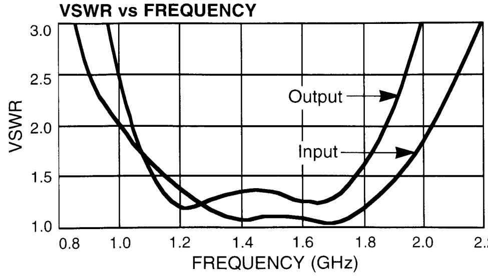
GAIN vs FREQUENCY



REVERSE ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



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M/A-COM an AMP company

Low Noise Amplifier 1.5 - 1.6 GHz

MAAM12021

V 2.00

Features

- Low Noise Figure: 1.55 dB
- High Gain: 21 dB
- Low Power Consumption: 3 to 5 V, 8 mA
- High Dynamic Range
- DC Decoupled RF Input and Output
- No External RF Tuning Elements Necessary
- Low Cost SOIC 8 Plastic Package

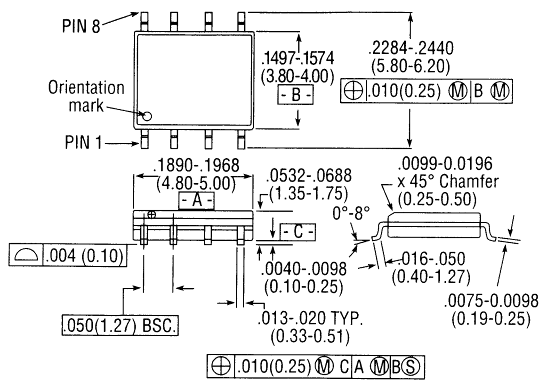
Description

M/A-COM's MAAM12021 is a high performance GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The MAAM12021 employs a fully monolithic design which eliminates the need for external tuning networks. It can be biased using 3- or 5-volt supplies and has an option for biasing at higher currents for increased dynamic range.

The MAAM12021 is ideally suited for use where low noise figure, high gain, high dynamic range and low power consumption are required. Typical applications include receiver front ends in the Global Positioning System (GPS) and Japanese Personal Digital Cellular (PDC-1500) markets, as well as standard gain blocks, buffer amps, driver amps and IF amps in both fixed and portable systems.

M/A-COM's MAAM12021 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
MAAM12021	SOIC 8-Lead Plastic
MAAM12021TR	Forward Tape and Reel*
MAAM12021RTR	Reverse Tape and Reel*
MAAM12021SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A= +25°C, Z_0 = 50Ω, V_{DD} = +5 V, P_{IN} = -30 dBm, f = 1.5 - 1.6 GHz

Parameter	Units	Min.	Typ.	Max.
Gain	dB	19	21	23
Noise Figure	dB		1.55	1.9
Input VSWR			1.5:1	
Output VSWR			1.5:1	
Output 1 dB Compression	dBm		6	
Input IP_3	dBm		-2	
Reverse Isolation	dB		40	
Bias Current	mA	5	8	11

1. See following pages for 3-volt data.

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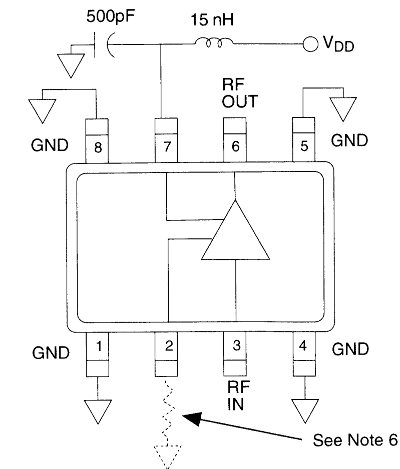
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+10 VDC
Input Power	+17 dBm
Current[2]	30 mA
Channel Temperature[3]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside these limits may cause permanent damage.
2. Only if pin #2 is used to increase current. (See note 6.)
3. Typical thermal resistance (θjc) = +165°C/W.

Functional Diagram

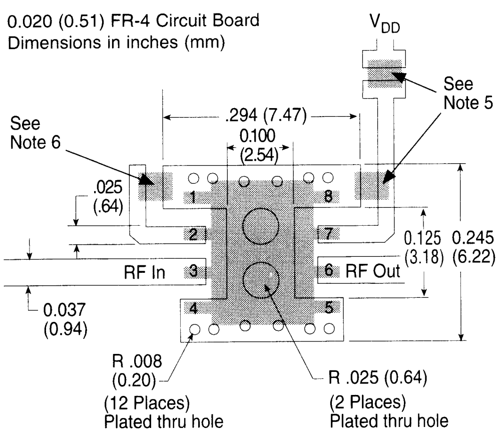


Notes:

4. Pins 1, 4, 5 and 8 must be RF and DC grounded as shown.
5. Pin 3 is the RF input; pin 6 is the RF output. V_{DD} is applied on pin 7. This pin must be bypassed with a 500-pF surface mount MLC capacitor, mounted as close as possible to pin 7, and RF decoupled with a chip inductor having a minimum value of 15 nH (as shown in the Recommended PCB Configuration).
6. Pin 2 allows use of an external resistor to ground for optional, higher current bias. For nominal current operation no resistor is used. For optional 20-mA current operation, connect a 35- to 40-ohm chip resistor (as shown in the Recommended PCB Configuration).

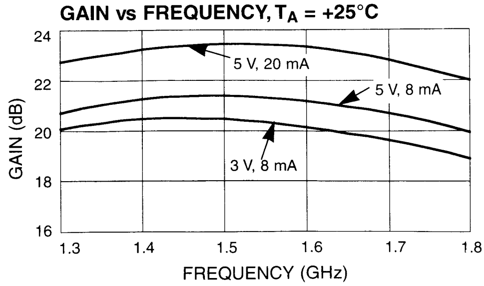
Recommended PCB Configuration

0.020 (0.51) FR-4 Circuit Board
Dimensions in inches (mm)

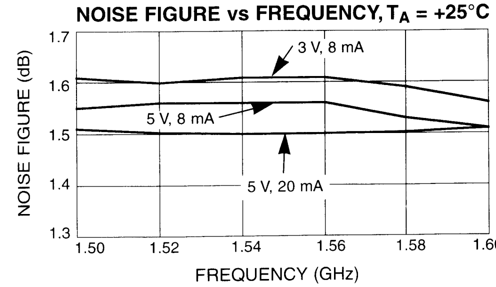


Typical Performance

GAIN vs FREQUENCY, T_A = +25°C



NOISE FIGURE vs FREQUENCY, T_A = +25°C



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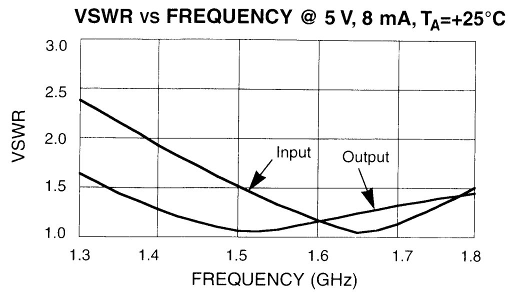

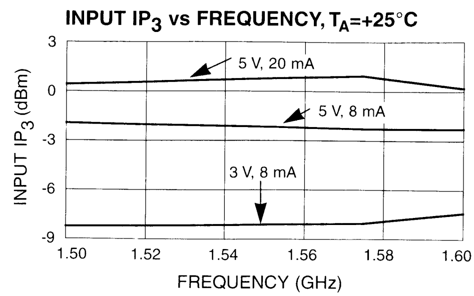

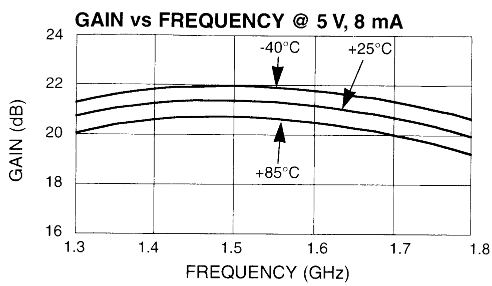

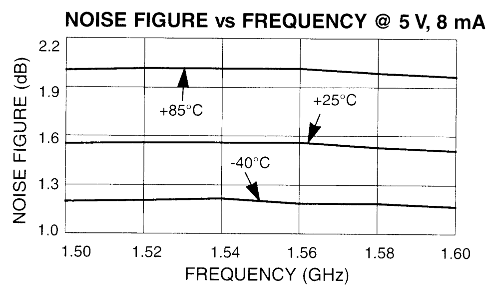

Additional information is available in Application Note M540, "M/A-COM GaAs MMIC LNA SOIC-8 Platform."

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an AMP company

Low Noise Amplifier
1.5 - 1.6 GHz

MAAM12022

V 2.00

Features

- Low Noise Figure: 1.85 dB
- High Gain: 14 dB
- Low Power Consumption: 3 to 5 V, 5 mA
- High Dynamic Range
- DC Decoupled RF Input and Output
- No External RF Tuning Elements Necessary
- Low Cost SOIC 8 Plastic Package

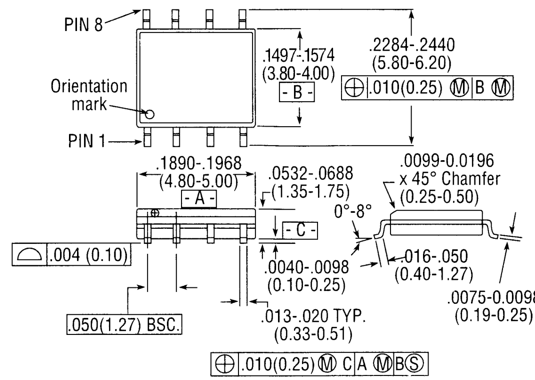
Description

M/A-COM's MAAM12022 is a high performance GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The MAAM12022 employs a fully monolithic design which eliminates the need for external tuning networks. It can be biased using 3- or 5-volt supplies and has an option for biasing at higher currents for increased dynamic range.

The MAAM12022 is ideally suited for use where low noise figure, high gain, high dynamic range and low power consumption are required. Typical applications include receiver front ends in the Global Positioning System (GPS) and Japanese Personal Digital Cellular (PDC-1500) markets, as well as standard gain blocks, buffer amps, driver amps and IF amps in both fixed and portable systems.

M/A-COM's MAAM12022 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
MAAM12022	SOIC 8-Lead Plastic
MAAM12022TR	Forward Tape and Reel*
MAAM12022RTR	Reverse Tape and Reel*
MAAM12022SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A = +25°C, Z_0 = 50Ω, V_{DD} = +5 V, P_{IN} = -30 dBm, f = 1.5 - 1.6 GHz

Parameter	Units	Min.	Typ.	Max.
Gain	dB	12	14	16
Noise Figure	dB		1.85	2.10
Input VSWR			1.5:1	
Output VSWR			1.5:1	
Output 1 dB Compression	dBm		2	
Input IP_3	dBm		0	
Reverse Isolation	dB		30	
Bias Current	mA	3	5	7

1. See following pages for 3-volt data.

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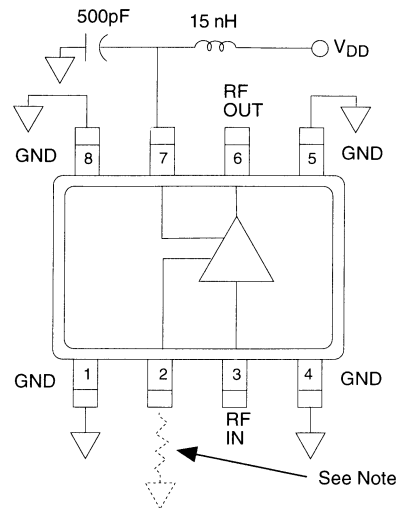
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+10 VDC
Input Power	+17 dBm
Current[2]	30 mA
Channel Temperature[3]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside these limits may cause permanent damage.
2. Only if pin #2 is used to increase current. (See note 6.)
3. Typical thermal resistance (θjc) = +165°C/W.

Functional Diagram

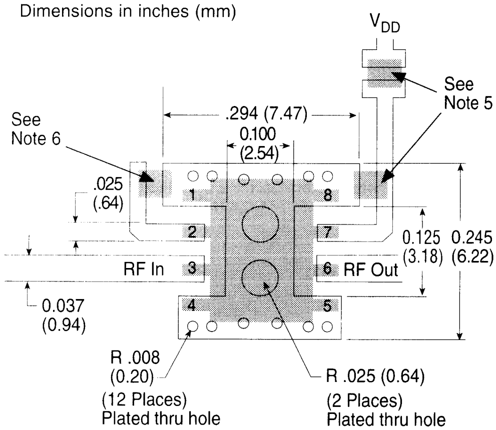


Notes:

4. Pins 1, 4, 5 and 8 must be RF and DC grounded as shown.
5. Pin 3 is the RF input; pin 6 is the RF output. V_{DD} is applied on pin 7. This pin must be bypassed with a 500-pF surface mount MLC capacitor, mounted as close as possible to pin 7, and RF decoupled with a chip inductor having a minimum value of 15 nH (as shown in the Recommended PCB Configuration).
6. Pin 2 allows use of an external resistor to ground for optional, higher current bias. For nominal current operation no resistor is used. For optional 20-mA current operation, connect a 30- to 35-ohm chip resistor (as shown in the Recommended PCB Configuration).

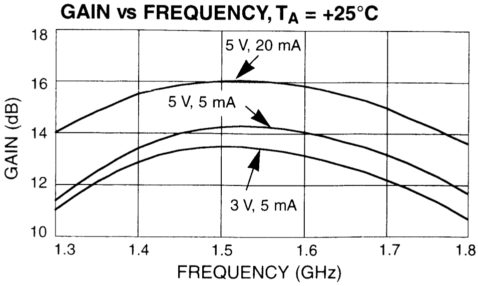
Recommended PCB Configuration

0.020 (0.51) FR-4 Circuit Board
Dimensions in inches (mm)

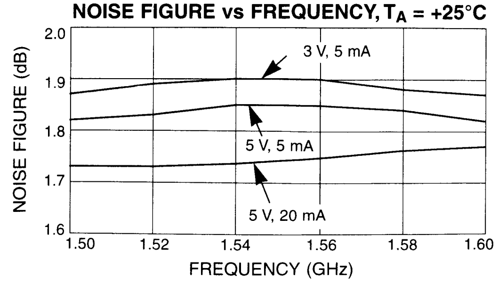


Typical Performance

GAIN vs FREQUENCY, T_A = +25°C



NOISE FIGURE vs FREQUENCY, T_A = +25°C



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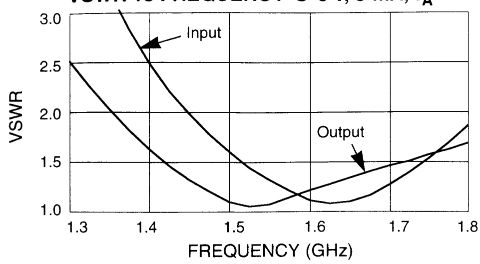
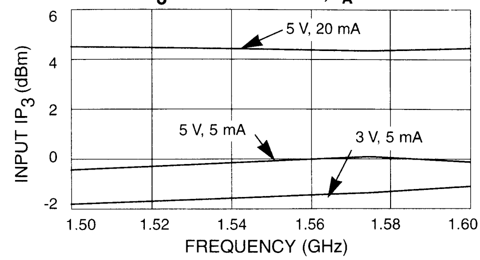
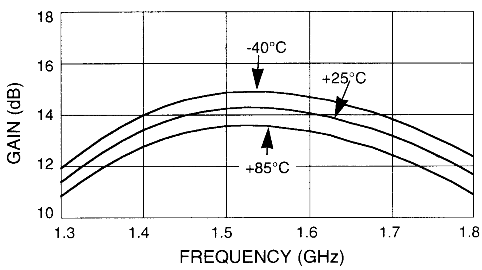
VSWR vs FREQUENCY @ 5 V, 5 mA, T_A = +25°C



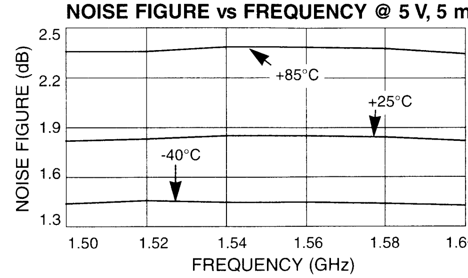
INPUT IP_3 vs FREQUENCY, T_A = +25°C



GAIN vs FREQUENCY @ 5 V, 5 mA



NOISE FIGURE vs FREQUENCY @ 5 V, 5 mA



Additional information is available in Application Note M540, "M/A-COM GaAs MMIC LNA SOIC-8 Platform."

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M/A-COM an AMP company

Low Noise Amplifier 1.7 - 2.0 GHz

MAAM12031

V 2.00

Features

- Low Noise Figure: 1.65 dB
- High Gain: 20 dB
- Low Power Consumption: 3 to 5 V, 8 mA
- High Dynamic Range
- DC Decoupled RF Input and Output
- No External RF Tuning Elements Necessary
- Low Cost SOIC 8 Plastic Package

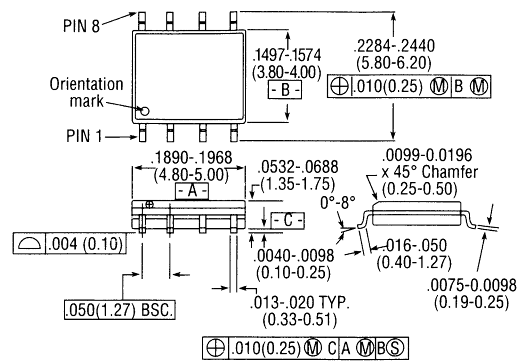
Description

M/A-COM's MAAM12031 is a high performance GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The MAAM12031 employs a fully monolithic design which eliminates the need for external tuning networks. It can be biased using 3 or 5-volt supplies and has an option for biasing at higher currents for increased dynamic range.

The MAAM12031 is ideally suited for use where low noise figure, high gain, high dynamic range and low power consumption are required. Typical applications include receiver front ends in the Japanese Personal Handy Phone Service (PHS), Private Branch Exchange (PBX) and Personal Communications Systems and Networks (PCS, PCN) markets, as well as standard gain blocks, buffer amps, driver amps and IF amps in both fixed and portable systems.

M/A-COM's MAAM12031 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
MAAM12031	SOIC 8-Lead Plastic
MAAM12031TR	Forward Tape and Reel*
MAAM12031RTR	Reverse Tape and Reel*
MAAM12031SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A= +25°C, Z_0 = 50Ω, V_{DD} = +5 V, P_{IN} = -30 dBm, f = 1.7 - 2.0 GHz

Parameter	Units	Min.	Typ.	Max.
Gain	dB	18	20	22
Noise Figure	dB		1.65	2.00
Input VSWR			1.7:1	
Output VSWR			1.7:1	
Output 1 dB Compression	dBm		7	
Input IP_3	dBm		-1	
Reverse Isolation	dB		38	
Bias Current	mA	5	8	11

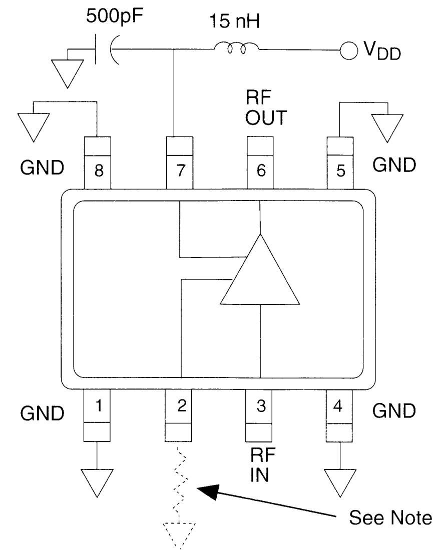
1. See following pages for 3-volt data.

Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+10 VDC
Input Power	+17 dBm
Current[2]	30 mA
Channel Temperature[3]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside these limits may cause permanent damage.
2. Only if pin #2 is used to increase current. (See note 6.)
3. Typical thermal resistance (θjc) = +165°C/W.

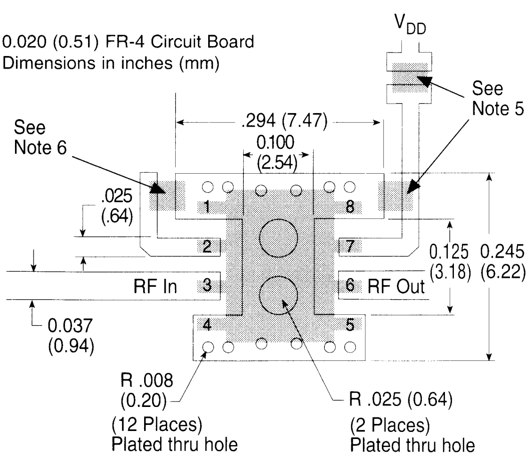
Functional Diagram



Notes:

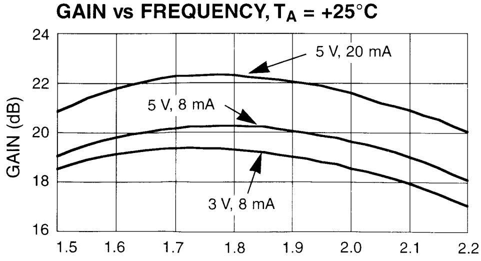
4. Pins 1, 4, 5 and 8 must be RF and DC grounded as shown.
5. Pin 3 is the RF input; pin 6 is the RF output. V_{DD} is applied on pin 7. This pin must be bypassed with a 500-pF surface mount MLC capacitor, mounted as close as possible to pin 7, and RF decoupled with a chip inductor having a minimum value of 15 nH (as shown in the Recommended PCB Configuration).
6. Pin 2 allows use of an external resistor to ground for optional, higher current bias. For nominal current operation no resistor is used. For optional 20-mA current operation, connect a 35- to 40-ohm chip resistor (as shown in the Recommended PCB Configuration).

Recommended PCB Configuration

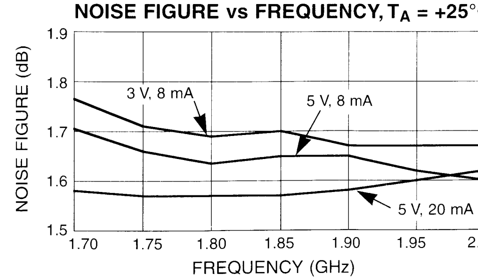


Typical Performance

GAIN vs FREQUENCY, T_A = +25°C



NOISE FIGURE vs FREQUENCY, T_A = +25°C



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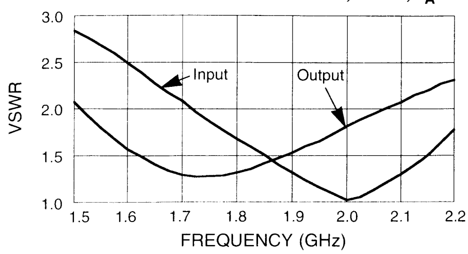
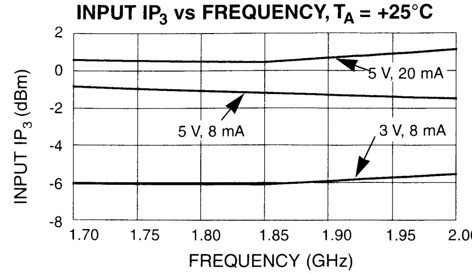
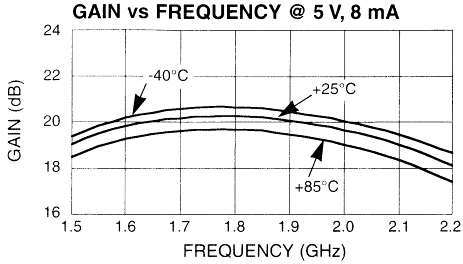
VSWR vs FREQUENCY @ 5 V, 8 mA, T_A = +25°C



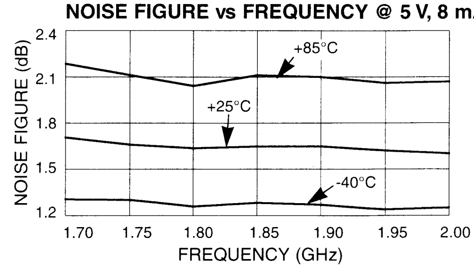
INPUT IP_3 vs FREQUENCY, T_A = +25°C



GAIN vs FREQUENCY @ 5 V, 8 mA



NOISE FIGURE vs FREQUENCY @ 5 V, 8 mA



Additional information is available in Application Note M540, "M/A-COM GaAs MMIC LNA SOIC-8 Platform."

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Low Noise Amplifier 1.7 - 2.0 GHz

MAAM12032

V 2.00

Features

- Low Noise Figure: 1.80 dB
- High Gain: 13 dB
- Low Power Consumption: 3 to 5 V, 5 mA
- High Dynamic Range
- DC Decoupled RF Input and Output
- No External RF Tuning Elements Necessary
- Low Cost SOIC 8 Plastic Package

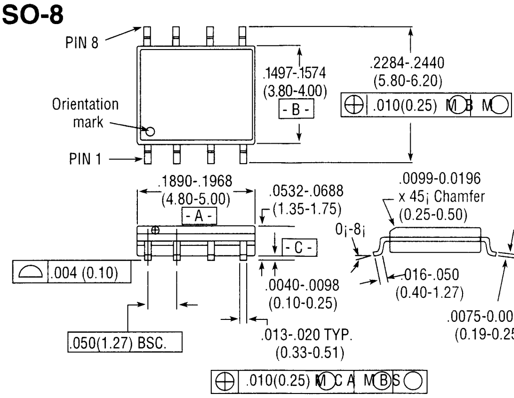
Description

M/A-COM's MAAM12032 is a high performance GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The MAAM12032 employs a fully monolithic design which eliminates the need for external tuning networks. It can be biased using 3- or 5-volt supplies and has an option for biasing at higher currents for increased dynamic range.

The MAAM12032 is ideally suited for use where low noise figure, high gain, high dynamic range and low power consumption are required. Typical applications include receiver front ends in the Japanese Personal Handy Phone Service (PHS), Private Branch Exchange (PBX) and Personal Communications Systems and Networks (PCS, PCN) markets, as well as standard gain blocks, buffer amps, driver amps and IF amps in both fixed and portable systems.

M/A-COM's MAAM12032 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = – 0.010 (.xx = – 0.25)
.xx = – 0.02 (.x = –0.5)

Ordering Information

Part Number	Package
MAAM12032	SOIC 8-Lead Plastic
MAAM12032TR	Forward Tape and Reel*
MAAM12032RTR	Reverse Tape and Reel*
MAAM12032SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A= +25°C, Z_0 = 50Ω, V_{DD} = +5 V, P_{IN} = -30 dBm, f = 1.7 - 2.0 GHz

Parameter	Units	Min.	Typ.	Max.
Gain	dB	10	13	16
Noise Figure	dB		1.8	2.1
Input VSWR			1.5:1	
Output VSWR			1.5:1	
Output 1 dB Compression	dBm		2	
Input IP_3	dBm		0	
Reverse Isolation	dB		30	
Bias Current	mA	3	5	7

1. See following pages for 3-volt data.

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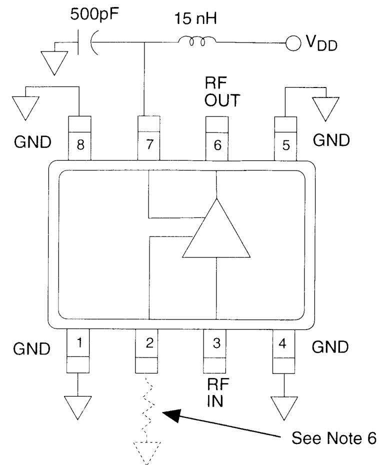
Absolute Maximum Ratings[1]

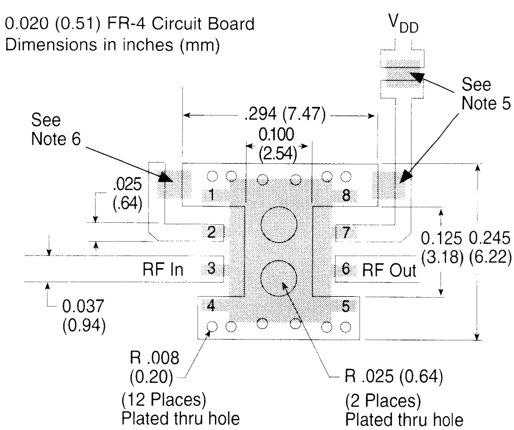
Parameter	Absolute Maximum
V_{DD}	+10 VDC
Input Power	+17 dBm
Current[2]	30 mA
Channel Temperature[3]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside these limits may cause permanent damage.
2. Only if pin #2 is used to increase current. (See note 6.)
3. Typical thermal resistance (θ_{jc}) = +165°C/W.

Functional Diagram



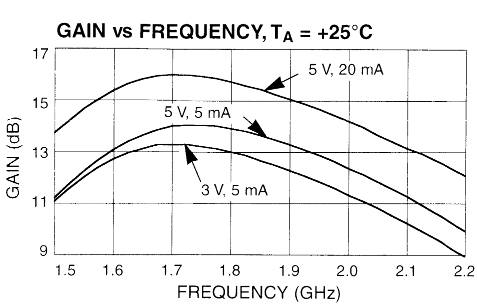
Recommended PCB Configuration

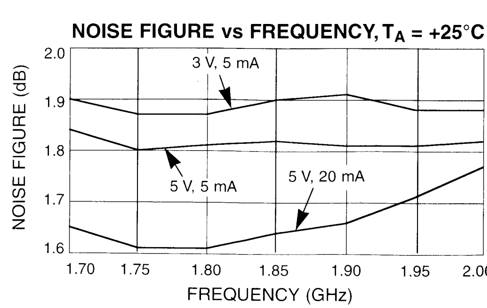


Notes:

4. Pins 1, 4, 5 and 8 must be RF and DC grounded as shown.
5. Pin 3 is the RF input; pin 6 is the RF output. V_{DD} is applied on pin 7. This pin must be bypassed with a 500-pF surface mount MLC capacitor, mounted as close as possible to pin 7, and RF decoupled with a chip inductor having a minimum value of 15 nH (as shown in the Recommended PCB Configuration).
6. Pin 2 allows use of an external resistor to ground for optional, higher current bias. For nominal current operation no resistor is used. For optional 20-mA current operation, connect a 30- to 35-ohm chip resistor (as shown in the Recommended PCB Configuration).

Typical Performance





Specifications Subject to Change Without Notice.

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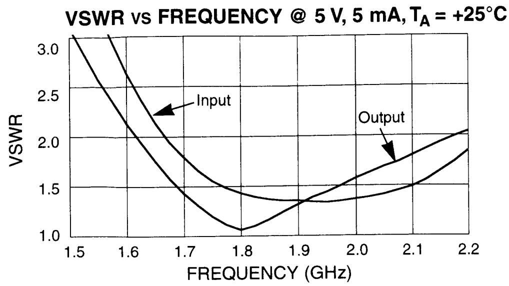

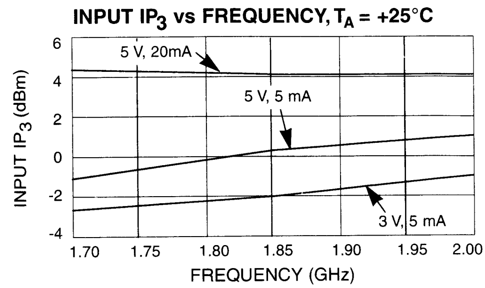

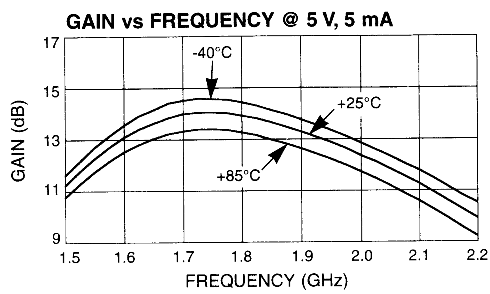

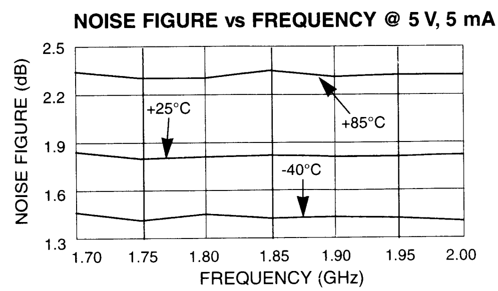

Additional information is available in Application Note M540, “M/A-COM GaAs MMIC LNA SOIC-8 Platform.”

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an AMP company

Low Noise Amplifier 2.4 - 2.5 GHz

MAAM22010

V 2.00

Features

- Low Noise Figure: 1.90 dB
- High Gain: 14 dB
- Low Power Consumption: 3 to 5 V, 5 mA
- High Dynamic Range
- DC Decoupled RF Input and Output
- No External RF Tuning Elements Necessary
- Low Cost SOIC 8 Plastic Package

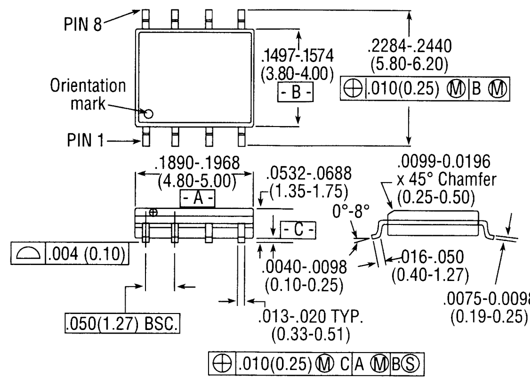
Description

M/A-COM's MAAM22010 is a high performance GaAs MMIC low noise amplifier in a low cost SOIC 8-lead surface mount plastic package. The MAAM22010 employs a fully monolithic design which eliminates the need for external tuning networks. It can be biased using 3- or 5-volt supplies and has an option for biasing at higher currents for increased dynamic range.

The MAAM22010 is ideally suited for use where low noise figure, high gain, high dynamic range and low power consumption are required. Typical applications include receiver front ends in the Wireless Local Area Network (WLAN) and wireless data collection markets in the Industrial, Scientific and Medical (2.4 GHz ISM) band, as well as standard gain blocks, buffer amps, driver amps and IF amps in both fixed and portable systems.

M/A-COM's MAAM22010 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
MAAM22010	SOIC 8-Lead Plastic
MAAM22010TR	Forward Tape and Reel*
MAAM22010RTR	Reverse Tape and Reel*
MAAM22010SMB	Designer's Kit

*If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A= +25°C, Z_0 = 50Ω, V_{DD} = +5 V, P_{IN} = -30 dBm, f = 2.4 - 2.5 GHz

Parameter	Units	Min.	Typ.	Max.
Gain	dB	12	14	16
Noise Figure	dB		1.90	2.30
Input VSWR			1.5:1	
Output VSWR			1.5:1	
Output 1 dB Compression	dBm		3	
Input IP_3	dBm		1	
Reverse Isolation	dB		30	
Bias Current	mA	3	5	7

1. See following pages for 3-volt data.

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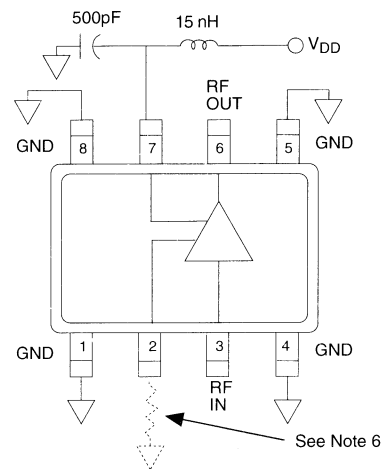
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
V_{DD}	+10 VDC
Input Power	+17 dBm
Current[2]	30 mA
Channel Temperature[3]	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

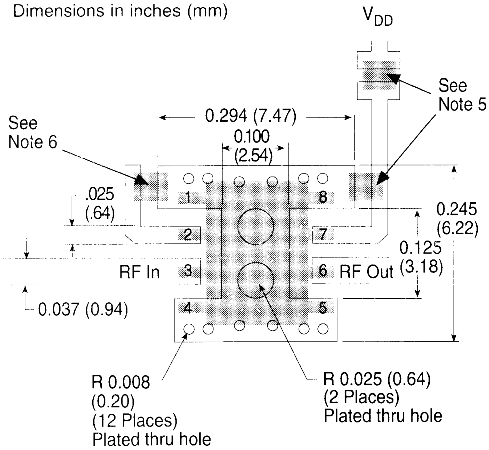
1. Operation of this device outside these limits may cause permanent damage.
2. Only if pin #2 is used to increase current. (See note 6.)
3. Typical thermal resistance (Øjc) = +165°C/W.

Functional Diagram



Recommended PCB Configuration

0.020 (0.51) FR-4 Circuit Board
Dimensions in inches (mm)

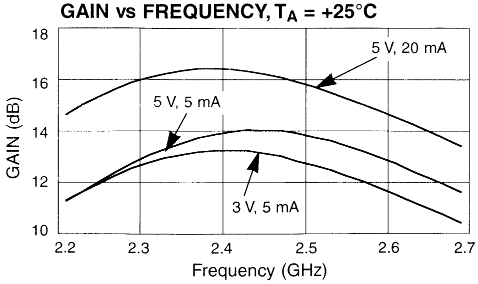


Notes:

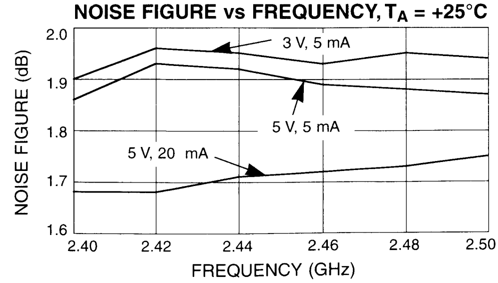
4. Pins 1, 4, 5 and 8 must be RF and DC grounded as shown.
5. Pin 3 is the RF input; pin 6 is the RF output. V_{DD} is applied on pin 7. This pin must be bypassed with a 500-pF surface mount MLC capacitor, mounted as close as possible to pin 7, and RF decoupled with a chip inductor having a minimum value of 15 nH (as shown in the Recommended PCB Configuration).
6. Pin 2 allows use of an external resistor to ground for optional, higher current bias. For nominal current operation no resistor is used. For optional 20-mA current operation, connect a 30- to 35-ohm chip resistor (as shown in the Recommended PCB Configuration).

Typical Performance

GAIN vs FREQUENCY, T_A = +25°C



NOISE FIGURE vs FREQUENCY, T_A = +25°C



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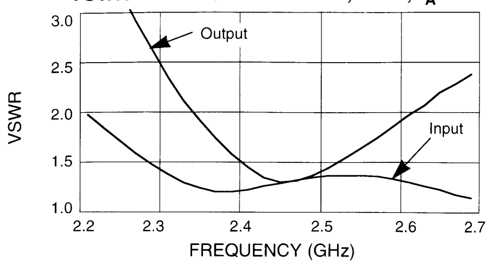
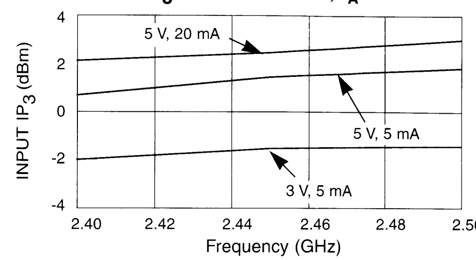
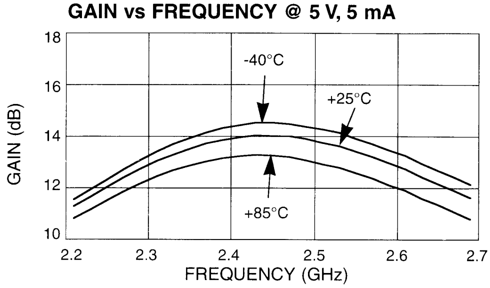
VSWR vs FREQUENCY @ 5 V, 5 mA, T_A=+25°C



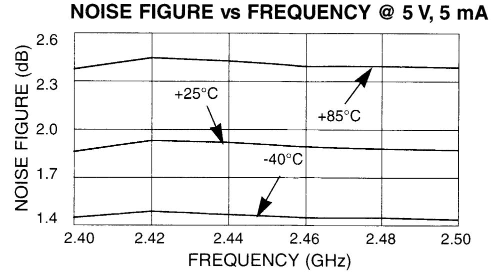
INPUT IP_3 vs FREQUENCY, T_A=+25°C



GAIN vs FREQUENCY @ 5 V, 5 mA



NOISE FIGURE vs FREQUENCY @ 5 V, 5 mA



Additional information is available in Application Note M540, "M/A-COM GaAs MMIC LNA SOIC-8 Platform."

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an AMP company

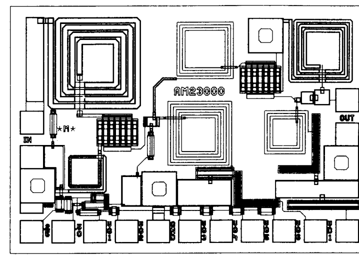
Low Noise GaAs MMIC Amplifier 2–3 GHz

MAAM23000

V 2.00

Features

- 1.1 dB Typical Noise Figure[1]
- 26 dB Typical Gain[1]
- On-Chip Bias Network
- DC Decoupled RF Input and Output



Electrical Specifications @ T_A = 25°C

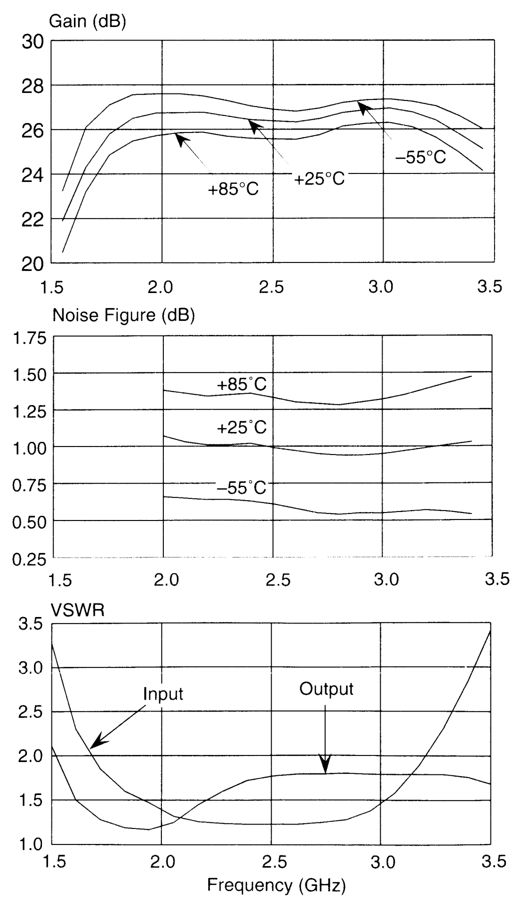
Frequency Range			2.0 – 3.0 GHz
Gain[1]		26.0 dB Typ	24.0 dB Min
Gain Flatness			±1.0 dB Typ
Noise Figure[1]		1.6 dB Max	1.1 dB Typ
VSWR[1]	Input Output		1.7:1 Typ 1.3:1 Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			40 dB Typ
Impedance			50 Ω Typ
Bias Voltage			Vdd = +5 Vdc, Vgg = –5 Vdc
Bias Conditions			Idd = 80 mA Typ,110 mA Max Igg = 1.0 mA Typ, 1.5 mA Max

Maximum Ratings

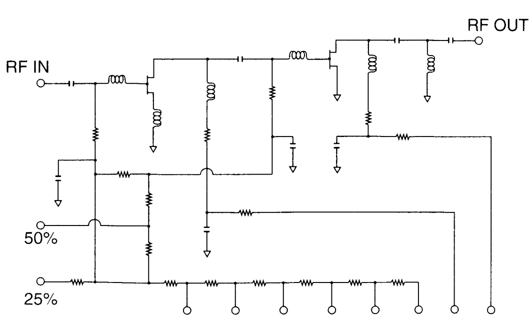
Voltage	+7v@Vdd, -10v@Vgg
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

Typical Performance



Schematic



Specifications Subject to Change Without Notice.

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Handling

Permanent damage to the MAAM23000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM23000 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM23000 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM23000. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM23000 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM23000 is back-metallized with Pd/Ni/Au (100/1,000/ 30,000Å) metallization. It can be die-mounted using Au/Sn eutectic preforms or a thermally and electrically conductive epoxy. The attachment surface should be clean and flat.

Eutectic Die Attach:

A. An 80/20 Au/Sn preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 95/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM23000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy is required.

B. Apply a minimum amount of epoxy and place the MAAM23000 into position. A thin epoxy fillet should be visible around the perimeter of the die.

C. Cure epoxy per manufacturer's recommended schedule.

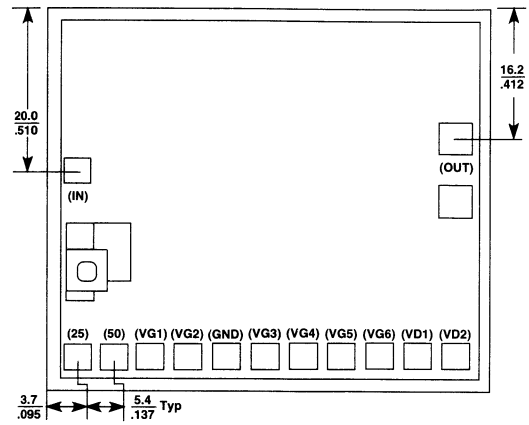
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

C. Bonding pads are 4.0 x 4.0 mils.

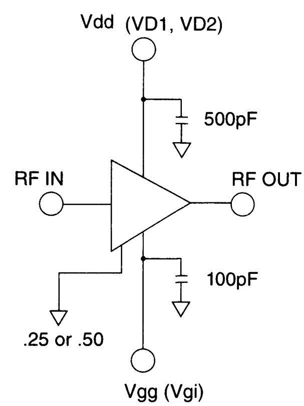
Outline



All dimensions are mils/mm.

Die Size	0.061" X 0.043" X 0.004" (1.560mm X 1.080mm X 0.102mm)

Typical Bias Configuration



1. Nominal bias is obtained by grounding pad .50 and connecting Vgg to pad VG4.
2. Grounding pad .25, instead of pad .50, will decrease second stage current.
3. Optional biasing can be obtained by connecting Vgg to pads VG1, VG2, VG3, VG5, or VG6, instead of VG4. Connecting to VG1 results in the lowest current; VG6 will yield the highest current. Adjusting the bias can customize performance to suit special requirements.

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M/A-COM an AMP company

Low Noise GaAs MMIC Amplifier 2-3 GHz

MAAM23000-A1

V 2.00

Features

- Low Noise Figure: 1.25 dB
- High Gain: 26 dB
- No External Components Required
- DC Decoupled RF Input and Output
- Small, Low Cost 8-Lead Ceramic Package

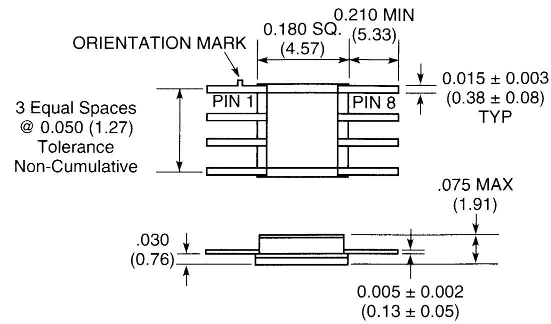
Description

M/A-COM's MAAM23000-A1 is a wide band, low noise, MMIC amplifier housed in a small 8-lead ceramic package. It includes two integrated gain stages and employs series-inductive feedback to obtain excellent noise figure and a good, 50-ohm, input and output impedance match over the 2 to 3 GHz band. The MAAM23000-A1 is fully monolithic, requires no external components and is provided in a low-cost, user-friendly, microwave package.

The MAAM23000-A1 performs well as a low noise amplifier in S-band receive applications and as a driver or buffer amplifier where high gain, excellent linearity and low power consumption are important. Because of its wide bandwidth, the MAAM23000-A1 can be used in numerous commercial and government system applications, such as PCS, WLAN, satellite communications and telemetry.

The MAAM23000-A1 is manufactured in-house using a reliable, 0.5-micron, GaAs MESFET process. This product is 100% RF tested to ensure compliance to performance specifications.

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
MAAM23000-A1	8-Lead Ceramic
MAAM23000-A1G	Gull Wing

Typical Electrical Specifications

Test Conditions: Test Conditions: T_A= +25°C, Z_0 = 50Ω , V_{DD} = +5 V, V_{GG} = -5V, P_{IN} = -30 dBm

Parameter	Units	Min.	Typ.	Max.
Gain	dB	23	26	
Noise Figure	dB		1.25	1.8
Input VSWR			1.7:1	
Output VSWR			1.3:1	
Output 1 dB Compression	dBm		+14	
Input IP_3	dBm		-2	
Reverse Isolation	dB		35	
Bias Current	mA		80	110

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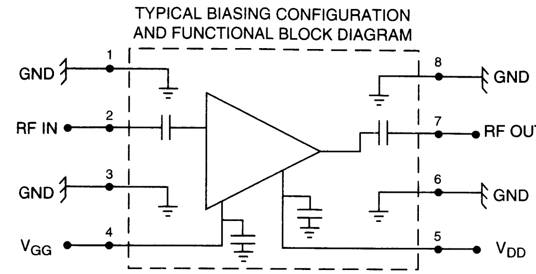
Absolute Maximum Ratings[1]

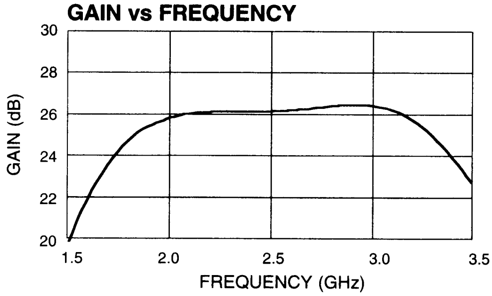
Parameter	Absolute Maximum
V_{DD}	+7 volts
V_{GG}	-10 volts
Input Power	+20 dBm
Current	110 mA
Channel Temperature	+150°C
Operating Temperature[2]	-55°C to +100°C
Storage Temperature	-65°C to +150°C

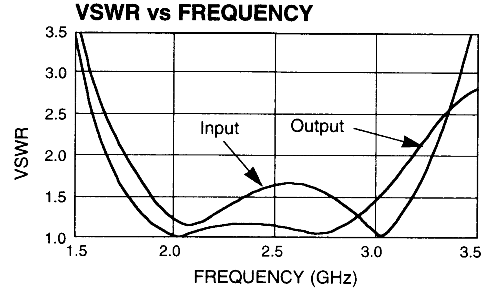
1. Operation of this device outside these limits may cause permanent damage.
2. Typical thermal resistance (θjc) = +100°C/W

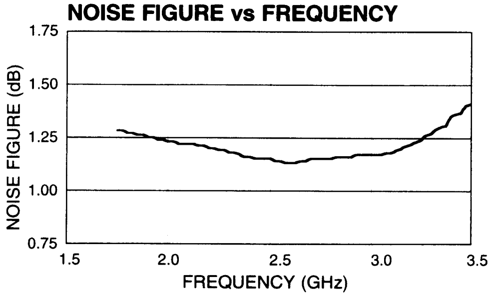
Schematic



Typical Performance @ 25°C







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an AMP company

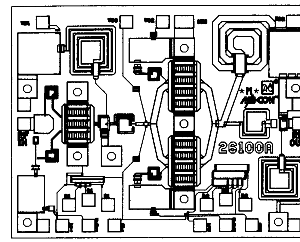
Power GaAs MMIC Amplifier 2 - 6.5 GHz

MAAM26100

V 2.00

Features

- +30 dBm Typical Saturated Power
- 19 dB Typical Gain
- 30% Typical Power Added Efficiency
- On-Chip Bias Network
- DC Decoupled RF Input and Output



Electrical Specifications @ T_A = +25°C

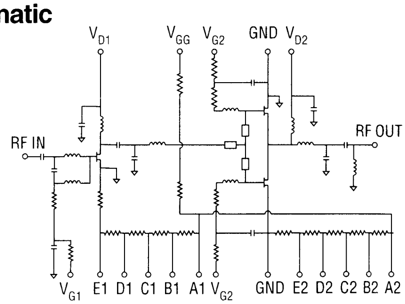
Frequency Range		2.0 – 6.5 GHz
Gain[1]	19.0 dB Typ	15.0 dB Min
VSWR[1]	Input Output	2.0:1 Typ 2.2:1 Typ
Saturated Power Output[1] (Input Power = +14 dBm)		+30 dBm Typ
Output Power at 1 Gain dB Compression		+28 dBm Typ
Third Order Intercept		+39 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		V_{DD} = +8 V_{DC}, V_{GG} = -1.3 V_{DC} Typ
Bias Current No RF P_{IN} = +14 dBm		 420 mA Typ 600 mA Typ
Thermal Resistance[2]		14°C/W Typ

Maximum Ratings

Voltage	V_{DD} = +10 Volts, V_{GG} = -5 Volts
Input Power	+23 dBm
Storage Temperature	–65°C to +150°C
Operating Channel Temperature	+150°C

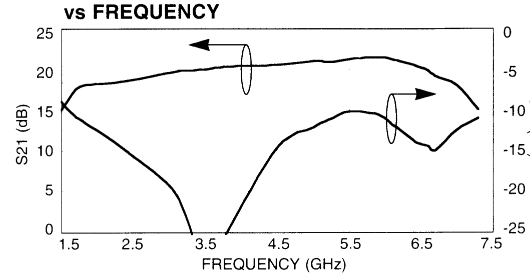
1. 100% on-waffer tested.
2. Attachment method not included.

Schematic

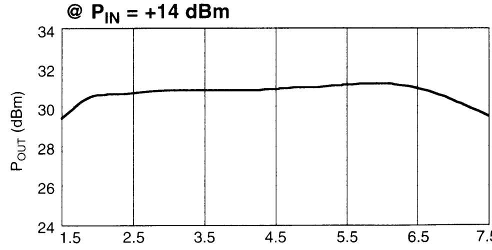


Typical Performance @ +25°C

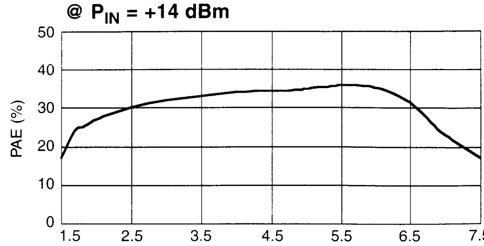
LINEAR GAIN AND INPUT RETURN LOSS vs FREQUENCY



OUTPUT POWER vs FREQUENCY @ P_{IN} = +14 dBm



POWER ADDED EFFICIENCY vs FREQUENCY @ P_{IN} = +14 dBm



Specifications Subject to Change Without Notice.

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Handling

Permanent damage to the MAAM26100 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM26100 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM26100 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM26100. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM26100 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM26100 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It is recommended that the die be mounted with Au/Sn eutectic preforms. The attachment surface should be clean and flat.

A. An 80/20 preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM26100 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

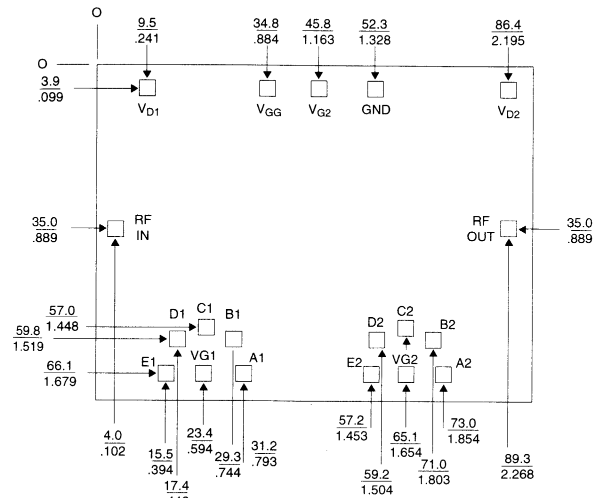
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

C. Bonding pads are 4.0 x 4.0 mils. minimum.

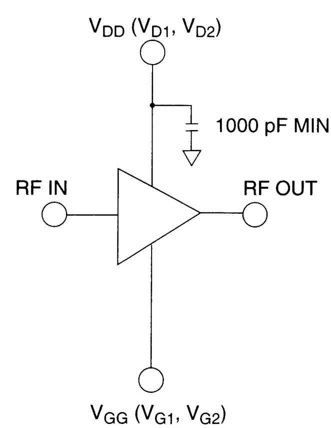
Outline



All dimensions are mils/mm.

Die Size 0.091" x 0.070" x 0.004"
(2.319mm x 0.889m x 0.102mm)

Typical Bias Configuration



1. Nominal bias is obtained by first connecting -1.2 volts to pads V_{G1} and V_{G2} followed by connecting +8 volts to pads V_{D1} and V_{D2} (note sequence).
2. The recommended V_{DD} range is +6 to +9 volts.
3. Optional on-chip resistor networks are used by connecting a nominal -5 volts to pad V_{GG} then connecting pad "B1", "C1", "D1", or "E1" to pad V_{G1}; and "B2", "C2", "D2", or "E2" to pad V_{G2}.

Power GaAs MMIC Amplifier 2 - 6 GHz

MAAM26100-B1

V 2.00

Features

- +29 dBm Typical Saturated Power
- 18 dB Typical Gain
- 25% Power Added Efficiency
- DC Decoupled RF Input and Output
- Small, 7-Lead Ceramic Package

Electrical Specifications @ T_A = +25°C

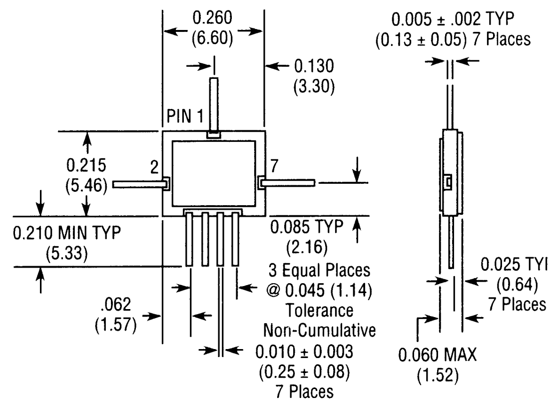
Frequency Range		2.0 – 6.0 GHz
Gain	18.0 dB Typ	14.0 dB Min
VSWR	Input Output	2.2:1 Typ 2.2:1 Typ
Saturated Power Output (Input Power = +14 dBm)		+29 dBm Typ
Output Power at 1 dB Gain Compression		+27 dBm Typ
Third Order Intercept		+39 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		V_{DD} = +8 V_{DC}, V_{GG} = -5 V_{DC}Typ
Bias Current No RF @ P_{IN} = +14 dBm		 I_{DD} = 420 mA Typ I_{DD} = 600 mA Typ I_{GG} = 10 mA Typ
Thermal Resistance[1]		16.5°C/w Typ

Maximum Ratings

Voltage	V_{DD} = +12 Volts, V_{GG} = -10 Volts
Input Power	+23 dBm
Storage Temperature	–65°C to +150°C
Operating Channel Temperature	+150°C

1. Attachment method not included.

CR-2



Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

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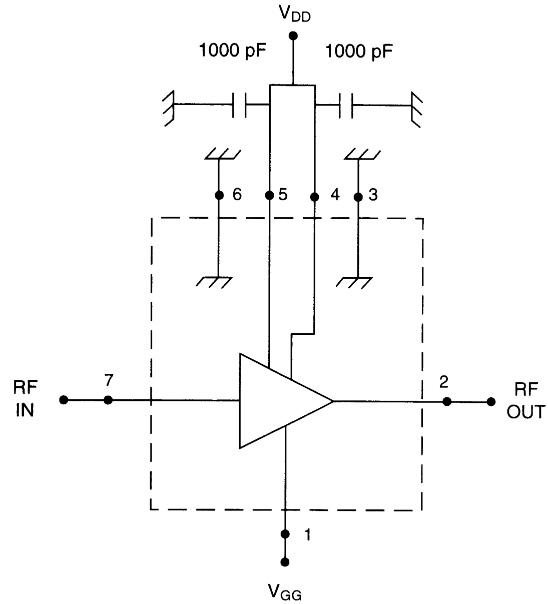
Pin Configuration

Pin No.	Function
1	V_{GG}
2	Output
3	Internal GND
4	V_{D2}
5	V_{D1}
6	Internal GND

Schematic

TYPICAL BIASING CONFIGURATION
AND FUNCTIONAL BLOCK DIAGRAM



1. Nominal bias is obtained by first connecting -5 volts to pin 1 (V_{GG}), followed by connecting +8 volts to pin 5 (V_{D1}) and pin 4 (V_{D2}). Note sequence.
2. RF ground and thermal interface are the case bottom. Adequate heat sinking is required.

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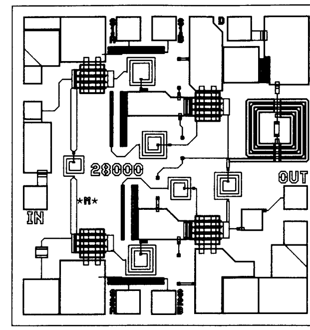
an AMP company

Wide Band GaAs MMIC Amplifier 2 - 8 GHz

MAAM28000

V 2.00



Features

- 18 dB Typical Gain[1]
- ±0.5 dB Typical Broadband Gain Flatness
- Single Bias Supply
- On-Chip Bias Network
- DC Decoupled RF Input and Output

Electrical Specifications @ T_A = +25°C

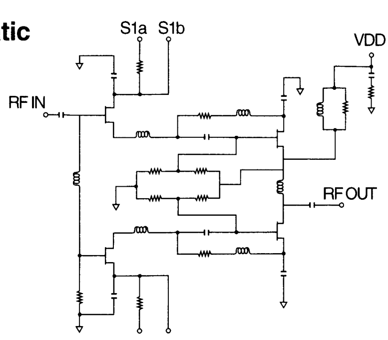
Frequency Range			2.0 - 8.0 GHz
Gain[1]		18.0 dB Typ	16.0 dB Min
Gain Flatness			±0.5 dB Typ
Noise Figure[1]	2.0 – 4.0 GHz 4.0 – 6.0 GHz 6.0 – 8.0 GHz	6.0 dB Typ 4.5 dB Typ 4.0 dB Typ	7.5 dB Max 6.0 dB Max 5.5 dB Max
VSWR[1]	Input Output		1.7:1 Typ 1.3.1 Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			40 dB Typ
Impedance			50 Ω Typ
Bias Voltage			Vdd = +10 Vdc
Bias Currents			Idd = 60 mA Typ, 100 mA Max

Maximum Ratings

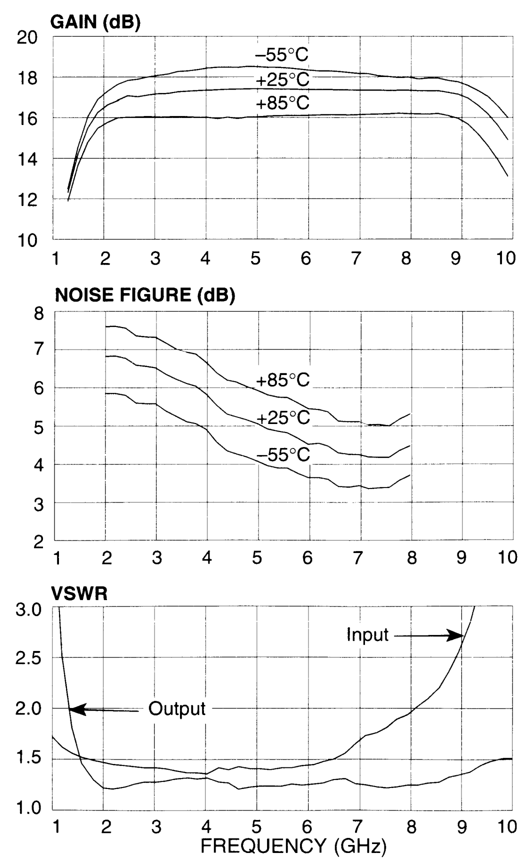
Voltage	+14 volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

Schematic



Typical Performance



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Handling

Permanent damage to the MAAM28000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM28000 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM28000 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM28000. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM28000 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM28000 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It can be die-mounted using Au/Sn eutectic preforms or a thermally and electrically conductive epoxy. The attachment surface should be clean and flat.

Eutectic Die Attach:

A. An 80/20 Au/Sn preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 95/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM28000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy is required.

B. Apply a minimum amount of epoxy and place the MAAM28000 into position. A thin epoxy fillet should be visible around the perimeter of the die.

C. Cure epoxy per manufacturer's recommended schedule.

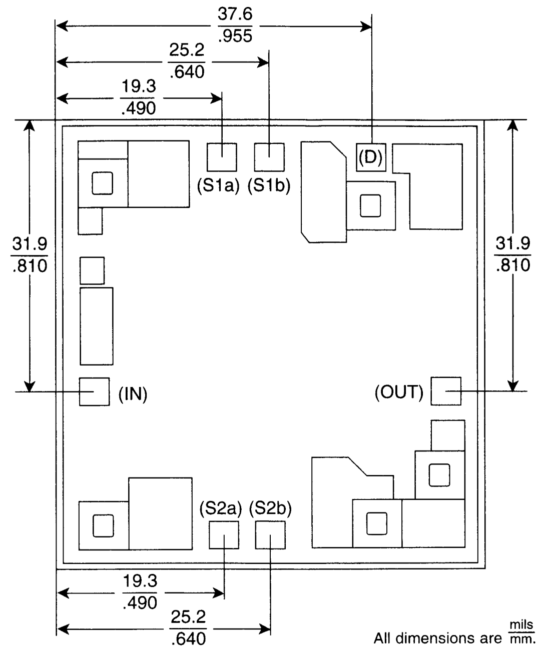
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

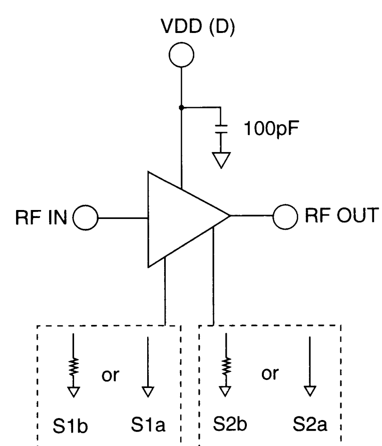
C. Bonding pads are 4.0 x 4.0 mils.

Outline



Die Size 0.051" X 0.053" X 0.004" (1.298mm X 1.349mm X 0.102mm)

Typical Bias Configuration



1. Nominal bias is obtained with on-chip resistors by grounding pads S1a and S2a.
2. Optional biasing can be obtained with off-chip resistors bonded from pads S1b and S2b to ground. Adjusting the bias can customize the performance to suit special requirements.

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an AMP company

Wide Band GaAs MMIC Amplifier 2-8 GHz

MAAM28000-A1

V 2.00

Features

- High Gain: 17 dB
- Gain Flatness: ±0.5 dB
- Single Supply: +10 V
- No External Components Required
- DC Decoupled RF Input and Output
- Small, Low Cost 8-Lead Ceramic Package

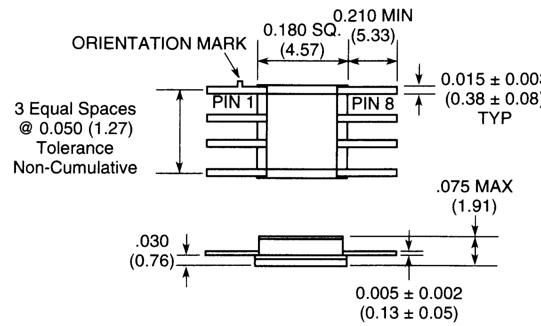
Description

M/A-COM's MAAM28000-A1 is a wide band, MMIC amplifier housed in a small 8-lead ceramic package. It includes two distributed gain stages to obtain flat gain and a good, 50-ohm, input and output impedance match over a very wide bandwidth. The MAAM28000-A1 operates from a single +10 V supply. It is fully monolithic, requires no external components, and is provided in a low-cost, user-friendly, microwave package.

The MAAM28000-A1 performs well as a generic IF, driver or buffer amplifier where high gain, excellent linearity and low power consumption are important. Because of its wide bandwidth, the MAAM28000-A1 can be used in numerous commercial and government system applications, such as satellite communications, RLL, EW and radar.

The MAAM28000-A1 is manufactured in-house using a reliable, 0.5-micron, GaAs MESFET process. This product is 100% RF tested to ensure compliance to performance specifications.

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
MAAM28000-A1	8-Lead Ceramic
MAAM28000-A1G	Gull Wing

Electrical Specifications

Test Conditions: T_A = +25°C, Z_O = 50 Ω, V_{DD} = +10 V, P_{IN} = -30 dBm

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Gain		dB	14	17	
Noise Figure	2 - 4 GHz	dB		6.5	8.0
	4 - 6 GHz	dB		5.5	6.5
	6 - 8 GHz	dB		4.5	6.0
Gain Flatness		dB		± 0.5	
Input VSWR				1.6:1	
Output VSWR				1.5:1	
Output 1 dB Compression		dBm		+14	
Input IP_3		dBm		+7	
Reverse Isolation		dB		35	
Bias Current		mA		70	100

Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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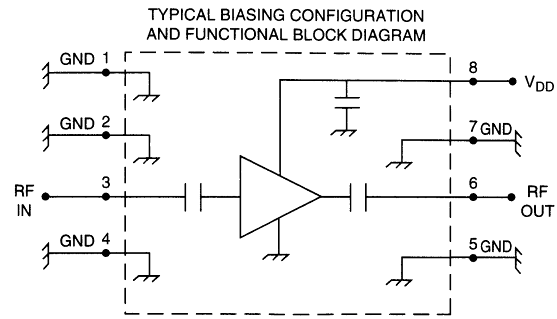
Absolute Maximum Ratings[1]

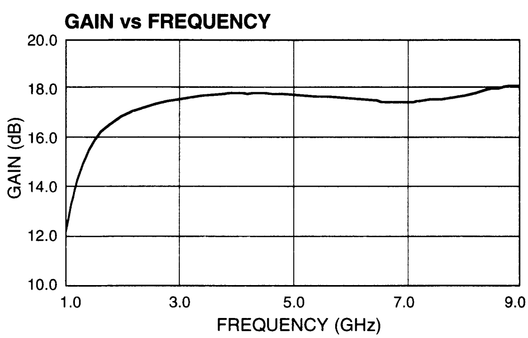
Parameter	Absolute Maximum
V_{DD}	+14 volts
Input Power	+20 dBm
Current	150 mA
Channel Temperature	+150°C
Operating Temperature[2]	-55°C to +100°C
Storage Temperature	-65°C to +150°C

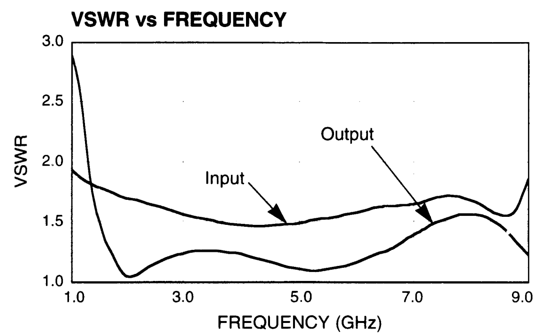
1. Operation of this device outside these limits may cause permanent damage.
2. Typical thermal resistance (θjc) = +45°C/W

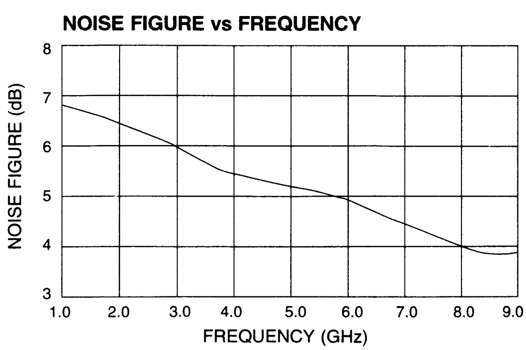
Schematic



Typical Performance @ +25°C







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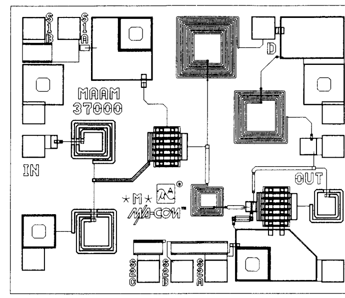
M/A-COM an AMP company

Low Noise GaAs MMIC Amplifier
3.5 - 7 GHz
MAAM37000

V 2.00



Features
- 1.8 dB Typical Noise Figure[1]
- 16 dB Typical Gain[1]
- Single Bias Supply
- DC Decoupled RF Input and Output

Electrical Specifications @ T_A = +25°C

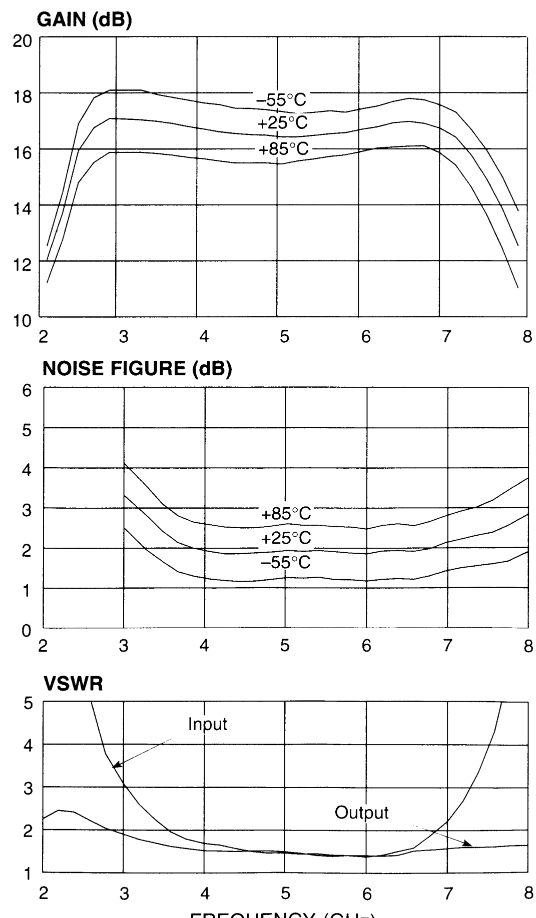
Frequency Range			3.5 – 7.0 GHz
Gain[1]		17.0 dB Typ	15.0 dB Min
Gain Flatness			±0.8 dB Typ
Noise Figure[1]		1.8 dB Typ	2.8 dB Max
VSWR	Input Output		1.5:1 Typ 1.5:1 Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			35 dB Typ
Impedance			50 Ω Typ
Bias Voltage			V_{DD} = +4 Vdc
Bias Current			I_{DD} = 75 mA Typ,100 mA Max

Maximum Ratings

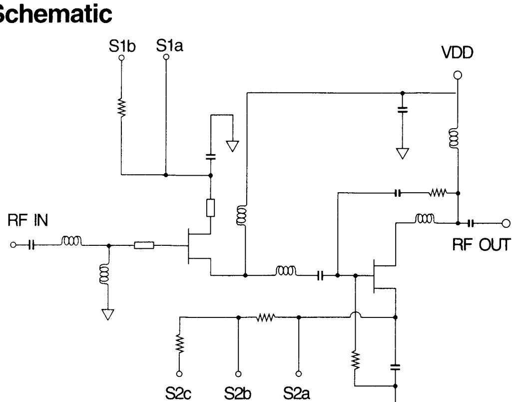
Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

Typical Performance



Schematic



Specifications Subject to Change Without Notice.

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Handling

Permanent damage to the MAAM37000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM37000 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM37000 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM37000. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM37000 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM37000 is back-metallized with Pd/Ni/Au(100/1,000/30,000Å) metallization. It can be die-mounted using Au/Sn eutectic preforms or a thermally and electrically conductive epoxy. The attachment surface should be clean and flat.

Eutectic Die Attach:

A. An 80/20 Au/Sn preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 95/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM37000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy is required.

B. Apply a minimum amount of epoxy and place the MAAM37000 into position. A thin epoxy fillet should be visible around the perimeter of the die.

C. Cure epoxy per manufacturer's recommended schedule.

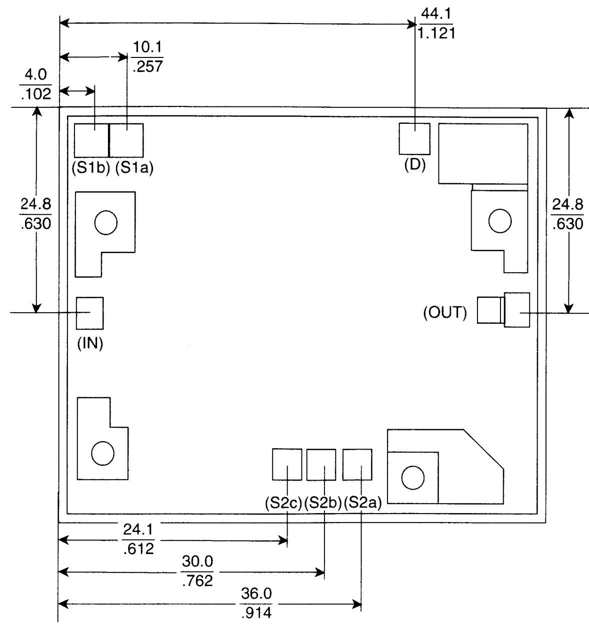
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

C. Bonding pads are 4.0 x 4.0 mils.

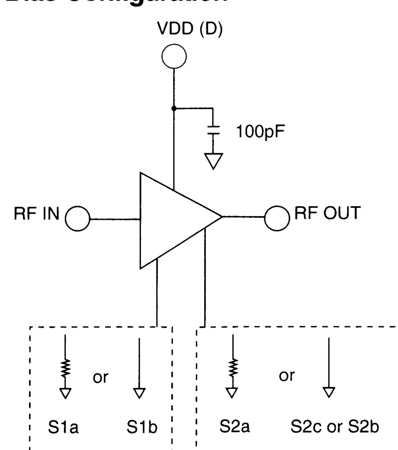
Outline



All dimensions are mils/mm.

Die Size 0.060" X 0.051" X 0.004" (1.529mm X 1.290mm X 0.0102mm)

Typical Bias Configuration



1. Nominal bias is obtained with on-chip resistors by grounding pads S1b and S2b.
2. Ground pads S1b and S2c for lower second stage current.
3. Optional biasing can be obtained with off-chip resistors bonded from pads S1a and S2a to ground. Adjusting the bias can customize performance to suit special requirements.

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Low Noise GaAs MMIC Amplifier 3.5 - 7 GHz

MAAM37000-A1

V 2.00

Features

- Low Noise Figure: 2.2 dB
- High Gain: 17 dB
- Gain Flatness: ±0.5 dB
- Single Supply: +4 V
- No External Components Required
- DC Decoupled RF Input and Output
- Small, 8-Lead Ceramic Package

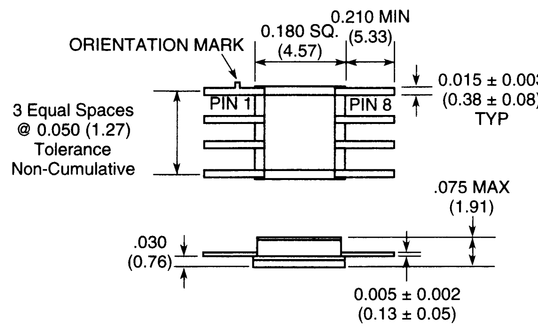
Description

M/A-COM's MAAM37000-A1 is a wide band, low noise, MMIC amplifier housed in a small 8-lead ceramic package. It includes two integrated gain stages and employs series inductive feedback to obtain excellent noise figure and a good, 50-ohm, input and output impedance match over the entire frequency band. The MAAM37000-A1 operates from a single +4 V supply. It is fully monolithic, requires no external components, and is provided in a user-friendly, microwave package.

The MAAM37000-A1 performs well as a low noise amplifier in receive applications and as a driver or buffer amplifier where high gain, excellent linearity and low power consumption are important. Because of its wide bandwidth, the MAAM37000-A1 can be used in numerous commercial and government system applications, such as TVRO, VSAT, missile guidance and radar.

The MAAM37000-A1 is manufactured in-house using a reliable, 0.5-micron, GaAs MESFET process. This product is 100% RF tested to ensure compliance to performance specifications.

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
MAAM37000-A1	8-Lead Ceramic
MAAM37000-A1G	Gull Wing

Electrical Specifications

Test Conditions: T_A = +25°C, Z_0 = 50 Ω, V_{DD} = +4 V, P_{IN} = -30 dBm

Parameter	Units	Min.	Typ.	Max.
Gain	dB	15	17	
Noise Figure	dB		2.2	3.2
Input VSWR			2.0:1	
Output VSWR			2.0:1	
Output 1 dB Compression	dBm		+14	
Input IP_3	dBm		+8	
Reverse Isolation	dB		35	
Bias Current	mA		75	110

Specifications Subject to Change Without Notice.

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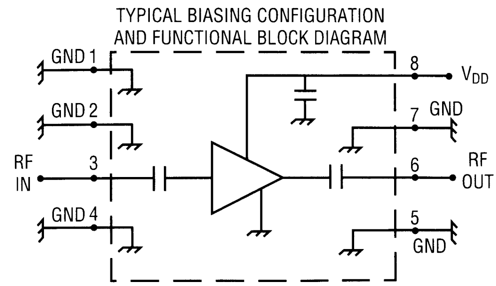
Absolute Maximum Ratings[1]

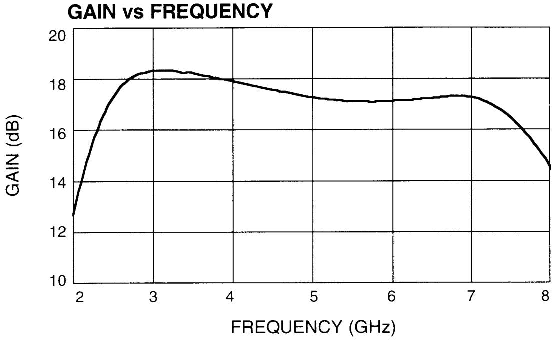
Parameter	Absolute Maximum
V_{DD}	+7 volts
Input Power	+20 dBm
Current	150 mA
Channel Temperature	+150°C
Operating Temperature[2]	-55°C to +100°C
Storage Temperature	-65°C to +150°C

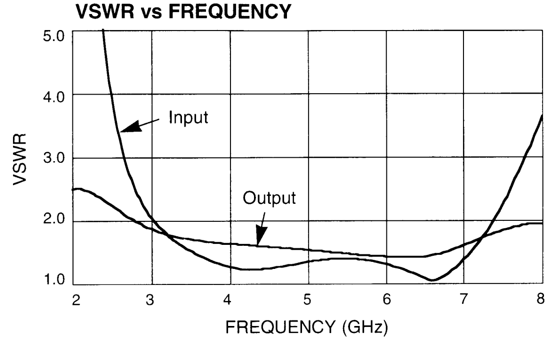
1. Operation of this device outside these limits may cause permanent damage.
2. Typical thermal resistance (θjc) = +120°C/W

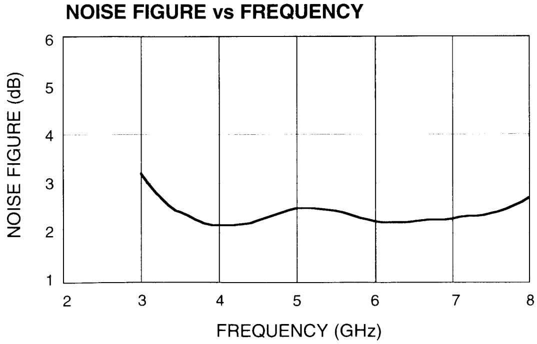
Schematic



Typical Performance @ +25°C







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![M/A-COM an AMP company]

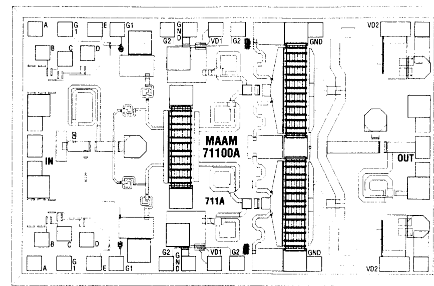
GaAs MMIC Power Amplifier 7 -11 GHz

MAAM71100

V 2.00

Features

- +31 dBm Typical Saturated Power
- 18 dB Typical Gain
- 30% Typical Power Added Efficiency
- On-Chip Bias Network
- DC Decoupled RF Input and Output



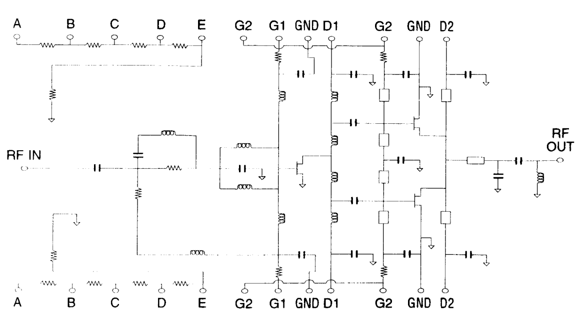
Guaranteed Specifications @ T_A = +25°C

Frequency Range		7.0– 11.0 GHz
Gain[1]	18.0 dB Typ	14 dB Min
VSWR[1]	Input Output	2.0:1 Typ 4.5:1 Typ
Saturated Power Output[1] (Input Power = +18 dBm)		+31 dBm Typ
Output Power at 1 dB Gain Compression		+28 dBm Typ
Third Order Intercept		+38 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		V_{DD} = +8 V_{DC}, V_{GG} = -1.2 V_{DC} Typ
Bias Current	No RF P_{IN} = +18 dBm	I_{DD} = 520 mA Typ I_{DD} = 750 mA
Typ		
Thermal Resistance[2]		12°C/W Typ

Maximum Ratings

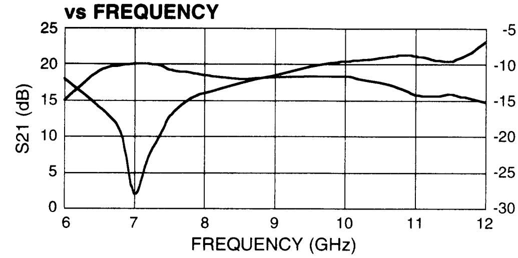
Voltage	V_{DD} = +10 Volts, V_{GG} = -5 Volts
Input Power	+23 dBm
Storage Temperature	–65°C to +150°C
Operating Channel Temperature	+150°C

Schematic

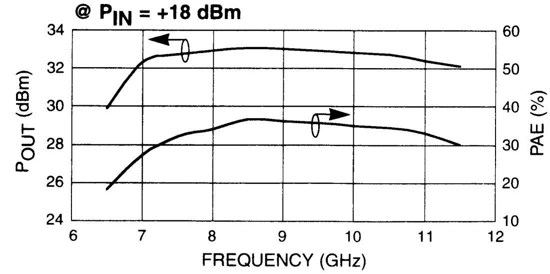


Typical Performance

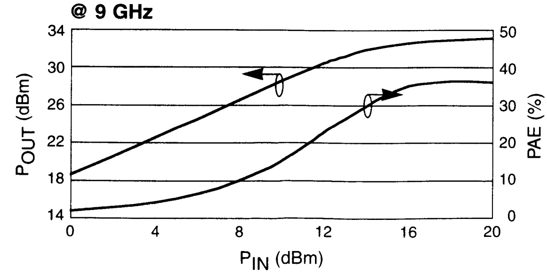
LINEAR GAIN & INPUT RETURN LOSS vs FREQUENCY



OUTPUT POWER & POWER ADDED EFFICIENCY vs FREQUENCY @ P_{IN} = +18 dBm



OUTPUT POWER & POWER ADDED EFFICIENCY vs INPUT POWER @ 9 GHz



Specifications Subject to Change Without Notice.

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Handling

Permanent damage to the MAAM71100 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM71100 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM71100 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM71100. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM71100 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM71100 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It is recommended that the die be mounted with Au/Sn eutectic preforms. The attachment surface should be clean and flat.

A. An 80/20 preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM71100 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

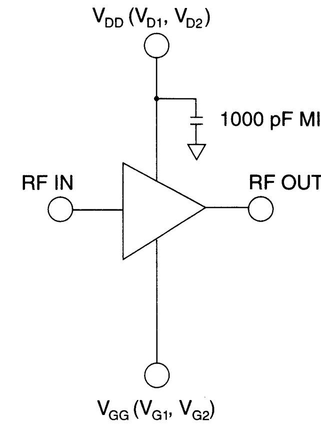
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

C. Bonding pads are 4.0 x 4.0 mils. minimum.

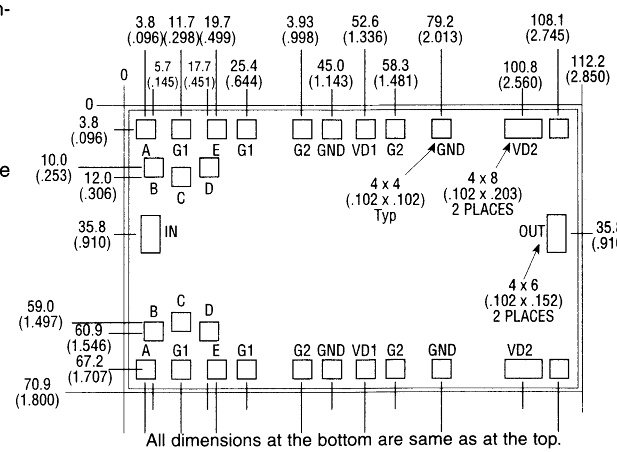
Typical Bias Configuration



1. Nominal bias is obtained by first connecting -1.2 volts to pads V_{G1} and V_{G2} followed by connecting +8 volts to pads V_{D1} and V_{D2} (note sequence).
2. The recommended V_{DD} range is +6 to +9 volts.
3. Optional on-chip resistor networks are used by connecting a nominal -5 volts to pad "A" and connecting pad "B", "C", "D", or "E" to pads V_{G1} and V_{G2}.

Die Size

0.113" X 0.072" X 0.004"
(2.88mm X 1.82mm X 0.10mm)



All dimensions at the bottom are same as at the top.

All dimensions are mils / mm

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M/A-COM an AMP company

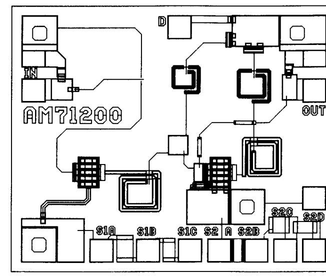
Low Noise GaAs MMIC Amplifier 7.5 -12 GHz

MAAM71200

V 2.00

Features

- 2.3 dB Typical Noise Figure[1]
- 16.5 dB Typical Gain[1]
- Low Bias Current
- Single Bias Supply
- On-Chip Bias Network
- DC Decoupled RF Input and Output



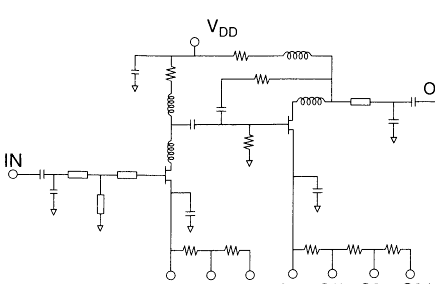
Electrical Specifications @ T_A= +25°C

Frequency Range			7.5 – 12.0 GHz
Gain[1]		16.5 dB Typ	15.0 dB Min
Gain Flatness			±0.8 dB Typ
Noise Figure[1]		3.2 dB Max	2.3 dB Typ
VSWR[1]	Input		1.8:1 Typ
	Output		1.5:1 Typ
Third Order Intercept			+22 dBm Typ
Output Power at 1 dB Gain Compression			+12 dBm Typ
Reverse Isolation			30 dB Typ
Impedance			50Ω Nominal
Bias Voltage			V_{DD} = +4 Vdc
Bias Current			I_{DD} = 40 mA Typ, 55 mA Max

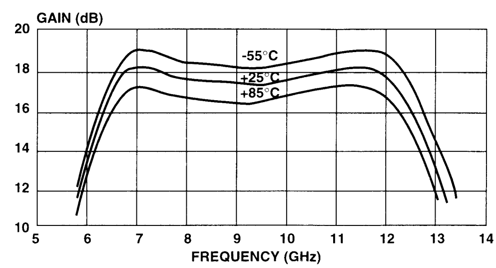
Maximum Ratings

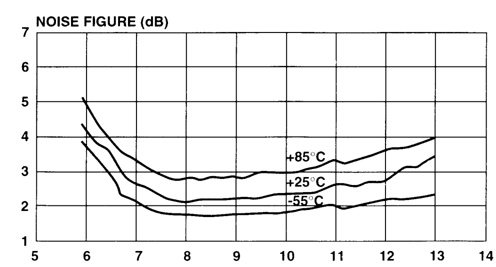
Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

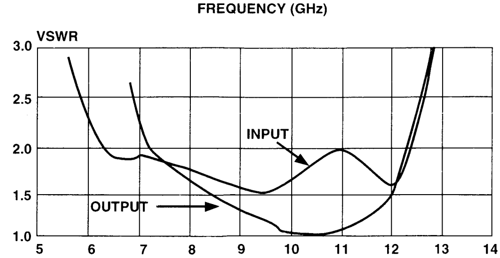
1. 100% on-wafer tested.



Typical Performance







Specifications Subject to Change Without Notice.

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Handling

Permanent damage to the MAAM71200 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAM71200 should be handled in a clean environment. DO NOT attempt to clean assembly after the MAAM71200 is installed.

B. Static Sensitivity — All die handling equipment and personnel should comply with DOD-STD-1686 Class I.

C. Transients — Avoid instrument and power supply transients while bias is connected to the MAAM71200. Use shielded signal and bias cables to minimize inductive pick-up.

D. General Handling — DO NOT touch the surface of the die. It is recommended that the MAAM71200 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM71200 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It can be die-mounted using Au/Sn eutectic preforms or a thermally and electrically conductive epoxy.The attachment surface should be clean and flat.

Eutectic Die Attach:

A. An 80/20 Au/Sn preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 95/5 nitrogen/hydrogen gas is applied, solder temperature should be approximately 290°C.

B. DO NOT expose the MAAM71200 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy is required.

B. Apply a minimum amount of epoxy and place the MAAM71200 into position. A thin epoxy fillet should be visible around the perimeter of the die.

C. Cure epoxy per manufacturer's recommended schedule.

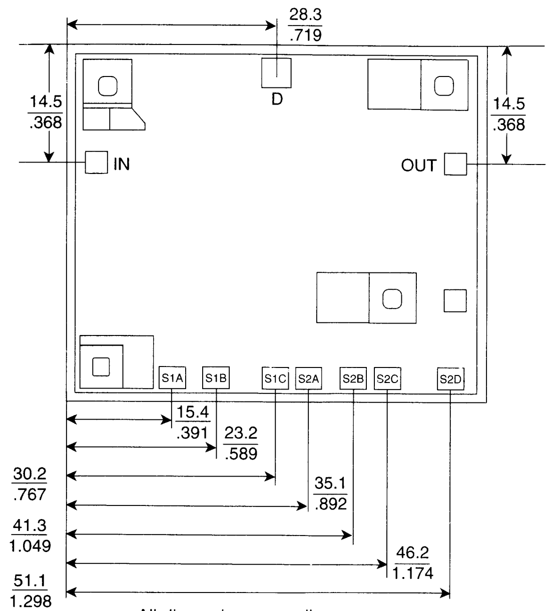
Bonding

A. Ball or wedge bond with 1.0 mil diameter gold wire or 3.0 mil x 0.5 mil ribbon. Thermosonic bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels necessary to achieve reliable bonds.

B. Bonds should be started on the die and terminated on the package.

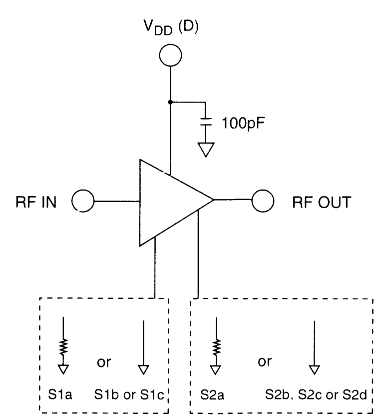
C. Bonding pads are 4.0 x 4.0 mils.

Outline



All dimensions are mils/mm

Die Size 55.1 x 45.3 x 4.0 (1.40 mm x 1.15 mm x 0.102 mm)



1. Nominal bias is obtained with on-chip resistors by grounding pads S1b and S2b.
2. Ground pads S1b and S2c for lower current or ground pads S1c and S2d for lowest current using on-chip resistors.
3. Optional biasing can be obtained with external resistors bonded to pads S1a and S2a. Adjusting the bias can customize the performance to suit special requirements.

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M/A-COM an AMP company

Low Noise GaAs MMIC Amplifier 7.5 - 12 GHz

MAAM71200-H1

V 2.00

Features

- 2.7 dB Typical Noise Figure
- 15.5 dB Typical Gain
- Single Bias Supply
- Low Current Consumption
- DC Decoupled RF Input and Output
- Ceramic Package

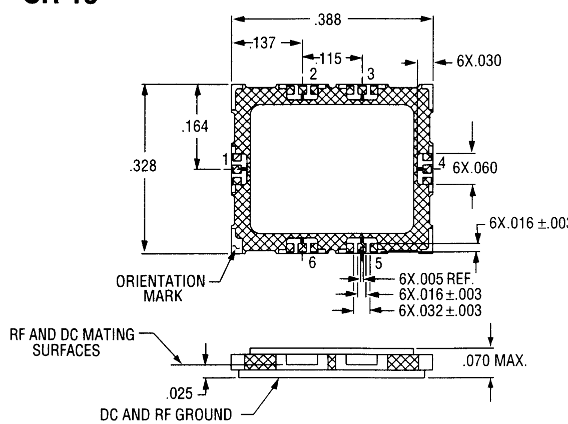
Description

M/A-COM's MAAM71200-H1 is a wide band, low noise GaAs MMIC amplifier enclosed in a leadless ceramic package[1]. The MAAM71200-H1 is a packaged version of M/A-COM's MAAM71200 low noise MMIC amplifier chip. The fully monolithic design operates in 50 ohms without the need for external components.

The MAAM71200-H1 is ideally suited for microstrip assemblies where wire or ribbon bonds are used for interconnects. Typical applications include radar, EW and communication systems.

The MAAM71200 is fabricated using a mature 0.5-micron gate length GaAs process for increased reliability and performance repeatability.

CR-16



Dimensions are in inches.

Typical Electrical Specifications, T_A = +25°C, V_{DD} = 4 V

Parameter	Units	Min.	Typ.	Max.
Gain	dB	14.5	15.5	
Noise Figure	dB		2.7	3.5
Input VSWR			2.0:1	
Output VSWR			1.8:1	
Output 1dB Compression Point	dBm		11	
Third Order Intercept Point	dBm		21	
Reverse Isolation	dB		30	
Bias Current (IDD)	mA		40	55

1. Consult factory for a leaded ceramic package version.

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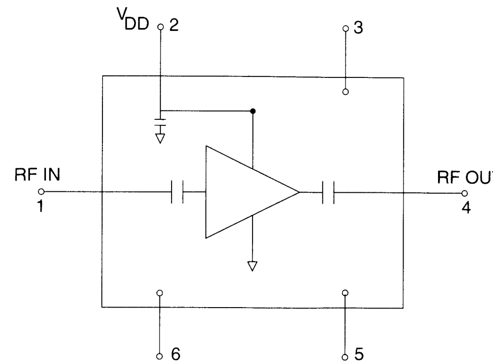
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
Input Power	+20 dBm
V_{DD}	+9 Volts
Junction Temperature	+150°C
Storage Temperature	-65°C to +150°C
Thermal Resistance	175°C/W

1. Operation of this device outside any of these limits may cause permanent damage

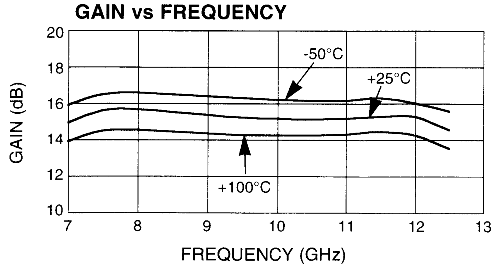
Functional Diagram



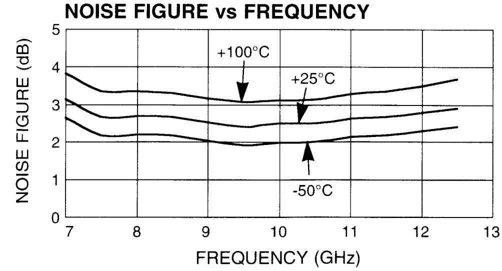
1. Case must be electrically connected to RF and DC ground.
2. The RF bond inductance from the transmission line to the package is assumed to be 0.25 nH. Variations in bond inductance will result in variations in VSWR and gain slope. A small capacitive stub may be needed depending on the inductance realized in the final assembly.
3. Nominal bias is obtained by setting V_{DD} = 4 volts.
4. Increasing V_{DD} from 4 volts to 6 volts increases output power and high frequency bandwidth.

Typical Performance

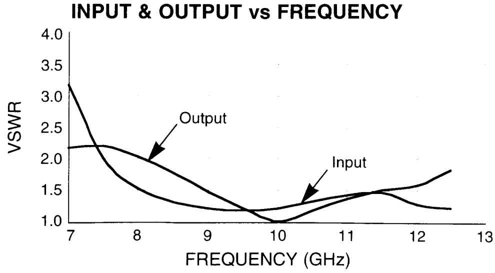
GAIN vs FREQUENCY



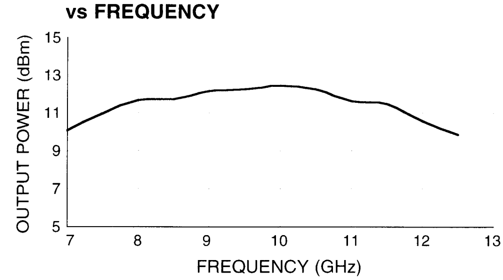
NOISE FIGURE vs FREQUENCY



INPUT & OUTPUT vs FREQUENCY



OUTPUT POWER @ 1dB COMPRESSION vs FREQUENCY



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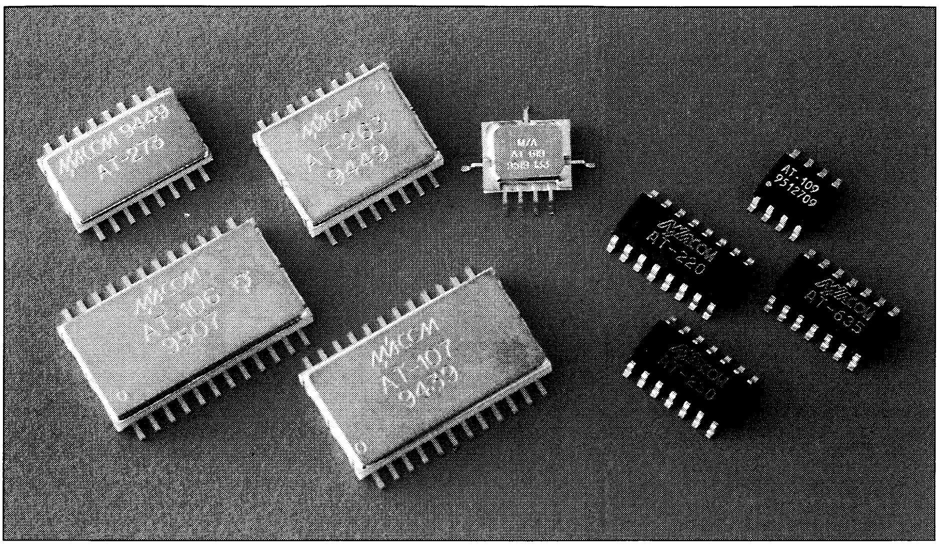
Attenuators



Title	Page

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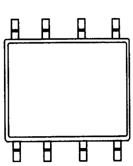
Plastic Packaged IC Attenuators

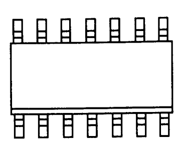
	Frequency (GHz)	Attenuation (dB)	Insertion Loss (900 MHz) (dB)	IP_3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
Voltage Variable (Single-Bias Control)								
New	0.4 - 2.5	0 - 30	3.0	12	SO-8	Positive control, linear, Ts: 200 nsec	AT-110	12-24
	0.4 - 2.5	0 - 35	2.5	12	SO-8	Positive control, linear	AT-109	12-21
	0.4 - 2.5	0 - 40	2.5	12	SO-8	Positive control, linear	AT-108	12-18
	DC - 2.0	0 - 15	3.2	18	SO-8	General purpose	AT-250	12-46
	DC - 2.0	0 - 15	3.2	18	SOT-143	General purpose	AT-259	12-50
	DC - 2.0	0 - 35	7.0	18	SO-14	General purpose	AT-635	12-80
Voltage Variable (Dual-Bias Control)								
	DC - 2.0	0 - 20*	1.0	30	SO-8	Low insertion loss	AT-309	12-70
	DC - 2.0	0 - 40*	1.0	30	SO-14	Low insertion loss	AT-339	12-74
Digital								
	DC - 1.0	15 -30	0.7	52	SO-8	Adjustable attenuation	AT-225	12-38
	DC - 2.0	1, 2, 4, 8	1.5	50	SO-16	Attenuation accuracy	AT-210	12-30
	DC - 2.0	2, 4, 8, 16	1.6	50	SO-16	Attenuation accuracy	AT-220	12-36
	DC - 2.0	4, 8, 16	1.6	50	SO-14	Attenuation accuracy	AT-230	12-40
	DC - 2.0	1, 2, 4, 8, 16	1.9	50	SSOP-20	Attenuation accuracy	AT-260	12-52
	DC - 2.0	0.5, 1, 2, 4, 8	1.6	45	SO-16	Attenuation accuracy	AT-280	12-62

* Under optimum match conditions.

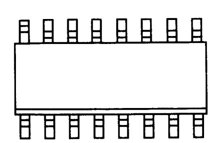
Stocked at your local distributor.



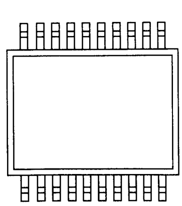
SO-8



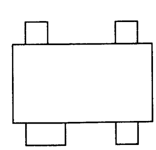
SO-14



SO-16



SSOP-20



SOT-143

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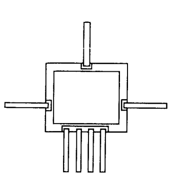
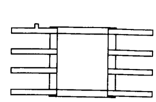
Ceramic Packaged Attenuators

	Frequency (GHz)	Attenuation (dB)	Insertion Loss (900 MHz) (dB)	IP_3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
Voltage Variable								
	DC - 5.0	0-20	1.0	30	CR-2	General microwave	AT-201	12-27
	DC - 5.0	0-20	1.0	30	CR-3	General microwave	AT-202	12-29
	DC - 2.0	0-20	1.2	30	CR-3	General microwave	AT-303	12-68
	DC - 2.0	0-20	1.2	30	CR-2	General microwave	AT-307	12-68
	DC - 2.0	0-40	0.8	30	CR-2	General microwave	AT-337	12-72
	DC - 3.0	0-30	7.0	18	CR-3	General microwave, single bias control	AT-637	12-82
	DC - 3.0	0-15	3.2	18	CR-3	General microwave, single bias control	AT-252	12-48
Digital								
	DC - 2.0	1,2,4,8	1.8	50	CR-6	Surface mount, attenuation accuracy	AT-212	12-32
	DC - 2.0	4,8,16	2.0	50	CR-6	Surface mount, attenuation accuracy	AT-232	12-42
	DC - 2.0	1,2,4,8,16	2.0	50	CR-8	Surface mount, attenuation accuracy	AT-262	12-54
	DC - 2.0	16,16	1.5	50	CR-6	Surface mount, attenuation accuracy	AT-272	12-58
	DC - 2.0	0.5,1,2,4,8	1.5	45	CR-6	Surface mount, attenuation accuracy	AT-282	12-64
	DC - 2.0	1,2,4,8,16,32	3.5	46	CR-13	Surface mount, temperature stability	AT-106	12-14
	DC - 2.0	0.5,1,2,4,8,16	2.9	48	CR-13	Surface mount, temperature stability	AT-107	12-16
	DC - 3.0	1,2,4,8	1.8	50	CR-11	Surface mount, temperature stability	AT-213	12-34
	DC - 2.0	2,4,8,16	2.0	50	CR-12	Surface mount, temperature stability	AT-233	12-44
	DC - 2.0	1,2,4,8,16	2.3	48	CR-12	Surface mount, temperature stability	AT-263	12-56
	DC - 2.0	0.5,1,2,4,8	1.9	47	CR-12	Surface mount, temperature stability	AT-283	12-66
	DC - 2.0	16,32	1.3	48	CR-11	Surface mount, temperature stability	AT-273	12-60
New	DC - 2.0	1,2,4,8,16,32	3.5	46	CR-13	Surface mount, low cost	AT20-0106	12-4
New	DC - 2.0	0.5,1,2,4,8,16	2.9	48	CR-13	Surface mount, low cost	AT20-0107	12-6
New	DC - 2.0	1,2,4,8,16	2.3	48	CR-12	Surface mount, low cost	AT20-0263	12-8
New	DC - 2.0	16,32	1.3	48	CR-11	Surface mount, low cost	AT20-0273	12-10

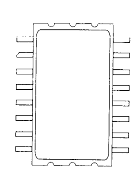
Stocked at your local distributor.



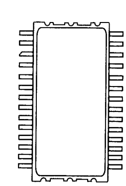
CR-2



CR-3



CR-6, CR-11, CR-12



CR-13

Specifications Subject to Change Without Notice.

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Chip Attenuators

Frequency (GHz)	Attenuation (dB)	Insertion Loss Typ. Range (dB)	IP_3 (>500 MHz) (dBm)	Features	Part No.	Page No.
Voltage Variable						
DC - 2.0	0 - 20	1.0 - 1.2	30	Dual bias	MAAA2000G	12-84
DC - 2.0	0 - 50	1.0 - 1.5	30	Dual bias	MAAA2010G	12-86
Digital						
DC - 2.0	1,2,4,8	1.3 - 1.7	45	Attenuation accuracy	MADA2000G	12-90
DC - 2.0	2,4,8,16	1.7 - 2.1	45	Attenuation accuracy	MADA2010G	12-92
DC - 2.0	1,2,4,8,16	1.6 - 2.1	45	Attenuation accuracy	MADA2020G	12-94
DC - 2.0	0.5,1,2,4,8	1.2 - 1.7	45	Attenuation accuracy	MADA2030G	12-96
DC - 12.0	1,2,4,8	2.0 - 3.3	45	Attenuation accuracy	MADA12000	12-88

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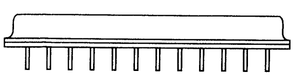
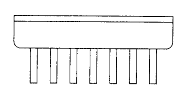
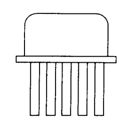
Other Surface Mount Attenuators

	Frequency (GHz)	Attenuation (dB)	Insertion Loss (900 MHz) (dB)	IP_3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
Voltage Variable								
	DC-2.0	0-20	1.2	30	TO-5	General RF	AT-302	12-68
	DC-2.0	0-40	1.0	30	TO-5	General RF	AT-332	12-72
	0.15 - 1.0	0 - 40	4.2	35	FP-2	General RF	AT-101	12-13
Digital								
	0.25 - 2.0	3 dB steps to 45	4.3	40	DI-6	General RF	AT-354	12-76
	0.02 - 2.0	10	1.0	35	TO-8-2	General RF	AT-358	12-78
New	DC - 2.0	1,2,4,8,16	6.0	40	DI-3	General RF	AT15-0001	12-2


DI-3


FP-2


DI-6


TO-5-4

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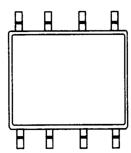
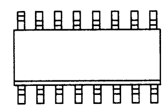
Drivers for GaAs FET Control Components

Bias	Transition Time (nsec) Typ.	Propagation Delay (nsec) Typ.	Package	Feature	Part No.	Page No.
+/- 5 V	10	45	SO-8	Single Channel	SWD-109	15-172
+/- 5 V	10	45	SO-16	Quad Channel	SWD-119	15-172



SO-8



SO-16

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Digital Attenuator, 31 dB, 5-Bit, TTL Driver DC-2.0 GHz

AT15-0001

V 2.00

Features

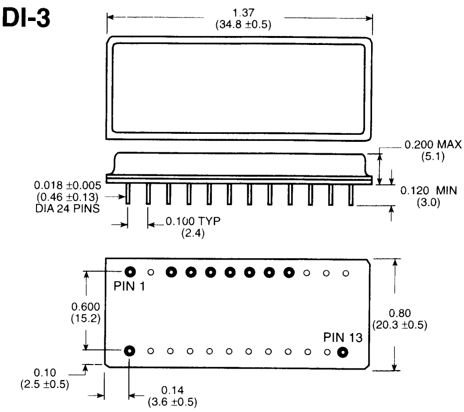
- Attenuation: 1-dB Steps to 31 dB
- Low DC Power Consumption
- Integral TTL Driver
- 50Ω Nominal Impedance

Description

M/A-COM's AT15-0001 is a GaAs FET 5-bit digital attenuator with a 1-dB minimum step size and 31 dB total attenuation. This attenuator and integral TTL driver is in a 24-pin dual inline package. The AT15-0001 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits.

Environmental screening is available. Contact the factory for information.

DI-3



Pin Configuration

1	2	3	4	5	6	7	8	9	10-12	13	14-23	24
+5 V	GND	-12 V	GND	C16	C1	C2	C4	C8	GND	RF2	GND	RF1

Dimensions in ( ) are in mm. Unless otherwise noted:
.xxx = ±0.010 (.xx = ±0.25)

Typical Electrical Specifications[1], T_A = -55°C to +85°C

Parameter	Test Conditions	Units	Minimum	Typical	Maximum
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			6.0 6.5 7.3
Attenuation Accuracy[2,3]	Any Single Bit DC - 1.0 GHz DC - 2.0 GHz Any Combination of Bits DC - 1.0 GHz DC - 2.0 GHz	± (0.2 dB + 2% of attenuation setting in dB) dB ± (0.25 dB + 2% of attenuation setting in dB) dB ± (0.2 dB + 2% of attenuation setting in dB) dB ± (0.3 dB + 2% of attenuation setting in dB) dB			
VSWR	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz				1.3:1 1.4:1 1.7:1
Trise, Tfall Ton, Toff Transients	10% RF to 90% RF 50% Control to 90%/10% RF In-band	nS nS mV		5 30 220	
1 dB Compression	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +27	
Input IP_3	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+40 +40	
Input IP_2	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+60 +75	
V_{CC} V_{EE}		V V	4.5 -16.5	5.0	5.5 -10.8
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			10
I_{EE}	V_{EE} = -16.5 to -10.8 V V_{EE} = -12.0 V	mA mA			8.0 5.0
Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current	Low 0 to 0.8 V High 2.0 to 5.0 V	μA μA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -16.5 V to -10.8 V for V_{EE}, and 50 Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. Replaces AT-104.

Specifications Subject to Change Without Notice.

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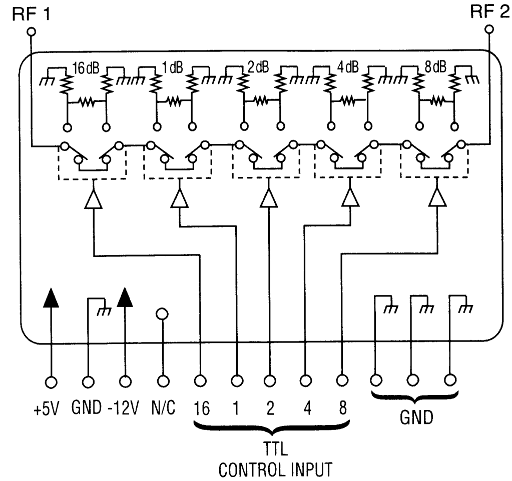
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Maximum Input Power	
DC - 0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	-0.5 V to +7.0 V
V_{EE}	-18 V to +0.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic



Truth Table

Control Inputs					Attenuation
C16	C8	C4	C2	C1	
0	0	0	0	0	Reference
0	0	0	0	1	1 dB
0	0	0	1	0	2 dB
0	0	1	0	0	4 dB
0	1	0	0	0	8 dB
1	0	0	0	0	16 dB
1	1	1	1	1	31 dB

0 = TTL Low
1 = TTL High

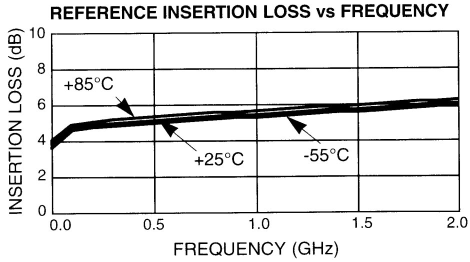
Ordering Information[2]

Part Number	Package
AT15-0001	Dual Inline

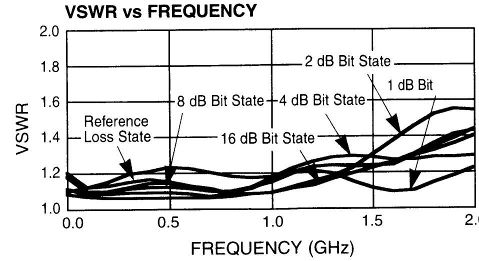
2. Contact the factory for standard or custom screening requirements.

Typical Performance

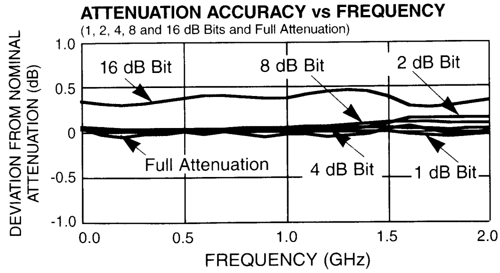
REFERENCE INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
(1, 2, 4, 8 and 16 dB Bits and Full Attenuation)



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Digital Attenuator, 50 dB, 6-Bit, TTL Driver DC-2 GHz

AT20-0106

V 2.00

Features

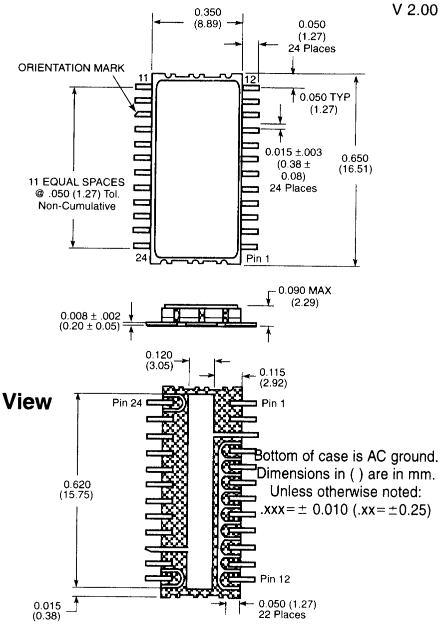
- Attenuation: 1-dB steps to 50 dB[2]
- Temperature Stability: ±0.18 dB from -40°C to +85°C Typical
- Low DC Power Consumption
- Surface Mount Package
- Integral TTL Driver
- High Intercept Point
- Low Cost/High Performance

Description

M/A-COM's AT20-0106 is a GaAs FET 6-bit digital attenuator with a 1-dB minimum step size and 50 dB total attenuation. This attenuator and integral TTL driver is in a ceramic 24-lead surface mount package. The AT20-0106 is ideally suited for use where accuracy, fast switching, low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Available with enhanced performance as fully hermetic version. Environmentally screenable as P/N AT-106.

CR-13

Bottom View



Electrical Specifications[1], $T_A = +25°C$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB		3.0 3.5 4.0	3.6 4.1 4.6
Attenuation Accuracy[3,4]	Any Single Bit DC - 2.0 GHz Any Combination of Bits DC - 2.0 GHz (For Attenuation to 26 dB) Any Combination of Bits DC - 1.5 GHz (For Attenuation to 50 dB)	± (0.2 + 3% of attenuation setting in dB) dB ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.8:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		50 150 50	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+34 +46	
Input IP_2[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+75 +79	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC}- 2.1 V to V_{CC}	mA			6.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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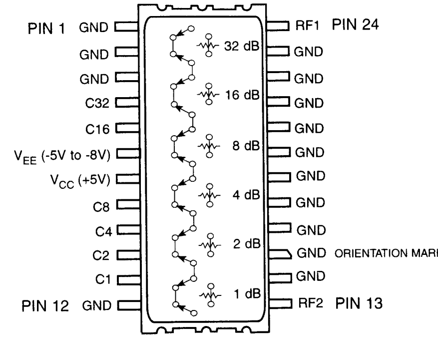
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-40°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs						
C6	C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	0	Reference
0	0	0	0	0	1	1 dB
0	0	0	0	1	0	2 dB
0	0	0	1	0	0	4 dB
0	0	1	0	0	0	8 dB
0	1	0	0	0	0	16 dB
1	0	0	0	0	1	32 dB
1	1	1	1	1	1	63 dB

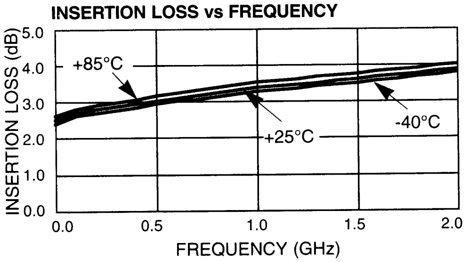
0 = TTL Low 1 = TTL High

Ordering Information

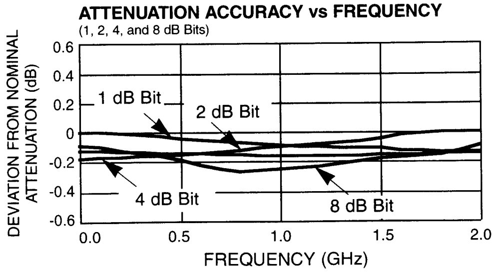
Part Number	Package
AT20-0106	Ceramic

Typical Performance @ +25°C

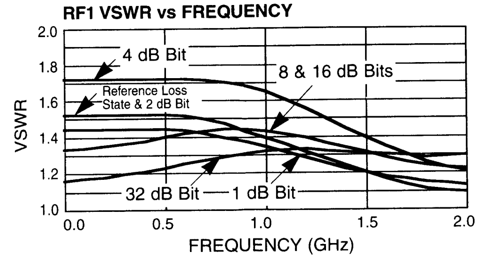
INSERTION LOSS vs FREQUENCY



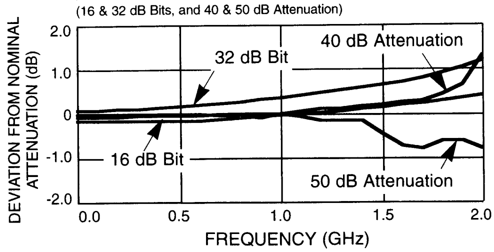
ATTENUATION ACCURACY vs FREQUENCY
(1, 2, 4, and 8 dB Bits)



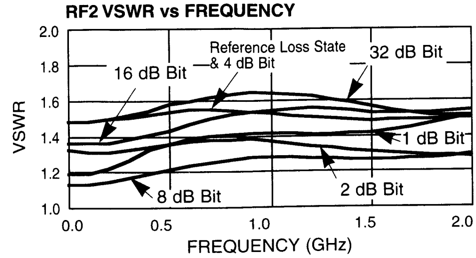
RF1 VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
(16 & 32 dB Bits, and 40 & 50 dB Attenuation)



RF2 VSWR vs FREQUENCY



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Digital Attenuator, 31.5 dB, 6-Bit, TTL Driver DC-2 GHz

AT20-0107

V 2.00

Features

- Attenuation: 0.5-dB Steps to 31.5 dB[2]
- Temperature Stability: ± 0.18 dB from -40°C to +85°C Typical
- Low DC Power Consumption
- Surface Mount Package
- Integral TTL Driver
- High Intercept Point
- Low Cost/High Performance

Description

M/A-COM's AT20-0107 is a GaAs FET 6-bit digital attenuator with a 0.5-dB minimum step size and 31.5 dB total attenuation. This attenuator and integral TTL driver is in a ceramic 24-lead surface mount package. The AT20-0107 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Available with enhanced performance as fully hermetic version. Environmentally screenable as P/N AT-107.

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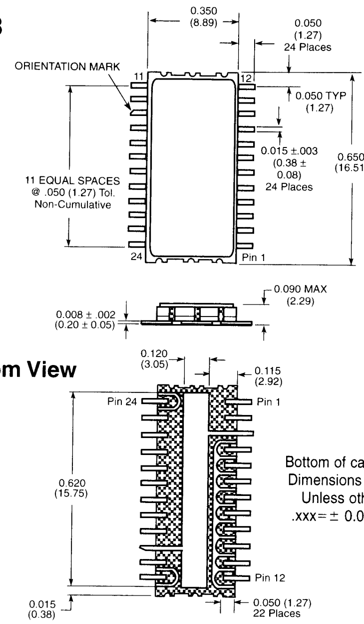
Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB		2.5 2.9 3.2	3.0 3.4 3.8
Attenuation Accuracy[3,4]	Any Single Bit DC - 1.0 GHz DC - 2.0 GHz Any Combination of Bits DC - 1.0 GHz DC - 2.0 GHz	± (0.15 + 3% of attenuation setting in dB) dB ± (0.2 + 3% of attenuation setting in dB) dB ± (0.2 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater ± (0.2 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.8:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		50 150 50	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+21 +29	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+35 +48	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+75 +79	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			6.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

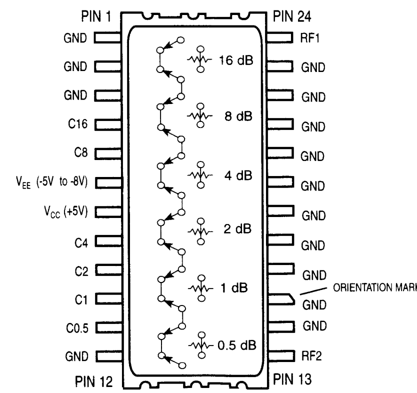
Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-40°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Ordering Information

Part Number	Package
AT20-0107	Ceramic

Functional Schematic (Top View)



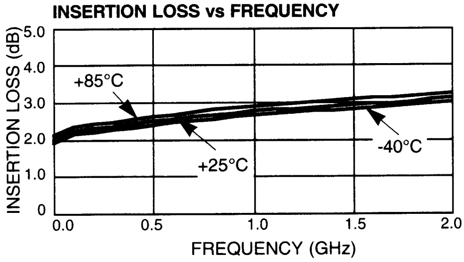
Truth Table

Control Inputs						
C6	C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	0	Reference
0	0	0	0	0	1	0.5 dB
0	0	0	0	1	0	1 dB
0	0	0	1	0	0	2 dB
0	0	1	0	0	0	4 dB
0	1	0	0	0	0	8 dB
1	0	0	0	0	0	16 dB
1	1	1	1	1	1	31.5 dB

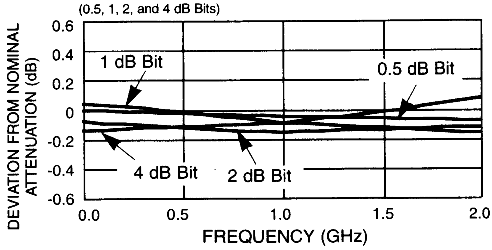
0 = TTL Low 1 = TTL High

Typical Performance @ +25°C

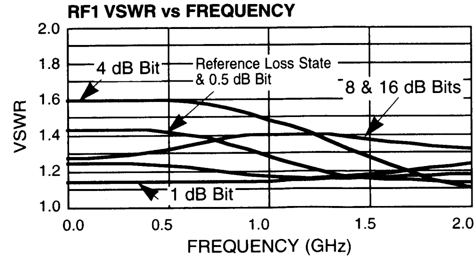
INSERTION LOSS vs FREQUENCY



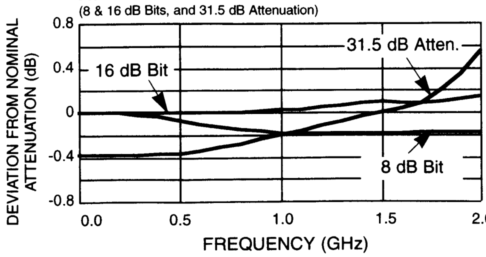
ATTENUATION ACCURACY vs FREQUENCY
(0.5, 1, 2, and 4 dB Bits)



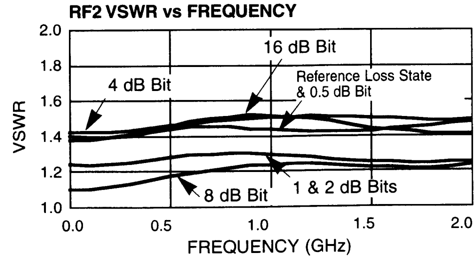
RF1 VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
(8 & 16 dB Bits, and 31.5 dB Attenuation)



RF2 VSWR vs FREQUENCY



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Digital Attenuator, 31 dB, 5-Bit, TTL Driver DC-2 GHz

AT20-0263

V 2.00

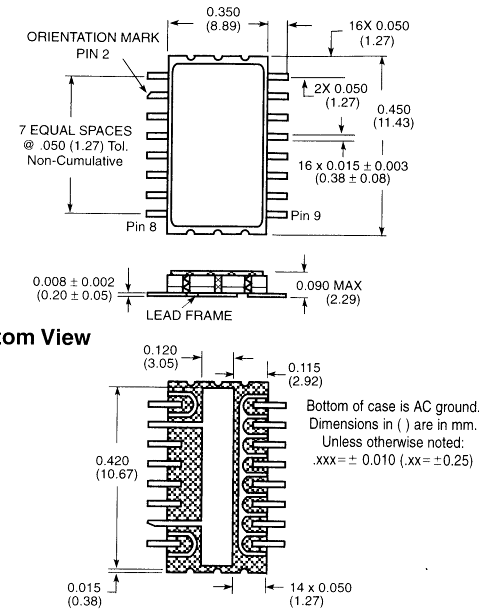
Features

- Attenuation: 1-dB Steps to 31 dB[2]
- Temperature Stability: ± 0.18 dB from -40°C to +85°C Typical
- Low DC Power Consumption
- Surface Mount Package
- Integral TTL Driver
- Low Cost/High Performance

Description

M/A-COM's AT20-0263 is a GaAs FET 5-bit digital attenuator with a 1-dB minimum step size and 31 dB total attenuation. This attenuator and integral TTL driver is in a ceramic 16-lead surface mount package. The AT20-0263 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Available with enhanced performance as fully hermetic version. Environmentally screenable as P/N AT-263.

CR-12



Electrical Specifications[1], $T_A = +25°C$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB		2.0 2.2 2.5	2.4 2.8 3.0
Attenuation Accuracy[3,4]	Any Single Bit DC - 1.0 GHz Any Combination of Bits DC - 2.0 GHz	± (0.25 + 3% of attenuation setting in dB) dB ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.6:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		50 150 50	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+40 +48	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+45 +68	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			5.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. VEE = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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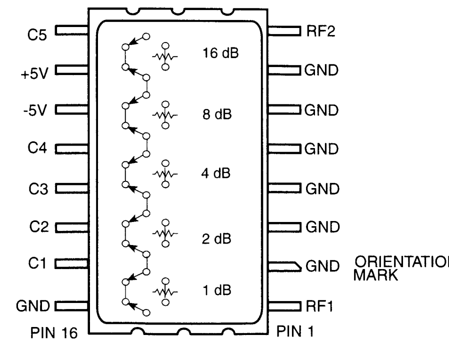
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-40°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs					
C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	Reference
0	0	0	0	1	1 dB
0	0	0	1	0	2 dB
0	0	1	0	0	4 dB
0	1	0	0	0	8 dB
1	0	0	0	0	16 dB
1	1	1	1	1	31 dB

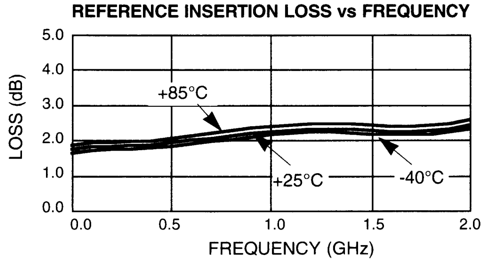
0 = TTL Low   1 = TTL High

Ordering Information

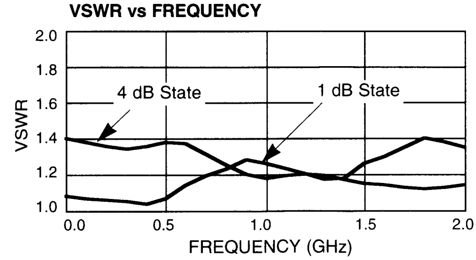
Part Number	Package
AT20-0263	Ceramic

Typical Performance @ +25°C

REFERENCE INSERTION LOSS vs FREQUENCY

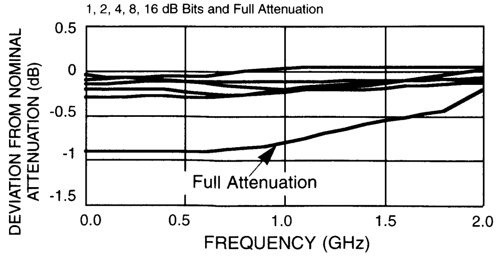


VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY

1, 2, 4, 8, 16 dB Bits and Full Attenuation



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Digital Attenuator, 32 dB, 2-Bit, TTL Driver DC-2 GHz

AT20-0273

V 2.00

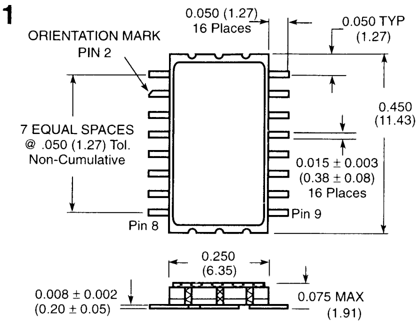
Features

- Attenuation: 16-dB Steps to 32 dB[2]
- Temperature Stability: ± 0.18 dB from -40°C to +85°C Typical
- Low DC Power Consumption
- Surface Mount Package
- Integral TTL Driver
- Low Cost/High Performance

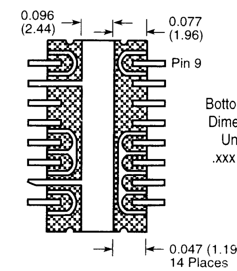
Description

M/A-COM's AT20-0273 is a GaAs FET digital attenuator with a 16-dB minimum step size and 32 dB total attenuation. This attenuator and integral TTL driver is in a sealed ceramic 24-lead surface mount package. The AT20-0273 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Available with enhanced performance as fully hermetic version. Environmentally screenable as P/N AT-273.

CR-11



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB		1.2 1.3 1.5	1.6 1.7 1.9
Attenuation Accuracy[3,4]	C1 Bit DC - 2.0 GHz	± 3% of attenuation setting in dB			
	Full Attenuation (32dB) DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	± 3% of attenuation setting in dB + 3% of attenuation setting in dB, -1dB + 3% of attenuation setting in dB, -3dB			
VSWR	DC - 2.0 GHz				1.4:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		50 150 50	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+38 +48	
Input IP_2[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+44 +68	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			2.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and −5.0 V to −8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = −5 V for the typical numbers given.

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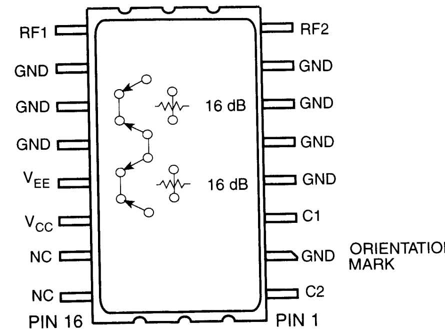
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-40°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)[2]



2. Use the C1 control for a single 16-dB bit.

Truth Table

Control Inputs		
C2	C1	Attenuation
0	0	Reference
0	1	16 dB
1	0	32 dB

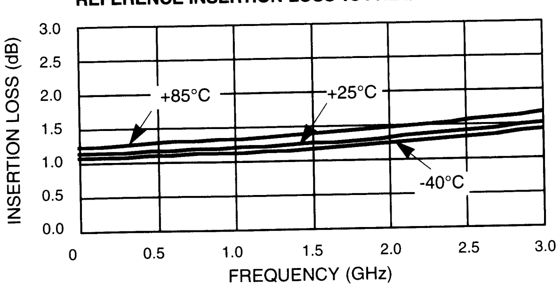
0 = TTL Low 1 = TTL High

Ordering Information

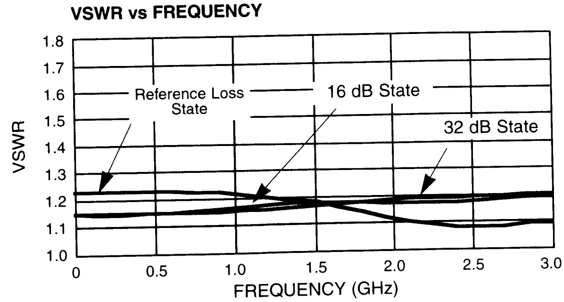
Part Number	Package
AT20-0273	Ceramic

Typical Performance @ +25°C

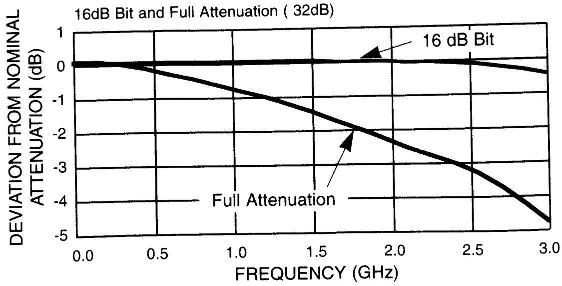
REFERENCE INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
16dB Bit and Full Attenuation (32dB)



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M/A-COM
an AMP company

Voltage Variable Attenuator 1.5 - 1000 MHz

AT-101

V 2.00

Features

- 2 dB Typical Midband Minimum Attenuation
- 60 dB Typical Midband Attenuation Range
- 1.5:1 Typical Midband VSWR Over Entire Attenuation Range

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		1.5-1000 MHz
Minimum Attenuation	1.5-1000 MHz	4.5 dB Max
(+15 V Control)	5-100 MHz	2.7 dB Max
Maximum Attenuation	1.5-1000 MHz	35 dB Min
(0 V Control)	1.5-5 MHz	55 dB Min
	5-100 MHz	55 dB Min
	100-500 MHz	40 dB Min
VSWR	1.5-1000 MHz	2.8:1 Max
(0-15 V Control)	5-100 MHz	2.0:1 Max
	100-500 MHz	2.0:1 Max
Control Bandwidth		0-100 kHz
Third Order IM		70 dB Typ
(0-15 V Control)		Below Input Levels
		for -10 dBm input signals
Bias Requirement		+ 15 VDC @ 1 mA Max
Control		0-15 VDC @ 10 mA Max

Operating Characteristics

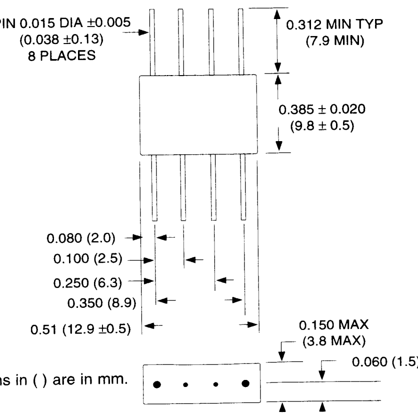
Impedance	50 Ohms Nominal
Maximum Ratings	
RF Input	250 mW @ +25°C
	Derated Linearly to 115 mW @ +85°C
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P5, Out; P1,
	+DC IN BIAS; P3 & P7,
	Control; P4 & P8,
	GND; P2 & P6

* All specifications apply with 50 ohm source and load impedance with input power up to the level shown In the Rated Input Power Curve.

Ordering Information

Model No.	**Package**
AT-101 PIN	Flatpack

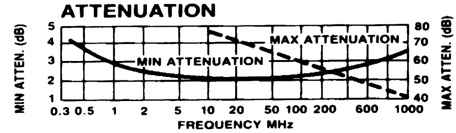
FP-2



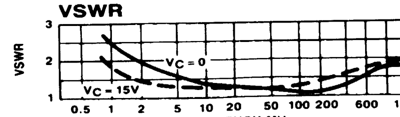
Dimensions in ( ) are in mm.

Typical Performance

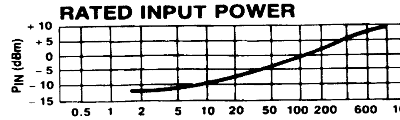
ATTENUATION



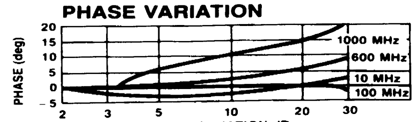
VSWR



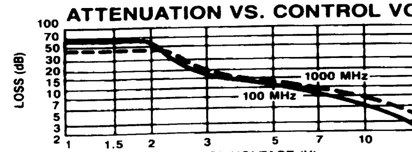
RATED INPUT POWER



PHASE VARIATION



ATTENUATION VS. CONTROL VOLTAGE



Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

Digital Attenuator, 50 dB, 6-Bit, TTL Driver DC-2 GHz

AT-106

V 2.00

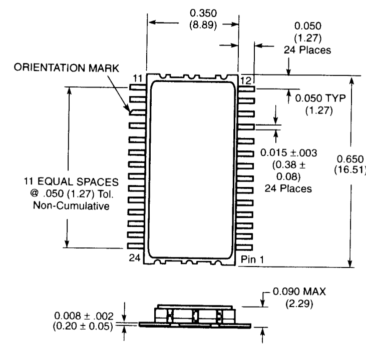
Features

- Attenuation: 1-dB steps to 50 dB[2]
- Temperature Stability: ±0.18 dB from -55°C to +85°C Typical
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50Ω Nominal Impedance

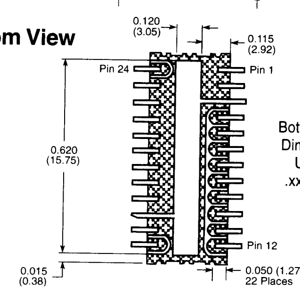
Description

M/A-COM's AT-106 is a GaAs FET 6-bit digital attenuator with a 1-dB minimum step size and 50 dB total attenuation. This attenuator and integral TTL driver is in a hermetically sealed ceramic 24-lead surface mount package. The AT-106 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

CR-13



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, $T_A = +25°C$[1]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			3.6 4.1 4.6
Attenuation Accuracy[3,4]	Any Single Bit DC - 2.0 GHz Any Combination of Bits (For Attenuation to 26 dB) DC - 2.0 GHz Any Combination of Bits (For Attenuation to 50 dB) DC - 1.5 GHz	± (0.2 + 3% of attenuation setting in dB) dB ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.8:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		9 45 40	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+34 +46	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+75 +79	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC}- 2.1 V to V_{CC}	mA			6.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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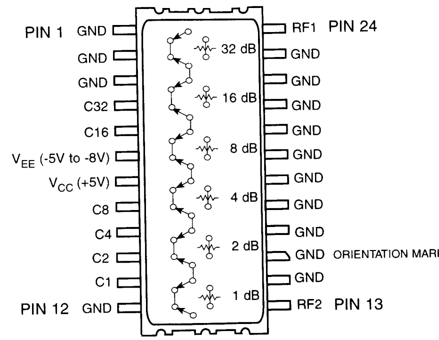
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Note: Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs						
C6	C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	0	Reference
0	0	0	0	0	1	1 dB
0	0	0	0	1	0	2 dB
0	0	0	1	0	0	4 dB
0	0	1	0	0	0	8 dB
0	1	0	0	0	0	16 dB
1	0	0	0	0	1	32 dB
1	1	1	1	1	1	63 dB

0 = TTL Low 1 = TTL High

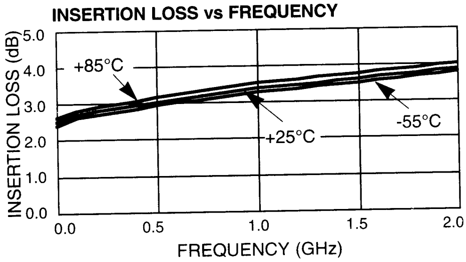
Ordering Information[6]

Part Number	Package
AT-106 PIN	Ceramic

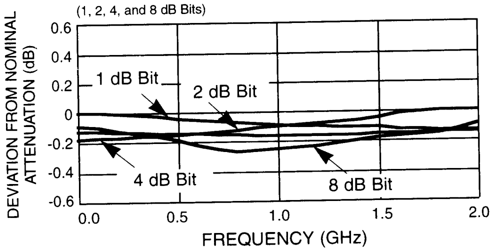
6. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C

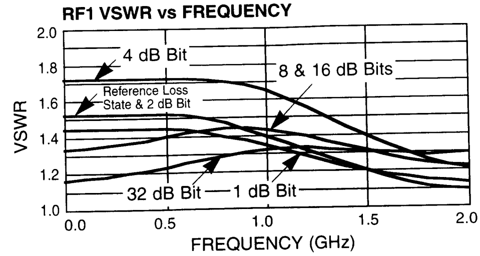
INSERTION LOSS vs FREQUENCY



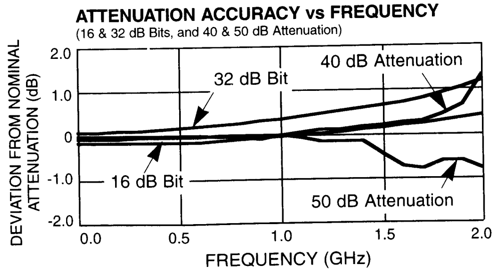
ATTENUATION ACCURACY vs FREQUENCY
(1, 2, 4, and 8 dB Bits)



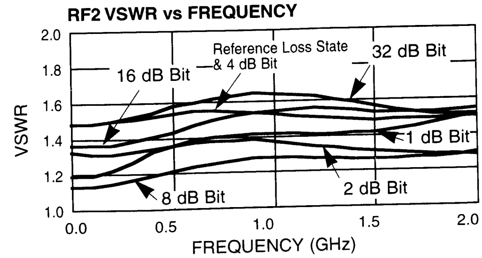
RF1 VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
(16 & 32 dB Bits, and 40 & 50 dB Attenuation)



RF2 VSWR vs FREQUENCY



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M/A-COM an AMP company

Digital Attenuator, 31.5 dB, 6-Bit, TTL Driver DC-2 GHz

AT-107

V 2.00

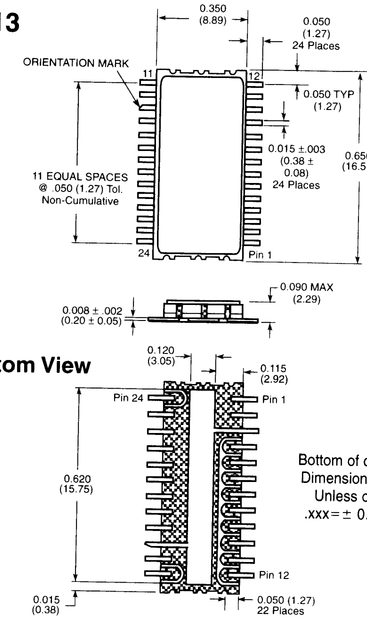
Features

- Attenuation: 0.5-dB Steps to 31.5 dB[2]
- Temperature Stability: ± 0.18 dB from -55°C to +85°C Typical
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50Ω Nominal Impedance

Description

M/A-COM's AT-107 is a GaAs FET 6-bit digital attenuator with a 0.5-dB minimum step size and 31.5 dB total attenuation. This attenuator and integral TTL driver is in a hermetically sealed ceramic 24-lead surface mount package. The AT-107 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

CR-13



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, T_A = +25°C[1]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			3.0 3.4 3.8
Attenuation Accuracy[3,4]	Any Single Bit DC - 1.0 GHz DC - 2.0 GHz Any Combination of Bits DC - 1.0 GHz DC - 2.0 GHz	± (0.15 + 3% of attenuation setting in dB) dB ± (0.2 + 3% of attenuation setting in dB) dB ± (0.2 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater ± (0.2 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.8:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		9 45 40	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+21 +29	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+35 +48	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+75 +79	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			6.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctll	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

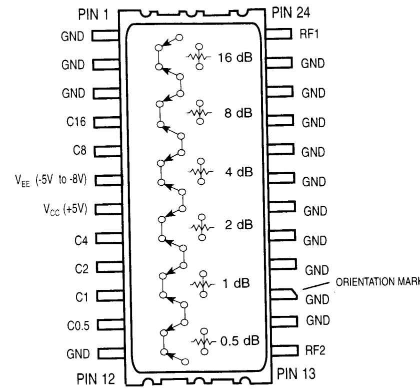
Note: Operation of this device above any one of these parameters may cause permanent damage.

Ordering Information[6]

Part Number	Package
AT-107 PIN	Ceramic

6. Contact the factory for standard or custom screening requirements.

Functional Schematic (Top View)



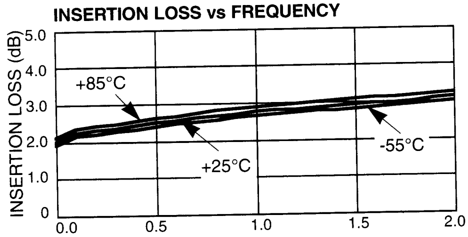
Truth Table

Control Inputs						
C6	C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	0	Reference
0	0	0	0	0	1	0.5 dB
0	0	0	0	1	0	1 dB
0	0	0	1	0	0	2 dB
0	0	1	0	0	0	4 dB
0	1	0	0	0	0	8 dB
1	0	0	0	0	0	16 dB
1	1	1	1	1	1	31.5 dB

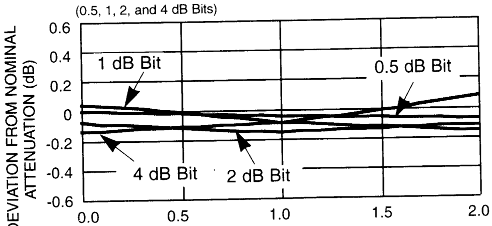
0 = TTL Low 1 = TTL High

Typical Performance @ +25°C

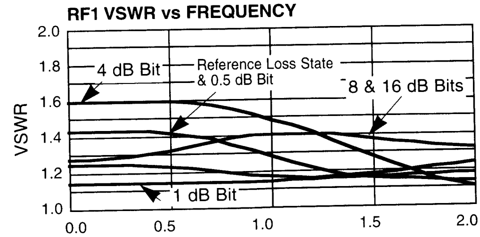
INSERTION LOSS vs FREQUENCY



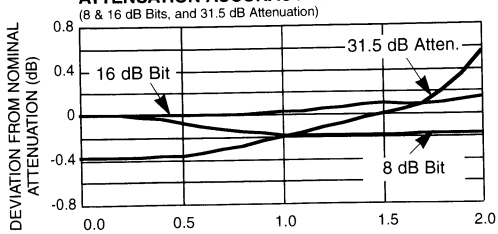
ATTENUATION ACCURACY vs FREQUENCY (0.5, 1, 2, and 4 dB Bits)



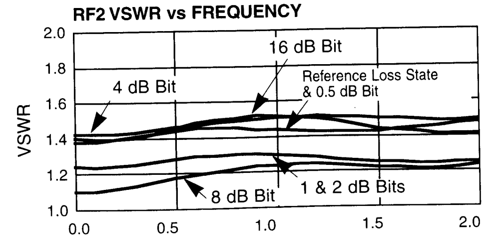
RF1 VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY (8 & 16 dB Bits, and 31.5 dB Attenuation)



RF2 VSWR vs FREQUENCY



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M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator, 40 dB 0.5 - 2 GHz

AT-108

V 2.00

Features

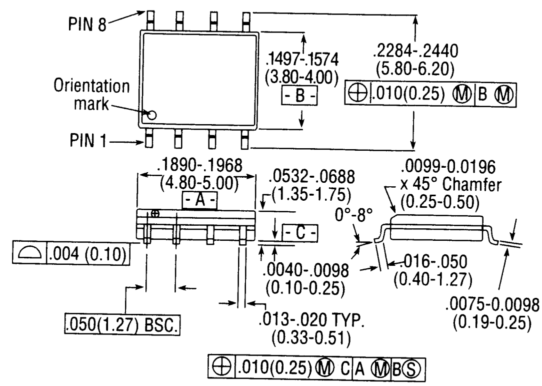
- Single Positive Voltage Control 0 to +5 Volts
- 40 dB Attenuation Range at 0.9 GHz
- ±2 dB Linearity from BSL
- Low DC Power Consumption
- Low-Cost SOIC 8 Plastic Package
- Tape and Reel Packaging Available

Description

M/A-COM's AT-108 is a GaAs MMIC voltage variable absorptive attenuator in a low-cost SOIC 8-lead surface mount plastic package. The AT-108 is ideally suited for use where linear attenuation fine tuning and very low power comsumption are required. Typical applications include radio, cellular, GPS equipment and automatic gain/level control circuits.

The AT-108 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part No.	Package
AT-108	SOIC 8-Lead Plastic Package
AT-108TR	Forward Tape & Reel*
AT-108RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A = 25°C

Parameter	Test Conditions[1]	Unit	Min.	Typ.	Max
Insertion Loss	0.5 - 1.0 GHz	dB		2.5	2.7
	1.0 - 2.0 GHz	dB		3.2	3.5
Attenuation	0.5 - 1.0 GHz	dB	40		
	1.0 - 2.0 GHz	dB	35		
Flatness (Peak-to-Peak)	0.5 - 1.0 GHz	dB		±0.5	±0.8
	1.0 - 2.0 GHz	dB		±1.2	±1.5
VSWR				2:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	µS		15	
Ton, Toff	50% Control to 90% RF, Control to 10% RF	µS		25	
Transients	In-band	mV		12	

1. All measurements at 1 GHz in a 50-Ω system, unless otherwise specified. The RF ports must be blocked out side of the package from ground or any other voltage.

Specifications Subject to Change Without Notice.

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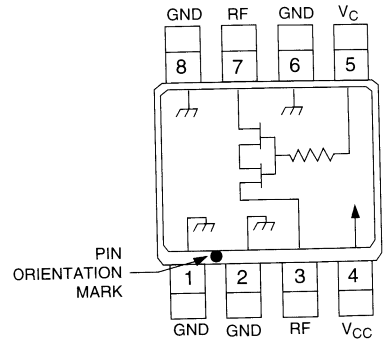
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Maximum Input Power	+21 dBm
Supply Voltage V_{cc}	-1 V, +8 V
Control Voltage V_c	-1 V, V_{cc} + 0.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

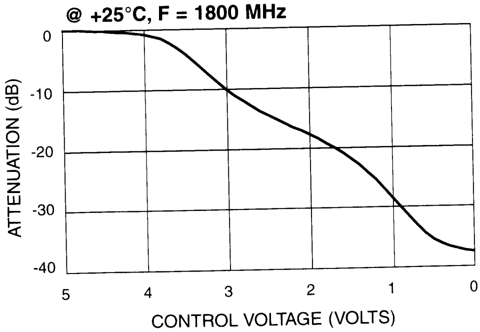
1. Operation of this device above any one of these parameters may cause permanent damage.

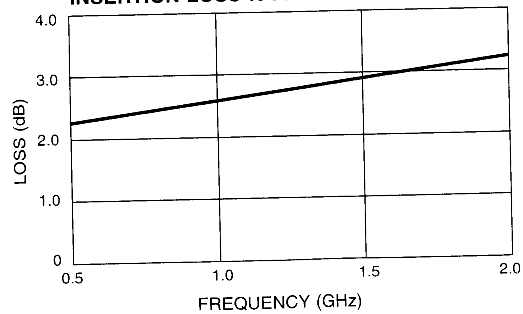
Functional Schematic

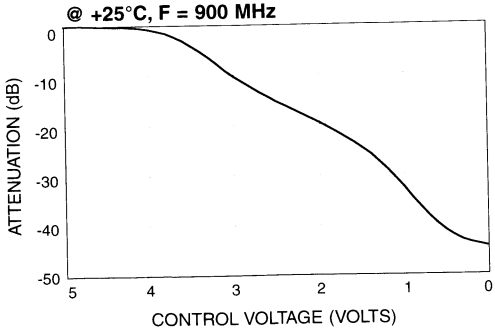


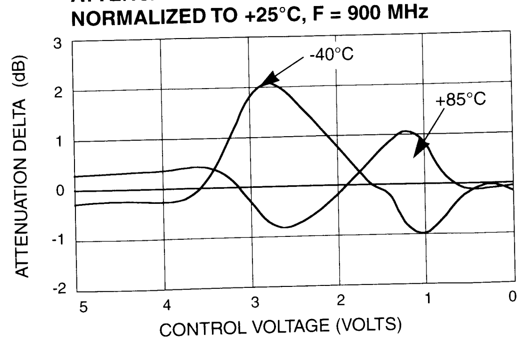
V_{cc} = +5 VDC ±0.5 VDC @ 50 μA max.
V_c = 0 VDC to +5 VDC @ 50 μA max.
External DC blocking capacitors are required on all RF ports.

Typical Performance









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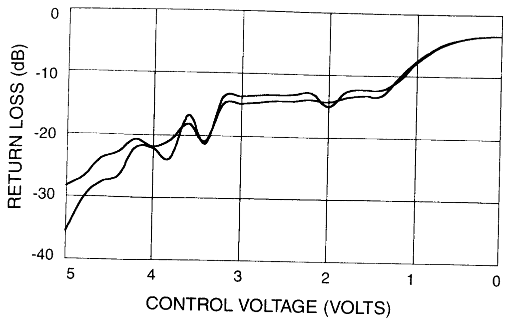
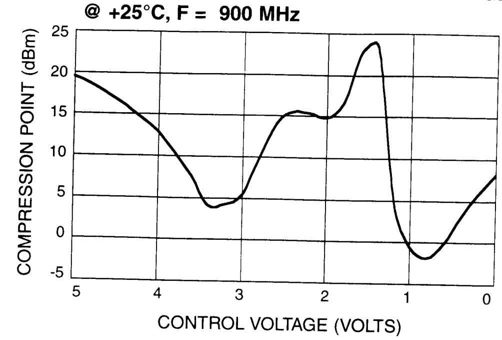
■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

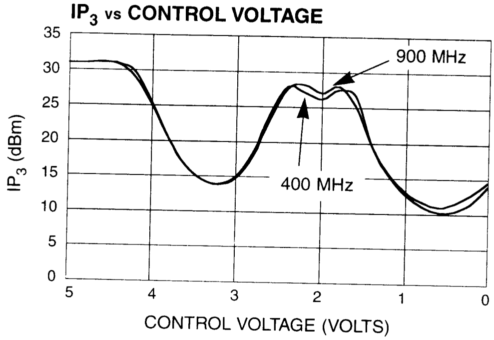
RETURN LOSS vs CONTROL VOLTAGE
@ +25°C, F = 900 MHz



1 dB COMPRESSION vs CONTROL VOLTAGE
@ +25°C, F = 900 MHz



IP_3 vs CONTROL VOLTAGE



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M/A-COM an AMP company

Voltage Variable Absorptive Attenuator, 35 dB 0.5 - 2 GHz

AT-109

V 2.00

Features

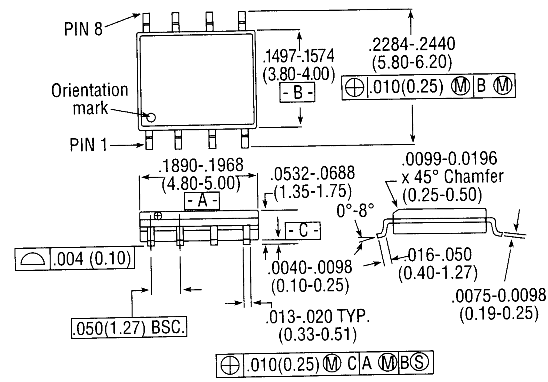
- Single Positive Voltage Control 0 to +5 Volts
- 35 dB Attenuation Range at 0.9 GHz
- ±2 dB Linearity from BSL
- Low DC Power Consumption
- Temperature Range: -40°C to +85°C
- Low-Cost SOIC 8 Plastic Package
- Tape and Reel Packaging Available

Description

M/A-COM's AT-109 is a GaAs MMIC voltage variable absorptive attenuator in a low-cost SOIC 8-lead surface mount plastic package. The AT-109 is more linear than the higher attenuation range AT-108. The AT-109 is ideally suited for use where linear attenuation fine tuning and very low power comsumption are required. Typical applications include radio, cellular, GPS equipment and automatic gain/level control circuits.

The AT-109 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part No.	Package
AT-109	SOIC 8-Lead Plastic Package
AT-109TR	Forward Tape & Reel*
AT-109RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], $T_A = +25°C$

Parameter	Test Conditions[1]	Unit	Min.	Typ.	Max
Insertion Loss	0.5 - 1.0 GHz 1.0 - 2.0 GHz	dB dB		2.5 3.2	2.7 3.5
Attenuation	0.5 - 1.0 GHz 1.0 - 2.0 GHz	dB dB	35 30		
Flatness (Peak-to-Peak)	0.5 - 1.0 GHz 1.0 - 2.0 GHz	dB dB		±0.5 ±1.2	±0.8 ±1.5
VSWR				2:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, Control to 10% RF In-band	µS µS mV		25 35 12	

1. All measurements at 1 GHz in a 50-Ω system, unless otherwise specified. The RF ports must be blocked outside of the package from ground or any other voltage.

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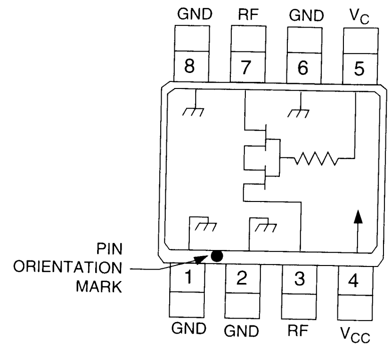
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Maximum Input Power	+21 dBm
Supply Voltage V_{CC}	-1 V, +8 V
Control Voltage V_{CC}	-1 V, V_{CC} + 0.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

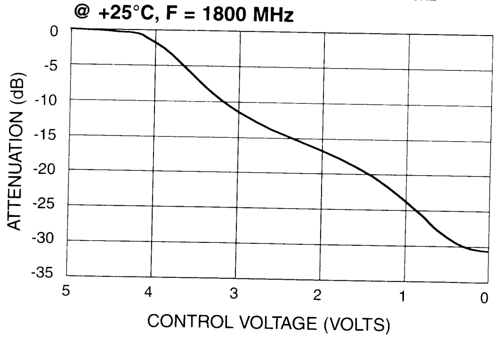
Functional Schematic



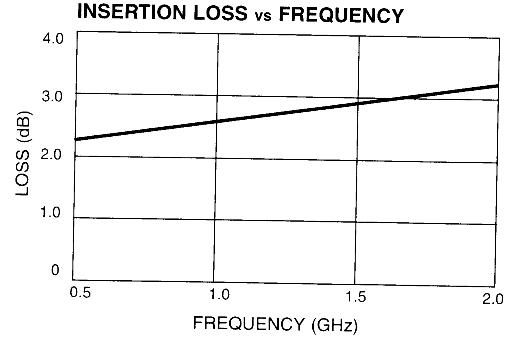
V_{CC} = +5 VDC ±0.5 VDC @ 50 μA max.
V_C = 0 VDC to +5 VDC @ 50 μA max.
External DC blocking capacitors are required on all RF ports.

Typical Performance

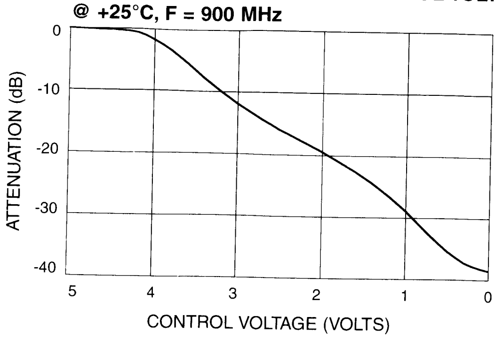
ATTENUATION vs CONTROL VOLTAGE @ +25°C, F = 1800 MHz



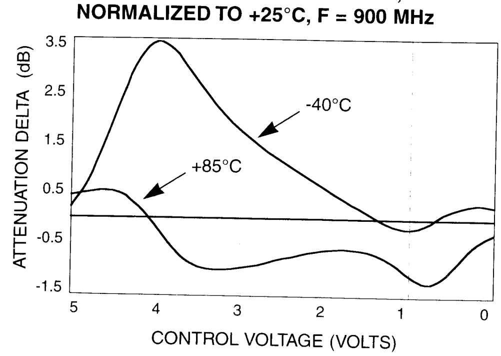
INSERTION LOSS vs FREQUENCY



RELATIVE ATTENUATION vs CONTROL VOLTAGE @ +25°C, F = 900 MHz



ATTENUATION vs TEMPERATURE, NORMALIZED TO +25°C, F = 900 MHz



Specifications Subject to Change Without Notice.

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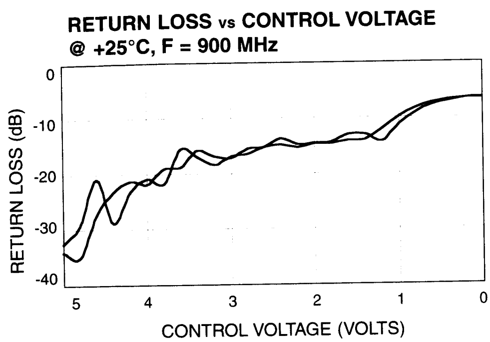

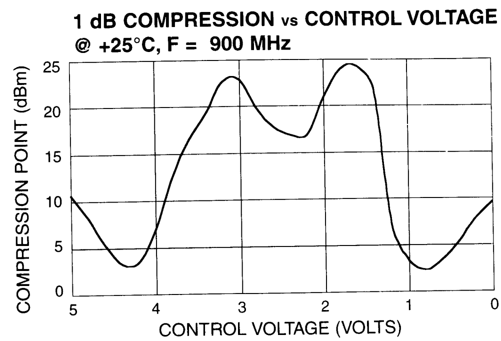

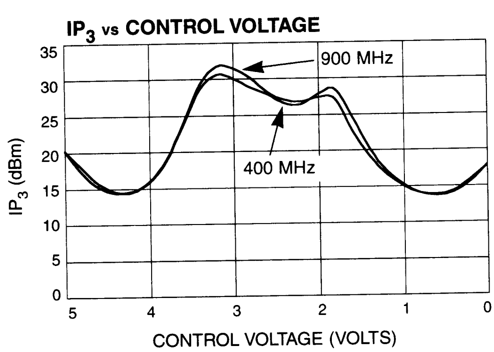

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M/A-COM an AMP company

Voltage Variable Absorptive Attenuator, 30 dB 0.5 - 2 GHz

AT-110

V 2.00

Features

- Single Positive Voltage Control 0 to +5 Volts
- 30 dB Voltage Variable Attenuation
- ±2 dB Linearity from BSL
- Low DC Power Consumption
- Temperature Range: -40°C to +85°C
- Low-Cost SOIC 8 Plastic Package
- Tape and Reel Packaging Available
- Fast Switching Speed

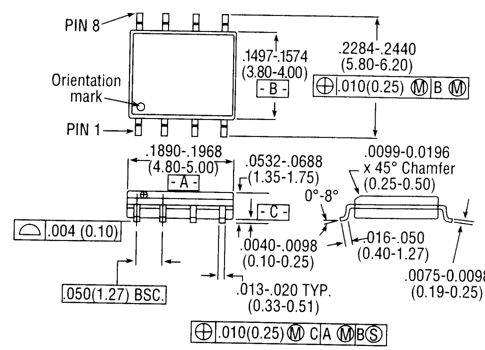
Description

M/A-COM's AT-110 is a linear GaAs MMIC voltage variable absorptive attenuator in a low-cost SOIC 8-lead surface mount plastic package. The AT-110 has a faster switching speed than the AT-108 or AT-109. The AT-110 is ideally suited for use where linear attenuation fine tuning and very low power consumption are required. Typical applications include radio,

cellular, GPS equipment and automatic gain/level control circuits.

The AT-110 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AT-110	SOIC 8-Lead Plastic Package
AT-110TR	Forward Tape & Reel*
AT-110RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	0.5 - 1.0 GHz	dB		2.8	3.0
	1.0 - 2.0 GHz	dB		3.3	3.6
Attenuation	0.5 - 16 GHz	dB	30		
	1.0 - 26 GHz	dB	25		
Flatness (Peak-to-Peak)	0.5 - 1.0 GHz	dB		±0.5	±0.8
	1.0 - 2.0 GHz	dB		±1.2	±1.5
VSWR				2:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	µS		0.2	
Ton, Toff	50% Control to 90% RF, Control to 10% RF	µS		0.2	
Transients	In-band	mV		70	

1. All measurements at 1 GHz in a 50-Ω system, unless otherwise specified. The RF ports must be blocked outside of the package from ground or any other voltage.

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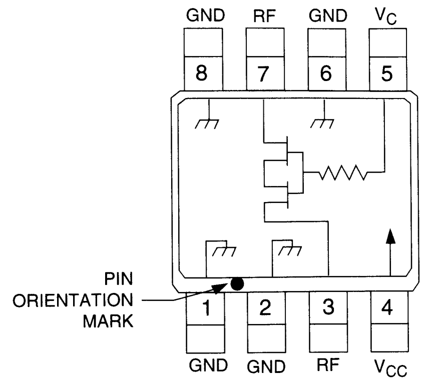
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
Maximum Input Power	+21 dBm
Supply Voltage V_{CC}	-1 V, +8 V
Control Voltage V_C	-1 V, V_{CC} +0.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

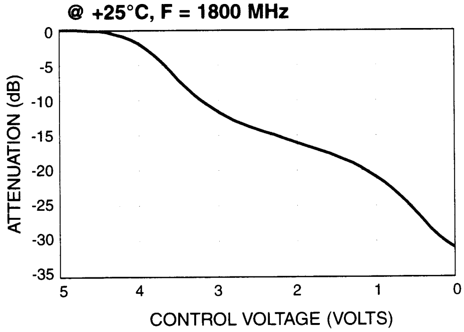
Functional Schematic



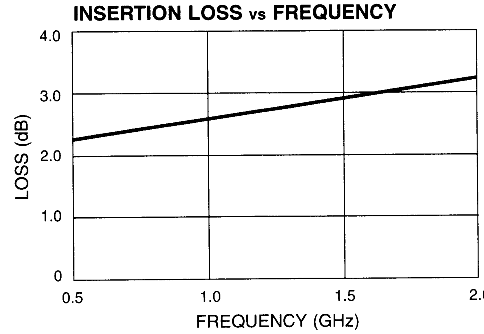
V_{CC} = +5 VDC ± 0.5 VDC @ 300 μA max.
V_C = 0 VDC to +5 VDC @ 6 mA max.
External DC blocking capacitors are required on all RF ports.

Typical Performance

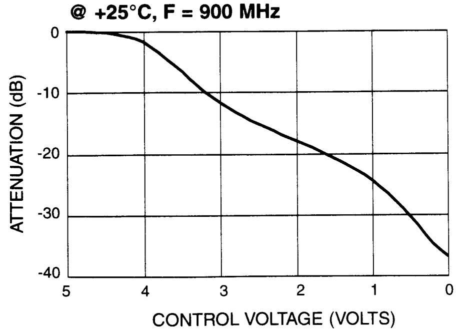
RELATIVE ATTENUATION vs CONTROL VOLTAGE @ +25°C, F = 1800 MHz



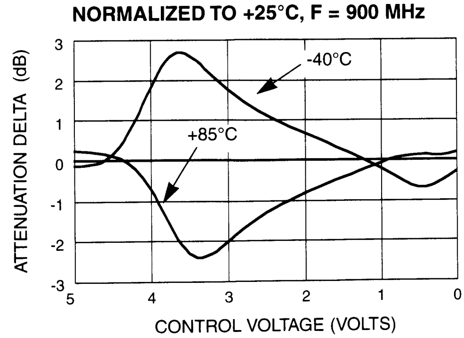
INSERTION LOSS vs FREQUENCY



ATTENUATION vs CONTROL VOLTAGE @ +25°C, F = 900 MHz



ATTENUATION vs TEMPERATURE, NORMALIZED TO +25°C, F = 900 MHz



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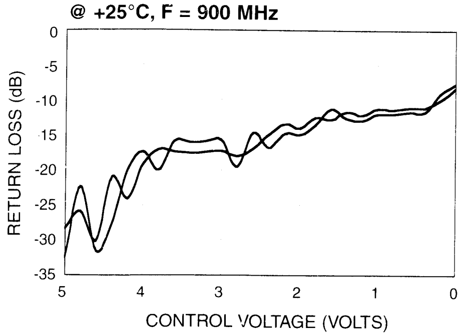
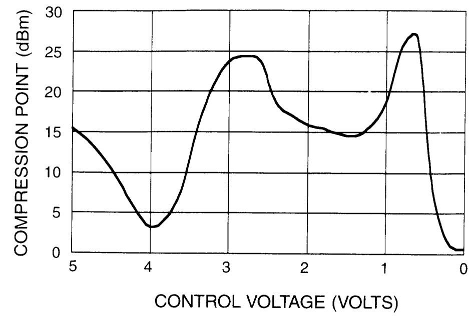
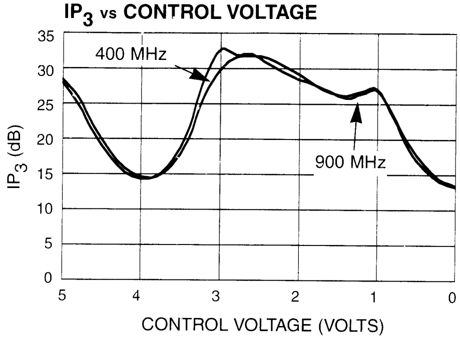
RETURN LOSS vs CONTROL VOLTAGE
@ +25°C, F = 900 MHz



1dB COMPRESSION vs CONTROL VOLTAGE
@ +25°C, F = 900 MHz



IP_3 vs CONTROL VOLTAGE



Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator DC - 5 GHz

AT-201

V 2.00

Features

- Miniature Ceramic Package
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications *
(From -55°C to +85°C)

Frequency Range		**DC - 5 GHz**
Insertion Loss	DC - 5 GHz	2.5 dB Max
	DC - 3 GHz	1.3 dB Max
	DC - 2 GHz	1.5 dB Max
VSWR	DC - 5 GHz	2.0:1 dBMax
	DC - 3 GHz	1.5:1 dB Max
	DC - 2 GHz	1.5:1 dB Max
Attenuation	DC - 4 GHz	20 dB Max
	DC - 5 GHz	18 dB Max
Flatness (Peak to Peak)	*DC - 5 GHz	2.5 dB Max
	DC - 3 GHz	1.5 dB Max
	DC - 2 GHz	1.0 dB Max
Attenuation vs. Temperature	0 to 10 dB Att.	±0.6 dB
	20 dB Att.	±2.5 dB

* To 15 dB attenuation

Operating Characteristics

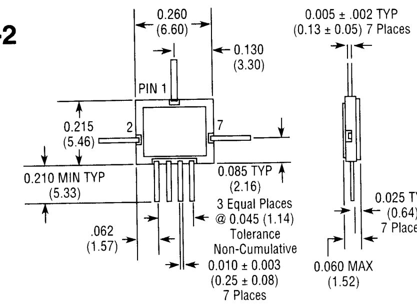
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			4 ns Typ
Ton, Toff (50% C+L to 90%/10% RF)			8 ns Typ
Transients (in band)			10 mv Typ
Input Power for 1 dB Compression			
Attenuation Level	0 dB	20 dB	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			-1.5 to -4 V @ 100 µA Max
B Input (Series FETS)			0 to -4 V @ 100 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm connected to all RF ports.
† Faster switching speed can be achieved with enhanced driver waveform. Switching speed is measured between 20 dB and 2 dB attenuation levels.

Ordering Information

Model No.	Package
AT-201 PIN	Ceramic

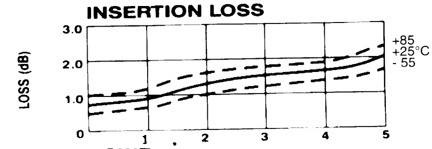
CR-2



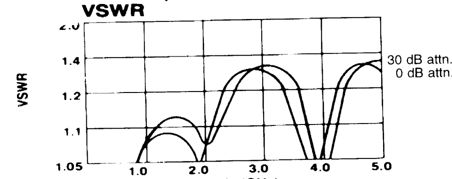
Dimensions in ( ) are in mm.
Bottom of Case is AC Ground.

Typical Performance

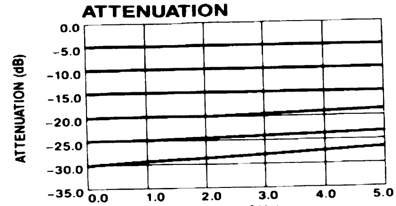
INSERTION LOSS



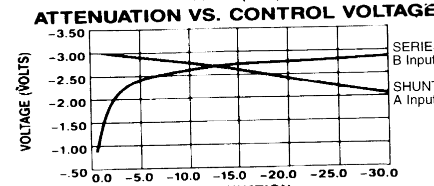
VSWR



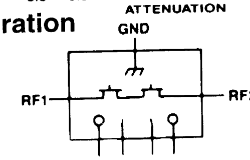
ATTENUATION



ATTENUATION VS. CONTROL VOLTAGES



Pin Configuration



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Voltage Variable Absorptive Attenuator DC - 5 GHz

AT-202

V 2.00

Features

- Fast Switching Speed, 4 ns Typical
- Ultra Low Dc Power Consumption
- Small Package Size, 0.180" (4.6mm) Sq

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		**DC - 5 GHz**
Insertion Loss	DC - 5 GHz	2.0 dB Max
	DC - 3 GHz	1.5 dB Max
	DC - 2 GHz	1.5 dB Max
VSWR	DC - 5 GHz	2.0:1 dBMax
	DC - 3 GHz	1.5:1 dB Max
	DC - 2 GHz	1.5:1 dB Max
Attenuation	DC - 4 GHz	20 dB Max
	DC - 5 GHz	18 dB Max
Flatness (Peak to Peak)	*DC - 5 GHz	2.5 dB Max
	DC - 3 GHz	1.5 dB Max
	DC - 2 GHz	1.0 dB Max
Attenuation vs. Temperature	0 to 10 dB Att.	±0.6 dB
	20 dB Att.	±2.5 dB

* To 15 dB attenuation

Operating Characteristics

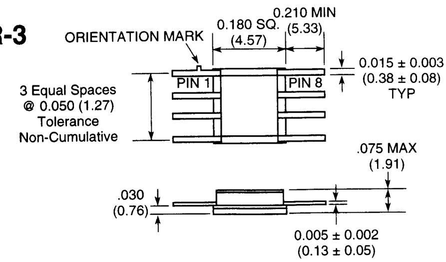
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			4 ns Typ
Ton, Toff (50% C+L to 90%/10% RF)			8 ns Typ
Transients (in band)			10 mv Typ
Input Power for 1 dB Compression			
Attenuation Level	0 dB	20 dB	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			-1.5 to -4V @ 100 µAMax
B Input (Series FETS)			0 to -4V @ 100 µAMax
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm connected to all RF ports.
† Faster switching speed can be achieved with enhanced driver waveform. Switching speed is measured between 20 dB and 2 dB attenuation levels.

Ordering Information

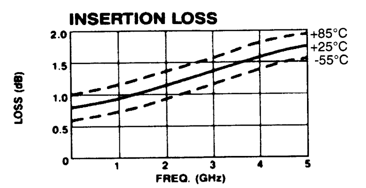
Model No.	**Package**
AT-202 PIN	Ceramic

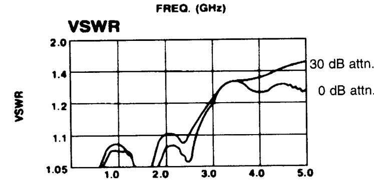
CR-3

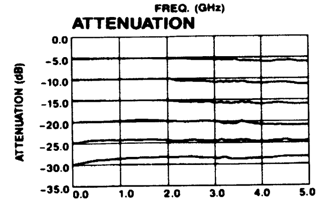


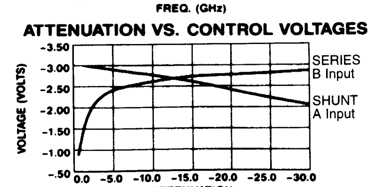
Dimensions in ( ) are in mm.
Bottom of Case is AC Ground.

Typical Performance

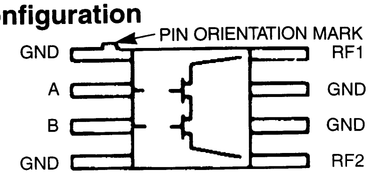








Pin Configuration



Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

Digital Attenuator, 15 dB, 4-Bit DC - 2 GHz

AT-210

V 2.00

Features

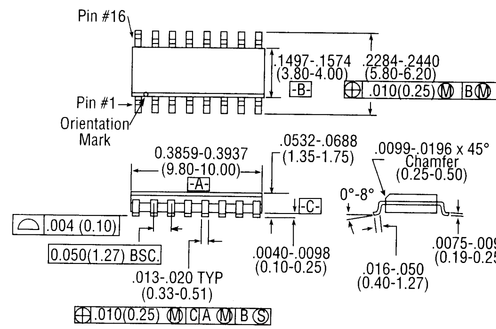
- Attenuation 1-dB Steps to 15 dB
- High Accuracy +/-3%
- Temperature Stability +/-0.15 dB from -40°C to +85°C
- Low Intermodulation Product: +50 dBm IP_3
- Low DC Power Consumption: 50 μW
- Low Cost SOIC16 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-210 is a 4-bit, 1-dB step GaAs MMIC digital attenuator in a low cost SOIC 16-lead surface mount plastic package. The AT-210 is ideally suited for use where high accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include radio, cellular, and wireless LANs, GPS equipment and other Gain/Level Control circuits.

The AT-210 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-16



16-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AT-210 PIN	SOIC 16-Lead Plastic Package
AT-210TR	Forward Tape & Reel
AT-210RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Reference Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.9 1.3 1.5 1.8	1.2 1.5 1.8 2.0
Attenuation Accuracy[3]	DC – 1.0 GHz DC – 2.0 GHz	±(0.15 dB + 3% of Attenuation Setting in dB) dB ±(0.30 dB + 3% of Attenuation Setting in dB) dB			
VSWR				1.8:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		10 15 18	
1 dB Compression	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		22 28	
IP_2	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		49 72	
IP_3	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		45 50	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.
3. Attenuation accuracy specifications apply with negative bias control and low inductance grounding.

Specifications Subject to Change Without Notice.

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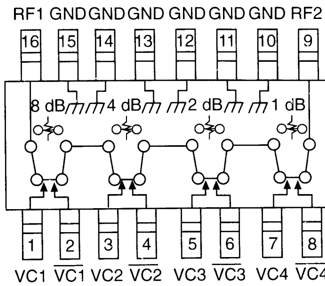
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic



Pin Configuration

Pin	Description	Pin No.	Description
1	VC1	9	RF2
2	$\overline{VC1}$	10	GND
3	VC2	11	GND
4	$\overline{VC2}$	12	GND
5	VC3	13	GND
6	$\overline{VC3}$	14	GND
7	VC4	15	GND
8	$\overline{VC4}$	16	RF1

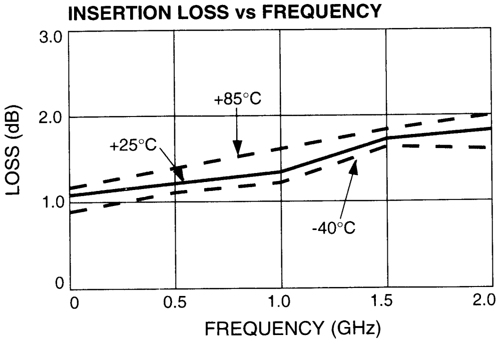
Truth Table

Control Inputs								
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	0	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	1 dB
1	0	0	1	1	0	1	0	2 dB
1	0	1	0	0	1	1	0	4 dB
1	0	1	0	1	0	0	1	8 dB
0	1	0	1	0	1	0	1	15 dB

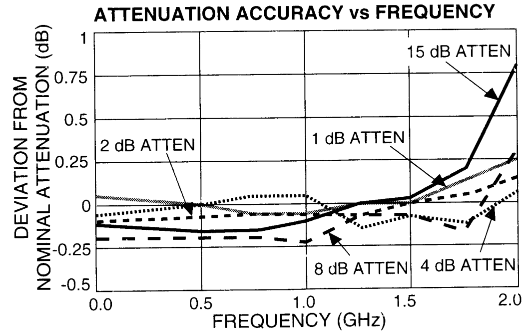
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V
"0" = 0 to -0.2V @ 20μA Max
"1" = -5V @ 10 μA typ to -8V @ 200 μA Max

Typical Performance

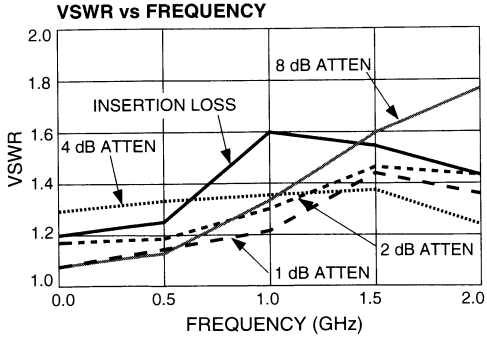
INSERTION LOSS vs FREQUENCY



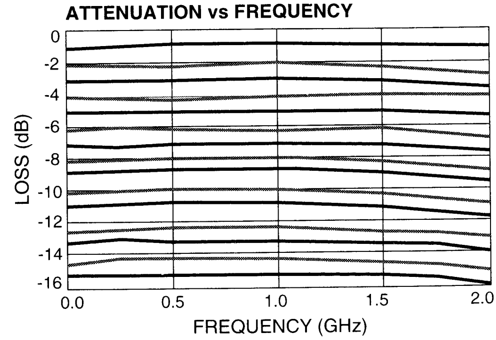
ATTENUATION ACCURACY vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION vs FREQUENCY



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M/A-COM
an AMP company

Digital Attenuator, 15 dB, 4-Bit DC - 2 GHz

AT-212

V 2.00

Features

- Attenuation 1-dB Steps to 15 dB
- Temperature Stability +/-0.18 dB from -55°C to +85°C Typical
- Ultra Low DC Power Consumption
- Hermetic Surface Mount Package
- Fast Switching Speed, 10 ns Typical

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		DC - 2.0 GHz
Nominal Attenuation[2]		1 dB Steps to 15 dB
Attenuation Accuracy		DC - 2.0 GHz
Any Single Bit		+/- (0.10 dB + 3% if Attenuation Setting in dB) dB
Any Combination of Bits		+/- (0.15 dB +3% if Attenuation Setting in dB) dB
VSWR	DC - 2.0 GHz	1.5:1 dB Max
Reference Insertion Loss	DC - 2.0 GHz	2.0 dB Max

Operating Characteristics

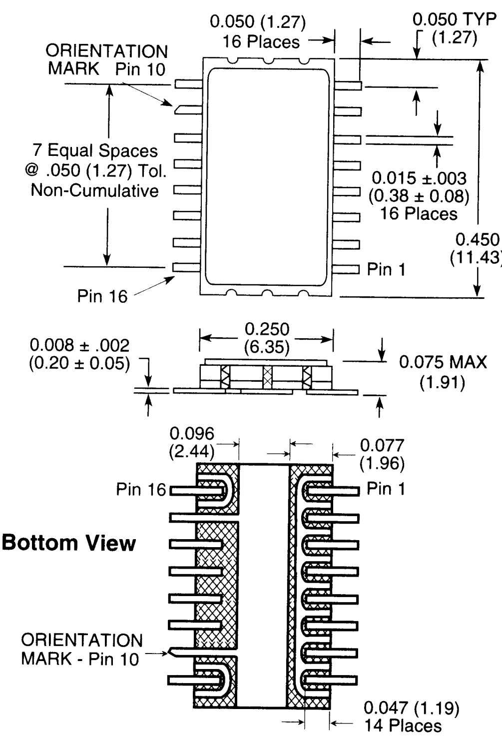
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			10 ns Typ
Ton, Toff (50% C+L to 90%/10% RF)			15 ns Typ
Transients (in band)			18 mV Typ
Input Power for 1 dB Compression			
.005 GHz			+22 dBm Typ
.05 GHz to 5 GHz			+28 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
.005 GHz to 5 GHz	+49	+45	dBm
.05 GHz to 5 GHz	+72	+50	dBm
Control Voltages (Complementary Logic)			
V_{IN} Low			0 V to -0.2 V @ 20µA Max
V_{IN} Hi			-5 V @ 10µA typ to -8 V @ 200 µA Max

1. All specifications apply with 50 ohm connected to all RF ports.
2. Above reference insertion loss.
3. Contact the factory for standard or custom screening requirements.

Ordering Information

Model No.	Package
AT-212 PIN	Surface Mount

CR-6



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max Input Power	
0.05 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150C

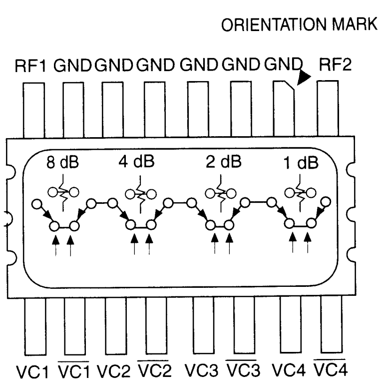
1. Operation of this device above any one of these parameters may cause permanent damage.

Truth Table

Control Inputs								
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	0	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	1 dB
1	0	0	1	1	0	1	0	2 dB
1	0	1	0	0	1	1	0	4 dB
1	0	1	0	1	0	0	1	8 dB
0	1	0	1	0	1	0	1	15 dB

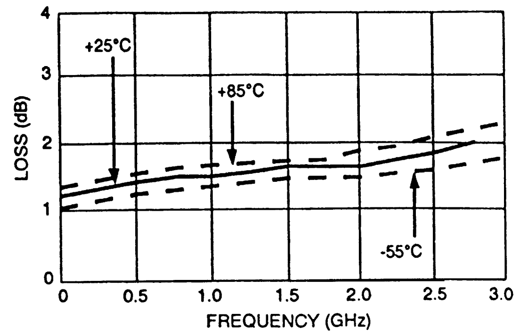
"0" = Vin Low, Vin Low = 0 V, "1" = Vin High, Vin High = -5 V

Functional Schematic (Top View)

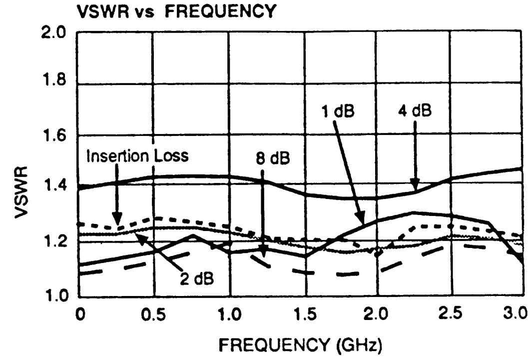


Typical Performance

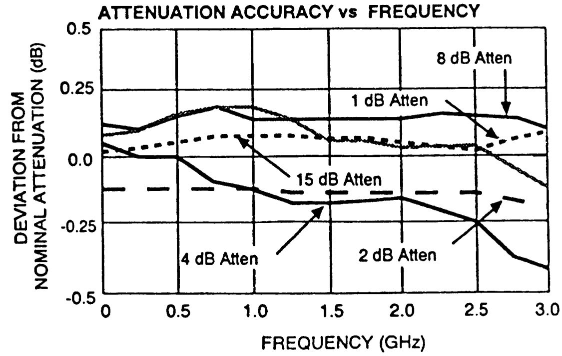
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY



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M/A-COM an AMP company

Digital Attenuator, 15 dB, 4-Bit, TTL Driver DC-3 GHz

AT-213

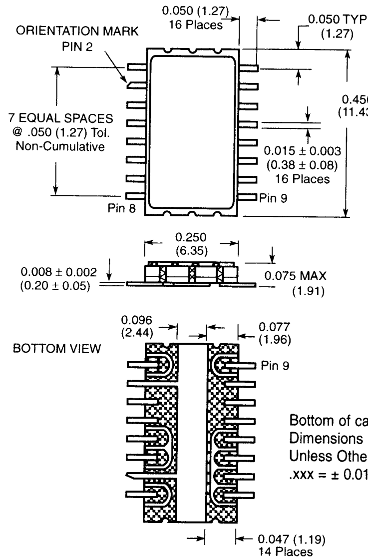
V 2.00

Features

- Attenuation: 1-dB Steps to 15 dB[2]
- Temperature Stability: ±0.18 dB from -55°C to +85°C
- Typ.
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver

50 Ohms Nominal Impedance

CR-11



Bottom of case is AC ground.
Dimensions in () are in mm.
Unless Otherwise Noted:
.xxx = ± 0.010 (.xx = ± 0.25)

Description

M/A-COM's AT-213 is a 4-bit, 1-dB step digital attenuator in a hermetically sealed ceramic 16-lead surface mount package. The AT-213 is ideally suited for use where high accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits.

Environmental screening is available. Contact the factory

Electrical Specifications[1], T_A = -55°C to +85°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB			1.7 1.9 2.2 2.5
Attenuation Accuracy[3,4]	Any Single Bit DC - 2.0 GHz DC - 3.0 GHz	± (0.15 dB + 3% of Attenuation Setting in dB) dB ± (0.2 dB + 3% of Attenuation Setting in dB) dB or ±0.4 dB, whichever is greater			
	Any Combination of Bits DC - 2.0 GHz DC - 3.0 GHz	± (0.2 dB + 3% of Attenuation Setting in dB) dB ± (0.2 dB + 3% of Attenuation Setting in dB) dB or ± 0.4 dB, whichever is greater			
VSWR					1.6:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90%/10% RF In-band	nS nS mV		9 40 30	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 3.0 GHz	dBm dBm		+22 +28	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 to 3.0 GHz	dBm dBm		+40 +50	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 to 3.0 GHz	dBm dBm		+45 +68	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8V, or V_{CC} - 2.1 V to V_{CC}	mA			4.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE} and 50Ω impedance at all RF ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 kΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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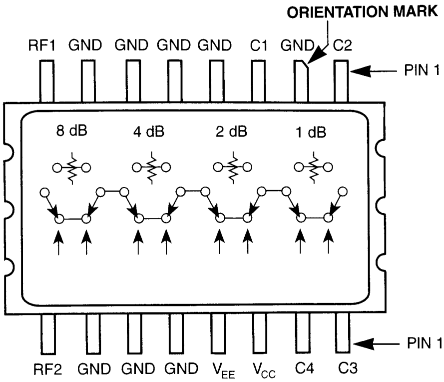
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 - 3.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5V
V_{EE}	-8.5V
Control Voltage	-0.5V to V_{CC} +0.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs				
C1	C2	C3	C4	Attenuation
0	0	0	0	Reference
1	0	0	0	1 dB
0	1	0	0	2 dB
0	0	1	0	4 dB
0	0	0	1	8 dB
1	1	1	1	15 dB

0 = TTL Low
1 = TTL High

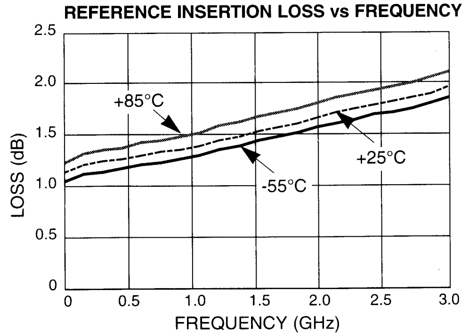
Ordering Information[2]

Part No.	Package
AT-213 PIN	Ceramic

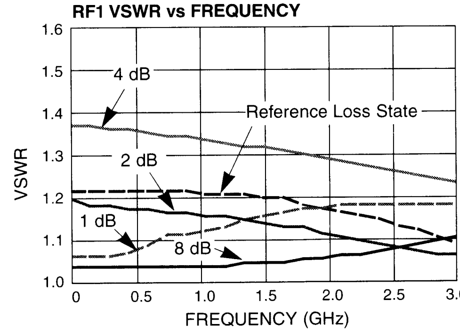
2. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C

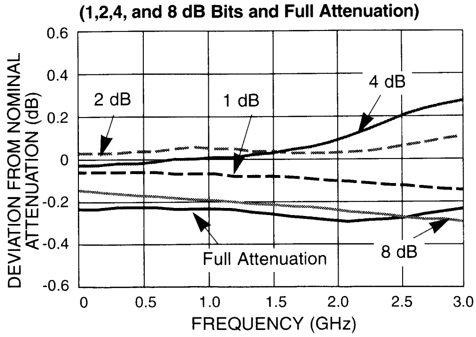
REFERENCE INSERTION LOSS vs FREQUENCY



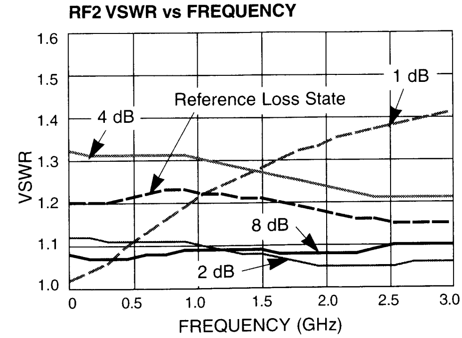
RF1 VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY (1,2,4, and 8 dB Bits and Full Attenuation)



RF2 VSWR vs FREQUENCY



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M/A-COM
an AMP company

Digital Attenuator, 30 dB, 4-Bit DC - 2 GHz

AT-220

V 2.00

Features

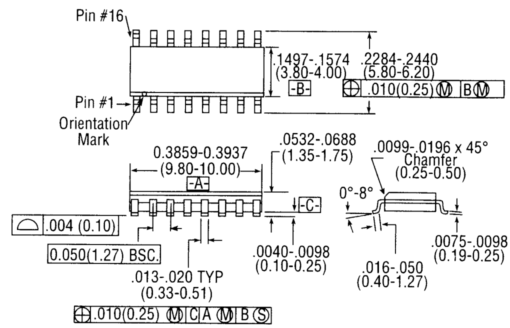
- Attenuation 2-dB Steps to 30 dB
- High Accuracy +/-3%
- Temperature Stability +/-0.15 dB from -40°C to +85°C
- Low Intermodulation Product: +50 dBm IP_3
- Low DC Power Consumption: 50 μW
- Low Cost SOIC 16 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-220 is a 4-bit, 2-dB step GaAs MMIC digital attenuator in a low cost SOIC 16-lead surface mount plastic package. The AT-220 is ideally suited for use where high accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include radio and cellular equipment, wireless LANs, GPS equipment and other Gain/Level Control circuits.

The AT-220 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-16



16-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AT-220 PIN	SOIC 16-Lead Plastic Package
AT-220TR	Forward Tape & Reel
AT-220RTR	Reverse Tape & Reel

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Reference Insertion Loss	DC – 0.1 GHz DC – 0.1 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		1.2 1.5 1.6 1.8	1.4 1.7 1.8 2.1
Attenuation Accuracy[3]	DC – 1.0 GHz DC – 2.0 GHz	±(0.15 dB + 3% of Attenuation Setting in dB) dB ±(0.30 dB + 3% of Attenuation Setting in dB) dB			
VSWR				1.2:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		12 18 25	
1 dB Compression	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		20 28	
IP_2	Measured Relative to Input Power 0.05 GHz / 0.5 – 2.0 GHz (For two-tone Input Power Up to +5 dBm)	dBm dBm		45 68	
IP_3	Measured Relative to Input Power 0.05 GHz / 0.5 – 2.0 GHz (For two-tone Input Power Up to +5 dBm)	dBm dBm		40 50	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.
3. Attenuation accuracy specifications apply with negative bias control and low inductance grounding.

Specifications Subject to Change Without Notice.

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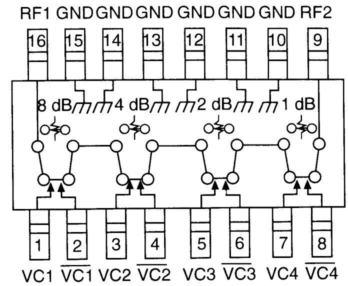
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic



Pin Configuration

Pin	Description	Pin No.	Description
1	VC1	9	RF2
2	$\overline{VC1}$	10	GND
3	VC2	11	GND
4	$\overline{VC2}$	12	GND
5	VC3	13	GND
6	$\overline{VC3}$	14	GND
7	VC4	15	GND
8	$\overline{VC4}$	16	RF1

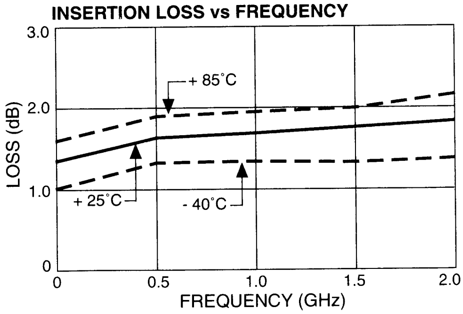
Truth Table

Control Inputs								
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	0	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	2 dB
1	0	0	1	1	0	1	0	4 dB
1	0	1	0	0	1	1	0	8 dB
1	0	1	0	1	0	0	1	16 dB
0	1	0	1	0	1	0	1	30 dB

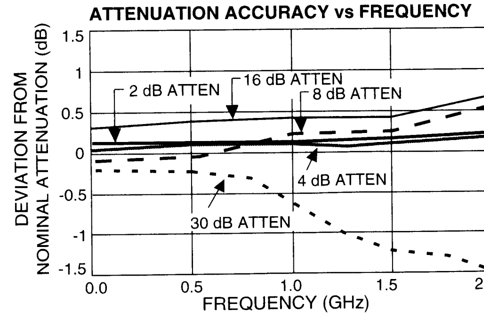
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V
"0" = 0 to -0.2V @ 20µA Max
"1" = -5V @ 10 µA typ to -8V @ 200 µA Max

Typical Performance

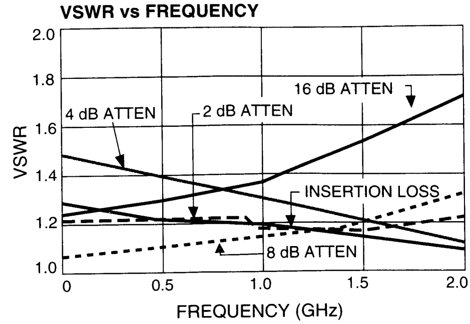
INSERTION LOSS vs FREQUENCY



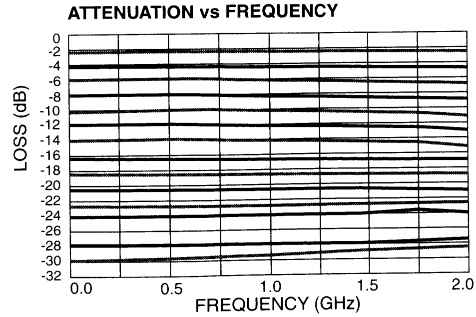
ATTENUATION ACCURACY vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION vs FREQUENCY



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an AMP company

Digital Attenuator, 1-Bit DC - 1 GHz

AT-225

V 2.00

Features

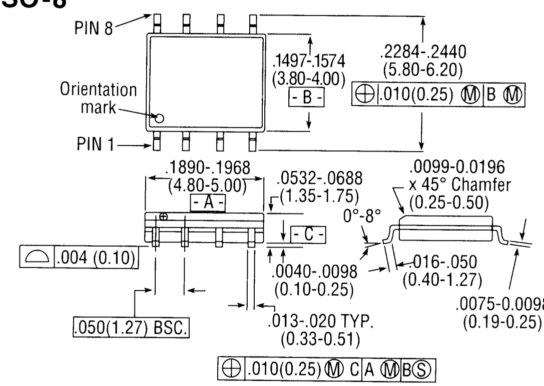
- Variable Step (15 to 30 dB) With an External Resistor
- Matched Input and Output
- Low Distortion 50 dBm IP_3 @ 100 MHz
- Low Power Consumption -3 to -5V < 20μA Typ.
- Low Cost Plastic SOIC 8-Lead Package

Description

The AT-225 is a GaAs MMIC matched 1-bit Attenuator in a low cost plastic SOIC 8-lead package. It is designed to be a building block for a single step Attenuator by placing a resistor across RF1-RF2. Attenuation levels of 15 to 30 dB with flat response are achievable to 400 MHz and 15 to 25 dB to 1 GHz. The AT-225 is ideally suited where fast switching, very low power consumption and low intermodulation products are required. Typical applications include Gain, Level and Sensitivity Control in radio and cellular equipment, wireless LANs, GPS equipment and other Gain/Level Control circuits.

