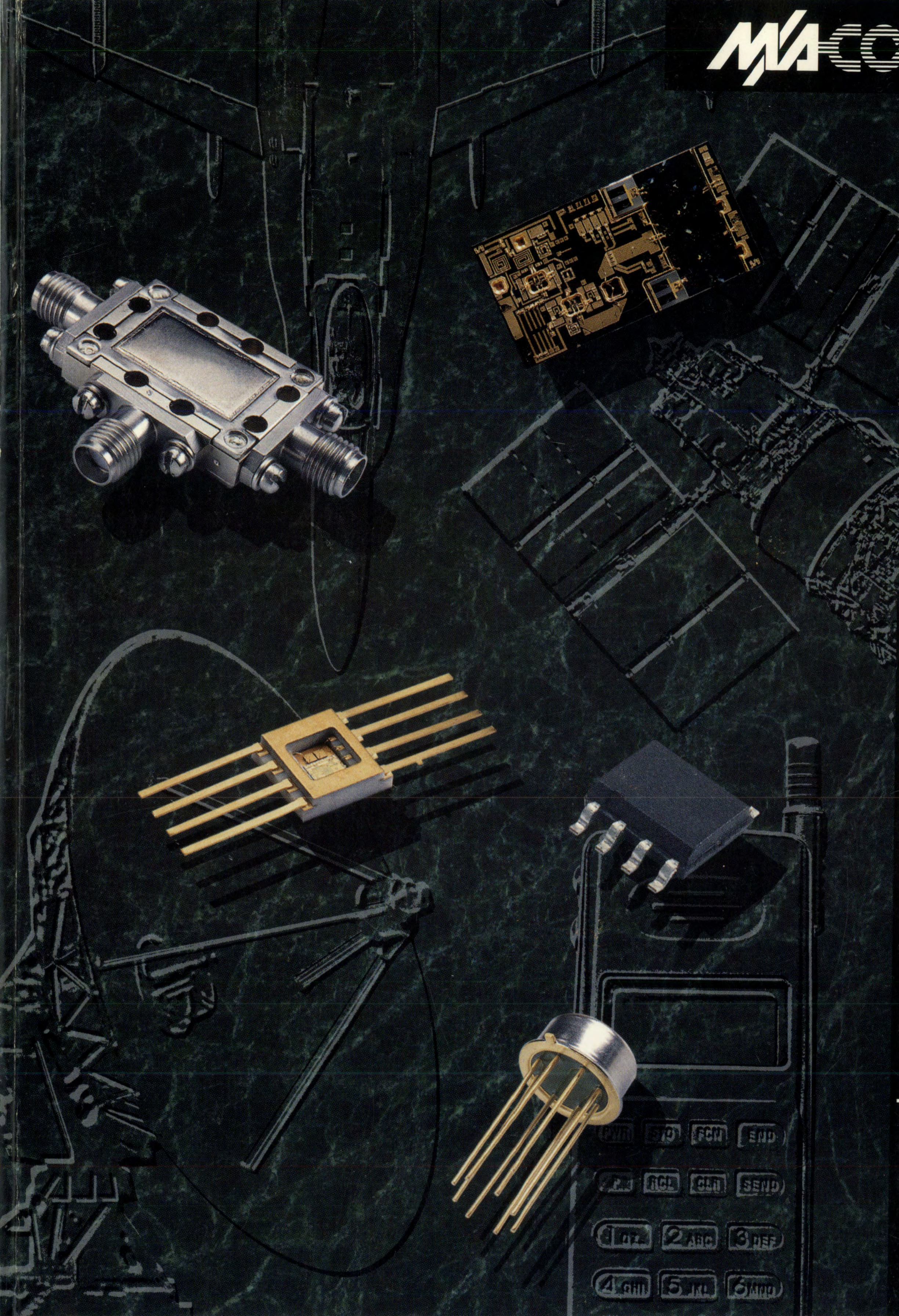
M/A-COM



RF, MICROWAVE AND MILLIMETER WAVE

MMIC, Hybrid and Passive Components

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 LAN's, 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
- Silicon and GaAs Wafers
- Transistors
- MMIC/HMIC™/GMIC™

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

Sources
- VCO
- Gunn
- Transceivers
- Transistor
- Synthesizers
- YIG Tuned

Amplifiers
- Low Noise
- Small Signal
- Linearized/Power
- Gain Blocks

Receiver Components
- Mixers
- LNA's
- Log IF Amps
- Discriminators
- Detectors
- DLVA's

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

Passive Components
- Isolators
- Circulators
- Filters
- Waveguide Ferrite
- Couplers
- Dividers
- 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
- Substrates
- Wafers
- Bulk

How to Order:

Specify by M/A-COM part number. If a 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 North America, call toll free: 800-366-2266.

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

Terms:

F.O.B. Origin, Net 30, days if credit has 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. If within 12 months after delivery to the original owner and after prepaid return by the original owner any M/A-COM product listed in the 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.

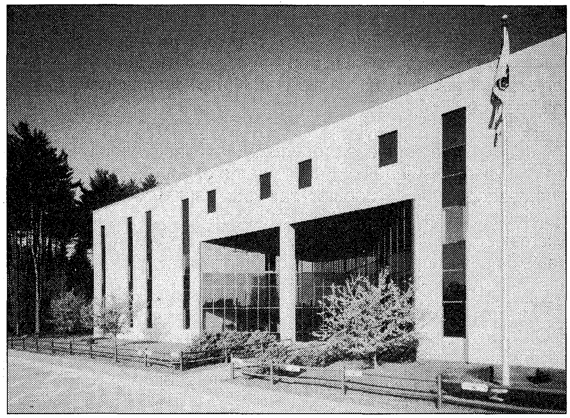
Contents

Introduction

Facilities

M/A-COM's Microelectronics Division is located in two modern facilities in Lowell, Massachusetts. These facilities contain over 40,000 square feet of clean room areas to support our semiconductor and Class-S Space production.

This catalog presents our standard active and passive devices, components and assemblies for radio frequency (RF), microwave and millimeter wave applications. In addition, the catalog contains capability overviews, application notes and appendices to provide technological information to help you in your selection process.



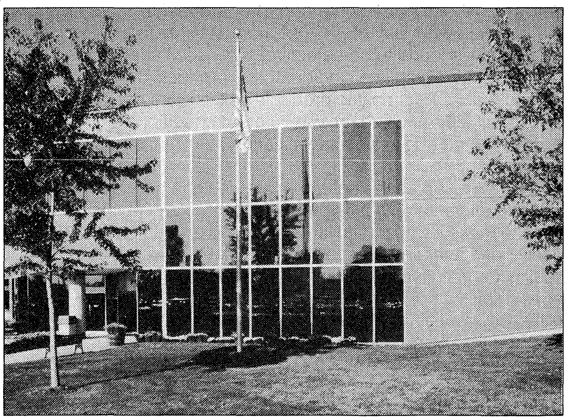
1011 Pawtucket Blvd, Lowell, Massachusetts

M/A-COM Microelectronics Division Background

Founded in 1950, M/A-COM now maintains operations in New England, California, Maryland, Ireland, United Kingdom, Puerto Rico and Japan. Our Microelectronics Division is the combination of several former operations, including:

Microwave Associates	Burlington, MA
Adams Russell/Anzac	Burlington, MA and Bangor, ME
RHG division of Anzac	Burlington, MA
Control Components Division (CCD)	Merrimack, NH
Radar Products Division (RPD)	Burlington, MA
Millimeter Wave Group of RPD	Burlington, MA
Ferrite Group of RPD	Burlington, MA
Integrated Subsystems Division (ISD)	Chelmsford, MA
M/A-COM Space Center	Waltham, MA
Lowell Semiconductor Operations (LSO)	Lowell, MA

Through this combining, we have created natural work groups to design and develop effective process areas. This workforce is part of M/A-COM's market-facing strategy, designed to lower costs and make us more competitive in today's challenging markets.



Richard M. Walker Advanced Technology Research Facility, 100 Chelmsford Street, Lowell, Massachusetts

A Continuing Tradition

M/A-COM Microelectronics Division has over 44 years 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.

To ensure continued growth, we are aggressively pursuing commercial applications for our technologies from our RF MMIC chipsets for PCs and wireless applications to our millimeter wave transmit/receive assembly for sensors on Intelligent Vehicle Highway Systems (IVHS). Our ongoing success in the commercial market will only bring benefits to our traditional government-oriented customers through continued improvements in volume production capabilities and an increase in public consumer recognition of the value of this technology.

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

- **GaAs & silicon single- and multi-function MMICs**
- **In-house IC design capabilities**
- **Glass Microwave Integrated Circuits (GMIC)TM**
- **Heterolithic Microwave Integrated Circuits (HMIC)TM**
- **Largest domestic producer of GaAs materials**
- **Extensive experience in traditional active and passive technologies**
- **Wide spectrum coverage producing components and assemblies from 0.5 MHz to 325.0 GHz**

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 US patent 4,737,236, owned by M/A-COM, Inc.

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

Commitment to Continuous Improvement

We are committed to continuous improvement in our ability to satisfy our customers' needs. Our goal is quality, delivery and cost performance that lead the industry. To achieve this goal, all managers of critical processes in the business flow are responsible for improvement in their core areas. They work together in teams aligned along the following processes:

Sales and Marketing - Improving our understanding of customer needs and our customer service

Design - Identifying new technologies that enhance manufacturability, performance and reliability through concurrent design using integrated CAE/CAD/CAM technology

Procurement - Certifying our suppliers to meet our requirements for quality, cost and delivery without the need for the added cost of inspection

Production - Optimizing manufacturing efficiency through improvement of process capability

Quality is what we do

Our improvement teams are the functions of our business. Quality is what we do. We have organized our design, assembly, inspection and test functions into Natural Work Cells that allow for flexible continuous flow manufacturing and real-time data analysis covering a wide range of product families from couplers 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 teammates in the work cell. 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

We designed the continuous improvement process to meet the requirements of the International Standard for Quality Excellence ISO9001 and MIL-Q-9858, which together form the basis of our Quality Systems Manual. 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.

Steering Committee

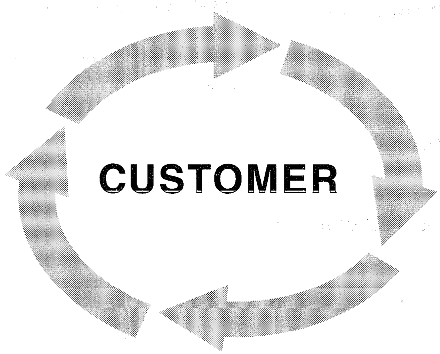
Goals for Division

Leadership

Management Review

Take Action

Feedback to Customer



Core Team

Goals for Core

Identify Critical Processes

Establish Metrics

Take Action

Feedback to Steering Committee

Improvement Team

Review Problem Statement

Apply Statistical Control/Structured Problem Solve

Identify Root Cause

Take Action

Feedback to Core Team

The Continuous Improvement Process

Reliability

M/A-COM uses failure modes and effects analysis, combined with reliability modeling and in-house qualification testing, to assure that new technology designs meet the reliability 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**
- **Accelerate life testing**

Volume Automated Production Capabilities

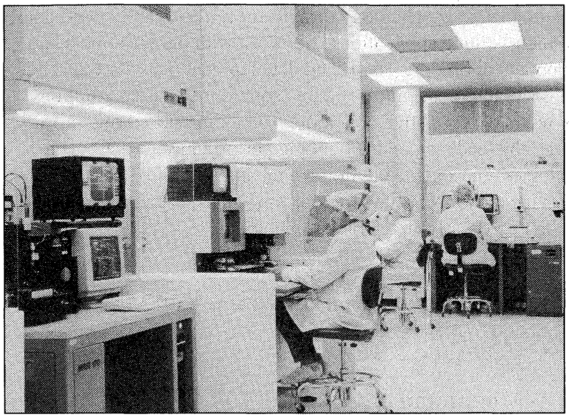
M/A-COM's Volume Automated Production (VAP) assembly line, located in Lowell, MA, offers a complete foundry of RF and microwave IC, hybrid and module products. VAP's major strengths and capabilities include fully automated on-wafer and "fixtureless" RF test, state-of-the-art automated assembly and a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

These capabilities were developed, enhanced and proven during the GE Cobra T/R module carrier build. This eight-month effort consisted of the assembly, test and MIL-STD-883 screening of over forty thousand carrier integrated GaAs MMIC based hybrids.

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 military 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.



Volume Automated Production (VAP) — Work cell based assembly

Integrated Product/Process Development

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

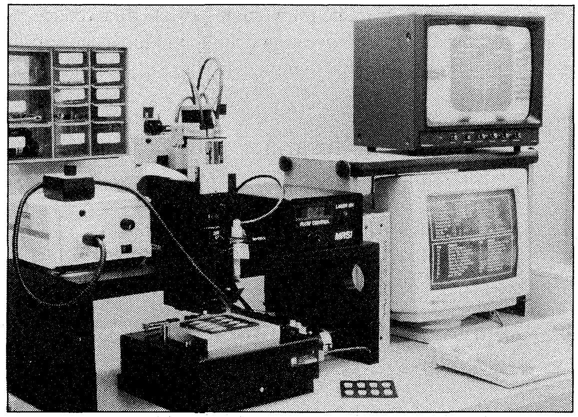
Traditionally, product development in many US companies has evolved in a progression of steps. They are:

- **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.

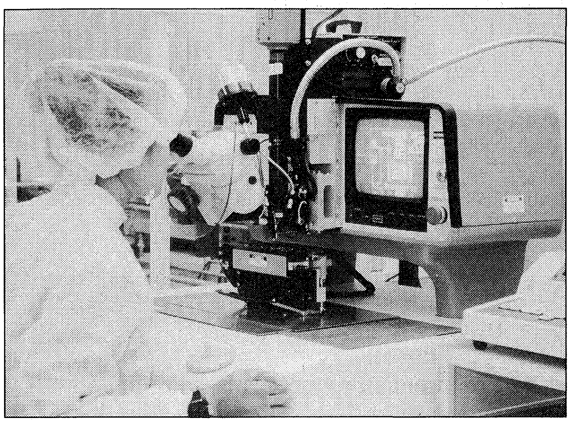
M/A-COM's approach is that of a Concurrent Engineering philosophy, where an integrated multi-discipline team is communicating on all aspects of product development. Product development is achieved through a field of concurrent contributing forces—not isolated, but integrated.

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

Automated Assembly Capabilities



"MRSI 170" — Fully automatic epoxy dispenser

The VAP 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 sealer**
- **Fully automatic programmable epoxy dispensing using full pattern recognition MRSI-170 dispenser**
- **Semi-automatic assembly pick and place using the Laurier HA225**
- **Fully automatic wire bond capability using two Hughes model 2470-3 bonders—one running a 1-mil gold wire process and the other running a 0.8-mil gold wire process**
- **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.

Automatic RF Test Capabilities: A Quality Focus Approach

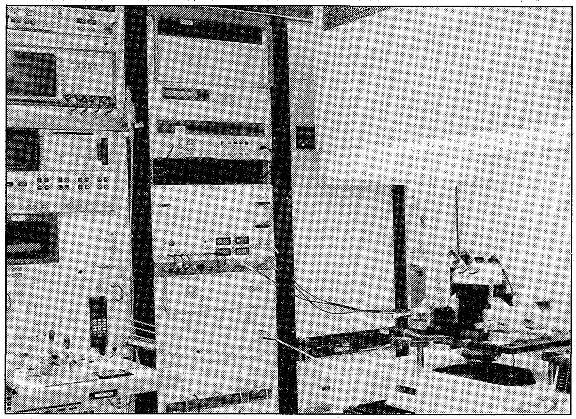
M/A-COM has developed extensive wafer-level RF test capabilities over the past several years for use in a production GaAs MMIC environment. These capabilities have been instrumental in all aspects of our business, as they allow us to accurately and cost-effectively quantify in advance the electrical success of design, process and assembly activities in terms of actual device use and conditions and performance requirements. The quality focus test begins with our MMIC wafers. This proactive approach ensures the use of Known Good Die in our assemblies, resulting in improved yields and a reduction of cycle time and cost.

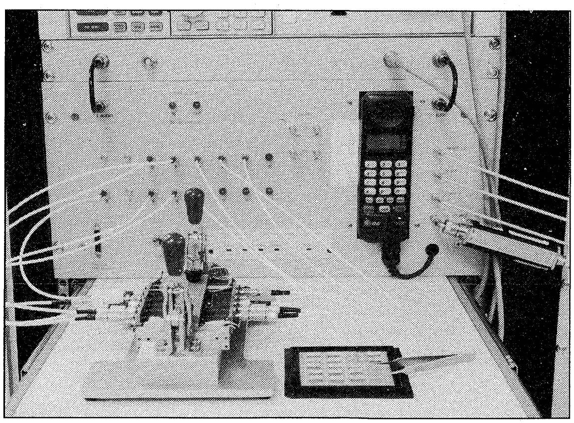
The production RF test facility currently consists of four automated test stands. Two of these stands (RF1, RF2) are configured for small signal S-parameter and noise figure measurements, while the other two (RF3, RF4) are configured for S-parameter and pulsed power vector measurements. One of the small signal stands (RF1) is able to test three-port devices in a single probe touchdown, while the second small signal stand (RF2) includes a six-port RF switch matrix. This six-port test capability is used to measure a five-port X-band variable gain switch amplifier (VGSA) in a single probe touchdown, as well as a number of commercial products in plastic packages with up to six RF ports.

Recent enhancements have been made to one of the pulsed power test stands (RF4) to accommodate the measurement of frequency translation devices (mixers, multipliers). This capability was established to fulfill the test requirements for a commercial hybrid frequency converter, but has been implemented in a generic fashion so it can be used for measurement of most any frequency translation device in the 1 GHz to 18 GHz range.

To accommodate the growing commercial market place, M/A-COM is developing a fifth production test stand for testing in plastic packages. Test hardware for performing essentially any common RF measurement up to 6 GHz is being procured. This system will allow us to measure power, harmonic or spurious performance, noise figure and S-parameters (gain/loss, isolation) on amplifiers, switches, phase shifters, modulators, oscillators and mixers.

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 four computers are networked together with four additional HP workstations used as analysis platforms. This network is also linked to a VAX cluster on which the process and test database resides. Furthermore, the HP network is accessible from PCs through an X-window protocol.


Automatic Test


High-Power Pulse and Multitone Measurement System

Two common techniques are used to interface between the test stands and the device under test (DUT)—device probing and fixture measurements. Each of the four test stands is connected to an automatic probe station 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 carrier fixture 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 disk, 8 mm DAT cartridge or 9 track tape).

M/A-COM believes there is a significant cost advantage to our products resulting from our extensive test capabilities, ready to integrate and satisfy not only military but commercial requirements. The cost advantage due to automation is obvious in reduced set up and test times, increased calibration and measurement accuracy and a diminished requirement for operator interaction. For assembled products (such as carrier assemblies), an even greater cost savings is realized from the ability to test the MMIC to the full set of carrier performance specifications at the wafer level. This results in only those die known to meet the final product specifications being submitted into the assembly activity, greatly enhancing the final electrical yield of the carrier assemblies. All of the experience gained in testing and delivering over 40,000 carrier assemblies in an eight-month time span on the Cobra program applies directly to our current and anticipated future test activities.

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 system provides a total capacity of up to 600 devices simultaneously in an inert (nitrogen gas) atmosphere. In situ monitoring of gate and drain voltages and currents can be performed automatically using an HP3852 data acquisition unit controlled by an HP series 320 computer.

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 15,000 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. Steady state life tests were successfully performed on the Cobra program for low noise amplifier, phase shifter, driver amplifier and high-power amplifier carrier assemblies.

Table of Contents

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Amplifiers, Plastic Packaged, MMIC

	Freq. Range (GHz)	Gain (dB) Typ	Noise Figure (dB) Typ	1 dB Comp. Pt. (dBm) Typ	3rd Order Intercept (dBm) Typ	Package	Part No.	Page No.
New	1.5-1.6*	21	1.65	6	19	SO-8	MAAM12021	**
New	1.5-1.6*	14	1.85	2	14	SO-8	MAAM12022	**
New	0.1-2.0	15.5	5.5	13	24	SOT-89	MAAM40134	1-204
New	0.1-2.0	15.5	5.5	13	24	Cer	MAAM41018	1-202
New	1.7-2.0	20	1.75	7	20	SO-8	MAAM12031	**
New	1.7-2.0	13	1.90	2	13	SO-8	MAAM12032	**
New	2.4-2.5	12	1.90	3	15	SO-8	MAAM22010	**
New	0.05-5.0	Active Mixer/IF Amp, See Product Pages				SO-8	MAMD12008	1-200
New	0.05-5.0	Active Mixer/IF Amp, See Product Pages				Cer	MAMD12018	1-198

Package Key: Cer = Ceramic

* GPS L1 Bank (1575.42) GHz Coverage
** Contact M/A-COM for Data Sheet

Attenuators, Plastic Packaged, MMIC

	Freq. Range (GHz)	Insertion Loss (dB) Typ.	Atten. Range (dB) Typ.	VSWR (:1)Typ.	Type	Package	Part No.	Page No.
New	dc-2.0	2.9	12	2.1	VVA	SOT-143	AT-259	1-40
	dc-2.0	2.9	12	2.1	VVA	SO-8	AT-250	1-42
	dc-2.0	0.7	20	1.4	VVA	SO-8	AT-309	1-44
New	dc-2.0	6.5	35	2	VVA	SO-14	AT-635	1-46
	dc-2.0	0.6	40	1.5	VVA	SO-14	AT-339	1-48
	dc-2.0	0.9	15	1.8	Digital	SO-16	AT-210	1-54
New	dc-2.0	1.1	15.5	1.5	Digital	SO-16	AT-280	1-56
	dc-2.0	1.2	28	1.2	Digital	SO-14	AT-230	1-58
	dc-2.0	1.2	30	1.2	Digital	SO-16	AT-220	1-60
New	dc-2.0	1.6	31	1.5	Digital	SSOP-20	AT-260	1-62
New	0.5-2.0	2.5	35	2	VVA	SO-8	AT-109	1-50
New	0.5-2.0	2.5	40	2	VVA	SO-8	AT-108	1-52

Switches, Plastic Packaged, MMIC

	Freq. Range (GHz)	Insertion Loss (dB) Typ	Isolation (dB) Typ	VSWR (:1) Typ.	Driver	Package	Part No.	Page No.
	SPST							
New	0.6-1.1	0.9	30	1.4	0/+3V	SO-8	SW-349[1]	1-18
	dc-2.5	0.5	65	1.2	0/-5V	SO-8	SW-259	1-16
	SPDT							
New	0.7-2.0	0.7	45	1.4	TTL	SO-8	SW-329	1-30
	dc-2.5	0.4	56	1.2	0/-5V	SO-8	SW-239	1-20
New	dc-2.5	0.2	38	1.2	*	SO-8	SW-277	1-22
New	dc-2.5	0.2	63	1.2	*	SO-8	SW-279	1-24
	dc-2.5	0.4	53	1.2	0/-5V	SO-8	SW-338	1-26
	dc-2.5	0.4	53	1.2	0/-5V	SO-8	SW-339	1-26
	dc-3.0	0.4	46	1.2	0/-5V	SSO-8	SW-328	1-28
	SP4T							
	dc-2.0	0.8	60	1.3	0/-5V	SO-24	SW-419	1-32
	DPDT							
New	dc-2.0	0.35	56	1.3	0/-5V	SO-14	SW-289	1-34
	T/R Diversity							
	dc-2.0	0.4	35	1.3	-	SOW-16	MASW2070G-1	1-38
New	dc-2.5	0.55	38	1.3	-	SSOP-20	SW-923	1-36

* Consult product page.
1. Matched

Specifications Subject to Change Without Notice.

Amplifiers, Chip, MMIC

	Freq. Range (GHz)	Gain (dB) Typ	Noise Figure (dB) Typ	1 dB Comp. Pt. (dBm) Typ.	3rd Order Intercept (dBm)Typ	VSWR (:1)Typ.	Part No.	Page No.
	1.25-1.75	26	1.25	14	24	1.7	MAAM12000	1-174
	0.2-3.0	19	3.7	14	24	1.7	MAAM02350	1-170
	2.0-3.0	26	1.2	14	24	1.7	MAAM23000	1-178
New	2.0-6.0	19	N/A	+28/+30[2]	39	2	MAAM26100[1]	1-192
	3.5-7.0	17	2.1	14	24	1.7	MAAM37000	1-182
	2.0-8.0	17	4.5	14	24	2	MAAM28000	1-186
New	7.0-11.0	18	N/A	+28/+31[2]	38	2	MAAM71100[1]	1-196
	7.5-12.0	15	3.2	17	22	2.3	MAAM71200	1-190

Notes:
1. Power Amplifier
2. MMIC power amp typical power out is notes as : /dB Comp Pt/Saturated Power Out.

Attenuators, Chip, MMIC

	Freq. Range (GHz)	Insert. Loss (db) Typ.	Atten. Range (db) Typ.	VSWR (:1) Typ.	Type	Part No.	Page No.
New	dc-2.0	1.2	40	1.5	VVA	MAAA2000G	1-136
New	dc-2.0	1.4	50	1.4	VVA	MAAA2010G	1-142
	dc-2.0	1.4	15	1.3	Digital	MADA2000G	1-146
	dc-2.0	1.4	15	1.3	Digital	MADA2000G	1-146
	dc-2.0	1.2	15.5	1.4	Digital	MADA2030G	1-152
	dc-2.0	1.8	30	1.4	Digital	MADA2010G	1-156
	dc-2.0	1.7	31	1.4	Digital	MADA2020G	1-162
	dc-12.0	2	15	1.5	Digital	MADA12000	1-168

Switches, Chip, MMIC

	Freq. Range (GHz)	Insertion Loss (db) Typ.	Isol. (db) Typ.	VSWR (:1) Typ.	Driver	Part No.	Page No.
	SPST						
	dc-4.0	0.4	35	1.2	0/-5V	MASW4010	1-74
New	dc-4.0	0.4	40	1.2	0/-5V	MASW4020	1-76
	dc-6.0	0.8	64	1.1	0/-8V	MASW6020G	1-78

Specifications Subject to Change Without Notice.

Switches, Chip, MMIC (cont.)

	Freq. Range (GHz)	Insertion Loss (db) Typ.	Isol. (db) Typ.	VSWR (:1) Typ.	Driver	Part No.	Page No.
	SPDT						
	dc-3.0	0.5	43	1.2	0/-5V	MASW2000	1-92
	dc-3.0	0.45	37	1.2	0/-5V	MASW2020G	1-94
	dc-4.0	0.6	60	1.2	0/-5V	MASW4030G	1-96
	dc-4.0	0.6	60	1.1	0/-5V	MASW4040	1-98
	dc-6.0	0.6	45	1.2	0/-8V	MASW6010G	1-100
	dc-8.0	0.8	35	1.3	0/-5V	MASW8000	1-102
	dc-20.0	1.7	50	1.6	0/-5V	MASW20000	1-104
	SP4T						
	dc-4.0	0.7	41	1.2	0/-5V	MASW4000	1-110
New	dc-4.0	1.3	50	1.4	0/-5V	MASW4060G	1-112
	DPDT						
	dc-2.0	0.4	25	1.1	0/-5V	MASW2040	1-120
	dc-6.0	0.6	40	1.2	0/-5V	MASW6030G	1-122
	dc-6.0	0.6	40	1.2	0/-5V	SW-280	1-124
	Transfer						
New	dc-12.0	1.3	40	1.3	0/-8V	MASW12000G	1-128

Specifications Subject to Change Without Notice.

Space Qualified Products

RF and MMIC Amplifiers

Freq. Range (GHz)	Gain (dB) Typ.	Noise Figure (dB) Typ.	Pt. 1 dB (dBm) Typ.	3rd Order Intercept (dBm)	Package	Part No.	Page No.
0.0005-.06	10	4.6	+31	+50	Conn	AM-109	2-84
0.0005-0.1	16	3.8	-2	+12	RH	AM-124	2-85
0.0005-0.1	30	4.5	+23	+40	Conn	AM-110	2-86
0.01-0.1	30	1.5	+18	+33	FP	AM-113	2-87
0.01-0.1	12.5	1.3	+15	+32	TO-8	AM-162	2-88
0.01-0.1	12.5	1.3	+15	+32	Conn	AMC-162	2-88
0.01-0.1	12.5	1.3	+15	+32	SMT	AMS-162	2-88
0.005-0.2	15	4.8	+28	+47	FP	AM-134	2-90
0.005-0.2	15	4.8	+28	+47	Conn	AMC-134	2-90
0.005-0.2	20	4.8	+29	+49	FP	AM-136	2-92
0.005-0.2	20	4.8	+29	+49	Conn	AMC-136	2-92
0.005-0.2	25	5.3	+29	+48	FP	AM-138	2-94
0.005-0.2	25	5.3	+29	+48	Conn	AMC-138	2-94
0.005-0.2	29	5.4	+28	+47	FP	AM-140	2-96
0.005-0.2	29	5.4	+28	+47	Conn	AMC-140	2-96
0.005-0.2	10	4.5	+29	+49	FP	AM-132	2-98
0.005-0.2	10	4.5	+29	+49	Conn	AMC-132	2-98
0.01-0.2	16	2	+9	+24	Conn	AM-112	2-99
0.01-0.2	8	1.3	+11	+30	FP	AM-117	2-100
0.01-0.2	8	1.3	+11	+30	Conn	AMC-117	2-100
0.01-0.2	8	1.3	+11	+30	SMT	AMS-117	2-100
0.03-0.25	8	2.3	+23	+40	TO-8	AM-119	2-102
0.03-0.25	8	2.3	+23	+40	Conn	AMC-119	2-102
0.005-0.3	19	5.0	+17	+33	Conn	AM-105	2-103
0.01-0.4	8.5	1.5	+12	+30	TO-8	AM-181	2-104
0.01-0.4	8.5	1.5	+12	+30	Conn	AMC-181	2-104
0.01-0.4	8.5	1.5	+12	+30	SMT	AMS-181	2-104
0.005-0.5	10	3.5	+22	+42	FP	AM-123	2-106
0.005-0.5	10	3.5	+22	+42	Conn	AMC-123	2-106
0.005-0.5	10	3.5	+22	+42	TO-8	AM-131	2-106
0.005-0.5	16	1.9	+6	+22	TO-8	AM-143	2-108
0.005-0.5	16	1.9	+6	+22	Conn	AMC-143	2-108
0.005-0.5	17	3.5	+21	+35	TO-8	AM-147	2-109
0.005-0.5	17	3.5	+21	+35	Conn	AMC-147	2-109
0.005-0.5	12	5.0	+21	+38	TO-8[3]	AM-151	2-110
0.005-0.5	12	5.0	+21	+38	Conn[3]	AMC-151	2-110
0.005-0.5	15	5.0	+16	+30	TO-8[3]	AM-149	2-111
0.01-0.5	21	4.0	+24	+38	FP	AM-146	2-112
0.01-0.5	21	4.0	+24	+38	Conn	AMC-146	2-112
0.005-0.5	10	2.7	+11	+25	FP	AM-103	2-114
0.005-0.5	10	2.7	+11	+25	Conn	AMC-103	2-114
0.02-0.5	12.5	5.5	+24	+42	TO-8[5]	AM-157	2-115
0.02-0.5	12.5	5.5	+24	+42	Conn[5]	AMC-157	2-115

Specifications Subject to Change Without Notice.

RF and MMIC Amplifiers (cont.)

	Freq. Range (GHz)	Gain (dB) Typ.	Noise Figure (dB) Typ.	Pt. 1 dB (dBm) Typ.	3rd Order Intercept (dBm)	Package	Part No.	Page No.
	0.1-0.6	23.5	2.5	+23	+32	FP	AM-191	2-116
	0.1-0.6	28	1.6	+19	+30	FP	AM-160	2-117
	0.005-1.0	15	3.0	+8	+22	TO-8	AM-175	2-118
	0.005-1.0	15	3.0	+8	+22	Conn	AMC-175	2-118
	0.005-1.0	13	4.0	+13	+30	TO-8[3]	AM-176	2-120
	0.005-1.0	13	4.0	+13	+30	Conn[3]	AMC-176	2-120
	0.005-1.0	28	2.7	+10	+22	TO-8[3]	AM-182	2-121
	0.005-1.0	28	2.7	+10	+22	Conn[3]	AMC-182	2-121
	0.01-1.0	11	4.5	+17	+35	TO-8	AM-145	2-122
	0.01-1.0	11	4.5	+17	+35	Conn	AMC-145	2-122
	0.01-1.0	12	7.5	+22	+40	TO-8[3]	AM-177	2-123
	0.01-1.0	28.5	2.9	+14	+25	TO-8[3]	AM-183	2-124
	0.01-1.0	28.5	2.9	+14	+25	Conn[3]	AMC-183	2-124
	0.02-1.0	9.5	2.0	+8	+20	TO-8	AM-154	2-125
	0.02-1.0	9.5	2.0	+8	+20	Conn	AMC-154	2-125
	0.2-1.0	12	2.2	+6	+20	TO-8	AM-142	2-126
	0.2-1.0	12	2.2	+6	+20	Conn	AMC-142	2-126
	0.3-1.0	12.5	2.5	+21	+37	TO-8	AM-155	2-128
	0.3-1.0	12.5	2.5	+21	+37	Conn	AMC-155	2-128
	0.3-1.0	12	1.9	+7	+19	TO-8	AM-153	2-130
	0.01-1.2	13	6.5	+18	+29	TO-8[4]	AM-188	2-129
	1.2-1.75	26	1.25	+14	+24	Chip[2]	MAAM12000	1-174
New	1.2-1.75	26	1.35	+14	+23	Cer[2]	MAAM12000-A1	1-176
	0.01-2.0	10	4.8	+14	+30	TO-8[3]	AM-180	2-131
	0.01-2.0	10	4.8	+14	+30	Conn[3]	AMC-180	2-131
	0.01-2.0	19	5.0	+15	+28	TO-8[3]	AM-185	2-132
	0.01-2.0	20	4.5	+12	+22	TO-8[3]	AM-184	2-133
	0.01-2.0	20	4.5	+12	+22	Conn[3]	AMC-184	2-133
New	0.2-3.0	18	4.0	+14	+24	Cer[2]	MAAM02350-A2	1-172
	0.2-3.0	19	3.7	+14	+24	Chip[2]	MAAM02350	1-170
	2.0-3.0	26	1.1	+14	+24	Chip[2]	MAAM23000	1-178
New	2.0-3.0	26	1.8	+14	+24	Cer[2]	MAAM23000-A1	1-180
New	2.0-6.0	19	N/A	+28/+30[1]	+39	Chip[2]	MAAM26100	1-192
New	2.0-6.0	18	N/A	+27/+29[1]	+39	Cer[2]	MAAM26100-B1	1-194
	3.5-7.0	17	1.8	+14	+24	Chip[2]	MAAM37000	1-182
	3.5-7.0	16	2.2	+14	+24	Cer[2]	MAAM37000-A1	1-184
	2.0-8.0	18	4	+14	+24	Chip[2]	MAAM28000	1-186
New	2.0-8.0	17	4.5	+14	+24	Cer[2]	MAAM28000-A1	1-188
New	7.0-11.0	18	N/A	+28/+31[1]	+38	Chip[2]	MAAM71100	1-196
	7.5-12.0	16.5	2.3	+14	+24	Chip[2]	MAAM71200	1-190

Package Key: SMT=Surface Mount, Conn=Connectorized, TO-#=TO Can, FP= Flatpack, Cer=Ceramic, RH=Relay Header

Notes:
1. MMIC Power Amp typical power out is noted as: /dB Comp. Pt./ Saturated Power Out
2. MMIC
3. Thin Film
4. Reverse Isolation
5. High Isolation

Specifications Subject to Change Without Notice.

Linear Power Amplifiers, Connectorized

Freq.Range (MHz)	Average[1] Output Power (dBm) Min	Gain (dB) Min	Oper. Mode Class	Linearity	Supply Voltage (Volts)	Part No.	Page No.
869-894	43.0	18	AB	IM3,-28 dBc	24-26	CPA-112-CBA	2-358
869-894	47.0	24	AB	IM3,-28 dBc	24-26	CPA-120-CBA	2-359
925-960	43.0	18	AB	IM3,-28 dBc	24-26	CPA-113-CBA	2-359
1805-1880	45.0	7.5	AB	AM/PM Max 1.0 deg/dB	24-25	CPA-110-PBM	2-360
1805-1880	38.5	29	AB	1M3,-25 dBc	24-25	CPA-111-PBA	2-360
1805-1880	43	18	AB	1M3,-25 dBc	23-24	CPA-114-PBA	2-361
1750-3000	29	23	A	AM/PM Max 1.0 deg/dB	7-10	CPA-118-PAA	2-361

Notes:
1. 1dB compression point

Logarithmic Amplifiers

Freq.Range (MHz)	Input Dynamic Range (dB) Min	Tang. Sens. (dBm) Min	Log Output: Linearity (dB) Max	Log Output: Slope (mV/dB) Typ	Log Output: %Slope Variation vs Freq. Typ	VSWR (:1) Max	Description	Part No.	Page No.
110-210	75	-70	1.50	15	5	1.5	Conn	LV160	2-144
100-300	75	-75	1.50	22	7	2.0	FP	ICLAP352	2-140
250-500	65	-70	1.50	22	10	2.0	FP	ICLAP361	2-142
250-500	65	-70	1.50	22	10	2.0	Conn	ICLA361	2-142
500-1000	65	-65	1.00	15	5	*	PC	ICLLWP750	2-148
650-1350	60	-60	1.00	15	5	2.0	Conn	MWLN1C	2-149
500-1500	65	-65	1.00	15	5	2.0	Conn	MWL-1000	2-150

*Consult product page.

Package Key: Conn=Connectorized, FP=Flatpack, PC=Printed Circuit Mount

GaAs FET Amplifiers

Freq.Range (GHz)	Description	Part Number	Page No.
0.0-2.0	Low Noise	MLA 2130 Series	4-206
2.7-3.1	Uncompensated	MLA 2543 Series	4-214
2.7-3.1	Temp. Compensated	MLA 2643 Series	4-214
3.1-3.5	Uncompensated	MLA 2544 Series	4-215
3.1-3.5	Temp. Compensated	MLA 2644 Series	4-215
4.0-4.6	Uncompensated	MLA 2546 Series	4-216
4.0-4.6	Temp. Compensated	MLA 2646 Series	4-216
5.5-6.5	Uncompensated	MLA 2549 Series	4-217
5.5-6.5	Temp. Compensated	MLA 2649 Series	4-217
2.0-8.0	Low Noise	MLA 2140 Series	4-206
2.0-8.0	Low Noise, Temp. Compensated	MLA 2240 Series	4-208
2.0-8.0	Medium Power	MLA 2140 Series	4-210
2.0-8.0	Medium Power, Temp Compensated	MLA 2240 Series	4-211
2.0-8.0	Limiting	MLA 2340 Series	4-212
7.9-8.4	Uncompensated	MLA 2554 Series	4-218
7.9-8.4	Temp. Compensated	MLA 2654 Series	4-218
8.5-9.5	Uncompensated	MLA 2555 Series	4-219
8.5-9.5	Temp. Compensated	MLA 2655 Series	4-219
9.5-10.5	Uncompensated	MLA 2556 Series	4-220
9.5-10.5	Temp. Compensated	MLA 2656 Series	4-220
6.0-12.0	Low Noise, Temp. Compensated	MLA 2250 Series	4-208
6.0-12.0	Medium Power	MLA 2150 Series	4-210
6.0-12.0	Medium Power, Temp Compensated	MLA 2250 Series	4-211
6.0-12.0	Limiting	MLA 2350 Series	4-212
6.0-12.4	Low Noise	MLA 2150 Series	4-206
13.5-14.5	Uncompensated	MLA 2564 Series	4-221
13.5-14.5	Temp. Compensated	MLA 2664 Series	4-221
16.5-17.5	Uncompensated	MLA 2567 Series	4-222
16.5-17.5	Temp. Compensated	MLA 2667 Series	4-222
2.0-18.0	Low Noise	MLA 2180 Series	4-207
6.0-18.0	Low Noise	MLA 2170 Series	4-207
6.0-18.0	Low Noise, Temp. Compensated	MLA 2270 Series	4-209
6.0-18.0	Medium Power	MLA 2170 Series	4-210
6.0-18.0	Medium Power, Temp Compensated	MLA 2270 Series	4-211
6.0-18.0	Limiting	MLA 2370 Series	4-212
12.0-18.0	Low Noise	MLA 2160 Series	4-206
12.0-18.0	Low Noise, Temp. Compensated	MLA 2260 Series	4-208
12.0-18.0	Medium Power	MLA 2160 Series	4-210
12.0-18.0	Medium Power, Temp Compensated	MLA 2260 Series	4-211
12.0-18.0	Limiting	MLA 2360 Series	4-212

RF and MMIC Attenuators

	Freq. Range (GHz)	Insert. Loss (dB) Typ.	Atten. Range (dB) Typ.	VSWR (:1)Typ.	Type	Desc.	Package	Part No.	Page No.
	0.0015-1.0	2.0	60	1.5	VVA		FP	AT-101	2-70
	0.02-1.0	3.8	31	1.3	Digital	5-Bit	DIP	AT-102	2-72
	0.02-1.0	3.8	15.5	1.3	Digital	5-Bit	DIP	AT-103	2-71
	0.02-2.0	8.0	31	1.3	Digital	5-Bit	DIP	AT-104	2-74
New	dc-2.0	2.9	12	2.1	VVA	MMIC	Plstc, SOT-143	AT-259	1-40
	dc-2.0	2.9	12	2.1	VVA	MMIC	Plstc, SO-8	AT-250	1-42
	dc-2.0	0.7	20	1.4	VVA	MMIC	Plstc, SO-8	AT-309	1-44
New	dc-2.0	6.5	35	2.0	VVA	MMIC	Plstc, SO-14	AT-635	1-46
	dc-2.0	0.6	40	1.5	VVA	MMIC	Plstc, SO-14	AT-339	1-48
	dc-2.0	0.9	15	1.8	Digital	MMIC	Plstc, SO-16	AT-210	1-54
New	dc-2.0	1.1	15.5	1.5	Digital	MMIC	Plstc, SO-16	AT-280	1-56
	dc-2.0	1.2	28	1.2	Digital	MMIC	Plstc, SO-14	AT-230	1-58
	dc-2.0	1.2	30	1.2	Digital	MMIC	Plstc, SO-16	AT-220	1-60
New	dc-2.0	1.6	31	1.5	Digital	MMIC	Plstc, SSOP-20	AT-260	1-62
New	dc-2.0	1.5	19	1.5	VVA	MMIC	TO-5	AT-302	1-134
	dc-2.0	1.5	19	1.5	VVA	MMIC	Cer	AT-303	1-134
New	dc-2.0	1.5	19	1.5	VVA	MMIC	Cer	AT-307	1-134
New	dc-2.0	1.2	40	1.5	VVA	MMIC	Chip	MAAA2000G	1-136
New	dc-2.0	1.2	40	1.25	VVA	MMIC	TO-5	AT-332	1-140
	dc-2.0	1.2	40	1.3	VVA	MMIC	Cer	AT-337	1-140
New	dc-2.0	1.4	50	1.4	VVA	MMIC	Chip	MAAA2010G	1-142
New	dc-2.0	1.5	15	1.2	Digital	MMIC	Cer	AT-212	1-144
	dc-2.0	1.4	15	1.3	Digital	MMIC	Chip	MADA2000G	1-146
New	dc-2.0	1.2	32	1.3	Digital	MMIC	Cer	AT-272	1-148
New	dc-2.0	1.2	15.5	1.2	Digital	MMIC	Cer	AT-282	1-150
	dc-2.0	1.2	15.5	1.4	Digital	MMIC	Chip	MADA2030G	1-152
New	dc-2.0	1.7	30	1.2	Digital	MMIC	Cer	AT-232	1-154
	dc-2.0	1.8	30	1.4	Digital	MMIC	Chip	MADA2010G	1-156
New	dc-2.0	1.5	31	1.2	Digital	MMIC	Cer	AT-262	1-158
New	dc-2.0	5.0	31	1.2	Digital	MMIC	Conn	AT-357	1-160
	dc-2.0	1.7	31	1.4	Digital	MMIC	Chip	MADA2020G	1-162
	0.02-2.0	0.8	10	1.2	Digital	MMIC	TO-8	AT-358	1-164
New	0.25-2.0	3.5	45	1.25	Digital	MMIC	DIP	AT-354	1-166
New	0.5-2.0	2.5	35	2.0	VVA	MMIC	Plstc, SO-8	AT-109	1-50
New	0.5-2.0	2.5	40	2.0	VVA	MMIC	Plstc, SO-8	AT-108	1-52
New	dc-3.0	7.2	34	3.2	VVA	MMIC	Cer	AT-637	1-138
New	dc-3.0	3.0	12	2.1	VVA	MMIC	Cer	AT-252	1-132
	2.0-4.0	1.8	6	1.5	VVA		Conn	2694-1001-XY	4-27
	2.0-4.0	2.0	6	1.5	VVA		Conn	2694-1002-XY	4-27
	dc-5.0	1.25	25	1.3	VVA		Cer[1]	AT-201	2-76

Specifications Subject to Change Without Notice.

RF and MMIC Attenuators

Freq. Range (GHz)	Insert. Loss (dB) Typ.	Atten. Range (dB) Typ.	VSWR (:1)Typ.	Type	Desc.	Package	Part No.	Page No.
dc-5.0	1.25	25	1.3	VVA		Cer[1]	AT-202	2-77
4.0-8.0	2.2	6	1.6	VVA		Conn	2694-1003-XY	4-27
4.0-8.0	2.5	6	1.6	VVA		Conn	2694-1004-XY	4-27
dc-12.0	2.0	15	1.5	Digital	MMIC	Chip	MADA12000	1-168
8.0-16.0	3.0	6	2.0	VVA		Conn	2694-1005-XY	4-27
8.0-16.0	3.4	6	2.0	VVA		Conn	2694-1006-XY	4-27

Package Key: Plstc=Plastic, Cer=Ceramic, Conn=Connectorized, TO-#=TO Can, FP=Flatpack, DIP=Dual Inline

Notes:
1. Absorptive

Fixed Coaxial Attenuators

Part No.	Freq. Range (GHz)	Atten. (dB)	Power (W) Avg	Power (W) Peak	Description	Page No.
2082 Series[1]	dc-12.4	1.0-30.0	*	*	*	4-147
2084 Series[1]	2.0-12.4	10.0-20.0	*	*	*	4-150
2082 Series	dc-18.0	0.0-60.0	2	500	Miniature Round	4-139
2082 Series	dc-18.0	3.0-40.0	2	500	Low Cost Miniature Round	4-140
2082 Series	dc-18.0	0.0-30.0	2	500	Subminiature Round	4-141
2082 Series	dc-18.0	0.0-30.0	2	500	Subminiature Hex	4-142
2082 Series	dc-18.0	3.0-30.0	2	500	Low Cost Subminiature Round	4-143
2082 Series	dc-18.0	1.0-30.0	2	200	Ultra Miniature Round	4-144
2082 Series	dc-18.0	3.0-30.0	5	500	High Power	4-145
2082 Series	dc-18.0	3.0-30.0	10	500	High Power	4-145
3082 Series	dc-18.0	3.0-30.0	2	500	Round	4-146
2082 Series[1]	dc-18.0	0.0-30.0	*	*	*	4-148
2082 Series[1]	dc-18.0	1.0-30.0	*	*	*	4-150
2782 Series	dc-26.5	3.0-20.0	2	500	Miniature Hex	4-140
2782 Series	dc-26.5	3.0-20.0	2	500	Subminiature Hex	4-143

Notes:
1. QPL Approved to MIL-A-3933/4
* Consult product page.

Circulator & Isolator

	Part No.	Freq.Range (MHz)	Package	Page No.	Description
	*	0.1-0.367	*	4-260	Gyrators
	7N Series	0.367-1.9	Conn	4-254	3-Port Cellular Circulators and Isolators
	7R Series	0.4-1.9	Conn	4-252	4-Port Cellular Circulators and Isolators
	*	1.7-2.07	Microstrip	4-428	Ferrodisc Microstrip Circulators and Isolators
	*	1.9-9.6	Microstrip	4-429	Ferrodisc Microstrip Circulators and Isolators
	*	0.39-12.0	Conn	4-258	4-Port Coaxial Circulators and Isolators
	*	12.8-17.5	Microstrip	4-430	Ferrodisc Microstrip Circulators and Isolators
	*	0.5-18.0	Conn	4-255	3-Port Coaxial Circulators and Isolators
	2(WG)250 Series	18.0-110.0	Waveguide	5-24	Waveguide Isolators
	2(WG)400 Series	18.0-110.0	Waveguide	5-24	3-Port Waveguide Junction Circulators and Isolators
New	7N300 Series	810-960	Conn	**	Cellular Band Coaxial Circulator and Isolator
New	7N200 Series	810-1970	SMT	**	Drop-In Circulators, Square
New	7N256 Series	810-1970	SMT	**	Drop-In Circulators with Mounting Holes, Square
New	7N258 Series	810-1970	SMT	**	Drop-In Circulators, Round
New	7N248 Series	1735-1970	SMT	**	Drop-In Circulators with Mounting Holes, Square

Package Key: SMT=Surface Mount, Conn=Connectorized,

* Consult product page
** Contact M/A-COM for data sheet

3dB Hybrid RF Couplers

Freq. Range (MHz)	VSWR (:1) Typ	Insertion Loss (dB) Typ	Isol (dB) Typ	Phase Dev Typ	Amp Balance (dB) Typ	Package	Part No.	Page No.
180° Hybrid Coupler								
0.2-35	1.07	0.1	40	2.0	0.05	Conn	HH-108[1]	2-242
2-200	1.05	0.5	45	1.0	0.05	FP	HH-106	2-243
2-200	1.10	0.5	45	1.0	0.05	Conn	HH-107	2-243
5-200	1.30	0.8	45	1.0	0.10	FP	HH-109	2-244
5-200	1.30	0.8	45	1.0	0.10	SMT	HHS-109	2-244
20-300	1.25	0.4	45	1.0	0.10	TO-5	HH-105	2-245
10-500	1.25	0.6	40	3.0	0.10	SMT	HHS-110	2-247
10-500	1.25	0.6	45	3.0	0.10	FP	HH-110	2-246
10-500	1.25	0.6	45	3.0	0.10	TO-8	HH-127	2-246
5-1000	N/A	1.2	45	1.0	0.30	Conn	H-1-4[2]	2-248
2-2000	1.20	0.4	55	1.0	0.10	Conn	H-9	2-249
20-2000	1.30	1.5	30	7.5	0.50	FP	HH-128	2-250
30-3000	1.30	0.7	35	7.0	0.10	Conn	H-183-4	2-251
Quadrature Hybrid Coupler								
7-14	1.02	0.5	25	1.0	0.75	FP	JH-113	2-252
7-14	1.05	0.5	25	3.0	0.75	SMT	JHS-113	2-252
2-32	1.05	0.4	30	1.0	0.30	Conn	JH-6-4	2-253
20-40	1.15	0.2	30	0.5	0.40	FP	JH-114	2-254
20-40	1.15	0.2	30	0.5	0.40	TO-8	JH-133	2-254
20-40	1.15	0.2	30	0.5	0.40	SMT	JHS-114	2-255
40-80	1.15	0.25	30	1.2	0.40	FP	JH-115	2-256
40-80	1.15	0.3	25	1.2	0.50	SMT	JHS-115	2-257
20-140	1.10	0.5	35	1.0	0.10	Conn	JH-10-4	2-258
80-160	1.20	0.3	35	2.0	0.50	FP	JH-119	2-259
80-160	1.20	0.3	35	2.0	0.50	SMT	JHS-119	2-259
20-200	1.10	0.5	35	0.5	0.10	Conn	JH-131	2-260
100-200	1.20	0.45	24	0.5	0.70	FP	JH-121	2-261
100-200	1.20	0.45	24	0.5	0.70	SMT	JHS-121	2-261
175-350	1.10	0.5	30	2.0	0.6	FP	JH-136	2-262
175-350	1.10	0.5	30	2.0	0.6	SMT	JHS-136	2-263
200-400	1.25	0.3	25	3.0	0.5	SMT	JHS-142	2-264
250-500	1.10	0.3	30	1.0	0.5	FP	JH-139	2-265
250-500	1.10	0.3	30	1.0	0.5	SMT	JHS-139	2-265
500-1000	1.20	0.2	25	2.0	1.0	FP	JH-140	2-266
1000-2000	1.15	0.2	25	3.0	1.0	FP	JH-141	2-267

Package Key: SMT=Surface Mount, Conn=Connectorized,TO-#=TO Can, FP=Flatpack

Notes:
1. High Power
2. UHF

RF Directional Couplers

Freq. Range (MHz)	Coupling (dB) Nom	Main Line Loss (dB) Typ	Direct. (dB) Typ	VSWR (:1)Typ	Power Rating (W) Typ	Package	Part No.	Page No.
2-32	20	0.15	40	1.05	50	Conn	CD-920-4	2-302
2-32	30	0.08	30	1.05	500	Conn	CH-130-4	2-303
0.5-400	20	0.30	30	1.15	3	RH-1	CH-137	2-304
0.5-400	20	0.30	35	1.15	3	SMT	CHS-137	2-304
10-500	11	0.80	30	1.20	1	FP	CH-134	2-306
10-500	11	0.80	30	1.20	1	SMT	CHS-134	2-306
10-500	11	0.80	30	1.30	1	TO-8	CH-138	2-308
1-1000	20	0.30	30	1.10	5	Conn	CH-132	2-309
5-1000	20	0.30	30	1.05	3	FP	CH-140	2-310
30-1000	10	1.10	30	1.30	5	Conn	DCG-10-4	2-311

Package Key: SMT=Surface Mount, Conn=Connectorized,TO-#=TO Can, FP=Flatpack,
RH=Relay Header,

Low Cost (E-Series) RF Directional Couplers

Description	Freq.Range (LO-RF MHz)	Package Type	Part No.	Page No.
10 dB Directional Coupler	1-400	Relay Header	ETDC-10-1	3-97
11.5 dB Directional Coupler	0.5-500	Relay Header	EPDC-10-1	3-96
10 dB Directional Coupler	930-960	Surface Mount	ESDC-10-1	3-98

3dB Hybrid Microwave Couplers

Hybrid Type	Crossover 90° Stripline	Non-crossover 90° Air Dielectric	Crossover 180° Stripline
Part Number Series	2032	2035	2031
Frequency Range (GHz)	Octave and Multi-Octave .06-18.0	Octave 1.0-18.0	Octave 1.0-18.0
VSWR[1]	1.25	1.25	1.35
Insertion Loss (dB)[1]	0.25	0.20	0.7
Isolation(dB)[1]	22	18	22
Amplitude Balance (dB)[1]	±0.5	±0.5	±0.5
Input Power (Avg. Watts)[1]	30	50	30
Major Features	Small Size	Low Loss	0° and 180° Outputs
Page No.	4-171	4-173	4-174

Notes:
1. Representative specifications for 3 dB hybrid in 2.0 - 4.0 GHz frequency range.

Directional Couplers, Microwave

Directional Coupler Type	Mini Stripline	Multi-Octave	Ultra Broadband
Part Number Series	2020	2025	2026
Frequency Range (GHz)	Octave .5-18.0	Octave .5-18.0	1.0-12.4 2.0-18.0 1.0-18.0
Terminated Isolated Port	Internal	Internal	Internal
Coupling Range (dB)	6-30	6-20	10-20
VSWR[1]	1.15	1.20[2]	1.30[3]
Insertion Loss (dB Max.)[1]	0.2	0.3[2]	0.85[3]
Directivity (dB)[1]	22	18[2]	18[3]
Freq. Sensitivity (dB)[1]	±0.75	±0.4[2]	±0.4[3]
Coupling Variation[1]	±1.0	±1.0[2]	±1.0[3]
Major Features	Smallest Size Low Cost	Bandwidth	Bandwidth
Page No.	4-178	4-179	4-180

Notes:
1. Representative specifications for 10 dB coupler in 2.0 - 4.0 GHz frequency range.
2. Representative specifications for 10 dB coupler in 1.0 - 4.0 GHz frequency range.
3. Representative specifications for 10 dB coupler in 1.0 - 12.4 GHz frequency range.

RF Power Dividers (In-phase)

Freq. Range (MHz)	Insert. Loss (dB) Typ.	Isolation (dB) Typ.	VSWR (:1) Typ.	Phase Bal. (Deg) Typ.	Amp. Bal. (dB) Typ.	Package	Part No.	Page No.
2-Way								
1-100	0.15	35	1.05	0.5	0.05	TO-5	MTH-50	2-274
2-200	0.20	35	1.05	0.5	0.10	Conn	THV-50	2-275
0.4-400	0.15	35	1.05	0.5	0.05	FP	DS-113	2-276
0.4-400	0.15	35	1.05	0.5	0.10	SMT	DSS-113	2-277
40-400	0.40	40	1.2	1.0	0.10	TO-5	MTV-50	2-274
20-400	0.30	40	1.1	1.0	0.10	Conn	TU-50	2-275
5-500	0.30	30	1.15	1.0	0.10	RH	DS-318	2-278
10-500	0.20	40	1.05	0.5	0.05	FP	DS-109	2-278
10-500	0.20	40	1.05	0.5	0.05	TO-8	DS-319	2-279
10-500	0.20	40	1.05	0.5	0.05	SMT	DSS-333	2-280
5-1000	0.30	35	1.1	1.5	0.10	FP	DS-327	2-284
5-1000	0.30	25	1.25	1.5	0.15	SMT	DSS-327	2-281
5-1000	0.60	25	1.15	2.0	0.10	Conn	H-81-4	2-282
10-1000	0.30	45	1.1	1.0	0.10	Conn	T-1000	2-283
2-2000	0.50	35	1.1	1.0	0.05	Conn	H-8-4	2-285
10-2000	0.60	28	1.15	2.0	0.10	FP	DS-313	2-286
10-2000	0.60	28	1.15	2.0	0.10	SMT	DSS-313	2-287
3-Way								
1-100	0.25	55	1.05	0.5	0.10	TO-5	M3H-50	2-289
1-300	0.30	45	1.05	2.0	0.20	FP	DS-117	2-288
1-300	0.30	45	1.05	2.0	0.20	Conn	DS-308	2-288
50-300	0.40	40	1.10	1.0	0.10	TO-5	M3V-50	2-289
3-700	0.30	30	1.20	3.0	0.20	TO-8	DS-328	2-290
25-1000	0.30	35	1.30	2.0	0.30	FP	DS-323	2-291
4-Way								
0.2-300	0.2	35	1.05	2.0	0.1	FP	DS-310	2-292
10-500	0.5	35	1.10	2.0	0.1	FP	DS-112	2-293
10-500	0.5	35	1.10	3.0	0.2	Conn	DS-312	2-293
25-1000	0.5	35	1.15	2.0	0.1	FP	DS-324	2-294
2-2000	0.5	30	1.05	2.0	0.5	Conn	DS-4-4	2-295
10-2000	0.5	30	1.20	2.0	0.1	Conn	DS-409-4	2-296
8-way								
2-500	0.5	40	1.10	1	0.1	Conn	DS-309	2-297
20-2000	1.0	30	1.20	2	0.1	Conn	DS-808-4	2-298

Package Key: SMT=Surface Mount, Conn=Connectorized, TO-#=TO Can, FP=Flatpack, RH=Relay Header

Low Cost (E-Series) RF Power Dividers/Combiners

	Description	Freq.Range (LO-RF MHz)	Package Type	Part No	Page No
	2-Way 0 Splitter/Combiner	0.1-400	Relay Header	ES-2-1	3-84
New	2-Way 0 Splitter/Combiner	0.1-400	Surface Mount	ES-2-1X1	3-87
New	2-Way 0 Splitter/Combiner	0.1-450	Relay Header	ESM-2-1	3-85
	2-Way 0 Splitter/Combiner	1-400	Relay Header	EST-2-1	3-86
New	2-Way 0 Splitter/Combiner	10-1000	Surface Mount	ES-2-4X1	3-88
New	2-Way 90 Splitter/Combiner	40-70	Relay Header	ESQ-2-70	3-89
New	2-Way 90 Splitter/Combiner	40-70	Surface Mount	ESQ-2-70X1	3-91
	2-Way 90 Splitter/Combiner	55-90	Relay Header	ESQ-2-90	3-90
New	2-Way 90 Splitter/Combiner	120-180	Surface Mount	ESQ-2-180X1	3-92
New	2-Way 90 Splitter/Combiner	820-980	Surface Mount	ESQ-2-900X1	3-93
	2-Way 90 Split./Comb., High Perf.	820-980	Surface Mount	EQSM-2-900	3-94
New	3-Way 0 Splitter/Combiner	1-200	Relay Header	ES-3-1	3-95

Dividers/Combiners, Microwave Power

Power Divider Type	Unmatched Coaxial	Wilkinson Stripline	Tapered Stripline	Microwave Integrated Circuit
Part Number Series	2041	2089	2090	2091 2092
Frequency Range (GHz)	N/A	Octave and Multi-Octave 1.0-18.0	Multi-Octave 0.5-26.0	Octave and Multi-Octave 0.9-18.0
Input VSWR[1]	N/A	1.35:1	1.35:1[2]	1.35:1
Insertion Loss (dB Max.)[1]	N/A	0.25	0.48[2]	0.6
Isolation (dB Min.)[1]	N/A	20	20[2]	20
Output Imbalance[1] Phase (Degrees)	N/A	4.0	5.0[2]	4.0
Amplitude (dB)	N/A	0.2	0.3[2]	0.2
Input Power (Avg. Watt)[1]	50	2.0	40.0[2]	5.0
Major Features	Low Cost	Size and Performance	Isolation, Power, Bandwidth and Price	Smallest Size
Configuration Available	2-Way	2- and 4-Way	2-, 3-, 4-, and 8-Way	2-Way
Page No.	4-182	4-184	4-187	4-183

Notes:
1. Representative specifications for 2-way power dividers in 2.0 - 4.0 GHz frequency range.
2. Representative specifications for 2-way power dividers in 2.0 - 18.0 GHz frequency range.

dc Blocks and Monitor Tee/dc Blocks

Freq.Range (GHz)	Description	Part No.	Page No.
0.1-18.0	Inside	2046 Series	4-194
0.75-18.0	Monitor Tee	2047 Series	4-194
1.0-18.0	Inside/Outside	2044 Series	4-194
1.0-18.0	Outside	2045 Series	4-195

Phase Detectors

Freq.Range RF/LO (MHz)	Impedance L&R (Ohms)	Impedance X (Ohms)	Signal Drive Levels (dBm)	Isolation L-R (dB)	DC[1] mV/mV/±	Package	Part No.	Page No.
3-200	50	500	+7	35	900/1.0/Pos	Flatpack	PD-121	2-229
5-1000	50	500	+7	30	250/1.0/Neg	Flatpack	PD-120	2-228

Note:
1. Phase Detector DC: Output (mV) Offset (mV)/ Output polarity (negative or positive)

Microwave Detectors

Freq.Range (GHz)	Description	Package	Part No.	Page No.
1.0-15.0	Zero Biased Schottky with Replaceable Diodes	Conn	2086 Series	4-106
0.01-18.0	Point Contact with Replaceable Diodes	Conn	2087 Series	4-108
0.1-18.0	Zero Biased Schottky	Mod	7744J Series	4-107
0.1-18.0	Tunnel Diode Limiter	Mod	7718N Series	4-103
0.1-18.0	Tunnel Diode	Mod	7700J Series	4-102
0.1-18.0	Biased Schottky	Mod	7709J Series	4-105
1.0-18.0	Biased Schottky with Replaceable Diodes	Conn	2086 Series	4-104
1.0-18.0	Detector Video Amplifier	Conn**	7700V Series	4-109
1.0-26.0	Back Diode with Replaceable Diodes	Conn	2085 Series	4-101

Package Key: Conn=Connectorized, Mod=Module
** Removable connectors for use as drop-in package

Frequency Doublers

Frequency Input (MHz)	Range Output (MHz)	Conversion Loss (dB) Typ	Spurious F1 (dB) Typ	Rejection F3 (dB) Typ	VSWR (1:) Typ	Package	Part No.	Page No.
0.1-600	0.2-1200	10	30	45	1.7	Conn	FM-102-4	2-232
10-750	20-1500	12	20	30	2.0	RH	FM-105	2-234
5-1000	10-2000	12	25	30	1.8	Conn	D-1-4	2-230
75-1500	150-3000	10	35	35	1.7	FP	FM-104	2-233
30-2100	60-4200	11	35	40	1.8	Conn	D-5-4	2-231
2000-3000	4000-6000	10	20	35	2.0	FP	FM-106	2-235

Package Key: Conn=Connectorized, FP=Flatpack, RF=Relay Header

Limiters

Freq. Range (GHz)	Insert Loss (dB) Typ.	VSWR Typ .	Peak Power (W)	Leak. Power (mW)	Package	Part No.	Page No.
0.001-0.1	0.5	1.3	*	50	Conn	2691-2001	4-127
0.1-0.5	0.6	1.3	*	100	Conn	2691-2002	4-127
0.5-1.0	0.6	1.3	*	100	Conn	2691-2003	4-127
0.5-2.0	1.2	1.5	1000	125	Conn**	2692-1001	4-131
0.5-2.0	0.9	1.5	1500	150	Mod	2970-2001	4-133
0.5-2.0	0.7	1.5	200	150	Mod	2970-1001	4-133
1.0-2.0	0.8	1.3	*	100	Conn	2691-2004	4-127
1.0-2.0	0.7	1.5	100	75	Conn	2690-1001	4-125
1.0-2.0	0.8	1.5	500	75	Conn	2690-1002	4-125
1.0-2.0	0.9	1.5	1000	100	Conn	2690-1003	4-125
10-2.0	0.8	1.5	500	75	Conn**	2691-1002	4-129
2.0-8.0	1.1	1.6	100	50	Conn**	2691-1005	4-129
2.0-8.0	1.3	1.6	1000	100	Conn**	2691-1007	4-129
2.0-8.0	1.1	1.6	100	50	Conn	2690-1005	4-125
2.0-8.0	1.2	1.6	500	75	Conn	2690-1006	4-125
2.0-8.0	1.3	1.6	1000	100	Conn	2690-1007	4-125
2.0-8.0	1.6	2.0	1000	50	Conn**	2692-1002	4-131
2.0-8.0	1.0	1.7	200	125	Mod	2970-1002	4-133
2.0-8.0	1.3	1.7	1000	125	Mod	2970-2002	4-133
2.0-18.0	2.0	2.0	100	50	Conn	2690-1013	4-125
2.0-18.0	2.2	2.0	500	75	Conn	2690-1014	4-125
2.0-18.0	2.3	2.0	1000	100	Conn	2690-1015	4-125
2.0-18.0	2.0	2.0	100	50	Conn**	2691-1013	4-129
2.0-18.0	2.2	2.0	500	75	Conn**	2691-1014	4-129
2.0-18.0	2.3	2.0	1000	100	Conn**	2691-1015	4-129
2.0-18.0	1.7	2.0	200	125	Mod	2970-1004	4-133
2.0-18.0	2.2	2.0	600	125	Mod	2970-2004	4-133
8.0-18.0	2.0	1.0	100	50	Conn**	2691-1009	4-129
8.0-18.0	1.6	1.9	200	100	Mod	2970-1003	4-133
8.0-18.0	2.2	2.0	600	100	Mod	2970-2003	4-133
8.0-18.0	1.8	2.0	100	50	Conn	2690-1009	4-125
8.0-18.0	2.0	2.0	500	75	Conn	2690-1010	4-125
8.0-18.0	2.3	2.0	1000	100	Conn	2690-1011	4-125

Package Key:, Conn=Connectorized, Mod=Module

*Consult product page
**Removable connectors for use as drop-in package

RF Hybrid Mixers

Frequency Range RF/LO MHz Typ	IF MHz Typ	Conv. Loss (dB) Typ	Isolation LO-RF (dB) Typ	LO-IF (dB) Typ	RF-IF (dB) Typ	Comp Pt 1dB (dBm) Typ	Package	Part No.	Page No.
0.2-200	dc-200	4.5	55	45	30	+2	RH	MD-109	2-160
0.2-200	dc-200	4.8	55	45	30	+2	SMT	MDS-222	2-161
0.2-200	dc-200	5.0	48	40	30	+1	TO-5	MAC-50	2-162
0.5-350	dc-350	6.0	40	35	28	+5	SMT	MDS-221	2-163
1-400	dc-400	6.0	35	34	30	+7	RH	MD-100	2-165
1-400	dc-400	6.0	35	34	30	+7	SMT	MDS-220	2-164
0.5-500	dc-500	6.0	45	38	32	+11	FP	MD-125	2-167
0.5-500	dc-500	5.6	38	35	22	+2	FP	MD-124	2-166
0.5-500	dc-500	5.6	38	35	22	+2	Conn	MD-140	2-166
1-500	dc-500	6.0	45	33	33	+20	FP	MD-139	2-169
1-500	dc-500	7.0	50	45	40	+1	SMT	MD-455	2-170
1-500	dc-500	5.7	35	44	35	+10	FP	MD-161	2-171
1-500	dc-500	5.7	35	44	35	+10	Conn[1]	MDC-161	2-171
1-500	dc-500	5.8	40	50	32	+19	RH	MD-138	2-168
5-500	dc-500	5.6	45	40	25	+2.5	RH	MD-108	2-172
5-500	dc-500	5.6	45	40	25	+2.5	Conn	MD-143	2-172
5-500	dc-500	5.6	45	40	25	+2.5	RH	MD-146	2-172
5-500	dc-500	5.6	45	40	30	+2.5	SMT	MDS-223	2-173
5-500	dc-500	8.2	40	38	25	+13	RH	MD-151	2-176
5-500	3-200	6.7	32	53	48	+23	FP	MD-155	2-174
5-500	dc-500	5.7	38	35	32	+2	TO-5	MAC-51	2-162
5-1000	dc-1000	6.6	37	32	28	0	FP	MD-113	2-177
5-1000	dc-1000	6.6	37	32	28	0	Conn	MD-141	2-177
5-1000	dc-1000	6.0	42	35	30	+1.5	FP	MD-159	2-178
5-1000	dc-1000	6.0	42	35	30	+1.5	SMT	MDS-159	2-178
5-1000	dc-1000	7.0	40	35	30	+2	SMT	MD-456	2-180
10-1000	dc-1000	7.0	40	27	20	0	RH	MD-110	2-182
1-1500	1-1000	6.5	28	28	25	+15	RH[1]	MD-160	2-183
5-1500	dc-1000	6.0	35	25	25	+1	SMT	MDS-158	2-184
5-1500	dc-1000	6.2	35	25	25	+1	FP	MD-158	2-185
10-1500	dc-1500	6.0	40	35	30	+10	SMT	MDS-147	2-186
10-1500	dc-1500	6.0	40	40	30	0	TO-8	MD-152	2-187
10-1500	dc-1500	6.0	40	40	30	0	FP	MD-149	2-188
10-1500	dc-1500	6.0	40	40	30	0	Conn	MDC-149	2-188
10-1500	dc-1500	6.0	40	40	30	0	SMT	MDS-149	2-188
10-1500	dc-1500	6.0	35	30	28	+1	FP	MD-148	2-190
10-1500	dc-1500	6.0	35	30	28	+5	SMT	MDS-148	2-190
600-2000	dc-1000	6.0	35	30	N/A	0	SMT	MDS-217	2-192
700-2000	dc-300	6.2	35	20	24	0	FP	MD-614	2-194
700-2000	dc-300	6.0	35	20	24	0	SMT	MDS-614	2-194
700-2000	dc-300	6.2	35	20	24	0	Conn	MD-150	2-193
700-2000	dc-300	6.2	35	20	24	0	TO-8	MD-153	2-193
1-2800	1-2000	6.5	32	38	30	+16	FP[1]	MD-174	2-196
1-2800	1-2000	6.5	32	38	30	+16	Conn[1]	MDC-174	2-196
10-3000	10-3000	7.4	35	32	28	+7	FP	MD-123	2-198
10-3000	10-3000	7.4	35	32	28	+7	Conn	MDC-123	2-198
300-3000	0.1-3000	6.0	27	28	28	+7	FP	MD-154	2-206
300-3000	0.1-3000	6.0	27	28	28	+7	Conn	MDC-154	2-206
600-3000	dc-1000	6.0	32	22	24	0	FP	MD-156	2-197
1-3500	5-1500	6.5	30	30	35	+7	FP[1]	MD-169	2-200
1-3500	5-1500	6.5	30	30	35	+7	Conn[1]	MDC-169	2-200
1-4000	5-1500	6.5	40	40	35	+5	FP[1]	MD-179	2-201
1-4000	5-1500	6.5	40	40	35	+5	Conn[1]	MDC-179	2-201
10-4000	5-1900	6.5	35	42	38	+6	Conn	MD-525-4	2-202
800-4000	dc-1500	5.8	32	23	28	0	FP	MD-157	2-203
2000-4000	dc-300	4.5	25	29	27	+2.5	FP	MD-176	2-204

Specifications Subject to Change Without Notice.

RF Hybrid Mixers (cont.)

Frequency Range RF/LO MHz Typ	Frequency Range IF MHz Typ	Conv. Loss (dB) Typ	Isolation LO-RF (dB) Typ	Isolation LO-IF (dB) Typ	Isolation RF-IF (dB) Typ	Comp Pt 1dB (dBm) Typ	Package	Part No.	Page No.
2000-4000	dc-300	4.5	25	29	27	+2.5	Conn	MDC-176	2-204
50-5000	dc-1000	8.5[2]	*	*	*	*	SO-8[3]	MAMD12008	1-200
50-5000	dc-1000	8.5[2]	*	*	*	*	Cer[3]	MAMD12018	1-198
2600-5200	dc-300	4.5	27	26	35	+2.5	FP	MD-178	2-208
2600-5200	dc-300	4.5	27	26	35	+2.5	Conn	MDC-178	2-208
1000-6000	10-2000	7.0	20	25	22	-2	FP[1]	MD-163	2-210
1000-6000	10-2000	7.0	20	25	22	-2	Conn[1]	MDC-163	2-210
1000-7000	10-2000	6.0	25	20	22	+8	FP[1]	MD-162	2-211
1000-7000	10-2000	6.0	25	20	22	+8	Conn[1]	MDC-162	2-211
500-9000	10-2000	6.5	22	27	25	+8	FP[1]	MD-164	2-212
500-9000	10-2000	6.5	22	27	25	+8	Conn[1]	MDC-164	2-212

Package Key: SMT=Surface Mount, Conn=Connectorized, TO-#=TO Can, FP=Flatpack, RH=Relay Header, CER= Ceramic

Notes:
1. Termination Insensitive Mixer (TIM)
2. Conversion Gain
3. Silicon MMIC

Low Cost (E-Series) RF Mixers

	Freq. Range (LO-RF MHz)	LO Power (dBm)	RF Power Up To (dBm)	Package	Part No.	Page No.
New	0.05-200	+17	+10	Relay Header	EMA-3H	3-14
New	0.1-250	+17	+14	Relay Header	EMT-3H	3-16
	0.04-400	+7	+1	Relay Header	EMT-3	3-13
New	0.1-500	+7	+1	Relay Header	EMM-3	3-17
	0.5-500	+7	+1	Relay Header	EMA-1	3-18
	0.5-500	+7	+1	Surface Mount	EMRS-1	3-42
New	0.5-500	+17	+14	Surface Mount	EMRS-1H	3-41
New	0.5-500	+27	+24	Relay Header	EVAY-1	3-19
	1-500	+7	+1	Relay Header	EMS-1	3-20
New	1-500	+7	+1	Surface Mount	ESCM-1	3-50
New	2-500	+13	+9	Relay Header	EMT-1MH	3-24
New	2-500	+13	+9	Surface Mount	EMRS-1MH	3-43
New	2-500	+17	+14	Relay Header	EMK-1H	3-25
	5-500	+7	+1	Relay Header[1]	EMD-108	3-27
	5-500	+7	+1	Relay Header	EMS-500X1	3-28
New	1-600	+7	+1	Surface Mount	EASK-1	3-53
New	2-600	+17	+14	Relay Header	ETUF-1H	3-26
New	1-750	+7	+1	Relay Header	EMA-1W	3-21
	890-915	+17	+14	Surface Mount	ESMD-C2HX2	3-58
	1-1000	+7	+1	Relay Header	EMT-2	3-22
	1-1000	+7	+1	Surface Mount	ESMD-C1	3-54
	5-1000	+7	+1	Surface Mount	EMRS-2	3-45
	5-1000	+7	+1	Surface Mount	ESCM-2	3-51
	5-1000	+17	+14	Relay Header	EMT-2H	3-29
	10-1000	+7	+1	Relay Header	EMS-1X	3-35
New	10-1000	+7	+1	Surface Mount	EMRS-2D	3-49
New	50-1000	+7	+1	Relay Header	ETUF-2SM	3-40
	5-1200	+17	+14	Relay Header	EMA-173HX	3-30
New	5-1250	+17	+1	Relay Header	EMT-4	3-31
New	5-1500	+3	-1	Surface Mount	EMRS-5L	3-46
New	5-1500	+7	+1	Relay Header	EMT-5	3-32

Specifications Subject to Change Without Notice.

Low Cost (E-Series) RF Mixers (cont.)

	Freq. Range (LO-RF MHz)	LO Power (dBm)	RF Power Up To (dBm)	Package	Part No.	Page No.
New	5-1500	+7	+1	Surface Mount	EMRS-5	3-47
	20-1500	+7	+1	Surface Mount	ESMD-C2	3-55
New	0.05-2000	+10	+5	Relay Header	EMA-220	3-15
	1-2000	+7	+1	Relay Header	EMT-11	3-23
	5-2000	+3	-1	Surface Mount	EMRS-2L	3-44
	5-2000	+7	+1	Relay Header[2]	EMA-11	3-33
New	5-2000	+7	+1	Relay Header	EMS-11	3-34
	5-2000	+7	+1	Surface Mount	EMRS-11	3-48
	20-2500	+7	+1	Surface Mount	ESMD-C3	3-56
New	20-2500	+17	+14	Surface Mount	ESMD-C3H	3-57
New	500-2500	+7	+1	Surface Mount	ESCM-2500	3-52
	10-3000	+10	+5	Relay Header	EMT-15	3-38
New	10-3000	+13	+9	Relay Header	EMA-11MH	3-36
New	10-3000	+17	+10	Relay Header	EMA-11H	3-37
	10-4200	+13	+9	Relay Header	EMT-42MH	3-39

Notes:
1. 1 dB Compression Point = +2.5.
2. Hermetic

Open Substrate Mixers

Freq. RF/LO (GHz)	Freq. IF (GHz)	Conv. Loss (dB) Typ.	Isol. LO-RF (dB) Typ	Isol. LO-IF (dB) Typ	Comp Pt 1dB (dBm) Typ	Part No.	Page No.
4.0-18.0	dc-1.0	9	20	15	2	2901-10-DBL	4-59
4.0-18.0	dc-1.0	9	20	15	5	2901-10-DBM	4-59
4.0-18.0	dc-1.0	9.5	20	15	8	2901-10-DBH	4-59
6.0-18.0	dc-1.0	9	20	15	2	2901-11-DBL	4-59
6.0-18.0	dc-1.0	9	20	15	5	2901-11-DBM	4-59
6.0-18.0	dc-1.0	9.5	20	15	8	2901-11-DBH	4-59
2.0-18.0	0.5-8.0	7	20	15	2	2902-10-DBL	4-57
2.0-18.0	0.5-8.0	7	20	15	5	2902-10-DBM	4-57
2.0-18.0	0.5-8.0	7.5	20	15	8	2902-10-DBH	4-57

Double Balanced Microwave Mixers

Freq. RF/LO (GHz)	Freq. IF (GHz)	Conv. Loss (dB) Typ	Isol. LO-RF (dB) Typ	Isol. LO-IF (dB) Typ	Comp Pt 1 dB (dBm) Typ	Package	Part No.	Page No
1.0-12.0	0.0010.3	8.0*	16	15	-5	Conn	DMB1-12A	4-62
1.0-18.0	dc-0.5	6.0	22	18	+3	Conn	DM1-18A	4-60
2.0-18.0	0.01-0.5	8.0*	20	15	-10	Conn	DMB2-18A	4-62
2.0-18.0	dc-1.0	7.0	20	12	+2	Conn**	2901-04-DBL	4-53
2.0-18.0	dc-1.0	7.0	20	12	+5	Conn**	2901-04-DBM	4-53
2.0-18.0	dc-1.0	7.5	20	12	+8	Conn**	2901-04-DBH	4-53
2.0-18.0	0.1-6.0	6.5	20	15	+2	Conn**	2902-04-DBL	4-53
2.0-18.0	0.1-6.0	6.5	20	15	+5	Conn**	2902-04-DBM	4-53
2.0-18.0	0.1-6.0	7.0	20	15	+8	Conn**	2902-04-DBH	4-53
2.0-18.0	0.5-8.0	7.0	20	15	+3	Conn**	2903-04-DBL	4-53
2.0-18.0	0.5-8.0	7.0	20	15	+6	Conn**	2903-04-DBM	4-53
2.0-18.0	0.5-8.0	7.0	20	15	+8	Conn**	2903-04-DBH	4-53
4.0-18.0	dc-1.0	6.5	18	15	+2	Mod	3601-05-DBL	4-55
4.0-18.0	dc-1.0	6.5	18	15	+5	Mod	3601-05-DBM	4-55
4.0-18.0	dc-1.0	7.0	18	15	+8	Mod	3601-05-DBH	4-55
4.0-18.0	dc-1.0	6.5	18	15	+2	Mod	3601-07-DBL	4-55
4.0-18.0	dc-1.0	6.5	18	15	+5	Mod	3601-07-DBM	4-55
4.0-18.0	dc-1.0	7.0	18	15	+8	Mod	3601-07-DBH	4-55

Package Key: Conn=Connectorized, Mod=Module

** Removable connectors for use as drop-in package.

QUIET® Mixers

Freq. RF/LO (GHz)	IF Center Freq. Bandwidth (MHz)	Noise Figure (db) Max	Isolation LO-RF (db) Typ	Image Rejection (db)Max	Comp Pt 1 dB (dBm) Typ	Part No.	Page No.
5.4-5.9	30/10	5.5	25	20	0	IRR5.9/30	4-75
5.4-5.9	60/20	5.5	25	20	0	IRR5.9/60	4-75
8.5-9.6	30/10	5.7	25	20	0	IRR9.6/30	4-75
8.5-9.6	60/20	5.7	25	20	0	IRR9.6/60	4-75

Specifications Subject to Change Without Notice.

Mixer Preamps

Freq. RF/LO (GHz) Typ	Freq. IF (GHz) Typ	Gain (dB) Typ.	LO-RF (dB) Typ	Isolation LO-IF (dB) Typ	Comp Pt. 1 dB (dBm) Typ	Part No.	Page No.
0.5-5	dc-1	8.5	*	*	*	MAMS12008[1]	1-200
0.5-5	dc-1	8.5	*	*	*	MAMD12018[1]	1-198
2.0-18.0	10-500	*	20	18	+5	2912-12-MBL	4-64
2.0-18.0	50-70	20	23	*	0	DML2-18/10B	4-65
2.0-18.0	*	25	20	-	-	IRMP2-18	4-66
2.0-26.0	*	25	20	-	-	IRMP2-26	4-66

Notes:
1. Silicon MMIC

* Consult product page.

Image Rejection Mixers

Freq. RF/LO (GHz) Typ	Image Rejection (dB) Min	Conv. Loss (dB) Typ.	LO-RF (dB) Typ	Isolation LO-IF (dB) Typ	Comp Pt. 1 dB (dBm) Typ	Part No.	Page No.
8.0-12.0	18	6.5	20	23	+3	25XX-09-IRL	4-64
8.0-12.0	18	6.5	20	23	+9	25XX-09-IRM	4-64
8.0-12.0	18	7.0	20	23	+13	25XX-09-IRH	4-64
12.0-18.0	18	7.0	20	23	+3	26XX-09-IRL	4-64
12.0-18.0	18	7.0	20	23	+9	26XX-09-IRM	4-64
12.0-18.0	18	7.5	20	23	+13	26XX-09-IRH	4-64
6.0-18.0	16	7.0	20	23	+3	27XX-09-IRL	4-64
6.0-18.0	16	7.0	20	23	+9	27XX-09-IRM	4-64
6.0-18.0	16	7.5	20	23	+13	27XX-09-IRH	4-64

Quadrature IF Mixers

Freq. RF/LO (GHz) Typ	Phase Accuracy From 90°	Conv. Loss (dB) Typ.	LO-RF (dB) Typ	Isolation LO-IF (dB) Typ	Comp Pt. 1 dB (dBm) Typ	Part No.	Page No.
6.0-18.0	12	9.5	20	23	+3	2713-09-QML	4-70
6.0-18.0	12	9.5	20	23	+9	2713-09-QMM	4-70
6.0-18.0	12	10.0	20	23	+13	2713-09-QMH	4-70

RF Bi-Phase Modulators

	Freq. Range (MHz) Typ.	Phase Deviation (deg) Typ	Insert. Loss (dB) Typ.	VSWR (:1)Typ.	Amp. Balance (dB) Typ.	Driver	Package	Part No.	Page No.
	10-750	0.5	2.5	1.1	0.1	DC	TO-8	PM-101	2-218
	10-750	0.5	2.5	1.1	0.1	ECL	TO-8	PM-102	2-218
	10-750	0.5	2.5	1.1	0.1	TTL	TO-8	PM-103	2-218
NEW	700-2000	2	3.0	2.8	0.1	DC	TO-8	PM-125	2-220
NEW	700-2000	2	3.0	2.8	0.1	ECL	TO-8	PM-126	2-220
NEW	700-2000	2	3.0	2.8	0.1	TTL	TO-8	PM-127	2-220
	2000-3000	1.0	3.5	1.5	0.1	DC	Flatpack	PM-104	2-222

QPSK Modulators, Flatpack

	Freq. Range (MHz) Typ.	Phase Deviation (deg) Typ	Insert. Loss (dB) Typ	VSWR (:1) Typ	Amp. Balance (dB) Typ	Driver	Part No.	Page No.
	20-40	2.0	5.0	1.3	0.15	DC	PM-105	2-224
	20-40	2.0	5.0	1.3	0.15	ECL	PM-106	2-224
	50-100	2.0	5.2	1.2	0.25	DC	PM-108	2-225
	50-100	2.0	5.2	1.2	0.25	ECL	PM-109	2-225
	50-100	2.0	5.2	1.2	0.25	TTL	PM-110	2-225
NEW	100-200	3.0	7.0	1.2	0.3	DC	PM-114	2-226
NEW	100-200	3.0	7.0	1.2	0.3	ECL	PM-115	2-226
NEW	100-200	3.0	7.0	1.2	0.3	TTL	PM-116	2-226

Low Cost (E-Series) RF Modulators and Demodulators

	Description	Carrier Freq. Range (MHz)	Package Type	Part No.	Page No.
	Modulator	30-50	Relay Header	EQKR8-40W	3-60
	Modulator	43-47	Relay Header	EQKR8-45	3-61
	Modulator	50-90	Relay Header	EQKR8-70W	3-62
	Modulator	86-95	Relay Header	EQKR8-91	3-64
	Modulator	60-120	Relay Header	EQKR8-90W	3-63
	Modulator	90-150	Relay Header	EQKR8-120W	3-65
	Modulator	147-175	Relay Header	EQKR8-160W	3-66
New	Modulator	830-850	Surface Mount	EKIN2-840	3-67
New	Modulator	869-894	Surface Mount	EKIN2-880	3-68
New	Modulator[1]	869-894	Surface Mount	EQKS8-880	3-69
	Modulator[1]	890-915	Relay Header	EQKR8-900	3-70
New	Modulator	925-960	Leaded SMT	EKIN-960	3-71
	Modulator[2]	925-960	Surface Mount	EQKS8-960	3-72
New	Modulator	925-960	Surface Mount	EKIN2-960	3-73
New	Modulator	1074-1090	Surface Mount	EKIN-1082	3-74
New	Demodulator	10	Surface Mount	EKIN-10D	3-75
New	Demodulator, 1.5 VSWR	70.2	Surface Mount	EKIN-70D	3-77
	Demodulator	70.2	Surface Mount	EQKS8-70D1	3-78
New	Demodulator	200-225	Surface Mount	EKIN-222.5D	3-76

Notes:
1. Suitable for GSM, TACS, NMT-900 receivers.
2. Suitable for GSM, TACS, NMT-900 transmitters.

Specifications Subject to Change Without Notice.

Microwave Bi-Phase Modulators

Freq.Range (GHz)	Insertion Loss (dB) Typ	VSWR (:1) Typ	Part No.	Page No.
2.0-4.0	1.8	1.6	2696-0101-XY	4-81
2.0-4.0	1.8	1.6	2696-0102-XY	4-81
4.0-8.0	2.2	1.8	2696-0103-XY	4-81
4.0-8.0	2.2	1.8	2696-0104-XY	4-81
8.0-12.0	2.8	1.8	2696-0105-XY	4-81
8.0-12.0	2.8	1.8	2696-0106-XY	4-81
8.0-16.0	3.3	2.0	2696-0107-XY	4-81
8.0-16.0	3.3	2.0	2696-0108-XY	4-81
2.0-18.0	*	*	DMK2-18	4-78
2.0-18.0	*	*	DMK2-18TTL	4-79
12.0-18.0	3.8	2.0	2696-0109-XY	4-81
12.0-18.0	3.8	2.0	2696-0110-XY	4-81

* Consult Product Page

Single Sideband Modulators

Freq. RF/LO (GHz)	Sideband Sup (dB) Min.	Conv. Loss (dB) Typ	LO-IF (dB) Typ	Iso LO-IF (dB) Typ	Comp Pt 1dB (dBm) Typ	LO Drive (dBm)	Part No.	Page No.
6.0-18.0	16	8.0	20	23	+3	+9/+13	27XX-09-SSL	4-77
6.0-18.0	16	8.0	20	23	+9	+13/+17	27XX-09-SSM	4-77
6.0-18.0	16	8.5	20	23	+13	+17/+21	27XX-09-SSH	4-77

Oscillators, Millimeter Wave

Freq.Range (GHz)	Specifications	Description	Part No.	Page No.
18.0-140.0	Consult Product Page	Electronically Tuned Gunn	6(WG)V Series	5-6
18.0-140.0	Consult Product Page	Mechanically Tuned Gunn	6(WG)M Series	5-8
18.0-60.0	Consult Product Page	Pulsed Gunn	6(WG)P Series	5-10

RF Phase Shifter

Freq.Range (MHz) Typ	Insertion Loss (dB) Typ.	VSWR (:1)Typ	Phase Range (Deg)	Package	Part No.	Page No.
28.5-31.5	0.8	1.3	180	Flatpack	PM-111	2-223

Microwave Phase Shifters

Freq.Range (GHz)	Description	Specifications	Part No.	Page No.
dc-18 GHz	Coaxial, Mechanical, Phase Shifter	Consult Product Page	2054 Series	4-196
dc-18 GHz	Line Stretcher	Consult Product Page	2054 Series	4-197

RF, MMIC, Microwave and Millimeter Wave Switches

	Freq. Range (GHz)	Insert. Loss (dB) Typ.	Isol. (dB) Typ	VSWR (:1)Typ.	Driver	Desc.	Package	Part No.	Page No.
SPST									
	dc-1.0	0.5	55	1.10	0/-5V	MMIC	Plst SMT	SW-239	2-22
	0.005-1.0	0.5	60	1.10	TTL	Si	DIP	SW-121	2-8
New	0.6-1.1	0.9	30	1.4	0/+3V	MMIC, Matched	Plstc, SO-8	SW-349	1-18
	0.01-1.5	0.8	60	1.10	TTL	Si Matched	DIP	SW-161	2-9
New	dc-2.0	0.5	55	1.2	0/-5V	MMIC, Matched	Cer	SW-344	1-64
New	dc-2.0	0.5	55	1.2	0/-5V	MMIC, Matched	Cer	SW-341	1-66
New	dc-2.0	0.6	42	1.2	0/-5V	MMIC, Matched	TO-5	SW-342	1-66
	dc-2.0	1.8	75	1.5	TTL	MMIC	Conn	SW-367	1-68
	0.005-2.0	1.2	80	1.10	TTL	Si	DIP	SW-111	2-11
	0.2-2.0	0.5	50	1.15	TTL	Si	DIP	SW-131	2-12
	0.5-2.0	0.6	40	1.4	*	Reflective	Conn	2660-1001-XY	4-7
	0.5-2.0	0.7	60	1.4	*	Reflective	Conn	2660-1004-XY	4-7
	0.5-2.0	1.2	60	1.5	*	Absorptive	Conn	2661-1001-XY	4-9
	0.5-2.0	1.2	60	1.5	*	Absorptive	Conn	2661-1002-XY	4-9
	0.5-2.0	0.7	40	1.4	*	ECL	Conn	2662-1001-XY	4-11
	0.5-2.0	0.6	40	1.5	*	Reflective	Mod	2951-2001	4-33
	dc-2.5	0.5	65	1.2	0/-5V	MMIC	Plstc, SO-8	SW-259	1-16
	dc-3.0	0.5	45	1.15	0/-5V		TO-5	SW-211	2-10
	dc-3.0	0.7	55	1.15	0/-5V	Matched	TO-5	SW-213	2-10
	dc-3.0	0.9	55	1.10	0/-5V	Matched	SMT	SWS-278	2-14
	dc-3.0	0.5	45	1.15	0/-5V		FP	SW-212	2-16
	dc-3.0	0.7	55	1.15	0/-5V	Matched	FP	SW-214	2-16
New	dc-3.0	0.8	65	1.2	TTL/CMOS	MMIC, Matched	Cer	SW-311	1-70
	dc-3.0	0.9	45	1.2	0/-5V	MMIC, Matched	Cer	SW-209	1-72
	0.005-4.0	1.0	60	1.20	TTL	Matched	DIP	SW-215	2-17
	0.005-4.0	1.0	60	1.20	CMOS	Matched	DIP	SW-216	2-17
	0.005-4.0	1.0	55	1.20	TTL	Matched	FP	SW-231	2-18
	0.005-4.0	1.0	55	1.20	CMOS	Matched	FP	SW-232	2-18
	dc-4.0	0.7	55	1.15	0/-5V	Matched	Cer	SW-221	2-20
	dc-4.0	0.7	60	1.15	0/-5V		Cer	SW-222	2-20
	dc-4.0	0.5	45	1.15	0/-5V		Cer	SW-223	2-20
	dc-4.0	0.4	35	1.2	0/-5V	MMIC	Chip	MASW4010	1-74
New	dc-4.0	0.4	40	1.2	0/-5V	MMIC	Chip	MASW4020	1-76
	dc-6.0	0.8	64	1.1	0/-8V	MMIC	Chip	MASW6020G	1-78
	2.0-8.0	0.8	40	1.5	*	Reflective	Conn	2660-1006-XY	4-7
	2.0-8.0	1.0	60	1.5	*	Reflective	Conn	2660-1007-XY	4-7
	2.0-8.0	1.0	60	1.5	*	Reflective	Conn	2660-1008-XY	4-7
	2.0-8.0	2.0	60	1.7	*	Absorptive	Conn	2661-1003-XY	4-9
	2.0-8.0	2.0	60	1.7	*	Absorptive	Conn	2661-1004-XY	4-9
	2.0-8.0	1.0	40	1.5	*	ECL	Conn	2662-1003-XY	4-11
	2.0-8.0	1.2	60	1.5	*	ECL	Conn	2662-1004-XY	4-11

Package Key: SMT=Surface Mount, Plstc=Plastic, Conn=Connectorized, Mod=Module, TO-#=TO Can, FP=Flatpack, PIN=Pin RH=Relay Header, PC=Printed Circuit Mount, Cer=Ceramic, DIP=Dual Inline Package

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RF, MMIC, Microwave and Millimeter Wave Switches (cont.)

	Freq. Range (GHz)	Insert. Loss (dB) Typ.	Isol. (dB) Typ	VSWR (:1)Typ.	Driver	Desc.	Package	Part No.	Page No.
	2.0-8.0	0.9	50	1.7	*	Reflective	Mod	2951-2002	4-33
	2.0-8.0	1.4	70	1.5	TTL	Reflective	Conn **	2680-1001	4-13
	2.0-18.0	2.5	70	2.1	TTL	Reflective	Conn **	2680-1003	4-13
	2.0-18.0	2.0	40	2.0	*	Reflective	Conn	2660-1013-XY	4-7
	2.0-18.0	2.2	55	2.0	*	Reflective	Conn	2660-1015-XY	4-7
	2.0-18.0	2.8	60	2.2	*	Absorptive	Conn	2661-1007-XY	4-9
	2.0-18.0	2.5	55	2.0	*	Reflective	Conn **	2662-1008-XY	4-11
	6.0-18.0	2.0	55	1.9	*	Reflective	Conn	2660-1011-XY	4-7
	6.0-18.0	2.0	55	1.9	*	Reflective	Conn	2660-1012-XY	4-7
	6.0-18.0	2.6	60	2.0	*	Absorptive	Conn	2661-1005-XY	4-9
	6.0-18.0	2.6	60	2.0	*	Absorptive	Conn	2661-1006-XY	4-9
	6.0-18.0	2.0	40	1.9	*	ECL	Conn	2662-1005-XY	4-11
	6.0-18.0	2.2	55	1.9	*	ECL	Conn	2662-1006-XY	4-11
	6.0-18.0	1.4	55	1.9	*	Reflective	Mod	2951-2003	4-33
	8.0-18.0	2.4	75	2.0	TTL	Reflective	Conn **	2680-1002	4-13
	18.0-26.5	1.2	30	2.0	*		Waveguide	7-42 Series	5-12
	26.5-40.0	1.5	30	2.0	*		Waveguide	7-28 Series	5-12
	33.0-50.0	1.5	30	2.0	*		Waveguide	7-22 Series	5-12
	40.0-60.0	1.8	25	2.0	*		Waveguide	7-19 Series	5-12
	50.0-75.0	2.0	20	2.0	*		Waveguide	7-15 Series	5-12
	60.0-90.0	2.0	20	2.0	*		Waveguide	7-12 Series	5-12
	75.0-110	2.0	20	2.0	*		Waveguide	7-10 Series	5-12
SPDT									
	0.01-1.5	0.8	60	1.10	TTL	Si Matched	DIP	SW-162	2-21
	dc-2.0	0.6	40	1.20	TTL		TO-5	SW-224	2-24
	dc-2.0	0.6	35	1.10	TTL		FP	SW-225	2-24
	dc-2.0	0.8	45	1.15	TTL		Conn	SW-229	2-26
	dc-2.0	0.9	52	1.3	0/-5V	MMIC, Matched	Cer	SW-331	1-80
New	dc-2.0	0.9	40	1.3	0/-5V	MMIC, Matched	Cer	SW-333	1-80
	0.005-2.0	1.0	55	1.20	CMOS		FP	SW-237	2-28
	0.005-2.0	1.0	50	1.20	TTL	Matched	FP	SW-233	2-30
	0.005-2.0	1.0	50	1.20	CMOS	Matched	FP	SW-236	2-30
	0.005-2.0	1.0	55	1.20	TTL		DIP	SW-217	2-32
	0.005-2.0	1.2	80	1.10	TTL	Si	DIP	SW-112	2-34
	0.01-2.0	0.8	50	1.10	TTL	Si	DIP	SW-118	2-33
	0.2-2.0	0.5	50	1.15	TTL	Si	DIP	SW-132	2-35
	0.5-2.0	0.9	40	1.4	*	Reflective	Conn	2664-1001-XY	4-15
	0.5-2.0	0.9	40	1.4	*	Reflective	Conn	2664-1002-XY	4-15
	0.5-2.0	1.1	60	1.4	*	Reflective	Conn	2664-1003-XY	4-15
	0.5-2.0	1.1	60	1.4	*	Reflective	Conn	2664-1004-XY	4-15
	0.5-2.0	0.8	40	1.5	*	Reflective	Mod	2954-1001	4-35
	0.5-2.0	0.8	40	1.5	*	Reflective	Mod	2954-2001	4-35

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Specifications Subject to Change Without Notice.

RF, MMIC, Microwave and Millimeter Wave Switches (cont.)

	Freq. Range (GHz)	Insert. Loss (dB) Typ.	Isol. (dB) Typ	VSWR (:1)Typ.	Driver	Desc.	Package	Part No.	Page No.
	0.5-2.0	1.2	50	1.5	TTL	Reflective	Mod	2956-1001	4-37
New	0.7-2.0	0.7	45	1.4	TTL	MMIC	Plstc, SO-8	SW-329	1-30
	dc-2.5	0.4	56	1.2	0/-5V	MMIC	Plstc, SO-8	SW-239	1-20
New	dc-2.5	0.2	38	1.2	*	MMIC	Plstc, SO-8	SW-277	1-22
New	dc-2.5	0.2	63	1.2	*	MMIC	Plstc, SO-8	SW-279	1-24
	dc-2.5	0.4	53	1.2	0/-5V	MMIC	Plstc, SO-8	SW-338	1-26
	dc-2.5	0.4	53	1.2	0/-5V	MMIC	Plstc, SO-8	SW-339	1-26
	dc-3.0	0.6	40	1.20	TTL/CMOS	Hi Pwr, 4 W	Cer	SW-110	***
	dc-3.0	0.5	50	1.15	0/-5V		TO-5	SW-201	2-23
	dc-3.0	0.8	50	1.15	0/-5V	Matched	TO-5	SW-203	2-23
	dc-3.0	0.5	50	1.15	0/-5V		FP	SW-202	2-36
	dc-3.0	0.8	50	1.15	0/-5V	Matched	FP	SW-204	2-36
	dc-3.0	0.4	46	1.2	0/-5V	MMIC	Plstc, SSO-8	SW-328	1-28
New	dc-3.0	0.5	34	1.3	*	MMIC	SMT	SW-106	1-82
New	dc-3.0	0.4	37	1.3	*	MMIC	Cer	SW-276	1-82
New	dc-3.0	0.8	45	1.3	TTL/CMOS	MMIC	Cer	SW-312	1-86
New	dc-3.0	0.8	53	1.25	TTL/CMOS	MMIC, Matched	Cer	SW-313	1-88
	dc-3.0	0.7	43	1.2	0/-5V	MMIC, Matched	Cer	SW-219	1-90
	dc-3.0	0.5	43	1.2	0/-5V	MMIC	Chip	MASW2000	1-92
	dc-3.0	0.45	37	1.2	0/-5V	MMIC	Chip	MASW2020G	1-94
	0.005-3.0	0.9	50	1.20	CMOS		FP	SW-238	2-38
	0.005-4.0	1.2	55	1.20	TTL	Matched	DIP	SW-205	2-40
	0.005-4.0	1.2	55	1.20	CMOS	Matched	DIP	SW-206	2-40
	dc-4.0	0.6	60	1.2	0/-5V	MMIC	Chip	MASW4030G	1-96
	dc-4.0	0.6	60	1.1	0/-5V	MMIC	Chip	MASW4040	1-98
	dc-4.0	0.8	55	1.15	0/-5V	Matched	Cer	SW-226	2-42
	dc-4.0	0.8	60	1.15	0/-5V		Cer	SW-227	2-42
	dc-4.0	0.5	45	1.10	0/-5V		Cer	SW-228	2-42
	0.005-4.0	0.8	45	1.20	TTL		DIP	SW-207	2-44
	0.005-4.0	0.8	45	1.20	CMOS		DIP	SW-208	2-44
	2.0-4.0	1.6	55	1.7	*	Reflective	Conn	2665-1002-XY	4-19
	dc-6.0	0.6	45	1.2	0/-8V	MMIC	Chip	MASW6010G	1-100
	dc-8.0	0.8	35	1.3	0/-5V	MMIC	Chip	MASW8000	1-102
	2.0-8.0	1.5	60	1.6	*	Reflective	Conn	2664-1007-XY	4-15
	2.0-8.0	1.5	60	1.6	*	Reflective	Conn	2664-1008-XY	4-15
	2.0-8.0	1.5	60	1.5	TTL	Reflective	Conn **	2681-1001	4-17
	2.0-8.0	1.2	50	1.7	*	Reflective	Mod	2954-1002	4-35
	2.0-8.0	1.1	50	1.7	*	Reflective	Mod	2954-2002	4-35
	2.0-8.0	1.8	50	1.8	TTL	Reflective	Mod	2956-1002	4-37
	4.0-8.0	2	55	1.9	*	Reflective	Conn	2665-1004-XY	4-19
	8.0-12.0	2.5	55	2.0	*	Reflective	Conn	2665-1006-XY	4-19
	6.0-18.0	2.4	40	2.0	*	Reflective	Conn	2664-1009-XY	4-15

Package Key: SMT=Surface Mount, Plstc=Plastic, Conn=Connectorized, Mod=Module, TO-#=TO Can, FP=Flatpack, PIN=Pin RH=Relay Header, PC=Printed Circuit Mount, Cer=Ceramic, DIP=Dual Inline Package

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RF, MMIC, Microwave and Millimeter Wave Switches (cont.)

Freq. Range (GHz)	Insert. Loss (dB) Typ.	Isol. (dB) Typ	VSWR (:1)Typ.	Driver	Desc.	Package	Part No.	Page No.
6.0-18.0	2.4	40	2.0	*	Reflective	Conn	2664-1010-XY	4-15
6.0-18.0	2.6	55	2.0	*	Reflective	Conn	2664-1011-XY	4-15
2.0-18.0	2.8	55	2.0	*	Reflective	Conn	2664-1015-XY	4-15
2.0-18.0	2.8	55	2.0	*	Reflective	Conn	2664-1016-XY	4-15
2.0-18.0	2.5	55	2.1	TTL	Reflective	Conn **	2681-1003	4-17
2.0-18.0	2.1	50	2.0	*	Reflective	Mod	2954-1004	4-35
2.0-18.0	1.6	55	1.9	*	Reflective	Mod	2954-2003	4-35
8.0-18.0	2.2	55	2.0	TTL	Reflective	Conn **	2681-1002	4-17
6.0-18.0	2.5	45	2.0	TTL	Reflective	Mod	2956-1003	4-37
12.0-18.0	2.4	40	2.2	*	Reflective	Conn	2665-1007-XY	4-19
dc-20.0	1.7	50	1.6	0/-5V	MMIC	Chip	MASW20000	1-104
18.0-26.5	1.8	30	2.0	*		Waveguide	7-42 Series	5-12
26.5-40.0	2.0	30	2.0	*		Waveguide	7-28 Series	5-12
33.0-50.0	2.0	30	2.0	*		Waveguide	7-22 Series	5-12
40.0-60.0	2.5	25	2.0	*		Waveguide	7-19 Series	5-12
50.0-75.0	2.5	25	2.0	*		Waveguide	7-15 Series	5-12
60.0-90.0	2.5	20	2.0	*		Waveguide	7-12 Series	5-12
75.0-110.0	2.5	20	2.0	*		Waveguide	7-10 Series	5-12
SP3T								
0.005-1.0	0.6	60	1.10	TTL	Si	DIP	SW-123	2-45
0.01-1.5	0.5	45	1.20	TTL	Si Matched	DIP	SW-163	2-46
0.005-2.0	1.0	60	1.20	TTL	Matched	DIP	SW-241	2-47
0.005-2.0	1.0	55	1.20	TTL	Matched	FP	SW-247	2-48
0.005-2.0	1.0	55	1.20	CMOS	Matched	FP	SW-251	2-48
0.005-2.0	1.3	60	1.10	TTL	Si	DIP	SW-113	2-50
0.2-2.0	0.6	45	1.20	TTL	Si	DIP	SW-133	2-51
0.5-2.0	1.2	70	1.5	*	Reflective	Conn **	2682-1001-XY	4-21
2.0-8.0	1.8	70	1.8	*	Reflective	Conn **	2682-1002-XY	4-21
6.0-18.0	2.5	70	2.0	*	Reflective	Conn **	2682-1003-XY	4-21
2.0-18.0	2.8	65	2.0	*	Reflective	Conn **	2682-1004-XY	4-21
SP4T								
0.005-1.0	0.6	60	1.10	TTL	Si	DIP	SW-124	2-52
0.01-1.5	0.9	60	1.10	TTL	Si Matched	DIP	SW-164	2-53
0.005-2.0	1.0	55	1.20	TTL	Matched	DIP	SW-254	2-54
0.005-2.0	1.0	55	1.20	CMOS	Matched	DIP	SW-257	2-54
0.005-2.0	1.0	55	1.20	TTL		DIP	SW-255	2-55
0.005-2.0	1.0	55	1.20	CMOS		DIP	SW-258	2-55
0.005-2.0	1.0	55	1.20	TTL	Matched	FP	SW-261	2-56
0.005-2.0	1.0	55	1.20	CMOS	Matched	FP	SW-264	2-56
0.005-2.0	1.0	55	1.20	TTL		FP	SW-262	2-58
0.005-2.0	1.2	80	1.10	TTL	Si	DIP	SW-114	2-60
0.2-2.0	0.6	45	1.20	TTL	Si	DIP	SW-134	2-61

Package Key: SMT=Surface Mount, Plstc=Plastic, Conn=Connectorized, Mod=Module, TO-#=TO Can, FP=Flatpack, PIN=Pin RH=Relay Header, PC=Printed Circuit Mount, Cer=Ceramic, DIP=Dual Inline Package

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RF, MMIC, Microwave and Millimeter Wave Switches (cont.)

	Freq. Range (GHz)	Insert. Loss (dB) Typ.	Isol. (dB) Typ	VSWR (:1)Typ.	Driver	Desc.	Package	Part No.	Page No.
	0.5-2.0	1.4	70	1.5	*	Reflective	Conn **	2683-1001-XY	4-23
	0.5-2.0	1.2	40	1.5	*	Reflective	Mod	2959-1001	4-39
	dc-4.0	0.7	40	1.20	0/-5V		Cer	SW-243	2-62
	2.0-8.0	2	70	1.8	*	Reflective	Conn **	2683-1002-XY	4-23
	2.0-8.0	1.8	50	1.8	*	Reflective	Mod	2959-1002	4-39
	2.0-18.0	3.2	65	2.0	*	Reflective	Conn **	2683-1004-XY	4-23
	2.0-18.0	2.9	40	2.0	*	Reflective	Mod	2959-1004	4-39
	6.0-18.0	2.9	70	2.0	*	Reflective	Conn **	2683-1003-XY	4-23
	6.0-18.0	2.7	40	2.0	*	Reflective	Mod	2959-1003	4-39
SP4T									
	dc-2.0	0.8	60	1.3	0/-5V	MMIC	Plstc, SO-24	SW-419	1-32
New	dc-2.0	1.8	45	1.4	CMOS	MMIC, Matched	FP	SW-415	1-106
New	dc-2.0	1.2	50	1.4	*	MMIC	FP	SW-411	1-108
New	0.02-2.0	1.8	50	1.4	0/+5V	MMIC, Matched	FP	SW-369	1-114
	dc-4.0	0.7	41	1.2	0/-5V	MMIC	Chip	MASW4000	1-110
New	dc-4.0	1.3	50	1.4	0/-5V	MMIC	Chip	MASW4060G	1-112
SP5T									
	0.5-2.0	1.5	70	1.5	TTL	Reflective	Conn **	2684-1001-XY	4-25
	2.0-8.0	2.2	70	1.8	TTL	Reflective	Conn **	2684-1002-XY	4-25
	6.0-18.0	3.1	70	2.0	TTL	Reflective	Conn **	2684-1003-XY	4-25
	2.0-18.0	3.3	65	2.0	TTL	Reflective	Conn **	2684-1004-XY	4-25
SP6T									
New	dc-2.0	2	33	0.9	-5/+5V	MMIC, Matched	FP	SW-284	1-116
DPDT									
New	dc-2.0	0.35	56	1.3	0/-5V	MMIC	Plstc, SO-14	SW-289	1-34
	dc-2.0	0.8	40	1.3	0/-5V	MMIC	TO-5	SW-355	1-118
	dc-2.0	0.4	25	1.1	0/-5V	MMIC	Chip	MASW2040	1-120
	dc-4.0	0.5	50	1.15	0/-5V		Cer	SW-281	2-64
	dc-6.0	0.6	40	1.2	0/-5V	MMIC	Chip	MASW6030G	1-122
	dc-6.0	0.6	40	1.2	0/-5V	MMIC	Chip	SW-280	1-124
Transfer									
New	dc-2.0	1.3	35	1.4	0/-5V	MMIC	TO-5	SW-362	1-126
	0.01-2.0	0.9	50	1.10	TTL	Si	DIP	SW-119	2-66
	dc-3.0	0.8	55	1.15	0/-5V		Cer	SW-283	2-68
New	dc-12.0	1.3	40	1.3	0/-8V	MMIC	Chip	MASW12000G	1-128
Solid State Relay									
New	dc-2.0	0.5	30	1.2	+5/-5V	MMIC	TO-5	SW-368	1-130
T/R Diversity									
	dc-2.0	0.4	35	1.3	-	MMIC	Plstc, SOW-16	MASW2070G-1	1-38
New	dc-2.5	0.55	38	1.3	-	MMIC	Plstc, SSOP-20	SW-923	1-36

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RF, MMIC, Microwave and Millimeter Wave Switches (cont.)

Freq. Range (GHz)	Insert. Loss (dB) Typ.	Isol. (dB) Typ	VSWR (:1)Typ.	Driver	Desc.	Package	Part No.	Page No.
Millimeter Wave, High Power								
18.0-110.0	1.0-1.6	20-30	1.6	*	Pin Diode	Waveguide	*	5-12

Package Key: SMT=Surface Mount, Plstc=Plastic, Conn=Connectorized, Mod=Module, TO-#=TO Can, FP=Flatpack, PIN=Pin RH=Relay Header, PC=Printed Circuit Mount, Cer=Ceramic, DIP=Dual Inline Package

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Electromechanical Switches

	Freq.Range (GHz)	Insertion Loss (dB) Typ.	Isolation (dB) Typ.	VSWR Typ.	Actuation	Part No.	Page No.
	SPDT						
QPL[1]	dc-18.0	0.15	80	1.1	Failsafe	7530-4179-00	4-49
QPL[1]	dc-18.0	0.15	80	1.1	Failsafe	7530-4178-00	4-49
	dc-18.0	0.15	80	1.1	Failsafe	7530-6412-00	4-44
	dc-18.0	0.15	80	1.1	Failsafe	7530-6412-10	4-44
	dc-18.0	0.15	80	1.1	Latching	7530-6414-00	4-44
	dc-18.0	0.15	80	1.1	Latching	7530-6414-10	4-44
	dc-26.5	0.15	80	1.1	Failsafe	7530-6422-00	4-44
	dc-26.5	0.15	80	1.1	Failsafe	7530-6422-10	4-44
	dc-26.5	0.15	80	1.1	Latching	7530-6424-00	4-44
	dc-26.5	0.15	80	1.1	Latching	7530-6424-10	4-44
	dc-12.4	0.3	70	1.3	Failsafe	7524-6132-00	4-47
	dc-12.4	0.3	70	1.3	Failsafe	7524-6132-10	4-47
	SP3T						
	dc-26.5	0.1	80	1.1	Failsafe	7533-6322-00	4-46
	SP4T						
	dc-26.5	0.1	80	1.1	Failsafe	7533-6422-00	4-46
	SP5T						
	dc-26.5	0.1	80	1.1	Failsafe	7533-6522-00	4-46
	SP6T						
	dc-26.5	0.1	80	1.1	Failsafe	7533-6622-00	4-46
						4-Port Transfer	
	4-Port Transfer						
	dc-12.4	0.3	70	1.3	Failsafe	7525-6132-00	4-48
	dc-12.4	0.3	70	1.3	Failsafe	7525-6132-10	4-48
	dc-18.0	0.2	80	1.2	Failsafe	7531-6200-00	4-45
	dc-18.0	0.2	80	1.2	Failsafe	7531-6210-00	4-45

1. QPL Approved to MIL-S-3928/15.

Synthesizers

Freq.Range (GHz)	Specifications	Description	Part No.	Page No.
4.0-15.0	Consult Product Page	Microstrip Low Noise	MLS-2000	4-232
5.0-15.0	Consult Product Page	Low Phase Noise	MLS-3000	4-233
1.0-18.0	Consult Product Page	Low Noise	MLS-5000	4-237
4.0-18.0	Consult Product Page	Dual Output Sampling	MLS-4000	4-236

Terminations

Freq.Range (GHz)	Average Power (W)	Connector	Description	Part No.	Page No.
dc-18.0	5/10	SMA Male	High Power	2001 Series	4-158
dc-18.0	0.5	SMA	Flange Mount	2068 Series	4-159
dc-18.0	0.5	SSMA	Subminiature	1001 Series	4-159
dc-18.0	2.0	N		3001 Series	4-159
dc-18.0	2.0	SMA	QPL Dummy Load	3001 Series[1]	4-164
dc-26.5	0.5	SMA Male	Ultra Miniature	2003 Series	4-156
dc-26.5	0.5/1.0	SMA Male	Miniature	2001 Series	4-156
dc-26.5	0.5	SMA Female	Ultra Miniature	2004 Series	4-157
dc-26.5	0.5/1.0	SMA Female	Miniature	2002 Series	4-157
dc-50.0	0.5	OS-2.4	2.4 mm	8501 Series	4-158
—	—	SMA	Short Circuit Termination	*	4-160
—	—	SSMA	Short Circuit Termination	*	4-160
—	—	N	Short Circuit Termination	*	4-160
—	—	TNC	Short Circuit Termination	*	4-160
—	—	BNC	Short Circuit Termination	*	4-160
—	—	SMA	Dust Cap	*	4-162
—	—	SSMA	Dust Cap	*	4-162
—	—	N	Dust Cap	*	4-162
—	—	TNC	Dust Cap	*	4-162
—	—	BNC	Dust Cap	*	4-162

* Consult product page.

1. QPL to MIL-D-39030/3.

RF Transformers

Freq. Range (MHz)	Impedence[1] Secondary (Ohms)	Insert. Loss (db) Typ	VSWR Typ	Power Rating (W) Typ	Package	Part No.	Page No.
2-200	75/unbal	0.25	1.1	10	Conn	TP-75	2-313
0.75-400	200/bal	0.4	1.2	1	FP	TP-104	2-314
1-500	200/unbal	0.6	1.2	1	FP	TP-102	2-315
0.5-1000	200/bal	0.4	1.1	3	FP	TP-103	2-316
0.5-1000	12.5/unbal	0.2	1.1	1.5	FP	TP-105	2-317
350-1125	200/bal	0.6	1.2	3	FP	TP-108	2-318
0.5-1500	50/bal	0.4	1.1	3	FP	TP-101	2-319
10-1500	75/unbal	0.25	1.1	2	Conn	TPX-75-4	2-320

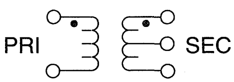
Package Key: Conn=Connectorized, FP=Flatpack

1. Primary impedance = 50 ohms, unbalanced.

Low Cost (E-Series) RF Transformers

	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
New	0.03-75	16	Surface Mount	ET16-6T-SM1	3-110
New	0.03-75	16	Leaded Surface Mount	ET16-6T-SM5	3-110
New	0.03-75	16	Gull Winged SMT	ET16-6T-SM20	3-110
New	0.03-75	16	PIN Surface Mount	ET16-6T-SM21	3-110
	0.03-140	8	Surface Mount	ET8-1T-SM1	3-112
	0.03-140	8	Leaded Surface Mount	ET8-1T-SM5	3-112
	0.03-140	8	Gull Winged SMT	ET8-1T-SM20	3-112
	0.03-140	8	PIN Surface Mount	ET8-1T-SM21	3-112
	0.05-200	1	Surface Mount	ET1-1T-SM1	3-116
	0.05-200	1	Leaded Surface Mount	ET1-1T-SM5	3-116
	0.05-200	1	Gull Winged SMT	ET1-1T-SM20	3-116
	0.05-200	1	PIN Surface Mount	ET1-1T-SM21	3-116
New	0.05-200	1	Relay Header	ETM01-1T	3-114
	0.02-250	4	Surface Mount	ET4-6T-SM1	3-106
	0.02-250	4	Leaded Surface Mount	ET4-6T-SM5	3-106
	0.02-250	4	Gull Winged SMT	ET4-6T-SM20	3-106
	0.02-250	4	PIN Surface Mount	ET4-6T-SM21	3-106
	0.003-300	1	Surface Mount	ET1-6T-SM1	3-100
	0.003-300	1	Leaded Surface Mount	ET1-6T-SM5	3-100
	0.003-300	1	Gull Winged SMT	ET1-6T-SM20	3-100
	0.003-300	1	PIN Surface Mount	ET1-6T-SM21	3-100
	0.2-350	4	Relay Header	ETM04-1	3-123
	0.2-350	4	Surface Mount	ET4-1-SM1	3-124
	0.2-350	4	Leaded Surface Mount	ET4-1-SM5	3-124
	0.2-350	4	Gull Winged SMT	ET4-1-SM20	3-124
	0.2-350	4	PIN Surface Mount	ET4-1-SM21	3-124
	0.5-800	4	Surface Mount	ETC-4-1-2	3-126

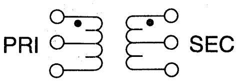
Schematic



Specifications Subject to Change Without Notice.

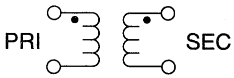
Low Cost (E-Series) RF Transformers (cont.)

Schematic



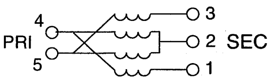
	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
	0.004-500	1	Surface Mount	ETT1-6-SM1	3-102
	0.004-500	1	Leaded Surface Mount	ETT1-6-SM5	3-102
	0.004-500	1	Gull Winged SMT	ETT1-6-SM20	3-102
	0.004-500	1	PIN Surface Mount	ETT1-6-SM21	3-102

Schematic



	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
	0.01-150	1	Surface Mount	ET1-6-SM1	3-104
New	0.01-150	1	Leaded Surface Mount	ET1-6-SM5	3-104
New	0.01-150	1	Gull Winged SMT	ET1-6-SM20	3-104
New	0.01-150	1	PIN Surface Mount	ET1-6-SM21	3-104
New	0.2-200	4	Surface Mount	ET4-6-SM1	3-108
New	0.2-200	4	Leaded Surface Mount	ET4-6-SM5	3-108
New	0.2-200	4	Gull Winged SMT	ET4-6-SM20	3-108
New	0.2-200	4	PIN Surface Mount	ET4-6-SM21	3-108
	0.15-300	1.5	Surface Mount	ET1.5-1-SM1	3-118
	0.15-300	1.5	Leaded Surface Mount	ET1.5-1-SM5	3-118
	0.15-300	1.5	Gull Winged SMT	ET1.5-1-SM20	3-118
	0.15-300	1.5	PIN Surface Mount	ET1.5-1-SM21	3-118
	0.15-400	1	Surface Mount	ET1-1-SM1	3-120
	0.15-400	1	Leaded Surface Mount	ET1-1-SM5	3-120
	0.15-400	1	Gull Winged SMT	ET1-1-SM20	3-120
	0.15-400	1	PIN Surface Mount	ET1-1-SM21	3-120
	0.15-400	1	Relay Header	ETM01-1	3-122

Schematic



Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
500-2500	4	Surface Mount	ETC1.6-4-2-3	3-127

Millimeter Wave, Waveguide Straights, Bends and Twists

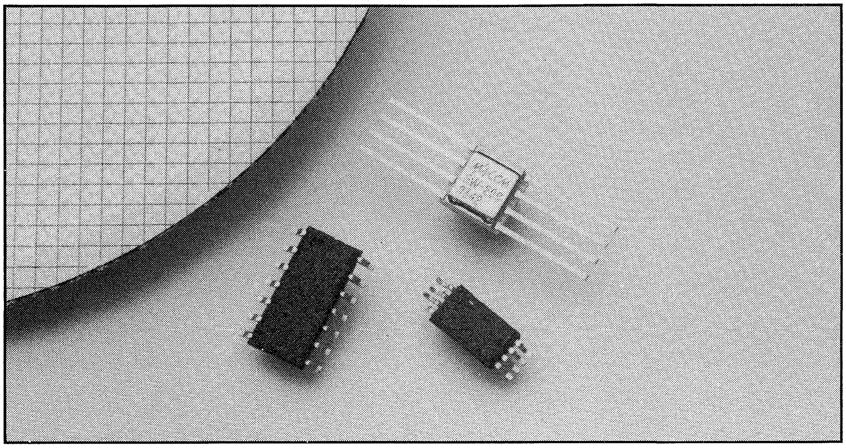
Freq.Range (GHz)	Specifications	Description	Part No.	Page No.
18.0-325.0	Consult Product Page	Straight	3(WG) 600 Series	5-34
18.0-325.0	Consult Product Page	Twists	3(WG) 670 Series	5-34
18.0-325.0	Consult Product Page	E-Bend	3(WG) 680 Series	5-34
18.0-325.0	Consult Product Page	H-Bend	3(WG) 690 Series	5-34

Rectangular Waveguide Adapters

Freq.Range (GHz)	Specifications	Description	Part No.	Page No.
2.6-18.0	See Product Page	N Connectors	3000 Series	4-192
2.6-26.5	See Product Page	SMA Connectors	2000 Series	4-191
26.5-40.0	See Product Page	SSMA Connectors	1000 Series	4-191
18.0-40.0	See Product Page	OS-2.4 (2.4mm) Connectors	8500 Series	4-192

Specifications Subject to Change Without Notice.

MMIC Based Components



Microwave Multi-Function Hybrid and MMIC Chip Assembly Capabilities

Features

- MIC
- GMIC
- HMIC
- GaAs MMIC
- On Wafer RF Measurements
- CAD/CAM
- CMC
- Packaging
- TR Modules
- MMW Transceivers

Background

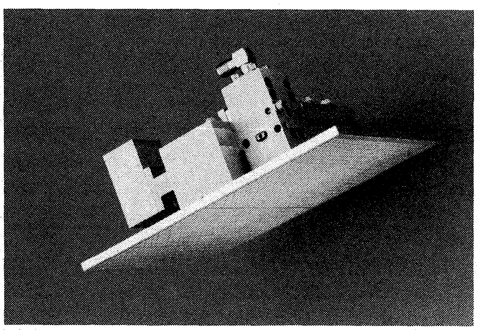
M/A-COM is the largest independent manufacturer of Microwave Multifunction Hybrid and MMIC Chip Assemblies (MFAs & MCAs) in the world today. We have extensive programs experience in assemblies for missiles, radar, space, EW, communications, and commercial applications. Production rates on these assemblies range from several a month for prototype systems, 300 to 500 a month for missile & T/R-Module assemblies, 6,000 a month for TVRO applications, to rates as high as 100,000 per month for some consumer applications.

Manufacturing

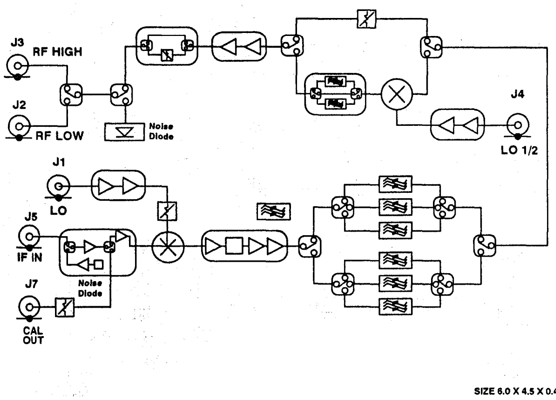
Production of complex microwave assemblies in the volumes noted above has been possible through the application of computer aided manufacturing, computer controlled test stands, MMIC designs and state-of-the-art integration technologies. Design guidelines for our Volume Automated Production (VAP) area are utilized to ensure the design is suitable for automated manufacturing from inception through to production without redesign. These techniques are being applied today to microwave assembly applications for T/R-Modules on DoD programs, plastic packaged (single and multifunction) MMICs for commercial applications and standard product programs.

Enabling Technologies

This catalog presents a wide spectrum of microwave devices and components, both active and passive, including MMICs, and integration mediums such as Glass Microwave Integrated Circuit (GMIC)™ and those products based on traditional hybrid technologies. These form the critical base from which our assembly designs are derived.



60 GHz Transceiver



Reverse Receiver

Design Philosophy

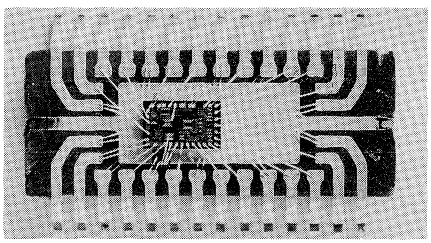
Our focus over the past few years has been on assemblies that utilize MMIC based technology along with our proprietary integration mediums such as GMIC & HMIC, automated design & manufacturing, and our extensive experience using traditional technologies for assembly requirements. This philosophy is derived from our in-house IC Design Center & Foundry, experienced design engineering staff and extensive program experience. Our integration technologies and MMIC design & fabrication capability allow us to offer unique and innovative solutions not available elsewhere in the industry.

Keys to Success

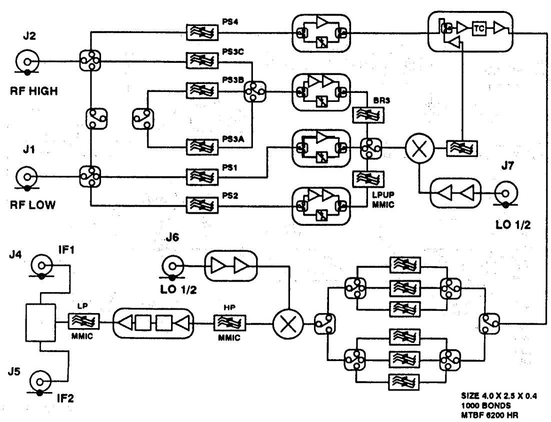
We key on the MCAs since that is how we can best give our customers the competitive advantage they require in cost and performance. Our integration mediums (GMIC, HMIC and multi-function MMICs) ensure the design is repeatable in volume production. The other advantages of this approach are that we are able to significantly reduce the recurring labor needed to produce the assembly, reduce active device count for inherently improved MTBF calculations & reliability; and ensuring producible designs to maximize yields and decrease cycle times to our customers. Of course we still offer custom designs based on traditional technology since that is where the above capabilities were developed over the years.

The M/A-COM advantage is our experience and our ability to utilize traditional and state-of-the-art technologies and multi-function MMIC integration to yield a robust design that meets or exceeds our customers' performance, cost and production lead time requirements.

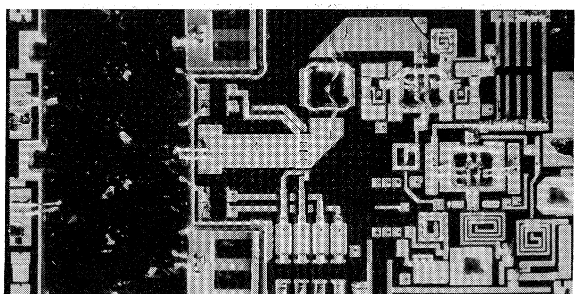
Please contact your local M/A-COM Field Sales Engineer to put our experience and capabilities to work for you.



GaAs MMIC Transceiver



RF Converter



Switch, Limiter and LNA Integrated Into A Common Medium.

![M/A-COM]

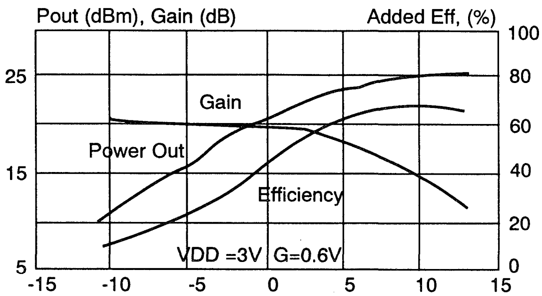
IC Foundry Facilities/Capabilities

Features

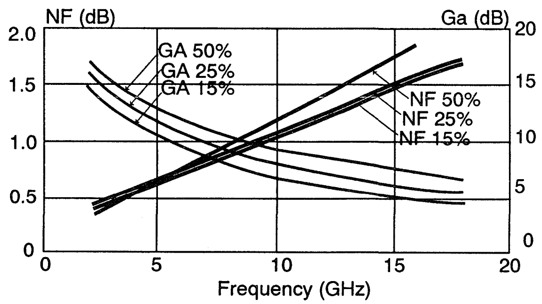
- MBE and Ion Implant Technologies
- Three Optimized Processes
  - HI2 - Low Noise/High Efficiency
  - SI1 - Switch/Low Loss
  - PE3 - Power/High Efficiency
- Power and Low Noise On a Single Wafer
- Design Service Available
- Test, Assembly and Packaging Capabilities

M/A-COM's IC Foundry and Corporate R&D group are jointly housed in the Richard M. Walker building (named in memory of a M/A-COM founder) at 100 Chelmsford Street, Lowell, Massachusetts. The building was designed and constructed to support up to 34,000 sq. ft. of modular Class 100 semiconductor processing space. Clean room modules (E-beam lithography, and semi-insulating substrate inspection/storage) maintain a Class 10 environment. The photolithography module typically operates at Class 50. The building foundation is sufficiently robust to support subquarter micron lithography and semi-insulating GaAs crystal growth from multiple pullers. The temperature of the modules is controlled to1 F and the relative humidity to 2%, truly a semiconductor manufacturing environment.

0.5μm GaAs FET F=2GHz



Process HI2 NF and GA

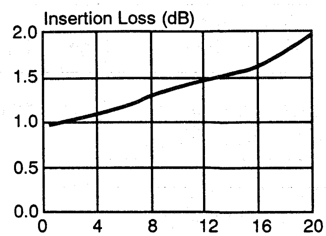


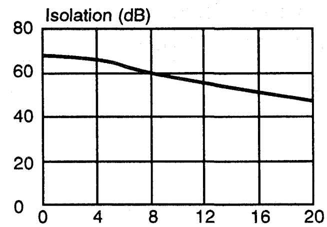
Processes

The GaAs MMIC foundry currently supports three processes based on epitaxial and ion implanted MESFETs.

1. Process SI1: 1.0um ion implanted MESFET process for switch/control and general purpose applications. The control device process used by the industry's MMIC control product leader. Space qualified devices have been produced using this process.

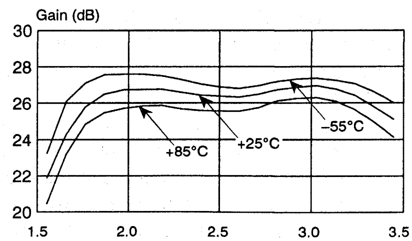
Typical FET RF Performance				
Symbol	Parameter/ Test Conditions	Freq.	Typ.	Units
R_{on}	FET On Resistence V_G =0V	–	3.0	Ohm-mm
C_{off}	FET Off Capacitance V_G =.5V	–	0.2	pF/mm
G_{max}	Maximum Available Gain V_{DS} = 3V I_{DS} = .5 I_{DSS}	4 GHz 8 GHz	13.5 9.0	dB
f_t	V_{DS} =3V I_{DS} = .5I_{DSS}	–	17	GHz

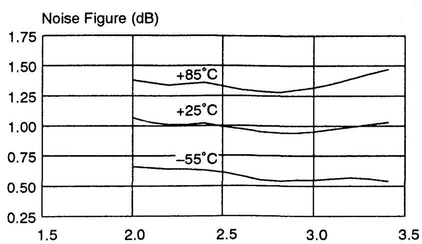




2. Process HI2: 0.5um, ion implanted, buried p-layer MESFET process based on E-beam mushroom gates for high gain/low noise applications.

Typical FET RF Performance (300 um-4 x 75 um)				
Symbol	Parameter/ Test Conditions	Freq.	Typ.	Units
G_{max}	Maximum Available Gain V_{DS} = 3V I_{DS} =.5I_{DSS}	12 GHz 18 GHz	12.7 9.0	dB
F_{min}	Device Noise Figure V_{DS} = 3V I_{DS} =.2I_{DSS}	12 GHz 18 GHz	1.3 1.9	dB
G_a	Associated Gain at F_{min}	12 GHz 8 GHz	7.5 6.0	dB
f_t	V_{DS} =3v I_{DS} = .51$_{DSS}$	–	27	GHz

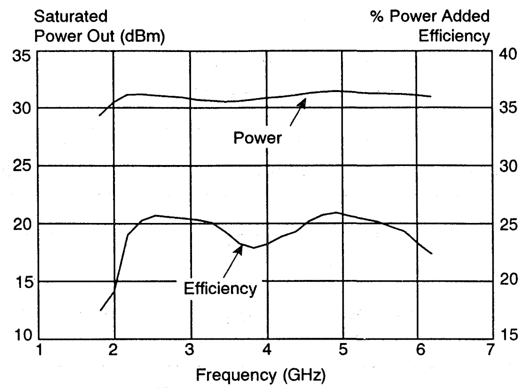




3. Process PE3: 0.5um epitaxial MESFET process based on E-beam mushroom gates for high efficiency high power applications.

Typical FET RF Performance (600 um-4 x 75 um)

Symbol	Parameter/ Test Conditions	Freq.	Typ.	Units
G_{max}	Maximum Available Gain V_{DS} = 4V I_{DS} =.5I_{DSS}	12 GHz	12.0	dB
P-1 dB	Power at 1 dB Compression V_{DS} = 8V I_{DS} =.6I_{DSS}	12 GHz	450	mW/mm
n_D	Drain Efficiency V_{DS} = 8V I_{DS} =.6I_{DSS}	12 GHz	56	%
f_t	V_{DS} =4V I_{DS} = .51$_{DSS}$	–	25	GHz



The above processes feature 1um or 0.5um mushroom gates for high performance, silicon nitride MIM capacitors and final passivation, nichrome thin film and bulk GaAs resistors, air-bridge crossovers, and backside vias on 10mil or 4mil substrate thickness. E-beam throughput of 100 wafers/week has been demonstrated.
Typical wafer processing cycle time to wafer backside quality control is 8 weeks. Contact lithography is currently utilized with plans to move to stepper technology in the near future. 0.25um ion implanted MESFET and small signal PHEMT, as well as HBT processes are under development. Current wafer size is 3 inches with critical 4 inch process steps under development. FLIP CHIP technology also exists at M/A- COM's MMIC foundry. 80um tall by 160um diameter gold bumps are plated onto the front side of full thickness wafers for flip chip assembly techniques.

All processes are under Statistical Process Control to ensure repeatability and reliability. SPC has been implemented on both DC and RF (small signal model) parameters using a central database that facilitates daily reporting and fast analysis required to keep tight parametric variances.

Design

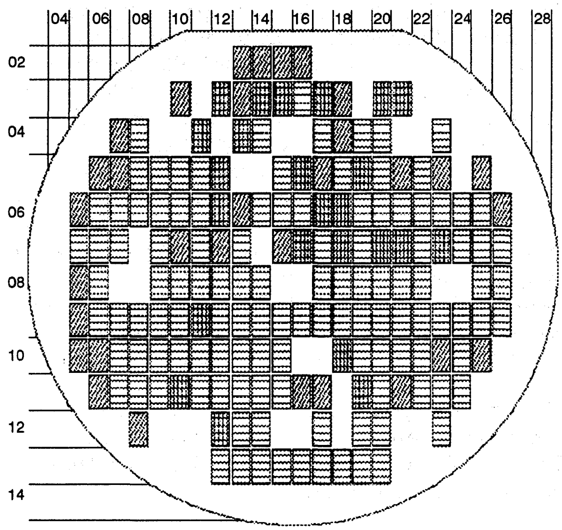
M/A-COM's IC Design Center is available for full custom design services when appropriate. This resource has extensive microwave and IC design experience. These engineers design M/A-COM's standard products and custom chip sets for commercial, government and dual-use applications - from single function MMICs to full receivers on a single chip, including hermetic and plastic packaging. Design rules to support Volume Added Production are used in most designs.

Foundry Service

M/A-COM foundry design support provides access to an extensive active and passive library of equivalent circuit models to enable accurate small signal and large signal simulations. In a standard foundry run, the customer supplies M/A- COM with circuit layouts arranged into a reticle to shorten the design cycle and increase the probability of an error free layout. The physical representation of the library elements is provided on a GDS2 formatted media. A design manual documenting the electrical and geometric design rules is provided with the purchase of a run at no charge.

IC Product Manufacturing/Test

Transferring a wafer of MMIC die into a product (to specifications) is an important area in which M/A-COM has placed much focus. Product in die form, packaged or assembled onto carriers are all provided in a dedicated test and assembly work center. 100% on-wafer testing for DC, small signal and noise on up to six ports, large signal, or pulsed power characteristics enables performance verification.



Assembly of ICs into packages or carriers is performed using automated epoxy dispense, pick-and-place, and wire bonding equipment with pattern recognition. ADAP sealer provides a highly controlled high yield batch die solder process. A voice recognition system is used in the visual inspection process allowing a real time data base of visual screening information closing the feedback loop on the process line. Burn-in and life test capability is utilized. Multi-up fixturing techniques and probe stations mounted with pattern recognition systems enable automated carrier electrical testing using the same equipment, hence the same capabilities as the on- wafer testing.

Quality

M/A-COM qualifies foundry wafers using process control monitor (PCM) parameters and sample mechanical test. A minimum of nine PCM sites are arranged in the center 2.5 inches of the 3 inch wafers. For each process, DC and FET equivalent circuit parameters are specified. The qualification criteria is that the fraction of the sites which fall within the specified limits must be 75% for each parameter.

A bond pull, die shear, high temperature stress, and a back metal tape test is also performed for mechanical qualification on all wafers. A five piece sample is used for each test, one device from each quadrant and one from the center of the wafer, except the tape test, which is a ten piece sample, two from each location.

The bond pull test has each device epoxied to a carrier and three mil ribbon bonds are made to bond pads. A pull force greater than five grams is the acceptance specification. Die shear samples are soldered to carriers, then epoxied on to a glass slide. The devices are sheared and screened in accordance with MIL-STD-883 METHOD 2019. The high temperature qualification is done on a hotplate at 300C for one minute. The samples are inspected for discoloration or any abnormalities that resulted from temperature stress. The ten piece tape test sample is mounted on a glass slide using wax and cleaned before Scotch brand 720 tape is applied to the backside of the chips. The tape is removed after three minutes and inspected for lifted backside metal.

100% visual inspections of customer circuits comply with MIL-STD-883 METHOD 2010B as a standard. Commercial grade inspections may also be implemented per customer requirements.

Reliability

SPC is fully utilized. M/A-COM is currently charting both DC and RF parameters to ensure consistent performance. Reliability engineering continues to monitor the three production processes. Device MTTF of 2 x 108 hours at 125C have been demonstrated.

Materials

M/A-COM is the largest domestic producer of GaAs materials. These materials are used by the IC design center as a benefit of our Vertical Integration Capability.

Products

The following pages represent existing released standard IC product; chip and package MMICs. Many of the packaged products are available through distribution. Please contact your local M/A-COM Sales Engineer if you require MIL-883 Screening, selected performance via a source control drawing or ASIC applications.

Application Note

GMIC™ Technology

(Glass Microwave Integrated Circuit) M501

Current Status

GMIC Technology currently is available with many standard circuits and powerful design tools. M/A-COM maintains a comprehensive library of characterized elements and well defined equivalent circuit models. The new lab is well equipped and staffed with the personnel to support the design and production requirements of many of the programs within and outside M/A-COM.

In addition to these on-line capabilities, GMIC is evolving through continued development programs to reduce costs further with larger wafer formats and automation, and to expand the product base with improved performance and commercial packaging. These R&D efforts will benefit all users and in no way obsolete designs that are implemented using the current process.

So What is GMIC?

Basically, GMIC is a new design and manufacturing technology for microwave circuits that has been developed and patented by M/A-COM. It provides a high level of repeatability, high performance, and low manufacturing costs through the use of wafer level processing to generate all of the common passive components and structures on a substrate that incorporates a dielectric layer (glass) and a carrier layer (silicon). A cross section of the GMIC substrate is illustrated in Figure 1.

Elements to note in Figure 1 are the use of the thin film capacitors, airbridge inductors, resistors and airbridges. The via holes, which are chemically etched, are used for contact to the ground plane between the glass and the silicon and also for mounting most of the semiconductors to the silicon carrier for good heat sinking. The silicon is heavily doped for good electrical conductivity and provides the chassis ground.

Some of the advantages of GMIC are obvious while others are more subtle. Since all of the passive elements are generated using thin film wafer level processing, there is a dramatic reduction in the number of piece parts needed and assembly time is greatly reduced. By improving automation, many manufacturing variables are also minimized, leading to a highly reproducible and more reliable product.

Other attributes of GMIC result from the integrated silicon carrier. Once the substrate has been fabricated, the subsequent assembly (insertion of the semiconductors) can be performed at wafer level because the devices are mounted to the silicon base.

Wire bonding and even RF testing can be performed on the intact GMIC wafer as well. These procedures can be automated more easily in GMIC since *individual circuit* handling is eliminated.

GMIC CROSS SECTION

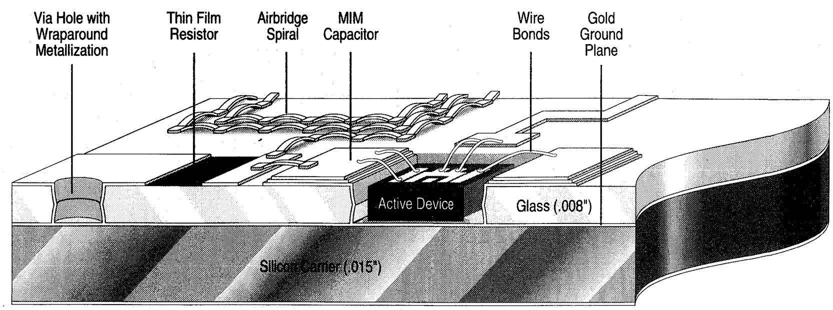


FIGURE 1.

The benefits of this technology are also found in the design phase. The high level of reproducibility has allowed M/A-COM to create an accurate design library that can be used for initial circuit design. There are element models for inductors, capacitors, via holes and airbridges as well as S-Parameter files for many characterized components. This library eliminates many of the uncertainties involved in design and has proven its value in many first iteration successes.

The completed GMICs are mechanically rugged and can be integrated into higher level assemblies with either epoxy or with an approved solder process. Interconnections between different GMICs maintain high performance standards because the overall .023" thick GMIC circuit presents very little discontinuity. These characteristics allow complex functions to be generated from multiple GMICs or a combination of GMICs and other circuit technologies.

For additional information on GMIC technology, an Application Note entitled "A True Low Cost High Volume Microwave Circuit/Multichip Module Technology: GMIC," is available from M/A-COM.

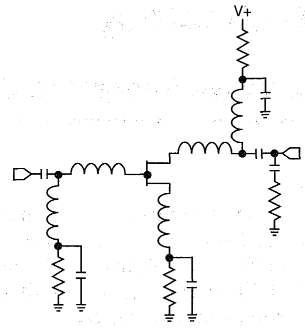
Why and When GMIC?

Perhaps the best way to describe some of the performance and integration advantages of GMIC is to examine some of the recent results obtained with the use of this technology.

Let us start with an LNA circuit that was developed recently for a GPS receiver. This application has a high volume potential (hundreds of thousands), and the requirements for size, ruggedness, performance (less than 1.0 dB NF, better than 1:1.3 VSWR at 1.575 GHz), are challenging. All of this needs to be accomplished at very low cost.

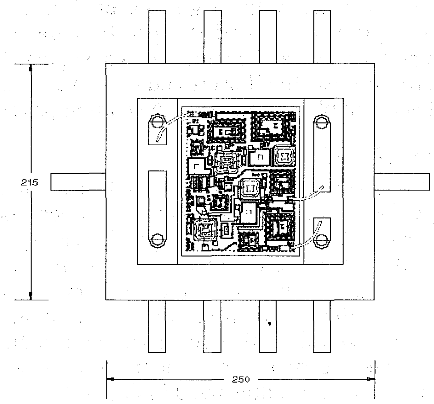
Initially, a MMIC approach was suggested, but there were no commercially available devices that met the performance criteria. M/A-COM tackled the problem by using off-the-shelf discrete GaAs FETs in a GMIC design for low cost and a quick design cycle. The use of GMIC simplifies automated bonding and can accommodate many low cost package configurations.

To balance the cost and performance, a single-ended design with source feedback was carried out using the models available in the GMIC Design Library. The final circuit schematic, shown in Figure 2, is 105 by 135 mils and over three hundred of them easily fit on a single wafer. The circuits met all of the requirements with the initial design.



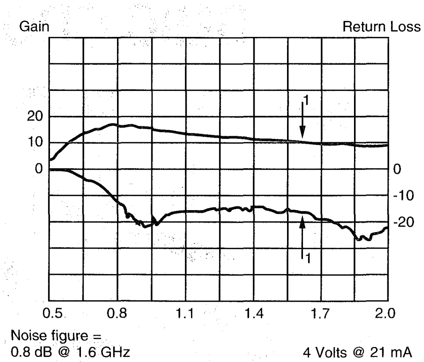
1.57 GHz Low Noise Amplifier Schematic
Noise Figure = .8 dB @ 1.6 GHz

FIGURE 2.



GPS Low Noise Amplifier

FIGURE 3.



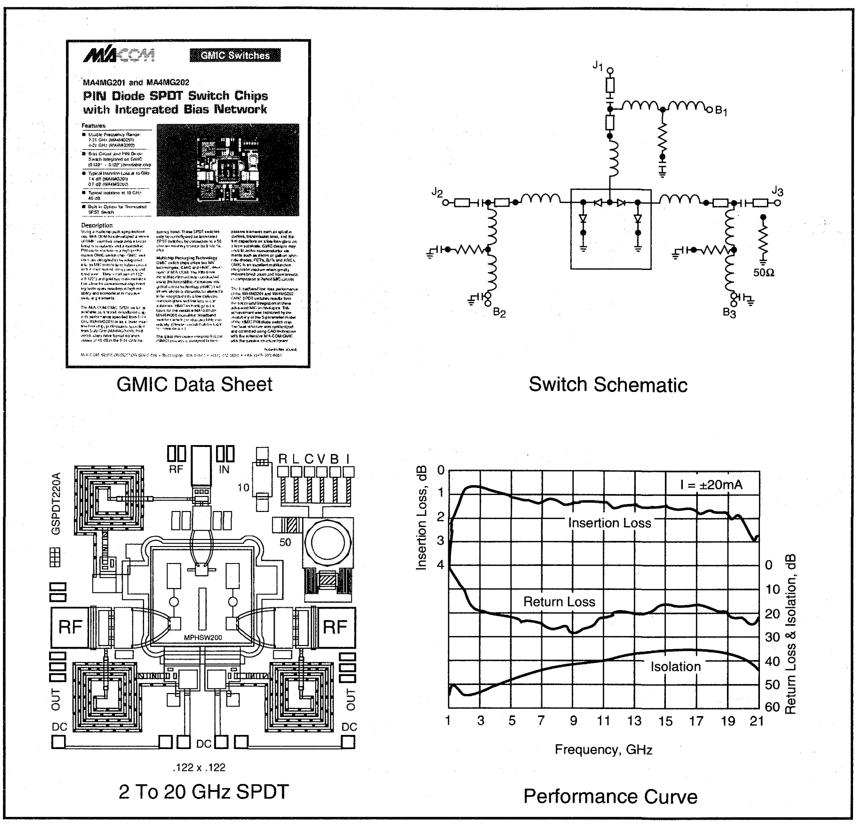
L-Band Low Noise GMIC Amplifier

FIGURE 4.

While low cost plastic packaging alternatives are investigated, a two-stage single-supply, 1 to 2 GHz version of this amplifier has been produced that has a smaller footprint than the single-stage and lower current drain. It also fits into a very low-cost surface mount ceramic package as shown in Figures 3 and 4. Several design variations using different devices were included on the original mask set to encourage competition between GaAs FET vendors for the lowest possible price.

Delivery of evaluation units to the customer was accomplished in a very short amount of time (under 10 weeks) which obviously enhances credibility for the production phase of this program.

An example of how GMIC has integrated some of the core technologies of M/A-COM is the wideband (2 to 20 GHz) GMIC switches introduced at the 1991 MTT-S. M/A-COM's PIN diode based HMIC™ (Heterolithic Microwave Integrated Circuit) SPDT chips were integrated in a GMIC which contained the wideband biasing network and terminations.



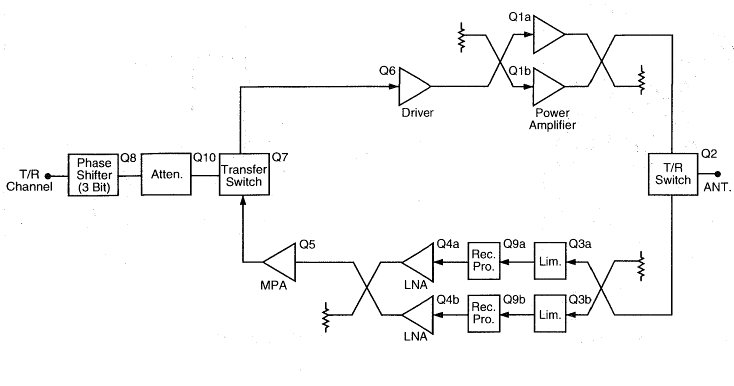
GMIC Data Sheet — Switch Schematic — 2 To 20 GHz SPDT — Performance Curve

FIGURE 5.

The actual GMIC, as shown in Figure 5, is a compact (.122" by .122") design that can be utilized in a broad range of applications. Wider bandwidth and multi-throw versions of these circuits with on-board drivers are in development to provide a full line of GMIC based switch products.

A dramatic example of subsystem integration is the X-bandTransmit/Receive module that was developed under DoD funding. This circuit contains twelve GaAs and Silicon MMICs and four discrete diodes to provide a low noise amplifier, variable gain control, phase shifting and power amplification to 2W. The entire circuit was executed on less than one square inch of GMIC substrate and the initial design met virtually all of the specifications.The physical layout plot of the module is shown on the front cover, the photo on page 8, and the block diagram in Figure 6.

In some cases GMIC has provided an integration medium for unique topologies and devices that would be difficult in any other technology. In the following example, GMIC was used to achieve low loss, high reproducibility, and extremely accurate design characteristics. The circuit is a wideband, 6-bit reflective phase shifter, shown in Figure 7, developed in support of a 6 to 18 GHz T/R module. The GMIC provides impedance matching to the PIN diodes, the required bias networks, and precision quadrature couplers. The circuit performance was excellent, with very low insertion loss (8 dB max) and phase error (3.5 deg RMS) across the 6 to 18 GHz bandwidth. The freedom to select the optimal active device and imbed it in a very predictable structure was the key to this circuit's performance.



T/R Module GMIC Test Vehicle

FIGURE 6.

GMIC is more than just an "integrator." The technology also offers some unique advantages at the component level. Coupled line structures often benefit from the precision lithography and low dielectric constant, and high impedance (in excess of 150 ohms) transmission lines can easily be realized. The use of airbridges on a low dielectric constant substrate supports lumped elements with very low stray capacitance and can greatly reduce the number of bondwires required in most circuits. The overall effect is more predictable high frequency performance, considerably less assembly effort and better reliability.

With all these performance and manufacturing advantages, GMIC can be a powerful medium for a broad range of applications.

Is There a GMIC Foundry?

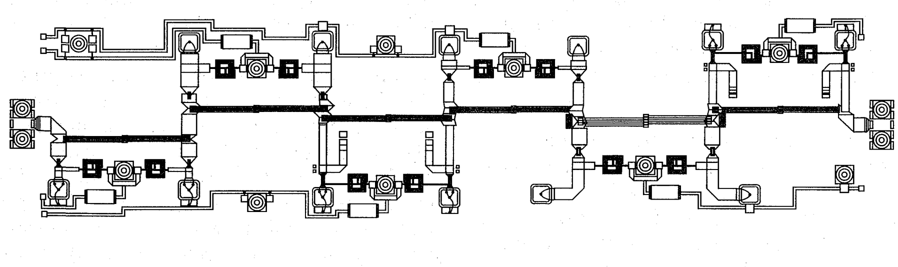
M/A-COM's GMIC fabrication facility serves as an internal foundry for other M/A-COM program/product groups and is not directly accessible to outside customers. M/A-COM does, however, work closely with customers on the development of custom circuits covering a broad scope of applications. This is usually arranged in cooperation with one or more of the product groups to provide the specific engineering expertise required to support a given requirement.

This sort of relationship has been used to provide products ranging from simple components to multifunction assemblies integrating customer specified MMIC chip sets. GMIC products developed with customer funding are strictly proprietary and can be supplied as open modules or in packaged form.

Facilities Description

The M/A-COM GMIC operation is housed in a shared facility where most IC based design and production activities take place.

In the IC Design Center, the ideas of the design engineers are carefully evaluated and transformed into circuit layouts. M/A-COM's engineering staff has many years of cumulative experience with expertise in amplifiers, switches, filters and subsystems and the tools to apply the knowledge to GMIC; and also to silicon and GaAs MMICs.



6 To 18 GHz 6-Bit Phase Shifter

FIGURE 7.

Specifications Subject to Change Without Notice

CONSIDER GMIC THE NEXT TIME:

1. ***You have an immediate need for a sure-shot design and deliverable circuits within months.***
2. ***You have a complex application with high volume potential and pricing is critical***
3. ***You have several MMICs and/or discrete devices that need to be integrated in a manufacturable, high performance motherboard.***
4. ***You need to reduce the circuit size without compromising performance.***
5. ***You would like to use a MMIC but can not live with the development cost, design time, or performance limitations.***
6. ***You need a production ready component quickly. (There are a broad range of GMIC designs on the shelf.)***

Industry standard microwave design software is enhanced by an extensive library of custom circuit component models and data files that greatly increases the accuracy of circuit simulation. Layout is performed on one of several networked workstations using highly customized CAD programs. The layout software incorporates a physical layout library of commonly used elements and the associated design rules. Experienced designers quickly use the custom subroutines and library elements to create mask-ready designs.

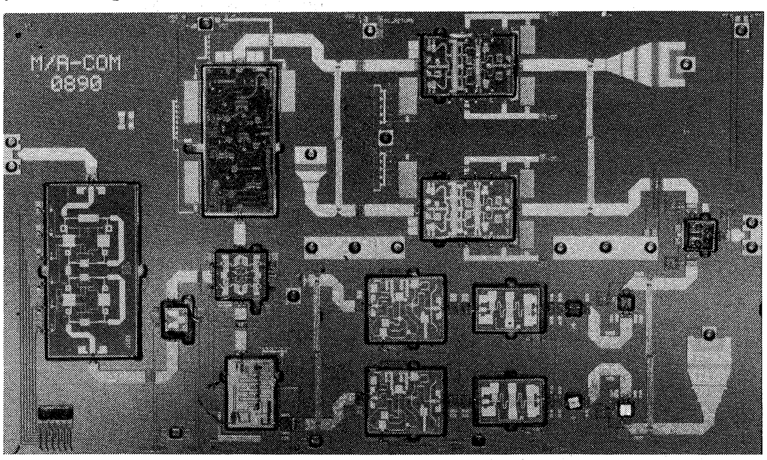
Bare glass and silicon wafers are processed into the completed GMICs in the Wafer Fabrication Lab. The Class 100 clean room is equipped with a wide range of equipment to support sputtering, CVD, plating, etching, photolithography and the other essential thin film processes.

In the the Test Lab, wafers are probed, prototypes are assembled, and the final yields and performance are unveiled. With automated DC and Microwave probing, measurement and hybrid assembly equipment, this lab is well equipped and staffed to evaluate a broad range of microwave functions.

Projects and products that do not require engineering development are handled by the Volume Automated Process (VAP) area. Through this process, GMIC wafers are assembled, tested, screened, diced, inspected, sorted and packaged by automated equipment with minimal manual labor involved.

What Does the Future Hold for GMIC?

GMIC provides a powerful new dimension to microwave circuit design and manufacturing. The highly reproducible fabrication techniques have allowed the refinement of design libraries and models to a level where the circuit performance most always matches the predicted results. This reduces development costs and brings new products to the market more quickly. Design flexibility is maximized by the ability to use whatever active devices are appropriate (the best junction for the function) such as rugged silicon PIN diodes in combination with sensitive GaAs FETs.



GMIC Technology...
Solutions for tomorrow's world

Specifications Subject to Change Without Notice

GaAs SPST Switch
DC-2.5 GHz

SW-259

Features

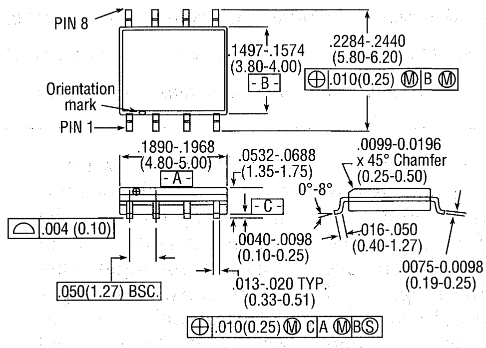
- Very Low Power Consumption: 50 μW
- Low Insertion Loss: 1.0 dB
- High Isolation: 35 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to + 85°C
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-259 is a GaAs MMIC SPST terminated switch in a low cost SOIC 8-LD 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)

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.

Ordering Information

Model No.	Package
SW-259 PIN	SOIC 8 Lead
SW-259TR	Forward Tape & Reel
SW-259RTR	Reverse Tape & Reel

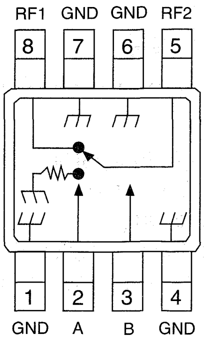
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

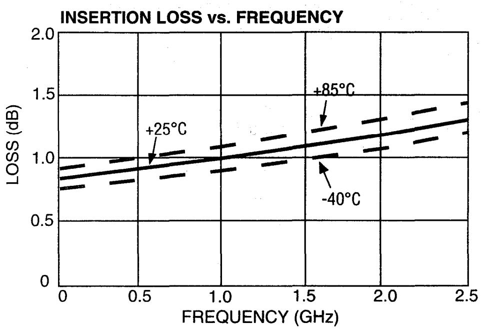
Parameter	Absolute Maximum[1,2]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2 GHz	+34 dBm
Control Voltage	+5V, -8.5V
Storage Temperature	-65°C to 150°C

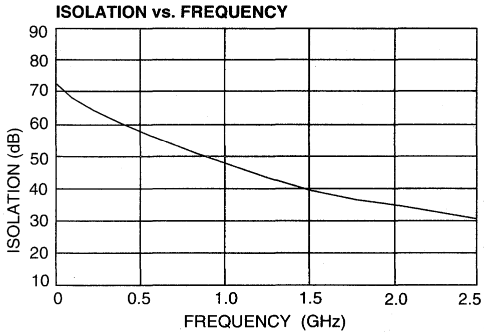
Notes:
1. Operation of this device above any one of these parameters may cause permanent damage
2. When the RF Input power is applied to a terminated port, the absolute maximum is +32 dBm.

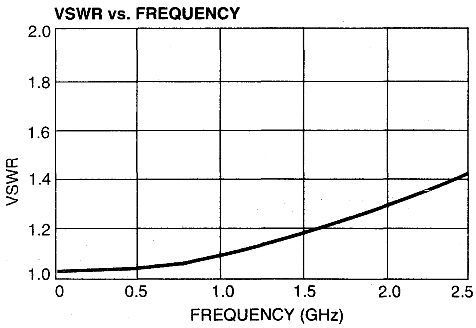
Functional Schematic



Typical Performance







Pin Configuration

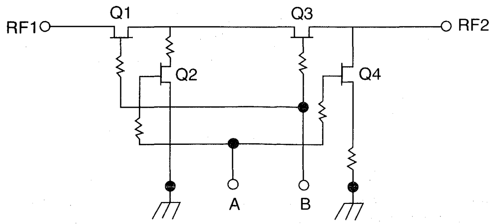
Pin No.	Description
1	GND
2	A
3	B
4	GND
5	RF2
6	GND
7	GND
8	RF1

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



GaAs SPST Matched Switch
GaAs SPST Matched Switch 0.6–1.1 GHz

NEW July '93 **SW-349**

Features

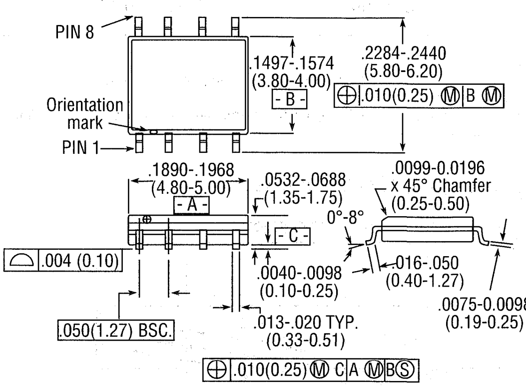
- Operates with +3 volts control
- Very Low Power Consumption
- Matched Input and Output
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-349 is a GaAs MMIC SPST terminated switch in a low cost SOIC 8-LD surface mount plastic package. The SW-349 is ideally suited for use where very low power consumption and +3 volt operation is required. Typical applications include RF blanking function, portable systems such as: phone and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-349 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)

Electrical Specifications, $T_A = 25°C$

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	0.6 – 1.1 GHz	dB		0.9	
Isolation	0.6 – 0.95 GHz 0.6 – 1.1 GHz	dB dB		30 25	
VSWR	On 0.6 – 1.1 GHz Off 0.6 – 1.1 GHz			1.4:1 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		20 40 20	
One dB Compression Point	Input Power (+3 volt) 0.6 – 1.1 GHz Input Power (+5 volt) 0.6 – 1.1 GHz	dBm dBm		17 25	
2nd Order Intercept	Measured Relative +3V 0.6 – 1.1 GHz to Input Power +5V 0.6 – 1.1 GHz (for two-tone input power up to +5 dBm)	dBm dBm		61 65	
3rd Order Intercept	Measured Relative +3V 0.6 – 1.1 GHz to Input Power +5V 0.6 – 1.1 GHz (for two-tone input power up to +5 dBm)	dBm dBm		38 43	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements with 0, +3 control voltages at 1 GHz in a 50Ω system, unless otherwise specified. The RF ports must be blocked outside of the package from ground or any other voltage.

Ordering Information

Model No.	Package
SW-349 PIN	SOIC 8 Lead
SW-349TR	Forward Tape & Reel
SW-349RTR	Reverse Tape & Reel

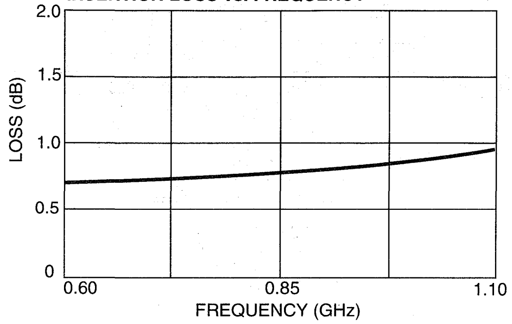
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

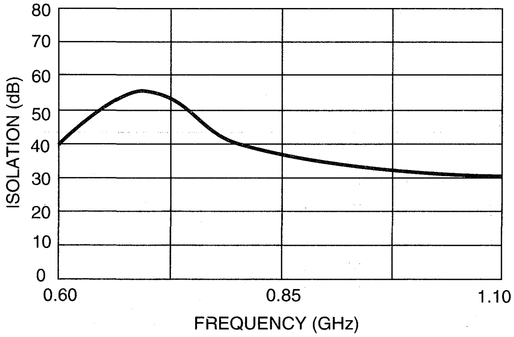
Parameter	Absolute Maximum
Max. Input Power	
0.6 – 1.1 GHz @ 3 v	+23 dBm
0.6 – 1.1 GHz @ 5 v	+28 dBm
Control Voltage	+8V
Operating Temperature	-40°C to 85°C
Storage Temperature	-65°C to 150°C

Typical Performance

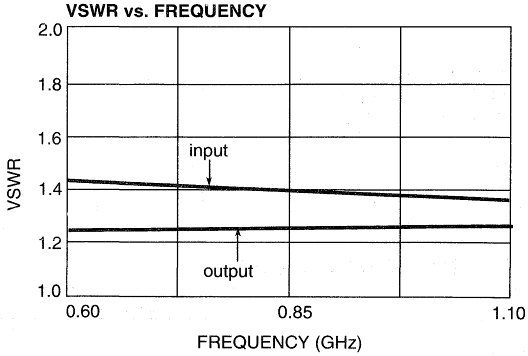
INSERTION LOSS vs. FREQUENCY



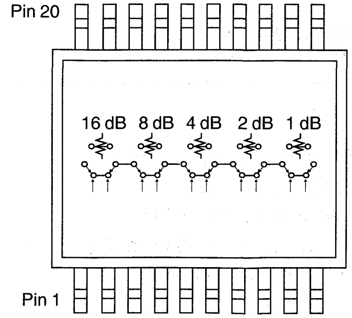
ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Functional Schematic



Pin Configuration

Pin No.	Description
1	GND
2	V_S[1]
3	RF1[2]
4	GND
5	GND
6	V_C
7	GND
8	RF[2]

1. V_S = +3 Volts
2. External DC blocks required

Truth Table

V_C[3]	RF-RF1
0	ON
+3	OFF

3. If V_C is 0 and +5, V_S must be +5 Volts.

GaAs SPDT Switch
DC-2.5 GHz

SW-239

Features

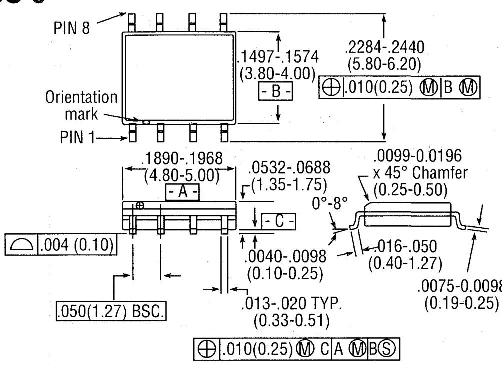
- Very Low Power Consumption: 50 μW
- Low Insertion Loss: 0.5 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40˚C to + 85˚C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

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.

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, 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 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, -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

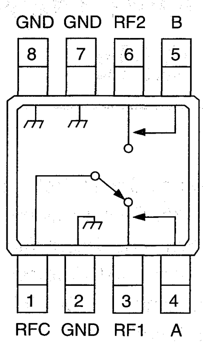
Specifications Subject to Change Without Notice

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

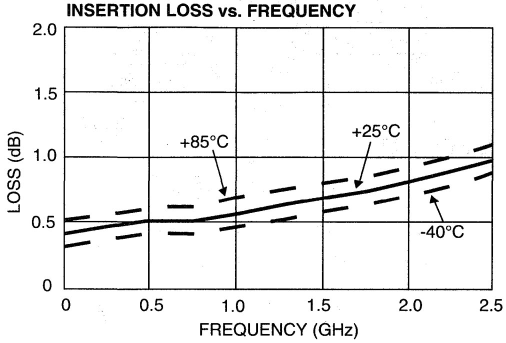
Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic

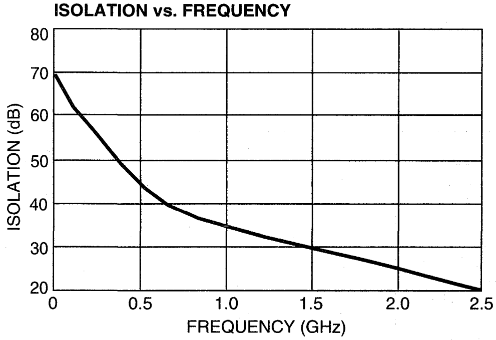


Typical Performance

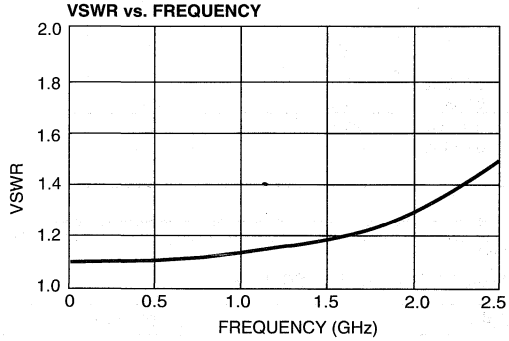
INSERTION LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Pin Configuration

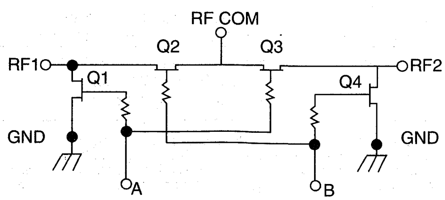
Pin No.	Description
1	RF Common
2	GND
3	RFI
4	A
5	B
6	RF2
7	GND
8	GND

Truth Table

Control 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



Specifications Subject to Change Without Notice

High Power GaAs SPDT Switch
High Power GaAs SPDT Switch DC–2.5 GHz

SW-277

Features

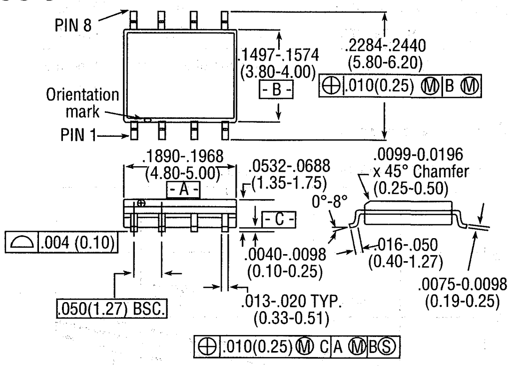
- Positive Supply and Control Voltages
- +36 dBm Typ. 1 dB Compression Point, 8V Supply
- +65 dBm Typ. 3rd Order Intercept Point, 8V Supply
- Low Insertion Loss: 0.4 dB Typical
- Low Power Consumption: 100 µW
- Fast Switching Speed
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-277 is a GaAs MMIC SPDT switch in a low cost SOIC 8-LD 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)

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.

Ordering Information

Model No.	Package
SW-277 PIN	SOIC 8 Lead
SW-277TR	Forward Tape & Reel
SW-277RTR	Reverse Tape & Reel

Specifications Subject to Change Without Notice

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	

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. T_{CASE} is the temperature of leads 1 and 4.

Two Tone IP3 Measurements

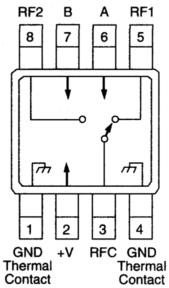
Supply & Control Voltage	Input Power (dBm)	3rd Order Intermodulation Products (dBc)	IP3 (dBm)	Second Harmonic (dBc)
0,5V	+27	-32	+43	-74
0,6V	+27	-45	+49.5	-77
0,7V	+27	-58	+56	-79
0,8V	+27	-72	+63	-79
0,10V	+27	-72	+63	-81
0,5V	+28	-30	+43	-69
0,6V	+28	-40	+48	-76
0,7V	+28	-53	+54.5	-78
0,8V	+28	-64	+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



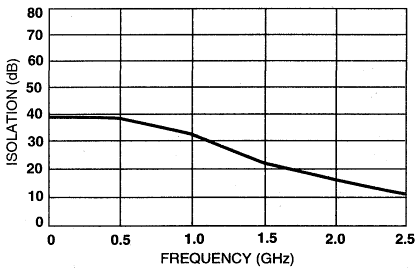
Truth Table

Control Inputs		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	Off	On
0	1	On	Off

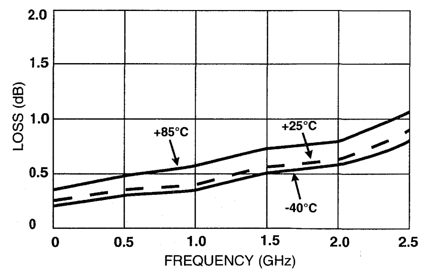
"0" – 0 to +0.2V @ 20 µA max.
"1" – +5V @ 20 µA Typ to 10V @ 500 µA max..

Typical Performance

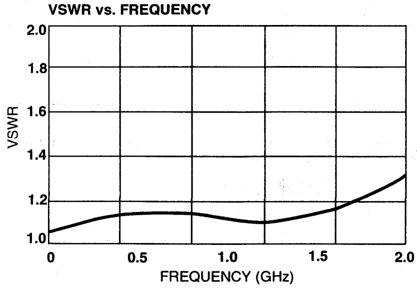
ISOLATION vs. FREQUENCY



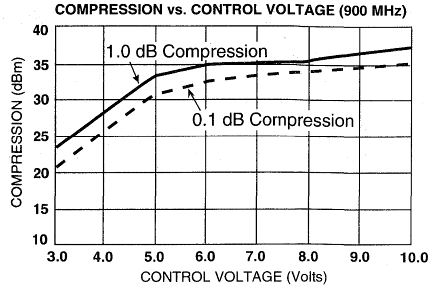
INSERTION LOSS vs. FREQUENCY



VSWR vs. FREQUENCY



COMPRESSION vs. CONTROL VOLTAGE (900 MHz)



M/A-COM

High Power GaAs SPDT Switch DC–2.5 GHz

SW-279

Features

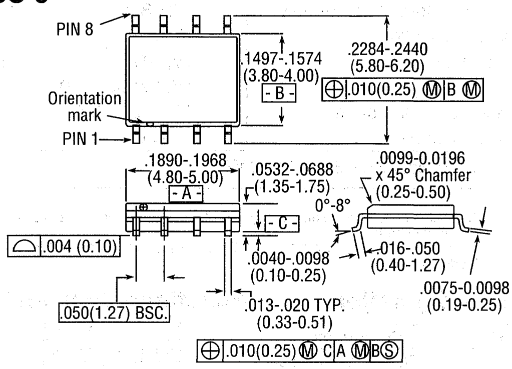
- +36 dBm Typ. 1 dB Compression Point, -8V Supply
- +65 dBm Typ. 3rd Order Intercept Point, -8V Supply
- Low Insertion Loss: 0.4 dB Typical
- Low Power Consumption: 100 µW
- Fast Switching Speed
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-279 is a GaAs MMIC SPDT switch in a low cost SOIC 8-LD 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)

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 0.3 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	15 25 33 60	18 29 36 63	
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 Control) 0.9 GHz Input Power (-8V Control) 0.9 GHz	dBm dBm		33 36	
3rd Order Intercept	Measured Relative (-5V Control) 0.9 GHz to Input Power (-8V 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 1 watt) handling specifications apply to cold switching only. For input powers under 1 watt, hot switching can be used.

Ordering Information

Model No.	Package
SW-279 PIN	SOIC 8 Lead
SW-279TR	Forward Tape & Reel
SW-279RTR	Reverse Tape & Reel

Specifications Subject to Change Without Notice

Absolute Maximum Ratings

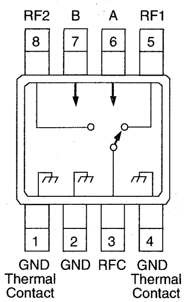
Parameter	Absolute Maximum[1]
Max. Input Power	
0.5 – 2.0 GHz	
5V Control and Supply	+37 dBm
8V Control and Supply	+40 dBm
10V Control and Supply	+42 dBm
Power Dissipation	1.0 W
Control Voltage	-12V, +1V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C
Thermal Resistance[2]: θ_{jc} = 87 °C/W	

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. T_{CASE} is the temperature of leads 1 and 4.

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



Two Tone IP3 Measurements

Bias Voltage	Input Power (dBm)	3rd Order Intermodulation Products (dBC)	IP3 (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

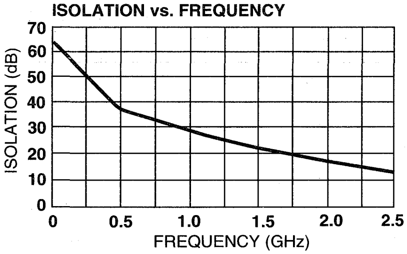
Truth Table

Control Inputs[1]		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1	0	On	Off
0	1	Off	On

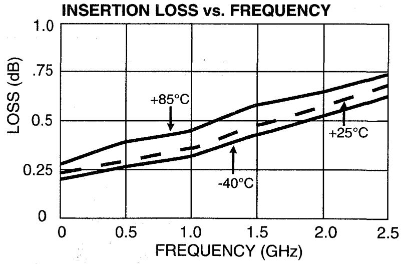
1. 0 – 0 to -0.2V @ 20 μA max.
1 – -5V @ 50 μA Typ to -10V @ 800 μA max.

Typical Performance

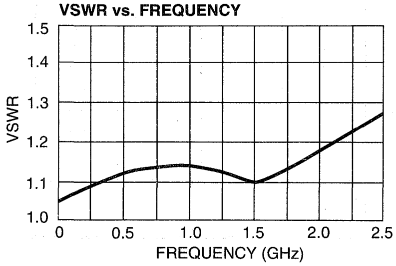
ISOLATION vs. FREQUENCY



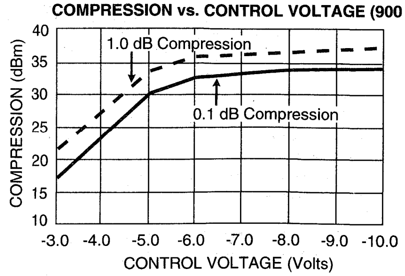
INSERTION LOSS vs. FREQUENCY



VSWR vs. FREQUENCY



COMPRESSION vs. CONTROL VOLTAGE (900 MHz)



GaAs SPDT Terminated Switch
DC–2.5 GHz

SW-338, SW-339

Features

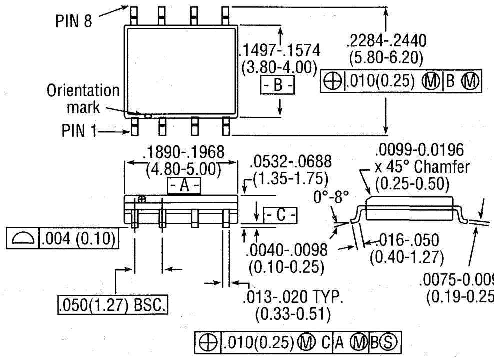
- Very Low Power Consumption: 75 μW
- Low Insertion Loss: 0.5 dB
- High Isolation: 33 dB up to 2 GHz (SW-338)
  28 dB up to 2 GHz (SW-339)
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-338 and SW-339 are GaAs MMIC SPDT terminated switches in a low cost SOIC 8-LD 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

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, TA = 25°C

			SW-338			SW-339		
Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max	Min.	Typ.	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 Compression Point	Input Power 0.05 GHz	dBm		25			25	
	Input Power 0.5 – 2.0 GHz	dBm		30			30	
2nd Order Intercept	Measured Relative 0.05 GHz	dBm		60			60	
	to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm		65			65	
3rd Order Intercept	Measured Relative 0.05 GHz	dBm		40			40	
	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

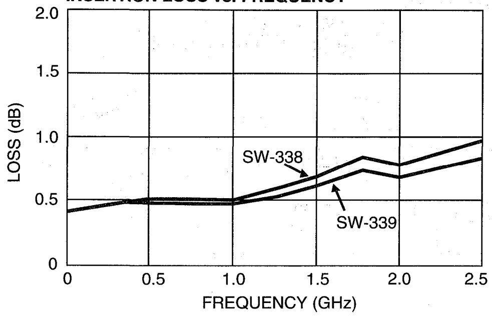
Absolute Maximum Ratings

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

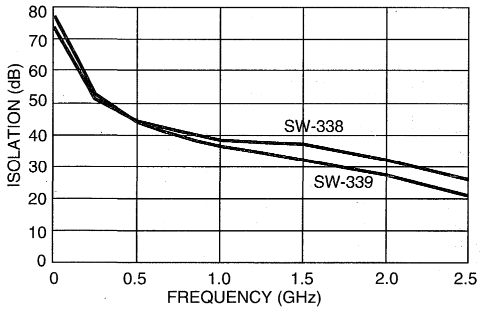
Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Typical Performances

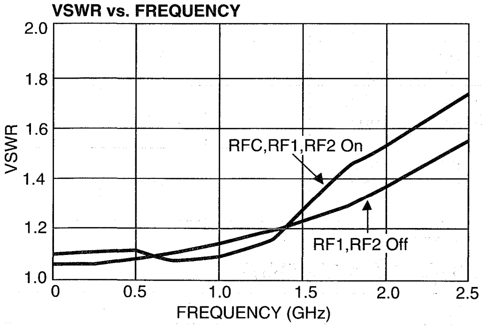
INSERTION LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY

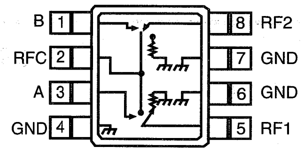


VSWR vs. FREQUENCY

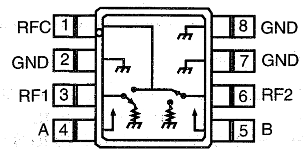


Functional Schematics

SW-338



SW-339



Pin Configurations

SW-338

Pin No.	Description
1	B
2	RF Common
3	A
4	GND
5	RF1
6	GND
7	GND
8	RF2

SW-339

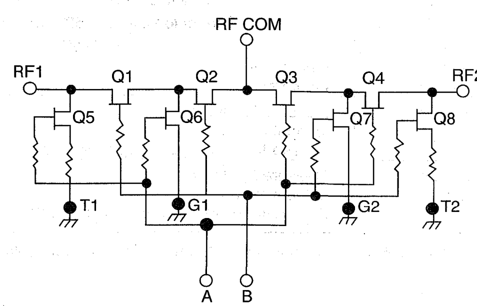
Pin No.	Description
1	RF Common
2	GND
3	RFI
4	A
5	B
6	RF2
7	GND
8	GND

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

GaAs SPDT Switch
DC–3 GHz

SW-328

Features

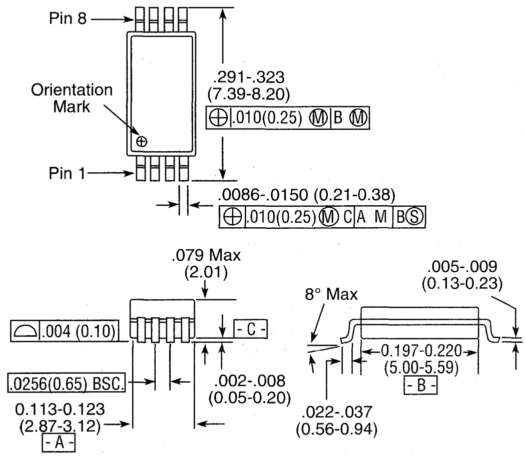
- Very Low Power Consumption: 50 µW
- Low Insertion Loss: 0.5 dB
- High Isolation: 20 dB up to 3 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40˚C to + 85˚C
- Low Cost SSOP8 Plastic Package

Description

M/A-COM's SW-328 is a GaAs MMIC SPDT switch in a low cost SSOP 8-LD 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.

SSO-8



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± .010 (.xx = ±0.25)
.xx = ± 0.02 (.x = ± 0.5)

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[1]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz DC – 3.0 GHz	dB dB dB dB		0.4 0.4 0.6 0.6	0.6 0.6 0.8 1.0
Isolation	DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz DC – 3.0 GHz	dB dB dB dB	42 33 22 15	46 37 25 18	
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		2 4 15	
One dB Compression Point	Input Power 0.05 GHz Input Power 0.5 – 3.0 GHz	dBm dBm		21 27	
2nd Order Intercept	Measured Relative 0.05 GHz to Input Power 0.5 – 3.0 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 – 3.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		40 46	

1. All measurements with 0, -5V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

Ordering Information

Model No.	Package
SW-328 PIN	SSOP 8 Lead

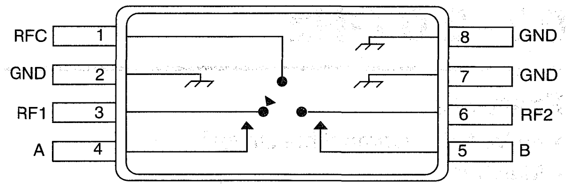
Specifications Subject to Change Without Notice

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

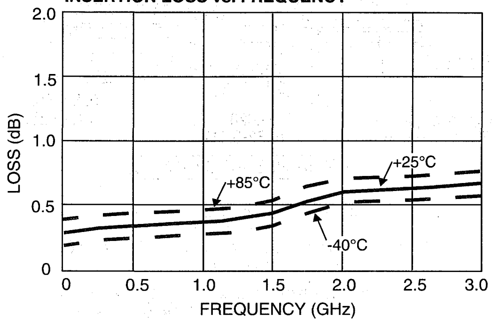
Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic

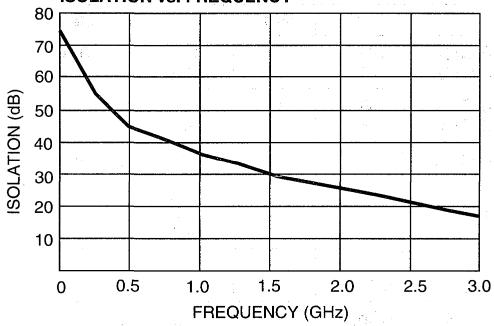


Typical Performance

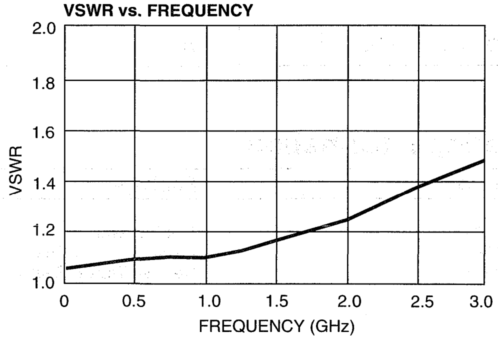
INSERTION LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Pin Configuration

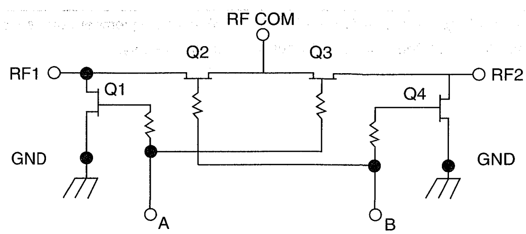
Pin No.	Description
1	RF Common
2	GND
3	RFI
4	A
5	B
6	RF2
7	GND
8	GND

Truth Table

Control Input		Condition of Switch RF Common to Each RF Port	
A	B	RF1	RF2
1 0	0 1	On Off	Off On

"0" – 0 – -0.2V @ 20 µA max.
"1" – -5V @ 20 µA Typ to -8V @ 480 µA max.

Electrical Schematic



GaAs SPDT Switch with Integral Driver 0.7–2.0 GHz

NEW July '93 **SW-329**

Features

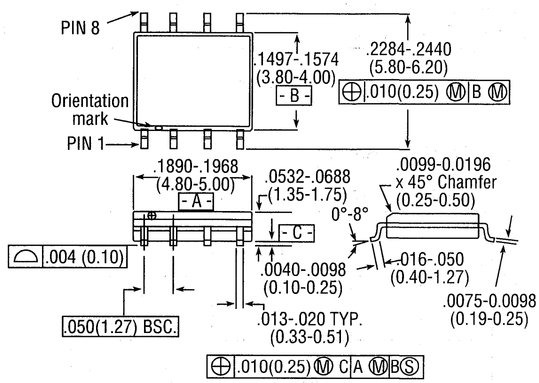
- +5 Volt TTL Compatible Driver[1]
- Matched
- Low Power Consumption, 62 mW Total Current
- Tape and Reel Packaging Available[2]

Description

M/A-COM's SW-329 is a GaAs MMIC matched SPDT switch in a low cost SOIC 8-LD surface mount plastic package.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-329 is fabricated with a GaAs MMIC. The process features a mature 1 micron process and 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)

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[1]	Unit	Min.	Typ.	Max
Insertion Loss	0.7 – 1.0 GHz 1.0 – 2.0 GHz	dB dB		0.7 0.8	0.8 1.0
Isolation	0.7 – 1.0 GHz 1.0 – 2.0 GHz	dB dB	37 32	45 35	
VSWR	0.7 – 2.0 GHz			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 µS mV		100 1.5 12	
One dB Compression Point	Input Power 0.7 – 2.0 GHz	dBm		28	
3rd Order Intercept	(for two-tone input power up to +5 dBm) 0.7 – 2.0 GHz	dBm		40	
Harmonic Distortion	+23 dBm Input 0.7 – 2.0 GHz	dBc		-70	

1. Operating voltage tolerances (+5 ± 0.25, -5 ± 0.25), operating temperature range: 0–70°C.
2. Refer to "Tape and Reel Packaging" Section, or contact factory.

Ordering Information

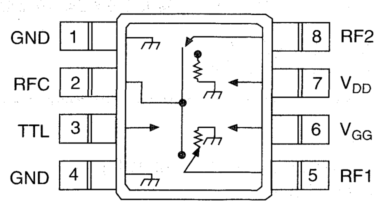
Model No.	Package
SW-329 PIN	SOIC 8 Lead
SW-329TR	Forward Tape & Reel
SW-329RTR	Reverse Tape & Reel

Revised 12/93.
Specifications Subject to Change Without Notice

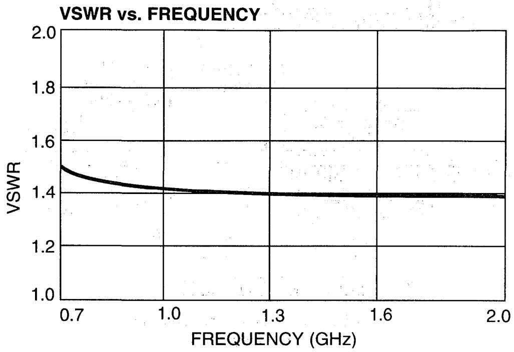
Absolute Maximum Ratings

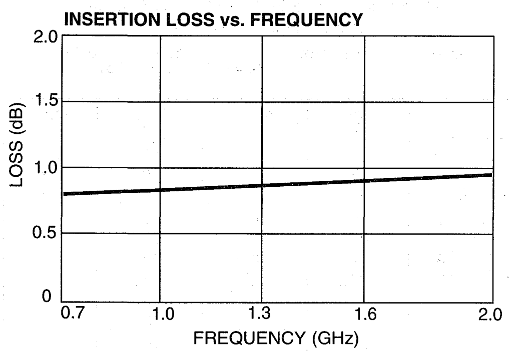
Parameter	Absolute Maximum
Max. Input Power	+33 dBm
Supply Voltage (V_{DD})	+7 volts
(V_{GG})	-7 volts
Operating Temperature	0°C to 70°C
Storage Temperature	-65°C to 150°C

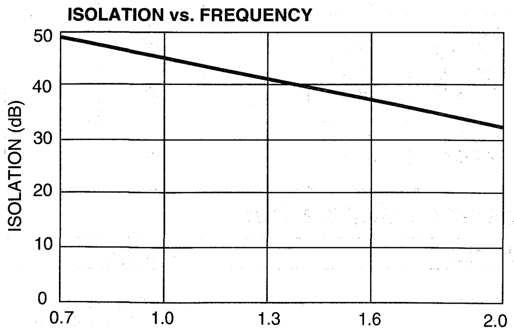
Functional Schematic



Typical Performance







Pin Configuration

Pin No.	Description
1	GND
2	RF COMMON
3	TTL INPUT
4	GND
5	RF1
6	V_{GG}
7	V_{DD}
8	RF2

Truth Table

TTL	RFC-RF2	RFC-RF1
1	Insertion Loss	Isolation
0	Isolation	Insertion Loss

LOGIC 0 = 0 to +1 Vdc
LOGIC 1 = +4 to +5 Vdc
VDD = +5.0 ± 0.25 V
VGG = -5.0 ± 0.25 V

Revised 12/93.
Specifications Subject to Change Without Notice

GaAs SP4T Terminated Switch
DC–2 GHZ

SW-419

Features

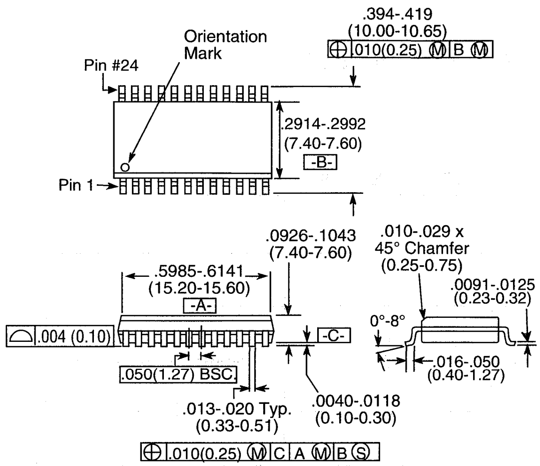
- Very Low Power Consumption: 100 μW
- Low Insertion Loss: 1 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40˚C to +85˚C
- Low Cost SOIC24 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-419 is a GaAs MMIC SP4T terminated switch in a low cost SOIC 24-LD 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)

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		0.8 0.8 0.9 1.2	1.0 1.1 1.2 1.4
Isolation	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB	54 46 36 20	60 51 39 24	
VSWR	On Off			1.3:1 1.3:1	
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 16 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 0.05 GHz to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		45 60	
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		35 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-419 PIN	SOIC 24 Lead
SW-419TR	Forward Tape & Reel
SW-419RTR	Reverse Tape & Reel

Specifications Subject to Change Without Notice

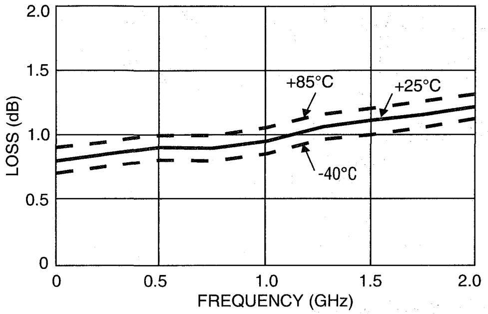
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	
Below 500 MHz	+27 dBm
Above 500 MHz	+30 dBm
Control Voltage	+5V, – 8.5 V
Storage Temperature	-65 to +150°C

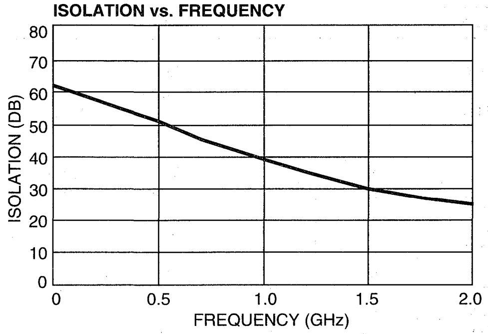
Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Typical Performance

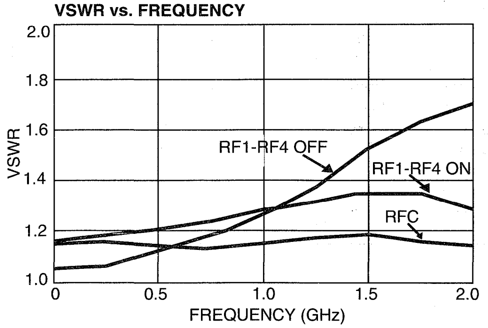
INSERTION LOSS vs. FREQUENCY



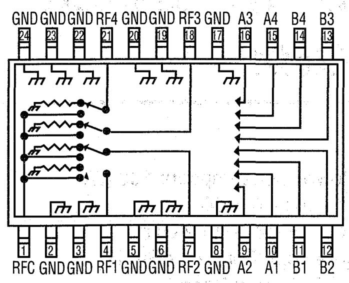
ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Functional Schematic



Pin Configuration

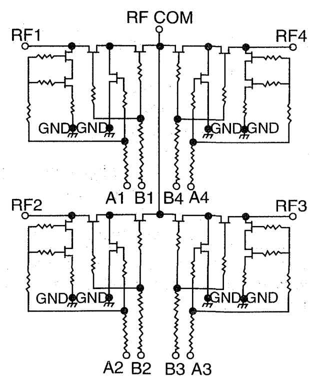
Pin No.	Description	Pin No.	Description
1	RF Common	13	B3
2	GND	14	B4
3	GND	15	A4
4	RF1	16	A3
5	GND	17	GND
6	GND	18	RF3
7	RF2	19	GND
8	GND	20	GND
9	A2	21	RF4
10	A1	22	GND
11	B1	23	GND
12	B2	24	GND

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 – -0.2V @ 20 µA max
"1" – -5V @ 20 µA Typ to -8V @ 300 µA max.

Electrical Schematic



Specifications Subject to Change Without Notice

GaAs DPDT Switch
DC–2 GHz

SW-289

Features

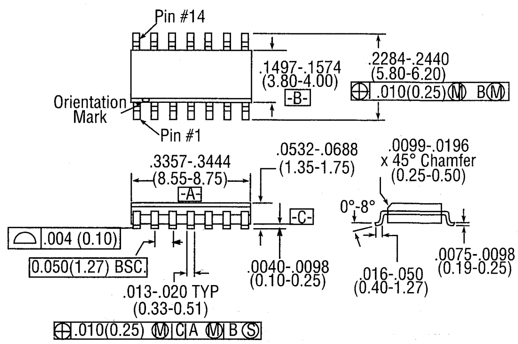
- Very Low Power Consumption: 100 μW
- Low Insertion Loss: 0.5 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 48 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40˚C to + 85˚C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-289 is a GaAs MMIC DPDT switch in a low cost SOIC 14-LD 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

Model No.	Package
SW-289 PIN	SOIC 14 Lead
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 Point	Input Power 0.05 GHz	dBm		22	
	Input Power 0.5 – 2.0 GHz	dBm		27	
2nd Order Intercept	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	
3rd Order Intercept	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, -5V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

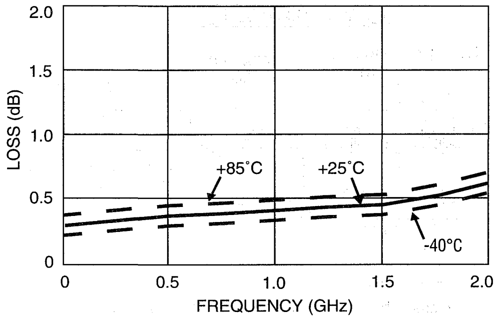
Absolute Maximum Ratings

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

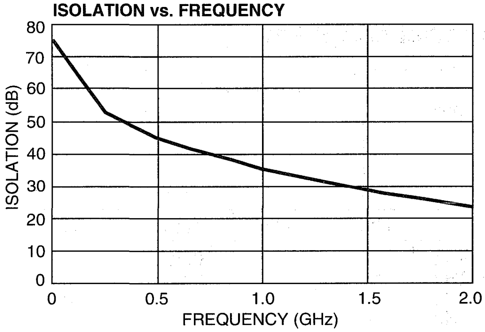
Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Typical Performance

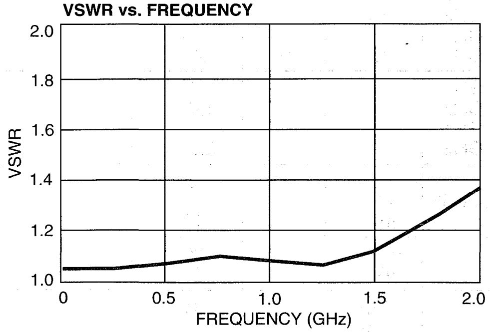
INSERTION LOSS vs. FREQUENCY



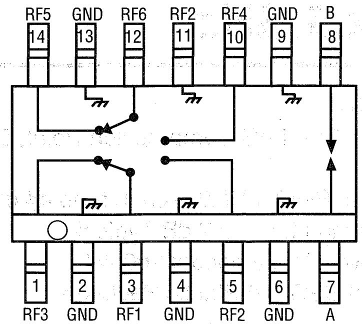
ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Functional Schematic



Pin Configuration

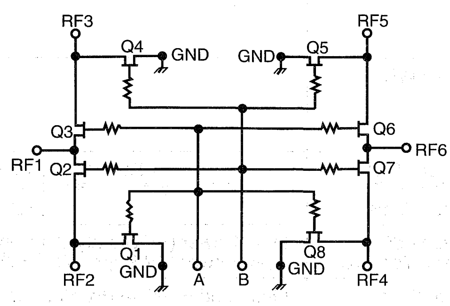
Pin No.	Description	Pin No.	Description
1	RF3	8	B
2	GND	9	GND
3	RFI	10	RF4
4	GND	11	GND
5	RF2	12	RF6
6	GND	13	GND
7	A	14	RF5

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



T/R Diversity Switch
DC–2.5 GHz

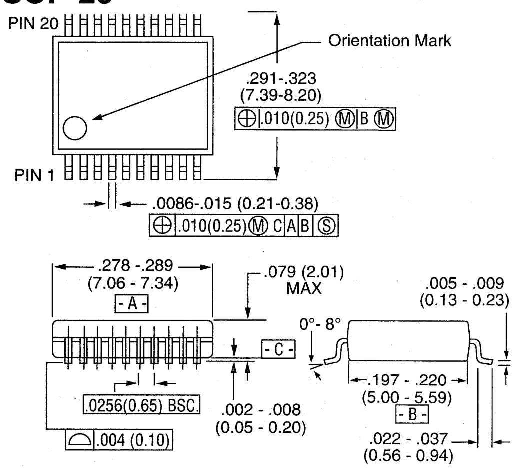
NEW July '93 **SW-923**

Features
- +36 dBm Typ. 1 dB Compression Point, 8V Supply
- Two Tone IP_3 @ 1 Watt – each tone 44 dBm
- Low Insertion Loss: 0.7 dB Typical
- Low Power Consumption: 100µW
- Low Cost SSOP20 Plastic Package

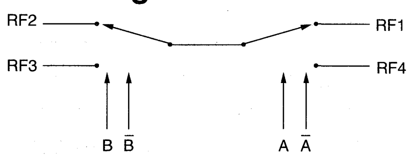
Description
M/A-COM's SW-923 is a GaAs MMIC transmit/receive antenna diversity switch for applications up to 2.5 GHz, with power levels up to 2 watts.

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

Model No.	Package
SW-923 PIN	SSOP 20 Lead

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 Point	Input Power (5V Supply/Control) 0.9 GHz Input Power (8V Supply/Control) 0.9 GHz	dBm dBm		32 36	
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	

Specifications Subject to Change Without Notice

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 (+V)	-1, +12
Control Voltage (+V)	-1, Vsupply to 0.2V
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.

IP3 Measurements with Two Tones

F1 = 0.9 GHz, F2 = 0.905 GHz

Input Power (Each Tone)	Control Voltage	3rd Order Intermodulation Product (dBc)	IP3 (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 $\bar{B}$
6	CTL $\bar{A}$	16	CTL B
7	GND	17	GND
8	RF4	18	RF2
9	GND	19	GND
10	GND	20	GND

Notes: 1. +V Supply voltage = +3V to +8V; +control voltage = +3V to +8V.
2. The high control voltage must be within ± 0.2V of the supply voltage.
3. The RF ports must be DC blocked outside of the package from ground or any other voltage.

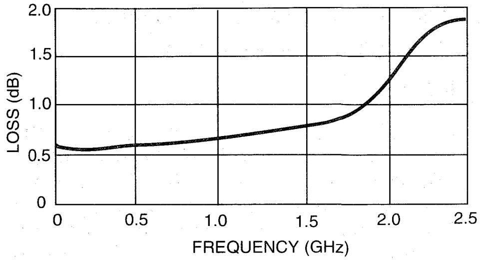
Truth Table

Control Input				RF Port			
A	$\bar{A}$	B	$\bar{B}$	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

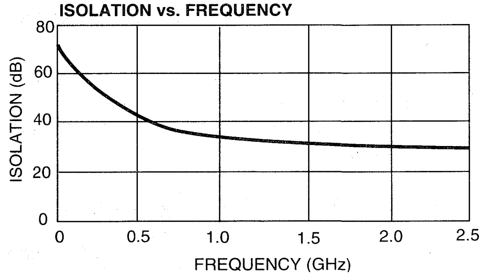
"0" = 0 to 0.2V @ 20 μA Max.
"1" = +3V @ 30 μA Typ. to +10V @ 800 μA Max.

Typical Performances

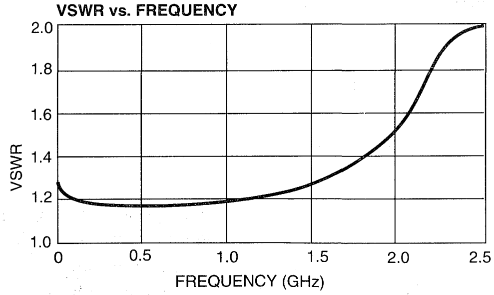
INSERTION LOSS vs. FREQUENCY



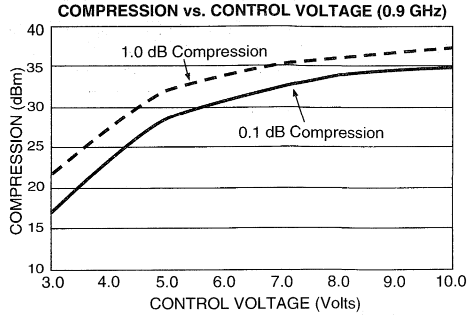
ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



COMPRESSION vs. CONTROL VOLTAGE (0.9 GHz)



Specifications Subject to Change Without Notice

High Power T/R Diversity Switch with Driver DC–2 GHz

NEW July '93 **MASW-2070G-1**

Features

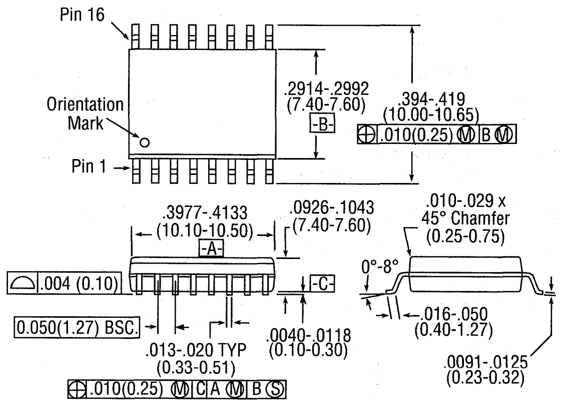
- +36 dBm Typ. 0.3 dB Compression Point, 8V Supply, @ 1.0 GHz
- -55 dBc THD @ 1 GHz, -10V, +36 dBm Pin
- Low Insertion Loss: 0.4 dB Typical
- TTL Compatible Driver with 2 Line Control
- Tape and Reel Packaging Available[1]

Description

M/A-COM's MASW-2070G-1 is a GaAs MMIC diversity switch in a low cost SOIC 16-LD surface mount plastic package. The MASW-2070G-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 MASW-2070G-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
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)

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.

Ordering Information

Model No.	Package
MASW-2070G-1	SOIC 16 Lead
MASW-2070G-1TR	Forward Tape & Reel
MASW-2070G-1RTR	Reverse Tape & Reel

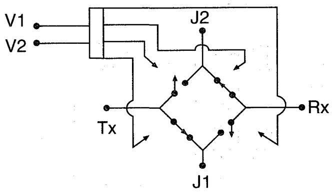
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

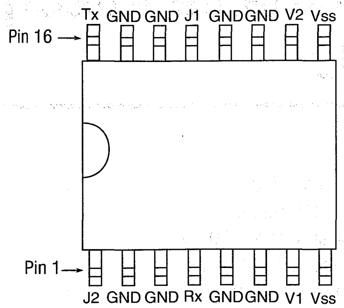
Parameter	Absolute Maximum[1]
Max. Input Power	
0.5 – 2.0 GHz	
-8V Control and Supply	+39 dBm
-10V Control and Supply	+40 dBm
-12V Control and Supply	+42 dBm
Power Dissipation	1.0 W
Operating Temperature	-40°C to 85°C
Storage Temperature	-65°C to 150°C
Thermal Resistance[2]: θ_{jc} = 87 °C/W	

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. T_{CASE} is the temperature of leads 1 and 4.

Functional Diagram



Pin Configuration

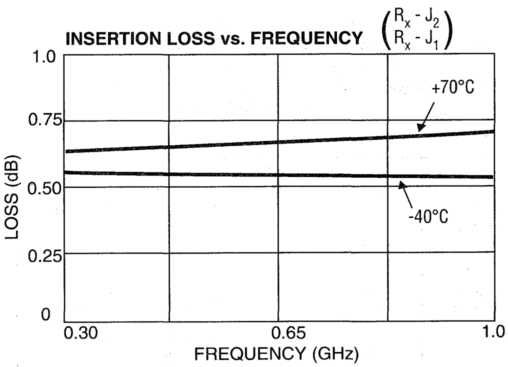


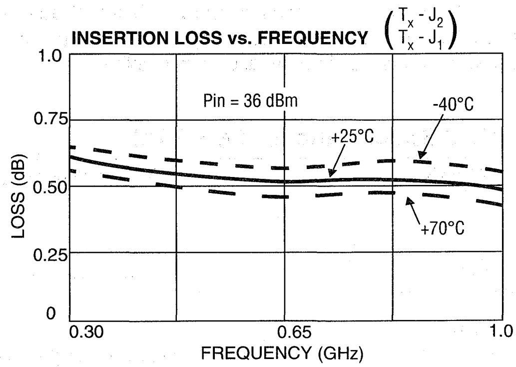
Truth Table

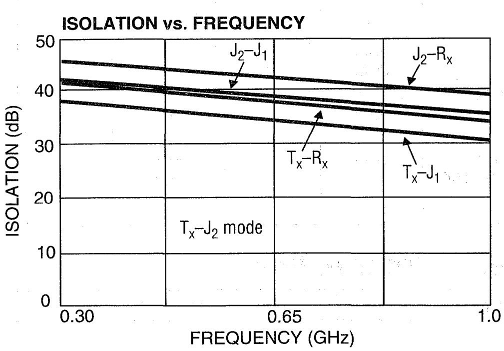
STATE	V2	V1
T_X–J_1	1	1
T_X–J_2	1	0
R_X–J_1	0	1
R_X–J_2	0	0

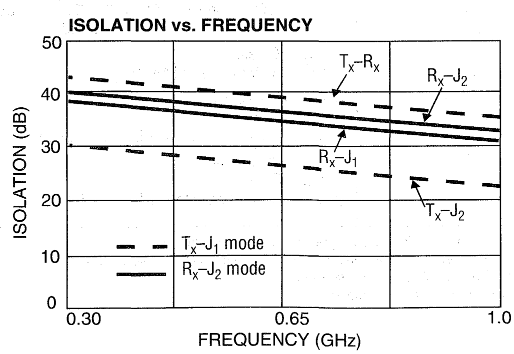
NOTE: LOGIC 0 = -8 Volts
LOGIC 1 = 0 Volts

Typical Performances









Voltage Variable Absorptive Attenuator
DC–2 GHz

AT-259

Features

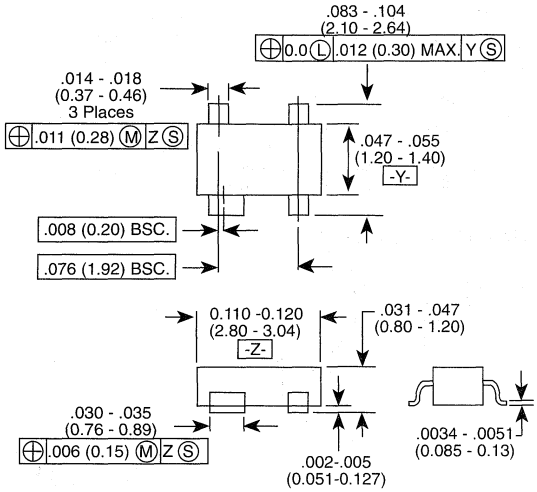
- Attenuation: 12 dB at 1 GHz
- Low Intermodulation Products
- Low DC Power Consumption: 50 µW
- Single Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to + 85°C
- Low Cost SOT143 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-259 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOT143 4-LD 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)

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 – 2.0 GHz 5 dB Attenuation 10 dB Attenuation 15 dB Attenuation	dB dB dB		± 0.2 ± 2.3 ± 7.0	± 0.4 ± 2.5 ± 7.5
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
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		34 47	
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		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 4 dB attenuation.

Ordering Information

Model No.	Package
AT-259 PIN	SOT 143
AT-259TR	Forward Tape & Reel
AT-259RTR	Reverse Tape & Reel

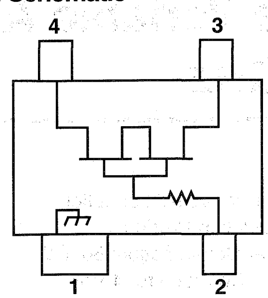
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	+21 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

Functional Schematic

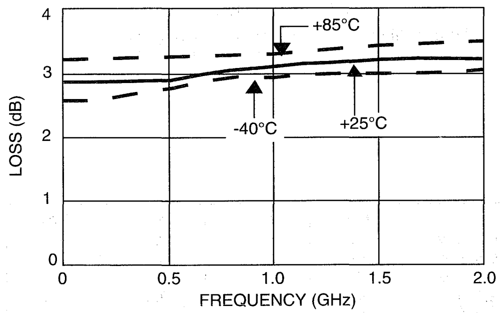


Pin Configuration

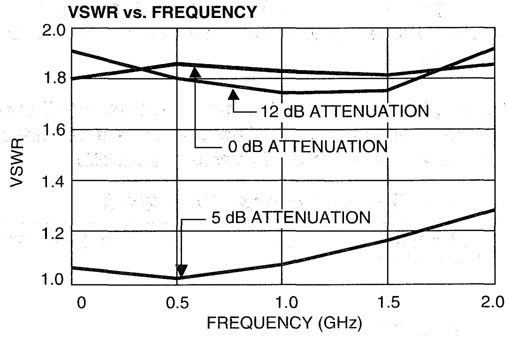
Pin No.	Description
1	GND
2	A
3	RF2
4	RF1

Typical Performance

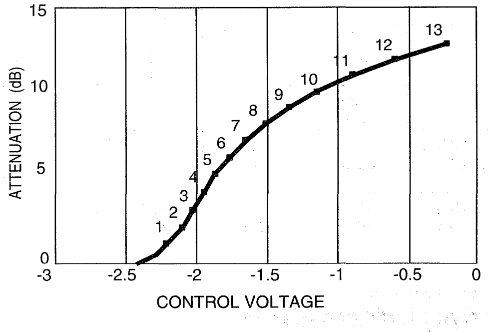
INSERTION LOSS vs. FREQUENCY



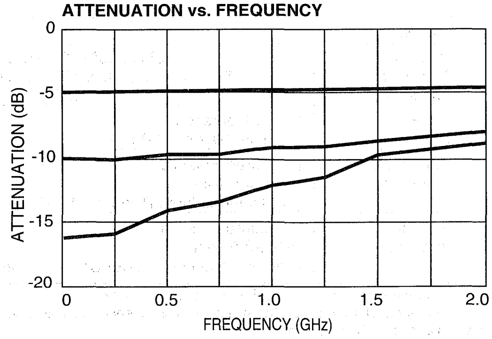
VSWR vs. FREQUENCY



CONTROL VOLTAGE vs. ATTENUATION AT 950 MHZ



ATTENUATION vs. FREQUENCY



![M/A-COM]

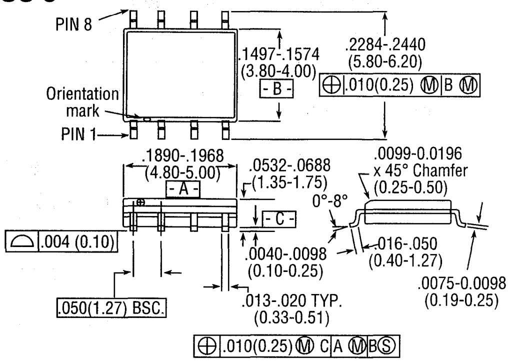
Voltage Variable Absorptive Attenuator DC–2 GHz

AT-250

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 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 AT-250 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 8-LD 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.

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
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	28 40	34 47	
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	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 4 dB attenuation.

Ordering Information

Model No.	Package
AT-250PIN	SOIC 8 Lead
AT-250TR	Forward Tape & Reel
AT-250RTR	Reverse Tape & Reel

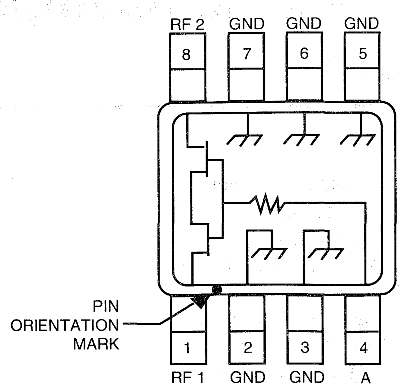
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	+21 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

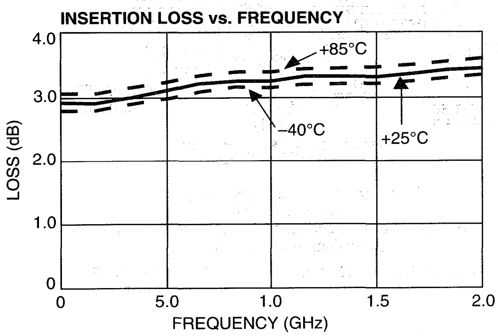
Functional Schematic

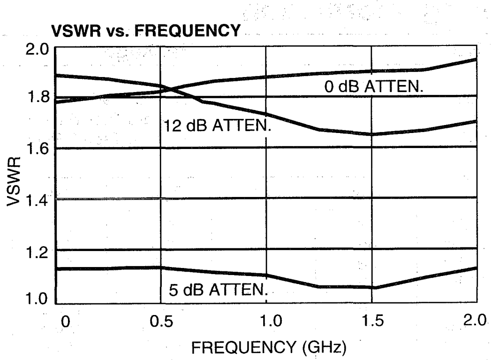


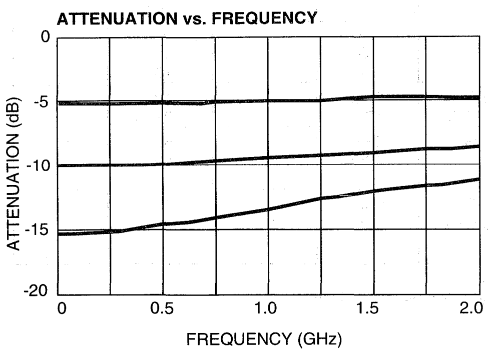
Pin Configuration

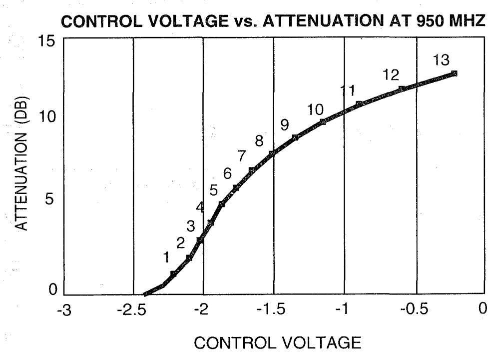
Pin No.	Description
1	RF1
2	GND
3	GND
4	A
5	GND
6	GND
7	GND
8	RF2

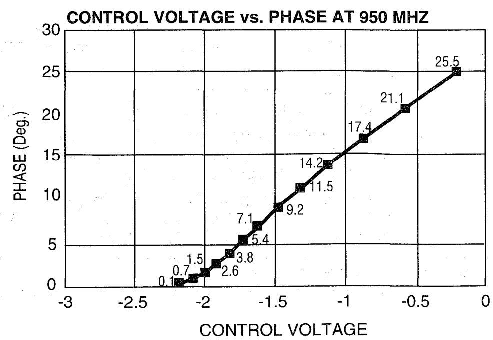
Typical Performance











Voltage Variable Absorptive Attenuator, 20 dB DC–2 GHz

AT-309

Features

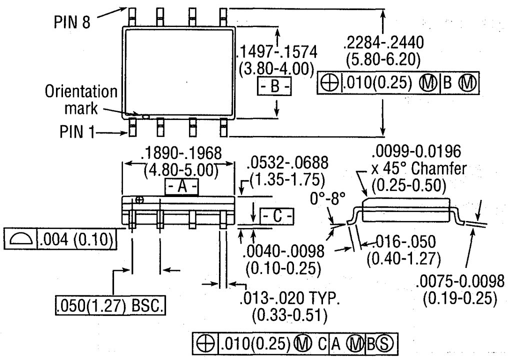
- 20 dB Voltage Variable Attenuation
- Very Low Power Consumption: 50 μW
- Low Intermodulation Products
- Dual Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-309 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 8-LD 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

Model No.	Package
AT-309 PIN	SOIC 8 Lead
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 Point	Input Power (Over Attenuation Range) 0.05 GHz Input Power (Over Attenuation Range) 0.5 – 2.0 GHz	dBm dBm		18 21	
2nd Order Intercept	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	
3rd Order Intercept	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.

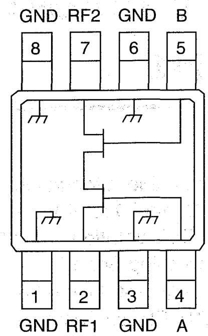
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

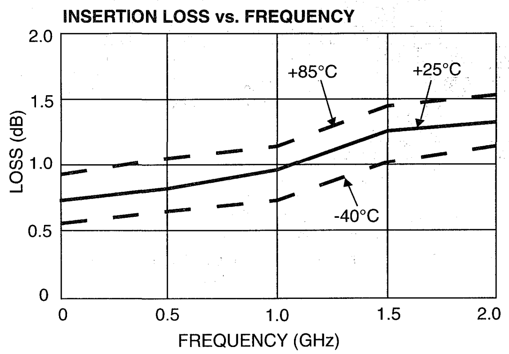
Parameter	Absolute Maximum[1]
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+30 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic

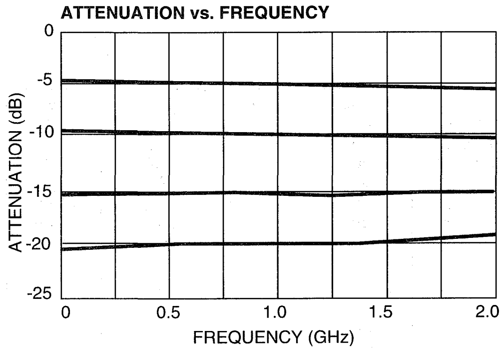


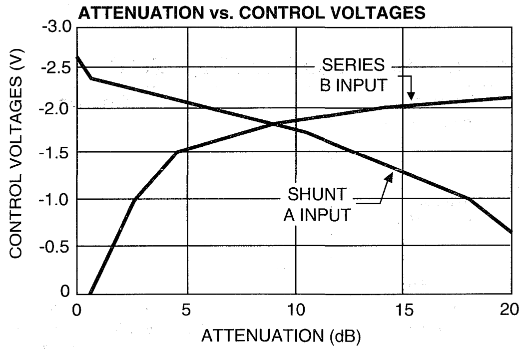
Typical Performance

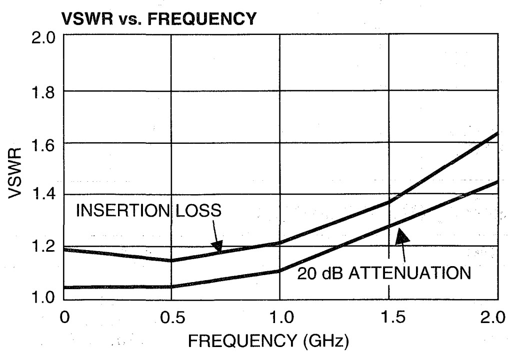


Pin Configuration

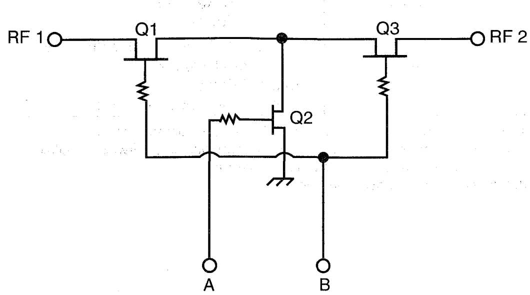
Pin No.	Description
1	GND
2	RF1
3	GND
4	A
5	B
6	GND
7	RF2
8	GND







Electrical Schematic



Voltage Variable Absorptive Attenuator, 35 dB
DC–2 GHz

AT-635

Features

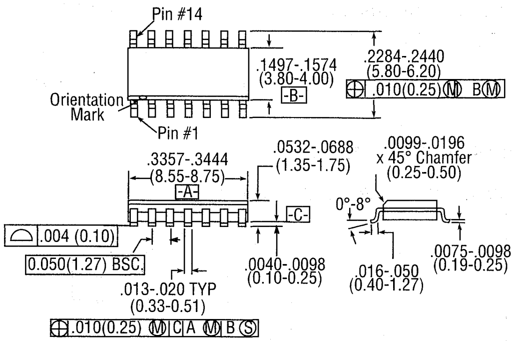
- 35 dB Voltage Variable Attenuation
- Single Voltage Control 0 to -4 Volts
- Low DC Power Consumption: 10 mW
- Nanosecond Switching Speed
- Temperature Range: -40˚C to + 85˚C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-635 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 14 LD 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)

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
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		34 47	
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		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 4 dB attenuation.

Ordering Information

Model No.	Package
AT-635 PIN	SOIC 14 Lead
AT-635TR	Forward Tape & Reel
AT-635RTR	Reverse Tape & Reel

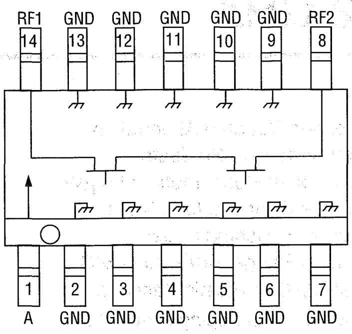
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	+21 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

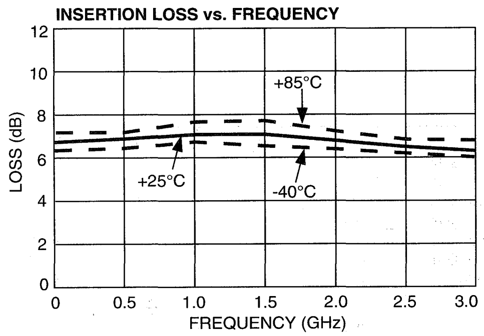
Functional Schematic

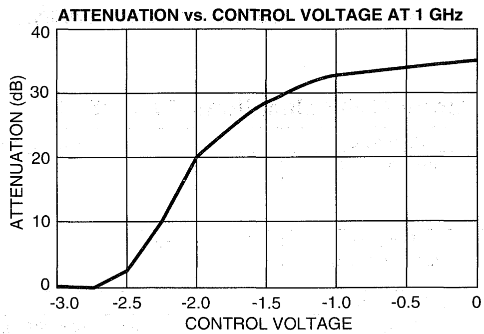


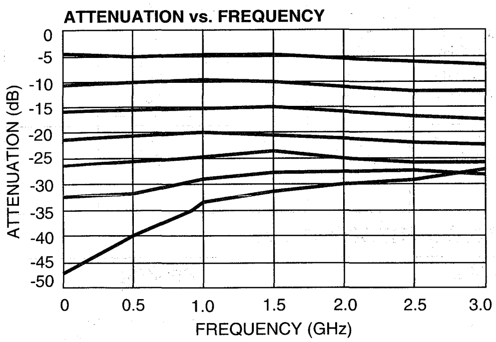
Pin Configuration

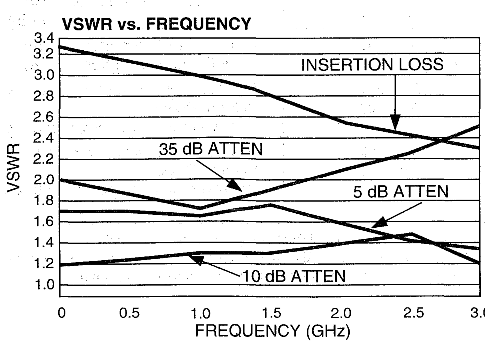
Pin No.	Description	Pin No.	Description
1	A	8	RF2
2	GND	9	GND
3	GND	10	GND
4	GND	11	GND
5	GND	12	GND
6	GND	13	GND
7	GND	14	RF1

Typical Performance









Specifications Subject to Change Without Notice

Voltage Variable Absorptive Attenuator, 40 dB DC–2 GHz

AT-339

Features

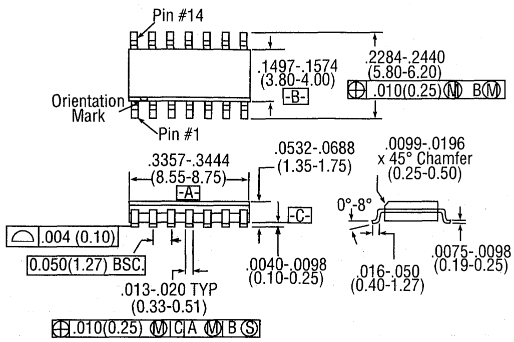
- 40 dB Voltage Variable Attenuation
- Low Intermodulation Products
- Very Low Power Consumption: 50 µW
- Dual Voltage Control 0 to -4 Volts
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-339 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 14-LD 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)

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 Point	Input Power (over atten. range) 0.05 GHz Input Power (over atten. range) 0.5 – 2.0 GHz	dBm dBm		21 27	
2nd Order Intercept	Measured Relative (over atten. range) 0.05 GHz to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	dBm dBm		39 49	
3rd Order Intercept	Measured Relative (over atten. range) 0.05 GHz to Input Power 0.5 – 2.0 GHz (for two-tone input power up to +5 dBm)	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.

Ordering Information

Model No.	Package
AT-339 PIN	SOIC 14 Lead
AT-339TR	Forward Tape & Reel
AT-339RTR	Reverse Tape & Reel

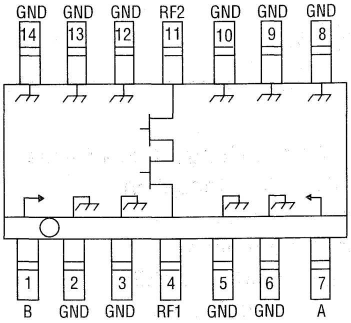
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
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

Note: 1. Operation of this device above any one of these parameters may cause permanent damage

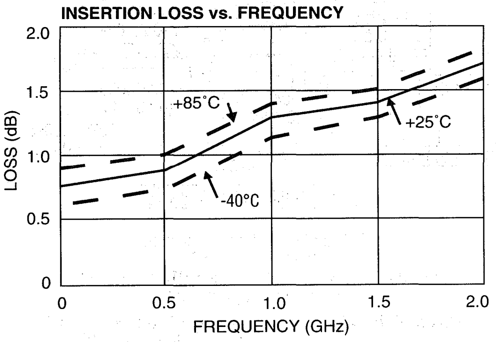
Functional Schematic

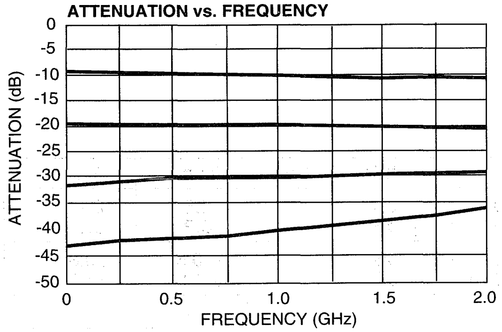


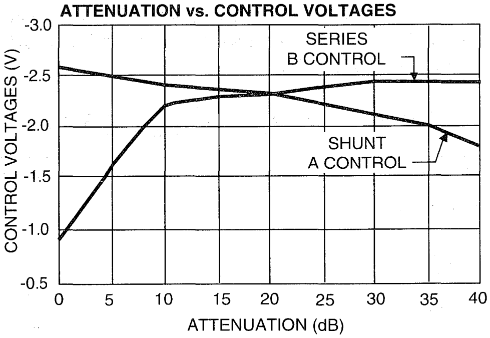
Pin Configuration

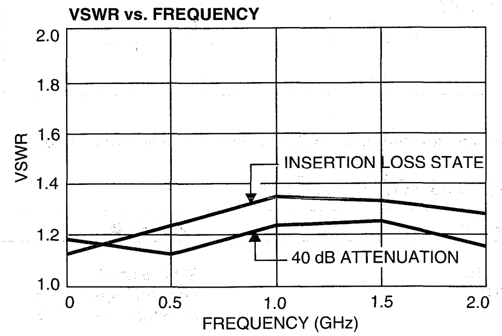
Pin No.	Description	Pin No.	Description
1	B	8	GND
2	GND	9	GND
3	GND	10	GND
4	RF1	11	RF2
5	GND	12	GND
6	GND	13	GND
7	A	14	GND

Typical Performance

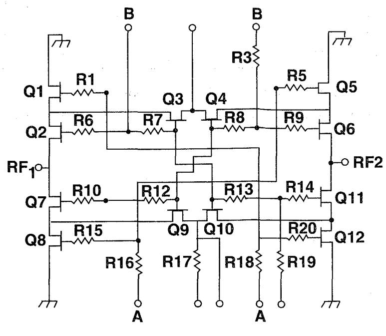








Electrical Schematic



Voltage Variable Absorptive Attenuator, 35 dB
0.5–2 GHz

NEW July '93 **AT-109**

Features

- Single Positive Voltage Control 0 to +5 volts
- 35 dB Voltage Variable Attenuation
- ± 2 dB Linearity from B.S.L.
- Low DC Power Consumption
- Temperature Range: -40°C to +85°C
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

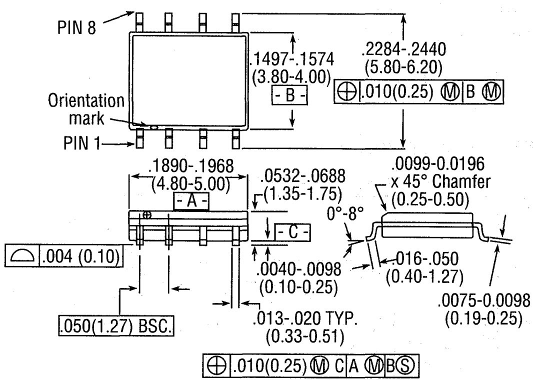
Description

M/A-COM's AT-109 is a linear GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 8-LD surface mount plastic package. The AT-109 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-109 is more linear than the higher attenuation range AT-108

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)

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[2]	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
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, 50% Control to 10% RF In Band	µS µS mV		20 40 12	
One dB Compression Point	Input Power 0.9 GHz	dBm		12	

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 RF ports must be blocked outside of the package from ground or any other voltage.

Ordering Information

Model No.	Package
AT-109 PIN	SOIC 8 Lead
AT-109TR	Forward Tape & Reel
AT-109RTR	Reverse Tape & Reel

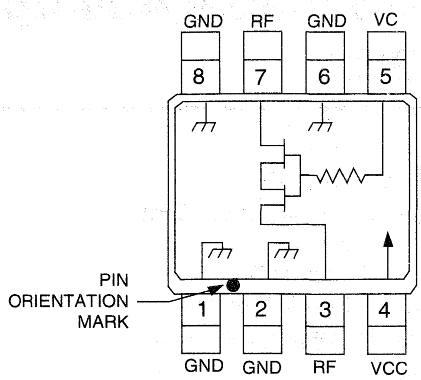
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	+21 dBm
Supply Voltage V_{CC}	-1V, +8V
Control Voltage V_C	-1V, V_{CC} +0.5V
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.

Functional Schematic



Pin Configuration

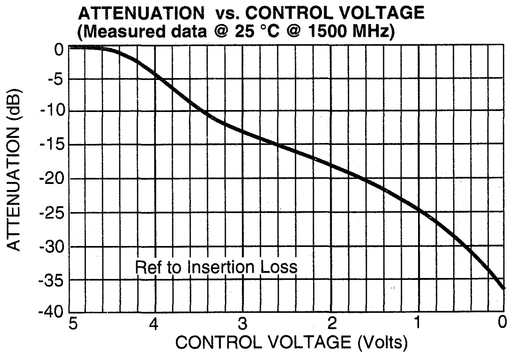
Pin No.	Description
1	GND
2	GND
3[1]	RF
4	VCC
5	VC
6	GND
7[1]	RF
8	GND

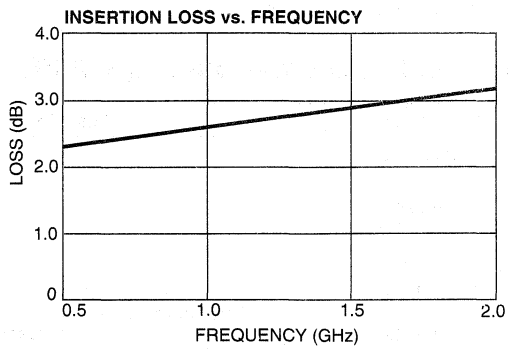
Vcc = +5 vdc ± 0.5 vdc

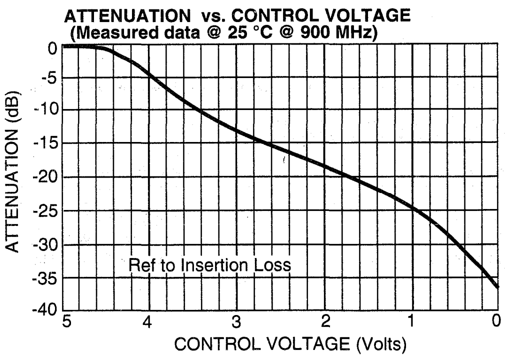
Vc = 0 vdc to +5 vdc

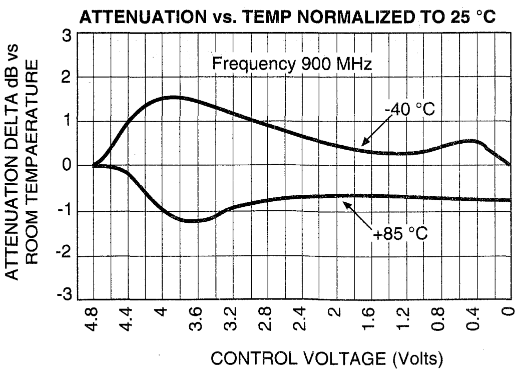
1. External DC blocking capacitors are required on RF ports

Typical Performance









Specifications Subject to Change Without Notice

![M/A-COM]

Voltage Variable Absorptive Attenuator, 40 dB 0.5–2 GHz

NEW July '93 **AT-108**

Features

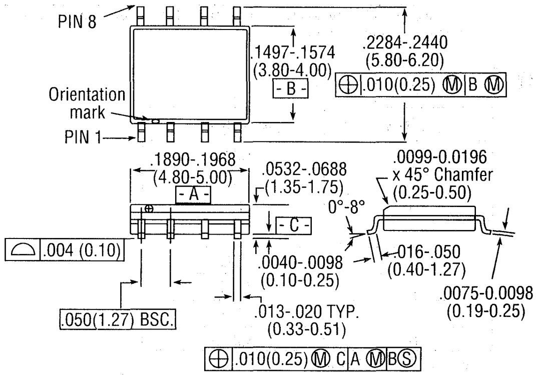
- Single Positive Voltage Control
- 40 dB Attenuation Range at 0.9 GHz
- ±2 dB Linearity from B.S.L.
- Low DC Power Consumption
- Low Cost SOIC8 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-108 is a GaAs MMIC voltage variable absorptive attenuator in a low cost SOIC 8-LD surface mount plastic package. The AT-108 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-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)

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[2]	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
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, 50% Control to 10% RF In Band	µS µS mV		20 40 12	
One dB Compression Point	0.9 GHz	dBm		12	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. The RF ports must be blocked outside of the package from ground or any other voltage. All measurements at 1 GHz in a 50 Ω system, unless otherwise specified.

Ordering Information

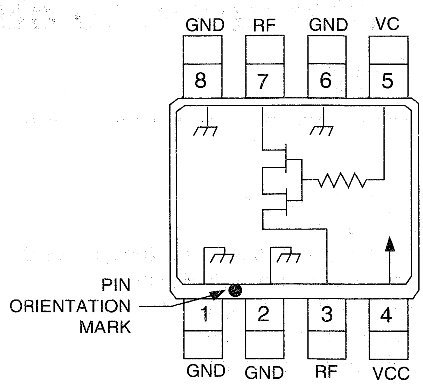
Model No.	Package
AT-108 PIN	SOIC 8 Lead
AT-108TR	Forward Tape & Reel
AT-108RTR	Reverse Tape & Reel

Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum
Max. Input Power	+21 dBm
Control Voltage V_C	-1V, V_{CC} +0.5V
Supply Voltage V_{CC}	-1V, +8V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

Functional Schematic

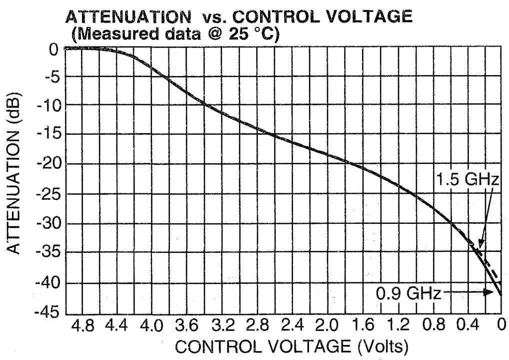


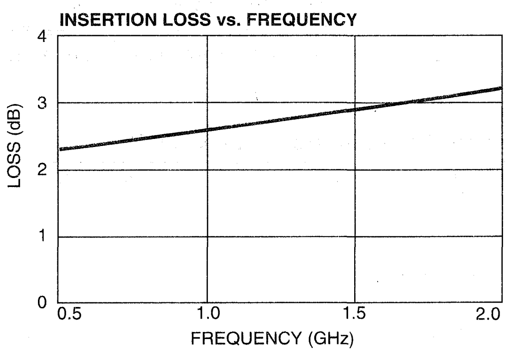
Pin Configuration

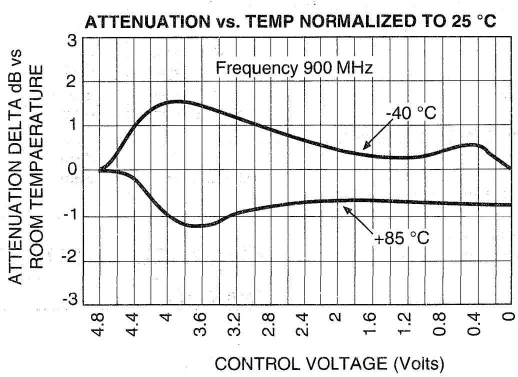
Pin No.	Description
1	GND
2	GND
3[1]	RF
4	V_{CC}
5	V_C
6	GND
7[1]	RF
8	GND

V_{CC} = +5 Vdc ± 0.5 Vdc
V_C = 0 Vdc to +5 Vdc
1. External DC blocking capacitors are required on RF ports

Typical Performance







Digital Attenuator, 15 dB, 4 Bit
DC–2 GHz

AT-210

Features

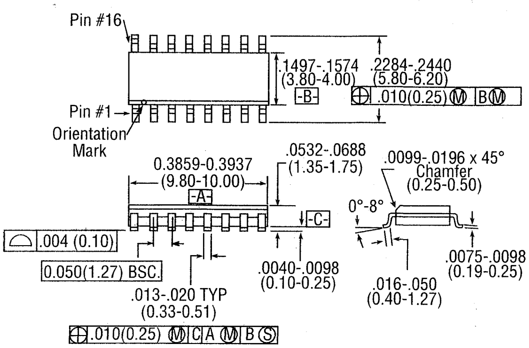
- Attenuation 1 dB Steps to 15 dB
- High Accuracy +/-3%
- Temperature Stability +/-0.15 dB from -40°C to +85°C
- Low Intermodulation Product: +50 dBm IP3
- Low DC Power Consumption: 50 μW
- Low Cost SOIC16 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-210 is a 4 bit, 1 dB step GaAs MMIC digital attenuator in a low cost SOIC 16-LD 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)

Electrical Specifications, T_A = 25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Reference Insertion Loss	DC – 0.1 GHz	dB		0.9	1.2
	DC – 0.5 GHz	dB		1.3	1.5
	DC – 1.0 GHz	dB		1.5	1.8
	DC – 2.0 GHz	dB		1.8	2.0
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				1.8:1	
Trise, Tfall	10% to 90% RF, 90% to 10% RF	nS		10	
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF	nS		15	
Transients	In Band	mV		18	
1 dB Compression Point	Input Power 0.05 GHz	dBm		22	
	Input Power 0.5 – 2.0 GHz	dBm		28	
2nd Order Intercept	Measured Relative to Input Power (For two-tone Input Power Up to +5 dBm) 0.05 GHz	dBm		49	
	0.5 – 2.0 GHz	dBm		72	
3rd Order Intercept	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		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.

Ordering Information

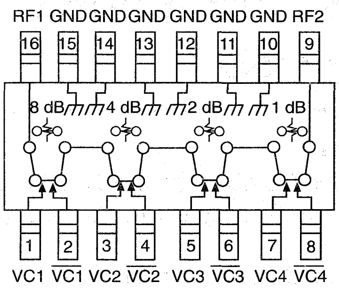
Model No.	Package
AT-210 PIN	SOIC 16 Lead
AT-210TR	Forward Tape & Reel
AT-210RTR	Reverse Tape & Reel

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
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

Note: 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

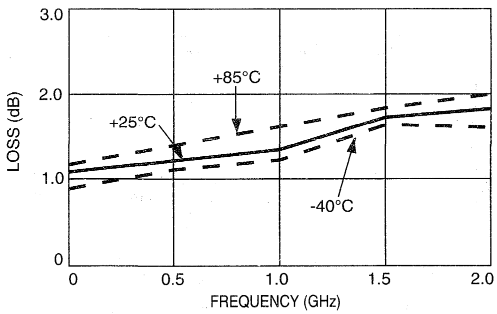
Truth Table

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

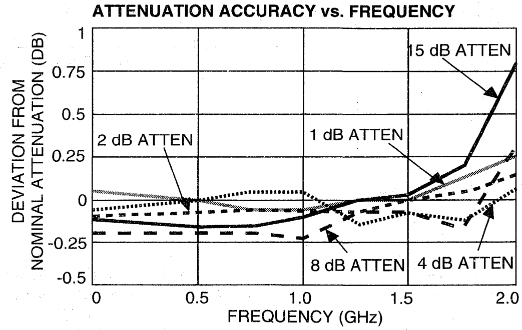
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V
"0" = 0 to -0.2V @ 20µA Max
"1" = -5V @ 10 µA typ to -8V @ 200 µA Max

Typical Performance

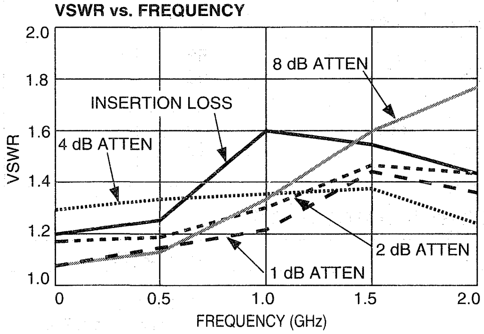
INSERTION LOSS vs. FREQUENCY



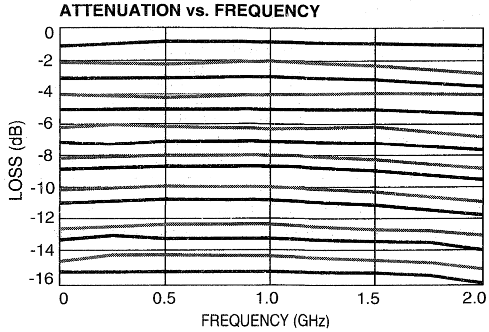
ATTENUATION ACCURACY vs. FREQUENCY



VSWR vs. FREQUENCY



ATTENUATION vs. FREQUENCY



Specifications Subject to Change Without Notice

Digital Attenuator, 15.5 dB, 5 Bit
DC–2 GHz

NEW July '93 **AT-280**

Features

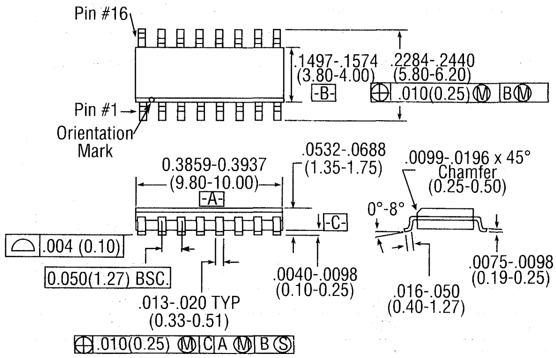
- Attenuation 0.5 dB Steps to 15.5 dB
- Temperature Stability ± 0.15 dB from -40°C to +85°C Typical
- Ultra Low DC Power Consumption
- Low Intermodulation Products, IP3: 43 dBm
- Tape and Reel Packaging Available[1]

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-LD 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)

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	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 Point	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		22 27	
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		53 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 43	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.

Ordering Information

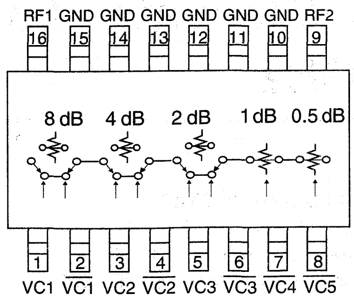
Model No.	Package
AT-280 PIN	SOIC 16 Lead
AT-280TR	Forward Tape & Reel
AT-280RTR	Reverse Tape & Reel

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.

Functional Schematic



Truth Table

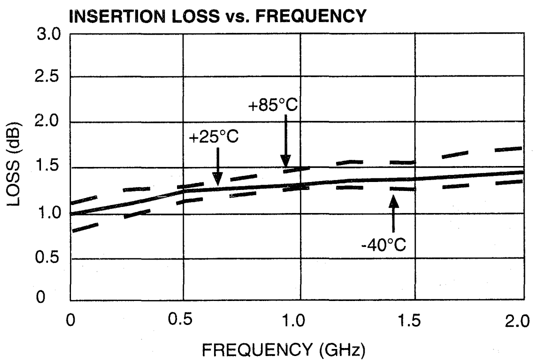
Control Inputs								
$\overline{VC5}$	$\overline{VC4}$	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	1	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	0.5 dB
1	0	1	0	1	0	1	0	1 dB
1	1	0	1	1	0	1	0	2 dB
1	1	1	0	0	1	1	0	4 dB
1	1	1	0	1	0	0	1	8 dB
0	0	0	1	0	1	0	1	15.5 dB

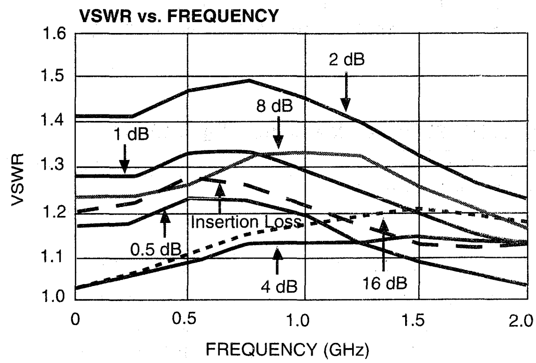
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Pin Configuration

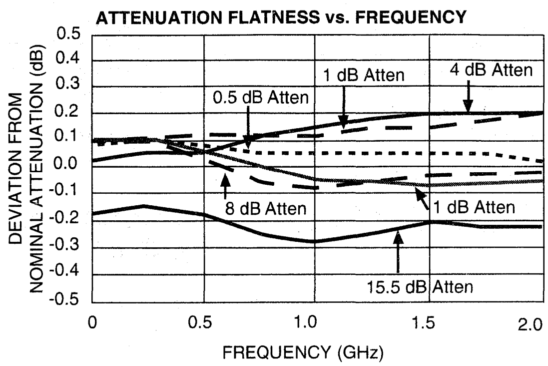
Pin No.	Description	Pin No.	Description
1	VC1	9	RF2
2	$\overline{VC1}$	10	GND
3	VC2	11	GND
4	$\overline{VC2}$	12	GND
5	VC3	13	GND
6	$\overline{VC3}$	14	GND
7	$\overline{VC4}$	15	GND
8	$\overline{VC5}$	16	RF1

Typical Performance[2]





Note: 2. The performance data has been obtained from MMIC chip in a ceramic flatpack. The data above 1 GHz may vary in the plastic package used for AT-280.



Specifications Subject to Change Without Notice

Digital Attenuator, 28 dB, 3 Bit
DC–2 GHz

AT-230

Features

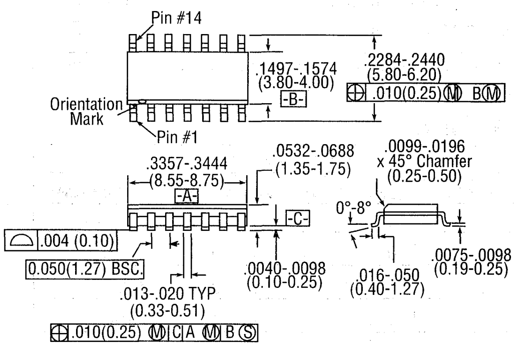
- Attenuation 4 dB Steps to 28 dB
- High Accuracy +/- 3%
- Low DC Power Consumption: 50 µW
- Low Intermodulation Product: +50 dBm IP3
- Temperature Range: -40˚C to + 85˚C
- Low Cost SOIC14 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-230 is a 3 bit, 4 dB step GaAs MMIC digital attenuator in a low cost SOIC 16-LD 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.

Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

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		1.2 1.5 1.6 1.8	1.4 1.7 1.8 2.1
Attenuation Accuracy	DC – 2.0 GHz	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 Point	Input Power Input Power	0.05 GHz 0.5 – 2.0 GHz	dBm dBm		20 28	
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		45 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 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.

Ordering Information

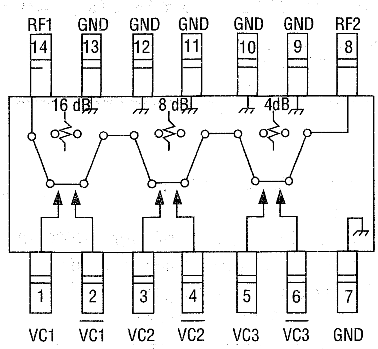
Model No.	Package
AT-230 PIN	SOIC 16 Lead
AT-230TR	Forward Tape & Reel
AT-230RTR	Reverse Tape & Reel

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
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

Note: 1. Operation of this device above any one of these parameters may cause permanent damage

Functional Schematic



Pin Configuration

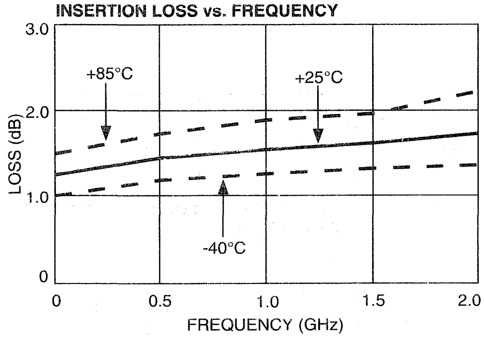
Pin	Description	Pin	Description
1	VC1	8	RF2
2	$\overline{VC1}$	9	6ND
3	VC2	10	GND
4	$\overline{VC2}$	11	GND
5	VC3	12	GND
6	$\overline{VC3}$	13	GND
7	GND	14	RF1

Truth Table

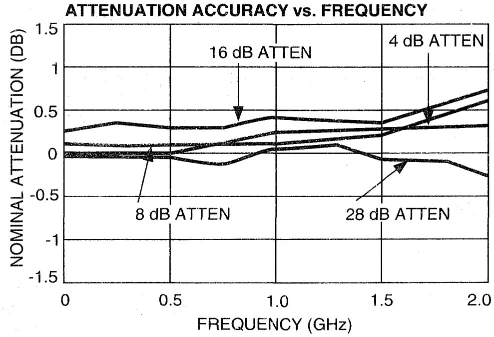
Control Input						
$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Atten (dB)
1	0	1	0	1	0	Reference
0	1	1	0	1	0	4 dB
1	0	0	1	1	0	8 dB
1	0	1	0	0	1	16 dB
0	1	0	1	0	1	28 dB

Typical Performance

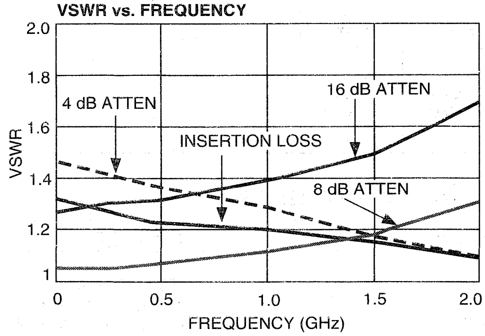
INSERTION LOSS vs. FREQUENCY



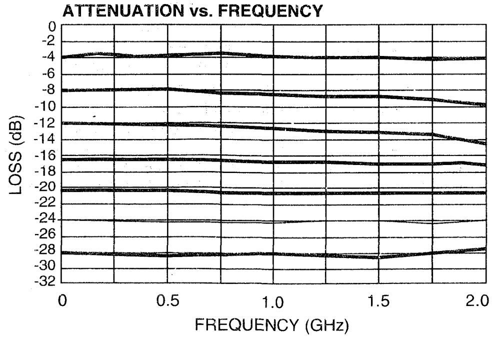
ATTENUATION ACCURACY vs. FREQUENCY



VSWR vs. FREQUENCY



ATTENUATION vs. FREQUENCY



Specifications Subject to Change Without Notice

M/A-COM

Digital Attenuator, 30 dB, 4 Bit DC–2 GHz

AT-220

Features

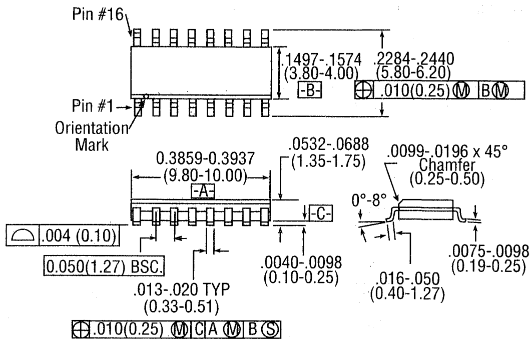
- Attenuation 2 dB Steps to 30 dB
- High Accuracy +/-3%
- Temperature Stability +/-0.15 dB from -40°C to +85°C
- Low Intermodulation Product: +50 dBm IP3
- Low DC Power Consumption: 50 μW
- Low Cost SOIC16 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's AT-220 is a 4 bit, 2 dB step GaAs MMIC digital attenuator in a low cost SOIC 16-LD 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)

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	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 Point	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		20 28	
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		45 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 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.

Ordering Information

Model No.	Package
AT-220 PIN	SOIC 16 Lead
AT-220TR	Forward Tape & Reel
AT-220RTR	Reverse Tape & Reel

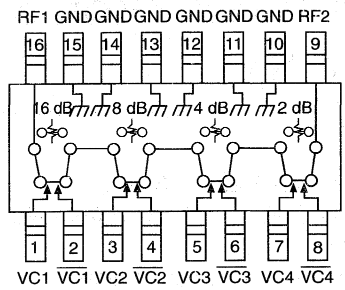
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
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

Note: 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

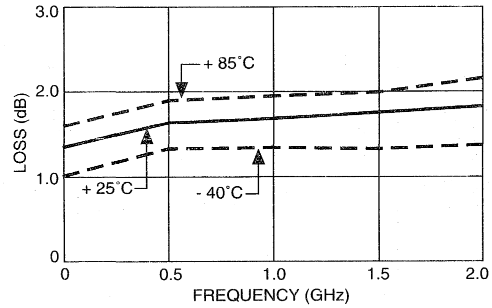
Truth Table

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

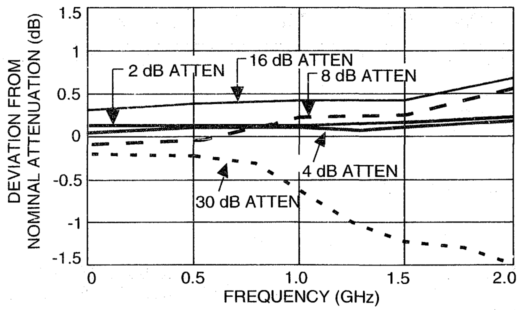
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V
"0" = 0 to -0.2V @ 20μA Max
"1" = -5V @ 10 μA typ to -8V @ 200 μA Max

Typical Performance

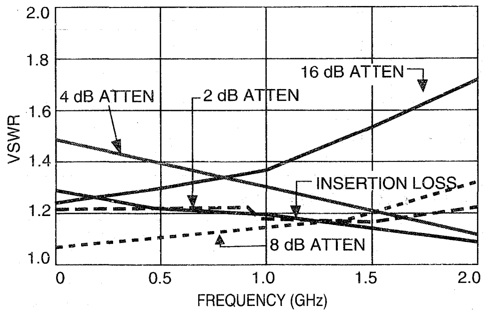
INSERTION LOSS vs. FREQUENCY



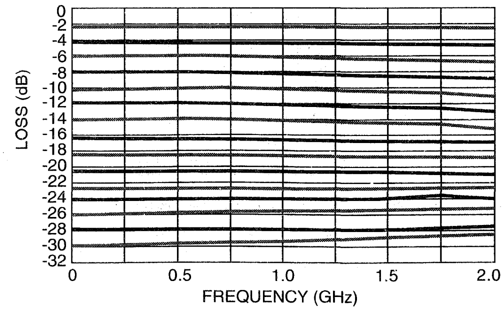
ATTENUATION ACCURACY vs. FREQUENCY



VSWR vs. FREQUENCY



ATTENUATION vs. FREQUENCY



Specifications Subject to Change Without Notice

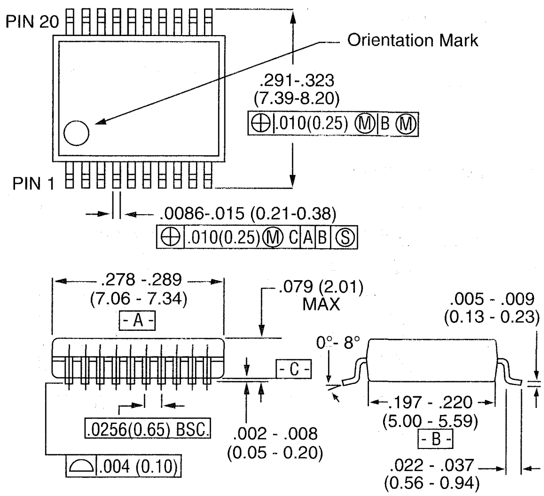
Digital Attenuator, 31 dB, 5 Bit
DC–2 GHz

NEW July '93 **AT-260**

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, IP3: 39 dBm
- Low Cost SSOP20 Plastic Package
- Tape and Reel Packaging available[1]

SSOP-20



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± .010 (.xx = ±0.25)
.xx = ± 0.02 (.x = ± 0.5)

Description

M/A-COM's AT-260 is a 5 bit, 1 dB step GaAs MMIC digital attenuator in a low cost SSOP20 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.

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		1.6 1.7 1.9 2.2	1.8 1.9 2.2 2.5
Attenuation Accuracy	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 25	
One dB Compression Point	Input Power 0.05 GHz Input Power 0.5-2.0 GHz	dBm dBm		20 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		45 60	
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		34 39	

1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements at 1 GHz in a 50Ω system, unless otherwise specified.

Ordering Information

Model No.	Package
AT-260 PIN	SSOP 20 Lead
AT-260TR	Forward Tape & Reel
AT-260RTR	Reverse Tape & Reel

Specifications Subject to Change Without Notice

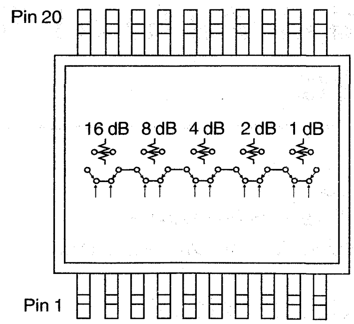
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Absolute Maximum Ratings

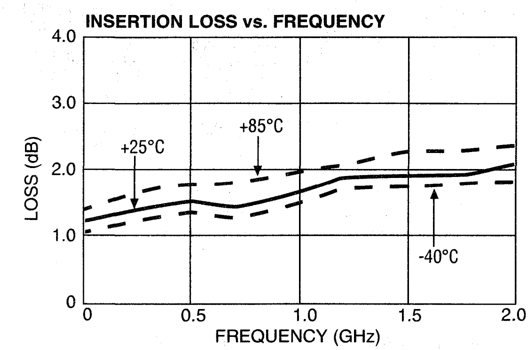
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–40°C to +85°C
Storage Temperature	–65°C to +150°C

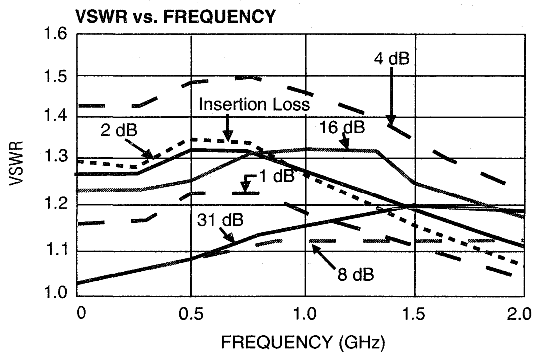
Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

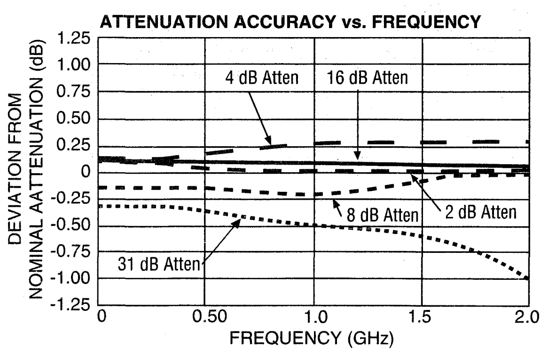
Functional Schematic



Typical Performance[2]







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	VC5	20	RF2

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

Truth Table

Matched GaAs SPST Switch
DC–2 GHz

SW-344

Features

- Low Insertion Loss
- High IP2 and IP3 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	0.7 dB Max
	DC – 1.0 GHz	0.6 dB Max
	DC – 0.5 GHz	0.5 dB Max
VSWR On	DC – 2.0 GHz	1.5:1 Max
	DC – 1.0 GHz	1.3:1 Max
	DC – 0.5 GHz	1.2:1 Max
VSWR Off	DC – 2.0 GHz	1.6:1 Max
	DC – 1.0 GHz	1.5:1 Max
	DC – 0.5 GHz	1.5:1 Max
Isolation	DC – 2.0 GHz	40 dB Min
	DC – 1.0 GHz	50 dB Min
	DC – 0.5 GHz	55 dB Min

Operating Characteristics

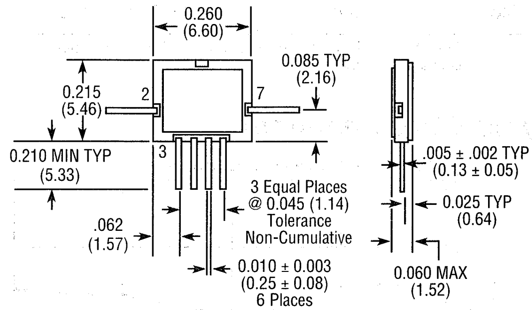
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90% RF, 90% to 10% RF)			1.8 µS, 17 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			3.0 µS , 24 ns Typ
Transients (In-Band)			30 mV Typ
Input Power for 1 dB Compression			
5-2000 MHz			+28 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
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.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

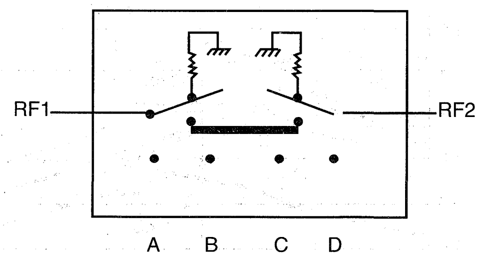
Model No.	Package
SW-344 PIN	Ceramic

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

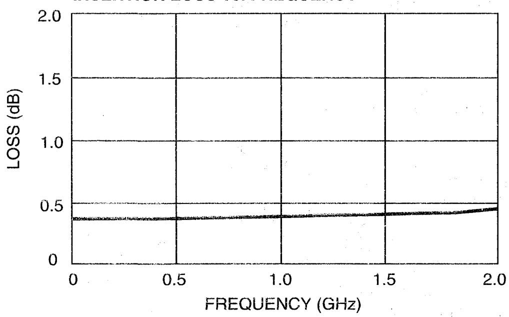
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power[2]	+34 dBm
Control Voltage	+5.5V, -8.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

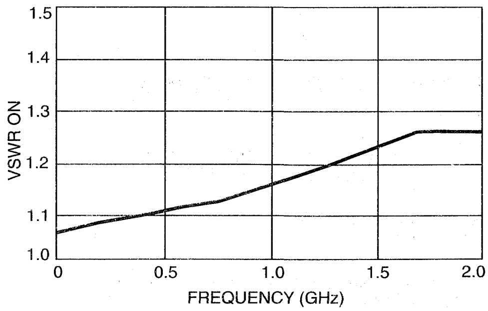
Notes:
1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +31 dBm.

Typical Performance

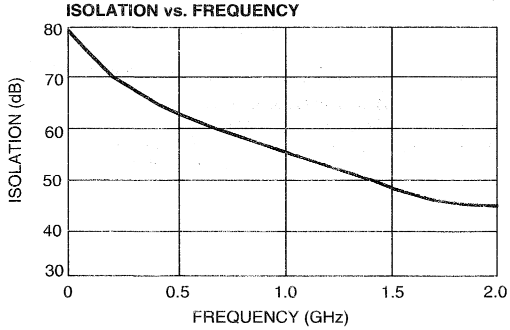
INSERTION LOSS vs. FREQUENCY



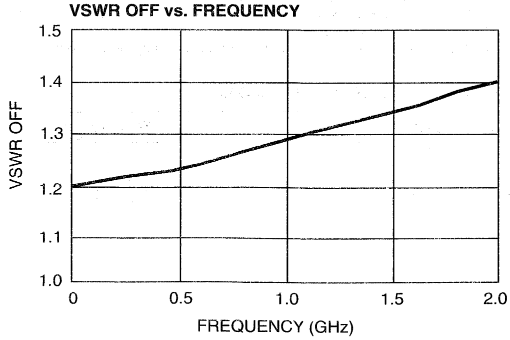
VSWR ON vs. FREQUENCY



ISOLATION vs. FREQUENCY



VSWR OFF vs. FREQUENCY



Specifications Subject to Change Without Notice

M/A-COM

Matched GaAs SPST Switch
DC-2 GHz
SW-341, SW-342

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

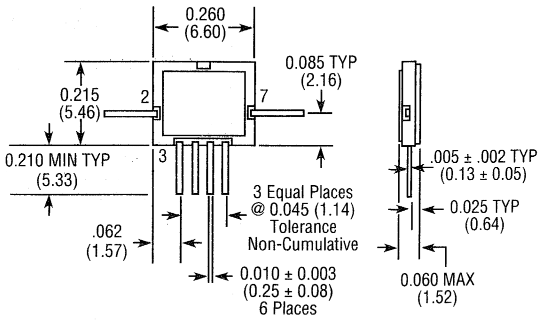
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90% RF, 90% to 10% RF)			3 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			10 ns Typ
Transients (In-Band)			20 mV Typ
Input Power for 1 dB Compression			
0.5-2 GHz		+26	dBm Typ
0.05 GHz		+23	dBm Typ
Intermodulation Intercept Point (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 -0.2V @ 20 µA Max
Vin High			5V @ 25 µA Typ to -8V @ 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

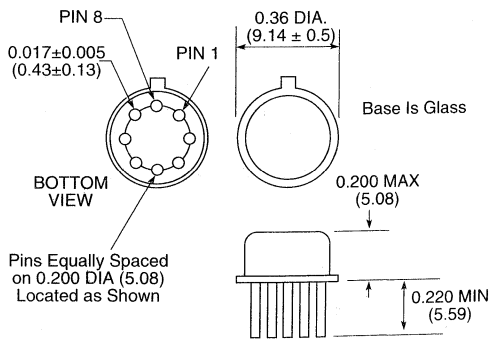
Model No.	Package
SW-341 PIN	Ceramic
SW-342 PIN	TO-5-4

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)

Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power[2] 0.05 GHz 0.5 - 2.0 GHz	 +27 dBm +34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

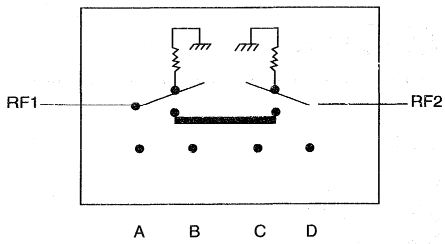
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +31 dBm.

Truth Table

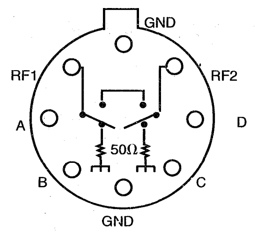
Control Inputs				Condition of Switch
A	B	C	D	RF1-RF2
High	Low	Low	High	On
Low	High	High	Low	Off

Functional Schematics (Top View)

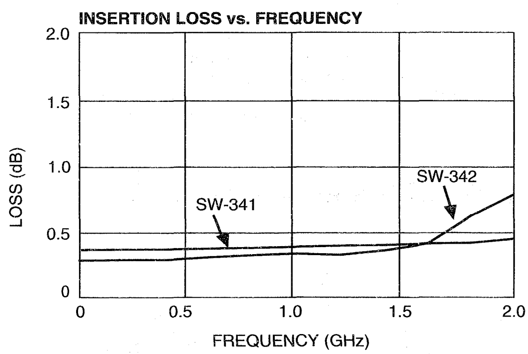
SW-341

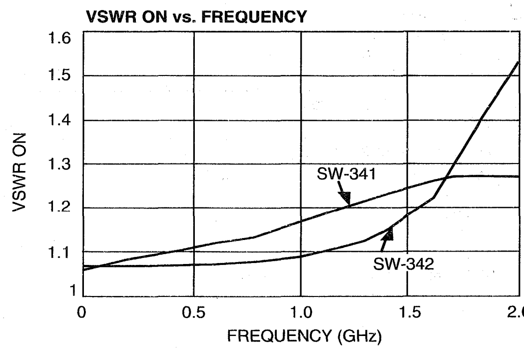


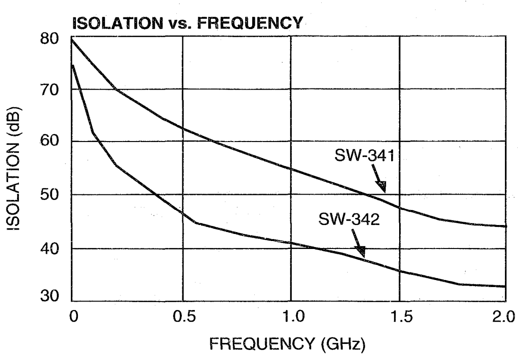
SW-342

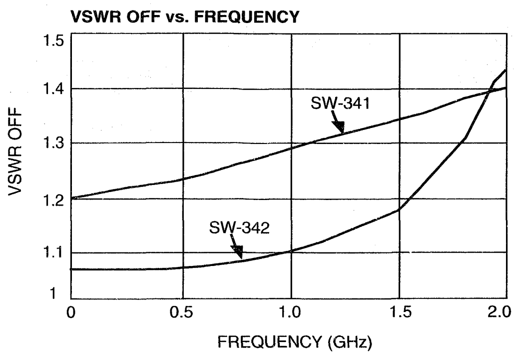


Typical Performances









Specifications Subject to Change Without Notice

High Isolation Absorptive GaAs SPST Switch
DC–2 GHz

SW-367

Features

- Very High Isolation
- Integral TTL Driver
- SMA Connectors
- Low DC Power Consumption

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		DC – 2.0 GHz
Insertion Loss	DC – 2.0 GHz	3.0 dB Max
	DC – 1.0 GHz	2.2 dB Max
	DC – 0.5 GHz	1.8 dB Max
Isolation	DC – 2.0 GHz	70 dB Min
	DC – 1.5 GHz	75 dB Min
VSWR	DC – 2.0 GHz	2.0:1 Max
	0.2 – 1.5 GHz	1.5:1 Max

Operating Characteristics

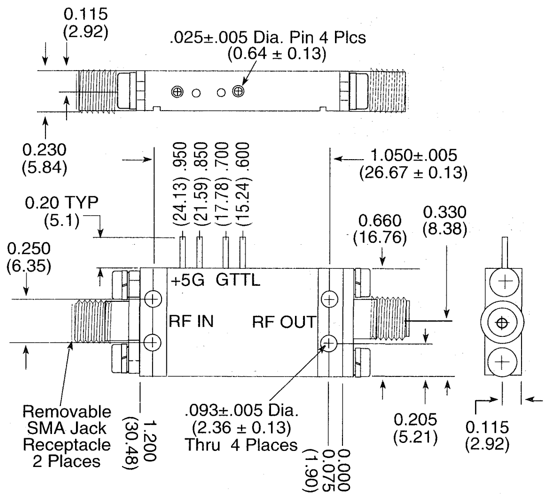
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			5 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			25 ns Typ
Transients (in-Band)			25 mV Typ
Input Power for 1 dB Compression			
0.05 – 2.0 GHz			+20 dBm
Intermodulation Intercept Point (With two +5 dBm Input Tones):			
Intercept Points	IP2	IP3	
0.05 GHz	+55	+40	dBm Typ
0.5 – 2.0 GHz	+70	+40	dBm Typ
Bias Voltage:			+5V @ 1 mA Max
Control Voltages (Complementary Logic)			
TTL Low			0 to 0.8V @ 1 µA Max
TTL High			2.4 to 5.0V @ 1 µA Max

1. All specifications apply when operated with a 50 ohm impedance at both RF ports.
2. Contact the factory for standard or custom screening requirements.

Ordering Information

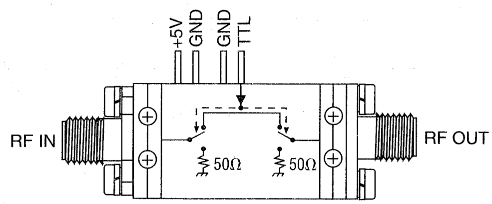
Model No.	Package
SW-367 SMA	Connectorized

C-47



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
TTL	RFIN to RFOUT
0	ON
1	OFF

"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Specifications Subject to Change Without Notice

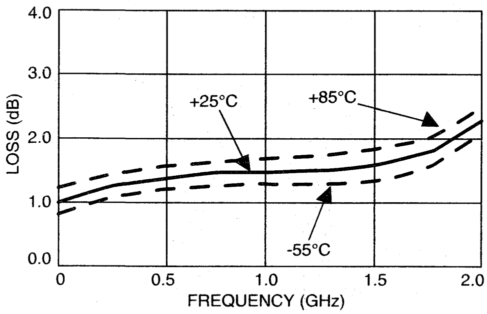
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power 0.05 GHz 0.5 – 2.0 GHz	 +27 dBm +30 dBm
Bias Voltage	-0.5 to +7V
Control Voltage	-0.5 to V_{bias} +0.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

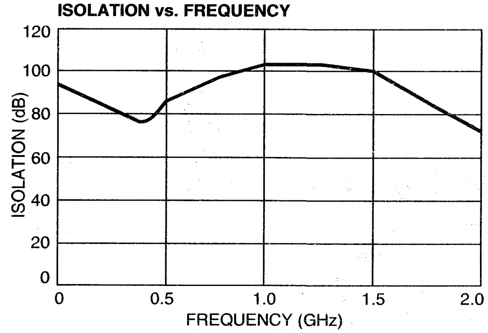
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance

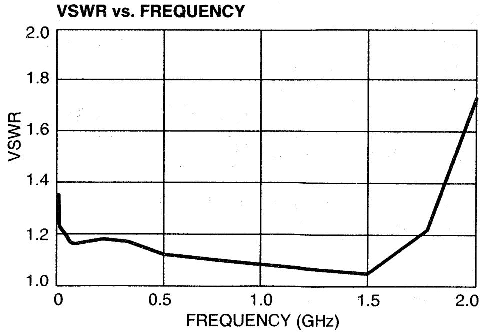
INSERTION LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Matched GaAs SPST Switch DC–3 GHz with TTL/CMOS Control Input SW-311

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)

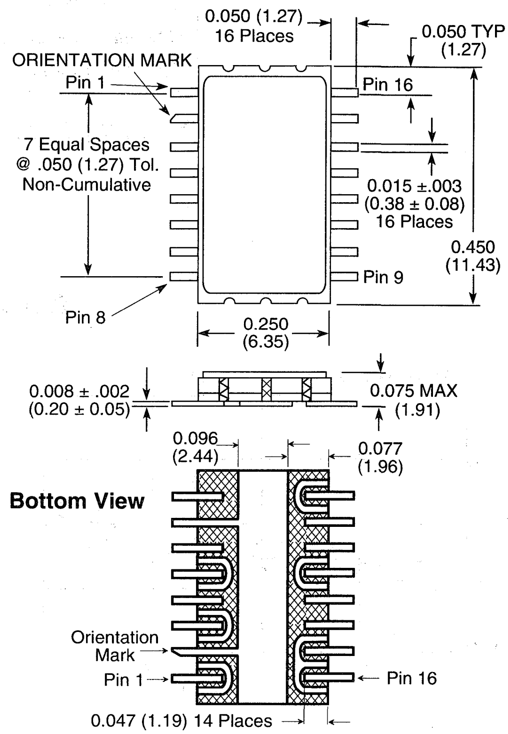
Frequency Range		DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.3 dB Max
	DC-2000 MHz	1.2 dB Max
	DC-1000 MHz	1.0 dB Max
	DC- 500 MHz	0.8 dB Max
VSWR	DC-3000 MHz	1.5:1 Max
	DC-2000 MHz	1.4:1 Max
	DC-1000 MHz	1.3:1 Max
	DC- 500 MHz	1.2:1 Max
Isolation	DC-3000 MHz	27 dB Min
	DC-2000 MHz	36 dB Min
	DC-1000 MHz	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			+27 dBm Typ
0.5 GHz to 3 GHz			+21 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+68	+46	dBm Typ
0.5 GHz to 3 GHz	+62	+40	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
Environmental			
See Appendix for MIL-STD-883 creening 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

Model No.	Package
SW-311 PIN	Ceramic

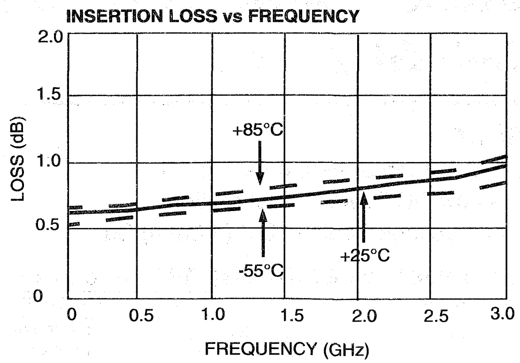
Specifications Subject to Change Without Notice

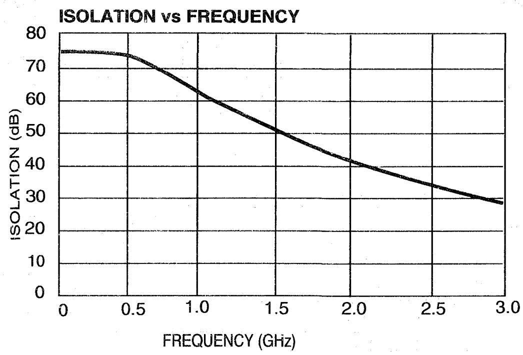
Absolute Maximum Ratings

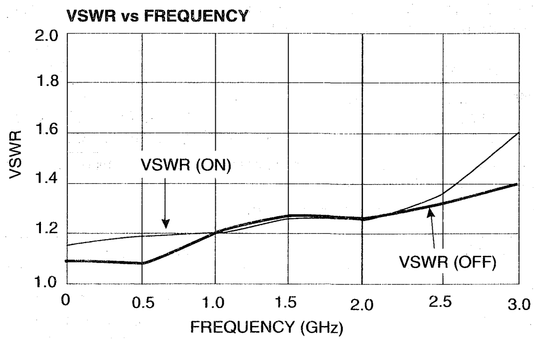
Parameter	Absolute Maximum
Max. Input Power	
50 MHz	+27 dBm
500-2000 MHz	+34 dBm
Supply Voltages	
V_{CC}	+5.5V
V_{EE}	–8.5V
Control Voltage	–0.5V, to V_{CC} +0.5V
Operating Temperature	–55˚C to 125˚C
Storage Temperature	–65˚C to 150˚C

Note: Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







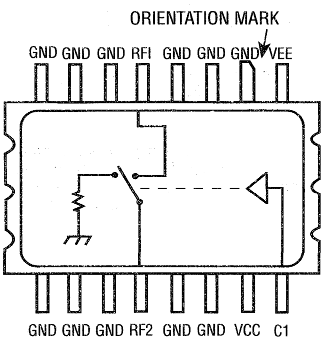
Pin Configuration

Pin No.	Description	Pin No.	Description
1	VEE	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	VCC
8	GND	16	C1

Truth Table

Control Input	Condition of Switch
C1	RF1 to RF2
LO HI	ON OFF

Pin Configuration (Top View)



Specifications Subject to Change Without Notice

Matched GaAs SPST Switch DC–3 GHz

SW-209

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

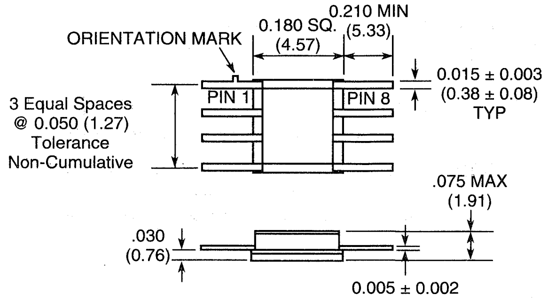
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall}			3 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			6 ns Typ
Transients (In-Band)			30 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 – 3.0 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept 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.

Ordering Information

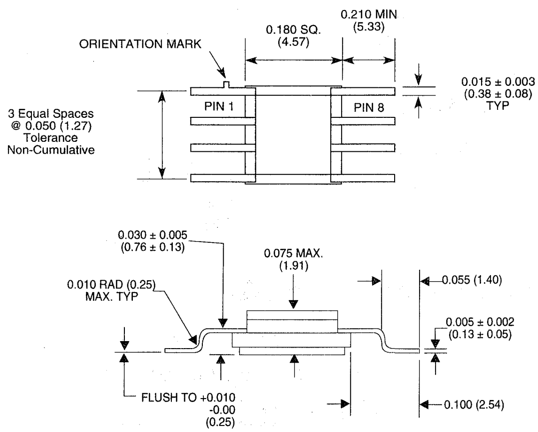
Model No.	Package
SW-209 PIN	Ceramic (CR-3)
SW-209B PIN	Screened To MIL-STD-883C, Method 5008.4, Table VII, Class B Hybrid
SW-209G	Ceramic Gull Winged (CR-10)

CR-3



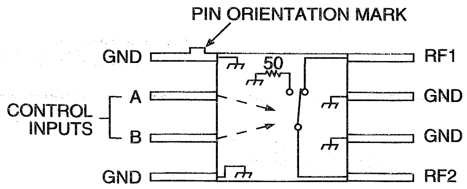
Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

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)

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

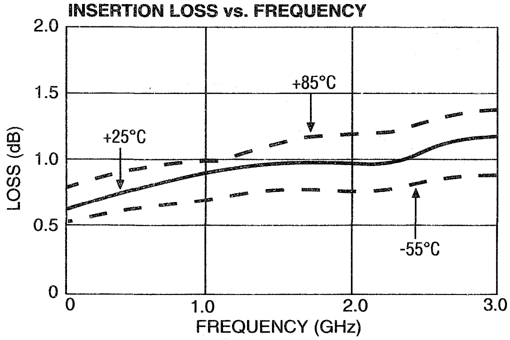
Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

Truth Table

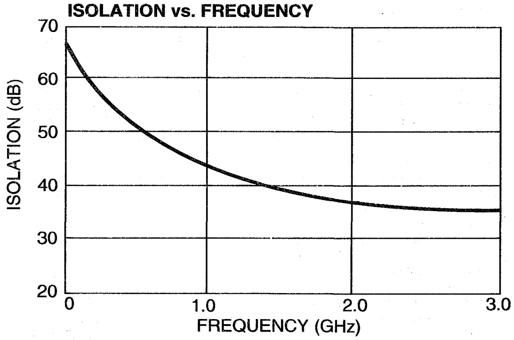
Control Input		Condition of Switch
A	B	RF1 to RF2
High	Low	ON
Low	High	OFF

Typical Performance

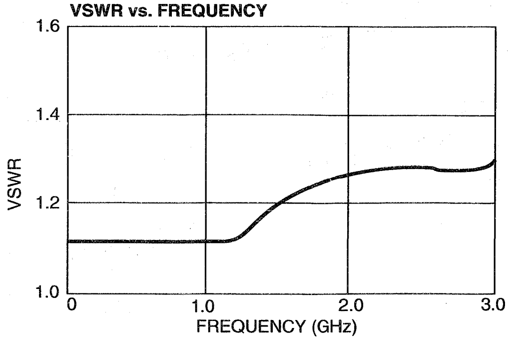
INSERTION LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY

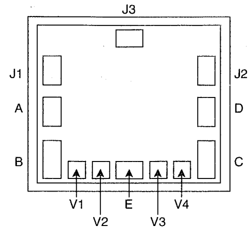


Specifications Subject to Change Without Notice

GaAs SPST Switch DC - 4 GHz

MASW4010

- **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

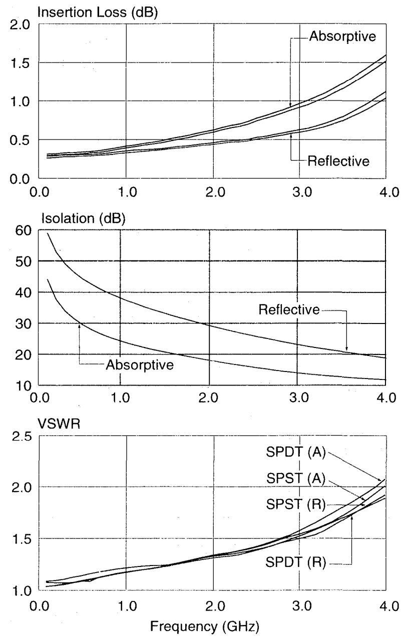
Operating Characteristics

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)

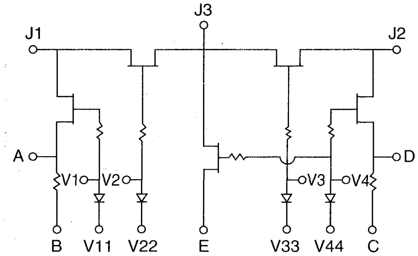
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages.

*** Loss changes 0.0025 dB/°C (-55°C to +85°C)

Typical Performance @ 25°C***



Schematic



Specifications Subject to Change Without Notice

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		

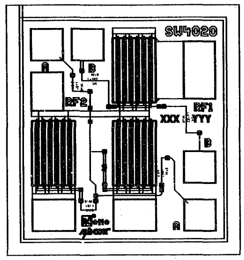
NOTES

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.

GaAs SPST Switch
DC - 4 GHz

MASW4020

- 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	0.40 dB Max
	DC - 2 GHz	0.40 dB Max
	DC - 4 GHz	0.45 dB Max
VSWR	DC - 2 GHz	1.2:1 Max
	2 - 4 GHz	1.2:1 Max
Isolation	DC - 1 GHz	40 dB Min
	DC - 2 GHz	30 dB Min
	DC - 4 GHz	25 dB Min

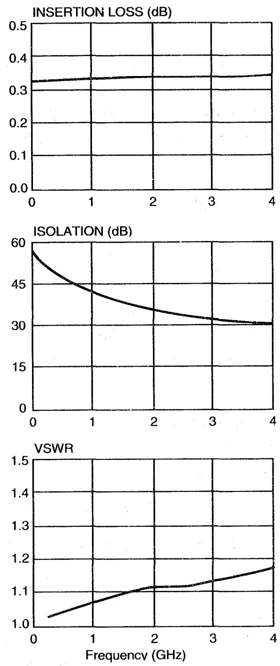
Operating Characteristics

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 (for two-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)

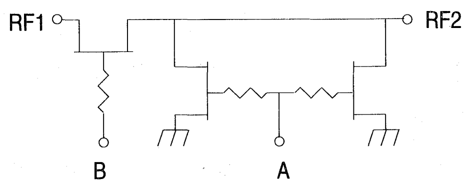
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -5 Vdc control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice

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 are recommended.

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

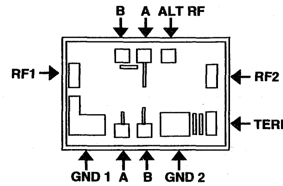
BondPad Dimensions Inches (mm)
RF1: 0.004 x 0.008 (0.100 x 0.200)
RF2: 0.004 x 0.005 (0.100 x 0.125)
V1,V2: 0.004 x 0.004 (0.100 x 0.100)
G1,G2: 0.004 x 0.005 (0.100 x 0.125)

Die Size Inches (mm)
0.029 x 0.031 x 0.010 (0.72 x 0.78 x 0.25)

GaAs SPST Switch
DC–6 GHz

MASW6020G

- 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

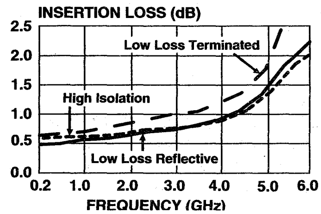
Operating Characteristics

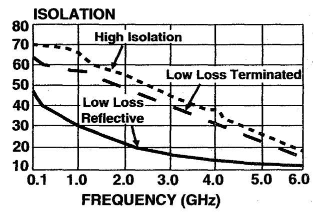
Impedance		50 Ω Nominal
Switching Characteristics		
Trise, Tfall (10%/90% or 90%/10% RF)		10 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)		10 ns Typ
Transients (In-Band)		10 mV Typ
Input Power for 1 dB Compression		
Control Voltages (VDC)	0/-5	0/-8
Above 500 MHz	+27 dBm	+33 dBm Typ
100 MHz	+21 dBm	+26 dBm 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)

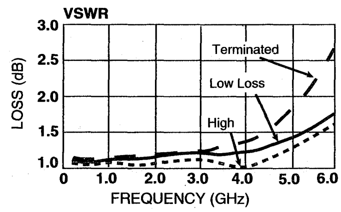
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -8 VDC control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

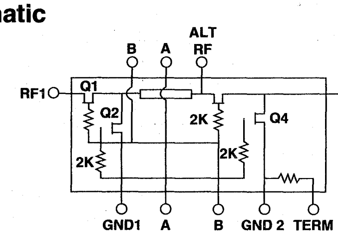
Typical Performance







Schematic



Specifications Subject to Change Without Notice

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	

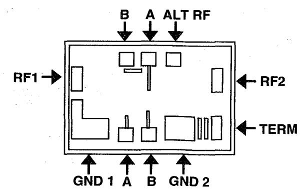
Maximum Ratings

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



M/A-COM

Matched GaAs SPDT Switch DC–2 GHz

SW-331, SW-333

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

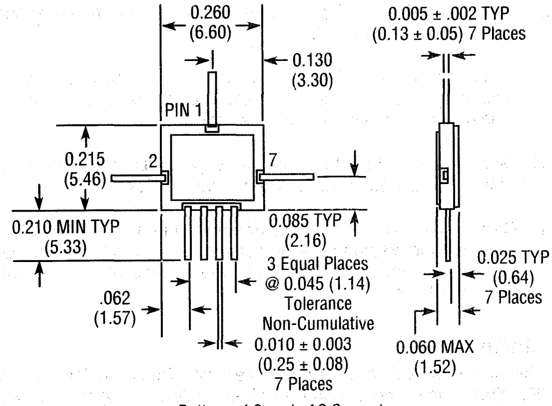
Control Voltages (Complementary Logic)	
Vin Low	0 to -0.2V @ 20 µA Max
Vin High	-5V @ 25 µA Typ to -8V @ 300 µA Max

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

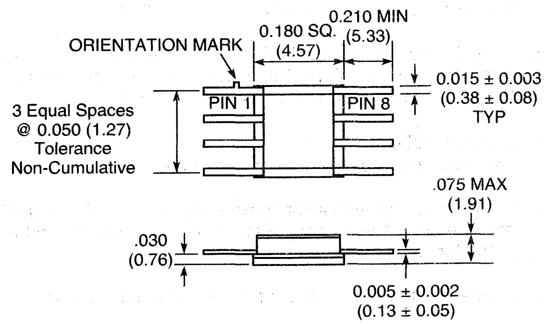
Model No.	Package
SW-331 PIN	Ceramic
SW-333 PIN	Ceramic

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

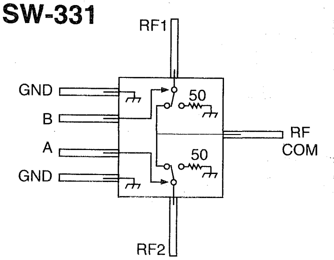
Absolute Maximum Ratings

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

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

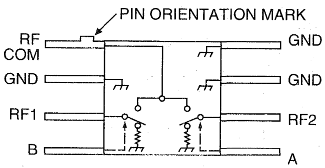
Functional Schematics (Top View)

SW-331



Bottom of case is AC Ground

SW-333



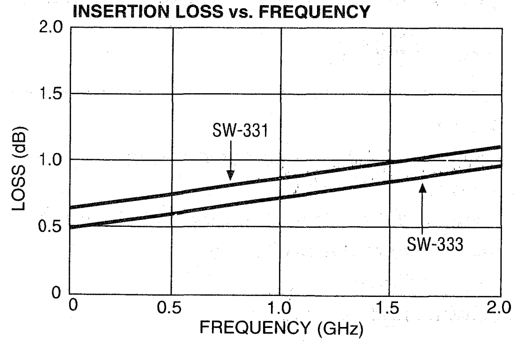
Bottom of case is AC Ground

Truth Table

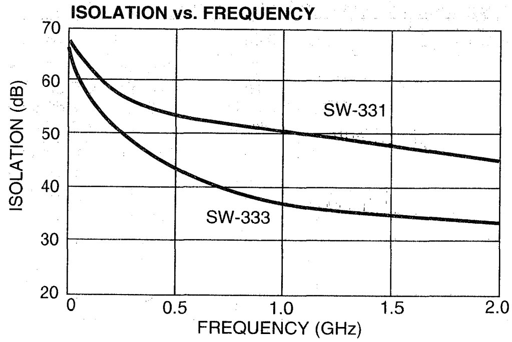
Control Input		Condition of Switch	
		RF Common to each RF Port	
A	B	RF1	RF2
High	Low	OFF	ON
Low	High	ON	OFF

Typical Performance

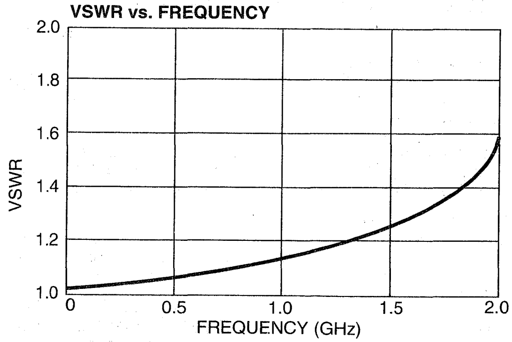
INSERTION LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY



VSWR vs. FREQUENCY



Specifications Subject to Change Without Notice

High Power GaAs SPDT Switch
DC–3 GHz

SW-106, SW-276

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]

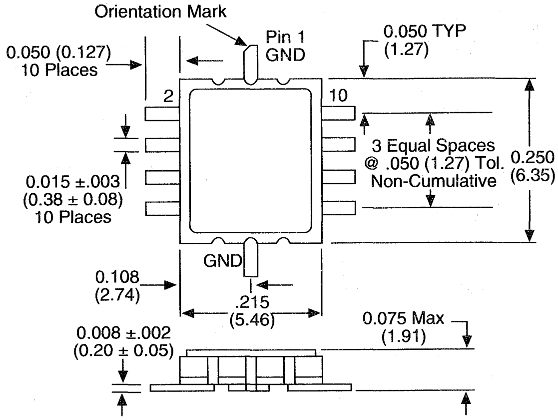
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			30 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			35 ns Typ
Transients (In-Band)			12 mV Typ
Input Power for Compression	0.1 dB	1.0 dB	
0.9 GHz (-5V Control)	+32.5 dBm	+35.5 dBm	Typ
0.9 GHz (-8V Control)	+35.5 dBm	+39.5 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.

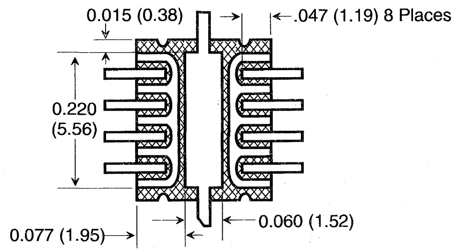
Ordering Information

Model No.	Package
SW-106 PIN	Surface Mount
SW-276 PIN	Ceramic

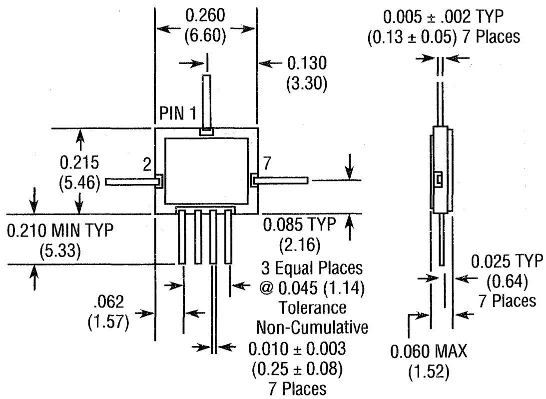
SW-106 (CR-5)



Bottom View



SW-276 (CR-2)



For both switches: Bottom of Case is AC Ground
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

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

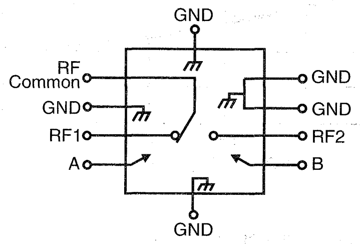
Notes:
1. Operation of this device above any one of these parameters may cause permanent damage.
2. T_{case} = 25˚C, where T_{case} is the temperature at the bottom of the case.
3. Special consideration must be given to the mounting of the switch to minimize the thermal resistance. The bottom of the case should be thermally attached to the mounting surface to maintain the junction temperature under the absolute maximum rating.

Two Tone IP3 Measurements

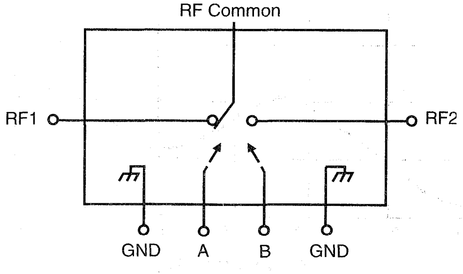
Bias Voltage	Input Power for each tone (dBm)	3rd Order Intermodulation Products (dBc)	IP3 (dBm)	Second Harmonic (dBc)
0, –5V	+27	–34	+44	-61
0, –6V	+27	–49	+51	-61
0, –7V	+27	–64	+59	-63
0, –8V	+27	–65	+59	-63
0, –5V	+28	–30	+43	-58
0, –6V	+28	–41	+48	-58
0, –7V	+28	–52	+54	-57
0, –8V	+28	–60	+58	-57
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

Functional Schematics (Top View)

SW-106



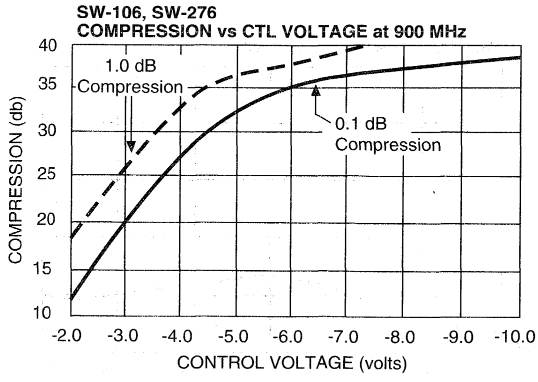
SW-276



Truth Table

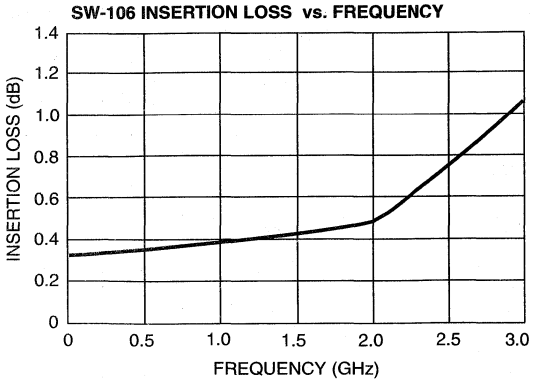
Control		Condition of Switch	
		RF Common to Each RF Port	
A	B	RF1	RF2
High	Low	On	Off
Low	High	Off	On

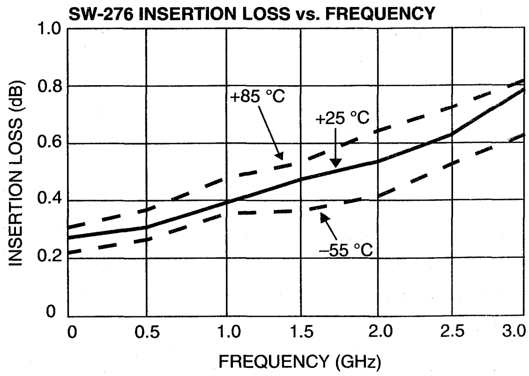
Typical Performances

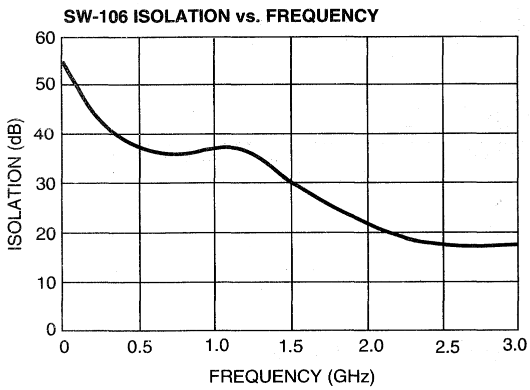


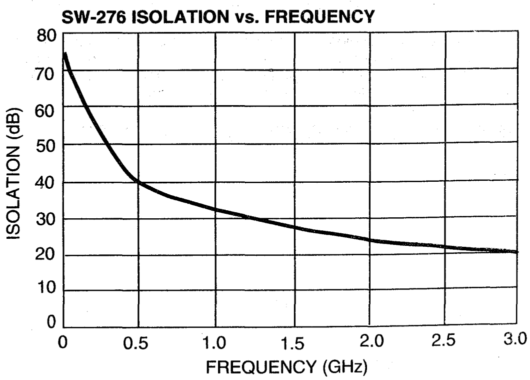
Specifications Subject to Change Without Notice

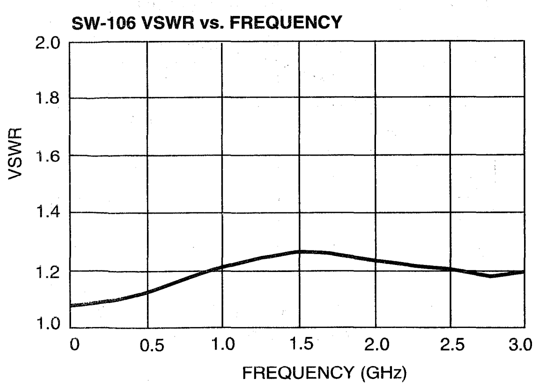
Typical Performances (cont'd.)

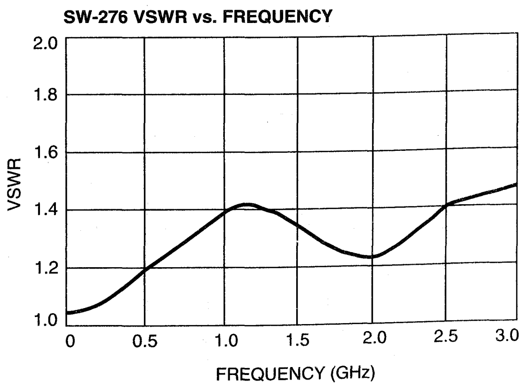












M/A-COM

GaAs SPDT Reflective Switch DC–3 GHz with TTL/CMOS Control Input SW-312

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)

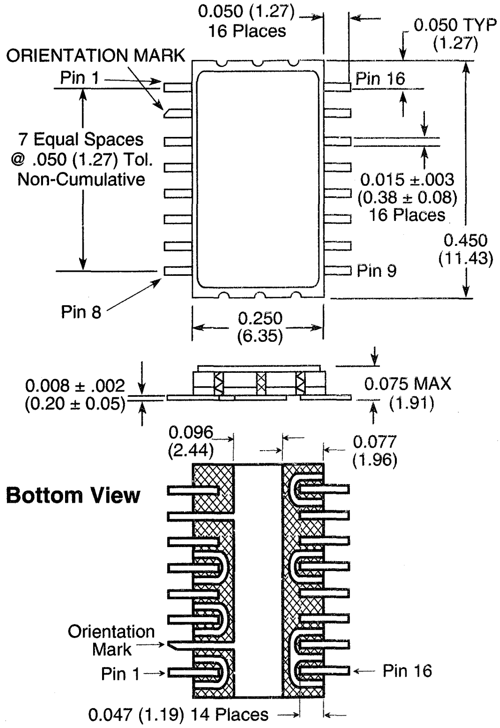
Frequency Range		DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.2 dB Max
	DC-2000 MHz	1.1 dB Max
	DC-1000 MHz	0.9 dB Max
	DC- 500 MHz	0.8 dB Max
VSWR	DC-3000 MHz	1.5:1 Max
	DC-2000 MHz	1.4:1 Max
	DC-1000 MHz	1.4:1 Max
	DC- 500 MHz	1.3:1 Max
Isolation	DC-3000 MHz	30 dB Min
	DC-2000 MHz	35 dB Min
	DC-1000 MHz	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 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
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

Model No.	Package
SW-312 PIN	Ceramic

Specifications Subject to Change Without Notice

Absolute Maximum Ratings

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	–55°C to +125°C
Storage Temperature	–65°C to +150°C

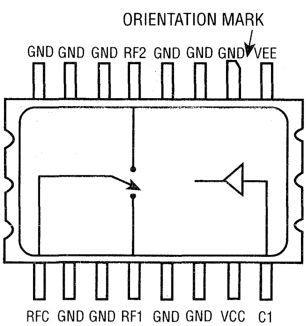
Pin Configuration

Pin No.	Description	Pin No.	Description
1	VEE	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	VCC
8	GND	16	C1

Truth Table

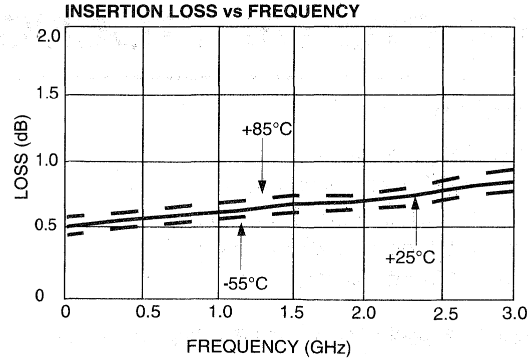
Control Input	Condition of Switch RF Common to Each RF Port	
C1	RF1	RF2
LO	ON	OFF
HIGH	OFF	ON

Pin Configuration (Top View)

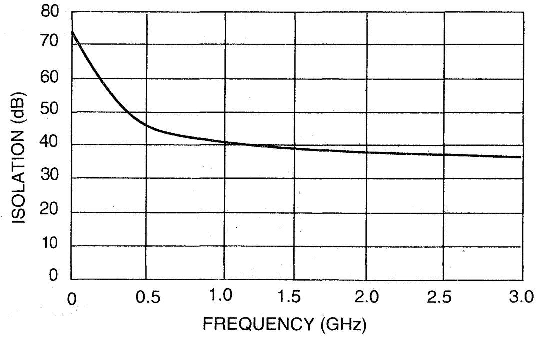


Typical Performance

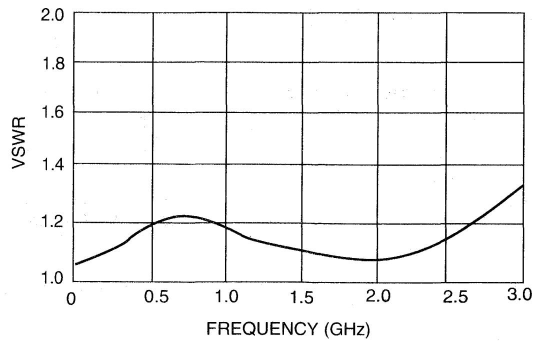
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Specifications Subject to Change Without Notice

M/A-COM

Matched GaAs SPDT Switch
DC-3 GHz with TTL/CMOS Control Input SW-313

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)

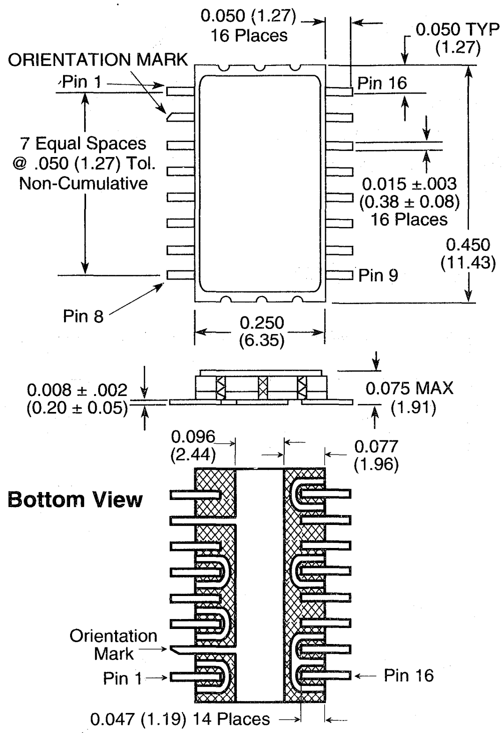
Frequency Range		DC-3000 MHz
Insertion Loss	DC-3000 MHz	1.2 dB Max
	DC-2000 MHz	1.1 dB Max
	DC-1000 MHz	0.9 dB Max
	DC- 500 MHz	0.8 dB Max
VSWR	DC-3000 MHz	1.4:1 Max
	DC-2000 MHz	1.35:1 Max
	DC-1000 MHz	1.35:1 Max
	DC- 500 MHz	1.3:1 Max
Isolation	DC-3000 MHz	35 dB Min
	DC-2000 MHz	45 dB Min
	DC-1000 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 (1.3V 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 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
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

Model No.	Package
SW-313 PIN	Ceramic

Specifications Subject to Change Without Notice

Absolute Maximum Ratings

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	–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.

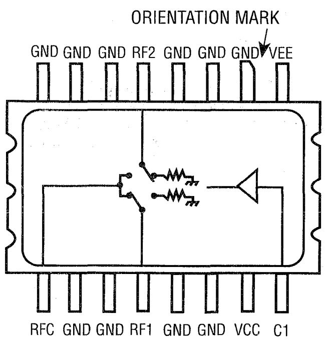
Pin Configuration

Pin No.	Description	Pin No.	Description
1	VEE	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	VCC
8	GND	16	C1

Truth Table

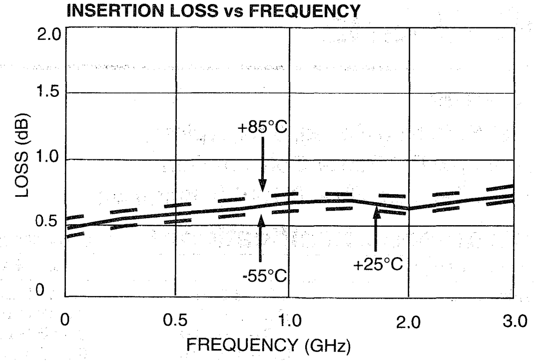
Control Input	Condition of Switch RF Common to Each RF Port	
C1	RF1	RF2
LO	ON	OFF
HIGH	OFF	ON

Pin Configuration (Top View)

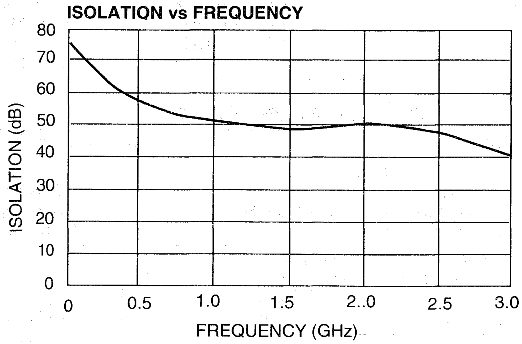


Typical Performance

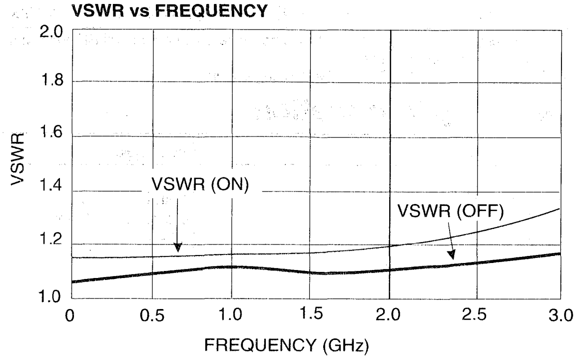
INSERTION LOSS vs FREQUENCY



ISOLATION vs FREQUENCY



VSWR vs FREQUENCY



Specifications Subject to Change Without Notice

GaAs SPDT RF Switch DC–3 GHz

SW-219

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

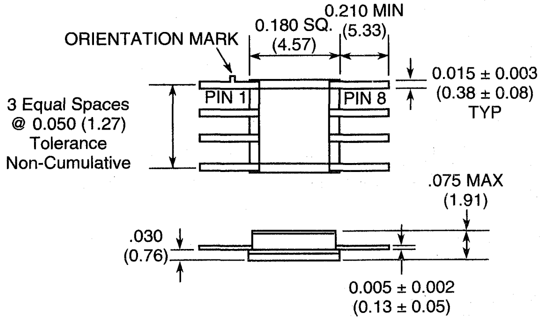
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall}			3 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			6 ns Typ
Transients (In-Band)			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 – 3.0 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation 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

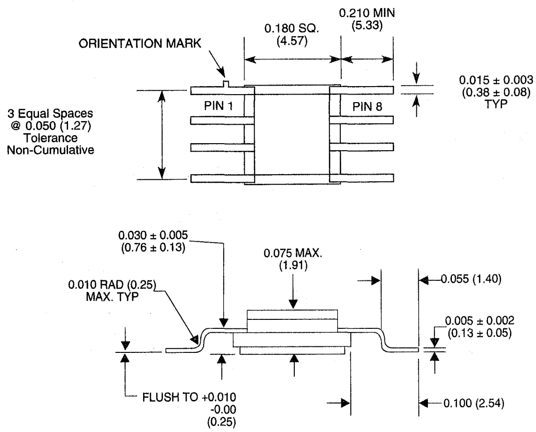
Model No.	Package
SW-219 PIN	Ceramic (CR-3)
SW-219G	Ceramic Gull Winged (CR-10)

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)

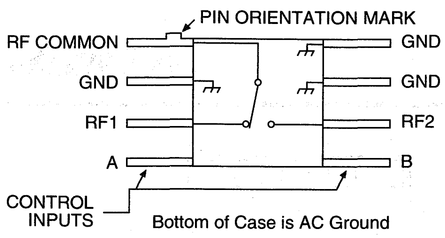
CR-10



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

Functional Schematic



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

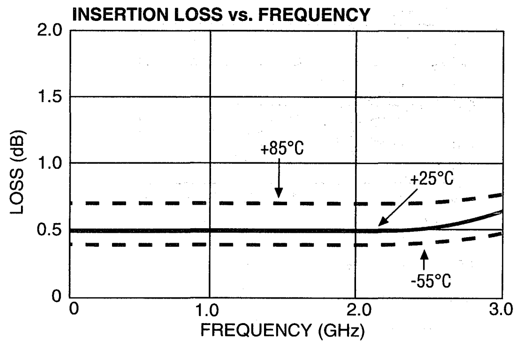
Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

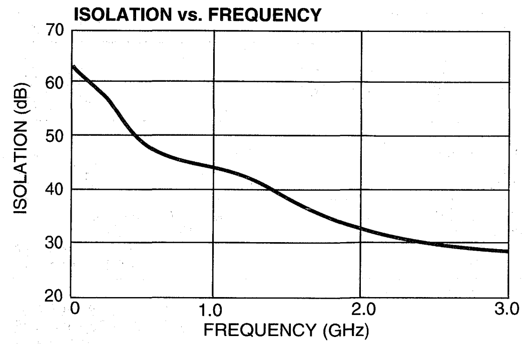
Truth Table

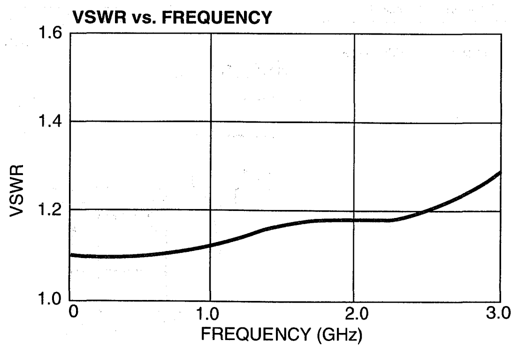
Control Input		Condition of Switch RF Common to each RF Port	
A	B	RF1	RF2
High	Low	ON	OFF
Low	High	OFF	ON

When an RF output is off, it is shorted to ground.

Typical Performance





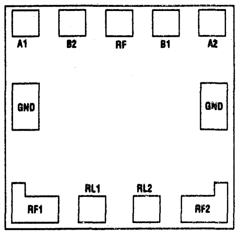


Specifications Subject to Change Without Notice

GaAs SPDT Switch
DC-3 GHz

MASW2000

- **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

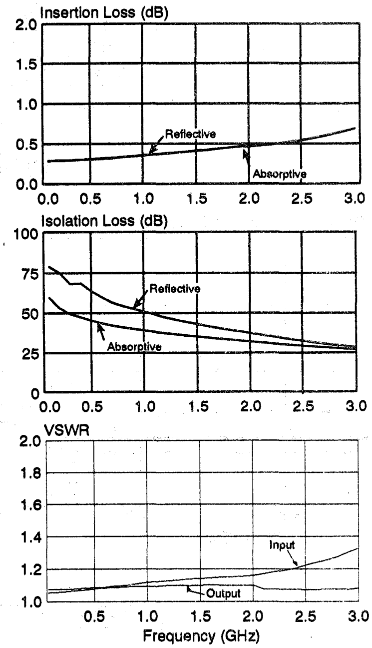
Frequency Range			DC - 3.0 GHz
Insertion Loss		DC–0.5 GHz DC–1.0 GHz DC–2.0 GHz DC–3.0 GHz	0.5dB Max 0.6dB Max 0.8dB Max 1.0dB Max
VSWR	Reflective+	DC–0.5 GHz DC–1.0 GHz DC–2.0 GHz DC–3.0 GHz	1.20:1 Max 1.20:1 Max 1.20:1 Max 1.40:1 Max
	Absorptive++	DC–2.0 GHz DC–3.0 GHz	1.20:1 Max 1.40:1 Max
Isolation		DC–0.5 GHz DC–1.0 GHz DC–2.0 GHz DC–3.0 GHz	43 dB Min 35 dB Min 27 dB Min 24 dB Min

Operating Characteristics

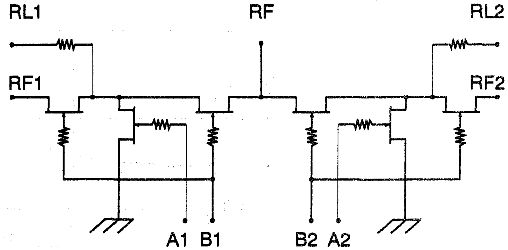
Impedance			50 Ω Nominal
Switching Characteristics t_{RISE}, t_{FALL} (10/90% or 90/10% RF) t_{ON}, t_{OFF} (50% CTL to 90/10% RF) Transients (In-Band)			 22 ns Typ 27 ns Typ 25 mV Typ
Input Power for 1dB Compression Control Voltages (Vdc) 0.05 GHz 0.5–3 GHz	 0/-5 +24 dBm +26 dBm		 0/-8 +26 dBm Typ +32 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm) Intercept Points 0.05 GHz 0.5–3 GHz	 IP_2 +63 +80	 IP_3 +43 +53	 dBm Typ dBm Typ
Control Voltage (Complementary Logic) V_{IN}Low V_{IN}Hi			 0 to 0.2V @ 5uA Max -5V @ 60uA Typ to -8V @ 500uA Max
Die Size			0.056" x 0.056" x 0.010" (1.40mm x 1.40mm x .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 (-55°C to +85°C)
+ For reflective operation RL1/RL2 are unconnected.
++For absorptive operation RL1 connets to RF1 and RL2 connects to RF2.

Typical Performance @ 25°C***



Schematic



Specifications Subject to Change Without Notice

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	On	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)

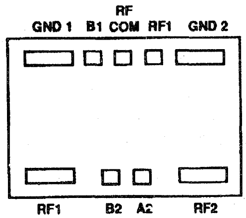
Die Size Inches (mm)
0.056 x 0.056 x 0.010 (1.40 x 1.40 x 0.25)

10W GaAs SPDT Switch
DC-3 GHz

MASW2020G

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

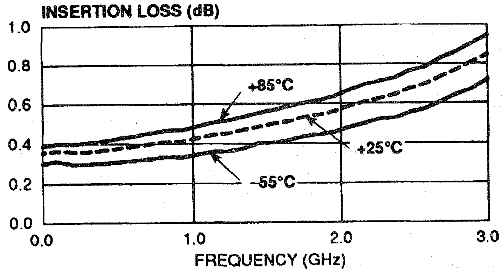
Operating Characteristics

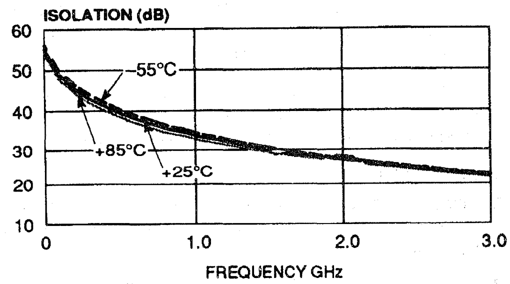
Impedance			50 Ω Nominal
Switching Characteristics			
Trise, Tfall (10%/90% or 90%/10% RF)			10 ns Typ
Ton, Toff (50% CTL to 90%/10%)			15 ns Typ
Transients (in-Band)			20 mV Typ
Input Power for 1 dB Compression**			
Control Voltages (Vdc)	0/-5	0/-8	0/-10
500-3000 MHz	2.5 Watts	7.5 Watts	10 Watts Typ
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)

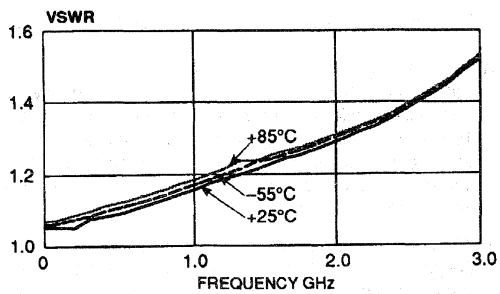
* All specifications apply with a 50 Ω impedance connected to all RF ports, 0 and -5 VDC control voltages.

** Enhanced power performance is achieved at higher control voltages without degradation in small signal performance.

Typical Performance







Specifications Subject to Change Without Notice

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.

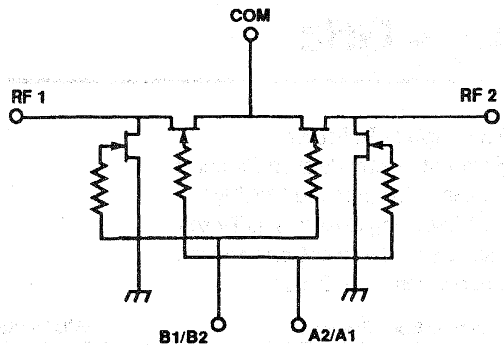
C. Electrically conductive epoxy may be used but is not required.

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

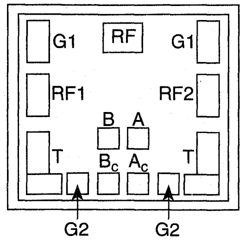
Control Inputs		Condition Of Switch: RF Common to Each RF Port	
A1/A2	B1/B2	RF1	RF2
V_{IN}Hi	V_{IN}Low	Off	On
V_{IN}Low	V_{IN}Hi	On	Off

V_{IN}Low 0 to -0.2V
V_{IN}Hi -5V to -10V

GaAs SPDT Switch
DC – 4 GHz

MASW4030G

- 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

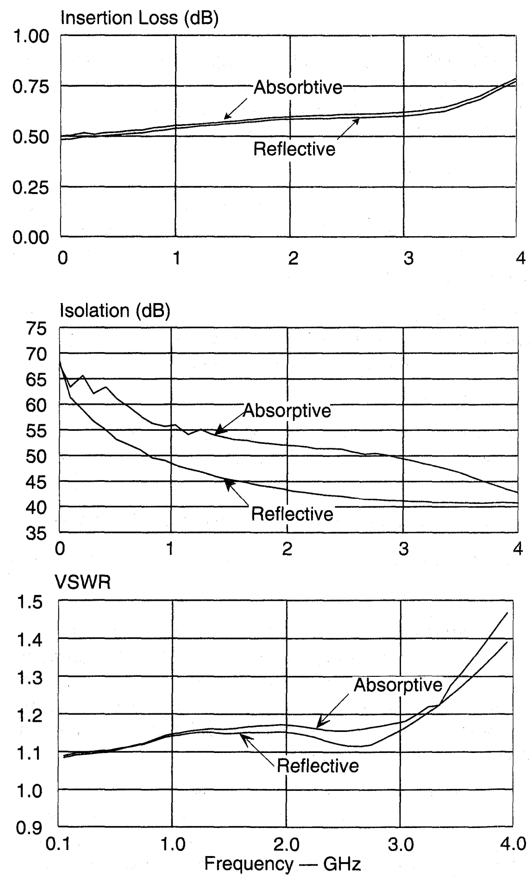
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		6 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression**		
Control Voltages (Vdc)	0/–5	0/–8
0.05 GHz	24 dBm	25 dBm Typ
0.5 – 4.0 GHz	30 dBm	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		0.043″ 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

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.

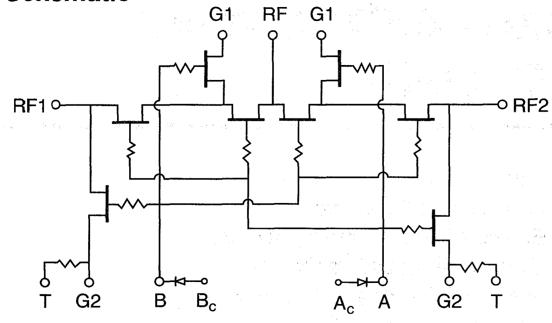
Epoxy Die Attach:

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

	Control Inputs		Condition of BondPad			Condition of Switch	
	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
SPDT	V_{IN}Hi	V_{IN}Low	—	GND	GND	Off	On

Specifications Subject to Change Without Notice

GaAs SPDT Switch
DC-4 GHz
MASW4040

Features
- Absorptive 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

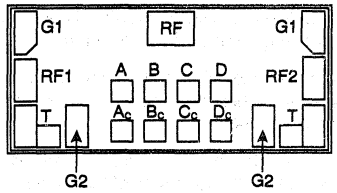
Frequency Range		DC – 4.0 GHz
Insertion Loss	DC – 1.0 GHz	0.6 dB Max
	DC – 2.0 GHz	0.8 dB Max
	DC – 4.0 GHz	1.0 dB Max
Isolation	DC – 1.0 GHz	60 dB Min
	Absorptive Mode DC – 2.0 GHz	50 dB Min
	Reflective Mode DC – 2.0 GHz	46 dB Min
	DC – 4.0 GHz	40 dB Min
VSWR	DC – 1.0 GHz	1.1:1 Max
	DC – 2.0 GHz	1.2:1 Max
	DC – 4.0 GHz	1.5:1 Max

Operating Characteristics

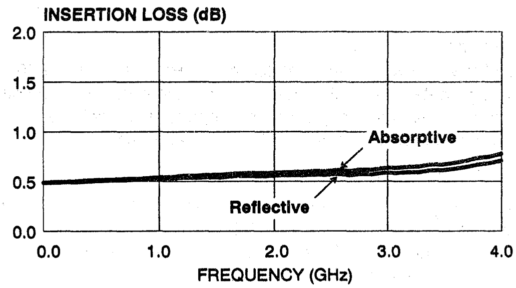
Impedance		50 Ω Nominal
Switching Characteristics		
Trise, Tfall (10%/90% or 90%/10% RF)		3 ns Typ
Ton,Toff (50% CTL to 90%/10% RF)		6 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1dB Compression**		
Control Voltages (Vdc)	0/–5	0/–8
0.05 GHz	24 dBm	25 dBm Typ
0.5 – 4.0 GHz	30 dBm	33 dBm Typ
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)

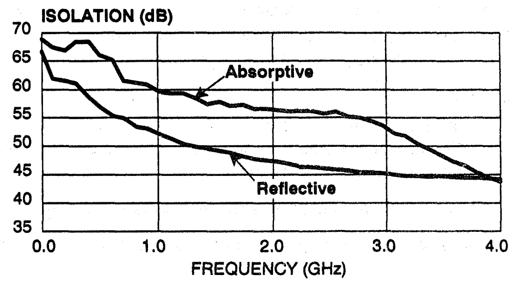
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages.
*** Loss changes 0.0025 dB/°C.

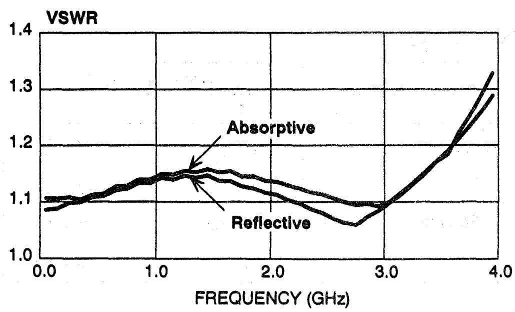
Bond Pad Layout



Typical Performance @ 25°C***







Specifications Subject to Change Without Notice

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.

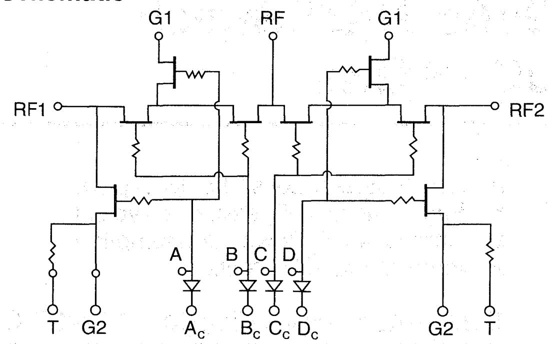
Epoxy Die Attach:

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)

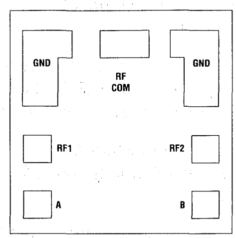
Truth Table

	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

GaAs SPDT Switch
DC–6 GHz

MASW6010G

- Low Insertion Loss, 0.5 dB Typical
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption
- Integral Static Protection



Guaranteed Specifications** @25°C***

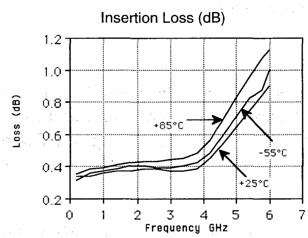
Frequency Range		DC - 6000 MHz
Insertion Loss		
	DC - 1.0 GHz	0.6dB Max
	DC - 2.0 GHz	0.8dB Max
	DC - 6.0 GHz	1.4dB Max
VSWR		
	DC - 1.0 GHz	1.2:1 Max
	DC - 2.0 GHz	1.3:1 Max
	DC - 6.0 GHz	2.0:1 Max
Isolation		
	DC - 1.0 GHz	45 dB Min
	DC - 2.0 GHz	38 dB Min
	DC - 6.0 GHz	22 dB Min

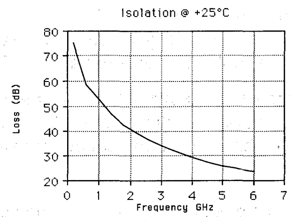
Operating Characteristics

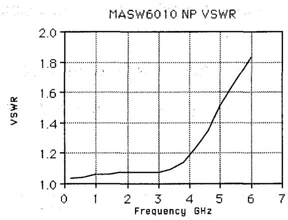
Impedance		50 Ω Nominal
Switching Characteristics		
tRISE, tFALL (10/90% or 90/10% RF)		2 ns Typ
tON, tOFF (50% CTL to 90/10% RF)		4 ns Typ
Transients (In-Band)		10 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
Above 500 MHz	+27 dBm	+33 dBm Typ
100 MHz	+21 dBm	+26 dBm Typ
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)

** 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)

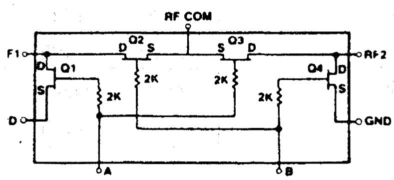
Typical Performance @ 25°C







Schematic



Specifications Subject to Change Without Notice

Handling Precautions

Permanent damage to the MASW6010G may occur if the following precautions are not adhered to:

A. Cleanliness – The MASW6010G should be handled in a clean environment. DO NOT attempt to clean unit after the MASW6010G 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 MASW6010G. 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 MASW6010G 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 MASW6010G 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 MASW6010G 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 MASW6010G 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

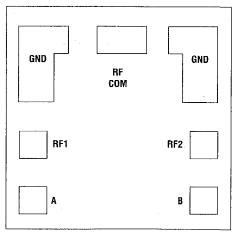
V_{in} Low 0 to -0.2V

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)

Bond Pad Layout



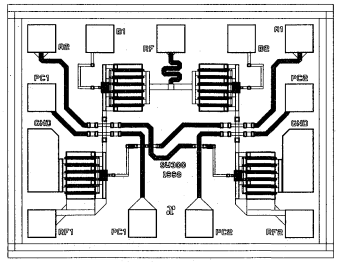
![M/A-COM]

GaAs SPDT Switch
DC-8 GHz

MASW8000

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

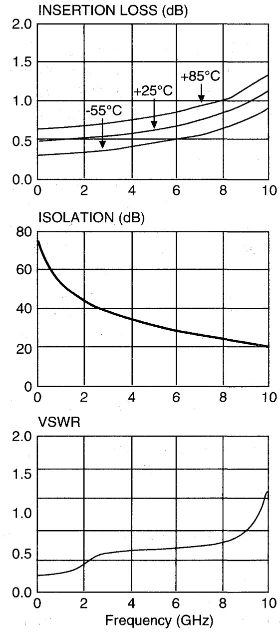
Operating Characteristics

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)

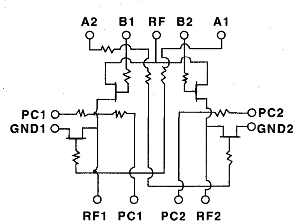
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -5 Vdc control voltages.

*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice

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)

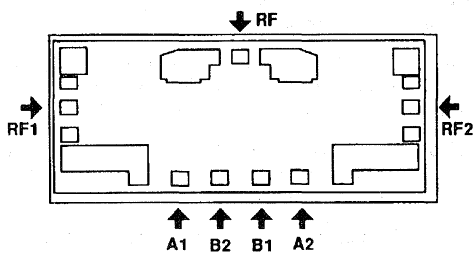
Die Size Inches (mm)
0.046 x 0.036 x 0.010 (1.15 x 0.90 x 0.25)

GaAs SPDT Switch DC-20 GHz

MASW20000

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**

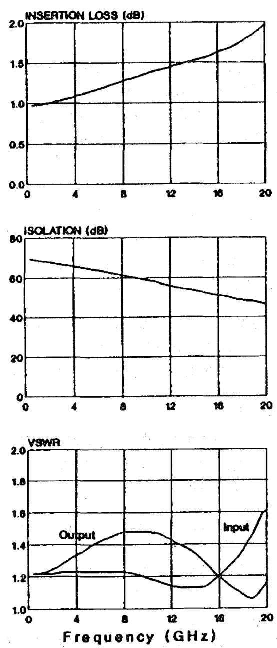
Frequency Range		DC-20.0 GHz
Insertion Loss	DC-10.0 GHz	1.7 dB Max
	DC-18.0 GHz	2.1 dB Max
	DC-20.0 GHz	2.5 dB Max
VSWR	DC-10.0 GHz	1.60:1 Max
	DC-18.0 GHz	1.80:1 Max
	DC-20.0 GHz	2.00:1 Max
Isolation	DC-10.0 GHz	50 dB Min
	DC-18.0 GHz	42 dB Min
	DC-20.0 GHz	40 dB Min

Operating Characteristics

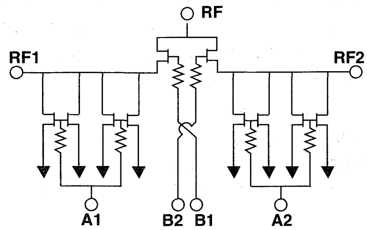
Impedance		50 Ω Nominal
Switching Characteristics		
T_{rise}, T_{fall} (10/90% or 90/10% RF) 2 ns Typ		
T_{on}, T_{off} (50% CTL to 90/10% RF)		3 ns Typ
Transients (in-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)		0/-5
0.5-20 GHz		+25 dBm Typ
0.05 GHz		+18 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)		
Intercept Points	IP_2	IP_3
0.5-20 GHz	+59 dBm	+43 dBm Typ
0.05 GHz		+27 dBm Typ
Control Voltages (Complimentary Logic)		
V_{in} Low		0 to -0.2V @ 5 μA Max
V_{in} Hi		-5V @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

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 (3.0mil X 0.5 mil) may also be used. 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	
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)

Matched GaAs SP4T Switch DC–2 GHz

SW-415

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

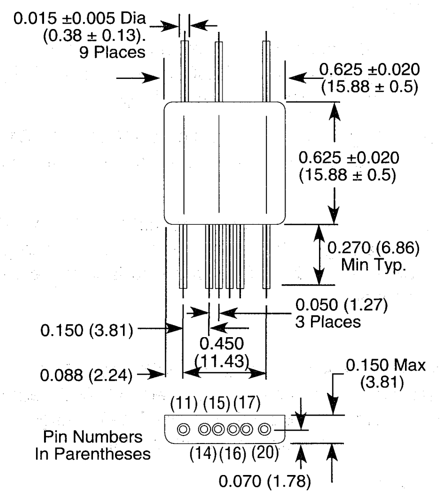
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			50 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			200 ns Typ
Transients (In-Band)			15 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+17 dBm Typ
Intermodulation Intercept Pt. (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

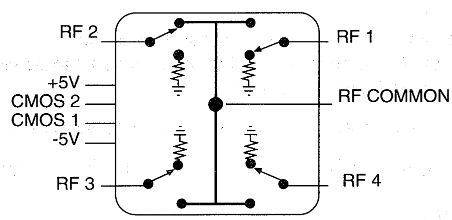
Model No.	Package
SW-415 PIN	Flatpack

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

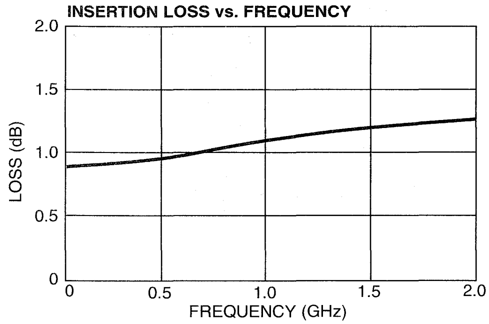
Specifications Subject to Change Without Notice

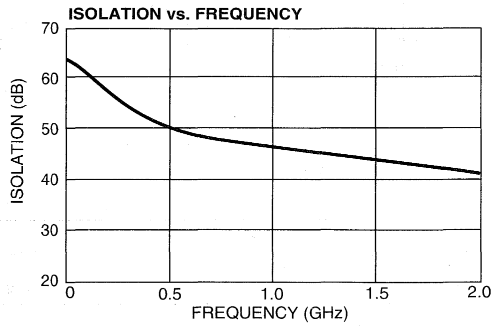
Absolute Maximum Ratings

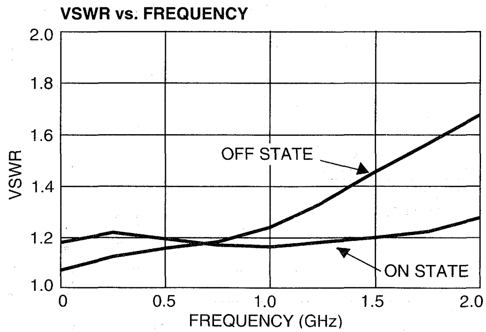
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+24 dBm
0.5–2.0 GHz	+30 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







Specifications Subject to Change Without Notice

GaAs SP4T Absorptive Switch

GaAs SP4T Absorptive Switch DC–2 GHz

SW-411

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

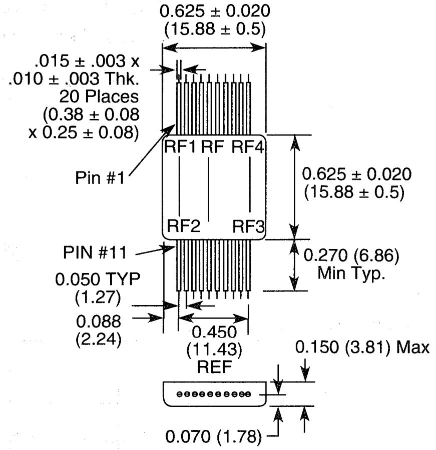
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise,Tfall (10% to 90% RF)			8 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			16 ns Typ
Transients (In band)			15 mV Typ
Output Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone 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

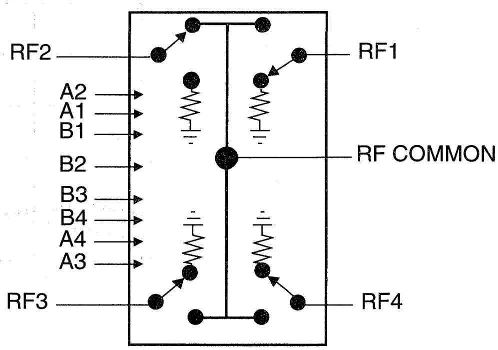
Model No.	Package
SW-411 PIN	Flatpack

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)



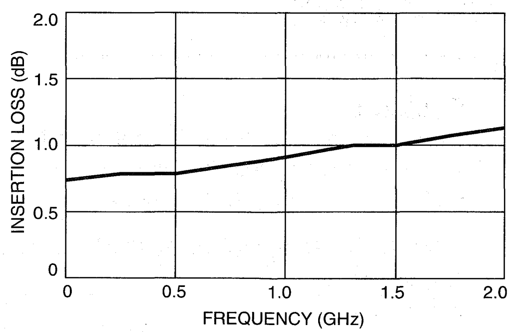
Specifications Subject to Change Without Notice

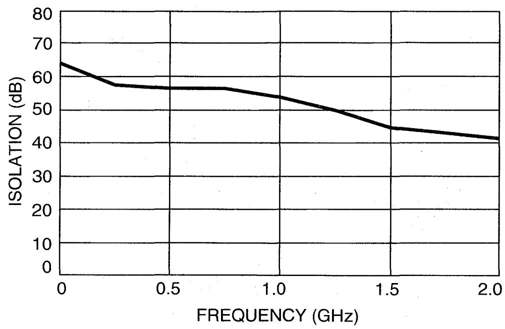
Absolute Maximum Ratings

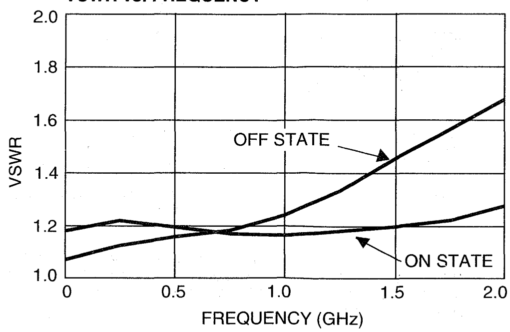
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz[2]	+34 dBm
Control Voltage	+5V, -8.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Notes: 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







Pin Configuration

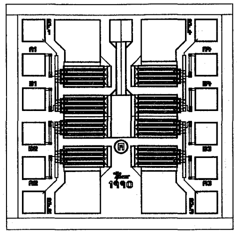
Pin No.	Description	Pin No.	Description
1	RF1	11	RF2
2	GND	12	A2
3	GND	13	A1
4	GND	14	B1
5	RF Common	15	B2
6	GND	16	B3
7	GND	17	B4
8	GND	18	A4
9	GND	19	A3
10	RF4	20	RF3

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

Specifications Subject to Change Without Notice

GaAs SP4T Switch
DC – 4 GHz
MASW4000



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)		
$V_{IN}L_{OW}$		0 to –0.2V @ 9 µA Max
$V_{IN}H_{I}$		–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)

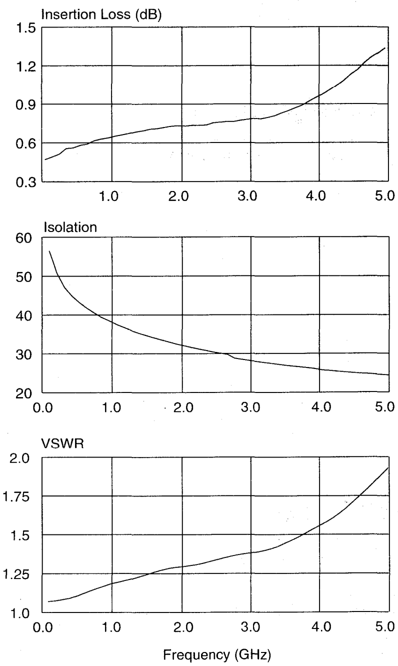
Environmental
These units are designed to meet or exceed the following: electrical, 100% probing at 25°C for selected parameters. Visual, 100% per MIL-STD-883 Method 2010 Condition B. Lot traceability supplied on request.

** 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.

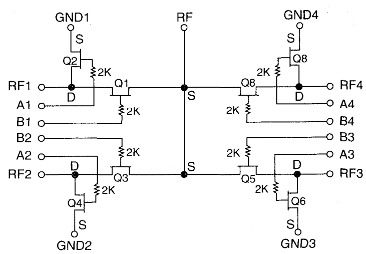
*** Faster switching speed can be achieved with enhanced driver waveform.

**** Loss changes 0.0025 dB/°C (-55°C to +85°C)

Typical Performance @ 25°C****



Schematic



Specifications Subject to Change Without Notice

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

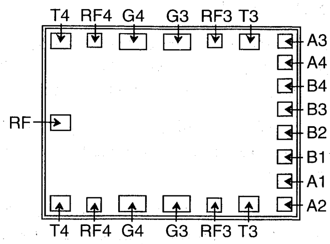
BondPad Dimensions — Inches (mm)	
RF1, RF2	0.004 x 0.004 (0.100 x 0.100)
GND1–GND4	0.004 x 0.008 (0.100 x 0.200)
A1, B1, A2, B2, A3, B3, A4, B4	0.004 x 0.004 (0.100 x 0.100)

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

GaAs SP4T Switch
DC – 4 GHz

MASW4060G

- Low Insertion Loss, 1.2 dB Typical
- Fast Switching Speed, 4 ns Typical
- Ultra Low DC Power Consumption



Guaranteed Specifications* –55˚C to +85˚C

Frequency Range		DC – 4.0 GHz
Insertion Loss	DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz DC – 4.0 GHz	1.3 dB Max 1.3 dB Max 1.3 dB Max 1.7 dB Max
Isolation	DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz DC – 4.0 GHz	50 dB Min 45 dB Min 40 dB Min 30 dB Min
VSWR	DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz DC – 4.0 GHz	1.4:1 Max 1.4:1 Max 1.5:1 Max 2.0:1 Max

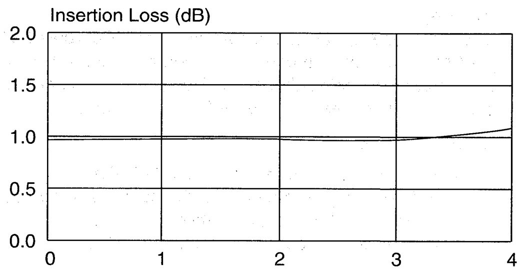
Operating Characteristics

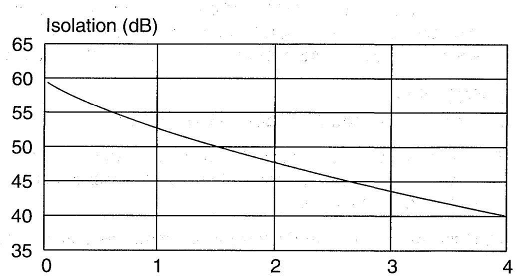
Impedance		50 Ω Nominal
Switching Characteristics tRISE, tFALL (10/90% or 90/10% RF) tON, tOFF (50% CTL to 90/10% RF) Transients (In-Band)		 2 ns Typ 4 ns Typ 20 mV Typ
Input Power for 1dB Compression Control Voltages (Vdc) 0.05 GHz 0.5 – 4.0 GHz		 0/–5 +17 dBm Typ +27 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm) Intercept Points 0.5 GHz 0.5 – 4.0 GHz	 IP2 +45 +60	 IP3 +35 dBm Typ +46 dBm Typ
Control Voltages (Complementary Logic) V_{IN}Low V_{IN}Hi		 0 to –0.2V @ 25 μA Max –5V @ 50 μA Typ to –5V @ 200 μA Max
Die Size		0.059″ x 0.077″ x 0.010″ (1.50mm x 1.95mm x 0.25mm)

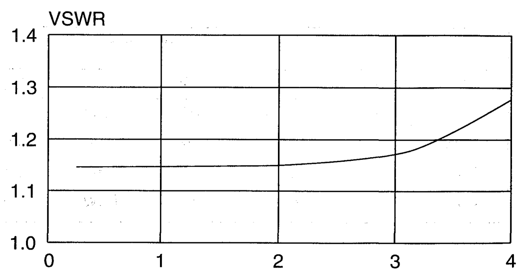
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and 0 and –5 Vdc control voltages.

*** Loss changes ±0.0025 dB/°C. (From -55°C to +85°C)

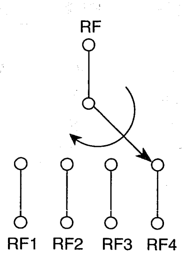
Typical Performance at 25°C







Schematic



Specifications Subject to Change Without Notice

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}Hi	V_{IN}Hi	V_{IN}Low	Off	Off	Off	On

GaAs Matched SP4T Switch
0.02–2 GHz

SW-369

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

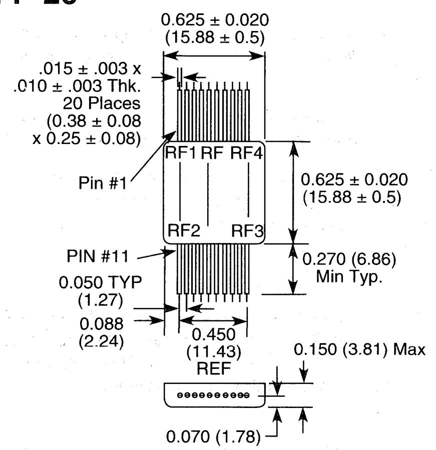
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise,Tfall (10% to 90% RF)			8 ns Typ
Ton, Toff (50% CTL to 90/10% RF)			60 ns Typ
Transients (in band)			50 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+23 dBm Typ
0.05 GHz			+17 dBm Typ
Intermodulation Intercept Point (for two-tone 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

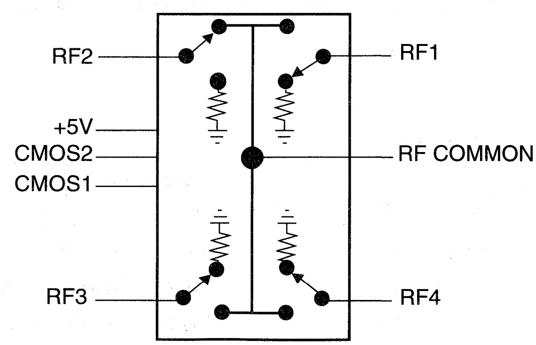
Model No.	Package
SW-369 PIN	Flatpack

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

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

Notes: 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.

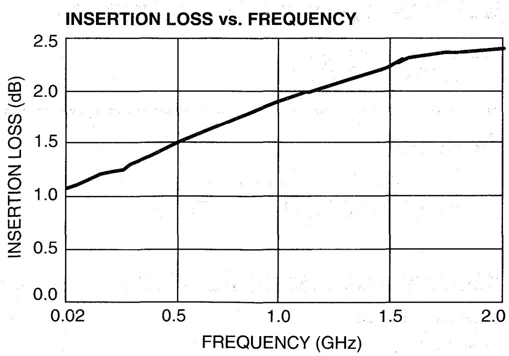
Pin Configuration

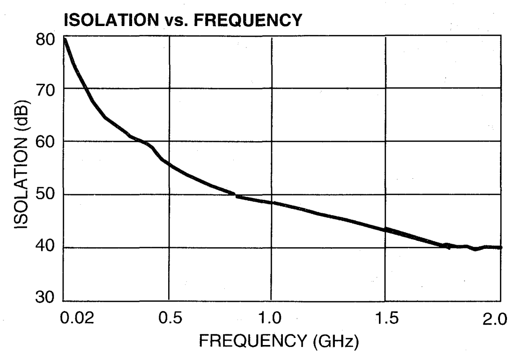
Pin No.	Description	Pin No.	Description
1	RF1	11	RF2
2	GND	12	GND
3	GND	13	GND
4	GND	14	+5VDC
5	RF Common	15	CMOS 2
6	GND	16	CMOS 1
7	GND	17	N/C
8	GND	18	GND
9	GND	19	GND
10	RF4	20	RF3

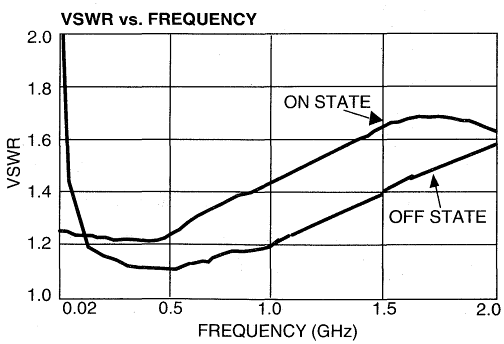
Truth Table

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







GaAs Matched SP6T Switch
DC–2 GHz

SW-284

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

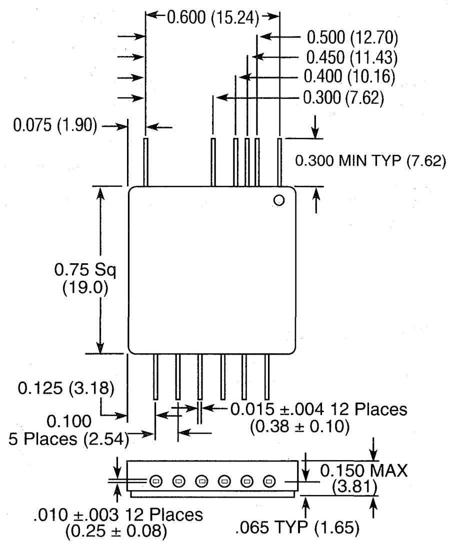
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90% RF)			3.0 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			180 ns Typ
Transients (In-Band)			150 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			23 dBm Typ
0.05 GHz			21 dBm Typ
Intermodulation Intercept Point (for 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

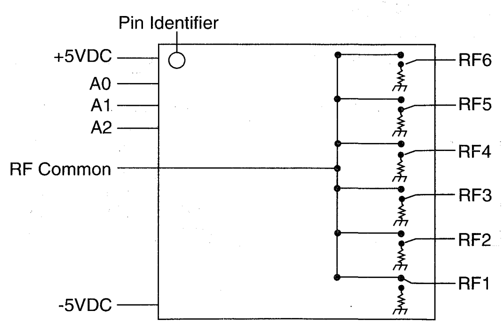
Model No.	Package
SW-284 PIN	Flatpack

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

Absolute Maximum Ratings

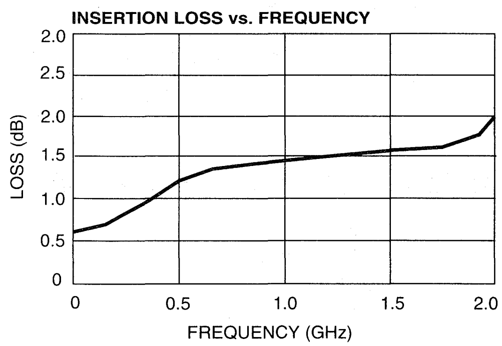
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz[2]	+34 dBm
Bias Voltage	
+5V Supply	-0.5 to +7V
-5V Supply	-7V to + 0.5V
Control Voltage	-0.5 to Vcc + 0.5V
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

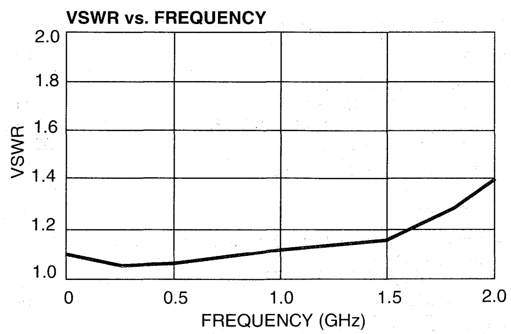
Notes:
1. Operation of this device above any one of these parameters may cause permanent damage.
2. When the RF input power is applied to the terminated port, the absolute maximum is +32 dBm.

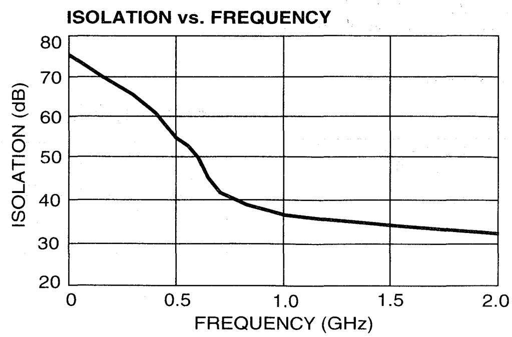
Truth Table

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







GaAs DPDT Switch
DC–2 GHz

SW-355

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

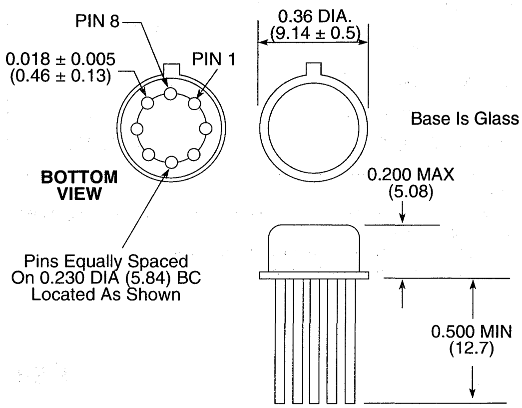
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			10 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			12 ns Typ
Transients (In-Band)			100 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Pt. (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 -0.2V @ 20 µA Max
Vin High			-5V @ 10 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. Isolation is measured from RF2 to RF1.
3. Contact the factory for standard or custom screening requirements.

Ordering Information

Model No.	Package
F PIN	TO-5-3

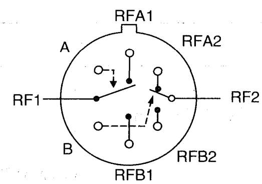
TO-5-3



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

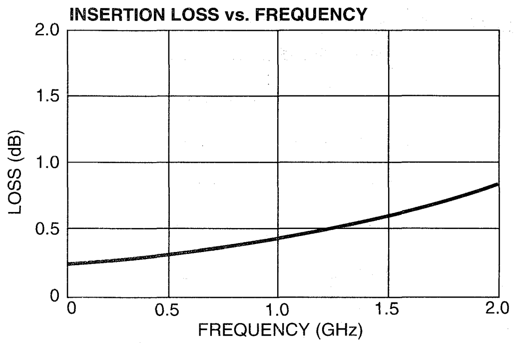
Specifications Subject to Change Without Notice

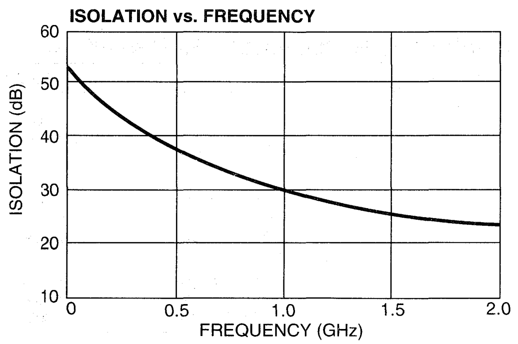
Absolute Maximum Ratings

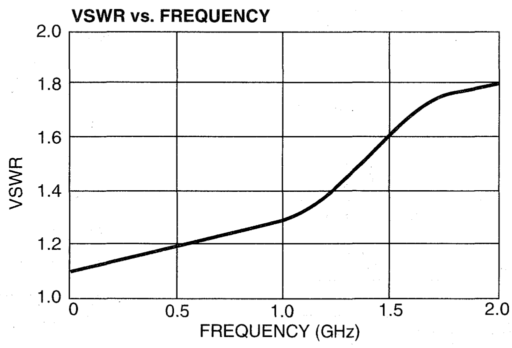
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125°C
Storage Temperature	–65˚C to +150˚C

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance



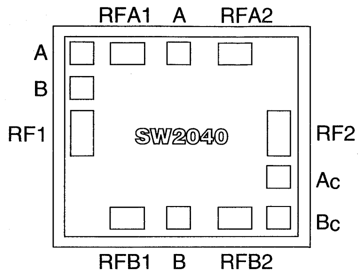




GaAs DPDT Switch DC – 2 GHz

MASW2040

- 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

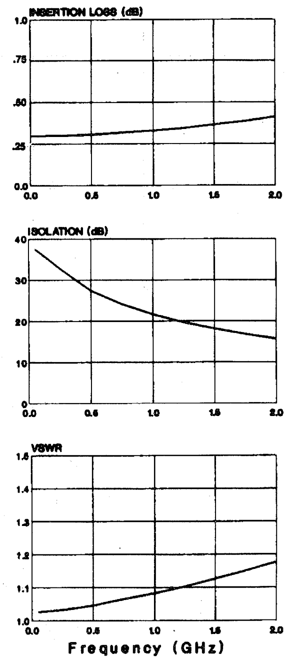
Operating Characteristics

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)

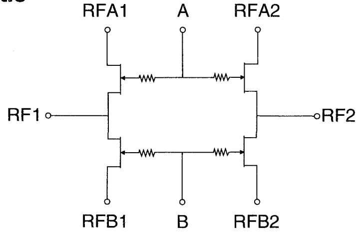
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages.

*** Loss change 0.0025dB/°C (-55°C to +85°C)

Typical Performance @ 25°C



Schematic



Specifications Subject to Change Without Notice

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 pads to package are recommended.

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)

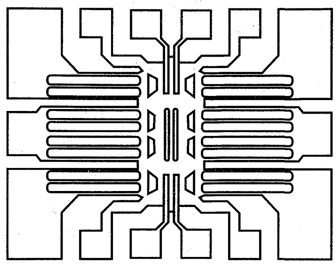
Die Size — Inches (mm)
0.045 x 0.038 x 0.010 (1.13 x 0.97 x 0.25)

M/A-COM

GaAs DPDT Switch
DC-6 GHz
MASW6030

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 DC – 2 GHz DC – 4 GHz DC – 6 GHz	0.6 dB Max 0.8 dB Max 1.0 dB Max 1.5 dB Max
VSWR	DC – 1 GHz DC – 2 GHz DC – 4 GHz DC – 6 GHz	1.2:1 Max 1.4:1 Max 1.5:1 Max 1.8:1 Max
Isolation	DC – 1 GHz DC – 2 GHz DC – 4 GHz DC – 6 GHz	40 dB Min 35 dB Min 25 dB Min 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)		15 mV Typ
Input Power for 1dB Compression		
Control Voltages (Vdc)	0/–5	0/–8
0.5 – 6 GHz	+27 dBm	+33 dBm Typ
0.05 GHz	+21 dBm	+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)		
$V_{IN}L_{OW}$		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)

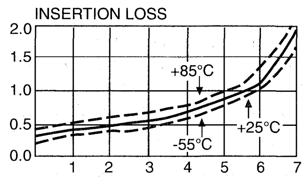
Environmental
These units are designed to meet or exceed the following: Electrical, 100% probing at 25°C for selected parameters. Visual, 100% per MIL-STD-883 Method 2010 Condition B. Lot traceability supplied on request.

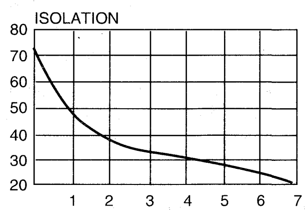
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages and chip interconnections made with 0.001" dia. wirebonds.

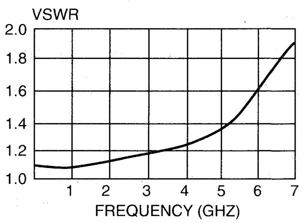
*** Loss changes 0.0025 dB/°C (-55°C to +85°C)

****Faster switching speed can be achieved with enhanced driver waveform.

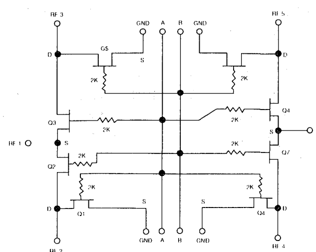
Typical Performance







Schematic



Specifications Subject to Change Without Notice

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.