The AT-225 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA,Issue C)
Dimensions in () are in mm. Unless Otherwise Noted: .xxx =+/- 0.010 (.xx = +/-0.25)
.xx = +/-0.02 (.x = +/-0.5)

Ordering Information

Part No.	Package
AT-225 PIN	SOIC 8-Lead
AT-225TR	Forward Tape & Reel*
AT-225RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A = +25°C, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	DC - 1 GHz	dB		0.7	1.0
Isolation	DC - 0.4 GHz 0.4 - 1.0 GHz	dB dB	30 25		
VSWR	DC - 1.0 GHz			1.15:1	1.2:1
Trise, Tfall Ton, Toff Transient	10% - 90% 50% Control to 90% RF, 50% Control to 10% RF In-band	nS nS mV		8 12 20	
1 dB Compression	>100 MHz, Vctl = -5 V >50 MHz, Vctl = -5 V >100 MHz, Vctl = -3 V >50 MHz, Vctl = -3 V	dBm dBm dBm dBm		24 18 12 5	
Input IP_3	>100 MHz, Vctl = -5 V <100 MHz, Vctl = -5 V >100 MHz, Vctl = -3 V <100 MHz, Vctl = -3 V	dBm dBm dBm dBm		52 49 40 35	
Input IP_2	>100 MHz, Vctl = -5 V <100 MHz, Vctl = -5 V >100 MHz, Vctl = -3 V <100 MHz, Vctl = -3 V	dBm dBm dBm dBm		82 60 55 40	

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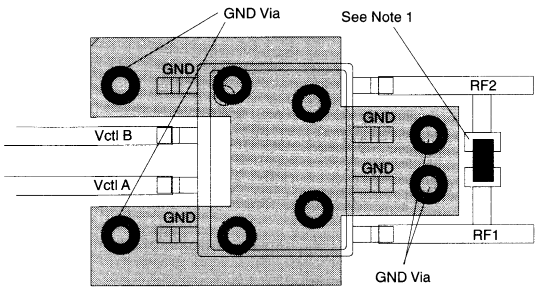
V 2.00

Absolute Maximum Ratings[1]

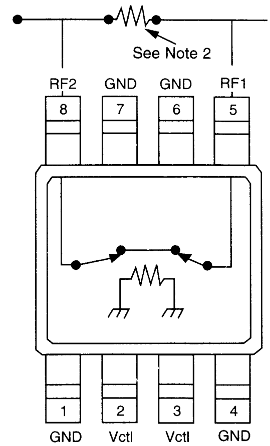
Parameter	Absolute Maximum
RF Input Power	+30 dBm
Max. Control Voltage	-8 VDC
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Recommended Board Layout



Functional Schematic



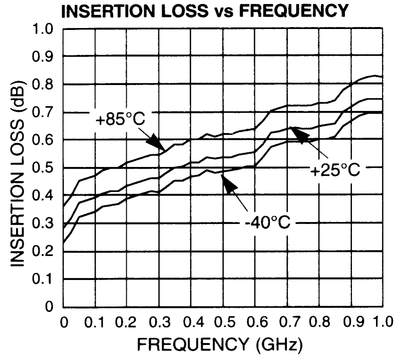
2. Chip Resistor value is selected for desired attenuation level. The usable range is 150Ω to 5000Ω to achieve 15 to 30 dB attenuation with >15 dB return loss. See Attenuation vs. External Resistor chart below.

Truth Table

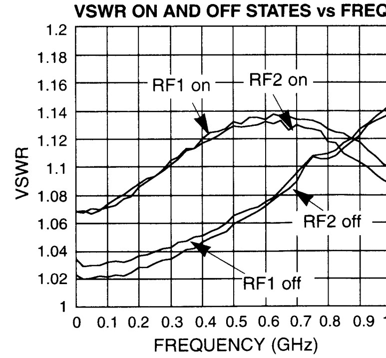
Control Input		
A	B	RF1-RF2
0	-5V	Insertion Loss
-5V	0	Attenuation

Typical Performance @ 25°C

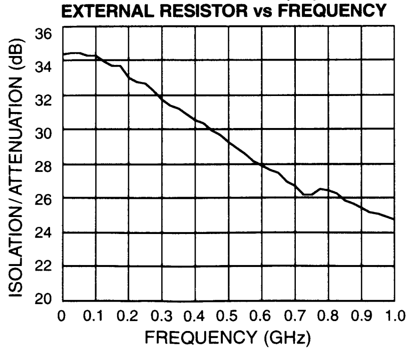
INSERTION LOSS vs FREQUENCY



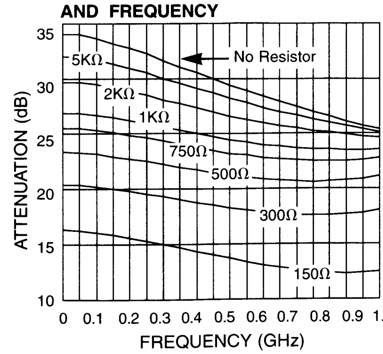
VSWR ON AND OFF STATES vs FREQUENCY



ISOLATION/ATTENUATION (dB) WITH NO EXTERNAL RESISTOR vs FREQUENCY



ATTENUATION vs EXTERNAL RESISTOR AND FREQUENCY



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M/A-COM an AMP company

Digital Attenuator, 28 dB, 3-Bit DC - 2 GHz

AT-230

V 2.00

Features

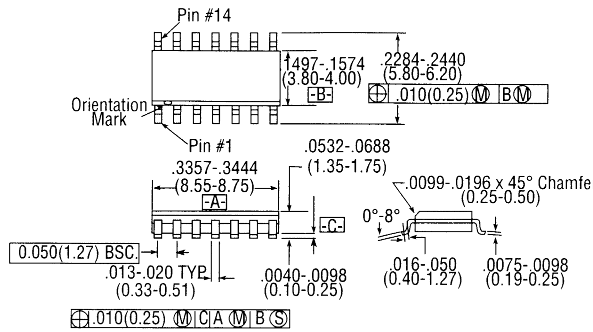
- Attenuation 4-dB Steps to 28 dB
- High Accuracy +/- 3%
- Low DC Power Consumption: 50 µW
- Low Intermodulation Product: +50 dBm IP_3
- Temperature Range: -40°C to +85°C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-230 is a 3-bit, 4-dB step GaAs MMIC digital attenuator in a low cost SOIC 14-lead surface mount plastic package. The AT-230 is ideally suited for use where high accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include radio and cellular equipment, wireless LANs, GPS equipment and other Gain/Level Control circuits.

The AT-230 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-14



14-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AB, Issue C)
Dimensions in ( ) are in mm.

Ordering Information

Part Number	Package
AT-230 PIN	SOIC 14-Lead Plastic
AT-230TR	Forward Tape & Reel
AT-230RTR	Reverse Tape & Reel

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions		Unit	Min.	Typ.	Max
Reference Insertion Loss		DC – 0.1 GHz	dB		1.2	1.4
		DC – 0.5 GHz	dB		1.5	1.7
		DC – 1.0 GHz	dB		1.6	1.8
		DC – 2.0 GHz	dB		1.8	2.1
Attenuation Accuracy		DC – 1.0 GHz	± (0.15 dB +3% of Attenuation Setting in dB) dB			
		DC – 2.0 GHz	± (0.30 dB +3% of Attenuation Setting in dB) dB			
VSWR					1.2:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF		nS		12	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF		nS		18	
Transients	In Band		mV		25	
1 dB Compression	Input Power	0.05 GHz	dBm		20	
	Input Power	0.5 – 2.0 GHz	dBm		28	
IP_2	Measured Relative	0.05 GHz	dBm		45	
	to Input Power	0.5 – 2.0 GHz	dBm		68	
	(for two-tone input power up to +5 dBm)					
IP_3	Measured Relative	0.05 GHz	dBm		40	
	to Input Power	0.5 – 2.0 GHz	dBm		50	
	(for two-tone input power up to +5 dBm)					

1. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.

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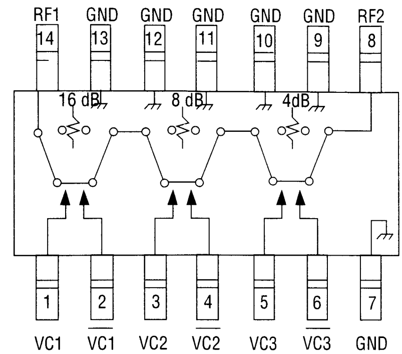
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic



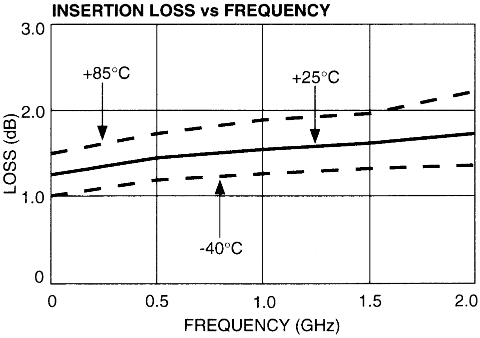
Truth Table

Control Input						
$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Atten (dB)
1	0	1	0	1	0	Reference
0	1	1	0	1	0	4 dB
1	0	0	1	1	0	8 dB
1	0	1	0	0	1	16 dB
0	1	0	1	0	1	28 dB

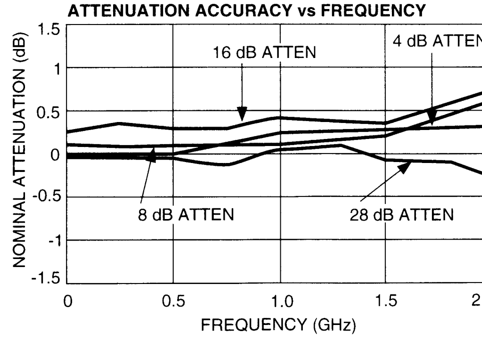
0 = VIN Low = 0 V to -0.2 V @ 20 *A maximum
1 = VIN High = -5 V @ 10 *A typ. to -8 V @ 200 *A maximum

Typical Performance

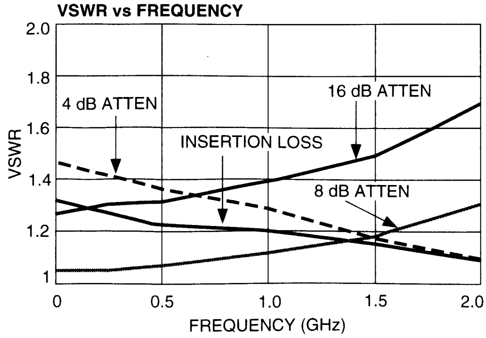
INSERTION LOSS vs FREQUENCY



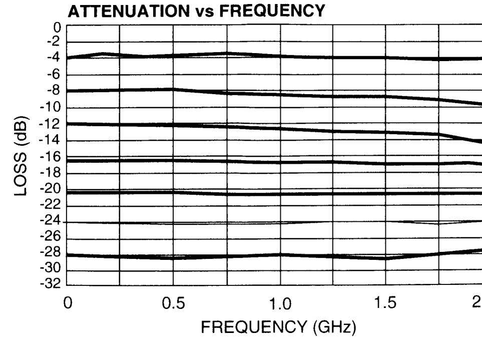
ATTENUATION ACCURACY vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION vs FREQUENCY



Specifications Subject to Change Without Notice.

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an AMP company

Digital Attenuator, 30 dB, 4-Bit DC - 2 GHz

AT-232

V 2.00

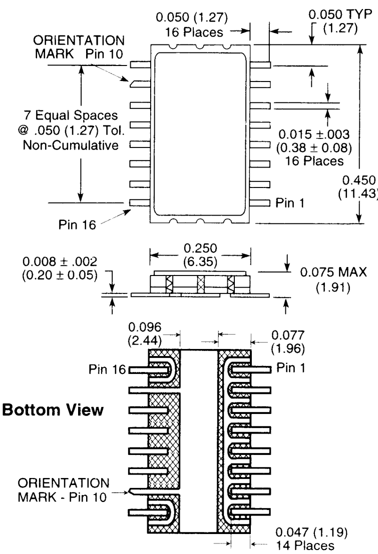
Features

- Attenuation 2-dB Steps to 30 dB[2]
- Temperature Stability +/- 0.18 dB from -55°C to +85°C Typical
- Ultra Low DC Power Consumption
- Hermetic Surface Mount Package
- Fast Switching Speed, 12 ns Typical

Description

M/A-COM's AT-232 is a GaAs FET 4-bit digital attenuator with a 2-dB minimum step size and 30 dB total attenuation. This attenuator is in a hermetically sealed ceramic 16-lead surface mount package. The AT-232 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

CR-6



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			2.0 2.3 2.5
Attenuation Accuracy[3,4]	Any Single Bit DC - 1.0 GHz DC - 2.0 GHz Any Combination of Bits DC - 1.0 GHz DC - 2.0 GHz	± (0.15 + 3% of attenuation setting in dB) dB ± (0.2 + 3% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater ± (0.22 + 3% of attenuation setting in dB) dB ± (0.25 + 4% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.6:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		12 18 25	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+40 +50	
Input IP_2[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+45 +68	
V_{IN} Low V_{IN} High		V V	-0.2 -8		0 -5
Input Leakage Current (Low)	-0.2 to 0 V	µA			20
Input Leakage Current (High)	-8.0 to -5 V	µA			200

1. All specifications apply when operated with 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Truth Table

Control Inputs								
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	0	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	2 dB
1	0	0	1	1	0	1	0	4 dB
1	0	1	0	0	1	1	0	8 dB
1	0	1	0	1	0	0	1	16 dB
0	1	0	1	0	1	0	1	30 dB

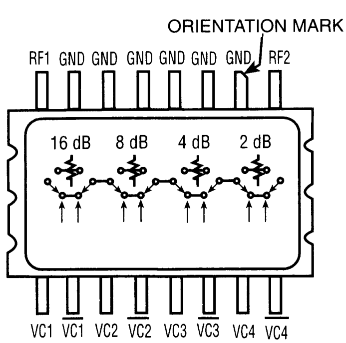
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Ordering Information[2]

Part Number	Package
AT-232 PIN	Ceramic

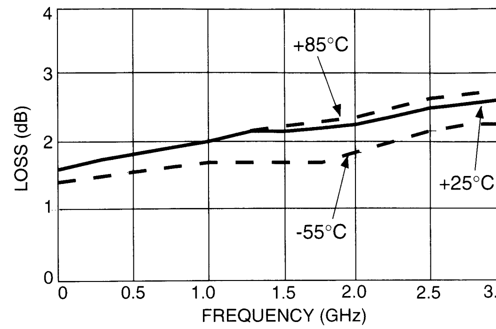
2. Contact the factory for standard or custom screening requirements.

Functional Schematic (Top View)

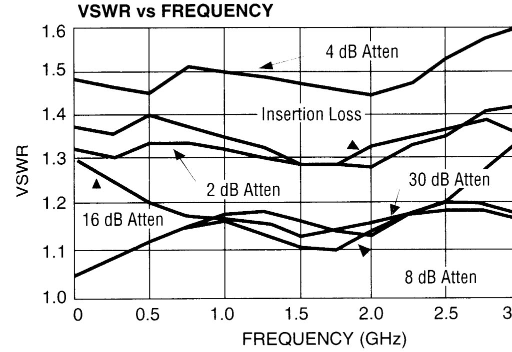


Typical Performance

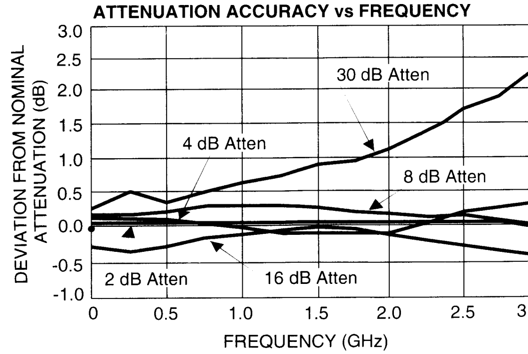
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY



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M/A-COM
an AMP company

Digital Attenuator, 30 dB, 4-Bit, TTL Driver DC-2 GHz

AT-233

V 2.00

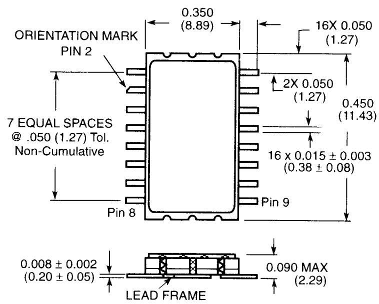
Features

- Attenuation: 2-dB Steps to 30 dB[2]
- Temperature Stability: ± 0.18 dB from -55°C to +85°C Typical
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50Ω Nominal Impedance

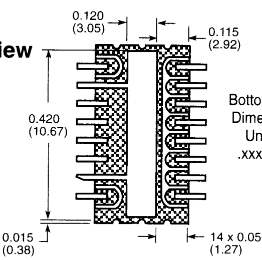
Description

M/A-COM's AT-233 is a GaAs FET 4-bit digital attenuator with a 2-dB minimum step size and 30 dB total attenuation. This attenuator and integral TTL driver is in a hermetically sealed ceramic 16-lead surface mount package. The AT-233 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

CR-12



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, $T_A = +25°C$ [1]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			2.0 2.4 2.8
Attenuation Accuracy[3,4]	Any Single Bit DC - 1.0 GHz DC - 2.0 GHz	± (0.15 + 3% of attenuation setting in dB) dB ± (0.2 + 3% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater			
	Any Combination of Bits DC - 1.0 GHz DC - 2.0 GHz	± (0.2 + 3% of attenuation setting in dB) dB ± (0.25 + 4% of attenuation setting in dB) dB or ± 0.45 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.7:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		10 30 35	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+40 +50	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+45 +68	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			4.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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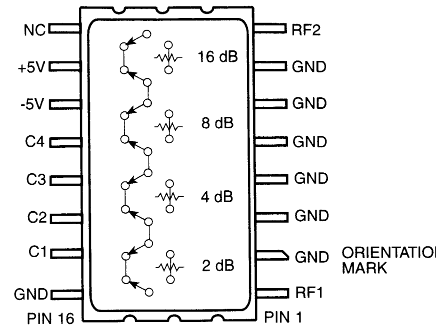
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Note: Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs				
C4	C3	C2	C1	Attenuation
0	0	0	0	Reference
0	0	0	1	2 dB
0	0	1	0	4 dB
0	1	0	0	8 dB
1	0	0	0	16 dB
1	1	1	1	30 dB

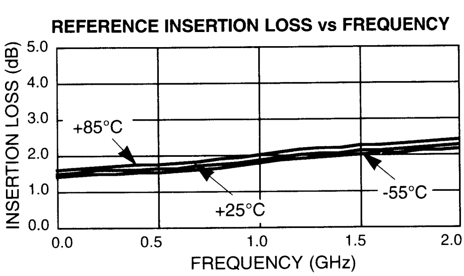
0 = TTL Low   1 = TTL High

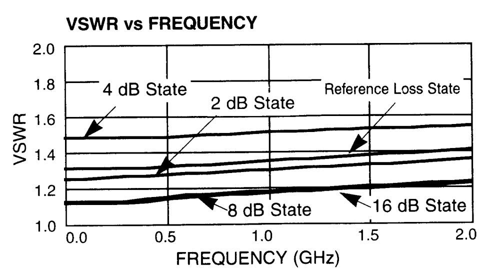
Ordering Information[6]

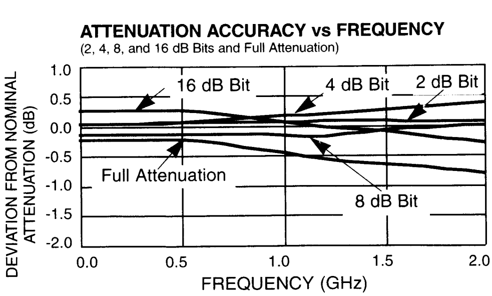
Part Number	Package
AT-233 PIN	Ceramic

6. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C







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an AMP company

Voltage Variable Absorptive Attenuator DC - 2 GHz

AT-250

V 2.00

Features

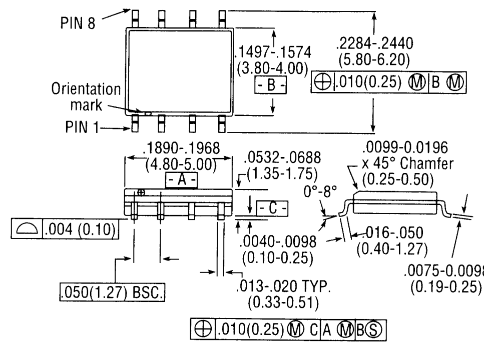
- 12 dB Voltage Variable Attenuation
- Low Intermodulation Products
- Low DC Power Consumption: 50 μW
- Single Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC 8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-250 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 8-lead surface mount plastic package. The AT-250 is ideally suited for use where attenuation fine tuning, fast switching and very low power consumption are required. Typical applications include radio, cellular, GPS equipment and other Automatic Gain/Level Control circuits.

The AT-250 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AT-250 PIN	SOIC 8-Lead Plastic Package
AT-250TR	Forward Tape & Reel
AT-250RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		2.9 3.0 3.2 3.4	3.1 3.2 3.5 3.8
Flatness (Peak to Peak)	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		+/– 0.1 +/– 0.2 +/– 0.5 +/– 1.2	+/– 0.3 +/– 0.4 +/– 0.8 +/– 1.5
VSWR				2.1:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		3 5 10	
Power Handling	Linear Operation Absolute Max Input Power	dBm dBm			13 21
IP_2	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm	28 40	34 47	
IP_3	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm	18 18.5	31[3] 36[3]	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified. A control voltage 0 to -4 volts @ 20 μA typ.
3. For levels above 6 dB attenuation. For levels below 6 dB, the minimum specification numbers apply.

Specifications Subject to Change Without Notice.

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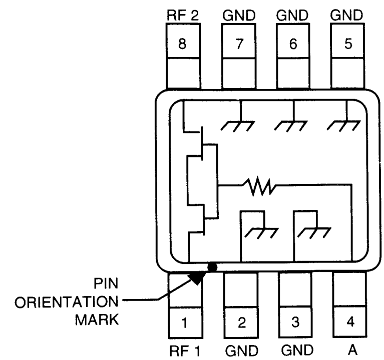
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	+21 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

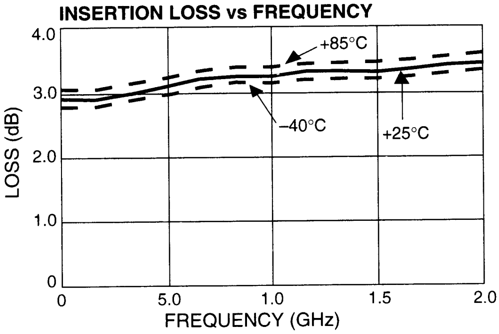
1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic

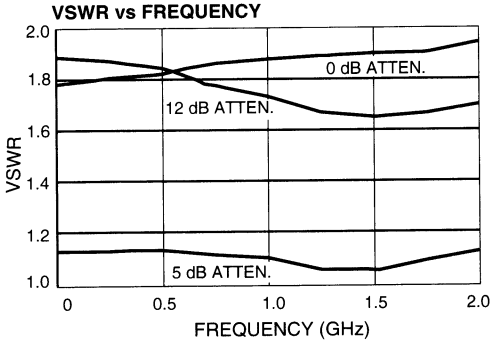


Typical Performance

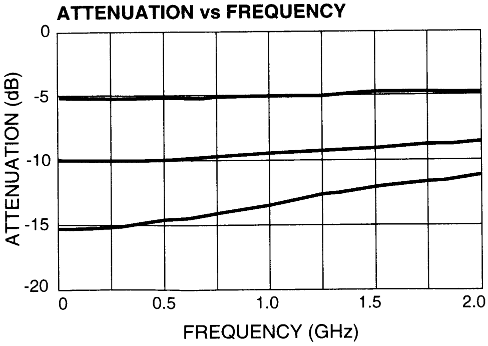
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



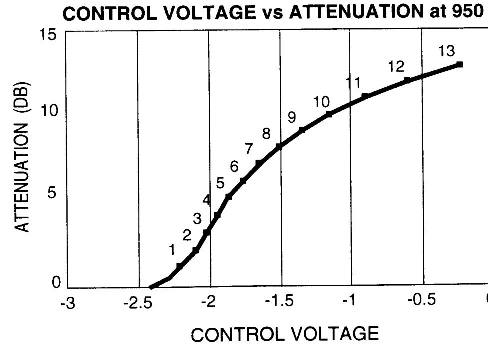
ATTENUATION vs FREQUENCY



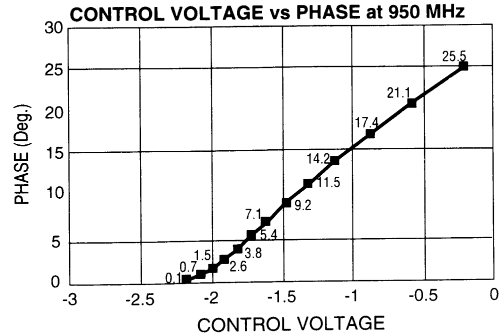
Pin Configuration

Pin No.	Description
1	RF1
2	GND
3	GND
4	A
5	GND
6	GND
7	GND
8	RF2

CONTROL VOLTAGE vs ATTENUATION at 950 MHz



CONTROL VOLTAGE vs PHASE at 950 MHz



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an AMP company

Voltage Variable Absorptive Attenuator
DC - 3 GHz

AT-252

V 2.00

Features

- Low Intermodulation Products
- Ultra Low DC Power Consumption
- Single Voltage Control 0 to -4 Volts
- Small Package Size, 0.180" (4.6 mm) Sq.

Guaranteed Specifications[1] (From -55°C to +85°C)

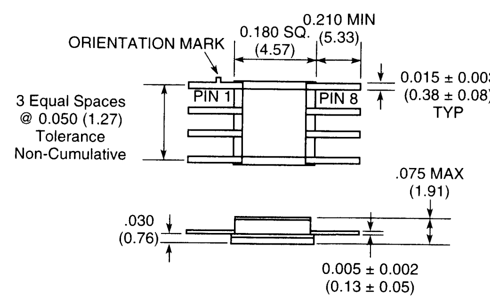
Frequency Range		DC – 3.0 GHz
Insertion Loss	DC – 3.0 GHz DC – 2.0 GHz	3.8 dB Max 3.5 dB Max
VSWR	DC – 3.0 GHz	2.1:1 Max
Attenuation[2]	DC – 3.0 GHz DC – 2.0 GHz	11 dB Min 12 dB Min
Flatness (to 12 dB Attenuation) (Peak to Peak)	DC – 3.0 GHz DC – 2.0 GHz DC – 1.0 GHz	±2.5 dB Max ±1.8 dB Max ±1.3 dB Max
Attenuation vs Temperature	0 to 10 dB Att.	±1.8 dB Max

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			3 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			5 ns Typ
Transients (In-Band)			10 mV Typ
Power Handling			
Linear Operation			+13 dBm Max
Absolute Max Input Power			+21 dBm Max
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3[3]	
0.05 GHz	34	+31	dBm Typ
0.5 GHz to 2.0 GHz	47	+36	dBm Typ
Control Voltages (A Input)	-4V to 0V @ 100 μA Max		

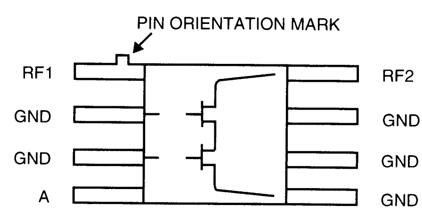
1. All specifications apply with 50 ohm connected to all RF ports.
2. Above reference insertion loss.
3. For levels above 6 dB attenuation. For levels below 6 dB, IP_3 = 18 dBm minimum.
4. Contact the factory for standard or custom screening requirements.

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



Ordering Information

Part Number	Package
AT-252 PIN	Ceramic

Specifications Subject to Change Without Notice.

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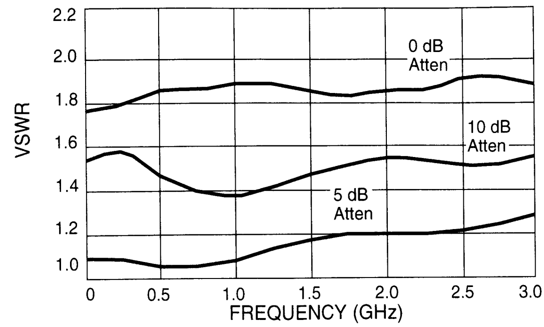
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	+21 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55˚C to +25˚C
Storage Temperature	–65˚C to +150˚C

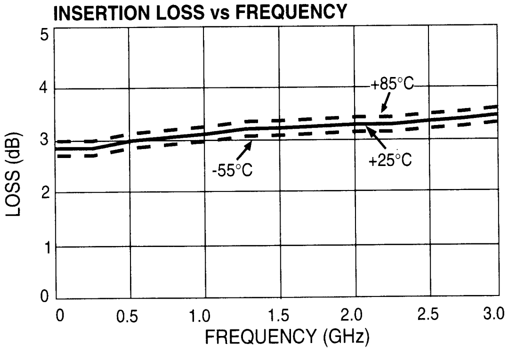
1. Operation of this device above any one of these parameters may cause permanent damage.

VSWR vs FREQUENCY

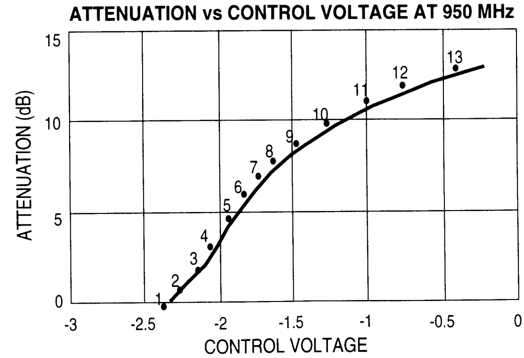


Typical Performance

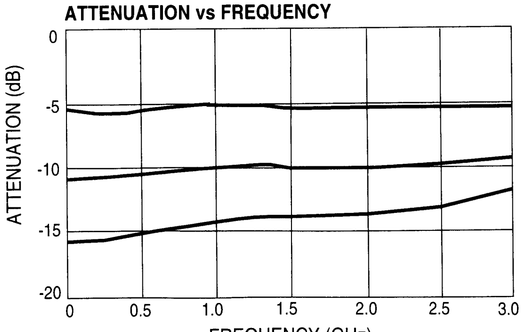
INSERTION LOSS vs FREQUENCY



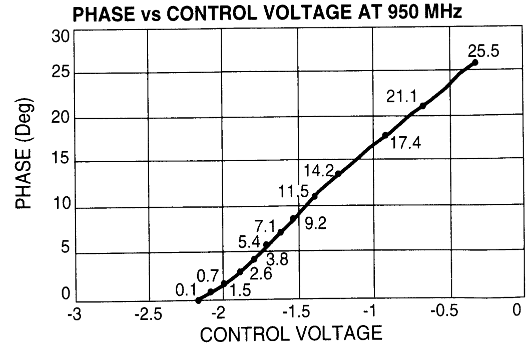
ATTENUATION vs CONTROL VOLTAGE AT 950 MHz



ATTENUATION vs FREQUENCY



PHASE vs CONTROL VOLTAGE AT 950 MHz



M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator DC - 2 GHz

AT-259

V 2.00

Features

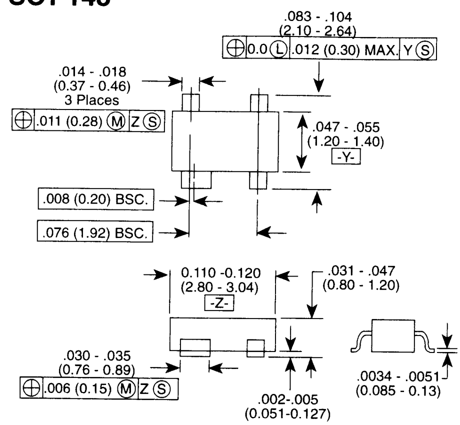
- Attenuation: 12 dB at 1 GHz
- Low Intermodulation Products
- Low DC Power Consumption: 50 µW
- Single Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to + 85°C
- Low Cost SOT/143 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-259 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOT/143 4-Lead surface mount plastic package. The AT-259 is ideally suited for use where attenuation fine tuning, fast switching and very low power consumption are required. Typical applications include radio, cellular, GPS equipment and other Automatic Gain/Level Control circuits.

The AT-259 is fabricated with a monolithic GaAs MMIC using a mature 1 micron process. The process features full chip passivation for increased performance and reliability.

SOT-143



SOT-143 outline dimensions
(All dimensions per JEDEC No. TO-253 Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ±0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
AT-259 PIN	SOT 4-Lead Plastic Package
AT-259TR	Forward Tape & Reel
AT-259RTR	Reverse Tape & Reel

Electrical Specifications, $T_A = +25°C$

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz	dB		2.9	3.1
	DC – 0.5 GHz	dB		3.0	3.2
	DC – 1.0 GHz	dB		3.2	3.5
	DC – 2.0 GHz	dB		3.4	3.8
Flatness (Peak to Peak)	DC – 2.0 GHz 5 dB Attenuation	dB		± 0.2	± 0.4
	10 dB Attenuation	dB		± 2.3	± 2.5
	15 dB Attenuation	dB		± 7.0	± 7.5
VSWR				2.1:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	nS		3	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		5	
Transients	In Band	mV		10	
Power Handling	Linear Operation	dBm			13
	Absolute Max. Input Power	dBm			21
IP_2	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz	dBm		34	
	0.5 – 2.0 GHz			47	
IP_3	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz	dBm	18	31[3]	
	0.5 – 2.0 GHz	dBm	18.5	36[3]	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified. A control voltage 0 to -4 volts @ 20 µA typ.
3. For levels above 6 dB attenuation. For levels below 6 dB, the minimum specification numbers apply.

Specifications Subject to Change Without Notice.

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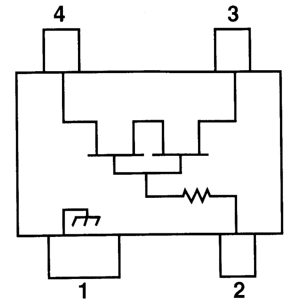
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	+21 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic

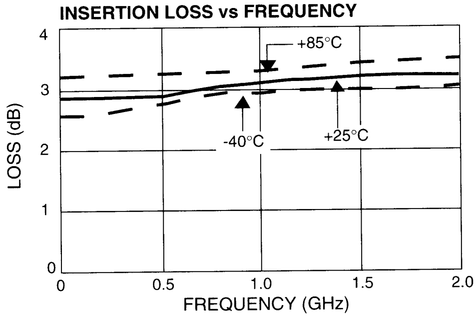


Pin Configuration

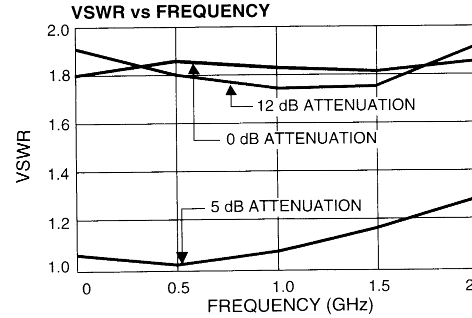
Pin No.	Description
1	GND
2	A
3	RF2
4	RF1

Typical Performance

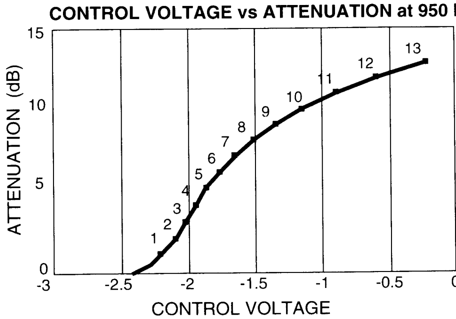
INSERTION LOSS vs FREQUENCY



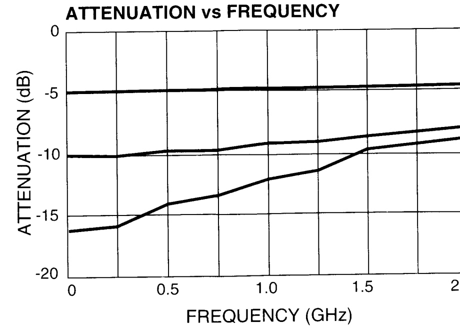
VSWR vs FREQUENCY



CONTROL VOLTAGE vs ATTENUATION at 950 MHz



ATTENUATION vs FREQUENCY



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M/A-COM an AMP company

Digital Attenuator, 31 dB, 5-Bit DC – 2 GHz

AT-260

V 2.00

Features

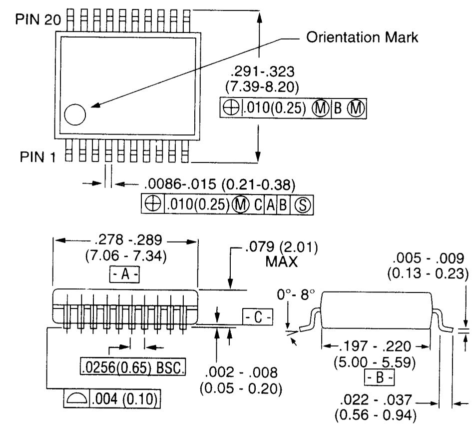
- Attenuation: 1-dB Steps to 31 dB
- Temperature Stability: ± 0.15 dB from -40°C to +85°C Typical
- Ultra Low DC Power Consumption
- Low Intermodulation Products: IP_3 = 50 dBm
- Low Cost SSOP 20 Plastic Package
- Tape and Reel Packaging Available

Description

M/A-COM's AT-260 is a 5-bit, 1-dB step GaAs MMIC digital attenuator in a low cost SSOP-20 surface mount plastic package. The AT-260 is ideally suited for use where high accuracy, fast switching, very low power consumption and low intermodulation products are required at a low cost. Typical applications include radio and cellular equipment, wireless LANS, GPS equipment and other Gain/Level Control circuits.

The AT-260 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SSOP-20



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± .010 (.xx = ±0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part No.	Package
AT-260 PIN	SSOP 20-Lead
AT-260TR	Forward Tape & Reel*
AT-260RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[1]	Unit	Min.	Typ.	Max
Reference Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		1.6 1.7 1.9 2.2	1.8 1.9 2.2 2.5
Attenuation Accuracy[2]	DC – 1.0 GHz DC – 2.0 GHz	± (0.20 dB + 3% of Atten. Setting in dB) dB ± (0.30 dB + 3% of Atten. Setting in dB) dB			
VSWR	(any state)			1.5:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		8 15 2	
One dB Compression	Input Power 0.05 GHz Input Power 0.5-2.0 GHz	dBm dBm		20 27	
IP_2	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5-2.0 GHz	dBm dBm		45 60	
IP_3	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5-2.0 GHz	dBm dBm		34 50	

1. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.
2. Attenuation accuracy specifications apply with negative bias control and low inductance grounding.

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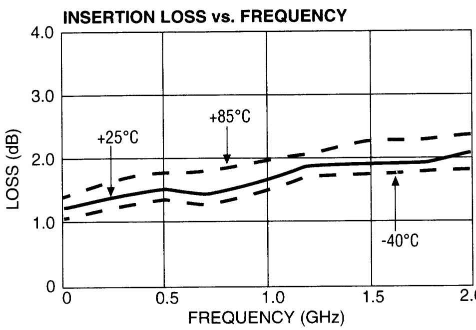
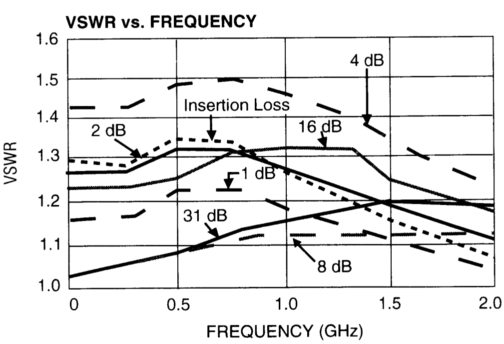
Absolute Maximum Ratings[1]

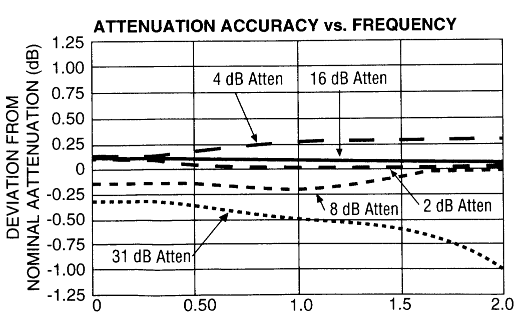
Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–40°C to +85°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

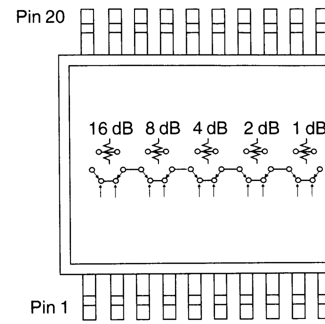
Typical Performance







Functional Schematic



Pin Configuration

Pin No.	Description	Pin No.	Description
1	VC1	11	RF1
2	$\overline{VC1}$	12	GND
3	VC2	13	GND
4	$\overline{VC2}$	14	GND
5	VC3	15	GND
6	$\overline{VC3}$	16	GND
7	VC4	17	GND
8	$\overline{VC4}$	18	GND
9	NC	19	GND
10	$\overline{VC5}$	20	RF2

Truth Table

Control Inputs									
$\overline{VC5}$	$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	**Attenuation (dB)**
1	1	0	1	0	1	0	1	0	Reference
0	1	0	1	0	1	0	1	0	1 dB
1	0	1	1	0	1	0	1	0	2 dB
1	1	0	0	1	1	0	1	0	4 dB
1	1	0	1	0	0	1	1	0	8 dB
1	1	0	1	0	1	0	0	1	16 dB
0	0	1	0	1	0	1	0	1	31 dB

0 = V_{IN} Low = 0 V = 0 to -0.2 V @ 20 µA maximum

1 = V_{IN} High = -5 V @ 20 µA typical to -8 V @ 200 µA maximum

Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

Digital Attenuator, 31 dB, 5-Bit DC - 2 GHz

AT-262

V 2.00

Features

- Attenuation 1 dB Steps to 31 dB
- Temperature Stability +/- 0.15 dB from -55°C to +85°C Typical
- Ultra Low DC Power Consumption
- Hermetic Surface Mount Package
- Fast Switching Speed, 12 ns Typical

Guaranteed Specifications[1] (From -55°C to + 85°C)

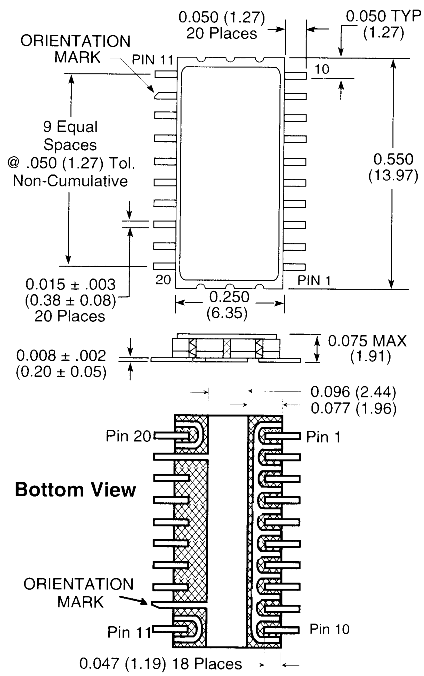
Frequency Range		DC – 2.0 GHz
Nominal Attenuation[2]		1 dB Steps to 31 dB
Attenuation Accuracy		DC – 2.0 GHz
DC – 1.0 GHz		+/-(0.2 dB +3% of Attenuation Setting in dB) dB
DC – 2.0 GHz		+/-(0.3 dB +3% of Attenuation Setting in dB) dB
VSWR	DC – 2.0 GHz	1.6:1 Max
Reference Insertion Loss	DC – 2.0 GHz	2.5 dB Max

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			8 ns Typ
Ton, Toff (50% CTL to 90%/10%)			15 ns Typ
Transients (in-Band)			20 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+20 dBmTyp
0.5 – 2.0 GHz			+28 dBmTyp
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+46	+34	dBm Typ
0.5 – 2.0 GHz	+60	+39	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0V to -0.2V @ 25 μA Max
Vin High			-5V @ 10 μA typ to -8V @ 200 μA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. Above reference insertion loss.
3. Contact the factory for standard or custom screening requirements.

CR-8



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Model No.	Package
AT-262 PIN	Surface Mount

Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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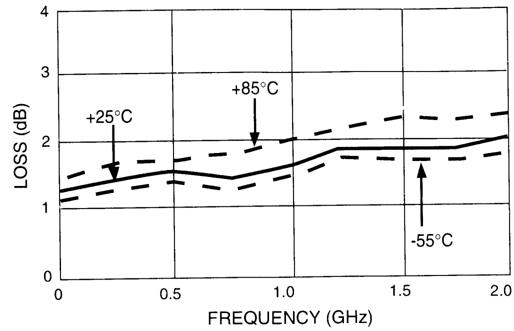
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

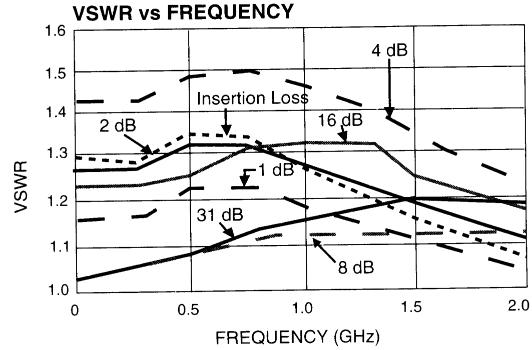
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance

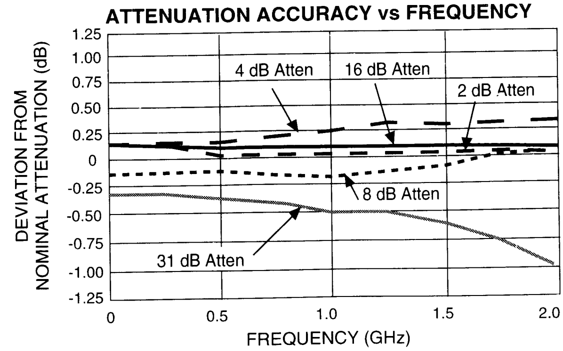
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY

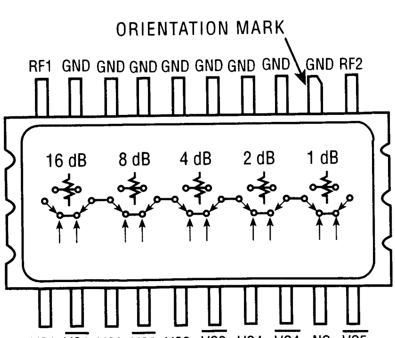


Truth Table

Control Inputs									
$\overline{VC5}$	$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	**Attenuation (dB)**
1	1	0	1	0	1	0	1	0	Reference
0	1	0	1	0	1	0	1	0	1 dB
1	0	1	1	0	1	0	1	0	2 dB
1	1	0	0	1	1	0	1	0	4 dB
1	1	0	1	0	0	1	1	0	8 dB
1	1	0	1	0	1	0	0	1	16 dB
0	0	1	0	1	0	1	0	1	31 dB

"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Functional Schematic (Top View)



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an AMP company

Digital Attenuator, 31 dB, 5-Bit, TTL Driver DC-2 GHz

AT-263

V 2.00

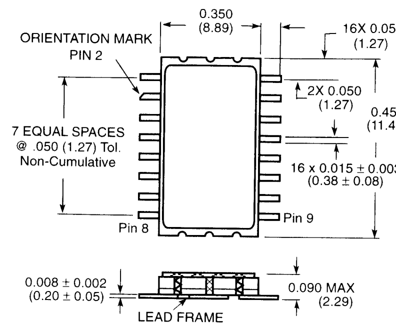
Features

- Attenuation: 1-dB Steps to 31 dB[2]
- Temperature Stability: ± 0.18 dB from -55°C to +85°C Typical
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50Ω Nominal Impedance

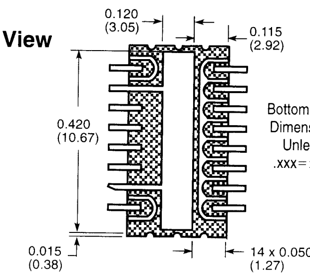
Description

M/A-COM's AT-263 is a GaAs FET 5-bit digital attenuator with a 1-dB minimum step size and 31 dB total attenuation. This attenuator and integral TTL driver is in a hermetically sealed ceramic 16-lead surface mount package. The AT-263 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

CR-12



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, T_A = +25°C[1]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			2.4 2.8 3.0
Attenuation Accuracy[3,4]	Any Single Bit DC - 1.0 GHz Any Combination of Bits DC - 2.0 GHz	± (0.25 + 3% of attenuation setting in dB) dB ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater			
VSWR	DC - 2.0 GHz				1.6:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		9 40 30	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+40 +48	
Input IP_2[5]	For two-tone input power up to +5 dBm 0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+45 +68	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			5.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	μA μA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. VEE = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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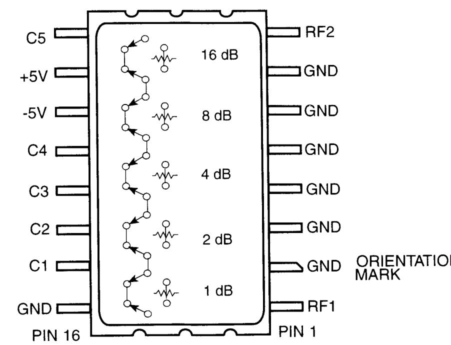
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Note: Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs					
C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	Reference
0	0	0	0	1	1 dB
0	0	0	1	0	2 dB
0	0	1	0	0	4 dB
0	1	0	0	0	8 dB
1	0	0	0	0	16 dB
1	1	1	1	1	31 dB

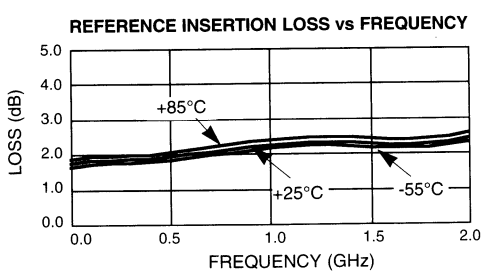
0 = TTL Low   1 = TTL High

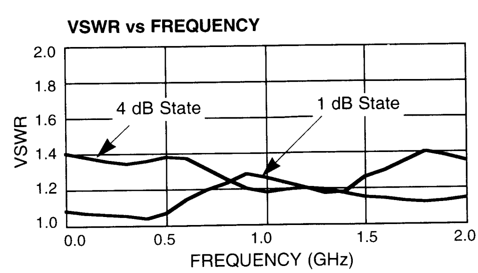
Ordering Information [6]

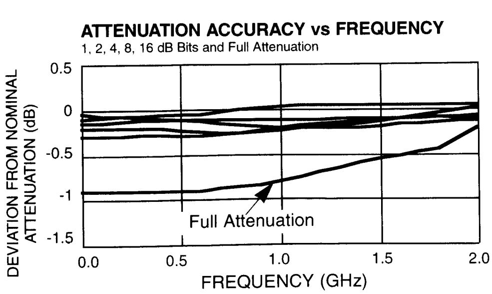
Part Number	Package
AT-263 PIN	Ceramic

6. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C







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M/A-COM
an AMP company

Digital Attenuator, 32 dB, 2-Bit
DC - 2 GHz

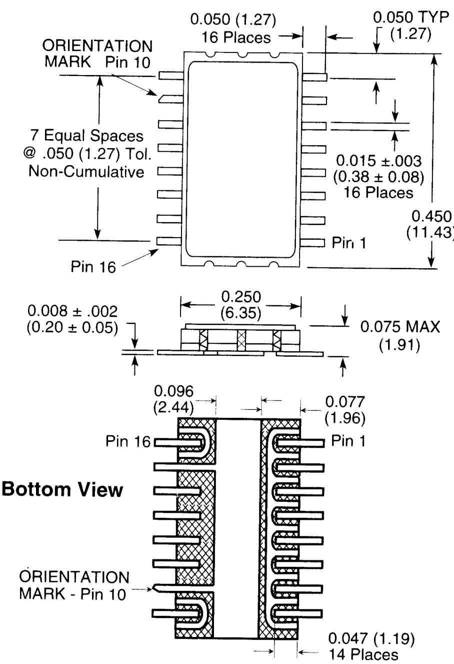
AT-272

V 2.00

Features

- Attenuation 16-dB Steps to 32 dB
- Temperature Stability +/- 0.18 dB from -55°C to +85°C Typical
- Ultra Low DC Power Consumption
- Hermetic Surface Mount Package
- Fast Switching Speed, 6 ns Typical

CR-6



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Guaranteed Specifications[1] (From -55°C to + 85°C)

Frequency Range		DC – 2.0 GHz
Nominal Attenuation[2]		16 dB Steps to 32 dB
Attenuation Accuracy		DC – 2.0 GHz
Any Single Bit	(DC-2 GHz ± 3% of Attenuation Setting in dB) dB	
Any Combination of Bits	(DC-1 GHz ± 3% of Attenuation Setting in dB) dB	
Any Combination of Bits	(1-2 GHz ± 7.5% of Attenuation Setting in dB) dB	
VSWR	DC – 2.0 GHz	1.6:1 Max
Reference Insertion Loss	DC – 2.0 GHz	2.0 dB Max

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			6 ns Typ
Ton, Toff (50% CTL to 90%/10%)			16 ns Typ
Transients (in-Band)			15 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+27 dBm Typ
0.5 GHz to 3 GHz			+30 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+44	+38	dBm Typ
0.5 GHz to 3 GHz	+68	+48	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0V to -0.2V @ 20 μA Max
Vin Hi			-5V @ 20 μA typ to -8V @ 100 μA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. Above reference insertion loss.

Ordering Information

Part Number	Package
AT-272 PIN	Ceramic

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

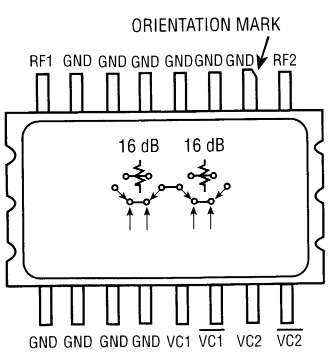
1. Operation of this device above any one of these parameters may cause permanent damage.

Truth Table

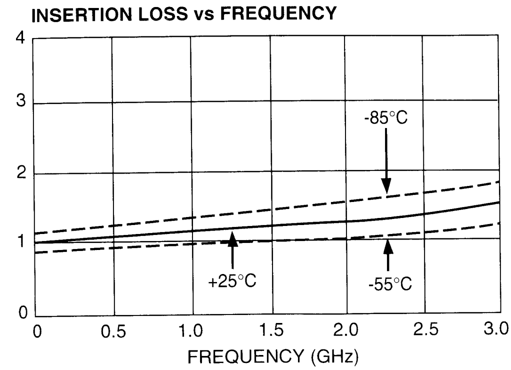
Control Inputs				
$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	0	1	0	Reference
1	0	0	1	16 dB
0	1	1	0	16 dB
0	1	0	1	32 dB

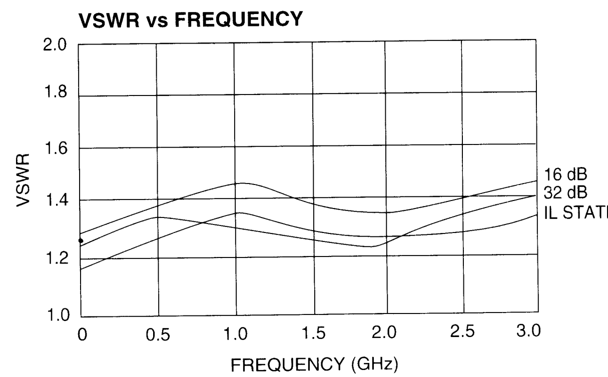
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

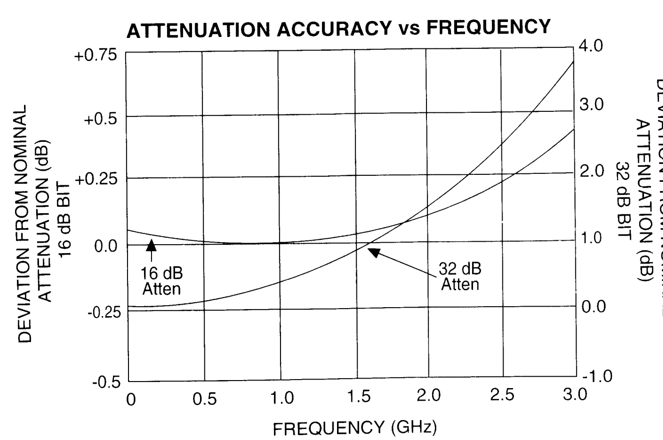
Functional Schematic (Top View)



Typical Performance







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an AMP company

Digital Attenuator, 32 dB, 2-Bit, TTL Driver DC-2 GHz

AT-273

V 2.00

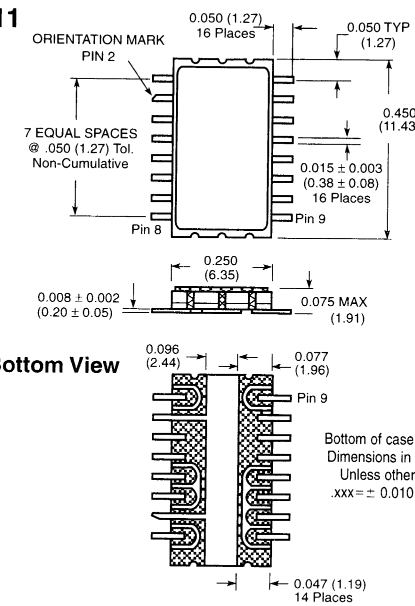
Features

- Attenuation: 16-dB Steps to 32 dB[2,6]
- Temperature Stability: ± 0.18 dB from -55°C to +85°C Typical
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50Ω Nominal Impedance

Description

M/A-COM's AT-273 is a GaAs FET digital attenuator with a 16-dB minimum step size and 32 dB total attenuation. This attenuator and integral TTL driver is in a hermetically sealed ceramic 24-lead surface mount package. The AT-273 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

CR-11



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx = ± 0.010 (.xx = ±0.25)

Electrical Specifications, $T_A = +25°C$[1]

Parameter	Test Conditions		Units	Min.	Typ.	Max.
Reference Insertion Loss		DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			1.6 1.7 1.9
Attenuation Accuracy[3,4]	C1 Bit	DC - 2.0 GHz	± 3% of attenuation setting in dB			
	Full Attenuation (32dB)	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	± 3% of attenuation setting in dB + 3% of attenuation setting in dB, -1dB + 3% of attenuation setting in dB, -3dB			
VSWR	DC - 2.0 GHz					1.4:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)		nS nS mV		7 28 20	
1 dB Compression[5]	Input Power Input Power	0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power up to +5 dBm	0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+38 +48	
Input IP_2[5]	For two-tone input power up to +5 dBm	0.05 GHz 0.5 - 2.0 GHz	dBm dBm		+44 +68	
V_{CC} V_{EE}			V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}		mA			2.0
I_{EE}	V_{EE} = -5.0 to -8.0 V		mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)		V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V		µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and −5.0 V to −8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = −5 V for the typical numbers given.
6. Use the C1 control for a single 16-dB bit.

Specifications Subject to Change Without Notice.

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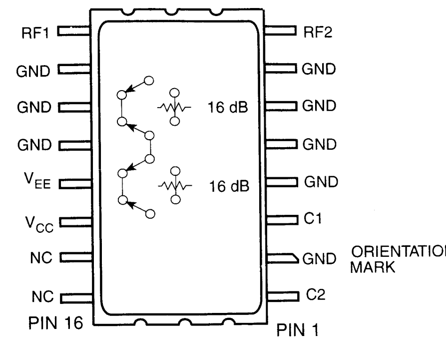
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Note: Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs		
C2	**C1**	**Attenuation**
0	0	Reference
0	1	16 dB
1	0	32 dB

0 = TTL Low 1 = TTL High

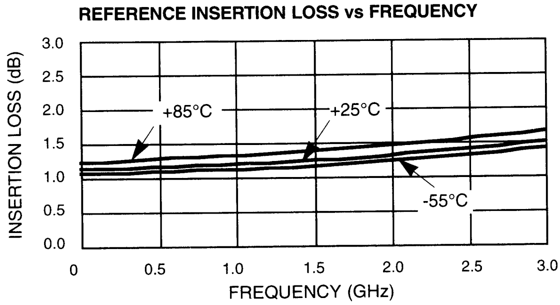
Ordering Information[7]

Part Number	Package
AT-273 PIN	Ceramic

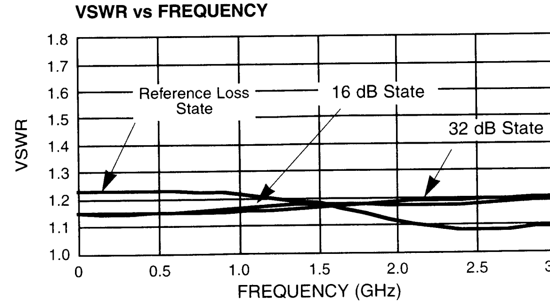
7. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C

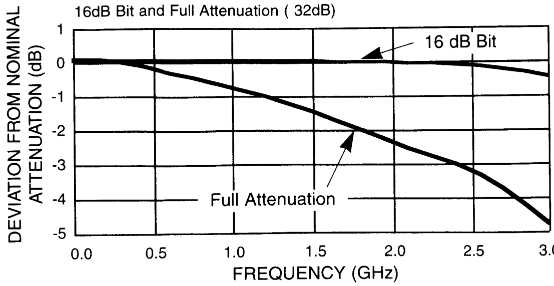
REFERENCE INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
16dB Bit and Full Attenuation (32dB)



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an AMP company

Digital Attenuator, 15.5 dB, 5-Bit DC - 2 GHz

AT-280

V 2.00

Features

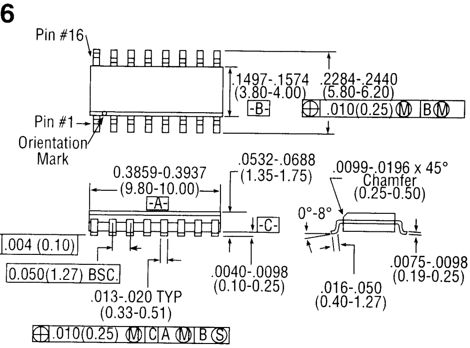
- Attenuation: 0.5-dB Steps to 15.5 dB
- Temperature Stability: ± 0.15 dB from -40°C to +85°C Typical
- Ultra Low DC Power Consumption
- Low Intermodulation Products, IP_3: 45 dBm
- Tape and Reel Packaging Available

Description

M/A-COM's AT-280 is a 5-bit, 0.5 dB-step GaAs MMIC digital attenuator in a low cost SOIC 16-lead surface mount plastic package. The AT-280 is ideally suited for use where high accuracy, fast switching, very low power consumption and low intermodulation products are required at a low cost. Typical applications include radio and cellular equipment, wireless LANS, GPS equipment and other Gain/Level Control circuits.

The AT-280 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-16



16-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AT-280 PIN	SOIC 16-Lead
AT-280TR	Forward Tape & Reel*
AT-280RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Reference Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		1.1 1.3 1.5 1.8	1.3 1.5 1.8 2.0
Attenuation Accuracy[2]	DC – 1.0 GHz DC – 2.0 GHz	± (0.20 dB + 3% of Atten. Setting in dB) dB ± (0.30 dB + 3% of Atten. Setting in dB) dB			
VSWR	(any state)		1.5:1	1.8:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		12 18 30	
One dB Compression	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		22 27	
IP_2	Measured Relative to Input Power 0.05 GHz 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		53 68	
IP_3	Measured Relative to Input Power 0.05 GHz 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		40 45	

1. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.
2. Attenuation accuracy specifications apply with negative bias control and low inductance grounding.

Specifications Subject to Change Without Notice.

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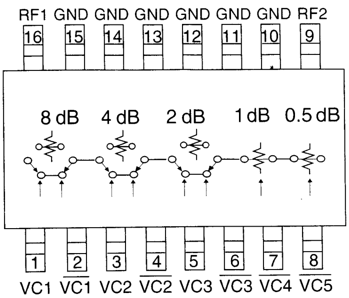
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–40°C to +85°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic



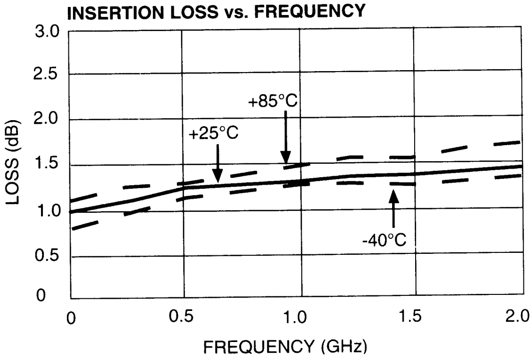
Truth Table

Control Inputs								
$\overline{VC5}$	$\overline{VC4}$	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	1	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	0.5 dB
1	0	1	0	1	0	1	0	1 dB
1	1	0	1	1	0	1	0	2 dB
1	1	1	0	0	1	1	0	4 dB
1	1	1	0	1	0	0	1	8 dB
0	0	0	1	0	1	0	1	15.5 dB

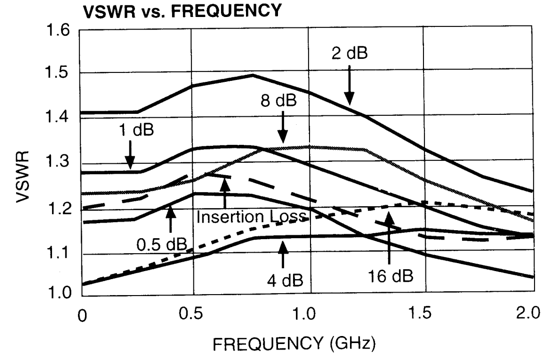
0 = VinLow = 0 V = 0 to -0.2 V @ 20 A maximum

Typical Performance

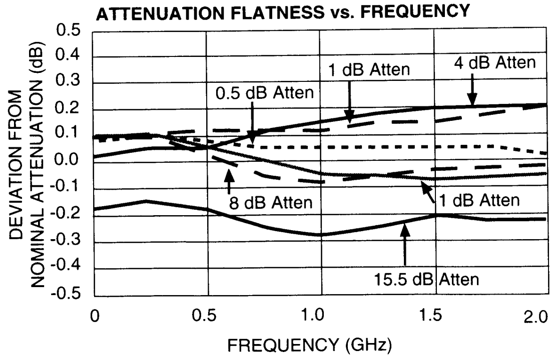
INSERTION LOSS vs. FREQUENCY



VSWR vs. FREQUENCY



ATTENUATION FLATNESS vs. FREQUENCY



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an AMP company

Digital Attentuator, 15.5 dB, 5-Bit DC - 2 GHz

AT-282

V 2.00

Features

- Attenuation 0.5 dB Steps to 15.5 dB
- Temperature Stability +/- 0.12 dB from -55°C to +85° C Typical
- Ultra Low DC Power Consumption
- Hermetic Surface Mount Package
- Fast Switching Speed, 12 ns Typical

Guaranteed Specifications[1] (From -55°C to + 85°C)

Frequency Range		DC – 2.0 GHz
Nominal Attenuation[2]		0.5 dB Steps to 15.5 dB
Attenuation Accuracy		DC-2 GHz
DC – 2.0 GHz dB	+/-(0.2 dB +3% of Attenuation Setting in dB)	
VSWR	DC – 2.0 GHz	1.6:1 Max
Reference Insertion Loss	DC – 2.0 GHz	2.2 dB Max

Operating Characteristics

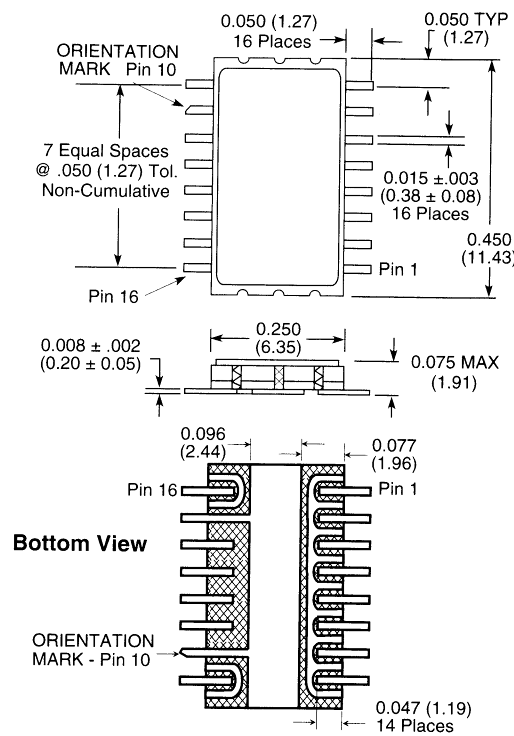
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			12 ns Typ
Ton, Toff (50% CTL to 90%/10%)			18 ns Typ
Transients (in-Band)			30 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+22 dBmTyp
0.5 – 2.0 GHz			+27 dBmTyp
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+53	+41	dBm Typ
0.5 – 2.0 GHz	+68	+43	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low Max			0V to -0.2V @ 30 µA
Vin High			-5V @ 10 µA typ to -8V @ 200 µA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. Above reference insertion loss.
3. Contact the factory for standard or custom screening requirements.

Ordering Information

Model No.	Package
AT-282 PIN	Surface Mount

CR-6



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

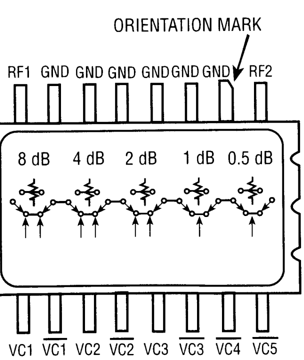
1. Operation of this device above any one of these parameters may cause permanent damage.

Truth Table

Control Inputs								
$\overline{VC5}$	$\overline{VC4}$	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	1	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	0.5 dB
1	0	1	0	1	0	1	0	1 dB
1	1	0	1	1	0	1	0	2 dB
1	1	1	0	0	1	1	0	4 dB
1	1	1	0	1	0	0	1	8 dB
0	0	0	1	0	1	0	1	15.5 dB

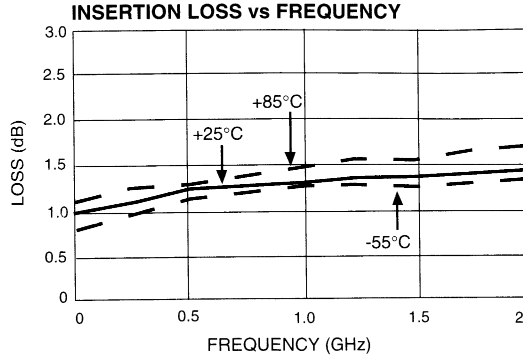
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Functional Schematic (Top View)

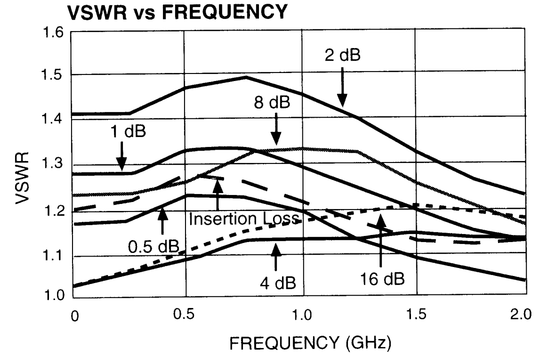


Typical Performance

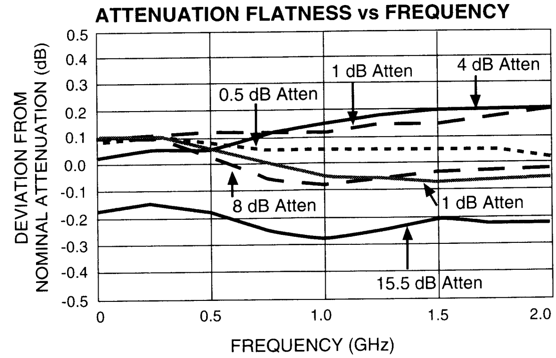
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION FLATNESS vs FREQUENCY



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M/A-COM an AMP company

Digital Attenuator, 15.5 dB, 5-Bit, TTL Driver DC-2 GHz

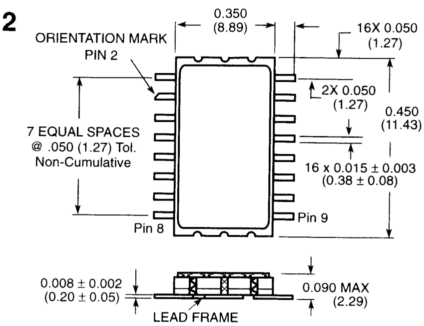
AT-283

V 2.00

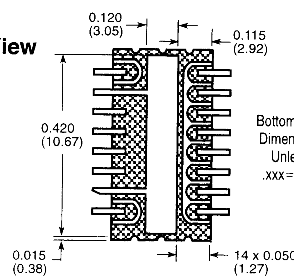
Features

- Attenuation: 0.5-dB Steps to 15.5 dB[2]
- Temperature Stability: ± 0.18 dB from -55°C to +85°C Typical
- Low DC Power Consumption
- Hermetic Surface Mount Package
- Integral TTL Driver
- 50Ω Nominal Impedance

CR-12



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Description

M/A-COM's AT-283 is a GaAs FET 5-bit digital attenuator with a 0.5-dB minimum step size and 15.5 dB total attenuation. This attenuator and integral TTL driver is in a hermetically sealed ceramic 16-lead surface mount package. The AT-283 is ideally suited for use where accuracy, fast switching, very low power consumption and low intermodulation products are required. Typical applications include dynamic range setting in precision receiver circuits and other gain/leveling control circuits. Environmental screening is available. Contact the factory for information.

Electrical Specifications, T_A = +25°C[1]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB			1.9 2.2 2.5
Attenuation Accuracy[3,4]	Any Single Bit DC - 2.0 GHz Any Combination of Bits DC - 2.0 GHz	± (0.25 + 3% of attenuation setting in dB) dB ± (0.25 + 3% of attenuation setting in dB) dB or ± 0.4 dB, whichever is greater			
VSWR	DC - 1.0 GHz DC - 2.0 GHz				1.6:1 1.7:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90/10% RF In-band (peak-peak)	nS nS mV		10 27 22	
1 dB Compression[5]	Input Power 0.05 GHz Input Power 0.5 - 2.0 GHz	dBm dBm		+20 +28	
Input IP_3[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+40 +47	
Input IP_2[5]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 2.0 GHz	dBm dBm		+53 +68	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			5.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all ports unless otherwise specified.
2. Above reference insertion loss.
3. This attenuator is guaranteed monotonic.
4. For the attenuator to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
5. V_{EE} = -5 V for the typical numbers given.

Specifications Subject to Change Without Notice.

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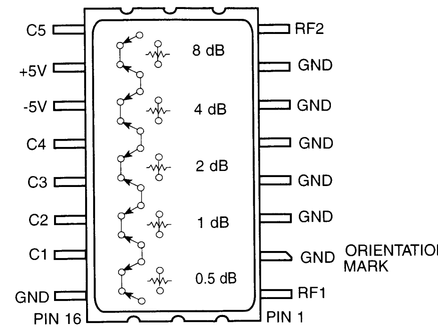
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.5 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	-8.5 V
Control Voltage	-0.5 V to V_{CC} + 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Note: Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs					
C5	C4	C3	C2	C1	Attenuation
0	0	0	0	0	Reference
0	0	0	0	1	0.5 dB
0	0	0	1	0	1 dB
0	0	1	0	0	2 dB
0	1	0	0	0	4 dB
1	0	0	0	0	8 dB
1	1	1	1	1	15.5 dB

0 = TTL Low 1 = TTL High

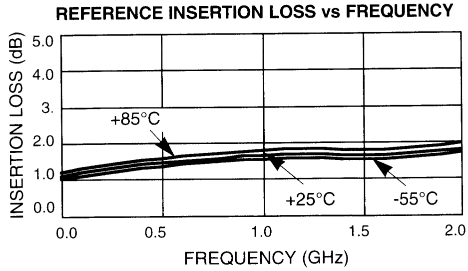
Ordering Information[6]

Part Number	Package
AT-283 PIN	Ceramic

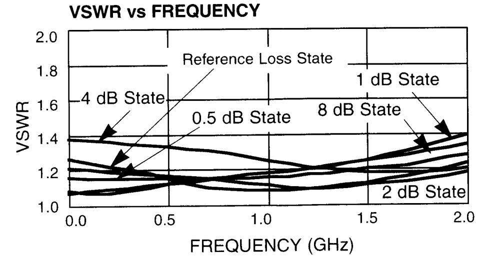
6. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C

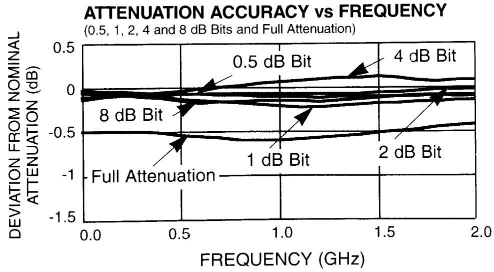
REFERENCE INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION ACCURACY vs FREQUENCY
(0.5, 1, 2, 4 and 8 dB Bits and Full Attenuation)



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M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator, 19 dB
DC - 2 GHz
AT-302, AT-303, AT-307

V 2.00

Features

- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption
- Small Package Size

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range	DC – 2.0 GHz	AT-302	AT-303	AT-307	
Insertion Loss	DC – 2.0 GHz	1.6	1.5	1.5	dB Max
	DC – 1.0 GHz	1.5	1.5	1.5	dB Max
VSWR (Matched)	DC – 2.0 GHz	2.0:1	1.6:1	1.6:1	Max
	DC – 1.0 GHz	2.0:1	1.5:1	1.5:1	Max
	DC – 0.5 GHz	1.5:1	1.5:1	1.5:1	Max
Attenuation	DC – 2.0 GHz	19	19	19	dB Min
Flatness (Peak to Peak)	DC – 2.0 GHz	1.5	1.5	1.5	dB Max
	DC – 1.0 GHz	1.0	1.5	1.5	dB Max
Attenuation vs. Temperature	0 to 10 dB Att.	±0.5	±0.5	±0.5	dB Max
	0 to 20 dB Att.	±1.5	±1.5	±1.5	dB Max

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics[2]	
Trise,Tfall (10% to 90%)	6 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)	8 ns Typ
Transients (in band)	10 mV Typ

Input Power for 1 dB Compression

Attenuation Level	0	2	5	10	20	dB
0.5 to 2.0 GHz	+29	+29	+21	+28	+30	dBm Typ
0.05 GHz	+24	+26	+18	+28	+30	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +5 dBm)

Intercept Points	IP2			IP3			
Attenuation Level:	0	5	10	0	5	10	dB
0.5 to 2.0 GHz	68	47	53	49	39	40	dBm Typ
0.05 GHz	51	40	38	48	32	32	dBm Typ

Phase Shift (Relative to 0 dB Attenuation)

Attenuation Level:	10	19	dB
0.5 GHz	2.5	11	Deg Typ

Control Voltages

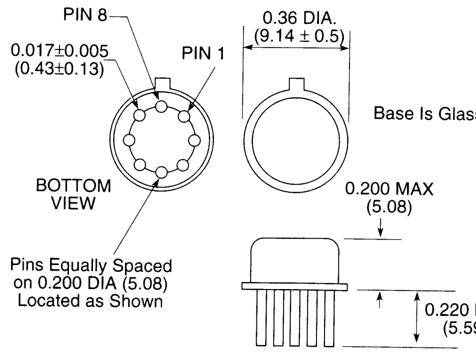
A Input (Shunt FETS)	0 to -4V @ 100 μA Max
B Input (Series FETS)	0 to -4V @ 100 μA Max

1. All specifications apply with 50 ohm connected to all RF ports.
2. Switching speed is measured between 19 dB and 0 dB attenuation levels.
3. Contact the factory for standard or custom screening requirements.

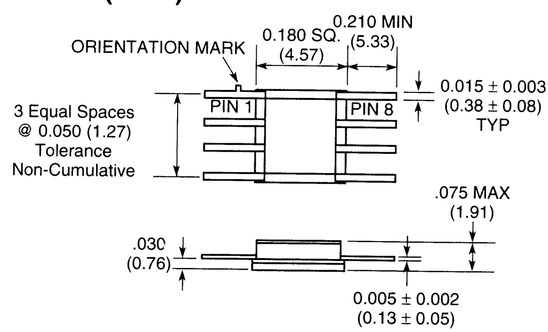
Ordering Information

Model No.	Package
AT-302 PIN	TO-5-4
AT-303 PIN	Ceramic
AT-307 PIN	Ceramic

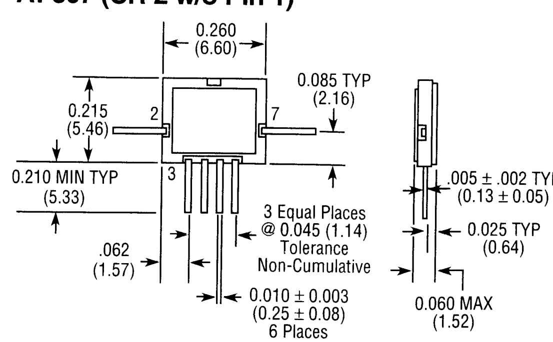
AT-302 (TO-5-4)



AT-303 (CR-3)



AT-307 (CR-2 w/o Pin 1)



For all packages: Bottom of case is AC ground.
Dimensions in ( ) are in mm.
nless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice.

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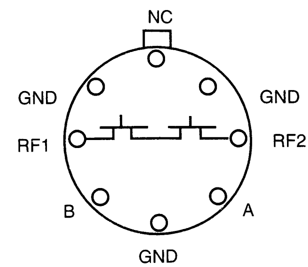
Absolute Maximum Ratings

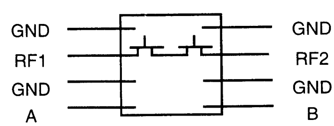
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+30 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

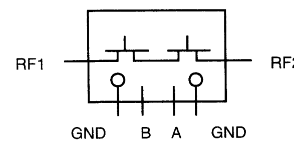
Functional Schematics (Top View)



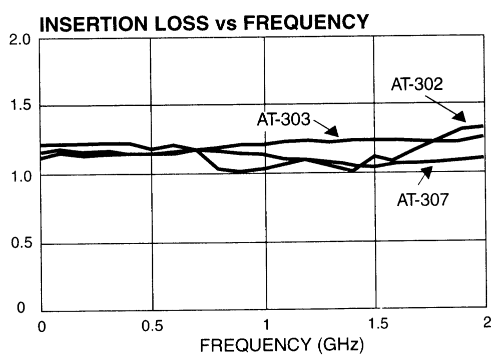
AT-303

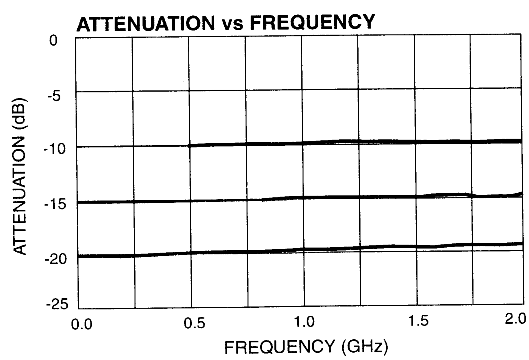


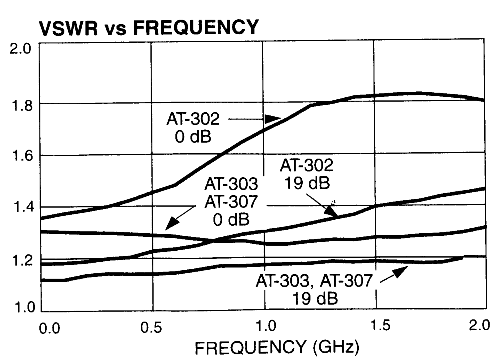
AT-307

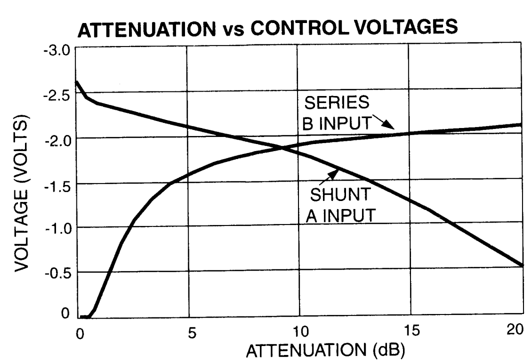


Typical Performance









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M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator, 20 dB DC - 2 GHz

AT-309

V 2.00

Features

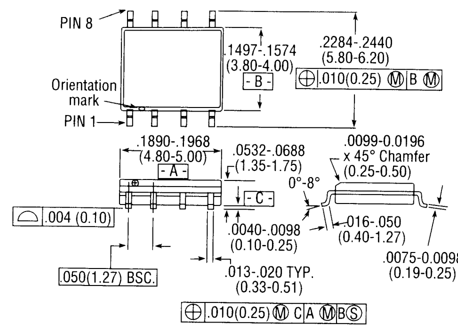
- 20 dB Voltage Variable Attenuation
- Very Low Power Consumption: 50 μW
- Low Intermodulation Products
- Dual Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-309 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 8-lead surface mount plastic package. The AT-309 is ideally suited for use where attenuation fine tuning, fast switching and very low power consumption are required. Typical applications include radio, cellular, and GPS equipment and other Automatic Gain/Level Control circuits.

The AT-309 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
AT-309 PIN	SOIC 8-Lead Plastic Package
AT-309TR	Forward Tape & Reel
AT-309RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.7 0.8 0.9 1.2	0.9 1.0 1.2 1.4
Flatness (Peak to Peak)	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		+/-0.5 +/-0.5 +/-0.8 +/-1.0	+/-0.8 +/-0.8 +/-1.0 +/-1.2
VSWR (Matched)				1.4:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		6 8 10	
One dB Compression	Input Power (Over Attenuation Range)	dBm		5	
IP_2	Measured Relative (Over Attenuation Range) 0.05 GHz to Input Power (Over Attenuation Range) 0.5 – 2.0 GHz (for two-tone input power up to +5 dbm)	dBm dBm		47 40	
IP_3	Measured Relative (Over Attenuation Range) 0.05 GHz to Input Power (Over Attenuation Range) 0.5 – 2.0 GHz (for two-tone input power up to +5 dbm)	dBm dBm		39 32	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified. The A and B control voltages vary 0 to -4V @ 20 μA typ.

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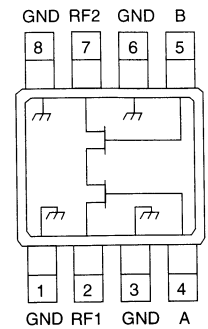
Absolute Maximum Ratings[1]

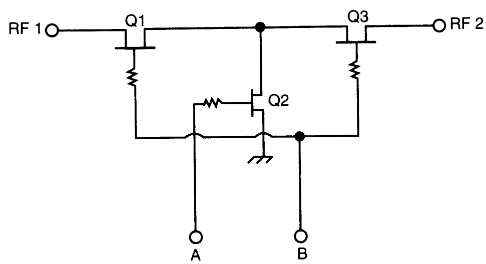
Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+30 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic



Electrical Schematic

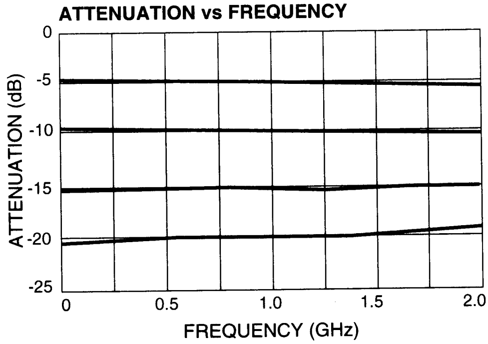


Pin Configuration

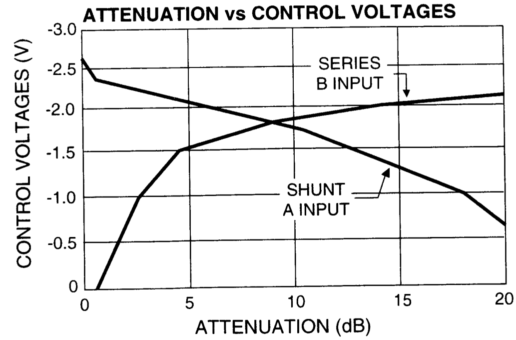
Pin No.	Description
1	GND
2	RF1
3	GND
4	A
5	B
6	GND
7	RF2
8	GND

Typical Performance

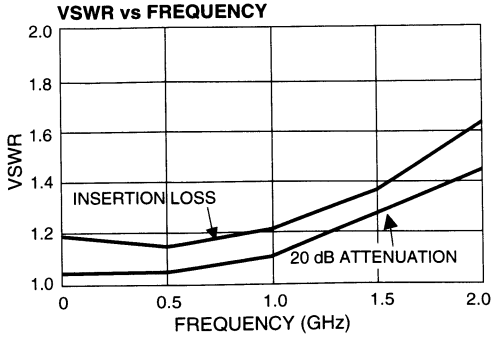
ATTENUATION vs FREQUENCY



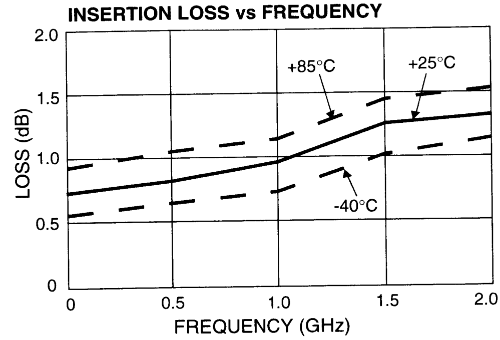
ATTENUATION vs CONTROL VOLTAGES



VSWR vs FREQUENCY



INSERTION LOSS vs FREQUENCY



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Voltage Variable Absorptive Attenuator DC - 2 GHz

AT-332, AT-337

V 2.00

Features

- Available in Ceramic and TO-5 packages
- 40 dB Matched Attenuation
- Low Insertion Loss

Guaranteed Specifications[1]

(From -55°C to + 85°C)

Frequency Range			DC – 2.0 GHz
Insertion Loss	DC – 2.0 GHz DC – 1.0 GHz		1.5 dB Max 1.2 dB Max
VSWR		AT-332	AT-337
	DC – 2.0 GHz DC – 1.0 GHz	1.4:1 1.25:1	1.5:1 Max 1.3:1 Max
Attenuation (Matched) @ 25°C	DC – 2.0 GHz		40 dB Min
Flatness (Peak to Peak)	0-20 dB Attenuation 0-30 dB Attenuation 0-40 dB Attenuation		1.0 dB Max 2.0 dB Max 3.0 dB Max
Attenuation vs Temperature (Relative to 25°C)	0 to 20 dB Attenuation 0 to 30 dB Attenuation 0 to 40 dB Attenuation		±2.5 dB ±4.0 dB ±6.0 dB

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
Trise, Tfall (10% to 90%)	14 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)	22 ns Typ
Transients (in band)	14 mV Typ

Input Power for 1 dB Compression

Attenuation Level	0 dB	
0.05 GHz	21	
0.5 GHz to 2.0 GHz	27	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +5 dBm)

Intercept Points	IP2			IP3			
Attenuation Level (dB)	0	5	10	0	5	10	
0.05 GHz	54	43	39	39	33	30	dBm Typ
0.5 to 2 GHz	65	54	49	47	44	38	dBm Typ

Phase Shift (Relative to 0 dB Attenuation)

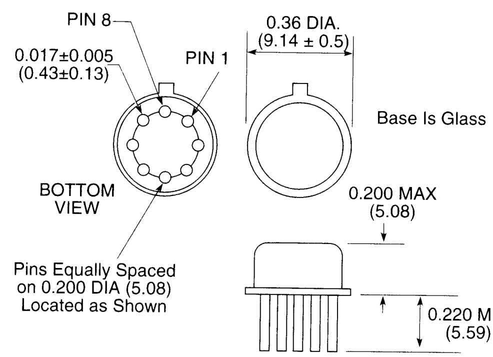
Attenuation Level	10 dB	20 dB	30 dB	40 dB	
0.5 GHz	0.1	3	10	19	Deg Typ
2.0 GHz	0.4	12	35	60	Deg Typ

Control Voltages

A input (Shunt FETS)	0 to -4V @ 100 μA Max
B input (Series FETS)	0 to -4V @ 100 μA Max

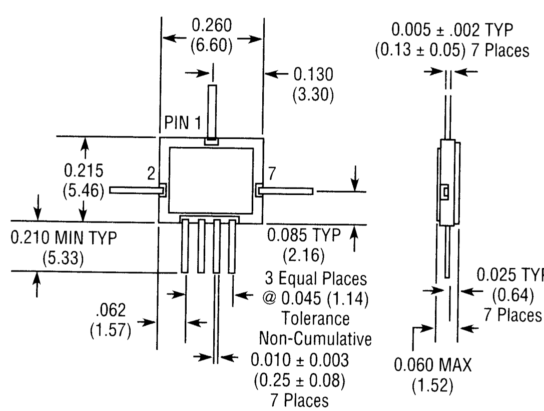
1. All specifications apply with 50 ohm connected to all RF Ports.
2. Contact the factory for standard or custom sreenig requirements.

AT-332 (TO-5-4)



Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

AT-337 (CR-2 w/o Pin 1)



Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
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Ordering Information

Model No.	Package
AT-354 PIN	Dual Inline

Specifications Subject to Change Without Notice.

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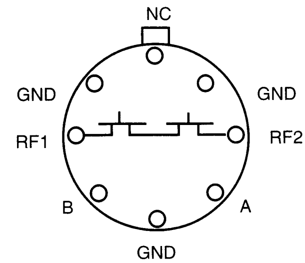
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+30 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

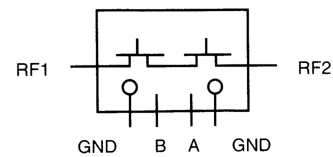
1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematics (Top View)

AT-332

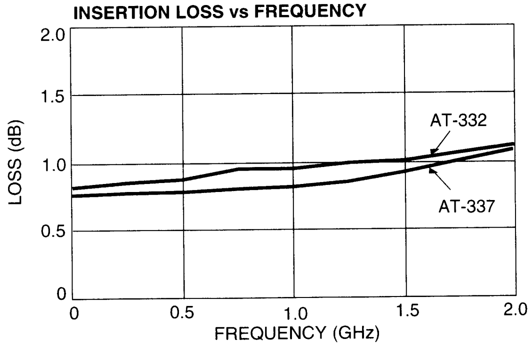


AT-337

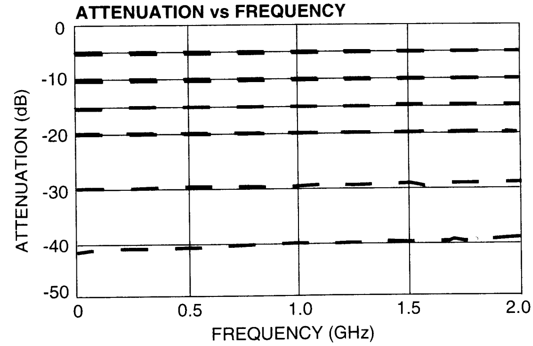


Typical Performance

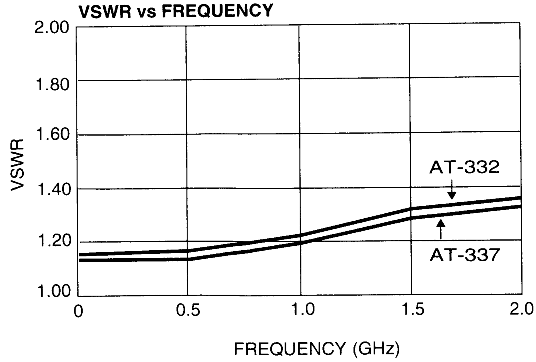
INSERTION LOSS vs FREQUENCY



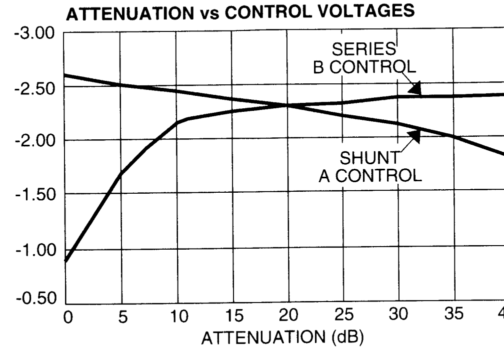
ATTENUATION vs FREQUENCY



VSWR vs FREQUENCY



ATTENUATION vs CONTROL VOLTAGES



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M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator, 40 dB DC - 2 GHz

AT-339

V 2.00

Features

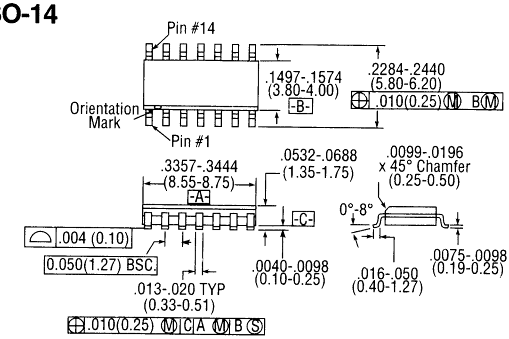
- 40 dB Voltage Variable Attenuation
- Low Intermodulation Products
- Very Low Power Consumption: 50 μW
- Dual Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-339 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 14-lead surface mount plastic package. The AT-339 is ideally suited for use where attenuation fine tuning, fast switching and very low power consumption are required. Typical applications include radio, cellular, and GPS equipment and other Automatic Gain/Level Control circuits.

The AT-339 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-14



14-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AB, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
AT-339 PIN	SOIC 14-Lead Plastic Package
AT-339TR	Forward Tape & Reel
AT-339RTR	Reverse Tape & Reel

Electrical Specifications, $T_A = +25°C$

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.6 0.8 1.2 1.3	0.9 1.1 1.4 1.5
Flatness (peak to peak)	DC – 2.0 GHz 20 dB Attenuation 30 dB Attenuation 40 dB Attenuation	dB dB dB		+/-0.5 +/-1.5 +/-5.0	+/-0.8 +/-1.8 +/-5.5
VSWR (Matched)				1.5:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		18 35 20	
One dB Compression	Input Power (over atten. range)	dBm		5	
IP_2	Measured Relative (over atten. range) to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		39 49	
IP_3	Measured Relative (over atten. range) to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		30 38	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified. The A and B control voltages vary 0 to -4 volts @ 20 μA typ.

Specifications Subject to Change Without Notice.

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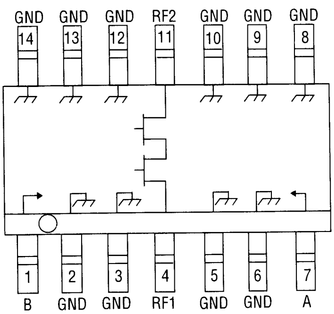
Absolute Maximum Ratings

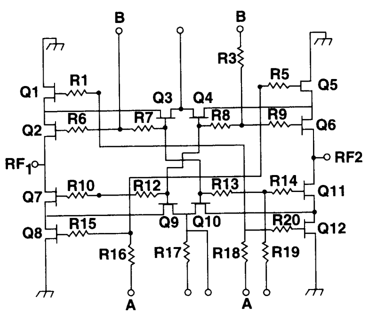
Parameter	Absolute Maximum[1]
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+30 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic



Electrical Schematic

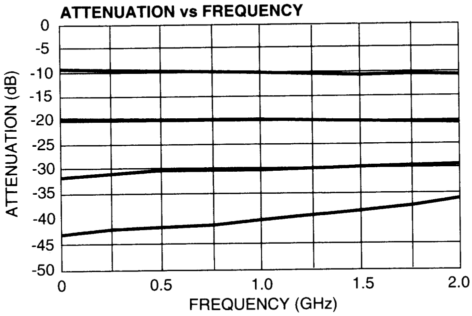


Pin Configuration

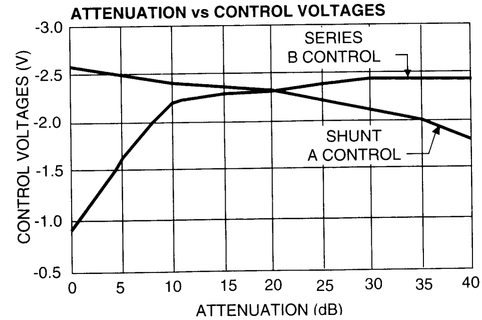
Pin No.	Description	Pin No.	Description
1	B	8	GND
2	GND	9	GND
3	GND	10	GND
4	RF1	11	RF2
5	GND	12	GND
6	GND	13	GND
7	A	14	GND

Typical Performance

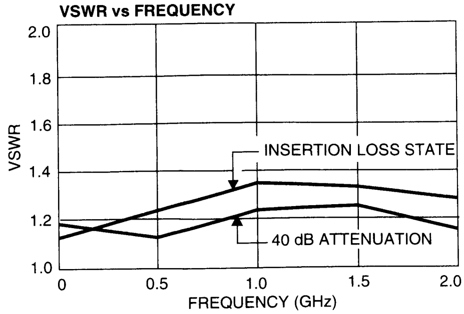
ATTENUATION vs FREQUENCY



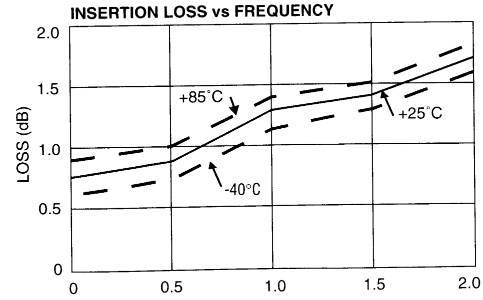
ATTENUATION vs CONTROL VOLTAGES



VSWR vs FREQUENCY



INSERTION LOSS vs FREQUENCY



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M/A-COM an AMP company

4-Bit GaAs MMIC/Hybrid Digital Attenuator 0.25 - 2 GHz

AT-354

V 2.00

Features

- Attenuation 3 dB Steps to 45 dB
- CMOS Control Interface
- Low Power Consumption
- Hermetic Case

Guaranteed Specifications[1] (-55°C to + 85°C)

Frequency Range		0.25 – 2.0 GHz
Nominal Attenuation[2]		3 dB Steps to 45 dB
Attenuation Accuracy		
3 dB	0.25 – 2.0 GHz	3 dB ±0.4 dB
6 dB	0.25 – 2.0 GHz	6 dB ±0.4 dB
12 dB	0.25 – 2.0 GHz	12 dB ±0.5 dB
24 dB	0.25 – 1.0 GHz	24 dB ±0.6 dB Max
	1.0 – 2.0 GHz	22.5 dB Min, 25.0 dB Max
45 dB	0.25 – 1.0 GHz	45 dB ± 1.5 dB
	1.0 – 1.8 GHz	45 dB ± 2.0 dB
	1.8 – 2.0 GHz	42.5 dB Min, 46.5 dB Max
VSWR	0.25 – 1.0 GHz	1.5:1 Max
	1.0 – 2.0 GHz	1.7:1 Max
Reference Insertion Loss	0.25 – 1.0 GHz	4.8 dB Max
	1.0 – 2.0 GHz	5.5 dB Max

Operating Characteristics

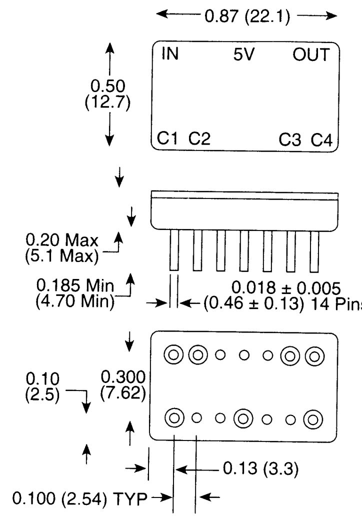
Impedance			50 Ohms Nominal
Switching Characteristics			
Switching Time (50% CTL to 90/10% RF)			70 ns Typ
Transients (In-Band)			80 mV Typ
Input Power for 1 dB Compression			
0.25 – 2.0 GHz			+19 dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.25 – 2.0 GHz	+50	+40	dBm Typ
Bias Power			+5 VDC @ 1 mA Max (2 mW Typ)
Control Voltages			
Vin Low (0)			0.0 to 1.5V @ 1 µA Max
Vin High (1)			3.5 to 5.0V @ 1 µA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports.
2. Above reference insertion loss.
3. Contact the factory for standard or custom screening requirements.

Ordering Information

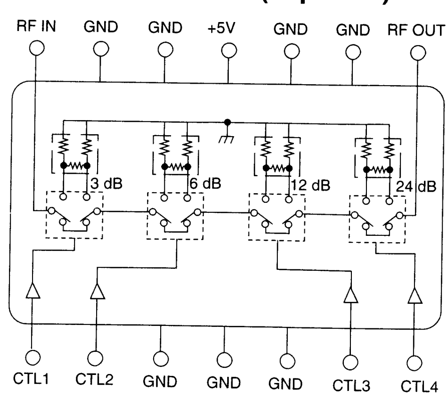
Model No.	Package
AT-354 PIN	Dual Inline

DI-6



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

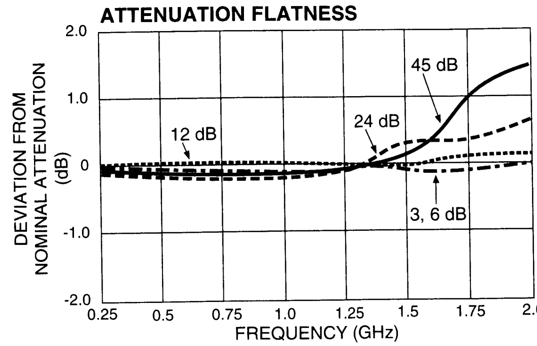
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

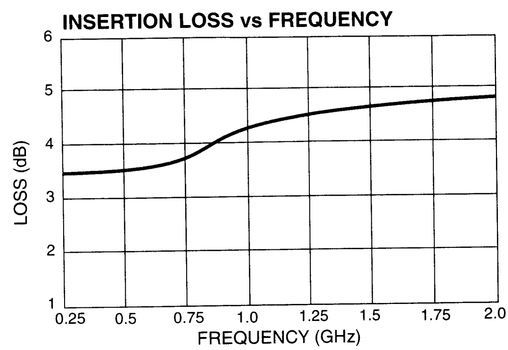
1. Operation of this device above any one of these parameters may cause permanent damage.

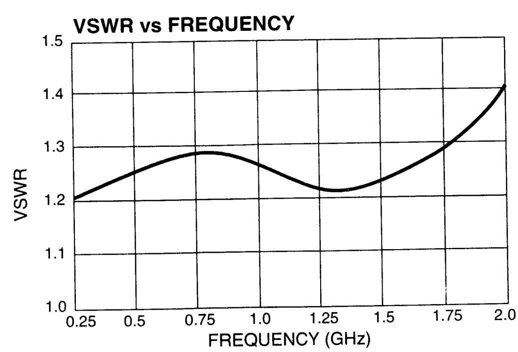
Truth Table

CTL 1	CTL 2	CTL 3	CTL 4	STATE
0	0	0	0	Reference
1	0	0	0	3 dB ATT.
0	1	0	0	6 dB ATT.
0	0	1	0	12 dB ATT.
0	0	0	1	24 dB ATT.
1	1	1	1	45 dB ATT.

Typical Performance







M/A-COM
an AMP company

1 Bit, 10 dB, GaAs Digital Attenuator 0.02 - 2 GHz

AT-358

V 2.00

Features

- CMOS Control Interface
- Low Power Consumption

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		0.02 – 2.0 GHz
Nominal Attenuation [2]		10 dB
Attenuation Accuracy	0.02 – 2.0 GHz	+/-0.5 dB Max
	0.02 – 1.0 GHz	+/-0.3 dB Max
	0.02 – 0.5 GHz	+/-0.2 dB Max
	0.02 – 0.2 GHz	+/-0.2 dB Max
VSWR	0.02 – 2.0 GHz	1.9:1 Max
	0.02 – 1.0 GHz	1.3:1 Max
	0.02 – 0.5 GHz	1.3:1 Max
	0.02 – 0.2 GHz	1.3:1 Max
Reference Insertion Loss	0.02 – 2.0 GHz	2.7 dB Max
	0.02 – 1.0 GHz	1.0 dB Max
	0.02 – 0.5 GHz	0.9 dB Max
	0.02 – 0.2 GHz	0.8 dB Max

Operating Characteristics

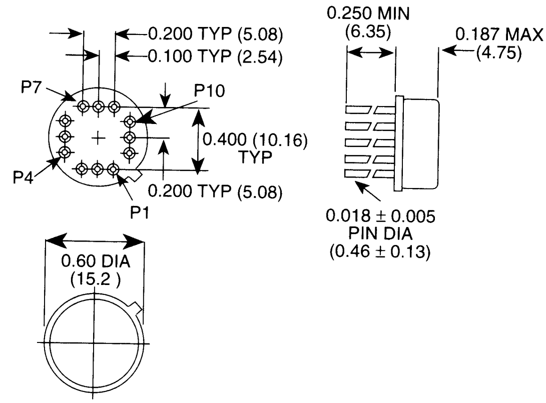
Impedance			50 Ohms Nominal
Switching Characteristics			
Ton, Toff (50% CTL to 90%/10% RF)			100 ns Typ
Trise, Tfall (10%/90% or 90%/10% RF)			40 ns Typ
Switching Transients (Unfiltered)			50 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+24 dBm Typ
0.05 GHz			+18 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.5 – 2.0 GHz	+58	+38	dBm Typ
0.05 GHz	+54	+35	dBm Typ
Bias Power			+5 VDC @ 1 mA Max
Control Voltages			
Vin Low (0)			0.0 to 1.5V @ 1µA Max
Vin High (1)			3.5 to 5.0V @ 1µA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports, with +5 VDC bias voltage.
2. Above reference insertion loss.
3. Contact the factoy for standard or custom screening requirements.

Ordering Information

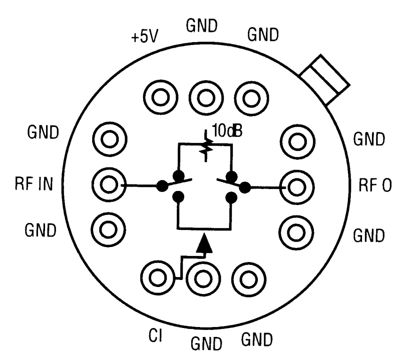
Model No.	Package
AT-358 PIN	TO-8-2

T0-8-2



Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Functional Schematic (Top View)



Truth Table

C1	State
0	Reference Loss
1	Attenuation

Specifications Subject to Change Without Notice.

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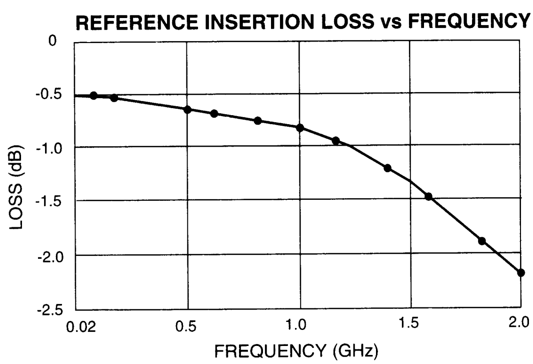
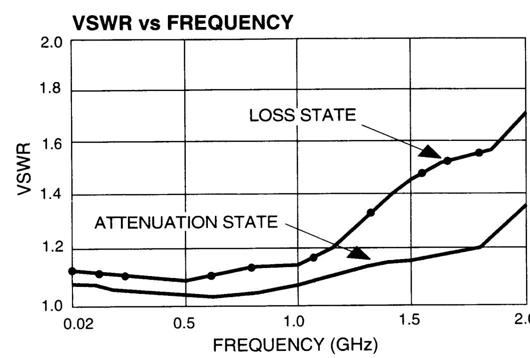
Absolute Maximum Ratings

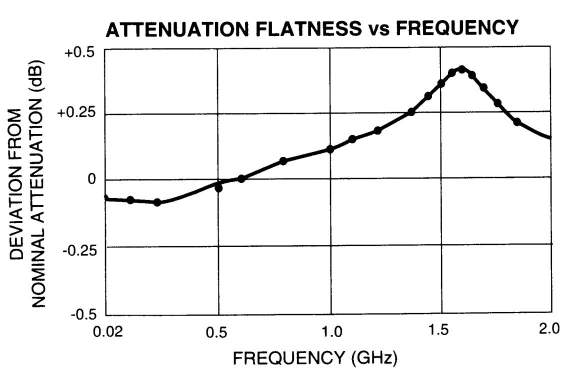
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+32 dBm
Bias Voltage	0.5 to +7 V
Control Voltage	-0.5 to V bias + 0.5 V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







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M/A-COM
an AMP company

Voltage Variable Absorptive Attenuator, 35 dB DC - 2 GHz

AT-635

V 2.00

Features

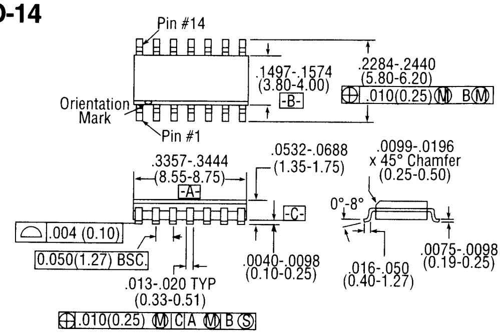
- 35 dB Voltage Variable Attenuation
- Single Voltage Control 0 to -4 Volts
- Low DC Power Consumption: 10 mW
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-635 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 14-lead surface mount plastic package. The AT-635 is ideally suited for use where attenuation fine tuning, fast switching and very low power consumption are required. Typical applications include radio, cellular, GPS equipment and other Automatic Gain/Level Control circuits.

The AT-635 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-14



14-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AB, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
AT-250 PIN	SOIC 14-Lead Plastic Package
AT-250TR	Forward Tape & Reel
AT-250RTR	Reverse Tape & Reel

Electrical Specifications, $T_A = +25°C$

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		6.5 6.7 7.2 7.5	6.7 7.0 7.4 7.8
Flatness (Peak to Peak)	DC-2 GHz 10 dB Attenuation 20 dB Attenuation 30 dB Attenuation	dB dB dB		+/-1.0 +/-1.2 +/-1.2	+/-1.3 +/-1.5 +/-1.5
VSWR				2.0:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		2 4 30	
Power Handling	Linear Operation Absolute Max Input Power	dBm dBm			13 21
IP_2	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		34 47	
IP_3	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm	18 18.5	31[3] 36[3]	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified. The A control voltage 0 to -4 volts @ 20 μA typ.
3. For levels above 6 dB attenuation. For levels below 6 dB, the minimum specification numbers apply.

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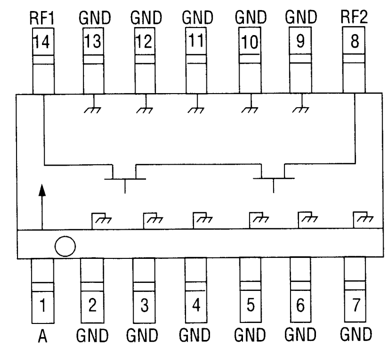
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	+21 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

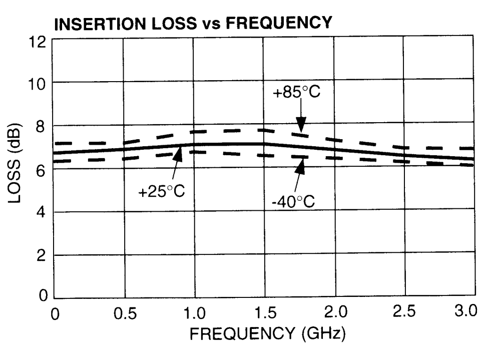
Functional Schematic

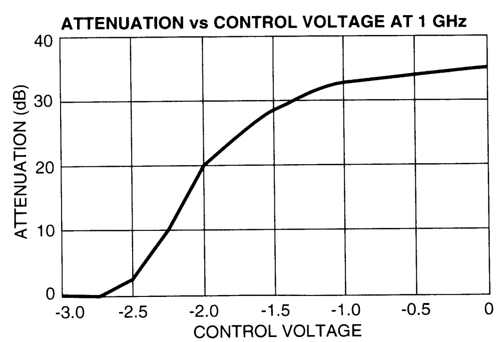


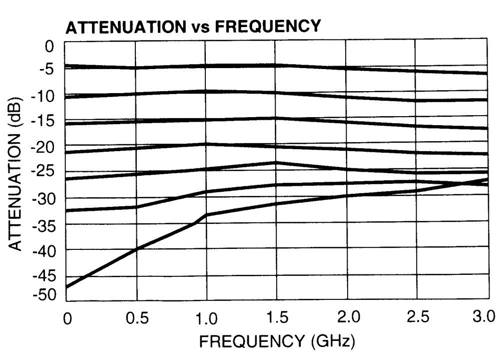
Pin Configuration

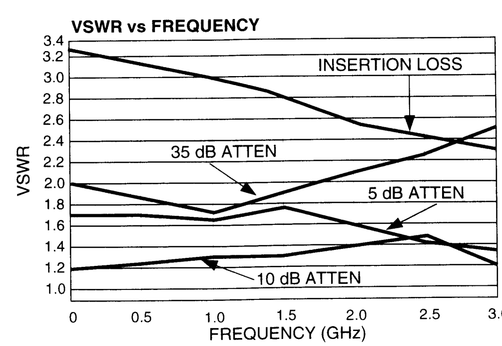
Pin No.	Description	Pin No.	Description
1	A	8	RF2
2	GND	9	GND
3	GND	10	GND
4	GND	11	GND
5	GND	12	GND
6	GND	13	GND
7	GND	14	RF1

Typical Performance









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Voltage Variable Absorptive Attenuator DC - 3 GHz

AT-637

V 2.00

Features

- Low Intermodulation Products
- Ultra Low DC Power Consumption
- Single Voltage Control 0 to -4 Volts
- Small Package Size, 0.180" (4.6 mm) Sq.

Guaranteed Specifications[1] (From -55°C to + 85°C)

Frequency Range		DC – 3.0 GHz
Insertion Loss	DC – 3.0 GHz DC – 2.0 GHz DC – 1.0 GHz	8.0 dB Max 7.5 dB Max 7.2 dB Max
VSWR	DC – 3.0 GHz	3.2:1 Max
Attenuation[2]	DC – 3.0 GHz DC – 2.0 GHz DC – 1.0 GHz	27 dB Min 30 dB Min 34 dB Min
Flatness (Peak to Peak)	DC – 3.0 GHz 10 dB Atten 20 dB Atten 30 dB Atten	 +/-1.0 dB Max +/-1.5 dB Max +/-3.5 dB Max
Attenuation vs Temperature	DC – 3.0 GHz	+/-3.5 dB Max

Operating Characteristics

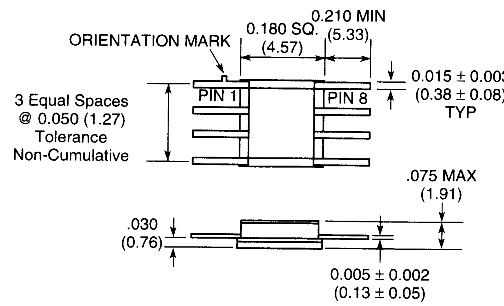
Impedance			50 Ohms Nominal
Switching Characteristics Trise, Tfall (10% to 90%) Ton, Toff (50% CTL to 90%/10%) Transients (In-Band)			 2 ns Typ 4 ns Typ 30 mV Typ
Power Handling Linear Operation Absolute Max Input Power			 +13 dBm Max +21 dBm Max
Intermodulation Intercept point (for two-tone input power up to +5 dBm) Intercept Points	 IP2	 IP3[3]	
0.05 GHz 0.5 – 3.0 GHz	+34 +47	+31 +36	dBm Typ dBm Typ
Control Voltage (A Input)			-4.0 to 0 V @ 100 µA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. Above reference insertion loss.
3. For levels above 6 dB attenuation. For levels below 6 dB, IP_3 = 18 dBm minimum.
4. Contact the factory for standard or custom screening requirements.

Ordering Information

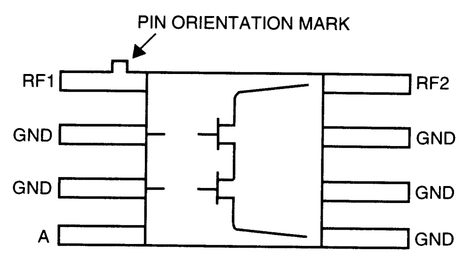
Part Number	Package
AT-637 PIN	Ceramic

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



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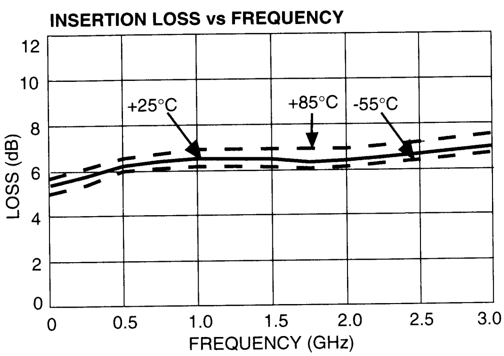
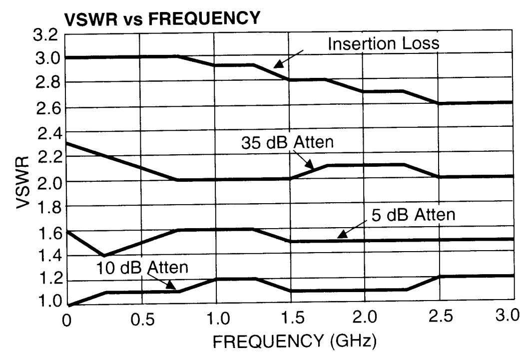
Absolute Maximum Ratings

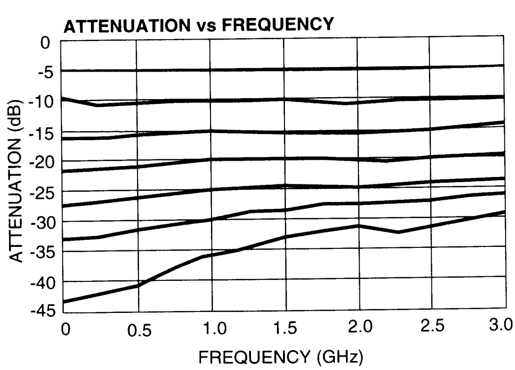
Parameter	Absolute Maximum[1]
Max. Input Power	+21 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

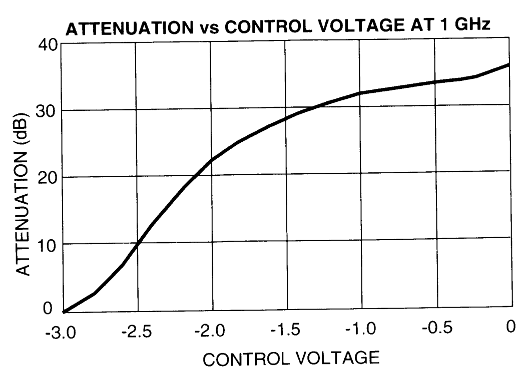
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance









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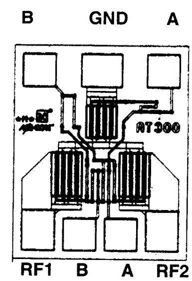
GaAs MMIC Voltage Variable Absorptive Attenuator DC - 2 GHz

MAAA2000G

V 2.00



Features

- Single or Dual DC Bias Control
- Easily Cascadable
- Small Size
- Attenuation Flatness DC - 2 GHz ± .2 dB
- Low Control Current Consumption
- Low Phase Shift
- Up to 20 dB Matched Attenuation with Dual Bias

Guaranteed Specifications**

Parameter		-55°C to +85°C
Frequency Range		DC – 12.0 GHz
Insertion Loss	DC – 1 GHz	1.2 dB Max
	DC – 2 GHz	1.4 dB Max
	DC – 12 GHz	1.5 dB Max
VSWR	DC – 1 GHz	1.5:1 Max
	DC – 2 GHz	1.5:1 Max
	DC – 12 GHz	1.8:1 Max
Relative Attenuation		
(Matched)	DC – 2 GHz	23 dB Min
(Reflective)	DC – 2 GHz	40 dB Min
(Matched)	2 – 12 GHz	12 dB Min

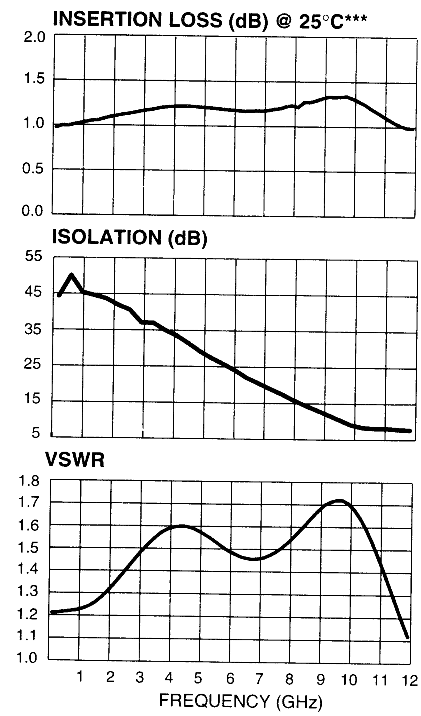
Operating Characteristics

Parameter		Value
Impedance		50 Ω Nominal
Switching Characteristics		
tRISE, tFALL (10/90% or 90/10% RF)		7 ns Typ
tON, tOFF (50% CTL to 90/10% RF)		10 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)		0/–5
0.5 – 4 GHz		15 dBm Typ
Control Voltages (Complementary Logic)		
	$V_{IN}L_{OW}$	0 to –0.2V @ 9 µA Max
	$V_{IN}H_{I}$	–5V @ 50 µA Typ Max
Die Size		0.025″ x 0.030″ x 0.010″ (1.63mm x 0.75mm x 0.25mm)

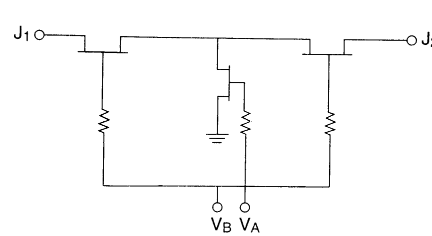
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages

*** Loss change 0.00025 dB/°C (-55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MAAA2000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MAAA2000 should be handled in a clean environment. DO NOT attempt to clean unit after the MAAA2000 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MAAA2000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port A or B only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MAAA2000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MAAA2000 is back-metallized with Pd/Ni/Au(100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with electrically conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MAAA2000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MAAA2000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

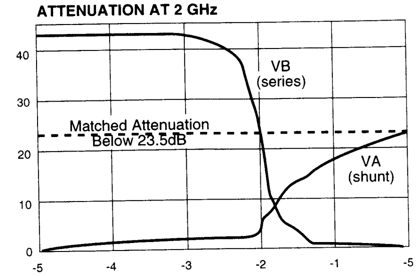
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

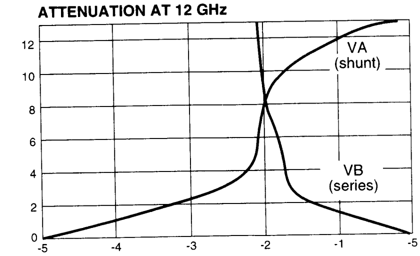
A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

ATTENUATION AT 2 GHz



ATTENUATION AT 12 GHz



Maximum Ratings
A. Control Voltage : -8.5 Vdc
B. Max Input RF Power: +34 dBm (500 MHz - 12 GHz)
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

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M/A-COM
an AMP company

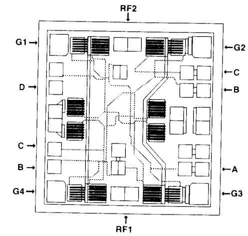
GaAs MMIC Variable Attenuator, 50 dB DC - 2 GHz

MAAA2010G

V 2.00

Features

- Single** or Dual DC Bias Control
- Easily Cascadable
- 50 dB Attenuation Range (Dual Bias)
- Low Control Current Consumption (100 μA)
- Low Phase Shift



Guaranteed Specifications** @+25°C***

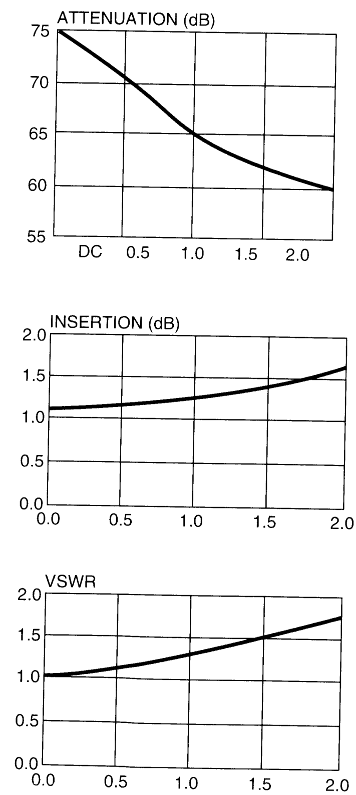
Frequency Range	DC - 12.0 GHz	
Insertion Loss	DC - 1 GHz DC - 2 GHz	1.4 dB Max 1.8 dB Max
VSWR	DC - 1 GHz DC - 2 GHz	1.4 Max 1.8 Max
Relative Attenuation	DC - 2 GHz	50 dB Min

Operating Characteristics***

Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		5 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		10 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	
0.5 - 12 GHz	+15 dBm	
Control Voltages (Complementary Logic)		
V_{IN}Low	0 to -0.2V @	μA Max
V_{IN}Hi	-5V @ 10 μA Typ to -8V @	μA Max
Die Size		0.053" x 0.053" x 0.010" (1.30mm x 1.34mm x 0.25mm)

** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -8 Vdc control voltages.
*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance for Dual Bias



FREQUENCY (GHz)

Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MAAA2010 may occur if the following precautions are not adhered to:

A. Cleanliness – The MAAA2010 should be handled in a clean environment. DO NOT attempt to clean unit after the MAAA2010 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MAAA2010. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port A or B only when the other is grounded. Neither port should be allowed to "float".

E. General Handling – It is recommended that the MAAA2010 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MAAA2010 is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MAAA2010 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MAAA2010 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

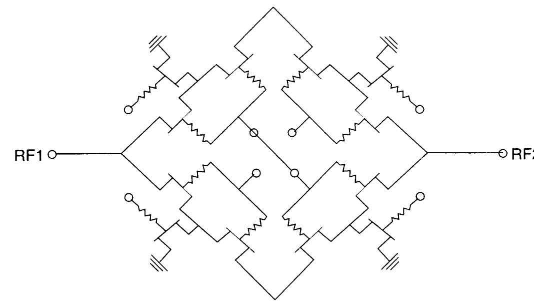
C. Electrically conductive epoxy may be used but is not required.

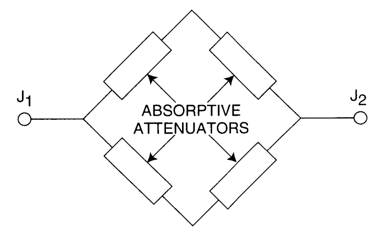
Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermo- sonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

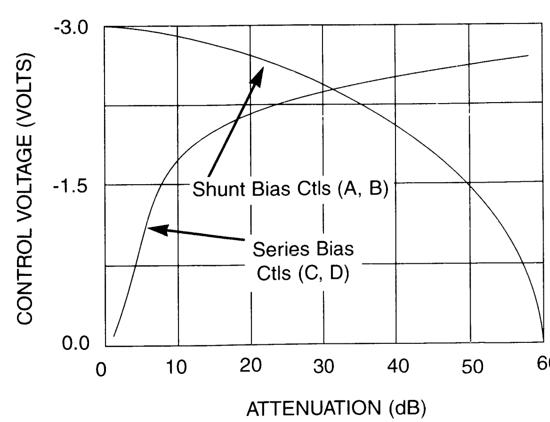
Attenuator Equivalent Circuit





Maximum Ratings
A. Control Voltage (A, B, C, D): -8.5 Vdc
B. Max Input RF Power: +34 dBm
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

Nominal Attenuator Control Voltages vs Attenuation



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an AMP company

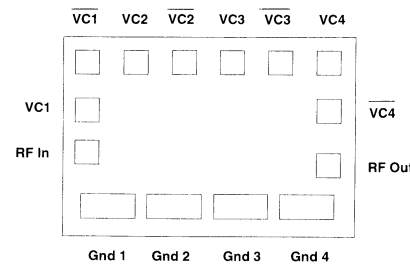
4 Bit GaAs Digital Attenuator DC -12 GHz

MADA12000

V 2.00

Features

- Ultra Broadband Performance
- Attenuation, 1 dB Steps to 15 dB
- Very Low DC Power Consumption
- Fast Switching Time, 10 ns Typical to 90% RF
- Low Phase Deviation, 20 Degrees Typical @ 6 GHz
- Small Size, 48 x 33 mils



Guaranteed Specifications* –55°C to +85°C

Frequency Range	DC –12.0 GHz
Nominal Attenuation**	1 dB Steps to 15 dB Max

Attenuation Accuracy ± _ dB ± _ % of Attenuation Setting

Atten(dB)	DC – 5	5 – 8	8 – 12
1 – 3	± 0.25dB ±14%	± 0.25dB ± 12%	± 0.2dB ± 4%
4 – 8	± 0.25dB ± 7%	± 0.2dB ± 6%	± 0.2dB ± 3%
9 – 15	± 0.25dB ± 8%	± 0.2dB ± 7%	± 0.2dB ± 3%

Reference Insertion Loss	DC – 2.0 GHz	3.00 dB Max
	DC – 6.0 GHz	3.50 dB Max
	DC – 12.0 GHz	4.25 dB Max
VSWR	DC – 2.0 GHz	1.6:1 Max
	DC – 6.0 GHz	1.7:1 Max
	DC – 12.0 GHz	1.8:1 Max

Operating Characteristics

Impedance — 50Ω Nominal

Phase Deviation (All states—relative to reference)

2 GHz	0/+7 Degrees Typ
6 GHz	0/+20 Degrees Typ
12 GHz	0/+40 Degrees Typ

Switching Characteristics
Switching Time (50% CTL to 90/10% RF)
10 ns Typ
Switching Transients (Unfiltered) — 10 mV Typ

Input Power for 1dB Compression

ABOVE 500 MHz	+27 dBm Typ
100 MHz	+20 dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +5dBm)

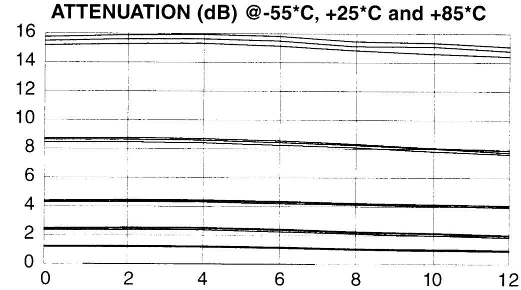
Intercept Points	IP2	P3
ABOVE 500 MHz	+68	+45 dBm Typ
20 MHz – 500 MHz	+45	+26 dBm Typ

Control Voltages (Complementary Logic)
VINLow — 0 to –0.2V @ 5 μA Max
VINHi — –5V @ 32μA Typ to –8V @ 200μA Max
Control Lines — 2 bits Complementary 2 single control

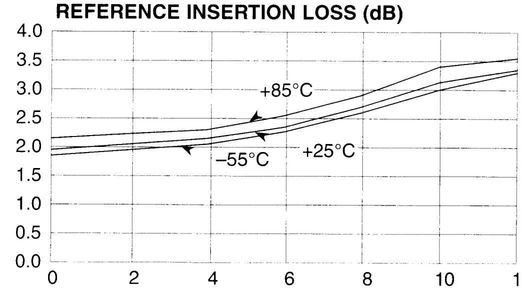
Die Size — 0.048"X 0.033"X 0.004" (1.22mm X 0.81mm X 0.10mm)

* AA specifications apply with 50Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages.
** Above reference insertion loss.

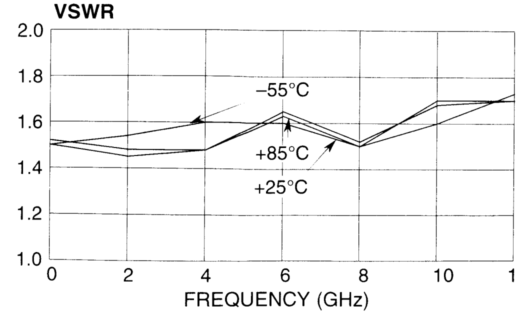
ATTENUATION (dB) @-55*C, +25*C and +85*C



REFERENCE INSERTION LOSS (dB)



VSWR



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MADA12000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MADA12000 should be handled in a clean environment. DO NOT attempt to clean unit after the MADA12000 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MADA12000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either of the complementary control ports only when the other is grounded. No port should be allowed to "float".

E. General Handling — It is recommended that the MADA12000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MADA12000 is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MADA12000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MADA12000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

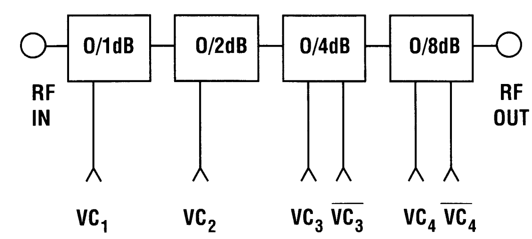
B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible.



DA12000 Truth Table
Control Input

VC1	VC2	VC3	$\overline{VC3}$	VC4	$\overline{VC4}$	Attenuator Setting
VinHi	VinHi	VinHi	VinLow	VinHi	VinLow	Reference
VinLow	VinHi	VinHi	VinLow	VinHi	VinLow	1 dB
VinHi	VinLow	VinHi	VinLow	VinHi	VinLow	2 dB
VinHi	VinHi	VinLow	VinHi	VinHi	VinLow	4 dB
VinHi	VinHi	VinHi	VinLow	VinLow	VinHi	8 dB

Vin Low: 0 to –0.2V
VinHi: –5V

Maximum Ratings

A.	Control Voltage:	–8.5 Vdc
B.	Max Input RF Power: (500 MHz – 4 GHz)	+34 dBm
C.	Storage Temperature:	–65°C to +175°C
D.	Maximum Operating Temperature:	+175°C

Bonding Pad Dimensions
Inches (mm)

RFIN, RFOUT:	0.004 x 0.004 (0.100 x 0.100)
VC1,VC2,VC3,VC4:	0.004 x 0.004 (0.100 x 0.100)
VC3,VC4:	0.004 x 0.004 (0.100 x 0.100)
GND1,GND2,GND3,GND4:	0.009 x 0.004 (0.225 x 0.100)

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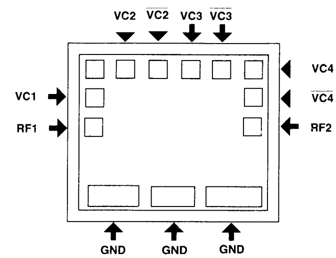
4 Bit GaAs Digital Attenuator DC - 2 GHz

MADA2000G

V 2.00

Features

- Attenuation 1dB Steps to 15 dB
- Temperature Stability ±0.1dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%



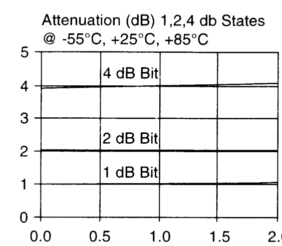
Guaranteed Specifications (From -55°C to +85°)

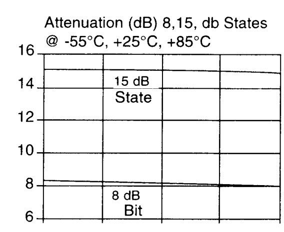
Frequency Range		DC - 2.0 GHz
Nominal Attenuation		1 dB Steps to 15 dB Max
Attenuation Accuracy	±0.15 dB	±3% of Attenuation Setting
VSWR **Worst Case Setting**	DC - 2 GHz	1.6:1 Max
Reference Insertion Loss	DC - 2 GHz DC - 1 GHz	2.2 dB Max 1.8 dB Max

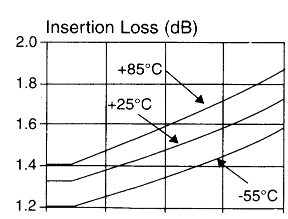
Operating Characteristics

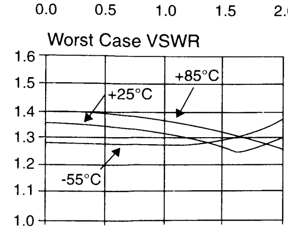
Impedance		50 Ω Nominal
Phase Deviation (All states)		
2 GHz		+5/-6 Degrees Typ
1 GHz		+3/-3 Degrees Typ
500 MHz		+2/-2 Degrees Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 1 dB Compression		
Above 500 MHz		+27 dBm Typ
100 MHz		+24 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
Above 500 MHz	+68 dBm Typ	+45 dBm Typ
100 MHz	+45 dBm Typ	+40 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2V @ 5μA Max
V_{IN}Hi		-5V @ 75 μA Typ to -8V @ 250μA Max
Die Size		0.045" x 0.039" x 0.010" (1.14mm x 0.99mm x 0.25mm)

Typical Performance









Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MADA2000G may occur if the following precautions are not adhered to:

A. Cleanliness – The MADA2000G should be handled in a clean environment. DO NOT attempt to clean unit after the MADA2000G is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MADA2000G. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either complementary control ports only when the other is grounded. Neither port should be allowed to "float".

E. General Handling – It is recommended that the MADA2000G chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MADA2000G is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MADA2000G to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MADA2000G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

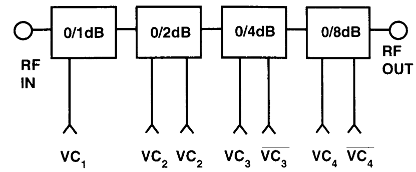
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermo- sonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Schematic



DA2000 Truth Table
Control Input

VC1	VC2	$\overline{VC2}$	VC3	$\overline{VC3}$	VC4	$\overline{VC4}$	Attenuation Settings
V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	Reference
V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	1dB
V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	2dB
V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	4dB
V_{in}Hi	V_{in}Hi	V_{in}Low	Vi_{n}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	8dB

V_{in}Low 0 t0 -0.2V
V_{in}Hi -5V to -8V

Maximum Ratings

A. Control Voltage : -8.5 Vdc

B. Max Input RF Power: +34 dBm (500 MHz - 4 GHz)

C. Storage Temperature: -65°C to +175°C

D. Maximum Operating Temperature: +175°C

Bonding Pad Dimensions
Inches (mm)

RFin, RFout: 0.004" x 0.004" (0.100mm x 0.100mm)
VC1,VC2,$\overline{VC2}$,VC3,$\overline{VC3}$,VC4,$\overline{VC4}$: 0.004" x 0.004" (0.100mm x 0.100mm)
GND1,GND2,GND3: 0.009" x 0.004" (0.229mm x 0.100mm)

Die Size
Inches (mm)

0.045" x 0.039" x 0.010"
(1.14mm x 0.99mm x 0.25mm)

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M/A-COM
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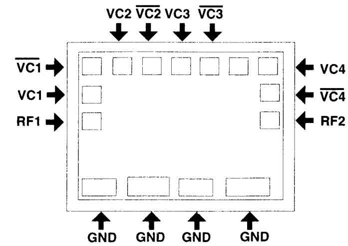
4-Bit GaAs Digital Attenuator DC - 2 GHz

MADA2010G

V 2.00



Features

- Attenuation 2-dB Steps to 30 dB
- Temperature Stability ±0.1dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%

Guaranteed Specifications (From -55°C to +85°)

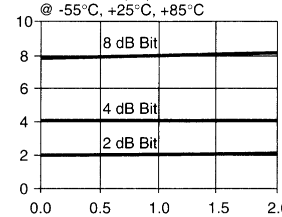
Frequency Range		DC - 2.0 GHz
Nominal Attenuation		1 dB Steps to 15 dB Max
Attenuation Accuracy	±0.15 dB	±3% of Attenuation Setting
VSWR Worst Case Setting	DC - 2 GHz	1.6:1 Max
Reference Insertion Loss	DC - 2 GHz	2.4 dB Max
	DC - 1 GHz	2.0 dB Max

Operating Characteristics

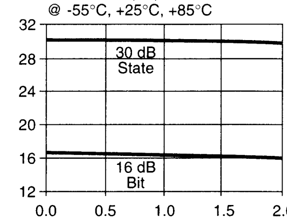
Impedance		50 Ω Nominal
Phase Balance (For any bit or combinations of bits per unit)		
2 GHz		+2/-25 Degrees Typ
1 GHz		+1/-13 Degrees Typ
500 MHz		+1/-8 Degrees Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 1 dB Compression		
Above 500 MHz		+27 dBm Typ
100 MHz		+24 dBm Typ
Intermodulation Intercept Point (for two-tone input pwer up to +5 dBm)		
Intercept Points	IP_2	IP_3
Above 500 MHz	+68 dBm Typ	+45 dBm Typ
100 MHz	+45 dBm Typ	+40 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2V @ 5µA Max
V_{IN}Hi		-5V @ 75 µA Typ to -8V @ 250µA Max
Die Size		0.051" x 0.039" x 0.010" (1.29mm x 0.99mm x 0.25mm

Typical Performance

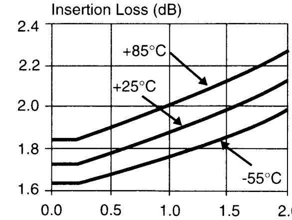
Attenuation (dB) 2,4,8 db States @ -55°C, +25°C, +85°C



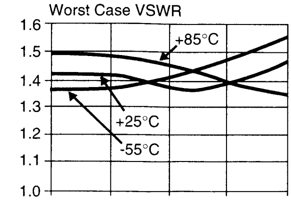
Attenuation (dB) 16,30, db States @ -55°C, +25°C, +85°C



Insertion Loss (dB)



Worst Case VSWR



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MADA2010G may occur if the following precautions are not adhered to:

A. Cleanliness – The MADA2010G should be handled in a clean environment. DO NOT attempt to clean unit after the MADA2010G is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MADA2010G. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either complementary control ports only when the other is grounded. Neither port should be allowed to "float".

E. General Handling – It is recommended that the MADA2010G chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MADA2010G is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MADA2010G to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MADA2010G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

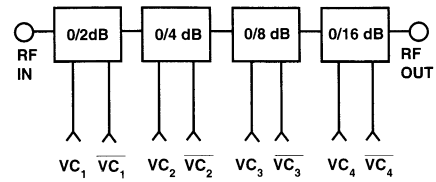
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermo- sonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Schematic



DA2010 Truth Table
Control Input

VC1	$\overline{VC1}$	VC2	$\overline{VC2}$	VC3	VC3	VC4	VC4	Attenuation Settings
V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	Reference
V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	2dB
V_{in}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	4dB
V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	8dB
V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	16dB

V_{in}Low 0 to -0.2 V
V_{in}Hi -5 V to -8 V

Maximum Ratings

A. Control Voltage : -8.5 Vdc

B. Max Input RF Power: +34 dBm (500 MHz - 4 GHz)

C. Storage Temperature: -65°C to +175°C

D. Maximum Operating Temperature: +175°C

BondPad Dimensions
Inches (mm)

RFin, RFout: 0.004" x 0.004" (0.100mm x 0.100mm)
VC1,$\overline{VC1}$,VC2,$\overline{VC2}$,VC3,VC3,VC4,VC4: 0.004" x 0.004" (0.100mm x 0.100mm)
GND1,GND2,GND3,GND4: 0.009" x 0.004" (0.229mm x 0.100mm)

Die Size
Inches (mm)

0.051" x 0.039" x 0.010"
(1.29mm x 0.99mm x 0.25mm)

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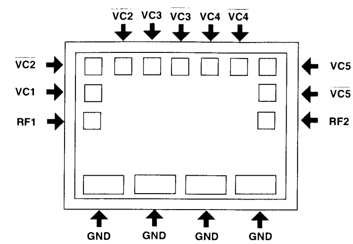
5-Bit GaAs Digital Attenuator DC - 2 GHz

MADA2020G

V 2.00



Features

- Attenuation 1dB Steps to 31 dB
- Temperature Stability ±0.1dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%

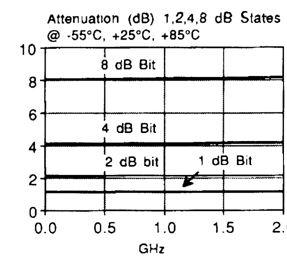
Guaranteed Specifications (From -55°C to +85°)

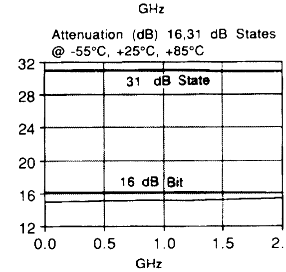
Frequency Range		DC - 2.0 GHz
Nominal Attenuation		1 dB Steps to 31 dB Max
Attenuation Accuracy	±0.2 dB	±3% of Attenuation Setting
VSWR Worst Case Setting	DC - 2 GHz	1.6:1 Max
Reference Insertion Loss	DC - 2 GHz	2.5 dB Max
	DC - 1 GHz	2.2 dB Max

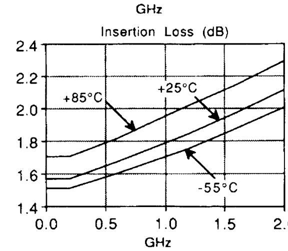
Operating Characteristics

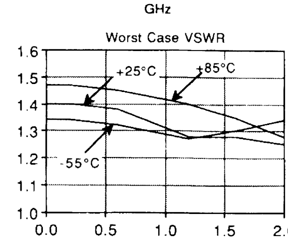
Impedance		50 Ω Nominal
Phase Balance (For any bit or combinations of bits per unit)		
2 Ghz		+3/20 Degrees Typ
1 Ghz		+1/-10 Degrees Typ
500 MHz		+1/-6 Degrees Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 1 dB Compression		
Above 500 MHz		+27 dBm Typ
100 MHz		+24 dBm Typ
Intermodulation Intercept Point (for two-tone input pwer up to +5 dBm)		
Intercept Points	IP_2	IP_3
Above 500 Mhz	+68 dBm Typ	+45 dBm Typ
100 MHz	+45 dBm Typ	+40 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2 V @ 5 μA Max
V_{IN}Hi		-5 V @ 75 μA Typ to -8 V @ 250 μA Max
Die Size		0.051" x 0.039" x 0.010" (1.29mm x 0.99mm x 0.25mm)

Typical Performance









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V 2.00

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B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

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A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MADA2020G to a temperature greater than 320°C for more than 20 seconds. No more than 30 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MADA2020G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermo- sonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

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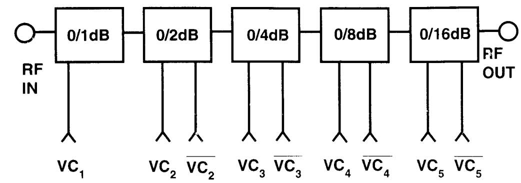
Schematic



MADA 2020 Truth Table Control Inputs

VC1	VC2	$\overline{VC2}$	VC3	$\overline{VC3}$	VC4	$\overline{VC4}$	VC5	$\overline{VC5}$	Attenuator Setting
V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	Reference
V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	1dB
V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	2dB
V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	4dB
V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Low	V_{IN}Low	V_{IN}Hi	V_{IN}Low	8dB
V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	16dB

V_{IN} Low 0 to -0.2 V
V_{IN} Hi -5 V to -8 V

Maximum Ratings

A. Control Voltage: -8.5 Vdc

B. Max Input RF Power: +34 dBm (500 MHz - 4 GHz)

C. Storage Temperature: -65°C to +175°C

D. Maximum Operating Temperature: +175°C

BondPad Dimensions Inches (mm)

RF_{IN}, RF_{OUT}: 0.004" x 0.004" (0.100mm x 0.000mm)

VC1,VC2,$\overline{VC2}$,VC3,$\overline{VC3}$,VC4,$\overline{VC4}$,VC5,$\overline{VC5}$: 0.004" x 0.004" (0.100mm x 0.100mm)

GN1, GN2, GN3, GN4: 0.009" x 0.004" (0.229mm x 0.100mm)

Die Size Inches (mm)

0.051" x 0.039" x 0.010"
(1.29mm x 0.99mm x 0.25mm)

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an AMP company

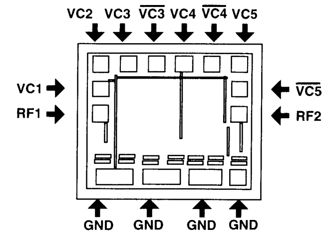
5-Bit GaAs Digital Attenuator DC - 2 GHz

MADA2030G

V 2.00

Features

- Attenuation 0.5-dB Steps to 15.5 dB
- Temperature Stability ±0.1 dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%



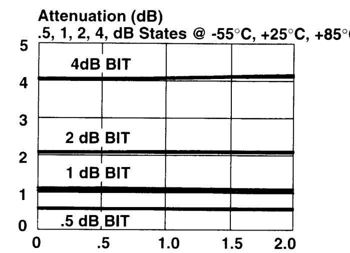
Guaranteed Specifications (From -55°C to +85°C)

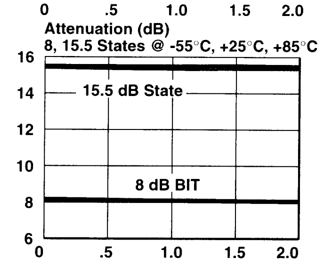
Frequency Range		DC - 2.0 GHz
Nominal Attenuation		0.5 dB Steps to 15.5 dB Max
Attenuation Accuracy	±0.15 dB	±3% of Attenuation Setting
VSWR Worst Case Setting	DC - 2 GHz	1.6:1 Max
Reference Insertion Loss	DC - 2 GHz	2.3 dB Max
	DC - 1 GHz	1.9 dB Max

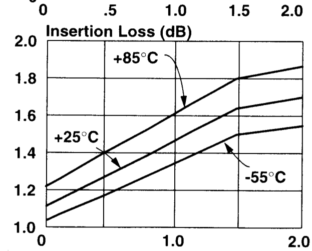
Operating Characteristics

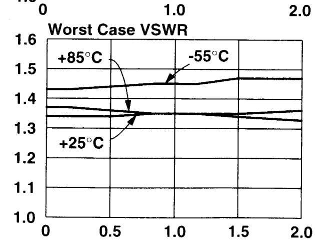
Impedance		50 Ω Nominal
Phase Balance (For any bit or combinations of bits per unit)		
2 GHz		+4/-6 Degrees Typ
1 GHz		+2/-3 Degrees Typ
500 MHz		+1/-2 Degrees Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 1 dB Compression		
Above 500 MHz		+27 dBm Typ
100 MHz		+24 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
Above 500 MHz	+68 dBm Typ	+45 dBm Typ
100 MHz	+45 dBm Typ	+40 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2 V @ 5 µA Max
V_{IN}Hi		-5 V @ 75 µA Typ to -8 V @ 250 µA Max
Die Size		0.045" x 0.039" x 0.010" (1.14mm x 0.99mm x 0.25mm

Typical Performance









Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MADA2030 may occur if the following precautions are not adhered to:

A. Cleanliness – The MADA2030 should be handled in a clean environment. DO NOT attempt to clean unit after the MADA2030 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MADA2030. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either complementary control ports only when the other is grounded. Neither port should be allowed to “float”.

E. General Handling – It is recommended that the MADA2030 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MADA2030 is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MADA2030 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MADA2030 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer’s recommended schedule.

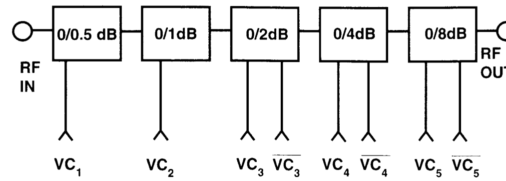
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermo- sonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Schematic



DA2030 Truth Table
Control Input

VC1	VC2	VC3	$\overline{VC3}$	VC4	$\overline{VC4}$	VC5	$\overline{VC5}$	Attenuation Settings
V_{in}Hi	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	Reference
V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	.5dB
V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	1dB
V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	2dB
V_{in}Hi	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	V_{in}Hi	V_{in}Low	4dB
V_{in}Hi	V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Low	V_{in}Hi	8dB

V_{in}Low	0 to -0.2V
V_{in}Hi	-5V to -8V

Maximum Ratings

A. Control Voltage : -8.5 Vdc

B. Max Input RF Power: +34 dBm (500 MHz - 4 GHz)

C. Storage Temperature: -65°C to +175°C

D. Maximum Operating Temperature: +175°C

BondPad Dimensions
Inches (mm)

RFin, RFout: 0.004" x 0.004" (0.100mm x 0.100mm)
VC1,VC2,VC3,$\overline{VC3}$,VC4,$\overline{VC4}$: 0.004" x 0.004" (0.100mm x 0.100mm)
GND1,GND2,GND3: 0.009" x 0.004"
GND4: 0.004" x 0.004" (0.100mm x 0.100mm)

Die Size
Inches (mm)

0.045" x 0.039" x 0.010"
(1.14mm x 0.99mm x 0.25mm)

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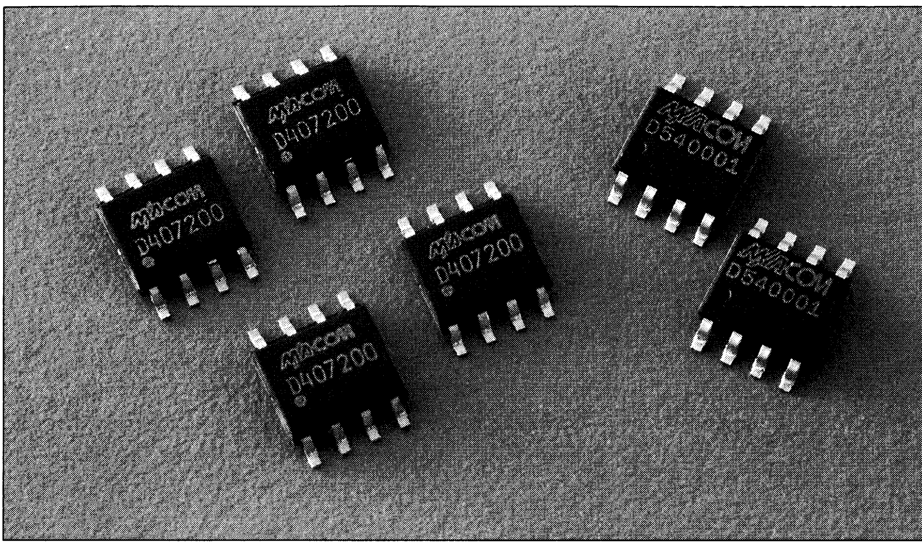
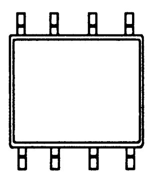
Mixers



Title	Page

Mixers

	Frequency Range RF (MHz)	IF (MHz)	Conv. Loss (dB)	Isolation LO-RF (dB)	LO-IF (dB)	RF-IF (dB)	Input 1 dB Comp Point	Part No.	Page No.
New	1400 - 2000	60	9.0	25	20	20	+3	MD40-7100	13-2
New	1700 - 2000	DC - 200	8.5	27	12	10	21	MD54-0003	13-8
New	700 - 1000	60	7.0	35	20	20	+3	MD40-7200	13-4
New	800 - 1000	DC - 100	7.5	38	22	12	21	MD54-0004	13-10
New	800 - 1000	DC - 100	7.8	40	-17	-13	+20	MD54-0001	13-6



SO-8

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Silicon Double Balanced Mixer 1400–2000 MHz

MD40-7100

V 2.00

Features

- 8.5 dB Noise Figure/Conversion Loss
- +17 dBm Input IP_3
- 30 dB LO/RF Isolation
- <20 dB LO to IF Isolation, RF to IF Isolation
- +4 to +10 dBm LO Drive Level
- DC -500 MHz IF Bandwidth
- Low Cost Plastic 8 Lead Package

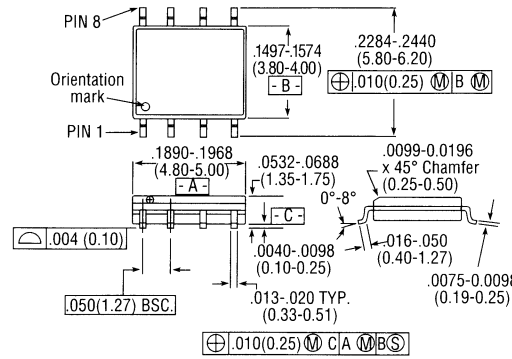
Description

M/A-COM's MD40-7100 is a passive double balanced mixer in a low cost surface mount plastic SOIC-8 lead package. The MD40-7100 is ideally suited for use where low power consumption is required. Typical applications include frequency up/down conversion, modulation, demodulation in 1800 MHz Personal Communication Network (PCN), Global Positioning System (GPS), 1500 MHz Japanese Digital Cellular (JDC-1500) and other wireless communication systems.

The MD40-7100 uses a Low Barrier schottky quad diode ring coupled with monolithic lumped element baluns to achieve very wide dynamic range in a low cost plastic package. The mixer operates with an LO drive level range of +4 to 10 dBm. The LO and RF ports are symmetrical, and therefore interchangeable.

M/A-COM's MD40-7100 is fabricated using a patented mature silicon process. The process features full IC passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Pin Configuration

Pin No.	Function	Pin No.	Function
1	GND	5	LO Port
2	IF Port	6	GND
3	GND	7	GND
4	GND	8	RF Port

Ordering Information

Model No.	Package
MD40-7100 PIN	SOIC 8 Lead
MD40-7100 TR	Forward Tape And Reel
MD40-7100 RTR	Reverse Tape and Reel

Electrical Specifications, T_A= 25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Conversion Loss	RF Frequency = 1400 to 2000 MHz	dB		9.0	11.5
Noise Figure	IF Frequency = 60 MHz	dB		9.0	
Isolation LO - IF	LO Drive = +7 dBm	dB		20	
Isolation LO - RF		dB		25	
Isolation RF - IF		dB		20	
VSWR LO Port				3.5:1	
VSWR RF Port				3.0:1	
VSWR IF Port	DC - 300 MHz			2.0:1	
IF Bandwidth	3 dB bandwidth	MHz		500	
Input 1 dB Compression	RF Freq.= 1550 MHz LO = +7 dBm	dBm		+3	
Input IP_3	RF Freq.= 1550 MHz LO = +7 dBm	dBm		+17.0	

Specifications Subject to Change Without Notice.

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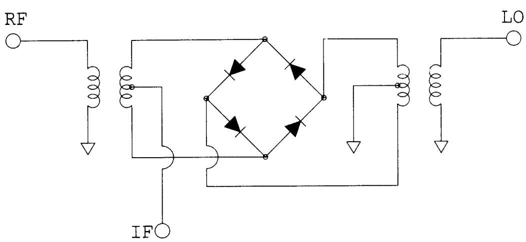
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Input Power	+17 dBm
LO Drive Power	+17 dBm
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

NOTES:
1. Operation of this device above any one of these parameters may cause permanent damage.
2. Total power for RF and LO ports should not exceeds +17 dBm.

Schematic



Spurious Table (dBC)

(n) Harmonic of LO		0X		1X		2X		3X		4X	
4X		33	X	51	41	54	50	> 65	43	> 65	62
		15	X	48	38	60	56	63	62	61	64
3X		20	X	33	20	51	45	57	42	> 65	59
		4	X	34	21	62	58	59	64	63	62
2X		17	X	29	25	48	37	> 65	45	> 65	> 65
		2	X	29	24	63	55	61	62	61	63
1X		13	X	4	0	41	44	60	44	> 65	> 65
		-2	X	4	0	57	54	64	63	60	63
0X		X	X	13	X	45	X	53	X	> 65	X
		X	X	14	X	61	X	63	X	63	X
		Harmonic of RF (m)									

The spurious table shows the spurious signals resulting from the mixing of the RF and LO input signals assuming down conversion. Mixing products are indicated by the number of dB below the conversion loss test.

Spurious Table Test Conditions

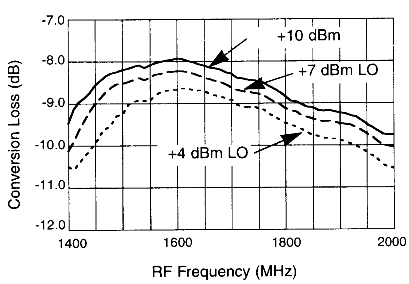
RF= -5 dBm	$nf_{LO} + mf_{RF}$	$nf_{LO} - mf_{RF}$
RF= -20 dBm	$nf_{LO} + mf_{RF}$	$nf_{LO} - mf_{RF}$

RF Frequency = 1550 MHz
LO Frequency = 1490 MHz

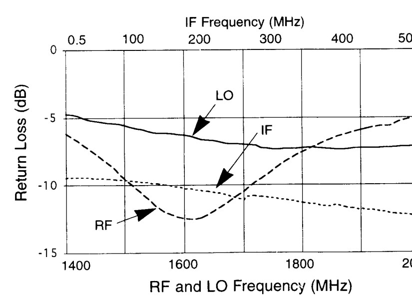
* Four spurious signal levels are shown in dBc for the test conditions where $nf_{LO} \pm mf_{RF}$ and RF Power is -5 or -20 dBm. (where n and m are integers).

Typical Performance

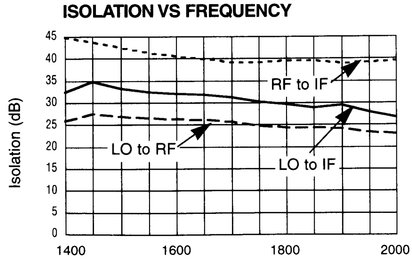
CONVERSION LOSS VS FREQUENCY



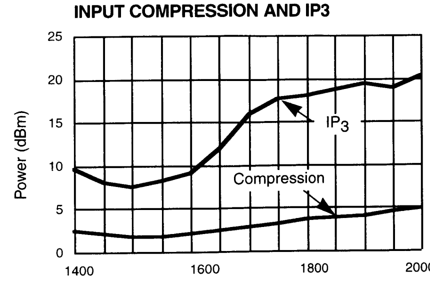
VSWR VS FREQUENCY



ISOLATION VS FREQUENCY



INPUT COMPRESSION AND IP3



Silicon Double Balanced Mixer 700–1000 MHz

MD40-7200

V 2.00

Features

- 7 dB Noise Figure/Conversion Loss
- +14 dBm Input IP_3
- 35 dB LO/RF Isolation
- <20 dB LO to IF Isolation, RF to IF Isolation
- +3 to +7 dBm LO Drive Level
- DC - 300 MHz IF Bandwidth
- Low Cost Plastic SOIC Package

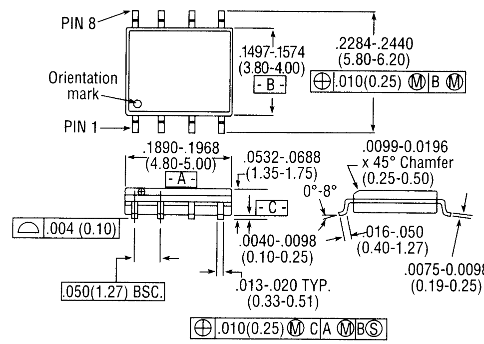
Description

M/A-COM's MD40-7200 is a passive double balanced mixer in a low cost surface mount plastic SOIC-8 lead package. The MD40-7200 is ideally suited for use where low LO drive and wide dynamic range are required. Typical applications include frequency up/down conversion, modulation, demodulation in systems such as 900 MHz cellular receivers and transmitters, and 900 MHz ISM Band applications.

The MD40-7200 uses a Low Barrier schottky quad diode ring coupled with monolithic lumped element baluns to achieve very wide dynamic range in a low cost plastic package. The mixer operates with an LO drive level range of +3 to +7 dBm. The LO and RF ports are symmetrical, and therefore interchangeable.

M/A-COM's MD40-7200 is fabricated using a patented mature silicon process. The process features full IC passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Pin Configuration

Pin No.	Function	Pin No.	Function
1	GND	5	RF Port
2	GND	6	GND
3	GND	7	GND
4	IF Port	8	LO Port

Ordering Information

Model No.	Package
MD40-7200 PIN	SOIC 8 Lead
MD40-7200 TR	Forward Tape And Reel
MD40-7200 RTR	Reverse Tape and Reel

Electrical Specifications, T_A= 25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Conversion Loss	RF Frequency = 700 to 1000 MHz	dB		7.0	8.5
Noise Figure	IF Frequency = 60 MHz	dB		7.0	
Isolation LO - IF	LO Drive = +5 dBm	dB		20	
Isolation LO - RF		dB		35	
Isolation RF - IF		dB		20	
VSWR LO Port				2.0:1	
VSWR RF Port				2.0:1	
VSWR IF Port	DC - 300 MHz			2.0:1	
IF Bandwidth	3 dB bandwidth	MHz		300	
Input 1 dB Compression	RF Freq.= 850 MHz LO = +5 dBm	dBm		+3	
Input IP_3	RF Freq.= 850 MHz LO = +5 dBm	dBm		+14.0	

Specifications Subject to Change Without Notice.

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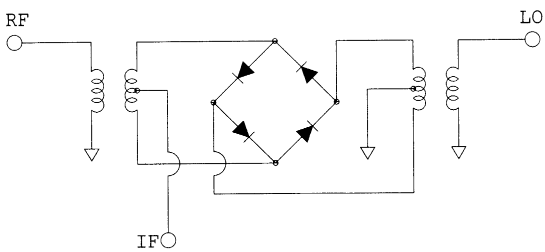
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Input Power	+17 dBm
LO Drive Power	+17 dBm
Operating Temperature	-40˚C to +85˚C
Storage Temperature	-65˚C to +150˚C

Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.
2. Total power for RF and LO ports should not exceed +17 dBm.

Schematic



Spurious Table (dBC)

(n) Harmonic of LO	0X	1X	2X	3X	4X
4X	23 X	52 39	> 65 > 65	> 65 55	> 65 > 65
	13 X	52 39	62 61	63 63	61 63
3X	14 X	53 33	55 44	> 65 51	> 65 > 65
	4 X	57 33	62 55	63 63	63 62
2X	13 X	28 27	57 41	> 65 64	> 65 > 65
	3 X	28 28	61 49	62 62	63 61
1X	1 X	20 0	54 49	> 65 > 65	> 65 > 65
	-8 X	20 0	60 59	62 61	62 61
0X	X X	7 X	48 X	64 X	> 65 X
	X X	7 X	58 X	61 X	62 X
	0X	1X	2X	3X	4X
	Harmonic of RF (m)				

The spurious table shows the spurious signals resulting from the mixing of the RF and LO input signals assuming down conversion. Mixing products are indicated by the number of dB below the conversion loss test.

Spurious Table Test Conditions

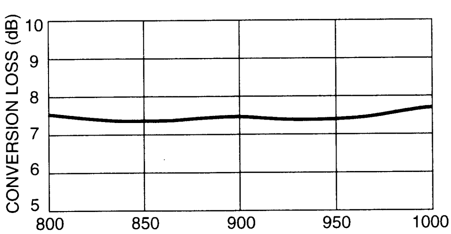
RF= -20 dBm	$nf_{LO} + mf_{RF}$	$nf_{LO} - mf_{RF}$
RF= -5 dBm	$nf_{LO} + mf_{RF}$	$nf_{LO} - mf_{RF}$

RF Frequency = 850 MHz
LO Frequency = 790 MHz

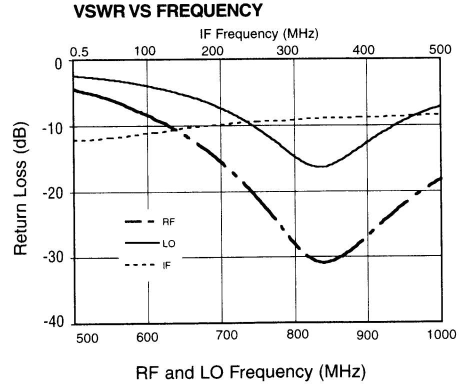
* Four spurious signal levels are shown in dBc for the test conditions where $nf_{LO} \pm mf_{RF}$ and RF Power is -5 or -20 dBm. (where n and m are integers).

Typical Performance

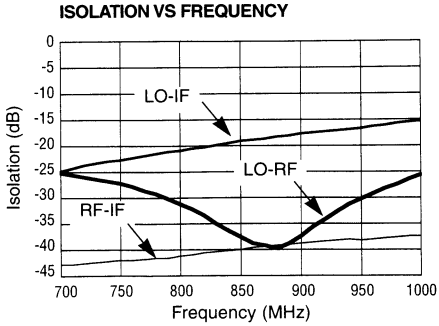
CONVERSION LOSS VS FREQUENCY



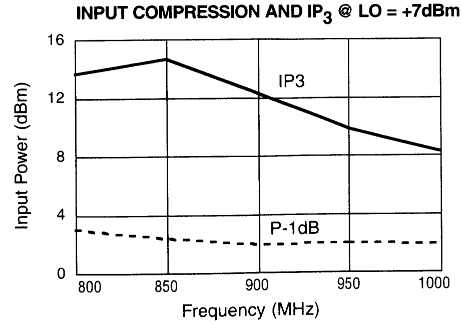
VSWR VS FREQUENCY



ISOLATION VS FREQUENCY



INPUT COMPRESSION AND IP_3 @ LO = +7dBm



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MMIC High Level Mixer 800 - 1000 MHz

MD54-0001

V 2.00

Features

- Low Conversion Loss
- +20 dBm Input Power @ 1 dB Compression
- LO Drive Level: +15 to +23 dBm
- DC - 100 MHz IF Bandwidth
- Low Cost Plastic SOIC Package

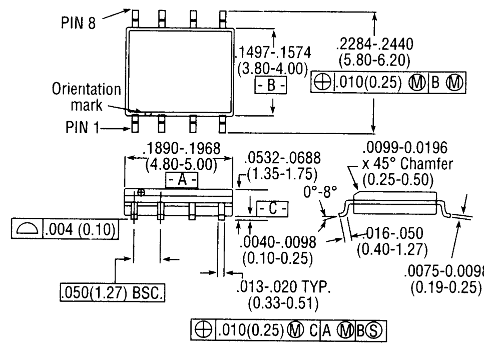
Description

M/A-COM's MD54-0001 is a passive mixer that achieves the performance of a double balanced diode mixer in a low cost surface mount plastic SOIC 8-lead package. The MD54-0001 is ideally suited for use where high level RF signals and very wide dynamic range are required. Typical applications include frequency up/down conversion, modulation, demodulation in systems such as cellular receivers and transmitters, and 900 MHz ISM band applications.

The MD54-0001 uses FETs as mixing elements to achieve very wide dynamic range in a low cost plastic package. The mixer operates with LO drive levels of +15 dBm to +23 dBm. DC bias is not required.

M/A-COM's MD54-0001 is fabricated using a mature 1-micron GaAs process. The process features full IC passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Description
MD54-0001	SOIC 8-Lead Plastic Package
MD54-0001TR	Forward Tape & Reel*
MD54-0001RTR	Reverse Tape & Reel*
MD54-0001SMB	Designer's Kit

* Standard reel size is 7 inches. If other reel size is required, consult factory for part number assignment.

Electrical Specifications

Test Conditions: RF = 900 MHz (-10 dBm), LO = 840 MHz (17 dBm), IF = 60 MHz, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Conversion Loss		dB		7.8	9.5
Isolation	LO to RF	dB		40	
	LO to IF (Absolute value)	dB		17	
	RF to IF (Absolute value)	dB		13	
VSWR	LO Port			2.5:1	
	RF Port			2.0:1	
	IF Port			2.0:1	
Input 1 dB Compression	RF Freq. = 900 MHz, LO = +17 dBm	dBm		+20	
Two-Tone IM Ratio1	Two tones at 0 dBm each, Tone spacing = 100 kHz, IF = 60 MHz	dBc		45	

1. IMR vs RF drive level can be calculated by the formula: IMR = 45 - (1.5 x P_{IN})

Specifications Subject to Change Without Notice.

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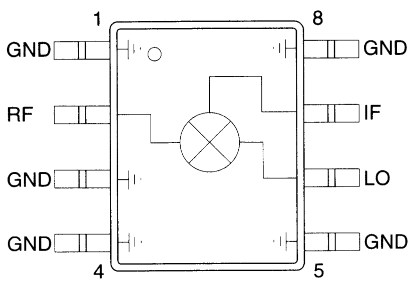
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
RF Input Power [2]	+22 dBm
LO Drive Power [2]	+23 dBm
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Total power for RF and LO ports should not exceed +27 dBm.

Functional Diagram



Spurious Table

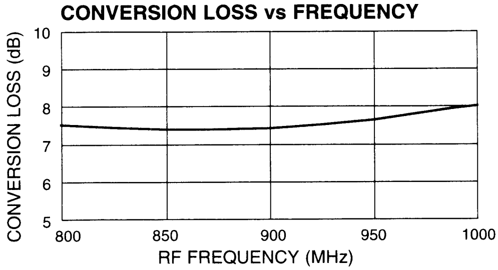
HARMONIC OF LO (n)	0x	1x	2x	3x	4x
4x	18.2	38.5	71.3	71.1	74.2
	8.3	38.1	61.3	63.7	64.2
3x	14.2	37.6	62	61.8	72.4
	4.2	37.3	63.6	64.3	62.8
2x	7.2	23.5	53.4	73	71.7
	-2.8	23.4	63.2	62.2	61.5
1x	-8.6	0	60.8	71.4	71.7
	-18.6	0	63	61.9	60
0x	X	5	61.6	71.6	70.5
	X	5	60.7	61.7	61.9
	HARMONIC OF RF (m)				

The spurious table shows the spurious signals resulting from the mixing of the RF and LO input signals, assuming down conversion. Mixing products are indicated by the number of dB below the conversion loss. The lower frequency mixing term is shown for two different RF input levels. The top number is for an RF input power of -5 dBm, the lower number is for -15 dBm.

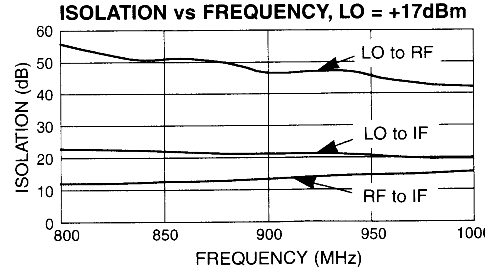
$|mF_{RF} - nF_{LO}|$, RF = -5 dBm
$|mF_{RF} - nF_{LO}|$, RF = -15 dBm
RF Frequency = 900 MHz
LO Frequency = 840 MHz

Typical Performance

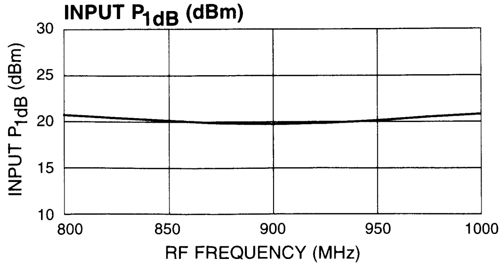
CONVERSION LOSS vs FREQUENCY



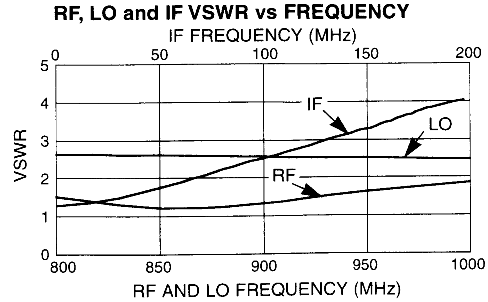
ISOLATION vs FREQUENCY, LO = +17dBm



INPUT P_{1dB} (dBm)



RF, LO and IF VSWR vs FREQUENCY



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MMIC Medium Level Mixer 1700 - 2000 MHz

MD54-0003

V 2.00

Features

- Low Conversion Loss
- +21 dBm Input Power @ 1 dB Compression
- Typical Two-Tone IM Ratio of ≥50 dBc
- LO Drive Level: +11 to +23 dBm
- DC - 200 MHz IF Bandwidth
- Low Cost Plastic SOIC Package

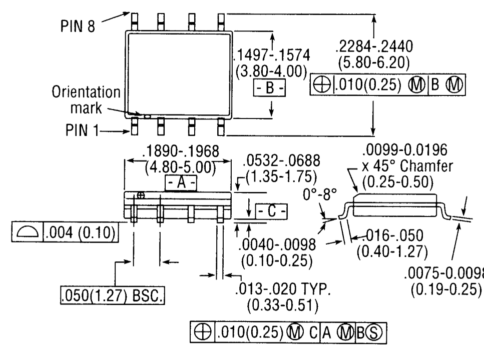
Description

M/A-COM's MD54-0003 is a passive mixer that achieves the performance of a double balanced diode mixer in a low cost surface mount plastic SOIC 8-lead package. The MD54-0003 is ideally suited for use where high level RF signals and very wide dynamic range are required. Typical applications include frequency up/down conversion, modulation, demodulation in systems such as base station receivers and transmitters for DCS1800, PCS and PHS applications.

The MD54-0003 uses FETs as mixing elements to achieve very wide dynamic range in a low cost plastic package. The mixer operates with LO drive levels of +11 dBm to +23 dBm. No DC bias is required.

M/A-COM's MD54-0003 is fabricated using a mature 1-micron GaAs process. The process features full IC passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Description
MD54-0003	SOIC 8-Lead Plastic Package
MD54-0003TR	Forward Tape & Reel*
MD54-0003RTR	Reverse Tape & Reel*
MD54-0003SMB	Designer's Kit

* Standard reel size is 7 inches. If other reel size is required, consult factory for part number assignment.

Electrical Specifications

Test Conditions: RF = 1850 MHz (-10 dBm), LO = 1710 MHz (13 dBm), IF = 140 MHz, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Conversion Loss		dB		8.5	9.5
Isolation	LO to RF	dB	20	27	
	LO to IF	dB		12	
	RF to IF	dB		10	
VSWR	LO Port			2.5:1	
	RF Port			2.0:1	
	IF Port			2.0:1	
Input 1 dB Compression	RF Freq. = 1800 MHz, LO = +13 dBm	dBm		+21	
Two-Tone IM Ratio1	Two tones at -10 dBm each, Tone spacing = 100 kHz, IF = 140 MHz	dBc	50	65	

1. IMR vs RF drive level can be calculated by the formula: IMR = 50 - (1.5 x P_{IN})

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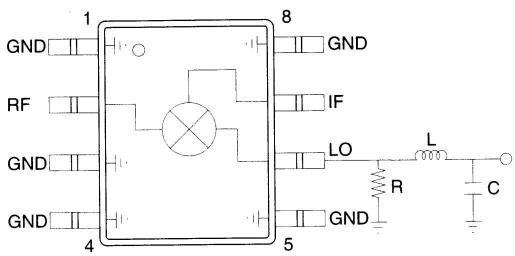
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
RF Input Power[2]	+22 dBm
LO Drive Power[2]	+23 dBm
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Total power for RF and LO ports should not exceed +23 dBm.

Functional Diagram[3]



3. External matching network on LO Port:
R = 330 ohms, L = 3 nH, C = 3.3 pF

Spurious Table

HARMONIC OF LO (n)					
4x	17	48.2	62.3	71.7	73.4
	6.9	47.2	61.1	61.7	63.4
3x	10.3	28.9	63.0	71.3	70.6
	0.3	28.9	61.3	63.5	61.6
2x	-8.8	25.7	52.1	71.5	72.1
	-18.8	25.9	61.3	61.5	62.1
1x	-13.1	0	67.5	71.3	72.6
	-23.1	0	61.1	61.9	62.6
0x	X	2.1	56.8	72.3	69.3
	X	2.1	61.7	62.3	59.8
	0x	1x	2x	3x	4x
	Harmonic of RF (m)				

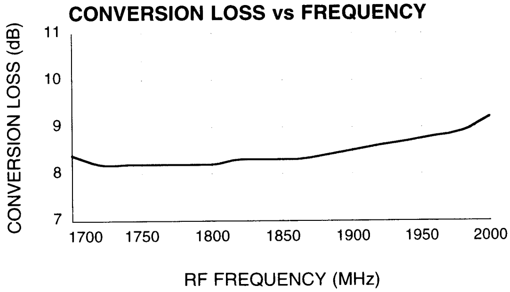
The spurious table shows the spurious signals resulting from the mixing of the RF and LO input signals, assuming down conversion. Mixing products are indicated by the number of dB below the conversion loss. The lower frequency mixing term is shown for two different RF input levels. The top number is for an RF input power of -5 dBm, the lower number is for -15 dBm.

$|mF_{RF} - nF_{LO}|$, RF = -5 dBm
$|mF_{RF} - nF_{LO}|$, RF = -15 dBm

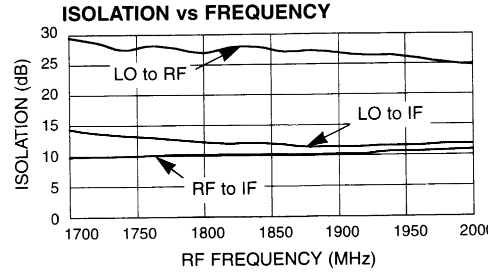
RF Frequency = 1850 MHz
LO Frequency = 1710 MHz

Typical Performance

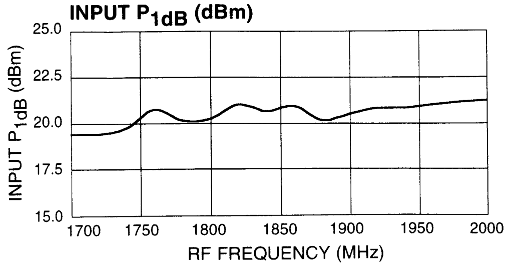
CONVERSION LOSS vs FREQUENCY



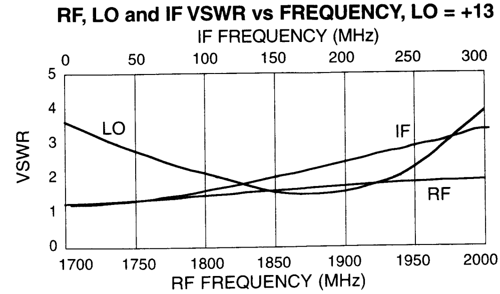
ISOLATION vs FREQUENCY



INPUT P_{1dB} (dBm)



RF, LO and IF VSWR vs FREQUENCY, LO = +13 dBm



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MMIC Medium Level Mixer 800 - 1000 MHz

MD54-0004

V 2.01

Features

- Low Conversion Loss
- +21 dBm 1 dB Compression
- LO Drive Level: +11 to +23 dBm
- DC - 100 MHz IF Bandwidth
- Low Cost Plastic SOIC Package

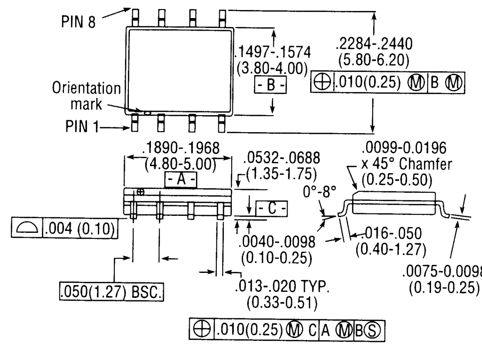
Description

M/A-COM's MD54-0004 is a passive mixer that achieves the performance of a double balanced diode mixer in a low cost surface mount plastic SOIC 8-lead package. The MD54-0004 is ideally suited for use where high level RF signals and very wide dynamic range are required. Typical applications include frequency up/down conversion, modulation, demodulation in systems such as cellular receivers and transmitters, and 900 MHz ISM band applications.

The MD54-0004 uses FETs as mixing elements to achieve very wide dynamic range in a low cost plastic package. The mixer operates with LO drive levels of +11 dBm to +25 dBm. DC bias is not required.

M/A-COM's MD54-0004 is fabricated using a mature 1-micron GaAs process. The process features full IC passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Description
MD54-0004	SOIC 8-Lead Plastic Package
MD54-0004TR	Forward Tape & Reel*
MD54-0004RTR	Reverse Tape & Reel*
MD54-0004SMB	Designer's Kit

* Standard reel size is 7 inches. If other reel size is required, consult factory for part number assignment.

Electrical Specifications

Test Conditions: RF = 900 MHz (-10 dBm), LO = 840 MHz (13 dBm), IF = 60 MHz, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Conversion Loss		dB		7.5	9.5
Isolation	LO to RF	dB		38	
	LO to IF	dB		22	
	RF to IF	dB		12	
VSWR	LO Port			2.5:1	
	RF Port			2.0:1	
	IF Port			2.0:1	
Input 1 dB Compression	RF Freq. = 900 MHz, LO = +13 dBm	dBm		+21	
Two-Tone IM Ratio1	Two tones at 0 dBm each, Tone spacing = 100 kHz, IF = 60 MHz	dBc		45	

1. IMR vs RF drive level can be calculated by the formula: IMR = 45 - (1.5 x P_{IN}).

Specifications Subject to Change Without Notice.

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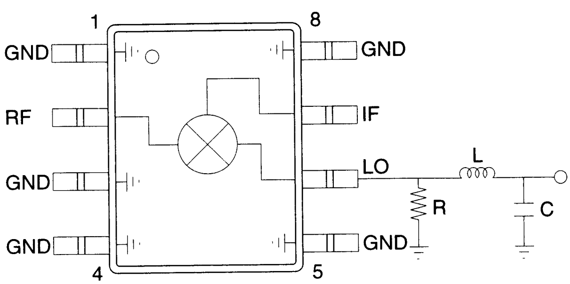
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
RF Input Power[2]	+22 dBm
LO Drive Power[2]	+23 dBm
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Total power for RF and LO ports should not exceed +23 dBm.

Functional Diagram[3]



3. External matching network on LO Port: R = 470 ohms, L = 18 nH, C = 4.7 pF

Spurious Table

HARMONIC OF LO (n)						
4x	8.9	40.1	70.1	69.9	73.4
	-1.1	39.9	61.6	63.9	64.4
3x	2.2	34.2	59.8	67.3	73
	-7.7	34.1	63.8	64.5	63
2x	2.9	23.7	72.8	72.9	71.9
	-7.1	23.8	64.7	63.3	61.9
1x	-2.2	0	61.4	71.3	71.1
	-12.2	0	63.3	61.8	61.9
0x	X	4.7	65.1	71.5	72.1
	X	4.8	61.3	61.9	62.3
	0x	1x	2x	3x	4x
	HARMONIC OF RF (m)				

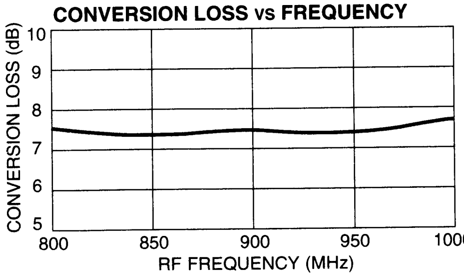
The spurious table shows the spurious signals resulting from the mixing of the RF and LO input signals, assuming down conversion. Mixing products are indicated by the number of dB below the conversion loss. The lower frequency mixing term is shown for two different RF input levels. The top number is for an RF input power of -5 dBm, the lower number is for -15 dBm.

$|mF_{RF} - nF_{LO}|$, RF = -5 dBm
$|mF_{RF} - nF_{LO}|$, RF = -15 dBm

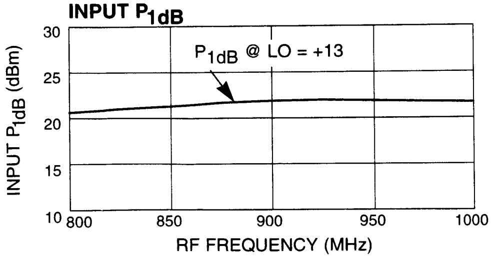
RF Frequency = 900 MHz
LO Frequency = 840 MHz

Typical Performance

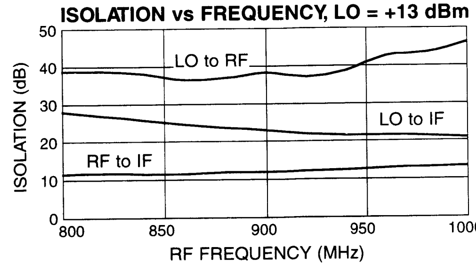
CONVERSION LOSS vs FREQUENCY



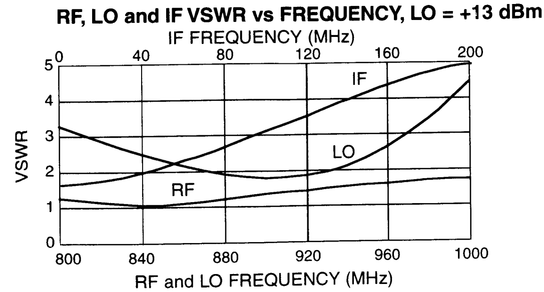
INPUT P_{1dB}



ISOLATION vs FREQUENCY, LO = +13 dBm



RF, LO and IF VSWR vs FREQUENCY, LO = +13 dBm



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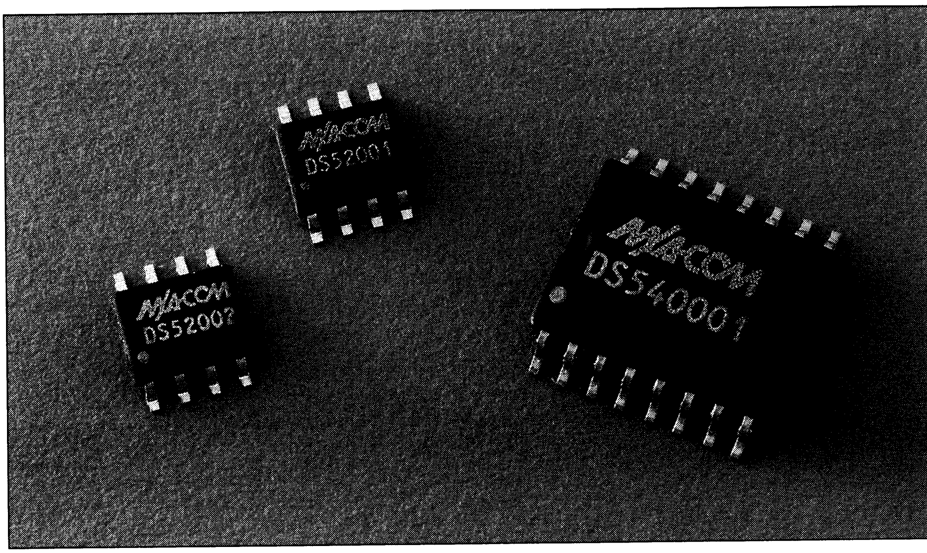
Power Splitters/Combiners



Power Splitters/Combiners

	Frequency (MHz)	Insertion Loss (dB) Typ.	Isolation (dB) Typ.	VSWR Typ.	Amplitude Balance (dB) Typ.	Phase Balance (°) Typ.	Part No.	Page No.
2-Channel								
	824 - 960	0.5	23	1.2:1	0.05	0.5	DS52-0001	14-6
	1510 - 1660	0.4	20	1.3:1	0.05	1	DS52-0004	14-12
	1700 - 1900	0.3	20	1.3:1	0.05	2	DS52-0005	14-14
	1850 - 1990	0.5	21	1.2:1	0.05	1	DS52-0002	14-8
	2200 - 2500	0.3	20	1.3:1	0.05	3	DS52-0003	14-10
3-Channel								
New	824 - 960	0.5	23	1.2:1	0.25	3	DS53-0001	14-2
New	1850 - 1990	0.5	23	1.2:1	0.25	3	DS53-0004	14-2
4-Channel								
	824 - 960	1	23	1.2:1	0.30	2	DS54-0001	14-16
	1200 - 1660	1	23	1.2:1	0.30	2	DS54-0003	14-20
	1700 - 2000	1	23	1.4:1	0.30	3	DS54-0002	14-18
New	2200 - 2500	1	21	1.4:1	0.20	2	DS54-0004	14-3
6-Channel								
	824 - 960	1.3	25	1.4:1	0.30	6	DS56-0001	14-22
New	1200 - 1660	1.3	22	1.5:1	0.40	8	DS56-0003	14-5
New	1700 - 2000	1.3	22	1.4:1	0.50	8	DS56-0002	14-5
New	2200 - 2500	1.3	22	1.4:1	0.60	8	DS56-0004	14-5

Stocked at your local distributor.

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Low Cost Three-Way SMT Power Splitter/Combiner

DS53 Series

V 2.00

Features

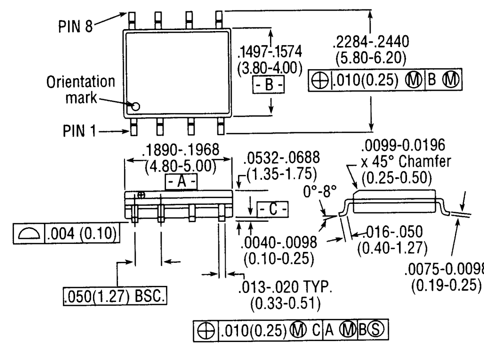
- Small Size, Low Profile
- Industry Standard SOW-16 SMT Plastic Package
- Superior Repeatability (Lot-to-Lot Variation)
- Typical Isolation: 25 dB
- Typical Insertion Loss: 0.5 dB
- Typical Amplitude Balance: 0.25 dB
- Low Cost

Description

M/A-COM's DS53 family is a series of IC-based monolithic power splitter/combiners in low cost SOIC-8 SMT plastic packages. This 3-way family is ideally suited for applications where PCB real estate and height are at a premium. Typical applications include base station switching networks, portables and PCMCIA cards. Available in tape and reel.

The DS53 family is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
DS53-0001	SOIC 8-Lead Plastic Package
DS53-0004	SOIC 8-Lead Plastic Package

* Available in tape and reel. Consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter	Units	DS53-0001	DS53-0004
Frequency	MHz	824-960	1850-1990
Insertion Loss	dB	0.5	0.5
Isolation	dB	23	23
VSWR		1.2:1	1.2:1
Amplitude Balance	dB	0.25	0.25
Phase Balance	°	3	3
Applications		GSM, AMPS, CDPD, RAM ARDIS	PCS, PCN, DECT, PHS

1. All specifications apply with a 50-ohm source and load impedance.

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M/A-COM an AMP company

Coming Attractions

Low Cost Four-Way SMT Power Splitter/Combiner 2200 - 2500 MHz

DS54-0004

V 2.00

Features

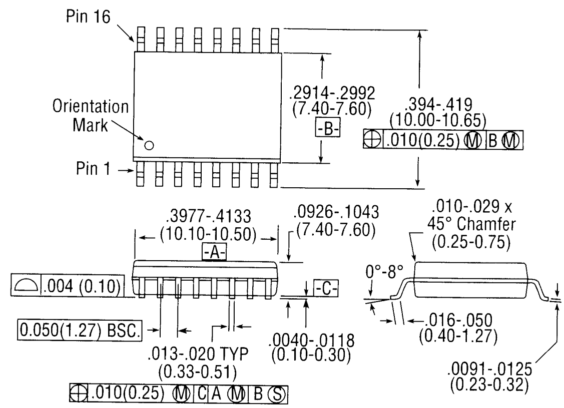
- Small Size and Low Profile
- Industry Standard SOW-16 SMT Plastic Package
- Superior Repeatability
- Insertion Loss: 1.0 dB Typical
- Isolation: 21 dB Typical
- Amplitude Balance: 0.2 dB Typical
- Low Cost

Description

M/A-COM's DS54-0004 is an IC-based monolithic power splitter/combiner in a low cost SOW 16-lead plastic package. This four-way power splitter/combiner is ideally suited for applications where small size, low profile and low cost, without sacrificing performance, are required. Typical applications include base stations, portables and PCMCIA cards for wireless data LAN/WAN and other applications using the 2200-2500 MHz frequency range. Available in tape and reel.

The DS54-0004 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SOW-16



16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
DS54-0004	SOW 16-Lead Plastic Package
DS54-0004-TR	Forward Tape & Reel*
DS54-0004-RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter	Units	Min.	Typ.	Max.
Insertion Loss Above 3.0 dB	dB		1.0	1.2
Isolation	dB	15	21	
VSWR Input			1.5:1	1.9:1
Output			1.4:1	1.7:1
Amplitude Balance	dB		0.2	0.5
Phase Balance	°		2	5

1. All specifications apply with a 50-ohm source and load impedance.

Specifications Subject to Change Without Notice.

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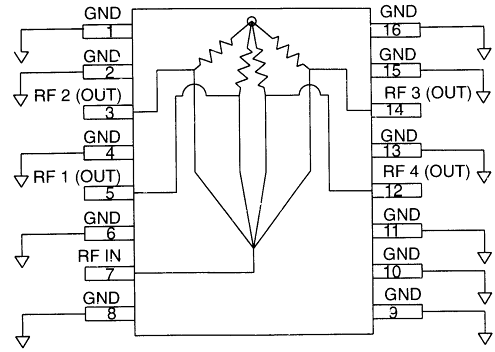
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Input Power[2]	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

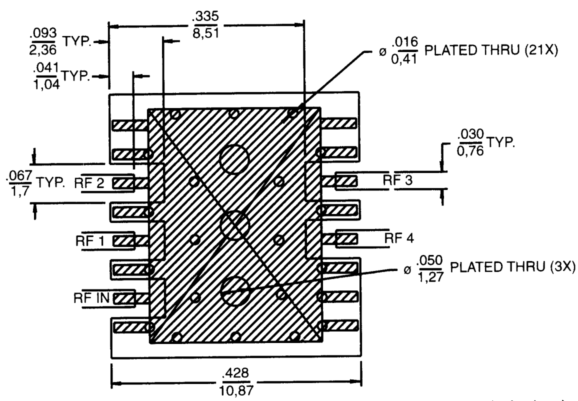
1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum.

Functional Diagram[3]



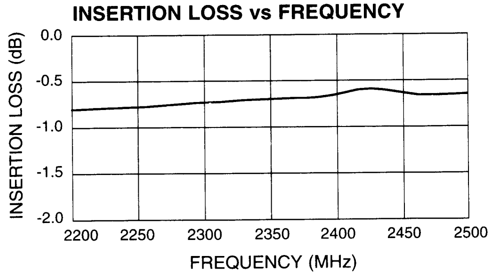
3. Pins 1, 2, 4, 6, 7, 8, 9, 10, 11, 13, 15 and 16 must be DC and RF grounded.

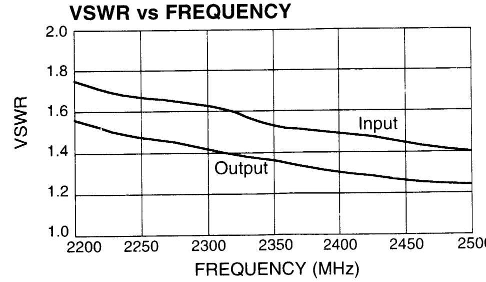
Recommended PCB Configuration

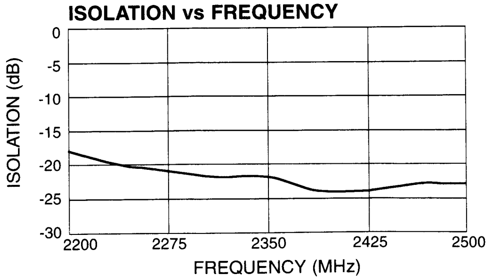


(Dimensions in Inches)

Typical Performance @ +25°C







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Low Cost Six-Way SMT Power Splitter/Combiner

DS56 Series

V 2.00

Features

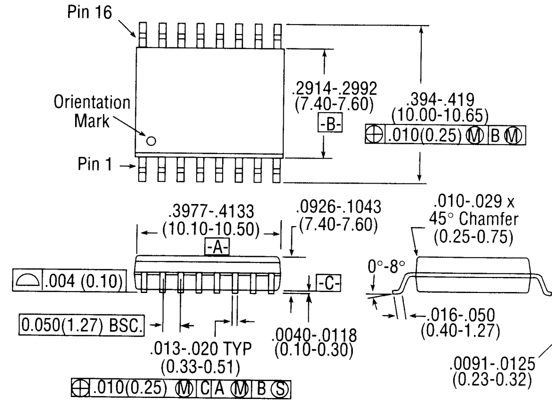
- Small Size, Low Profile
- Industry Standard SOW-16 SMT Plastic Package
- Superior Repeatability (Lot-to-Lot Variation)
- Typical Isolation: 25 dB
- Typical Insertion Loss: 1.3 dB
- Typical Amplitude Balance: 0.3 dB
- Low Cost

Description

M/A-COM's DS56 family is a series of IC-based monolithic power splitter/combiners in low cost SOW-16 plastic packages. These 6-way power splitters are ideally suited for applications where PCB real estate is at a premium and part count reduction and cost are critical. Typical applications include base station switching networks, portables and PCMCIA cards. Available in tape and reel.