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)

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

Specifications Subject to Change Without Notice

GaAs DPDT Switch Chip
DC-6 GHz

SW-280

- Low Insertion Loss, 0.5 dB Typical
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications*
(From -55°C to +85°C)

Frequency Range		DC - 6 GHz
Insertion Loss	DC - 6 GHz	1.5dB Max
	DC - 4 GHz	1.0dB Max
	DC - 2 GHz	0.8dB Max
	DC - 1 GHz	0.6dB Max
VSWR	DC - 6 GHz	1.8:1 Max
	DC - 4 GHz	1.5:1 Max
	DC - 2 GHz	1.4:1 Max
	DC - 1 GHz	1.2:1 Max
Isolation	DC - 6 GHz	20dB Min
	DC - 4 GHz	25dB Min
	DC - 2 GHz	35dB Min
	DC - 1 GHz	40dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			15mV Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/-5	0/-8	
0.5 to 6 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 6 GHz	+68	+40	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 @ 100 μA Max
Die Size			0.036″x0.046″x0.010″ (0.91mm x 1.17mm x 0.25mm)

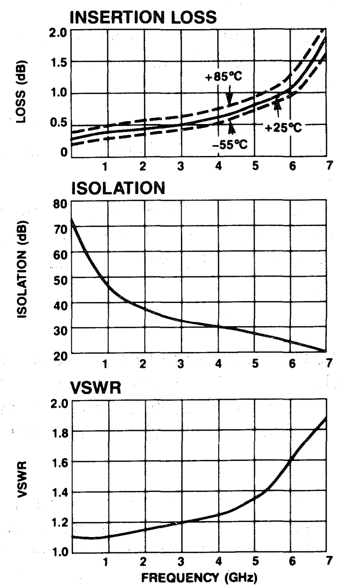
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm 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
**When an RF output port is "off" it is shorted to ground through an "on" shunt MESFET

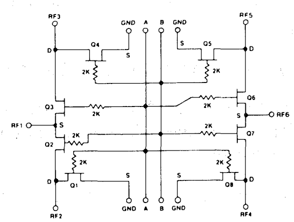
Ordering Information

Model No.	Package
SW-280 CHP	Chip

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

Specifications Subject to Change Without Notice.

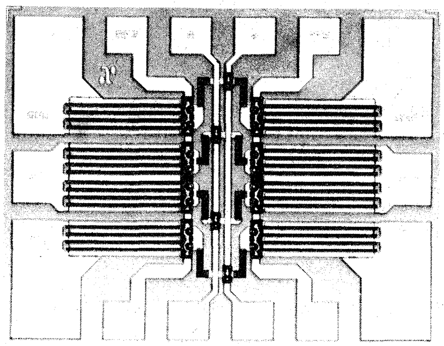
Maximum Ratings

A. Control Voltage (A or B): -8.5 Vdc

B. Max Input RF Power: +34dBm (0.5 - 6.0 GHz with 0/–8V CTL)

C. Storage Temperature: -65 °C to +175 °C

D. Maximum Operating Temperature: +175 °C



BondPad Dimensions Inches (mm)

RF1, RF6:	(.005 x .006) (.130 x .150)
RF2-RF5:	(.004 x .004) (.100 x .100)
GND:	(.005 x .013) (.130 x .320)

Die Size Inches (mm)

0.036 x 0.046 x 0.010
(0.91 x 1.17 x 0.25)

Handling Precautions

Permanent damage to the SW-280 may occur if the following precautions are not adhered to:

A. Cleanliness — The SW-280 should be handled in a clean environment. DO NOT attempt to clean unit after the SW-280 is installed.

B. Static Sensitivity — All chip handling equipment and personnel should be DC grounded.

C. Transients — Avoid instrument and power supply transients while bias is applied to the SW-280. 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 A nor B should be allowed to "float".

E. General Handling — It is recommended that the SW-280 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 SW-280 is back-metallized with TiPtAu (300/1000/5000Å) 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 SW-280 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 SW-280 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 required to achieve reliable wirebonds.

B. Wirebonds should be started on the chip 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.

GaAs Transfer Switch
DC–2 GHz

SW-362

Features

- Broad Bandwidth
- Low Power Consumption
- Fast Switching Speed

Guaranteed Specifications[1] (-55°C to + 85°C)

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

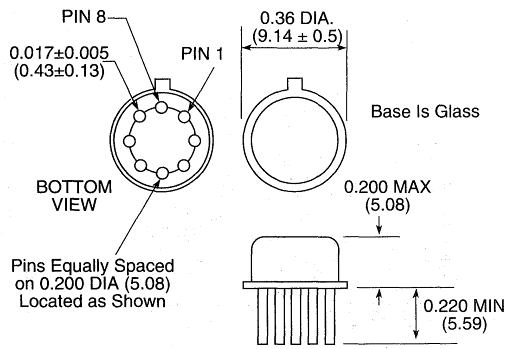
Impedance			50 Ohms Nominal
Switching Characteristics			
T_{rise}, T_{fall} (10% to 90%)			4 ns Typ
T_{on}, T_{off} (50% CTL to 90%/10% RF)			7 ns Typ
Transients (In-Band)			25 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Pt. (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.

Ordering Information

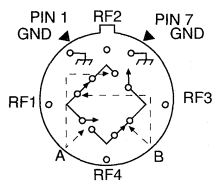
Model No.	Package
SW-362 PIN	Ceramic

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)

Functional Schematic (Top View)



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

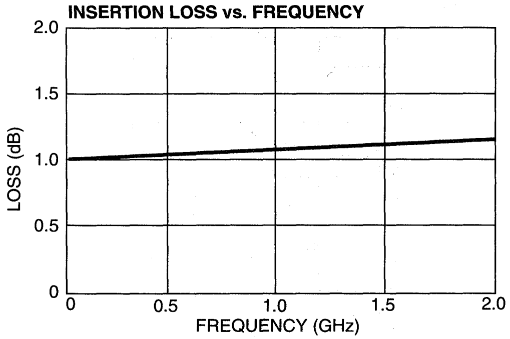
Specifications Subject to Change Without Notice

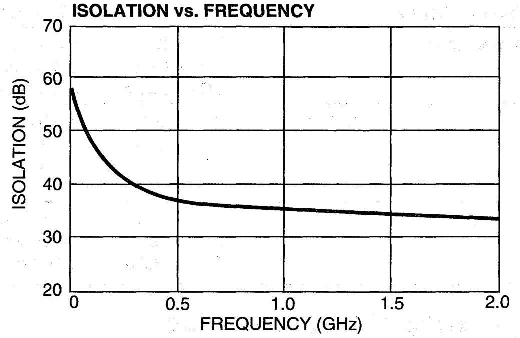
Absolute Maximum Ratings

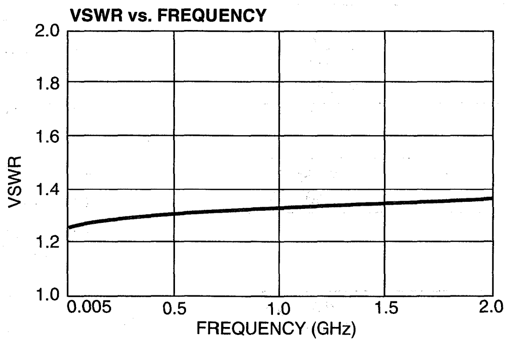
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5–2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performances





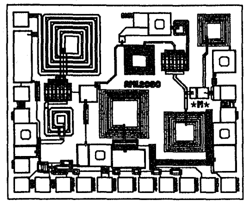


![M/A-COM]

GaAs Transfer Switch DC–12 GHz

MASW12000G

- 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***

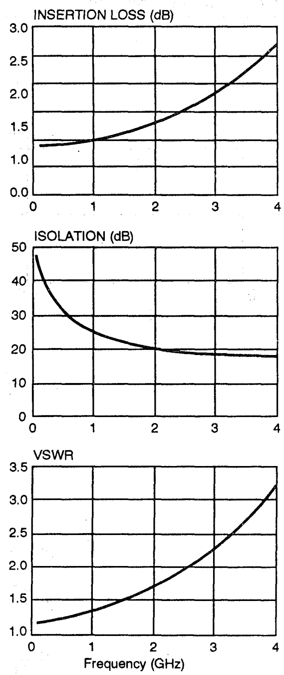
Frequency Range			DC - 12.0 GHz
Insertion Loss		DC - 1 GHz	1.3 dB Max
		DC - 4 GHz	1.5 dB Max
		DC - 12 GHz	3.2 dB Max
VSWR	Reflective	DC - 1 GHz	1.3 Max
		DC - 4 GHz	1.5 Max
		DC - 12 GHz	3.0 Max
	Absorptive	DC - 4 GHz	2.5 Max
Isolation		DC - 1 GHz	40 dB Min
		DC - 4 GHz	20 dB Min
		DC - 12 GHz	10 dB Min

Operating Characteristics

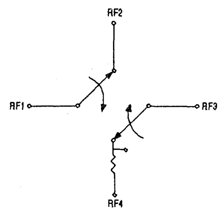
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		5 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		10 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	0/-8
0.5 - 12 GHz	+27 dBm	+29 dBm Typ
0.05 GHz	dBm	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Intercept Points		IP_3
0.5 - 12 GHz		dBm Typ
0.05 GHz		dBm Typ
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



Schematic



Specifications Subject to Change Without Notice

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

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

BondPad 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

M/A-COM

GaAs Solid State Relay
DC–2 GHz

SW-368

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)

Frequency Range			DC – 2.0 GHz	
		RF2- RF1	RF1-RFA1/ RF2-RFA2	
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

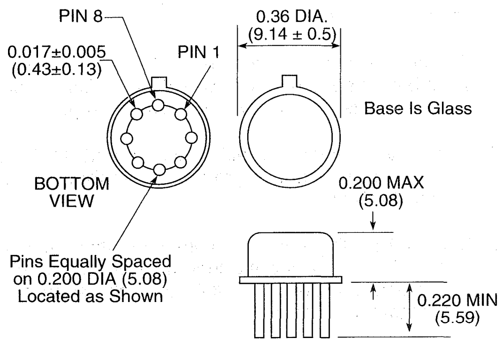
Control Voltage (Complementary Logic)	
Vin Low	-5 to -8V @ 200 µA Max
Vin High	+3 to +5V @ 100 µA Max

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

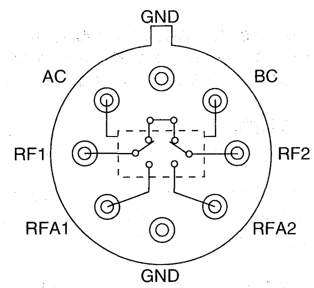
T0-5-4



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)

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

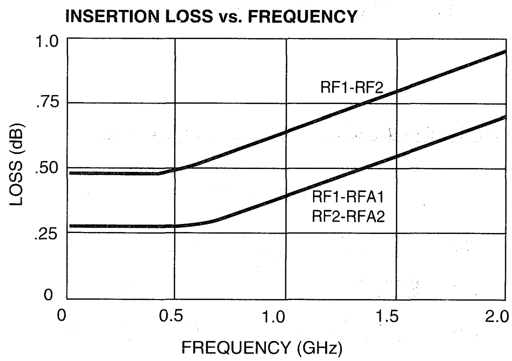
Specifications Subject to Change Without Notice

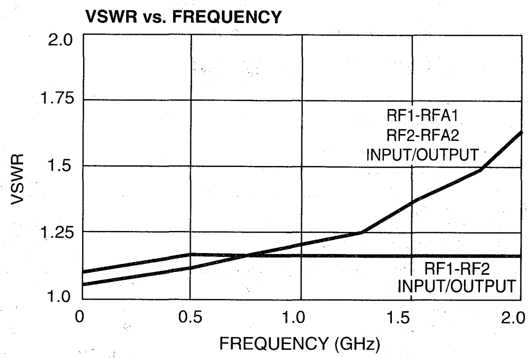
Absolute Maximum Ratings

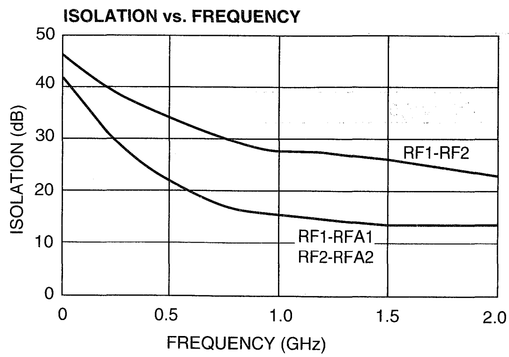
Parameter	Absolute Maximum
Max. Input Power	+34 dBm
Control Voltage	+5.5V, –8.5V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

Notes:
1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







Voltage Variable Absorptive Attenuator DC–3 GHz

AT-252

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

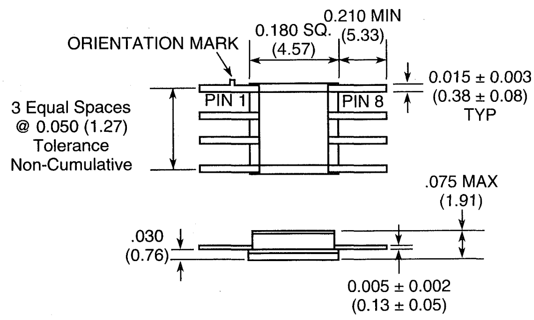
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			3 ns Typ
Ton, Toff (50% CTL to 90%/10% RF)			5 ns Typ
Transients (In-Band)			10 mV Typ
Power Handling			
Linear Operation			+13 dBm Max
Absolute Max Input Power			+21 dBm Max
Intermodulation Intercept Point (for two-tone 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 4 dB attenuation.
4. Contact the factory for standard or custom screening requirements.

Ordering Information

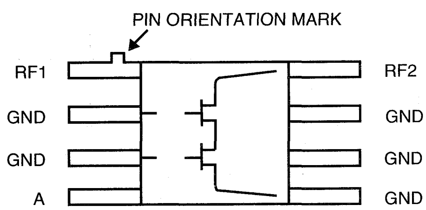
Model No.	Package
AT-252 PIN	Ceramic

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)

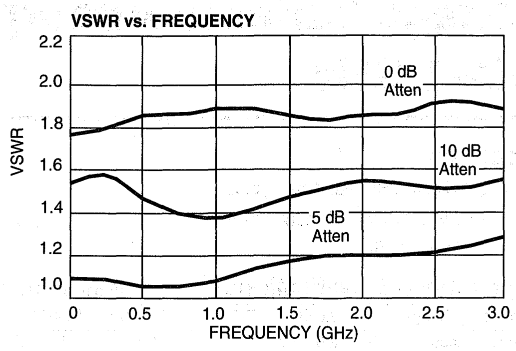


Specifications Subject to Change Without Notice

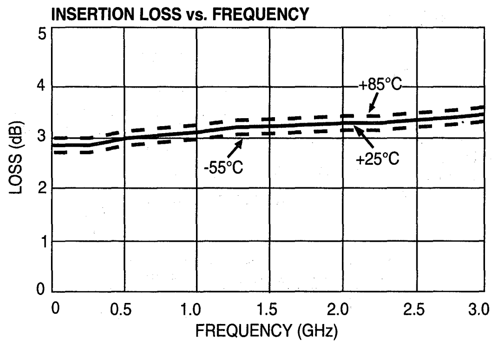
Absolute Maximum Ratings

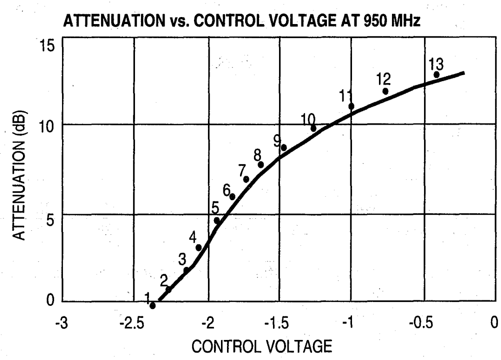
Parameter	Absolute Maximum[1]
Max. Input Power	+21 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +25˚C
Storage Temperature	–65˚C to +150˚C

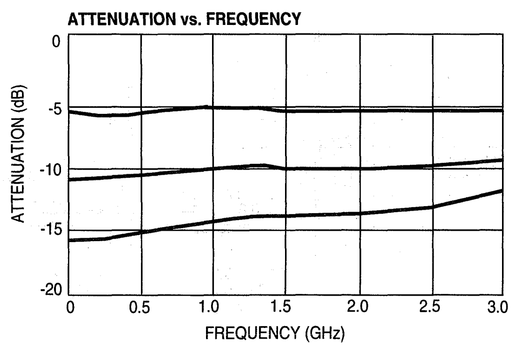
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.

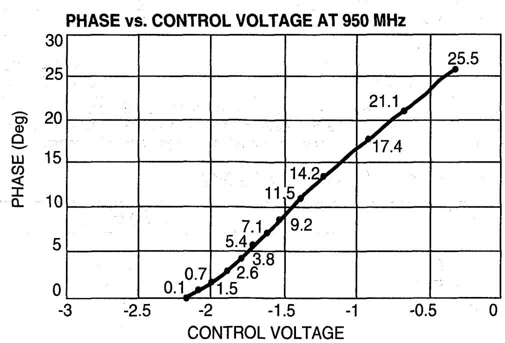


Typical Performance









M/A-COM

Voltage Variable Absorptive Attenuator, 19dB
DC–2 GHz
AT-302, AT-303, AT-307

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	DC – 2.0 GHz	1.5	1.5	1.5	dB Max
(Peak to Peak)	DC – 1.0 GHz	1.0	1.5	1.5	dB Max
Attenuation vs.	0 to 10 dB Att.	±0.5	±0.5	±0.5	dB Max
Temperature	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

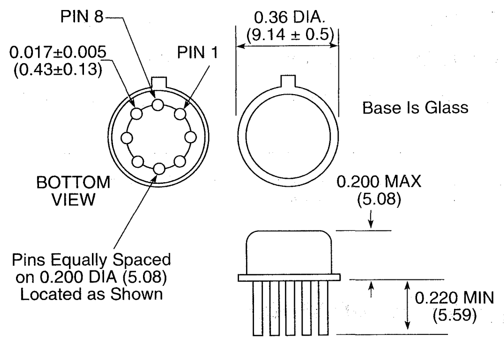
A Input (Shunt FETS)	0 to -4V @ 100 µA Max
B Input (Series FETS)	0 to -4V @ 100 µA Max

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.

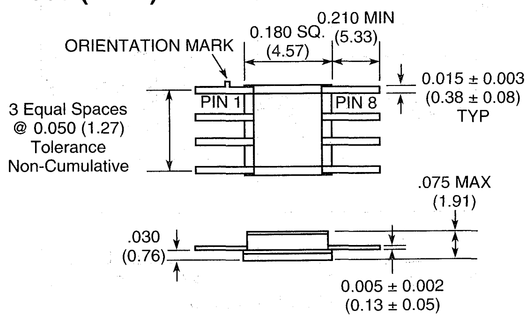
Ordering Information

Model No.	Package
AT-302 PIN	TO-5-4
AT-303 PIN	Ceramic
AT-307 PIN	Ceramic

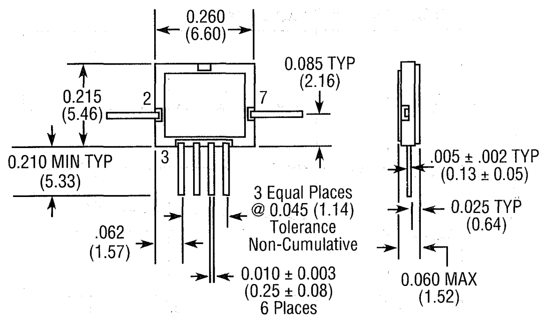
AT-302 (TO-5-4)



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.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice

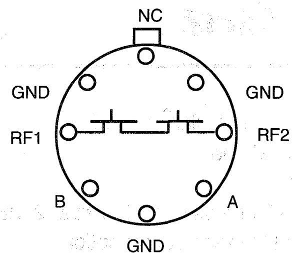
Absolute Maximum Ratings

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

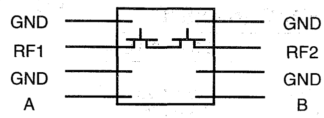
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematics (Top View)

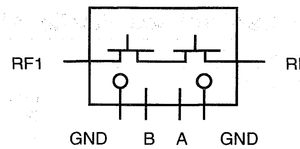
AT-302



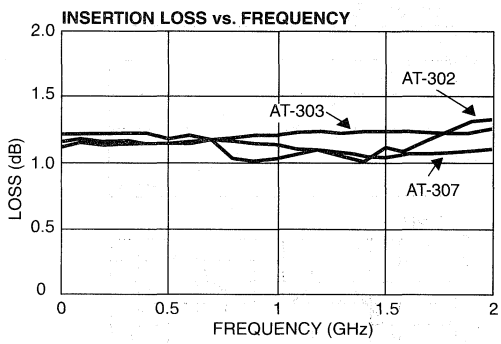
AT-303

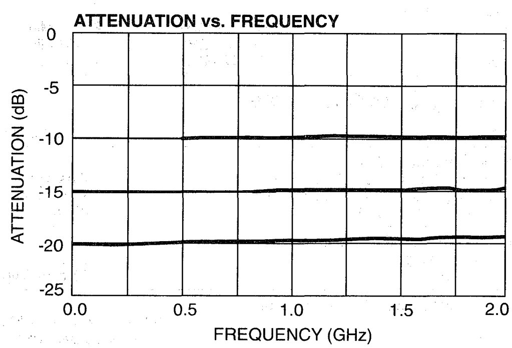


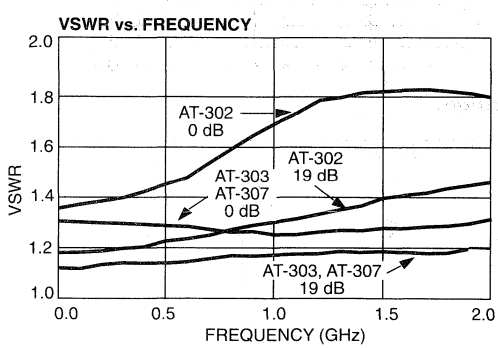
AT-307

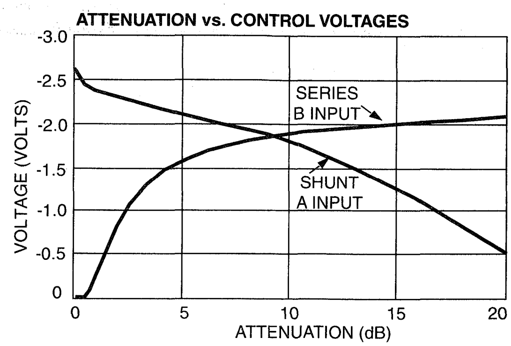


Typical Performance





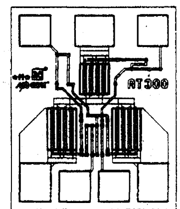




Specifications Subject to Change Without Notice

GaAs MMIC Voltage Variable Absorptive Attenuator
DC - 2 GHz MAAA2000G

- 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** -55°C to +85°C

Frequency Range		DC – 12.0 GHz
Insertion Loss	DC – 1 GHz DC – 2 GHz DC – 12 GHz	1.2 dB Max 1.4 dB Max 1.5 dB Max
VSWR	DC – 1 GHz DC – 2 GHz DC – 12 GHz	1.5:1 Max 1.5:1 Max 1.8:1 Max
Relative Attenuation (Matched) (Reflective) (Matched)	 DC – 2 GHz DC – 2 GHz 2 – 12 GHz	 23 dB Min 40 dB Min 12 dB Min

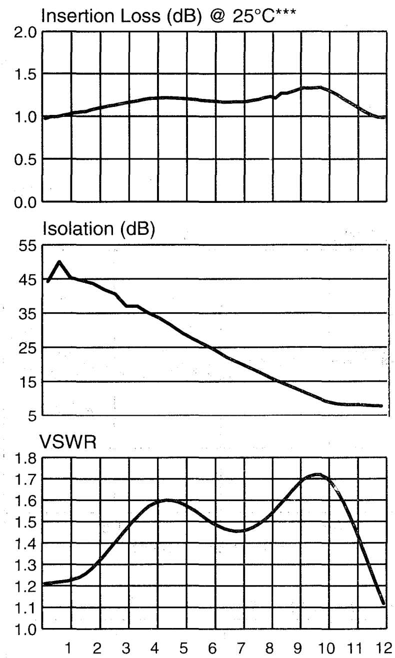
Operating Characteristics

Impedance		50 Ω Nominal
Switching Characteristics t_{RISE}, t_{FALL} (10/90% or 90/10% RF) t_{ON}, t_{OFF} (50% CTL to 90/10% RF) Transients (In-Band)		 7 ns Typ 10 ns Typ 20 mV Typ
Input Power for 1dB Compression Control Voltages (Vdc) 0.5 – 4 GHz		 0/–5 15 dBm Typ
Control Voltages (Complementary Logic) $V_{IN}L_{OW}$ $V_{IN}H_{I}$		 0 to –0.2V @ 9 μA Max –5V @ 50 μA Typ Max
Die Size		0.025" x 0.030" x 0.010" (1.63mm x 0.75mm x 0.25mm)

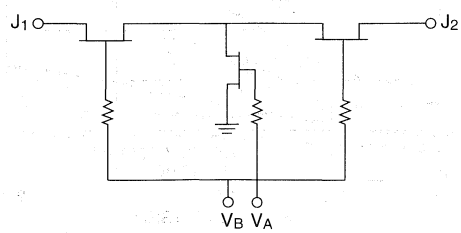
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and –5 Vdc control voltages

*** Loss change 0.00025 dB/°C (-55°C to +85°C)

Typical Performance



Schematic



Specifications Subject to Change Without Notice

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.

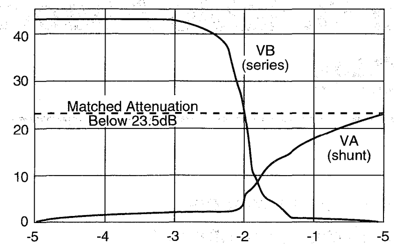
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

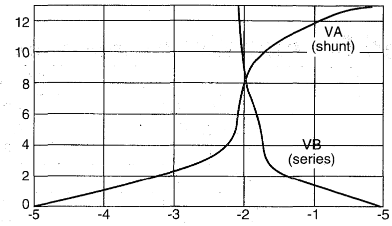
A. Ball or wedge with 1.0 mil diameter pure gold wire. Thermosonic wirebonding with a nominal stage temperature of 150°C and a ball bonding force of 40 to 50 grams or wedge bonding force of 18 to 22 grams is recommended. Ultrasonic energy and time should be adjusted to the minimum levels achieve reliable 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

M/A-COM

Voltage Variable Absorptive Attenuator DC–3 GHz

AT-637

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	8.0 dB Max
	DC – 2.0 GHz	7.5 dB Max
	DC – 1.0 GHz	7.2 dB Max
VSWR	DC – 3.0 GHz	3.2:1 Max
Attenuation[2]	DC – 3.0 GHz	27 dB Min
	DC – 2.0 GHz	30 dB Min
	DC – 1.0 GHz	34 dB Min
Flatness (Peak to Peak)	DC – 3.0 GHz	
	10 dB Atten	+/-1.0 dB Max
	20 dB Atten	+/-1.5 dB Max
	30 dB Atten	+/-3.5 dB Max
Attenuation vs. Temperature	DC – 3.0 GHz	+/-3.5 dB Max

Operating Characteristics

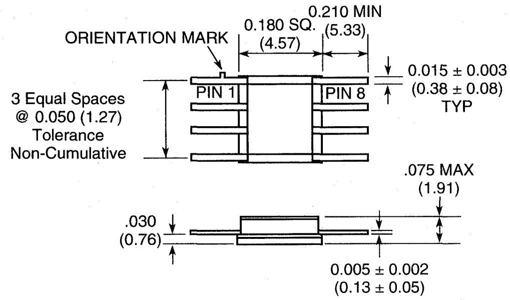
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			2 ns Typ
Ton, Toff (50% CTL to 90%/10%)			4 ns Typ
Transients (In-Band)			30 mV Typ
Power Handling			
Linear Operation			+13 dBm Max
Absolute Max Input Power			+21 dBm Max
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3[3]	
0.05 GHz	+34	+31	dBm Typ
0.5 – 3.0 GHz	+47	+36	dBm Typ
Control Voltage (A Input)			-4.0 to 0v @ 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 4 dB attenuation.
4. Contact the factory for standard or custom screening requiremets.

Ordering Information

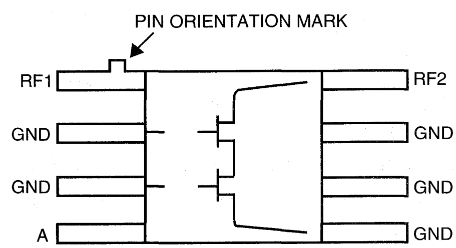
Model No.	Package
AT-637 PIN	Ceramic

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)



Specifications Subject to Change Without Notice

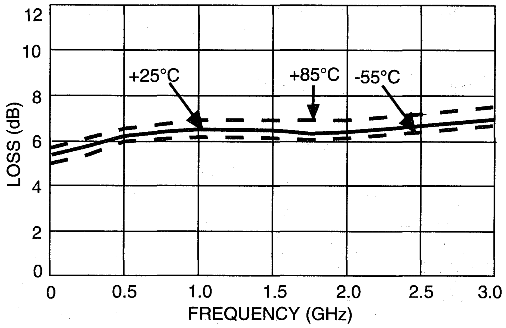
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power	+21 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55°C to +125°C
Storage Temperature	–65°C to +150°C

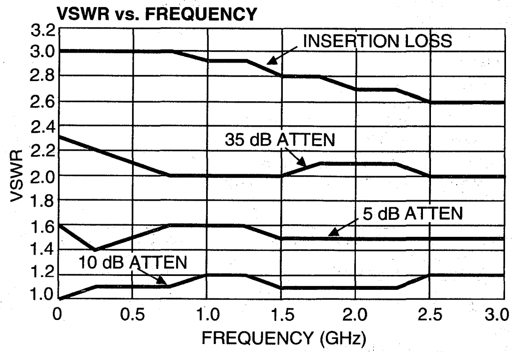
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance

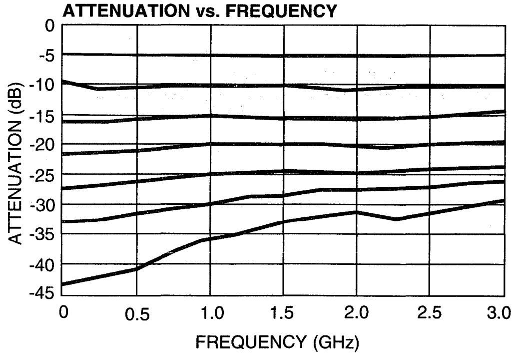
INSERTION LOSS vs. FREQUENCY



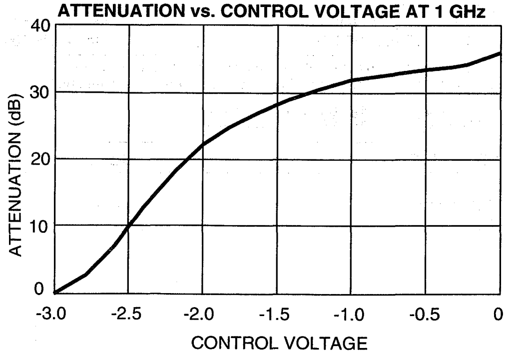
VSWR vs. FREQUENCY



ATTENUATION vs. FREQUENCY



ATTENUATION vs. CONTROL VOLTAGE AT 1 GHz



Voltage Variable Absorptive Attenuator DC–2 GHz

AT-332, AT-337

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		1.5 dB Max
	DC – 1.0 GHz		1.2 dB Max
VSWR		AT-332	AT-337
	DC – 2.0 GHz	1.4:1	1.5:1 Max
	DC – 1.0 GHz	1.25:1	1.3:1 Max
Attenuation (Matched) @ 25°C	DC – 2.0 GHz		40 dB Min
Flatness (Peak to Peak)	0-20 dB Attenuation		1.0 dB Max
	0-30 dB Attenuation		2.0 dB Max
	0-40 dB Attenuation		3.0 dB Max
Attenuation vs Temperature (Relative to 25°C)	0 to 20 dB Attenuation		±2.5 dB
	0 to 30 dB Attenuation		±4.0 dB
	0 to 40 dB Attenuation		±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

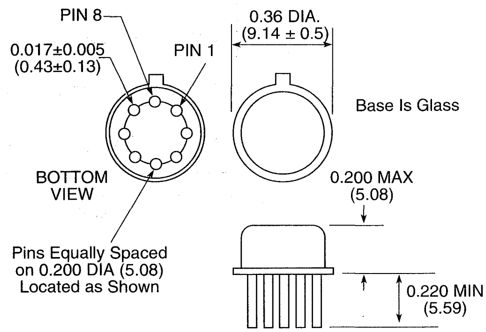
A input (Shunt FETS)	0 to -4V @ 100 μA Max
B input (Series FETS)	0 to -4V @ 100 μA Max

1. All specifications apply with 50 ohm connected to all RF Ports.
2. Contact the factory for standard or custom sreenig requirements.

Ordering Information

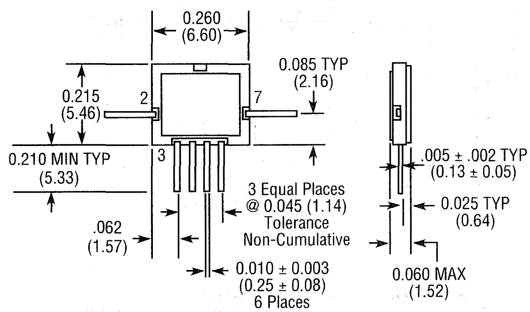
Model No.	Package
AT-332 PIN	TO-5-4
AT-337 PIN	Ceramic

AT-332 (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)

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)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice

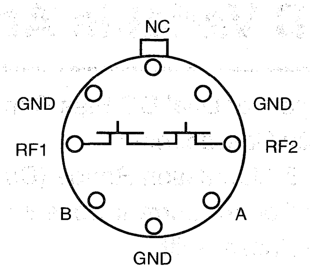
Absolute Maximum Ratings

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

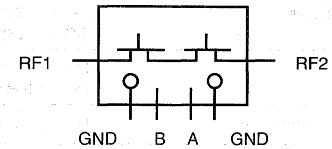
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.

Functional Schematics (Top View)

AT-332

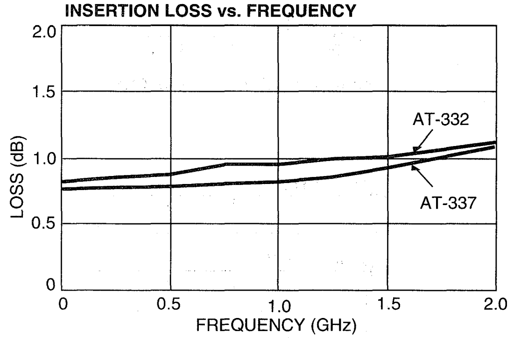


AT-337

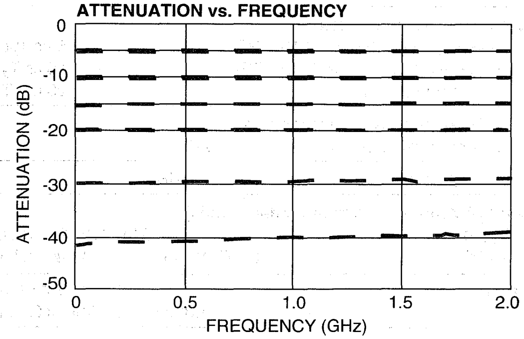


Typical Performance

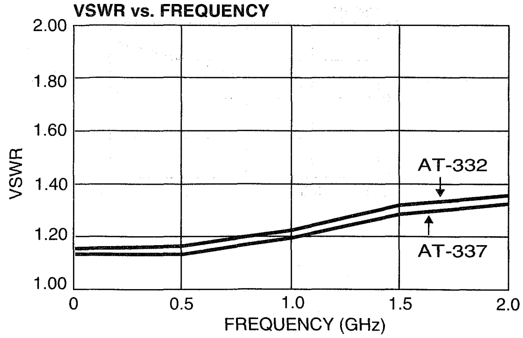
INSERTION LOSS vs. FREQUENCY



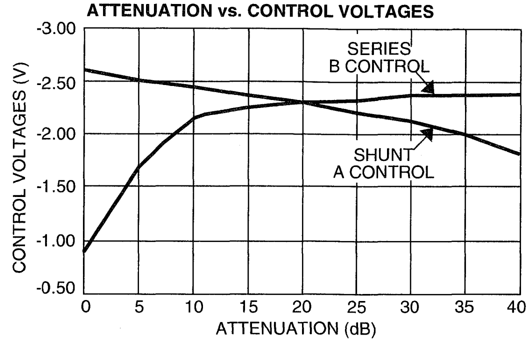
ATTENUATION vs. FREQUENCY



VSWR vs. FREQUENCY



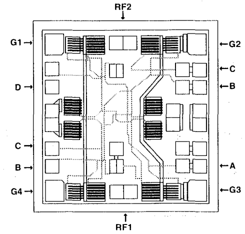
ATTENUATION vs. CONTROL VOLTAGES



GaAs MMIC DC - 2 GHz 50 dB Variable Attenuator

MAAA2010G

- 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***

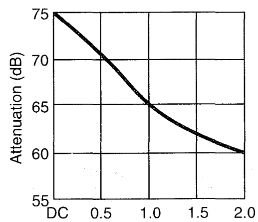
Frequency Range		DC - 12.0 GHz
Insertion Loss	DC - 1 GHz DC - 2 GHz	1.4 dB Max 1.8 dB Max
VSWR	DC - 1 GHz DC - 2 GHz	1.4 Max 1.8 Max
Relative Attenuation	DC - 2 GHz	50 dB Min

Operating Characteristics***

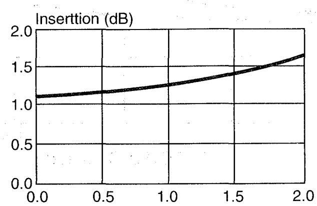
Impedance		50 Ω Nominal
Switching Characteristics		
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)		5 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		10 ns Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression		
Control Voltages (Vdc)	0/-5	
0.5 - 12 GHz	+15 dBm	
Control Voltages (Complementary 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)

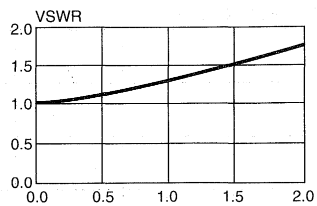
** All specifications apply with 50 Ω impedance connected to all RF ports, 0 and -8 Vdc control voltages.
*** Loss change 0.0025 dB/°C. (From -55°C to +85°C)

Typical Performance for Dual Bias



Attenuation (dB) vs. Frequency (GHz).





Specifications Subject to Change Without Notice

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.

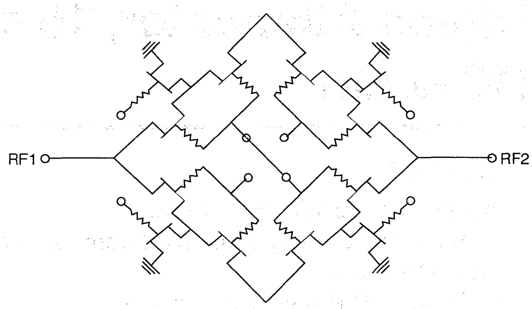
C. Electrically conductive epoxy may be used but is not required.

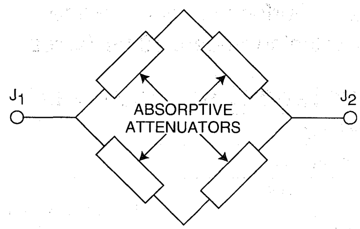
Wire Bonding

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

Specifications Subject to Change Without Notice

Digital Attenuator, 15 dB, 4 Bit
DC–2 GHz

AT-212

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% of Attenuation Setting in dB) dB
Any Combination of Bits		+/-(0.15 dB +3% of Attenuation Setting in dB) dB
VSWR	DC – 2.0 GHz	1.5:1 Max
Reference Insertion Loss	DC – 2.0 GHz	2.0 dB Max

Operating Characteristics

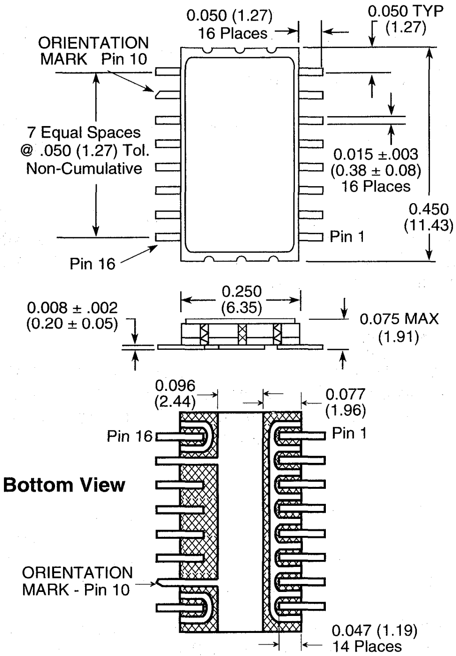
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			10 ns Typ
Ton, Toff (50% CTL to 90%/10%)			15 ns Typ
Transients (in-Band)			18 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+22 dBm Typ
0.5 GHz to 3 GHz			+28 dBm Typ
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+49	+45	dBm
0.5 GHz to 3 GHz	+72	+50	dBm
Control Voltages (Complementary Logic)			
Vin Low			0V to -0.2V @ 20 µA Max
Vin Hi			-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-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

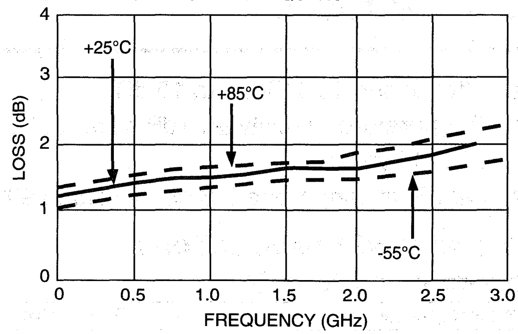
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power 0.05 GHz 0.5 – 2.0 GHz	 +27 dBm +34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125˚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

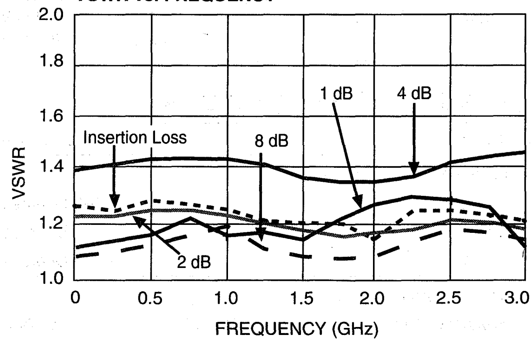


Truth Table

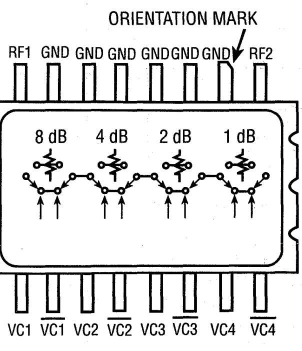
Control Inputs								
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	Attenuation (dB)
1	0	1	0	1	0	1	0	Reference
0	1	1	0	1	0	1	0	1 dB
1	0	0	1	1	0	1	0	2 dB
1	0	1	0	0	1	1	0	4 dB
1	0	1	0	1	0	0	1	8 dB
0	1	0	1	0	1	0	1	15 dB

"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

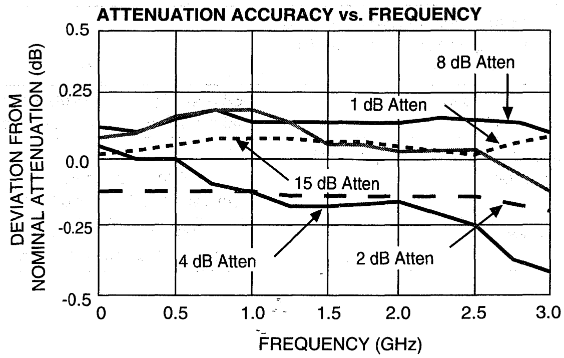
VSWR vs. FREQUENCY



Functional Schematic (Top View)



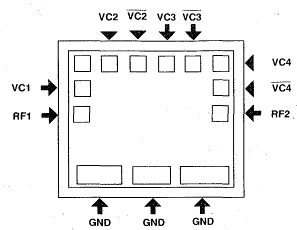
ATTENUATION ACCURACY vs. FREQUENCY



4 Bit GaAs Digital Attenuator
DC - 2 GHZ

MADA2000G

- 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°)

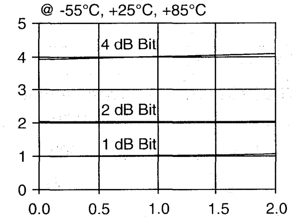
Frequency Range	DC - 2.0 GHz	
Nominal Attenuation	1 dB Steps to 15 dB Max	
Attenuation Accuracy	±0.15 dB	±3% of Attenuation Setting
VSWR Worst Case Setting	DC - 2 GHz	1.6:1 Max
Reference Insertion Loss	DC - 2 GHz DC - 1 GHz	2.2 dB Max 1.8 dB Max

Operating Characteristics

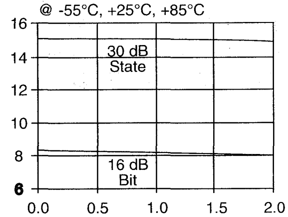
Impedance		50 Ω Nominal
Phase Deviation (All states)		
2 Ghz		+5/-6 Degrees Typ
1 Ghz		+3/-3 Degrees Typ
500 MHz		+2/-2 Degrees Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 1 dB Compression		
Above 500 MHz		+27 dBm Typ
100 MHz		+24 dBm Typ
Intermodulation Intercept Point (for two-tone input 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		0.045" x 0.039" x 0.010" (1.14mm x 0.99mm x 0.25mm)

Typical Performance

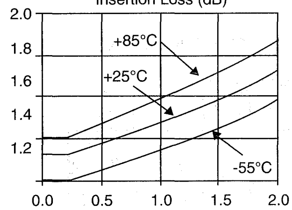
Attenuation (dB) 1,2,4 db States
@ -55°C, +25°C, +85°C



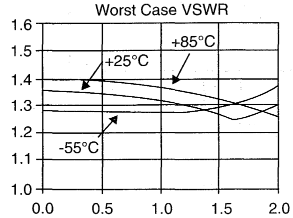
Attenuation (dB) 8,15, db States
@ -55°C, +25°C, +85°C



Insertion Loss (dB)



Worst Case VSWR



Specifications Subject to Change Without Notice

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.

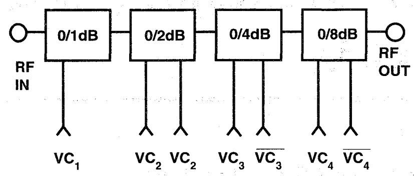
C. Electrically conductive epoxy may be used but is not required.

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 Reference
V_{in}Hi	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	V_{in}Hi	V_{in}Low	
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_nHi	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)

![M/A-COM]

Digital Attenuator, 32 dB, 2 Bit
DC-2 GHz

AT-272

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

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

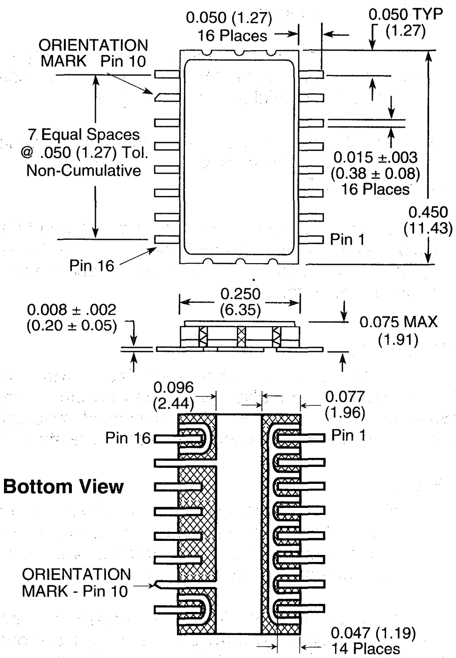
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			6 ns Typ
Ton, Toff (50% CTL to 90%/10%)			16 ns Typ
Transients (in-Band)			15 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+27 dBm Typ
0.5 GHz to 3 GHz			+30 dBm Typ
Intermodulation Intercept point (for two-tone 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.
3. See Appendix for MIL-STD-883 screening option.

Ordering Information

Model No.	Package
AT-272 PIN	Ceramic

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)

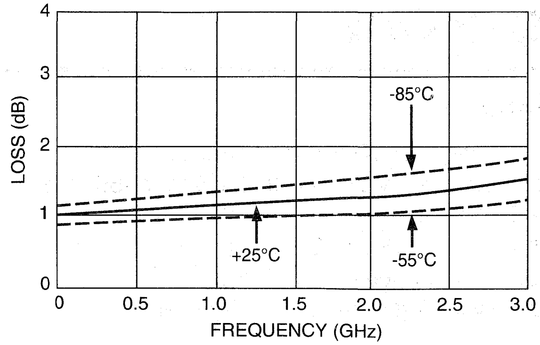
Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Max. Input Power 0.05 GHz 0.5 – 2.0 GHz	 +27 dBm +34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125˚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

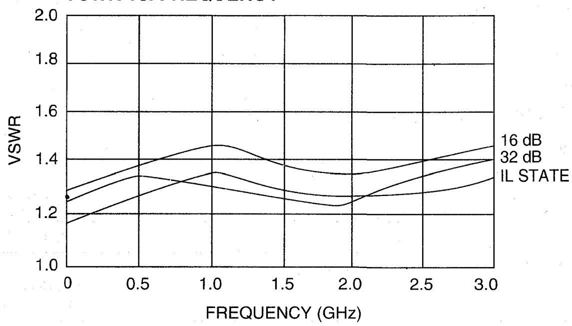


Truth Table

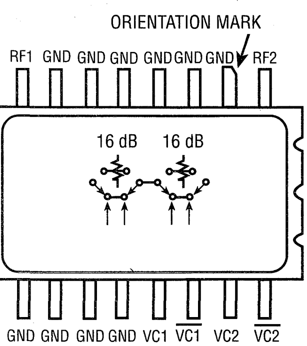
Control Inputs				
$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	**Attenuation (dB)**
1	0	1	0	Reference
1	0	0	1	16 dB
0	1	1	0	16 dB
0	1	0	1	32 dB

"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

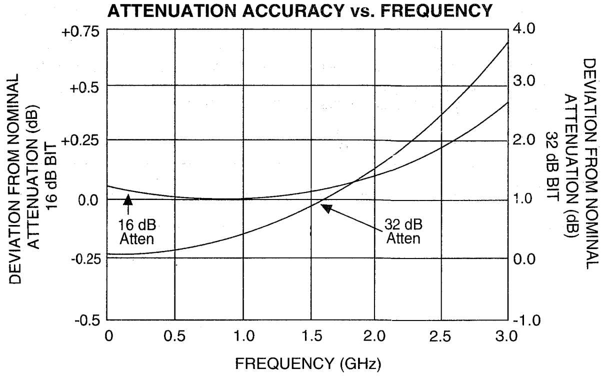
VSWR vs. FREQUENCY



Functional Schematic (Top View)



ATTENUATION ACCURACY vs. FREQUENCY



Specifications Subject to Change Without Notice

Digital Attenuator, 15.5 dB, 5 Bit
DC–2 GHz

AT-282

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		+/-(0.2 dB +3% of Attenuation Setting in dB) dB
VSWR	DC – 2.0 GHz	1.6:1 Max
Reference Insertion Loss	DC – 2.0 GHz	2.2 dB Max

Operating Characteristics

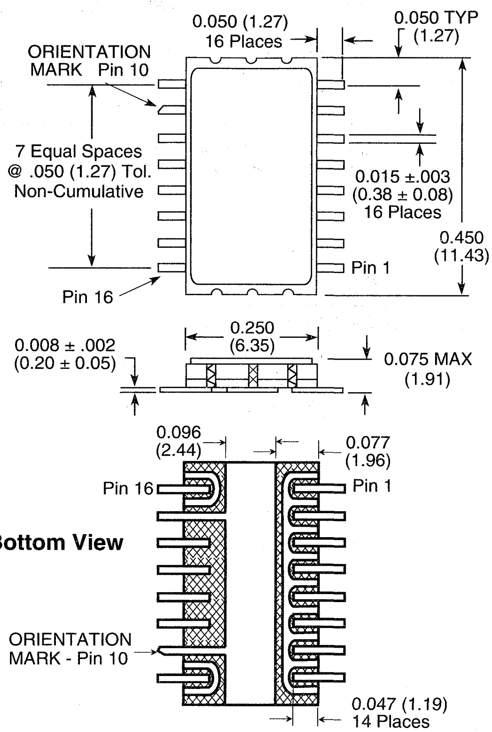
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			12 ns Typ
Ton, Toff (50% CTL to 90%/10%)			18 ns Typ
Transients (in-Band)			30 mV Typ
Input Power for 1 dB Compression			
0.05 GHz			+22 dBmTyp
0.5 – 2.0 GHz			+27 dBmTyp
Intermodulation Intercept point (for two-tone 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			0V to -0.2V @ 30 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.

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

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

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

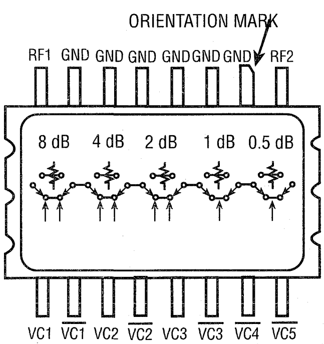
Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

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

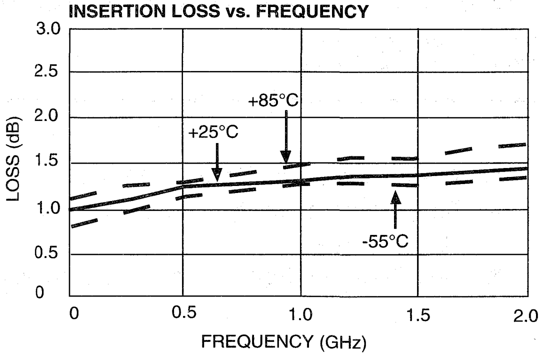
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Functional Schematic (Top View)

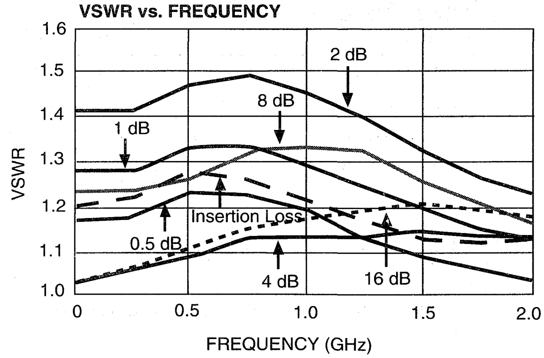


Typical Performance

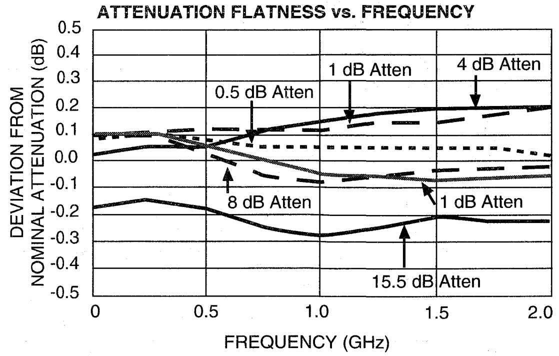
INSERTION LOSS vs. FREQUENCY



VSWR vs. FREQUENCY



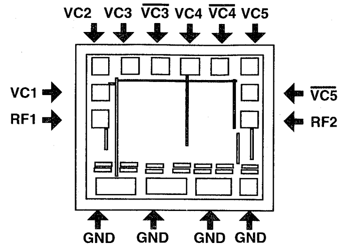
ATTENUATION FLATNESS vs. FREQUENCY



5 Bit GaAs Digital Attenuator DC - 2 GHZ

MADA2030G

- Attenuation 0.5 dB Steps to 15.5 dB
- Temperature Stability ±0.1dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%



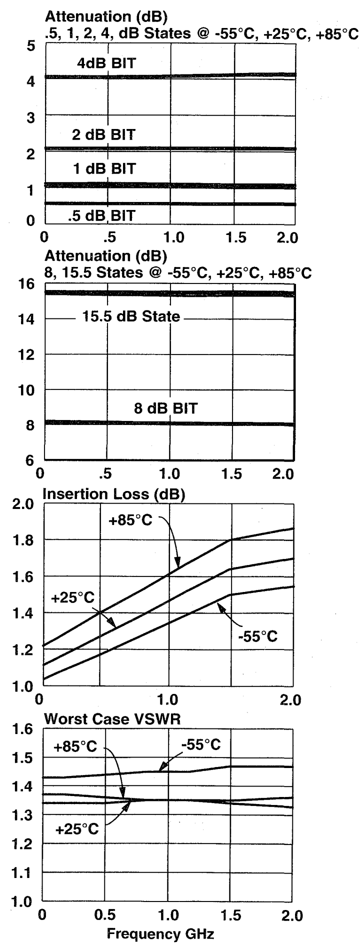
Guaranteed Specifications (From -55°C to +85°)

Frequency Range		DC - 2.0 GHz
Nominal Attenuation		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 DC - 1 GHz	2.3 dB Max 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 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		0.045" x 0.039" x 0.010" (1.14mm x 0.99mm x 0.25mm

Typical Performance



Specifications Subject to Change Without Notice

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.

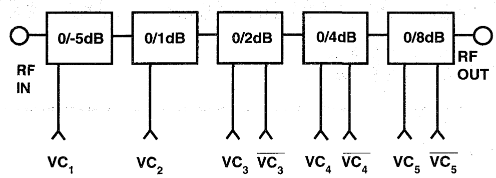
C. Electrically conductive epoxy may be used but is not required.

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,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)

Specifications Subject to Change Without Notice

M/A-COM

Digital Attenuator, 30 dB, 4 Bit DC–2 GHz

AT-232

Features

- Attenuation 2 dB Steps to 30 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, 12 ns Typical

Guaranteed Specifications[1] (From -55° C to + 85° C)

Frequency Range		DC – 2.0 GHz
Nominal Attenuation[2]		2 dB Steps to 30 dB
Attenuation Accuracy		DC – 2.0 GHz
Any Single Bit		+/-(0.1 dB +3% of Attenuation Setting in dB) dB
Any Combination of Bits		+/-(0.2 dB +4% 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

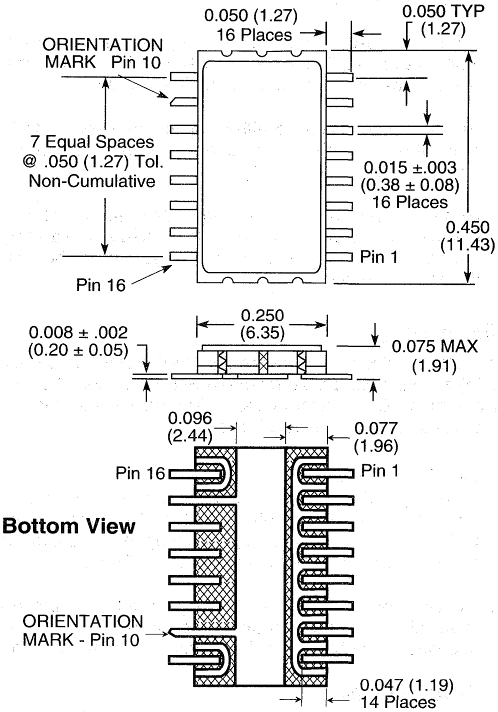
Impedance			50 Ohms Nominal
Switching Characteristics			
Trise, Tfall (10% to 90%)			12 ns Typ
Ton, Toff (50% CTL to 90%/10%)			18 ns Typ
Transients (In-Band)			25 mV Typ
Input Power for 1 dB Compression	0.05 GHz		+20 dBm Typ
	0.5 GHz to 3 GHz		+28 dBm Min
Intermodulation Intercept point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.05 GHz	+45	+40	dBm Typ
0.5 GHz to 3.0 GHz	+68	+50	dBm Typ
Control Voltage (Complementary Logic)			
Vin Low			0 to -0.2V @ 20 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.

Ordering Information

Model No.	Package
AT-232 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)

Absolute Maximum Ratings

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	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

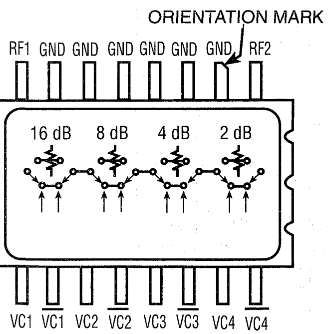
Notes: 1. Operation of this device above any one of these parameters may cause permanent damage.

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

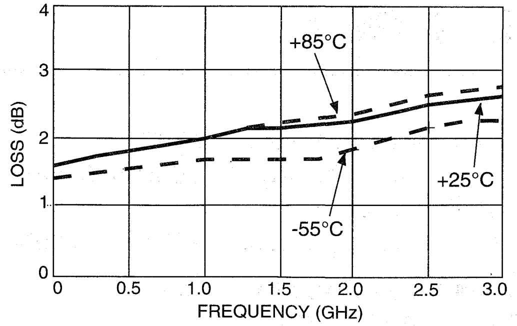
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Functional Schematic (Top View)

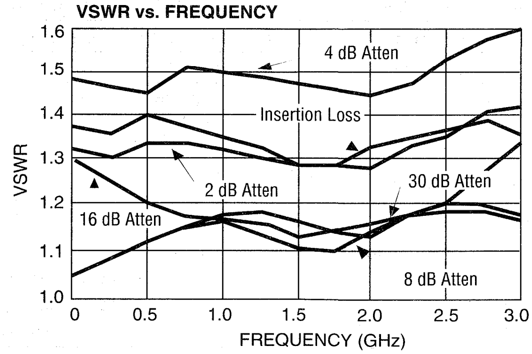


Typical Performance

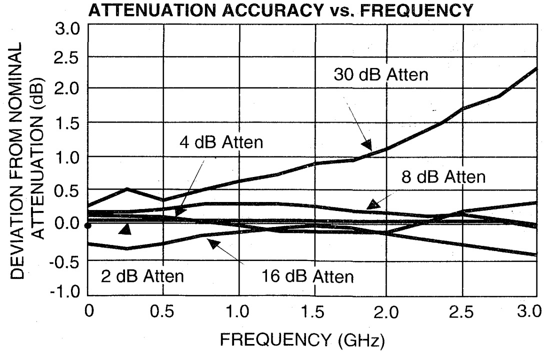
INSERTION LOSS VS. FREQUENCY



VSWR vs. FREQUENCY



ATTENUATION ACCURACY vs. FREQUENCY

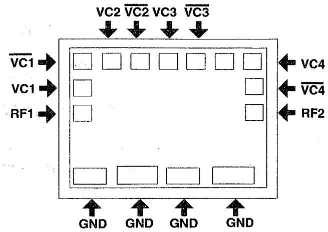


Specifications Subject to Change Without Notice

4 Bit GaAs Digital Attenuator DC–2 GHz

MADA2010G

- Attenuation 2dB Steps to 30 dB
- Temperature Stability ±0.1dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%



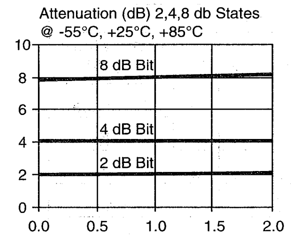
Guaranteed Specifications (From -55°C to +85°)

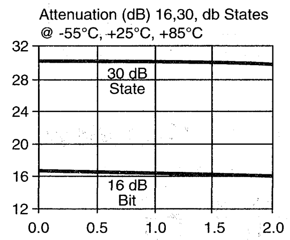
Frequency Range	DC - 2.0 GHz	
Nominal Attenuation	1 dB Steps to 15 dB Max	
Attenuation Accuracy	±0.15 dB	±3% of Attenuation Setting
VSWR Worst Case Setting	DC - 2 GHz	1.6:1 Max
Reference Insertion Loss	DC - 2 GHz DC - 1 GHz	2.4 dB Max 2.0 dB Max

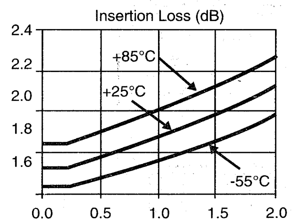
Operating Characteristics

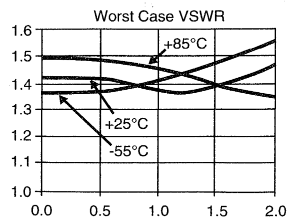
Impedance		50 Ω Nominal
Phase Balance (For any bit or combinations of bits per unit)		
2 Ghz		+2/-25 Degrees Typ
1 Ghz		+1/-13 Degrees Typ
500 MHz		+1/-8 Degrees Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 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









Specifications Subject to Change Without Notice

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.

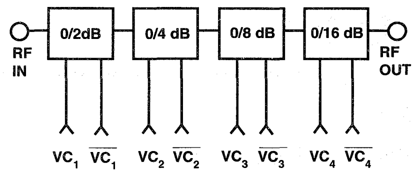
C. Electrically conductive epoxy may be used but is not required.

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	$\overline{VC3}$	VC4	$\overline{VC4}$	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 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

BondPad Dimensions
Inches (mm)

RFin, RFout: 0.004" x 0.004" (0.100mm x 0.100mm)
VC1,$\overline{VC1}$,VC2,$\overline{VC2}$,VC3,$\overline{VC3}$,VC4,$\overline{VC4}$: 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)

Digital Attenuator, 31 dB, 5 Bit
DC–2 GHz

AT-262

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)

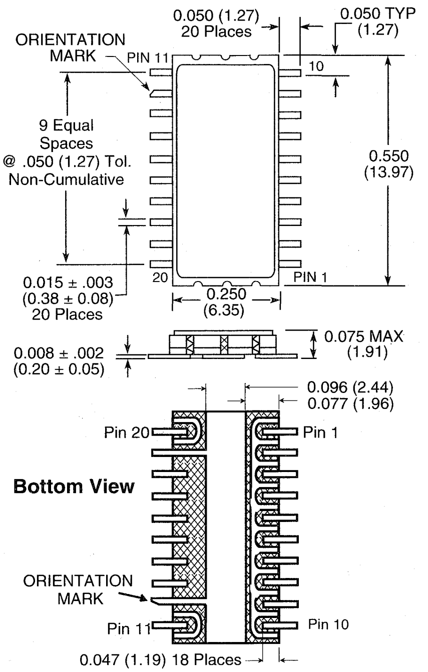
Frequency Range		DC – 2.0 GHz
Nominal Attenuation[2]		1 dB Steps to 31 dB
Attenuation Accuracy		DC – 2.0 GHz
DC – 1.0 GHz		+/-(0.2 dB +3% of Attenuation Setting in dB) dB
DC – 2.0 GHz		+/-(0.3 dB +3% of Attenuation Setting in dB) dB
VSWR	DC – 2.0 GHz	1.6:1 Max
Reference Insertion Loss	DC – 2.0 GHz	2.5 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

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

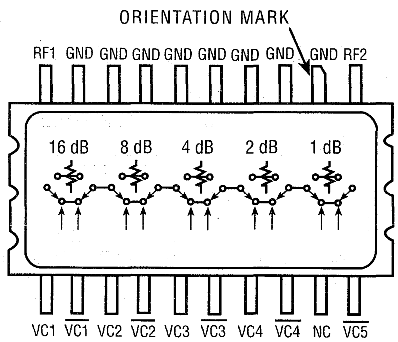
Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

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

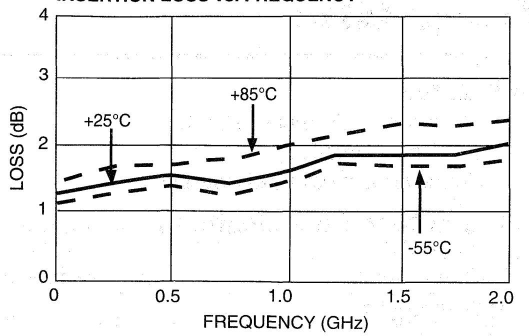
"0" = Vin Low, Vin Low = 0V, "1" = Vin High, Vin High = -5V

Functional Schematic (Top View)

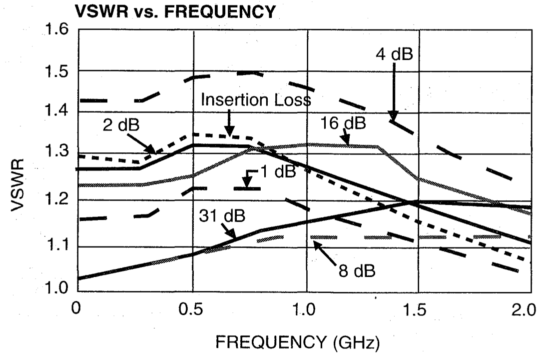


Typical Performance

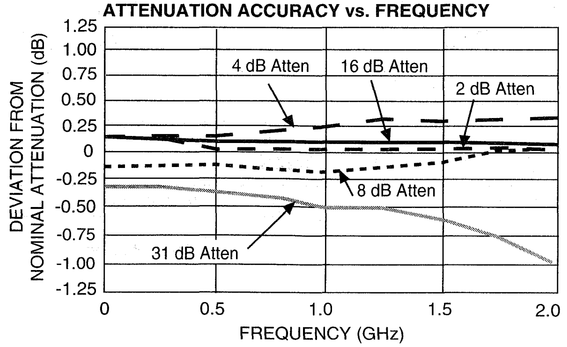
INSERTION LOSS vs. FREQUENCY



VSWR vs. FREQUENCY



ATTENUATION ACCURACY vs. FREQUENCY



Specifications Subject to Change Without Notice

GaAs Digital Attenuator, 31dB, 5 Bit
DC–2 GHz

AT-357

Features

- Attenuation 1 dB Steps to 31 dB
- TTL Control Interface
- Hermetic Connectorized Housing

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		DC to 2.0 GHz
Nominal Attenuation [2]		1 dB Steps to 31 dB
Attenuation Accuracy		
DC – 1.0 GHz		±(0.2 dB + 2% of Attenuation Setting in dB) dB
1.0 – 2.0 GHz		±(0.3 dB + 2% of Attenuation Setting in dB) dB
VSWR	DC – .025 GHz	2.2:1 Max
	.025 – 0.5 GHz	1.8:1 Max
	0.2 – 2.0 GHz	1.5:1 Max
	0.5 – 1.0 GHz	1.4:1 Max
Reference Insertion Loss	DC – 0.5 GHz	5.5 dB Max
	0.5 – 1.0 GHz	6.0 dB Max
	1.0 – 2.0 GHz	6.5 dB Max

Operating Characteristics

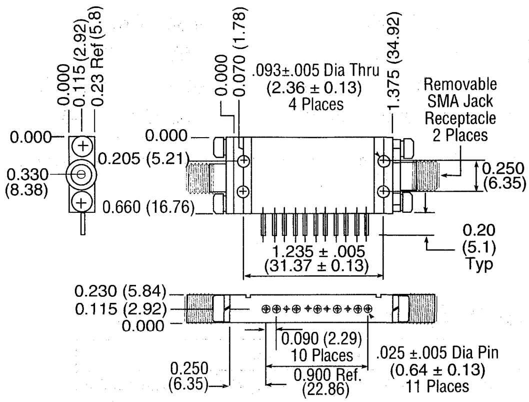
Impedance			50 Ohms Nominal
Switching Characteristics			
Ton, (50% CTL to 90% RF)			160 ns Typ
Toff (50% CTL to 10% RF)			80 ns Typ
Trise, (10% RF to 90% RF)			15 ns Typ
Tfall (90% RF to 10% RF)			3 ns Typ
Switching Transients (unfiltered)			130 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			28 dBm Typ
0.05 GHz			15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)			
Intercept Points	IP2	IP3	
0.5 – 2.0 GHz	+55	+47	dBm Typ
0.05 GHz	+45	+28	dBm Typ
Bias Power			+15 VDC @ 5 mA Max
			-12 VDC @ 3 mA Max
Control			5 line, TTL Data Bus
Vin Low (0)			0.0 to 0.8V @ 1 µA Max
Vin High (1)			2.4 to 5.0V @ 1 µA Max

1. All specifications apply when operated with bias voltages of +15 VDC and -12VDC and 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

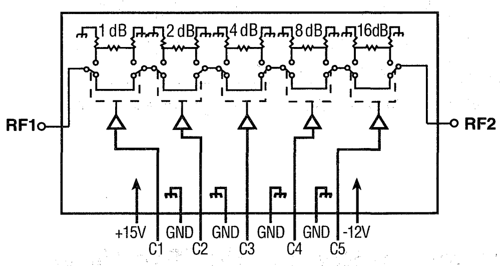
Model No.	Package
AT-357 SMA	Connectorized

C-46



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					Attenuator Setting
C1	C2	C3	C4	C5	
0	0	0	0	0	REFERENCE
1	0	0	0	0	1 dB
0	1	0	0	0	2 dB
0	0	1	0	0	4 dB
0	0	0	1	0	8 dB
0	0	0	0	1	16 dB
Any Combination					Sum of Bits Selected
"1" = Logic High (TTL)					"0" = Logic Low (TTL)

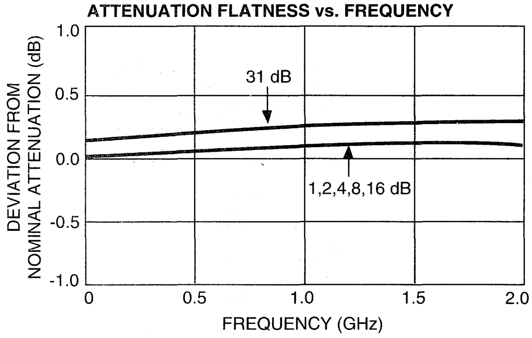
Specifications Subject to Change Without Notice

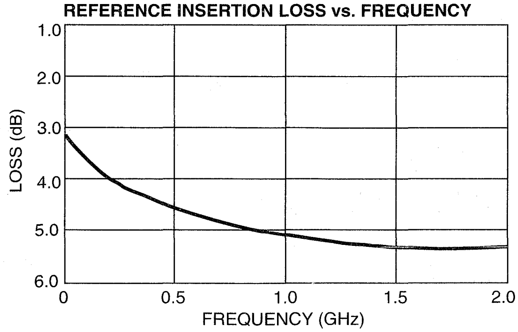
Absolute Maximum Ratings

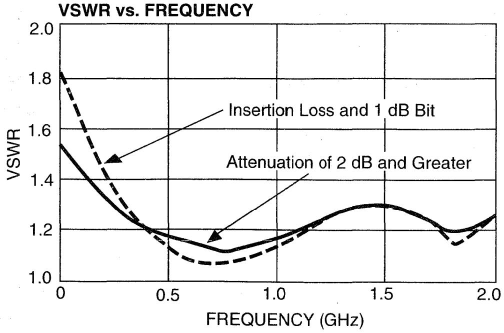
Parameter	Absolute Maximum[1]
Max. Input Power 0.05 GHz 0.5 – 2.0 GHz	 +27 dBm +32 dBm
Bias Voltage +15V Supply (V+) -12V Supply (V-)	 -0.7V to + 18V -15V to + 0.7V
Control Voltage	(V-)-2V to (V+)+2V (or 30 mA, whichever comes first)
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance





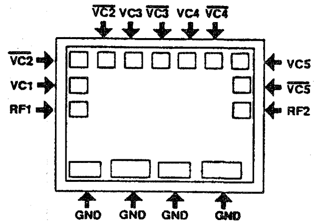


5 Bit GaAs Digital Attenuator DC-2 GHz

MADA2020G

Features

- Attenuation 1 dB Steps to 31 dB
- Temperature Stability ±0.1 dB from -55° to +85°C Typical
- Fast Switching Speed, 3 ns Typical to 90%



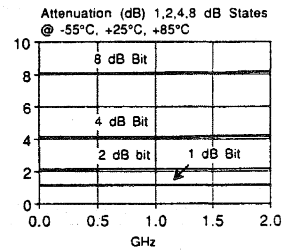
Guaranteed Specifications (From -55°C to +85°C)

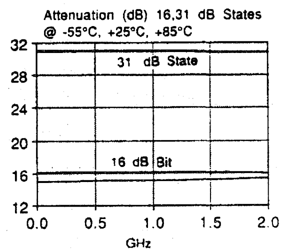
Frequency Range		DC-2.0 GHz
Nominal Attenuation		1 dB Steps to 31 dB Max
Attenuation Accuracy	±0.2 dB	±3% of Attenuation Setting
VSWR Worst Case Setting	DC-2 GHz	1.6.1 Max
Reference Insertion Loss	DC-2 GHz DC-1 GHz	2.5 dB Max 2.2 dB Max

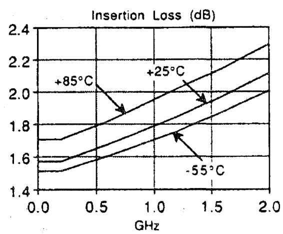
Operating Characteristics

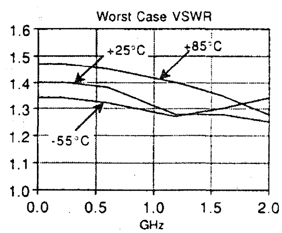
Impedance		50 Ω Nominal
Phase Balance (For any bit or combinations of bits per unit)		
2 GHz		+3/20 Degrees Typ
1 GHz		+1/-10 Typ
500 MHz		+1/-6 Typ
Switching Characteristics		
Switching Time (50% CTL to 90/10% RF)		3 ns Typ
Switching Transients (Unfiltered)		7 mV Typ
Input Power for 1 dB Compression		
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 @ 5 µA Max
V_{in} Hi		-5V @ 75 µA Typ to -8V @ 250 µA Max
Die Size		0.051" x 0.039" X 0.010" (1.29mm X 0.99mm X 0.25mm)

Typical Performance









Specifications Subject to Change Without Notice

Handling Precautions

Permanent damage to the MADA2020G may occur if the following precautions are not adhered to:

A. Cleanliness — The MADA2020G should be handled in a clean environment. DO NOT attempt to clean unit after the MADA2020G 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 MADA2020G. 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 MADA2020G 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 MADA2020G 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 MADA2020G 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 MADA2020G into position. A thin epoxy fillet should be visible around the perimeter of the chip.

B. Cure epoxy per manufacturer's recommended schedule.

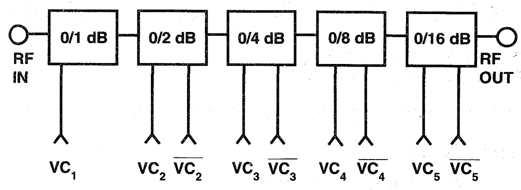
C. Electrically conductive epoxy may be used but is not required.

Wire Bonding

A. Ball or wedge bond with 1.0 mil diameter pure gold wire. 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



DA2010 Truth Table
Control Input

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}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	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	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	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}Hi	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}Low	V_{in}Low	V_{in}Hi	16dB

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

BondPad Dimensions
Inches (mm)

RFin, RFout: 0.004" x 0.004" (0.100mm x 0.100mm)
VC1,VC2,$\overline{VC2}$,VC3,$\overline{VC3}$,VC4,$\overline{VC4}$, VC5, $\overline{VC5}$: 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)

Specifications Subject to Change Without Notice

1 Bit, 10 dB, GaAs Digital Attenuator 0.02–2 GHz

AT-358

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

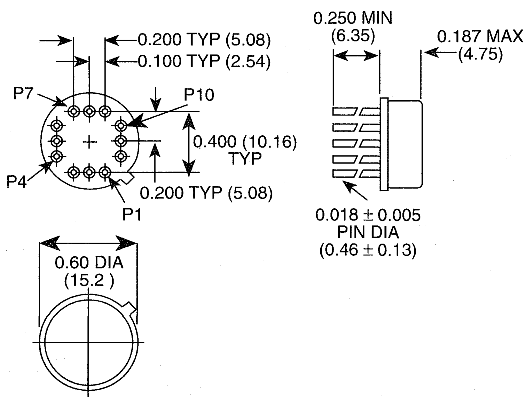
Impedance			50 Ohms Nominal
Switching Characteristics			
Ton, Toff (50% CTL to 90%/10% RF)			100 ns Typ
Trise, Tfall (10%/90% or 90%/10% RF)			40 ns Typ
Switching Transients (Unfiltered)			50 mV Typ
Input Power for 1 dB Compression			
0.5 – 2.0 GHz			+24 dBm Typ
0.05 GHz			+18 dBm Typ
Intermodulation 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

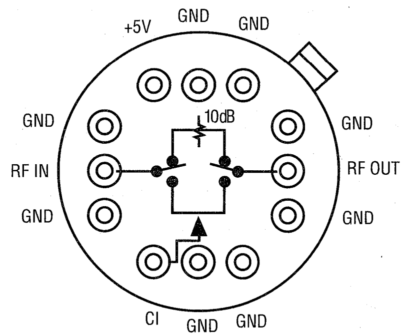
Model No.	Package
AT-358 PIN	TO-8-2

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

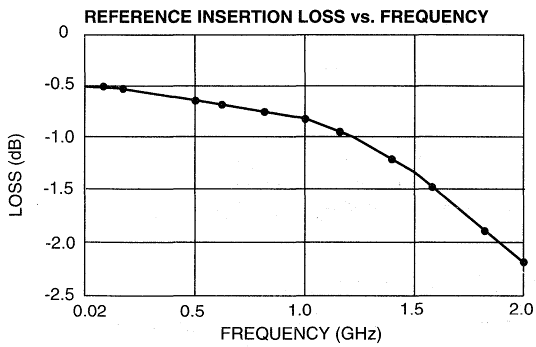
Specifications Subject to Change Without Notice

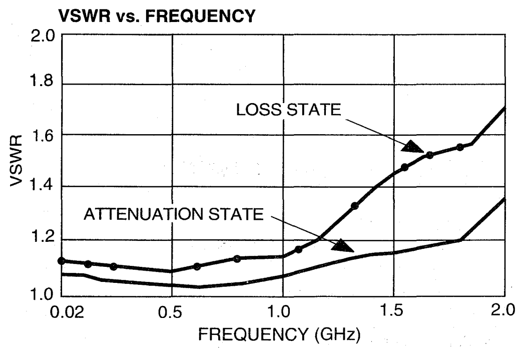
Absolute Maximum Ratings

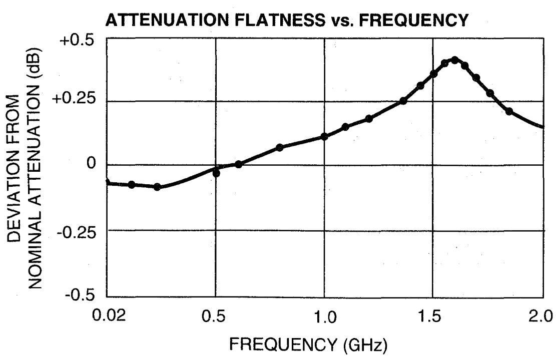
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+32 dBm
Bias Voltage	0.5 to +7 V
Control Voltage	-0.5 to V bias + 0.5V
Operating Temperature	–55˚C to +125˚C
Storage Temperature	–65˚C to +150˚C

Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

Typical Performance







4 Bit GaAs MMIC/Hybrid Digital Attenuator 0.25–2 GHz

AT-354

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

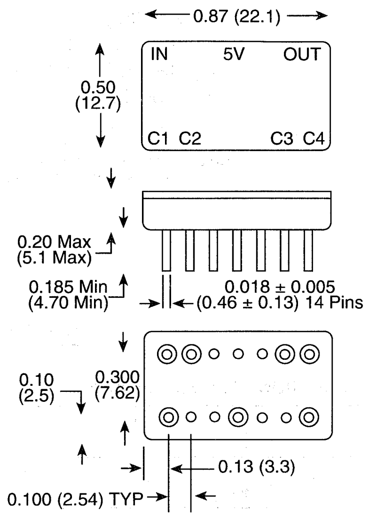
Impedance			50 Ohms Nominal
Switching Characteristics			
Switching Time (50% CTL to 90/10% RF)			70 ns Typ
Transients (In-Band)			80 mV Typ
Input Power for 1 dB Compression			
0.25 – 2.0 GHz			+19 dBm Typ
Intermodulation Intercept Pt. (for two-tone input power up to +5 dBm)			
Intercept Points	IP_2	IP_3	
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

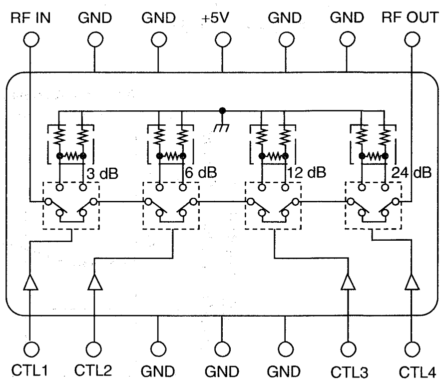
Model No.	Package
AT-354 PIN	Dual Inline

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

Absolute Maximum Ratings

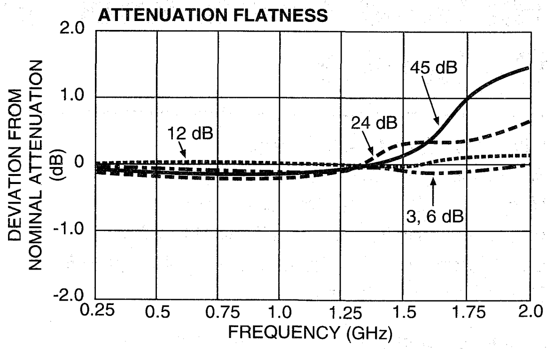
Parameter	Absolute Maximum[1]
Max. Input Power	
0.05 GHz	+27 dBm
0.5 – 2.0 GHz	+34 dBm
Control Voltage	+5V, –8.5V
Operating Temperature	–55˚C to +125°C
Storage Temperature	–65˚C to +150˚C

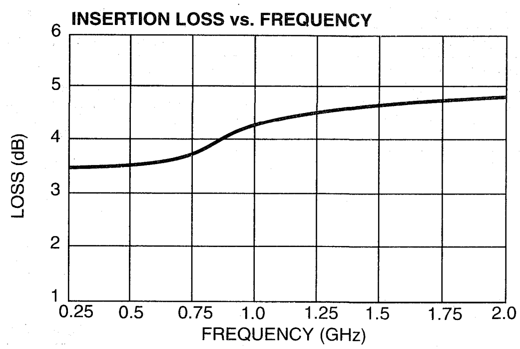
Note: 1. Operation of this device above any one of these parameters may cause permanent damage.

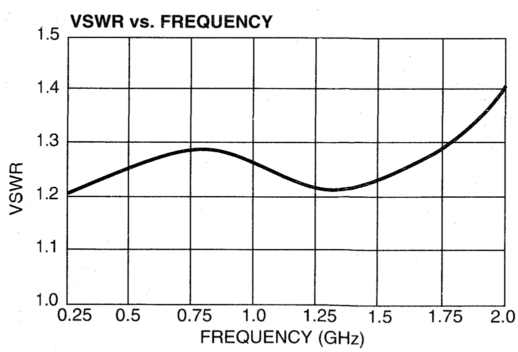
Truth Table

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



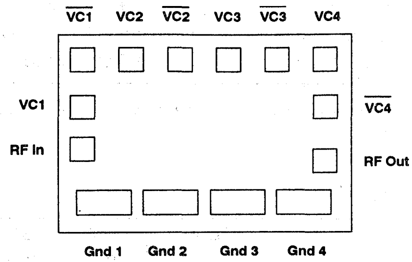




4 Bit GaAs Digital Attenuator DC –12 GHz

MADA12000

- 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

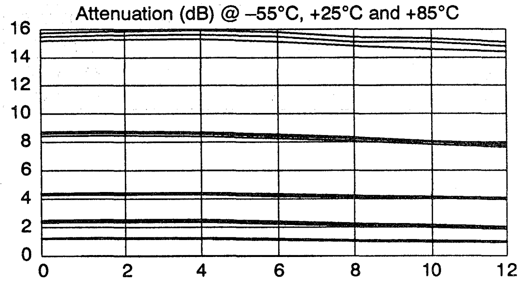
Atten(dB)	DC – 5	5 – 8	8 – 12
1 – 3	∓0.25dB∓14%	∓0.25dB∓12%	∓0.2dB∓4%
4 – 8	∓0.25dB∓7%	∓0.2dB∓6%	∓0.2dB∓3%
9 – 15	∓0.25dB∓8%	∓0.2dB∓7%	∓0.2dB∓3%

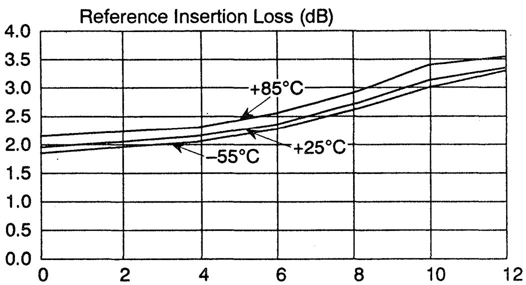
Reference Insertion Loss	DC – 2.0 GHz	3.00 dB Max
	DC – 6.0 GHz	3.50 dB Max
	DC – 12.0 GHz	4.25 dB Max
VSWR	DC – 2.0 GHz	1.6:1 Max
	DC – 6.0 GHz	1.7:1 Max
	DC – 12.0 GHz	1.8:1 Max

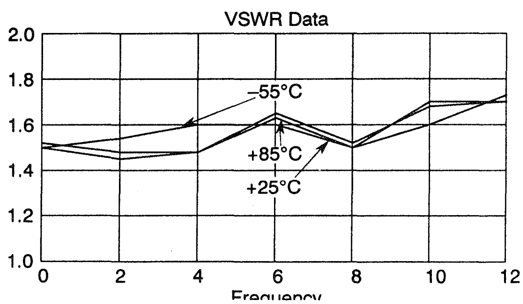
Operating Characteristics

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.







Specifications Subject to Change Without Notice

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.

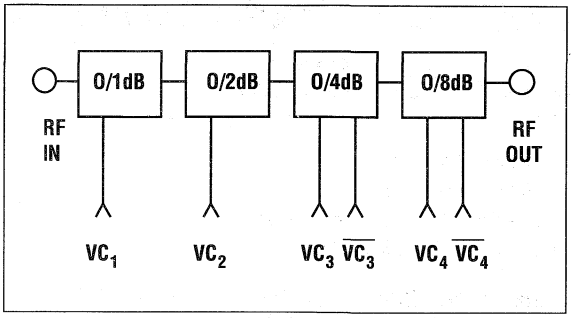
B. Cure epoxy per manufacturer's recommended schedule.

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

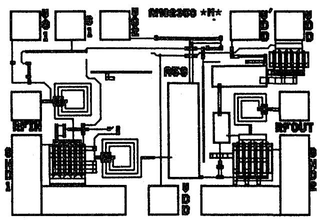
Bonding Pad Dimensions
Inches (mm)

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)

Specifications Subject to Change Without Notice

Wide Band GaAs MMIC Amplifier 0.2–3.0 GHz

MAAM02350



Features

- 19 dB Typical Gain[1]
- +14 dBm Typical Output Power
- 3.7 dB Typical Noise Figure[1]

Electrical Specifications @ Ta = 25°C

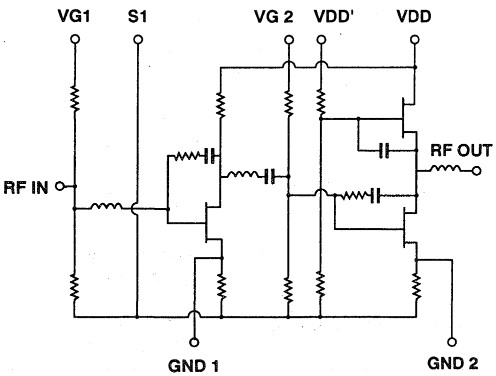
Frequency Range		0.2–3.0 GHz
Gain[1]	19.0 dB Typ	17.0 dB Min
Gain Flatness		±1.0 dB Typ
Noise Figure[1]	4.1 dB Max	3.7 dB Typ
VSWR[1] Input		1.8:1 Typ
VSWR[1] Output		1.5:1 Typ
Ouput Power at 1 dB Gain Compression		+14 dBm Typ
Third Order Intercept		+24 dBm Typ
Reverse Isolation		+35 dB Typ
Impedance		50 Ω Typ
Bias Voltage		Vdd = +6 Vdc
Bias Current		Idd = 65mA Typ, 100mA Max

Maximum Ratings

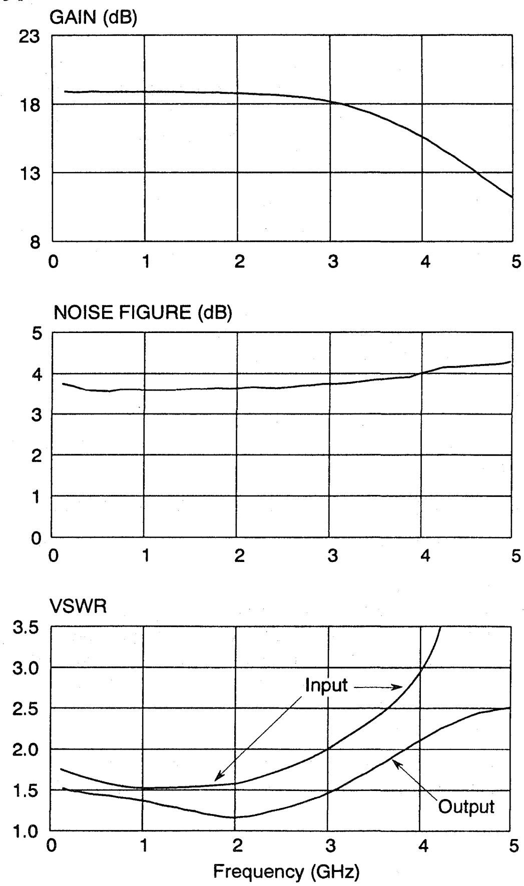
Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

Schematic



Typical Performance



Specifications Subject to Change Without Notice

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

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.

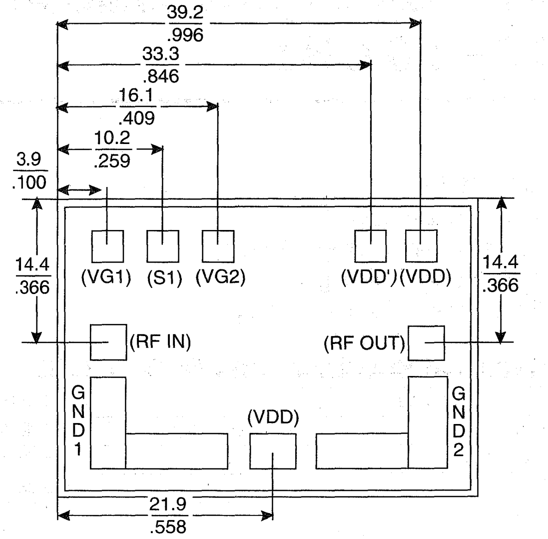
Bonding

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.

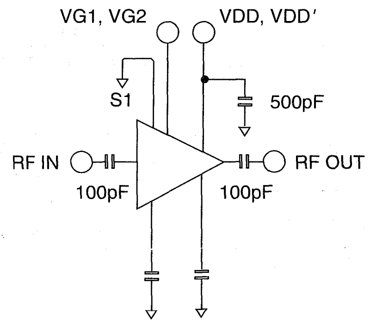
C. Bonding Pads are 4.0 x 4.0 mils.

Outline



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.

Advanced Information

Wide Band GaAs MMIC Amplifier 0.2–3.0 GHz

MAAM02350-A2

Features

- 18 dB Typical Gain
- +14 dBm Typical Output Power
- 4 dB Typical Noise Figure
- Small, 8 Lead Ceramic Package[1]

Electrical Specifications @ Ta = 25°C

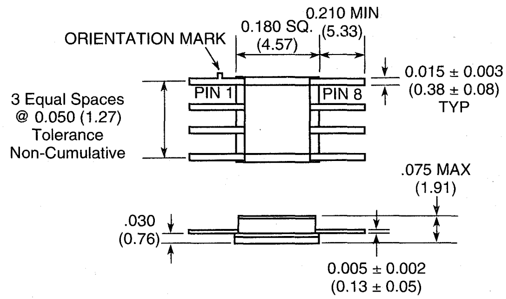
Frequency Range		0.2–3.0 GHz
Gain	18 dB Typ	16.0 dB Min
Gain Flatness		±1.5 dB Typ
Noise Figure	4.5 dB Max	4.0 dB Typ
VSWR Input		2.2:1 Typ
VSWR Output		2.0:1 Typ
Ouput Power at 1 dB Gain Compression		+14 dBm Typ
Third Order Intercept		+24 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		Vdd = +6 Vdc
Bias Current		Idd = 75 mA Typ, 110 mA Max

Maximum Ratings

Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +100°C

1. Gull winged package available. Contact factory.

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)

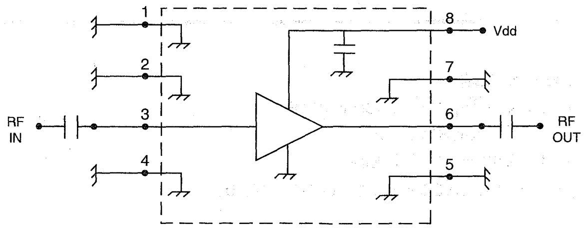
Specifications Subject to Change Without Notice

Pin Configuration

Pin No.	Function
1	Internal GND
2	Internal GND
3	Input
4	Internal GND
5	Internal GND
6	Output
7	Internal GND
8	Vdd

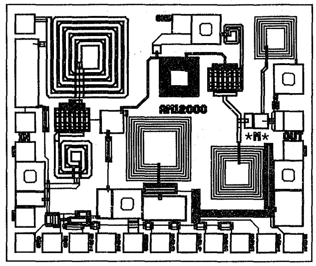
Schematic

TYPICAL BIASING CONFIGURATION
AND FUNCTIONAL BLOCK DIAGRAM



Low Noise GaAs MMIC Amplifier
1.2 – 1.75 GHz

MAAM12000



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 @ Ta = 25°C

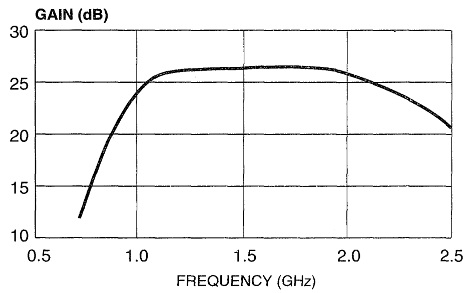
Frequency Range			1.20 – 1.75 GHz
Gain[1]		26 dB Typ	23.5 dB Min
Gain Flatness			±0.8 dB Typ
Noise Figure[1]		1.6 dB Max	1.25 dB Typ
VSWR[1]	Input Output		1.4:1 Typ 1.5:1 Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			40 dB Typ
Impedance			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

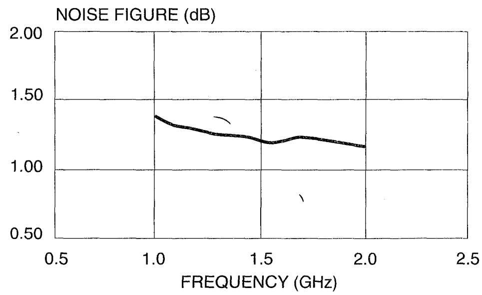
Maximum Ratings

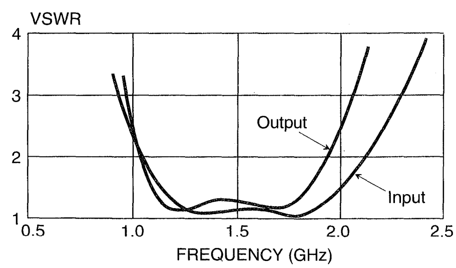
Voltage	+7 V @ Vdd, -10 V @ Vgg
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

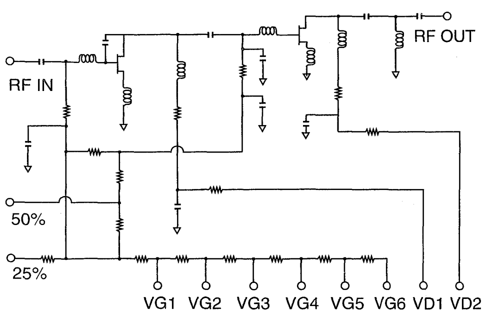
Typical Performance







Schematic



Specifications Subject to Change Without Notice

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.

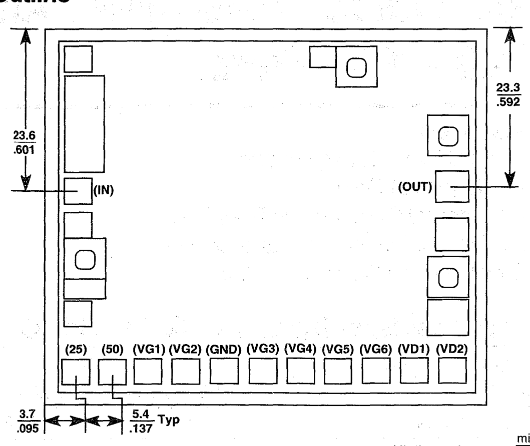
Bonding

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.

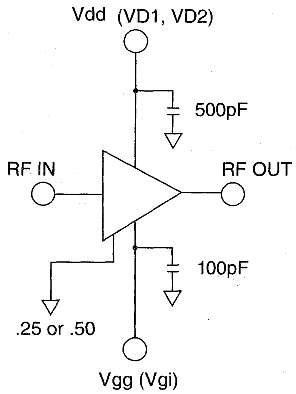
Outline



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.

Specifications Subject to Change Without Notice

Low Noise GaAs MMIC Amplifier
1.20 – 1.75 GHz

MAAM12000-A1

Features

- 1.35 dB Typical Noise Figure
- 26 dB Typical Gain
- No External Components Required
- DC Decoupled RF Input and Output
- Small, 8 Lead Ceramic Package[1]

Electrical Specifications @ Ta = 25°C

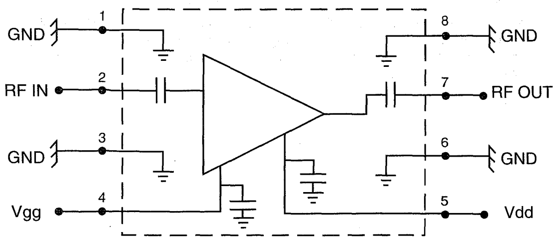
Frequency Range			1.20–1.75 GHz
Gain		26.0 dB Typ	23.0 dB Min
Gain Flatness			±1.0 dB Typ
Noise Figure		1.35 dB Typ	1.8 dB Max
VSWR	Input Output		1.7:1 Typ 1.7:1 Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			35 dB Typ
Bias Conditions	Vdd = 5 Vdc @ Idd = 80 mA Typ, 110 mA Max Vgg = -5 Vdc @ Igg = 1 mA Typ, 1.5 mA Max		
Impedence			50 Ω Typ

Maximum Ratings

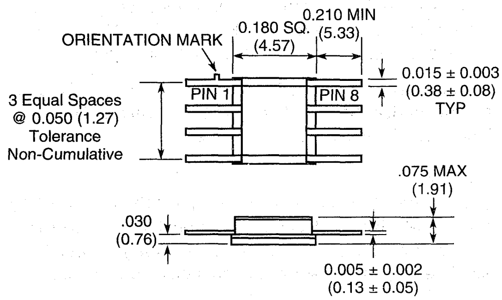
Voltage	+7 V @ Vdd, -10 V @ Vgg
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +100°C

Schematic

TYPICAL BIASING CONFIGURATION
AND FUNCTIONAL BLOCK DIAGRAM



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)

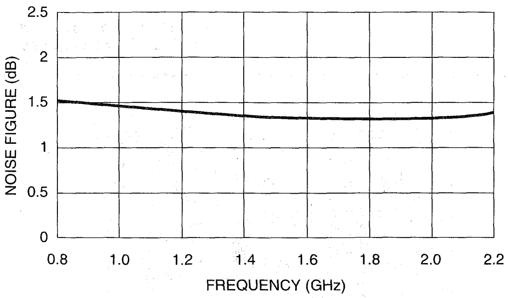
Pin Configuration

Pin No.	Function
1	Internal GND
2	Input
3	Internal GND
4	Vgg
5	Vdd
6	Internal GND
7	Output
8	Internal GND

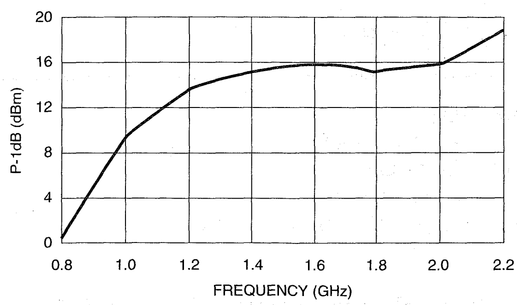
Specifications Subject to Change Without Notice

Typical Performance

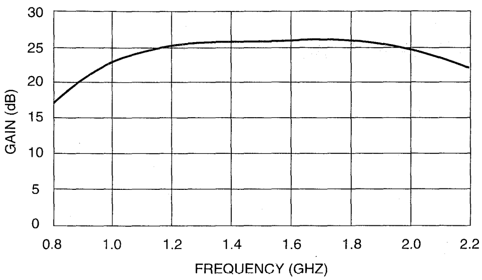
NOISE FIGURE VS FREQUENCY



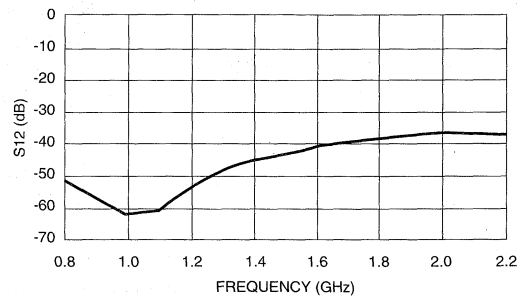
OUTPUT POWER VS FREQUENCY



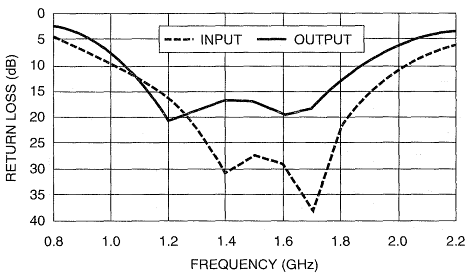
GAIN vs FREQUENCY



REVERSE ISOLATION VS FREQUENCY



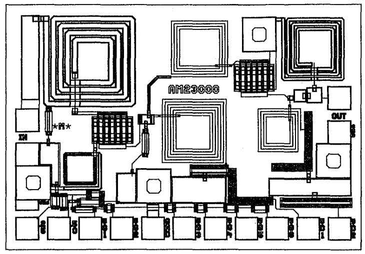
RETURN LOSS VS FREQUENCY



Specifications Subject to Change Without Notice

Low Noise GaAs MMIC Amplifier
2–3 GHz
MAAM23000

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 @ Ta = 25°C

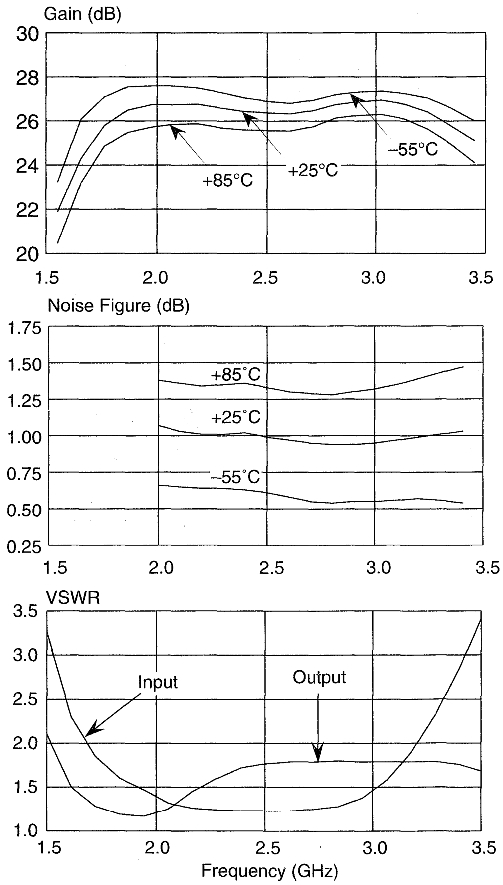
Frequency Range		2.0– 3.0 GHz
Gain[1]	26.0 dB Typ	24.0 dB Min
Gain Flatness		±1.0 dB Typ
Noise Figure[1]	1.6 dB Max	1.1 dB Typ
VSWR[1]	Input Output	1.7:1 Typ 1.3:1 Typ
Output Power at 1 dB Gain Compression		+14 dBm Typ
Third Order Intercept		+24 dBm Typ
Reverse Isolation		40 dB Typ
Impedance		50 Ω Typ
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

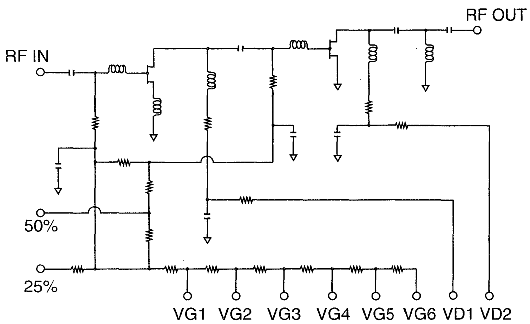
Voltage	+7v@Vdd, -10v@Vgg
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

Typical Performance



Schematic



Specifications Subject to Change Without Notice

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.

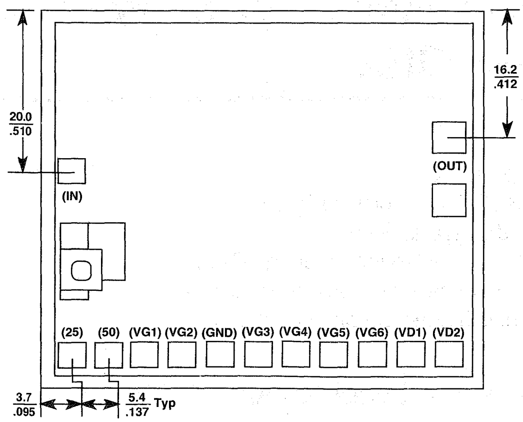
Bonding

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.

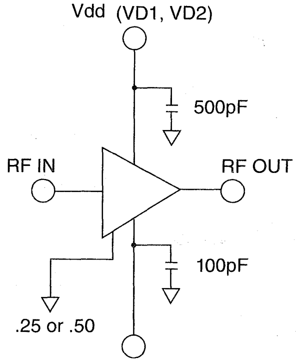
Outline



All dimensions are $\frac{\text{mils}}{\text{mm}}$.

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.

Low Noise GaAs MMIC Amplifier 2–3 GHz

MAAM23000-A1

Features

- 1.3 dB Typical Noise Figure
- 26 dB Typical Gain
- DC Decoupled RF Input and Output
- No External Components Required
- Small, 8 Lead Ceramic Package[1]

Electrical Specifications @ Ta = 25°C

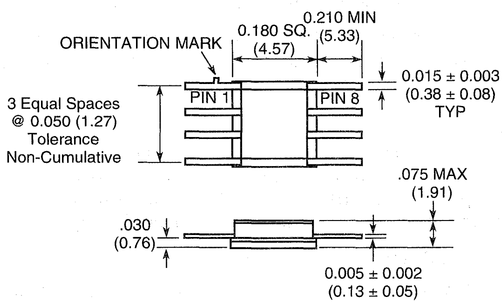
Frequency Range		2.0 – 3.0 GHz
Gain	26.0 dB Typ	23.0 dB Min
Gain Flatness		±1.0 dB Typ
Noise Figure	1.3 dB Typ	1.8 dB Max
VSWR Input Output		2.0:1 Typ 2.0:1 Typ
Output Power at 1 dB Gain Compression		+14 dBm Typ
Third Order Intercept		+24 dBm Typ
Reverse Isolation		35 dB Typ
Impedance		50 Ω Typ
Bias Voltage		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 +100°C

1. Gull winged package available. Contact factory.

CR-3



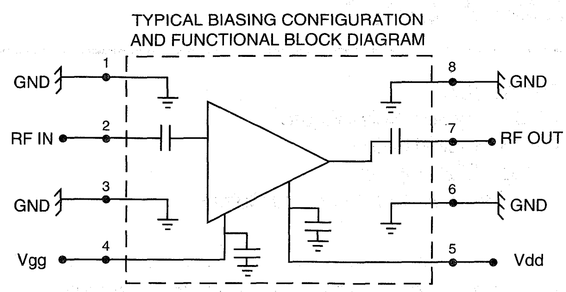
Bottom of case is AC ground.
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Specifications Subject to Change Without Notice

Pin Configuration

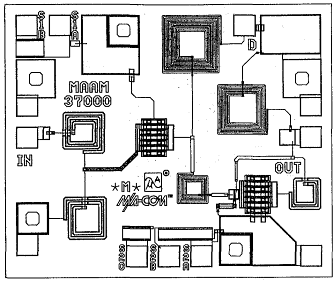
Pin NO.	Function
1	Internal GND
2	Input
3	Internal GND
4	Vgg
5	Vdd
6	Internal GND
7	Output
8	Internal GND

Schematic



Low Noise GaAs MMIC Amplifier
3.5–7 GHz

MAAM37000



Features
- 1.8 dB Typical Noise Figure[1]
- 16 dB Typical Gain[1]
- Single Bias Supply
- DC Decoupled RF Input and Output

Electrical Specifications @ Ta = 25°C

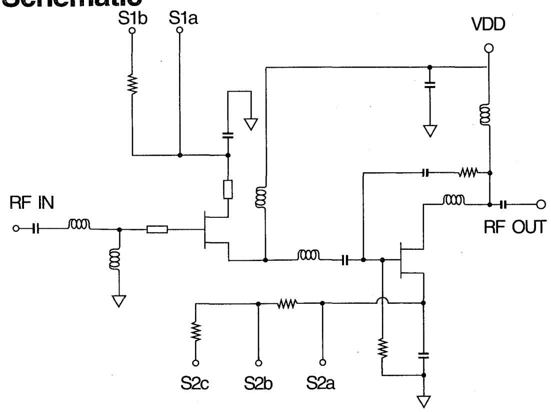
Frequency Range		3.5 – 7.0 GHz
Gain[1]	17.0 dB Typ	15.0 dB Min
Gain Flatness		±0.8 dB Typ
Noise Figure[1]	1.8 dB Typ	2.8 dB Max
VSWR	Input Output	1.5:1 Typ 1.5:1 Typ
Output Power at 1 dB Gain Compression		+14 dBm Typ
Third Order Intercept		+24 dBm Typ
Reverse Isolation		35 dB Typ
Impedance		50 Ω Typ
Bias Voltage		Vdd = +4 Vdc
Bias Current		Idd = 75 mA Typ,100 mA Max

Maximum Ratings

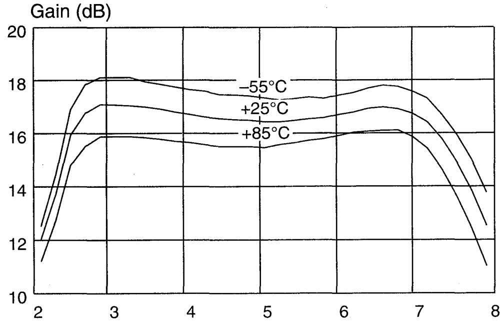
Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

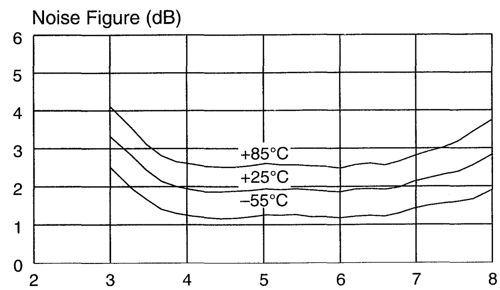
1. 100% on-wafer tested.

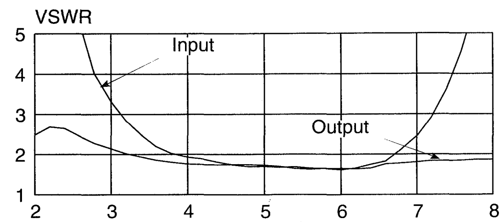
Schematic



Typical Performance







Specifications Subject to Change Without Notice

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.

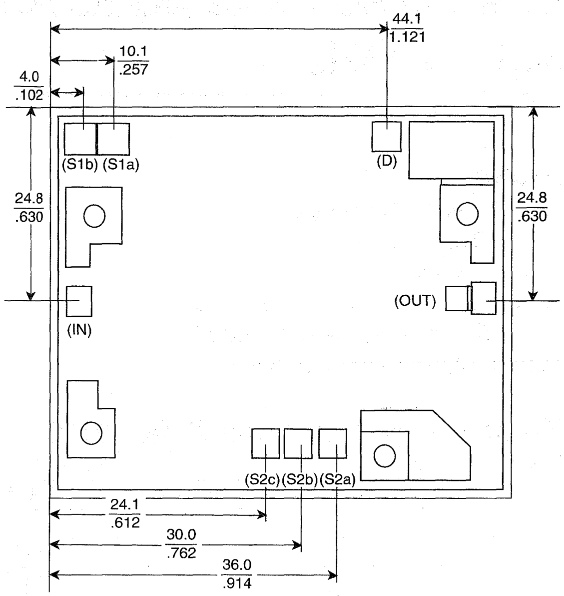
Bonding

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.

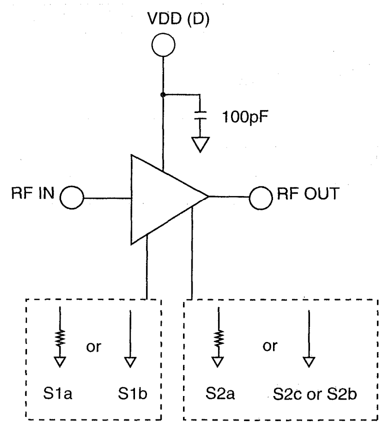
Outline



All dimensions are $\frac{\text{mils}}{\text{mm.}}$

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.

Advanced Information

Low Noise GaAs MMIC Amplifier
3.5 – 7 GHz

MAAM37000-A1

Features

- 2.2 dB Typical Noise Figure
- 16 dB Typical Gain
- Single Bias Supply
- DC Decoupled RF Input and Output
- No External Components Required
- Small, 8 Lead Ceramic Package

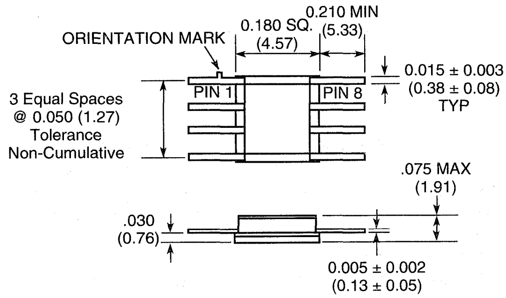
Electrical Specifications @ Ta = 25°C

Frequency Range			3.5 – 7.0 GHz
Gain		16.0 dB Typ	14.0 dB Min
Gain Flatness			±1.0 dB Typ
Noise Figure		2.2 dB Typ	3.2 dB Max
VSWR	Input Output		2.0:1 Typ 2.0:1 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			Vdd = +4 Vdc
Bias Current			Idd = 75 mA Typ, 110 mA Max

Maximum Ratings

Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to 150°C
Operating Temperature	–55°C to +100°C

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

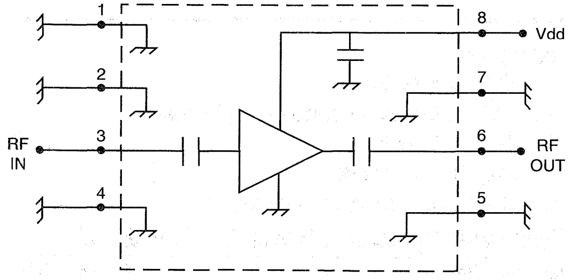
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Pin Configuration

Pin NO.	Function
1	Internal GND
2	Internal GND
3	Input
4	Internal GND
5	Internal GND
6	Output
7	Internal GND
8	Vdd

Schematic

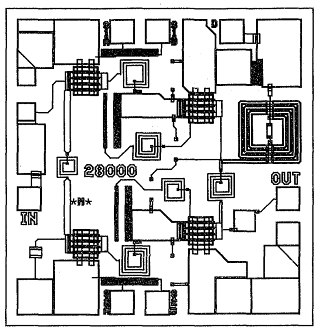
TYPICAL BIASING CONFIGURATION
AND FUNCTIONAL BLOCK DIAGRAM



M/A-COM

Wide Band GaAs MMIC Amplifier
2–8 GHz

MAAM28000



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 @ Ta = 25°C

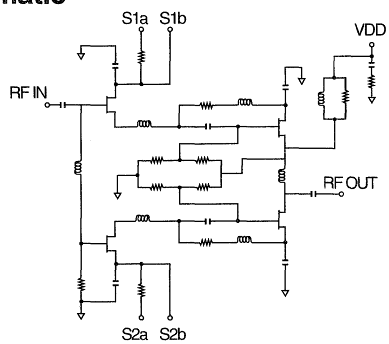
Frequency Range			2.0– 8.0 GHz
Gain[1]		18.0 dB Typ	16.0 dB Min
Gain Flatness			±0.5 dB Typ
Noise Figure[1]	2.0 – 4.0 GHz 4.0 – 6.0 GHz 6.0 – 8.0 GHz	6.0 dB Typ 4.5 dB Typ 4.0 dB Typ	7.2 dB Max 5.7 dB Max 5.2 dB Max
VSWR[1]	Input Output		1.7:1 Typ 1.3.1 Typ
Output Power at 1 dB Gain Compression			+14 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

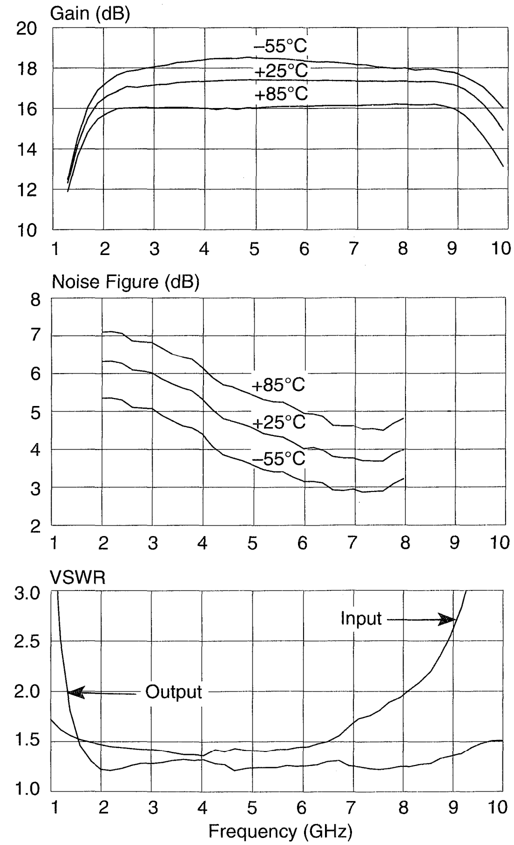
Voltage	+14 volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested

Schematic



Typical Performance



Specifications Subject to Change Without Notice

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.

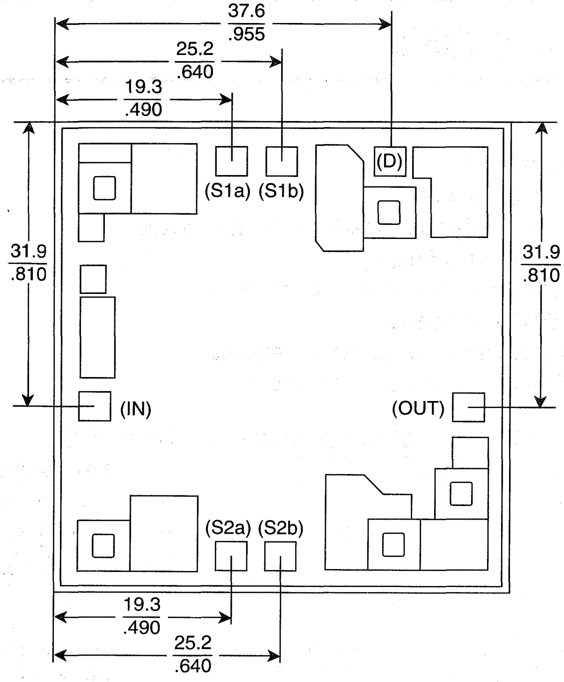
Bonding

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.

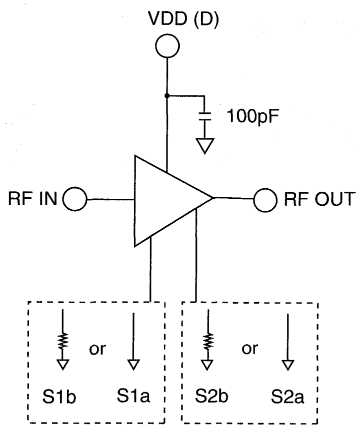
Outline



All dimensions are $\frac{\text{mils}}{\text{mm}}$.

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.

Wide Band GaAs MMIC Amplifier 2–8 GHz

MAAM28000-A1

Features

- 17 dB Typical Gain
- ±1.0 dB Typical Broadband Gain Flatness
- Single Bias Supply
- DC Decoupled RF Input and Output
- 50 Ohm Impendance
- No External Components Required
- Small, 8 Lead Ceramic Package

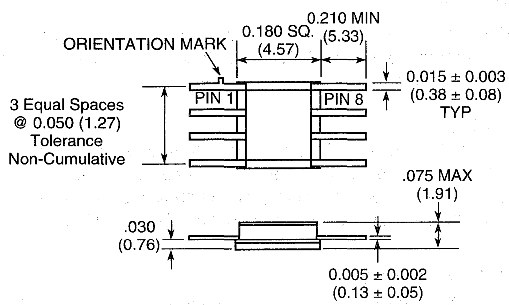
Electrical Specifications @ Ta = 25°C

Frequency Range			2.0–8.0 GHz
Gain		17.0 dB Typ	14.0 dB Min
Noise Figure	2.0 – 4.0 GHz 4.0 – 6.0 GHz 6.0 – 8.0 GHz	6.5 dB Typ 5.0 dB Typ 4.5 dB Typ	7.7 dB Max 6.2 dB Max 5.7 dB Max
VSWR	Input Output		2.0:1 Typ 1.7:1 Typ
Output Power at 1 Gain dB Compression			+14 dBm Typ
Third Order Intercept			+24 dBm Typ
Reverse Isolation			35 dB Typ
Impedance			50 Ω Typ
Bias Voltage			Vdd = +10 Vdc
Bias Currents			Idd = 70 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 +100°C

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)

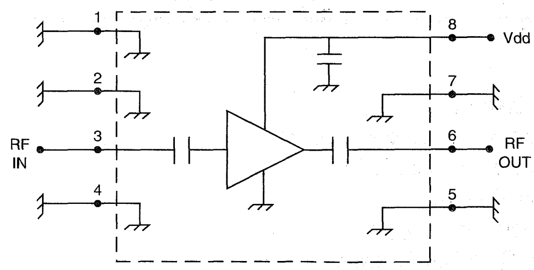
Specifications Subject to Change Without Notice

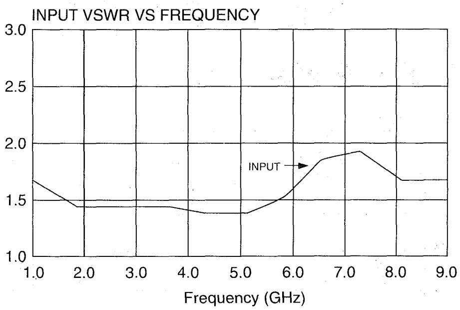
Pin Configuration

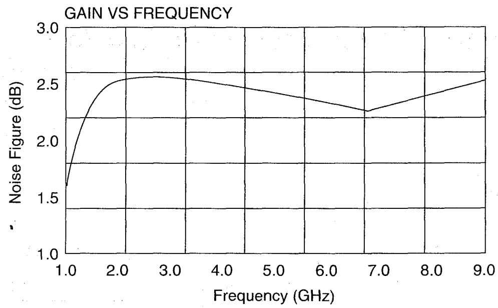
Pin No.	Function
1	Internal GND
2	Internal GND
3	Input
4	Internal GND
5	Internal GND
6	Output
7	Internal GND
8	Vdd

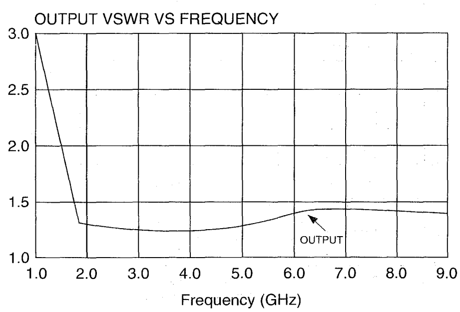
Schematic

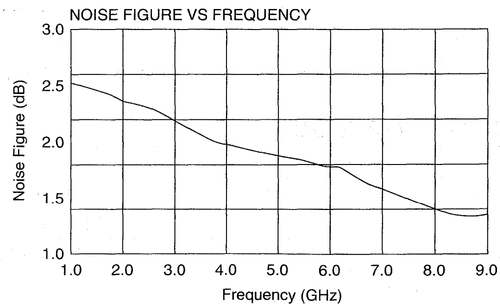
TYPICAL BIASING CONFIGURATION
AND FUNCTIONAL BLOCK DIAGRAM







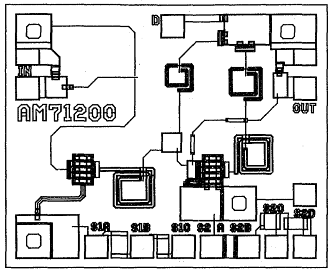




Low Noise GaAs MMIC Amplifier
Low Noise GaAs MMIC Amplifier 7.5 –12 GHz

MAAM71200

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 @ Ta = 25°C

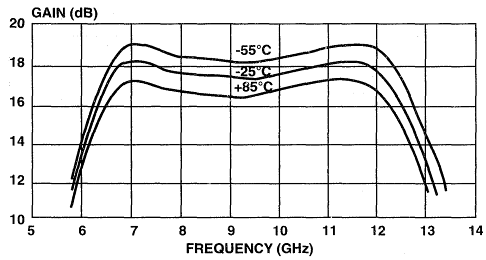
Frequency Range			7.5 – 12.0 GHz
Gain[1]		16.5 dB Typ	15.0 dB Min
Gain Flatness			±0.8 dB Typ
Noise Figure[1]		3.2 dB Max	2.3 dB Typ
VSWR[1]	Input Output		1.8:1 Typ 1.5:1 Typ
Third Order Intercept			+24 dBm Typ
Output Power at 1 dB Gain Compression			+14 dBm Typ
Reverse Isolation			30 dB Typ
Impedance			50Ω Nominal
Bias Voltage			Vdd = +4 Vdc
Bias Current			Idd = 40 mA Typ, 55 mA Max

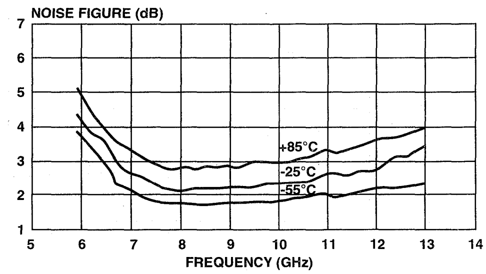
Maximum Ratings

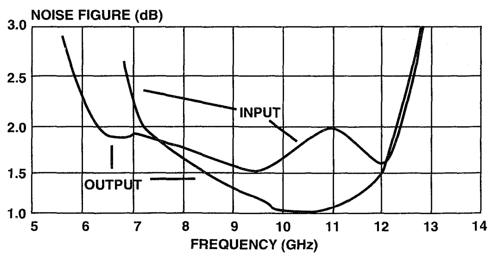
Voltage	+7 Volts
Input Power	+20 dBm
Storage Temperature	–65°C to +150°C
Operating Temperature	–55°C to +125°C

1. 100% on-wafer tested.

Typical Performance







Specifications Subject to Change Without Notice

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 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 MAAM71200 die be handled along the long side with a sharp pair of tweezers.

Mounting

The MAAM71200 is back-metallized with d/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 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. 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.

B. Cure epoxy per manufacturer's recommended schedule.

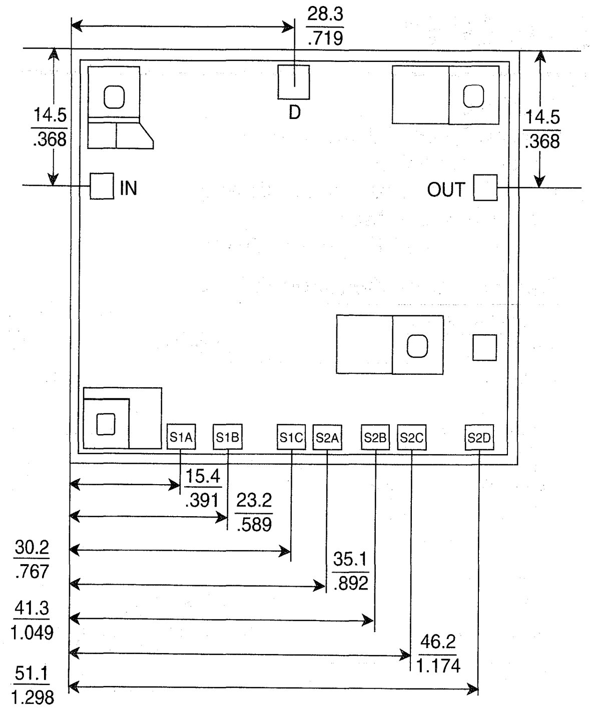
Bonding

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.

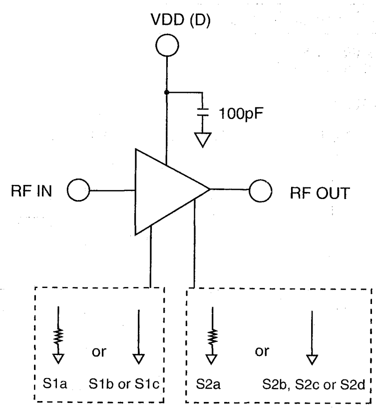
C. Bonding Pads are 4.0 x 4.0 mils.

Outline



Die Size 55.1 x 45.3 x 4.0
(1.34 mm x 1.51 mm x 0.102 mm)

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 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.

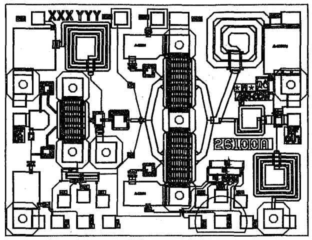
Specifications Subject to Change Without Notice

Power GaAs MMIC Amplifier 2–6 GHz

MAAM26100

Features

- +30 dB Typical Saturated Power
- 19 dB Typical Gain
- 25% Typical Power Added Efficiency
- On-Chip Bias Network
- DC Decoupled RF Input and Output



Electrical Specifications @ Ta = 25°C

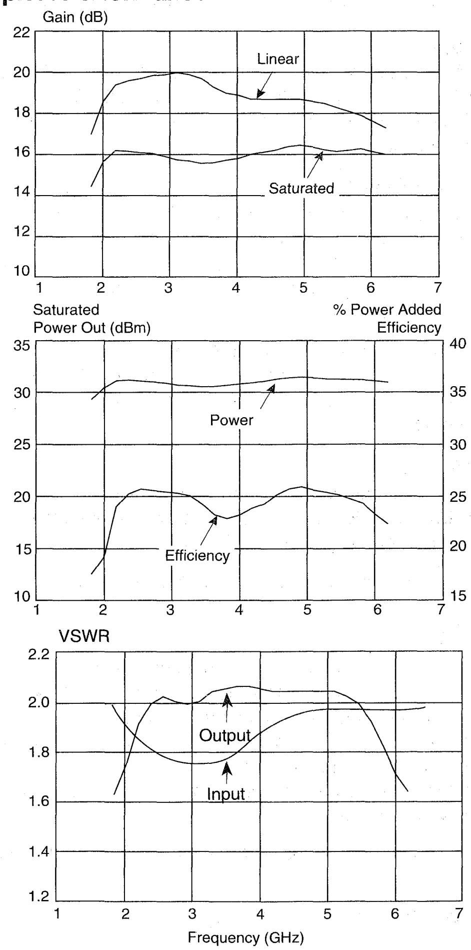
Frequency Range		2.0 – 6.0 GHz
Gain[1]	19.0 dB Typ	15.0 dB Min
VSWR[1]	Input Output	2.0:1 Typ 2.2:1 Typ
Saturated Power Output[1] (Input Power = +18dBm)		+30 dBm Typ
Output Power at 1 Gain dB Compression		+28 dBm Typ
Third Order Intercept		+39 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		Vdd = +8 Vdc, Vgg = -1.3 Vdc Typ
Bias Current		Idd = 500 mA Typ, 650 mA Max Igg = 10 mA Typ, Igg = 20 mA Max
Thermal Resistance[2]		14°C/w Typ

Maximum Ratings

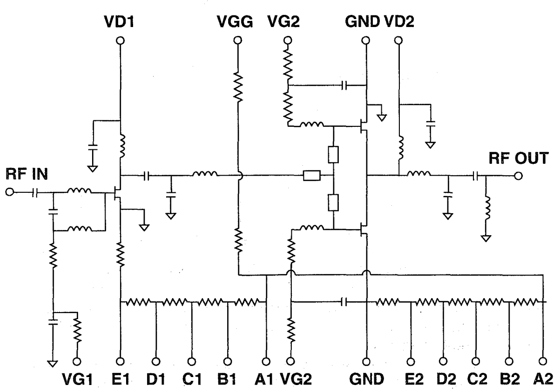
Voltage	Vdd = +10 Volts, Vgg = -5 Volts
Input Power	+23 dBm
Storage Temperature	–65°C to +150°C
Operating Channel Temperature	+150°C

1. 100% on-waffer tested.
2. Attachment method not included.

Typical Performance



Schematic



Specifications Subject to Change Without Notice

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.

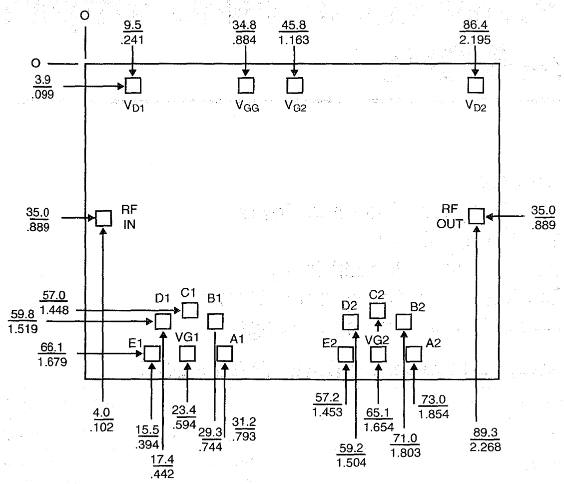
Bonding

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

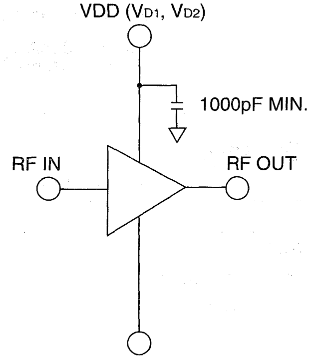


Die Size 0.091" x 0.070" x 0.004
(2.319mm x 0.889m x 0.102mm)

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 -1.3 volts to pads VG1 and VG2 followed by connecting +8 volts to pads VD1 and VD2 (note sequence).
2. The recommended VDD range is +6 to +9 volts.
3. Optional on-chip resistor networks are used by connecting a nominal -5 volts to pad Vgg then connecting pad "B1", "C1", "D1", or "E1" to pad VG1; and "B2", "C2", "D2", or "E2" to pad VG2.

Advanced Information

Power GaAs MMIC Amplifier
2–6 GHz

MAAM26100-B1

Features
- +29 dB Typical Saturated Power
- 18 dB Typical Gain
- 25% Power Added Efficiency
- DC Decoupled RF Input and Output
- Small, 7 Lead Ceramic Package

Electrical Specifications @ Ta = 25°C

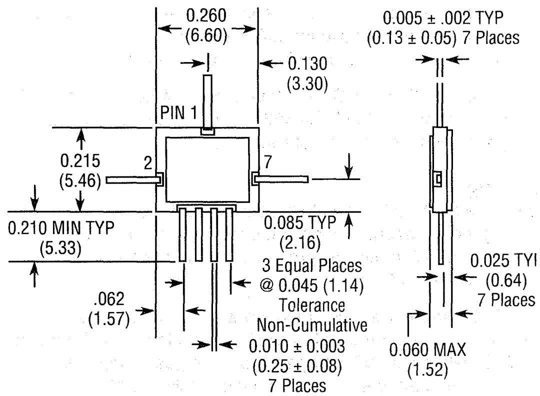
Frequency Range		2.0– 6.0 GHz
Gain	18.0 dB Typ	14.0 dB Min
VSWR	Input Output	2.2:1 Typ 2.2:1 Typ
Saturated Power Output (Input Power = +18 dBm)		+29 dBm Typ
Output Power at 1 dB Gain Compression		+27 dBm Typ
Third Order Intercept		+39 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		Vdd = +8 Vdc, Vgg = -5 Vdc Typ
Bias Current		Idd = 500 mA Typ, 650 mA Max Igg = 10 mA Typ, 20 mA Typ
Thermal Resistance[1]		16.5°C/w Typ

Maximum Ratings

Voltage	Vdd = +10 Volts, Vgg = -5 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)

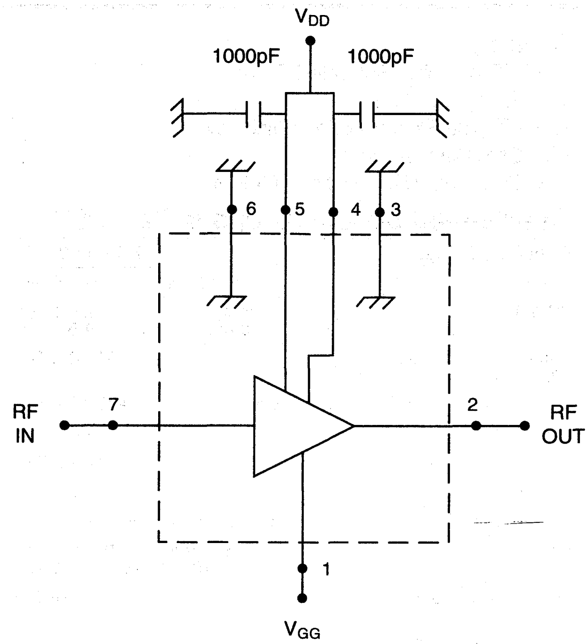
Specifications Subject to Change Without Notice

Pin Configuration

Pin No.	Function
1	Vgg
2	Output
3	Internal GND
4	VD2
5	VD1
6	Internal GND
7	Input

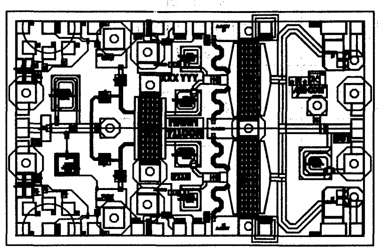
Schematic

TYPICAL BIASING CONFIGURATION
AND FUNCTIONAL BLOCK DIAGRAM



GaAs MMIC Power Amplifier
7 – 11 GHz

MAAM71100



Features
- +31 dBm Typical Saturated Power
- 18 dB Typical Gain
- 25% Typical Power Added Efficiency
- On-Chip Bias Network
- DC Decoupled RF Input and Output

Guaranteed Specifications @ Ta = 25°C

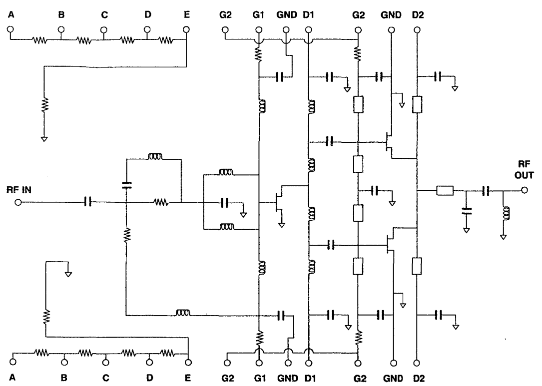
Frequency Range		7.0– 11.0 GHz
Gain[1]	18.0 dB Typ	14 dB Min
VSWR[1]	Input Output	2.0:1 Typ 4.5:1 Typ
Saturated Power Output[1] (Input Power = +18 dBm)		+31 dBm Typ
Output Power at 1 dB Gain Compression		+28 dBm Typ
Third Order Intercept		+38 dBm Typ
Reverse Isolation		30 dB Typ
Impedance		50 Ω Typ
Bias Voltage		Vdd = +8 Vdc, Vgg = -1.3 Vdc Typ
Bias Current		Idd = 650 mA Typ, 750 mA Max Igg = 10 mA Typ, 20 mA Max
Thermal Resistance[2]		12°C/w Typ

Maximum Ratings

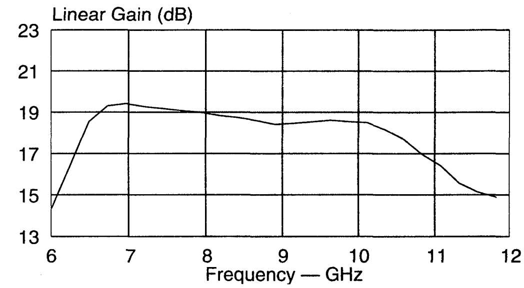
Voltage	Vdd = +10 Volts, Vgg = -5 Volts
Input Power	+23 dBm
Storage Temperature	–65°C to +150°C
Operating Channel Temperature	+150°C

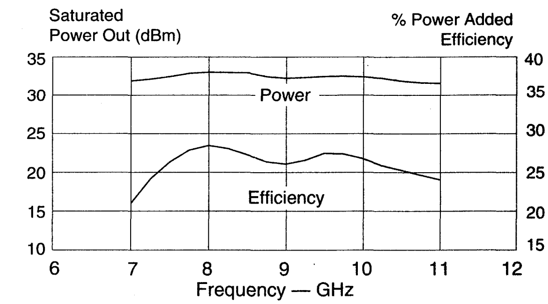
1. 100% on-wafer tested
2. Attachment method not included

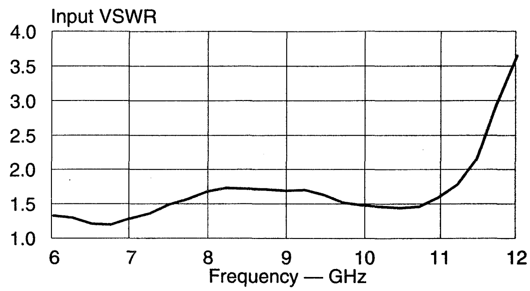
Schematic



Typical Performance







Specifications Subject to Change Without Notice

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.

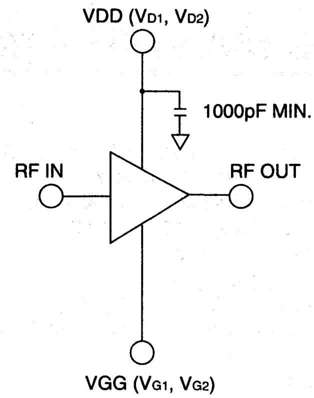
Bonding

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.

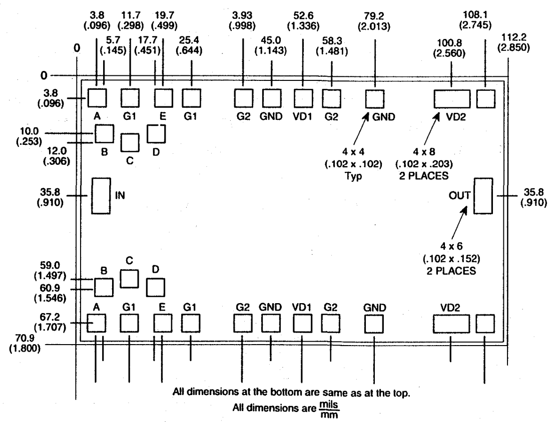
Typical Bias Configuration



1. Nominal bias is obtained by first connecting -1.3 volts to pads VG1 and VG2 followed by connecting +8 volts to pads VD1 and VD2 (note sequence).
2. The recommended VDD 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 VG1 and VG2.

Die Size

0.113" X 0.072" X 0.004"
(2.88mm X 1.82mm X 0.10mm)



Silicon Bipolar MMIC Active Mixer/IF Amplifer

MAMD12018

Features

- 8 dB Conversion Gain from 50 MHz to 5 GHz
- IF Output from DC to 1000 MHz
- Single Positive Supply: 4 to 8V @ 14 mA
- Temperature Range: -55 to + 95°C
- Termination Insensitive
- LO Power: -10 to 0 dBm
- High Isolation RF/IF, Low LO Leakage
- Hermetic Glass-Metal Surface Mount Package

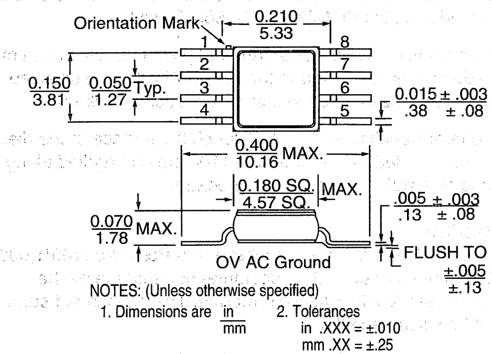
Description

M/A-COM's MAMD12018 is a double balanced active mixer in a glass-metal hermetic surface mount package. The MAMD12018 is ideally suited for use where very low power consumption is required. Typical applications include frequency down conversion, modulation, demodulation and phase detection in systems such as GPS receivers, fiber optic modules, cordless phones and battery powered radio receivers.

The MAMD12018 is based on the Gilbert cell topology. It can operate over a narrow or wide frequency range with RF inputs up to 5 GHz and IF output up to 1 GHz. RF and LO operation can be extended below 50 MHz by adding optional capacitors to ground. The mixer is particularly suitable for applications where insensitivity to termination impedance is required. In addition, the MAMD12018 provides good spurious signal suppresion with very low LO power and minimal bias power consumption.

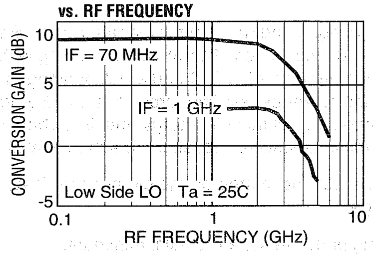
The MAMD12018 is fabricated with a monolithic chip using a mature, 12 GHz f_t silicon bipolar technology. The process features full IC passivation for increased performance and reliability.

CR-7



Pin Description			
1	IF Output	8	RF Ground, Optional
2	AC Ground; 0V	7	V_{CC}
3	AC Ground; 0V	6	LO Ground, Optional
4	RF Input	5	LO Input
Bottom of the Package is AC/DC Ground			

RF to IF CONVERSION GAIN vs. RF FREQUENCY



Electrical Specifications, $T_A = 25°C$

Symbol	Parameters, Test Conditions: Vcc = 5V, Z0 = 50Ω, LO = -5dBm, RF = -20dBm		Units	Min.	Typ.	Max.
Gc	Conversion Gain	RF = 2 GHz, LO = 1.75 GHz	dB	7	8.5	10
F_{3dB} RF	RF Bandwidth (G_C 3 dB down)	IF = 250 MHz	GHz		4.2	
F_{3dB} IF	IF Bandwidth (G_C 3 dB down)	LO = 2 GHz	GHz		0.6	
IP_{1dB}	IF Output at 1 dB Gain Compression	RF = 2 GHz, LO = 1.75 GHz	dBm		-5.5	
IP_3	IF Output Third Order Intercept Point	RF = 2 GHz, LO = 1.75 GHz	dBm		+3	
NF	SSB Noise Figure	RF = 2 GHz, LO = 1.75 GHz	dB		14.5	
VSWR	RF Port	f = 0.05 to 5 GHz			1.5:1	
	LO Port	f = 0.05 to 5 GHz			1.5:1	
	IF Port	f < 1 GHz			1.5:1	
RF/IF	RF Feedthrough at IF Port	RF = 2 GHz, LO = 1.75 GHz	dBc		-22	
LO/IF	LO Leakage at IF Port	LO = 1.75 GHz	dBm		-23	
LO/RF	LO Leakage at RF Port	LO = 1.75 GHz	dBm		-25	
Icc	Supply Current		mA	12	14	16

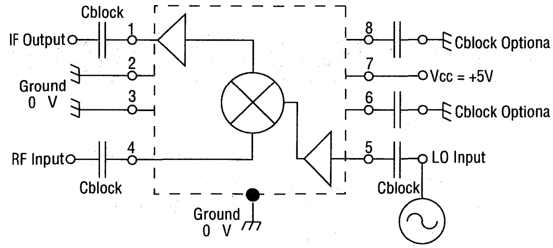
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Device Voltage	10V
Power Dissipation[2,3]	300 mW
RF Input Power	+14 dBm
LO Input Power	+14 dBm
Junction Temperature	150°C
Storage Temperature	-65°C to 200°C
Thermal Resistance[2]: Θ_{jc} = 50°C/W	

Notes: 1. Operation outside these limits may result in permanent damage.
2. T_{case} - Case temperature = 25°C (Bottom of the case)
3. Derate at 20 mW/°C for T_{case} > 135°C

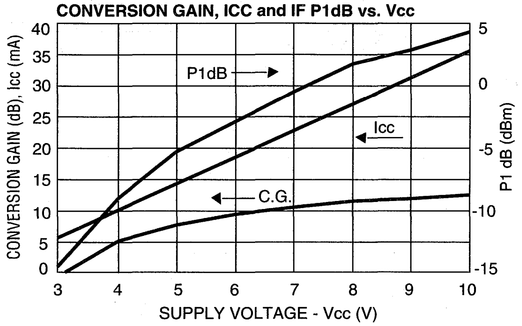
TYPICAL BIASING CONFIGURATION AND FUNCTIONAL BLOCK DIAGRAM



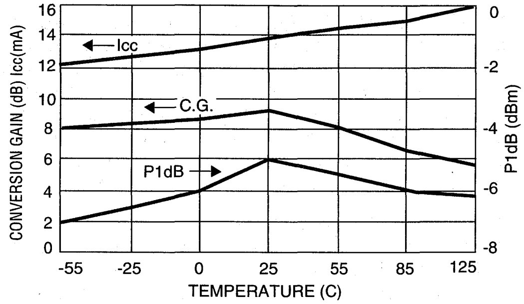
Typical Performance, T_A = 25°C, V_{CC} = 5V, RF: -20 dBm at 2 GHz, LO: -5 dBm at 1.75 GHz

(unless otherwise noted)

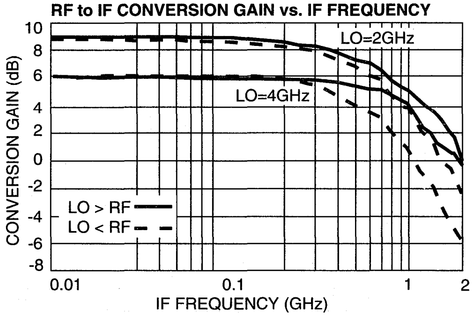
CONVERSION GAIN, ICC and IF P1dB vs. Vcc



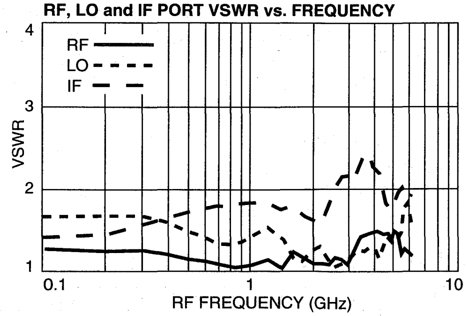
CONVERSION GAIN, IF P1dB and Icc CURRENT vs. CASE TEMPERATURE



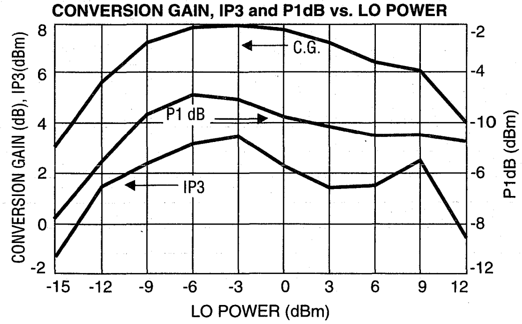
RF to IF CONVERSION GAIN vs. IF FREQUENCY



RF, LO and IF PORT VSWR vs. FREQUENCY



CONVERSION GAIN, IP3 and P1dB vs. LO POWER



HARMONIC INTERMODULATION SUPPRESSION (dB BELOW DESIRED OUTPUT)
RF - 1 GHz, LO - 0.752 GHz, IF - 0.248 GHz

HARMONIC LO ORDER \ HARMONIC RF ORDER	0	1	2	3	4	5
0	-	31	33	67	71	>75
1	18	0	43	44	70	>75
2	12	36	35	61	68	>75
3	39	18	44	66	>75	>75
4	27	49	45	70	70	>75
5	41	34	57	71	>75	>75

Specifications Subject to Change Without Notice

Silicon Bipolar MMIC Active Mixer/IF Amplifier

MAMD12008

Features

- 8 dB Conversion Gain from 50 MHz to 5 GHz
- IF Output from DC to 1000 MHz
- Single Positive Supply: 4 to 8V @ 14 mA
- Termination Insensitive
- LO Power: -10 to 0 dBm
- High Isolation RF/IF, Low LO Leakage
- Low Cost Plastic 8 Lead SOIC Package

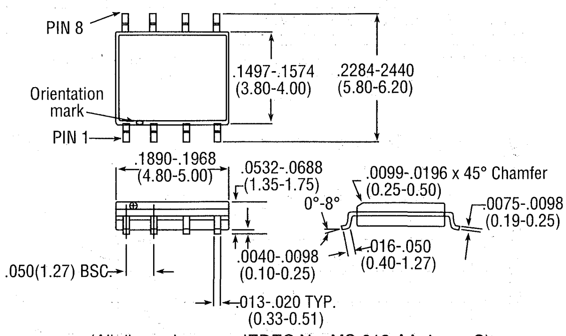
Description

M/A-COM's MAMD12008 is a double balanced active mixer in a low cost surface mount plastic SOIC package. The MAMD12008 is ideally suited for use where very low power consumption is required. Typical applications include frequency down conversion, modulation, demodulation and phase detection in systems such as GPS receivers, fiber optic modules, cordless phones and battery powered radio receivers.

The MAMD12008 is based on the Gilbert cell topology. It can operate over a narrow or wide frequency range with RF inputs up to 5 GHz and IF output up to 1 GHz. RF and LO operation can be extended below 50 MHz by adding optional capacitors to ground. The mixer is particularly suitable for applications where insensitivity to termination impedance is required. In addition, the MAMD12008 provides good spurious signal suppression with very low LO power and minimal bias power consumption.

The MAMD12008 is fabricated with a monolithic chip using a mature, 12 GHz f_t silicon bipolar technology. The process features full IC passivation for increased performance and reliability.

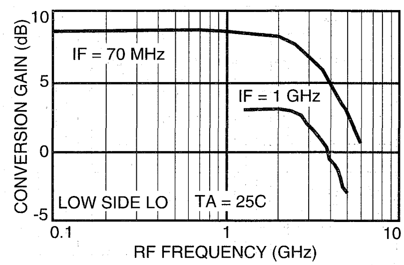
S0-8



(All dimensions per JEDEC No. MS-012-AA, Issue C)
Dimensions in ( ) are in mm.

Pin Description			
1	IF Output	8	RF Ground, Optional
2	AC Ground; 0V	7	V_{CC}
3	AC Ground; 0V	6	LO Ground, Optional
4	RF Input	5	LO Input

RF to IF CONVERSION GAIN vs. RF FREQUENCY



Electrical Specifications, T_A = 25°C

Symbol	Parameters, Test Conditions: Vcc = 5V, Z0 = 50Ω, LO = -5dBm, RF = -20dBm		Units	Min.	Typ.	Max.
Gc	Conversion Gain	RF = 2 GHz, LO = 1.75 GHz	dB	6	8.5	10
F_{3dB} RF	RF Bandwidth (G_C 3 dB down)	IF = 250 MHz	GHz		3.5	
F_{3dB} IF	IF Bandwidth (G_C 3 dB down)	LO = 2 GHz	GHz		0.6	
IP_{1dB}	IF Output at 1 dB Gain Compression	RF = 2 GHz, LO = 1.75 GHz	dBm		-6	
IP_3	IF Output Third Order Intercept Point	RF = 2 GHz, LO = 1.75 GHz	dBm		+3	
NF	SSB Noise Figure	RF = 2 GHz, LO = 1.75 GHz	dB		17	
VSWR	RF Port	f = 0.05 to 3.75 GHz			1.5:1	
	LO Port	f = 0.05 to 3.75 GHz			2.0:1	
	IF Port	f < 1 GHz			1.5:1	
RF/IF	RF Feedthrough at IF Port	RF = 2 GHz, LO = 1.75 GHz	dBc		-22	
LO/IF	LO Leakage at IF Port	LO = 1.75 GHz	dBm		-23	
LO/RF	LO Leakage at RF Port	LO = 1.75 GHz	dBm		-25	
Icc	Supply Current		mA	12	14	16

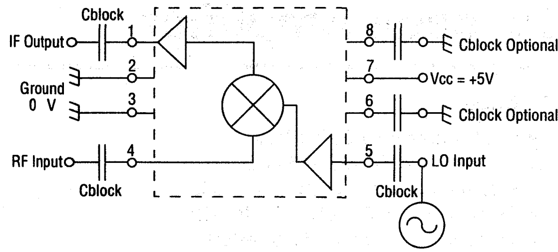
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Device Voltage	10V
Power Dissipation[2,3]	300 mW
RF Input Power	+14 dBm
LO Input Power	+14 dBm
Junction Temperature	150°C
Storage Temperature	-65°C to 150°C
Thermal Resistance[2]: Θ_{jc} = 225°C/W	

Notes:
1. Operation outside these limits may result in permanent damage.
2. T_{case} - Case temperature = 25°C (Bottom of the case)
3. Derate at 4.44 mW/°C for T_{case} > 82.5°C

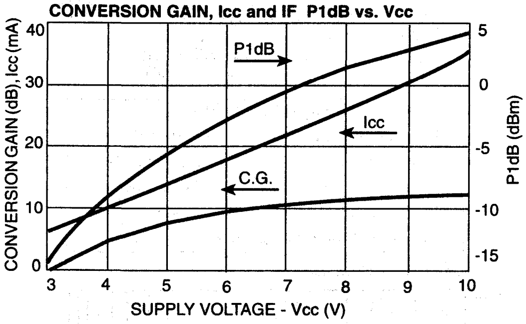
TYPICAL BIASING CONFIGURATION AND FUNCTIONAL BLOCK DIAGRAM



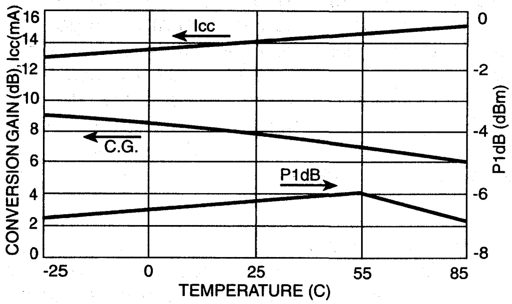
Typical Performance, T_A = 25°C, V_{CC} = 5V, RF: -20 dBm at 2 GHz, LO: -5 dBm at 1.75 GHz

(unless otherwise noted)

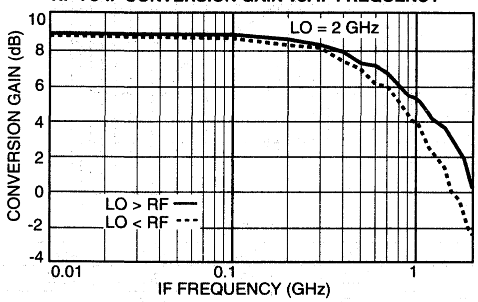
CONVERSION GAIN, Icc and IF P1dB vs. Vcc



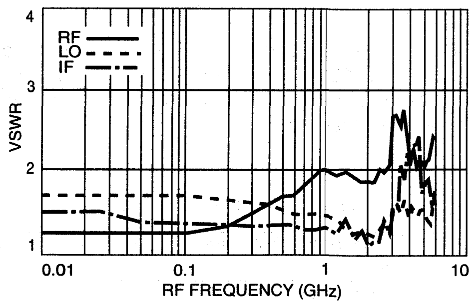
CONVERSION GAIN, IF P1dB and Icc CURRENT vs. CASE TEMPERATURE



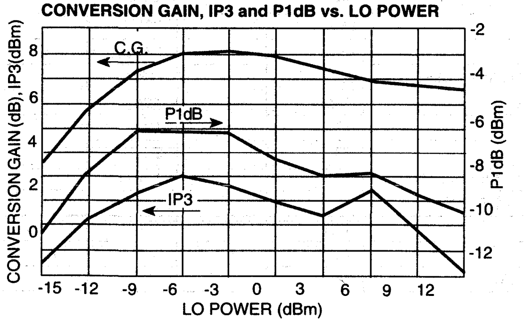
RF TO IF CONVERSION GAIN vs. IF FREQUENCY



RF, LO and IF PORT VSWR vs. FREQUENCY



CONVERSION GAIN, IP3 and P1dB vs. LO POWER



HARMONIC INTERMODULATION SUPPRESSION (dB BELOW DESIRED OUTPUT)
RF - 1 GHz, LO - 0.752 GHz, IF - 0.248 GHz

HARMONIC LO ORDER \ HARMONIC RF ORDER	0	1	2	3	4	5
0	-	32	35	60	75	>75
1	27	0	42	46	>75	>75
2	15	28	41	65	71	>75
3	40	17	40	66	>75	>75
4	30	42	56	65	73	>75
5	45	36	52	72	>75	>75

Specifications Subject to Change Without Notice

Silicon Bipolar MMIC Cascade Amplifier

MAAM41018

Features

- Cascadable 50Ω Gain Block
- 15 dB Power Gain at 0.5 GHz
- Medium Power: +13 dBm at 1 GHz
- Single Positive Supply: +3.3 to +12V
- Temperature Range: -55 to +95°C
- Hermetic Glass-Metal Surface Mount Package

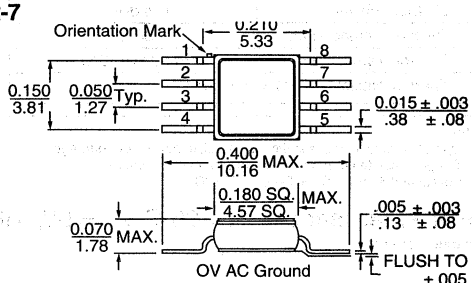
Description

M/A-COM's MAAM41018 is a high performance medium power cascadable gain block amplifier in a glass-metal hermetic surface mount package. The MAAM41018 is ideally suited for use where a general purpose amplifier with moderate power consumption from a low voltage supply is required. Typical applications include narrow and wide band RF and IF amplifiers in systems such as GPS receivers, fiber optic modules, cordless phones and battery powered radio receivers.

The MAAM41018 is based on the Darlington pair with internal feedback configuration. It can operate over a narrow or wide frequency range with useful power gain up to 2 GHz over the full military temperature range.

The MAAM41018 is fabricated with a monolithic chip using a mature, 12 GHz f_t silicon bipolar technology. The process features full IC passivation for increased performance and reliability.

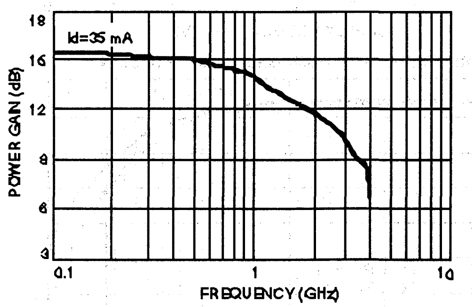
CR-7



NOTES: (Unless otherwise specified)
1. Dimensions are in / mm
2. Tolerances
in .XXX = ±.010
mm .XX = ±.25

Pin Description	
1 AC Ground; 0V	8 AC Ground; 0V
2 AC Ground; 0V	7 AC Ground; 0V
3 RF Input	6 RF Output/Bias
4 AC Ground; 0V	5 AC Ground; 0V
Bottom of the Package is AC/DC Ground	

GAIN vs. FREQUENCY



Electrical Specifications, $T_A = 25°C$

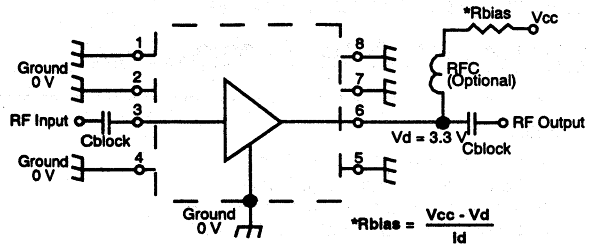
Symbol	Parameters, Test Conditions: Id = 35 mA $Z_o = 50\Omega$		Units	Min.	Typ.	Max.
Gp	Power Gain	f = 0.1 GHz	dB	15	15.5	16.5
ΔGp	Gain Flatness	f = 0.1 GHz to 1 GHz	dB		±0.6	
F_{1dB}	1 dB Bandwidth		MHz		800	
F_{3dB}	3 dB Bandwidth		MHz		1700	
S_{12}	Reverse Isolation	f = 0.1 GHz to 1.5 GHz	dB		-18	
IP_3	Third Order Intercept Point	f = 1 GHz	dBm		+24	
P_{1dB}	Output Power @ 1 dB Gain Compression	f = 1 GHz	dBm		13	
$NF_{50\Omega}$	Noise Figure measured with a 50Ω source	f = 1 GHz	dB		5.5	
VSWR	RF Input	f = 0.05 to 1.5 GHz			1.5:1	
VSWR	RF Output	f = 0.05 to 1.5 GHz			1.5:1	
t_d	Group Delay	f = 1 GHz	psec		500	
V_d	Device Voltage		Volt	2.8	3.3	3.75
dV/dT	Device Voltage to Temperature Coefficient	(Id = 35 mA)	mV/°C		-5	

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Device Current	75 mA
Power Dissipation[2,3]	200 mW
RF Input Power	+13 dBm
Junction Temperature	150°C
Storage Temperature	-65°C to 200°C
Thermal Resistance[2]: Θ_{jc} = 100°C/W	

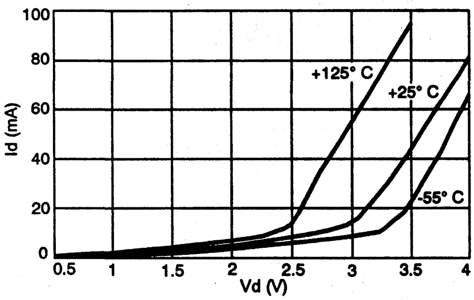
Notes:
1. Operation outside these limits may result in permanent damage.
2. T_{case} - Case temperature = 25°C (Bottom of the case)
3. Derate at 10.0 mW/°C for T_{case} > 130°C

TYPICAL BIASING CONFIGURATION AND FUNCTIONAL BLOCK DIAGRAM

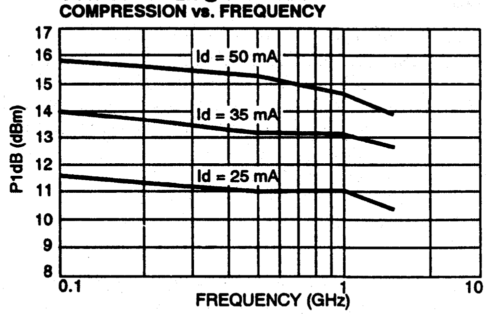


Typical Performance, T_A = 25°C (unless otherwise noted)

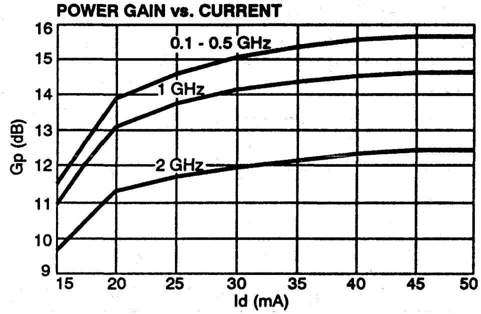
DEVICE CURRENT vs. VOLTAGE



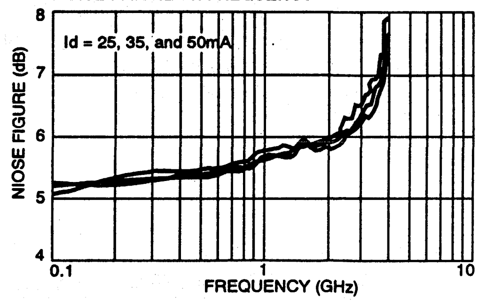
OUTPUT POWER @ 1 dB GAIN COMPRESSION vs. FREQUENCY



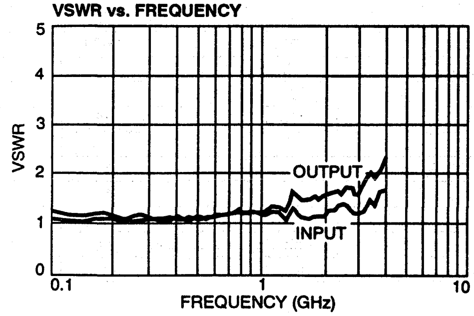
POWER GAIN vs. CURRENT



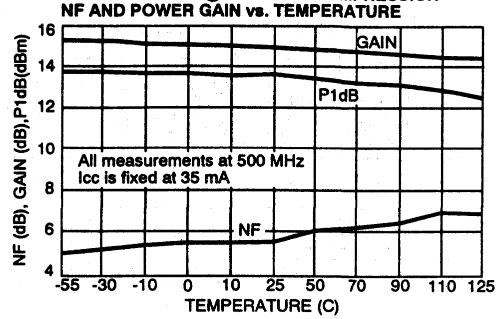
NOISE FIGURE vs. FREQUENCY



VSWR vs. FREQUENCY



OUTPUT POWER @ 1 dB GAIN COMPRESSION NF AND POWER GAIN vs. TEMPERATURE



Specifications Subject to Change Without Notice

![M/A-COM]

Advanced Information

Silicon Bipolar MMIC Cascadable Amplifier

MAAM41034

Features

- Cascadable 50Ω Gain Block
- 15 dB Power Gain at 0.5 GHz
- Medium Power: +13 dBm at 1 GHz
- Single Positive Supply: +3.3 to +12V
- Temperature Range: -55 to +95°C
- Low Cost, Low Inductance Plastic Surface Mount Package

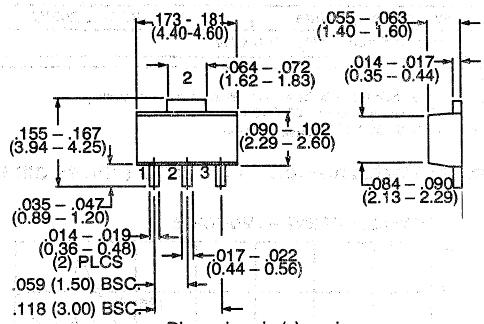
Description

M/A-COM's MAAM41034 is a high performance medium power cascadable gain block amplifier in a low inductance plastic surface mount package. The MAAM41034 is ideally suited for use where a general purpose amplifier with moderate power consumption from a low voltage supply is required. Typical applications include narrow and wide band RF and IF amplifiers in systems such as GPS receivers, fiber optic modules, cordless phones and battery powered radio receivers.

The MAAM41034 is based on the Darlington pair with internal feedback configuration. It can operate over a narrow or wide frequency range with useful power gain up to 2 GHz over the full military temperature range.

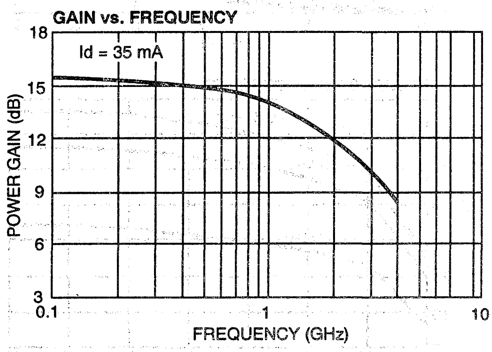
The MAAM41034 is fabricated with a monolithic chip using a mature, 12 GHz f_t silicon bipolar technology. The process features full IC passivation for increased performance and reliability.

SOT-89



Dimensions in ( ) are in mm

Pin Description	
1	RF Input
2	AC/DC Ground
3	RF Output/Bias



Electrical Specifications, $T_A = 25°C$

Symbol	Parameters, Test Conditions: Id = 35 mA Z_o = 50Ω		Units	Min.	Typ.	Max.
Gp	Power Gain	f = 0.1 GHz	dB	15	15.5	16.5
ΔGp	Gain Flatness	f = 0.1 GHz to 1 GHz	dB		±0.6	
F_{1dB}	1 dB Bandwidth		MHz		800	
F_{3dB}	3 dB Bandwidth		MHz		1600	
S_{12}	Reverse Isolation	f = 0.1 GHz to 1.5 GHz	dB		-18	
IP_3	Third Order Intercept Point	f = 1 GHz	dBm		+24	
P_{1dB}	Output Power @ 1 dB Gain Compression	f = 1 GHz	dBm		13	
$NF_{50Ω}$	Noise Figure measured with a 50Ω source	f = 1 GHz	dB		5.5	
VSWR	RF Input	f = 0.05 to 1.5 GHz			1.5:1	
VSWR	RF Output	f = 0.05 to 1.5 GHz			1.5:1	
t_d	Group Delay	f = 1 GHz	psec		350	
V_d	Device Voltage		Volt	2.8	3.3	3.75
dV/dT	Device Voltage to Temperature Coefficient	(Id=35 mA)	mV/°C		-5	

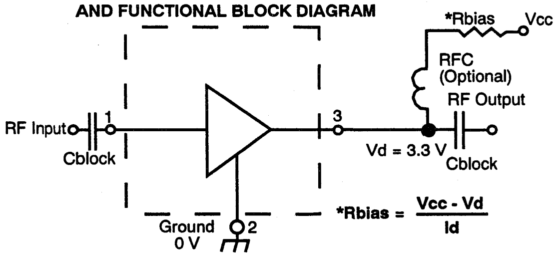
Specifications Subject to Change Without Notice

Absolute Maximum Ratings

Parameter	Absolute Maximum[1]
Device Current	75 mA
Power Dissipation[2,3]	200 mW
RF Input Power	+13 dBm
Junction Temperature	150°C
Storage Temperature	-65°C to 150°C
Thermal Resistance[2]: Θ_{jc} = 55°C/W	

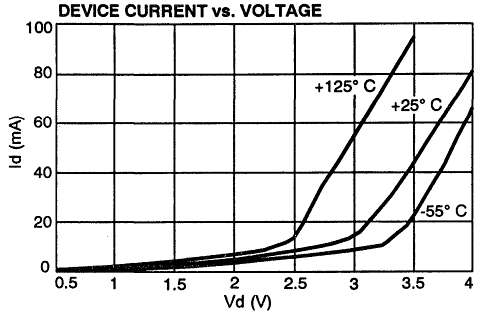
Notes:
1. Operation outside these limits may result in permanent damage.
2. T_{case} - Case temperature = 25°C (Bottom of the case)
3. Derate at 18.18 mW/°C for T_{case} > 139°C

TYPICAL BIASING CONFIGURATION AND FUNCTIONAL BLOCK DIAGRAM

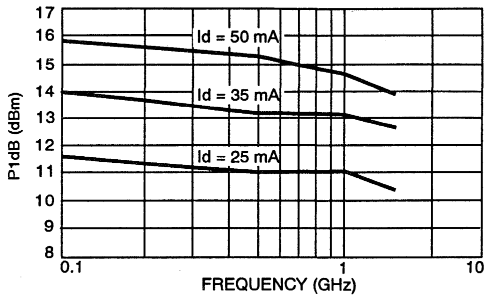


Typical Performance, T_A = 25°C (unless otherwise noted)

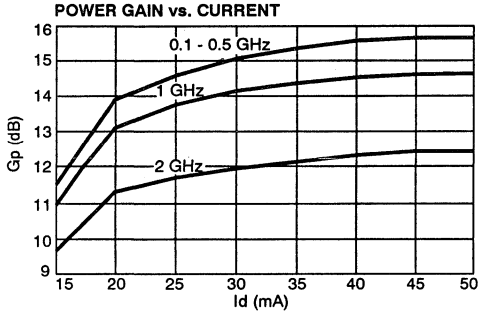
DEVICE CURRENT vs. VOLTAGE



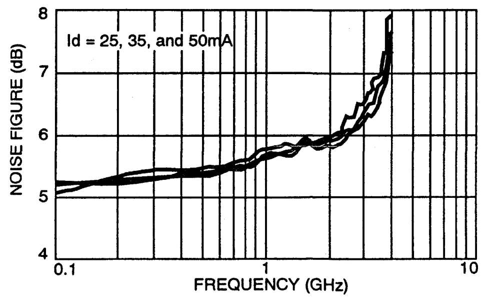
OUTPUT POWER @ 1 dB GAIN COMPRESSION vs. FREQUENCY



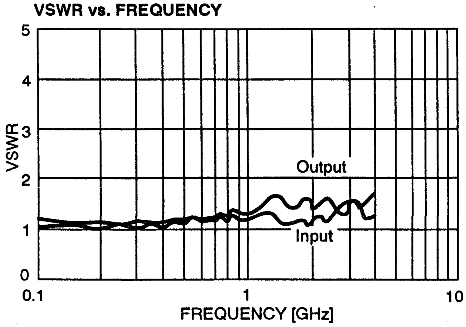
POWER GAIN vs. CURRENT



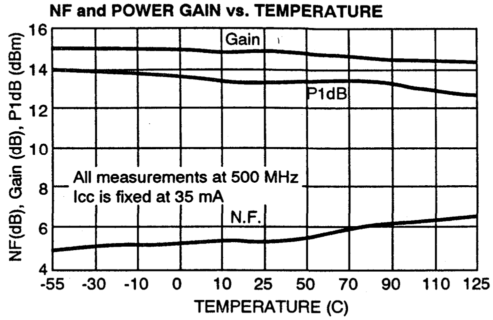
NOISE FIGURE vs. FREQUENCY



VSWR vs. FREQUENCY



OUTPUT POWER @ 1 dB GAIN COMPRESSION NF and POWER GAIN vs. TEMPERATURE



Specifications Subject to Change Without Notice

Gallium Arsenide IC Grade Substrates

Overview

Experience/Capabilities

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.

Order Work Sheet for Bulk Materials is included at the end of this section.

HPLEC 3 Inch Undoped Semi-Insulating GaAs Wafers

Electronic and Crystallographic Specifications

Parameter	Value			Unit
	Minimum	Typical	Maximum	
Hall Mobility	6,000	7,000	—	$cm^2 V^{-1} s^{-1}$
Resistivity	1×10^7	3×10^7	—	ohm-cm
Etch Pit Density (EPD)	4×10^4	8×10^4	1×10^5	cm^{-2}

Mechanical Specifications

Orientation	(100) ± 0.25°
Off Orientation	2° ± 0.25° toward nearest (110)
Diameter	3.000 ± 0.010 inches (76.2 ± 0.25mm)
Thickness*	625 ± 25 µm
Total Thickness Variation (TTV) †	≤ 3 µm
Total Indicated Reading (TIR) †	≤ 3 µm
Bow †	≤ 2 µm
Warp†	≤ 4 µm

* Non-standard thicknesses may be provided when requested.

† As measured by a GCA Tropel Autosort Mark II.

Dimensions

MAJOR FLAT*	Position :	On (011) plane within .5° (V-groove)
	Length:	22.2mm ± 2mm
MINOR FLAT*	Position :	90° ± 1° counterclockwise from Major Flat (on 011)
	Length:	11.2mm ± 2mm

* Also available in EJ Flat Orientation.

Surface Preparation

As Cut	Both faces as sawn, free from saw resist marks and chemically cleaned.
Surface*	Both faces chemically/mechanically polished, free from all scratches, haze, orange peel, and dimples.
Edge Rounding	Precision rounded to semi-std.
Particle Contamination	Front side surface < 50 particles of .5m or greater.

* Laser marking available upon request.

Packaging:

Sealed cassettes packaged in class 10 environment.

M/A-COM substrates are supplied to you either in cassettes for automatic loading or in individual fluoroware containers. Both package types are vacuum sealed in sterile poly-coated mylar bags that satisfy the MIL-B-2219C Type II Specifications and DOT Regulations.

For additional information, please contact JoAnne Dalton, Product Manager.

HPLEC 100mm Undoped Semi-Insulating GaAs Wafers

Electronic and Crystallographic Specifications

Parameter	Value			Unit
	Minimum	Typical	Maximum	
Hall Mobility	6,000	7,000	—	$cm^2 V^{-1} s^{-1}$
Resistivity	1×10^7	3×10^7	—	ohm-cm
Etch Pit Density (EPD)	4×10^4	8×10^4	1×10^5	cm^{-2}

Mechanical Specifications

Orientation	(100) ± 0.25°
Off Orientation	2° ± 0.25° toward nearest (110)
Diameter	100mm ± .5mm
Thickness*	625 ± 25 µm
Total Thickness Variation (TTV) †	≤ 3 µm
Total Indicated Reading (TIR) †	≤ 3 µm
Bow †	≤ 2 µm
Warp†	≤ 4 µm

* Non-standard thicknesses may be provided when requested.

† As measured by a GCA Tropel Autosort Mark II.

Dimensions

MAJOR FLAT*	Position :	On (011) plane within .5° (V-groove)
	Length:	32.5mm ± 2.0mm
MINOR FLAT*	Position :	90° ± 1° counterclockwise from Major Flat (on 011)
	Length:	18mm ± 2mm

* Also available in EJ Flat Orientation.

Surface Preparation

As Cut	Both faces as sawn, free from saw resist marks and chemically cleaned.
Surface*	Both faces chemically/mechanically polished, free from all scratches, haze, orange peel, and dimples.
Edge Rounding	Precision rounded to semi-std.
Particle Contamination	Front side surface < 50 particles of .5m or greater.

* Laser marking available upon request.

Packaging:

Sealed cassettes packaged in class 10 environment.

M/A-COM substrates are supplied to you either in cassettes for automatic loading or in individual fluoroware containers. Both package types are vacuum sealed in sterile poly-coated mylar bags that satisfy the MIL-B-2219C Type II Specifications and DOT Regulations.

For additional information, please contact JoAnne Dalton, Product Manager.

M/A-COM

Bulk GaAs Material Ordering Sheet For Standard Products

Please copy this page to use as an order form. Fax to 508-453-3535

	M/A-COM Part # MA4G	X	X	X	X	X
MODEL						
MAB 200 Undoped Czochralski		2				
MAB 300 Light Chromium Doped Czochralski		3				
DIAMETER						
2" Round			1			
3" Round			3			
4" Round			4			
ORIENTATION						
(100)				0		
(100) 2° to (110)				2		
Other (Check Availability)				4		
STANDARD THICKNESS						
20 mils					H	
25 mils					M	
FINISH						
As Sawn with Flats						B
Edge Rounded as Sawn w/Flats						E
Edge Rounded w/Flats Polished Both Sides						K

_______________WAFER QUANTITY MA Part # MA4G_______________

_______________PRICE Per Wafer DEL._______________

Note: 2 inch wafer = 3 sq. in.
3 inch wafer = 7sq. in.
4 inch wafer = 12 sq. in

M/A-COM ALSO SUPPLIES TO CUSTOMER SPECIFICATIONS UPON REVIEW AND APPROVAL.

Please Contact: JoAnne Dalton
Product Manager
GaAs Materials

MMIC Based Components

Application Notes

Application Note

Techniques to Achieve High Isolation with GaAs MMIC Switch Chips

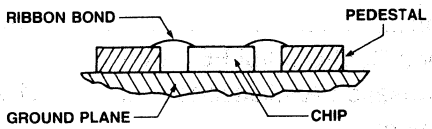
M515

Mounting Techniques

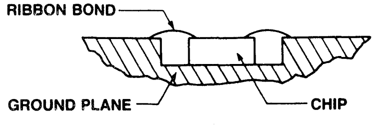
1. Mount the base of the chip directly on the ground plane (i.e. the metal floor of the package) and use short connections from the ground pads of the MMIC to the ground plane.

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 MASW6010* 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 MASW6020* 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 MASW6010 supersedes SW-200 and MASW6020 supersedes SW-210

Application Note

MASW6020* Configuration Guide

M516

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.

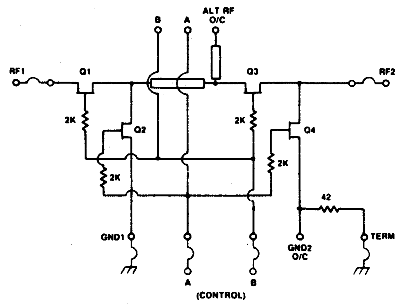


Figure 1 ***Terminated Schematic***

High Isolation Unterminated (H) Configuration

The High Isolation (H) Configuration is achieved by switching between RF1 and RF2 with GND1 and GND2 grounded. ALT RF and TERM remain open in this configuration.

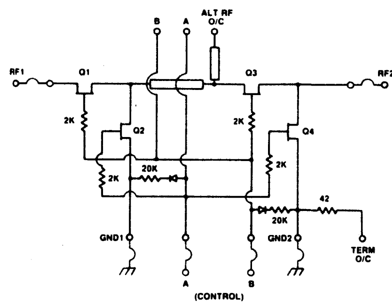


Figure 2 ***High Isolation Schematic***

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 MASW6020 part number replaces SW-210.

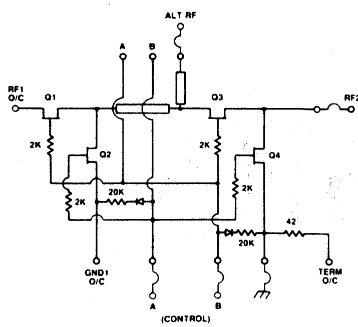


Figure 3 ***Low Loss Schematic***

SCHEMATIC KEY: **O/C = OPEN-CIRCUIT**

= WIREBOND CONNECTION

Specifications Subject to Change Without Notice.

Application Note

MASW6010* GaAs SPDT MMIC Switch Performance and Driver Circuit Techniques

M517

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..

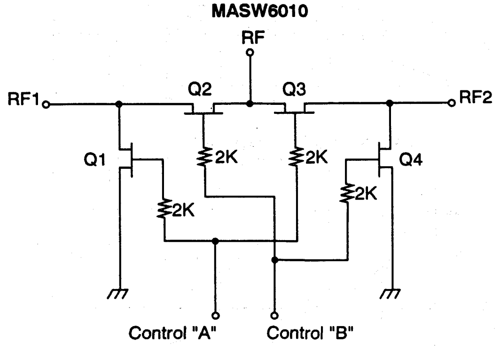
MESFET Switch Operation

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 wi.h 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

* The plastic packaged version is SW-239; the ceramic version is SW-219.



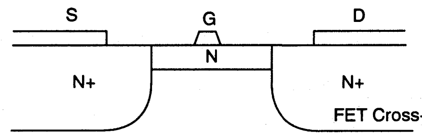
Truth Table

Control Input		Condition of Switch	
		Rf Common to each RF Port	
A	B	RF1	RF2
HI	LOW	ON	OFF
LOW	HI	OFF	ON

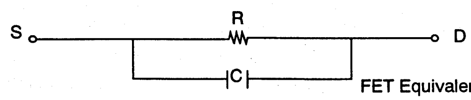
Control Voltages (Complementary Logic)
V_{IN} Low 0 to -0.2V @ 20 μA Max
V_{IN} Hi -5V @ 40 μ A Typ to -8V @ 200 μA Max

Figure 1a

FET Operation



FET Cross-Section



FET Equivalent Circuit

Equivalent Circuit Truth Table

RF STATE	VG	R	C
"ON"	0V	2.5 Ω	0.2 pF
"OFF"	-5V	10 KΩ	0.2 pF

Figure 1b

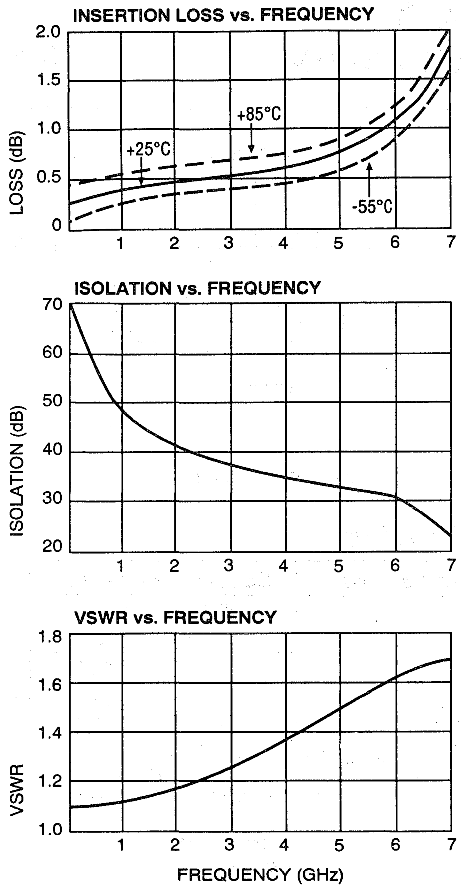


Figure 2. MASW6010 Typical Performance

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 broadbandperformance 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 speed, and with such low current consumption.

DRIVER CIRCUIT DESIGN

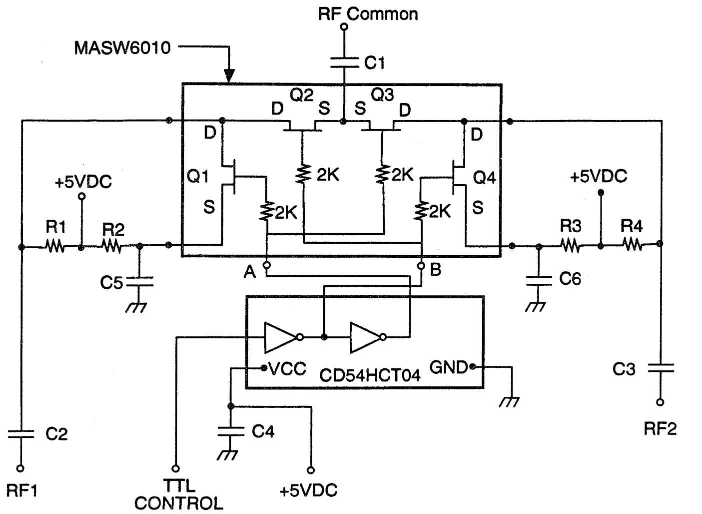
In order to integrate the MASW6010 into a signal processing system, a driving circuit must be provided. The circuit must supply bias voltages of 0 to -0.2 Vdc and -5 Vdc to the MASW6010. It would be desirable for such a driver circuit to be compatible with a popular logic family such as TTL or CMOS, 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



Control Input	Condition of Switch	
"1" = Logic High TTL	RF Common to Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

*54LS04 LSTTL may be substituted with additional pull-up circuitry or CD4041UB may be directly substituted.

Figure 3: GaAs SPDT Switch with QMOS* Driver

bias; they are alternately pulled to +5 Vdc by R1 and R4 during each respective switching condition.

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 LSTTL 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 MC10H350. This circuit achieves very fast switching speed at the sacrifice of extra DC current. See **Figure 4** for implementation of the MC10H350 with the MASW6010 switch.

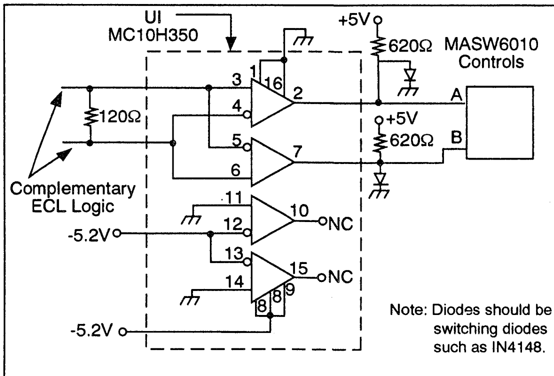


Figure 4: Driver circuit to drive MASW6010 chip for <10 ns operation, using MC10H350 ECL to TTL converter.

Power GaAs MMIC Switches for Mobile and Portable Radios

M520

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.

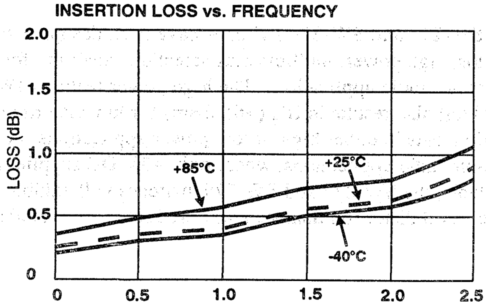


Figure 1

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.

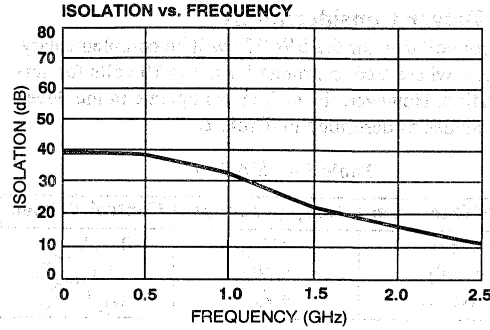


Figure 2

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.

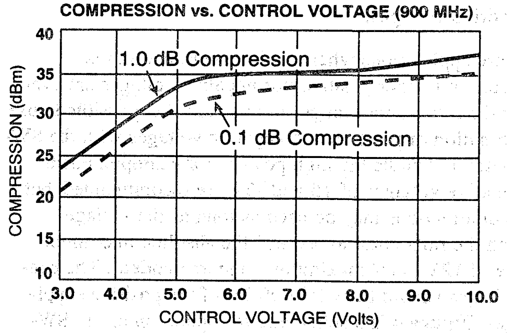


Figure 3

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 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. $3v \leq V_{CC} \leq 12v$
2. $-3v \geq V_{neg} \geq -12v$
3. $3v \leq (V_{CC}+V_{neg}) \leq 12v$

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.

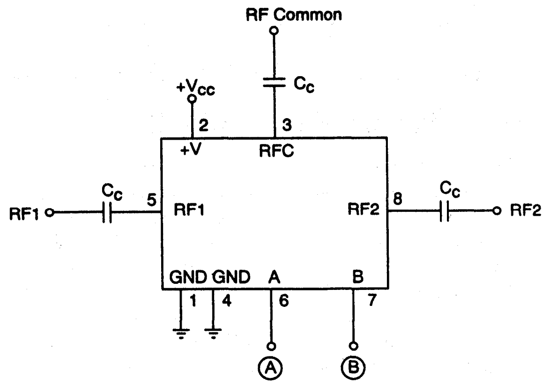


Figure 4

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 los, 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.

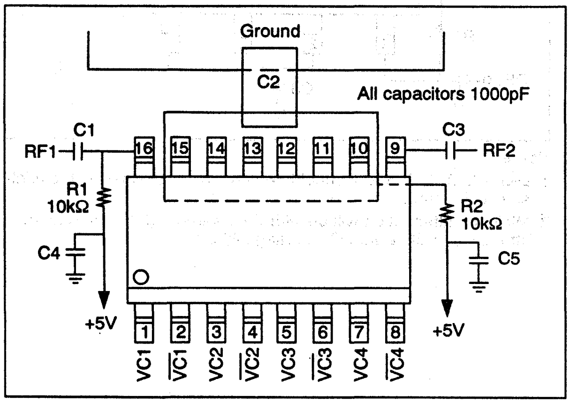
Application Note

Positive Voltage Operation of Plastic Packaged GaAs MMIC Control Devices

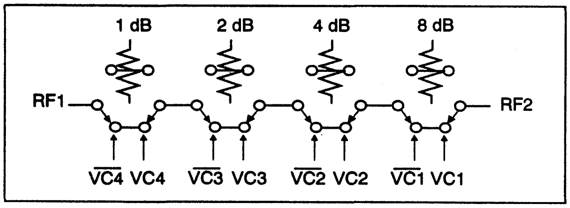
M521

In this application note we show detailed positive biasing techniques for the plastic package parts, i.e. SW-239, AT-210/AT-220, and AT-250.

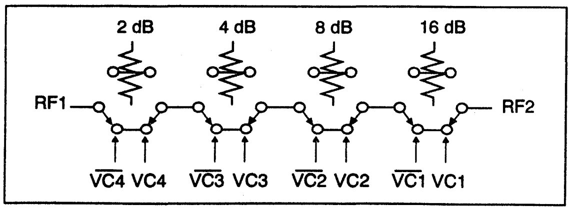
AT-210/AT-220 with +5 V Supply



AT-210 Schematic



AT-220 Schematic



AT-210/AT-220 Truth Table (+5V CTL)

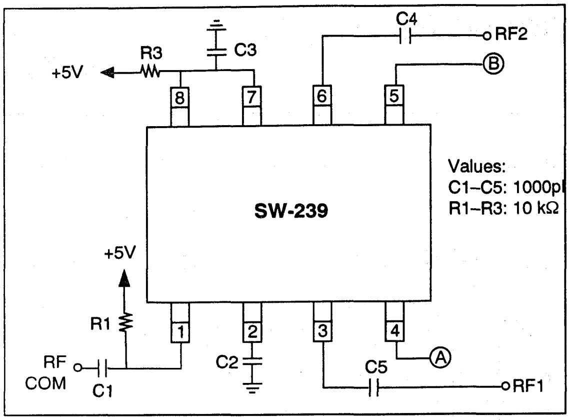
Control Inputs								Attenuation (dB)	
$\overline{VC4}$	VC4	$\overline{VC3}$	VC3	$\overline{VC2}$	VC2	$\overline{VC1}$	VC1	AT-210	AT-220
0	1	0	1	0	1	0	1	Reference	
1	0	0	1	0	1	0	1	1	2
0	1	1	0	0	1	0	1	2	4
1	0	1	0	0	1	0	1	3	6
0	1	0	1	1	0	0	1	4	8
1	0	0	1	1	0	0	1	5	10
0	1	1	0	1	0	0	1	6	12
1	0	1	0	1	0	0	1	7	14
1	0	0	1	0	1	1	0	8	16
1	0	0	1	0	1	1	0	9	18
0	1	1	0	0	1	1	0	10	20
1	0	1	0	0	1	1	0	11	22
0	1	0	1	1	0	1	0	12	24
1	0	0	1	1	0	1	0	13	26
0	1	1	0	1	0	1	0	14	28
1	0	1	0	1	0	1	0	15	30

"0" = VIN Low = 0 V, "1" = VIN High = 5 V

Notes:

1. Pins 10 through 15 are connected together on either the top or bottom of the printed circuit board. Capacitor C2 must be as close as possible to pins 10 through 15. As is the case for -5V operation, good RF ground to C2 is required in order to achieve the highest possible isolation.
2. C2 must be a high-Q capacitor, such as ATC100A series supplied by American Technical Ceramics or equivalent. For operation at low frequencies, higher values of capacitors may be substituted.

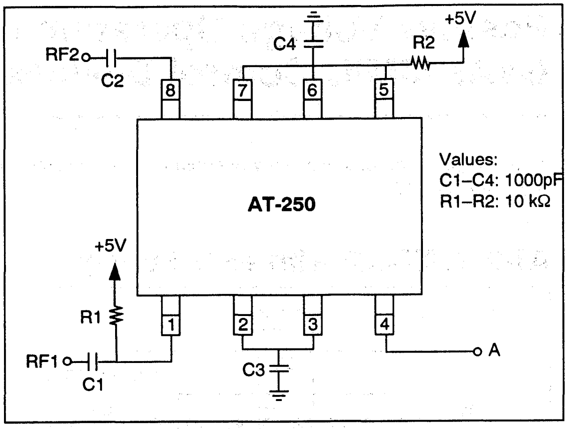
SW-239 with +5 V Supply



Notes:

1. Pins 2, 7, and 8 are connected together on either the top or bottom of the printed circuit board. Capacitors C2 and C3 must be as close as possible to pins 2, 7, and 8. As is the case for -5V operation, good RF ground to C2 and C3 is required in order to achieve the highest possible isolation.
2. C2 and C3 must be high-Q capacitors, such as ATC100A series supplied by American Technical Ceramics or equivalent. For operation at low frequencies, higher values of capacitance may be substituted.
3. Higher resistance values may be chosen for R1 and R3. This will rsult in slower switching speed, but will minimize coupling of RF signals along the +5 volt line.

AT-250 with +5 V Supply



Notes:

1. Leads 2, 3, 5, 6, and 7 should be connected together on the printed circuit board.
2. Minimum attenuation will be with CTL voltage @ 0 V. Maximum attenuation will be with CTL voltage @ 5 V.

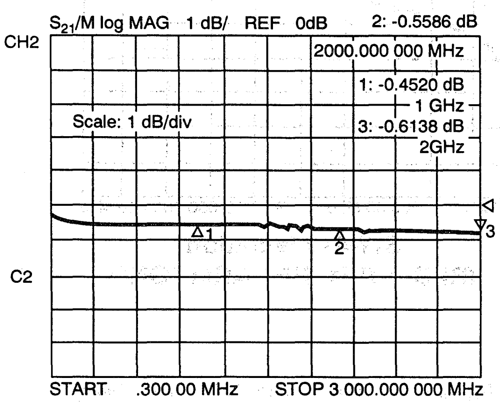
SW-239 Truth Table

Control A	Control B	RF1	RF2
0V	+5V	ON	OFF
+5V	0V	OFF	ON

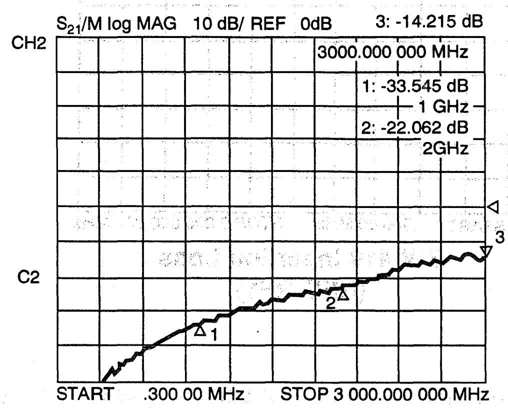
S-Parameter Data for SW-239 (SPDT), SW-419 (SP4T) AT-210 and AT-230 (Digital Attenuators)

M522

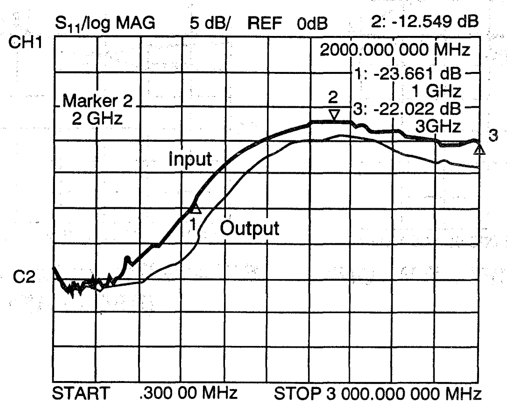
SW-239 S-Parameter Data



SW-239 Insertion Loss



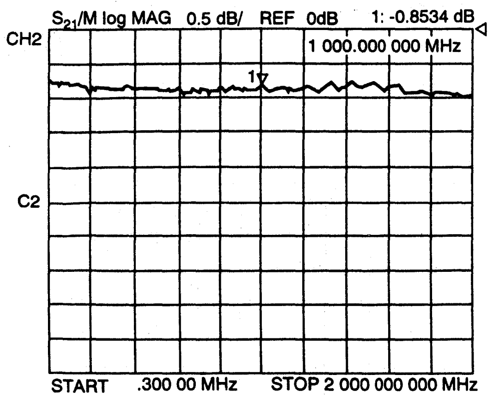
SW-239 Isolation



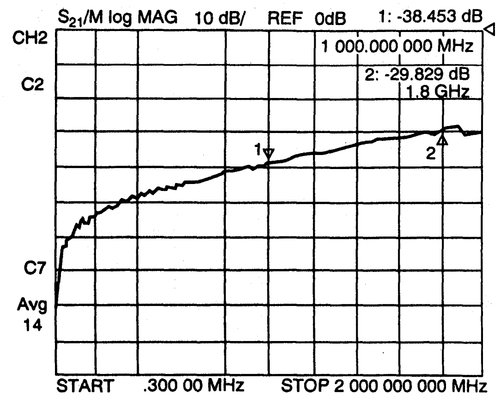
SW-239 Input/Output Return Loss

Specifications Subject to Change Without Notice

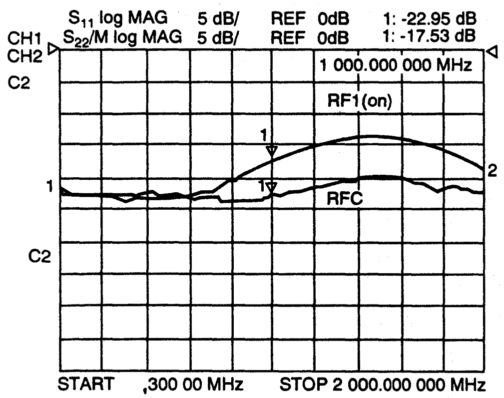
SW419 S-Parameter Data



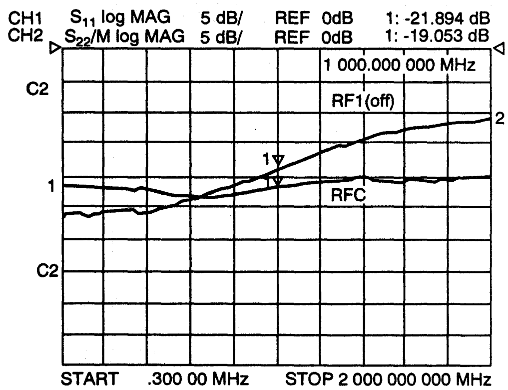
SW-419 Insertion Loss (RFC-RF1)



SW-419 Isolation (RFC → RF1, RF4 ARM "ON")

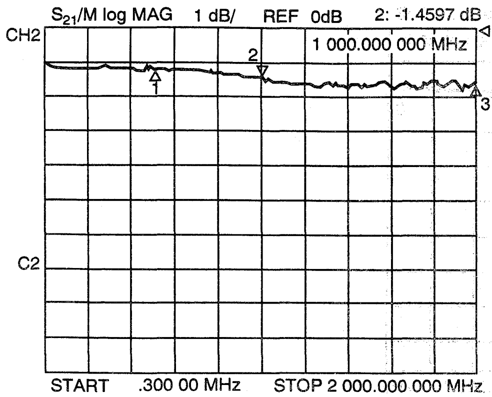


SW-419 Return Loss — RF1 ARM "ON" (RFC-RF1)

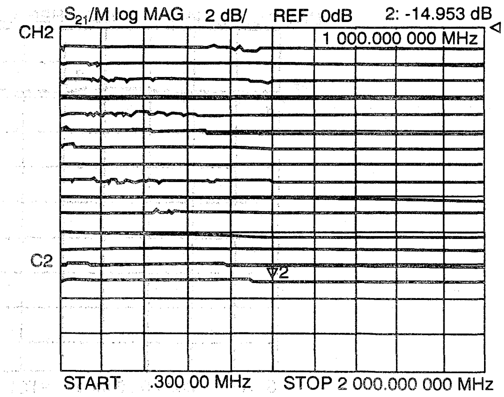


SW-419 Return Loss — RF1 ARM "OFF" (RFC → RF1, RF2 "ON")

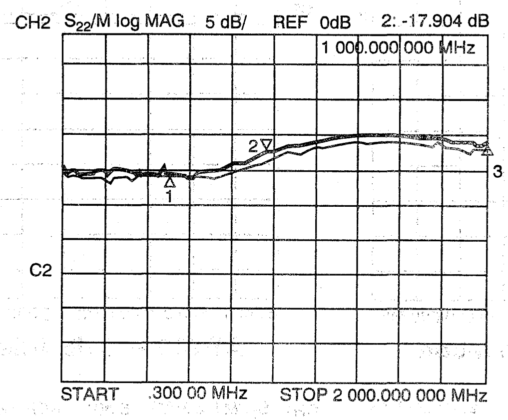
AT-210 S-Parameter Data



AT-210 Reference Insertion Loss

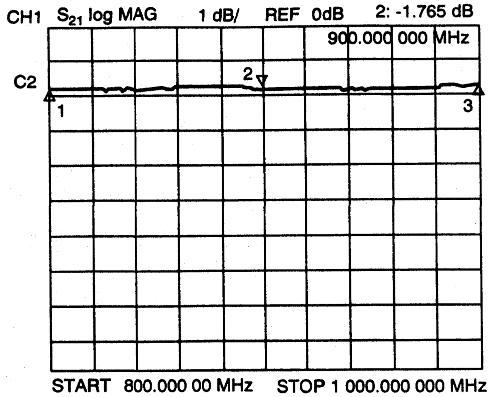


AT-210 Attenuation Accuracy

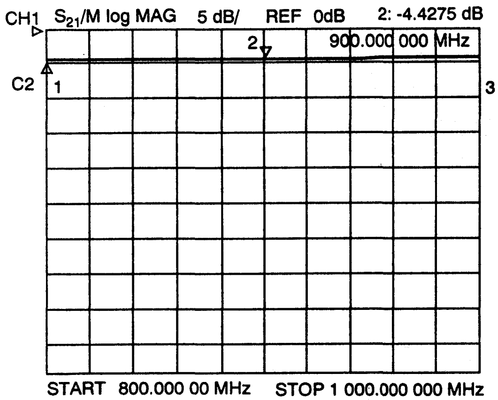


AT-210 Input/Output Return Loss — Reference State

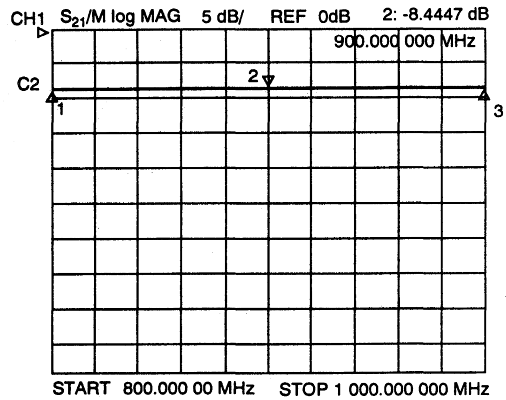
AT-230 S-Parameter Data



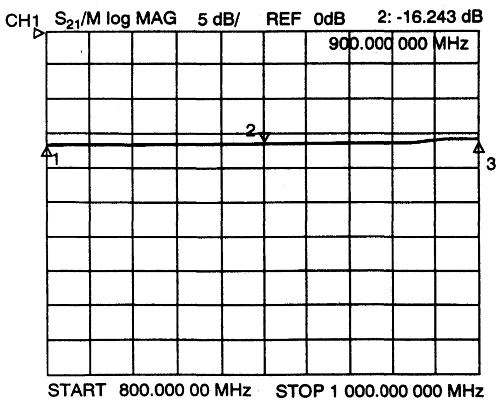
AT-230 Reference Insertion Loss



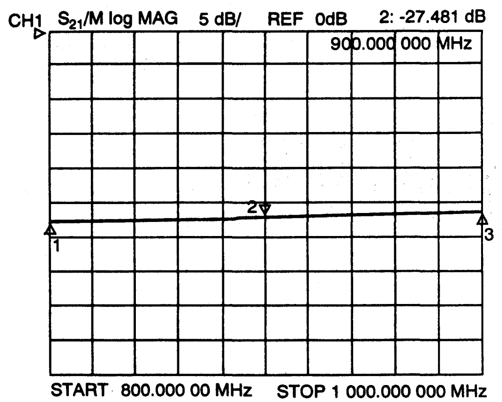
AT-230 — 4 dB Attenuation



AT-230 — 8 dB Attenuation



AT-230 — 16 dB Attenuation



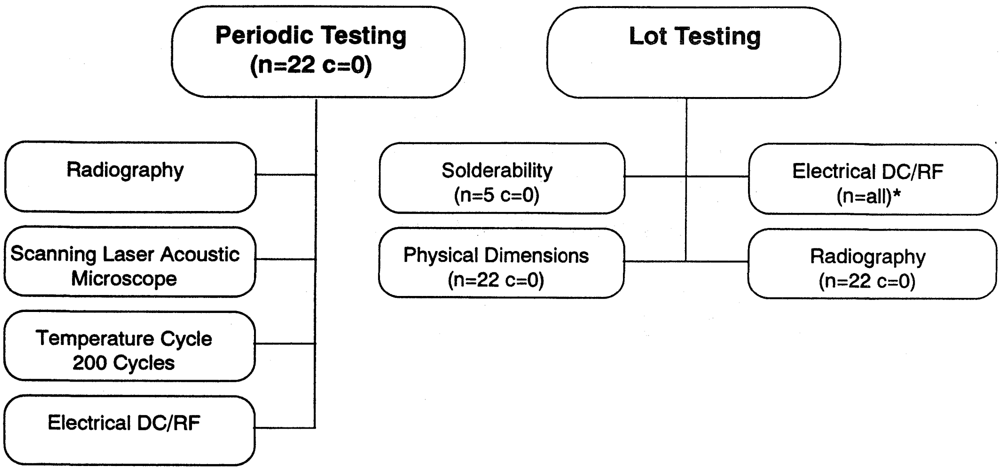
AT-230 — 28 dB Attenuation

Application Note

Attenuator and Switch Plastic Encapsulated Product and Lot Qualification

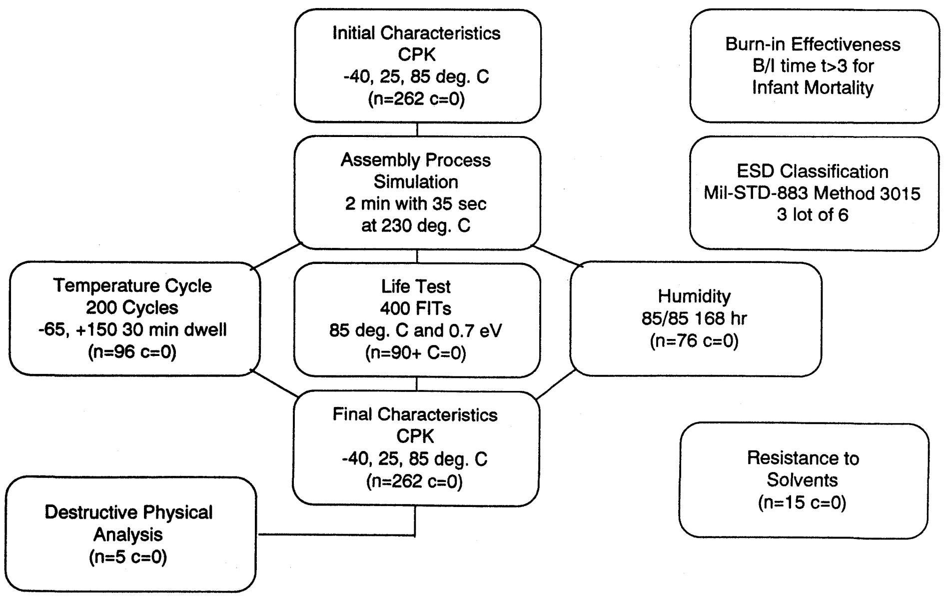
M523

1. Ongoing Lot Qualification



*Product dependent

2. Product Qualification



Suggested Circuit Controller for a Dual-Control FET VVA in AGC Temperature Compensation Applications M524

MA-COM's dual bias voltage variable attenuators AT-302, AT-303, AT-307, and AT-309 are designed with series and shunt FETs in a T-pad configuration (**Figure 1**). The attenuation as a function of voltage bias under matched conditions is shown in **Figure 2**.

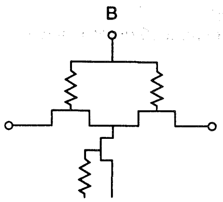


Figure 1

A circuit is described that allows the dual bias VVA to be used in AGC applications where temperature compensation is required. Control of the absorptive attenuators is based on a linear approximation of the control function about its most linear region. It should be noted that this circuit as described is a suggested approach and may require component selection to optimize performance.

A schematic of the T/C control circuit is shown in **Figure 3** . 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 nonlinearity 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 -.77 to +.77volts. This output can be used to drive both FETs with some sleight of hand. A T-pad resistive network is used to scale the linear output from the buffer to 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

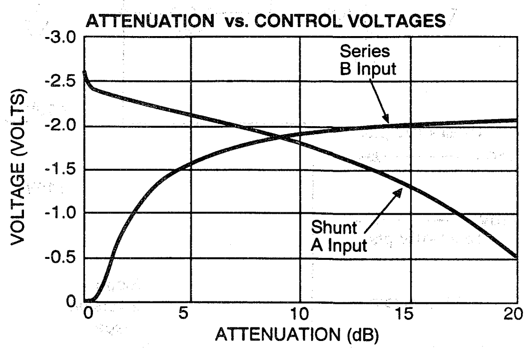


Figure 2

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 as 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.

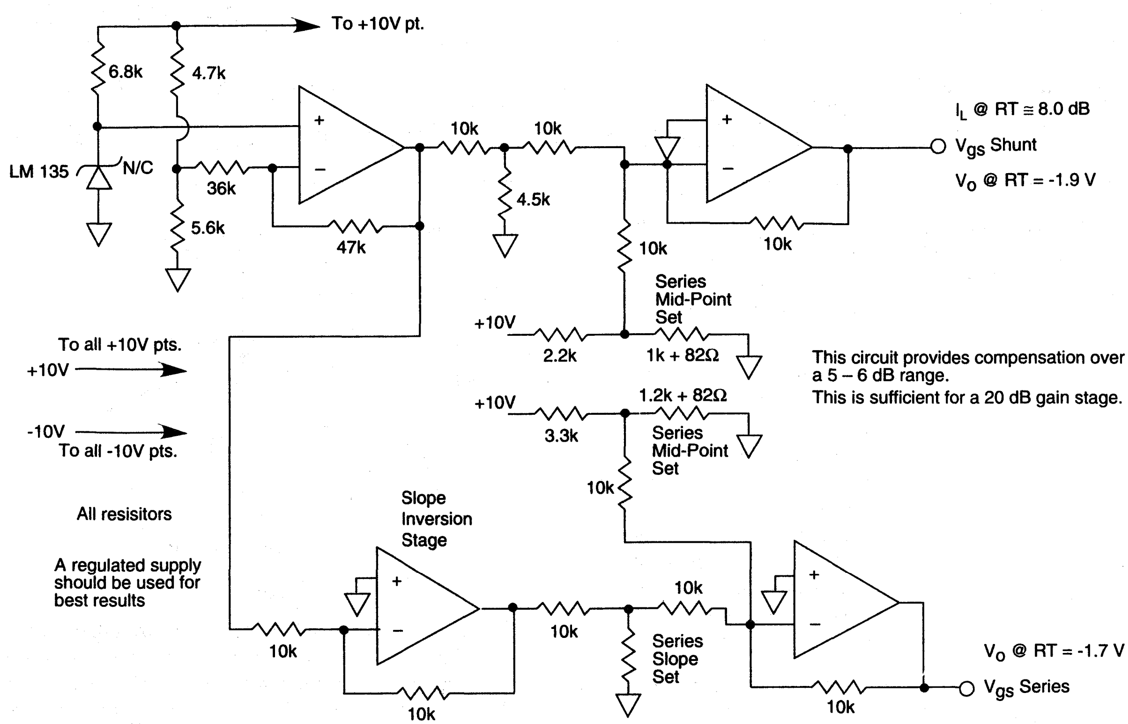
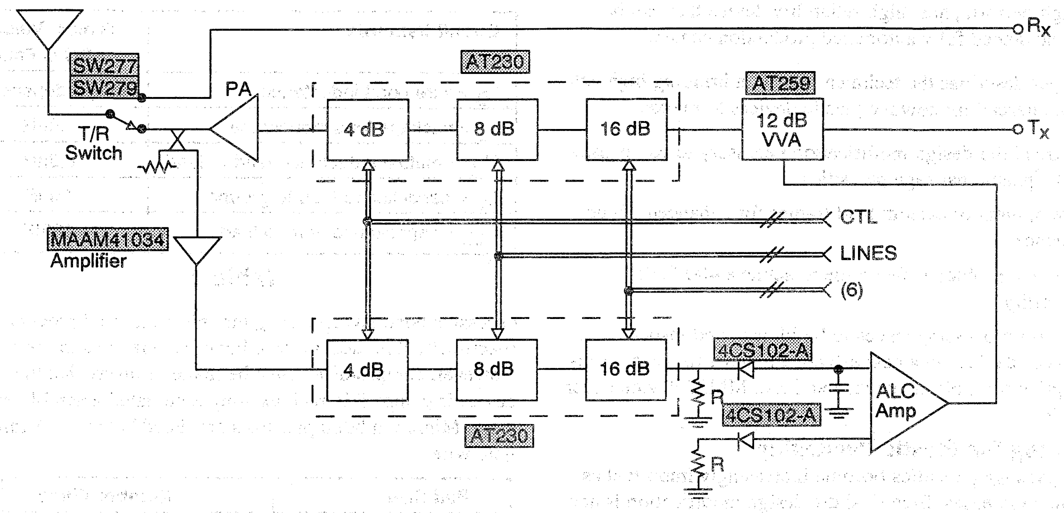


Figure 3: Temperature Compensation Circuit Schematic

Design Solution-Amplitude Control M525

Application for Precise Power Control in a TX Chain for Cellular Applications



M/A-COM Components

SW-277, SW-279	TR High Power TR Switch
AT-230	3 Bit Digital Attenuator
AT-259	12 dB Voltage Variable Attenuator
MAAM 41034	Silicon 15 dB Gain Amplifier
4CS102-A	Silicon Detector Diode

Application Note

High-Volume Commercial Plastic Packaged GaAs Monolithic Devices

M526

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**.

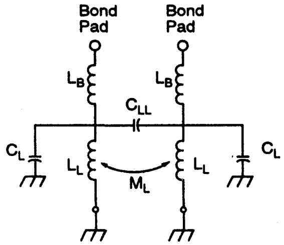


Figure 1

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 bomds

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 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.

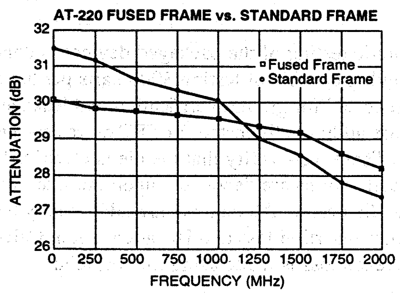


Figure 2

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.

$$\text{Cpk} = \frac{\text{(Upper Spec Limit} - \text{Mean)}}{\text{3 Sigma Actual}}$$

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:

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 reliability 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.

Plastic MMIC Reliability Process

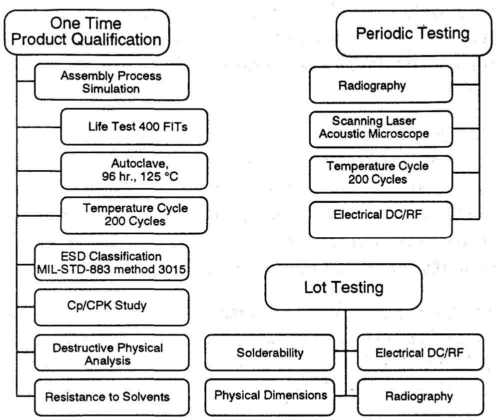


Figure 3

Packaging

The major issue controlling the packaging process is our design tends to be non-standard, and packaging houses want very high volumes of the same thing. Also, the packaging houses are reaching maximum volumes and are not interested in doing low volume (as they identify our current volume) of below 500,000 per year. In addition, another major stumbling block to developing new plastic packaged products is lead time to have samples and to have volume.

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:

$$\text{Ref. Loss} = 10*\log10((VRF1^2/50)/(VRF2*IRF2))$$

Equation 2

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 handler measures VRF2 and IRF2. Attenuation is calculated in a similar manner using the formula:

$$\text{Atten.} = 10*\log10((VRF1^2/50)/(VRF2*IRF2)) - \text{Ref. Loss}$$

Equation 3

Note: Five pc. sample RF testing from each lot is used to verify that no undetected anomalies have slipped through the screening process.

Design

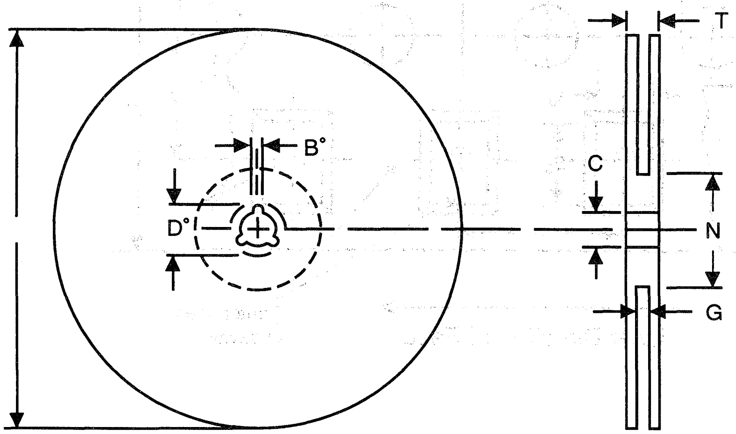
Designs must be carefully thought through prior to any action being taken. For each new product the following question must be asked: What can I do up front to control costs, not just for the design phase but for the whole process? An example of this might be to design a device for a CPK of 2.0 on all 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.

Application Note

Tape and Reel Packaging for Surface Mount Components

M513



SO-8

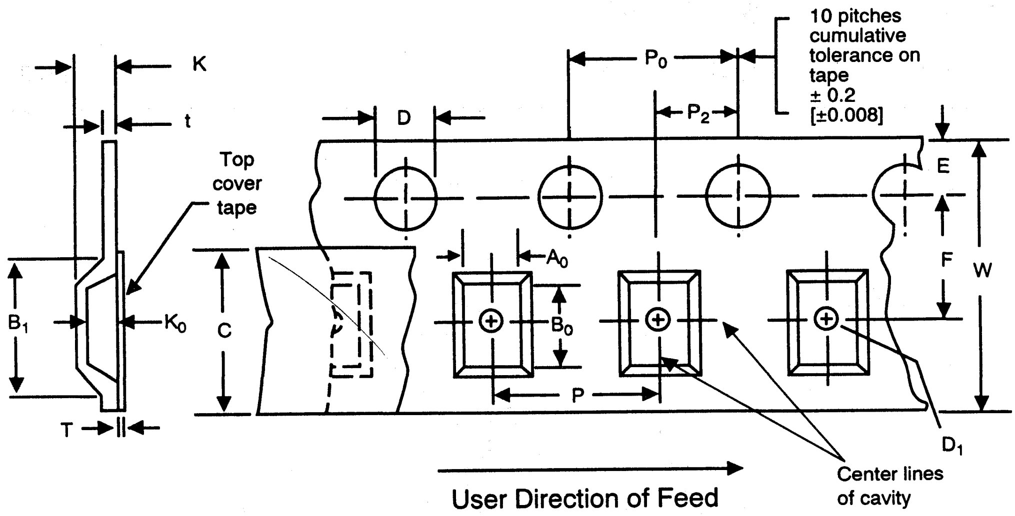
			13" Reel	
	Items	**Symbol**	**Size (mm)**	**Size (in)**
Flange	Diameter	A	330 ± 2.0	13.0 ± .079
	Thickness	T	18.4 Max	0.724 Max
	Space Between Flange	G	12.4 ± 2.0, -0.0	0.488 ± .08, -0.0
Hub	Outer Diameter	N	63 Min	2.48 Min
	Spindle Hole Diameter	C	13.0 ± 0.2	0.512 ± .008
	Keyslit Width	B	1.5 Min	0.059 Min
	Keyslit Diameter	D	20.2 Min	0.795 Min

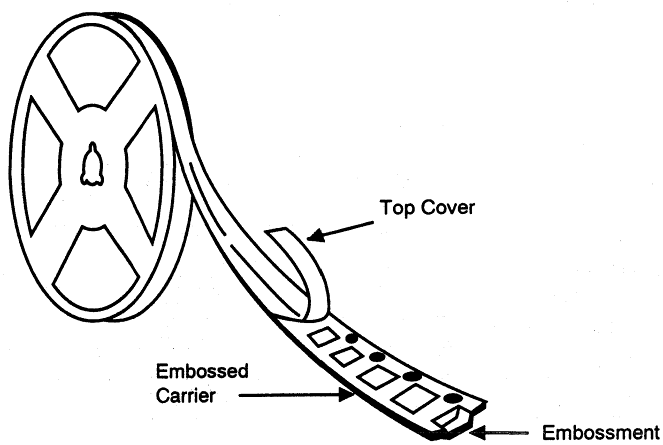
SO-14, SO-16

			13" Reel	
	Items	**Symbol**	**Size (mm)**	**Size (in)**
Flange	Diameter	A	330 ± 2.0	13.0 ± .079
	Thickness Maximum	T	22.4 Max	0.882 Max
	Space Between Flange	G	16.4 ± 2.0, -0.0	0.646 ± .08, -0.0
Hub	Outer Diameter	N	63 Min	2.48 Min
	Spindle Hole Diameter	C	13.0 ± 0.2	0.512 ± .008
	Keyslit Width	B	1.5 Min	.059 Min
	Keyslit Diameter	D	20.2 Min	0.795 Min

Specifications Subject to Change Without Notice

12, 16, 24mm Tape Only





Fixed Dimensions

Description		Symbol	Inches	mm
Cavity	Bottom hole diameter	D_1	.059 +.004, -.000	1.5 ± 0.10
Perforation	Diameter Pitch Position	D P_0 E	.059 +.004, -.000 .157 ±.004 .069 ±.004	1.5 ± 0.10 4.0 ± 0.10 1.75 ± 0.10
Cover tape	Width	T	.003 ± .004	.065 ± 0.01
Carrier tape	Width	t	0.12 ± .002	0.30 ± 0.05

SO-8

Description		Symbol	Inches	mm
Cavity	Length	A_0	0.254 ± .004	6.45 ± 0.10
	Width	B_0	0.202 ± .004	5.13 ± 0.10
	Depth	K_0	.083 ± .004	2.11 ± 0.10
	Pitch	P_1	0.315 ± .004	8.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.217 ±.002	5.5 ± .05
Cover tape	Width	C	0.366 ± .004	9.30 ± 0.10
Carrier tape	Width	W	0.472 ± .002	12.0 ± 0.20

SO-16

Description		Symbol	Inches	mm
Cavity	Length	A_0	0.256 ± .004	6.50 ± 0.10
	Width	B_0	0.404 ± .004	10.26 ± 0.10
	Depth	K_0	.084 ± .004	2.13 ± 0.10
	Pitch	P_1	0.315 ± .004	8.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.295 ±.002	7.5 ± .05
Cover tape	Width	C	0.524 ± .004	13.30 ± 0.10
Carrier tape	Width	W	0.630 ± .012	16.0 ± 0.20

SO-14

Description		Symbol	Inches	mm
Cavity	Length	A_0	0.258 ± .004	6.55 ± 0.10
	Width	B_0	0.351 ± .004	8.92 ± 0.10
	Depth	K_0	.083 ± .004	2.11 ± 0.10
	Pitch	P_1	0.315 ± .004	8.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.295 ±.002	7.5 ± .05
Cover tape	Width	C	0.524 ± .004	13.30 ± 0.10
Carrier tape	Width	W	0.630 ± .008	16.0 ± 0.20

SOT-143

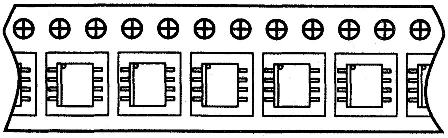
Description		Symbol	Inches	mm
Cavity	Length	A_0	0.120 ± .004	3.05 ± 0.10
	Width	B_0	0.104 ± .004	2.64 ± 0.10
	Depth	K_0	.049 ± .004	1.24 ± 0.10
	Pitch	P_1	0.158 ± .004	4.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.138 ±.002	3.5 ± .05
Cover tape	Width	C	0.217 ± .004	5.5 ± 0.10
Carrier tape	Width	W	0.315 ± .008	8.0 ± 0.20

SOW-16

Description		Symbol	Inches	mm
Cavity	Length	A_0	0.428 ± .004	10.87 ± 0.10
	Width	B_0	0.423 ± .004	10.74 ± 0.10
	Depth	K_0	0.120 ± .004	3.05 ± 0.10
	Pitch	P_1	0.472 ± .004	11.99 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.295 ±.002	7.5 ± .05
Cover Tape	Width	C	0.524 ± .004	13.30 ± 0.10
Carrier tape	Width	W	0.630 ± .012	16.0 ± 0.20

Typical Component Orientation For Tape and Reel

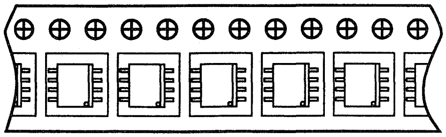
example: SW-239TR



User Direction of Feed

Forward Tape and Reel

example: SW-239RTR



User Direction of Feed

Reverse Tape and Reel

Ordering Information on Reel Size and Number of Units Per Reel

Package Type	Max. Qty. – 7" Reel	Max. Qty. – 13" Reel
SO-8	1000	2500
SO-14	1000	2500
SO-16	1000	2500
SOW-16	Not Recommended	1000
SO-20	Not Recommended	1000
SO-24	Not Recommended	1000
SOT-143	3000	10,000

Products ordered on tape and reel require adding a suffix of TR or RTR to part number (e.g., SW-239 becomes SW-239TR or SW-239RTR when on tape and reel).

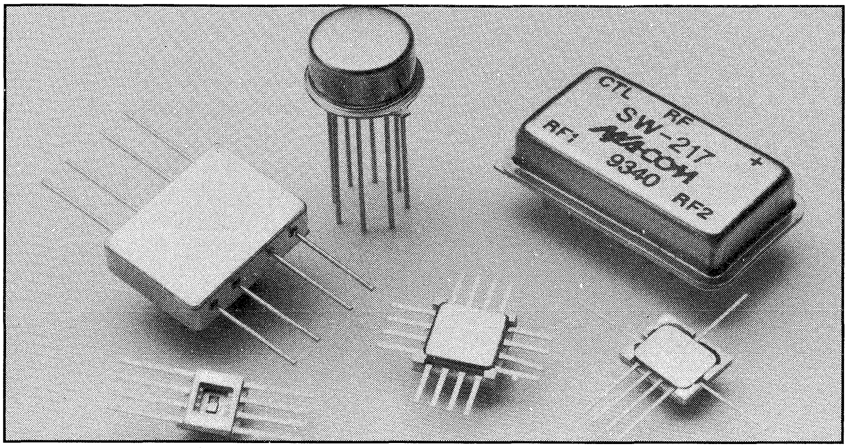
Products using the SO-8, SO-14, and SO-16 designations should sell standard TR and RTR in quantities of 500, 1000, 2500, or any multiple thereof.

Products using the SOW-16, SO-20, and SO-24 designations should sell standard TR and RTR in quantities of 500, 1000, or any multiple thereof.

Products using the SOT-143 should sell standard TR and RTR in quantities of 1000, 5000, 10,000, or any multiple thereof.

Note: A ½ meter leader and ½ meter trailer tape will be provided with each reel. Other lengths may be specified by the customer.

RF Components



Title **Page**

Shunt

The shunt switch is the workhorse configuration for PIN diode switches. Shown in figure 2a, the shunt switch has excellent isolation properties over a very broad frequency range (approximately 20 dB for a single diode & switch.) In addition, insertion loss is low because of the lack of any elements in series with the transmission line. Insertion loss and VSWR are limited at 10 GHz and above by the shunt capacitance of the diode. Good performance with moderate VWSR to 18 GHz is possible.
sertion loss and VSWR are limited at 10 GHz and above by the shunt capacitance of the diode. Good performance with moderate VSWR to 18 GHz is possible.

To enhance isolation over octave bandwidths, several shunt diodes separated by quarter-wave transmission lines may be incorporated. One such switch is shown in Figure 2b. The isolation is approximately double that of the single shunt diode plus 6 dB.[4] Although limited in bandwidth, this configuration can achieve very high isolation values (70-90 dB) with additional shunt diodes and transmission line sections. However, insertion loss will increase as more components are added to the circuit.

Multithrow switches are difficult to realize using only shunt diodes. A band-limited shunt multithrow as shown in Figure 2c uses quarter-wave transmission lines to give the "off" arm a high input impedance at the common port to prevent loading of the "on" arm. Because this is achieved with quarter-wave sections, the switch is inherently band-limited to approximately one octave.[7]

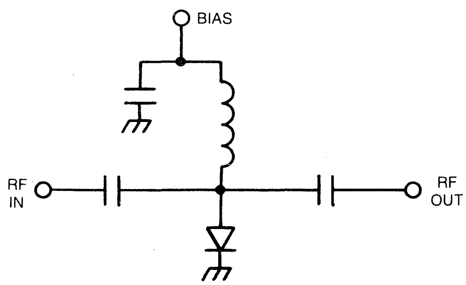


Figure 2a. Shunt SPST

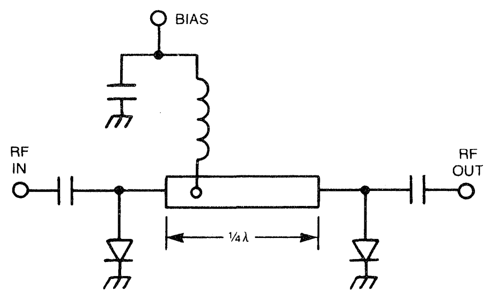


Figure 2b. Shunt ¼λ Spaced Diodes

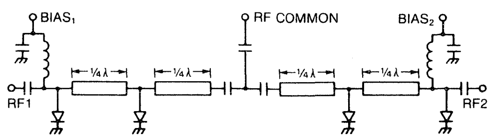


Figure 2c. Band-Limited Shunt Multithrow

Series-Shunt

To combine the broadband insertion loss of the series switch with the broadband isolation of the shunt switch, plus adding multithrow capability, a PIN diode switch is given the series-shunt configuration as shown in Figure 3a. The increased complexity degrades insertion loss and VSWR but overall performance is greatly enhanced. Like the shunt switch, isolation can be increased with the addition of diode/quarter-wave transmission line sections at the expense of insertion loss and VSWR.

Multithrow series-shunt switches are configured as shown in Figure 3b. Arms may be added to construct a switch of the desired order. Multithrow series-shunt switches are the best overall performers when broadband isolation is required and reasonable (1-2 dB) insertion loss is tolerable.

Additional variations are possible from those shown here. Modifications and innovations can be made to optimize a particular parameter. However, with the adoption of a given configuration comes a set of performance characteristics which the designer has to live with. Although he can modify them somewhat, the designer is often limited to what he can achieve without a total change in his design.

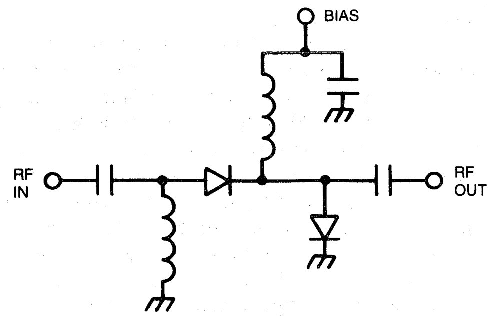


Figure 3a. Series-Shunt SPST

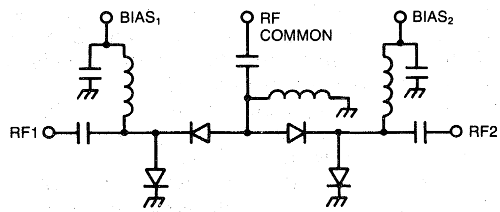


Figure 3b. Multithrow Seris-Shunt

UNDERSTANDING PARAMETERS

Insertion Loss

Insertion Loss, as well as Isolation, and VSWR are the primary parameters which describe a PIN switch. Insertion Loss is a measure of RF signal loss when passing through the switch when it is in the "on" condition. Although it is desirable for Insertion Loss to be ideally non-existent, it is nevertheless a necessary evil. Some amount of Insertion Loss must be tolerated in order to allow tradeoffs for other parameters. Typical values are between 0.5 dB and 2 dB. See Figure 4a.

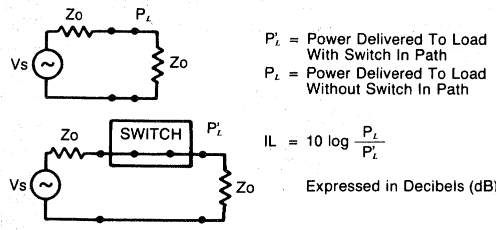


Figure 4a. Insertion Loss

Isolation

Isolation is a measure of the degree which an unwanted RF signal is attenuated when the switch path is in the "off" condition. Being the difference in power levels appearing at a load with the switch "off" as compared to the switch "on", isolation is sometimes referred to as the on/off ratio. A minimum amount of isolation is required by the system designer to provide adequate rejection of unwanted signals in a given RF path. Because realizable isolation values are finite and are at the expense of other parameters, no higher isolation than necessary should be specified. Isolation levels range from 20 dB to 70 dB or more with values above 90 dB achievable but designs to achieve these levels are at the expense of other parameters, principally insertion loss. A switch in the isolated state presents a reflective termination at each port at which no alternate RF path exists. In cases where this is a problem, a switch can be designed to present a matched termination in both "on" and "off" states (at the expense of other design parameters, of course). This type of switch is commonly called a "matched" or "terminated switch". See Figure 4b.

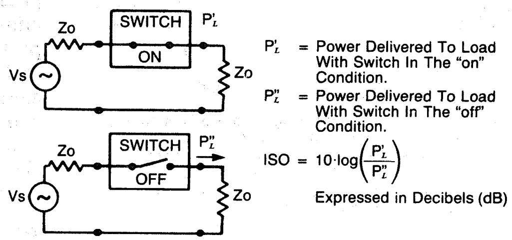


Figure 4b. Isolation

VSWR

VSWR (Voltage Standing Wave Ratio) measures the degree of impedance match present at a PIN switch RF port. Because a switch is used to merely control the path of RF signals, VSWR levels of the switch are expected to be better than other devices used in the system. As a switch design parameter, VSWR usually follows from good insertion loss design. It has a major impact when considering internal switch transmission line media, component parasitics and RF port transitions and therefore is very sensitive to the layout of the switch. Minimizing VSWR is a case of reducing parasitics and designing a good layout. See Figure 4c.

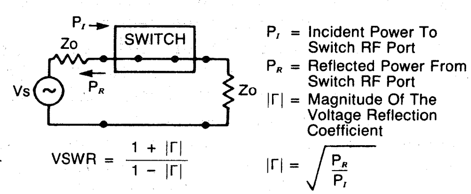


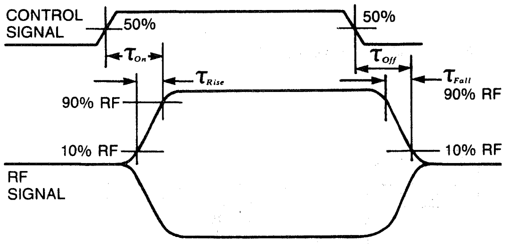
Figure 4c. VSWR

Switching Speed

One of the features of PIN diode RF switches is the ability to switch quickly and reliably. The all-solid-state electronics allows frequent switching with no impact on reliability and as such, PIN diode switches find application as pulse modulators, time multiplexers and any application requiring many switching operations.

To specify switching characteristics, an understanding of the various parameters is required. Terminology and definitions vary, but the most popular parameters are listed as follows and are defined in Figure 5:

τ_{Rise} = Rise Time
τ_{Fall} = Fall Time
τ_{On} = On Time
τ_{Off} = Off Time



τ_{Rise} = Rise Time = Time for RF signal to rise from 10% to 90% of the maximum "on" level.
τ_{Fall} = Fall Time = Time for RF signal to fall from 90% to 10% of the maximum "on" level.
τ_{On} = On Time = Time from 50% of the control pulse to 90% of the maximum "on" level.
τ_{Off} = Off Time = Time from 50% of the control pulse to 10% of the maximum "on" level.

Figure 5. Switching Parameters

The most significant parameters are rise time and fall time. They determine the upper limit in switching rate and dictate the minimum time necessary for the switch to change state. On and Off time measures the total switching time starting at control pulse transition (50% point) to RF level stabilization (90% point). Although the on/off time parameter includes control pulse delay which is internal to the RF switch, this delay may be designed out at the system level by allowing adequate control lead time to anticipate this delay.

Typical τ_{on} and τ_{off} *are around 1* μs to 2 μs for switches below 1 GHz. Switches above 1 GHz can easily achieve 100-500 ns switching times while faster times of 10-30 ns have been designed. High speeds of 1-10 ns can be achieved at lower frequencies (1-500 MHz) by using Schottky diodes in a balanced configuration similar to that of a double balanced mixer. These switches are inherently limited in bandwidth (one or two octaves) due to the use of input and output ferrite transformers.

Switching Transients

One of the consequences of fast switching is the switching transients which appear at the RF ports. The transients are due to the DC shifts which occur internally in the switch during switching. Transients can cause problems because their spectral content can cause false signals to occur during switching. The problem is particularly serious when the spectral content is inside the RF band of the switch. The frequency of the transient spectral content is a function of the speed of the switch. Faster switching produces transient energy at higher frequencies. The amplitude of the transients are higher for faster switching speeds and for switches designed for lower frequencies.

Transients are specified several ways. One approach is to specify the maximum allowable amplitude of the transient found at each of the RF ports. Alternately, when the majority of the spectral content is outside the switch RF band, transient amplitude can be specified in-band only. This can be measured by filtering off the out-of-band transient energy. An additional method specifies the spectral content, in dBm, in the RF band of interest.

RF Power Handling

PIN diode switches are usually considered to be small signal devices and generally handle RF power levels up to +20 dBm (100 mW) with optimum performance below +5 dBm. The basic power limitation is the use of the PIN diode devices in series with the RF path. Any power loss due to the diodes themselves is dissipated by the diode. Heat sinking can improve this somewhat but the real solution is to change the design approach.

Switches specifically designed for high power use specially designed high power PIN diodes mounted in shunt with the RF line. As opposed to series mounting, shunt mounting offers fewer obstacles to RF power passing through the switch. Because of the limitations of shunt mounting and the use of high power devices, electrical performance is severely limited when compared to small signal switch designs.

"Hot Switching" is a term used to describe switching states with RF power applied. This is the most stringent condition for a high power switch because, in the transition, the diodes are in an intermediate resistance state and bear the brunt of the RF power for a short period of time. High power switches may or may not be designed for hot switching and are specified accordingly.

INTERMODULATION PRODUCTS

PIN diode switches by nature are low distortion devices. The reason is that the PIN diodes themselves have excellent distortion characteristics. The letters PIN stand for Positive-Intrinsic-Negative and refer to the layers of doped silicon which comprise the diode structure. The intrinsic (undoped) layer is incorporated to provide exceptionally low back bias capacitance which allows high isolation and low insertion loss RF performance. A benefit of the intrinsic layer is that it provides spacing between the P and N layers. This causes the transition time of carriers crossing the intrinsic layer to be lengthened which reduces the effect of non-linear diode resistance on an RF signal. Thus, switches in the 2 to 18 GHz range are seldom specified for intermodulation.

PIN diode switches used at lower frequencies have more of a problem. As the RF signal approaches lower frequencies, the transition time is no longer long enough to prevent non-linear effects. Second and third order intercept points degrade for lower frequencies and can determine the lower frequency limit of operation. Typical values are a +30 dBm third order intercept and a +60 dBm second order intercept.

UNDERSTANDING SWITCH DESIGN TRADEOFFS

As can be expected, each parameter has a possible tradeoff relative to other parameters. It helps to understand some of the fundamental tradeoffs made by switch designers because it yields insight as to what is feasible and where to emphasize switch performance.

Insertion loss and isolation are fundamental tradeoff parameters. Changes of 0.6 dBm in insertion loss can mean a 10 dB change in isolation. It is seldom that a change in one does not affect another. Another pair is switching speed vs. switching transients. Faster switches yield larger transients and can be critical for systems design. Specifying unnecessary low end frequency operation will aggravate both achievable speed and transients. RF power level may dictate switch design and has severe consequences for all other parameters, particularly isolation. Bandwidth considerations may dictate broadband or narrowband designs. Narrowband design, where possible, offers higher performance with less complexity. This is especially true at microwave frequencies where distributed line lengths can be used to great advantage to improve overall performance.

CONCLUSION

The PIN diode switch proves to be an excellent choice when fast switching or frequent switching is required. Optimum performance can be achieved by understanding the trade-offs inherent in PIN diode switch operation and by specifying only what is actually needed for system operation. M/A-COM's switch line adds the versatility of broadband operations, internal driver and hermetic packaging to further simplify usage and improve reliability. The devices shown in this catalog are only a few of the many switch devices M/A-COM can supply. Custom versions are available and our applications Engineers can help the designer in specifying the design of a custom unit, if necessary, or application of one of our standard units to your system needs.

REFERENCES

1. **Applications of PIN Diodes,** Application Note 922, Hewlett Packard Inc.
2. **PIN Diode Basics,** Application Note 80200, Alpha Industries, Inc., Woburn, Mass.
3. **PIN Diode Switching Times,** Application Note 80900 Alpha Industries, Inc., Woburn, Mass.
4. **PIN Diode Designers Guide,** Microwave Associates, 1980
5. **PIN Diode Designers Handbook and Catalog,** Publication No. PD-500, 1979, Unitrode Corp., Watertown, Mass.
6. White, Joseph F., **Semiconductors Control,** 1977 Artech House Inc., Dedham, Mass.
7. **Broadbanding the Shunt PIN Diode SPDT Switch,** Application Note 957-1 Hewlett Packard Inc.

SPST RF Switch
10-1000 MHz

SW-121

- Low Loss — 0.5 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		10-1000 MHz
Insertion Loss	10-1000 MHz	1.0 dB Max
	10-500 MHz	0.8 dB Max
VSWR	10-1000 MHz	1.25:1 Max
	10-500 MHz	1.2:1 Max
Isolation	10-1000 MHz	40 dB Min
	10-500 MHz	50 dB Min
	10-100 MHz	60 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max
	−5 VDC ±5% @ 35 mA Max
	(450 mW Typical)
Environmental	

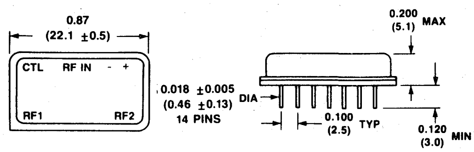
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-121 PIN	Dual Inline

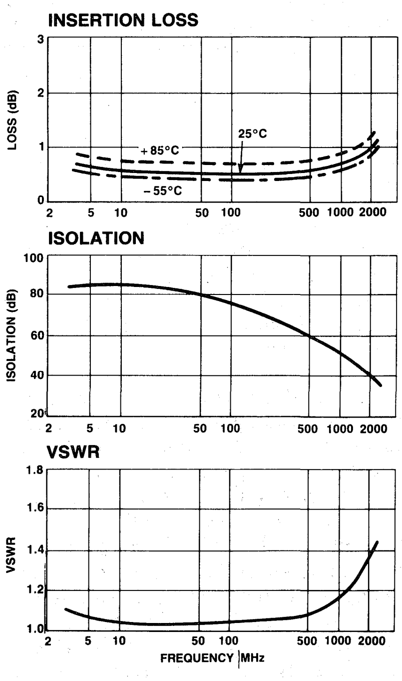
DI-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF1 TO RF2
0	OFF
1	ON

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Matched SPST RF Switch 20-1500 MHz

SW-161

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.8 dB Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-1500 MHz
Insertion Loss	20-1500 MHz	1.5 dB Max
	20-1000 MHz	1.2 dB Max
	30-500 MHz	1.0 dB Max
VSWR (All States)	20-1500 MHz	1.50:1 Max
	30-1000 MHz	1.25:1 Max
Isolation	20-1500 MHz	40 dB Min
	20-1000 MHz	50 dB Min
	20-500 MHz	60 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 μS Typ
t_{OFF}		1.5 μS Typ
Transients (In-Band)		40 mV Typ
Input Power	20-1500 MHz	+5 dBm Typ
for 1 dB Compression	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(20-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(20-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 35 mA Max
		−5 VDC ±5% @ 35 mA Max
		(450 mW Typical)

Environmental

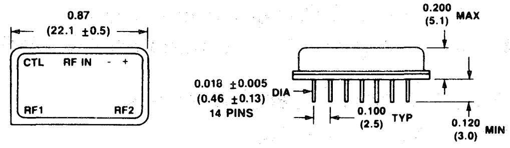
See Appendix for MIL-STD-883 screening option.

* All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-161 PIN	Dual Inline

DI-1

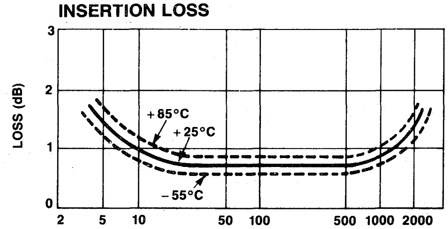


Dimensions in ( ) are in mm.

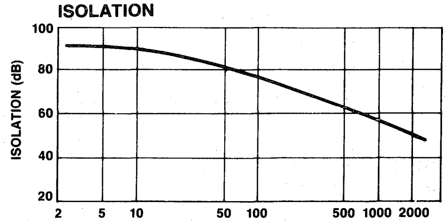
See Appendix for complete physical dimensions.

Typical Performance

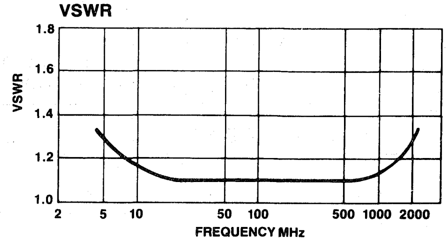
INSERTION LOSS



ISOLATION



VSWR



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF PATH RF1 TO RF2
0	OFF
1	ON

Specifications Subject to Change Without Notice.

GaAs SPST Switch
DC-3 GHz

SW-211/213

- Fast Switching Speed, 6ns 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

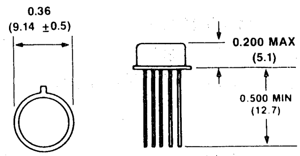
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			6 ns Typ
Transients (In-Band) SW-213			30 mV Typ
Transients (In-Band) SW-211			10 mV Typ
Input Power for 1 dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5-3 GHz	+27	+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			−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-211 only, RF1 is an open circuit and RF2 is shorted to case ground

Ordering Information

Model No.	Package
SW-211 PIN	TO-5-3
SW-213 PIN	TO-5-3

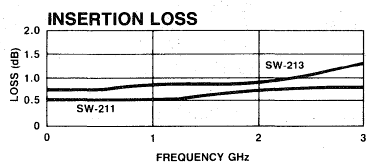
TO-5-3

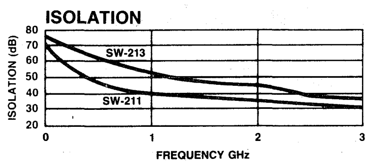


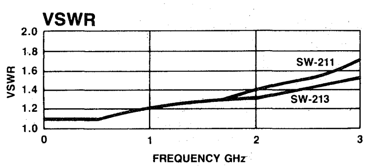
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

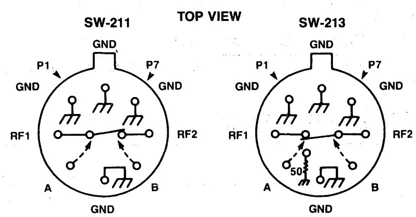
Typical Performance







Pin Configuration



Truth Table**

Control Input		Condition Of Switch
A	**B**	**RF1 to RF2**
Hi	Low	ON
Low	Hi	OFF

Specifications Subject to Change Without Notice.

SPST RF Switch
10-2000 MHz

SW-111

- Ultra Broadband
- High Isolation — 80 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	2.0 dB Max
	10-1000 MHz	1.8 dB Max
	10-500 MHz	1.6 dB Max
VSWR	10-2000 MHz	1.5:1 Max
	10-1000 MHz	1.2:1 Max
Isolation	10-2000 MHz	50 dB Min
	10-1000 MHz	60 dB Min
	10-500 MHz	70 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		2.0 μS Typ
t_{OFF}		1.0 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression		+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order		+60 dBm Typ
Third Order		+30 dBm Typ
Bias Power		+9 to +15 VDC @ 35 mA Max
		−5 VDC ±5% @ 35 mA Max
		(450 mW Typical)

Environmental

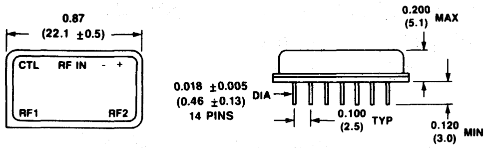
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-111 PIN	Dual Inline

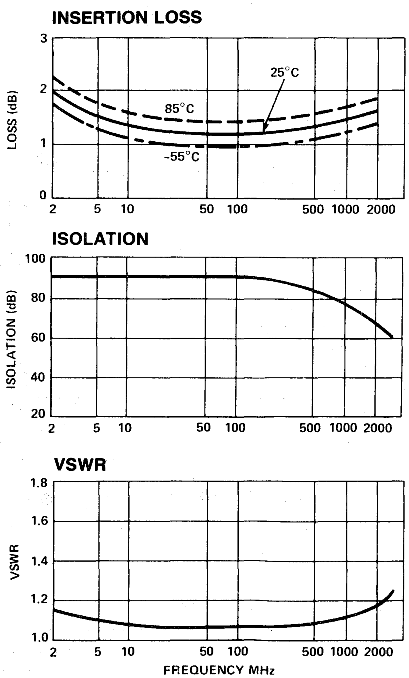
DI-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF1 TO RF2
0	OFF
1	ON

Specifications Subject to Change Without Notice.

SPST RF Switch
200-2000 MHz

SW-131

- Low Loss — 0.5 dB Typical
- High Isolation — 50 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.0 dB Max
	200-1000 MHz	0.8 dB Max
VSWR	200-2000 MHz	1.65:1 Max
	500-1500 MHz	1.35:1 Max
Isolation	200-2000 MHz	30 dB Min
	200-1000 MHz	40 dB Min
	200-500 MHz	50 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max
	−5 VDC ±5% @ 35 mA Max
	(450 mW Typical)

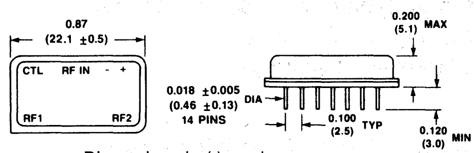
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-131 PIN	Dual Inline

DI-1

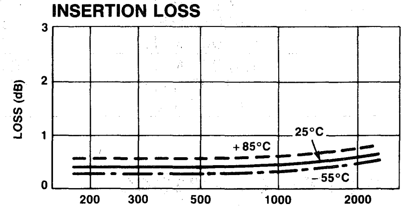


Dimensions in ( ) are in mm.

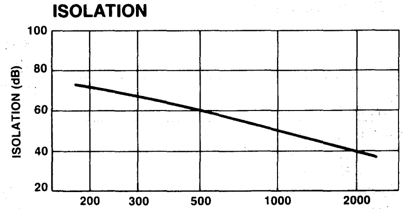
See Appendix for complete physical dimensions.

Typical Performance

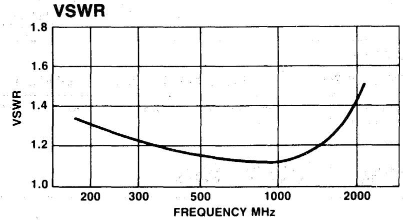
INSERTION LOSS



ISOLATION



VSWR



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF1 TO RF2
0	OFF
1	ON

Specifications Subject to Change Without Notice.

Matched GaAs SPST Switch DC-3 GHz

SWS-278

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Surface Mount Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		DC - 3 GHz
Insertion Loss	DC - 3 GHz	1.4dB Max
	DC - 2 GHz	1.1dB Max
	DC - 1 GHz	1.0dB Max
	DC - 0.5 GHz	1.0dB Max
VSWR	DC - 3 GHz	1.5:1 Max
	DC - 2 GHz	1.3:1 Max
	DC - 1 GHz	1.2:1 Max
	DC - 0.5 GHz	1.2:1 Max
Isolation	DC - 3 GHz	23dB Min
	DC - 2 GHz	30dB Min
	DC - 1 GHz	40dB Min
	DC - 0.5 GHz	50dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			3ns Typ
t_{ON}, t_{OFF} (50% CTL to 90%/10% RF)			6ns Typ
Transients (In-Band)			30mv Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5 to 3 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +13dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 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.			

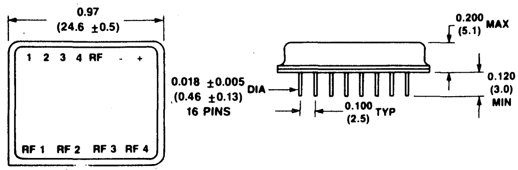
*All specifications apply with 50 ohm connected to all RF ports.

†Faster switching speed can be achieved with enhanced driver waveform.

Ordering Information

Model No.	Package
SWS278 PIN	Surface Mount

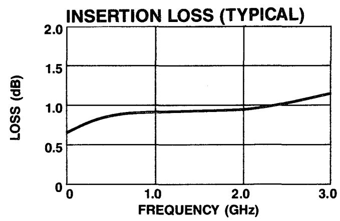
DI-2

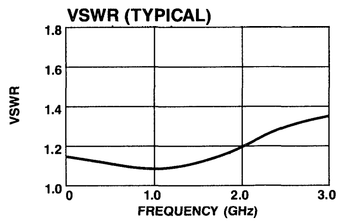


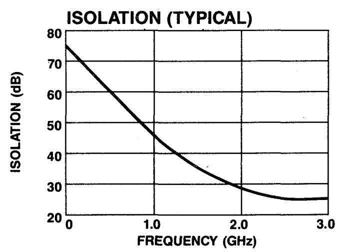
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

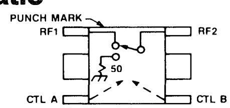
Typical Performance







Schematic



Truth Table

Control Input		Condition Of Switch
A	B	RF1 to RF2
Hi	Low	ON
Low	Hi	OFF

Specifications Subject to Change Without Notice.

M/A-COM

GaAs SPST Switch DC-3 GHz

SW-212/214

- Fast Switching Speed, 6ns 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†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/100% 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.

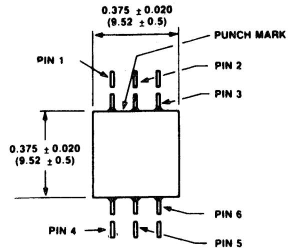
†Faster switching speed can be achieved with enhanced driver waveform.

**For the "Off" switch condition of the SW-212 only, RF1 is an open circuit and RF2 is shorted to case ground.

Ordering Information

Model No.		Package
SW-212	PIN	Flatpack
SW-214	PIN	Flatpack

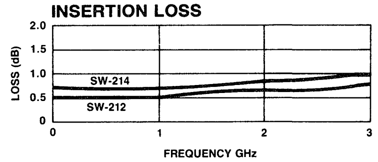
FP-13

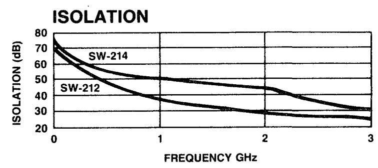


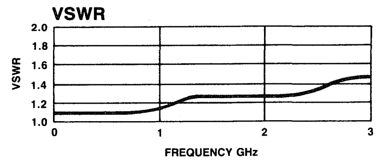
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

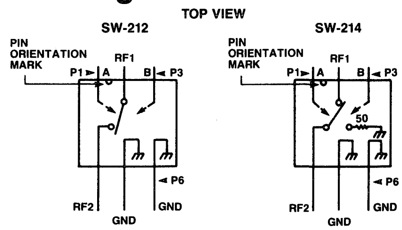
Typical Performance







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.

M/A-COM

Matched GaAs SPST Switch 5-3000 MHz

SW-215/216

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07mA 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)**
t_{RISE}, t_{FALL}		7 ns	20 ns Typ
t_{ON}, t_{OFF} (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-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.

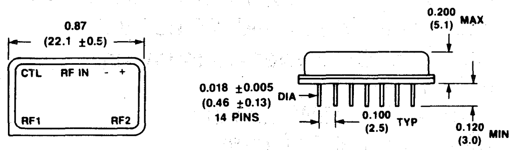
All specifications apply when operated with bias voltages of +5 VDC (SW-215) or +8 VDC (SW-216) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-215 PIN	Dual Inline
SW-216 PIN	Dual Inline

Specifications Subject to Change Without Notice.

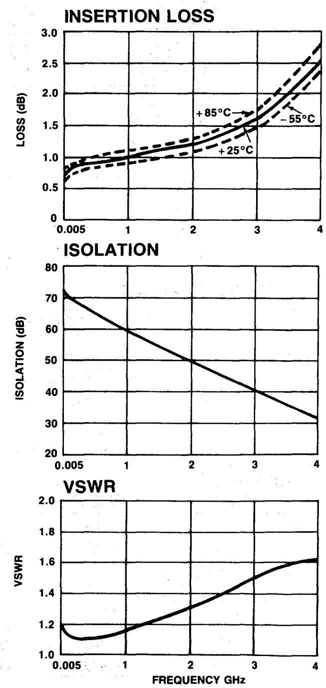
DI-1



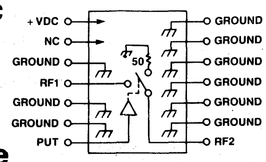
Dimensions in ( ) are in mm.

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

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Matched GaAs SPST Switch
5-4000 MHz

SW-231/232

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07mA Typical
- Integral TTL (SW-231) or CMOS (SW-232) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-4000 MHz
Insertion Loss	5-4000 MHz	2.8 dB Max
	5-2000 MHz	1.5 dB Max
	5-1000 MHz	1.2 dB Max
	5- 500 MHz	1.1 dB Max
VSWR	5-4000 MHz	2.3:1 Max
	5-2000 MHz	1.9:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.4:1 Max
Isolation	5-4000 MHz	22 dB Min
	5-2000 MHz	37 dB Min
	5-1000 MHz	50 dB Min
	5- 500 MHz	60 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-231 (TTL)**	**SW-232 (CMOS)**
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)	7 ns	20 ns Typ
t_{ON}, t_{OFF}	20 ns	40 ns Typ
Transients (In-Band)	70 mV	35 mV Typ

Input Power for 1 dB Compression

Model #'s	SW-231	SW-232	
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-231	+5 VDC @ 0.07 mA Typ, 1 mA Max
SW-232	+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1 mA Max

Environmental

See Appendix for MIL-STD-883 screening option.

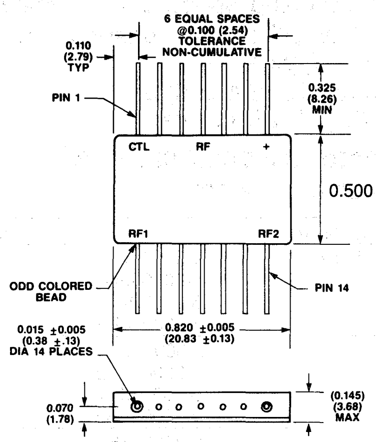
*All specifications apply when operated with bias voltages of +5 VDC (SW-231) or +8 VDC (SW-232). 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-231 PIN	Flatpack
SW-232 PIN	Flatpack

Specifications Subject to Change Without Notice.

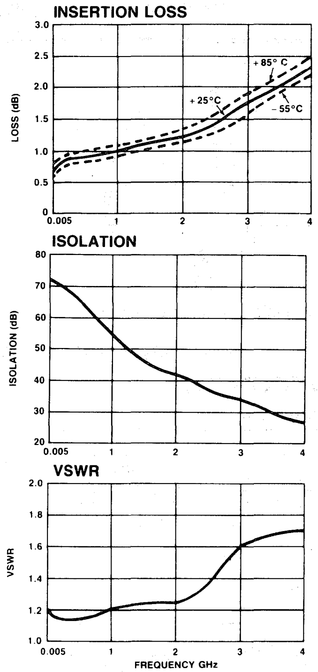
FP-16



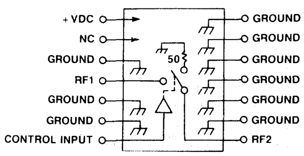
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input	Condition Of Switch
"1" = Logic High TTL (SW-231)/CMOS (SW-232)	RF1 to RF2
1 0	ON OFF

GaAs SPST Switch
DC-4 GHz

SW-221/222/223

- Miniature Ceramic Package
- Terminated (SW-221), High Isolation (SW-222), Low Loss (SW-223)
- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range					DC-4GHz
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†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (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.

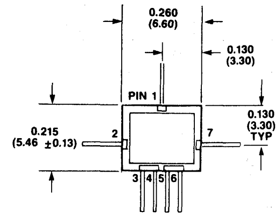
*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 VDC control voltages. †Faster switching speed can be achieved with enhanced driver waveform.
**For the SW-222 and SW-223 only, RF1 is an open circuit and RF2 is shorted to case ground for the "OFF" switch condition.

Ordering Information

Model No.		**Package**
SW-221	PIN	Ceramic
SW-222	PIN	Ceramic
SW-223	PIN	Ceramic

Specifications Subject to Change Without Notice.

CR-2

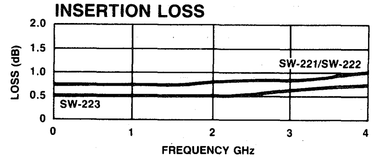


Dimensions in ( ) are in mm.

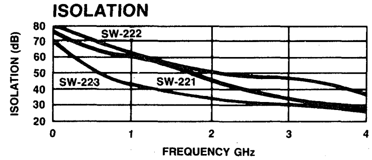
See Appendix for complete physical dimensions.

Typical Performance

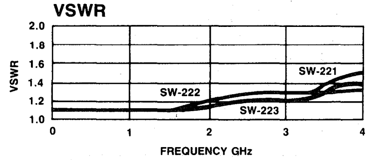
INSERTION LOSS



ISOLATION

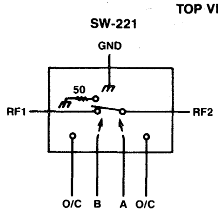


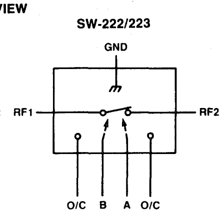
VSWR



Pin Configuration

TOP VIEW





Truth Table

Control Input		Condition Of Switch
A	**B**	**RF1 to RF2**
Hi	Low	ON
Low	Hi	OFF

Matched SPDT RF Switch
20-1500 MHz

SW-162

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.8 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		20-1500 MHz
Insertion Loss	20-1500 MHz	1.5 dB Max
	20-1000 MHz	1.2 dB Max
	30-500 MHz	1.0 dB Max
VSWR (All States)	20-1500 MHz	1.50:1 Max
	30-1000 MHz	1.25:1 Max
Isolation	20-1500 MHz	40 dB Min
	20-1000 MHz	50 dB Min
	20-500 MHz	60 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 μS Typ
t_{OFF}		1.5 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression	20-1500 MHz	+5 dBm Typ
	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(20-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(20-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 35 mA Max
		−5 VDC ±5% @ 35 mA Max
		(500 mW Typical)

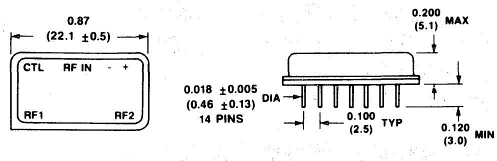
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-162 PIN	Dual Inline

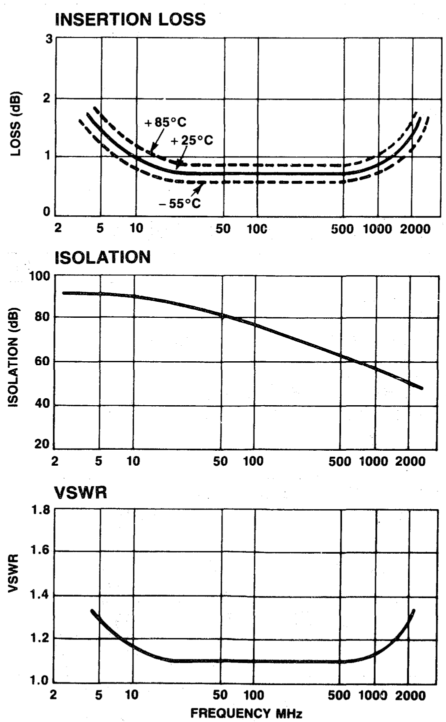
DI-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

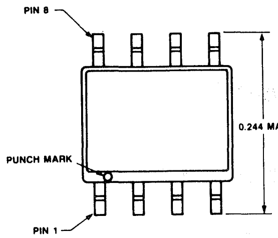
Specifications Subject to Change Without Notice.

GaAs SPDT RF Switch DC-1600 MHz

SW-239

- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption
- Small Package Size, 0.150″ x 0.190″ (3.8mm x 4.8mm)
- Surface Mount Package

SF-2



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −40°C to +85°C)

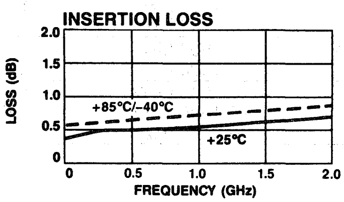
Frequency range		DC - 1600 MHz
Insertion Loss	DC - 1600 MHz	0.9dB Max
	DC - 1000 MHz	0.8dB Max
	DC - 500 MHz	0.7dB Max
	DC - 100 MHz	0.7dB Max
VSWR	DC - 1600 MHz	1.5:1 Max
	DC - 1000 MHz	1.2:1 Max
	DC - 500 MHz	1.2:1 Max
	DC - 100 MHz	1.15:1 Max
Isolation	DC - 1600 MHz	23dB Min
	DC - 1000 MHz	30dB Min
	DC - 500 MHz	40dB Min
	DC - 100 MHz	50dB Min

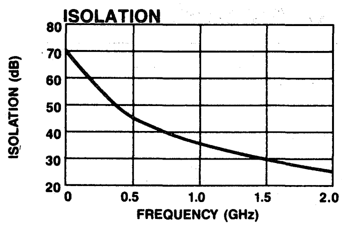
Operating Characteristics

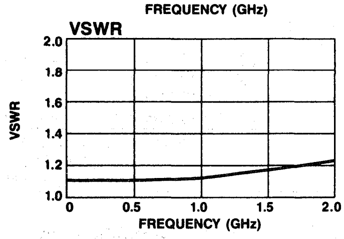
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			2ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			4ns Typ
Transients (In-Band)			15mv Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5 to 1.6 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to + 13 dBm)			
Intercept Points	IP_2	IP_3	
0.5 to 1.6 GHz	+68	+46	dBm Typ
0.05 GHz	+55	+40	dBm Typ
Control Voltages (Complementary Logic)			
V_{IN} Low			0 to −0.2V @ 20 μA Max
V_{IN} Hi			−5V @ 10 μA Typ to −8V @ 800 μA Max

*All specifications apply with 50 ohm impedance connected to all RF ports with 0 and −5 Vdc control voltages. Data achieved from unit soldered into text fixture.
†Faster switching speed can be achieved with enhanced driver waveform.
**Note that when either output port (RF1 or RF2) is "OFF" it is shorted to package ground.

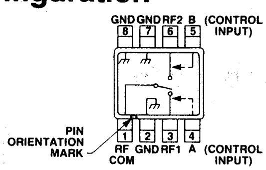
Typical Performance







Pin Configuration**



Ordering Information

Model No.	Package
SW-239 PIN	Surface Mount

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
Hi	Hi	OFF	OFF

Specifications Subject to Change Without Notice.

GaAs SPDT Switch
DC-2 GHz

SW-201/203

- Fast Switching Speed, 6ns 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†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (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.

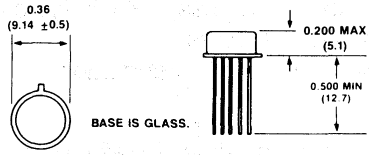
†Faster switching speed can be achieved with enhanced driver waveform.

**For the SW-201 only, 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

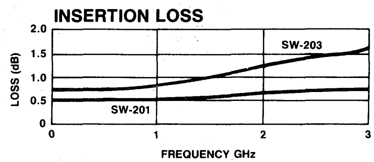
TO-5-3

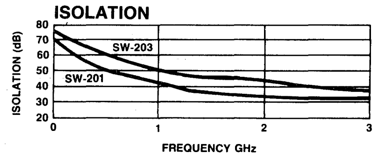


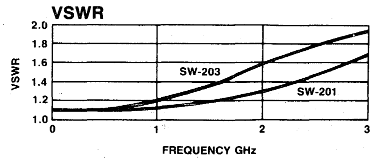
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

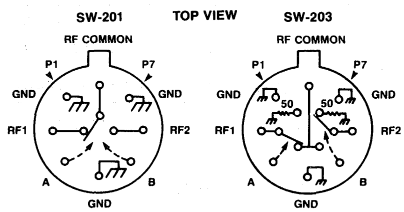
Typical Performance







Pin Configuration



Truth Table**

Control Input		Condition Of Switch	
		RF Common To Each RF Port	
A	B	RF1	RF2
Hi	Low	ON	OFF
Low	Hi	OFF	ON

Specifications Subject to Change Without Notice.

M/A-COM

GaAs SPDT Switch DC-2 GHz

SW-224/225

- 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

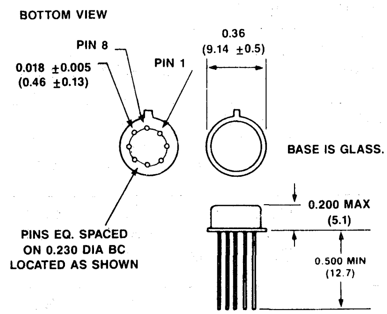
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL}			10 ns Typ
t_{ON}, t_{OFF}			150 ns Typ
Transients (In-Band)			15 mV Typ
Input Power for 1 dB Compression			
0.5-2 GHz			+27 dBm Typ
0.05 GHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +13 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.

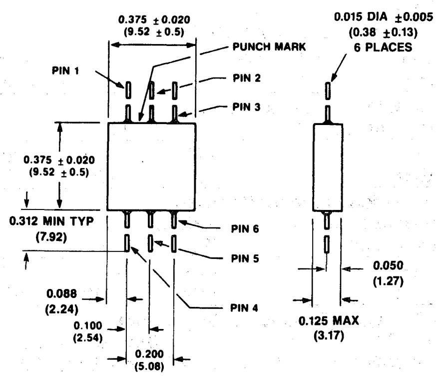
Ordering Information

Model No.	Package
SW-224 PIN	TO-5-3
SW-225 PIN	Flatpack

TO-5-3



FP-13

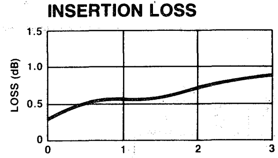


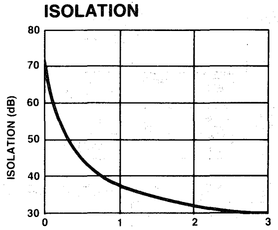
Dimensions in ( ) are in mm.

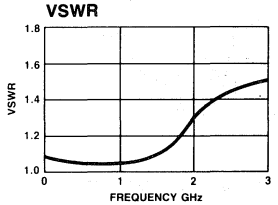
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

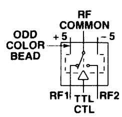
Typical Performance







Pin Configuration



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

M/A-COM

Connectorized SPDT GaAs Switch
DC-2 GHz

SW-229

- Integrated TTL Driver
- Ultra Low DC Power Consumption

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		DC-2 GHz
Insertion Loss	DC-2 GHz	1.5 dB Max
	DC-1 GHz	1.2 dB Max
	DC-0.5 GHz	0.9 dB Max
VSWR	DC-2 GHz	2.0:1 Max
	DC-1 GHz	1.5:1 Max
	DC-0.5 GHz	1.2:1 Max
Isolation	DC-2 GHz	25 dB Min
	DC-1 GHz	35 dB Min
	DC-0.5 GHz	40 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
t_{RISE}			20 nS Typ
t_{FALL}			45 nS Typ
t_{ON} (50% CTL to 90% RF)			150 nS Typ
t_{OFF} (50% CTL to 10% RF)			175 nS Typ
Transients (In-Band)			25 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

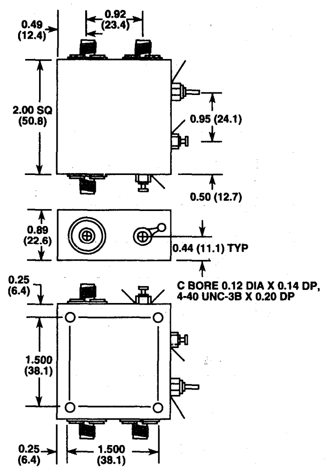
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm impedance connected to all RF ports with TTL control voltages

Ordering Information

Model No.	Package
SW-229 SMA	Ceramic

C-34

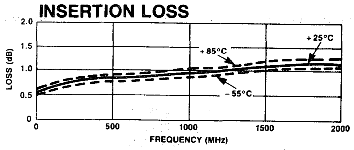


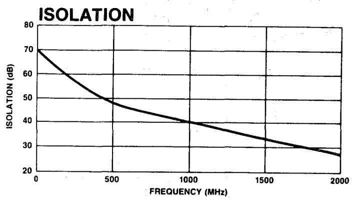
Dimensions in ( ) are in mm.

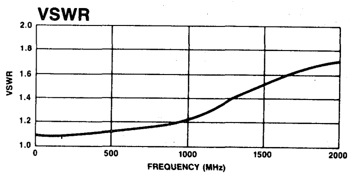
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

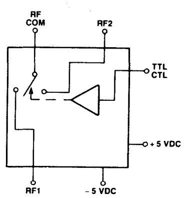
Typical Performance







Schematic



Truth Table**

Control Input	Condition Of Switch	
"1" Logic High	RF Common To Each RF Port	
	RF1	RF2
1	ON	OFF
0	OFF	ON

**When an RF output is off, it is shorted to case ground.

Specifications Subject to Change Without Notice.

GaAs SPDT Switch 5-2000 MHz

SW-237

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12mA 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			
t_{RISE}, t_{FALL}			20 ns Typ
t_{ON}, t_{OFF} (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			

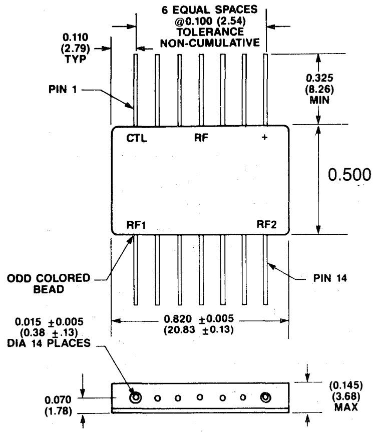
Environmental
See Appendix for MIL-STD-883 screening option.

*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.

Ordering Information

Model No.	Package
SW-237 PIN	Flatpack

FP-16

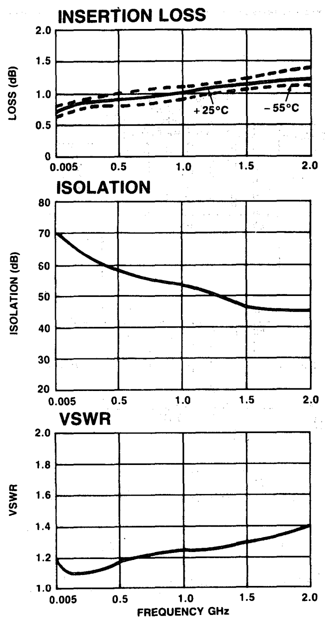


Dimensions in ( ) are in mm.

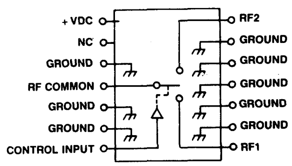
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

Typical Performance



Schematic



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

Specifications Subject to Change Without Notice.

Matched GaAs SPDT Switch
5-2000 MHz

SW-233/236

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12mA 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)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (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
50 MHz	+60	+40	dBm Typ

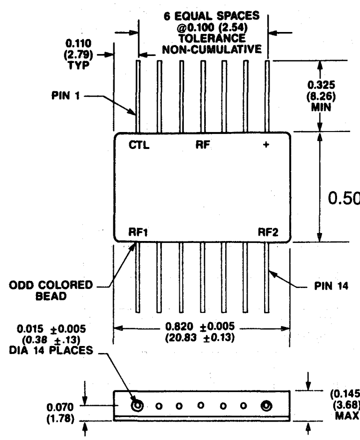
Bias Power

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.

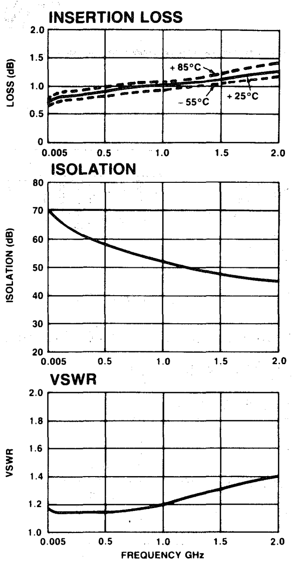
See Appendix for complete physical dimensions.

Ordering Information

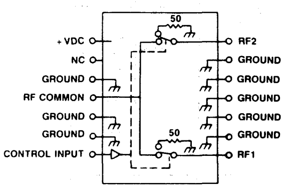
Model No.	Package
SW-233 PIN	Flatpack
SW-236 PIN	Flatpack

Specifications Subject to Change Without Notice.

Typical Performance



Schematic



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

Specifications Subject to Change Without Notice.

GaAs SPDT Switch 5-2000 MHz

SW-217

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.12mA 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)**
t_{RISE}, t_{FALL}			7 ns
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			20 ns
Transients (In-Band)			100 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 @ 0.12 mA Typ, 1 mA Max

Environmental

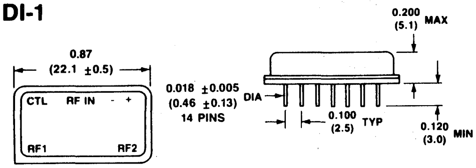
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +5 VDC (SW-218) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-217 PIN	Dual Inline

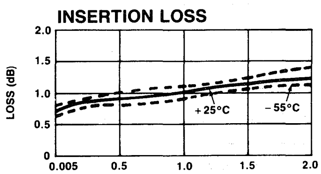
DI-1

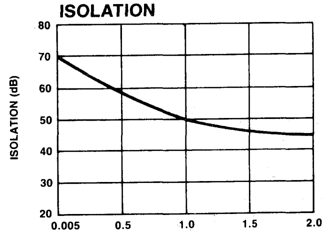


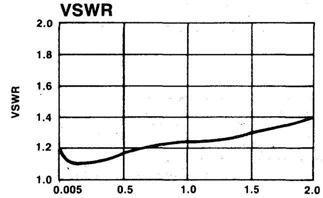
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

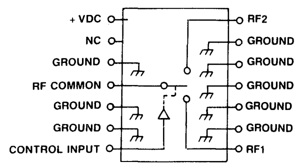
Typical Performance







Schematic



Truth Table

Control Input	Condition Of Switch	
"1" = Logic High TTL (SW-217)/CMOS (SW-218)	RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

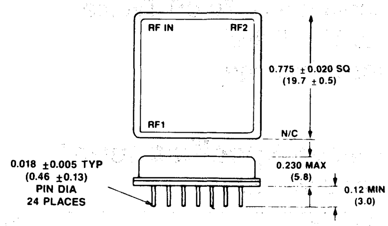
Specifications Subject to Change Without Notice.

SPDT RF Switch
10-2000 MHz

SW-118

- Integral Driver, TTL
- Low Loss — 0.6 dB Typical
- High Isolation — 50 dB Typical
- Fast Switching Speed — 50 nSec Typical

DI-4



Dimensions in ( ) are in mm.

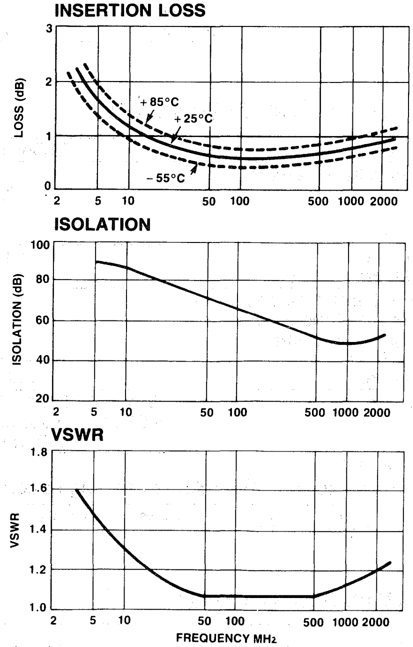
See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	1.6 dB Max
	20-2000 MHz	1.1 dB Max
	50-1000 MHz	1.0 dB Max
VSWR	10-2000 MHz	1.5:1 Max
	20-1000 MHz	1.3:1 Max
Isolation	10-2000 MHz	35 dB Min
	10-800 MHz	40 dB Min
	10-300 MHz	50 dB Min
Amplitude Balance		±0.2 dB
Phase Balance	10-2000 MHz	±8°
	10-1000 MHz	±4°
	10-100 MHz	±1°

Typical Performance



Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}, t_{OFF}		60 nS Typ
t_{RISE}, t_{FALL}		50 nS Typ
Transients (In-Band)		300 mV Typ
Input Power for 1 dB Compression	10-2000 MHz	+4 dBm Typ
	200-2000 MHz	+25 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-2000 MHz)	+42 dBm Typ
	(50-2000 MHz)	+65 dBm Typ
Third Order	(10-2000 MHz)	+16 dBm Typ
	(50-2000 MHz)	+35 dBm Typ
Bias Power		+5 to +15 VDC @ 20 mA Max (150 mW Typical)
Environmental		
See Appendix for MIL-STD-883 screening option.		

* All specifications apply when operated with bias voltage of +15 VDC and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-118 PIN	Dual Inline

Truth Table

CONTROL INPUT	CONDITION OF SWITCH RF PATH: RF-IN TO RF1	CONDITION OF SWITCH RF PATH: RF-IN TO RF2
LOGIC HIGH	OFF	ON
LOGIC LOW	ON	OFF

Control logic is CMOS or open collector TTL with external pull up to +V

Specifications Subject to Change Without Notice.

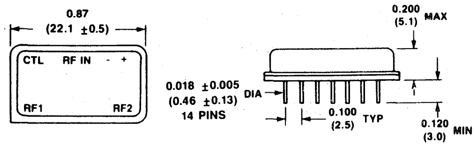
M/A-COM

SPDT RF Switch 10-2000 MHz

SW-112

- Ultra Broadband
- High Isolation — 70 dB Typical
- Integral TTL Driver
- Hermetic Package

DI-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	2.2 dB Max
	10-1000 MHz	2.0 dB Max
	10-500 MHz	1.8 dB Max
VSWR	10-2000 MHz	1.5:1 Max
	10-1000 MHz	1.2:1 Max
Isolation	10-2000 MHz	50 dB Min
	10-1000 MHz	60 dB Min
	10-500 MHz	70 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max −5 VDC ±5% @ 35 mA Max (500 mW Typical)

Environmental

See Appendix for MIL-STD-883 screening option.

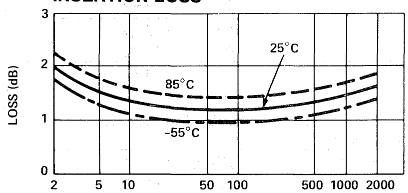
*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

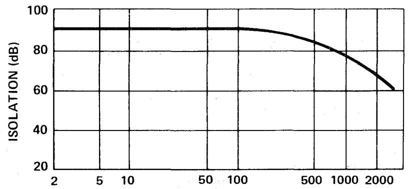
Model No.	Package
SW-112 PIN	Dual Inline

Typical Performance

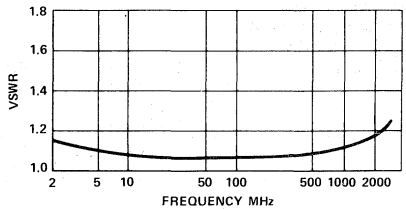
INSERTION LOSS



ISOLATION



VSWR



Truth Table

TTL CONTROL INPUT "1" = TTL LOGIC HIGH	CONDITION OF SWITCH RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Specifications Subject to Change Without Notice.

M/A-COM

SPDT RF Switch 200-2000 MHz

SW-132

- Low Loss — 0.5 dB Typical
- High Isolation — 50 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.0 dB Max
	200-1000 MHz	0.8 dB Max
VSWR	200-2000 MHz	1.65:1 Max
	500-1500 MHz	1.35:1 Max
Isolation	200-2000 MHz	35 dB Min
	200-1000 MHz	40 dB Min
	200-500 MHz	50 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 35 mA Max
	−5 VDC ±5% @ 35 mA Max
	(500 mW Typical)

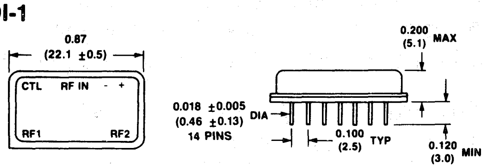
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-132 PIN	Dual Inline

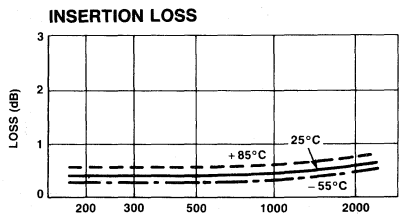
DI-1

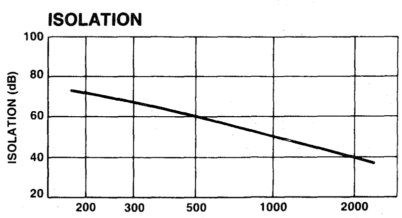


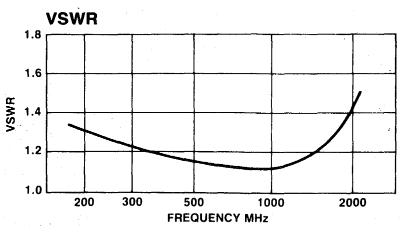
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Truth Table

TTL CONTROL INPUT	CONDITION OF SWITCH	
"1" = TTL LOGIC HIGH	RF COMMON TO EACH RF PORT	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Specifications Subject to Change Without Notice.

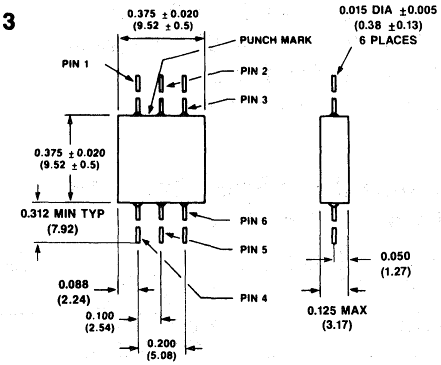
M/A-COM

GaAs SPDT Switch
DC-3 GHz

SW-202/204

- Fast Switching Speed, 6ns Typical
- Ultra Low DC Power Consumption
- Low Loss (SW-202), Terminated (SW-204)

FP-13



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

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†			
t_{RISE}, t_{FALL}			3 ns Typ
t_{ON}, t_{OFF} (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.

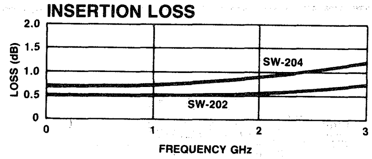
Ordering Information

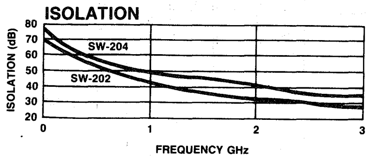
Model No.	Package
SW-202 PIN	Flatpack
SW-204 PIN	Flatpack

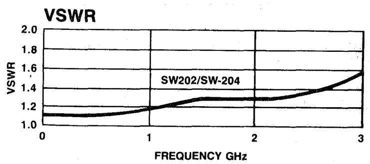
Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

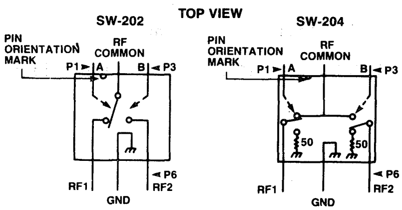
Typical Performance







Pin Configuration



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

Specifications Subject to Change Without Notice.

M/A-COM

GaAs SPDT Switch 5-3000 MHz

SW-238

- Low Insertion Loss, 0.8 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.07mA Typical
- CMOS Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-3000 MHz
Insertion Loss	5-3000 MHz	1.5 dB Max
	5-2000 MHz	1.2 dB Max
	5-1000 MHz	1.0 dB Max
	5- 500 MHz	0.9 dB Max
VSWR	5-3000 MHz	1.8:1 Max
	5-2000 MHz	1.6:1 Max
	5-1000 MHz	1.4:1 Max
	5- 500 MHz	1.25:1 Max
Isolation	5-3000 MHz	22 dB Min
	5-2000 MHz	30 dB Min
	5-1000 MHz	40 dB Min
	5- 500 MHz	50 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
t_{RISE}, t_{FALL}			20 ns Typ
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			40 ns Typ
Transients (In-Band)			35 mV Typ
Input Power for 1 dB Compression			
500-3000 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	
500-3000 MHz	+68	+46	dBm Typ
50 MHz	+60	+40	dBm Typ
Bias Power			
+5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1 mA Max			

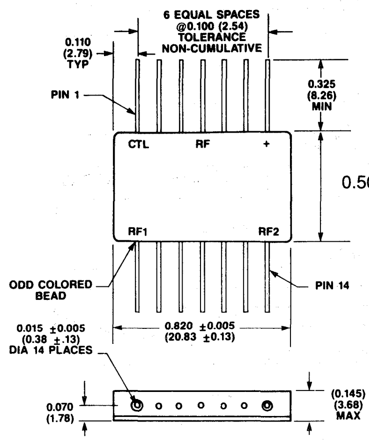
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltage of +8 VDC (SW 238) and 50 ohm impedance at all RF ports

Ordering Information

Model No.	Package
SW-238 PIN	Flatpack

FP-16

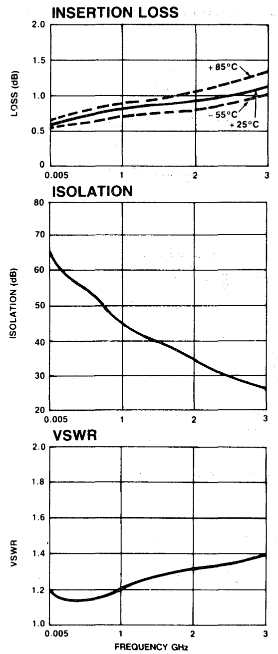


Dimensions in ( ) are in mm.

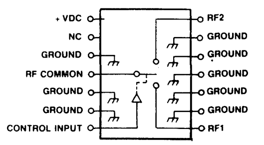
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

Typical Performance



Schematic



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

Specifications Subject to Change Without Notice.

![M/A-COM]

Matched GaAs SPDT Switch 5-3000 MHz

SW-205/206

- 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

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-205 (TTL)**	**SW-206 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (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

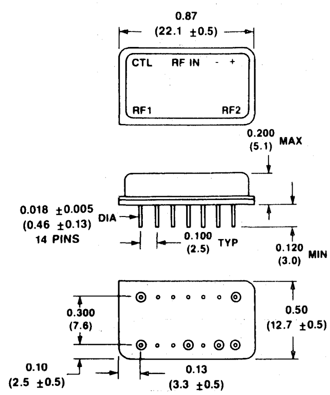
See Appendix for MIL-STD-883 screening option.

*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

DI-1



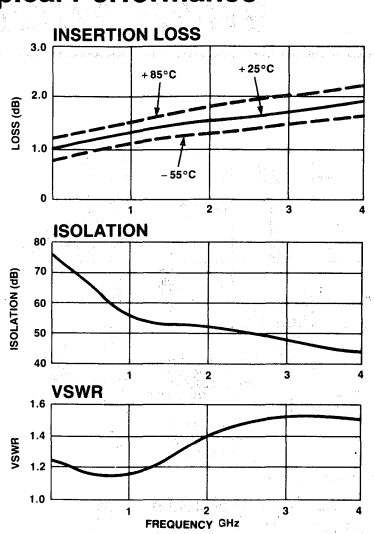
(POSITIVE VOLTAGE ONLY SW-205 & 206, 207 & 208)

Dimensions in ( ) are in mm.

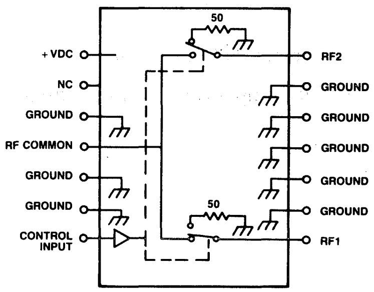
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-205)/CMOS (SW-206)	Condition Of Switch RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Specifications Subject to Change Without Notice.

M/A-COM

GaAs SPDT Switch DC-4 GHz

SW-226/227/228

- Miniature Ceramic Package
- Terminated (SW-226), High Isolation (SW-227), Low Loss (SW-228)
- Fast Switching Speed, 6ns 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-1 GHz	48	50	42	dB Min
	DC-0.5 GHz	53	55	50	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) 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 (SW-228)	−5V @ 50 μA Typ	to −8V @300 μA Max

Environmental

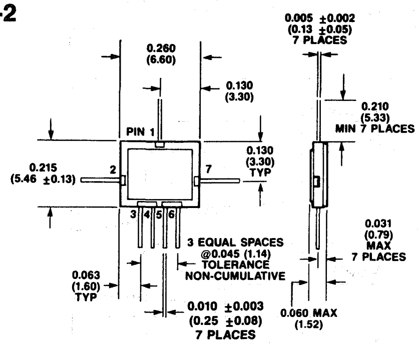
See Appendix for MIL-STD-883 screening option.

*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 enhanced driver waveform.
**For the SW-227 and SW-228 only, when an RF output if "OFF" it is shorted to case ground.

Ordering Information

Model No.		Package
SW-226	PIN	Ceramic
SW-227	PIN	Ceramic
SW-228	PIN	Ceramic

CR-2



PIN CONFIGURATION

	RF COM	RF1	RF2	A1	B1	A2	B2
SPST	N/A	2	7	5	4	N/A	N/A
SW-226/227	1	2	7	3	4	6	5
SW-228	1	2	7	3	6	OC	OC

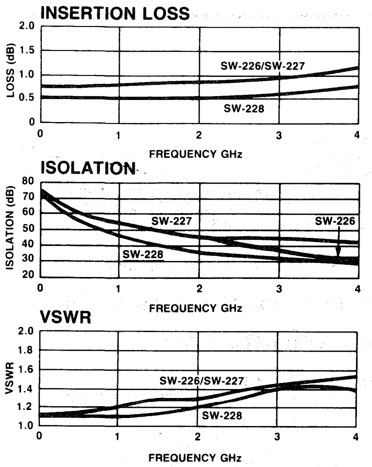
ALL OTHER PINS ARE GROUND.

Dimensions in ( ) are in mm.

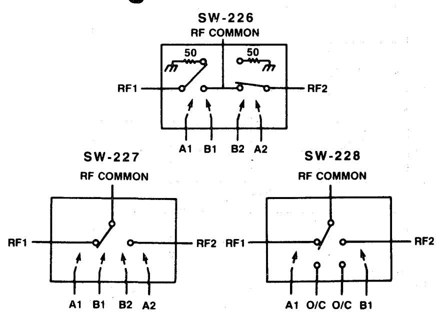
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

Typical Performance



Pin Configuration



Truth Table**

	Control Input A1 B1 A2 B2	Condition Of Switch RF Common To Each RF Port: 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

Specifications Subject to Change Without Notice.

GaAs SPDT Switch
5-4000 MHz

SW-207/208

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed
- Low DC Power Consumption
- Integral TTL (SW-207) or CMOS (SW-208) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-4000 MHz
Insertion Loss	5-4000 MHz	2.3 dB Max
	5-2000 MHz	1.4 dB Max
	5-1000 MHz	1.0 dB Max
VSWR	5-4000 MHz	2.5:1 Max
	5-2000 MHz	1.7:1 Max
	5-1000 MHz	1.5:1 Max
Isolation	5-4000 MHz	18 dB Min
	5-2000 MHz	28 dB Min
	5-1000 MHz	38 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics	**SW-207 (TTL)**	**SW-208 (CMOS)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (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-207	SW-208	
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	+60	+40	dBm Typ

Bias Power

SW-207 +5 VDC @ 1 mA Max

SW-208 +5 to +8 VDC @ 0.07 to 0.22 mA Typ, 1mA Max

Environmental

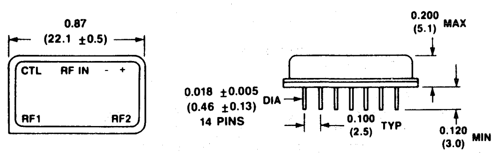
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +5 VDC (SW-207) or +8 VDC (SW-208) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-207 PIN	Dual Inline
SW-208 PIN	Dual Inline

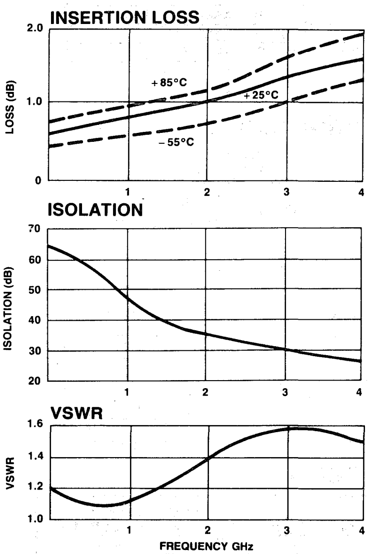
DI-1



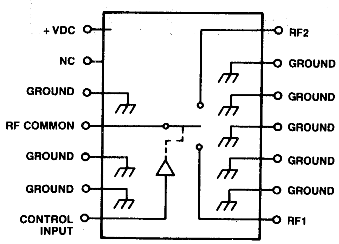
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input	Condition Of Switch	
"1" = Logic High TTL (SW-207)/CMOS (SW-208)	RF Common To Each RF Port	
	RF1	RF2
0	ON	OFF
1	OFF	ON

Specifications Subject to Change Without Notice.

M/A-COM

SP3T RF Switch
10-1000 MHz

SW-123

- Low Loss — 0.6 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		10-1000 MHz
Insertion Loss	10-1000 MHz	1.4 dB Max
	10-500 MHz	1.0 dB Max
VSWR	10-1000 MHz	1.5:1 Max
	10-500 MHz	1.2:1 Max
Isolation	10-1000 MHz	40 dB Min
	10-500 MHz	50 dB Min
	10-100 MHz	60 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 40 mA Max −5 VDC ±5% @ 25 mA Max (540 mW Typical)

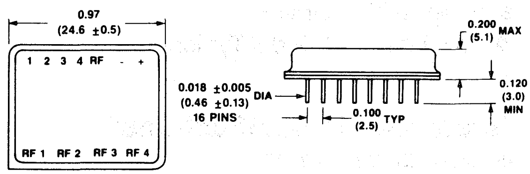
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-123 PIN	Dual Inline

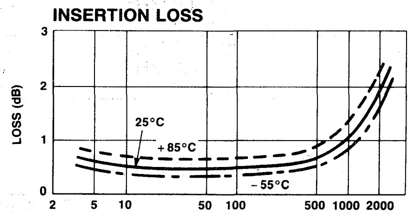
DI-2

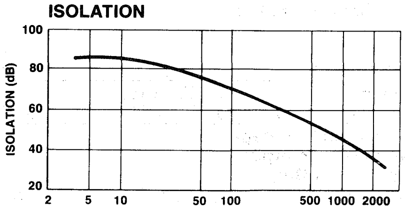


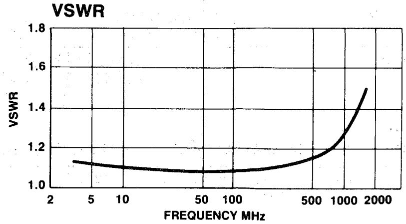
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Specifications Subject to Change Without Notice.

Matched SP3T RF Switch
20-1500 MHz

SW-163

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.9 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		20-1500 MHz
Insertion Loss	20-1500 MHz	2.0 dB Max
	20-1000 MHz	1.5 dB Max
	30-500 MHz	1.2 dB Max
VSWR (All States)	20-1500 MHz	1.80:1 Max
	20-1000 MHz	1.50:1 Max
	30-500 MHz	1.25:1 Max
Isolation	20-1500 MHz	35 dB Min
	20-1000 MHz	40 dB Min
	20-500 MHz	50 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 μS Typ
t_{OFF}		1.5 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression	20-1500 MHz	+5 dBm Typ
	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(20-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(20-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 45 mA Max −5 VDC ±5% @ 25 mA Max (540 mW Typical)

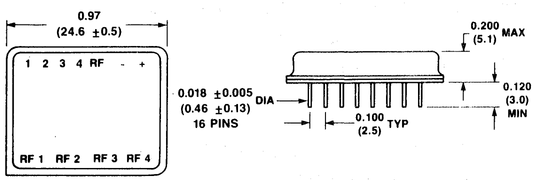
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-163 PIN	Dual Inline

DI-2

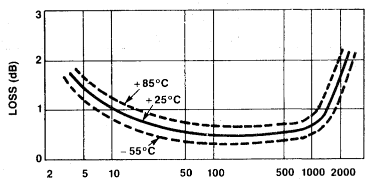


Dimensions in ( ) are in mm.

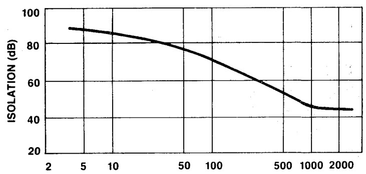
See Appendix for complete physical dimensions.

Typical Performance

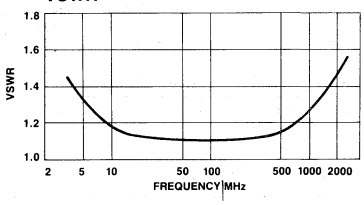
INSERTION LOSS



ISOLATION



VSWR



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Specifications Subject to Change Without Notice.

M/A-COM

Matched GaAs SP3T Switch
5-2000 MHz

SW-241

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22mA Typical
- Integral TTL Driver

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	1.7dB 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

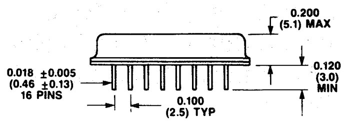
Impedance			50 Ohms Nominal
Switching Characteristics			**(TTL)**
t_{RISE}, t_{FALL}			7 ns
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			20 ns
Transients (In-Band)			80 mV
Input Power for 1 dB Compression			
500-2000 MHz			+27 dBm Typ
50 MHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input 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 voltage of +5 VDC (SW 241) and 50 ohm impedance at all RF ports

Ordering Information

Model No.	**Package**
SW-241 PIN	Dual Inline

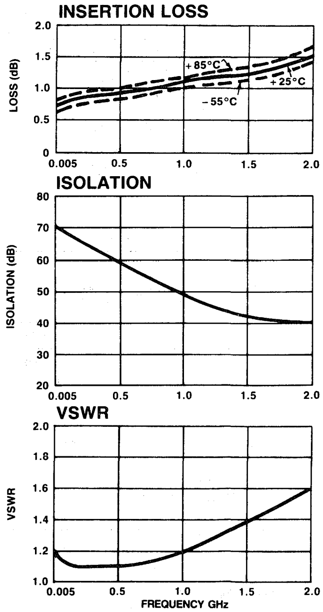
DI-5



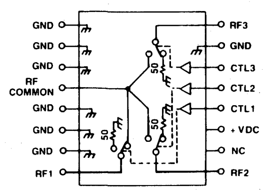
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input			Condition of Switch		
"1" = Logic High TTL			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

Specifications Subject to Change Without Notice.

Matched GaAs SP3T Switch
5-2000 MHz

SW-247/251

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.22mA 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)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (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.

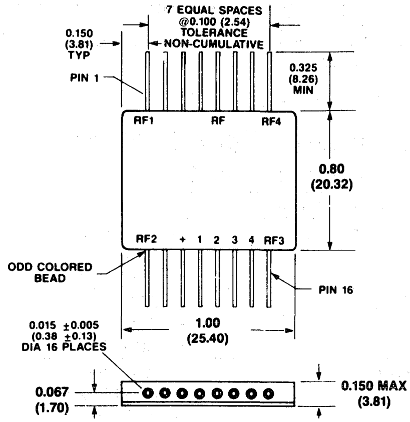
*All specifications apply when operated with bias voltages of +5 VDC (SW-247) or +8 VDC (SW-251) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-247 PIN	Flatpack
SW-251 PIN	Flatpack

Specifications Subject to Change Without Notice.

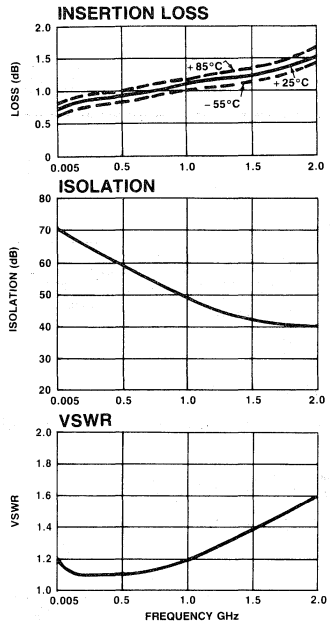
FP-17



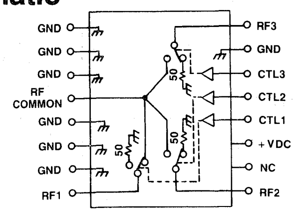
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input			Condition of Switch		
"1" = Logic High TTL (SW-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

Specifications Subject to Change Without Notice.

SP3T RF Switch
10-2000 MHz

SW-113

- Ultra Broadband
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	2.8 dB Max
	10-1000 MHz	2.1 dB Max
	10-500 MHz	1.8 dB Max
VSWR	10-2000 MHz	1.8:1 Max
	10-1000 MHz	1.2:1 Max
Isolation	10-2000 MHz	35 dB Min
	10-500 MHz	45 dB Min
	10-100 MHz	60 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 45 mA Max
	−5 VDC ±5% @ 25 mA Max
	(540 mW Typical)

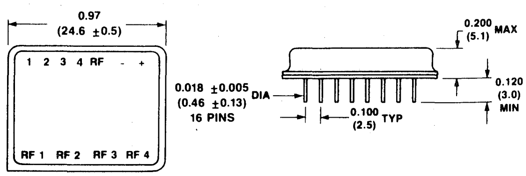
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-113 PIN	Dual Inline

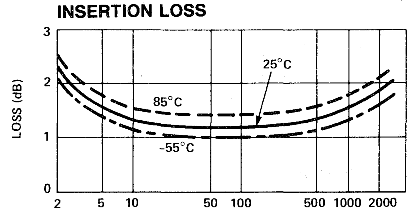
DI-2

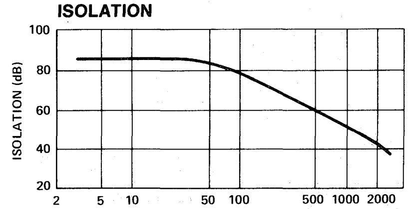


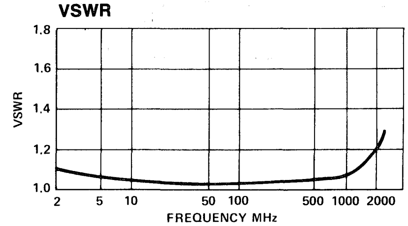
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

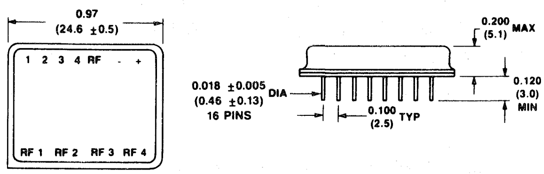
Specifications Subject to Change Without Notice.

SP3T RF Switch
200-2000 MHz

SW-133

- Low Loss — 0.6 dB Typical
- High Isolation — 45 dB Typical
- Integral TTL Driver
- Hermetic Package

DI-2



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.5 dB Max
	200-1000 MHz	1.0 dB Max
VSWR	200-2000 MHz	1.6:1 Max
Isolation	200-2000 MHz	30 dB Min
	200-1000 MHz	35 dB Min
	200-500 MHz	45 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		2.0 μS Typ
t_{OFF}		1.0 μS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression		+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order		+60 dBm Typ
Third Order		+30 dBm Typ
Bias Power		+9 to +15 VDC @ 50 mA Max
		−5 VDC ±5% @ 25 mA Max
		(550 mW Typical)

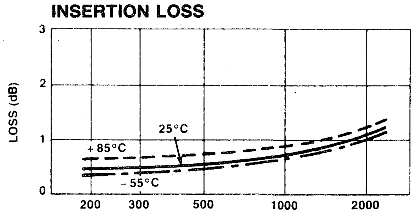
Environmental

These units are designed to meet the environmental and screening requirements of Table 1B, page 497 of the Adams-Russell catalog.

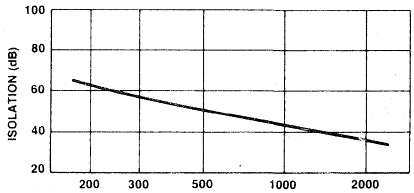
*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Typical Performance

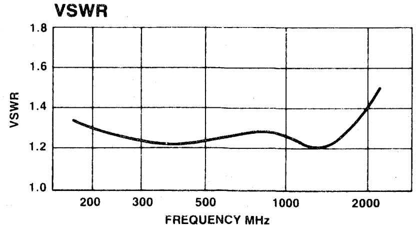
INSERTION LOSS



ISOLATION



VSWR



Ordering Information

Model No.	Package
SW-133 PIN	Dual Inline

Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH			CONDITION OF SWITCH RF COMMON TO EACH RF PORT		
1	2	3	RF1	RF2	RF3
1	0	0	ON	OFF	OFF
0	1	0	OFF	ON	OFF
0	0	1	OFF	OFF	ON

Specifications Subject to Change Without Notice.

SP4T RF Switch 10-1000 MHz

SW-124

- Low Loss — 0.6 dB Typical
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-1000 MHz
Insertion Loss	10-1000 MHz	1.4 dB Max
	10-500 MHz	1.0 dB Max
VSWR	10-1000 MHz	1.5:1 Max
	10-500 MHz	1.2:1 Max
Isolation	10-1000 MHz	40 dB Min
	10-500 MHz	50 dB Min
	10-100 MHz	60 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 50 mA Max −5 VDC ±5% @ 25 mA Max (450 mW Typical)

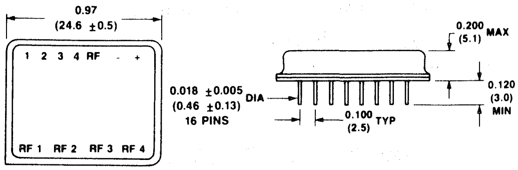
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-124 PIN	Dual Inline

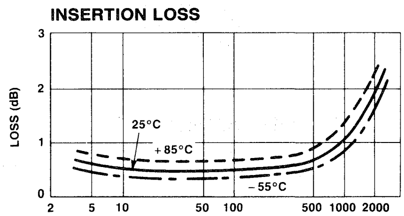
DI-2

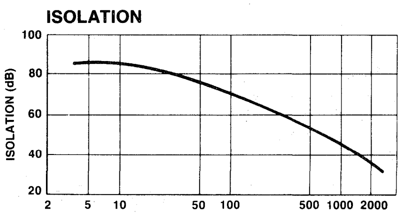


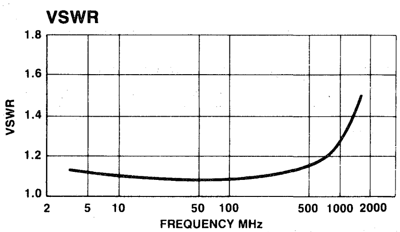
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	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

Specifications Subject to Change Without Notice.

Matched SP4T RF Switch
20-1500 MHz
SW-164

- Internally Terminated
- Integral TTL Driver
- Low Loss — 0.9 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		20-1500 MHz
Insertion Loss	20-1500 MHz	2.0 dB Max
	20-1000 MHz	1.5 dB Max
	30-500 MHz	1.2 dB Max
VSWR (All States)	20-1500 MHz	1.80:1 Max
	20-1000 MHz	1.50:1 Max
	30-500 MHz	1.25:1 Max
Isolation	20-1500 MHz	35 dB Min
	20-1000 MHz	40 dB Min
	20-500 MHz	50 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}		3.0 µS Typ
t_{OFF}		1.5 µS Typ
Transients (In-Band)		40 mV Typ
Input Power for 1 dB Compression	20-1500 MHz	+5 dBm Typ
	50-1500 MHz	+15 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(20-1500 MHz)	+55 dBm Typ
	(50-1500 MHz)	+70 dBm Typ
Third Order	(20-1500 MHz)	+25 dBm Typ
	(50-1500 MHz)	+40 dBm Typ
Bias Power		+9 to +15 VDC @ 50 mA Max
		−5 VDC ±5% @ 25 mA Max
		(550 mW Typical)

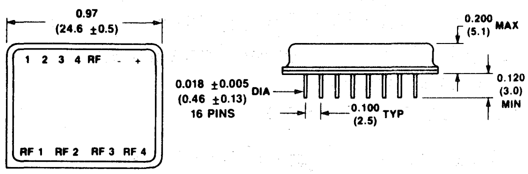
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-164 PIN	Dual Inline

DI-2

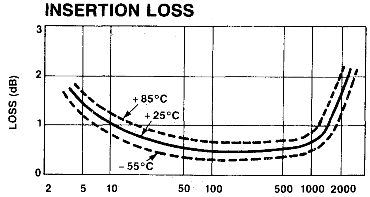


Dimensions in ( ) are in mm.

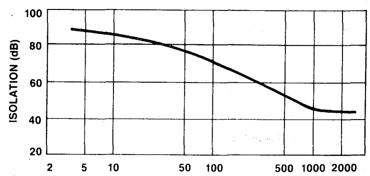
See Appendix for complete physical dimensions.

Typical Performance

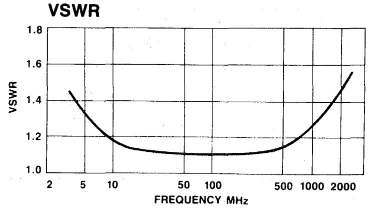
INSERTION LOSS



ISOLATION



VSWR



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	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

Specifications Subject to Change Without Notice.

Matched GaAs SP4T Switch
5-2000 MHz

SW-254/257

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA 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	1.4:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	36 dB Min
	5- 500 MHz	42 dB Min

Operating Characteristics

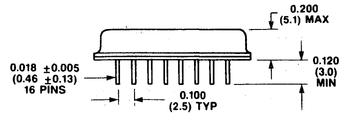
Impedance			50 Ohms Nominal
Switching Characteristics			**(TTL)**
t_{RISE}, t_{FALL}			7 ns
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)			20 ns
Transients (In-Band)			80 mV
Input Power for 1 dB Compression			
500-2000 MHz			+27 dBm Typ
50 MHz			+21 dBm Typ
Intermodulation Intercept Point (for two-tone input 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.

Ordering Information

Model No.	Package
SW-254 PIN	Dual Inline
SW-257 PIN	Dual Inline

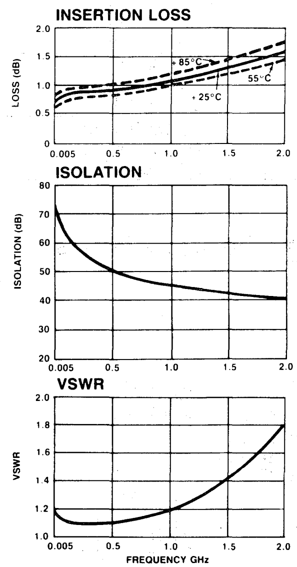
DI-5



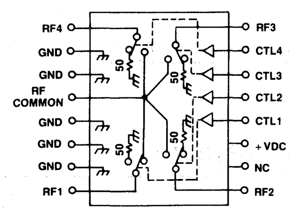
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input				Condition of Switch			
"1" = Logic High TTL				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

Specifications Subject to Change Without Notice.

GaAs SP4T Switch 5-2000 MHz

SW-255/258

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA Typical
- Integral TTL

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

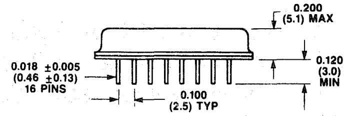
Impedance		50 Ohms Nominal
Switching Characteristics		**(TTL)**
t_{RISE}, t_{FALL}		7 ns
t_{ON}, t_{OFF} (50% CTL to 90/10% RF)		20 ns
Transients (In-Band)		80 mV
Input Power for 1 dB Compression		
500-2000 MHz	+27	dBm Typ
50 MHz	+21	dBm Typ
Intermodulation Intercept Point (for two-tone input power up 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 voltages of +5 VDC (SW-255) or +8 VDC (SW-258) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-255 PIN	Dual Inline
SW-258 PIN	Dual Inline

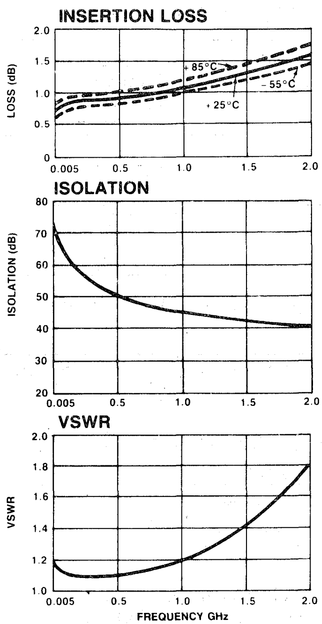
DI-5



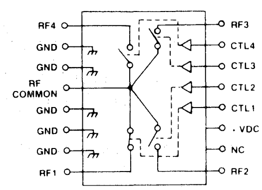
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Schematic



Truth Table

Control Input "1" = Logic High TTL (SW-255)/CMOS (SW-258)				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

Specifications Subject to Change Without Notice.

Matched GaAs SP4T Switch
5-2000 MHz

SW-261/264

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA 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)**
t_{RISE}, t_{FALL}	7 ns	20 ns Typ
t_{ON}, t_{OFF} (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
50 MHz	+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

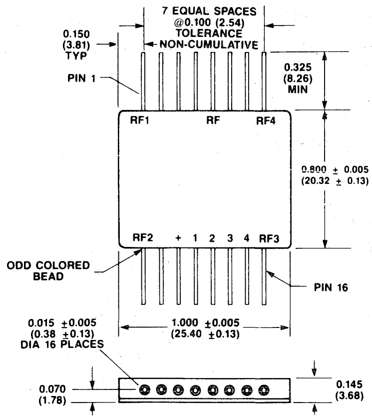
See Appendix for MIL-STD-883 screening option.

*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.

Ordering Information

Model No.	Package
SW-261 PIN	Flatpack
SW-264 PIN	Flatpack

FP-17

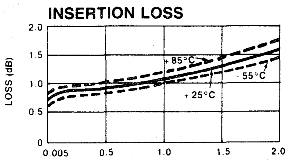


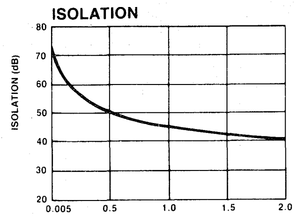
Dimensions in ( ) are in mm.

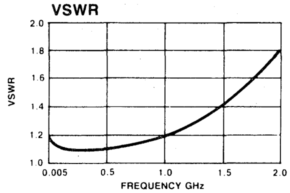
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

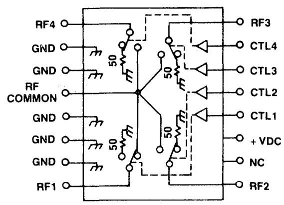
Typical Performance







Schematic



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

Specifications Subject to Change Without Notice.

GaAs SP4T Switch 5-2000 MHz

SW-262

- Low Insertion Loss, 1.0 dB Typical
- Fast Switching Speed, 20 ns Typical
- Ultra Low DC Power Consumption, 0.3mA Typical
- Integral TTL (SW-262) or CMOS (SW-265) Driver

Guaranteed Specifications*

(From −55°C to +85°C)

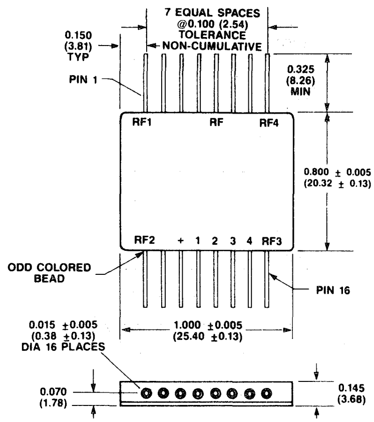
Frequency Range		5-2000 MHz
Insertion Loss	5-2000 MHz	2.0 dB Max
	5-1000 MHz	1.4 dB Max
	5- 500 MHz	1.2 dB Max
VSWR	5-2000 MHz	2.5:1 Max
	5-1000 MHz	1.5:1 Max
	5- 500 MHz	1.3:1 Max
Isolation	5-2000 MHz	35 dB Min
	5-1000 MHz	37 dB Min
	5- 500 MHz	42 dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			(TTL)
t_{RISE}, t_{FALL}			7 ns
t_{ON}, t_{OFF} (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			
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.

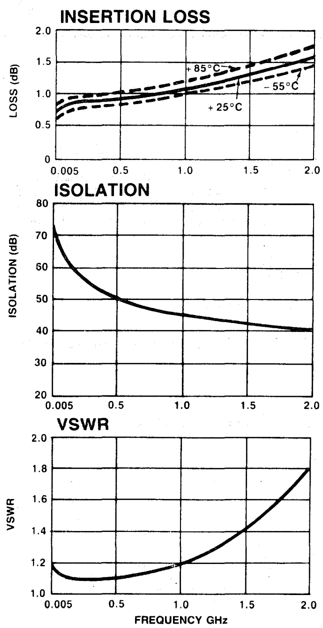
See Appendix for complete physical dimensions.

Ordering Information

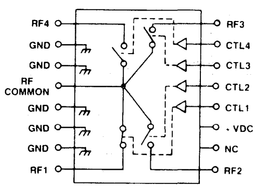
Model No.	Package
SW-262 PIN	Flatpack

Specifications Subject to Change Without Notice.

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

SP4T RF Switch
10-2000 MHz

SW-114

- Ultra Broadband
- High Isolation — 60 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	2.8 dB Max
	10-1000 MHz	2.1 dB Max
	10-500 MHz	1.8 dB Max
VSWR	10-2000 MHz	1.8:1 Max
	10-1000 MHz	1.2:1 Max
Isolation	10-2000 MHz	35 dB Min
	10-500 MHz	45 dB Min
	10-100 MHz	60 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 µS Typ
t_{OFF}	1.0 µS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 50 mA Max
	−5 VDC ±5% @ 25 mA Max
	(550 mW Typical)

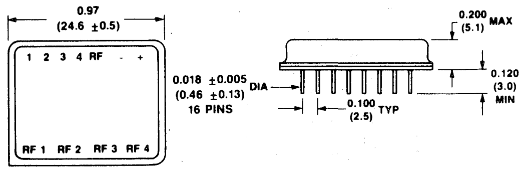
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-114 PIN	Dual Inline

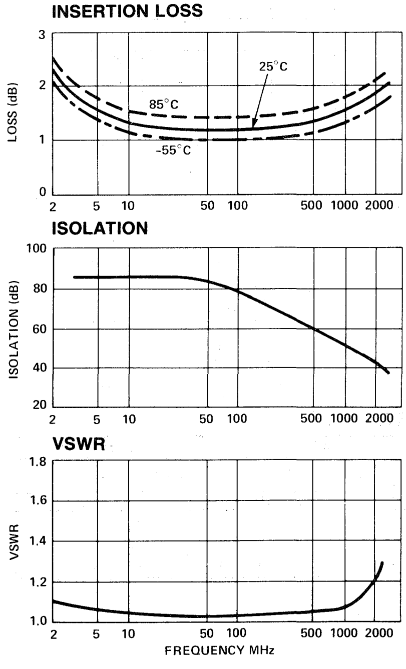
DI-2



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	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

Specifications Subject to Change Without Notice.

SP4T RF Switch
200-2000 MHz

SW-134

- Low Loss — 0.6 dB Typical
- High Isolation — 45 dB Typical
- Integral TTL Driver
- Hermetic Package

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		200-2000 MHz
Insertion Loss	200-2000 MHz	1.5 dB Max
	200-1000 MHz	1.0 dB Max
VSWR	200-2000 MHz	1.6:1 Max
Isolation	200-2000 MHz	30 dB Min
	200-1000 MHz	35 dB Min
	200-500 MHz	45 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Switching Characteristics	
t_{ON}	2.0 μS Typ
t_{OFF}	1.0 μS Typ
Transients (In-Band)	40 mV Typ
Input Power for 1 dB Compression	+13 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)	
Second Order	+60 dBm Typ
Third Order	+30 dBm Typ
Bias Power	+9 to +15 VDC @ 45 mA Max
	−5 VDC ±5% @ 25 mA Max
	(540 mW Typical)

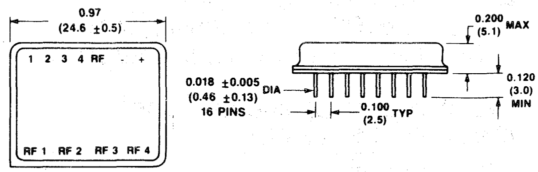
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltages of +12 VDC and −5 VDC (±5%) and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-134 PIN	Dual Inline

DI-2

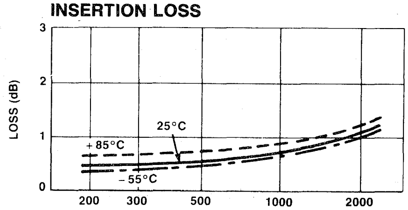


Dimensions in ( ) are in mm.

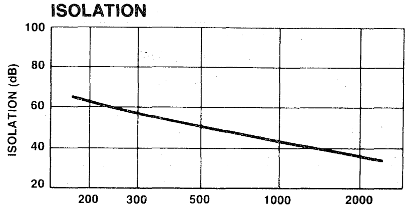
See Appendix for complete physical dimensions.

Typical Performance

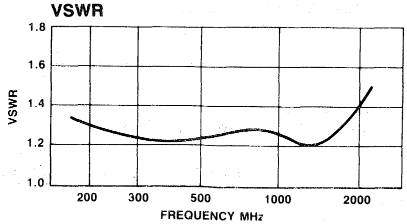
INSERTION LOSS



ISOLATION



VSWR



Truth Table

TTL CONTROL INPUTS "1" = TTL LOGIC HIGH				CONDITION OF SWITCH RF COMMON TO EACH RF PORT			
1	2	3	4	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

Specifications Subject to Change Without Notice.

GaAs SP4T Switch
GaAs SP4T Switch DC-4 GHz

SW-243

- Low Insertion Loss, 0.7 dB Typical
- Fast Switching Speed, 4ns 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	1.3dB Max
	DC - 2 GHz	1.0dB Max
	DC - 1 GHz	0.9dB Max
	DC - 0.5 GHz	0.8dB 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	20dB Min
	DC - 2 GHz	25dB Min
	DC - 1 GHz	30dB Min
	DC - 0.5 GHz	35dB Min

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			25mv Typ
Input Power for 1dB 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 +5dBm)			
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 −0.2V @ 5 μA Max
V_{IN} Hi			−5V @ 10 μA Typ to −8V @ 100 μA Max

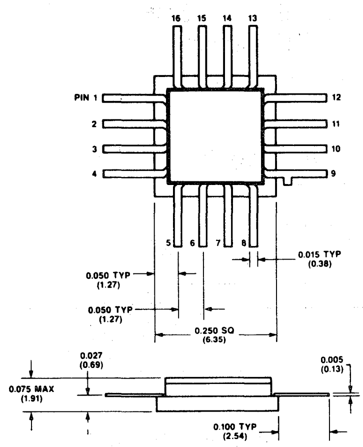
Environmental
See Appendix for MIL-STD-883 screening option.

*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 port is "off" it is shorted to ground through an "on" shunt MESFET.

Ordering Information

Model No.	Package
SW-243 PIN	Ceramic

CR-4



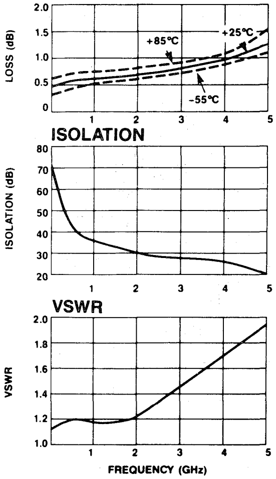
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

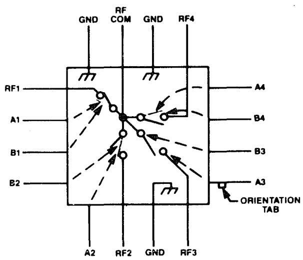
Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Performance



Schematic



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

Specifications Subject to Change Without Notice.

GaAs DPDT Switch DC-4 GHz

SW-281

- Low Insertion Loss, 0.5 dB Typical
- Miniature Relay Replacement, 0.250″ Sq. Pkg.
- Fast Switching Speed, 4ns Typical
- Ultra Low DC Power Consumption

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		DC - 4 GHz
Insertion Loss	DC - 4 GHz	1.2dB Max
	DC - 2 GHz	0.8dB Max
	DC - 1 GHz	0.7dB Max
	DC - 0.5 GHz	0.6dB 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	20dB Min
	DC - 2 GHz	30dB Min
	DC - 1 GHz	40dB Min
	DC - 0.5 GHz	50dB Min

Operating Characteristics

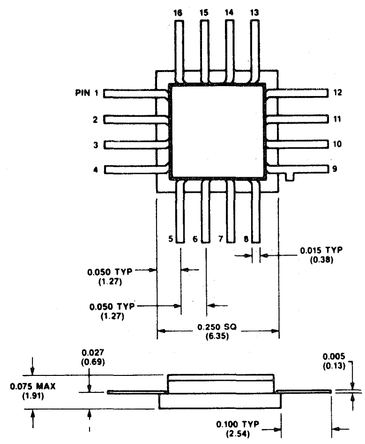
Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2ns Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4ns Typ
Transients (In-Band)			15mV Typ
Input Power for 1dB Compression			
Control Voltages (Vdc)	0/−5	0/−8	
0.5 to 4 GHz	+27	+33	dBm Typ
0.05 GHz	+21	+26	dBm Typ
Intermodulation Intercept Point			
(for two-tone input power up to +5dBm)			
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 −0.2V @ 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 port is "off" it is shorted to ground through an "on" shunt MESFET.

Ordering Information

Model No.	Package
SW-281 PIN	Ceramic

CR-4



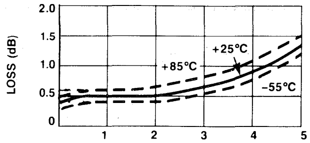
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

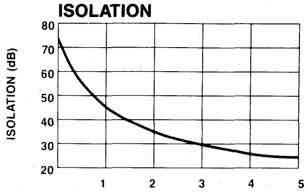
Specifications Subject to Change Without Notice.

Typical Performance

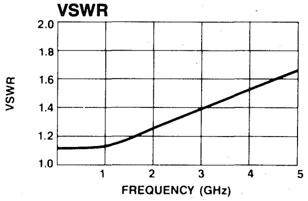
INSERTION LOSS



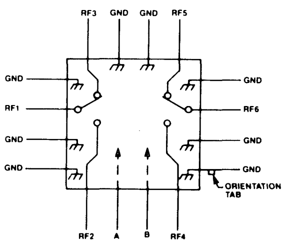
ISOLATION



VSWR



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

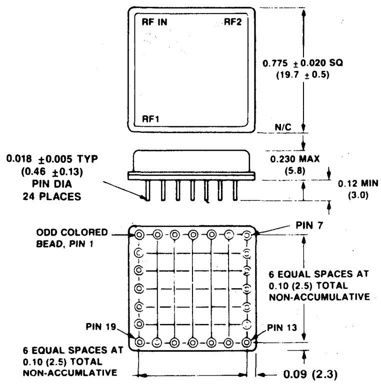
Specifications Subject to Change Without Notice.

RF Transfer Switch
10-2000 MHz

SW-119

- High Isolation — 60 dB Typical
- Low Loss — 0.7 dB Typical
- Fast Switching — 50 nSec Typical
- Integral Driver, TTL

DI-4



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss	10-2000 MHz	1.6 dB Max
	20-2000 MHz	1.1 dB Max
	50-1000 MHz	1.0 dB Max
VSWR	10-2000 MHz	1.5:1 Max
	20-1000 MHz	1.3:1 Max
Isolation	10-2000 MHz	35 dB Min
	10-800 MHz	40 dB Min
	10-300 MHz	50 dB Min
Amplitude Balance		±0.2 dB
Phase Balance	10-2000 MHz	±8°
	10-1000 MHz	±4°
	10-100 MHz	±1°

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
t_{ON}, t_{OFF}		60 nS Typ
t_{RISE}, t_{FALL}		50 nS Typ
Transients (In-Band)		300 mV Typ
Input Power for 1 dB Compression	10-2000 MHz	+4 dBm Typ
	200-2000 MHz	+25 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order	(10-2000 MHz)	+42 dBm Typ
	(50-2000 MHz)	+65 dBm Typ
Third Order	(10-2000 MHz)	+16 dBm Typ
	(50-2000 MHz)	+35 dBm Typ
Bias Power		+5 to +15 VDC @ 20 mA Max (150 mW Typical)

Environmental

See Appendix for MIL-STD-883 screening option.

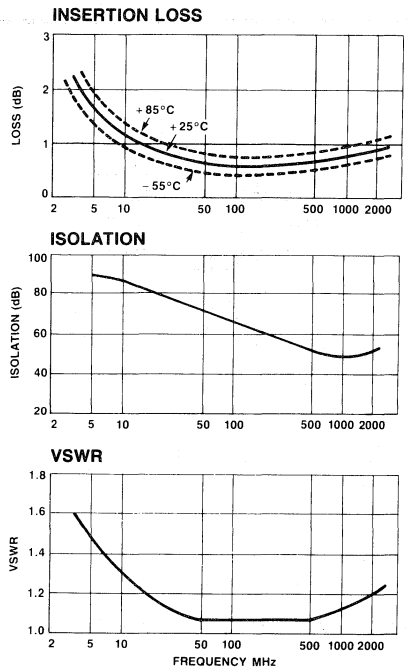
*All specifications apply when operated with a bias voltage of +15 VDC and 50 ohm impedance at all RF ports.

Ordering Information

Model No.	Package
SW-119 PIN	Dual Inline

Specifications Subject to Change Without Notice.

Typical Performance



Truth Table

CONTROL INPUT	CONDITION OF SWITCH — RF PATH			
	RF1-RF2	RF2-RF3	RF3-RF4	RF4-RF1
LOGIC HIGH	ON	OFF	ON	OFF
LOGIC LOW	OFF	ON	OFF	ON

Control logic is CMOS or open collector TTL with external pull up to +V.

GaAs Transfer Switch DC-3 GHz

SW-283

- Small Ceramic Package, 0.250″ Sq
- Fast Switching Speed, 4ns 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

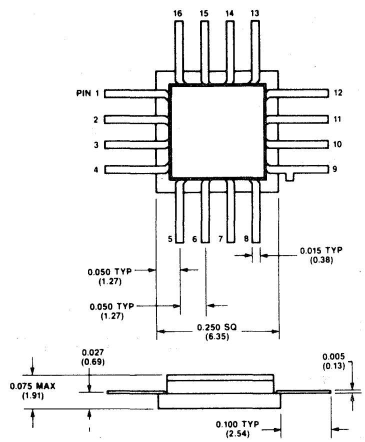
Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics†			
t_{RISE}, t_{FALL} (10/90% or 90/10% RF)			2 nS Typ
t_{ON}, t_{OFF} (50% control to 90/10% RF)			4 nS Typ
Transients (In-Band)			30 mV Typ
Input Power for 1dB 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 +5dBM)			
Intercept Points	Ip2	Ip3	
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



Dimensions in ( ) are in mm.

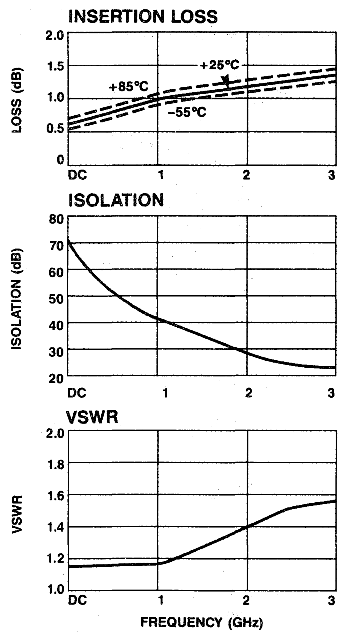
See Appendix for complete physical dimensions.

Ordering Information

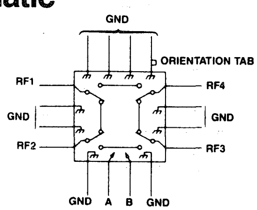
Model No.	Package
SW-283 PIN	Ceramic

Specifications Subject to Change Without Notice.

Typical Performance



Schematic



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

Specifications Subject to Change Without Notice.

Voltage Variable Attenuator 1.5-1000 MHz

AT-101

- 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

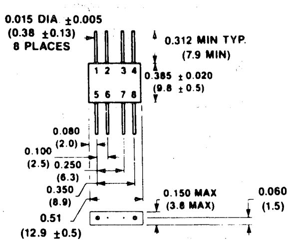
Impedance	50 Ohms Nominal
Maximum Ratings	
RF Input	250 mW @ 25°C
	Derated Linearly to 115 mW @ +85°C
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P5, Out; P1,
	+DC IN BIAS; P3 & P7,
	Control; P4 & P8,
	GND; P2 & P6

*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

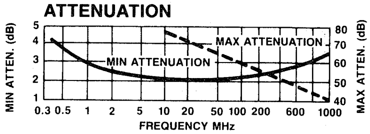


Dimensions in ( ) are in mm.

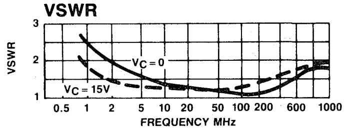
See Appendix for complete physical dimensions.

Typical Performance

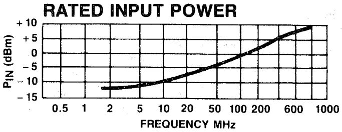
ATTENUATION



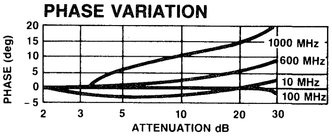
VSWR



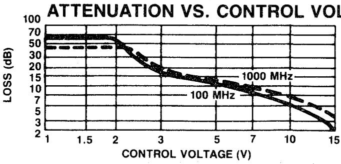
RATED INPUT POWER



PHASE VARIATION



ATTENUATION VS. CONTROL VOLTAGE



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

5-Bit Digital Attenuator 20-1000 MHz

AT-103

- Attenuation 0.5 dB Steps to 15.5 dB
- CMOS Control Interface
- Internal Latch on Control Input
- Hermetic Case

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-1000 MHz
Nominal Attenuation**		0.5 dB Steps to 15.5 dB
Attenuation Accuracy	20-500 MHz	±0.25 dB ±2% Max
	20-1000 MHz	±0.35 dB ±2% Max
VSWR	20-500 MHz	1.6:1 Max
	20-1000 MHz	2.0:1 Max
Reference Insertion Loss		5.0 dB Max

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
Switching Time (50% CTL to 90%/10% RF)		8 μS Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression	20-1000 MHz	+18 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order		+40 dBm Typ
Third Order		+30 dBm Typ
Bias Power		+5 to +15 VDC @ 30 mA Max (330 mW Typ)
Control		5 line, CMOS Data Bus with Internal Latch controlled by Clock (Data Strobe) and reset inputs.
Environmental See Appendix for MIL-STD-883 screening option.		

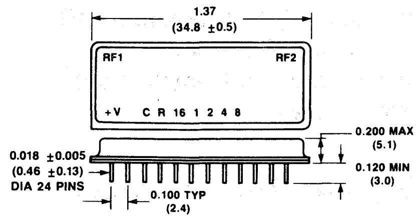
*All specifications apply when operated with bias voltage of +15 VDC and a 50 ohm impedance at both RF ports.

** Above reference insertion loss.

Ordering Information

Model No.	Package
AT-103 PIN	Dual Inline

DI-3

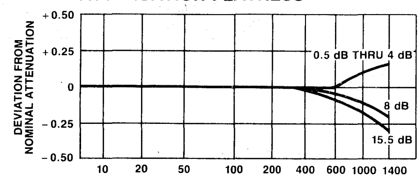


Dimensions in ( ) are in mm.

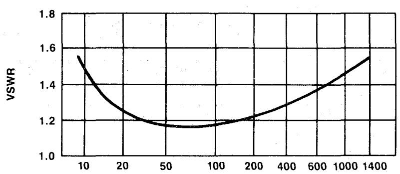
See Appendix for complete physical dimensions.

Typical Performance

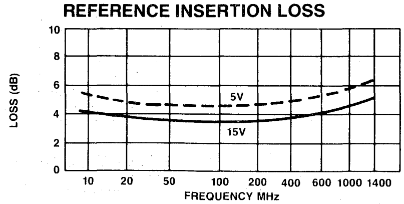
ATTENUATION FLATNESS



VSWR



REFERENCE INSERTION LOSS



Truth Table

CONTROL INPUT							ATTENUATOR SETTING
0.5	1	2	4	8	C*	R	
0	0	0	0	0	1	1	REFERENCE
1	0	0	0	0	1	1	0.5 dB
0	1	0	0	0	1	1	1 dB
0	0	1	0	0	1	1	2 dB
0	0	0	1	0	1	1	4 dB
0	0	0	0	1	1	1	8 dB
ANY COMBINATION					1	1	SUM OF BITS SELECTED
X	X	X	X	X	0	1	NO CHANGE IN ATTENUATION
X	X	X	X	X	X	0	RESET TO REFERENCE

"1" = LOGIC HIGH
"0" = LOGIC LOW
"X" = DON'T CARE
*CLOCK INPUT STROBES DATA ON RISING EDGE

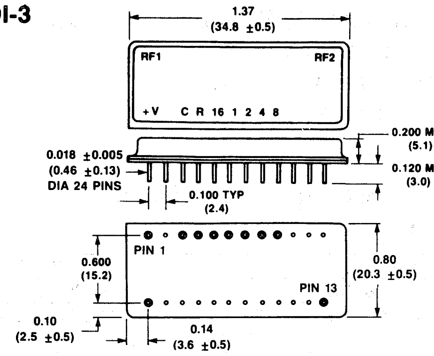
Specifications Subject to Change Without Notice.

5-Bit Digital Attenuator 20-1000 MHz

AT-102

- Attenuation 1 dB Steps to 31 dB
- CMOS Control Interface
- Internal Latch on Control Input
- Hermetic Case

DI-3



	RF1	RF2	+5V	-12V	C	R	16	1	2	4	8	0.5
	24	13	1	N/A	3	4	5	6	7	8	9	N/A
PINS UNMARKED ARE GROUND												

Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-1000 MHz
Nominal Attenuation**		1 dB Steps to 31 dB
Attenuation Accuracy	20-500 MHz	±0.25 dB ±2% Max
	20-1000 MHz	±0.35 dB ±2% Max
VSWR	20-500 MHz	1.6:1 Max
	20-1000 MHz	2.0:1 Max
Reference Insertion Loss		5.0 dB Max

Operating Characteristics

Impedance		50 Ohms Nominal
Switching Characteristics		
Switching Time (50% CTL to 90%/10% RF)		8μ S Typ
Transients (In-Band)		20 mV Typ
Input Power for 1 dB Compression	20-1000 MHz	+18 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5 dBm)		
Second Order		+40 dBm Typ
Third Order		+30 dBm Typ
Bias Power		+5 to +15 VDC @ 30 mA Max (330 mW Typ)
Control		5 line, CMOS Data Bus with Internal Latch controlled by Clock (Data Strobe) and reset inputs.

Environmental

See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated with bias voltage of +15 VDC and a 50 ohm impedance at both RF ports.
** Above reference insertion loss.

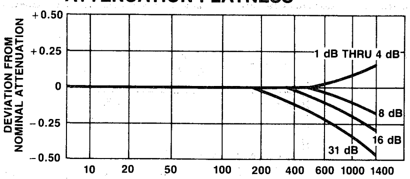
Ordering Information

Model No.	Package
AT-102 PIN	Dual Inline

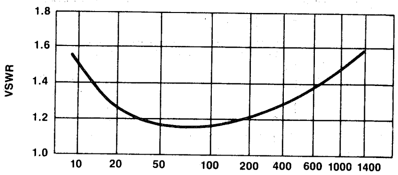
Specifications Subject to Change Without Notice.

Typical Performance

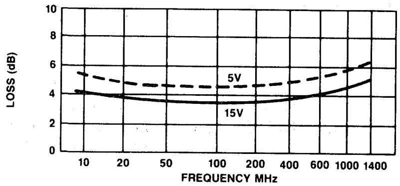
ATTENUATION FLATNESS



VSWR



REFERENCE INSERTION LOSS



Truth Table

CONTROL INPUT							ATTENUATOR SETTING
1	2	4	8	16	C*	R	
0	0	0	0	0	1	1	REFERENCE
1	0	0	0	0	1	1	1 dB
0	1	0	0	0	1	1	2 dB
0	0	1	0	0	1	1	4 dB
0	0	0	1	0	1	1	8 dB
0	0	0	0	1	1	1	16 dB
ANY COMBINATION					1	1	SUM OF BITS SELECTED
X	X	X	X	X	0	1	NO CHANGE IN ATTENUATION
X	X	X	X	X	X	0	RESET TO REFERENCE

"1" = LOGIC HIGH
"0" = LOGIC LOW
"X" = DON'T CARE
*CLOCK INPUT STROBES DATA ON RISING EDGE

Specifications Subject to Change Without Notice.

5-Bit GaAs Digital Attenuator 20-2000 MHz

AT-104

- Attenuation 1 dB Steps to 31 dB
- TTL Control Interface
- Fast Switching Speed, 20 ns TYP
- Phase Balance, +2/-4 Degrees TYP
- @ 500 MHz

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		20 to 2000 MHz
Nominal Attenuation**		1 dB Steps to 31 dB
Attenuation Accuracy	20-2000 MHz	±0.35 dB Max
	20-1000 MHz	±0.30 dB Max
	20-500 MHz	±0.30 dB Max
VSWR	20-2000 MHz	1.6:1 Max
	20-1000 MHz	1.6:1 Max
	20-500 MHz	1.6:1 Max
Reference Insertion Loss	20-2000 MHz	8.5 dB Max
	20-1000 MHz	8.0 dB Max
	20-500 MHz	7.5 dB Max

Operating Characteristics

Impedance			50 Ohms Nominal
Phase Balance (For any bit or combinations of bits per unit)			
2000 MHz			+2/–12 Degrees Typ
1000 MHz			+2/–7 Degrees Typ
500 MHz			+2/–4 Degrees Typ
100 MHz			±2.0 Degrees Typ
Switching Characteristics			
Switching Time (50% control to 90/10% RF)			20 nS Typ
Switching Transients (unfiltered)			350 mV Typ
Input Power for 1dB Compression			
500-2000 MHz			+27 dBm Typ
20-50 MHz			+20 dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP2	IP3	
500-2000 MHz	+58	+50	dBm Typ
20-50 MHz	+41	+35	dBm Typ
Bias Power			+5 Vdc @ 5 mA Max
			–12 Vdc @ 8 mA Max
Control			5 Line, TTL Data Bus
Environmental			
See Appendix for MIL-STD-883 screening option.			

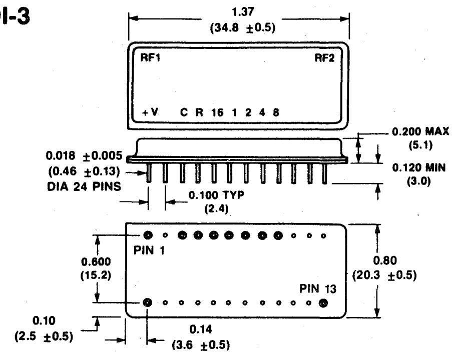
*All specifications apply when operated with bias voltages of +5 Vdc and –12 Vdc and a 50 ohm impedance at both RF ports.
**Above reference insertion loss.

Ordering Information

Model No.	Package
AT-104 PIN	Dual Inline

Specifications Subject to Change Without Notice.

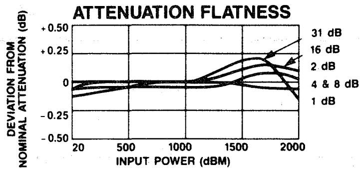
DI-3

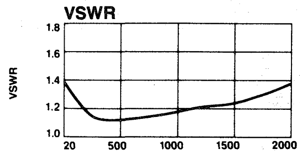


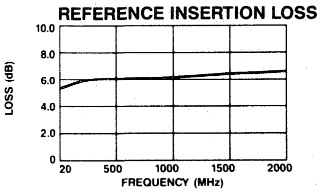
	RF1	RF2	+5V	-12V	C	R	16	1	2	4	8	0.5
	24	13	1	3	N/A	N/A	5	6	7	8	9	N/A
PINS UNMARKED ARE GROUND												

Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

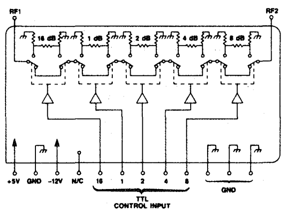
Typical Performance







Schematic



Truth Table

Control Input					Attenuator Setting
1	2	4	8	16	
0	0	0	0	0	REFERENCE
1	0	0	0	0	1 dB
0	1	0	0	0	2 dB
0	0	1	0	0	4 dB
0	0	0	1	0	8 dB
0	0	0	0	1	16 dB
Any Combination					Sum of Bits Selected
"1" = Logic High (TTL)					"0" = Logic Low (TTL)

Specifications Subject to Change Without Notice.

Voltage Variable Absorptive Attenuator DC-5 GHz

AT-201

- 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 Max
	DC - 3GHz	1.5:1 Max
	DC - 2 GHz	1.5:1 Max
Attenuation	DC - 4 GHz	20 dB Min
	DC - 5 GHz	18 dB Min
Flatness (Peak to Peak)	*DC - 5 GHz	2.5dB Max
	DC - 3 GHz	1.5dB Max
	DC - 2 GHz	1.0dB Max
Attenuation vs. Temperature	0 to 10dB Att.	±0.6dB
	20dB Att.	±2.5dB

*To 15 dB attenuation

Operating Characteristics

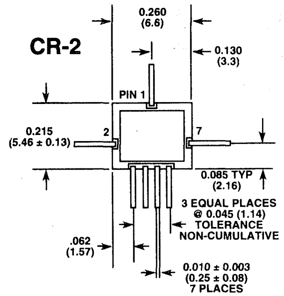
Impedance			50 Ohms Nominal
Switching Characteristics			
t_{rise}, t_{fall} (10% to 90%)			4ns Typ
t_{on}, t_{off} (50% C+L to 90%/10% RF)			8ns Typ
Transients (in band)			10mv Typ
Input Power for 1dB Compression			
Attenuation Level	0db	20db	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			−1.5 to −4V @ 100 μA Max
B Input (Series FETS)			0 to −4V @ 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 20dB and 2dB attenuation levels.

Ordering Information

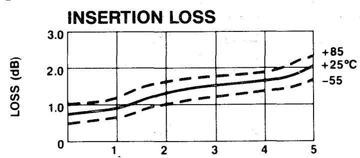
Model No.	Package
AT-201 PIN	Ceramic

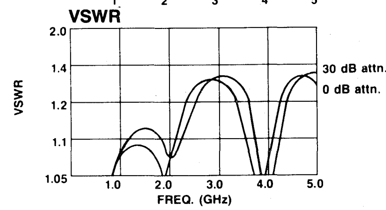


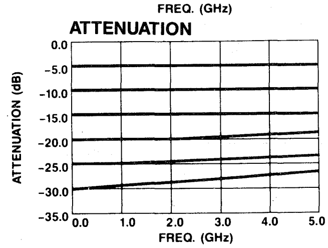
Dimensions in ( ) are in mm.

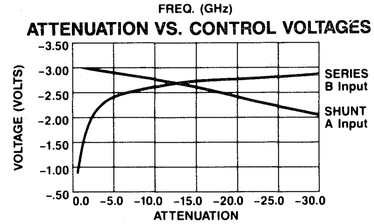
See Appendix for complete physical dimensions.

Typical Performance

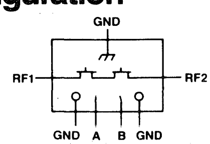








Pin Configuration



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

![M/A-COM]

Voltage Variable Absorptive Attenuator DC-5 GHz

AT-202

- 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	2.0dB Max
	DC - 3 GHz	1.5 dB Max
	DC - 2 GHz	1.5 dB Max
VSWR	DC - 5 GHz	2.0:1 Max
	DC - 3 GHz	1.5:1 Max
	DC - 2 GHz	1.5:1 Max
Attenuation	DC - 4 GHz	20dB Min
	DC - 5 GHz	18 dB Min
Flatness (Peak to Peak)	* DC - 5 GHz	2.5dB Max
	DC - 3 GHz	1.5dB Max
	DC - 2 GHz	1.0dB Max
Attenuation vs. Temperature	0 to 10dB Att.	±0.6dB
	20dB Att.	±2.5dB

*To 15 dB attenuation.

Operating Characteristics

Impedance			50 Ohms Nominal
Switching Characteristics			
t_{rise}, t_{fall} (10% to 90%)			4ns Typ
t_{on}, t_{off} (50% C+L to 90%/10% RF)			8ns Typ
Transients (in band)			10mv Typ
Input Power for 1dB Compression			
Attenuation Level	0dB	20dB	
.05 GHz to 5 GHz	+16	+11	dBm Typ
Intermodulation Intercept Point (for two-tone input power up to +5dBm)			
Intercept Points	IP2	IP3	
.05 GHz to 5 GHz	+25	+13	dBm Typ
Control Voltages			
A Input (Shunt FETS)			−1.5 to −4V @ 100 μA Max
B Input (Series FETS)			0 to −4V @ 100 μA Max
Environmental			
See Appendix for MIL-STD-883 screening option.			

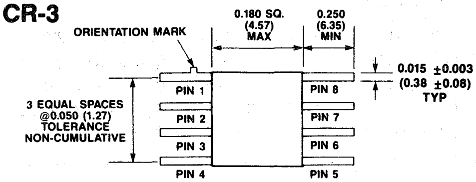
*All specifications apply with 50 ohm connected to all RF ports.

†Faster switching speed can be achieved with enhanced driver waveform. Switching speed is measured between 20dB and 2dB attenuation levels.

Ordering Information

Model No.	Package
AT-202 PIN	Ceramic

CR-3

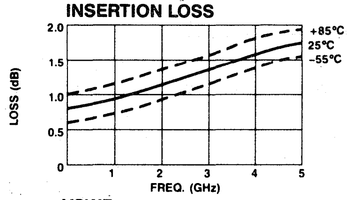


Dimensions in ( ) are in mm.

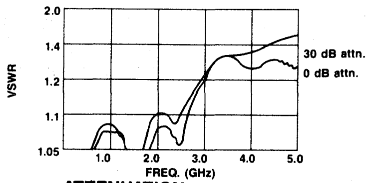
See Appendix for complete physical dimensions.

Typical Performance

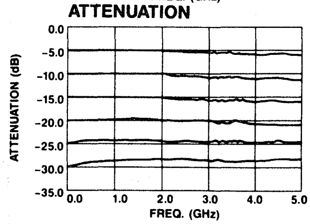
INSERTION LOSS



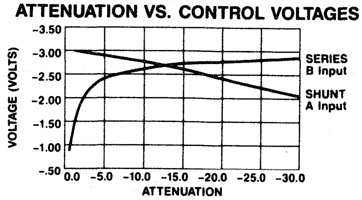
VSWR



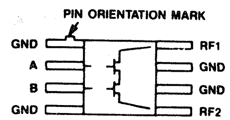
ATTENUATION



ATTENUATION VS. CONTROL VOLTAGES



Pin Configuration



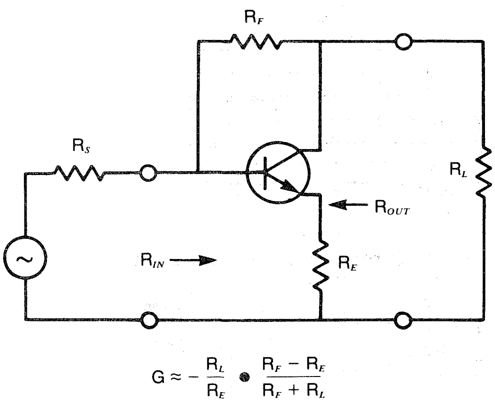
Specifications Subject to Change Without Notice.

INTRODUCTION

Broadband radio frequency amplifiers, designed for operation below microwave frequencies, generally use high-gain bipolar transistors in combination with negative feedback circuitry. This note presents a discussion of feedback with emphasis on the unique circuits, which M/A-COM produces having fundamental advantage in noise figure and dynamic range performance. Also included are basic amplifier definitions and information useful for predicting the noise figure and intermodulation performance of amplifier cascades.

FEEDBACK AMPLIFIERS

The bipolar and field effect transistors, which are the basic gain producing devices used in virtually all RF receiving amplifiers, are not particularly attractive for that use from a design standpoint. They are characterized by frequency dependent gain, poor impedance match, and non-linear operation. Negative feedback circuits are designed to overcome these effects and it is the designer's task to provide amplifiers having flat gain, good impedance match, and reduced distortion for acceptable systems operation.



$$G \approx -\frac{R_L}{R_E} \bullet \frac{R_F - R_E}{R_F + R_L}$$

$$R_{IN} \approx R_E \frac{R_F - R_L}{R_E - R_L} \qquad R_{OUT} \approx R_E \frac{R_F + R_S}{R_E + R_S}$$

Figure 1. Resistive Feedback Amplifier

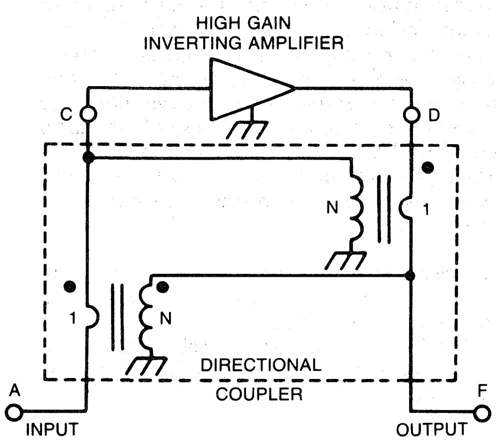
Most such amplifiers are designed using a technique commonly known as resistive feedback, shown in Figure 1. One feedback resistor connects between collector and base; a second connects between emitter and the ground of the common emitter transistor. Selection of these two resistors controls the gain and terminal impedances as given by the approximate equations in Figure 1. These feedback resistors are inherent noise producers and power dissipators. As feedback is increased in order to decrease gain and distortion, these resistors add more noise and dissipate more output power. With feedback sufficient to reduce gain to 10 dB, the noise figure will have increased by about 3 dB and the available output power will have decreased by about 3 dB compared to the performance of the same transistor operating without feedback.

To avoid this degradation of performance, M/A-COM developed a negative feedback structure based on its ferrite transformer capabilities. This patented technique, known as "lossless feedback," provides lower noise figure and higher linear output than can be achieved using resistive feedback with the same transistors. Figure 2 shows a block diagram of a transformer feedback circuit in which a directional coupler is the feedback network. The coupling ratio between ports D and C determines the magnitude of the feedback, and hence, the gain. The feedback is negative due to the in-phase coupling between ports D and C and the inversion of the active device.

The isolation of the coupler prevents output power from the active element applied to port D from appearing at the input port A; therefore, impedance match can be maintained in the presence of feedback. Finally, the signal transfer properties of the coupler are such that all of the input signal at A is added to the transistor output signal at D to yield a total output signal at B which is greater than the active device output; this is in contrast to the resistive feedback configuration in which the output power is less than that delivered by the active device. The only noise figure degradation is that produced by the very small incidental losses in the coupler.

The directional coupler feedback circuit gives great flexibility in application. The gain can be varied over a wide range by changing the transformer turns ratio and therefore the coupling ratio. Taps are regularly added to the transformers allowing the source and load impedances presented to the transistor to be changed. This allows noise figure and output linearity characteristics to be optimized. The couplers are very broadband devices allowing wide bandwidths, limited only by the active device, to be achieved.

A more detailed discussion of these circuits is contained in reference 1.



GAIN:

$$G = \frac{A}{1-A\beta}$$

FOR $|A\beta| >> |$

$$G \cong -\frac{1}{\beta}$$

G: Gain in the Presence of Feedback

A: Gain without Feedback or Open Loop Gain

β: Feedback Transfer Function or Coupling Ratio

DISTORTION:

$$D = \frac{d}{1-A\beta}$$

D: Distortion in the Presence of Feedback

d: Distortion without Feedback

Figure 2.

DEFINITION AND MEASUREMENT OF AMPLIFIER PARAMETERS

Gain

A network analyzer is used to measure the two-port scattering parameters of the amplifier as shown in the accompanying flow graph (Figure 3). The small signal insertion gain is defined as the ratio of the power delivered to the load to the power available from the source, in a 50 ohm measuring system on dB,

$$G = 20 \log_{10} |S_{21}| \text{ dB}$$

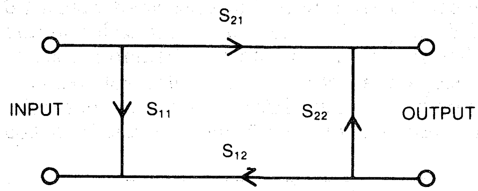


Figure 3.

Return Loss and VSWR

The input and output return loss and VSWR are related to the input and output scattering parameters as follows:

$$\rho_{in} = |S_{11}| \qquad \rho_{out} = |S_{22}|$$

$$\text{Return Loss} = 20 \log_{10} \rho \text{ dB}$$

$$\text{VSWR} = \frac{1+\rho}{1-\rho}$$

Noise Figure

The noise factor is the ratio of the signal to noise at the input to that at the output.

$$f = \frac{\text{Signal-to-noise ratio at input}}{\text{Signal-to-noise ratio at output}}$$

The noise figure is the noise factor expressed in dB

$$F = 10 \log f \text{ dB}$$

For very low noise figure determination, measurement is made using a highly accurate hot-cold noise source. For less critical determination of higher noise figures, an accurately calibrated diode noise source is used.