The DS56 family is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SOW-16



16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
DS56-0002	SOW 16-Lead Plastic Package
DS56-0003	SOW 16-Lead Plastic Package
DS56-0004	SOW 16-Lead Plastic Package

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], $T_A = +25°C$

Parameter	Units	DS56-0003	DS56-0002	DS56-0004
Frequency	MHz	1200-1660	1700-2000	2200-2500
Insertion Loss	dB	1.3	1.3	1.3
Isolation	dB	22	22	22
VSWR		1.5:1	1.4:1	1.4:1
Amplitude Balance	dB	0.4	0.5	0.6
Phase Balance	°	8	8	8
Applications		GPS, LEOs	PCS, PCN, DECT, PHS, DCS-1800	Wireless Data, SST

1. All specifications apply with a 50-ohm source and load impedance.

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M/A-COM an AMP company

Low Cost Two-Way SMT Power Divider 824 - 960 MHz

DS52-0001

V 2.00

Features

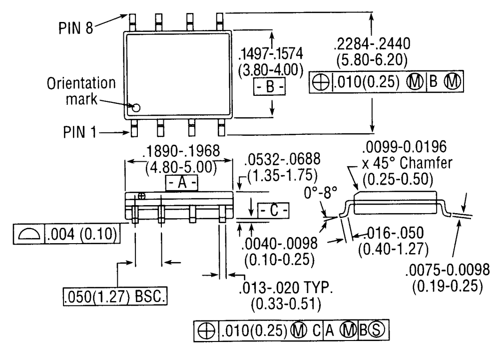
- Small Size and Low Profile
- Industry Standard SOIC-8 SMT Plastic Package
- Excellent Amplitude and Phase Balance
- Superior Repeatability
- Typical Insertion Loss 0.5 dB
- Typical Isolation 23 dB
- 1 Watt Power Handling

Description

M/A-COM's DS52-0001 is an IC based monolithic power divider in a low cost SOIC-8 plastic package. This 2-way power divider is ideally suited for applications where small size, low insertion loss, superior phase/amplitude tracking and low cost are required. Typical applications include base station switching networks and other communication applications where size and PCB real estate are at a premium. Available in tape and reel.

The DS52-0001 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
DS52-0001	SOIC 8-Lead Plastic Package
DS52-0001TR	Forward Tape and Reel*
DS52-0001RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter		Units	Min.	Typ.	Max.
Insertion Loss	Above 3.0 dB	dB		0.5	0.6
Isolation		dB	15	23	
VSWR	RF Input			1.4:1	1.6:1
	RF1, RF2 Outputs			1.2:1	1.4:1
Amplitude Balance		dB		0.05	0.1
Phase Balance		°		0.5	1.5

1. All specifications apply with a 50-ohm source and load impedance.

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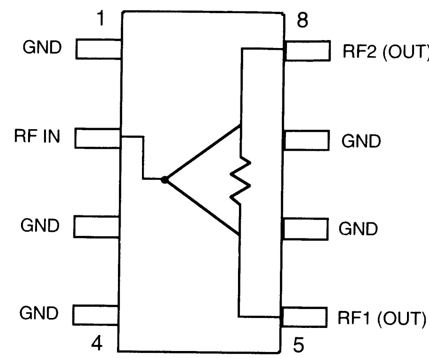
V 2.00

Absolute Maximum Ratings 1

Parameter	Absolute Maximum
Input Power2	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum

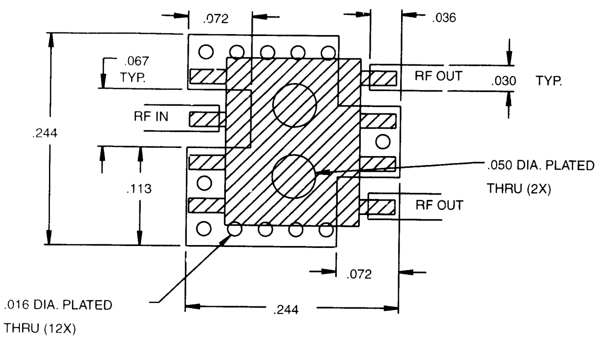
Functional Diagram 3



3. Pins 1, 3, 4, and 6 must be RF and DC grounded.

Recommended PCB Configuration

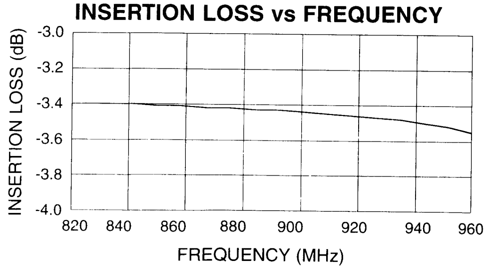
(Dimensions in Inches)



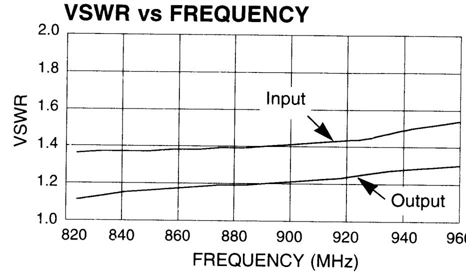
CIRCUIT MATERIAL: FR-4, .016 THIC

Typical Performance @ +25°C

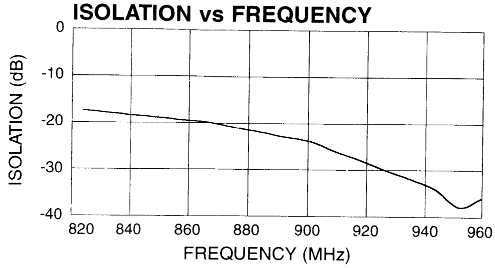
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



Specifications Subject to Change Without Notice.

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Low Cost Two-Way SMT Power Divider 1850 - 1990 MHz

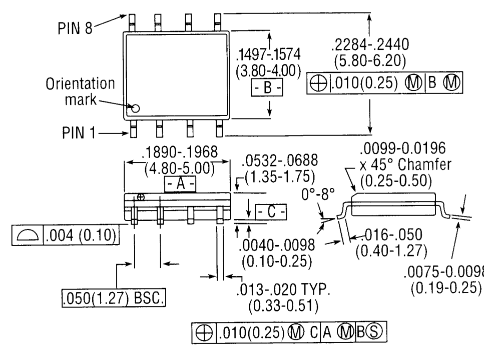
DS52-0002

V 2.00

Features

- Small Size and Low Profile
- Industry Standard SOIC-8 SMT Plastic Package
- Excellent Amplitude and Phase Balance
- Superior Repeatability
- Typical Insertion Loss 0.5 dB
- Typical Isolation 21 dB
- 1 Watt Power Handling

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Description

M/A-COM's DS52-0002 is an IC based monolithic power divider in a low cost SOIC-8 plastic package. This 2-way power divider is ideally suited for applications where small size, low insertion loss, superior phase/amplitude tracking and low cost are required. Typical applications include personal communication systems and other communication applications where size and PCB real estate are at a premium. Available in tape and reel.

The DS52-0002 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

Ordering Information

Part Number	Package
DS52-0002	SOIC 8-Lead Plastic Package
DS52-0002TR	Forward Tape and Reel*
DS52-0002RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter		Units	Min.	Typ.	Max.
Insertion Loss	Above 3.0 dB	dB		0.5	0.6
Isolation		dB	15	21	
VSWR				1.2:1	1.4:1
Amplitude Balance		dB		0.05	0.1
Phase Balance		°		1.0	3.0

1. All specifications apply with a 50-ohm source and load impedance.

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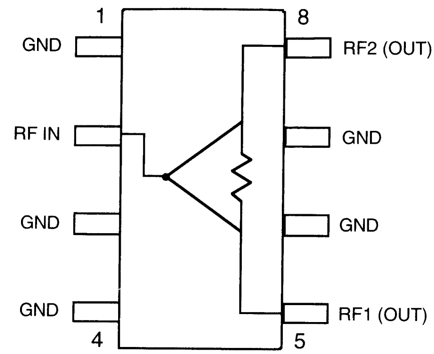
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
Input Power 2	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum

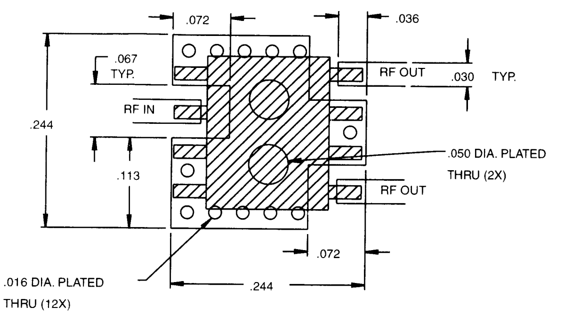
Functional Diagram [3]



3. Pins 1, 3, 4, and 6 must be RF and DC grounded.

Recommended PCB Configuration

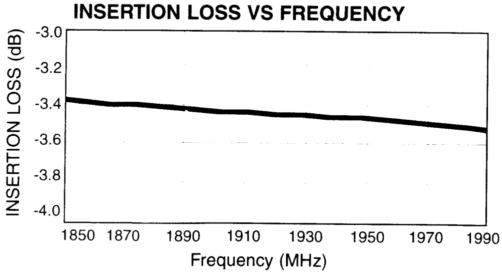
(Dimensions in Inches)



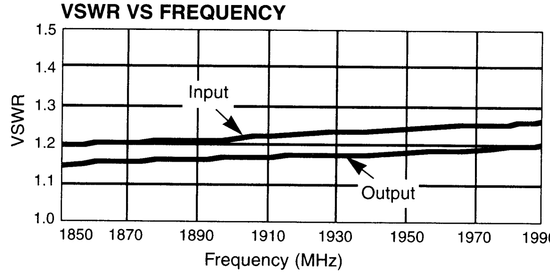
CIRCUIT MATERIAL: FR-4, .016 THICK.

Typical Performance @ +25°C

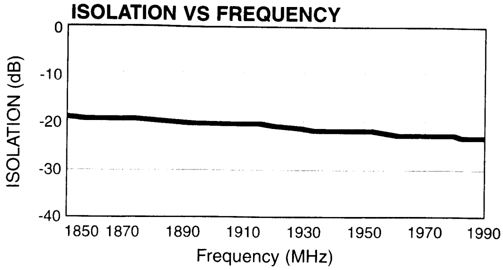
INSERTION LOSS VS FREQUENCY



VSWR VS FREQUENCY



ISOLATION VS FREQUENCY



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M/A-COM an AMP company

Low Cost Two-Way SMT Power Splitter/Combiner 2200 - 2500 MHz

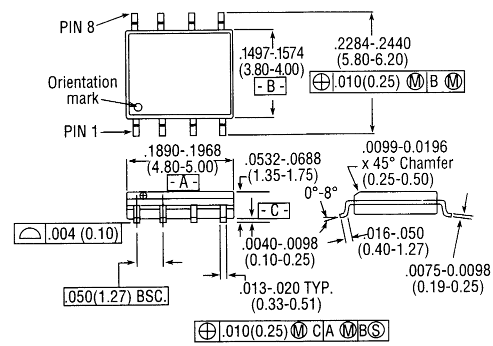
DS52-0003

V 2.00

Features

- Small Size, Low Profile and Low Cost
- Industry Standard SOIC-8 SMT Plastic Package
- Superior Repeatability
- Excellent Amplitude Balance: 0.05 dB Typical
- Excellent Insertion Loss: 0.3 dB Typical
- Low Cost
- Wireless Data Frequency Coverage

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Description

M/A-COM's DS52-0003 is an IC based monolithic power splitter in a low cost SOIC-8 plastic package. This 2-way device is ideally suited for applications where small size, low profile and low cost, without sacrificing performance, are required. Typical applications include base station, portables and PCMCIA cards for wireless data and spread spectrum applications. Available in tape and reel.

The DS52-0003 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

Ordering Information

Part Number	Package
DS52-0003	SOIC 8-Lead Plastic Package
DS52-0003-TR	Forward Tape and Reel*
DS52-0003-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter	Units	Min.	Typ.	Max.
Insertion Loss	dB		0.3	0.5
Isolation	dB	15	20	
VSWR			1.3:1	1.5:1
Amplitude Balance	dB		0.05	0.1
Phase Balance	°		3	5

1. All specifications apply with a 50-ohm source and load impedance.

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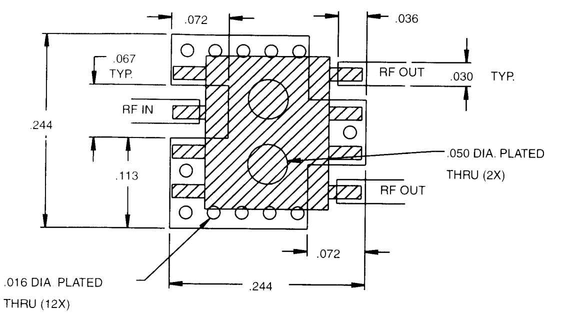
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
Input Power 2	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

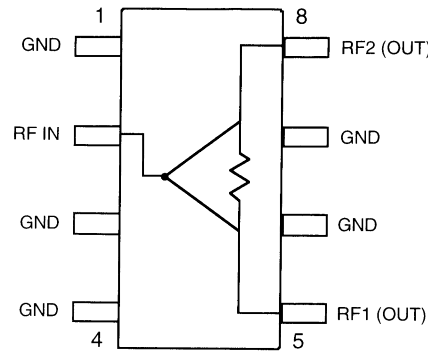
1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum.

Recommended PCB Configuration

(Dimensions in Inches)

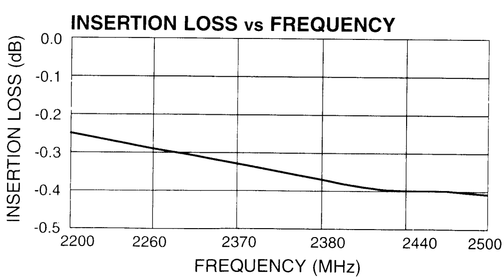


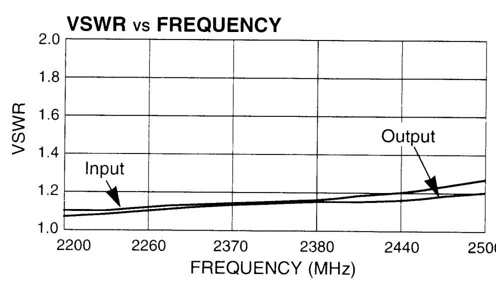
Functional Diagram [3]

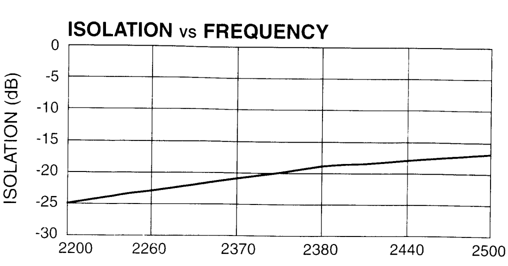


3. Pins 1, 3, 4, 6 and 7 must be RF and DC grounded.

Typical Performance @ +25°C







Specifications Subject to Change Without Notice.

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an AMP company

Low Cost Two-Way SMT Power Splitter/Combiner 1510 - 1660 MHz

DS52-0004

V 2.00

Features

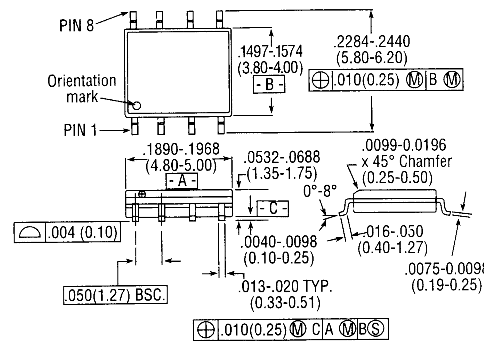
- Small Size, Low Profile and Low Cost
- Industry Standard SOIC-8 SMT Plastic Package
- Excellent Amplitude and Phase Balance
- Superior Repeatability
- Typical Insertion Loss: 0.4 dB
- Typical Isolation: 20 dB
- 1 Watt Power Handling
- Frequency Coverage for GPS and LEO Programs

Description

M/A-COM's DS52-0004 is an IC-based monolithic power splitter/combiner in a low cost SOIC-8 plastic package. This 2-way power splitter/combiner is ideally suited for applications where small size, low insertion loss, excellent phase/amplitude tracking and low cost are required. Typical applications include GPS receivers and LEO satellite programs, where size and PCB real estate are at a premium. Available in tape and reel.

The DS52-0004 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
DS52-0004	SOIC 8-Lead Plastic Package
DS52-0004-TR	Forward Tape and Reel*
DS52-0004-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1, 2], T_A = +25°C

Parameter		Units	Min.	Typ.	Max.
Insertion Loss	Above 3.0 dB	dB		0.4	0.6
Isolation		dB	15	20	
VSWR				1.3:1	1.5:1
Amplitude Balance		dB		0.05	0.1
Phase Balance		°		1.0	3.0

1. All specifications apply with a 50-ohm source and load impedance.
2. This device operates at L2 GPS frequency (1228 MHz) with compatible performance as cited above, with the exception of isolation which is rated at 12 dB min.

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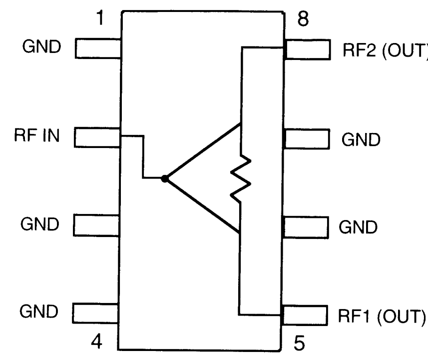
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
Input Power [2]	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum

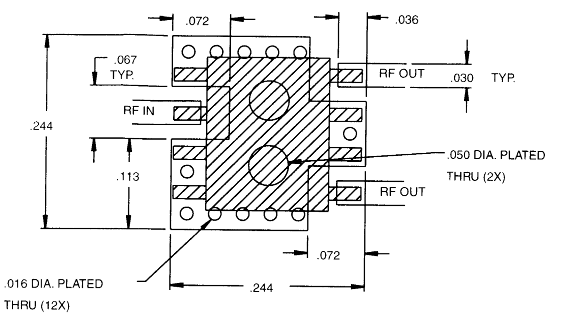
Functional Diagram [3]



3. Pins 1, 3, 4, 6 and 7 must be RF and DC grounded.

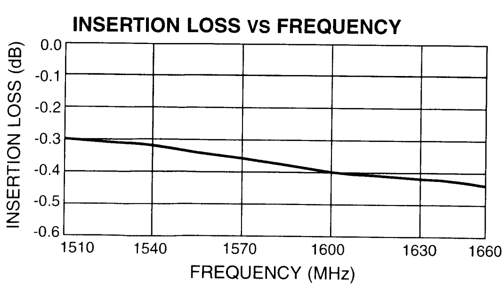
Recommended PCB Configuration

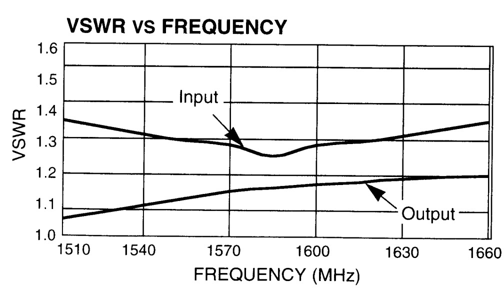
(Dimensions in Inches)

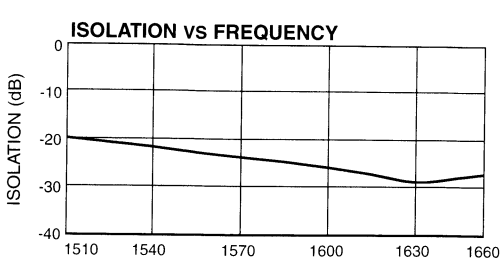


CIRCUIT MATERIAL: FR-4, .016 THICK.

Typical Performance @ +25°C







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an AMP company

Low Cost Two-Way SMT Power Splitter/Combiner 1700 - 1900 MHz

DS52-0005

V 2.00

Features

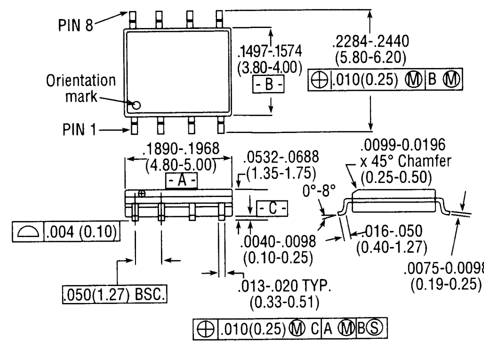
- Small Size and Low Profile
- Industry Standard SOIC-8 SMT Plastic Package
- Superior Repeatability
- Excellent Amplitude Balance: 0.05 dB Typical
- Excellent Insertion Loss: 0.3 dB Typical
- Low Cost
- DCS-1800 Frequency Coverage

Description

M/A-COM's DS52-0005 is an IC based monolithic power splitter in a low cost SOIC-8 plastic package. This 2-way power splitter is ideally suited for applications where small size, low profile and low cost, without sacrificing performance, are required. Typical applications include base station, portables and PCMCIA cards for DCS-1800 European applications. Available in tape and reel.

The DS52-0005 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
DS52-0005	SOIC 8-Lead Plastic Package
DS52-0005-TR	Forward Tape and Reel*
DS52-0005-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter	Units	Min.	Typ.	Max.
Insertion Loss	dB		0.3	0.5
Isolation	dB	15	20	
VSWR			1.3:1	1.5:1
Amplitude Balance	dB		0.05	0.1
Phase Balance	°		2	4

1. All specifications apply with a 50-ohm source and load impedance.

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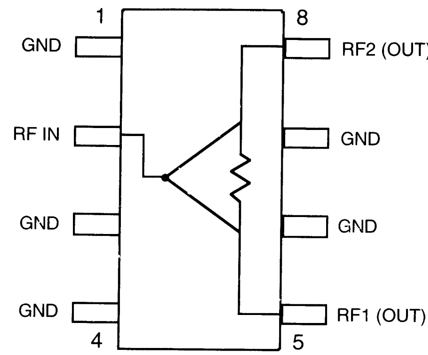
Absolute Maximum Ratings [1]

Parameter	Absolute Maximum
Input Power 2	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum.

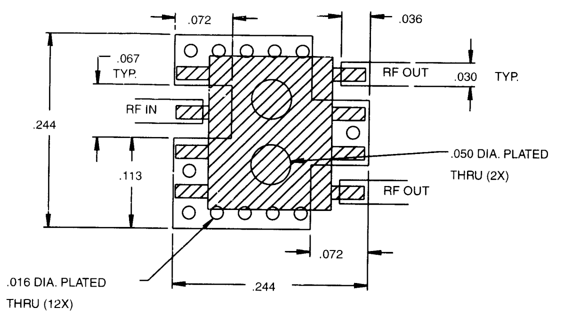
Functional Diagram [3]



3. Pins 1, 3, 4, 6 and 7 must be RF and DC grounded.

Recommended PCB Configuration

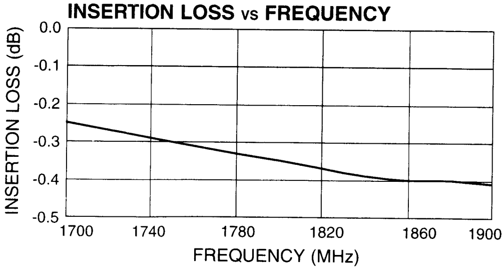
(Dimensions in Inches)



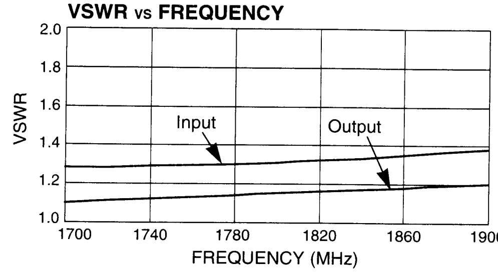
CIRCUIT MATERIAL: FR-4, .016 THICK.

Typical Performance @ +25°C

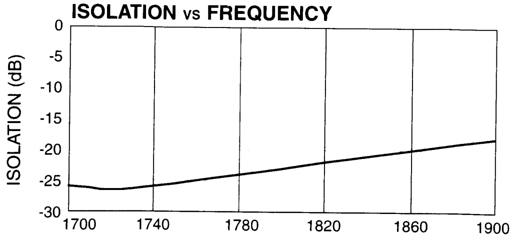
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



Specifications Subject to Change Without Notice.

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an AMP company

Low Cost Four-Way SMT Power Splitter/Combiner 824 - 960 MHz

DS54-0001

V 2.00

Features

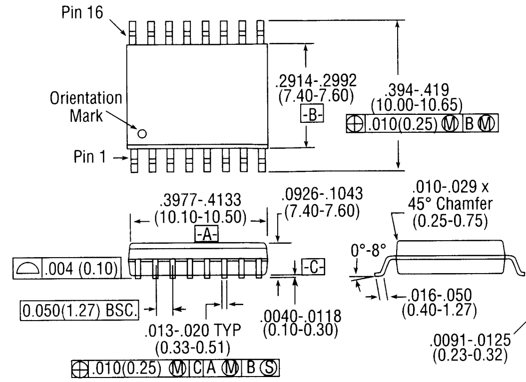
- Low Cost
- Small Size and Low Profile
- Industry Standard SOW-16 SMT Plastic Package
- Excellent Repeatability (Lot-to-Lot Variation)
- Typical Isolation: 23 dB
- Typical Amplitude Balance: 0.3 dB
- Typical Insertion Loss: 1.0 dB

Description

M/A-COM's DS54-0001 is an IC based monolithic power splitter/combiner in a low cost SOW-16 plastic package. This device is ideally suited for applications where PCB real estate is at a premium and standard packaging for automated assembly and low cost are critical. Typical applications include infrastructure, portables and peripheral devices (PCMCIA cards) for wireless standards such as GSM, AMPS, CDPD, RAM and ARDIS. Available in tape and reel.

The DS54-0001 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SOW-16



16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
DS54-0001	SOW-16 Lead Plastic Package
DS54-0001-TR	Forward Tape and Reel*
DS54-0001-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], $T_A = +25°C$

Parameter	Units	Min.	Typ.	Max.
Insertion Loss	dB		1.0	1.2
Isolation	dB	18	23	
VSWR				
Input			1.2:1	1.4:1
Output			1.4:1	1.7:1
Amplitude Balance	dB		0.3	0.5
Phase Balance	°		2	4

1. All specifications apply with a 50-ohm source and load impedance.

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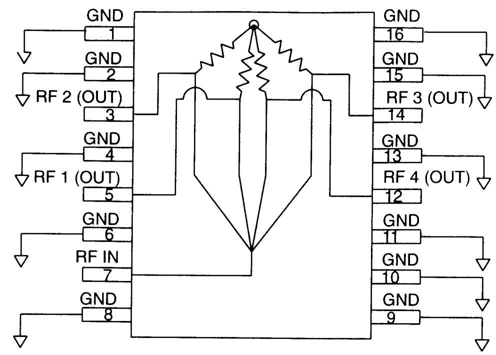
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Input Power[2]	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

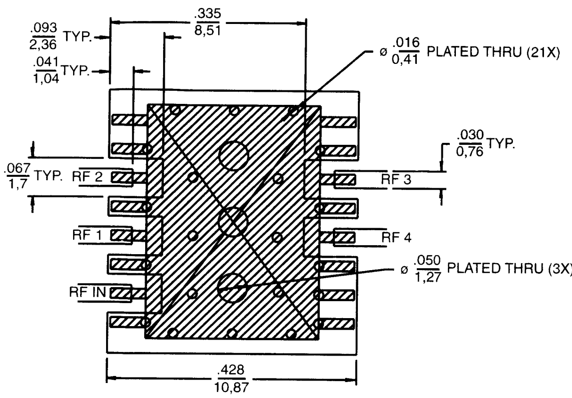
1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum.

Functional Diagram[3]



3. Pins 1, 2, 4, 6, 7, 8, 9, 10, 11, 13, 15 and 16 must be DC and RF grounded.

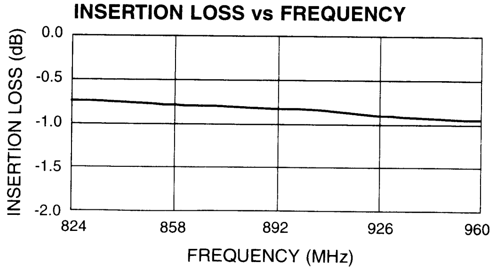
Recommended PCB Configuration



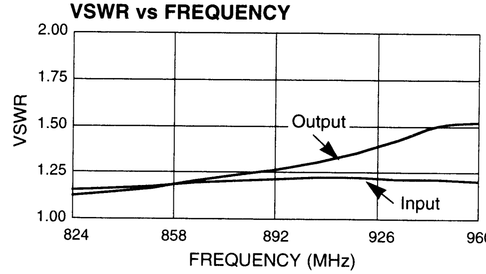
(Dimensions in Inches)

Typical Performance @ +25°C

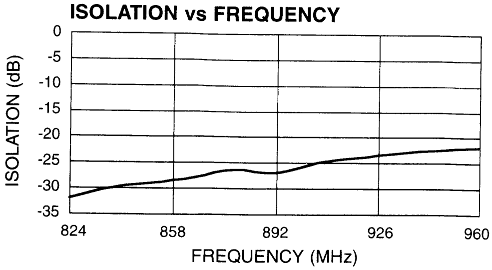
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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an AMP company

Low Cost Four-Way SMT Power Splitter/Combiner 1700 - 2000 MHz

DS54-0002

V 2.00

Features

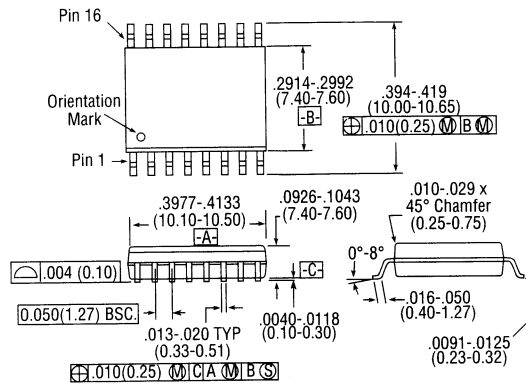
- Low Cost
- Small Size and Low Profile
- Industry Standard SOW-16 SMT Plastic Package
- Excellent Repeatability (Lot-to-Lot Variation)
- Typical Isolation: 23 dB
- Typical Amplitude Balance: 0.3 dB
- Typical Insertion Loss: 1.0 dB

Description

M/A-COM's DS54-0002 is an IC based monolithic power splitter/combiner in a low cost SOW-16 plastic package. This device is ideally suited for applications where PCB real estate is at a premium and standard packaging for automated assembly and low cost are critical. Typical applications include infrastructure, portables and peripheral devices (PCMCIA cards) for wireless standards such as PCS, PCN, DECT, PHS, and DCS-1800. Available in tape and reel.

The DS54-0002 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SOW-16



16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
DS54-0002	SOW-16 Lead Plastic Package
DS54-0002-TR	Forward Tape and Reel*
DS54-0002-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], $T_A = +25°C$

Parameter	Units	Min.	Typ.	Max.
Insertion Loss	dB		1.0	1.2
Isolation	dB	18	23	
VSWR			1.4:1	1.7:1
Amplitude Balance	dB		0.3	0.5
Phase Balance	°		3	6°

1. All specifications apply with a 50-ohm source and load impedance.

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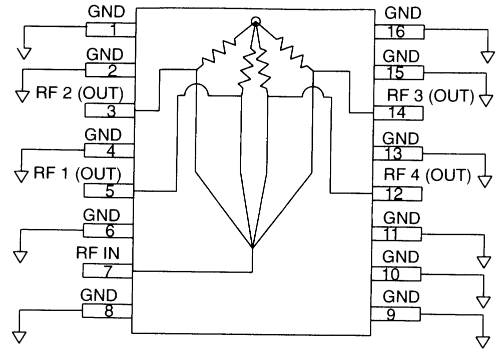
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Input Power[2]	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

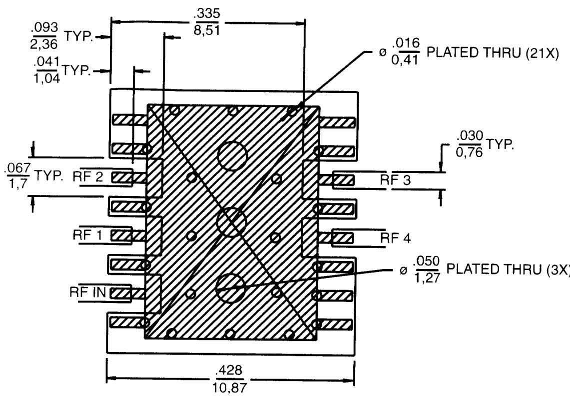
1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum.

Functional Diagram[3]



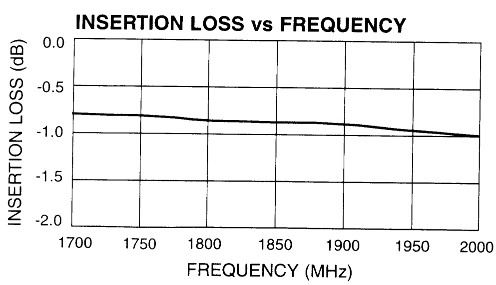
3. Pins 1, 2, 4, 6, 7, 8, 9, 10, 11, 13, 15 and 16 must be DC and RF grounded.

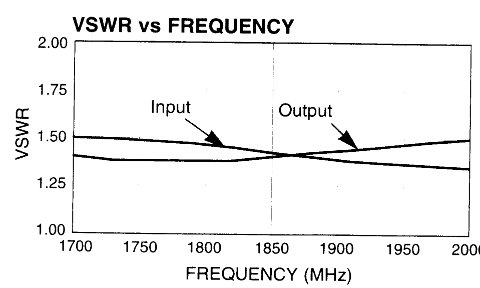
Recommended PCB Configuration

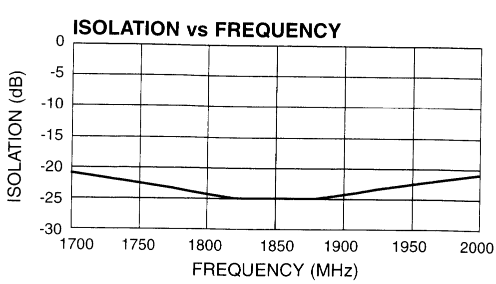


(Dimensions in Inches)

Typical Performance @ +25°C







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M/A-COM an AMP company

Low Cost Four-Way SMT Power Splitter/Combiner 1200 - 1660 MHz

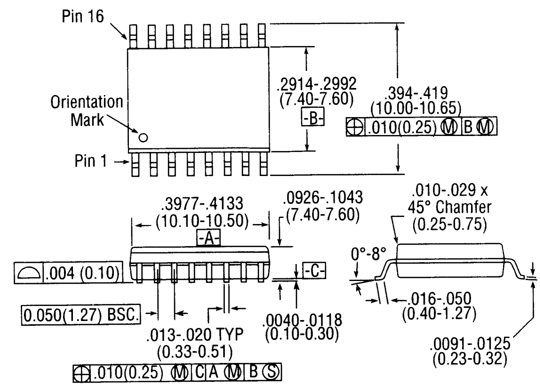
DS54-0003

V 2.00

Features

- Low Cost
- Small Size and Low Profile
- Industry Standard SOW-16 SMT Plastic Package
- Excellent Repeatability (Lot-to-Lot Variation)
- Typical Isolation: 23 dB
- Typical Amplitude Balance: 0.3 dB
- Typical Insertion Loss: 1.0 dB
- Commercial and Military GPS and LEO Frequency Coverage

SOW-16



16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Description

M/A-COM's DS54-0003 is an IC based monolithic power splitter/combiner in a low cost SOW-16 plastic package. This device is ideally suited for applications where PCB real estate is at a premium and standard packaging for automated assembly and low cost are critical. Typical applications include infrastructure, portables and peripheral devices (PCMCIA cards) for commercial and military GPS plus LEO applications. Available in tape and reel.

The DS54-0003 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

Ordering Information

Part Number	Package
DS54-0003	SOW-16 Lead Plastic Package
DS54-0003-TR	Forward Tape and Reel*
DS54-0003-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications[1], T_A = +25°C

Parameter	Units	Min.	Typ.	Max.
Insertion Loss	dB		1.0	1.2
Isolation	dB	18	23	
VSWR				
Input			1.2:1	1.4:1
Output			1.4:1	1.7:1
Amplitude Balance	dB		0.3	0.6
Phase Balance	°		2	5°

1. All specifications apply with a 50-ohm source and load impedance.

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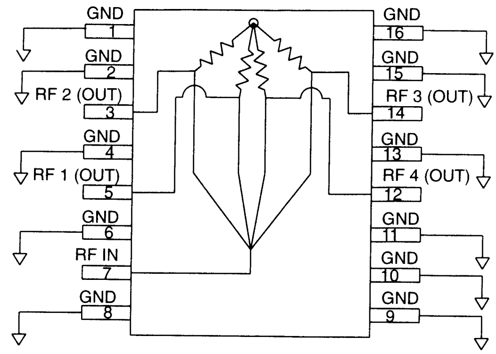
Absolute Maximum Ratings 1

Parameter	Absolute Maximum
Input Power2	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

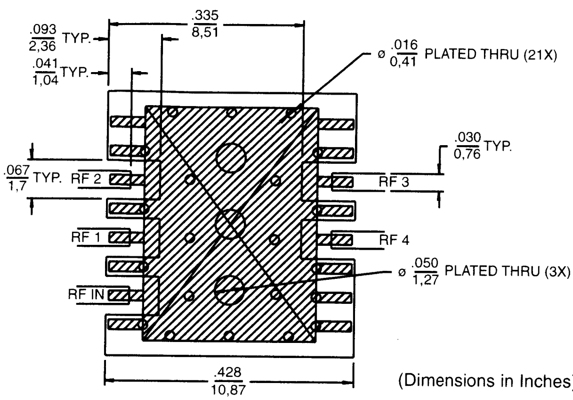
1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum.

Functional Diagram 3



3. Pins 1, 2, 4, 6, 7, 8, 9, 10, 11, 13, 15 and 16 must be DC and RF grounded.

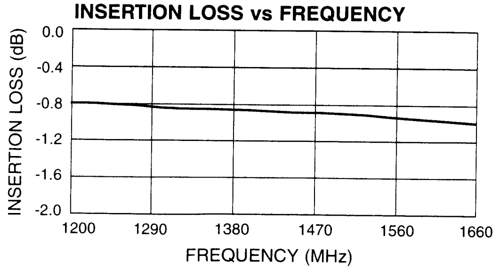
Recommended PCB Configuration



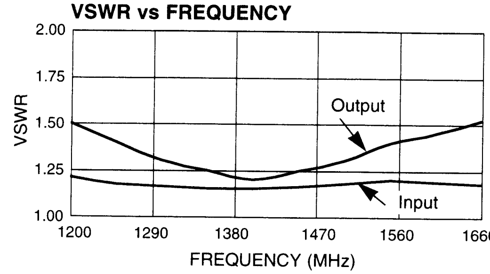
(Dimensions in Inches)

Typical Performance @ +25°C

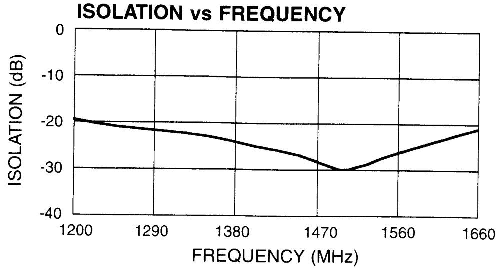
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



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Low Cost Six-Way SMT Power Divider
824 - 960 MHz

DS56-0001

V 2.00

Features

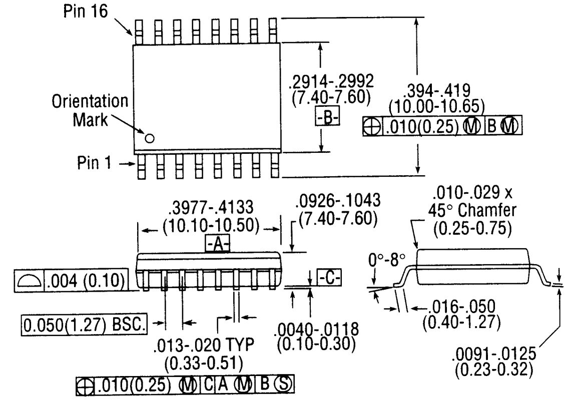
- Small Size, Low Profile
- Superior Repeatability (Lot-to-lot Variation)
- Industry Standard SOW-16 SMT Plastic Package
- Typical Isolation 25 dB
- Typical Amplitude Balance 0.3 dB
- Low Cost
- 1-Watt Power Handling

Description

M/A-COM's DS56-0001 is an IC-based monolithic power divider in a low cost SOW-16 plastic package. This 6-way power divider is ideally suited for applications where PCB real estate is at a premium and part count reduction and cost are critical. Typical applications include base station switching networks and other cellular equipment, including subscriber units. Available in tape and reel.

The DS56-0001 is fabricated using a passive-integrated circuit process. The process features full chip passivation for increased performance and reliability.

SOW-16



16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
DS56-0001	SOW 16-Lead Plastic Package
DS56-0001-TR	Forward Tape and Reel*
DS56-0001-RTR	Reverse Tape and Reel*

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications[1], T_A = +25°C

Parameter		Units	Min.	Typ.	Max.
Insertion Loss	Above 3.0 dB	dB		1.3	1.5
Isolation		dB	20	25	
VSWR				1.4:1	1.6:1
Amplitude Balance		dB		0.3	0.5
Phase Balance		°		6	8

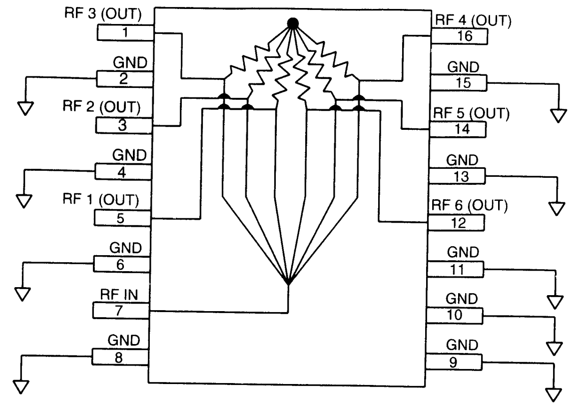
1. All specifications apply with a 50-ohm source and load impedance.

Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Input Power[2]	1 W CW
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. With internal load dissipation of 0.125 W maximum

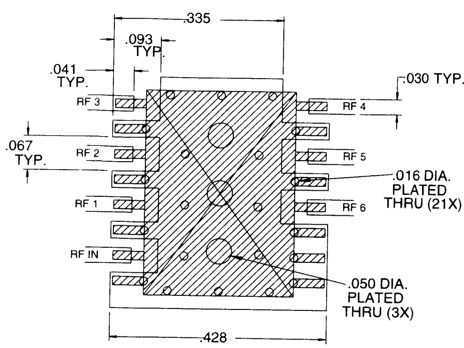
Functional Diagram[3]



3. Pins 2, 4, 6, 7, 8, 9, 10, 11, 13 and 15 must be DC and RF grounded.

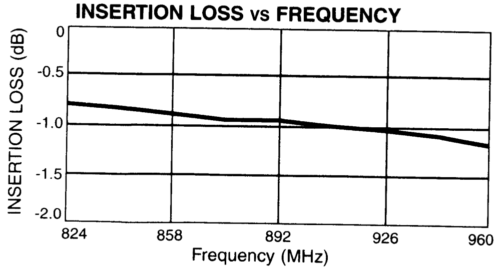
Recommended PCB Configuration

(Dimensions in Inches)

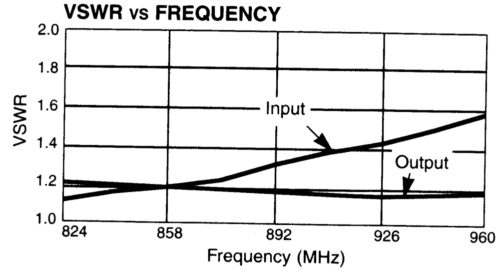


Typical Performance @ +25°C

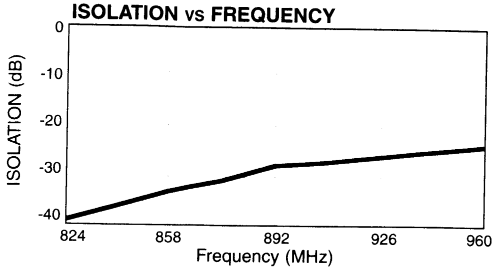
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



Specifications Subject to Change Without Notice.

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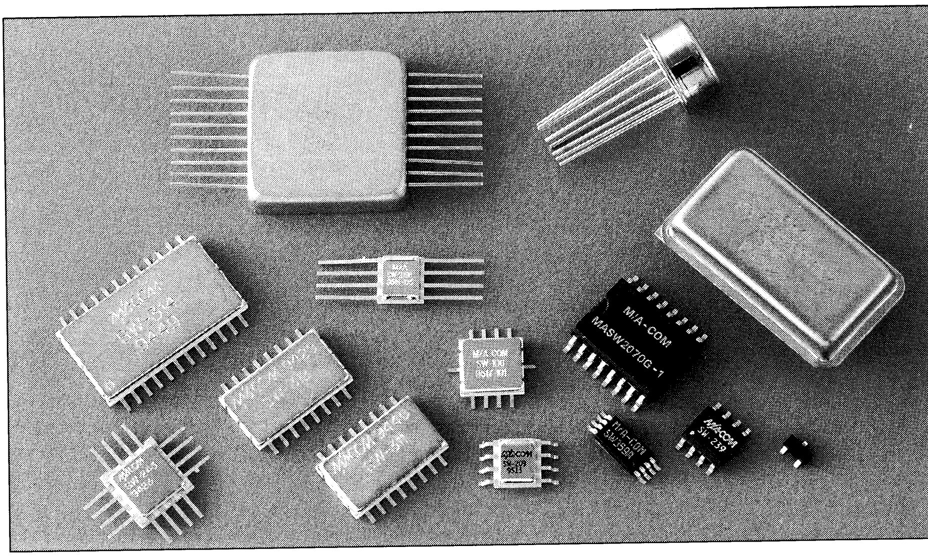
Switches



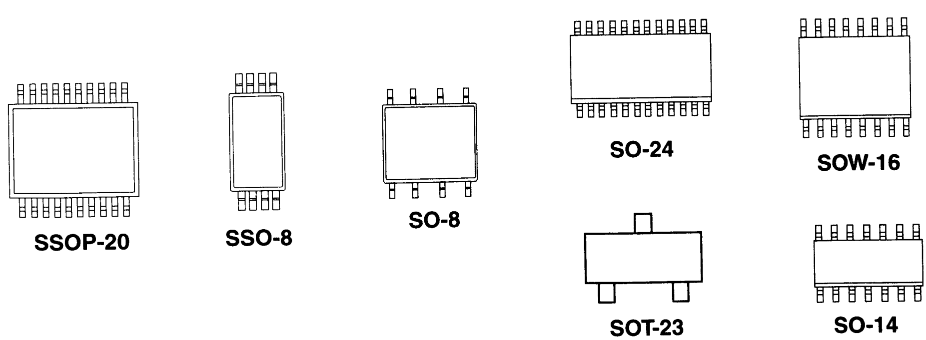
M/A-COM
an AMP company

V 2.00

Plastic Packaged IC Switches

	Frequency (GHz)	Insertion Loss (900 MHz) (dB)	Isolation Typ. Range (dB)	IP_3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
SPST								
	0.1 - 4.0	0.3 @ 2 GHz	80 - 25	-	SOT-23	PIN diode, monolithic	MA4SW101	15-32
	0.5 - 1.2	0.8	50 - 30	38	SO-8	+3 volt control, terminated	SW-349	15-148
	DC - 2.5	1.0	70 - 30	46	SO-8	General purpose, terminated	SW-259	15-112
SPDT								
	0.1 - 4.0	0.4 @ 2 GHz	80 - 23	-	SO-8	PIN diode, module	MA4SW201	15-32
New	0.8 - 2.0	0.8	50-35	50	SO-8	Integral CMOS driver	SW-335	15-4
New	2.0 - 2.8	1.2 @ 2.4 GHz	25-15	45	SO-8	0.5 watt, diversity	SW-356	15-6
	DC - 1.0	0.5	30 - 15	45	SO-8	+3 V control	SW-373	15-162
	DC - 2.0	0.5	35-10	55	SSO-8	2 watt, antenna changeover, +3V control	SW-358	15-152
	DC - 2.0	0.5	35-10	55	SSO-8	2 watt, antenna changeover, +3V control	SW-359A	15-152
	DC - 2.0	0.6	50-25	61	SOW-16	Diversity with driver	MASW2070G-1	15-42
	DC - 2.5	0.5	40-15	61	SO-8	Power handling, positive control	SW-277	15-118
	DC - 2.5	0.5	60-15	61	SO-8	Power handling	SW-279	15-120
	DC - 2.5	0.5	70-25	46	SO-8	General purpose, terminated	SW-338	15-142
	DC - 2.5	0.5	70-25	46	SO-8	General purpose, terminated	SW-339	15-142
	DC - 2.5	0.6	70-20	46	SO-8	General purpose	SW-239	15-102
	DC - 2.5	0.6	70-30	61	SSOP-20	1 watt, diversity	SW-923	15-170
	DC - 3.0	0.5	70-20	46	SSO-8	General purpose	SW-328	15-138
SP3T								
	0.1 - 4.0	0.6 @ 2 GHz	65 - 20	-	SO-8	PIN diode, module	MA4SW301	15-32
SP4T								
	DC - 2.0	1.0	60-25	46	SO-24	General purpose, terminated	SW-419	15-168
DPDT								
	DC - 2.0	0.5	70-25	48	SO-14	General purpose	SW-289	15-128

Stocked at your local distributor.



Switches Selection Guides

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Ceramic Packaged Switches

V 2.00

Frequency (GHz)	Insertion Loss (900 MHz) (dB)	Isolation Typ. Range (dB)	IP3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
SPST							
0.1 - 2.0	0.25 @ 1 GHz	30 Min.	-	115	PIN diode module, 500 V VR	MA47201	15-20
0.1 - 2.0	0.25 @ 1 GHz	30 Min.	-	114	PIN diode module, 1000 V VR	MA47208	15-20
0.1 - 2.0	0.25 @ 1 GHz	30 Min.	-	114	PIN diode module, 500 V VR	MA47200	15-20
2.0 - 6.0	0.5 @ 6 GHz	25 Min.	-	115	PIN diode module, 500 V VR	MA47203	15-20
2.0 - 12.0	0.5 @ 10 GHz	20 Min.	-	144	PIN diode module, 150 V VR	MA47220	15-20
4.0 - 10.0	0.5 @ 8 GHz	20 Min.	-	144	PIN diode module, 500 V VR	MA47223	15-20
4.0 - 10.0	0.5 @ 8 GHz	20 Min.	-	144	PIN diode module, 150 V VR	MA47222	15-20
4.0 - 10.0	1.0 @ 8 GHz	20 Min.	-	144	PIN diode module, 70 V VR	MA47221	15-20
DC - 2.0	0.5	70 - 45	47	CR-2	General microwave	SW-344	15-146
DC - 2.0	0.5	70 - 45	50	CR-2	General microwave, terminated	SW-341	15-144
New DC - 3.0	0.7	75 - 30	46	CR-9	Low cost, TTL/CMOS driver	SW05-0311	15-8
DC - 3.0	0.7	75 - 30	46	CR-9	TTL/CMOS Driver, Matched	SW-311	15-130
DC - 3.0	1.0	65 - 35	46	CR-3	Military screening	SW-209B	15-84
DC - 3.0	1.0	65 - 35	46	CR-10	Gull winged surface mount leads	SW-209G	15-84
DC - 3.0	1.0	65 - 35	46	CR-3	General microwave	SW-209	15-84
DC - 4.0	0.5	60 - 25	46	CR-2	General microwave, low loss	SW-223	15-92
DC - 4.0	0.7	70 - 25	46	CR-2	General microwave, terminated	SW-221	15-92

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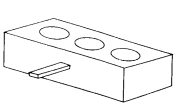

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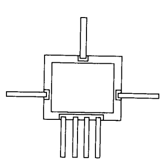
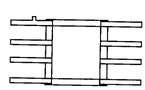


CR-2



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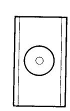

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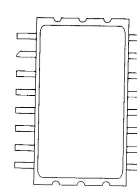

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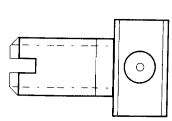

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Specifications Subject to Change Without Notice.

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	Frequency (GHz)	Insertion Loss (900 MHz) (dB)	Isolation Typ. Range (dB)	IP3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
SPDT								
	DC - 2.0	0.7	65 - 35	46	CR-3	General microwave, terminated	SW-333	15-140
	DC - 2.0	0.8	65 - 45	46	CR-2	General microwave, terminated	SW-331	15-140
	DC - 3.0	0.4	55 - 20	61	CR-5	4 watt power, surface mount	SW-106	15-70
	DC - 3.0	0.4	70 - 20	61	CR-2	4 watt power, microwave	SW-276	15-70
	DC - 3.0	0.5	60 - 30	46	CR-3	General microwave	SW-219	15-90
	DC - 3.0	0.5	60 - 30	46	CR-3	Screened for military	SW-219B	15-90
	DC - 3.0	0.5	60 - 30	46	CR-10	Gull winged surface mount leads	SW-219G	15-90
	DC - 3.0	0.5	70 - 20	61	CR-9	TTL/CMOS Driver	SW-110	15-74
New	DC - 3.0	0.6	72 - 38	46	CR-9	Low cost, TTL/CMOS driver	SW10-0312	15-10
	DC - 3.0	0.6	72 - 38	46	CR-9	TTL/CMOS Driver	SW-312	15-132
New	DC - 3.0	0.7	75 - 40	46	CR-9	Low cost, TTL/CMOS driver	SW10-0313	15-12
	DC - 3.0	0.7	75 - 40	46	CR-9	TTL/CMOS Driver, matched	SW-313	15-134
	DC - 4.0	0.5	70 - 25	46	CR-2	General microwave	SW-228	15-96
	DC - 4.0	0.8	70 - 25	46	CR-2	General microwave, terminated	SW-226	15-96
	DC - 4.0	0.8	70 - 35	46	CR-2	General microwave	SW-227	15-96
SP4T								
New	DC - 3.0	1.2	75 - 38	46	CR-14	Low cost, TTL/CMOS driver	SW15-0314	15-14
	DC - 3.0	1.2	75 - 38	46	CR-14	TTL/CMOS Driver, matched	SW-314	15-136
	DC - 4.0	0.6	70-20	46	CR-4	General microwave	SW-243	15-106
DPDT								
	DC - 4.0	0.5	70 - 25	48	CR-4	General purpose	SW-281	15-122
Transfer								
	DC - 3.0	1.0	70 - 22	50	CR-4	General purpose	SW-283	15-124

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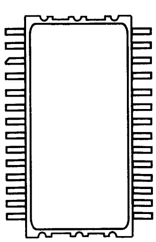

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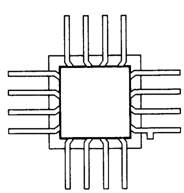

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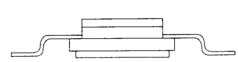

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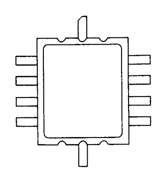

CR-5

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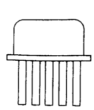
Other Surface Mount Switches

	Frequency (GHz)	Insertion Loss (900 MHz) (dB)	Isolation Typ. Range (dB)	IP_3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
SPST								
	0.005 - 4.0	1.0	70 - 30	46	DI-1	TTL Driver, Matched	SW-215	15-88
	0.005 - 4.0	1.0	70 - 30	46	DI-2	CMOS Driver, Matched	SW-216	15-88
	DC - 2.0	0.5	70 - 35	50	TO-5-4	General purpose, terminated	SW-342	15-144
	DC - 3.0	0.5	60 - 30	46	TO-5-3	General purpose	SW-211	15-86
	DC - 3.0	0.5	65 - 25	46	FP-13	General purpose	SW-212	15-87
	DC - 3.0	0.7	75 - 30	46	FP-13	General purpose	SW-214	15-87
	DC - 3.0	0.8	70 - 35	46	TO-5-3	General purpose	SW-213	15-86
SPDT								
	0.005 - 2.0	1.0	70 - 45	46	DI-1	TTL Driver	SW-217	15-89
	0.005 - 2.0	1.0	70 - 45	46	FP-16	TTL Driver, matched	SW-233	15-98
	0.005 - 2.0	1.0	70 - 45	46	FP-16	CMOS Driver, matched	SW-236	15-98
	0.005 - 2.0	1.0	70 - 45	46	FP-16	CMOS Driver	SW-237	15-100
	0.005 - 4.0	1.2	75 - 45	46	DI-1	TTL Driver, matched	SW-205	15-82
	0.005 - 4.0	1.2	75 - 45	46	DI-1	CMOS Driver, matched	SW-206	15-82
	0.01 - 3.0	0.7	75 - 37	46	DI-1	CMOS Driver, matched	SW-137	15-76
	0.02 - 1.0	0.35 @ 450 MHz	48 - 20	-	844-001	100 W PIN module	MA8334-001	15-17
	DC - 2.0	0.6	70 - 30	46	TO-5-3	General purpose	SW-201	15-78
	DC - 2.0	0.6	70 - 30	46	TO-5-3	TTL Driver	SW-224	15-94
	DC - 2.0	0.6	70 - 30	46	FP-13	TTL Driver	SW-225	15-94
	DC - 2.0	0.8	70 - 35	46	TO-5-3	General purpose	SW-203	15-78
	DC - 3.0	0.5	70 - 29	46	FP-13	0/-5V Driver, matched	SW-202	15-80
	DC - 3.0	0.8	80 - 37	46	FP-13	0/-5V Driver, matched	SW-204	15-80

Stocked at your local distributor.

*See data sheets for individual pin configurations.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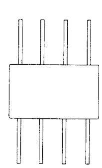
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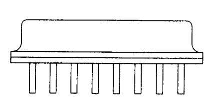
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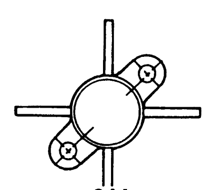
844

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Frequency (GHz)	Insertion Loss (900 MHz) (dB)	Isolation Typ. Range (dB)	IP3 (>500 MHz) (dBm)	Package	Features	Part No.	Page No.
SP3T							
0.005 - 2.0	1.0	70 - 40	46	FP-17	TTL Driver,matched	SW-247	15-108
0.005 - 2.0	1.0	70 - 40	46	FP-17	CMOS Driver, matched	SW-251	15-108
0.005 - 2.0	1.0	90 - 45	46	DI-5	TTL Driver, matched	SW-241	15-104
0.02 - 1.0	0.35 @ 450 MHz	48 - 20	-	844-004	100 W PIN module	MA8334-004	15-17
SP4T							
0.005 - 2.0	1.0	70 - 40	46	DI-5	TTL Driver, matched	SW-254	15-110
0.005 - 2.0	1.0	70 - 40	46	DI-5	TTL Driver	SW-255	15-111
0.005 - 2.0	1.0	70 - 40	46	FP-17	TTL Driver, matched	SW-261	15-114
0.005 - 2.0	1.0	70 - 40	46	FP-17	TTL Driver	SW-262	15-116
0.005 - 2.0	1.0	70 - 40	46	FP-17	CMOS Driver, matched	SW-264	15-114
0.02 - 2.0	1.7	80 - 40	44	FP-26	0/+5V Driver, matched	SW-369	15-160
0.1 - 2.0	1.3	75-50	44	DI-1	TTL/CMOS Driver	SW-128	15-2
DC - 2.0	0.8	65 - 40	46	FP-26	General purpose, matched	SW-411	15-164
DC - 2.0	1.1	65 - 40	46	FP-25	CMOS Driver, Matched	SW-415	15-166
SP6T							
DC - 2.0	1.4	75 - 32	45	FP-27	-5/+5V Driver, matched	SW-284	15-126
DPDT							
DC - 2.0	0.5	50 - 25	46	TO-5-3	General purpose	SW-355	15-150
DC - 2.0	0.7	45 - 25	47	TO-5-4	General purpose	SW-368	15-158
Transfer							
DC - 2.0	1.1	55 - 35	46	TO-5-4	General purpose	SW-362	15-156

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Chip Switches

V 2.00

	Frequency (GHz)	Insertion Loss Typ. Range (dB)	Isolation Typ. Range (dB)	IP3 (>500 MHz) (dBm)	Features	Part No.	Page No.
SPST							
	0.05 - 26.0	0.5 - 1.5	70 - 35	-	PIN diode, monolithic	MA4SW100	15-24
	DC - 20	1.0 - 1.5	60 - 38	43	Via hole grounding	MASW20010	15-68
	DC - 4.0	0.4 - 1.5	60 - 12	46	Multi-function	MASW4010	15-46
	DC - 4.0	0.3 - 0.4	55 - 30	46	Reflective, low insertion loss	MASW4020	15-48
	DC - 6.0	0.5 - 2.5	70 - 43	46	Multi-function	MASW6020G	15-58
SPDT							
	0.05 - 26.0	0.5 - 1.5	70 - 35	-	PIN diode, monolithic	MA4SW200	15-24
	DC - 3.0	0.5 - 0.8	75 - 25	53	Terminated option	MASW2000	15-36
	DC - 3.0	0.4 - 0.9	55 - 22	67	High power, 10 watts	MASW2020G	15-38
	DC - 4.0	0.5 - 0.8	65 - 40	46	Independent bias control	MASW4030G	15-50
	DC - 4.0	0.5 - 0.8	65 - 40	46	Independent bias control	MASW4040	15-52
	DC - 6.0	0.4 - 1.0	75 - 25	46	Low insertion loss	MASW6010G	15-56
	DC - 8.0	0.5 - 1.1	78 - 20	52	Low insertion loss	MASW8000	15-62
	DC - 20.0	1.0 - 2.0	70 - 45	43	Via hole grounding	MASW20000	15-66
SP3T							
	0.05 - 18.0	0.5 - 1.2	70 - 32		PIN diode, monolithic	MA4SW300	15-25
SP4T							
	DC - 4.0	0.5 - 1.0	57 - 26	50	Low insertion loss	MASW4000	15-44
	DC - 4.0	1.0 - 1.1	59 - 40	46	High isolation, terminated option	MASW4060G	15-54
DPDT							
	DC - 2.0	0.3 - 0.5	37 - 16	46	Cascadable	MASW2040	15-40
	DC - 6.0	0.5 - 1.1	70 - 20	45	Cascadable	MASW6030G	15-58
Transfer							
	DC - 12.0	1.0 - 2.6	48 - 18		Absorptive option	MASW12000G	15-64

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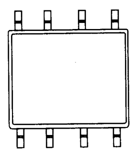
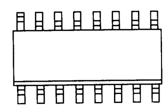
V 2.00

Drivers for GaAs FET Control Components

Bias	Transition Time (nsec) Typ.	Propagation Delay (nsec) Typ.	Package	Feature	Part No.	Page No.
+/- 5 V	10	45	SO-8	Single Channel	SWD-109	15-172
+/- 5 V	10	45	SO-16	Quad Channel	SWD-119	15-172



SO-8



SO-16

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GaAs SPDT Reflective Switch 0.1 - 2 GHz

SW-128

V 2.00

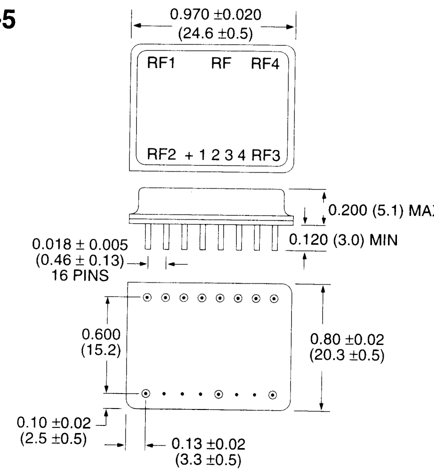
Features

- High Isolation: 65 dB Typ. at 1 GHz
- VSWR: 1.2:1 Typ.
- Trise, Tfall: 5 nS Typ.
- DIP Package
- Integral TTL Driver
- 50 Ohm Nominal Impedance

Description

M/A-COM's SW-128 is a GaAs MMIC SP4T reflective switch with an integral silicon TTL driver. This device is in a 16-lead DIP package. This switch offers high isolation over a wide bandwidth of operation, while maintaining low DC power dissipation. These switches exhibit excellent performance and repeatability from 0.01 GHz to 2.0 GHz. The SW-128 is ideally suited for RF/IF communications applications. Contact the factory for information about environmental screening.

DI-5



Dimensions in ( ) are in mm.

Part Number	Package
SW-128 PIN	Dual Inline

Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions	Unit	Min.	Typ.	Max
Insertion Loss	0.01 - 0.5 GHz 0.01 - 1.0 GHz 0.01 - 2.0 GHz	dB dB dB			1.3 1.7 2.2
Isolation	0.01 - 0.5 GHz 0.01 - 1.0 GHz 0.01 - 2.0 GHz	dB dB dB	65 60 52		
VSWR	0.01 - 0.5 GHz 0.01 - 1.0 GHz 0.01 - 2.0 GHz				1.3:1 1:4:1 1:6:1
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		5, 20 18, 28 60	
1 dB Compression	0.05 GHz 0.5 – 2.0 GHz	dBm dBm		+18 +25	
IP_3	For two-tone input power up to +5 dBm — 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		+35 +44	
IP_2	For two-tone input power up to +5 dBm — 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		+62 +75	
V_{CC}		V	4.5	+5.0	+5.5
I_{CC}	V_{CC} = +5 V	mA			1
Vctl Vctl	Low High	V V	0.0 2.0		0.8 5.0
Input Leakage Current	Low 0 to 0.8 V High 2.0 to 5.0 V	µA µA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and 50-ohm impedance at all RF ports unless otherwise specified.

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Absolute Maximum Ratings[1]

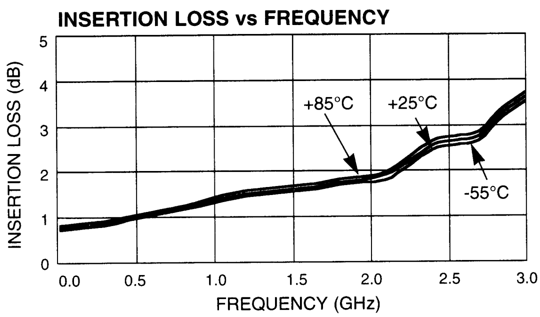
Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	-0.5 V to +7.0 V
Control Voltage	-0.5 V to V_{CC} +0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

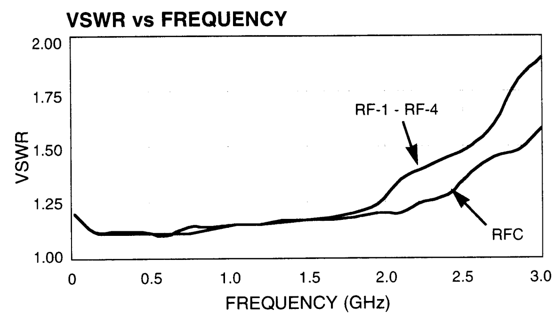
1. Operation of this device above any one of these parameters may cause permanent damage.

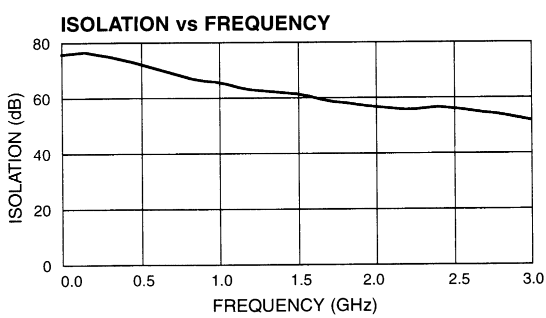
Truth Table

Control Inputs				Condition of Switch			
				RF Common to Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
High	Low	Low	Low	On	Off	Off	Off
Low	High	Low	Low	Off	On	Off	Off
Low	Low	High	Low	Off	Off	On	Off
Low	Low	Low	High	Off	Off	Off	On

Typical Performance







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SPDT Switch With Integral CMOS Driver 800 - 2000 MHz

SW-335

V 2.00

Features

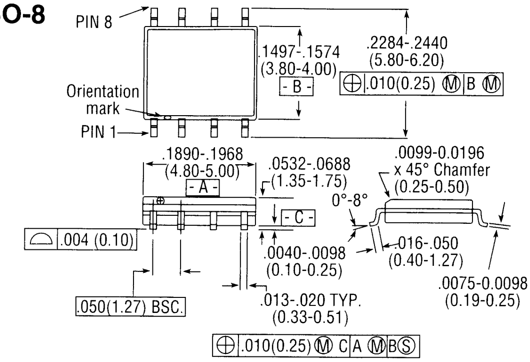
- Low Cost Plastic SOIC-8 Package[1]
- Intergral TTL/CMOS Compatible Driver
- Matched Input and Output
- Low Distortion: > 40 dBm IP_3 @ 900 MHz and > 62 dBm IP_2 @ 900 MHz
- Low DC Current: < 1.5 mA Typical Per Supply

Description

The SW-335 is a GaAs MMIC matched SPDT with an on-chip TTL/CMOS driver in a low-cost, SOIC 8-lead plastic package. The SW-335 is ideally suited for use in TTL/CMOS environment applications where low power consumption and small size are required. Typical applications include switch matrices, filter banks and general switching applications, in systems such as celluar, PCN/PCS, GPS and 900 MHz ISM band applications.

The SW-335 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
SW-335 PIN	SOIC 8-Lead Plastic
SW-335TR	Forward Tape & Reel*
SW-335RTR	Reverse Tape & Reel*

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A= +25°C, V_{DD} = 5.0 V_{GG} = -5.0 V

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	800-2000 MHz	dB		0.9	1.1
Isolation	800-1000 MHz	dB	35	45	
	1000-1500 MHz	dB	35	38	
	1500-2000 MHz	dB	30	32	
VSWR	800-1000 MHz			1.2:1	1.3:1
	1000-2000 MHz			1.2:1	1.3:1
Trise, Tfall	10%-90% RF, 90% - 10% RF	nS		75	
Ton , Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		200	
Transient	In-Band	mV		20	
1 dB Compression	900 MHz	dBm		29	
Input IP_3	2-Tone, 10 dBm (13 dBm total) 900 MHz	dBm	40	45	
Input IP_2	2-Tone, 10 dBm (13 dBm total) 900 MHz	dBm	62	70	
Current	V_{DD} @ 5.0 V	mA		1.1	1.5
	V_{GG} @ -5.0 V	mA		-0.8	-1.5
	V_{CTL} @ 0 V	µA		-5	-10
	V_{CTL} @ 5 V	µA		10	20

1. Available in tape and reel packaging.
2. All measurements are in a 50Ω system.
3. Replaces SW-329.
4. DC blocks required on RF ports.

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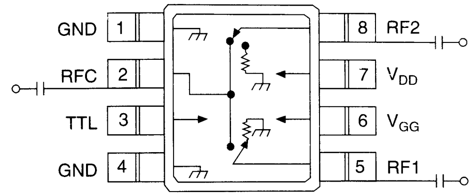
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
RF Input Power	+31 dBm
Max. Control Voltages	
V_{DD}	+6 VDC
V_{GG}	-6 VDC
V_{CTL} Maximum	+6 VDC
V_{CTL} Minimum	-1 VDC
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device outside these limits may cause permanent damage.

Functional Schematic



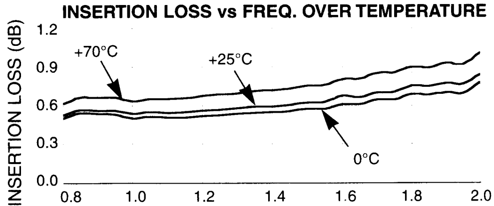
Truth Table

Control Input		
TTL/CMOS	RFC-RF1	RFC-RF2
1	OFF	ON
0	ON	OFF

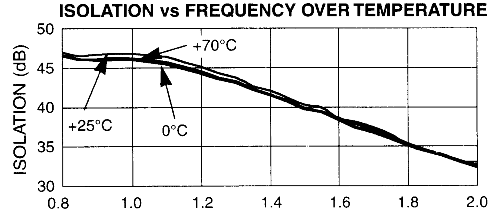
Logic 0 = 0 to 1 V
Logic 1 = 3.5 to 5 V, 10 µA typ.
V_{DD} = 5 ±0.5 V @ < 1.5 mA typ.
V_{GG} = -5 ±0.25 V @ < 1.5 mA

Typical Performance

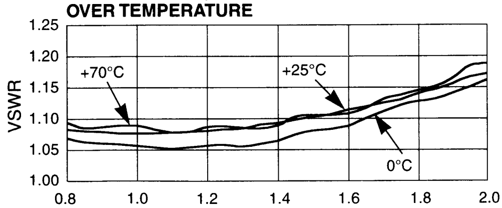
INSERTION LOSS vs FREQ. OVER TEMPERATURE



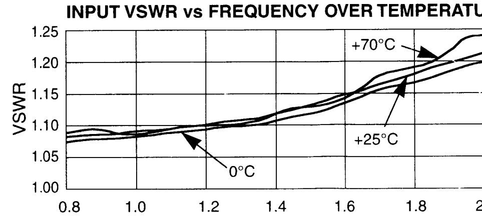
ISOLATION vs FREQUENCY OVER TEMPERATURE



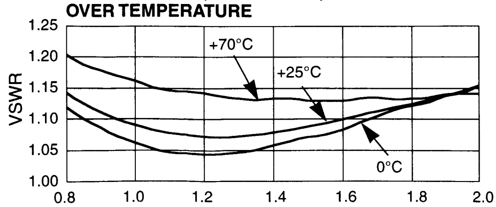
OUTPUT VSWR ("ON" STATE) vs FREQUENCY OVER TEMPERATURE



INPUT VSWR vs FREQUENCY OVER TEMPERATURE



OUTPUT VSWR ("OFF" STATE) vs FREQUENCY OVER TEMPERATURE



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1 Watt, T/R Diversity Switch 2.4 - 2.5 GHz

SW-356

V 2.00

Features

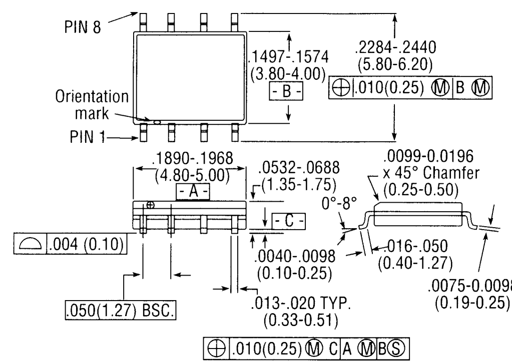
- Low Cost Plastic SOIC 8 Package Available in Tape and Reel
- Positive Control Applied @ RF Common
- High Intercept Point: 45 dBm IP_3
- Very Low Power Consumption: 50 µW
- No Power Consumption in Tx Mode (Vctl = 0 V)
- 2.4 to 2.5 GHz ISM Applications

Description

The SW-356[2] is a GaAs MMIC SPDT switch in a low cost SOIC 8-lead surface mount plastic package. The SW-356 switch is controlled by applying a single 0/+5 V control signal on the RF common port through an external RF choke or bias resistor. Typical applications are T/R, diversity, or antenna select switches for 2.4 to 2.5 GHz ISM applications, up to a power level of 1 W. The RF and control signal can be applied on the same wire, making this switch ideal for applications where the antenna (or in the case of diversity, the two antennas) location is a distance away from the transmitter.

The SW-356 is fabricated with monolithic GaAs MMICs using a mature 1 micron process. The process features full passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Electrical Specifications[1], T_A = +25°C

Parameter	Test Conditions			Units	Min.	Typ.	Max.
Insertion Loss		RFC-Rx	2.3-2.5 GHz	dB		1.2	1.5
		RFC-Tx	2.3-2.5 GHz	dB		1.2	1.5
		RFC-Rx	2.0-2.8 GHz	dB		1.5	1.7
		RFC-Tx	2.0-2.8 GHz	dB		1.5	1.7
Isolation		RFC-Rx	2.0-2.8 GHz	dB	18	22	
		RFC-Tx	2.3-2.5 GHz	dB	14	14.5	
		RFC-RF1	2.5-2.8 GHz	dB	15	16	
		RFC-Tx	2.5-2.8 GHz	dB	12	13	
VSWR		Input On	2.3-2.5 GHz			1.1	1.3
		Input On	2.0-2.8 GHz			1.25	1.4
		Output On	2.3-2.5 GHz			1.2	1.35
		Output On	2.0-2.8 GHz			1.4	1.5
1 dB Compression		RF1 On (0 V)	2.4 GHz	dBm	27	30	
		RF2 On (5 V)	2.4 GHz	dBm	27	30	
IP_3	Two Tone @ +10 dBm	RF1 On (0 V)	F1 = 2.0 GHz	dBm		45	
	Each Tone		F2 = 2.005 GHz	dBm		45	
	Two Tone @ +10 dBm	RF2 On (5 V)	F1 = 2.0 GHz	dBm		40	
	Each Tone		F2 = 2.005 GHz	dBm		40	
Trise, Tfall	10-90% RF and 90-10% RF			nS		10	
Ton, Toff	50% Vctl to 90% RF and 50% Vctl to 10% RF			nS		20	

1. All specifications apply when operated with bias voltages of 0 and +5 V at 2.4 GHz in a 50 Ω system, unless otherwise specified.
2. SW-356 replaces SW-029.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max Input Power (2.0 - 3.0 GHz)	
3 V Control and Supply	+24 dBm
5 V Control and Supply	+34 dBm
Operating Temperature	-40C° to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Ordering Information

Part Number	Package
SW-356 PIN SW-356TR SW-356RTR	SOIC 8-Lead Plastic Forward Tape & Reel * Reverse Tape & Reel *

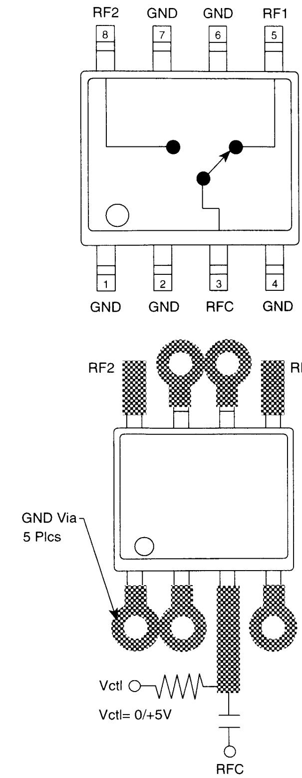
* If specific reel size is required, consult factory for part number assignment.

Truth Table

Vctl[2]	RFC-RF2	RFC-RF1
0 V	Off	On
5 V	On	Off

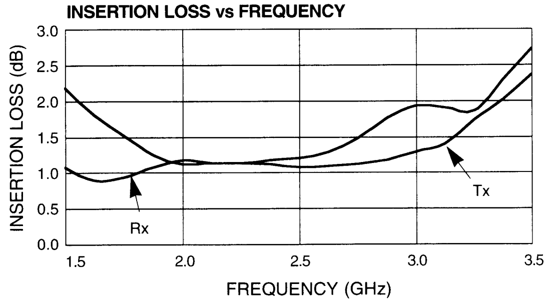
2. Through a bias tee at RF common.
0 V – -0.2 V @ 20 μA max.
5 V – +5 V @ 20 μA typ to +8 V @ 480 μA max.

Functional Schematic

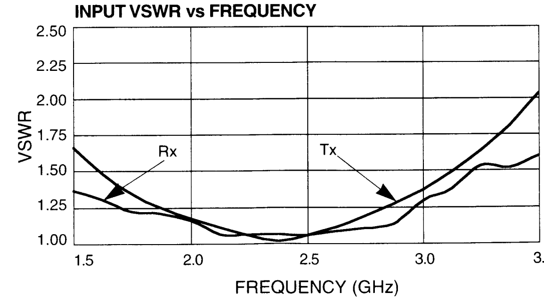


Typical Performance @ +25°C

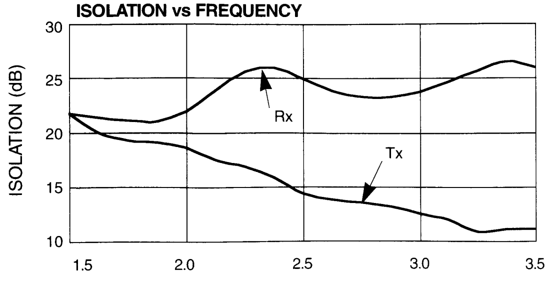
INSERTION LOSS vs FREQUENCY



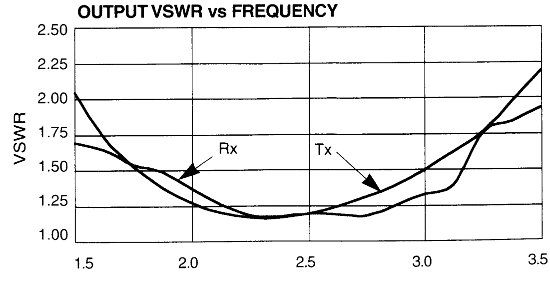
INPUT VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



OUTPUT VSWR vs FREQUENCY



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Matched GaAs SPST Switch DC-3 GHz with TTL/CMOS Control Input SW05-0311

V 2.00

Features

- Integral Driver
- Low DC Power Consumption
- TTL and CMOS Input Compatible
- Surface Mount Package
- Low Cost/High Performance

Guaranteed Specifications[1,2] (From -40°C to + 85°C)

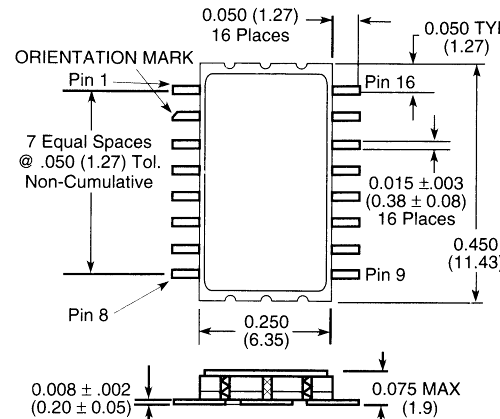
Frequency Range			DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.0 Typ.	1.3 dB Max
	DC-2000 MHz	0.8 Typ.	1.2 dB Max
	DC-1000 MHz	0.7 Typ.	1.0 dB Max
	DC- 500 MHz	0.6 Typ.	0.8 dB Max
VSWR	DC-3000 MHz	1.4 Typ.	1.5:1 Max
	DC-2000 MHz	1.3 Typ.	1.4:1 Max
	DC-1000 MHz	1.2 Typ.	1.3:1 Max
	DC- 500 MHz	1.1 Typ.	1.2:1 Max.
Isolation	DC-3000 MHz	29 Typ.	25 dB Min
	DC-2000 MHz	40 Typ.	35 dB Min
	DC-1000 MHz	60 Typ.	35 dB Min
	DC- 500 MHz	70 Typ.	65 dB Min

Operating Characteristics

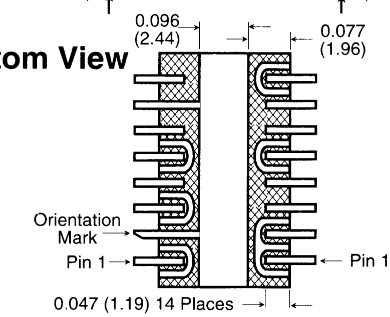
Impedance			50 Ohms Nominal
Switching Characteristics			
	Trise, Tfall (10% to 90%)		50 ns Typ
	Ton, Toff (1.3V CTL to 90%/10%)		150 ns Typ
Transients (in-Band)			50 mV Typ
Input Power for 1 dB Compression			
	0.05 GHz		+21 dBm Typ
	0.5 GHz to 3 GHz		+27 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+62	+40	dBm Typ
0.5 GHz to 3 GHz	+68	+46	dBm Typ
Supply Voltage Ranges			
V_{CC}			+5.0V ±10% @ 1 mA max.
V_{EE}			-5.0V to -8.0V @ 1 mA max.
Control Voltages Range			
Vin Low			0V to 0.8V @ 1 µA Max
Vin Hi			2.0V to 5.0V @ 1 µA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. There should be a DC return on the RFC port. The DC return can be either a 10K ohm resistor or an RF choke.

CR-9



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Model No.	Package
SW05-0311	Ceramic

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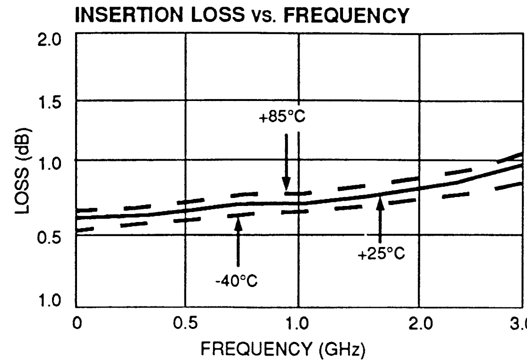
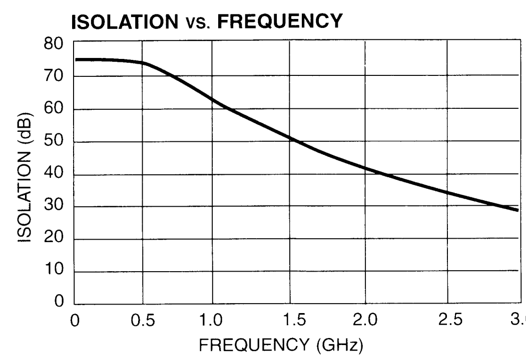
Absolute Maximum Ratings[1]

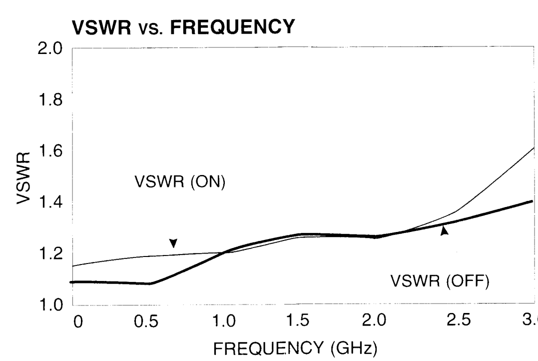
Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5V
V_{EE}	–8.5V
Control Voltage	–0.5V, to V_{CC} +0.5V
Operating Temperature	–40˚C to 125˚C
Storage Temperature	–65˚C to 150˚C

1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







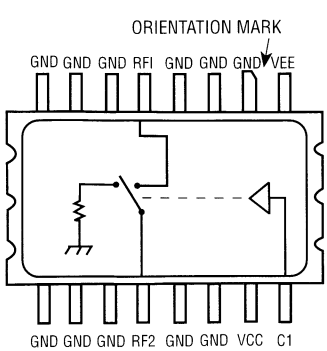
Pin Configuration

Pin No.	Description	Pin No.	Description
1	V_{EE}	9	GND
2	GND	10	GND
3	GND	11	GND
4	GND	12	RF2
5	RFI	13	GND
6	GND	14	GND
7	GND	15	V_{CC}
8	GND	16	C1

Truth Table

Control Input	Condition of Switch
C1	RF1 to RF2
LO	ON
HI	OFF

Pin Configuration (Top View)



Specifications Subject to Change Without Notice.

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GaAs SPDT Reflective Switch DC - 3 GHz with TTL/CMOS Control Input SW10-0312

V 2.00

Features

- Integral Driver
- Low DC Power Consumption
- TTL and CMOS Input Compatible
- Fast Switching Speed: 7 ns Typical
- Surface Mount Package
- Low Cost/High Performance

Guaranteed Specifications[1,2] (From -40°C to +85°C)

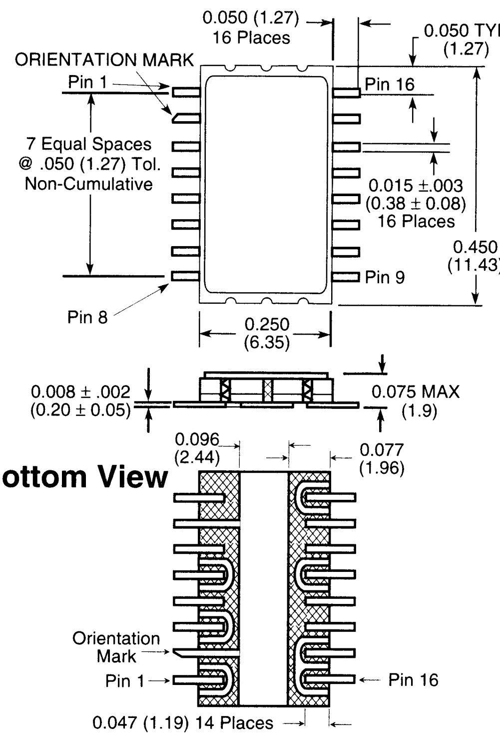
Frequency Range			DC-3000 MHz
Insertion Loss	DC-3000 MHz	0.9 Typ.	1.2 dB Max
	DC-2000 MHz	0.8 Typ.	1.1 dB Max
	DC-1000 MHz	0.7 Typ.	0.9 dB Max
	DC- 500 MHz	0.6 Typ.	0.8 dB Max
VSWR	DC-3000 MHz	1.4 Typ.	1.5:1 Max
	DC-2000 MHz	1.3 Typ.	1.4:1 Max
	DC-1000 MHz	1.2 Typ.	1.4:1 Max
	DC- 500 MHz	1.1 Typ.	1.3:1 Max
Isolation	DC-3000 MHz	36 Typ.	27 dB Min
	DC-2000 MHz	38 Typ.	30 dB Min
	DC-1000 MHz	42 Typ.	35 dB Min
	DC- 500 MHz	45 Typ.	40 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			50 ns Typ
Ton, Toff (1.3V CTL to 90%/10%)			150 ns Typ
Transients (in-Band)			50 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			25 dBm Typ
0.5 GHz to 3 GHz			30 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+60	+40	dBm Typ
0.5 GHz to 3 GHz	+65	+46	dBm Typ
Supply Voltage Ranges			
V_{CC}			+5.0V ±10% @ 1 mA max.
V_{EE}			-5.0V to -8.0V @ 1 mA max.
Control Voltage Range			
Vin Low			0V to 0.8V @ 1 µA Max
Vin Hi			2.0V to 5.0V @ 1 µA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. There should be a DC return on the RFC port. The DC return can be either a 10k ohm resistor or an RF choke.

CR-9



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Model No.	Package
SW10-0312	Ceramic

North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5V
V_{EE}	–8.5V
Control Voltage	–0.5V, to V_{CC} +0.5V
Operating Temperature	–40˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

1. Operation of this device above any one of these parameters may cause permanent damage.

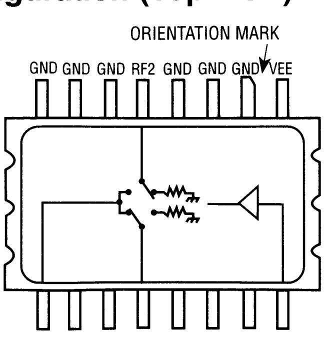
Pin Configuration

Pin No.	Description	Pin No.	Description
1	V_{EE}	9	RFC
2	GND	10	GND
3	GND	11	GND
4	GND	12	RF1
5	RF2	13	GND
6	GND	14	GND
7	GND	15	V_{CC}
8	GND	16	C1

Truth Table

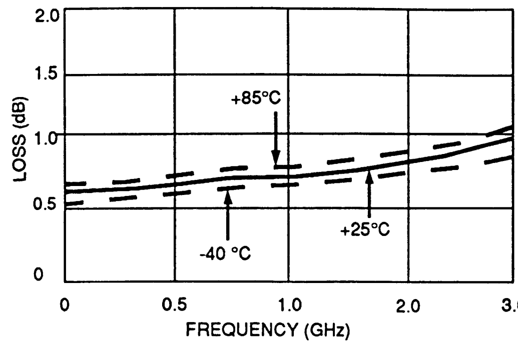
Control Input	Condition of Switch RF Common to Each RF Port	
C1	RF1	RF2
LO	ON	OFF
HIGH	OFF	ON

Pin Configuration (Top View)

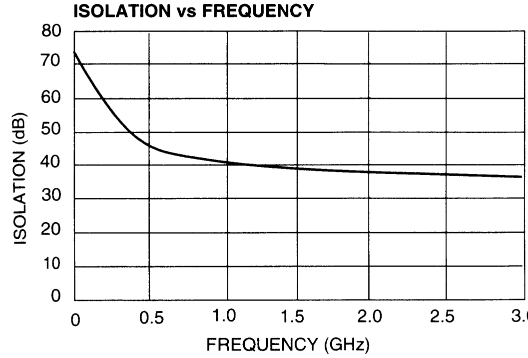


Typical Performance

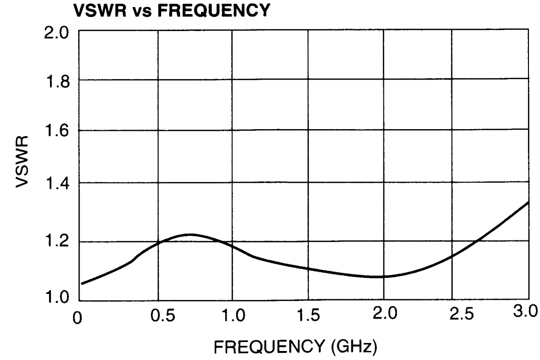
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Matched GaAs SPDT Switch DC-3 GHz with TTL/CMOS Control Input SW10-0313

V 2.00

Features

- Integral Driver
- Low DC Power Consumption
- TTL and CMOS Input Compatible
- Fast Switching Speed: 7 ns Typical
- Surface Mount Package
- Low Cost/High Performance

Guaranteed Specifications[1,2] (From -40°C to + 85°C)

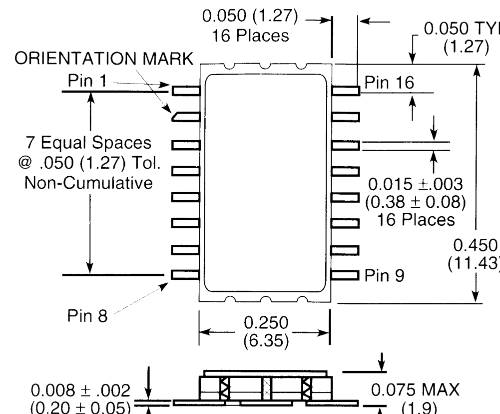
Frequency Range			DC-3000 MHz
Insertion Loss	DC-3000 MHz	0.8 Typ.	1.2 dB Max
	DC-2000 MHz	0.7 Typ	1.1 dB Max
	DC-1000 MHz	0.7 Typ.	0.9 dB Max
	DC- 500 MHz	0.6 Typ.	0.8 dB Max
VSWR	DC-3000 MHz	1.2 Typ.	1.4:1 Max
	DC-2000 MHz	1.2 Typ.	1.35:1 Max
	DC-1000 MHz	1.2 Typ.	1.35:1 Max
	DC- 500 MHz	1.1 Typ.	1.3:1 Max
Isolation	DC-3000 MHz	40 Typ.	35 dB Min
	DC-2000 MHz	50 Typ.	45 dB Min
	DC-1000 MHz	50 Typ.	45 dB Min
	DC- 500 MHz	55 Typ.	50 dB Min

Operating Characteristics

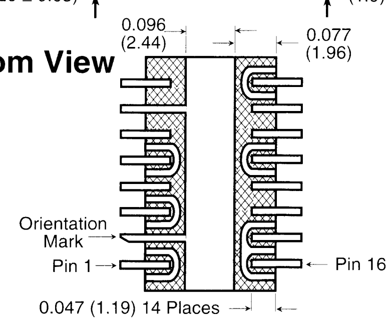
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			50 ns Typ
Ton, Toff (1.3V CTL to 90%/10%)			150 ns Typ
Transients (in-Band)			50 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+25 dBm Typ
0.5 GHz to 3 GHz			+30 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+60	+40	dBm Typ
0.5 GHz to 3 GHz	+65	+46	dBm Typ
Supply Voltage Ranges			
V_{CC}			+5.0V ±10% @ 1 mA max.
V_{EE}			-5.0V to -8.0V @ 1 mA max.
Control Voltage Range			
Vin Low			0V to 0.8V @ 1 µA Max
Vin Hi			2.0V to 5.0V @ 1 µA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. There should be a DC return on the RFC port. The DC return can be either a 10k ohm resistor or an RF choke.

CR-9



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Model No.	Package
SW10-0313	Ceramic

Specifications Subject to Change Without Notice.

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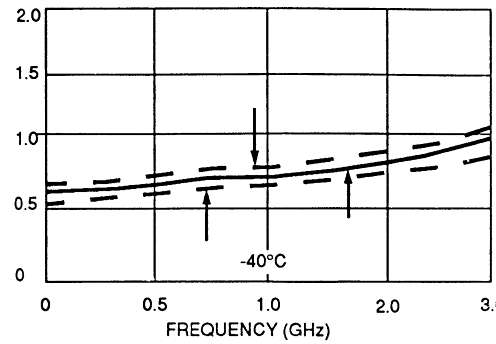
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5V
V_{EE}	–8.5V
Control Voltage	–0.5V, to V_{CC} +0.5V
Operating Temperature	–40˚C to 125˚C
Storage Temperature	–65˚C to + 150˚C

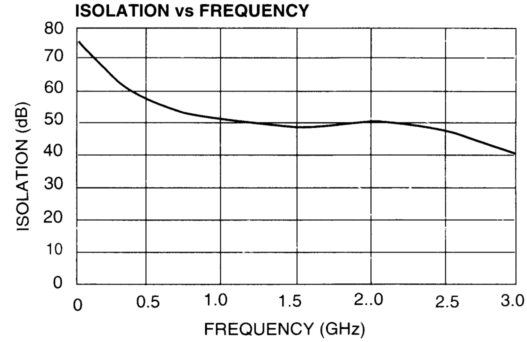
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance

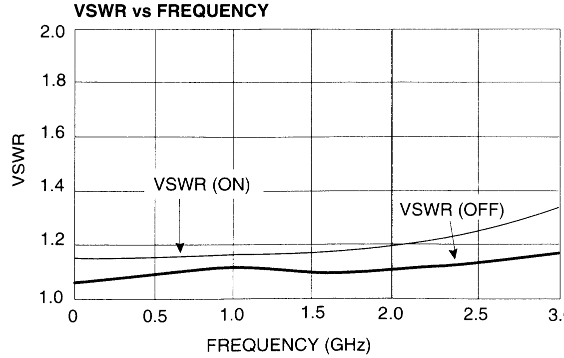
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



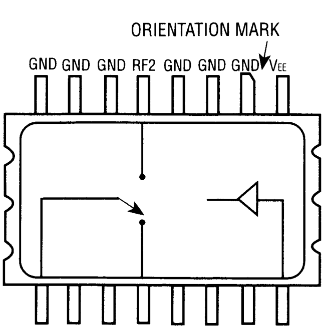
Pin Configuration

Pin No.	Description	Pin No.	Description
1	V_{EE}	9	RFC
2	GND	10	GND
3	GND	11	GND
4	GND	12	RF1
5	RF2	13	GND
6	GND	14	GND
7	GND	15	V_{CC}
8	GND	16	C1

Truth Table

Control Input	Condition of Switch RF Common to Each RF Port	
C1	RF1	RF2
LO	ON	OFF
HIGH	OFF	ON

Pin Configuration (Top View)



Specifications Subject to Change Without Notice.

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GaAs SP4T Absorptive Switch DC-3 GHz

SW15-0314

V 2.00

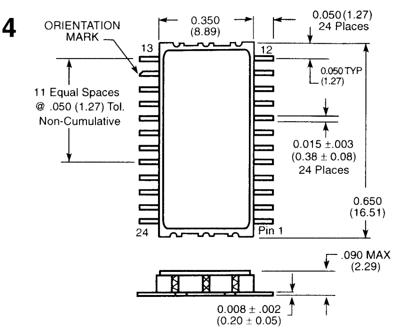
Features

- Integral Driver
- Isolation: 50 dB Typ. at 1 GHz
- Low DC Power Consumption
- Surface Mount Package
- TTL and CMOS Input Compatible
- Low Cost/High Performance

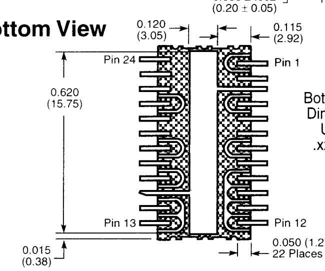
Description

M/A-COM's SW15-0314 is a GaAs MMIC SP4T absorptive switch with an integral silicon ASIC driver. This device is in a 24-lead ceramic surface mount package. These switches exhibit excellent performance from DC to 3 GHz, with very low DC power dissipation. The SW15-0314 is ideally suited for wireless infrastructure applications. Available with enhanced performance as fully hermetic version. Environmentally screenable as SW-314.

CR-14



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications[1,2], T_A = +25°C

Parameter	Test Conditions	Units	Minimum	Typical	Maximum
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB		1.0 1.2 1.2 1.4	1.3 1.4 1.6 1.8
Isolation	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB	50 40 30 25	60 50 40 35	
VSWR	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	RFC, RF1 - RF4 (On) 1.6:1 Typ. 1.6:1 Typ. 1.6:1 Typ. 1.8:1 Typ.		RF1 - RF4 (Off) 1.3:1 Typ. 1.5:1 Typ. 1.9:1 Typ. 2.4:1 Typ.	
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90%/10% RF In-band (peak-peak)	nS nS mV		50 150 50	
1 dB Compression[3]	Input Power 0.05 GHz Input Power 0.5 - 3.0 GHz	dBm dBm		+20 +27	
Input IP_3[3]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 3.0 GHz	dBm dBm		+35 +46	
Input IP_2[3]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 3.0 GHz	dBm dBm		+45 +60	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}[4]	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			4.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0

1. All specifications apply when operated with bias voltages of +5V for V_{CC} and -5.0V to-8.0V for V_{EE} and 50Ω impedance at all RF ports unless otherwise specified.
2. For this switch to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
3. V_{EE}= -5V for the typical numbers given.
4. For CMOS control levels, V_{CC} current is 2 µA typ. and V_{EE} current is <100 µA typ.

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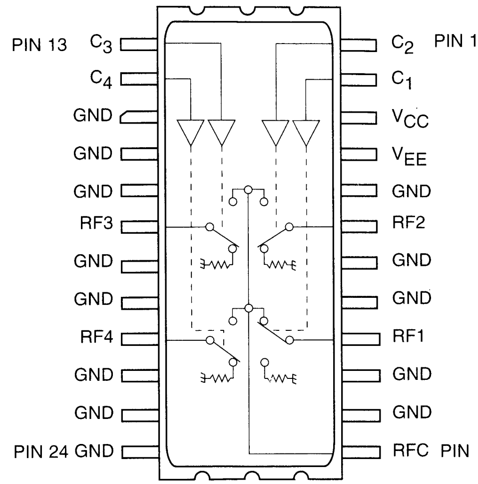
Absolute Maximum Ratings[1, 2]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 - 3.0 GHz[2]	+34 dBm
Bias Voltages	
V_{CC}	-0.5 to +5.5V
V_{EE}	-8.5V to +0.5V
Control Voltage	-0.5V to V_{CC} +0.5V
Operating Temperature	-40°C to +85°
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the input power is applied to the terminated port, the absolute maximum is +30 dBm.

Functional Schematic



Truth Table

TTL Control Inputs				Condition of Switch: RF Common to Each RF Port			
C1	C2	C3	C4	RF1	RF2	RF3	RF4
1	0	0	0	On	Off	Off	Off
0	1	0	0	Off	On	Off	Off
0	0	1	0	Off	Off	On	Off
0	0	0	1	Off	Off	Off	On

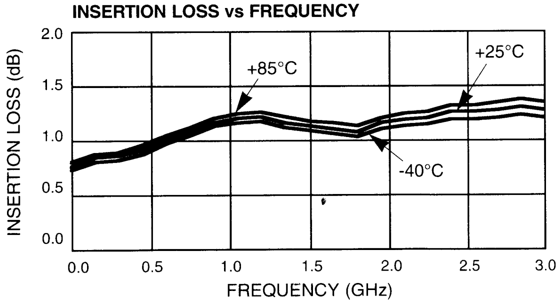
0= TTL Low 1= TTL High

Ordering Information

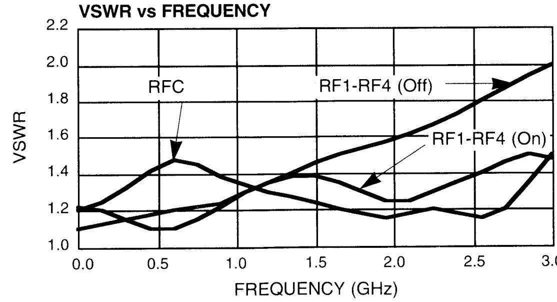
Part No.	Package
SW15-0314	Ceramic

Typical Performance @ +25°C

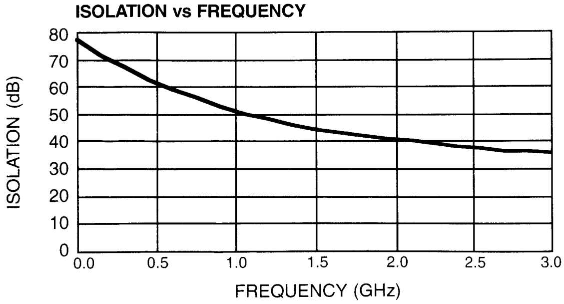
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



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M/A-COM
an AMP company

RF Multi-throw PIN Diode Switch Modules

MA8334 Series

V 2.00

Features

- SPDT and SP3T Designs
- Low Distortion
- High Reliability
- Usable from 10 MHz to 1 GHz
- Low Insertion Loss
- High Isolation

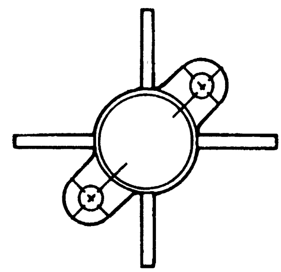
Description

M/A-COM's MA8334 series Multi-throw Switch Modules are SPDT and SP3T switches designed for use from 20 MHz to 1000 MHz. They are rated to handle 100 watts CW RF power.

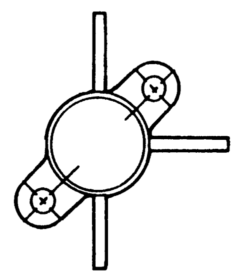
These switch modules are constructed using advanced hybrid technology and utilize PIN diode chips distinguished by their low loss and high reliability. These switch modules employ M/A-COM's high voltage CERMACHIP PIN diodes.

Applications of the MA8334 switch modules include 100 watt TR antenna and diversity switches. The semiconductor elements have been selected for low distortion performance.

Case Styles



844-004



844-001

Specifications @ T_A = +25°C

Model Number	Case Style	Maximum[3] CW Input Power (Watts)	Switch Type	Frequency Range (MHz)	Minimum[1,2] Isolation (dB)	Maximum[1,2] Insertion Loss (dB)	Diode Voltage Rating (Volts)
MA8334-001	844-001	100	SPDT	10-1000	24	0.35	900
MA8334-004	844-004	100	SP3T	10-1000	24	0.35	900

Notes:
1. For the MA8334-001 and the MA8334-004 the isolation and insertion loss at small signals is specified at 450 MHz with the "ON" branch forward biased at 50 mA and the "OFF" branch at zero bias. For "high power" reverse bias will be required on the off arm.
2. Maximum SWR for all switches is 1.35 at specified frequency.
3. Nominal thermal resistance is 20° C/W, per diode.

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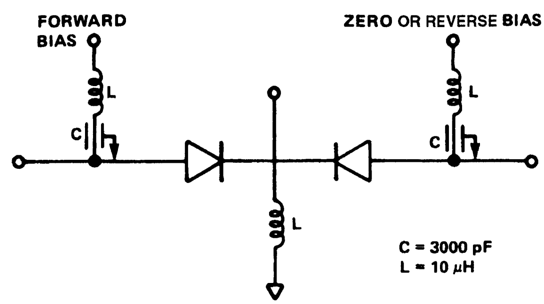
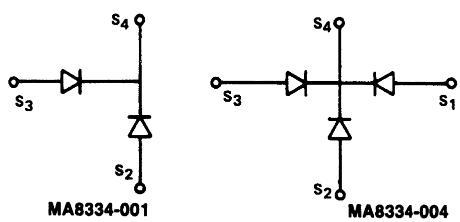
Applications Circuits

SUGGESTED BIAS CIRCUIT FOR SPDT



Internal Wiring Diagrams

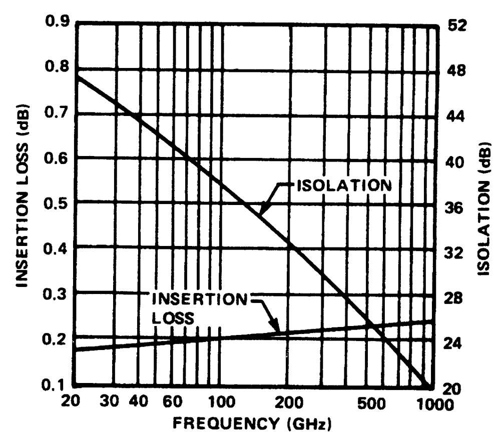


Maximum Ratings

Parameters	Absolute Maximum
Storage Temperature	-65°C to +125°C
Operating Temperature	-65°C to +125°C
Power Dissipation	5 watts derated to 0 watts at max. operating temperature
Voltage	Voltage Rating

Typical Performance Curves

INSERTION LOSS AND ISOLATION vs FREQUENCY



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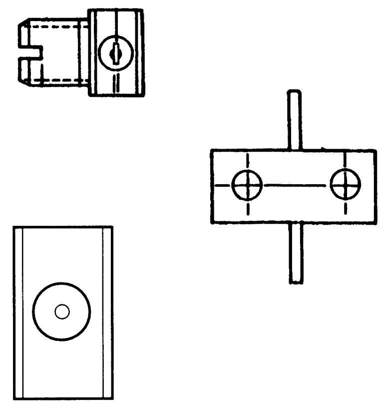
Stripline PIN Diode Switch Modules

MA47200 Series

V 2.00

Features

- Broadband 50 Ohm Designs Through X Band
- Circuit Characterized
- High Power Capacity
- Voltage Ratings to 1000 Volts
- Fast Switching Speed to 10 Nanoseconds
- Hermetically Sealed Packages



Description

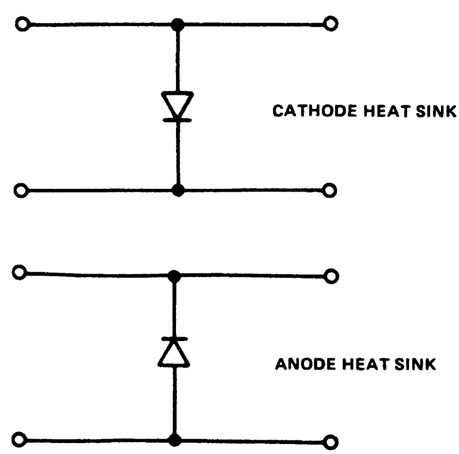
This series of M/A-COM semiconductor products is hermetically sealed stripline package PIN diodes designed to drop into a 50 ohm stripline circuit without external matching. The MA47200 series can be used as SPST reflective switches and are useful in applications from VHF through X band. Several models are provided with different power and switching speed capability.

This series of stripline switch modules consists of shunt-mounted passivated PIN diodes in hermetic stripline packages. These modules are optimized for 50 ohm microstrip and stripline circuits. The MA47200 series modules may be operated as a switch by applying the appropriate forward and reverse DC excitation. They can also be used as attenuators by varying the forward DC current.

Applications

The MA47200 series of broadband shunt-mounted PIN diodes features a shunt-mounted PIN chip with an appropriate series inductance to produce a matched low-pass filter structure at zero or reverse bias. By applying +10 mA to +100 mA to the center conductor the diode's impedance changes to a low-impedance inductive short causing the diode to reflect RF power (+10 mA to +100 mA) must be supplied to the center conductor of the MA47200 to provide high isolation.

Internal Wiring Diagram



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V 2.00

Specifications @ T_A = +25°C

Model[1] Number	Case[4] Style	Test Frequency (GHz)	Maximum[2] insertion Loss (dB) @ V_R	Minimum Isolation (dB) @ I_F	Minimum[3] Reverse Voltage V_R (Volts)	Maximum Thermal Resistance (C/W°)	Nominal Switching Speed (ns)	
							RF Off to RF On	RF On to RF Off
MA47208	114	1.0	0.25 @ 20V	30 @ 25 mA	1000	10	300	150
MA47200	114	1.0	0.25 @ 20V	30 @ 25 mA	500	10	200	60
MA47201	115	1.0	0.25 @ 20V	30 @ 25 mA	500	10	200	60
MA47203	115	6.0	0.50 @ 20V	25 @ 25 mA	500	15	150	30
MA47223	144	4-8**	0.50 @ 0V	20 @ 100 mA	500	20	150	30
MA47222	144	8.0	0.50 @ 0V	20 @ 100 mA	150	20	100	30
MA47220*	144	10.0	0.50 @ 0V	20 @ - 100 mA	150	30	100	30
MA47221	144	4-8**	1.00 @ 0V	20 @ 20 mA	70	20	10	10

* Anode heat sink
** Swept frequency measurement

Notes:
1. All models have a cathode heatsink, except MA47220.
2. Maximum SWR is 1.5 at specified insertion loss condition.
3. Maximum reverse current is 10 microamperes at specified voltage rating.
4. These parts are available only in the indicated case style.

Environmental Performance

The MA47200 series of diodes is capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500 MIL-STD-202 and MIL-STD-750 which specify mechanical electrical thermal and other environmental test common to semiconductor products.

Environmental Ratings (PER MIL-STD-750)

	Method	Level
Storage Temperature	1031	See maximum ratings
Operating Temperature	—	See maximum ratings
Temperature Cycling	1051	5 cycles -65°C to +150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Maximum Ratings

Parameter	Absolute Maximum
Storage Temp.	-65°C to +175°C
Operating Temp.	-65°C to +150°C
Voltage	Voltage Rating
Power Dissipation	$P_{diss} = \frac{150°C - T\ ambient}{Thermal\ Resistance}$

Screened Diodes

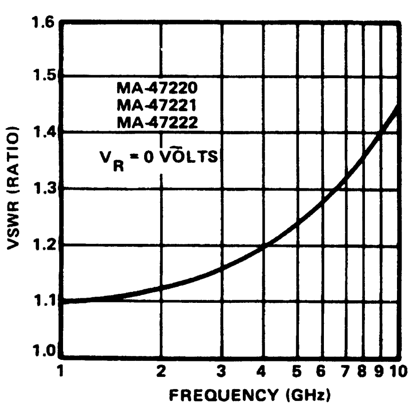
Table 1. Typical 100% Preconditioning and Screening Program for TX Level Screening

Inspections	Method	Condition
Internal Visual and/or X-ray	2072/2076	See note 1
High Temperature Life	1032	48 hours minimum at maximum storage temperature
Thermal Shock	1051	10 cycles
Constant Acceleration	2006	20 000 g s Y1
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical	——	See note 2
Burn-In	1038	See note 2

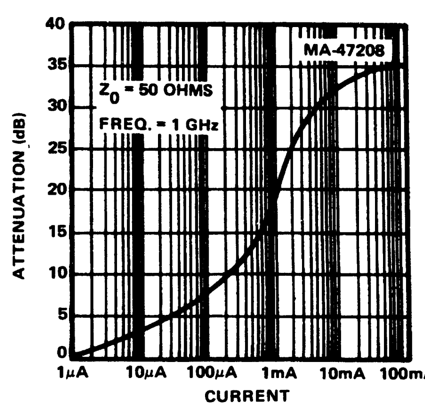
Notes:
1. Internal visual on TXV screening programs only. X-ray is optional for any screening plan.
2. Conditions and details of test depend on specific part number. Information available on request.

Typical Performance Curves

VSWR vs FREQUENCY



ATTENUATION vs FORWARD CURRENT



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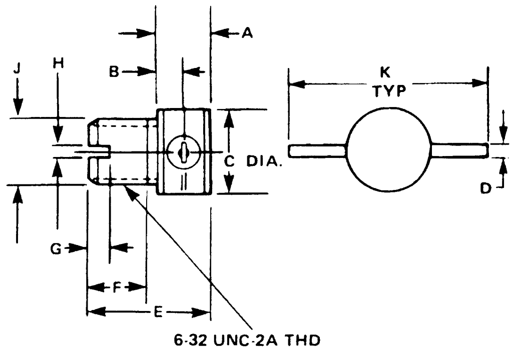
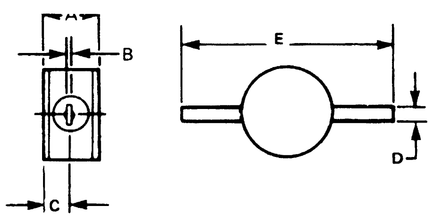
Case Style 114



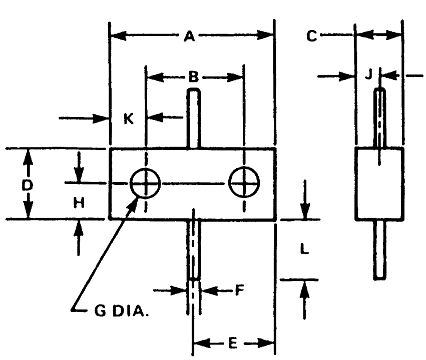
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.120	0.140	3.04	3.55
B	0.058	0.072	1.47	1.82
C	—	0.255	—	6.47
D	0.011	0.013	0.76	1.52
E	0.380	0.400	9.65	10.16
F	0.205	—	5.20	—
G	—	—	—	—
H	—	—	—	—
J	0.1312	0.1372	3.33	3.48
K	—	—	—	—

Case Style 115



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.118	0.140	3.00	3.55
B	0.002	0.006	0.051	0.152
C	0.058	0.072	1.47	1.82
D	0.011	0.013	1.76	1.52
E	—	—	—	—

Case Style 144



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.405	0.415	10.16	10.67
B	0.240	0.260	6.10	6.60
C	0.120	0.130	3.05	3.30
D	0.155	0.165	3.94	4.19
E	0.195	0.215	4.95	5.46
F	0.015	0.035	0.38	0.89
G	0.092	0.100	2.34	2.54
H	0.075	0.085	1.91	2.16
J	0.056	0.066	1.42	1.68
K	0.075	0.085	1.91	2.16
L	0.120	—	3.05	—

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Monolithic PIN Diode Switches

MA4SW100, 200, 300

V 2.00

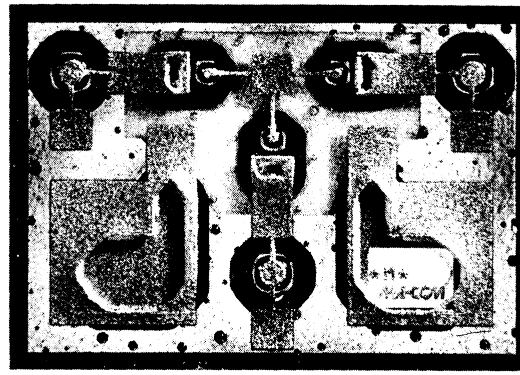
Features

- Broadband Performance:
  Specified 1-18 GHz
  Usable 1-26 GHz (SPST, SPDT)
  Usable 1-20 GHz (SP3T)
- Insertion Loss 1.2 dB to 18 GHz
  Isolation 40 dB to 18 GHz
- Single Chip Replaces up to
  Six Diodes and Twelve Bonds
- Rugged, Monolithic, Glass
  Encapsulated, Junction Construction

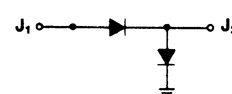
Description

The MA4SW100-300 series are broadband monolithic switches using M/A-COM's patented HMIC technology. They utilize a series and shunt connected PIN diode in each arm. The close spacing of these series/shunt diodes results in low loss and high isolation. They are available as SPST, SPDT and SP3T switches. These monolithic switches are specifically designed as easy to use replacements for beam lead and chip PIN diodes in MIC circuits.

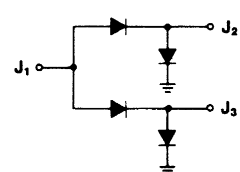
The MA4SW100 SPST and MA4SW200 SPDT are usable through 26 GHz. The MA4SW300 SP3T is usable through 20 GHz. Each of the chips has 5 mil square (0.13 mm) gold plated bonding pads at each RF port. Gold backside plating allows conventional chip bonding techniques using solder, thermal compression bonding or conductive epoxy. The large pads facilitate convenient low inductance ribbon bonds to adjacent circuit elements. The PIN diodes are fully encapsulated in a hermetic low loss glass and the RF connection is deposited on this glass to reduce line losses.



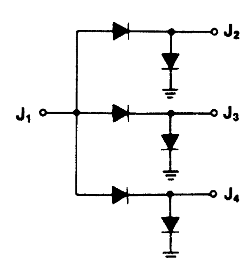
SPST



SPDT



SP3T



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Electrical Specifications at +25°C

MA4SW100 (SPST)[1]

Parameters	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	0.6 1.0 1.5	0.8 1.5 —	dB dB dB
Isolation[2]	1-8 GHz 8-18 GHz 18-26 GHz	42 35 —	45 40 35	— — —	dB dB dB
Input Return Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	15 10 10	— — —	dB dB dB
Signal Compression @ 500 mW	1 GHz	—	0.2	—	dB
Switching Speed[3]	—	—	20	—	nS
Voltage Rating[4]	—	50	—	—	V

MA4SW200 (SPDT)[1]

Parameters	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	0.6 1.0 1.5	0.8 1.5 —	dB dB dB
Isolation[2]	1-8 GHz 8-18 GHz 18-26 GHz	42 35 —	45 40 35	— — —	dB dB dB
Input Return Loss[2]	1-8 GHz 8-18 GHz 18-26 GHz	— — —	15 10 10	— — —	dB dB dB
Signal Compression @ 500 mW	1 GHz	—	0.2	—	dB
Switching Speed[3]	—	—	20	—	nS
Voltage Rating[4]	—	50	—	—	V

Notes:
1. Standard case styles are: 1053 for part number MA4SW100; 1052 for part number MA4SW200; 1051 for part number MA4SW300.
2. Switching parameters specified with ±20 mA current applied to J_2, J_3 and J_4. Specifications are verified by measurement in a 50 Ohm test mount and 3 mil ribbons bonded to the RF pads.
3. Typical switching speed measured from 10% to 90% of detected RF signal.
4. Reverse current specified not to exceed 10 μA at voltage rating.

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Electrical Specifications (Cont'd.)

MA4SW300 (SP3T)[1]

Parameters	Frequency	Minimum	Nominal	Maximum	Units
Insertion Loss[2]	1-8 GHz	—	1.0	1.5	dB
	8-18 GHz	—	1.2	1.5	dB
Isolation[2]	1-8 GHz	35	37	—	dB
	8-18 GHz	30	32	—	dB
Input Return Loss[2]	1-8 GHz	10	15	—	dB
	8-18 GHz	10	12	—	dB
Signal Compression @ 500 mW	1 GHz	—	0.20	—	dB
Switching Speed[3]	—	—	20	—	nS
Voltage Rating[4]	—	50	—	—	V

Notes:
1. Standard case styles are: 1053 for part number MA4SW100; 1052 for part number MA4SW200; 1051 for part number MA4SW 300.
2 Switching parameters specified with ±20 mA current applied to J_2, J_3 and J_4. Specifications are verified by measurement in a 50 Ohm test mount and 3 mil ribbons bonded to the RF pads.
3. Typical switching speed measured from 10% to 90% of detected RF signal.
4. Reverse current specified not to exceed 10 µA at voltage rating.

Absolute Maximum Ratings

Operating Temperature	-65°C to +150°C
Storage Temperature	-65°C to +175°C
Power Dissipation at 25°C	100 mW
Incident CW RF Power at 25°C	1 Watt
Applied Voltage	50 Volts

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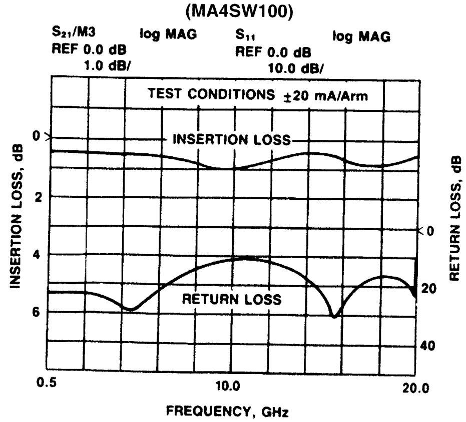
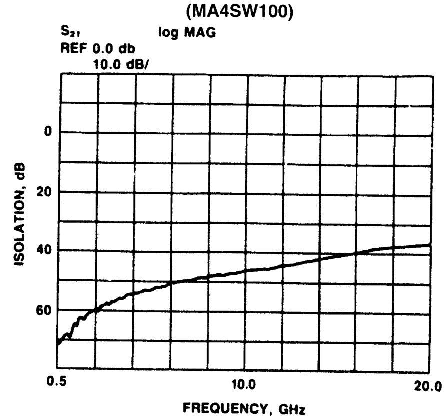
Typical Performance Curves

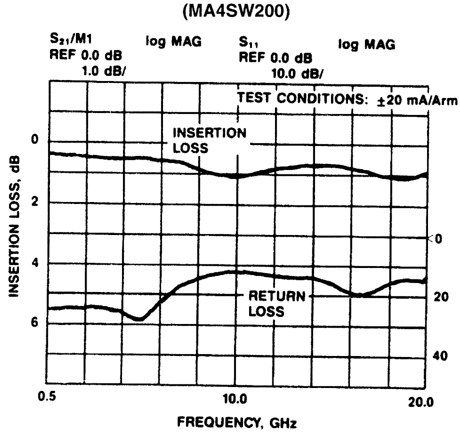
INSERTION LOSS AND RETURN LOSS vs FREQUENCY
(MA4SW100)



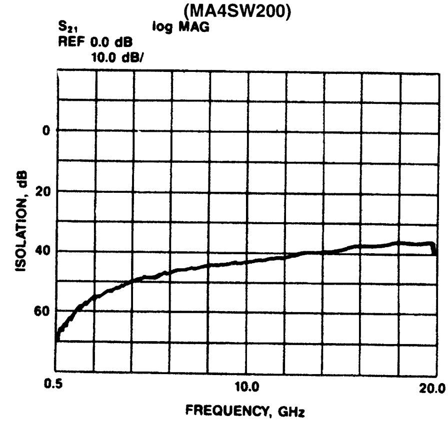
ISOLATION vs FREQUENCY
(MA4SW100)



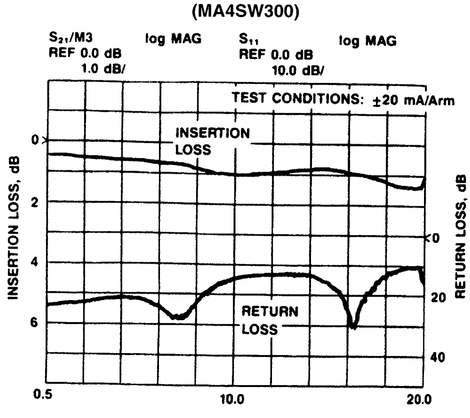
INSERTION LOSS AND RETURN LOSS vs FREQUENCY
(MA4SW200)



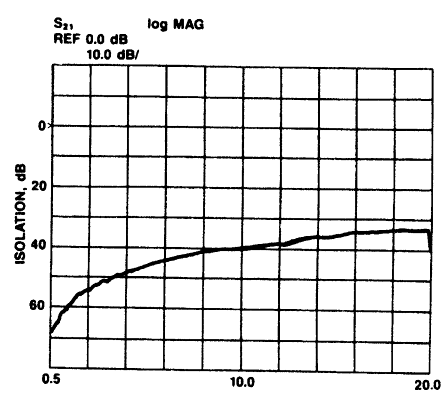
ISOLATION vs FREQUENCY
(MA4SW200)



INSERTION LOSS AND RETURN LOSS vs FREQUENCY
(MA4SW300)



ISOLATION vs FREQUENCY
(MA4SW300)



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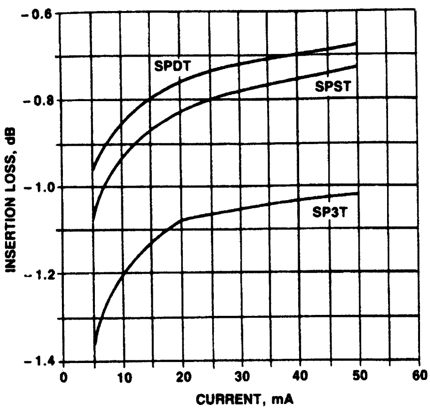
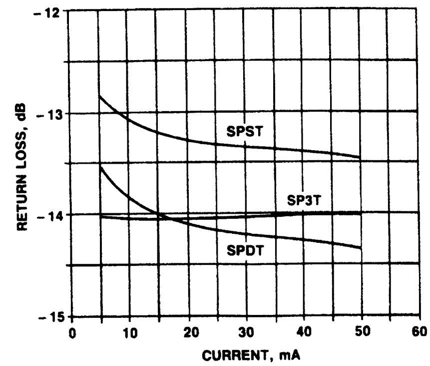
Typical Performance Curves (Cont'd)

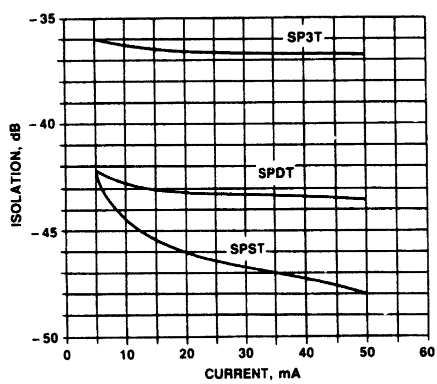
INSERTION LOSS vs CURRENT AT 10 GHZ



RETURN LOSS vs CURRENT AT 10 GHZ



ISOLATION vs CURRENT AT 10 GHZ



S-Parameters

The following files are abstracted "real" S-parameters calculated for the MA4SW series from "Touchstone" by EESOF. Only the chip is simulated with port 1 being the "RF in" and ports 2, 3 and 4 being the output for various configurations. Bias circuit design should include parasitic elements from ribbons, wires, etc.

M/A-COM can supply the Touchstone file on a 5 1/2 inch disk (DOS format) on special order. Contact Factory for details.

MA4SW100 **SPST**

Frequency (GHz)	Off (S21) dB	On (S21) dB	Off (S11) dB	On (S11) dB
2.00000	56.786	0.300	0.026	31.140
4.00000	50.757	0.334	0.052	32.395
6.00000	47.206	0.370	0.078	32.219
8.00000	44.658	0.406	0.105	31.343
10.0000	42.650	0.444	0.133	29.327
12.0000	40.976	0.484	0.161	26.884
14.0000	39.526	0.527	0.189	24.498
16.0000	38.234	0.574	0.218	22.325
18.0000	37.056	0.626	0.248	20.380
20.0000	35.965	0.684	0.279	18.638
22.0000	34.937	0.749	0.311	17.072
24.0000	33.956	0.822	0.344	15.656
26.0000	33.011	0.905	0.379	14.368

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S-Parameters (Cont'd)

MA4SW200 SPDT

Frequency (GHz)	Off (S31) dB	On (S21) dB	Off (S11) dB	On (S11) dB
0.0000	88.560	0.264	89.081	29.266
2.0000	62.142	0.314	62.675	26.950
4.0000	56.390	0.382	56.885	20.999
6.0000	53.011	0.465	53.435	17.647
8.0000	50.617	0.557	50.943	15.468
10.000	48.766	0.656	48.969	13.855
12.000	47.250	0.760	47.307	12.627
14.000	45.951	0.864	45.847	11.683
16.000	44.791	0.964	44.518	10.961
18.000	43.713	1.058	43.272	10.421
20.000	42.670	1.143	42.075	10.038
22.000	41.620	1.217	40.902	9.791
24.000	40.526	1.282	39.733	9.661
26.000	39.417	1.337	38.615	9.620

MA4SW300 SP3T

Frequency (GHz)	Off (S21) dB	On (S31) dB	Off (S14) dB	On (S11) dB
2.00000	62.572	0.327	62.572	25.976
4.00000	56.624	0.415	56.624	19.786
6.00000	53.188	0 522	53.188	16.404
8.00000	50.769	0.641	50.769	14.228
10.0000	48.897	0.768	48.897	12.655
12.0000	47.352	0.897	47.352	11.481
14.0000	46.008	1.025	46.008	10.593
16.0000	44.780	1.149	44.780	9.915
18.0000	43.608	1.267	43.608	9.390
20.0000	42.443	1.383	42.443	8.964
22.0000	41.252	1.505	41.252	8.575
24.0000	40.013	1.649	40.013	8.146
26.0000	38.722	1.839	38.722	7.592

Driver Connections

SPST (MA4SW100)

Control Level (DC Current) at	Condition of RF Output
J_2	J_1–J_2
-20 mA	Low Loss
+20 mA	Isolation

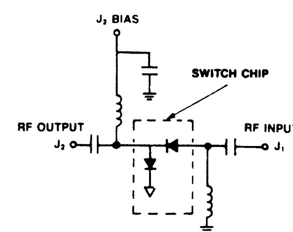
SPDT (MA4SW200)

Control Level (DC Current) at		Condition of RF Output	Condition of RF Output
J_2	J_3	J_1–J_2	J_1–J_3
-20 mA	+20 mA	Low Loss	Isolation
+20 mA	-20 mA	Isolation	Low Loss

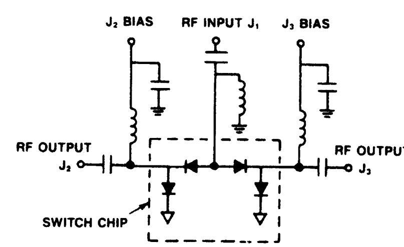
SP3T (MA4SW300)

Control Level (DC Current) at			Condition of RF Output	Condition of RF Output	Condition of RF Output
J_2	J_3	J_4	J_1–J_2	J_1–J_3	J_1–J_4
-20 mA	+20 mA	+20 mA	Low Loss	Isolation	Isolation
+20 mA	-20 mA	+20 mA	Isolation	Low Loss	Isolation
+20 mA	+20 mA	-20 mA	Isolation	Isolation	Low Loss

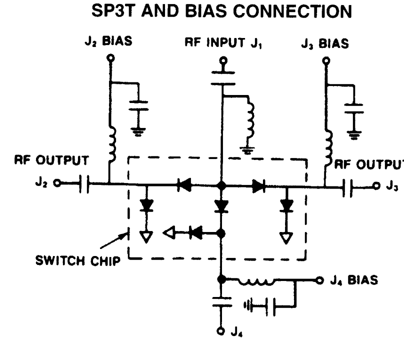
SPST AND BIAS CONNECTION



SPDT AND BIAS CONNECTION



SP3T AND BIAS CONNECTION



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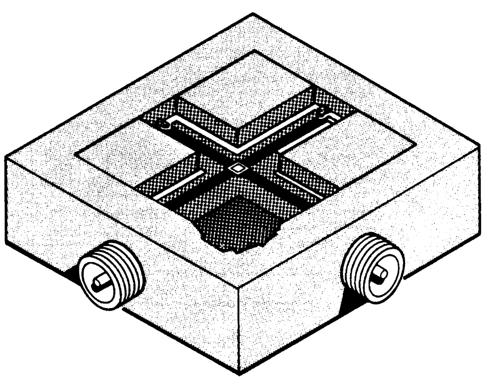
General Information

Testing the MA4SW Series

The MA4SW series of switches are tested in stripline test fixtures. They contain 5 mil duroid microstrip circuit boards in a channelized housing. The lines are approximately 15 mils wide. K connectors are used to make contact to the circuit boards. The channel width is 120 mils (3 mm). Connections to the RF ports are made with ribbons approximately 3 mils wide.

Bias is supplied through broadband bias tees connected to each port. Reference data is first established using a straight through microstrip board connecting the input port J_1 to the output port.

TYPICAL SP3T TEST FIXTURE



Operation of the MA4SW Series

Operation of the MA4SW series of switches is achieved by simultaneous application of positive and negative DC currents to ports J_2–J_4 as required (see bias connections). A DC return is required at J_1. The driver currents should be supplied by a constant current source. The voltage at these points will not exceed ±1.5 volts at currents up to ±50 mA. In the low loss state, the series diode must be forward biased and the shunt diode reverse biased. In the isolated arm the shunt diode is forward biased and the series diode reverse biased. The switch is specified with ±20 mA diode currents.

Bonding and Handling Considerations

for the MA4SW Series

The normal handling precautions used with silicon chips in microelectronic circuits are appropriate to the MA4SW series of monolithic switches. The MA4SW series of switches are packaged for delivery in waffle packs and should be stored in a dry, clean environment until used. The chips should be removed from the waffle pack and handled with a vacuum pencil; tweezers should not be used.

Die Metallization

Gold metallization is used on both the back and all bonding pads. All die attach and bonding methods should be compatible with gold contacts.

Die Bonding

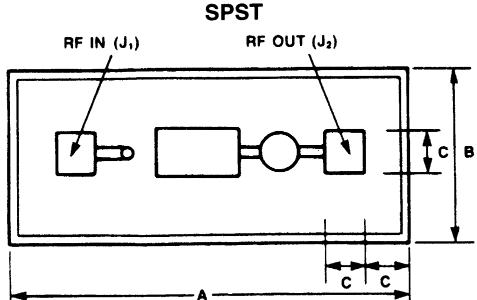
Hot gas bonding is preferred. The surfaces should have a nickel flash under gold or tin plating. The use of gold-tin solder (80%-20%, melting point ~280°C)is recommended. During the bonding operation, the mating surfaces should be heated to approximately 250°C. A collet pressure of 55 to 85 grams is satisfactory. The hot gas should be applied only until the solder flows (less than 5 seconds). Conductive epoxies can also be used.

Ribbon Bonding

Wedge thermocompression bonding may be used to attach ribbons to the bonding pads. The gold ribbons should be between 3-5 mils wide and 0.50-1.0 mils thick. The bonding pressure should be between 600 and 900 grams/mm2 and the force should be adjusted according to the size of the tip. Aluminum leads are not recommended.

Case Style 1053

SPST



MA4SW100

DIM.	NOMINAL DIMENSIONS	
	INCHES	MILLIMETERS
A	0.070	1,780
B	0.050	1,270
C	0.005	0,127
Thickness	0.008 Max.	0,20 Max.

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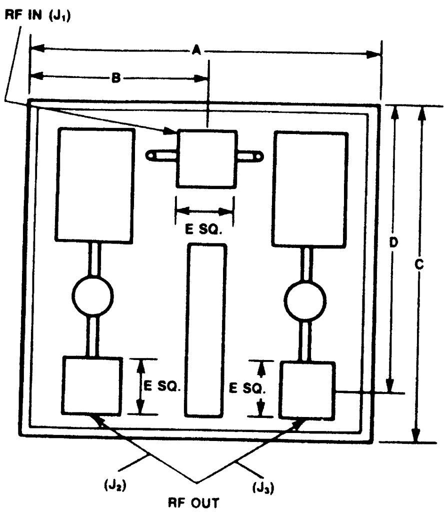
Case Styles (Cont'd)

1052

SPDT

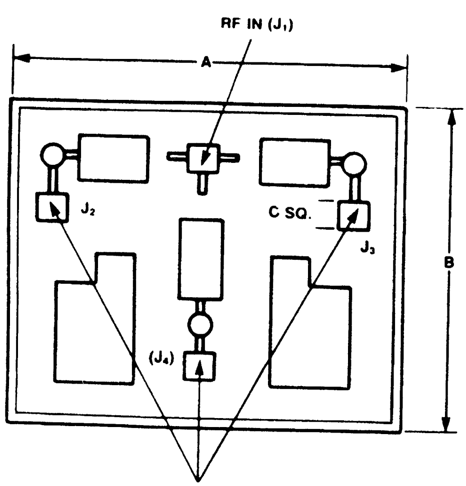


MA4SW200

DIM.	NOMINAL DIMENSIONS	
	INCHES	MILLIMETERS
A	0.041	1,04
B	0.020	0,508
C	0.040	1,01
D	0.029	0,74
E	0.005	0,127
Thickness	0.008 Max.	0,20 Max.

1051

SP3T



MA4SW300

DIM.	NOMINAL DIMENSIONS	
	INCHES	MILLIMETERS
A	0.070	1,780
B	0.050	1,270
C	0.005	0,127
Thickness	0.008 Max.	0,20 Max.

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an AMP company

Surface Mount Monolithic PIN Diode Switches

MA4SW101, 201, and 301

V 2.00

Features

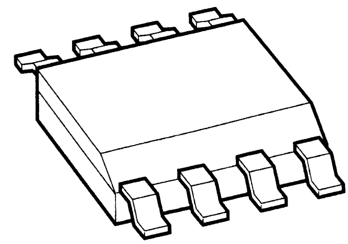
- Low Cost/High Volume
- Broadband Performance 50 MHz - 4 GHz
- Low Insertion Loss
- High Isolation
- Low Distortion
- Available in Tape & Reel

Description

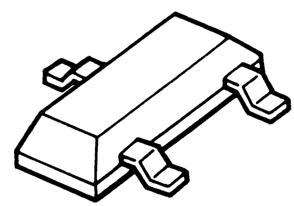
Using M/A-COM's HMIC monolithic technology, M/A-COM has developed a family of broadband PIN diode MMIC switches packaged in popular, industry standard surface mount packages. The MA4SW101 is an SPST SOT-23 packaged switch utilizing two PIN diodes in a series-shunt configuration. The MA4SW201 is an SPDT switch based on four PIN diodes in series-shunt configuration. The MA4SW301 is an SP3T switch using six PIN diodes in series-shunt configuration.

All switches offer broadband (50 MHz-4 GHz) performance, fast switching speed and low distortion. The switches have been designed for low cost, high volume applications. These switches are available for tape and reel insertion.

SO-8



SOT-23



Description	Model Number	Package Type	Typical Performance at 2 GHz		
			Insertion Loss (dB)	Isolation (dB)	Input Return Loss (dB)
SPST	MA4SW101	SOT-23	0.3	36	21
SPDT	MA4SW201	SO-8	0.4	33	17
SP3T	MA4SW301	SO-8	0.6	29	13

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V 2.00

Electrical Specifications @ +25°C

		MA4SW101			MA4SW201			MA4SW301			
Parameter[1]	**Frequency**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Min.**	**Typ.**	**Max.**	**Units**
Insertion Loss	50 MHz	—	0.3	0.4	—	0.3	0.4	—	0.3	0.4	dB
	1 GHz	—	0.3	0.5	—	0.4	0.5	—	0.4	0.6	dB
	2 GHz	—	0.3	0.5	—	0.4	0.6	—	0.6	0.9	dB
	3 GHz	—	0.4	—	—	0.7	—	—	0.8	—	dB
	4 GHz	—	0.5	—	—	1.1	—	—	1.3	—	dB
Isolation	50 MHz	60	70	—	60	70	—	50	65	—	dB
	1 GHz	40	46	—	40	43	—	30	36	—	dB
	2 GHz	30	36	—	30	33	—	22	29	—	dB
	3 GHz	—	30	—	—	27	—	—	24	—	dB
	4 GHz	—	26	—	—	23	—	—	20	—	dB
Input Return Loss	50 MHz	25	28	—	20	30	—	20	30	—	dB
	1 GHz	20	23	—	20	27	—	12	16	—	dB
	2 GHz	17	21	—	13	17	—	10	13	—	dB
	3 GHz	—	18	—	—	14	—	—	11	—	dB
	4 GHz	—	15	—	—	11	—	—	9	—	dB
Voltage Rating[2]	—	50	—	—	50	—	—	50	—	—	Volts
Second Harmonic Distortion @ 0 dBm	1 GHz	—	75	—	—	75	—	—	75	—	dBc
Third Harmonic Distortion @ 0 dBm—	1 GHz	—	90	—	—	90	—	—	90	—	dBc
Switching Speed		—	50	—	—	50	—	—	50	—	nsec
Signal Compression @ 100mW	1 GHz	—	0.1	—	—	0.1	—	—	0.1	—	dB

Notes:
1. Parameters (except for voltage rating) are specified with ±20 mA at all output ports in a 50 ohm microstrip test fixture.
2. Reverse current will not exceed 10 μA at the rated voltage.

Absolute Maximum Ratings

Operating Temperature	-65°C to +85°C
Storage Temperature	-65°C to +125°C
Applied Voltage	50 Volts
Power Dissipation @ +25°C	50 mW maximum
Incident Power @ +25°C	100 mW

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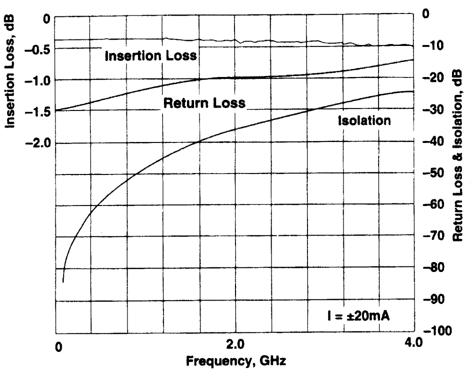
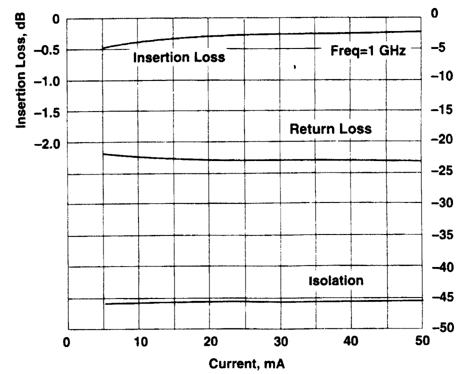
Typical Performance Curves

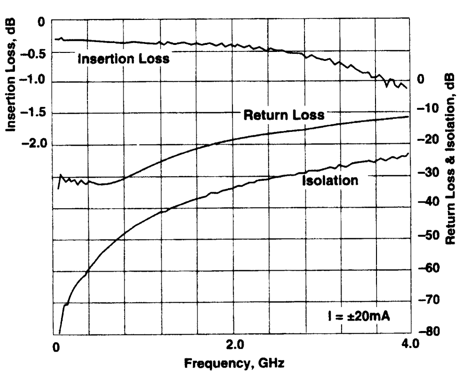
INSERTION LOSS, RETURN LOSS AND ISOLATION vs FREQUENCY (MA4SW101)



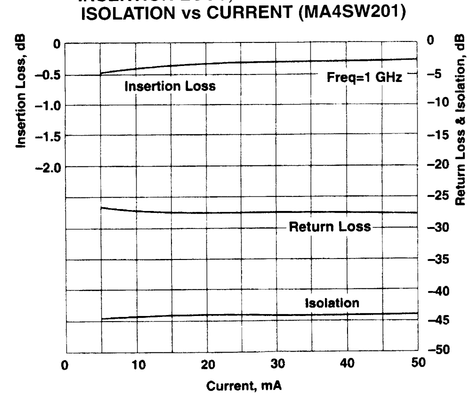
INSERTION LOSS, RETURN LOSS AND ISOLATION vs CURRENT (MA4SW101)



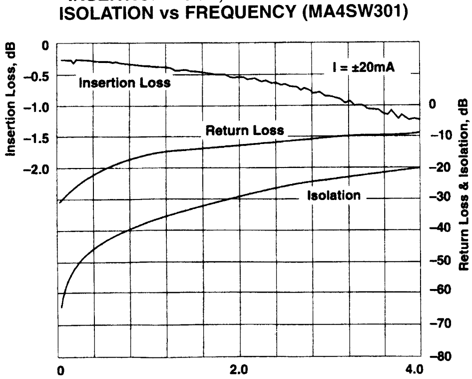
INSERTION LOSS, RETURN LOSS AND ISOLATION vs FREQUENCY (MA4SW201)



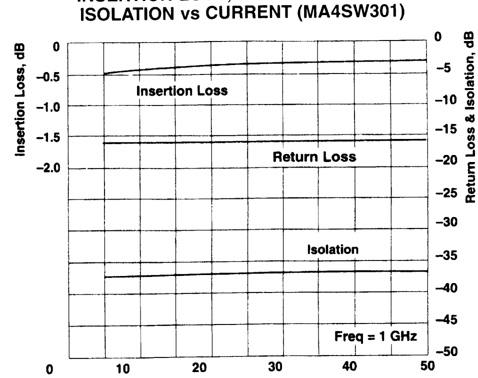
INSERTION LOSS, RETURN LOSS AND ISOLATION vs CURRENT (MA4SW201)



INSERTION LOSS, RETURN LOSS AND ISOLATION vs FREQUENCY (MA4SW301)



INSERTION LOSS, RETURN LOSS AND ISOLATION vs CURRENT (MA4SW301)



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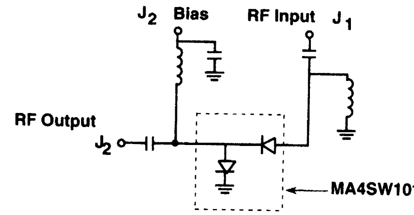
Driver Connections

SPST (MA4SW101)

Control Level (DC Current) at	Condition of RFOutput
J_2	J_1–J_2
-20 mA	Low Loss
+20 mA	Isolation

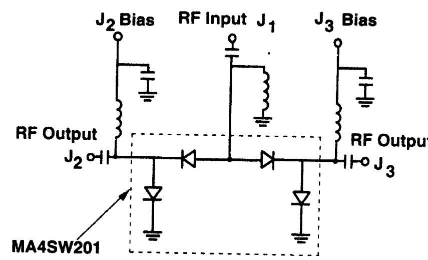
SPST and Bias Connection



SPDT (MA4SW201)

Control Level (DC Current) at		Condition of RF Output	Condition of RF Output
J_2	J_3	J_1–J_2	J_1–J_3
-20 mA	+20 mA	Low Loss	Isolation
+20 mA	-20 mA	Isolation	Low Loss

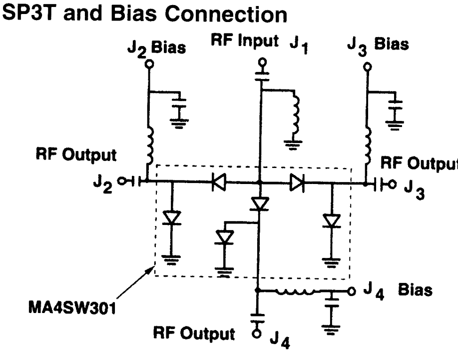
SPDT and Bias Connection



SP3T (MA4SW301)

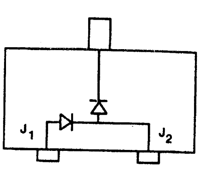
Control Level (DC Current) at			Condition of RF Output	Condition of RF Output	Condition of RF Output
J_2	J_3	J_4	J_1–J_2	J_1–J_3	J_1–J_4
-20 mA	+20 mA	+20 mA	Low Loss	Isolation	Isolation
+20 mA	-20 mA	+20 mA	Isolation	Low Loss	Isolation
+20 mA	+20 mA	-20 mA	Isolation	Isolation	Low Loss

SP3T and Bias Connection



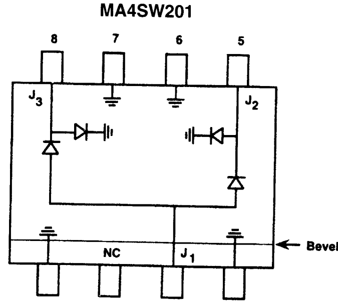
Schematics

SPST
MA4SW101



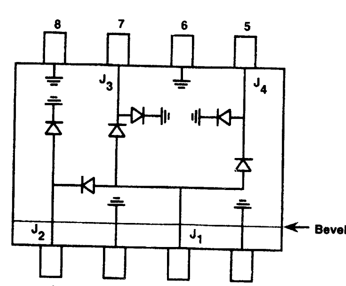
Top View

SPDT
MA4SW201



Top View

SP3T
MA4SW301



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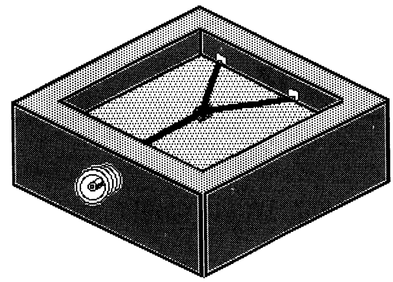
Testing Information

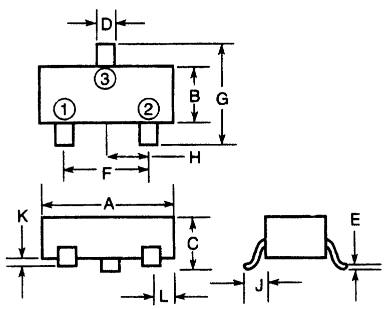
The MA4SW series of switches are tested in either coplanar waveguide or microstrip test fixtures. These fixtures allow for each of the device's leads to be connected to an RF port or to the ground plane. Input and output characteristic impedances are 50 Ohms. The switches are pressure-fitted into the fixtures and tested against standards. Bias is supplied externally at all ports through broadband bias tees.

Test Fixture



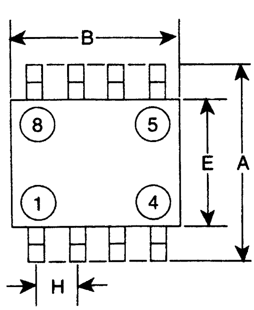
Case Styles

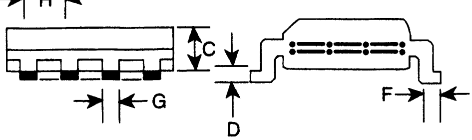
SOT-23



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX
A	0.010	0.120	2.80	3.50
B	0.047	0.055	1.20	1.40
C	0.034	0.047	0.85	1.20
D	0.015	0.017	0.37	0.43
E	0.003	0.005	0.08	0.13
F	0.070	0.080	1.78	2.04
G	0.083	0.098	2.10	2.50
H	0.035	0.040	0.89	1.02
J	0.018	0.024	0.45	0.61
K	0.006	0.009	0.15	0.23
L	0.018	0.022	0.45	0.56

S0-8





DIM.	INCHES	MILLIMETERS
	MAXIMUM	MAXIMUM
A	0.244	6.20
B	0.202	5.13
C	0.068	1.73
D	0.010	0.25
E	0.163	4.19
F	0.035	0.89
G	0.020	0.50
H	0.050 Nominal	1.27 Nominal

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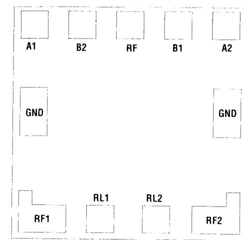
GaAs SPDT Switch
DC - 3 GHz

MASW2000

V 2.00



Features

- Low Insertion Loss, 0.5 dB Typical @ 2 GHz
- Fast Switching Speed, 22 ns Typical
- Reflective/Absorptive Configuration
- Ultra Low DC Power Consumption

Guaranteed Specifications** (-55°C to +85°C)

Frequency Range			DC - 3.0 GHz
Insertion Loss		DC–0.5 GHz	0.5 dB Max
		DC–1.0 GHz	0.6 dB Max
		DC–2.0 GHz	0.8 dB Max
		DC–3.0 GHz	1.0 dB Max
VSWR	Relective◊	DC–0.5 GHz	1.20:1 Max
		DC–1.0 GHz	1.20:1 Max
		DC–2.0 GHz	1.20:1 Max
		DC–3.0 GHz	1.40:1 Max
	Absorptive◊◊	DC–2.0 GHz	1.20:1 Max
		DC–3.0 GHz	1.40:1 Max
Isolation		DC–0.5 GHz	43 dB Min
		DC–1.0 GHz	35 dB Min
		DC–2.0 GHz	27 dB Min
		DC–3.0 GHz	24 dB Min

Operating Characteristics

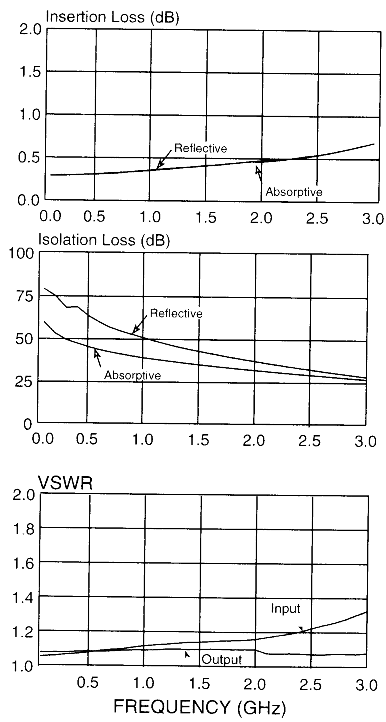
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		22 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		27 ns Typ
Transients (In-Band)		25 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
0.05 GHz	+24 dBm	+26 dBm Typ
0.5–3.0 GHz	+26 dBm	+32 dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.05 GHz	+63	+43	dBm Typ
0.5–3.0 GHz	+80	+53	dBm Typ

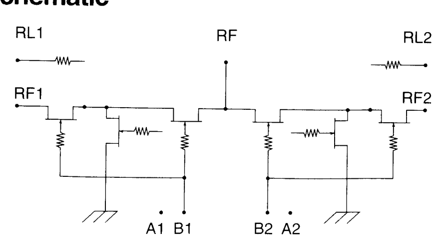
Control Voltage (Complementary Logic)	
V_{IN}Low	0 to -0.2 V @ 5 uA Max
V_{IN}Hi	-5 V @ 60 uA Typ to -8 V @500 uA Max
Die Size	0.056" x 0.056" x 0.010" 1.40mm x 1.40mm x 0.25mm)

** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and 0 and -5 Vdc control voltages.
*** Loss changes 0.0025 dB/°C (From -55°C to +85°C)
◊ For relective operation RL1/RL2 are unconnected.
◊◊ For absorptive operation RL1 connects to RF1 and RL2 connects to RF2.

Typical Performance @ +25°C***



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW2000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW2000 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW2000 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW2000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias —Apply voltage to either control port A1/B2 or A2/B1 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MASW2000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW2000 is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW2000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW2000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Truth Table***

Control Inputs		Condition Of Switch	
A1/B2	**A2/B1**	**RF1**	**RF2**
V_{IN}Hi	V_{IN}Low	On	Off
V_{IN}Low	V_{IN}Hi	Off	On

*** For normal SPDT operation A1 is connected to B2 and A2 is connected to B1.

Maximum Ratings
A. Control Voltage (A1/B2 or A2/B1): -8.5 Vdc
B. Max Input RF Power: +34 dBm
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

BondPad Dimensions Inches (mm)
RF: 0.004 x 0.004 (0.100 x 0.100)
RF1, RF2: 0.009 x 0.009 (0.225 x 0.225)
A1, A2, B1, B2: 0.004 x 0.004 (0.100 x 0.100)
GND1, GND2: 0.009 x 0.004 (0.225 x 0.105)
RL1, RL2: 0.004 x 0.005 (0.100 x 0.125)

Die Size Inches (mm)
0.056 x 0.056 x 0.010 (1.40 x 1.40 x 0.25)

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an AMP company

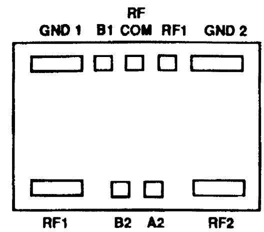
10W GaAs SPDT Switch DC-3 GHz

MASW2020G

V 2.00

Features

- Very High Power, 10 Watts @ 1 dB Compression @-10V
- Low Insertion Loss, 0.4 dB Typical @ 1 GHz
- Very Low Distortion, 33 dBc @ 2.5 W and -5 Vdc



Guaranteed Specifications* -55°C to +85°C

Frequency Range		DC-3 GHz
Insertion Loss	DC-0.5 GHz	0.45 dB Max
	DC-1.0 GHz	0.50 dB Max
	DC-2.0 GHz	0.80 dB Max
	DC-3.0 GHz	1.00 dB Max
Isolation	DC-0.5 GHz	37 dB Min
	DC-1.0 GHz	32 dB Min
	DC-2.0 GHz	24 dB Min
	DC-3.0 GHz	20 dB Min
VSWR	DC-0.5 GHz	1.20:1 Max
	DC-1.0 GHz	1.30:1 Max
	DC-2.0 GHz	1.50:1 Max
	DC-3.0 GHz	1.60:1 Max

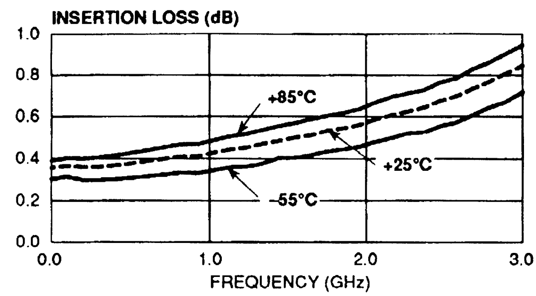
Operating Characteristics

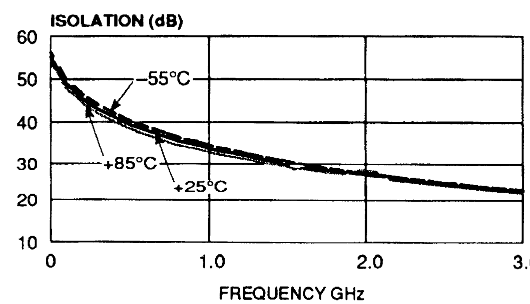
Impedance			50 Ω Nominal
Switching Characteristics			
Trise, Tfall (10%/90% or 90%/10% RF)			10 ns Typ
Ton, Toff (50% CTL to 90%/10%)			15 ns Typ
Transients (in-Band)			20 mV Typ
Input Power for 1 dB Compression**			
Control Voltages (Vdc)	0/-5	0/-8	0/-10
500-3000 MHz	2.5 Watts	7.5 Watts	10 Watts Typ
Intermodulation Intercept point (for two-tone input power of 20 dBm)			
Intercept Points		IP_3@	
	-5V	-8V	-10V
above 500 MHz	+60	+65	+67 dBm Typ
Control Voltages (Complimentary Logic)			
Vin Low			0V to- 0.2V @ 50 µA Max
Vin Hi			-5V @ 40 µA Typ to -10V @ 0.6mA Max
Die Size			0.048" x 0.039" X 0.010" (1.22mm X 0.99mm X 0.25mm)

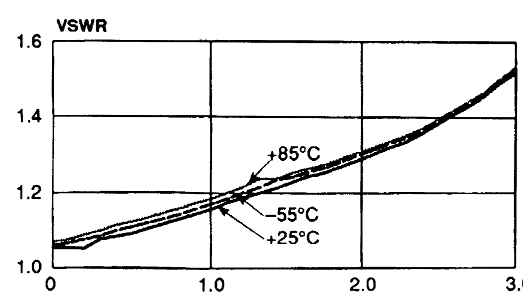
* All specifications apply with a 50 Ω impedance connected to all RF ports, 0 and -5 VDC control voltages.

** Enhanced power performance is achieved at higher control voltages without degradation in small signal performance.

Typical Performance







Handling Precautions

Permanent damage to the MASW2020G may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW2020G should be handled in a clean environment. DO NOT attempt to clean unit after the MASW2020G is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW2020G. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias —Apply voltage to either of the complementary control portsonly when the other is grounded. No port should be allowed to "float".

E. General Handling — It is recommended that the MASW2020G chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW2020G is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW2020Gto a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW2020G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

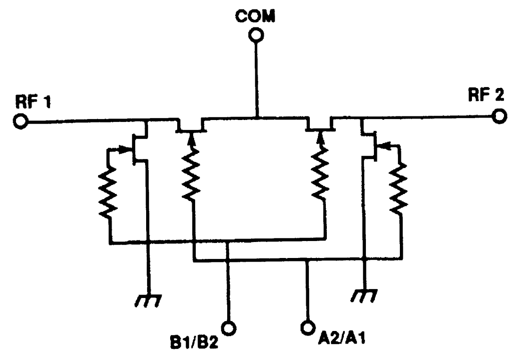
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires or two 3-mil ribbons from ground pads to package are recommended.

Schematic



Maximum Ratings	
A. Control Voltage	–10 Vdc
B. Max Input RF Power: (500 MHz-2 GHz)	+44 dBm (CW)
C. Storage Temperature:	–55°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions Inches (mm)	
RFIN1, RFOUT:	0.009 x 0.004 (0.240 x 0.100)
A1, A2, B1, B2:	0.004 x 0.004 (0.100 x 0.100)
RF COM:	0.004 x 0.004 (0.100 x 0.100)
GND 1, GND2:	0.012 x 0.004 (0.285 x 0.100)

Truth Table

Control Inputs		Condition Of Switch: RF Common to Each RF Port	
A1/A2	B1/B2	RF1	RF2
VINHi	VINLow	Off	On
VINLow	VINHi	On	Off

VINLow 0 to -0.2V
VINHi -5V to -10V

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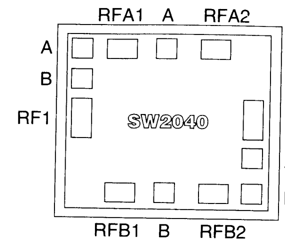
GaAs DPDT Switch DC - 2 GHz

MASW2040

V 2.00

- Cascadable
- Low Insertion Loss
- Low DC Power Consumption
- Low Distortion Operation (Quiet Mode)
- Useful as a Building Block for
  - Digital Attenuators
  - Digital Delay Lines
  - Digital Phase Shifters
  - Digital Switched Filter Elements



Guaranteed Specifications** -55°C to +85°C

Frequency Range		DC – 2.0 GHz
Insertion Loss	DC – 0.5 GHz	0.4 dB Max
	DC – 1.0 GHz	0.4 dB Max
	DC – 2.0 GHz	0.6 dB Max
VSWR	DC – 0.5 GHz	1.1:1 Max
	DC – 1.0 GHz	1.2:1 Max
	DC – 2.0 GHz	1.2:1 Max
Isolation	DC – 0.5 GHz	25 dB Min
	DC – 1.0 GHz	20 dB Min
	DC – 2.0 GHz	15 dB Min

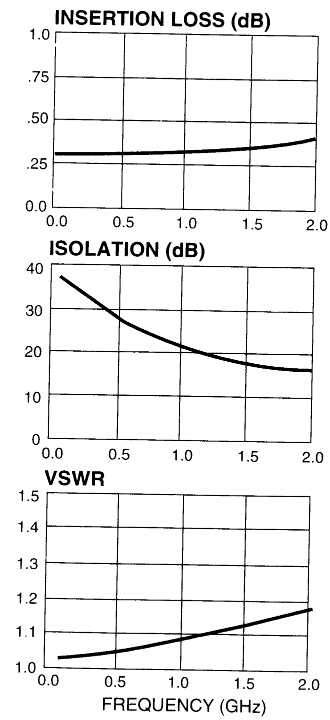
Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		6 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)	0/–5	0/–8
0.05 GHz	+24 dBm	+25 dBm Typ
0.5 - 2 GHz	+30 dBm	+33 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP2	IP3
0.05 GHz	+62	+39 dBm Typ
0.5 - 2 GHz	+68 dBm	+46 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to –0.2V @ 9 μA Max
V_{IN}Hi		–5V @ 25 μA Typ to –8V @ 75 μA Max
Die Size		0.045″ x 0.038″ x 0.010″ (1.13mm x 0.97mm x 0.25mm)

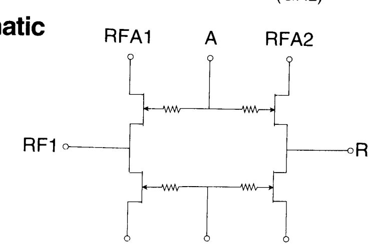
**All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages.

*** Loss change 0.0025dB/°C (-55°C to +85°C)

Typical Performance @ +25°C



Schematic



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Handling Precautions

Permanent damage to the MASW2040 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW2040 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW2040 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW2040. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port A or B only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MASW2040 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW2040 is back-metallized with Pd/Ni/Au(100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW2040 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW2040 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground

Truth Table

Control Inputs		Condition of Switch			
A	B	RF1 - RFA1	RF1 - RFB1	RF2 - RFA2	RF2 - RFB2
$V_{IN}H_I$	$V_{IN}L_{OW}$	OFF	ON	OFF	ON
$V_{IN}L_{OW}$	$V_{IN}H_I$	ON	OFF	ON	OFF

$V_{IN}L_{OW}$ = 0.0 TO -0.2V

$V_{IN}H_I$ = -0.5V

Maximum Ratings	
A. Control Value (A or B):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm (500 MHz– 4 GHz)
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions — Inches (mm)	
RF1, RF2	0.004 x 0.008 (0.100 x 0.200)
RFA1, RFB1	0.004 x 0.005 (0.100 x 0.125)
RFA2, RFB2	0.004 x 0.005 (0.100 x 0.125)
A, B, Ac, Bc	0.004 x 0.004 (0.100 x 0.100)

Die Size — Inches (mm)
0.045 x 0.038 x 0.010 (1.13 x 0.97 x 0.25)

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M/A-COM an AMP company

High Power T/R Diversity Switch with Driver DC - 2 GHz

MASW2070G-1

V 2.00

Features

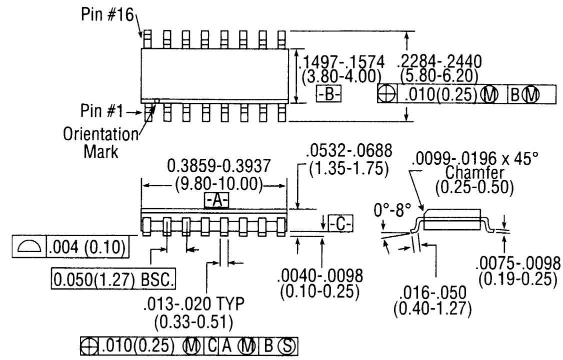
- +36 dBm Typ. 0.3 dB Compression Point, 8V Supply, @ 1.0 GHz
- -55 dBc THD @ 1 GHz, -10V, +36 dBm Pin
- Low Insertion Loss: 0.4 dB Typical
- TTL Compatible Driver with 2 Line Control
- Tape and Reel Packaging Available[1]

Description

M/A-COM's MASW2070G-1 is a GaAs MMIC diversity switch in a low cost SOIC 16-lead wide body surface mount plastic package. The MASW2070G-1 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive diversity switching in land mobile and portable transceiver applications, and other battery powered radio equipment.

The MASW2070G-1 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SOW-16



16-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
MASW2070G-1	SOIC 16-Lead Plastic Package
MASW2070G-1TR	Forward Tape & Reel
MASW2070G-1RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions		Unit	Min.	Typ.	Max
Insertion Loss	$T_x - J_1$, $T_x - J_2$	DC – 1.0 GHz DC – 2.0 GHz	dB dB		0.4 0.6	0.6 0.8
	$R_x - J_1$, $R_x - J_2$	DC – 1.0 GHz DC – 2.0 GHz	dB dB		0.6 0.8	0.8 1.0
Isolation	$T_x - R_x$	DC – 1.0 GHz DC – 2.0 GHz	dB dB	33 29	35 32	
VSWR		DC – 1.0 GHz DC – 2.0 GHz			1.3:1 1.6:1	
Trise, Tfall Ton, Toff	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF		nS nS		60 200	
One dB Compression Point	Input Power (5V Supply/Control) Input Power (8V Supply/Control)	0.9 GHz 0.9 GHz	dBm dBm		33 37	
3nd Order Intercept	Measured Relative (5V Supply/Control) to Input Power (8V Supply/Control) (for two-tone input power up to +10 dBm)	0.9 GHz 0.9 GHz	dBm dBm		61 65	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.

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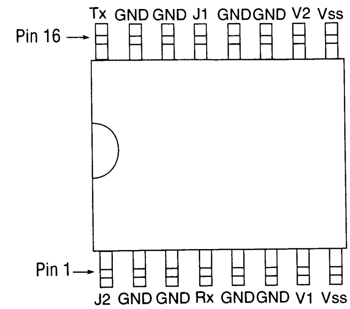
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.5 – 2.0 GHz	
-8 V Control and Supply	+39 dBm
-10 V Control and Supply	+40 dBm
-12 V Control and Supply	+42 dBm
Power Dissipation	1.0 W
Operating Temperature	-40°C to 85°C
Storage Temperature	-65°C to 150°C
Thermal Resistance[2]: θ_{jc} = 87 °C/W	

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Thermal resistance is given for T_A = 25°C. T_{CASE} is the temperature of leads 1 and 4.

Pin Configuration

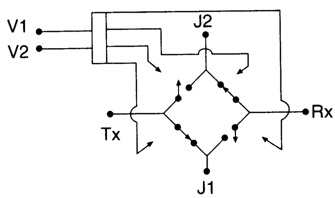


Truth Table

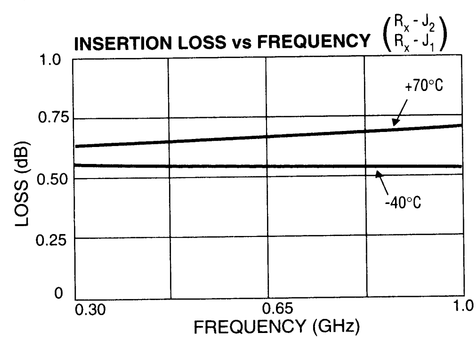
STATE	V2	V1
T_X–J_1	1	1
T_X–J_2	1	0
R_X–J_1	0	1
R_X–J_2	0	0

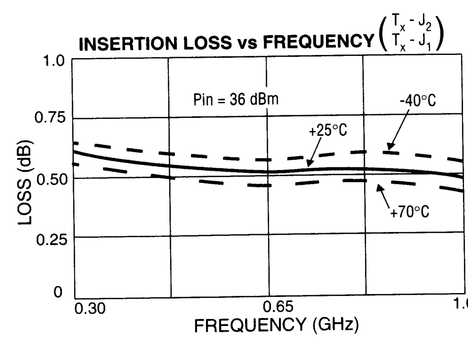
NOTE: LOGIC 0 = -8 Volts
LOGIC 1 = 0 Volts

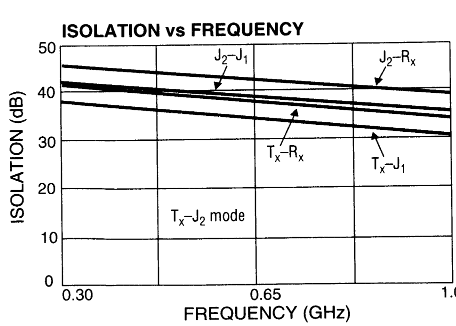
Functional Diagram

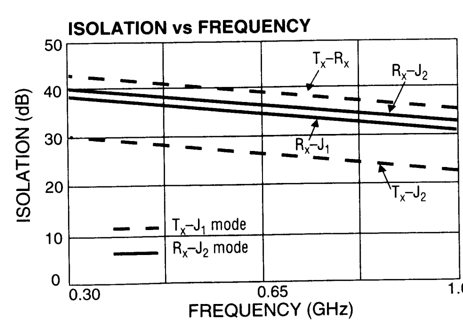


Typical Performance









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an AMP company

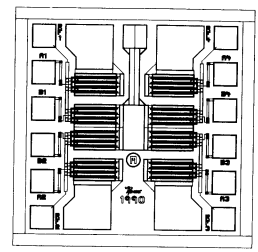
GaAs SP4T Switch
DC - 4 GHz

MASW4000

V2.00

Features

- Low Insertion Loss, 0.7 dB Typical @ 1 GHz
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications** -55°C to +85°C

Frequency Range		DC – 4 GHz
Insertion Loss	DC – 0.5 GHz	0.7 dB Max
	DC – 1.0 GHz	0.8 dB Max
	DC – 2.0 GHz	0.9 dB Max
	DC – 4.0 GHz	1.2 dB Max
Isolation	DC – 0.5 GHz	41 dB Min
	DC – 1.0 GHz	35 dB Min
	DC – 2.0 GHz	30 dB Min
	DC – 4.0 GHz	25 dB Min
VSWR	DC – 0.5 GHz	1.2:1 Max
	DC – 1.0 GHz	1.2:1 Max
	DC – 2.0 GHz	1.4:1 Max
	DC – 4.0 GHz	1.8:1 Max

Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics*		
tRISE, tFALL (10/90% or 90/10% RF)		2 ns Typ
tON, tOFF (50% CTL to 90/10% RF)		4 ns Typ
Transients (In-Band)		25 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)	0/–5	0/–8
0.5 – 4 GHz	+26 dBm	+32 dBm Typ
0.05 GHz	+20 dBm	+23 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP2	IP3
0.5 – 4 GHz	+68	+50 dBm Typ
0.05 GHz	+55	+37 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN} Low		0 to –0.2V @ 9 µA Max
V_{IN} Hi		–5V @ 10 µA Typ to –8V @ 100 µA Max
Die Size		0.040" x 0.040" x 0.010" (1.02mm x 1.02mm x 0.25mm)

Environmental

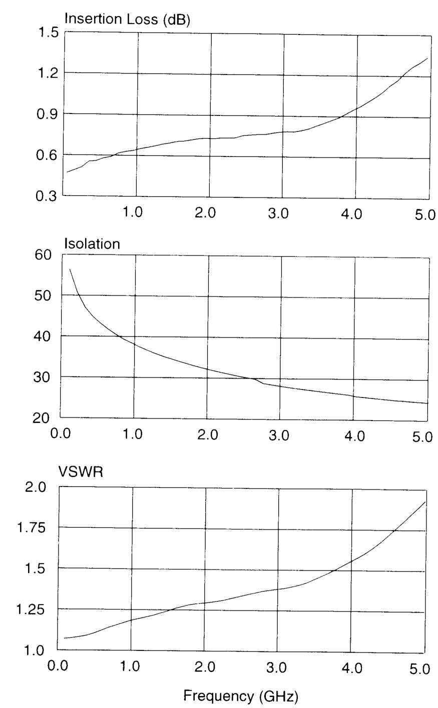
These units are designed to meet or exceed the following:
Electrical, 100% probing at 25°C for selected parameters.
Visual, 100% per MIL-STD-883 Method 2010 Condition B.
Lot traceability supplied on request.

** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages and chip interconnections made with 0.001" dia. wirebonds.

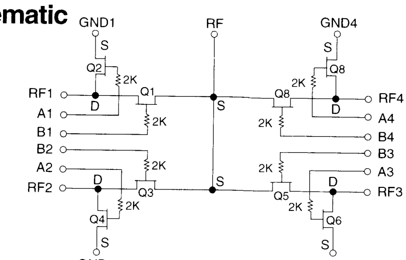
*** Faster switching speed can be achieved with enhanced driver waveform.

**** Loss changes 0.0025 dB/°C (-55°C to +85°C)

Typical Performance @ 25°C****



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW4000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW4000 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW4000 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW4000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port A1/B2 or A2/B1 only when the other is grounded. Neither port should be allowed to “float”.

E. General Handling — It is recommended that the MASW4000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW4000 is back-metallized with Pd/Ni/Au(100/1,000/30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with electrically conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW4000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy must be used.

B. Apply a minimum amount of epoxy and place the MASW4000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

C. Cure epoxy per manufacturer’s recommended schedule.

Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Maximum Ratings	
A. Control Value (A or B):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm (0.5–0.4 GHz with 0/-8V CTL)
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions — Inches (mm)	
RF1, RF2	0.004 x 0.004 (0.100 x 0.100)
GND1–GND4	0.004 x 0.008 (0.100 x 0.200)
A1, B1, A2, B2, A3, B3, A4, B4	0.004 x 0.004 (0.100 x 0.100)

Truth Table

Control Input								Condition Of Switch RF Common to Each RF Port			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
Hi	Low	Low	Hi	Low	Hi	Low	Hi	On	Off	Off	Off
Low	Hi	Hi	Low	Low	Hi	Low	Hi	Off	On	Off	Off
Low	Hi	Low	Hi	Hi	Low	Low	Hi	Off	Off	On	Off
Low	Hi	Low	Hi	Low	Hi	Hi	Low	Off	Off	Off	On

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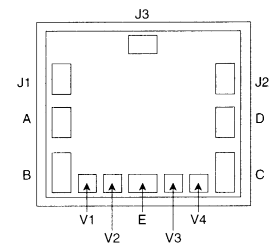
GaAs SPST Switch
DC – 4 GHz

MASW4010

V 2.00



Features

- Broad Bandwidth
- Fast Switching Speed, 3ns Typical
- Very Low DC Power Consumption
- Low Intermodulation Products Option
- Easily Cascadable
- — SPST Low Loss SPST Reflective (R)
- — SPST Absorptive (A)
- — SPDT Low Loss Reflective (R)
- — SPDT Absorptive (A)

Guaranteed Specifications** @ 25°C***

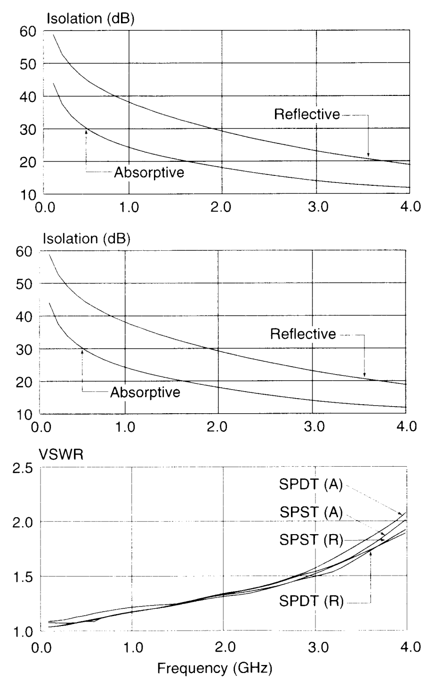
Frequency Range				DC – 4.0 GHz
Insertion Loss	SPST/A	SPST/R	SPDT/A	SPDT/R
DC – 1 GHz	0.45 dB	0.4 dB	0.5 dB	0.4 dB Max
DC – 2 GHz	0.7 dB	0.4 dB	0.8 dB	0.5 dB Max
DC – 4 GHz	1.7 dB	1.25 dB	1.8 dB	1.2 dB Max
Isolation				
DC – 1 GHz	20 dB	35 dB	22 dB	35 dB Min
DC – 2 GHz	17 dB	25 dB	16 dB	27 dB Min
DC – 4 GHz	10 dB	15 dB	10 dB	17 dB Min
VSWR				
DC – 1 GHz	1.2:1	1.2:1	1.3:1	1.2:1 Max
DC – 2 GHz	1.4:1	1.4:1	1.4:1	1.4:1 Max
DC – 4 GHz	2.0:1	2.1:1	2.0:1	2.1:1 Max

Operating Characteristics

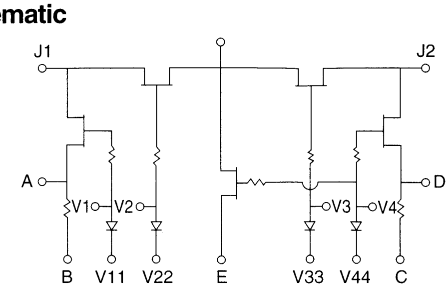
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		6 ns Typ
Transients (In-Band)		30 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)	0/–5	0/–8
0.05 GHz	21 dBm	26 dBm Typ
0.5 – 5.6 GHz	27 dBm	33 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP2	IP3
0.05 GHz	62 dBm Typ	40 dBm Typ
0.5 – 5.6 GHz	68 dBm Typ	46 dBm Typ
Control Voltages (Complementary Logic)		
$V_{IN}L_{OW}$		0 to –0.2V @ 20 µA Max
$V_{IN}H_{I}$		–5V @ 50 µA Typ to –8V @ 300 µA Max
Die Size		0.047″ x 0.045″ x 0.010″ (1.19mm x 1.15mm x 0.25mm)

** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages.
***Loss changes 0.0025 dB/°C (-55°C to +85°C)

Typical Performance @ 25°C***



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW4010 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW4010 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW4010 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW4010. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port V1 or V2 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MASW4010 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW4010 is back-metallized with Pd/Ni/Au(100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW4010 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW4010 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy must be used but is not required.

Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended

BondPad Dimensions — Inches (mm)

J1, J2, J3	0.004 x 0.007 (0.100 x 0.175)
B, C	0.008 x 0.004 (0.200 x 0.100)
A, D, E	0.004 x 0.005 (0.100 x 0.150)
V1, V2, V3, V4	0.004 x 0.004 (0.100 x 0.100)

Maximum Ratings

A. Control Voltage (A/C or B/D): -8.5 Vdc

B. Max Input RF Power: +34 dBm

C. Storage Temperature: -65°C to +175°C

D. Maximum Operating Temperature: +175°C

	Control Input				Condition Of Switch RF Common to Each RF Port							
	V1	V2	V3	V4	J1	J2	J3	A	B	C	D	E
SPST Matched	V_{IN}Hi V_{IN}Low	V_{IN}Low V_{IN}Hi	V_{IN}Low V_{IN}Hi	V_{IN}Hi V_{IN}Low	On Off	On Off			GND GND	GND GND		GND GND
Low Loss SPST Reflective	V_{IN}Hi V_{IN}Hi	V_{IN}Low V_{IN}Low			On Off		On Off	GND GND	GND GND			
SPDT Reflective	V_{IN}Hi V_{IN}Low	V_{IN}Low V_{IN}Hi	V_{IN}Hi V_{IN}Low	V_{IN}Low V_{IN}Hi	On Off	Off On	On On	GND GND			GND GND	
SPDT Matched	V_{IN}Hi V_{IN}Low	V_{IN}Low V_{IN}Hi	V_{IN}Hi V_{IN}Low	V_{IN}Low V_{IN}Hi	On Off	Off On	On On		GND GND	GND GND		

1. These are four suggested configurations of this MASW4010 chip. Similar variations are obtainable by selective input/output options.
2. For low distortion mode of operation use bias pads V11, V22, V33, V44 (outside pads) in place V1, V2, V3, V4 and use +5 volts in place of zero (0) volts.
3. All ports not listed are left open.

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an AMP company

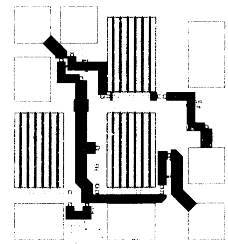
GaAs SPST Switch
DC - 4 GHz

MASW4020

V 2.00

Features

- Broad Bandwidth: DC - 4 GHz
- Low Loss
- Excellent Intermodulation Products
- Excellent Temperature Stability
- Fast Switching Speed, (3 ns Typical)
- Very Low DC Power Consumption
- Independent Bias Control



Guaranteed Specifications** @ +25°C***

Frequency Range		DC - 4.0 GHz
Insertion Loss	DC - 1 GHz DC - 2 GHz DC - 4 GHz	0.40 dB Max 0.40 dB Max 0.45 dB Max
VSWR	DC - 2 GHz 2 - 4 GHz	1.2:1 Max 1.2:1 Max
Isolation	DC - 1 GHz DC - 2 GHz DC - 4 GHz	40 dB Min 30 dB Min 25 dB Min

Operating Characteristics

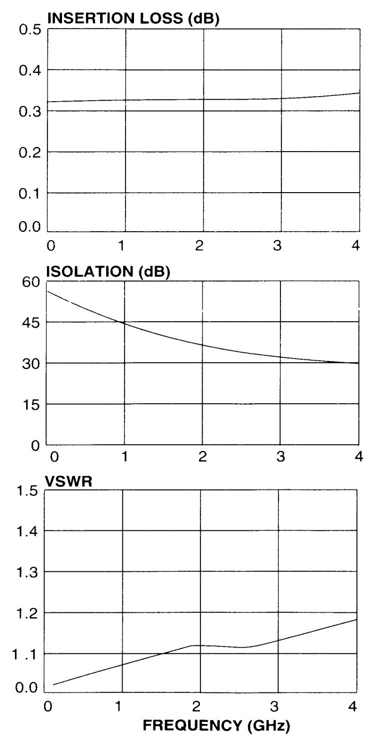
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		6 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
0.05 GHz	24 dBm	25 dBm Typ
0.5 - 2 GHz	30 dBm	33 dBm Typ
Intermodulation Intercept Point (fortwo-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
0.05 GHz	62	39 dBm Typ
0.5 - 2 GHz	68	46 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2V @ 10 μA Max
V_{IN}Hi		-5V @ 20 μA Typ to -8V @ 60 μA Max
Die Size		0.029" x 0.031" x 0.010" (0.72mm x 0.78mm x 0.25mm)

* Previously MA4GM202F

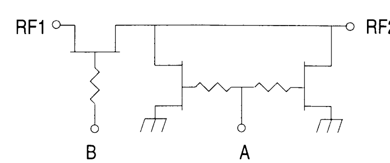
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -5 Vdc control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW4020 may occur if the following precautions are not adhered to:

A. Cleanliness – The MASW4020 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW4020 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MASW4020. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port V1 or V2 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling – It is recommended that the MASW4020 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW4020 is back-metallized with Pd/Ni/Au (100/1,000/ 10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW4020 to a temperature greater than 320°C for more than 20 seconds. No more than 30 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW4020 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermo- sonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package

Truth Table

Control Inputs		Condition Of Switch	
V1	V2	RF1	RF2
V_{IN}Low	V_{IN}Low	On	On
V_{IN}Hi	V_{IN}Hi	Off	Off

Maximum Ratings
A. Control Voltage (V1 or V2): -8.5 Vdc
B. Max Input RF Power: +34 dBm
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

BondPad Dimensions Inches (mm)
RF1: 0.004 x 0.008 (0.100 x 0.200)
RF2: 0.004 x 0.005 (0.100 x 0.125)
V1,V2: 0.004 x 0.004 (0.100 x 0.100)
G1,G2: 0.004 x 0.005 (0.100 x 0.125)

Die Size Inches (mm)
0.029 x 0.031 x 0.010 (0.72 x 0.78 x 0.25)

M/A-COM an AMP company

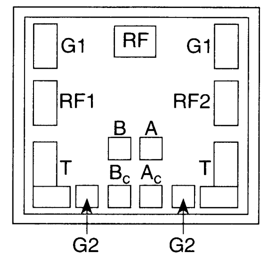
GaAs SPDT Switch DC - 4 GHz

MASW4030G

V 2.00

Features

- Absorbtive or Reflective
- Excellent Intermodulation Products
- Excellent Temperature Stability
- Fast Switching Speed, 3 ns Typical
- Ultra Low DC Power Consumption
- Independent Bias Control



Guaranteed Specifications*

		–55˚C to +85˚C
Frequency Range		DC – 4.0 GHz
Insertion Loss	DC – 1.0 GHz	0.6 dB Max
	DC – 2.0 GHz	0.8 dB Max
	DC – 4.0 GHz	1.0 dB Max
Isolation	DC – 1.0 GHz	60 dB Min
	Absorbtive Mode DC – 2.0 GHz	50 dB Min
	Reflective Mode DC – 2.0 GHz	42 dB Min
	DC – 4.0 GHz	40 dB Min
VSWR	DC – 1.0 GHz	1.2:1 Max
	DC – 2.0 GHz	1.2:1 Max
	DC – 4.0 GHz	1.5:1 Max

Operating Characteristics

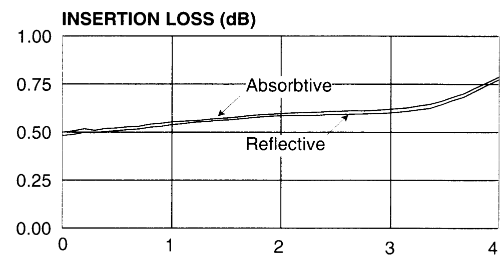
Impedance		50 Ω Nominal
Switching Characteristics		
tRISE, tFALL (10/90% or 90/10% RF)		3 ns Typ
tON, tOFF (50% CTL to 90/10% RF)		6 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression**		
Control Voltages (Vdc)	0/–5	0/–8
0.05 GHz	24 dBm	25 dBm Typ
0.5 – 4.0 GHz	30 dBm	33 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
0.5 GHz	62	39 dBm Typ
0.5 – 4.0 GHz	68	46 dBm Typ
Control Voltages (Complementary Logic)		
VINLow		0 to –0.2 V @ 9 μA Max
VINHi		–5 V @ 25 μA Typ to –8 V @ 0.75 μA Max
Die Size		0.043″ x 0.041″ x 0.010″ (1.08mm x 1.03mm x 0.25mm)

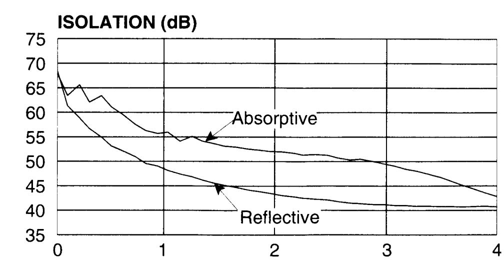
* Previously MA4GM202MTC

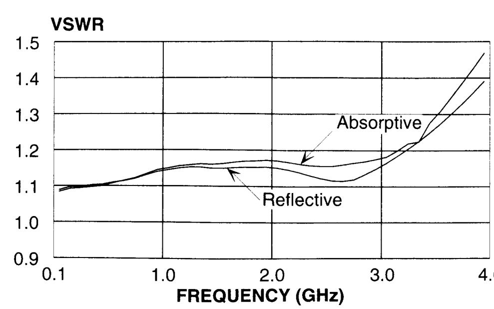
**All specifications apply with 50 Ω impedance connected to all RF ports, and –5 Vdc control voltages.

***Loss changes 0.0025 dB/°C

Typical Performance @ +25°C***







Specifications Subject to Change Without Notice.

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V 2.00

Handling Precautions

Permanent damage to the MASW4030G may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW4030G should be handled in a clean environment. DO NOT attempt to clean unit after the MASW4030G is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW4030G. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either of the complementary control ports only when the other is grounded. No port should be allowed to "float".

E. General Handling — It is recommended that the MASW4030G chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW4030G is back-metallized with Pd/Ni/Au(100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW4030G to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

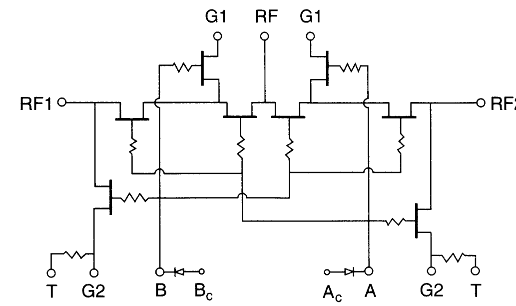
Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW4030G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Schematic



Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Maximum Ratings	
A. Control Value (A or B):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm (500 MHz–4 GHz)
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions — Inches (mm)	
RF1, RF2	0.005 x 0.008 (0.125 x 0.200)
RFA1, RFB1	0.008 x 0.004 (0.200 x 0.100)
RFA2, RFB2	0.004 x 0.004 (0.100 x 0.100)
A, B, A_C, B_C	0.008 x 0.004 (0.200 x 0.100)

Truth Table

Condition of Switch	Control Inputs					Condition of BondPad	
	A	B	T	G1	G2	RF1	RF2
Absorbtive	V_{IN}Low	V_{IN}Hi	GND	GND	—	On	Off
SPDT	V_{IN}Hi	V_{IN}Low	GND	GND	—	Off	On
Reflective	V_{IN}Low	V_{IN}Hi	—	GND	GND	On	Off

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M/A-COM an AMP company

GaAs SPDT Switch DC-4 GHz

MASW4040

V 2.00

Features

- Absortive or Reflective
- Excellent Intermodulation Products
- Excellent Temperature Stability
- Fast Switching Speed, 3 ns Typical
- Ultra Low DC Power Consumption
- Independent Bias Control

Guaranteed Specifications* –55˚C to +85˚C

Frequency Range		DC – 4.0 GHz
Insertion Loss	DC – 1.0 GHz	0.6 dB Max
	DC – 2.0 GHz	0.8 dB Max
	DC – 4.0 GHz	1.0 dB Max
Isolation	DC – 1.0 GHz	60 dB Min
	Absorptive Mode DC – 2.0 GHz	50 dB Min
	Reflective Mode DC – 2.0 GHz	46 dB Min
	DC – 4.0 GHz	40 dB Min
VSWR	DC – 1.0 GHz	1.1:1 Max
	DC – 2.0 GHz	1.2:1 Max
	DC – 4.0 GHz	1.5:1 Max

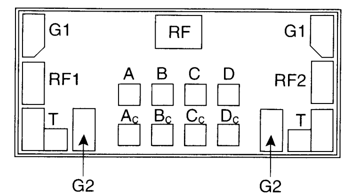
Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics		
Trise, Tfall (10%/90% or 90%/10% RF)		3 ns Typ
Ton,Toff (50% CTL to 90%/10% RF)		6 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression**		
Control Voltages (Vdc)	0/–5	0/–8
0.05 GHz	24 dBm	25 dBm Typ
0.5 – 4.0 GHz	30 dBm	33 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP2	IP3
0.5 GHz	62	39 dBm Typ
0.5 – 4.0 GHz	68	46 dBm Typ
Control Voltages (Complementary Logic)		
VinLow		0 to –0.2V @ 9 μA Max
VinHi		–5V @ 25 μA Typ to –8V @ 0.75 μA Max
Die Size		0.031" x 0.062" x 0.010" (0.79 mm x 1.58 mm x 0.25 mm)

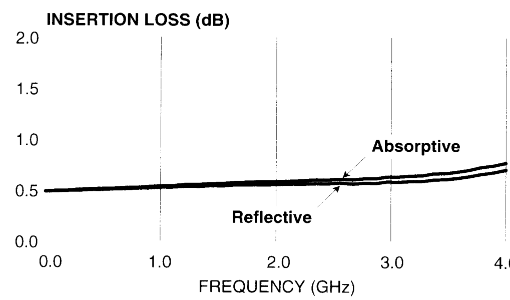
** All specifications apply with 50 Ω connected to all RF ports, 0 and -5 Vdc control voltages.

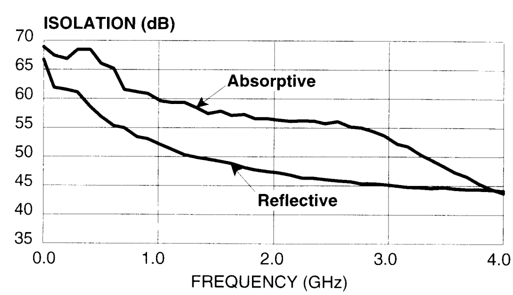
*** Loss changes 0.0025 dB/°C.

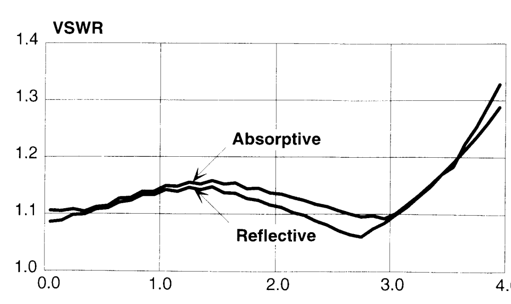
Bond Pad Layout



Typical Performance @ +25°C







Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW4040 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW4040 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW4040 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW4040. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either of the complementary control ports only when the other is grounded. No port should be allowed to "float".

E. General Handling — It is recommended that the MASW4040 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW4040 is back-metallized with Pd/Ni/Au(100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW4040 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

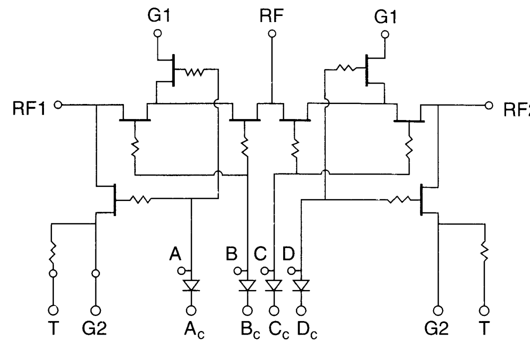
Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW4040 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Schematic



Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Maximum Ratings	
A. Control Value (A or B):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm (500 MHz–2 GHz)
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions — Inches (mm)	
RF	0.005 x 0.008 (0.125 x 0.200)
RF1, RF2	0.008 x 0.004 (0.200 x 0.100)
A, B, C, D	0.004 x 0.004 (0.100 x 0.100)
G1, T	0.008 x 0.004 (0.200 x 0.100)
G2	0.004 x 0.004 (0.100 x 0.100)

Truth Table

	Control Inputs				Condition of BondPad			Condition of Switch	
	A	B	C	D	T	G1	G2	RF1	RF2
Absorbtive	$V_{IN}H_I$	$V_{IN}L_{OW}$	$V_{IN}H_I$	$V_{IN}L_{OW}$	GND	GND	—	On	Off
SPDT	$V_{IN}L_{OW}$	$V_{IN}H_I$	$V_{IN}L_{OW}$	$V_{IN}H_I$	GND	GND	—	Off	On
Reflective	$V_{IN}H_I$	$V_{IN}L_{OW}$	$V_{IN}H_I$	$V_{IN}L_{OW}$	—	GND	GND	On	Off
SPDT	$V_{IN}L_{OW}$	$V_{IN}H_I$	$V_{IN}L_{OW}$	$V_{IN}H_I$	—	GND	GND	Off	On

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M/A-COM an AMP company

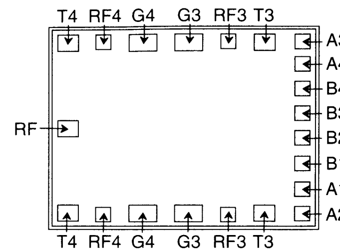
GaAs SP4T Switch
DC - 4 GHz

MASW4060G

V 2.00

Features

- Low Insertion Loss, 1.2 dB Typical
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption
- Terminated Option



Guaranteed Specifications*

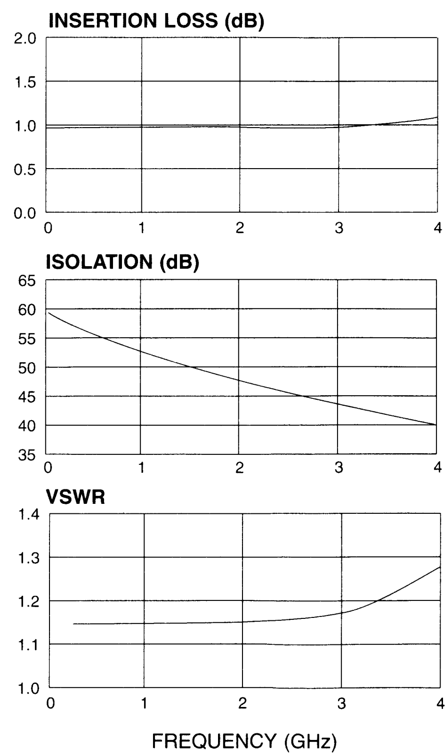
		−55°C to +85°C
Frequency Range		DC – 4.0 GHz
Insertion Loss	DC – 0.5 GHz	1.3 dB Max
	DC – 1.0 GHz	1.3 dB Max
	DC – 2.0 GHz	1.3 dB Max
	DC – 4.0 GHz	1.7 dB Max
Isolation	DC – 0.5 GHz	50 dB Min
	DC – 1.0 GHz	45 dB Min
	DC – 2.0 GHz	40 dB Min
	DC – 4.0 GHz	30 dB Min
VSWR	DC – 0.5 GHz	1.4:1 Max
	DC – 1.0 GHz	1.4:1 Max
	DC – 2.0 GHz	1.5:1 Max
	DC – 4.0 GHz	2.0:1 Max

Operating Characteristics

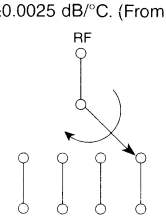
Impedance		50 Ω Nominal
Switching Characteristics		
tRISE, tFALL (10/90% or 90/10% RF)		2 ns Typ
tON, tOFF (50% CTL to 90/10% RF)		4 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)		0/–5
0.05 GHz		+17 dBm Typ
0.5 – 4.0 GHz		+27 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP2	IP3
0.5 GHz	+45	+35 dBm Typ
0.5 – 4.0 GHz	+60	+46 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to –0.2 V @ 25 µA Max
V_{IN}Hi		–5 V @ 50 µA Typ to –5 V @ 200 µA Max
Die Size		0.059″ x 0.077″ x 0.010″ (1.50mm x 1.95mm x 0.25mm)

**All specifications apply with 50 Ω impedance connected to all RF ports, 0 and 0 and –5 Vdc control voltages.
***Loss changes ±0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance @ + 25°C



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW4060 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW4060 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW4060 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW4060. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias — Apply voltage to either control port V1 or V2 only when the other is grounded. No port should be allowed to "float".

E. General Handling — It is recommended that the MASW4060 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW4060 is back-metallized with Pd/Ni/Au(100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW4060 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW4060 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires from ground pads to package are recommended.

Maximum Ratings	
A. Control Value (A/C or B/D):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions — Inches (mm)	
RF	0.005 x 0.005 (0.125 x 0.125)
RF1, RF2, RF3, RF4	0.005 x 0.005 (0.125 x 0.125)
A1, A2, A3, A4 B1, B2, B3, B4	0.004 x 0.004 (0.100 x 0.100)
G1, G2, G3, G4	0.008 x 0.004 (0.200 x 0.100)
T1, T2, T3, T4	0.004 x 0.005 (0.100 x 0.125)

Truth Table

Control Inputs								Condition of Switch			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
V_{IN}Hi	V_{IN}Low	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	On	Off	Off	Off
V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	Off	On	Off	Off
V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Hi	V_{IN}Low	V_{IN}Low	V_{IN}Hi	Off	Off	On	Off
V_{IN}Low	V_{IN}Hi	V_{IN}Low	V_{IN}Hi	V_{IN}Low	$V_{IN}H_I$	V_{IN}Hi	V_{IN}Low	Off	Off	Off	On

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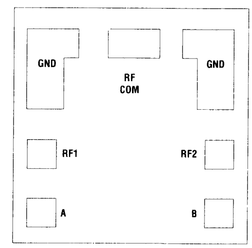
an AMP company

GaAs SPDT Switch DC-6 GHz

MASW6010G

V 2.00

- Low Insertion Loss, 0.5 dB Typical @ 4 GHz
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption
- Integral Static Protection



Guaranteed Specifications** @25°C***

Frequency Range MHz		DC - 6000
Insertion Loss		
	DC - 1.0 GHz	0.6 dB Max
	DC - 2.0 GHz	0.8 dB Max
	DC - 6.0 GHz	1.4 dB Max
Isolation		
	DC - 1.0 GHz	45 dB Min
	DC - 2.0 GHz	38 dB Min
	DC - 6.0 GHz	22 dB Min
VSWR		
	DC - 1.0 GHz	1.1:1 Max
	DC - 2.0 GHz	1.2:1 Max
	DC - 6.0 GHz	1.9:1 Max

Operating Characteristics

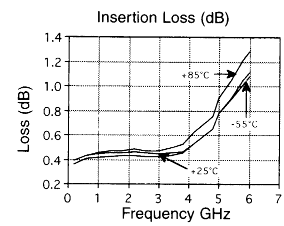
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		2 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		4 ns Typ
Transients (In-Band)		10 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
Above 500 MHz	+27 dBm	+33 dBm Typ
100 MHz	+21 dBm	+26 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
Above 500 MHz	+68 dBm	+46 dBm Typ
100 MHz	+62 dBm	+40 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2V @ 20 µA Max
V_{IN}Hi		-5V @ 50 µA Typ to -8V @ 300 µA Max
Die Size		0.031" x 0.031" x 0.010" (0.80mm x0.80mm x 0.25mm)

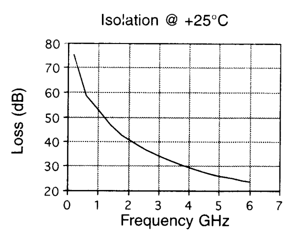
* Equivalent to Anzac SW200

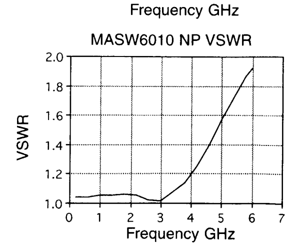
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -8 Vdc control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

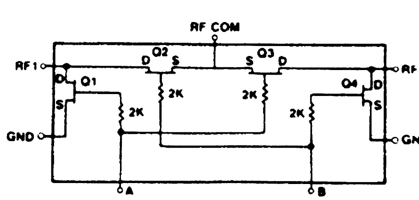
Typical Performance @ +25°C







Schematic



Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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Handling Precautions

Permanent damage to the MASW6010 may occur if the following precautions are not adhered to:

A. Cleanliness – The MASW6010 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW6010 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MASW6010. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port A/B or only when the other is grounded. Neither port should be allowed to “float”.

E. General Handling – It is recommended that the MASW6010 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW6010 is back-metallized with Pd/Ni/Au (100/1,000/ 30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW6010 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy must be used.

B. Apply a minimum amount of epoxy and place the MASW6010 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

C. Cure epoxy per manufacturer's recommended schedule.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Truth Table

Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
V_{in}Hi	V_{in}Low	On	Off
V_{in}Low	V_{in}Hi	Off	On

V_{in} Low 0 to -0.2V

V_{in}Hi -5V to -8V

Maximum Ratings
A. Control Voltage (A / B): -8.5 Vdc
B. Max Input RF Power: +42 dBm (500 MHz - 6 GHz)
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

Bonding Pad Dimensions Inches (mm)
RFcom: 0.004 x 0.004 (0.100 x 0.100)
RF2,RF3: 0.004 x 0.004 (0.100 x 0.100)
A,B: 0.004 x 0.004 (0.100 x 0.100)
GND1,GND2: 0.012 x 0.004 (0.300 x 0.100)

Die Size Inches (mm)
0.031 x 0.031 x 0.010 (0.80 x 0.80 x 0.25)

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an AMP company

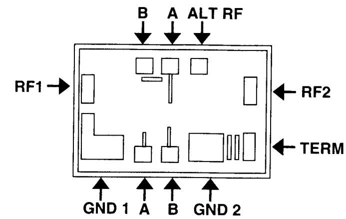
GaAs SPST Switch DC-6 GHz

MASW6020G

V 2.00

Features

- Low Insertion Loss, 0.6 dB Typical @ 1 GHz
- Fast Switching Speed, 10 ns Typical
- Ultra Low DC Power Consumption
- Integral Static Protection



Guaranteed Specifications** @25°C***

Frequency Range			DC - 6000 MHz
Insertion Loss	(L) Low Loss	Low Loss Matched	(H) High Isolation
DC-1.0 GHz	0.8 dB	1.0 dB	0.9 dB
DC-2.0 GHz	0.9 dB	1.1 dB	1.0 dB
DC-6.0 GHz	2.5 dB	2.7 dB	2.5 dB
Isolation	(L) Low Loss	Low Loss Matched	(H) High Isolation
DC-1.0 GHz	30 dB	63 dB	64 dB
DC-2.0 GHz	22 dB	46 dB	52 dB
DC-6.0 GHz	11 dB	14 dB	19 dB
VSWR	(L) Low Loss	Low Loss Matched	(H) High Isolation
DC-1.0 GHz	1.1:1	1.1:1	1.1:1
DC-2.0 GHz	1.3:1	1.2:1	1.1:1
DC-6.0 GHz	2.0:1	2.7:1	2.0:1

Operating Characteristics

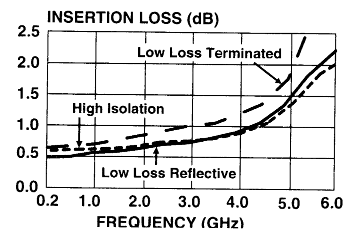
Impedance		50 Ω Nominal
Switching Characteristics		
Trise, Tfall (10%/90% or 90%/10% RF)		10 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)		10 ns Typ
Transients (In-Band)		10 mV Typ
Input Power for 1 dB Compression		
Control Voltages (VDC)	0/-5	0/-8
Above 500 MHz	+27 dBm	+33 dBm Typ
100 MHz	+21 dBm	+26 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP2	IP3
Above 500 MHz	+68 dBm	+46 dBm Typ
100 MHz	+62 dBm	+40 dBm Typ
Control Voltages (Complementary Logic)		
Vin Low		0 to -0.2V @ 20 µA Max
Vin Hi		-5V @ 50 µA Typ to -8V @ 300 µA Max
Die Size		0.031" x 0.051" x 0.010" (0.80 mm x 01.30 mm x 0.25 mm)

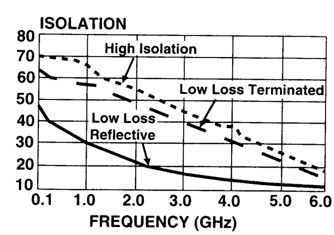
* Equivalent to Microelectronics Division (ANZAC) SW210H

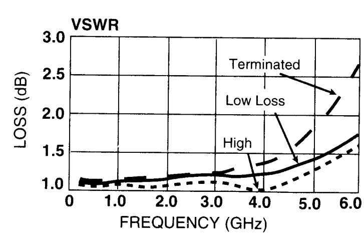
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -8 VDC control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

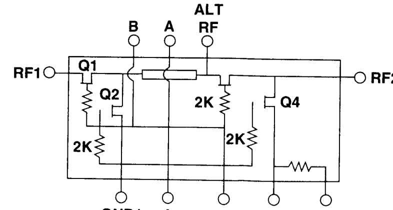
Typical Performance







Schematic



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Handling Precautions

Permanent damage to the MASW6020G may occur if the following precautions are not adhered to:

A. Cleanliness – The MASW6020G should be handled in a clean environment. DO NOT attempt to clean unit after the MASW6020G is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MASW6020G. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port A/B or only when the other is grounded. Neither port should be allowed to "float."

E. General Handling – It is recommended that the MASW6020G chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW6020G is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW6020G to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy must be used.

B. Apply a minimum amount of epoxy and place the MASW6020G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

C. Cure epoxy per manufacturer's recommended schedule.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Truth Table

Option	Control Voltage		Switch Condition & Bonding			Ground Bonds		
	A	B	RF1	RF2	ALT	GND1	GND2	Term
T	V Hi	V Low	on	on		G		G
	V Low	V Hi	off	off		G		G
L	V Hi	V Low		on	on	G	G	
	V Low	V Hi		off	off	G	G	
H	V Hi	V Low	on	on		G	G	
	V Low	V Hi	off	off		G	G	

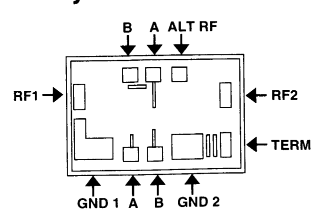
Maximum Ratings

Control Voltage (A/B):	-8.5 VDC
Max Input RF Power:	+34 dBm (500 MHz - 4 GHz)
Storage Temperature:	-65°C to +175°C
Maximum Operating Temperature:	+175°C

Bond Pad Dimensions – Inches (mm)

RF1, RF2:	0.004 x 0.006 (0.100 x 0.150)
Alt RF:	0.004 x 0.005 (0.100 x 0.125)
A,B:	0.004 x 0.004 (0.100 x 0.100)
GND1:	0.012 x 0.007 (0.300 x 0.175)
GND2 :	0.009 x 0.008 (0.225 x 0.200)
Term:	0.004 x 0.008 (0.100 x 0.200)

Bond Pad Layout



an AMP company

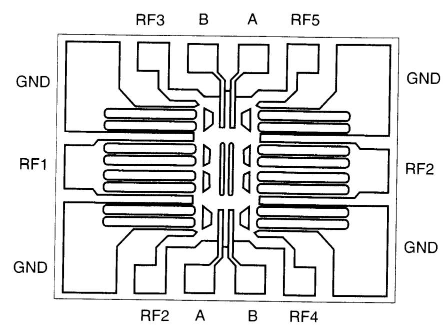
GaAs DPDT Switch DC - 6 GHz

MASW6030G

V 2.00

Features

- Low Insertion Loss, 0.5 dB Typical
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications** @ +25°C***

Frequency Range		DC – 6 GHz
Insertion Loss	DC – 1 GHz	0.6 dB Max
	DC – 2 GHz	0.8 dB Max
	DC – 4 GHz	1.0 dB Max
	DC – 6 GHz	1.5 dB Max
VSWR	DC – 1 GHz	1.2:1 Max
	DC – 2 GHz	1.4:1 Max
	DC – 4 GHz	1.5:1 Max
	DC – 6 GHz	1.8:1 Max
Isolation	DC – 1 GHz	40 dB Min
	DC – 2 GHz	35 dB Min
	DC – 4 GHz	25 dB Min
	DC – 6 GHz	20 dB Min

Operating Characteristics

Impedance 50 Ω Nominal

Switching Characteristics***

tRISE, tFALL (10/90% or 90/10% RF)	2 ns Typ
tON, tOFF (50% CTL to 90/10% RF)	4 ns Typ
Transients (In-Band)	15 mV Typ

Input Power for 1dB Compression

Control Voltages (Vdc)	0/–5	0/–8	
0.5 – 6 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +5 dBm)

Intercept Points	IP_2	IP_3	
0.5 – 6 GHz	+68	+45	dBm Typ
0.05 GHz	+62	+40	dBm Typ

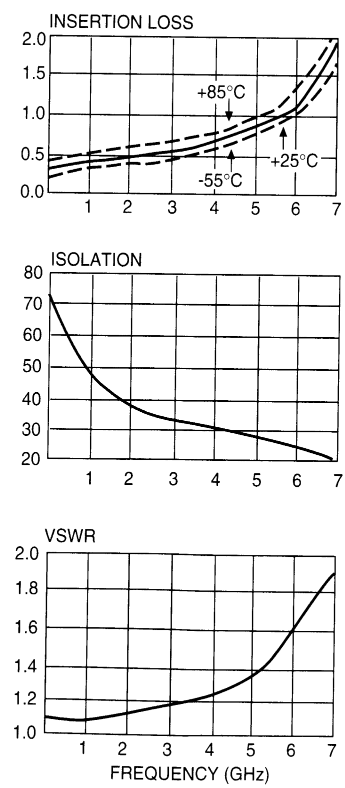
Control Voltages (Complementary Logic)

V_{IN} Low	0 to –0.2V @ 5 μA Max
V_{IN} Hi	–5V @ 10 μA Typ to –8V @ 100 μA Max

Die Size 0.036″ x 0.046″ x 0.010″ (0.91mm x 1.17mm x 0.25mm)

Environmental
These units are designed to meet or exceed the following:
Electrical, 100% probing at 25°C for selected parameters.
Visual, 100% per MIL-STD-883 Method 2010 Condition B.
Lot traceability supplied on request.

Typical Performance



** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages and chip interconnections made with 0.001" dia. wirebonds.

*** Loss changes 0.0025 dB/°C (-55°C to +85°C)

**** Faster switching speed can be achieved with enhanced driver waveform.

Specifications Subject to Change Without Notice.

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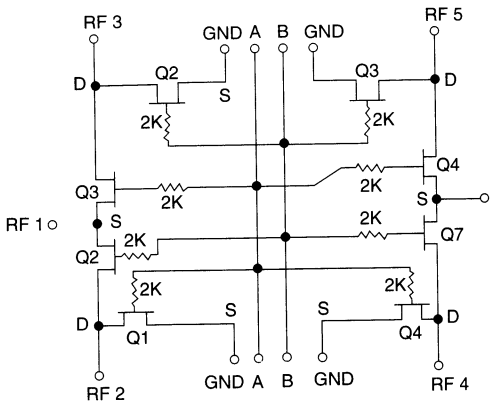
Schematic



Handling Precautions

Permanent damage to the MASW6030 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW6030 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW6030 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW6030. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias —Apply voltage to either control port A1/B2 or A2/B1 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MASW6030 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW6030 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW6030 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy may be used.

B. Apply a minimum amount of epoxy and place the MASW6030 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

C. Cure epoxy per manufacturer's recommended schedule.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Truth Table*

Control Inputs		Condition Of Switch			
		RF1 to		RF6 to	
A	B	RF2	RF3	RF4	RF5
V_{Hi}	V_{Low}	On	Off	On	Off
V_{Low}	V_{Hi}	Off	On	Off	On

* When an RF output port is "off" it is shorted to ground through an "on" shunt MESFET

Maximum Ratings	
A. Control Voltage (A or B):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm (0.5 - 6.0 GHz with 0/8V CTL)
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions Inches (mm)	
RF1, RF6:	0.005 x 0.005 (0.130 x 0.150)
RF2, RF5:	0.004 x 0.004 (0.100 x 0.100)
GND:	0.005 x 0.013 (0.130 x 0.320)

Die Size Inches (mm)
0.036 x 0.046 x 0.010 (0.91 x 1.17 x 0.25)

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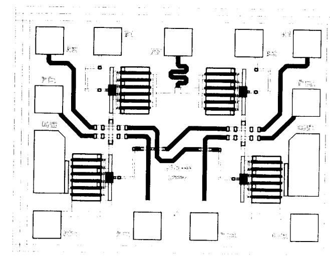
M/A-COM an AMP company

GaAs SPDT Switch DC - 8 GHz

MASW8000

V 2.00



Features

- Low Insertion Loss, 0.8 dB Typical @ 8 GHz
- Fast Switching Speed, 3 ns Typical
- Flexible Bonding Configurations

Guaranteed Specifications** @+25°C***

Frequency Range		DC-8.0 GHz
Insertion Loss	DC-2.0 GHz	0.8 dB Max
	DC-4.0 GHz	0.9 dB Max
	DC-8.0 GHz	1.0 dB Max
VSWR	DC-2.0 GHz	1.3:1 Max
	DC-4.0 GHz	1.4:1 Max
	DC-8.0 GHz	1.5:1 Max
Isolation	DC-2.0 GHz	37 dB Min
	DC-4.0 GHz	30 dB Min
	DC-8.0 GHz	20 dB Min

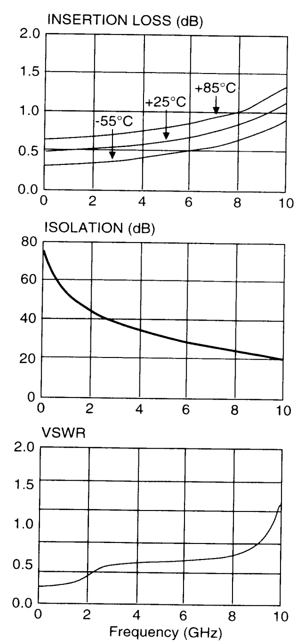
Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics		
T_{rise}, T_{fall} (10/90% or 90/10% RF)		2 ns Typ
T_{on}, T_{off} (50% CTL to 90/10% RF)		4 ns Typ
Transients (in-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
0.05 GHz	+20 dBm	+22 dBm Typ
0.5-8 GHz	+27 dBm	+30 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
0.05 GHz	+53 dBm	+40 dBm Typ
0.5-8 GHz	+78 dBm	+52 dBm Typ
Control Voltages (Complimentary Logic)		
V_{in} Low		0 to -0.2V @ 20 µA Max
V_{in} Hi		-5V @ 50 µA Typ to -8V @ 350 µA Max
Die Size		0.046" x 0.036" X 0.010" (1.15mm X 0.90mm X 0.25mm)

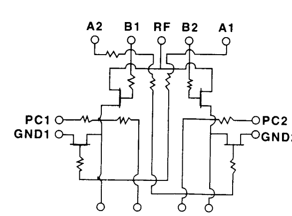
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -5 Vdc control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW8000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW8000 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW8000 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW8000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias —Apply voltage to either of the complementary control port A1/B2 or A2/B1 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MASW8000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW8000 is back-metallized with Pd/Ni/Au (100/1,000/10,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW8000 to a temperature greater than 320°C for more than 20 seconds. No more than 30 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW8000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package. GND bonds should be as short as possible; at least three and no more than four bond wires or two 3-mil ribbons from ground pads to package are recommended.

Truth Table****

Control Inputs		Condition Of Switch	
A1/B2	**A2/B1**	**RF1**	**RF2**
V_{IN}Hi	V_{IN}Low	On	Off
V_{IN}Low	V_{IN}Hi	Off	On

****For normal SPDT operation A1 is connected to B2 and A2 is connected to B1.

Maximum Ratings	
A. Control Voltage (A1/B2 or A2/B1):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions Inches (mm)	
RF:	0.004 x 0.004 (0.100 x 0.100)
RF1, RF2:	0.004 x 0.004 (0.100 x 0.100)
A1, A2, B1, B2:	0.004 x 0.004 (0.100 x 0.100)
PC1, PC2	0.004 x 0.004 (0.100 x 0.100)
GND1, GND2:	0.005 x 0.009 (0.110 x 0.225)

Die Size Inches (mm)
0.046 x 0.036 x 0.010 (1.15 x 0.90 x 0.25)

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M/A-COM an AMP company

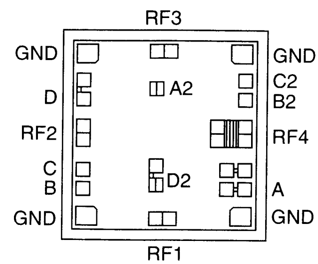
GaAs Transfer Switch DC - 12 GHz

MASW12000G

V 2.00

Features

- Broad Bandwidth DC - 12 GHz
- Low Differential Phase Between Paths (Typ ±3° at 2 GHz)
- Fast Switching Speed, 3 ns Typical
- Ultra Low DC Power Consumption
- Absorptive Option



Guaranteed Specifications** @ 25°C***

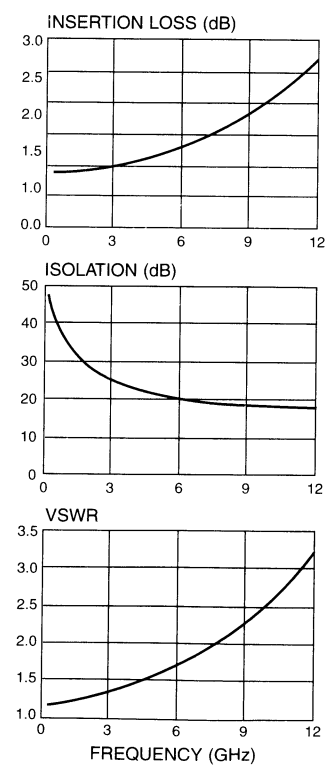
Frequency Range			DC - 12.0 GHz
Insertion Loss		DC - 1 GHz	1.3 dB Max
		DC - 4 GHz	1.5 dB Max
		DC - 12 GHz	3.2 dB Max
VSWR	Reflective	DC - 1 GHz	1.3 Max
		DC - 4 GHz	1.5 Max
		DC - 12 GHz	3.0 Max
	Absorptive	DC - 4 GHz	2.5 Max
Isolation		DC - 1 GHz	40 dB Min
		DC - 4 GHz	20 dB Min
		DC - 12 GHz	10 dB Min

Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		5 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		10 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
0.5 - 12 GHz	+27 dBm	+29 dBm Typ
0.05 GHz	dBm	dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2 V @ μA Max
V_{IN}Hi		-5 V @ 10 μA Typ to -8 V @ μA Max
Die Size		0.053 " x 0.053" x 0.010" (1.30mm x 1.34mm x 0.25mm)

** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -8 Vdc control voltages.
*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance



Specifications Subject to Change Without Notice.

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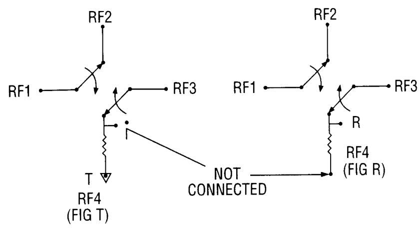
Schematic



BOND T PAD TO GROUND FOR TERMINATED PORT OPERATION
BOND AT R PAD FOR RF THRU (TX/RX) SWITCH OPERATION

Handling Precautions

Permanent damage to the MASW12000 may occur if the following precautions are not adhered to:

A. Cleanliness – The MASW12000 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW12000 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MASW12000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either control port A1/B2 OR A2/B1 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling – It is recommended that the MASW12000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW12000 is back-metallized with Pd/Ni/Au (100/1,000/ 30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with electrically conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW12000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy may be used.

B. Apply a minimum amount of epoxy and place the MASW12000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

C. Cure epoxy per manufacturer's recommended schedule.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Maximum Ratings
A. Control Voltage (A, B, C, D): -8.5 Vdc
B. Max Input RF Power: +34 dBm
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

Bonding Pad Dimensions Inches (mm)
RF: 0.004 x 0.004 (0.100 x 0.100)
G1,G2,G3,G4: 0.005 x 0.005 (0.100 x 0.100)

Truth Table

A	B	C	D	1-2	2-3	3-4	4-1
Hi	Lo	Hi	Lo	Off	On	Off	On
Lo	Hi	Lo	Hi	On	Off	On	Off

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an AMP company

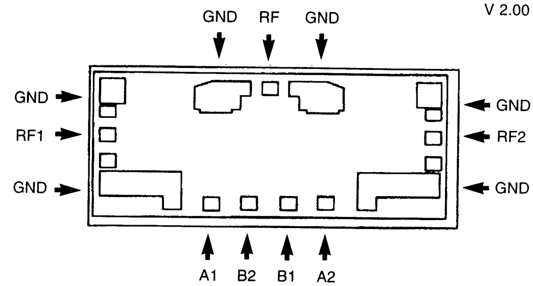
GaAs SPDT Switch
DC - 20 GHz

MASW20000

V 2.00

Features

- Very Broadband Performance
- Low Insertion Loss, 1.75 dB Typical @ 18 GHz
- High Isolation, 50 dB Typical @ 18 GHz
- Fast Switching Time, 2 nS Typical
- Reflective Configuration
- Ultra Low DC Power Consumption
- Via Hole Grounding



Guaranteed Specifications* @ +25°C**

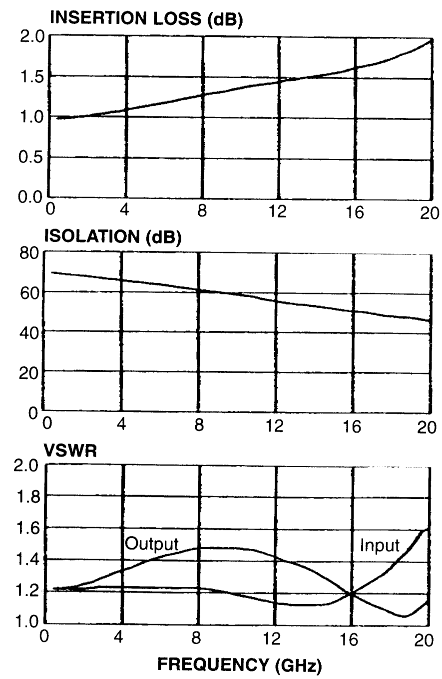
Frequency Range		DC-20.0 GHz
Insertion Loss	DC-10.0 GHz DC-18.0 GHz DC-20.0 GHz	1.7 dB Max 2.1 dB Max 2.5 dB Max
VSWR	DC-10.0 GHz DC-18.0 GHz DC-20.0 GHz	1.60:1 Max 1.80:1 Max 2.00:1 Max
Isolation	DC-10.0 GHz DC-18.0 GHz DC-20.0 GHz	50 dB Min 42 dB Min 40 dB Min

Operating Characteristics

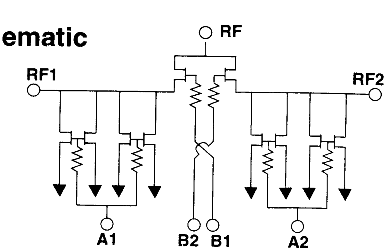
Impedance		50 Ω Nominal
Switching Characteristics		
T_{rise}, T_{fall} (10/90% or 90/10% RF) 2 ns Typ		
T_{on}, T_{off} (50% CTL to 90/10% RF) Transients (in-Band)		3 ns Typ 20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)		0/-5
0.5-20 GHz 0.05 GHz		+25 dBm Typ +18 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
0.5-20 GHz 0.05 GHz	+59 dBm	+43 dBm Typ +27 dBm Typ
Control Voltages (Complimentary Logic)		
V_{in} Low V_{in} Hi		0 to -0.2 V @ 5 µA Max -5 V @50 µA Max
Die Size		0.083" x 0.035" X 0.004" (2.10mm X 0.89mm X 0.10mm)

* Wafer level data. All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -5 Vdc control voltages.
** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice.

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Handling Precautions

Permanent damage to the MASW20000 may occur if the following precautions are not adhered to:

A. Cleanliness — The MASW20000 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW20000 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transient — Avoid instrument and power supply transients while bias is applied to the MASW20000. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias —Apply voltage to either control port A1/B2 or A2/B1 only when the other is grounded. Neither port should be allowed to "float".

E. General Handling — It is recommended that the MASW20000 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW20000 is back-metallized with Pd/Ni/Au (100/1,000/ 30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with thermally conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW2000 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Apply a minimum amount of epoxy and place the MASW20000 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Gold ribbon (3.0 mil X 0.5 mil) may also be used. Thermosonic wire bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Truth Table***

Control Inputs		Condition Of Switch	
A1/B2	A2/B1	RF1	RF2
V_{IN}Hi	V_{IN}Low	On	Off
V_{IN}Low	V_{IN}Hi	Off	On

VinLow 0 to -0.2V
VinHi -5V
***For normal SPDT operation A1 is connected to B2 and A2 is connected to B1.

Maximum Ratings	
A. Control Voltage (A1/B2 or A2/B1):	–8.5 Vdc
B. Max Input RF Power:	+34 dBm
C. Storage Temperature:	–65°C to +175°C
D. Max Operating Temperature:	+175°C

BondPad Dimensions Inches (mm)	
RF, RF1, RF2:	0.004 x 0.004 (0.100 x 0.100)
A1, A2, B1, B2:	0.004 x 0.004 (0.100 x 0.100)

Die Size Inches (mm)
0.083 x 0.035 x 0.004 (2.10 x 0.89x 0.10)

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an AMP company

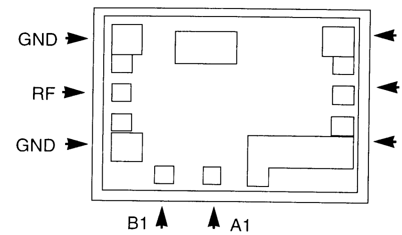
GaAs SPST Switch DC - 20 GHz

MASW20010

V 2.00

Features

- Very Broadband Performance
- Low Insertion Loss, 1.5 dB Typical @ 18 GHz
- High Isolation, 40 dB Typical @ 18 GHz
- Fast Switching Time, 2 nS Typical
- Reflective Configuration
- Ultra Low DC Power Consumption
- Via Hole Grounding



Guaranteed Specifications* @ +25°C**

Frequency Range		DC - 20.0 GHz
Insertion Loss	DC - 10.0 GHz	1.8 dB Max
	DC - 18.0 GHz	1.9 dB Max
	DC - 20.0 GHz	2.0 dB Max
VSWR	DC - 10.0 GHz	1.80:1 Max
	DC - 18.0 GHz	1.80:1 Max
	DC - 20.0 GHz	1.80:1 Max
Isolation	DC - 10.0 GHz	40 dB Min
	DC - 18.0 GHz	35 dB Min
	DC - 20.0 GHz	32 dB Min

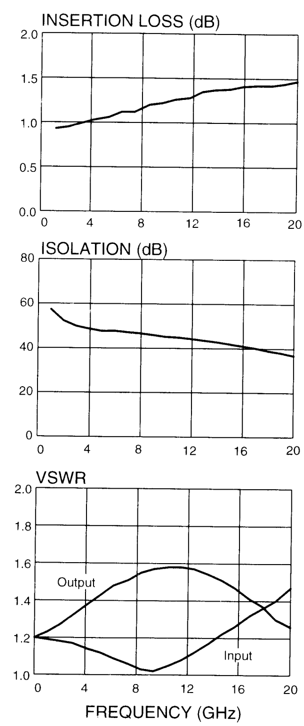
Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics		
T_{Rise}, T_{Fall} (10/90% or 90/10% RF)		2 ns Typ
T_{On}, T_{Off} (50% CTL to 90/10% RF)		3 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)		0/-5
0.5 - 20 GHz		+25 dBm Typ
0.05 GHz		+18 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
0.5 - 20 GHz	+59 dBm Typ	+43 dBm Typ
0.05 GHz		+27 dBm Typ
Control Voltages (Complementary Logic)		
V_{IN}Low		0 to -0.2 V @ 5µA Max
V_{IN}Hi		-5 V @ 50 µA Max
Die Size		0.050" x 0.035" x 0.004" (1.26mm x 0.89mm x 0.10mm

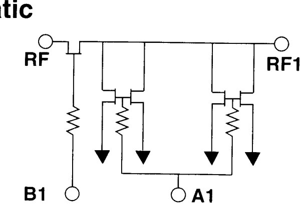
* Wafer level data. All specifications apply with 50Ω impedance connected to all RF ports, 0 and -5 Vdc control voltages.

** Loss change 0.0025 dB/°C. (-55°C to +85°C)

Typical Performance



Schematic



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Handling Precautions

Permanent damage to the MASW20010 may occur if the following precautions are not adhered to:

A. Cleanliness – The MASW20010 should be handled in a clean environment. DO NOT attempt to clean unit after the MASW20010 is installed.

B. Static Sensitivity – All chip handling equipment and personnel should be DC grounded.

C. Transient – Avoid instrument and power supply transients while bias is applied to the MASW20010. Use shielded signal and bias cables to minimize inductive pick-up.

D. Bias – Apply voltage to either complementary control port, A1 or B1, only when the other is grounded. Neither port should be allowed to "float".

E. General Handling – It is recommended that the MASW20010 chip be handled along the long side of the die with a sharp pair of bent tweezers. DO NOT touch the surface of the chip with fingers or tweezers.

Mounting

The MASW20010 is back-metallized with Pd/Ni/Au (100/1,000/30,000Å) metallization. It can be die-mounted with AuSn eutectic preforms or with electrically conductive epoxy. The package surface should be clean and flat before attachment.

Eutectic Die Attach:

A. A 80/20 gold/tin preform is recommended with a work surface temperature of approximately 255°C and a tool temperature of 265°C. When hot 90/10 nitrogen/hydrogen gas is applied, tool tip temperature should be approximately 290°C.

B. DO NOT expose the MASW20010 to a temperature greater than 320°C for more than 20 seconds. No more than 3 seconds of scrubbing should be required for attachment.

Epoxy Die Attach:

A. Electrically conductive epoxy must be used.

B. Apply a minimum amount of epoxy and place the MASW20010 into position. A thin epoxy fillet should be visible around the perimeter of the chip.

C. Cure epoxy per manufacturer's recommended schedule.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. Gold ribbon (3.0 mil X 0.5 mil) may also be used. Thermosonic wire bonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels to achieve reliable wirebonds.

B. Wirebonds should be started on the chip and terminated on the package.

Truth Table

Control Inputs		Condition of Switch
A1	B1	RF1
V_{IN}Hi	V_{IN}Low	On
V_{IN}LOW	V_{IN}HI	Off

V_{IN} Low 0 to -0.2 V
V_{IN} Hi -5 V

Maximum Ratings
A. Control Voltage (A1 or B1): -8.5 Vdc
B. Max Input RF Power: +34 dBm
C. Storage Temperature: -65°C to +175°C
D. Maximum Operating Temperature: +175°C

Bonding Pad Dimensions Inches (mm)	
RF, RF1:	0.004 x 0.004 (0.100 x 0.100)
A1, B1:	0.004 x 0.004 (0.100 x 0.100)

Die Size Inches (mm)
0.050" x 0.035" x 0.004" (1.26 x 0.89 x 0.10)

an AMP company

High Power GaAs SPDT Switch DC - 3 GHz

SW-106, SW-276

V 2.00

Features

- +39 dBm Typ. 1 dB Compression Point, -8V Control
- +65 dBm Typ. 3rd Order Intercept, -8V Control
- Insertion Loss of 0.4 dB Typical
- Low Power Consumption
- Fast Switching Speed

Guaranteed Specifications[1] (–55°C to +85°C)

Frequency Range	DC - 3.0 GHz	SW-106	SW-276
Insertion Loss	DC - 0.5 GHz	0.5 dB	0.4 dB Max
	DC - 1.0 GHz	0.6 dB	0.5 dB Max
	DC - 2.0 GHz	0.8 dB	0.7 dB Max
	DC - 3.0 GHz	1.2 dB	1.0 dB Max
Isolation	DC - 0.5 GHz	34 dB	37 dB Min
	DC - 1.0 GHz	32 dB	31 dB Min
	DC - 2.0 GHz	20 dB	24 dB Min
	DC - 3.0 GHz	15 dB	19 dB Min
VSWR	DC - 0.5 GHz	1.3:1	1.3:1 Max
	DC - 1.0 GHz	1.5:1	1.5:1 Max
	DC - 2.0 GHz	1.5:1	1.5:1 Max
	DC - 3.0 GHz	1.6:1	1.6:1 Max

Operating Characteristics[2]

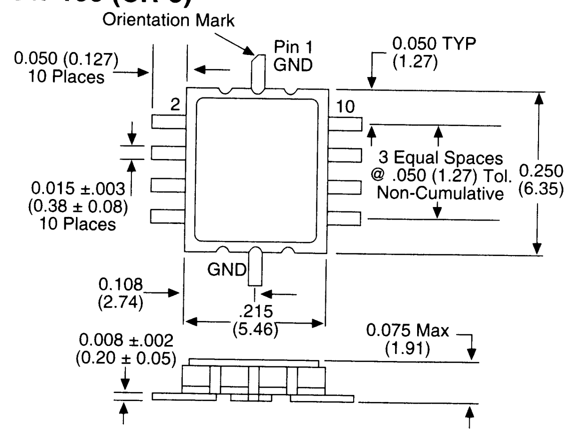
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			30 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			35 ns Typ
Transients (In-Band)			12 mV Typ
Input Power for Compression		0.1 dB	1.0 dB
0.9 GHz	(-5V Control)	+32.5 dBm	+35.5 dBm Typ
0.9 GHz	(-8V Control)	+35.5 dBm	+39.5 dBm Typ
Third Order Intercept Point (with two +10 dBm Input Tones)			
0.9 GHz	(-5V Control)		+61 dBm Typ
0.9 GHz	(-8V Control)		+65 dBm Typ
Control Voltages			
Vin Low			0 to -0.2V @ 20 μA Max
Vin High			-5V @ 50 μA Typ to -10V @ 800 μA Max

1. All specifications apply when operated with bias voltages of 0V for Vin Low and -5 to -10V for Vin High, and 50 ohm impedance at all RF ports, unless otherwise specified.
2. High power (greater than 1W) handling specifications apply to cold switching only. For input powers under 1W hot switching can be used.
3. Contact the factory for standard or custom screening requirements.

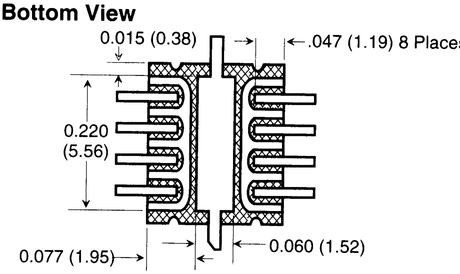
Ordering Information

Part Number	Package
SW-106 PIN	Surface Mount
SW-276 PIN	Ceramic

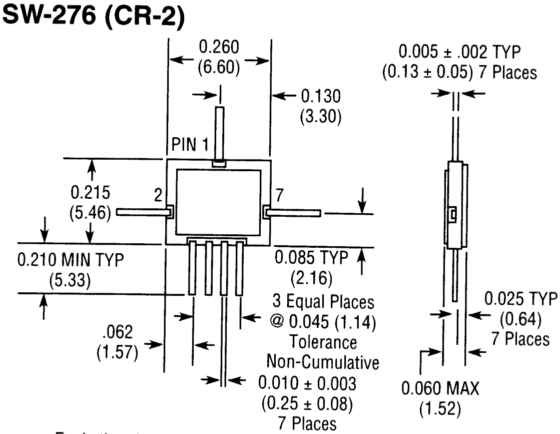
SW-106 (CR-5)



Bottom View



SW-276 (CR-2)



For both switches: Bottom of Case is AC Ground

Unless Otherwise Noted: Dimension in ( ) are in mm. .xxx = ± 0.010 (.xx = ± 0.25) .xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice.

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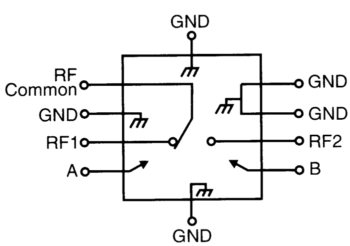
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+35 dBm
0.5 - 2.0 GHz	
–5V Control	+36 dBm
–8V Control	+39 dBm
–10V Control	+40 dBm
Power Dissipation [2,3]	2.0 W
Control Voltage	–12V, +1V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C
Maximum Junction Temperature	+175˚C
Thermal Resistance[2]: θ_{jc}	+50˚C/W

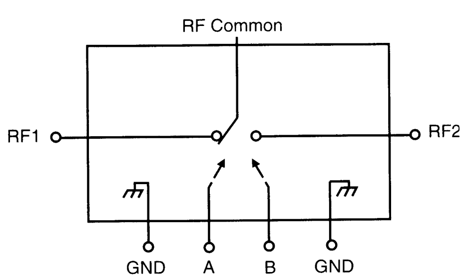
1. Operation of this device above any one of these parameters may cause permanent damage.
2. T_{case} = 25˚C, where T_{case} is the temperature at the bottom of the case.
3. Special consideration must be given to the mounting of the switch to minimize the thermal resistance. The bottom of the case should be thermally attached to the mounting surface to maintain the junction temperature under the absolute maximum rating.

Functional Schematics (Top View)

SW-106



SW-276



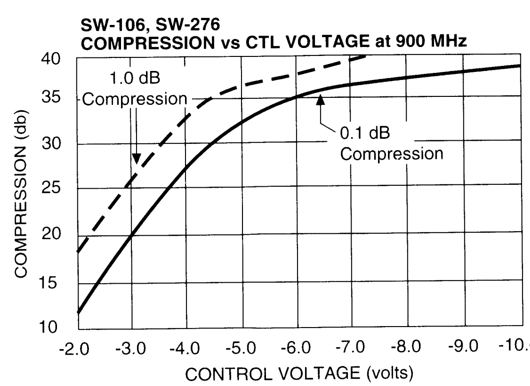
Two Tone IP_3 Measurements

Bias Voltage	Input Power for each tone (dBm)	3rd Order Intermodulation Products (dBc)	IP_3 (dBm)	Second Harmonic (dBc)
0, –5V	+27	–34	+44	-61
0, –6V	+27	–49	+51	-61
0, –7V	+27	–64	+59	-63
0, –8V	+27	–65	+59	-63
0, –5V	+28	–30	+43	-58
0, –6V	+28	–41	+48	-58
0, –7V	+28	–52	+54	-57
0, –8V	+28	–60	+58	-57
0, –5V	+29	–28	+43	-54
0, –6V	+29	–34	+46	-54
0, –7V	+29	–44	+51	-54
0, –8V	+29	–52	+55	-54
0, –5V	+30	–26	+43	-52
0, –6V	+30	–32	+46	-51
0, –7V	+30	–38	+49	-51
0, –8V	+30	–44	+52	-51

Truth Table

Control		Condition of Switch	
		RF Common to Each RF Port	
A	B	RF1	RF2
High	Low	On	Off
Low	High	Off	On

Typical Performance



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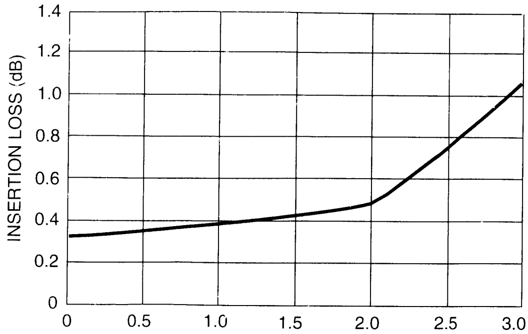
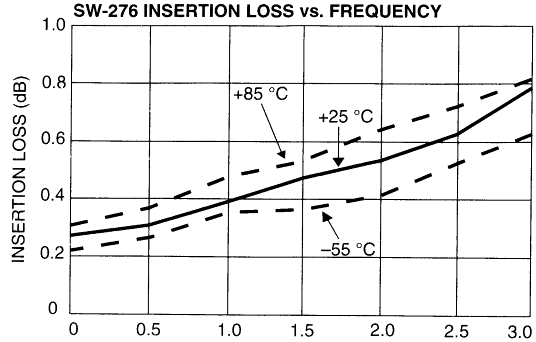
Typical Performances (cont'd.)

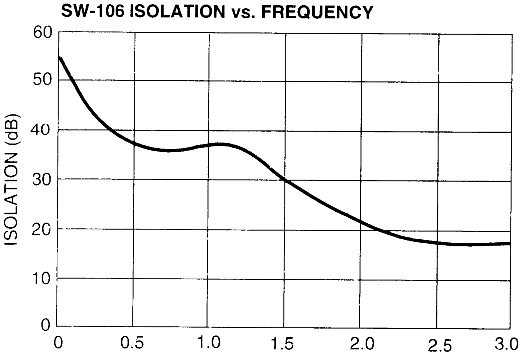
SW-106 INSERTION LOSS vs. FREQUENCY



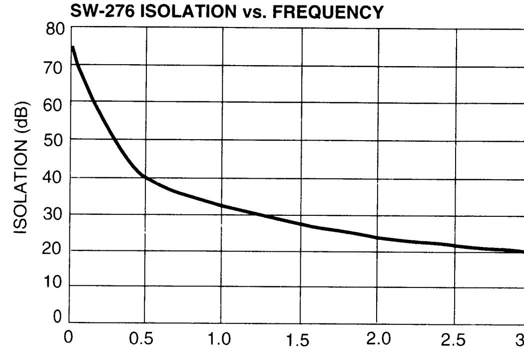
SW-276 INSERTION LOSS vs. FREQUENCY



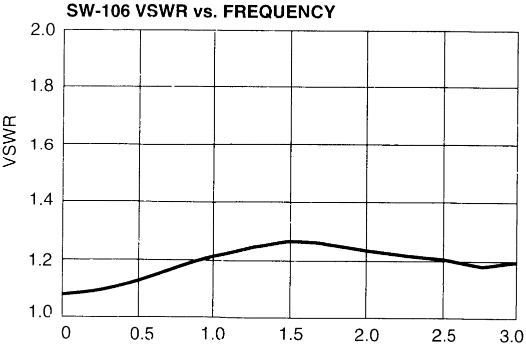
SW-106 ISOLATION vs. FREQUENCY



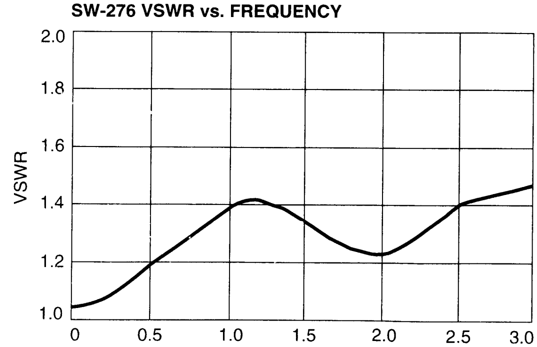
SW-276 ISOLATION vs. FREQUENCY



SW-106 VSWR vs. FREQUENCY



SW-276 VSWR vs. FREQUENCY



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an AMP company

GaAs SPDT Reflective Switch DC-3 GHz with TTL/CMOS Control Input

SW-110

V 2.00

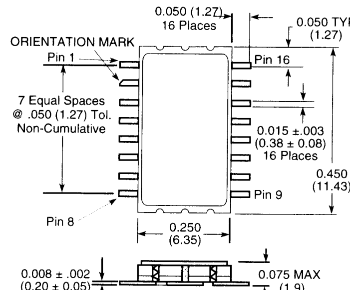
Features

- 1 dB Compression Point: +39 dBm Typ., -8V Control
- IP_3: +65 dBm, Typ., -8V Control
- Insertion Loss: 0.45 dB Typ.
- Low Power Consumption
- Fast Switching Speed
- 50Ω Nominal Impedance

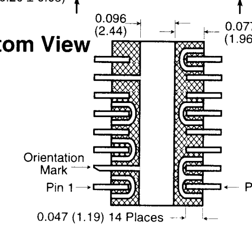
Description

M/A-COM's SW-110 is a GaAs MMIC SPDT reflective switch with an integral silicon ASIC driver. This device is in a 16 lead ceramic surface mount package. These switches exhibit excellent performance and repeatability from DC to 3.0 GHz, with very low DC power dissipation. The SW-110 is ideally suited for RF/IF communications applications. Environmental screening is available. Contact the factory for information.

CR-9



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise note:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, T_A = +25°C [1, 2, 3]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB			0.6 0.7 0.9 1.1
Isolation	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB	40 35 24 18		
VSWR	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz				1.2:1 1.4:1 1.4:1 1.5:1
Trise, Tfall Ton, Toff Transients	10% to 90% 1.3V Control to 90/10% RF In-band (peak-peak)	nS nS mV		12 35 30	
1 dB Compression	Input Power, 0.1 dB, -5V Control 0.9 GHz Input Power, 1.0 dB, -5V Control 0.9 GHz Input Power, 0.1 dB, -8V Control 0.9 GHz Input Power, 1.0 dB, -8V Control 0.9 GHz	dBm dBm dBm dBm		+32.5 +32.5 +32.5 +39.5	
Input IP_3	For two-tone input power up to +10 dBm -5V Control 0.9 GHz -8V Control 0.9 GHz	dBm dBm		+61 +65	
V_{CC} V_{EE}		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			1.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	μA μA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5 V for V_{CC} and -5.0 V to -8.0 V for V_{EE}, and 50Ω impedance at all RF ports unless otherwise specified.
2. For this switch to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10k Ω resistor, or an RF choke.
3. High power (greater than 1W) handling specifications apply to cold switching only. For input powers under 1 W, hot switching can be used.

Specifications Subject to Change Without Notice.

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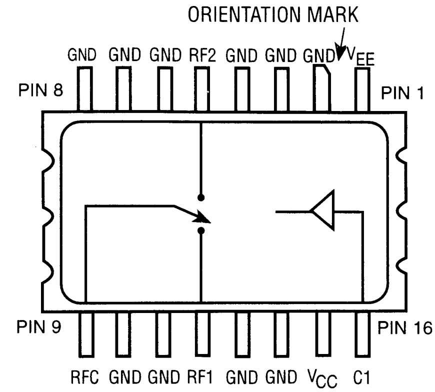
V 2.00

Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Input Power	
0.05 GHz	+35 dBm
0.5 - 3.0 GHz	
-5V Control	+36 dBm
-8V Control	+39 dBm
Power Dissipation [2,3]	2.0W
Control Voltage	-0.5 V to V_{CC} to 0.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C
Junction Temperature	+175°C
Thermal Resistance [2]: θ_{jc}	+50°C/W

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Tcase = 25°C, where Tcase is the temperature at the bottom of the case.
3. Special consideration must be given to the mounting of the switch to minimize the thermal resistance. The bottom of the case should be thermally attached to the mounting surface to maintain the junction temperature under the absolute maximum rating.

Functional Schematic (Top View)



Truth Table

	Condition of Switch	
Control Inputs	RFCommon to Each RF Port	
C1	RF1	RF2
Low	On	Off
High	Off	On

0 = TTL Low 1 = TTL High

Two Tone IP_3 Measurements

Bias Voltage	Input Power for Each Tone (dBm)	3rd Order Intermodulation Products (dBc)	IP_3 (dBm)	Second Harmonic (dBc)
0, -5V	+27	-34	+44	-61
0, -6V	+27	-49	+51	-61
0, -7V	+27	-64	+59	-63
0, -8V	+27	-65	+59	-63
0, -5V	+28	-30	+43	-58
0, -6V	+28	-41	+48	-58
0, -7V	+28	-52	+54	-57
0, -8V	+28	-60	+58	-57
0, -5V	+29	-28	+43	-54
0, -6V	+29	-34	+46	-54
0, -7V	+29	-44	+51	-54
0, -8V	+29	-52	+55	-54
0, -5V	+30	-26	+43	-52
0, -6V	+30	-32	+46	-51
0, -7V	+30	-38	+49	-51
0, -8V	+30	-44	+52	-51

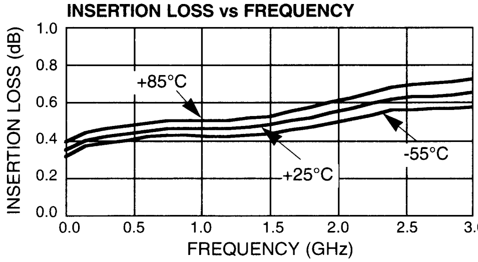
Ordering Information[4]

Part Number	Package
SW-110 PIN	Ceramic

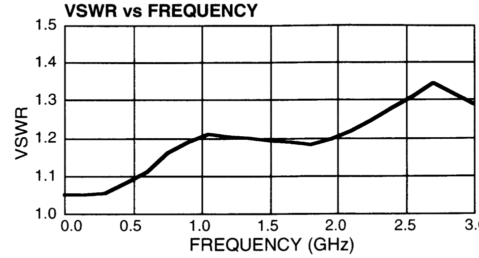
4. Contact the factory for standard or custom screening requirements.

Typical Performance @ +25°C

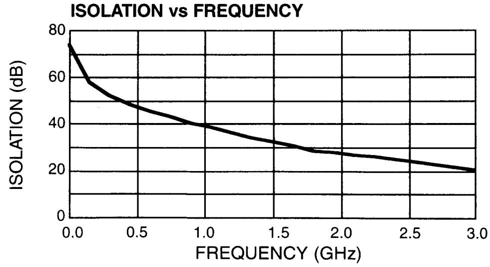
INSERTION LOSS vs FREQUENCY



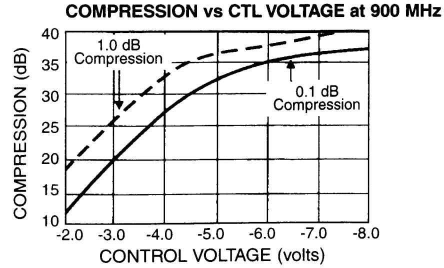
VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



COMPRESSION vs CTL VOLTAGE at 900 MHz



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M/A-COM
an AMP company

GaAs SPDT Reflective Switch 0.01-3 GHz

SW-137

V 2.00

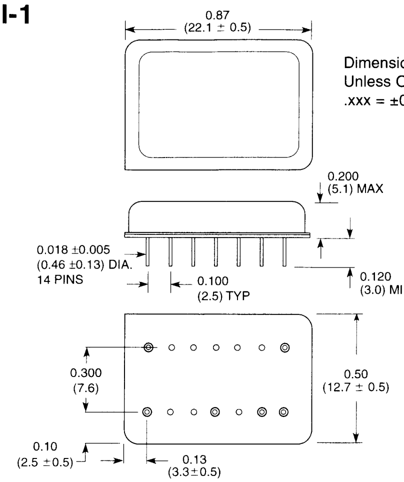
Features

- Isolation: 48dB Typ. at 1 GHz
- High Intercept Point Over Wide Bandwidth
- Trise, Tfall: 5 nS Typ.
- DIP Package
- Integral TTL Driver (CMOS Compatible)
- 50Ω Nominal Impedance

Description

M/A-COM's SW-137 is a GaAs MMIC SPDT reflective switch with an integral Silicon ASIC driver. This device is in a 14-lead DIP package. These switches offer high intercept points over a wide bandwidth of operation, while maintaining low DC power dissipation. These switches exhibit excellent performance and repeatability from 0.01 to 3.0 GHz. The SW-137 is ideally suited for RF/IF communications applications. Contact the factory for environmental screening.

DI-1



Dimensions in () are in mm.
Unless Otherwise Noted:
.xxx = ±0.010(.xx = ±0.25)

Electrical Specifications[1], T_A = -55°C to +85°C

Parameter	Test Conditions	Units	Minimum	Typical	Maximum
Reference Insertion Loss	.01 - 0.5 GHz .01 - 1.0 GHz .01 - 2.0 GHz .01 - 3.0 GHz	dB dB dB dB			0.9 1.0 1.4 1.6
Isolation	.01 - 0.5 GHz .01 - 1.0 GHz .01 - 2.0 GHz .01 - 3.0 GHz	dB dB dB dB	48 43 37 32		
VSWR	.01 - 0.5 GHz .01 - 1.0 GHz .01 - 2.0 GHz .01 - 3.0 GHz				1.25:1 1.4:1 1.7:1 2.0:1
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90%/10% RF In-band (peak-peak)	nS nS mV		5 22 45	
1 dB Compression	0.01 - 3.0 GHz	dBm		+25	
Input IP_3	For two-tone input power up to +5 dBm .01 - 3.0 GHz	dBm		+46	
Input IP_2	For two-tone input power up to +5 dBm .01 - 3.0 GHz	dBm		+76	
V_{CC} V_{EE}		V V	+9 -15	+12 -12	+15 -9
I_{CC}	V_{CC} = +9 to +15 V	mA			20.0
I_{EE}	V_{EE} = -9 to -15 V	mA			15.0
Vctl Vctl	Low High	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	μA μA			1.0 1.0

1. All specifications apply when operated with bias voltages of +9 to +15V for V_{CC} and -9 to -15V for V_{EE} and 50Ω impedance at all RF ports unless otherwise specified.

Specifications Subject to Change Without Notice.

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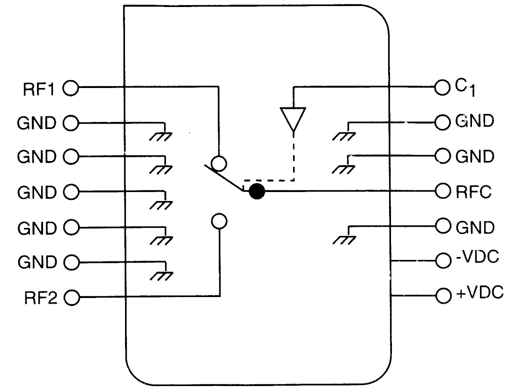
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 - 3.0 GHz	+34 dBm
Supply Voltages	
V_{CC}	-0.5V to +16.5V
V_{EE}	-16.5V to +0.5V
Control Voltage	-0.5V to V_{CC} +0.5V
Operating Temperature	-55°C to +125°
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic (Top View)



Truth Table

Control Inputs	Condition of Switch	
	RF Common to Each RF Port	
C1	RF1	RF2
Low	On	Off
High	Off	On

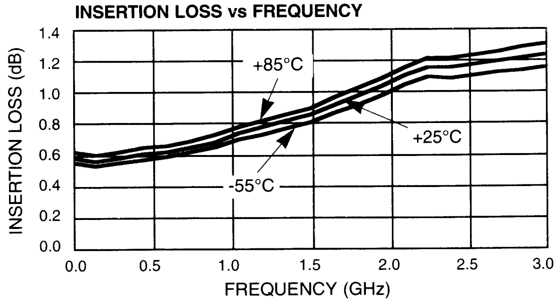
Ordering Information[2]

Part No.	Package
SW-137 PIN	Dual Inline

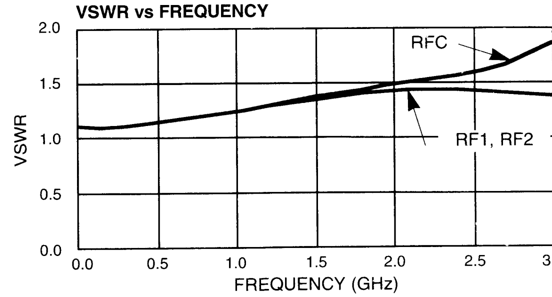
2. Contact the factory for standard or custom screening requirements

Typical Performance

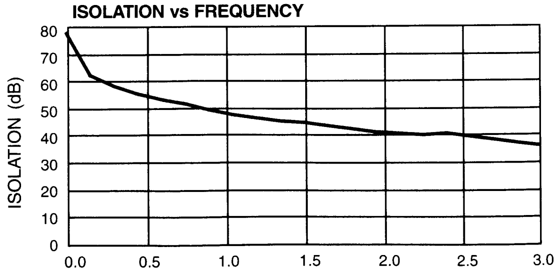
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



Current (mA)

	±9 V	±12 V	±15 V
V_{CC}	8	11	15
V_{EE}	4	7	9

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an AMP company

GaAs SPDT Switch DC-2 GHz

SW-201/203

V 2.00

Features

- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-201), Terminated (SW-203)

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range				DC-2 GHz
Model Number		**SW-201 (L)**	**SW-203 (T)**	
Insertion Loss	DC-2 GHz	0.9	1.5	dB Max
	DC-1 GHz	0.8	1.1	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-2 GHz	1.5:1	2.0:1	Max
	DC-1 GHz	1.3:1	1.3:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	Max
Isolation	DC-2 GHz	30	38	dB Min
	DC-1 GHz	38	45	dB Min
	DC-0.5 GHz	45	50	dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			3 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-203			30 mV Typ
Transients (In-Band) SW-201			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0 /-8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low (SW-201/203)			0 to -0.2V @ 20 µA Max
V_{IN} HI (SW-201)			-5V @ 50 µA Typ to -8V @ 300 µA Max
V_{IN} Hi (SW-203)			-5V @ 110 µA Typ to -8V @ 600 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 VDC control voltages.

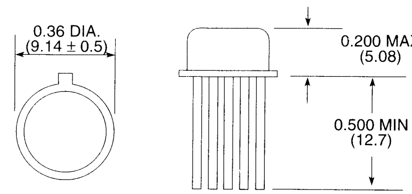
† Faster switching speed can be achieved with enhanced driver waveform.

**For the SW-201, when an RF output is "OFF" it is shorted to case ground.

Ordering Information

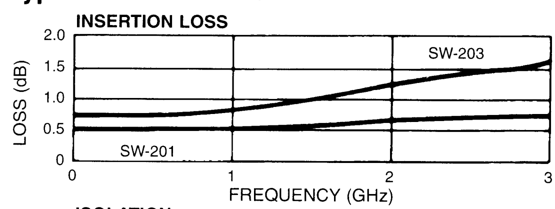
Model No.	Package
SW-201 PIN	TO-5-3
SW-203 PIN	TO-5-3

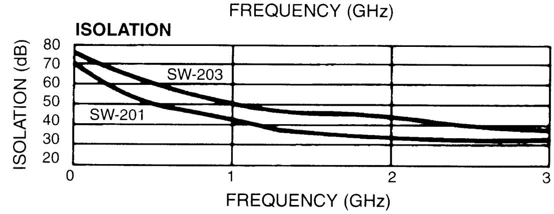
TO-5-3

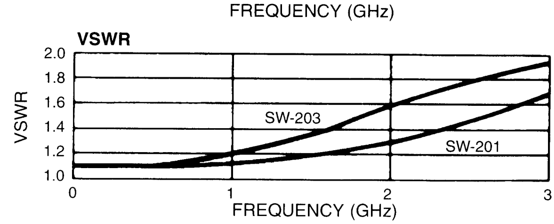


Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

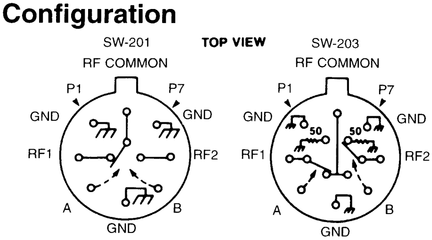
Typical Performance







Pin Configuration



Truth Table**

Control Input		Condition of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	ON
Low	Hi	OFF	ON

Specifications Subject to Change Without Notice.

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GaAs SPDT Switch DC-3 GHz

SW-202/204

V 2.00

Features

- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-202), Terminated (SW-204)

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range				DC - 3 GHz
Model Number		**SW-202**	**SW-204**	
Insertion Loss	DC-3 GHz	1.0	1.5	dB Max
	DC-2 GHz	0.9	1.2	dB Max
	DC-1 GHz	0.7	1.0	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-3 GHz	2.0:1	2.0:1	Max
	DC-2 GHz	1.5:1	1.5:1	Max
	DC-1 GHz	1.3:1	1.4:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	Max
Isolation	DC-3 GHz	22	28	dB Min
	DC-2 GHz	28	35	dB Min
	DC-1 GHz	38	45	dB Min
	DC-0.5 GHz	45	45	dB Min

Operating Characteristics

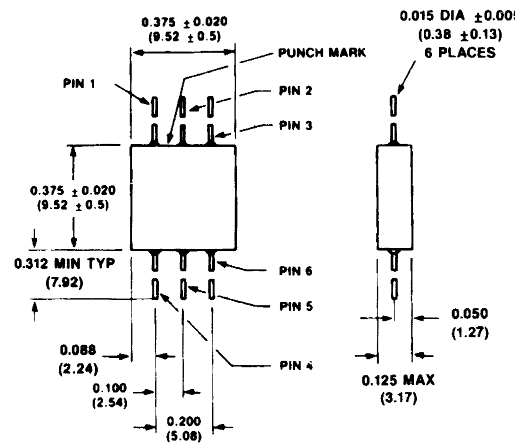
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			3 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-204			30 mV Typ
Transients (In-Band) SW-202			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low (SW-202/204)			0 to -0.2V @ 20 μA Max
V_{IN} Hi (SW-202)			-5V @ 50 μA Typ to -8V @ 300 μA Max
V_{IN} Hi (SW-204)			-5V @ 110 μA Typ to -8V @ 600 μA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 VDC control voltages.

† Faster switching speed can be achieved with enhanced driver waveform.

** For the SW-202 only, when an RF output is 'OFF" it is shorted to case ground.

FP-13



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Model No.		Package
SW-202	PIN	Flatpack
SW-204	PIN	Flatpack

Specifications Subject to Change Without Notice.

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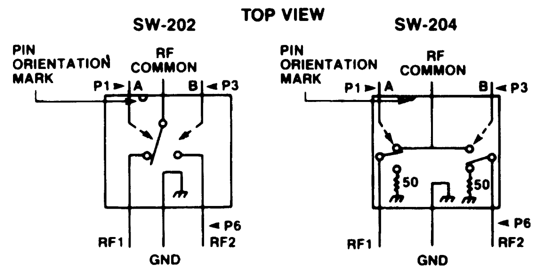
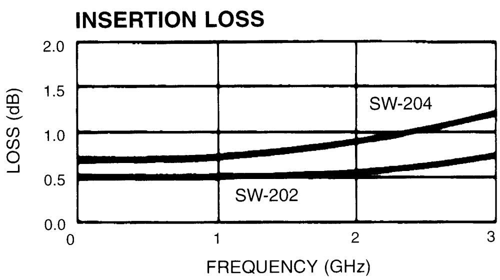
Truth Table**

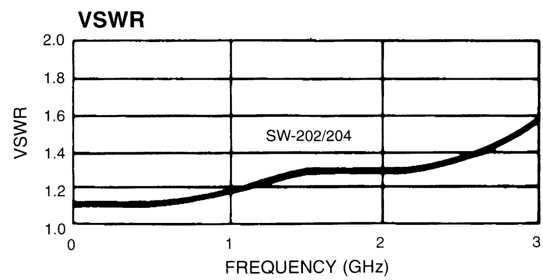
Control Input		Condition of Switch	
		RF Common To Each RF PORT	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

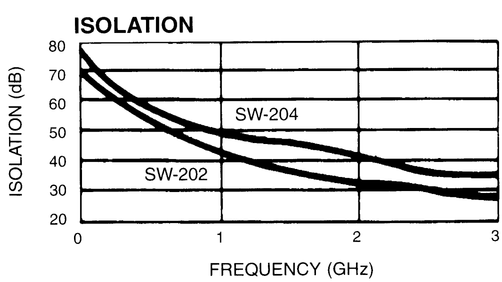
Pin Configuration



Typical Performance @ +25°C







M/A-COM an AMP company

Matched GaAs SPDT Switch 5 - 3000 MHz

SW-205/206

V 2.03

Features

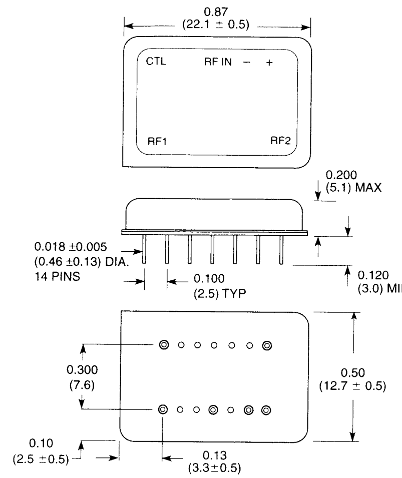
- High Isolation, 50 dB Typical
- Fast Switching Speed
- Low DC Power Consumption
- Integral TTL (SW-205) or CMOS (SW-206) Driver

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		5 - 3000 MHz
Insertion Loss	5-3000 MHz	2.6 dB Max
	5-2000 MHz	2.1 dB Max
	5-1000 MHz	1.6 dB Max
VSWR	5-3000 MHz	2.5:1 Max
	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.5:1 Max
Isolation	5-3000 MHz	35 dB Min
	5-2000 MHz	40 dB Min
	5-1000 MHz	45 dB Min

DI-1



Dimensions in ( ) are in mm.
Unless Otherwise Noted:
.xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics		**SW-205 (TTL)**	**SW-206 (CMOS)**
Trise, Tfall		7 ns	20 ns Typ
Ton, Toff (50% CTL to 90/10%RF)		20 ns	40 ns Typ
Transients (In-Band)		70 mV	35 mV Typ
Input Power for 1 dB Compression			
Model #'s	SW-205	SW-206	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-4 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Bias Power			
SW-205			+5 VDC @ 1 mA Max
SW-206			+5 to +8 VDC @ 0.150 to 0.400 mA Typ, 1 mA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply when operated with bias voltages of +5 VDC (SW-205) or + 8 VDC (SW-206) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-205 PIN	Dual Inline
SW-206 PIN	Dual Inline

Specifications Subject to Change Without Notice.

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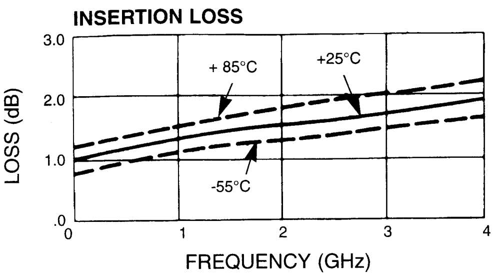
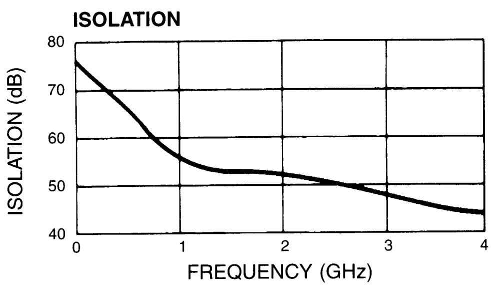
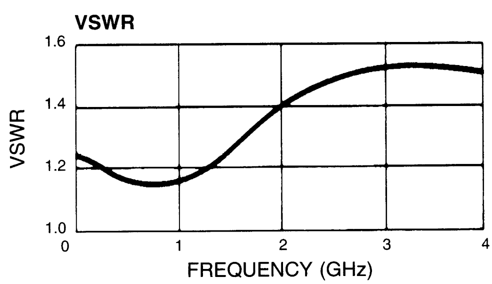
Typical Performance



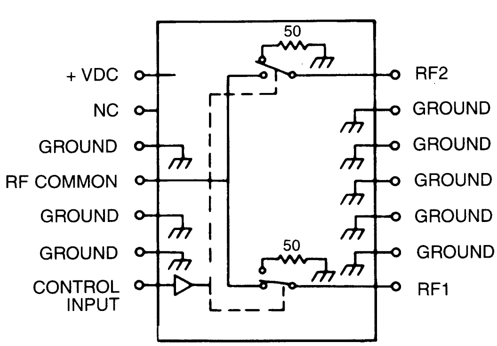




Truth Table

Control Input	Condition of Switch	
"1" = Logic High TTL(SW-205)/CMOS(SW-206)	RF Common To Each RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Schematic



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an AMP company

Matched GaAs SPST Switch
DC - 3 GHz

SW-209

V 2.00

Features

- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.180" (4.6mm) Sq.

Guaranteed Specifications[1] (-55°C to + 85°C)

Frequency Range		DC – 3.0 GHz
Insertion Loss	DC – 3.0 GHz	1.5 dB Max
	DC – 2.0 GHz	1.2 dB Max
	DC – 1.0 GHz	1.1 dB Max
	DC – 0.5 GHz	0.9 dB Max
VSWR	DC – 3.0 GHz	1.6:1 Max
	DC – 2.0 GHz	1.5:1 Max
	DC – 1.0 GHz	1.2:1 Max
	DC – 0.5 GHz	1.2:1 Max
Isolation	DC – 3.0 GHz	27 dB Min
	DC – 2.0 GHz	32 dB Min
	DC – 1.0 GHz	40 dB Min
	DC – 0.5 GHz	45 dB Min

Operating Characteristics

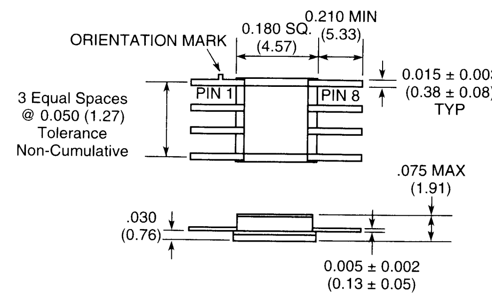
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall}			3 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			6 ns Typ
Transients (In-Band)			30 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 – 3.0 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 – 3.0 GHz	+62	+40	dBm Typ
0.05 GHz	+68	+46	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0 to -0.2V @ 20 µA Max
Vin High			-5V @ 50 µA Typ to -8V @ 300 µA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.

Ordering Information

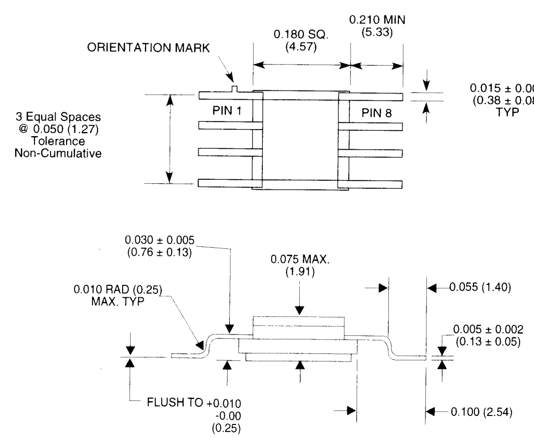
Model No.		Package
SW-209	PIN	Ceramic (CR-3)
SW-209B	PIN	Screened To MIL-STD-883C, Method 5008.4, Table VII, Class B Hybrid
SW-209G	PIN	Ceramic Gull Winged (CR-10)

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

CR-10



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = 0.02 (.x = ±0.5)

Specifications Subject to Change Without Notice.

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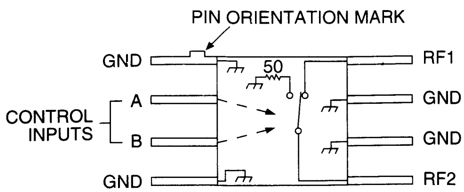
Functional Schematic



Bottom of case is AC Ground.

Absolute Maximum Ratings

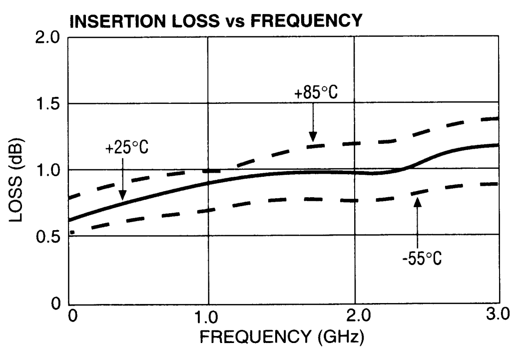
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125°C
Storage Temperature	–65˚C to +150˚C

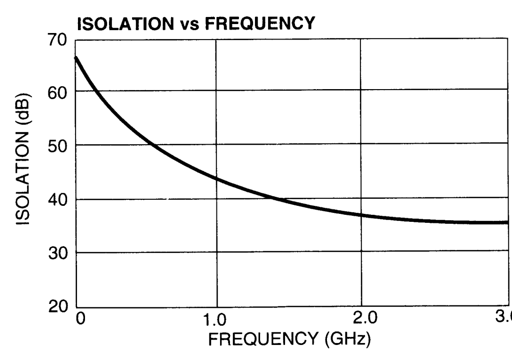
1. Operation of this device above any one of these parameters may cause permanent damage.

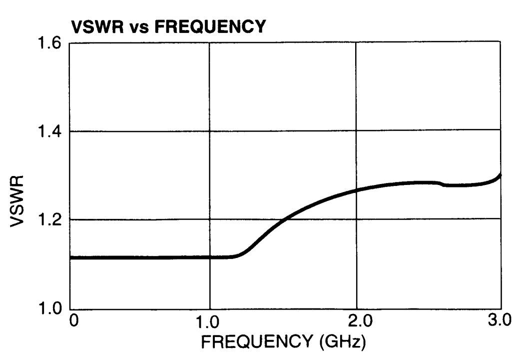
Truth Table

Control Input		Condition of Switch
A	B	RF1 to RF2
High	Low	ON
Low	High	OFF

Typical Performance







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GaAs SPST Switch DC-3 GHz

SW-211/213

V 2.00

Features

- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-211), Terminated (SW-213)

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range				DC-3 GHz
Model Number		SW-211	SW-213	
Insertion Loss	DC-2 GHz	0.9	1.2	dB Max
	DC-1 GHz	0.8	1.0	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-2 GHz	1.6:1	1.6:1	Max
	DC-1 GHz	1.4:1	1.5:1	Max
	DC-0.5 GHz	1.2:1	1.3:1	Max
Isolation	DC-2 GHz	27	38	dB Min
	DC-1 GHz	35	45	dB Min
	DC-0.5 GHz	43	50	dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			3 ns Typ
Ton, Toff (50% CTL to 90/10%RF)			6 ns Typ
Transients (In-Band) SW-213			30 mV Typ
Transients (In-Band) SW-211			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to -0.2V @ 20 μA Max
V_{IN} Hi			-5 V @ 50 μA Typ to -8V @ 300 μA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 VDC control voltages.

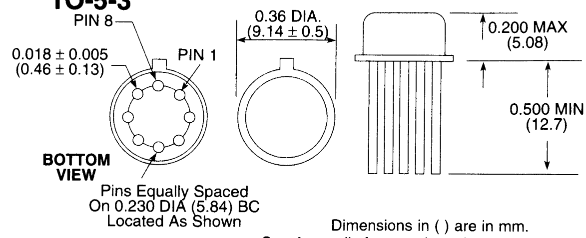
† Faster switching speed can be achieved with enhanced driver waveform.

** For the 'off' switch condition of the SW-211 only, RF1 is an open circuit and RF2 is shorted to case ground.

Truth Table**

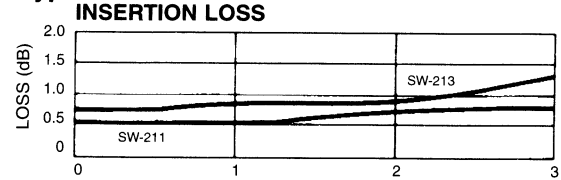
Control Input		Condition of Switch
A	B	RF1 To RF2
Hi	Low	ON
Low	Hi	OFF

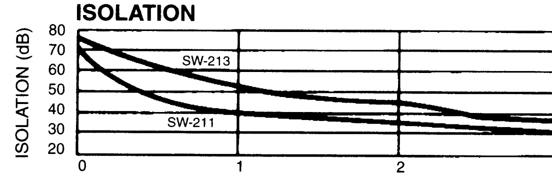
TO-5-3

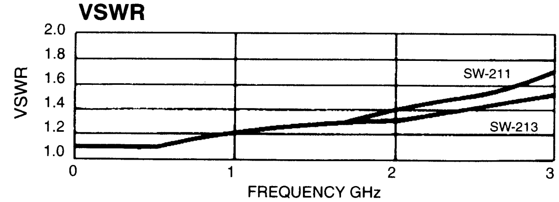


Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

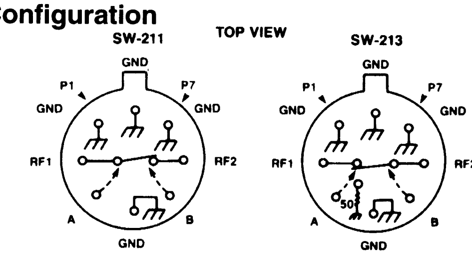
Typical Performance







Pin Configuration



Ordering Information

Model No.		Package
SW-211	PIN	TO-5-3
SW-213	PIN	TO-5-3

Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

GaAs SPST Switch DC-3 GHz

SW-212/214

V 2.00

Features

- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-212), Terminated (SW-214)

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range				DC-3 GHz
Model Number		**SW-212**	**SW-214**	
Insertion Loss	DC-3 GHz	1.0	1.3	dB Max
	DC-2 GHz	0.9	1.2	dB Max
	DC-1 GHz	0.7	0.9	dB Max
	DC-0.5 GHz	0.7	0.9	dB Max
VSWR	DC-3 GHz	1.8:1	2.0:1	Max
	DC-2 GHz	1.5:1	1.7:1	Max
	DC-1 GHz	1.3:1	1.3:1	Max
	DC-0.5 GHz	1.2:1	1.3:1	Max
Isolation	DC-3 GHz	20	25	dB Min
	DC-2 GHz	22	38	dB Min
	DC-1 GHz	32	45	dB Min
	DC-0.5 GHz	40	50	dB Min

Operating Characteristics

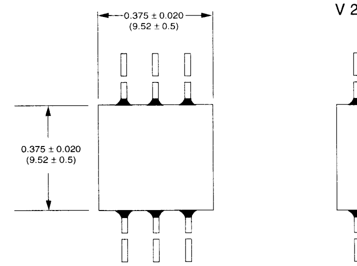
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			3 ns Typ
Ton, Toff (50% CTL to 90/10%RF)			6 ns Typ
Transients (In-Band) SW-214			30 mV Typ
Transients (In-Band) SW-212			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to @ -0.2V @ 20 µA Max
V_{IN} Hi			-5V @ 50 µA Typ to -8V @ 300 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 VDC control voltages.
† Faster switching speed can be achieved with enhanced driver waveform.
** For the 'off' switch condition of the SW-212 only, RF1 is an open circuit and RF2 is shorted to case ground.

Truth Table**

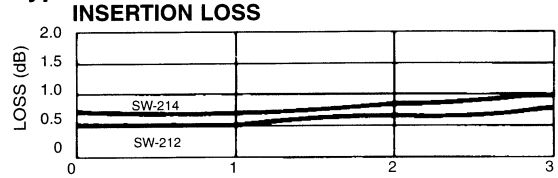
Control Input		Condition of Switch
A	B	RF1 to RF2
Hi	Low	ON
Low	Hi	OFF

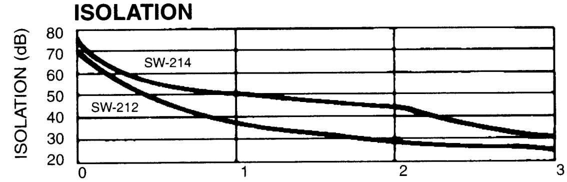
FP-13

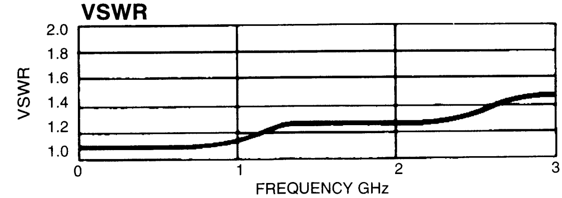


Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance

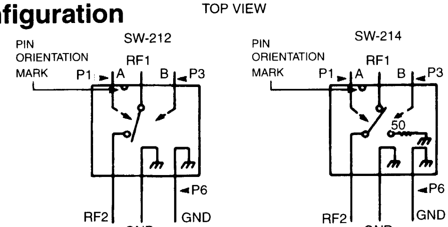






Pin Configuration

TOP VIEW



Ordering Information

Model No.	Package
SW-212 PIN	Flatpack
SW-214 PIN	Flatpack

Specifications Subject to Change Without Notice.

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M/A-COM
an AMP company

Matched GaAs SPST Switch 5 - 3000 MHz

SW-215/216

V 2.00

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07 mA Typical
- Integral TTL (SW-215) or CMOS (SW-216) Driver

Guaranteed Specifications *(From -55°C to +85°C)

Frequency Range		5-3000 MHz
Insertion Loss	5-3000 MHz	2.9 dB Max
	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5-500 MHz	1.1 dB Max
VSWR	5-3000 MHz	2.0:1 Max
	5-2000 MHz	1.9:1 Max
	5-1000 MHz	1.4:1 Max
	5-500 MHz	1.25:1 Max
Isolation	5-3000 MHz	27 dB Min
	5-2000 MHz	45 dB Min
	5-1000 MHz	55 dB Min
	5-500 MHz	60 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics	**SW-215 (TTL)**	**SW-216 (CMOS)**	
Trise, Tfall	7 ns Typ	20 ns Typ	
Ton, Toff (50% CTL to 90/10% RF)	20 ns Typ	40 ns Typ	
Transients (In-Band)	70 mV Typ	35 mV Typ	

Input Power for 1 dB Compression

Model #'s	SW-215	SW-216	
500-4000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point
(for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-4000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

SW-215	+5 VDC @ 0.07 mA Typ, 1 mA Max
SW-216	+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1 mA Max

Environmental

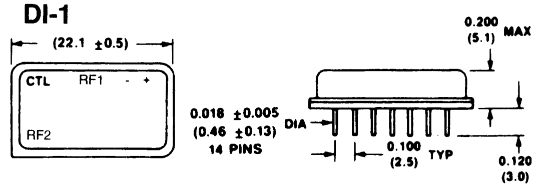
See Appendix for MIL-STD-883 screening option.

* All specifications apply when operated with bias voltages of +5 VDC (SW 215) or +8 VDC (SW-216) and 50 ohm impedance at all RF ports.

Ordering Information

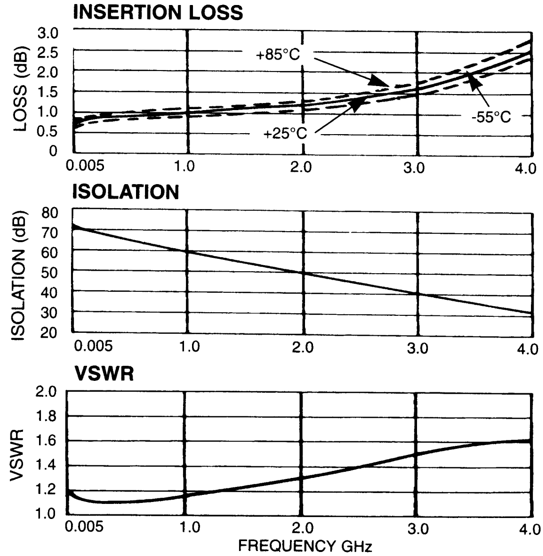
Model No.	Package
SW-215 PIN	Dual Inline
SW-216 PIN	Dual Inline

DI-1

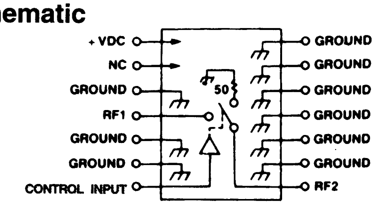


Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input	Condition of Switch
"1" = Logic High TTL(SW-215)/CMOS(SW-216)	RF1 to RF2
1	ON
0	OFF

Specifications Subject to Change Without Notice.

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GaAs SPDT Switch 5-2000 MHz

SW-217

V 2.00

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20ns Typical
- Ultra Low DC Power Consumption, 0.12 mA Typical
- Integral TTL Driver

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5-500 MHz	1.1 dB Max
VSWR	5-2000 MHz	1.8:1 Max
	5-1000 MHz	1.4:1 Max
	5-500 MHz	1.25:1 Max
Isolation	5-2000 MHz	40 dB Min
	5-1000 MHz	45 dB Min
	5-500 MHz	53 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			**(TTL)**
Trise, Tfall			7 ns Typ
Ton, Toff (50% CTL to 90/10%RF)			20 ns Typ
Transients (In-Band)			100 mV Typ
Input Power for 1 dB Compression			
500-2000 MHz			+27 dBm Typ
50 MHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
+5 VDC @ 0.12 mA Typ, 1 mA Max			

Environmental

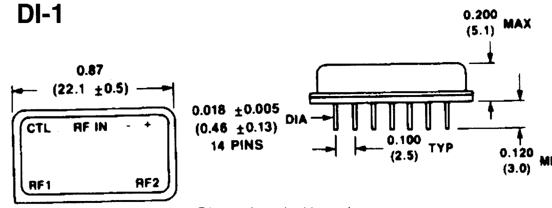
See Appendix for MIL-STD-883 screening option.

* All specifications apply when operated with bias voltages of +5 VDC (SW 218) and 50 ohm impedance at all RF ports.

Truth Table

Control Input	Condition of Switch	
"1" = Logic High TTL(SW-217)/CMOS(SW-218)	RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

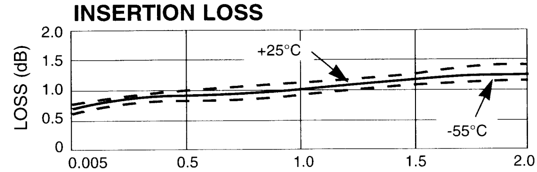
DI-1



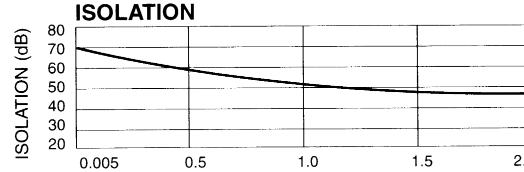
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance

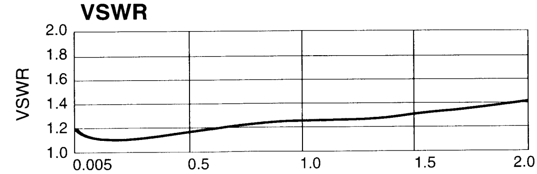
INSERTION LOSS



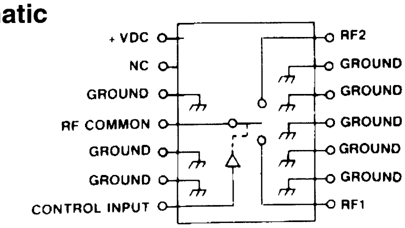
ISOLATION



VSWR



Schematic



Ordering Information

Model No.	Package
SW-217 PIN	Dual Inline

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an AMP company

GaAs SPDT RF Switch
DC - 3 GHz

SW-219

V 2.00

Features

- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.180" (4.6mm) Sq.

Guaranteed Specifications[1] (-55°C to +85°C)

Frequency Range		DC – 3.0 GHz
Insertion Loss	DC – 3.0 GHz	0.9 dB Max
	DC – 2.0 GHz	0.8 dB Max
	DC – 1.0 GHz	0.8 dB Max
	DC – 0.5 GHz	0.7 dB Max
VSWR	DC – 3.0 GHz	1.6:1 Max
	DC – 2.0 GHz	1.3:1 Max
	DC – 1.0 GHz	1.2:1 Max
	DC – 0.5 GHz	1.2:1 Max
Isolation	DC – 3.0 GHz	23 dB Min
	DC – 2.0 GHz	28 dB Min
	DC – 1.0 GHz	38 dB Min
	DC – 0.5 GHz	43 dB Min

Operating Characteristics

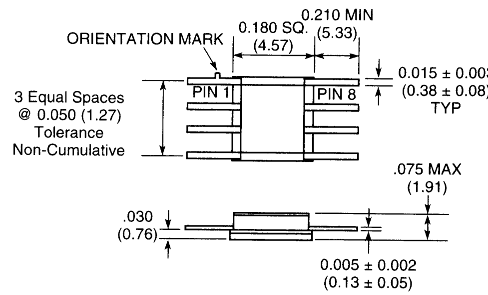
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall}			3 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			6 ns Typ
Transients (In-Band)			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 – 3.0 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 – 3.0 GHz	+62	+40	dBm Typ
0.05 GHz	+68	+46	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0 to -0.2V @ 20 µA Max
Vin High			-5V @ 50 µA Typ to -8V @ 300 µA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.
2. See Appendix for MIL-STD-883 screening option.

Ordering Information

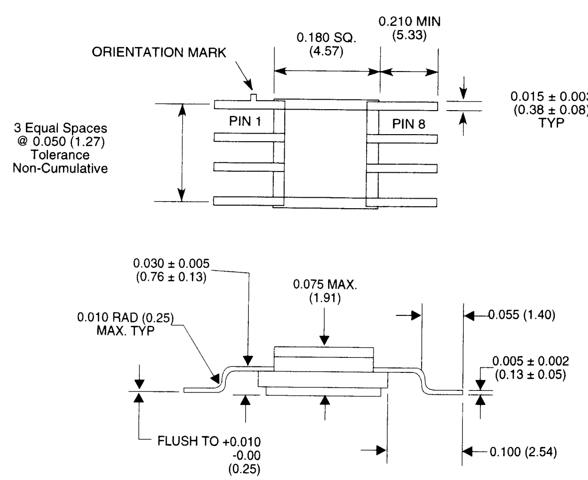
Part Number	Package
SW-219 PIN	Ceramic (CR-3)
SW-219G PIN	Ceramic Gull Winged (CR-10)
SW-219B PIN	Screened to MIL-STD-883C, Method 5008.4, Table VII Class B Hybrid (CR-3)

CR-3



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

CR-10



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = 0.02 (.x = ±0.5)

Specifications Subject to Change Without Notice.

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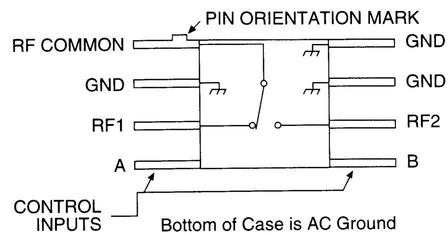
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55˚C to +125°C
Storage Temperature	–65˚C to +150˚C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic

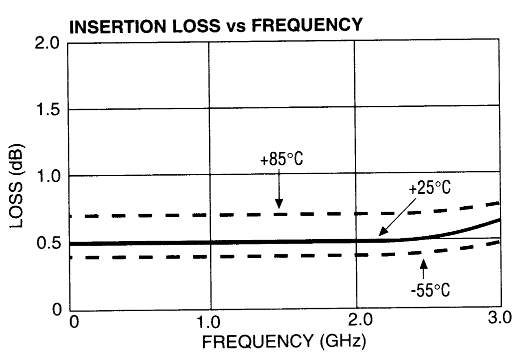


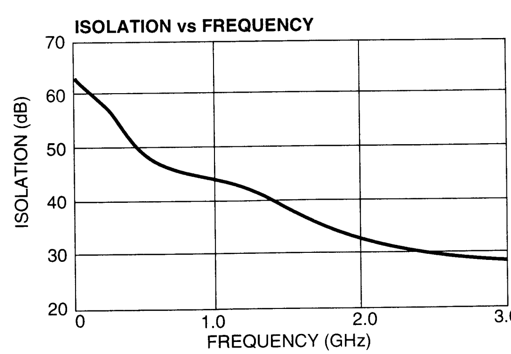
Truth Table

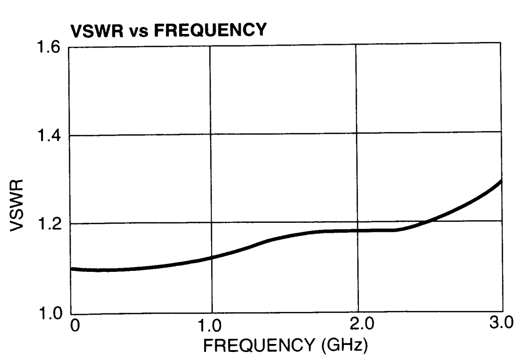
Control Input		Condition of Switch	
		RF Common to each RF Port	
A	B	RF1	RF2
High	Low	ON	OFF
Low	High	OFF	ON

When an RF output is off, it is shorted to ground.

Typical Performance







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GaAs SPST Switch DC-4 GHz

SW-221/222/223

V 2.00

Features

- Miniature Ceramic Package
- Terminated (SW-221), High Isolation (SW-222), Low Loss (SW-223)
- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range					DC-4 GHz
Model Number		**SW-221**	**SW-222**	**SW-223**	
Insertion Loss	DC-4 GHz	1.2	1.2	1.0	dB Max
	DC-2 GHz	1.0	1.0	0.8	dB Max
	DC-1 GHz	0.9	0.9	0.7	dB Max
	DC-0.5 GHz	0.9	0.9	0.7	dB Max
VSWR	DC-4 GHz	1.9:1	1.6:1	1.8:1	Max
	DC-2 GHz	1.4:1	1.4:1	1.3:1	Max
	DC-1 GHz	1.2:1	1.2:1	1.2:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	1.2:1	Max
Isolation	DC-4 GHz	22	32	22	dB Min
	DC-2 GHz	40	45	28	dB Min
	DC-1 GHz	55	55	38	dB Min
	DC-0.5 GHz	60	65	45	dB Min

Operating Characteristics

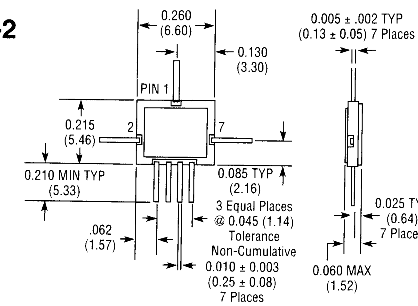
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			3 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-221/222			30 mV Typ
Transients (In-Band) SW-223			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0 /-8	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-4 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to -0.2V @ 20 µA Max
V_{IN} Hi			-5V @ 50 µA Typ to -8V @ 300 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 VDC Control Voltages.
† Faster switching speed can be achieved with enhanced driver waveform.
** For the SW-222 and SW-223 only. RF1 is an open circuit and RF2 is shorted to case ground for the "OFF" switch condition.

Ordering Information

Model No.	Package
SW-221 PIN	Ceramic
SW-222 PIN	Ceramic
SW-223 PIN	Ceramic

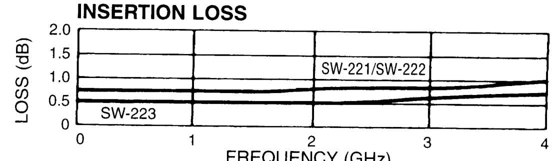
CR-2



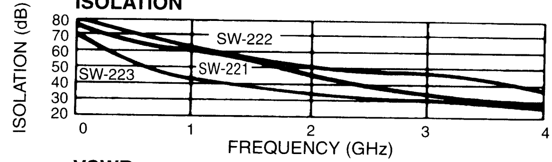
Dimensions in ( ) are in mm.
Bottom of Case is AC Ground.

Typical Performance

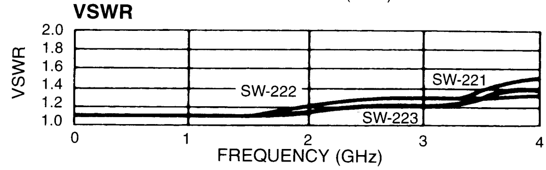
INSERTION LOSS



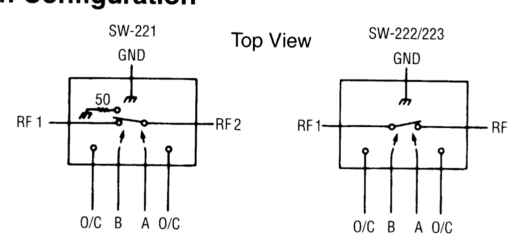
ISOLATION



VSWR



Pin Configuration



Truth Table

Control Input		Condition of Switch
A	**B**	**RF1 to RF2**
Hi	Low	ON
Low	Hi	OFF

Specifications Subject to Change Without Notice.

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GaAs SPDT Switch DC-2 GHz

SW-224/225

V 2.01

Features

- Low Insertion Loss, 0.5 dB Typical
- Integral TTL Driver
- Low DC Power Consumption

Guaranteed Specifications *
(From -55°C to +85°C)

Frequency Range		**DC-2 GHz**
Insertion Loss	DC-2 GHz	0.8 dB Max
	DC-1 GHz	0.7 dB Max
	DC-0.5 GHz	0.7 dB Max
VSWR	DC-2 GHz	1.5:1 Max
	DC-1 GHz	1.25:1 Max
	DC-0.5 GHz	1.15:1 Max
Isolation	DC-2 GHz	30 dB Min
	DC-1 GHz	35 dB Min
	DC-0.5 GHz	40 dB Min

Operating Characteristics

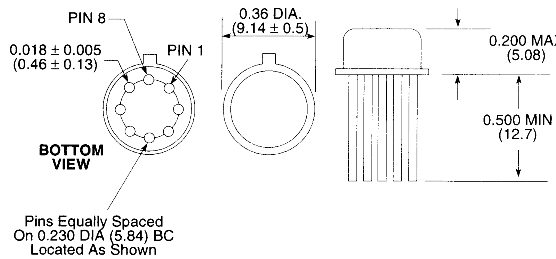
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			10 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			150 ns Typ
Transients (In-Band)			15 mV Typ
Input Power for 1 dB Compression			
0.5-2 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5-2 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Bias Power			+5 VDC @ 1 mA Max
			-5 VDC @ 1 mA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply when operated with bias voltages of +5 VDC and -5 VDC and 50 ohm impedance at all RF ports.

Ordering Information

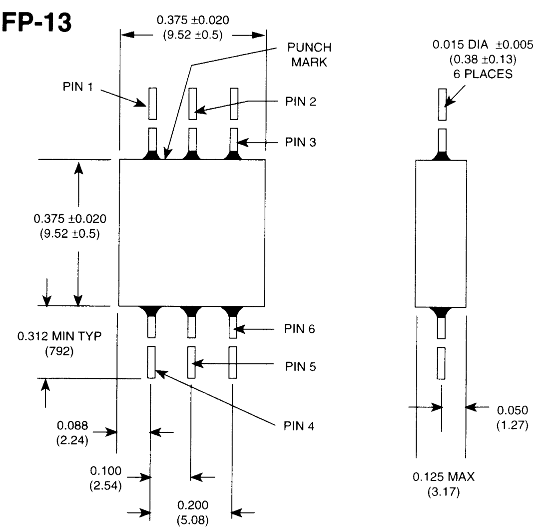
Model No.		Package
SW-224	PIN	TO-5-3
SW-225	PIN	Flatpack

TO-5-3



Bottom of Case is AC Ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)
WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

FP-13



Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice.

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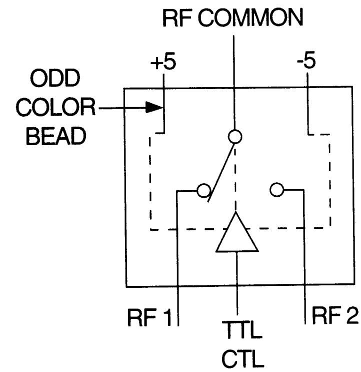
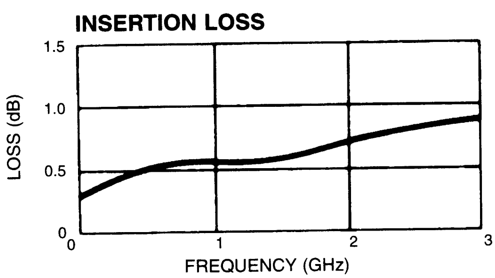
Truth Table

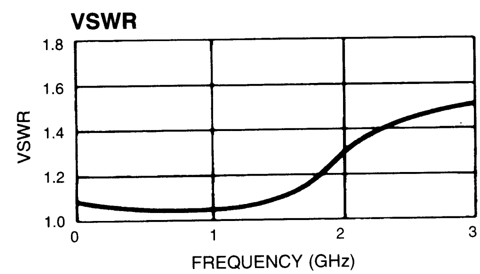
TTL Control Input	Condition of Switch	
"1" = TTL Logic High	RF Common To Each RF Port	
	RF1	RF2
1	ON	OFF
0	OFF	ON

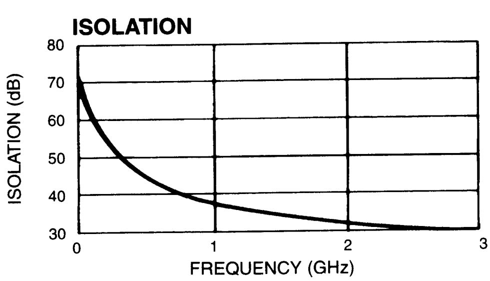
Pin Configuration



Typical Performance







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an AMP company

GaAs SPDT Switch DC-4 GHz

SW-226/227/228

V 2.01

Features

- Miniature Ceramic Package
- Terminated (SE-226), High Isolation (SW-227), Low Loss (SW-228)
- Fast Switching Speed, 6 ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range					DC-4 GHz
Model Number		**SW-226**	**SW-227**	**SW-228**	
Insertion Loss	DC-4 GHz	1.5	1.4	1.0	dB Max
	DC-2 GHz	1.2	1.1	0.8	dB Max
	DC-1 GHz	1.0	1.0	0.7	dB Max
	DC-0.5 GHz	0.9	0.9	0.7	dB Max
VSWR	DC-4 GHz	2.3:1	2.0:1	1.9:1	Max
	DC-2 GHz	1.6:1	1.6:1	1.3:1	Max
	DC-1 GHz	1.4:1	1.4:1	1.2:1	Max
	DC-0.5 GHz	1.2:1	1.2:1	1.2:1	Max
Isolation	DC-4 GHz	25	35	22	dB Min
	DC-2 GHz	40	40	32	dB Min
	DC-2 GHz	48	50	42	dB Min
	DC-0.5 GHz	53	55	50	dB Min

Operating Characteristics

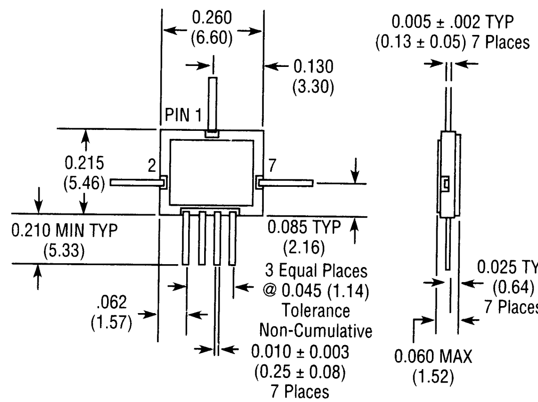
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall			3 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-226/227			30 mV Typ
Transients (In-Band) SW-228			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5-4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to + 13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 - 4 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low (SW-226/227/228)			0 to -0.2V @ 20 μA Max
V_{IN} Hi (SW-226/227)			-5V @ 110 μA Typ to -8V @ 600 μA Max
V_{IN} Hi (228)			-5V @ 50 μA Typ to -8V @ 300 μA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 VDC control voltages.

† Faster switching speed can be achieved with enhaned driver waveform.

** For the SW-227 and SW-228 only, when an RF output is 'OFF' it is shorted to case ground.

CR-2



Bottom of Case is AC Ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	**Package**
SW-226 PIN	Ceramic
SW-227 PIN	Ceramic
SW-228 PIN	Ceramic

Specifications Subject to Change Without Notice.

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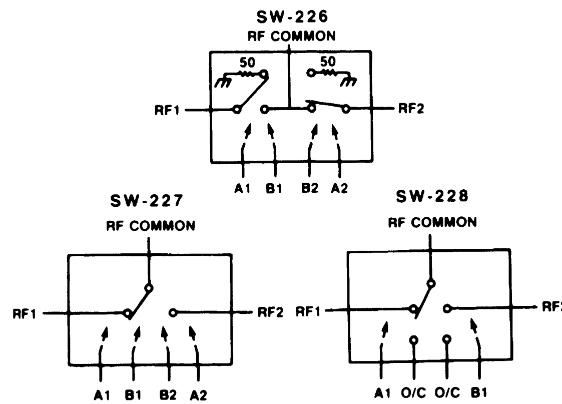
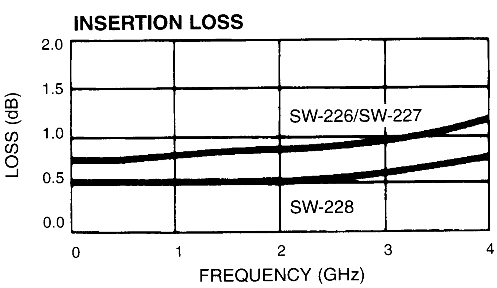
Truth Table**

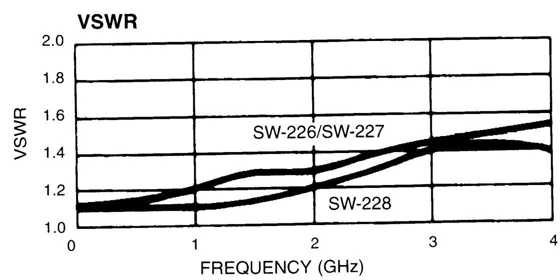
Control Input		Condition of Switch	
		RF Common To Each RF PORT	
	A1 B1 A2 B2	RF1	RF2
SW-226/227	HI LO LO HI	ON	OFF
	LO HI HI LO	OFF	ON
SW-228	HI LO NC NC	ON	OFF
	LO HI NC NC	OFF	ON

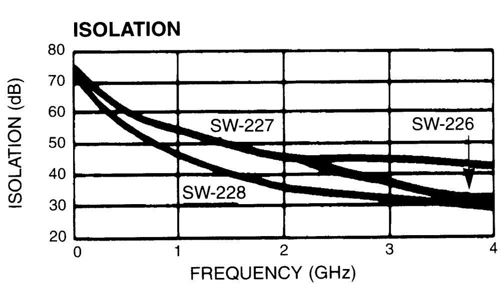
Pin Configuration



Typical Performance







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M/A-COM an AMP company

Matched GaAs SPDT Switch 5-2000 MHz

SW-233/236

V 2.01

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12 mA Typical
- Integral TTL (SW-233) or CMOS (SW-236) Driver

Guaranteed Specifications *

(From -55°C to +85°C)

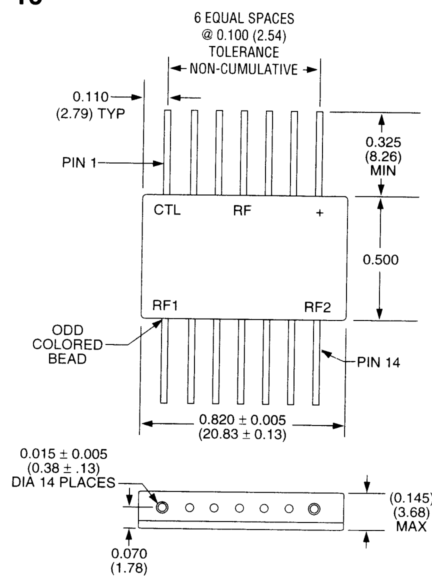
Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-2000 MHz	1.9:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	40 dB Min
	5-1000 MHz	45 dB Min
	5- 500 MHz	53 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics	**SW-233 (TTL)**		**SW-236 (CMOS)**
Trise, Tfall	7 ns		20 ns Typ
Ton, Toff (50% CTL to 90/10% RF)	20 ns		40 ns Typ
Transients (In-Band)	100 mV		70 mV Typ
Input Power for 1 dB Compression			
Model #'s	SW-233	SW-236	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to + 13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50MHz	+60	+40	dBm Typ
Bias Power			
SW-233	+5 VDC @ 0.12 mA Typ, 1 mA Max		
SW-236	+5 to +8 VDC @ 0.12 to 0.40 mA Typ, 1 mA Max		
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply when operated with bias voltages of +5 VDC (SW-233) or +8 VDC (SW-236) and 50 ohm impedance at all RF ports.

FP-16



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-233 PIN	Flatpack
SW-236 PIN	Flatpack

Specifications Subject to Change Without Notice.

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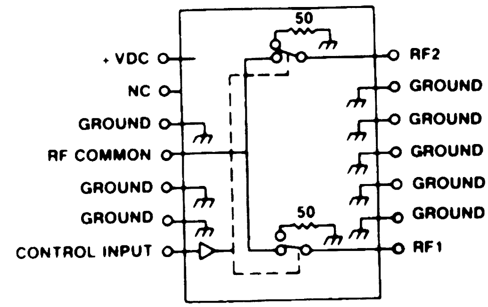
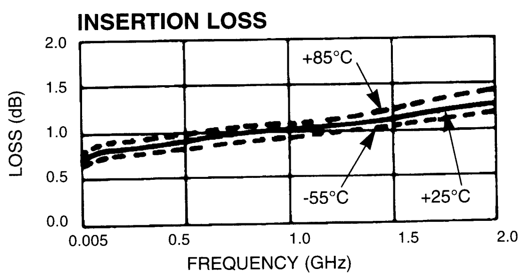
Truth Table

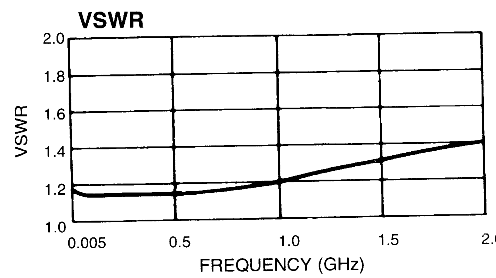
Control Input	Condition of Switch	
"1" = Logic High TTL(SW-233)/CMOS(SW-236)	RF Common To Each RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

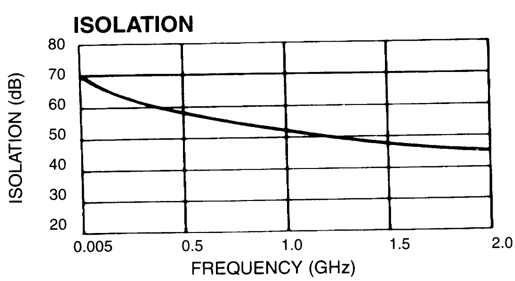
Schematic



Typical Performance







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an AMP company

GaAs SPDT Switch 5-2000 MHz

SW-237

V 2.01

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12 mA Typical
- CMOS Driver

Guaranteed Specifications *

(From -55°C to +85°C)

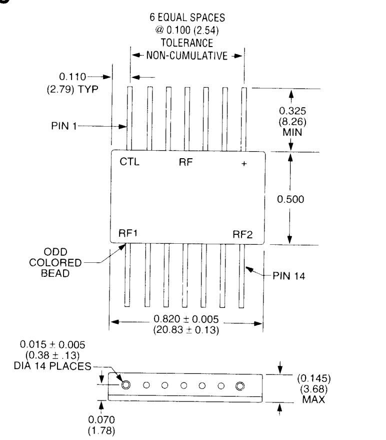
Frequency Range		5 - 2000 MHz
Insertion Loss	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-2000 MHz	1.7:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	40 dB Min
	5-1000 MHz	48 dB Min
	5- 500 MHz	53 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall			20 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			40 ns Typ
Transients (In-Band)			70 mV Typ
Input Power for 1 dB Compression			
500-2000 MHz			+33 dBm Typ
50 MHz			+26 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
+5 to +8 VDC @ 0.12 to 0.40 mA Typ, 1 mA Max			
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply when operated with bias voltages of +5 VDC (SW-234) or +8 VDC (SW-237) and 50 ohm impedance at all RF ports.

FP-16



Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-237 PIN	Flatpack

Specifications Subject to Change Without Notice.

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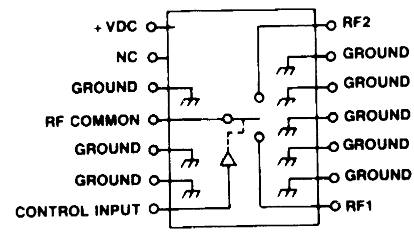
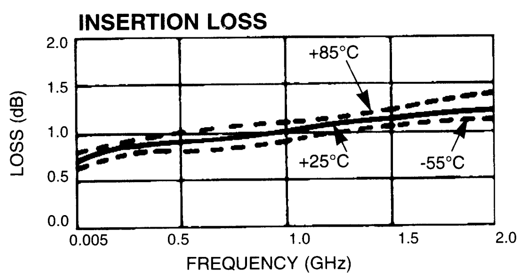
Truth Table

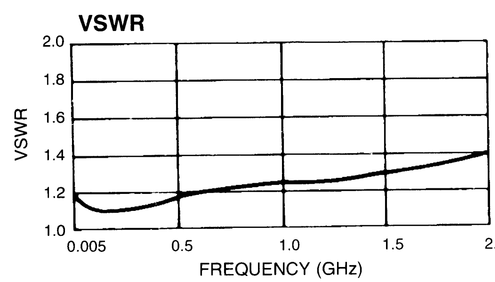
Control Input	Condition of Switch	
"1" Logic High (CMOS)	RF Common To Each RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

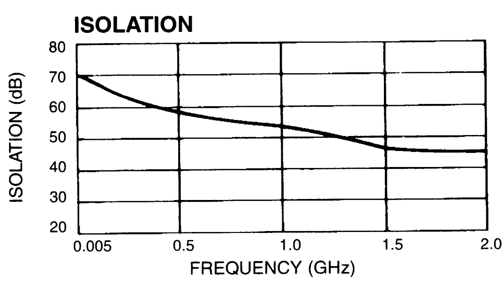
Schematic



Typical Performance







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M/A-COM an AMP company

GaAs SPDT Switch DC-2.5 GHz

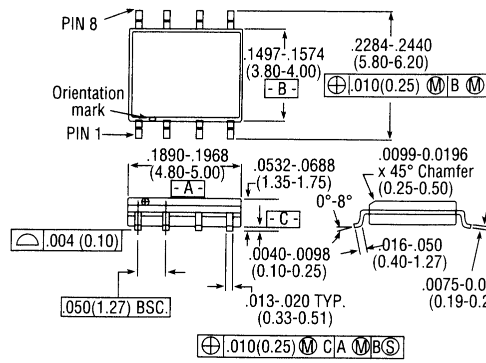
SW-239

V 2.01

Features

- Very Low Power Consumption: 50 μW
- Low Insertion Loss: 0.5 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to + 85°C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Description

M/A-COM's SW-239 is a GaAs MMIC SPDT switch in a low cost SOIC 8-LD surface mount plastic package. The SW-239 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-239 is fabricated with a monolithic GaAs MMIC using a mature 1 micron process. The process features full chip passivation for increased performance and reliability.

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.4 0.4 0.5 0.6	0.6 0.6 0.7 0.8
Isolation	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB	52 40 30 22	56 43 33 24	
VSWR	DC – 2.0 GHz		1.2:1		
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		2 4 15	
One dB Compression Point	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		21 27	
2nd Order Intercept	Measured Relative to Input Power (for two-tone input power up to +5 dbm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		55 68	
3rd Order Intercept	Measured Relative to Input Power (for two-tone input power up to +5 dbm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		40 46	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements with 0, -5V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

Ordering Information

Model No.	Package
SW-239 PIN	SOIC 8 Lead
SW-239TR	Forward Tape & Reel
SW-239RTR	Reverse Tape & Reel

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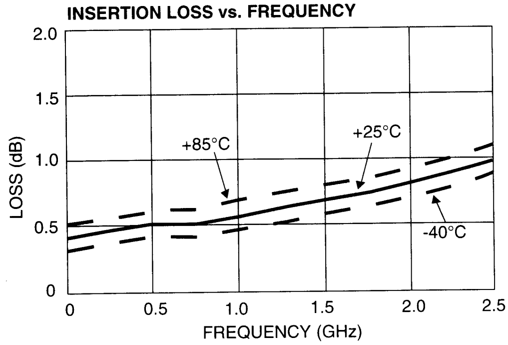
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

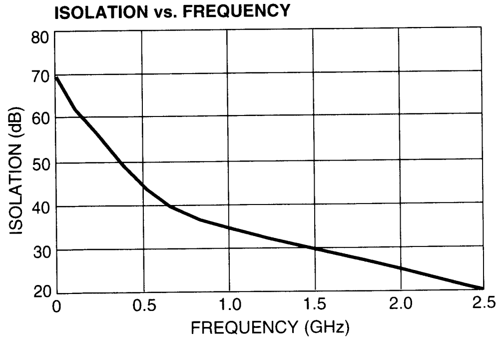
Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Typical Performance

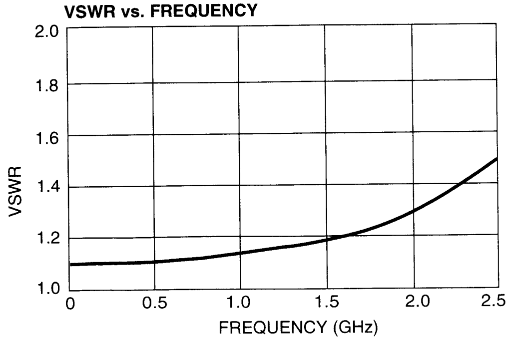
INSERTION LOSS vs. FREQUENCY



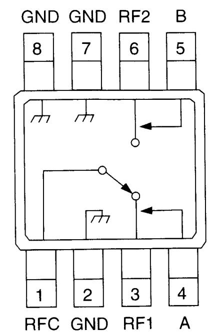
ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Functional Schematic



Pin Configuration

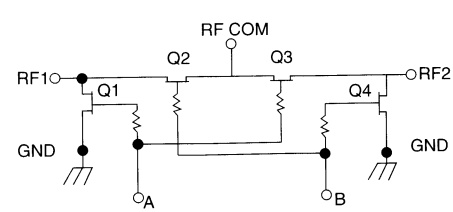
Pin No.	Description
1	RF Common
2	GND
3	RFI
4	A
5	B
6	RF2
7	GND
8	GND

Truth Table

Control Inputs		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	On	Off
0	1	Off	On

"0" – 0 – -0.2V @ 20 µA max.
"1" – -5V @ 20 µA Typ to -8V @ 480 µA max.

Electrical Schematic



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an AMP company

Matched GaAs SP3T Switch 5-2000 MHz

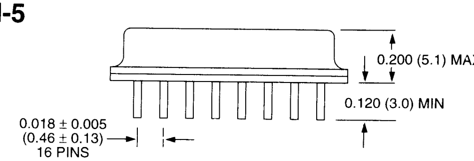
SW-241

V 2.00

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22 mA Typical
- Integral TTL Driver

DI-5



Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Guaranteed Specifications *

(From -55°C to +85°C)

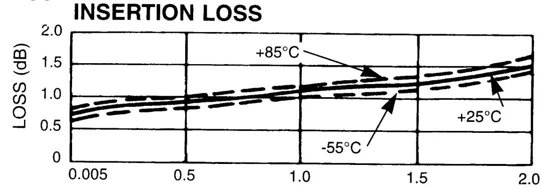
Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.5 dB Max
	5-1000 MHz	1.7 dB Max
	5- 500 MHz	1.4 dB Max
VSWR	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.6:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	45 dB Min
	5- 500 MHz	55 dB Min

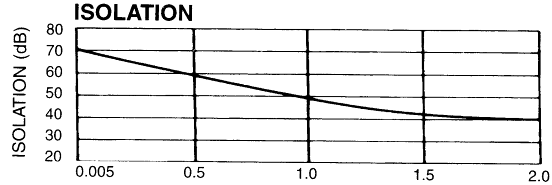
Operating Characteristics

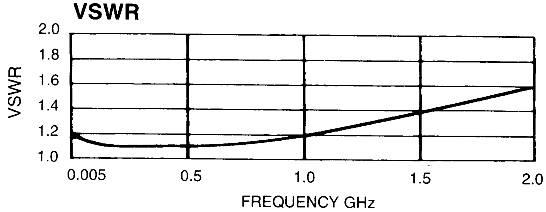
Impedance			50 Ohms Nominal
Switching Characteristics			**(TTL)**
Trise, Tfall			7 ns
Ton, Toff (50% CTL to 90/10%RF)			20 ns
Transients (In-Band)			80 mV
Input Power for 1 dB Compression			
500-2000 MHz			+27 dBm Typ
50 MHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
			+5 VDC @ 0.22 mA Typ, 1 mA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply when operated with bias voltages of +5 VDC (SW 241) and 50 ohm impedance at all RF ports.

Typical Performance



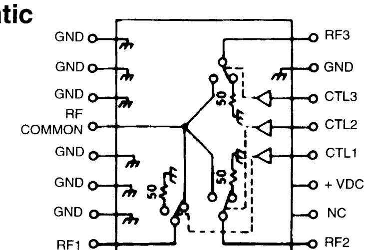




Truth Table

Control Input			Condition of Switch		
"1" = Logic High (TTL)			RF Common To Each RF Port		
CTL1	CTL2	CTL3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Schematic



Ordering Information

Model No.	Package
SW-241 PIN	Dual Inline

Specifications Subject to Change Without Notice.

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an AMP company

Matched GaAs SP4T Switch DC-4 GHz

SW-243

V 2.03

Features

- Low Insertion Loss, 0.7 dB Typical
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.250" Square

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		DC - 4 GHz
Insertion Loss	DC - 4 GHz	1.3 dB Max
	DC - 2 GHz	1.0 dB Max
	DC - 1 GHz	0.9 dB Max
	DC - 0.5 GHz	0.8 dB Max
VSWR	DC - 4 GHz	1.9:1 Max
	DC - 2 GHz	1.5:1 Max
	DC - 1 GHz	1.25:1 Max
	DC - 0.5 GHz	1.25:1 Max
Isolation	DC - 4 GHz	20 dB Min
	DC - 2 GHz	25 dB Min
	DC - 1 GHz	30 dB Min
	DC - 0.5 GHz	35 dB Min

Operating Characteristics

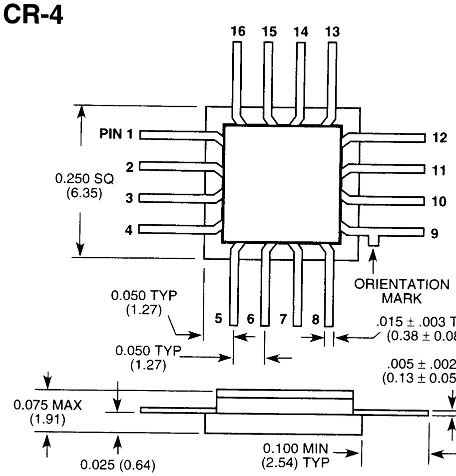
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall (10/90% or 90/10% RF)			2 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			4 ns Typ
Transients (In-Band)			25 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 to 4 GHz	+26	+32	dBm Typ
0.05 GHz	+20	+23	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 4 GHz	+68	+46	dBm Typ
0.05 GHz	+55	+37	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to -0.2 V @ 5 µA Max
V_{IN} Hi			-5V @ 10 µA Typ to -8 V @ 100 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.

† Faster switching speed can be achieved with enhanced driver waveform.

** When an RF output port is 'off' it is shorted to ground through an 'on' shunt MESFET.

CR-4



Bottom of Case is AC Ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
SW-243 PIN	Ceramic

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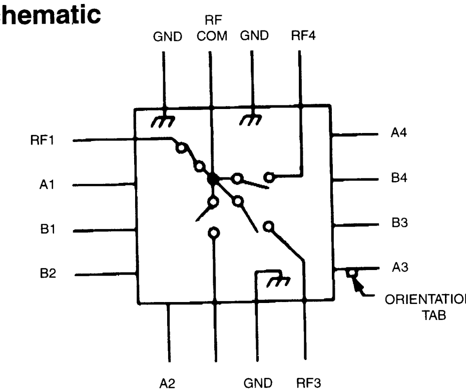
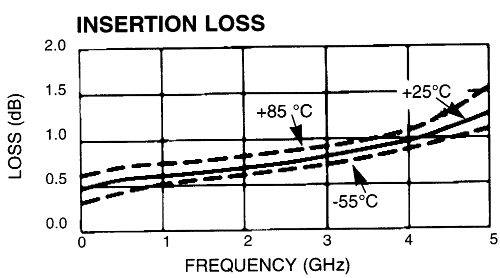
Truth Table**

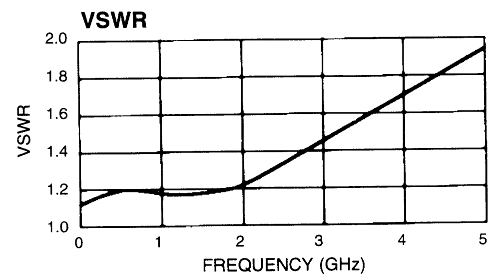
Control Input								Condition of Switch			
								RF Common To Each RF PORT			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
Hi	Lo	Lo	Hi	Lo	Hi	Lo	Hi	ON	OFF	OFF	OFF
Lo	Hi	Hi	Lo	Lo	Hi	Lo	Hi	OFF	ON	OFF	OFF
Lo	Hi	Lo	Hi	Hi	Lo	Lo	Hi	OFF	OFF	ON	OFF
Lo	Hi	Lo	Hi	Lo	Hi	Hi	Lo	OFF	OFF	OFF	ON

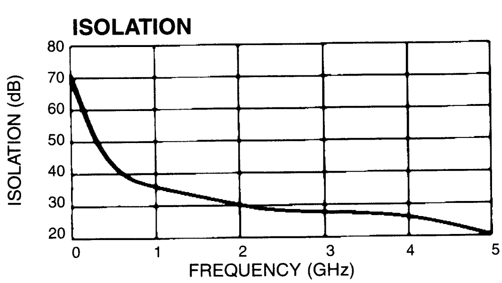
Schematic



Typical Performance







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an AMP company

Matched GaAs SP3T Switch 5-2000 MHz

SW-247/251

V 2.01

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22 mA Typical
- Integral TTL (SW-247) or CMOS (SW-251) Driver

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		5 - 2000 MHz
Insertion Loss	5-2000 MHz	1.8 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.0:1 Max
	5-1000 MHz	1.6:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	42 dB Min
	5- 500 MHz	52 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-247 (TTL)**	**SW-251 (CMOS)**
Trise, Tfall	7 ns	20 ns Typ
Ton, Toff (50% CTL to 90/10% RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-247	SW-251	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point (for two-tone input power up to +13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ

Bias Power

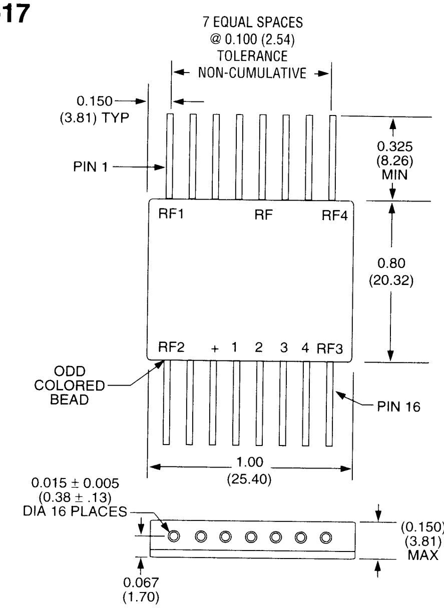
SW-247	+5 VDC @ 0.22 mA Typ, 1 mA Max
SW-251	+5 to +8 VDC @ 0.22 to 0.40 mA Typ, 1 mA Max

Environmental

See Appendix for MIL-STD-883 screening option.

* All specifications apply when operated with bias voltages of +5 VDC (SW-247) or +8 VDC (SW-251) and 50 ohm impedance at all RF ports.

FP-17



Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-247 PIN	Flatpack
SW-251 PIN	Flatpack

Specifications Subject to Change Without Notice.

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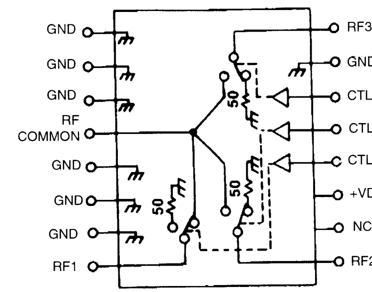
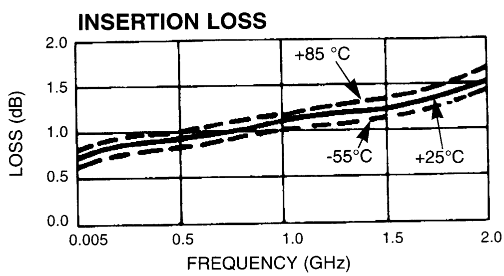
Truth Table

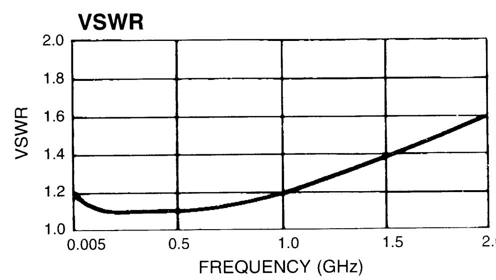
Control Input			Condition of Switch		
"1" = Logic High TTL (SW-247)/CMOS(SW-251)			RF Common To Each RF PORT		
CTL1	CTL2	CTL3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

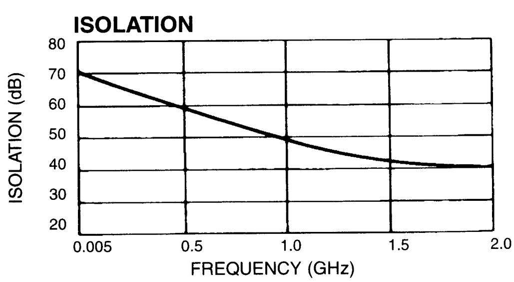
Schematic



Typical Performance







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M/A-COM an AMP company

Matched GaAs SP4T Switch 5-2000 MHz

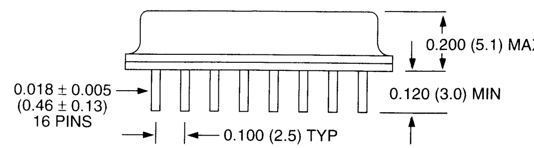
SW-254

V 2.01

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3 mA Typical
- Integral TTL Driver

DI-5



Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.1 dB Max
	5-1000 MHz	1.6 dB Max
	5-500 MHz	1.4 dB Max
VSWR	5-2000 MHz	2.3:1 Max
	5-1000 MHz	1.8:1 Max
	5-500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	36 dB Min
	5-500 MHz	42 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			**(TTL)**
Trise, Tfall			7 ns
Ton, Toff (50% CTL to 90/10% RF)			20 ns
Transients (In-Band)			80 mV
Input Power for 1 dB Compression			
500-2000 MHz			+27 dBm Typ
50 MHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
			+5 VDC @ 0.30 mA Typ, 1 mA Max

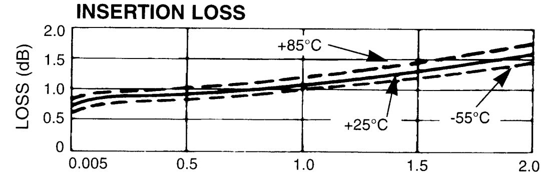
Environmental

See Appendix for MIL-STD-883 screening option.

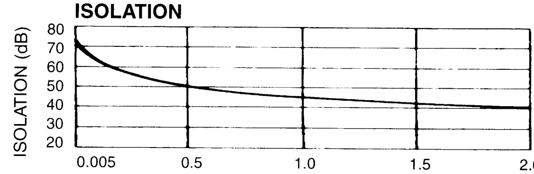
* All specifications apply when operated with bias voltage of +5 VDC and 50 ohm impedance at all RF ports.

Typical Performance

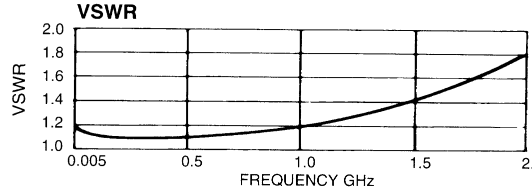
INSERTION LOSS



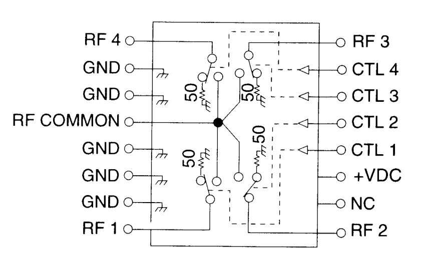
ISOLATION



VSWR



Schematic



Truth Table

Control Input "1" = Logic High TTL				Condition of Switch RF Common To Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

Ordering Information

Model No.	Package
SW-254 PIN	Dual Inline

Specifications Subject to Change Without Notice.

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M/A-COM an AMP company

GaAs SP4T Switch 5-2000 MHz

SW-255

V 2.02

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3 mA Typical
- Integral TTL Driver

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.1 dB Max
	5-1000 MHz	1.6 dB Max
	5-500 MHz	1.4 dB Max
VSWR	5-2000 MHz	2.3:1 Max
	5-1000 MHz	1.8:1 Max
	5-500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	36 dB Min
	5-500 MHz	42 dB Min

Operating Characteristics

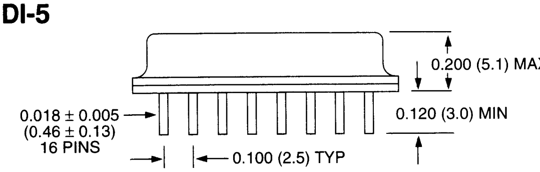
Impedance		50 Ohms Nominal
Switching Characteristics		(TTL)
Trise, Tfall		7 ns
Ton, Toff (50% CTL to 90/10% RF)		20 ns
Transients (In-Band)		80 mV
Input Power for 1 dB Compression		
500-2000 MHz		+27 dBm Typ
50 MHz		+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)		
Intercept Points	IP_2	
500-2000 MHz	+68	dBm Typ
50 MHz	+60	dBm Typ
Bias Power		
SW-255	+5 VDC @ 0.30 mA Typ, 1 mA Max	
Environmental		
See Appendix for MIL-STD-883 screening option.		

* All specifications apply when operated with bias voltage of +5 VDC (SW-255) or +8 VDC (SW-258) and 50 ohm impedance at all RF ports.

Truth Table

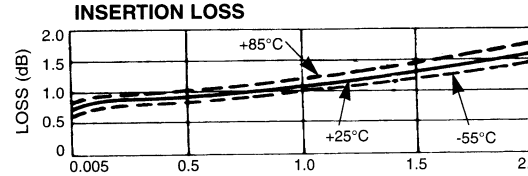
Control Input				Condition of Switch			
"1" = Logic High TTL(SW-255)/CMOS(SW-258)				RF Common To Each RF Port			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

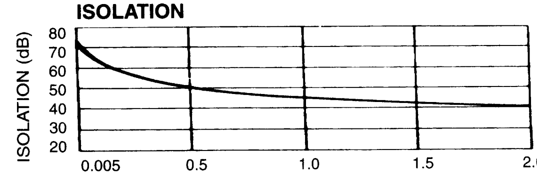
DI-5

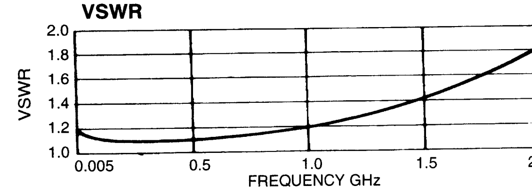


Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

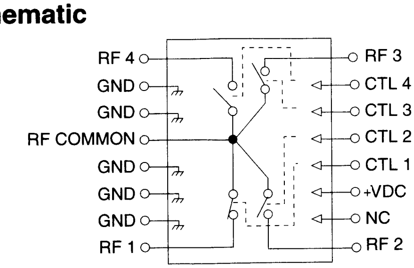
Typical Performance







Schematic



Ordering Information

Model No.	Package
SW-255 PIN	Dual Inline

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M/A-COM an AMP company

GaAs SPST Switch DC-2.5 GHz

SW-259

V 2.00

Features

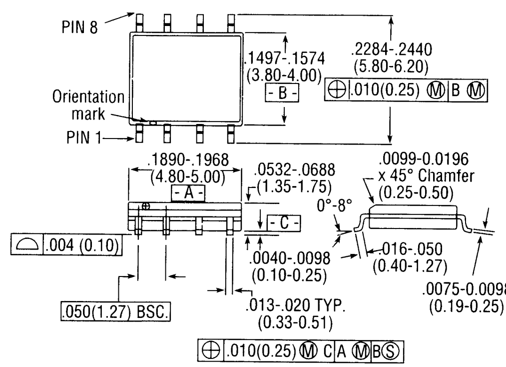
- Very Low Power Consumption: 50 μW
- Low Insertion Loss: 1.0 dB
- High Isolation: 35 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to + 85°C
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-259 is a GaAs MMIC SPST terminated switch in a low cost SOIC 8-lead surface mount plastic package. The SW-259 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-259 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-259 PIN	SOIC 8-Lead Plastic
SW-259TR	Forward Tape & Reel
SW-259RTR	Reverse Tape & Reel

Electrical Specifications, $T_A = +25°C$

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.5 0.8 1.0 1.4	0.6 1.0 1.2 1.6
Isolation	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB	62 55 45 32	65 58 48 35	
VSWR	On DC – 2.0 GHz Off DC – 2.0 GHz		1.2:1 1.2:1		
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		4 8 35	
One dB Compression Point	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		18 23	
2nd Order Intercept	Measured Relative 0.05 GHz to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		55 68	
3rd Order Intercept	Measured Relative 0.05 GHz to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		40 46	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements with 0, -5 control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

Specifications Subject to Change Without Notice.

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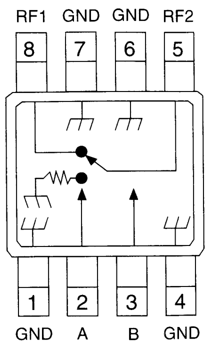
Absolute Maximum Ratings

Parameter	Absolute Maximum[1,2]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2 GHz	+34 dBm
Control Voltage	+5V, -8.5V
Storage Temperature	-65°C to 150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF Input power is applied to a terminated port, the absolute maximum is +32 dBm.

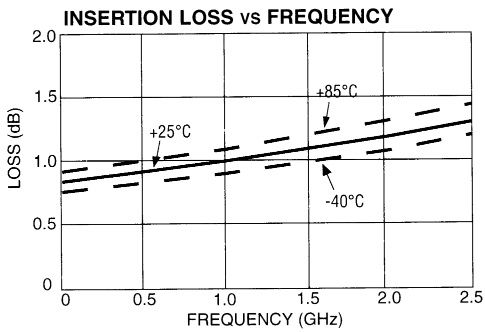
Functional Schematic

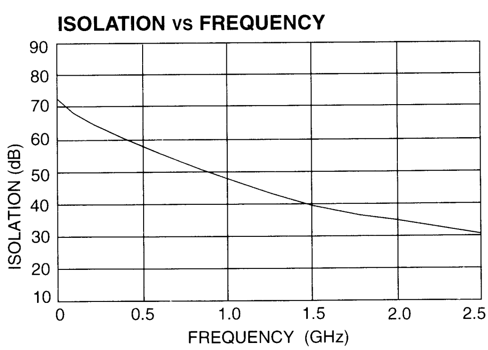


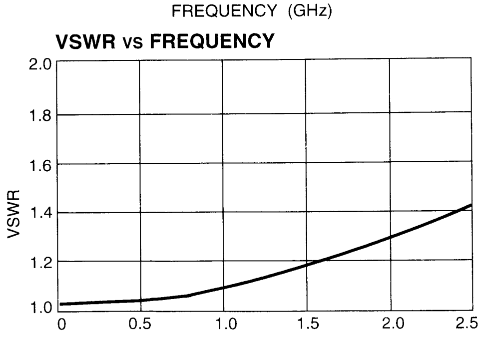
Pin Configuration

Pin No.	Description
1	GND
2	A
3	B
4	GND
5	RF2
6	GND
7	GND
8	RF1

Typical Performance





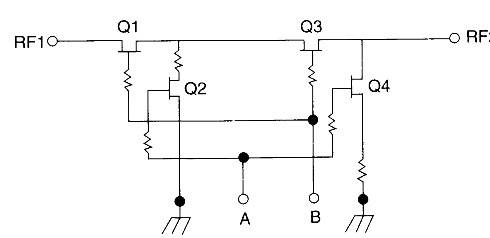


Truth Table

Control Inputs		Condition of Switch
A	B	RF STATE
1	0	On
0	1	Off

"0" – 0 – -0.2V @ 20 μA max.
"1" – -5V @ 20μA Typ to -8V @ 600 μA max.

Electrical Schematic



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an AMP company

Matched GaAs SP4T Switch 5-2000 MHz

SW-261/264

V 2.01

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3 mA Typical
- Integral TTL (SW-261) or CMOS (SW-264) Driver

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.1 dB Max
	5-1000 MHz	1.6 dB Max
	5- 500 MHz	1.4 dB Max
VSWR	5-2000 MHz	2.5:1 Max
	5-1000 MHz	1.8:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	36 dB Min
	5- 500 MHz	42 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-261 (TTL)**	**SW-264 (CMOS)**
Trise, Tfall	7 ns	20 ns Typ
Ton, Toff (50% CTL to 90/10%RF)	20 ns	40 ns Typ
Transients (In-Band)	80 mV	40 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-261	SW-264	
500-2000 MHz	+27	+33	dBm Typ
50 MHz	+21	+26	dBm Typ

Intermodulation Intercept Point
(for two-tone input power up to + 13 dBm)

Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50MHz	+60	+40	dBm Typ

Bias Power

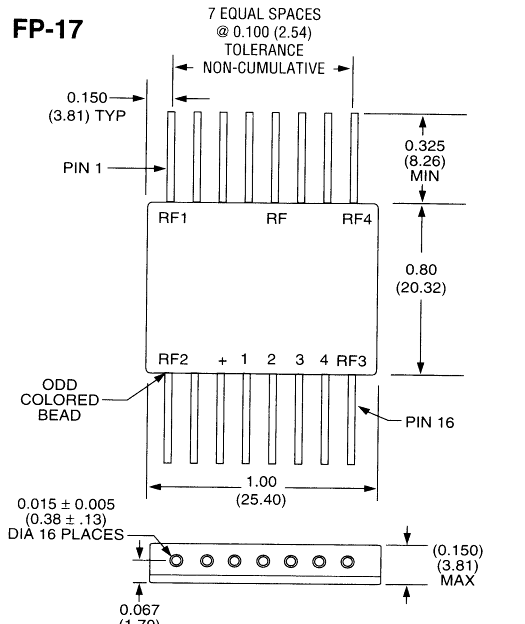
SW-261	+5 VDC @ 0.30 mA Typ, 1 mA Max
SW-264	+5 to +8 VDC @ 0.30 to 0.60 mA Typ, 1 mA Max

Environmental

See Appendix for MIL-STD-883 screening option.

* All specifications apply when operated with bias voltages of +5 VDC (SW-261) or +8 VDC (SW-264) and 50 ohm impedance at all RF ports.

FP-17



Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-261 PIN	Flatpack
SW-264 PIN	Flatpack

Specifications Subject to Change Without Notice.

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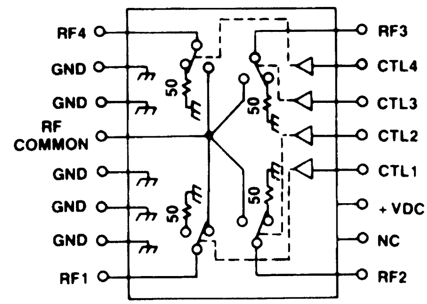
Truth Table

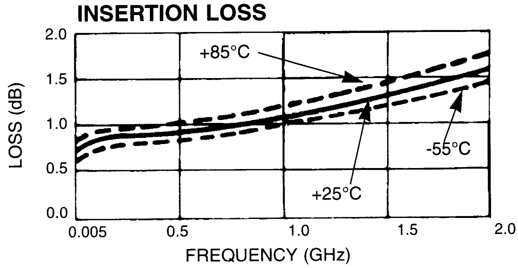
Control Input				Condition of Switch			
"1" = Logic High TTL(SW-261)/CMOS(SW-264)				RF Common To Each RF PORT			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

Schematic

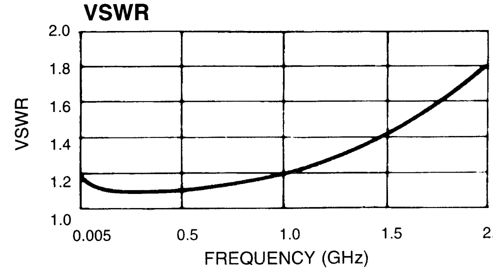


Typical Performance

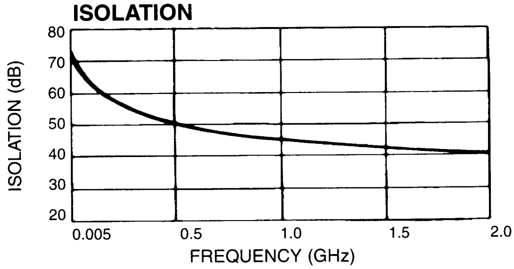
INSERTION LOSS



VSWR



ISOLATION



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M/A-COM an AMP company

GaAs SP4T Switch 5 - 2000 MHz

SW-262

V 2.00

Features

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3 mA Typical
- Integral TTL (SW-262) or CMOS (SW-265) Driver

Guaranteed Specifications *

(From -55°C to +85°C)

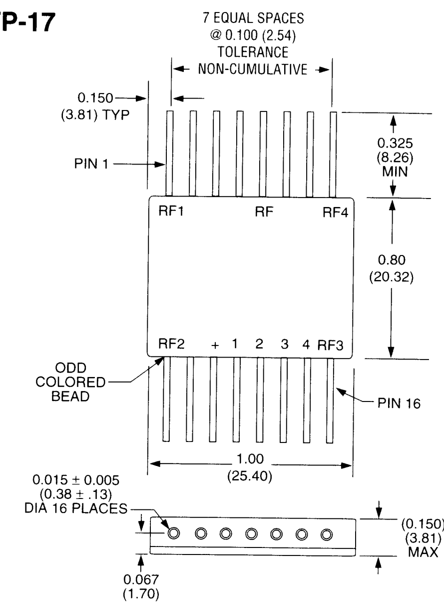
Frequency Range		5 - 2000 MHz
Insertion Loss	5-2000 MHz	2.0 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.5:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	37 dB Min
	5- 500 MHz	42 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			**(TTL)**
Trise, Tfall			7 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			20 ns Typ
Transients (In-Band)			80 mV Typ
Input Power for 1 dB Compression			
500-2000 MHz			+27 dBm Typ
50 MHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
500-2000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
SW-262			+5 VDC @ 0.30 mA Typ, 1 mA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply when operated with bias voltages of +5 VDC (SW-262) and 50 ohm impedance at all RF ports.

FP-17



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-262 PIN	Flatpack

Specifications Subject to Change Without Notice.

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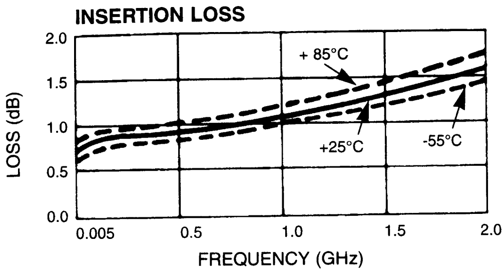
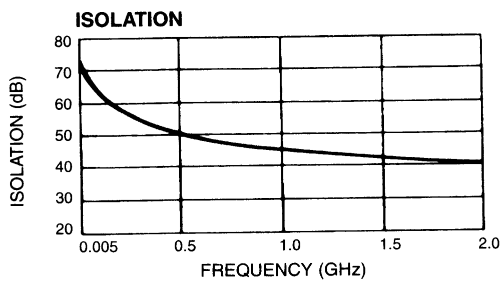
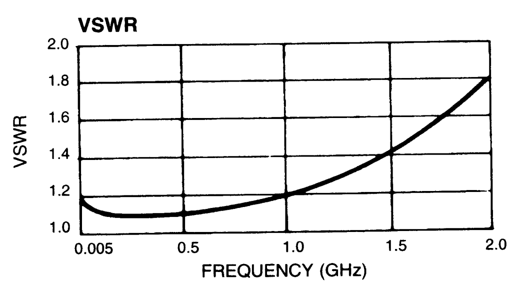
North America: Tel. (800) 366-2266 Fax (800) 618-8883 ■ Asia/Pacific: Tel. +81 (03) 3226-1671 Fax +81 (03) 3226-1451 ■ Europe: Tel. +44 (1344) 869 595 Fax +44 (1344) 300 020

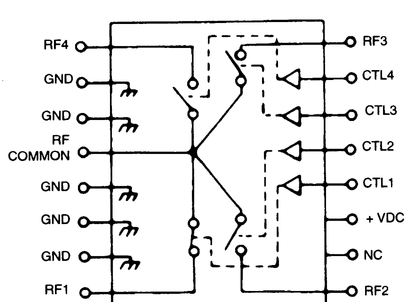
Typical Performance







Schematic



Truth Table

Control Input				Condition of Switch			
"1" = Logic High TTL(SW-262)/CMOS(SW-265)				RF Common To Each RF PORT			
CTL1	CTL2	CTL3	CTL4	RF1	RF2	RF3	RF4
1	0	0	0	ON	OFF	OFF	OFF
0	1	0	0	OFF	ON	OFF	OFF
0	0	1	0	OFF	OFF	ON	OFF
0	0	0	1	OFF	OFF	OFF	ON

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M/A-COM an AMP company

High Power GaAs SPDT Switch DC-2.5 GHz

SW-277

V 2.00

Features

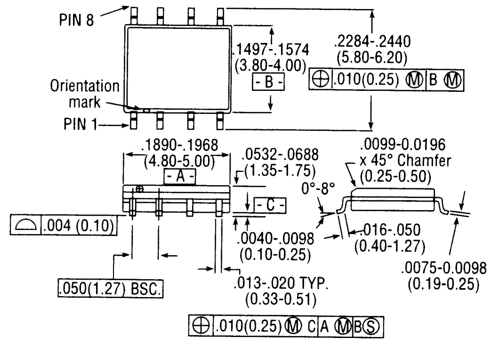
- Positive Supply and Control Voltages
- +36 dBm Typ. 1 dB Compression Point, 8V Supply
- +65 dBm Typ. 3rd Order Intercept Point, 8V Supply
- Low Insertion Loss: 0.4 dB Typical
- Low Power Consumption: 100 μW
- Fast Switching Speed
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-277 is a GaAs MMIC SPDT switch in a low cost SOIC 8-lead surface mount plastic package. The SW-277 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-277 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-277 PIN	SOIC 8-Lead Plastic Package
SW-277TR	Forward Tape & Reel
SW-277RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]		Unit	Min.	Typ.	Max
Insertion Loss		DC – 2.0 GHz	dB		0.6	0.8
		DC – 1.0 GHz	dB		0.4	0.6
		DC – 0.5 GHz	dB		0.35	0.5
		DC – 0.1 GHz	dB		0.2	0.4
Isolation		DC – 2.0 GHz	dB	14	16	
		DC – 1.0 GHz	dB	28	32	
		DC – 0.5 GHz	dB	35	38	
		DC – 0.1 GHz	dB	35	38	
VSWR		DC – 2.0 GHz			1.2:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF		nS		30	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF		nS		35	
Transients	In Band		mV		12	
One dB Compression Point	Input Power (5V Supply/Control)	0.9 GHz	dBm		33	
	Input Power (8V Supply/Control)	0.9 GHz	dBm		35.8	
3rd Order Intercept	Measured Relative (5V Supply/Control)	0.9 GHz	dBm		61	
	to Input Power (8V Supply/Control)	0.9 GHz	dBm		65	
	(for two-tone input power up to +10 dBm)					

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All specifications apply when operated with bias voltages of 0V for Vin Low and 5 to 10V for Vin Hi, and 50 Ohm impedance at all RF ports, unless otherwise specified. High power (greater than 1W) handling specifications apply to cold switches only. For input powers under 1W, hot switching can be used. The high control voltage must be within +/- 0.2V of the supply voltage. The RF ports must be blocked outside of the package from ground or any other voltage.

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

Parameter	Absolute Maximum
Max. Input Power	
0.5 – 2.0 GHz	
5V Control and Supply	+37 dBm
8V Control and Supply	+40 dBm
10V Control and Supply	+42 dBm
Power Dissipation	1.0 W
Supply Voltage	-1V, +12V
Control Voltage	-1V, Vsupply + 0.2V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Thermal Resistance[2]: θ_{jc} = 87 °C/W	

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Thermal resistance is given for T_A = 25°C. T_{CASE} is the temperature of leads 1 and 4.

Two Tone IP3 Measurements

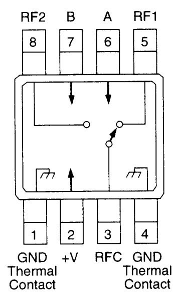
Supply & Control Voltage	Input Power (dBm)	3rd Order Intermodulation Products (dBc)	IP_3 (dBm)	Second Harmonic (dBc)
0,5V	+27	-32	+43	-74
0,6V	+27	-45	+49.5	-77
0,7V	+27	-58	+56	-79
0,8V	+27	-72	+63	-79
0,10V	+27	-72	+63	-81
0,5V	+28	-30	+43	-69
0,6V	+28	-40	+48	-76
0,7V	+28	-53	+54.5	-78
0,8V	+28	-64	+60	-79
0,10V	+28	-72	+64	-80
0,5V	+29	-28	+43	-59
0,6V	+29	-37	+47.5	-74
0,7V	+29	-49	+53.5	-75
0,8V	+29	-50	+54	-75
0,10V	+29	-50	+54	-75
0,5V	+30	-36	+43	-67
0,6V	+30	-46	+48	-73
0,7V	+30	-50	+53	-75
0,8V	+30	-50	+55	-75
0,10V	+30	-50	+55	-75

Pin Configuration

Pin No.	Description
1	GND, Thermal Contact
2	+V Supply
3[1]	RF Common
4	GND, Thermal Contact
5[1]	RF1
6	A
7	B
8[1]	RF2

1. External DC blocking capacitors required on all RF ports.

Functional Schematic



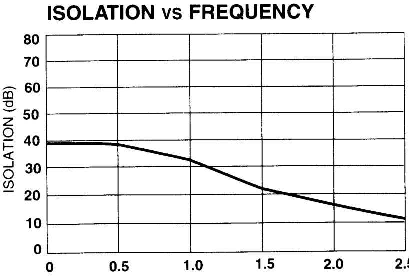
Truth Table

Control Inputs		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	Off	On
0	1	On	Off

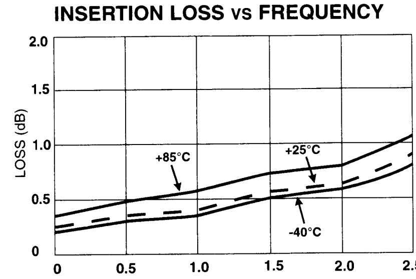
"0" – 0 to +0.2V @ 20 µA max.
"1" – +5V @ 20 µA Typ to 10V @ 500 µA max.

Typical Performance

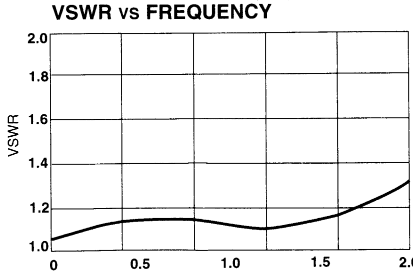
ISOLATION vs FREQUENCY



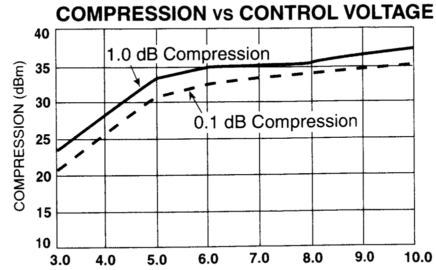
INSERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



COMPRESSION vs CONTROL VOLTAGE (900MHz)



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M/A-COM an AMP company

High Power GaAs SPDT Switch DC-2.5 GHz

SW-279

V 2.00

Features

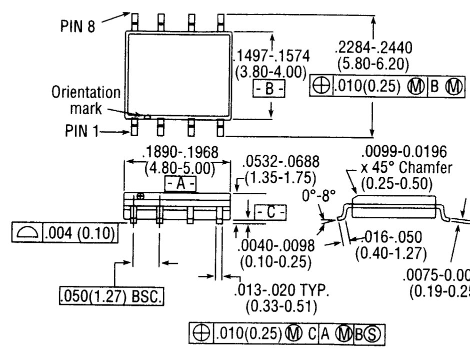
- +36 dBm Typ. 1 dB Compression Point, -8V Supply
- +65 dBm Typ. 3rd Order Intercept Point, -8V Supply
- Low Insertion Loss: 0.4 dB Typical
- Low Power Consumption: 100 μW
- Fast Switching Speed
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-279 is a GaAs MMIC SPDT switch in a low cost SOIC 8-lead surface mount plastic package. The SW-279 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-279 is fabricated with a monolithic GaAs MMIC using a mature 1 micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-279 PIN	SOIC 8 Lead
SW-279TR	Forward Tape & Reel
SW-279RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 2.0 GHz DC – 1.0 GHz DC – 0.5 GHz DC – 0.1 GHz	dB dB dB dB		0.6 0.4 0.35 0.2	0.8 0.6 0.5 0.4
Isolation	DC – 2.0 GHz DC – 1.0 GHz DC – 0.5 GHz DC – 0.1 GHz	dB dB dB dB	14 28 35 35	16 32 38 38	
VSWR	DC – 2.0 GHz			1.2:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		30 35 12	
One dB Compression Point	Input Power (5V Supply/Control) 0.9 GHz Input Power (8V Supply/Control) 0.9 GHz	dBm dBm		33 35.8	
3rd Order Intercept	Measured Relative (5V Supply/Control) 0.9 GHz to Input Power (8V Supply/Control) 0.9 GHz (for two-tone input power up to +10 dBm)	dBm dBm		61 65	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All specifications apply when operated with bias voltages of 0V for Vin Low and 5 to 10V for Vin Hi, and 50 Ohm impedance at all RF ports, unless otherwise specified. High power (greater than 1W) handling specifications apply to cold switches only. For input powers under 1W, hot switching can be used. The high control voltage must be within +/- 0.2V of the supply voltage. The RF ports must be blocked outside of the package from ground or any other voltage.

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Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.5 – 2.0 GHz	
5V Control and Supply	+37 dBm
8V Control and Supply	+40 dBm
10V Control and Supply	+42 dBm
Power Dissipation	1.0 W
Control Voltage	-12V, +1V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Thermal Resistance[2]: θ_{jc} = 87 °C/W	

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Thermal resistance is given for T_A = 25°C. T_{CASE} is the temperature of leads 1 and 4.

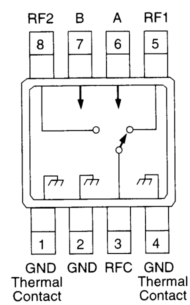
Two Tone IP_3 Measurements

Bias Voltage	Input Power (dBm)	3rd Order Intermodulation Products (dBC)	IP_3 (dBm)	Second Harmonic (dBc)
0,-5V	+27	-34	+44	-61
0,-6V	+27	-49	+51	-61
0,-7V	+27	-64	+59	-63
0,-8V	+27	-65	+59	-63
0,-10V	+27	-66	+60	-63
0,-5V	+28	-30	+43	-58
0,-6V	+28	-41	+48.5	-58
0,-7V	+28	-52	+54	-57
0,-8V	+28	-60	+58	-57
0,-10V	+28	-60	+58	-57
0,-5V	+29	-28	+43	-54
0,-6V	+29	-34	+46	-54
0,-7V	+29	-44	+51	-54
0,-8V	+29	-52	+55	-54
0,-10V	+29	-52	+55	-54
0,-5V	+30	-26	+43	-52
0,-6V	+30	-32	+46	-51
0,-7V	+30	-38	+49	-51
0,-8V	+30	-44	+52	-51
0,-10V	+30	-44	+52	-51

Pin Configuration

Pin No.	Description
1	GND, Thermal Contact
2	GND
3	RF Common
4	GND, Thermal Contact
5	RF1
6	A
7	B
8	RF2

Functional Schematic



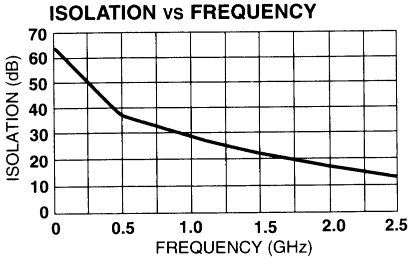
Truth Table

Control Inputs[1]		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	On	Off
0	1	Off	On

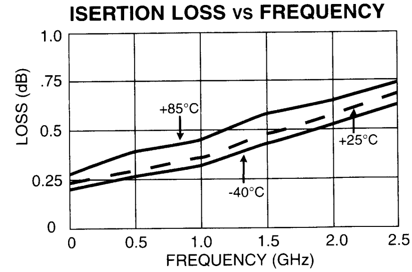
1. 0 – 0 to -0.2V @ 20 μA max.
1 – -5V @ 50 μA Typ to -10V @ 800 μA max.

Typical Performance

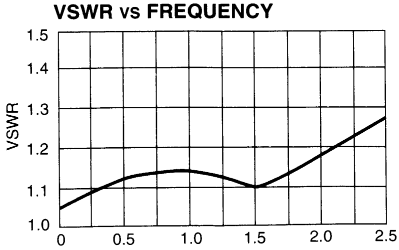
ISOLATION vs FREQUENCY



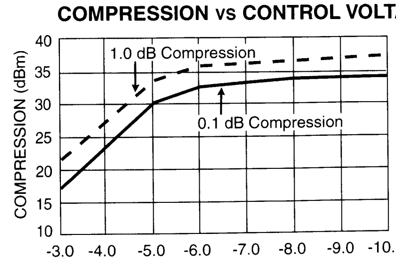
ISERTION LOSS vs FREQUENCY



VSWR vs FREQUENCY



COMPRESSION vs CONTROL VOLTAGE (900 MHZ)



Specifications Subject to Change Without Notice.

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an AMP company

GaAs DPDT Switch DC-4 GHz

SW-281

V 2.00

Features

- Low Insertion Loss, 0.5 dB Typical
- Miniature Relay Replacement, 0.250" Sq. Pkg.
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications *

(From -55°C to +85°C)

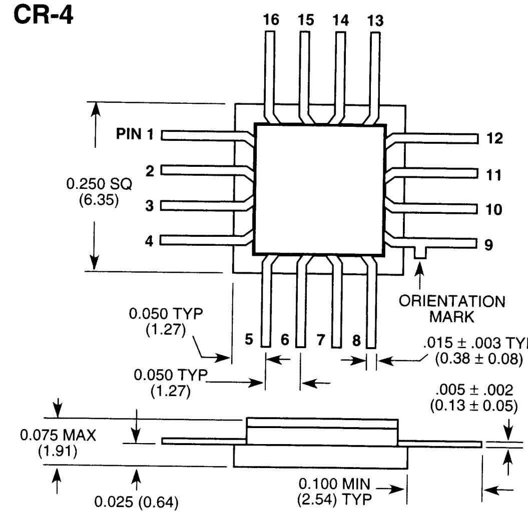
Frequency Range		DC - 4 GHz
Insertion Loss	DC-4 GHz	1.2 dB Max
	DC-2 GHz	0.8 dB Max
	DC-1 GHz	0.7 dB Max
	DC-0.5 GHz	0.6 dB Max
VSWR	DC-4 GHz	1.8:1 Max
	DC-2 GHz	1.5:1 Max
	DC-1 GHz	1.2:1 Max
	DC-0.5 GHz	1.2:1 Max
Isolation	DC-4 GHz	20 dB Min
	DC-2 GHz	30 dB Min
	DC-1 GHz	40 dB Min
	DC-0.5 GHz	50 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall (10/90% or 90/10% RF)			2 ns Typ
Ton, Toff (50% Control to 90/10% RF)			4 ns Typ
Transients (In-Band)			15 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 to 4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 4 GHz	+68	+48	dBm Typ
0.05 GHz	+62	+45	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to -0.2 V @ 5 µA Max
V_{IN} Hi			-5V @ 10 µA Typ to -8V @ 100 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.
† Faster switching speed can be achieved with enhanced driver waveform.
** When an RF output is 'off' it is shorted to ground through an 'on' shunt MESFET.

CR-4



Bottom of Case is AC Ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-281 PIN	Ceramic

Specifications Subject to Change Without Notice.

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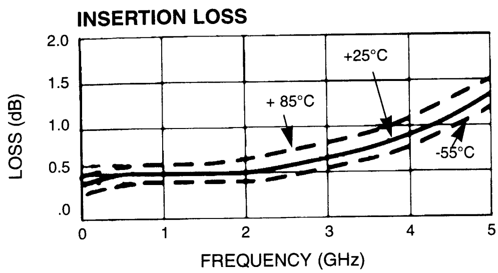
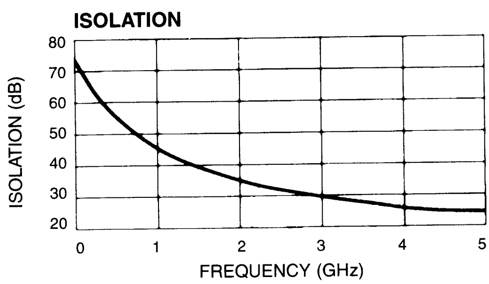
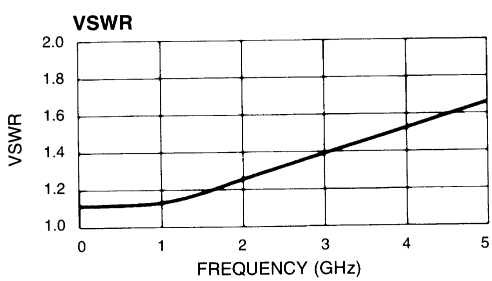
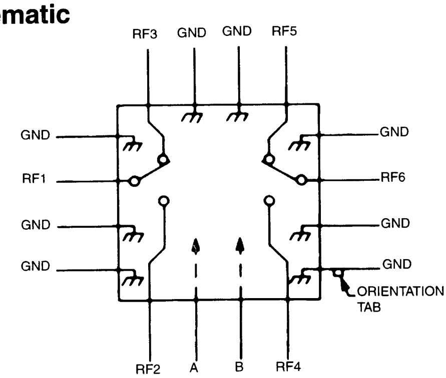
Typical Performance







Schematic



Truth Table**

Control Input		Condition of Switch			
		RF1 to		RF6 to	
A	B	RF2	RF3	RF4	RF5
Hi	Low	ON	OFF	ON	OFF
Low	Hi	OFF	ON	OFF	ON

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an AMP company

GaAs Transfer Switch DC-3 GHz

SW-283

V 2.00

Features

- Small Ceramic Package
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications *

(From -55°C to +85°C)

Frequency Range		DC - 3 GHz
Insertion Loss	DC-3 GHz	2.1 dB Max
	DC-2 GHz	1.8 dB Max
	DC-1 GHz	1.3 dB Max
	DC-0.5 GHz	1.0 dB Max
VSWR	DC-3 GHz	1.9:1 Max
	DC-2 GHz	1.7:1 Max
	DC-1 GHz	1.3:1 Max
	DC-0.5 GHz	1.25:1 Max
Isolation	DC-3 GHz	20 dB Min
	DC-2 GHz	25 dB Min
	DC-1 GHz	40 dB Min
	DC-0.5 GHz	45 dB Min

Operating Characteristics

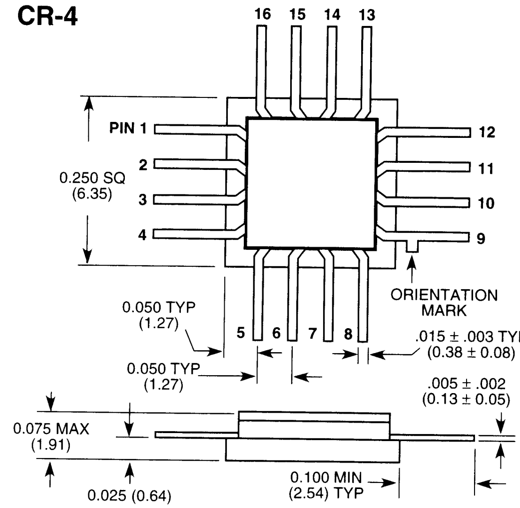
Impedance			50 Ohms Nominal
Switching Characteristics†			
Trise, Tfall (10/90% or 90/10% RF)			2 ns Typ
Ton, Toff (50% control to 90/10% RF)			4 ns Typ
Transients (In-Band)			30 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5-3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.5-3 GHz	+68	+50	dBm Typ
0.05 GHz	+62	+45	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to -0.2V @ 5 μA Max
V_{IN} Hi			-5V @ 10 μA Typ to -8V @ 200 μA Max

Environmental

See Appendix for MIL-STD-883 screening option.

* All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.
† Faster switching speed can be achieved with enhanced driver waveform.

CR-4



Bottom of Case is AC Ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted:.xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-283 PIN	Ceramic

Specifications Subject to Change Without Notice.

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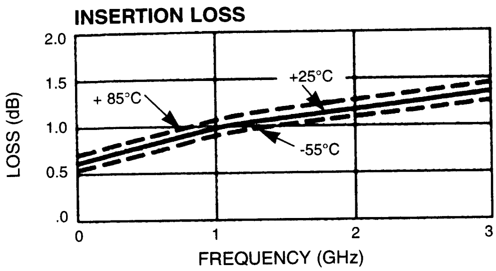
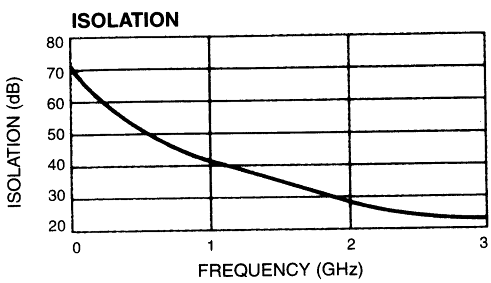
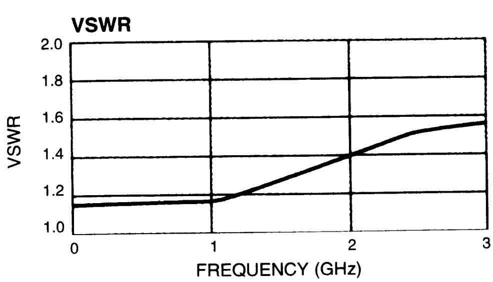
Typical Performance



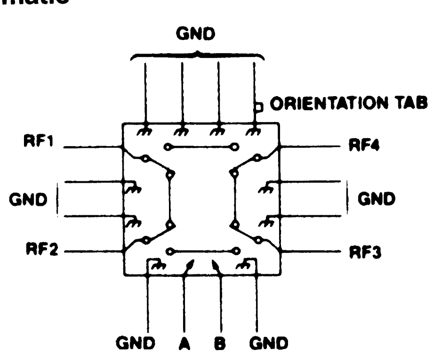




Truth Table

Control Input		Condition of Switch			
A	B	RF1-RF2	RF2-RF3	RF1-RF4	RF3-RF4
Hi	Low	OFF	ON	ON	OFF
Low	Hi	ON	OFF	OFF	ON

Schematic



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an AMP company

GaAs Matched SP6T Switch DC-2 GHz

SW-284

V 2.00

Features

- Low DC Power Consumption
- Integral CMOS Decoder/Driver

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		DC - 2.0 GHz
Insertion Loss	DC – 2.0 GHz DC – 1.0 GHz	2.8 dB Max 2.0 dB Max
VSWR (RF Common)	DC – 2.0 GHz DC – 1.0 GHz	.9:1 Max 1.3:1 Max
VSWR (RF1-RF6 On)	DC – 2.0 GHz DC – 1.0 GHz	1.7:1 Max 1.3:1 Max
VSWR (RF1-RF6 Terminated)	DC – 2.0 GHz DC – 1.0 GHz	1.3:1 Max 1.3:1 Max
Isolation	DC – 2.0 GHz DC – 1.0 GHz	28 dB Min 33 dB Min

Operating Characteristics

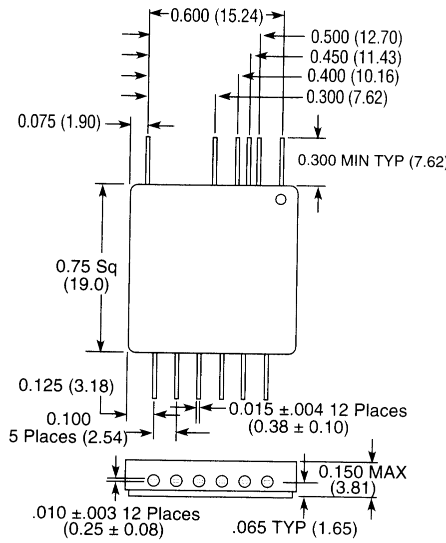
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90% RF)			3.0 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			180 ns Typ
Transients (In-Band)			150 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			23 dBm Typ
0.05 GHz			21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.5 – 2.0 GHz	+60	+45	dBm Typ
0.05 GHz	+53	+35	dBm Typ
Bias Power			-5 VDC @ 2 mA Max +5 VDC @ 1 mA Max
Control Voltages			
Vin Low (0)			0.0 to 1.5V @ 1 μA Max
Vin Hi (1)			3.5 to 5.0V @ 1 μA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports, with -5 and +5 VDC bias voltages.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

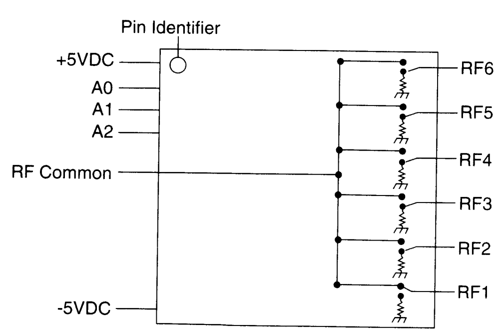
Model No.	Package
SW-284 PIN	Flatpack

FP-27



Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

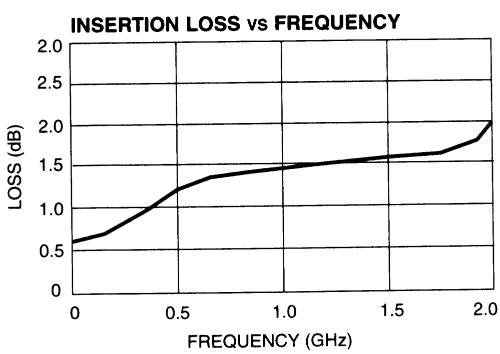
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz[2]	+34 dBm
Bias Voltage	
+5V Supply	-0.5 to +7V
-5V Supply	-7V to + 0.5V
Control Voltage	-0.5 to Vcc + 0.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

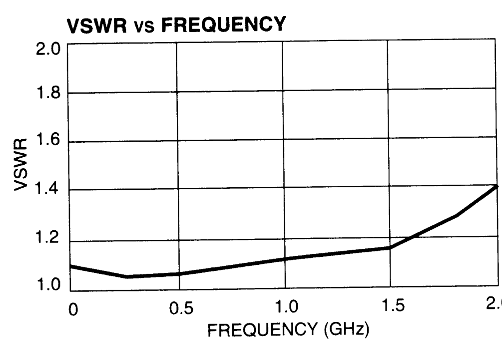
1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +32 dBm.

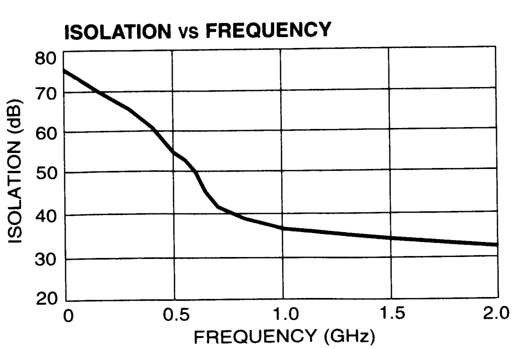
Truth Table

Control Input			Condition of Switch
A2	A1	A0	RF Common to
0	0	1	RF1
0	1	0	RF2
0	1	1	RF3
1	0	0	RF4
1	0	1	RF5
1	1	0	RF6

Typical Performance







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M/A-COM
an AMP company

GaAs DPDT Switch DC - 2 GHz

SW-289

V 2.00

Features

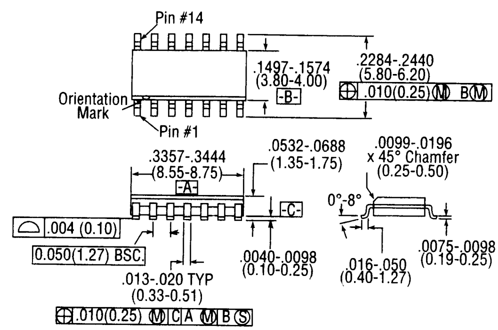
- Very Low Power Consumption: 100 μW
- Low Insertion Loss: 0.5 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 48 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-289 is a GaAs MMIC DPDT switch in a low cost SOIC 14-lead surface mount plastic package. The SW-289 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, digital step attenuators, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-289 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-14



14-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AB, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
SW-289 PIN	SOIC 14-Lead Plastic Package
SW-289TR	Forward Tape & Reel
SW-289RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]		Unit	Min.	Typ.	Max
Insertion Loss		DC – 0.1 GHz	dB		0.35	0.5
		DC – 0.5 GHz	dB		0.35	0.5
		DC – 1.0 GHz	dB		0.4	0.6
		DC – 2.0 GHz	dB		0.6	0.8
Isolation		DC – 0.1 GHz	dB	50	56	
		DC – 0.1 GHz	dB	40	43	
		DC – 1.0 GHz	dB	32	35	
		DC – 2.0 GHz	dB	20	23	
VSWR		DC – 2.0 GHz		1.3:1		
Trise, Tfall	10% to 90% RF, 90% to 10% RF		nS		3	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF		nS		6	
Transients	In Band		mV		15	
One dB Compression	Input Power	0.05 GHz	dBm		22	
	Input Power	0.5 – 2.0 GHz	dBm		27	
IP_2	Measured Relative to Input Power (for two-tone input power up to +5 dBm)	0.05 GHz	dBm		54	
		0.5 – 2.0 GHz	dBm		66	
IP_3	Measured Relative to Input Power (for two-tone input power up to +5 dBm)	0.05 GHz	dBm		45	
		0.5 – 2.0 GHz	dBm		48	

1. Refer to "Tape and Reel Packaging" section, or contact factory.
2. All measurements with 0, -5 V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

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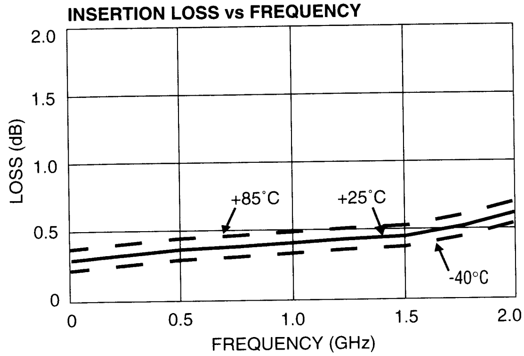
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

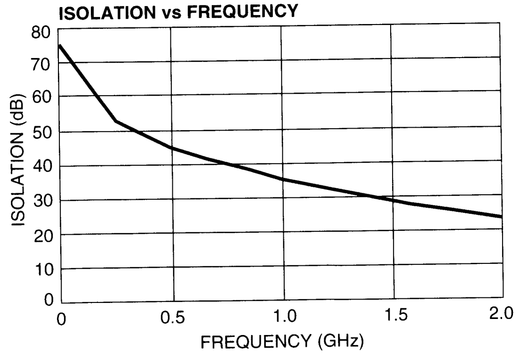
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance

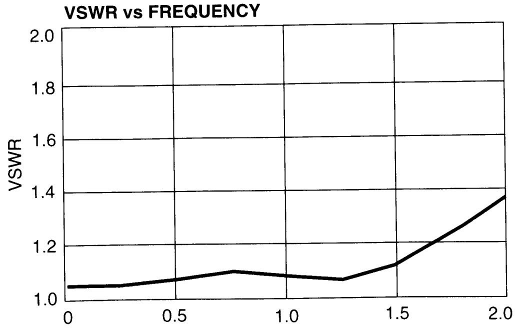
INSERTION LOSS vs FREQUENCY



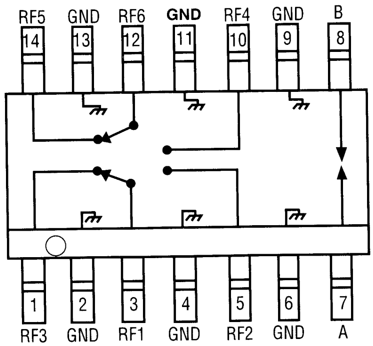
ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Functional Schematic



Pin Configuration

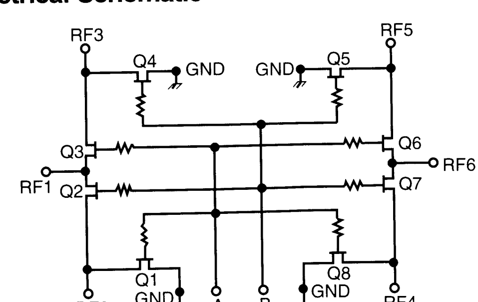
Pin No.	Description	Pin No.	Description
1	RF3	8	B
2	GND	9	GND
3	RFI	10	RF4
4	GND	11	GND
5	RF2	12	RF6
6	GND	13	GND
7	A	14	RF5

Truth Table

Control Input		Condition of Switch			
A	B	RF1 TO		RF6 TO	
		RF2	RF3	RF4	RF 5
1	0	On	Off	On	Off
0	1	Off	On	Off	On

"0" – 0 – -0.2V @ 20 μA max.
"1" – -5V @ 40 μA Typ to -8V @ 900 μA max.

Electrical Schematic



Specifications Subject to Change Without Notice.

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an AMP company

Matched GaAs SPST Switch DC - 3 GHz with TTL/CMOS Control Input SW-311

V 2.00

Features

- Integral Silicon Driver
- Ultra Low Power Consumption
- TTL and CMOS Input Compatible
- Fast Switching Speed: 4 ns Typical
- Surface Mount Package

Guaranteed Specifications[1] (From -55°C to + 85°C)

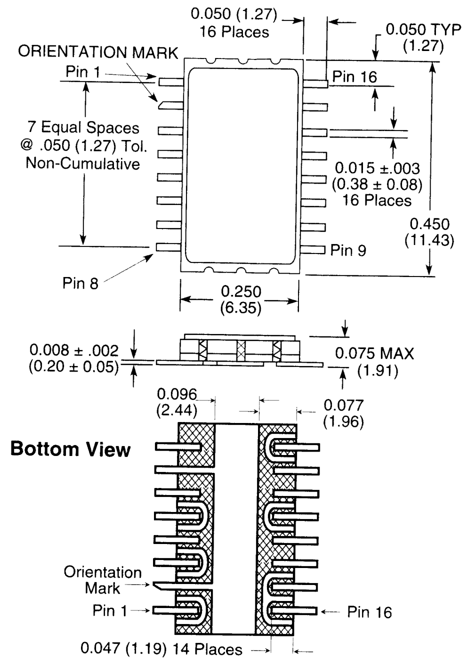
Frequency Range		DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.3 dB Max
	DC-2000 MHz	1.2 dB Max
	DC-1000 MHz	1.0 dB Max
	DC- 500 MHz	0.8 dB Max
VSWR	DC-3000 MHz	1.5:1 Max
	DC-2000 MHz	1.4:1 Max
	DC-1000 MHz	1.3:1 Max
	DC- 500 MHz	1.2:1 Max
Isolation	DC-3000 MHz	27 dB Min
	DC-2000 MHz	36 dB Min
	DC-1000 MHz	50 dB Min
	DC- 500 MHz	65 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			4 ns Typ
Ton, Toff (1.3V CTL to 90%/10%)			12 ns Typ
Transients (in-Band)			40 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+21 dBm Typ
0.5 GHz to 3 GHz			+27 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+62	+40	dBm Typ
0.5 GHz to 3 GHz	+68	+46	dBm Typ
Supply Voltage Ranges			
V_{CC}			+5.0 V ±10% @ 1 mA max.
V_{EE}			-5.0 V to -8.0V @ 1 mA max.
Control Voltages Range			
Vin Low			0 V to 0.8 V @ 1 µA Max
Vin Hi			2.0 V to 5.0 V @ 1 µA Max
Environmental			
See Appendix for MIL-STD-883 screening options.			

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.

CR-9



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
SW-311 PIN	Ceramic

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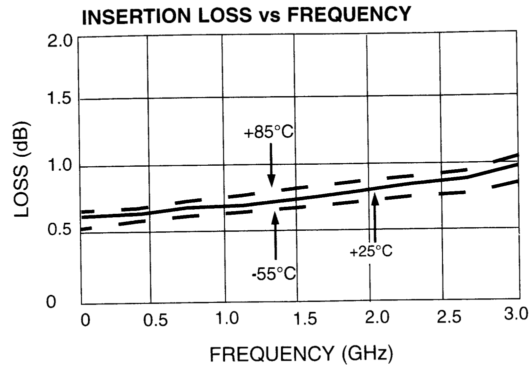
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	–8.5 V
Control Voltage	–0.5 V, to V_{CC} +0.5 V
Operating Temperature	–55°C to 125°C
Storage Temperature	–65°C to 150°C

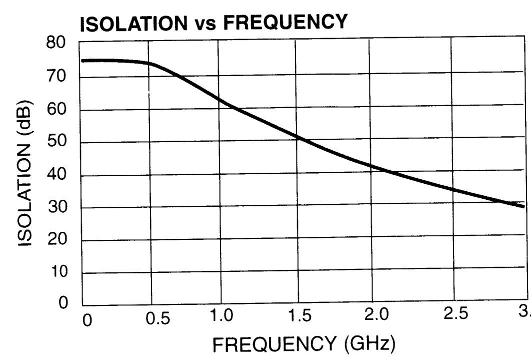
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance



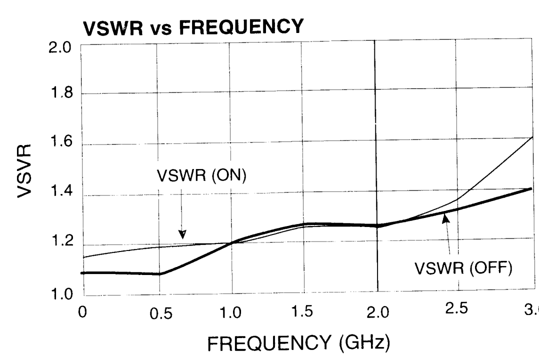
Pin Configuration

Pin No.	Description	Pin No.	Description
1	V_{EE}	9	GND
2	GND	10	GND
3	GND	11	GND
4	GND	12	RF2
5	RFI	13	GND
6	GND	14	GND
7	GND	15	V_{CC}
8	GND	16	C1

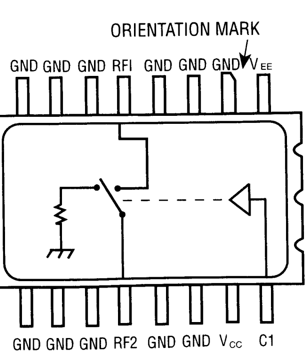


Truth Table

Control Input	Condition of Switch
C1	RF1 to RF2
LO HI	ON OFF



Pin Configuration (Top View)



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M/A-COM an AMP company

GaAs SPDT Reflective Switch DC - 3 GHz with TTL/CMOS Control Input SW-312

V 2.00

Features

- Integral Silicon Driver
- Ultra Low Power Consumption
- TTL and CMOS Input Compatible
- Fast Switching Speed: 7 ns Typical
- Surface Mount Package

Guaranteed Specifications[1] (From -55°C to +85°C)

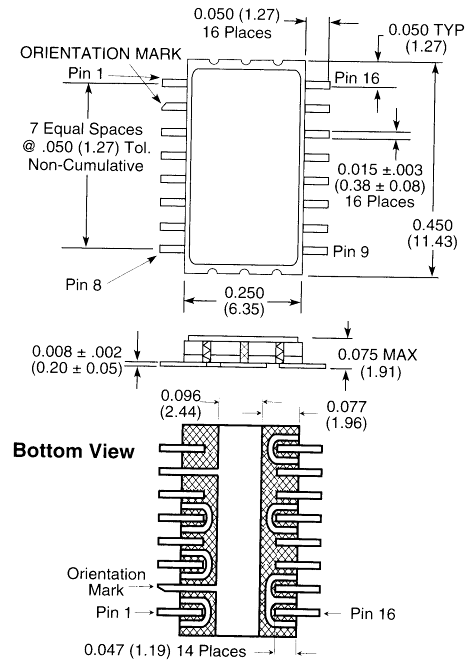
Frequency Range		DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.2 dB Max
	DC-2000 MHz	1.1 dB Max
	DC-1000 MHz	0.9 dB Max
	DC- 500 MHz	0.8 dB Max
VSWR	DC-3000 MHz	1.5:1 Max
	DC-2000 MHz	1.4:1 Max
	DC-1000 MHz	1.4:1 Max
	DC- 500 MHz	1.3:1 Max
Isolation	DC-3000 MHz	30 dB Min
	DC-2000 MHz	35 dB Min
	DC-1000 MHz	40 dB Min
	DC- 500 MHz	45 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			7 ns Typ
Ton, Toff (1.3V CTL to 90%/10%)			18 ns Typ
Transients (In-Band)			25 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			25 dBm Typ
0.5 GHz to 3 GHz			30 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+60	+40	dBm Typ
0.5 GHz to 3 GHz	+65	+46	dBm Typ
Supply Voltage Range			
V_{CC}			+5.0 V ±10% @ 1 mA Max
V_{EE}			-5.0 V to -8.0 V @ 1 mA Max
Control Voltage Range			
Vin Low			0 V to 0.8 V @ 1 µA Max
Vin Hi			2.0 V to 5.0 V @ 1 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option			

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.

CR-9



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
SW-312 PIN	Ceramic

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5 V
V_{EE}	−8.5 V
Control Voltage	−0.5 V, to V_{CC} +0.5 V
Operating Temperature	−55°C to +125°C
Storage Temperature	−65°C to +150°C

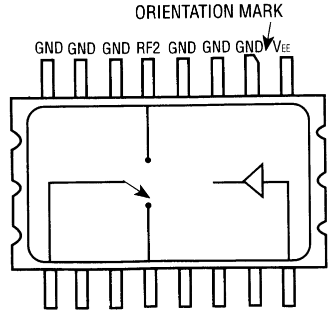
Pin Configuration

Pin No.	Description	Pin No.	Description
1	V_{EE}	9	RFC
2	GND	10	GND
3	GND	11	GND
4	GND	12	RF1
5	RF2	13	GND
6	GND	14	GND
7	GND	15	V_{CC}
8	GND	16	C1

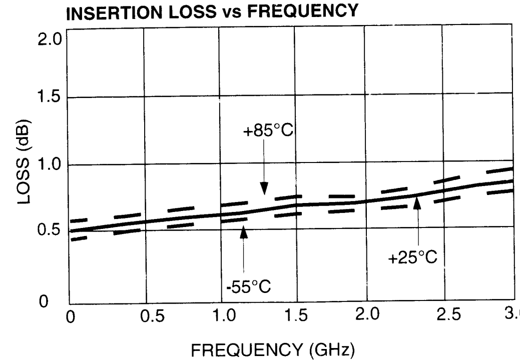
Truth Table

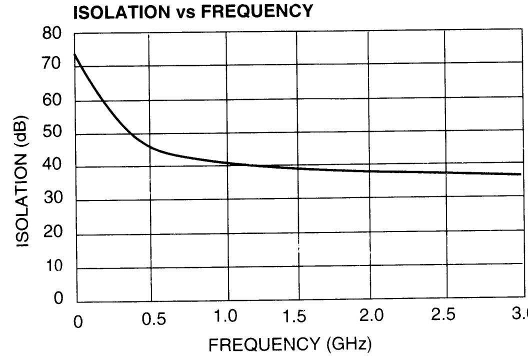
Control Input	Condition of Switch RF Common to Each RF Port	
C1	RF1	RF2
LO	ON	OFF
HIGH	OFF	ON

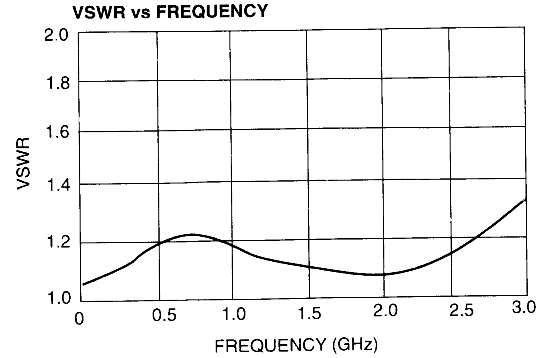
Pin Configuration (Top View)



Typical Performance







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M/A-COM
an AMP company

Matched GaAs SPDT Switch DC - 3 GHz with TTL/CMOS Control Input SW-313

V 2.00

Features

- Integral Silicon Driver
- Ultra Low Power Consumption
- TTL and CMOS Input Compatible
- Fast Switching Speed: 7 ns Typical
- Surface Mount Package

Guaranteed Specifications[1] (From -55°C to +85°C)

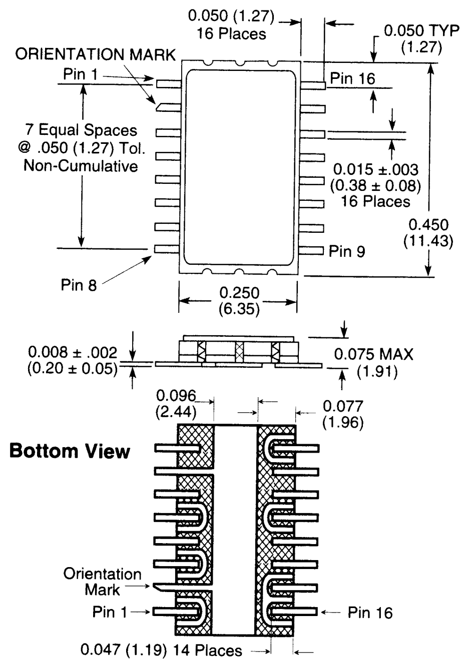
Frequency Range		DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.2 dB Max
	DC-2000 MHz	1.1 dB Max
	DC-1000 MHz	0.9 dB Max
	DC- 500 MHz	0.8 dB Max
VSWR	DC-3000 MHz	1.4:1 Max
	DC-2000 MHz	1.35:1 Max
	DC-1000 MHz	1.35:1 Max
	DC- 500 MHz	1.3:1 Max
Isolation	DC-3000 MHz	35 dB Min
	DC-2000 MHz	45 dB Min
	DC-1000 MHz	50 dB Min
	DC- 500 MHz	55 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			7 ns Typ
Ton, Toff (1.3 V CTL to 90%/10%)			18 ns Typ
Transients (in-Band)			25 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+25 dBm Typ
0.5 GHz to 3 GHz			+30 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+60	+40	dBm Typ
0.5 GHz to 3 GHz	+65	+46	dBm Typ
Supply Voltage Ranges			
V_{CC}			+5.0 V ±10% @ 1 mA max.
V_{EE}			-5.0 V to -8.0 V @ 1 mA max.
Control Voltage Range			
Vin Low			0 V to 0.8 V @ 1 µA Max
Vin Hi			2.0 V to 5.0 V @ 1 µA Max
Environmental			
See Appendix for MIL-STD-883 screening option			

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.

CR-9



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
SW-313 PIN	Ceramic

Specifications Subject to Change Without Notice.

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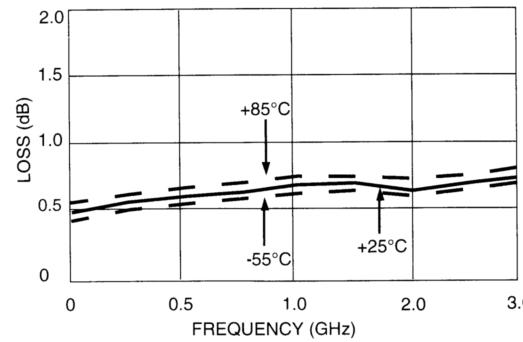
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5V
V_{EE}	–8.5V
Control Voltage	–0.5 V, to V_{CC} +0.5 V
Operating Temperature	–55˚C to 125˚C
Storage Temperature	–65˚C to 150˚C

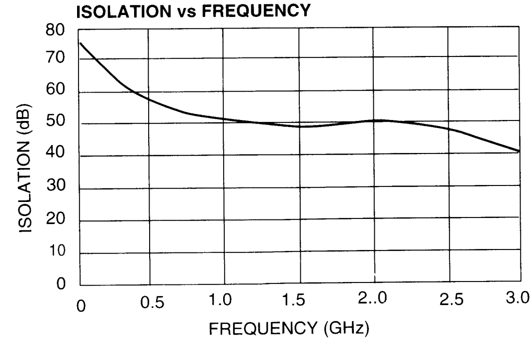
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance



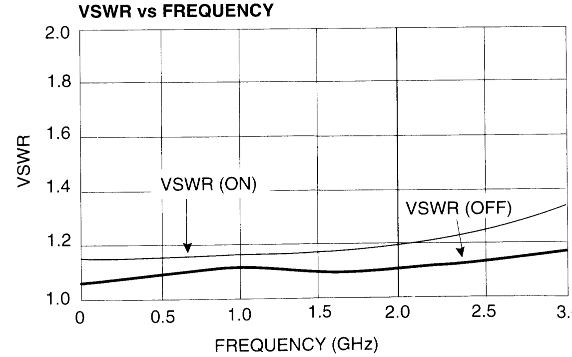
Pin Configuration

Pin No.	Description	Pin No.	Description
1	V_{EE}	9	RFC
2	GND	10	GND
3	GND	11	GND
4	GND	12	RF1
5	RF2	13	GND
6	GND	14	GND
7	GND	15	V_{CC}
8	GND	16	C1

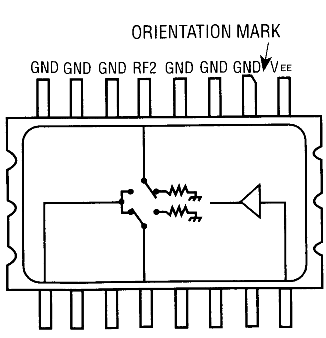


Truth Table

Control Input	Condition of Switch RF Common to Each RF Port	
C1	RF1	RF2
LO	ON	OFF
HIGH	OFF	ON



Pin Configuration (Top View)



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an AMP company

GaAs SP4T Absorptive Switch
DC-3 GHz

SW-314

V 2.00

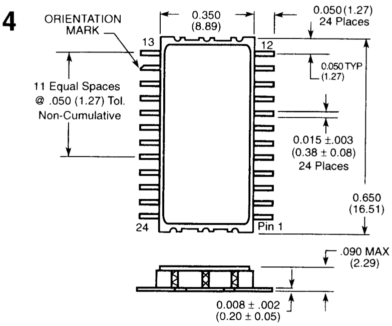
Features

- Integral Silicon Driver
- Isolation: 50dB Typ. at 1 GHz
- Ultra Low DC Power Consumption
- Hermetic Surface Mount Package
- TTL and CMOS Input Compatible
- 50Ω Nominal Impedance

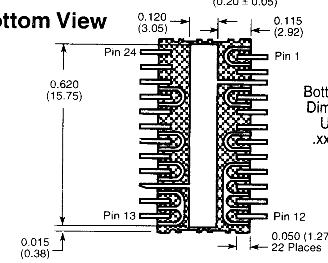
Description

M/A-COM's SW-314 is a GaAs MMIC SP4T absorptive switch with an integral silicon ASIC driver. This device is in a 24 lead ceramic surface mount package. These switches exhibit excellent performance and repeatability from DC to 3 GHz, with very low DC power dissipation. The SW-314 is ideally suited for RF/IF communications applications. Environmental screening is available. Contact the factory for information.

CR-14



Bottom View



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, TA = +25°C [1,2]

Parameter	Test Conditions	Units	Minimum	Typical	Maximum
Reference Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB			1.3 1.4 1.6 1.8
Isolation	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	dB dB dB dB	50 45 35 30		
VSWR	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz DC - 3.0 GHz	RFC, RF1 - RF4 (On) 1.6:1 Max. 1.6:1 Max. 1.6:1 Max. 1.8:1 Max.		RF1 - RF4 (Off) 1.3:1 Max. 1.5:1 Max. 1.9:1 Max. 2.4:1 Max.	
Trise, Tfall Ton, Toff Transients	10% to 90% 50% Control to 90%/10% RF In-band (peak-peak)	nS nS mV		7 25 20	
1 dB Compression[3]	Input Power 0.05 GHz Input Power 0.5 - 3.0 GHz	dBm dBm		+20 +27	
Input IP_3[3]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 3.0 GHz	dBm dBm		+35 +46	
Input IP_2[3]	For two-tone input power 0.05 GHz up to +5 dBm 0.5 - 3.0 GHz	dBm dBm		+45 +60	
V_{CC}[5] V_{EE}[5]		V V	4.5 -8.0	5.0	5.5 -5.0
I_{CC}[4]	V_{CC} = 4.5 to 5.5 V Vctl = 0 to 0.8 V, or V_{CC} - 2.1 V to V_{CC}	mA			4.0
I_{EE}	V_{EE} = -5.0 to -8.0 V	mA			1.0
Vctl Vctl	Logic 0 (TTL) Logic 1 (TTL)	V V	0.0 2.0		0.8 5.0
Input Leakage Current (Low) Input Leakage Current (High)	0 to 0.8 V 2.0 to 5.0 V	μA μA			1.0 1.0

1. All specifications apply when operated with bias voltages of +5V for V_{CC} and -5.0V to-8.0V for V_{EE} and 50Ω impedance at all RF ports unless otherwise specified.
2. For this switch to meet the guaranteed specifications, it is necessary to have a DC return on either RF1 or RF2. The DC return can be either a 10 KΩ resistor, or an RF choke.
3. V_{EE}= -5V for the typical numbers given.
4. For CMOS control levels, V_{CC} current is 2 μA typ. and V_{EE} current is <100 μA typ.