Intermodulation Intercept

The intermodulation intercept is an expression of the low level linearity of the amplifier. The intermodulation ratio is the difference in dB between the fundamental output signal level and the generated distortion product level. The relationship between intercept and intermodulation ratio is illustrated in Figure 4, which shows product output levels plotted versus the level of the fundamental output for two equal strength output signals at different frequencies. The upper line shows the fundamental output plotted against itself with a 1 dB to 1 dB slope. The second and third order products lie below the fundamentals and exhibit a 2:1 and 3:1 slope respectively. The intercept point for either product is the intersection of the extensions of the product curve with the fundamental output.

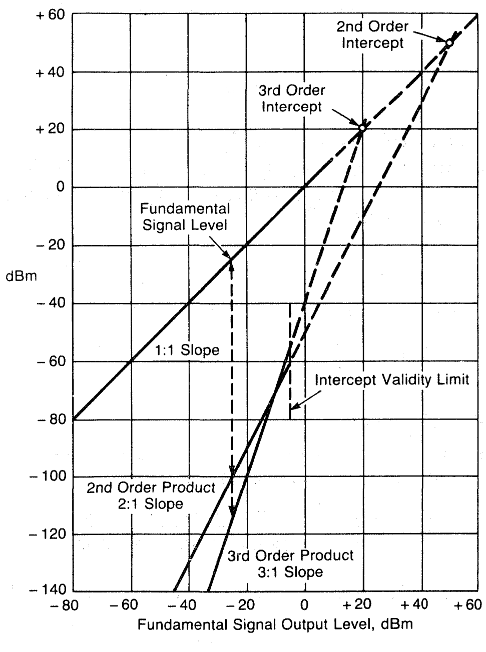


Figure 4. Intercept Diagram

The intercept point is determined by measuring the intermodulation ratio at a single output level and projecting along the appropriate product slope to the point of intersection with the fundamental. When the intercept point is known the intermodulation ratio can be determined by the reverse process. The second order IMR is equal to the difference in dB between the second order intercept and the fundamental output level. The third order IMR is equal to twice the difference between the third order intercept and the fundamental output level. These are expressed as:

$$IP_2 = P_{OUT} + IMR_2$$
$$IP_3 = P_{OUT} + \tfrac{1}{2}\, IMR_3$$

where P_{OUT} is the power level in dBm of each of a pair of equal level fundamental output signals, IP_2 and IP_3 are the second and third order output intercepts in dBm, and IMR_2 and IMR_3 are the second and third order intermodulation ratios in dB.

The intermodulation intercept is a valid indicator of intermodulation performance only in the small signal operating range of the amplifier. Above some output level which is below the 1 dB compression point, the active device moves into large signal operation attended by signal strength dependent bias level shifts. At this point the intermodulation products no longer follow the straight line output slopes, and the intercept description is no longer valid.

The intermodulation ratios are determined by measurement using a conventional spectrum analyzer. The measurement dynamic range is enhanced using appropriate cancellation techniques when required to accomodate high dynamic range amplifiers.

Compression

The 1 dB compression point is the output level at which the amplifier gain drops 1 dB below its small signal value. It is an indication of the signal level at which small signal conditions no longer apply. At this level, the intermodulation intercepts no longer adequately predict the amplifier distortion behavior.

The measurement of the compression level is made using a frequency discriminating detector in order to detect the gain decrease at the fundamental frequency. This is preferable to using a total power detection measurement, since it is the fundamental frequency which is probably of most interest to the user.

Maximum Signal

The maximum signal level is the largest CW or pulsed RF signal which may be safely applied to the amplifier. Larger signals will exceed the emitter base breakdown voltage of the transistor and will result in permanent degradation of noise figure and, for large enough signals, reduction of gain and increase in distortion.

The specified level is determined by applying successively larger CW signals and measuring the noise figure until 0.5 dB degradation is observed. The maximum signal level is specified 3 dB below the level which causes the 0.5 dB degradation.

Stability

Broadband feedback amplifiers, in general, may not be unconditionally stable at all frequencies, particularly outside of their specified operating bandwidth. When lossless feedback techniques are employed, stability margins tend to be smaller than when resistive methods are used. Indeed, it has been observed that when completely lossless feedback networks are utilized, for the purpose of achieving the lowest possible noise figures and highest dynamic range, it may not also be possible to achieve unconditional stability simultaneously. Unconditional stability may well be a trade-off against the noise figure requirement in particular.

For this reason, M/A-COM has utilized the analysis capability of automatic network analyzers in order to calculate the stability conditions for amplifiers from their measured S-parameters. Using equations from reference (2) it is possible to compute the K factor and the stability circle locations directly from the S-parameters at all frequencies of measurement. If the K factor is greater than unity, the amplifier is unconditionally stable at that frequency. If K is less than unity, then the stability circles, which are the boundaries between the stable and the potentially unstable load regions, may be calculated and plotted on the source and load plane Smith charts. This information, along with the system designer's knowledge of the source and load impedances in which the amplifier will be embedded, make it possible to utilize, with confidence, amplifiers whose desirable characteristics outweigh their lack of unconditional stability. Intelligent utilization of this information has allowed M/A-COM to supply the lowest noise, highest dynamic range amplifiers to the industry.

Survivability

Published work (3) has been done at M/A-COM on the topic of amplifier survivability and protection against strong RF signal inputs. It was found that the most probable overload failure mechanism is breakdown of the emitter base junction when the applied signal negative peaks drive the base beyond the BV_{EBO} rating of the transistor. The majority of the transistor. The majority of M/A-COM amplifiers utilize transistors with breakdown voltages in excess of 3 volts, and these devices can withstand signals up to +20 dBm. Recently designed high frequency amplifiers use very high ft devices with 1.5 volt breakdown voltages. These devices are susceptible to damage with signals in the vicinity of +13 dBm.

The problem is related to peak voltages rather than average power and is therefore as severe for low duty cycle pulses as for CW signals. Indeed, it may be more severe for repetitive pulses if the transient response of the input biasing circuitry is not well controlled.

Special protection technique against overdrive is not included in M/A-COM standard amplifiers. However, such techniques have been developed and can be incorporated in special designs as required. The most effective protection has been obtained by placing a low resistance Schottky diode directly across the emitter-base junction in the reverse bias direction. This diode has no effect on the small signal operation of the amplifier; specifically, it does not degrade noise figure or intermodulation intercept. When overloading signals are applied, however, the diode conducts on the negative peaks and limits the emitter-base voltage below th level of breakdown. By proper application of this technique, including the design of the bias circuitry, it is possible to protect very low noise amplifiers against overloading signals in excess of one watt.

FIGURES OF MERIT

There are two figures of merit which are useful for comparing the performance capabilities of similar amplifiers. These have been designated the dynamic range and the intercept efficiency.

The first combines the third order intercept, the gain, and the noise figure into a single number which compares the dynamic range capabilities of one amplifier with another. The second compares amplifiers based on their conversion of applied DC power to third order intercept. These concepts are described in the following sections.

DYNAMIC RANGE

The dynamic range of an amplifier is the range of signal levels over which the signal quality meets some specified criteria of usability. The low signal limit relates to noise while the high limit relates to nonlinearities. The lowest usable signal level is determined by the device noise figure, the detection bandwidth, and the required signal-to-noise ratio.

The largest usable signal level is determined by the device nonlinearity according to criteria which reflect the system operation requirements. Linearity requirements are variously expressed by 2nd and 3rd order harmonic and and intermodulation limits, cross-modulation, desensitization, or output compression criteria. The dynamic range can be determined only after a large signal criterion has been selected. Since most system requirements are expressed in terms of low-level non-linearities with observed results in a relatively narrow frequency window, it becomes advantageous to typify the device in terms of its third-order output intermodulation intercept, IP_3. Although this is an arbitrary choice not necessarily suitable to all needs, it does yield a readily found measure upon which device comparisons can conveniently be made.

observed results in a relatively narrow frequency window, it becomes advantageous to typify the device in terms of its third-order output intermodulation intercept, IP_3. Although this is an arbitrary choice not necessarily suitable to all needs, it does yield a readily found measure upon which device comparisons can conveniently be made.

An expression of dynamic range based on the third-order intercept will involve terms expressing noise figure, gain, output intercept, detection bandwidth, signal-to-noise ratio, and intermodulation ratio.

The last three of these quantities are system or user determined while the first three are attributes of the device. Therefore, it is useful to introduce the Dynamic Range Number concept with the following definition:

$$D = IP_3 - G - F$$

where IP_3 is the third-order output intercept in dBm, G is the gain in dB, and F is the amplifier noise figure, also in dB. The Dynamic Range Number "D" is a positive or a negative number. Since the output intercept minus the gain is the input intercept, it is seen that the Dynamic Range Number is simply the input intercept minus the noise figure.

The dynamic range of an amplifier is directly proportional to its dynamic range number. The dynamic range may be maximized by increasing the output intercept and lowering the noise figure. It may also be increased by lowering the gain, but this leads to a conflict. In a single stage, it may not be possible to vary the gain at will without impacting both the distortion intercept and the noise figure.

In general, the object is not to maximize the dynamic range of a single stage, but to maximize that of a chain of components. Hence, the main usage for the Dynamic Range Number will be found in the comparison of similar devices.

Intercept Efficiency

In single stage amplifiers, the range of variation of gain, noise figure, and intercept point, the elements contained in the Dynamic Range Number, is relatively small for the first two items, but is large for the third. Stage gains usually lie within a 10 dB range from 6 to 18 dB, while noise figures vary by about the same amount, lying roughly between 1 and 10 dB. A much larger variation is found in the third order intermodulation intercept point, which may lie anywhere in a 60 dB range upward from about 0 dBm. This intercept is roughly proportional to the amount of DC power applied to the device.

In many applications there is little concern for the DC power required to achieve the desired amplifier performance. In some cases however, this may be a prime consideration. Instances where this can be true are in missile, satellite, and man-pack equipment, where the matter of prime power requirement of thermal dissipation may be very important. Also, in any system where a very large number of amplifiers is required, the total amount of power supplied may be subject to limitation. Under these circumstances, it will be desirable to maximize the intercept point relative to the applied power.

As a measurement of the relationship between the third-order intercept and the DC applied power, it is useful to define the Intercept Efficiency as follows:

$$\text{Intercept Efficiency} = 10 \log \frac{I_P}{P_{DC}} \text{ dB}$$

where I_P is the third order intercept power expressed in milliwatts and P_{DC} is the total DC power applied to the amplifier, also in milliwatts. As an example, an amplifier dissipating 1200 mW or +30.8 dBm having a third-order intercept of +32 dBm will have an Intercept Efficiency of +1.2 dB. If it were found possible to improve the design so that a +35 dBm intercept could be achieved with the same dissipation, a 3 dB improvement in efficiency would be obtained with important implications to the power-limited system designer.

M/A-COM amplifiers, which utilize lossless feedback, will exhibit higher dynamic range numbers and intercept efficiencies than similar amplifiers using resistive feedback.

CASCADING AMPLIFIERS

Two graphs are presented here which are useful in designing cascades of amplifiers or other components. The first graph is an easily used presentation of the added noise figure due to the second stage in a cascade of two units. The standard formula for the total noise figure, f_t, in terms of the first and second stage noise figures and the first stage gain is:

$$f_t = f_1 + \frac{f_2 - 1}{g_1}$$

Since noise figure is normally given in dB rather than in power terms, it is useful to reformulate the above to:

$F_t = F_1 + \Delta$ in dB, where Δ is given by

$$\Delta = 10 \log \left(1 + \frac{f_2 - 1}{f_1 g_1}\right)$$

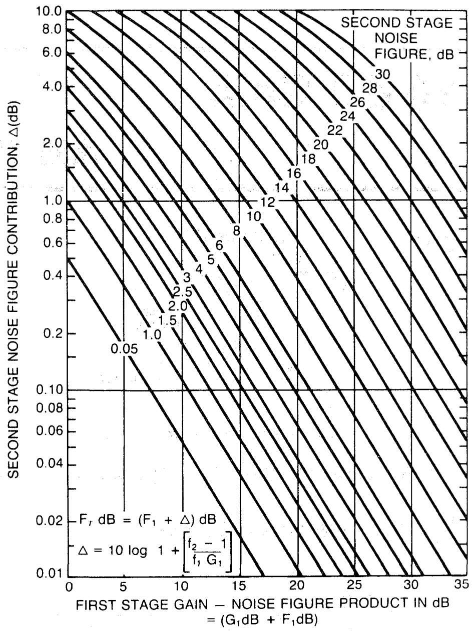


Figure 5. Graphical Solution for Cascaded Noise Figure

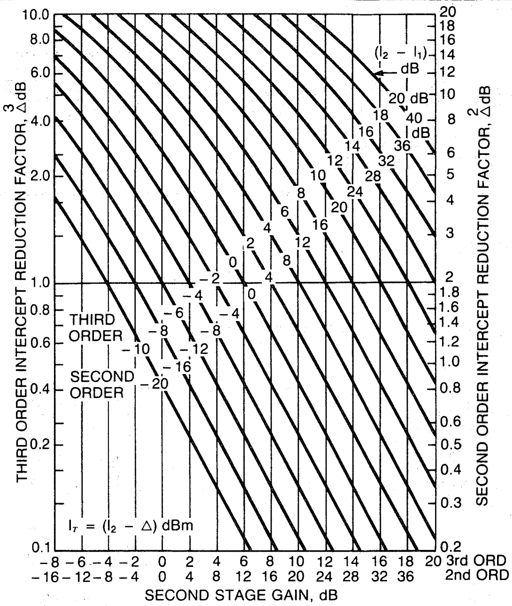


Figure 6. Graphical Solution for Cascaded Intercept

Figure 5 allows Δ to be read directly on the ordinate in dB at the crossing of the abscissa, which represents the sum of the first stage gain and noise figure in dB, and the diagonal, which represents the second stage noise figure.

The second graph shows the effect on the intermodulation intercept caused by the total cascade intercept, I_T, is related to that of the second stage, I_2 by:

$$I_T = I_2 - \Delta$$

where I_T and I_2 are in dBm and Δ is in dB, where

$$\overset{2}{\Delta} = 20 \log \left[1 + \sqrt{\frac{1}{g_2} \bullet \frac{\overset{2}{i}_2}{\overset{2}{i}_1}} \right] \quad \text{for second order}$$

$$\text{and } \overset{3}{\Delta} = 10 \log \left[1 + \frac{1}{g_2} \bullet \frac{\overset{3}{i}_2}{\overset{3}{i}_1} \right] \quad \text{for third order}$$

Here i_1, i_2, and g_2 are the first stage intercept, the second stage intercept, and the second stage gain, respectively, expressed as powers and power ratio. The superscripts 2 and 3 identify the product order. Δ is seen to represent the reduction in the cascade intercept from that of the second stage alone.

Figure 6 allows Δ to be read directly in dB at the intersection of the abcissa which represents the second stage gain and the diagonals which represent the difference between the third and second stage intercept in dB. Both second and third order products are represented.

CONCLUSION

Low noise amplifiers utilizing various negative feedback techniques are available. M/A-COM produces both resistive and "lossless" coupler feedback designs. Understanding the advantages of coupler feedback allows the system designer to achieve improved system performance and when necessary the ultimate possible amplifier performance. As with all our products, applications engineers are ready to assist the systems engineer in proper selection, specification and use of our devices. Please refer to the application note appendix of this catalog for flatpack installation data.

REFERENCES

1. D.E. Norton, **High Dynamic Range Transistor Amplifier Using Lossless Feedback,** Microwave Journal, May, 1976, pp. 53-57.
2. Hewlett Packard application note 154.
3. D.E. Norton, **Strong Signal Survivability Design for Lossless Feedback Amplifiers,** Proceedings, Eleventh Annual European Microwave Conference.

High Performance Amplifier, 10 dB Gain 0.5-60 MHz

AM-109

- Push-Pull Circuitry
- Ideal for HF Antenna Distribution

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	0.5-60 MHz
Gain (+25°C) @ 10 MHz	10.7 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
0.5-60 MHz	+27 dBm Min
2-32 MHz	+28 dBm Min
Noise Figure	
0.5-60 MHz	7 dB Max
2-32 MHz	6 dB Max
Reverse Transmission	−15 dB Max −18 dB Typ
VSWR	
0.5-60 MHz	1.6:1 Max
2-32 MHz	1.3:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order (0.5-60 MHz)	+70 dBm Min
Second Order (2-32 MHz)	+75 dBm Min
Third Order (0.5-60 MHz)	+40 dBm Min
Third Order (3-32 MHz)	+45 dBm Min
Bias Power	+20 VDC @ 225 mA Max (180 mA, 3.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+24 dBm Max

Environmental

See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +20 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

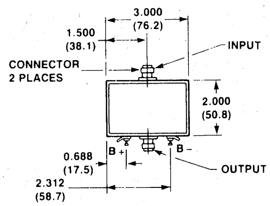
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 3.6 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-109 BNC	Connectorized
AM-109 SMA	Connectorized

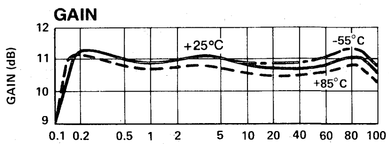
C-15

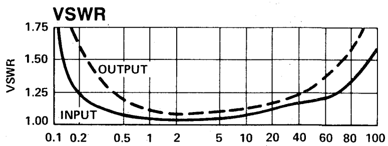


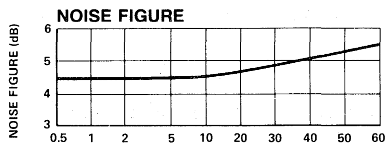
Dimensions in ( ) are in mm.

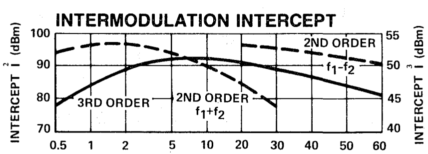
See Appendix for complete physical dimensions.

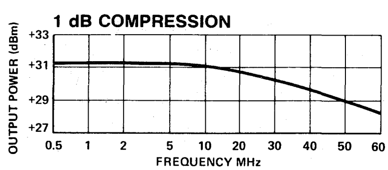
Typical Performance











Specifications Subject to Change Without Notice.

General Purpose Amplifier, 16 dB Gain 0.5-100 MHz

AM-124

- 3.8 dB Typical Noise Figure
- Low Cost

Guaranteed Specifications*

(@25°C)

Frequency Range	0.5-100 MHz
Gain	16 ±1 dB
Output Power (1 dB Compression)	−5 dBm Min
Noise Figure	4.5 dB Max
Reverse Transmission	−19 dB Max −22 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −15 dBm)	
Second Order	+8 dBm Min
Third Order	+8 dBm Min
Bias Power	+15 VDC @ 15 mA Max (10 mA, 150 mW Typical)

Operating Characteristics

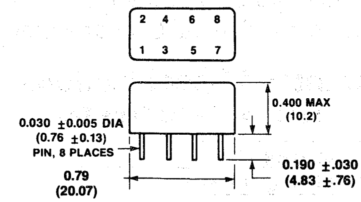
Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P6, Out; P5, VDC; P1, All other pins are ground

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
AM-124 PIN	Relay Header

RH-1

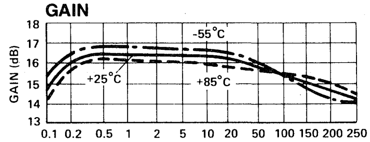


Dimensions in ( ) are in mm.

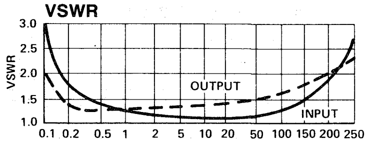
See Appendix for complete physical dimensions.

Typical Performance

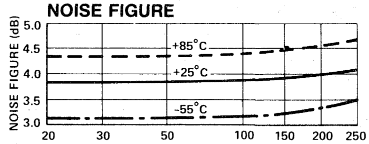
GAIN



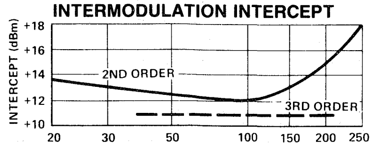
VSWR



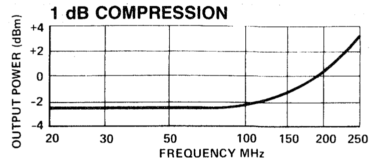
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

M/A-COM

General Purpose Amplifier, 30 dB Gain 0.5-100 MHz

AM-110

- 4.5 dB Typical Midband Noise Figure
- + 23 dBm Typical Compression Level

Guaranteed Specifications*

(From − 55°C to + 85°C Case Temp)

Frequency Range	0.5-100 MHz
Gain (+ 25°C) @ 10 MHz	29.7 ±0.5 dB
Frequency Response	
0.5-100 MHz	±0.5 dB Max
1-60 MHz	±0.3 dB Max
Gain Variation with Temperature	
0.5-100 MHz	±0.8 dB Max
1-60 MHz	±0.4 dB Max
Output Power (1 dB Compression)	+21 dBm Min
Noise Figure	5.5 dB Max
Reverse Transmission	−35 dB Max −37 dB Typ
VSWR	
0.5-100 MHz	1.7:1 Max
1-60 MHz	1.4:1 Max
Intermodulation Intercept Point (for two-tone output power up to + 10 dBm)	
Second Order (0.5-100 MHz)	+33 dBm Min
Second Order (1-60 MHz)	+42 dBm Min
Third Order	+33 dBm Min
Bias Power	20 VDC @ 130 mA Max (110 mA, 2.2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+ 18 dBm Max
Environmental	

See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at 20 VDC, with 50 ohm source and load impedance.

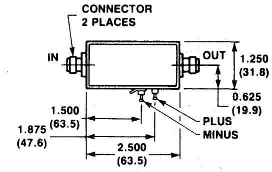
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.2 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-110 BCN	Connectorized
AM-110 SMA	Connectorized

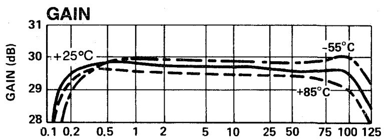
C-23

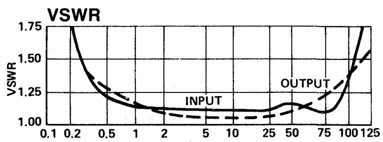


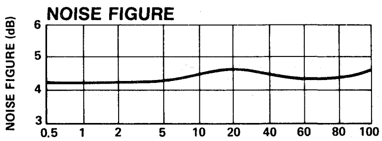
Dimensions in ( ) are in mm.

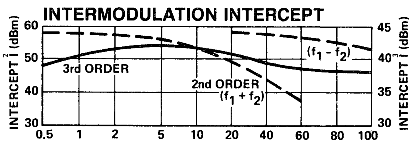
See Appendix for complete physical dimensions.

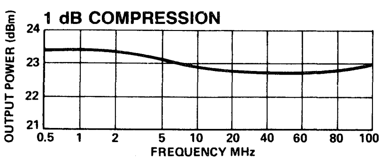
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Low Noise Amplifier, 30 dB Gain 10-100 MHz
AM-113

- 1.5 dB Typical Midband Noise Figure
- +18 dBm Compression Level
- Ideal for Broadband IF Applications

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	10-100 MHz
Gain (+25°C) @ 60 MHz	30.6 ±0.5 dB
Frequency Response	±0.8 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+14 dBm Min
Noise Figure	
−55 to +30°C	1.8 dB Max
+30 to +85°C	2.3 dB Max
Reverse Transmission	−37 dB Max −40 dB Typ
VSWR	2.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+45 dBm Min
Third Order	+28 dBm Min
Bias Power	+15 VDC @ 70 mA Max (50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 ohms Nominal
Maximum Rating	
RF Input	+20 dBm

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	IN; P12, Out; P4, DC IN; P8, All other pins are ground.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,891,934.

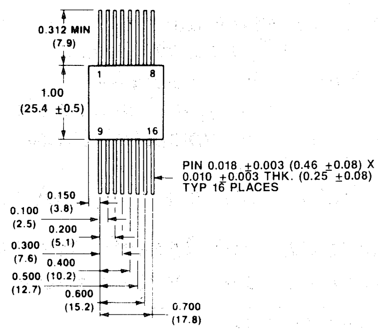
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.75 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-113 PIN	Flatpack

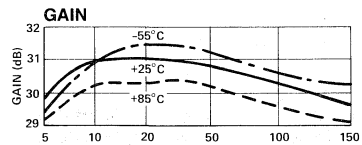
FP-6

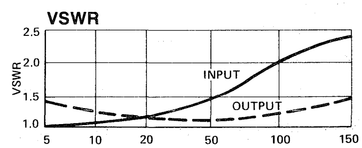


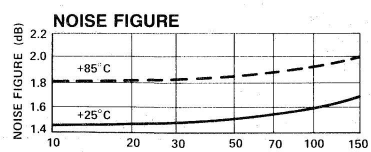
Dimensions in ( ) are in mm.

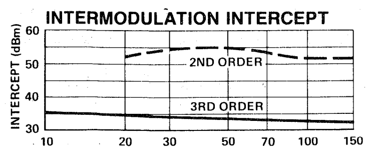
See Appendix for complete physical dimensions.

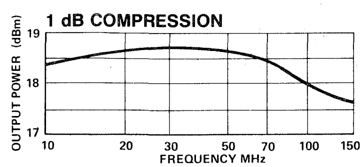
Typical Performance











Specifications Subject to Change Without Notice.

Low Noise Amplifier, 12.5 dB Gain
10-100 MHz

AM-/AMC-/AMS-162

- Low Noise Figure — 1.1 dB Typical @ 50 MHz
- High Output Power — +15 dBm Typical @ 50 MHz
- +32 dBm Typical 3rd Order Intercept @ 50 MHz
- Fully Hermetic Package (AMS-162)

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-100 MHz
Gain (+25°C) @50 MHz	12.5 ±0.5 dB
Frequency Response	±0.6 dB Max
Gain Variation with Temperature	±0.6 dB Max
Output Power (1 dB Compression)	+13 dBm Min
Noise Figure	1.6 dB Max
Reverse Transmission	−14 dB Max −15 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+40 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @15 mA Max (11 mA, 165 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

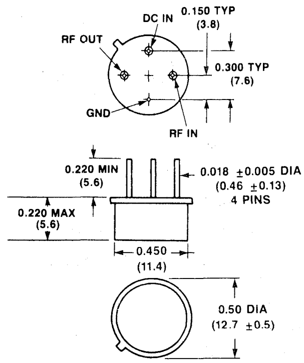
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by U.S. Patent Number 3,891,934.

S-Parameters: For typical S-Parameter data, see appendix.

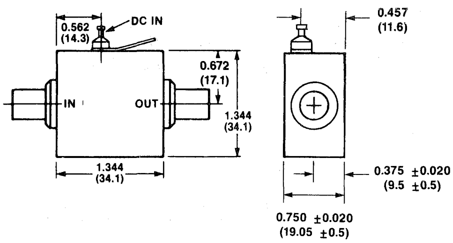
Ordering Information

Model No.	Package
AM-162 PIN	Pin
AMC-162 SMA	Connectorized
AMS-162 PIN	Pin

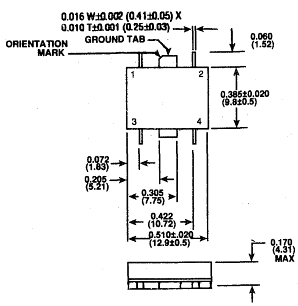
TO-8-1



C-6



SF-1



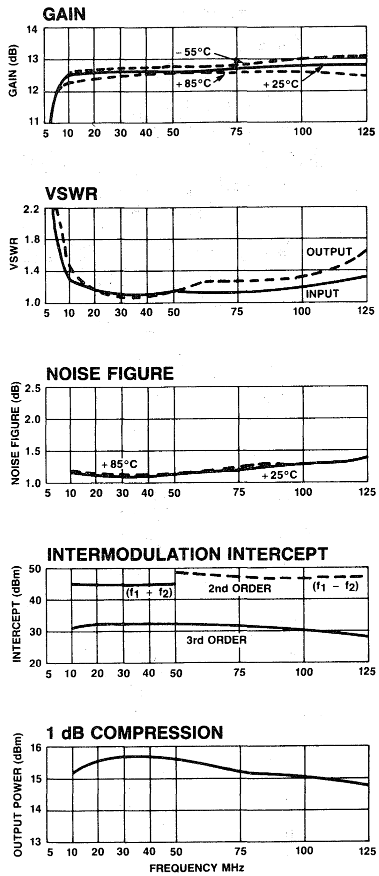
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Performance



Pin Configuration

AMS-162

Pin Number	Description
1	Output
2	VDC
3	Input
4	Ground

High Performance Amplifiers, 15 dB Gain 5-200 MHz

AM-/AMC-134

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 4.8 dB Typical Midband Noise Figure

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	14.6 ±0.6 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	+0.5, −1.0 dB Max
Output Power (1 dB Compression)	+23 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−19 dB Max −21 dB Typ
VSWR	2.5:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order	+55 dBm Min
Third Order (5-200 MHz)	+37 dBm Min
Third Order (5-70 MHz)	+42 dBm Min
Bias Power	+24 VDC @ 130 mA Max (110 mA, 2.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm Max
Bias	26 VDC Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN, P6; OUT, P1; VDC, P5

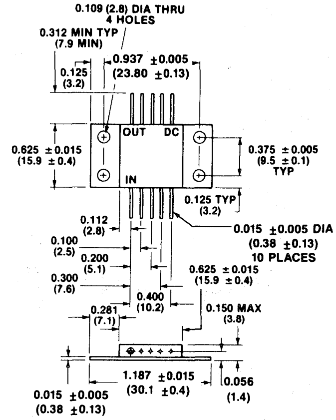
*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

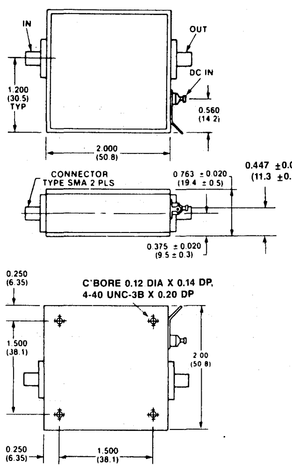
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.6 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

FP-8



C-25



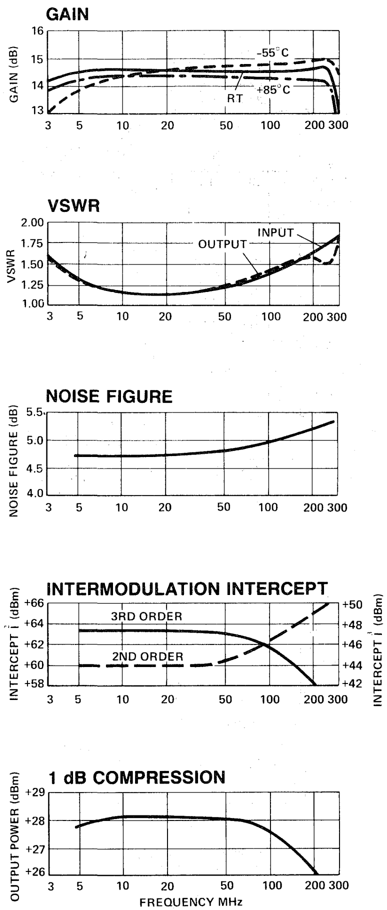
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010
.xx = ± 0.02

Ordering Information

Model No.		Package
AM-134	PIN	Flatpack
AMC-134	SMA	Connectorized

Specifications Subject to Change Without Notice.

Typical Performance



High Performance Amplifiers, 20 dB Gain
5-200 MHz AM-/AMC-136

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 4.8 dB Typical Midband Noise Figure

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

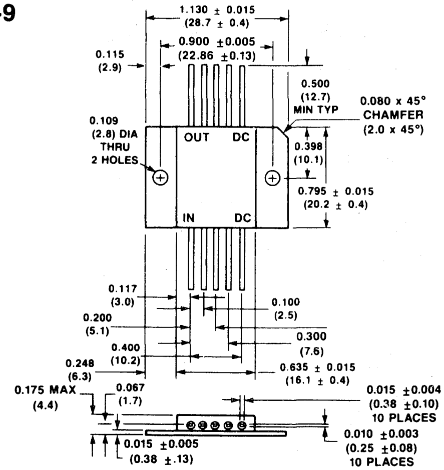
Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	20 ± 0.8 dB
Frequency Response	± 0.8 dB Max
Gain Variation with Temperature	± 1.0 dB Max
Output Power (1 dB Compression)	
5-200 MHz	+23 dBm Min
5-70 MHz	+25 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−26 dB Max −28 dB Typ
VSWR	
5-200 MHz	2.5:1 Max
5-70 MHz	1.7:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order (5-200 MHz)	+53 dBm Min
Second Order (5-70 MHz)	+57 dBm Min
Third Order (5-200 MHz)	+36 dBm Min
Third Order (5-70 MHz)	+44 dBm Min
Bias Power	+24 VDC @ 250 mA Max (210 mA, 5W Typical)

Operating Characteristics

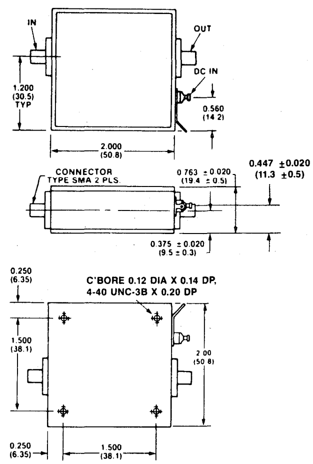
Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+15 dBm Max
Bias	26 VDC Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 5 W. Must be provided in use.

FP-9



C-25



Dimensions in ( ) are in mm.

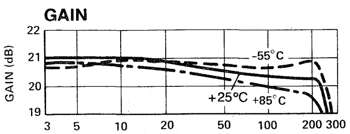
See Appendix for complete physical dimensions.

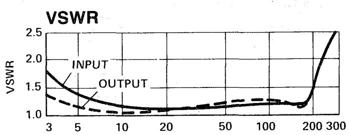
Ordering Information

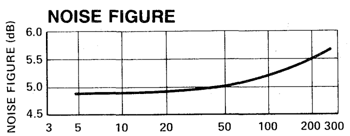
Model No.		Package
AM-136	PIN	Flatpack
AMC-136	SMA	Connectorized

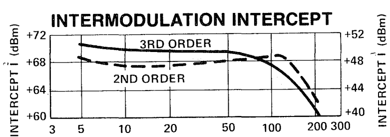
Specifications Subject to Change Without Notice.

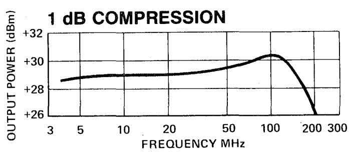
Typical Performance











High Performance Amplifiers, 25 dB Gain
5-200 MHz
AM-/AMC-138

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 5.3 dB Typical Midband Noise Figure

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	25 ±0.8 dB
Frequency Response	±1.0 dB Max
Gain Variation with Temperature	+1.0, −1.4 dB Max
Output Power (1 dB Compression)	
5-200 MHz	+23 dBm Min
5-70 MHz	+25 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−33 dB Max −35 dB Typ
VSWR	
5-200 MHz	2.5:1 Max
5-70 MHz	1.8:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order (5-200 MHz)	+50 dBm Min
Second Order (5-70 MHz)	+56 dBm Min
Third Order (5-200 MHz)	+35 dBm Min
Third Order (5-70 MHz)	+41 dBm Min
Bias Power	+24 VDC @ 250 mA Max (210 mA, 5W Typical)

Operating Characteristics

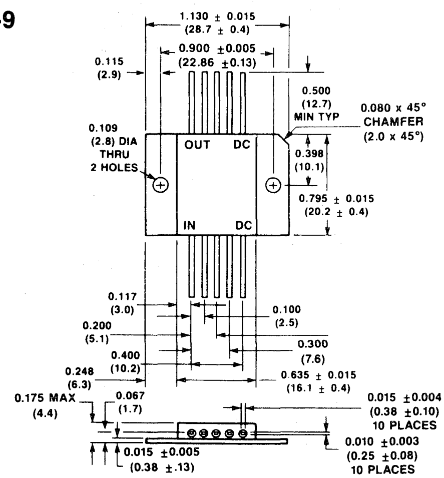
Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Bias	26 VDC Max

Environmental
See Appendix for MIL-STD-883 screening option.

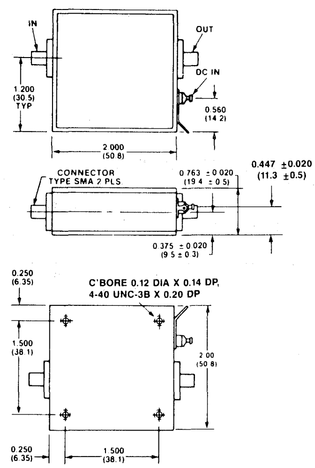
Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 5 W. Must be provided in use.
S-Parameters: For typical S-Parameter data, see appendix.

FP-9



C-25



Dimensions in ( ) are in mm.

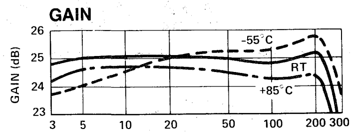
See Appendix for complete physical dimensions.

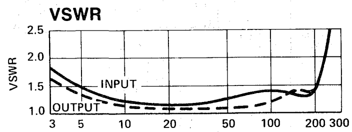
Ordering Information

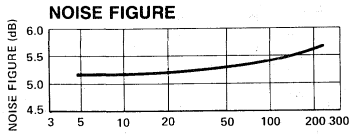
Model No.		Package
AM-138	PIN	Flatpack
AMC-138	SMA	Connectorized

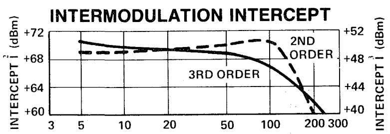
Specifications Subject to Change Without Notice.

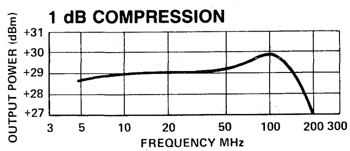
Typical Performance











High Performance Amplifiers, 29 dB Gain
5-200 MHz
AM-/AMC-140

- +47 dBm Typical Midband Third Order Intercept
- +28 dBm Typical Midband 1 dB Compression
- 5.4 dB Typical Midband Noise Figure

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	29.3 ±1 dB
Frequency Response	±1.2 dB Max
Gain Variation with Temperature	±1.2 dB Max
Output Power (1 dB Compression)	
5-200 MHz	+23 dBm Min
5-70 MHz	+24 dBm Min
Noise Figure	7 dB Max
Reverse Transmission	−38 dB Max −42 dB Typ
VSWR	
5-200 MHz	2.5:1 Max
5-70 MHz	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+52 dBm Min
Third Order (5-200 MHz)	+36 dBm Min
Third Order (5-70 MHz)	+40 dBm Min
Bias Power	+24 VDC @ 250 mA Max (210 mA, 5W Typical)

Operating Characteristics

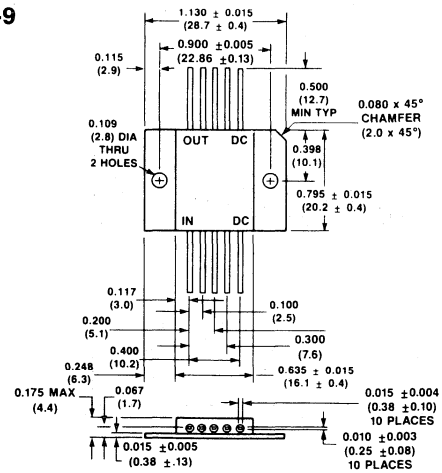
Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+5 dBm Max
Bias	26 VDC Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN, P6; OUT, P1, VDC, P5, P10

*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

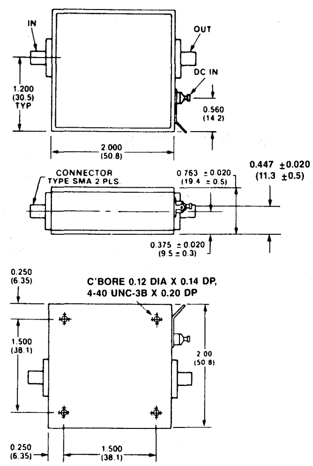
This product contains elements protected by United States Patent Number 3,624,536.

S-Parameters: For typical S-Parameter data, see appendix.

FP-9



C-25



Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010
.xx = ± 0.02

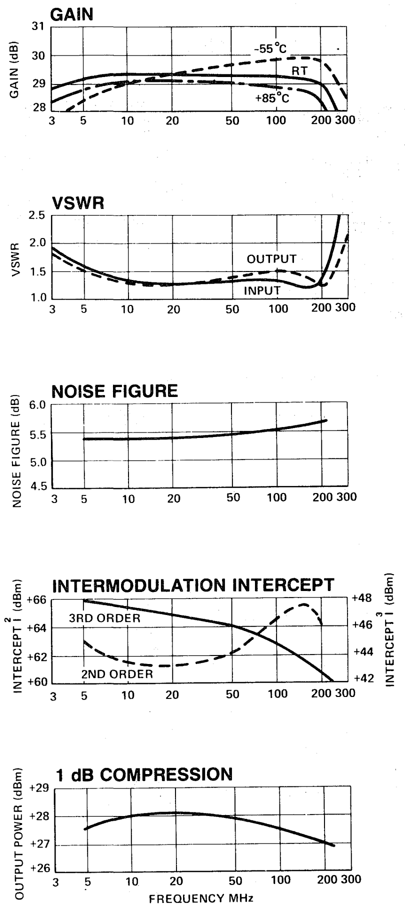
Ordering Information

Model No.		Package
AM-140	PIN	Flatpack
AMC-140	SMA	Connectorized

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Performance



M/A-COM

High Performance Amplifiers, 10 dB Gain
5-200 MHz　　AM-/AMC-132

- +49 dBm Typical Midband Third Order Intercept
- +29 dBm Typical Midband 1 dB Compression
- 4.5 dB Typical Midband Noise Figure

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-200 MHz
Gain (+25°C) @ 50 MHz	10 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±0.6 dB Max
Output Power (1 dB Compression)	+25 dBm Min
Noise Figure	6 dB Max
Reverse Transmission	−13 dB Max −14 dB Typ
VSWR	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power to +10 dBm)	
Second Order	+54 dBm Min
Third Order (5-200 MHz)	+38 dBm Min
Third Order (5-70 MHz)	+45 dBm Min
Bias Power	+24 VDC @ 130 mA Max (110 mA, 2.6W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm Max
Bias	26 VDC Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN, P6; OUT, P1; VDC, P5

*All specifications apply when operated at +24 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

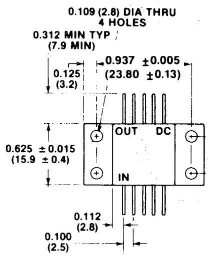
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.6 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

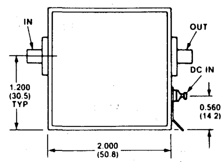
Ordering Information

Model No.		Package
AM-132	PIN	Flatpack
AMC-132	SMA	Connectorized

FP-8



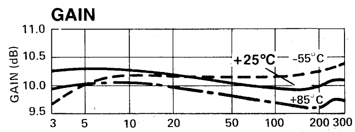
C-25

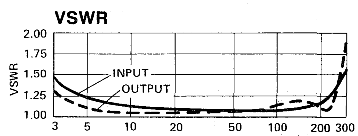


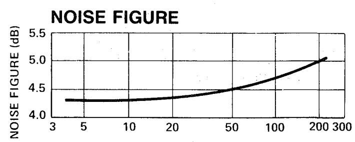
Dimensions in ( ) are in mm.

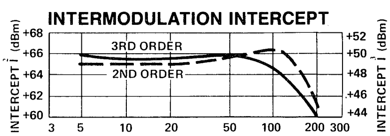
See Appendix for complete physical dimensions.

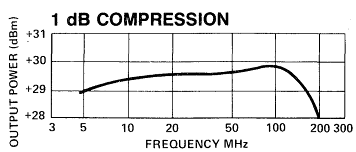
Typical Performance











Specifications Subject to Change Without Notice.

Low Noise Amplifier, 16 dB Gain 10-200 MHz

AM-112

- 2.0 dB Typical Midband Noise Figure
- +22 dBm Typical Midband Intercept
- +9 dBm Typical Compression Level

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-200 MHz
Gain (+25°C) @ 50 MHz	16.4 ±0.5 dB
Frequency Response	+0.25, −1.0 dB Max
Gain Variation with Temperature	±0.75 dB Max
Output Power (1 dB Compression)	+7 dBm Min
Noise Figure	
10-200 MHz	4.0 dB Max
10-100 MHz	3.5 dB Max
Reverse Transmission	−18 dB Max −23 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order	+25 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @ 33 mA Max (27 mA, 405 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

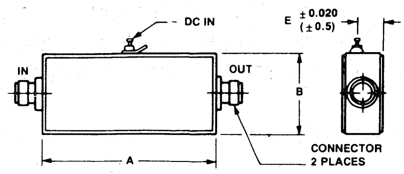
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.4 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-112 BNC	Connectorized

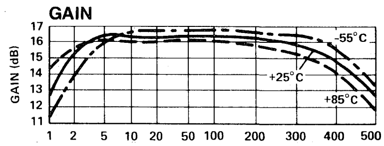
C-16

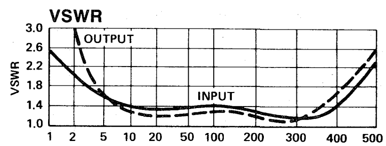


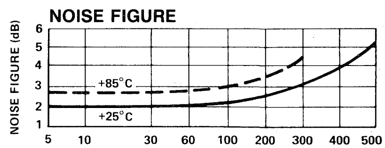
Dimensions in ( ) are in mm.

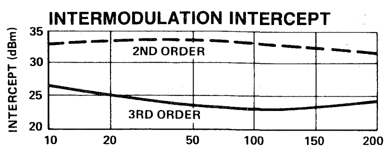
See Appendix for complete physical dimensions.

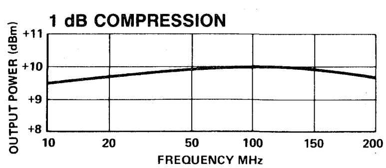
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM

Low Noise Amplifier, 8 dB Gain 10-200 MHz

AM-/AMC-/AMS-117

- 1.3 dB Typical Midband Noise Figure
- +30 dBm Typical Midband Intercept
- Ideal for Broadband IF Applications
- Fully Hermetic Package (AMS -117)

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-200 MHz
Gain (+25°C) @ 60 MHz	8.2 ±0.5 dB
Frequency Response	±0.3 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
10-200 MHz	+7 dBm Min
10-100 MHz	+9 dBm Min
Noise Figure	
10-200 MHz	2.5 dB Max
10-100 MHz	2.0 dB Max
Reverse Transmission	−9 dB Max −11 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order (10-200 MHz)	+32 dBm Min
Second Order (10-100 MHz)	+35 dBm Min
Third Order (10-200 MHz)	+20 dBm Min
Third Order (10-100 MHz)	+23 dBm Min
Bias Power	+15 VDC @ 13 mA Max (11 mA, 165 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

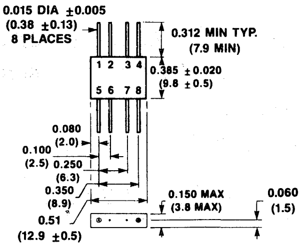
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by United States Patent Number 3,891,934.

S-Parameters: For typical S-Parameter data, see appendix.

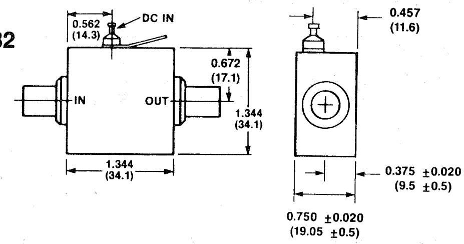
Ordering Information

Model No.		Package
AM-117	PIN	Flatpack
AMC-117	SMA	Connectorized
AMS-117	PIN	Surface Mount

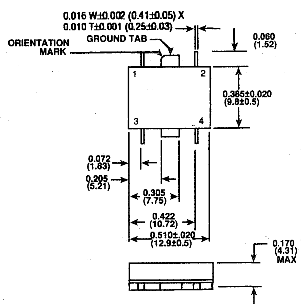
FP-2



C-32



SF-1



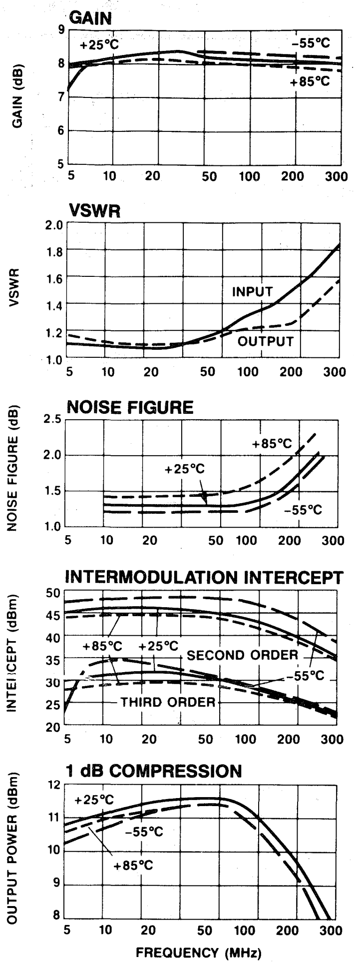
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Performance



Pin Configuration

AMC-117

Pin Number	Description
1	Output
2	Ground
3	Ground
4	DC Input
5	Input
6	Ground
7	Ground
8	Ground

AMS-117

Pin Number	Description
1	Output
2	DC Input
3	Input
4	Ground

Specifications Subject to Change Without Notice.

M/A-COM

High Performance Amplifier, 8 dB Gain 30-250 MHz

AM-/AMC-119

- 2.3 dB Typical Midband Noise Figure
- +23 dBm Typical Midband Output Power
- +40 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	30-250 MHz
Gain (+25°C) @250 MHz	8.0 ±0.5 dB
Frequency Response	±0.75 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+20 dBm Min
Noise Figure	3.5 dB Max
Reverse Transmission	−9.5 dB Max −11.0 dB Typ
VSWR	2.3:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+39 dBm Min
Third Order	+34 dBm Min
Bias Power	+15 VDC @60 mA Max (50 mA, 750 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Environmental	

See Appendix for MIL-STD-883 screening option.

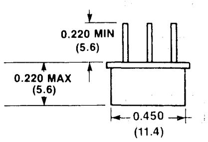
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by United States Patent Number 3,891,934.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1 W. Must be provided in use.

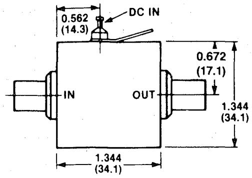
Ordering Information

Model No.		Package
AM-119	PIN	TO-8-1
AMC-119	SMA	Connectorized

TO-8-1



C-6

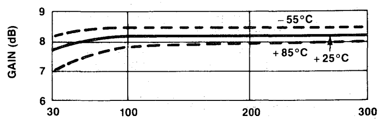


Dimensions in ( ) are in mm.

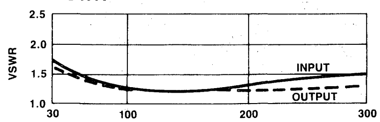
See Appendix for complete physical dimensions.

Typical Performance

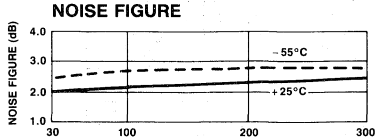
GAIN



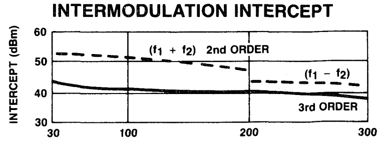
VSWR



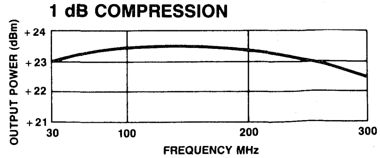
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



FREQUENCY MHz

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

General Purpose Amplifier, 19 dB Gain
5-300 MHz
AM-105

- 5.2 dB Typical Midband Noise Figure
- +17 dBm Typical Compression Level

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-300 MHz
Gain (+25°C) @ 50 MHz	19 ±0.5 dB
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	+1.0, −1.5 dB Max
Output Power (1 dB Compression)	+15 dBm Min
Noise Figure	
5-300 MHz	14 dB Max
10-100 MHz	9 dB Max
Reverse Transmission	−29 dB Max −30 dB Typ
VSWR	
Input (5-300 MHz)	1.5:1 Max
Input (10-100 MHz)	1.5:1 Max
Output (5-300 MHz)	2.5:1 Max
Output (10-100 MHz)	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power to +5 dBm)	
Second Order (5-300 MHz)	+28 dBm Min
Second Order (10-100 MHz)	+36 dBm Min
Third Order (5-300 MHz)	+23 dBm Min
Third Order (10-100 MHz)	+27 dBm Min
Bias Power	−20 VDC @ 130 mA Max (105 mA, 2.1W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+19 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at −20 VDC, with 50 ohm source and impedance.

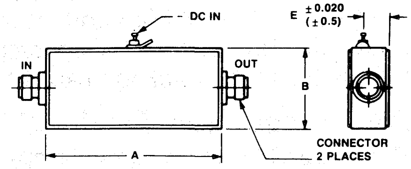
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2.6 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.		Package
AM-105	BNC	Connectorized
AM-105	SMA	Connectorized

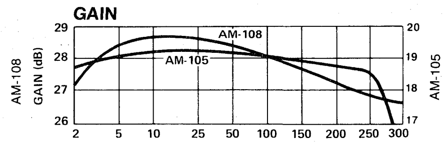
C-16

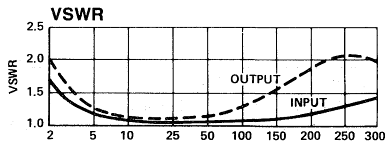


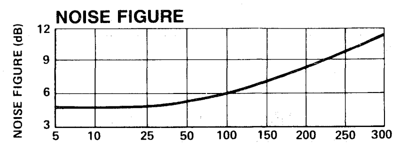
Dimensions in ( ) are in mm.

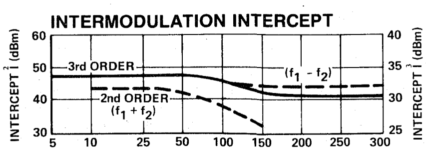
See Appendix for complete physical dimensions.

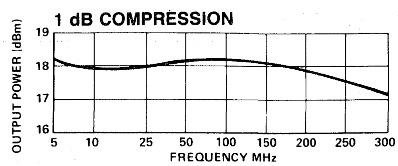
Typical Performance











Specifications Subject to Change Without Notice.

Low Noise Amplifier, 8.5 dB Gain
10-400 MHz

AM-/AMC-/AMS-181

- 1.5 dB Typical Midband Noise Figure
- +31 dBm Typical Midband Intercept
- Ideal for Broadband IF Applications
- Fully Hermetic Package (AMS-181)

Guaranteed Specifications*

(From –55°C to +85°C Case Temp)

Frequency Range	10 - 400 MHz
Gain (+25°C) @ 60 MHz	8.5 ±0.5 dB
Frequency Response	+1.0, –0.5 dB Max
Gain Variation with Temperature	±0.5 dB Max
Output Power (1 dB Compression)	
10-400 MHz	+6 dBm Min
10-200 MHz	+9 dBm Min
Noise Figure	
10-400 MHz	2.5 dB Max
10-200 MHz	2.2 dB Max
Reverse Transmission	–9 dB Max –11 dB Typ
VSWR	
10-400 MHz	2.2:1 Max
10-300 MHz	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order (10-400 MHz)	+25 dBm Min
Second Order (10-200 MHz)	+35 dBm Min
Third Order (10-400 MHz)	+15 dBm Min
Third Order (10-200 MHz)	+23 dBm Min
Bias Power	+15 VDC @ 15 mA Max (11 mA, 165 mW Typ)

Operating Characteristics

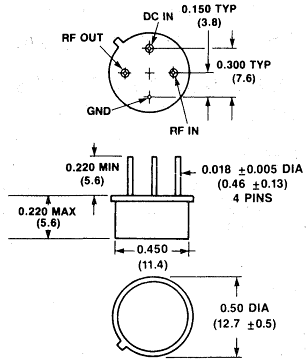
IF Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,891,934.
S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-181 PIN	Pin
AMC-181 SMA	Connectorized
AMS-181 PIN	Surface Mount

TO-8-1



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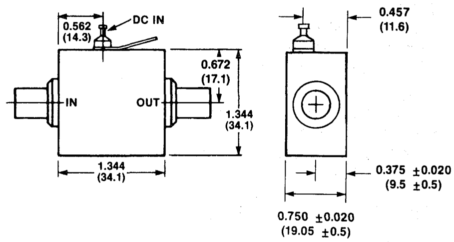
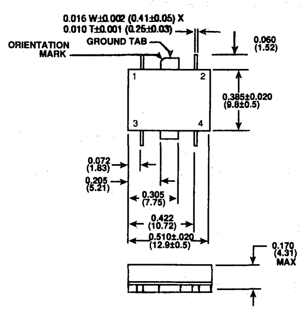


SF-1

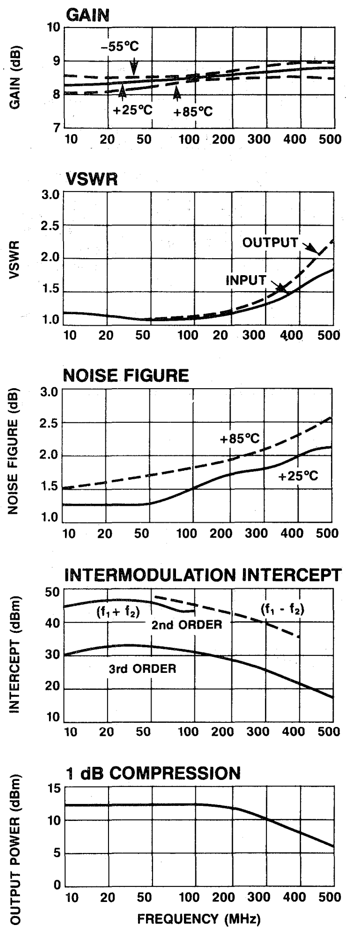


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

Typical Performance



Pin Configuration

AMS-181

Pin Number	Description
1	Output
2	DC Input
3	Input
4	Ground

Specifications Subject to Change Without Notice.

M/A-COM

High Performance Amplifier, 10 dB Gain
5-500 MHz AM-/AMC-123/AM-131

- 3.5 dB Typical Midband Noise Figure
- +42 dBm Typical Midband Intercept

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	10.0 ±0.6 dB
Frequency Response	±0.7 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	
5-500 MHz	+16 dBm Min
10-300 MHz	+19 dBm Min
Noise Figure	
5-500 MHz	7.5 dB Max
10-300 MHz	5.5 dB Max
Reverse Transmission	−15 dB Max −18 dB Typ
VSWR	
5-500 MHz	2.5:1 Max
10-400 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to 10 dBm)	
Second Order (5-500 MHz)	+33 dBm Min
Second Order (10-300 MHz)	+40 dBm Min
Third Order (5-500 MHz)	+22 dBm Min
Third Order (10-300 MHz)	+32 dBm Min
Bias Power	+15 VDC @ 75 mA Max (62 mA, 930 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+23 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	(AM-123 only) IN; P5, Out; P1 DC IN; P4/P8 All other pins are ground.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

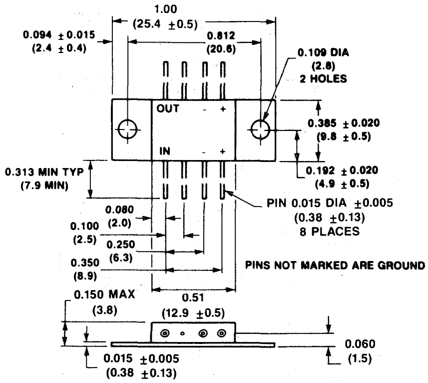
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.0 W must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

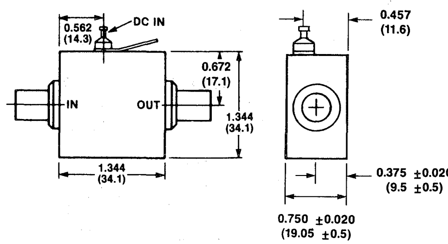
Model No.		Package
AM-123	PIN	Flatpack
AMC-123	SMA	Connectorized
AM-131	PIN	Pin

FP-7

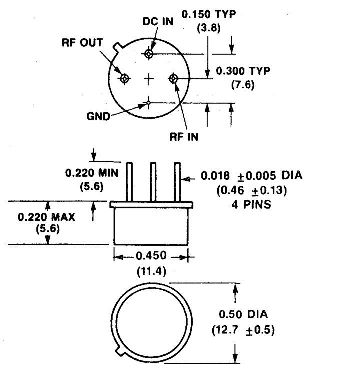


(NOTE: AM-123 POSITIVE VOLTAGE ONLY.)

C-6



TO-8-1

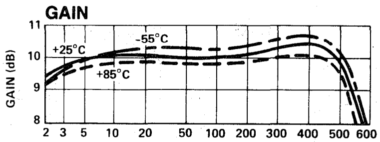


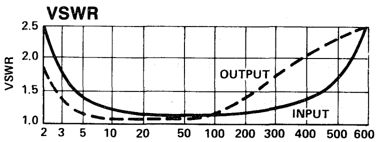
Dimensions in ( ) are in mm.

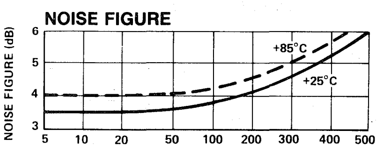
See Appendix for complete physical dimensions.

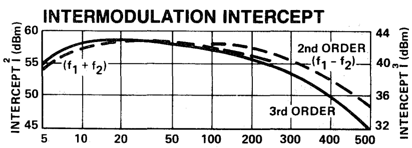
Specifications Subject to Change Without Notice.

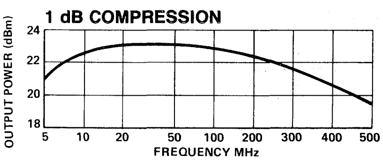
Typical Performance











Specifications Subject to Change Without Notice.

Low Noise Amplifier, 16 dB Gain 5-500 MHz

AM-/AMC-143

- 1.9 dB Typical Midband Noise Figure
- +7 dBm Typical Midband Output Power
- +20 dBm Typical Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	15.8 ±0.5 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±0.8 dB Max
Output Power (1 dB Compression)	+4 dBm Min
Noise Figure	
5-500 MHz	3.5 dB Max
5-100 MHz	2.7 dB Max
Reverse Transmission	−16 dB Max −21 dB Typ
VSWR	2.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+24 dBm Min
Third Order	+16 dBm Min
Bias Power	+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm Max

Environmental
See Appendix for MIL-STD-883 screening option.

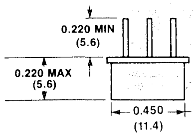
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

S-Parameters: For typical S-Parameter data, see appendix.

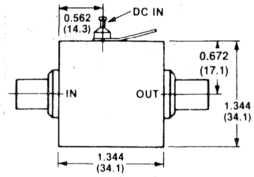
Ordering Information

Model No.		Package
AM-143	PIN	TO-8-1
AMC-143	SMA	Connectorized

TO-8-1



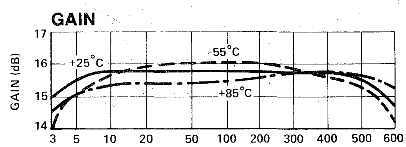
C-6

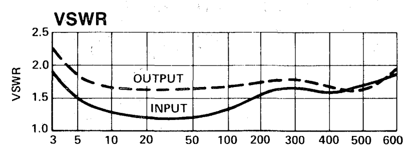


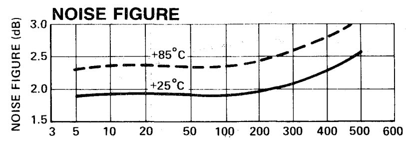
Dimensions in ( ) are in mm.

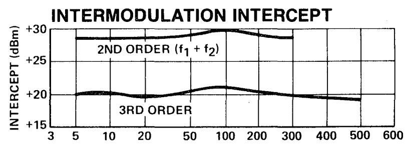
See Appendix for complete physical dimensions.

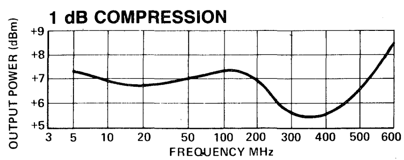
Typical Performance











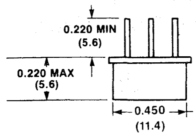
Specifications Subject to Change Without Notice.

High Performance Amplifier, 17 dB Gain
5-500 MHz

AM-/AMC-147

- 2 dB Typical Midband Noise Figure
- +20 dBm Typical Midband Output Power
- +38 dBm Typical Midband Third Order Intercept

TO-8-1



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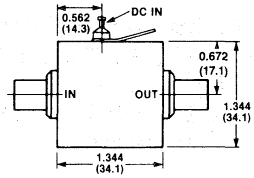


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5 - 500 MHz
Gain (+25°C) @ 50 MHz	17 ±0.6 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	-1.2, +.5dB
Output Power (1 dB Compression)	+19 dBm Min
Noise Figure	
5-500 MHz	4.5 dB Max
5-300 MHz	3.5 dB Max
Reverse Transmission	−16 dB Max −20 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+38 dBm Min
Third Order	+28 dBm Min
Bias Power	+15 VDC @ 60 mA Max (50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

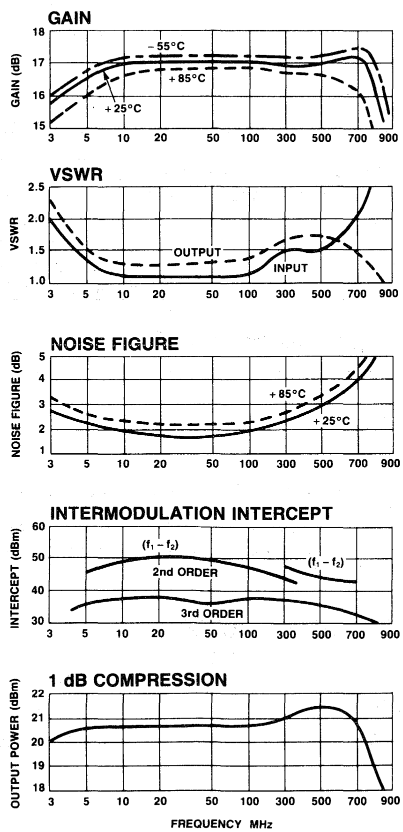
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.75 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.		Package
AM-147	PIN	TO-8-1
AMC-147	SMA	Connectorized

Typical Performance



Specifications Subject to Change Without Notice.

M/A-COM

Cascadable Thin Film Amplifier, 12 dB Gain
5-500 MHz
AM-/AMC-151

- 5 dB Typical Midband Noise Figure
- +38 dBm Typical Midband Third Order Intercept
- +21 dBm Typical Midband 1 dB Compression

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	12 ±0.5 dB
Frequency Response	±1 dB
Gain Variation with Temperature	±0.8 dB
Output Power (1 dB Compression)	
5-500 MHz	+19 dBm Min
10-500 MHz	+20 dBm Min
Noise Figure	
5-500 MHz	7 dB Max
Reverse Transmission	−13 dB Max −16 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+48 dBm Min
Third Order	+34 dBm Min
Bias Power	+15 VDC @ 100 mA Max (85 mA, 1275 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm

Environmental

See Appendix for MIL-STD-883 screening option.

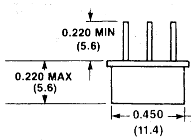
*All specifications apply when operated at +15 VDC, with 50 ohm source and impedance.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.3 W. Must be provided in use.

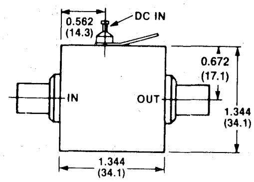
Ordering Information

Model No.		Package
AM-151	PIN	TO-8-1
AMC-151	SMA	Connectorized

TO-8-1



C-6

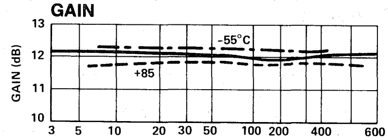


Dimensions in ( ) are in mm.

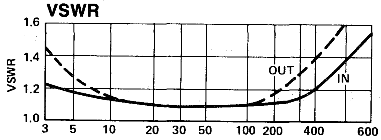
See Appendix for complete physical dimensions.

Typical Performance

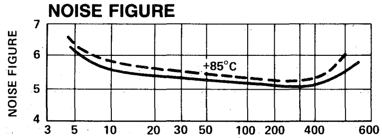
GAIN



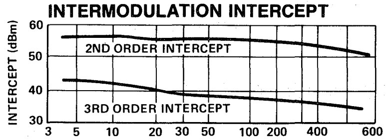
VSWR



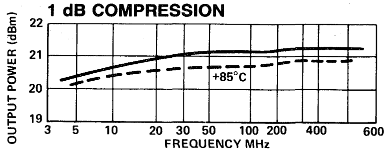
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

Cascadable Thin Film Amplifier, 15 dB Gain
5-500 MHz AM-149

- 5 dB Midband Noise Figure
- +16 dBm Midband Output Power
- +30 dBm Typical Third Order Intercept

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+25°C) @ 50 MHz	15.25 ±0.5 dB
Frequency Response	±1 dB
Gain Variation with Temperature	±0.8 dB
Output Power (1 dB Compression)	+14.5 dBm Min
Noise Figure	
5-500 MHz	6.5 dB Max
Reverse Transmission	−15 dB Max −19 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+35 dBm Min
Third Order	+28 dBm Min
Bias Power	+15 VDC @ 49 mA Max (47 mA, 700 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

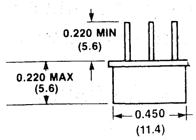
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.7 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-149 PIN	TO-8-1

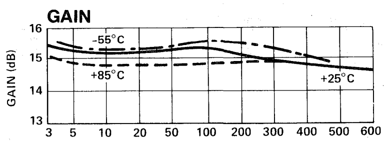
TO-8-1

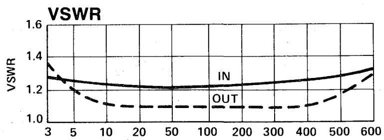


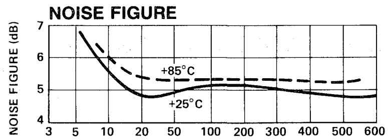
Dimensions in ( ) are in mm.

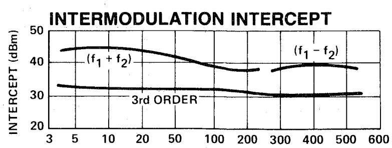
See Appendix for complete physical dimensions.

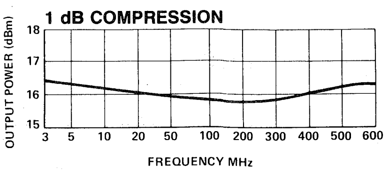
Typical Performance











Specifications Subject to Change Without Notice.

High Performance Amplifier, 21 dB Gain
10-500 MHz

AM-/AMC-146

- 4 dB Typical Midband Noise Figure
- +38 dBm Typical Midband Third Order Intercept
- +24 dBm Typical Midband 1 dB Compression

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-500 MHz
Gain (+25°C) @ 50 MHz	21 ±0.7 dB
Frequency Response	±1 dB
Gain Variation with Temperature	+0.8, −1.2 dB
Output Power (1 dB Compression)	+20.0 dBm Min
Noise Figure	
10-500 MHz	7 dB Max
10-300 MHz	5.5 dB Max
Reverse Transmission	−30 dB Max −35 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)	
Second Order	+40 dBm Min
Third Order	+30 dBm Min
Bias Power	+15 VDC @ 140 mA Max (130 mA, 2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

*All specifications apply when operated at +15 VDC with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

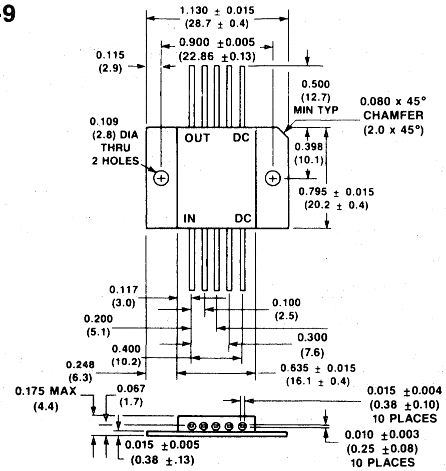
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

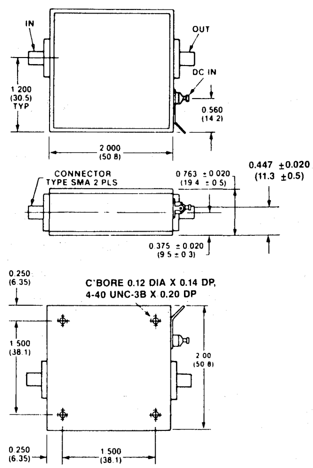
Ordering Information

Model No.		Package
AM-146	PIN	Flatpack
AMC-146	SMA	Connectorized

FP-9



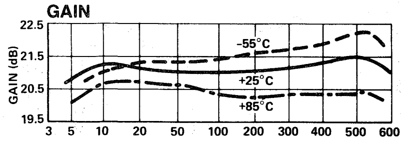
C-25

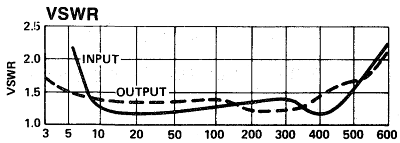


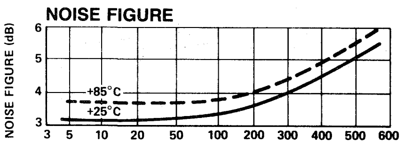
Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010
.xx = ± 0.02

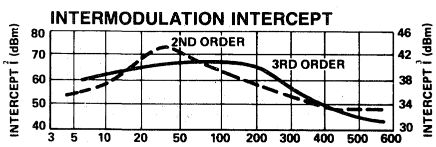
Specifications Subject to Change Without Notice.

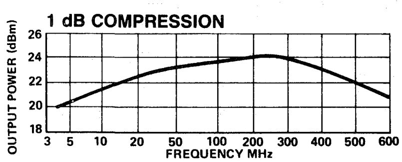
Typical Performance











M/A-COM

Low Noise Amplifier, 10 dB Gain
5-500 MHz

AM-/AMC-103

- 2.7 dB Typical Midband Noise Figure
- + 11 dBm Typical Compression Level
- Lower Dissipation Version of AM-101

Guaranteed Specifications*

(From − 55°C to + 85°C Case Temp)

Frequency Range	5-500 MHz
Gain (+ 25°C) @ 100 MHz	10.0 ± 0.5 dB
Frequency Response	± 0.75 dB Max
Gain Variation with Temperature	± 1.0 dB Max
Output Power (1 dB Compression)	+ 8 dBm Min
Noise Figure	
5-500 MHz	5.0 dB Max
5-200 MHz	3.5 dB Max
Reverse Transmission	− 15 dB Max − 18 dB Typ
VSWR	2.1:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order (5-500 MHz)	+ 20 dBm Min
Second Order (5-200 MHz)	+ 30 dBm Min
Third Order (5-500 MHz)	+ 15 dBm Min
Third Order (5-200 MHz)	+ 21 dBm Min
Bias Power	+ 15 VDC @ 25 mA Max (20 mA, 300 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+ 22 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	Output; P1, Input; P5, +DC IN; P4 & P8, −DC IN; P3 & P7, GND; P2 & P6

*All specifications apply when operated at + 15 VDC with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

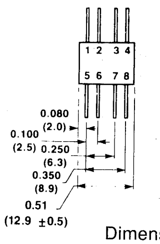
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.32 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

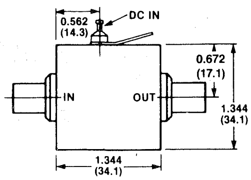
Ordering Information

Model No.	Package
AM-103 PIN	Flatpack
AMC-103 SMA	Connectorized

FP-2



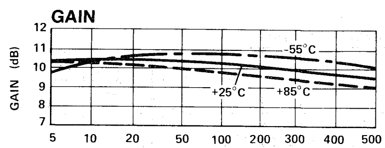
C-32

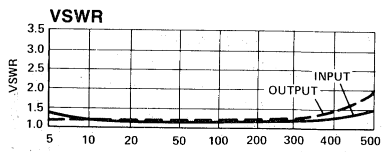


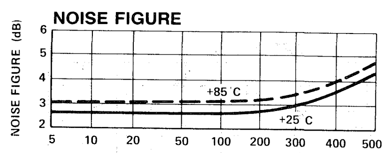
Dimensions in ( ) are in mm.

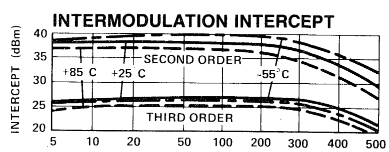
See Appendix for complete physical dimensions.

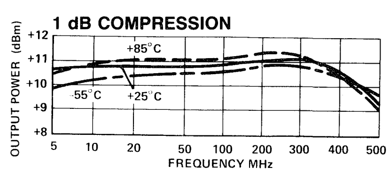
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

High Performance Isolation Amplifier, 12.5 dB Gain 20-500 MHz

AM-/AMC-157

- 35 dB Typical Reverse Isolation
- +42 dBm Typical Third Order Intercept
- +24 dBm Typical 1 dB Compression
- 1.2:1 Typical VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	20-500 MHz
Gain (+25°C) @ 50 MHz	12.5 ±0.8 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±1.0 dB Max
Output Power (1 dB Compression)	+21 dBm Min
Noise Figure	7.5 dB Max
Reverse Transmission	−22 dB Max −30 dB Typ
VSWR	
20-30 MHz	2.0:1 Max
30-500 MHz	1.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+40 dBm Min
Third Order	+30 dBm Min
Bias Power	+15 VDC @ 90 mA Max (80 mA, 1.2W Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,426,298.

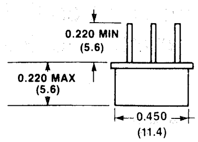
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 1.2 W must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.		**Package**
AM-157	PIN	TO-8-1
AMC-157	SMA	Connectorized

TO-8-1



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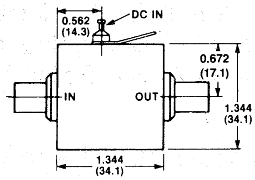
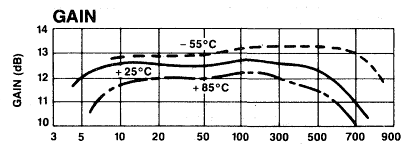
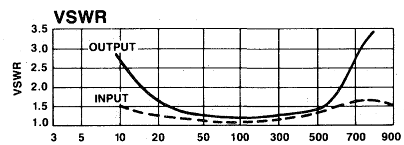


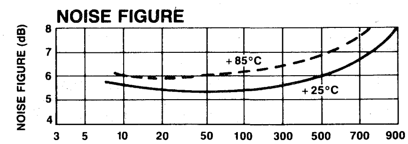
Dimensions in ( ) are in mm.

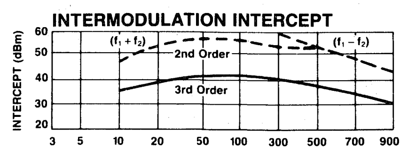
See Appendix for complete physical dimensions.

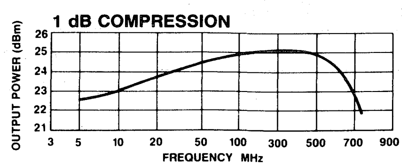
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM

Low Noise Amplifier 100-600 MHz

AM-191

- 2.5 dB Typical Midband Noise Figure
- +23 dBm Typical 1 dB Compression Point
- +32 dBm Typical 3rd Order Intercept Point

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		100-600 MHz
Gain (+25°C) @ 250 MHz		23.5 ±0.5 dB
Frequency Response		±1.0 dB Max
Gain Variation with Temperature		±1.0 dB Max
Output Power (1 dB Compression)		+20 dBm Min
Noise Figure		4.5 dB Max
Reverse Transmission		−28 dB Max −30 dB Typ
VSWR	100-600 MHz 200-500 MHz	2.5:1 Max 2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +10 dBm)		
Second Order		+38 dBm Min
Third Order		+28 dBm Min
Bias Power		+15 VDC @ 95 mA Max (77 mA, 1155 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	(AM-191) IN, P6; OUT, P1; VDC, P5

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,891,934 and 3,624,536.

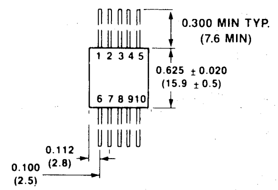
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.25 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-191 PIN	Flatpack

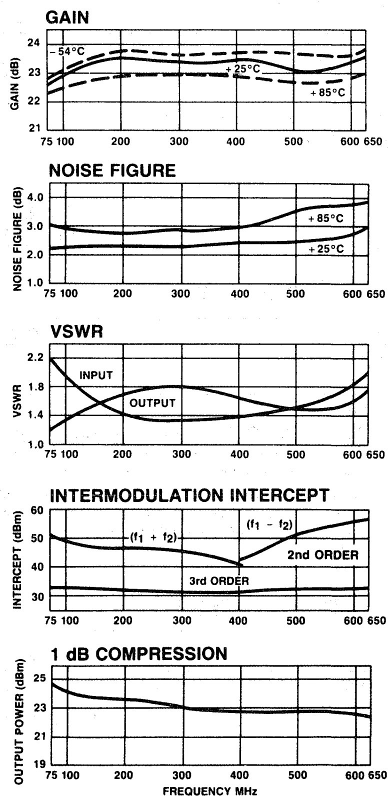
FP-3



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Specifications Subject to Change Without Notice.

Low Noise Amplifier, 28 dB Gain
100-600 MHz

AM-160

- 1.6 Typical Midband Noise Figure
- +19 dBm Typical 1 dB Compression Point
- +30 dBm Typical Third Order Intercept Point

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	100-600 MHz
Gain (+25°C) @ 250 MHz	28.2 ±1 dB
Frequency Response	±1.25 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	+16 dBm Min
Noise Figure	3.0 dB Max
Reverse Transmission	−32 dB Max −38 dB Typ
VSWR	
100-600 MHz	2.5:1 Max
100-400 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+36 dBm Min
Third Order	+27 dBm Min
Bias Power	+15 VDC @ 75 mA Max (70 mA, 1050 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	

See Appendix for MIL-STD-883 screening option.

Pin Configuration	IN, P6; OUT, P1; VDC, P5, P10

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

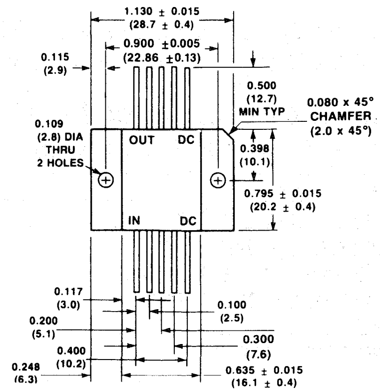
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.2 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-160 PIN	Flatpack

FP-9

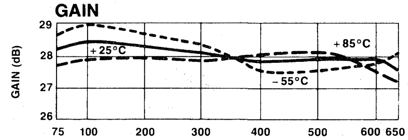


Dimensions in ( ) are in mm.

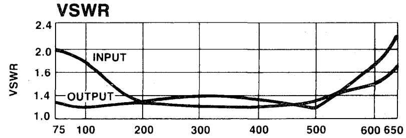
See Appendix for complete physical dimensions.

Typical Performance

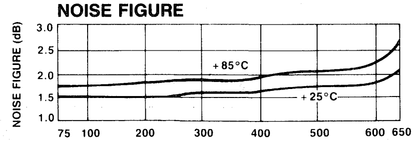
GAIN



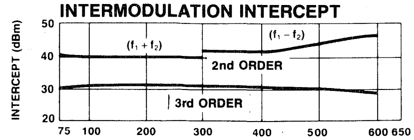
VSWR



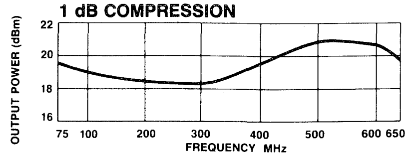
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

Cascadable Thin Film Amplifier, 15 dB Gain
5-1000 MHz AM-/AMC-175

- 3.0 dB Typical Midband Noise Figure
- +8.5 dB Typical 1 dB Compression

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @ 500 MHz	15.4 ±0.7 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	±1.0 dB
Output Power (1 dB Compression)	+7.0 dBm Min
Noise Figure	4.2 dB Max
Reverse Transmission	−17 dB Max −20 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)	
Second Order	+28 dBm Min
Third Order	+19 dBm Min
Bias Power	+15 VDC @ 29 mA Max (25 mA, 375 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	

See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

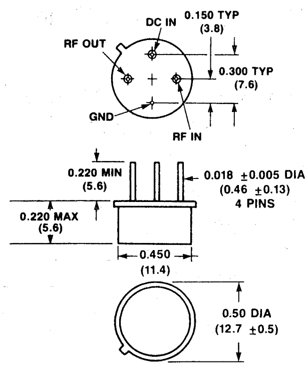
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 0.375 W must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

Model No.	Package
AM-175 PIN	Pin
AMC-175 SMA	Connectorized

TO-8-1



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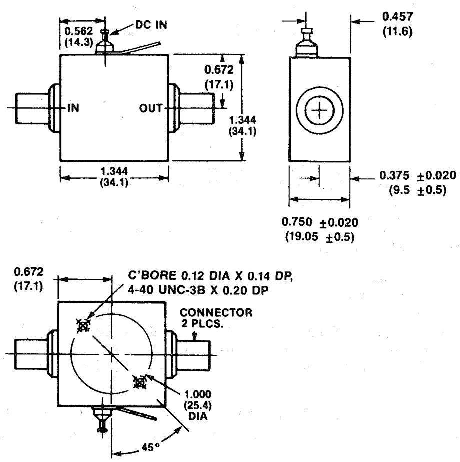
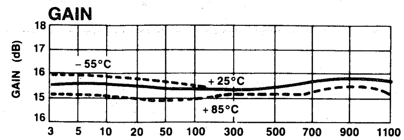


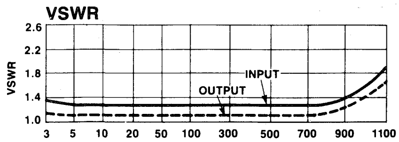
Dimensions in ( ) are in mm.

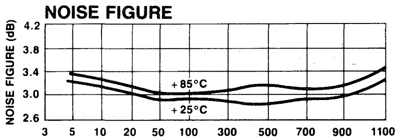
See Appendix for complete physical dimensions.

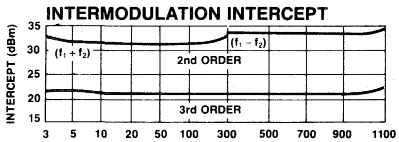
Specifications Subject to Change Without Notice.

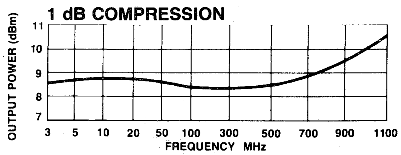
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM

Cascadable Thin Film Amplifier, 13 dB Gain 5-1000 MHz

AM-/AMC-176

- 4.0 dB Typical Noise Figure
- 13.5 dBm Typical Midband 1 dB Compression
- 1.25:1 Typical VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @ 500 MHz	13.2 ±1 dB
Frequency Response	±1 dB Max
Gain Variation with Temperature	±1 dB Max
Output Power (1 dB Compression)	
5-1000 MHz	+12 dBm Min
Noise Figure	
5-1000 MHz	5.0 dB Max
Reverse Transmission	−14 dB Max −17 dB Typ
VSWR	1.8:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+37 dBm Min
Third Order	+25 dBm Min
Bias Power	+15 VDC @ 43 mA Max (38 mA, 570 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm

Environmental

See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

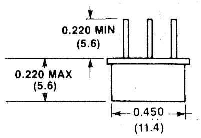
Heat Sinking: Operation at case temperatures above 95°C is not recommended. Heat sinking adequate to dissipate 0.575 W must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

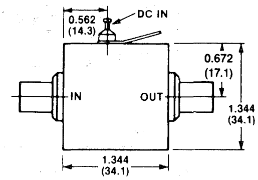
Ordering Information

Model No.		Package
AM-176	PIN	TO-8-1
AMC-176	SMA	Connectorized

TO-8-1



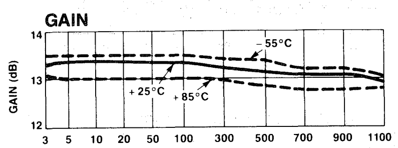
C-6

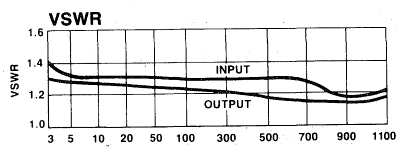


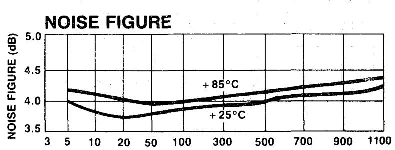
Dimensions in ( ) are in mm.

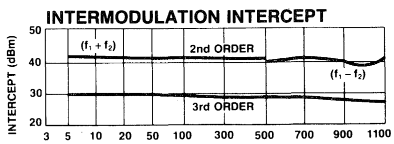
See Appendix for complete physical dimensions.

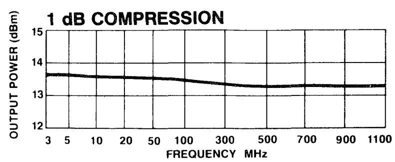
Typical Performance











Specifications Subject to Change Without Notice.

Cascadable Thin Film Amplifier, 28 dB Gain
5-1000 MHz

AM-/AMC-182

- High Gain — 28.5 dB Typical
- Low Noise — 2.7 dB Typical

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	5-1000 MHz
Gain (+25°C) @300 MHz	28.2±1.0 dB
Frequency Response	±1.2 dB Max
Gain Variation with Temperature	±1.2 dB Max
Output Power (1 dB Compression)	+9 dBm Min
Noise Figure	4.5 dB Max
Reverse Transmission	−32 dB Max −36 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+28 dBm Min
Third Order	+18 dBm Min
Bias Power	+15 VDC @50 mA Max (44 mA, 660 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm
Environmental	

See Appendix for MIL-STD-883 screening option.

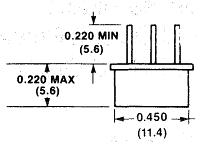
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by U.S. Patent Number 3,891,934.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.8 W. Must be provided in use.

Ordering Information

Model No.		Package
AM-182	PIN	TO-8-1
AMC-182	SMA	Connectorized

TO-8-1



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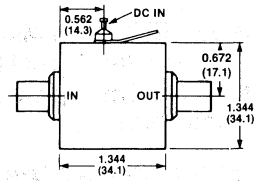
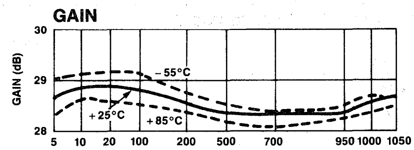
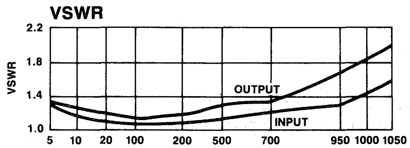


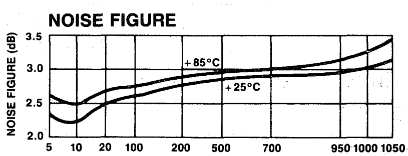
Dimensions in ( ) are in mm.

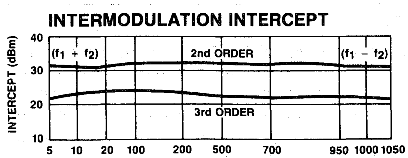
See Appendix for complete physical dimensions.

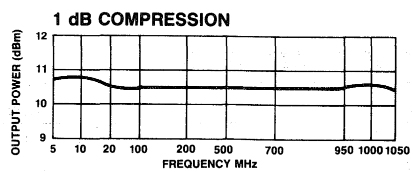
Typical Performance











Specifications Subject to Change Without Notice.

High Performance Amplifier, 11 dB Gain
10-1000 MHz
AM-/AMC-145

- 2.5 dB Typical Midband Noise Figure
- +19 dBm Typical Midband Output Power
- +37 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range	10-1000 MHz
Gain (+25°C) @ 300 MHz	10.7 ±0.6 dB
Frequency Response	±1.0 dB
Gain Variation with Temperature	+1.0, −0.8 dB
Output Power (1 dB Compression)	
10-1000 MHz	+14 dBm Min
100-1000 MHz	+17 dBm Min
Noise Figure	
10-1000 MHz	5.5 dB Max
10-500 MHz	4.0 dB Max
Reverse Transmission	−11 dB Max −13.5 dB Typ
VSWR	
10-1000 MHz	3:1 Max
10-500 MHz	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)	
Second Order	+38 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @ 60 mA Max (50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	

See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

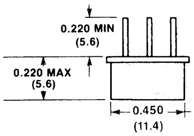
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.8 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

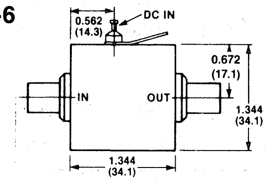
Ordering Information

Model No.		Package
AM-145	PIN	TO-8-1
AMC-145	SMA	Connectorized

TO-8-1



C-6

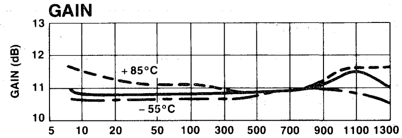


Dimensions in ( ) are in mm.

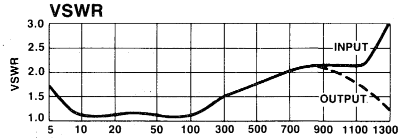
See Appendix for complete physical dimensions.

Typical Performance

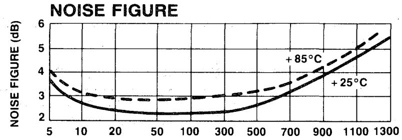
GAIN



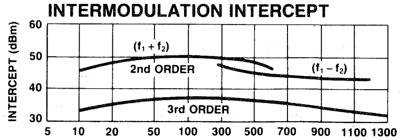
VSWR



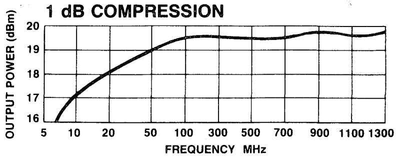
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

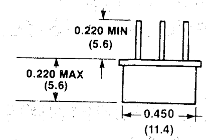
M/A-COM

Cascadable Thin Film Amplifier, 12 dB Gain 10-1000 MHz

AM-177

- High 1dB Compression — +22 dBm Typical
- High 3rd Order Intercept — +38 dBm Typical
- 1.2:1 Typical VSWR

TO-8-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1000 MHz
Gain (+25°C) @500 MHz	12.0 ±0.5 dB
Frequency Response	±0.5 dB Max
Gain Variation with Temperature	±0.8 dB Max
Output Power (1 dB Compression)	+20 dBm Min
Noise Figure	8.5 dB Max
Reverse Transmission	−14 dB Max −16 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+42 dBm Min
Third Order	+30 dBm Min
Bias Power	+15 VDC @115 mA Max (105 mA, 1575 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Environmental	

See Appendix for MIL-STD-883 screening option.

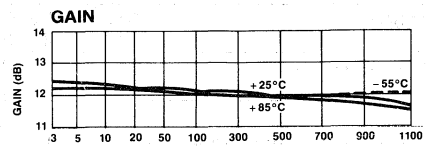
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by U.S. Patent Number 3,891,934.

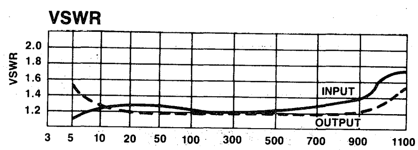
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.75 W. Must be provided in use.

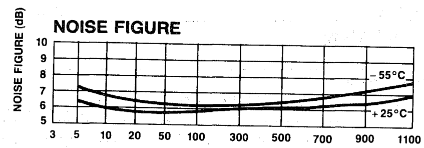
Ordering Information

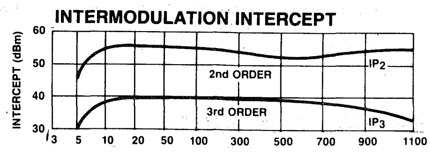
Model No.	Package
AM-177 PIN	TO-8-1

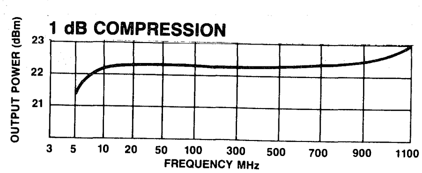
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Cascadable Thin Film Amplifier, 28.5 dB Gain 10-1000 MHz

AM-/AMC-183

- High Gain — 28 dB Typical
- High Compression — +15 dBm Typical

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1000 MHz
Gain (+25°C) @700 MHz	28.5 ±1.0 dB
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±1.2 dB Max
Output Power (1 dB Compression)	+13 dBm Min
Noise Figure	10-500 MHz 4.5 dB Max 10-1000 MHz 5.0 dB Max
Reverse Transmission	−32 dB Max −35 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+30 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @80 mA Max (72 mA, 1.1W Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance. This product contains elements protected by U.S. Patent Number 3,891,934.

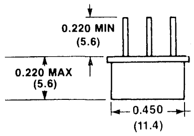
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.25 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

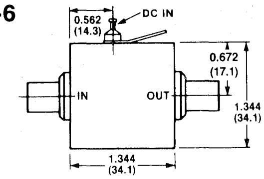
Ordering Information

Model No.		Package
AM-183	PIN	TO-8-1
AMC-183	SMA	Connectorized

TO-8-1



C-6

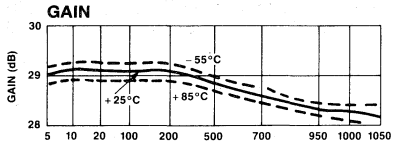


Dimensions in ( ) are in mm.

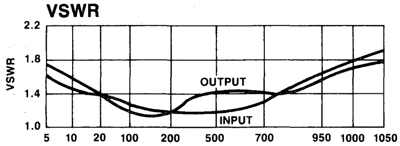
See Appendix for complete physical dimensions.

Typical Performance

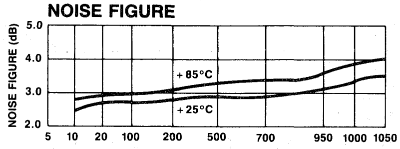
GAIN



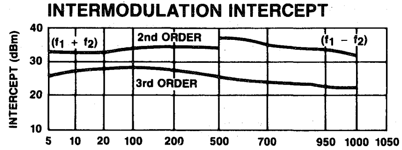
VSWR



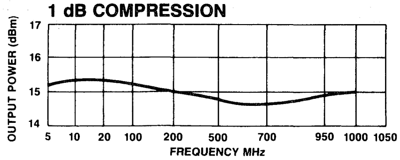
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

Low Noise Amplifier, 9.5 dB Gain

20-1000 MHz

AM-/AMC-154

- 2 dB Typical Midband Noise Figure
- +8 dBm Typical Midband Output Power
- +20 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		20-1000 MHz
Gain (+25°C) @ 300 MHz		9.5 ±1.0 dB
Frequency Response		±1.0 dB Max
Gain Variation with Temperature		+0.5, −1 dB Max
Output Power (1 dB Compression)		+4 dB Min
Noise Figure		
20-500 MHz		3.0 dB Max
500-1000 MHz		3.8 dB Max
Reverse Transmission		−10 dB Max −14 dB Typ
VSWR	Input	Output
20-500 MHz	2:1	2.5:1 Max
500-1000 MHz	2.5:1	3.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)		
Second Order		+22 dBm Min
Third Order		+18 dBm Min
Bias Power		+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

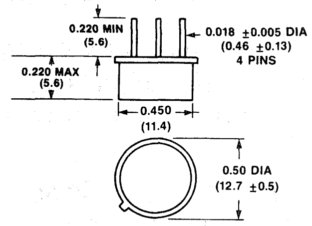
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,624,536.

Ordering Information

Model No.	Package
AM-154 PIN	Pin
AMC-154 SMA	Connectorized

TO-8-1



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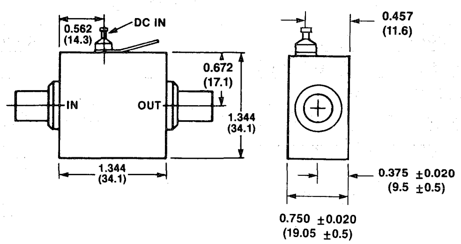
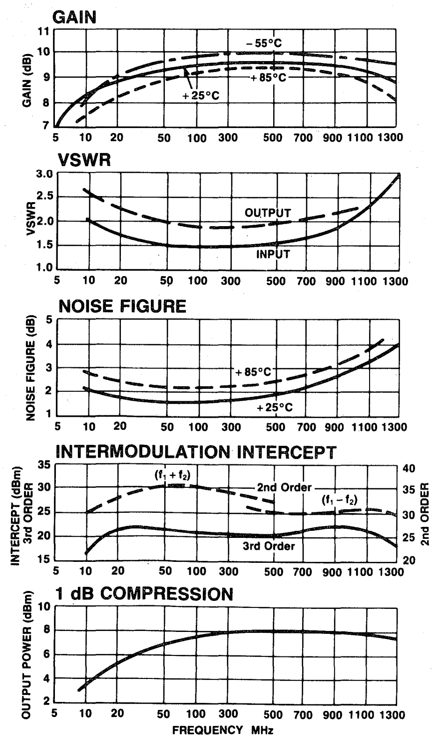


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Specifications Subject to Change Without Notice.

Low Noise Amplifier, 12 dB Gain
200-1000 MHz

AM-/AMC-142

- 2.2 dB Typical Midband Noise Figure
- +6 dBm Typical Midband Output Power
- +20 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	200-1000 MHz
Gain (+25°C) @ 600 MHz	12 ±0.6 dB
Frequency Response	+0.5, −0.8 dB Max
Gain Variation with Temperature	+0.8, −0.6 dB Max
Output Power (1 dB Compression)	+2 dBm Min
Noise Figure	3.8 dB Max
Reverse Transmission	−13 dB Max −15 dB Typ
VSWR	3.5:1 Max
Intermodulation Intercept Point (for two-tone output power up to −10 dBm)	
Second Order	+25 dBm Min
Third Order	+15 dBm Min
Bias Power	+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+20 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

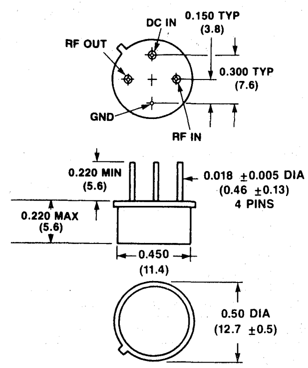
This product contains elements protected by United States Patent Number 3,624,536.

S-Parameters: For typical S-Parameter data, see page 97.

Ordering Information

Model No.	Package
AM-142 PIN	Pin
AMC-142 SMA	Connectorized

TO-8-1



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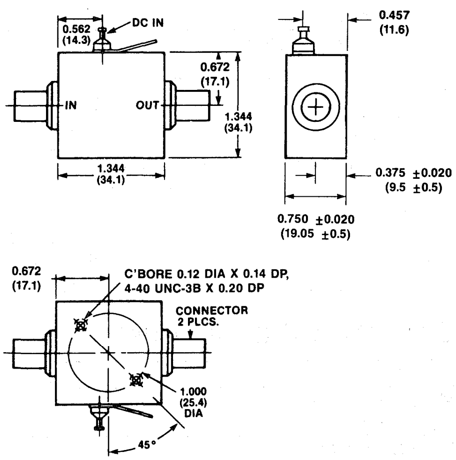
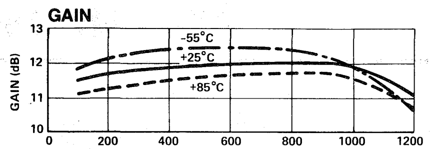


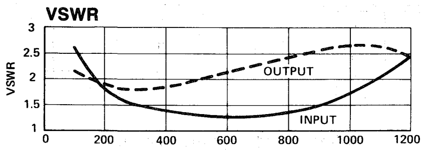
Dimensions in ( ) are in mm.

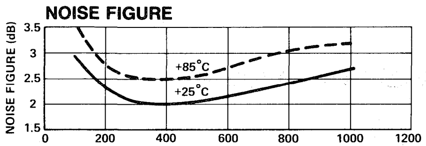
See Appendix for complete physical dimensions.

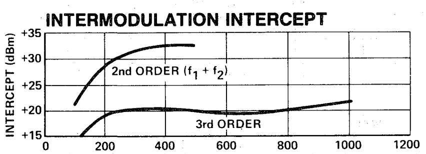
Specifications Subject to Change Without Notice.

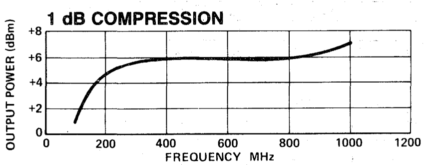
Typical Performance











Specifications Subject to Change Without Notice.

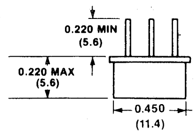
M/A-COM

High Dynamic Range Amplifier, 12.5 dB Gain 300-1000 MHz

AM-/AMC-155

- 2.5 dB Typical Midband Noise Figure
- +21 dBm Typical Midband Output Power
- +37 dBm Typical Midband Third Order Intercept

TO-8-1



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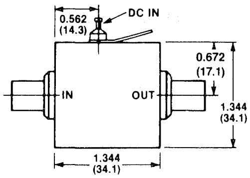


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range		300-1000 MHz
Gain (+25°C) @ 600 MHz		12.25 ±1.0 dB
Frequency Response		±0.5 dB Max
Gain Variation with Temperature		±0.7 dB Max
Output Power (1 dB Compression)		+18 dBm Min
Noise Figure		
300-700 MHz		4.0 dB Max
300-1000 MHz		5.5 dB Max
Reverse Transmission		−10 dB Max −14 dB Typ
VSWR	Input 2.0:1	Output 3.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to +5 dBm)		
Second Order		+40 dBm Min
Third Order		+27 dBm Min
Bias Power		+15 VDC @ 60 mA Max (50 mA, 750 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	

See Appendix for MIL-STD-883 screening option.

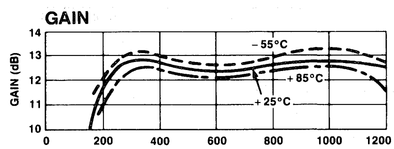
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

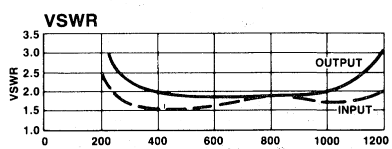
This product contains elements protected by United States Patent Number 3,624,536.

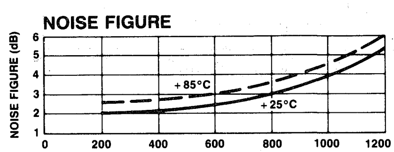
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.90 W. Must be provided in use.

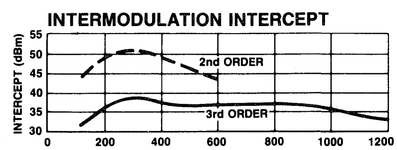
S-Parameters: For typical S-Parameter data, see appendix.

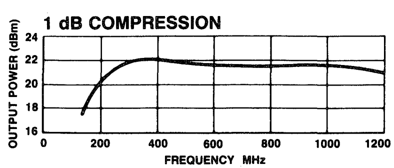
Typical Performance











Ordering Information

Model No.	Package
AM-155 PIN	TO-8-1
AMC-155 SMA	Connectorized

Specifications Subject to Change Without Notice.

High Reverse Isolation Amplifier, 13 dB Gain
10-1200 MHz

AM-188

- 26 dB Typical Reverse Isolation
- +18 dBm Typical 1 dB Compression
- 1.2:1 Typical VSWR

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-1200 MHz
Gain (+25°C) @500 MHz	12.8 ±0.5 dB
Frequency Response	±1.0 dB Max
Gain Variation with Temperature	+0.5, −1.0 dB Max
Output Power (1 dB Compression)	+16.0 dBm Min
Noise Figure	8.0 dB Max
Reverse Transmission	−24 dB Max −26 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+40 dBm Min
Third Order	+26 dBm Min
Bias Power	+15 VDC @150 mA Max (130 mA, 1950 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	
See Appendix for MIL-STD-883 screening option.	

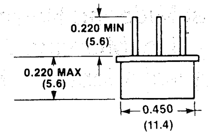
*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by U.S. Patent Number 3,891,934.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 2 W. Must be provided in use.

Ordering Information

Model No.	Package
AM-188 PIN	TO-8-1

TO-8-1

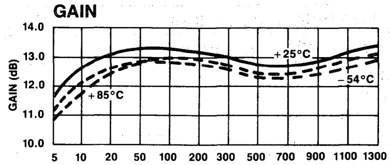


Dimensions in ( ) are in mm.

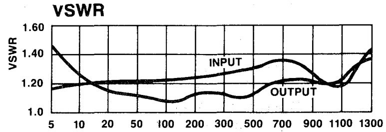
See Appendix for complete physical dimensions.

Typical Performance

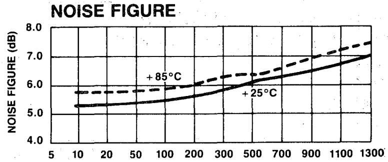
GAIN



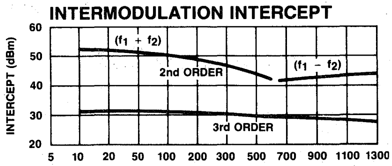
VSWR



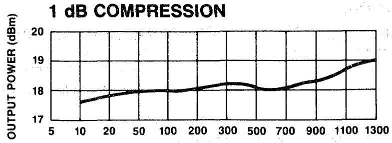
NOISE FIGURE



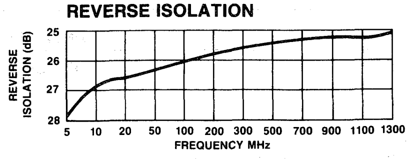
INTERMODULATION INTERCEPT



1 dB COMPRESSION



REVERSE ISOLATION



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Low Noise Amplifier, 12 dB Gain
300-1800 MHz

AM-153

- 1.9 dB Typical Midband Noise Figure
- +7.5 dBm Typical Midband Output Power
- +19 dBm Typical Midband Third Order Intercept

Guaranteed Specifications*
(From −55°C to +85°C Case Temp)

Frequency Range		300 - 1800 MHz
Gain (+25°C) @ 600 MHz		12.4 ±0.5 dB
Frequency Response		±1.2 dB Max
Gain Variation with Temperature		+0.5, −0.7 dB Max
Output Power (1 dB Compression)		+6 dB Min
Noise Figure		
300-1500 MHz		3.0 dB
1500-1800 MHz		3.5 dB
Reverse Transmission		−12 dB Max −14 dB Typ
VSWR		
Output	300-400 MHz	3.5:1
	400-1500 MHz	3.0:1
	1500-1800 MHz	2.5:1
Input	300-1500 MHz	2.5:1
	1500-1800 MHz	3.3:1
Intermodulation Intercept Point (for two-tone output power up to −5 dBm)		
Second Order		+22 dBm Min
Third Order		
300-1000 MHz		+17 dBm Min
1000-1800 MHz		+15 dBm Min
Bias Power		+15 VDC @ 15 mA Max (13 mA, 200 mW Typical)

Operating Characteristics

Impedance	50 ohms Nominal
Maximum Rating	
RF Input	+10 dBm
Environmental	

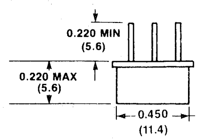
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,624,536.

Ordering Information

Model No.	Package
AM-153 PIN	TO-8-1

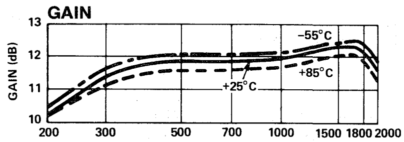
TO-8-1

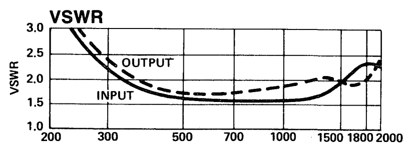


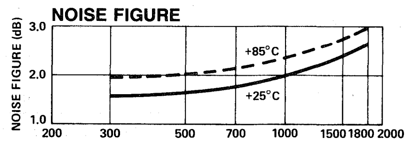
Dimensions in ( ) are in mm.

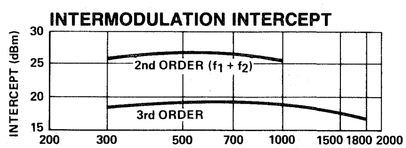
See Appendix for complete physical dimensions.

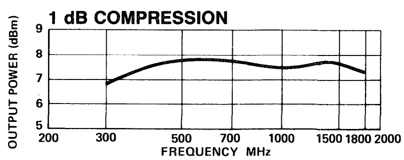
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Cascadable Thin Film Amplifier, 10 dB Gain
10-2000 MHz — AM-/AMC-180

- + 14 dBm Typical 1 dB Compression
- 5 dB Typical Noise Figure
- 1.4:1 Typical VSWR

Guaranteed Specifications*

(From − 55°C to + 85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @ 1000 MHz	9.7 ± 1 dB
Frequency Response	± 1 dB Max
Gain Variation with Temperature	± 1 dB Max
Output Power (1 dB Compression) 10-2000 MHz	+ 13 dB Min
Noise Figure 10-2000 MHz	7.0 dB Max
Reverse Transmission	− 12 dB Max − 14 dB Typ
VSWR	2:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+ 39 dBm Min
Third Order	+ 25 dBm Min
Bias Power	+ 15 VDC @ 50 mA Max (45 mA, 680 mW Typical)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating RF Input	+ 10 dBm
Environmental See Appendix for MIL-STD-883 screening option.	

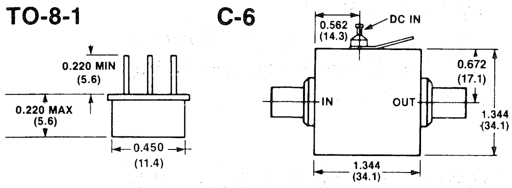
*All specifications apply when operated at + 15 VDC, with 50 ohm source and load impedance.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 0.75 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

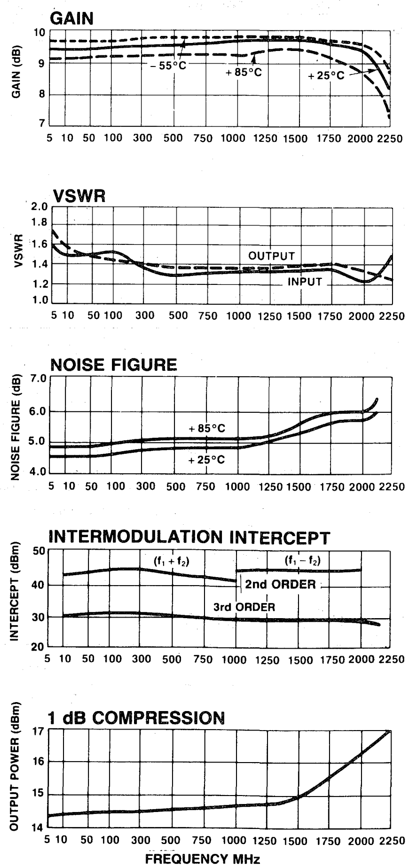
Model No.		Package
AM-180	PIN	TO-8-1
AMC-180	SMA	Connectorized



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



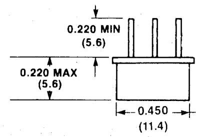
Specifications Subject to Change Without Notice.

Cascadable Thin Film Amplifier, 19 dB Gain 10-2000 MHz

AM-185

- High Gain, 19 dB
- High Power, +15 dBm Typical
- High 3rd Order Intercept Point, +28 dBm Typical

TO-8-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @1000 MHz	19 ±1.0 dB Max
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±2.0 dB Max
Output Power (1 dB Compression)	+13 dBm Min
Noise Figure	6.8 dB Max
Reverse Transmission	−26 dB Max −29 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+33 dBm Min
Third Order	+22 dBm Min
Bias Power	+15 VDC @ 90 mA Max (76 mA, 1.14 W Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1.5 W. Must be provided in use.

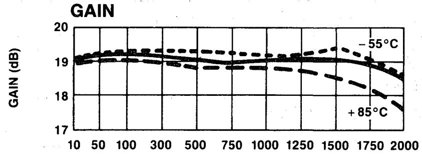
S-Parameters: For typical S-Parameter data, see appendix.

Ordering Information

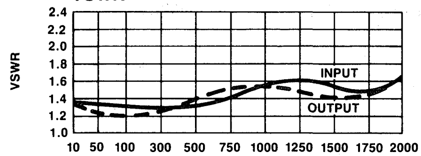
Model No.	Package
AM-185 PIN	TO-8-1

Typical Performance

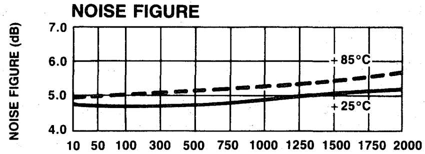
GAIN



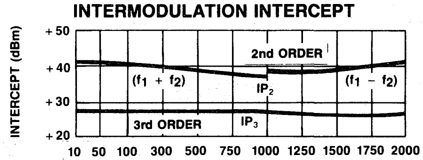
VSWR



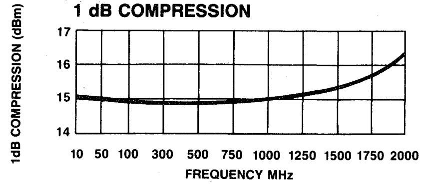
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

Cascadable Thin Film Amplifier, 20 dB Gain 10-2000 MHz

AM-/AMC-184

- High Gain, 20 dB
- Low Power, 60 mA Max

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	10-2000 MHz
Gain (+25°C) @1000 MHz	20 ±1.0 dB Max
Frequency Response	±1.5 dB Max
Gain Variation with Temperature	±1.5 dB Max
Output Power (1 dB Compression)	+10 dBm Min
Noise Figure	6.0 dB Max
Reverse Transmission	−27 dB Max −30 dB Typ
VSWR	2.0:1 Max
Intermodulation Intercept Point (for two-tone output power up to 0 dBm)	
Second Order	+30 dBm Min
Third Order	+20 dBm Min
Bias Power	+15 VDC @ 60 mA Max (52 mA, 780 mW Typ)

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating	
RF Input	+13 dBm Max
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply when operated at +15 VDC, with 50 ohm source and load impedance.

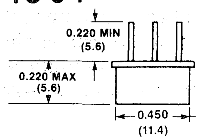
Heat Sinking: Operation at case temperature above 95°C is not recommended. Heat sinking adequate to dissipate 1 W. Must be provided in use.

S-Parameters: For typical S-Parameter data, see appendix.

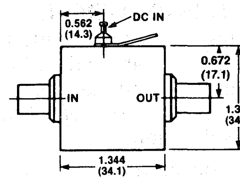
Ordering Information

Model No.		Package
AM-184	PIN	TO-8-1
AMC-184	SMA	Connectorized

TO-8-1



C-6

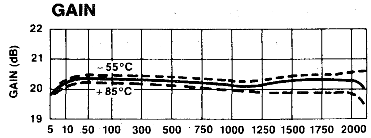


Dimensions in ( ) are in mm.

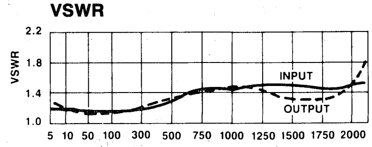
See Appendix for complete physical dimensions.

Typical Performance

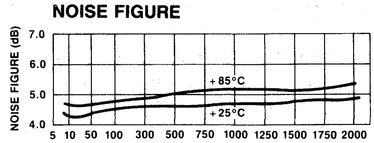
GAIN



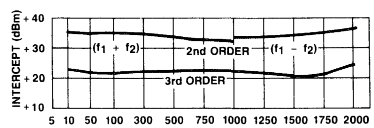
VSWR



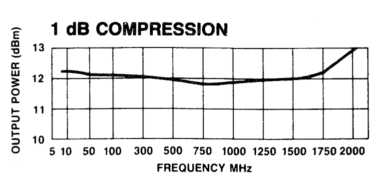
NOISE FIGURE



INTERMODULATION INTERCEPT



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

Logarithmic IF Amplifiers

M527

INTRODUCTION

This article is presented to give a basic understanding of logarithmic IF amplifiers. It describes the design technique utilized to produce these units, as well as the definitions of terms and design applications.

A logarithmic IF amplifier/detector, conventionally called a log amp, is a device that produces a video output that is proportional to the logarithm of the RF input amplitude. This can be represented by the equation:

$$\Delta E_O = K \log \frac{E_{IN\ 1}}{E_{IN\ 2}}$$

Where: E_O = video output voltage

K = constant which determines log slope

$\frac{E_{IN\ 1}}{E_{IN\ 2}}$ = ratio of RF input signals

$E_{IN\ 2}$ can be approximated by the equivalent amplifier input noise and the expression can be rewritten:

$$E_O = K \log \frac{E_{IN}}{E_{Noise}}$$

where E_O will be 0 when the input signal is equal to noise. This non-linear response enables the device to accept an extremely wide dynamic range of input signals (70 to 80 dB) without limiting or overloading. Because the log amp has no AGC, it can respond to a single pulse or a train of pulses of widely differing amplitudes on a pulse to pulse basis. It can also be used to measure CW signals, and a combination of pulses in the presence of CW or noise without overload problems.

TWO DISTINCT DESIGN APPROACHES

The log IF amplifiers offered in this catalog are based on two differerent approaches both using the successive detection techniques. The first approach provides a piecewise approximation of a logarithmic funciton of output vs. input. This is achieved by using a number of iterative cascaded stages, each consisting of an amplifier, detector, and limiter, as shown in Figure 1. Each stage will have a gain and a linear dynamic range of about 10 dB, and the output of each detector/limiter is fed to a video delay line called a sum line. The sum of all the detector/limiter outputs will be fed to an operational video amplifier.

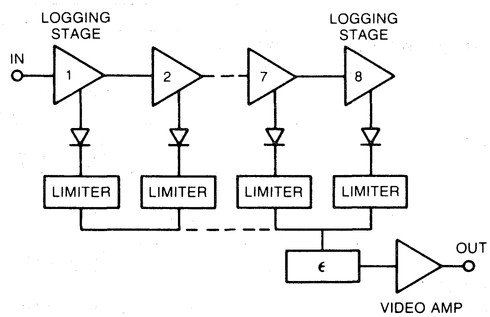


Figure 1. Functional Schematic

Since the output of each stage is linear, rather than logarithmic, there is a limit to the dynamic range of a single detector that can be utilized before deviating excessively from the desired logarithmic response. Figure 2 shows a linear input/output curve with an ideal log curve superimposed. Examination, of these curves shows the ideal linear logarithmic approximation deviates ±1 dB over a 12 dB range, therefore the gain and dynamic range of each stage must be held to less than this value to insure log accuracy, and a sufficient number of stages must be used to provide the required dynamic range (Figure 3).

Specifications Subject to Change Without Notice.

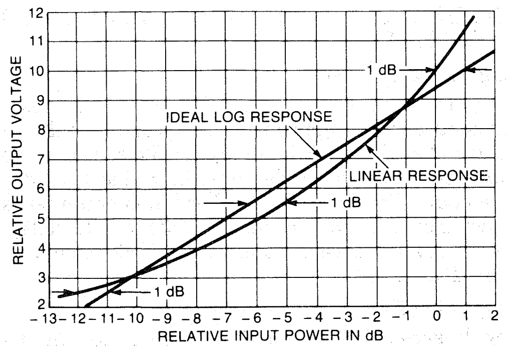


Figure 2. Linear-Logarithmic Approximation

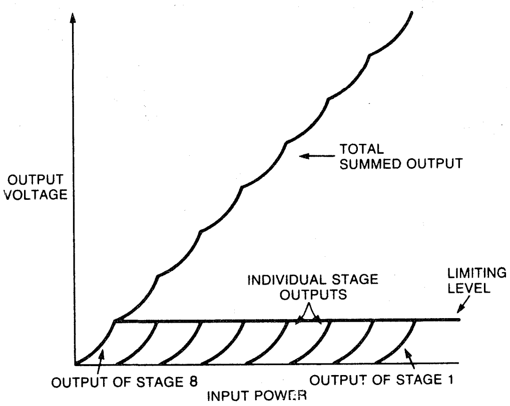


Figure 3. Successive Detecting Logging

A unique feature of this circuit is the use of video limiting rather than RF or IF limiting. This eliminates the constraint of designing an RF amplifier stage with controlled limiting characteristics, while maintaining the desired linear response. Video limiting will begin while the RF stage is operating in its linear region, thus making the transistor limiting characteristics unimportant.

This technique allows design of a logarithmic amplifier at any frequency and bandwidth where it is practical to build a linear amplifier, and eliminates RF limiting problems such as bandwidth variations with signal level, and limiting variation with temperature.

The mechanical design of the log amp uses thick film hybrid integrated circuitry mounted in hermetically sealed flatpacks. These flatpacks are mounted on a printed circuit board which is assembled into a machined housing for the connectorized units.

The second approach is based on the development of a successive detection technique which uses a highly advanced differential amplifier configuration. Using wideband differential amplifiers eliminates video delay lines which lead to improved pulse performance.

A block diagram of this technique is shown in Figure 4. The input preamp and filter serves three purposes:

- It adjusts the sensitivity of the overall amplifier
- It proves a good input power match (typical VSWR 1.5:1).
- The filter is used to align the overall bandpass of the amplifier.

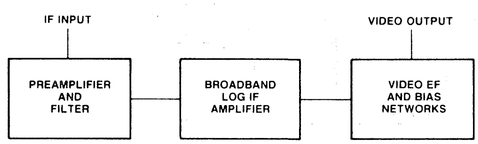


Figure 4. Typical Block Diagram

The broadband log section consists of several identical differential IF stages which amplify and detect the incoming signal. The video emitter follower is then used to provide a low impedance video output capable of supplying 2V into the typical 50 ohm or 93 ohm video load. Video amplification is usually not required.

An individual log IF amplifier stage (with the attendant video bias and output circuitry) is shown in Figure (5). Detection in each stage occurs when the signal level at the base of the IF transistor increases causing the base-emitter junction to be overdriven. This results in an increase in the collector current on the IF side of the differential pair which causes a corresponding decrease in video current until the video transistor is turned off.

The composite log curve is obtained by connecting all the video collectors to the sum line and driving the appropriate video load depending on the log slope required. This technique results in unsurpassed stability, accuracy, and pulse fidelity.

The circuit configuration uses an alumina substrate with selective etching techniques to provide the conductors and resistive elements. Discrete semiconductors, coils and capacitors are then added. The IC board is then enclosed in a housing providing RFI protection and SMA connectors or pins are used to bring out the RF and video signals.

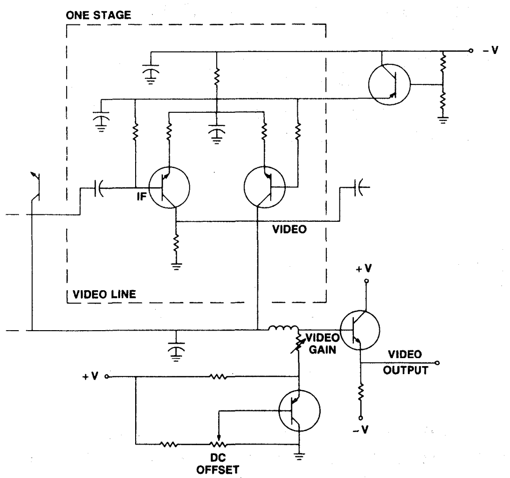


Figure 5. Individual Log IF Amplifier Stages Provide Amplification and Detection

DEFINITION OF TERMS RELATED TO LOG AMPS

Log IF Amplifier

A log IF amplifier is an amplifier that provides a video output voltage that varies proportionally to the log of an IF or RF input signal. This is not to be confused with a log video amplifier that provides video out with video in. The log video amplifier is sometimes used in conjunction with an RF detector, however this technique has limited sensitivity (−45 dBm Typ.).

Log Linearity

Log linearity is the maximum deviation in dB (referred to the input) from a best fit straight line of the input/output characteristic over the dynamic range. See Figure 6.

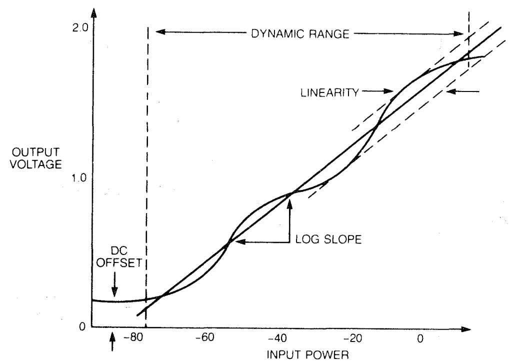


Figure 6. Definition of Terms

Log Slope

The log slope is the average slope of the input/output characteristic over the dynamic range, expressed in millivolts per dB. See Figure 6.

D.C. Offset

D.C. offset is the residual D.C. output of a log amp with no signal applied to the input. See Figure 6.

Log Accuracy

Log accuracy is the absolute accuracy with which the output voltage represents the input power. Note that log accuracy is a combined effect of log linearity, log slope, and D.C. offset. Changes in any of these parameters over frequency and temperature will affect the log accuracy.

Dynamic Range

The dynamic range is the input signal range in dB over which the output linearity requirements are met.

Tangential Sensitivity (TSS)

TSS defines the input level that results in an output signal to noise ratio of 7 dB. TSS is related to bandwidth and noise figure and aids in defining the lower limit of the input dynamic range of a log amp. Since noise figure is not easily measured in a log amp because it provides video out, TSS is a convenient way of specifying noise performance.

Equivalent Input Noise

The equivalent input noise is the equivalent RMS noise power appearing at the input of an amplifier, related to noise figure and bandwidth. Input noise is defined by the equation:

$$P_n = -174 + 10 \log BW + NF$$

Applications of Log IF Amplifiers

Logarithmic IF amplifiers are designed for operation in military environments and for systems requiring high precision. Log amplifiers have been found useful in applications which require the compression of high/input dynamic ranges into smaller, more manageable ranges without loss of level information and in systems that need high sensitivity and instantaneous pulse to pulse response.

Some typical examples are:

Monopulse Receivers

A monopulse receiver often has very wide variations in signal level from channel to channel and within any channel. In this type of system the outputs of matched sets of log amps can be subtracted to give the necessary ratio or angle information ($\log \frac{A}{B} = \text{Log } A - \text{Log } B$). The pulse response capability of the log amp allows this information to be made available on a pulse to pulse basis so important in today's difficult threat environments.

Instantaneous Frequency Discriminators

By using log amplifiers, after a bank of filters each tuned to a different frequency, the output of the log amps can provide single pulse frequency information proportional to output level. Further, if the system's signal processor can handle the information, multiple signals can be discriminated simultaneously.

ECM Receivers

In general, the log amplifier allows the ECM receiver to handle low level pulse signals in the presence of CW or noise jamming without overload. This feature can be most advantageous in today's complex EW environment.

Spectrum Analysis

Spectrum analysis requires high sensitivity and the capability to handle a wide input dynamic range as well as preserve low level signals in the presence of noise and other signals. The log amplifier allows this to be done as well as compressing the input dynamic range into a more useable output range.

CONCLUSION

Now you have a choice in logarithmic amplifier techniques from one source. M/A-COM can supply you the right unit for your specific requirement. So if you require fast response, or broadband hermetic flatpack's or need to operate at +5V, we've got the Logarithmic Amplifier to meet your needs.

Our application engineering staff can supply more detailed information and technical assistance in using these devices in systems application and in adapting circuits to specific system problems.

Logarithmic Amplifier 60 MHz

ICLAP310/ICLA310

- Linearity ±1.0 dB Typical
- Dynamic Range 85 dB Typical
- Hermetically Sealed Microcircuit Construction

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	60 MHz
Input Dynamic Range	80 dB Min (−80 to 0 dBm)
Tangential Sensitivity	−80 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.50 dB Max
Slope	22 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±7% Max
−55 to +85°C	±10% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	25 nsec Max
Limited IF Output	0 dBm ±1.5 dB
Bias Power	+12 VDC @ 45 mA Max −12 VDC @ 160 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max

Environmental

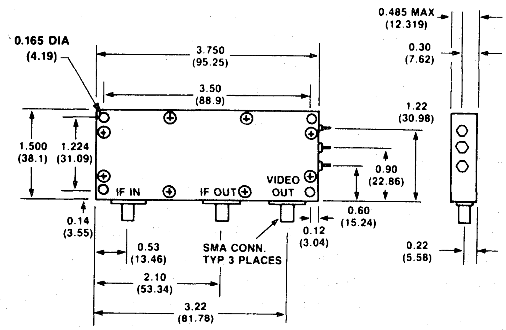
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

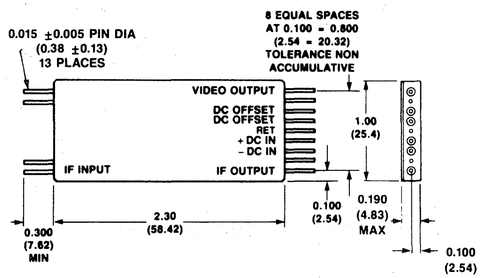
Ordering Information

Model No.	Package
ICLAP310PIN	Flatpack
ICLA310 SMA	Connectorized

C-22



FP-12

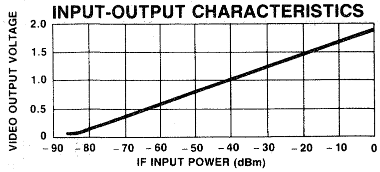


Dimensions in ( ) are in mm.

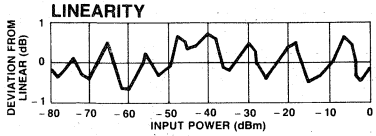
See Appendix for complete physical dimensions.

Typical Performance

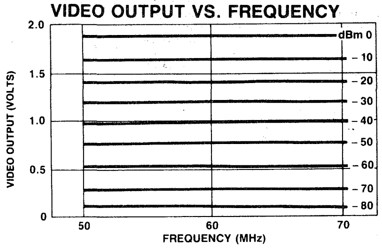
INPUT-OUTPUT CHARACTERISTICS



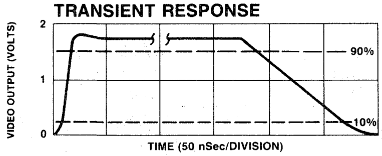
LINEARITY



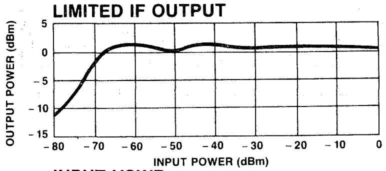
VIDEO OUTPUT VS. FREQUENCY



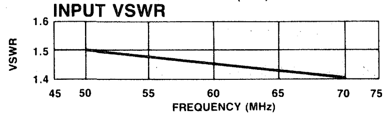
TRANSIENT RESPONSE



LIMITED IF OUTPUT



INPUT VSWR



5Vdc Logarithmic Amplifier 100-300 MHz

ICLAP352/ICLA352

- Linearity ±1.0 dB Typical
- Dynamic Range 80 dB Typical
- Hermetically Sealed Microcircuit Construction
- 0.55 Watt Quiescent DC Power

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	100-300 MHz
Input Dynamic Range	75 dB Min (−70 to +5 dBm)
Tangential Sensitivity	−75 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.5 dB Max
Slope	22 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±7% Max
−55 to +85°C	±10% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	0 dBm ±1.5 dB
Bias Power: Quiescent	+5 VDC @ 16 mA Max
	−5 VDC @ 95 mA Max
+5 dBm C.W. Signal In	+5 VDC @ 40 mA Max
	−5 VDC @ 130 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max

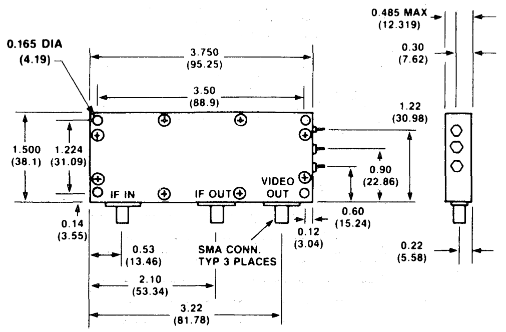
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±5 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

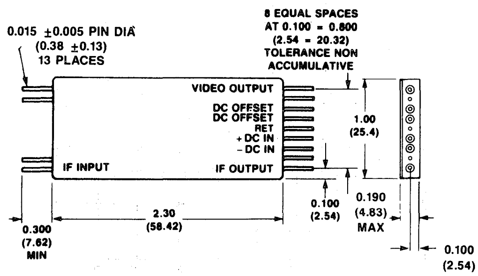
Ordering Information

Model No.	Package
ICLAP352PIN	Flatpack
ICLA352 SMA	Connectorized

C-22



FP-12



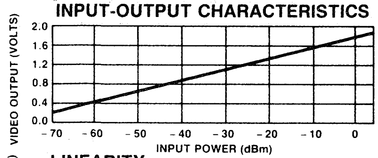
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

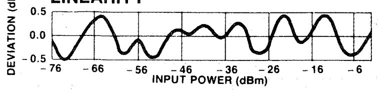
Specifications Subject to Change Without Notice.

Typical Performance

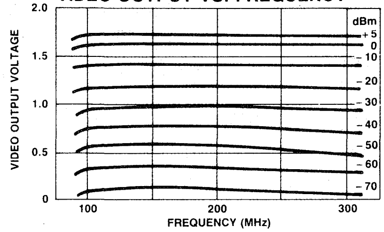
INPUT-OUTPUT CHARACTERISTICS



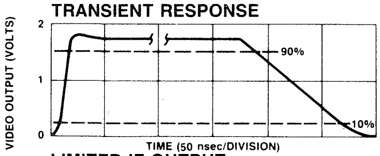
LINEARITY



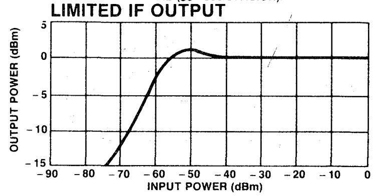
VIDEO OUTPUT VS. FREQUENCY



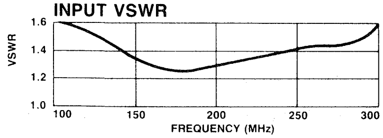
TRANSIENT RESPONSE



LIMITED IF OUTPUT



INPUT VSWR



M/A-COM

Logarithmic Amplifier 250-500 MHz

ICLAP361/ICLA361

- Linearity ±1.0 dB Typical
- Dynamic Range 70 dB Typical
- Hermetically Sealed Microcircuit Construction

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	250-500 MHz
Input Dynamic Range	65 dB Min (−65 to 0 dBm)
Tangential Sensitivity	−70 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.5 dB Max
Slope	25 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±10% Max
−55 to +85°C	±15% Max
Voltage Range (Direct Coupled)	0 to 1.75V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	0 dBm ±1.5 dB
Bias Power	+12 VDC @ 45 mA Max −12 VDC @ 160 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max

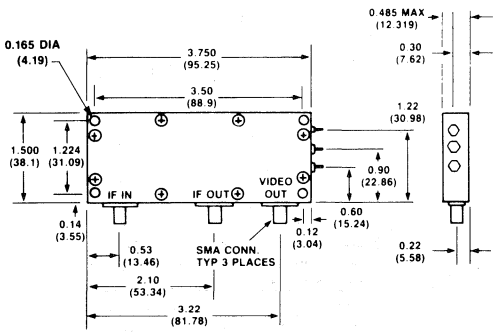
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

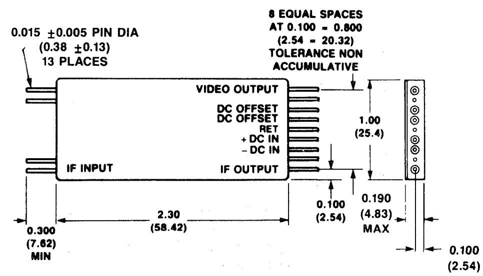
Ordering Information

Model No.	Package
ICLAP361PIN	Flatpack
ICLA361 SMA	Connectorized

C-22



FP-12



Dimensions in ( ) are in mm.

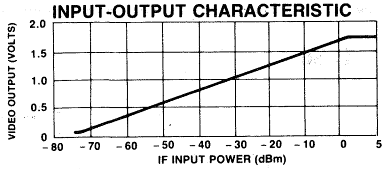
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

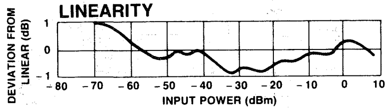
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Performance

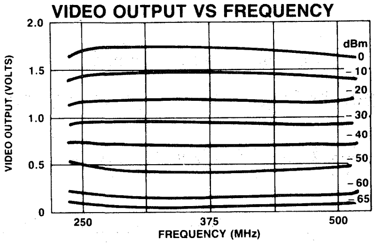
INPUT-OUTPUT CHARACTERISTIC



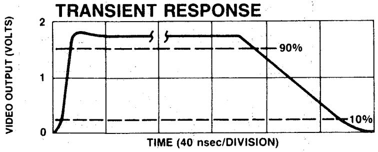
LINEARITY



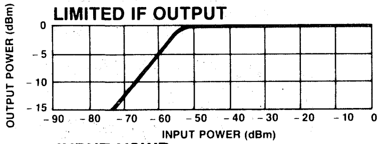
VIDEO OUTPUT VS FREQUENCY



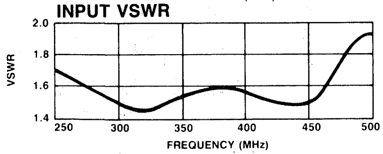
TRANSIENT RESPONSE



LIMITED IF OUTPUT



INPUT VSWR



Low Voltage Wideband Logarithmic Amplifier 110-210 MHz

LV160

- ±5 VDC Operation
- Low Power Dissipation; 0.5 Watts
- Wideband Operation
- Hermetically Sealed

Guaranteed Specifications*
(From –30°C to +71°C Case Temp)

Frequency Range	110 - 210 MHz
Input VSWR	≤1.5:1
Input Dynamic Range	–70 dBm to +5 dBm
Log Output	
Linearity	
(@ room temp)	±1.5 dB Max
(–30°C to +71°C)	±2.25 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1.15V Nom
Rise Time (10-90%)	20 nsec Max
Limited IF Output	0 dBm Nom
DC Power	
Quiescent	+5 VDC @ 30 mA Typ
	–5 VDC @ 80 mA Typ
Max. Signal	+5 VDC @ 45 mA Typ
	–5 VDC @ 105 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal

Environmental

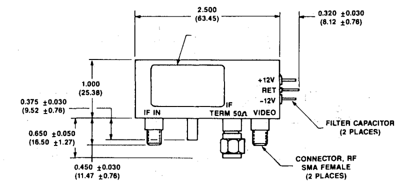
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±5 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

Ordering Information

Model No.	Package
LV160	Connectorized

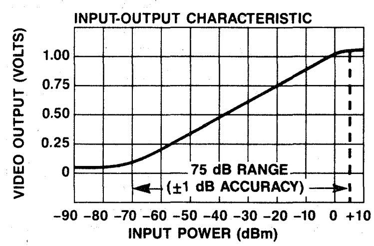
C-36

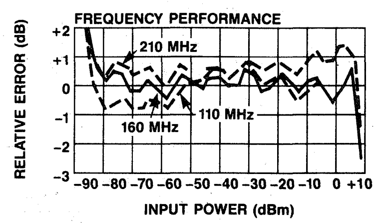


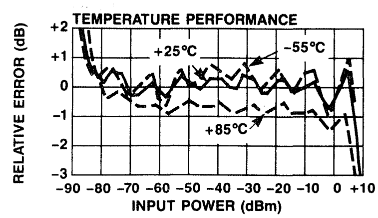
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Wideband Logarithmic Amplifier 100-500 MHz

ICLLWP300

- Hermetic Ultraminiature Design
- Linearity ±1 dB
- Greater than Two Octave Operating Band

Guaranteed Specifications*

(From –30°C to +71°C Case Temp)

Frequency Range	100 - 500 MHz
Input Dynamic Range	–70dBm to 0dBm
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(-30°C to +71°C)	±2 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(-30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1V Nom
Rise Time (10-90%)	20 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ -12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Environmental	

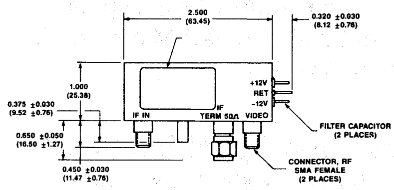
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.
**±15 VDC option available. Consult factory.

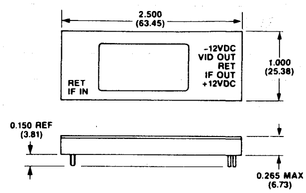
Ordering Information

Model No.	Package
ICLLW300SMA	Connectorized
ICLLWP300PIN	P.C. Mount

C-36



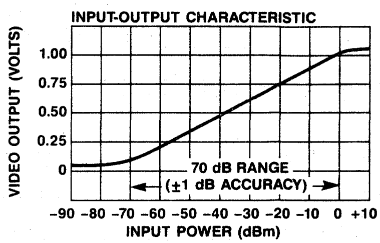
FP-21

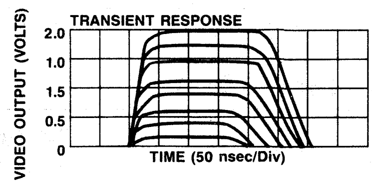


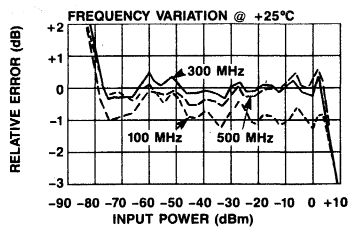
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Logarithmic Amplifier 500-1000 MHz

ICLAP371/ICLA371

- Linearity ±1.0 dB Typical
- Dynamic Range 70 dB Typical
- Hermetically Sealed Microcircuit Construction

Guaranteed Specifications*

(From −55°C to +85°C Case Temp)

Frequency Range	500-1000 MHz
Input Dynamic Range	65 dB Min (−65 to 0 dBm)
Tangential Sensitivity	−70 dBm Min
Input VSWR	2.0:1 Max
Log Output	
Linearity	±1.75 dB Max
Slope	25 mV/dB Nom
Slope Variation vs. Frequency and Temperature	
−40 to +70°C	±10% Max
−55 to +85°C	±15% Max
Voltage Range (Direct Coupled)	0 to 1.70V Nom
Rise Time (10-90%)	10 nsec Max
Limited IF Output	−3 dBm Min
Bias Power	+12 VDC @ 45 mA Max -12 VDC @ 240 mA Max

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
RF Input Power	+10 dBm Max

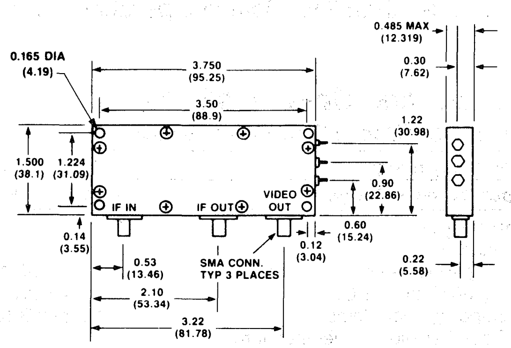
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

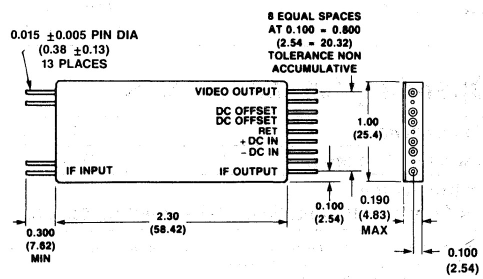
Ordering Information

Model No.	Package
ICLAP371PIN	Flatpack
ICLA371 SMA	Connectorized

C-22



FP-12

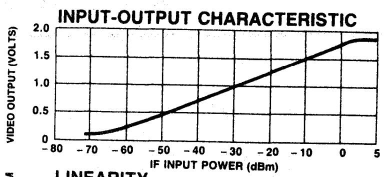


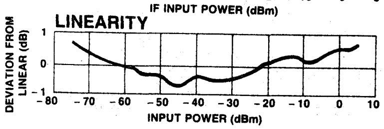
Dimensions in ( ) are in mm.

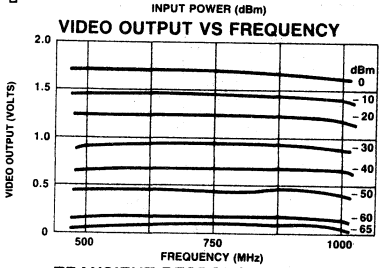
See Appendix for complete physical dimensions.

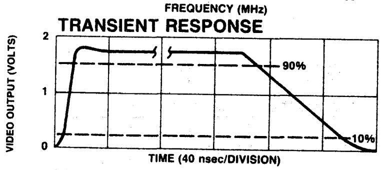
Specifications Subject to Change Without Notice.

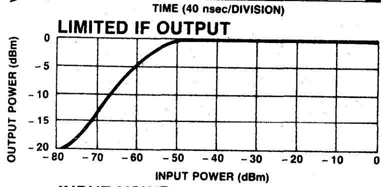
Typical Performance

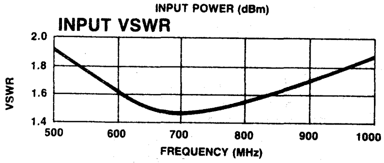












Specifications Subject to Change Without Notice.

M/A-COM

Wideband Logarithmic Amplifier 500-1000 MHz

ICLLWP750

- Hermetic Ultraminiature Design
- Linearity ±1 dB
- Wideband Log Characteristics

Guaranteed Specifications*

(From –30°C to +71°C Case Temp)

Frequency Range	500 - 1000 MHz
Input Dynamic Range	–65dBm to 0dBm
Log Output	
Linearity @ room temp.	±1.0dB
–30°C to +71°C	±2.0dB
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(–30°C to +71°C)	±2 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1V Nom
Rise Time (10-90%)	20 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 60 mA Typ –12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal

Environmental

See Appendix for MIL-STD-883 screening option.

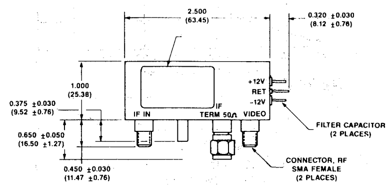
*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.

**±15 VDC option available. Consult factory.

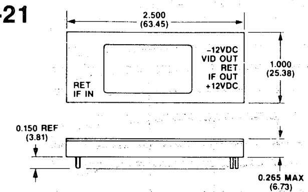
Ordering Information

Model No.	Package
ICLLW750SMA	Connectorized
ICLLWP750PIN	P.C. Mount

C-36



FP-21

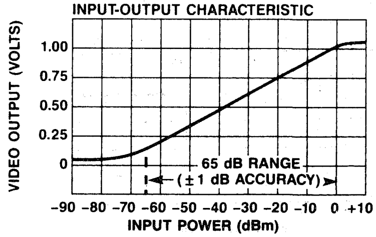


Dimensions in ( ) are in mm.

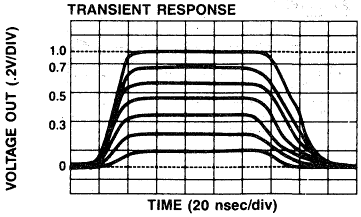
See Appendix for complete physical dimensions.

Typical Performance

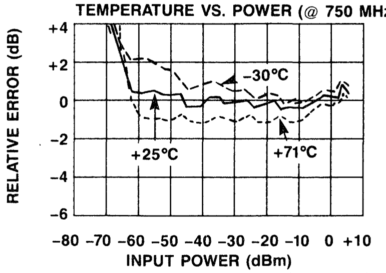
INPUT-OUTPUT CHARACTERISTIC



TRANSIENT RESPONSE



TEMPERATURE VS. POWER (@ 750 MHz)



Specifications Subject to Change Without Notice.

1 nsec Rise Time Logarithmic Amplifier 1000 MHz

MWLN1C

- 1 nsec Rise Time
- 60 dB Dynamic Range
- MIL Grade

Guaranteed Specifications*

(From −30°C to +71°C)

Frequency		1000 MHz
Input Dynamic Range		-60 dBm to 0 dBm
Log Output		
Linearity		
(@ room temp)		±1 dB Max
(-30°C to +71°C)		±2 dB Max
Slope (@ room temp)		15 mV/dB Nom
Slope Variation vs. Temperature		
(-30°C to +71°C)		5% Max
Voltage Range (Direct Coupled)		0 to 1V Nom
Input VSWR (50 Ohms)		≤2:1
Rise Time		1 nsec Max
Bias Power	+15 VDC	75 mA Typ
	-15 VDC	150 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	50 Ohms Nominal

Environmental

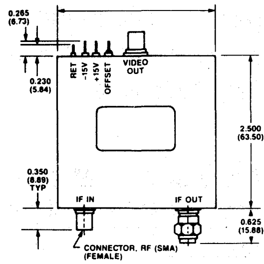
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±15 VDC and with a 50 ohm IF source and load impedance and 50 ohm video load impedance.

Ordering Information

Model No.	Package
MWLN1C	Connectorized

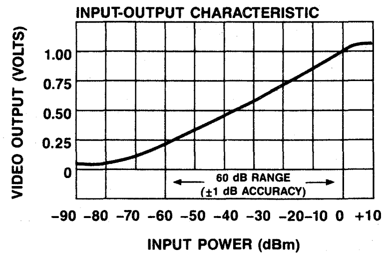
C-38

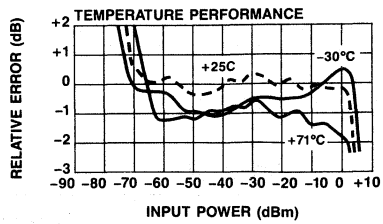


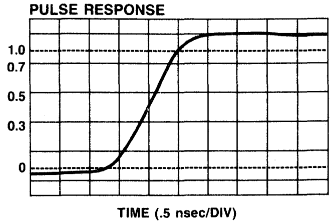
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Wideband Logarithmic Amplifier
500-1500 MHz **MWL 1000**

- 1 GHz Operating Bandwidth
- Hermetic Ultraminiature Design
- Clean Pulse Response

Guaranteed Specifications*
(From –30°C to +71°C Case Temp)

Frequency Range	500 - 1500 MHz
Input VSWR	2.0:1 Max
Input Dynamic Range	–65 dBm to 0 dBm
Log Output	
Linearity	
(@ room temp)	±1 dB Max
(–30°C to +71°C)	±2 dB Max
Slope (@ room temp)	15 mV/dB Nom
Slope Variation vs. Temperature	
(–30°C to +71°C)	5% Max
Voltage Range (Direct Coupled)	0 to 1V Nom
Rise Time (10-90%)	15 nsec Max
Limited IF Output	0 dBm Nom
Bias Power**	+12 VDC @ 50 mA Typ –12 VDC @ 100 mA Typ

Operating Characteristics

IF Impedance	50 Ohms Nominal
Video Load Impedance	93 Ohms Nominal
Environmental	

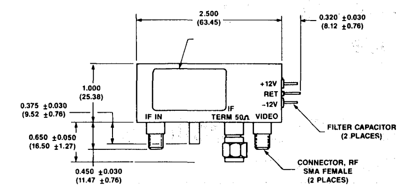
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at ±12 VDC and with a 50 ohm IF source and load impedance and 93 ohm video load impedance.
**±15 VDC option available, consult factory.

Ordering Information

Model No.	Package
MLW1000	Connectorized

C-36

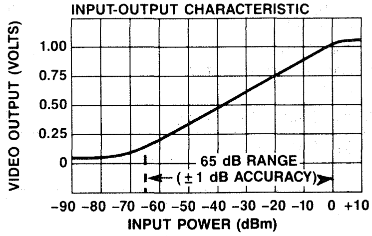


Dimensions in ( ) are in mm.

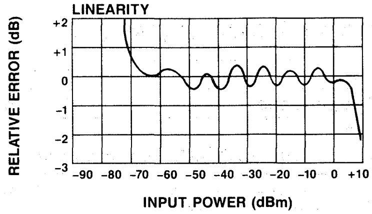
See Appendix for complete physical dimensions.

Typical Performance

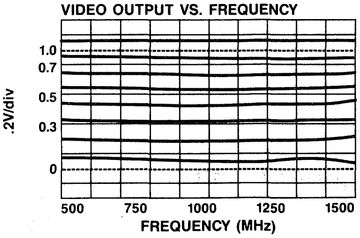
INPUT-OUTPUT CHARACTERISTIC



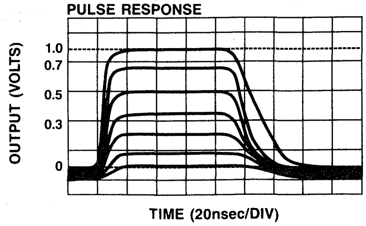
LINEARITY



VIDEO OUTPUT VS. FREQUENCY



PULSE RESPONSE



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

RF Double Balanced Mixers

Overview

INTRODUCTION

Specifying a double-balanced mixer to provide cost effective system performance can only be accomplished by carefully considering and understanding how mixers behave in practical system environments. This note is intended to provide a basic understanding of trade-offs and various design approaches.

MIXER OPERATION

Diode-type double-balanced mixers belong to the general classification of "Resistive Switching" mixers wherein an LO input signal is applied that is sufficiently large to cause strong conduction of the alternate diode pairs (Figure 1) thereby changing them from a low to a high resistance state during each half of the LO cycle. A virtual ground is, therefore, switched or commutated between the RF/IF transformer windings at a rate corresponding to the LO frequency. Since this switching causes a 180° phase reversal of the RF to IF port transmission during each half of the LO cycle, the mixing process is called bi-phase modulation.

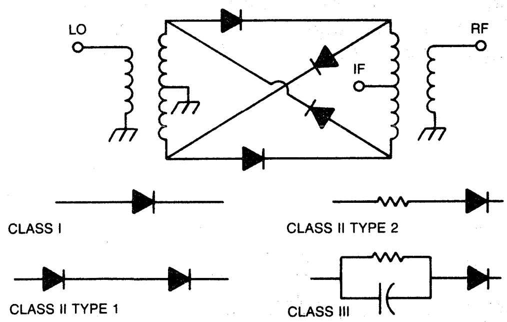


Figure 1. Standard Double Balanced Mixer Schematic

For low frequency operation, these devices typically use ferrite core flux coupled transformers which exhibit leakage inductance and stray capacitance limiting upper frequency operation to approximately 4 GHz. For higher frequency operation, true transmission line realizations of the transformer functions (Figure 2) will allow 4 diode mixer operation to beyond 18 GHz. The low frequency performance is determined by the high pass nature of the RF and LO transmission line structure.

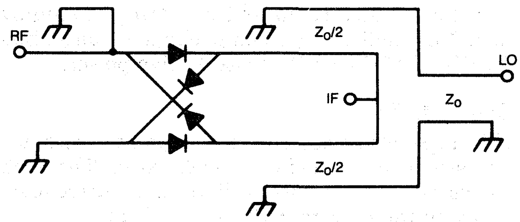


Figure 2. Typical 4 Diode Microwave Mixer Schematic

Overlapping RF-IF or LO-IF frequency coverage is very difficult to attain because the IF output encounters both the RF and LO structures in series for the IF signal path. To produce an overlapping IF frequency range, a more complex 8 diode mixer (Figure 3) was developed. Examination of this structure reveals that this time, the LO is switching 2 diode pairs at a time which are in series with the RF-IF signal path. By tracing out the RF to IF signal connections for each half of the LO input cycle, we see that bi-phase modulation is again being performed. The IF port can be seen to be an RF and LO null. The principle advantage of this design is its large RF-IF frequency range overlap, but with twice as many diodes it requires 3 dB more LO drive.

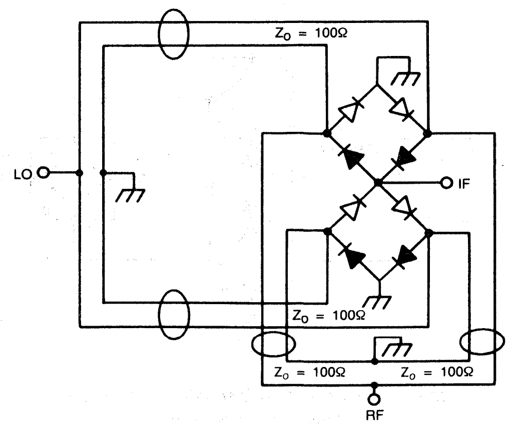


Figure 3. Typical 8 Diode Microwave Mixer Schematic

MIXER CLASSES

These basic mixer types can be further sub-divided into categories by the nature of their mixing elements. (Figure 1).

Class I

The most common design consists of a pair (or more) of the ferrite-core wideband transformers with four diodes connected in a "ring" configuration. Nominally, these components require about +7 dBm LO (Local Oscillator) drive power.

Class II, Type 1

This type also uses the ring topology with two series-connected diodes in each arm. The eight diodes may be similar or different. LO drive levels typically range from +13 to +17 dBm.

Class II, Type 2

These rely on a ring configuration, but feature a precision resistor in series with a single diode in each arm. These four-diode designs are typically driven at +17 dBm.

Class III

These are essentially Class II, type 2 circuits with a large capacitor connected in parallel with the precision series resistor; and they are driven by an LO signal in the +20 to +30 dBm range.

Class IV – Termination Insensitive Mixers

This mixer circuit, called TIM, consists of a transmission line hybrid network driving two sets of diodes (Figure 4). Isolation between each hybrid's opposite ports allows the LO to independently control the switching action of alternately conducting diode sets. The reverse bias applied to the "off" diodes is determined only by available LO input power and not by the diode's forward potential as in the conventional "ring" type mixers. An internal resistor absorbs mixer generated, even-order LO frequency terms, and improves LO VSWR by terminating the hybrid port opposite its LO input. These circuit features improve performance by closely approximating a "square wave" LO drive. For more details, refer to the separate application note under this heading.

In Classes I-III, the inclusion of additional series or parallel combinations of diodes does not alter the classification of a given mixer. Such modifications may allow the component to accept a higher LO drive level to reduce intermodulation distortion. These additional complexities offer little advantage and usually reduce the upper frequency of operation. The Class IV, TIM Mixer, is also available in a "high level" +20 to +30 dBm LO drive model (MD-174) that offers further advantages over the Class II and III types. Microwave TIM's have similar advantages with standard +13 dBm and biasable 0 dBm models offered in both connectorized and "drop-in" versions.

FREQUENCY CONVERTERS – GENERAL CONSIDERATIONS

Double-balanced mixers are most commonly used to convert an input RF signal frequency to another frequency called the intermediate (IF) frequency. The RF signal and a higher level local oscillator (LO) signal interact to produce the sum and dif-

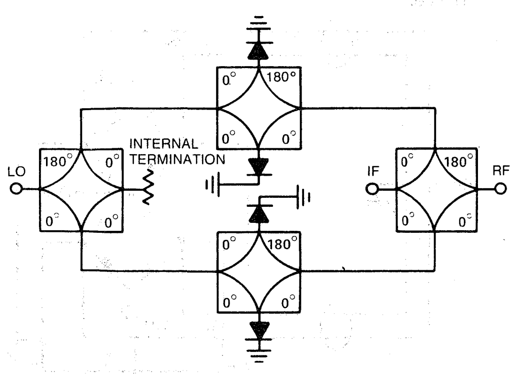


Figure 4. Termination Insensitive Mixer (TIM) Schematic, Class IV

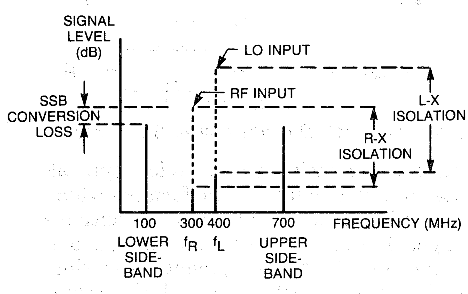


Figure 5. Typical Output Spectrum of Double Balanced Mixer

ference frequencies at the output, as shown in Figure 5. When the mixer is being used as an up-converter, the LO + RF frequency output (upper sideband) is the frequency of interest. A down-converter uses the LO-RF signal (lower sideband). Generally, the two sidebands are of equal amplitude, the amplitude being a function of the side-band frequencies and the frequency response of the output port.

Anzac's line of double-balanced mixers have interchangeable ports. For example, the input signal may be inserted at the IF port (commonly called the X port) and the output taken at the RF port as is generally done in up-converter applications. The high level LO signal may be fed into any port, but it is generally fed into the LO port because of the higher isolation between this port and the remaining two ports.

SPURIOUS SIGNAL GENERATION

The output spectrum of practical double balanced mixers unfortunately contains many frequency terms other than $F_{LO} \pm F_{RF}$. Some are produced by "Irrevocable Laws of Mother Nature", some by mixer design, and others may be caused by reflective terminations at one or more of the mixer's ports when interfaced with other system components.

Ideal mixers would generate only the desired IF output of $F_{LO} \pm F_{RF}$. Practical diode mixers, however, internally generate harmonics of their LO and RF input signals which mix and cause the harmonic modulation products $NF_{RF} \pm MF_{LO}$ in their output frequency spectrum.

Double-balanced mixers have a reasonable (20 to 30 dB) suppression of internally generated, even-order harmonic modulation products compared to a single diode mixer. An $NF_{RF} \pm MF_{LO}$ mixing product will be suppressed if it is caused by an even order RF harmonic, an even order LO harmonic, and, obviously, even orders of both (if these products are being generated within the mixer). This cancellation is obtained by the symmetry of matched diodes coupled with phase and amplitude balanced transformers but depends on frequency. The frequency dependence of "even order" suppression implies that only products caused by odd orders of RF and LO harmonics will be predictably suppressed by most high level mixer designs – a fact confirmed by subsequent measurements. ("Odd order" suppression depends only on LO and RF power.)

Most mixer manufacturers show N x M product data using fixed RF and LO frequencies of about 50 MHz for a very good reason. As frequency increases, even-order harmonic suppression degrades drastically because conventional mixers use flux-coupled transformers. The balance of these devices becomes 10 to 20 dB worse at higher frequencies due to their unavoidable leakage inductance and parasitic capacitances. Since single frequency specifications can be misleading, swept techniques were utilized to measure the various mixer classes over a more practical range of 300 to 500 MHz.

Four classes of mixers were tested with LO drive level appropriate to the type of mixer as listed below:

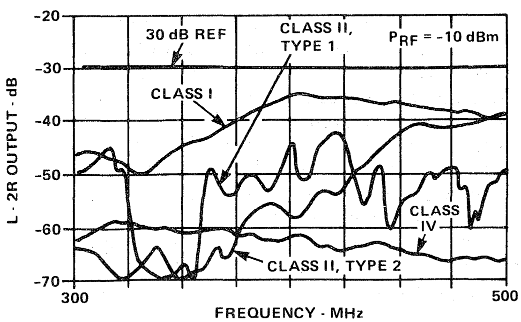
Type	LO Drive Level
Class I	+10 dBm
Class II, Type I	+17 dBm
Class II, Type II	+17 dBm
Class IV, TIM	+10 dBm

Some spurious products such as 3 RF x 2 LO can be reduced by increasing LO drive levels; thus a comparison of test results of the four classes of mixers will show variation with frequency but not necessarily absolute levels achievable with the circuit. For example, a high level TIM mixer circuit operating at +17 dBm LO drive would show nearly a 14 dB improvement in 3 RF x 2 LO spurious performance over the TIM tested at +10 dBm LO drive.

The four classes of mixers were tested from 300 to 500 MHz for the following products:

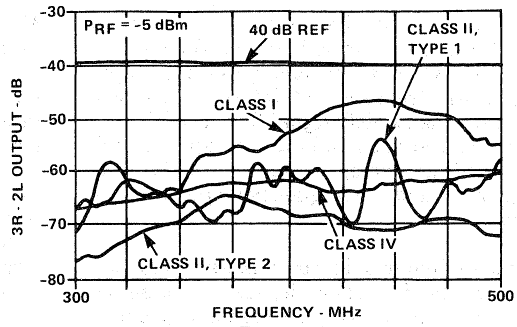
Product	Figure Number
$2\ F_{RF} \times F_{LO}$	6A
$3\ F_{RF} \times 2\ F_{LO}$	6B
$F_{RF} \times 2\ F_{LO}$	6C
$2\ F_{RF} \times 2\ F_{LO}$	6D

The reference level is taken relative to a desired IF side-band, and RF input power is indicated on the data. Not unexpectedly, the Class I; Class II, Type I; and Class II, Type II mixers exhibit widely varying results with frequency due to their transformer construction. The Class IV TIM mixer, on the other hand, is well-behaved with only 3 to 5 dB variation over frequency as well as excellent suppression levels. Only in the LO drive sensitive 3 F_{RF} x 2 F_{LO} case is the performance of the TIM exceeded by the Class II mixers and, as was mentioned, a +17 dBm LO drive TIM would match or exceed these levels.



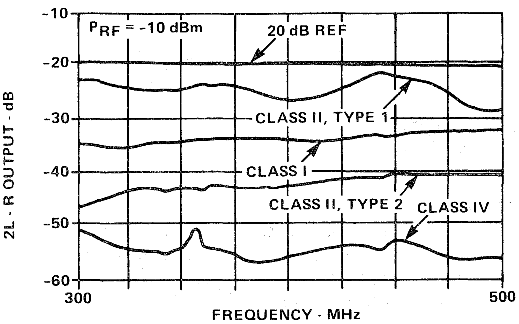
$2F_{RF} \times 2F_{LO}$

Figure 6a.



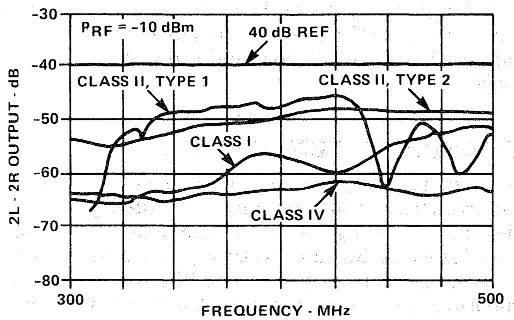
$3F_{RF} \times 2F_{LO}$

Figure 6b.



$F_{RF} \times 2F_{LO}$

Figure 6c.



$2F_{RF} \times 2F_{LO}$

Figure 6d.

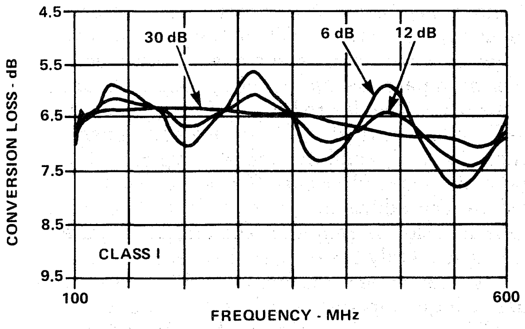
Figure 6. N x M Harmonic Intermodulation Products

The preceding data suggests that publicized "spur-charts" are not even useful as a design "guideline" and should probably be totally disregarded in favor of actual measurements at system operating frequencies and power levels. Also, the data presented is only for 50 ohms terminations at all mixer ports, and reflective terminations will greatly effect some mixer N x M output products. A more detailed explanation of mixer N x M performance is contained in Reference 3.

INTERMODULATION DISTORTION

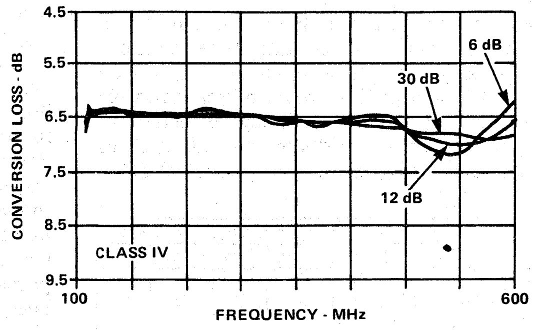
Study a data sheet for even the best low-distortion mixer and you will discover that the third-order IM response specified by the manufacturer is carefully qualified by a string of test conditions such as tone separation and frequency, LO level, LO frequency, and termination impedances. Such specifications do not tell the system designer how well the mixer will operate over a band of frequencies with the realistic source and load mismatches of the other components that interface to the mixer.

For this reason, an investigation of swept IM performance of mixers both in a well matched 50 ohm environment and with variable mismatches presented to the ports of the mixer was undertaken. An outgrowth of these efforts was the development of the Class IV, or TIM, mixer. While conventional Class I mixers may have 10 dB or more variation in IMR (Intermodulation Distortion Ratio) even over the range of 100 to 500 MHz, the TIM mixer has only 1 or 2 dB variation. The presence of a 3:1 IF port load mismatch can increase the IMR variation over frequency in a Class I mixer to 20 dB or more, while the TIM normally exhibits only a 3 dB degradation making it a very "predictable" mixer for IM performance. A more detailed explanation of mixer IM performance and swept frequency mixer IMR measurements for all mixer types can be found in the references or the "Meet TIM" brochure.



CLASS I
$P_{RF} = -10$ dBm, $P_{LO} = +10$ dBm

Figure 7a.



TIM
$P_{RF} = -10$ dBm, $P_{LO} = +10$ dBm

Figure 7b.

Figure 7. Conversion Loss Variation Due to RF Source Match

CONVERSION LOSS CAN VARY

Manufacturers always specify converison loss in an ideal 50 or 75 ohm system for a very good reason; it varies greatly with port mismatches. Amplitude ripple, much larger than one would expect from a simple VSWR problem, can appear over the frequency range. During mismatch calculations, designers often fail to use the worst-case equivalent which must be determined by multiplying the source VSWR by the mixer VSWR. A mixer VSWR of 2:1, a source VSWR of 2:1, and a source/mixer electrical separation of one-quarter wavelength or more can produce a 4:1 system VSWR and about 1.95 dB conversion loss variation or ripple if the frequency band is an octave or more. In narrow-band systems, properly designed reflective terminations can actually decrease a mixer's conversion loss compared to matched conditions.

Figure 7a shows a Class I mixer's relative conversion loss from 100 to 600 MHz at a −10 dBm RF input. The LO and IF ports are terminated at 50 ohms. The RF source return loss is varied from 30 dB (a nearly perfect 50 ohm impedance) to a value of 12 dB and 6 dB. By assuming a mixer RF input VSWR of 2:1 and multiplying the VSWR's, the 12 dB source termination should produce about 1.5 dB; and the 6 dB case should cause nearly 3 dB conversion loss ripple. The actual mixer performed a little better than theory predicts, particularly at lower frequencies probably, due to the Class I mixer VSWR measuring closer to 1.5:1 then the assumed 2:1 value.

Class II and III mixers showed essentially the same conversion loss changes as RF source match was varied. The Class IV, TIM, Mixer's relative conversion loss is measured with the LO drive level at +10 dBm (Figure 7b). The 12 dB RF source termination causes about 0.4 dB ripple, and the 6 dB case has under 1 dB variation for most of the frequency range. Since this performance approximates a 1.0:1 mixer VSWR for the 12 dB ripple and betters the theoretical 1.25 dB ripple possible in the 6 dB source example, some other things must be happening.

MIXER INTERFACING EFFECTS

To achieve reproducible system performance, particularly using conventional mixers, designers should consider how reflective terminations may affect mixer performance. All mixer source and load terminations can modify mixer operation, but mismatches at certain ports affect some mixer performance greatly, others only slightly. The tabulation (Figure 8) shows the relative effects of broadband source and load mismatches upon various mixer parameters for both conventional and Class IV, TIM, Mixers. Obviously, system interfacing circuit aids are required to varying degrees for all mixer types. Some solutions to common system problems now follow.

MIXER INTERFACE CIRCUITS

The IF output port of a double-balanced mixer is most sensitive to reflective terminations. In most applications, only one sideband, either ($F_{LO} + F_{RF}$) or ($F_{LO} - F_{RF}$) is desired, but many mixers produce both with equal conversion efficiency, especially in the up-converter case. Additionally, all mixers have a very large ($3F_{LO} \pm F_{RF}$) output (−13 dBc).

	LO Source		RF Source		IF Load	
Parameter	Conv.	Tim	Conv.	Tim	Conv.	Tim
Conv. Loss	S	S	L	S	M	S
Harmonic (N x M)	S	S	M	S	L	M
Intermodulation						
3rd Order IMD	S	S	M	S	L	S
RF Port VSWR	S	S	N/A	N/A	L	L
IF Port VSWR	S	S	L	L	N/A	N/A

S = Small M = Moderate L = Large

Figure 8. Variation Vs. Port Mismatch

These four frequency terms $F_{LO} - F_{RF}$, $F_{LO} + F_{RF}$, $3F_{LO} - F_{RF}$, and $3F_{LO} + F_{RF}$ exit the mixer's IF port (Figure 9a). The non-broadband IF load terminates only one of these frequency terms ideally, while the others are reflected back into the mixers IF port where they then remix with the local oscillator. This condition greatly affects the mixer parameters of N x M harmonic modulation products, 3rd order IMD and conversion loss. A "Di-plexer" type filter network is required to achieve non-reflective broadband mixer terminations while still preserving frequency selectivity. When the system frequency plan allows, such as in a down-converter, a 3rd order high-pass/low-pass configuration (Figure 9b) can be used. The desired $F_{LO} - F_{RF}$ can be well matched by the next stage interface component, and since $F_{LO} + F_{RF}$ and $3F_{LO} \pm F_{RF}$ typically fall above the high-pass filter cut-off, they are well terminated by the additional 50 ohm load. When a bandpass function is required, the circuit (Figure 9c) can be used. Only the desired frequency term is passed by the series resonant circuit since it becomes a high impedance below and above F_o. The parallel L-C circuit exhibits a high impedance at resonance and becomes a low impedance above and below F_o, therefore doubly terminating the mixer and interface component at unwanted frequencies. Narrow bandwidths are difficult to attain using this circuit because of the extremely high element Q's required for the anti-resonant section.

Another effective but more complex filtering technique, particularly useful for up-converters, consists of two reflection coefficient matched filters interconnected between a pair of 90° hybrids (Figure 9d). Very narrowband filtering is possible using helical resonators or transmission line filters in this configuration.

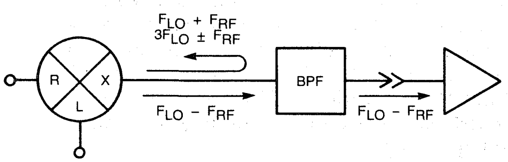


Figure 9a.

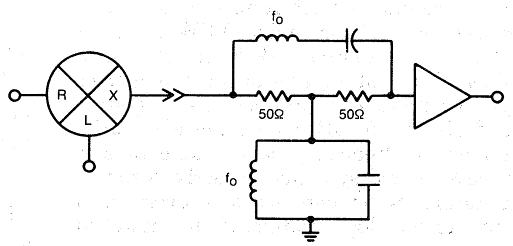


Figure 9c.

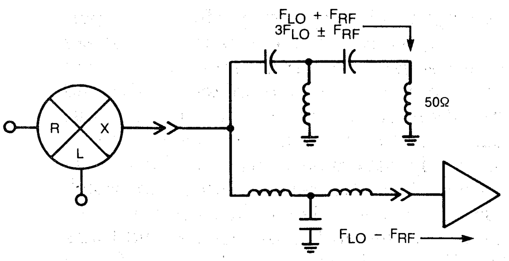


Figure 9b.

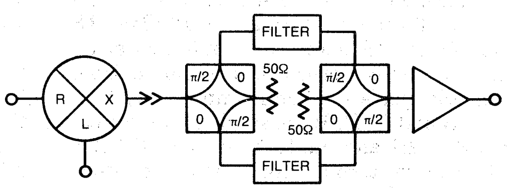


Figure 9d.

Figure 9. IF Matching Circuits Improve Mixer Performance

Broadband matching may also be required at the mixer's RF and LO ports. Even order $NF_{RF} \times MF_{LO}$ harmonics are suppressed in a mixer's IF output spectrum, therefore, they must exit at another mixer port. The output spectrum at each of an "ideal" mixer's 3 ports (Figure 10) reveals that IM products containing odd order RF and even order LO harmonics appear at the R or low level port while products having even order RF and odd order LO harmonics exit at the high level or LO mixer port. Odd order RF and LO harmonic mixing products appear at the IF port, even order products only are suppressed. Broadband LO port matching is often required particularly if the system LO has a very high harmonic content, or is a poor source impedance for mixer generated harmonics exiting the mixer's LO port. These multiple reflections can inhibit the mixing process causing an increase in 3rd order IMD and N x M harmonic modulation products.

These circuits and techniques are only intended to illustrate design philosophies that allow a mixer to be non-reflectively terminated while directly interfaced to a frequency selective network. Class IV TIM Mixers are generally the best choice, as they are less susceptible to non-ideal terminations than other mixer classes.

ELECTROMECHANICAL EFFECTS

Improper physical interfacing will also create reflective mixer terminations, causing changes in conversion loss, N x M harmonic suppression and 3rd order IMD. Inadequate case grounding and long signal lead lengths are the common offenders.

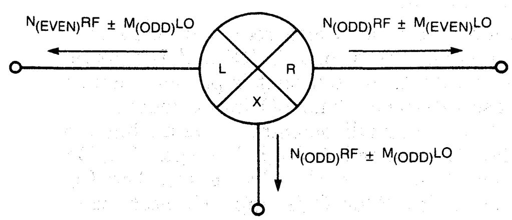


Figure 10. Harmonic Output of a Double Balanced Mixer

PHASE DETECTORS

Application of two identical-frequency, constant-amplitude signals to a mixer's RF and LO ports, results in a D.C. IF output that is proportional to their phase difference. The LO input causes currents to flow through diode pair D1, D2 during one half of the LO cycle and through diode pair D3, D4 during the other half cycle (Figure 11). The LO voltage at nodes B or C is approximately zero because of diode and transformer balance. Since the diode pairs D1, D2, and D3, D4 are in alternate conduction states, the RF transformers secondary terminals B or C are alternately commutated to a virtual ground at a rate equal to the LO input frequency. When an RF input signal is applied, the instantaneous IF output voltage depends upon the instantaneous level and polarity at the RF transformer secondary and whether terminal B or C is switched to ground by the LO at that moment. The IF output contains both $F_{LO} + F_{RF}$ and $F_{LO} - F_{RF}$ and when F_{LO} and F_{RF} are identical frequencies $F_{LO} - F_{RF}$ is zero Hz or a D.C. output proportional to their phase difference. The sum frequency $F_{LO} + F_{RF}$ may be filtered if it falls within the mixer's IF port response. Recommended input levels for this application are nominal specified as a LO drive for one signal and an input at or below the 1 dB compression point for the other. The D.C. IF port TIM Mixer (MD-161) and conventional model MD-125 are good mixer choices, having a 1 dB compression point very close to their LO drive levels.

OTHER MIXER APPLICATIONS

Double-balanced mixers can be combined with other signal processing components to realize functions such as Single Sideband Modulators, Image Rejection Mixers, and QPSK modulators/demodulators. The article on pages 8 to 16 discusses our capabilities in integrated sub-assemblies.

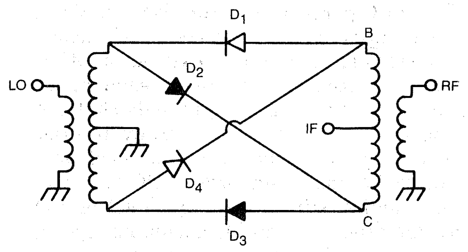


Figure 11. Double Balanced Mixer Operates as Biphase Modulator

CONCLUSION

Correct selection of a double balanced mixer to fit the application can greatly improve system performance. Once a proper selection is made, careful installation and matching can further improve performance. Utilizing the Class IV, TIM Mixer will, in many cases, provide improved system performance and often significant improvement under mismatch environments. A detailed application note on TIM mixers is provided in the appendix. Regardless of which mixer is used, understanding mixer operation and tradeoffs can save system designers from major performance problems.

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5. P. Will, "Reactive Loads – The Big Mixer Menace", **Microwaves,** Vol. 10, No. 4, pp. 38-42 (April 1971).

Plug-In Double-Balanced Mixer
200 kHz-200 MHz

MD-109

- Three Decade Coverage
- All Internal Connections Accessible

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.2-200 MHz
	IF Port		DC-200 MHz
Conversion Loss	0.2-50 MHz		6.0 dB Max
	50-200 MHz		7.5 dB Max
Isolation	LO to RF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	30 dB Min
	LO to IF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	25 dB Min
	RF to IF	(0.2-50 MHz)	25 dB Min
		(50-200 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated linearly to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative (When connected as indicated under Mech. Data)
DC Offset	⩽ 3 mV Typical
RF Input†	
1 dB Compression	+2 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-200 MHz⩾50 dB 200-300 MHz⩾36 dB

Environmental
See Appendix for MIL-STD-883 screening option.

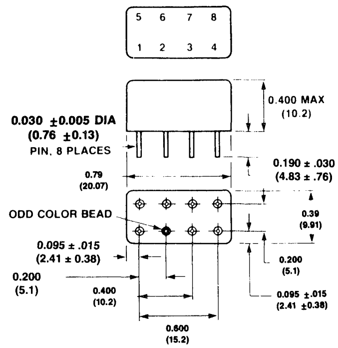
Pin Configuration	RF; P8, LO; P1 & P5, IF; P3 & P7** All other pins are ground.***

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**P3 & P7 connected together externally to make IF Port.
***No internal case connections.
†Measured at 100 MHz.

Ordering Information

Model No.	Package
MD-109 PIN	Relay Header

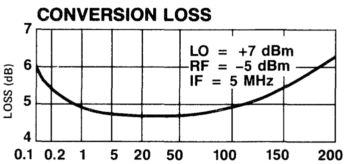
RH-3

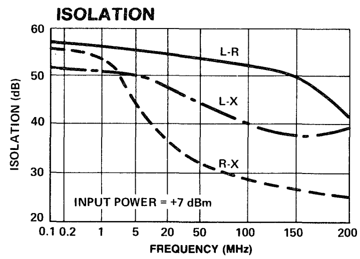


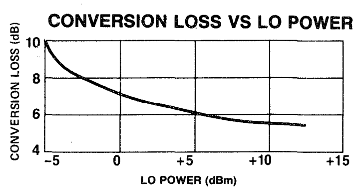
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Surface Mount Double-Balanced Mixer 200 kHz-200 MHz

MDS-222

- Fully Hermetic Package
- Three Decade Coverage

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.2-200 MHz
	IF Port		DC-200 MHz
Conversion Loss	0.2-50 MHz		6.0 dB Max
	50-200 MHz		7.5 dB Max
Isolation	LO to RF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	30 dB Min
	LO to IF	(0.2-50 MHz)	35 dB Min
		(50-200 MHz)	25 dB Min
	RF to IF	(0.2-50 MHz)	25 dB Min
		(50-200 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated linearly to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative (When connected as indicated under Mech. Data)
DC Offset	⩽ 3 mV Typical
RF Input†	
1 dB Compression	+2 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-200 MHz ⩾ 50 dB 200-300 MHz ⩾ 36 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

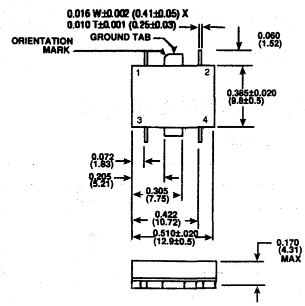
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

†Measured at 100 MHz.