Specifications Subject to Change Without Notice.

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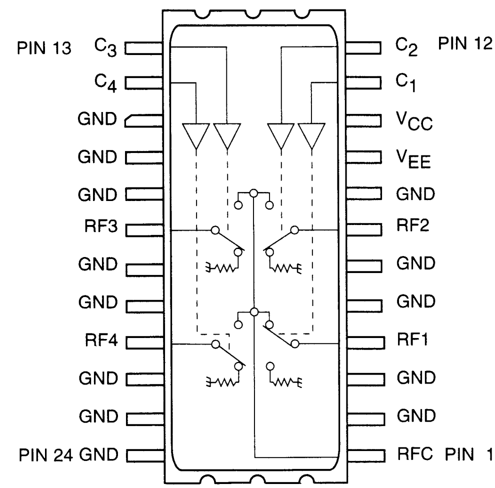
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 - 3.0 GHz[2]	+34 dBm
Bias Voltages	
V_{CC}	-0.5 to +5.5V
V_{EE}	-8.5V to +0.5V
Control Voltage	-0.5V to V_{CC} +0.5V
Operating Temperature	-55°C to +125°
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the input power is applied to the terminated port, the absolute maximum is +30 dBm.

Functional Schematic



Truth Table

TTL Control Inputs				Condition of Switch RF Common to Each RF Port			
C1	C2	C3	C4	RF1	RF2	RF3	RF4
1	0	0	0	On	Off	Off	Off
0	1	0	0	Off	On	Off	Off
0	0	1	0	Off	Off	On	Off
0	0	0	1	Off	Off	Off	On

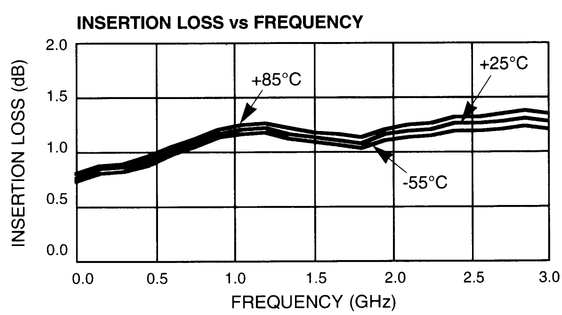
0= TTL Low 1= TTL High

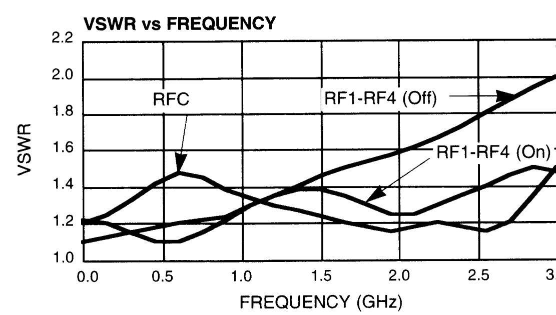
Ordering Information[5]

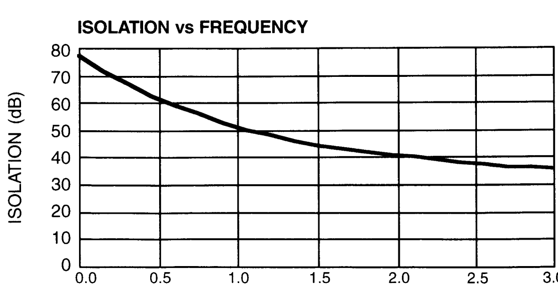
Part No.	Package
SW-314 PIN	Ceramic

5. Contact the factory for standard or custom screening requirements

Typical Performance @ +25°C







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an AMP company

GaAs SPDT Switch
DC - 3 GHz

SW-328

V 2.00

Features

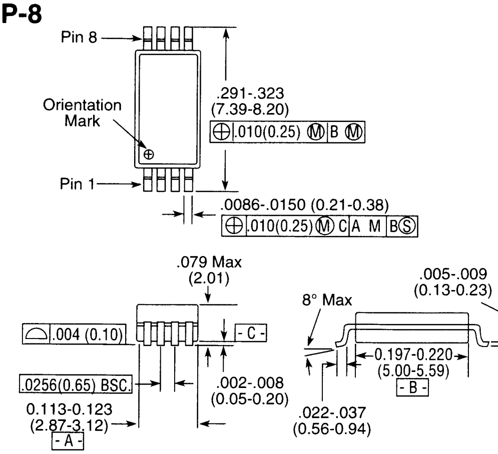
- Very Low Power Consumption: 50 µW
- Low Insertion Loss: 0.5 dB
- High Isolation: 20 dB up to 3 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SSOP-8 Plastic Package

Description

M/A-COM's SW-328 is a GaAs MMIC SPDT switch in a low cost SSOP 8-lead surface mount plastic package. The SW-328 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-328 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SSOP-8



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± .010 (.xx = ±0.25)
.xx = ± 0.02 (.x = ± 0.5)

Ordering Information

Part Number	Package
SW-328 PIN	SSOP 8-Lead Plastic Package
SW-328TR	Forward Tape & Reel
SW-328RTR	Reverse Tape & Reel

*If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[1]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.5 GHz	dB		0.4	0.6
	DC – 1.0 GHz	dB		0.4	0.6
	DC – 2.0 GHz	dB		0.6	0.8
	DC – 3.0 GHz	dB		0.6	1.0
Isolation	DC – 0.5 GHz	dB	42	46	
	DC – 1.0 GHz	dB	33	37	
	DC – 2.0 GHz	dB	22	25	
	DC – 3.0 GHz	dB	15	18	
VSWR				1.2:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	nS		2	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		4	
Transients	In Band	mV		15	
One dB Compression	Input Power 0.05 GHz	dBm		21	
	Input Power 0.5 – 3.0 GHz	dBm		27	
IP_2	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz	dBm		55	
	0.5 – 3.0 GHz	dBm		68	
IP_3	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz	dBm		40	
	0.5 – 3.0 GHz	dBm		46	

1. All measurements with 0, -5 V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

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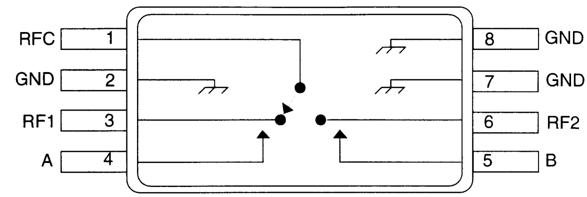
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5 V, -8.5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

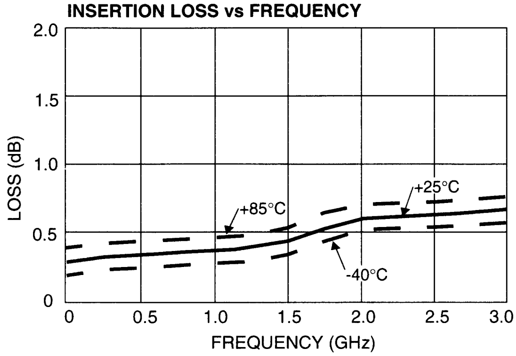
1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic

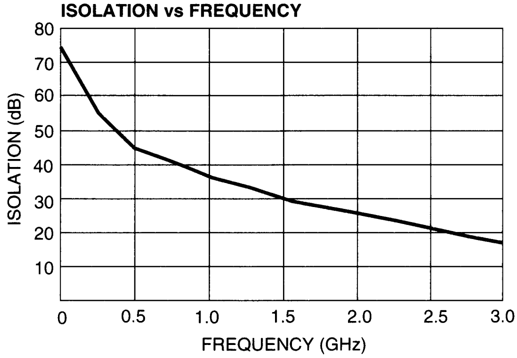


Typical Performance

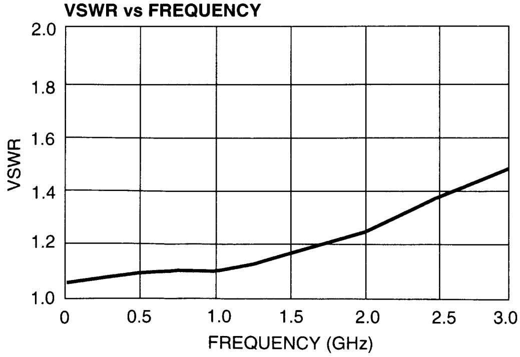
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Pin Configuration

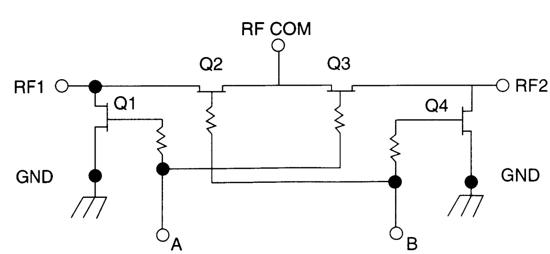
Pin No.	Description
1	RF Common
2	GND
3	RFI
4	A
5	B
6	RF2
7	GND
8	GND

Truth Table

Control Input		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	On	Off
0	1	Off	On

"0" – 0 – -0.2 V @ 20 µA max.
"1" – -5 V @ 20 µA Typ to -8 V @ 480 µA max.

Electrical Schematic



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Matched GaAs SPDT Switch DC - 2 GHz

SW-331, SW-333

V 2.00

Features

- Miniature Ceramic Package
- Fast Switching Speed, 7 ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications[1] (-55°C to +85°C)

Frequency Range	DC – 2.0 GHz	SW-331	SW-333	
Insertion Loss	DC – 2.0 GHz	1.4	1.4	dB Max
	DC – 1.0 GHz	1.0	1.0	dB Max
	DC – 0.5 GHz	0.9	0.9	dB Max
VSWR	DC – 2.0 GHz	2.0:1	2.0:1	Max
	DC – 1.0 GHz	1.4:1	1.4:1	Max
	DC – 0.5 GHz	1.3:1	1.3:1	Max
Isolation	DC – 2.0 GHz	40	30	dB Min
	DC – 1.0 GHz	47	35	dB Min
	DC – 0.5 GHz	52	40	dB Min

Operating Characteristics

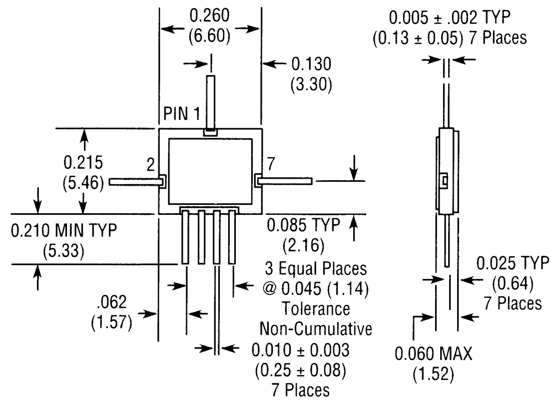
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			7 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			10 ns Typ
Transients (In-Band)			25 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+30 dBm Typ
0.05 GHz			+25 dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 – 2.0 GHz	+65	+46	dBm Typ
0.05 GHz	+60	+40	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0 to -0.2V @ 20 μA Max
Vin High			-5V @ 25 μA Typ to -8V @ 300 μA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

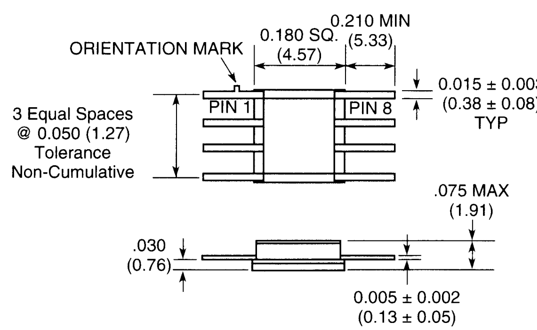
Part Number	Package
SW-331 PIN	Ceramic
SW-333 PIN	Ceramic

SW-331 (CR-2)



Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

SW-333 (CR-3)



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice.

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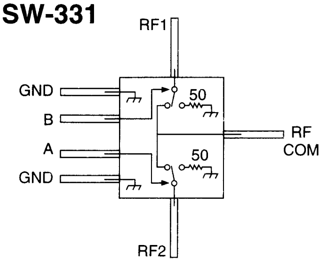
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55˚C to +125°C
Storage Temperature	–65˚C to +150˚C

1. Operation of this device above any one of these parameters may cause permanent damage.

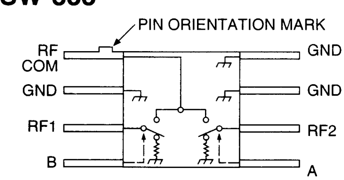
Functional Schematics (Top View)

SW-331



Bottom of case is AC Ground

SW-333

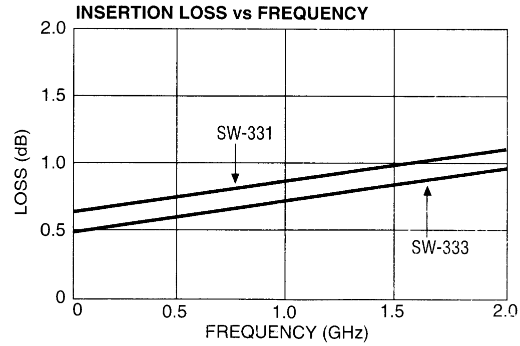


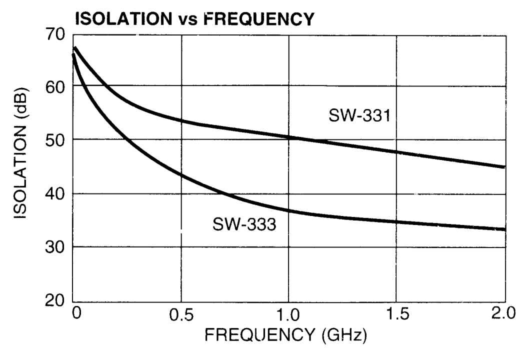
Bottom of case is AC Ground

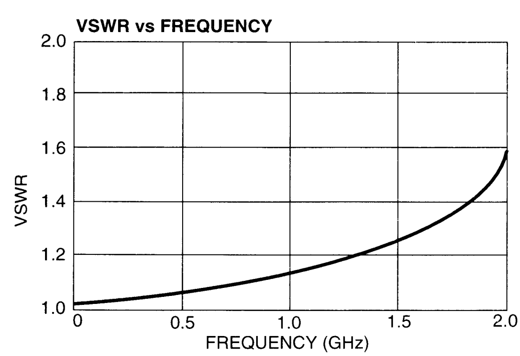
Truth Table

Control Input		Condition of Switch	
		RF Common to each RF Port	
A	B	RF1	RF2
High	Low	OFF	ON
Low	High	ON	OFF

Typical Performance







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M/A-COM an AMP company

GaAs SPDT Terminated Switch DC-2.5 GHz

SW-338, SW-339

V 2.00

Features

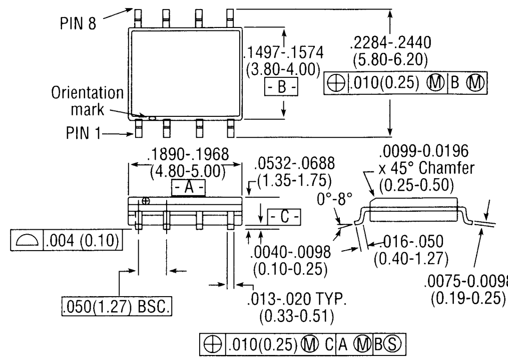
- Very Low Power Consumption: 75 μW
- Low Insertion Loss: 0.5 dB
- High Isolation: 33 dB up to 2 GHz (SW-338)
  28 dB up to 2 GHz (SW-339)
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-338 and SW-339 are GaAs MMIC SPDT terminated switches in a low cost SOIC 8-lead surface mount plastic package. They are ideally suited for use where very low power consumption is required. Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment. The difference between the switches is in the pin configuration.

The SW-338 and SW-339 are fabricated with monolithic GaAs MMICs using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Model No.	Package
SW-338 PIN	SOIC 8 Lead
SW-338TR	Forward Tape & Reel
SW-338RTR	Reverse Tape & Reel
SW-339 PIN	SOIC 8 Lead
SW-339TR	Forward Tape & Reel
SW-339RTR	Reverse Tape & Reel

Electrical Specifications, T_A = ±25°C

Parameter	Test Conditions[2]	Unit	SW-338 Min.	SW-338 Typ.	SW-338 Max	SW-339 Min.	SW-339 Typ.	SW-339 Max.
Insertion Loss	DC – 0.1 GHz	dB		0.4	0.6		0.4	0.6
	DC – 0.5 GHz	dB		0.5	0.7		0.5	0.7
	DC – 1.0 GHz	dB		0.5	0.7		0.5	0.7
	DC – 2.0 GHz	dB		0.7	0.9		0.7	0.9
Isolation	DC – 0.1 GHz	dB	50	53		50	53	
	DC – 0.5 GHz	dB	43	46		43	46	
	DC – 1.0 GHz	dB	36	39		35	38	
	DC – 2.0 GHz	dB	30	33		25	28	
VSWR	On DC – 2.0 GHz			1.2:1			1.2:1	
	Off DC – 2.0 GHz			1.2:1			1.2:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	nS		7			7	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		10			10	
Transients	In Band	mV		25			25	
One dB	Input Power 0.05 GHz	dBm		25			25	
Compression Point	Input Power 0.5 – 2.0 GHz	dBm		30			30	
2nd Order	Measured Relative 0.05 GHz	dBm		60			60	
Intercept	to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm		65			65	
3rd Order	Measured Relative 0.05 GHz	dBm		40			40	
Intercept	to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm		46			46	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements with 0, -5 control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

Specifications Subject to Change Without Notice.

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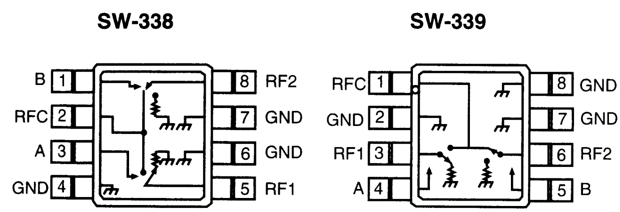
Absolute Maximum Ratings

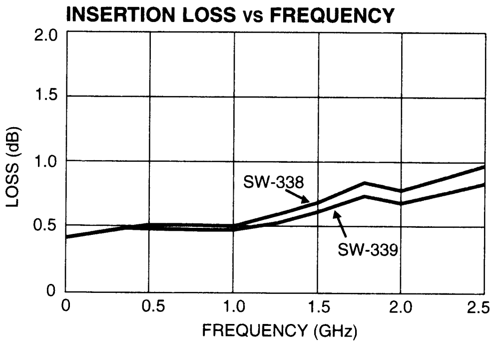
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

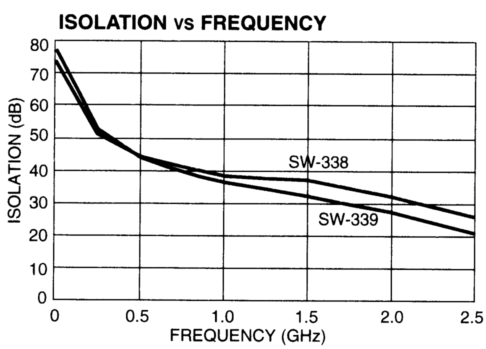
1. Operation of this device above any one of these parameters may cause permanent damage

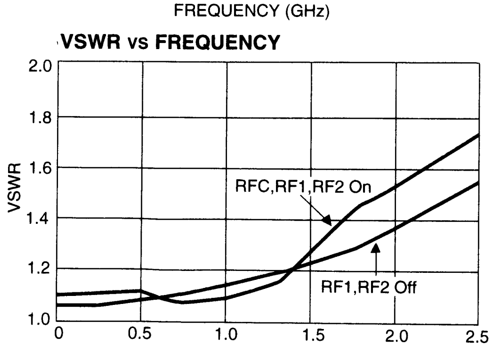
Functional Schematics



Typical Performance







Pin Configuration

SW-338

Pin No.	Description
1	B
2	RF Common
3	A
4	GND
5	RF1
6	GND
7	GND
8	RF2

SW-339

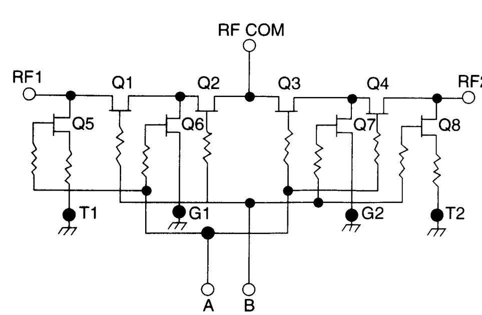
Pin No.	Description
1	RF Common
2	GND
3	RFI
4	A
5	B
6	RF2
7	GND
8	GND

Truth Table

Control Inputs		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	ON	OFF
0	1	OFF	ON

"0" – 0 – -0.2V @ 20 µA max.
"1" – -5V @ 30 µA Typ to -8V @ 720 µA max.

Electrical Schematic



Specifications Subject to Change Without Notice.

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an AMP company

Matched GaAs SPST Switch DC-2000 MHz

SW-341, SW-342

V 2.00

Features

- Low Insertion Loss
- Ultra Low DC Power Consumption
- Fast Switching Speed

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range			DC - 2.0 GHz
Model Number		SW-341	SW-342
Insertion Loss	DC – 2.0 GHz	0.7 dB Max	0.9 dB Max
	DC – 1.0 GHz	0.6 dB Max	0.7 dB Max
	DC – 0.5 GHz	0.5 dB Max	0.6 dB Max
VSWR On	DC – 2.0 GHz	1.5:1 Max	1.7:1 Max
	DC – 1.0 GHz	1.3:1 Max	1.3:1 Max
	DC – 0.5 GHz	1.2:1 Max	1.2:1 Max
VSWR Off	DC – 2.0 GHz	1.6:1 Max	1.7:1 Max
	DC – 1.0 GHz	1.5:1 Max	1.3:1 Max
	DC – 0.5 GHz	1.5:1 Max	1.2:1 Max
Isolation	DC – 2.0 GHz	40 dB Min	30 dB Min
	DC – 1.0 GHz	50 dB Min	35 dB Min
	DC – 0.5 GHz	55 dB Min	42 dB Min

Operating Characteristics

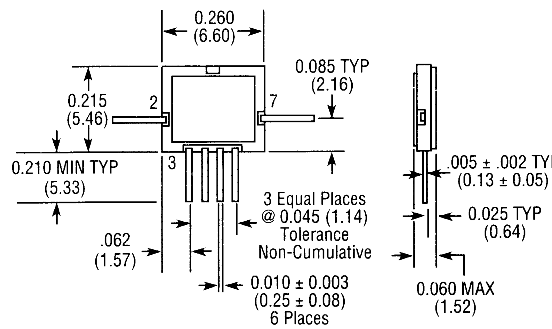
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90% RF, 90% to 10% RF)			3 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			10 ns Typ
Transients (In-Band)			20 mV Typ
Input Power for 1 dB Compression			
0.5-2 GHz		+26	dBm Typ
0.05 GHz		+23	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.5-2 GHz	75	50	dBm Typ
0.05 GHz	67	48	dBm Typ
Control Voltages			
Vin Low			0 to -0.2 V @ 20 µA Max
Vin High			5 V @ 25 µA Typ to -8 V @ 300 µA Max

1. All specifications apply when operated with control voltages of 0 and -5 VDC and 50 ohm impedance at all RF ports.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

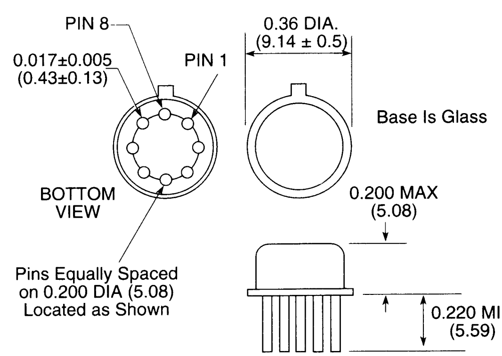
Part No.	Package
SW-341	Ceramic
SW-342	TO-5-4

SW-341 (CR-2 w/o Pin 1)



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

SW-342 (T0-5-4)



WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS
Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

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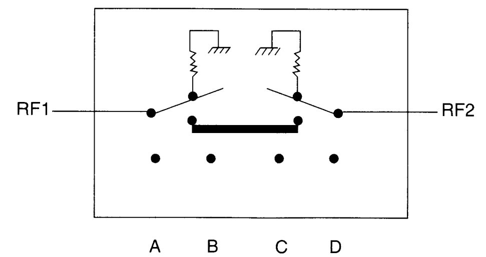
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power[2]	
0.05 GHz	+27 dBm
0.5 - 2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

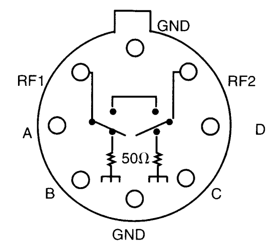
1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +31 dBm.

Functional Schematics (Top View)

SW-341



SW-342

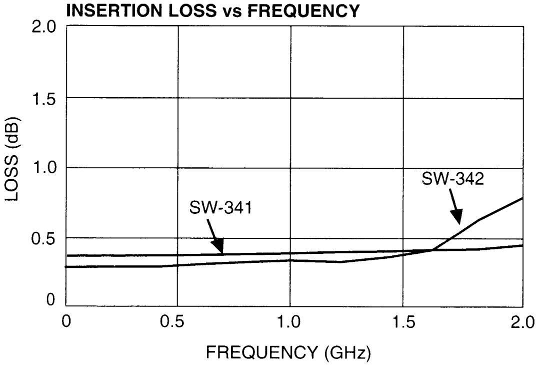


Truth Table

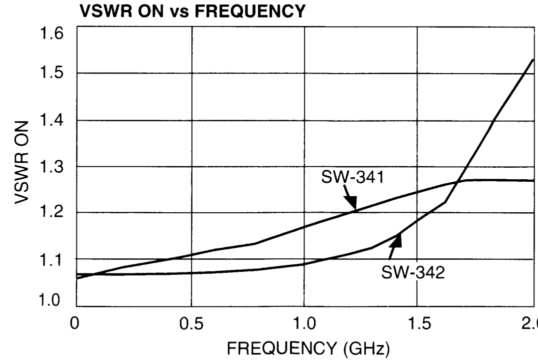
Control Inputs				Condition of Switch
A	B	C	D	RF1-RF2
High	Low	Low	High	On
Low	High	High	Low	Off

Typical Performance

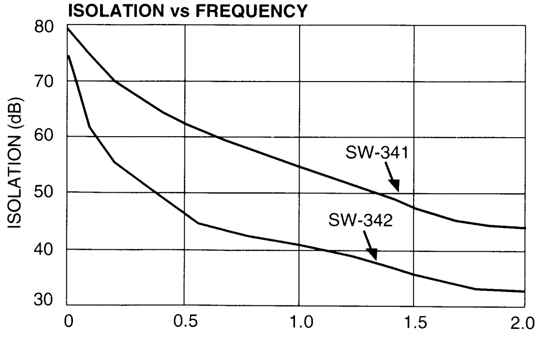
INSERTION LOSS vs FREQUENCY



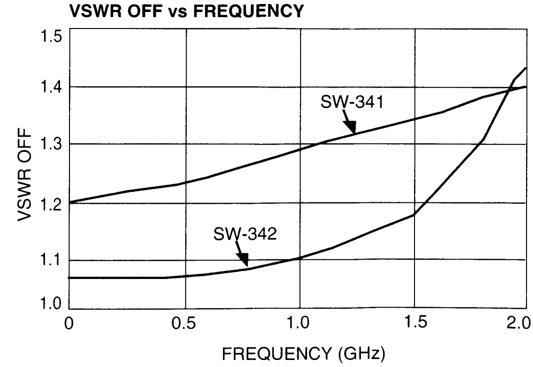
VSWR ON vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR OFF vs FREQUENCY



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Matched GaAs SPST Switch
DC - 2000 MHz

SW-344

V 2.00

Features

- Low Insertion Loss
- High IP_2 and IP_3 at Low Frequencies
- High Compression Point at Low Frequencies

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		DC - 2000 MHz
Insertion Loss	DC – 2.0 GHz DC – 1.0 GHz DC – 0.5 GHz	0.7 dB Max 0.6 dB Max 0.5 dB Max
VSWR On	DC – 2.0 GHz DC – 1.0 GHz DC – 0.5 GHz	1.5:1 Max 1.3:1 Max 1.2:1 Max
VSWR Off	DC – 2.0 GHz DC – 1.0 GHz DC – 0.5 GHz	1.6:1 Max 1.5:1 Max 1.5:1 Max
Isolation	DC – 2.0 GHz DC – 1.0 GHz DC – 0.5 GHz	40 dB Min 50 dB Min 55 dB Min

Operating Characteristics

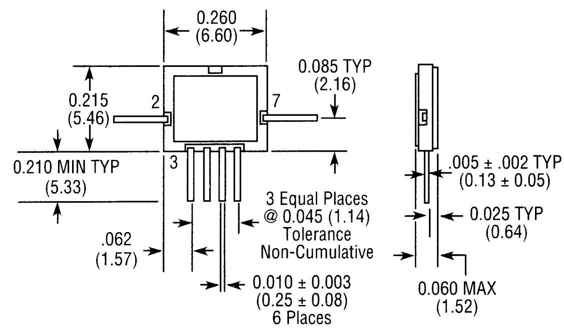
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90% RF, 90% to 10% RF)			1.8 µS, 17 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			3.0 µS , 24 ns Typ
Transients (In-Band)			30 mV Typ
Input Power for 1 dB Compression			
5-2000 MHz			+28 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
5-2000 MHz	75	47	dBm Typ
Control Voltages			
Vin Low			-5V @ 100 µA Max
Vin High			+5V @ 100 µA Max

1. All specifications apply when operated with control voltages of 0 and -5 VDC and 50 ohm impedance at all RF ports.

Ordering Information

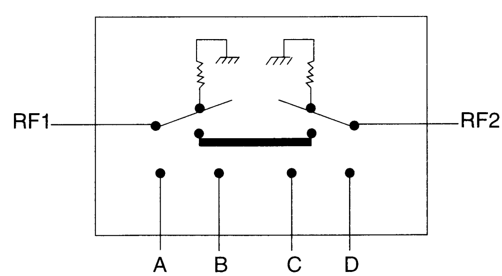
Part No.	Package
SW-341	Ceramic
SW-342	TO-5-4

CR-2 w/o Pin 1



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



Truth Table

Control Inputs				Condition of Switch
A	B	C	D	RF1-RF2
Low	High	High	Low	On
High	Low	Low	High	Off

Specifications Subject to Change Without Notice.

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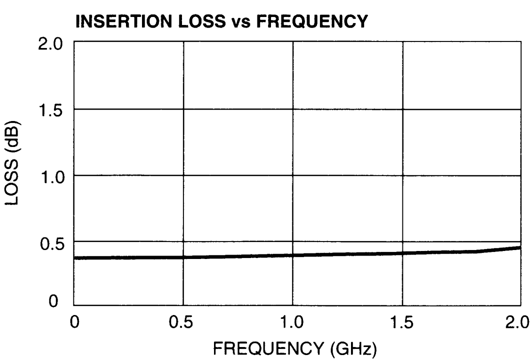
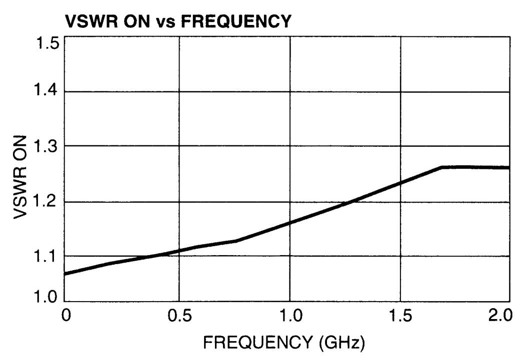
Absolute Maximum Ratings[1]

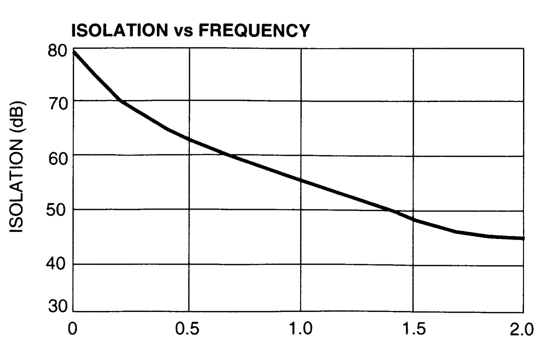
Parameter	Absolute Maximum
Max. Input Power[2]	+34 dBm
Control Voltage	+5.5 V, -8.5 V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

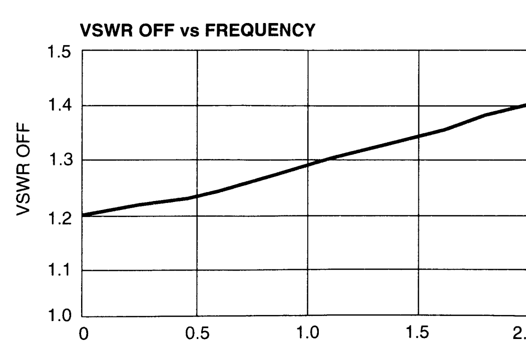
1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +31 dBm.

Typical Performance @ +25°C









Specifications Subject to Change Without Notice.

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an AMP company

GaAs SPST Single Positive Control Matched Switch 0.5-1.5 GHz

SW-349

V 2.00

Features

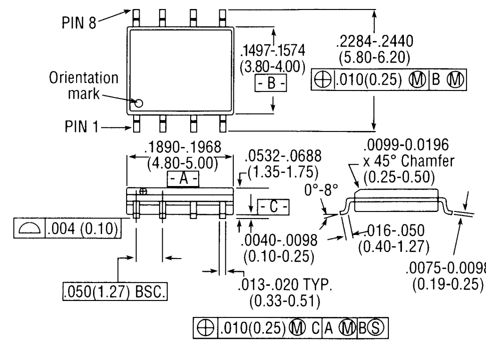
- Single Supply Voltage +3 V to +5 V
- Single Control +3 V to +5 V
- Matched Input and Output
- Low Distortion 47 dBm IP_3 @ 0.5 GHz with +5 V
- Low Power Consumption <10 mA @ 5 V typ.
- Low Cost Plastic SOIC-8 Package

Description

The SW-349 is a GaAs MMIC matched SPST switch in a low cost plastic SOIC 8-lead package. This switch is designed for high isolation from 0.5-1.5 GHz, with typical isolation greater than 40 dB @ 0.9 GHz. The SW-349 requires external DC blocks on the RF ports. The SW-349 is ideally suited for applications where very low power consumption (<10 mA @ 5 V) and low intermodulation products are required. Typical applications include switching and blanking for radio and cellular equipment, wireless LANs, GPS equipment and other RF control circuits.

The SW-349 is fabricated with a GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
SW-349 PIN	SOIC 8-Lead Plastic
SW-349TR	Foward Tape & Reel *
SW-349RTR	Reverse Tape & Reel *

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A= +25°C

Parameter	Test Conditions[1]	Units	Min.	Typ.	Max.
Insertion Loss	500-1500 MHz	dB		0.9	1.2
Isolation	500 - 1500 MHz 750 - 960 MHz	dB dB	20 35	 38	
VSWR	500 - 750 MHz 750 - 960 MHz 960 - 1500 MHz			1.5:1 1.3:1 1.2:1	1.7:1 1.4:1 1.3:1
Trise, Tfall Ton , Toff Transients	10%-90% RF, 90% - 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	µS µS mV		1 2 20	
1 dB Compression	Vctl = +5 V 500 MHz Vctl = +3 V 500 MHz	dBm dBm		26 20	
Input IP_3	Vctl = +5 V[2] Vctl = +3 V[2]	dBm dBm		47 44	
Input IP_2	Vctl = +5 V[2] Vctl = +3 V[2]	dBm dBm		60 56	

1. All measurements are in a 50 ohm system. DC blocks are required on RF1 and RF2. Vin Low = 0V ±0.2V, Vin High = V_S ±0.2V, V_S = +3 to +5V. For inputs under 20 dBm, hot switching can be used.
2. Two tone +5 dBm each (+8 dBm total) F1 = 900 MHz, F2 = 900.05 MHz.

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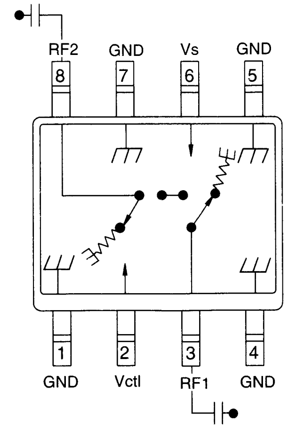
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
RF Input Power @ +3 V	+23 dBm
RF Input Power @ +5 V	+29 dBm
Supply Voltage (V_s)	+8 V
Control Voltage (Vctl)	V_s+0.2 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic[2]



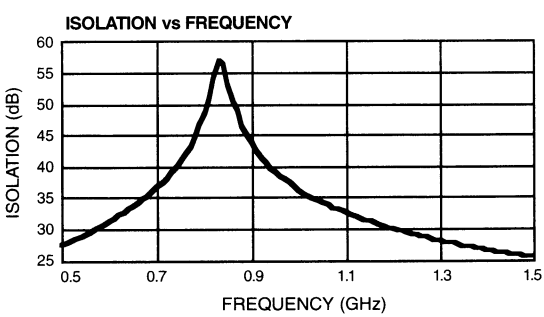
2. DC Blocks are required on RF1 and RF2.

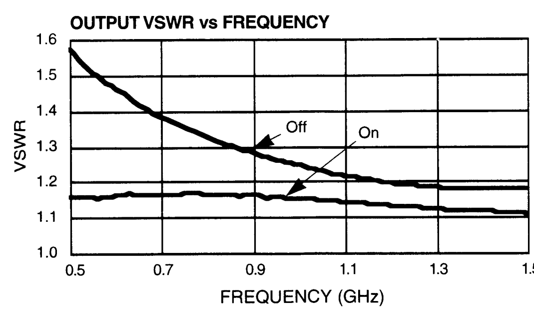
Truth Table

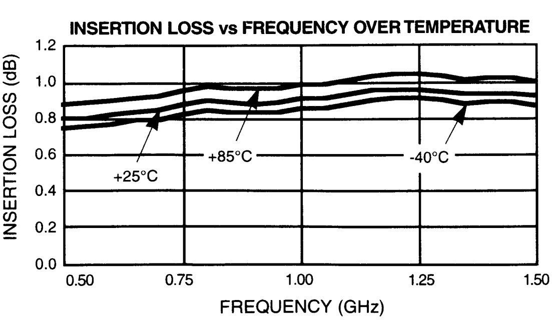
Control Input	
+Vctl	RF1-RF2
V_{in} Low	ON
V_{in} High	OFF

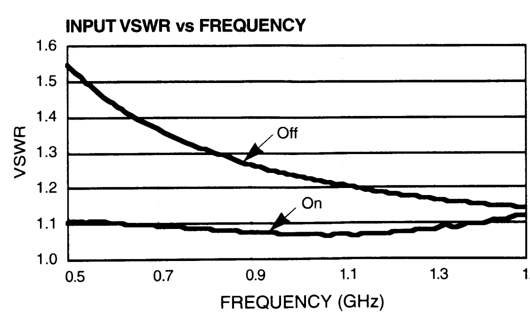
V_{in} Low = 0 to +0.2 V @ 5 μA typ.
V_{in} High = V_S ± 0.2 V @ 10 μA typ.

Typical Performance @ +25°C









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M/A-COM an AMP company

GaAs DPDT Switch DC - 2 GHz

SW-355

V 2.00

Features

- Fast Switching Speed, 10 ns Typical
- Ultra Low DC Power Consumption
- Low Insertion Loss

Guaranteed Specifications[1] (-55°C to +85°C)

Frequency Range		DC – 2.0 GHz
Insertion Loss	DC – 2.0 GHz	1.3 dB Max
	DC – 1.0 GHz	1.0 dB Max
	DC – 0.5 GHz	0.9 dB Max
	DC – 0.05 GHz	0.8 dB Max
VSWR	DC – 2.0 GHz	2.0:1 Max
	DC – 1.0 GHz	1.7:1 Max
	DC – 0.5 GHz	1.5:1 Max
	DC – 0.05 GHz	1.3:1 Max
Isolation[2]	DC – 2.0 GHz	23 dB Min
	DC – 1.0 GHz	27 dB Min
	DC – 0.5 GHz	35 dB Min
	DC – 0.05 GHz	40 dB Min

Operating Characteristics

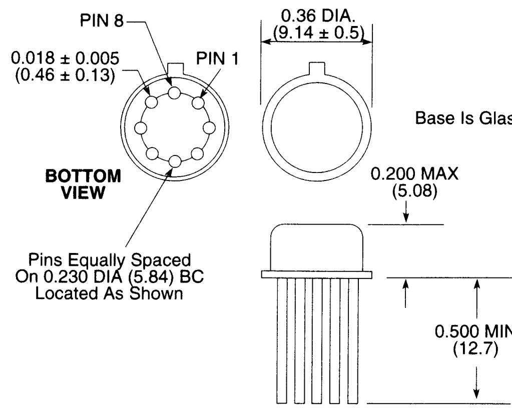
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			10 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			12 ns Typ
Transients (In-Band)			100 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.5 – 2.0 GHz	+68	+46	dBm Typ
0.05 GHz	+62	+40	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0 to -0.2 V @ 20 µA Max
Vin High			-5 V @ 10 µA Typ to -8 V @ 300 µA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.
2. Isolation is measured from RF2 to RF1.
3. Contact the factory for standard or custom screening requirements.

Ordering Information

Part Number	Package
SW-355 PIN	TO-5-3

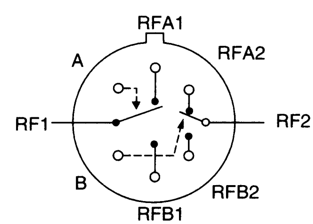
TO-5-3



WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Functional Schematic (Top View)



Truth Table

Control Input		Condition of RF path			
A	B	RF1–RFA1	RF1–RFB1	RF2–RFA2	RF2–RFB2
High	Low	OFF	ON	OFF	ON
Low	High	ON	OFF	ON	OFF

Specifications Subject to Change Without Notice.

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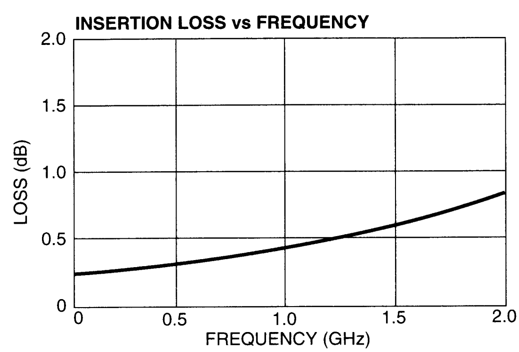
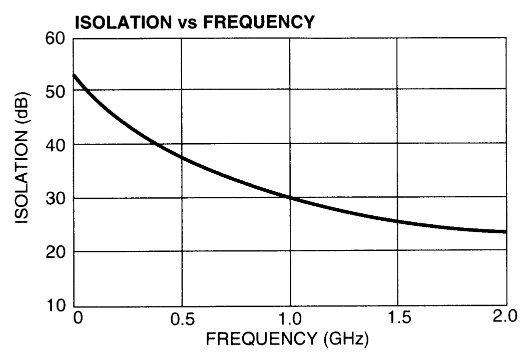
Absolute Maximum Ratings[1]

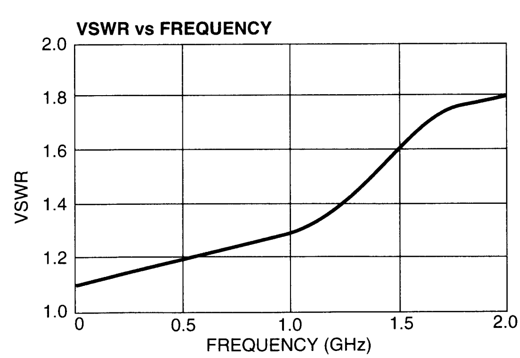
Parameter	Absolute Maximum
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5 V, –8.5 V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance @ +25°C







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2 Watt Cellular T/R and Antenna Changeover Switch DC-2.0 GHz

SW-358, 359A

V 2.00

Features

- Low Cost Plastic SSOP-8 Package[1]
- Both Positive and/or Negative 3 to 10 V Control
- Low Insertion Loss: 0.4 dB
- Very High Intercept Point: 55 dBm IP_3
- Very Low Power Consumption: 50μW
- For AMPS, NAMPS, ETACS, NMT, GSM, PCN, PDC, and DECT Applications

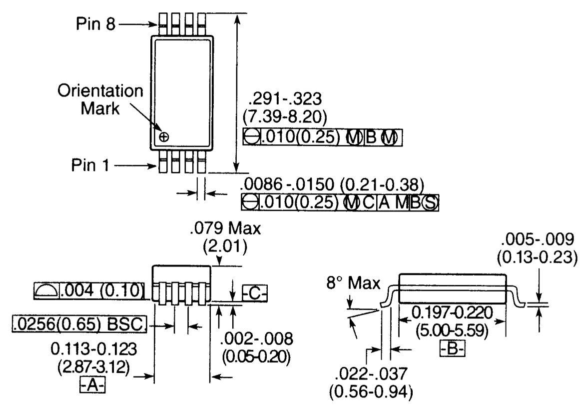
Description

The SW-358[3] and SW-359A[4] are GaAs MMIC SPDT switches in low cost SSOP 8-lead surface mount plastic packages.

These switches are ideally suited for use where very low distortion and low loss are required. The SW-358 and the SW-359A can be operated with negative, positive, or a combination of positive/negative control voltages. Typical application is an internal/external antenna select switch for portable telephones and data radios. In addition, because of its low loss, good isolation and inherent speed, the SW-358 can be used as a conventional T/R switch, or as an antenna diversity switch. Both switches can be used for power applications up to 2 watts in systems such as cellular, PCM, GSM, and other analog/digital wireless communication systems.

The SW-358 and SW-359A are fabricated with monolithic GaAs MMICs using a mature 1 micron process. The process features full passivation for increased performance and reliability.

SSOP-8



Dimensions in ( ) are in mm.
Unless otherwise noted:
.xxx= ± 0.010 (.xx= ±0.25)

Electrical Specifications, T_A = +25°C[2]

Parameter	Test Conditions		SW-358			SW-359A		
		Units	Min.	Typ.	Max.	Min.	Typ.	Max.
Insertion Loss	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB		0.35 0.45 1.0	0.4 0.6 1.2		0.35 0.45 1.0	0.4 0.6 1.2
Isolation	DC - 0.5 GHz DC - 1.0 GHz DC - 2.0 GHz	dB dB dB	20 15 8	23 17 10		20 15 8	23 17 10	
VSWR	DC - 1.0 GHz DC - 2.0 GHz			1.2:1 1.6:1	1.4:1 1.8:1		1.2:1 1.6:1	1.4:1 1.8:1
Trise, Tfall Ton , Toff Transients	10%-90% RF, 90% - 10% RF 50% Control to 90% RF, 50% Control to 10% RF In-Band	nS nS mV		38 42 30			38 42 30	
1 dB Compression	Input Power, (5V Supply/Control) 0.9 GHz Input Power, (8V Supply/Control) 0.9 GHz	dBm dBm		35 37			35 37	
Input IP_3	2-Tone, 5 MHz spacing, +10 dBm (+13 dBm total) 0.9 GHz	dBm		55			55	
Input IP_2	2-Tone, 5 MHz spacing, +10 dBm (+13 dBm total) 0.9 GHz	dBm		98			98	
T/R Intermodulation Products[5]	TX Tone +30 dBm @ 830 MHz (5V Supply/Control) RX Spurious +10 dBm @ 785 MHz (8.5V Supply/Control)	dBm dBm		-45 -78			-45 -78	

1. Available in Tape and Reel packaging.
2. All specifications apply when operated with bias voltages of 0 and 5V at 1 GHz in a 50 ohm system, unless otherwise specified
3. SW-358 replaces SW-031.
4. SW-359A replaces SW-030.
5. See diagram on following page for test set up.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power (0.5 - 2.5GHz)	
3 V Control and Supply	+34dBm
5 V Control and Supply	+37dBm
9 V Control and Supply	+40dBm
Power Dissipation	1.0W
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Thermal Resistance[2]	θ_{jc} = 87°C/W

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.
2. Thermal resistance is given for T_A = +25° C. Tcase is the temperature of leads 1 and 4.

Ordering Information

Part Number	Package
SW-358 PIN	SSOP 8 Lead Plastic
SW-358TR	Forward Tape & Reel*
SW-358RTR	Reverse Tape & Reel*
SW-359A PIN	SSOP 8 Lead Plastic
SW-359ATR	Forward Tape & Reel*
SW-359ARTR	Reverse Tape & Reel*

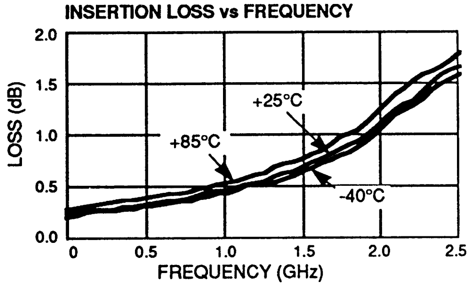
* If Specific reel size is required, consult factory for part number assignment.

Two Tone IP_3 Measurements

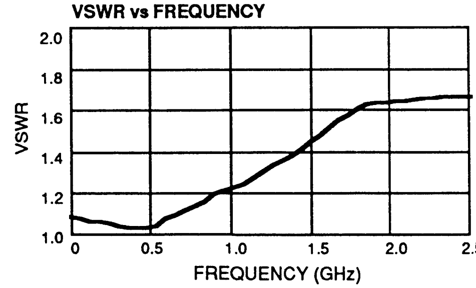
Supply & Control Voltage	Input Power (dBm)	3rd Order Intermodulation Products (dBc)	IP_3 (dBm)	Second Harmonic (dBc)
0, 3 V	+27	-33	+43	-54
0, 5 V	+27	-38	+46	-63
0, 8 V	+27	-66	+60	-65
0, 10 V	+27	-65	+60	-67
0, 3 V	+28	-33	+45	-55
0, 5 V	+28	-35	+45	-63
0, 8 V	+28	-64	+60	-68
0, 10 V	+28	-63	+60	-66
0, 3 V	+29	-32	+45	-51
0, 5 V	+29	-36	+47	-64
0, 8 V	+29	-62	+60	-67
0, 10 V	+29	-63	+61	-67
0, 3 V	+30	-33	+46	-51
0, 5 V	+30	-31	+45	-59
0, 8 V	+30	-54	+57	-67
0, 10 V	+30	-62	+61	-67

Typical Performance @ +25°C

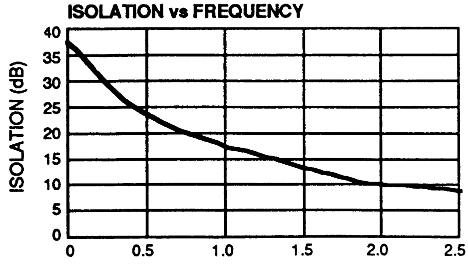
INSERTION LOSS vs FREQUENCY



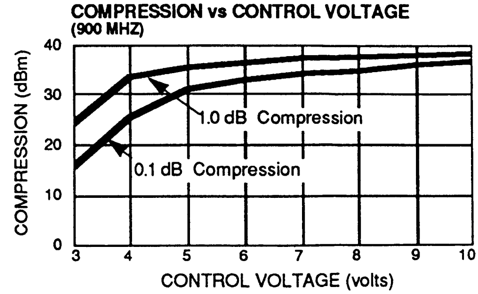
VSWR vs FREQUENCY



ISOLATION vs FREQUENCY



COMPRESSION vs CONTROL VOLTAGE (900 MHZ)



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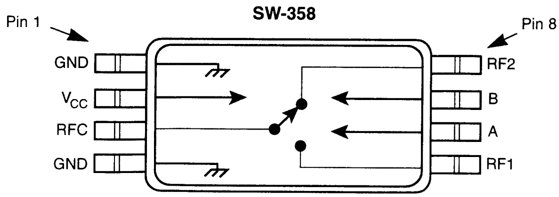
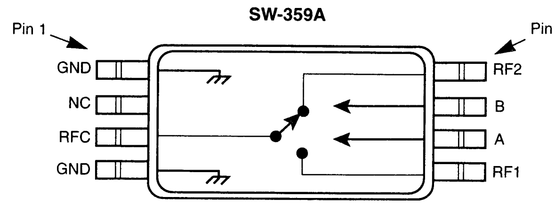
Functional Schematics





SW-358 Voltage Selection Truth Table

Mode	V_{CC}	Control Input A	Control Input B	RFC - RF1	RFC - RF2
Positve Control and Supply[1]	+3 to +8.5 V	0 ±0.2 V V_{CC} ±0.2 V	V_{CC} ±0.2 V 0 ±0.2 V	On Off	Off On
Positive Supply and Positive/Negative Control[1,2]	+3 to +8.5 V	-V V_{CC}	V_{CC} -V	On Off	Off On
Negative Control[3]	0 V (GND)	0 ±0.2 V -3 V -8.5 V	-3 V to -8.5 V 0 ±0.2 V	Off On	On Off

Note: 1. External DC blocking capacitors are required on all RF ports.
2. $|-V| + V_{CC} \leq 8.5$ volts.
3. If negative control is used, DC blocking capacitors are not required on the RF ports.

SW-359A Voltage Selection Truth Table

Mode	Control Input A	Control Input B	RFC - RF1	RFC - RF2
Positve Control[1]	0 ±0.2 V +3 to +8.5 V	+3 to +8.5 V 0 ±0.2 V	On Off	Off On
Positive/Negative Control[1,2]	-V +V	+V -V	On Off	Off On
Negative Control[3]	0 ±0.2 V -3 V to -8.5 V	-3 V to -8.5 V 0 ±0.2 V	Off On	On Off

Note: 1. External DC blocking capacitors are required on all RF ports.
2. $|-V| + V \leq 8.5$.
3. If negative control is used, DC blocking capacitors are not required on the RF ports.

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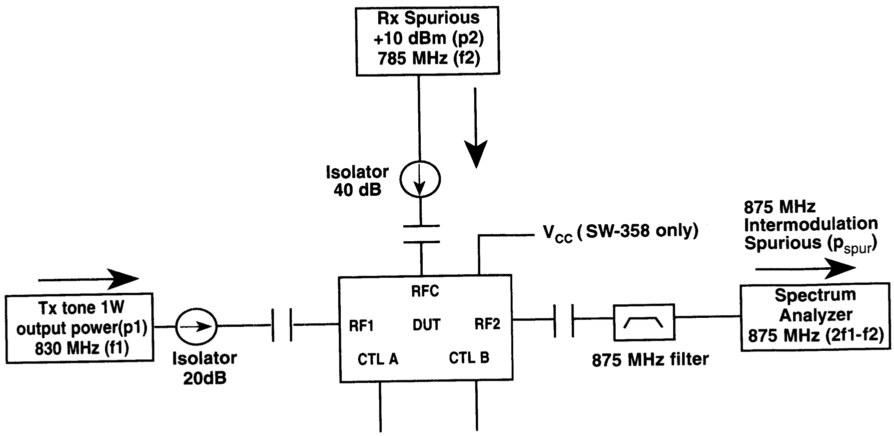
T/R Intermodulation Products Test Set-Up



This set-up tests the intermodulation product at the receiver frequency of 875 MHz generated by the intermodulation of the 1W Tx signal at 830 MHz (f1) and a Rx spurious at 785 MHz (f2). A +10 dBm spurious signal is used in order to overcome measurement sensitivity.
To calculate the intermodulation product, at the RF2 port, for a different Tx power level (p1) and a different Rx spurious level (p2), use the following formula:

$$p_{spur}\ (@\ RF2) = (2p1 + p2) - 148\ dBm$$

To calculate the intermodulation product, at the RF1 port, for a different Tx power level (p1) and a different Rx spurious level (p2), use the following formula:

$$p_{spur}\ (@\ RF1) = (2p1 + p2) - 130\ dBm$$

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an AMP company

GaAs Transfer Switch
DC - 2 GHz

SW-362

V 2.00

Features

- Broad Bandwidth
- Low Power Consumption
- Fast Switching Speed

Guaranteed Specifications[1]

(-55°C to + 85°C)

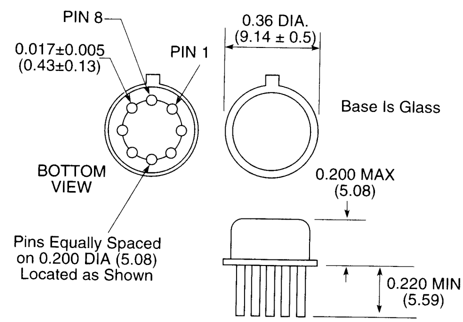
Parameter	Frequency	Value
Frequency Range		DC – 2.0 GHz
Insertion Loss	DC – 2.0 GHz	1.5 dB Max
	DC – 1.0 GHz	1.4 dB Max
	DC – 0.5 GHz	1.3 dB Max
VSWR	DC – 2.0 GHz	1.6:1 Max
	DC – 1.0 GHz	1.5:1 Max
	DC – 0.5 GHz	1.4:1 Max
Isolation	DC – 2.0 GHz	30 dB Min
	DC – 1.0 GHz	32 dB Min
	DC – 0.5 GHz	35 dB Min

Operating Characteristics

Parameter			Value
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			4 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			7 ns Typ
Transients (In-Band)			25 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 – 2.0 GHz	+68	+46	dBm Typ
0.05 GHz	+56	+40	dBm Typ
Control Voltages (Complementary Logic)			
Vin Low			0 to -0.2V @ 20 µA Max
Vin High			-5V @ 50 µA Typ to -8V @ 300 µA Max

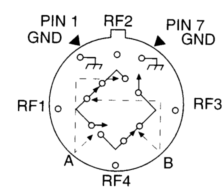
1. All specifications apply with 50 ohm impedance connected to all RF ports with 0 and -5 Vdc control voltages.
2. Contact the factory for standard or custom screening requirements.

TO-5-4



WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS
Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Functional Schematic (Top View)



Ordering Information

Model No.	Package
SW-362 PIN	Ceramic

Truth Table

Control Input		Condition of RF path			
A	B	RF1–RF2	RF2–RF3	RF3–RF4	RF1–RF4
Low	High	OFF	ON	OFF	ON
High	Low	ON	OFF	ON	OFF

Specifications Subject to Change Without Notice.

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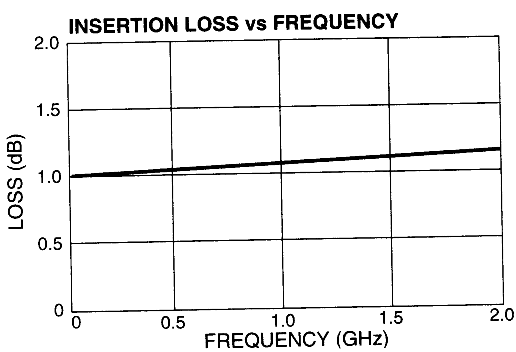
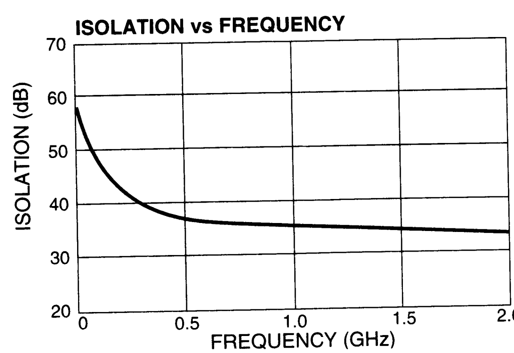
Absolute Maximum Ratings

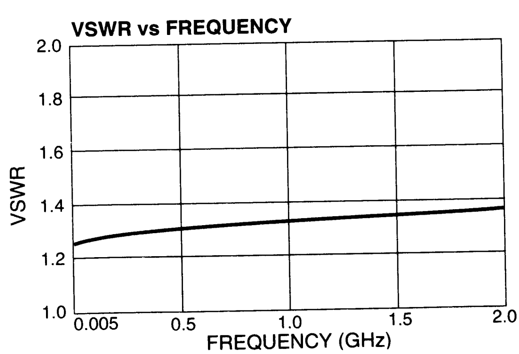
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







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GaAs Solid State Relay DC-2 GHz

SW-368

V 2.00

Features

- High IP2 and IP3 at Low Frequencies
- High Compression Point at Low Frequencies
- Low Insertion Loss

Guaranteed Specifications[1]

(From -55° C to +85°C)

		RF2- RF1	RF1-RFA1/ RF2-RFA2	
Frequency Range			DC – 2.0 GHz	
Insertion Loss	DC – 2.0 GHz	1.3 dB	1.0 dB	Max
	DC – 1.0 GHz	1.0 dB	0.7 dB	Max
	DC – 0.5 GHz	0.8 dB	0.5 dB	Max
VSWR (On State) Input/Output	DC – 2.0 GHz	1.9:1	1.9:1	Max
	DC – 1.0 GHz	1.4:1	1.4:1	Max
	DC – 0.5 GHz	1.2:1	1.2:1	Max
Isolation	DC – 2.0 GHz	20 dB	10 dB	Min
	DC – 1.0 GHz	25 dB	15 dB	Min
	DC – 0.5 GHz	30 dB	20 dB	Min

Operating Characteristics

Impedance	50 Ohms Nominal	
Switching Characteristics		
Trise (10% to 90% RF)	27 µs	Typ
Tfall (90% to 10% RF)	22 ns	Typ
Ton (50% CTL-90% RF)	29 µs	Typ
Toff (50% CTL-10% RF)	25 ns	Typ
Transients (In-Band)	63 mV	Typ
Input Power for 1 dB Compression		
0.5 to 2.0 GHz	30 dBm	Typ
0.005 – 0.05 GHz	28 dBm	Typ

Intermodulation Intercept point (for two-tone input power up to +5 dBm)

Intercept Points	IP2	IP3	
0.5 to 2.0 GHz	+68	+40	dBm Typ
0.005 – 0.05 GHz	+80	+47	dBm Typ

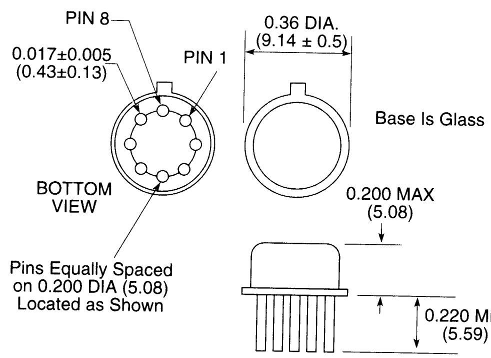
Control Voltage (Complementary Logic)	
Vin Low	-5 to -8V @ 200 µA Max
Vin High	+3 to +5V @ 100 µA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports with +5 and -5 V control voltages.
2. Above reference insertion loss.
3. Contact the factory for standard or custom screening requirements.

Ordering Information

Model No.	Package
SW-368 PIN	TO-5-4

TO-5-4



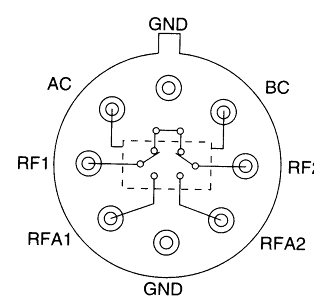
WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

Bottom of Case is AC Ground

Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Functional Schematic (Top View)



Truth Table

Control Input		Condition of Switch		
AC	BC	RF1-RF2	RF1-RFA1	RF2-RFA2
-5	+5	OFF	ON	ON
+5	-5	ON	OFF	OFF

Specifications Subject to Change Without Notice.

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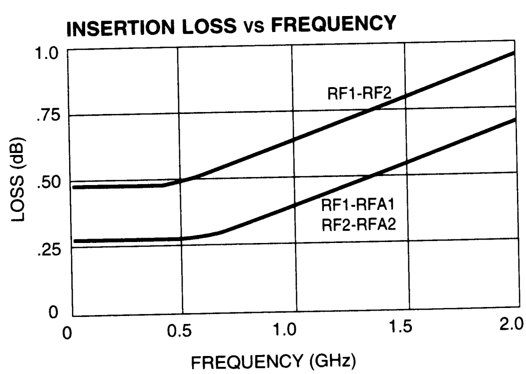
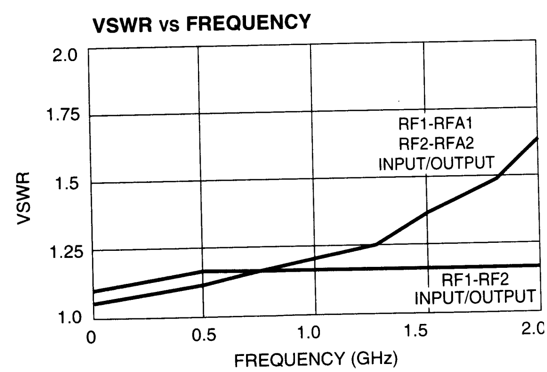
Absolute Maximum Ratings

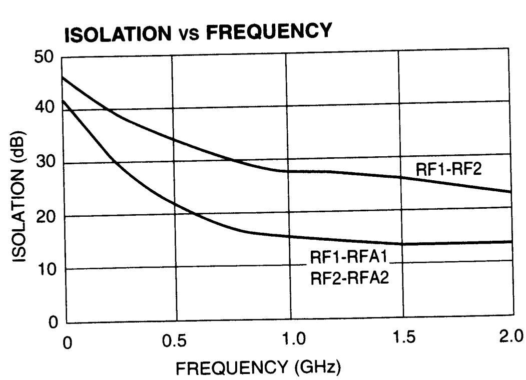
Parameter	Absolute Maximum
Max. Input Power	+34 dBm
Control Voltage	+5.5 V, –8.5 V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







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M/A-COM an AMP company

GaAs Matched SP4T Switch 0.02-2 GHz

SW-369

V 2.00

Features

- Internal CMOS Decoder/Driver
- Low Power Consumption
- Fast Switching Speed, 60 ns Typ
- Very High Intercept Points

Guaranteed Specifications[1]

(From -55°C to +85°C)

Frequency Range			0.02 – 2.0 GHz
Insertion Loss	0.02 – 2.0 GHz		2.8 dB Max
	0.02 – 1.0 GHz		2.4 dB Max
	0.02 – 0.5 GHz		1.8 dB Max
VSWR		Common, RF1 – RF4 On	RF1 - RF4 Off
	0.2 – 2.0 GHz	2.0:1 Max	2.0:1 Max
	0.2 – 1.0 GHz	1.6:1 Max	1.6:1 Max
	0.2 – 0.5 GHz	1.5:1 Max	1.5:1 Max
	0.1 – 0.2 GHz	1.5:1 Max	1.7:1 Max
	0.02 – 0.1 GHz	1.4:1 Max	Not Specified
Isolation	0.02 – 2.0 GHz		40 dB Min
	0.02 – 1.0 GHz		45 dB Min
	0.02 – 0.5 GHz		50 dB Min

Operating Characteristics

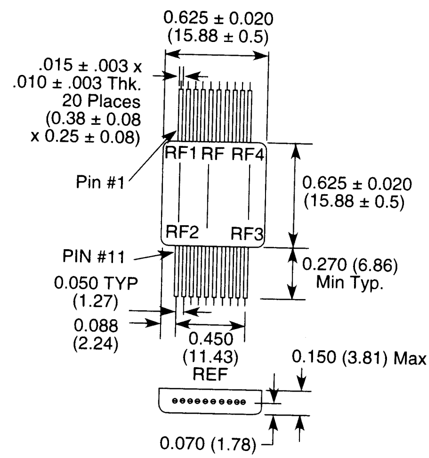
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise,Tfall (10% to 90% RF)			8 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			60 ns Typ
Transients (in band)			50 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+23 dBm Typ
0.05 GHz			+17 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.5 – 2.0 GHz	+72	+44	dBm Typ
0.05 GHz	+50	+40	dBm Typ
Bias Power	+5 VDC	@	2 mA Max
Control Voltages			
Vin Low (0)			0.0 to 1.5 V @ 1 μA Max
Vin High (1)			3.5 to 5.0 V @ 1 μA Max

1. All specifications apply with 50 ohm impedance to all RF ports with 0 and +5 Vdc control voltages.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

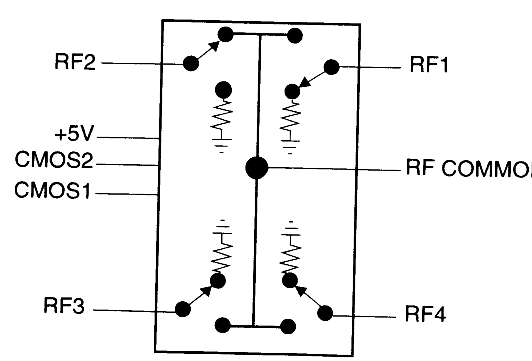
Model No.	Package
SW-369 PIN	Flatpack

FP-26



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz[2]	+34 dBm
Bias Voltage	-0.5 to +7V
Control Voltage	-0.5 to V_{CC} +0.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +30 dBm.

Pin Configuration

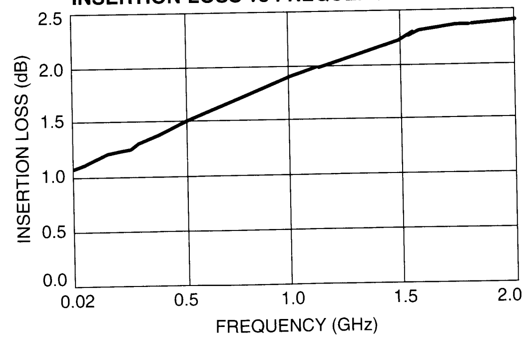
Pin No.	Description	Pin No.	Description
1	RF1	11	RF2
2	GND	12	GND
3	GND	13	GND
4	GND	14	+5VDC
5	RF Common	15	CMOS 2
6	GND	16	CMOS 1
7	GND	17	N/C
8	GND	18	GND
9	GND	19	GND
10	RF4	20	RF3

Truth Table

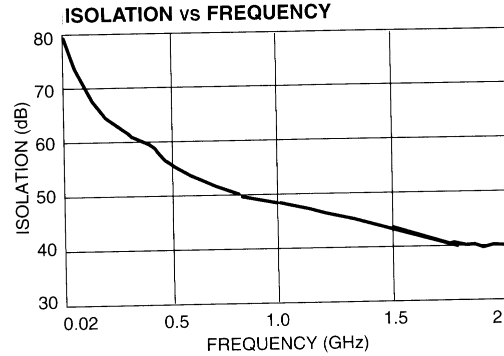
Control Inputs		Condition of Switch			
"1" = Logic High (CMOS)		RF Common to Each RF Port			
CMOS 1	CMOS 2	RF1	RF2	RF3	RF4
0	0	ON	OFF	OFF	OFF
1	0	OFF	ON	OFF	OFF
0	1	OFF	OFF	ON	OFF
1	1	OFF	OFF	OFF	ON

Typical Performance

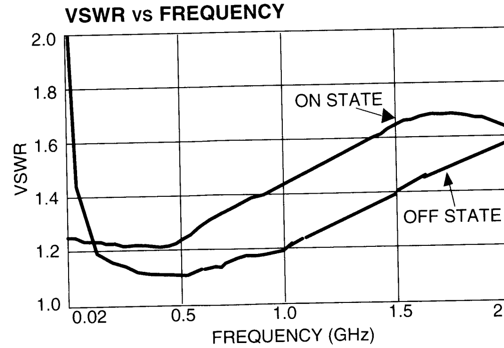
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



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M/A-COM an AMP company

GaAs MMIC Low Loss SPDT Switch DC-2.0 GHz

SW-373

V 2.00

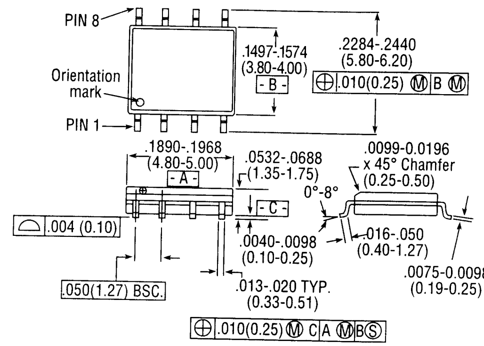
Features

- Low Insertion Loss: 0.5 dB Typ.@900 MHz
- Low Cost Plastic SOIC 8 Lead Package[1]
- Positive and/or Negative Control, Single Supply Voltage
- Very High Intercept Point: 55 dBm IP_3
- Very Low Power Consumption: 50 µW
- For AMPS, NAMPS, ETACS, NMT, GSM, PCN, PDC, and DECT Applications

Description

The SW-373 is a GaAs MMIC SPDT switch in a low cost SOIC 8-lead surface mount plastic package.
The switch is ideally suited for use where very low distortion and low loss are required. The SW-373 can be operated with negative, positive, or a combination of positive/negative control voltages. Typical application is an internal/external antenna select switch for portable telephones and data radios. In addition, because of its low loss, good isolation and inherent speed, the SW-373 can be used as a conventional T/R switch, or as an antenna diversity switch. This switch can be used for low power applications up to 100 mW in systems such as cellular, PCM, GSM, and other analog/digital wireless communication systems.
The SW-373 is fabricated with monolithic GaAs MMICs using a mature 1 micron process. The process features full passivation for increased performance and reliability.

SO-8



8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part Number	Package
SW-373 PIN	SOIC 8 Lead Plastic
SW-373TR	Foward Tape & Reel *
SW-373RTR	Reverse Tape & Reel *

* If specific reel size is required, consult factory for part number assignment.

Electrical Specifications, T_A= +25°C [2,3]

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	DC - 1.0 GHz	dB		0.45	0.7
	1.0 - 2.0 GHz	dB		1.0	1.2
Isolation	DC - 0.5 GHz	dB	25	27	
	0.5 - 1.0 GHz	dB	20	23	
	1.0 - 2.0 GHz	dB	15	17	
VSWR	DC - 1.0 GHz			1.2:1	1.3:1
	1.0 - 1.5 GHz			1.6:1	1.8:1
	1.5 - 2.0 GHz			2.4:1	2.6:1
Trise, Tfall	10%-90% RF, 90% - 10% RF	nS		<10	
Ton , Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		<12	
Transients	In-Band	mV		15	
1 dB Compression	Input Power, +3V Control/Supply 0.9 GHz	dBm		14	
	Input Power, +5V Control/Supply 0.9 GHz	dBm		24	
Input IP_3	For two-tone input power up to +10 dBm (+3 V V_S) 0.9 GHz	dBm		33	
Input IP_3	For two-tone input power up to +10 dBm (+5 V V_S) 0.9 GHz	dBm		55	

1. Available in Tape and Reel packaging. Consult factory for ordering instructions.
2. All specifications apply when operated with bias voltages of 0 and +5V at 1 GHz in a 50Ω system, unless otherwise specified.
3. External DC blocking capacitors are required on all RF ports.

Specifications Subject to Change Without Notice.

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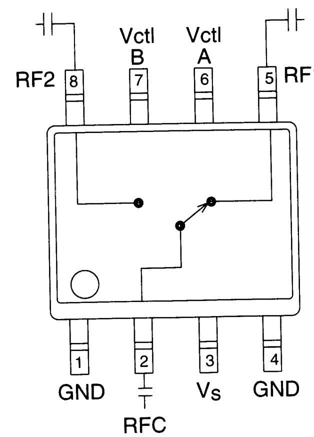
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power (0.5 - 2.5 GHz)	
3 V Control and Supply	+17 dBm
5 V Control and Supply	+30 dBm
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Thermal Resistance[2]	Θ_{jc} = 87°C/W

1. Operation of this device above any one of these parameters may cause permanent damage.
2. Thermal resistance is given for T_A = +25° C. Tcase is the temperature of leads 1 and 4.

Functional Schematic[3]



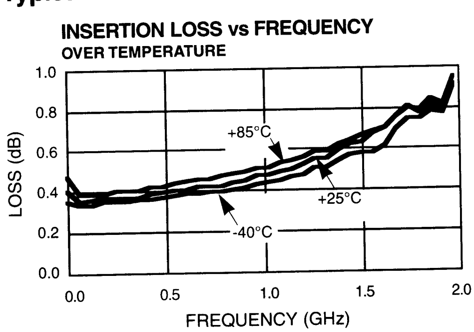
3. External DC blocking capacitors are required on all RF ports.

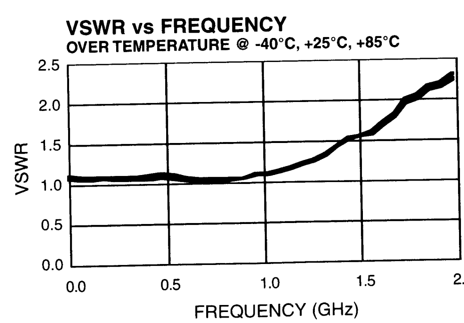
Truth Table

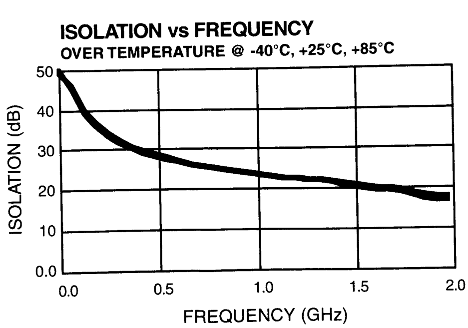
Control Input			
VA	VB	RFC - RF1	RFC - RF2
0	1	On	Off
1	0	Off	On

0 = 0 ±0.2 V
1 = V_S ±0.2 V

Typical Performance @ +25°C







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GaAs SP4T Absorptive Switch
DC-2 GHz

SW-411

V 2.00

Features

- Low Insertion Loss
- Low Power Consumption
- Fast Switching Speed, 8 ns Typ
- Very High Intercept Points

Guaranteed Specifications[1]

(From -55°C to +85°C)

Frequency Range			DC – 2.0 GHz
Insertion Loss	DC – 2.0 GHz		1.6 dB Max
	DC – 1.0 GHz		1.4 dB Max
	DC – 0.5 GHz		1.2 dB Max
VSWR		Common, RF1 – RF4 On	RF1 - RF4 Off
	DC – 2.0 GHz	1.8:1 Max	1.8:1 Max
	DC – 1.0 GHz	1.6:1 Max	1.6:1 Max
	DC – 0.5 GHz	1.4:1 Max	1.4:1 Max
Isolation	DC – 2.0 GHz		40 dB Min
	DC – 1.0 GHz		45 dB Min
	DC – 0.5 GHz		50 dB Min

Operating Characteristics

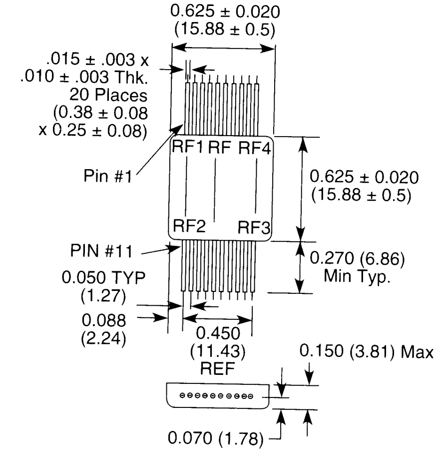
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise,Tfall (10% to 90% RF)			8 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			16 ns Typ
Transients (In band)			15 mV Typ
Output Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.5 – 2.0 GHz	+60	+46	dBm Typ
0.05 GHz	+45	+35	dBm Typ
Control Voltages			
Vin Low (0)			0.0 to -0.2 V @ 20 µA Max
Vin High (1)			-5.0 V to -8.0 V @ 300 µA Max

1. All specifications apply with 50 ohm impedance to all RF ports.
2. Contact the factory for standard or custom screening.

Ordering Information

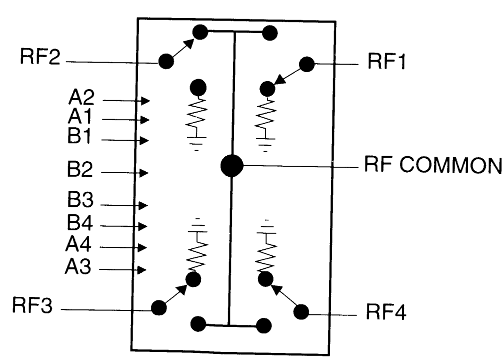
Model No.	Package
SW-411 PIN	Flatpack

FP-26



Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic (Top View)



Specifications Subject to Change Without Notice.

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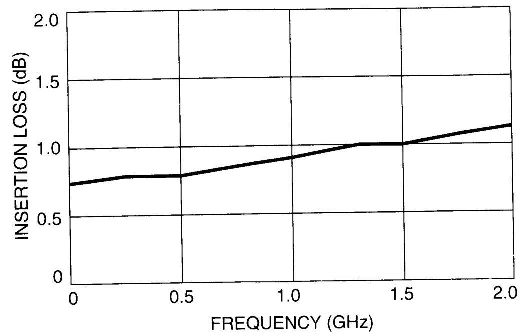
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz[2]	+34 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

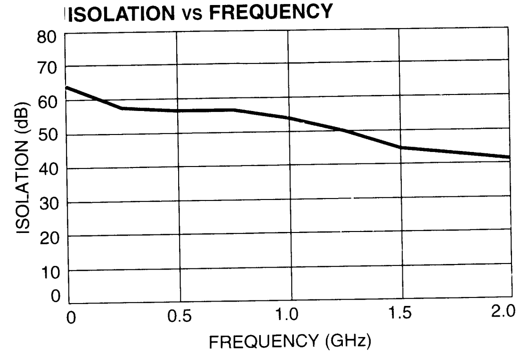
1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +30 dBm.

Typical Performance

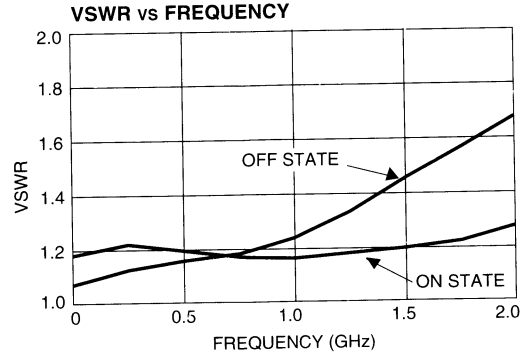
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Pin Configuration

Pin No.	Description	Pin No.	Description
1	RF1	11	RF2
2	GND	12	A2
3	GND	13	A1
4	GND	14	B1
5	RF Common	15	B2
6	GND	16	B3
7	GND	17	B4
8	GND	18	A4
9	GND	19	A3
10	RF4	20	RF3

Truth Table

Control Input								Condition of Switch RF Common to Each RF Port			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
1	0	0	1	0	1	0	1	On	Off	Off	Off
0	1	1	0	0	1	0	1	Off	On	Off	Off
0	1	0	1	1	0	0	1	Off	Off	On	Off
0	1	0	1	0	1	1	0	Off	Off	Off	On

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Matched GaAs SP4T Switch DC - 2 GHz

SW-415

V 2.00

Features

- Low Insertion Loss, 1.4 dB Typical
- Fast Switching Speed, 200 ns Typical
- Low DC Power Consumption
- Integral CMOS Decoder/Driver

Guaranteed Specifications[1]

(-55°C to + 85°C)

Frequency Range		DC – 2.0 GHz
Insertion Loss	DC – 2.0 GHz	1.8 dB Max
	DC – 1.0 GHz	1.5 dB Max
	DC – 0.5 GHz	1.2 dB Max
VSWR	DC – 2.0 GHz	1.8:1 Max
	DC – 1.0 GHz	1.8:1 Max
	DC – 0.5 GHz	1.4:1 Max
Isolation	DC – 2.0 GHz	37 dB Min
	DC – 1.0 GHz	43 dB Min
	DC – 0.5 GHz	45 dB Min

Operating Characteristics

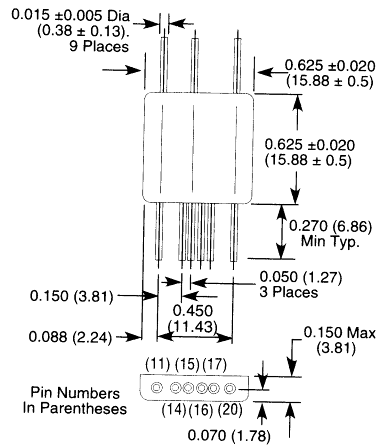
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			50 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			200 ns Typ
Transients (In-Band)			15 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+17 dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
0.5 – 2.0 GHz	+60	+46	dBm Typ
0.05 GHz	+45	+35	dBm Typ
Control Voltages			
Vin Low (0)			0.0 to 1.5V @ 1 µA Max
Vin High (1)			3.5 to 5.0V @ 1 µA Max
Bias Power			-5 VDC @ 5 mA Max
			+5 VDC @ 1 mA Max

1. All specifications apply with 50 ohm impedance connected to all RF ports.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

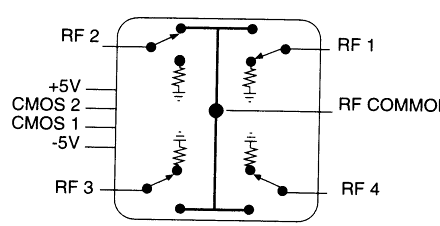
Model No.	Package
SW-415 PIN	Flatpack

FP-25



Weight (approx.): 0.12 Ounces 3.4 Grams
Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Schematic



Truth Table

Control Input		Condition of Switch			
"1" = Logic High (CMOS)		RF Common to Each RF Port			
CMOS 2	CMOS 1	RF1	RF2	RF3	RF4
0	0	ON	OFF	OFF	OFF
0	1	OFF	ON	OFF	OFF
1	0	OFF	OFF	ON	OFF
1	1	OFF	OFF	OFF	ON

Specifications Subject to Change Without Notice.

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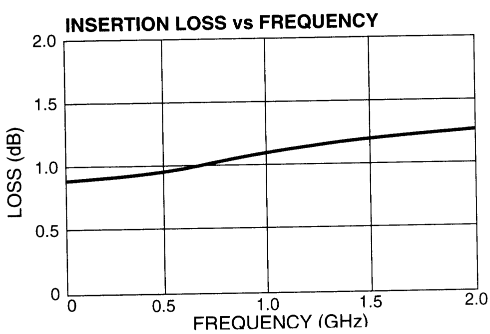
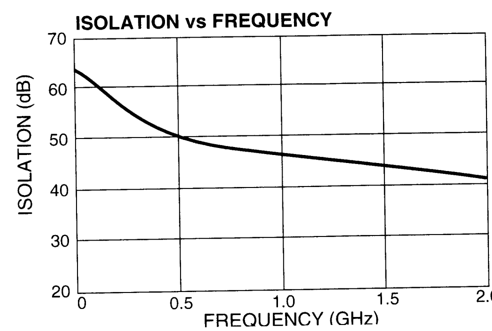
Absolute Maximum Ratings

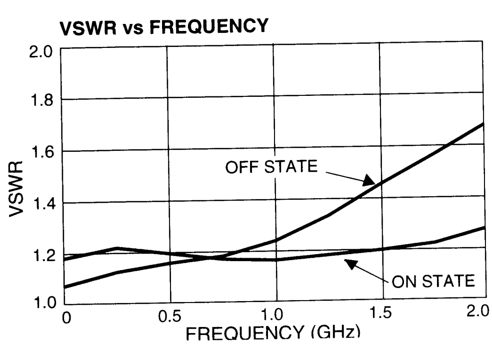
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+24 dBm
0.5–2.0 GHz	+30 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125°C
Storage Temperature	–65˚C to +150˚C

1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







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M/A-COM
an AMP company

GaAs SP4T Terminated Switch DC - 2 GHz

SW-419

Features

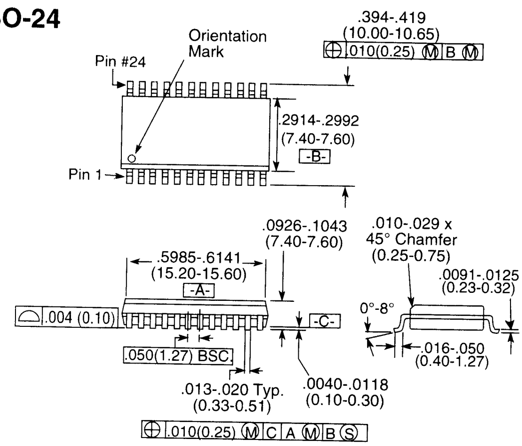
- Very Low Power Consumption: 100 μW
- Low Insertion Loss: 1 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC24 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-419 is a GaAs MMIC SP4T terminated switch in a low cost SOIC 24-lead wide body surface mount plastic package. The SW-419 is ideally suited for use where very low power consumption is required. Typical applications include switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-419 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-24



24-Lead SOP outline dimensions
Wide body .300
(All dimensions per JEDEC No. MS-013-AD, Issue C)
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ±0.5)

Ordering Information

Part No.	Package
SW-419 PIN	SOIC 24-Lead Plastic Package
SW-419 TR	Forward Tape & Reel
SW-419 RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz	dB		0.8	1.0
	DC – 0.5 GHz	dB		0.8	1.1
	DC – 1.0 GHz	dB		0.9	1.2
	DC – 2.0 GHz	dB		1.2	1.4
Isolation	DC – 0.1 GHz	dB	54	60	
	DC – 0.5 GHz	dB	46	51	
	DC – 1.0 GHz	dB	36	39	
	DC – 2.0 GHz	dB	20	24	
VSWR	On			1.3:1	
	Off			1.3:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	nS		8	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		16	
Transients	In Band	mV		15	
One dB Compression	Input Power 0.05 GHz	dBm		21	
	Input Power 0.5 – 2.0 GHz	dBm		27	
IP_2	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz	dBm		45	
	0.5 – 2.0 GHz	dBm		60	
IP_3	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz	dBm		35	
	0.5 – 2.0 GHz	dBm		46	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements with 0, -5 V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

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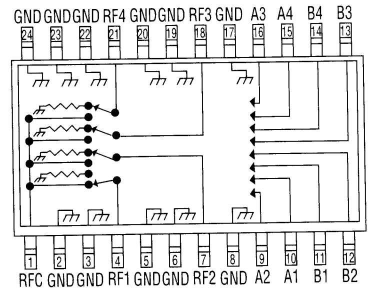
Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
Below 500 MHz	+27 dBm
Above 500 MHz	+30 dBm
Control Voltage	+5 V, – 8.5 V
Storage Temperature	-65° to +150°C

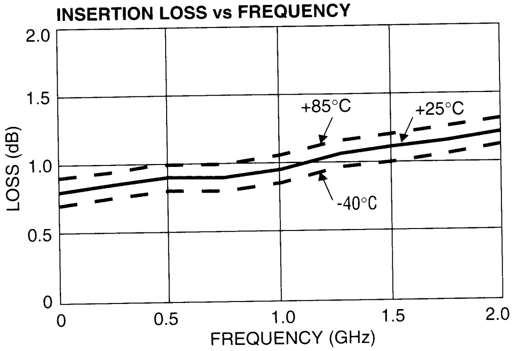
1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematic

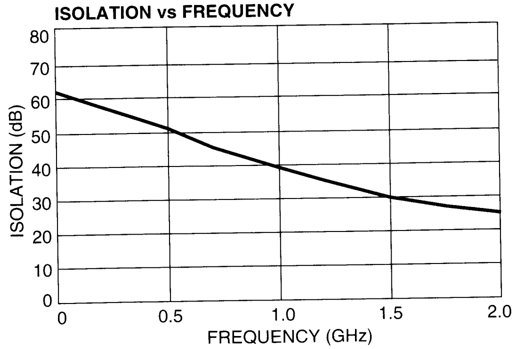


Typical Performance

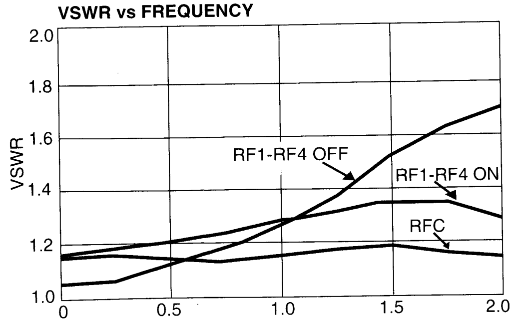
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Pin Configuration

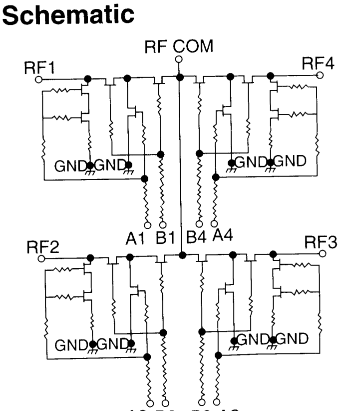
Pin No.	Description	Pin No.	Description
1	RF Common	13	B3
2	GND	14	B4
3	GND	15	A4
4	RF1	16	A3
5	GND	17	GND
6	GND	18	RF3
7	RF2	19	GND
8	GND	20	GND
9	A2	21	RF4
10	A1	22	GND
11	B1	23	GND
12	B2	24	GND

Truth Table

Control Input								Condition Of Switch RF Common to Each RF Port			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
1	0	0	1	0	1	0	1	On	Off	Off	Off
0	1	1	0	0	1	0	1	Off	On	Off	Off
0	1	0	1	1	0	0	1	Off	Off	On	Off
0	1	0	1	0	1	1	0	Off	Off	Off	On

"0" – 0 – -0.2 V @ 20 μA max
"1" – -5 V @ 20 μA Typ to -8 V @ 300 μA max.

Electrical Schematic



Specifications Subject to Change Without Notice.

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an AMP company

T/R Diversity Switch DC - 2.5 GHz

SW-923

V 2.00

Features

- +36 dBm Typ. 1 dB Compression Point, 8 V Supply
- Two Tone IP_3 @ 1 Watt - Each Tone 44 dBm
- Low Insertion Loss: 0.7 dB Typical
- Low Power Consumption: 100 μW
- Low Cost SSOP20 Plastic Package

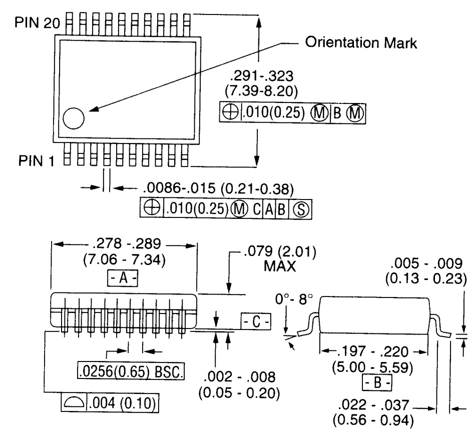
Description

M/A-COM's SW-923 is a GaAs MMIC transmit/receive antenna diversity switch for applications up to 2.5 GHz, with power levels up to 2 watts.

The SW-923 is ideally suited for use where very low power consumption is required. Typical applications include transmit/receive diversity switching in land mobile and portable transceiver applications and other battery powered radio equipment.

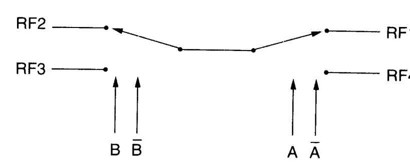
The SW-923 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SSOP-20



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± .010 (.xx = ±0.25)
.xx = ± 0.02 (.x = ± 0.5)

Functional Diagram



Ordering Information

Part Number	Package
SW-923 PIN	SSOP 20-Lead Plastic Package

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.55 0.65 0.7 0.9	0.6 0.7 0.9 1.2
Isolation	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB	36 36 32 22	38 38 36 25	
VSWR	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz			1.3:1 1.5:1 1.5:1 2.0:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		5 8 12	
One dB Compression	Input Power (5 V Supply/Control) 0.9 GHz Input Power (8 V Supply/Control) 0.9 GHz	dBm dBm		32 36	
IP_3	Measured Relative (5 V Supply/Control) 0.9 GHz to Input Power (8 V Supply/Control) 0.9 GHz (for two-tone input power up to +10 dBm)	dBm dBm		61 65	

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	
0.5 – 2.0 GHz	
5 V Control and Supply	+37 dBm
8 V Control and Supply	+40 dBm
10 V Control and Supply	+42 dBm
Power Dissipation	1.0 W
Supply Voltage (+V)	-1, +12
Control Voltage (+V)	-1, V supply to 0.2 V
Operating Temperature	-40°C to 85°C
Storage Temperature	-65°C to 150°C

1. Operation of this device above any one of these parameters may cause pemanent damage.

IP_3 Measurements with Two Tones

F1 = 0.9 GHz, F2 = 0.905 GHz			
Input Power (Each Tone)	**Control Voltage**	**3rd Order Intermodulation Product (dBc)**	**IP_3 (dBm)**
+24 dBm	0, +5	-32	+40
	0, +6	-46	+47
	0, +7	-66	+57
	0, +8	-66	+57
+25 dBm	0, +5	-28	+ 39
	0, +6	-38	+44
	0, +7	-56	+53
	0, +8	-65	+57.5
+26 dBm	0, +5	-25	+38.5
	0, +6	-32	+42
	0, +7	-46	+49
	0, +8	-64	+58
+27 dBm	0, +5	-24	+39
	0, +6	-46	+41.5
	0, +7	-66	+45
	0, +8	-66	+50.5
+28 dBm	0, +8	-40	+48
+29 dBm	0, +8	-34	+46
+30 dBm	0, +8	-28	+44

Pin Configuration

Pin No.	Description	Pin No.	Description
1	+V Supply	11	+V Supply
2	GND	12	GND
3	RF1	13	RF3
4	GND	14	GND
5	CTL A	15	CTL $\overline{B}$
6	CTL $\overline{A}$	16	CTL B
7	GND	17	GND
8	RF4	18	RF2
9	GND	19	GND
10	GND	20	GND

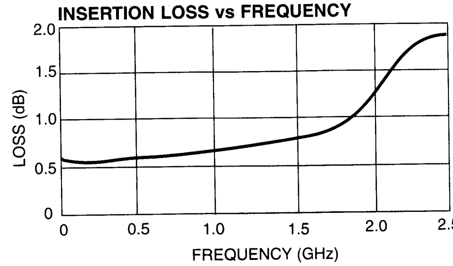
1. +V Supply voltage = +3 V to +8 V; +control voltage = +3 V to +8 V.
2. The high control voltage must be within ± 0.2 V of the supply voltage.
3. The RF ports must be DC blocked outside of the package from ground or any other voltage.

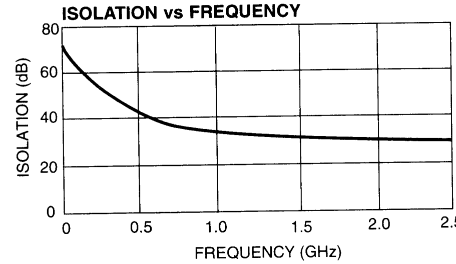
Truth Table

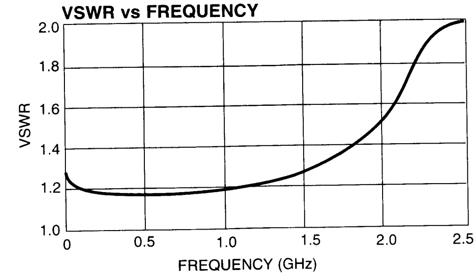
Control Input				RF Port			
A	$\overline{A}$	B	$\overline{B}$	RF1	RF2	RF3	RF4
0	1	0	1	ON	ON	OFF	OFF
0	1	1	0	ON	OFF	ON	OFF
1	0	0	1	OFF	ON	OFF	ON
1	0	1	0	OFF	OFF	ON	ON

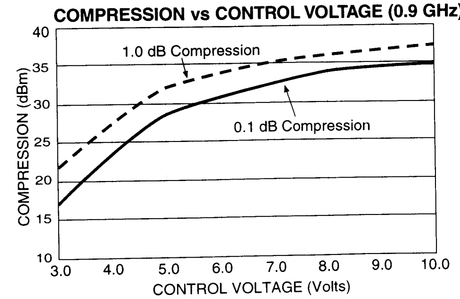
"0" = 0 to 0.2 V @ 20 µA Max.
"1" = +3 V @ 30 µA Typ. to +10 V @ 800 µA Max.

Typical Performance









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![M/A-COM an AMP company]

Single/Quad Drivers for GaAs FET Switches and Attenuators

SWD-109/119

V 2.00

Features

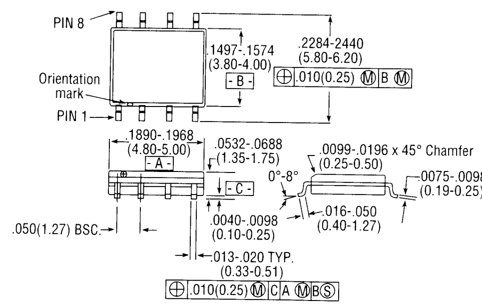
- High Speed CMOS Technology
- Single Channel (SWD-109)
- Quad Channel (SWD-119)
- Positive Voltage Control
- Low Power Dissipation
- Low Cost Plastic SOIC Package[3]

Description

The SWD-109 is a single channel driver used to translate TTL control inputs into gate control voltages for GaAs FET microwave switches and attenuators. High speed analog CMOS technology is utilized to achieve low power dissipation at moderate to high speeds, encompassing most microwave switching applications. The output HIGH level is optionally 0 to +2.0V (relative to GND) to optimize the intermodulation products of the control devices at low frequencies.

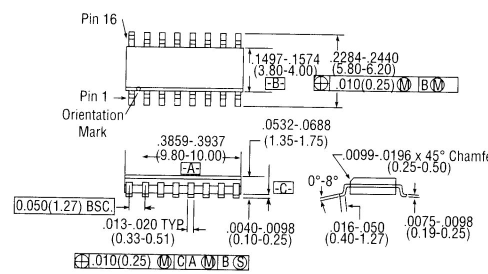
The SWD-119 is a quad channel driver with performance similiar to the single channel version.

SO-8 (SWD-109)



SOIC 8 Lead outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)

SO-16 (SWD-119)



SOIC 16 lead outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx =± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Guaranteed Operating Ranges

Symbol	Parameter[1]	Unit	Min.	Typ.	Max.
V_{CC}	Positive DC Supply Voltage	V	4.5	5.0	5.5
V_{EE}	Negative DC Supply Voltage	V	-8.5	-5.5	-4.5
V_{OPT}[2]	Optional DC Output Supply Voltage	V	0	1.0	2.0
V_{OPT}-V_{EE}	Negative Supply Voltage Range	V	4.5	6.5	8.5
V_{CC}-V_{EE}	Positive to Negative Supply Range	V	9.0	10.0	14.0
T_A	Operating Ambient Temperature	°C	-40	+25	+85
I_{OH}	DC Output Current - HIGH	mA			-1.0
I_{OL}	DC Output Current - LOW	mA			1.0
T_{rise}, T_{fall}	Maximum Input Rise or Fall Time	ns			500

Note 1: All voltages are relative to GND **Note 2:** See note on following page **Note 3:** Tape and reel packaging available. Contact factory.

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

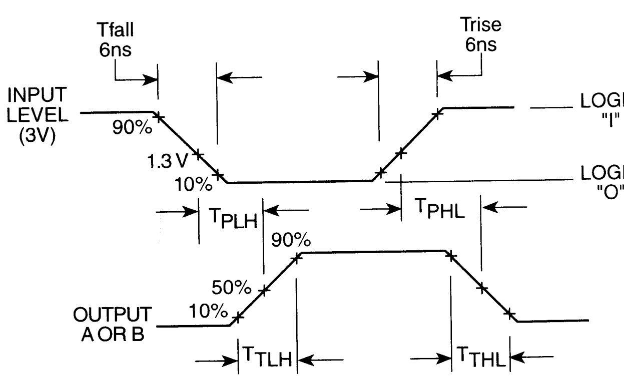
Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Positive DC Supply Voltage	-0.5	5.5	V
V_{EE}	Negative DC Supply Voltage	-9.0	0.5	V
V_{OPT}	Optional DC Output Supply Voltage	-0.5	2.0	V
V_{OPT} - V_{EE}	Output to Negative Supply Voltage Range	-0.5	9.0	V
V_{CC} - V_{EE}	Positive to Negative Supply Range	-0.5	14.5	V
V_I	DC Input Voltage	-0.5	V_{CC} + 0.5	V
I_I	DC Input Current	-25	25	mA
V_O	DC Output Voltage	V_{EE} - 0.5	V_{OPT} + 0.5	V
I_O	DC Output Current	-25	25	mA
T_{STG}	Storage Temperature	-65	150	°C

All voltage are referenced to GND. All inputs and outputs incorporate latch-up protection structures.

DC Characteristics Over Guaranteed Operating Range

Symbol	Parameter	Test Conditions		Units	Limits		
					Min.	Typ.	Max.
V_{IH}	Input HIGH Voltage	Guaranteed HIGH Input Voltage		V	2.0	1.5	
V_{IL}	Input LOW Voltage	Guaranteed LOW Input Voltage		V		1.5	0.8
V_{OH}	Output HIGH Voltage	I_{OH} = -1 mA	V_{EE} = Max	V	V_{OPT} - 0.1		
V_{OL}	Output LOW Voltage	I_{OL} = 1 mA	V_{EE} = Max	V			V_{EE} + 0.1
I_{IN}	Input Leakage Current	V_{IN} = V_{CC} or GND	V_{EE} = Min	µA	-1.0	0	1.0
I_{CC}	Quiescent Supply Current	V_{CC} = Max V_{OPT} = Min or Max	V_{EE} = Min V_{IN} = V_{CC} or GND	µA			100
ΔI_{CC}	Additional Supply Current, per TTL Input pin	V_{CC} = Max	V_{IN} = V_{CC} - 2.1 V	mA			1.0

Switching Waveforms



2. V_{OPT} is grounded for most applications. To improve the intermodulation performance and the 1dB compression point of GaAs control devices at low frequencies, V_{OPT} can be increased to between 1.0 and 2.0V. The nonlinear characteristics of the GaAs control devices will approximate performance at 500 MHz. It should be noted that the control currents on the GaAs MMICs will increase when positive controls are applied.

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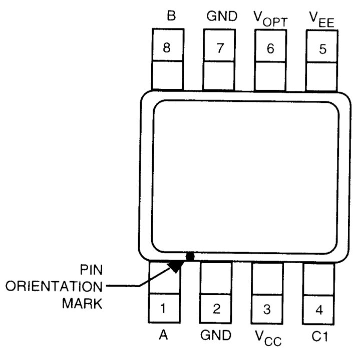
Truth Table for Single Driver (SWD-109)

Input	Outputs	
C1	A	B
Logic "0"	V_{EE}	V_{OPT}
Logic "1"	V_{OPT}	V_{EE}

Ordering Information

Part No.	Package
SWD-109 PIN	SOIC 8 Lead
SWD-109TR	Forward Tape and Reel
SWD-109RTR	Reverse Tape and Reel

Functional Schematic (SWD-109)



AC Characteristics Over Guaranteed Operating Range[4] (SWD - 109)

Symbol	Parameter	V_{OPT} - V_{EE}	Max Limits -55 to +25°C	≤ +85°C	≤ +125°C	Unit
T_{PLH}	Propagation Delay, I to either O	4.5 6.5 8.5	45 44 43	55 54 52	61 59 57	ns
T_{PHL}	Propagation Delay, I to either O	4.5 6.5 8.5	45 43 41	55 52 49	61 57 53	ns
T_{TLH}	Output Rising Transition Time	4.5 6.5 8.5	10.0 9.0 8.0	10.0 9.0 8.0	11.0 9.0 8.0	ns
T_{THL}	Output Falling Transition Time	4.5 6.5 8.5	10.0 9.0 8.0	10.0 9.0 8.0	11.0 9.0 8.0	ns
T_{skew}	Delay Skew, OA to OB	4.5 6.5 8.5	8.0 8.0 7.5	8.5 8.5 8.0	10.0 10.0 9.5	ns
C_{IN}	Input Capacitance	-	10	10	10	pF
C_{PDC}	Power Dissipation Capacitance[5]	-	10	10	10	pF
C_{PDE}	Power Dissipation Capacitance[5]	-	140	140	140	pF

4. V_{CC} = 4.5V, V_{EE} = -4.5V, V_{OPT} = 0V, C_L = 25 pF, Trise, Tfall = 6 ns. These conditions represent the worst case for slow delays.
5. Total Power Dissipation is calculated by the following formula: $PD = V_{CC}{}^2 fC_{PDC} + (V_{OPT} - V_{EE})^2 fC_{PDE}$

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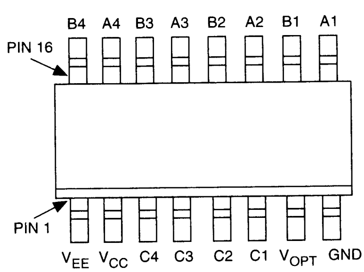
Truth Table for Quad Driver (SWD-119)

Inputs				Outputs							
C4	C3	C2	C1	B4	A4	B3	A3	B2	A2	B1	A1
0	0	0	0	X	Y	X	Y	X	Y	X	Y
0	0	0	1	X	Y	X	Y	X	Y	Y	X
0	0	1	0	X	Y	X	Y	Y	X	X	Y
0	0	1	1	X	Y	X	Y	Y	X	Y	X
0	1	0	0	X	Y	Y	X	X	Y	X	Y
0	1	0	1	X	Y	Y	X	X	Y	Y	X
0	1	1	0	X	Y	Y	X	Y	X	X	Y
0	1	1	1	X	Y	Y	X	Y	X	Y	X
1	0	0	0	Y	X	X	Y	X	Y	X	Y
1	0	0	1	Y	X	X	Y	X	Y	Y	X
1	0	1	0	Y	X	X	Y	Y	X	X	Y
1	0	1	1	Y	X	X	Y	Y	X	Y	X
1	1	0	0	Y	X	Y	X	X	Y	X	Y
1	1	0	1	Y	X	Y	X	X	Y	Y	X
1	1	1	0	Y	X	Y	X	Y	X	X	Y
1	1	1	1	Y	X	Y	X	Y	X	Y	X

Where X = V_{VAR} ,Y = V_{EE}

Functional Schematic (SWD-119)



Ordering Information

Pin No.	Package
SWD-119 PIN	SOIC 8 Lead
SWD-119TR	Forward Tape and Reel
SWD-119RTR	Reverse Tape and Reel

AC Characteristics Over Guaranteed Operating Range[4] (SWD-119)

Symbol	Parameter	$V_{OPT} - V_{EE}$	Max. Limits			Unit
			-55 to +25°C	≤ +85°C	≤ +125°C	
T_{PLH}	Propagation Delay, I to either O	4.5 6.5 8.5	45 44 43	55 54 52	61 59 57	ns
T_{PHL}	Propagation Delay, I to either O	4.5 6.5 8.5	45 43 41	55 52 49	61 57 53	ns
T_{TLH}	Output Rising Transition Time	4.5 6.5 8.5	10.5 10.0 9.0	11.0 10.0 9.0	12.0 10.0 9.0	ns
T_{THL}	Output Falling Transition Time	4.5 6.5 8.5	10.0 9.0 8.0	10.0 9.0 8.0	11.0 9.0 8.0	ns
T_{skew}	Delay Skew, OA to OB	4.5 6.5 8.5	8.0 8.0 7.5	8.5 8.5 8.0	10.0 10.0 9.5	ns
C_{IN}	Input Capacitance	-	10	10	10	pF
C_{PDC}	Power Dissipation Capacitance[5]		10	10	10	pF
C_{PDE}	Power Dissipation Capacitance[5]	-	140	140	140	pF

4. V_{CC} = 4.5V, V_{EE} = -4.5V, V_{OPT} = 0V, C_L = 25 pF, Trise, Tfall = 6 ns. These conditions represent the worst case for slow delays.
5. Total Power Dissipation is calculated by the following formula: $PD = V_{CC}^2 fC_{PDC} + (V_{OPT} - V_{EE})^2 fC_{PDE}$

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M/A-COM an AMP company

Single/Quad Drivers for GaAs FET Switches and Attenuators

SWD-109/119

V 2.00

Features

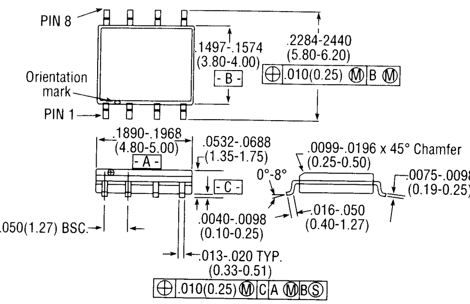
- High Speed CMOS Technology
- Single Channel (SWD-109)
- Quad Channel (SWD-119)
- Positive Voltage Control
- Low Power Dissipation
- Low Cost Plastic SOIC Package[3]

Description

The SWD-109 is a single channel driver used to translate TTL control inputs into gate control voltages for GaAs FET microwave switches and attenuators. High speed analog CMOS technology is utilized to achieve low power dissipation at moderate to high speeds, encompassing most microwave switching applications. The output HIGH level is optionally 0 to +2.0V (relative to GND) to optimize the intermodulation products of the control devices at low frequencies.

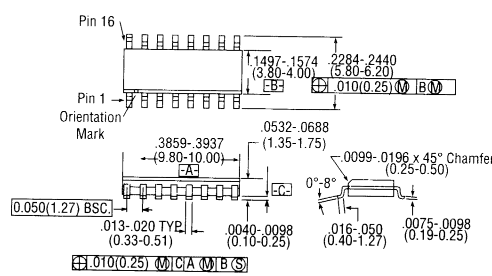
The SWD-119 is a quad channel driver with performance similiar to the single channel version.

SO-8 (SWD-109)



SOIC 8 Lead outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)

SO-16 (SWD-119)



SOIC 16 lead outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)
Dimensions in ( ) are in mm.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx =± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Guaranteed Operating Ranges

Symbol	Parameter[1]	Unit	Min.	Typ.	Max.
V_{CC}	Positive DC Supply Voltage	V	4.5	5.0	5.5
V_{EE}	Negative DC Supply Voltage	V	-8.5	-5.5	-4.5
V_{OPT}[2]	Optional DC Output Supply Voltage	V	0	1.0	2.0
V_{OPT}-V_{EE}	Negative Supply Voltage Range	V	4.5	6.5	8.5
V_{CC}-V_{EE}	Positive to Negative Supply Range	V	9.0	10.0	14.0
T_A	Operating Ambient Temperature	°C	-40	+25	+85
I_{OH}	DC Output Current - HIGH	mA			-1.0
I_{OL}	DC Output Current - LOW	mA			1.0
T_{rise}, T_{fall}	Maximum Input Rise or Fall Time	ns			500

Note 1: All voltages are relative to GND **Note 2:** See note on following page **Note 3:** Tape and reel packaging available. Contact factory.

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings

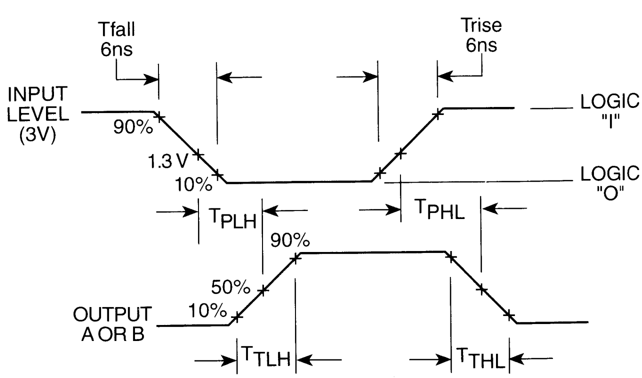
Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Positive DC Supply Voltage	-0.5	5.5	V
V_{EE}	Negative DC Supply Voltage	-9.0	0.5	V
V_{OPT}	Optional DC Output Supply Voltage	-0.5	2.0	V
V_{OPT} - V_{EE}	Output to Negative Supply Voltage Range	-0.5	9.0	V
V_{CC} - V_{EE}	Positive to Negative Supply Range	-0.5	14.5	V
V_I	DC Input Voltage	-0.5	V_{CC} + 0.5	V
I_I	DC Input Current	-25	25	mA
V_O	DC Output Voltage	V_{EE} - 0.5	V_{OPT} + 0.5	V
I_O	DC Output Current	-25	25	mA
T_{STG}	Storage Temperature	-65	150	°C

All voltage are referenced to GND. All inputs and outputs incorporate latch-up protection structures.

DC Characteristics Over Guaranteed Operating Range

Symbol	Parameter	Test Conditions		Units	Limits		
					Min.	Typ.	Max.
V_{IH}	Input HIGH Voltage	Guaranteed HIGH Input Voltage		V	2.0	1.5	
V_{IL}	Input LOW Voltage	Guaranteed LOW Input Voltage		V		1.5	0.8
V_{OH}	Output HIGH Voltage	I_{OH} = -1 mA	V_{EE} = Max	V	V_{OPT} - 0.1		
V_{OL}	Output LOW Voltage	I_{OL} = 1 mA	V_{EE} = Max	V			V_{EE} + 0.1
I_{IN}	Input Leakage Current	V_{IN} = V_{CC} or GND	V_{EE} = Min	µA	-1.0	0	1.0
I_{CC}	Quiescent Supply Current	V_{CC} = Max V_{OPT} = Min or Max	V_{EE} = Min V_{IN} = V_{CC} or GND	µA			100
ΔI_{CC}	Additional Supply Current, per TTL Input pin	V_{CC} = Max	V_{IN} = V_{CC} - 2.1 V	mA			1.0

Switching Waveforms



2. V_{OPT} is grounded for most applications. To improve the intermodulation performance and the 1dB compression point of GaAs control devices at low frequencies, V_{OPT} can be increased to between 1.0 and 2.0V. The nonlinear characteristics of the GaAs control devices will approximate performance at 500 MHz. It should be noted that the control currents on the GaAs MMICs will increase when positive controls are applied.

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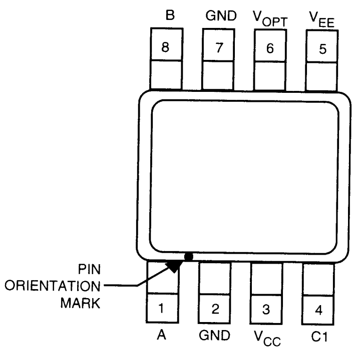
Truth Table for Single Driver (SWD-109)

Input	Outputs	
C1	A	B
Logic "0"	V_{EE}	V_{OPT}
Logic "1"	V_{OPT}	V_{EE}

Ordering Information

Part No.	Package
SWD-109 PIN	SOIC 8 Lead
SWD-109TR	Forward Tape and Reel
SWD-109RTR	Reverse Tape and Reel

Functional Schematic (SWD-109)



AC Characteristics Over Guaranteed Operating Range[4] (SWD - 109)

Symbol	Parameter	V_{OPT} - V_{EE}	Max Limits -55 to +25°C	Max Limits ≤ +85°C	Max Limits ≤ +125°C	Unit
T_{PLH}	Propagation Delay, I to either O	4.5 6.5 8.5	45 44 43	55 54 52	61 59 57	ns
T_{PHL}	Propagation Delay, I to either O	4.5 6.5 8.5	45 43 41	55 52 49	61 57 53	ns
T_{TLH}	Output Rising Transition Time	4.5 6.5 8.5	10.0 9.0 8.0	10.0 9.0 8.0	11.0 9.0 8.0	ns
T_{THL}	Output Falling Transition Time	4.5 6.5 8.5	10.0 9.0 8.0	10.0 9.0 8.0	11.0 9.0 8.0	ns
T_{skew}	Delay Skew, OA to OB	4.5 6.5 8.5	8.0 8.0 7.5	8.5 8.5 8.0	10.0 10.0 9.5	ns
C_{IN}	Input Capacitance	-	10	10	10	pF
C_{PDC}	Power Dissipation Capacitance[5]	-	10	10	10	pF
C_{PDE}	Power Dissipation Capacitance[5]	-	140	140	140	pF

4. V_{CC} = 4.5V, V_{EE} = -4.5V, V_{OPT} = 0V, C_L = 25 pF, Trise, Tfall = 6 ns. These conditions represent the worst case for slow delays.
5. Total Power Dissipation is calculated by the following formula: $PD = V_{CC}{}^2 fC_{PDC} + (V_{OPT} - V_{EE})^2 fC_{PDE}$

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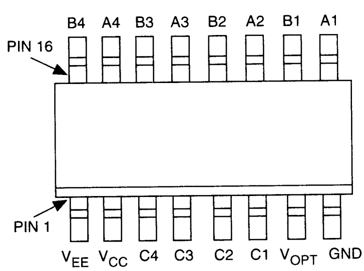
Truth Table for Quad Driver (SWD-119)

Inputs				Outputs							
C4	C3	C2	C1	B4	A4	B3	A3	B2	A2	B1	A1
0	0	0	0	X	Y	X	Y	X	Y	X	Y
0	0	0	1	X	Y	X	Y	X	Y	Y	X
0	0	1	0	X	Y	X	Y	Y	X	X	Y
0	0	1	1	X	Y	X	Y	Y	X	Y	X
0	1	0	0	X	Y	Y	X	X	Y	X	Y
0	1	0	1	X	Y	Y	X	X	Y	Y	X
0	1	1	0	X	Y	Y	X	Y	X	X	Y
0	1	1	1	X	Y	Y	X	Y	X	Y	X
1	0	0	0	Y	X	X	Y	X	Y	X	Y
1	0	0	1	Y	X	X	Y	X	Y	Y	X
1	0	1	0	Y	X	X	Y	Y	X	X	Y
1	0	1	1	Y	X	X	Y	Y	X	Y	X
1	1	0	0	Y	X	Y	X	X	Y	X	Y
1	1	0	1	Y	X	Y	X	X	Y	Y	X
1	1	1	0	Y	X	Y	X	Y	X	X	Y
1	1	1	1	Y	X	Y	X	Y	X	Y	X

Where X = V_{VAR} ,Y = V_{EE}

Functional Schematic (SWD-119)



Ordering Information

Pin No.	Package
SWD-119 PIN	SOIC 8 Lead
SWD-119TR	Forward Tape and Reel
SWD-119RTR	Reverse Tape and Reel

AC Characteristics Over Guaranteed Operating Range[4] (SWD-119)

Symbol	Parameter	V_{OPT} - V_{EE}	Max. Limits			Unit
			-55 to +25°C	≤ +85°C	≤ +125°C	
T_{PLH}	Propagation Delay, I to either O	4.5 6.5 8.5	45 44 43	55 54 52	61 59 57	ns
T_{PHL}	Propagation Delay, I to either O	4.5 6.5 8.5	45 43 41	55 52 49	61 57 53	ns
T_{TLH}	Output Rising Transition Time	4.5 6.5 8.5	10.5 10.0 9.0	11.0 10.0 9.0	12.0 10.0 9.0	ns
T_{THL}	Output Falling Transition Time	4.5 6.5 8.5	10.0 9.0 8.0	10.0 9.0 8.0	11.0 9.0 8.0	ns
T_{skew}	Delay Skew, OA to OB	4.5 6.5 8.5	8.0 8.0 7.5	8.5 8.5 8.0	10.0 10.0 9.5	ns
C_{IN}	Input Capacitance	-	10	10	10	pF
C_{PDC}	Power Dissipation Capacitance[5]		10	10	10	pF
C_{PDE}	Power Dissipation Capacitance[5]	-	140	140	140	pF

4. V_{CC} = 4.5V, V_{EE} = -4.5V, V_{OPT} = 0V, C_L = 25 pF, Trise, Tfall = 6 ns. These conditions represent the worst case for slow delays.
5. Total Power Dissipation is calculated by the following formula: PD = $V_{CC}{}^2 fC_{PDC} + (V_{OPT} - V_{EE})^2 fC_{PDE}$

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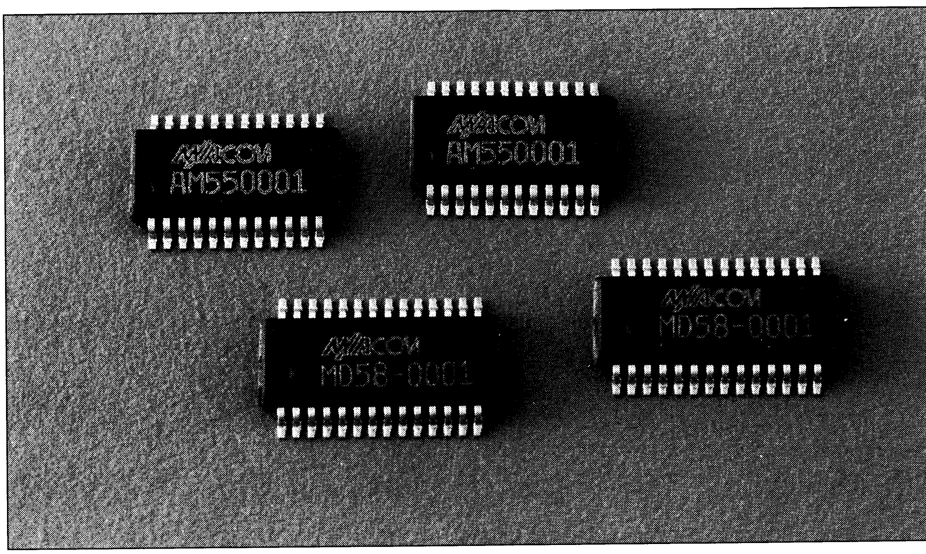
Multi-function and Integrated Technologies

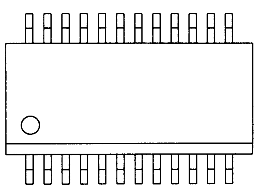


M/A-COM an AMP company

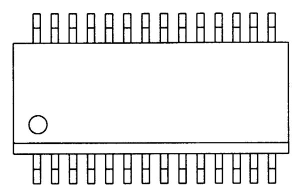
Multi-function Power Amplifiers/Switch

V 2.00

	Frequency (GHz)	Power Output (dBm)	Gain (dBm)	Switch Functions Type	Loss Typ. (dB)	Isolation Typ. (dB)	Package	Part No.	Page No.
New	1.8 - 2.0	24.0	24	T/R	0.6	20	SSOP-28	AM55-0004	16-17
New	2.4 - 2.5	22.0	26.5	T/R	1.2	15	SSOP-24	AM55-0007	16-25
New	2.4 - 2.5	22.0	26.5	T/R	1.2	15	SSOP-24	AM55-0001	16-2
				Diversity	1.2	15			
New	2.4 - 2.5	24.5	28	T/R	1.2	12	SSOP-28	AM55-0003	16-9
				Diversity	1.2	12			



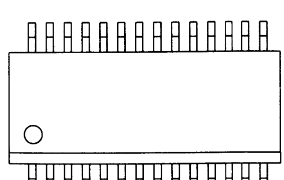
SSOP-24



SSOP-28

Multi-function Integrated Transceivers

	Frequency (GHz)	Receive Mode Conversion Gain (dB)	Noise Figure (db)	Input P-1dB (dBm)	Transmit Mode Output Power (dBm)	LO Leakage (dBm)	Part No.	Page No.
New	2.4 - 2.5	13.5	4.0	-8.0	-2	-20	MD58-0001	16-32
New	2.4 - 2.5	16.0	5.2	-15.5	9	-2	MD58-0002	16-40



SSOP-28

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140 mW Power Amplifier with T/R and Diversity Switches 2.4 - 2.5 GHz

AM55-0001

V 2.00

Features

- Highly Integrated PA/Attenuator and T/R Switch
- Low Current Consumption: 120 mA Typ.
- Switch and Attenuator Controls CMOS Compatible
- High Power (140 mW) and Low Power (16 mW) Transmit Power Control
- +5 V/-5 V Fixed Supply Voltages

Description

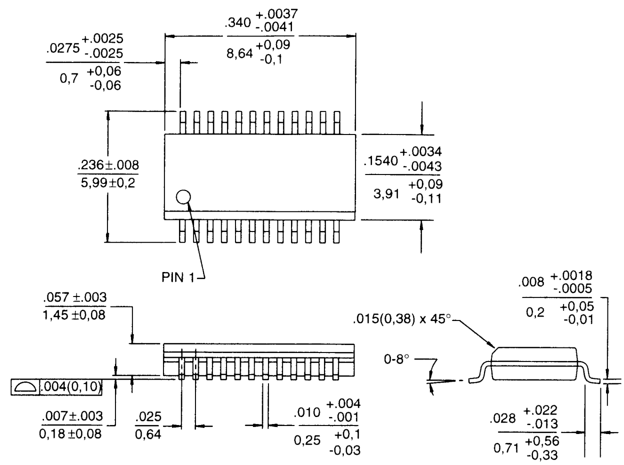
M/A-COM's AM55-0001 is a GaAs power amplifier with integrated transmit/receive and an antenna diversity switch in a low cost SSOP 24 plastic package. The AM55-0001 employs active bias circuits that eliminate the need for external bias adjustment. A 'Sleep Mode' is incorporated which turns off current draw from the positive supply of the PA during receive mode. The AM55-0001 provides a 10-dB step attenuator for use as a transmit power controller.

The AM55-0001 is designed for low power consumption and is ideally suited for FSK systems in the 2.4 - 2.5 GHz bands (North American ISM, Japanese RCR.32 and European ETSI). Typical applications include WLAN and wireless portable data collection.

This amplifier is also available without diversity switching (AM55-0007). Either power amplifier can be combined with a transceiver IC (MD58-0001) to form a complete RF front end.

M/A-COM's AM55-0001 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance and reliability.

SSOP-24



Dimensions are in inches over millemeters.

Ordering Information

Part Number	Description
AM55-0001	SSOP 24-Lead Plastic Package
AM55-0001TR	Forward Tape & Reel*
AM55-0001RTR	Reverse Tape & Reel*
AM55-0001SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications

Test Conditions: Frequency: 2.45 GHz, V_{DD} = 5 V ±5%, V_{GG} = - 5 V ±5%, T_A= +25°C

Parameter	Test Conditions		Units	Min.	Typ.	Max.
Power Amplifier						
Linear Gain		High Power Mode	dB	23	26.5	
		Low Power Mode	dB	12	16	
VSWR In/Out		Both Modes			1.5:1	
Output Power	P_{IN} = -3 dBm	High Power Mode	dBm	19	21.5	
		Low Power Mode	dBm	8	12	
Second Harmonic			dBc		-25	
Third Harmonic	P_{IN} = -3 dBm	High Power Mode	dBc		-17	
I_{DD} (V_{DD1} + V_{DD2} + V_{DD} PA)			mA		120	200
T/R and Diversity Switches						
Insertion Loss			dB		1.2	
Isolation			dB	10	15	
VSWR In/Out					1.5:1	

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power[2]	+23 dBm
Operating Voltages[2,3]	V_{DD} = 8 V
	V_{GG} = -8 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. Ambient temperature (T_A) = +25°C
3. $|V_{DD}| + |V_{GG}|$ not to exceed 12 volts.

Pin Configuration

Pin No.	Pin Name	Description
1	V_{GG}	Negative voltage to all active bias networks
2	T/R CTRL	0 V for transmit mode, +5 V for receive mode
3	Rx OUT	Output of T/R switch for receive mode
4	GND	DC and RF Ground
5	PA OUT	Output of T/R switch for transmit mode
6	V_{DD} PA	V_{DD} for output stage of PA, V_{DD} for active bias circuit of output stage
7	GND	DC and RF Ground
8	ATTN CTRL	0 V for high power mode, +5 V for low power mode
9	GND	DC and RF Ground
10	ANT COMMON	Common port of diversity switch
11	GND	DC and RF Ground
12	ANT 2	Output #2 of diversity switch
13	ANT 1	Output #1 of diversity switch
14	GND	DC and RF Ground
15	ANT CTRL	0 V for ANT Common to ANT 1, +5 V for ANT Common to ANT 2
16	GND	DC and RF Ground
17	V_{DD2}	V_{DD} for both diversity and T/R switches, V_{DD} for second stage of PA
18	GND	DC and RF Ground
19	V_{DD1}	V_{DD} for first stage of PA, V_{DD} of active bias for the first and second stage of PA
20	GND	DC and RF Ground
21	GND	DC and RF Ground
22	PA IN	RF input to PA
23	GND	DC and RF Ground
24	SLEEP CTRL	0 V PA "on" mode, -5 V PA "sleep" mode. Sleep mode shuts off active bias and "pinches off" all PA FETs.

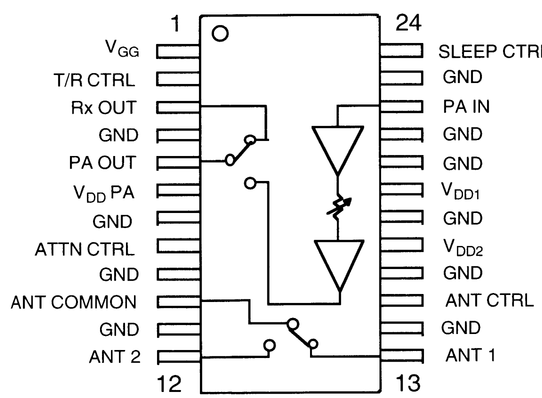
Truth Table

Control Line				Operating Mode
ANT CTRL	ATTN CTRL	T/R CTRL	SLEEP CTRL*	
X	X	1	-5 V	Receive
X	0	0	0 V	High Power
X	1	0	0 V	Low Power
X	X	1	-5 V	Sleep Mode
0	X	X	X	ANT 1
1	X	X	X	ANT 2

X - Don't Care
"0" = 0 V to 0.2 V @ 100 μA
"1" = V_{DD} to V_{DD} -0.2 V @ 200 μA

* Control voltage levels between 0 V and V_{GG} must be used on SLEEP CTRL control line. (Pin 24)

Functional Diagram and Pin Configuration



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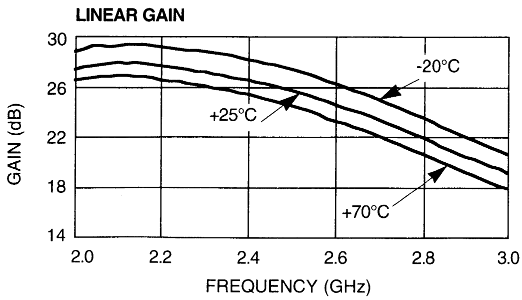
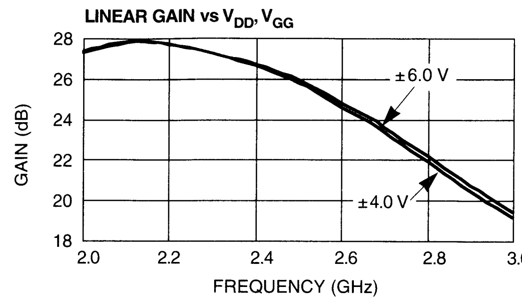
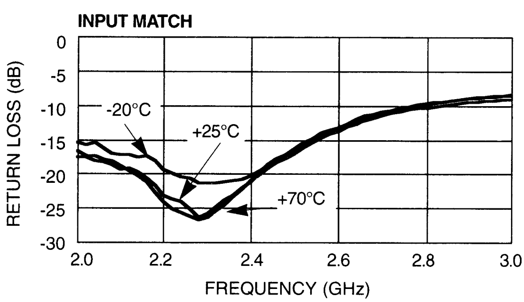
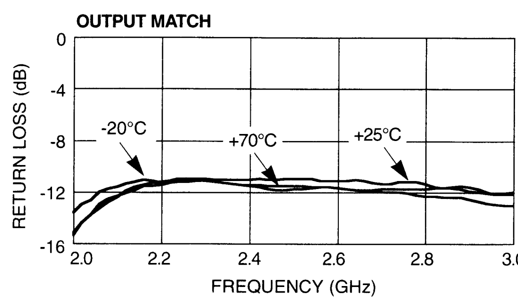
Small Signal Power Amplifier[1]

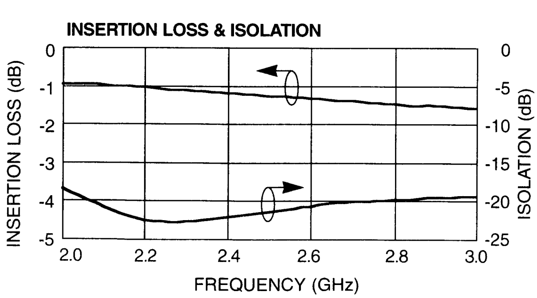


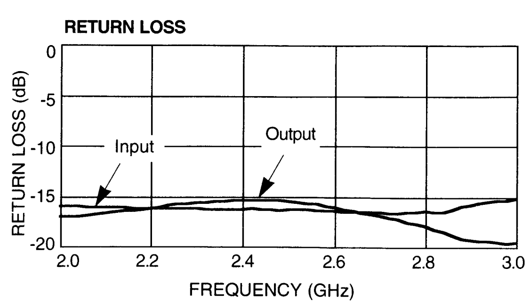






T/R Switch Small Signal Performance[1]





1. Unless otherwise noted, Frequency: 2.45 GHz, V_{DD} = 5 V ±5%, V_{GG} = - 5 V ±5%, T_A= +25°C

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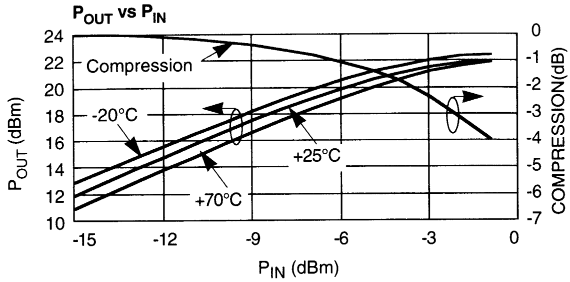
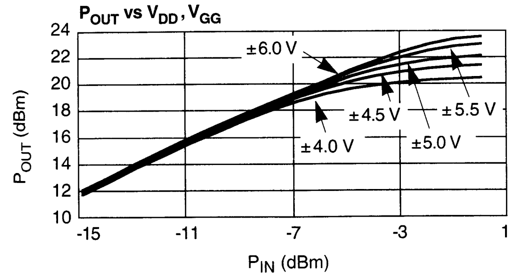
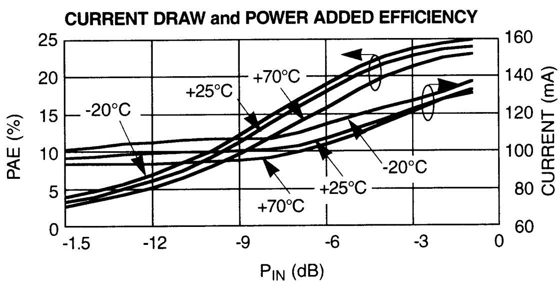
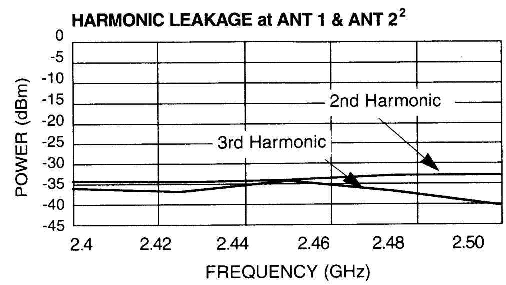
Power Amplifier Power Performance[1]



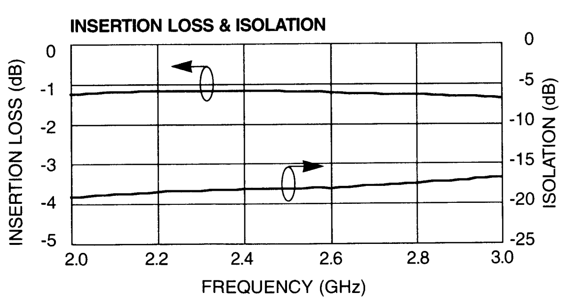


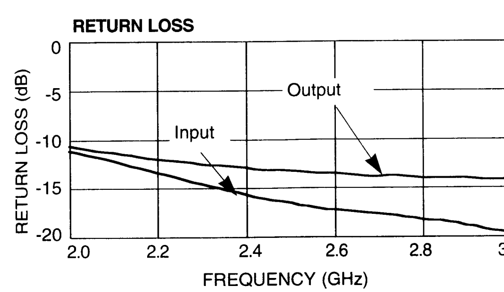




2. Measured with an RF input power of -3 dBm at PA IN. Output measured at ANT 1 and ANT 2 with PA OUT and ANT COMMON terminated in 50Ω.

Diversity Switch Small Signal Performance[1]

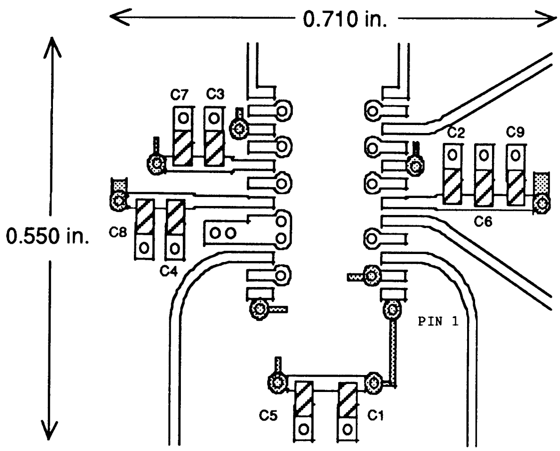




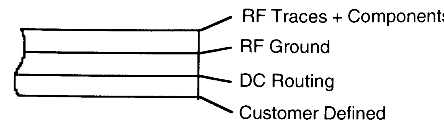
1. Unless otherwise noted, Frequency: 2.45 GHz, V_{DD} = 5 V ±5%, V_{GG} = - 5 V ±5%, T_A= +25°C

Recommended PCB Configuration

Layout View



Cross-Section View



The PCB dielectric between RF traces and RF ground layers should be chosen to reduce RF discontinuities between 50-Ω lines and package pins. M/A-COM recommends an FR-4 dielectric thickness of 0.008 in. (0.2 mm), yielding a 50-Ω line width of 0.015 in. (0.38 mm). The recommended metalization thickness is 1 oz. copper.

Shaded traces are vias to DC routing layer and traces on DC routing layer.

Biasing Procedure

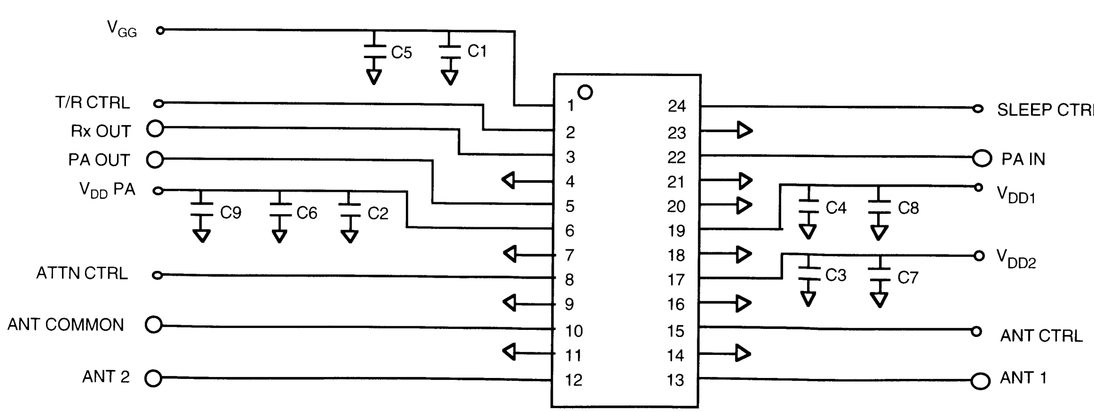
The AM55-0001 requires the V_{GG} bias be applied prior to ***any*** V_{DD} bias. Permanent damage may occur if this procedure is not followed. All FETs in the PA will draw excessive current and damage internal circuitry.

External Circuitry Parts List

Label	Value	Purpose
C1 - C4	33 pF	Bypass (GHz)
C5 - C8	1000 pF	Bypass (MHz)
C9	0.01 µF	Bypass (kHz)

All off-chip components are low-cost surface mount components obtainable from multiple sources. (0.020 in. x 0.040 in. or 0.030 in. x 0.050 in.)

External Circuitry



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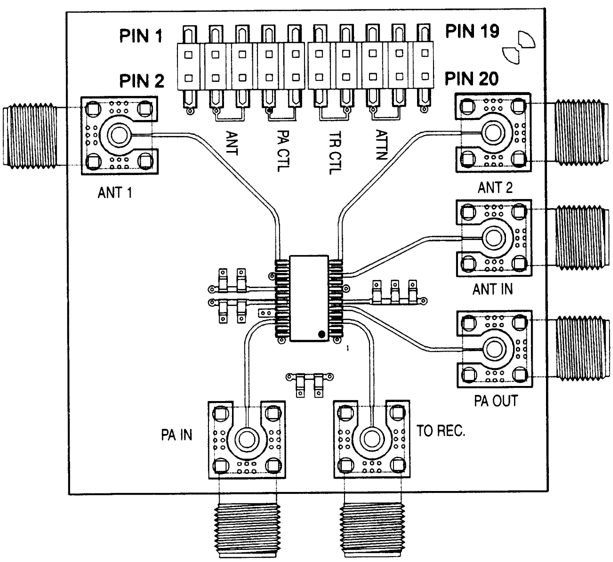
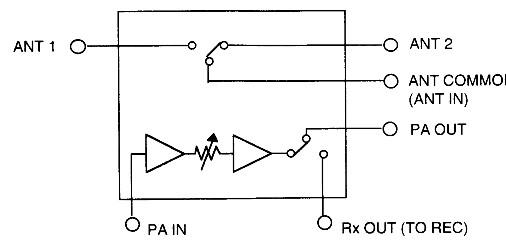
Designer's Kit (AM55-0001SMB)

The AM55-0001SMB Designer's Kit allows for immediate evaluation of M/A-COM's AM55-0001 integrated Power Amplifier with T/R and Diversity Switch. The evaluation board consists of an AM55-0001, recommended external surface mount circuitry, RF connectors and a DC multi-pin connector, all mounted to a multi-layer FR-4 PCB. Other items included in the Designer's Kit: a floppy disk (with typical performance data and a .DXF file of the recommended PCB layout) and any additional Application Notes. The AM55-0001SMB evaluation PCB and block diagram are illustrated below with all functional ports labeled.

P/A Switch Sample Board



Functional Block Diagram



DC Connector Pinout

PCB DC Connector	Function	Device Pin Number
1	V_{DD1} (+ 5 V)	19
2	V_{DD2} (+ 5 V)	17
3	Logic Low (GND)	N/C
4	ANT Control (0 V/+5 V)	15
5	Logic High (V_{DD1})	19
6	ANT Control (0 V/+5 V)	15
7	Negative Logic High (GND)	N/C
8	PA Control (0 V/-5 V)	24
9	Negative Logic Low (V_{GG})	1
10	PA Control (0 V/-5 V)	24

PCB DC Connector	Function	Device Pin Number
11	Logic High (V_{DD1})	19
12	T/R Control (0 V/+5 V)	2
13	Logic Low (GND)	N/C
14	T/R Control (0 V/+5 V)	2
15	Logic High (V_{DD1})	19
16	ATTN Control (0 V/+5 V)	8
17	Logic Low (GND)	N/C
18	ATTN Control (0 V/+5 V)	8
19	V_{DD} PA (+5 V)	6
20	V_{GG} (- 5 V)	1

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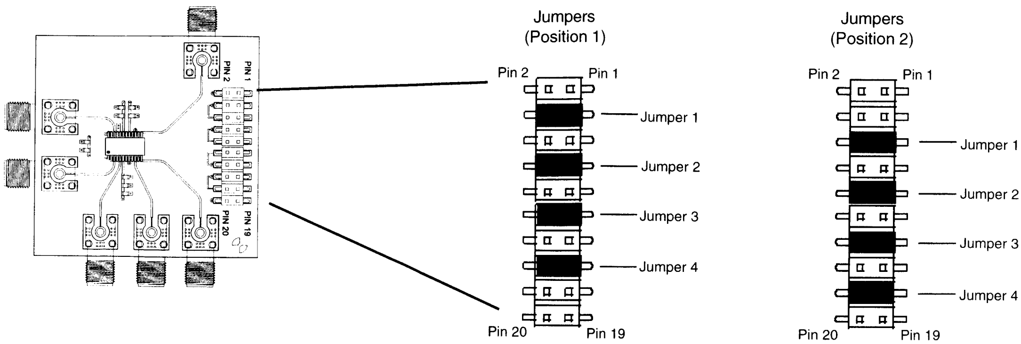
PCB DC Connector Jumper Settings



Jumper 1 (Diversity Switch Control)	Position 1 = ANT Common to ANT 2 Insertion Loss Position 2 = ANT Common to ANT 1 Insertion Loss
Jumper 2 (PA Sleep Control)	Position 1 = PA ON Position 2 = PA Sleep Mode
Jumper 3 (T/R Switch Control)	Position 1 = Receive Mode Position 2 = Transmit Mode
Jumper 4 (Attenuator Control)	Position 1 = Attenuator ON (Low Power Transmit) Position 2 = Attenuator OFF (High Power Transmit)

AM55-0001SMB Biasing Procedure

In order to prevent transients which may damage the MMIC, please adhere to the following procedure.

- Turn on all power supplies and set all voltages to 0 volts BEFORE connecting the power supplies to the DC connector.
- Set jumpers for desired test mode.
- Apply a -5.0 volt supply to DC connector pin 20 (V_{GG}).
- Apply a +5.0 volt supply to the DC connector pin 1 (V_{DD1}).
- Apply a +5.0 volt supply to the DC connector pin 2 (V_{DD2}).
- Apply a +5.0 volt supply to the DC connector pin 19 (V_{DD} PA).
- Adjust V_{GG} supply to -5 volts.
- Adjust all V_{DD} supplies to +5 volts.
- Hot switching of jumpers will not damage device.
- To power off, reverse above procedure.
  1. Set V_{DD1} & V_{DD2} & V_{DD} PA to 0 volts.
  2. Set V_{GG} to 0 volts.
  3. Disconnect bias lines from DC connector.
  4. Turn off power supplies.

Evaluation PCB and RF Connector Losses

Port Reference	Approximate Loss (dB)
PA IN	0.25
PA OUT	0.25
Rx OUT (TO REC)	0.25
ANT COMMON (ANT IN)	0.25
ANT1	0.30
ANT2	0.30

The DC connector on the Designer's Kit PCB allows selection of all the device's operating modes. It is accomplished by one or more of the following methods:

1. A mating female multi-pin connector (Newark Electronics Stock # 46F-4658, not included)
2. Wires soldered to the necessary pins (not included)
3. Clip leads (not included)
4. A combination of clip leads or wires and jumpers (jumpers included as required)

250 mW Power Amplifier with T/R and Diversity Switches 2.4 - 2.5 GHz

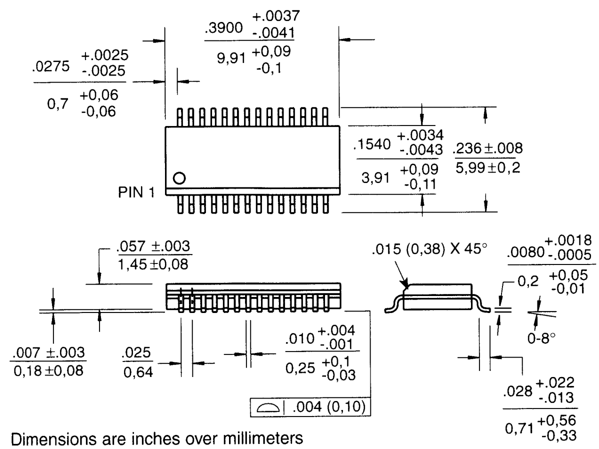
AM55-0003

V 2.00

Features

- Highly Integrated Power Amplifier With T/R and Diversity Switches
- Operates Over 2.7 V to 6 V Supply Voltage
- High Linear Output Power (P_{1dB}: +24 dBm)
- Individual Gate Control for Each Amplifier Stage
- Low Cost SSOP-28 Plastic Package

SSOP-28



Dimensions are inches over millimeters

Description

M/A-COM's AM55-0003 is a GaAs power amplifier with integrated transmit/receive and an antenna diversity switch in a low cost SSOP 28 plastic package. The power amplifier delivers +24 dBm of linear power with high efficiency and can be operated with voltages as low as 2.7 volts. The power amplifier switch is fully monolithic. The T/R and diversity switches achieve good insertion loss and isolation without degrading the overall linearity. The switches can be controlled with CMOS logic levels.

The AM55-0003 is ideally suited for QPSK, BPSK or other linearly modulated systems in the 2.4 GHz ISM frequency band. It can also be used in GFSK systems where levels of +25 dBm are required. Typical applications include WLAN and wireless portable data collection. This power amplifier can be combined with a transceiver IC (MD58-0001 or MD58-0002) to form a complete RF front end.

M/A-COM's AM55-0003 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance and reliability.

Ordering Information

Part Number	Description
AM55-0003	SSOP 28-Lead Plastic Package
AM55-0003TR	Forward Tape & Reel*
AM55-0003RTR	Reverse Tape & Reel*
AM55-0003SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications

Test Conditions: Frequency: 2.45 GHz, $V_{DD1,2,3}$ = 5 V±5%, V_{G1} adjusted for 20 mA quiescent bias on V_{DD1}, V_{G2} adjusted for 70 mA quiescent bias on V_{DD2}, V_{G3} adjusted for 90 mA quiescent bias on V_{DD3}, T_A = +25°C

Parameter	Units	Min.	Typ.	Max.
Power Amplifier				
Linear Gain	dB	24	28	32
VSWR In/Out			1.75:1	
Output Power @ P_{1dB}	dBm	22.5	24.5	
Second Harmonic @ P_{1dB}	dBc		-20	0
Third Harmonic @ P_{1dB}	dBc		-30	-10
I_{DD} @ P_{1dB} (V_{DD1} + V_{DD2} + V_{DD3})	mA		270	375
T/R and Diversity Switches				
Insertion Loss	dB		1.2	
Isolation	dB	10	12	
VSWR In/Out			1.5:1	

Specifications Subject to Change Without Notice.

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Pin Configuration

Pin No.	Pin Name	Description
1	ANT CTRL	Antenna selection: Select ANT 1 (0V) or ANT 2 (+5 V)
2	ANT COMMON	Common Port of Diversity Switch
3	GND	DC and RF Ground
4	ANT 1	Output #1 of Diversity Switch
5	GND	DC and RF Ground
6	ANT 2	Output #2 of Diversity Switch
7	GND	DC and RF Ground
8	RX OUT	Output of T/R Switch for receive mode
9	V_{G2}	Negative bias control for the second PA stage, adjusted to set V_{DD2} quiescent bias current, which is typically 70 mA. Typical voltage at pin = -0.55 V Input impedance: > 1 MΩ
10	GND	DC and RF Ground
11	V_{DD1}	Positive bias for the first stage of the PA, 2.7 to 6 volts
12	GND	DC and RF Ground
13	GND	DC and RF Ground
14	V_{G1}	Negative bias control for the first PA stage, adjusted to set V_{DD1} quiescent bias current, which is typically 20 mA. Typical voltage at pin = -0.75 V Input impedance: > 1 MΩ
15	RF IN	RF Input of the Power Amplifier
16	GND	DC and RF Ground
17	V_{G3}	Negative bias control for the third PA stage, adjusted to set V_{DD3} quiescent bias current, which is typically 90 mA. Typical voltage at pin = -0.95 V Input impedance: > 1 MΩ
18	V_{DD2}	Positive bias for the second stage of the PA, 2.7 to 6 volts
19	GND	DC and RF Ground
20	GND	DC and RF Ground
21	GND	DC and RF Ground
22	GND	DC and RF Ground
23	V_{DD3}	Positive bias for the third stage of the PA, 2.7 to 6 volts
24	GND	DC and RF Ground
25	RF OUT	RF output of T/R switch and power amplifier for transmit mode
26	T/R CTRL	0 V for transmit mode, +5 V for receive mode
27	V_{DD} TR	V_{DD} for T/R switch
28	V_{DD} ANT	V_{DD} for Diversity Switch

Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power[2]	+23 dBm
Operating Voltages[2,3]	V_{DD} = 8 V V_{GG} = -8 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

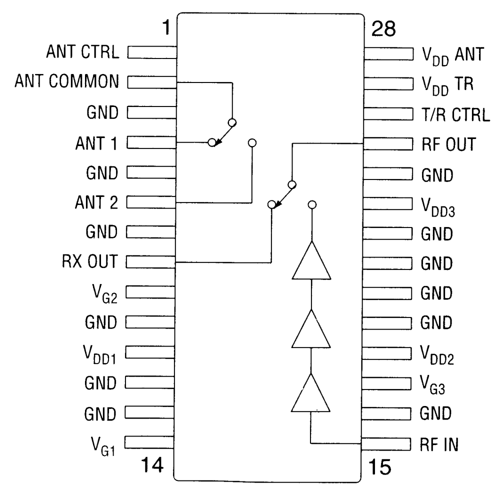
1. Exceeding these limits may cause permanent damage.
2. Ambient temperature (T_A) = +25°C
3. $|V_{DD}| + |V_{GG}|$ not to exceed 12 volts.

Truth Table

Control Line		Operating Mode
ANT CTRL	T/R CTRL	
X	1	Receive
X	0	Transmit
0	X	ANT 1
1	X	ANT 2

X - Don't Care
"0" = 0 V to 0.2 V @ 100 µA
"1" = V_{DD} to V_{DD} - 0.2 V @ 200 µA

Functional Diagram and Pin Configuration



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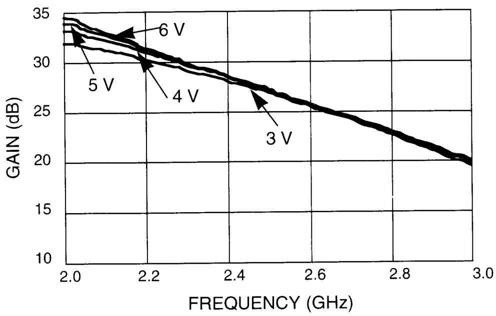
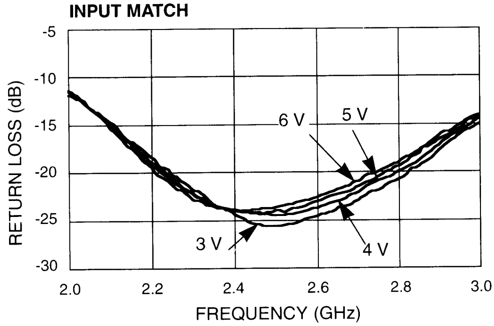
Power Amplifier Small Signal Performance[1]

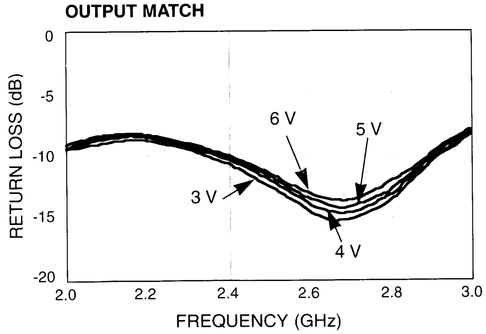
LINEAR GAIN, $V_{DD1} = V_{DD2} = V_{DD3}$



INPUT MATCH

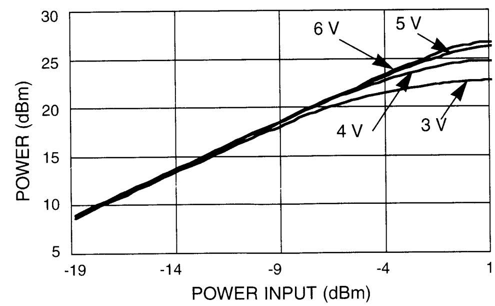


OUTPUT MATCH

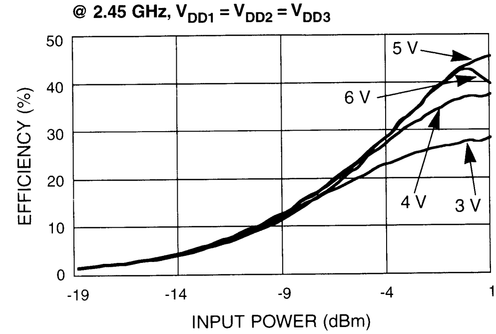


Power Amplifier CW Performance at Various Supply Voltages[1]

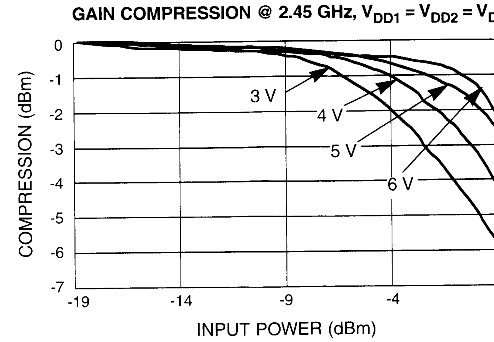
POWER OUTPUT @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3}$



POWER ADDED EFFICIENCY (%) @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3}$



GAIN COMPRESSION @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3}$



1. All data measured at $T_A = +25°C$ and V_{G1}, V_{G2} and V_{G3} adjusted for first stage quiescent current of 20 mA, second stage current of 70 mA and third stage current of 90 mA, respectively.

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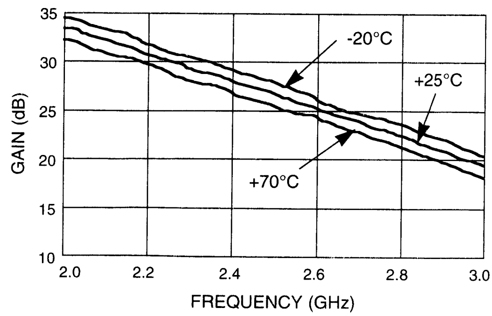
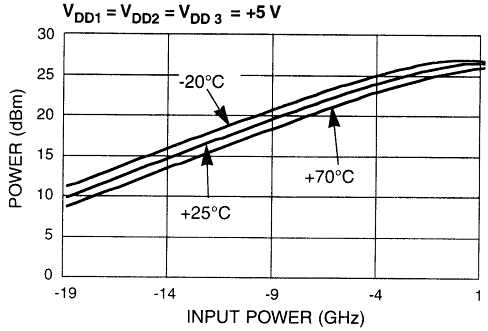
Power Amplifier Temperature Performance[1]

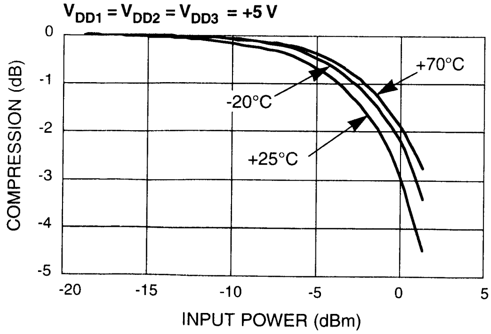
LINEAR GAIN, $V_{DD1} = V_{DD2} = V_{DD3} = +5$ V



POWER OUTPUT @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3} = +5$ V

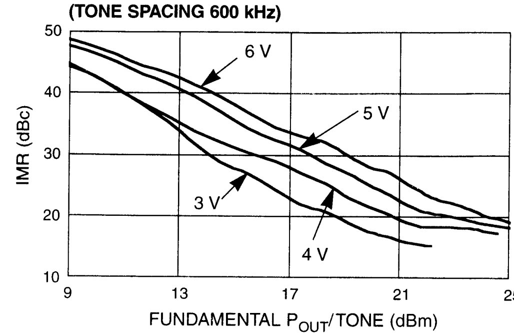


GAIN COMPRESSION @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3} = +5$ V

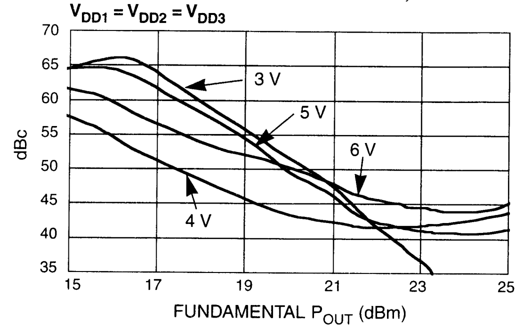


Power Amplifier Spurious Response at Various Supply Voltages[1]

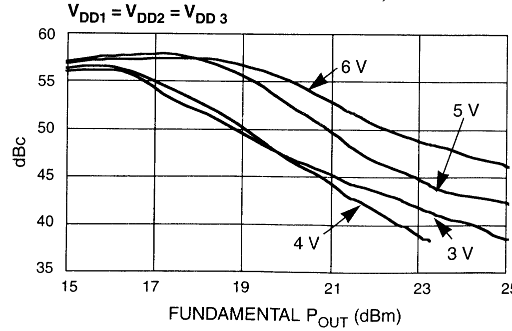
THIRD ORDER INTERMODULATION RATIO@ 2.45 GHz, (TONE SPACING 600 kHz)



SECOND HARMONIC RATIO @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3}$



THIRD HARMONIC RATIO @ 2.45 GHz, $V_{DD1} = V_{DD2} = V_{DD3}$



1. All data measured at $T_A = +25°C$ and V_{G1}, V_{G2} and V_{G3} adjusted for first stage quiescent current of 20 mA, second stage current of 70 mA and third stage current of 90 mA, respectively.

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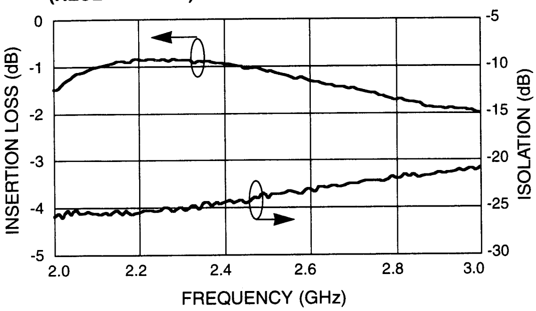
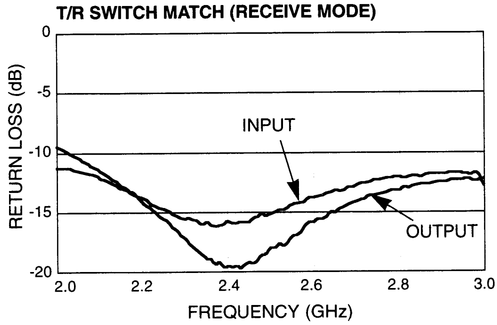
Transmit/Receive Switch Performance[1]

T/R INSERTION LOSS/ISOLATION (RECEIVE MODE)

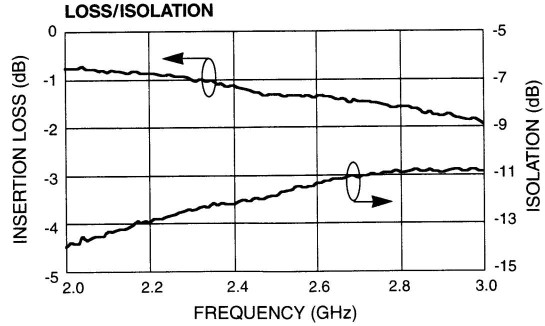


T/R SWITCH MATCH (RECEIVE MODE)

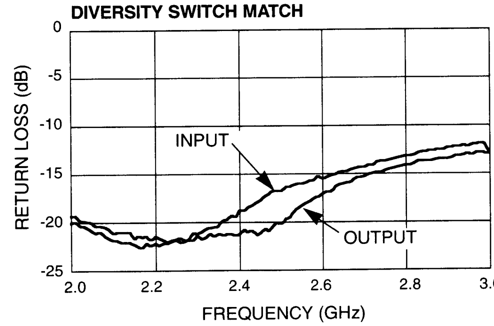


Diversity Switch Performance[1]

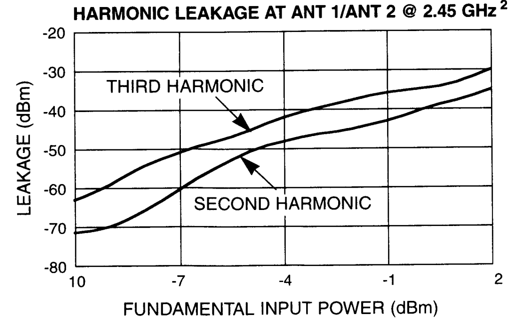
DIVERSITY SWITCH INSERTION LOSS/ISOLATION



DIVERSITY SWITCH MATCH



HARMONIC LEAKAGE AT ANT 1/ANT 2 @ 2.45 GHz[2]



1. All data measured with V_{DD} TR = V_{DD} ANT = +5 V, T_A = +25°C.
2. Measured at 2.45 GHz at RF IN. Output measured at ANT 1 or ANT 2, with RF OUT and ANT COMMON terminated in 50 Ω.

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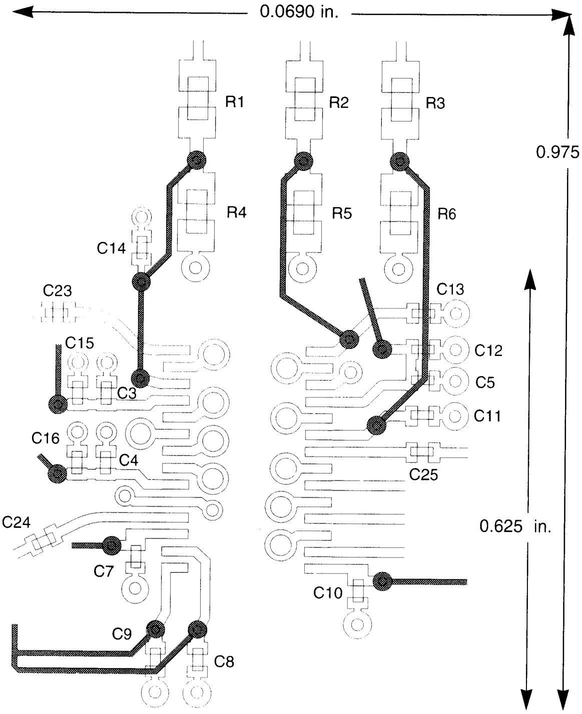
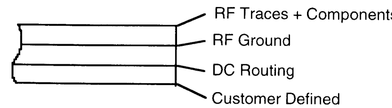
Recommended PCB Configuration

Layout View



Cross-Section View



The PCB dielectric between RF traces and RF ground layers should be chosen to reduce RF discontinuities between 50-Ω lines and package pins. M/A-COM recommends an FR-4 dielectric thickness of 0.008 in. (0.2 mm), yielding a 50-Ω line width of 0.015 in. (0.38 mm). The recommended metalization thickness is 1 oz. copper.

Shaded traces are vias to DC routing layer and traces on DC routing layer.

Biasing Procedure

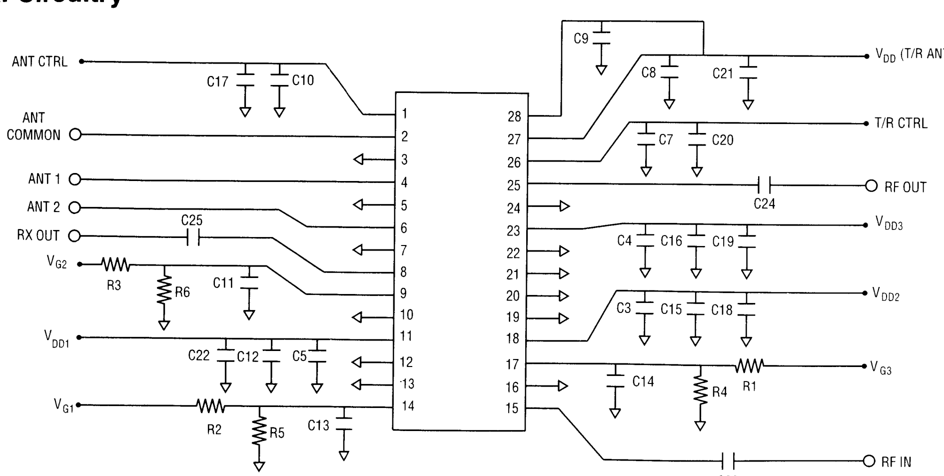
The AM55-0003 requires that V_{GG} bias be applied prior to ***any*** V_{DD} bias. Permanent damage may occur if this procedure is not followed. All FETs in the PA will draw excessive current and damage internal circuitry.

External Circuitry Parts List

Label	Value	Purpose
C1 - C6	22 pF	Bypass (GHz)
C23 - C24	22 pF	DC Block
C7 - C16	1000 pF	Bypass (MHz)
C17 - C22	0.01 µF	Bypass (kHz)
R1, R6	1.5 kΩ	FET Gate Divider Network
R3, R5	5 kΩ	
R2	12 kΩ	
R4	1 kΩ	

All off-chip components are low-cost surface mount components obtainable from multiple sources. (0.020 in. x 0.040 in. or 0.030 in. x 0.050 in.)

External Circuitry



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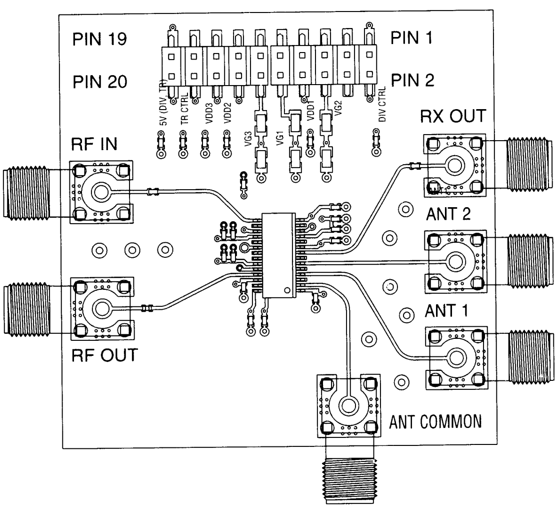
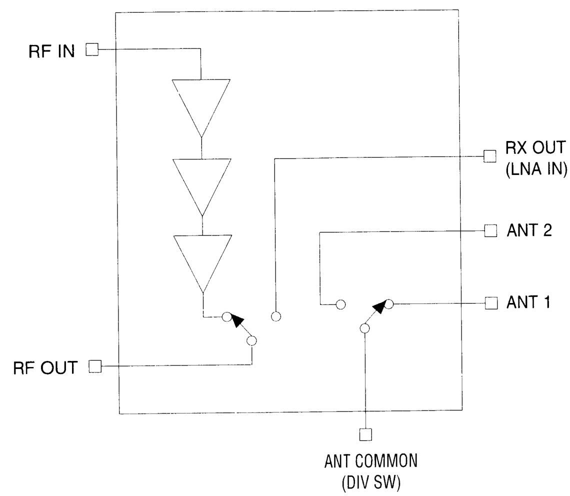
Designer's Kit (AM55-0003SMB)

The AM55-0003SMB Designer's Kit allows for immediate evaluation of M/A-COM's AM55-0003 integrated power amplifier with T/R and diversity switches. The evaluation board consists of an AM55-0003, recommended external surface mount circuitry, RF connectors and a DC multi-pin connector, all mounted to a multi-layer FR-4 PCB. Other items included in the Designer's Kit: a floppy disk (with typical performance data and a .DXF file of the recommended PCB layout) and any additional Application Notes. The AM55-0003SMB evaluation PCB and block diagram are illustrated below with all functional ports labeled.

P/A Switch Sample Board



Functional Block Diagram



DC Connector Pinout

PCB DC Connector	Function	Device Pin Number
1	GND	N/C
2	ANT CTRL (0 V/ +5 V)	1
3	N/C	N/C
4	N/C	N/C
5	N/C	N/C
6	V_{G2}	9
7	VSW	N/C
8	V_{DD1} (+5 V)	11
9	N/C	N/C
10	V_{G1}	14

PCB DC Connector	Function	Device Pin Number
11	N/C	N/C
12	V_{G3}	17
13	N/C	N/C
14	V_{DD2} (+5 V)	18
15	N/C	N/C
16	V_{DD3} (+5 V)	23
17	N/C	N/C
18	T/R CTRL (0 V/ +5 V)	8
19	GND	N/C
20	V_{DD} TR, V_{DD} ANT(+5 V)	27, 28

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AM55-0003SMB Biasing Procedure

In order to prevent transients which may damage the MMIC, please adhere to the following procedure.

- Turn on all power supplies and set all voltages to 0 volts BEFORE connecting the power supplies to the DC connector.
- Apply a -5.0 volt supply to DC connector pin 10 (V_{G1}).
- Apply a -5.0 volt supply to DC connector pin 6 (V_{G2}).
- Apply a -5.0 volt supply to DC connector pin 12 (V_{G3}).
- Apply a +5.0 volt supply to the DC connector pin 20 (V_{DD} TR, V_{DD} ANT).
- Apply a +5.0 volt supply to the DC connector pin 8 (V_{DD1}).
- Apply a +5.0 volt supply to the DC connector pin 14 (V_{DD2}).
- Apply a +5.0 volt supply to the DC connector pin 16 (V_{DD3}).
- Apply a GND or +5.0 volt supply to the DC connector pin 18 (T/R CTRL, see truth table for desired mode).
- Apply a GND or +5.0 volt supply to the DC connector pin 2 (ANT CTRL, see truth table for desired mode).
- Adjust V_{G1}, V_{G2}, V_{G3} supplies to -5 volts.
- Adjust all V_{DD} supplies to +5 volts.
- Adjust V_{G1} supply for desired V_{DD1} quiescent current (typically 20 mA, V_{G1} nominally -2.5 volts).
- Adjust V_{G2} supply for desired V_{DD2} quiescent current (typically 70 mA, V_{G2} nominally -2.5 volts).
- Adjust V_{G3} supply for desired V_{DD3} quiescent current (typically 90 mA, V_{G3} nominally -2.5 volts).
- To power off, reverse above procedure.
  1) Set all V_{DD} lines to 0 volts.
  2) Set V_{G1}, V_{G2} and V_{G3} to 0 volts.
  3) Disconnect bias lines from DC connector.
  4) Turn off power supplies.

Evaluation PCB and RF Connector Losses

Port Reference	Loss (dB)
RF IN	0.25
RF OUT	0.25
RX OUT (LNA IN)	0.25
ANT COMMON (DIV SW)	0.25
ANT 1	0.25
ANT 2	0.25

The DC connector on the Designer's Kit PCB allows selection of all the device's operating modes. It is accomplished by one or more of the following methods.

1. A mating female multi-pin connector (Newark Electronics Stock #46F-4658, not included)
2. Wires soldered to the necessary pins (not included)
3. Clip leads (not included)
4. A combination of clip leads or wires and jumpers (jumpers included as required)

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250 mW Linear Power Amplifier and T/R Switch 1.8 - 2.0 GHz

AM55-0004

V 2.00

Features

- Operates Over Full PCN/PCS/PHS Bands
- Operates Over +3 V to +5 V Supply Voltage
- +24 dBm P_{1dB} Typical at PA Out
- 35% PAE @ P_{1dB} for Linear Operation
- On-Chip T/R Switch, Linear Operation to +30 dBm
- Low Cost SSOP-28 Plastic Package

Description

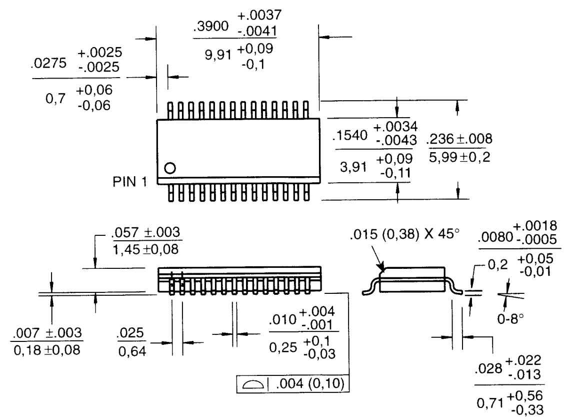
M/A-COM's AM55-0004 power amplifier/switch integrates a power amplifier and transmit/receive switch in a low cost SSOP package. The power amplifier delivers +24 dBm of linear power with high efficiency and can be operated at supply voltages as low as 2.7 V. It is ideally suited for QPSK or other linearly modulated systems in the 1.8 to 2.0 GHz frequency band.

The power amplifier/switch is fully monolithic and requires only one output capacitor for power match. The T/R switch achieves good insertion loss and isolation without degrading the overall linearity.

The AM55-0004 is ideally suited for final stage power amplification in linear TDD systems. The integrated switch is convenient for duplexing. The AM55-0004 can also be used as a driver stage for high power systems. Typical applications include Japanese PHS systems or PCN/PCS transmit chains.

M/A-COM's AM55-0004 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance and reliability.

SSOP-28



Dimensions are inches over millimeters.

Ordering Information

Part Number	Description
AM55-0004	SSOP 28-Lead Plastic Package
AM55-0004TR	Forward Tape & Reel*
AM55-0004RTR	Reverse Tape & Reel*
AM55-0004SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications

Test conditions: Frequency: 1.9 GHz, $V_{DD1} = V_{DD2} = 4.8$ V ±10%, V_{G1} adjusted for 30 mA quiescent bias on V_{DD1}, V_{G2} adjusted for 65 mA quiescent bias on V_{DD2}, T_A= +25°C

Parameter	Units	Min.	Typ.	Max.
Power Amplifier				
Linear Gain	dB	22	24	
Power Output @ P_{1dB} at PA OUT port	dBm	22.5	24	
Current From Positive Supply @ P_{1dB}	mA	75	175	275
Input VSWR			2.0:1	
T/R Switch				
Insertion Loss	dB		0.6	1.0
Input Match			1.5:1	
Isolation	dB	15	20	

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power[2]	+23 dBm
Operating Voltages[2]	V_{DD} = 7 V V_{GG} = -5 V V_{DD} - V_{GG} = 8 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. Ambient temperature (T_A) = +25°C

Truth Table

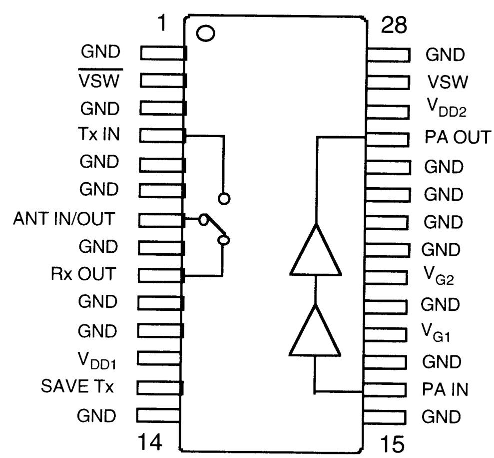
Operating Mode	VSW	$\overline{VSW}$	SAVE Tx
PA Tx	X	X	0 V
PA Sleep	X	X	-4.0 Volts
T/R Switch Tx	0 Volts	-4.0 Volts	X
T/R Switch Rx	-4.0 Volts	0 Volts	X

X - Don't Care

Pin Configuration

Pin No.	Pin Name	Description
1	GND	DC and RF Ground
2	$\overline{VSW}$	Complimentary T/R Switch Control, -4 V Tx mode/0 V Rx mode
3	GND	DC and RF Ground
4	Tx IN	Transmit side of T/R switch
5	GND	DC and RF Ground
6	GND	DC and RF Ground
7	ANT IN/OUT	Common port of T/R switch which is connected to the antenna
8	GND	DC and RF Ground
9	Rx OUT	Receive side of T/R switch
10	GND	DC and RF Ground
11	GND	DC and RF Ground
12	V_{DD1}	Positive bias for the first stage of PA, +2.7 to +6.0 volts
13	SAVE Tx	Sleep mode control of first stage of PA ONLY 0 V — first PA stage on -4 V — first PA stage off
14	GND	DC and RF Ground
15	GND	DC and RF Ground
16	PA IN	RF input of the Power Amplifier
17	GND	DC and RF Ground
18	V_{G1}	Negative bias control for the first PA stage, voltage divider is on the MMIC, adjusted to set V_{DD1} quiescent bias current, which is typically 30 mA. Input impedance: 10 kΩ
19	GND	DC and RF Ground
20	V_{G2}	Negative bias control for the second PA stage, adjusted to set V_{DD2} quiescent bias current, which is typically 65 mA. Input impedance: > 1MΩ
21	GND	Second Stage DC and RF Ground
22	GND	Second Stage DC and RF Ground
23	GND	Second Stage DC and RF Ground
24	GND	Second Stage DC and RF Ground
25	PA OUT	RF output of the Power Amplifier
26	V_{DD2}	Positive bias for the second stage of the PA, +2.7 to +6.0 volts
27	VSW	T/R Switch Control, 0 V Tx mode/-4 V Rx mode
28	GND	DC and RF Ground

Functional Diagram and Pin Configuration



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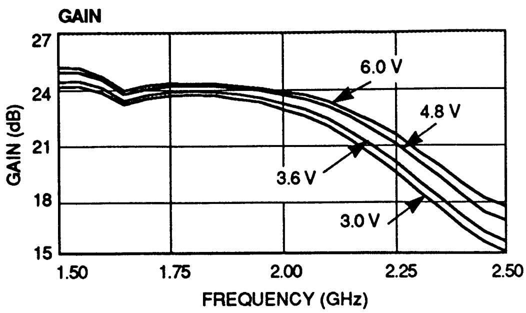
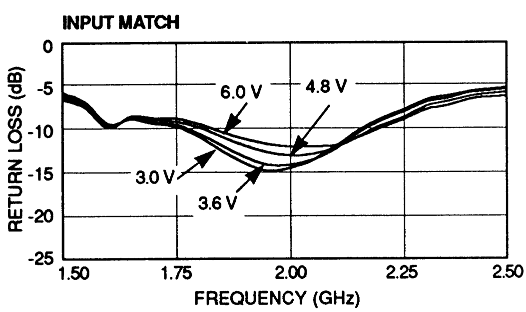
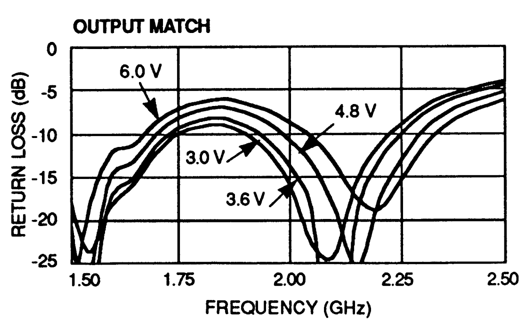
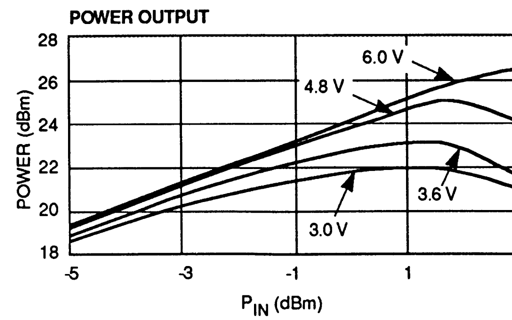
Power Amplifier Small Signal Performance[1]

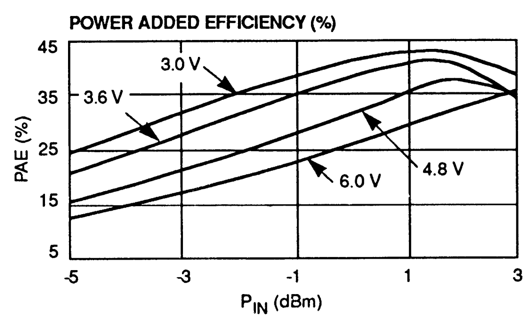


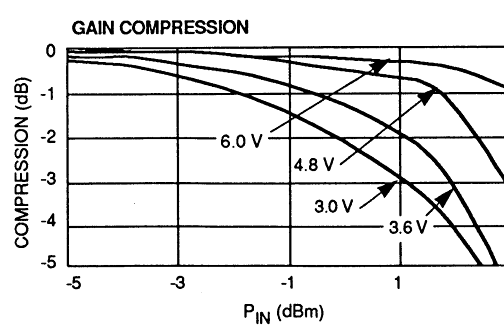




Power Amplifier CW Performance at 1.9 GHz[1]







1. All data measured at T_A = +25°C and V_{G1}, V_{G2} adjusted for first stage quiescent current of 30 mA and second stage current of 65 mA, respectively.

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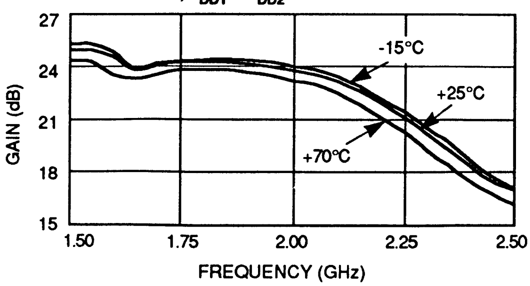
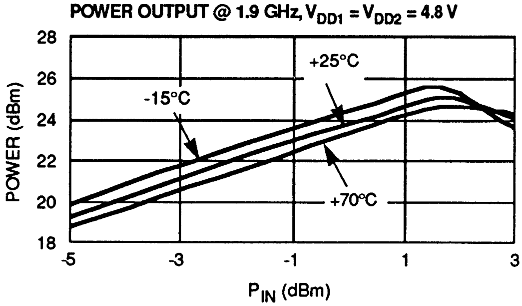
Power Amplifier Temperature Performance[1]

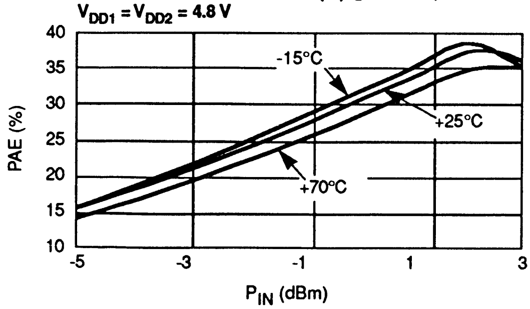
LINEAR GAIN, $V_{DD1} = V_{DD2} = 4.8$ V



POWER OUTPUT @ 1.9 GHz, $V_{DD1} = V_{DD2} = 4.8$ V

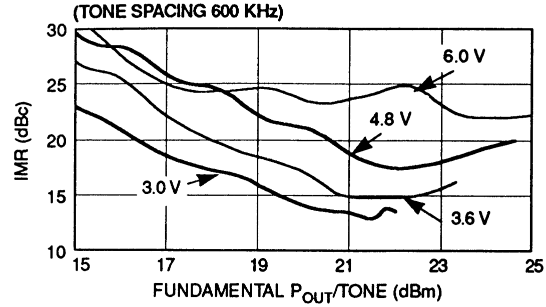


POWER ADDED EFFICIENCY (%) @ 1.9 GHz, $V_{DD1} = V_{DD2} = 4.8$ V

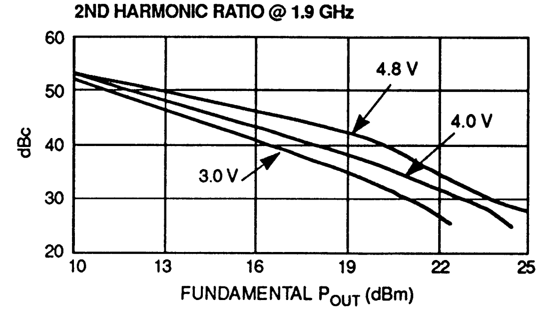


Power Amplifier Spurious Response at Various Supply Voltages[1]

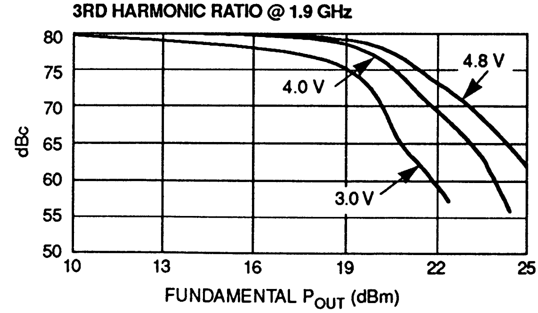
THIRD ORDER INTERMODULATION RATIO @ 1.9 GHz (TONE SPACING 600 KHz)



2ND HARMONIC RATIO @ 1.9 GHz



3RD HARMONIC RATIO @ 1.9 GHz



1. All data measured at $T_A = +25°C$ and V_{G1}, V_{G2} adjusted for first stage quiescent current of 30 mA and second stage current of 65 mA, respectively.

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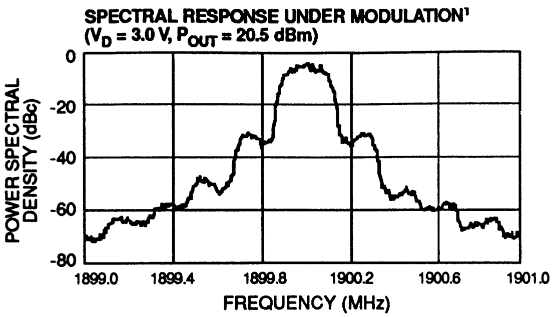
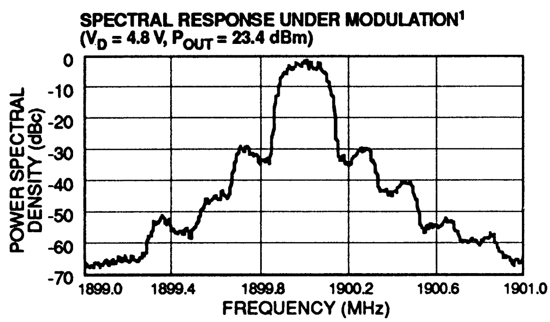
Power Amplifier Spectral Response Under Modulation Drive

(π/4 DQPSK, α = 0.5, 384 kB/sec, 9-bit PN code)





Output Power Under Modulation[2]

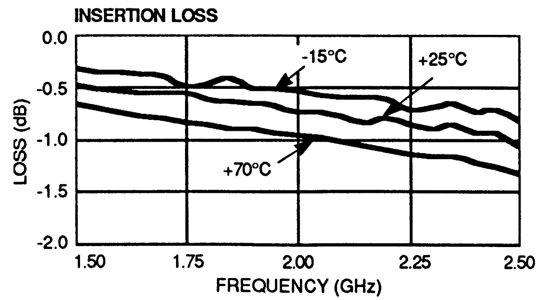
V_D (volts)	P_{OUT} (dBm)
3	20.5
3.6	21.4
4	22.2
4.8	23.4
6	23.7

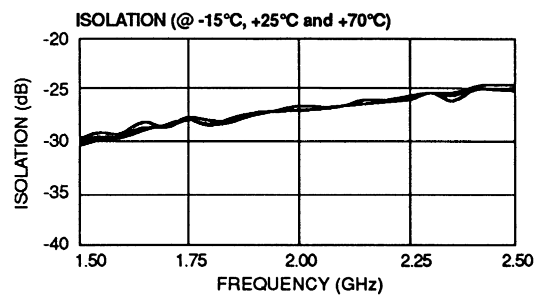
1. Spectral output is tested under the following conditions: Modulation scheme is π/4 DQPSK with a bit transfer rate of 384 kB/sec and a root Nyquist filter with α = 0.5 per RCR STD-28. The spectrum analyzer settings are as follows:

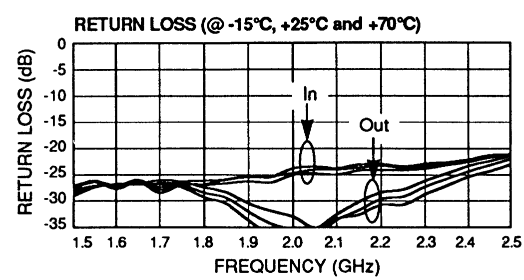
   Resolution bandwidth: 10 kHz
   Video bandwidth: 100 kHz
   Sweep time: 5 seconds

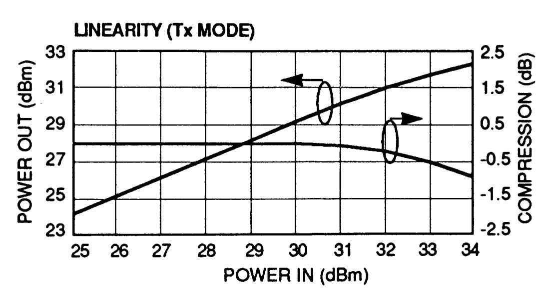
2. This chart documents the modulated output power delivered for a fixed adjacent channel interference (ACI) rejection of 55 dBc at a 600-kHz offset.

Transmit/Receive Switch Performance









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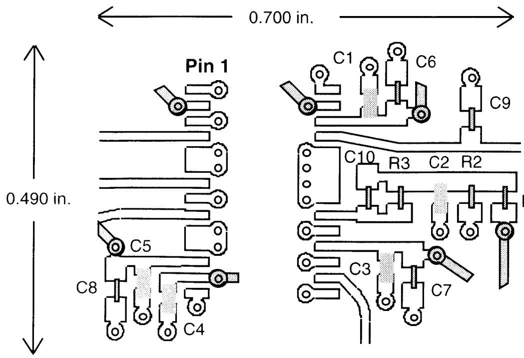
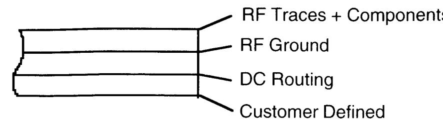
Recommended PCB Configuration

Layout View



Cross-Section View



The PCB dielectric between RF traces and RF ground layers should be chosen to reduce RF discontinuities between 50-Ω lines and package pins. M/A-COM recommends an FR-4 dielectric thickness of 0.008 in. (0.2 mm), yielding a 50-Ω line width of 0.015 in. (0.38 mm). The recommended metalization thickness is 1 oz. copper.

Shaded traces are vias to DC routing layer and traces on DC routing layer.

Biasing Procedure

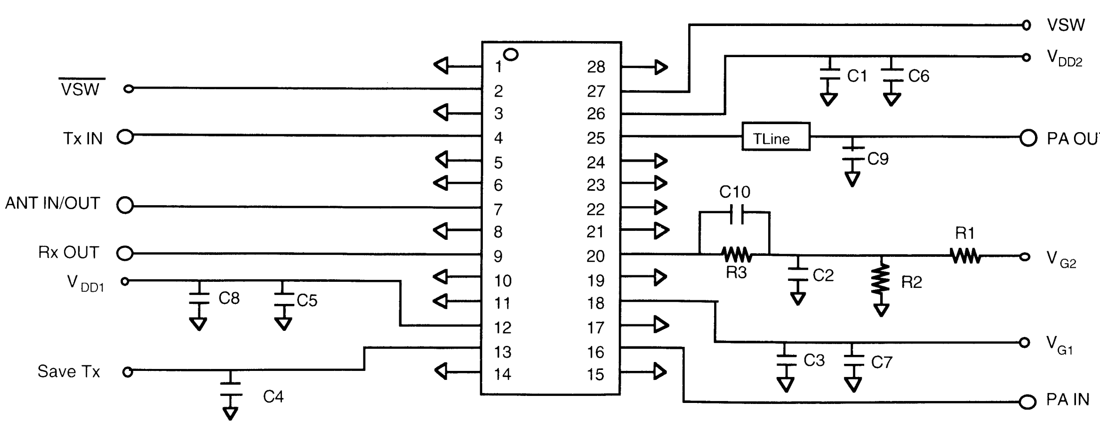
The AM55-0004 requires that V_{GG} bias be applied prior to ***any*** V_{DD} bias. Permanent damage may occur if this procedure is not followed. All FETs in the PA will draw excessive current and damage internal circuitry.

External Circuitry Parts List

Label	Value	Purpose
C1 - C5	1000 pF	Low frequency bypass
C6 - C8	68 pF	RF bypass
C9	1.5 pF	Output power tuning
C10	15 pF	Reduces low frequency gain
R1	2.7 k Ω	Voltage divider to V_{G2}
R2	1.5 k Ω	Voltage divider to V_{G2}
R3	150 Ω	Reduces low frequency gain
Tline	0.250 in. long	Power match

All off-chip components are low-cost surface mount components obtainable from multiple sources. (0.020 in. x 0.040 in. or 0.030 in. x 0.050 in.)

External Circuitry



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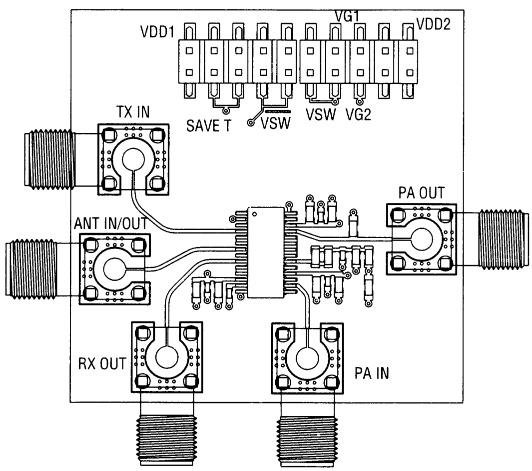
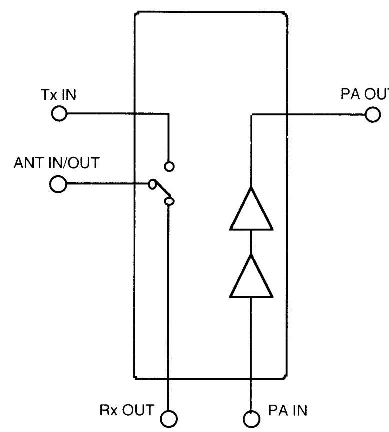
Designer's Kit (AM55-0004SMB)

The AM55-0004SMB Designer's Kit allows for immediate evaluation of M/A-COM's AM55-0004 integrated Power Amplifier and T/R Switch. The evaluation board consists of an AM55-0004, recommended external surface mount circuitry, RF connectors and a DC multipin connector, all mounted to a multi-layer FR-4 PCB. Other items included in the Designer's Kit: a floppy disk (with typical performance data and a .DXF file of the recommended PCB layout) and any additional Application Notes. The AM55-0004SMB PA/Switch evaluation PCB and block diagram are illustrated below with all functional ports labeled.

P/A Switch Sample Board



Functional Block Diagram



DC Connector Pinout

PCB DC Connector	Function	Device Pin Number
1	N/C	N/C
2	V_{DD1} (+ 4.8 V)	12
3	SAVE Tx (0 V/-4 V)	13
4	GND	N/C
5	SAVE Tx (0 V/-4 V)	13
6	V_{G1}	18
7	$\overline{VSW}$	2
8	GND	N/C
9	$\overline{VSW}$	2
10	V_{G1}	18

PCB DC Connector	Function	Device Pin Number
11	VSW	27
12	V_{G1}	18
13	VSW	27
14	GND	N/C
15	V_{G2}	20
16	V_{G1}	18
17	N/C	N/C
18	V_{G2}	20
19	N/C	N/C
20	V_{DD2} (+ 4.8 V)	26

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AM55-0004SMB Biasing Procedure

In order to prevent transients which may damage the MMIC, please adhere to the following procedure.

- Turn on all power supplies and set all voltages to 0 volts BEFORE connecting the power supplies to the DC connector.
- Apply -4.0 volt supply or GND to DC connector pin 9 ($\overline{VSW}$, see truth table for desired mode).
- Apply -4.0 volt supply or GND to DC connector pin 13 (VSW, see truth table for desired mode).
- Apply a -4.0 volt supply to the DC connector pin 16 (V_{G1}).
- Apply a -4.0 volt supply to the DC connector pin 18 (V_{G2}).
- Apply a +4.8 volt supply to the DC connector pin 2 (V_{DD1}).
- Apply a +4.8 volt supply to the DC connector pin 20 (V_{DD2}).
- Apply GND to DC connector pin 5 (Save Tx).
- Adjust V_{G1} supply for desired V_{DD1} quiescent current (typically 30 mA).
- Adjust V_{G2} supply for desired V_{DD2} quiescent current (typically 65 mA).
- Change voltage on DC connector pin 5 as required (Save Tx, see truth table for desired mode).
- Apply RF power and test.
- To power off, reverse above procedure
    1. Set V_{G1} & V_{G2} to -4 V.
    2. Set V_{DD1} & V_{DD2} to 0 V.
    3. Set control voltage supplies to 0 V.
    4. Disconnect bias lines from DC connector.
    5. Turn off power supplies.

Evaluation PCB and RF Connector Losses

Port Reference	Estimated Loss (dB)
PA IN	0.15
PA OUT	0.20
Tx IN	0.20
ANT IN/OUT	0.20
Rx OUT	0.20

The DC connector on the Designer's Kit PCB allows selection of all the device's operating modes. It is accomplished by one or more of the following methods:

1. A mating female multi-pin connector (Newark Electronics Stock # 46F-4658, not included)
2. Wires soldered to the necessary pins (not included)
3. Clip leads (not included)
4. A combination of clip leads or wires and jumpers (jumpers included as required)

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an AMP company

140 mW Power Amplifier with T/R Switch 2.4 - 2.5 GHz

AM55-0007

V 2.00

Features

- Highly Integrated PA/Attenuator and T/R Switch
- Low Current Consumption: 120 mA Typ.
- Switch and Attenuator Controls CMOS Compatible
- High Power (140 mW) and Low Power (16 mW) Transmit Power Control
- +5 V/-5 V Fixed Supply Voltages

Description

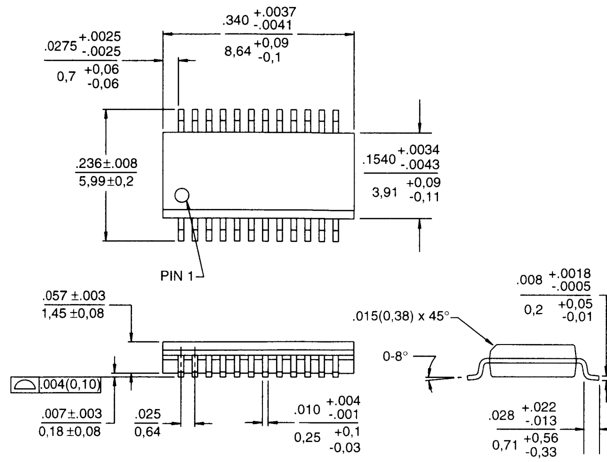
M/A-COM's AM55-0007 is a GaAs power amplifier with an integrated transmit/receive switch in a low cost SSOP 24 plastic package. The AM55-0007 employs active bias circuits that eliminate the need for external bias adjustment. A 'Sleep Mode' is incorporated which turns off current draw from the positive supply of the PA during receive mode. The AM55-0007 provides a 10-dB step attenuator for use as a transmit power controller.