Ordering Information

Model No.	Package
MDS-222 PIN	Surface Mount

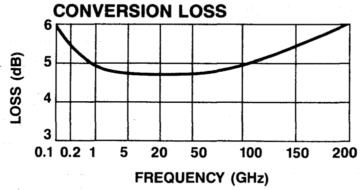
SF-1

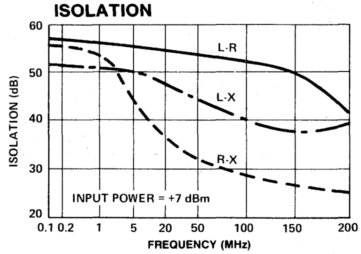


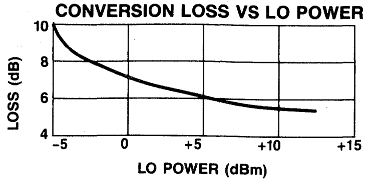
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

TO-5 Double-Balanced Mixers 0.2-200 MHz and 5-500 MHz

MAC-50/51

- Convenient Microstrip or Stripline Mounting
- Low Conversion Loss — 6 dB (MAC-50) 7 dB (MAC-51)

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL		MAC-50	MAC-51
Frequency Range			
RF, LO Ports		0.2-200	5-500 MHz
IF Port		DC-200	DC-500 MHz
Conversion Loss		6.0	7.0 dB Max
Isolation			
LO to RF	(0.2-50 MHz)	35	35 dB Min
	(50-200 MHz)	25	25 dB Min
LO to IF	(0.2-50 MHz)	35	35 dB Min
	(50-200 MHz)	25	25 dB Min
RF to IF	(0.2 MHz)	25	20 dB Min
	(50-200 MHz)	20	20 dB Min

Operating Characteristics

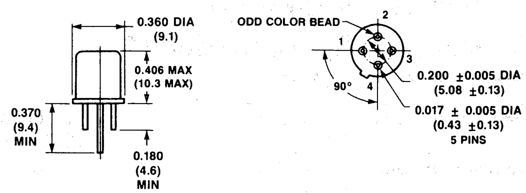
Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated Linearly to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset	⩽ 1	⩽ 3 mV Typ
RF Input**		
1 dB Compression	+1	+2 dBm Typ
1 dB Desensitization	−3	−1.5 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Environmental		
See Appendix for MIL-STD-883 screening option.		
Pin Configuration		LO; P1, IF; P2, RF; P3, P4 and case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**Measured at 100 MHz.

Ordering Information

Model No.	Package
MAC-50 PIN	Pin
MAC-51 PIN	Pin

TO-5-2

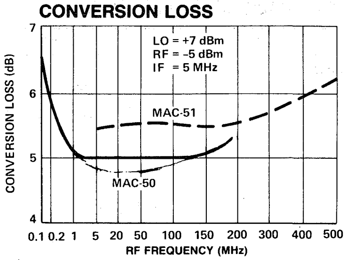


Dimensions in ( ) are in mm.

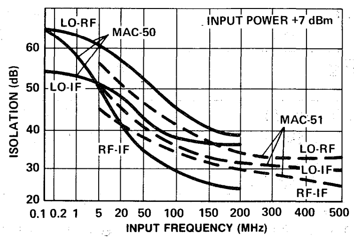
See Appendix for complete physical dimensions.

Typical Performance

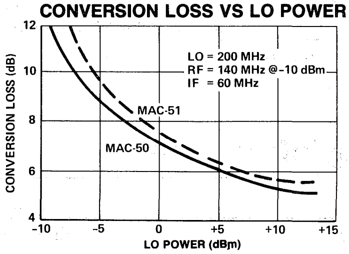
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Surface Mount Double-Balanced Mixer 0.5-350 MHz

MDS-221

- Fully Hermetic Package
- Low Cost, Medium Level
  +15 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
  +5 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-350 MHz
	IF Port		DC-350 MHz
Conversion Loss	2-300 MHz		7 dB Max
	0.5-350 MHz		8 dB Max
Isolation	LO to RF	(0.5-100 MHz)	35 dB Min
		(100-350 MHz)	28 dB Min
	LO to IF	(0.5-100 MHz)	32 dB Min
		(100-350 MHz)	25 dB Min
	RF to IF	(0.5-100 MHz)	25 dB Min
		(100-350 MHz)	18 dB Min

Operating Characteristics

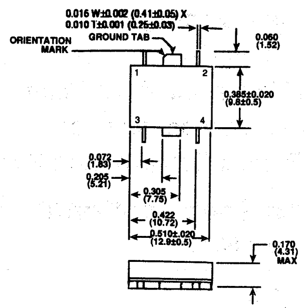
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input)	⩾ 50 dB Min
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**P3 & P4 are connected together externally to make an IF Port.

Ordering Information

Model No.	Package
MDS-221 PIN	Surface Mount

SF-1

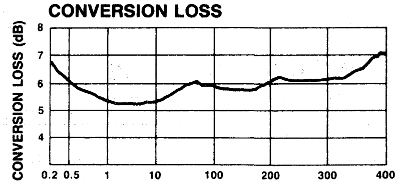


Dimensions in ( ) are in mm.

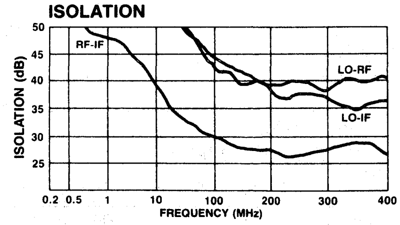
See Appendix for complete physical dimensions.

Typical Performance

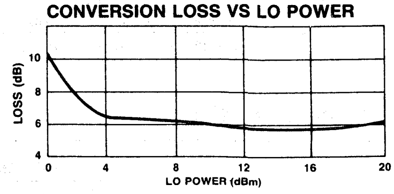
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



M/A-COM

Surface Mount Double-Balanced Mixer 1-400 MHz

MDS-220

- Fully Hermetic Package
- Low Cost, High Level
- +17 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
- +7 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-400 MHz
	IF Port		DC-400 MHz
Conversion Loss	3-300 MHz		7 dB Max
	1-400 MHz		8 dB Max
Isolation	LO to RF	(1-300 MHz)	32 dB Min
		(300-400 MHz)	28 dB Min
	LO to IF	(1-300 MHz)	30 dB Min
		(300-400 MHz)	25 dB Min
	RF to IF	(1-150 MHz)	25 dB Min
		(150-400 MHz)	20 dB Min

Operating Characteristics

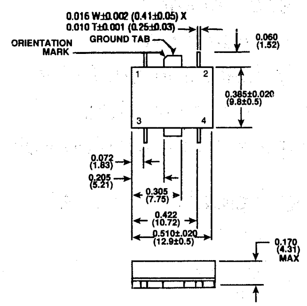
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input)	⩾ 55 dB Min
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

*All specifications apply when operated at + 13 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MDS-220 PIN	Surface Mount

SF-1

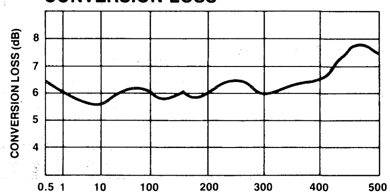


Dimensions in ( ) are in mm.

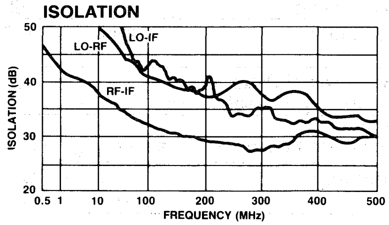
See Appendix for complete physical dimensions.

Typical Performance

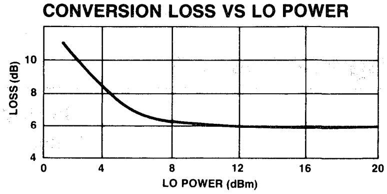
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

Double-Balanced Mixer
1-400 MHz

MD-100

- Low Cost, High Level
- +17 dBm Typical Intercept Point
- 6 dB Typical Conversion Loss
- +7 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-400 MHz
	IF Port		DC-400 MHz
Conversion Loss	3-300 MHz		7 dB Max
	1-400 MHz		8 dB Max
Isolation	LO to RF	(1-300 MHz)	32 dB Min
		(300-400 MHz)	28 dB Min
	LO to IF	(1-300 MHz)	30 dB Min
		(300-400 MHz)	25 dB Min
	RF to IF	(1-150 MHz)	25 dB Min
		(150-400 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input)	≥ 55 dB Min
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P1, LO; P8, IF; P2 & P6** Case and all other pins are ground.

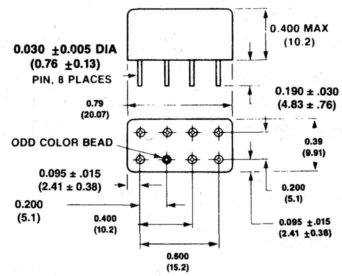
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

**P2 & P6 are connected together externally to make an IF Port.

Ordering Information

Model No.	Package
MD-100 PIN	Relay Header

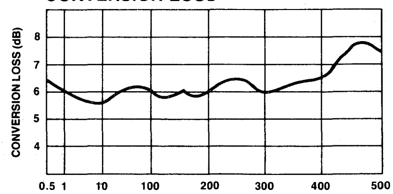
RH-3

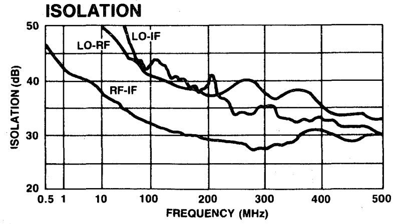


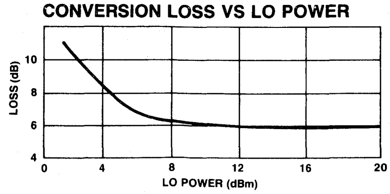
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Double-Balanced Mixers
500 kHz-500 MHz

MD-124/140

- Usable Down to 200 kHz
- 6.5 dB Typical Conversion Loss
- Available in Flatpack (MD-124) and Connectorized (MD-140) Versions

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss			7 dB Max
Isolation	LO to RF	(0.5-10 MHz)	35 dB Min
		(10-200 MHz)	30 dB Min
		(200-500 MHz)	25 dB Min
	LO to IF	(0.5-10 MHz)	30 dB Min
		(10-200 MHz)	25 dB Min
		(200-500 MHz)	20 dB Min
	RF to IF	(0.5-10 MHz)	25 dB Min
		(10-200 MHz)	15 dB Min
		(200-500 MHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	+2 dBm Typical
1 dB Desensitization	−2 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-400 MHz ≥50 dB 400-500 MHz ≥40 dB
Environmental	

See Appendix for MIL-STD-883 screening option.

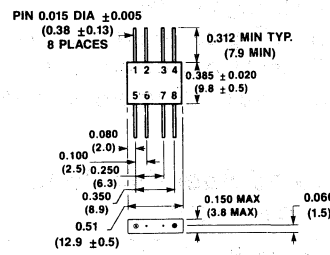
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

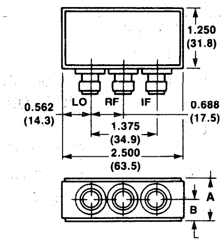
Ordering Information

Model No.	Package
MD-124 PIN	Flatpack
MD-140 SMA	Connectorized
MD-140 BNC	Connectorized

FP-2



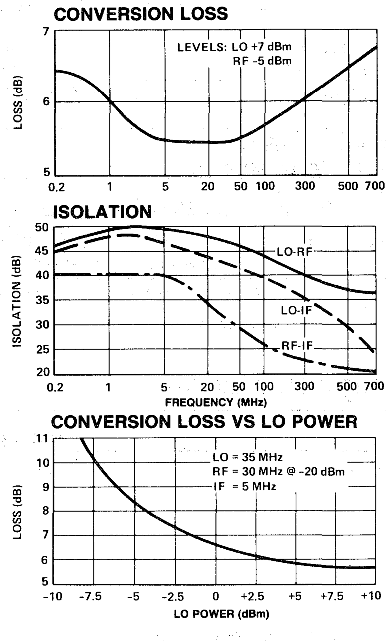
C-9



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance



Specifications Subject to Change Without Notice.

High-Level Double-Balanced Mixer 500 kHz-500 MHz

MD-125

- 17.5 dBm Typical 3rd Order Intercept
- High Input Compression Point
- 6 dB Typical Conversion Loss
- High Level Phase Detector

Guaranteed Specifications*

(From −54°C to +85°C)

Frequency Range	RF, LO Ports IF Port	0.5-500 MHz DC-500 MHz
Conversion Loss	0.5-500 MHz 1-200 MHz	9 dB Max 7 dB Max
Isolation	LO to RF (0.5-500 MHz) LO to IF (0.5-500 MHz) RF to IF (0.5-500 MHz)	30 dB Min 30 dB Min 20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Positive
DC Offset	≤2 mV Typical
RF Input	
1 dB Compression†	+11 dBm Typical
1 dB Desensitization†	+8 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	20-30 MHz≥65 dB 80-430 MHz≥55 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

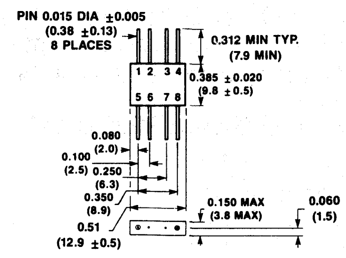
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

†These characteristics apply at +20 dBm LO power.

Ordering Information

Model No.	Package
MD-125 PIN	Flatpack

FP-2

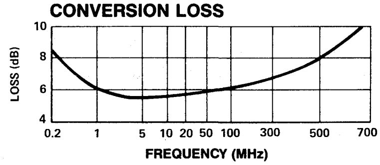


Dimensions in ( ) are in mm.

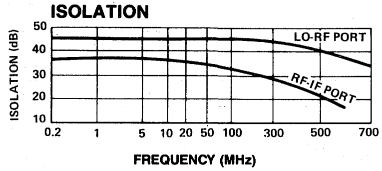
See Appendix for complete physical dimensions.

Typical Performance

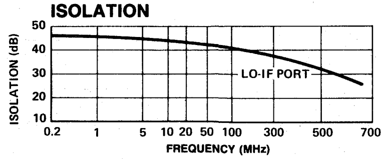
CONVERSION LOSS



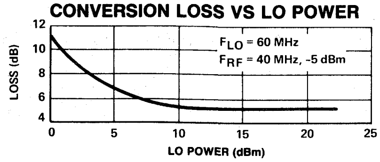
ISOLATION



ISOLATION



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

M/A-COM

High-Level Double-Balanced Mixer 1-500 MHz

MD-138

- Low Third Order Distortion — Typical +24 dBm Third Order Intercept Point
- High Compression Point — +14 dBm Minimum

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	1-400 MHz		8.5 dB Max
	400-500 MHz		9.5 dB Max
Isolation	LO to RF	(1-150 MHz)	45 dB Min
		(150-400 MHz)	25 dB Min
		(400-500 MHz)	20 dB Min
	LO to IF	(1-150 MHz)	45 dB Min
		(150-400 MHz)	25 dB Min
		(400-500 MHz)	20 dB Min
	RF to IF	(1-150 MHz)	25 dB Min
		(150-400 MHz)	20 dB Min
		(400-500 MHz)	20 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive (with P5 grounded)
DC Offset		≤ 2 mV Typical
RF Input		
1 dB Compression		
1-100 MHz		+19 dBm Typical
100-500 MHz		+14 dBm Typical
1 dB Desensitization		+12 dBm Typical
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −5 dBm input, each input, 60 MHz and 70 MHz IF)	80-125 MHz	≥ 55 dB
	175-350 MHz	≥ 60 dB

Environmental
See Appendix for MIL-STD-883 screening option.

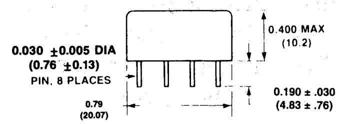
Pin Configuration	RF; P8, LO; P1 & P5, IF; P3 & P7. Case and all other pins are ground.

*All specifications apply when operated at +23 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MD-138 PIN	Relay Header

RH-3

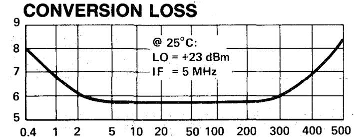


Dimensions in ( ) are in mm.

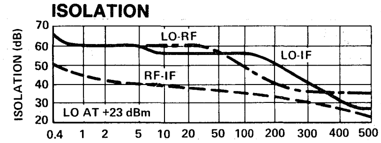
See Appendix for complete physical dimensions.

Typical Performance

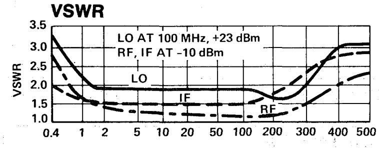
CONVERSION LOSS



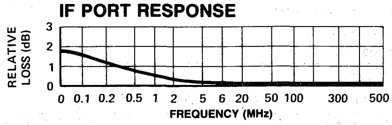
ISOLATION



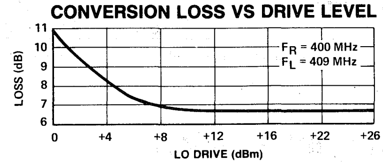
VSWR



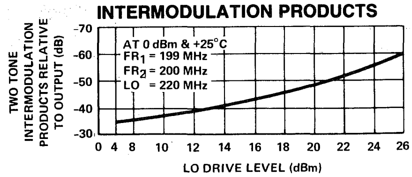
IF PORT RESPONSE



CONVERSION LOSS VS DRIVE LEVEL



TWO-TONE INTERMODULATION PRODUCTS



Specifications Subject to Change Without Notice.

M/A-COM

High-Level Double-Balanced Mixer 1-500 MHz

MD-139

- High Compression Level — Typically +20 dBm
- Typical +24 dBm Third Order Intercept Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	1-200 MHz		7 dB Max
	200-500 MHz		9 dB Max
Isolation	LO to RF	(1-50 MHz)	45 dB Min
		(50-500 MHz)	30 dB Min
	LO to IF	(1-50 MHz)	35 dB Min
		(50-500 MHz)	25 dB Min
	RF to IF	(1-50 MHz)	45 dB Min
		(50-500 MHz)	30 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Positive
DC Offset	≤2 mV Typical
RF Input**	
1 dB Compression	+20 dBm Typical
1 dB Desensitization	+17 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −5 dBm input, each input, 60 MHz and 70 MHz IF)	80-300 MHz ≥58 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P10, LO; P6, IF; P3. Case and all other pins are ground.

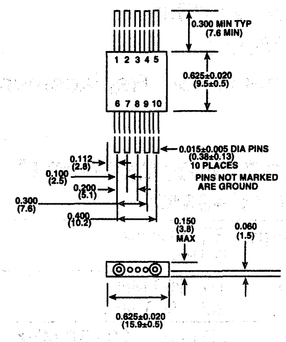
*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

**These specifications apply at +23 dBm LO power.

Ordering Information

Model No.	Package
MD-139 PIN	Flatpack

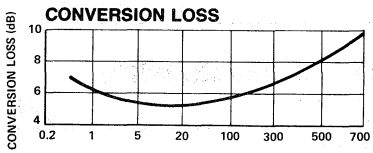
FP-3

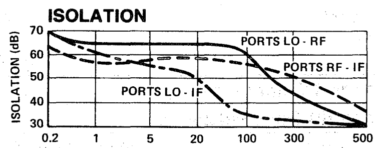


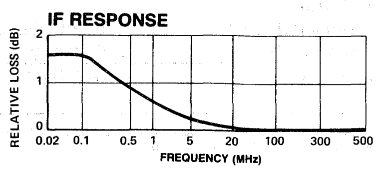
Dimensions in ( ) are in mm.

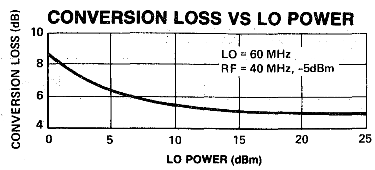
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

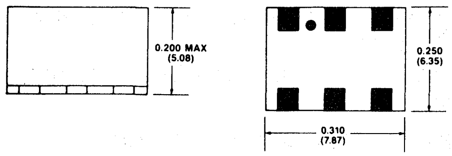
M/A-COM

Double-Balanced Mixer 1.0-500 MHz

MD-455

- LO Power +7 dBm
- Surface Mount
- MCL Model RMS-1 Replacement

SF-3



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1.0 - 500 MHz
	IF Port		DC - 500 MHz
Conversion Loss	1.0 - 250 MHz		7.5 dB Max
	250 - 500 MHz		8.0 dB Max
Isolation	LO to RF	1.0 - 5.0 MHz	50 dB Min
		5.0 - 250 MHz	25 dB Min
		250 - 500 MHz	20 dB Min
	LO to IF	1.0 - 5.0 MHz	45 dB Min
		5.0 - 250 MHz	23 dB Min
		250 - 500 MHz	19 dB Min
	RF to IF	1.0 - 5.0 MHz	40 dB Min
		5.0 - 250 MHz	20 dB Min
		250 - 500 MHz	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 Max
IF Port Current	40 mA Max
DC Polarity	Pos
DC Offset	≤ 10.0 mV Typ
RF Input for 1dB Compression	+1.0 dBm Typ
RF Input for 1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	
(with −10 dBm input, each	50 dB Typ at 160 MHz
tone and 50 & 60 MHz IF)	44 dB Typ at 500 MHz
Pin Configuration	RF; P4, LO; P1, IF; P5

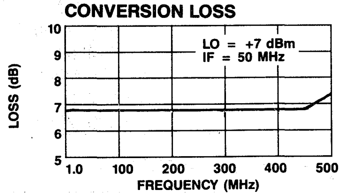
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 3 & 6 grounded.

Ordering Information

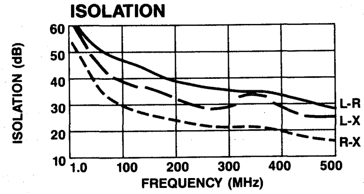
Model No.	Package
MD-455 PIN	Surface Mount

Typical Performance

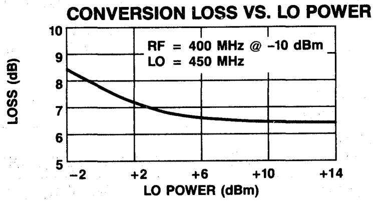
CONVERSION LOSS



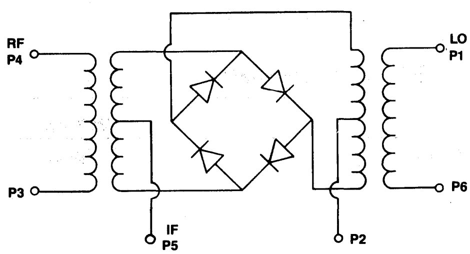
ISOLATION



CONVERSION LOSS VS. LO POWER



Schematic



Specifications Subject to Change Without Notice.

M/A-COM

Termination-Insensitive Mixer
1-500 MHz

MD-/MDC-161

- Third Order Intermodulation Ratio is Insensitive to Port Mismatches
- 6 dB Typical Midband Conversion Loss
- DC Coupled IF Port
- High Level Phase Detector

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	5-300 MHz		7 dB Max
	1-500 MHz		8 dB Max
Isolation	LO to RF	(1-500 MHz)	25 dB Min
	LO to IF	(1-500 MHz)	30 dB Min
	RF to IF	(1-300 MHz)	20 dB Min
		(300-500 MHz)	17 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		350 mW Max @ 25°C
		Derated to 85°C @ 3.2 mW/°C
LO Power		+24 dBm Max
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		⩽5 mV Typ
RF Input	1 dB Compression	+10 dBm Typ
	1 dB Desensitization	+7 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio (with −10 dBm input, each tone and 60 MHz IF)		50 dB @ 100 MHz 55 dB @ 500 MHz
3rd Order Intermodulation Ratio Degradation		3 dB Typ @ IF VSWR 3:1
Environmental See Appendix for MIL-STD-883 screening option.		
Pin Configuration		RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

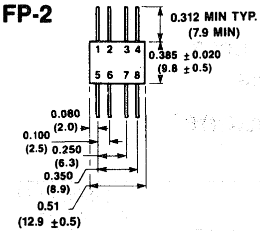
*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 4,224,572.

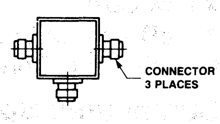
Ordering Information

Model No.	Package
MD-161 PIN	Flatpack
MDC-161 SMA	Connectorized

FP-2



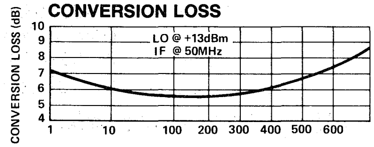
C-7



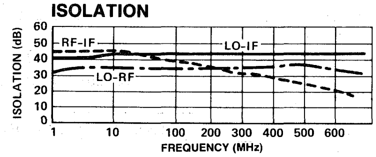
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance

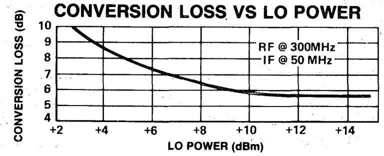
CONVERSION LOSS



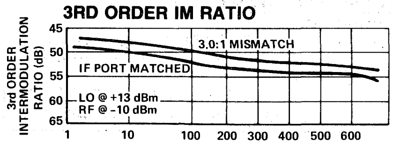
ISOLATION



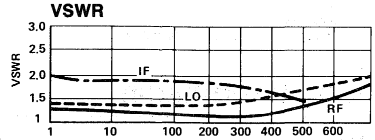
CONVERSION LOSS VS LO POWER



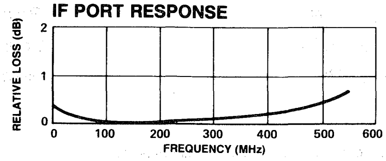
3RD ORDER IM RATIO



VSWR



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Double-Balanced Mixer 5-500 MHz

MD-108/143/146

- Low Cost
- 7 dB Typical Conversion Loss
- Available in Three Models

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	5-150 MHz		7.0 dB Max
	150-500 MHz		9.0 dB Max
Isolation	LO to RF	(5-150 MHz)	40 dB Min
		(150-500 MHz)	35 dB Min
	LO to IF	(5-150 MHz)	35 dB Min
		(150-500 MHz)	25 dB Min
	RF to IF	(5-150 MHz)	25 dB Min
		(150-500 MHz)	20 dB Min

Operating Characteristics

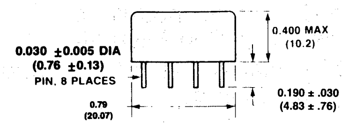
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative (Positive if LO input at pin 5)
DC Offset	⩽ 1 mV Typical
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 25 MHz and 35 MHz IF)	100-350 MHz ⩾ 55 dB 350-500 MHz ⩾ 40 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	(MD-108) LO; P1 & P5, RF; P8, IF; P3 & P7*** (MD-146) LO; P1 & P5, RF; P8 & P4, IF; P3 & P7***

All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**No internal connection.
***P3 and P7 are connected together to make IF port.

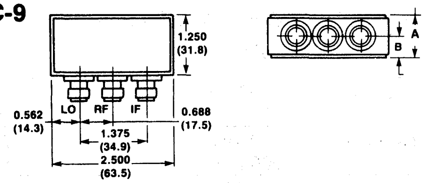
Ordering Information

Model No.		Package
MD-108	PIN	Relay Header
MD-143	BNC	Connectorized
MD-146	PIN	Relay Header

RH-3



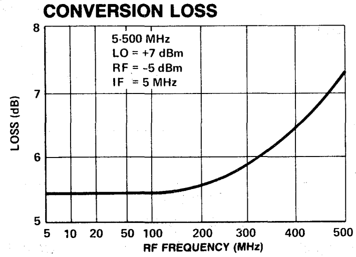
C-9

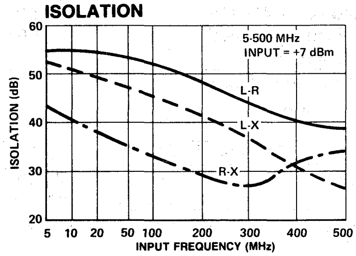


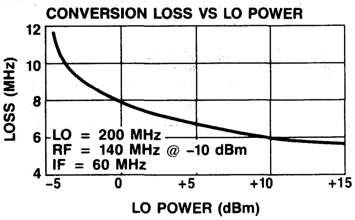
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Surface Mount Double-Balanced Mixer 10-500 MHz

MDS-223

- Fully Hermetic Package
- Low Cost
- 7 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-500 MHz
	IF Port		DC-500 MHz
Conversion Loss	5-150 MHz		7.0 dB Max
	150-500 MHz		9.0 dB Max
Isolation	LO to RF	(5-150 MHz)	40 dB Min
		(150-500 MHz)	35 dB Min
	LO to IF	(5-150 MHz)	35 dB Min
		(150-500 MHz)	25 dB Min
	RF to IF	(5-150 MHz)	25 dB Min
		(150-500 MHz)	20 dB Min

Operating Characteristics

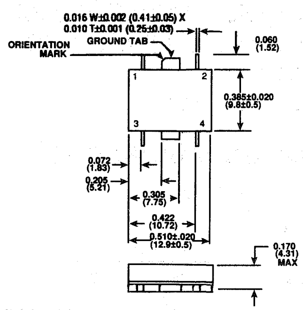
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	400 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 1 mV Typical
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 25 MHz and 35 MHz IF)	100-350 MHz ≥ 55 dB 350-500 MHz ≥ 40 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground All other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**No internal connection.
***P3 and P7 are connected together to make IF port.

Ordering Information

Model No.	Package
MDS-223 PIN	Surface Mount

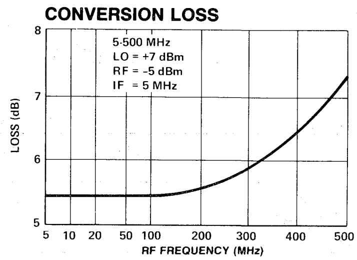
SF-1

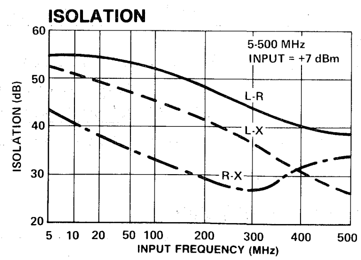


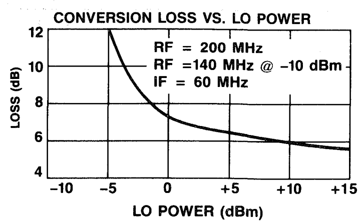
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

High-Level Double-Balanced Mixer 5-500 MHz

MD-155

- +35 dBm Typical Third Order IM Intercept
- +23 dBm Typical Midband 1 dB Compression
- +27 dBm LO Power

Guaranteed Specifications*

(From −55°C to +85°C)

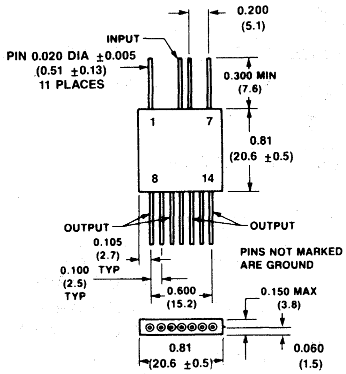
Frequency Range	RF, LO Ports	5-500 MHz
	IF Port	3-200 MHz
Conversion Loss	5-100 MHz	8.0 dB Max
	5-500 MHz	9.5 dB Max
Isolation	LO to RF (5-500 MHz)	20 dB Min
	LO to IF (5-500 MHz)	25 dB Min
	RF to IF (5-500 MHz)	25 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	1 Watt Max Derated to 85°C @ 4.8 mW/°C
RF Input	
1 dB Compression	+23 dBm Typical
1 dB Desensitization	+23 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Two-Tone IM Ratio (with 0 dBm input, each tone and 60 MHz IF)	70 dB Typical
Package Type	Flatpack (FP-5) (See page 475 for physical dimensions.)
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P10, LO; P12, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +27 dBm available LO power with 50 ohm source and load impedance.

FP-5



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

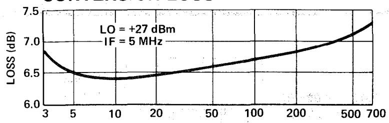
Ordering Information

Model No.	Package
MD-155 PIN	Flatpack

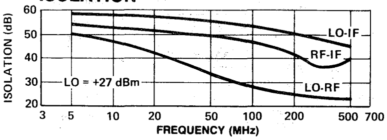
Specifications Subject to Change Without Notice.

Typical Performance

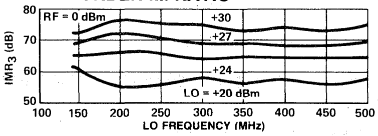
CONVERSION LOSS



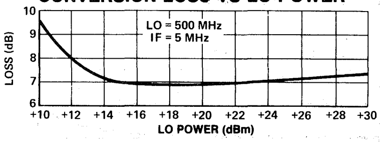
ISOLATION



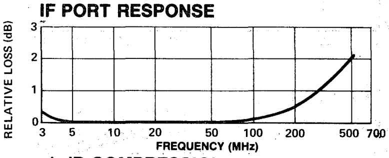
3RD ORDER IM RATIO



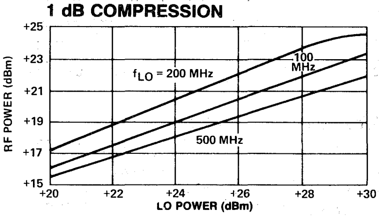
CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



1 dB COMPRESSION



Specifications Subject to Change Without Notice.

M/A-COM

High-Level Double-Balanced Mixer 5-500 MHz

MD-151

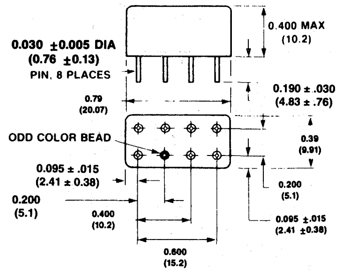
- +19 dBm Typical Third Order IM Intercept
- +13 dBm Typical Compression Point

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-500 MHz
	IF Port		DC-500 MHz
Conversion Loss			
	5-200 MHz		8.8 dB Max
	200-500 MHz		9.8 dB Max
Isolation	LO to RF	(5-200 MHz)	30 dB Min
		(200-500 MHz)	25 dB Min
	LO to IF	(5-200 MHz)	25 dB Min
		(200-500 MHz)	15 dB Min
	RF to IF	(5-200 MHz)	18 dB Min
		(200-500 MHz)	13 dB Min

RH-3



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

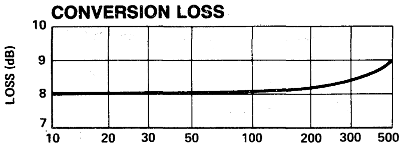
Operating Characteristics

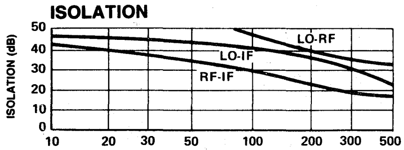
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	+13 dBm Typical
1 dB Desensitization	+10 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	80-250 MHz ≥48 dB 250-430 MHz ≥51 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO; P1, IF; P3 & P7**, P5; External ground. Case and all other pins are ground.

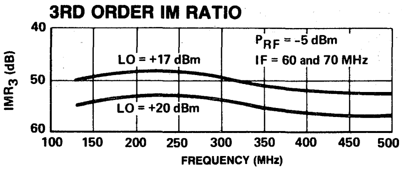
*All specifications apply when operated at + 17 dBm available LO power with 50 ohm source and load impedance.

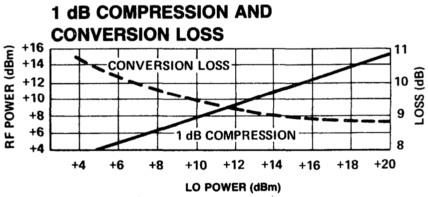
**P3 & P7 are connected together externally to make an IF Port.

Typical Performance









Ordering Information

Model No.	Package
MD-151 PIN	Relay Header

Specifications Subject to Change Without Notice.

![M/A-COM]

High-Performance Double-Balanced Mixer 5-1000 MHz

MD-113/141

- 7 dB Typical Conversion Loss
- Low Cost Flatpack (MD-113)
- Connectorized Package (MD-141)

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-1000 MHz
	IF Port		DC-1000 MHz
Conversion Loss	5-50 MHz		7.5 dB Max
	50-500 MHz		7.5 dB Max
	500-1000 MHz		8.0 dB Max
Isolation	LO to RF	(5-50 MHz)	35 dB Min
		(50-500 MHz)	30 dB Min
		(500-1000 MHz)	25 dB Min
	LO to IF	(5-50 MHz)	30 dB Min
		(50-500 MHz)	25 dB Min
		(500-1000 MHz)	20 dB Min
	RF to IF	(5-50 MHz)	25 dB Min
		(50-500 MHz)	20 dB Min
		(500-1000 MHz)	15 dB Min

Operating Characteristics

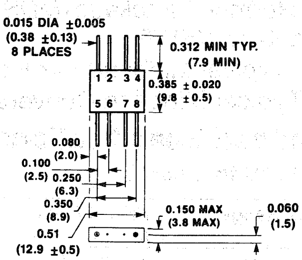
Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated linearly to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		≤2 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)		100-550 MHz ≥47 dB
		550-800 MHz ≥38 dB
		800-1000 MHz ≥44 dB
Environmental See Appendix for MIL-STD-883 screening option.		
Pin Configuration		RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

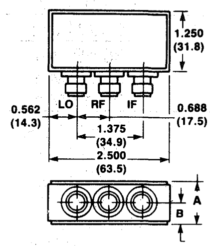
Ordering Information

Model No.		Package
MD-113	PIN	Flatpack
MD-141	BNC	Connectorized
MD-141	SMA	Connectorized

FP-2



C-9

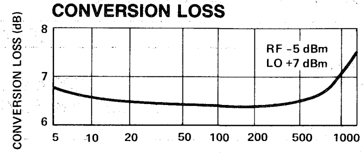


Dimensions in ( ) are in mm.

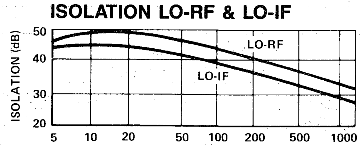
See Appendix for complete physical dimensions.

Typical Performance

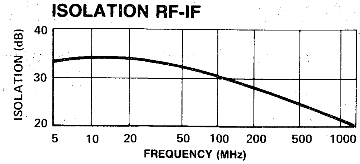
CONVERSION LOSS



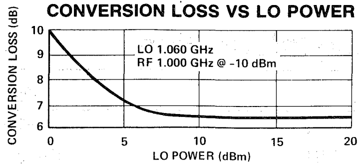
ISOLATION LO-RF & LO-IF



ISOLATION RF-IF



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

![M/A-COM]

Surface Mount Double-Balanced Mixer 5-1000 MHz

MD-/MDS-159

- Fully Hermetic Package (MDS-159)
- Guaranteed VSWR
- 45 dB Typical Midband L-R Isolation
- 6 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-1000 MHz
	IF Port		DC-1000 MHz
Conversion Loss	10-500 MHz		7.5 dB Max
	5-1000 MHz		8.5 dB Max
Isolation		5-500 MHz	500-1000 MHz
LO to RF		35 dB Min	30 dB Min
LO to IF		30 dB Min	22 dB Min
RF to IF		25 dB Min	20 dB Min
VSWR (LO, RF)		10-500 MHz	5-1000 MHz
LO Port		1.8:1 Max	2.0:1 Max
RF Port**		1.7:1 Max	3.0:1 Max
VSWR (IF Port)**	DC-100 MHz		1.5:1 Max
	DC-500 MHz		2.0:1 Max
	DC-1000 MHz		2.5:1 Max

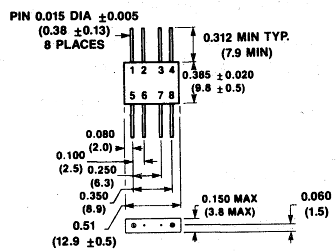
Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Positive
DC Offset		≤1 mV Typical
RF Input	1 dB Compression	+1.5 dBm Typ
	1 dB Desensitization	−1.5 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio		50 dB @ 10 MHz
(with −10 dBm input, each		50 dB @ 100 MHz
tone and 10 MHz separation)		45 dB @ 500 MHz

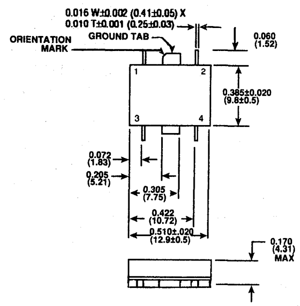
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**Specified for LO power @ +7 dBm, 250 MHz; test port power @ −10 dBm.

FP-2



SF-1



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

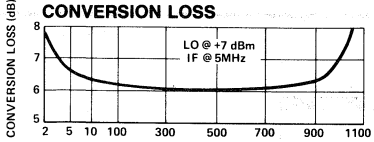
Ordering Information

Model No.		Package
MD-159	PIN	Flatpack
MDS-159	PIN	Surface Mount

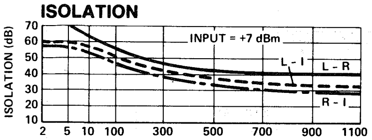
Specifications Subject to Change Without Notice.

Typical Performance

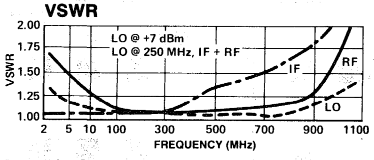
CONVERSION LOSS



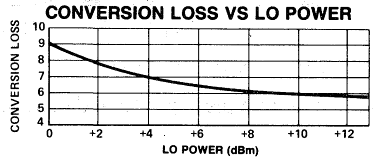
ISOLATION



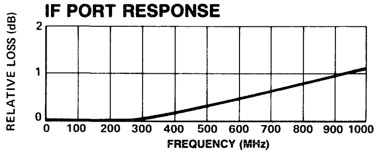
VSWR



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Pin Configuration

MD-159

Pin Number	Description
1	Ground
2	Ground
3	Ground
4	IF
5	LO
6	Ground
7	Ground
8	RF

MDS-159

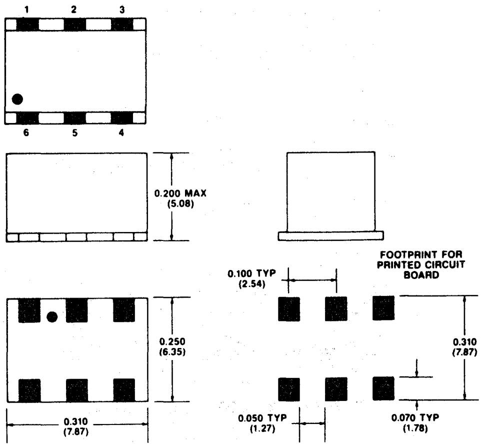
Pin Number	Description
1	Ground
2	IF
3	LO
4	RF

Double-Balanced Mixer 5-1000 MHz

MD-456

- LO Power +7 dBm
- Surface Mount
- MCL Model RMS-2 Replacement

SF-3



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5 - 1000 MHz
	IF Port		DC - 1000 MHz
Conversion Loss	5 - 500 MHz		8.0 dB Max
	500 - 1000 MHz		9.5 dB Max
Isolation	LO to RF	5 - 50 MHz	40 dB Min
		50 - 500 MHz	20 dB Min
		500 - 1000 MHz	18 dB Min
	LO to IF	5 - 50 MHz	30 dB Min
		50 - 500 MHz	20 dB Min
		500 - 1000 MHz	12 dB Min
	RF to IF	5 - 50 MHz	30 dB Min
		50 - 500 MHz	17 dB Min
		500 - 1000 MHz	10 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	50 Max
IF Port Current	40 mA Max
DC Polarity	Neg
DC Offset	≤ 2.0 mV Typ
RF Input for 1dB Compression	+2.0 dBm Typ
RF Input for 1 dB Desensitization	0.0 dBm Typ
SSB Noise Figure	Within 1.0 dB of Conversion
Two-Tone IM Ratio	60 dB Typ at 160 MHz
(with −10 dBm input, each	52 dB Typ at 500 MHz
tone and 50 & 60 MHz IF)	42 dB Typ at 1000 MHz
Pin Configuration	RF; P4, LO; P1, IF; P5

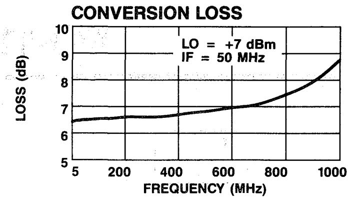
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance, and with pins 2, 3 & 6 grounded.

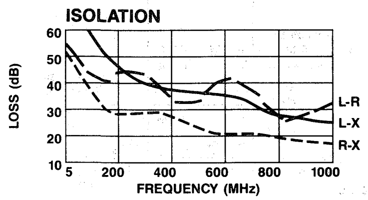
Ordering Information

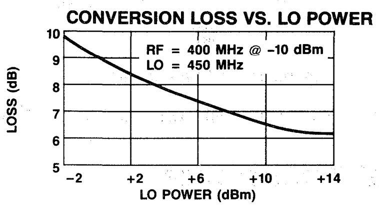
Model No.	Package
MD-456 PIN	Surface Mount

Specifications Subject to Change Without Notice.

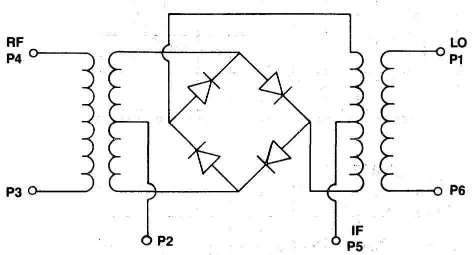
Typical Performance







Schematic



Specifications Subject to Change Without Notice.

M/A-COM

Double-Balanced Mixer 10-1000 MHz

MD-110

- Low Cost
- 7 dB Typical Conversion Loss
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1000 MHz
	IF Port		DC-1000 MHz
Conversion Loss	10-50 MHz		8.0 dB Max
	50-800 MHz		7.5 dB Max
	800-1000 MHz		9.0 dB Max
Isolation	LO to RF	(10-100 MHz)	45 dB Min
		(100-400 MHz)	40 dB Min
		(400-800 MHz)	30 dB Min
		(800-1000 MHz)	25 dB Min
	LO to IF	(10-100 MHz)	40 dB Min
		(100-400 MHz)	27 dB Min
		(400-800 MHz)	25 dB Min
		(800-1000 MHz)	20 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-400 MHz)	20 dB Min
		(400-800 MHz)	15 dB Min
		(800-1000 MHz)	12 dB Min

Operating Characteristics

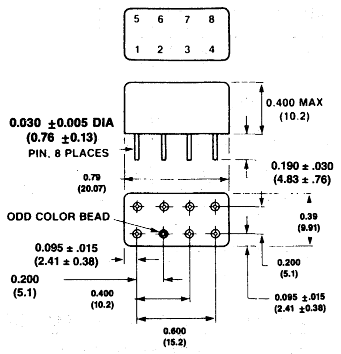
Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		⩽ 1 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 50 MHz and 60 MHz IF)		200 MHz ⩾ 55 dB 600 MHz ⩾ 40 dB
Environmental See Appendix for MIL-STD-883 screening option.		
Pin Configuration		RF; P8, LO; P1, IF; P3 & P7**. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**P3 & P7 are connected together externally to make and IF Port.

Ordering Information

Model No.	Package
MD-110 PIN	Relay Header

RH-3

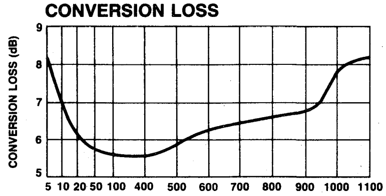


Dimensions in ( ) are in mm.

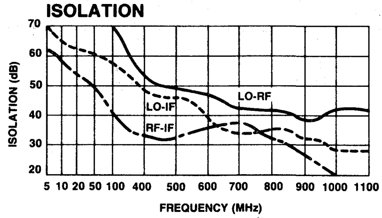
See Appendix for complete physical dimensions.

Typical Performance

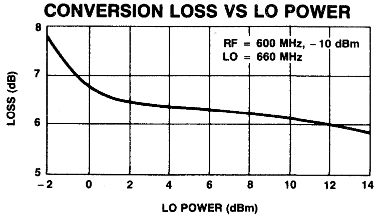
CONVERSION LOSS



ISOLATION



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

Termination-Insensitive Mixer 1-1500 MHz

MD-160

- Third Order Intermodulation Ratio is Insensitive to Port Mismatches
- 7.5 dB Typical Midband Conversion Loss
- VSWR Typically Less Than 1.5:1

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-1500 MHz
	IF Port (3 dB BW)		1-1000 MHz
Conversion Loss**	5-1000 MHz		7.5 dB Max
	1-1500 MHz		9.0 dB Max
Isolation	LO to RF	(1-5 MHz)	20 dB Min
		(5-500 MHz)	28 dB Min
		(500-1500 MHz)	25 dB Min
	LO to IF	(1-5 MHz)	20 dB Min
		(5-500 MHz)	28 dB Min
		(500-1500 MHz)	17 dB Min
	RF to IF	(1-5 MHz)	20 dB Min
		(5-500 MHz)	25 dB Min
		(500-1500 MHz)	17 dB Min

Operating Characteristics

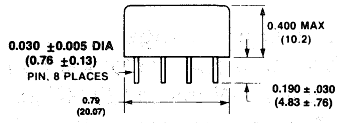
Impedance			50 Ohms Nominal
Maximum Input			
Total Power			350 mW Max @ 25°C
			Derated 3.5 mW/°C
RF Input	1 dB Compression***		+15 dBm Typ
	1 dB Desensitization***		+13 dBm Typ
SSB Noise Figure			Within 1 dB of Conversion Loss Max
3rd Order Input Intercept			
	P_{LO} +13 dBm	P_{LO} +20 dBm	
	+18 dBm Typ	+23 dBm Typ	@ 15 MHz
	+20 dBm Typ	+25 dBm Typ	@ 500 MHz
	+19 dBm Typ	+25 dBm Typ	@ 1000 MHz
3rd Order Intercept Degradation			3 dB Typ @ IF VSWR 3.0:1
Environmental			
See Appendix for MIL-STD-883 screening option.			
Pin Configuration			RF; P8, LO; P1, IF; P3 & P7. Case and all other pins are ground.

*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.
**For IF frequencies of 5-1000 MHz and an RF of −10 dBm or lower.
***These characteristics apply @ +20 dBm LO power.
This product contains elements protected by United States Patent Number 4,224,572.

Ordering Information

Model No.	Package
MD-160 PIN	Relay Header

RH-3

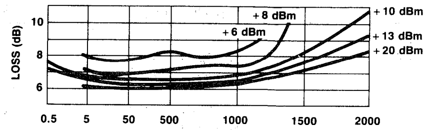


Dimensions in ( ) are in mm.

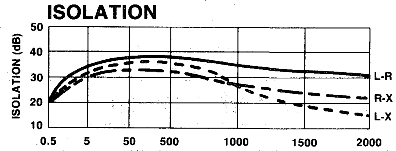
See Appendix for complete physical dimensions.

Typical Performance

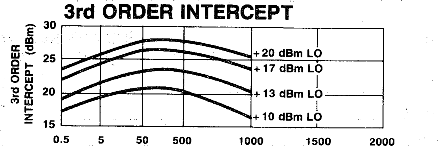
CONVERSION LOSS



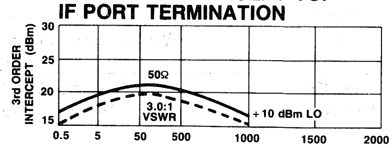
ISOLATION



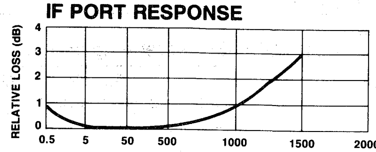
3rd ORDER INTERCEPT



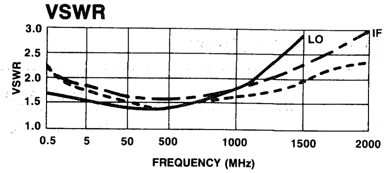
3rd ORDER INTERCEPT VS. IF PORT TERMINATION



IF PORT RESPONSE



VSWR



Specifications Subject to Change Without Notice.

M/A-COM

Double-Balanced Mixer 5-1500 MHz

MDS-158

- Surface Mount Package
- 6 dB Typical Midband Conversion Loss
- 30 dB Typical Midband LO-RF Isolation
- 1.5 dB Typical Conversion Loss Flatness

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
RF, LO Ports		5-1500 MHz
IF Port		DC-1000 MHz
Conversion Loss	5-1500 MHz	9 dB Max
	5-1000 MHz	7.5 dB Max
Isolation		
LO to RF	(5-1500 MHz)	20 dB Min
	(5-1000 MHz)	25 dB Min
LO to IF	(5-1500 MHz)	15 dB Min
	(5-600 MHz)	20 dB Min
RF to IF	(5-1500 MHz)	8 dB Min
	(5-1000 MHz)	16 dB Min
	(5-600 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	⩽1 mV Typical
RF Input	
1 dB Compression	+1 dBm Typical
1 dB Desensitization	−1 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	50 dB @ 300 MHz 48 dB @ 1000 MHz

Environmental
See Appendix for MIL-STD-883 screening option.

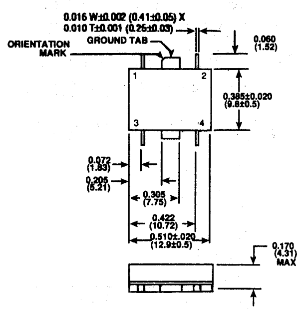
Pin Configuration	RF; P4, LO; P3, IF; P2. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MDS-158 PIN	Surface Mount

SF-1

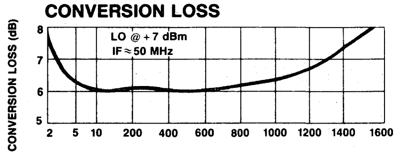


Dimensions in ( ) are in mm.

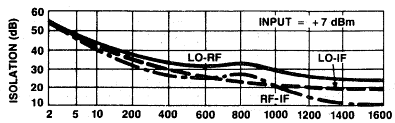
See Appendix for complete physical dimensions.

Typical Performance

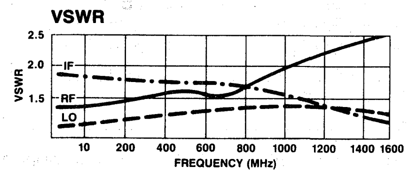
CONVERSION LOSS



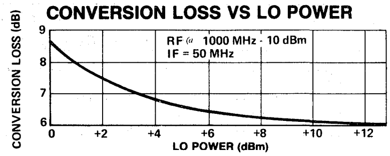
ISOLATION



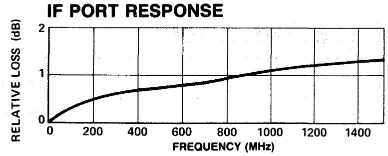
VSWR



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

M/A-COM

Double-Balanced Mixer 5-1500 MHz

MD-158

- 6 dB Typical Midband Conversion Loss
- 35 dB Typical Midband LO-RF Isolation
- 1.5 dB Typical Conversion Loss Flatness

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-1500 MHz
	IF Port		DC-1000 MHz
Conversion Loss	5-1500 MHz		9 dB Max
	5-1000 MHz		7 dB Max
Isolation	LO to RF	(5-1500 MHz)	20 dB Min
		(5-1000 MHz)	25 dB Min
		(5-600 MHz)	30 dB Min
	LO to IF	(5-1500 MHz)	17 dB Min
		(5-1000 MHz)	20 dB Min
	RF to IF	(5-1500 MHz)	8 dB Min
		(5-1000 MHz)	18 dB Min
		(5-600 MHz)	20 dB Min

Operating Characteristics

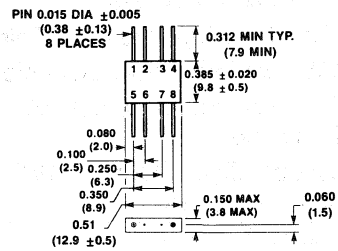
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤1 mV Typical
RF Input	
1 dB Compression	+1 dBm Typical
1 dB Desensitization	−1 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	50 dB @ 300 MHz 48 dB @ 1000 MHz
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MD-158 PIN	Flatpack

FP-2

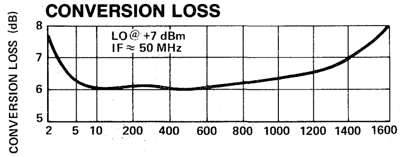


Dimensions in ( ) are in mm.

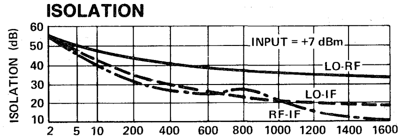
See Appendix for complete physical dimensions.

Typical Performance

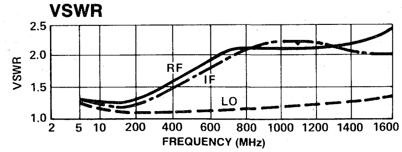
CONVERSION LOSS



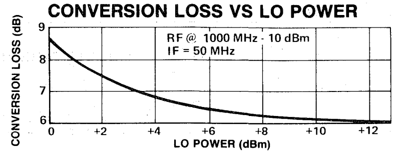
ISOLATION



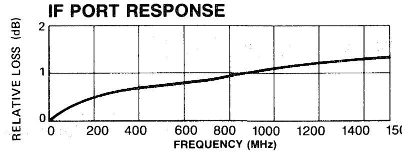
VSWR



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

M/A-COM

Surface Mount Double-Balanced Mixer 10-1500 MHz

MDS-147

- Fully Hermetic Package
- +5 dBm 1 dB Compression Point
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF, LO-IF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

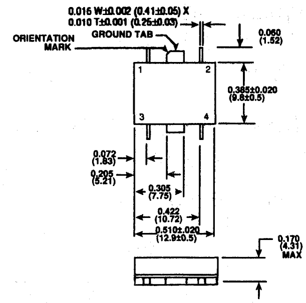
Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-800 MHz		7.5 dB Max
	800-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	25 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤10 mV Typical
RF Input	
1 dB Compression	+10 dBm Typical
1 dB Desensitization	+8 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 50 MHz and 60 MHz IF)**	≥ 54 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

*All specifications apply when operated at +17 dBm available LO power with 50 ohm source and load impedance.
**Measured at 1500 MHz

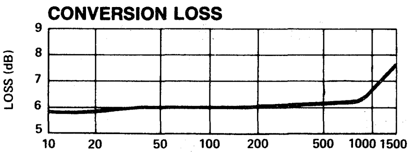
SF-1

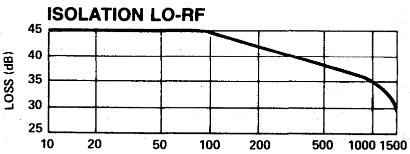


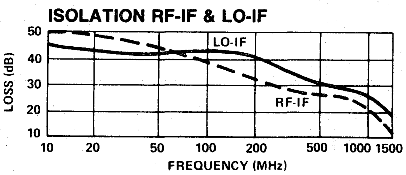
Dimensions in ( ) are in mm.

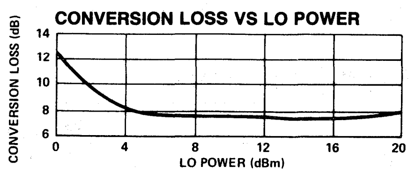
See Appendix for complete physical dimensions.

Typical Performance









Ordering Information

Model No.	Package
MDS-147 PIN	Surface Mount

Specifications Subject to Change Without Notice.

Broadband Double-Balanced Mixer
10-1500 MHz

MD-152

- Over Two-Decade Frequency Range
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF Isolation

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-1000 MHz		7.5 dB Max
	1000-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	30 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

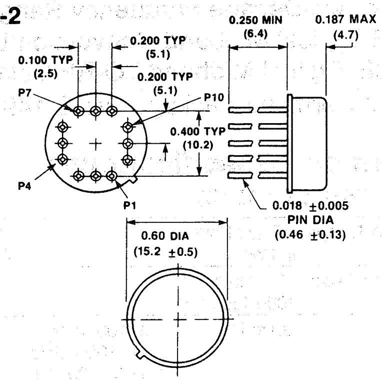
Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max
		Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		≤4 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio		100-500 MHz ≥48 dB
(with −10 dBm input, each		500-1000 MHz ≥43 dB
input, 25 MHz and 35 MHz IF)		1000-1500 MHz ≥35 dB
Environmental		
See Appendix for MIL-STD-883 screening option.		
Pin Configuration		RF; P11, LO; P8, IF; P2.
		All other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MD-152 PIN	Pin

TO-8-2

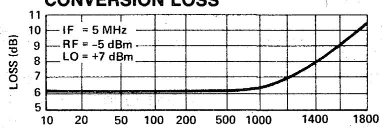


Dimensions in ( ) are in mm.

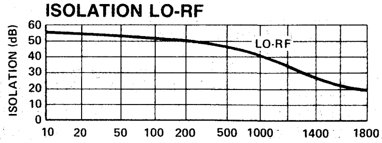
See Appendix for complete physical dimensions.

Typical Performance

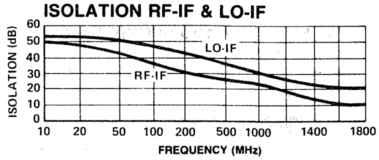
CONVERSION LOSS



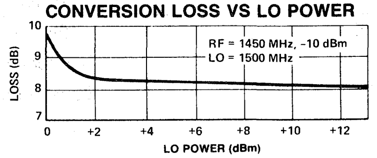
ISOLATION LO-RF



ISOLATION RF-IF & LO-IF



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

Double-Balanced Mixer 10-1500 MHz

MD-/MDC-/MDS-149

- Over Two-Decade Frequency Range
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF Isolation
- Fully Hermetic Package (MDS-149)

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-1000 MHz		7.5 dB Max
	1000-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	30 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
Maximum Input		
Total Power		300 mW Max
		Derated to 85°C @ 3.2 mW/°C
IF Port Current		50 mA Max
DC Polarity		Negative
DC Offset		≤4 mV Typical
RF Input	1 dB Compression	0 dBm Typ
	1 dB Desensitization	−2.0 dBm Typ
SSB Noise Figure		Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)		100-500 MHz ≥48 dB
		500-1000 MHz ≥43 dB
		1000-1500 MHz ≥35 dB
Environmental		

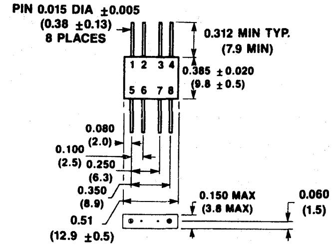
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

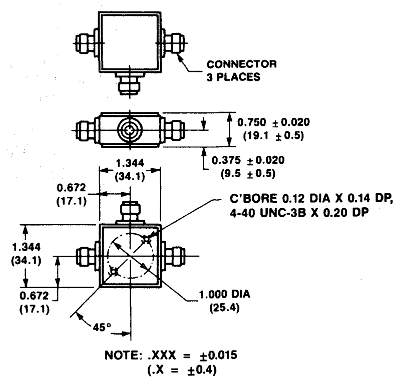
Ordering Information

Model No.	Package
MD-149 PIN	Flatpack
MDC-149 SMA	Connectorized
MDS-149 PIN	Surface Mount

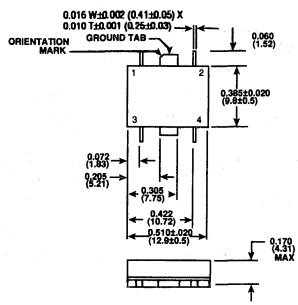
FP-2



C-7



SF-1

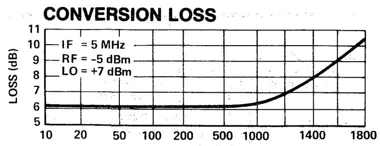


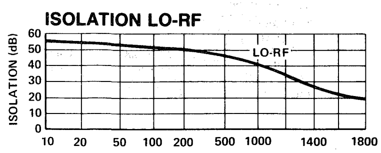
Dimensions in ( ) are in mm.

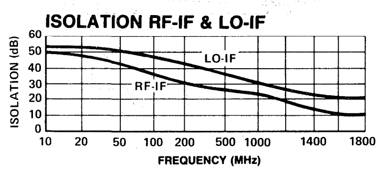
See Appendix for complete physical dimensions.

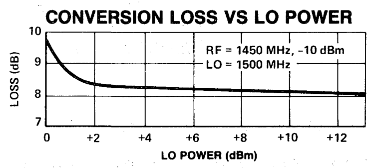
Specifications Subject to Change Without Notice.

Typical Performance









Pin Configuration

MD-149

Pin Number	Description
1	Ground
2	Ground
3	Ground
4	IF
5	LO
6	Ground
7	Ground
8	RF

MDS-149

Pin Number	Description
1	Ground
2	IF
3	LO
4	RF

Double-Balanced Mixer 10-1500 MHz

MD-/MDS-148

- Fully Hermetic Package (MDS-148)
- +5 dBm 1 dB Compression Point
- 6 dB Typical Midband Conversion Loss
- 40 dB Typical Midband LO-RF, LO-IF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		10-1500 MHz
	IF Port		DC-1500 MHz
Conversion Loss	10-800 MHz		7.5 dB Max
	800-1500 MHz		10 dB Max
Isolation	LO to RF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	25 dB Min
		(1000-1500 MHz)	20 dB Min
	LO to IF	(10-100 MHz)	35 dB Min
		(100-1000 MHz)	20 dB Min
		(1000-1500 MHz)	12 dB Min
	RF to IF	(10-100 MHz)	30 dB Min
		(100-1000 MHz)	18 dB Min
		(1000-1500 MHz)	8 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
X Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤10 mV Typical
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 50 MHz and 60 MHz IF)**	≥ 50 dB @ 1500 MHz

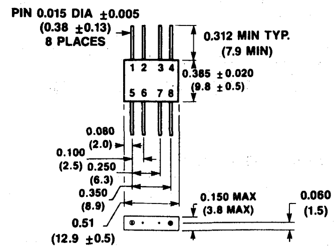
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**Measured at 1500 MHz

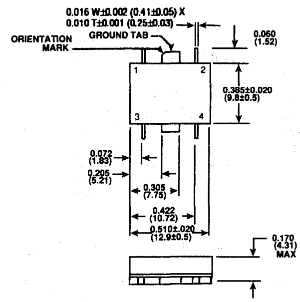
Ordering Information

Model No.	Package
MD-148 PIN	Flatpack
MDS-148 PIN	Surface Mount

FP-2



SF-1

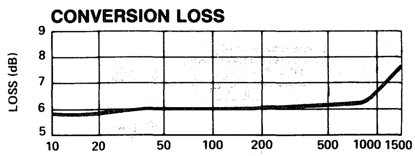


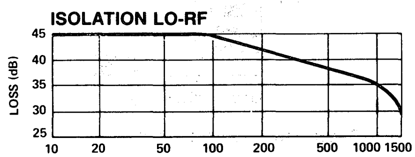
Dimensions in ( ) are in mm.

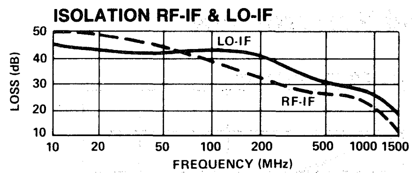
See Appendix for complete physical dimensions.

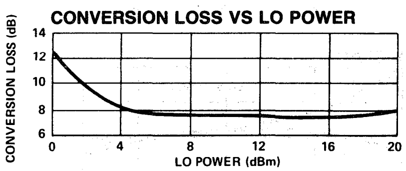
Specifications Subject to Change Without Notice.

Typical Performance









Pin Configuration

MD-148

Pin Number	Description
1	Ground
2	Ground
3	Ground
4	IF
5	LO
6	Ground
7	Ground
8	RF

MDS-148

Pin Number	Description
1	Ground
2	IF
3	LO
4	RF

Specifications Subject to Change Without Notice.

Surface Mount Double-Balanced Mixer 600-2000 MHz

MDS-217

- Fully Hermetic Package
- 6.5 dB Typical Noise Figure
- 30 dB Typical LO-RF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		600-2000 MHz
	IF Port		DC-1000 MHz
Conversion Loss and SSB Noise Figure	600-2000 MHz		8.0 dB Max
Isolation	LO to RF	(600-2000 MHz)	25 dB Min
	LO to IF	(600-2000 MHz)	20 dB Min

Operating Characteristics

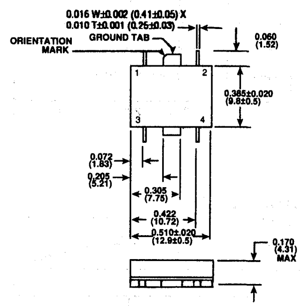
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 6 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−4 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 60 MHz and 70 MHz IF)	44 dB @ 800 MHz 40 dB @ 1500 MHz
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P4, LO; P3, IF; P2 Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MDS-217 PIN	Surface Mount

SF-1

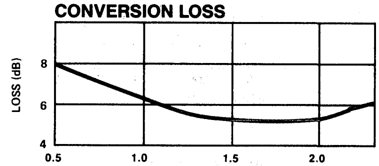


Dimensions in ( ) are in mm.

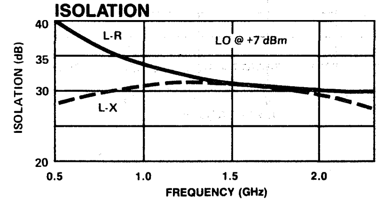
See Appendix for complete physical dimensions.

Typical Performance

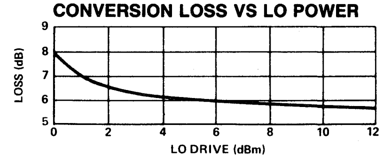
CONVERSION LOSS



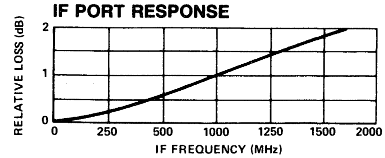
ISOLATION



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

Broadband Double-Balanced Mixers 0.7-2 GHz

MD-150/153

- 6 dB Typical Midband Conversion Loss
- 25 dB Typical Midband Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		700 MHz-2 GHz
	IF Port		DC-300 MHz
Conversion Loss			** 8 dB Max
Isolation	LO to RF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	20 dB Min
	LO to IF	(0.7-1 GHz)	20 dB Min
		(1-2 GHz)	12 dB Min
	RF to IF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	600-2000 MHz ≥36 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	
MD-153	RF; P11, LO; P8, IF; P2. Case and all other pins are ground.

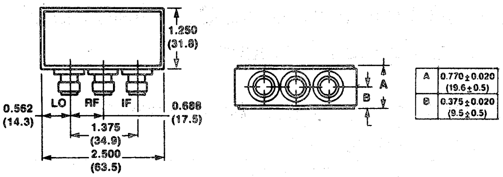
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

** 8.5 dB max for MD-150

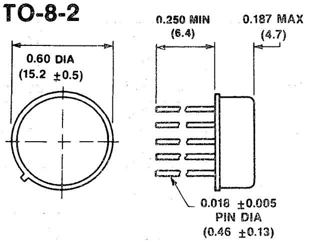
Ordering Information

Model No.		Package
MD-150	SMA	Connectorized
MD-153	PIN	Pin

C-9



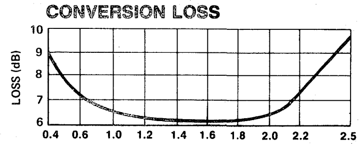
TO-8-2

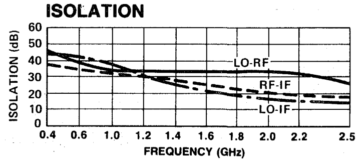


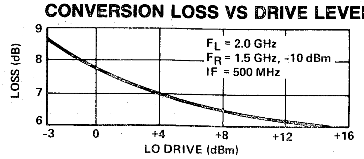
Dimensions in ( ) are in mm.

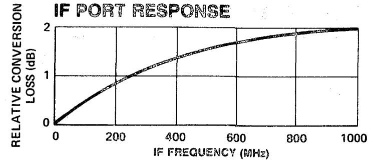
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

Double-Balanced Mixer 0.7-2 GHz

MD-/MDS-614

- Fully Hermetic Package (MDS-614)
- 6 dB Typical Midband Conversion Loss
- 25 dB Typical Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.7 - 2 GHz
	IF Port		DC-300 MHz
Conversion Loss			8 dB Max
Isolation	LO to RF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	20 dB Min
	LO to IF	(0.7-1 GHz)	20 dB Min
		(1-2 GHz)	12 dB Min
	RF to IF	(0.7-1 GHz)	23 dB Min
		(1-2 GHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	600-2000 MHz ≥ 36 dB
Package Type	Surface Mount (SF-1) (See page 490 for physical dimensions)

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration

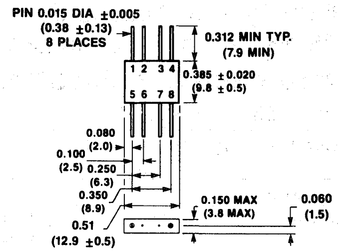
MDS-614	RF; P4, LO; P3, IF; P2 Case and all other pins are ground

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

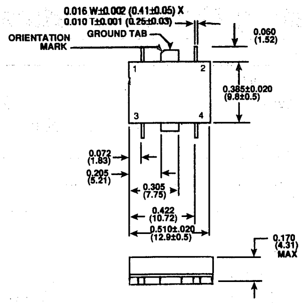
Ordering Information

Model No.	Package
MD-614 PIN	Flatpack
MDS-614 PIN	Surface Mount

FP-2



SF-1



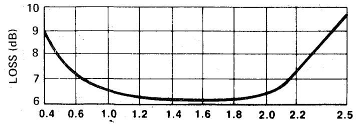
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

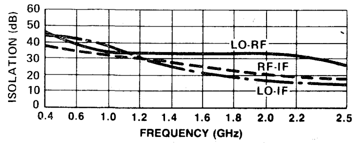
Specifications Subject to Change Without Notice.

Typical Performance

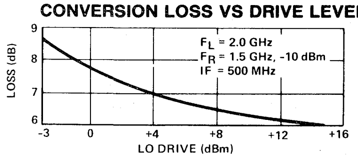
CONVERSION LOSS



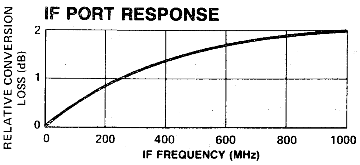
ISOLATION



CONVERSION LOSS VS DRIVE LEVEL



IF PORT RESPONSE



Pin Configuration

MD-614

Pin Number	Description
1	Ground
2	Ground
3	Ground
4	IF
5	LO
6	Ground
7	Ground
8	RF

MDS-614

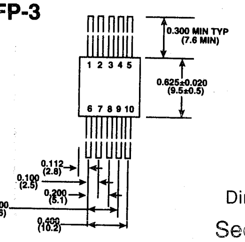
Pin Number	Description
1	Ground
2	IF
3	LO
4	RF

High-Level Termination-Insensitive Mixer
1-2800 MHz

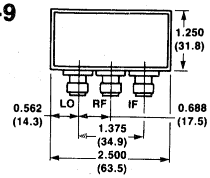
MD-/MDC-174

- Intermodulation Ratio Insensitive to Port Mismatches
- Typical Midband VSWR < 2.0:1
- LO Drive to +27 dBm

FP-3



C-9



Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-2800 MHz
	IF Port		1-2000 MHz
Conversion Loss**		**MDC-174**	**MD-174**
	5-1200 MHz	7.5 dB Max	7.5 Max
	5-2000 MHz	8.5 dB Max	8.0 Max
	1-2800 MHz	9.5 dB Max	9.0 Max
Isolation	LO to RF	(1-1000 MHz)	30 dB Min
		(1-2000 MHz)	20 dB Min
		(1-2800 MHz)	15 dB Min
	LO to IF	(1-1500 MHz)	30 dB Min
		(1-2800 MHz)	25 dB Min
	RF to IF	(5-1000 MHz)	25 dB Min
		(1-2000 MHz)	20 dB Min
		(1-2800 MHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	0.5 Watt Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power	+26 dBm Max
RF Input	
1 dB Compression	+16 dBm Typical
1 dB Desensitization	+14 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio (with 0 dBm input, each tone and 10 MHz IF)	60 dB @ 100 MHz 55 dB @ 1000 MHz 52 dB @ 2800 MHz

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	RF; P10, LO; P6, IF; P5. Case and all other pins are ground.

*All specifications apply when operated at +20 dBm available LO power with 50 ohm source and load impedance.
**Conversion loss for 60 MHz IF.
This product contains elements protected by United States Patent Number 4,224,572.

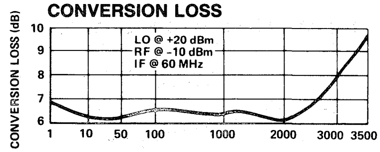
Ordering Information

Model No.	Package
MD-174 PIN	Flatpack
MDC-174 SMA	Connectorized

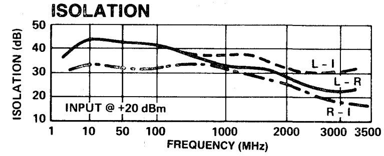
Specifications Subject to Change Without Notice.

Typical Performance

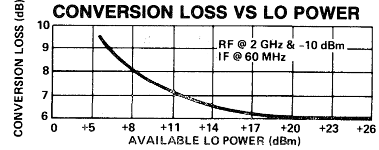
CONVERSION LOSS



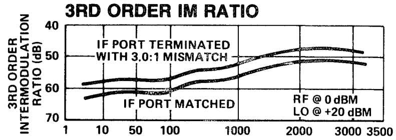
ISOLATION



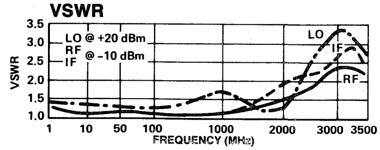
CONVERSION LOSS VS LO POWER



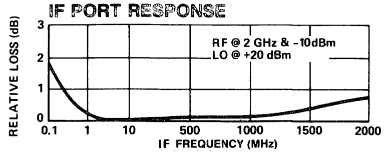
3RD ORDER IM RATIO



VSWR



IF PORT RESPONSE



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M/A-COM

Flatpack Double-Balanced Mixer 0.6-3 GHz

MD-156

- 6.5 dB Typical Noise Figure
- 30 dB Typical LO-RF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		600-3000 MHz
	IF Port		DC-1000 MHz
Conversion Loss and SSB Noise Figure	800-2000 MHz		8.0 dB Max
	600-3000 MHz		9.0 dB Max
Isolation	LO to RF	(600-2000 MHz)	25 dB Min
		(2000-3000 MHz)	20 dB Min
	LO to IF	(600-2000 MHz)	20 dB Min
		(2000-3000 MHz)	17 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 6 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−4 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input 60 MHz and 70 MHz IF)	44 dB @ 800 MHz 40 dB @ 1500 MHz 40 dB @ 2500 MHz

Environmental
See Appendix for MIL-STD-883 screening option.

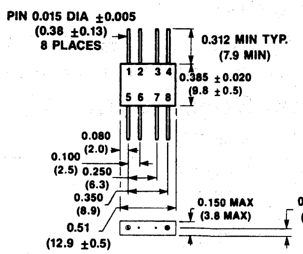
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MD-156 PIN	Flatpack

FP-2

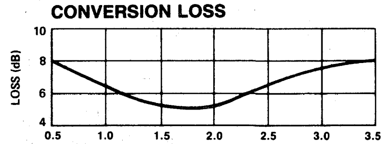


Dimensions in ( ) are in mm.

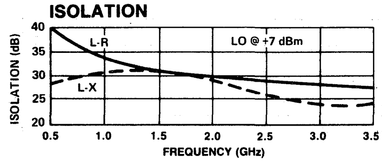
See Appendix for complete physical dimensions.

Typical Performance

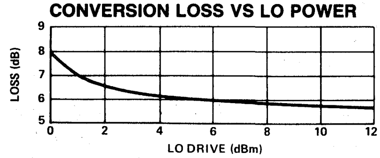
CONVERSION LOSS



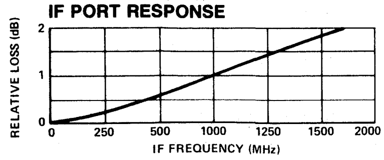
ISOLATION



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

High-Performance Double-Balanced Mixer 10 MHz-3 GHz

MD-/MDC-123

- Usable to 4 GHz
- +7 dBm Typical Compression Level
- Excellent Intermodulation Rejection

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.01 - 3 GHz
	IF Port		0.01 - 3 GHz
Conversion Loss**			8 dB Max†
Isolation	LO to RF	(10-500 MHz)	25 dB Min
		(500-1000 MHz)	30 dB Min
		(1000-3000 MHz)	25 dB Min
	LO to IF	(10-500 MHz)	20 dB Min
		(500-1000 MHz)	25 dB Min
		(1000-3000 MHz)	25 dB Min
	RF to IF	(10-500 MHz)	20 dB Min
		(500-1000 MHz)	25 dB Min
		(1000-3000 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤ 7 mV Typical
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 25 MHz and 35 MHz IF)	100-2000 MHz ≥56 dB
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +10 to +13 dBm available LO power with 50 ohm source and load impedance.

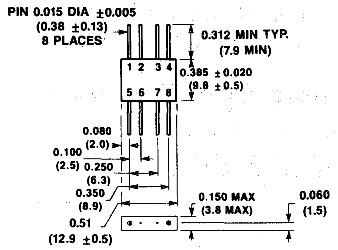
**Specified for IF frequency of 10 MHz to 2 GHz. See IF Port Bandwidth Graph.

†8.5 dB for MDC-123, 1500-3000 MHz.

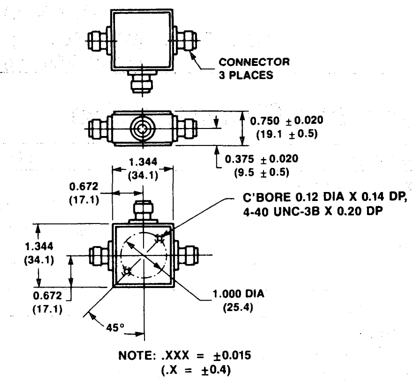
Ordering Information

Model No.	Package
MD-123 PIN	Flatpack
MDC-123 SMA	Connectorized

FP-2



C-7



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

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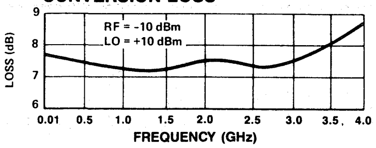
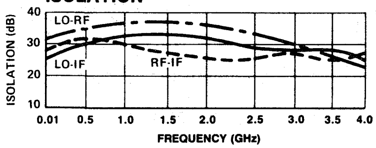
Typical Performance

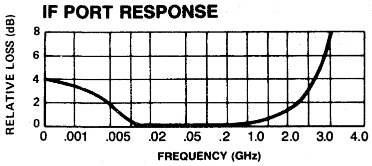
CONVERSION LOSS



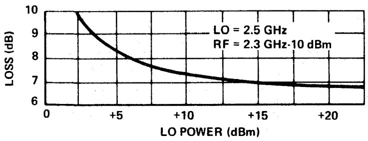
ISOLATION



IF PORT RESPONSE



CONVERSION LOSS VS LO POWER



Specifications Subject to Change Without Notice.

M/A-COM

Termination-Insensitive Mixer 1 MHz-3.5 GHz

MD-/MDC-169

- Intermodulation Ratio is Insensitive to Port Mismatches
- Typical Midband VSWR < 2.0:1
- 35 dB Typical Midband Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.001 - 3.5 GHz
	IF Port		5-1500 MHz
Conversion Loss	5-1000 MHz		7 dB Max
	5-3000 MHz		8 dB Max**
	1-3500 MHz		10 dB Max
Isolation	LO to RF	(5-1000 MHz)	30 dB Min
		(1-3500 MHz)	20 dB Min
	LO to IF	(5-1000 MHz)	30 dB Min
		(1-3500 MHz)	20 dB Min
	RF to IF	(10-500 MHz)	30 dB Min
		(1-3000 MHz)	20 dB Min
		(1-3500 MHz)	18 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio: (with −10 dBm input, each tone and 60 MHz IF)	55 dB @ 10 MHz 58 dB @ 500 MHz 56 dB @ 3000 MHz
3rd Order Intermodulation Ratio Degradation	3 dB Typical @ IF VSWR 3:1
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO; P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

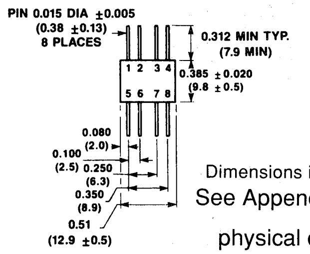
**8.5 dB for MDC-169.

This product contains elements protected by United States Patent Number 4,224,572.

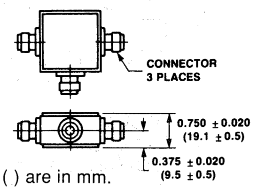
Ordering Information

Model No.	Package
MD-169 PIN	Flatpack
MDC-169 SMA	Connectorized

FP-2

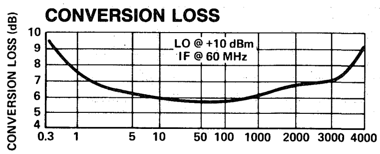


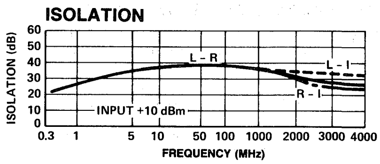
C-7

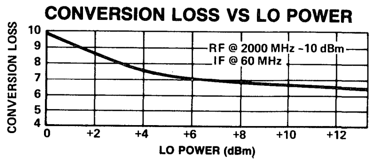


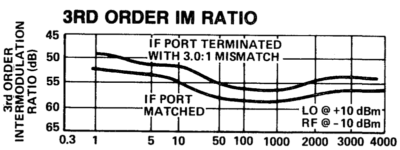
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

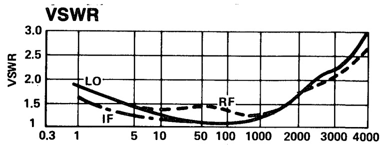
Typical Performance

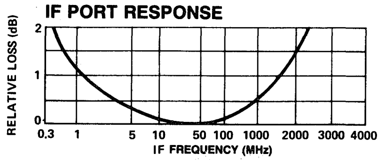












Specifications Subject to Change Without Notice.

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Termination-Insensitive Mixer 1-4000 MHz

MD-/MDC-179

- Intermodulation Ratio is Insensitive to Port Mismatches
- Typical Midband VSWR < 2.0:1
- 35 dB Typical Midband Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-4000 MHz
	IF Port		5-1500 MHz
Conversion Loss†**	5 - 1000 MHz		7.5 dB Max
	5 - 2500 MHz		8.5 dB Max
	5 - 3500 MHz		9.5 dB Max
	1 - 4000 MHz		10.5 dB Max
Isolation	LO to RF	(5-1000 MHz)	30 dB Min
		(1-4000 MHz)	20 dB Min
	LO to IF	(5-1000 MHz)	30 dB Min
		(1-4000 MHz)	20 dB Min
	RF to IF	(10-500 MHz)	30 dB Min
		(1-4000 MHz)	16 dB Min

Operating Characteristics

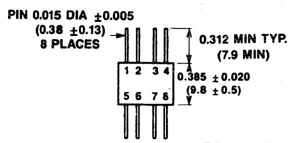
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+5 dBm Typical
1 dB Desensitization	+3 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two Tone IM Ratio: (with −10 dBm input, each tone and 60 MHz IF)	49 dB @ 10 MHz 52 dB @ 500 MHz 50 dB @ 3000 MHz
3rd Order Intermodulation Ratio Degradation	3 dB Typical @ IF VSWR 3:1
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO: P5, IF; P4. Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.
**For IF frequencies of 5-300 MHz and an RF of −10 dBm or lower.
This product contains elements protected by United States Patent Number 4,224,572.
† For MDC-179, add 1.0 dB to conversion loss.

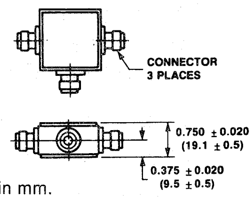
Ordering Information

Model No.	Package
MD-179 PIN	Flatpack
MDC-179 SMA	Connectorized

FP-2



C-7

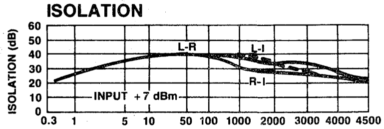


Dimensions in ( ) are in mm.

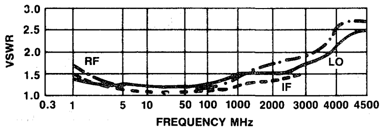
See Appendix for complete physical dimensions.

Typical Performance

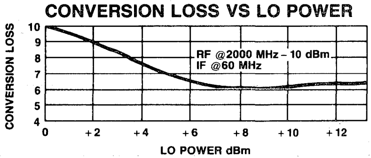
ISOLATION



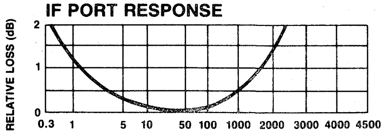
VSWR



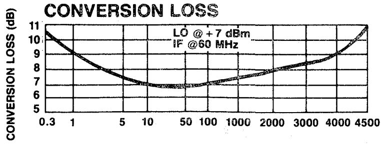
CONVERSION LOSS VS LO POWER



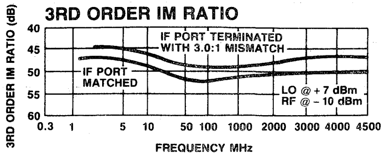
IF PORT RESPONSE



CONVERSION LOSS



3RD ORDER IM RATIO



Specifications Subject to Change Without Notice.

High-Level Double-Balanced Mixer
5-4000 MHz

MD-525-4

- Broadband Frequency Range
- +17 dBm Typical Third Order Intercept Point

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	RF, LO Ports		5-4000 MHz
	IF Port		5-1900 MHz
Conversion Loss	5-2000 MHz		9 dB Max
	2000-4000 MHz		10 dB Max
Isolation	LO to RF	(5-50 MHz)	20 dB Min
		(50-2000 MHz)	25 dB Min
		(200-4000 MHz)	20 dB Min
	LO to IF	(5-50 MHz)	20 dB Min
		(50-2000 MHz)	30 dB Min
		(200-4000 MHz)	25 dB Min
	RF to IF	(5-50 MHz)	20 dB Min
		(50-2000 MHz)	25 dB Min
		(200-4000 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C
	Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤5 mV Typical
RF Input	
1 dB Compression	+6 dBm Typical
1 dB Desensitization	+0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio: (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	80-430 MHz≥53 dB

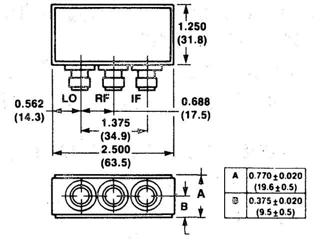
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MD-525-4 SMA	Connectorized
MD-525-4 TNC	Connectorized

C-9

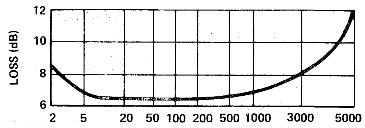


Dimensions in ( ) are in mm.

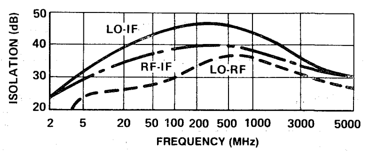
See Appendix for complete physical dimensions.

Typical Performance

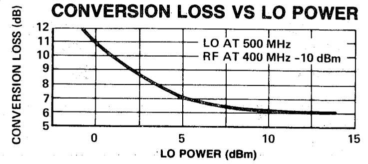
CONVERSION LOSS



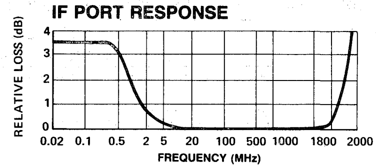
ISOLATION



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

M/A-COM

Double-Balanced Mixer 0.8-4 GHz

MD-157

- 6 dB Typical Midband Conversion Loss
- 30 dB Typical Midband LO-RF Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.8-4 GHz
	IF Port		DC-1500 MHz
Conversion Loss**	800-4000 MHz		8 dB Max
	1500-3500 MHz		7 dB Max
Isolation	LO to RF	(800-4000 MHz)	20 dB Min
		(800-2000 MHz)	25 dB Min
	LO to IF	(800-4000 MHz)	12 dB Min
		(800-2000 MHz)	17 dB Min
	RF to IF	(800-4000 MHz)	15 dB Min
		(800-3000 MHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤8 mV Typical
RF Input	
1 dB Compression	0 dBm Typical
1 dB Desensitization	−4 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input, each input, 60 MHz and 70 MHz IF)	36 dB @ 2 GHz 32 dB @ 4 GHz

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	RF; P5, LO; P8, IF; P4. Case and all other pins are ground.

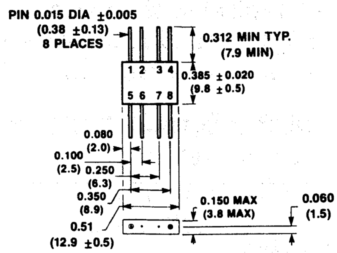
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF Frequencies to 500 MHz.

Ordering Information

Model No.	Package
MD-157 PIN	Flatpack

FP-2

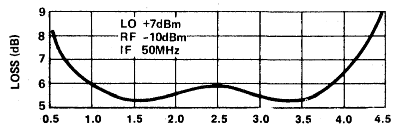


Dimensions in ( ) are in mm.

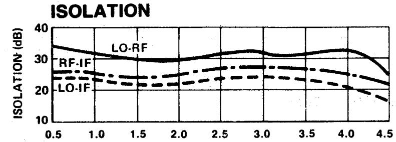
See Appendix for complete physical dimensions.

Typical Performance

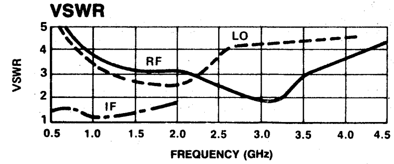
CONVERSION LOSS



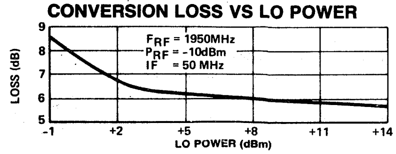
ISOLATION



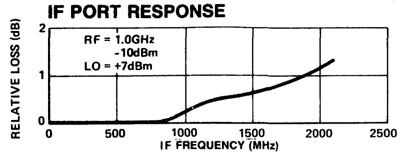
VSWR



CONVERSION LOSS VS LO POWER



IF PORT RESPONSE



Specifications Subject to Change Without Notice.

M/A-COM

Double-Balanced Mixer 2.0-4.0 GHz

MD-/MDC-176

- 4.5 dB Typical Midband Conversion Loss
- 25 dB Typical Midband L-R Isolation
- Operable with Starved LO

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		2.0-4.0 GHz
	IF Port (3 dB BW)		DC-300 MHz
Conversion Loss**			6.0 dB Max
Isolation	LO to RF	(2.0-3.0 GHz)	15 dB Min
		(3.0-4.0 GHz)	20 dB Min
	LO to IF	(2.0-2.5 GHz)	17 dB Min
		(2.5-4.0 GHz)	20 dB Min
	RF to IF	(2.0-4.0 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+7 dBm Typical
4.0 GHz	+7 dBm Typical
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

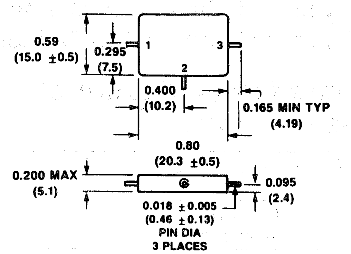
**For IF frequencies of DC-100 MHz and an RF of −10 dBm or lower.

This product contains elements protected by United States Patent Number 4,224,572.

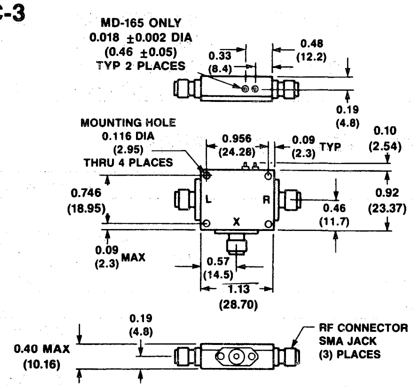
Ordering Information

Model No.	Package
MD-176 PIN	Flatpack
MDC-176 SMA	Connectorized

FP-10



C-3

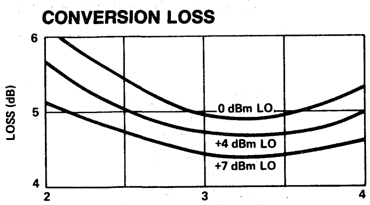


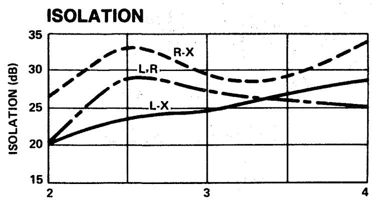
Dimensions in ( ) are in mm.

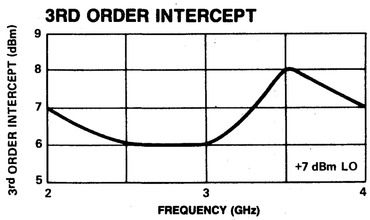
See Appendix for complete physical dimensions.

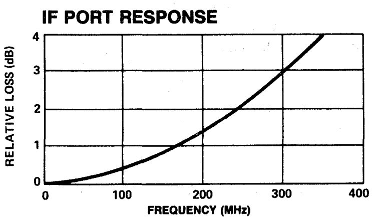
Specifications Subject to Change Without Notice.

Typical Performance









Specifications Subject to Change Without Notice.

Broadband Double-Balanced Mixer 0.3-5 GHz

MD-/MDC-154

- Broadband Frequency Coverage
- 6.5 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.3-5 GHz
	IF Port		0.1-3000 MHz
Conversion Loss†	0.3-4 GHz		9 dB Max
	0.3-5 GHz		10 dB Max**
Isolation	LO to RF	(0.8-2 GHz)	20 dB Min
		(0.5-5 GHz)	14 dB Min
		(0.3-0.5 GHz)	11 dB Min
	LO to IF	(0.8-2 GHz)	20 dB Min
		(0.3-5 GHz)	15 dB Min
	RF to IF	(0.5-4 GHz)	20 dB Min
		(0.3-5 GHz)	17dB Min

Operating Characteristics

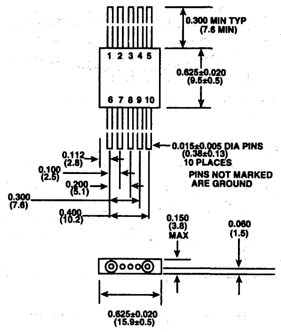
Impedance	50 Ohms Nominal
Maximum Input	
Total Power	600 mW Max @ 25°C Derated to 85°C @ 3.2 mW/°C
IF Port Current	50 mA Max
DC Polarity	Negative
DC Offset	≤3 mV Typical
RF Input	
1 dB Compression	+7 dBm Typical
1 dB Desensitization	+4.5 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
Typical Two-Tone IM Ratio (with −10 dBm input each tone and 10 MHz IF)	62 dB Typical @ 400 MHz 57 dB Typical @ 1500 MHz

Environmental
See Appendix for MIL-STD-883 screening option.

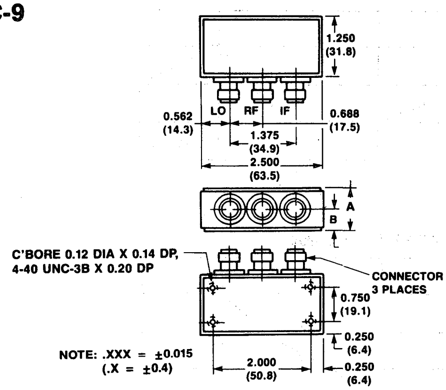
Pin Configuration	RF; P10, LO; P6, IF; P5. Case and all other pins are ground.

All specifications apply when operated at +10 dBm available LO power with 50 ohm source and load impedance.
**11 dB for MDC-154.
†For IF Frequencies to 500 MHz.

FP-3



C-9



Dimensions in ( ) are in mm.

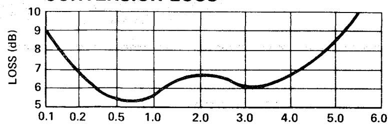
See Appendix for complete physical dimensions.

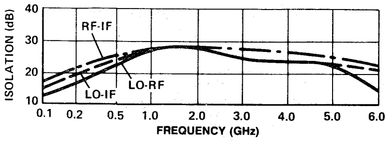
Ordering Information

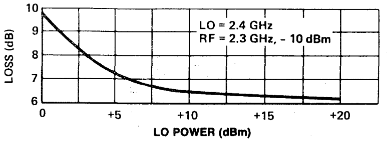
Model No.	Package
MD-154 PIN	Flatpack
MDC-154 SMA	Connectorized

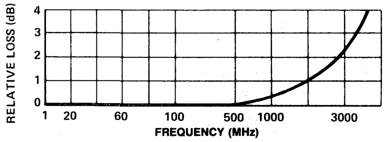
Specifications Subject to Change Without Notice.

Typical Performance









Specifications Subject to Change Without Notice.

Double-Balanced Mixer 2.6-5.2 GHz

MD-/MDC-178

- 4.5 dB Typical Midband Conversion Loss
- 27 dB Typical Midband L-R Isolation
- Operable with Starved LO

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		2.6-5.2 GHz
	IF Port (3 dB BW)		DC-300 MHz
Conversion Loss**			6 dB Max
Isolation	LO to RF	(2.6 - 5.2 GHz)	20 dB Min
	LO to IF	(2.6 - 5.2 GHz)	20 dB Min
	LO to IF	(2.6 - 5.2 GHz)	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max @ 25°C Derated 3.2 mW/°C
RF Input	
1 dB Compression	+2.5 dBm Typical
1 dB Desensitization	0 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.5 GHz	+9 dBm Typical
4.0 GHz	+8 dBm Typical
5.2 Ghz	+12 dBm Typical

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

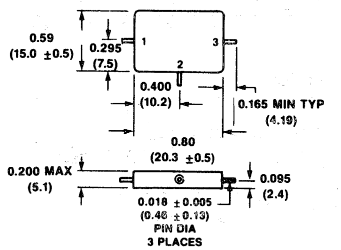
*All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of DC-100 MHz and an RF of −10 dBm or lower.

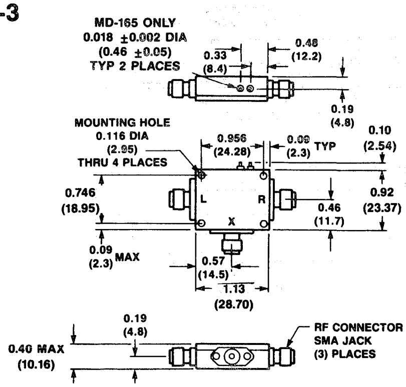
Ordering Information

Model No.	**Package**
MD-178 PIN	Flatpack
MDC-178 SMA	Connectorized

FP-10



C-3

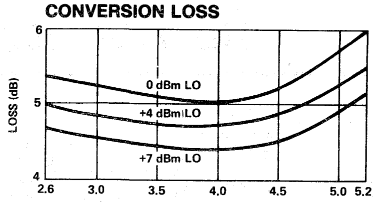


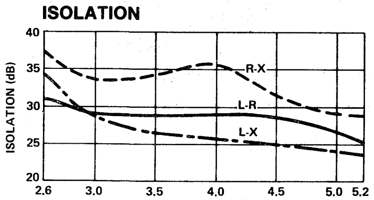
Dimensions in ( ) are in mm.

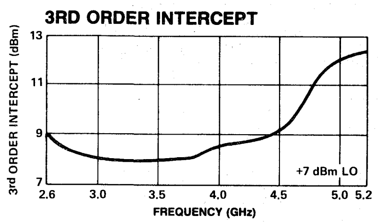
See Appendix for complete physical dimensions.

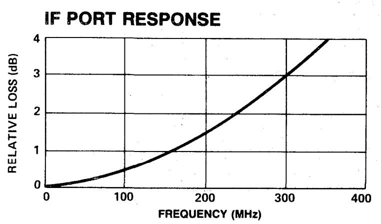
Specifications Subject to Change Without Notice.

Typical Performance









Termination-Insensitive Biasable Mixer
1-6 GHz

MD-/MDC-163

- LO DRIVE 0 dBm
- Intermodulation Ratio Insensitive to IF Port Mismatches
- 7 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-6 GHz
	IF Port		10-2000 MHz
Conversion Loss**	1-3 GHz		9.0 dB Max
	1-6 GHz		10.5 dB Max
Isolation	LO to RF	(1-2 GHz)	10 dB Min
		(2-6 GHz)	13 dB Min
	LO to IF	(1-6 GHz)	13 dB Min
	RF to IF	(1-6 GHz)	15 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	500 mW Max @ 25°C Derated 6.4 mW/°C
DC Bias	+5, −5 VDC @ 12 mA each
RF Input	
1 dB Compression	−2 dBm Typical
1 dB Desensitization	−6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+7.0 dBm Typical
4.0 GHz	+8.0 dBm Typical
6.0 GHz	+5.0 dBm Typical
3rd Order Intercept Degradation	1.5 dB Typical @ IF Termination VSWR 3:1

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	RF; P3, LO; P1, IF; P2. Bias connection as marked, case ground.

*All specifications apply when operated at 0 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

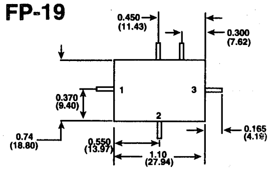
† Independent of sum frequency match.

This product contains elements protected by United States Patent Number 4,224,572.

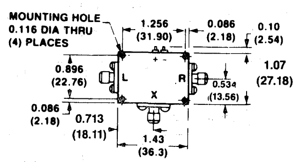
Ordering Information

Model No.	Package
MD-163 PIN	Flatpack
MDC-163 SMA	Connectorized

FP-19



C-2

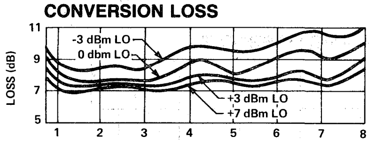


Dimensions in ( ) are in mm.

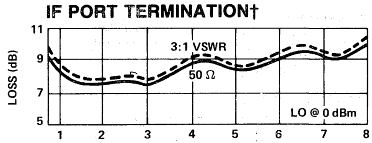
See Appendix for complete physical dimensions.

Typical Performance

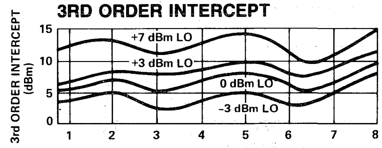
CONVERSION LOSS



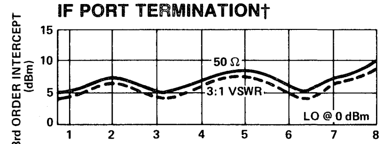
CONVERSION LOSS VS IF PORT TERMINATION†



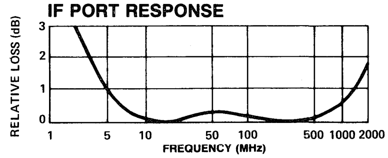
3RD ORDER INTERCEPT



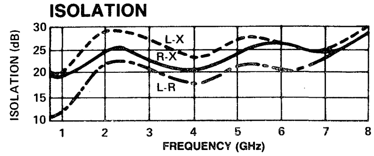
3RD ORDER INTERCEPT VS IF PORT TERMINATION†



IF PORT RESPONSE



ISOLATION



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Termination-Insensitive Mixer 1-7 GHz

MD-/MDC-162

- Intermodulation Ratio Insensitive to IF Port Mismatches
- 6 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		1-7 GHz
	IF Port		10-2000 MHz
Conversion Loss**	1.5-5.5 GHz		7.5 dB Max
	1-7 GHz		8.5 dB Max
Isolation	LO to RF	(1-3 GHz)	15 dB Min
		(3-7 GHz)	17 dB Min
	LO to IF	(1-3 GHz)	20 dB Min
		(3-7 GHz)	13 dB Min
	RF to IF	(1-3 GHz)	17 dB Min
		(3-7 GHz)	12 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	350 mW Max @ 25°C Derated 3.5 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+8 dBm Typical
1 dB Desensitization	+6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+16.5 dBm Typical
7.0 Ghz	+18.0 dBm Typical
3rd Order Intercept Degradation	1.5 dB Typical @ IF Termination VSWR 3:1
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

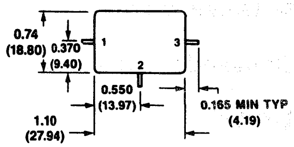
† Independent of sum frequency match.

This product contains elements protected by United States Patent Number 4,224,572.

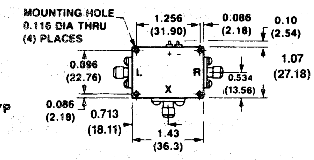
Ordering Information

Model No.	Package
MD-162 PIN	Flatpack
MDC-162 SMA	Connectorized

FP-18



C-2

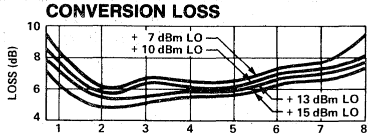


Dimensions in ( ) are in mm.

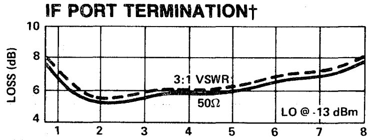
See Appendix for complete physical dimensions.

Typical Performance

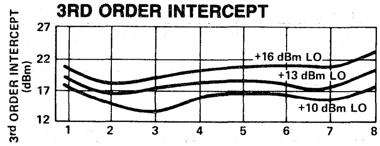
CONVERSION LOSS



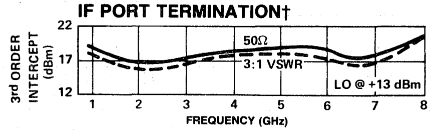
CONVERSION LOSS VS IF PORT TERMINATION†



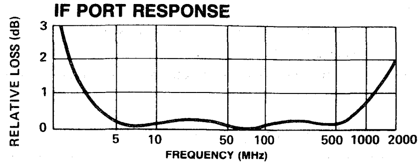
3RD ORDER INTERCEPT



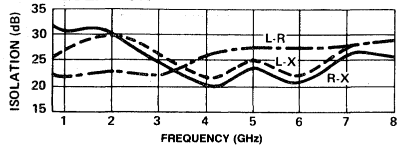
3RD ORDER INTERCEPT VS IF PORT TERMINATION†



IF PORT RESPONSE



ISOLATION



Specifications Subject to Change Without Notice.

M/A-COM

Termination-Insensitive Mixer 0.5-9 GHz

MD-/MDC-164

- Intermodulation Ratio Insensitive to IF Port Mismatches
- 6.5 dB Typical Midband Conversion Loss

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	RF, LO Ports		0.5-9 GHz
	IF Port		10-2000 MHz
Conversion Loss**	1-7 GHz		8.5 dB Max
	0.5-1 GHz		10 dB Max
	7-9 GHz		11 dB Max
Isolation	LO to RF	(1.5-7 GHz)	17 dB Min
		(0.5-9 GHz)	13 dB Min
	LO to IF	(1-7 GHz)	20 dB Min
		(0.5-9 GHz)	17 dB Min
	RF to IF	(0.5-9 GHz)	17 dB Min

Operating Characteristics

Maximum Input	
Total Power	350 MW Max @ 25°C Derated 3.5 mW/°C
LO Power	+24 dBm Max
RF Input	
1 dB Compression	+8 dBm Typical
1 dB Desensitization	+6 dBm Typical
SSB Noise Figure	Within 1 dB of Conversion Loss Max
3rd Order Input Intercept	
2.0 GHz	+15 dBm Typical
8.0 GHz	+17 dBm Typical
3rd Order Intercept Degradation	+1.5 dB Typical @ IF Termination VSWR 3:1

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration	RF; P3, LO; P1, IF; P2. Case ground.

*All specifications apply when operated at +13 dBm available LO power with 50 ohm source and load impedance.

**For IF frequencies of 10-500 MHz and an RF of −10 dBm or lower.

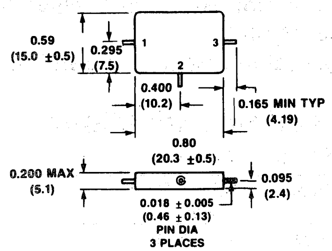
† Independent of sum frequency match.

This product contains elements protected by United States Patent Number 4,224,572.

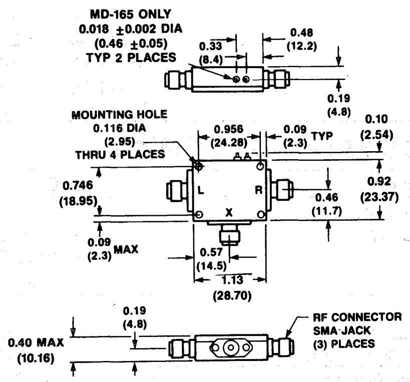
Ordering Information

Model No.	Package
MD-164 PIN	Flatpack
MDC-164 SMA	Connectorized

FP-10



C-3



Dimensions in ( ) are in mm.

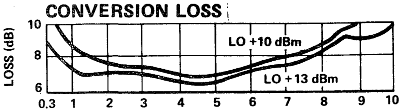
See Appendix for complete physical dimensions.

Specifications Subject to Change Without Notice.

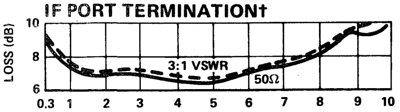
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Performance

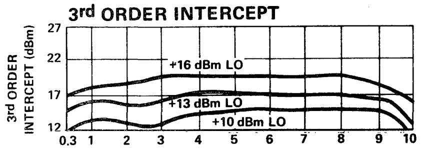
CONVERSION LOSS



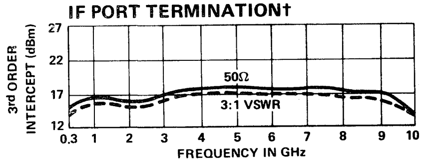
CONVERSION LOSS VS IF PORT TERMINATION†



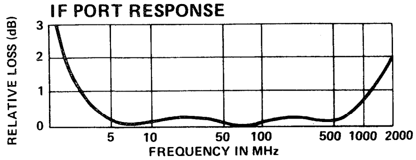
3rd ORDER INTERCEPT



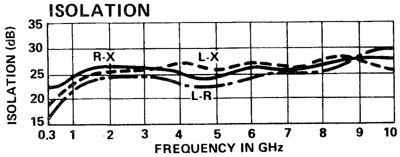
3rd ORDER INTERCEPT VS IF PORT TERMINATION†



IF PORT RESPONSE



ISOLATION



Specifications Subject to Change Without Notice.

RF Biphase and Quadriphase Digital Modulators

Overview

INTRODUCTION

M/A-COM produces a line of miniature, hybrid circuit, digital modulators (our PM-XXX series of products.) These modulators include biphase and quadriphase units with integral ECL series 10,000 digital drivers to facilitate their use with data systems, as well as similar models without drivers. They provide the basic building blocks for bridging the boundary between the quantized video world of the data user or digital designer and the RF oriented discipline of the communicator or communications system designer. The modulators will accept a digital data stream and an RF carrier input and produce a phase modulated output. The properties of the output signal are dependent upon those of the inputs, and the only variable source will be the data waveform.

DESCRIPTION

Biphase Modulators

Biphase Modulators utilize a circuit similar to that of doubly balanced mixers as the basic modulating device as shown in Figure 1. A carrier signal injected at the RF input will appear at the RF output reduced slightly in amplitude due to inherent diode and transformer losses and in one of two possible phase states with the modulating signal and the carrier suppressed. In the 0° phase state, control current is supplied to the diode ring to turn on a pair of diodes (either D1/D4 or D2/D3) which directly connect the input and output transformers. In the 180° phase state, current of opposite polarity switches on the other pair of diodes causing a 180° phase inversion relative to the 0° state. If the modulating bit rate is near the carrier frequency, a waveform of the sort shown in Figure 1 might be obtained. This waveform can be interpreted as a biphase signal or as a double sideband suppressed carrier modulation since in this case they are equivalent.

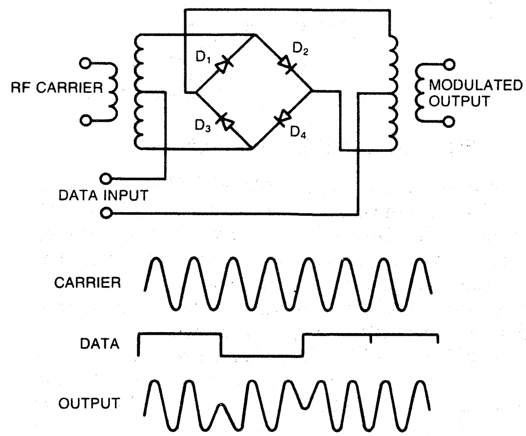


Figure 1. Biphase Modulator

Quadriphase Modulators

The basic modulating elements in a quadriphase or QPSK modulator are a pair of matched biphase modulators similar to those previously described. The carrier signal applied to the RF input first passes through a quadrature hybrid. The two resulting carrier signals, now having a 90° phase relation, then pass through the matched pair of biphase modulators, and finally the resulting signals are added vectorially in an output power combiner as shown in Figure 2. In this case, two control bits at a time are used, each controlling the phase of one of the orthogonal components of the output signal. It is assumed that any serial to parallel conversion required to generate the simultaneous modulating bits will be performed with external logic.

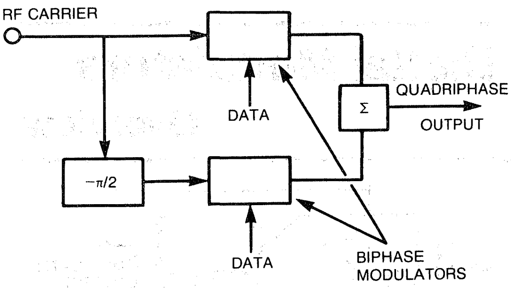


Figure 2. Quadriphase Modulator

Four phase states are possible with this configuration. The reference or 0° state occurs when both biphase modulators are in the straight through or 0° state. In this case, the two signals from the quadrature hybrid at 0° and −90° relative phase appear unshifted at the output power combiner and add vectorially to give a resultant insertion phase shift of −45°. The other three states occur when the biphase modulators are in the 0° and 180° states, 180° and 180° states, and 180° and 0° states, giving respective insertion phase shifts of +45°, −135° and +135°.

The circuit element that generally limits the usable range of carrier frequency in a QPSK modulator is the quadrature hybrid. M/A-COM models utilize a patented, compact, octive bandwidth circuit and thus can be used over a full octave range.

Function as Digital Modulators

Both biphase and QPSK modulators transform a stream of digital "1" and "0" bits into phase shift keyed modulation on an RF carrier. While the RF parameters of a biphase or QPSK modulator can be determined by static measurements, it is important to consider the actual operation with digital signals applied. The bit pattern of the data waveform will tend to be random with the exception of any overhead bits used for framing or synchronization.

Figure 3 shows the envelope of the baseband spectrum and the output from the phase modulators. As indicated, the quadriphase modulators will produce the same spectrum as the biphase unit with the appropriate 2 to 1 scale change for frequency. The width of the main lobe envelope of the $((\sin x)/x)^2$ distribution is determined by the bit rate of the modulating sequence and the line spacing under the envelope is determined by the repetition rate of the sequence.

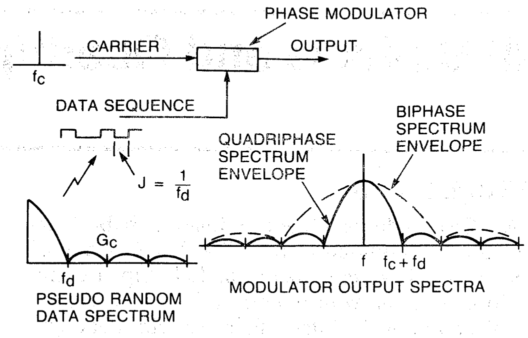


Figure 3. Data and Modulator Spectra

Most of the energy in the spectra is contained in the main lobe, only about 10% is contained in the sidelobes; and the spectral bandwidth is directly dependent upon the data bit rate.

The data rate often is an indication of the type of logic which will be supplying the modulating signal and the type of driver used in the modulator.

The two major types of drivers used are TTL and ECL. The TTL logic employing Schottky type elements will function at bit rates up to near 100 mbps, while emitter coupled logic can extend operation into the 500 mbps region. M/A-COM modulators are available with or without integral ECL series 10,000 drivers.

Spurious Spectrum Components

The previous section has described the general character of the input data stream and the resulting spectra observable at the modulator output. The data user or digital designer is often less interested in the spectra shown in Figure 3 than in the measurement of the quality of the recovered data sequence at the demodulator output. However, there are spectral properties which may affect system operation which are not readily deduced by studying the recovered data stream. A modulator output spectrum contains a variety of spurious signals which might be treated by a demodulating system as interference. The component most often specified is the suppressed carrier. The carrier component is in band and can be reduced by improving modulator balance. Levels of 30 dB or more carrier suppression are commonly achieved in well designed biphase and QPSK modulators.

Insertion Loss

Insertion loss of a biphase or QPSK modulator is measured statically in either of the possible phase states and represents the worst case loss for any state.

Biphase modulators theoretically would have no loss when measured in this manner. However, finite losses do occur because of transformer and diode dissipation. Typical losses of 3-3.5 dB are to be expected. QPSK modulators have a theoretical insertion loss of 3 dB due to the quadrature phase relation of the two signals fed to the output power combiner. Additional dissipative losses in the biphase modulator, quadrature hybrid and power combiner increase this loss. Typical losses of 5.5-6.5 dB are to be expected.

VSWR

VSWR is a measure of the impedance mismatch at the RF input and output ports of the modulator. It is of importance because the presence of imperfect source and load impedances in real system application combined with mismatches at the input and output of the modulator may introduce phase errors due to multiple reflections. For this reason, the VSWR of modulators should be tightly controlled with typical results being 1.3:1.

Amplitude Balance

Amplitude balance is a measure of the variation in insertion loss between the possible phase states of the modulator. For biphase modulators, it is simply the variation in insertion loss between the 0° and 180° states, while for QPSK modulators it is a measure of the worst case variation between any of the four possible states.

Phase Deviation

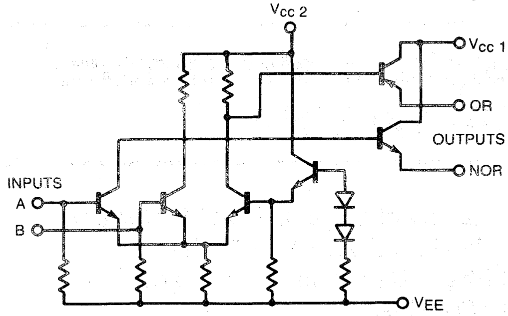
Phase deviation is a measure of the offset from the desired carrier relative phase shift in any of the possible phase states. It is measured with respect to a reference or 0° phase state.

Carrier Suppression

Carrier suppression is the difference in level in dB between the modulation sidebands and the suppressed carrier. It is dependent upon symmetry in both the modulator circuitry and in the modulating waveform. Carrier suppression is typically 35 dB or greater in well designed biphase and QPSK modulators.

Logic Interface for Anzac Modulators

All M/A-COM biphase and QPSK modulators are available in two versions: with and without integral ECL series 10,000 drivers. The modulators containing ECL drivers simplify the designers task by standardizing the logic interface while still allowing the



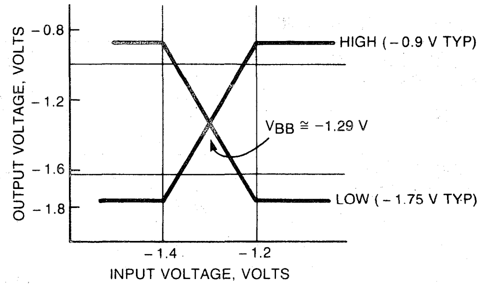


Figure 4. Typical ECL & Transfer Characteristic

high data rates typical of ECL logic. The interface to the control ports of these devices should follow standard ECL practices with the control voltages being -0.9 V typically for a high state and -1.75 typically for a low state. (See Figure 4).

The modulators without integral drivers require an external driver capable of delivering +10 and −10 mA. Care should be taken in design of the external driver to maintain symmetry of the positive and negative half cycles of the driving waveform and RF interfacing practices appropriate to the data rate should be used in connecting the driver to the modulator.

CONCLUSION

Phase modulators provide the designer with a compact component capable of providing complex waveform modulations needed for today's systems. M/A-COM's products bridge the Digital-RF boundary allow engineers from both fields to utilize these devices. Specific or customized versions of both biphase and quadraphase modulators are available from M/A-COM. Our Applications Engineers are ready to assist the designer in adapting M/A-COM's capabilities to the specific system requirements.

Biphase Modulators
10-750 MHz

PM-101/102/103

- Variety of Drivers: PM-101; Current, PM-102; ECL, PM-103; TTL
- Phase Deviation — 1° Typical
- TO-8 Case

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-750 MHz
Insertion Loss	10-500 MHz	3.0 dB Max
	10-750 MHz	3.5 dB Max
VSWR	50-500 MHz	1.3:1 Max
	10-750 MHz	1.6:1 Max
Amplitude Balance		0.2 dB Max
Phase Deviation	10-500 MHz	2° Max
	10-750 MHz	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
RF Input Level	
Operating	−3 dBm Max
Non-Destruct	+17 dBm Max
Carrier Suppression (100 MHz RF, 1 MHz Modulation)	35 dB Typ
Control Input	
PM-101	
Logic 1	+10 mA Drive Current
Logic 0	−10 mA Drive Current
PM-102 (ECL Series 10,000)	
Logic 1	ECL High
Logic 0	ECL Low
PM-103 (LS TT L)	
Logic 1	TTL High
Logic 0	TTL Low
Bias Power	
PM-102	−4.7 to −6.2 VDC @ 50 mA Max (260 mW Typ)
PM-103	+5.0 VDC ±5% @ 30 mA Max (125 mW Typ)

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration

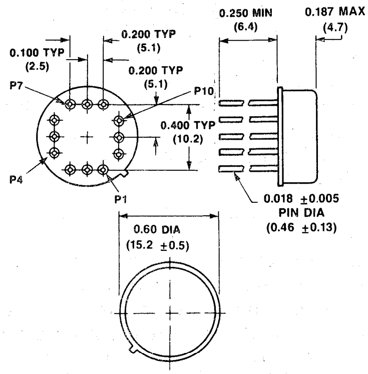
PM-101	RF IN; P2, RF Out; P5, D1; P11, D2; P8
PM-102	RF IN; P2, RF Out; P5, D1; P11, D2; P8, DC; P7
PM-103	RF IN; P2, RF Out; P5, D1, P11, DC; P8
	All other pins are ground.

*All specifications apply with 50 ohm source and load impedance and inputs to −3 dBm.

Ordering Information

Model No.	Package
PM-101 PIN	TO-8-2
PM-102 PIN	TO-8-2
PM-103 PIN	TO-8-2

TO-8-2

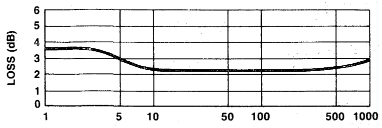


Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

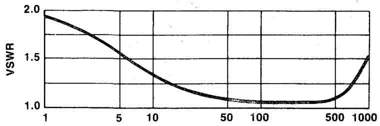
Specifications Subject to Change Without Notice.

Typical Performance

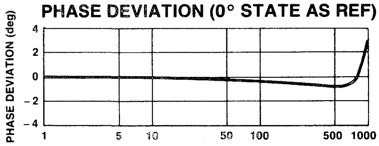
INSERTION LOSS



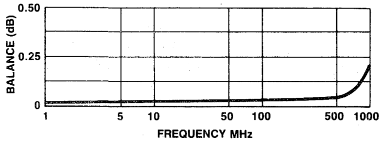
VSWR



PHASE DEVIATION (0° STATE AS REF)



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE	
	D1	D2
0°	1	0
+180°	0	1

Specifications Subject to Change Without Notice.

Biphase Modulators
700 – 2000 MHz

PM-125/126/127

Features

- Variety of Drivers
- Amplitude Balance: .1dB Typ
- Hermetic TO-8 Package

Guaranteed Specifications[1] (From -55°C to +85°C)

Frequency Range		700 – 2000 MHz
Insertion Loss	1000 – 1500 MHz 700 – 2000 MHz	4.0 dB Max 4.5 dB Max
VSWR		3.5:1 Max
Amplitude Balance		0.3 dB Max
Phase Deviation		3° Max

Operating Characteristics

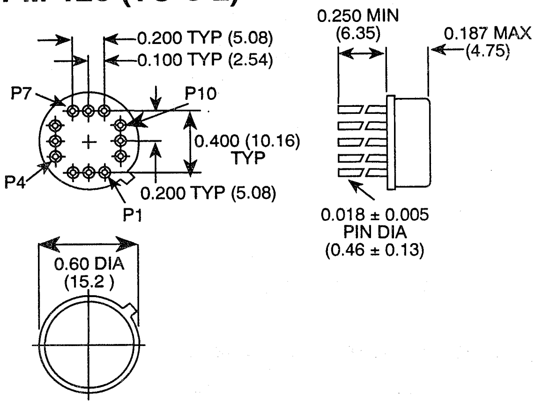
Impedance		50 Ohms Nominal
RF Input Level Operating Non-Destruct		 -3 dBm Max +17 dBm Max
Carrier Supression (1000 MHz RF, 1MHz Modulation)		35 dB Typ
Contol Input PM-125 Logic 1 Logic 0 PM-126 Logic 1 Logic 0 PM-127 (LS TTL) Logic 1 Logic 0		 +10 mA Drive Current -10 mA Drive Current ECL High ECL Low TTL High TTL Low
Bias Power PM-126 PM-127		 -4.7 to -6.2 VDC @ 50 mA Max (260 mW Typ) +5.0 VDC ± 5% @ 30 mA Max (125 mW Typ)
Package Type	PM-126 PM-125, 127	TO-8-2 TO-8-4
Environmental See Appendix for MIL-STD-883 screening option		

1. All specifications apply with 50 ohm and load impedance and inputs to - 3 dBm.

Ordering Information

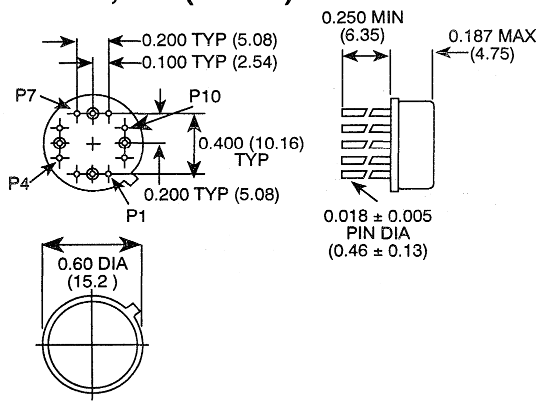
Part No.	Package
PM-125 PIN	Pin, Current Driver
PM-126 PIN	Pin, ECL Driver
PM-127 PIN	Pin, TTl Driver

PM-126 (TO-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)

PM-126, 127 (TO-8-4)



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)

Truth Table

PHASE STATE	LOGIC STATE D1	LOGIC STATE D2
0 Deg.	1	0
180 Deg.	0	1

Specifications Subject to Change Without Notice

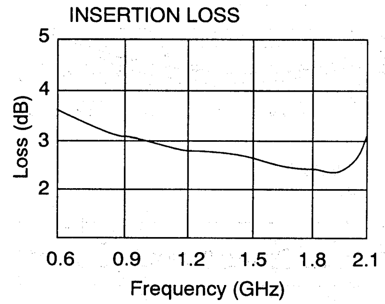
Pin Configurations

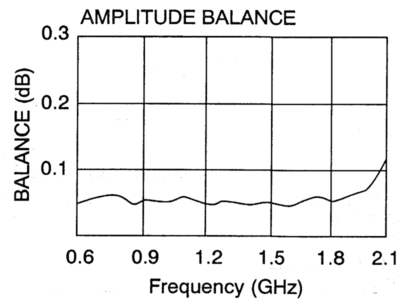
PM 125 Pin No.	Description
1	GND
2	RF IN
3	GND
4	GND
5	RF OUT
6	GND
7	GND
8	D2
9	GND
10	GND
11	D1
12	GND

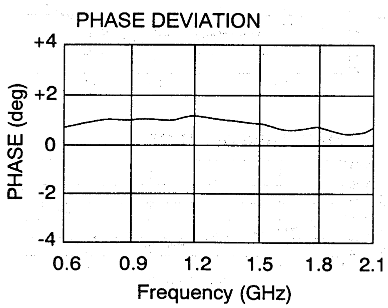
PM 126 Pin No.	Description
1	GND
2	RF IN
3	GND
4	GND
5	RF OUT
6	GND
7	DC
8	D2
9	GND
10	GND
11	D1
12	GND

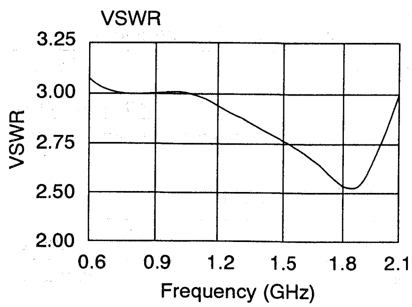
PM 127 Pin No.	Description
1	GND
2	RF IN
3	GND
4	GND
5	RF OUT
6	GND
7	GND
8	DC
9	GND
10	GND
11	D1
12	GND

Typical Performance







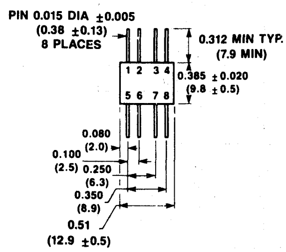


Biphase Modulator
2.0-3.0 GHz

PM-104

- 3.5 dB Typical Insertion Loss
- 1.5:1 Typical VSWR
- 1° Typical Phase Deviation
- 3 nS Switch Speed

FP-2



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2.0-3.0 GHz
Insertion Loss	2.0-2.8 GHz	5.5 dB Max
	2.8-3.0 GHz	6.0 dB Max
VSWR	2.0-2.8 GHz	2.0:1 Max
	2.8-3.0 GHz	2.25:1 Max
Amplitude Balance		0.6 dB Max
Phase Deviation		5° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Input	
Total Power	300 mW Max Derated to 85°C @ 3.2 mW/°C
Bias Port Current	50 mA Max
Carrier Suppression (2.5 GHz RF, 5 MHz Modulation)	28 dB Typ
Switching Speed	3 nS Typ
Input Power for 1 dB Compression	+6 dBm Typ
Control Input	
Logic 1	+20 mA Drive Current
Logic 0	−20 mA Drive Current
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P5, Out; P8 D1; P4, All other pins are ground.

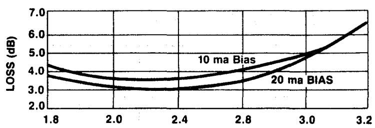
* All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm.

Ordering Information

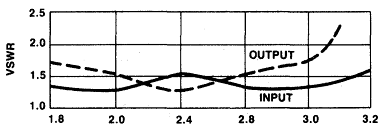
Model No.	Package
PM-104 PIN	Flatpack

Typical Performance

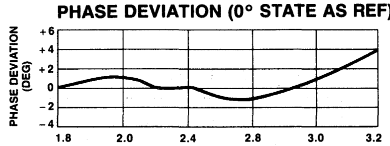
INSERTION LOSS



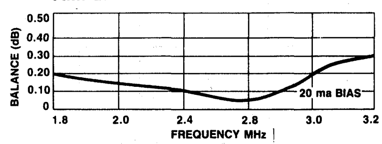
VSWR



PHASE DEVIATION (0° STATE AS REF)



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE D1
0°	1
+180°	0

Specifications Subject to Change Without Notice.

Phase Shifter
28.5-31.5 MHz

PM-111

- Low Loss – 0.8 dB Typical
- 180° Phase Range
- Hermetic Flatpack

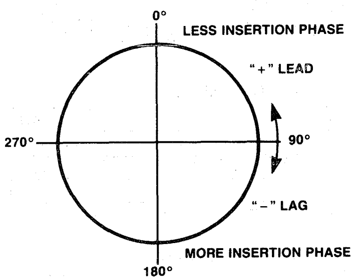
Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	28.5-31.5 MHz
Insertion Loss	1.2 dB Max
VSWR (All Ports)	1.6:1 Max
Phase Shift Range	180° Min

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Rating RF Input	1 mW
Control Voltage	0 to +30 VDC
Control Bandwidth	DC to 80 kHz
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P7, Out: P14, Control DC IN: P1 & P8. All other pins and case are ground.

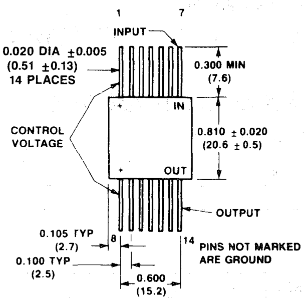
*All specifications apply with 50 ohm source and load impedance.



Ordering Information

Model No.	Package
PM-111 PIN	Flatpack

FP-4

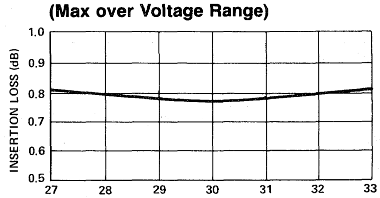


Dimensions in ( ) are in mm.

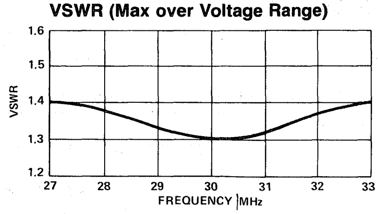
See Appendix for complete physical dimensions.

Typical Performance

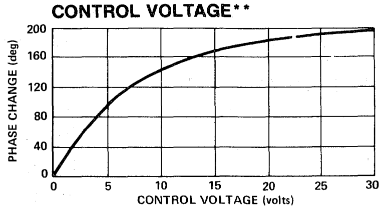
INSERTION LOSS (Max over Voltage Range)



VSWR (Max over Voltage Range)



PHASE CHANGE VS CONTROL VOLTAGE**



Specifications Subject to Change Without Notice.

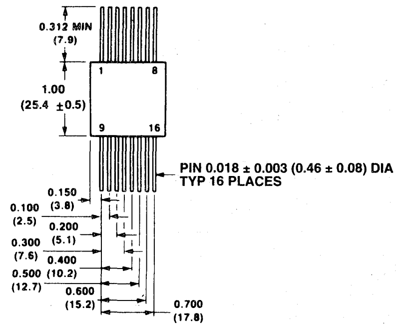
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

QPSK Modulator
20-40 MHz

PM-105/106

- Hermetic Module
- 2° Phase Deviation
- Integral ECL Series 10,000 Driver (PM-106)

FP-6



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		20-40 MHz
Insertion Loss		5.8 dB Max
VSWR		
Input		1.25:1 Max
Output		1.70:1 Max
Amplitude Balance		0.5 dB Max
Phase Deviation**	30 MHz	2° Max
	20-40 MHz	6° Max

Operating Characteristics

Impedance	50 Ohms Nominal
RF Input Level	
Operating	0 dBm Max
Non-Destruct	+20 dBm Max
Carrier Suppression (30 MHz RF, 1 MHz Modulation)	35 dB Typ
Bias Power (PM-106 only)	−4.7 to −6.2 VDC @ 120 mA Max (520 mW Typical)
Control Input	
PM-105	
Logic 1	+10 mA Drive Current
Logic 0	−10 mA Drive Current
PM-106 (ECL Series 10,000)	
Logic 1	ECL High
Logic 0	ECL Low

Environmental
See Appendix for MIL-STD-883 screening option.

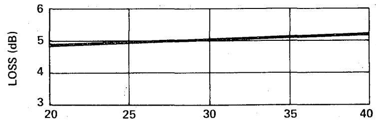
Pin Configuration

PM-105	IN; P14, OUT; P6, DI; P9, D2; P1 D3; P8, D4; P16
PM-106	IN; P14, OUT; P6, DI; P9, D2; P1 D3; P8, D4; P16, DC; P11
	All other pins are ground.

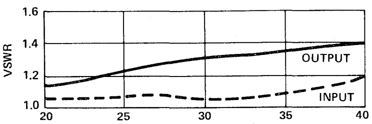
†PM-106 only, ground on PM-105.
*All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm.
**All states relative to 0° state.
This product contains elements protected by United States Patent Number 3,484,724.

Typical Performance

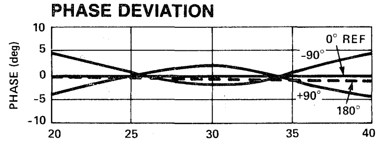
INSERTION LOSS



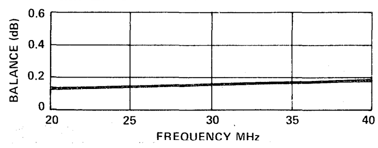
VSWR



PHASE DEVIATION



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE			
	D1	D2	D3	D4
0°	1	0	1	0
-90°	0	1	1	0
+90°	1	0	0	1
+180°	0	1	0	1

Ordering Information

Model No.	Package
PM-105 PIN	Flatpack
PM-106 PIN	Flatpack

Specifications Subject to Change Without Notice.

QPSK Modulators
50-100 MHz
PM-108/109/110

- Variety of Drivers: PM-108; Current, PM-109; ECL, PM-110; TTL
- Hermetic Module
- 2.5° Phase Deviation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		50-100 MHz
Insertion Loss		6.25 dB Max
VSWR		
Input		1.4:1 Max
Output		1.6:1 Max
Amplitude Balance		0.5 dB Max
Phase Deviation**	70 MHz	2.5° Max
	50-100 MHz	6.5° Max

Operating Characteristics

Impedance		50 Ohms Nominal
RF Input Level		
Operating		0 dBm Max
Non-Destruct		+20 dBm Max
Carrier Suppression (70 MHz RF, 1 MHz Modulation)		35 dB Typ
Bias Power		
PM-109	−4.7 to −6.2 VDC @ 120 mA Max	(520 mW Typ)
PM-110	+5.0 VDC ±5% @ 50 mA Max	(200 mW Typ)
Control Input		
PM-108		
Logic 1		+10 mA Drive Current
Logic 0		−10 mA Drive Current
PM-109 (ECL Series 10,000)		
Logic 1		ECL High
Logic 0		ECL Low
PM-110 (LS TT L)		
Logic 1		TTL High
Logic 0		TTL Low

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration

PM-108/PM-109	IN; P14, OUT; P6, DI; P9, D2; P1, D3; P8, D4; P16
PM-110	IN; P14, OUT; P6, DI; P9, D2; P16†DC; P11
	All other pins are ground.

†PM-109 only, ground on PM-108.

*All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm.

**All states relative to 0° state.

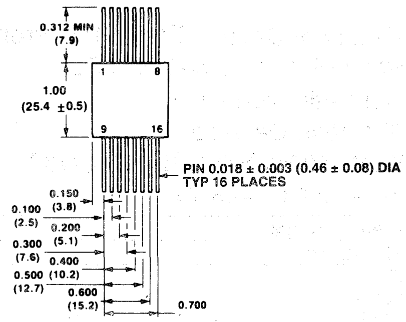
This product contains elements protected by United States Patent Number 3,484,724.

Ordering Information

Model No.	Package
PM-108 PIN	Flatpack
PM-109 PIN	Flatpack
PM-110 PIN	Flatpack

Specifications Subject to Change Without Notice.

FP-6

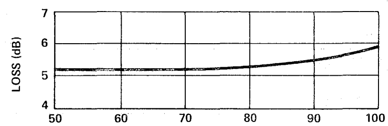


Dimensions in ( ) are in mm.

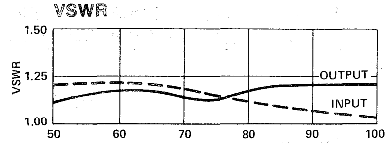
See Appendix for complete physical dimensions.

Typical Performance

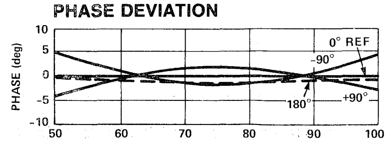
INSERTION LOSS



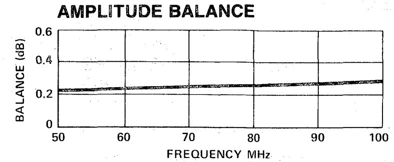
VSWR



PHASE DEVIATION



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE			
	D1	D2[1]	D3[2]	D4[1]
0°	1	0	1	0
-90°	0	1	1	0
+90°	1	0	0	1
+180°	0	1	0	1

1. Not used on PM-110
2. D2 for PM-110

QPSK Modulators
100-200 MHz

PM-114/115/116

- Variety of Drivers: PM-114; Current,
- PM-115; ECL, PM-116; TTL
- Hermetic Module
- 3° Phase Deviation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		100-200 MHz
Insertion Loss		7.5 dB Max
VSWR		
Input		1.4:1 Max
Output		1.6:1 Max
Amplitude Balance		0.5 dB Max
Phase Deviation**	150 MHz	3.0° Max
	100-200 MHz	6.5° Max

Operating Characteristics

Impedance		50 Ohms Nominal
RF Input Level		
Operating		0 dBm Max
Non-Destruct		+20 dBm Max
Carrier Suppression (70 MHz RF, 1 MHz Modulation)		30 dB Typ
Bias Power		
PM-109	−4.7 to −6.2 VDC @ 120 mA Max	(520 mW Typ)
PM-110	+5.0 VDC ±5% @ 50 mA Max	(200 mW Typ)
Control Input		
PM-108		
Logic 1		+10 mA Drive Current
Logic 0		−10 mA Drive Current
PM-109 (ECL Series 10,000)		
Logic 1		ECL High
Logic 0		ECL Low
PM-110 (LS TT L)		
Logic 1		TTL High
Logic 0		TTL Low
Environmental		
See Appendix for MIL-STD-883 screening option.		
Pin Configuration		
PM-114/PM-115		IN; P14, OUT; P6, DI; P9, +DC;P11† D2; P1, D3; P8, D4; P16
PM-116		IN; P14, OUT; P6, DI; P9, D2; P16, DC; P11
		All other pins are ground.

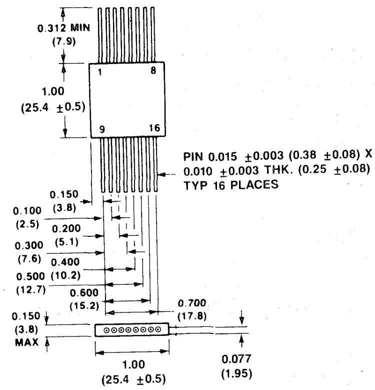
†PM-115 only, ground on PM-114
*All specifications apply with 50 ohm source and load impedance and inputs to 0 dBm.
**All states relative to 0° state.
This product contains elements protected by United States Patent Number 3,484,724.

Ordering Information

Model No.	Package
PM-114 PIN	Flatpack
PM-115 PIN	Flatpack
PM-116 PIN	Flatpack

Specifications Subject to Change Without Notice.

FP-6

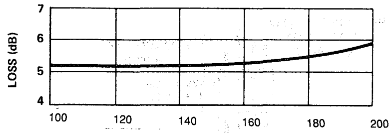


Dimensions in ( ) are in mm.

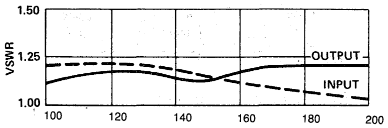
See Appendix for complete physical dimensions.

Typical Performance

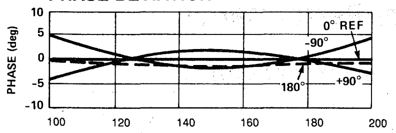
INSERTION LOSS



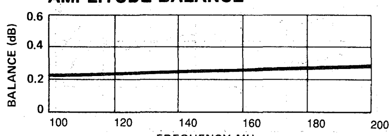
VSWR



PHASE DEVIATION



AMPLITUDE BALANCE



PHASE STATE	LOGIC STATE			
	D1	D2[1]	D3[2]	D4[1]
0°	1	0	1	0
-90°	0	1	1	0
+90°	1	0	0	1
+180°	0	1	0	1

1. Not used on PM- 116
2. D2 for PM-116

M/A-COM

Phase Detector 5-1000 MHz

PD-120

- Wide Bandwidth
- Low DC Offset

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Maximum DC Output	5-500 MHz	300 mV Min
	5-1000 MHz	250 mV Min
Isolation (L-R)	5-200 MHz	50 dB Min
	200-500 MHz	40 dB Min
	500-1000 MHz	30 dB Min
DC Offset (100 MHz RF)		1.0 mV Max

Operating Characteristics

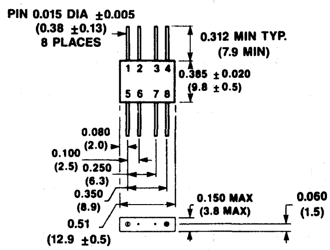
Impedance	
(L,R Ports)	50 Ohms Nominal
Load (X Port)	500 Ohms
Input Power (L & R Ports)	+7 dBm Nominal
Maximum Input (Non-Destruct)	
Total Power	300 mW Max @ 25°C
	Derated to 85°C @ 3.2 mW/°C
DC Output Polarity	Negative
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P8, LO; P5, IF; P4.
	All other pins and case are ground.

*All specifications apply when operated at +7 dBm available LO and RF power and 50 ohms impedance at the L & R ports and with 500 ohm load at the X port.

Ordering Information

Model No.	Package
PD-120 PIN	Flatpack

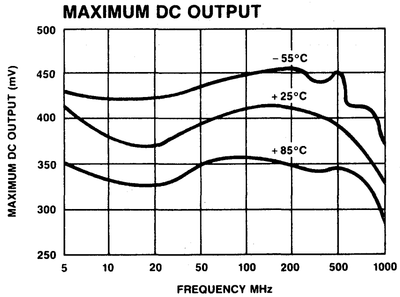
FP-2

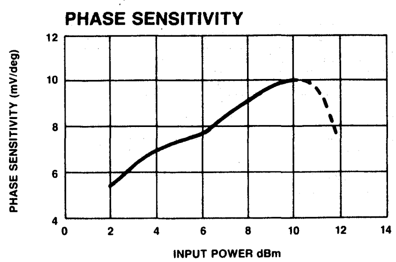


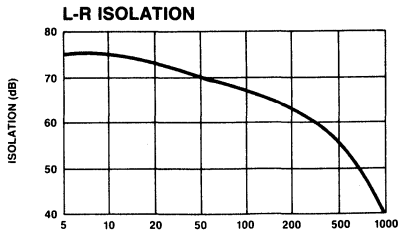
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Phase Detector
3-200 MHz

PD-121

- High DC Output Voltage
- Low DC Offset

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		3-200 MHz
Maximum DC Output	10-100 MHz	900 mV Min
	3-200 MHz	800 mV Min
Isolation (L-R)	3-100 MHz	40 dB Min
	100-200 MHz	35 dB Min
DC Offset (50 MHz RF)		1.0mV Max

Operating Characteristics

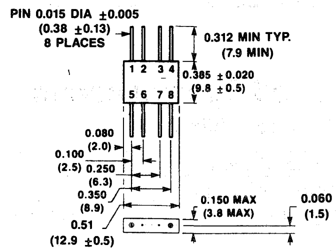
Impedance	
(L,R Ports)	50 Ohms Nominal
Load (X Port)	500 Ohms
Input Power (L & R Ports)	+7 dBm Nominal
Maximum Input (Non-Destruct)	
Total Power	600 mW Max @ 25°C
	Derated to 85°C @ 6.4mW/°C
DC Output Polarity	Positive
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	RF; P5, LO; P8, IF; P1.
	Case and all other pins are ground.

*All specifications apply when operated at +7 dBm available LO and RF power and 50 ohms impedance at the L & R ports and with 500 ohm load at the X port.

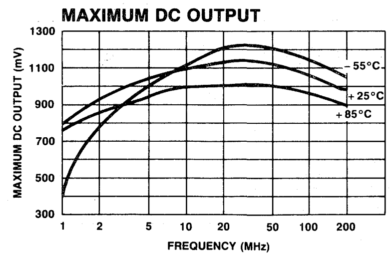
Ordering Information

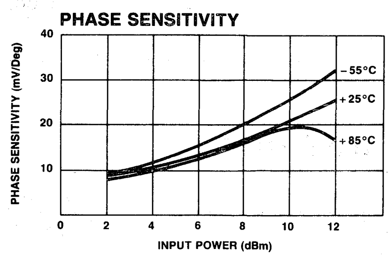
Model No.	Package
PD-121 PIN	Flatpack

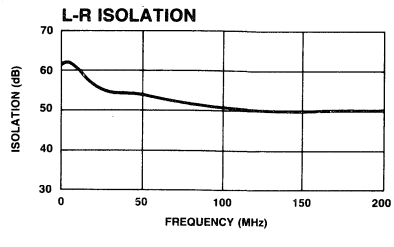
FP-2



Typical Performance







Specifications Subject to Change Without Notice.

Broadband Frequency Doubler
10 MHz-2.0 GHz Output

D-1-4

- Conversion Loss – 13 dB Max
- Untuned

Guaranteed Specifications*
(From −55°C to +85°C)

Input Frequency Range		5 MHz-1 GHz
Output Frequency Range		10 MHz-2 GHz
Conversion Loss*		13 dB Max @ 20 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	5-500 MHz	−20 dB
	0.5-1.0 GHz	−10 dB
F_3	15-1500 MHz	−20 dB
	1.5-3.0 GHz	−15 dB

Operating Characteristics

Typical Input VSWR	5-500 MHz	1.8:1
	500 MHz-1 GHz	2.5:1
Typical Conversion Loss as Quadrupler		25 dB
Input/Output Impedance		50 Ohms
Maximum Input Power		0.5 Watt
Environmental		

See Appendix for MIL-STD-883 screening option.

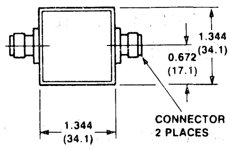
*Optimum Input. Output 3 dB down @ 7 mW and @ 100 mW input.

*All specifications apply when operated at +13 dBm input power 50 ohm source and load impedance.

Ordering Information

Model No.		Package
D-1-4	BNC	Connectorized
D-1-4	SMA	Connectorized

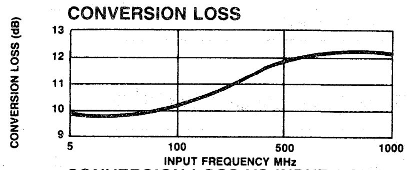
C-5

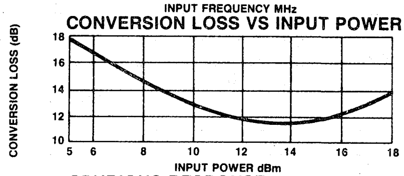


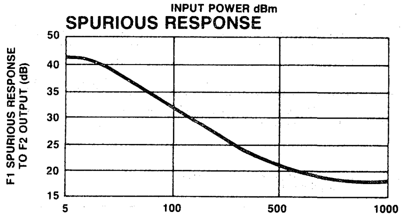
Dimensions in ( ) are in mm.

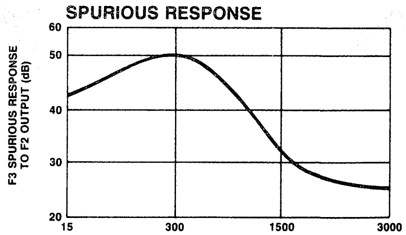
See Appendix for complete physical dimensions.

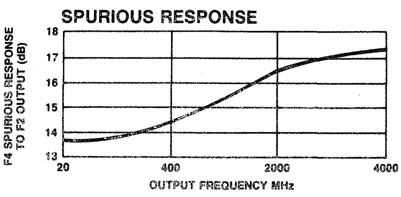
Typical Performance











Specifications Subject to Change Without Notice.

Broadband Frequency Doubler 30 MHz-2.1 GHz

D-5-4

Conversion Loss — 13 dB Max
Untuned

Guaranteed Specifications*

(From −55°C to +85°C)

Input Frequency Range		30 MHz-2.1 GHz
Output Frequency Range		60 MHz-4.2 GHz
Conversion Loss*		13 dB Max @ 30 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	30-500 MHz	−25 dB
	0.5-2.1 GHz	−15 dB
F_3	90-1500 MHz	−30 dB
	1.5-6.3 GHz	−20 dB

Operating Characteristics

Typical Input VSWR	30 MHz-1 GHz	1.5:1
	1-2.1 GHz	1.8:1
Typical Conversion Loss as Quadrupler		26 dB
Input/Output Impedance		50 Ohms
Maximum Input Power		1.0 Watt
Environmental See Appendix for MIL-STD-883 screening option.		

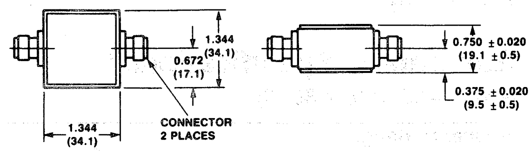
*All specifications apply when operated at +14 .8 dBm input power 50 ohm source and load impedance.

Ordering Information

Model No.	Package
D-5-4 N	Connectorized
D-5-4 SMA	Connectorized

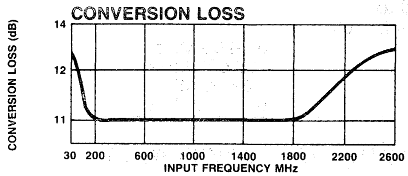
C-5

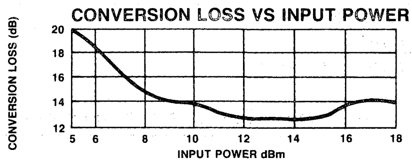
Dimensions in ( ) are in mm.

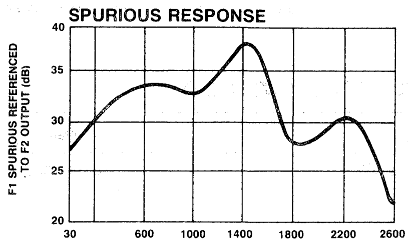


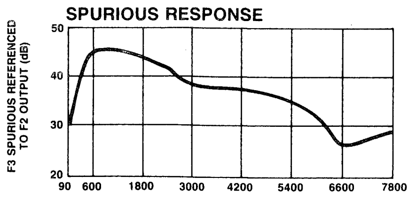
See Appendix for complete physical dimensions.

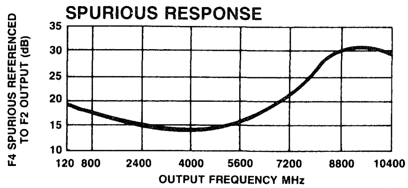
Typical Performance











Specifications Subject to Change Without Notice.

Broadband Frequency Doubler
200 kHz-1.2 GHz Output

FM-102-4

- Conversion Loss – 13 dB Max
- Untuned

Guaranteed Specifications*

(From –55°C to +85°C)

Frequency Range		
Input		100 kHz-600 MHz
Output		200 kHz-1.2 GHz
Conversion Loss*		12 dB Max @ 20 mW Input
Spurious (Referred to Output F_2 Level)		
F_1	0.1-200 MHz	–24 dB
	200-600 MHz	–18 dB
F_3	0.3-600 MHz	–35 dB
	600-1800 MHz	–24 dB

Operating Characteristics

Maximum Input Power	0.5 Watt
Typical Input VSWR	1.5:1
Input/Output Impedance	50 Ohms

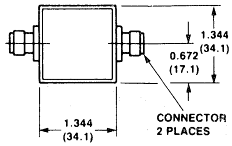
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply when operated at +13 dBm input power 50 ohm source and load impedance.

Ordering Information

Model No.	Package
FM-102-4 SMA	Connectorized

C-5

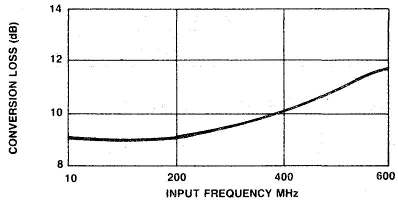


Dimensions in ( ) are in mm.

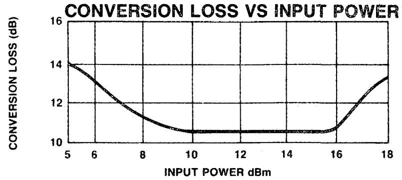
See Appendix for complete physical dimensions.

Typical Performance

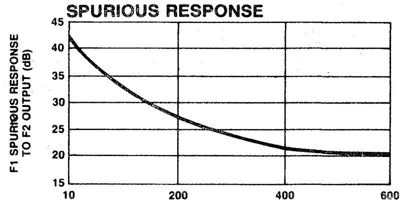
CONVERSION LOSS



CONVERSION LOSS VS INPUT POWER



SPURIOUS RESPONSE



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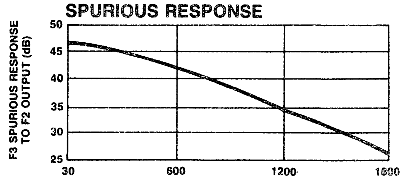

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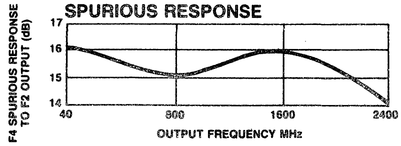


Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Broadband Frequency Doubler
150-3000 MHz Output

FM-104

- Hermetic Flatpack
- Multioctave Frequency Coverage
- Midband Conversion Loss – 10 dB

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		75-1500 MHz
Output		150-3000 MHz
Conversion Loss	75-1000 MHz	12 dB Max
	1000-1500 MHz	14 dB Max
Spurious (Referred to Output F_2 Level)		
F_1	75-1000 MHz	20 dB Min
	1000-1500 MHz	17 dB Min
F_3	225-3000 MHz	20 dB Min
	3000-4500 MHz	17 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
VSWR, Input	2.5:1
Typical Conversion Loss as Quadrupler	26 dB
Maximum Input Power	300 mW

Environmental

See Appendix for MIL-STD-883 screening option.

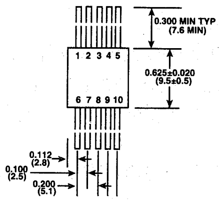
Pin Configuration	IN; P3, Out P8 Case and all other pins are ground.

*All specifications apply when operated at +13 dBm input power with 50 ohm source and load impedance

Ordering Information

Model No.	Package
FM-104 PIN	Flatpack

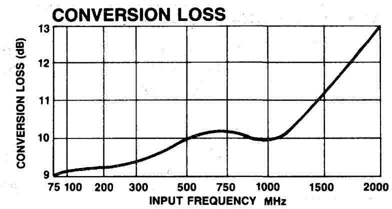
FP-3

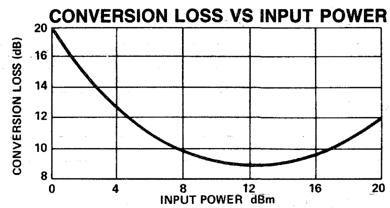


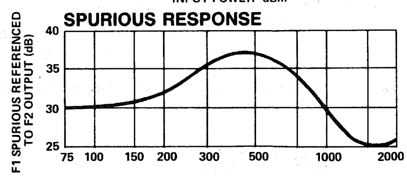
Dimensions in ( ) are in mm.

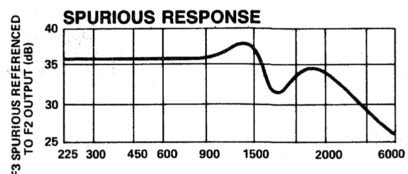
See Appendix for complete physical dimensions.

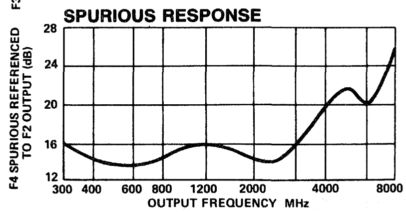
Typical Performance











Specifications Subject to Change Without Notice.

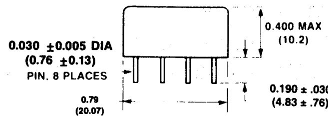
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Plug-in Frequency Doubler 20-1500 MHz Output

FM-105

- Relay Header Case
- Multioctave Frequency Coverage
- Midband Conversion Loss – 12 dB
- Typical Input VSWR – Less Than 1.8

RH-3



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		10-750 MHz
Output		20-1500 MHz
Conversion Loss	10-500 MHz	14.5 dB Max
	500-750 MHz	15.5 dB Max
Spurious (Referred to Output F_2 Level)		
F_1	10-100 MHz	25 dB Min
	100-300 MHz	20 dB Min
	300-500 MHz	15 dB Min
	500-750 MHz	10 dB Min
F_3	30-300 MHz	35 dB Min
	300-900 MHz	30 dB Min
	900-1500 MHz	25 dB Min
	1500-2250 MHz	20 dB Min

Operating Characteristics

Impedance	50 Ohms Nominal
VSWR, Input	2.0:1
Typical Conversion Loss as Quadrupler	30 dB
Maximum Input Power	300 mW

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration	IN; P1, Out; P8 Case and all other pins are ground.

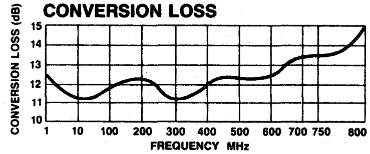
*All specifications apply when operated at +13 dBm input power with 50 ohm source and load impedance

Ordering Information

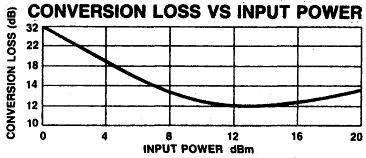
Model No.	Package
FM-105 PIN	Relay Header

Typical Performance

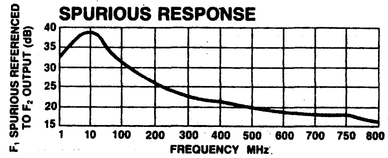
CONVERSION LOSS



CONVERSION LOSS VS INPUT POWER



SPURIOUS RESPONSE



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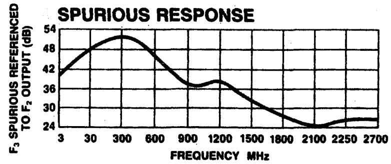

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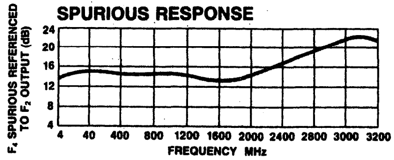


Specifications Subject to Change Without Notice.

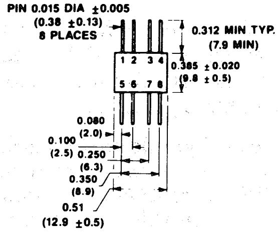
M/A-COM

Broadband Frequency Doubler 400-6000 MHz Output

FM-106

■ Hermetic Flatpack
■ Multioctave Operation
■ Typical Conversion Loss – 11 dB

FP-2



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		
Input		200-3000 MHz
Output		400-6000 MHz
Conversion Loss	200-400 MHz	14.5 dB Max
	400-2500 MHz	13.0 dB Max
	2500-3000 MHz	15.5 dB Max
Spurious (Referred to Output F_2 Level)		
F_1	200-500 MHz	20 dB Min
	500-3000 MHz	15 dB Min
F_3	600-2400 MHz	25 dB Min
	2400-9000 MHz	20 dB Min

Operating Characteristics

Impedance		50 Ohms Nominal
VSWR, Input	200-500 MHz	3.0:1 Typ
	500-3000 MHz	2.0:1 Typ
Typical Conversion Loss as Quadrupler		30 dB
Maximum Input Power		300 mW
Environmental		
See Appendix for MIL-STD-883 screening option.		
Pin Configuration		IN; P4, Out; P8, Case and all other pins are ground.

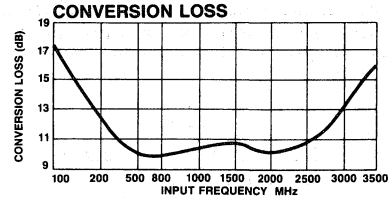
*All specifications apply when operated at +13 dBm input power with 50 ohm source and load impedance

Ordering Information

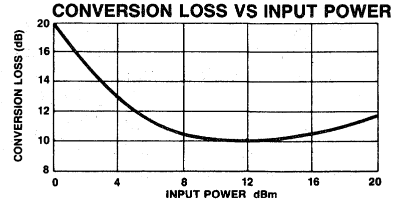
Model No.	Package
FM-106 PIN	Flatpack

Typical Performance

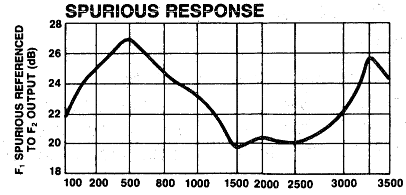
CONVERSION LOSS



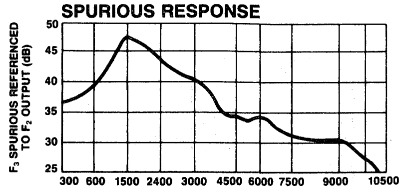
CONVERSION LOSS VS INPUT POWER



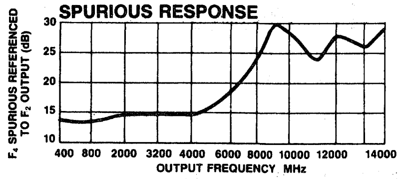
SPURIOUS RESPONSE



SPURIOUS RESPONSE



SPURIOUS RESPONSE



Specifications Subject to Change Without Notice.

RF Hybrid Devices

Overview

M/A-COM offers a comprehensive list of standard RF Hybrids through our "HH-XXX" and "JH-XXX" series of products. The following explains the purpose and use of these products.

The 90° and 180° hybrids are two forms of passive, reciprocal four-port devices which have wide application in RF and microwave system design. The devices described in this article are equal power split versions of the general four-port hybrid configuration. Directional couplers, described in a separate article, are actually 180° hybrids having unequal power splits. Power dividers/summers generally represent another variation of the basic 180° hybrid with an internal termination on one port. These devices are also described in detail in a separate article.

The purpose of this article is to provide the designer with basic information describing the function of these devices, the basic specification parameters with possible tradeoffs and the relationships that apply for various combinations of signal inputs and port terminations. Signal flow descriptions in this article assume the ideal, lossless version of the 180° and 90° hybrid. This is a reasonable approximation for this purpose because of the generally low loss, well matched characteristics of the actual circuits.

FUNCTIONAL DESCRIPTION

180° Hybrid

A 180° hybrid is a reciprocal four-port device which provides two equal amplitude in-phase signals when fed from its sum port and two equal amplitude 180° out-of-phase signals when fed from its difference port. Opposite ports of the hybrid are isolated. Figure 1 is a functional diagram which will be used in this article to represent the 180° hybrid. Port B can be considered the sum port with port A the difference port. Ports A and B and ports C and D are isolated pairs of ports.

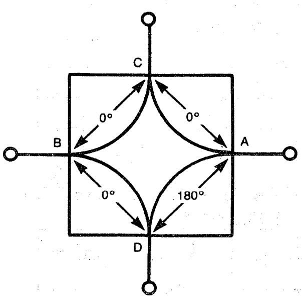


Figure 1. 180° Hybrid

Utilizing the functional diagram of Figure 1, we can consider the application of signal at one or more of the ports of the hybrid. The convention used for explaining signal flow is based on Figure 2. The cases that are important to consider are the following:

1. Operation as a power divider – One source operating at ports A, B, C or D.
2. Operation as a power summer – Two sources operating at ports A and B, or C and D.

For these cases, the impedances Z_A, Z_B, Z_C, and Z_D, are assumed to be Z_O, the characteristic impedance of the 180° hybrid. Under this matched condition, the source voltage of 2E cos ωt will supply a voltage of E cos ωt to the input of the hybrid.

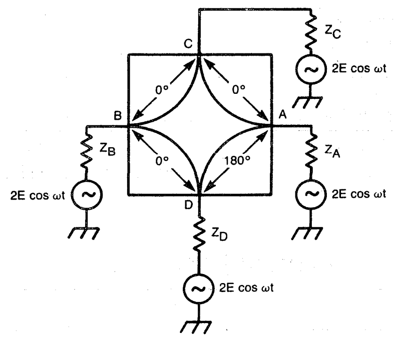


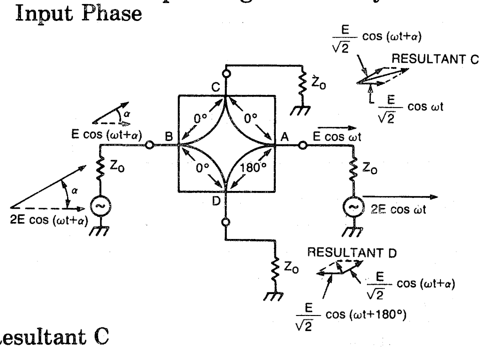
Figure 2. Signal Source Configurations for 180° Hybrid (Reference Tables I, II, III, IV)

As a power divider, the hybrid will equally split the input signal and deliver one half the power to each load. Since all ports are considered to be at Z_O impedance, the voltages at the outputs will be proportional to the square root of the output power and will be phase shifted by the amount indicated for that path of the hybrid, since $P_{OUT} = \frac{1}{2} P_{IN}$, $V_{OUT} = \frac{1}{\sqrt{2}} V_{IN}$. For example, if an input signal at Port

A of E cos ωt is injected, the resultant output at Port C is $\frac{1}{\sqrt{2}}$ E cos ωt and the output at Port D is $\frac{1}{\sqrt{2}}$ E cos (ωt − 180°). No signal will appear at Port B. The various power divider relationships are summarized in Table 1.

When used as a power summer, the function of the 180° hybrid is somewhat less obvious due to the vector addition of the two signals. Figure 3 shows the signal flow and resultant outputs for the general case of two equal amplitude, equal frequency signals of arbitrary phase. The vector representation of the input signals as well as the resultant output signals is shown graphically together with the algebraic expression for the signal. It should be noted that, in the general case, the phases of the resultant outputs are in quadrature. Table II lists the relationships for various combinations of signals applied in pairs to Ports A and B or Ports C and D.

- Equal Amplitude, Equal Frequency Input
- Resultant Output Phases are in Quadrature
- Resultant Output Magnitudes vary based on Input Phase



Resultant C

$$= \frac{E}{\sqrt{2}} [\cos \omega t + \cos (\omega t + \alpha)]$$

$$= \frac{E}{\sqrt{2}} [2 \cos {}^1\!/\!_2 (2\omega t + \alpha) \cos {}^1\!/\!_2 (-\alpha)]$$

$$= \sqrt{2}\, E \cos (-\frac{\alpha}{2}) \cos (\omega t + \frac{\alpha}{2})$$

Resultant D

$$= \frac{E}{\sqrt{2}} [\cos (\omega t + 180°) + \cos (\omega t + \alpha)]$$

$$= \frac{E}{\sqrt{2}} [2 \cos {}^1\!/\!_2 (2\omega t + \alpha + 180°) \cos {}^1\!/\!_2 (180° - \alpha)]$$

$$= \sqrt{2}\, E \cos (90° - \frac{\alpha}{2}) \cos (\omega t + \frac{\alpha}{2})$$

∴ Phase of Resultant D = Phase of Resultant C + 90°

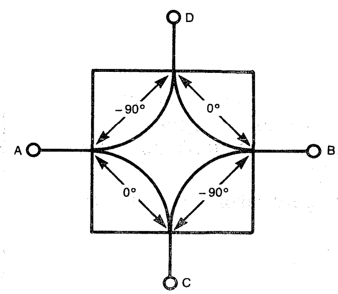
Figure 3. 180° Hybrid

Tables III and IV provide useful relations for determining isolation and VSWR under varying loading conditions. One point to note from the expressions in these tables is that equal mismatches on opposite ports of the hybrid do not effect isolation since the reflected signal will cancel at the isolated port while they will add at the port where the signal is injected. Thus, for example, if we inject a signal at Port A with equal mismatches at Ports C and D ($\rho_C = \rho_D$), then no signal will appear at Port B because the reflected components are 180° out-of-phase. The VSWR at Port A will be degraded because the reflections add in phase at this port. In general, equal mismatches may not be present. The relations in Tables III and IV may be used to calculate VSWR and isolation for any known combination of load impedance.

90° Hybrid

A 90° hybrid functions in much the same manner as 180° hybrid since it is also a reciprocal four-port device. Equal amplitude outputs result when a signal is fed to one of the inputs. Opposite ports of the 90° hybrid are also isolated as in the 180° hybrid. The different phase relationship of the 90° hybrid does however, cause important functional differences.

Figure 4 shows the circuit diagram and truth table that will be used in explaining the operation of the 90° hybrid. As can be seen from this diagram, a signal applied to any input will result in two quadrature or 90° outputs. Ports A and B and Ports C and D are isolated. Following an analysis



	A	B	C	D
A		ISO.	0	-90
B	ISO.		-90	0
C	0	-90		ISO.
D	-90	0	ISO.	

ISO. = ISOLATION

Truth Table

Figure 4. 90° Hybrid

Power Divider

The relationships given in Table I apply when the 180° hybrid is used as a power divider. The following conditions apply.

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Only one generator at a time is operating.
3. Infinite isolation is assumed in the junction.

Table I — Power Divider Relationships for 180° Hybrids

Input Signal	Input Port	Output Signals			
		Port A	Port B	Port C	Port D
E cosωt	A	–	0	$\frac{1}{\sqrt{2}}$ E cosωt	$\frac{1}{\sqrt{2}}$ E cos(ωt+180°)
	B	0	–	$\frac{1}{\sqrt{2}}$ E cosωt	$\frac{1}{\sqrt{2}}$ E cosωt
	C	$\frac{1}{\sqrt{2}}$ E cosωt	$\frac{1}{\sqrt{2}}$ E cosωt	–	0
	D	$\frac{1}{\sqrt{2}}$ E cos(ωt+180°)	$\frac{1}{\sqrt{2}}$ E cosωt	0	–

Power Summer

The relationships given in Table II apply when the 180° hybrid is used as a power summer. The following conditions apply.

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Two generators are operating simultaneously.
3. Infinite isolation is assumed in the junction.

* Reference Figure 3.

Table II — Power Summer Relationships for 180° Hybrids

Input Signal	Input Port	Output Signals			
		Port A	Port B	Port C	Port D
*E cosωt	A	–	–	$\sqrt{2}$ E cos(−α/2)	$\sqrt{2}$ E cos(90°−α/2)
*E cos(ωt+α)	B			[cos(ωt+α/2)]	[cos(ωt+α/2+90°)]
E cosωt	A	–	–	$\sqrt{2}$ E cosωt	0
E cosωt	B				
E cos(ωt+180°)	A	–	–	0	$\sqrt{2}$ E cosωt
E cosωt	B				
E cosωt	C	0	$\sqrt{2}$ E cosωt	–	–
E cosωt	D				
E cosωt	C	$\sqrt{2}$ E cosωt	0	–	–
E cos(ωt+180°)	D				
E cosω_1t	A	–	–	$\frac{1}{\sqrt{2}}$ E(cosω_1t+cosω_2t)	$\frac{1}{\sqrt{2}}$ E(cosω_1t+cosω_2t)
E cosω_1t	B				

Isolation

Isolation between ports is expressed by those relationships given in Table III. The following conditions and definitions apply.

1. Only one generator is operating at a time.
2. $\rho = \dfrac{Z - Z_O}{Z + Z_O}$

Table III — Isolation Between Ports of 180° Hybrids

Terminations				Isolation (dB)	
A	B	C	D	A to B	C to D
Z_O	Z_O	Z_C	Z_D	$6+20\log\frac{1}{\lvert\rho_C-\rho_D\rvert}$	∞
Z_O	Z_O	Z_O	Z_D	$6+20\log\frac{1}{\lvert\rho_D\rvert}$ = 6+return loss of Z_D	∞
Z_A	Z_B	Z_O	Z_O	∞	$6+20\log\frac{1}{\lvert\rho_B-\rho_A\rvert}$
Z_O	Z_B	Z_O	Z_O	∞	$6+20\log\frac{1}{\lvert\rho_B\rvert}$ = 6+return loss of Z_B

VSWR-With Various Terminations

Voltage Standing Wave Ratio (VSWR) with various terminations is expressed by using those relationships given in Table IV.

Table IV — VSWR with Various Terminations for 180° Hybrids

Port Terminations				VSWR	
A	B	C	D	A to B	C to D
Z_O	Z_O	Z_O	Z_O	1:1	1:1
Z_A	Z_B	Z_O	Z_O	1:1	$\dfrac{1+\frac{\lvert\rho_A+\rho_B\rvert}{2}}{1-\frac{\lvert\rho_A+\rho_B\rvert}{2}}$
Z_O	Z_O	Z_C	Z_D	$\dfrac{1+\frac{\lvert\rho_C+\rho_D\rvert}{2}}{1-\frac{\lvert\rho_C+\rho_D\rvert}{2}}$	1:1

similar to that applied to the 180° hybrid, we can apply signal sources in various combinations to ports of the 90° hybrid and determine the resultant outputs. Figure 5 shows the arrangement used for this analysis, and once again we will consider the operation of the hybrid as a power divider and power summer, with all terminating impedances assumed equal to Z_o.

The analysis of the 90° hybrid as a power divider is straightforward and, as previously mentioned, two equal amplitude outputs result when any one of the ports is fed by a signal source. These outputs are in quadrature as indicated in Table V.

To analyze to 90° hybrid as a power summer, we will once again make use of a diagram showing the vector and algebraic relationships of the signals at all ports when two equal amplitude, equal frequency, arbitrary phase signals are applied.

In Figure 6, these two signals are shown applied to Ports A and B of the 90° hybrid. The amplitudes of the resultant outputs at Ports C and D vary based on the phase of the inputs, while the phases of the outputs are always equal. This can be a useful property in certain applications since the relative phase of the input signals can be determined by measuring the relative amplitudes of the outputs. The relationships for a 90° hybrid with signals applied to Ports A and B or C and D are shown in Table VI.

Tables VII and VIII provide the relations for analysis of VSWR and Isolation in 90° hybrids. If we consider the same condition described for the 180° hybrid, two equal mismatches on opposite ports of the hybrid, we get an interesting result. The reflected signal will appear at the normally isolated port, but will not be present at the input. Thus, if we inject a signal at Port A, and apply equal mismatches at Ports C and D with a Z_o termination at Port B, the reflected components from the mismatches will be in phase at Port B and will be 180° out of phase at Port A. The isolation between Ports A and B is reduced, but the VSWR at Port A is unchanged by the presence of the mismatches. This property allows 90° hybrids to be

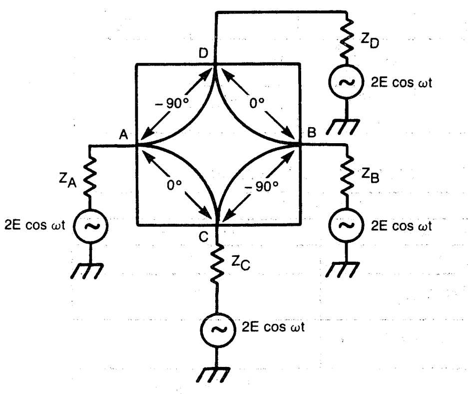
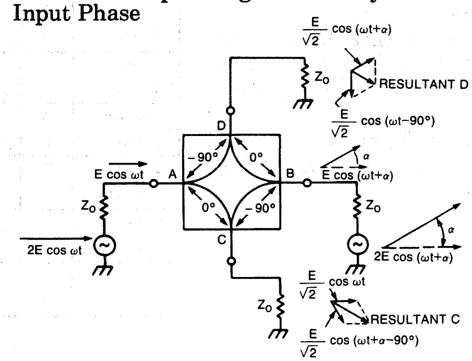


Figure 5. Signal Source Configuration for 90° Hybrid (Reference Tables V, VI, VII, VIII)

- Equal Amplitude, Equal Frequency Input
- Resultant Output Phases are Equal
- Resultant Output Magnitudes vary based on Input Phase



Resultant C

$$= \frac{E}{\sqrt{2}}[\cos \omega t + \cos(\omega t + \alpha - 90°)]$$

$$= \frac{E}{\sqrt{2}}[2 \cos ½ (2\omega t + \alpha - 90°) \cos ½ (-\alpha + 90°)]$$

$$= \sqrt{2}\,E \cos\left(45° - \frac{\alpha}{2}\right) \cos\left(\omega t + \frac{\alpha}{2} - 45°\right)$$

Resultant D

$$= \frac{E}{\sqrt{2}}[\cos(\omega t - 90°) + \cos(\omega t + \alpha)]$$

$$= \frac{E}{\sqrt{2}}[2 \cos ½ (2\omega t + \alpha - 90°) \cos ½ (-\alpha - 90°)]$$

$$= \sqrt{2}\,E \cos\left(-45° - \frac{\alpha}{2}\right) \cos\left(\omega t + \frac{\alpha}{2} - 45°\right)$$

$\therefore$ Phase of Resultant C = Phase of Resultant D $= (\omega t + \frac{\alpha}{2} - 45°)$

Figure 6. 90° Hybrid

Power Divider

Table V shows applicable relationships when the 90° hybrid is used as a power divider. The following conditions apply:

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Only one generator at a time is operating.

Table V – 90° Hybrid as a Power Divider

Input Signal	Input Port	Output Signals: Port A	Port D	Port C	Port B
E cosωt	A		$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$	$\frac{E}{\sqrt{2}}\cos\omega t$	0
	B	$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$		0	$\frac{E}{\sqrt{2}}\cos\omega t$
	C	$\frac{E}{\sqrt{2}}\cos\omega t$	0		$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$
	D	0	$\frac{E}{\sqrt{2}}\cos\omega t$	$\frac{E}{\sqrt{2}}\cos(\omega t-90°)$	

Power Summer

Table VI shows applicable relationships when the 90° hybrid is used as a power summer. The following conditions apply:

1. $Z_A = Z_B = Z_C = Z_D = Z_O$
2. Two generators are operating simultaneously.