The AM55-0007 is designed for low power consumption and is ideally suited for FSK systems in the 2.4 - 2.5 GHz bands (North American ISM, Japanese RCR.32 and European ETSI). Typical applications include WLAN and wireless portable data collection.

This amplifier is also available with diversity switching (AM55-0001). Either power amplifier can be combined with a transceiver IC (MD58-0001) to form a complete RF front end.

M/A-COM's AM55-0007 is fabricated using a mature 0.5-micron gate length GaAs process. The process features full passivation for increased performance and reliability.

SSOP-24



Dimensions are in inches over millimeters.

Ordering Information

Part Number	Description
AM55-0007	SSOP 24-Lead Plastic Package
AM55-0007TR	Forward Tape & Reel*
AM55-0007RTR	Reverse Tape & Reel*
AM55-0007SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications

Test Conditions: Frequency: 2.45 GHz, V_{DD} = 5 V ±5%, V_{GG} = - 5 V ±5%, T_A= +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Power Amplifier					
Linear Gain	High Power Mode	dB	23	26.5	
	Low Power Mode	dB	12	16	
VSWR In	Both Modes			1.5:1	
Output Power	P_{IN} = -3 dBm High Power Mode	dBm	19	21.5	
	Low Power Mode	dBm	8	12	
Second Harmonic	P_{IN} = -3 dBm High Power Mode	dBc		-25	
Third Harmonic		dBc		-17	
I_{DD} (V_{DD1} + V_{DD2} + V_{DD} PA)		mA		120	200
T/R Switch					
Insertion Loss		dB		1.2	
Isolation		dB	10	15	
VSWR In/Out				1.5:1	

Specifications Subject to Change Without Notice.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power[2]	+23 dBm
Operating Voltages[2,3]	V_{DD} = 8 V V_{GG} = -8 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. Ambient temperature (T_A) = +25°C
3. $|V_{DD}| + |V_{GG}|$ not to exceed 12 volts.

Pin Configuration

Pin No.	Pin Name	Description
1	V_{GG}	Negative voltage to all active bias networks
2	T/R CTRL	0 V for transmit mode, +5 V for receive mode
3	Rx OUT	Output of T/R switch for receive mode
4	GND	DC and RF Ground
5	PA OUT	Output of T/R switch for transmit mode
6	V_{DD} PA	V_{DD} for output stage of PA, V_{DD} for active bias circuit of output stage
7	GND	DC and RF Ground
8	ATTN CTRL	0 V for high power mode, +5 V for low power mode
9	GND	DC and RF Ground
10	GND	DC and RF Ground
11	GND	DC and RF Ground
12	GND	DC and RF Ground
13	GND	DC and RF Ground
14	GND	DC and RF Ground
15	GND	DC and RF Ground
16	GND	DC and RF Ground
17	V_{DD2}	V_{DD} for both diversity and T/R switches, V_{DD} for second stage of PA
18	GND	DC and RF Ground
19	V_{DD1}	V_{DD} for first stage of PA, V_{DD} of active bias for the first and second stage of PA
20	GND	DC and RF Ground
21	GND	DC and RF Ground
22	PA IN	RF input to PA
23	GND	DC and RF Ground
24	SLEEP CTRL	0 V PA "on" mode, -5 V PA "sleep" mode. Sleep mode shuts off active bias and "pinches off" all PA FETs.

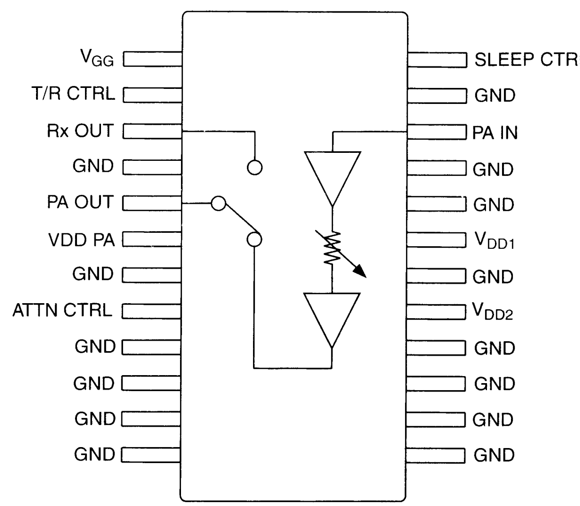
Truth Table

Control Line			Operating Mode
ATTN CTRL	T/R CTRL	SLEEP CTRL*	
X	1	-5 V	Receive
0	0	0 V	High Power
1	0	0 V	Low Power
X	1	-5 V	Sleep Mode

X - Don't Care
"0" = 0 V to 0.2 V @ 100 μA
"1" = V_{DD} to V_{DD} -0.2 V @ 200 μA

* Controi voltage levels between 0 V and V_{GG} must be used on SLEEP CTRL control line. (Pin 24)

Functional Diagram and Pin Configuration



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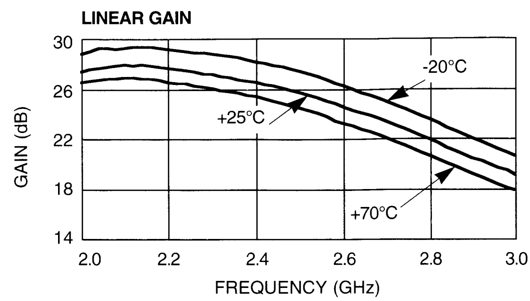
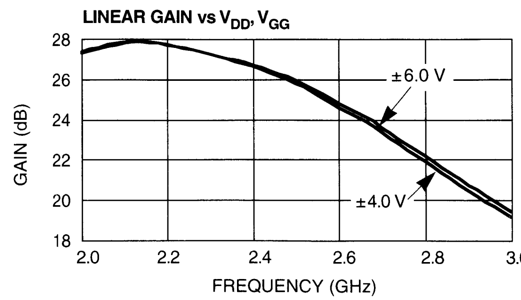
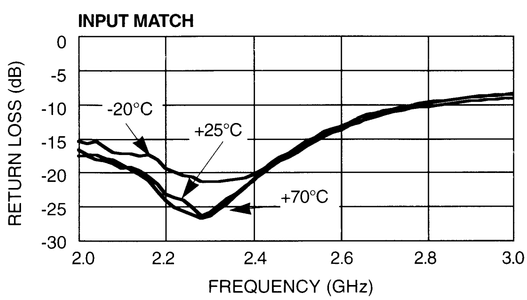
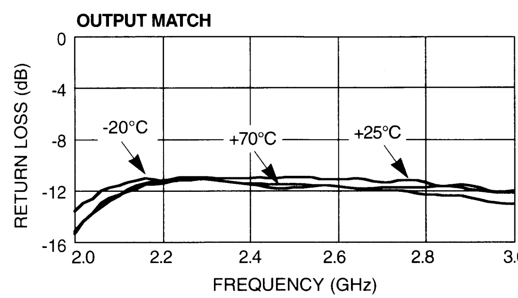
Small Signal Power Amplifier[1]

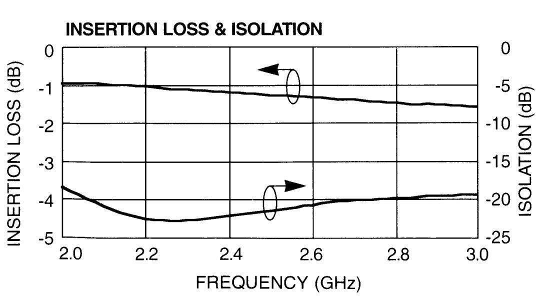


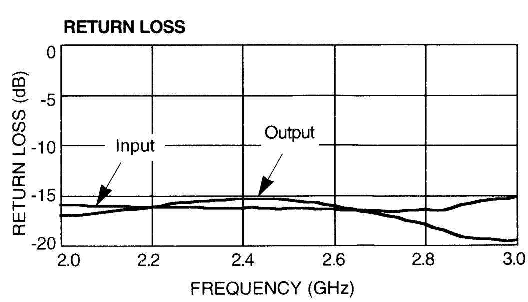






T/R Switch Small Signal Performance[1]





1. Unless otherwise noted, Frequency: 2.45 GHz, V_{DD} = 5 V ±5%, V_{GG} = - 5 V ±5%, T_A= +25°C

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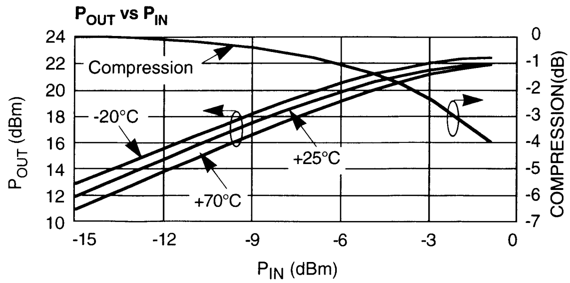
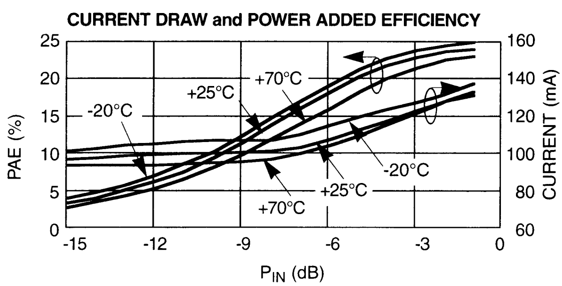
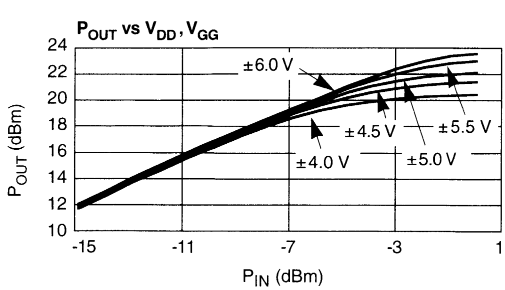
Power Amplifier Power Performance[1]







1. Unless otherwise noted, Frequency: 2.45 GHz, V_{DD} = 5 V ±5%, V_{GG} = - 5 V ±5%, T_A= +25°C

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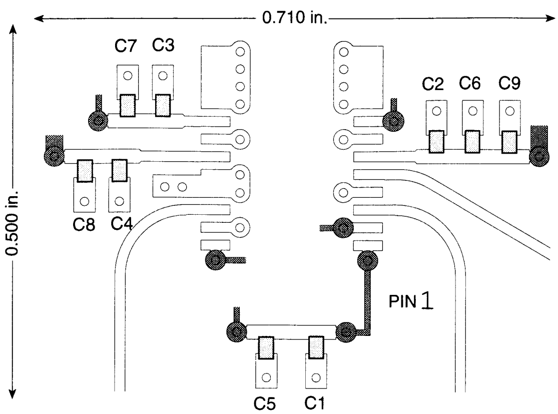
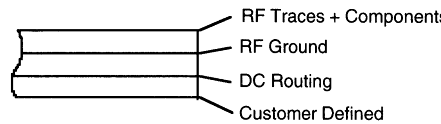
Recommended PCB Configuration

Layout View



Cross-Section View



The PCB dielectric between RF traces and RF ground layers should be chosen to reduce RF discontinuities between 50-Ω lines and package pins. M/A-COM recommends an FR-4 dielectric thickness of 0.008 in. (0.2 mm), yielding a 50-Ω line width of 0.015 in. (0.38 mm). The recommended metalization thickness is 1 oz. copper.

Shaded traces are vias to DC routing layer and traces on DC routing layer.

Biasing Procedure

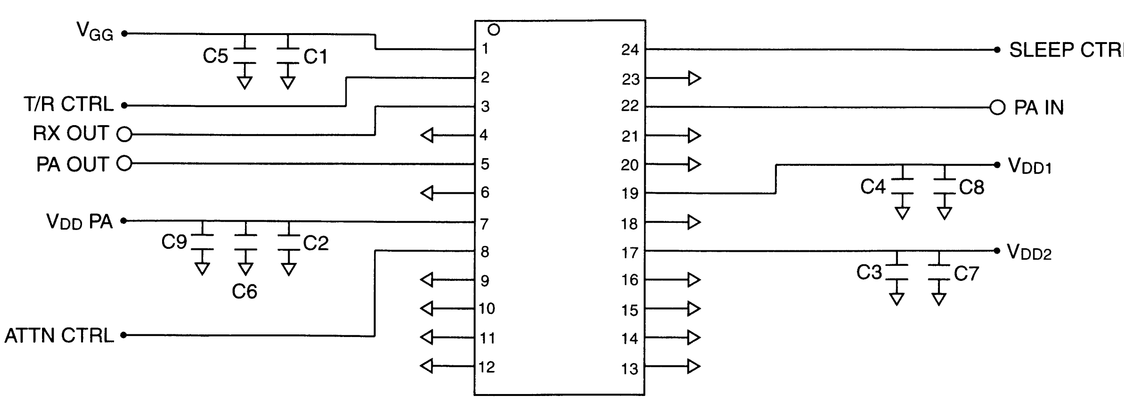
The AM55-0007 requires the V_{GG} bias be applied prior to ***any*** V_{DD} bias. Permanent damage may occur if this procedure is not followed. All FETs in the PA will draw excessive current and damage internal circuitry.

External Circuitry Parts List

Label	Value	Purpose
C1 - C4	33 pF	Bypass (GHz)
C5 - C8	220 pF	Bypass (MHz)
C9	0.01 µF	Bypass (kHz)

All off-chip components are low-cost surface mount components obtainable from multiple sources. (0.020 in. x 0.040 in. or 0.030 in. x 0.050 in.)

External Circuitry



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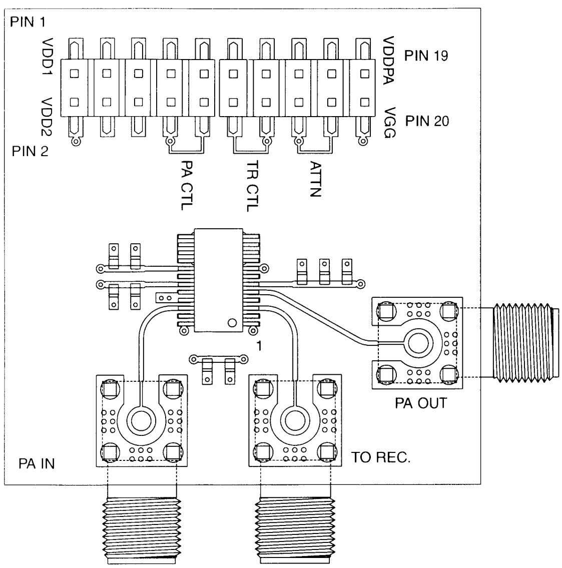
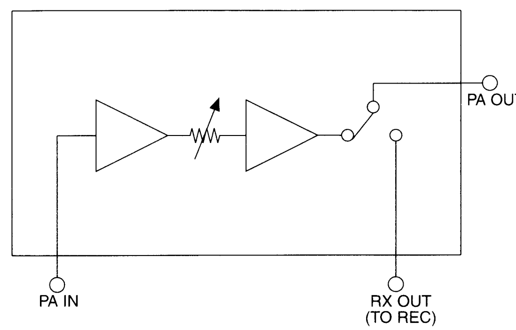
Designer's Kit (AM55-0007SMB)

The AM55-0007SMB Designer's Kit allows for immediate evaluation of M/A-COM's AM55-0007 integrated Power Amplifier with T/R and Diversity Switch. The evaluation board consists of an AM55-0007, recommended external surface mount circuitry, RF connectors and a DC multi-pin connector, all mounted to a multi-layer FR-4 PCB. Other items included in the Designer's Kit: a floppy disk (with typical performance data and a .DXF file of the recommended PCB layout) and any additional Application Notes. The AM55-0007SMB evaluation PCB and block diagram are illustrated below with all functional ports labeled.

P/A Switch Sample Board



Functional Block Diagram



DC Connector Pinout

PCB DC Connector	Function	Device Pin Number
1	V_{DD1} (+ 5 V)	19
2	V_{DD2} (+ 5 V)	17
3	N/C	N/C
4	N/C	N/C
5	N/C	N/C
6	N/C	N/C
7	Negative Logic High (GND)	N/C
8	PA Control (0 V/-5 V)	24
9	Negative Logic Low (V_{GG})	1
10	PA Control (0 V/-5 V)	24

PCB DC Connector	Function	Device Pin Number
11	Logic High (V_{DD1})	19
12	T/R Control (0 V/+5 V)	2
13	Logic Low (GND)	N/C
14	T/R Control (0 V/+5 V)	2
15	Logic High (V_{DD1})	19
16	ATTN Control (0 V/+5 V)	8
17	Logic Low (GND)	N/C
18	ATTN Control (0 V/+5 V)	8
19	V_{DD} PA (+5 V)	6
20	V_{GG} (- 5 V)	1

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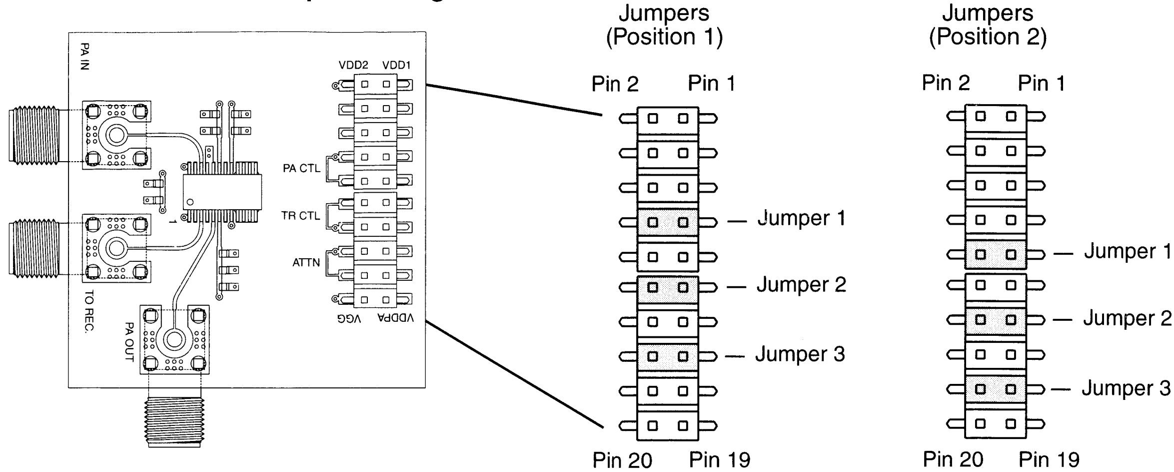
PCB DC Connector Jumper Settings



Jumper 1 (PA Sleep Control)	Position 1 = PA ON Position 2 = PA Sleep Mode
Jumper 2 (T/R Switch Control)	Position 1 = Receive Mode Position 2 = Transmit Mode
Jumper 3 (Attenuator Control)	Position 1 = Attenuator ON (Low Power Transmit) Position 2 = Attenuator OFF (High Power Transmit)

AM55-0007SMB Biasing Procedure

In order to prevent transients which may damage the MMIC, please adhere to the following procedure.

- Turn on all power supplies and set all voltages to 0 volts BEFORE connecting the power supplies to the DC connector.
- Set jumpers for desired test mode.
- Apply a -5.0 volt supply to DC connector pin 20 (V_{GG}).
- Apply a +5.0 volt supply to the DC connector pin 1 (V_{DD1}).
- Apply a +5.0 volt supply to the DC connector pin 2 (V_{DD2}).
- Apply a +5.0 volt supply to the DC connector pin 19 (V_{DD} PA).
- Adjust V_{GG} supply to -5 volts.
- Adjust all V_{DD} supplies to +5 volts.
- Hot switching of jumpers will not damage device.
- To power off, reverse above procedure.
  1. Set V_{DD1} & V_{DD2} & V_{DD} PA to 0 volts.
  2. Set V_{GG} to 0 volts.
  3. Disconnect bias lines from DC connector.
  4. Turn off power supplies.

Evaluation PCB and RF Connector Losses

Port Reference	Approximate Loss (dB)
PA IN	0.25
PA OUT	0.25
Rx OUT (TO REC)	0.25

The DC connector on the Designer's Kit PCB allows selection of all the device's operating modes. It is accomplished by one or more of the following methods:

1. A mating female multi-pin connector (Newark Electronics Stock # 46F-4658, not included)
2. Wires soldered to the necessary pins (not included)
3. Clip leads (not included)
4. A combination of clip leads or wires and jumpers (jumpers included as required)

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Integrated Transceiver 2.4 - 2.5 GHz

MD58-0001

V 2.00

Features

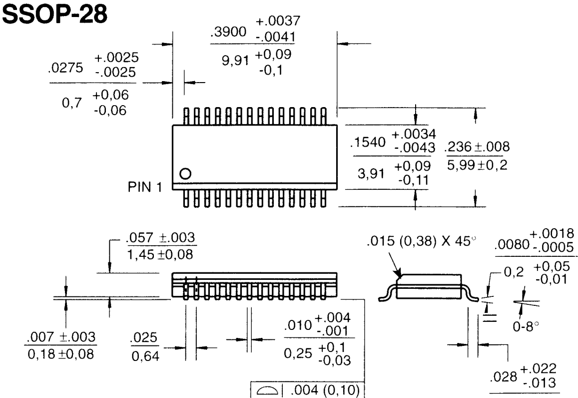
- Fully Integrated Transmit and Receive Functions
- Operates Over +3 V to +5 V Supply
- Low 30 mA Receive Current (Gain = 13.5 dB)
- High Receiver Dynamic Range (IIP_3 = +2 dBm, SSB NF = 4dB)
- On-Chip Receive Image Rejection (18 dB @ 350 MHz IF)
- Low Transmit Mode Current: 40 mA @ 5 V
- Transmit Spurious In-Band, -70 dBc
- Receive, Transmit & Standby Operation Modes
- Low Cost SSOP 28-Lead Plastic Package

Description

M/A-COM's MD58-0001 is a highly integrated front end transceiver with exceptional RF performance. The transceiver is ideally suited for FSK systems in the 2.4 - 2.5 GHz ISM band. The receive functions include an LNA, image reject filter, balanced mixer, with a balanced IF output for high data rate applications. The transmit chain utilizes a balanced IF input to drive the upconverting mixer and an RF combiner to provide exceptional output spurious performance. The transceiver applications include WLAN, WPBX and portable data collection terminals, where battery operation demands low current consumption. The transceiver can be used stand-alone for low-power transmission, or in conjunction with M/A-COM's AM55-0001 or AM55-0007 power amplifier for high power applications.

The MD58-0001 is a GaAs MMIC and is fabricated using an industry standard 1-micron process. This process features full chip passivation for increased performance and reliability.

SSOP-28



Dimensions are inches over millimeters.

Ordering Information

Part Number	Description
MD58-0001	SSOP 28-Lead Plastic Package
MD58-0001TR	Forward Tape & Reel*
MD58-0001RTR	Reverse Tape & Reel*
MD58-0001SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assignment.

Typical Electrical Specifications

Test Conditions: RF = 2.4 - 2.5 GHz, IF = 350 MHz, LO = -5 dBm, V_{DD} = +5 V ±5%, V_{GG} = -5 V ±10%[4], T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Receive Mode					
RF Frequency Range	Each IF output impedance[1] externally matched to 50 Ω. The balanced IF outputs are combined with a 180° hybrid.	GHz	2.4		2.5
IF Frequency Range		MHz	200		400
Conversion Gain		dB	10	13.5	
SSB Noise Figure		dB		4	5.5
Input P_{1dB}		dBm		-8	
V_{DD} (+5V) Current		mA		30	45
V_{GG} (-5V) Current		mA		0.5	1.5
Transmit Mode					
RF Frequency Range	IF input[2] of -8 dBm is applied to a 180° hybrid to inject a balanced IF input.	GHz	2.4		2.5
IF Frequency Range		MHz	200		400
RF Output Power		dBm		-2	
LO Leakage Level		dBm		-20	
Output Spurious Levels in RF Band[3]		dBc		-65	
V_{DD} (+5 V) Current		mA		40	60
V_{GG} (-5 V) Current		mA		0.5	1.5
Standby Mode					
V_{DD} (+5 V) Current		mA		0.5	1.5
V_{GG} (-5 V) Current		mA		0.5	1.5

1. The receive IF output impedance is 300 ohms for each IF output (600 ohms differential). An external LC circuit is used for impedance matching and bias injection.
2. The transmit IF input impedance is 100 ohms for each IF input (200 ohms differential)
3. In-band spurious, 7IF and 2 LO-5IF.
4. See performance charts for V_{DD} = +3 V and V_{GG} = -3 V.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power	+20 dBm
Operating Voltages	V_{DD} = 7 V V_{GG} = -7 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. Ambient temperature (T_A) = +25°C

Transceiver Truth Table

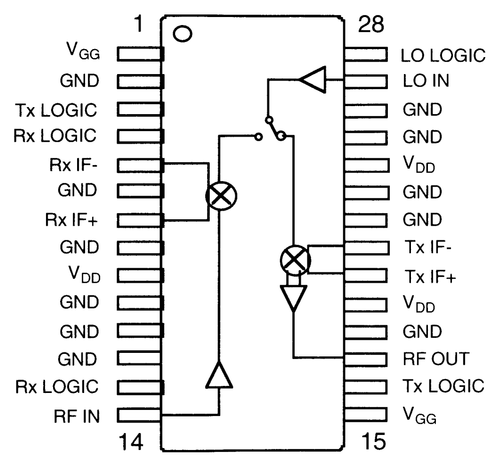
Pins	Receive Mode	Transmit Mode	Standby Mode
4, 13 (Rx LOGIC)	1	0	0
3, 16 (Tx LOGIC)	0	1	0
28 (LO LOGIC)	1	1	0

"0" = -5 V @ 100 µA Typ. to -7 V @ 200 µA Typ.
"1" = 0 V to -0.2 V @ 100 µA Typ.

Pin Description

Pin No.	Pin Name	Description
1	V_{GG}	Negative Supply Voltage (-5 V)
2	GND	DC and RF Ground
3	Tx LOGIC	Logic control line for transmit functions
4	Rx LOGIC	Logic control line for receive functions
5	Rx IF -	Receive IF output, first of two balanced IF outputs, external LC match and bias injection
6	GND	DC and RF Ground
7	Rx IF +	Receive IF output, second of two balanced IF outputs,external LC match and bias injection
8	GND	DC and RF Ground
9	V_{DD}	Positive Supply Voltage (+5 V)
10	GND	DC and RF Ground
11	GND	DC and RF Ground
12	GND	DC and RF Ground
13	Rx LOGIC	Logic control line for receive functions
14	RF IN	RF input to the receive LNA, internally AC coupled, Z_{in} = 50 Ω
15	V_{GG}	Negative Supply Voltage (-5 V)
16	Tx LOGIC	Logic control line for transmit functions
17	RF OUT	Transmit RF output, internally AC coupled, Z_{out} = 50 Ω
18	GND	DC and RF Ground
19	V_{DD}	Positive Supply Voltage (+5 V)
20	Tx IF +	Transmit IF input, first of two balanced IF inputs, externally AC coupled
21	Tx IF -	Transmit IF input,second of two balanced IF inputs,externally AC coupled
22	GND	DC and RF Ground
23	GND	DC and RF Ground
24	V_{DD}	Positive Supply Voltage (+5 V)
25	GND	DC and RF Ground
26	GND	DC and RF Ground
27	LO IN	LO buffer input, internally AC coupled, Z_{in} = 50 Ω
28	LO LOGIC	Logic control line for LO buffer functions

Functional Diagram



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General Information

The MD58-0001 is a highly integrated MMIC transceiver designed for the 2.4 - 2.5 GHz ISM band. The transceiver provides exceptional RF performance while consuming low DC current and is packaged in low cost plastic package. It is ideal for light weight battery operated portable radio systems.

The receive chain consists of an LNA, image reject filter, balanced mixer and balanced IF output buffers. The balanced IF outputs allow for a balanced mixer design for the second IF down conversion. The entire receiver consumes only 30 mA while achieving 13.5 dB gain and 4 dB of SSB NF with an IIP3 of +2 dBm. The transmit chain consists of a double-balanced mixer and RF combiner to provide low in-band output spurious while consuming only 40 mA. The LO signal is amplified by an on-chip buffer and injected to the receive and transmit mixers by a LO switch.

The RF output, RF input and LO input ports are designed for a 50-ohm impedance. All RF ports are internally AC coupled. The receive IF output impedance is 300 ohms for each IF output (600-ohm differential). For the Receive IF outputs, external components are used for impedance matching and bias injection. The transmit IF inputs are designed for 100-ohm impedance (200-ohm differential).

Transceiver Operation Modes

The transceiver is designed for three modes of operation, transmit, receive and stand-by. These modes are set by using three logic lines: one for receive, a second for transmit and a third logic line for the LO buffer. These logic lines allow rise times within micro seconds for fast "turn-on" and "turn-off" of each function. (See the transceiver truth table for logic and voltage levels.)

Bias Sequence

The transceiver bias sequence is as follows. Always make the ground connection first, then apply the V_{GG} supply voltage. After the V_{GG} supply voltage, connect all logic lines to the logic "0" so the transceiver will bias up in the stand-by mode when the positive supply is connected. Then apply the V_{DD} supply voltage and change the logic levels as desired.

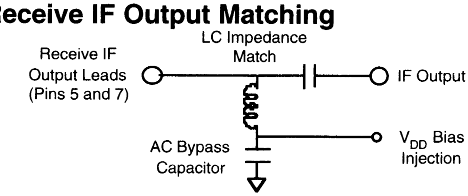
External Components and Circuit Board Layout

This data sheet contains a suggested PCB layout and schematic to follow when designing a full radio board. For more detailed information, contact the number listed below. The external components serve two basic functions. The first purpose is to bypass the power supply lines since all power supply lines require external capacitive bypass to present an AC short over a wide frequency band. The second use is for LC matching/bias injection for the receive IF output, as described below.

Receive IF Output Impedance

The receiver is designed for an output impedance of 300 ohms for each IF output (600-ohm differential). The receive IF output also requires a V_{DD} bias for each IF output. Using an external "LC match," as shown in the figure below, the IF output impedance matching and bias injection can be accommodated simultaneously. The table below shows suggested matching elements for various IF frequencies when matching to 50 ohms. Element values may vary slightly depending on component vendor and radio board layout.

Receive IF Output Matching



Receive IF Frequency Matching

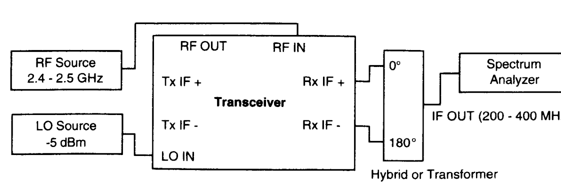
IF Frequency (MHz)	Shunt Inductor	Series Capacitor
200 - 249	90 nH	6 pF
250 - 299	68 nH	4 pF
300 - 349	58 nH	4 pF
350 - 400	47 nH	3 pF

Test Set-Up Information

The following two figures illustrate the test set-up suggested for transceiver evaluation, indicating the power levels used for the data displayed in the typical performance figures.

Receive Test Set-Up

The receiver test set-up uses an IF hybrid (i.e. M/A-COM H-183-4) to combine the two IF outputs. The receive gain is measured as the total combined IF output power. Receiver small signal gain measurements are made for -20 dBm RF input power. The figure below shows the typical receiver test set-up. The LO drive level is -5 dBm. Transmit ports should be terminated in 50 ohms.



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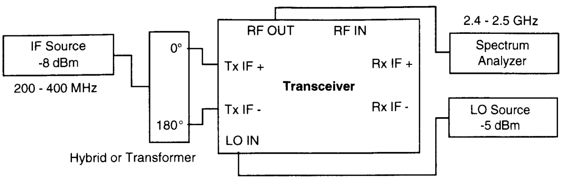
Transmit Test Set-Up

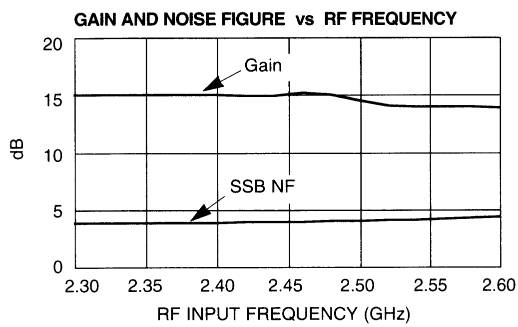
The transmit test set-up uses an IF hybrid to apply a balanced IF input to the transceiver. The IF input power level is typically -9 dBm and the LO input power level is -5 dBm. Receive ports should be terminated in 50 ohms.

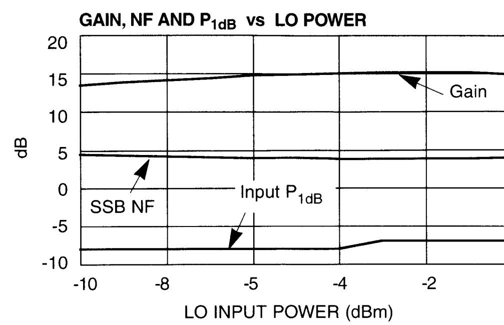


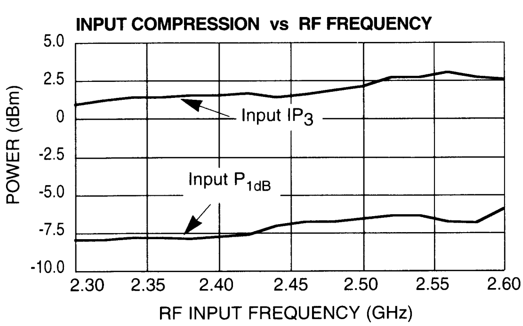
Typical Measured Results

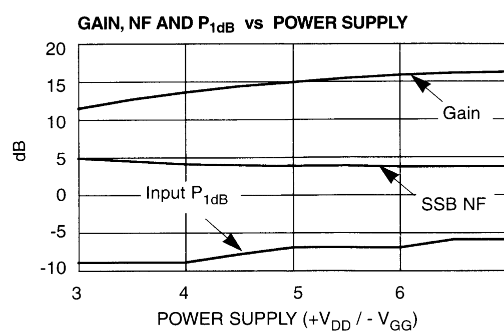
Measured results for a typical board mounted transceiver sample are shown in the performance curve section of this data sheet. The measurements were made using the test set-up described above for receive and transmit. The board used for these measurements is the MD58-0001SMB, or transceiver evaluation board. This evaluation board can be ordered for engineering evaluation.

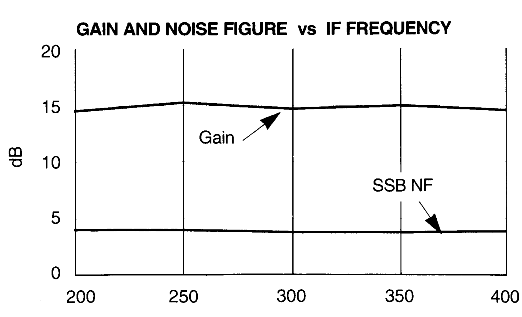
Typical Receiver Performance Characteristics[1]

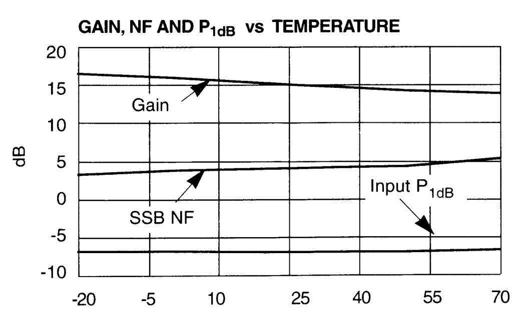












1. Test conditions (unless otherwise specified): RF = 2.45 GHz, IF = 350 MHz, LO Input Power = -5 dBm (@ 2.1 GHz), V_{DD} = +5 V, V_{GG} = -5 V, T_A = +25°C

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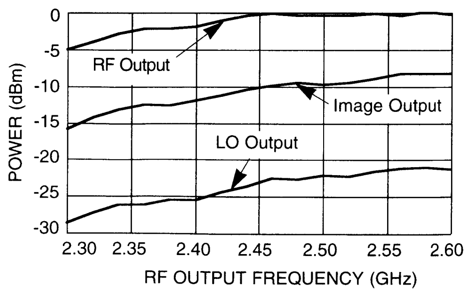
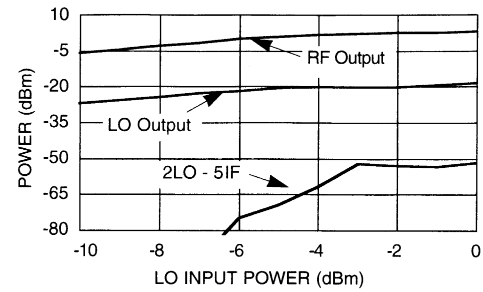
Typical Transmitter Performance Characteristics[1]

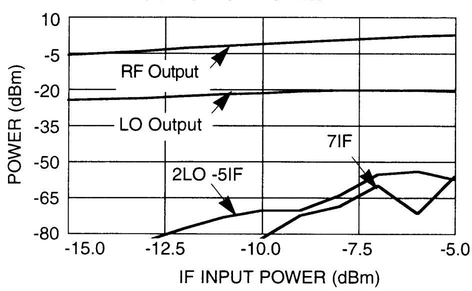
POWER OUTPUT vs RF FREQUENCY



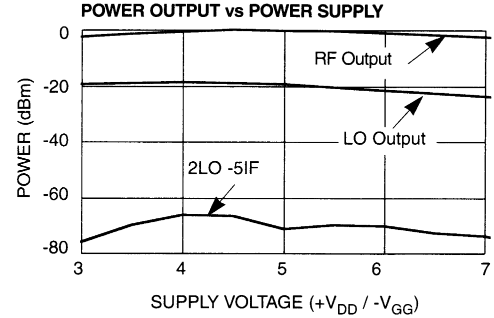
POWER OUTPUT vs LO POWER



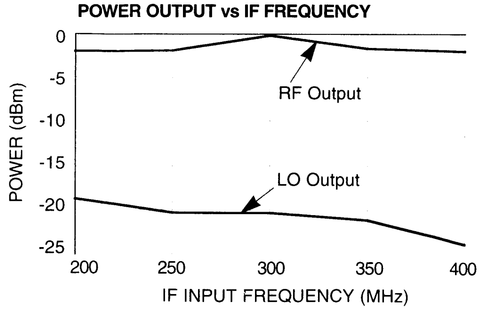
POWER OUTPUT vs IF POWER



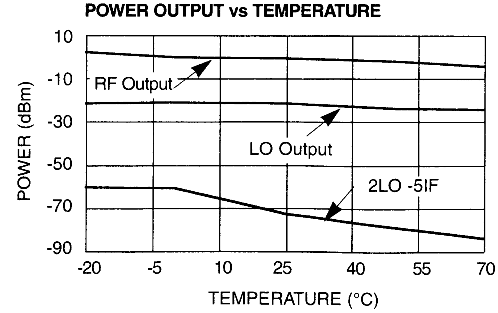
POWER OUTPUT vs POWER SUPPLY



POWER OUTPUT vs IF FREQUENCY



POWER OUTPUT vs TEMPERATURE



1. Test conditions (unless otherwise specified): RF = 2.45 GHz, IF = 350 MHz, LO Input Power = -5 dBm (@ 2.1 GHz), V_{DD} = +5 V, V_{GG} = -5 V, T_A = +25°C

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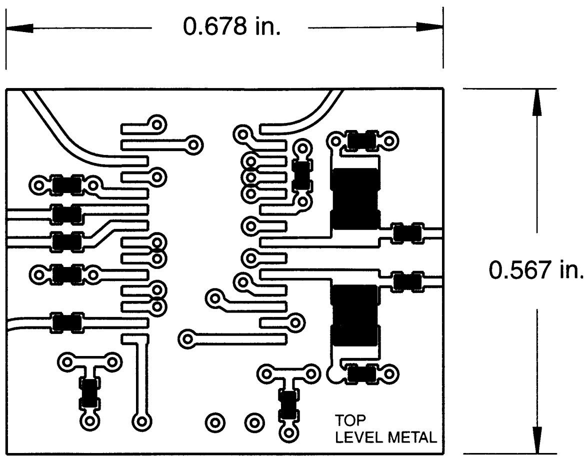
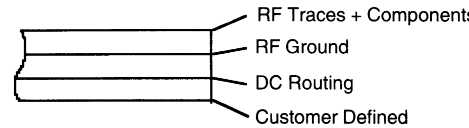
Recommended PCB Configuration

Layout View



Cross Section View

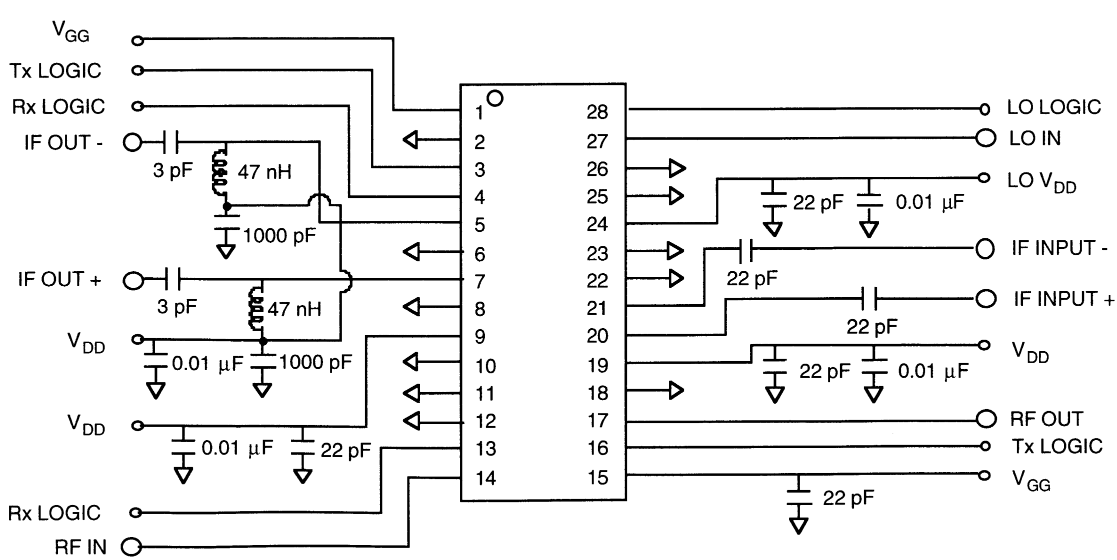


The PCB dielectric between RF traces and RF ground layers should be chosen to reduce RF discontinuities between 50-Ω lines and package pins. M/A-COM recommends an FR-4 dielectric thickness of 0.008 in. (0.2 mm), yielding a 50-Ω line width of 0.015 in. (0.38 mm). The recommened metalization thickness is 1 oz. copper.

Biasing Procedure

The MD58-0001 requires that V_{GG} bias be applied prior to ***any*** V_{DD} bias. Permanent damage may occur if this procedure is not followed.

External Circuitry



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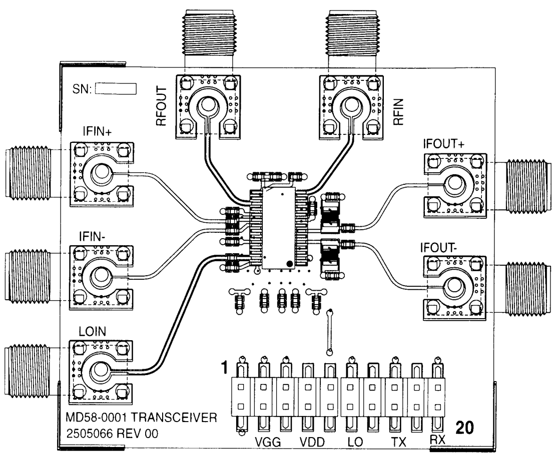
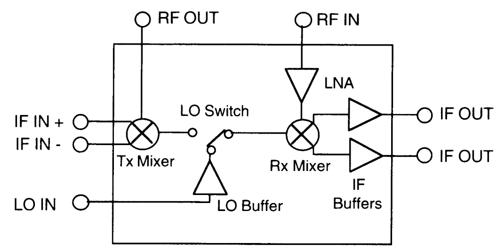
Designer's Kit (MD58-0001SMB)

The MD58-0001SMB Designer's Kit allows for immediate evaluation of M/A-COM's MD58-0001 integrated transceiver without the delays or cost of designing evaluation test boards. The evaluation board consists of the MD58-0001, recommended external surface mount circuitry, RF connectors and a DC multi-pin connector, all mounted to a multi-layer FR-4 PCB. The Designer's Kit also includes any additional application notes, a floppy disk containing typical performance data and a .DXF file of the recommended PCB layout. The MD58-0001SMB evaluation PCB and block diagram are illustrated below with all functional ports labeled.

Transceiver Sample Board



Functional Block Diagram



DC Connector Pinout

Pin	Function/DC Volt	Device Pin Number
1	GND/0V	GND PINS
2	GND/0V	GND PINS
3	V_{GG}/-5 V	1, 15
4	V_{GG}/-5 V	1, 15
5	V_{DD}/+5 V	5, 7, 9, 19, 24
6	V_{DD}/+5 V	5, 7, 9, 19, 24
7	N/C	N/C
8	N/C	N/C
9	N/C	N/C
10	N/C	N/C

Pin	Function/DC Volt	Device Pin Number
11	LO LOGIC	28
12	LO LOGIC PULLUP	N/C
13	N/C	N/C
14	N/C	N/C
15	Tx LOGIC	3, 16
16	Tx LOGIC PULLUP	N/C
17	N/C	N/C
18	N/C	N/C
19	Rx LOGIC	4, 13
20	Rx LOGIC PULLUP	N/C

Note: 5% tolerance for +5 V, 10% tolerance for -5 V

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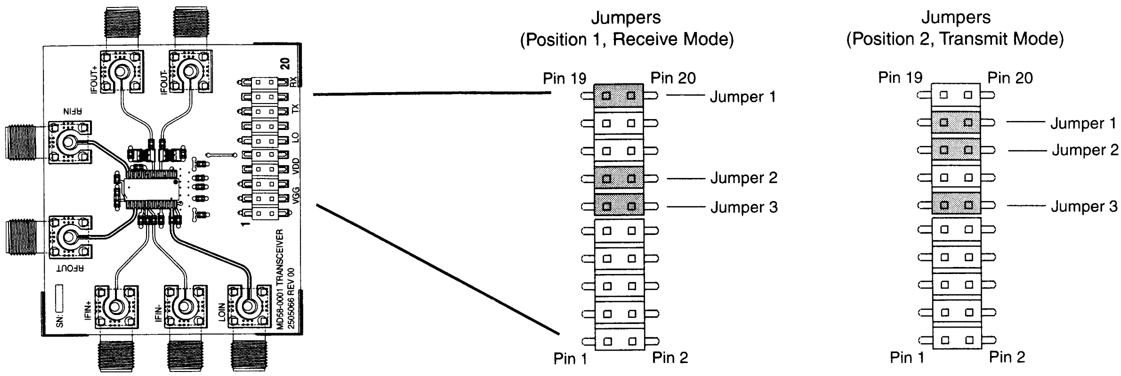
PCB DC Connector Jumper Settings



Jumper 1 (Receive Control)	Position 1 = Receive Functions "On" Position 2 = Receive Functions in "Sleep Mode"
Jumper 2 (Transmit Control)	Position 1 = Transmit Functions in "Sleep Mode" Position 2 = Transmit Functions "On"
Jumper 3 (LO Control)	Position 1, Position 2 = LO Buffer Function "On," Remove Jumper to disable LO Buffer.

MD58-0001SMB Biasing Procedure

In order to prevent transients which may damage the MMIC, please adhere to the following procedure.

- Turn on all power supplies and set all voltages to 0 volts BEFORE connecting the power supplies to the DC connector.
- Connect pin 1 or 2 to ground.
- Set jumpers for desired test mode.
- Apply a -5.0 volt supply to DC connector pin 3 or 4 (V_{GG}).
- Apply a +5.0 volt supply to the DC connector pin 5 or 6 (V_{DD}).
- Adjust V_{GG} supply to -5 volts.
- Adjust all V_{DD} supplies to +5 volts.
- Hot switching of jumpers will not damage device.
- To power off, reverse above procedure.
  1. Set V_{DD} to 0 volts.
  2. Set V_{GG} to 0 volts.
  3. Disconnect bias lines from DC connector.
  4. Turn off power supplies.

Evaluation PCB and RF Connector

Port Reference	Approximate Loss (dB)
RF IN	0.2
RF OUT	0.2
IF IN	0.1
IF OUT	0.1
LO IN	0.25

The DC connector on the Designer's Kit PCB allows selection of all the device's operating modes. It is accomplished by one or more of the following methods:

1. A mating female multi-pin connector (Newark Electronics Stock # 46F-4658, not included)
2. Wires soldered to the necessary pins (not included)
3. Clip leads (not included)
4. A combination of clip leads or wires and jumpers (jumpers included as required)

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Linear Integrated Transceiver 2.4 - 2.5 GHz

MD58-0002

V 2.00

Features

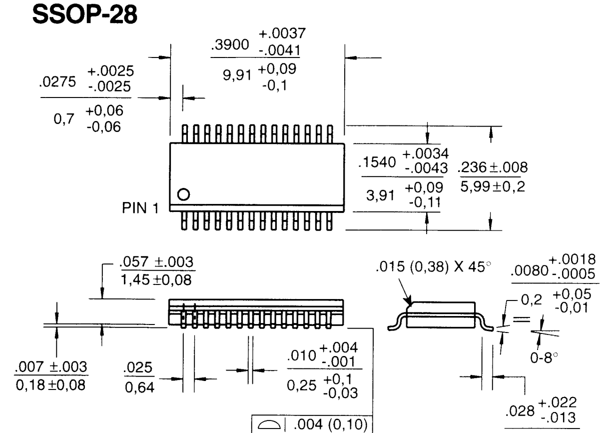
- Fully Integrated Transmit and Receive Functions
- High Linear Transmit Power: Output P_{1dB} = 9 dBm
- High Up/Down Conversion Gains (26 dB/16 dB)
- Generic Architecture with Single-Ended Input/Output Ports
- 4 dB, 8 dB and 12 dB Transmit Power Control
- Low Cost SSOP 28-Lead Plastic Package
- Integrated Image Reject Filter with 10 dB Rejection @ 200 MHz IF
- Offers Lower-Side-Band Suppression in Transmit Mode

Description

M/A-COM's MD58-0002 is a highly integrated RF front end transceiver with high linear transmit power. The transceiver is ideally suited for linear phase modulation systems in the 2.4 - 2.5 GHz ISM band. The receiver features an LNA, image reject filter, double balanced mixer and IF amplifier. The transmit chain includes IF amplifier, double balanced mixer, digital attenuator and two RF amplifiers. Applications include WLAN, portable data terminals and wireless PBX.

The MMIC is fabricated using an industry standard 1.0-µm MESFET process.

SSOP-28



Dimensions are inches over millimeters

Ordering Information

Part Number	Description
MD58-0002	SSOP 28-Lead Plastic Package
MD58-0002TR	Forward Tape & Reel*
MD58-0002RTR	Reverse Tape & Reel*
MD58-0002SMB	Designer's Kit

* If specific reel size is required, consult factory for part number assign-

Typical Electrical Specifications

Test Conditions: RF = 2484 MHz (-30 dBm), IF = 200 MHz (-30 dBm), LO = 2284 MHz (0 dBm), V_{DD} = +5 V ±5%, V_{GG} = -5 V ±10%, T_A = +25°C

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Receive Mode					
RF Frequency Range	IF port is matched to 50 Ω by LC network (see External Components section)	GHz	2.4		2.5
IF Frequency Range		MHz	200		400
Conversion Gain		dB	11	16	
SSB Noise Figure		dB		5.2	6.0
Input P_{1dB}		dBm		-15.5	
V_{DD} (+5V) Current		mA		50	75
V_{GG} (-5V) Current		mA		2.6	5.0
Transmit Mode					
RF Frequency Range	IF port is matched to 50 Ω by LC network (see External Components section)	GHz	2.4		2.5
IF Frequency Range		MHz	200		400
Conversion Gain		dB	20	26	
Output P_{1dB}		dBm	5	9	
LO Leakage		dBm		-2	
Power Control Accuracy For 4 dB, 8 dB and 12 dB states		dB		±1.5	
V_{DD} (+5 V) Current		mA		95	150
V_{GG} (-5 V) Current		mA		3.6	5.0

Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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Absolute Maximum Ratings[1]

Parameter	Absolute Maximum
Max. Input Power[2]	+23 dBm
Operating Voltages[2]	V_{DD} = 7 V V_{GG} = -7 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding these limits may cause permanent damage.
2. Ambient temperature (T_A) = +25°C

Pin Description

Pin No.	Pin Name	Description
1	GND	DC and RF Ground
2	V_{GG}	Negative supply voltage (-5 V) for receive and transmit
3	GND	DC and RF Ground
4	RF IN	Receive input to LNA. Signal is internally AC coupled. Z_{in} = 50 Ω
5	V_{DD}	Positive supply voltage (+5 V) for receive and transmit
6	GND	DC and RF Ground
7	GND	DC and RF Ground
8	$T2V_{DD}$	Positive supply voltage (+5 V) for transmit
9	TxV_{DD}	Positive supply voltage (+5 V) for transmit
10	GND	DC and RF Ground
11	IF IN	Transmit input to IF amplifier. Signal is internally AC coupled. Z_{in} = 140 Ω + 12 pF
12	GND	DC and RF Ground
13	LOV_{DD}	Positive supply voltage (+5 V) for LO amplifier should be ON for receive and transmit.
14	A0	Logic control signal for 4 dB attenuator. CMOS level compatible.
15	A1	Logic control signal for 8 dB attenuator. CMOS level compatible.
16	GND	DC and RF Ground
17	GND	DC and RF Ground
18	LO IN	Input of LO signal. Signal is internally AC coupled. Z_{in} = 50 Ω
19	LOSEL	Logic control signal for LO switch. CMOS level compatible.
20	IF OUT	Receive output from IF amplifier. Signal is internally AC coupled. Z_{out} = 140 Ω + 12 pF
21	RxV_{DD}	Positive supply voltage (+5 V) for receive
22	RxV_{DD}	Positive supply voltage (+5 V) for receive
23	GND	DC and RF Ground
24	$T3V_{DD}$	Positive supply voltage (+5 V) for transmit
25	RF OUT	Transmit output from RF amplifier. Signal is internally AC coupled. Z_{out} = 50 Ω
26	GND	DC and RF Ground
27	$R1V_{DD}$	Positive supply voltage (+5V) for receive
28	GND	DC and RF Ground

Transceiver Truth Table

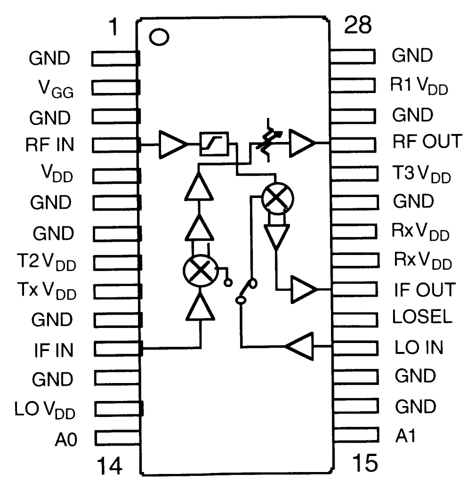
Pins	Receive	Transmit
LOSEL	1	0
$R1V_{DD}$, RxV_{DD}	5 V	0 V
TxV_{DD}, $T2V_{DD}$, $T3V_{DD}$	0 V	5 V

Digital Attenuator Truth Table

Attenuation	A1	A0
0 dB	1	1
4 dB	1	0
8 dB	0	1
12 dB	0	0

"0" = 0 V to 0.5 V @ 3 μA Typ.
"1" = V_{DD} to V_{DD} - 0.5 V @ 3 μA Typ.

Functional Diagram



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General Information

The MD58-0002 is a highly integrated MMIC transceiver designed for 2.4 - 2.5 GHz ISM band operation. Its generic architecture and complete up/down conversion functions make this device suitable for low cost, small size and light weight portable radio systems.

The transceiver is composed of a low noise receive chain and a high linearity transmit chain. The receive chain consists of an LNA, on-chip image rejection filter, double balanced mixer and an IF amplifier. The transmit chain consists of IF amplifier, double balanced mixer, two common source RF amplifiers and a digital attenuator with 4- and 8-dB step size. All signal ports, IF input/output, LO input, RF input/output, are terminated single-ended to reduce the complexity of the off-chip component design and ease the interface to other components in the system, such as IF SAW filters and voltage controlled oscillators (VCO).

The transceiver typically consumes 50 mA in receive mode and 95 mA in transmit mode from a +5 V supply. The negative supply current from a -5 V source is typically 2.6 mA for receive mode and 3.6 mA in transmit mode.

Power Management

Power supply lines of the MD58-0002 are configured flexibly so that different modes of operation can be achieved. There are eight supply lines which can be grouped into three categories: (1) Standby Group - V_{DD}, V_{GG}, LOV_{DD}; (2) Receive Group - $R1V_{DD}$, RxV_{DD}; and (3) Transmit Group - TxV_{DD}, $T2V_{DD}$, $T3V_{DD}$.

When the radio is disabled, the MD58-0002 is in a sleep mode where all the groups are 0 V. During standby mode, the LO amplifier and some other bias circuitry need to be ready for receive/transmit modes. The standby group should be ON at all times during standby, receive and transmit modes. The following table summarizes the operation:

Group	Pins	Sleep Mode	Standby Mode	Rx Mode	Tx Mode
Standby	V_{DD}	0 V	+5 V	+5 V	+5 V
	V_{GG}	0 V	-5 V	-5 V	-5 V
	LOV_{DD}	0 V	+5 V	+5 V	+5 V
Receive	$R1V_{DD}$	0 V	0 V	+5 V	0 V
	RxV_{DD}	0 V	0 V	+5 V	0 V
Transmit	TxV_{DD}	0 V	0 V	0 V	+5 V
	$T2V_{DD}$	0 V	0 V	0 V	+5 V
	$T3V_{DD}$	0 V	0 V	0 V	+5 V

To guarantee safe operation, the negative supply V_{GG} should be applied prior to any positive supplies.

Control Signals

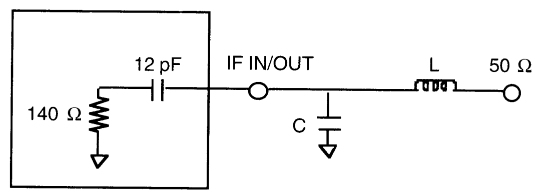
All the control signals (LO switch select, LOSEL and digital attenuator, A0 and A1) are CMOS compatible single positive logic (0 V and V_{DD}).

External Components

The MD58-0002 integrates all passive components required for transceiver functions. The only passive components which cannot be absorbed into MMIC are (1) AC bypass capacitors of 22 pF & 1000 pF and (2) single LC matching section for IF ports.

The AC bypass capacitors are designed to bypass both high (GHz) and low (MHz) frequencies. The absolute values are not critical, but they need to be the right order of magnitude. The placement of these capacitors needs to be as close to the package as possible in order to serve their purpose. (See printed circuit board layout for example.)

The IF input and output ports have an impedance equivalent to a series RC (R = 140Ω , C = 12 pF) network. This impedance can be matched to 50Ω by using a single LC section, as shown below.



The values of inductance (L) and capacitance (C) are determined by the IF frequency and the length of 50 Ω line between the package and the LC section. The L & C values for the layout depicted in the sample board layout are listed below for a variety of IF frequencies.

IF Frequency	Inductor (L)	Capacitor (C)
200 MHz	68 nH	3 pF
250 MHz	68 nH	3 pF
350 MHz	33 nH	0.5 pF
400 MHz	33 nH	0.5 pF

There are several vendors available to supply chip inductors and capacitors.

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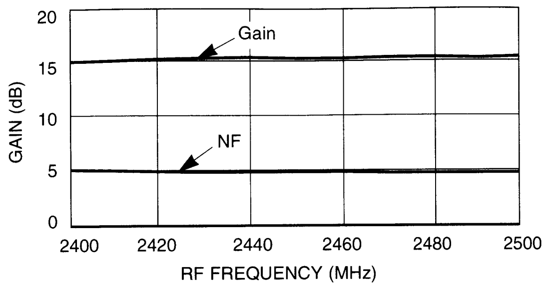
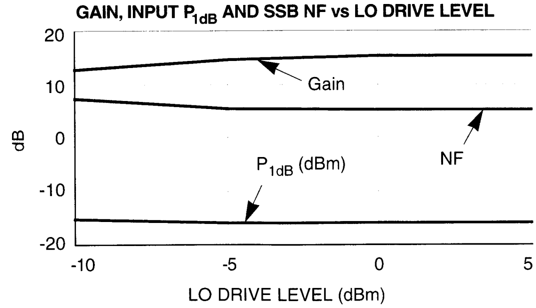
Typical Receiver Performance Characteristics[1]

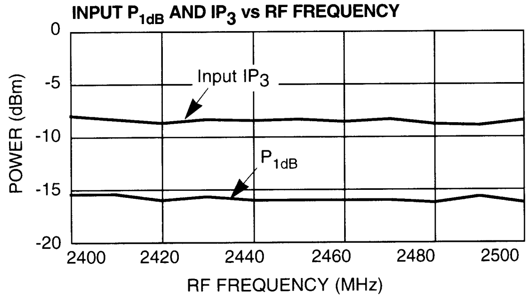
GAIN AND SSB NOISE FIGURE vs RF FREQUENCY



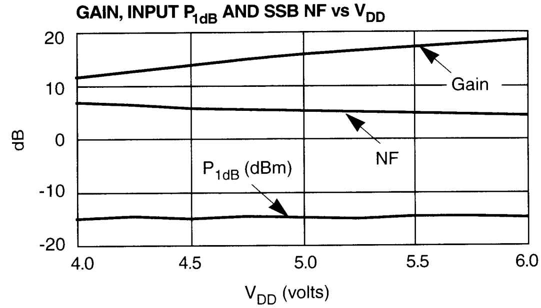
GAIN, INPUT P_{1dB} AND SSB NF vs LO DRIVE LEVEL



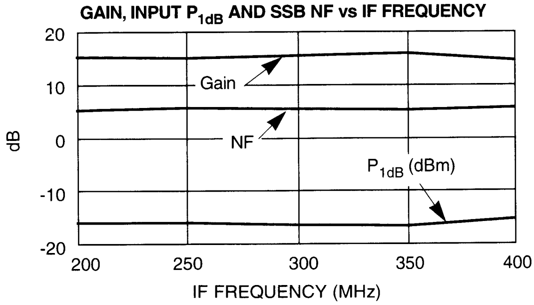
INPUT P_{1dB} AND IP_3 vs RF FREQUENCY



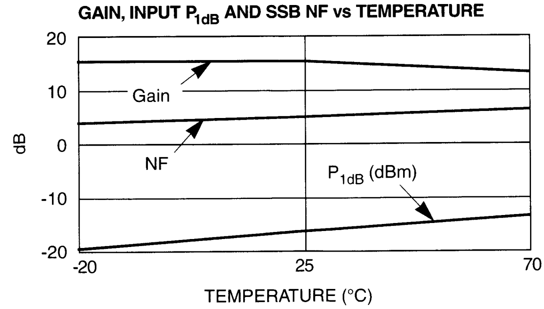
GAIN, INPUT P_{1dB} AND SSB NF vs V_{DD}



GAIN, INPUT P_{1dB} AND SSB NF vs IF FREQUENCY



GAIN, INPUT P_{1dB} AND SSB NF vs TEMPERATURE



1. Test conditions (unless otherwise specified):
RF = 2450 MHz, IF = 200 MHz, LO = 2250 MHz, 0 dBm, V_{DD} = +5 V, V_{GG} = -5 V, T_A = +25°C

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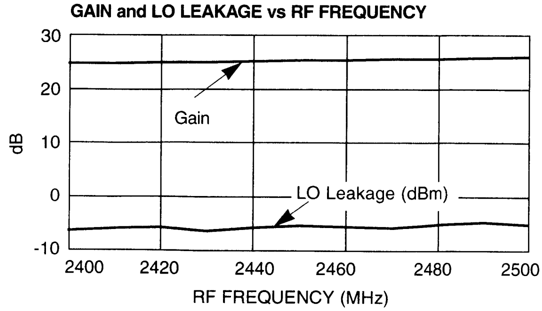
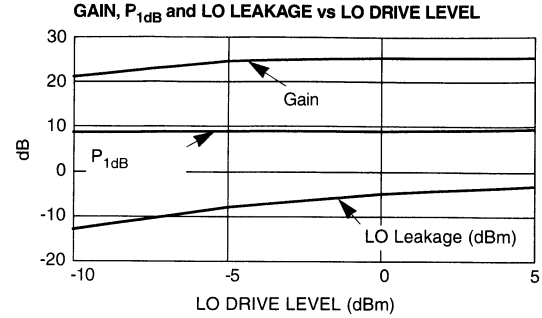
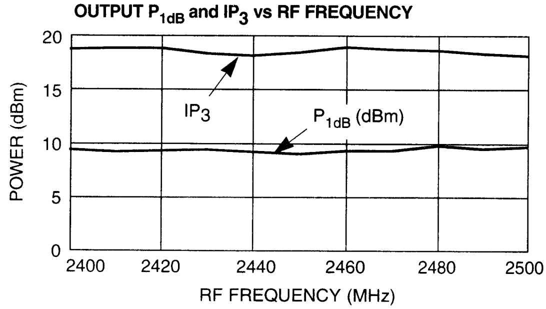
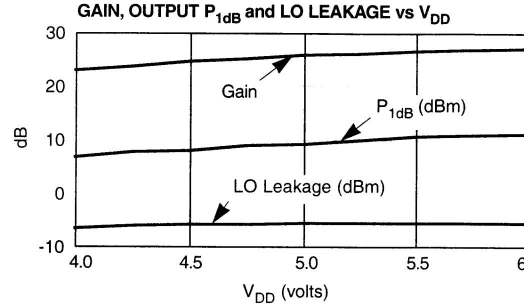
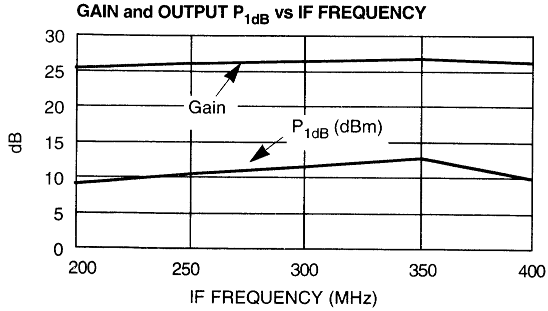
Typical Transmitter Performance Characteristics[1]

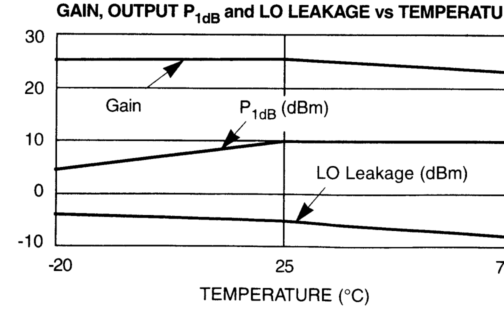












1. Test conditions (unless otherwise specified):
RF = 2450 MHz, IF = 200 MHz, LO = 2250 MHz, 0 dBm, V_{DD} = +5 V, V_{GG} = -5 V, T_A = +25°C

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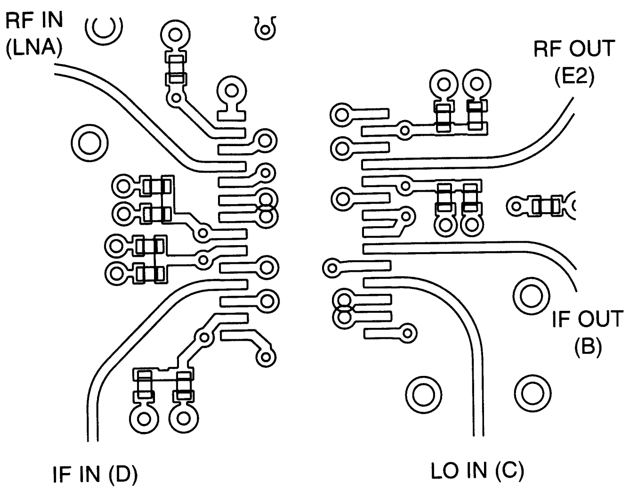
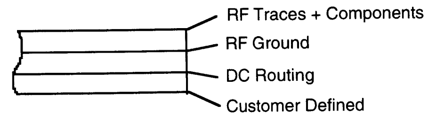
Recommended PCB Configuration

Layout View



Cross-Section View

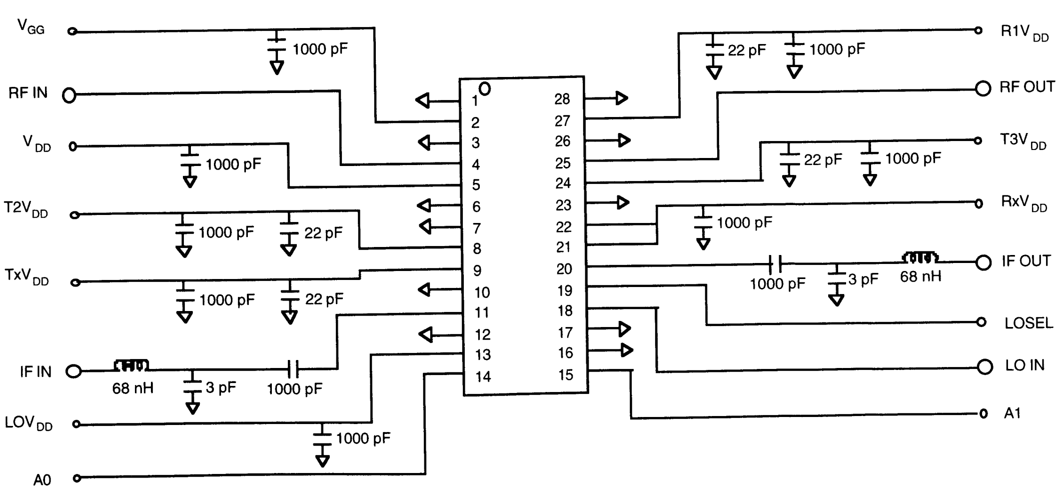


The PCB dielectric between RF traces and RF ground layers should be chosen to reduce RF discontinuities between 50-Ω lines and package pins. M/A-COM recommends an FR-4 dielectric thickness of 0.008 in. (0.2 mm), yielding a 50-Ω line width of 0.015 in. (0.38 mm). The recommened metalization thickness is 1 oz. copper.

Biasing Procedure

The MD58-0002 requires that V_{GG} bias be applied prior to ***any*** V_{DD} bias. Permanent damage may occur if this procedure is not followed. All FETs will draw excessive current and damage internal circuitry.

External Circuitry



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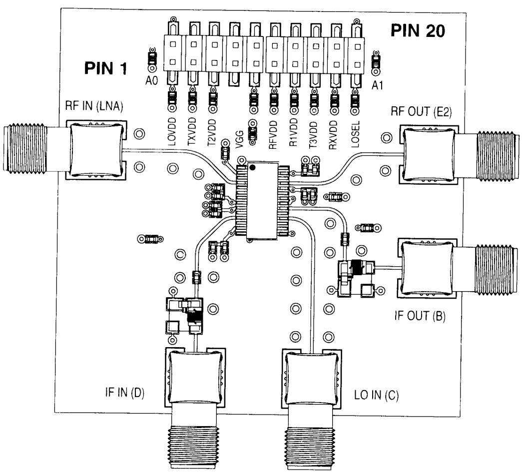
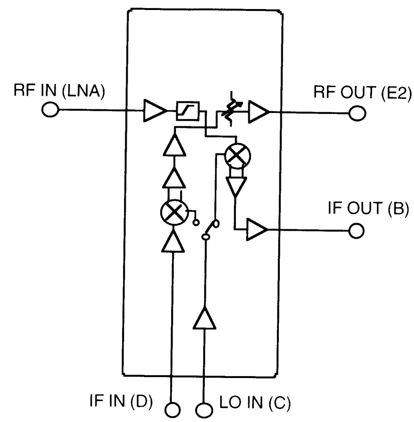
Designer's Kit (MD58-0002SMB)

The MD58-0002SMB Designer's Kit allows for immediate evaluation of M/A-COM's MD58-0002 integrated transceiver without the delays and cost of designing evaluation test boards. The evaluation board consists of an MD58-0002, recommended external surface mount circuitry, RF connectors and a DC multi-pin connector, all mounted to a multi-layer FR-4 PCB. Other items included in the Designer's Kit: a floppy disk (with typical performance data and a DXF file of the recommended PCB layout) and any additional Application Notes. The MD58-0002SMB integrated transceiver evaluation PCB and block diagram are illustrated below with all functional ports labeled.

Transceiver Sample Board



Functional Block Diagram



DC Connector Pinout

Pin	Function/DC Volt	Device Pin Number
1	LOV_{DD}/+5 V	13
2	GND/0 V	N/C
3	TxV_{DD}/+5 V	9
4	A0/0 V, +5 V	14
5	$T2V_{DD}$/+5 V	8
6	N/C	N/C
7	N/C	N/C
8	N/C	N/C
9	V_{GG}/-5 V	2
10	N/C	N/C

Pin	Function/DC Volt	Device Pin Number
11	V_{DD}/+5 V	5
12	N/C	N/C
13	$R1V_{DD}$/+5 V	27
14	N/C	N/C
15	$T3V_{DD}$	24
16	N/C	N/C
17	RxV_{DD}/+5 V	21, 22
18	A1/0V, +5 V	15
19	LOSEL/0 V, +5 V	19
20	GND/0 V	N/C

Note: 5% tolerance for +5 V, 10% tolerance for -5 V

The evaluation of MD58-0002 transceiver is greatly simplified by using this ready-to-measure Sample Board. There are five RF/IF ports: two for transmit input/output, two for receive input/output and one for LO signal input. All the RF/IF ports are AC coupled, either on the board or inside MMIC, and there is no need for any DC blocking. The RF and LO ports are designed to be 50 ohm and the IF ports are matched to 50 ohm on the board @ 200 MHz. The following test procedure will guide you to evaluate several key parameters of the highly integrated transceiver.

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Transmit Mode Test Procedure

DC Bias Sequence:

1. Set V_{GG} pin to -5 V.
2. Set V_{DD}, LOV_{DD}, $T2V_{DD}$, $T3V_{DD}$, TxV_{DD}, A0, and A1 pins to +5 V.
3. Set LOSEL, $R1V_{DD}$, and RxV_{DD} pins to 0 V.

RF/IF Signals:

1. Apply LO signal of 2284 MHz, 0 dBm to LO IN (C) port.
2. Apply IF signal of 200 MHz, -30 dBm to IF IN (D) port.

Measurements:

1. Measure transmit upper-side-band conversion gain at 2484 MHz from RF OUT (E2) port.
2. Measure transmit lower-side-band conversion gain at 2084 MHz from RF OUT (E2) port.
3. Measure transmit LO leakage at 2284 MHz from RF OUT (E2) port.

Other Measurements:

1. Measure DC supply currents from both +5 V and -5 V source.
2. Set A0 pin to 0 V to obtain 4 dB attenuation. Set A1 pin to 0 V to obtain 8 dB attenuation.
3. Increase input IF power until 1-dB gain compression occurs.

Receive Mode Test Procedure

DC Bias Sequence:

1. Set V_{GG} pin to -5 V.
2. Set V_{DD}, LOV_{DD}, RxV_{DD}, $R1V_{DD}$, LOSEL, A0, and A1 pins to +5 V.
3. Set $T2V_{DD}$, $T3V_{DD}$, and TxV_{DD} pins to 0 V.

RF/IF Signals:

1. Apply LO signal of 2284 MHz, 0 dBm to LO IN (C) port.
2. Apply RF signal of 2484 MHz, -30 dBm to RF IN (LNA) port.

Measurements:

1. Measure receive conversion gain at 200 MHz from IF OUT (B) port.

RF/IF Signals:

1. Apply LO signal of 2284 MHz, 0 dBm to LO IN (C) port.
2. Apply RF image signal of 2084 MHz, -30 dBm to RF IN (LNA) port.

Measurements:

1. Measure receive image conversion gain at 200 MHz from IF OUT (B) port.

Other Measurements:

1. Measure DC supply currents from both +5 V and -5 V source.
2. Increase input RF power until 1-dB gain compression occurs.

Evaluation PCB and RF Connector Losses

Port Reference	Estimated Loss (dB)
RF IN (LNA)	0.28
RF OUT (E2)	0.28
LO IN (C)	0.29
IF IN (D)	0.10
IF OUT (B)	0.10

The DC connector on the Designer's Kit PCB allows selection of all the device's operating modes. It is accomplished by one or more of the following methods:

1. A mating female multi-pin connector (Newark Electronics Stock # 46F-4658, not included)
2. Wires soldered to the necessary pins (not included)
3. Clip leads (not included)
4. A combination of clip leads or wires and jumpers (jumpers included as required)

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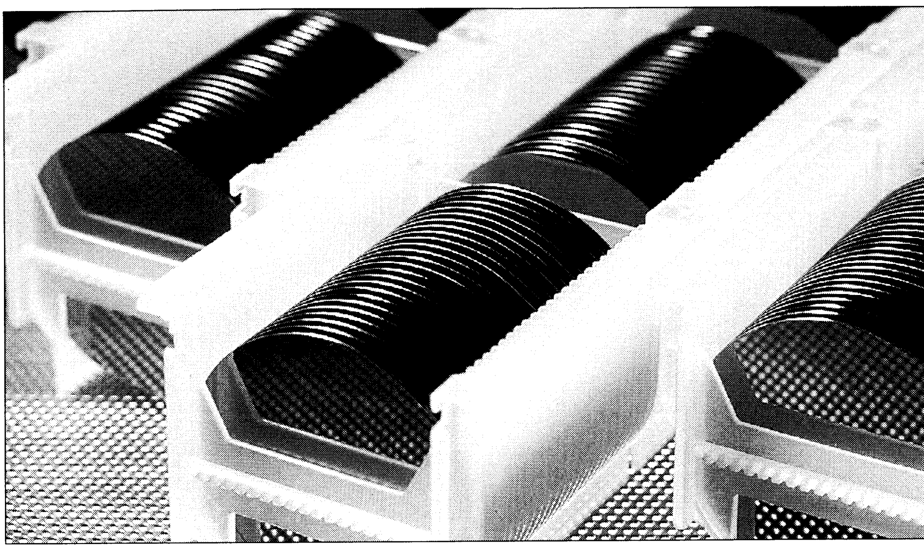
Semiconductor Materials



Semi-insulating GaAs
Silicon Epitaxial

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Silicon Epitaxial Wafers and Services

V 2.00

Silicon Epitaxial Wafers

M/A-COM grows high quality epitaxial silicon (Si). Our broad experience and extensive equipment base allow us to accommodate applications ranging from research to high-volume
production. Our epitaxial services can support product evolution from research and development through commercialization. Our knowledgeable staff specializes in engineered microelectronic structures for integrated circuits as well as discrete microwave devices.

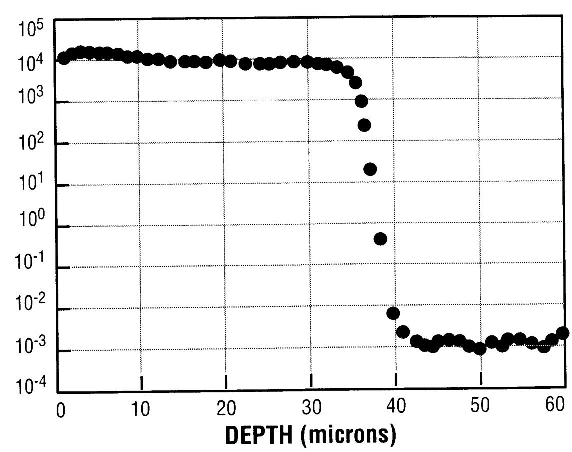
Device Applications

- Epitaxial Si is used in a wide variety of semiconductor products, including:
- RF, microwave and millimeter wave discrete and MMIC products
- Analog and digital bipolar products
- Bipolar complementary MOS (BiCMOS)
- Charge coupled devices (CCD)
- Metal-oxide-semiconductors (MOS)

Silicon Wafer Processing Services

In addition to growing custom epitaxial layers, we also provide high purity testing and qualification of silane compounds (>10,000 ohm-cm layer resistivities). Our wide range of services include:

- Oxidation Processing
- Silicon Nitride Deposition
- Photo
- Metal Deposition
- Wafer Dicing
- Polishing and Grinding
- Certification of Epitaxial Gases



High resistivity silicon spreading resistance profile

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Silicon Epitaxial Wafers

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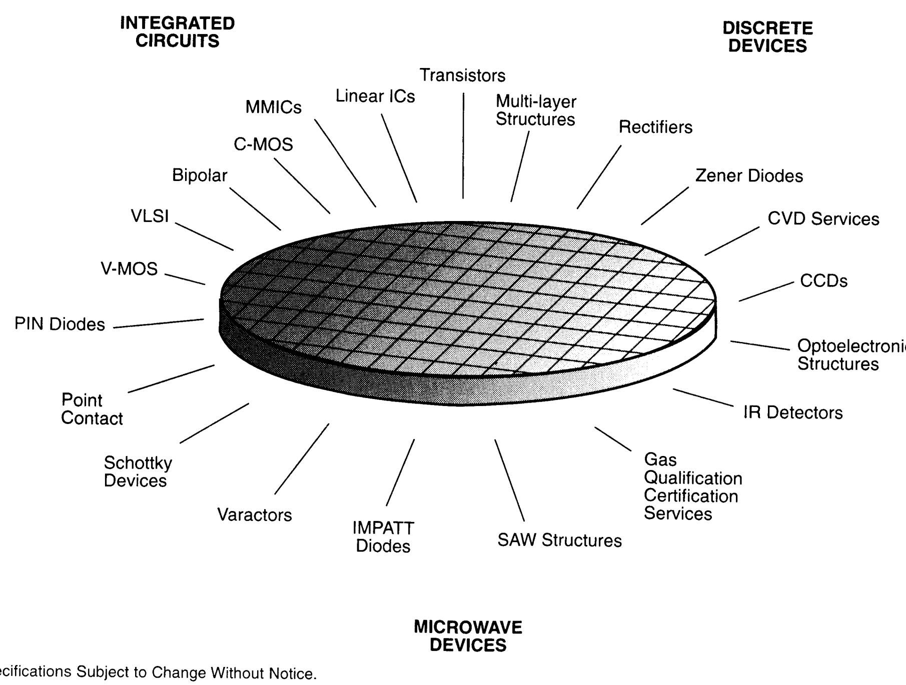
Silicon Epitaxial Wafers

- Si Epitaxial Layers (N/N+, N/P+, P/P+)
- Si Layer Thickness From 0.1 to 150μm ±5%
- Abrupt Interfaces
- Tailored Doping Profiles
- Multiple Si Layers
- Deposition on Wafers up to 150 mm
- Choice of Dopants (Arsenic, Phosphorus, Antimony, Boron)
- High-resistivity Si Layers >1000 ohm-cm

Characterization and Quality Control

Epitaxial layers are thoroughly inspected in-house to assure quality, using the following procedures:

- Thickness measurement 100% by Fourier transformer infrared spectrometer (FTIR) (per SEMI standard M2-85)
- Resistivity measurement by computerized mercury probe
- Measurement of thickness and/or resistivity for single or multiple layers using spreading resistance profiles (per SEMI standard F672-88)
- Resistivity of N/P and P/N structures measured by four-point probe
- Automated optical surface scan inspection
- 100% visual inspection using high intensity white light (per SEMI standard M-12)
- Refractive index measured by ellipsometry
- Scanning electron microscopy (SEM) and EDX for surface quality



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Silicon Wafer Processing Service

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Oxidation Processing Services

Thermal Oxides for 76 mm or 100 mm Wafers

- Available temperature range 900 -1200°C
  - Available thickness 300 -10,000 Å
  - Thickness tolerance negotiable

Low Temperature Oxide Deposition (LTO)

- Available thickness range 100-10,000 Å
- Thickness tolerance negotiable
- Wafer sizes 76 mm or 100 mm

Plasma Enhanced Chemical Vapor Deposition (PECVD)

- Available thickness range 1,000-10,000 Å
- Thickness tolerance negotiable
- Wafer sizes 76 mm or 100 mm

Silicon Nitride Deposition Services

Low Pressure Chemical Vapor Deposition
LPCVD Nitride

- Available temperature 810°C
- Available thickness range 500-3000 Å
- Thickness tolerance negotiable

Plasma Enhanced Chemical Vapor Deposition
Silicon Nitride (PECVD)

- Temperature 300°C
- Available thickness 500-3000 Å
- Thickness tolerance negotiable
- Wafer size 76 mm or 100 mm

Wafer Dicing Services

- Saws for 50 mm to 125 mm wafers
- Can deliver dice on tape or in vials

Polish and Grinding Services

- Substrate reclaiming and backside thinning
- Wafer size 76 mm or 100 mm
- Polish finish negotiable
- Grind tolerances negotiable

Photo Services

- Positive and negative resist processing
- Wafer size 76 mm or 100 mm
- Cassette to cassette or single wafer
- (Submicron capability on special order)

Metal Deposition Services

- DC & RF Sputtering to 125 mm wafers
- Electron beam evaporation to 100 mm wafers
- DC Pulse Plating
- Metal thickness negotiable
- Tolerances negotiable
- Choice of metal schemes negotiable

Certification of Epitaxial Gases

- Silane
- Dichlorosilane

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Semi-Insulating GaAs Substrates

V 2.00

Experience/Capabilities

Features

- Semi-insulating GaAs Wafers
- Undopped, High Pressure LEC Process
- Outstanding Consistency Boule-Boule, Wafer-Wafer
- Typical Hall Mobility of 700 cm2/V-s
- Stringent Process Control - ISO 9001 Certified

M/A-COM was the first commercial producer of Czochralski grown semi-insulating gallium arsenide in the world and is the largest supplier of this material in the U.S. Our GaAs crystal growth facility is equipped with state-of-the-art crystal growth, evaluation, slicing, lapping and polishing equipment. It is staffed with highly trained personnel dedicated to continuing the research and development required to improve GaAs crystal growth and fabrication technology.

Through our in-house and customer supported R & D programs, we have been in the forefront of GaAs Technology and its application for more than a decade. Our modern, well-equipped facilities, use of computer controlled material processing and automated testing, have provided the basis for our outstanding technological/production expertise.

We are committed to satisfying the needs of our customers, and look forward to helping you manufacture products that are the best in the industry.

M/A-COM is entering its second decade of customer service to the GaAs industry and is dedicated to being a high volume supplier of quality GaAs Substrates to make your efforts in device processing successful.

M/A-COM has the most extensive materials data base in the industry. This growing data base, which includes over 1300 ingots, tracks bulk properties such as Resistivity, Mobility and Etch Pit Density as well as ion implanted activation characteristics such as Sheet Resistivity, Threshold Voltage, and uniformity. In total each ingot is tracked by 300 data points from raw materials to customer shipments. You can take advantage of this unique capability and consider including our data in the chip fabrication data at your facility to:

1.) Correlate vendor and customer qualification results and

2.) Provide extensive traceability from raw materials to devices.

M/A-COM's semi-insulating substrates are being used by the largest GaAs production lines in the world. Through this extensive experience, we have identified the key substrate properties that are really important to meet these customer's needs. However, our customers' needs are continually changing with the technology and improvements in manufacturing techniques, therefore, we as a substrate supplier have built in the flexibility to meet these changing demands.

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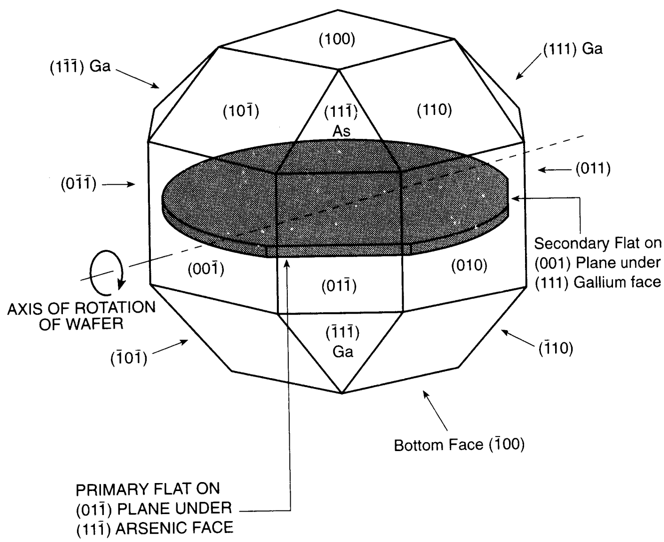
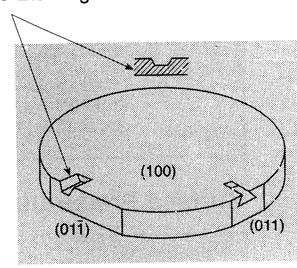
Semi-Insulating GaAs Wafers Undoped, High Pressure LEC

V 2.00



Cross Section on Device Side of Wafer Showing V-Groove Etch Figure



Mechanical Specifications in accordance with SEMI specifications

Parameter	Diameter: 3 inch	Diameter: 100 mm	Diameter: 150 mm
Diameter	3.000 ± 0.025" 76.2 ± 0.63 mm	100.0 ± 0.5 mm	150.0 ± 0.5 mm
Thickness*	625 ± 25μm	625 ± 25μm	625 ± 25μm (TBD)
Orientation	(100) ± 0.5°		
Off-Orientation	2° ± 0.5° toward nearest (110)		
Major Flat: Position	on (011) plane within 0.5° (V-Groove)**		
: Length	22.2 ± 2 mm	32.5 ± 2.5 mm	57.5 ± 2.5 mm (TBD)
Minor Flat: Position	on (011), 90° ± 1° counterclockwise from Major Flat**		
: Length	11.2 ± 2 mm	18 ± 2 mm	37.5 ± 2.5 mm (TBD)
Edge Rounding	Precision rounded to ASTM standard F928		
Laser Marking	Standard alphanumeric marking on device-quality		

* Non-standard thickness may be provided upon request
** Also available in Dovetail Flat Option

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V 2.00

Electronic and Crystallographic Specifications

Parameter	Value		Units
	Minimum	Typical	
Hall Mobility	6000	7000	cm^2/V-s
Resistivity	1 x10^7	3 x 10^7	ohm-cm
Etch Pit Destiny (EPD)	4 x 10^4	8 x 10^4	cm^{-2}

Surface Preparation

Parameter	Diameter		
	3 inch	100 mm	150 mm
Surface	Both faces chemically/mechanically polished, free from all scratches, haze, orange peel, and dimples		
Particle Contamination of 0.5 μm2 or larger	<50	<50	<100
Total Indicated Reading (TIR)	≤3 μm	≤3 μm	TBD
Total Thickness Variation (TTV)	≤3 μm	≤4 μm	TBD
Warp	≤4μm	≤5 μm	≤10 μm
Bow	≤2 μm	≤2 μm	≤10 μm
Local Focal Plane Deviation (LFPD)	≤1.5 μm (15x15 mm field)	≤1.5 μm (15x15 mm field)	TBD

Flatness data measured on GCA Tropel
Particulates measured on Tencor 4500

Packaging:

M/A-COM substrates are supplied to you either in cassettes or in individual fluoroware containers. Both are packaged in a class 10 environment and are sealed in sterile poly-coated mylar bags that satisfy the MIL-B-2219C Type II Specifications and DOT Regulations.

For additional information, please contact Chuck Snider, Technical Sales Manager.

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HPLEC Grown GaAs Material Ordering Worksheet for Standard Products

V 2.00

M/A-COM Part # MA4GX X X X X X X

	MA4GX	X	X	X	X	X	X
GRADE							
Test Grade Wafers	0						
† Prime Undopped	2						
Prime Cr-Doped	3						
DIAMETER							
2" Round		1					
3" Round		3					
100mm Round		4					
150mm Round		6					
ORIENTATION							
† (100)			0				
(100) 2° to (110)			2				
Other (Check Availability)			4				
STANDARD THICKNESS							
20 mils (508μm) - for 2" dia.				H			
25 mils (635μm) - for 3", 100 mm dia.				M			
FINISH							
Edge Rounded as Sawn w/Flats					S		
† Polished Both Sides					K		
DEVICE- QUALITY SIDE							
† SEMI Standard V-Groove side						A	
SEMI Standard Dovetail side						E	
LASER MARKING							
† Located on V-Groove side							A
Located on Dovetail side							E
No marking allowed							X

†Standard Product

________________ WAFER QUANTITY   MA Part # MA4G ________________

________________ PRICE Per Wafer   DELIVERED ________________

M/A-COM ALSO SUPPLIES TO CUSTOMER SPECIFICATIONS UPON REVIEW AND APPROVAL.

Please Contact: Chuck Snider
Manager, Sales and Technical Support
GaAs Materials

FORM 3280B

Specifications Subject to Change Without Notice.

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Appendix

Application Note Table of Contents

Discrete Semiconductors

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Diodes and Small Signal Transistors

Power Transistors and Modules

Monolithic Semiconductors

Amplifiers

Control Components

General

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Application Note

Design With PIN Diodes

By Gerald Hiller

AG312

V 2.00

Introduction

The PIN diode finds wide usage in RF, UHF and microwave circuits. It is fundamentally a device whose impedance, at these frequencies, is controlled by its DC excitation. A unique feature of the PIN diode is its ability to control large amounts of RF power with much lower levels of DC.

PIN Diode Modeling

The PIN diode is a current controlled resistor at radio and microwave frequencies. It is a silicon semiconductor diode in which a high resistivity intrinsic I-region is sandwiched between a P-type and N-type region. When the PIN diode is forward biased, holes and electrons are injected into the I-region. These charges do not immediately annihilate each other; Instead they stay alive for an average time called the carrier lifetime, τ. This results in an average stored charge, Q, which lowers the effective resistance of the I-region to a value R_S.

When the PIN diode is at zero or reverse bias there is no stored charge in the I-region and the diode appears as a capacitor, C_T, shunted by a parallel resistance R_P.

PIN diodes are specified for the following parameters:

- R_S series resistance under forward bias
- C_T total capacitance at zero or reverse bias
- R_D parallel resistance at zero or reverse bias
- V_R maximum allowable DC reverse bias voltage
- τ carrier lifetime
- θ_{AVE} average thermal resistance ***or***
- P_D maximum average power dissipation
- θ_{pulse} pulse thermal impedance ***or***
- P_P maximum peak power dissipation

By varying the I-region width and diode area it is possible to construct PIN diodes of different geometrics to result in the same R_S and C_T characteristic. These devices may have similar small signal characteristics. However, the thicker I-region diode would have a higher bulk or RF breakdown voltage and better distortion properties. On the other hand the thinner device would have faster switching speed.

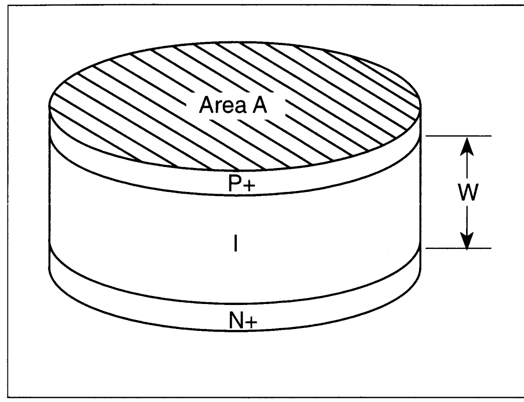

Figure 1

There is a common misconception that carrier life time, τ, is the only parameter that determines the lowest frequency of operation and the distortion produced. This is indeed a factor, but equally important is the thickness of the I-region, W, which relates to the transit time frequency of the PIN diode.

Low Frequency Model

At low frequencies (below the transit time frequency of the I-region) and DC the PIN diode behaves like a silicon PN junction semiconductor diode. Its I-V characteristic determines the DC voltage at the forward bias current level. PIN diodes often are rated for the forward voltage, V_F, at a fixed DC bias.

The reverse voltage ratings on a PIN diode, V_R, are a guarantee from the manufacturer that no more than a specified amount, generally 10μA, of reverse current will flow when V_R is applied. It is not necessarily the avalanche or bulk breakdown voltage, V_B, which is determined by the I-region width (approximately 10V/μm.) PIN diodes of the same bulk break down voltage may have different voltage ratings. Generally, the lower the voltage rating the less expensive the PIN diode.

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Large Signal Model

When the PIN diode is forward biased the stored charge, Q, must be much greater than the incremental stored charge added or removed by the RF current, I_{RF}. To insure this the following inequality must hold:

$$Q >> \frac{I_{RF}}{2\pi f}$$

Under reverse bias the diode should not be biased beyond its DC voltage rating, V_R. The avalanche or bulk breakdown voltage, V_B, of a PIN diode is proportional to the I-region width, W, and is always higher than V_R. In a typical application maximum negative voltage swing should never exceed V_B. An instantaneous excursion of the RF signal into the positive bias direction generally does not cause the diode to go into conduction because of the slow reverse to forward switching speed, T_{RF}, of the PIN diode. Refer to Figure 2.

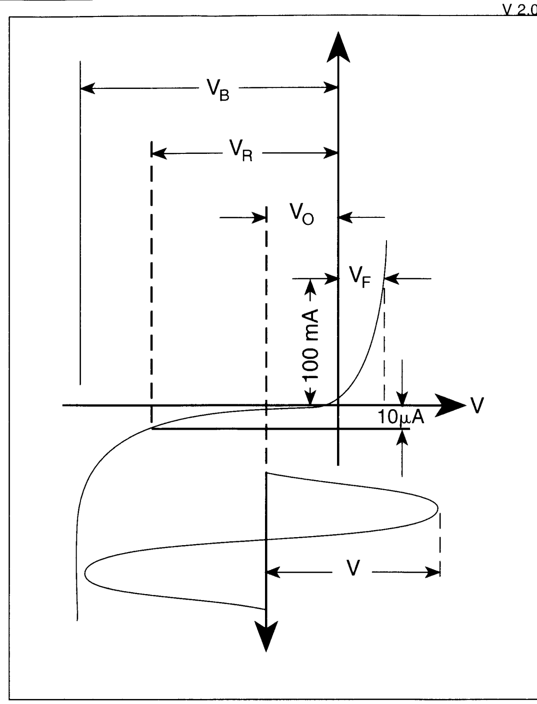
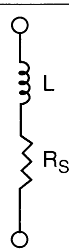


Figure 2

RF Electrical Modeling of PIN Diode

Forward Bias Model

$$R_S = \frac{W^2}{(\mu_n + \mu_p)\, Q} \quad (ohms)$$



Where

- Q = $I_F \times \tau$ (coulombs)
- W = I-region width
- I_F = forward bias current
- τ = carrier lifetime
- μ_n = electron mobility
- μ_p = hole mobility

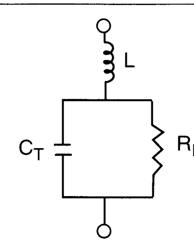
Notes:

1. In practical diode the parasitic resistance of the diode package and contact limit the lowest resistance value.
2. The lowest impedance will be affected by the parasitic inductance, L, which is generally less than 1 nHy.
3. The equation is valid at frequencies higher than the I-region transmit time frequency, i.e.,

   $f > \frac{1300}{W^2}$ *(where frequency is in MHz and W in µm).*
4. The equation assumes that the RF signal does not affect the stored charge.

Zero or Reverse Bias Model

$$C_T = \frac{\varrho A}{W}$$



Where

ϱ = dielectric constant of silicon

A = area of diode junction

Notes:

1. The above equation is valid at frequencies above the dielectric relaxation frequency of the I-region, i.e.

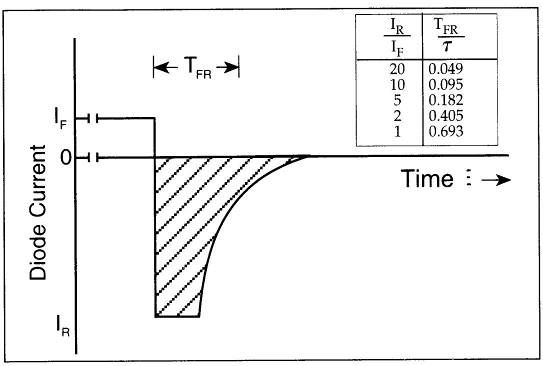
   $f > \frac{1}{2\pi\rho}$ *(where ρ is the resistivity of the I-region). At lower frequencies the PIN diode acts like a varactor.*
2. The value R_P is proportional to voltage and inversely proportional to frequency. In most RF applications its value is higher than the reactance of the capacitance, C_T, and is less significant.

Switching Speed Model

The switching speed in any application depends on the driver circuit as well as the PIN diode. The primary PIN properties that influence switching speed may be explained as follows:

A PIN diode has two switching speeds from forward bias to reverse bias T_{FR}, and from reverse bias to forward bias T_{RF}. The diode characteristic that affects T_{FR} is τ, carrier lifetime. The value ot T_{FR} may be computed from the forward current, I_F, and the initial reverse current I_R, as follows:

$$T_{FR} = \tau \log_e \left(1 + \frac{I_F}{I_R}\right) \qquad Secs$$



I_R / I_F	T_{FR} / τ
20	0.049
10	0.095
5	0.182
2	0.405
1	0.693

Figure 3

T_{RF} depends primarily on I-region width, W, as indicated in the following chart which shows typical data:

I-Width	To 10mA from		To 50mA from		To 100mA from	
μm	10V	100V	10V	100V	10V	100V
175	7.0μS	5.0μS	3.0μS	2.5μS	2.0μS	1.5μS
100	2.5μS	2.0μS	1.0μS	0.8μS	0.6μS	0.6μS
50	0.5μS	0.4μS	0.3μS	0.2μS	0.2μS	0.1μS

Thermal Model

The maximum allowable power dissipation, P_D, is determined by the following equation:

$$P_D = \frac{T_J - T_A}{\theta} \qquad Watts$$

where T_J is the maximum allowable junction temperature (usually 175°C) and T_A is the ambient or heat sink temperature. Power dissipation may be computed as the product ot the RF current squared multiplied by the diode resistance, R_S.

For CW applications the value of thermal resistance, θ, used is the average thermal resistance, θ_{AV}.

In most pulsed RF and microwave applications where the duty factor, DF, is less than 10 percent and the pulse width, t_p, is less than the thermal time constant of the diode, good approximation of the effective value of θ in the above equation may be computed as follows:

$$\theta = DF \times \theta_{AVE} + \theta_{tp} \qquad °C/W$$

Where θ_{tp} is the thermal impedance of the diode for the time interval corresponding to t_P.

The following diagram indicates how junction temperature is affected during a pulsed RF application.

PIN Diode Applications

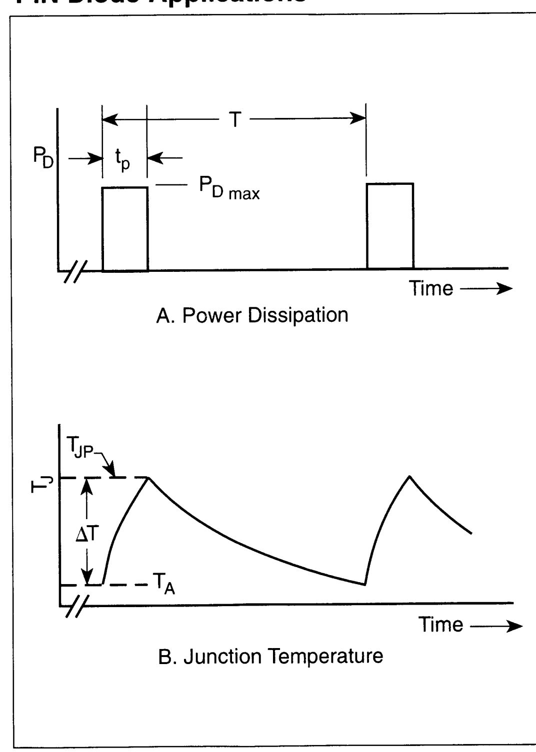


Figure 4

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Switches

PIN diodes are commonly used as a switching element to control RF signals. In these applications, the PIN diode can be biased to either a high or low impedance device state, depending on the level of stored charge in the I-region.

A simple untuned single-pole, single-throw (SPST) switch may be designed using either a single series or shunt connected PIN diode as shown in Figure 5. The series connected diode switch is commonly used when minimum insertion loss is required over a broad frequency range. This design is also easier to physically realize using printed circuit techniques, since no through holes are required in the circuit board.

A single shunt mounted diode will, on the other hand produce higher isolation values across a wider frequency range and will result in a design capable of handling more power since it is easier to heat sink the diode.

Multi-throw switches are more frequently used than single-throw switches. A simple multi-throw switch may be designed employing a series PIN diode in each arm adjacent to the common port. Improved performance is obtained by using "compound switches," which are combinations of series and shunt connected PIN diodes, in each arm.

For narrow-band applications, quarter-wave spaced multiple diodes may also be used in various switch designs to obtain improved operation in the following section, we shall discuss each of these types of switches in detail and present design information for selecting PIN diodes and predicting circuit performance.

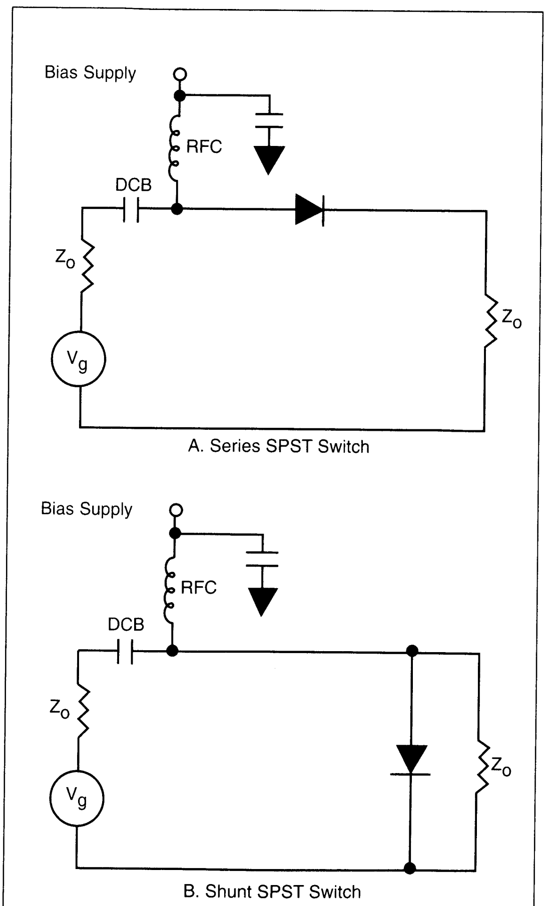

Figure 5

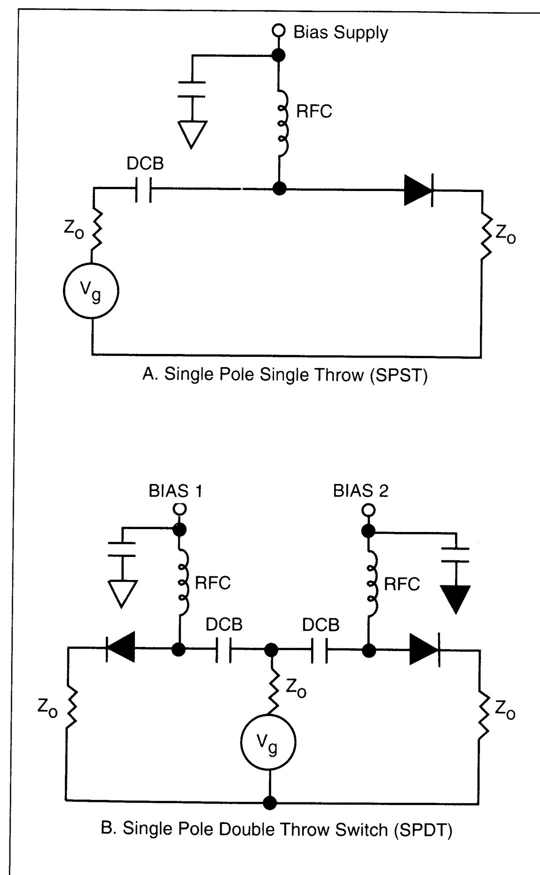

Figure 6

Series Connected Switch

Figure 6 shows two basic types of PIN diode series switches, (SPST and SPDT), commonly used in broadband designs. In both cases, the diode is in a "pass power" condition when it is forward biased and presents a low forward resistance, R_S, between the RF generator and load. For the "stop power" condition, the diode is at zero or reverse bias so that it presents a high impedance between the source and load. In series connected switches, the maximum isolation obtainable depends primarily on the capacitance of the PIN diode, while the insertion loss and power dissipation are functions of the diode resistance. The principal operating parameters of a series switch may be obtained using the following equations:

A. Insertion Loss (Series Switch)

$$IL = 20\ log_{10}\ [1 + R_S/2Z_O] \qquad dB \quad (1)$$

This equation applies for a SPST switch and is graphically presented in Figure 7 for a 50 ohm impedance design. For multi-throw switches, the insertion loss is slightly higher due to any mismatch caused by the capacitance of the PIN diodes in the "off" arms. This additional insertion loss can be determined from Figure 10 after first computing the total shunt capacitance of all "off" arms of the multi-throw switch.

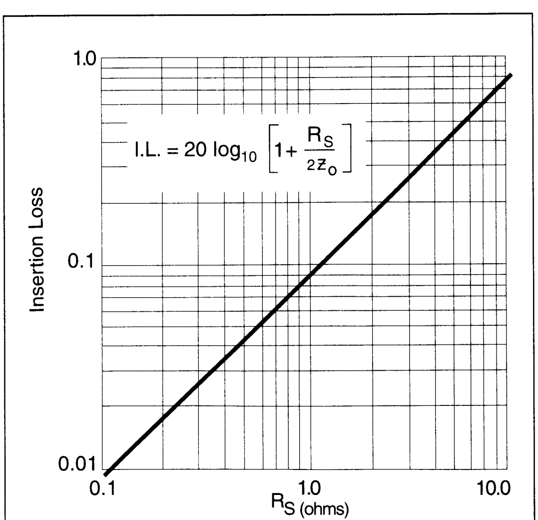

Figure 7

Insertion loss for PIN Diode series switch in 50Ω system.

B. Isolation (Series Switch)

$$I = 10\ log_{10}\ [1 + (4\pi f C Z_0)^{-2}] \qquad dB \quad (2)$$

This equation applies for a SPST diode switch. Add 6 dB for a SPNT switch to account for the 50 percent voltage reduction across the "off" diode due to the termination of the generator in its characteristic impedance. Figure 8 graphically presents isolation as a function of capacitance for simple series switches. These curves are plotted for circuits terminated in 50 ohm loads.

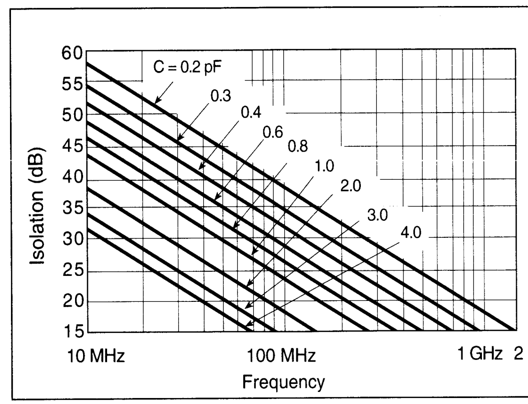

Figure 8

Isolation for SPST Diode series switch in 50Ω system. Add 6 dB to isolation for multi throw switches (SPNT).

C. Power Dissipation (Series Switch in Forward Bias)

$$P_D = \frac{4\, R_S\, Z_O}{(2Z_O + R_S)^2} \bullet P_{AV} \qquad watts \quad (3)$$

For $Z_O >> R_S$, this becomes:

$$P_D \approx \frac{R_S}{Z_O} \bullet P_{AV} \qquad watts \quad (4)$$

Where the maximum available power is given by:

$$P_{AV} = \frac{V_g^{\,2}}{4Z_O} \qquad watts \quad (5)$$

It should be noted that Equations 3 and 4 apply only for perfectly matched switches. For SWR (σ) values other than unity, multiply these equations by $[2\sigma/(\sigma + 1)]^2$ to obtain the maximum required diode power dissipation rating.

D. Peak Current (Series Switch)

$$I_P = \frac{2P_{AV}}{Z_O} \bullet \left(\frac{2\,\sigma}{\sigma + 1}\right) \ amps \qquad (6)$$

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In the case of a 50 ohm system, this reduces to:

$$I_P = \sqrt{\frac{P_{AV}}{5}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \textit{amps} \qquad (7)$$

C. Peak RF Voltage (Series Switch)

$$V_P = \sqrt{8 Z_O P_{AV}} \quad \textit{volts} \quad (SPST)$$

$$V_P = \sqrt{2 Z_O P_{AV}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \textit{volts} \quad (SPST) \qquad (8)$$

For a 50 ohm system, this becomes:

$$V_P = 20\sqrt{P_{AV}} \quad \textit{volts} \quad (SPST)$$

$$V_P = 10\sqrt{P_{AV}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \textit{volts} \quad (SPST) \qquad (9)$$

Shunt Connected Switch

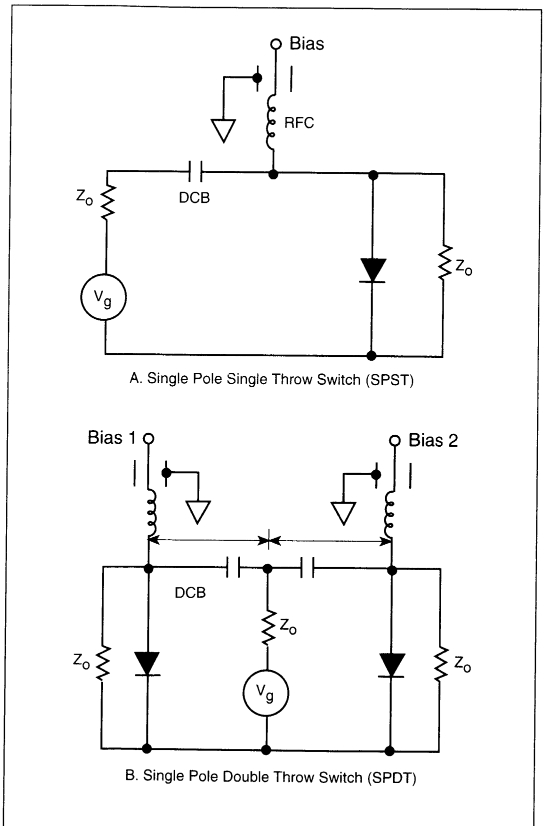

Figure 9

Shunt Connected Switches 2-5

Figure 9 shows two typical shunt connected PIN diode switches. These shunt diode switches offer high isolation for many applications and since the diode may be heat sinked at one electrode, it is capable of handling more RF power than a diode in a series type switch.

In shunt switch designs, the isolation and power dissipation are functions of the diode's forward resistance, whereas the insertion loss is primarily dependent on the capacitance of the PIN diode. The principal equations describing the operating parameters of shunt switches are given by:

A. Insertion Loss (Shunt Switch)

$$IL = 10 \log_{10} [1 + (\pi f C_T Z_0)^2] \quad dB \qquad (10)$$

This equation applies for both SPST and SPNT shunt switches and is graphically presented in Figure 10 for a 50 ohm load impedance design.

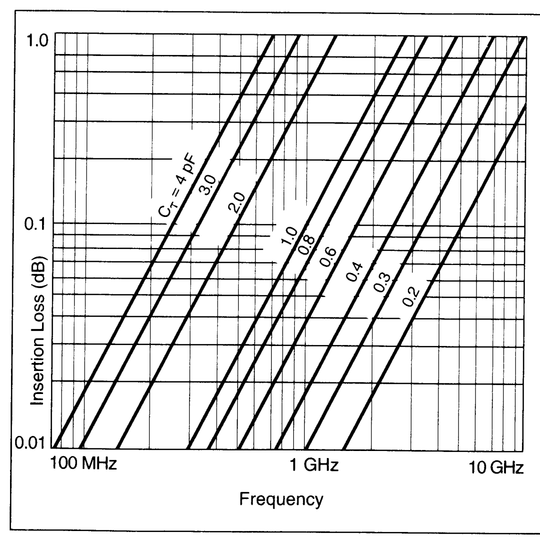

Figure 10

Insertion loss for shunt PIN switch in 50Ω system.

B. Isolation (Shunt Switch)

$$I = 20 \log_{10} \left(1 + \frac{Z_0}{2 R_S}\right) \quad dB \qquad (11)$$

This equation, which is illustrated in Figure 11, applies for a SPST shunt switch. Add 6 dB to these values to obtain the correct isolation for a multi-throw switch.

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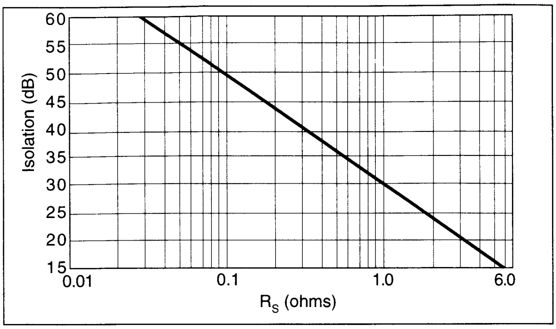


Figure 11

Isolation for SPST shunt PIN switches in 50Ω system. Add 6 dB to isolation for multi-throw switches (SPNT).

C. Power Dissipation (Shunt Switch in Forward Bias)

$$P_D = \frac{4\,R_S\,Z_O}{(Z_O + 2\,R_S)^2} \bullet P_{AV} \quad \text{watt} \qquad (12)$$

For $Z_O >> R_S$, this becomes:

$$P_D = \frac{4\,R_S}{Z_O} \bullet P_{AV} \quad \text{watts} \qquad (13)$$

where the maximum available power is given by:

$$P_{AV} = \frac{V_g^2}{4Z_O} \qquad (14)$$

D. Power Dissipation (Shunt Switch in Reverse)

$$P_D = \frac{Z_O}{R_p} P_{AV} \quad \text{watts} \qquad (15)$$

where R_P is the reverse biased diode's parallel resistance.

E. Peak RF Current (Shunt Switch)

$$I_P = \sqrt{\frac{8\,P_{AV}}{Z_O}} \quad \text{amps} \quad (SPST)$$

$$I_P = \sqrt{\frac{2\,P_{AV}}{Z_O}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \text{amps} \quad (SPNT) \qquad (16)$$

For a 50 ohm system, this becomes:

$$I_P = 0.4 \sqrt{P_{AV}} \quad \text{amps} \quad (SPST)$$

$$I_P = 0.2 \sqrt{P_{AV}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \text{amps} \quad (SPNT) \qquad (17)$$

F. Peak RF Voltage (Shunt Switch)

$$V_P = \sqrt{2 Z_O P_{AV}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \text{volts} \qquad (18)$$

In the case of a 50 ohm system, this reduces to:

$$V_P = 10 \sqrt{P_{AV}} \left(\frac{2\sigma}{\sigma + 1}\right) \quad \text{volts} \qquad (19)$$

Compound and Tuned Switches

In practice, it is usually difficult to achieve more than 40 dB isolation using a single PIN diode, either in shunt or series, at RF and higher frequencies. The causes of this limitation are generally radiation effects in the transmission medium and inadequate shielding. To overcome this there are switch designs that employ combinations of series and shunt diodes (compound switches) and switches that employ resonant structures (tuned switches) affecting improved isolation performance.

The two most common compound switch configurations are PIN diodes mounted in either ELL (series-shunt) or TEE designs as shown in Figure 12. In the insertion loss state for a compound switch the series diode is forward biased and the shunt diode is at zero or reverse bias. The reverse is true for the isolation state. This adds some complexity to the bias circuitry in com-

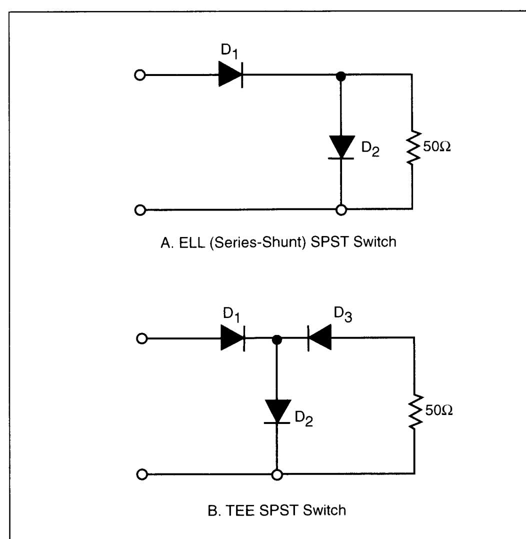
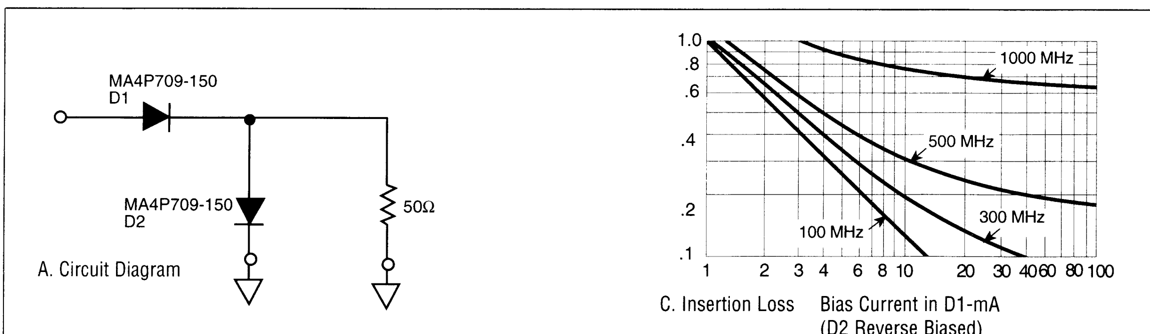


Figure 12
Compound Switches

Type	Isolation	Insertion Loss (dB)
Series	$10\log_{10}\left[1+\left(\frac{X_C}{2Z_O}\right)^2\right]$	$20\log_{10}\left[1+\frac{R_S}{2Z_O}\right]$
Shunt	$20\log_{10}\left[1+\frac{Z_O}{2R_S}\right]$	$10\log_{10}\left[1+\left(\frac{Z_O}{2X_C}\right)^2\right]$
Series-Shunt	$10\log_{10}\left[\left(1+\frac{Z_O}{2R_S}\right)^2 + \left(\frac{X_C}{2Z_O}\right)^2\left(1+\frac{Z_O}{R_S}\right)^2\right]$	$10\log_{10}\left[\left(1+\frac{R_S}{2Z_O}\right)^2 + \left(\frac{Z_O+R_S}{2X_C}\right)^2\right]$
TEE	$10\log_{10}\left[1+\left(\frac{X_C}{Z_O}\right)^2\right] + 10\log_{10}\left[\left(1+\frac{Z_O}{2R_S}\right)^2+\left(\frac{X_C}{2R_S}\right)^2\right]$	$20\log_{10}\left[1+\frac{R_S}{Z_O}\right] + 10\log_{10}\left[1+\left(\frac{Z_O+R_S}{2X_C}\right)^2\right]$

Figure 13
Summary of Formulas for SPST Switches.
(Add 6 dB to Isolation to obtain value for single-pole multiple throw switch.)



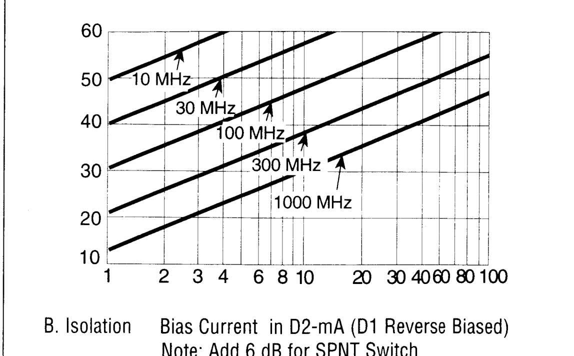


Figure 14
Series Shunt Switch

parison to simple switches. A summary of formulas used for calculating insertion loss and isolation for compound and simple switches is given in Figure 13.

Figure 14 shows the performance of an ELL type switch utilizing M/A-COM MA4P709 series diodes. These diodes are rated at 3.3pF, maximum capacitance, and 0.25Ω, R_S maximum at 100 mA. In comparison, a simple series connected using the same diode switch would

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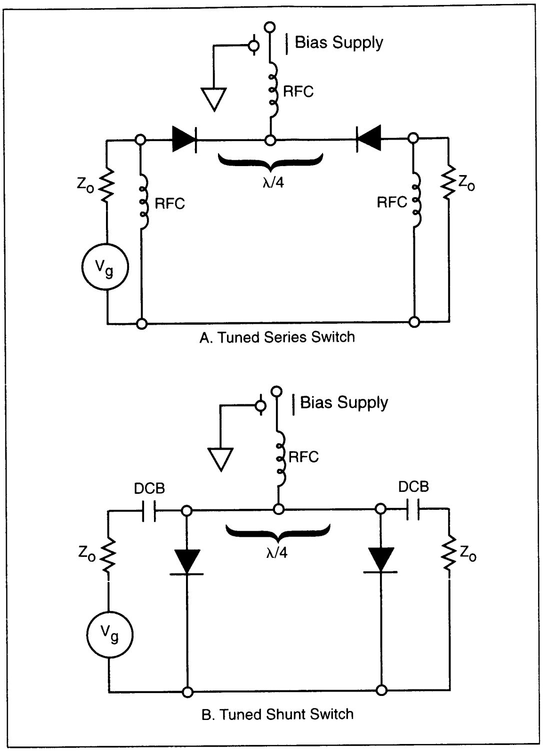


Figure 15

have similar insertion loss to the 100 MHz contour and the isolation would be 15 dB maximum at 100 MHz, falling off at the rate of 6 dB per octave.

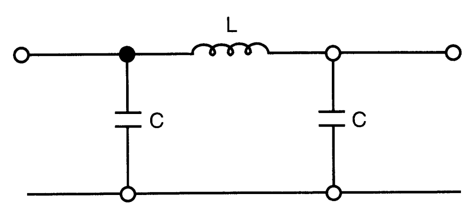
A tuned switch may be constructed by spacing two series diodes or two shunt diodes a wavelength apart as shown in Figure 15. The resulting value of isolation in the tuned switch is twice that obtainable in a single diode switch. The insertion loss of the tuned series switch is higher than that of the simple series switch and may be computed using the sum of the diode resistance as the RS value in equation 1. In the tuned shunt switch the insertion loss may even be lower than in a simple shunt switch because of a resonant effect of the spaced diode capacitances.

Quarter-wave spacing need not be limited to frequencies where the wavelength is short enough to install a discrete length of line. There is a lumped circuit equivalent which simulates the quater-wave section and may be used in RF band. This is shown in Figure 16. These tuned circuit techniques are effective in applications having bandwidths on the order of 10 percent of the center frequency.

Transmit-Receive Switches

There is a class of switches used in transceiver applications whose function is to connect the antenna to the transmitter (exciter) in the transmit state and to the receiver during the receiver state. When PIN diodes are used as elements in these switches they offer higher reliability, better mechanical ruggedness and faster switching speed than electro-mechanical designs.

The basics circuit for an electronic switch consists of a PIN diode connected in series with the transimitter, and a shunt diode connected a quarter wavelength (λ/4 section (Figure 16) and, of course, are preferable for transceivers that operate at long wavelengths.



$$L = \frac{Z_O}{2_\pi f_O} \quad \text{(henries)}$$

$$C = \frac{1}{2_\pi f_O Z_O} \quad \text{(farads)}$$

Figure 16
Quarter Wave Line Eqivalent

When switched into the transmit state each diode becomes forward biased. The series diode appears as a low impedance to the signal heading toward the antenna. and the shunt diode effectively shorts the receiver's antenna terminals to prevent overloading. Transmitter insertion loss and receiver isolation depend on the diode resistance. If R_S is 1Ω greater than 30 dB isolation and less than 0.2 dB insertion, loss can be expected. This performance is achievable over a 10 percent bandwidth.

In the receive condition the diodes are at zero or reverse bias and present essentially a low capacitance, C_T, which creates a direct low-insertion-loss path between the antenna and receiver. The off-transmitter is isolated form this path by the high impedance series diode.

The amount of power, PA, this switch can handle depends on the power rating of the PIN diode, PD, and the diode resistance. The equation showing this relationship is as follows for an antenna maximum SWR of σ:

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$$P_A = \frac{P_D Z_O}{R_S}\left(\frac{\sigma + 1}{2\sigma}\right)^2 \quad \text{Watts} \quad (20)$$

In a 50 ohm system where the condition of a totally mismatched antenna must be considered this equation reduces to:

$$P_A = \frac{12.5 \times P_D}{R_S} \quad \text{Watts} \quad (21)$$

Using these equations it can be shown that using a MA4P709 (or equivalent) insulated stud and MA4P709-150 stud mounted diode biased at 1 ampere where the R_S value is <.2Ω and installed in a 50°C heat sink where the MA4P709-985 is rated at 20 watts that a power level of 2.5 kW may be safely controlled even for a totally mismatched antenna. For a perfectly matched antennna, 10 kW may be controlled.

The MA47266 is an axial leaded PIN diode rated at 1.5W dissipation at 1/2″ (12.7 mm) total length to a 50°C contact. The resistance of this diode is a 0.5Ω (max) at 50 mA. A quarter-wave switch using 2 MA47266s may then be computed to handle 40 watts with a totally mismatched antenna.

It should be pointed out that the shunt diode of the quarter-wave antenna swltch dlssipates about as much power as the series diode. This may not be apparent from Figure 17; however, it may be shown that the RF current In both the series and shunt diode is practically identical.

Broadband antenna switches using PIN diodes may be designed using the series connected diode circuit shown in Figure 18. The frequency limitation of this switch results primarily from the capacitance of D_2.

In this case forward bias is applied either to D_1 during transmit or D_2 during receive. In high power application (>50W) it is often necessary to apply reverse voltage on D_2 during transmit. This may be accomplished either by a negative polarity power supply at Bias 2 or by having the forward bias current of D_1 flow through resistor R to apply the required negative voltage.

The selection of diode D_1 is based primarily on its power handling capability. It need not have a high voltage rating since it is always forward biased in its low resistance state when high RF power is applied. Diode D_2 does not pass high RF current but must be able to hold off the RF voltage generated by the transmitter. It is primarily selected on the basis of its capacitance which determines the upper frequency limit and its ability to operate at low distortion.

Using an MA47266 as D_1, and a 1N5767 which is rated at 0.4pf max, as D_2, greater than 25 dB receiver isolation may be achieved up to 400 MHz. The expected transmit and receive insertion loss with the PIN diodes biased at 50 mA are 0.1 dB and 0.3 dB respectively. This switch can handle RF power levels up to 40 watts.

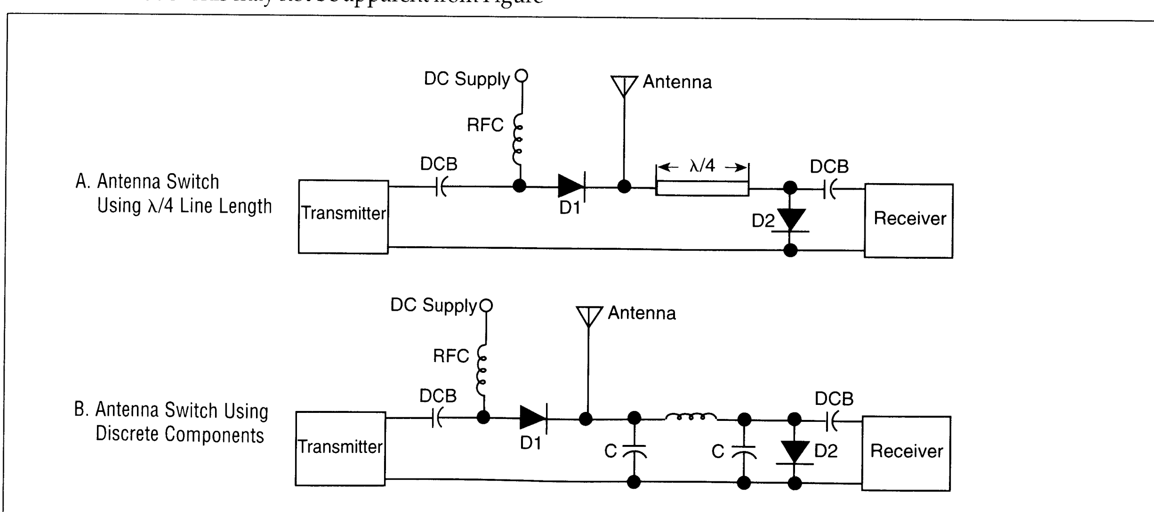

Figure 17
Quarter Wave Antenna Switches

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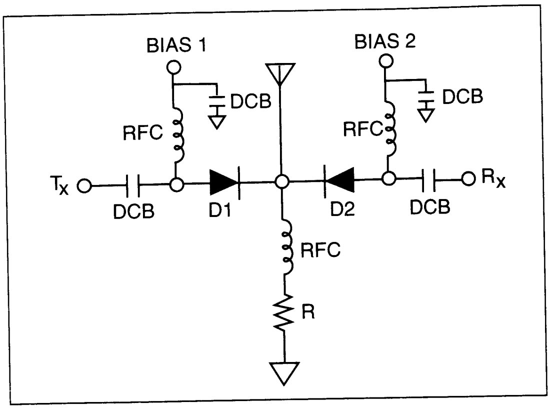

Figure 18
Broadband Antenna Switch

Practical Design Hints

PIN diode circuit pertormance at RF frequencies is predictable and should conform closely to the design equations. When a switch is not performing satistactorily, the fault is often not due to the PIN diode but to other circuit limitations such as circuit loss, bias circuit interaction or lead length problems (primarily when shunt PIN diodes are employed).

It is good practice in a new design to first evaluate the circuit loss by substituting alternatlvely a wire short or open in place of the PIN diode. This will simulate the circuit performance with "ideal PIN diodes." Any deficiency in the external circuit may then be corrected before inserting the PIN diodes.

PIN Diode Attenuators

In an attenuator application the resistance characteristic of the PIN diode is exploited not only at its extreme high and low values as in switches but at the finite values in between.

The resistance characteristic of a PIN diode when forward biased to I_{F1}depends on the I-region width (W) carrier lifetime (τ), and the hole and electron mobilities μP, μn) as follows:

$$R_S = W^2/(\mu_p + \mu_n)\, I_F \tau. \qquad ohms \qquad (1)$$

For a PIN diode with an I-region width of typically 250μm, carrier lifetime of 4μS, and μ_n of .13, μ_p of .05 $m^2/v\bullet s$, Figure 19 shows the R_S vs current characteristic.

In the selection of a PIN diode for an attenuator application the designer must often be concerned about the range of diode resistance which will define the dynamic range of the attenuator. PIN diode attenuators tend to be more distortion sensitive than switches since their operating bias point often occurs at a Iow value of quiescent stored charge. A thin I-region PIN will operate at lower forward bias currents than thick PIN diodes but the thicker one will generate less distortion.

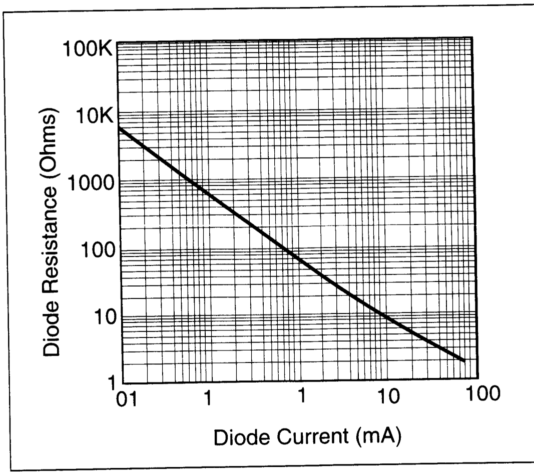

Figure 19
Typical Diode Resistance vs Forward Current

PIN diode attenuator circuits are used extensively in automatic gain control (AGC) and RF leveling applications as well as in electronically controlled attenuators and modulators. A typical configuration of an AGC application is shown in Figure 20. The PIN diode attenuator may take many forms ranging from a simple series or shunt mounted diode acting as a lossy reflective switch or a more complex structure that maintains a constant matched input impedance across the full dynamic range of the attenuator.

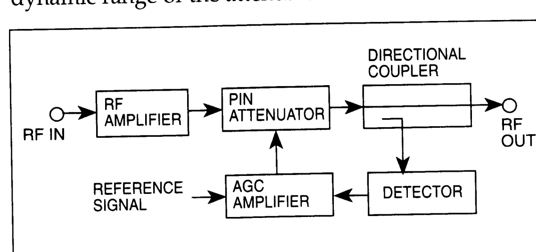

Figure 20
RF AGC/Leveler Circuit

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Although there are other methods for providing AGC functions such as varying the gain of the RF transistor amplifier, the PIN diode approach generally results in lower power drain, less frequency pulling, and lower RF signal distortion The latter results are especially true, when diodes with thick I-regions and long carrier lifetimes are used in the attenuator circuits. Using these PIN diodes, one can achieve wide dynamic range attenuation with low signal distortion at frequencies ranging from below 1 MHz up to well over 1 GHz.

Reflective Attenuators

An attenuator may be designed using single series or shunt connected PIN diode switch configurations as shown in Figure 21. These attenuator circuits utilize the current controlled resistance characteristic of the PIN diode not only in its low loss states (very high or low resistance) but also at in-between, finite resistance values. The attenuation value obtained using these circuits may be computed from the following equations:

Attenuation of Series Connected PIN Diode Attenuator

$$A = 20 \log \left(1 + \frac{R_S}{2Z_O}\right) \quad dB \qquad (2)$$

Attenuation of Shunt Connected PIN Diode Attenuator

$$A = 20 \log \left(1 + \frac{Z_O}{2R_S}\right) \quad dB \qquad (3)$$

These quations assume the PIN diode to be purely resistive. The reactance of the PIN diode capacitance, however, must also be taken into account at frequencies where its value begins to approach the PIN diode resistance value.

Matched Attenuators

Attenuators built from switch design are basically reflective devices which attenuate the signal by producing a mismatch between the source and the load. Matched PIN diode attenuator designs, which exhibit constant input impedance across the entire attenuation range, are also available which use either multiple PIN diodes biased at different resistance points or bandwidth-limited circuits utilizing tuned elements. They are described as follows:

Quadrature Hybrid Attenuators

Although a matched PIN attenuator may be achieved by combining a ferrite circulator with one of the previous simple reflective devices, the more common approach makes use of quadrature hybrid circuits. Quadrature hybrids are commonly available at frequencies from below 10 MHz to above 1 GHz, with bandwidth coverage often exceeding a decade. Figures 21 and 22 show typical quadrature hybrid circuits employing series and shunt connected PIN diodes. The following equations summarize this performance:

Quadrature Hybrid
(Series Connected PIN Diodes)

$$A = 20 \log \left(1 + \frac{2Z_0}{R_S}\right) \quad dB \qquad (4)$$

Quadrature Hybrid
(Shunt Connected PIN Diodes)

$$A = 20 \log \left(1 + \frac{2R_S}{Z_O}\right) \quad dB \qquad (5)$$

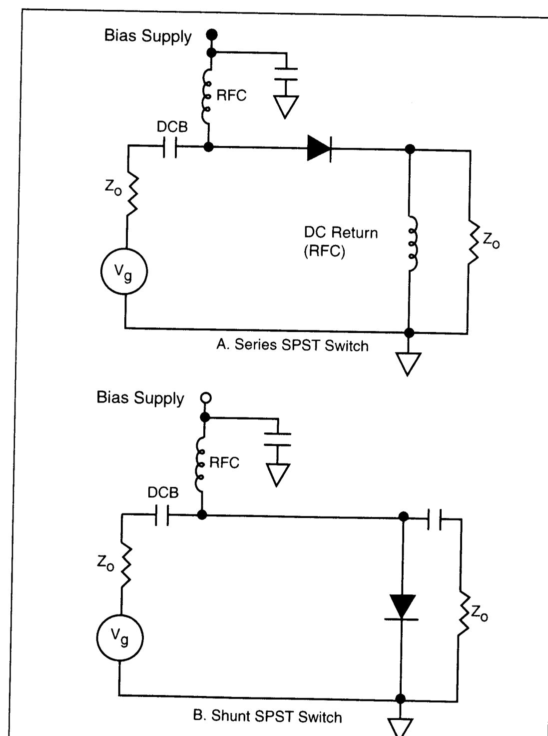

Figure 21
SPST PIN Diode Switches

The quadrature hybrid design approach is superior to the circulator coupled attenuator from the standpoint of lower cost and the achievement of lower frequency operation. Because the incident power is divided into two paths, the quadrature hybrid configuration is also capable of handling twice the power and this occurs at the 6 dB attenuation point. Each load resistor, however, must be capable of dissipating one half the total input power at the time of maximum attenuation.

Both the above types of hybrid attenuators offer good dynamic range. The series connected diode configuration is, however, recommended for attenuators used primarily at high attenuation levels (greater than 6 dB) while the shunt mounted diode configuration is better suited for low attenuation ranges.

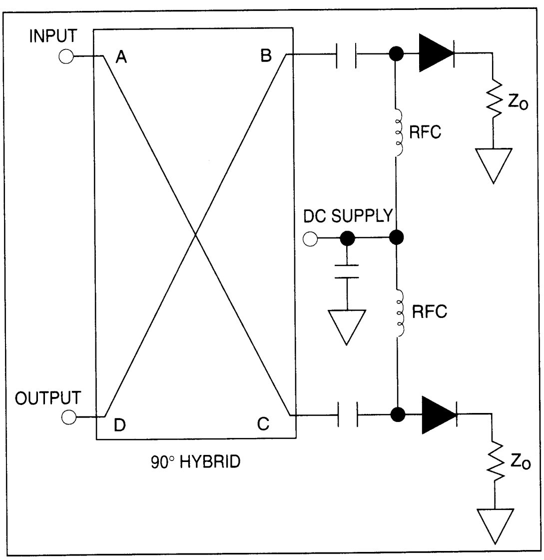

Figure 22
Quadrature Matched Hybrid Attenuator
(Series Connected Diodes)

Quadrature hybrid attenuators may also be constructed without the load resistor attached in series or parallel to the PIN diode as shown. In these circuits the forward cirrent is increased from the 50Ω, maximum attenuation/R_S value to lower resistance values. This results in increased stored charge as the attenuation is lowered which is desirable for lower distortion. The purpose of the load resistor is both to make the attenuator less sensitive to individual diode differences and increase the power handling capacity by a factory of two.

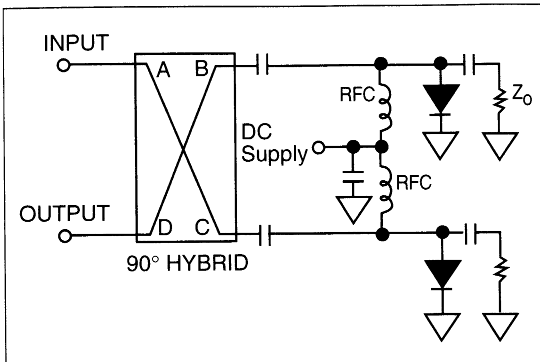

Figure 23
Quadrature Hybrid Matched Attenuator
(Shunt Connected PIN Diodes)

Constant impedance attenuator circuit. The power incident on port A divides equally between ports B and C, port D is isolated. The mismatch produced by the PIN Diode resistance in parallel with the load resistance at ports B & C reflects part of the power. The reflected power exits port D isolating port A. Therefore, A appears matched to the input signal.

Quarter-Wave Attenuators

A matched attenuator may also be built using quarter-wave techniques. Figures 24 and 25 show examples of these circuits. For the quarter-wave section a lumped equivalent may be employed at frequencies too low for practical use of line lengths. This equivalent is shown in Figure 26.

The performance equations for these circuits are given below:

Quarter-Wave Attenuator
(Series Connected Diode)

$$A = 20 \log \left(1 + \frac{Z_O}{R_S} \right) \quad dB \qquad (6)$$

$$A = 20 \log \left(1 + \frac{R_S}{Z_o} \right) \quad dB \qquad (7)$$

A matched condition is achieved in these circuits when both diodes are at the same resistance. This condition should normally occur when using similar diodes since they are DC series connected, with the same forward bias current flowing through each diode. The series circuit of Figure 24 is recommended for use at high attenuation levels while the shunt diode circuit of Figure 25 is better suited for low attenuation circuits.

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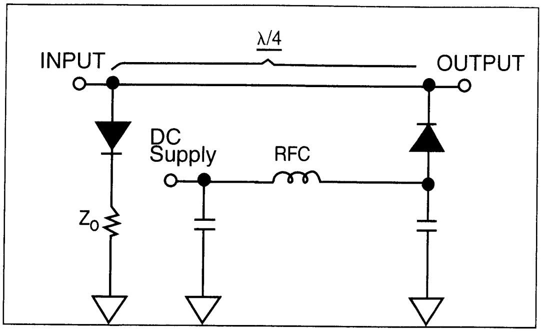

Figure 24
Quarter Wave Matched Attenuator
(Series Connected Diodes)

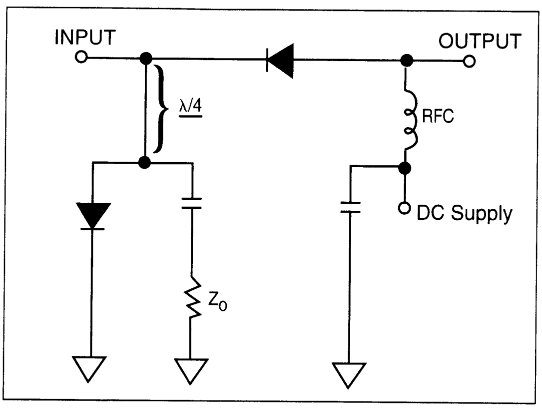

Figure 25
Quarter Wave Matched Attenuator
(Shunt Connected Diodes)

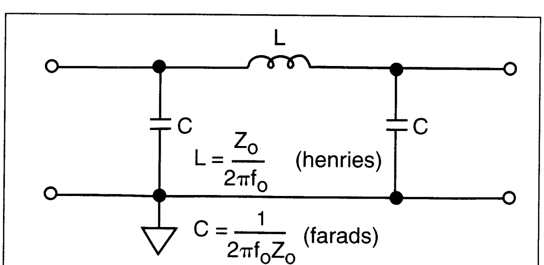

Figure 26
Lumped Circuit Equivalent
Of Quarter Wave Line

Bridged TEE and PI Attenuators

For matched broadband applications, especially those covering the low RF (1 MHz) through UHF, attenuator designs usiong multiple PIN diodes are employed. Commonly used for this application are the bridged TEE and PI circuits shown in Figures 27 and 28.

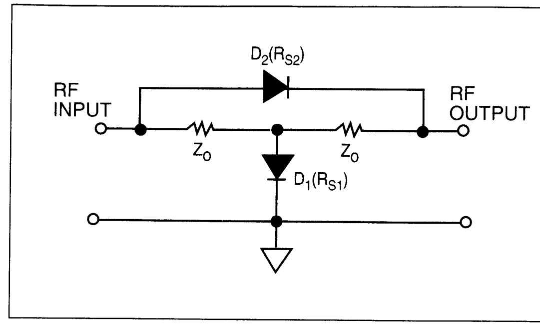

Figure 27
Bridged Tee Attenuator

The attenuation obtained using a bridged TEE circuit may be calculated from the following:

$$A = 20 \log \left(1 + \frac{Z_0}{R_{S1}}\right) \quad dB \qquad (8)$$

Where:

$$Z_0^2 = R_{S_1} \times R_{S_2} \quad ohms^2 \qquad (9)$$

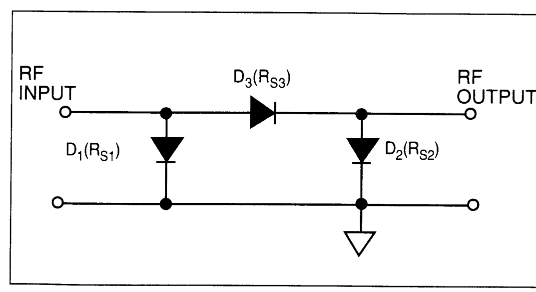

Figure 28
PI Attenuator
(The π and Tee are broadband matched attenuator circuits.)

The relationship between the forward resistance of the two diodes insures maintenance of a matched circuit at all atenuation values.

The expressions for attenuation and matching conditions for the Pl attenuator are given as follows:

$$A = 20\log\left(\frac{R_{S1} + Z_0}{R_{S1} - Z_0}\right) \quad dB \qquad (10)$$

Where:

$$R_{S_3} = \frac{2R_{S1} + Z_{02}}{R_{S1^2} - Z_{02}} \quad ohms \qquad (11)$$

$$R_{S_1} = R_{S2} \quad ohms \qquad (12)$$

Using these expressions, Figure 29 gives a graphical display of diode resistance values for a 50Ω Pl attenuator. Note that the minimum value for R_{S1} and R_{S2} is 50Ω. In both the bridged TEE and Pl attenuators, the PIN diodes are biased at two different resistance points simultaneously which must track in order to achieve proper attenuator performance.

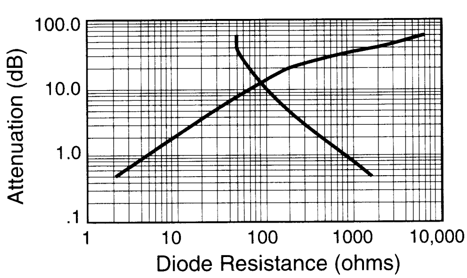

Figure 29
Attenuation of PI Attenuators

PIN Diode Modulators

PIN diode switches and attenuators may be used as RF amplitude modulators. Square wave or pulse modulation use PIN diode switch designs whereas linear modulators use attenuator designs.

The design of high power or distortion sensitive modulator applications follows the same guidelines as their switch and attenuator counterparts. The PIN diodes they employ should have thick I-regions and long carrier lifetimes. Series connected or preferably back-to-back configurations always reduce distortion. The sacrifice in using these devices will be lower maximum frequencies and higher modulation current requirements.

The quadrature hybrid design is recommended as a building block for PIN diode modulators. Its inherent built-in isolation minimizes pulling and undesired phase modulation on the driving source.

PIN Diode Phase Shifters

PIN diodes are utilized as series or shunt connected switches in phase shifter circuit designs. In such cases, the elements switched are either lengths of transmission line or reactive elements. The criteria for choosing PIN diodes for use in phase shifters is similar to those used in selecting diodes for other switching applications. One additional factor, however, that must often be considered, is the possibility of introducing phase distortion particularly at high RF power levels or low reverse bias voltages. Of significant note is the fact that the properties inherent in PIN diodes which yield low distortion, i.e., a long carrier lifetime and thick I-regions, also result in low phase distortion of the RF signal. Three of the most common types of semiconductor phase shifter circuits, namely: the switched line, loaded line and hybrid coupled designs are described as follows:

A. Switched Line Phase Shifter

A basic example of a switched line phase shifter circuit is shown in Figure 30. In this design, two SPDT switches employing PIN diodes are used to change the electrical length of transmission line by some length. Δ . The phase shift obtained from this circuit varies with frequency and is a direct function of this differential line length as shown below:

$$\Delta\phi = 2\pi\Delta\ell / \lambda \quad radians \qquad (13)$$

The switched line phase shifter is inherently a broad band circuit producing true time delay, with the actual phase shift dependent only on $\Delta\ell$. Because of PIN diode capacitance limitations this design is most frequently used at frequencies below 1 GHz.

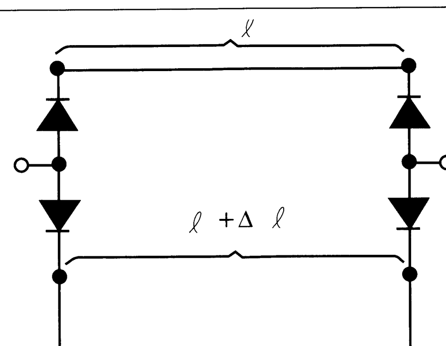

Figure 30
Switched Line Phase Shifter

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The power capabilities and loss characteristics of the switched line phase shifter are the same as those of a series connected SPDT switch. A unique characteristic of this circuit is that the power and voltage stress on each diode is independent of the amount of differential phase shift produced by each phase shifter. Thus, four diodes are required for each bit with all diodes having the same power and voltage ratings.

B. Loaded Line Phase Shifter

The loaded line shifter design shown in Figure 31 operates on a different principle than the switched line phase shifter. In this design the desired maximum phase shift is divided into several smaller phase shift sections, each containing a pair of PIN diodes which do not completely pertubate the main transmission line. A major advantage of this phase shifter is its extremely high power capability due partly to the use of shunt mounted diodes plus the fact that the PIN diodes are never in the direct path of the full RF power.

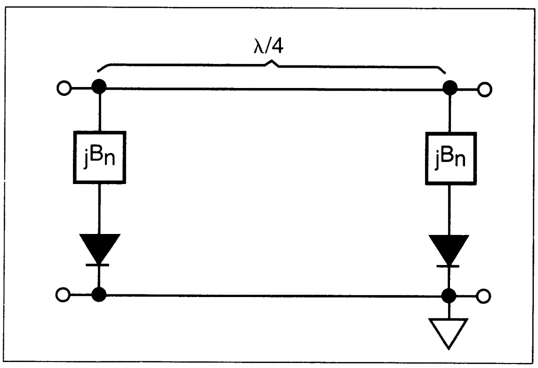

Figure 31

Loaded Line Phase Shifter

In loaded line phase shifters, a normalized susceptance, B_n, is switched in and out of the transmission path by the PIN diodes. Typical circuits use values of B_n, much less than unity, thus resulting in considerable decoupling of the transmitted RF power from the PIN diode. The phase shift for a single section is given as follows:

$$\phi = 2 \tan^{-1} \left(\frac{B_n}{1 - \left(\frac{B_n^2}{8}\right)} \right) \quad \text{radians} \qquad (14)$$

The maximum phase shift obtainable from a loaded line section is limited by both bandwidth and diode power handling considerations. The power constraint on obtainable phase shift is shown as follows:

$$\phi\, max = 2 \tan^{-1} \left(\frac{V_{BR} I_F}{4P_L} \right) \quad \text{radians} \qquad (15)$$

Where:

ϕmax	= maximum phase angle
P_L	= power transmitted
V_{BR}	= diode breakdown voltage
I_F	= diode current rating

The above factors limit the maximum phase shift angle in practical circuits to about 45°. Thus, a 180° phase shift would require the use of four 45° phase shift sections in its design.

C. Reflective Phase Shifter

A circuit design which handles both high RF power and large incremental phase shifts with the fewest number of diodes is the hybrid coupled phase shifter shown in Figure 32. The phase shift for this circuit is given below:

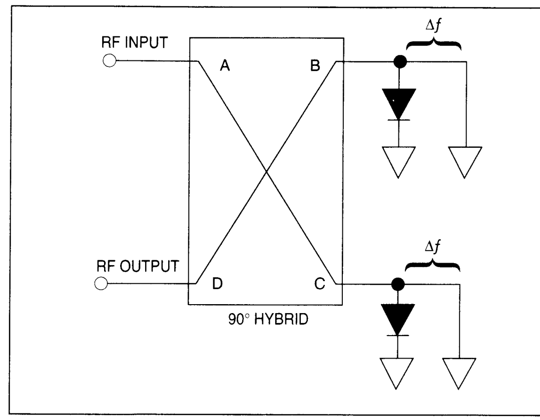

Figure 32

Hybrid Coupler Reflective Phase Shifter

The voltage stress on the shunt PIN diode in this circuit also depends on the amount of desired phase shift or "bit" size. The greatest voltage stress is associated with the 180° bit and is reduced by the factor $(\sin\phi/2)^{1/2}$ for other bit sizes. The relationship between maximum phase shift, transmitted power, and PIN diode ratings is as follows:

$$\phi max = 2\sin^{-1} \left(\frac{V_{BR} I_F}{8P_L} \right) \quad \text{radians} \qquad (17)$$

In comparison to the loaded line phase shifter, the hybrid design can handle up to twice the peak power when using the same diodes. In both hybrid and loaded line designs, the power dependency of the maximum bit size relates to the product of the maximum RF current and peak RF voltage the PIN diodes can handle. By judicious choice of the nominal impedance in the plane of the PIN diode, the current and voltage

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stress can usually be adjusted to be within the device ratings. In general, this implies lowering the nominal impedance to reduce the voltage stress in favor of higher RF currents. For PIN diodes, the maximum current rating should be specified or is dependent upon the diode power dissipation rating while the maximum voltage stress at RF frequencies is dependent on I-region thickness.

PIN Diode Distortion Model

The beginning sections of this article concerned with large signal operation and thermal considerations allows the circuit designer to avoid conditions that would lead to significant changes in PIN diode performance or excessive power dissipation. A subtle but often significant operating characteristic is the distortion or change in signal shape which is always produced by a PIN diode in the signal it controls.

The primary cause of distortion is any variation or non-linearity of the PIN diode impedance during the period of the applied RF signal. These variations could be in the diode's forward bias resistance, R_S, parallel resistance, Rp, capacitance, C_T, or the effect ot the low frequency I-V characteristic. The level of distortion can range from better than 100 dB below, to levels approaching the desired signal. The distortion could be analyzed in a fourier series and takes the traditional form of harmonic distortion of all orders, when applied to a single input signal, and harmonic intermodulation distortion when applied to multiple input signals.

Non-linear, distortion generating behavior is often desired in PIN and other RF oriented semiconductor diodes. Self-biasing limiter diodes are often designed as thin I-region PIN diodes operating near or below their transit time frequency. In a detector or mixer diode the distortion that results from the ability of the diode to follow its I-V characteristic at high frequencies is exploited. In this regard the term "square law detector" applied to a detector diode implies a second order distortion generator. In the PIN switch circuits discussed at the beginning of this article, and the attenuator and other applications discussed here, methods of selecting and operating PIN diodes to obtain low distortion are described.

There is a common misconception that minority carrier lifetime is the only significant PIN diode parameter that affects distortion. This is indeed a major factor, but another important parameter is the width of the I-region, which determines the transit time of the PIN diode. A diode with a long transit time will have more of a tendency to retain its quiescent level of stored charge. The longer transit time of a thick PIN diode reflects its ability to follow the stored charge model for PIN diode resistance according to:

$$Q = I_F \tau \quad \text{coulombs} \qquad (18)$$

$$R_S = \frac{W^2}{(\mu_p + \mu_n)Q} \quad \text{ohms} \qquad (19)$$

Where:

- I_F = forward bias current
- τ = carrier lifetime
- W = I region width
- μ_n = electron mobility
- μ_p = hole mobility

rather than the non-linear I-V characteristic.

The effect of carrier lifetime on distortion relates to the quiescent level of stored charge induced by the DC forward bias current and the ratio of this stored charge to the incremental stored charge added or removed by the RF signal.

Distortion In PIN Diode Switches

The distortion generated by a forwad biased PIN diode switch has been analyzed* and has been shown to be related to the ratio of stored charge to diode resistance and the operating frequency. Prediction equations for the second order intermodutation intercept point (IP2) and the third order intermodutation intercept point (IP3) have been developed from PIN semiconductor analysis and are presented as follows:

$$IP2 = 34 + 20 \text{ Log } \frac{FQ}{R_S} \quad \text{dBm} \qquad (20)$$

$$IP3 = 24 + 15 \text{ Log } \frac{FQ}{R_S} \quad \text{dBm} \qquad (21)$$

Where:

- F = Frequency in MHz
- Rs - PIN diode resistance in ohms
- Q = Stored Charge in nC

In most applications, the distortion generated by a reversed biased diode is smaller than forward biased generated distortion for small or moderate signal size. This is particularly the case when the reverse bias applied to the PIN diode is larger than the peak RF voltage preventing any instantaneous swing into the forward bias direction.

Distortion produced in a PIN diode circuit may be reduced by connecting an additional diode in a back to back orientation, (cathode to cathode or anode to anode). This results in a cancallation of distortion currents. The cancellation should be total, but the distortion produced by each PIN diode is not exactly equal in mag-

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nitude and opposite in phase. Approximately 20 dB distortion improvement may be expected by this back to back configuration.

Distortion in Attenuator Circuits

In attenuator applications, distortion is directly relatable to the ratio of RF to DC stored charge. In such applications, PIN diodes operate only in the forward bias state and often at high resistance values where the stored charge may be very low. Under these operating conditions, distortion will vary with charges in the attenuation level. Thus, PIN diodes selected for use in attenuator circuits need only be chosen for their thick I-region width, since the stored charge at any fixed diode resistance, Rs_1 is only dependent on this dimension.

Consider an MA4PH451 PIN diode used in an application where a resistance of 50Ω is desired. The MA4PH451 data sheet indicates the 1 mA is the typical diode current at which this occurs. Since the typical carrier lifetime for this diode is ≈5 μS, the stored charge for the MA4PH451 diode at 50Ω is 5 nC. If two MA4PH451 PIN diodes, however, are inserted in series, to achieve the same 50Ω resistance level, each diode must be biased at 2 mA. This results in a stored charge of 10 nC per diode or a net stored charge of 20 nC. Thus, adding a second diode in series multiplies the effective stored charge by a factor of 4. This would have a significant positive impact on reducing the distortion produced by attenuator circuits.

Measuring Distortion

Because distortion levels are often 50 dB or more below the desired signal, special precautions are required in order to make accurate second and third order distortion measurements. One must first ensure that the signal sources used are free of distortion and that the dynamic range of the spectrum analyzer employed is adequate to measure the specified level of distortion. These requirements often lead to the use of fundumental frequency band stop filters at the device output as well as pre-selectors to clean up the signal sources employed. In order to establish the adequacy of the test equipment and signal sources for making the desired distortion measurements, the test circuit should be initially evaluated by removing the diodes and replacing them with passive elements. This approach permits one to optimize the test set-up and establish basic measurement limitations.

Since harmonic distortion appears only at multiples of the signal frequency, these signals may be filtered out in narrow band systems. Second order distortion, caused by the mixing of two input signals, will appear at the sum and difference of these frequencies and may also be filtered. As an aid to identifying the various distortion signals seen on a spectrum analyzer, it should be noted that the level of a second distortion signal will vary directly at the same rate as any change of input signal level. Thus, a 10 dB signal increase will cause a corresponding 10 dB increase in second order distortion.

Third order intermodulation distortion of two input signals at frequencies F_A and F_B often produce in-band, nonfilterable distortion components at frequencies of $2F_A - F_B$ and $2F_B - F_A$. This type of distortion is particularly troublesome in receivers located nearby transmitters operating on equally spaced channels. In identifying and measuring such signals, it should be noted that third order distortion signal levels vary at twice the rate of change of the fundamental signal frequency. Thus a 10 dB change in input signal will result in a 20 dB change of the third order signal distortion power observed on a spectrum analyzer.

* *G Hiller, R. Caverly, "Predict Distortions Intercept Points in PIN Diode Switches," Microwaves and RF, Dec. 1985 and Jan. 1986.*

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Bonding and Handling Procedures for Chip Diode Devices

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Discussion

Chip diode devices for use in integrated circuit and hybrid integrated circuits have proliferated in the last few years. Today's circuit designer is faced with a multiplicity of alternatives in the selection of diodes and packaging, with each choice involving tradeoffs of particular advantages and disadvantages. The obvious advantages in the use of chip diodes in hybrid integrated circuit applications are their very small size and potentially lower cost. Small size and simplicity of structure give the benefit of minimal parasitics, but as the size of the diode becomes smaller, handling and production problems increase. By outlining our conclusions, we hope to help the designer overcome some of the difficulties encountered when using chips in MIC applications. M/A-COM, Inc. manufactures a large selection of chip and packaged diodes for hybrid integrated circuits. Obviously not all diode types are available in all configurations. Characteristics such as breakdown voltage or capacitance may limit the size of the chip or its form.

Silicon Chip Devices

- CERMACHIP™ PIN Diodes
- Oxide Passivated PIN chips
- Beam Lead PINs
- Snap Varactor Chips
- Tuning Varactor Chips
- MNS Chip Capacitors
- Schottky Chips
- Beam Lead Schottky Diodes
- RF Transistor Chips (Low Noise)

GaAs Chip Devices

- Gunn Diodes
- GaAs Tuning Varactors
- Beam Lead GaAs Tuning Varactors
- GaAs Multipliers
- GaAs Schottky Mixers
- GaAs Abrupt and Hyperabrupt Tuning Varactors
- GaAs Beam Lead Schottky Diodes

Microstrip Packages and Chip Carriers

Chip diodes usually require specialized equipment for die attachment to the circuit and for wire or strap bonding to the top of the chip. These operations require a clean work environment and special handling equipment such as vacuum pickups, hot gas bonders and/or thermal compression bonding equipment.

Not all MIC circuits require chips. In many cases (especially for conventional stripline circuits) a hybrid circuit package or carrier will give satisfactory results and can be handled much more easily without a large investment in fabrication equipment. M/A-COM supplies a broad band of diodes in stripline or carrier packages.

Handling and Assembling of Chips and Circuits

The problems of handling and assembling chips into packages can be best separated into two areas: putting the chip into the circuit (die down) and making top contact to the chip (top bonding). The following sections will discuss these problems.

Chip Bonding Methods

The biggest problem in using chip diodes is the damage encountered when assembling chips into circuits. In general, the value of the integrated circuits far exceeds the cost of the chip itself. When packaged diodes are used, the critical die attach and top contact operations are performed by M/A-COM and all devices are RF tested after assembly into the packages. When the circuit fabricator performs the die attach and wire bonding operation on a complex substrate, he/she runs the risk of losing or damaging a chip during the bonding operation which can result in the loss of the whole circuit or in an expensive rework cycle.

The most common problems that arise when bonding chips to the circuit are: the introduction of excessive series resistance, especially under forward bias conditions due to the improper bonding of the chip to the ground plane; poor reliability due to the entrapment of fluxes under the bond; and mechanical failure of the bond under thermal shock or temperature cycling. All three conditions are the result of improper wetting of the die to the ground plane and are usually caused by inadequate cleanliness or inadequate bonding conditions.

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The Influence of the Circut Board on Chip Bonding Methods

Selection of the chip bonding method must take into consideration the characteristics of the circuit board material being used.

Stripline teflon-fiberglass circuits should be soft soldered. Most eutectic solders melt at temperatures too high (250-300°C) to be used with teflon fiberglass boards. Conductive epoxies can also be used, but the results may not be reliable. The use of Gunn diodes on teflon fiberglass circuits is not recommended because the major problem in operating these diodes is the removal of heat. It is absolutely essential that eutectic solders or thermal compression bonding be used to bond these diodes to achieve the best thermal resistance. Soft solders and conductive epoxies are not acceptable methods for bonding Gunn diodes. The use of beam lead diodes with teflon fiberglass boards is not generally recommended. Because these boards are flexible, they may bend during or after bonding and cause the diode leads to break.

In many cases conductive epoxies will give good results with little or no complex equipment required. Although the high temperature and long term reliability of this type of bond is not generally as good as eutectic solders, the use of conductive epoxies is an acceptable and simple way to fabricate most circuits.

Soft solders, such as the eutectic composition of antimony or lead tin, give excellent reliability and good high temperature characteristics. The use of flux for soldering is not recommended at any time. Instead, a cover gas such as a forming gas (80% N_2, 20% H_2, or 95% N_2, 5% H_2) should be used. When applicable, probably the best die down procedure is an ultrasonic silicon gold thermal compression bond or a high temperature eutectic solder (such as gold tin eutectic solder– 80% Au, 20% Sn) with a melting point of approximately 280°C.

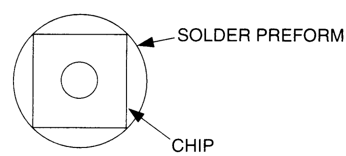
Chip Die Down Bonding Techniques

Hot Gas Bonding of Chips

The hot gas bonder is one of the most convenient ways of bonding chips onto a metal ground plane or circuit. Both silicon and GaAs chips may be bonded using similar techniques.

GaAs is brittle and softer than silicon. The use of gold tin solder preform (80% Au, 20% Sn) with an eutectic melting point of 280°C is recommended. A clean, gold plated surface is required to insure good wetting. The preform should be large enough to insure that the die fits within the areas shown. The preform should be ~1 mil thick.

The heating stage should be set at 250 ± 5°C. An 80% N_2, 20% H_2 forming gas is effective as the hot gas jet. The temperature at the tip should be approximately 400°C. The wetting time after the solder reflow is critical for strong bonding. It should be carefully controlled; 3 sec ± 1 sec. If done correctly, the shear strength of a 10 X 10 mil die will average 250-300 grams.



Die Down Method	Resultant Thermal Resistance	Temperature Required	High Temperature Capabilities	Power Handling Capability	Ease Of Operation	Special Equipment Required	Potential Problems
Conductive Epoxy	Good with proper technique	Room temp. to 150°C	Good	Low to medium power	Easiest to apply	Little or none	High series or thermal resistance
Soft Solder ie: Pb-Sn-Ag (90, 5, 5) Pb-Sn (60, 40)	Good to very good	200-280°C 180-200°C	Good	Good to very good for low or high power	Simple application	Heated stage, hot gas bonder or gas curtain and furnace	Flux is usually required with lead solders. Cleaning of flux must be done carefully.
Eutectic solder Au-Sn (80, 20) Sn-Sb (97, 3)	Very good	Approx. 300°C Approx. 230°C	Good	Very Good	Simple application	Heated stage or hot gas bonder	Needs clean reducing atmosphere
Gold silicon Eutectic[1] (Thermal Compression Bond)	Very good	Approx. 380°C	Good	Very good	Most difficult	Ultrasonic bonder with heated stage & tip preferable	Cleanliness, proper bonding conditions

1. Excluded for Schottky diodes and some PIN linear diodes. Consult factory for specific assistance.

Table 1. Selection Guide for Die Down Bonding Techniques

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Chip Die Down Bonding Techniques (Cont'd)

Ribbon and Wire Attachment

It is recommended that thermo-compression bonding be used. The bonding tip should be smaller than the anode contact. The exact conditions will depend on the tool types used. It is recommended that a half hard gold wire or strap be used. The wire or strap diameter should be smaller than the diameter of the anode contact. Typical bonding force should be 20 and 25 grams, and should not exceed 30 grams. When wire bonding, a thermal compression wedge bonder is recommended using a heated stage and heated tip. The stage temperature should be approximately 240°C ± 10°C and the recommended temperature for the tip is 120°C. Ultrasonic scrubbing is not recommended.

Furnace Solder of Dice

A moving belt furnace is also an excellent method for soldering chips. A belt furnace with an 80-20 forming gas atmosphere and nitrogen curtains on the ends of the furnace is recommended. All parts should be clean and free of oil and grease.

The temperature and speed of the belt should be adjusted so that the parts reach approximately 25-50°C over the melting point of the solder for a period of 2 to 5 minutes. Adequate tooling and furnace temperatures are usually necessary to obtain good alignment. "Clean" gases are also very important. The criteria for acceptable solder die is shown on the following page.

Ultrasonic Thermal Compression Bonding of Dice

In a small circuit, ultrasonic bonding gives a very reliable and strong bond. The die should be free of oxides and have no metallization. The bonding surface should have approximately 2.5 micrometers of a soft gold, preferably from a high cyanide gold bath.

The stage of the bonder should be set at approximately 200-250°C and the bond pressure approximately 400 grams/mm^2.

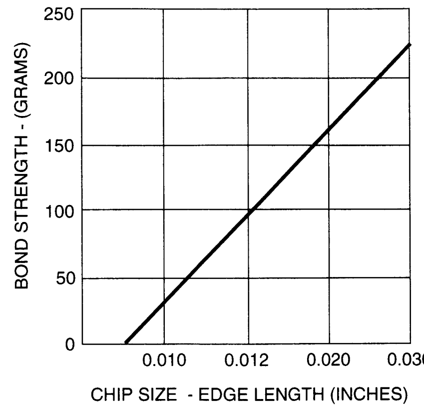
i.e.: ~ 50 grams for 0.010 X 0.010 inch die
~ 200 grams for 0.020 X 0.020 inch die
~ 300 grams for 0.030 X 0.030 inch die

These values can vary rather widely and some experimentation may be necessary to find the best results.

The criteria for a good thermal compression bond should be the same as for a soldered joint.

Die Bonding with Conductive Epoxies

Although some military and telecommunications systems do not allow the use of conductive expoxies, satisfactory die down bonds may be obtained using these epoxies. The following precautions should be observed to obtain consistently strong bonds.



Cleanliness

Everything should be clean and degreased. It is a good idea to clean the circuit in an alkaline solution to remove any traces of plating solutions. The circuit should then be degreased.

Shelf Life

The conductive epoxy must be within the warranty shelf and/or pot life. It is advisable to use one half the listed pot life since manufacturers tend to be optimistic on pot life estimates. Thus, if the pot life is stated to be 2 days, it is much safer to use new epoxy every day.

Curing

The epoxy must be cured in air or in an oxidizing atmosphere. The reaction requires oxygen. The epoxy oven should be clean (not used for other functions) and should have a good air flow to carry fumes. The epoxy will not cure well if there are other solvent fumes in the atmosphere.

Carrier Fluid

The carrier fluid must not be allowed to flow on the top of the chip. Not only will it make the chip unbondable, it will be almost virtually impossible to detect under normal bonding procedures. If a vacuum tip is used to put the chip in place remove the vacuum when the chip is 10 to 30 mils from the epoxy. Static charge will hold the chip to the tip. If the vacuum tip touches the epoxy it will become coated with the epoxy carrier fluid and contaminate the next chip with the carrier material. This same problem may occur with the use of tweezers. The tweezers should be cleaned before picking up another chip if they touch the epoxy.

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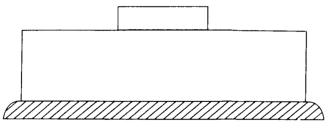
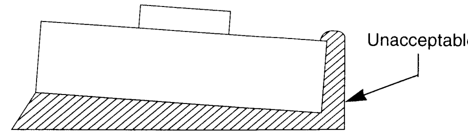
Good Bond



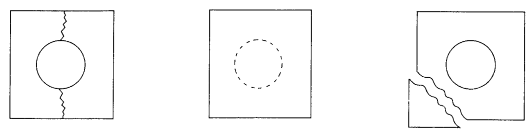
Unacceptable Bond



Good Bond
Solder or Epoxy Thin (Approx. .001" Max)
No Meniscus Around the Edge
Solder Surface Shiny
No Holes, Cracks, Etc.
Minimum 90% Wetting

Unacceptable Bond
Tilted Die
Loose or Foreign Material on Top of Chip
Solder or Epoxy Carrier on Top of Surface of Die
No Evidence of Dice to Substrate Melt Around at Least 10% of the Die
Less than 90% Wetting

Other Unacceptable Bonds



Cracked Dice **Metallization Missing** **Broken Dice**

Figure 3. Die Bonding Criteria

Table 2. Visual Inspection for Good Die-Down Bonds (Using a 5-15X Microscope)

Die Down Method	Visual (Good Bond Criteria)	Typical Bond Strength (In Stress)	Extra R_S From[1] Die Down (.020" Chip)
Conductive epoxy	Flat and maximum epoxy thickness approx. .001 inch. – 90% minimum wetting	approx. 50-100 kgms/cm^2	less than 0.15 ohms
Soft Solder	Flat – maximum solder thickness 0.001 inch – 90% minimum wetting	approx. 70-100 kgms/cm^2	less than 0.1 ohms
Gold-tin eutectic solder	Flat – maximum solder thickness 0.001 inch – 90% minimum wetting	approx. 100-150 kgms/cm^2	less than 0.1 ohms
Thermal compression bond	Flat – 90% minimum wetting	approx. 100 kgms/cm^2	less than 0.1 ohms

Note: 1. This is the approximate extra RF series resistance from an ideal lossless bond of a .020" x .020" chip.

Table 3. Methods for Top-Bonding Diode Chips

Type of Chip	Type of Circuit Board: Ceramic	Type of Circuit Board: Teflon Fiberglass Metal Ground
Planer chip with gold metal on anode	Wedge bond 0.002 diameter gold wire or 0.001 x .005 strap. Bonding tool must be smaller than anode pad.	
Beam lead	Ultrasonic Bond Bonding tip size 0.002 minimum,. Special tools are available for beam leads.	NOT RECOMMENDED
Schottky diodes with planer contacts	Wedge bond 0.0007 diameter gold wire. Bonding tip size 0.001 maximum	
Hermetic CERMACHIPS ™	Wedge bond. 0.001 x 0.005 strap is best. Bonding tip size 0.005 maximum.	Wedge bond, or parallel gap or welded strap.
Planer chips with very small node pads (less than 0.002)	Wedge bond 0.0007 to 0.001 diameter gold wire. Bonding tool size 0.001 maximum.	
Mesa Diodes (small)	Wedge bond. Use 5 mil strap, if possible. Bonding tool tip size 0.001 to 0.002.	

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Reliability Problems

Silver conductive epoxies should not be used where they will come into contact with lead tin solders or high tin solder. There can be an anodic reaction which may cause failure of the bond.

Bond Strength

The shear bond strength of a good epoxy joint can approach that of solder 50-100 kgms/cm^2. The thickness of the conductive epoxy should be kept at 0.001" or less.

The shear bond strength should be about:
40-60 grams for 0.010 X 0.010 inch chip
150-250 grams for 0.020 X 0.020 inch chip
350-500 grams for 0.030 X 0.030 inch chip

In general the epoxy will shear before the chip breaks. Weak bonds are usually caused by the use of old epoxy, bonds that are too thick, or lack cleanliness.

Thermal Resistance

Although the thermal resistance of silver conductive epoxy bonds is a little higher than that of gold tin eutectic solder, it is still satisfactory for all but the highest power applications as long as the epoxy is kept thin.

Visual Inspection

Die down bonds should be checked regularly using a 5-15X microscope and should meet the visual criteria shown in Table 2.

Top Bonding to the Chip

Most chips can be bonded with a wedge bonder. The size and shape of the top contact will depend on the size of the bonding pads and the parasitic inductance or capacitance requirement of the circuit.

A gold strap is effective for the majority of applications. Critical criteria in this procedure are cleanliness, bond ing tip shape, tip pressure, and stage temperature.

Top Contacting Methods

The usual criteria for choosing a specific top bonding technique are the size of the top contact of the chip, the type of chip, the sensitivity of the chip to temperature and pressure, the type of circuit board and the equipment available. Table 3 illustrates some of the suggested top bonding methods listed by type of chip and circuit applications. Usually the simplest contacts are a gold strap .001 X .005 inch or a 0.0007 to.001 inch diameter wedge bonded gold wire. The inductance of a 1 mil diameter wire will be ~0.5 nH for a 0.20 inch long lead. This inductance can be reduced considerably by using multiple contact wires or by using straps (a technique which also increases reliability).

Selection of Bonding Equipment Tools & Tips

The choice of bonding equipment and tools depends greatly on the type of circuit and chips to be used. Most bonding equipment manufacturers have useful literature available.

Wire Bonding

It is very difficult to give definite parameter values of force pressure time and temperature for an optimum bonding schedule. Different wire or strap sizes, bonding surfaces or semiconductor die characteristics require different bonding conditions. In general, the bonding parameters should be adjusted to maximize reproducibility at a high bond pull strength.

Most problems are caused by improper bonding machine and tool settings as well as improper maintenance and cleanliness. It is important to control the movement of the part being bonded, alignment of tools, tool height, angle, and tool condition.

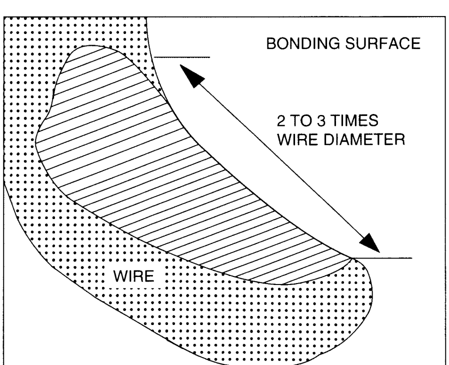

Figure 4. Typical Strong Wire Bond

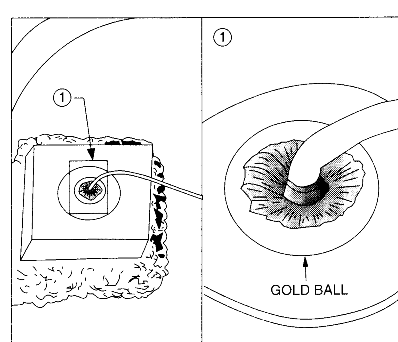

Figure 5. Sketch of a Good Nail Head Bond

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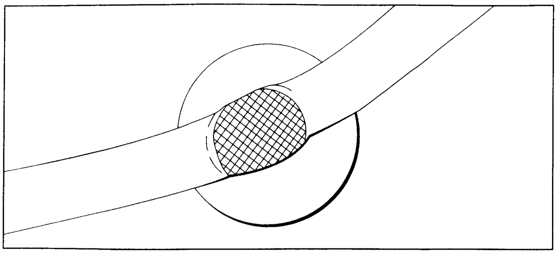

Figure 6. Single Strap Bond

In general, the die will crack or "crater" if too hard a wire or excessive pressure is used. Too little pressure results in small, weak bonds.

A good wire bond should be stronger than the wire and should also be two to three times the wire diameter as illustrated.

Also illustrated are drawings of another type of wire bond, the ball bond. As with all top bonds to planar die, the wire (or strap) should break during a pull test before the bond breaks.

When wire bonding, the deformed width of the wire should be about 1.3 to 1.8 times the wire thickness as shown in the wire bond sketch below.

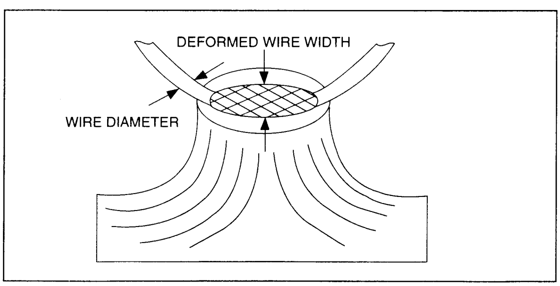

Figure 7. Appropriate Wire Bond Deformation for Maximum Strength

If the deformed width is too small, the bond will tend to lift off. If it is too large (greater than 1.8 times the wire diameter) the wire tends to weaken and break.

Also shown is a curve of the pull strength vs. deformed width of ultrasonic bonded wire.

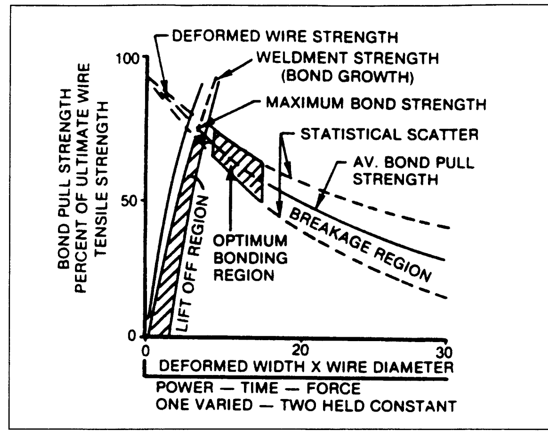

Figure 8. Pull Strength vs. Deformation for a Wirebond

Wire Bonding to GaAs Junctions

GaAs is very brittle, and although the above mentioned procedures apply, the following extra precautions should be taken when wire bonding.

Wire bonds to the junctions are best made using a thermal compression wedge bonder with a heated stage and tip. A stage temperature of 240°C and a tip temperature of 120°C is recommended. Typical bonding force should be in the region of 20 grams for the smallest junctions but less than 40 grams for all other junctions. It is recommended that dead soft gold wire be used with a diameter of 0.0007 inches for the smallest mesa and 3 mil X .0005 ribbon for the largest mesa and 50 ohms attachment. For GaAs diodes, such as PIN diodes in parallel configuration, two ribbons are preferable.

Strap Bonding

When bonding a strap, the bond should not deform the strap by more than 50%. The tool and conditions should be selected to provide a bond that has at least the same cross sectional area as the strap itself. For example, a 0.5 mil x 5 mil strap should have a bond cross section of 2.5 mils square or greater. The schematic shown illustrates a typically strong single strap bond to a large mesa. Cross strapping is used for low parasitic inductance. Careful heat and pressure control must be exercised in order to form a strong, damage free cross strap bond.

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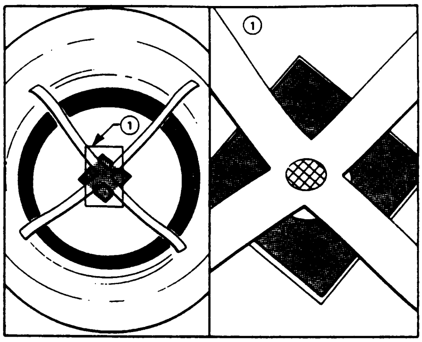

Figure 9. Cross Strap Bonding in a Packaged Device

Bonding to Small Mesas

When bonding to a small mesa type diode, it is suggested to always use a strap. The strap, in many cases, may be larger than the top of the mesa (the larger the cross section area of the strap, the lower the parasitic inductance). In this case, it is advisable to bond all or as much of the entire top of the mesa as possible.

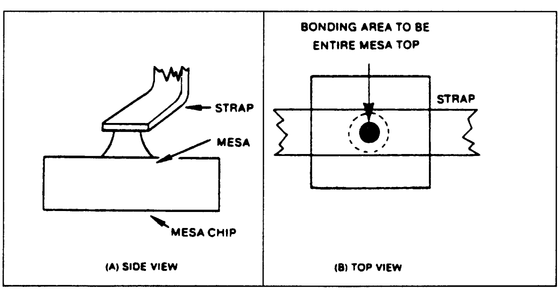

Figure 10. Mesa Bonding

Good Bonding Criteria

When testing a mesa diode, if the bond is good, the mesa will usually break off before the bond or strap breaks. For all other bonds, the bonds should be as strong as the wire or strap when tested by pulling. Improper top bonding usually results in one of the following problems:

Cracking or stressing the die through excessive pressure.

Weak bonds from inadequate cleanliness or improper bonding conditions.

Excessive parasitic capacitance from overlapping wire or straps.

Acceptable Bonds

Wire or strap does not separate when tested.
No fractures in bond.
No separation of metallization.
Wire breaks before bond.

Bad Bonds

Wire separates from bond.
Bond fractures at weld.
Separation of metallization from dice.

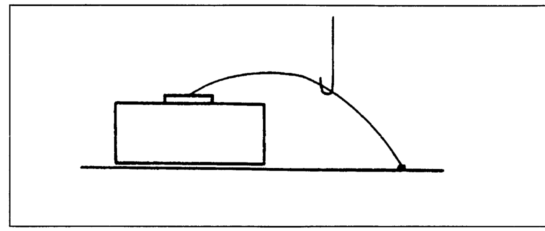

Figure 11.

Bond Strength Pull Test

It is extremely important to maintain good quality control procedures in order to ensure good bonding. The following figures and tables illustrate criteria for visual inspection and for testing of bond strength.

Wire or Ribbon Size (inches)	Minimum Pull Strength (grams)
0.0007 wire diameter	1.5
0.001 wire diameter	3.0
0.002 wire diameter	9.0
0.00025 X 0.002 strap	1.0
0.00025 X 0.005	4.0
0.00025 X 0.010 strap	6.5
0.001 X 0.005 strap	10.0
0.001 X 0.010 strap	16.0

Table 4. Bond Strength Criteria (Gold Wire or Strap)

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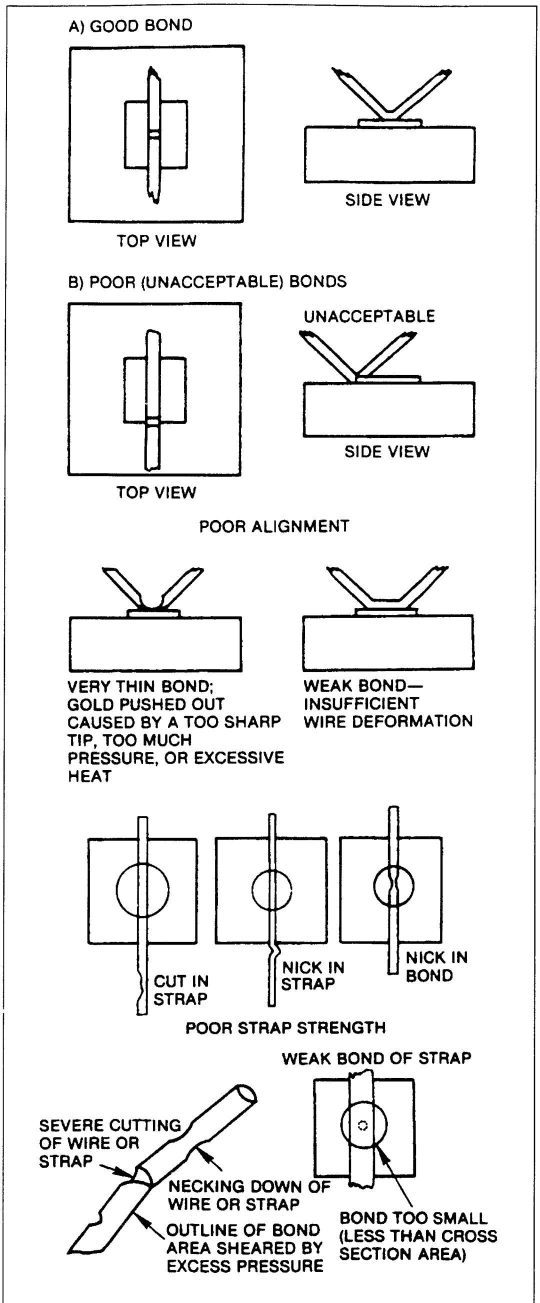

Figure 12. Visual Bond Inspection Criteria (Gold Wire or Strap Bonds)

Bonding Beam Lead Diodes

Selection of the beam lead bonding method must take into consideration the characteristics of the circuit board material used. Hard substrates such as alumina and quartz are recommended. Various bonding techniques are described below and may all be used on hard surfaces.

The beam lead diode is a silicon chip with planar gold leads which extend from the top surface of the chip (approximately 0.010 to 0.030 inches). Beam lead diodes are generally the smallest size chips available. They must be handled with care because the leads may easily be distorted or broken by the normal pressure of tweezer handling. Most vacuum tips are too large. A vacuum pencil with a #27 tip is recommended. A pointed wooden stick such as a sharpened Q tip or toothpick which has been dipped in isopropyl alcohol can also be used as a pick and place tool since the beam lead will adhere to the moistened point. This work should be performed under 10X to 30X magnification.

Beam lead diodes are easily damaged by static electricity and/or current from a small low impedance ground loop in the circuit. When mounting the diode in the circuit, contact should never be made across the gap. A static discharge from the operator may flow through the diode and destroy it. The circuit should always be grounded before the second lead of the diode is attached.

The preferred methods for bonding a beam lead diode are thermal compression bonding and parallel gap welding. For thermal compression bonding, the beam lead diode is placed down (gold beam to gold plated substrate) with the leads resting flat on the pad and the bond made by using a heated wedge. Heat and pressure form a metallurgical bond. A minimum of 100 microinches of gold on the substrate is recommended for optimum bonding.

In the parallel gap technique, current is first passed through the substrate metallization, then through the device lead. Most of the heat is generated at the interface. Extreme care must be taken to see that the step welder does not discharge through the diode junction, or the diode will be destroyed. The bonding pressure should be approximately 900 gms/mm^2.

The major advantage of the parallel gap technique is that a cold ambient may be used. Heat is only generated in the vicinity of the bond itself. Caution must be taken when making the second bond because if the diode is placed in tension, the leads may break.

The following precautions will ensure better results when bonding beam leads:

To minimize the lead inductance, the wedge, or heat ed tips should be placed as close as possible to the

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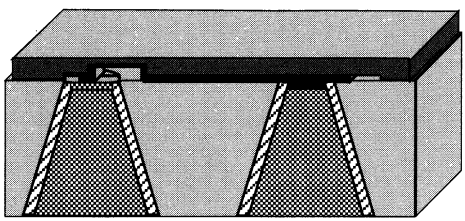
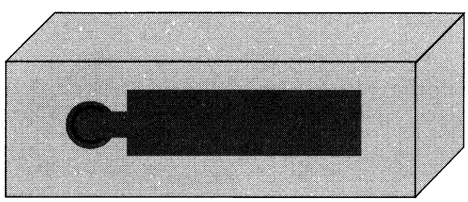
the chip without touching it. The chip is very easily damaged and care must be taken that the bonding tip does not contact the chip at any time during the bonding process.

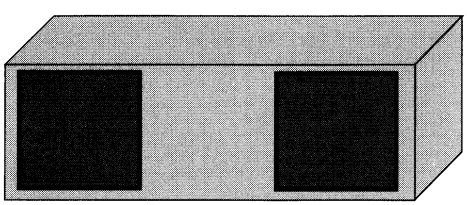
The bonding tip must be perpendicular to the beam during bonding, to prevent a torsional force which will pull the beams apart. This is particularly important when bonding the second lead.



Cross Section



Top View



Bottom View

Handling and Bonding

The rugged construction of the SurMount chip devices allows the use of standard handling and die attach techniques. It is important to note that industry standard electrostatic discharge (ESD) control is required at all times, due to the nature of Schottky junctions.

Handling

The devices can be handled with # 3c tweezers for manual placement. The top surface of the die has a protective coating to minimize damage. These devices are compatible with vacuum pencil or automatic pick and place installation.

Bonding

Die attach for these devices is made simple through the use of surface mount die attach technology. Mounting pads are conveniently located on the bottom surface of these devices and are removed from the active junction locations. The devices are well suited for high temperature solder attachment onto hard substrates. The use of 80% gold, 20% tin solder is recommended, but lead tin solders are acceptable. Conductive epoxy may also be used for die attach.

When soldering these devices to a hard substrate, hot gas die bonding is preferred. We recommend utilizing vacuum tip and force of 60 to 100 grams applied normal to the top surface of the device. When soldering to soft substrates, it is recommended to use a lead-tin interface at the circuit board mounting pads. Position the die so that its mounting pads are aligned with the circuit board mounting pads, and reflow the solder by heating the circuit trace near the mounting pad while applying 60 to 100 grams force perpendicular to the top surface of the die. Solder reflow must not be accomplished by causing heat to flow through the die. Consequently, the solder joints must be made one at a time, or a multi-tip soldering iron could be used to simultaneously reflow all the solder joints.

Since the HMIC glass is transparent, the edges of the mounting pads closest to each other can be visually inspected through the die after die attach is completed.

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Application Note

Microwave Power Transistor Impedance Measurement

AN001

V2.00

Introduction

The required input and output impedances for M/A-COM microwave power transistors are specified as Z_{IF} and Z_{OF} respectively. Z_{IF} is the test fixture matching circuitry impedance as seen by the input of the transistor. Z_{OF} is the test fixture matching circuitry impedance as seen by the output of the transistor. These are shown in Figure 1. Measurements of Z_{IF} and Z_{OF} are obtained by using a 50 Ω microstrip impedance launcher in conjunction with a break-apart test fixture.

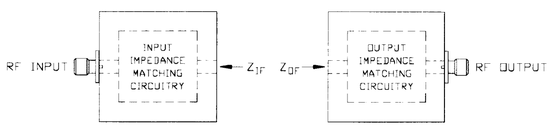

Figure 1

50 Ω Microstrip Impedance Launcher

The 50 Ω microstrip impedance launcher is constructed with a connector and an etched 50 Ω microstrip line on a pc board, both of which are mounted on a brass carrier as shown in Figure 2.

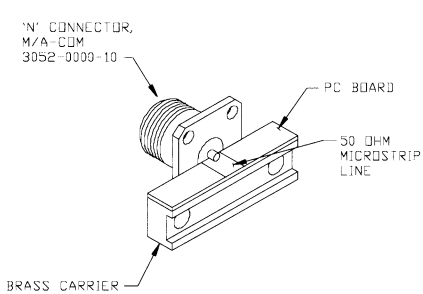

Figure 2

The launcher is designed so that a repeatable reference plane calibration may be achieved at the transistor-to-test fixture interface.

Introduction

A complete one-port (s_{11} or s_{22}) calibration for the frequency range under consideration is performed on the port of the network analyzer S-parameter test set that will be used for the measurements. This calibration should be executed using precision short, open and load calibration standards. After this calibration is complete, the 50 Ω launcher is placed on the network analyzer port with the shorting block and indium foil tab in place as shown in Figure 3.

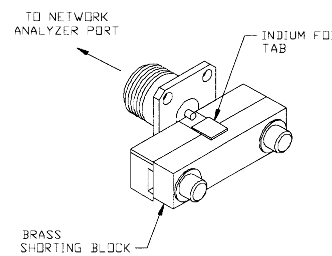

Figure 3

At this point the network analyzer electrical delay is adjusted to compensate for the additional 50 Ω launcher electrical length. This allows the reference plane to be moved from the network analyzer port-to-connector interface to the 50 Ω launcher -to- test fixture interface.

Z_{IF} and Z_{OF} Impedance Measurement

To measure Z_{IF} or Z_{OF} the 50 Ω launcher shorting block is removed and replaced with the appropriate break-apart test fixture half. The fixture half is terminated with a 50 Ω load as shown in Figure 4. Z_{IF} or Z_{OF} may now be read at any desired frequency within the calibrated frequency range.

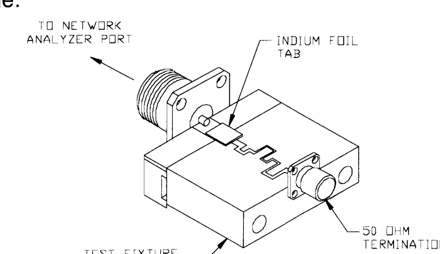

Figure 4

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RF Power MOSFET SPICE Models

AN002

V2.00

Introduction

Personal computer versions of the popular SPICE program developed at Berkeley have become widely available. These programs contain three MOSFET models that were derived for low power lateral MOSFET's. These are called the level 1 through level 3 models in Spice documentation. Silicon RF Power MOSFETs are not lateral, but are DMOS devices in which the substrate forms the drain contact. The level 1 model generally is not sufficiently accurate for DMOS devices while the more complex models require many parameters not readily available to the circuit designer. It is not obvious which of these are most important, or how the lateral device parameters should be used to simulate a short channel, high frequency DMOS device. The models do not include the variation of gate capacitance with gate to drain voltage.

Finman[1] has described a model for RF MOSFETs that uses, in addition to a level 1 NMOS model, a JFET and a network of controlled sources to model the effect of a nonlinear gate capacitance. The additional components provide a direct method of modeling FET switching characteristics and Finman has reported successful use of the model with RF MOSFETs. The nonlinear gate charging effects in DMOS switching transistors have been described by Clemente et al[2]. Bowers and Nienhous[3] have derived SPICE models for DMOS FETs, and Antognetti and Massobrio4 discuss Spice Modelling in detail.

The model presented here has been implemented in PSPICE[5] on a personal computer using only standard component models. Other SPICE implementations would be equally satisfactory. The model uses the level 3 MOSFET model because it includes short channel effects and permits control of the transconductance vs drain current characteristics. At the same time, the semi-empirical level 3 model provides faster simulation than the more theoretically oriented level 2 model. Linear passive elements and a junction diode are used to simulate the non-linear DMOS gate capacitance not present in the SPICE NMOS model.

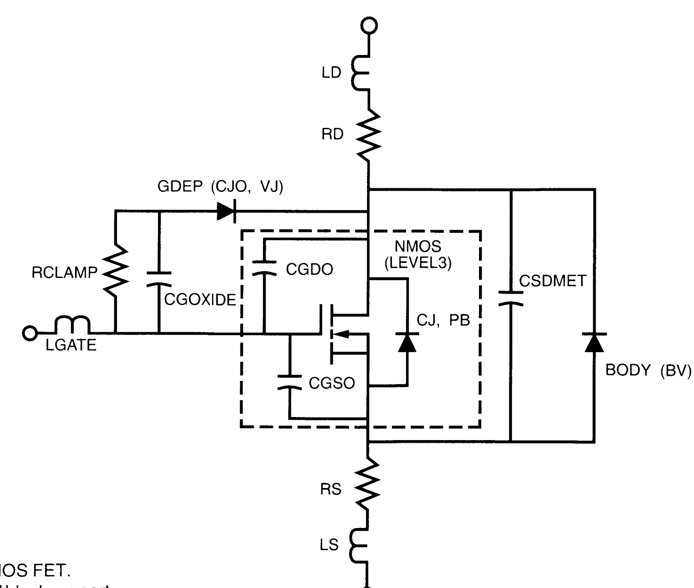

Figure 1.
SPICE model of RF power DMOS FET. Components inside the dashed block are part of the NMOS model in SPICE.

Modelling Procedure

Figure 1 shows the SPICE model. Parameter values for many power transistors from M/A-COM are shown in the following tables. A knowledge of how the parameter values are selected for a given device is valuable in estimating the usefulness and limitations of the resulting model. The modelling procedure is briefly outlined below.

First, the common source drain characteristics of a sample of the FETs of each type are measured in the region of normal operation. Normal operating conditions are determined from the nominal voltage and rated power of the part.

Means of estimating a load line and peak current and voltage excursions for power amplifiers of different classes are well known[6]. Figure 2 shows generic FET drain characteristics. The regions labelled "ohmic" and "pinchoff" are frequently called the linear and saturation regions, respectively in FET literature. These terms are not used here to avoid confusion stemming from other common uses of the term saturation.

Second, three points in the pinchoff region of the DC characteristics are selected. These are typically near the maximum current expected and approximately 30% and 10% of this value. The SPICE parameters VTO, KP and THETA fit the model to these points but also affect the ohmic region. Next the modelled slope in the ohmic region is matched to the measured curves. This is accomplished by adjusting the parasitic source and drain resistances R_S and R_D. There is no simple way to separate source from drain resistance, so their ratio is estimated from the device geometry, and their total value is adjusted to match the measured $R_{D(ON)}$ ($R_{D(ON)}$ is the inverse slope of the drain characteristics in the ohmic region).

The ohmic region and pinchoff region are not independent, so an iterative procedure is used. First the channel transport parameters VTO, KP and THETA are determined from the pinchoff region drain characteristics, then source and drain resistors R_S and R_D are determined from $R_{D(ON)}$. The Process is repeated using the new values of R_S and R_D. Because parasitic resistance dominates the ohmic region and the channel transport parameters VTO, KP and THETA dominate the pinchoff region, the iteration converges rapidly.

All three terminal capacitances (C_{OSS}, C_{RSS}, C_{ISS}) are measured with respect to drain voltage. A combination of diode capacitances and linear capacitors fits the model to the measured curves.

Output capacitance C_{OSS} includes contributions from the drain-body junction diode and the MOS capacitance of bonding pads. It is modelled by a fixed capacitance and a junction diode in parallel. The junction diode model in SPICE has three parameters, zero bias capacitance, built in voltage and junction grading coefficient. The junction grading coefficient is left at its default value of 0.5, corresponding to an abrupt junction. The remaining parameters plus the fixed MOS capacitance are sufficient to fit the measured capacitance-voltage characteristic exactly at three points and give an excellent overall fit.

The feedback capacitance C_{RSS} consists of an oxide layer in series with a depletion region. The depletion region has the same capacitance characteristic as a reverse biased junction diode. The combination is modelled by a fixed capacitor in series with a junction diode. A large resistor across the capacitor guards against any voltage buildup due to rectification in the junction diode. A 1 Megohm resistor has proven to be adequate to prevent problems due to the fictitious diode while not affecting RF characteristics. Again, the zero bias diode capacitance, built in voltage, and the fixed capacitor representing the oxide are sufficient to match the measured transistor capacitance at 3 voltages and provide an excellent overall fit.

The remaining model parameters represent package parasitics. They are determined by a combination of calculation from physical dimensions and small signal S-parameter measurements on packages containing no active device.