Table VI – 90° Hybrid as a Power Summer

Input Signal	Input Port	Output Ports: Port A	Port D	Port C	Port B
$E\cos\omega t$ $E\cos(\omega t+\alpha)$	A B		$\sqrt{2}E\cos(-45°-\alpha/2)$ $[\cos(\omega t+\alpha/2-45°)]$	$\sqrt{2}E\cos(45°-\alpha/2)$ $[\cos(\omega t+\alpha/2+45°)]$	
$E\cos\omega t$ $E\cos\omega t$	A B		0	$\sqrt{2}E\cos\omega t$	
$E\cos(\omega t+90°)$ $E\cos\omega t$	A B		$\sqrt{2}E\cos\omega$	0	
$E\cos\omega t$ $E\cos\omega t+90°)$	D C	0			$\sqrt{2}E\cos\omega t$
$E\cos\omega t$ $E\cos(\omega t+90°)$	D C	$\sqrt{2}E\cos\omega t$			0
$E\cos\omega_1 t$ $E\cos\omega_2 t$	B A		$\frac{E}{\sqrt{2}}\left[\cos\omega_1 t + \cos(\omega_2 t-90°)\right]$	$\frac{E}{\sqrt{2}}\left[\cos(\omega_1 t+90°) + \cos\omega_2 t\right]$	

VSWR

Table VII shows relationships used in determining port Voltage Standing Wave Ratios (VSWR's) for 90° hybrids. The following condition applies:

$$\rho = \frac{Z - Z_O}{Z + Z_O}$$

Table VII – VSWR of 90° Hybrids

Port Terminations: A	B	C	D	Port VSWR's: Port A	Port D	Port C	PortB
Z_O	Z_O	Z_O	Z_O	1:1	1:1	1:1	1:1
Z_O	Z_D	Z_C	Z_O	$\frac{1+\frac{\lvert\rho_D-\rho_C\rvert}{2}}{1-\frac{\lvert\rho_D-\rho_C\rvert}{2}}$	1:1	1:1	$\frac{1+\frac{\lvert\rho_D-\rho_C\rvert}{2}}{1-\frac{\lvert\rho_D-\rho_C\rvert}{2}}$
Z_A	Z_O	Z_O	Z_B	1:1	$\frac{1+\frac{\lvert\rho_A-\rho_B\rvert}{2}}{1-\frac{\lvert\rho_A-\rho_B\rvert}{2}}$	$\frac{1+\frac{\lvert\rho_A-\rho_B\rvert}{2}}{1-\frac{\lvert\rho_A-\rho_B\rvert}{2}}$	

Isolation

Table VIII shows relationships used in determining isolation between ports of 90° hybrids. The following conditions apply:

1. Only one generator at a time is operating.
2. $\rho = \frac{Z - Z_O}{Z + Z_O}$
3. Return loss $= 20 \log \frac{1}{\lvert\rho\rvert}$

Table VIII – Isolation for 90° Hybrids

Terminations: A	B	C	D	Isolation (dB): Ports A to B	Ports C to D
Z_O	Z_O	Z_O	Z_O	∞	∞
Z_O	Z_O	Z_C	Z_D	$6+20\log\frac{1}{\lvert\rho_D+\rho_C\rvert}$	∞
Z_O	Z_D	Z_O	Z_O	$6+20\log\frac{1}{\lvert\rho_D\rvert}$ = 6+return loss of Z_D	∞
Z_A	Z_O	Z_O	Z_B	∞	$6+20\log\frac{1}{\lvert\rho_B+\rho_A\rvert}$
Z_O	Z_O	Z_O	Z_B	∞	$6+20\log\frac{1}{\lvert\rho_B\rvert}$ = 6+return loss of Z_B

used in applications such as balanced amplifiers, where two equal impedance but mismatched amplifier stages are combined at inputs and outputs with 90° hybrids to achieve a low VSWR. VSWR and Isolation can be determined based on the relationships in Tables VII and VIII.

PERFORMANCE PARAMETERS

The 180° or 90° hybrid electrical parameters of principal importance to the designer or components engineer and commonly specified by manufacturers are the following:

Frequency Range

This is the range over which specifications are guaranteed for the particular device.

Insertion Loss

The amount of attenuation, in excess of signal splitting losses, of an input signal from a source of characteristic impedance Z_O measured at an output port terminated in Z_O.

Isolation

Isolation between two ports of a passive device is the amount of attenuation that a signal from a source of characteristic impedance Z_O applied to one port undergoes when measured at the other port terminated in Z_O.

Impedance

This is the nominal characteristic impedance (Z_O) for the device.

VSWR

Voltage Standing Wave Ratio – VSWR is a measure of the impedance of a device relative to Z_O.

It can be expressed as $VSWR = \dfrac{1 + |\rho|}{1 - |\rho|}$

where $|\rho|$ is the magnitude of the reflection coefficient at the frequency of interest.

Amplitude Balance

The difference in attenuation between two or more output signals fed from a common input generally expressed as a maximum variation.

Phase Balance

The difference in phase between two or more output signals fed from a common input generally expressed as a maximum variation relative to the nominal phase difference between the paths. This nominal phase difference may be 0, 90, or 180°.

Some performance tradeoffs may be made between certain of these parameters. The principal tradeoff is between frequency range, insertion loss and amplitude balance for 90° hybrids. Several different design approaches are used for quadrature hybrids. These can generally be separated into narrow band and broadband designs. For single frequency applications the 10% bandwidth design can achieve very low insertion loss (0.1 to 0.2 dB), but the amplitude balance will degrade rapidly away from the center frequency. Octave bandwidth designs have slightly more loss, but the amplitude balance is maintained over the octave range. For this design, two crossover points occur where the output signals are equal. The broadband design is normally used only where frequency ranges of a decade or more are required. It is a more complex design generally consisting of a pair of 180° hybrids interconnected with a pair of phase tracking 90° all pass lattice filter networks, and will usually have higher insertion loss because of this complexity.

CONCLUSION

The 90° and 180° hybrids are basic system and component building blocks. Understanding their basic relationships allows the designer, through clearer application, to overcome system problems and/or improve system performance with these simple devices. The reader is urged to study the tables of relationships carefully since some of the hybrid's unique capabilities are not inherently obvious. There are special cases of these devices discussed in more detail in the RF power divider, coupler, and RF multi-function assembly sections of this catalog.

High-Power Hybrid Junction
200 kHz-35 MHz

HH-108

- High Power Handling Capability
- Low VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		200 kHz-35 MHz
Insertion Loss (Less coupling)		0.4 dB Max
Isolation	200 kHz-10 MHz	30 dB Min
	10 MHz-35 MHz	20 dB Min
Amplitude Balance	200 kHz-10 MHz	0.1 dB Max
	10 MHz-35 MHz	0.2 dB Max
VSWR		1.3:1 Max
Phase Balance	200 kHz-10 MHz	3° Max
	10 MHz-35 MHz	10° Max

Operating Characteristics

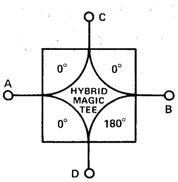
Impedance	50 Ohms Nominal
Input Power	25 Watts Max Up to 50°C 20 Watts Max Up to 85°C

Environmental

See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

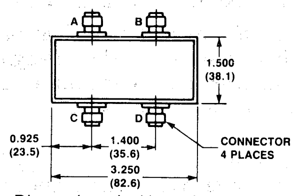
Functional Diagram



Ordering Information

Model No.	Package
HH-108 BNC	Connectorized
HH-108 SMA	Connectorized

C-11

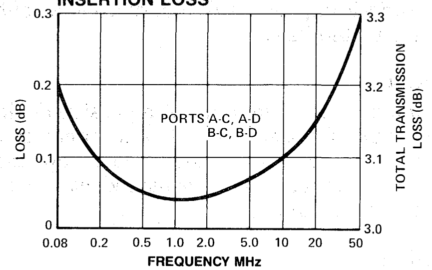


Dimensions in ( ) are in mm.

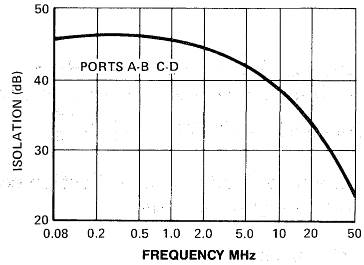
See Appendix for complete physical dimensions.

Typical Performance

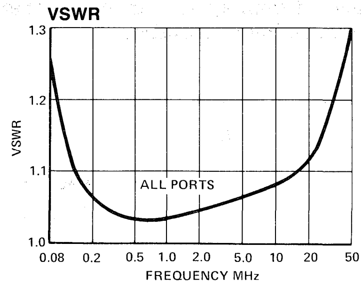
INSERTION LOSS



ISOLATION



VSWR



Specifications Subject to Change Without Notice.

180° Hybrid Junctions 2-200 MHz

HH-106/107

- 0°-180° Hybrid with Symmetrical Time Delay Between Ports
- Available in Flatpack and Connectorized Packages

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range			2-200 MHz
Insertion Loss (Less coupling)			1.0 dB Max
Isolation	A-B	2-200 MHz	25 dB Min
		5-50 MHz	30 dB Min
	C-D	2-200 MHz	30 dB Min
		5-50 MHz	35 dB Min
Amplitude Balance			0.3 dB Max
VSWR		2-200 MHz	1.5:1 Max
		5-50 MHz	1.3:1 Max
Phase Balance			3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max

Environmental

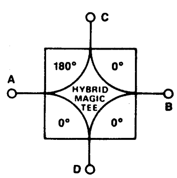
See Appendix for MIL-STD-883 screening option.

Pin Configuration

HH-106	A; P1, C; P4, B; P5, D; P8. All other pins and case ground.

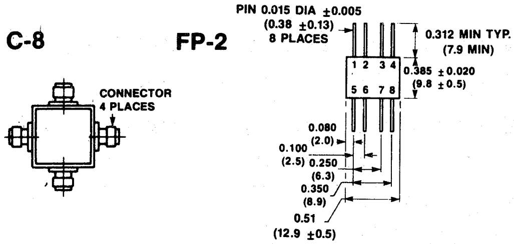
*All specifications apply with 50 ohm source and load impedance.

Functional Diagram



Ordering Information

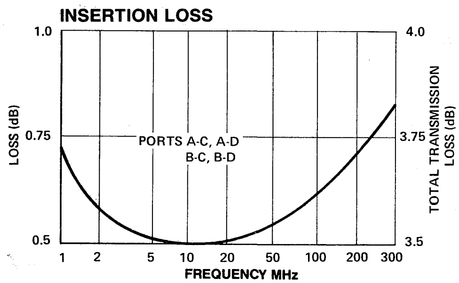
Model No.		Package
HH-106	PIN	Flatpack
HH-107	BNC	Connectorized
HH-107	SMA	Connectorized

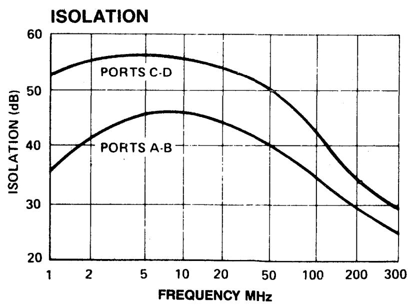


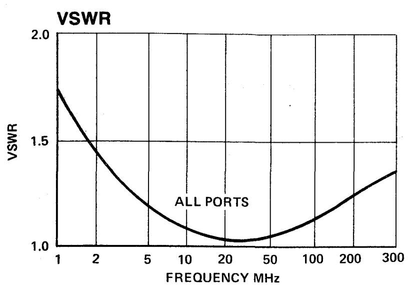
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Hybrid Junction
5-200 MHz

HH-/HHS-109

- 0°-180° Hybrid with High Isolation
- Usable from 500 kHz-500 MHz

Guaranteed Specifications*

(From −55°C to +85°C)

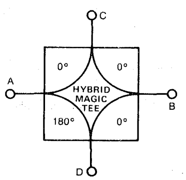
Frequency Range		5-200 MHz
Insertion Loss (Less coupling)		1.4 dB Max
Isolation	5-100 MHz	30 dB Min
	100-200 MHz	25 dB Min
Amplitude Balance		0.3 dB Max
VSWR	5-100 MHz	1.5:1 Max
	100-200 MHz	1.7:1 Max
Phase Balance	5-100 MHz	4° Max
	100-200 MHz	8° Max

Operating Characteristics

Impedance		50 Ohms Nominal
Input Power		0.5 Watts Max
Environmental		
See Appendix for MIL-STD-883 screening option.		
Pin Configuration		
	FP-2	A; P1, B; P4, C; P8, D; P5 All other pins and case ground.
	SF-1	A; P1, B; P2, C; P4, D; P3 All other pins and case ground.

*All specifications apply with 50 ohm source and load impedance.

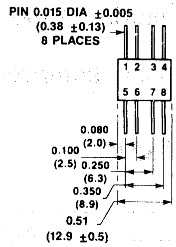
Functional Diagram



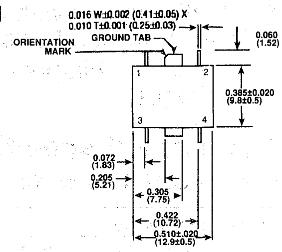
Ordering Information

Model No.	Package
HH-109 PIN	Flatpack
HHS-109 PIN	Surface Mount

FP-2



SF-1

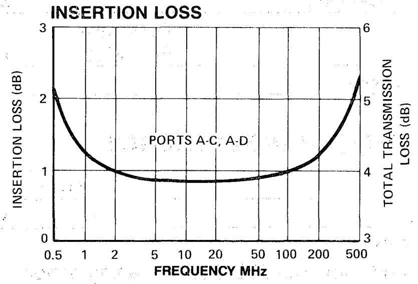


Dimensions in ( ) are in mm.

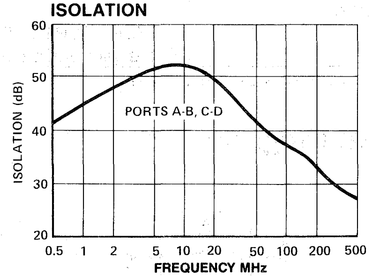
See Appendix for complete physical dimensions.

Typical Performance

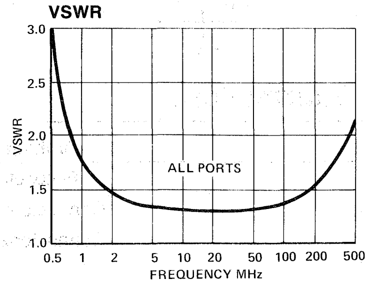
INSERTION LOSS



ISOLATION



VSWR



Specifications Subject to Change Without Notice.

Hybrid Junction
20-300 MHz

HH-105

- 0°-180° Hybrid in TO-5 Package
- High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

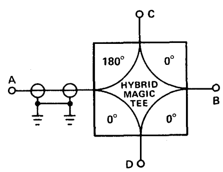
Frequency Range	20-300 MHz
Insertion Loss (Less coupling)	1.0 dB Max
Isolation	28 dB Min
Amplitude Balance	0.25 dB Max**
VSWR	1.3:1 Max
Phase Balance	2° Max**

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	0.5 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	A; P1, B; P2, D; P3, C; P4. Case ground.

*All specifications apply with 50 ohm source and load impedance.
**Differences measure between C & D feeding A or B.

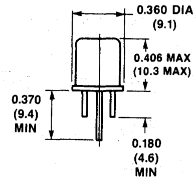
Functional Diagram



Ordering Information

Model No.	Package
HH-105 PIN	TO-5-2

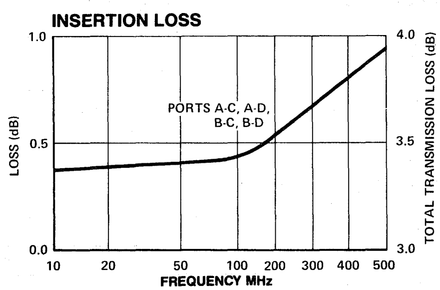
TO-5-2

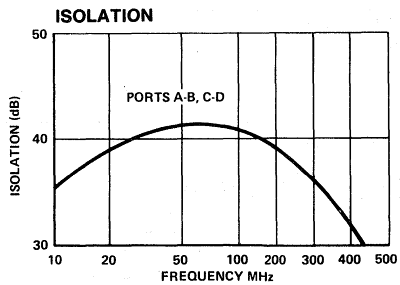


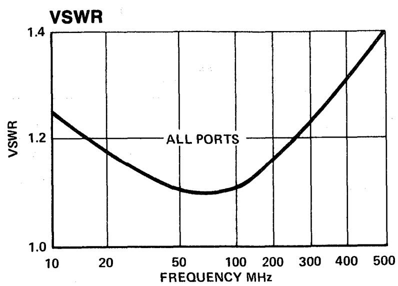
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

![M/A-COM]

Hybrid Junction 10-500 MHz

HH-110/127

- Broad Frequency Range
- High Isolation — Typically 30 dB
- Available in Flatpack and TO-8 Packages

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-500 MHz
Insertion Loss (Less coupling)	10-500 MHz	1.4 dB Max
	25-200 MHz	1.0 dB Max
Isolation	10-500 MHz	20 dB Min
	25-200 MHz	30 dB Min
Amplitude Balance	10-500 MHz	0.6 dB Max
	25-200 MHz	0.4 dB Max
VSWR	10-500 MHz	2.0:1 Max
	25-200 MHz	1.6:1 Max
Phase Balance	10-500 MHz	7° Max
	25-200 MHz	5° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max

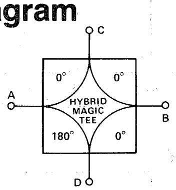
Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

HH-110	A; P1, C; P4, B; P5, D; P8. All other pins and case ground.
HH-127	A; P5, B; P8, C; P2, D; P11. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

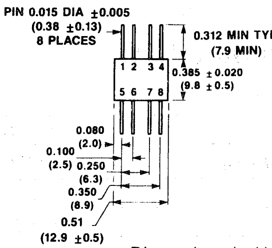
Functional Diagram



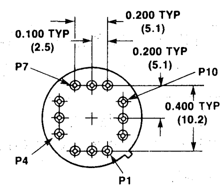
Ordering Information

Model No.	Package
HH-110 PIN	Flatpack
HH-127 PIN	TO-8-2

FP-2

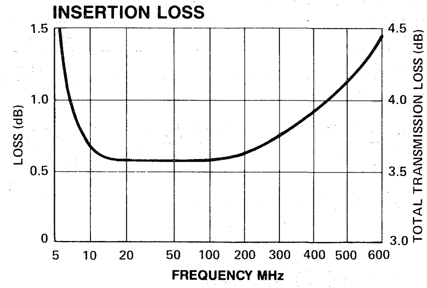


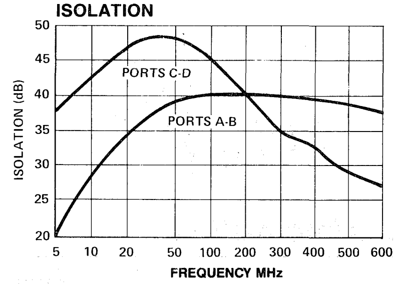
TO-8-2

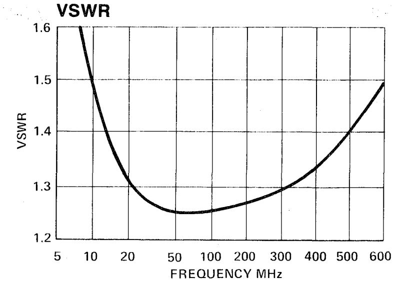


Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Surface Mount Hybrid Junction
10-500 MHz
HHS-110

- Fully Hermetic Package
- Broad Frequency Range
- High Isolation — Typically 30 dB

Guaranteed Specifications*
(From −55°C to +85°C)

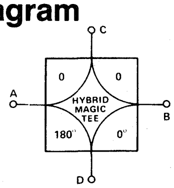
Frequency Range		10-500 MHz
Insertion Loss (Less coupling)	10-500 MHz	1.4 dB Max
	25-200 MHz	1.0 dB Max
Isolation	10-500 MHz	20 dB Min
	25-200 MHz	30 dB Min
Amplitude Balance	10-500 MHz	0.6 dB Max
	25-200 MHz	0.4 dB Max
VSWR	10-500 MHz	2.0:1 Max
	25-200 MHz	1.6:1 Max
Phase Balance	10-500 MHz	7° Max
	25-200 MHz	5° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	A; P1, C; P2, B; P3, D; P4. All other pins and case ground.

*All specifications apply with 50 ohm source and load impedance.

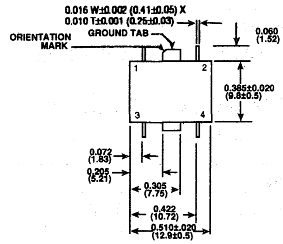
Functional Diagram



Ordering Information

Model No.	Package
HHS-110 PIN	Surface Mount

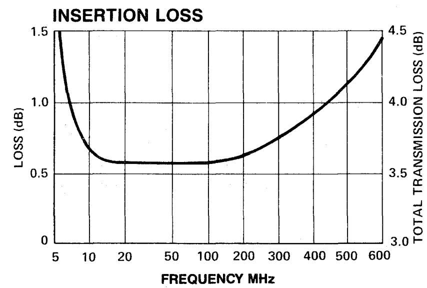
SF-1

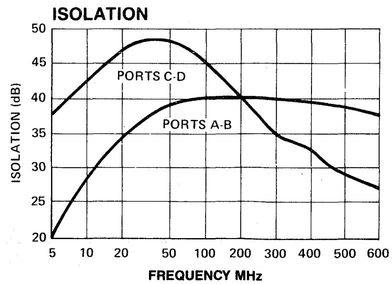


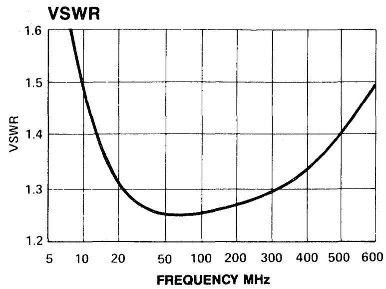
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

UHF Hybrid Junction
5 MHz-1GHz

H-1-4

- Broad Frequency Range
- 0°-180° Hybrid with High Isolation

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5 MHz-1 GHz
Isolation (A-B Ports)	5-300 MHz	50 dB Min
	300 MHz-1 GHz	40 dB Min

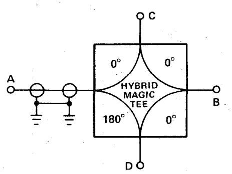
Operating Characteristics

Impedance	
A & B Ports	50 Ohms Nominal
C & D Ports	100 Ohms Nominal
Input Power	7 Watts Max
Phase Shift (A to C or D)	Linear with Frequency (~45° @ 300 MHz)

Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,311,850.

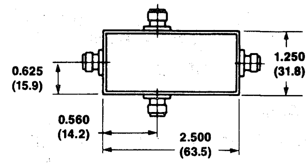
Functional Diagram



Ordering Information

Model No.		Package
H-1-4	BNC	Connectorized
H-1-4	N	Connectorized
H-1-4	SMA	Connectorized

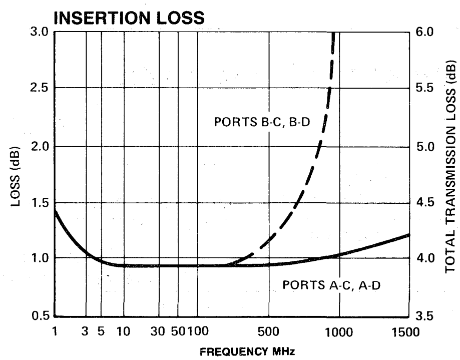
C-33

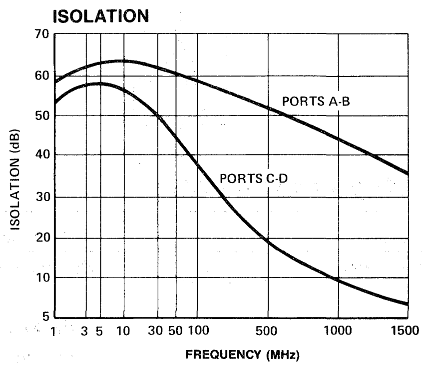


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance





Specifications Subject to Change Without Notice.

Hybrid Junction
2 MHz-2 GHz

H-9

- 0°-180° Hybrid with 10 Octave Bandwidth
- 30 dB Minimum Isolation
- Low VSWR

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		2-2000 MHz
Insertion Loss (Less coupling)	2-5 MHz	1.7 dB Max
	5-20 MHz	1.7 dB Max
	20-300 MHz	0.7 dB Max
	300-1000 MHz	1.25 dB Max
	1000-2000 MHz	2.25 dB Max
Isolation	2-20 MHz	35 dB Min
	20-300 MHz	40 dB Min
	300-1000 MHz	30 dB Min
	1000-2000 MHz	30 dB Min
Amplitude Balance	2-2000 MHz	0.5 dB Max
VSWR	2-5 MHz	3.0:1 Max
	5-20MHz	2.4:1 Max
	20-300 MHz	1.4:1 Max
	300-1000 MHz	1.7:1 Max
	1000-2000 MHz	1.7:1 Max
Phase Unbalance	2-20 MHz	1° Max
	20-300 MHz	2° Max
	300-1000 MHz	3° Max
	1000-2000 MHz	7° Max

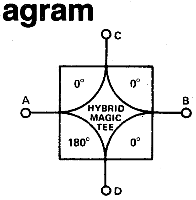
Operating Characteristics

Impedance		50 Ohms Nominal
Input Power	2-20 MHz	5 Watts Max
	20-2000 MHz	25 Watts Max

Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,325,587.

Functional Diagram

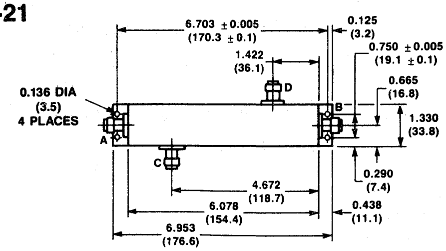


Ordering Information

Model No.		Package
H-9	N	Connectorized
H-9	SMA	Connectorized

Specifications Subject to Change Without Notice.

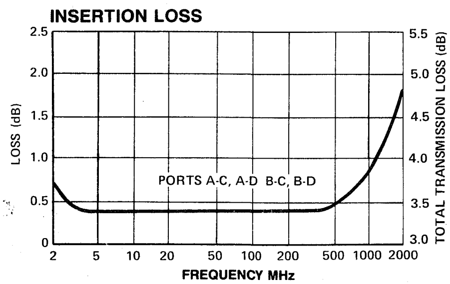
C-21

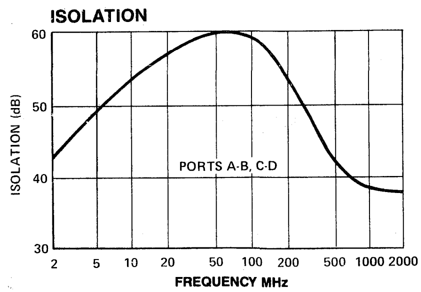


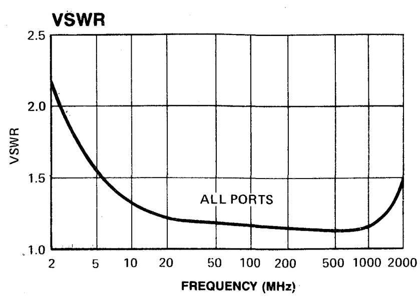
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Flatpack Hybrid Junction 20-2000 MHz

HH-128

- 1.5 dB Typical Midband Insertion Loss
- 30 dB Typical Midband Isolation
- 1.3:1 Typical Midband VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		20-2000 MHz
Insertion Loss (Less coupling)	20-2000 MHz	3.0 dB Max
	20-1000 MHz	2.5 dB Max
Isolation	20-2000 MHz	15 dB Min
	20-1000 MHz	20 dB Min
Amplitude Balance	20-2000 MHz	1.2 dB Max
	20-1000 MHz	0.5 dB Max
VSWR	20-2000 MHz	2.0:1 Max
Phase Balance	20-2000 MHz	20° Max
	20-1000 MHz	15° Max
	20-500 MHz	10° Max

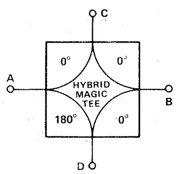
Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	0.5 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	C; P1, D; P5, A; P6, B; P10. All other pins and case ground.

*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,508,171.

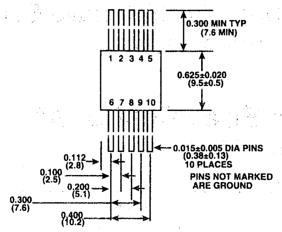
Functional Diagram



Ordering Information

Model No.	Package
HH-128 PIN	Flatpack

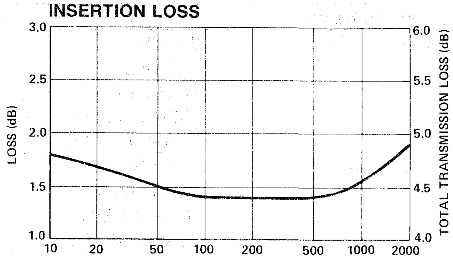
FP-3

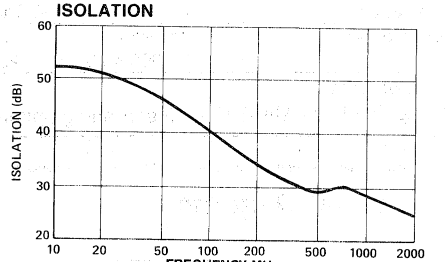


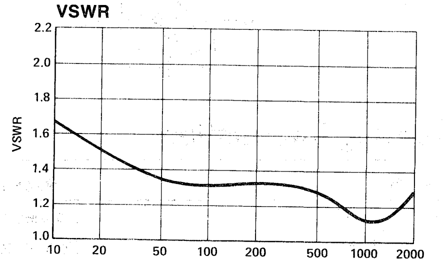
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Microwave Hybrid Junction
30 MHz-3 GHz

H-183-4

- 0°-180° Hybrid
- Seven Octave Frequency Range

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		30-3000 MHz
Insertion Loss (Less coupling)	30-100 MHz	1.2 dB Max
	100-1500 MHz	1.5 dB Max
	1500-3000 MHz	2.5 dB Max
Isolation	30-100 MHz	25 dB Min
	100-1500 MHz	20 dB Min
	1500-3000 MHz	20 dB Min
Amplitude Balance	30-3000 MHz	0.4 dB Max
VSWR	30-100 MHz	1.6:1 Max
	100-1500 MHz	1.6:1 Max
	1500-3000 MHz	2.5:1 Max
Phase Unbalance	30-100 MHz	3° Max
	100-1500 MHz	7.5° Max
	1500-3000 MHz	15° Max

Operating Characteristics

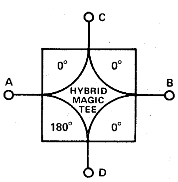
Impedance	50 Ohms Nominal
Input Power	5 Watts Max
Environmental	

See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

This product contains elements protected by United States Patent Number 3,508,171.

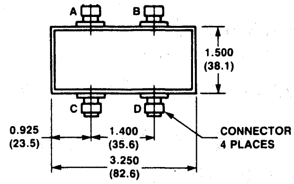
Functional Diagram



Ordering Information

Model No.	Package
H-183-4 SMA	Connectorized

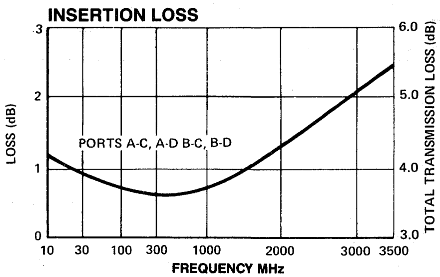
C-11

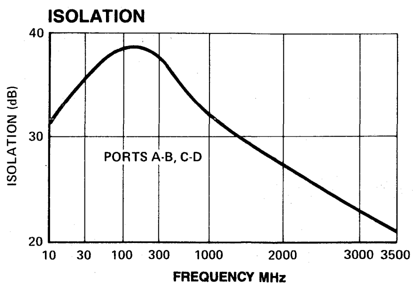


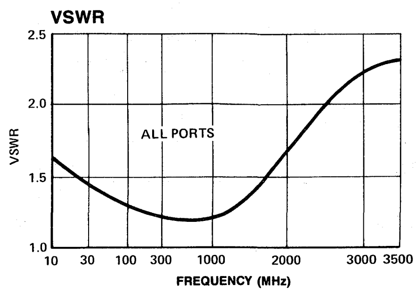
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM

Quadrature Hybrid
7-14 MHz

JH-/JHS-113

- Octave Bandwidth
- Low VSWR — 1.2:1
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	7-14 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

FP-2	A; P1, B; P4, C; P8, D; P5	
	All other pins and case ground.	
SF-1	A; P1, B; P2, C; P4, D; P3	
	All other pins and case ground.	

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.

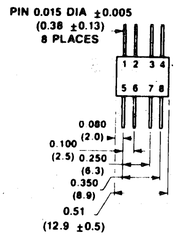
Phasing Diagram

IN \ OUT	A	B	C	D
A	X	ISO.	0°	−90°
B	ISO.	X	−90°	0°
C	0°	−90°	X	ISO.
D	−90°	0°	ISO.	X

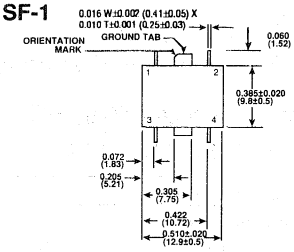
Ordering Information

Model No.	Package
JH-113 PIN	Flatpack
JHS-113 PIN	Surface Mount

FP-2



SF-1

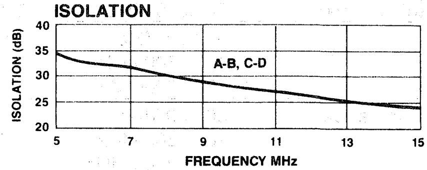


Dimensions in ( ) are in mm.

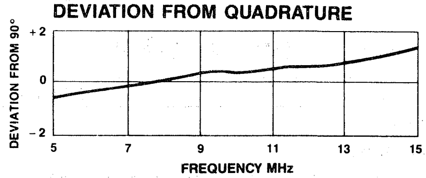
See Appendix for complete physical dimensions.

Typical Performance

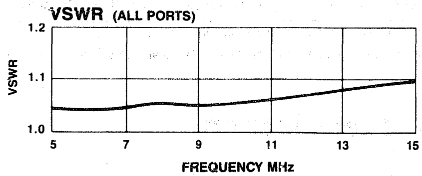
ISOLATION



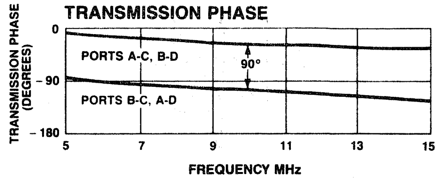
DEVIATION FROM QUADRATURE



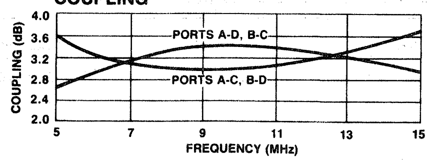
VSWR (ALL PORTS)



TRANSMISSION PHASE



COUPLING



Specifications Subject to Change Without Notice.

Quadrature Hybrid
2-32 MHz

JH-6-4

- Covers the HF Band
- Low VSWR — 1.2:1
- 3° Maximum Deviation from 90°

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	2-32 MHz
Insertion Loss (Less coupling)	0.8 dB Max
Isolation	20 dB Min
Amplitude Balance	0.7 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max

Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

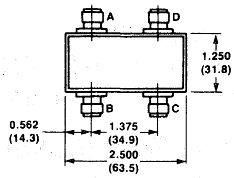
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Ordering Information

Model No.		Package
JH-6-4	BNC	Connectorized
JH-6-4	N	Connectorized
JH-6-4	SMA	Connectorized

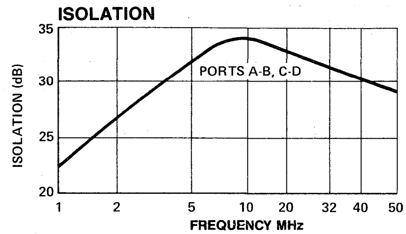
C-10

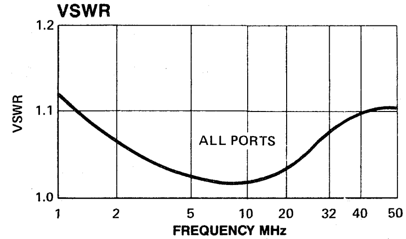


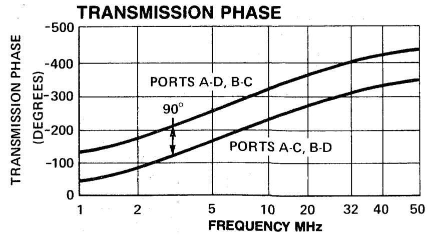
Dimensions in ( ) are in mm.

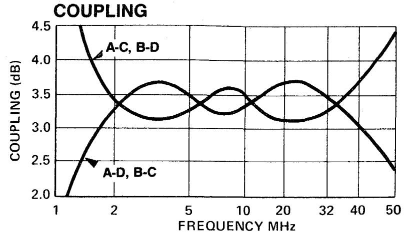
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

Quadrature Hybrid
20-40 MHz

JH-114/133

- Octave Bandwidth
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	20-40 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @ 25°C Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

JH-114	A; P1, B; P4, C; P8, D; P5. All other pins are ground.
JH-133	A; P5, B; P2, C; P11, D; P8. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

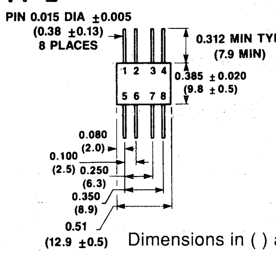
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

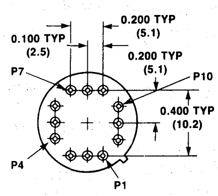
Ordering Information

Model No.	Package
JH-114 PIN	Flatpack
JH-133 PIN	TO-8-2

FP-2

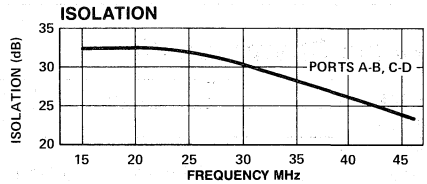


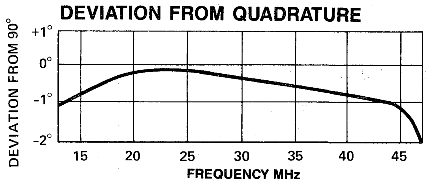
TO-8-2

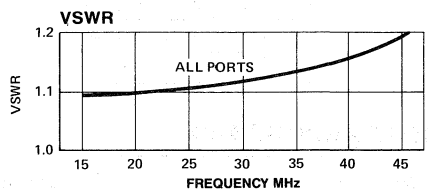


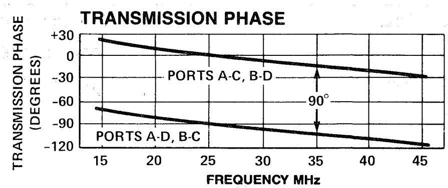
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

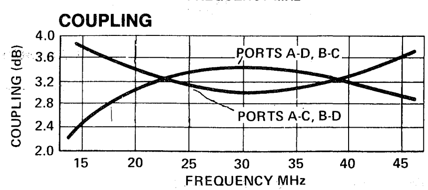
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Surface Mount Quadrature Hybrid
20-40 MHz

JHS-114

- Fully Hermetic Package
- Octave Bandwidth
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	20-40 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @ 25°C Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

JHS-114	A; P1, B; P2, C; P4, D; P3 All other pins are ground

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

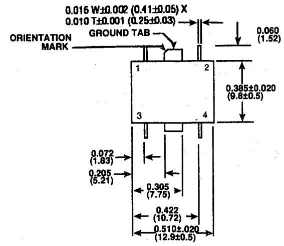
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Ordering Information

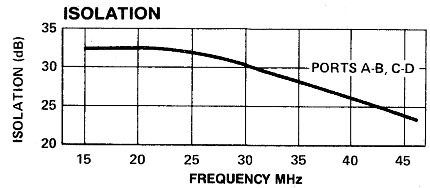
Model No.	Package
JHS-114 PIN	Surface Mount

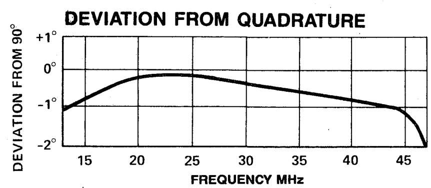
SF-1

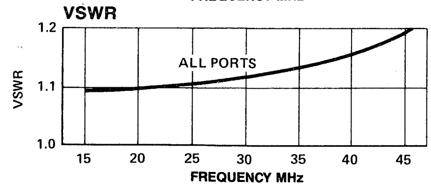


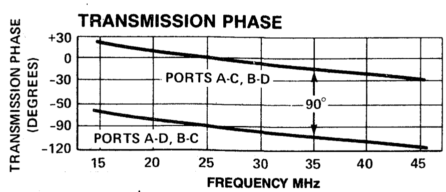
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

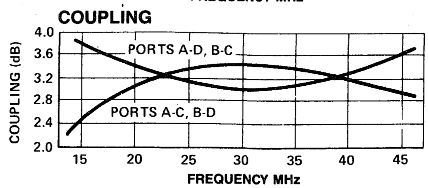
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Quadrature Hybrid
40-80 MHz

JH-115

- Octave Bandwidth
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	40-80 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @25°C Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

JH-115	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

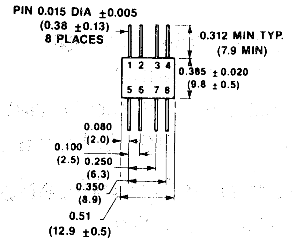
Phasing Diagram

IN \ OUT	A	B	C	D
A	X	ISO.	0°	-90°
B	ISO.	X	-90°	0°
C	0°	-90°	X	ISO
D	-90°	0°	ISO.	X

Ordering Information

Model No.	Package
JH-115 PIN	Flatpack

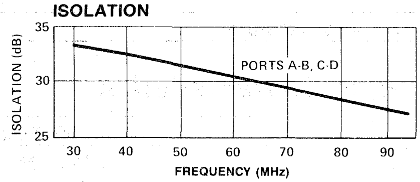
FP-2



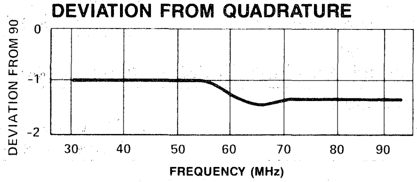
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance

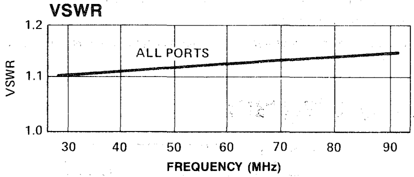
ISOLATION



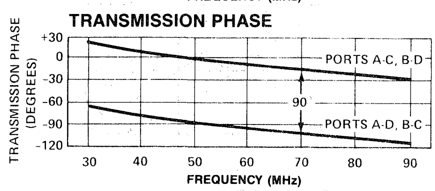
DEVIATION FROM QUADRATURE



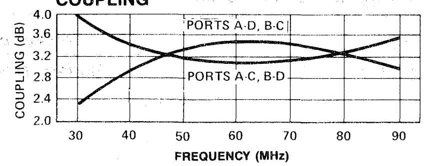
VSWR



TRANSMISSION PHASE



COUPLING



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Surface Mount Quadrature Hybrid
40-80 MHz

JHS-115

- Fully Hermetic Package
- 3° Maximum Phase Deviation from 90°
- Low Loss — 0.5 dB Maximum

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	40-80 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.8 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max Derated to 1 Watt @ 100°C
Typical Phase Linearity	3° from Straight Line
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	A; P1, B; P2, C; P4, D; P3

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.

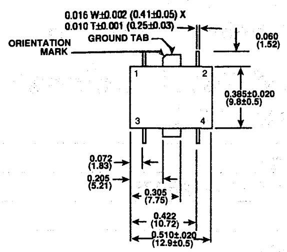
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Ordering Information

Model No.	Package
JHS-115 PIN	Surface Mount

SF-1

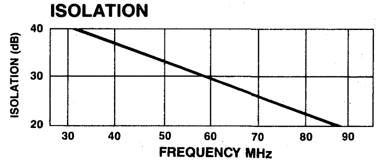


Dimensions in ( ) are in mm.

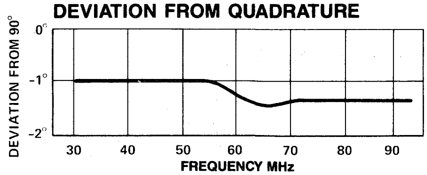
See Appendix for complete physical dimensions.

Typical Performance

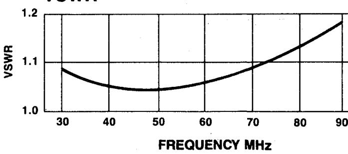
ISOLATION



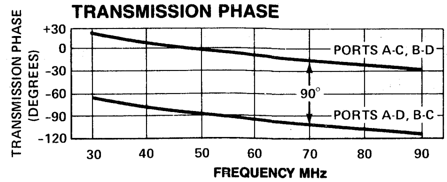
DEVIATION FROM QUADRATURE



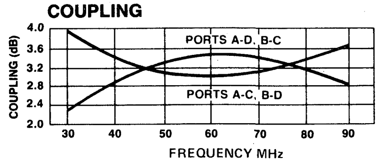
VSWR



TRANSMISSION PHASE



COUPLING



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Quadrature Hybrid
20-140 MHz

JH-10-4

- Multi-Octave Bandwidth
- Low VSWR — 1.25:1
- Amplitude Balance — 0.6 dB

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	20-140 MHz
Insertion Loss (Less coupling)	1.0 dB Max
Isolation	20 dB Min
Amplitude Balance	0.6 dB Max
VSWR	1.25:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	1 Watt Max

Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

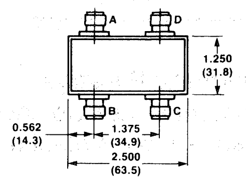
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

Ordering Information

Model No.	Package
JH-10-4 BNC	Connectorized
JH-10-4 SMA	Connectorized

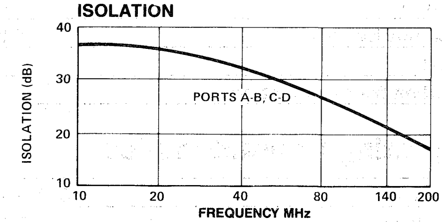
C-10

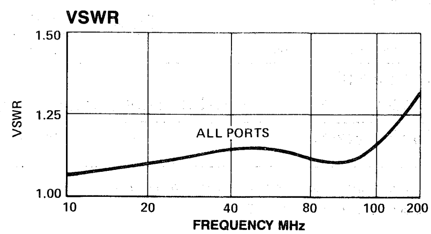


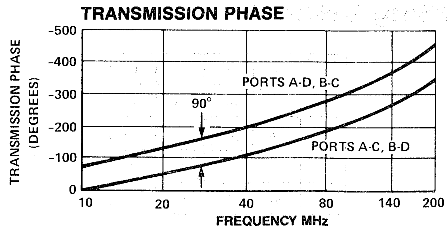
Dimensions in ( ) are in mm.

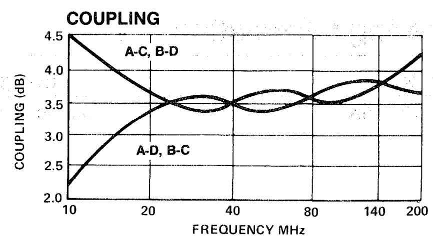
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

Quadrature Hybrid
80-160 MHz

JH-/JHS-119

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.3:1

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	80-160 MHz
Insertion Loss (Less coupling)	0.75 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C Derated to 1 Watt @ 85°C

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

	FP-2	A; P1, B; P2, C; P4, D; P3 All other pins are ground.
	SF-1	A; P1, B; P4, C; P8, D; P5 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled loss exceeding 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

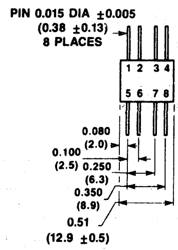
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

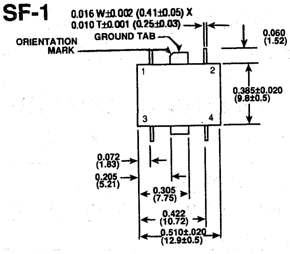
Ordering Information

Model No.	Package
JH-119 PIN	Flatpack
JHS-119 PIN	Surface Mount

FP-2



SF-1

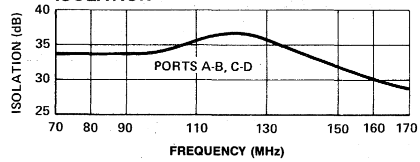


Dimensions in ( ) are in mm.

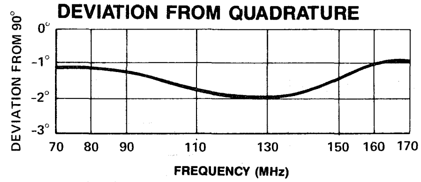
See Appendix for complete physical dimensions.

Typical Performance

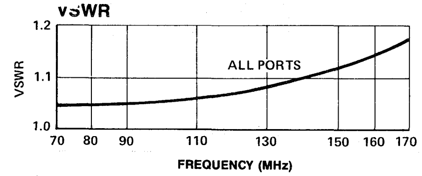
ISOLATION



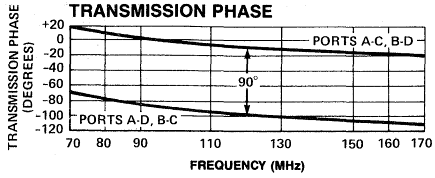
DEVIATION FROM QUADRATURE



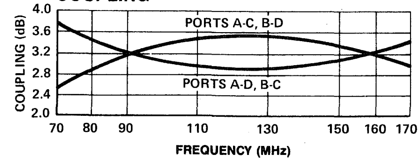
VSWR



TRANSMISSION PHASE



COUPLING



Specifications Subject to Change Without Notice.

Three-Port Quadrature Hybrid
20-200 MHz

JH-131

- Internally Terminated Fourth Port
- Amplitude Balance 0.4 dB

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	20-200 MHz
Insertion Loss (Less coupling)	1.0 dB Max
Isolation	20 dB Min
Amplitude Balance	0.4 dB Max
VSWR	1.4:1 Max
Deviation from Quadrature	6° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	250 mW Max

Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

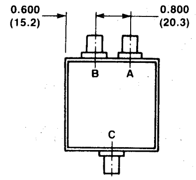
Phasing Diagram

IN \ OUT	A	B	C
A	X	ISO.	90°
B	ISO.	X	0°
C	90°	0°	X

Ordering Information

Model No.	Package
JH-131 BNC	Connectorized
JH-131 SMA	Connectorized

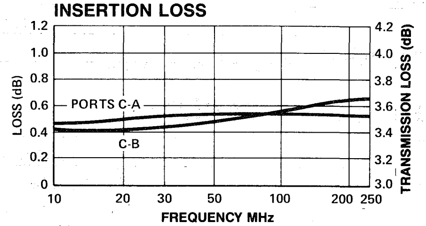
C-13



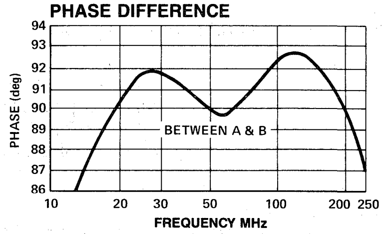
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance

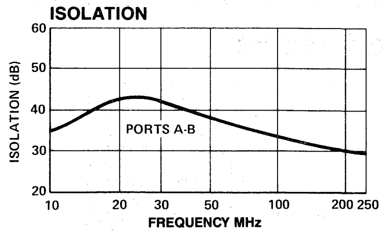
INSERTION LOSS



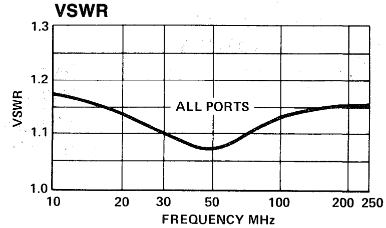
PHASE DIFFERENCE



ISOLATION



VSWR



Specifications Subject to Change Without Notice.

Quadrature Hybrid
100-200 MHz

JH-/JHS-121

- Octave Bandwidth
- Low VSWR — 1.2:1

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	100-200 MHz
Insertion Loss (Less coupling)	0.75 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C Derated to 1 Watt @ 85°C

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

	FP-2	A; P1, B; P2, C; P4, D; P3 All other pins are ground.
	SF-1	A; P1, B; P2, C; P4, D; P3 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

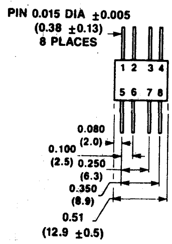
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

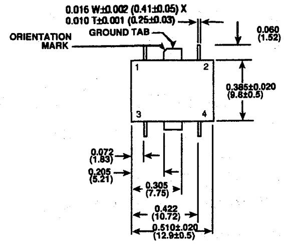
Ordering Information

Model No.	Package
JH-121 PIN	Flatpack
JHS-121 PIN	Surface Mount

FP-2



SF-1

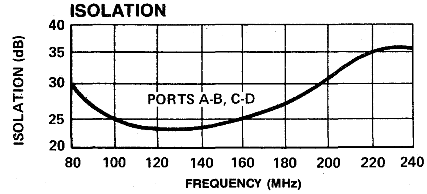


Dimensions in ( ) are in mm.

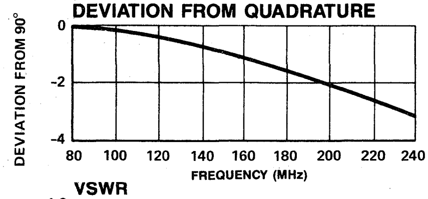
See Appendix for complete physical dimensions.

Typical Performance

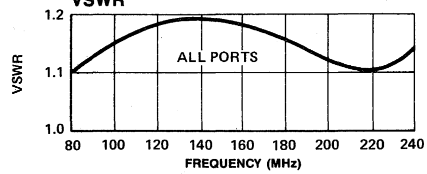
ISOLATION



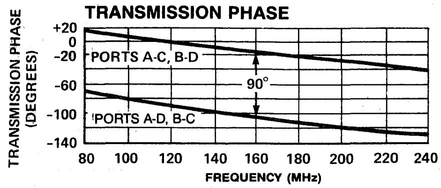
DEVIATION FROM QUADRATURE



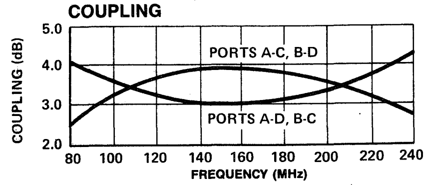
VSWR



TRANSMISSION PHASE



COUPLING



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Flatpack Quadrature Hybrid
175-350 MHz

JH-136

- Octave Bandwidth
- Low VSWR — 1.2:1 Typical

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	175-350 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

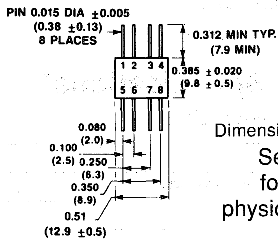
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Ordering Information

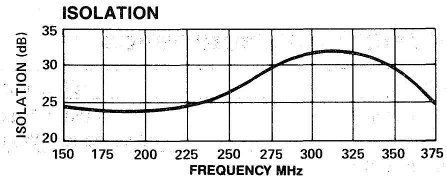
Model No.	Package
JH-136 PIN	Flatpack

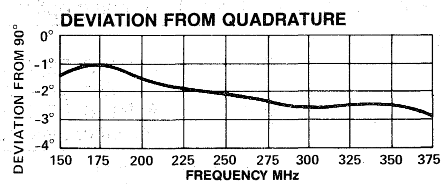
FP-2

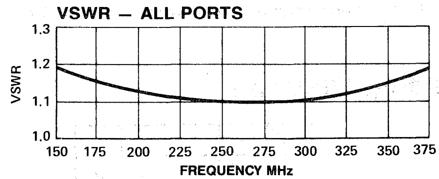


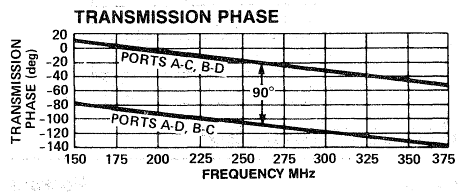
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

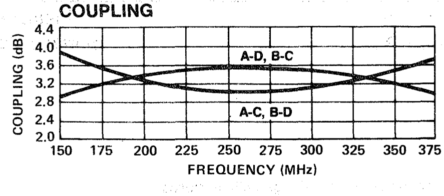
Typical Performance











Specifications Subject to Change Without Notice.

Surface Mount Quadrature Hybrid
175-350 MHz

JHS-136

- Fully Hermetic Package
- Octave Bandwidth
- Low VSWR — 1.2:1 Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	175-350 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 All other pins are ground

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

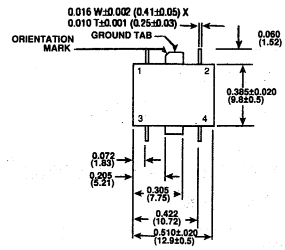
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Ordering Information

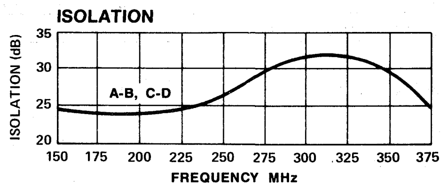
Model No.	Package
JHS-136 PIN	Surface Mount

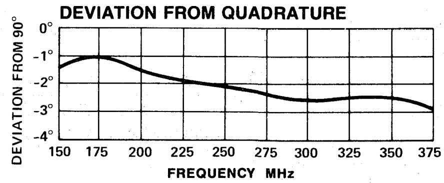
SF-1

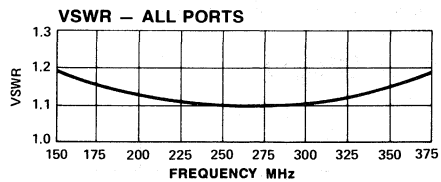


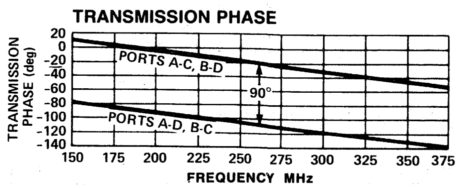
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

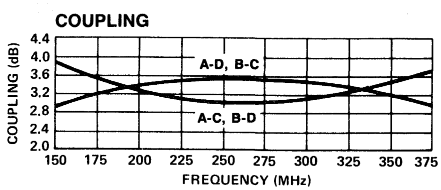
Typical Performance











Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Surface Mount Quadrature Hybrid
200-400 MHz

JHS-142

- Fully Hermetic
- Octave Bandwidth
- Low VSWR – 1.1:1 Typical

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	200-400 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	18 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	5 Watts Max @ 25°C Derated to 1 Watt @ 85°C
Typical Phase Linearity	3° from Straight Line

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 Case and all other pins are ground

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.
This product contains elements protected by United States Patent Number 3,484,724.

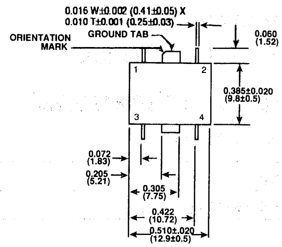
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	-90°	0°
B	ISO.		0°	-90°
C	-90°	0°		ISO.
D	0°	-90°	ISO.	

Ordering Information

Model No.	Package
JHS-142 PIN	Surface Mount

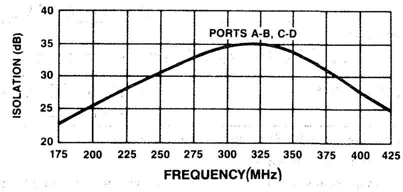
SF-1

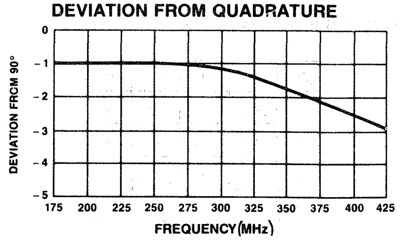


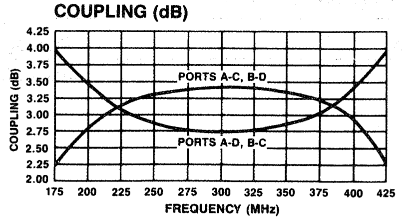
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Quadrature Hybrid
250-500 MHz

JH-/JHS-139

- Octave Bandwidth
- Low VSWR — 1.1:1 Typical
- High Isolation — 30 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range	250-500 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.3:1 Max
Deviation from Quadrature	4° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Environmental	

See Appendix for MIL-STD-883 screening option.

Pin Configuration

FP-2	A; P1, C; P4, B; P5, D; P8	All other pins and case ground.
SF-1	A; P1, C; P2, B; P3, D; P4	All other pins and case ground.

*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB.

This product contains elements protected by United States Patent Number 3,484,724.

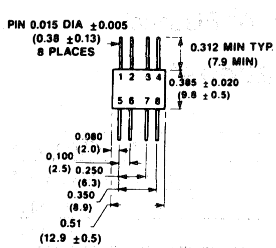
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	−90°
B	ISO.		−90°	0°
C	0°	−90°		ISO.
D	−90°	0°	ISO.	

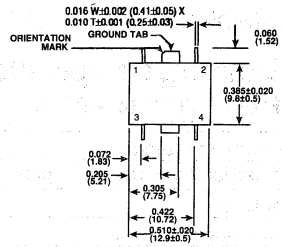
Ordering Information

Model No.	Package
JH-139 PIN	Flatpack
JHS-139 PIN	Surface Mount

FP-2



SF-1

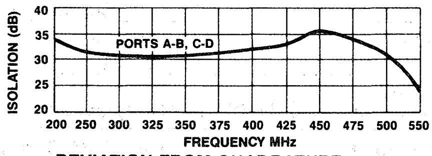


Dimensions in ( ) are in mm.

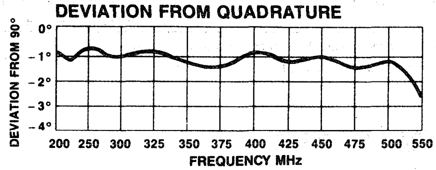
See Appendix for complete physical dimensions.

Typical Performance

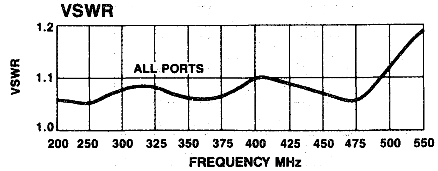
ISOLATION



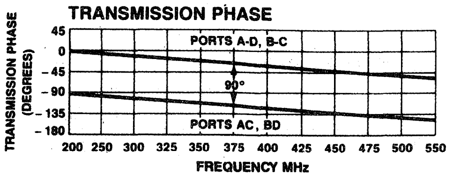
DEVIATION FROM QUADRATURE



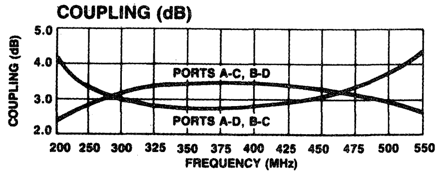
VSWR



TRANSMISSION PHASE



COUPLING (dB)



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

High-Frequency Quadrature Hybrid 500-1000 MHz

JH-140

- Octave Bandwidth
- Low VSWR — 1.2:1 Typical
- Miniature Size — ½″ x ⅜″ Flatpack

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	500-1000 MHz
Insertion Loss (Less coupling)	0.3 dB Max Avg**
Isolation	18 dBm Min
Amplitude Balance	1.0 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	2° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	25 Watts Max @ 25°C; Derated to 1 Watt @ 85°C

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.

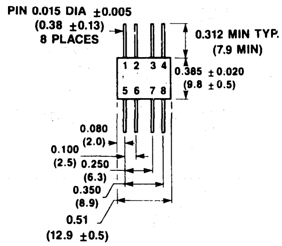
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

Ordering Information

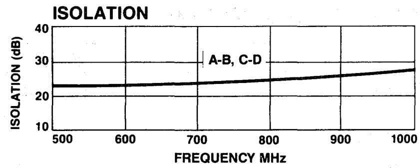
Model No.	Package
JH-140 PIN	Flatpack

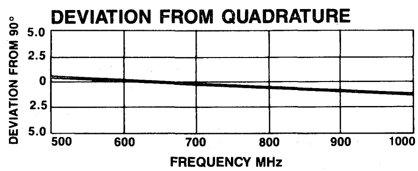
FP-2

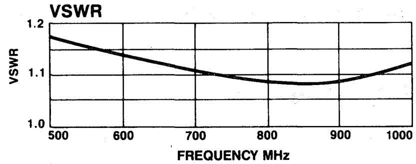


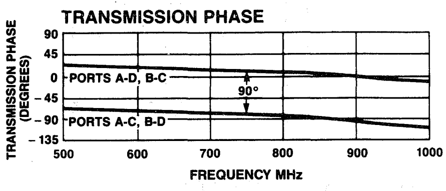
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

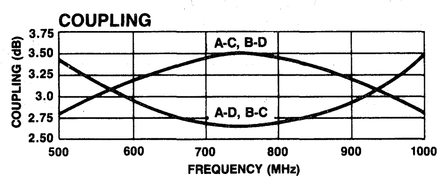
Typical Performance











Specifications Subject to Change Without Notice.

High-Frequency Quadrature Hybrid 1-2 GHz

JH-141

- Octave Bandwidth
- Low VSWR — 1.25:1 Typical
- Miniature Size — ½″ x ⅜″ Flatpack

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	1-2 GHz
Insertion Loss (Less coupling)	0.3 dB Max**
Isolation	20 dB Min
Amplitude Balance	1.0 dB Max
VSWR	1.25:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	25 Watts Max @ 25°C; Derated to 1 Watt @ 85°C
Package Type	Flatpack (FP-2) (See page 474 for physical dimensions.)
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	A; P1, B; P4, C; P8, D; P5. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

**Average of coupled outputs less 3 dB.

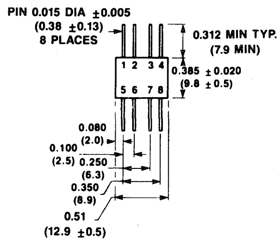
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	−90°	0°
B	ISO.		0°	−90°
C	−90°	0°		ISO.
D	0°	−90°	ISO.	

Ordering Information

Model No.	Package
JH-141 PIN	Flatpack

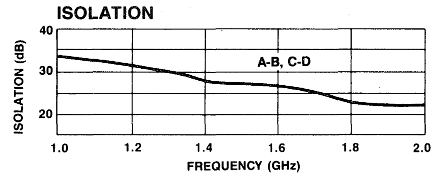
FP-2

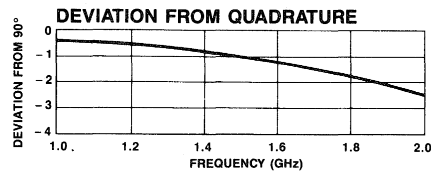


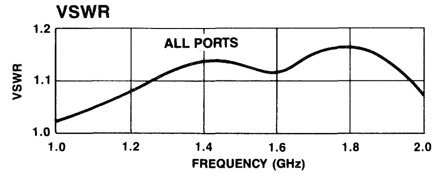
Dimensions in ( ) are in mm.

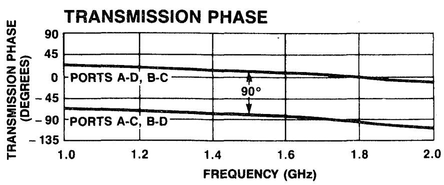
See Appendix for complete physical dimensions.

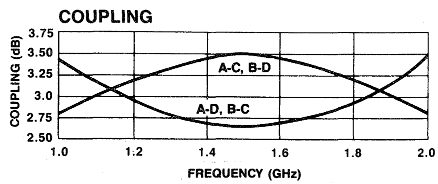
Typical Performance











Specifications Subject to Change Without Notice.

Power Dividers/Splitters/Combiner

Overview

Introduction

A power divider is ideally a lossless reciprocal device which can also perform vector summation of two or more signals and thus is sometimes called a power combiner or summer. Two forms of power dividers are considered in this discussion; binary and N-way. A binary power divider is composed of one or more terminated 180° hybrids and may have 2, 4, 8, 16, --- 2N outputs. An N-way power divider has an odd number of outputs, generally 3, and utilizes a unique patented transformer circuit for frequencies below 1 GHz. Although power dividers could be composed of 90° hybrids, the term normally refers to a device that splits an input signal into two or more in-phase outputs. The purpose of this article is to provide the designer with basic information describing the function of these devices and to define the performance parameters and trade-offs critical to specifying a power divider.

Functional Description
Binary Power Dividers

A binary power divider is in fact an internally terminated 180° hybrid. **Figure 1** shows the standard diagram for a 180° hybrid with a termination at Port A.

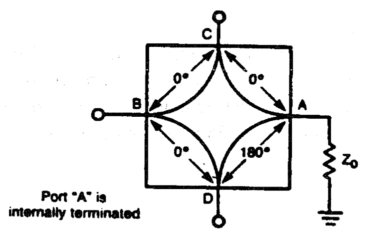


Figure 1. 2-Way, In-Phase (0°) Power Divider/Summer, or ISO-T

Physically, the 2-way power divider appears to be a three terminal device, since the Z_O termination at Port A is normally mounted inside the package. Also, although a conventional 180° hybrid can be used as a power divider, the usual form of 2-way power divider does not have a Z_O impedance level at all four ports. **Figure 2** shows a simplified, schematic for a transformer design realization of a 2-way power divider together with impedance, voltage and current levels. Elements such as shunt capacitors, used to tune out the parasitic elements of non-ideal transformers, are not shown.

The internal termination shown as Z_O to ground on Port A in **Figure 2** is actually realized by connecting a termination equal to 2 Z_O between ports C and D. This structure is utilized because of its greater simplicity and the fact Port A,

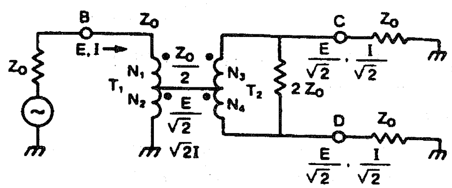


Figure 2.

the difference port, does not need to be used externally. Port A can be thought of as a balanced output of impedance 2 Z_O which has been terminated. T1 is an autotransformer which steps the Z_O impedance at Port B down to Z_O /2 at its tap. Its turns ratio must be equal to the square root of the desired impedance ratio. Thus,

$$\frac{N_2}{N_1 + N_2} = \sqrt{\frac{Z_O/2}{Z_O}} = \frac{1}{\sqrt{2}}$$

In practice a turns ratio approximating this value is used. T2 is a center tapped transformer; therefore N3 = N4 and thus,

$$Z_{C-D} = \left(\frac{N_3 + N_4}{N_4}\right)^2 \frac{Z_O}{2} = \frac{2^2 Z_O}{2} = 2\,Z_O$$

The use of an internal termination of 2 Z_O satisfies the required conditions for impedance match at all ports.

Higher order binary power dividers, such as 4-way and 8-way power dividers, are realized by cascading 2-way dividers of various circuit configurations. The functional diagram for a 4-way divider is shown in **Figure 3** while the 8-way diagram would simply have the "B" port of additional 2-way dividers connected at ports 1, 2, 3, and 4.

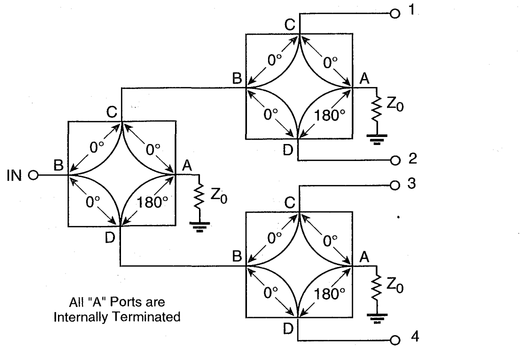


Figure 3. 4-Way Divider Functional Diagram

N-Way Dividers

Power dividers having an odd number of outputs (3, 5, 7, etc.) are sometimes classified as N-way power dividers. Because of the complexity of higher order circuits, the 3-way power divider is the only type of this class of divider normally used. The circuit actually used to realize a true 3-way divider, as opposed to a terminated 4-way power divider, is a unique transformer circuit covered by U.S. patent number 3,428,920. It is beyond the scope of this article to review in detail the transformer operation of this circuit, however, **Figure 4** shows a functional diagram of a 3-way power divider.

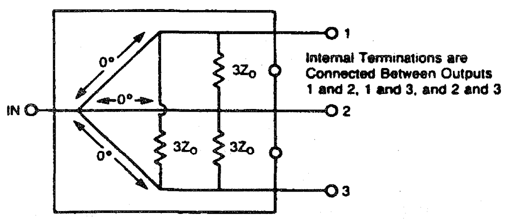


Figure 4. 3-Way Power Divider Functional Diagram

The transformer circuit is interconnected in such a manner as to produce three mutually isolated outputs. Three internal terminations of value 3 Z_O must be connected between ports 1 and 2, 1 and 3, and 2 and 3 in order to maintain port match and port-to-port isolation. We can see the operation of the divider by considering signals injected at two ports.

First, if we inject a signal at the input with outputs 1, 2, and 3 loaded in ZO, three equal phase and amplitude outputs appear at ports 1, 2, and 3. Since all signals are equal, no voltage differential appears across the internal terminations and thus no power is dissipated in them.

In the second case, if we inject a signal at output 1 with all other ports terminated in Z_O, 1⁄3 of the current will flow in the 3 Z_O internal terminations connected between ports 1 and 2, and 1 and 3, and 1⁄3 will flow directly into the transformer connection at port 1. The power injected is I2 Z_O, while the power dissipated in each of the internal terminations is (I/3)2 (3 Z_O) = 1⁄3 I2 Z_O. Thus 2⁄3 of the power is lost in the internal loads and 1⁄3 appears at the input. This satisfies the requirement for a lossless reciprocal device.

Performance Parameters

The critical parameters in selecting a power divider are normally frequency range, insertion loss, isolation and VSWR. In addition to these parameters the following two parameters are often specified and are related to the power rating of the internal load resistors.

Matched Power Rating or Input Power

This is the highest power level that can be applied to the input and still maintain other performance limits. It is stated with Z_O terminations on all outputs to avoid reflected signals from unbalanced loads which may exceed the limit for power dissipation in the internal terminations.

Internal Load Dissipation

This is simply the power rating of any one of the internal terminations. These two parameters are related and the input power rating is normally several times larger than the internal load dissipation. The reason for this is intuitively obvious since most of the input power is delivered to the output loads, not the internal termination.

There are three considerations affecting the amount of input power that a power divider can withstand.

I. Insertion Loss

The first consideration is the total power dissipated in the power divider. Total power dissipation in a power divider under matched conditions can be determined to a reasonable approximation from the insertion loss and the known input power as follows:

Insertion Loss (dB) = 10 log PinPout

Therefore:

$$P_{OUT} = \frac{P_{IN}}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}$$

$$P_{Dissipated} = P_{IN} - P_{OUT}$$

$$= P_{IN} - \frac{P_{IN}}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}$$

$$= P_{IN}\left(1 - \frac{1}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}\right)$$

As an example, consider a power divider with the following conditions

$$\text{Ins. Loss} = 0.5 \text{ dB}$$

$$P_{IN} = 2 \text{ Watts}$$

$$P_{Dissipated} = 2\left(1 - \frac{1}{10^{\frac{.5}{10}}}\right)$$

$$= .218 \text{ Watts}$$

Most of this power will be dissipated in the wire and ferrite cores making up the transformer circuits and not in the internal load.

II. Amplitude Balance
In a power divider operating under matched conditions, a second consideration for input power dissapation is the dissapated power in the internal load. If we consider a 2-Way power divider similar to that shown in **Figure 1**, we observe that ideally no power would be dissipated in the 2 Z_O load between Ports C and D, because the voltages at C and D would be equal. In practice, a small differential may occur because of imperfect Amplitude Balance. The approximate dissipation due to this unbalance can be calculated from the following:

Let Voltage at Port C = VC
Let Voltage at Port D = VD
Let Power at Port C = PC
Let Power at Port D = PD

If we make the simplifying assumption:

$$P_D = \frac{V_D^2}{Z_O} \cong \frac{P_{OUT}}{2}$$

then 1)

$$V_D \cong \sqrt{\frac{P_{OUT\,(Z_O)}}{2}}$$

The relationship for Amplitude Balance is as follows:

$$\text{Amp Bal (dB)} = 10 \text{ Log } \frac{P_C}{P_d} = 20 \text{ Log } \frac{V_C}{V_d}$$

$$\text{Therefore } V_C = V_D\, 10^{\left(\frac{\text{Amp Bal}}{20}\right)}$$

$$\text{and } V_C - V_D = V_D\, 10^{\left(\frac{\text{Amp Bal}}{20}\right)} - V_D$$

$$= V_D\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)$$

Substituting from 1)

2)
$$V_C - V_D \cong \sqrt{\frac{P_{OUT\,(Z_O)}}{2}}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)$$

This gives the voltage drop across the internal termination of 2 Z_O between C and D. The power dissipated in this load is then given by the following:

$$P_{INT\ LOAD} = \frac{(V_C - V_D)^2}{2\, Z_O}$$

$$\cong \frac{1}{2\, Z_O}\left[\sqrt{\frac{P_{OUT\,(Z_O)}}{2}}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)\right]^2$$

or 3)

$$P_{INT\ LOAD} \cong \frac{P_{OUT}}{4}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)^2$$

A very small amount of power normally is dissipated due to this effect. Consider the following example:
Let

$$\mathbf{P_{OUT} = 2\ Watts}$$
$$\mathbf{Amp\ Bal = .25\ dB}$$
$$\mathbf{P_{INT\ LOAD} \cong \tfrac{1}{2}\left(10^{\frac{.25}{20}} - 1\right)^2}$$
$$\mathbf{= 0.4\ mW}$$

III. When determining input power limits, the third and perhaps most important case to consider is the condition of mismatched loads at the outputs of the power divider. Reflections from these mismstches can cause a considerably larger voltage differential to appear across the internal load. If the VSWR of the two loads is K_1, and K_2, the limit on input power P_{IN}, is given in the following:

$$P_{IN} \leqslant \frac{\text{Internal Load Rating (Watts)}}{\left[\frac{K_1 - 1}{K_1 + 1}\right]^2 + \left[\frac{K_2 - 1}{K_2 + 1}\right]^2}$$

As an example, if the internal load rating is 0.5 Watts and the VSWR of K_1 and K_2 is 2.0:1 then:

$$P_{IN} \leqslant \frac{0.5}{\left[\frac{2 - 1}{2 + 1}\right]^2 + \left[\frac{2 - 1}{2 + 1}\right]^2}$$
$$\leqslant 2.25\ \text{Watts}$$

This is the worst case formula, which assumes that the two load reflections are out of phase at the output port. If they are identical impedances, P_{IN} may be several times larger without causing damage.

From the preceeding discussion of power divider input power ratings, we can draw two conclusions:

1. Under matched loading conditions (Z_O terminations at all ports) the input power is limited by heating effects in the ferrite transformers, not by the internal load dissipation. Absolute maximum temperatures for ferrite core transformers are limited by the curie temperature of the ferrite, generally in 130°C to 500°C range, and the temperature rating of the magnet wire which is usually 130°C. It is advisable to stay well below these temperature limits (20°C or more) to avoid performance degradation, particularly increased insertion loss. The actual temperature rise in the ferrite core is dependent on the heat transfer path from the core to the heat sink or surrounding air. This determination involves measuring or calculating the thermal resistance, q, expressed in °C/Watt of this path. Thermal resistance will be highly dependent on the mounting of the power divider as well as its internal construction. For this reason, manufacturers normally provide a very conservative maximum input power rating that applies under absolute worst case conditions with no specific heatsinking of the unit. In many instances powers several times higher than this rating can be applied with little, if any, performance degradation.

2. Under conditions where mismatches are present at the power divider output, the internal load power dissipation rating may limit the input power that can be applied. A simple worst case calculation can be performed to determine if this is the case using the formula provided.

A final point relative to power ratings that should be considered is the application as a power summer. In this case signals are applied to the ports we have been calling outputs (for example Ports C and D in **Figure 2**) with the vector sum appearing at the input or S port (Port B in Figure 6). In this case equal signals are normally applied, and little if any power is dissipated in the internal load. A possible condition may occur where one or more of the signal sources fails or is removed. For example, if two equal sources are applied at Ports C and D and the source at D fails, 50% of the power supplied by the source at C will be dissipated in the 2 Z_O internal load. Thus the power injected at each port should not exceed twice the rating of the internal load to avoid this condition.

Performance Trade-offs

Since power dividers are low loss passive devices, few tradeoffs in performance are possible once the frequency range is selected. One trade-off that is sometimes possible is between isolation and VSWR. If we consider the 2-way divider schematic of **Figure 2**, we see that an internal load of 2 Z_O is shown between Ports C and D. This is correct for an ideal lossless transformer circuit, however the actual transformers have parasitic dissipative and reactive elements. For this reason the value of the 2 Z_O load is sometimes varied and additional small amounts of shunt capacitance and series inductance are added in an attempt to optimize VSWR and isolation. The optimum compensation for isolation is often slightly different than that required for VSWR. In fact, it is possible over limited frequency ranges to improve isolation by in effect "balancing the bridge" while VSWR may be slightly degraded.

Conclusions

Power dividers are often considered the simplest of the many RF devices that may be required in designing a system, and in some respects this is true. Despite the functional simplicity of power dividers and generally rugged and reliable components used in their construction, their specification and application in systems can still lead to unexpected problems.

In this article we have presented some basic information to give the system designer insight into the internal construction of power dividers and how this influences the operation of the device and its function in the real world of imperfect matches and less than ideal physical installation. On this latter point, the consideration of power dividers was dealt with both analytically and in terms of expected results in the normally mounted configuration. The devices described in this article are generally intended for receive rather than transmit applications and are thus quite conservatively rated for power handling. Care must be taken, however, in using them at higher powers because both internal designs and external mounting provisions are not optimally suited for heat transfer.

Many of the points made and expressions derived for the operation of 180° hybrids can be applied to power dividers, particularly 2-way power dividers, and questions that may arise pertaining to points not covered in this article, such as isolation in the presence of mismatch or other signal flow relationships, can be analyzed by reference to the tables contained in that article.

M/A-COM

Two-Way Power Dividers 1-100 MHz and 40-400 MHz

MTH-50/MTV-50

- Ideal for High Density Packaging
- High Isolation – 30 dB Min
- VSWR – 1.3:1 Max

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	MTH-50	MTV-50
Frequency Range	1-100	40-400 MHz
Insertion Loss (Less coupling)	0.5	0.6 dB Max
Isolation	30	30 dB Min
Amplitude Balance	0.1	0.2 dB Max
Phase Balance	1.0	2.0° Max
VSWR	1.3:1	1.3:1 Max

Operating Characteristics

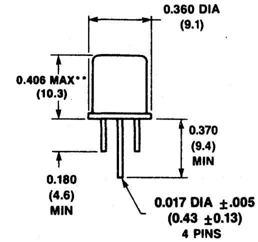
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P2, Out; P1 & P3 Case Ground

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
MTH-50 PIN	TO-5-1
MTV-50 PIN	TO-5-1

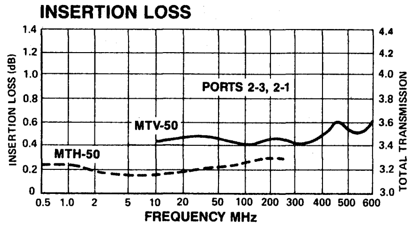
TO-5-1

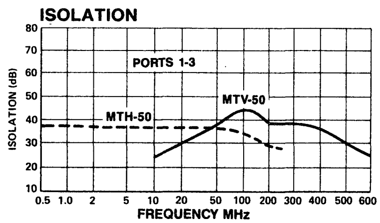


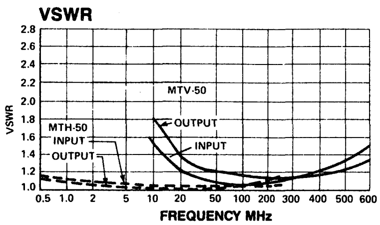
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Two-Way Power Dividers
2-200 MHz and 20-400 MHz — THV-50/TU-50

- Isolation – 30 dB Min
- Loss – 0.5 dB Max
- Low VSWR – 1.3:1 Max

Guaranteed Specifications*
(From −55°C to +85°C)

MODEL	THV-50	TU-50
Frequency Range	2-200	20-400 MHz
Insertion Loss (Less coupling)	0.5	0.5 dB Max
Isolation	30	30 dB Min
Amplitude Balance	0.2	0.2 dB Max
Phase Balance	1.0	2.0° Max
VSWR (All Ports)	1.3:1	1.3:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.5 Watts Max
Internal Load Dissipation	0.5 Watts Max

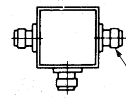
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.		Package
THV-50	BNC	Connectorized
THV-50	N	Connectorized
THV-50	SMA	Connectorized
TU-50	BNC	Connectorized
TU-50	TNC	Connectorized
TU-50	N	Connectorized
TU-50	SMA	Connectorized

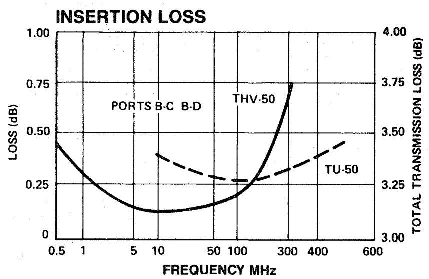
C-7

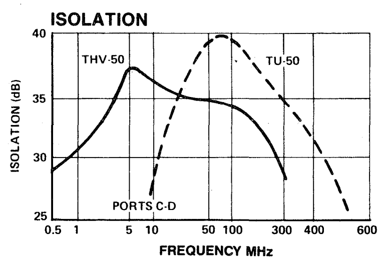


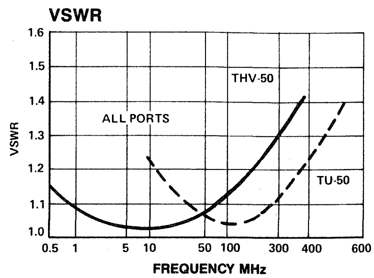
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Flatpack Two-Way Divider 400-kHz-400 MHz

DS-113

- Three Decade Bandwidth
- Low Loss – 0.25 dB Typically

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	0.4-400 MHz
Insertion Loss (Less coupling)	0.75 dB Max
Isolation	25 dB Min
Amplitude Balance	0.15 dB Max
Phase Balance	1.0° Max
VSWR (All Ports)	1.5:1 Max

Operating Characteristics

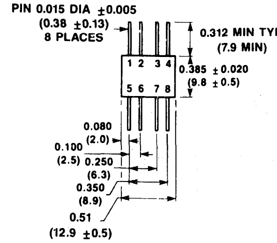
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	Σ; P1, Output 'C'; P4; Output 'D'; P8 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-113 PIN	Flatpack

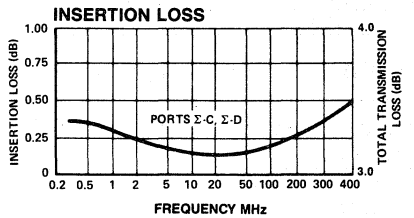
FP-2

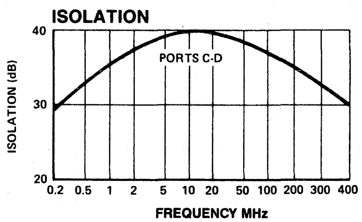


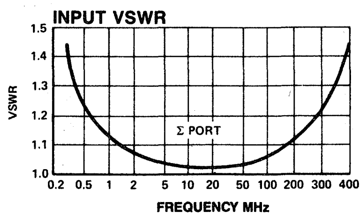
Dimensions in ( ) are in mm.

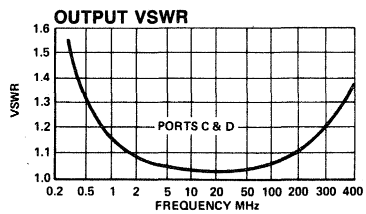
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Surface Mount Two-Way Power Divider 400 kHz-400 MHz

DSS-113

- Fully Hermetic Package
- Three Decade Bandwidth
- Low Loss – 0.25 dB Typically

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range	7-14 MHz
Insertion Loss (Less coupling)	0.5 dB Max**
Isolation	20 dB Min
Amplitude Balance	0.75 dB Max
VSWR	1.2:1 Max
Deviation from Quadrature	3° Max

Operating Characteristics

Impedance	50 Ohms Nominal
Input Power	4 Watts Max @ 25°C; Derated to 1 Watt @ 85°C

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration	A; P1, B; P2, C; P4, D; P3 All other pins and case ground

*All specifications apply with 50 ohm source and load impedance.
**Average of coupled outputs less 3 dB.

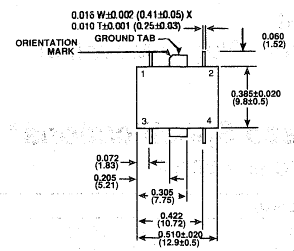
Phasing Diagram

IN \ OUT	A	B	C	D
A		ISO.	0°	-90°
B	ISO.		-90°	0°
C	0°	-90°		ISO.
D	-90°	0°	ISO.	

Ordering Information

Model No.	Package
DSS-113 PIN	Surface Mount

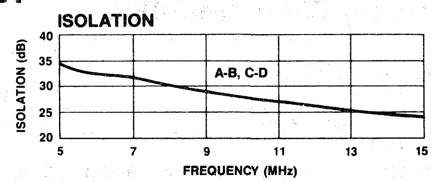
SF-1

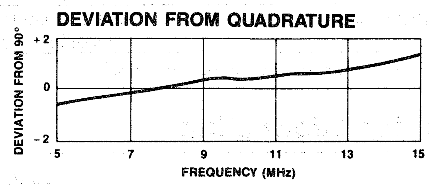


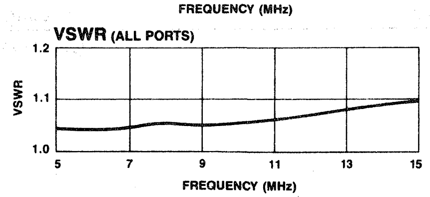
Dimensions in ( ) are in mm.

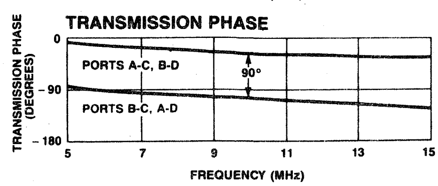
See Appendix for complete physical dimensions.

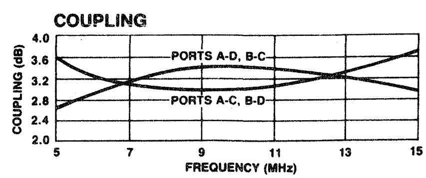
Typical Performance











Specifications Subject to Change Without Notice.

Plug-In Two-Way Power Divider 5-500 MHz

DS-318

- Low Cost
- Convenient Plug-In Mounting

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		5-500 MHz
Insertion Loss	10-200 MHz	0.5 dB Max
(Less coupling)	5-500 MHz	1.0 dB Max
Isolation		18 dB Min
Amplitude Balance		0.2 dB Max
Phase Balance		2° Max
VSWR (All Ports)		1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.125 Watts Max
Environmental	

See Appendix for MIL-STD-883 screening option.

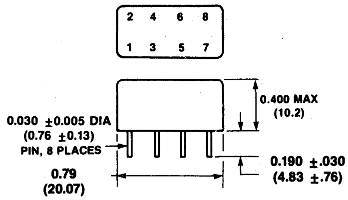
Pin Configuration	Σ; P1, Outputs P5 & P6, All other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-318 PIN	Relay Header

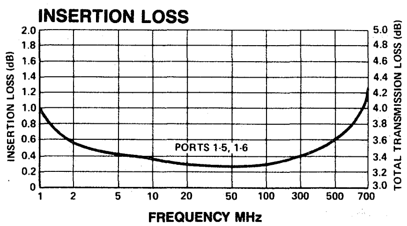
RH-1

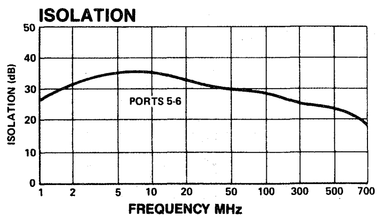


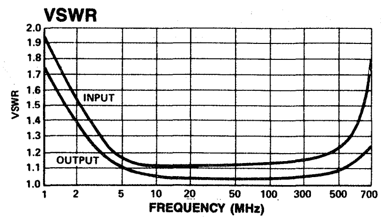
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM

Two-Way Power Divider 10-500 MHz

DS-109/319

- 1° Phase Balance Max
- 35 dB Typical Midband Isolation
- 1.1 Typical Midband VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	DS-109	DS-319
Frequency Range	10-500	10-500 MHz
Insertion Loss (Less coupling)		
10-200 MHz		0.6 dB Max
10-500 MHz	0.6	0.9 dB Max
Isolation	25	25 dB Min
Amplitude Balance		
10-200 MHz		0.15 dB Max
10-500 MHz	0.15	0.2 dB Max
Phase Balance	1°	1° Max
VSWR (All Ports)		
10-200		1.3:1 Max
10-500	1.3:1	1.6:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration

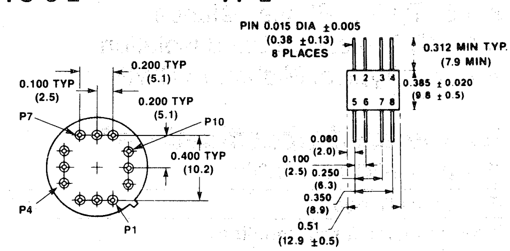
DS-109	ΣIN; P1, Output C; P4, Output D; P8, Case and all other pins ground.
DS-319	ΣIN; P5, Output 'C'; P8, Output 'D'; P2 All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-109 PIN	Flatpack
DS-319 PIN	TO-8-2

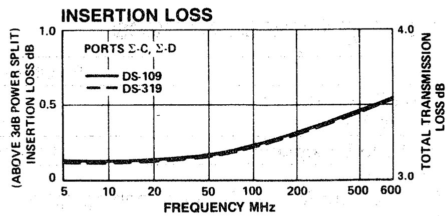
TO-8-2 **FP-2**

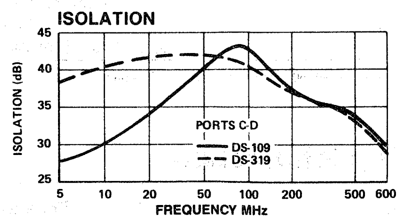


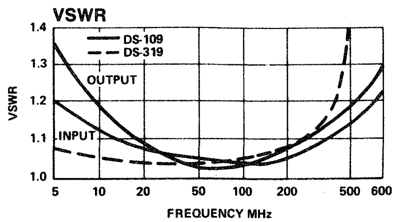
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Surface Mount Two-Way Power Divider
10-500 MHz
DSS-333

- Fully Hermetic Package
- 0.5° Typical Phase Balance
- 40 dB Typical Midband Isolation
- 1.05:1 Typical Midband VSWR

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	10-500 MHz
Insertion Loss (Less Coupling)	
10-500 MHz	0.6 dB Max
Isolation	25 dB Max
Amplitude Balance	
10-500 MHz	0.15 Max
Phase Balance	2° Max
VSWR (All Ports)	
10-500 MHz	1.4:1 Max

Operating Characteristics

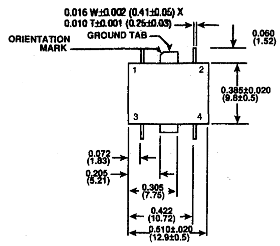
Impedance	50 Ohms Nominal
Maximum Power Rating or INput Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	Σ IN P1, Output C; P2 Output D; P4 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DSS-333 PIN	Surface Mount

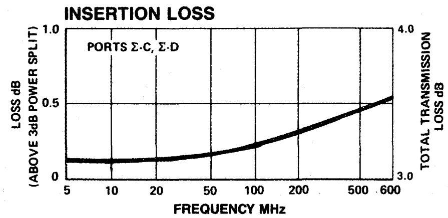
SF-1

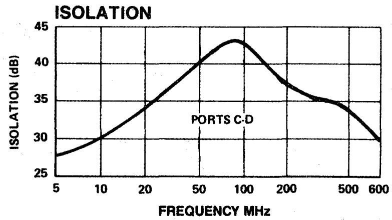


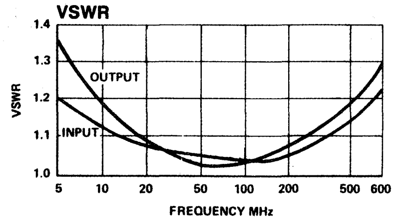
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Surface Mount Two-Way Power Divider
5-1000 MHz

DSS-327

- Fully Hermetic Package
- Low Loss – 0.3 dB Typical
- Amplitude Balance – 0.05 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss (Less coupling)	5-500 MHz	0.5 dB Max
	500-1000 MHz	1.0 dB Max
Isolation	5-500 MHz	20 dB Min
	500-1000 MHz	16 dB Min
Amplitude Balance	5-1000 MHz	0.3 dB Max
Phase Balance	5-500 MHz	2° Max
	500-1000 MHz	3° Max
VSWR (All Ports)	5-500 MHz	1.4:1 Max
	500-1000 MHz	1.6:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watt Max

Environmental

See Appendix for MIL-STD-883 screening option.

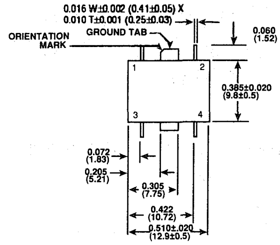
Pin Configuration	Σ; P1, Output 'C'; P2, Output 'D'; P4, P3 & Case ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DSS-327 PIN	Surface Mount

SF-1

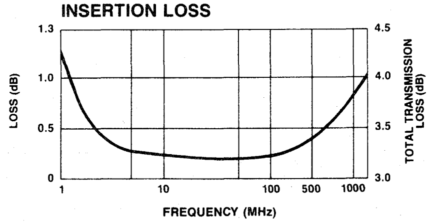


Dimensions in ( ) are in mm.

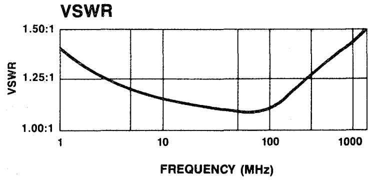
See Appendix for complete physical dimensions.

Typical Performance

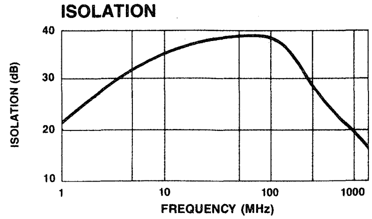
INSERTION LOSS



VSWR



ISOLATION



Specifications Subject to Change Without Notice.

180° Two-Way Power Divider
5-1000 MHz

H-81-4

- Broadband Frequency Range
- Low Loss – Less Than 1.3 dB Max
- VSWR – 1.4:1 Max

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss (Less coupling)	5-100 MHz 100-1000 MHz	0.7 dB Max 1.3 dB Max
Isolation	5-100 MHz 100-1000 MHz	20 dB Min 25 dB Min
Amplitude Balance	5-100 MHz 100-1000 MHz	0.2 dB Max 0.5 dB Max
Phase Balance	5-100 MHz 100-1000 MHz	5° Max 2.5° Max
VSWR (All Ports)		1.4:1 Max

Operating Characteristics

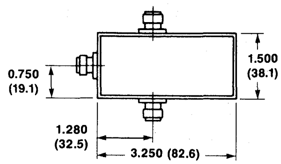
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.0 Watts Max
Internal Load Dissipation	0.5 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
H-81-4 N	Connectorized
H-81-4 SMA	Connectorized

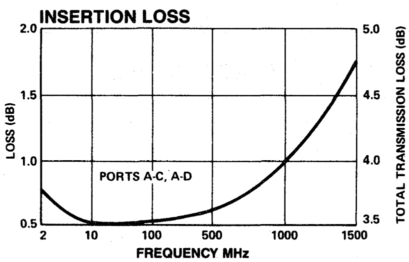
C-19

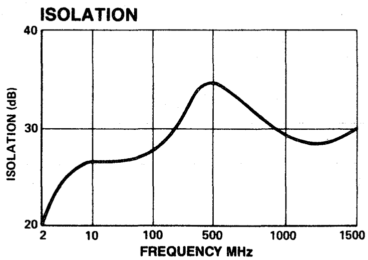


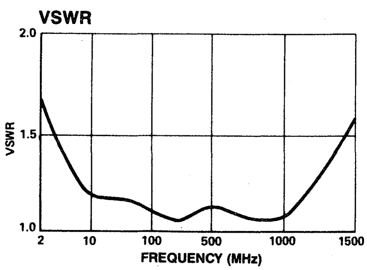
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Two-Way Power Divider
10-1000 MHz
T-1000

- Broadband Frequency Range
- Isolation – 25 dB Min
- Insertion Loss – 0.8 dB Max

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range		10-1000 MHz
Insertion Loss	10-500 MHz	0.5 dB Max
(Less coupling)	500-1000 MHz	0.8 dB Max
Isolation		25 dB Min
Amplitude Balance		0.2 dB Max
Phase Balance		2° Max
VSWR (All Ports)	10-500 MHz	1.5:1 Max
	500-1000 MHz	1.3:1 Max

Operating Characteristics

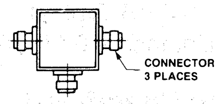
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.5 Watts Max
Internal Load Dissipation	0.5 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.		Package
T-1000	BNC	Connectorized
T-1000	TNC	Connectorized
T-1000	N	Connectorized
T-1000	SMA	Connectorized

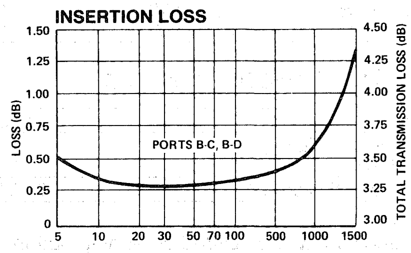
C-7

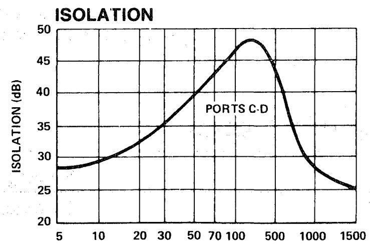


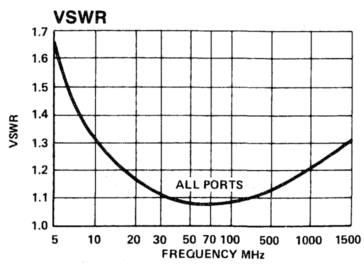
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Flatpack Two-Way Power Divider
5-1000 MHz

DS-327

- Broadband, IN Phase Divider
- Low Loss – 0.3 dB Typical
- Amplitude Balance – 0.05 dB Typical

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Insertion Loss (Less coupling)	5-500 MHz	0.5 dB Max
	500-1000 MHz	1.0 dB Max
Isolation	5-500 MHz	25 dB Min
	500-1000 MHz	20 dB Min
Amplitude Balance	5-1000 MHz	0.2 dB Max
Phase Balance	5-500 MHz	2° Max
	500-1000 MHz	3° Max
VSWR (All Ports)	10-500 MHz	1.3:1 Max
	5-1000 MHz	1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watt Max

Environmental
See Appendix for MIL-STD-883 screening option.

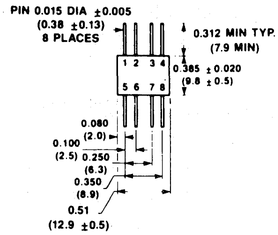
Pin Configuration	Σ; P1, Output 'C'; P4, Output 'D'; P8 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-327 PIN	Flatpack

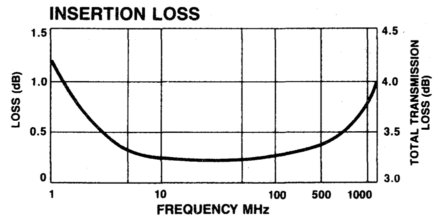
FP-2

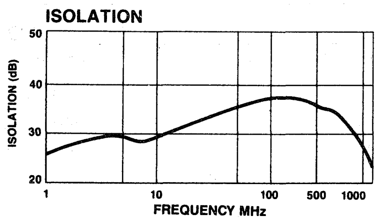


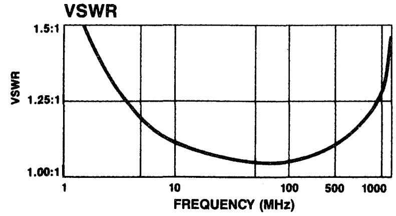
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM

Broadband Two-Way Power Divider 2 MHz-2 GHz

H-8-4

- 11 Octave Coverage
- Low Loss — 1.25 dB Max
- High Isolation — 20 dB Min

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2 MHz-2 GHz
Insertion Loss (Less coupling)	2-10 MHz	1.0 dB Max
	10-1000 MHz	1.0 dB Max
	2 MHz-2 GHz	1.5 dB Max
Isolation	2-10 MHz	20 dB Min
	10-1000 MHz	25 dB Min
	2 MHz-2 GHz	20 dB Min
Amplitude Balance	2-10 MHz	0.1 dB Max
	10-1000 MHz	0.1 dB Max
	2 MHz-2 GHz	0.5 dB Max
Phase Balance	2-1000 MHz	2.5° Max
	2 MHz-2 GHz	5° Max
VSWR (All Ports)	2-10 MHz	2.5:1 Max
	10-1000 MHz	1.3:1 Max
	2 MHz-2 GHz	1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.0 Watts Max
Internal Load Dissipation	0.5 Watt Max

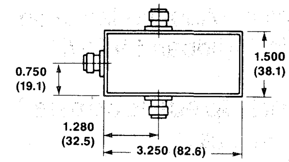
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.		Package
H-8-4	N	Connectorized
H-8-4	SMA	Connectorized

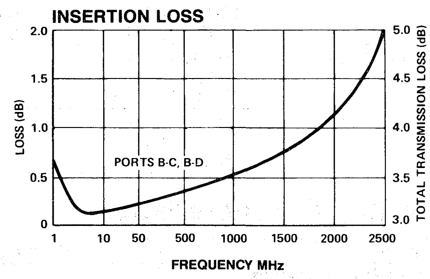
C-19

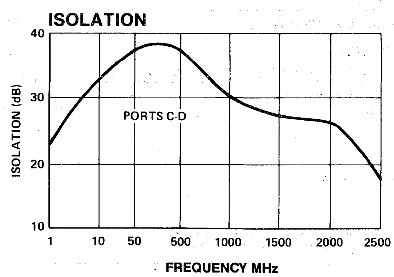


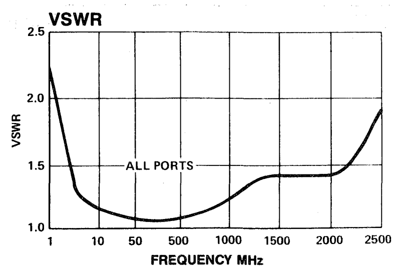
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Two-Way In-Phase Power Divider
10-2000 MHz

DS-313

- 0.6 dB Typical Midband Loss
- 28 dB Typical Midband Isolation
- 1.2:1 Typical Midband VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss (Less coupling)	20-1000 MHz	1.1 dB Max
	10-1500 MHz	1.3 dB Max
	1500-2000 MHz	1.8 dB Max
Isolation	20-1000 MHz	23 dB Min
	10-1500 MHz	18 dB Min
	1500-2000 MHz	12 dB Min
Amplitude Balance	20-1000 MHz	0.3 dB Max
	10-1500 MHz	0.4 dB Max
	1500-2000 MHz	0.6 dB Max
Phase Balance	20-1000 MHz	4° Max
	10-1500 MHz	6° Max
	1500-2000 MHz	8° Max
VSWR (All Ports)	20-1000 MHz	1.5 Max
	10-1500 MHz	1.6 Max
	1500-2000 MHz	1.8 Max

Operating Characteristics

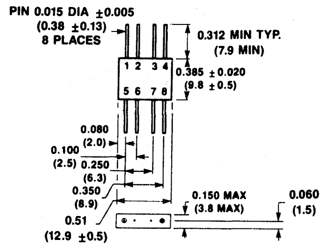
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	250 mW Max
Internal Load Dissipation	50 mW Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	Σ; P1, Output 'C'; P4, Output 'D'; P8 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-313 PIN	Flatpack

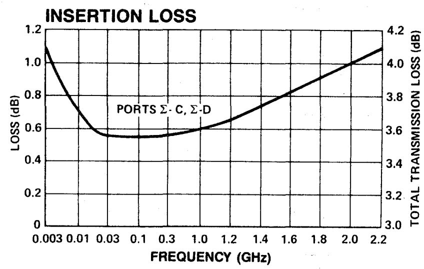
FP-2

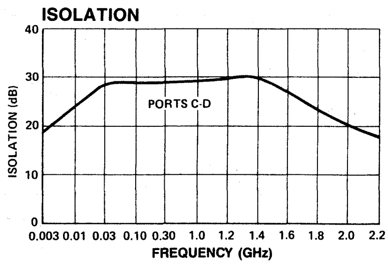


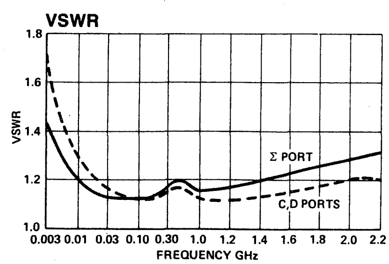
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM

Surface Mount Two-Way Phase Power Divider 10-2000 MHz

DSS-313

- Fully Hermetic Package
- 0.6 dB Typical Midband Loss
- 28 dB Typical Midband Isolation
- 1.2:1 Typical Midband VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss (Less Coupling)	20-1000 MHz	1.1 dB Max
	10-1500 MHz	1.3 dB Max
	1500-2000 MHz	1.8 dB Max
Isolation	20-1000 MHz	22 dB Min
	10-1500 MHz	18 dB Min
	1500-2000 MHz	12 dB Min
Amplitude Balance	20-1000 MHz	0.3 dB Max
	10-1500 MHz	0.4 dB Max
	1500-2000 MHz	0.6 dB Max
Phase Balance	20-1000 MHz	5° Max
	10-1500 MHz	8° Max
	1500-2000 MHz	11° Max
VSWR (All Ports)	20-1000 MHz	1.5 Max
	10-1500 MHz	1.6 Max
	1500-2000 MHz	1.8 Max

Operating Characteristics

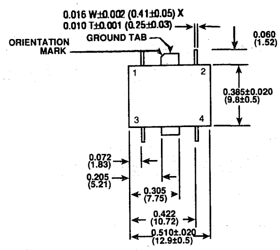
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	250 mW Max
Internal Load Dissipation	50 mW Max
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	Σ P1, Output 'C'; P2 Output 'D'; P4 Case and all other pins ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	**Package**
DSS-313 PIN	Surface Mount

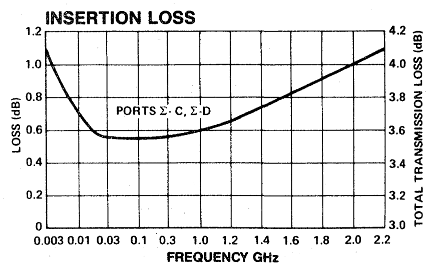
SF-1

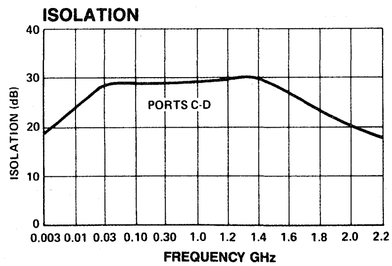


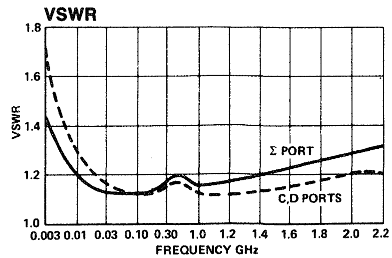
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Three-Way Power Dividers
1-300 MHz

DS-117/308

- Low Loss – Typically Less Than 0.5 dB
- Available in Flatpack and Connectorized
- Versions

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		1-300 MHz
Insertion Loss (Less coupling)	2-200 MHz 1-300 MHz	0.75 dB Max 1.0 dB Max
Isolation	2-200 MHz 1-300 MHz	30 dB Min 20 dB Min
Amplitude Balance		0.25 dB Max
Phase Balance	2-200 MHz 1-300 MHz	3° Max 4° Max
VSWR (All Ports)	2-200 MHz 1-300 MHz	1.3:1 Max 1.5:1 Max

Operating Characteristics

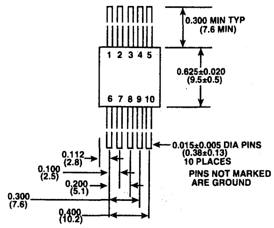
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.05 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration (DS-117)	IN; P3, Outputs P6, P8 & P10 Case and all other pins are ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-117 PIN	Flatpack
DS-308 BNC	Connectorized
DS-308 N	Connectorized
DS-308 SMA	Connectorized

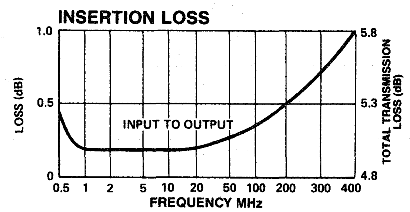
FP-3

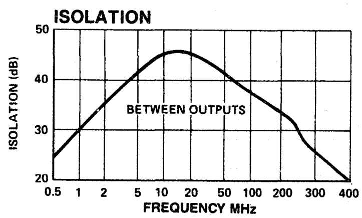


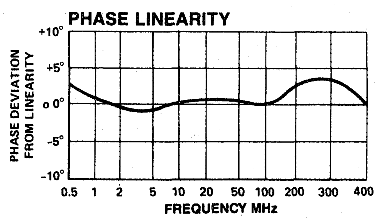
Dimensions in ( ) are in mm.

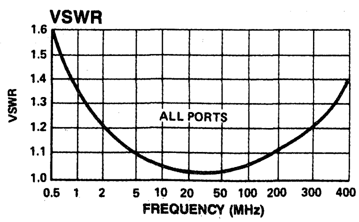
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

Three-Way Power Dividers 1-100 MHz and 50-300 MHz

M3H-50/M3V-50

- Ideal for High Density Packaging
- High Isolation
- VSWR – 1.3:1 Max

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	M3H-50	M3V-50
Frequency Range	1-100	50-300 MHz
Insertion Loss (Less coupling)	0.5	0.75 dB Max
Isolation	30	25 dB Min
Amplitude Balance	0.2	0.2 dB Max
Phase Balance	1.0	2.0° Max
VSWR	1.3:1	1.3:1 Max

Operating Characteristics

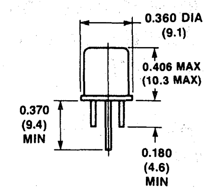
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1 Watt Max
Internal Load Dissipation	0.05 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P2, Outputs P1, P3 & P4 Case ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
M3H-50 PIN	TO-5-2
M3V-50 PIN	TO-5-2

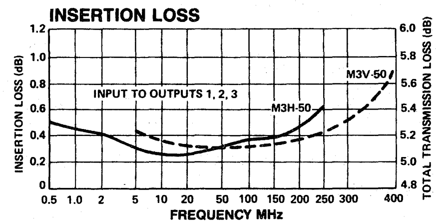
TO-5-2

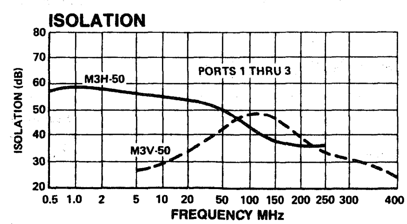


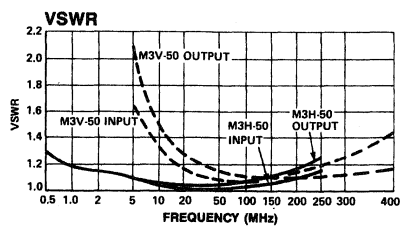
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM

Flatpack Three-Way Power Divider
3-700 MHz

DS-328

- 0.4 dB Typical Midband Insertion Loss
- 28 dB Typical Midband Isolation
- 1.2:1 Typical Input VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		3-700 MHz
Insertion Loss (Less coupling)	3-500 MHz 500-700 MHz	0.70 dB Max 1.0 dB Max
Isolation	3-700 MHz	20 dB Min
Amplitude Balance	3-500 MHz 500-700 MHz	0.25 dB Max 0.4 dB Max
Phase Balance	3-500 MHz 500-700 MHz	3° Max 4° Max
VSWR (All Ports)	10-500 MHZ 3-700 MHz	1.3:1 Max 1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.125 Watt Max

Environmental
See Appendix for MIL-STD-883 screening option.

Pin Configuration

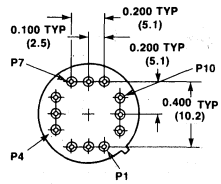
DS 328	IN;P11, Outputs, P2, P5, P8

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,428,920.

Ordering Information

Model No.	Package
DS-328 PIN	TO-8-2

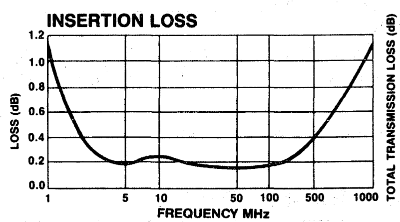
TO-8-2

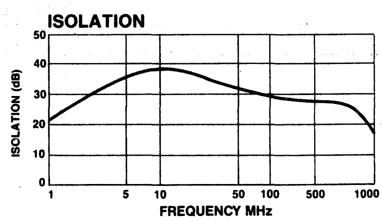


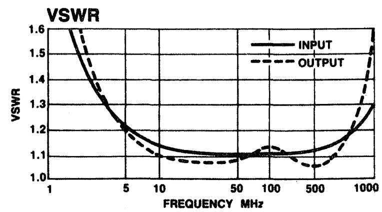
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Flatpack Three-Way Power Divider
25-1000 MHz

DS-323

- 0.4 dB Typical Midband Insertion Loss
- 35 dB Typical Midband Isolation
- 1.2:1 Typical Input VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		25-1000 MHz
Insertion Loss (Less coupling)	25-200 MHz	0.5 dB Max
	200-1000 MHz	1.0 dB Max
Isolation	25-50 MHz	15 dB Min
	50-200 MHz	22 dB Min
	200-1000 MHz	24 dB Min
Amplitude Balance	25-200 MHz	0.25 dB Max
	200-1000 MHz	0.4 dB Max
Phase Balance	25-200 MHz	2° Max
	200-1000 MHz	4° Max
VSWR		
Input	25-1000 MHz	1.4:1 Max
Output	25-50 MHz	1.9:1 Max
	50-200 MHz	1.7:1 Max
	200-1000 MHz	1.5:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.05 Watt Max

Environmental
See Appendix for MIL-STD-883 screening option.

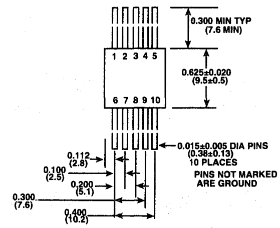
Pin Configuration	IN; P3, Outputs P6, P8 & P10 Case and all other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,428,920.

Ordering Information

Model No.	Package
DS-323 PIN	Flatpack

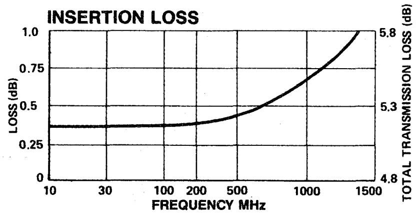
FP-3

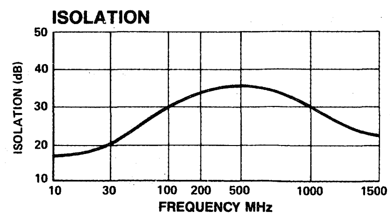


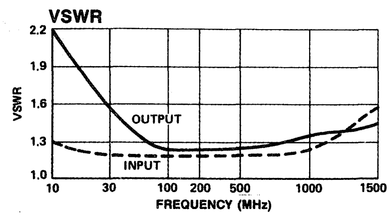
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Four-Way Power Divider
0.2-300 MHz

DS-310

- 0.5 dB Typical Insertion Loss
- 1.1:1 Typical Midband VSWR

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		0.2-300 MHz
Insertion Loss (Less coupling)	0.2-0.5 MHz	1.0 dB Max
	0.5-100 MHz	0.5 dB Max
	100-300 MHz	1.0 dB Max
Isolation	0.2-0.5 MHz	20 dB Min
	0.5-100 MHz	25 dB Min
	100-300 MHz	15 dB Min
Amplitude Balance	0.2-0.5 MHz	0.2 dB Max
	0.5-100 MHz	0.2 dB Max
	100-300 MHz	0.4 dB Max
Phase Balance	0.2-0.5 MHz	1.5° Max
	0.5-100 MHz	4.0° Max
	100-300 MHz	6.0° Max
VSWR (All Ports)	0.2-0.5 MHz	2.0:1 Max
	0.5-100 MHz	1.3:1 Max
	100-300 MHz	1.4:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	50 mW Max

Environmental
See Appendix for MIL-STD-883 screening option.

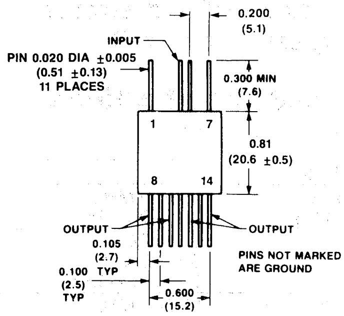
Pin Configuration	IN; P4
	Outputs; P8, P10, P12 & P14
	All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-310 PIN	Flatpack

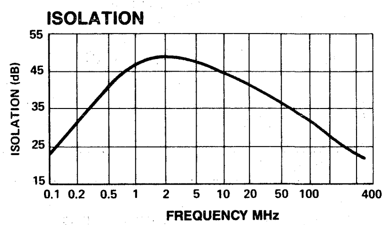
FP-5

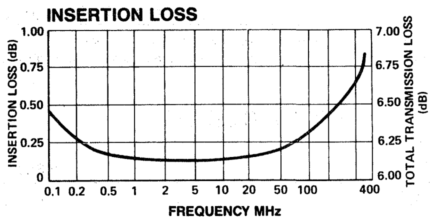


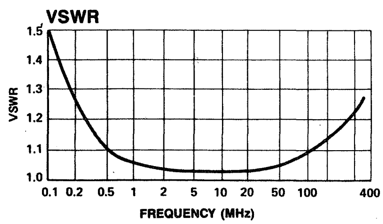
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Four-Way Power Dividers 10-500 MHz

DS-112/312

- Low Loss – 0.6 dB Typical
- High Isolation – 30 dB Typical
- Low VSWR – 1.2:1 Typical

Guaranteed Specifications*

(From −55°C to +85°C)

MODEL	DS-112	DS-312
Frequency Range	10-500	10-500 MHz
Insertion Loss (Less coupling)		
10-400 MHz	0.75	0.75 dB Max
400-500 MHz	0.85	0.85 dB Max
Isolation	25	25 dB Min
Amplitude Balance	0.2	0.2 dB Max
Phase Balance	5°	2° Max
VSWR (All Ports)		
10-25 MHz	1.5:1 Max	
25-500 MHz	1.35:1 Max	
10-400 MHz		1.5:1 Max
400-500 MHz		1.35:1 Max

Operating Characteristics

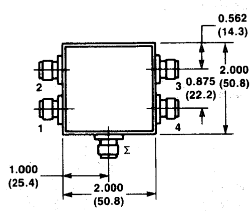
Impedance		50 Ohms Nominal
Maximum Power Rating or Input Power		1.0 Watt Max
Internal Load Dissipation	0.05	0.25 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.		
Pin Configuration (DS-112)		IN; P4 Outputs; P8, P10, P12 & P14 All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

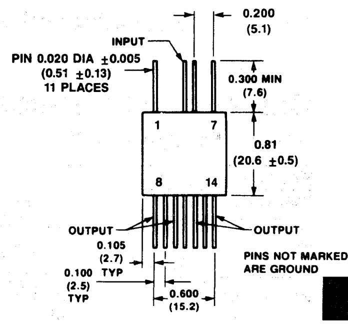
Ordering Information

Model No.		Package
DS-112	PIN	Flatpack
DS-312	BNC	Connectorized
DS-312	TNC	Connectorized
DS-312	N	Connectorized
DS-312	SMA	Connectorized

C-14



FP-5

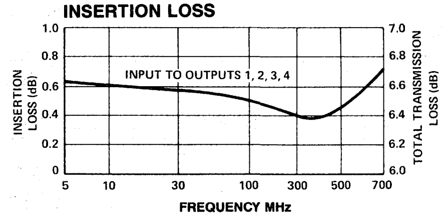


Dimensions in ( ) are in mm.

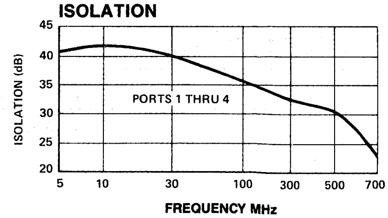
See Appendix for complete physical dimensions.

Typical Performance

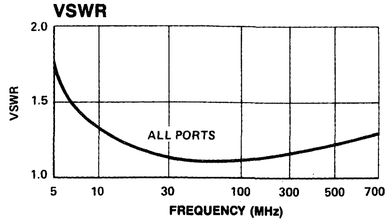
INSERTION LOSS



ISOLATION



VSWR



Specifications Subject to Change Without Notice.

Flatpack Four-Way Power Divider
25-1000 MHz

DS-324

- 0.5 dB Typical Midband Insertion Loss
- 38 dB Typical Midband Isolation
- 1.2:1 Typical Midband VSWR

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		25-1000 MHz
Insertion Loss	25-500 MHz	0.75 dB Max
(Less coupling)	25-1000 MHz	1.0 dB Max
Isolation	25-1000 MHz	20 dB Min
Amplitude Balance	25-1000 MHz	0.25 dB Max
Phase Balance	25-500 MHz	3° Max
	500-1000 MHz	6° Max
VSWR (All Ports)		
In		1.3:1 Max
Out		1.4:1 Max

Operating Characteristics

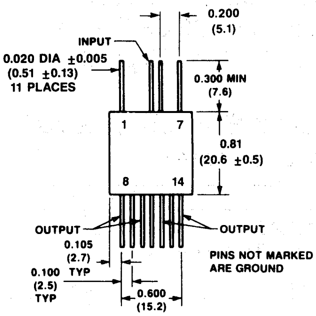
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.05 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	IN; P4 Outputs; P8, P10, P12 & P14 All other pins and case are ground.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-324 PIN	Flatpack

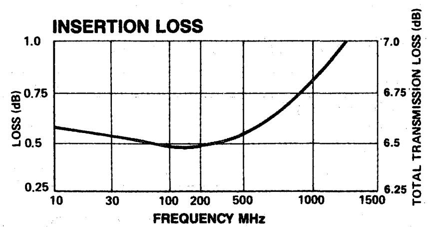
FP-5

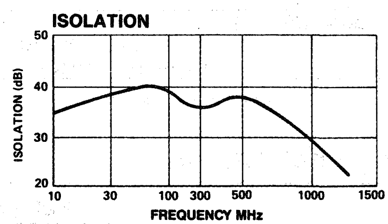


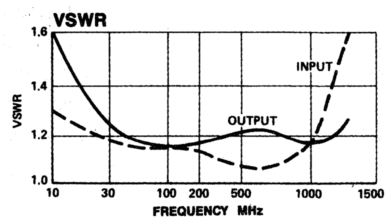
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Broadband Four-Way Power Divider
2-2000 MHz

DS-4-4

- 3 Decade Frequency Range
- Low Loss — 1 dB Maximum to 1000 MHz
- High Isolation — 25 dB Midband Minimum

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		2-2000 MHz
Insertion Loss (Less coupling)	2-30 MHz	0.75 dB Max
	30-400 MHz	0.5 dB Max
	400-1000 MHz	1.0 dB Max
	1000-2000 MHz	2.0 dB Max
Isolation	2-30 MHz	15 dB Min
	30-400 MHz	30 dB Min
	400-1000 MHz	25 dB Min
	1000-2000 MHz	20 dB Min
Amplitude Balance	2-30 MHz	0.6 dB Max
	30-400 MHz	1.0 dB Max
	400-1000 MHz	1.0 dB Max
	1000-2000 MHz	1.0 dB Max
Phase Balance	2-30 MHz	13° Max
	30-400 MHz	5° Max
	400-1000 MHz	5° Max
	1000-2000 MHz	5° Max
VSWR (All Ports)	2-30 MHz	2.0:1 Max
	30-400 MHz	1.3:1 Max
	400-1000 MHz	1.3:1 Max
	1000-2000 MHz	1.9:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	1.0 Watt Max
Internal Load Dissipation	0.25 Watt Max

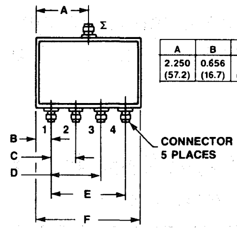
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,325,587.

Ordering Information

Model No.		**Package**
DS-4-4	N	Connectorized
DS-4-4	BNC	Connectorized

C-17

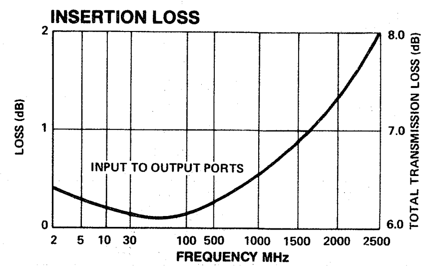


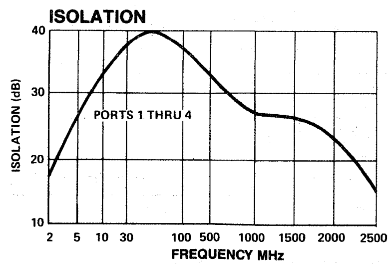
A	B	C	D	E	F
2.250 (57.2)	0.656 (16.7)	1.062 (27.0)	2.125 (54.0)	3.188 (8.10)	4.500 (114.3)

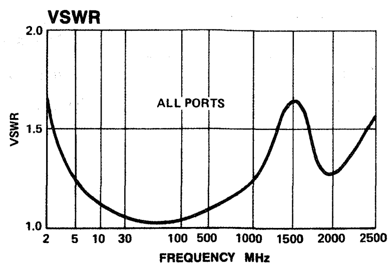
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

Four-Way Power Divider
10-2000 MHz

DS-409-4

- Broad Frequency Range
- Low Loss — Typically 1.0 dB

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		10-2000 MHz
Insertion Loss (Less coupling)	10-30 MHz	0.6 dB Max
	30-100 MHz	0.6 dB Max
	100-1000 MHz	1.25 dB Max
	1000-2000 MHz	1.5 dB Max
Isolation	10-30 MHz	15 dB Min
	30-100 MHz	20 dB Min
	100-1000 MHz	25 dB Min
	1000-2000 MHz	20 dB Min
Amplitude Balance	10-30 MHz	0.25 dB Max
	30-100 MHz	0.25 dB Max
	100-1000 MHz	0.5 dB Max
	1000-2000 MHz	1.0 dB Max
Phase Balance	10-30 MHz	2.5° Max
	30-100 MHz	2.5° Max
	100-1000 MHz	5.0° Max
	1000-2000 MHz	10.0° Max
VSWR (All Ports)	10-30 MHz	2.0:1 Max
	30-100 MHz	1.5:1 Max
	100-1000 MHz	1.5:1 Max
	1000-2000 MHz	1.75:1 Max

Operating Characteristics

Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	5.0 Watts Max
Internal Load Dissipation	0.5 Watt Max

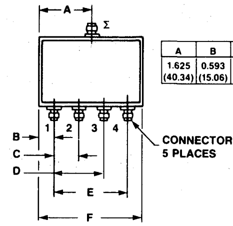
Environmental
See Appendix for MIL-STD-883 screening option.

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.		Package
DS-409-4	BNC	Connectorized
DS-409-4	SMA	Connectorized

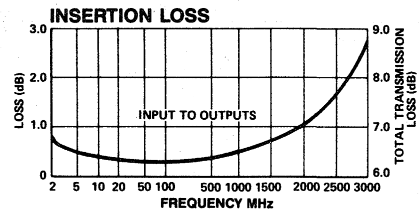
C-17

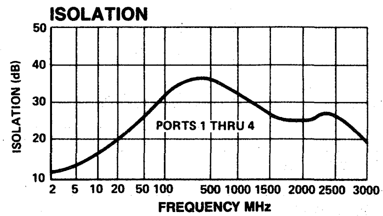


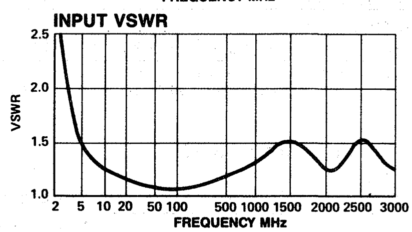
A	B	C	D	E	F
1.625 (40.34)	0.593 (15.06)	0.688 (17.47)	1.376 (34.95)	2.064 (52.42)	3.250 (82.6)

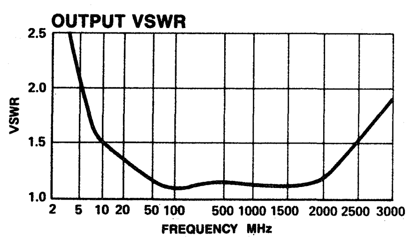
Dimensions in ( ) are in mm.
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

M/A-COM

Eight-Way Power Divider 2-500 MHz

DS-309

- Low Loss — Typically 1 dB
- High Isolation — Typically 30 dB
- Low VSWR — Typically 1.3:1

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range		2-500 MHz
Insertion Loss (Less coupling)		1.2 dB Max
Isolation	2-100 MHz	30 dB Min
	100-500 MHz	25 dB Min
Amplitude Balance	2-100 MHz	0.15 dB Max
	100-500 MHz	0.25 dB Max
Phase Balance	2-100 MHz	2.0° Max
	100-500 MHz	3.5° Max
VSWR (All Ports)	2-5 MHz	1.6:1 Max
	5-500 MHz	1.35:1 Max

Operating Characteristics

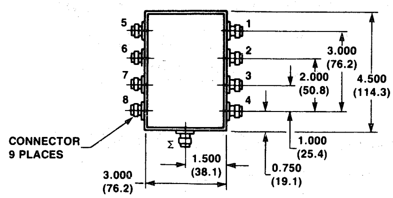
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	2.0 Watts Max
Internal Load Dissipation	0.25 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.

Ordering Information

Model No.	Package
DS-309 BNC	Connectorized
DS-309 SMA	Connectorized

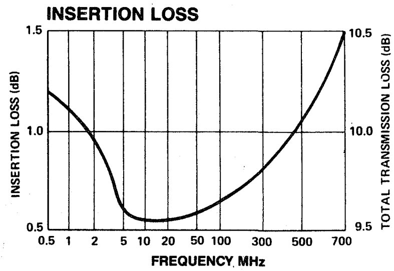
C-18

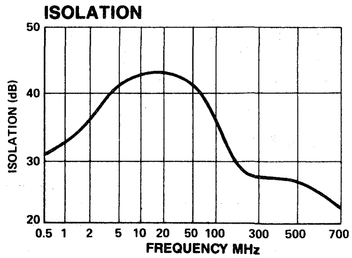


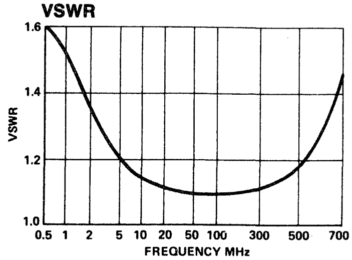
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Broadband Eight-Way Power Divider
20-2000 MHz

DS-808-4

- Two-Decade Frequency Range
- High Isolation — 20 dB Min
- Typical Midband VSWR 1.2:1

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		20-2000 MHz
Insertion Loss (Less coupling)	20-600 MHz	1.0 dB Max
	600-1000 MHz	1.3 dB Max
	1000-2000 MHz	3.0 dB Max
Isolation		20 dB Min
Amplitude Balance	20-600 MHz	0.6 dB Max
	600-1000 MHz	0.6 dB Max
	1000-2000 MHz	1.2 dB Max
Phase Balance	20-600 MHz	5° Max
	600-1000 MHz	5° Max
	1000-2000 MHz	15° Max
VSWR (All Ports)	20-60 MHz	1.7:1 Max
	60-600 MHz	1.4:1 Max
	600-1000 MHz	2.0:1 Max
	1000-2000 MHz	2.0:1 Max

Operating Characteristics

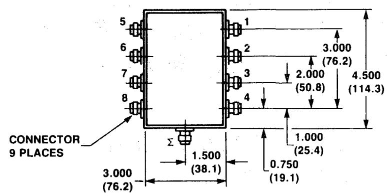
Impedance	50 Ohms Nominal
Maximum Power Rating or Input Power	5.0 Watts Max
Internal Load Dissipation	0.5 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,325,587.

Ordering Information

Model No.		Package
DS-808-4	BNC	Connectorized
DS-808-4	SMA	Connectorized

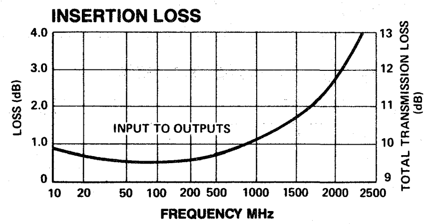
C-18

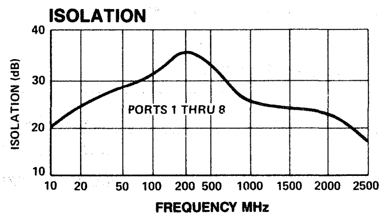


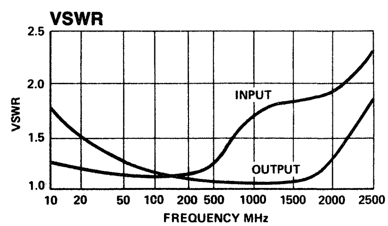
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

RF Directional Couplers

Overview

INTRODUCTION

Directional Couplers as described in this article are actually a particular form of 180° hybrid. While a 180° hybrid splits an input into two equal amplitude outputs, a directional coupler normally splits into two unequal amplitude outputs. This terminology "directional coupler" and "180° hybrid" is based on convention, however, the 180° hybrid could be thought of as a 3 dB directional coupler. Despite these similarities, the parameters used to describe signal flow in directional couplers and the application, in actual use, is sufficiently different to warrant separate considerations. This information supports our CH/CD/DCG series of couplers.

FUNCTIONAL DESCRIPTION

A directional coupler is ideally a lossless reciprocal four-port device which normally provides two unequal amplitude outputs when a signal is fed to one of its inputs. Depending upon which port is fed, the outputs may be in-phase or 180° out-of-phase. Directional couplers are usually described by indicating the coupling ratio to the low signal level output. Thus a 20 dB directional coupler will provide a "coupled path" output which is 20 dB below the input, while the "main line" or through path has very little loss (.04 dB theoretically).

At this point it is useful to consider the terminology and functional diagram normally used for directional couplers. First, for comparison, consider the diagram used for 180° hybrids. Figure 1 shows a four-port 180° hybrid.

This diagram can be utilized for analyzing the function of a directional coupler by simply noting which paths are coupled or high loss paths and which paths are main line or low loss paths. However, a different form of diagram is often used to denote graphically this information.

In Figure 2, path C to A is the mainline or low loss path while C to B is the coupled path. For a signal fed to Port A, Port D is the coupled output, but the signal undergoes a 180° phase shift. Ports C, D and A, B are isolated pairs. The phase shift of paths C to A and B to D is 0° although this is not

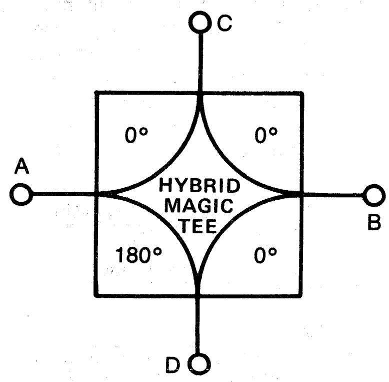


Figure 1. General Diagram for 180° Hybrid

usually noted on the conventional diagram. If we compare Figure 2 with Figure 1, we see that the relative phase for all possible paths between similar ports is the same and the same pairs of ports are isolated. Figure 2 does, however, clearly indicate the main line and coupled paths.

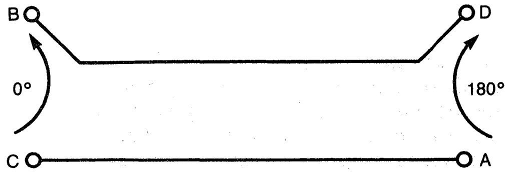


Figure 2. Directional Coupler Functional Diagram

It was earlier mentioned that a directional coupler is ideally a lossless device. Once again, as was the case with 180° and 90° hybrids, this approximation is a reasonable one to make when describing the function of the actual device. If we assume a lossless condition, then the signal splitting losses are easily determined knowing only the coupling ratio. Using the equations below, a calculation of the losses can be easily performed for any given coupling ratio, with Table 1 providing the power splitting losses for several common coupling ratios.

$$\text{Coupling Ratio (dB)} = 10 \log \frac{P_{OUT}\text{ (coupled path)}}{P_{IN}}$$

$$\text{Main line loss} = 10 \log \frac{P_{OUT}\text{ (Main Line)}}{P_{IN}}$$

Table 1

Coupling Ratio	Coupled Path Output (dB)	Coupled Path Power Ratio	Main Line Power Ratio	Main Line Loss
3 dB	−3 dB	0.50 P_{IN}	0.50 P_{IN}	3.0 dB
6 dB	−6 dB	0.25 P_{IN}	0.75 P_{IN}	1.25 dB
10 dB	−10 dB	0.10 P_{IN}	0.90 P_{IN}	0.46 dB
20 dB	−20 dB	0.01 P_{IN}	0.99 P_{IN}	0.04 dB
30 dB	−30 dB	0.001 P_{IN}	0.999 P_{IN}	0.004 dB

A "Directional Coupler" has the ability to separate and sample signal components based on the direction of signal flow. Refering to Figure 3, the diagram shows a 20 dB directional coupler with a signal source at Port A. Ports B and D are terminated in Z_O while Port C is terminated in an unknown impedance, Z_C. As we observed in Table 1, a 20 dB directional coupler splits a signal into two unequal components with the coupled output attenuated by 20 dB and the main line output attenuated by 0.04 dB theoretically. Thus the incident signal at Port A, V_{IN}, is split into two components, V_{IN} −20 dB which is delivered to the Z_O load at Port D and V_{IN} −0.04 dB which appears at the unknown load Z_C at Port C. If Z_C is any value other than Z_O part of the incident signal is reflected and appears back at Port C as V_{REFL}. The magnitude of the return loss of Z_C can be determined knowing either Z_C or ρ_C (the reflection coefficient) as follows:

$$\rho_C = \frac{Z_C - Z_O}{Z_C + Z_O}$$

$$\text{Return loss of } Z_C = 20 \log \frac{1}{|\rho_C|}$$

$$= 20 \log \left|\frac{Z_C + Z_O}{Z_C - Z_O}\right|$$

$$V_{REFL} = V_{IN} - 0.04\text{ dB} - \text{Return Loss of } Z_C$$

$$= V_{IN} - 0.04\text{ dB} - 20 \log \left|\frac{Z_C + Z_O}{Z_C - Z_O}\right|$$

The signal V_{REFL}, which enters Port C, is in turn split with (V_{REFL} − 20 dB) appearing at the Z_O termination on Port B and (V_{REFL} − 0.04 dB) being dissipated in the source impedance, Z_O at Port A. If we compare signal levels at Ports D and B, we find the following:

$$V_D = V_{IN} - 20\text{ dB}$$
$$V_B = V_{REFL} - 20\text{ dB}$$
$$= V_{IN} - 20.04\text{ dB} - \text{Return Loss of } Z_C$$

Thus we find that a comparison of signal levels at Ports B and D gives us a direct measure of the return loss or complex impedance of Z_C. In fact, the signal levels are offset only by the return loss and the small main line loss.

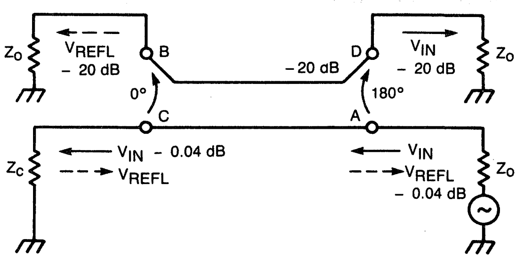


Figure 3. Incident and Reflected Signal Flow

We can also see that if $Z_C = Z_O$ the return loss of Z_C becomes infinite and no signal will reach Port B. This, of course, should follow from the consideration that Ports A and B and C and D are isolated when the directional coupler is terminated in Z_O impedance loads. Practical directional couplers have finite isolation and this introduces an error in the comparative levels at Ports B and D.

Directional couplers are often used for measurements where an unknown mismatch is expected at one port as was illustrated in Figure 3. The directivity of the coupler is a limiting parameter in the ability to accurately measure the return loss of this unknown.

As an example, consider the coupler shown in Figure 3. We will assume the following parameters:

Isolation, A to B = 40 dB
Coupling, A to D or C to B = 20 dB

Therefore:

Directivity, A to B = 40 dB − 20 dB = 20 dB

If we connect an unknown impedance which has an actual return loss of 20 dB, we observe that two equal amplitude signal components are present at Port B, the first, V_{INT}, due to internal mismatches and unbalance in the coupler as measured by the directivity and the second, V_{EXT}, due to reflection from the external unknown. For stated conditions:

$$|V_{INT}| = |V_{EXT}|$$

Since the relative phase of the complex voltages V_{INT} and V_{EXT} is unknown, the resultant voltage can vary over a wide range. Two extremes exist: in-phase and 180° out-of-phase.

1. In-Phase
   $V_{INT} = V_{EXT} = V$
   $V_{RESULTANT} = V_{INT} + V_{EXT}$
   Apparent Return Loss =
   Actual Return Loss − 6 dB
2. 180° Out-Of-Phase
   $V_{INT} = V_{EXT}$
   $V_{RESULTANT} = V_{INT} + (-V_{EXT}) = 0$
   Apparent Return Loss = ∞

The apparent return loss of the unknown can be seen to vary from 6 dB worse than the actual return loss to infinity or an apparent perfect match. As a rule-of-thumb the directivity of the coupler should be 20 dB greater than the return loss of the unknown load. This will keep directivity errors below 1 dB.

PERFORMANCE PARAMETERS

The parameters of frequency range, impedance and VSWR previously defined also apply to directional couplers (see pages 294 to 302). In addition, four new parameters are defined.

Coupling

This is the attenuation of a signal at the coupled port relative to the input signal level.

Coupling Flatness

This is the variation in coupling over the frequency range specified.

Directivity

This is the signal level at an isolated port relative to the signal level at a coupled port when the signal is injected at an input. (Example: The signal at B relative to D when A Port is fed).

Main Line Loss

This is the total insertion loss in the main line.

CONCLUSION

The directional coupler is a unique type of 180° hybrid. It can be used effectively in systems to monitor power or match, branch signals, feedback power in amplifiers and for signal injection. The designer who understands the unique features of directional couplers will find many other applications where a coupler's properties can solve difficult system problems.

20 dB Bidirectional Coupler 2-32 MHz

CD-920-4

- Low Loss — 0.2 dB Max
- High Directivity — 35 dB Min
- Constant Coupling — Typically
- Within ±0.15 dB

Guaranteed Specifications*

(From −55°C to +85°C)

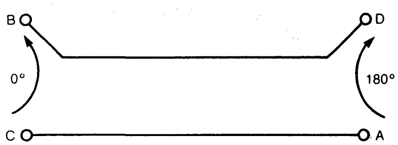
Frequency Range	2-32 MHz
Coupling (Input to Output)	20 ±0.15 dB
Coupling Flatness	±0.15 dB Max
VSWR	1.07:1 Max
Directivity (Both Directions)	35 dB Min
Main Line Loss	0.2 dB Max

Operating Characteristics

Input Power	50 Watts Max
Environmental See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.

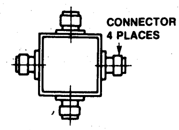
Functional Diagram



Ordering Information

Model No.	Package
CD-920-4 BNC	Connectorized

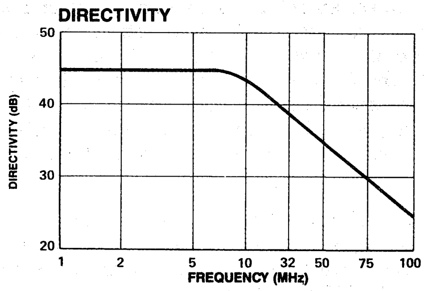
C-8

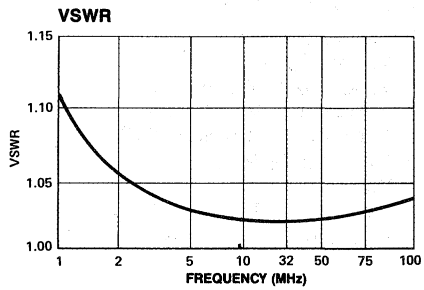


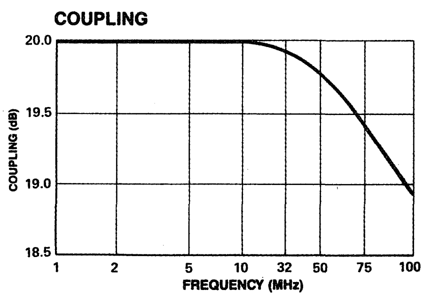
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







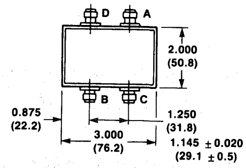
Specifications Subject to Change Without Notice.

30 dB Bidirectional Coupler, 500 Watt
2-32 MHz

CH-130-4

- High Power Handling Capability — 500 Watts
- Very Low Insertion Loss — 0.1 dB Max
- Low VSWR — 1.1:1 Max

C-12



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*

(From −55°C to +85°C)

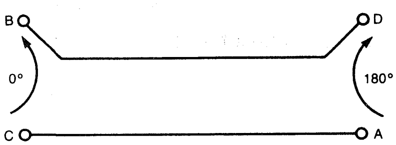
Frequency Range	2-32 MHz
Coupling (Input to Output)	30 ±0.5 dB
Coupling Flatness	±0.25 dB Max
VSWR (All Ports)	1.1:1 Max
Directivity (Both Directions)	25 dB Min
Main Line Loss	0.1 dB Max

Operating Characteristics

Input Power	500 Watts Max
Environmental See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.

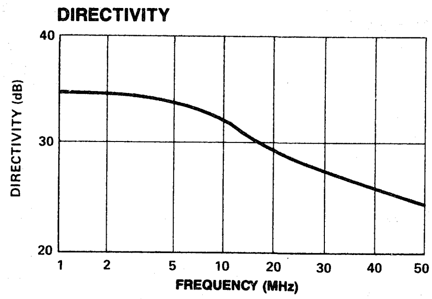
Functional Diagram

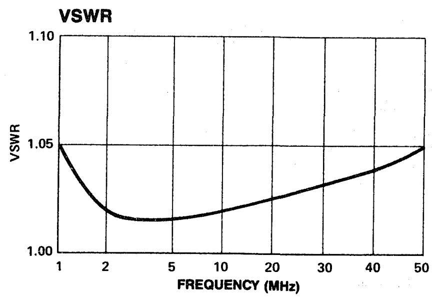


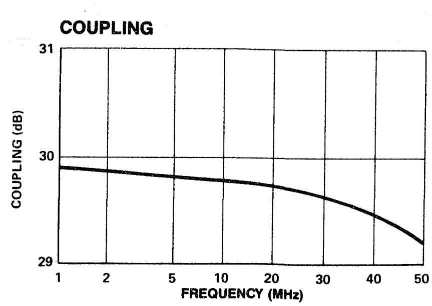
Ordering Information

Model No.	Package
CH-130-4 N	Connectorized

Typical Performance







Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

19.5 dB Directional Coupler 0.5-400 MHz

CH-/CHS-137

- Low Cost
- Convenient Plug-In Mounting
- Fully Hermetic Package (CHS-137)

Guaranteed Specifications*

(From −55°C to +85°C)

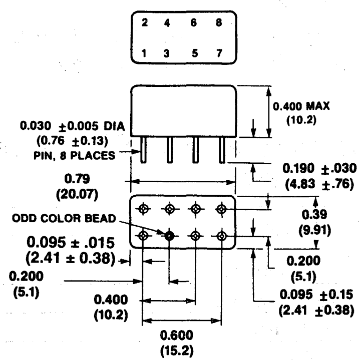
Frequency Range		0.5-400 MHz
Coupling (Input to Output)		
0.5-200 MHz		19.5 ±0.5 dB
200-400 MHz		20 ±1.0 dB
VSWR (All Ports)		
5-200 MHz		1.2:1 Max
0.5-400 MHz		1.5:1 Max
Directivity (Both Directions)		
0.5-50 MHz		30 dB Min
50-200 MHz		20 dB Min
200-400 MHz		15 dB Min
Main Line Loss**	**CH-137**	**CHS-137**
0.5-50 MHz	0.5 dB Max	0.5 dB Max
50-200 MHz	0.4 dB Max	0.4 dB Max
200-400 MHz	0.6 dB Max	0.7 dB Max

Operating Characteristics

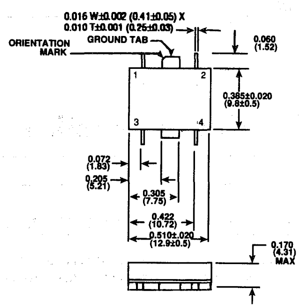
Input Power	3.0 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.
**Includes theoretical power split.

RH-1



SF-1



Dimensions in ( ) are in mm.

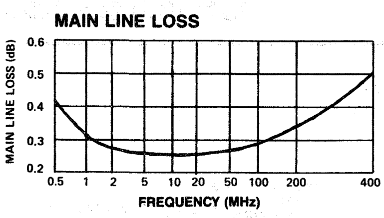
See Appendix for complete physical dimensions.

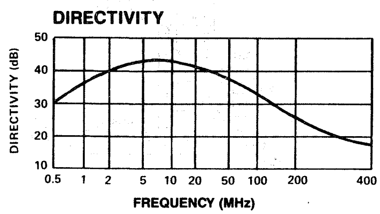
Ordering Information

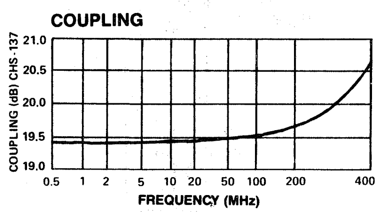
Model No.	Package
CH-137 PIN	Relay Header
CHS-137 PIN	Surface Mount

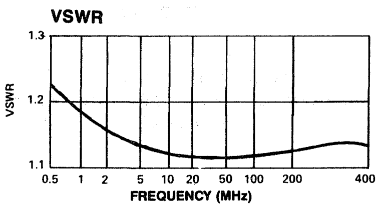
Specifications Subject to Change Without Notice.

Typical Performance

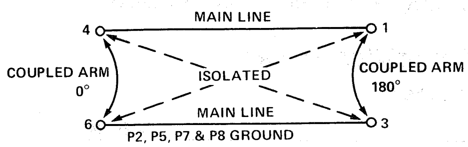




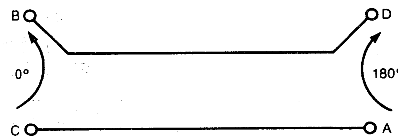




Functional Diagram & Pin Configuration (CH-137)



Functional Diagram (CHS-137)



Pin Configuration

CHS-137

Pin Number	Description
1	C
2	B
3	A
4	D

Specifications Subject to Change Without Notice.

Directional Couplers
10-500 MHz

CH-/CHS-134

- Constant Coupling — Within ±0.5 dB Max

Guaranteed Specifications*
(From −54°C to +85°C)

	CH-134
Frequency Range	10-500 MHz
Coupling (Input to Output)	10.8 ±0.7 dB
Coupling Flatness	±0.5 dB Max
VSWR (All Ports)	
10-500 MHz	1.8:1 Max
25-200 MHz	1.5:1 Max
Directivity (Both Directions)	20 dB Min
Main Line Loss**	1.6 dB Max

Operating Characteristics

Input Power	1.0 Watt Max

Environmental

See Appendix for MIL-STD-883 screening option.

Pin Configuration

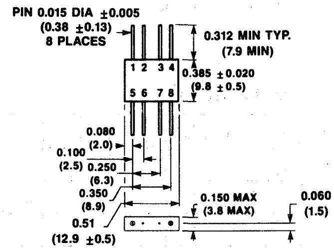
CH-134	C; P1, B; P4, A; P5, D; P8. Case and all other pins ground.
CHS-134	C; P1, B; P2, A; P3, D; P4. Case ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

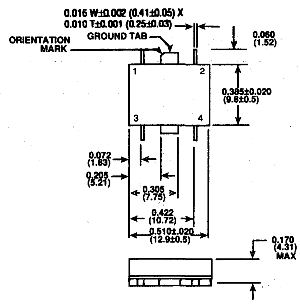
Ordering Information

Model No.	Package
CH-134 PIN	Flatpack
CHS-134 PIN	Surface Mount

FP-2



SF-1

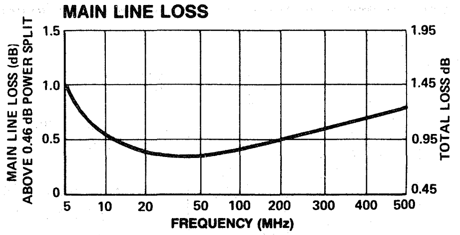


Dimensions in ( ) are in mm.
Unless Otherwise Noted: .xxx = ± 0.010 (.xx = ± 0.25)
.xx = ± 0.02 (.x = ± 0.5)

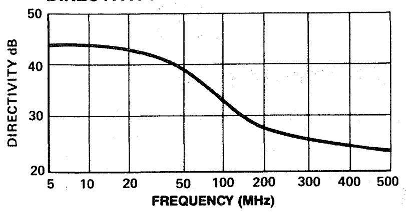
Specifications Subject to Change Without Notice.

Typical Performance

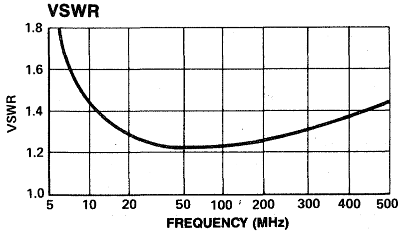
MAIN LINE LOSS



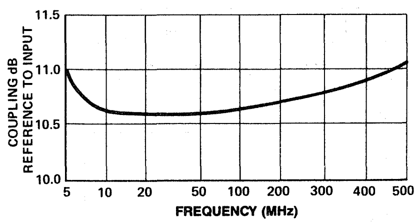
DIRECTIVITY



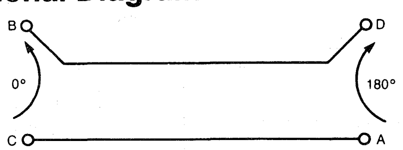
VSWR



COUPLING



Functional Diagram



Specifications Subject to Change Without Notice.

11 dB Directional Coupler
10-500 MHz

CH-138

■ Constant Coupling — Within ±0.5 dB Max

Guaranteed Specifications*

(From −54°C to +85°C)

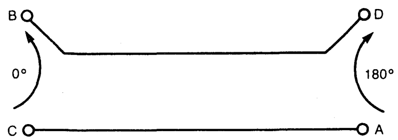
MODEL	CH-138
Frequency Range	10-500 MHz
Coupling (Input to Output)	10.8 ±1.0 dB
Coupling Flatness	±0.5 dB Max
VSWR (All Ports)	
10-500 MHz	1.8:1 Max
25-200 MHz	1.5:1 Max
Directivity (Both Directions)	17 dB Min
Main Line Loss**	1.6 dB Max

Operating Characteristics

Input Power	1.0 Watt Max
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	
CH-138	A; P8, B; P2, C; P5, D; P11. All other pins are ground.

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

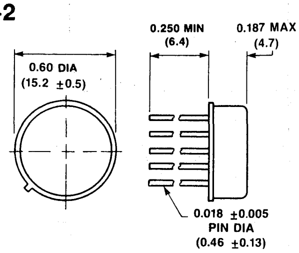
Functional Diagram



Ordering Information

Model No.	Package
CH-138 PIN	Pin

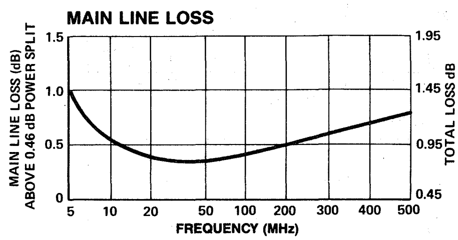
TO-8-2

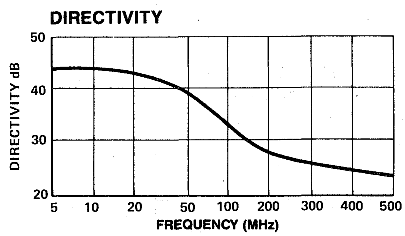


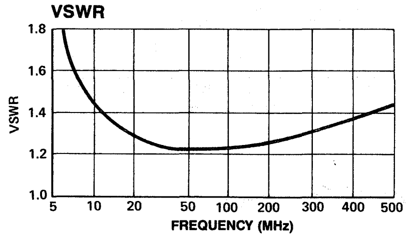
Dimensions in ( ) are in mm.

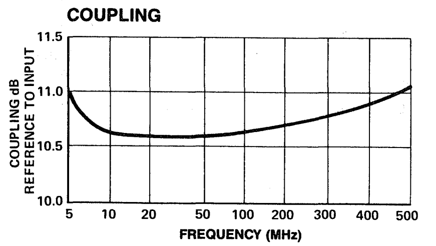
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

20 dB Bidirectional Coupler
1-1000 MHz

CH-132

- Broad Frequency Range
- Constant Coupling — Within ±0.5 dB Max
- VSWR — 1.3:1 Max

Guaranteed Specifications*

(From −55°C to +85°C)

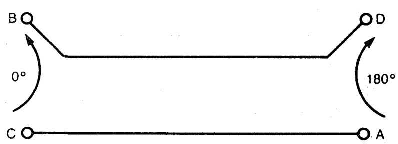
Frequency Range		1-1000 MHz
Coupling (Input to Output)		20 ±1.0 dB
Coupling Flatness	10-500 MHz	±0.25 dB Max
	1-1000 MHz	±0.5 dB Max
VSWR (All Ports)	10-500 MHz	1.2:1 Max
	1-1000 MHz	1.3:1 Max
Directivity (Both Directions)	10-500 MHz	25 dB Min
	1-1000 MHz	20 dB Min
Main Line Loss**	10-500 MHz	0.5 dB Max
	1-1000 MHz	0.7 dB Max

Operating Characteristics

Input Power	5.0 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes transitional power split.

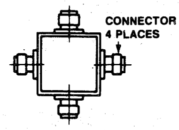
Functional Diagram



Ordering Information

Model No.	Package
CH-132 BNC	Connectorized
CH-132 N	Connectorized
CH-132 SMA	Connectorized

C-8

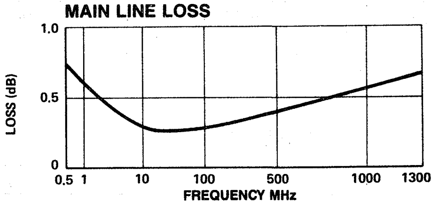


Dimensions in ( ) are in mm.

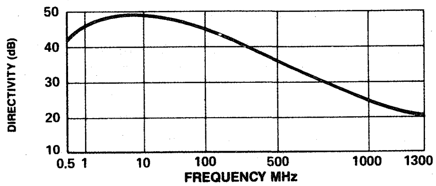
See Appendix for complete physical dimensions.

Typical Performance

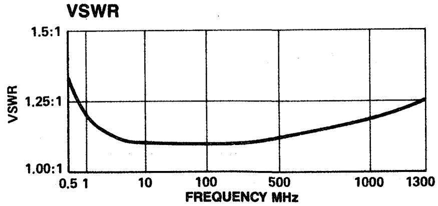
MAIN LINE LOSS



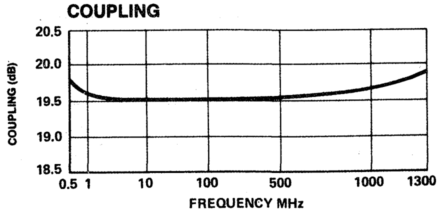
DIRECTIVITY



VSWR



COUPLING

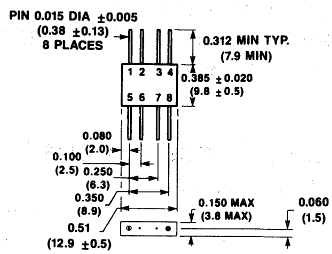


Specifications Subject to Change Without Notice.

20 dB Directional Coupler
5-1000 MHz
CH-140

- Broadband Flat Coupling
- 0.3 dB Typical Insertion Loss
- 30 dB Typical Directivity

FP-2



Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range		5-1000 MHz
Coupling (Input to Output)		19.75 ±1 dB
Coupling Flatness		±0.5 dB
VSWR (All Ports)		1.35:1 Max
Directivity (Both Directions)	5-800 MHz 800-1000 MHz	20 dB Min 17 dB Min
Main Line Loss**		0.75 dB Max

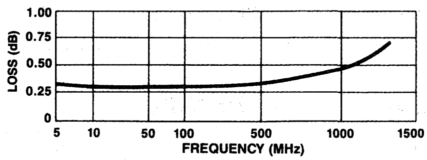
Operating Characteristics

Input Power	3.0 Watts Max
Internal Power Dissipation	0.25 Watts
Environmental See Appendix for MIL-STD-883 screening option.	
Pin Configuration	C; P1, A; P5, D; P8. Case and all other pins ground.

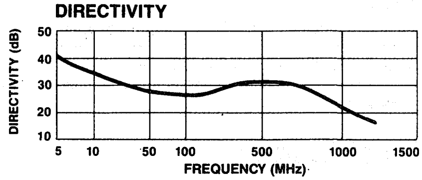
*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

Typical Performance

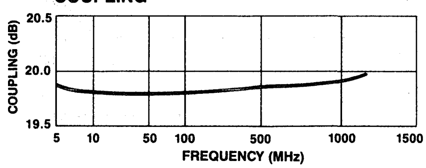
MAIN LINE LOSS



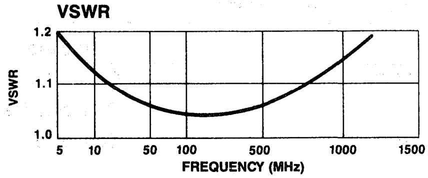
DIRECTIVITY



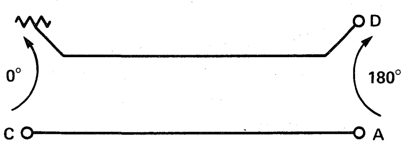
COUPLING



VSWR



Functional Diagram



Ordering Information

Model No.	Package
CH-140 PIN	Flatpack

Specifications Subject to Change Without Notice.

11 dB Directional Coupler 30-1000 MHz

DCG-10-4

- Wide Frequency Range
- Constant Coupling — Within ±0.5 dB

Guaranteed Specifications*

(From −55°C to +85°C)

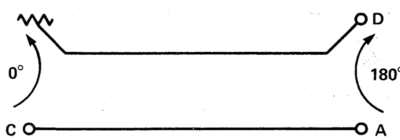
Frequency Range	30-1000 MHz
Coupling (Input to Output)	11.0 ±0.5 dB
Coupling Flatness	±0.5 dB Max
VSWR (All Ports)	1.35:1 Max
Directivity (Both Directions)	20 dB Min
Main Line Loss (Including Theoretical 0.46 dB Power Split)	1.5 dB Max

Operating Characteristics

Input Power	5.0 Watts Max
Environmental See Appendix for MIL-STD-883 screening option.	

*All specifications apply with 50 ohm source and load impedance.
This product contains elements protected by United States Patent Number 3,426,298.
**Includes theoretical power split.

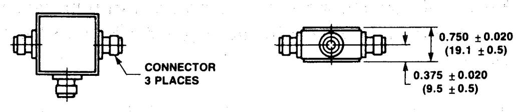
Functional Diagram



Ordering Information

Model No.	Package
DCG-10-4 BNC	Connectorized
DCG-10-4 SMA	Connectorized

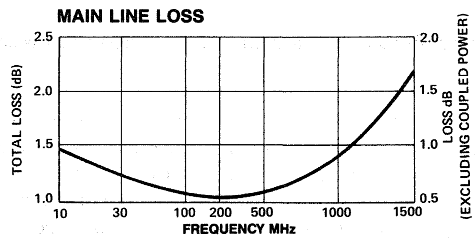
C-7

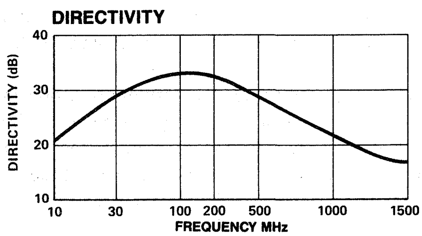


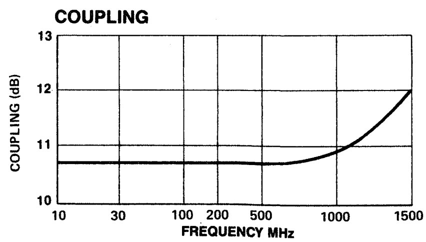
Dimensions in ( ) are in mm.

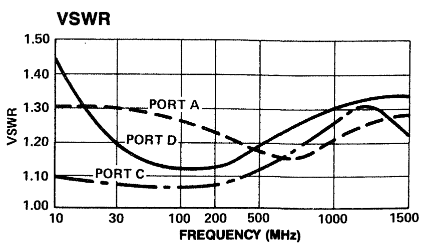
See Appendix for complete physical dimensions.

Typical Performance









Specifications Subject to Change Without Notice.

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RF Transformer Applications

Overview

3 KHz to 1000 MHz
M/A-COM transformers provide a variety of impedance transformations over the frequency band 3 KHz to 1000 MHz.

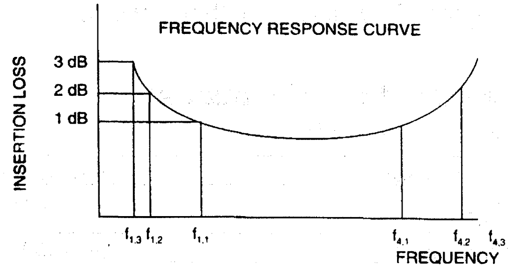
The impedance ratios are always specified as step-up, i.e., the secondary impedance is greater than the primary impedance. Although the primary side is nominally 50 ohms these transformers can be operated as low as 12.5 ohms at the primary side with about the same impedance matching ratio. Frequency response will show a slight change .

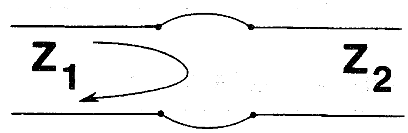
A typical frequency response curve of a transformer is shown opposite.

The 1 dB bandwidth of each transformer implies that the insertion loss of the transformer (for the specified ohms ratio) over this frequency range is less than 1 dB. 1 dB is the guaranteed maximum insertion loss but, in most cases, it will be less, typically 0.5dB for many devices. Similarly, the 2dB bandwidth implies that the insertion loss is less than 2dB over this frequency range, and so on for the 3dB bandwidth

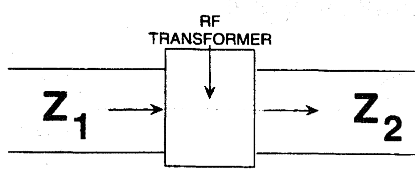
The primary application of RF transformers is "impedance matching." This means that, if the user desires to send an RF signal from a source (of impedance Z1) to a load of impedance Z2, then the appropriate RF transformer will ensure that the signal will reach the load with minimal reflection.

For the majority of RF transformers, DC isolation is also provided between primary and secondary.





LARGE REFLECTIONS WHEN $Z_2 \neq Z_1$ IF NO TRANSFORMER



WITH TRANSFORMER, MAX INSERTION LOSS = 1 dB
OVER DESIRED FREQUENCY RANGE

M/A-COM

50/75-Ohm Transformer 2-200 MHz

TP-75

- Low Insertion Loss
- Low VSWR

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	2 - 200 MHz
Impedance	
Input	50 Ohms
Output	75 Ohms
Insertion Loss	
2-200 MHz	0.25 dB Max
VSWR	
2-100 MHz	1.35:1 Max
100-200 MHz	1.35:1 Max

Operating Characteristics

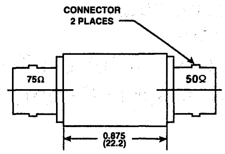
Input Power	10 W Max
Environmental	

See Appendix for MIL-STD-883 screening option.

Ordering Information

Model No.		Package
TP-75	BNC	Connectorized
TP-75	N	Connectorized
TP-75	SMA	Connectorized

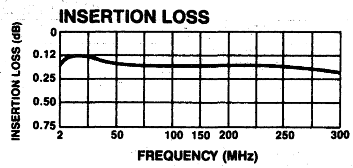
C-1

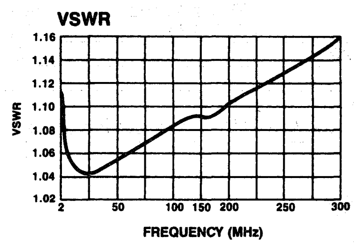


Dimensions in ( ) are in mm.

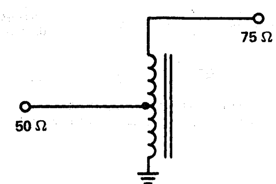
See Appendix for complete physical dimensions.

Typical Performance





Schematic



Specifications Subject to Change Without Notice.

RF Pulse Transformer
750 kHz-400 MHz

TP-104

- 50 Ohms Unbalanced/
  200 Ohms Balanced
- Low Insertion Loss — 0.4 dB Typ
- DC Isolation — Input to Output

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		750 kHz-400 MHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Balanced
Insertion Loss	10-50 MHz	0.55 dB Max
VSWR	5-200 MHz	1.3:1 Max
	750 kHz-400 MHz	2.0:1 Max

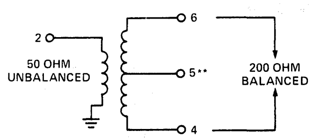
Operating Characteristics

Input Power	750 kHz-4 MHz	0.4 Watts Max
	4-400 MHz	1.0 Watts Max
Rise Time (10-90%)		0.55 nS Typ
Droop (10%)		130 nS Typ

Environmental
See Appendix for MIL-STD-883 screening option.

Schematic

PIN CONFIGURATION:

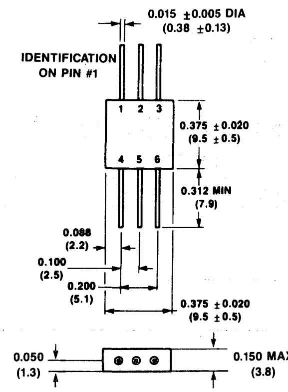


PINS 1 & 3 ARE GROUNDED TO CASE
**PIN 5 TO BE EXTERNALLY GROUNDED

Ordering Information

Model No.	Package
TP-104 PIN	Flatpack

FP-1

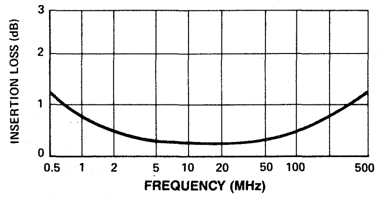


Dimensions in ( ) are in mm.

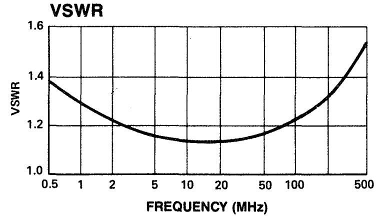
See Appendix for complete physical dimensions.

Typical Performance

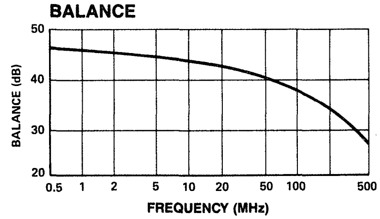
INSERTION LOSS



VSWR



BALANCE



Specifications Subject to Change Without Notice.

RF Pulse Transformer
1-500 MHz

TP-102

- 50 Ohms Unbalanced/
- 200 Ohms Unbalanced
- Fast Rise Time — 0.35 nS
- Low Insertion Loss — 0.75 dB Typ

Guaranteed Specifications*

(From −55°C to +85°C)

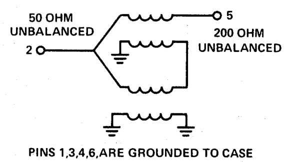
Frequency Range (1 dB Bandwidth)		1-500 MHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Unbalanced
Insertion Loss	10-50 MHz	0.75 dB Max
VSWR	5-250 MHz	1.3:1 Max
	2-500 MHz	1.6:1 Max
	1-2 MHz	2.0:1 Max

Operating Characteristics

Input Power	1-5 MHz	0.5 Watt Max
	5 MHz-1 GHz	1.0 Watt Max
Rise Time (10-90%)		0.35 nS Typ
Droop (10%)		150 nS Typ
Environmental		
See Appendix for MIL-STD-883 screening option.		

Schematic

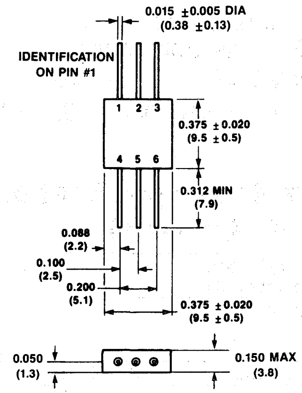
PIN CONFIGURATION:



Ordering Information

Model No.	Package
TP-102 PIN	Flatpack

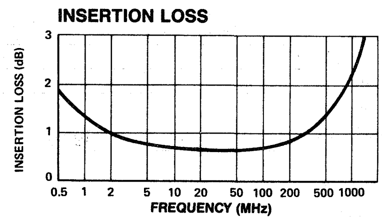
FP-1

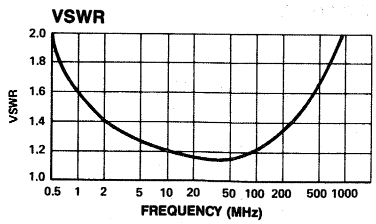


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance





Specifications Subject to Change Without Notice.

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RF Pulse Transformer
500 kHz-1 GHz
TP-105

- 50 Ohms Unbalanced/
  12.5 Ohms Unbalanced
- Low VSWR — 1.1:1 Typ
- Low Insertion Loss — 0.4 dB Typ

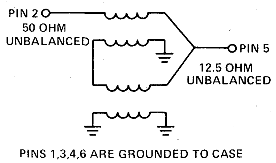
Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		500 kHz-1 GHz
Impedance		
Input		50 Ohms Unbalanced
Output		12.5 Ohms Unbalanced
Insertion Loss	10-50 MHz	0.50 dB Max
VSWR	1-500 MHz	1.4:1 Max
	500 kHz-1 GHz	1.6:1 Max

Operating Characteristics

Input Power	500 kHz-1 MHz	0.375 Watts Max
	1 MHz-5 MHz	0.75 Watts Max
	5 MHz-1 GHz	1.5 Watts Max
Rise Time (10-90%)		0.3 nS Typ
Droop (10%)		350 nS Typ
Environmental		
See Appendix for MIL-STD-883 screening option.		

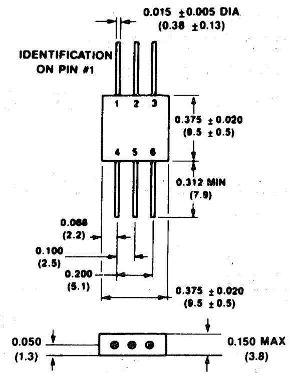
Schematic
PIN CONFIGURATION:



Ordering Information

Model No.	Package
TP-105 PIN	Flatpack

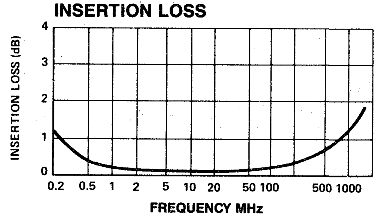
FP-1

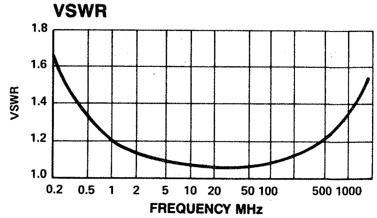


Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance





Specifications Subject to Change Without Notice.

RF Pulse Transformer
500 kHz-1GHz

TP-103

- 50 Ohms Unbalanced/
- 200 Ohms Balanced
- Fast Rise Time — 0.18 nS
- Low Insertion Loss — 0.4 dB Typ

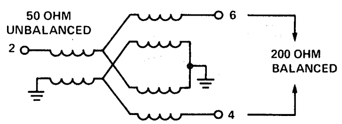
Guaranteed Specifications*
(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		500 kHz-1 GHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Balanced
Insertion Loss	10-50 MHz	0.6 dB Max
VSWR	2-500 MHz	1.4:1 Max
	500 kHz-1 GHz	2.0:1 Max

Operating Characteristics

Input Power	500 kHz-1 MHz	1.0 Watt Max
	1 MHz-5 MHz	1.5 Watts Max
	5 MHz-1 GHz	3.0 Watts Max
Rise Time (10-90%)		0.18 nS Typ
Droop (10%)		160 nS Typ
Environmental See Appendix for MIL-STD-883 screening option.		

Schematic
PIN CONFIGURATION:

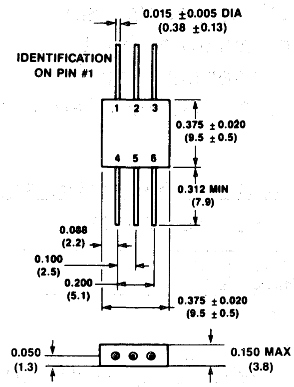


PINS 1,3,5 ARE GROUNDED TO CASE

Ordering Information

Model No.	Package
TP-103 PIN	Flatpack

FP-1

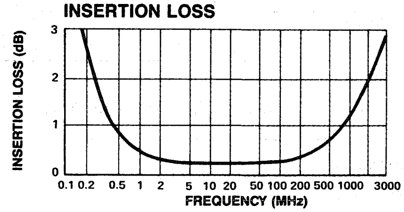


Dimensions in ( ) are in mm.

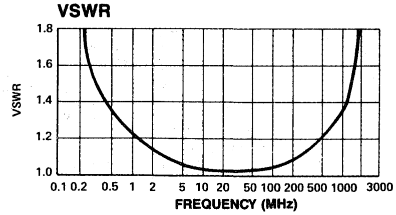
See Appendix for complete physical dimensions.

Typical Performance

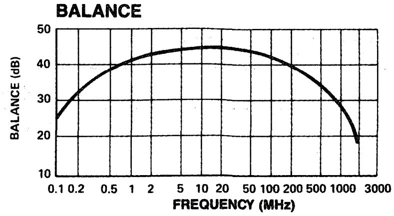
INSERTION LOSS



VSWR



BALANCE



Specifications Subject to Change Without Notice.

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RF Transformer
350-1125 MHz

TP-108

- 50 Ohms Unbalanced to Dual 100 Ohms
- Unbalanced or 200 Ohms Balanced
- Low Insertion Loss
- Accessible Center Tap for DC Bias

Guaranteed Specifications*

(From −55°C to +85°C)

Frequency Range (1 dB Bandwidth)		350-1125 MHz
Impedance		
Input		50 Ohms Unbalanced
Output		200 Ohms Balanced
Insertion Loss	500-1000 MHz	1.0 dB Max
VSWR	500-1000 MHz	1.5:1 Max
	350-1125 MHz	2.5:1 Max

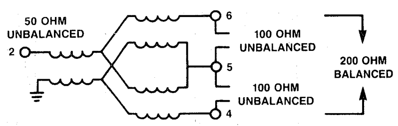
Operating Characteristics

Input Power	350-1125 MHz	3.0 Watts Max
Package Type		Flatpack (FP-1)
		(See page 474 for physical dimensions.)
Environmental		

See Appendix for MIL-STD-883 screening option.

Schematic

PIN CONFIGURATION:

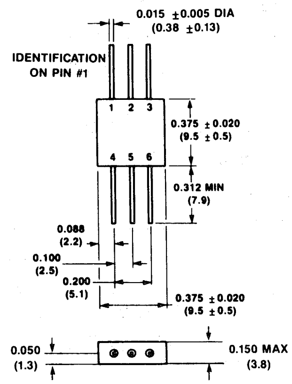


PINS 1,3 ARE GROUNDED TO CASE
PIN 5 IS TO BE EXTERNALLY BIASED OR GROUNDED

Ordering Information

Model No.	Package
TP-108 PIN	Flatpack

FP-1

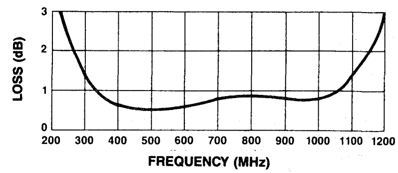


Dimensions in ( ) are in mm.

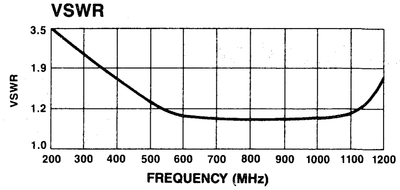
See Appendix for complete physical dimensions.

Typical Performance

INSERTION LOSS



VSWR



Specifications Subject to Change Without Notice.

RF Pulse Transformer
500 kHz-1.5 GHz

TP-101

- 50 Ohms Unbalanced/50 Ohms Balanced
- Fast Rise Time — 0.18 nS
- Low Insertion Loss — 0.4 dB Typ

Guaranteed Specifications*
(From −55°C to +85°C)

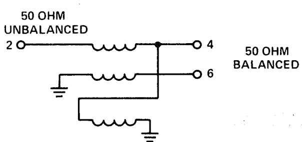
Frequency Range (1 dB Bandwidth)		500 kHz-1.5 GHz
Impedance		
Input		50 Ohms Unbalanced
Output		50 Ohms Balanced
Insertion Loss	10-50 MHz	0.5 dB Max
VSWR	1 MHz-1 GHz	1.4:1 Max
	750 kHz-1.5 GHz	1.6:1 Max

Operating Characteristics

Input Power	750 kHz-1 MHz	1.0 Watt Max
	1 MHz-5 MHz	1.5 Watts Max
	5 MHz-1.5 GHz	3.0 Watts Max
Rise Time (10-90%)		0.18 nS Typ
Droop (10%)		300 nS Typ
Environmental		

See Appendix for MIL-STD-883 screening option.