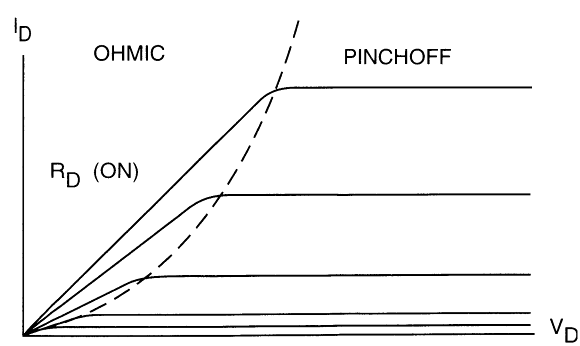

Figure 2.
FET drain characteristics showing the ohmic and pinchoff regions. The models give and exact fit to the test device at three points in the pinchoff region and 1 point in the ohmic region. This results in a good overall fit

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Model Limitations

The models presented here are based on an equivalent circuit closely resembling the actual structure of the DMOS FET. The level 3 SPICE model is well established, and the added components each represent, as closely as possible, a physical structure or effect. As a majority carrier device, the FET exhibits no minority carrier storage effects and its large signal RF performance is controlled by the same mechanisms that control its static and capacitance characteristics. A model that adequately describes these effects is also useful for RF work.

As with any computer model, the accuracy is limited and there are pitfalls due to simplifications and potential artifacts due to the modelling approach.

All leakage currents have been ignored. In general these will be much less than the operating currents.

The finite slope of the drain characteristics in the pinchoff region is not modelled. This appears to be a good approximation for DMOS power devices. In addition, the most important portion of the curve for modelling power amplifiers is the region near the load line, and a good match can be obtained without adding the complexity of additional parameters. However, if the models were used to generate S-parameters, a considerable error in S22 might occur because the slope has been ignored.

No attention has been paid to the subthreshold and reverse regions of FET operation. In a power amplifier, these regions make a negligible contribution to circuit behavior.

Diode GDEP and resistor R_{CLAMP} in Figure 1 are not physical elements. The diode is used solely for its depletion capacitance, which is an excellent model for the depletion component of the gate-drain capacitance. Current in the diode or in R_{CLAMP} has not been a problem in any simulation run to date. (The Finman[1] RF FET model also contains non-physical components that can potentially result in current flow across the gate oxide).

The separation of parasitic resistance into source and drain components is somewhat arbitrary due to the difficulty of resolving these components. Additional modelling effort in this area would be valuable.

Junction temperature is always an issue in RF power amplifiers but the models do not take this into account. No temperature coefficients have been assigned to components, and the models have not been verified over a range of temperatures.

In summary, the SPICE models presented here can be a useful tool for the circuit designer if approached with the caution due all computer models of physical devices.

[1] Paul F. Finman, "10 Watt MHz Oscillator Tests Improved Power MOSFET Modelling with SPICE", RF Technology Expo 90, Anaheim, CA, March 28, 1990.

[2] S. Clemente, B. R. Pelly, A. Isidori, "Understanding HEXFET Switching Performance", Application Note 947, International Rectifier Hexfet Databook, 1983.

[3] J. C. Bowers nad H. A. Nienhous, "SPICE-2 Computer Models for HEXFETs", Application Note 954A, International Rectifier Corporation.

[4] Paolo Antognetti and Guiseppe Massobrio, "Semiconductor Device Modelling with SPICE", McGraw-Hill, N.Y. 1987.

[5] Microsim Corporation, 20 Fairbanks, Irvine, CA 92718.

[6] H. L. Krause, C. W. Bostian and F. H. Raab, "Solid State Radio Engineering", John Wiley & Sons, New York.

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Model No.			DU1215S	DU1230S	DU1260T	DU2805S	DU2810S	
Symbol	**Units**	**Parameter**						
DC								
Gate Width	M	W(MOS1)	0.061	0.122	0.366	0.008	0.016	
Channel L	M	L(MOS1)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	
Vto	V	VTO(NMOS)	4.09	3.2	3.2	3	3	
THETA	-	THETA(NMOS)	0.592	0	0	0.6	0.6	
KP	A/V^2	KP(NMOS)	3.79E-05	9.02E-06	9.02E-06	5.00E-05	2.46E-05	
Rs	OHM	Rsource	0.066	0.03	0.01	1.5	0.75	
Rd	OHM	Rdrain	0.133	0.06	0.02	2.9	1.4	
C_{OSS}								
AD	-	AD(MOS1)	1	1	1	1	2	
Cjd	pF(0)	CJ(NMOS)	95.9	183.2	577.2	7.99	104	
Cmd	pF	CSDMET	12.86	26.9	66.4	2.3	2.87	
Vbio	V	PB(NMOS)	1.27	1.27	1.38	1.59	1.86	
C_{RSS}								
Cgm	F/M	CGDO(NMOS)	7.05E-11	7.13E-13	5.90E-11	-	-	
Cgox	pF	CGoxide	75.3	56.4	294.7	3.78	7.56	
CJG	pF(0)	CJO(Gdep)	54	104.5	414.7	17.3	34.6	
Vbir	V	VJ(Gdep)	0.1	0.1	0.1	0.1	0.1	
C_{ISS}								
Cgs	F/M	CGSO(NMOS)	4.75E-10	3.77E-10	5.44E-10	-	-	
Package								
Lg	nH	Lgate	1.2	0.7	0.9	0.6	0.5	
Ls	nH	Lsource	0.8	0.4	0.1	0.8	0.4	
Ld	nH	Ldrain	1.1	1.1	1.3	1.1	1.1	
BVdss	V	BV(BODY)	40	40	40	65	65	

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Model No.			DU2820S	DU2840S	DU2840V	DU2860U	DU2860T	DU2880T
Symbol	**Units**	**Parameter**						
DC								
Gate Width	M	W(MOS1)	0.061	0.122	0.061	0.183	0.183	0.244
Channel L	M	L(MOS1)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Vto	V	VTO(NMOS)	3.24	3.35	3.24	3.5	3.2	3.2
THETA	-	THETA(NMOS)	0.194	1	0.194	3	3	0.29
KP	A/V^2	KP(NMOS)	1.97E-05	4.43E-05	1.97E-05	9.29E-05	9.29E-05	2.46E-05
Rs	OHM	Rsource	0.164	0.1	0.164	0.11	0.11	0.08
Rd	OHM	Rdrain	0.33	0.2	0.33	0.22	0.22	0.16
C_{OSS}								
AD	-	AD(MOS1)	1	1	1	1	1	1
Cjd	pF(0)	CJ(NMOS)	80.2	163.7	80.2	245.3	245.3	439.2
Cmd	pF	CSDMET	5.97	6.65	5.97	4.46	4.46	25.8
Vbio	V	PB(NMOS)	2.1	2.33	2.1	2.54	2.54	0.785
C_{RSS}								
Cgm	F/M	CGDO(NMOS)	0.00E+00	7.38E-12	0.00E+00	1.99E-11	1.99E-11	0.00E+00
Cgox	pF	CGoxide	42	48.6	42	81.2	81.2	141
CJG	pF(0)	CJO(Gdep)	95	118.2	95	52.1	52.1	53
Vbir	V	VJ(Gdep)	0.1	0.1	0.1	0.1	0.1	2
C_{ISS}								
Cgs	F/M	CGSO(NMOS)	4.59E-10	6.31E-10	4.59E-10	5.46E-10	5.46E-10	5.70E-10
Package								
Lg	nH	Lgate	1.2	0.7	2.3	1.0	1.0	0.9
Ls	nH	Lsource	0.8	0.5	0.4	0.5	0.2	0.25
Ld	nH	Ldrain	1.1	1.1	1.2	1.0	1.2	1.3
BVdss	V	BV(BODY)	65	65	65	65	65	65

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Model No.			DU2880U	DU2880V	DU28120T	DU28120U	DU28120V	DU28200M
Symbol	**Units**	**Parameter**						
DC								
Gate Width	M	W(MOS1)	0.244	0.122	0.366	0.366	0.183	0.305
Channel L	M	L(MOS1)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Vto	V	VTO(NMOS)	3.2	3.35	3.6	3.6	3.5	3.6
THETA	-	THETA(NMOS)	0.29	1	0.6	0.6	3	0.6
KP	A/V^2	KP(NMOS)	2.46E-05	4.43E-05	2.60E-05	2.60E-05	9.29E-05	2.59E-05
Rs	OHM	Rsource	0.08	0.1	0.045	0.045	0.11	0.05
Rd	OHM	Rdrain	0.16	0.2	0.09	0.09	0.22	0.11
C_{OSS}								
AD	-	AD(MOS1)	1	1	1	1	1	1
Cjd	pF(0)	CJ(NMOS)	439.2	163.7	537.5	537.5	245.3	
Cmd	pF	CSDMET	25.8	6.65	7.75	7.75	4.46	
Vbio	V	PB(NMOS)	0.785	2.33	2.39	2.39	2.54	
C_{RSS}								
Cgm	F/M	CGDO(NMOS)	0.00E+00	7.38E-12	2.24E-11	2.24E-11	1.99E-11	2.24E-11
Cgox	pF	CGoxide	141	48.6	2700	2700	81.2	2250
CJG	pF(0)	CJO(Gdep)	53	118.2	60.7	60.7	52.1	50.6
Vbir	V	VJ(Gdep)	2	0.1	0.1	0.1	0.1	0.1
C_{ISS}								
Cgs	F/M	CGSO(NMOS)	5.70E-10	6.31E-10	5.33E-10	5.33E-10	5.46E-10	5.31E-10
Package								
Lg	nH	Lgate	1	0.8	0.9	0.9	0.7	0.6
Ls	nH	Lsource	0.15	0.3	0.1	0.1	0.2	0.2
Ld	nH	Ldrain	1	1.2	1.3	1	1.2	0.9
BVdss	V	BV(BODY)	65	65	65	65	65	65

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Model No.			FH2114	FH2164	FH2165	LF2802A	LF2805A	LF2810A
Symbol	**Units**	**Parameter**						
DC								
Gate Width	M	W(MOS1)	0.244	0.061	0.061	0.004	0.008	0.016
Channel L	M	L(MOS1)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Vto	V	VTO(NMOS)	3.62	3.21	3.21	2.76	2.95	2.95
THETA	-	THETA(NMOS)	1	0.171	0.171	0.066	0.301	0.301
KP	A/V^2	KP(NMOS)	5.33E-05	2.05E-05	2.05E-05	1.43E-05	2.56E-05	2.56E-05
Rs	OHM	Rsource	0.12	0.35	0.35	2.7	1.04	0.5
Rd	OHM	Rdrain	0.25	0.71	0.71	5.4	2.09	1
C_{OSS}								
AD	-	AD(MOS1)	1	1	1	1	1	1
Cjd	pF(0)	CJ(NMOS)	333.2	85	85	3.99	8.12	
Cmd	pF	CSDMET	0.5	5.2	5.2	2.09	2.61	
Vbio	V	PB(NMOS)	2.4	1.63	1.63	2.18	1.53	
C_{RSS}								
Cgm	F/M	CGDO(NMOS)	1.76E-11	0.00E+00	0.00E+00	0.0	1.25E-11	2.50E-11
Cgox	pF	CGoxide	400	16	16	9.8	38	76
CJG	pF(0)	CJO(Gdep)	60	26	26	1.36	2.8	5.6
Vbir	V	VJ(Gdep)	0.1	0.5	0.5	2	2	2
C_{ISS}								
Cgs	F/M	CGSO(NMOS)	6.02E-10	5.90E-10	5.90E-10	7.75E-10	7.00E-10	1.49E-09
Package								
Lg	nH	Lgate	0.9	1.6	1.4	1.7	1	0.7
Ls	nH	Lsource	0.25	0.5	0.5	0.6	0.3	0.2
Ld	nH	Ldrain	1.3	0.7	0.6	0.6	0.6	0.6
BVdss	V	BV(BODY)	65	65	65	65	65	65

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Model No.			UF2820R	UF2840G	UF2840P	UF28100H	UF28100M	UF28100V
Symbol	**Units**	**Parameter**						
DC								
Gate Width	M	W(MOS1)	0.58	0.058	0.058	0.174	0.174	0.174
Channel L	M	L(MOS1)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Vto	V	VTO(NMOS)	2.97	3.44	3.19	3.66	3.66	3.57
THETA	-	THETA(NMOS)	0	1.47	0	0.445	0.445	1.98
KP	A/V^2	KP(NMOS)	3.45E-05	4.81E-05	1.36E-05	2.18E-05	2.18E-05	6.55E-05
Rs	OHM	Rsource	0.52	0.215	0.49	0.08	0.08	0.8
Rd	OHM	Rdrain	1.04	0.431	1	0.17	0.17	0.17
C_{OSS}								
AD	-	AD(MOS1)	1	1	1	1	1	2
Cjd	pF(0)	CJ(NMOS)	254	100.3	695	298.6	298.6	348
Cmd	pF	CSDMET	6.41	6.3	5.11	5.57	5.57	17.5
Vbio	V	PB(NMOS)	0.095	0.6	1.23	1.06	1.06	0.41
C_{RSS}								
Cgm	F/M	CGDO(NMOS)	1.72E-11	1.72E-12	3.45E-12	4.02E-12	4.02E-12	2.87E-12
Cgox	pF	CGoxide	131.6	23.5	20.6	87.5	87.5	76.7
CJG	pF(0)	CJO(Gdep)	13	22.7	21.4	57.4	57.4	50.3
Vbir	V	VJ(Gdep)	1.4	1.4	1.4	1.4	1.4	1.4
C_{ISS}								
Cgs	F/M	CGSO(NMOS)	5.52E-10	5.34E-10	5.34E-10	6.32E-10	6.32E-10	6.38E-10
Package								
Lg	nH	Lgate	1	1.2	1.1	0.7	0.6	0.6
Ls	nH	Lsource	0.3	0.2	0.3	0.1	0.1	0.15
Ld	nH	Ldrain	1.1	0.6	0.7	0.8	0.9	1.2
BVdss	V	BV(BODY)	65	65	65	65	65	65

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Model No.			UF28150J	UF2801KI	UF2805B	UF2810P	UF2815B	UF2820P
Symbol	**Units**	**Parameter**						
DC								
Gate Width	M	W(MOS1)	0.232	0.004	0.008	0.008	0.024	0.016
Channel L	M	L(MOS1)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Vto	V	VTO(NMOS)	3.29	2.76	3.1	3.26	3.26	3.26
THETA	-	THETA(NMOS)	0	0.066	1.35	0.313	0.313	0.313
KP	A/V^2	KP(NMOS)	1.40E-05	1.43E-05	8.31E-05	3.05E-05	3.05E-05	3.05E-05
Rs	OHM	Rsource	0.11	2.7	1.13	1.8	0.6	0.9
Rd	OHM	Rdrain	0.22	5.4	2.27	3.7	1.2	1.8
C_{OSS}								
AD	-	AD(MOS1)	1	1	1	1	1	1
Cjd	pF(0)	CJ(NMOS)	286	3.99	10.35	2.36	23.6	
Cmd	pF	CSDMET	1.36	2.09	2.12	0.2	2.57	
Vbio	V	PB(NMOS)	2.12	2.18	1.91	3	1.97	
C_{RSS}								
Cgm	F/M	CGDO(NMOS)	3.45E-12	2.50E-11	1.25E-11	2.78E-10	3.69E-11	2.78E-10
Cgox	pF	CGoxide	105.1	38	38	14.1	13.53	28.2
CJG	pF(0)	CJO(Gdep)	68.7	2.8	2.8	42.4	39.02	84.8
Vbir	V	VJ(Gdep)	1.4	2	2	0.1	0.1	0.1
C_{ISS}								
Cgs	F/M	CGSO(NMOS)	5.91E-10	7.75E-10	7.00E-10	2.87E-10	5.42E-10	2.87E-10
Package								
Lg	nH	Lgate	0.6	2.6	0.9	1	0.5	0.7
Ls	nH	Lsource	0.1	2.2	0.5	0.5	0.2	0.3
Ld	nH	Ldrain	0.8	2.2	0.6	0.6	0.6	0.5
BVdss	V	BV(BODY)	65	65	65	65	65	65

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Infrared Method of Measuring Thermal Resistance of a Bipolar Pulsed Power Transistor

AN003

V2.00

Why Junction Temperature?

The junction temperature of a solid state device is the maximum temperature at the active junction while the device is operated under a given condition. For a bipolar power transistor, the junction temperature is measured at the emitter-base junction.

Junction temperature is useful in evaluating the rate of metal migration in a device. This is a primary consideration in determining the long term reliability of the device. Metal migration is the mechanism by which, due to a combination of the current through the device and the temperature of the device, the metal ions near the active junction physically start to migrate. Some of the areas will fuse after a period of time, and eventually a failure of the device will occur. Equations are available which show the Mean Time To Failure (MTTF) as a function of the junction temperature, the metal area and the current flow. Once a MTTF is known for a given temperature, a general rule of thumb is that for every 10°C decrease in junction temperature, the MTTF will double.

The junction temperature of a device operated under a given condition can indicate several things. It will show the ability of the device to dissipate the heat generated at the junction. It also will show when a device is operated under a condition which will support long-term reliability.

What is Infrared Measurement?

An infrared measurement is a measurement of the intensity of the infrared energy which radiates from a given material at a given temperature. Different materials at the same temperature will have different levels of infrared radiation.

By measuring the intensity of the infrared energy that the active junction of a device is radiating, the junction temperature can be determined. The following is an explanation of how this is done.

Determining Junction Temperature Using IR Measurement

A common instrument for making infrared measurements is the infrared (IR) radiometric microscope. In this section, a suggested method of measuring the junction temperature of a pulsed power device using an infrared radiometric microscope will be discussed. The basic principles in this example should be applicable to other similar type measurements. Before beginning an infrared measurement, several requirements must be met. There must be a visual, or rather, an infrared path between the measured area and the infrared detector or lens. It also is desirable to constrain the device in a stable and adjustable position at the measurement location of the IR microscope. When measuring to determine thermal resistance, it is necessary to monitor the temperature of some reference point on the device (i.e. package or flange).

The structure of many solid state devices is complex, and therefore it is desirable to use a measurement method which does not require any specific knowledge of the measured materials or structures. One such method is to measure the electrical output of the infrared detector directly on an oscilloscope and to develop and use a calibration curve.

Key to this method is maintaining a fixed reference point for the IR measurement. This is accomplished through the use of the internal chopper of the IR microscope. The chopper provides a window in the path between the lens and the IR detector. This chopper window alternately opens and closes. The result of using the chopper is an AC signal displayed on an oscilloscope which shows the electrical output in Volts of the infrared detector. The peak to peak measurement is proportional to the difference in infrared energy between the ambient reference (chopper closed) and the active measured area (chopper open). By using the chopper in developing a calibration curve, the peak to peak measurement can be used directly to determine the temperature of the measured area.

For a pulsed application, there will be two events operating asynchronously: the pulsed RF signal and the IR signal. To determine the maximum temperature, it is

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important to measure the IR signal at the end of the application pulse. To achieve this, the oscilloscope should be triggered from the pulsed signal. Because the pulsed signal and the IR signal are not synchronized, the IR signal will constantly be moving across the oscilloscope screen. By displaying the detected application pulse on the oscilloscope as a reference, it still should be possible to read the peak to peak IR signal at the end of the pulsed signal. This will represent the maximum junction temperature. Figure 1 shows an example of an infrared (IR) output on an oscilloscope display. In this example, the pulse length is long compared to the period of the chopper.

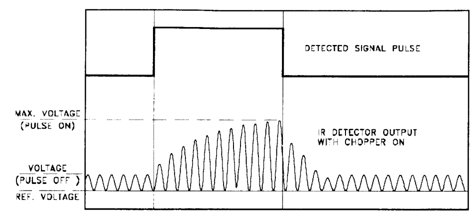

Figure 1: Example of oscilloscope output

A calibration curve is made by externally heating the device while it is not in operation, and measuring the peak to peak IR signal at a number of temperatures within the desired temperature range. It is necessary that the same areas be measured for calibration as those measured under the operating conditions (i.e. same materials in the same configuration). Only one area needs to be calibrated if it is identical to all of the other areas measured (i.e. for a repeated pattern). For each different type of pattern and/or material measured under a given operating condition, a separate calibration curve will be necessary. Figure 2 shows a typical calibration curve.

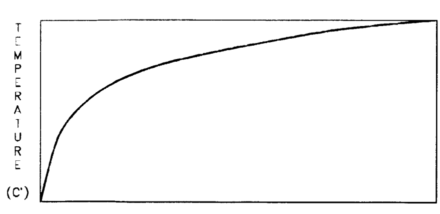

Figure 2: Example of calibration curve

The measurement(s) made under the operating condition(s) can now be compared to the appropriate calibration curve, and the temperature of the measured area(s) can be determined.

Thermal Resistance

The thermal resistance of a solid state device is a measure of the ability of the device to transport heat energy away from the active area(s). This is an important consideration when attempting to keep the junction at a desirable temperature. Thermal resistance is expressed in terms of temperature differential per unit of dissipated power.

$$\theta_{JC} = (T_{JC} - T_F) + P_{DIS} \ (°C/W) \text{ or} \quad (1)$$

$$\theta_{JC} = T_{JF} + P_{DIS} \ (°C/W) \quad (2)$$

θ_{JC} = Hot spot thermal resistance

T_{JC} = Hot spot junction temperature in °C

T_F = Flange Temperature in °C

P_{DIS} = Dissipated power in Watts

ΔT_{JF} = Temperature difference between the hot spot and the flange in °C

Hot spot junction temperature and thermal resistance are measurements based on the hottest point(s) in the device. This will give a higher thermal resistance result than other methods which only take into consideration the average effect of the junction temperatures.

For pulsed devices, the peak dissipated power is used. In this case the peak dissipated power is the average power being dissipated during the pulse, or more accurately, the power being dissipated at the same time during the pulse that the maximum hot spot temperature occurs.

Most solid state devices are made up of a combination of various materials of various thicknesses in a stacked or layered configuration. Each of these layers each has a thermal resistance which contributes to the overall thermal resistance.

The thermal resistance of a device, however, is not constant over all conditions. The thermal resistance of a given material will change as the temperature of that material changes. For example, the thermal resistance of silicon increases by approximately .3 percent per degree C increase in temperature. Also, because of the heat capacity of materials, the thermal resistance of a device operated in a pulsed application is really a complex

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impedance. This complex impedance will change with the pulse width and pulse frequency. It is desirable, therefore, to measure the thermal resistance of a pulsed device under the exact pulse conditions the device will be operated in its final application. It is also desired that the temperature be measured with the same electrical conditions under which the device will be operated (i.e., the same dissipated power).
When the thermal resistance of a device is known for the desired operating condition, an interfacing structure can be designed to achieve the most desirable performance and reliability of the device.

> For example: For a desired operating condition, a device has a thermal resistance of .70°C/W, and will dissipate 130 Watts. For performance and reliability, it is desired that the maximum junction temperature be less than or equal to 175°C. Using equation (1), an interfacing structure must be designed which can maintain a temperature of 84°C.

Conclusion

The use of infrared measurement to determine junction temperature and/or thermal resistance is a straightforward method which can take into consideration the exact application in which a device will be used. It can provide valuable information for verifying the suitability of a device in a particular application and for designing an interfacing structure which will provide the best performance and most reliability.

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VSWR Tuner

AN004

V2.00

Introduction

M/A-COM has developed a trough line tuner for tuning RF circuits. This tuner facilitates transistor impedance measurement and allows load pull testing to be performed. The tuner is constructed as a 50 ohm impedance air line, and uses dielectric tuning slugs to transform the 50 ohm impedance to a pre-determined reflection coefficient and phase. The slug is moved along the tuner to provide full Smith chart coverage. See Figure 1.

The tuner is an improvement over coaxial tuners in that it allows a smooth and repeatable movement around the Smith chart.

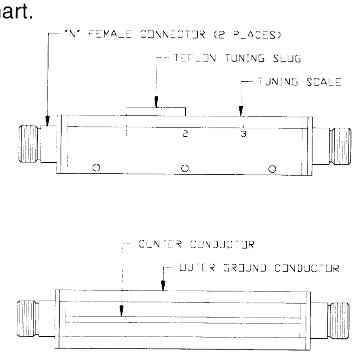

Figure 1: 50 Ohm Z0 VSWR Tuner

Tuner Application

The tuner is typically used in a RF test bench environment as seen in Figure 2. Two tuners are used to allow tuning of both the input and output circuit of the transistor matching network. A breakapart RF test fixture then allows conjugate impedance measurements.

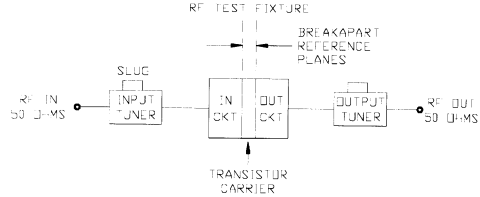

Figure 2: Typical Test Bench Application

When the fixture is optimally tuned at a given frequency, both the value of the slug and its position in the tuner are recorded. The impedance of the fixture half circuit, along with its respective tuner and positioned slug is then measured on a network analyzer. See Figure 3. Impedances measured will be transistor conjugate impedances.

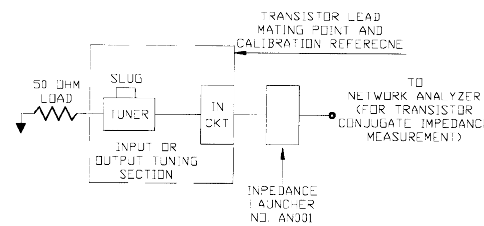

Figure 3: Transistor Impedance Measurement

Theory of Operation

The tuner is designed to provide at least 360° rotation around the Smith chart at the lowest required frequency of operation. Since standing waves repeat every 180°, the line is designed to be 180° long at the lowest frequency of operation.

The tuning slug basically acts as a shunt capacitor in parallel with the 50 ohm line. The value of this capacitance determines the VSWR or tuning range of the tuner, while the position of the slug dictates the phase. For broadband VSWR tuning at high frequencies, the slug must be treated as a transmission line with finite length. The slug is then optimized to a length of one-quarter wavelength at center band to provide a more constant VSWR with frequency.

The VSWR that a tuning slug will provide is related to the Er of the slug material through the following derivation.

For a quarter wave dielectric slug, we have the transformer equation:

$Z2 = (Z3 \times Z1)^{1/2}$ Z2 = Quarter Wave Slug Impedance
Z3 = Required VSWR Impedance
Z1 = 50 Ω

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$Z2 = 50 \times Er^{-1/2}$ Er = Effective Dielectric Constant of Slug

$Z3 = 50 \div Er$ Solving for Z3

$\Gamma = \frac{Z3 - 50}{Z3 + 50}$ Calculate Reflection Coefficient

$= \frac{1 - Er}{1 + Er}$ Substituting for Z3

$VSWR = (1 + |\Gamma|) \div (1 - |\Gamma|)$ Calculate VSWR

$VSWR = Er$ Substituting for Γ

We see that the tuned VSWR is simply equal to the dielectric constant of the quarter wavelength tuning slug when it completely fills a section of the line. For a VSWR between 2:1 and 10:1, the trough line is partially filled with a high dielectric constant material, with air gaps reducing the effective Er and VSWR accordingly.

Design Example

A 3.1 to 3.5 GHz VSWR tuner with a 2:1 tuning slug will be designed. Slugs for a 1.5:1 and 3.0:1 tuning range will also be presented.

Tuner Characteristic Impedance

For the trough line design, a center conductor bar is used, along with outer conductor walls spaced for the required impedance of 50 ohms. The dimensions (in inches) optimized at **M/A-COM** are presented in Figure 4.

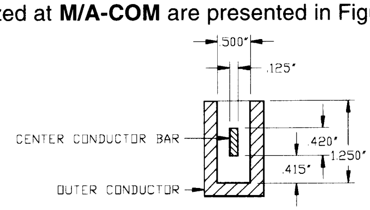

Figure 4: 50 Ohm Impedance Line Design

Tuning Slug Design

The slug length is designed to be a quarter wavelength at the center of the frequency band.

$\lambda / 4 = (c \times Er^{-1/2}) \div (4f)$ Basic Wavelength Equation

$= (3 \times 10^8 \times 39.4 \times 2^{-1/2}) \div (4 \times 3.3 \times 10^9)$

$\lambda / 4 = 0.63$ in The Er = 2 slug is made 0.63 inches long for 90°

1.5:1, 2:1, 3:1 Tuning Slugs

The 2:1 tuning slug is designed by completely filling a section of air line with Er = 2 dielectric (Teflon material) following results from the theory of operation section.

Other tuning slugs, including higher VSWR ranges, are constructed using a material with Er = 10. Because of the high dielectric constant, the air line is not entirely filled, and is constructed as shown in Figure 5. Note that a 2:1 VSWR can also be constructed with high dielectric constant material.

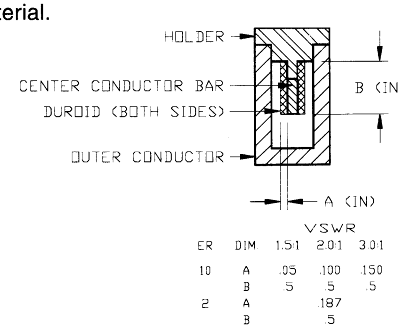

Figure 5: Tuning Slug Dimensions

Tuner Length

To get full Smith chart coverage, the tuner must be designed for 180° minimum phase length at the lowest required frequency of operation.

$\lambda / 2 = (c \times Er^{-1/2}) \div (2f_L)$ Basic Wavelength Equation

$= (3 \times 10^8 \times 39.4 \times 1) \div (2 \times 3.1 \times 10^9)$

$\lambda / 2 = 1.9$ inches 180° of airline is 1.9 inches long

Because the tuning slug has a finite length of 0.63 inches, the tuner length must be made longer by that amount to allow full rotation. A tuner length of 2.53 inches will be sufficient.

The tuner's 50 Ω characteristic impedance should be tuned to better than 35 dB return loss to keep VSWR constant as phase is rotated.

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MOSFET Impedance Matching Using Published Data

AN005

V2.00

Introduction

The use of S-parameters for RF linear circuit design is well established, and sophisticated design tools are readily available. Yet S-parameters for many MOSFETs remain unpublished, though the transistors are clearly intended for linear Class AB operation. Is this evidence of a plot against the beleagured circuit designer? S-parameter design techniques are so powerful that it is easy to forget that they contain no information about the ability of a device to deliver the required output power. Large signal S-parameters, to be generally useful, must be measured over a wide range of drain voltages and currents. Even then they do not contain all the information required to match the output of a power device.

Input and output matching circuits can be designed using the data published for nearly all RF power MOSFETs and understanding how the MOSFET reacts to its surroundings. The general design procedure is first to obtain an output match that will permit the device to convert the required power from the specified DC voltage source to RF power and deliver it to a load, generally 50 ohms. Then an input matching circuit that minimizes reflected power when the output is matched can be designed. Fortunately, the required information is generally included in the published data sheet.

Output Match

Figure 1 shows a model of a FET output as it applies to an amplifier operating at saturated power. Cout is the non-linear output capacitance, LD is the internal package parasitic drain inductance, and Ron is the sum of the channel resistance and the parasitic source and drain resistances of the FET. The controlled switch represents the effect of the gate, turning the channel on and off.

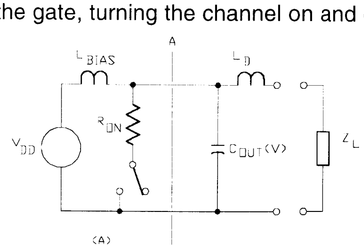

Figure 1

The fundamental power crossing plane a-a' is:

$$P = \frac{1}{2} V_{pk} \cdot I_{pk} = \frac{1}{2} \frac{V_{pk}^2}{R_0} \qquad (1)$$

Where R_o is the (real) load impedance of the right half of the circuit seen from plane a-a'.

The maximum value of V_{pk} is $2 \bullet (V_{dd} - V_{sat})$ where V_{sat} will be discussed below. This leads directly to Figure 2 and the well known formula for optimum load resistance for a power transistor.

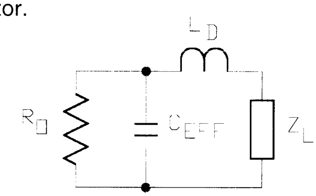

Figure 2

$$R_0 = \frac{(V_{dd} - V_{sat})^2}{2 \cdot P_{out}} \qquad (2)$$

R_o = required load impedance, neglecting parasitics

P_{out} = required saturated output power

V_{dd} = drain supply voltage

V_{sat} = minimum drain voltage

Note that, except for V_{sat}, none of these are device parameters, but depend entirely on the application. The circuit of Figure 2 has an output impedance which may be considered the output impedance of the FET because its value is the conjugate of the optimum load impedance. In practice it is the load impedance that is always measured and for this reason M/A-COM data sheets specify optimum load. The output impedance used in power amplifier design cannot be measured directly, and cannot be calculated from S-parameters, even large signal S-parameters.

Unlike bipolar transistors, FETs have no built-in junction potentials to overcome, so Vsat is simply the peak voltage across the internal resistance R_{on}.

$$V_{sat} = I_{pk} \bullet R_{on} \quad (3)$$

Peak current cannot be measured directly but can be readily estimated from DC current and drain current wave form. For Class A operation, drain current is sinusoidal and I_{pk} is twice I_{dc}.

In a Class B circuit, the conduction angle is 180° and the drain current is a full wave rectified sine wave (in a push-pull circuit) or a half wave rectified sine wave (in a single ended circuit). Class C and more non-linear classes have smaller conduction angles and higher ratios of peak current to DC current.

$$\frac{V_{sat}}{R_{on} \cdot I_{dc}} = \alpha \quad (4)$$

where:		
	$\alpha = 2$	Class A
	$2 < \alpha < \pi$	Class AB, single ended
	$\alpha = \pi/2$	Class B, push pull
	$\alpha > \pi$	Class C

The effective output capacitance C_{eff} is generally 15-20% higher than the C_{oss} on the data sheet. This occurs because C_{oss} is measured at a nominal V_{dd}, and its value increases at lower voltages. The average value of C_{oss} over an RF cycle is greater than its static value at V_{dd}. In addition, included in C_{oss} is the feedback capacitance C_{rss} which will have an additional effect (generally small) on optimum load impedance.

If an RF power FET is operated at its rated power and voltage, the circuit model in Figure 2 usually gives good agreement with the measured series equivalent optimum load impedance given in the device data sheet. If there is a difference, the measured value is preferred. The circuit in Figure 2 can be used to see how the optimum load impedance changes with various choices of power supply voltage and saturated power.

Input Match

The input impedance of an RF power FET has significant dependence on the circuit load impedance due to internal feedback capacitance and common mode source inductance. A significant portion of the input impedance is the Miller effect enhanced contribution of C_{rss}. In S-parameter design, these effects are represented by the reverse transfer parameter S_{12}. For power MOSFETs, the input impedances given in data sheets are measured large signal values obtained with the device output optimally matched at each frequency. The reverse transfer (S_{12}) is small enough that using these impedances will give a good power match as long as the output circuit does not differ greatly from optimum.

A quick look at nearly any MOSFET data sheet will show a huge change in input impedance across the useful frequency range of the device. The power gain of the FET follows a 6 dB per octave slope over the same frequency range.

Over a restricted frequency range, the circuit can be designed to match the input impedances from the data sheet. For a multi-octave design, the solution to both the gain slope and impedance matching problem is an appropriate swamping resistor from gate-to-source (or gate-to-gate in a push-pull design). The resistor should be mounted as close as possible to the FET input. If the swamping resistor is small compared to the magnitude of Z_{in}, power gain is nearly flat and is given by (5).

$$G = g_m^2 R_0 R_s \left(\frac{1}{1 + R_s / Z_{in}}\right) \quad (5)$$

where R_S is the swamping resistor and R_o is determined from equation (2). Here the following assumptions have been made:

1. The output is well matched so that the load, including parasitics, is nearly real and equal to R_o at the internal drain.

2. g_m is nearly constant with frequency. (This is true at frequencies at and below the maximum frequency for which the FET is intended).

The design procedure for a multi-octave input match is as follows:

First, determine the gain at the maximum frequency from the data sheet. The expected gain slope of 6dB per octave is not a guaranteed parameter, and designing for higher gain than the specified gain of the part is risky and not recommended.

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Second, determine the swamping resistor value that will give the same gain at low frequency that the matched part can provide at the upper band edge.

Third, determine the transformer ratio needed to match the swamping resistor. This transformer needs to cover the entire required bandwidth.

Finally, design a low pass matching circuit to match the transformer output to Z_{in} at the upper band edge. Any slight reduction in gain at the upper band edge due to R_S can be minimized by using a more complex matching circuit, perhaps including an inductor in series with R_S to remove its effect at high frequency. However, the improved performance is unlikely to justify the increased complexity.

Summary

In spite of the wide usage of powerful S-parameter design techniques, RF power MOSFETs often do not have specified small signal or large signal S-parameters. S-parameters contain only a part of the information required for designing power amplifiers. The specified input impedance and optimum load impedance, which apply to operation at rated power and voltage, provide the necessary information for designing a circuit to operate under these conditions. A simple equivalent circuit for the transistor output provides an excellent guide for adjusting the load impedance to accommodate other operating conditions.

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MOSFET Temperature Compensation

AN006

V2.00

Introduction

MOSFETs do not depend upon PN junctions for control of forward current and therefore are not subject to thermal runaway problems in the same way as bipolar transistors. However, both gate threshold voltage and carrier mobility are temperature dependent. If quiescent current of a Class A or class AB amplifier is to remain stable with ambient temperature, compensation is required.

MOSFET Temperature Characteristics

All MOSFETs manufactured by M/A-COM are silicon enhancement mode N-channel FET's. In these devices, the gate threshold voltage, defined as the gate voltage necessary to invert the channel and just begin to turn on the device, decreases as temperature increases. A MOSFET biased just above threshold will increase its drain current with increasing temperature.

As gate to source voltage increases above threshold, the transconductance becomes more and more significant until at the large gate voltage, the current is limited by transconductance and parasitic resistance, both of which are controlled by electron mobility. Because mobility decreases with increasing temperature, drain current of a heavily biased FET will decrease at increased temperature. This tends to limit current, stabilize operation, and is the reason FETs do not require internal ballast resistors such as those used in power bipolar transistors.

At the relatively small quiescent currents typical of Class AB operation, the temperature coefficient of threshold voltage tends to dominate that of the transconductance. Figure 1 shows typical drain current vs temperature characteristics.

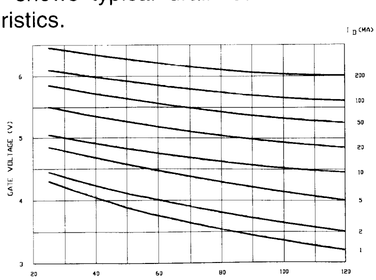

Figure 1

The curves are for a 50V, 30 watt transistor but are typical of transistors of other ratings. The temperature coefficient of V_{gs} is in the range of -1 to -2mV/°C, comparable to that of a junction transistor. Temperature compensating a FET is simple and requires little power because no DC gate current is drawn by the MOSFET.

Temperature Sensing

The most important, yet sometimes overlooked, aspect of temperature compensation is the location of the temperature sensing element. The sensing element, whether a diode, thermistor, or other device must track the temperature of the power FET over all conditions of ambient temperature, heat sink temperature, air flow, and power dissipated in the RF transistor.

The most reliable method of ensuring good tracking is simply to clamp the sensing element to the transistor flange with one of the existing mounting screws.

Diode Compensation

Figure 2 shows a bias circuit using one or more diodes. Table 1 shows typical forward voltage and temperature coefficient over the 25°C - 100°C range for a 1N4245 diode.

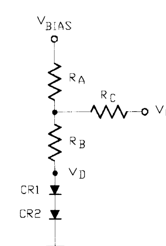

Figure 2

I mA	V @25°C	C_T mV/°C
0.1	.47	-1.9
1.0	.56	-1.8
10	.67	-1.6
100	.76	-1.3

Table 1

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Output voltage V_g and its temperature coefficient α are given by:

$$V_g = V_d + (1-k)(V_b - V_d) \quad (1)$$

$$\alpha = k\,C_T \quad (2)$$

where $k = \dfrac{R_b}{R_a + R_b}$

α = temperature coefficient of Vg

C_T = temperature coefficient of sensing diode

A power FET may be compensated by setting α equal to the net temperature variation due to threshold voltage and transconductance. Once the desired value and temperature coefficient of the FET gate voltage are established, equations (1) and (2) can be solved for V_{bias} and k.

$$k = \frac{C_T}{\alpha} \quad (k < 1) \quad (3)$$

$$V_{bias} = \frac{k(V_g - V_d)}{C_T} + V_d \quad (4)$$

If k is greater than 1 or V_{bias} is unacceptably high, it will be necessary to use two diodes, as shown in Figure 2. The major drawback of this circuit is the necessity of attaching both diodes to the MOSFET flange if two are required. The final step is determining R_A and R_B to set the diode current.

$$R_B = \frac{V_{bias} - V_d}{I} \bullet \frac{(1-k)}{(1+k)} \quad (5)$$

$$R_A = \frac{k}{1-k} \bullet R_B \quad (6)$$

If V_{bias} is derived from a potentiometer, R_A must include the Thevenin equivalent source resistance of the potentiometer. Since the FET gate draws no DC current, R_C is not critical. It can be left out if a suitable bias choke is used. If no other bias isolation is used, R_C should be made much larger than the RF input impedance of the FET, and a bypass capacitor will be needed.

Thermistor Compensation

Thermistors exhibit resistance changes with temperature that are large but very non-linear. Nevertheless, it is possible to obtain a suitably linear voltage vs temperature characteristic over a specified temperature range. Figure 3 shows an voltage divider including a thermistor. Figure 4 shows V_o vs temperature for this voltage divider. Output voltage approaches V_1 and 0 in the limits as thermistor resistance approaches infinity and zero. For best linearity, the voltage excursions above and below the midpoint should be equalized. The temperature compensation network design procedure is as follows:

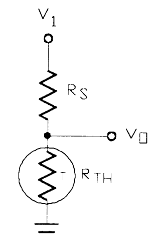

Figure 3

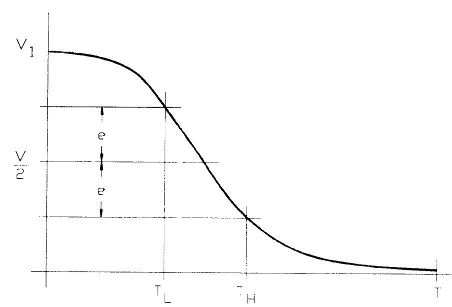

Figure 4

1. Determine the desired gate voltage at the high and low temperature extremes.
2. Select a thermistor and determine its resistance at the high and low temperature extremes.
3. Design a voltage divider to use the linear portion of the curve in Figure 3.
4. Scale the voltage divider design to provide the correct output voltage at the temperature extremes. The resulting voltage characteristic will be exact at the two temperature extremes, and will cross the straight line connecting the extremes at one intermediate point.

Some thermistors are provided with a calibration equation, either equation 7, or a similar exponential curve with additional parameters.

$$R_2 = R_1 \exp\left(\beta\left(\frac{1}{T_2} - \frac{1}{T_1}\right)\right) \tag{7}$$

where T_i = Kelvin Temperature

R_i = resistance at T_i

β = Thermistor constant.

If an equation is not given, the resistance at one temperature and the ratio of resistance at two different temperatures, often 0°C and 50°C will be given. The constant β in equation 7 is readily determined from this information.

$$\beta = \frac{\ln(R_2 / R_1)}{\left(\frac{1}{T_2} - \frac{1}{T_1}\right)} \tag{8}$$

Using equation 7, determine thermistor resistance at the temperature extremes, then determine R_s.

$$R_S = \sqrt{R_L \cdot R_H} \tag{9}$$

R_L = thermistor resistance at low temperature

R_H = thermistor resistance at high temperature

Voltage divider output voltage will be

$$\frac{V_0}{V_1} = \frac{1}{1 + \frac{R_{TH}}{R_S}} \tag{10)a}$$

$$\frac{V_L}{V_1} = \frac{1}{1 + a} \tag{10)b}$$

$$\frac{V_H}{V_1} = \frac{1}{1 + \frac{1}{a}} \tag{10)c}$$

where $a = \frac{R_S}{R_L} = \frac{R_H}{R_S}$

The change in voltage with temperature is

$$\frac{\Delta V}{V_1} = \frac{V_L - V_H}{V_1} = \frac{1-a}{1+a} \tag{11}$$

V_1 can now be determined from the required ΔV

$$V_1 = \frac{(1+a)}{1-a} \Delta V_g \tag{12}$$

where ΔV_g is the required gate voltage change over the specified temperature range.

At this point we have established the desired temperature coefficient, using the most linear portion of the curve, but the output voltage is offset from the desired value by a constant.

$$V_{offset} = V_{GL} - V_1 \cdot \frac{1}{1+a} \tag{13}$$

where V_{GL} = desired gate voltage at the low temperature extreme.

To increase V_G by a constant, we split R_S into 2 resistors, as in Figure 5, and increase the bias supply voltage to V_B. V_G will be increased by V_{offset} at any temperature if

$$V_B = V_1 + V_{offset} = V_{GL} - V_1 \cdot \frac{1}{1+a} \tag{14)a}$$

and

$$R_2 = R_S \left(\frac{V_{offset}}{V_{offset} + V_1}\right) = R_S \left(\frac{(1+a)V_{GL} - V_1}{(1+a)V_{GL} + aV_1}\right) \tag{14)b}$$

$$R_1 = R_S - R_2 \tag{14)c}$$

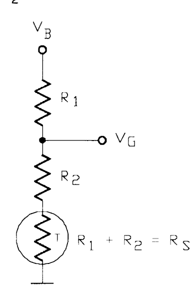

Figure 5

The performance of the new voltage divider may be readily checked by considering the limiting cases of R_{th} = 0 and $R_{th} = \infty$

If the new bias source voltage V_B is derived from a potentiometer, the Thevenin source resistance of the potentiometer should be included in R_1.

Closed Loop Bias

Closed loop bias control, in which drain current is sensed and used to control gate bias, provides excellent results in Class A circuits, without the use of a temperature sensor. However, such a circuit cannot differentiate between an undesired current change and the normal increase of current with output power in a Class AB circuit. Such circuits will bias the transistor into Class C operation when RF power is applied, unless the gate voltage is clamped to a suitable value.

Figure 6 is a generic closed loop active bias circuit included here for reference. Drain current is set by DC feedback to:

$$i_d = \frac{i_1 R_1}{R_{SENSE}} \quad (15)$$

If this type of circuit is to be used for a class AB amplifier, the common mode input voltage range and the minimum output voltage of the operational amplifier need to be considered.

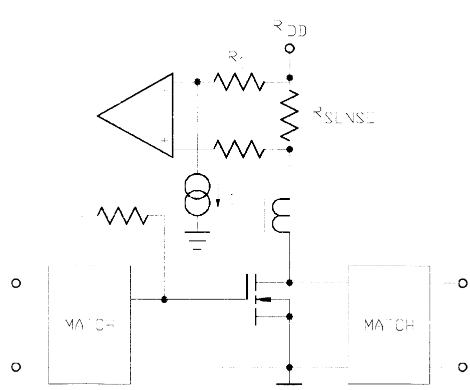

Figure 6

Conclusion

Although MOSFETs are not subject to thermal runaway in the same way as bipolar transistors are, at low quiescent currents, the temperature coefficient of gate voltage at constant drain current is negative. It is possible to compensate for this effect by using a temperature sensing device, such as a diode or thermistor, attached to the transistor flange. Feedback controlled bias circuits are primarily useful for Class A applications.

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Specifying RF Power Transistors

AN007

V2.00

Introduction

How you specify a transistor can have a large effect on its cost. It is of no use to load down a specification with process requirements or test parameters that add no value to the transistor.This application note is meant as a tutorial which can serve as a foundation for the decision making processes involved when designing a specification. To this end, various processes and testing issues will be addressed. The following discussions are formatted in the form of a manufacturing process traveler for ease of discussion.

Die Mount

For most high power RF devices die mount is achieved through the formation of gold-silicon eutectic bond, formed between the die and substrate. Early failure can occur during the operation of the device if there is excessive voiding under the active area of the die. Good die attach may be defined as having enough of a eutectic bond to give the die solid mechanical adhesion to the substrate and minimum thermal impedance. Various methods can be used to assure good die attach. The most common methods are die mount inspection, x-ray, die shear, delta Vbe, IR scan, and RF load pull (VSWR).

It is worth noting that x-ray will detect voids, but is somewhat subjective as to whether or not the voids are of adequate size to impede heat transfer from the die to the substrate. The true effect of a void on a device's thermal impedance depends not only on its size, but also on its location under the active area. Unless the x-ray is evaluated by an image processing computer program (time consuming and expensive) the interpretation of the x-ray is left to the person reading it, which adds to the subjectivity. The same thing can be said of die shear, which really only proves that the die had good mechanical attachment to the substrate (accurate void detection is difficult using this method). In addition it is destructive to the transistor. The most accurate tests are IR scan, followed by delta Vbe. Both of these methods detect poor thermal impedance quantitatively. Since IR scan is very time consuming, it is not practical to test each device, and is best done as an occasional monitor. Delta Vbe testing is faster, and is a practical monitor for the production line environment once testing parameters have been established. One concern with delta Vbe testing is specifying absolute limits. A number of variables can affect the results and cause good devices to exceed specified limits. The answer to this problem is to apply SPC methods. Should testing display undesirable trends, an IR scan can be done to verify results. The best method of detecting excessive voiding (both die mount and flange attach) is at RF test. Operating the devices into an output mismatch (all phase angles) will thermally stress the transistor to the point of destruction if the level of mismatch is chosen correctly. Excessive voiding will prevent adequate die heat dissipation and cause the device to go into thermal runaway.

Wire Bonding

For obvious reasons, any customer will want to be concerned with the quality of the bond wire attachment. This is best achieved through monitoring bond pull strength. The manufacturer should be monitoring the pull strength for each bonding process as part of their process control program. There is no reason why bond pulls shouldn't meet or exceed the military standard.

In - Process Inspections

Inspections can and should be performed by the personnel performing the operation. Too many QA inspections are inefficient and a sign that the company is trying to inspect quality into the product, rather than build it in. Emphasis for production personnel should be placed on process controls (i.e. SPC Charts) and the on-going inspection of their own workmanship. In addition to the on-going production inspections, the Quality Assurance Department guarantees compliance to all requirements via process auditing and sample inspections. This form of inspection also assures continuous improvement in the product quality.

One QA inspection point that should be required is pre-cap. After this step the devices are normally sealed, making further inspection of the components impossible.

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This step serves both the vendor and customer by detecting assembly defects that may have been missed previously. Though most manufacturers will have a pre-cap inspection as part of their process controls, it should still be specified as part of the procurement specification. An understanding of the inspection criteria will help in determining if any additional requirements need to be added.

Capping

The two common methods of lid attachment are epoxy and solder, each having certain hermeticity and temperature limitations. Knowing the environmental requirements of the application, as well as the transistor's environmental limitations can save a great deal of lead time should a different transistor package style be required. Note that 12 week lead times for ordering packages are normal. Should the new package RF parasitics be different, more development time will be required. The chart below will assist you as to which type of seal is appropriate for the anticipated environment.

LID MATERIAL	SEALANT	MELTING TEMP.	HERMETICITY LEVEL
CERAMIC	EPOXY	175°C	5 x 10^{-3} atm cc/s
	AuSn SOLDER	280°C	5 x 10^{-7} atm cc/s
SAPPHIRE	AuSn SOLDER	280°C	5 x 10^{-7} atm cc/s
METAL ALLOY (i.e. KOVAR)	AuSn SOLDER	280°C	5 x 10^{-7} atm cc/s

Flange Attach

Two of the most common flange materials used are charted below along with the appropriate solder type and its melting temperature. The user should be aware of several considerations concerning flange and solder combinations. The first consideration is the temperature rating of the solder. This temperature should not be approached again once the flange has been attached. Another consideration is if the flange is to be removed after device processing to solder the package directly into a module. Solder alloys like AuSn are very hard to re-flow (this requires going to a higher temperature), making flange removal difficult. In addition, the solder used to attach the flange needs to be compatible with the solder used to attach the device to the module.

FLANGE MATERIAL	SOLDER ALLOY	MELTING TEMP.
COPPER (PLAIN OR Au PLATED)	50/50 PbIn (LEAD-INDIUM)	180°C
	SN 60 (LEAD TIN)	183°C
TUNGSTEN-COPPER (TRADE NAME ELKONITE)	AuSn (GOLD TIN)	280°C
	50/50 InPb (LEAD-INDIUM)	180°C

High Temperature Storage

This process is a conditioning step prior to submitting devices to burn-in testing. Its main function is to stabilize DC parameters (i.e., Hfe) so the true parameter deltas can be measured after burn-in. Unless a post HTRB and/or burn-in delta measurement follows, this step adds no value to the transistor.

Temp Cycle (Thermal Shock)

Whenever high reliability is required, or extreme variations in temperature are expected, this process should be done on at least a sample basis. Temperature cycling will subject the devices to the temperature stresses that may cause mechanical failure in the field and during production processing. The specification should include temperature extremes that are not only representative of what the devices will see in the field, but what the assembly processes are designed to withstand. This is a good point in the assembly process at which to check the compatibility of the lid, flange, and package solder combinations during the initial qualification.

Acceleration

For most applications there is little, if any, benefit from accelerating devices. The exceptions are applications where a great deal of acceleration will be experienced (i.e. space). The mass of a bond wire is too small to be affected by the acceleration levels seen in most applications. Acceleration was probably more meaningful in the early days of transistor processing. Today however, it is very rare to see devices suffer mechanical failure due to stresses induced by common acceleration levels. This is due to the maturity of the metalization systems and bonding technologies currently in use. Unless it is required by the MIL spec, acceleration should be omitted from the specification whenever possible as it adds no value to the transistor.

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PIND (Particle Impact Noise Detection)

For applications where unpassivated die is used and device replacement is nearly impossible (i.e. space applications), the inclusion of this test in the specification is a good idea. For less critical applications and also where passivated die is used, the test adds no value to the transistor. Failures induced by loose particles are rare. In addition, most pre-cap inspection procedures have criteria that will reject devices having the potential to develop conductive particles (i.e. slivers on bond wires, chips on the die).

Fine Leak

Fine Leak and Gross Leak test the hermeticity of a sealed cavity. In the Fine Leak test helium is forced under pressure into the package via any holes in the sealant material or package. The package is then placed into a helium detector under negative pressure. Naturally, if there is any helium in the package cavity, it will escape and be detected. The Fine Leak test will not detect all non-hermetic devices. Specifically, if the seal has a large hole, the helium will escape before the device can be placed into the leak detector. This is why Fine Leak testing is always followed by Gross Leak testing. The customer will have to be the judge of hermeticity requirements. If the application exposes the transistor package to an environment that requires a hermetic seal, then it should be tested. Whether both Fine Leak and Gross Leak are tested or only Gross Leak depends on the level of hermeticity required in the final application.

Gross Leak

The Gross Leak test can be done in any one of several ways, all of which are similar. One process involves enclosing the devices in a vacuum chamber, which draws out all the air. Indicator fluid is then added under pressure. Any packages with holes will then fill up with the fluid. Devices are then placed into a viewing chamber containing an inert hot liquid medium. The heat causes any of the indicator fluid trapped in the package cavity during the soak to expand and escape. An operator viewing the devices will witness bubbles escaping the package and reject the device. A more cost effective method is to place the devices into the viewing chamber and simply rely on air escaping any holes in the package, which will also be witnessed as bubbles. This method is also very reliable and is frequently used for applications where military standards are not imposed. If hermeticity is to be tested per MIL standard, the former method must be used.

DC Test

Volumes can and have been written on this subject. Specifying DC parameters is a true art. Over-specifying can be like painting yourself into a corner. Overly tight specifications will impact not only wafer fab yields, but prevent the fabrication department from optimizing their process. This is because wafer processing requires a balancing of nearly all the DC parameters. One example is that to achieve a certain Hfe, BVceo would have to be lowered. Since a transistor would not normally go into a BVceo condition during Class C operation, it would make no sense to force what could be an undesirable trade-off by specifying BVceo. On the other hand, not maintaining tight control on key parameters can result in undesirable RF performance. Either extreme can hurt the consumer as well as the manufacturer. It is very important to determine up front which parameters are key to performance in the application. Whenever there is doubt about the importance of a parameter, have it measured and recorded for information purposes only. Should an undesirable trend be traced to a particular DC parameter it will be possible to go back and impose specification limits.

Capacitance

Once the transistor design has been agreed upon, capacitance should not need to be specified by the customer. The controlling factor in the specification is the RF test circuit and it will be up to the transistor manufacturer to meet this requirement. Some exceptions may occur when the application is an oscillator circuit, or when the RF test circuit is narrow band but the application is broadband.

HTRB & HTGH (High Temperature Reverse Bias / Gate Bias)

For bipolar transistors this is a BVces test, for FETs this is a Vgs or Vds (as applicable) test. The test is performed at 80-85% of the rated breakdown voltage and at an elevated temperature, usually greater than 150° C, to simulate an operating junction temperature. Normal test duration is 48 hours. The purpose of these tests is to verify the absence of mobile ions in the device and to verify the purity of the various oxide layers present in the transistor

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chip. Pre- and post- test leakage current delta is the parameter that is measured to verify this purity.

Burn-In (Operational Life Test, Forward Bias)

This test is done with the device in a forward bias condition. The voltage and current are adjusted until the transistor die achieves a pre-determined junction temperature. Like HTRB, this test is used to judge the integrity of the transistor junctions (collector to base for bipolars, drain to source for FETs), and eliminate devices that may have a less than average mean time to failure rate. The normal duration of burn-in for 100% screening is 160 hours. When Group B or C testing is required, the test duration can be anywhere from 160 hours to 1000 hours. Burn-in failures tend to occur either in the first few hours, or after a few hundred hours. Failure rates tend to be low during the middle of burn-in. For this reason it makes good sense to perform an extensive burn-in (≥340 hours) as part of the initial qualification of any high reliability program. Thereafter a 160 hour burn-in should be adequate. An economical alternative to performing 100% burn-in on all production lots is to include it as part of each wafer qualification. This will assure that nothing has gone wrong with wafer fabrication, which is the real concern here. Just as in HTRB testing, the appropriate DC leakage current deltas should be specified as a minimum.

RF Testing

This is a subject worth its own application note. Let us stress that it is important that the RF test circuit and test conditions represent the application. Remember the RF test circuit will exert a great deal of influence over various transistor parameters. An investment in the quality of the RF test circuit is an investment in the quality of the transistor performance. It is important that the transistor application be well understood so that key performance parameters can be identified and specified from the beginning. Understand what the device can do, and what variances in performance are to be expected before completing the design. Do not base a final design on too small a sample size. Whenever possible get samples that represent several different wafer fabrication runs. Build specifications around devices that represent performance levels common to the die type. Avoid specifications that add no value to the transistor.

Typical Screening Requirement

The charts below were originally generated in response to customer inquiries and present three levels of device processing. "Commercial" screening is the minimum acceptable level required to ensure a quality product. The next level, "Military Screening", is available for applications that may be non-military yet demand a higher level of screening. The third chart is a list of available screening and testing capabilities for M/A-COM's power transistors.

COMMERCIAL SCREENING

TEST	METHOD
WAFER PROBE	M/A-COM AUTO PROBE SPEC
WAFER QUALIFICATION	M/A-COM PRODUCT SPEC.
BOND STRENGTH	Q0058 (production monitor)
PRE-CAP VISUAL INSPECTION	Q0015
GROSS LEAK	100%, (NO VACUUM SOAK)
DC ELECTRICAL	TP0187
RF ELECTRICAL	PRODUCT SPEC.
FINAL INSPECTION	Q0056 PROD. LOT SAMP.

MILITARY SCREENING

TEST	METHOD
WAFER PROBE	M/A-COM AUTO PROBE SPEC
WAFER QUALIFICATION	M/A-COM PRODUCT SPEC.
DIE VISUAL	M/A-COM SPEC Q0015, MIL-S-750 / 2072
DIE MOUNT X-RAY	M/A-COM SPEC Q0039 (non-brazed flanges)
BOND STRENGTH	MIL-S-750 / 2037 (prod. line monitor)
PRE-CAP VISUAL INSP.	M/A-COM SPEC Q0015, MIL-S-750 / 2072
HIGH TEMP. STORAGE	MIL-S-750 / 1032
THERMAL SHOCK	MIL-S-750 / 1051
CONSTANT ACCELERATION	MIL-S-750 / 2006
FINE LEAK	MIL-S-750 / 1071
GROSS LEAK	MIL-S-750 / 1071
INTERIM ELECTRICAL	M/A-COM SPEC TP0187
HTRB (BIPOLAR)	MIL-S-750 / 1039
HTGB (MOSFET)	MIL-S-750 / 1042
DC ELECTRICAL	M/A-COM SPEC TP0187
RF ELECTRICAL	M/A-COM PRODUCT SPEC
FINAL QA INSPECTION	M/A-COM SPEC Q0056

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SCREENING / TESTING CAPABILITIES

TEST	METHOD
WAFER PROBE	M/A-COM AUTO PROBE SPEC
SEM WAFER INSPECTION	MIL-S-750 / 277
WAFER QUAL	M/A-COM PRODUCT SPEC PER S.C.D.
DIE VISUAL	M/A-COM SPEC Q0015 MIL-S-750 / 2072
DIE MOUNT X-RAY	M/A-COM SPEC Q0039 (non-brazed flanges)
BOND STRENGTH	M/A-COM SPEC Q0058 MIL-S-750 / 2037
PRE-CAP VISUAL	M/A-COM SPEC Q0015 MIL-S-750 / 2072
HIGH TEMP STORAGE	MIL-S-750 / 1032
THERMAL SHOCK	MIL-S-750 / 1051
CONSTANT ACCEL	MIL-S-750 / 2006
PIND	MIL-S-750 / 2052, 883 / 2020
FINE LEAK	MIL-S-750 / 1071
GROSS LEAK	MIL-S-750 / 1071
INTERIM ELECTRICAL	M/A-COM PRODUCT SPEC PER S.C.D.
HTRB (BIPOLAR)	MIL-S-750 / 1039
HTGB (MOSFET)	MIL-S-750 / 1042
BURN-IN	M/A-COM SPEC TP0067 / TP0168
DC ELECTRICAL	M/A-COM SPEC TP0187 PER S.C.D.
RF ELECTRICAL	M/A-COM PRODUCT SPEC PER S.C.D.
FINAL QA	M/A-COM SPEC Q0056 MIL-S-750 / 2071
GROUPS A, B, & C TESTING	MIL-S-19500

Conclusion

A quality specification will ensure the procurement of a quality product. Choosing the correct test parameters and processes are key to efficient procurement. Working closely with the vendor's engineering and quality departments will help to identify which processes, parameters and limits are appropriate and which add no value to the product. Approach the specification process with the creativity it deserves, and the results will be rewarding.

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MOSFET Capacitance Measurements

AN008

V2.00

MOSFET Capacitance Measurements

By convention, MOSFET capacitances are reported in the data sheets as the input capacitance C_{ISS}, the output capacitance C_{OSS} and the reverse capacitance C_{RSS}. The purpose of this note is to explain how these parameters relate to the physical capacitances in the MOSFET and to describe the techniques for measuring them.

Figure 1 shows the three internal capacitances and their relation to the physical transistor.

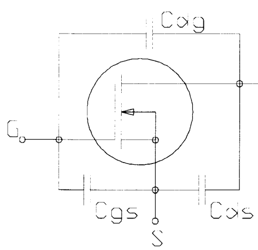

Figure 1: MOSFET Capacitances

C_{ISS}, C_{OSS} and C_{RSS} are related to the three internal capacitances by the following simple formulas:

$$C_{dg} = C_{RSS}$$
$$C_{ds} = C_{OSS} - C_{RSS}$$
$$C_{gs} = C_{ISS} - C_{RSS}$$

The easiest of the three to measure is the output capacitance, C_{OSS}. A schematic is shown in Figure 2.

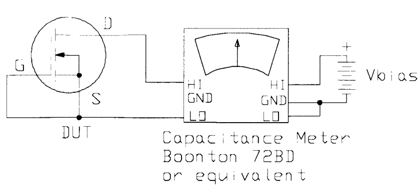

Figure 2: C_{OSS} Measurement

The voltage V_{bias} is stated in the data sheet. Graphs which show the relationship between capacitance and V_{bias} may also be provided.

The measurement of the reverse capacitance C_{RSS}, is similar but the source is grounded:

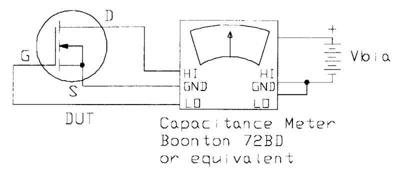

Figure 3: C_{RSS} Measurement

Note that C_{RSS} is a three terminal measurement. This requires a capacitance meter with three input terminals: High, Low, and Ground. If the source is not connected to the guard (i.e., the ground terminal), an erroneously high reading for C_{RSS} will result because of the effect of the gate-source and the source-drain capacitances.

The input capacitance, C_{ISS} is the most difficult to measure because it requires extra components to provide the bias. The inductors should represent open circuits at the measurement frequency. (A choke that is self-resonant at the measurement frequency is ideal.) The capacitor should be an AC short at the measurement frequency which is specified on the data sheet.

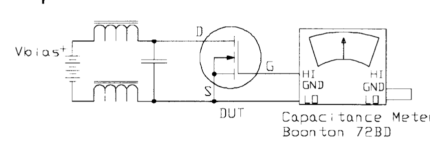

Figure 4: C_{ISS} Meaurement

Some MOSFETs have internal matching networks that prevent the direct measurement of C_{ISS}. There are two ways to handle this. One method is not to specify C_{ISS}, just C_{OSS} and C_{RSS}. The other method is to add the shunt input matching capacitor value to the chip C_{ISS} and report that number on the data sheet. The data sheet indicates which technique was used.

If you are interested, Application Note AN002: RF Power MOSFET SPICE Models, has more information on the physical modeling of the MOSFET capacitances.

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How to Avoid Getting Burned By Junction Temperature

AN009

V2.00

Introduction

M/A-COM MOSFET and bipolar transistors have several thermal specifications listed in the data sheets. The purpose of this brief note is to explain these specifications, how they are measured and how to use them for reliable thermal design. While there may be differences of opinion about failure mechanisms, everyone agrees that transistor failure rate is proportional to the temperature of the active area or junction, hence the need for accurate thermal design.

Thermal Model of the Transistor

Figure 1 shows a simplified drawing of a typical transistor. Most of the heat generated by the transistor comes from the junction in the top 5 microns of the silicon chip. To cool the junction there must be a low thermal resistance path to the heat sink and the outside air. Attention must be paid to all of the materials and interfaces (regions where two materials join together) in the path of the heat flow. Just like a series electrical circuit, if there is one high resistance component in the path, the heat flow will be impeded and the junction temperature will increase. That is why RF power transistors are made of materials with high heat conductivities: gold, beryllium oxide and copper or copper loaded tungsten (also known as Elkonite).

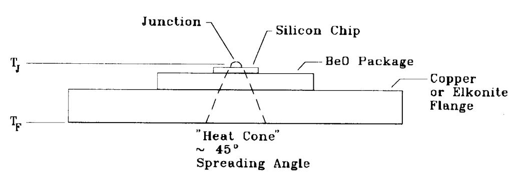

Figure 1: Simple Thermal Model Transistor

The major portion of the heat flow occurs in the heat cone spreading out in an approximate 45° angle as it flows from the junction to the bottom of the flange. At any vertical point the hottest temperature is found at the center of the heat cone. Of course, transistors with multiple cells and chips have many heat cones that interfere with one another and complicate the temperature distribution, but the principal is the same. It is important to note that the hottest flange temperature will be centered underneath the device in the middle of the flange.

Measurement Methods

Measuring the temperature of the transistor junction under RF operating conditions is not an easy task. There are several methods available, but the most common way is to measure the peak (i.e. the hottest spot across the die) junction temperature under actual operating conditions by using an infrared microscope to thermally scan the active transistor. Refer to Application Note #AN003, "Infrared Method of Measuring Thermal Resistance", for more information on this procedure. This is the method that is used to generate the thermal resistance numbers reported in the data sheets.

Measuring the flange or case temperature is usually straightforward. On devices which dissipate less than 20 W of average output power, little error is introduced by attaching a thermocouple to the flange at the screw hole location. However, for devices which dissipate larger amounts of power, a hole must be drilled in the heatsink or flange for the insertion of the thermocouple so that it may be physically located at the hottest position as described in the previous section. It is very important to have a correct value for the flange temperature to calculate the thermal resistance accurately.

Junction Temperature and Thermal Resistance

The thermal resistance is one of the most important thermal specifications on the data sheet and it is measured in degrees Celsius per watt (°C/W). There are several ways to define the thermal resistance, but M/A-COM reports the thermal resistance from junction to case, or θjc. In other words, for every watt the transistor chip dissipates, the temperature of the junction will be θjc degrees above the flange temperature.

It is time to consider a typical transistor to assist us in describing these various specifications. Figure 2 shows an RF MOSFET transistor that has an output power of 20W CW and an efficiency of 50%.

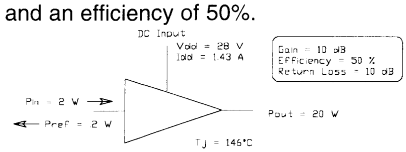

Figure 2: Typical Transistor

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What is the thermal resistance of this transistor?

First we calculate the dissipated power:

$$P_{DISS} = P_{DC} - P_{OUT} + P_{IN} - P_{REF}$$

$$P_{DISS} = (28.0V \times 1.43A) - 20W + 2W - 0.2W$$

$$P_{DISS} = 21.8W$$

Next we calculate the junction temperature rise above the flange temperature. Let us assume that the peak junction temperature of the chip was measured under operating conditions by an infrared microscope and found to be 146°C. The flange temperature is measured with a thermocouple attached to the hottest part of the flange.

$$T_{JC} = \text{(Peak Temperature of the Junction)} - \text{(Flange Temperature)}$$

$$T_{JC} = 146°C - 85°C$$

$$T_{JC} = 61°C$$

Now it is easy to calculate thermal resistance:

$$\theta_{JC} = T_{JC} \div P_{DISS}$$

$$\theta_{JC} = 61°C \div 21.8W$$

$$\theta_{JC} = 2.8°C/W$$

Absolute Maximum Junction Temperature

M/A-COM recommends that a device's junction temperature should not exceed the absolute maximum value as specified in the data sheet. This value is typically 200°C for both MOSFET and bipolar devices.

Using the methods given in the preceeding section, a device's worst case junction temperature may be calculated given the application's worst case power dissipation and flange temperature. Verification that this operation is within the limit of the maximum junction temperature specification will guarantee that the device will have a long and reliable life. It should be noted however, that such a device will not suffer a catastrophic failure when operated at 201°C! M/A-COM has had devices survive thousands of hours at 300°C junction temperatures during accelerated RF life tests. Just remember that operation above the Absolute Maximum Junction Temperature can shorten the life of the transistor.

Absolute Maximum Power Dissipation

The thermal resistance and absolute maximum junction temperature are used to calculate the absolute maximum power dissipation at 25°C:

First calculate the junction temperature rise at the maximum allowed dissipation:

$$T_{JC,\,MAX} = \text{Absolute Maximum Junction Temperature} - T_{FLANGE}$$

$$= 200°C - 25°C$$

$$= 175°C$$

The thermal resistance is used with the maximum rise to calculate the maximum power dissipation at 25°C:

$$P_D = T_{JC,\,MAX} \div \theta_{JC}$$

$$P_D = 175°C \div 2.8°C/W$$

$$P_D = 62.5W \text{ at } 25°C$$

For any other temperature above 25°C, you must use the derating factor of $1/\theta_{JC}$ to calculate the power dissipation. The dissipation decreases linearly from the data sheet value at 25°C to 0 watts at $T_{JC,MAX}$.

Safe Operating Area

Given the above information, plus two other numbers from the data sheet, one can calculate the Safe Operating Area (SOA) at 25°C. Using our example transistor from above, we find the absolute maximum voltage and absolute maximum current and use them with our absolute maximum power dissipation to graph the chart in Figure 3.

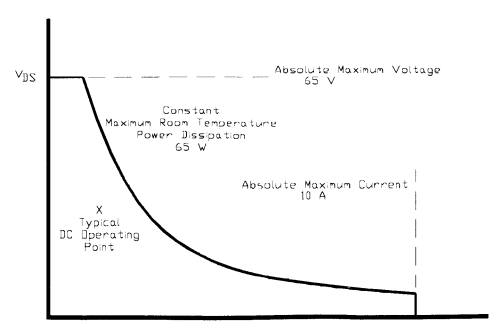

Figure 3: Safe Operating Area

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As you can see, the typical DC operating point is well within the SOA. However, unless you are designing a switching regulator or some other DC type circuit, most RF designers are not too concerned about the SOA of the transistor. VSWR, the next topic discussed, is usually of more concern.

VSWR

There is another factor to consider and that is the VSWR of the load. Any power reflected back to the transistor adds to the dissipated power. In addition, the actual DC operating point depends on the phase of the reflected signal. The best way to allow for this problem is to design in plenty of margin. How much margin depends on the application.

If the transistor has a circulator on the output, or if there is some other way to guarantee a good 50 ohm load, then you do not need much margin. If the device will be subject to relatively small amounts of mismatch during a tuning operation somewhat more margin is required. If your application is located at a remote site and consequently may have to operate for months in a soft failure mode with several failed transistors you need as much margin as you can afford. Of course, you should never exceed the output VSWR that is specified on the data sheet, or catastrophic failure may occur.

Application

So, what do you do with all this neat information? Once you know the operating conditions of your device, the worst case heatsink temperature and VSWR conditions, a check of the worst-case junction temperature is in order.

In the 20 W example transistor listed above, the 85°C flange temperature resulted in a 146°C junction temperature which is well below the 200°C limit. However, if we assume a long duration high VSWR load, the dissipated power may double for a long period of time. In that case the junction temperature rises to (21.8W x 2 x 2.8°C/W) + 85° = 207°. This number is slightly above the Absolute Maximum Junction Temperature. While the device will not fail catastrophically, operation for long periods under these conditions will shorten the lifetime. Engineering judgment should be used to determine the proper response. Possible responses may be to shorten the duration of the VSWR, use a larger transistor or lower the heatsink temperature.

Summary

The purpose of this note was to acquaint you with the thermal specifications of M/A-COM MOSFET and bipolar transistors and their application.

Thermal resistance or θ_{JC} is the temperature difference between the transistor junction and the case of a device that is associated with a power dissipation of 1 watt. θ_{JC} is specified in °C/W.

Absolute maximum junction temperature is the maximum junction temperature for safe, reliable operation.

Maximum power dissipation is the maximum power that can be dissipated in the device, with the case at 25°C, while keeping the junction temperature below the absolute maximum.

Use of these numbers and the procedures outlined will enable you to design units that can maintain reliable temperatures under the most extreme conditions.

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Designing Multi-Octave MOSFET Power Amplifier Circuits

AN010

V2.00

Introduction

This note describes the design of a 300 watt 1-200 MHz FET amplifier. This represents a bandwidth of over 7 octaves. The emphasis is on methods of using the characteristics of RF power Silicon MOSFETs to achieve the desired performance. A 500 watt amplifier containing two of the 300 watt circuits combined with a 50 ohm 180° hybrid power combiner is briefly described.

The 300 watt and 500 watt amplifiers were developed as test and demonstration vehicles for the 300 watt transistors and were built using breakaway construction, a high power version of the breakaway circuits and matching impedance launchers which are described in Application Note #AN001.

Numerous factors must be considered during design of high power FET amplifiers. These include:

1. Stability
2. Use of feedback for gain sloping, stability or impedance matching
3. Output matching for efficiency and saturated power
4. Input match
5. Power supply voltage
6. Transformer design
7. Common mode impedances
8. DC gate and drain bias
9. Thermal design

The basic design steps are as follows:

First, determine the gain and power achievable at the high end of the band by matching input and output impedances, then determine the real source and load impedances required to obtain this performance at the lower band edge. These low frequency values must be obtained by broadband matching transformers. Reactive matching is then used to match the transistor impedances at the high frequencies to the impedance of the matching transformers. The transformers must be designed with sufficient flux handling capability to avoid saturation at the lowest frequency and highest power and must have low parasitics and good thermal capability.

Stability

VHF MOSFETs are generally not unconditionally stable. S-parameters, which could be used to evaluate stability, being of limited usefulness for power amplifier design, are generally not provided by the manufacturer. Instabilities (other than those caused by external feedback) generally occur when source and load impedances are highly inductive. This is because both the internal feedback (C_{RSS}) and the input impedance are nearly pure capacitances. Together they form a capacitive voltage divider with no phase shift. At low frequencies, transit times are negligible and feedback is negative. An inductive source impedance introduces phase shift in the feedback path by resonating with the input capacitance. An inductive load impedance provides additional phase shift.

In push-pull amplifiers, instabilities sometimes occur in the common mode. This is because differential mode impedances will of necessity be well controlled to obtain good amplifier performance, but common mode impedances may be overlooked. The high input impedance of the FET at low frequencies makes it easy to provide a resistive common mode source impedance without adversely affecting circuit performance.

Avoiding highly inductive impedances in both the common and differential modes is generally sufficient to guarantee stability. Additional margin can be obtained by using a shunt feedback resistor. It can be of a value that does not affect in-band performance, and parasitics are not critical because it is important only at low frequencies. In the present design, feedback resistors are used, but the amplifier is stable without them except at very low drain voltage (less than 5 volts) where the nonlinear C_{RSS} is large.

Voltage Selection

Assuming transistors of any desired voltage rating are available, several factors may be considered in selecting an operating voltage. As is well known, optimum output impedance of either a FET or bipolar transistor is determined by the power supply voltage, the operating power level and output capacitance. Unless the capacitance dominates, the impedance increases as the square of the

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power supply voltage at any given power level . This favors higher voltages at the higher powers. In addition, a high voltage reduces the current requirement, usually an advantage.

The high frequency rolloff of a FET is determined by an RC time constant; the product of the load impedance and the FET's output capacitance C_{OSS}. Although C_{OSS} decreases somewhat as the voltage capability of a transistor increases, the increase of optimum load impedance with voltage dominates, so that in any given technology, higher voltage parts will have somewhat less bandwidth. For the present amplifier, a 50 volt operating level allows the use of 4:1 output transformer, and the bandwidth of the 50 volt VHF transistor is sufficient to meet the 200 MHz requirement.

Output Impedance

The solid curve in Figure 1 shows optimum load impedance for the 300 watt VHF transistor. For most of the band, it is real and given by the well known equation

$$R_L = \frac{(V_{dd} - V_{sat})^2}{2P_o} \quad (1)$$

where V_{sat} = RF saturation voltage
P_o = output power level
V_{dd} = Supply voltage

(For a push-pull transistor the equation may be applied to one side of the part, or the total power may be used, and the resulting load resistance should be multiplied by 4 to obtain the required balanced load resistance).

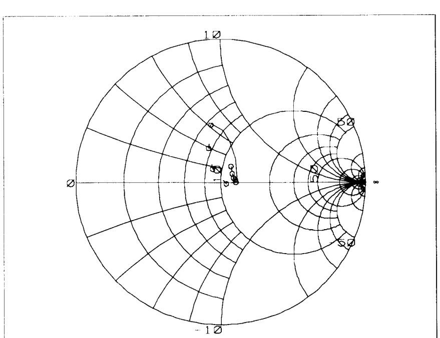

Figure 1

The required 12.5 ohm load is provided at low frequencies by a 4:1 transformer. A single low pass L-C section matches the transistor to the transformer at 200 MHz as shown by the broken line in Figure 1. (A two section match would greatly increase circulating currents, a significant factor at 300 watts, with only a small improvement in matching.)

Input Match

The solid line in Figure 2 shows input impedance of the device. The impedance can be made more manageable in one of two ways:

1. Feedback
2. A swamping resistor

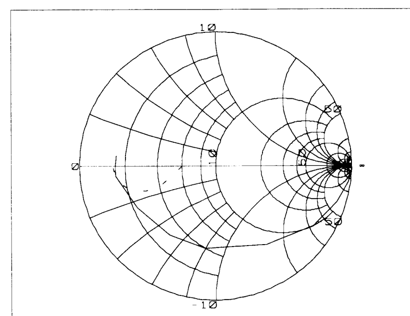

Figure 2

Using feedback to control the impedance would require a very broadband, high ratio transformer to provide sufficiently low impedance to affect the input without excessive loading of the output and very high power dissipation. Parasitics and delay could be serious problems, and this approach was not attempted.

A swamping resistor connected directly between the gates of the push-pull transistor provides frequency independent input impedance and flat gain, provided it is small compared to the transistor input impedance. The flat gain and well defined input impedance occur because input power is being matched into the resistor and the FET is amplifying the voltage across the resistor, while absorbing a negligible amount of drive power. Gain is substantially below that of the transistor itself and is given by

$$\frac{P_{out}}{P_{in}} = G_m^2 R_L \bullet R_S \quad (2)$$

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where

G_m = transconductance

R_L = load impedance (real)

R_S = swamping resistance

If the swamping resistor is made smaller than the FET input impedance even at the highest frequency, gain will be sacrificed. The solution is to determine the matched power gain available at the upper band edge, and select a swamping resistor that provides this same gain at low frequency.

The RF2280 FET used in this amplifier can provide approximately 17 dB of gain at 300 watts when tuned at 200 MHz. A design goal was to achieve this gain across the band. From equation 3, for 17 dB gain, the required swamping resistor is 6.0 ohms.

$$R_S = \frac{G_p}{G_m^{\,2} \bullet R_L} \qquad (3)$$

R_L = load line resistance from equation (12.5 ohm)
G_p = required power gain
G_m = transconductance
R_S = 6 ohms for 17 dB gain

The measured input impedance of the transistor at 200 MHz is well below 6 ohms, so the gain loss at 200 MHz due to the resistor is insignificant. An inductor in series with the swamping resistor further reduces this loss by effectively removing the resistor at 200 MHz.

As shown in Figure 2 by the broken line, the input impedance of the RF2280 FET with a 6 ohm resistor across the gates is far more manageable than the original FET input impedance, and the power gain is constant when input power is matched to this characteristic.

Transformer Design

Figure 3 shows the 300 watt circuit configuration, which uses coaxial transformers for broadband performance.

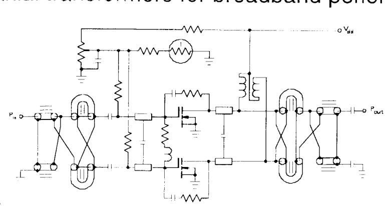

Figure 3

Optimizing the bandwidth of high power matching transformers and baluns consists of minimizing low frequency shunt leakage flux while keeping ferrite losses low and the transmission lines short to avoid high frequency problems. The ferrite needs to have sufficient flux capacity and also needs to be well heat sinked.

The shunt leakage inductance of a coaxial transformer is the inductance of the coaxial shield due to flux outside the coax. Calculating the leakage inductance of a cable passing through a ferrite bead is analogous to calculating the inductance of a coaxial line.

$$L = \frac{\ell\mu}{2\pi}\,\ell n\left(\frac{r_o}{r_i}\right) \qquad (4)$$

where ℓ = length of bead

μ = permeability

r_o = effective outer radius of ferrite

r_i = inner radius of ferrite

(A high permeability ferrite is assumed so that only the magnetic flux in the bead is significant.)

A ferrite configuration that provides both high inductance and good heat sinking capability is shown in Figure 4. This core shape provides 2.5 times the inductance per unit length of a conventional bead due to the high ratio of outer diameter to inner diameter. It also has flat surfaces through which heat may readily be removed.

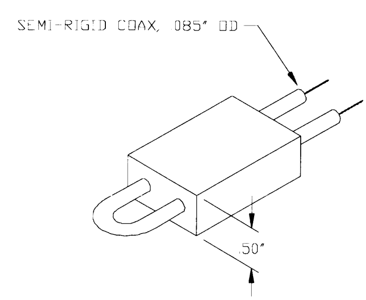

Figure 4

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The flux carrying capacity at a given maximum field strength is:

$$\Phi = \frac{\ell \bullet \beta_m}{r_i} \bullet \ell n\left(\frac{r_o}{r_i}\right) \qquad (5)$$

β_m = maximum magnetic field strength

ℓ = length of core

The maximum flux density at 300 watts and 1 MHz is 1400 Gauss. This occurs only in a very small volume, and the average flux density is much lower, again because of the high ratio of effective outside diameter to inside diameter.

The output transformers are mounted to a recessed area in the baseplate so that the coaxial lines are at circuit board height. This minimizes the portion of the coaxial transmission line that is not surrounded by ferrite.

Ferrites of different permeability from 40 to 10,000 were evaluated for this application. Ceramic Magnetics CMD5005 (μ_i = 1200) was selected for its high permeability coupled with low loss at 200 MHz. An alternate material, MN60LL (μ_i = 10,000) showed surprisingly low loss at 200 MHz in spite of its high permeability, but was not further evaluated.

In the 300 watt amplifier (Figure 3), the output match consists of a balanced 4:1 transformer followed by a 1:1 coaxial balun. Reference[1] describes in detail how to compensate this type of transformer for low and high frequency parasitics. However in this case, no low frequency compensation was required. Small capacitors across the low impedance side of the transformer were all that was required to achieve better than 1.1:1 VSWR from 1 MHz to 200 MHz. Loss was 0.1 dB when measured at low level.

The input match is a 9:1 unbalanced to balanced autotransformer. Because of the lower power level and less critical impedance requirements, ferrite beads are used rather than rectangular blocks.

DC Bias

Drain voltage is not applied at the mid-point of the output transformer because the resulting DC current would saturate the transformer core. Instead, a separate twisted-pair balun is used. Here, a low μ core could be used, but we chose to use the same CMD5005 material used elsewhere. Air gaps were sawed in the ferrite beads to prevent saturation due to any current imbalance in the push-pull amplifier. Using beads of lower μ material would have the same effect. The beads are enclosed in an aluminum casing for cooling.

Thermal Design

The 300 watt transistor has a very low thermal impedance of 0.3°C/watt. To take advantage of this characteristic requires an excellent interface to the heat sink. Soldering the flange to the heat sink is highly desirable. To permit evaluation of alternate configurations and mounting techniques, a breakaway design with separate input match, output match, and transistor sections was built. The breakaway concept and its use in measuring large signal device characteristics is described in Application Note #AN001. For this application, the center, transistor section is copper and can be water cooled if desired. Transistors may be clamped or soldered to the heat sink and changed without disturbing the matching circuits. Single ended and common mode circuit impedances may be measured by replacing the transistor section by a suitable microstrip launcher.

The ferrite of the matching transformers is bonded directly to the metal base plate with thermally conductive epoxy. Gate bias is temperature compensated using a thermistor circuit like that is described in Application Note #AN006. The temperature sensing thermistor is clamped to the transistor flange.

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300 Watt Amplifier

Performance of the single transistor 300 watt amplifier is given in Figure 5. Efficiency is 50 to 60%, and saturated power is up to 400 watts. Flat gain from 1 MHz to 200 MHz was achieved without sacrificing the gain available from the part at 200 MHz. Worst case input return loss was 8 dB, and occurred near 100 MHz, in the transition region between low frequencies, where equation (2) is valid, and the high frequency limit, where the input is matched for power transfer. This return loss can be improved by using a more complex matching network, or by selecting a smaller swamping resistor, reducing broadband gain but making the variation of input impedance with frequency much smaller.

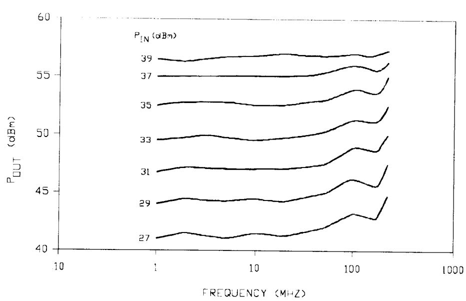

Figure 5

500 Watt Amplifier

The two 300 watt amplifiers are combined by the 50 ohm hybrid shown in Figure 6. The combiner consists of a 180° hybrid with a 25 ohm sum port and a 4:9 equal phase transformer. (Using a 4:9 transformer ratio instead of 1:2 causes a 1.12:1 VSWR but makes possible the use of an equal phase coaxial transformer, necessary for this bandwidth.) Isolation between the amplifiers is provided by a 25 ohm difference port termination.

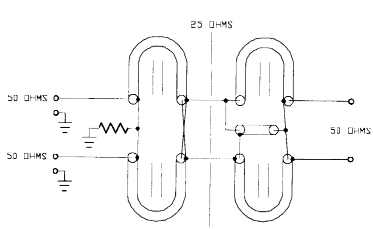

Figure 6

The combiner has a peak flux density of 1000 Gauss at 1 MHz and 600 watts, less than the flux in the matching transformers. The entire outer surfaces of the ferrite cores are bonded to the aluminum case with thermally conductive epoxy. The power splitter is of the same electrical design, but power is lower and heat sinking is less critical.

The driver stage is quite straightforward. The output match consists of a 1:1 balun with a single section reactive match to compensate for C_{OSS} of the driver, while the input is essentially the same as that of the power amplifiers.

Figure 7 shows broadband performance of a demonstration amplifier consisting of two power combined 300 watt amplifier stages and a driver stage.

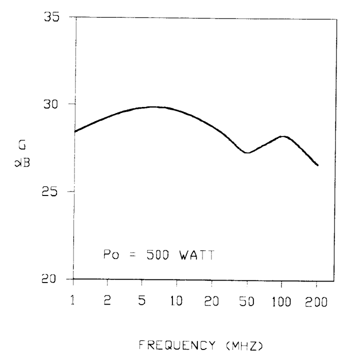

Figure 7

Acknowledgment

The transistors and demonstration circuits described here were developed for the U.S. Army CECOM, Vint Hill Farms Station under Contract #DAAL02-85-C-0159. The technology developed is used in a broad line of RF power MOSFETs.

1 Jerry Sevick, W2FMI, Transmission Line Transformers", American Radio Relay League 1987

Authored by William Leighton, Senior Principal Engineer

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Device Hermeticity

AN011

V2.00

Introduction

Webster's dictionary defines hermeticity as "airtight-impervious to external influence". In the semiconductor component world this is translated to mean the effectiveness of the seal of a semiconductor device with internal cavities to outside environmental conditions.

This application note will broadly lead you through the methods of test that M/A-COM uses to both achieve compliance with MIL-STD, Method 1071.2 and MIL-STD-883, Method 1014 and to manfacture reliable, cost effective products. An outline of the different sealing options available at M/A-COM will also be given.

Why Ask For Hermeticity Testing?

Why should we want a RF/microwave semiconductor component to be hermetic? The reason lies in the very nature of the geometry of the active transistor die and capacitor die, and the associated necessary construction techniques used to assemble them into devices that will operate at RF/microwave frequencies with high speed and power. The die, wire-bond and package metallization geometries involved are all very small. Conductive particles must not be allowed into the hermetic cavity due to the possibility of shorting across any of these geometries. Corrosive material must not be allowed into the hermetic cavity for the obvious possible deleterious reasons. Contaminating ions and all of their potential source materials must be prevented from entering the active transistor die junction, therefore affecting the transistor's active performance characteristics. Any of these actions can result in a reduction of electrical performance and possible catastrophic failure over either short or long time spans. Therefore, the active devices are sealed using many different methods designed to keep this hostile world out.

The type of materials and the corresponding sealing process chosen for a particular component depends on many factors:

1. The end use and its requirements. Is it military or commercial?
2. Is there an acceptable level of failure? What is the level of redundancy built into the system? Can the device be easily replaced should a failure occur? Is the component designed for space use where a failure could shut down an entire mission?
3. What are the cost factors? Is there a price target that drives you towards certain manufacturing methods?
4. What are the environmental conditions that the device must be able to withstand?

All these factors must be considered at the start of the design stage. Otherwise a hermeticity design failure may be found later when a device sealing/package redesign may be costly in time and money.

Hermeticity Testing Methods

Hermeticity itself is defined in terms of a leak rate through an opening in a cavity: a leak path. A standard leak rate is defined as that quantity of air at 25°C in atmosphere cubic centimeters per second (atm cm^3/s) flowing through a leak path when the high pressure side is at 101.3 kPa (1 atmosphere) and the low pressure side is at a pressure of not greater than 133 Pa (1mm Hg absolute). A measured leak rate is defined as the leak rate of a given package under specified conditions and employing a specified test medium.

There are basically two levels of leak rate that most companies and the MIL-STD's refer to. These are gross leak and fine leak.

The gross leak test by its very name is the less stringent of the two. The hole/leak path that is measured is relatively large which allows for a leak rate up to 5×10^{-3} atm cm^3/s. This can be measured in many ways. The following are available at M/A-COM.

The first method we shall discuss and that which is most commonly used at M/A-COM is the fluorocarbon gross leak. This method is based on the fact that the material in an enclosed cavity under temperature will expand. If there

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is a leak path in the seal any gas/fluid inside will be forced out. This escape indicator can be viewed in another fluid as a stream of bubbles. You could use plain heated water but this could potentially damage the device and is not allowed by the MIL-STD's; instead, an inert fluid is used. This has the property of heating up uniformly at temperatures over 100°C and also, by virtue of being inert, does not cause any potential electrical dangers to a good device. Such fluids are known as type I fluids. There are different type I fluids available but for this discussion we shall not go into their pro's and con's. In this case the bubbles seen are air bubbles.

Should a greater sensitivity be required then the indicator medium is changed to a sister fluid that has a slightly lower boiling temperature. This indicator fluid is forced first through any available leak paths into the device's cavity under a sequence of vacuum and pressure in a preconditioning stage. When the device is placed in the heated detector fluid the resulting bubbles now consist of the lower boiling point fluid. This addition of fluid extends the detection range of the gross leak method because this indicator fluid has a molecular size in the same size range as the leak paths.

The other two methods available at M/A-COM are less favored as a method used in a continuous production testing environment. These are the die penetrant test and the weight gains test.

The die penetrant is useful only in failure analysis where the exact location of the leak path needs to be found. This method involves a fluorescent dye that is forced under pressure into the cavity via any leak paths. Leak paths can then be viewed by looking for entrapped dye in that leak path under an ultraviolet light and microscope. For greater accuracy the device may be delidded and, under the UV light, any dye inside the cavity can be traced back to the leak path. This method is messy and may not always give you a true answer as it depends on the porosity of the package construction of the device. A porous material will absorb the dye, leaving you with a bright flow, and no idea where the true leak path is.

The weight gains method is often used as a back up to the other gross leak methods. It is very time consuming and is generally not used in production. Basically the devices weight is measured before and after a pressure stage in an indicator fluid. Should the device have a leak path there will be a weight gain due to the addition of the fluid in the cavity. This method is simple on large devices but with the very small size of most semiconductor devices it can be arduous to measure small weight changes accurately.

The preconditioning stage used in these various methods has different levels of pressure and soak and depends on the internal cavity size of the package. Details of this can be found in the MIL-STD's.

Another gross leak method that is becoming available, and is currently under evaluation, is the fluorocarbon vapor detection system which uses the same indicator fluid as the gross leak method, but the escaping heated vapors are detected in a dry test cell by a small mass spectrometer sensitized to these fluid vapors. This has the potential of being more accurate because the subjective viewing of escaping bubbles by the human eye is removed and replaced with a numerical pass/fail level. This method also has more potential of being automated.

The fine leak test method, as the name states, is designed to detect smaller leak paths. The indicator "fluid" used is the gas helium. Possessing a smaller molecular size, helium is better sized for detecting these smaller leak paths. The device under test goes through a similar vacuum/pressure cycle and is then transferred into a detector chamber, connected to a helium mass spectrometer, where a negative pressure is pulled. Should there be a leak path, and subsequently helium inside the device, then the helium escaping out of the cavity will be detected. The detector gives you a leak rate which can be calibrated to a pass/fail criteria. To fully test a device's hermeticity, should this be required, both fine leak and gross leak tests are required in order to cover the full range of possible leak paths sizes. A fine leak test will not detect a large leak path because the helium in the cavity will escape straight away in normal air pressure when the device is transferred to the helium detector chamber. This is due to the relative large size of the leak path compared to the small molecular size of the helium, therefore not allowing any helium entrapment in the cavity. Similarly, gross leak will not detect a small leak path due to the larger molecular size of the fluids used in gross leak; these cannot penetrate a small leak path and will give a false "pass" reading. The order of testing is always fine leak followed by gross leak because the gross leak fluid has the potential to block leak paths when the size of these paths are in the mid-size range which occurs at the sensitivity crossover region between the two methods and will result in an incorrect reading.

Radioisotope leak test methods are not used at M/A-COM and therefore are not discussed here.

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Sealing Methods Options

In order to meet the various leak rates the design of the sealing method must be carefully thought out. Apart from the level of hermeticity required, the physical construction of the package must also be taken into consideration. This construction is dictated by the electrical design and mechanical/environmental configuration.

The different sealing methods presently available are:

1. Metal lids for packages with high temperature solder seal. The metal lids with the solder seal are designed for a multilayer ceramic package where the package has a gold plated seal area. These will enable you to pass the highest level of hermeticity and environmentalprotection.

2. Ceramic lids for packages with high temperature solder seal.

   The ceramic lid will give you the same levels but depends on the porosity rating of the ceramic for it's fine leak capability.

3. Ceramic lids for packages with lower temperature B stage cured epoxy seal.

   The ceramic lid with the epoxy cannot obtain the high levels of the fine leak nor can it be used on applications over about 200°C. This kind of lid is used on single layer package where the electrical paths are all on one layer. The package does not have an isolated sealing area therefore the epoxy has to be non-conductive to allow epoxy flow over thecircuits without electrically connecting them.

4. Encapsulation of the device using a polymer or other such low temperaturematerial.

   The encapsulation method is generally used only on devices that are going to be enclosed in another circuit, where this encapsulation is not the primary sealing method for the active component. The choice of material is important as some encapsulants may not be able to stand the high temperatures, may outgas certain chemical causing failure, or may not be able to withstand other certain environmental or mechanical constraints.

Conclusion

The hermeticity of the semiconductor component is a critical part of the product specification. Great care should be given through the initial and later stages of the product design and specification. This application note has given you the basics of the testing methods that are the results of specifying certain hermeticity levels and also show what sealing methods/materials are available to achieve your required sealing criteria.

Authored by Brian Caplen, Senior Engineer

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Biasing Consideration for Linear (Class A, AB) Bipolar Power Transistors

AN012

V2.00

Introduction

An important part of an amplifier design is the design of a biasing network suitable for the specific application. Typically, a biasing network consists of an assortment of inductors, capacitors, resistors, diodes, transistors, microstrip lines, and anything else deemed necessary to make the RF transistor function per specifications. Generally, for linear bipolar power transistors (i.e. common emitter Class A or AB), four different performance characteristics need to be considered in designing the biasing network. These characteristics are: (i) The relationship between base bias voltage and saturated output power, (ii) stability and oscillation concerns, (iii) the effects of the biasing network on the level of distortion generated at the output of the RF transistor, and finally (iv) temperature compensation.

After these four topics are discussed, two simple biasing networks will be presented.

Base Bias Conditions And Saturated Output Power

The maximum base current of a transistor is equal to $I_C(peak)/h_{FE}$.

When the transistor is biased for Class A operation, the base to emitter voltage V_{BE} is set such that there is enough current going into the base of the transistor to generate the required current at the collector terminal. The DC current through the collector does not change as the RF power is varied, and thus the base current stays constant.

For Class AB operation, the voltage V_{BE} is set such that the base emitter junction is forward biased with the collector drawing only a fraction of $I_c(peak)$. As RF power is applied and varied, the collector current changes. The base bias circuit must be able to deliver enough current to support the required collector current at a given operating power level without a significant change in the V_{BE} voltage; otherwise, the device will experience premature output power saturation. This requires a constant voltage supply of around 0.7 volts depending on the desired quiescent current level and the characteristics of the transistor emitter-base junction. If a clamping diode is used to set the V_{BE} voltage, the DC forward current through the diode has to be greater than (at least twice) the peak base current of the transistor. Otherwise, when the base needs to draw $I_B(peak)$, the current through the diode will drop to zero causing V_{BE} to drop significantly. As V_{BE} begins to drop, the output power will start compressing.

Biasing For Oscillation Free Operation

Most RF and microwave power transistors in the industry today are not unconditionally stable. Special considerations need to be made in the bias circuitry to guarantee stable, oscillation free operation. Theoretical treatments of stability conditions are available in many textbooks [1,2] and will not be discussed here.

Bipolar devices can oscillate with just DC bias applied when the source and load impedances presented to the device satisfy the conditions for sustained oscillations (i.e. positive feedback internal or external to the transistor with closed loop gain greater than unity). This occurs most commonly at frequencies much lower than the operating frequency where the gain of the device is very high. At low frequencies the source and load impedance characteristics are inductive, high Q (where Q is defined as the impedance ratio of X_L to R), and tend to support the feedback phase shift required for oscillations.

If such oscillations do occur, the base biasing network can be modified to present a less inductive and more resistive impedance to the device at the oscillating frequency. This can be done by inserting a parallel resistor-inductor combination in series with the base where the resistor and inductor values are manipulated to kill the oscillation. If the oscillations persist, the same technique can be tried in the output circuit where a parallel resistor-inductor combination is inserted in series with the collector.

Signal Distortion And The Bias Network

In many RF and microwave power amplifier applications the distortion characteristics of the transistors are of

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utmost importance. When a modulated or a multi-tone signal is applied to the input of the amplifier, the transistor needs to amplify the signal with a minimum level of distortion introduced in the frequency band of operation. For Class AB operation, a poorly designed bias network can introduce significant signal distortion at the output of the transistor. Since the currents going through the base and collector bias networks vary according to the output envelope power level of the transistor, the bias networks act as filters, distorting the amplitude and phase of these current wave forms. So, unless the collector and base bias networks, as seen from the transistor, act as short circuits at the baseband frequencies of the modulated signal or the beat frequency for a two tone case, the bias networks will contribute to the distortion seen at the output of the transistor.

In some multi-channel applications, the channel separations and modulation schemes dictate the need for biasing networks with low impedances for frequencies ranging from 10 KHz to 35 MHz. In such cases, special care needs to be taken in the choice of bypass capacitors and other components. A good practice is to connect a network analyzer to the bias network and make sure no resonances exist in the frequency band of interest. On the collector side, such a bias circuit is easily realized with the use of three bypass capacitors such as a 50 μF for low frequencies, 5000 pF for bypassing the series resonance of the 50 μF capacitor and the higher frequencies, and a smaller capacitor to bypass the RF operating frequencies. If a similar type of a network is used on the base side, the device will most probably oscillate. A compromise must be reached between how stable the transistor is and how low the impedance of the bias network can get.

Temperature Compensation Considerations

Temperature compensation in the bias network is used to hold the quiescent current constant with variations in the transistor parameters that occur due to changes in temperature. The range of temperature variation and the amount of allowable variation in the quiescent current dictate how complex the temperature compensation circuit needs to be. In general, a silicon diode will have a negative temperature coefficient similar to that of a silicon RF transistor and provide sufficient temperature compensation to avoid thermal runaway.

The most critical aspect of temperature compensation is the location of the temperature sensing element. Whether a diode or a transistor is used, it should be placed so that its temperature tracks the junction temperature of the RF transistor as closely as possible given the mechanical constraints involved with the particular design. Reference 3 has more information on temperature compensation.

Simple Biasing Networks

Figures 1 and 2 below show two simple biasing networks.

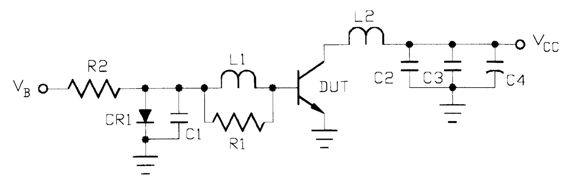

Figure 1.

In Figure 1, the base bias voltage is set by the forward current through the diode, which should be located such that the body is in physical contact with the heat sink close to the device for good temperature compensation. The parallel combination of R1, L1 ensures stability and provides a low impedance termination (around 0.2Ω) at baseband frequencies. Refer to the transistor data sheets for specific values.

This type of a bias network is very simple to design and use but is not practical if only one supply voltage is available because (V_{CC} - V_B)Ibmax will always be dissipated across a dropping resistor. The biasing network shown in Figure 2 does not have this disadvantage since the current through the dropping resistor R2 is reduced when the current through the base is less than its peak value. The diode CR2 can be used for temperature compensation of the RF transistor.

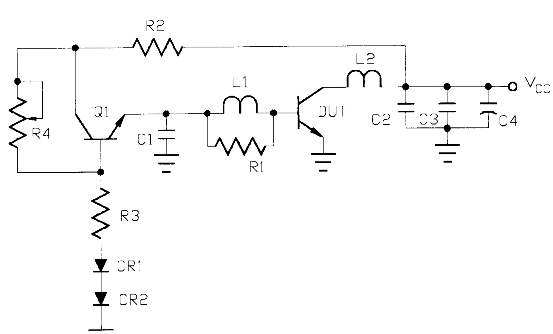

Figure 2.

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Conclusion

In designing a biasing network for a linear power bipolar transistor, special considerations need to be made so as not to adversely effect the transistor performance. Transistor performance comes at a premium and we cannot sacrifice its performance by having a poor DC bias design.

Although this application note dealt with bipolar power devices only, most of the concepts presented apply to MOSFETs and other microwave power transistors as well.

References

1 Guillermo Gonzalez, "Microwave Transistor Amplifiers", Prentice- Hall, 1984.
2 Krauss, Bostian, and Raab, "Solid State Radio Engineering", John Wiley & Sons, 1980.
3 M/A-COM Application Note #AN006.

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Application Note

RF/Microwave High Power Test Bench Calibration Method

AN013

V2.00

Introduction

The purpose of this discussion is to describe a method of calibration for rf/microwave high power device measurement systems made up of fixed attenuators, directional couplers, and calibrated power meters. This is a real time calibration method which does not require much disruption of the measurement system, and can be done with relatively minor system disassembly.

This discussion is broken down into four sections:

1. Calibration Preparation
2. Input Power Measurement Calibration
3. Reflected Power Measurement Calibration
4. Output Power Measurement Calibration

Figure 1 shows a typical power device measurement system.

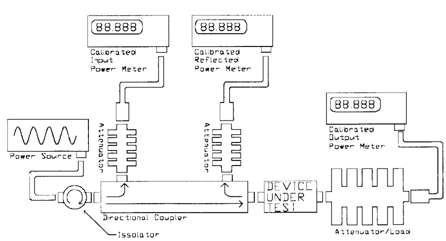

FIGURE 1: TYPICAL POWER MEASUREMENT SYSTEM

Calibration Preparation

The standard used for this calibration method is the power meter. For this reason, it is important that the calibrations of the power meters used in the measurement system are maintained. These calibrations should be traceable to the National Bureau of Standards. Because power meters generally have low maximum allowable input power levels, it is necessary when calibrating high power measurement systems to use attenuators. This will protect the power meters from damage.

A calibrated attenuator / power meter combination must be prepared to provide a known reference measurement. The power level at the input to the attenuator can be exactly determined by adjusting the power meter indication by the exact attenuation of the attenuator. If the exact insertion loss of the attenuator is not known, it can be measured using a network analyzer. The attenuation of the attenuator should be measured at each frequency of interest as the value may vary over frequency.

Example 1: Use of the calibrated attenuator / power meter combination

The attenuation of the attenuator is measured on a network analyzer to be 29.8 dB at 1.0 GHz. In order to determine the power level at the input to the attenuator at 1.0 GHz, the indication on the power meter attached to the output of the attenuator must be adjusted by +29.8 dB.

If the power meter indicates +17.2 dBm (52.4 mW), the power at the input to the attenuator is +47 dBm (+17.2 dBm + 29.8 dB) or 50 Watts.

Input Power Measurement Calibration

Attach the calibrated attenuator / power meter combination to the point at which it is desired to measure the input power (i.e. at the output of the directional coupler; see test point #1 in Figure 2). Another calibrated power meter should be placed in a permanent location for measuring the input power (i.e. at the forward coupled port of the directional coupler; see test point #2 in Figure 2). For a given incident power level, the meter indications will be different. These differences are caused by differences in attenuation, insertion losses, and coupler ripple.

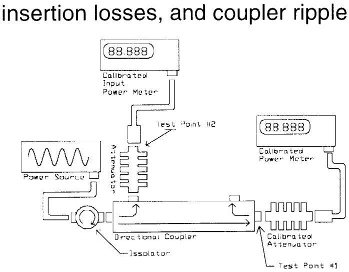

FIGURE 2: POWER INPUT MEASUREMENT CALIBRATION

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Apply power to the measurement system. Using the calibrated attenuator / power meter combination, the power at the measurement location (test point #1) can be set to a known level. This power level can be compared to the indicated power reading of the permanent input power meter (test point #2). By noting the error in the indicated power reading of the permanent input power meter at each frequency, the calibration adjustment factors for this meter can be determined.

Example 2: Input Power Measurement Calibration

An incident power level of 50.0 Watts (47.0 dBm) determined by the calibrated attenuator / power meter combination is applied to test point #1 of the configuration of Figure 2 at 1.0 GHz. The nominal coupling factor of the directional coupler is 20 dB, and the attenuator attached to the forward coupled port has a nominal attenuation of 10 dB. Based on these nominal values, the expected correction factor for the input power meter is -30 dB, and therefore the expected power meter indication is 17 dBm (47 dBm - 30 dB) or 50 mW. If the input power meter indicates 53.6 mW (17.3 dBm), it is known that the input power meter indicates +0.3 dB compared to the expected indication (17.3 dBm [actual] - 17.0 dBm [expected]), and therefore has a calibration factor of -29.7 dB (-30 dB [nominal] + 0.3 dB [correction]) at 1.0 GHz.

Reflected Power Measurement Calibration

Attach a calibrated attenuator terminated with a short to the same point to which the input meter is calibrated (See Figure 3). Use of a calibrated attenuator between the calibration point and the short limits the percentage of reflected power. This reduces the possible effect of poor coupler isolation on the input power measurement.

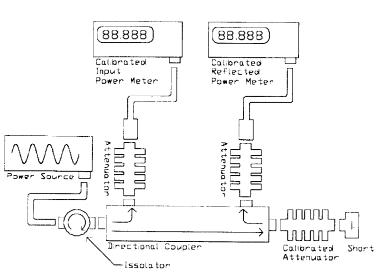

FIGURE 3: REFLECTED POWER MEASUREMENT CALIBRATION

Apply power to the measurement system. Set the power level using the calibrated input power meter. The incident power will travel through the calibrated attenuator, reflect at the short and return through the calibrated attenuator. The effective attenuation will be twice the calibrated attenuator value. Compensating for the calibrated attenuator value, the exact reflected power value will be known and can be compared with the power indicated on the calibrated reflected power meter. Using this method, the calibration adjustment factors for the reflected power meter can be determined at each frequency of interest.

Example 3: Reflected Power Measurement Calibration

A known 5.0 dB attenuator terminated in a short is placed on the output port of the directional coupler of Figure 3. At 1.0 GHz, an incident power of 50 Watts (47.0 dBm) is applied to the system as determined by the calibrated input power meter. The power will be attenuated by 5 dB, reflect at the short, and be attenuated by an additional 5 dB moving in the opposite direction. The total attenuation will be 10 dB (5 dB [forward] + 5 dB [reverse]). The reflected power is known to be 37 dBm (47 dBm - 10 dB) or 5 Watts.

The nominal coupling factor of the directional coupler is 20 dB, and the attenuator attached to the reverse coupled port has a nominal attenuation of 10 dB. Based on these nominal values, the expected correction factor for the reflected power meter is -30 dB, and therefore the expected indicated power on the meter is 7 dBm (37 dBm - 30 dB) or 5 mW.

If the reflected power meter indicates 4.77 mW (6.8 dBm), it is known that the reflected power meter indicates -0.2 dB compared to the expected indication (6.8 dBm [actual] - 7.0 dBm [expected]), and therefore has a calibration factor of -30.2 dB (-30 dB [nominal] - 0.2 dB [correction]) at 1.0 GHz.

Output Power Measurement Calibration

Attach the Attenuator / Load directly to the point at which the input power measurement has been calibrated (i.e. at the output of the directional coupler; see test point #1 in Figure 4). A calibrated meter should be placed in a permanent location for measuring the output power (i.e. at the output of the Attenuator/Load; see test point #2 in Figure 4). For a given incident power level, the output meter indication may have an error due to deviations of

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attenuation from the nominal value (i.e. a 30dB attenuator may in fact be only 29.7dB introducing a 0.3dB measurement error).

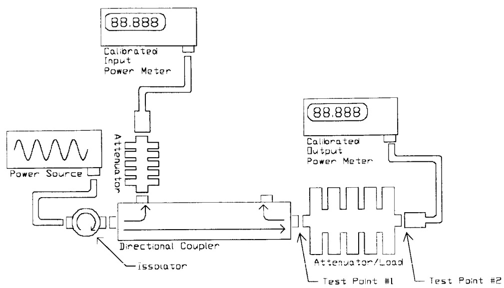

FIGURE 4: POWER OUTPUT MEASUREMENT CALIBRATION

Apply power to the measurement system. Set the power level (test point #1) using the calibrated input power meter. This power level can be compared to the indicated power reading of the permanent output power meter (test point #2). By noting the error in the indicated power reading of the permanent output power meter at each frequency, the calibration adjustment factors for this meter can be determined.

Example 4: Output power meter calibration

An incident power level of 50.0 Watts (47.0 dBm) determined by the calibrated input power meter is applied to test point #1 of the configuration of Figure 4 at 1.0 GHz. The attenuator / load attached to test point #1 of the configuration of Figure 4 has a nominal attenuation of 40 dB. Based on this nominal value, the expected correction factor for the input power meter is -40 dB, and therefore the expected power meter indication is 7 dBm (47 dBm - 40 dB) or 5 mW. If the output power meter indicates 4.9 mW (6.9 dBm), it is known that the output power meter indicates -0.1 dB compared to the expected indication (6.9 dBm [actual] - 7.0 dBm [expected]), and therefore has a calibration factor of -40.1 dB (-40 dB [nominal] - 0.1 dB [correction]) at 1.0 GHz.

Conclusion

In all of the above procedures, the insertion losses of any temporary connectors and/or adapters should be measured on a network analyzer and accounted for when determining the calibration adjustment factors.

Now the Device Under Test may be placed in the test setup. Using the input forward, the input reflected and the output power calibration adjustment factors, the exact power levels for the device under test can be determined from the indications on the three power meters.

Authored by Thomas Fowler, Senior Engineer

Application and Theory of a Passive Gain Sloping Network

AN014

V2.00

Introduction

An ideal application for using gain sloping networks is in a system of cascaded microwave high power transistor amplifiers operating under a Class C condition.

The natural physical response of transistors as the frequency increases is that the gain and the saturated output power capability decrease. This is due to the parasitic reactances within the transistor. In fact, at very high frequencies approaching f_T the gain approaches unity. Under optimally tuned conditions, a single transistor stage can have a 2.5 dB gain slope within a 15% bandwidth. Multiply this by 3 or 4 stages, and the resulting system gain slope can be quite large.

The gain slope problem is especially acute in a system using high power transistors operating under a Class C condition. In this case, the transistors tend to be sensitive both to overdrive conditions and to load mismatches. The gain slope of the transistors introduces a natural overdrive condition in a cascaded application. Unlike small signal transistors, the high power transistor matching circuits cannot be tuned for better gain flatness without introducing a load mismatch which will affect both short term reliability (ruggedness) and possibly long term reliability (MTTF).

By using gain sloping networks, the transistor matching circuits can be optimized, the transistor can be operated under conditions that maximize performance, and the system reliability can be maintained. Some other methods of achieving the same results will be covered briefly at the end of this discussion.

Basic Theory of a Two Section Gain Sloping Network

The gain sloping network discussed here consists of two sets of chip resistors along with printed microstrip shorted stubs separated by a quarter wavelength 50 ohm printed microstrip line. Figure 1 shows a basic schematic of the gain sloping network. This network is designed to be implemented in line at the 50 ohm input to the stage whose gain slope is being compensated.

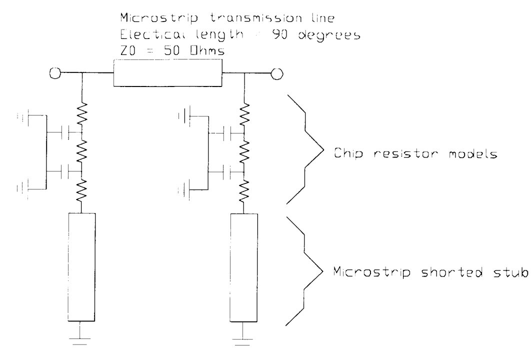

Figure 1. Two Section Gain Sloping Network Schematic

The first section of the gain sloping network consists of a chip resistor in series with a microstrip shorted stub. The microstrip shorted stub is designed to have an electrical length of 90 degrees at the frequency where the transistor has the lowest gain. At this frequency, the short is transformed to an open at the chip resistor. An ideal resistor in series with an open circuit will dissipate no power, therefore this shunt section will not introduce any attenuation into the overall network at this frequency. As the frequency is changed, the microstrip shorted stub electrical length will change and the chip resistor will be in series with a complex impedance instead of an open circuit. This will allow power to be dissipated in the chip resistor, therefore introducing attenuation into the overall network and decreasing the amount of power input to the transistor. This has the effect of decreasing the overall gain of the system at the higher gain frequencies. The effects of a realistic chip resistor with parasitic losses will be discussed in the next section.

At the frequencies in which the first section is dissipating power, this first section introduces a mismatch condition to the circuit causing power to be reflected towards the source. To compensate for this mismatch, an identical second section is added to the network. This second section is separated from the first section by a 50 ohm microstrip transmission line with an electrical length of 90 degrees at midband. The power reflected from the second

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section will be 180 degrees phase shifted from the power being reflected from the first section, and it will therefore cancel a significant portion of the reflected power. The value of the chip resistor and the characteristic impedance of the microstrip shorted stub can be optimized to give the desired gain sloping compensation.

More On the Chip Resistor

Because of the physical dimensions of the chip resistor, the parasitic capacitances at microwave frequencies can have a significant influence. Figure 2 shows a model of the chip resistor including the parasitic capacitances. This model should be used when optimizing the performance of the gain sloping network.

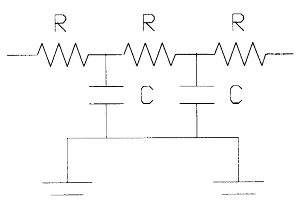

Figure 2. Chip Resistor Model

The parasitic capacitances (C) can be determined using empirical methods by measuring some chip resistors on a network analyzer. Care must be taken in the method of measuring these resistors to make sure the dielectric material under the resistors and the orientation of the resistors are the same as in the final application.

A design which minimizes the chip resistor parasitic capacitances will result in the lowest insertion loss of the gain sloping network at the frequency where the transistor has the lowest gain, therefore the maximum system gain possible at this frequency will be maintained.

Alternate Methods of Gain Slope Control

1. Tuning the input matching circuit for a sloped return loss will flatten the gain slope by reflecting the input power at the high gain frequencies. This approach works well when amplifiers are combined with quadrature hybrids because the reflected power is dissipated at the isolated port of the hybrid. Otherwise, a circulator must be used because the power is being reflected back to the output of the previous stage.

2. An active gain sensing and control system can be implemented to control the gain of each stage. This requires a complete system design or redesign, and is not a trivial task.

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Application Note

GaAs MMIC Low Noise Amplifiers SOIC-8 Platform

M540

V 2.00

Introduction

Early in 1994, M/A-COM began offering a family of plastic packaged GaAs MMIC low noise amplifiers (LNAs) featuring single positive supply voltage, low noise figure, high dynamic range, and low power consumption for the high volume commercial wireless communications market. These MMIC LNAs use M/A-COM's 0.5-micron, low noise GaAs MESFET process and are housed in low cost, 8-lead SOIC packages. These LNAs are tested in M/A-COM's volume automated facility to achieve low production cost. The LNAs share a common 'platform,' a product concept explained in the first major section below, enabling fast development and delivery cycles.

This application note will show the user how to achieve the performance in the product data sheets, i.e., how to "get what we get," and will answer some commonly asked questions such as how performance varies over bias. This note also expands on the data sheet information to show some interesting properties of the MMIC LNAs for use in other applications and at slightly different frequencies than those in the product data sheet.

To allow the reader to use only those sections that are of interest, the following is a brief synopsis of the major sections of this application note:

GaAs MMIC LNA SOIC-8 Product Family: This section discusses the 'platform' concept and gives an overview of the salient features for each MMIC LNA.

MMIC LNA Product Design and Performance Features: This section is a detailed look inside the design, manufacturing, and reliability issues for these GaAs MMIC LNAs.

MMIC LNA Product Customer Use Considerations: This section discusses the issues of importance to the customer in order to "get what we get" in the data sheet.

MMIC LNA Product Applications: This section shows additional performance features of the MMIC LNAs for their designed applications, as well as performance characteristics for other applications such as power amplifier driver amplifiers and using off-chip tuning networks to shift the frequency range of performance.

Performance Data & Recommended Board Layouts: This section discusses the measurement data that is available, evaluation samples, and printed circuit boards.

Conclusion: This section summarizes the application note and gives names, addresses, and phone numbers for worldwide support.

Glossary: This section defines the abbreviated terms and acronyms used in this application note.

GaAs MMIC LNA SOIC-8 Product Family

The MMIC LNA SOIC-8 product family establishes a 'platform' for M/A-COM's Integrated Circuits Business Unit. A 'platform' is a proven product concept and manufacturing methodology that translates core competencies into product families which fulfill the needs of strategic markets. The MMIC LNA SOIC-8 platform products share some common attributes, namely:

Standard Circuit Design: All internal design blocks such as low noise stage, gain stage, and biasing schemes are based on proven design topologies.

Standard IC Fabrication: Only one fixed production IC process is used; it has proven yields and well defined SPC parameters.

Standard Manufacturing: All chips are assembled on the same ISO-9001 certified manufacturing line in the same SOIC-8 package. The methods for product assembly, test, qualification, in-line quality monitoring, and documentation are identical for each device in the platform.

The advantages of a platform approach to GaAs MMIC product development are several. Using a common design topology and methodology for similar products means that many such products can be designed in parallel–essentially a batch process–enabling fast development times. The entire development cycle from inception to preliminary release for the original five LNAs (MAAM12021, MAAM12022, MAAM12031, MAAM12032, and MAAM22010) in this platform took six months. Additionally, these five LNAs are housed in one style package, the SOIC-8, with identical pin assignments. This commonality greatly simplifies the assembly, fixturing, test, and documentation requirements.

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Another advantage to the platform approach is that derivative products, such as those with a different frequency range or gain level, can be developed quickly in one single design and manufacturing cycle; it is not unusual to make the transition from concept to full production in three months. Both the AM50-0001 and AM50-0002 LNAs are derivative products which have benefited from the platform approach. The AM50-0001 is a higher dynamic range LNA in a lower frequency band which utilizes the SOIC-8 platform design methodology and has identical pin assignments to the original LNAs. The AM50-0002 combines design topologies from the original LNAs to produce a higher gain LNA in the SOIC-8 platform.

The present MMIC LNA product family consists of the following products:

Part #	Intended Market	Features	
AM50-0002	GPS, PDC	Frequency:	1.575 GHz
		Gain:	27 dB
		Noise Figure:	1.15 dB
		Bias:	3-5 V @ 20 mA
MAAM12021	GPS, PDC	Frequency:	1.5-1.6 GHz
		Gain:	21 dB
		Noise Figure:	1.55 dB
		Bias:	3-5 V @ 8 mA
MAAM12022	GPS, PDC	Frequency:	1.5-1.6 GHz
		Gain:	14 dB
		Noise Figure:	1.85 dB
		Bias:	3-5 V @ 5 mA
MAAM12031	PCN, PCS, PHS, DCS-1800, DECT	Frequency:	1.7-2.0 GHz
		Gain:	20 dB
		Noise Figure:	1.65 dB
		Bias:	3-5 V @ 8 mA
MAAM12032	PCN, PCS, PHS, DCS-1800, DECT	Frequency:	1.7-2.0 GHz
		Gain:	13 dB
		Noise Figure:	1.8 dB
		Bias:	3-5 V @ 5 mA
MAAM22010	ISM, WLAN	Frequency:	2.4-2.5 GHz
		Gain:	14 dB
		Noise Figure:	1.9 dB
		Bias:	3-5 V @ 5 mA
AM50-0001	GSM, AMPS, TACS	Frequency:	0.8-1.0 GHz
		Gain:	14 dB
		Noise Figure:	1.5 dB
		Output IP3:	+30 dBm
		Bias:	5 V @ 50 mA

All these products are offered in industry standard (JEDEC) SOIC-8 narrow body plastic packages.

MMIC LNA Product Design and Performance Features

The GaAs MMIC LNAs discussed in this application note were carefully designed, considering not only the electrical specifications but also ease and cost of manufacturing as well as quality and reliability. The following three subsections discuss in detail the inner workings of these MMIC LNAs in terms of circuit design, manufacturing, and quality.

MMIC Electrical Design Considerations

The key to any IC design is a well modeled stable process to predict circuit performance. The MMIC LNAs are based on M/A-COM's mature 0.5-micron (μm) low noise GaAs MESFET process. The active layer of the GaAs substrate is formed using ion-implantation for high throughput and low cost. A "buried-p" doping layer combined with 0.5-μm T-gates results in high performance MESFETs; the f_T of the process is 30 GHz and the F_{min} and G_{max} at 12 GHz are 1.3 and 13 dB, respectively. Every wafer is characterized for DC and RF performance. Process control parameters, as well as MIM capacitance, thin film resistance, and FET RF equivalent circuit, are stored in a database. From this database, a statistical circuit model is derived for designers to use in optimizing their design for maximum yield.

Another critical aspect in the success of this MMIC LNA product family is the ability to model all aspects of the product performance in the plastic packaging environment. Quantifying the impact of the plastic encapsulant on the electrical performance of the die for both the FETs and spiral inductors was a significant challenge. No less a challenge was the electrical circuit modeling of the SOIC-8 package itself in terms of the self and mutual inductances of the leads, bond wires, and split paddle lead frame.

This extensive modeling of the MMIC elements (FETs, MIM capacitors, thin film resistors, and spiral inductors), bond wires, and plastic package effects has allowed M/A-COM to predict with high confidence the performance of these and other designs. Utilizing these models with our statistical design methodology has allowed us to achieve high performance, unconditionally stable LNAs with high yield and, therefore, low cost. Figures 1 and 2 show the statistical distribution of the gain and noise figure, respectively, for the MAAM12021.

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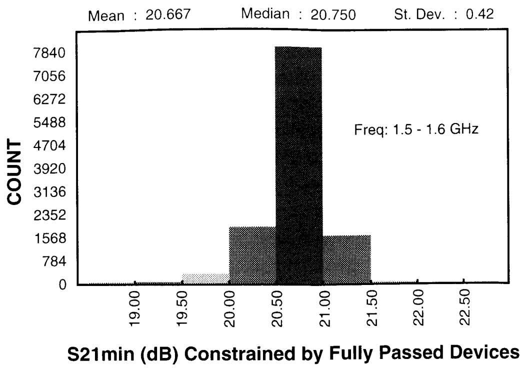

Figure 1. MAAM12021 Statistical Gain Performance

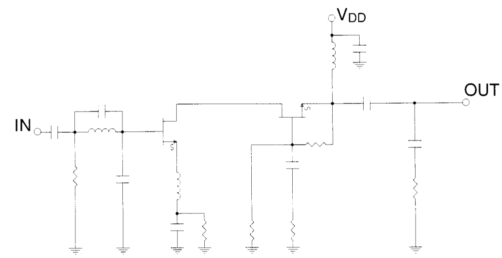

Figure 3. Low Gain MMIC LNA Schematic

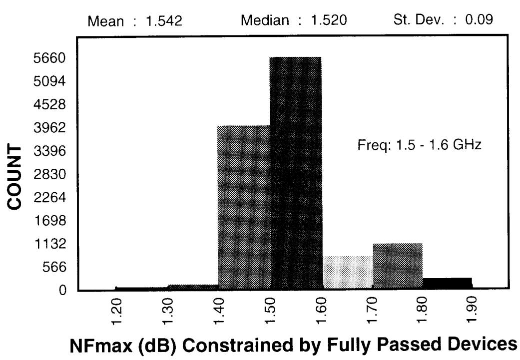

Figure 2. MAAM12021 Statistical Noise Figure Performance

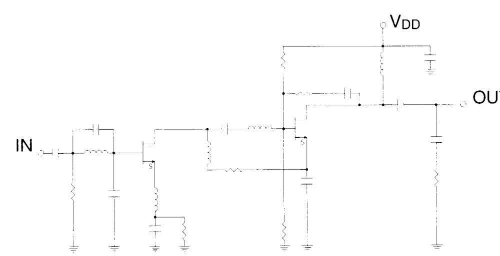

Figure 4. High Gain MMIC LNA Schematic

In this product platform there are essentially two circuit design types, a low gain (LG) and a high gain (HG). The LG design (MAAM12022, MAAM12032, MAAM22010, and AM50-0001), shown in Figure 3, employs a single stage cascode configuration with sèries feedback to simultaneously achieve impedance match and minimum noise figure. The HG design (MAAM12021 and MAAM12031), shown in Figure 4, uses two cascaded common source stages biased in series to achieve the high gain at low current consumption, and also employs series feedback to simultaneously achieve impedance match and minimum noise figure. The AM50-0002 employs a combination of the LG and HG designs to create a three stage, higher gain, LNA. The AM50-0002, however, uses a simple external input matching network to obtain minimum noise figure. A detailed discussion of this external matching network is contained in the section on customer use considerations.

The MMIC layout of Figure 5 is the MAAM12021, the largest chip of the family; it measures 1 mm on a side. Figure 6 illustrates the assembly of this MMIC into the SOIC-8 package. Immediately one notices that the lead frame is split and there is more than one chip in the plastic package. The amplifier employs a custom fused split paddle lead frame to ensure unconditional stability when used on a typical FR4 board application. The other chip in the package is a metal-nitride-silicon (MNS) single-layer capacitor used for internal RF by-passing to allow biasing from a single positive 3-5 V supply. These MNS capacitors, supplied by M/A-COM's Semiconductor Business Unit, have almost ideal performance for very little cost. After assembly, the MAAM12021 has the functional diagram as shown in Figure 7. Six of the seven LNAs in this product platform share these assembly and functional diagrams. The AM50-0002 utilizes a slightly different lead frame and pin assignment to accommodate the special requirements of its three stage, high gain design.

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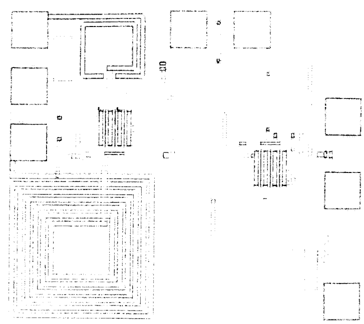

Figure 5. MAAM12021 GaAs MMIC Layout

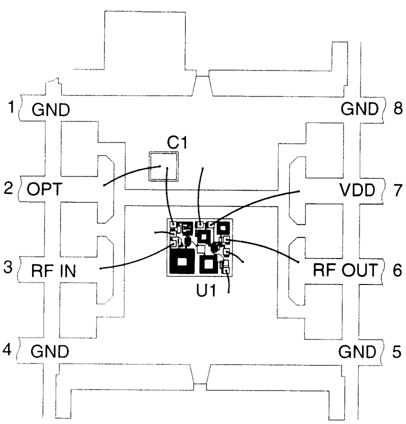

Figure 6. MAAM12021 Assembly Drawing

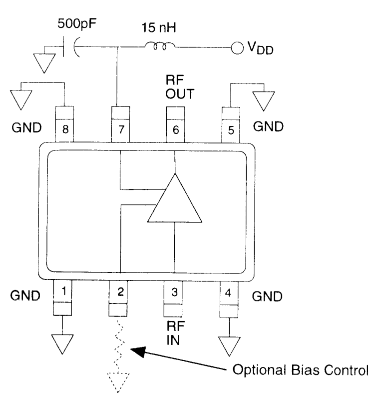

Figure 7. MMIC LNA Family Functional Diagram (except AM50-0002)

MMIC Manufacturing Considerations

The MMIC LNAs are automatically assembled on to custom designed, fused, split paddle lead frames as shown previously in Figure 6. Careful consideration is given to die placement, both for the GaAs MMIC LNA and the MNS capacitor, to ensure repeatable bond wire inductance and good mechanical strength for reliability. The ground leads are fused to ensure low inductance grounds as well as low thermal impedance. These fused ground leads also lower cost in volume production by eliminating eight ground bonds (2 per lead). Once assembled onto the lead frames, the assembly is transfer molded with a plastic which has both good moisture resistance properties for reliability and well controlled dielectric constant for repeatable RF performance. Fully assembled MMIC LNAs are stored in antistatic tubes, ready for automatic test.

Fully assembled MMIC LNAs are 100% RF tested for compliance against the guaranteed data sheet performance of gain, noise figure, and DC current. Standard automatic digital IC testers have been modified to make rapid RF measurements. Accuracy is maintained by establishing correlation coefficients between the high speed automated production testers and the highly accurate engineering measurement system.

Quality and Reliability

The MMIC LNA products are subjected to a one-time product qualification, either before product release or when there is a major process change. In the case of the MMIC LNAs, the one-time qualification, according to Table 1, has established the MMIC LNA product family to be capable of serving the high volume global commercial electronics market with a 400-FIT reliability rate (300 devices at an activation energy of 0.7 eV, normal operating temperature of 85°C, and 90% confidence level). The MMIC LNAs are also ESD classified as low level class 1— as low as 350 volts can induce damage. Table 2 shows the on-going quality monitoring of plastic packaged devices in production to maintain the established level of product quality.

This 400-FIT reliability level is established at a junction temperature of 150°C or less. This is the reason for the maximum rating on the data sheet of 150°C. The junction temperature can be calculated from the product of the thermal resistance and power dissipated. The thermal resistance for the MMIC LNAs is 165°C/W on all LNAs, except for the AM50-0001 where it is 125°C/W.

Sub Lot	Operation	Condition	Qty
	Visual Inspection	General	500
	Electrical test	ATP at +25°C	500
	Sub Lot split		
A	Electrical test	ATP at -40,25,85°C	40
A	Infrared Reflow Simulation	35 seconds above 235°C max 245°C total of 180 seconds	392
A	Electrical test	ATP at +25°C	392
	Sub Lot split		
B	High Temperature operational bias	150°C for 600 hrs	300
B	Electrical Test	ATP +25°C -40,25,85°C	280 20
C	Autoclave	96 hrs 100% RH 15 psi	76
C	Electrical Test	ATP at +25°C	76
D	Temperature Cycle	200 cycles -55 to +150°C 30 min dwell at extremes	96
D	Electrical	ATP at 25°C -40,25,85°C	76 20
E	ESD classification	MIL-STD-3015	6
F	DPA	REL-002	4
G	Physical Dimensions	100% of dimensions coplanarity < 4 mils	22
G	Resistance to solvents	MIL-STD-2015	22

Table 1. One-time Product Qualification Procedure

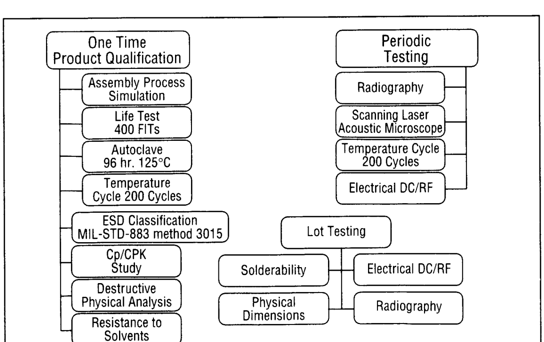

Table 2. On-going Quality Monitoring Procedure

MMIC LNA Product Customer Use Considerations

The SOIC-8 MMIC LNAs are fairly straightforward to use. By following some basic design considerations, the performance in the data sheet is easily achieved. The following sections discuss the electrical (DC and RF), manufacturing, and reliability considerations the customer must keep in mind for proper use of these MMIC LNAs.

Customer Electrical Considerations

These MMIC LNAs were designed to be used on low cost FR4 printed circuit boards. Before discussing the proper board layout, an understanding of each of the pins of the LNA family is necessary. All the products of the MMIC LNA family have the same pin assignments, shown previously in Figure 7, except for the AM50-0002, which will be discussed separately below. Pins 1, 4, 5, and 8 are DC and RF ground. Pins 3 and 6 are RF_{IN} and RF_{OUT}, respectively. Pin 7 is V_{DD}, a positive voltage, and pin 2 is an optional bias control pin. For nominal current operation, no external connection is made to pin 2.

An important consideration is the off-chip components used for DC biasing. Pin 7, the V_{DD} pin, must be bypassed with a 500-pF surface mount MLC capacitor mounted as close as possible to the pin. RF decoupling of the power supply with a chip inductor of at least 15 nH is recommended. Pin 2 is a parallel connection to the first stage FET source resistor and is normally left open. Connecting a chip resistor from pin 2 to ground will increase the current draw and extend the dynamic range of the LNAs as shown on the data sheets and discussed below in the product applications section. For the low gain MAAM12022, MAAM12032, and MAAM22010, connecting a 30-35 ohm resistor from pin 2 to ground will increase the current to 20 mA from the nominal 5 mA. For the high gain MAAM12021 and MAAM12031, connecting a 35-40 ohm resistor from pin 2 to ground will increase the current to 20 mA from the nominal 8 mA. For the higher current AM50-0001, a resistor ranging from 10-40 ohms can be used. For each of these six LNAs, care must be taken so the maximum current rating on the data sheet is not exceeded.

The AM50-0002 has DC and RF ground pins everywhere except for pin 2, RF_{IN}, and pin 6, which is both the RF_{OUT} and V_{DD}. To realize minimum noise performance, the AM50-0002 requires a simple low loss external input matching network. Figure 8 shows the functional diagram of the AM50-0002 and details the requirements of the matching network at 1.575 GHz.

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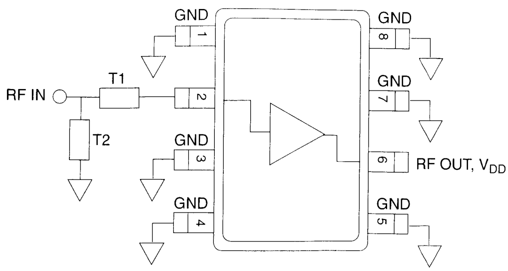
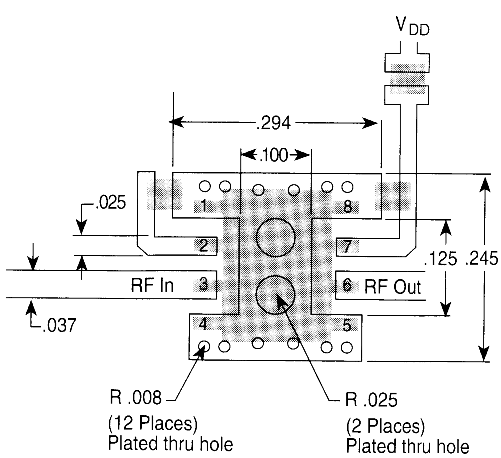


Frequency = 1.575 GHz		
	Impedance	Electrical Length
T1	57.2 Ω	36.0°
T2	82.7 Ω	16.2°

Figure 8. AM50-0002 Functional Diagram

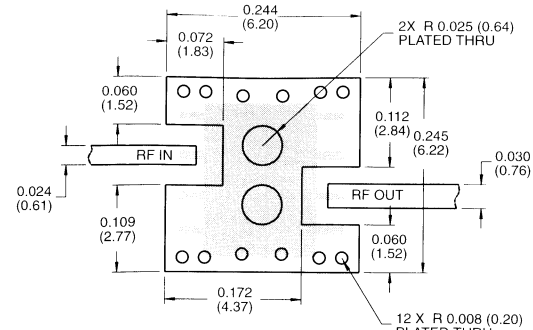
If the system does not provide the bias (V_{DD}) on the RF output line, the bias can be coupled to the RF output line using a simple bias tee network. Please note that the AM50-0002 has no optional bias pin.

The recommended PCB layout for this MMIC LNA product family, except the AM50-0002, is shown in Figure 9; the AM50-0002 layout is in Figure 10. The main point of both PCB layouts is, first and foremost, proper low inductance grounding. The use of plated through holes close to and under the package is strongly recommended. Board thickness is a trade-off between RF transmission line losses on thin boards and ground inductance



Dimensions in inches (mm)
0.020 (0.51) FR-4 Circuit Board

Figure 9. Recommended PCB Layout for the MMIC LNA Family (except AM50-0002)



Dimensions in inches (mm)
FR-4 circuit board, thickness = 0.016 inches (0.41)

Figure 10. Recommended PCB Layout for AM50-0002

and transmission line width on thick boards; M/A-COM has used RF board thicknesses from 0.008 to 0.032 inches without significant change in RF performance.

Customer Manufacturing Considerations

Most commercial microwave high volume applications use automated soldering techniques. M/A-COM provides guidelines for surface mount board layout, solder selection and screening, and reflow soldering temperature versus time profile in the application note "Surface Mounting Instructions."

Another manufacturing consideration is getting the heat out of the package. With all of the MMIC LNAs, except for the AM50-0001, the typical temperature rise is less than 20°C even with the higher current optional bias installed. However, care must be taken when using the AM50-0001 not to exceed the 150°C junction temperature maximum rating; with a thermal resistance of 125°C/W and an operating temperature of 85°C, the maximum power dissipation is 0.5 W.

Customer Quality and Reliability

There are two main areas of concern for the long term reliability of these MMIC LNAs: heat from exceeding the junction temperature maximum ratings and ESD. Thermal effects are relatively straightforward to correct–namely, provide adequate heat sinking. For all the LNAs, except for the AM50-0001, a good RF ground will provide sufficient heat sinking. For the AM50-0001, care must be taken to provide an adequate thermal path, also.

ESD is a major issue for customers to take seriously to ensure long term reliability. As stated before, M/A-COM's GaAs MMIC LNAs are low level class 1 ESD devices. What this means is that ESD voltages as low as 350 volts can damage the ICs. Remember, static kills; please do as much as possible to eliminate ESD from the manufacturing floor.

MMIC LNA Product Applications

M/A-COM's GaAs MMIC LNAs are intended to be used in the receive chain as the first gain stage of a low noise, high dynamic range receiver. They provide the requisite gain, very low noise figure, high dynamic range, and very low bias current at low cost. While the receive chain applications for the MMIC LNA family are relatively obvious, these MMIC LNAs can provide unique solutions for LO buffering, transmitter driver amplifiers, and a wide variety of applications in addition to those depicted in the data sheet. The following subsections describe a few alternative applications for these MMIC LNAs.

MAAM12022 As An LO Buffer Amplifier

The MAAM12022 was originally designed as a GPS or JDC receive MMIC LNA. However, if you bias the device at 8 volts on pin 7 (V_{DD}) and 20 mA through the use of an external resistor of approximately 30 ohms from pin 2 to ground, it becomes an excellent LO buffer amplifier. It exhibits 16 dB gain, better than 40 dB of reverse isolation, and produces +14 dBm of output power at -1 dB gain compression. The noise figure performance remains essentially unchanged. The performance graphs of this amplifier over bias are shown in Figures 11 and 12 for gain and P1dB, respectively.

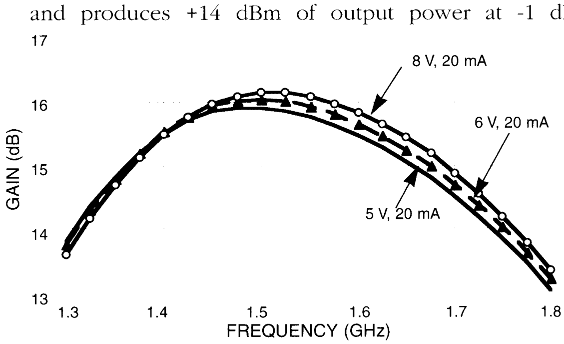


Figure 11. MAAM12022 Gain Performance over Bias Voltage, I_{DD} = 20 mA

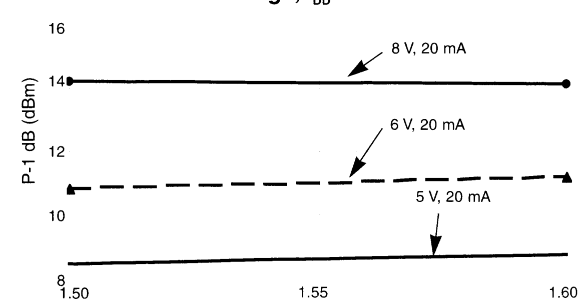


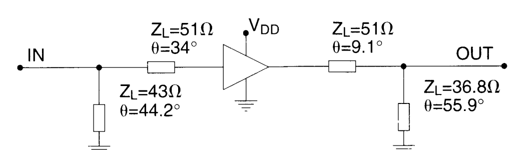
Figure 12. MAAM12022 P1dB Power Output Performance over Bias Voltage, I_{DD} = 20 mA

Five other LNAs in this product platform share the capability to increase gain and dynamic range through the use of an external resistor from pin 2 to ground and higher bias voltage. The increase in performance for the AM50-0001 is discussed below in a separate subsection. The other two low gain LNAs, the MAAM12032 and MAAM22010, will exhibit performance gains similar to those shown above for the MAAM12022. The two high gain LNAs, MAAM12021 and MAAM12031, will exhibit a gain increase of 2 dB and produce better than +14 dBm at -1 dB gain compression when biased at 8 V and 20 mA.

MAAM12022 over the 1.2 - 1.6 GHz Frequency Range

Both the MAAM12021 and MAAM12022 can be tuned to cover the 1.2 - 1.6 GHz frequency range with the addition of some external matching networks. The matching networks to accomplish this for both LNAs are shown schematically in Figure 13. Distributed matching is shown, although an equivalent lumped element approach would also suffice. The gain performance of the MAAM12022 when matched using the distributed topology of Figure 13 is shown in Figure 14; the noise figure performance is shown in Figure 15. For this LNA, the external matching has even improved the noise figure in the original frequency range, but at the expense of input match in that range.

External matching networks can be used to extend the frequency range of all the LNAs in this product platform. In fact, the AM50-0002 has been designed to require an



θ is the electrical length in degrees at 1.4 GHz.

Figure 13. Distributed Matching Network to extend the MAAM12021 or MAAM12022 to cover the 1.2 - 1.6 GHz Frequency Range

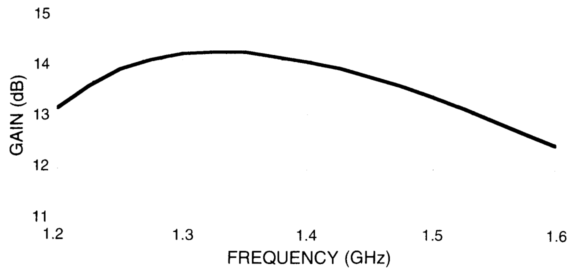


Figure 14. MAAM12022 Gain Performance for the Circuit of Figure 13

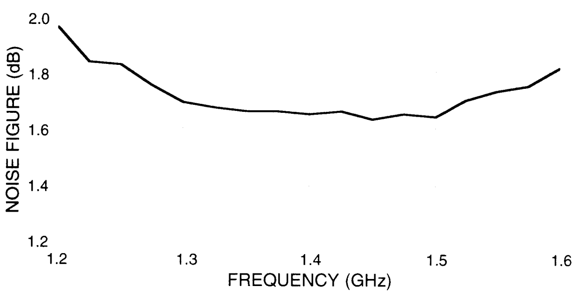


Figure 15. MAAM12022 Noise Figure Performance for the Circuit of Figure 13

external matching network to achieve a good match and minimum noise figure performance at the intended frequency. In some instances, as shown above for the MAAM12022, it may be possible to improve the noise figure of the LNA at the expense of input match. It is also possible to combine external tuning with the bias options described in the previous subsection to create additional performance possibilities with these LNAs.

AM50-0001 as a Transmit Driver Amplifier

The AM50-0001 was originally designed for the cellular industry as a high dynamic range, base station receive amplifier with a noise figure of 1.5 dB and output IP3 of +30 dBm. However, if V_{DD} (pin 7) is set to 8 volts with the same current drain of 50 mA, the AM50-0001 can put out more than +20 dBm of power as shown in the output power versus input power curve of Figure 16.

Performance Data & Recommended Board Layouts

To facilitate ease of evaluation by the customer for either alternative matching networks or to simulate system performance directly, de-embedded S-parameter and noise parameter data is available for all members of the GaAs MMIC LNA family discussed in this application note.

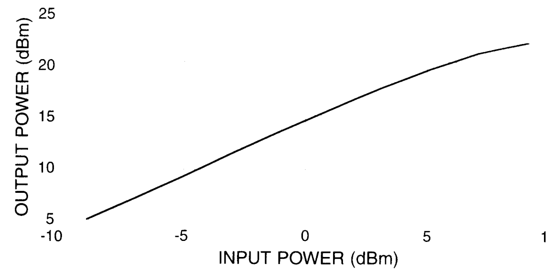


Figure 16. AM50-0001 P_{OUT} vs P_{IN} Performance with V_{DD} = 8 V

These data files are in DOS ASCII Touchstone® format. Please note that not all biases of each device are available; please consult the factory. Additional performance data, which is discussed in the product applications section, is also available.

Another avenue for evaluating these MMIC LNAs is by mounting the SOIC-8 to an FR4 board. A typical sample board layout is shown in Figure 17. This sample board accommodates the AM50-0002 and includes the recommended external input matching network for 1.575 GHz operation. A similar sample board layout accommodates the other six LNAs in this product platform. The .dxf files for these layouts are available from the factory. Additionally, these sample boards, as well as LNA samples, can be ordered from the factory.

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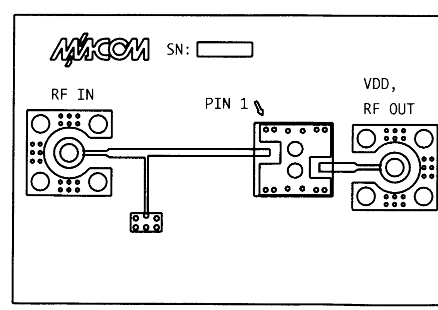

Figure 17. FR4 PCB Sample Board Layout for AM50-0002

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Conclusion

This application note was written to show the user how to achieve the performance in the product data sheets, i.e., how to "get what we get." Hopefully, this note has answered some commonly asked questions and expanded on the data sheet information to show some interesting properties of the MMIC LNAs for not only the intended applications of the products but also other applications not immediately obvious from the data sheet.

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Glossary

.dxf	Drawing Interchange File: a standard format for graphics software
AMPS	Advanced Mobile Phone Service: an 800-MHz analog cellular system
ASCII	American Standard Code for Information Interchange
DCS-1800	Digital Communication System: an 1800-MHz mobile cordless system
DECT	Digital European Cordless Telecommunications: a 1900-MHz system
DOS	Disk Operating System
ESD, class 1	Electrostatic Discharge: class 1 ranges from 250 to 2000 volts
FET	Field Effect Transistor
FIT	Failures In Time: a figure of merit for reliability
F_{min}	Minimum Noise Figure
FR4	An epoxy fiberglass dielectric material used for printed circuit boards
f_T	Frequency at which current gain equals unity: a figure of merit for field effect transistors
GaAs	Gallium Arsenide
G_{max}	Maximum Available Gain
GPS	Global Positioning System
GSM	Global System for Mobile Communications: a 900-MHz digital cellular system
IC	Integrated Circuit
IP_3	Third Order Intercept Point: a figure of merit for intermodulation distortion performance
IR	Infrared
ISM	Industrial, Scientific, and Medical: 900 MHz, 2.4 & 5.8 GHz spread spectrum applications
ISO-9001	International Standards Organization Quality Specification 9001
JDC	Japanese Digital Cellular–now known as PDC (Personal Digital Cellular)
JEDEC	Joint Electron Device Engineering Council
L1	Global Positioning System band centered at 1.575 GHz
L2	Global Positioning System band centered at 1.227 GHz
LNA	Low Noise Amplifier
LO	Local Oscillator
MESFET	Metal Semiconductor Field Effect Transistor
MIM	Metal-Insulator-Metal
MLC	Multilayer Capacitor
MMIC	Microwave Monolithic Integrated Circuit
MNS	Metal-Nitride-Semiconductor
PCB	Printed Circuit Board
PCN	Personal Communications Network
PCS	Personal Communications Service
PDC	Personal Digital Cellular: 900- and 1500-MHz systems
PHS	Personal Handy-phone Service: a 1900-MHz digital cordless system
RF	Radio Frequency
SOIC-8	Small Outline Integrated Circuit 8-Lead Plastic Package
SPC	Statistical Process Control
TACS	Total Access Communications System: a 900-MHz analog cellular system
WLAN	Wireless Local Area Network

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M/A-COM an AMP company

Application Note

Techniques to Achieve High Isolation with GaAs MMIC Switch Chips

M515

V 2.00

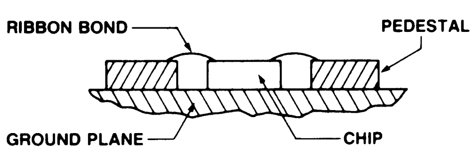
Mounting Techniques

1. Mount the base of the chip directly on the ground plane (i.e. the metal floor of the package) and use short connections from the ground pads of the MMIC to the ground plane.

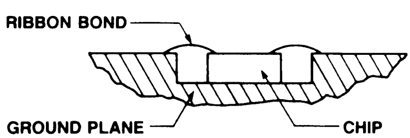
2. Use short ribbon bonds (0.005 to 0.010" wide) instead of wirebonds in the connection of the ground pads to ground.

3. Elevate the ground plane to be at the same level as the ground pads on the chip surface. This can be done by:

   A. Using ground plane pedestals next to the chip, as shown.



   B. Depressing the chip into a channel in the ground plane, as shown.



Isolation performance of a GaAs MMIC switch can be degraded by parasitic effects introduced by the circuit in which the MMIC is used. Two primary causes of isolation degradation are excessive ground path inductances and crosstalk between RF paths (external to the MMIC). This note will focus on techniques to reduce ground path inductances.

The achievable isolation of a GaAs MMIC switch is a function of how low an inductance one can achieve between the ground pad of the MMIC and the ground plane within a particular circuit. The lower the inductance, of course, the higher the isolation that can be achieved.

For example, the curves shown for the MASW6010G* chip in the catalog were obtained using coplanar RF probes directly on the chip. Because this is a coplanar probe configuration (which also includes the ground plane), there is virtually no ground inductance in the measurement. Thus, the isolation obtained in the data sheet is for a very small ground inductance that exists and should be considered optimum.

However, the isolation curves for the MASW6020G* chip in the catalog were obtained with the chip mounted in a package having a flat ground plane on the floor of the package. Short wirebonds were used from the ground pads to the ground plane. Thus, the isolation obtained in the data sheet is when a finite inductance exists in the ground path.

In practice, when a chip is mounted into a circuit, there will always be some finite inductance which can degrade the isolation performance. Several precautions can be taken to improve the isolation within a particular circuit. (See box.)

The technique used by M/A-COM in most of the packaged MMIC switch products is that of #1 above. Catalog performance of these products can be used as an indicator of what can be expected if technique #1 is used. However, improvements can be expected in isolation performance if techniques 2 or 3 are used.

This note briefly described techniques to obtain the maximum possible isolation when using GaAs MMIC switch chips. Several options were outlined which involved varying degrees of complexity. Crosstalk, not addressed here, can also degrade isolation, and must be minimized to obtain overall performance.

* Part number MASW6010G supersedes SW-200 and MASW6020G supersedes SW-210.

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Application Note

MASW6020G* Configuration Guide

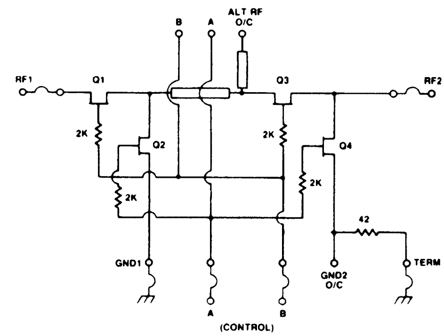
M516

V 2.00

Terminated (T) Configuration

The Terminated (T) Configuration is achieved by switching between RF1 and RF2 with GND1 and TERM grounded. ALT RF and GND2 remain open in this configuration.

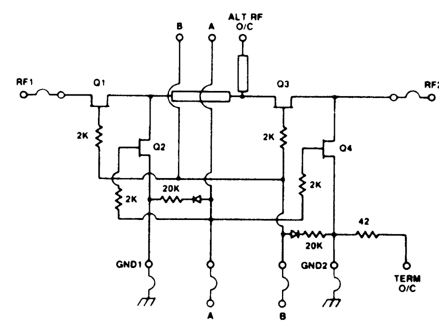
Terminated Schematic



High Isolation Unterminated (H) Configuration

The High Isolation (Hi Configuration is achieved by switching between RF1 and RF2 with GND1 and GND2 grounded. ALT RF and TERM remain open in this configuration.

High Isolation Schematic

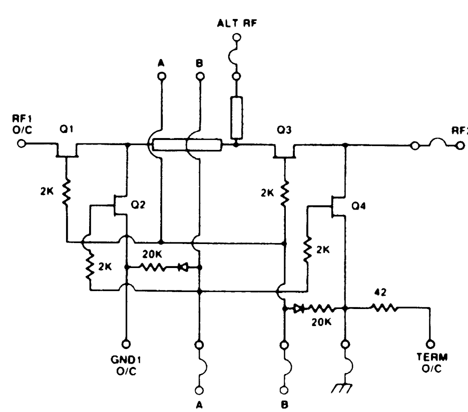


Low Loss Unterminated (L) Configuration

The Low Loss (L) Configuration is achieved by switching between ALT RF and RF2 with GND2 grounded. RF1, GND1 and TERM remain open in this configuration.

* The MASW6020G part number replaces SW-210.

Low Loss Schematic



Schematic Key

O/C = Open Circuit

o⌒o = Wirebond Connection

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MASW6010* GaAs SPDT Switch Performance and Driver Circuit Techniques M517

V 2.00

MMIC SPDT Switch Design

The MASW6010 is based on the use of Metal-Semiconductor Field Effect Transistors (MESFET) as the active elements. As shown in the schematic of Figure 1a, four MESFET's are arranged in two mirror-image series-shunt configurations originating at the common RF node. The Series MESFET provides a through path for the "on" arm while the shunt MESFET provides isolation for the "off" arm. Four 2 kohm resistors connect control inputs A and B to the MESFET gates while providing isolation between the RF path and the control circuitry. Each series MESFET gate is connected to the shunt MESFET gate on the opposite arm of the switch..

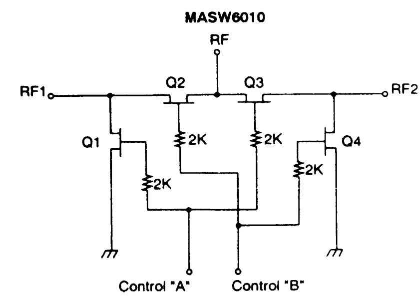
MESFET Switch Operation

Arrangement of the control network is such that complementary gate control voltages of 0/-3 to -10 Vdc applied at control inputs A and B switch the series-shunt MESFET's "on" or "off" per the truth table shown in Figure 1a. Therefore, if the RF to RF1 path of Figure 1a is "on" MESFETs Q2 and Q4 are "on" while Q1 and Q3 are "off." Control of an individual MESFET is demonstrated by the MESFET equivalent circuit/truth table of Figure 1b. The "on" or low impedance state occurs when 0 to -0.2 Vdc is applied to the MESFET gate. Conversely, the "off" or high impedance state occurs when a voltage greater than the MESFET pinch-off voltage is applied to the gate. The pinch-off voltage is determined by the ion implantation dose of the MESFET channel and is designed to be -2.5 Vdc typical. This voltage provides the highest channel conductance and lowest "on" resistance that can be reliably turned "off" by a -3.0 Vdc gate bias.

GaAs MMIC Technology

N-channel depletion mode GaAs MESFETs with 1 µm Schottky gates are used in the MASW6010. Implanted resistors along with the MESFETs are configured into a switch circuit utilizing dielectric crossovers to form a GaAs monolithic integrated circuit. MMIC wafer fabrication follows an eight-mask process using direct ion implantation into semi-insulating GaAs substrates. Contact lithography with deep UV optics defines circuit patterns by exposing photoresist in areas determined by each mask. An E-beam evaporation system deposits metals that are later defined by the liftoff of the unexposed photo-resist, removing undesired metal areas.

* The plastic packaged version is SW-239; the ceramic version is SW-219.



Truth Table

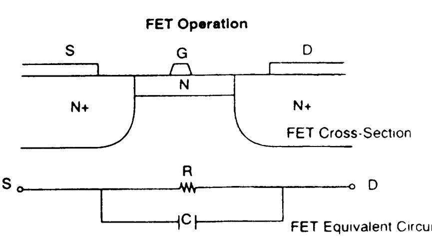
Control Input		Condition of Switch	
		RF Common to Each RF Port	
A	B	RF1	RF2
HI	LOW	ON	OFF
LOW	HI	OFF	ON

Control Voltages (Complementary Logic)

V_{IN} Low   0 to -0.2 V @ 20 µA Max

V_{IN} Hi   -5V @ 40 µA Typ to -8 V @ 200 µA Max

Figure 1a.



Equivalent Circuit Truth Table

RF STATE	VG	R	C
"ON"	0 V	2.5 Ω	0.2 pF
"OFF"	-5 V	10 KΩ	0.2 pF

Figure 1b.

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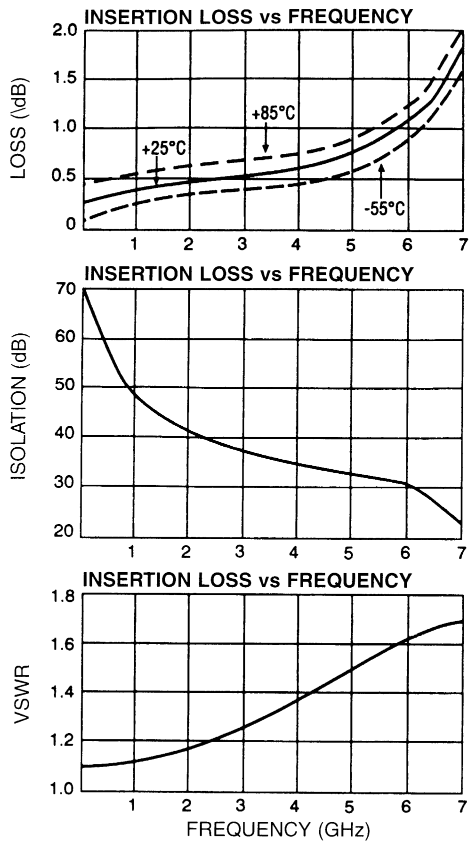

Figure 2. Typical Performance

MMIC Switch Performance

Figure 2 shows measured performance for the MASW6010 GaAs SPDT switch. With less than 1 dB insertion loss and more than 30 dB isolation at 4 GHz, the MASW6010 demonstrates impressive RF performance in a small package. The absence of DC blocking capacitors and bias chokes enables broadband performance literally down to DC and minimizes the area occupied by the circuit. The upper frequency is limited to 6 GHz by parasitic source-drain capacitance. Direct coupling such as this enables the MASW6010 to achieve high switching speeds of $T_{rise/fall}$ = 2 ns typical at frequencies down to DC. (The RC time constant of the 2 kohm resistor and the 1 pF input gate capacitance defines the speed of the switch.) This accomplishment has only been approximated by more complex balanced mixer type switches.

Input power for 1 dB compression is +27 dBm for standard 0/-5 Vdc control voltages. A maximum power capacity of +31 dBm occurs at 0/-8 Vdc control (midway between pinch off and gate breakdown voltage). Second and third order intermodulation intercept points are +66 and +45 dBm typical, respectively. This is excellent power handling capability for a control device of this simplicity and speeds and with such low current consumption.

Driver Circuit Design

In order to integrate the MASW6010 into a signal processing system, a driving circuit must be provided. The circuit must supply bias voltages of 0 to -0.2 Vdc and -5 Vdc to the MASW6010. It would be desirable for such a driver circuit to be compatible with a popular logic family such as TTL or CMOS, require only a single supply voltage, introduce little switching delay, and consume little DC current.

One driver technique that satisfies the above requirements "floats" the channel of each MESFET on the MMIC switch above ground potential. Through the use of pull-up resistors and DC blocking and bypass capacitors, -5 Vdc control now becomes 0 Vdc and 0 Vdc control becomes +5 Vdc at the MASW6010's control nodes. Therefore, the MESFETs will now turn "off" with 0 Vdc and turn "on" with +5 Vdc applied to the respective control port.

Figure 3 shows a schematic of the MASW6010 being driven by a QMOS CD54HCT04 hex inverter. QMOS, (Quick-CMOS), is a LSTTL input compatible logic family. Characteristics include the fast speed of LSTTL and the low DC power consumption and +5 Vdc output voltage of CMOS. Unlike CMOS, the QMOS bias supply is limited to +5 Vdc ± 10%. This driver makes an ideal partner for the fast, low DC current switch.

As shown in Figure 3, DC blocking capacitors C1, C2, C3, (required at each RF port, are chosen to give minimum insertion loss at the desired low frequency. Bypass capacitors, C5 and C6, required to float the MASW6010 ground above circuit ground, are chosen to give maximum isolation at the desired high frequency. A bypass capacitor, C4, of the same value as C1, C2, C3, is required between DC bias and ground to bypass any RF signal leakage on the DC bias line.

The floating bias circuit must hold the drain/source potentials to +5 Vdc, and must also isolate the RF ports from each other and ground (see Figure 3). Resistors, R2 and R3, that connect DC bias to the sources of Q1 and Q4, may be approximately 1 kohm. However, the resistors, R1 and R4, that connect DC bias to the drains of Q1, Q2, Q3, Q4 must be much larger in value, approximately 10 kohm; these resistors are critical in reducing crosstalk between the RF paths. The sources of Q2 and Q3 do not need a direct connection to DC bias; they are alternately pulled to +5 Vdc by R1 and R4 during each respective switching condition.

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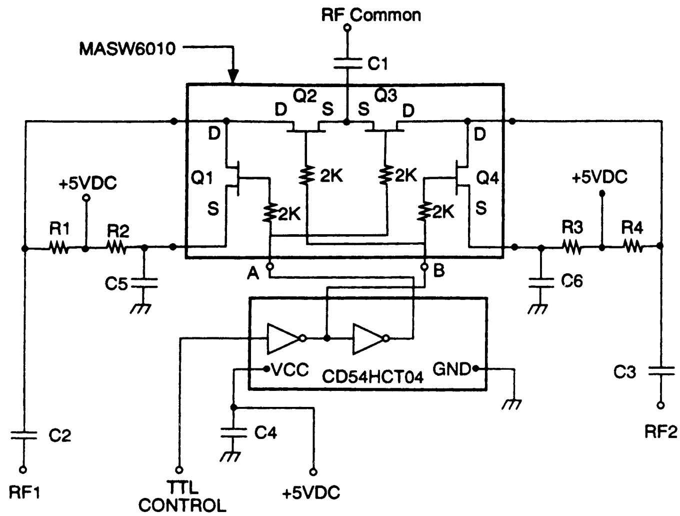

Control Input	Condition of Switch	
"1" = Logic High TTL	RF Common to Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

* 54LSO4 LSTTL may be substituted with additional pull-up circuitry or CD4041UB may be directly substituted.

Figure 3. GaAs SPDT Switch with QMOS* Driver

Driver Circuit Design (Cont'd)

Driver selection is determined by tradeoffs of switching speed, DC power consumption, and maximum allowable RF input power. Alternate drivers to the QMOS CD54HCT04 include the LSTTL 54LS04 hex inverter and the CMOS CD4041UB quad true/complement buffer. The logic gates of these devices are also connected as true/complement buffers as shown in Figure 3.

With additional pull-up circuitry connected between the 54LS04 outputs and +5 Vdc, the LSTTL driver can be substituted for the pin compatible QMOS driver. However, a degradation in switching speed and an increase in DC current consumption from the QMOS performance will result.

The CMOS driver can be implemented in place of the QMOS driver with no additional circuitry. The CD4041UB interface to the MASW6010 connects the complement output to control B and the true output to control A. Due to the MASW6010's control voltage input limitations the CMOS driver may only be biased up to +8 Vdc. This delivers +8 Vdc to the switch and increases the maximum allowable RF input power from +25 to +31 dBm.

In some applications, the two previously discussed LS1TL and CMOS driver circuits may be sufficient, but they do not take full advantage of MASW6010's fast switching speed and ultra low DC power consumption. A QMOS driver circuit makes optimal use of these high performance characteristics with a total switching speed of 20 nS and DC current consumption of less than 1 mA at +5 Vdc.

For even faster switching ECL logic may be used. T_{on} and T_{off} of less than 10 nanoseconds may be achieved using the MC1OH350. This circuit achieves very fast switching speed at the sacrifice of extra DC current. See Figure 4 for implementation of the MC1OH350 with the MASW6010 switch.

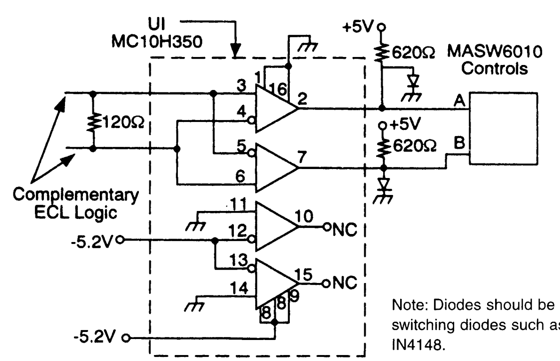

Figure 4. Driver Circuit to Drive MASW6010 CHIP for <10 ns Operation, using MC10H350 ECL to TTL Converter.

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Power GaAs MMIC Switches for Mobile and Portable Radios

M520

V 2.00

M/A-COM is now offering two low-cost, single-pole double-throw switches for high power applications. These switches are targeted for commercial applications including T/R switching, antenna diversity and antenna changeover functions. The low DC power consumption makes them ideal for portable and mobile telephony. In addition, the wide frequency bandwidth (DC – 2.5 GHz) means they are well suited for UHF/cellular voice and data and LANs applications.

SW-277 and SW-279 switches are high power (4W) GaAs MMICs packaged in a plastic SOIC-8 designed specifically for maximum power dissipation. The SW-277 switch is floated internally with capacitors to allow for operation with a **single positive supply**. The SW-279 is not floated and operates with negative voltage.

Key Features

- ☐ High Power (4W)
- ☐ Operates on positive or negative power supply
- ☐ Low insertion loss (less than 0.5 dB at 900 MHz)
- ☐ Low power consumption

Low Insertion Loss and Low Power Consumption

A key feature of the switches is the low insertion loss as shown in **Figure 1**. At 900 MHz and 25 °C, the loss is less than 0.5 dB, which translates to less than 10% of the incident RF power being absorbed. For the rated power of 4 watts, less than 400 mWs will be dissipated, and with a thermal resistance of channel to lead of 87°C, the temperature rise is a very acceptable 43°C. To minimize any further channel temperature rise, the thermal resistance of the package ground leads to the ground plane must be minimized.

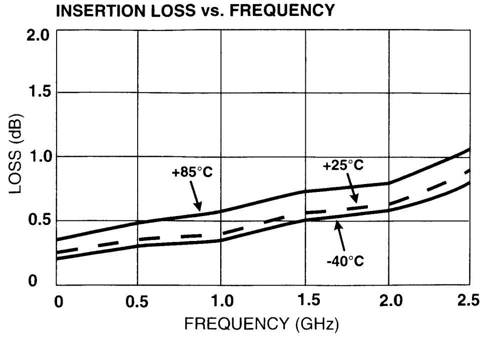

Figure 1

The isolation for SW-277 is 35 dB at 900 MHz. **Figure 2** show the swept isolation from DC to 2 GHz. The SW-279, which is not DC isolated to ground, has increasing isolation from 900 MHz of 35 dB to 65 dB at low frequencies.

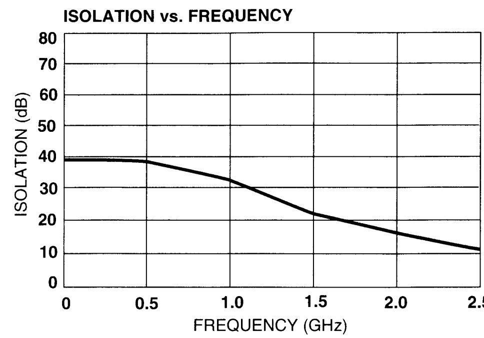

Figure 2

The power compression data, as a function of control voltage, is detailed in **Figure 3**. The third order intercept, at 900 MHz with two-tone input of +10 dBm at 8 volt bias, is typically +65 dBm. Power handling increases with increase in control voltage up to a maximum recommended value of 12 volts. Beyond that point, breakdown of the FETs may occur from the RF voltage swing. Lower voltages than 8v result in reduced power handling due to the RF voltage swing approaching the pinch off voltage of the FETs.

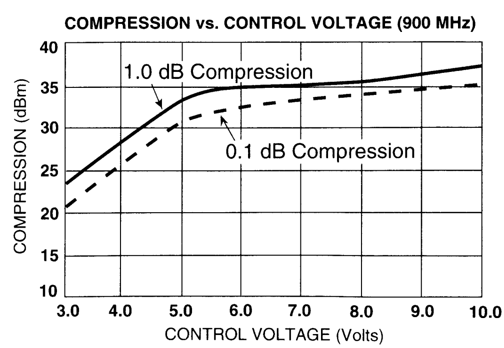

Figure 3

The power ratings for the switch assume cold switching (RF power is off when the switch is switched). For hot switching (RF power is on), the power ratings should be reduced by 6 dB. The reduction is due to the 100% voltage reflection that may occur with hot switching, which would double the

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voltage across the switch to a 200% voltage during the reflection. The power ratings apply to frequencies above 500 MHz. For frequencies below 100 MHz the following derating should be used:

Frequency of Operation (MHz)	Power Handling Derating (dB)
100	2
50	4
25	7

Switch Driver Considerations

The control voltages for the SW-277 will be complementary (0,Vcc) pair where Vcc can range form 3 to 10 volts for normal operation. However, the switch can operate in the three different modes as described in **Table 1**.

Table 1 — SW-277

Mode of Operation	Supply Voltage	Control Voltage
Positive Only	$+V_{cc}$	$0 / +V_{cc}$ (1)
Negative Only	GND	$0 / V_{neg}$ (2)
Positive/Negative	$+V_{cc}$	$-V_{neg} / +V_{cc}$ (3)

1. $3v \le V_{cc} \le 12v$
2. $-3v \ge V_{neg} \ge -12v$
3. $3v \le (V_{cc}+V_{neg}) \le 12v$

The SW-277 is designed to be operated with a single positive supply. The SW-277 has internal capacitors on the shunt grounds, and pull-up resistors to float the voltages to achieve operation with a single positive supply. **External DC blocking capacitors are required on all RF ports**. A single positive bias voltage is required. The control voltages should be 0V and the positive bias voltage, with a tolerance of ±0.2V. We recommend the use of CMOS drive levels to achieve the proper drive voltages.

There are applications where high power handling is required, but neither positive nor negative voltages are available in the 5 to 10 volt range. In this case it is possible to use a combination of positive and negative voltages with the SW-277 switch to handle the high power. For example, positive and negative voltages of +5 and -5V are recommended, but other combinations may be used as long as the voltage between the rails does not exceed the absolute maximum voltage of 12V (11V maximum is recommended). The control voltages should be within ±0.2V of the positive supply voltages. **Figure 4** is a schematic for operation of the SW-277 with positive and negative voltages.

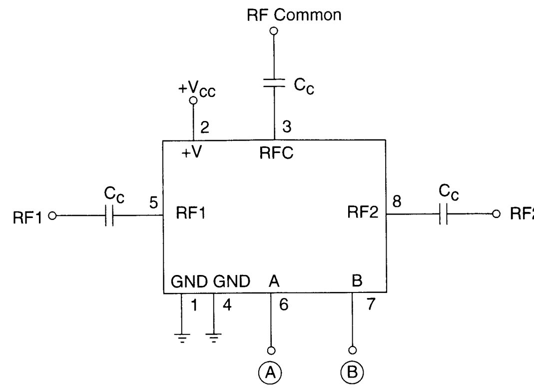

Figure 4

Applications

There are three primary commercial applications for the M/A-COM switches. These are:

1. Transmit/Receive – Transmit/receive switches require a switch which can handle high power with low insertion loss when in the transmit mode to minimize power loss and to minimize power dissipation in the switch. In the receive mode it is desirable to have low loss to minimize noise figure in the switch. SW-277 and SW-279 are ideally suited for both electrical performance and their ultra-low power consumption.

2 Antenna Diversity – Antenna diversity switches are used to switch between two antennas and have the same electrical requirements as transmit/receive switches.

3. Antenna Switchover – This is used for radios which have small antennas to allow switching to a larger stationary antenna when the radio is installed. An example of this is a radio which, when plugged into a car, would switch from the small antenna to a larger antenna mounted on the car.

The SW-277 and SW-279 switches have been designed with low loss, high power, multiple bias selection capability for voice/data radio applications. The high power feature (4W handling) also results in IP_3 (+65 dBm) for low distortion requirements in either high or low power applications. In portable radio applications, where only +3V DC supplies are available, the SW-277 and SW-279 switches will exhibit lower level distortion than standard products now available.

For applications in portable radios where isolation is not critical, the SW-358 or SW-359A may be a more cost effective solution. See the specific data sheet for detailed information.

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Positive Voltage Control of GaAs MMIC Control Devices

M521

V 2.00

Discussion

GaAs control devices have seen a tremendous growth in recent years with M/A-COM being the market leader in this area. The fact that these devices are negative voltage controlled devices has precluded the use of standard low cost CMOS drivers and has forced users to develop hybrid driver circuits to accomplish the driver function. This application note discusses a configuration which allows the user to drive GaAs control devices with standard CMOS logic gates. Although specific examples are presented, this application is generic and can be applied to any GaAs control device.

Design Approach

Since the GaAs FET requires a 0 V to -5 V relative voltage between the source and the gate, an alternative to using negative control voltage is to elevate or float the DC voltage at the source of the FET to +5 V and use a 0 V to +5 V control voltage. This would produce the required voltage differential between the source and gate to 0 V and -5 V. In many circuit applications, the source of the FET's are required to be RF ground. This grounding is very critical to circuit performance requiring the 5 V supply which is applied to the source be AC coupled to ground. Figure 1 shows a typical schematic of this topology for a single bit of a digital attenuator.

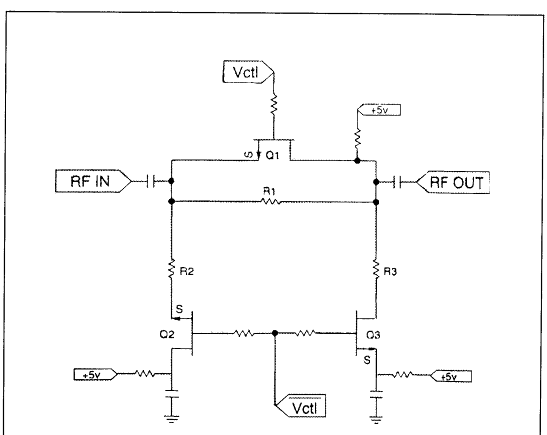

Figure 1.
Positive voltage control configuration of a single attenuator bit

Design Considerations

One area of concern in RF design is the adequate grounding of the devices. If good ground is not maintained, the performance of the device at the higher attenuation / isolation states will be degraded and will not meet the expected specification. When floating the source of a FET which is required to have a ground connection, the quality of the AC coupling capacitor and the PCB layout becomes extremely critical. The coupling capacitor must be a high-Q capacitor such as the ATC1OOA series supplied by American Technical Ceramics or equivalent. For operation at lower frequencies, a higher value of capacitor must be chosen. Any increase in inductance or path length will degrade the performance of the device so the designer must exercise good judgment in the placement of components and the number of via holes used to pick up ground. The best solution would be to utilize a coplanar layout where the AC coupling capacitor can be soldered directly to ground. If a microstrip layout is used, the designer must use as many via holes as possible and place them in very close proximity to the capacitor.

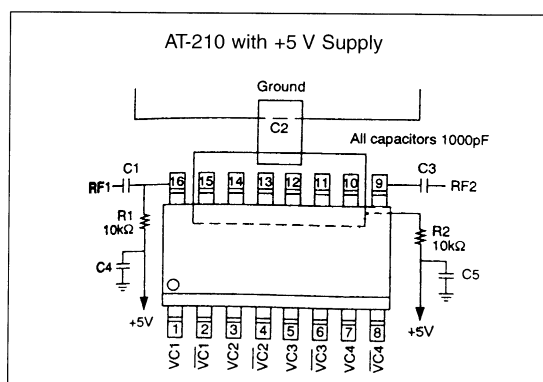

Figure 2a.
Positive voltage control configuration of the AT-210

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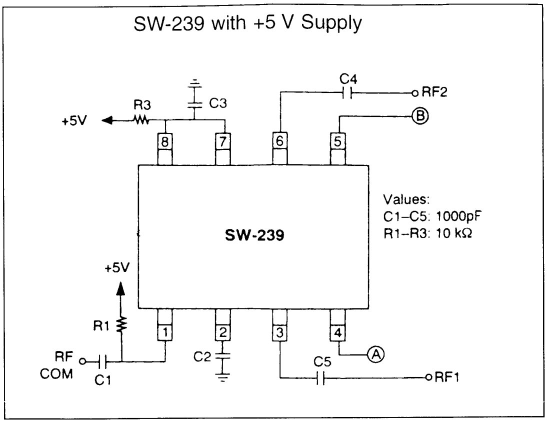

Figure 2b.
Positive voltage control configuration of the SW-239

Applications

This type of voltage floating technique can be used in most control component applications. A typical switch and digital attenuator application are presented in Figure 2. Each application is similar in that the source of the FET's are biased at +5V and the gates can be controlled by O and +5V.

In all cases, the ground pins which have a source connection must be AC coupled with the shortest possible path to ground.

Control Inputs								Attn (dB)
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	
0	1	0	1	0	1	0	1	Ref.
1	0	0	1	0	1	0	1	1
0	1	1	0	0	1	0	1	2
1	0	1	0	0	1	0	1	3
0	1	0	1	1	0	0	1	4
1	0	0	1	1	0	0	1	5
0	1	1	0	1	0	0	1	6
1	0	1	0	1	0	0	1	7
0	1	0	1	0	1	1	0	8
1	0	0	1	0	1	1	0	9
0	1	1	0	0	1	1	0	10
1	0	1	0	0	1	1	0	11
0	1	0	1	1	0	1	0	12
1	0	0	1	1	0	1	0	13
0	1	1	0	1	0	1	0	14
1	0	1	0	1	0	1	0	15

0 = V_{IN} Low = 0 V, 1 = V_{IN} High = 5 V

Table 1.
AT-210 Truth Table (+5V Control)

The AT-210 is shown as an example of a digital attenuator which is floated. Pins 10 through 15 are normally grounded, but in this case are floated to the +5V supply and AC coupled to ground. One of the RF connections must also be tied to +5V to ensure the source of the series FET's are floated. As mentioned above, all efforts to minimize inductance to ground must be taken to ensure the full attenuation range of the device. A truth table for the digital attenuator in the floated configuration is shown in Table 1.

The SW-239 is shown as an example of a SPDT switch which is floated using this technique. Pins 2, 7, and 8 are normally ground and must be floated with +5V as well as being AC coupled to ground. A +5V supply is also required at the RF common to ensure that the source of the series FET's are floated. The resistors R1 and R3 will result in slower switching speed, but will minimize coupling of RF signals along the +5V line. A truth table for this device in the floated configuration is given in Table 2.

Control A	Control B	RF 1	RF2
0 V	+5 V	ON	OFF
+5 V	0 V	OFF	ON

Table 2.
SW-239 Truth Table

The AT-250 is a VVA that can, similarly, be floated for positive bias operation as shown in Figure 3.

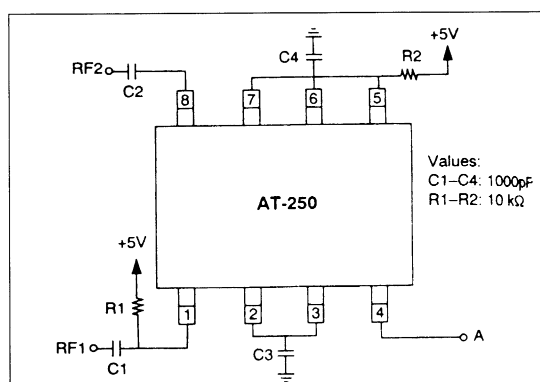

Figure 3.
Positive voltage control configuration of the AT-250

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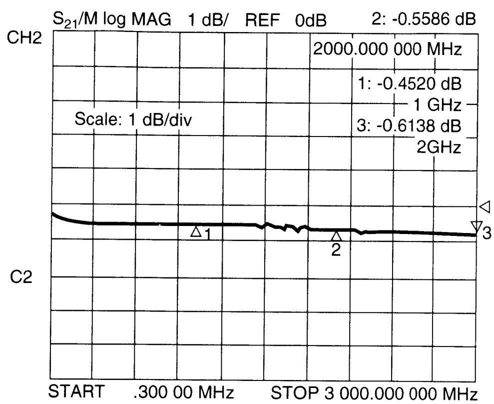
Application Note

S-Parameter Data for SW-239 (SPDT), SW-419 (SP4T) AT-210 and AT-230 (Digital Attenuators) M522

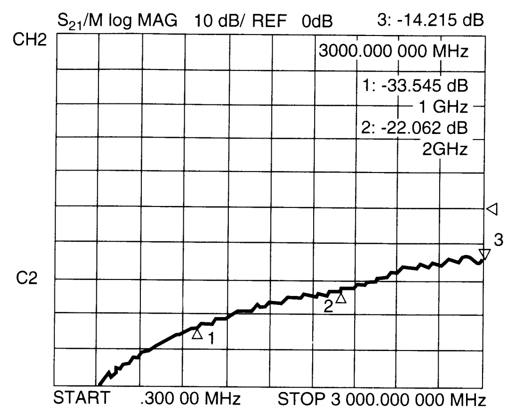
V 2.00

SW-239 S-Parameter Data

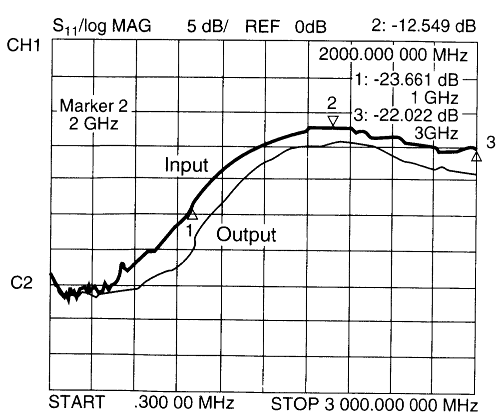
INSERTION LOSS



ISOLATION



INPUT/OUTPUT RETURN LOSS



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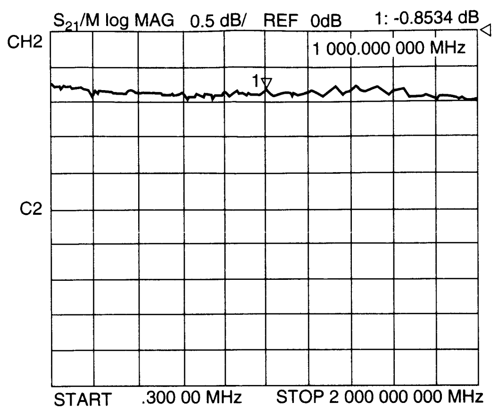
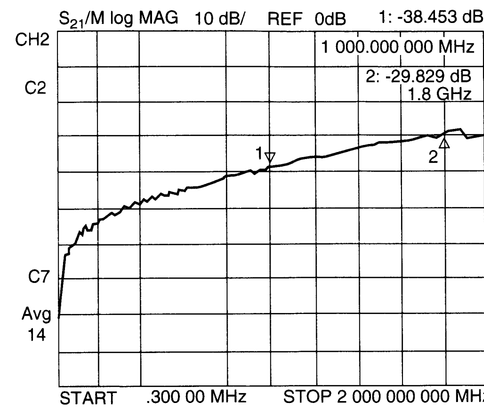
SW 419 S-Parameter Data

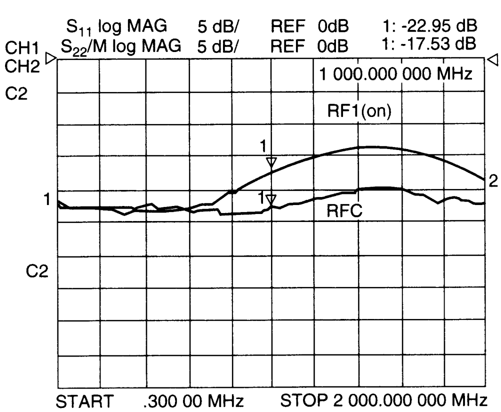
INSERTION LOSS (RFC-RF1)



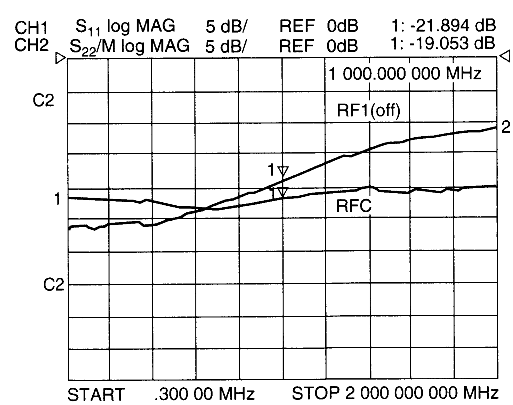
ISOLATION (RFC → RF1, RF4 ARM "ON")



RETURN LOSS — RF1 ARM "ON" (RFC-RF1)

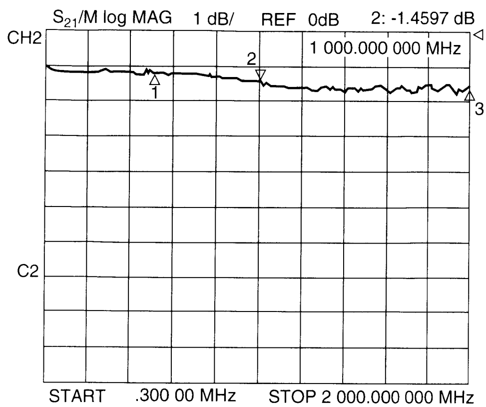


RETURN LOSS - RF1 ARM "OFF" (RFC – RF1, RF2 "ON")

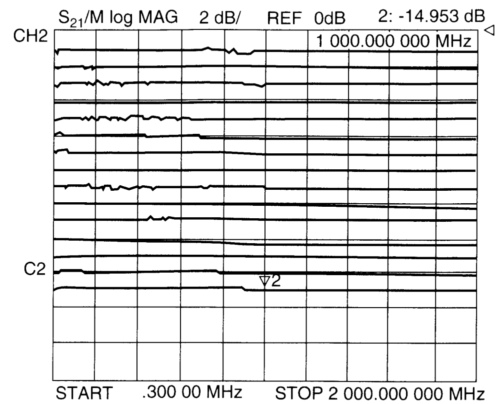


AT-210 S-Parameter Data

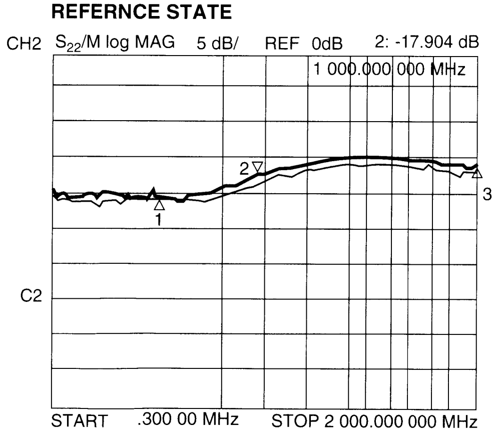
REFERENCE INSERTION LOSS



ATTENUATION ACCURACY



INPUT/OUTPUT RETURN LOSS REFERNCE STATE



Specifications Subject to Change Without Notice.

M/A-COM, Inc.

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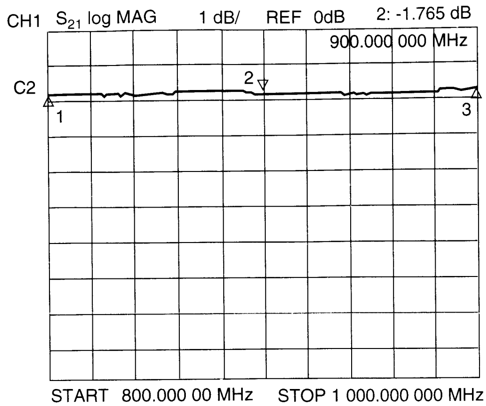
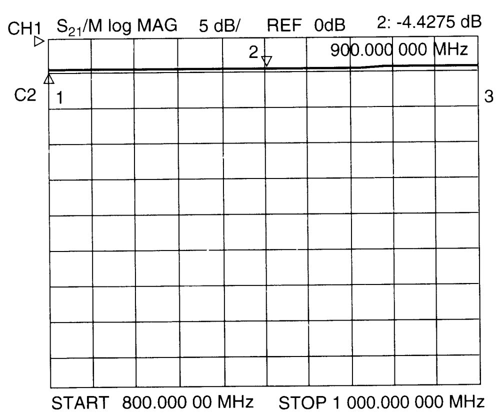
AT-230 S-Parameter Data

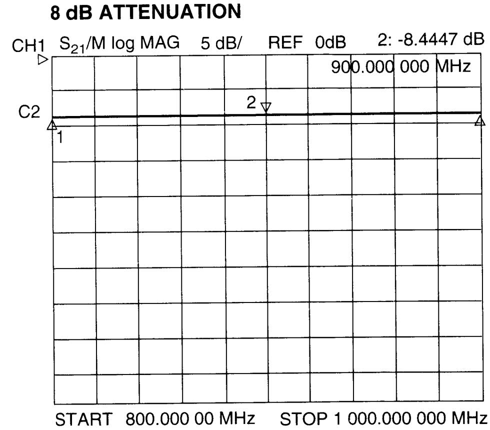
REFERENCE INSERTION LOSS



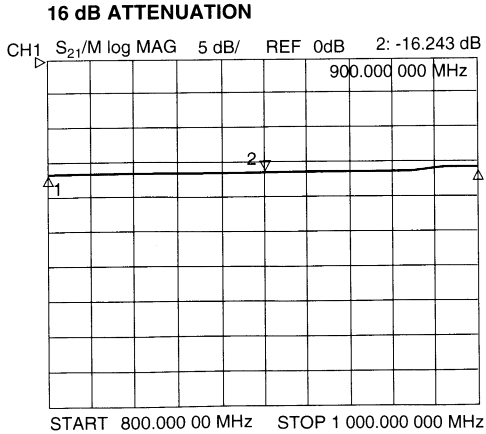
4 dB ATTENUATION



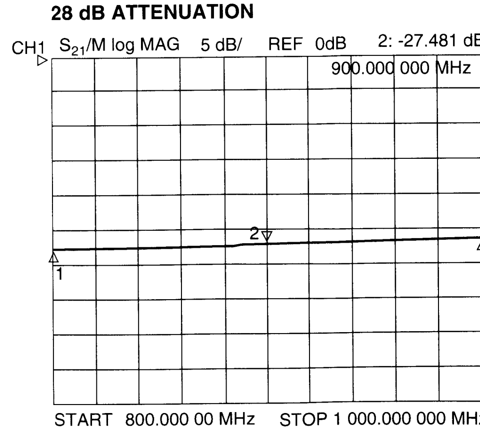
8 dB ATTENUATION



16 dB ATTENUATION



28 dB ATTENUATION



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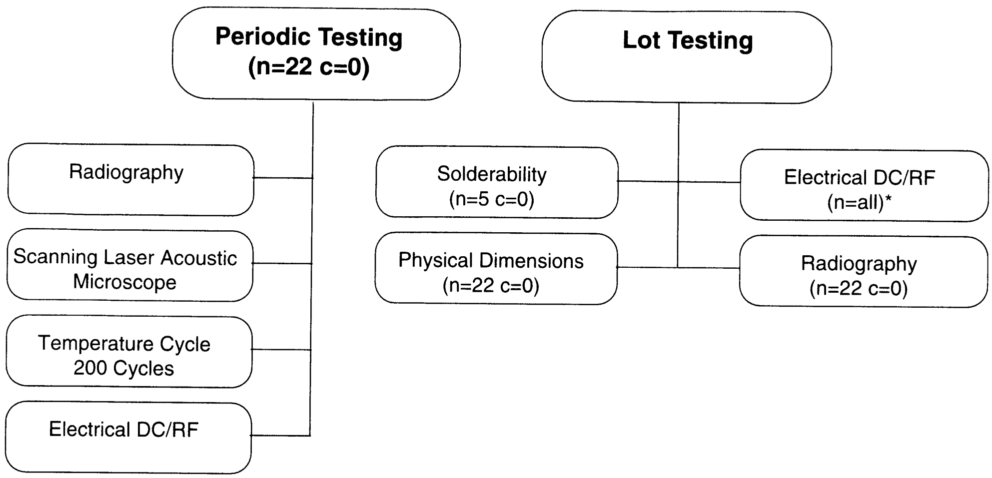
Attenuator and Switch Plastic Encapsulated Product and Lot Qualification

M523

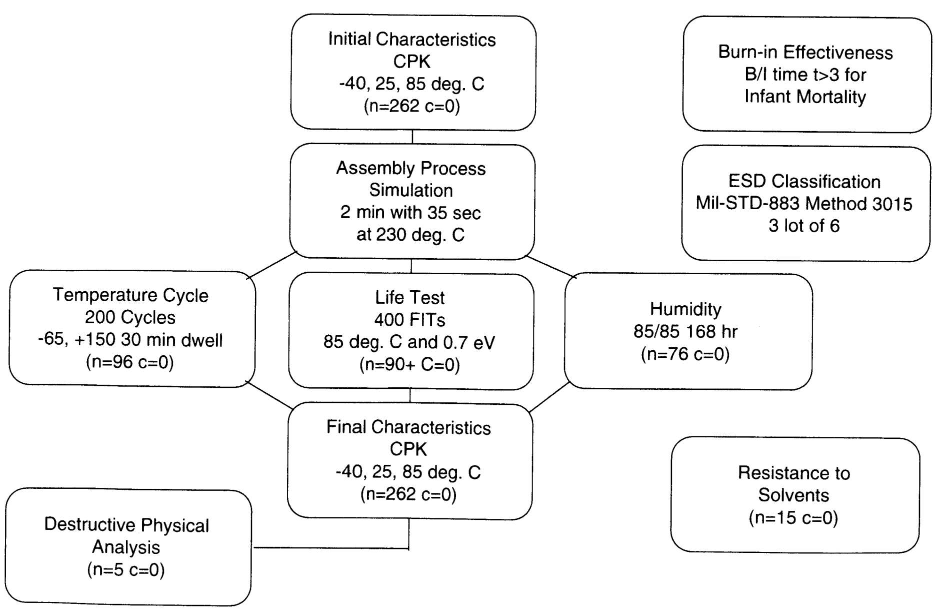
V 2.00

1. Ongoing Lot Qualification



*Product dependent

2. Product Qualification



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Application Note

Suggested Circuit Controller for a Dual-Control FET VVA in AGC Temperature Compensationt M524

This application note describes a useful broadband technique of temperature compensation for GaAs FET amplifiers. A control circuit is given for use with M/A-COM's dual bias 20 dB attenuator MMIC. Although the transfer function for attenuator control is non-linear, reasonably good results have been noted. The control circuit is not overly complex, consisting of four op-amps and several resistors. Control of the attenuator is based on a linear approximation of the control function about its most linear region. Exceptional bandwidth and flatness can be easily achieved up to about 12 GHz. Improvements are possible in the basic concept to extend the technology to 18 GHz.

Care must be exercised in using the exact attenuator data since the attenuation curve is very dependent on VVA pinch-off voltage. Also, data depends on the set of bias conditions used for "optimum match".

The temperature compensation network uses the dual bias voltage variable absorptive attenuator. A T-pad circuit topology was employed in the attenuator MMIC due to the ease with which broad bandwidth performance could be obtained. The MMIC requires two control voltages that nearly complement each other. Using the T-pad equations from Ref. #1, a unique solution for perfect matching in a 50-ohm system may be derived. As a practical matter, the solution is not exact because of tolerances on pinch-off voltages at the foundry level. Additionally, a tolerance on allowable input VSWR leads to the conclusion that infinitely many solutions are possible. A compromise function has been developed at M/A-COM that seems to be sufficiently accurate for most applications. Figure 1 shows the relative agreement of this function with that of a mathematically derived one.

The temperature stability of the MMIC frees the control circuit designer from undue concern over the stability of the FETs themselves. The circuit designer's job becomes one of taming the control circuit. A differential amplifier-based, balanced topology with ratiometric dividers is suggested. Figures 2 and 3 show the temperature stability and flatness of the FET over wide bands of frequencies.

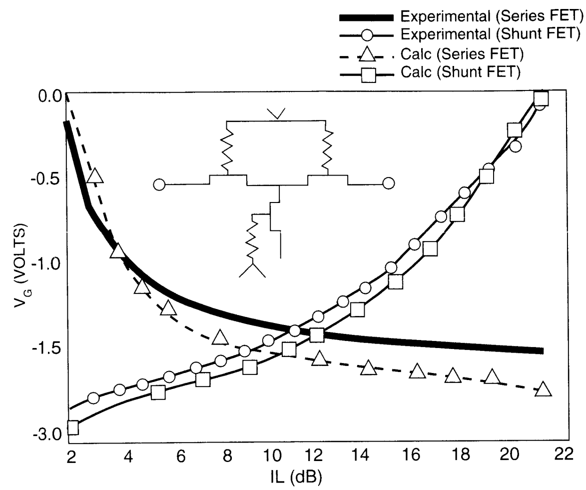

Figure 1. Comparison of Experimental and Calculated Control Functions

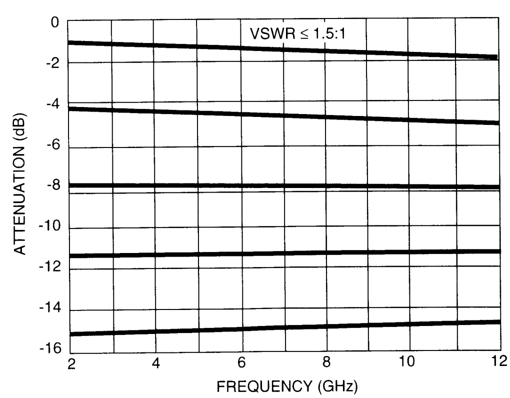

Figure 2. Attenuation Flatness vs Frequency for Various Levels of Attenuation

Temperature Performance		
	Room Temp.	120°
Ins. Loss	1.35 dB	1.65 dB
3 dB State	3.20 dB	3.70 dB
10 dB State	10.3 dB	10.5 dB

Figure 3. Temperature Variation of the MMIC GaAs FET Matched Attenuator

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A temperature compensation circuit for a FET amplifier operates at room temperature at an intermediate value of insertion loss. At high room temperatures, the T/C network is required to have as low an insertion loss as possible due to the fall-off of the FETs. At low temperatures, the T/C is required to have a high insertion loss. The absolute value of this loss should equal that of the high temperature case. The amount of drift one should expect in a FET amplifier is generally expressed in dB/°C/stage.

A new technique was used to calculate the amount of drift to be expected for various gains. Based on the evaluation of several different commercial and military MMIC and MIC amplifiers, a normalized amount of drift/dB of gain resulted. The value obtained was 0.28 ±0.02 dB/dB. That is, for every dB of gain, a drift over the military specification range can be expected that is about 30% of the linear gain at room temperature. Therefore, the amount of drift over one-half of the temperature range is 0.14 ±0.01 dB/dB. It should be noted here that this is an empirically derived value at this time with no rigorous analysis having been performed to establish its validity.

This remarkable result provides a means of estimating the drift of any GaAs FET amplifier of known gain. A series of best-fit lines may be generated from the non-linear control functions. The lines differ in the amount of insertion loss at room temperature and slight changes in slope. A set of lines was picked that provided the widest linear range of control centered at an insertion loss of -7.0 dB at room temperature.

The first design attempt had the following goals:

IL at room = 7.0 dB
IL at cold = 9.8 dB
IL at hot = 4.2 dB

Ideally this would be sufficient to compensate a 20 dB gain amplifier with a drift calculated at 5.6 dB. The results of this first circuit are plotted over 10 MHz to 6 GHz in Figure 4. Additional data from 2 GHz to 12 GHz is given in Figure 5.

Internal losses within the MMIC accounted for about 0.8 dB of additional loss so the room temperature set point was about 7.8 dB. Therefore, the expected endpoints would be 10.6 dB at cold and 5.0 dB at hot. The range of temperatures for which the normalized drift figures were obtained was -55°C to +100°C. A slight error is apparent in the data shown, since the maximum temperature used was +95°C. Interpreting the data indicates that slightly increasing the linear gain of both channels would allow a slight improvement in the accuracy of the approximation.

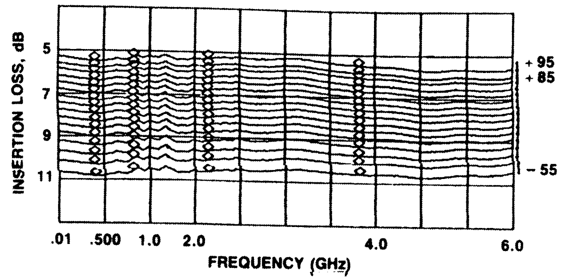
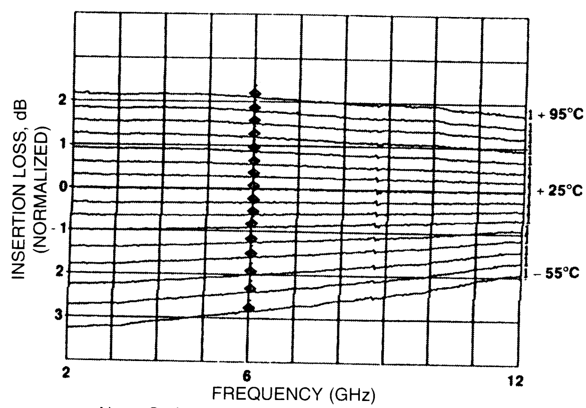


Figure 4. T/C Circuit and M/A-COM Attenuator Evaluated from 10 MHz



Note: Optimized for flatness and return loss over frequency band.

Figure 5. T/C Circuit and M/A-COM Attenuator Evaluated from 2 GHz

However, this has not been attempted at the time of this writing. It should be possible to operate at even lower insertion loss at room temperature with the circuit described by changing values of the mid-point set resistors.

A schematic of the T/C control circuit is in Figure 6. Circuit analysis is easy, since the whole circuit is DC. A monolithic band-gap temperature sensor with an output voltage of 10 mV/K is used to drive the circuit. Since the variation of the FET gain with temperature is essentially linear, only the non-linearity of the FETs in the attenuator need be considered. The sensor drives a buffer stage operating as a differential amplifier. A resistive divider is used to offset the output of the sensor so that at room temperature the output of the buffer is zero. Output from the buffer varies over temperature in a linear fashion from -0.77 to +0.77 volts. This output can be used to drive both FETs with some "slight of hand". A T-pad resistive network is used to scale the linear output from the buffer to

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the correct level to swing the shunt FET about the room temperature point. Another T-pad network is used to set the room temperature mid-point or reference for the shunt FET gate bias. The output stage of the control circuit for the shunt FET operates as an inverting unity gain summer.

Output from the buffer stage goes through an inverting unity gain amplifier to obtain the correct slope for the series FET drive. A T-pad network connected to the buffer scales the inverted output of the temperature sensor to the level necessary to drive the series FET. Another T-pad network is used to set the room temperature mid-point. Again, the output stage operates as an inverting unity gain summer. T-pad networks are used to set the room temperature mid-points and slopes. T-pads are less sensitive to small changes in values of the elements of the network. Note that the overall component count is increased using T-pads, but the amount of time needed for trimming goes down drastically. A hybrid realization of the circuit can use a quad op-amp and screened resistors.

A temperature compensation concept has been described that, in its present form, is at least as good as current techniques using PIN diodes. However, the proposed circuit is easier to trim up and operates down to very low frequencies. Improvements may be made by re-optimizing the measured control functions for mid-band of the frequency range of interest. Another possibility is the use of a MMIC with lower parasitic capacitance. This would reduce the error at higher frequencies. A more complex control circuit using compensated breakpoint diodes is under development as of this writing. The new circuit should enable more of the range of the attenuator to be covered with less error.

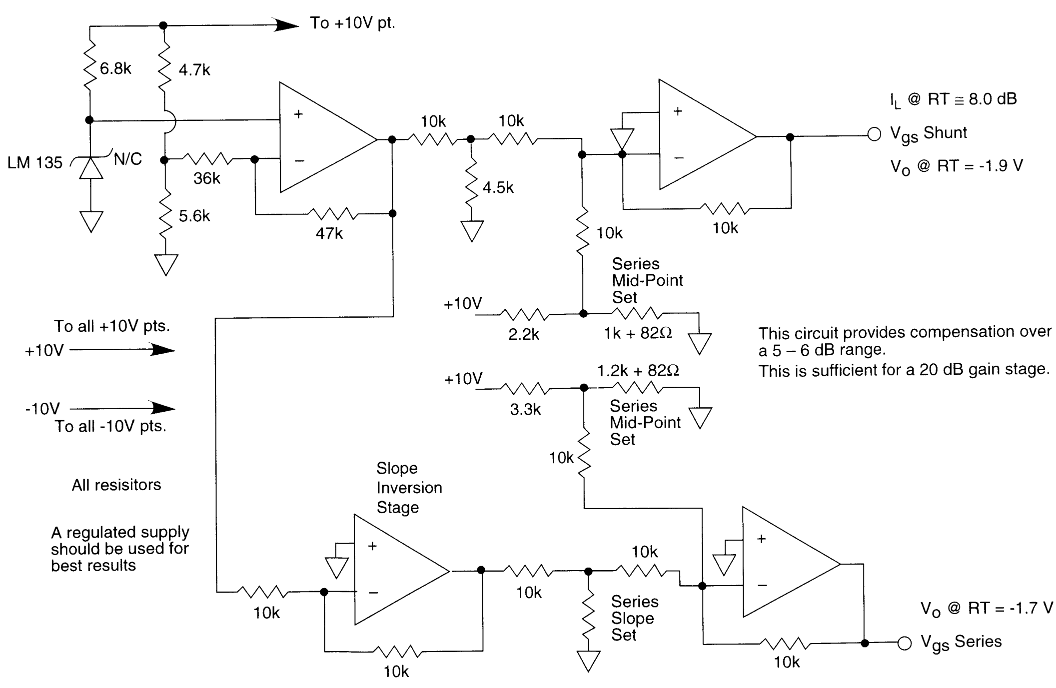

Figure 6: Temperature Compensation Circuit Schematic

High-Volume Commercial Plastic Packaged GaAs Monolithic Devices

M526

V 2.00

Abstract

In developing a new product line of high volume commercial plastic packaged GaAs monolithic devices, it has become evident that normal design, fabrication, and evaluation techniques no longer apply. Today's customer demands a low cost, high performance, high reliability device that can be used in advanced fully automated production centers.

This paper describes the technical issues in bringing high volume commercial microwave plastic devices to market:

- Electrical die design modification necessary to compensate for the plastic package parasitics
- Development of custom lead frames for enhanced RF performance
- Technical problems overcome to achieve 400 FITs Reliability
- In-house processing issues to build, test, and inspect thousands of devices in a cost effective manner to reach a selling price for a plastic packaged GaAs MMIC device under $2.00.

Designing for Plastic Packaging

Plastic package parasitics become increasingly important as frequency increases. Electrical die design modification is necessary to compensate for these parasitics. A typical equivalent circuit is shown in **Figure 1**.

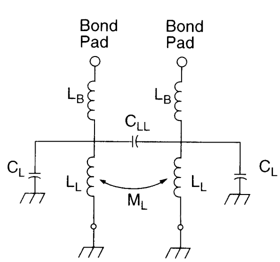

Figure 1

This can be used to develop TOUCHSTONE or PSPICE models to be used along with models of the device being packaged to optimize performance in plastic. Values of the parasitic elements vary according to package family, lead to lead spacing, and lead length. Definitions of the equivalent circuit symbols and typical parasitic element values for the SOIC family are shown in **Table 1**.

Other areas of concern when designing for plastic packaging are die bonding pad location and bond pad size. Bond pad location should eliminate the need for bonds crossing over the die, or each other. Pads should be located to minimize bond length for better RF performance and lessen the possibility of excessive bond sweep during the injection mold process. Electrically it is ideal to keep bond pad size to a minimum. However, compromises must be made to insure that the device is compatible with existing automated assembly equipment. Minimum bond pad sizes are listed below for 1 mil gold wire.

Circuit Symbols	Typical Values for SOIC Family
L_B = wire bond inductance	length dependent
L_L = package lead inductance	0.9nH
M_L = mutual inductance lead to lead	0.3nH
C_L = capacitance lead to ground	50 fF
C_{LL} = capacitance lead to lead	100fF

Table 1

Pad Size	Number Wires
4 x 4 mils	1 bond
4 x 9 mils	2 bonds
4 x 13 mils	3 bonds

Table 2

Careful planning of die design and layout will result in high yield assembly, high reliability, and lower final costs.

Custom Lead Frames

In order to improve both high frequency RF performance (1–2 GHz), and thermal dissipation of high power devices (0.5–4 watts), custom fused lead frames are being used in selected plastic devices.

Improved RF performance is achieved because of reduced ground bond inductance. Package ground bonds can be reduced by fusing leads directly to the die attach area. Total bond count can be reduced and as many as 3 bonds/lead can be eliminated.

One example is the M/A-COM AT-220 digital attenuator. Due to increased ground bond inductance, the original die design had to be modified to compensate for the package

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lead inductance and mutual inductance from lead to lead. The modified design was optimized for the cellular band with significant roll-off above and below 1 GHz. Using a custom fused lead frame, ground bond inductance was significantly reduced allowing for linear performance up to 1 GHz using the original die design. **Figure 2** shows the attenuation performance of both designs.

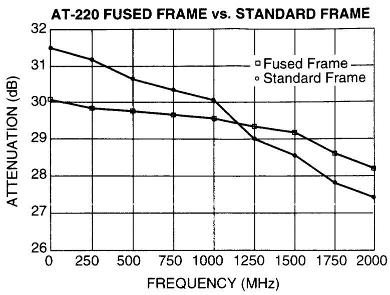

Figure 2

With the increased demand for low cost, high power devices, another benefit of the fused lead frame is increased power dissipation. While there is some minor dissipation through the wire bonds, enhanced power dissipation occurs through the fused leads to the package exterior. This influences both the performance of the device in circuit and its reliability over time. The M/A-COM SW-279 SPDT switch is a high power device (4 watts) constructed using a fused lead frame in an 8-lead SOIC. Using the fused lead frame $theta_{ch-a}$ = 86.5 °C/W; without the fused lead frame $theta_{ch-a}$ is approximately equal to 240 °C/W.

Fused lead frames can be designed and manufactured for all lead counts for most standard packages. The majority of the added cost is for the tooling of the fused lead frame. There is no change in the transfer molding tooling. Lead frame materials can be selected for enhanced thermal performance. Cost can be minimized by eliminating the need for a die paddle downset. However this reduces maximum die height allowed by approximately 5 mils. If die height is critical, fused lead frames with downsets can be designed. The fused leads must be symmetrical and the need for new downset tooling may be required.

400 FITS Reliability

In today's high volume low cost component market, our customers demand a product that will survive under the most strenuous of conditions for extended periods of time. While developing the GaAs Monolithic product line, many issues evolved that directly affected the reliability and producibility of these devices. The major effect on reliability was the die design.

The first attempts to package GaAs devices resulted in extremely low yield. Those that passed the first electrical testing failed in short order. The failure analysis of the first devices found several pattern failures: mechanical surface damage induced during the die attach process given that the auto processing equipment uses vacuum pickup tools that attach directly to the die surface; crushed air bridges damaged during die attach and thermal set injection process; liquid trapped on die surface shorting active elements due to the hydroscopic nature of the plastic material. Several attempts at resolving these failures with various package techniques failed. It quickly became apparent that the die had to be robust on its own prior to packaging. The die was then redesigned to remove the air bridges, and to fully passivate the die surface with a minimum of 5000 angstrom of Si_2N_3 over the full die surface.

After the resolution of the die related issues, low level failures continued to occur. Radiography identified that wire bond sweep was the next major failure mode. Caution must be taken during package and bond wire layout in combination with feedback to the injection process. These were key to elimination of this failure mode.

Once the major reliability issues were resolved, product family qualification had to occur. Many of our key customers of the GaAs MMIC devices refused to use these products until their reliability could be proven. The qualification consisted of the following:

- Burn-in effectiveness (no failures in 1000 hours)
- Life Test Simulation (400 FITs, 6,000,000 hours MTBF)
- Resistance to moisture (96 hours at 125 °C, 30 PSI 100%)
- Thermal stability (200 thermal cycles +125/-55 °C, 10 min. soak with a 1 min. transition time)
- Assembly process simulation (IR reflow simulation, IR furnace 240 °C for 30 sec)
- Resistance to solvents (boiling freon TMS); ESD classification (ESD classification IAW MIL-STD-83 method 3015)
- Electrical statistical process capability study (Cpk 15 min.) Capability in relation to spec. mean: This is the capability of the process expressed in relation to a worst case view of the data.

$$Cpk = \frac{\text{(Upper Spec Limit – Mean)}}{\text{3 Sigma Actual}}$$

Equation 1

Designing for Unit Manufacturing Cost

In order to economically produce high volume plastic GaAs MMIC devices, cost issues must be controlled. A minimum labor cost can be attributed to each component in order to meet a selling price target of below $2.00 each. The focus of bringing these devices in under $2.00 each has been in five main areas:

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Wafer Processing/Wafer Testing

The wafer fabrication process needs to be understood to ensure that only those steps that are necessary are performed. The mask set must be simplified as much as possible to reduce all operations to a minimum. No 100% inspections can be performed. One must rely on statistical process controls to ensure quality, not to inspect quality in. Those inspections that are performed are based on relia-

Plastic MMIC Reliability Process

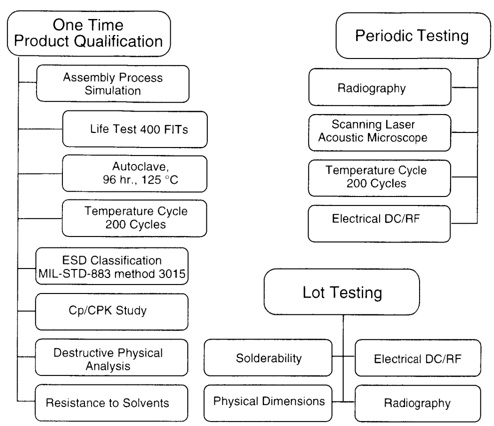


Figure 3

bility issues, not some arbitrary military specification. The testing process needs a thorough review. A cost assessment must be performed to identify the most effective testing location (i.e. on wafer vs. end item testing). Currently M/A-COM requires GaAs wafers procured for plastic packaging be tested only on 100 sites and that an assessment is made to its acceptability based on that 100 site test.

Packaging

The major issue controlling the packaging process is that RF designs are slight modifications of industry standard plastic packages. The leading packaging suppliers require high volume standard part releases. Fortunately, M/A-COM's RFIC production has reached the multi-million part-per month level and our products are now setting the industry standard for RF plastic packaging.

Inspection

Only a minimum amount of inspection can occur to a device given the cost constraints, but quality cannot be sacrificed. To ensure quality, M/A-COM currently performs sample lot testing for: real time radiographic inspection of bond placement, bond sweep, mold voids, and overall general construction; solderability; mechanical verification of coplanarity and physical dimensions. In addition, random lots are selected for reliability testing.

Test

Currently the cost of on-wafer testing to ensure that each die conforms to requirements exceeds the price of packaging all visually acceptable die, and autotesting the complete devices after packaging. Through the use of statistical analysis DC testing can be used in most cases to ensure the RF performance.

DC parametric testing of the packaged devices is done using an auto handler capable of testing 3000 parts per hour. All devices are tested for ground verification and leakage current. Switches are additionally tested for FET on resistance and off resistance. These tests verify that the die is electrically functional. Specifications are dependent upon the size of the FETs used in the die design. Attenuators are additionally tested for DC reference insertion loss and DC attenuation. Calculation of the reference loss is made using the formula:

The GND pins are grounded and the RF2 port is terminated into 50 ohms. 0.2 volts is applied to the RFl port and the

$$\text{Ref. Loss} = 10*\log10((VRF1^2/50)/(VRF2*IRF2))$$

Equation 2

handler measures VRF2 and IRF2. Attenuation is calculated in a similar manner using the formula:

Note: Five pc. sample RF testing from each lot is used to

$$\text{Atten.} = 10*\log10((VRF1^2/50)/(VRF2*IRF2)) - \text{Ref. Loss}$$

Equation 3

verify that no undetected anomalies have slipped through the screening process.

Design

Designs must be carefully thought through prior to any action being taken. For each new product the following question must be asked: What can I do up front to control costs, not just for the design phase but for the whole process? An example of this might be to design a device for a CPK of 2.0 on all parameters to make testing unnecessary.

When designing and developing new products for high volume plastic packaging, the full process must be assessed to assure that all possible impacts on the unit manufacturing cost have been identified and minimized, and the design's reliability also must be built into the product on the first delivery. M/A-COM's first attempts at plastic packaging (1986) had start finish yield in the low 20% but through the use of the above process M/A-COM has achieved a finished 6 sigma yield.

GaAs MMIC Based Control Components With Integral Drivers

M537

V 2.00

Application Note M537

This application note describes the fundamental operation and features of a new series of control components. These switches comprise a family of devices that use GaAs FET MMIC technology for the RF circuitry and incorporate application specific integrated circuit (ASIC) technology to realize an integral TTL or CMOS compatible driver. The circuitry is housed in ceramic surface mount packages that give repeatable and predictable performance from DC to 3 GHz.

GaAs MMIC Switch Technology

This family of switches is based on metal semiconductor field effect transistor (MESFET) technology. The MESFETs are N-channel depletion mode devices with 1-µm Schottky gates. Depletion mode devices are low resistance at 0 bias. When a negative voltage is applied to the gate, the electric field begins to narrow the channel, increasing the resistance. The voltage that closes off the channel and creates the highest resistance of the MESFET device is known as the "pinch-off" voltage. Pinch-off voltages for M/A-COM MESFETs are typically -2.5 volts.

By varying the gate voltage between 0 volts and some value greater than pinch-off (typically -5 to -8 volts), the MESFET acts as a variable resistor. MESFETs can be arranged into series and/or shunt configurations and biased to provide *on* and *off* switching characteristics. A representative schematic for a GaAs MMIC switch chip is shown in Figure 1.

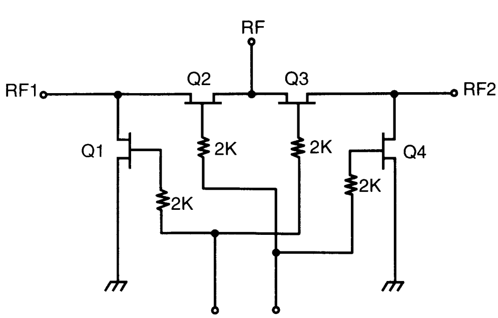


Figure 1. Schematic for MASW6010

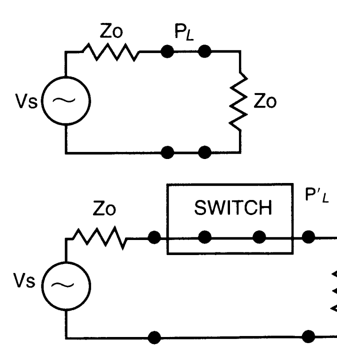
The voltages at control inputs A and B are complementary. From the preceding discussion, when control input A is low (0 to -0.2 volts), the MESFETs controlled by input A will be low resistance. Since the inputs are complementary, control input B will be high (-5 to -8 volts). The MESFETs controlled by this input will be in the high resistance state. Under this set of logic conditions, the incident RF signal will be switched to port RF2 as shown in Figure 1.

Definition of Terms

The final design of a switch represents a trade-off among several performance parameters. Many of these parameters are interrelated; so improved performance in one area comes at the expense of degraded performance in another. This section will define commonly used terms and provide insight into design trade-offs.

Insertion Loss

Insertion loss, represented in Figure 2, is a measure of the difference between the input and output power of the *on* path of a device. This loss, expressed in decibels (dB), is composed of power dissipated in components, reflected from mismatches and radiated into free space. Insertion loss arises from the fact that components used in the design of the switch are not ideal.



P'_L = Power delivered to load with switch in path

P_L = Power delivered to load without switch in path

$IL = 10 \log \frac{P_L}{P'_L}$

Expressed in Decibels (dB)

Figure 2. Insertion Loss

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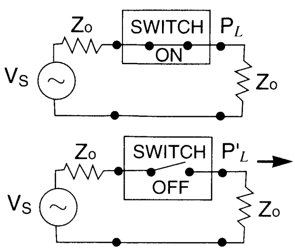
Isolation

Isolation, shown in Figure 3, is a measure of the difference between the input and output power of the *off* path of a device. To increase isolation, additional components can be added to a design, or the existing components can be optimized for isolation performance. In either case, the result will be increased insertion loss. Typically, a path in isolation presents a reflective termination.



P'_L = Power delivered to load with switch in the "on" condition

P = Power delivered to load with switch in the "off" condition.

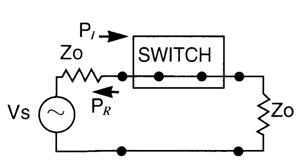
$ISO = 10 \log \left(\frac{P_L}{P'_L}\right)$

Expressed in Decibels (dB)

Figure 3. Isolation

VSWR

VSWR (Voltage Standing Wave Ratio) is a measure of how well the device matches the characteristic impedance of the system. VSWR is a number derived from a return loss measurement. Return loss compares the input power to a device with the power level that is reflected from that device. Knowing these two powers, a reflection coefficient can be derived which translates to a VSWR number as follows in Figure 4.



$$VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

P_I = Incident power to switch RF port

P_R = Reflected power from switch RF port

$|\Gamma|$ = Magnitude of the voltage reflection coefficient

$$|\Gamma| = \sqrt{\frac{P_R}{P_I}}$$

Figure 4. VSWR

As mentioned, typical designs result in the isolation path appearing as a short circuit that will reflect a significant portion of the input power. This results in a low return loss and a correspondingly high VSWR. If this presents a problem, a switch can be designed so that when the path is in isolation, incident signals are terminated in a resistive load. This technique allows the VSWR of the isolation path to be comparable to that of the insertion loss path. These devices are called absorptive or nonreflective switches.

Switching Speed

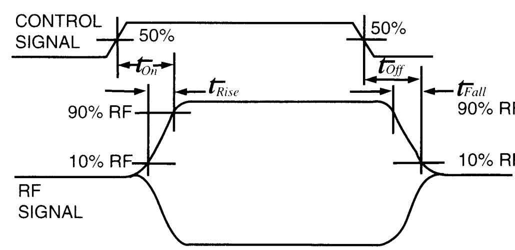
As discussed previously, the MESFET is essentially a voltage variable resistor. With MESFETs configured as a switch, switching speed is a measure of time required to change from insertion loss (*on*) to isolation (*off*) or vice versa. To completely specify switching speed, four terms must be known. A pictorial representation and definition appear in Figure 5.

T_{Rise} = Rise Time

T_{Fall} = Fall Time

T_{On} = On Time

T_{Off} = Off Time



T_{Rise} = Rise Time = Time for RF signal to rise from 10% to 90% of the maximum "on" level.

T_{Fall} = Fall Time = Time for RF signal to fall from 90% to 10% of the maximum "on" level.

T_{On} = On Time = Time from 50% of the control pulse to 90% of the maximum "on" level.

T_{Off} = Off Time = Time from 50% of the control pulse to 10% of the maximum "on" level.

Figure 5. Switching Parameters

Rise and fall times relate primarily to the device and reflect how quickly a change of state can occur.

On and *off* times include a component of delay, which is dependent on how the devices are being driven. This family of switches with integral drivers includes this delay in their *on* and *off* times. These quantities are a measure of the time elapsed between the command pulse reaching a specified level and the detected RF response changing state to within a certain level (typically, to within 10% of its final state). When a device contains no driver, *on* and *off* times are not specified, because the times will be dependent on how the device is driven.

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Switching Transients

When a device is pulsed, the leading and falling edge of the pulse contains many higher frequency components. The number of components and their contribution is determined by the sharpness of the pulse edges. In addition, the MESFETs are non-linear devices that generate harmonics of the incident signals. The fundamental switching structure filters out some of these frequency components; however, some component of these switching signals will be present in the switch output. These signals can be specified as a maximum voltage amplitude, or in terms of spectral content with a maximum power level.

Power Handling

Any RF signal has an associated RF voltage. This RF voltage is sinusoidal with a period related to the frequency. As we have discussed, the MESFET can be thought of as a voltage variable resistor. As the RF voltage swing gets high enough, it can counteract the DC bias level. If this happens, the resistance of the MESFET will change. If the MESFET is in its low resistance state, the increase in resistance appears as increased loss.

Power handling is measured in many ways. One convenient benchmark is to specify the power level at which the device has an additional 1 dB of insertion loss. This quantity, known as the 1dB compression point, is not a maximum power level. It is a standard measurement point that provides information about the range of usable input power levels. The 1dB compression point is frequency dependent, reflecting the increasing period of the RF voltage with decreasing frequency. At very low frequencies, the RF voltage is closely approximated as a DC signal that more efficiently increases the resistance than a higher frequency, time-varying signal. The 1dB compression point can be increased by increasing the negative bias to the MMIC chip from -5 volts to -8 volts. This increases the DC bias level that the RF voltage swing must counteract, increasing the power level required to get the same amount of compression.

Another measure of power handling is the maximum power, which is the highest input power that is guaranteed without damage. Implicit in this specification is that the device is "cold switched." Cold switching means the device is switched in the absence of power. This is an important consideration. If the device changes state in the presence of power ("hot switching"), the MESFETs will transition through a resistance region where a significant portion of the incident power will be dissipated. This can easily lead to damage.

Intermodulation Intercept Points

Intermodulation intercept points are measured with two equal amplitude input signals spaced closely together in frequency. Since MESFETs are non-linear devices, they exhibit "mixing" or frequency-generation characteristics. In any kind of receiving system, signals that are generated internal to the device can degrade overall system performance. This measurement is used to determine the intercept points (typically second and third order) of a device. The intercept points are calculated values and are defined as the power at which the intermodulation product amplitude is equal to the input. This quantity plays a major role in system dynamic range and sensitivity performance. The intercept points are calculated as follows:

$$IP_n = [IMD_n/(n-1)] + P_{in}$$

where: IP_n = n^{th} order intercept point (dBm)
IMDn = n^{th} order intermodulation distortion product (dBc)
n = order
P_{in} = input power (dBm)

Distortion is a measure of the non-linearity of a device. GaAs FET based switches offer significant advantages in performance over PIN diode based switches. Distortion arises when non-linearities in device operation are introduced. Non-linearities result from time-varying changes in resistance or capacitance of a device. Since GaAs MESFET switches are voltage controlled, they are less susceptible to modulation at normal operating power levels. This results in superior distortion performance.

Internal Driver Circuitry

To realize the performance parameters outlined in this application note, the GaAs MESFETs must be driven with complementary voltages in the range of 0 to -0.2 volts and -5 to -8 volts. M/A-COM's switch family accomplishes this with an integral ASIC driver. The integral driver is configured to be compatible with TTL or CMOS input signals. The ASIC chip driver technology results in very low power consumption (10 mW at nominal voltages) and quiescent current (1 mA max from either power supply). Despite low power consumption, the devices have typical switching speeds of 12-18 nSec (including driver delay). Inclusion of a driver greatly simplifies the integration of the switches into systems. The user needs only to supply the recommended bias voltages and control signals, and the switch is operational.

For more detailed information on the M/A-COM GaAs FET ASIC driver, contact M/A-COM.

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Drivers for GaAs FET MMIC Switches and Digital Attenuators

M539

V 2.00

Application Note

M/A-COM's Microelectronics Division produces a silicon CMOS Application Specific Integrated Circuit (ASIC) that drives GaAs Field Effect Transistor (FET) based switches or digital attenuators from a single TTL or compatible IC. These ASICs are available in single (SW-109) or quad-channel (SWD-119) plastic packages. This application note provides technical and application information to simplify the use of these drivers.

Introduction

GaAs MMIC control devices like switches and digital attenuators typically employ FET technology. The most common FET is the N-channel depletion mode device which has low source-to-drain resistance when there is no bias. When a negative voltage is applied to the gate, the electric field narrows the channel, increasing the source-to-drain resistance. The voltage that closes off the channel and creates the highest resistance of the FET is known as the "pinch-off" voltage. For MA-COM FETs, the pinch-off voltage is typically -2.5 volts.

FETs can be arranged in series and/or shunt configurations, then biased to provide varying insertion loss values. By varying the gate voltage between zero volts and some value greater than pinch-off (typically -5 to -8 volts), the FET acts as a voltage variable resistor. If the device is biased at the extremes (0 V and -5 V), *on* and *off* switching results, providing the basis for both the GaAs MMIC switches and digital attenuators. Switches require low loss (*on*) and high loss (*off*) paths during operation. Digital attenuators use bits of different loss values to switch in or out of the transmission path, either individually or in combination.

FET based control devices are most often configured in series/shunt arrangements, resulting in the broadest bandwidth for the available size. In these configurations, the driver output must be complementary, supplying different voltage levels to the series and shunt mounted FETs. This is usually accomplished with level translation and multiple IC chips, increasing the complexity, size and DC power dissipation of the device.

Design Considerations

To accommodate the need for a large output voltage swing and low DC power dissipation, the ASIC design uses a standard CMOS analog fabrication process. A buffering stage is added so that the driver will switch with standard TTL, as well as CMOS logic levels, increasing the flexibility and ease of use for system designers. The ASIC driver requires only a single control input per channel, further simplifying the external drive requirements.

TTL Input Buffer

The input buffer operates at standard TTL input levels, despite being fabricated with a CMOS process. The CMOS process keeps the quiescent current in the micro-amp range when the input control signal is close to V_{CC}. When the control signal level drops, the quiescent current increases. At a control voltage of 2.9 volts, the current increases to only 0.7 mA.

As the block diagram shows, the TTL input buffering is followed by additional buffering stages that take the input TTL signal and generate two complementary signals. The two signals, noninverting and inverting, are also buffered to ensure they are at the proper levels. The need for complementary signals arises, as described earlier, from the series-shunt schematic of most GaAs MMIC based control devices.

Voltage Translator

The input buffering is followed by a voltage translator. This stage translates the 0-V and 5-V TTL levels to the voltage levels required to switch the GaAs MMIC device to the *on* and *off* states. As described earlier, switching in a GaAs FET MMIC occurs when the incident voltages change from 0 V to a level greater than pinch-off. These drivers include a feature in the translator section that allows the user to optimize the performance of the GaAs MMIC device being driven.

At pinch-off, the electric field on the gate closes the channel of the FET resulting in the high resistance state of the FET. If the gate voltage is near the pinch-off value, the incident RF voltage may modulate this resistance.

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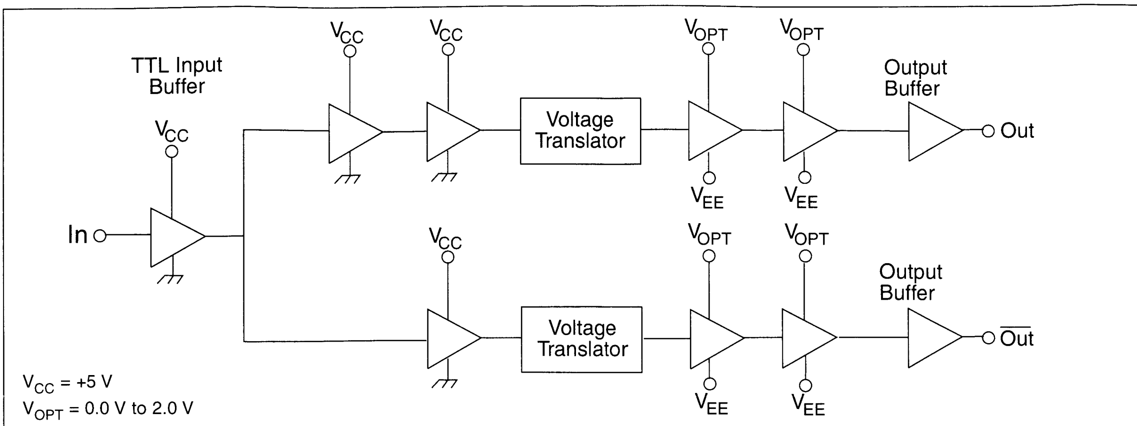

Figure 1. Driver Block Diagram

This effect can be minimized by increasing the gate voltage. With higher gate voltage, the incident RF voltage needs to be at a higher level to cause the same resistance modulation. The gate voltage level affects performance in two regards.

First, if the RF signal level is high enough to cause the resistance to modulate, the insertion loss of the MMIC may increase, a condition known as compression. The common measurement of this phenomenon is the 1-dB compression point. This is a measure of the power level where the loss of the device increases by 1 dB from the low power loss levels. If the gate voltage increases, the incident RF power must be higher to cause compression. The net result is an increase in the 1-dB compression point, allowing the device to operate at higher input power levels. The voltage that biases the gate, shown as V_{EE} in the block diagram, is adjustable from -5 V to -8 V and appears directly at the gate of the GaAs FET.

The second impact occurs in the intermodulation performance. The modulation described above causes the FET to become more non-linear as the resistance of the GaAs FET acquires a time varying component. Modulation increases the distortion of the GaAs FET, degrading the harmonic and intermodulation performance. Increasing the gate voltage minimizes this modulation effect for a given power level.

Since the GaAs FET is a voltage variable resistance from 0 V to pinch-off, it follows that the same modulation effect may occur at the 0-V bias level. M/A-COM has found that if a GaAs FET is biased slightly positive, this effect is minimized. In this case, the resistance of the GaAs FET may increase during the negative portion of the incident RF signal. A small positive offset minimizes this, improving the intermodulation performance. The voltage is referred to in these switch drivers as V_{OPT}. The drivers will accommodate this voltage being varied from 0 V to +2 V to optimize intermodulation performance.

Output Buffer

The final section of the driver is an output buffer that occurs after the voltage translation and is composed of successively larger buffer stages. A GaAs FET MMIC control component usually consists of several FETs with the gates of multiple devices tied together. Since each device has finite isolation, tying the gates together presents a cross-talk isolation concern. The standard technique to minimize this is to add capacitance to ground on the control lines, shunting any RF energy on the control lines to ground. The buffering stages are designed to allow the driver to drive a load capacitance up to 25 pF.

Performance

For guaranteed maximum ratings and performance over temperature, please refer to the SWD-109 and SWD-119 data sheet.

Additional Notes

1) To achieve the fastest switching performance, the GaAs FET MMIC die should be floated at a potential of +5 V.

2) V_{OPT} of 1.4 V can be derived from a circuit consisting of a resistor from the +5 volt supply to a pair of diodes mounted to ground (see Fig. 2).

3) The single-channel driver (SWD-109) is available in an SOIC 8-lead plastic package. The quad-channel driver (SWD-119) is available in an SOIC 16-lead plastic package.

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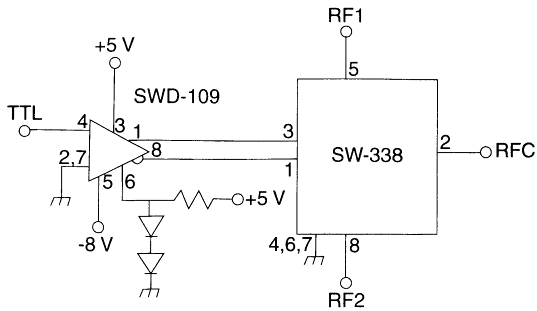

Figure 2. SWD-109 Single-Channel Driver and SW-338 GaAs MMIC Switch

TTL Input	Outputs	
C1	A	B
Logic 0	V_{EE}	V_{OPT}
Logic 1	V_{OPT}	V_{EE}

Control Inputs		RF Common To:	
A	B	RF1	RF2
1(V_{EE})	0(V_{OPT})	On	Off
0(V_{OPT})	1(V_{EE})	Off	On

4) The SWD-109 is supplied with two ground pins (Pin 2 and 7). Only one of the two pins needs to be grounded.

5) If V_{OPT} is not required, the pin should be grounded.

Summary

MA-COM Microelectronics Division has introduced a silicon CMOS ASIC driver for GaAs FET MMIC control devices. This driver is designed to operate with TTL or CMOS input logic levels, without the need for any external components. The ASIC driver requires positive (+5 V) and negative (-5 V to -8 V) voltages for operation. A third voltage (Vopr) can be supplied to improve the low frequency performance of GaAs FET MMIC control devices.

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Electrical Characterization of Packages for Use With GaAs MMIC Amplifiers

M542

V 2.00

Abstract

A test methodology will be presented which combines the advantages of on-wafer RF probing with a TRL calibration to create a completely de-embeddable, novel "test fixture" capable of electrically characterizing most any style package or device. This scheme has been used to characterize many of the currently available microwave packages in order to identify appropriate packages for our MMIC amplifier products which cover frequencies up to 12 GHz. In addition, the technique has been employed to characterize injection-molded plastic packages and to evaluate non-probeable MMICs.

Introduction

Most package vendors have very little microwave design and characterization capability. Their limited characterization efforts typically involve the use of poor fixturing, which obscures the true frequency response of the package. Companies specializing in fixturing, while investing considerable mechanical engineering effort, expend far less on electrical considerations, often producing fixtures inadequate for use at microwave frequencies. Consequently, there is very little microwave performance data available from package vendors.

Therefore, to evaluate and identify candidate packages for each of the amplifiers in our MMIC amplifier product line, specific fixturing had to be developed for each package style considered. A novel fixturing approach was designed and implemented, which not only eliminates the need for expensive, package specific fixtures, but also overcomes the frequency limitations of traditional connectorized, plunger-style fixtures. Additionally, a rigorous calibration method was developed which allows complete fixture de-embedding.

This test methodology is applicable to practically any style device. Table 1 lists the package styles investigated. Through this work, proper electrical characterization of commonly used packages has indicated useful frequency ranges broader than expected by even the package manufacturers. This finding has allowed us to use low-cost packages for frequency applications where our competitors typically resort to high-priced custom packages.

Package Description	Manufacturer
5 lead, ceramic	Kyocera
6 lead, ceramic	Kyocera
Leadless, 6 port, ceramic	StratEdge
7 lead, ceramic	Kyocera
8 lead, ceramic	Kyocera
8 lead, glass Mini-Systems	
8 lead, glass, ground straps	Mini-Systems
Leadless, 8 port, ceramic	Oxley
Leadless, 10 port, ceramic	Alcoa

Table 1. Summary of Packages

Design Approach

To eliminate the need for expensive, device specific, traditional fixtures and overcome their frequency limitations, an RF probeable ceramic substrate was designed as the interface to the device-under-test (DUT). Figure 1 illustrates this coplanar probe to microstrip transition. It is a 50-ohm line fabricated on 10-mil thick alumina, with an 8-mil pitch, ground-signal-ground (G-S-G) probe pattern at one end. The two ground pads are connected to the substrate backside with 8-mil diameter plated vias. The G-S-G pattern can be probed using commercially available microwave probes on a standard microwave probe station. The opposite end of the substrate can be bonded to a test port of the DUT.

To complete the "test fixture," only a thin brass block is

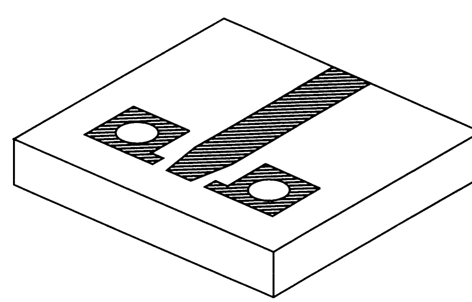

Figure 1. Probeable Ceramic Substrate

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required to serve as the mounting surface for the ceramic substrates and the DUT. If necessary, the brass block could be machined to compensate for any difference in height between the substrate and DUT test port. To fixture practically any DUT, all that is needed is a brass plate and the probeable ceramic substrates. Figure 2 shows the configuration used for characterizing our MAAM71200-H1, a packaged 7-12 GHz GaAs MMIC low noise amplifier.

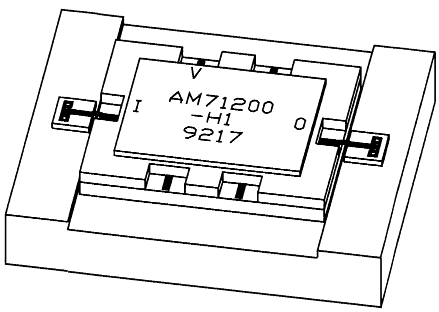

Figure 2. Fixtured MAAM71200-H1

To de-embed this "test fixture," a set of through-reflect-line (TRL) standards was employed. A "zero-length" through, a short, and two delay lines were fabricated. These standards, shown in Figure 3, are used with the common TRL de-embedding algorithm. This allows any measurement made with the probeable ceramic substrates to be de-embedded to yield data for only the DUT with connecting bonds. Bond wires can also be de-embedded by first characterizing and modeling them using this same "probeable ceramic" technique. For this work, multiple bond wire and ribbon lengths were characterized to generate fully scalable bond models.

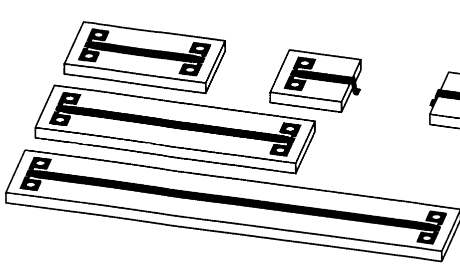

Figure 3. TRL Calibration Standards

To demonstrate the package characterization method, the evaluation of a standard Kyocera 8-lead ceramic flat pack will be examined. Figure 4 shows how one feedthrough structure in the wall of this package was tested. Package leads were cut close to the package body, and the ceramic substrates were mounted flush to the package ports. Two short 3-mil wide gold ribbons bond the substrates to the package.

Similarly, sealed packages with leads internally terminated with 50-ohm chip resistors were tested to determine the cross-coupling between opposite and adjacent leads. Through-lines within sealed packages were also measured. With this data, the true electrical performance of the package was determined and models for the feedthrough and coupling were developed.

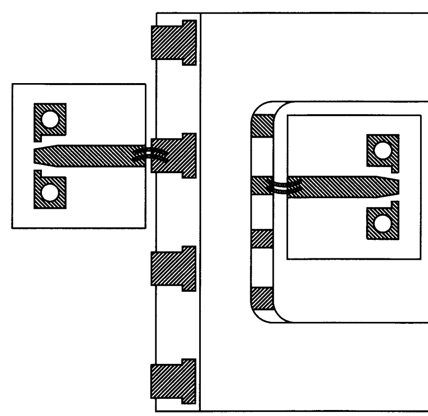

Figure 4. Fixtured Feedthrough

This information allows the identification of an appropriate package for existing MMIC products and provides an accurate model for incorporating package effects into future design work.

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Experimental Results

The feedthrough walls of each package listed in Table 1 have been tested and modeled. This feedthrough data alone largely indicates the useful frequency range of each package. Figure 5 shows the frequency response for the feedthrough of the 8-lead ceramic flatpack. This package, previously thought to be useful only at lower frequencies, demonstrates excellent performance well into X-band before resonating. Based on this result, we assembled our 2-8 GHz GaAs MMIC amplifier into this package. The performance of this packaged amplifier, part number MAAM28000-A1, is shown in Figure 6.

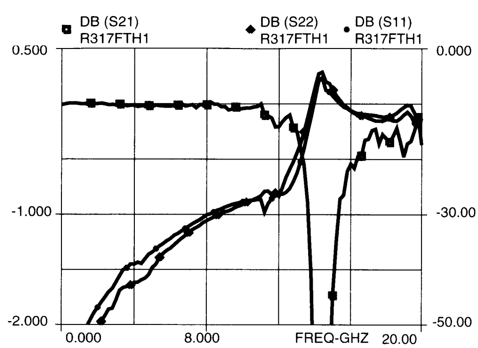

Figure 5. Feedthrough Frequency Response

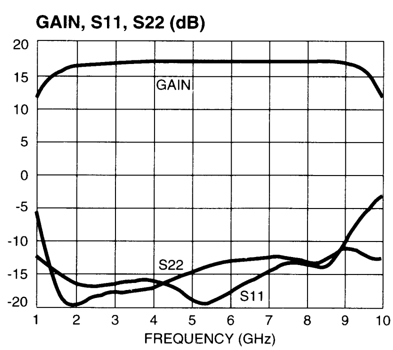

Figure 6. MAAM28000-A1 Performance

Using the de-embedded feedthrough data, a Y-parameter extraction followed by a constrained optimization was performed to derive the feedthrough model shown in Figure 7. Figure 8 shows the measured versus modeled insertion loss and input return loss for this package feedthrough. The model simulates the feedthrough performance closely over the useful frequency range of the package.

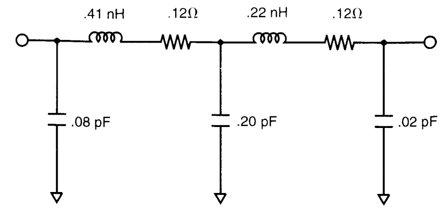

Figure 7. Feedthrough Model

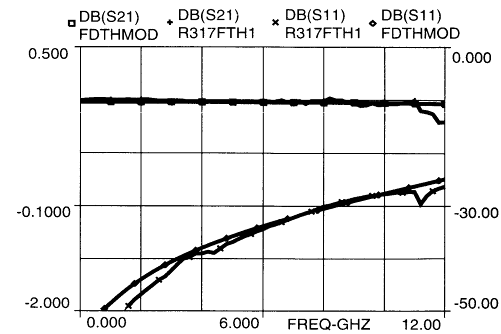

Figure 8. Measured vs Modeled Performance

Coupling effects between package ports were also measured and modeled. A Y-parameter extraction showed that the coupling could be attributed to equivalent capacitance values. In the case of the 8-lead ceramic flatpack, coupling between adjacent ports along one side of the flatpack can be represented by a 0.03-pF capacitance. Between alternate ports along the same side, the coupling capacitance is nominally 0.003 pF. Coupling between internally terminated ports on opposite sides of the flatpack was modeled with a 0.007-pF capacitor. This coupling model accurately predicts the measured input to output isolation, as illustrated in Figure 9, over the package's useful frequency range.

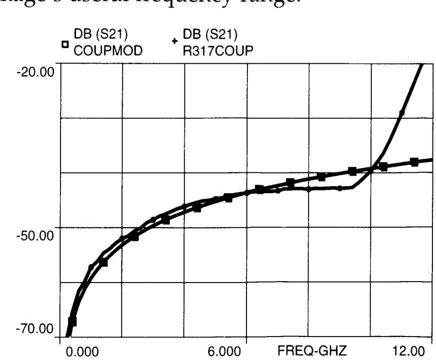

Figure 9. Package Isolation

Characterizing the packages in Table 1 produced interesting results. The five relatively inexpensive packages (the 5-, 7-, and 8-lead flatpacks) are commonly used for fairly low frequency applications. However, as detailed above, the 8-lead ceramic flatpack, supplied by Kyocera, exhibits excellent performance into X-band. Mini-Systems' 8-lead glass flatpack also exhibits excellent performance into X-band, and their version with ground straps has similar performance through C-band. The Kyocera 5- and 7-lead ceramic flatpacks, often used in switching applications, have higher insertion loss and lower return loss, but demonstrate reasonably good performance into X-band and C-band, respectively. The Oxley manufactured leadless 8-port ceramic package has excellent performance through C-band.

The remaining three packages shown in Table 1 are all advertised for high frequency applications. Of these, StratEdge's leadless 6-port ceramic flatpack exhibits the best performance through 20 GHz. The Alcoa 10-port ceramic package also works reasonably well up to 20 GHz. Kyocera's leaded version of the 6-port ceramic package demonstrates reasonably good performance to 16 GHz.

At least one suitable package was chosen for each of the small signal amplifiers, and one of the power amplifiers, in our GaAs MMIC amplifier product line. Table 2 lists all the packaged amplifiers now offered as standard products. This test method was also used to characterize the lead parasitics of the SOP and SSOP plastic packages. That data has been incorporated into the design of several new products specifically targeted for high-volume, low-cost, commercial applications. Bond wires, bond wire pairs and ribbons have also been characterized with this test method, resulting in scalable, empirically-derived models. In addition, this test methodology is widely employed in our engineering test lab to RF probe MMICs which are otherwise not RF probeable.

P/N (MAAM-)	Function		Package Style
02350-A2	.2-3.5 GHz	IFA	8 lead, ceramic
12000-A1	1-2 GHz	LNA	8 lead, ceramic
23000-A1	2-3 GHz	LNA	8 lead, ceramic
37000-A1	3-7 GHz	LNA	8 lead, ceramic
71200-H1	7-12 GHz	LNA	Leadless, 6 port ceramic
28000-A1	2-8 GHz	WBA	8 lead, ceramic
26100-B1	2-6 GHz	PA	7 lead, ceramic

Table 2. Packaged Amplifier Products

A novel fixturing and test methodology has been designed and implemented which allows accurate microwave frequency characterization of virtually any device. This approach has been used to evaluate many of the currently available microwave packages. Appropriate packages have been identified for our GaAs MMIC amplifiers, resulting in many new standard products. Models for package feedthrough structures, plastic packages, and bond wires and ribbons have all been developed using this method.

Acknowledgements

Written by Stephen R. Smith and Michael T. Murphy. The authors thank Scott Mitchell and Ted Begnoche for testing these devices, Brenda Milinazzo for assembling them and Bill Fahey for helping to prepare this paper.

ESD Considerations for IC GaAs FET Devices

M543

V 2.00

Introduction

Military ESD control procedures have been established in MIL-HDBK-263 and MIL-STD-1686. Recent studies show that GaAs devices can be damaged by ESD voltages in the 250 volt range; this classifies these products as Class O.

When dealing with GaAs devices, the elimination of electrostatic generators is necessary to protect against ESD voltages. Work procedures should be followed as outlined in the next section.

Protective Procedures

a. Real time wrist strap monitors

A monitor that detects and sounds an alarm if out of range impedance to earth ground conditions are detected. A typical high alarm would be an open circuit; the wrist strap is not connected correctly to the user preventing a slow and controlled discharge of electrons to earth ground. A typical low alarm is that the user is in direct contact with earth ground allowing for the rapid flow of electrons.

b. Static dissipative work surfaces

The work surface must be static dissipative and connected to earth ground.

c. Conductive flooring

The flooring where any product is to be handled outside its protective transport must be conductive and connected to earth ground.

d. Dissipative footwear

All operators handling devices must wear two static dissipative foot straps or shoes at all times while handling devices.

e. Protective product transport conductive containers

The product may only be transported in a conductive carrier in contact with a static dissipative barrier enclosed in a sealed conductive tote, bag, or box.

f. Conductive smocks

Each operator must wear a conductive type smock designed to enclose a charge produced on a person and dissipate the charge through tile wrist strap to ground in a controlled manner.

Failure Analysis of ESD Damaged Devices

Failure of GaAs devices from ESD voltages is evident by increased system noise, increased leakage of dc current, increased insertion loss, or lower isolation. Depending on the severity of the damage, any or all of the above indicators can occur.

Major degradation (i.e. shorts or open circuits) may be visible with optical examination in the 500X to 1000X magnification. Moderate damage (i.e. loss in isolation or large increase in insertion loss) may be detectable with standard scanning electron microscope techniques.

In a minor degradation, system noise and an increase in reverse leakage current (> 100%) may occur. Failures are from a flow of electrons from a high voltage potential to a low voltage potential through a channel or blow hole (material dislocated by ESD voltage).

Visual inspection at 1000X magnification or standard SEM analysis may not show a minor damaged location. Low Voltage Contrast Scanning Electron Microscopy is an analysis technique that is more sensitive in detecting these small damaged areas.

Low Voltage Contract Scanning Electron Microscopy (LVCSHM)

The theory of Low Voltage Contrast Scanning Electron Microscopy (LVCSEM) is based on the detection of surface emitted electrons. The usual SEM function is to detect the reflected electrons from the surface of a component under analysis, producing a high magnification image of the device. But in LVCSEM an external bias is applied to the component under analysis. The device surface areas connected to bias emit free electrons, which are detected by the SEM chamber detector to produce a glowing image of the biased areas, against an unenhanced image of unbiased areas.

ESD is the rapid flow of electrons from a high voltage potential to a lower voltage potential. When this occurs, small amounts of materials are dislocated and a new channel or blow hole is established for tile flow of electrons to the low voltage potential (i.e. a leakage path). Using the scanning electron microscope with the device under bias allows for the inspection of the component surface for any nonstandard flow patterns. In this way the site of the ESD channel or blow hole can be detected.

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The Application of LVCSBM Proceeds as Follows:

a. Component Bias

A bias is introduced into the vacuum chamber that will not violate the chamber integrity. The bias can be a dc signal or a pulsed signal at the customary bias levels for the device under tests.

b. System Power

The power Level of the SEM is set in the range of 1 to 7 KV. Higher levels may overpower the electron emission from the component's surface.

c. Sample Preparation

Gold or carbon coating of the sample is not recommended; the new conductive layer will prevent normal current flow. Note that some surface charging will occur during SEM analysis. For this reason a pulsed bias signal will give the best results.

LVCSBM Analysis

Knowledge of the normal bias flow patterns for the device under test is necessary to isolate the non-standard bias flow of ESD degraded devices. The sample is inspected at low magnification to establish that bias is present, and to give an overview of the normal electron flow patterns. At a higher magnification the examination is conducted slowly over the device surface, inspecting it for any site of nonstandard electron flow, channels, bridges, holes or other abnormalities. The analysis using LVCSEM of the field failures can identify both bridging and blow holes which induce high leakage current.

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Application Note

FET Switching Below 50 MHz at 1 Watt

By Nitin Jain, Ronald J. Gutmann

M546

V 2.00

Discussion

Use of FETs for dc to 20 GHz switching is common, but distortion occurs at power levels above 100 milliwatts, especially below 50 MHz. The authors present a diode gate bias method which extends operation to 1 watt.

Introduction

Gallium Arsenide metal-semiconductor field effect transistors (GaAs MESFETs) are becoming widely used as control elements in switches and variable attenuators for a variety of reasons. The control port (gate) is naturally isolated from the RF ports (source and drain) with the result that no bandwidth limiting filters need be used to separate signals and bias. This has resulted in decade bandwidth switches operating from dc to 20 GHz or more.

Furthermore, the MESFET consumes little prime power for bias in either state because it is voltage rather than current controlled, as the PIN diode.

The MESFET is capable of nanosecond switching, and the device is compatible with conventional MMIC processing so that it can be built onto more complex GaAs chips.

MESFETs are increasingly considered for baseband applications such as kHz-to-GHz sweep oscillators, high-speed A/D converters, digital step attenuators and even solid-state relay replacements.

However, a limitation, compared with the PIN diode, is the decreased power handling capability and increased distortion at low frequencies especially below 50 MHz. This phenomenon has been documented experimentally and confirmed by recent switches that otherwise show excellent broadband characteristics [1-3].

This paper summarizes the mechanisms that degrade the low frequency power handling performance of MESFET switches with conventional gate bias circuitry (typically a 5 kohm resistor) and presents a circuit that eliminates the low frequency power degradation [4], the diode-gate MESFET switch.

This diode-gate biasing circuit has been implemented monolithically with a significant improvement in the low frequency power handling capability (constant power handling to below 100 Hz) and total harmonic distortion (THD) in the transmission state (as much as 50 dB improvement in THD). In addition, the diode-gate permits the 5 kohm series resistor to be reduced by at least a factor of 10, thereby also improving in switching speed without a serious power handling penalty.

Low-Frequency Distortion Mechanisms

We have described the various distortion causing mechanisms that significantly limit the power handling capability of control MESFET devices [5]. In summary, the non-conducting state power handling limitations are related to non-pinch-off conditions and avalanche breakdown, while the conducting state power handling capability limitations are related to current saturation and forward gate current injection during part of the AC cycle of the controlled signal.

The low frequency power handling degradation of a conventionally biased control FET results from the reduced AC signal coupling to the gate. At high frequencies (above 100 MHz), the capacitive reactance from the active device-to-gate is much lower than the gate biasing resistance so that the gate is floating (that is, the AC voltage at the gate is between the source and drain voltages).

However, at low frequencies the capacitive reactances are much higher, and therefore the gate is AC grounded (that is, the gate bias resistance is much less than the active device-to-gate capacitive reactance).

In the non-conducting state, the reduced AC signal coupling to the gate at low frequencies results in lower AC voltages at which the device comes out of pinch-off and goes into avalanche breakdown. The avalanche breakdown produces comparatively little distortion due to the presence of the large gate bias resistance (typically 5 kohm). For most applications, therefore, the non-conducting state power handling capability can be improved by biasing the MESFET control device closer to the breakdown voltage [5-6].

Similarly, in the conducting state the gate is effectively grounded at low frequencies. Therefore, in the positive-going AC cycle the gate is biased negative with respect to the channel, pinching the channel height. This is the primary mechanism responsible for early power saturation at low frequencies in series-mounted FETs. This problem is alleviated by the diode-gate biasing scheme to be described.

Diode-Gate MESFET Switch Device

The new diode-gate MESFET switch device (patent pending submitted by M/A-COM, Inc.) that reduces the low frequency distortions consists of a 5 kohm resistance connected in series with a Schottky barrier diode as shown schematically in Figure 1. The diode is directed towards the gate bias supply, which is positive in the conducting state and negative in the non-conducting state.

In the conducting state, the bias voltage is chosen to be near the highest positive AC voltage in the channel. Since the diode is reverse biased under the influence of a positive voltage, the gate floats for most of the AC cycle, eliminating premature pinch-off. In the non-conducting state, the negative bias voltage (which for low distortion is chosen closer to the avalanche breakdown voltage than the pinch-off voltage) is transmitted through the diode, and therefore the diode-gate MESFET behaves in a way similar to the conventionally biased MESFET.

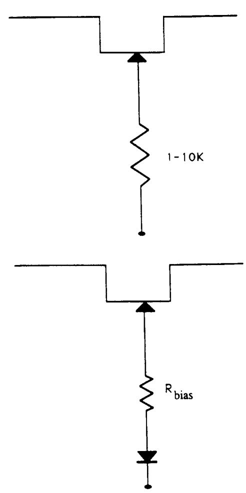

Figure 1. The diode-gate FET biasing method and the conventional resistive circuit.

The design of the Schottky diode is constrained by two factors. First, the capacitive reactance of the Schottky diode in the reversed bias state must be higher than the reactance of the MESFET gate coupling capacitive reactance. This follows directly from our earlier discussion in which the low frequency distortions were attributed to gate biasing impedances lower than the capacitive reactances between the active device and the gate. From this perspective, the Schottky diode has small area in order to have small capacitance.

On the other hand, the diode must be large enough in area to accommodate the required current to switch the device and handle any avalanche breakdown current. This avalanche current is low, however, because of the large gate bias resistance in series with the diode. Accordingly, the diode should be as small in area as its needs permit to sustain the current swings in the gate bias circuitry.

The diode parameters also must be selected so that the RF switching time is not degraded appreciably. As shown by the analysis in the Appendix, a Schottky diode junction area approximately that of the MESFET gate area is generally appropriate. The optimum size is dependent upon the positive bias and the relative priorities of certain switch parameters. Furthermore, the 5 kohm series resistor can be reduced by one to two orders of magnitude without serious reduction in diode-gate MESFET RF performance. This reduction in gate bias resistance reduces the switching time of the MESFET switch to below 1 nanosecond. Sub-nanosecond switching times, useful principally in modulation, mixing and signal processing applications, may not be achieved in actual devices because of material-related gate-lag effects [7].

The gate biasing diode does not affect other characteristics significantly. The insertion loss actually shows some improvement at lower frequencies because the MESFET gate is more effectively floated. The size of the Schottky diode is small compared to the MESFET size and is easily implemented monolithically. The only disadvantage of the diode-gate method is that a positive supply voltage is required (rather than zero volts) to achieve the conducting state of the MESFET switch.

Results and Discussion

We evaluated a dual 2-throw (D2T) control component which was modified using the diode-gate biasing scheme. The D2T is schematically shown in Figure 2, in which the AC signal is either directed through the upper branch (by pinching off the lower branch FETs) in the low-loss state, or through the lower branch (by pinching off the upper branch FETs) in the isolation state. The MESFETs used for the D2T component are standard M/A-COM power FETs, which have a channel doping of 8 x 10exp16 per cc, pinched voltage of about 3.4 V, gate periphery of 1.2 mm and I(DSS) of about 210 mA.

To evaluate the conducting state MESFETs, the FETs in the lower branch were removed and the FETs were biased initially in a conventional manner [5]. Figure 3 shows the typical power handling capability (measured by the 1 dB compression point) versus frequency of the two FETs in series. The power handling capability decreases from about 33 dBm at frequencies above 100 MHz to about 22 dBm at frequencies below 1 MHz.

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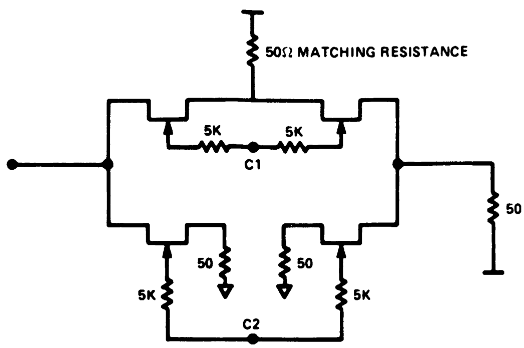

C1 & C2 ARE CONTROL SIGNALS

The series FETs were then modified (through external) bonding) to employ the diode-gate method shown in Figure 1. The power handling capability was remeasured with varying positive gate biases. The typical 1 dB compression point with bias voltage is shown in Figure 3, and indicates that the low frequency power capability can be the same as that experienced at microwave frequencies, provided that sufficient positive bias is applied. Single frequency measurements were made as low as 100 Hz with little change observed in the 1 dB compression level.

Figure 4 shows the complete monolithic implementation of the diode-gate bias scheme. The Schottky diodes shown in the gate biasing circuitry are 3 by 35 microns. Table 1 shows the 1 dB compression points at 0.01, 30, and 100 MHz for the two different biasing schemes. Case 2 (diode-gate biasing scheme) can handle about 7 dB more power than case 1 (conventional biasing scheme) at 30 MHz and about 13 dB more at 10 kHz.

In addition to the significant improvement in 1 dB compression level at low frequencies, the total harmonic distortion (THD) is reduced very appreciably. Figure 5 shows that the THD of a D2T control component with 23 dBm incident power at 10 kHz was reduced from -16 dBc to -65 dBc with the new diode-gate biasing method. Similar improvements are observed in other switch configurations wherein the nonlinearities are primarily encountered in the conducting state of the MESFETs.

The switching time characteristic of a conventionally biased MESFET switch is depicted in Figure 6a. The video breakthrough and the rise and decay of the RF envelope are apparent. Figure 6b depicts similar transient information with an adequately sized diode gate bias circuit and appropriate forward bias. Note that the rise time is comparable in both cases, nominally 3 nanoseconds. However, with a marginally sized diode, the rise time will be significantly increased as indicated in Figure 7a (to approximately 100 ns).

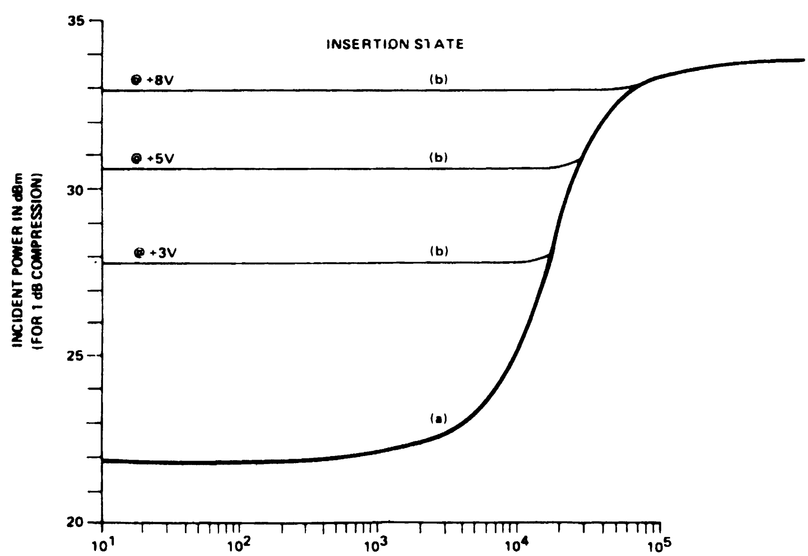

Figure 3. Measured power handling capability of dual 2-throw control component with (a) conventional 5 kohm gate resistance and (b) diode-gate biasing circuit.

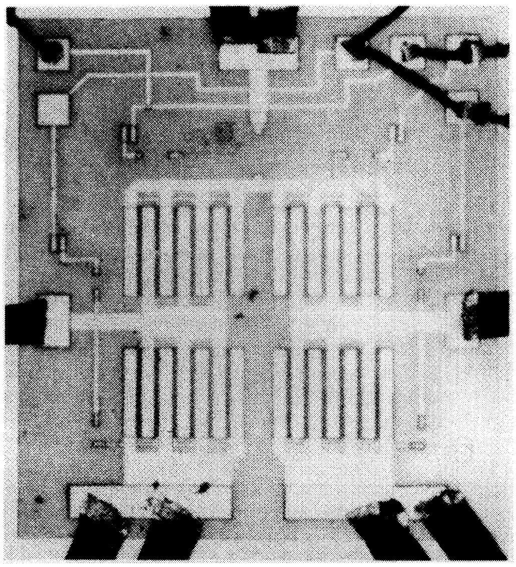

Figure 4. The monolithic implementation of the diode-gate biasing scheme dual 0.30-inch 2-throw control component.

This represents a poor design for the diode-gate circuit, requiring a higher forward bias to achieve reduced switching time, as depicted in Figure 7b. In all cases a 5 kohm gate resistance is included. However, with a properly sized diode-gate, the series resistance can be reduced to about 100 ohms, resulting in an inherent switching time below 1 ns. In practice, the lowest switching time that can be achieved becomes limited by other factors including material-related defects (gate-lag phenomena) and, in some cases, driver electronics.

Summary

Acknowledgments

The authors gratefully acknowledge the contributions of David Fryklund and William Moroney for providing the stimulus for the initial work on improving the low-frequency power handling capability of MESFET switches; David Johnson for establishing the measurement facilities and procedures; Peter Onno for helpful technical discussions: and members of the GaAs MMIC Control Product Group at M/A-COM ASD for processing and assembly. The work at Rensselaer was sponsored by a M/A-COM grant administered by Gerald DiPiazza and Douglas Maki.

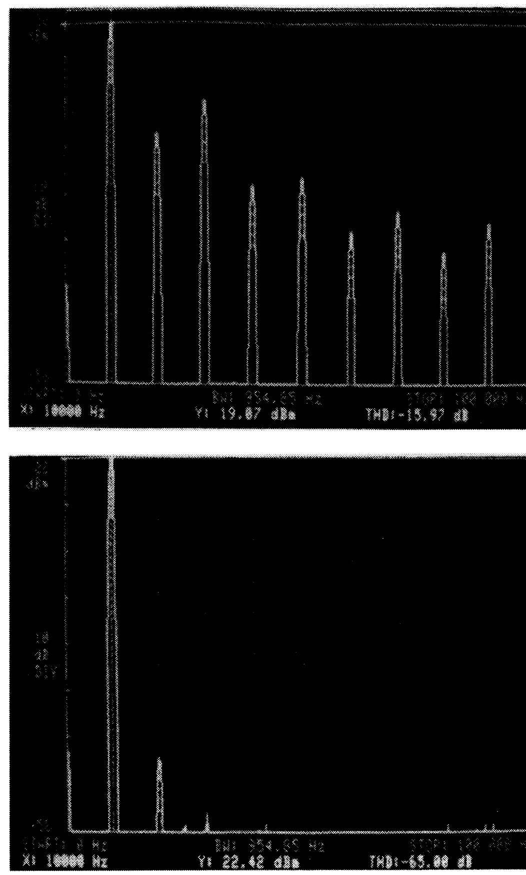

Figure 5. Total harmonic distortion versus frequency for dual 2-throw component: (a) conventional biasing circuit at 0-7 V and (b) with diode-gate bias circuit at + 8 to - 10 V.

Case	Bias High/Low	Frequency .01 MHz	30 MHz	100 MHz
1	0/-7	22 dBm	28 dBm	32 dBm
2	+10/-7	> 34 dBm	> 34 dBm	> 34 dBm

Table 1. Incident power for 1 dB compression for Case 1 (conventional circuit) and Case 2 (with diode-gate bias circuit).

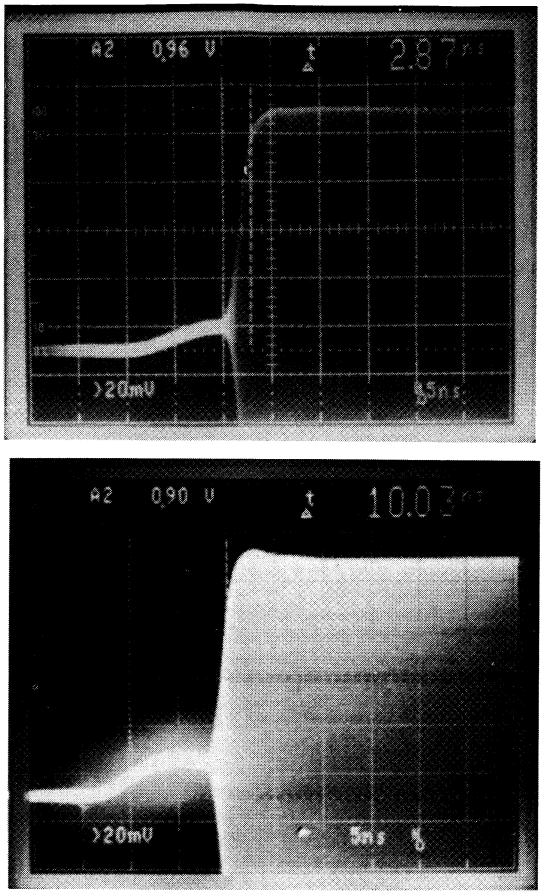

Figure 6. **Switching characteristics of MESFET control devices: (a) conventional MESFET (bias voltage switched from -7 to 0 V) and (b) with adequately sized diode-gate (bias voltage switched from -7 to 5 V).**

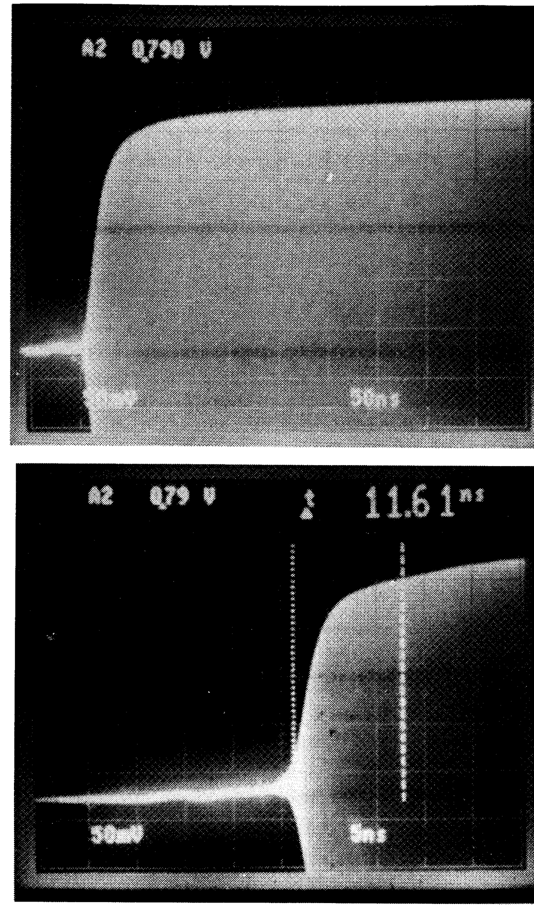

Figure 7. **Switching characteristics of diode-gate MESFET control devices: (a) with marginally sized diode-gate and low forward bias and (b) with marginally sized diode gate and sufficient forward bias.**

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Appendix

Diode-Gate MESFET Switching Capability

Consider that a diode-gate MESFET that is being switched from -V1 to +V2 volts (where V1, V2 > 0 and /V1/ > /VP/) Under steady state conditions the diode attains a reverse-bias voltage of about V2 volts. If it is required that the diode capacitance must be much less than the gate-to-device capacitance, it follows that CD(V2) < < CM(0) where CD(V2) is the incremental reverse-biased diode capacitance (mainly sidewall capacitance for the monolithic Schottky with top-surface contacts), while CM(0) is the zero-bias gate-to-active device capacitance (mainly due to the metal-to-semiconductor junction capacitance). Detailed models that simulate the RF switching waveform are presented in Reference 7. Here, we shall consider the sufficient conditions for the control device to have fast switching.

For fast switching (in the nanosecond range), we require that the depletion-layer charge in the MESFET in the off-state to be completely removed without any delay introduced by the diode. Consider the worst case scenario in which the diode must absorb all the off-state MESFET depletion-layer charge when an ideal voltage-step input is assumed. Under these conditions, the diode depletion-layer charge under reverse bias must be more than the off-state MESFET depletion-layer charge.

Consider, for example, a 1.2 mm recessed-gate control FET with a channel doping density of 10exp17 per cc, a pinch-off of 3 V, and gate-length of 1 micron. Let this FET have a planar Schottky diode 45 microns x 45 microns in the gate, with a channel doping of 10exp17 per cc, and a pinch-off of 4 V. When switched from -7V to +5V, this device has CD(5) of about 0.02 pF, while CM(0) is approximately 1.5 pF, which will clearly reduce low-frequency distortions. The depletion-layer charge at -7 V in the MESFET is about 7 pC, while the diode depletion-layer charge at +5 V is approximately 8.5 pC. Therefore, the FET is able to switch fast as well.

The V2 to -V1 transition is inherently fast with any sensible diode design. The dominant constraint for fast switching is the -V1 to +V2 transition as the control FET switches from the non-conducting or OFF state to the conducting or ON state.

Reprinted from Applied Microwave and Wireless Magazine, Summer 1990, J. F. White Publications, Inc., Lexington, MA, pp. 100-108.

M/A-COM an AMP company

Application Note

MMIC Control Circuits, VSWR, Switching Equations for Shunt and Series Elements

M547

V 2.00

MMIC Control Circuits

Important parameters to describe the circuit performance of Control Circuit Elements.

Insertion Loss (IL)—Switch is in the "On" Condition:

Insertion Loss is defined as the ratio

$$IL(dB) = 10 \log_{10} \frac{(PL_0)}{(PL_1)}$$

PL = Power delivered to the load with the switch not in the RF circuit.

PL_1 = Power delivered to the load with the switch in the RF current path ("ON" Condition).

Isolation (ISO)—Switch is in the "OFF" Condition:

$$ISO(dB) = 10 \log_{10} \frac{(PL_0)}{(PL_1)}$$

PL_1 = As above.

PL_2 - Power delivered to the load with the switch in the RF current path ("OFF" Condition).

VSWR (Voltage Standing Wave Ratio)

The SPST switch is a two part network. VSWR at the input port is a measure of the mismatch between the RF Signal Source's internal impedance and the input impedance of the switch. VSWR (input) depends on the switch's load impedance but usually:

$Z_{load} = Z_{10}$
(Characteristic Impedance of the Transmission Medium)

VSWR at the output port of the switch is the measure of impedance mismatch between the switch's load and the switch's output impedance.

The switch as a Reciprocal Circuit Element. If the RF Signal Source's internal impedance and the load impedance equal the transmission line impedance and the switch is a reciprocal network element then:

VSWR (input) = VSWR (output)

VSWR is related to the magnitude of the voltage reflection coefficient.

$$VSWR = \frac{1 + |r|}{1 - |r|} \qquad |r| = \frac{P_{-1}}{P_R}^{1/2}$$

P_1 = Power incident on the switch

P_R = Power reflected from the switch

Return Loss (RL) is often used to describe the magnitude of transmission line mismatch. Thus RL is defined to be:

$$RL\ (dB) = 20 \log_{10} \frac{1}{|r|}$$

Transmission Loss (TL) describes the transmission properties of the network element and we expect that:

$$|r| + |T| = 1$$

because energy is conserved in the network.

$$TL = 20 \log_{10} \frac{1}{|T|}$$

$$|T| = \frac{P_{-1}}{P_T}$$

PT = Power transmitted through the switch to the load.

A conversion chart of VSWR and Return Loss is given. Thus a Return Loss of 20 dB represents a VSWR of approximately 1.22.

Switching Equations for Shunt and Series Elements

Insertion Loss (IL) and Isolation (ISO) for Shunt and Series Switching Impedances are represented by the following equations:

Shunt: $IL = 10 \log [1 + (R_R / Z_0)]$
$ISO = 10 \log [1 + (Z_0 / 2R_S)]^2$

Series: $IL = 10 \log [1 + (RS / 2Z_0)]^2$
$ISO = 10 \log [1 + (X_C / 2Z_0)]^2$

Shunt: $R_R = Z_0$ ([Antilog (IL/10)] -1)
$R_S = Z_0/2$ [{Antilog (ISO/20)}-1]$^{-1}$

Series: $R_S = 2Z_0$ [{Antilog (IL/20)] -1}]

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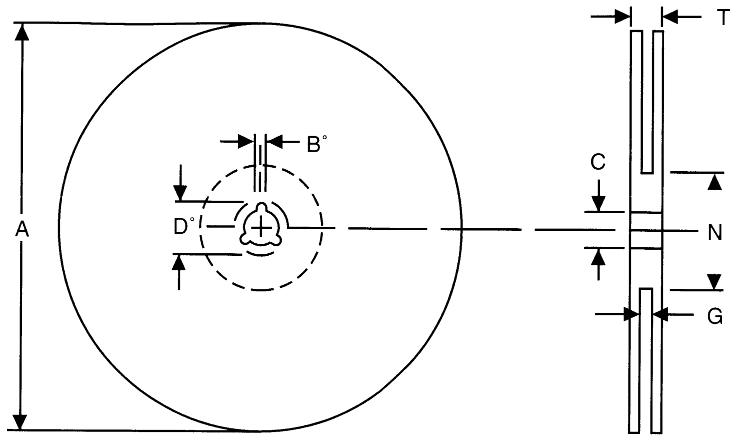
Tape and Reel Packaging for Surface Mount Components

M513

V 2.00

Reel Dimensions



SOIC 8 (SO-8)

			13" Reel		7" Reel	
	Item	Symbol	Size (in.)	Size (mm)	Size (in.)	Size (mm)
Flange	Diameter	A	13.000 ± 0.079	330.0 ± 2.0	7.000 ± 0.079	178.0 ± 2.0
	Thickness	T	0.724 Max.	18.4 Max.	0.724 Max.	18.4 Max.
	Space Between Flange	G	0.488 +0.080, -0.0	12.4 +2.0, -0.0	0.488 +0.080, -0.0	12.4 +2.0, -0.0
Hub	Outer Diameter	N	2.48 Min.	63.0 Min.	2.16 Min.	55.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.008	13.0 ±0.2	0.512 ±0.008	13.0 ±0.2
	Key Slit Width	B	0.059 Min.	1.5 Min.	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min.	0.795 Min.	20.2 Min.

SOIC 14 (SO-14), SOIC 16 (SO-16 & SOW-16), SSOP-8, SSOP-20

			13" Reel		7" Reel	
	Item	Symbol	Size (in.)	Size (mm)	Size (in.)	Size (mm)
Flange	Diameter	A	13.000 ± 0.079	330.0 ± 2.0	7.000 ± 0.079	178.0 ± 2.0
	Thickness	T	0.882 Max.	22.4 Max.	0.882 Max.	22.4 Max.
	Space Between Flange	G	0.646 +0.080, -0.0	16.4 +2.0, -0.0	0.646 +0.080, -0.0	16.4 +2.0, -0.0
Hub	Outer Diameter	N	2.48 Min.	63.0 Min.	2.16 Min.	55.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.008	13.0 ±0.2	0.512 ±0.008	13.0 ±0.2
	Key Slit Width	B	0.059 Min.	1.5 Min.	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min.	0.795 Min.	20.2 Min.

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Reel Dimensions (Cont'd)

SOIC 24 (SO-24)

			13" Reel	
	Item	Symbol	Size (in.)	Size (mm)
Flange	Diameter	A	14.173 Max.	360.0 Max.
	Thickness	T	1.197 Max.	30.4 Max.
	Space Between Flange	G	0.961 +0.078, - 0.0	24.4 +2.0, -0.0
Hub	Outer Diameter	N	2.48 Min.	63.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.008	13.0 ±0.2
	Key Slit Width	B	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min.

SOT-23, SOT-89, SOT-143

			13" Reel		7" Reel	
	Item	Symbol	Size (in.)	Size (mm)	Size (in.)	Size (mm)
Flange	Diameter	A	13.000 ± 0.079	330.0 ± 2.0	7.000 ± 0.079	178.0 ± 2.0
	Thickness	T	0.567 Max.	14.4 Max.	0.567 Max.	14.4 Max.
	Space Between Flange	G	0.331 +0.059, -0.0	8.4 +1.5, -0.0	0.331 +0.059, 0.0	8.4 +1.5, -0.0
Hub	Outer Diameter	N	2.48 Min.	63.0 Min.	2.16 Min.	55.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.008	13.0 ±0.2	0.512 ±0.008	13.0 ±0.2
	Key Slit Width	B	0.059 Min.	1.5 Min.	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min.	0.795 Min.	20.2 Min.

SM-1

			13" Reel	
	Item	Symbol	Size (in.)	Size (mm)
Flange	Diameter	A	13.000 ±0.079	330.0 ±2.0
	Thickness	T	0.898 Max.	22.8 Max.
	Space Between Flange	G	0.646 +0.080, -0.0	16.4 +2.0, -0.0
Hub	Outer Diameter	N	2.36 Min.	60.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.020	13.0 ±0.5
	Key Slit Width	B	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min.

SM-2

			13" Reel	
	Item	Symbol	Size (in.)	Size (mm)
Flange	Diameter	A	13.000 ±0.079	330.0 ±2.0
	Thickness	T	0.961 Max.	30.8 +2.0, -0.0
	Space Between Flange	G	1.212 +0.080, -0.0	24.4 Max.
Hub	Outer Diameter	N	2.36 Min.	60.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.020	13.0 ±0.5
	Key Slit Width	B	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min

SM-22

			13" Reel	
	Item	Symbol	Size (in.)	Size (mm)
Flange	Diameter	A	13.000 ±0.079	330.0 ±2.0
	Thickness	T	0.740 Max.	18.8 Max.
	Space Between Flange	G	0.488 +0.080, -0.0	12.4 +2.0, -0.0
Hub	Outer Diameter	N	2.36 Min.	60.0 Min.
	Spindle Hole Diameter	C	0.512 ±0.020	13.0 ±0.5
	Key Slit Width	B	0.059 Min.	1.5 Min.
	Key Slit Diameter	D	0.795 Min.	20.2 Min

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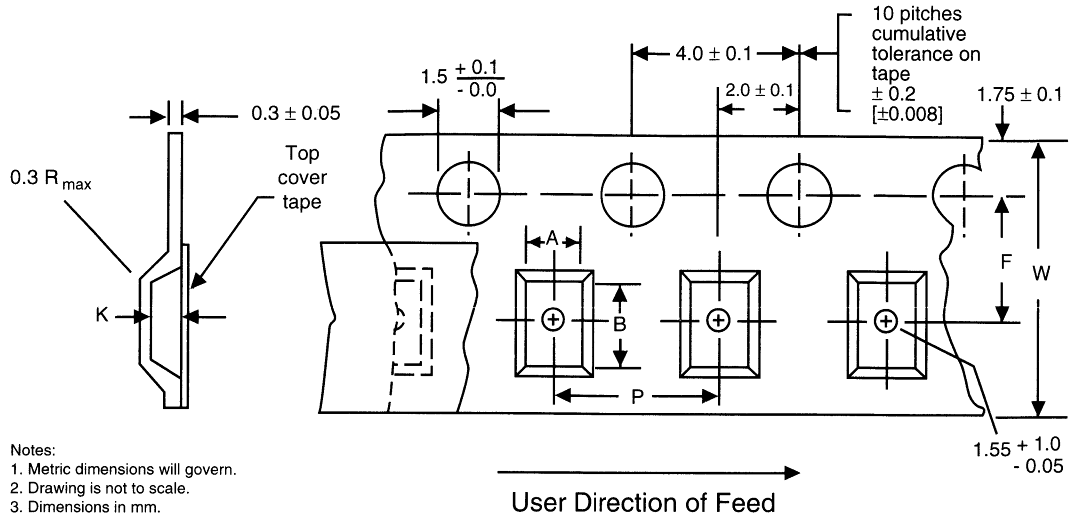
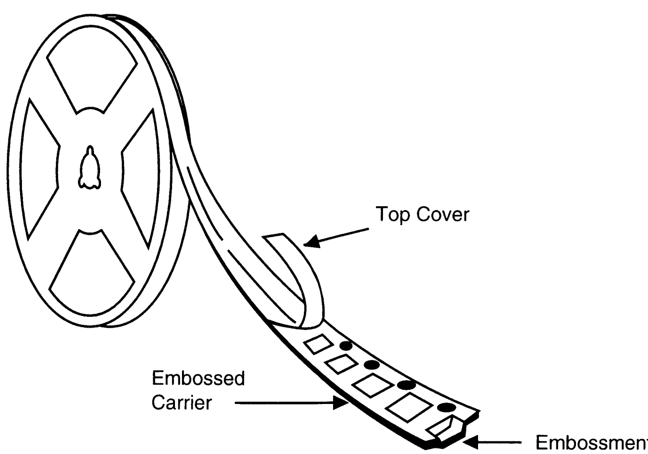
Tape Dimensions
6, 12, 16, and 24 mm Tape Only



Notes:
1. Metric dimensions will govern.
2. Drawing is not to scale.
3. Dimensions in mm.



Fixed Dimensions

	Description	Symbol	Size (in.)	Size (mm)
Cavity	Bottom Hole Diameter	D1	0.059 +0.004, -0.000	1.5 ±0.1
Perforation	Diameter	D	0.059 +0.004, -0.000	1.5 ±0.1
	Pitch	P0	0.157 ±0.004	4.0 ±0.1
	Position	E	0.069 ±0.004	1.75 ±0.10
Cover Tape	Thickness	T	0.003 ±0.004	0.065 ±0.100
Carrier Tape	Thickness	t	0.120 ±0.002	0.30 ±0.05

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Tape Dimensions (Cont'd)

SOIC 8 (SOT-8)

	Description	Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.254 ±0.004	6.45 ±0.10
	Width	B0	0.202 ±0.004	5.13 ±0.10
	Depth	K0	0.083 ±0.004	2.11 ±0.10
	Pitch	P1	0.315 ±0.004	8.0 ±0.1
		K	0.177 Max.	4.5 Max.
		B1	0.323 Max.	8.2 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.217 ±0.002	5.50 ±0.05
Cover Tape	Width	C	0.366 ±0.004	9.3 ±0.1
Carrier Tape	Width	W	0.472 ±0.002	12.0 ±0.2

SSOP-8

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.134 Nom.	3.4 Nom.
	Width	B0	0.327 Nom.	8.31 Nom.
	Depth	K0	0.100 Nom.	2.54 Nom.
	Pitch	P1	0.492 Nom.	12.5 Nom.
		K	0.256 Max.	6.5 Max.
		B1	0.476 Max.	12.1 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.295 ±0.002	7.50 ±0.05
Cover Tape	Width	C	0.524 ±0.004	13.3 ±0.1
Carrier Tape	Width	W	0.630 ±0.012	16.0 ±0.2

SOIC 14 (SO-14)

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.258 ±0.004	6.55 ±0.10
	Width	B0	0.351 ±0.004	8.92 ±0.10
	Depth	K0	0.083 ±0.004	2.11 ±0.10
	Pitch	P1	0.315 ±0.004	8.0 ±0.1
		K	0.256 Max.	6.5 Max.
		B1	0.476 Max.	12.1 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.295 ±0.002	7.50 ±0.05
Cover Tape	Width	C	0.524 ±0.004	13.3 ±0.1
Carrier Tape	Width	W	0.630 ±0.012	16.0 ±0.2

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Tape Dimensions (Cont'd)

SOIC 16 (SO-16)

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.256 ±0.004	6.50 ±0.10
	Width	B0	0.404 ±0.004	10.26 ±0.10
	Depth	K0	0.084 ±0.004	2.13 ±0.10
	Pitch	P1	0.315 ±0.004	8.0 ±0.1
		K	0.256 Max.	6.5 Max.
		B1	0.476 Max.	12.1 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.295 ±0.002	7.50 ±0.05
Cover Tape	Width	C	0.524 ±0.004	13.3 ±0.1
Carrier Tape	Width	W	0.630 ±0.012	16.0 ±0.2

SOIC 16 Wide Body (SOW-16)

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.428 ±0.004	10.87 ±0.10
	Width	B0	0.423 ±0.004	10.74 ±0.10
	Depth	K0	0.120 ±0.004	3.05 ±0.10
	Pitch	P1	0.472 ±0.004	11.99 ±0.10
		K	0.256 Max.	6.5 Max.
		B1	0.476 Max.	12.1 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.295 ±0.002	7.50 ±0.05
Cover Tape	Width	C	0.524 ±0.004	13.3 ±0.1
Carrier Tape	Width	W	0.630 ±0.012	16.0 ±0.2

SOIC 24 (SO-24)

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.421 ±0.010	10.7 ±0.2
	Width	B0	0.622 ±0.010	15.8 ±0.2
	Depth	K0	0.118 ±0.004	3.0 ±0.1
	Pitch	P1	0.157 ±0.004	4.0 ±0.1
		K	0.256 Max.	6.5 Max.
		B1	0.791 Max.	20.1 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.453 ±0.004	11.5 ±0.1
Cover Tape	Width	C	0.79 Nom.	20.0 Nom.
Carrier Tape	Width	W	0.945 ±0.012	24.0 ±0.3

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Tape Dimensions (Cont'd)

SOT-89

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.181 ±0.004	4.6 ±0.1
	Width	B0	0.188 ±0.004	4.78 ±0.10
	Depth	K0	0.075 ±0.004	1.9 ±0.1
	Pitch	P1	0.315 ±0.004	8.0 ±0.1
		K	0.177 Max.	4.5 Max.
		B1	0.323 Max.	8.2 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.0 ±0.05
	Cavity to Perforation (Width Direction)	F	0.217 ±0.004	5.5 ±0.05
Cover Tape	Width	C	0.366 ±0.004	9.3 ±0.1
Carrier Tape	Width	W	0.472 ±0.002	12.0 ±0.2

SOT-23, SOT-143

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.120 ±0.004	3.05 ±0.10
	Width	B0	0.104 ±0.004	2.64 ±0.10
	Depth	K0	0.049 ±0.004	1.24 ±0.10
	Pitch	P1	0.158 ±0.004	4.0 ±0.1
		K	0.094 Max.	2.4 Max.
		B1	0.165 Max.	4.2 Max.
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.002	2.00 ±0.05
	Cavity to Perforation (Width Direction)	F	0.138 ±0.004	3.50 ±0.05
Cover Tape	Width	C	0.217 ±0.004	5.5 ±0.1
Carrier Tape	Width	W	0.315 ±0.008	8.0 ±0.2

SM-1

Description		Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.264	6.7
	Width	B0	0.323	8.2
	Depth	K0	0.209	5.3
	Pitch	P1	4.72	12.0
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.004	2.0 ±0.1
	Cavity to Perforation (Width Direction)	F	0.295	7.5
Carrier Tape	Width	W	0.630	16.0

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Tape Dimensions (Cont'd)

SM-2

	Description	Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.382	9.7
	Width	B0	0.508	12.9
	Depth	K0	0.240	6.1
	Pitch	P1	0.630	16.0
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.004	2.0 ±0.1
	Cavity to Perforation (Width Direction)	F	0.453	11.5
Carrier Tape	Width	W	0.945	24.0

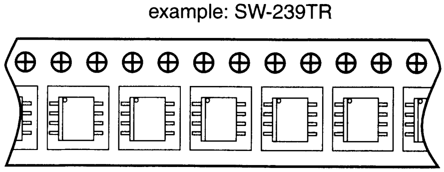
SM-22

	Description	Symbol	Size (in.)	Size (mm)
Cavity	Length	A0	0.169	4.3
	Width	B0	.0169	4.3
	Depth	K0	0.126	3.2
	Pitch	P1	0.315	8.0
Distance Between Centerline	Cavity to Perforation (Length Direction)	P2	0.079 ±0.004	2.0 ±0.1
	Cavity to Perforation (Width Direction)	F	0.217	5.5
Carrier Tape	Width	W	7.0	12.0

Component Orientation for Tape and Reel

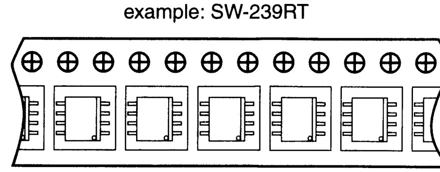
SOIC 8 (SO-8)

example: SW-239TR



User Direction of Feed →

example: SW-239RT



User Direction of Feed →

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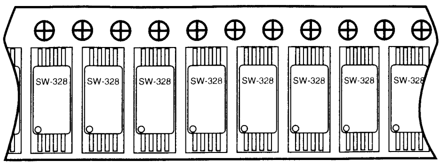
Component Orientation for Tape and Reel (Cont'd)

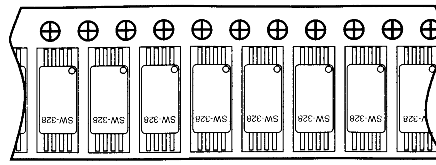
SSOP-8

example: SW-328TR



User Direction of Feed →

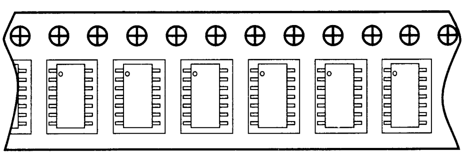
example: SW-328RT



User Direction of Feed →

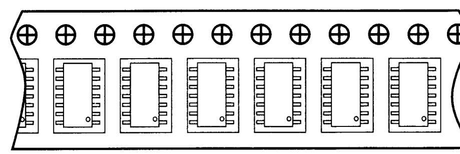
SOIC 14 (SO-14)

example: AT-230TR



User Direction of Feed →

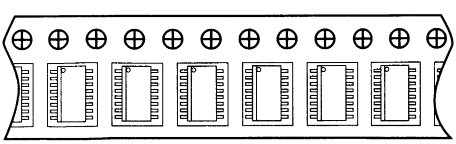
example: AT-230RT



User Direction of Feed →

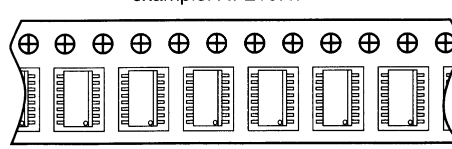
SOIC 16 (SO-16)

example: AT-210TR



User Direction of Feed →

example: AT-210RT



User Direction of Feed →

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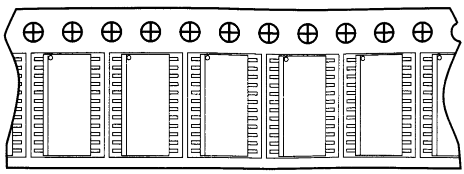
Component Orientation for Tape and Reel (Cont'd)

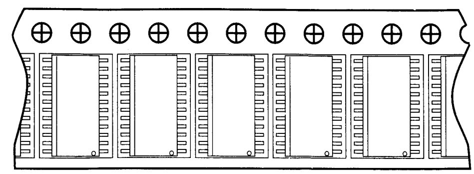
SOIC-24 (SO-24)

example: SW-419TR



User Direction of Feed

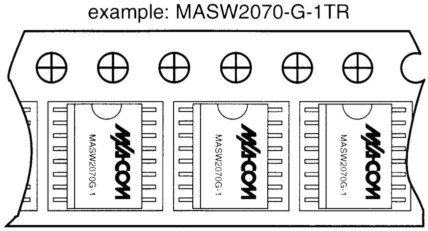
example: SW-419 RTR



User Direction of Feed

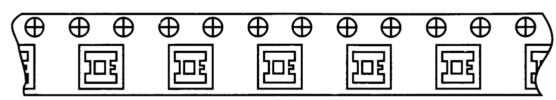
SOIC 16 Wide Body (SOW-16)

example: MASW2070-G-1TR



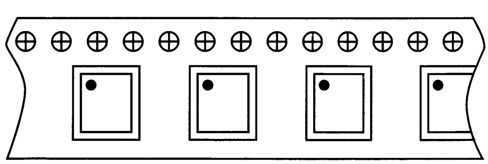
User Direction of Feed

SM-22



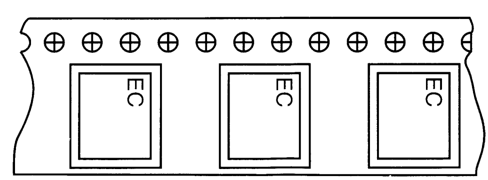
User Direction of Feed

SM-1



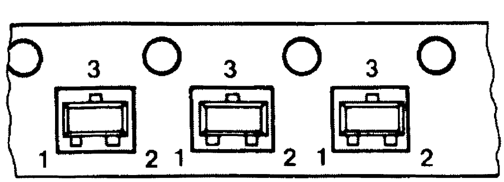
User Direction of Feed

SM-2

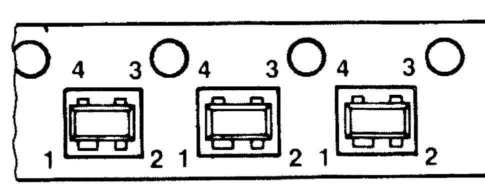


User Direction of Feed

SOT-23



SOT-143



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Ordering Information

Package Type	Max. Devices per Reel	Reel Size (Diameter)	Part Number Suffix[1]
SOIC 8 (SO-8)	1,000 3,000	7 inches 13 inches	TR7 or RT7 TR3 or RT3
SSOP-8	900 3,000	7 inches 13 inches	TR7 or RT7 TR3 or RT3
SOIC 14 (SO-14)	1,000 3,000	7 inches 13 inches	TR7 or RT7 TR3 or RT3
SOIC 16 (SO-16)	1,000 3,500	7 inches 13 inches	TR7 or RT7 TR3 or RT3
SOIC-16 Wide Body (SOW-16)	1,800	13 inches	TR3 or RT3
SSOP-20	2,000	13 inches	TR3 or RT3
SOIC 24 (SO-24)	1,500	13 inches	TR3 or RT3
SOT-23, SOT-143	3,000 10,000	7 inches 13 inches	TR7 or RT7 TR3 or RT3
SOT-89	3,000 10,000	7 inches 13 inches	TR7 or RT7 TR3 or RT3
535 Micro-X	1,000 4,000	7 inches 13 inches	TR7 or RT7 TR3 or RT3
535 Micro-X		7 inches	TR7 or RT7
(Gull-wing)		13 inches	TR3 or RT3
SM-1	900	13 inches	TR3 or RT3
SM-2	600	13 inches	TR3 or RT3
SM-22	2000	13 inches	TR3 or RT3

1. Devices ordered on tape and reel require a suffix to indicate direction of feed and reel diameter:
   TR = Forward Tape and Reel.
   RT = Reverse Tape and Reel.

   To indicate the desired reel diameter, add the complete suffix to the part number.
   For example, to order MD40-7200 on a 13 inch diameter reverse feed reel, request part number MD40-7200RT3.

SOIC 8 (SO-8), SSOP 8, SOIC 14 (SO-14), SOIC 16 (SO-16 and SOW-16) SSOP 30, SOIC 24 (SO-24) and SOT-89 devices in tape and reel must be ordered in multiples of 100 pieces, with a minimum order quantity of 500 pieces per part number.

SM-1, SM-2 and SM-22 devices must be ordered in multiples of 100 pieces, with no minimum order quantity.

Package type SOT-143 must be ordered in multiples of 50 pieces, with a minimum order quantity of 1,000 pieces per part number.

Note: a $1/2$ meter leader and $1/2$ meter trailer are provided on each reel. Other lengths may be specified at the time of order.

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Surface Mounting Instructions

M538

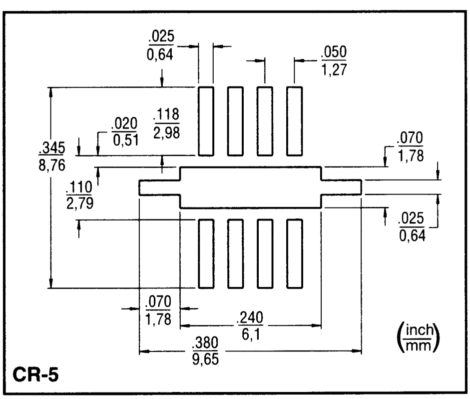
V 2.00

Footprint Guidelines

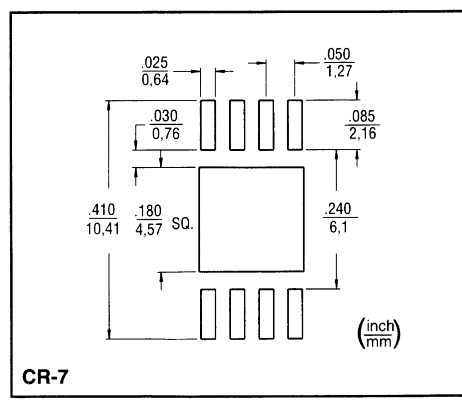
Surface mount board layout is a critical portion of the total design. The footprint must be the correct size to ensure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self-align when subjected to a solder reflow process and will also allow for just enough excess surface area for adequate solder filleting. The following footprints are suggested guidelines only and may require ground plane modifications for electrical and/or thermal considerations. When an increase in ground plane size is necessary, solder mask over bare copper (SMOBC) should be utilized to contain solder and eliminate alignment problems during solder reflow.

Electrical and/or thermal considerations may also require the board to contain plated-thru holes located under a surface mount package (i.e., CR-5 package style). When this is necessary, the recommended plated-thru hole diameter is 0.010 inch to 0.015 inch. This diameter range, along with the solder's viscosity, generally prevents flow down these holes. Although a 0.031-inch diameter hole is typically used, holes this large will drain solder away from the base of the package and will make solder paste thickness difficult to control.

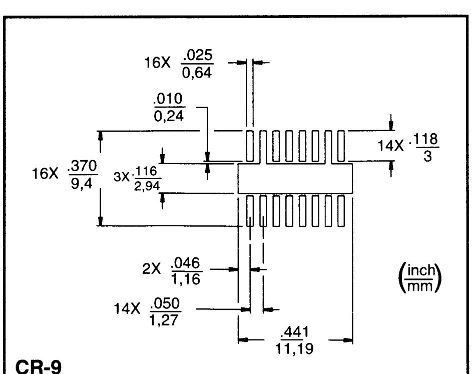
Package Style Footprints



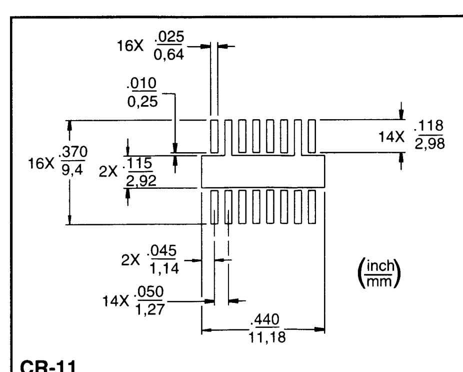
CR-5



CR-7



CR-9



CR-11

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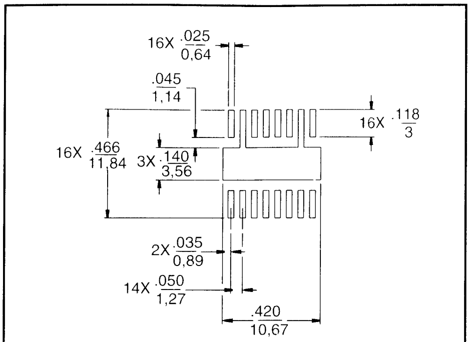
Package Style Footprints



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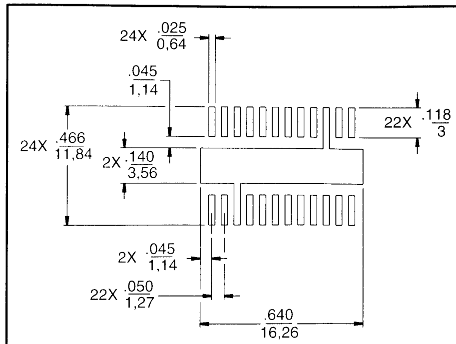
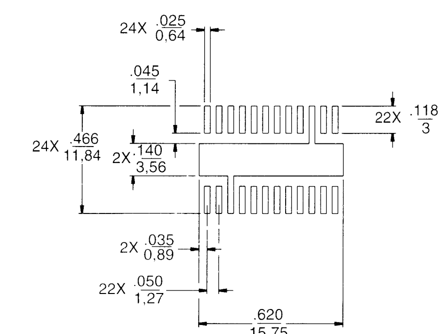
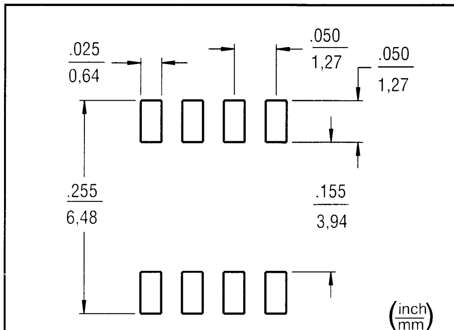


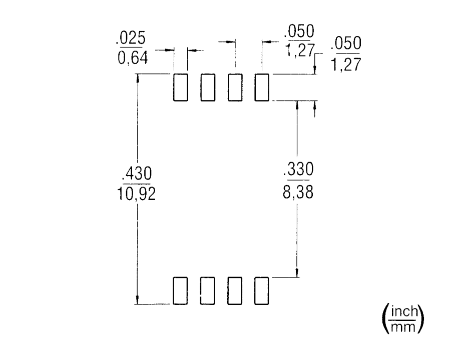
CR-13



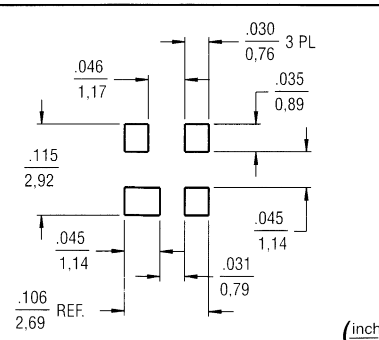
CR-14



SOIC 8, SOIC 14, SOIC 16, NARROW BODY



SOIC 24, SOIC 16, WIDE BODY



SOT-143

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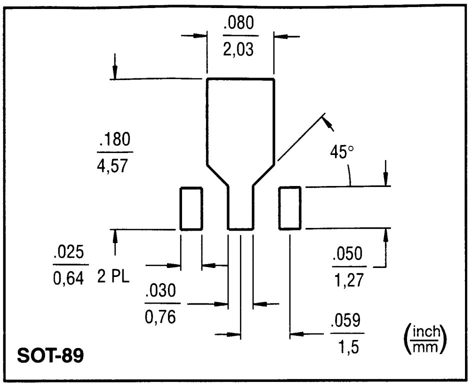
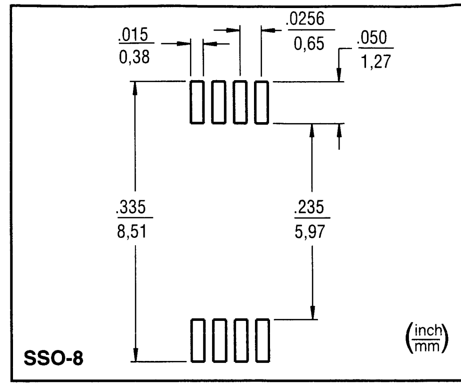
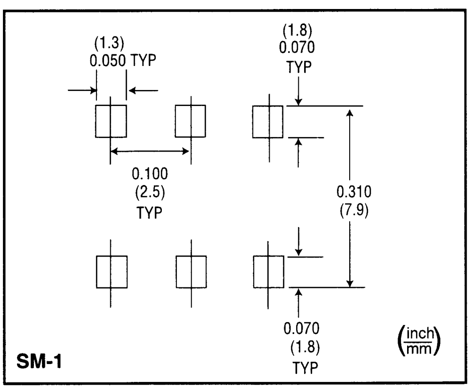
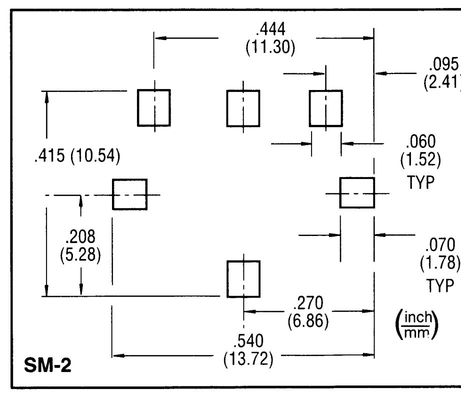
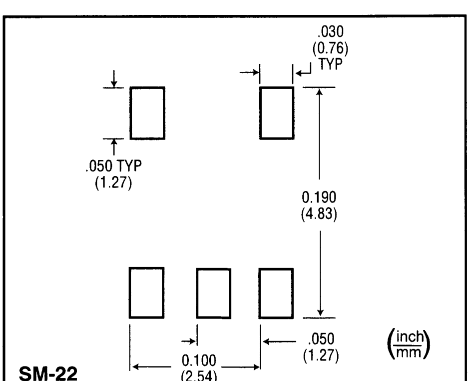
Package Style Footprints











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General Thermal Considerations

- Thermal resistance will be a function of the following:
  - Thermal conductivity of the substrate or board material
  - Footprint size available for heat spreading
  - Circuit board copper foil weight (2 oz recommended for power applications)
  - Via hole quantity and location
  - Substrate or board thickness
  - Proximity of additional thermal loads on the board
  - Velocity of air flow (forced air cooling)
- It may be necessary to place the power surface mount devices (SMDs) on a separate board assembly away from low power components.
- Thorough testing of the prototype is the only way to prove the adequacy of a thermal design.

Solder Selection

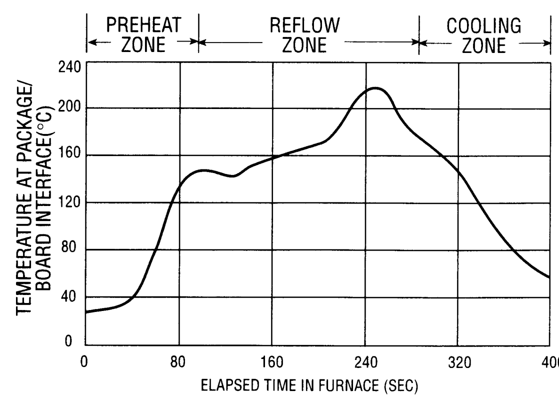
A typical solder is Sn63 (63% Sn, 37% Pb), which clearly is the industry standard for a number of reasons. Sn63 is a eutectic compound with a melting point (+183°C) high enough to exceed the standard operating temperature limit of most components (+150°C) and low enough so that internal component materials are not damaged during proper solder reflow. The one draw back of Sn63 solder when used in combination with gold plated components is a phenomenon called "scavenging." This occurs when gold plating migrates into the solder joint during reflow, which may cause embrittlement of the solder joint. Pretinning the package leads with Sn63 solder paste with RMA flux reduces the gold concentration and produces a stronger joint.

Solder Screen Guidelines

A solder screen or stencil is required to screen the optimum amount of solder paste onto the pads of the footprint. This amount or thickness will directly effect the quality of the joint. The optimum thickness is 0.007 inch to 0.010 inch. Silk screen techniques can control paste thickness well enough to keep it in the optimum range; the thickness being a function of the screen mesh, emulsion thickness, and printer setup parameters. A stencil technique can also achieve similar results by using a stencil made of 0.008 inch thick brass or stainless steel. The stencil or screen opening should be the same size as the pads on the footprint (1:1 registration), excluding SMOBC areas.

Recommended Profile for Reflow Soldering

The most common solder reflow method is accomplished in a belt furnace using convection/IR heat transfer. A typical profile that shows temperature versus time is shown below. The profile reflects the three distinct heating stages or zones (preheat, reflow, and cooling) recommended in automated reflow processes to ensure reliable, finished joints. This profile will vary among soldering systems, but is a good starting point. Other factors that can affect the profile include the density and types of components on the board, type of solder used and type of board or substrate material being used. The profile shows the actual temperature that might be experienced on the surface of a test board at or near a central solder joint. During this type of reflow soldering, the circuit board and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30°C cooler than adjacent solder joints.



CONVECTION/IR TEMPERATURE PROFILE

General Soldering Precautions

The melting temperature of solder is higher than the recommended maximum operating temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device (failure to do so can cause excessive thermal shock and stress which can result in damage to the device).
- The change in temperature between the preheat stage and the maximum solder temperature should be 100°C or less.
- Temperature in reflow stage should be limited to a maximum of +230°C.
  - Temperatures greater than +220°C may be sustained for up to 30 seconds.
  - Temperatures greater than +200°C may be sustained for up to 60 seconds.
- After soldering has been completed, the device should be allowed to cool naturally for at least 3 minutes. Gradual cooling should be used, as the use of forced cooling will increase the temperature gradient and may result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

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Intermodulation Test Procedure

M544

V 2.00

Theory of Operation:

The Intermodulation Test Set is used in the testing of high dynamic range devices. High dynamic range devices are devices that have very good intermodulation products (typically better than 50 dBc). Because their intermodulation products are so low, run the spectrum analyzer with no attenuation on the input. This creates the possibility of intermodulation occurring inside the spectrum analyzer. To eliminate this possibility, use the Test Set to suppress the fundamentals so that intermodulation inside the spectrum analyzer will not occur.

The cancellation of the fundamental input signals is accomplished by vector addition of these fundamental signals to reference signals that are amplitude matched and 180 degrees out of phase with the fundamental signals. Accomplish this vector addition by creating two independent reference signals from the fundamentals and modifying them to match the resultant output of the device under test. This modification is done by using both variable attenuators and line stretchers to create a signal that will have exactly the same frequency and amplitude but will be 180 degrees out of phase with the fundamental. After the signals pass through the attenuators and line stretcher they are summed together with the fundamental output of the device. This summing will cause the cancellation of all signals that are common to both the fundamental and reference signals.

Method of Signal Cancellation:

1. Set the step attenuator on the test box to the gain of the device if it is an amplifier or to O if it is a switch.
2. Set the RF signal sources to the specified frequencies and input power to the DUT if the device is a switch or the output power of the DUT if the device is an amplifier to the specified power for each source.
3. Set the inverting/noninverting switch to inverting for odd stage amplifiers and noninverting for even stage amplifiers. If the device is a switch it should be set to noninverting as a rule.
4. With the reference delay line cable disconnected, set the fundamental signals to top line reference on the spectrum analyzer.
5. Connect the reference delay line cable to the test box. (Note: The length of this cable should be the same length as those used on the test path. Failure to follow this rule will cause the test set not to be broadband cancelled. This may cause errors in some of the intermodulation product measurements.)
6. Adjust the variable attenuators and line stretchers to phase and amplitude match each of the fundamental inputs. (Note: If the signal is above the top line reference adjust the phase first; if the signal is below the top line reference adjust the amplitude first. Cancellation must reach at least 30 dBc from the top line reference to ensure accurate measurements.)
7. Measurement of the third order intermodulation products will be the difference between the signals found at 2F1-F2 and 2F2-F1 and the top line reference; this is designated as the IMR3 and is measured in dBc. (To convert this to the intercept point use the following formula:

   ICP3 = 1/2CIMR3) + P

   (P is the input power to the DUT if it is a switch and the output power if it is an amplifier.)

   This measurement is represented in terms of dBm.
8. Measurement of the second order intermodulation products will be the difference between the signal found at F2-F1 and F2+F1 and the top line reference; this is designated as the IMR2 and is measured in dBc. To convert this to the intercept point use the following formula:

   ICP2=IMR2+P

   (P is the input power to the DUT if it is a switch and the output power if it is an amplifier.)

   This measurement is represented in terms of dBm.

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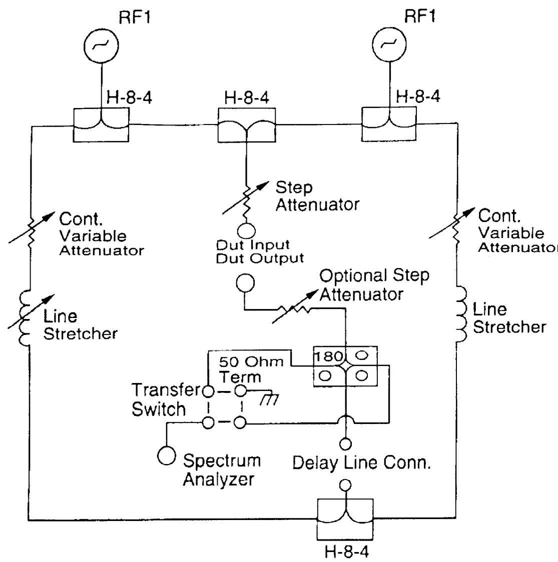
Intermodulation Test Box Schematic



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Power Conversion dBm to Watts

V 2.00

dBm	Milli-watt	dBm	Milli-watt	dBm	Milli-watt	dBm	Milli-watt	dBm	Milli-watt	dBm	Milli-watt	dBm	Watts	dBm	Watts
0.0	1.00	5.0	3.16	10.0	10.0	15.0	31.6	20.0	100	25.0	316	30.1	1.02	35.1	3.24
0.1	1.02	5.1	3.24	10.1	10.2	15.1	32.4	20.1	102	25.1	324	30.2	1.05	35.2	3.31
0.2	1.05	5.2	3.31	10.2	10.5	15.2	33.1	20.2	105	25.2	331	30.3	1.07	35.3	3.39
0.3	1.07	5.3	3.39	10.3	10.7	15.3	33.9	20.3	107	25.3	339	30.4	1.10	35.4	3.47
0.4	1.10	5.4	3.47	10.4	11.0	15.4	34.7	20.4	110	25.4	347	30.5	1.12	35.5	3.55
0.5	1.12	5.5	3.55	10.5	11.2	15.5	35.5	20.5	112	25.5	355	30.6	1.15	35.6	3.63
0.6	1.15	5.6	3.63	10.6	11.5	15.6	36.3	20.6	115	25.6	363	30.7	1.17	35.7	3.72
0.7	1.17	5.7	3.72	10.7	11.7	15.7	37.2	20.7	117	25.7	372	30.8	1.20	35.8	3.80
0.8	1.20	5.8	3.80	10.8	12.0	15.8	38.0	20.8	120	25.8	380	30.9	1.23	35.9	3.89
0.9	1.23	5.9	3.89	10.9	12.3	15.9	38.9	20.9	123	25.9	389	31.0	1.26	36.0	3.98
1.0	1.26	6.0	3.98	11.0	12.6	16.0	39.8	21.0	126	26.0	398	31.1	1.29	36.1	4.07
1.1	1.29	6.1	4.07	11.1	12.9	16.1	40.7	21.1	129	26.1	407	31.2	1.32	36.2	4.17
1.2	1.32	6.2	4.17	11.2	13.2	16.2	41.7	21.2	132	26.2	417	31.3	1.35	36.3	4.27
1.3	1.35	6.3	4.27	11.3	13.5	16.3	42.7	21.3	135	26.3	427	31.4	1.38	36.4	4.37
1.4	1.38	6.4	4.37	11.4	13.8	16.4	43.7	21.4	138	26.4	437	31.5	1.41	36.5	4.47
1.5	1.41	6.5	4.47	11.5	14.1	16.5	44.7	21.5	141	26.5	447	31.6	1.45	36.6	4.57
1.6	1.45	6.6	4.57	11.6	14.5	16.6	45.7	21.6	145	26.6	457	31.7	1.48	36.7	4.68
1.7	1.48	6.7	4.68	11.7	14.8	16.7	46.8	21.7	148	26.7	468	31.8	1.51	36.8	4.79
1.8	1.51	6.8	4.79	11.8	15.1	16.8	47.9	21.8	151	26.8	479	31.9	1.55	36.9	4.90
1.9	1.55	6.9	4.90	11.9	15.5	16.9	49.0	21.9	155	26.9	490	32.0	1.58	37.0	5.01
2.0	1.58	7.0	5.01	12.0	15.8	17.0	50.1	22.0	158	27.0	501	32.1	1.62	37.1	5.13
2.1	1.62	7.1	5.13	12.1	16.2	17.1	51.3	22.1	162	27.1	513	32.2	1.66	37.2	5.25
2.2	1.66	7.2	5.25	12.2	16.6	17.2	52.5	22.2	166	27.2	525	32.3	1.70	37.3	5.37
2.3	1.70	7.3	5.37	12.3	17.0	17.3	53.7	22.3	170	27.3	537	32.4	1.74	37.4	5.50
2.4	1.74	7.4	5.50	12.4	17.4	17.4	55.0	22.4	174	27.4	550	32.5	1.78	37.5	5.62
2.5	1.78	7.5	5.62	12.5	17.8	17.5	56.2	22.5	178	27.5	562	32.6	1.82	37.6	5.75
2.6	1.82	7.6	5.75	12.6	18.2	17.6	57.5	22.6	182	27.6	575	32.7	1.86	37.7	5.89
2.7	1.86	7.7	5.89	12.7	18.6	17.7	58.9	22.7	186	27.7	589	32.8	1.91	37.8	6.03
2.8	1.91	7.8	6.03	12.8	19.1	17.8	60.3	22.8	191	27.8	603	32.9	1.95	37.9	6.17
2.9	1.95	7.9	6.17	12.9	19.5	17.9	61.7	22.9	195	27.9	617	33.0	2.00	38.0	6.31
3.0	2.00	8.0	6.31	13.0	20.0	18.0	63.1	23.0	200	28.0	631	33.1	2.04	38.1	6.46
3.1	2.04	8.1	6.46	13.1	20.4	18.1	64.6	23.1	204	28.1	646	33.2	2.09	38.2	6.61
3.2	2.09	8.2	6.61	13.2	20.9	18.2	66.1	23.2	209	28.2	661	33.3	2.14	38.3	6.76
3.3	2.14	8.3	6.76	13.3	21.4	18.3	67.6	23.3	214	28.3	676	33.4	2.19	38.4	6.92
3.4	2.19	8.4	6.92	13.4	21.9	18.4	69.2	23.4	219	28.4	692	33.5	2.24	38.5	7.08
3.5	2.24	8.5	7.08	13.5	22.4	18.5	70.8	23.5	224	28.5	708	33.6	2.29	38.6	7.24
3.6	2.29	8.6	7.24	13.6	22.9	18.6	72.4	23.6	229	28.6	724	33.7	2.34	38.7	7.41
3.7	2.34	8.7	7.41	13.7	23.4	18.7	74.1	23.7	234	28.7	741	33.8	2.40	38.8	7.59
3.8	2.40	8.8	7.59	13.8	24.0	18.8	75.9	23.8	240	28.8	759	33.9	2.45	38.9	7.76
3.9	2.45	8.9	7.76	13.9	24.5	18.9	77.6	23.9	245	28.9	776	34.0	2.51	39.0	7.94
4.0	2.51	9.0	7.94	14.0	25.1	19.0	79.4	24.0	251	29.0	794	34.1	2.57	39.1	8.13
4.1	2.57	9.1	8.13	14.1	25.7	19.1	81.3	24.1	257	29.1	813	34.2	2.63	39.2	8.32
4.2	2.63	9.2	8.32	14.2	26.3	19.2	83.2	24.2	263	29.2	832	34.3	2.69	39.3	8.51
4.3	2.69	9.3	8.51	14.3	26.9	19.3	85.1	24.3	269	29.3	851	34.4	2.75	39.4	8.71
4.4	2.75	9.4	8.71	14.4	27.5	19.4	87.1	24.4	275	29.4	871	34.5	2.82	39.5	8.91
4.5	2.82	9.5	8.91	14.5	28.2	19.5	89.1	24.5	282	29.5	891	34.6	2.88	39.6	9.12
4.6	2.88	9.6	9.12	14.6	28.8	19.6	91.2	24.6	288	29.6	912	34.7	2.95	39.7	9.33
4.7	2.95	9.7	9.33	14.7	29.5	19.7	93.3	24.7	295	29.7	933	34.8	3.02	39.8	9.55
4.8	3.02	9.8	9.55	14.8	30.2	19.8	95.5	24.8	302	29.8	955	34.9	3.09	39.9	9.77
4.9	3.09	9.9	9.77	14.9	30.9	19.9	97.7	24.9	309	29.9	977	35.0	3.16	40.0	10.00
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VSWR, Return Loss and Transmission Loss vs. Transmitted Power

V 2.00

VSWR	RETURN LOSS (dB)	TRANS LOSS (dB)	VOLT REFL COEFF.	POWER TRANS. (%)	POWER REFL (%)	VSWR	RETURN LOSS (dB)	TRANS LOSS (dB)	VOLT. REFL COEFF.	POWER TRANS. (%)	POWER REFL (%)
1.00	∞	.000	.00	100.0	.0	1.64	12.3	.263	.24	94.1	5.9
1.01	46.1	.000	.00	100.0	.0	1.66	12.1	.276	.25	93.8	6.2
1.02	40.1	.000	.01	100.0	.0	1.68	11.9	.289	.25	93.6	6.4
1.03	36.6	.001	.01	100.0	.0	1.70	11.7	.302	.26	93.3	6.7
1.04	34.2	.002	.02	100.0	.0	1.72	11.5	.315	.26	93.0	7.0
1.05	32.3	.003	.02	99.9	.1	1.74	11.4	.329	.27	92.7	7.3
1.06	30.7	.004	.03	99.9	.1	1.76	11.2	.342	.28	92.4	7.6
1.07	29.4	.005	.03	99.9	.1	1.78	11.0	.356	.28	92.1	7.9
1.08	28.3	.006	.04	99.9	.1	1.80	10.9	.370	.29	91.8	8.2
1.09	27.3	.008	.04	99.8	.2	1.82	10.7	.384	.29	91.5	8.5
1.10	26.4	.010	.05	99.8	.2	1.84	10.6	.398	.30	91.3	8.7
1.11	25.7	.012	.05	99.7	.3	1.86	10.4	.412	.30	91.0	9.0
1.12	24.9	.014	.06	99.7	.3	1.88	10.3	.426	.31	90.7	9.3
1.13	24.3	.016	.06	99.6	.4	1.90	10.2	.440	.31	90.4	9.6
1.14	23.7	.019	.07	99.6	.4	1.92	10.0	.454	.32	90.1	8.9
1.15	23.1	.021	.07	99.5	.5	1.94	9.9	.468	.32	89.8	10.2
1.16	22.6	.024	.07	99.5	.5	1.96	9.8	.483	.32	89.5	10.5
1.17	22.1	.027	.08	99.4	.6	1.98	9.7	.497	.33	89.2	10.8
1.18	21.7	.030	.08	99.3	.7	2.00	9.5	.512	.33	88.9	11.1
1.19	21.2	.033	.09	99.2	.8	2.50	7.4	.881	.43	81.6	18.4
1.20	20.8	.036	.09	99.2	.8	3.00	6.0	1.249	.50	75.0	25.0
1.21	20.4	.039	.10	99.1	.9	3.50	5.1	1.603	.56	69.1	30.9
1.22	20.1	.043	.10	99.0	1.0	4.00	4.4	1.938	.60	64.0	36.0
1.23	19.7	.046	.10	98.9	1.1	4.50	3.9	2.255	.64	59.5	40.5
1.24	19.4	.050	.11	98.9	1.1	5.00	3.5	2.553	.67	55.6	44.4
1.25	19.1	.054	.11	98.8	1.2	5.50	3.2	2.834	.69	52.1	47.9
1.26	18.8	.058	.12	98.7	1.3	6.00	2.9	3.100	.71	49.0	51.0
1.27	18.5	.062	.12	98.6	1.4	6.50	2.7	3.351	.73	46.2	53.8
1.28	18.2	.066	.12	98.5	1.5	7.00	2.5	3.590	.75	43.7	56.2
1.29	17.9	.070	.13	98.4	1.6	7.50	2.3	3.817	.76	41.5	58.5
1.30	17.7	.075	.13	98.3	1.7	8.00	2.2	4.033	.78	39.5	60.5
1.32	17.2	.083	.14	98.1	1.9	8.50	2.1	4.240	.79	37.7	62.3
1.34	16.8	.093	.15	97.9	2.1	9.00	1.9	4.437	.80	36.0	64.0
1.36	16.3	.102	.15	97.7	2.3	9.50	1.8	4.626	.81	34.5	65.5
1.38	15.9	.112	.16	97.5	2.5	10.00	1.7	4.807	.82	33.1	66.9
1.40	15.6	.122	.17	97.2	2.8	11.00	1.6	5.149	.83	30.6	69.4
1.42	15.2	.133	.17	97.0	3.0	12.00	1.5	5.466	.85	28.4	71.6
1.44	14.9	.144	.18	96.7	3.3	13.00	1.3	5.762	.86	26.5	73.5
1.46	14.6	.155	.19	96.5	3.5	14.00	1.2	6.040	.87	24.9	75.1
1.48	14.3	.166	.19	96.3	3.7	15.00	1.2	6.301	.88	23.4	76.6
1.50	14.0	.177	.20	96.0	4.0	16.00	1.1	6.547	.88	22.1	77.9
1.52	13.7	.189	.21	95.7	4.3	17.00	1.0	6.780	.89	21.0	79.0
1.54	13.4	.201	.21	95.5	4.5	18.00	1.0	7.002	.89	19.9	80.1
1.56	13.2	.213	.22	95.2	4.8	19.00	.9	7.212	.90	19.0	81.0
1.58	13.0	.225	.22	94.9	5.1	20.00	.9	7.413	.90	18.1	81.9
1.60	12.7	.238	.23	94.7	5.3	25.00	.7	8.299	.92	14.8	85.2
1.62	12.5	.250	.24	94.4	5.6	30.00	.6	9.035	.94	12.5	87.5

Specifications Subject to Change Without Notice.

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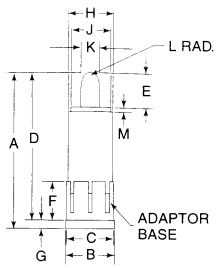
3



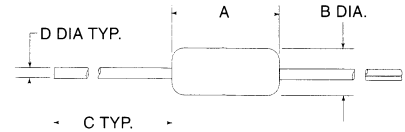
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.800	0.840	20.32	21.34
B	0.292	0.296	7.42	7.52
C	0.246	0.250	6.25	6.35
D	0.753	0.783	19.13	19.89
E	0.180	0.190	4.57	4.83
F	0.193	0.199	4.90	5.05
G	0.047	0.057	1.19	1.45
H	0.222	0.240	5.64	6.10
J	0.195	0.215	4.95	5.46
K	0.092	0.094	2.34	2.39
L	0.030	0.046	0.76	1.17
M	0.020	0.030	0.51	0.76

Adaptor base optional.

C_P = 0.12 pF Typical

L_S = 0.50 nH Typical

4



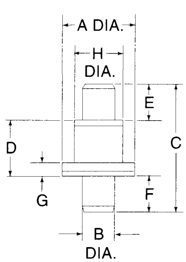
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.230	0.300	5.84	7.62
B	0.085	0.107	2.16	2.72
C	1.000	—	25.40	—
D	0.018	0.022	0.46	0.56

Notes:

C_P = 0.15 pF Typical

L_S = 2.50 nH Typical

30



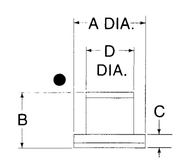
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3.02	3.22
B	0.060	0.064	1.52	1.63
C	0.205	0.225	5.21	5.72
D	0.085	0.097	2.16	2.46
E	0.060	0.064	1.52	1.63
F	0.060	0.064	1.52	1.63
G	0.016	0.024	0.41	0.61
H	0.079	0.083	2.01	2.11

Notes:

C_P = 0.18 pF Typical

L_S = 0.40 nH Typical

31



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3.02	3.23
B	0.085	0.097	2.16	2.46
C	0.016	0.024	0.41	0.61
D	0.077	0.083	1.96	2.11

Notes:

C_P = 0.18 pF Typical

L_S = 0.60 nH Typical

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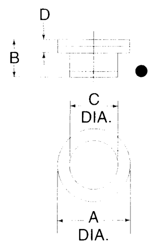
Case Styles (Cont'd)

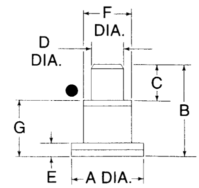
32



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3.02	3.18
B	0.055	0.065	1.40	1.65
C	0.077	0.083	1.96	2.11
D	—	0.025	—	0.64

Notes:
C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

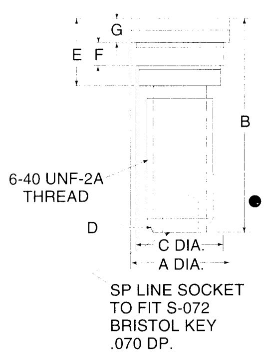
36



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3.02	3.18
B	0.143	0.163	3.63	4.14
C	0.060	0.064	1.52	1.63
D	0.060	0.064	1.52	1.63
E	—	0.025	—	0.64
F	0.077	0.083	1.96	2.11
G	0.086	0.096	2.18	2.44

Notes:
C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

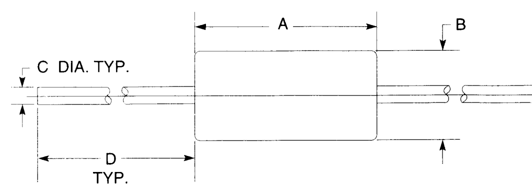
43



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.255	0.265	6.48	6.73
B	0.440	0.460	11.18	11.68
C	0.208	0.212	5.28	5.38
D	0.020 x 45° REF.		0.51 x 45° REF.	
E	0.119	0.131	3.02	3.33
F	50 REF.		1.27 REF.	
G	0.025	0.035	0.64	0.89

Notes:
C_P = 0.75 pF Typical
L_S = 0.60 nH Typical

54



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.150	0.170	3.800	4.300
B	0.068	0.075	1.720	1.910
C	0.014	0.016	0.350	0.410
D	1.000	1.500	25.400	38.100

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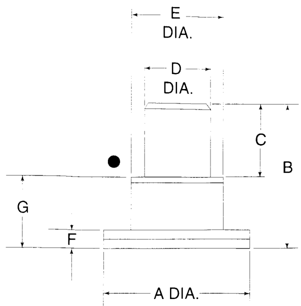
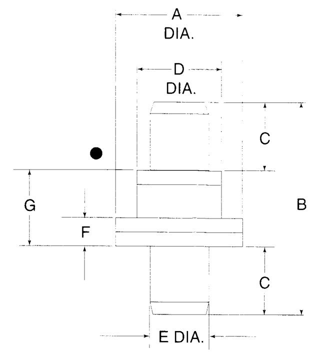
91



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3.02	3.23
B	0.115	0.129	2.92	3.28
C	0.060	0.064	1.52	1.63
D	0.060	0.062	1.52	1.57
E	0.077	0.083	1.96	2.11
F	0.016	0.024	0.00	0.61
G	0.055	0.065	1.40	1.65

Notes:
C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

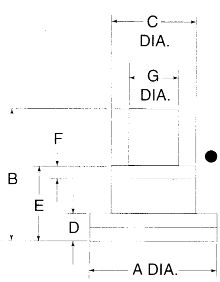
92



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3.02	3.23
B	0.174	0.194	4.42	4.93
C	0.060	0.064	1.52	1.63
D	0.077	0.083	1.96	2.11
E	0.060	0.062	1.52	1.57
F	0.016	0.024	0.41	0.61
G	0.055	0.065	1.40	1.65

Notes:
C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

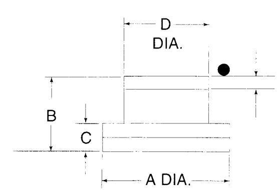
93



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.059	0.069	1.50	1.75
B	0.070	0.080	1.78	2.03
C	0.047	0.053	1.19	1.35
D	—	0.015	—	0.36
E	0.040	0.050	1.02	1.27
F	0.004	0.010	0.10	0.25
G	0.024	0.026	0.51	0.66

Notes:
C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

94



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1.98	2.18
B	0.040	0.050	1.02	1.27
C	—	0.015	—	0.38
D	0.047	0.053	1.19	1.35
E	0.004	0.010	0.10	0.24

Notes:
C_P = 0.15 pF Typical
L_S = 0.40 nH Typical

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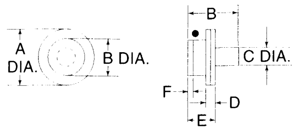
Case Styles (Cont'd)

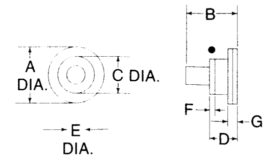
95



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1.98	2.18
B	0.075	0.085	1.97	2.17
C	0.024	0.026	0.61	0.66
D	—	0.018	—	0.46
E	0.045	0.055	1.14	1.39
F	0.004	0.010	0.10	0.25
G	0.047	0.053	1.19	1.35

Notes:
C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

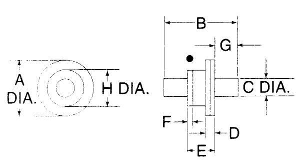
96



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1.98	2.18
B	0.070	0.080	1.78	2.03
C	0.047	0.053	1.19	1.35
D	0.040	0.050	1.02	1.27
E	0.024	0.026	0.61	0.66
F	0.004	0.010	0.10	0.25
G	—	0.015	—	0.38

Notes:
C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

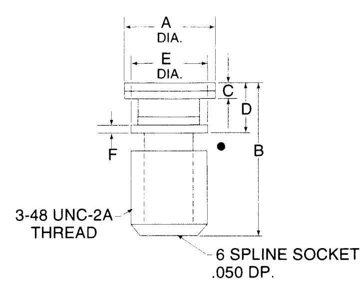
97



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1.98	2.18
B	0.100	0.110	2.54	2.79
C	0.024	0.026	0.61	0.66
D	—	0.015	—	0.38
E	0.040	0.050	1.02	1.27
F	0.004	0.010	0.10	0.25
G	0.029	0.031	0.74	0.79
H	0.047	0.053	1.19	1.35

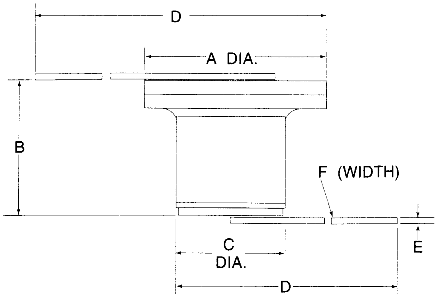
Notes:
C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

103



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3.02	3.23
B	0.188	0.208	4.78	5.28
C	0.016	0.024	0.41	0.61
D	0.058	0.071	1.47	1.80
E	0.098	0.102	2.49	2.59
F	0.009	0.011	0.23	0.28

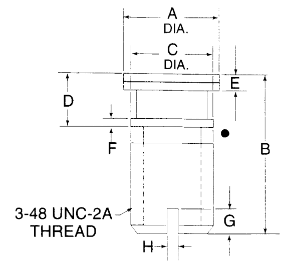
108



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3.02	3.23
B	0.085	0.097	2.16	2.46
C	0.077	0.083	1.96	2.11
D	0.975	1.025	24.77	26.04
E	0.002	0.004	0.05	0.09
F	0.077	0.083	1.96	2.11

Notes:
C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

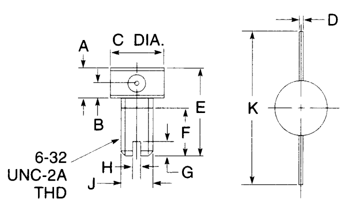
111



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3.020	3.230
B	0.188	0.208	4.780	5.280
C	0.098	0.102	2.490	2.590
D	0.057	0.071	1.450	1.800
E	0.016	0.024	0.410	0.610
F	0.009	0.011	0.230	0.280
G	0.025	0.045	0.640	1.140
H	0.015	0.025	0.380	0.640

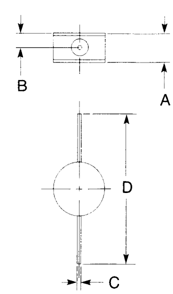
Notes:
C_P = 0.27 pF Typical
L_S = 0.30 nH Typical

114



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.120	0.140	3.040	3.550
B	0.058	0.072	1.470	1.820
C	—	0.255	—	6.470
D	0.011	0.013	0.270	0.330
E	0.380	0.400	9.650	10.160
F	0.205	—	5.200	—
G	0.060 NOMINAL		1.520 NOMINAL	
H	0.030 NOMINAL		0.760 NOMINAL	
J	0.1312	0.1372	3.330	3.480
K	0.670 NOMINAL		17.000 NOMINAL	

115



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.118	0.1400	3.000	3.550
B	0.058	0.0720	1.470	1.820
C	0.011	0.0130	0.270	0.330
D	0.670 NOMINAL		17.00 NOMINAL	

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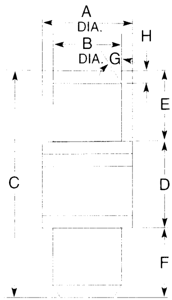
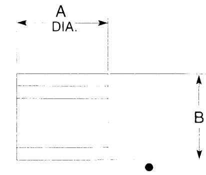
119



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0780	0.0860	2.010	2.110
B	0.0600	0.0640	1.520	1.630
C	0.1900	0.2100	4.850	5.330
D	0.0700	0.0870	1.680	2.210
E	0.0600	0.0640	1.520	1.630
F	0.0600	0.0640	1.520	1.630
G	30° NOMINAL		30° NOMINAL	
H	0.0090	0.0150	0.229	0.381

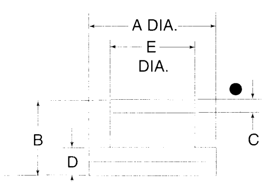
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	0.30	1.40
B	0.040	0.050	1.02	1.27

Notes:
C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

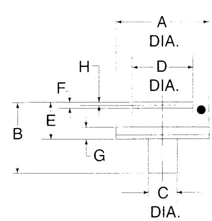
126



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.079	0.087	2.01	2.21
B	0.030	0.038	0.76	0.97
C	0.003	REF	0.76	REF
D	1.009	0.015	0.23	0.38
E	0.047	0.053	1.19	1.35

Notes:
C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

128



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0770	0.0830	1.960	2.110
B	0.0545	0.0675	1.384	1.715
C	0.0220	0.0280	0.560	0.710
D	0.0470	0.0530	1.190	1.350
E	0.0295	0.0325	0.749	0.826
F	0.0020	0.0070	0.050	0.180
G	0.0100	0.0150	0.250	0.380
H	0.0015	0.0030	0.038	0.076

Notes:
C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

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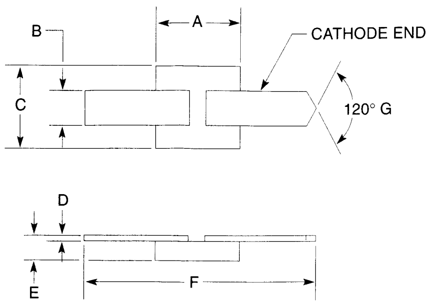
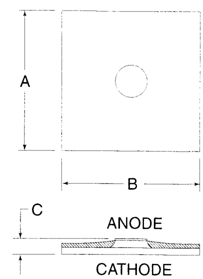
129



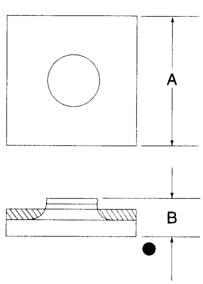
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0110	0.0070	0.280	0.170
B	0.0055	0.0045	1.390	0.114
C	0.0110	0.0070	0.280	0.170
D	0.0006	0.0004	0.015	0.010
E	0.0040	0.0020	0.101	0.050
F	0.0340	0.0300	0.860	0.760
G	120° NOMINAL		120° NOMINAL	

130



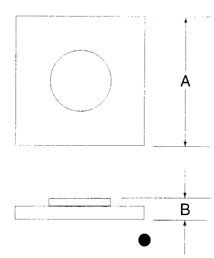
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0750	0.0950	1.900	2.510
B	0.0750	0.0950	1.900	2.510
C	0.0085	0.0105	0.021	0.026

131



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0280	0.033	0.760	0.890
B	0.0085	0.014	0.216	0.267

132



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.180	0.023	0.510	0.610
B	0.004	0.012	0.080	0.150

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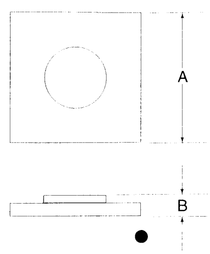
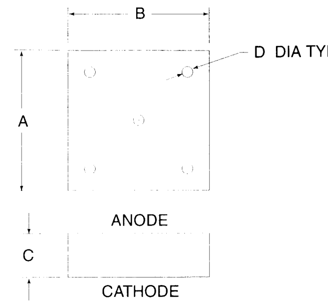
Case Styles (Cont'd)

134



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0120	0.0150	0.340	0.420
B	0.0035	0.0065	0.090	0.170

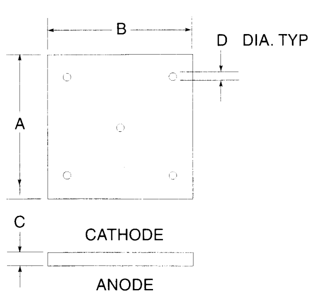
135



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.013	0.017	0.330	0.431
B	0.013	0.017	0.330	0.431
C	0.004	0.006	0.102	0.152
D	0.001	—	0.020	—

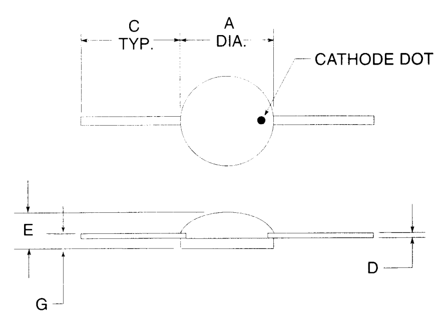
Notes:
Junction height is .0002 typical
reference mask #SK-DS-607

135A



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.013	0.017	0.330	0.431
B	0.013	0.017	0.330	0.431
C	0.004	0.006	0.102	0.152
D	0.001	—	0.020	—

137



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.090	0.110	2.290	2.800
B	0.018	0.022	0.460	0.560
C	0.095	0.105	2.410	2.670
D	0.003	0.005	0.080	1.300
E	—	0.050	—	1.270
F	45° NOMINAL		45° NOMINAL	
G	—	0.014	—	0.360

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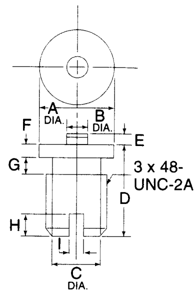
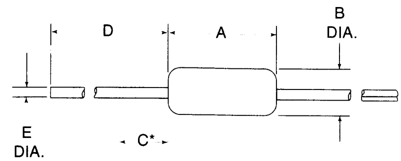
138



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.1180	0.1130	3.000	2.870
B	0.0340	0.0270	0.860	0.690
C	0.0700	0.0680	1.780	1.730
D	0.1450	0.1400	3.680	3.560
E	0.0190	0.0160	0.480	0.410
F	0.0220	0.0180	0.560	0.460
G	0.0250	0.0150	0.640	0.380
H	0.0450	0.0250	0.114	0.640
I	0.0250	0.0150	0.640	0.380

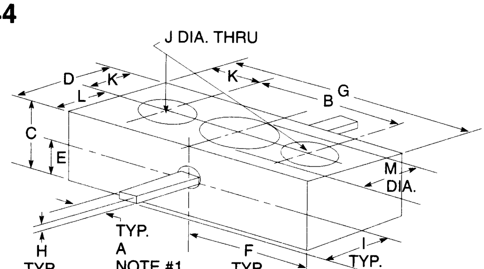
139



*LEAD DIA. UNCONTROLLED IN THIS AREA

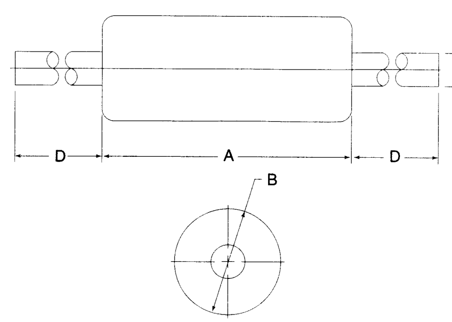
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.135	0.165	3.43	4.19
B	0.050	0.070	1.27	1.78
C	—	0.050	—	1.27
D	1.000	1.250	25.40	31.75
E	0.017	0.023	0.43	0.58

144



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.022 NOMINAL		0.590 NOMINAL	
B	0.250 NOMINAL		6.350 NOMINAL	
C	0.125 NOMINAL		3.180 NOMINAL	
D	0.155	0.165	3.940	4.190
E	0.065 NOMINAL		0.159 NOMINAL	
F	0.195	0.215	4.950	5.460
G	0.405	0.415	10.290	10.540
H	0.003	—	0.070	—
I	0.120	—	3.040	—
J	0.096 NOMINAL		2.440 NOMINAL	
K	0.075	0.085	1.910	2.160
L	0.080 NOMINAL		2.030 NOMINAL	
M	0.125 NOMINAL		3.180 NOMINAL	

146

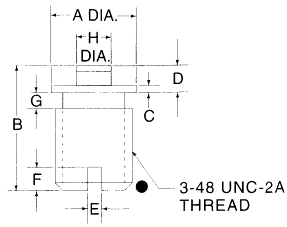


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.200	0.240	5.080	6.330
B	0.085	0.105	2.160	2.670
C	0.027	0.033	0.685	0.838
D	1.000	1.250	25.400	31.750

Notes:

1. Digital marking and polarity symbol.
2. Leads tin plated.

148



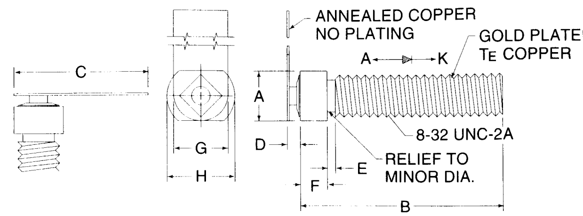
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.113	0.118	2.87	3.00
B	0.167	0.187	4.24	4.75
C	0.018	0.022	0.46	0.56
D	0.040	0.052	1.02	1.32
E	0.015	0.025	0.38	0.64
F	0.035	0.045	0.89	1.14
G	0.025	0.035	0.64	0.89
H	0.048	0.052	1.22	1.32

Notes:

C_P = 0.26 pF Typical

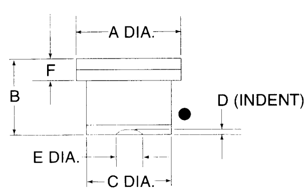
L_S = 0.16 nH Typical

150



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.180	0.0950	1.900	2.510
B	0.730	0.0950	1.900	2.510
C	0.500	0.0105	0.021	0.026
D	048 REF.		1.22 REF.	
E	0.020	0.040	0.51	1.02
F	0.095	0.105	2.41	2.67
G	0.190	0.210	4.83	5.33
H	0.245	0.255	6.22	6.48

166



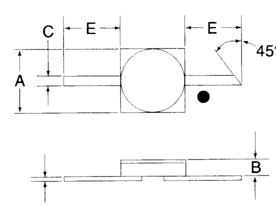
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.043	0.047	1.09	1.19
B	0.026	0.033	0.66	0.84
C	0.029	0.031	0.74	0.79
D	0.001	0.002	0.03	0.05
E	0.010	0.016	0.25	0.41
F	0.006	0.008	0.15	0.20

Notes:

C_P = 0.13 pF Typical

L_S = 0.16 nH Typical

186



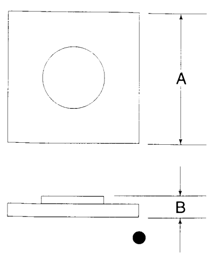
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.094	0.102	2.39	2.59
B	0.031	0.044	0.79	1.12
C	0.019	0.021	0.48	0.53
D	0.003	0.006	0.076	0.15
E	0.130	0.170	3.30	4.32

Notes:

C_P = 0.15 pF Typical

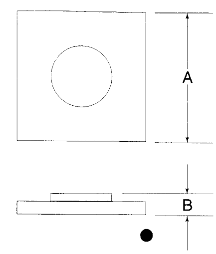
L_S = 0.40 nH Typical

199



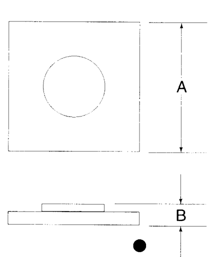
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.027	0.031	0.69	0.79
B	0.004	0.005	0.10	0.13

200



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.037	0.041	0.94	1.04
B	0.004	0.005	0.10	0.13

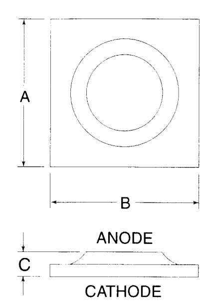
201



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.047	0.051	1.19	1.30
B	0.004	0.005	0.10	0.13

210

PLATED HEATSINK GUNN CHIP



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.024	0.028	0.610	0.711
B	0.024	0.028	0.610	0.711
C	0.004	0.007	0.102	0.178

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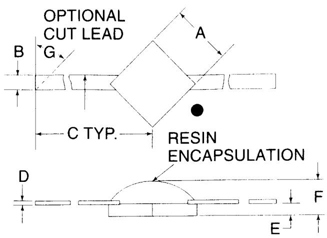
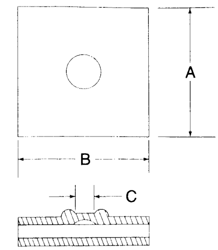
213



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.045	0.055	1.14	1.40
B	0.012	0.018	0.30	0.46
C	0.150	0.180	3.81	4.57
D	0.003	0.005	0.08	0.13
E	—	0.014	—	0.36
F	—	0.035	—	0.89
G	40°	50°	—	—

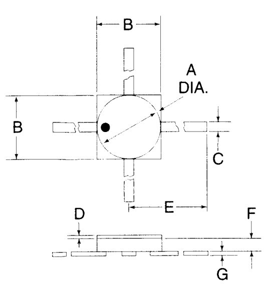
Notes:
C_P = 0.12 pF Typical
L_S = 0.30 nH Typical

223



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.110	0.130	2.79	3.30
B	0.110	0.130	2.79	3.30
C	0.008	0.012	0.20	0.30

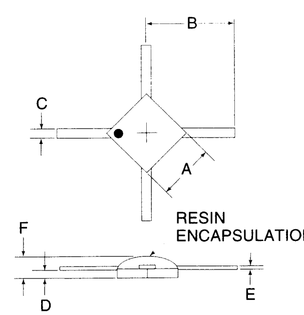
226



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.094	0.102	2.39	2.59
B	0.092	0.106	2.34	2.69
C	0.017	0.023	0.43	0.58
D	0.004	0.008	0.10	0.20
E	0.200	—	5.08	—
F	0.025	0.035	0.64	0.89
G	0.003	0.006	0.08	0.15

Note:
C_P = 0.12 pF Typical

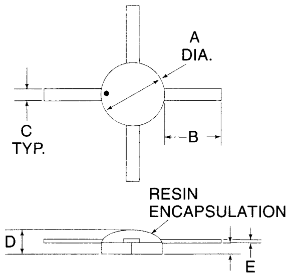
227



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.045	0.055	1.14	1.400
B	0.150	—	3.81	—
C	0.012	0.018	0.300	0.460
D	—	0.014	—	0.360
E	0.003	0.006	0.080	0.150
F	—	0.035	—	0.890

Note:
C_P = 0.05 pF Typical

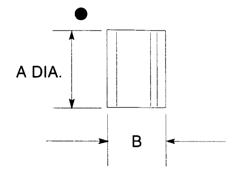
228



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2.29	2.79
B	0.090	0.110	2.29	2.79
C	0.018	0.022	0.46	0.56
D	—	0.035	—	0.89
E	0.003	0.006	0.08	0.15
F	—	0.014	—	0.36

Note:
C_P = 0.10 pF Typical

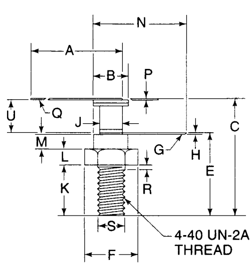
255



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.075	0.085	1.190	2.16
B	0.045	0.055	1.140	1.40

Notes:
C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

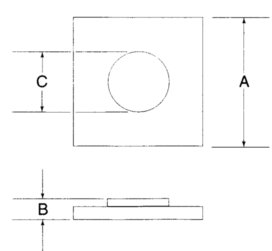
258



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.600	—	15.24	—
B	0.119	0.127	3.02	3.230
C	0.385	0.430	8.78	10.920
D	0.085	0.097	2.16	2.460
E	0.292	0.330	7.42	8.380
F	0.202	—	1.13	—
G	0.090	0.105	2.28	2.670
H	0.002	0.010	0.05	0.254
J	0.077	0.083	1.96	2.110
K	0.183	0.193	4.65	4.900
L	0.050	0.060	1.27	1.520
M	0.057	0.067	1.45	1.700
N	0.650	—	16.51	—
P	0.002	0.004	0.05	0.100
Q	0.090	0.105	2.28	2.670
R	—	0.030	—	0.762
S	0.106	0.111	2.69	2.820

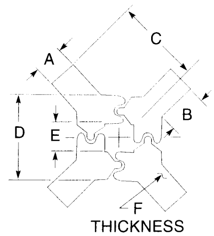
Note:
Dim. "G" and "Q" are the width of tab.

263



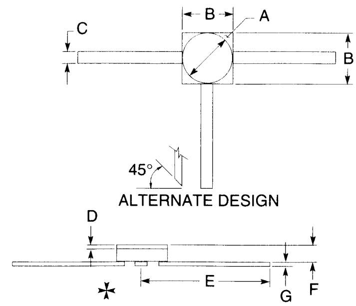
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.060	—	2.510
B	0.004	0.005	0.10	0.130

264



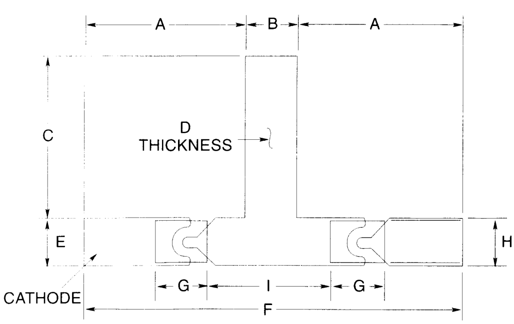
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0045	0.0065	0.114	0.165
B	0.0070	0.0090	0.178	0.229
C	0.0170	0.0190	0.432	0.483
D	0.0170	0.0190	0.432	0.483
E	0.0060	0.0080	0.152	0.203
F	0.0003	0.0005	0.008	0.013

270



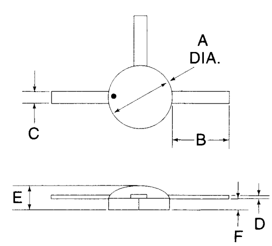
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2.390	2.590
B	0.094	0.102	2.390	2.590
C	0.019	0.021	0.482	0.533
D	0.005	0.009	0.127	0.288
E	0.200	—	5.080	—
F	0.030	0.044	0.762	1.117
G	0.003	0.005	0.680	0.083

271



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0180	0.0200	0.460	0.508
B	0.0045	0.0065	0.114	0.165
C	0.0170	0.0190	0.043	0.048
D	0.0003	0.0005	0.008	0.013
E	0.0045	0.0065	0.114	0.165
F	0.0440	0.0540	1.118	1.372
G	0.0033	0.0048	0.084	0.122
H	0.0036	0.0040	0.091	0.102
I	0.0102	0.0112	0.259	0.284

272



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2.29	2.75
B	0.090	0.110	2.29	2.75
C	0.018	0.022	0.48	0.56
D	0.003	0.006	0.08	0.15
E	—	0.035	—	0.09
F	—	0.014	—	0.36

Notes:
C_P = 0.10 pF Typical

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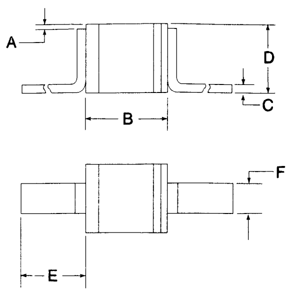
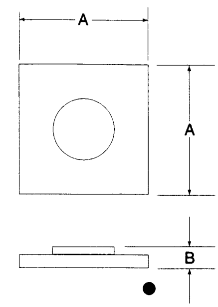
276



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.020	0.254	0.058
B	0.040	0.050	1.020	1.270
C	—	0.005	—	0.127
D	0.051	0.055	1.290	1.390
E	0.200	—	5.060	—
F	0.019	0.021	0.483	0.533

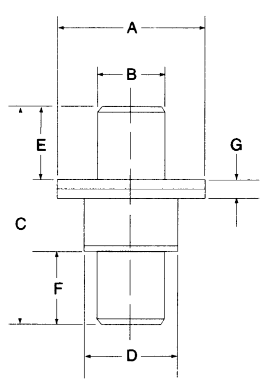
Notes:
C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

277



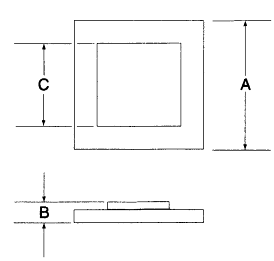
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.012	0.25	0.31
B	0.004	0.005	0.10	0.13

296



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.156	0.164	3.96	4.17
B	0.060	0.064	1.52	1.63
C	0.205	0.225	5.21	5.72
D	0.120	0.128	3.05	3.25
E	0.060	0.064	1.52	1.63
F	0.060	0.064	1.52	1.63
G	0.016	0.024	2.01	2.11

350



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.021	0.46	0.53
B	—	0.005	—	0.13
C	—	0.009	—	0.23

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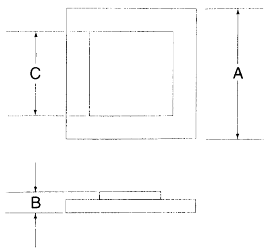
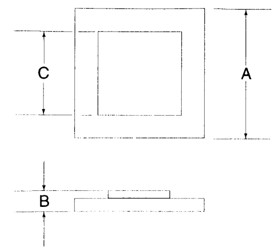
Case Styles (Cont'd)

351



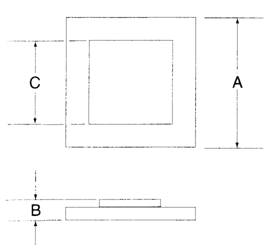
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.021	0.46	0.53
B	—	0.005	—	0.13
C	—	0.012	—	0.30

352



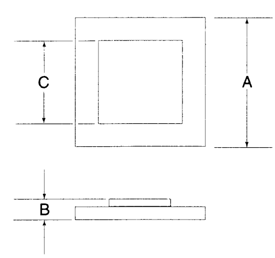
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.021	0.46	0.53
B	—	0.005	—	0.13
C	—	0.015	—	0.38

354



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.020	0.023	0.51	0.58
B	—	0.005	—	0.13
C	—	0.018	—	0.46

358



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.021	0.46	0.53
B	—	0.005	—	0.13
C	—	0.013	—	0.33

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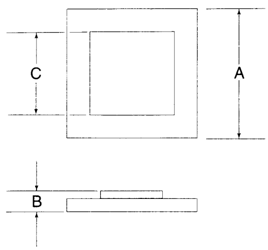
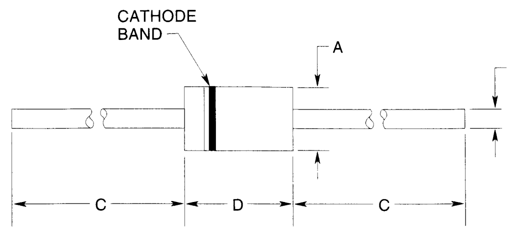
359



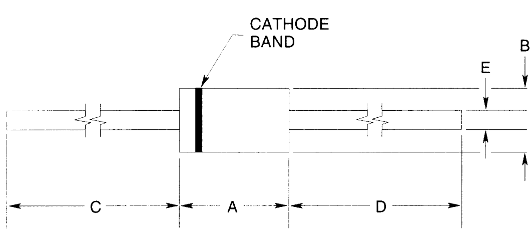
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.021	0.46	0.53
B	—	0.005	—	0.13
C	—	0.016	—	0.41

401



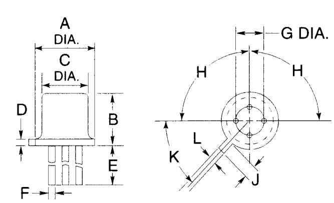
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.090	—	2.290
B	0.027	0.029	0.690	0.740
C	0.975	—	24.800	—
D	—	0.190	—	4.830

402



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.230	—	5.842
B	—	0.140	—	3.556
C	0.975	—	24.765	—
D	0.975	—	24.765	—
E	0.039	0.041	0.991	1.041

507



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.209	0.230	5.31	5.84
B	0.170	0.210	4.32	5.33
C	0.178	0.195	4.52	4.95
D	—	0.030	—	0.76
E	0.500	—	12.70	—
F	0.016	0.021	0.41	0.53
G	0.090	0.110	2.29	2.75
H	89°	91°	89°	91°
J	0.028	0.048	0.71	1.22
K	43°	47°	43°	47°
L	0.036	0.046	0.91	1.17

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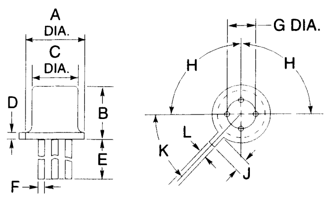
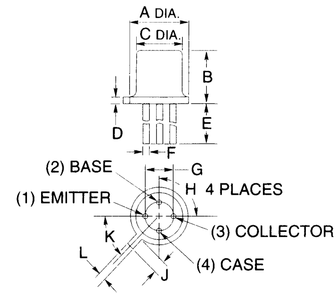
Case Styles (Cont'd)

508



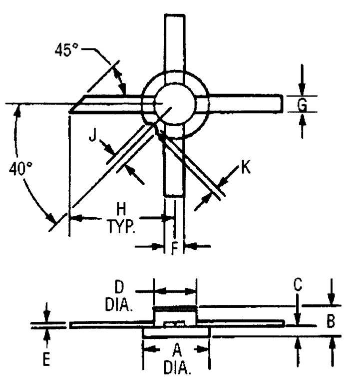
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.209	0.230	5.31	5.84
B	0.065	0.085	1.65	2.16
C	0.178	0.195	4.52	4.95
D	—	0.030	—	0.76
E	0.500	—	12.70	—
F	0.016	0.021	0.41	0.53
G	0.090	0.110	2.29	2.75
H	89°	91°	89°	91°
J	0.028	0.048	0.71	1.22
K	43°	47°	43°	47°
L	0.036	0.046	0.91	1.17

509



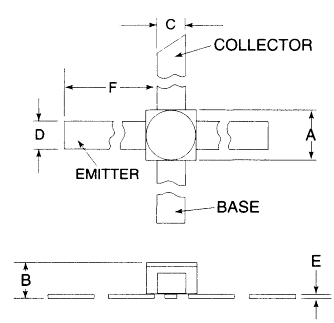
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.209	0.230	5.31	5.84
B	0.170	0.210	4.32	5.33
C	0.178	0.195	4.52	4.95
D	—	0.020	—	0.51
E	0.500	—	12.70	—
F	0.016	0.019	0.41	0.48
G	0.090	0.110	2.29	2.79
H	89°	91°	89°	91°
J	0.028	0.048	0.71	1.22
K	43°	47°	43°	47°
L	0.036	0.046	0.91	1.17

510



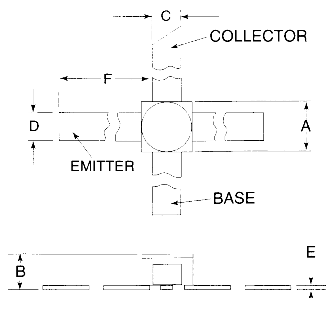
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.1950	0.2150	4.95	5.46
B	0.0430	0.0630	1.09	1.60
C	0.0160	0.0240	0.41	0.61
D	0.1290	0.1410	3.28	3.58
E	0.0015	0.0045	0.04	0.11
F	0.0540	0.0660	1.37	1.68
G	0.0240	0.0360	0.61	0.91
H	0.2790	0.3210	7.09	8.15
J	0.030 REF.		0.76 REF.	
K	0.150 REF.		0.38 REF.	

511



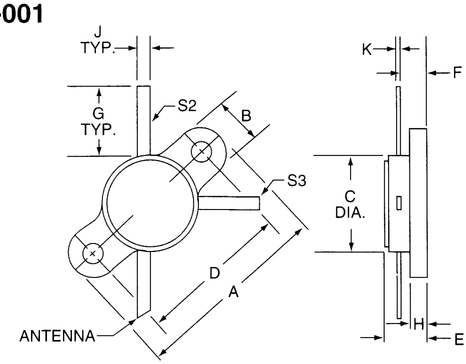
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.095	0.105	2.41	2.68
B	—	0.050	—	1.27
C	0.016	0.024	0.41	0.61
D	0.036	0.044	0.91	1.12
E	0.002	0.006	0.05	0.15
F	0.190	0.260	4.83	6.60

512



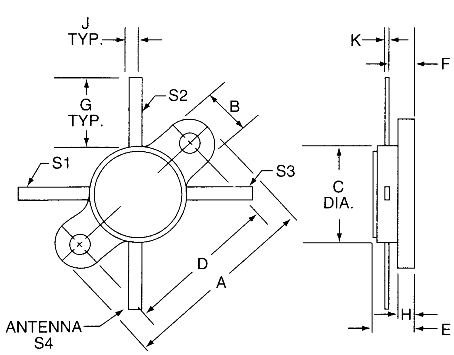
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.065	0.075	1.65	1.91
B	—	0.050	—	1.27
C	0.016	0.024	0.41	0.61
D	0.036	0.044	0.91	1.12
E	0.002	0.006	0.05	0.15
F	0.230	0.280	5.84	7.11

844-001



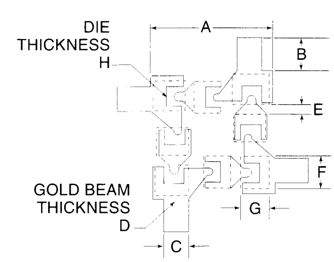
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.970	0.980	24.64	24.89
B	0.240	0.260	6.10	6.60
C	0.460	0.500	11.68	12.70
D	0.720	0.730	18.29	18.54
E	0.250	0.290	6.35	7.37
F	0.150	0.190	3.81	4.83
G	0.350	0.390	8.89	9.91
H	0.080	0.120	2.03	3.05
J	0.045	0.055	1.14	1.40
K	0.010	—	0.25	—

844-004



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.970	0.980	24.64	24.89
B	0.240	0.260	6.10	6.60
C	0.460	0.500	11.68	12.70
D	0.720	0.730	18.29	18.54
E	0.250	0.290	6.35	7.37
F	0.150	0.190	3.81	4.83
G	0.350	0.390	8.89	9.91
H	0.080	0.120	2.03	3.05
J	0.045	0.055	1.14	1.40
K	0.010	—	0.25	—

905

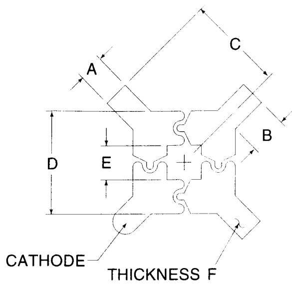


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0220	0.0240	0.559	0.61000
B	0.0050	0.0070	0.127	0.17800
C	0.0040	0.0060	0.101	0.15200
D	0.0002	0.0005	0.005	0.01267
E	0.0020	0.0030	0.051	0.07600
F	0.0060	0.0070	0.152	0.17700
G	0.0045	0.0055	0.114	0.13900
H	0.0015	0.0025	0.0381	0.0635

Note:
Measurement A, B, C & D 4 places
Measurement E, F, G & H 8 places

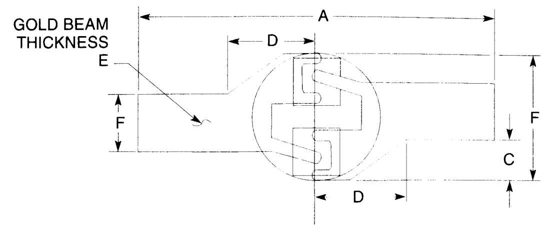
Case Styles (Cont'd)

906



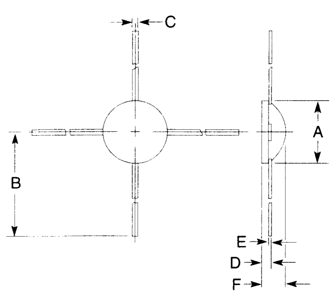
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0045	0.0065	0.114	0.165
B	0.0070	0.0090	0.178	0.229
C	0.0170	0.0190	0.432	0.483
D	0.0170	0.0190	0.432	0.483
E	0.0060	0.0080	0.152	0.203
F	0.0003	0.0005	0.008	0.013

942



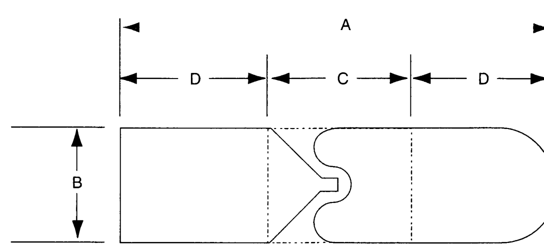
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0260	0.0280	0.660	0.7110
B	0.0045	0.0055	0.114	0.1400
C	0.0019	0.0029	0.048	0.0740
D	0.0060	0.0070	0.152	0.1780
E	0.0002	0.0005	0.0051	0.0127
F	0.0085	0.010	0.216	0.254

963



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.050	0.058	1.270	1.470
B	0.140	—	3.550	—
C	0.012	0.018	0.300	0.460
D	0.007	0.015	0.178	0.400
E	0.003	0.006	0.076	0.152
F	—	0.035	—	0.89

965



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0270	0.0300	0.6860	0.762
B	0.0050	0.0060	0.1270	0.152
C	0.0122	0.0132	0.3100	0.335
D	0.0130	0.0140	0.3300	0.356
E	0.0010	0.0015	0.0254	0.038
F	0.00025	0.0003	0.00635	—

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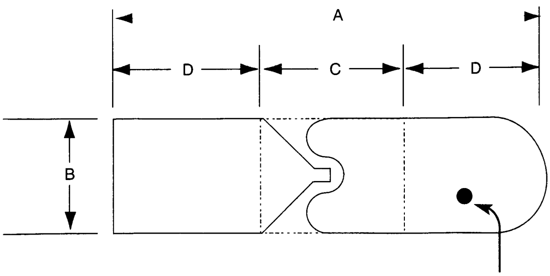
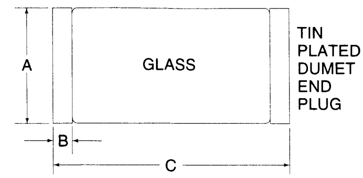
965A



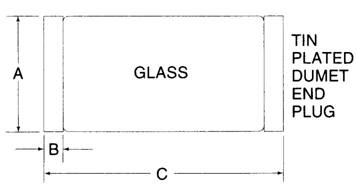
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0270	0.0290	0.6860	0.737
B	0.0050	0.0060	0.1270	0.152
C	0.0130	0.0140	0.3300	0.356
D	0.0122	0.0132	0.3100	0.335
E	0.0010	0.0015	0.0254	0.038
F	0.00025	0.0003	0.00635	0.00762

983



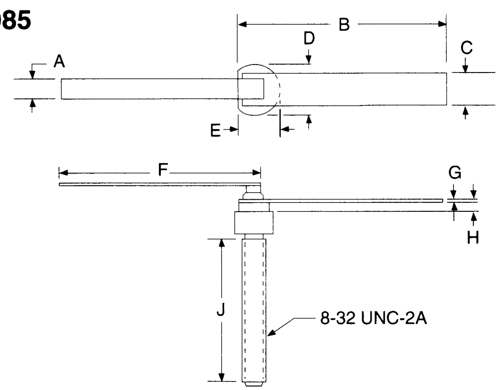
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.057	0.067	1.450	1.700
B	0.011	0.019	0.280	0.482
C	0.130	0.150	3.30	3.810

984



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.095	0.100	2.410	2.540
B	0.010	0.020	0.280	0.482
C	0.185	0.205	0.469	0.520

985



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.095	.105	2.41	2.67
B	.500	.750	12.70	19.05
C	.148	.152	3.75	3.86
D	.245	.255	6.22	6.48
E	.180	.190	4.57	4.83
F	.500	.750	12.70	19.05
G	.003	.005	0.076	.127
H	.050	.060	1.27	1.52
J	.730	.770	18.54	19.56

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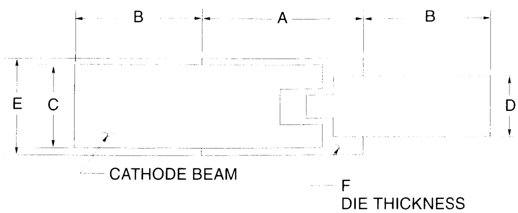
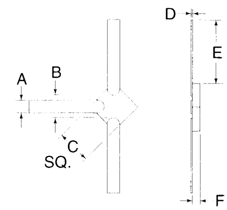
Case Styles (Cont'd)

992



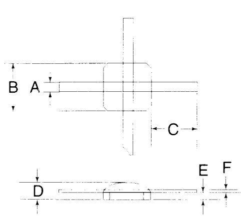
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.012	0.014	0.305	0.356
B	0.010	—	0.254	—
C	0.006	0.008	0.152	0.203
D	0.004	0.006	0.102	0.152
E	0.007	0.009	0.178	0.229
F	—	0.004	0.305	0.1026

1000



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.013	0.017	0.330	0.432
B	0.022	0.028	0.559	0.711
C	0.048	0.052	1.220	1.320
D	0.003	0.005	0.076	0.127
E	0.090	—	2.290	—
F	0.008	0.012	0.230	0.305

1008

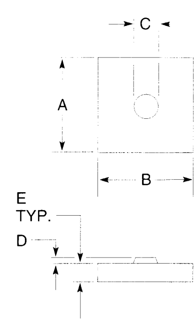


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.018	0.022	0.457	0.559
B	0.090	0.110	2.290	2.790
C	0.090	0.110	2.290	2.790
D	—	0.050	—	1.270
E	—	0.015	—	0.381
F	0.003	0.005	0.076	0.127

Notes:

C_P = 0.05 pF Typical

1009



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0140	0.0160	0.3550	0.406
B	0.0140	0.0160	0.3550	0.406
C	0.0018	0.0022	0.0460	0.056
D	0.0002	—	0.0051	—
E	0.0040	0.0060	0.1020	0.152

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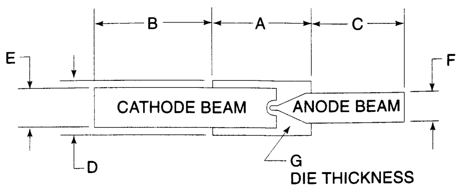
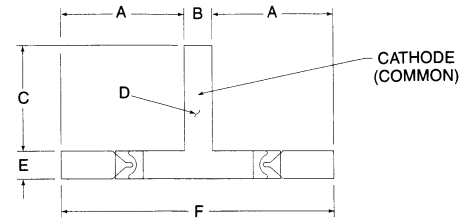
1010



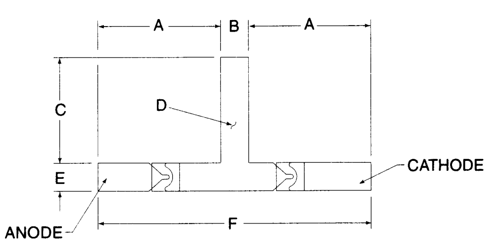
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.012	0.254	0.305
B	0.012	—	0.305	—
C	0.010	—	0.254	—
D	0.006	0.008	0.154	0.203
E	0.005	0.006	0.127	0.152
F	0.004	0.005	0.101	0.127
G	0.003	0.004	0.076	0.101

1011



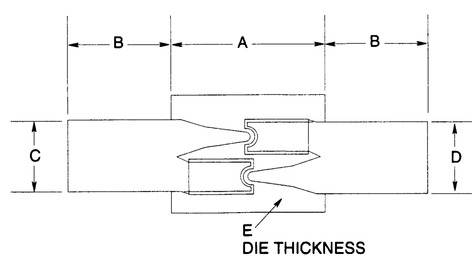
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0180	0.0200	0.460	0.508
B	0.0045	0.0065	0.114	0.165
C	0.0170	0.0190	0.430	0.480
D	0.0003	0.0005	0.008	0.013
E	0.0045	0.0065	0.114	0.165
F	0.0440	0.0540	1.118	1.372

1012



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0180	0.0200	0.460	0.508
B	0.0045	0.0065	0.114	0.165
C	0.0170	0.0190	0.430	0.480
D	0.0003	0.0005	0.008	0.013
E	0.0045	0.0065	0.114	0.165
F	0.0440	0.0540	1.118	1.372

1013



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0135	0.015	0.330	0.380
B	0.0070	–	1.178	–
C	0.0105	0.012	0.260	0.300
D	0.0050	0.006	0.127	0.152
E	0.0030	0.004	0.076	0.102

Note:
1. Both beams are the same width.

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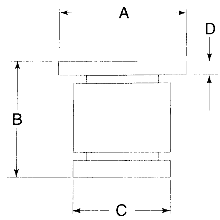
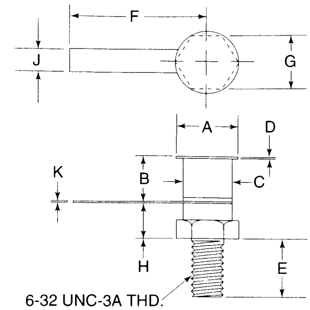
1027



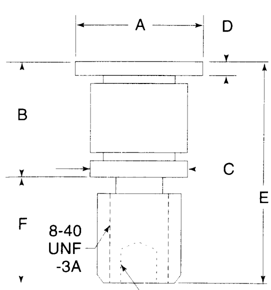
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.304	.316	7.72	8.02
B	.254	.270	6.45	6.86
C	.245	.255	6.22	6.48
D	.023	.031	0.58	0.79

1038



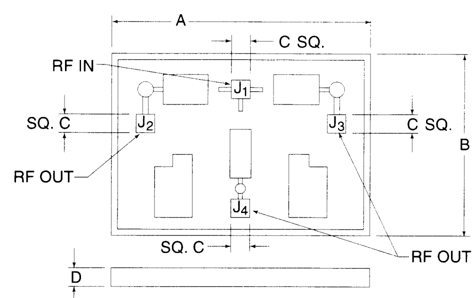
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.304	0.316	7.72	8.02
B	0.254	0.270	6.45	6.86
C	0.245	0.255	6.22	6.48
D	0.023	0.031	0.58	0.79
E	0.221	0.252	5.61	6.40
F	0.780	0.790	19.80	20.10
G	0.245	0.255	6.22	6.48
H	0.128	0.137	3.25	3.48
J	0.120	0.130	3.05	3.30
K	0.007	0.009	0.18	0.23

1048



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.304	0.316	7.72	8.02
B	0.266	0.292	6.76	7.42
C	0.245	0.255	6.22	6.48
D	0.023	0.031	0.58	0.79
E	0.547	0.597	13.90	15.20
F	0.281	0.305	7.14	7.75

1051



CHIP IS A DETAIL 60X

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.069	0.071	1.75	1.800
B	0.049	0.051	1.24	1.300
C	0.005	—	0.127	—
D	0.005	0.007	0.127	0.178

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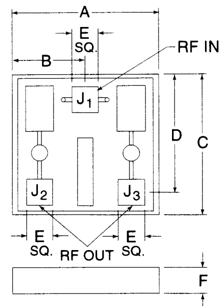
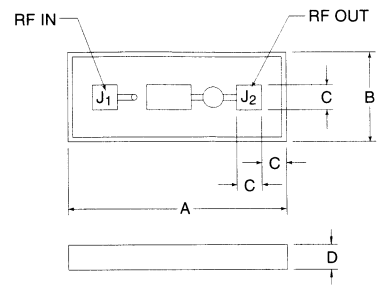
1052



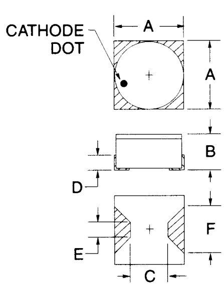
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.039	0.041	0.991	1.040
B	0.019	0.021	0.483	0.533
C	0.038	0.040	0.965	1.020
D	0.028	0.030	0.711	0.762
E	0.007	0.008	0.178	0.203
F	0.007	0.008	0.178	0.203

1053



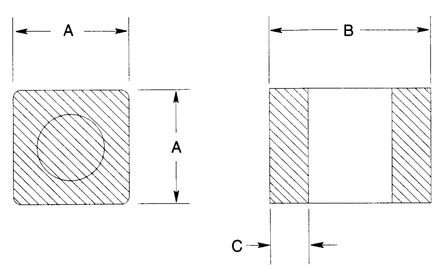
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.044	0.046	1.120	1.170
B	0.018	0.020	0.457	0.508
C	0.005	—	0.127	—
D	0.005	0.007	0.127	0.178

1056



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.065	0.075	1.720	1.900
B	0.034	0.041	0.860	1.040
C	0.030	0.036	0.760	0.910
D	0.013	0.017	0.330	0.440
E	0.010	0.014	0.254	0.356
F	0.043	0.053	1.090	1.350

1072



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.080	0.0950	2.032	2.413
B	0.115	0.1350	2.921	3.429
C	0.008	0.0300	0.203	0.762

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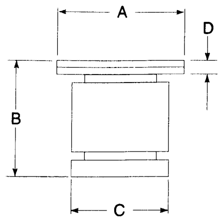
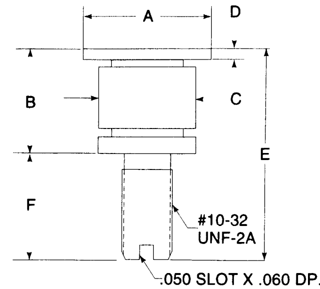
1073



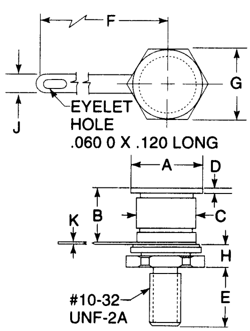
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.468	0.485	11.90	12.30
B	0.373	0.395	9.46	10.00
C	0.390	0.400	9.91	10.20
D	0.028	0.042	0.711	1.06

1074



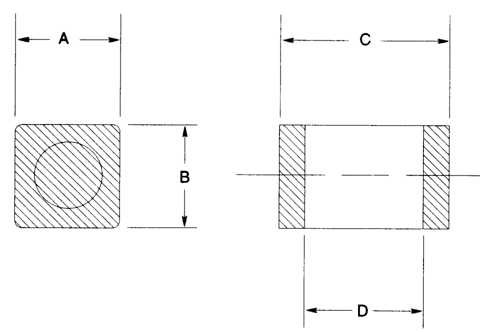
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.468	0.485	11.887	12.319
B	0.387	0.411	9.830	10.400
C	0.390	0.400	9.910	10.100
D	0.028	0.042	0.710	1.000
E	0.812	0.856	20.600	21.700
F	0.425	0.445	10.7	11.3

1075



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.468	0.485	11.887	12.319
B	0.373	0.395	9.450	10.000
C	0.390	0.400	9.906	10.160
D	0.028	0.042	0.711	1.066
E	0.422	0.452	10.700	11.500
F	0.805	0.820	20.400	20.800
G	0.490	0.500	12.400	12.700
H	0.148	0.170	3.760	4.320
J	0.120	0.130	3.050	3.300
K	0.022	0.026	0.559	0.660

1079



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.098	0.118	2.490	3.000
B	0.098	0.118	2.490	3.000
C	0.185	0.205	4.700	5.210
D	0.128	—	3.250	—

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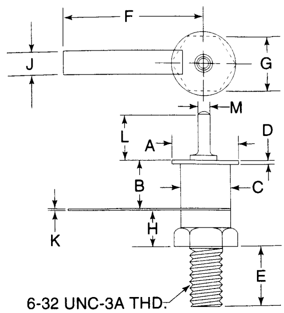
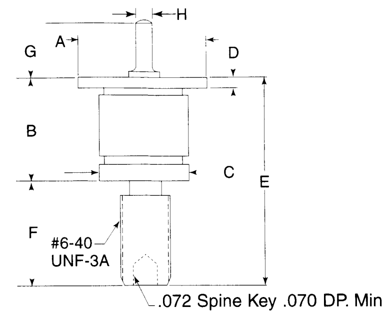
1080



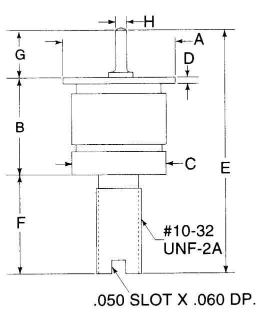
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.304	0.316	7.72	8.020
B	0.254	0.270	6.45	6.860
C	0.245	0.255	6.22	6.480
D	0.023	0.031	0.58	0.790
E	0.221	0.252	5.61	6.400
F	0.780	0.790	19.80	20.100
G	0.245	0.255	6.22	6.480
H	0.128	0.137	3.25	3.480
J	0.120	0.130	3.05	3.300
K	0.007	0.009	0.18	0.230
L	0.190	0.205	4.83	5.210
M	0.060	0.065	1.52	1.65

1082



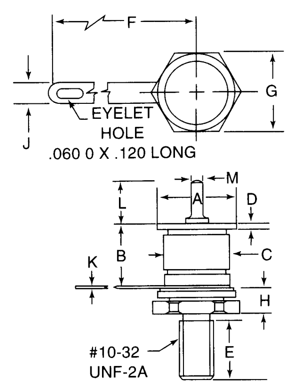
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.304	.316	7.720	8.02
B	.266	.292	6.450	6.86
C	.245	.255	6.220	6.48
D	.023	.031	.058	0.79
E	.547	.597	13.900	15.20
F	.281	.305	7.140	7.75
G	.190	.205	4.830	5.21
H	.060	.065	1.520	1.65

1084



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.468	.485	11.90	12.30
B	.387	.411	9.83	10.40
C	.390	.400	9.90	10.10
D	.028	.042	0.71	1.06
E	.986	1.035	25.00	26.30
F	.425	.445	10.80	11.30
G	.190	.205	4.83	5.21
H	.060	.065	1.52	1.65

1085



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.468	0.485	11.90	12.300
B	0.373	0.395	9.47	10.000
C	0.390	0.400	9.91	10.200
D	0.028	0.042	0.71	1.070
E	0.422	0.452	10.70	11.500
F	0.805	0.820	20.40	20.800
G	0.490	0.500	12.40	12.700
H	0.148	0.170	3.76	4.320
I	0.120	0.130	3.05	3.300
J	0.022	0.026	0.559	0.660
K	0.190	0.205	4.83	5.210
L	0.060	0.065	1.52	1.65

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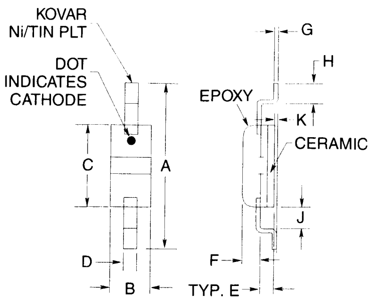
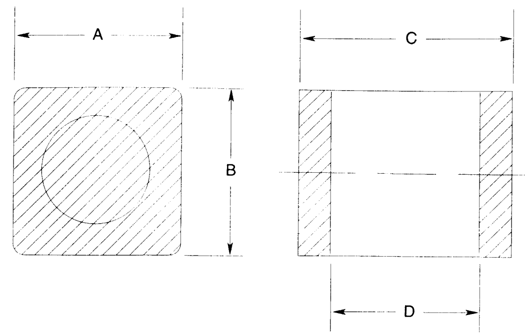
Case Styles (Cont'd)

1088



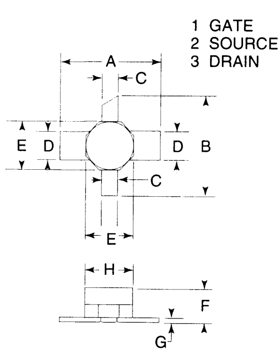
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.1750	0.1950	4.440	4.950
B	0.0400	0.0500	1.020	1.270
C	0.0850	0.0950	2.160	2.410
D	0.0150	0.0250	0.381	0.635
E	0.0100	0.0150	0.254	0.381
F	0.0150	0.0200	0.381	0.508
G	0.0040	0.0060	0.102	0.152
H	0.0200	0.0300	0.508	0.762
K	0.0130	0.0330	0.330	0.838
L	0.0030	0.0050	0.076	0.127

1091



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.138	0.155	3.510	3.940
B	0.138	0.155	3.510	3.940
C	0.180	0.200	4.570	5.080
D	0.120	—	3.050	—

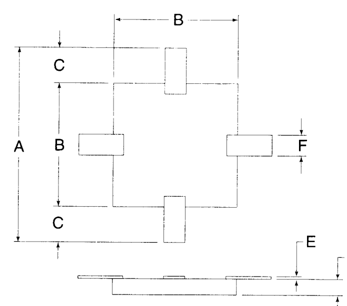
1105



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.150	0.165	3.80	4.20
B	0.150	0.165	3.80	4.20
C	0.014	0.026	0.35	0.65
D	0.032	0.047	0.80	1.20
E	0.063	0.079	1.60	2.00
F	–	0.057	–	1.45
G	0.002	0.008	0.05	0.20
H	0.063	0.079	1.60	2.00

1108

SCHOTTSKY GaAs RING QUAD



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0370	0.0390	0.940	0.991
B	0.0235	0.0245	0.597	0.622
C	0.0065	0.0075	0.165	0.191
D	0.0030	0.0040	0.070	0.100
E	0.0005	NOMINAL	0.012	NOMINAL
F	0.0040	0.0050	0.100	0.120

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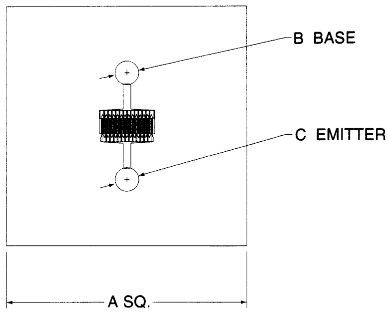
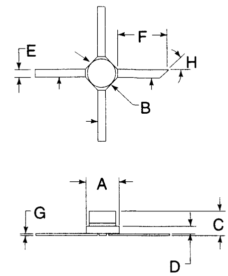
1138



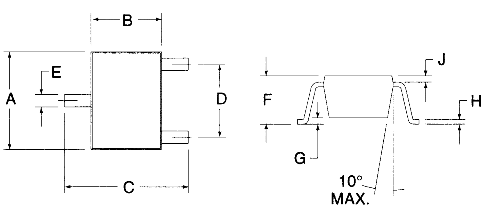
	INCHES		MILLIMETERS	
DIM.	MIN.	MAX.	MIN.	MAX.
A	0.0110	0.013	0.279	0.330
B	0.0006	NOMINAL	0.015	NOMINAL
C	0.0006	NOMINAL	0.015	NOMINAL

1139



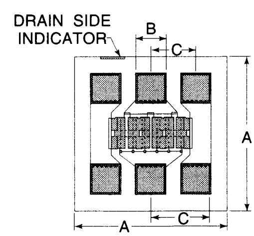
	INCHES		MILLIMETERS	
DIM.	MIN.	MAX.	MIN.	MAX.
A	0.092	1.08	2.34	2.74
B	0.079	0.87	2.01	2.21
C	—	0.70	—	1.78
D	0.019	0.25	0.48	0.64
E	0.018	0.22	0.46	0.56
F	0.150	—	3.81	—
G	0.003	0.06	0.08	0.15
H	45°		45°	

1146



	INCHES		MILLIMETERS	
DIM.	MIN.	MAX.	MIN.	MAX.
A	0.063	0.087	1.60	2.20
B	0.045	0.053	1.15	1.35
C	0.079	0.087	2.00	2.20
D	0.047	0.055	1.20	1.40
E	0.008	0.016	0.20	0.40
F	0.031	0.039	0.80	1.00
G	—	0.004	—	0.10
H	0.003	0.006	0.08	0.15
J	0.004	0.010	0.10	0.25

1161



	INCHES	MILLIMETERS
DIM.	NOMINAL	NOMINAL
A	0.016	0.406
B	0.002	0.050
C	0.003	0.075

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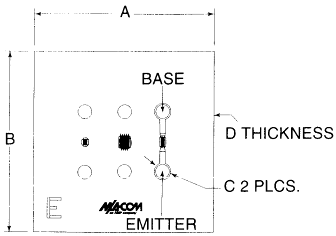
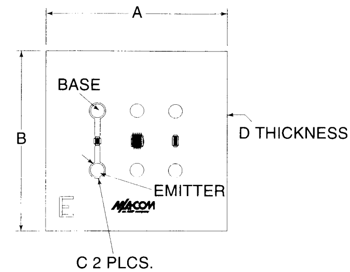
1165



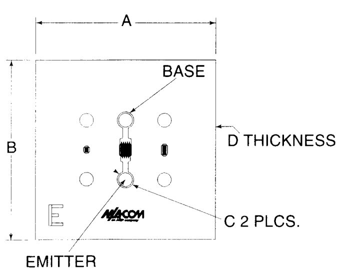
DIM.	INCHES NOMINAL	MILLIMETERS NOMINAL
A	0.0013	0.35
B	0.0013	0.35
C	0.0012	0.03
D	0.0045	0.11

1166



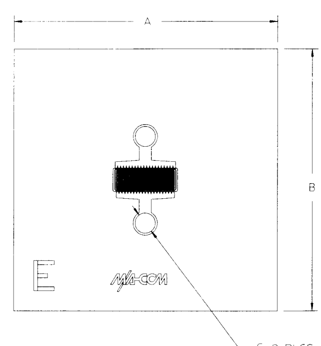
DIM.	INCHES NOMINAL	MILLIMETERS NOMINAL
A	0.0013	0.35
B	0.0013	0.35
C	0.0012	0.03
D	0.0045	0.11

1167



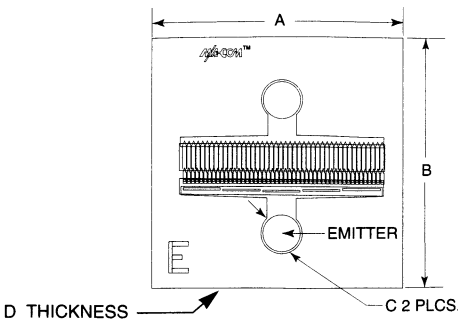
DIM.	INCHES NOMINAL	MILLIMETERS NOMINAL
A	0.013	0.35
B	0.013	0.35
C	0.0016	0.04
D	0.0045	0.11

1169



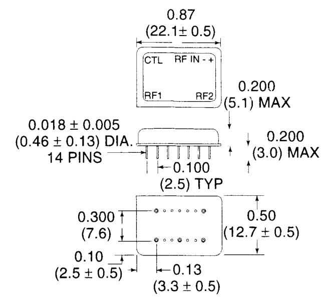
DIM.	INCHES NOMINAL	MILLIMETERS NOMINAL
A	0.0130	0.35
B	0.0130	0.35
C	0.0012	0.03
D	0.0045	0.11

1170



DIM.	INCHES NOMINAL	MILLIMETERS NOMINAL
A	0.0013	0.35
B	0.0013	0.35
C	0.0020	0.05
D	0.0045	0.11

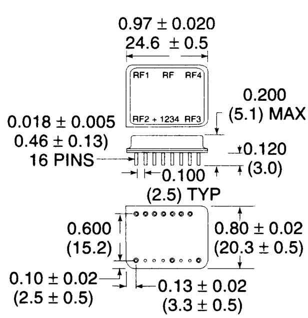
DI-1



WEIGHT (APPROX.): 0.14 OUNCES 4 GRAMS

Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

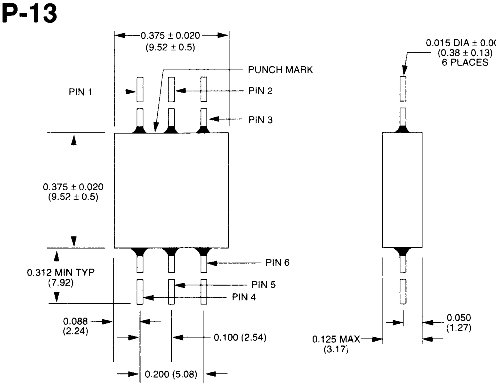
DI-5



WEIGHT (APPROX.): 0.26 OUNCES 73 GRAMS

Unless Otherwise Noted: .xxx = ±0.010 (.xx = ±0.25)
.xx = ±0.02 (.x = ±0.5)

FP-13



WEIGHT (APPROX.): 0.03 OUNCES 0.8 GRAMS

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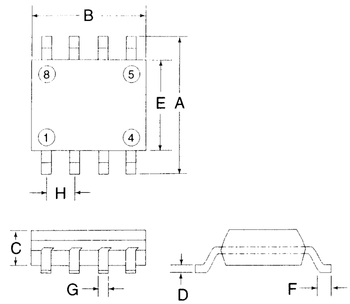
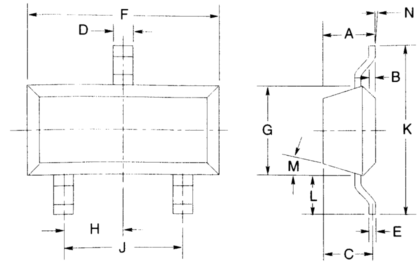
Case Styles (Cont'd)

SO-8



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.244	—	6.200
B	—	0.202	—	5.130
C	—	0.068	—	1.730
D	—	0.010	—	0.250
E	—	0.185	—	4.190
F	—	0.035	—	0.890
G	—	0.020	—	0.500
H	0.050 NOMINAL		1.270 NOMINAL	

SOT-23 High Profile

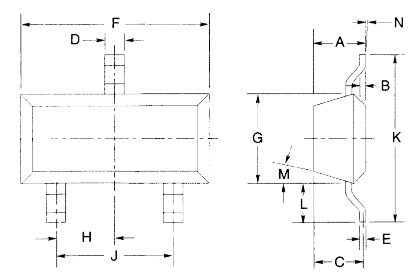


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.048	—	1.22
B	—	0.008	—	0.20
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 TYPICAL		0.95 TYPICAL	
J	0.075 TYPICAL		1.90 TYPICAL	
K	—	0.103	—	2.60
L	—	0.024	—	0.60

DIM.	GRADIENT
M	10° MAX[1]
N	2° …30

Note:
1. Application on all sides

SOT-23 Low Profile

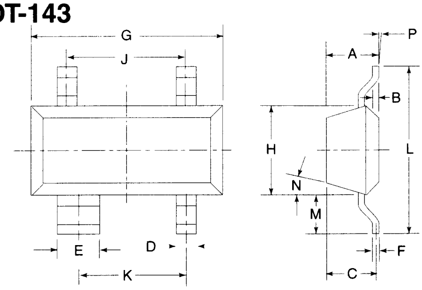


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.044	—	1.12
B	—	0.004	—	0.10
C	—	0.040	—	1.00
D	0.013	0.020	0.35	0.50
E	0.003	0.006	0.08	0.15
F	0.110	0.119	2.80	3.00
G	0.047	0.056	1.20	1.40
H	0.037 TYPICAL		0.95 TYPICAL	
J	0.075 TYPICAL		1.90 TYPICAL	
K	—	0.103	—	2.60
L	—	0.024	—	0.60

DIM.	GRADIENT
M	10° MAX[1]
N	2° …30

Note:
1. Application on all sides

SOT-143



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	—	0.044	—	1.10
B	—	0.044	—	0.10
C	—	0.040	—	1.00
D	0.013	0.035	0.75	0.50
E	0.003	0.020	0.35	0.15
F	0.003	0.006	0.08	0.15
G	0.110	0.119	2.80	3.00
H	0.047	0.056	1.20	1.40
J	0.075 TYPICAL		1.90 TYPICAL	
K	0.065 TYPICAL		1.90 TYPICAL	
L	—	0.013	—	2.60
M	—	0.024	—	0.60

DIM.	GRADIENT
N	10° MAX[1]
P	2° …30

Note:
1. Application on all sides

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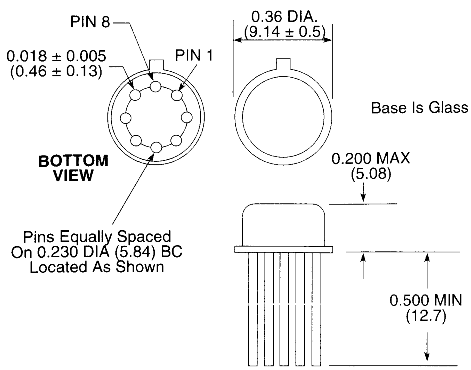
TO-5-3



WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

Bottom of Case is AC Ground
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
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