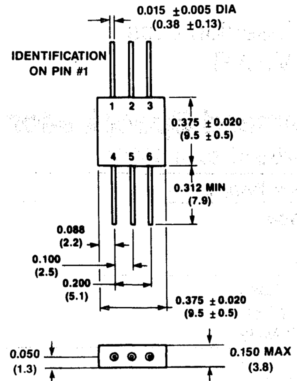
Schematic
PIN CONFIGURATION:



Ordering Information

Model No.	Package
TP-101 PIN	Flatpack

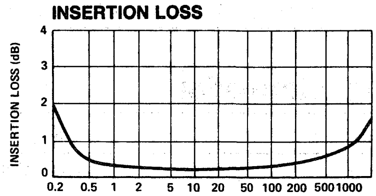
FP-1

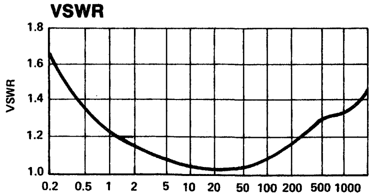


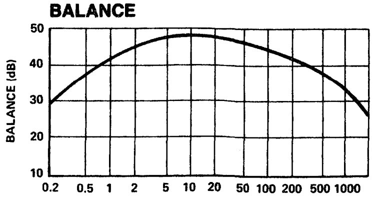
Dimensions in ( ) are in mm.

See Appendix for complete physical dimensions.

Typical Performance







Specifications Subject to Change Without Notice.

50/75-Ohm Transformer
10-1500 MHz

TPX-75-4

- Low Insertion Loss
- Low VSWR

Guaranteed Specifications*
(From –55°C to +85°C)

Frequency Range	10 -1500 MHz
Impedance	
Input	50 Ohms
Output	75 Ohms
Insertion Loss	
50-500 MHz	0.4 dB Max
10-1500 MHz	0.75 dB Max
VSWR	
10-1500 MHz	1.35:1 Max

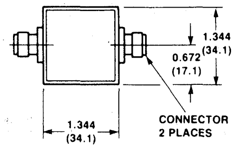
Operating Characteristics

Input Power	2 Watts Max
Environmental	
See Appendix for MIL-STD-883 screening option.	

Ordering Information

Model No.	Package
TPX-75-4 N	Connectorized

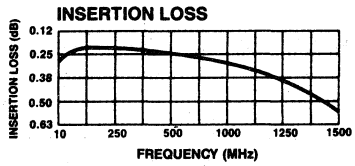
C-5

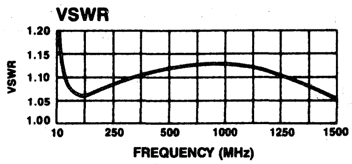


Dimensions in ( ) are in mm.

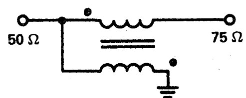
See Appendix for complete physical dimensions.

Typical Performance





Schematic



Specifications Subject to Change Without Notice.

RF Multi-Function Products

Capabilites

M/A-COM's Engineering staff offers an unsurpassed capability in the areas of RF multi-function assembly (RF-MFA) design. This capability is based on the standard products included in this catalog and many custom products designed and manufactured for specialized applications. M/A-COM's vast RF product base provides a unique library of amplifier, switch, mixer, and passive designs to form an exceptional foundation for subassembly integration.

M/A-COM's engineering staff is supported by in-house facilities and equipment to perform and control product life cycle from electrical design and fabrication through environmental testing. These in-house capabilities include:

- Thin and thick film substrate fabrication
- GaAs MMIC design and fabrication
- GMIC & HMIC Integration Mediums
- CAD/CAE design
- Automated Test and Production
- Hermetic Welding and Sealing
- Screening and environmental testing

MIC AND MMIC DESIGN EXPERTISE

The major strength of M/A-COM's RF-MFA capability is that critical components are internally designed and produced. Technology capabilities include stripline and microstrip design expertise and, additionally, a broad range of GaAs MMIC building blocks such as amplifiers, switches, and passives to complement the hybrid circuits.

Our experience in interconnection and packaging technology and system interface performance makes M/A-COM an excellent choice for critical production requirements. Packaging techniques range from multiple modules integrated in a connectorized package to several interconnected carriers in a hermetically sealed package. The combination of components may include hybrids, MMICs, or hybrids complemented by MMICs.

ADVANTAGES OF INTEGRATION

Several different levels of integration can be achieved. Packages may be connectorized housings, DIP or flatpack housings. Our experience with interconnection and packaging and a broad product library provides many advantages of integration.

- Enhanced Performance – improves RF match by reducing interconnections and physical size, allows design optimization for specific requirements, and reduces parametric tolerance build-up.
- Reduced Size and Weight – eliminates separate packages, cabling, connectors, feedthroughs, and redundant circuitry.
- Improved Reliability – reduces number of parts and interconnects.
- Improved Efficiency – reduces power requirements through optimized designs, lowers RF losses, and eliminates redundant circuitry.
- Availability of Technical Resources – customers can concentrate their critical engineering resources to their system needs.

THE M/A-COM ADVANTAGE

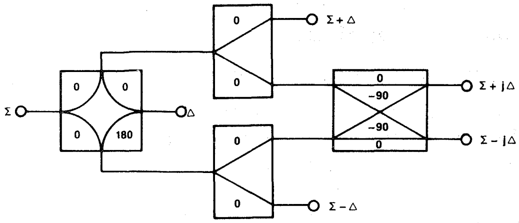
M/A-COM has years of experience and a strong technology base in component interconnection, multi-function packaging, automated manufacturing integration mediums and system interfacing. We will work with our customer in the design phase, continuing through the production phase, and offer support through the critical system integration phase.

Several examples of RF-MFA's designed and manufactured by M/A-COM are shown on the following pages. These examples illustrate the technologies and techniques available to meet your needs.

BEAMFORMING NETWORKS

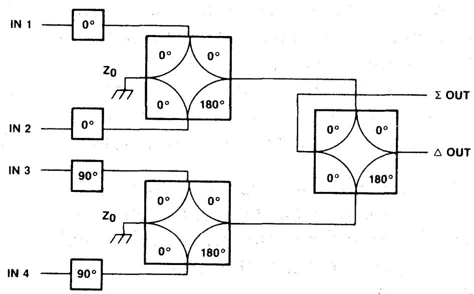
M/A-COM's traditional passive ferrite, transformer, microstrip and hybrid component technologies are combined to produce broadband and narrowband beamforming networks. These are used in applications where signal amplitudes and phase relationships from several channels are processed and combined vectorially to provide information such as direction, altitude, range, speed and depth in systems used for guidance, direction finding (DF), navigation and communication.

FEATURES
- **Octave Bandwidth**
- **Low Loss**
- **High DF Accuracy**



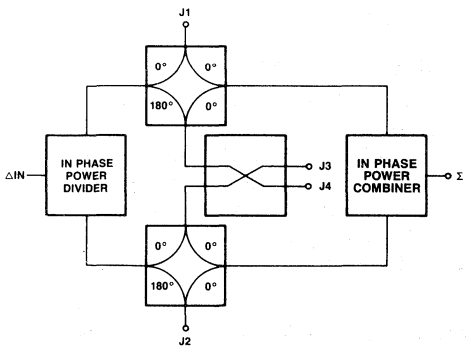
MONOPULSE BEAMFORMER

FEATURES
- **Frequency: A to C-Band**
- **Loss: <1 dB**
- **Isolation: >23 dB**
- **VSWR: <1.3:1**
- **Computer Aided Network Design**



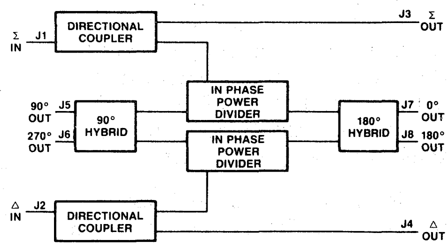
SPACE QUALIFIED BEAMFORMER

FEATURES
- **Octave Bandwidth**
- **Low Loss**
- **Phase Tracking ≤8°**
- **Null Depth > −30 dB**



NAVIGATION GUIDANCE BEAMFORMER

FEATURES
- **Small 1" x 1" Flatpack**
- **Hi Rel Qualified**
- **Optimized For IF Frequencies**



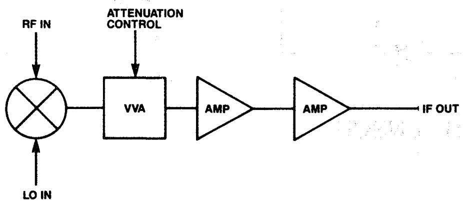
AIRBORNE/SEEKER BEAMFORMER

UP AND DOWN CONVERTER FRONT-ENDS

M/A-COM's thick and thin film process technologies are combined with MIC and packaging experience to produce multifunctional up and down converter supercomponents and subsystems.

Applications include receivers used in EW, radar, navigation, guidance, communication and ground support equipment, Digital RF Memories (DRFM's), test and measurement equipment, etc.

FEATURES
- **Input Frequency: 40% BW, C-Band**
- **IF Frequency: HF to L-Band**
- **Output Power: +16 dBm**
- **−40 dBC In Band Spurious and Harmonics**
- **Linear Attenuation: +15 dB**

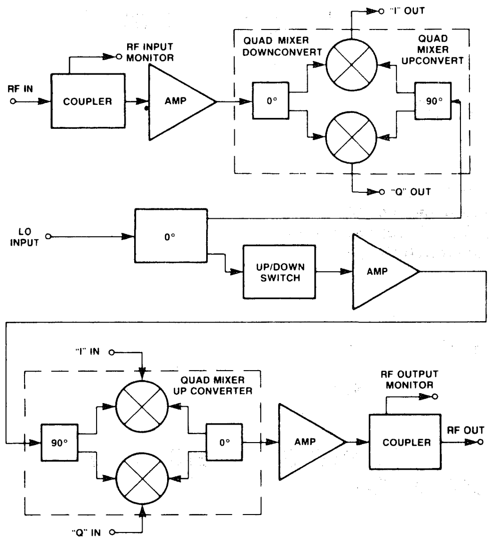


C-BAND DOWN CONVERTER

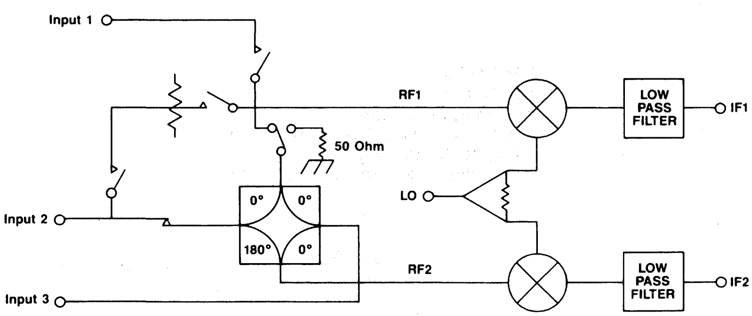
FEATURES
- **Channel-to-Channel Tracking of 5° and 0.5 dB**
- **Isolation: >50 dB**
- **Designed for Severe Airborne Environment**
- **L-Band RF, S-Band LO and P-Band IF**

This down converter features switched inputs and a test port on the RF with a high isolation pin diode switch module. The 180° hybrid has amplitude balance of 0.1 dB typical with 1° phase accuracy typical. The mixer/filter outputs are phase and amplitude matched with the filters providing LO and RF isolation >50 dB.

FEATURES
- **Frequency: C and D-Band**
- **Image Rejection: >20 dB**
- **High Dynamic Range**
- **Pulse/CW Operation**

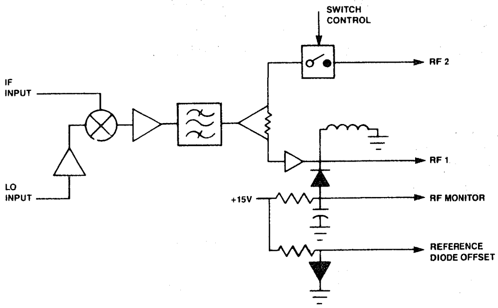


EW/DRFM UP/DOWN CONVERTERS



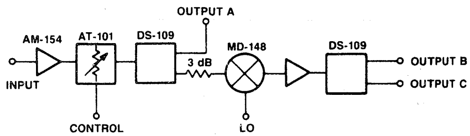
NAVIGATION/GUIDANCE DOWN CONVERTERS

FEATURES
- Compact Packaging
- 30 dB Image Rejection
- Switched Output has 55 dB Isolation



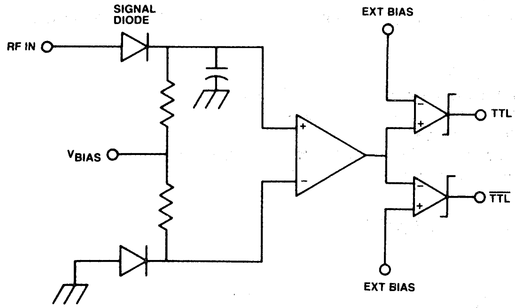
IF CONVERTER

FEATURES
- Frequency to E-Band
- Broadband/Narrowband IF's
- Low Noise/High Output Amplitude
- >30 dB Attenuation Range



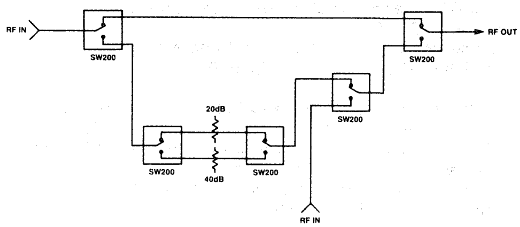
COMMUNICATIONS SYSTEM ATTENUATOR/ DOWN CONVERTER

FEATURES
- IF Frequency Range
- Temperature Compensated
- Fast Rise Time: < 50 ns



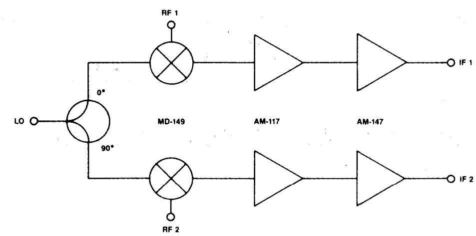
POWER SENSOR

FEATURES
- Wide Bandwidth
- Low Current: < 5 mA
- Fast Switching: < 50 ns



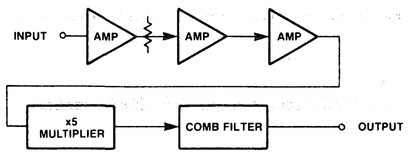
SWITCHED ATTENUATOR

FEATURES
- L-Band Inputs
- Quadrature IF Outputs
- +15 dBm typical 1 dB Compression
- Amplitude Tracking
- Low Risk – Features Standard Components



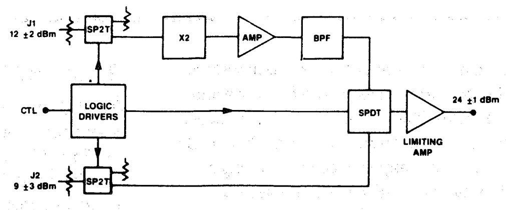
DUAL CHANNEL DOWNCONVERTER

FEATURES
- **Input Freq: C-Band**
- **Output Freq: 3,600-3,850 MHz**
- **Output Power: +13 dBm**
- **Spurious Outputs: <80 dBc**



TRANSMITTER/RECEIVER MULTIPLIERS

FEATURES
- **Output Power: +24 dBm ±1 dB**
- **J1/J2 to J3 Isolation: 90 db**
- **Spurious Outputs: −60 dBC**
- **Phase Noise @ 1 KHz from Carrier: −145 dBc/Hz**
- **Size: 3.2″ x 1.25″ x 0.3″**



MULTIPLIER MULTI-FUNCTION ASSEMBLY

Space Qualified Components

Overview

In the environment of space, your system must perform perfectly the first time and every time. There are no second chances, no repairs and no replacements. M/A-COM has extensive experience in providing a wide variety of RF and microwave components, connectors and subsystems for major space applications, where reliability is of critical importance. The M/A-COM Space Center production area is the focal point of this activity. The Space Center is located in our Lowell, Massachusetts facility and is dedicated exclusively to the manufacture and test of space-qualified hardware.

The Space Center also plays a major role in managing the overall space-related activity for M/A-COM. The center provides Hi-rel design expertise and program management to other M/A-COM divisions supporting the space community.

M/A-COM is a leading worldwide producer of RF, microwave and millimeter wave devices, components and subsystems for the defense and commercial industries. A high level of vertical integration, along with a focus on both standard and custom designed products, enhances our ability to service our customers with versatility and high quality.

M/A-COM uses dedicated production facilities to service the specialized needs of the space community. We have applied expertise in such areas as product design, material selection, process control, documentation and program management in a dedicated production area. Additional M/A-COM engineering and manufacturing resources, along with full environmental testing capabilities and a worldwide field sales and service network, combine to enhance the Space Center's capabilities.

Technical Expertise

The M/A-COM Space Center offers space-qualified versions of the M/A-COM product spectrum, including:

- GaAs MMIC Devices
- Thick and Thin Film Hybrids
- RF and Microwave Components
- Multi-Function Subassemblies
- Hi-Reliability Microwave Connectors

Our space center personnel specialize in meeting the stringent reliability standards for space hardware. We integrate material selection and process control into the initial design and can adapt our designs and processes to meet a wide range of reliability requirements. We are experienced in defining Class-B and Class-S requirements to support the OEM's commercial or military payload applications.

M/A-COM has extensive experience in designing and manufacturing multi-function subassemblies. The Space Center capitalizes on this expertise by providing space-qualified subassemblies. These products offer a number of RF and microwave active and passive functions within a single module, providing the user with better utilization of size and weight, lower cost and improved reliability compared to components purchased separately.

Manufacturing and Quality Assurance

M/A-COM uses state-of-the-art technology in designs and implements special control processes to provide performance that will endure the most severe launch and environmental conditions associated with space flight. We established the Space Center's manufacturing system in 1985 to meet the demanding process control and documentation requirements for space hardware. We perform assembly and test in Class 10,000 clean rooms, with certain workstations capable of meeting Class 100 standards. All manufacturing and material handling has ESD protection per MIL-STD-1686. The test laboratory includes both manual and automated testing for RF and microwave products. The overall system has been audited and approved to MIL-Q-9858A by a number of domestic and international customers and we have been approved to manufacture product for Space Station Freedom.

The M/A-COM Space Center has complete capabilities for producing both thick and thin film hybrid components with surface mounting of gallium arsenide monolithic microwave integrated circuits (GaAs MMICs). We assure cleanliness, accuracy and survivability of all devices processed by the Space Center through the use of the latest equipment--from cleanliness testing, laser trimming and programmable substrate furnaces to liquid-to-liquid thermal shock and particle impact noise detection (PIND).

We have designed and documented all our processes to be fully compliant with the latest industry standards. All of our assemblers and inspectors are certified to MIL-STD-2000 and other NASA standards.

M/A-COM performs a wide range of environmental screening, including:

- Temperature Cycling
- Temperature Shock
- Altitude Testing
- Shock Testing
- Constant Acceleration
- PIND Testing
- Group A, B, C and D Testing

M/A-COM's Reliability Analysis Lab can provide detailed reports and photographs generated from microscopical examination of all plating thicknesses, dimensions and internal workmanship of finished products.

Other specialized tests such as SEM and radiation testing are readily performed either at M/A-COM or through local certified test facilities.

Program Experience

Military Programs

MILSTAR
- Low Noise Amplifiers
- Logarithmic Amplifiers

RSP
- Mixers

FLTSATCOM
- Low Noise Amplifiers
- Mixers

GPS
- Mixers
- PIN Diode Switches

CLASSIFIED
- IF Processing Subassembly
- Low Noise Amplifiers
- Digital Attenuators
- Mixers
- Beamforming Module
- QPSK Modulators
- Power Dividers

HELIOS
- 5-Bit Digital Attenuator

Commercial Programs

INMARSAT III
- Dual 3 x 1 GaAs MMIC Switch Modules
- SP2T, SP3T and SP5T GaAs MMIC Switches
- RF Mixer
- 3-Bit GaAs Digital Attenuators

M-SAT
- SAW Filter Board Assembly
- 8-Way Power Divider
- Buffer Amplifier
- 3-Bit GaAs Digital Attenuators
- Hybrid Mixer/LO Driver Amplifier
- RF Mixer

RADARSAT
- 5-Bit Digital Attenuators

SOLIDARIDAD
- PIN Diode Digital Attenuator

TELCOM 2
- Digital Attenuators
- Mixers
- Quadrature Hybrids
- Power Hybrids

ITALSAT
- Power Dividers
- Mixers
- Quadrature Hybrids

INTELSAT III
- Mixers

Scientific Programs

ERS
- Digital Attenuator
- Quadrature Hybrid

MARS OBSERVER
- Mixers

METEOSAT
- Mixers
- Power Dividers
- Couplers

SPACE STATION
- Transfer Switch
- RF Amplifiers

Hi-Rel Connectors and Passive Microwave Components
- All Major Commercial and Government Programs

Low Noise Amplifiers Space Qualified

AM-S500X Series

Electrical Specifications

Part #	AM-S5001	AM-S5002	AM-S5003	AM-S5004	AM-S5005	AM-S5006
Frequency Range	20–60 MHz	60–100 MHz	100–176 MHz	154–322 MHz	288–576 MHz	520–900 MHz
Gain	21.0 dB ±0.9	27.0 dB ±0.9	3.5 dB ±0.9	34.0 dB ±0.9	35.0 dB ±1.1	38.0 dB ±1.2
Gain Variations	0.6 dB	0.6 dB	0.6 dB	0.6 dB	0.6 dB	0.6 dB
Noise Figure	1.7 dB	1.9 dB	1.9 dB	1.7 dB	2.0 dB	2.5 dB
RF Input Power, max	–12 dBm	–2 dBm	+3 dBm	+9 dBm	+14 dBm	+16 dBm
Reverse Isolation	23 dB	32 dB	45 dB	44 dB	40 dB	40 dB
Output Intercept IP3	29 dBm	32 dBm	31 dBm	31 dBm	32 dBm	30 dBm
Supply Current	55 mA	70 mA	115 mA	110 mA	110 mA	115 mA
Supply Voltage	+18V	+18V	+18V	+18V	+18V	+18V

Specifications Subject to Change Without Notice.

Low Noise Amplifiers Space Qualified

AM-S502X Series

Electrical Specifications

Part #	AM-S5022	AM-S5023	AM-S5024	AM-S5025	AM-S5026	AM-S5027
Frequency Range	20–100 MHz	100–190 MHz	170–360 MHz	320–670 MHz	630–1250 MHz	1150–2100 MHz
Gain	27 ±1.0 dB	27 ±1.0 dB	27 ±1.0 dB	27 ±1.0 dB	31 ±1.3 dB	31 ±1.3 dB
Gain Variation	0.7 dB	0.8 dB	0.7 dB	0.7 dB	0.8 dB	0.8 dB
Noise Figure	1.5 dB max	1.9 dB max	1.9 dB max	1.9 dB max	1.7 dB max	1.7 dB max
RF Input Power, max	+10 dBm	+10 dBm	+10 dBm	+10 dBm	+10 dBm	+10 dBm
Reverse Isolation	30 dB min	38 dB min	38 dB min	38 dB min	45 dB min	45 dB min
Output Intercept IP2	36 dBm	36 dBm	36 dBm	36 dBm	35 dBm	35 dBm
Output Intercept IP3	25 dBm	25 dBm	25 dBm	25 dBm	25 dBm	28 dBm
Power Consumption (2)	1.3 W	1.1 W	1.1 W	1.1 W	2.0 W	2.0 W
Supply Voltage	+18V	+18V	+18V	+18V	+8V	+8V
Supply Current	72 mA	61 mA	61 mA	61 mA	250 mA	250 mA

Specifications Subject to Change Without Notice.

Logarithmic Amplifiers Space Qualified

LA-5XX Series

Electrical Specifications

Part #	LA-514
Frequency Range	130–170 MHz
Input Dynamic Range	0 to –70 dBm
Video Output	
Input @ –70 dBm	150 mV ±25 mV
Input @ 0 dBm	1.900 V ±25 mV
VSWR	
RF Input	1.8:1 Max
IF Output	2.0:1 Max
IF AM/PM	3°/dB Max
Log Output	
Linearity	±1.0 dB Max
Rise Time	8.5 nS Max
Fall Time	80 nS Max
Absolute Propagation Delay	20 nS Max
Propagation Delay Variation	3.5 nS Max for Range –70 to –15 dBm
RF Leakage @ Video Output	30 mV p-p
Video Output Variation (40 MHz Bandwidth-All Power Inputs)	25 mV Max
Bias Power	
Positive	+15 ±3% Vdc (90 mA Max)
Negative	–15 ±3% Vdc (165 mA Max)
Max RF Input	+10 dBm
Package — Flatpak	1.000" x 2.300"

Part #	LA-528
Frequency Range	675–825 MHz
Input Dynamic Range	–65 to 0 dBm
VSWR	
RF Input	2.0:1 Max
IF Output	
Tangential Sensitivity	–65 dBm Min
Video Load Impedance	93 Ohms
Log Output	
Linearity	±1.5 dB Max
Rise Time	20 nS Max
Fall Time	80 nS Max
Slope	25 mV/dB Nom
Amplitude Flatness vs. Freq and Temp	±2.0 dB
Voltage Range	0 to 1.6V Min
Bias Power	
Positive (45 mA Max)	+12 ±3% Vdc
Negative (160 mA Max)	–12 ±3% Vdc
Max RF Input	+10 dBm
Package — Flatpak	1.000" x 2.300"

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Non-Destructive Bond Pull	Mil-Std-883C	2023	
Internal Visual	Mil-Std-883C	2017	
Stabilization Bake	Mil-Std-883C	1008	C
Temperature Cycling	Mil-Std-883C	1010	C
Constant Acceleration	Mil-Std-883C	2001	A
PIND	Mil-Std-883C	2020	A
Interim Electrical	Per Detail Spec		
High Temp Burn-in (320 Hours)	Mil-Std-883C	1015	A–E
Final Electrical	Per Detail Spec		
Seal Test			
Fine Leak	Mil-Std-883C	1014	A or B
Gross Leak	Mil-Std-883C	1014	C
Radiographic	Mil-Std-883C	2012	
External Visual	Mil-Std-883C	2009	

Quality Conformance Testing			
Group B			
Physical Dimensions	Mil-Std-883C	2016	
PIND	Mil-Std-883C	2020	A
Resistance to Solvents	Mil-Std-883C	2015	
Internal Visual & Mechanical	Mil-Std-883C	2014	
Bond Strength	MIl-Std-883C	2011	C or D
Die Shear Strength	Mil-Std-883C	2019	
Solderability	Mil-Std-883C	2003	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Electrical Tests	Per Detail Spec		
ESD Sensitivity	Mil-Std-883C	3016	A-1
Electrical Tests	Per Detail Spec		
Group C			
External Visual	Mil-Std-883C	2009	
Temperature Cycling	Mil-Std-883C	1010	C
Acceleration	Mil-Std-883C	2001	A
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Radiographic	Mil-Std-883C	2012	
External Visual	Mil-Std-883C	1010	
Electrical Tests	Per Detail Spec		
Operating Life (1000 Hours)	Mil-Std-883C	1005	
Group D			
Thermal Shock	Mil-Std-883C	1011	B
Stabilization Bake	Mil-Std-883C	1008	C
Lead Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A or B
Gross Leak	Mil-Std-883C	1014	C

Specifications Subject to Change Without Notice.

M/A-COM

RF Cascadeable Amplifiers Space Qualified

AM-Series

Electrical Specifications

Part #	AM-1057	AM-1064	AM-1067	AM-1081	AM-S5029	AM-S5037
Frequency Range	10–1000 MHz	10–1024 MHz	10–1000 MHz	2–22 MHz	335-970 MHz	335-970 MHz
Gain	15.7 ±0.7 dB	12.2 ±1 dB	15 dB Min	13.0 ±0.5 dB	12.0±0.8 dB	15.4±1.4 dB
Frequency Response	±1.0 dB Max	±1.0 dB Max	±1.0 dB Max	±0.4 dB Max	±0.25 dB	±0.35 dB
Gain Variation w/Temp	±1.0 dB Max	±1.0 dB Max	±1.25 dB Max	±0.8 dB Max	+0.4 dB -1.0 dB	±0.7 dB
Output Power (1 dB comp)	–3 dBm Min	+12 dBm Min	+7 dBm Min	+12 dBm Min	-2 dBm Min +4 dBm Max	-3 dBm Min
Noise Figure	3.7 dB Max	5.0 dB Max	4.2 dB Max	5.0 dB Max	4.5 dB Max	3.3 dB Max
Reverse Transmission	–17 dB Max –20 dB Typ	–14 dB Min –17 dB Typ	–17 dB Max –20 dB Typ	— —	— —	— —
VSWR	2.0:1 Max	1.8:1 Max	2.5:1 Max	1.8:1 Max	1.7:1 Max	1.7:1 Max
Intermodulation						
Second Order	+11.5 dB Min	+37 dB Min	+26 dBm Min	—	—	—
Third Order	+8.5 dB Min	+25 dB Min	+19 dBm Min	—	—	—
Bias Power	+15 Vdc 12.5 mA Max	+15 Vdc 43 mA Max	+15 Vdc 29 mA Max	+15 Vdc 43 mA Max	+5 Vdc 12 mA Max	+15 Vdc 12.5 mA Max
Impedance	50 Ohms	50 Ohms	50 Ohms	50 Ohms	50 Ohms	50 Ohms
Max RF Input	+10 dBm	+10 dBm	+10 dBm	+10 dBm	+5 dBm	+7 dBm
Package	TO–8	TO–8	TO–8	TO–8	TO–8	TO–8

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
High Temp Burn-In (240 Hours)	Mil-Std-883C	1015	B, D, or E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Operating Life (1000 Hours)	Mil-Std-883C	1015	B, D, or E

* Qualification testing was successfully performed on the AM-1067.
The AM-1057, AM-1064, AM-1081, AM-S5029 and AM-S5037 were qualified by similarity to the AM-1067.

Buffer Amplifiers for SAW Filter Banks
Space Qualified

AM-S502X Series

Electrical Specifications

Part #	AM-S5020	AM-S5021
Description	Input Filter Amplifier	Output Filter Amplifier
Frequency Range	265–300 MHz	265–300 MHz
Gain	17.0 dB	17.0 dB
Gain Var vs Temp	1.5 dB max	1.0 dB max
Noise Figure	6.5 dB max	3.5 dB max
Reverse Isolation	40 dB min	22 dB min
IP3 Output	+18 dBm min	+18 dBm min
VSWR	1.2:1	1.2:1
On/Off Control	TTL	TTL
Current +5V On +5V Off –5V On/Off	 28 mA 3 mA 2 mA	 19 mA 3 mA 2 mA

Specifications Subject to Change Without Notice.

M/A-COM

GaAs MMIC Digital Attenuators Space Qualified

AT-S500X Series

Electrical Specifications

Part #	AT-S5007	AT-S5008	AT-S5009
Description	**3 Bit, Thick Film with TTL Driver**	**3 Bit, Thin Film with No Driver**	**3 Bit, Thin Film with No Driver**
Frequency Range	265–300 MHz	120–1700 MHz	120–1700 MHz
Attenuation Steps	2.5 dB Steps	1, 8, 16 dB[1]	2, 4, 16 dB[1]
Attenuation Flatness	0.1 dB	0.1 dB[1]	0.1 dB[1]
Attenuation Accuracy	0.1 dB	0.2 dB	0.2 dB
VSWR	1.2:1	1.3:1	1.3:1
Switching Time	1.0 µsec max	1.0 µsec max	1.0 µsec max
1 dB Comp Point	+10 dBm min	+20 dBm min	+20 dBm min
IP3	≥30 dBm	≥30 dBm	≥30 dBm
Control/Power	60 mW	100 µA @ –5V 20 µA @ 0V	100 µA @ –5V 20 µA @ 0V
Weight	7.4 Grams	1.0 Gram	1.0 Gram

1 Over any 40 MHz Bandwidth.

Specifications Subject to Change Without Notice.

Digital Attenuators Space Qualified

AT-5XX Series

Electrical Specifications

Part #	AT-537
Frequency Ra<None>nge	20–600 MHz
VSWR	1.5:1 Max
Insertion Loss (REF)	5.5 dB Max
Input Power for 1dB Comp	+10 dBm Min
Inter Mod Intercept	
Second Order	
EA Weighted Bit	+30 dBm Min
for 31dB Total	+15 dBm Min
Third Order	
For Bits 0,1, 2 & 4	+20 dBm Min
For Bits 8, 16	+15 dBm Min
For 31dB Total	0 dBm Min
Attenuation	31 dB in 1 dB Steps
Attenuation Accuracy	±0.25 dB ±2%
Switching Time	
t On	12 μS
t Off	50 mS
Bias Voltage	+5 to +15 Vdc
Control Voltage	5 line CMOS Data Bus w/Internal Latch
Package	24 Pin DIP

Part #	AT-540
Frequency Range	60–100 MHz 900–1000 MHz
VSWR	1.6:1 Max
Insertion Loss (REF)	
60–100 MHz	5.5 dB Max
900–1000 MHz	7.5 dB Max
Attenuation	31 dB in 1 dB Steps
Attenuation Accuracy	
60–100 MHz	±0.25 dB ±2%
900–1000 MHz	±0.5 dB ±4%
Bias Voltage	+5 Vdc Min
Control Voltage	5 line CMOS Data Bus w/Internal Latch
Package	24 Pin DIP

Specifications Subject to Change Without Notice.

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AT-537

Test Step	Mil Spec	Method	Cond.
100% Screening			
Precap Visual	Mil-Std-883C	2017	
High Temp Storage	Mil-Std-883C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	A, Y1
PIND	Mil-Std-883C	2020	A or B
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Radiographic	Mil-Std-883C	2012	
Interim Electrical	Per Detail Spec		
High Temp Burn-In	Mil-Std-883C	1015	B, D, E
Final Electrical	Per Detail Spec		
External Visual	Mil-Std-883C	2009	

Quality Conformance Testing			
Group B			
Physical Dimensions	Mil-Std-883C	2016	
Marking Permanency	Mil-Std-883C	2015	
Internal Visual	Mil-Std-883C	2014	
Bond Strength	Mil-Std-883C	2011	D
Die Shear Strength	Mil-Std-883C	2019	
Solderability	Mil-Std-883C	2003	
Group C			
External Visual	Mil-Std-883C	2009	
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A or B
Gross Leak	Mil-Std-883C	1014	C
Radiographic	Mil-Std-883C	2012	
Visual	Mil-Std-883C	1010	
End Point Electrical	Per Detail Spec		
Internal Water Vapor	Mil-Std-883C	1018	

AT-540

Test Step	Mil Spec	Method	Cond.
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883 C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
High Temp Burn-In	Mil-Std-883C	1015	B, D, E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Testing*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Operating Life (1000 Hours)	Mil-Std-883C	1015	B, D, E

* The AT-540 was qualified by similarity to the SW-582.

RF Switches
Space Qualified

SW-58X Series

Electrical Specifications

Part #	SW-580 SPDT Switch	SW-582 Transfer Switch	SW-584 SP3T Switch	SW-581 Pulse Modulator	SW-583 Pulse Modulator
Frequency Range	5–1000 MHz	2 –100 MHz	5 –100 MHz	70 –900 MHz	900 –1000 MHz
Insertion Loss	1.3 dB Max	1.8 dB Max	1.4 dB Max	4.5 dB Max	4.5 dB Max
VSWR	1.6:1 Max	1.5:1 Max	1.6:1 Max	1.7:1 Max	1.7:1 Max
Isolation	40 dB Max	50 dB Max	40 dB Max	60 dB Max	55 dB Max
Switching Characteristics					
t On	2.0 mSec	—	2.0 mSec	—	—
t Off	1.0 mSec	—	1.0 mSec	—	—
Rise Time	—	—	—	2.4 mSec	2.0 mSec
Input Power	+13 dBm	0 dBm Max	+13 dBm	0 dBm Max	0 dBm Max
Bias Power	35 mA @ +9 to +15 V 35 mA @ –5 V	25 mA @ +12 to +15 V —	45 mA @ +9 to +15 V 25 mA @ –5 V	ON: +20 mA Max OFF: –20 mA Max	ON: +20 mA Max OFF: 0 to –20 mA Max
Package	14 Pin DIP	24 Pin DIP	16 Pin DIP	0.7 x 1.10 Flatpak	0.74 x 1.10 Flatpak

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
High Temp Burn-In (240 Hours)	Mil-Std-883C	1015	B, D, or E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Operating Life (1000 Hours)	Mil-Std-883C	1015	B, D, or E

* Qualification Testing was successfully performed on theSW-582.
The SW-580, SW-581, SW-583 and SW-584 were qualified by similarity to the SW-582.

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GaAs MMIC Switches Space Qualified

SW-S500X Series

Electrical Specifications

Part #	SW-S5004	SW-S5008	SW-S5007	SW-S5006
Description	DUAL 3 X 1 RF Switch	SPDT	SP3T	SP5T
Frequency Range	144–176 MHz	140–1570 MHz	1100–1180 MHz	1100–1180 MHz
Isolation	60 dB	38 dB	40 dB	40 dB
Phase Match	0.5° max	—	—	—
Amplitude Match	±0.1 dB max	—	—	—
Insertion Loss	10 dB[1]	1.0 dB	1.5 dB	1.5 dB
VSWR	1.3:1	1.3:1	1.3:1	1.3:1
Third-Order IMR	70 dBc	70 dBc	70 dBc	70 dBc
1 dB Comp Point	+20 dBm	+20 dBm	+20 dBm	+20 dBm
Control Power	200 μA @ –5V 20 μA @ 0V	100 μA @ –5V 20 μA @ 0V	200 μA @ –5V 20 μA @ 0V	200 μA @ –5V 20 μA @ 0V
Switching Speed	<1.0 μsec	<1.0 μsec	<1.0 μsec	<1.0 μsec
Overall Weight	1.9 Grams	1.0 Gram	1.9 Grams	1.9 Grams

1 RF Path of SW-S5004 includes a Resistive Power Combiner.

M/A-COM

Mixers
Space Qualified

MD-S50XX Series

Electrical Specifications

Part #		MD-S5007	MD-S5008	MD-S5010
Description		Mixer with LO Drive	RF Mixer	RF Mixer
Frequency Range	LO	800–2000 MHz	10–1000 MHz	1140–1190 MHz
	RF	200–1700 MHz	10–1000 MHz	1300–1650 MHz
	IF	200–1700 MHz	10–1000 MHz	160 MHz
Conversion Loss		8.0 dB max	8.0 dB max	7.5 dB max
Conversion Loss Variation vs LO Drive		0.1 dB max	—	0.2 dB max
VSWR		2.0:1 max	2.0:1 max	2.0:1 max
LO Power		–8 to –12 dBm	+7 dBm	+9 to +11.5 dBm
Isolation	LO–RF	7 dB min	25 dB min	35 dB min
	LO–IF	4 dB min	30 dB min	30 dB min
	RF–IF	22 dB min	30 dB min	30 dB min
RF Noise Figure		9.0 dB max	9.0 dB max	8.5 dB max
2-Tone IM Ratio		52 dBc min	40 dBc min	50 dBc min
Inband Spurious	2RF+2LO	–50 dBc min	—	—
	2RF+3LO	–50 dBc min	—	—
	3RF+2LO	–50 dBc min	—	—
1 dB Comp Point		+7 dBm min	—	—
Bias Current @ +5 Vdc		90 mA max	—	—

Specifications Subject to Change Without Notice.

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Double Balanced Mixers
Space Qualified

MD-12XX Series

Electrical Specifications

Part #	MD-1213	MD-1214	MD-1215	MD-1221	MDC-1216
Frequency Range					
RF	10–3000 MHz	10–150 MHz	10–1500 MHz	0.5–500 MHz	2.6–5.2 GHz
LO	10–3000 MHz	10–1500 MHz	10–1500 MHz	0.5–500 MHz	2.6–5.2 GHz
IF	DC–3000 MHz	DC–1500 MHz	DC–1500 MHz	0.5–500 MHz	DC–300 MHz
Conversion Loss	8.7 dB Max	11.0 dB Max	11.0 dB Max	7.0 dB Max	6.0 dB Max
Isolation					
LO to RF	25 dB Min	18 dB Min	18 dB Min	25 dB Min	20 dB Min
LO to IF	20 dB Min	10 dB Min	10 dB Min	20 dB Min	18 dB Min
RF to IF	18 dB Min	7 dB Min	7 dB Min	15 dB Min	20 dB Min
RF Input					
1 dB Compression	+7 dBm	0 dBm	0 dBm	+2 dBm	+2.5 dBm
1 dB Desensitization	+5 dBm	–2 dBm	–2 dBm	–2 dBm	0 dBm
SSB Noise Figure	8.7 dB Max	11 dB Max	11 dB Max	7 dB Max	6 dB Max
Max Input Power (at +25°C)	600mW	300mW	300mW	150mW	300mW
VSWR					
RF Port	4.0:1 Max	2.0:1 Max	2.0:1 Max	2.8:1 Max	3.4:1 Max
LO Port	6.0:1 Max	2.0:1 Max	2.0:1 Max	2.8:1 Max	8.0:1 Max
IF Port	6.5:1 Max	1.8:1 Max	1.8:1 Max	3.0:1 Max	2.25:1 Max
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
Two Tone IM Ratio	56 dB Min	—	—	40 dB Min	—
Package	0.385" x 0.510" Flatpak	0.385" x 0.510" Flatpak	12-Lead T0–8	0.385" x 0.510" Flatpak	1.14" x 0.93" x 0.39" SMA Conn

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883 C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
High Temp Burn-In (240 Hours)	Mil-Std-883C	1015	B, D, or E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Operating Life (1000 Hours)	Mil-Std-883C	1015	B, D, or E

* Qualification was successfully performed on the MDC-1216.
The MD-1213, MD-1214, MD-1215 and MD-1221 were qualified by similarity to the MDC-1216.

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Double Balanced Mixers Space Qualified

MD-135X Series

Electrical Specifications

Part #	MD-1355	MD-1356	MD-1357
Frequency Range			
RF	1800–2200 MHz	5–1000 MHz	5–500 MHz
LO	1800–2200 MHz	5–1000 MHz	5–500 MHz
IF	100–150 MHz	DC–1000 MHz	DC–500 MHz
Conversion Loss	9.5 dB Max	7.5 dB Max	
Isolation			
LO to RF	25 dB Min	30 dB Min	25 dB Min
LO to IF	10 dB Min	25 dB Min	25 dB Min
RF to IF	12 dB Min	20 dB Min	20 dB Min
RF Input	300 mW Max	0 dBm	400 mW Max
Noise Figure	—	7 .5 dB Max	7.5 dB Max
Two Tone IM Ratio	36 dB Min	45 dB Min	—
Package	0.385" x 0.510" Flatpak	0.385" x 0.510" Flatpak	0.385" x 0.510" Flatpak

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Internal Visual Inspection	Mil-Std-883C	2017	
External Visual Inspection	Mil-Std-883C	2009	
Initial Electrical	Per Detail Spec		
Thermal Shock	Mil-Std-883C	1010	B
Vibration	Mil-Std-883C	2007	B
Interim Electrical	Per Detail Spec		
High Temp Burn-In (240 Hours)	Mil-Std-883C	1015	B, D, or E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Test Step	Mil Spec	Method	Condition
Quality Conformance Tests			
Soldering Heat	Mil-Std-202	210	C
Thermal Shock	Mil-Std-883C	1011	B
Mechanical Shock	Mil-Std-883C	2002	A
Vibration	Mil-Std-883C	2007	B
Electrical Measurements	Per Detail Spec		
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Internal Visual	Mil-Std-883C	2017	
Operating Life (1000 Hours)	Mil-Std-883C	1015	B, D, or E
2000 Hours for QUAL			
1000 Hours for VOQ			

Double Balanced Mixers
Space Qualified

MD-1058 Series

Electrical Specifications

Part #	MD-1058
Frequency Range	
LO Ports	2352–3550 MHz
RF Ports	1890–4010 MHz
IF Ports	448–470 MHz
LO Power	+17 ±1.5 dBm
Conversion Loss REF to Input	7.5 dB Max
Conversion Loss Var w/ Frequency	0.7 dB Max
Isolation	
LO to RF	18 dB Min
LO to IF	20 dB Min
RF to IF	12 dB Min
VSWR	
LO Ports	2.5:1 Max
RF Ports	3.0:1 Max
IF Ports	2.5:1 Max
Third Order Intercept Point	+17 dBm
Conversion Compression	+1 dBm
Spurious Products	
2Rx-2L RF @ –15 dBm	45 dBc
–2Rx2L RF @ –15 dBm	45 dBc
4Rx-3L RF @ +0 dBm	50 dBc
Package Style — Flatpack	0.740" x 1.100"

Specifications Subject to Change Without Notice.

Test	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Vibration	Mil-Std-202	204	B
Temperature Cycling	Mil-Std-202	107	A
Seal Test			
Fine Leak	Mil-Std-202	112	C
Gross Leak	Mil-Std-202	112	D
Interim Electrical	Per Detail Spec		
High Temp Burn-In (240 Hours)	Mil-Std-883C	1015	B, D, or E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
External Visual	Mil-Std-883C	2009	

Phase Modulators Space Qualified

PM-5XX Series

Electrical Specifications

Part #	PM-589	PM-591
Frequency Range	50–100 MHz	10–20 MHz
Insertion Loss	6.75 dB Max	6.7 dB Max
VSWR		
Input	1.4:1 Max	1.4:1 Max
Output	1.6:1 Max	1.7:1 Max
Amplitude Balance	0.5 dB Max	0.8 Max
Phase Deviation	70 MHz: 2.5° Max 50–100 MHz: 6.5° Max	15 MHz: 3.8° Max 10–20 MHz: 6.0° Max
Impedance	50 Ohm Max	50 Ohm Max
RF Input Level		
Operating	0 dBm Max	0 dBm Max
Non-Destruct	+20 dBm Max	+20 dBm Max
Carrier Suppression 70 MHz, 1 MHz Modulation	35 dB Typ	35 dB Typ
Package — Flatpak	0.385" x 0.510"	1.000" x 1.000"

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
High Temp Burn-in (240 Hours)	Mil-Std-883C	1015	B, D or E
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Operating Life (1000 Hours)	Mil-Std-883C	1015	B, D or E

* Qualification testing was successfully completed on the PM-591. The PM-589 was qualified by similarity to the PM-591.

M/A-COM

Power Dividers
Space Qualified

DS-Series

Electrical Specifications

Part #	DS-1177 Two-way	DS-1178 Two-way	DS-11880 Three-way
Frequency Range	10–500 MHz	10–2000 MHz	200–1024 MHz
Insertion Loss	0.8 dB Max	20–1000 MHz: 1.3 dB Max 1000–1500 MHz: 1.4 dB Max 1500–2000 MHz: 2.0 dB Max	1.3 dB Max
Isolation	25 dB Min	20–1000 MHz: 2.0 dB Min	18 dB Min
VSWR	Input: 1.5.1 Max Output: 1.4:1 Max	20–1000 MHz: 1.5:1 Max 1000–1500 MHz: 1.6:1 Max 1500–2000 MHz: 2.0:1 Max	Input: 1.4:1 Max Output: 1.7:1 Max
Amplitude Balance	0.2 dB Max	20–1000 MHz: 0.3 dB Max 1000–1500 MHz: 0.4 dB Max 1500–2000 MHz: 0.6 dB Max	0.4 dB Max
Phase Balance	2.0° Max	20–1000 MHz: 4.0° Max 1000–1500 MHz: 6.0° Max 1500–2000 MHz: 8.0° Max	4.0° Max
Impedance	50 Ohm	50 Ohm	50 Ohm
Input Power Rating	1.0W Max	250mW Max	1.0W Max
Internal Load Dissipation	50mW Max	50mW Max	50mW Max
Package: Flatpak	0.385" x 0.510"	0.385" x 0.510"	0.625" x 0.625"

Part #	DS-5000 Two-way	DS-S5001 Four-way
Frequency	0.4–400 MHz	0.5–100 MHz
Isolation	25 dB Min	25 dB Min
Insertion Loss (less coupling)	0.75 dB Max	0.5 dB Max
VSWR	1.5:1 Max	1.3:1 Max
Amplitude Balance	0.15 dB Max	0.2 dB Max
Phase Balance	1.0° Max	4.0° Max
Package Size — Flatpak	0.385" x 0.510"	0.810" x 0.810"

Specifications Subject to Change Without Notice.

DS-1177, DS-1178, DS-1180

Test Step	Mil Spec	Method	Cond.
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883 C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
Heat Soak Test	240 Hrs./+125°		C
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Heat Soak Test	1000 hrs @ +125°C C		

* The DS-1177, DS-1178 and DS-1180 were qualified by similarity to the HH-597.

DS-S5000 and DS-S5001

Test Step	Mil Spec	Method	Cond
100% Screening			
Internal Visual	Mil-Std-883C	2017	
Stabilization Bake	Mil-Std-883C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-202	212	C
PIND	Mil-Std-883C	2020	A or B
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Electrical Test @ Room	Per Detail Spec		
Electrical Test @ Temp	Per Detail Spec		
Visual Inspection	ESA Spec No. 20500		
PDA. Initial	Per Detail Spec		
High Temp Burn-In	240 Hrs @ +125°C		
Electrical Tests @ Temp	Per Detail Spec		
PDA, Final	Per Detail Spec		
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	ESA Spec No. 20500		

Quality Conformance Tests		
Endurance Subgroup		
Operating Life	240 Hours @ +125°	
Electrical Tests	Per Detail Spec	
Electrical Dimensional Subgroup		
Detail Dimensions	Per Detail Spec	
Mass	Per Detail Spec	
Marking	ESA Spec No. 21700	
Solderability	Mil-Std-202	208
Terminal Strength	Mil-Std-202	211
Electrical Tests @ Room	Per Detail Spec	
Electrical Tests @ Temp	Per Detail Spec	

Specifications Subject to Change Without Notice.

M/A-COM

Directional Coupler
Space Qualified

CH-704

Electrical Specifications

Part #		CH-704
Frequency Range		10–500 MHz
Coupling	(Input to Output)	19.6 to 21.8 dB
Coupling Flatness		±1.1 dB Max
VSWR	(All Ports)	1.4:1 Max
Directivity	(Both Directions)	18 dB Min
Main Line Loss	10–150 MHz 150–500 MHz	0.5 dB Max 0.7 dB Max
Input Power		3 W Max
Package—Flatpak		0.385" x 0.510"

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Test Step	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883 C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
Heat Soak Test	240 Hours @ +125°C		
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests*			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1004	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Heat Soak Test	1000 Hours @ +125°C		

* The CH-704 was qualified by similarity to the HH-597.

Quadrature Hybrids Space Qualified

JH-Series

Electrical Specifications

Part #	JH-708	JH-709
Frequency Range	4–21 MHz	900–1030 MHz
Insertion Loss	1 dB Max	0.5 dB Max
Isolation	18 dB Min	18 dB Min
Amplitude Balance	3 dB Max	1.2 dB Max
VSWR (All Ports)	1.25:1 Max	1.4:1 Max
Deviation from Quadrature	10° Max	5° Max
Impedance	50 Ohms Nom	50 Ohms Nom
Input Power	4 W Max @ +25°C	25 W Max @ +25°C
Coupling (A–C, A–D)	1.5–5.0 dB	1.2 dB
Package (Flatpak)	0.385" x 0.510"	0.385" x 0.510"

Part #	JH-S5000	JH-S5001
Frequency Range	7–14 MHz	40–80 MHz
Isolation	20 dB Min	20 dB Min
Insertion Loss (Less Coupling)	0.5 dB Max	0.5 dB Max
VSWR	1.2:1 Max	1.2:1 Max
Amplitude Balance	0.75 dB Max	0.75 dB Max
Phase Balance	3° Max	3° Max
Package (Flatpak)	0.385" x 0.510"	0.385" x 0.510"

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	
100% Screening			
Internal Visual	Mil-Std-883C	2017	
Stabilization Bake	Mil-Std-883 C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	212	C
PIND	Mil-Std-883C	2020	A or B
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Electrical Test @ Room	Per Detail Spec		
Electrical Test @ Temp	Per Detail Spec		
Visual Inspection	ESA Spec No. 20500		
PDA,. Initial	Per Detail Spec		
High Temp Burn-in	240 Hours @ +125ºC		
Electrical Tests @ Temp	Per Detail Spec		
PDA, FInal	Per Detail Spec		
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	ESA Spec No. 20500		

Quality Conformance Tests			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistence to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Heat Soak Test	1000 Hours @ +125ºC		

Test Step	Mil Spec	Method	
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
Heat Soak Test		240 Hrs. @ +125°C	
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
SealTest			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests			
Environmental Subgroup			
Shock	MilStd-202	204	D
Vibration	Mil-Std-202	213	C
Thermal Shock	Mil-Std-202	107	B
Moisture Resistance	Mil-Std-202	106	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Electrical Tests	Per Detail Spec		
External Visual	Per Detail Spec		
Endurance Subgroup			
Operating Life	240 Hours @ +125°		
Electrical Dimensional Subgroup			
Detail Dimensions	Per Detail Spec		
Mass	Per Detail Spec		
Marking	ESA Spec No. 21700		
Solderability	Mil-Std-202	208	
Terminal Strength	Mil-Std-202	211	
Electrical Tests @ Room	Per Detail Spec		
Electrical Tests @ Temp	Per Detail Spec		

* The JH-708 and JH-709 were qualified by similarity to the HH-597.

M/A-COM

180° Hybrid
Space Qualified

HH-597

Electrical Specifications

Part #		HH-597
Frequency Range		2–200 MHz
Insertion Loss (Less Coupling)	2–5 MHz 5–50 MHz 50–200 MHz	1.6 dB Max 1.0 dB Max 1.6 dB Max
Isolation		
A–B	2–200 MHz 5–50 MHz	25 dB Min 30 dB Min
C–D	2–200 MHz 5–50 MHz	30 dB Min 35 dB Min
Amplitude Balance		
A–C & A–D	2–5 MHz 50–200 MHz	0.5 dB Max 0.3 dB Max
B–C & B–D	2–5 MHz 50–200 MHz	0.3 dB Max 0.5 dB Max
VSWR	2–50 MHz 5–50 MHz 50–200 MHz	1.7:1 Max 1.5:1 Max 1.7:1 Max
Phase Balance		
A–C & A–D	2–5 MHz 5–200 MHz	4° Max 3° Max
B–C & B–D	2–5 MHz 5–200 MHz	3° Max 4° Max
Impedance		50 Ohm nom
Input Power Rating		1 W Max
Package—Flatpak		0.385" x 0.510"

Specifications Subject to Change Without Notice.

Test Step	Mil Spec	Method	Condition
100% Screening			
Initial Electrical	Per Detail Spec		
Stabilization Bake	Mil-Std-883 C	1008	B
Temperature Cycling	Mil-Std-883C	1010	B
Constant Acceleration	Mil-Std-883C	2001	B
PIND	Mil-Std-883C	2020	A or B
Interim Electrical	Per Detail Spec		
Heat Soak Test		240 Hours @ +125°C	
Final Electrical	Per Detail Spec		
Radiographic	Mil-Std-883C	2012	
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	

Quality Conformance Tests			
Group IIC			
Thermal Shock	Mil-Std-202	204	D
Temperature Cycling	Mil-Std-883C	1010	B
Moisture Resistance	Mil-Std-883C	1004	
Seal test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
Acceleration	Mil-Std-883C	2001	B
Vibration	Mil-Std-883C	2007	A
Seal Test			
Fine Leak	Mil-Std-883C	1004	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IIIC			
Resistance to Solvents	Mil-Std-883C	2015	
Solderability	Mil-Std-883C	2003	
Leads Integrity	Mil-Std-883C	2004	B2
Seal Test			
Fine Leak	Mil-Std-883C	1014	A
Gross Leak	Mil-Std-883C	1014	C
External Visual	Mil-Std-883C	2009	
Group IV			
Heat Soak Test		1000 Hours @ +125°C	

Specifications Subject to Change Without Notice.

M/A-COM

Linear Power Amplifiers

CPA Series

Features

- Amplifier packages available in the ADC, GSM and both PDC/JDC bands.
- Linearity can be further enhanced for custom applications.
- Single Channel and Multi-Carrier
- Custom packaging available.

Description

M/A-COM's single channel and multi-carrier Linear Power Amplifiers meet the demanding needs of higher capacity Digital Cellular and PCN systems. Enhanced linearity required to meet strict FCC mask requirements can be accomplished through the use of Feed Forward techniques.

Put M/A-COM on your team today to develop Power Amplifiers optimized to meet your exact needs. As a first step, these standard design amplifiers are available for evaluation in your facility.

Model Number	Frequency	Output Power (Average)	Gain	Operating Mode	Linearity	Supply Voltage (Vs)
CPA-112-CBA	869-894 MHz	43.0 dBm min	18 dB min	Class AB	IM3, -28 dBc max	24-26 volts
CPA-120-CBA	869-894 MHz	47.0 dBm min	24 dB min	Class AB	IM3, -28 dBc max	24-26 volts
CPA-113-CBA	925-960 MHz	43.0 dBm min	18 dB min	Class AB	IM3, -28 dBc max	24-26 volts
CPA-110-PBM	1805-1880 MHz	45.0 dBm min	7.5 dB min	Class AB	AM/PM max 1.0 deg/dB	24-25 volts
CPA-111-PBA	1805-1880 MHz	38.5 dBm min	29 dB min	Class AB	IM3, -25 dBc max	24-25 volts
CPA-114-PBA	1805-1880 MHz	43.0 dBm min	24 dB min	Class AB	IM3, -25 dBc max	23-24 volts
CPA-118-PAA	1750-3000 MHz	29.0 dBm min	23 dB min	Class A	AM/PM max 1.0 deg/dB	7-10 volts

869-894 MHz, P_{out} > 43 dBm Average

Specifications

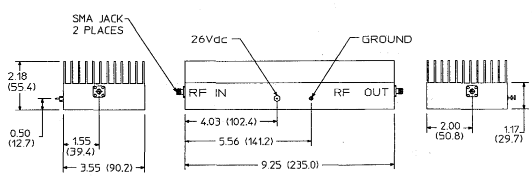
Parameter	
Frequency	869-894 MHz
Supply Voltage	24-26 volts
Supply Current	4 amperes max
Temperature	0° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_s = 26 V	43 dBm min
Gain	V_s = 26 V	18 dB min
Gain Flatness	F = 869-894 MHz	1 dB max
In/Out VSWR		1.5:1 max
Efficiency	P_{out} > 43 dBm average	25% min[1]
Harmonics		-35 dBc max
Phase Linearity	P_{out} = 1 to 43 dBm	1.5 °/dB
Intermodulation	P_{out} = 43 dBm average, Tone spacing = 100 KHz	-28 dBc max

NOTES:
1) Operating mode Class AB

CPA-112-CBA



Specifications Subject to Change Without Notice.

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869-894 MHz, P_{out} > 46 dBm Average

CPA-120-CBA

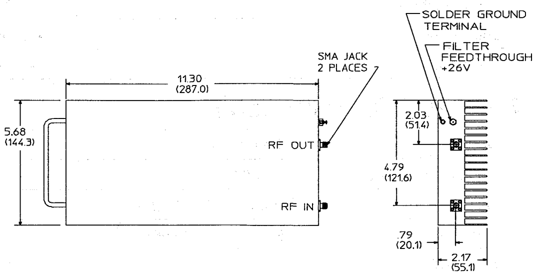
Specifications

Parameter	
Frequency	869-894 MHz
Supply Voltage	24-26 volts
Supply Current	7 amperes max
Temperature	0° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_s = 26 V	47 dBm min
Gain	V_s = 26 V	24 dB min
Gain Flatness	F = 869-894 MHz	1 dB max
In/Out VSWR		1.5:1 max
Efficiency	P_{out} > 46 dBm average	25% min[1]
Harmonics		-35 dBc max
Phase Linearity	P_{out} = 1 to 46 dBm	1.5 °/dB max
Intermodulation	P_{out} = 46 dBm average, Tone spacing = 100 KHz	-28 dBc max

NOTES:
1) Operating mode Class AB



925-960 MHz, P_{out} > 43 dBm Average

CPA-113-CBA

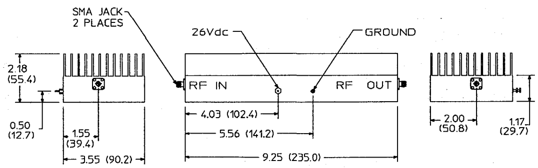
Specifications

Parameter	
Frequency	925-960MHz
Supply Voltage	24-26 volts
Supply Current	4 amperes max
Temperature	0° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_s = 26 V	43 dBm min
Gain	V_s = 26 V	18 dB min
Gain Flatness	F = 925-960 MHz	1 dB max
In/Out VSWR		1.5:1 max
Efficiency	P_{out} > 43 dBm average	25% min[1]
Harmonics		-35 dBc max
Phase Linearity	P_{out} = 1 to 43 dBm	1.5 °/dB max
Intermodulation	P_{out} = 43 dBm average, Tone spacing = 100 KHz	-28 dBc max

NOTES:
1) Operating mode Class AB



Specifications Subject to Change Without Notice.

1805-1880 MHz, P_{out} > 43 dBm Average

Specifications

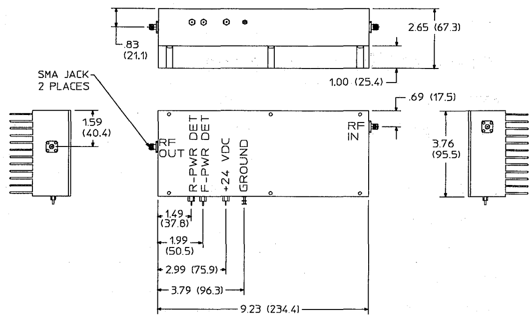
Parameter	
Frequency	1805-1880 MHz
Supply Voltage	24-25 volts
Supply Current	4 amperes max
Temperature	-10° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_s = 24 V	45 dBm min
Gain	P_{out} = +1 to +45 dBm	7.5 dB min
Gain Flatness	P_{out} = +1 to +45 dBm	1 dB max
In/Out VSWR		1.5:1 max
Efficiency	P_{out} > 43 dBm average	25% min[1]
Harmonics	2nd	30 dBc min
	3rd	50 dBc max
Output power detector		0.35 V/dBm max
Reverse output power detector		0.065 V/dBm max
Phase Linearity	P_{out} < 45 dBm	1.0 °/dB max
Reverse Intermodulation	P_{out} = 43 dBm cw, -13 dBm tone, 200 KHz offset, injected back into output	-70 dBc max -36 dBm max[2]

NOTES:
1) Operating mode Class AB
2) Output, whichever is higher

CPA-110-PBM



1805-1880 MHz, P_{out} > 36 dBm Average

Specifications

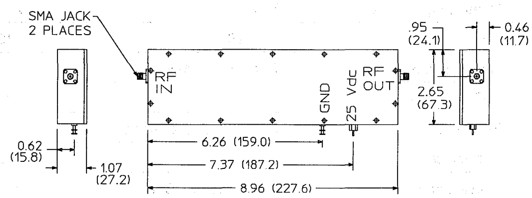
Parameter	
Frequency	1805-1880 MHz
Supply Voltage	24-25 volts
Supply Current	2 amperes max
Temperature	0° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_s = 24 V	38.5 dBm min
Gain	P_{out} = +1 to +38 dBm	29 dB min
Gain Flatness	P_{out} = +1 to +38 dBm	1 dB max
In/Out VSWR		1.5:1 max
Efficiency	P_{out} > 36 dBm average	15% min[1]
Harmonics		-60 dBc max
Phase Linearity	P_{out} = 1 to 39 dBm	1.0 °/dB max
Intermodulation	P_{out} = 36 dBm average, Tone spacing = 200 KHz	-25 dBc max

NOTES:
1) Operating mode Class AB

CPA-111-PBA



Specifications Subject to Change Without Notice.

1805-1880 MHz, P_{out} > 40 dBm Average

Specifications

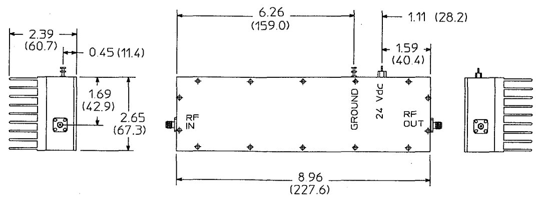
Parameter	
Frequency	1805-1880 MHz
Supply Voltage	23-24 volts
Supply Current	3 amperes max
Temperature	0° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_s = 24 V	43 dBm min
Gain	V_s = 26 V	18 dB min
Gain Flatness	F = 1805-1880 MHz	1 dB max
In/Out VSWR		1.5:1 max
Efficiency	P_{out} > 40 dBm average	25% min[1]
Harmonics		-35 dBc max
Phase Linearity	P_{out} = 1 to 40 dBm	1.5 °/dB max
Intermodulation	P_{out} = 40 dBm average, Tone spacing = 100 KHz	-25 dBc max

NOTES:
1) Operating mode Class AB

CPA-114-PBA



1750-3000 MHz, P_{out} > 30 dBm Average

Specifications

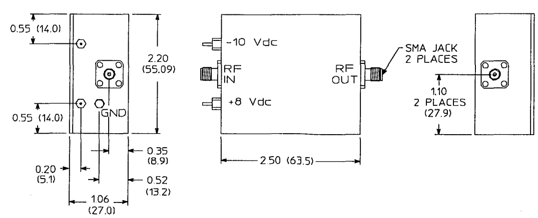
Parameter	
Frequency	1750-3000 MHz
Drain Voltage	7-10 volts
Gate Voltage[2]	-10.5 min/-9.5 max volts[2]
Drain Current	0.8 amperes max
Gate Current	40 mA max
Temperature	-10° to + 60°C

Electrical Characteristics

Parameter	Conditions	
Linear Output Power	V_{dd} = 9 V, V_{gg} = -10V	29 dBm min
Gain	P_{out} = 30 dBm	23 dB min[3,4]
Gain Flatness	P_{out} = 30 dBm	1 dB max
Input VSWR		1.3:1 max
Output VSWR		2:1 max
Phase Linearity	P_{out} < 30 dBm	1.0 °/dB max

NOTES:
1) Operating mode Class A
2) Gain varies by 0.04 dB/°C (decreases for increasing temperature)
3) Gain set by resistive input attenuator network. Up to 35 dB gain is available by changing component values
4) Units are supplied with voltage sequencer.
5) Units with up to +33 dBm output power are available on special order.

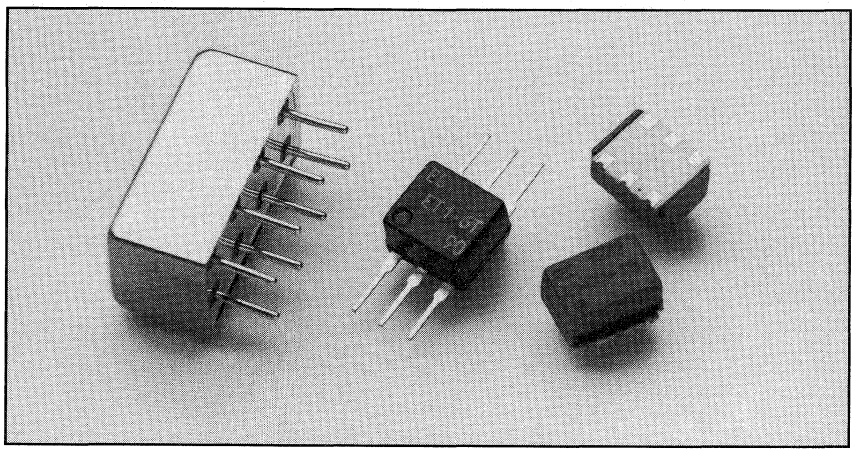
CPA-118-PAA



Specifications Subject to Change Without Notice.

Low Cost (E-Series) RF Components

Relay Header and Surface Mount



ISO 9001
Certified

Title **Page**

M/A-COM

	Freq. Range (LO-RF MHz)	LO Power (dBm)	RF Power Up To (dBm)	Package	Part No.	Page No.
New	0.05-200	+17	+10	Relay Header	EMA-3H	3-14
New	0.1-250	+17	+14	Relay Header	EMT-3H	3-16
	0.04-400	+7	+1	Relay Header	EMT-3	3-13
New	0.1-500	+7	+1	Relay Header	EMM-3	3-17
	0.5-500	+7	+1	Relay Header	EMA-1	3-18
	0.5-500	+7	+1	Surface Mount	EMRS-1	3-42
New	0.5-500	+17	+14	Surface Mount	EMRS-1H	3-41
New	0.5-500	+27	+24	Relay Header	EVAY-1	3-19
	1-500	+7	+1	Relay Header	EMS-1	3-20
New	1-500	+7	+1	Surface Mount	ESCM-1	3-50
New	2-500	+13	+9	Relay Header	EMT-1MH	3-24
New	2-500	+13	+9	Surface Mount	EMRS-1MH	3-43
New	2-500	+17	+14	Relay Header	EMK-1H	3-25
	5-500	+7	+1	Relay Header[1]	EMD-108	3-27
	5-500	+7	+1	Relay Header	EMS-500X1	3-28
New	1-600	+7	+1	Surface Mount	EASK-1	3-53
New	2-600	+17	+14	Relay Header	ETUF-1H	3-26
New	1-750	+7	+1	Relay Header	EMA-1W	3-21
	890-915	+17	+14	Surface Mount	ESMD-C2HX2	3-58
	1-1000	+7	+1	Relay Header	EMT-2	3-22
	1-1000	+7	+1	Surface Mount	ESMD-C1	3-54
	5-1000	+7	+1	Surface Mount	EMRS-2	3-45
	5-1000	+7	+1	Surface Mount	ESCM-2	3-51
	5-1000	+17	+14	Relay Header	EMT-2H	3-29
	10-1000	+7	+1	Relay Header	EMS-1X	3-35
New	10-1000	+7	+1	Surface Mount	EMRS-2D	3-49
New	50-1000	+7	+1	Relay Header	ETUF-2SM	3-40
	5-1200	+17	+14	Relay Header	EMA-173HX	3-30
New	5-1250	+17	+1	Relay Header	EMT-4	3-31
New	5-1500	+3	-1	Surface Mount	EMRS-5L	3-46

	Freq. Range (LO-RF MHz)	LO Power (dBm)	RF Power Up To (dBm)	Package	Part No.	Page No.
New	5-1500	+7	+1	Relay Header	EMT-5	3-32
New	5-1500	+7	+1	Surface Mount	EMRS-5	3-47
	20-1500	+7	+1	Surface Mount	ESMD-C2	3-55
New	0.05-2000	+10	+5	Relay Header	EMA-220	3-15
	1-2000	+7	+1	Relay Header	EMT-11	3-23
	5-2000	+3	-1	Surface Mount	EMRS-2L	3-44
	5-2000	+7	+1	Relay Header[2]	EMA-11	3-33
New	5-2000	+7	+1	Relay Header	EMS-11	3-34
	5-2000	+7	+1	Surface Mount	EMRS-11	3-48
	20-2500	+7	+1	Surface Mount	ESMD-C3	3-56
New	20-2500	+17	+14	Surface Mount	ESMD-C3H	3-57
New	500-2500	+7	+1	Surface Mount	ESCM-2500	3-52
	10-3000	+10	+5	Relay Header	EMT-15	3-38
New	10-3000	+13	+9	Relay Header	EMA-11MH	3-36
New	10-3000	+17	+10	Relay Header	EMA-11H	3-37
	10-4200	+13	+9	Relay Header	EMT-42MH	3-39

Notes:
1. 1 dB Compression Point = +2.5.
2. Hermetic

	Description	Carrier Freq. Range (MHz)	Package Type	Part No.	Page No.
	Modulator	30-50	Relay Header	EQKR8-40W	3-60
	Modulator	43-47	Relay Header	EQKR8-45	3-61
	Modulator	50-90	Relay Header	EQKR8-70W	3-62
	Modulator	86-95	Relay Header	EQKR8-91	3-64
	Modulator	60-120	Relay Header	EQKR8-90W	3-63
	Modulator	90-150	Relay Header	EQKR8-120W	3-65
	Modulator	147-175	Relay Header	EQKR8-160W	3-66
New	Modulator	830-850	Surface Mount	EKIN2-840	3-67
New	Modulator	869-894	Surface Mount	EKIN2-880	3-68
New	Modulator[1]	869-894	Surface Mount	EQKS8-880	3-69
	Modulator[1]	890-915	Relay Header	EQKR8-900	3-70
New	Modulator	925-960	Leaded SMT	EKIN-960	3-71
	Modulator[2]	925-960	Surface Mount	EQKS8-960	3-72
New	Modulator	925-960	Surface Mount	EKIN2-960	3-73
New	Modulator	1074-1090	Surface Mount	EKIN-1082	3-74
New	Demodulator	10	Surface Mount	EKIN-10D	3-75
New	Demodulator, 1.5 VSWR	70.2	Surface Mount	EKIN-70D	3-77
	Demodulator	70.2	Surface Mount	EQKS8-70D1	3-78
New	Demodulator	200-225	Surface Mount	EKIN-222.5D	3-76

Notes:
1. Suitable for GSM, TACS, NMT-900 receivers.
2. Suitable for GSM, TACS, NMT-900 transmitters.

Low Cost (E-Series) RF Power Dividers/Combiners

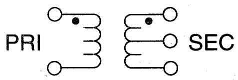
	Description	Freq.Range (LO-RF MHz)	Package Type	Part No	Page No
	2-Way 0 Splitter/Combiner	0.1-400	Relay Header	ES-2-1	3-84
New	2-Way 0 Splitter/Combiner	0.1-400	Surface Mount	ES-2-1X1	3-87
New	2-Way 0 Splitter/Combiner	0.1-450	Relay Header	ESM-2-1	3-85
	2-Way 0 Splitter/Combiner	1-400	Relay Header	EST-2-1	3-86
New	2-Way 0 Splitter/Combiner	10-1000	Surface Mount	ES-2-4X1	3-88
New	2-Way 90 Splitter/Combiner	40-70	Relay Header	ESQ-2-70	3-89
New	2-Way 90 Splitter/Combiner	40-70	Surface Mount	ESQ-2-70X1	3-91
	2-Way 90 Splitter/Combiner	55-90	Relay Header	ESQ-2-90	3-90
New	2-Way 90 Splitter/Combiner	120-180	Surface Mount	ESQ-2-180X1	3-92
New	2-Way 90 Splitter/Combiner	820-980	Surface Mount	ESQ-2-900X1	3-93
	2-Way 90 Split./Comb., High Perf.	820-980	Surface Mount	EQSM-2-900	3-94
New	3-Way 0 Splitter/Combiner	1-200	Relay Header	ES-3-1	3-95

Low Cost (E-Series) RF Directional Couplers

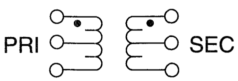
Description	Freq.Range (LO-RF MHz)	Package Type	Part No.	Page No.
10 dB Directional Coupler	1-400	Relay Header	ETDC-10-1	3-97
11.5 dB Directional Coupler	0.5-500	Relay Header	EPDC-10-1	3-96
10 dB Directional Coupler	930-960	Surface Mount	ESDC-10-1	3-98

	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
New	0.03-75	16	Surface Mount	ET16-6T-SM1	3-110
New	0.03-75	16	Leaded Surface Mount	ET16-6T-SM5	3-110
New	0.03-75	16	Gull Winged SMT	ET16-6T-SM20	3-110
New	0.03-75	16	PIN Surface Mount	ET16-6T-SM21	3-110
	0.03-140	8	Surface Mount	ET8-1T-SM1	3-112
	0.03-140	8	Leaded Surface Mount	ET8-1T-SM5	3-112
	0.03-140	8	Gull Winged SMT	ET8-1T-SM20	3-112
	0.03-140	8	PIN Surface Mount	ET8-1T-SM21	3-112
	0.05-200	1	Surface Mount	ET1-1T-SM1	3-116
	0.05-200	1	Leaded Surface Mount	ET1-1T-SM5	3-116
	0.05-200	1	Gull Winged SMT	ET1-1T-SM20	3-116
	0.05-200	1	PIN Surface Mount	ET1-1T-SM21	3-116
New	0.05-200	1	Relay Header	ETM01-1T	3-114
	0.02-250	4	Surface Mount	ET4-6T-SM1	3-106
	0.02-250	4	Leaded Surface Mount	ET4-6T-SM5	3-106
	0.02-250	4	Gull Winged SMT	ET4-6T-SM20	3-106
	0.02-250	4	PIN Surface Mount	ET4-6T-SM21	3-106
	0.003-300	1	Surface Mount	ET1-6T-SM1	3-100
	0.003-300	1	Leaded Surface Mount	ET1-6T-SM5	3-100
	0.003-300	1	Gull Winged SMT	ET1-6T-SM20	3-100
	0.003-300	1	PIN Surface Mount	ET1-6T-SM21	3-100
	0.2-350	4	Relay Header	ETM04-1	3-123
	0.2-350	4	Surface Mount	ET4-1-SM1	3-124
	0.2-350	4	Leaded Surface Mount	ET4-1-SM5	3-124
	0.2-350	4	Gull Winged SMT	ET4-1-SM20	3-124
	0.2-350	4	PIN Surface Mount	ET4-1-SM21	3-124
	0.5-800	4	Surface Mount	ETC-4-1-2	3-126

Schematic

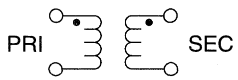


Schematic



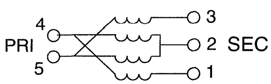
	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
	0.004-500	1	Surface Mount	ETT1-6-SM1	3-102
	0.004-500	1	Leaded Surface Mount	ETT1-6-SM5	3-102
	0.004-500	1	Gull Winged SMT	ETT1-6-SM20	3-102
	0.004-500	1	PIN Surface Mount	ETT1-6-SM21	3-102

Schematic



	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
	0.01-150	1	Surface Mount	ET1-6-SM1	3-104
New	0.01-150	1	Leaded Surface Mount	ET1-6-SM5	3-104
New	0.01-150	1	Gull Winged SMT	ET1-6-SM20	3-104
New	0.01-150	1	PIN Surface Mount	ET1-6-SM21	3-104
New	0.2-200	4	Surface Mount	ET4-6-SM1	3-108
New	0.2-200	4	Leaded Surface Mount	ET4-6-SM5	3-108
New	0.2-200	4	Gull Winged SMT	ET4-6-SM20	3-108
New	0.2-200	4	PIN Surface Mount	ET4-6-SM21	3-108
	0.15-300	1.5	Surface Mount	ET1.5-1-SM1	3-118
	0.15-300	1.5	Leaded Surface Mount	ET1.5-1-SM5	3-118
	0.15-300	1.5	Gull Winged SMT	ET1.5-1-SM20	3-118
	0.15-300	1.5	PIN Surface Mount	ET1.5-1-SM21	3-118
	0.15-400	1	Surface Mount	ET1-1-SM1	3-120
	0.15-400	1	Leaded Surface Mount	ET1-1-SM5	3-120
	0.15-400	1	Gull Winged SMT	ET1-1-SM20	3-120
	0.15-400	1	PIN Surface Mount	ET1-1-SM21	3-120
	0.15-400	1	Relay Header	ETM01-1	3-122

Schematic



	Frequency Range (MHz)	Z Ratio	Package Type	Part No.	Page No.
	500-2500	4	Surface Mount	ETC1.6-4-2-3	3-127

Mixer Terminology

Overview

1. Mixers
A mixer converts radio-frequency energy at one frequency to a second frequency. While the most common use for mixers is in the front end of radio receivers **(See Figure 1)**, where they convert input signal frequencies to a lower "intermediate frequency," mixers are also used in up-converters, modulators, phase detectors, frequency synthesizers, etc.

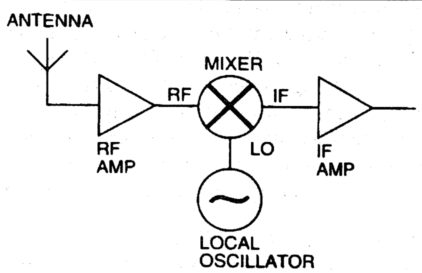


Figure 1: Standard Superheterodyne Radio Receiver Front End

2. Mixing Action
The mixing action of a mixer arises from two distinct processes acting in tandem. The input signal (designated "RF") is multiplied with a locally generated signal (the local oscillator, "LO"), thus generating two output signals at the sum and difference frequencies. The difference frequency is referred to as the intermediate (IF) frequency.

In a receiver, the sum frequency is normally rejected by a low pass IF filter leaving only the difference. Multiplication, however, is effected using non-linear elements (diodes) and these non-linearities are responsible for the generation of many additional frequencies other than the pure sum and difference frequencies.

3. Spurious Products
While we would wish all input signal power to be converted without loss to the IF frequency, mathematics tells us that the generation of both sum and difference frequencies is inevitable. Thus, even with an ideal mixer we will necessarily lose half the input signal power (or 3 dB) in the mixing process.

Other undesired or spurious products generated as a result of diode non-linearities will further increase the amount of signal power lost. In designing M/A-COM mixers, every effort is made to ensure that the generation of such spurious products is kept at a minimum.

4. Sum and Image Frequencies
We have seen above that an input RF signal and a local oscillator LO signal are multiplied to generate sum and difference IF frequencies. If another input frequency is found that, when mixed with the local oscillator, the correct IF frequency will be generated, then signal or noise power at this frequency will also be passed to the mixer IF terminals.

A frequency of 2LO-RF is such an input frequency. This particular frequency is called the image frequency **(See Figure 2)**.

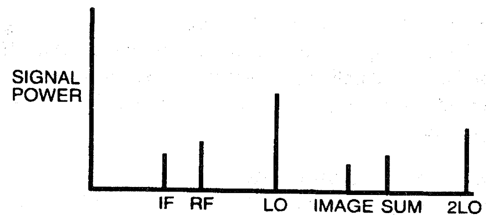


Figure 2: Mixer Frequency Spectrum

5. Conversion Loss
We have seen above that half the converted power is inevitably lost in the mixing process. Hence this loss (the SINGLE SIDEBAND CONVERSION LOSS) between RF input power and IF output power will have a minimum value of 3 dB. In practice, extra losses due to the generation of spurious products, resistive losses in the diodes, mismatches at the mixer ports, etc., will combine to increase this figure. Careful selection of local oscillator power to bias the diodes at their optimum operating points will minimize mixer conversion loss. All mixers have been designed with optimum diode/LO drive power combinations. Accordingly, our devices always should be operated with the LO drive power specified in this catalog.

6. Two-Tone Third Order Intercept

The generation of spurious output frequencies in a mixer is the result of using non-linear switching elements. Even for the single input frequency the number of such products that is generated as discernible power levels is quite large. The situation is further exacerbated when the input signal contains multitone components. A figure of merit indicative of the ability of a mixer to suppress such intermodulation products is the "two-tone third order intercept point" (usually measured in dBm). (See **Figure 3.**)

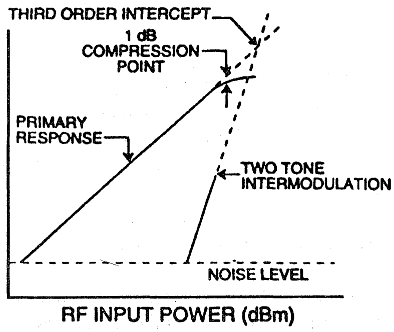


Figure 3.

The hypothetical intercept point is arrived at by extrapolating measured data to suggest an input RF power level at which IF power and intermodulation products would be equal. Mixers with high intercept points generate low intermodulation distortion products.

7. 1 dB Compression Point

The dynamic range of a mixer is the range of input RF power levels (in dBm) for which the mixer produces useful IF output power. Dynamic range is limited at the low end by the noise performance of the mixer devices. When the input power is such as to produce a discernible IF output signal a constant power ratio (equal to the conversion loss) is established between input RF power and output IF power.

As input power is increased, a point is reached where this constant power ratio is no longer maintained and conversion loss begins to increase. When conversion loss has increased by 1 dB, the upper limit of the mixers dynamic range is deemed to have been reached and this "1 dB COMPRESSION POINT" generally delineates the upper level of input power for which the mixer should be used. This catalog contains mixers with 1 dB compression points as high as +14 dBm.

The 1 dB compression point is tied in closely with the third order intercept point; as a rule of thumb, two-tone third order intercept point is 10-15 dB above the 1 dB compression point.

8. Voltage Standing Wave Ratio (VSWR)

Efficient operation of a mixer requires that maximum signal power transfer be effected at each of the three ports. The degree to which this ideal is met is indicated by the voltage standing wave ratio (VSWR) which quantifies the amount of mismatch at each port. A perfect match of a 50 ohm system implies a VSWR of 1:1 while a port with a VSWR of 2:1 means that approximately ten percent of the incident power would be reflected from that port. The importance of minimizing mixer VSWR to ensure efficient driving of the diodes and power transfer of RF/IF energies is, therefore, apparent.

9. Intercept Isolation

All references to the mixer so far have assumed that RF/LO/IF signal powers are present at their respective ports and at no other. In practice, a small portion of the power applied to any port will leak through to the other two ports. This is particularly undesirable in the case of the relatively high level LO signal. The degree to which the LO power is masked from the other two ports is specified by the L-R and L-I isolations (in dB). These are the insertion losses between the respective ports.

10. Double Balanced Mixers

It is evident from the foregoing that when designing a mixer our goals will be to minimize conversion loss, noise figure, VSWR and the generation of spurious products while maintaining interport isolation, 1 dB compression point and the third order intercept point.

Unfortunately, no single mixer type exists which will simultaneously satisfy all these requirements. The simplest mixer configuration, the "single-ended" mixer, uses a single diode as the switching element. Due to performance, single-ended mixers at frequencies in the RF and low microwave region are unsuitable for general use.

Improved performance is obtained from a "single-balanced" configuration where two diodes are used in a balanced arrangement.

However, further significant improvements in intermodulation suppression and dynamic range, as well as low VSWR, conversion loss and noise figure are possible with a "double-balanced" mixer configuration. This is the optimum configuration for most applications and so is the configuration used in all M/A-COM mixers. Figure 4 shows a typical M/A-COM implementation of a double-balanced mixer configuration. Optimum mixer operation requires the four diodes to have identical characteristics. This requirement is most closely met by a ring quad which contains the four Schottky-barrier ring diodes in a single package. Baluns at mixer ports are carefully designed to match the mixer over the broadest possible frequency ranges.

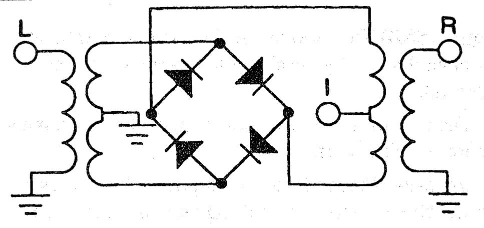


Figure 4: Schematic

11. Pulse Modulators

The principle of the current controlled attenuator outlined above can be extended to develop a pulse modulator. If the control current is pulsed, the unmodulated input carrier at the LO port will appear at the output RF port as a pulse modulated carrier. Because the switching elements of the mixer are Schottky diodes, very high switching speeds of about 1 nanosecond are possible. **Figure 5** shows the functional schematic of a pulse modulator.

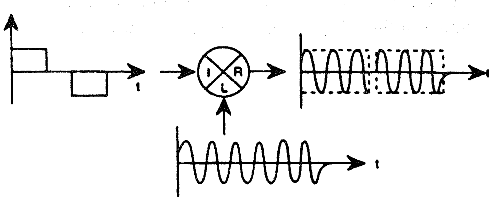


Figure 5: Pulse Modulator

Figure 8: Pulse Modulator

12. Phase Detectors

If the signals applied to the RF and LO ports of a mixer have the same frequency, then it can be shown that the resultant IF voltage will be DC and will vary as the cosine of the phase difference between the input signals. Accordingly, a double balanced mixer may be used as a phase detector. **Figure 6** shows the fundamental schematic of the phase detector and a plot of the DC output voltage vs. phase difference.

Theoretically, when DF is equal to $\pi/2$ the DC voltage at the IF port should be zero. In practice diode imbalance and transformer asymmetry may cause a DC offset. This offset can be counteracted by applying a DC bias to the IF port.

13. Quadraphase-Shift Keying (QPSK) Modulator

A QPSK modulator modulates the phase of a carrier with discrete 0°, 90°, 180°, or 270° phase shifts. A functional schematic of such a modulator is shown in **Figure 7**. The input carrier is passed through a 90° hybrid which provides quadrature signals to two double balanced mixers. Control signals to each mixer switch the transmission paths through the diodes causing a 0° or 180° relative phase shift. The mixer outputs are then combined yielding the required four equal amplitude phase states. An output amplifier restores the carrier signal to its original level. (See technical information on I/Q Modulators.)

14. Current Controlled Variable Attenuators

In normal operation, the LO and RF isolation is required to be a maximum. However, in some cases this isolation can be lessened by feeding the IF port with a negative bias current.

In this way a low level variable attenuator with a typical control range of about 50 dB can be constructed. With signal input at the LO port and output at the RF port, attenuation is maximum (and equal to LO-RF isolation) at zero bias current. Typically attenuations as low as 3 dB are attainable with maximum bias current. **Figure 8** shows the typical attenuation vs. IF port bias.

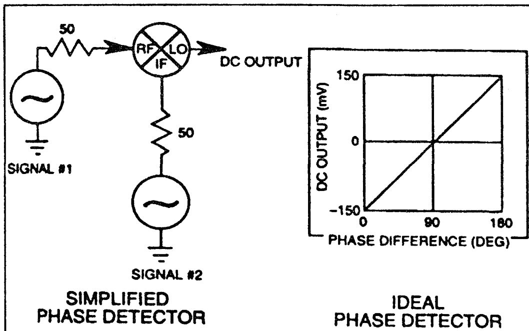


Figure 1: Phase Detector

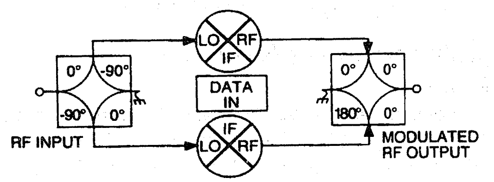


Figure 2: QPSK Modulator

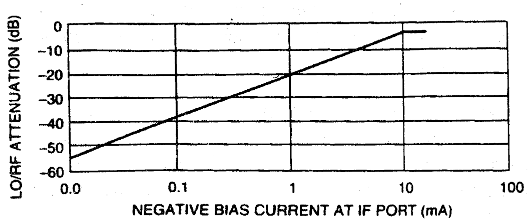


Figure 3: Current Controlled Variable Attenuator

15. Glossary of Terms

Conversion Loss (SSB) The ratio of RF input power to the IF output power of one sideband. (Either F_{LO}-F_{RF} or F_{LO} + F_{RF}.)

Noise Figure (SSB) The ratio of the signal-to-noise ratio at the mixer input divided by the signal-to-noise ratio of one mixer sideband.

Isolation The amount an input signal is attenuated when measured at another mixer port.

1 dB Compression Point The RF input power that causes a 1 dB increase above a mixer's small signal conversion loss.

1 dB Desensitization Level The RF input level of an interfering signal that causes a mixer's small signal conversion loss to increase by 1 dB.

Harmonic Intermodulation Products

Mixer output signals other than the desired $F_{LO} \pm F_{RF}$ which are harmonically related to either or both of the input signals. (Also termed $N_{RF} \pm M_{LO}$, NxM or "Spurs".)

Two-tone Intermodulation Products

Undesired mixer output products caused by the simultaneous presence of two RF input signals (3rd order IM consists of $[(2F_{RF1} \pm F_{RF2}) \pm (F_{LO})]$ and $[(F_{RF1} \pm 2F_{RF2}) \pm (F_{LO})]$.)

DC Polarity The mixer IF voltage polarity, either positive or negative when in phase LO and RF signals are applied.

DC Offset The IF output voltage measured with only the LO operating and the RF port terminated in 50 ohms.

E-Series Plug-In Mixer
0.04 – 400 MHz

EMT-3

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25°C

Frequency Range		
RF, LO		0.04–400 MHz
IF		DC–400 MHz
Conversion Loss		
0.4–200 MHz	5.3 dB Typ	7.0 dB Max
0.04–400 MHz	6.0 dB Typ	8.0 dB Max
Isolation		
LO to RF		
0.04–0.4 MHz	60 dB Typ	50 dB Min
0.4–200 MHz	50 dB Typ	35 dB Min
200–400 MHz	35 dB Typ	25 dB Min
LO to IF		
0.04–0.4 MHz	55 dB Typ	40 dB Min
0.4–200 MHz	45 dB Typ	30 dB Min
200–400 MHz	35 dB Typ	25 dB Min

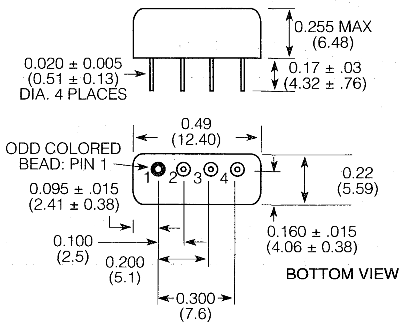
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

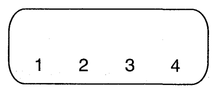
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
0.05 – 200 MHz

EMA-3H

Features
- +17 dBm LO Power
- Up to +10 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		0.05–200 MHz
IF		DC–200 MHz
Conversion Loss		
0.5–100 MHz	5.5 dB Typ	7.0 dB Max
0.05–200 MHz	5.5 dB Typ	7.5 dB Max
Isolation		
LO to RF		
0.05–0.5 MHz	50 dB Typ	45 dB Min
0.5–100 MHz	40 dB Typ	30 dB Min
100–200 MHz	35 dB Typ	25 dB Min
LO to IF		
0.05–0.5 MHz	45 dB Typ	35 dB Min
0.5–100 MHz	40 dB Typ	30 dB Min
100–200 MHz	30 dB Typ	20 dB Min

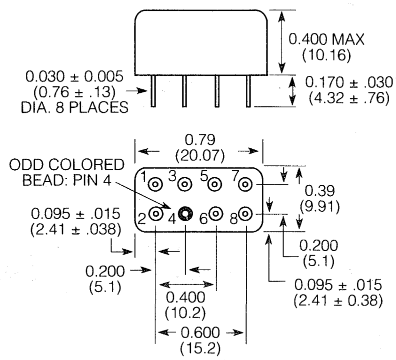
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+10 dBm

Absolute Maximum Ratings

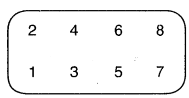
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-2



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
0.05 – 2000 MHz

EMA-220

Features

- +10 dBm LO Power
- Up to +5 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		0.05–2000 MHz
IF		0.05–2000 MHz
Conversion Loss		
0.5–1000 MHz	6.0 dB Typ	8.0 dB Max
0.05–2000 MHz	7.0 dB Typ	9.0 dB Max
Isolation		
LO to RF		
0.05–0.5 MHz	25 dB Typ	20 dB Min
0.5–1000 MHz	40 dB Typ	30 dB Min
1000–2000 MHz	30 dB Typ	20 dB Min
LO to IF		
0.05–0.5 MHz	25 dB Typ	20 dB Min
0.5–1000 MHz	40 dB Typ	30 dB Min
1000–2000 MHz	25 dB Typ	15 dB Min

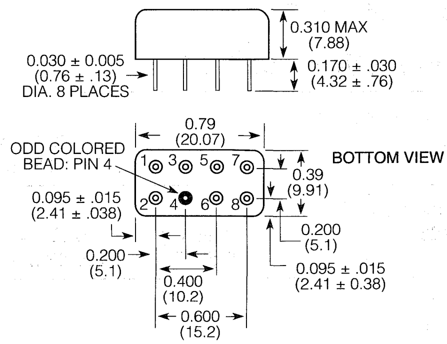
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+5 dBm

Absolute Maximum Ratings

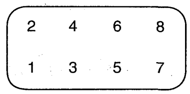
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2

* Pins must be externally connected together.

E-Series Plug-In Mixer
0.1 – 250 MHz

EMT-3H

Features
- +17 dBm LO Power
- Up to +14 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		0.1–250 MHz
IF		DC–250 MHz
Conversion Loss		
1–125 MHz	5.0 dB Typ	7.0 dB Max
0.1–250 MHz	6.0 dB Typ	8.5 dB Max
Isolation		
LO to RF		
0.1–1 MHz	50 dB Typ	45 dB Min
1–125 MHz	40 dB Typ	30 dB Min
125–250 MHz	28 dB Typ	23 dB Min
LO to IF		
0.1–1 MHz	45 dB Typ	40 dB Min
1–125 MHz	35 dB Typ	25 dB Min
125–250 MHz	26 dB Typ	20 dB Min

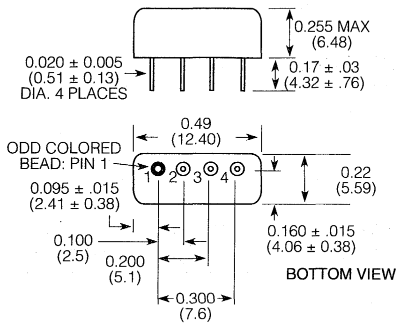
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

Absolute Maximum Ratings

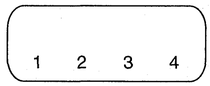
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
0.1 – 500 MHz

EMM-3

Features

- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25°C

Frequency Range		
RF, LO		0.1–500 MHz
IF		DC–500 MHz
Conversion Loss		
1–250 MHz	5.5 dB Typ	7.0 dB Max
0.1–500 MHz	6.5 dB Typ	8.5 dB Max
Isolation		
LO to RF		
0.1–1 MHz	60 dB Typ	50 dB Min
1–250 MHz	50 dB Typ	35 dB Min
250–500 MHz	35 dB Typ	30 dB Min
LO to IF		
0.1–1 MHz	50 dB Typ	40 dB Min
1–250 MHz	45 dB Typ	30 dB Min
250–500 MHz	30 dB Typ	20 dB Min

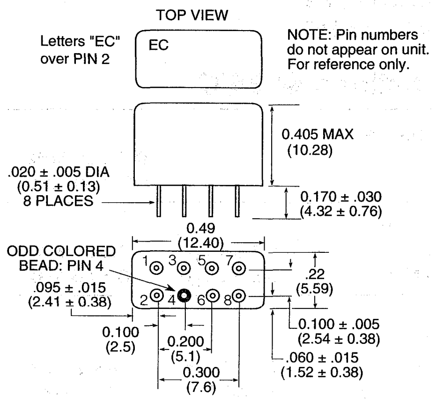
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-6



WEIGHT(APPROX.): 0.06 OUNCES 1.6 GRAMS

Pin Configuration (Top View)

2	4	6	8
1	3	5	7

Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
0.5 – 500 MHz

EMA-1

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		0.5–500 MHz
IF		DC–500 MHz
Conversion Loss		
1–250 MHz	5.5 dB Typ	7.0 dB Max
0.5–500 MHz	6.5 dB Typ	8.5 dB Max
Isolation		
LO to RF		
0.5–10 MHz	50 dB Typ	45 dB Min
10–250 MHz	45 dB Typ	30 dB Min
250–500 MHz	35 dB Typ	25 dB Min
LO to IF		
0.5–10 MHz	45 dB Typ	35 dB Min
10–250 MHz	40 dB Typ	25 dB Min
250–500 MHz	30 dB Typ	20 dB Min

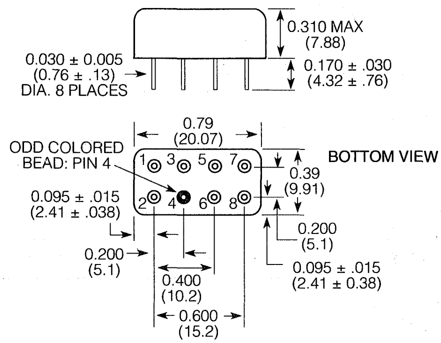
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

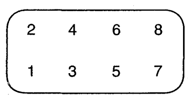
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer 0.5 – 500 MHz

EVAY-1

Features

- +27 dBm LO Power
- Up to +24 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		0.5–500 MHz
IF		0.02–500 MHz
Conversion Loss		
5–250 MHz	6.0 dB Typ	7.5 dB Max
0.5–500 MHz	7.5 dB Typ	8.5 dB Max
Isolation		
LO to RF		
0.5–5 MHz	47 dB Typ	40 dB Min
5–250 MHz	46 dB Typ	35 dB Min
250–500 MHz	35 dB Typ	25 dB Min
LO to IF		
0.5–5 MHz	47 dB Typ	40 dB Min
5–250 MHz	46 dB Typ	35 dB Min
250–500 MHz	35 dB Typ	25 dB Min

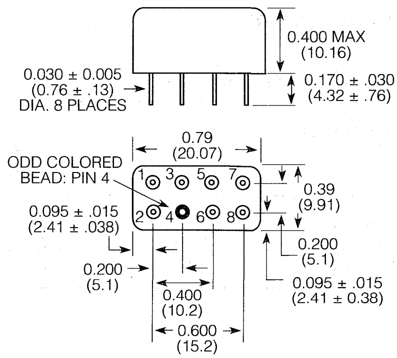
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+24 dBm

Absolute Maximum Ratings

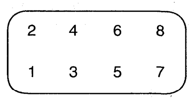
Parameter	Absolute Maximum
RF Power	500 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C
Pin Tempature (10 sec.)	+260 °C

R-2



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3
Ground	2,5,6,7
Case Ground	2,5,6,7

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
1 – 500 MHz

EMS-1

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		1–500 MHz
IF		DC–500 MHz
Conversion Loss		
2–250 MHz	5.5 dB Typ	7.0 dB Max
1–500 MHz	6.5 dB Typ	8.0 dB Max
Isolation		
LO to RF		
1–10 MHz	60 dB Typ	45 dB Min
10–250 MHz	45 dB Typ	35 dB Min
250–500 MHz	40 dB Typ	25 dB Min
LO to IF		
1–10 MHz	45 dB Typ	35 dB Min
10–250 MHz	40 dB Typ	25 dB Min
250–500 MHz	30 dB Typ	20 dB Min

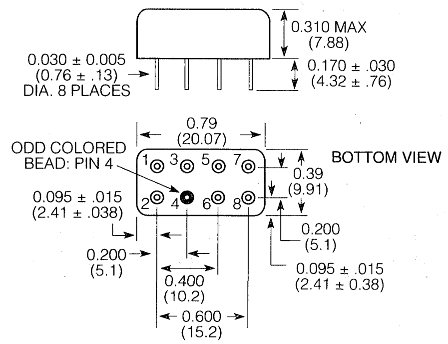
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

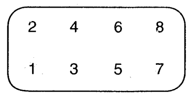
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	–

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

M/A-COM

E-Series Plug-In Mixer 1 – 750 MHz

EMA-1W

Features

- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		1–750 MHz
IF		DC–750 MHz
Conversion Loss		
2–375 MHz	5.5 dB Typ	7.5 dB Max
1–750 MHz	7.5 dB Typ	8.5 dB Max
Isolation		
LO to RF		
1–10 MHz	50 dB Typ	45 dB Min
10–375 MHz	45 dB Typ	30 dB Min
375–750 MHz	35 dB Typ	25 dB Min
LO to IF		
1–10 MHz	45 dB Typ	30 dB Min
10–375 MHz	40 dB Typ	25 dB Min
375–750 MHz	30 dB Typ	20 dB Min

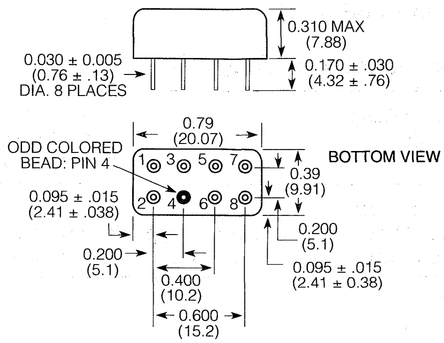
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

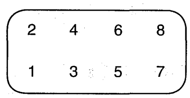
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C
Pin Tempature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2,5,6,7

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
1 – 1000 MHz
EMT-2

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		1–1000 MHz
IF		DC–1000 MHz
Conversion Loss		
2–500 MHz	6.0 dBm Typ	7.5 dBm Max
1–1000 MHz	7.0 dBm Typ	8.5 dBm Max
Isolation		
LO to RF		
1–10 MHz	50 dBm Typ	45 dBm Min
10–500 MHz	40 dBm Typ	25 dBm Min
500–1000 MHz	30 dBm Typ	25 dBm Min
LO to IF		
1–10 MHz	45 dBm Typ	40 dBm Min
10–500 MHz	35 dBm Typ	25 dBm Min
500–1000 MHz	25 dBm Typ	20 dBm Min

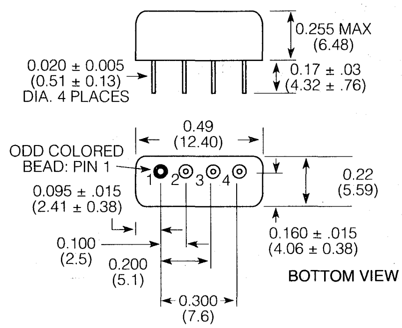
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

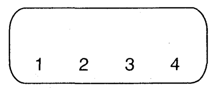
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

M/A-COM

E-Series Plug-In Mixer
1 – 2000 MHz

EMT-11

Features

- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		1–2000 MHz
IF		5–600 MHz
Conversion Loss		
2–1000 MHz	7.0 dB Typ	8.5 dB Max
2–2000 MHz	7.5 dB Typ	9.0 dB Max
Isolation		
LO to RF		
1–10 MHz	50 dB Typ	45 dB Min
10–1000 MHz	35 dB Typ	25 dB Min
1000–2000 MHz	25 dB Typ	10 dB Min
LO to IF		
1–10 MHz	45 dB Typ	40 dB Min
10–1000 MHz	27 dB Typ	20 dB Min
1000–2000 MHz	25 dB Typ	20 dB Min

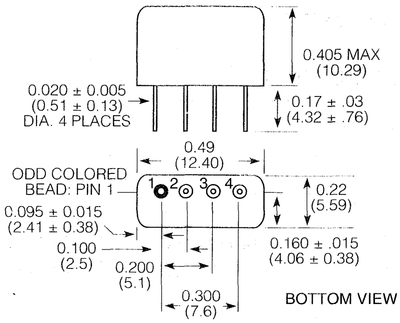
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

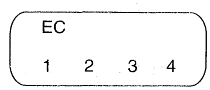
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-4



WEIGHT (APPROX.): 0.04 OUNCES 1.3 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
E-Series Plug-In Mixer 2 – 500 MHz

EMT-1MH

Features

- +13 dBm LO Power
- Up to +9 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		2–500 MHz
IF		DC–500 MHz
Conversion Loss		
20–250 MHz	6.0 dB Typ	7.5 dB Max
2–500 MHz	7.0 dB Typ	8.5 dB Max
Isolation		
LO to RF		
2–20 MHz	50 dB Typ	45 dB Min
20–250 MHz	40 dB Typ	30 dB Min
250–500 MHz	30 dB Typ	20 dB Min
LO to IF		
2–20 MHz	45 dB Typ	40 dB Min
20–250 MHz	35 dB Typ	25 dB Min
250–500 MHz	25 dB Typ	20 dB Min

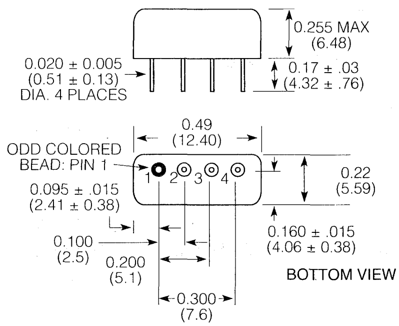
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+9 dBm

Absolute Maximum Ratings

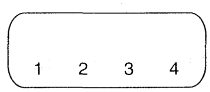
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C
Pin Tempature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
2 – 500 MHz

EMK-1H

Features

- +17 dBm LO Power
- Up to +14 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		2–500 MHz
IF		DC–500 MHz
Conversion Loss		
20–250 MHz	6.0 dB Typ	7.5 dB Max
2–500 MHz	7.0 dB Typ	8.5 dB Max
Isolation		
LO to RF		
2–20 MHz	50 dB Typ	40 dB Min
20–250 MHz	40 dB Typ	30 dB Min
250–500 MHz	30 dB Typ	25 dB Min
LO to IF		
2–20 MHz	45 dB Typ	35 dB Min
20–250 MHz	35 dB Typ	25 dB Min
250–500 MHz	25 dB Typ	20 dB Min

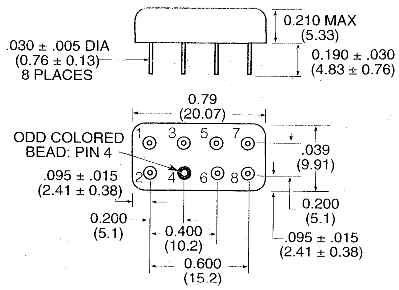
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

Absolute Maximum Ratings

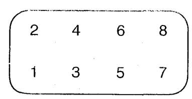
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C
Pin Tempature (10 sec.)	+260 °C

R-5



WEIGHT(APPROX.): 0.13 OUNCES 3.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

M/A-COM

E-Series Plug-In Mixer
2 – 600 MHz

ETUF-1H

Features
- +17 dBm LO Power
- Up to +14 dBm RF

Specifications @ 25°C

Frequency Range		
RF, LO		2–600 MHz
IF		DC–600 MHz
Conversion Loss		
4–300 MHz	5.9 dB Typ	7.0 dB Max
2–600 MHz	6.5 dB Typ	8.0 dB Max
Isolation		
LO to RF		
2–20 MHz	68 dB Typ	50 dB Min
20–300 MHz	50 dB Typ	30 dB Min
300–600 MHz	43 dB Typ	25 dB Min
LO to IF		
2–20 MHz	62 dB Typ	45 dB Min
20–300 MHz	48 dB Typ	30 dB Min
300–600 MHz	33 dB Typ	22 dB Min

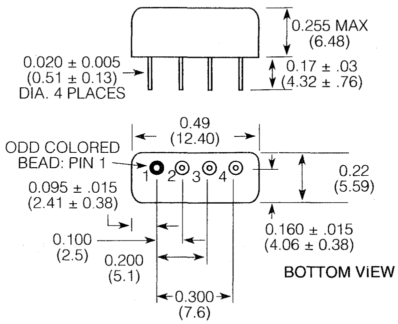
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm
DC Polarity	Negative

Absolute Maximum Ratings

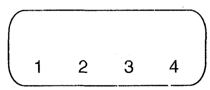
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C
Pin Tempature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Double-Balanced Mixer 5 – 500 MHz

EMD-108

Features

- Low Cost
- +7 dB Typical Conversion Loss

Specifications @ 25˚C

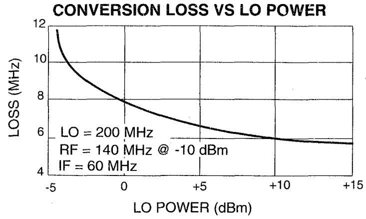
Freq. Range		RF, LO	5–500 MHz
		IF	DC–500 MHz
Conversion Loss		5–150 MHz	7.0 dB Max
		150–500 MHz	9.0 dB Max
Isolation	LO to R	5–150 MHz	40 dB Min
		250–500 MHz	35 dB Min
	LO to IF	5–150 MHz	35 dB Mn
		250–500 MHz	25 dB Min
	RF to IF	5–150 MHz	25 dB Min
		250–500 MHz	20 dB Min

Operating Characteristics

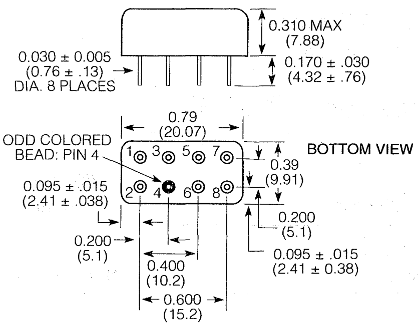
Impedance		50 Ohms Nominal
Max Input	Total Power	400 mW @ 25 °C
		Derated to 85 °C @ 3.2 mW/°C
	IF Port Current	50 mA Max
DC Polarity		Negative (Positive if LO input at pin 1)
DC Offset		≤ 1 mV Typical
RF Input		
1 dB Compression		+2.5 dBm Typical
1 dB Desensitization		0 dBm Typical
SSB Noise Figure		Within 1 dB ofConv. Loss Max
Typical Two-Tone IM Ratio (with -10 dBm input, each input 25 MHz and 35 MHz IF)		100–350 MHz ≥ 55 dB 350–500 MHz ≥ 40 dB
Pin Temperature (10 sec.)		+260 °C

All specifications apply when operated at +7 dBm available LO power with 50 ohm source and load impedance

CONVERSION LOSS VS LO POWER

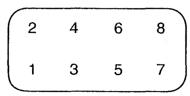


R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)

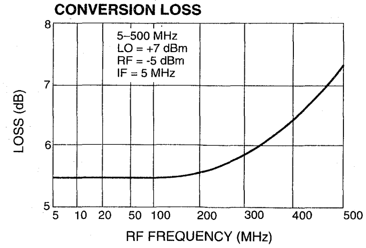


Function	Pin No.
LO	1,2
RF	8
IF	5,6*
Case Ground	3,4,7

* Pins must be externally connected together.

Typical Performance

CONVERSION LOSS



Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
5 – 500 MHz

EMS-500X1

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range	
RF, LO	5–500 MHz
IF (set at 60 MHz)	DC–500 MHz
Conversion Loss	
Total Range	8.0 dB Max
Isolation	
LO to RF	
Total Range	30 dB Min
LO to IF	
Total Range	25 dB Min
3rd Order Intercept Point	
400 MHz	15 dB Typ

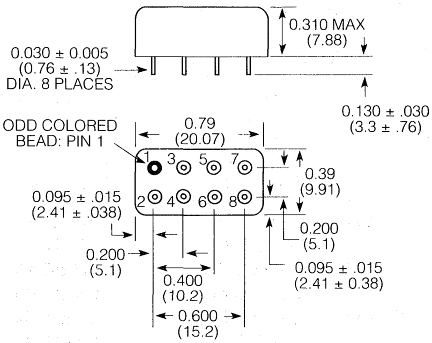
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

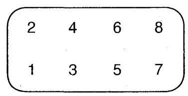
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec)	+260 °C

R-11



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	2,5,6,7

* Pins must be externally connected together.

E-Series Plug-In Mixer
5 – 1000 MHz

E-Series Plug-In Mixer 5 – 1000 MHz

EMT-2H

Features

- +17 dBm LO Power
- Up to +14 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1000 MHz
IF		DC–1000 MHz
Conversion Loss		
10–500 MHz	6.2 dBm Typ	7.0 dBm Max
5–1000 MHz	7.0 dBm Typ	10.0 dBm Max
Isolation		
LO to RF		
5–50 MHz	50 dBm Typ	45 dBm Min
50–500 MHz	40 dBm Typ	30 dBm Min
500–1000 MHz	30 dBm Typ	20 dBm Min
LO to IF		
5–50 MHz	45 dBm Typ	40 dBm Min
50–500 MHz	35 dBm Typ	25 dBm Min
500–1000 MHz	25 dBm Typ	17 dBm Min

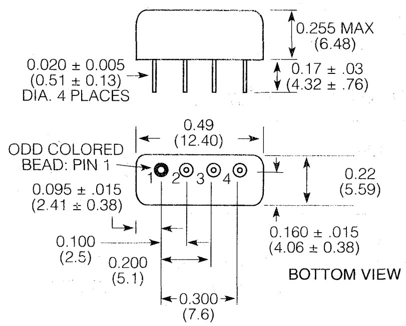
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

Absolute Maximum Ratings

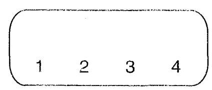
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

M/A-COM

E-Series Plug-In Mixer
5 – 1200 MHz

EMA-173HX

Features

- +17 dBm LO Power
- Up to +14 dBm RF
- High IP3; +29dBm typ.

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1200 MHz
IF		1–1200 MHz
Conversion Loss		
10–600 MHz	6.0 dB Typ	7.0 dB Max
5–1200 MHz	7.0 dB Typ	8.5 dB Max
Isolation		
LO to RF		
5–50 MHz	40 dB Typ	35 dB Min
50–600 MHz	35 dB Typ	25 dB Min
600–1200 MHz	35 dB Typ	20 dB Min
LO to IF		
5–50 MHz	40 dB Typ	35 dB Min
50–600 MHz	35 dB Typ	20 dB Min
600–1200 MHz	30 dB Typ	20 dB Min
3rd Order Intercept Point		+29 dBm Typ

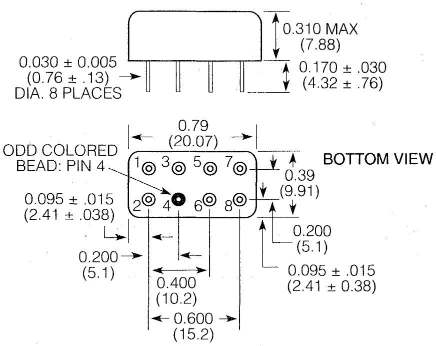
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

Absolute Maximum Ratings

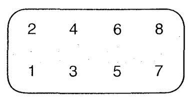
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.	
LO	3,4*	8
RF	1	1
IF	8	3,4*
Ground	2,5,6,7	2,5,6,7
Case Ground	2,5,6,7	2,5,6,7

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
5 – 1250 MHz

EMT-4

Features

- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1250 MHz
IF		DC–1250 MHz
Conversion Loss		
50–625 MHz	6.0 dB Typ	7.5 dB Max
5–1250 MHz	7.5 dB Typ	8.5 dB Max
Isolation		
LO to RF		
5–50 MHz	50 dB Typ	45 dB Min
50–625 MHz	40 dB Typ	30 dB Min
625–1250 MHz	30 dB Typ	25 dB Min
LO to IF		
5–50 MHz	45 dB Typ	40 dB Min
50–625 MHz	35 dB Typ	30 dB Min
625–1250 MHz	25 dB Typ	20 dB Min

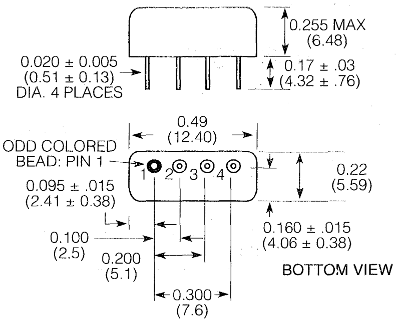
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

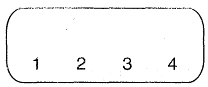
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
5 – 1500 MHz

EMT-5

Features

- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1500 MHz
IF		DC–1000 MHz
Conversion Loss		
50–750 MHz	6.5 dB Typ	8.5 dB Max
5–1500 MHz	8.0 dB Typ	9.5 dB Max
Isolation		
LO to RF		
5–50 MHz	60 dB Typ	45 dB
50–750 MHz	35 dB Typ	25 dB
750–1500 MHz	30 dB Typ	25 dB
LO to IF		
5–50 MHz	60 dB Typ	40 dB
50–750 MHz	35 dB Typ	15 dB
750–1500 MHz	25 dB Typ	14 dB

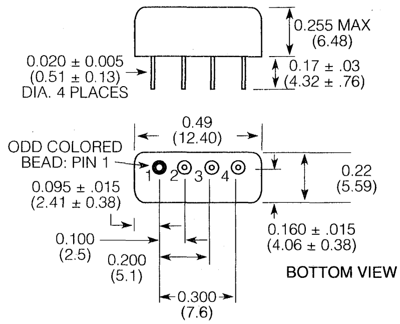
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

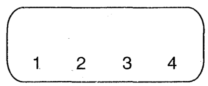
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	2
Ground	3
Case Ground	3

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
5 — 2000 MHz

EMA-11

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Hermetically Sealed

Specifications @ 25˚C

Frequency Range		
RF, LO		5–2000 MHz
IF		10–600 MHz
Conversion Loss		
50–1000 MHz	7.0 dB Typ	8.5 dB Max
5–2000 MHz	7.5 dB Typ	9.0 dB Max
Isolation		
LO to RF		
5–50 MHz	50 dB Typ	45 dB Min
50–1000 MHz	35 dB Typ	25 dB Min
1000–2000 MHz	30 dB Typ	20 dB Min
LO to IF		
5–50 MHz	45 dB Typ	40 dB Min
50–1000 MHz	30 dB Typ	20 dB Min
1000–2000 MHz	20 dB Typ	15 dB Min

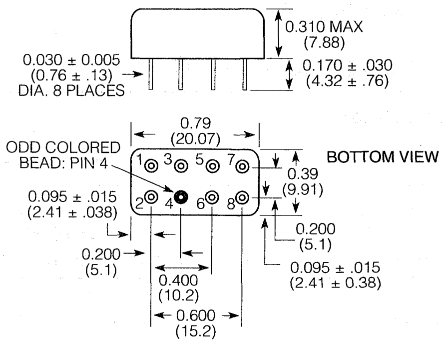
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

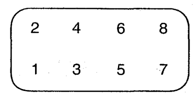
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3
Ground	2,5,6,7
Case Ground	2,5,6,7

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
5 – 2000 MHz

EMS-11

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		5–2000 MHz
IF		10–600 MHz
Conversion Loss		
50–1000 MHz	7.0 dB Typ	8.5 dB Max
5–2000 MHz	7.5 dB Typ	9.0 dB Max
Isolation		
LO to RF		
5–50 MHz	50 dB Typ	45 dB Min
50–1000 MHz	35 dB Typ	25 dB Min
1000–2000 MHz	30 dB Typ	20 dB Min
LO to IF		
5–50 MHz	45 dB Typ	40 dB Min
50–1000 MHz	30 dB Typ	20 dB Min
1000–2000 MHz	25 dB Typ	15 dB Min

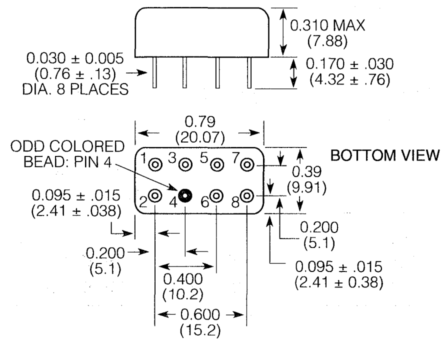
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

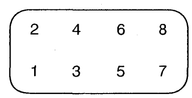
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3
Ground	2,5,6,7
Case Ground	2,5,6,7

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
10 – 1000 MHz

EMS-1X

Features

- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		10–1000 MHz
IF		5–500 MHz
Conversion Loss		
20–500 MHz	6.0 dB Typ	7.5 dB Max
10–1000 MHz	7.0 dB Typ	8.0 dB Max
Isolation		
LO to RF		
10–100 MHz	50 dB Typ	40 dB Min
100–500 MHz	40 dB Typ	30 dB Min
500–1000 MHz	30 dB Typ	20 dB Min
LO to IF		
10–100 MHz	50 dB Typ	45 dB Min
100–500 MHz	40 dB Typ	35 dB Min
500–1000 MHz	35 dB Typ	25 dB Min

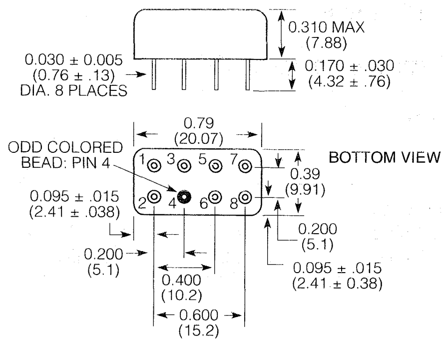
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

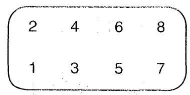
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	3,4*
IF	1
Ground	2,5,6,7
Case Ground	2,5,6,7

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
10 – 2000 MHz

EMA-11MH

Features
- +13 dBm LO Power
- Up to +9 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		10–2000 MHz
IF		DC–600 MHz
Conversion Loss		
20–1000 MHz	7.0 dB Typ	8.0 dB Max
10–2000 MHz	7.5 dB Typ	8.5 dB Max
Isolation		
LO to RF		
10–100 MHz	40 dB Typ	30 dB Min
100–1000 MHz	38 dB Typ	30 dB Min
1000–2000 MHz	32 dB Typ	25 dB Min
LO to IF		
10–100 MHz	35 dB Typ	30 dB Min
100–1000 MHz	30 dB Typ	25 dB Min
1000–2000 MHz	30 dB Typ	20 dB Min

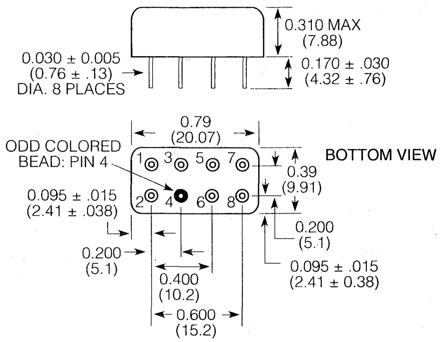
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+10 dBm

Absolute Maximum Ratings

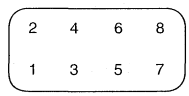
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C
Pin Tempature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3
Ground	2,5,6,7
Case Ground	2,5,6,7

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
10 – 3000 MHz

EMA-11H

Features

- +17 dBm LO Power
- Up to +10 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		10–3000 MHz
IF		10–1000 MHz
Conversion Loss		
20–1500 MHz	8.0 dB Typ	10 dB Max
10–3000 MHz	10 dB Typ	12 dB Max
Isolation		
LO to RF		
10–100 MHz	27 dB Typ	20 dB Min
100–1500 MHz	25 dB Typ	18 dB Min
1500–3000 MHz	23 dB Typ	16 dB Min
LO to IF		
10–100 MHz	27 dB Typ	20 dB Min
100–1500 MHz	25 dB Typ	18 dB Min
1500–3000 MHz	23 dB Typ	16 dB Min

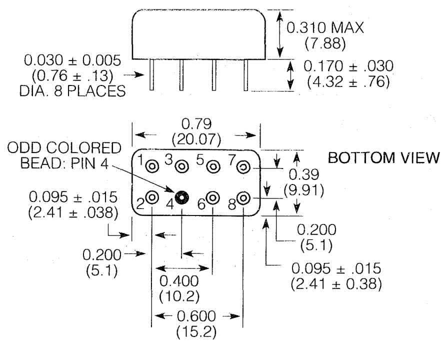
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+10 dBm

Absolute Maximum Ratings

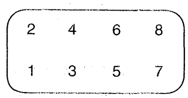
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3
Ground	2,5,6,7
Case Ground	2,5,6,7

E-Series Plug-In Mixer
10 – 3000 MHz

EMT-15

Features
- +10 dBm LO Power
- Up to +5 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		10–3000 MHz
IF		10–800 MHz
Conversion Loss		
100–1500 MHz	6.3 dBm Typ	8.0 dBm Max
10–3000 MHz	6.5 dBm Typ	8.5 dBm Max
Isolation		
LO to RF		
10–100 MHz	35 dBm Typ	25 dBm Min
100–1500 MHz	35 dBm Typ	25 dBm Min
1500–3000 MHz	35 dBm Typ	25 dBm Min
LO to IF		
10–100 MHz	30 dBm Typ	20 dBm Min
100–1500 MHz	30 dBm Typ	20 dBm Min
1500–3000 MHz	30 dBm Typ	20 dBm Min

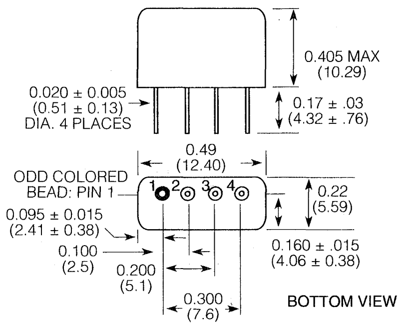
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+5 dBm

Absolute Maximum Ratings

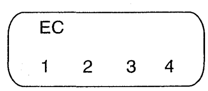
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-4



WEIGHT (APPROX.): 0.04 OUNCES 1.3 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
10 – 4200 MHz

EMT-42MH

Features

- +13 dBm LO Power
- Up to +9 dBm RF

Specifications @ 25˚C

Frequency Range		
RF, LO		10–4200 MHz
IF		10–1000 MHz
Conversion Loss		
100–2100 MHz	7.3 dBm Typ	8.5 dBm Max
10–4200 MHz	7.5 dBm Typ	11 dBm Max
Isolation		
LO to RF		
10–100 MHz	35 dBm Typ	25 dBm Min
100–2100 MHz	40 dBm Typ	25 dBm Min
2100–4200 MHz	35 dBm Typ	25 dBm Min
LO to IF		
10–100 MHz	35 dBm Typ	20 dBm Min
100–2100 MHz	35 dBm Typ	25 dBm Min
2100–4200 MHz	27 dBm Typ	20 dBm Min

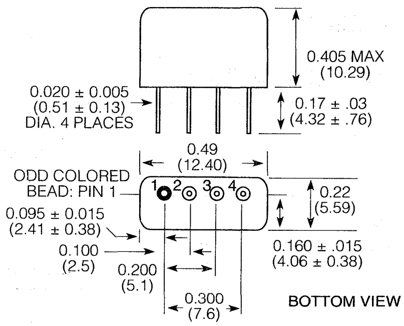
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+9 dBm

Absolute Maximum Ratings

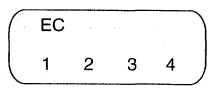
Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-4



WEIGHT (APPROX.): 0.04 OUNCES 1.3 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Plug-In Mixer
E-Series Plug-In Mixer 50 – 1000 MHz

ETUF-2SM

Features
- +7 dBm LO Power
- Up to +1 dBm RF

Specifications @ 25°C

Frequency Range		
RF, LO		50–1000 MHz
IF		DC–1000 MHz
Conversion Loss		
100–500 MHz	6.0 dB Typ	7.5 dB Max
50–1000 MHz	6.6 dB Typ	9.0 dB Max
Isolation		
LO to RF		
50 MHz	58 dB Typ	40 dB Min
1000 MHz	42 dB Typ	25 dB Min
LO to IF		
50 MHz	50 dB Typ	35 dB Min
1000 MHz	29 dB Typ	18 dB Min

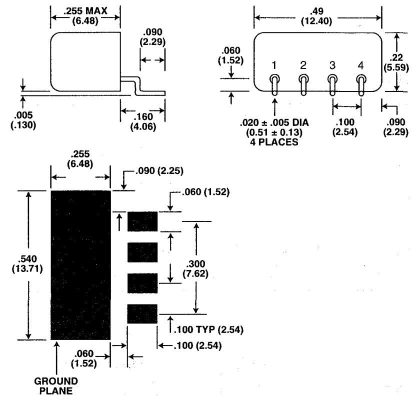
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

Absolute Maximum Ratings

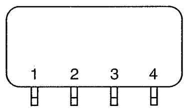
Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

R-15



FOOTPRINT FOR P.C. DESIGN

Pin Configuration (Top View)



Function	Pin No.
LO	4
RF	1
IF	2
Ground	3
Case Ground	3

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
0.5 – 500 MHz

EMRS-1H

Features
- +17 dBm LO Power
- Up to +14 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		0.5–500 MHz
IF		DC–500 MHz
Conversion Loss		
1–250 MHz	5.5 dB Typ	7.0 dB Max
0.5–500 MHz	6.2 dB Typ	8.5 dB Max
Isolation		
LO to RF		
0.5–5 MHz	55 dB Typ	50 dB Min
5–250 MHz	33 dB Typ	25 dB Min
250–500 MHz	27 dB Typ	20 dB Min
LO to IF		
0.5–5 MHz	55 dB Typ	45 dB Min
5–250 MHz	30 dB Typ	23 dB Min
250–500 MHz	24 dB Typ	19 dB Min

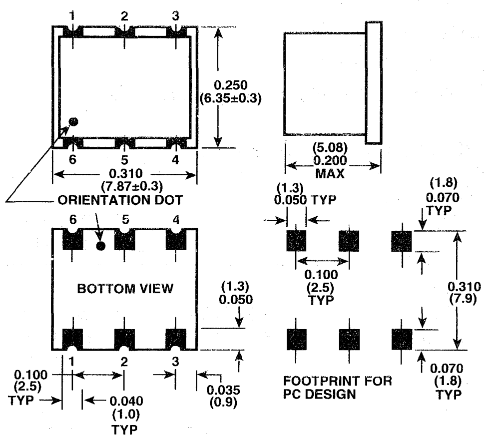
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

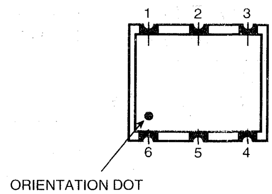
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
0.5 – 500 MHz

EMRS-1

Features
- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		0.5–500 MHz
IF		DC–500 MHZ
Conversion Loss		
1.0–250 MHz	5.5 dB Typ	7.0 dB Max
0.5–500 MHz	6.2 dB Typ	8.5 dB Max
Isolation		
LO to RF		
0.5–5.0 MHz	55 dB Typ	50 dB Min
5–250 MHz	33 dB Typ	25 dB Min
250–500 MHz	27 dB Typ	20 dB Min
LO to IF		
0.5–5.0 MHz	55 dB Typ	45 dB Min
5–250 MHz	30 dB Typ	23 dB Min
250–500 MHz	24 dB Typ	19 dB Min

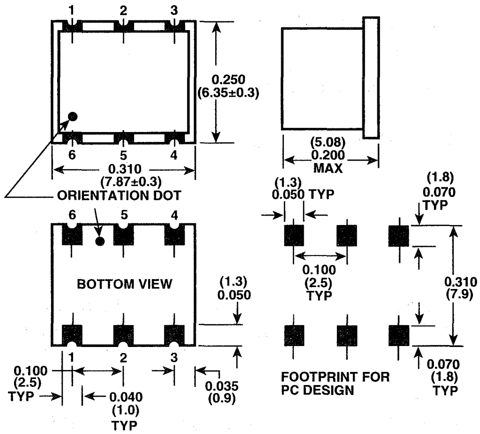
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

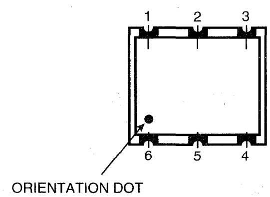
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

M/A-COM

E-Series Surface Mount Mixer
2 – 500 MHz

EMRS-1MH

Features

- +13 dBm LO Power
- Up to +9 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		2–500 MHz
IF		DC–500 MHz
Conversion Loss		
4–250 MHz	5.7 dB Typ	7.0 dB Max
2–500 MHz	6.0 dB Typ	8.0 dB Max
Isolation		
LO to RF		
2–20 MHz	58 dB Typ	45 dB Min
20–250 MHz	44 dB Typ	25 dB Min
250–500 MHz	30 dB Typ	20 dB Min
LO to IF		
2–20 MHz	55 dB Typ	40 dB Min
20–250 MHz	36 dB Typ	25 dB Min
250–500 MHz	28 dB Typ	17 dB Min

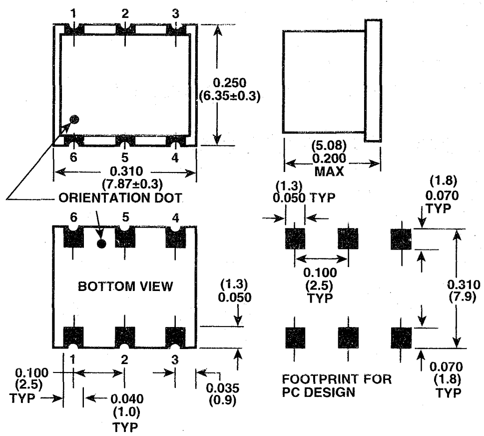
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+9 dBm

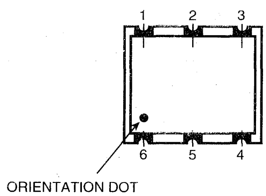
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	150 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	—

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer, +3 dBm LO Power
5 – 1000 MHz
EMRS-2L

Features
- +3 dBm LO Power
- Up to -1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1000 MHz
IF		DC–1000 MHz
Conversion Loss		
10–500 MHz	6.5 dB Typ	8.0 dB Max
5–1000 MHz	7.5 dB Typ	9.5 dB Max
Isolation		
LO to RF		
5–50 MHz	60 dB Typ	40 dB Min
50–500 MHz	40 dB Typ	20 dB Min
500–1000 MHz	25 dB Typ	18 dB Min
LO to IF		
5–50 MHz	55 dB Typ	30 dB Min
50–500 MHz	30 dB Typ	20 dB Min
500–1000 MHz	20 dB Typ	12 dB Min

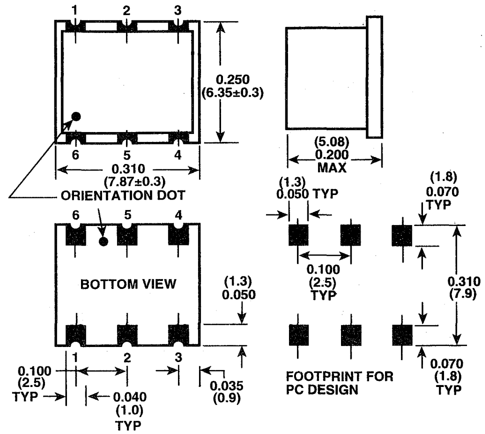
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	-1 dBm

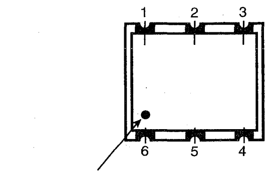
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer, +7 dBm LO Power 5 – 1000 MHz

EMRS-2

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1000 MHz
IF		DC–1000 MHz
Conversion Loss		
50–500 MHz	6.5 dB Typ	8.0 dB Max
5–1000 MHz	7.0 dB Typ	9.5 dB Max
Isolation		
LO to RF		
5–50 MHz	60 dB Typ	40 dB Min
50–500 MHz	40 dB Typ	20 dB Min
500–1000 MHz	25 dB Typ	18 dB Min
LO to IF		
5–50 MHz	55 dB Typ	30 dB Min
50–500 MHz	30 dB Typ	20 dB Min
500–1000 MHz	20 dB Typ	12 dB Min

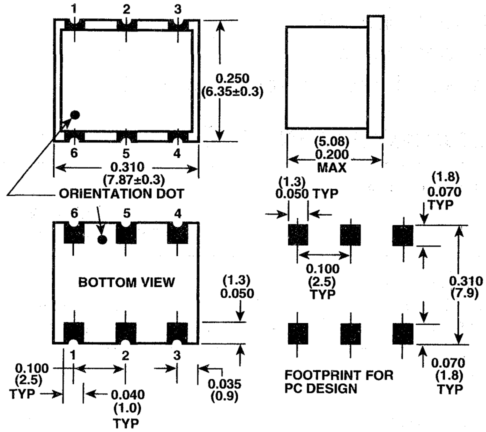
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

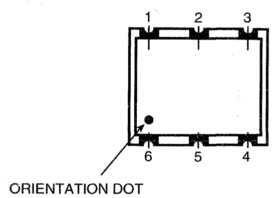
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

M/A-COM

E-Series Surface Mount Mixer, +3 dBm LO Power 5 – 1500 MHz

EMRS-5L

Features

- +3 dBm LO Power
- Up to -1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1500 MHz
IF		DC–1000 MHz
Conversion Loss		
50–750 MHz	6.5 dB Typ	7.5 dB Max
5–1500 MHz	7.5 dB Typ	9.5 dB Max
Isolation		
LO to RF		
5–50 MHz	60 dB Typ	40 dB Min
50–750 MHz	40 dB Typ	20 dB Min
750–1500 MHz	30 dB Typ	18 dB Min
LO to IF		
5–50 MHz	55 dB Typ	30 dB Min
50–750 MHz	30 dB Typ	18 dB Min
750–1500 MHz	15 dB Typ	8 dB Min

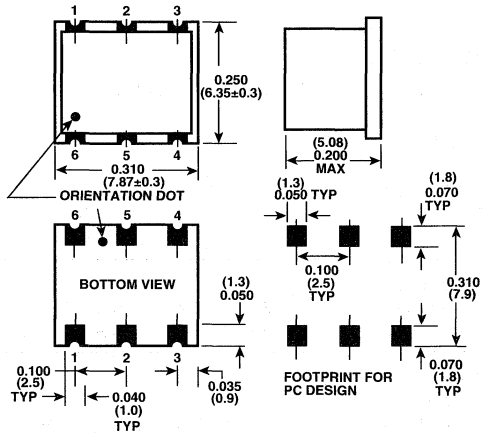
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	-1 dBm

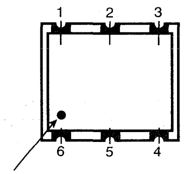
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer, +7 dBm LO Power
5 – 1500 MHz EMRS-5

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1500 MHz
IF		DC–1000 MHz
Conversion Loss		
50–750 MHz	6.5 dB Typ	7.5 dB Max
5–1500 MHz	7.5 dB Typ	9.5 dB Max
Isolation		
LO to RF		
5–50 MHz	60 dB Typ	40 dB Min
50–750 MHz	40 dB Typ	20 dB Min
750–1500 MHz	30 dB Typ	18 dB Min
LO to IF		
5–50 MHz	55 dB Typ	30 dB Min
50–750 MHz	30 dB Typ	18 dB Min
750–1500 MHz	15 dB Typ	8 dB Min

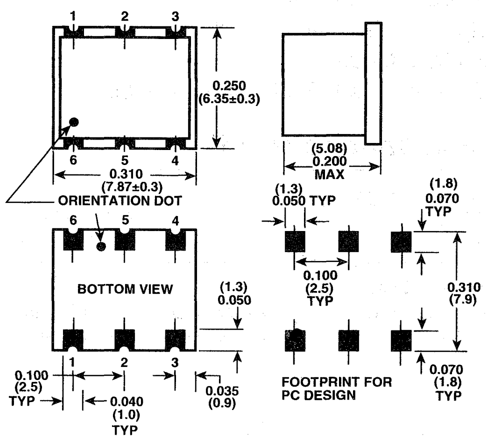
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

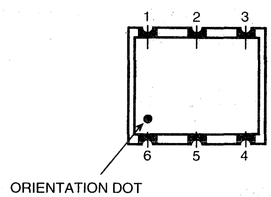
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
5 – 2000 MHz

EMRS-11

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		5–2000 MHz
IF		10–600 MHz
Conversion Loss		
10–1000 MHz	7.0 dB Typ	8.5 dB Max
5–2000 MHz	7.5 dB Typ	9.0 dB Max
Isolation		
LO to RF		
5–50 MHz	50 dB Typ	45 dB Min
50–1000 MHz	35 dB Typ	25 dB Min
1000–2000 MHz	30 dB Typ	20 dB Min
LO to IF		
5–50 MHz	45 dB Typ	40 dB Min
50–1000 MHz	30 dB Typ	20 dB Min
1000–2000 MHz	25 dB Typ	15 dB Min

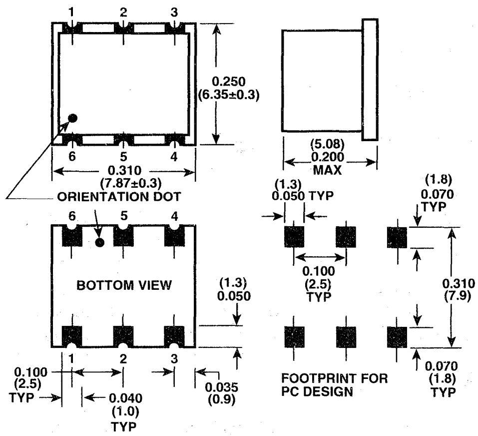
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

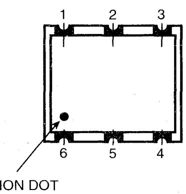
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Suface Mount Mixer
10 – 1000 MHz

EMRS-2D

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		
RF, LO		10–1000 MHz
IF		DC–1000 MHz
Conversion Loss	Typical	Maximum
100–500 MHz	6.8 dB	8.0 dB
10–1000 MHz	7.5 dB	10.0 dB
Isolation	Typical	Minimum
LO to RF		
10–100 MHz	59 dB	40 dB
100–500 MHz	40 dB	30 dB
500–1000 MHz	33 dB	22 dB
LO to IF		
10–100 MHz	55 dB	30 dB
100–500 MHz	40 dB	22 dB
500–1000 MHz	30 dB	20 dB

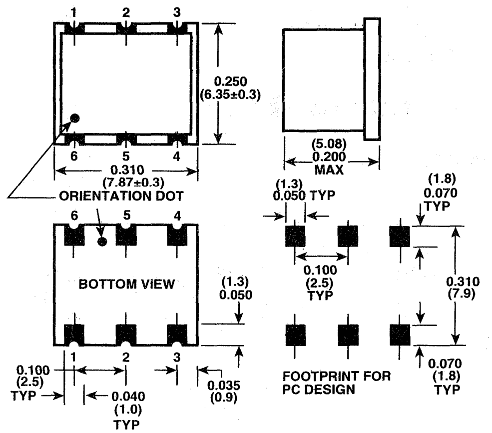
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

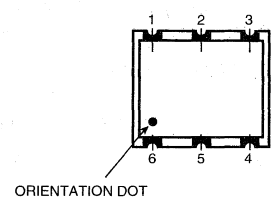
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C

SM-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
1 – 500 MHz

ESCM-1

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25°C

Frequency Range		
RF, LO		1–500 MHz
IF		DC–500 MHz
Conversion Loss		
10–250 MHz	6.0 dB Typ	7.0 dB Max
1–500 MHz	6.5 dB Typ	8.0 dB Max
Isolation		
LO to RF		
1–10 MHz	60 dB Typ	40 dB Min
10–250 MHz	45 dB Typ	35 dB Min
250–500 MHz	40 dB Typ	30 dB Min
LO to IF		
1–10 MHz	50 dB Typ	40 dB Min
10–250 MHz	45 dB Typ	35 dB Min
250–500 MHz	40 dB Typ	25 dB Min

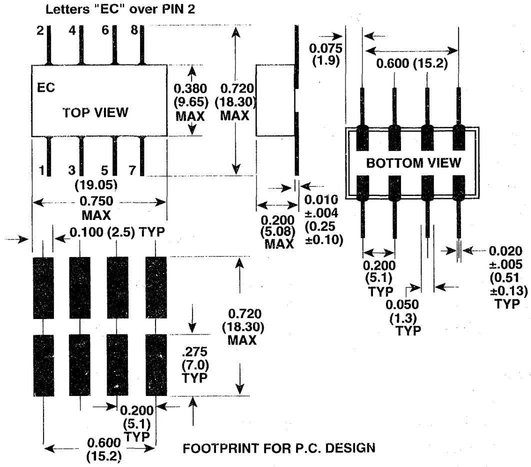
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

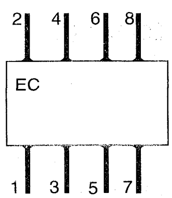
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C

SM-3



Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3,4*
Ground	2,5,6,7
Case Ground	–

* Pins must be externally connected together.

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer, +17 dBm LO Pwr.
5 – 1000 MHz
ESCM-2

Features
- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25˚C

Frequency Range		
RF, LO		5–1000 MHz
IF		DC–500 MHz
Conversion Loss		
50–500 MHz	6.0 dB Typ	7.5 dB Max
5–1000 MHz	7.0 dB Typ	9.8 dB Max
Isolation		
LO to RF		
5–50 MHz	50 dB Typ	40 dB Min
50–500 MHz	40 dB Typ	25 dB Min
500–1000 MHz	35 dB Typ	20 dB Min
LO to IF		
5–50 MHz	55 dB Typ	30 dB Min
50–500 MHz	40 dB Typ	25 dB Min
500–1000 MHz	30 dB Typ	18 dB Min

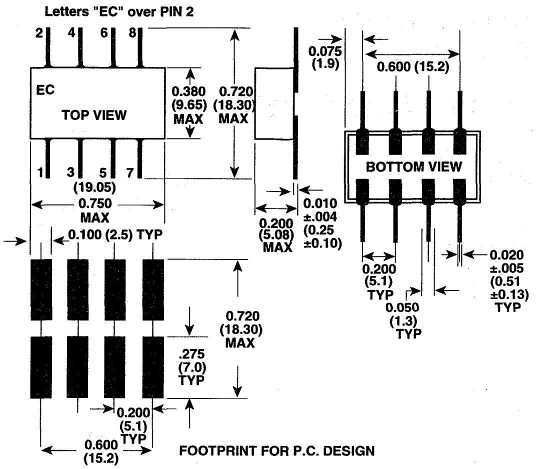
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

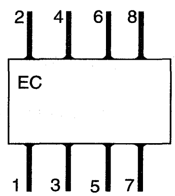
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-3



Pin Configuration (Top View)



Function	Pin No.
LO	8
RF	1
IF	3
Ground	2,5,6,7
Case Ground	–
not connected	4

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
500 – 2500 MHz

ESCM-2500

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25°C

Frequency Range		
RF, LO		500–2500 MHz
IF		DC–500 MHz
Conversion Loss		
1500 MHz		6.9 dB Max
500–2500 MHz		10.0 dB Max
Isolation		
LO to RF		
500–2500 MHz	35 dB Typ	22 dB Min
LO to IF		
500–2500 MHz	18 dB Typ	12 dB Min

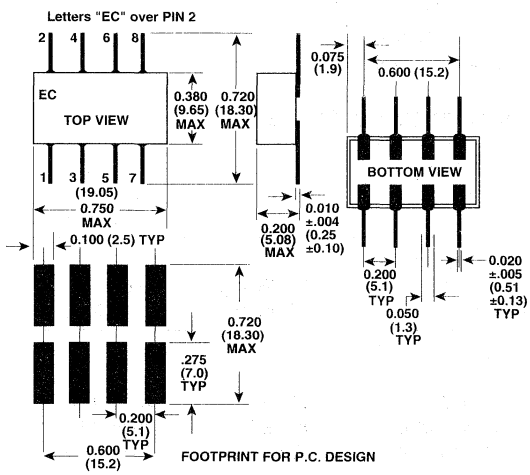
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

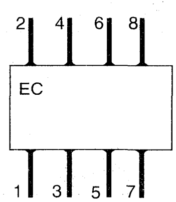
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C

SM-3



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
IF	3
Ground	2,4,5,6,7
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
1 – 600 MHz

EASK-1

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25˚C

Frequency Range		
RF, LO		1–600 MHz
IF		DC–600 MHz
Conversion Loss		
2–300 MHz	5.5 dB Typ	7.0 dB Max
1–600 MHz	6.0 dB Typ	8.5 dB Max
Isolation		
LO to RF		
1–10 MHz	50 dB Typ	30 dB Min
10–300 MHz	35 dB Typ	25 dB Min
300–600 MHz	30 dB Typ	20 dB Min
LO to IF		
1–10 MHz	45 dB Typ	35 dB Min
10–300 MHz	30 dB Typ	20 dB Min
300–600 MHz	25 dB Typ	15 dB Min

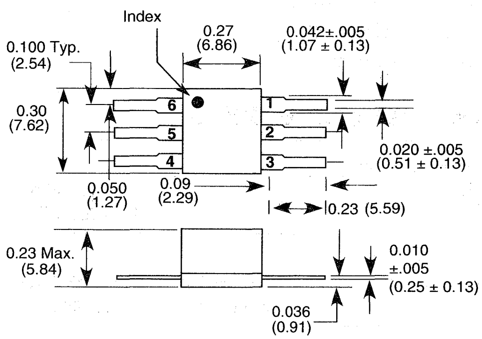
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm
DC Polarity	Negative

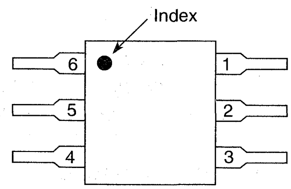
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C

SM-5



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	4
IF	5
Ground	2,3,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
1 – 1000 MHz

ESMD-C1

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25˚C

Frequency Range		
RF, LO		1–1000 MHz
IF		DC–1000 MHz
Conversion Loss		
2–500 MHz	6.5 dB Typ	7.5 dB Max
1–1000 MHz	7.5 dB Typ	9.5 dB Max
Isolation		
LO to RF		
1–10 MHz	60 dB Typ	45 dB Min
10–500 MHz	45 dB Typ	30 dB Min
500–1000 MHz	40 dB Typ	25 dB Min
LO to IF		
1–10 MHz	60 dB Typ	40 dB Min
10–500 MHz	35 dB Typ	23 dB Min
500–1000 MHz	30 dB Typ	15 dB Min

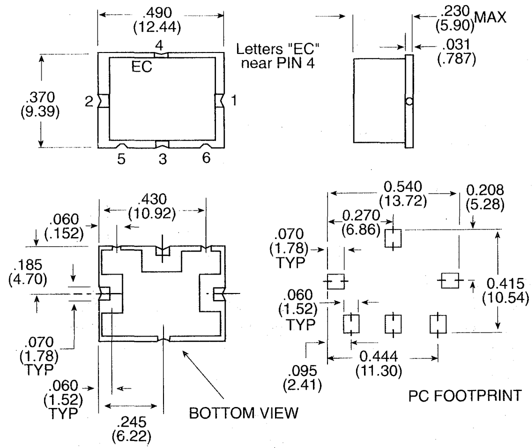
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

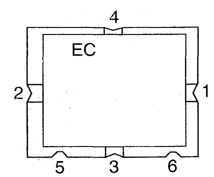
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-2



Pin Configuration (Top View)



Function	Pin No.
LO	2
RF	1
IF	3
Ground	4,5,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
20 – 1500 MHz

ESMD-C2

Features

- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25°C

Frequency Range		
RF, LO		20–1500 MHz
IF		DC–1500 MHz
Conversion Loss		
40–750 MHz	7.0 dB Typ	8.5 dB Max
20–1500 MHz	8.5 dB Typ	9.0 dB Max
Isolation		
LO to RF		
20–200 MHz	50 dB Typ	35 dB Min
200–750 MHz	35 dB Typ	25 dB Min
750–1500 MHz	20 dB Typ	10 dB Min
LO to IF		
20–200 MHz	40 dB Typ	25 dB Min
200–750 MHz	25 dB Typ	18 dB Min
750–1500 MHz	15 dB Typ	8 dB Min

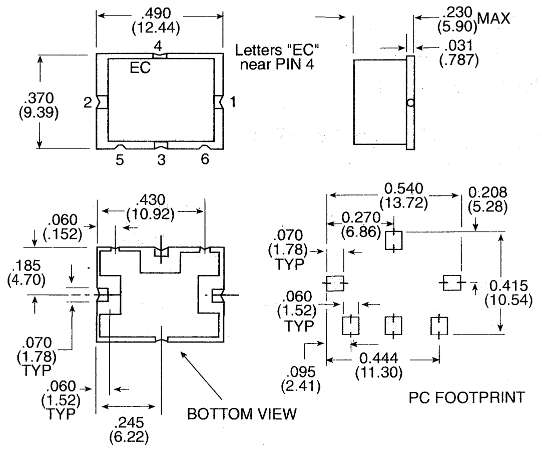
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

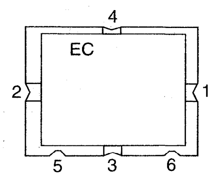
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-2



Pin Configuration (Top View)



Function	Pin No.
LO	2
RF	1
IF	3
Ground	4,5,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer, +7 dBm LO Pwr.
20 – 2500 MHz ESMD-C3

Features
- +7 dBm LO Power
- Up to +1 dBm RF
- Surface Mount

Specifications @ 25˚C

Frequency Range		
RF, LO		20–2500 MHz
IF		20-600 MHz
Conversion Loss		
200–1250 MHz	8.0 dB Typ	9.0 dB Max
20–2500 MHz	9.0 dB Typ	10.5 dB Max
Isolation		
LO to RF		
20–200 MHz	45 dB Typ	30 dB Min
200–1250 MHz	30 dB Typ	23 dB Min
1250–2500 MHz	30 dB Typ	15 dB Min
LO to IF		
20–200 MHz	40 dB Typ	20 dB Min
200–1250 MHz	25 dB Typ	15 dB Min
1250–2500 MHz	25 dB Typ	12 dB Min

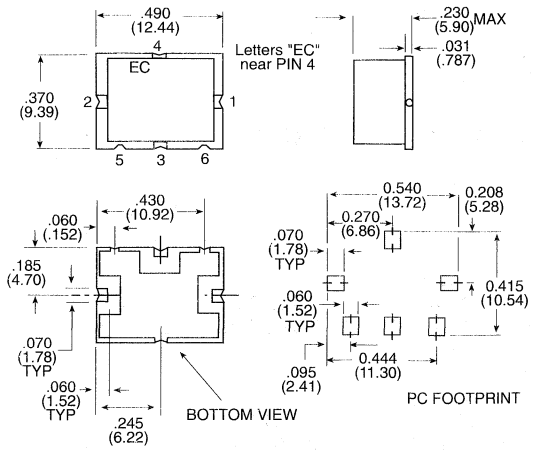
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+1 dBm

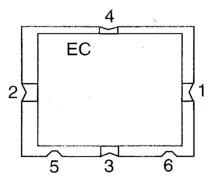
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	50 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-2



Pin Configuration (Top View)



Function	Pin No.
LO	2
RF	1
IF	3
Ground	4,5,6
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer, +17 dBm LO Pwr.

20 – 2500 MHz ESMD-C3H

Features

- +17 dBm LO Power
- Up to +14 dBm RF
- Surface Mount

Specifications @ 25˚C

Frequency Range		
RF, LO		20–2500 MHz
IF		20–600 MHz
Conversion Loss		
200–1250 MHz	8.0 dB Typ	9.0 dB Max
20–2500 MHz	9.0 dB Typ	10.5 dB Max
Isolation		
LO to RF		
20–200 MHz	45 dB Typ	30 dB Min
200–1250 MHz	30 dB Typ	23 dB Min
1250–2500 MHz	30 dB Typ	15 dB Min
LO to IF		
20–200 MHz	40 dB Typ	20 dB Min
200–1250 MHz	25 dB Typ	15 dB Min
1250–2500 MHz	25 dB Typ	12 dB Min

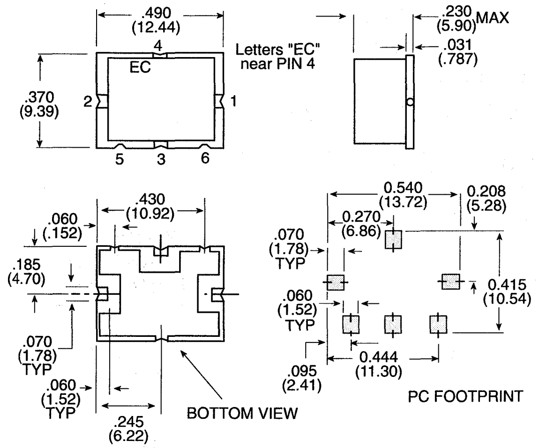
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

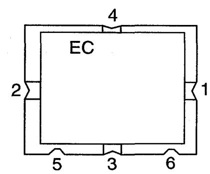
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp	-55 °C to +100 °C

SM-2



Pin Configuration (Top View)



Function	Pin No.
LO	2
RF	1
IF	3
Ground	4,5
Case Ground	–

Specifications Subject to Change Without Notice

E-Series Surface Mount Mixer
890 – 915 MHz

ESMD-C2HX2

Features

- +17 dBm LO Power
- Up to +14 dBm RF
- Surface Mount
- High IP_3; +29 dBm typ

Specifications @ 25˚C

Frequency Range		
RF		890–915 MHz
LO		819–844 MHz
IF		71 MHz Const.
Conversion Loss		
890–915 MHz		7.5 dBm Max
Isolation		
LO to RF		
890–915 MHz		25 dBm Min
LO to IF		
890–915 MHz		15 dBm Min
3rd Order Intercept Point		
	29 dBm Typ	27 dBm Min
VSWR		
LO Port		2.0 :1 Max
RF Port		1.7 :1 Max
IF Port		2.0 :1 Max

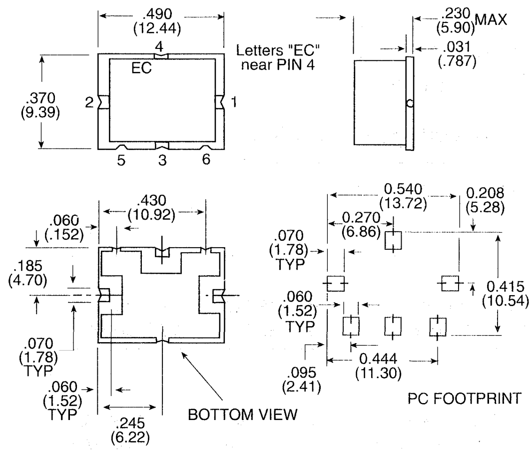
Operating Characteristics

Impedance	50 Ohms Nominal
RF Input for 1 dB Compression	+14 dBm

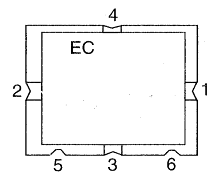
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	200 mW
Peak IF Current	40 mA
Operating/Storage Temp.	-55 °C to +100 °C
Pin Temperature (10 sec.)	+260 °C

SM-2



Pin Configuration (Top View)



Function	Pin No.
LO	2
RF	1
IF	3
Ground	4,5,6
Case Ground	–

Specifications Subject to Change Without Notice

I/Q Modulators

Overview

I/Q modulators consist of two double balanced mixers, a quadrature power divider, and an in-phase combiner configured as shown in Figure 1. The unmodulated carrier signal is applied to the input port. The in-phase and quadrature modulation signals are applied to the I and Q ports, respectively, and the resulting modulated signal emerges from the output port.

The characteristics of the modulated signal depend on the nature of the modulation inputs. Single sideband, suppressed carrier modulation results when identical analog modulation input signals are applied to the I and Q ports in quadrature phase. Constant amplitude, phase modulated output in four phase states separated by ninety degrees results when binary modulation input signals are applied in time quadrature.

The M/A-COM family of modulators covers carrier frequencies from 30 to 960 MHz, with higher frequency units in development. They are specifically designed for use in cellular radio systems with modulation frequencies up to 67 KHz, but will actually operate with much wider modulation bandwidths. They are linear at the modulation input ports and will operate in a wide variety of complex vector modulation modes.

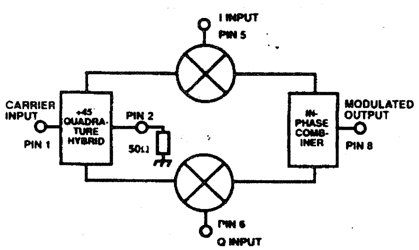


Figure 1: I/Q Modulator Block Diagram

Operation

The modulators operate at 50 ohm impedance at all ports. Optimum operation is obtained with a +10 dBm signal applied at the carrier input port. Two -7 dBm modulation inputs in phase quadrature will produce a single sideband output at -10 dBm at either of the frequencies Fc + Fm, or Fc - Fm, when the Q input leads or lags the I input, respectively, where Fc is the carrier frequency and Fm is the modulation frequency. Alternatively, digital input signals at ±100 mV will produce phase shifted carrier output at -10dBm, with four phase states separated by 90 degrees in accordance with **Table 1**.

I	Q	Phase
+100 mV	+100 mV	0°
+100 mV	-100 mV	90°
-100 mV	-100 mV	180°
-100 mV	+100 mV	270°

Table 1. Phase States

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
30 – 50 MHz

EQKR8-40W

Features

- High carrier suppression
- High 3I and 5I suppression
- Wide band

Specifications @ 25°C

Frequency Range		
(LO) Carrier		30–50 MHz
I/Q		DC–5 MHz
(LO) Carrier Suppression(1)	35 dBc Typ	30 dBc Min
SSB Rejection(1)	35 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
3 x I/Q	48 dBc Typ	45 dBc Min
5 x I/Q	58 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
LO Power		10 dBm
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

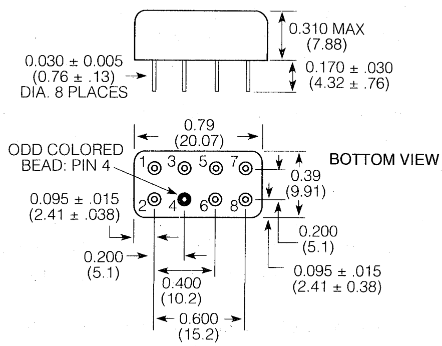
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

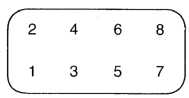
Parameter	Absolute Maximum
Operating Temp.	0°C to 70 °C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260°C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View



Function	Pin No.
LO	1
RF	8
I	5
Q	6
External 50 Ohms	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
43 – 47 MHz

EQKR8-45

Features

- High carrier suppression
- High 3I and 5I suppression

Specifications @ 25˚C

Frequency Range		
(LO) Carrier		43–47 MHz
I/Q		DC–5 MHz
(LO) Carrier Suppression(1)	37 dBc Typ	30 dBc Min
SSB Rejection(1)	36 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
3 x I/Q	48 dBc Typ	45 dBc Min
5 x I/Q	58 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
LO Power		+10 dBm
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

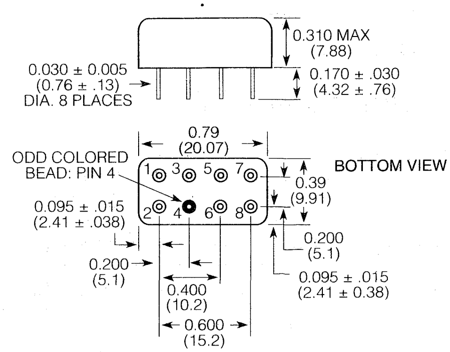
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

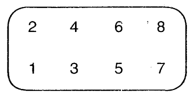
Parameter	Absolute Maximum
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260˚C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
External 50 Ohms	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

M/A-COM

E-Series I/Q Modulator
50 – 90 MHz

EQKR8-70W

Features
- High carrier suppression
- High 3I and 5I suppression
- Wide bandwidth

Specifications @ 25˚C

Frequency Range		
(LO) Carrier		50–90 MHz
I/Q		DC–5 MHz
(LO) Carrier Suppression(1)	35 dBc Typ	30 dBc Min
SSB Rejection(1)	35 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
±3 (I)	48 dBc Typ	45 dBc Min
±5 (I)	58 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
LO Power		+10 dBm
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

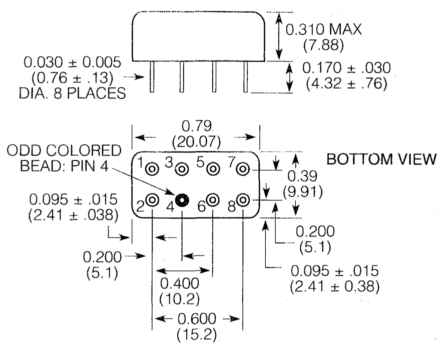
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

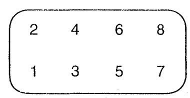
Parameter	Absolute Maximum
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260˚C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
External 50 Ohms	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
60 – 120 MHz

EQKR8-90W

Features

- High carrier suppression
- High 3I and 5I suppression
- Wide bandwidth

Specifications @ 25°C

Frequency Range		
(LO) Carrier		60–120 MHz
I/Q		DC–5 MHz
(LO) Carrier Suppression(1)	35 dBc Typ	30 dBc Min
SSB Rejection(1)	36 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
3 x I/Q	50 dBc Typ	45 dBc Min
5 x I/Q	60 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
(LO) Carrier Power		+10 dBm
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

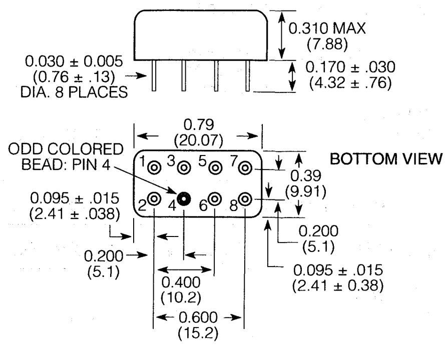
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

Parameter	Absolute Maximum
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260°C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)

2	4	6	8
1	3	5	7

Function	Pin No.
(LO) Carrier	1
RF	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
86 — 95 MHz

EQKR8-91

Features

- High carrier suppression
- High 3I and 5I suppression

Specifications @ 25˚C

Frequency Range		
(LO) Carrier		86–95 MHz
I/Q		DC–5 MHz
(LO) Carrier Suppression(1)	38 dBc Typ	30 dBc Min
SSB Rejection(1)	38 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
3 x I/Q	50 dBc Typ	45 dBc Min
5 x I/Q	60 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
(LO) Carrier Power		+10 dBm nominal
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

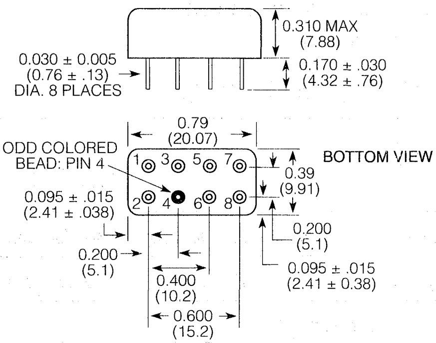
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

Parameter	Absolute Maximum
Operating Temp.	0 °C to 70 °C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260°C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)

2	4	6	8
1	3	5	7

Function	Pin No.
(LO) Carrier	1
RF	8
I	7
Q	4
Case Ground	2,3,5,6

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
90 – 150 MHz

EQKR8-120W

Features

- High carrier suppression
- High 3I and 5I suppression
- Wide band

Specifications @ 25˚C

Frequency Range		
(LO) Carrier		90–150 MHz
I/Q		DC–5 MHz
(LO) Carrier Suppression(1)	37 dBc Typ	30 dBc Min
SSB Rejection(1)	36 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
3 x I/Q	48 dBc Typ	45 dBc Min
5 x I/Q	58 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
(LO) Carrier Power		+10 dBm
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

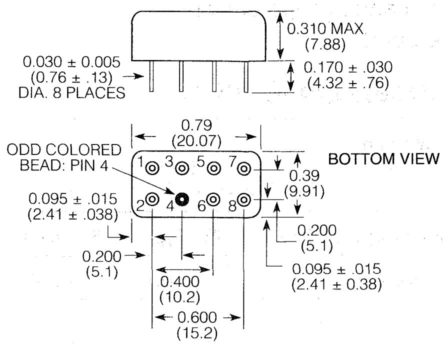
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

Parameter	Absolute Maximum
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260˚C

R-1



WEIGHT (APPROX.): 0.16 OUNCES, 4.4 GRAMS

Pin Configuration (Top View)

2	4	6	8
1	3	5	7

Function	Pin No.
(LO) Carrier	1
RF	8
I	5
Q	6
External 50 Ohms	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

M/A-COM

E-Series I/Q Modulator
147 – 175 MHz

EQKR8-160W

Features
- High carrier suppression
- High 3I and 5I suppression
- Wide band

Specifications @ 25°C

Frequency Range		
(LO) Carrier	147–175 MHz	
I/Q	DC–270 KHz	
(LO) Carrier Suppression(1)	40 dBc Typ	35 dBc Min
SSB Rejection(1)	40 dBc Typ	35 dBc Min
Harmonic Suppression(1)		
3 x I/Q	40 dBc Typ	38 dBc Min
5 x I/Q	60 dBc Typ	55 dBc Min
Conversion Loss	5 dB Typ	6 dB Max
(LO) Carrier Power		10 dBm
I/Q Drive Level		-7 dBm

Note (1): Related to wanted sideband power

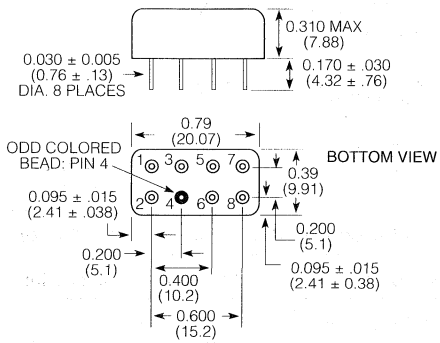
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

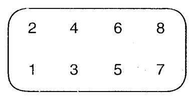
Parameter	Absolute Maximum
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260°C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
RF	8
I	5
Q	6
External 50 Ohms	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
840 MHz

EKIN2-840

Features

- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25°C[1]

Frequency Range	
(LO) Carrier	840 ± 10 MHz
I/Q	270 KHz
(LO) Carrier Suppression[2]	30 dBc Min
SSB Rejection[2]	30 dBc Min
Harmonic Suppression[2]	
3 x I/Q	38 dBc Min
5 x I/Q	55 dBc Min
Conversion Loss	7.5 dB Max
LO Power	+10 dBm ± 1dB
I/Q Drive Level	-10 dBm

Notes:

1. When Q = +90° relative to I; Lower sideband is suppressed
2. Related to wanted sideband power.

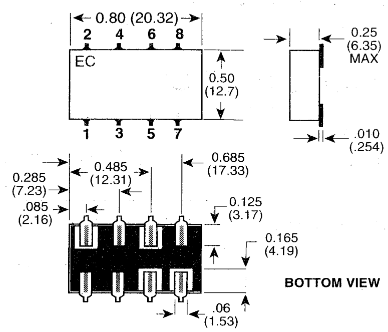
Operating Characteristics

Impedance	
LO Port	50 Ohms Nom
Output Port	50 Ohms Nom
I/Q Port	50 Ohms Nom

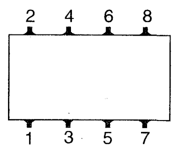
Absolute Maximum Ratings

Parameter	Absolute Maximum
Tempature Range	0°C to +55 °C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
Case Ground	2,3,4,7

M/A-COM

E-Series I/Q Modulator
869 – 894 MHz
EKIN2-880

Features

- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25°C[1]

Frequency Range	
(LO) Carrier	869-894 MHz
I/Q	270 KHz
(LO) Carrier Suppression[2]	30 dBc Min
SSB Rejection[2]	30 dBc Min
Harmonic Suppression[2]	
3 x I/Q	38 dBc Min
5 x I/Q	55 dBc Min
Conversion Loss	7.5 dB Max
LO Power	+10 dBm ± 1dB
I/Q Drive Level	-10 dBm

Notes:
1. When Q = +90° relative to I; Lower sideband is suppressed
2. Related to wanted sideband power.

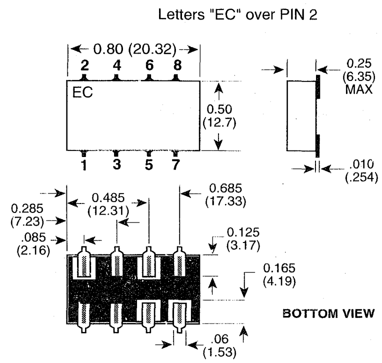
Operating Characteristics

Impedance	
LO Port	50 Ohms Nom
Output Port	50 Ohms Nom
I/Q Port	50 Ohms Nom

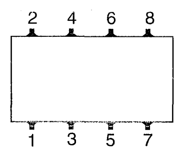
Absolute Maximum Ratings

Parameter	Absolute Maximum
Tempature Range	0°C to +55 °C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
869 – 894 MHz

EQKS8-880

Features

- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25˚C[1]

Frequency Range	
(LO) Carrier	869–894 MHz
I/Q	DC–2 MHz
(LO) Carrier Suppression[2]	34 dBc Min
SSB Rejection[2]	36 dBc Min
Harmonic Suppression[2]	
3 x I/Q	37 dBc Min
5 x I/Q	55 dBc Min
Conversion Loss	11 dB Max
LO Power	+10 dBm ±1 dB
I/Q Drive Level	-7 dBm

Note 1. When Q = +90 ° relative to I; Lower sideband is suppressed
2. Related to wanted sideband power.

Operating Characteristics

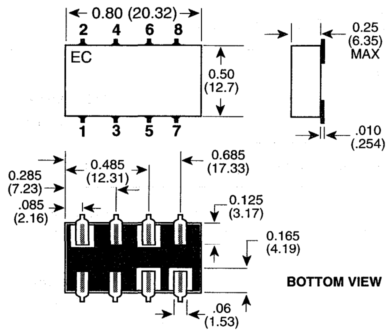
Impedance	
LO Port	50 Ohms Nom
Output Port	50 Ohms Nom
I/Q Port	50 Ohms Nom

Absolute Maximum Ratings

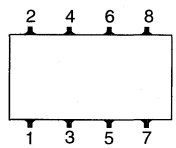
Parameter	Absolute Maximum
Operating Temp.	0˚C to +70 °C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260˚C

SM-7-1

Letters "EC" over PIN 2



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
Termination	2*
Case Ground	3,4,7

*Internal 50 Ohm Termination.
Pin 2 must be connected to circuit grand.

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
890 – 915 MHz

EQKR8-900

Features

- High carrier suppression
- High 3I and 5I suppression

Specifications @ 25˚C

Frequency Range		
(LO) Carrier		890–915 MHz
I/Q		DC–1 MHz
(LO) Carrier Suppression(1)	35 dBc Typ	30 dBc Min
SSB Rejection(1)	36 dBc Typ	30 dBc Min
Harmonic Suppression(1)		
3 x I/Q	50 dBc Typ	45 dBc Min
5 x I/Q	65 dBc Typ	60 dBc Min
Conversion Loss	6 dB Typ	7 dB Max
(LO) Carrier Power		10±1 dBm
I/Q Drive Level		-7 dBm Nominal

Note (1): Related to wanted sideband power

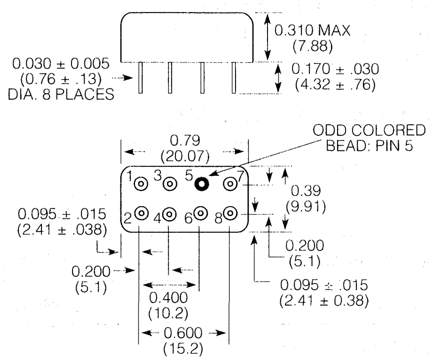
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

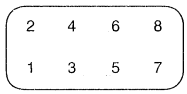
Parameter	Absolute Maximum
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260˚C

R-14



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
RF Out	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
925 – 960 MHz

EKIN-960

Features

- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25˚C[1]

Frequency Range	
(LO) Carrier	925-960 MHz
I/Q	DC–270 KHz
(LO) Carrier Suppression[2]	30 dBc Min
SSB Rejection[2]	30 dBc Min
Harmonic Suppression[2]	
3 x I/Q	40 dBc Min
5 x I/Q	60 dBc Min
Conversion Loss	10 dB Max
LO Power	+10 dB ±0.5dB
I/Q Drive Level	-10 dBm

Notes:
1. When Q = +90˚ relative to I; lower sideband is suppressed.
2. Related to wanted sideband power.

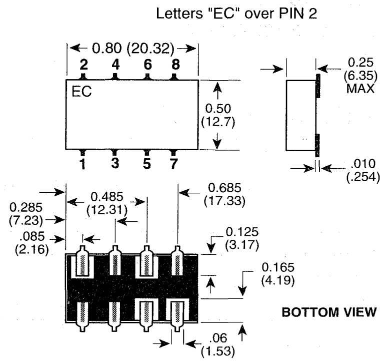
Operating Characteristics

Impedance	
LO Port	50 Ohms Nom
Output Port	50 Ohms Nom
I/Q Port	50 Ohms Nom

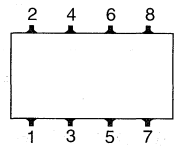
Absolute Maximum Ratings

Parameter	Absolute Maximum
Tempature Range	-10˚C to +85 °C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
925 – 960 MHz

EQKS8-960

Features
- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25˚C

Frequency Range		
(LO) Carrier		925–960 MHz
I/Q		DC–1 MHz
(LO) Carrier Suppression	35 dBc Typ	30 dBc Min
SSB Rejection	36 dBc Typ	30 dBc Min
Harmonic Suppression		
3 x I/Q	50 dBc Typ	40 dBc Min
5 x I/Q	65 dBc Typ	60 dBc Min
Conversion Loss	9 dB Typ	10 dB Max
(LO) Carrier Power		10±1 dBm
I/Q Drive Level		-7 dBm Nominal

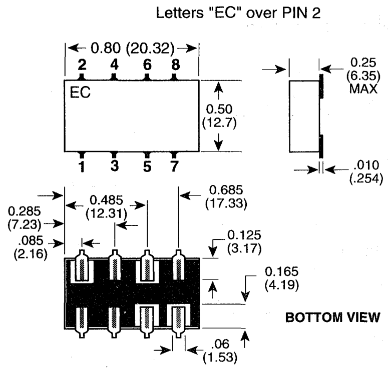
Operating Characteristics

Impedance	50 Ohms Nominal

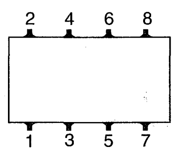
Absolute Maximum Ratings

Parameter	Absolute Maximum
Peak IF Current	40 mA
Operating Temp.	0°C to 70°C
Storage Temp.	-55 °C to +100 °C
Pin Temp (10 sec)	260˚C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
RF Out	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
925 – 960 MHz

EKIN2-960

Features
- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25°C[1]

Frequency Range	
(LO) Carrier	925-960 MHz
I/Q	270 KHz
(LO) Carrier Suppression[2]	30 dBc Min
SSB Rejection[2]	30 dBc Min
Harmonic Suppression[2]	
3 x I/Q	40 dBc Min
5 x I/Q	55 dBc Min
Conversion Loss	+10 dB Max
LO Power	+10 dBm ±0.5dB
I/Q Drive Level	-10 dBm

Notes:
1. When Q = +90° relative to I; lower sideband is suppressed
2. Related to wanted sideband power.

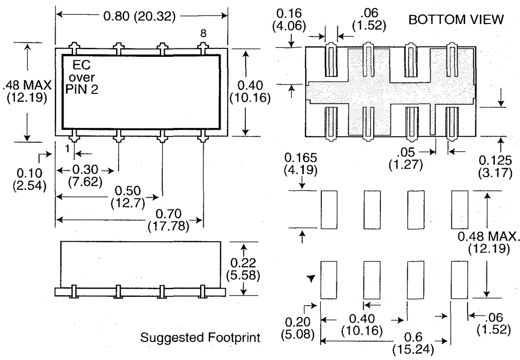
Operating Characteristics

Impedance	
LO Port	50 Ohms Nom
Output Port	50 Ohms Nom
I/Q Port	50 Ohms Nom

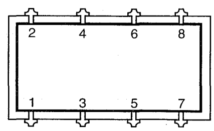
Absolute Maximum Ratings

Parameter	Absolute Maximum
Tempature Range	-10°C to +85°C

SM-27



Pin Configuration (Top View



Function	Pin No.
LO	1
RF	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Modulator
1074 – 1090 MHz

EKIN-1082

Features

- High carrier suppression
- High 3I and 5I suppression
- Surface Mount

Specifications @ 25˚C[1]

Frequency Range	
(LO) Carrier	1074-1090 MHz
I/Q	DC–1 MHz
(LO) Carrier Suppression[2]	30 dBc MIn
SSB Rejection[2]	30 dBc Min
Harmonic Suppression[2]	
3 x I/Q	40 dBc Min
5 x I/Q	50 dBc Min
Conversion Loss	7.5 dB Max
LO Power	+10 dBm ±1dB
I/Q Drive Level	-10 dBm

Notes:

1. When Q = +90˚ relative to I; lower sideband is suppressed
2. Related to wanted sideband power.

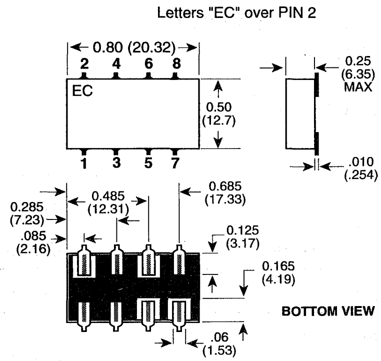
Operating Characteristics

Impedance	
LO Port	50 Ohms Nom
Output Port	50 Ohms Nom
I/Q Port	50 Ohms Nom

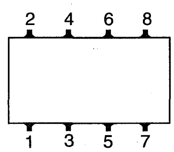
Absolute Maximum Ratings

Parameter	Absolute Maximum
Tempature Range	0˚C to 70 °C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
LO	1
RF	8
I	5
Q	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Demodulator
10 MHz

EKIN-10D

Features

- Surface mount
- Excellent phase and amplitude balance

Specifications @ 25˚C[1]

Frequency Range	
(LO) Carrier, IF	10 MHz
I/Q	DC–1 MHz
Conversion Loss[2]	8 dB Max
Isolation	
LO to RF	50 dB Min
LO to I/Q	50 dB Min
Amplitude Unbalance (I/Q)	±0.5 dB Max
Phase Unbalance (I/Q)	±1 ° Max
(LO) Carrier Power	10 dBm

Notes:
1. Q = I + 90° for RF > LO
2. (RF - I/Q Out) = (RF Power - (I + Q) Power)

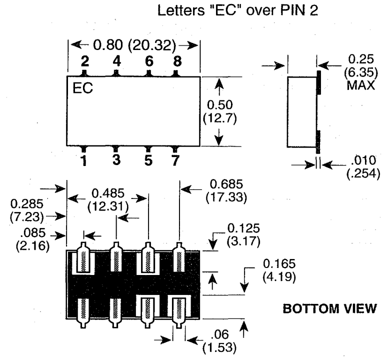
Operating Characteristics

Impedance	50 Ohms Nominal
RF Power (1 dB Compression)	+3 dBm

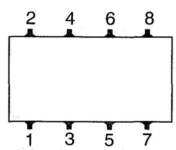
Absolute Maximum Ratings

Parameter	Absolute Maximum
Operating Temature	0°C to + 70°C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
RF (in)	8
I (0°)	5
Q (90°)	6
Case Ground	2,3,4,7

M/A-COM

E-Series I/Q Demodulator 220 – 225 MHz

EKIN-222.5D

Features

- Surface mount
- Excellent phase and amplitude balance

Specifications @ 25°C[1]

Frequency Range (LO) Carrier, IF I/Q	 220-225 MHz DC–1 MHz
Conversion Loss[2]	7 dB Max
Isolation LO to RF LO to I/Q	 40 dB Min 60 dB Min
Amplitude Unbalance	±0.5 dB Max
Phase Unbalance	±1.5 ° Max
(LO) Carrier Power	+10 dBm

Notes:

1. Q = I - 90° for RF > LO
2. (RF Power - (I + Q) Power)

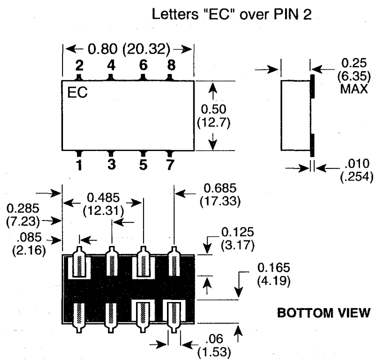
Operating Characteristics

Impedance	50 Ohms Nom
RF Power (1 dB Compression)	+3 dBm

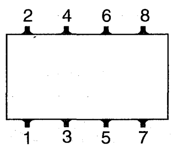
Absolute Maximum Ratings

Parameter	Absolute Maximum
Operating Tempature	0 °C to +70 °C

SM-7-1



Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
IF (in)	8
I (0°)	5
Q (90°)	6
Case Ground	2,3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Demodulator
70.2 MHz

EKIN-70D

Features

- Surface mount
- Excellent phase and amplitude balance

Specifications @ 25˚C

Frequency Range	
(LO) Carrier, IF	70.2 MHz
I/Q	DC–1 MHz
Insertion Loss	10 dB Max
VSWR (LO/RF)	1.5
Conversion Loss (RF - I/Q Out)	10dB Max
Isolation	
LO to IF	40 dB Min
LO to I/Q	30 dB Min
Amplitude Unbalance (I/Q)	±0.5 dB Max
Phase Unbalance (I/Q)	±1 ° Max
(LO) Carrier Power	10±2 dBm

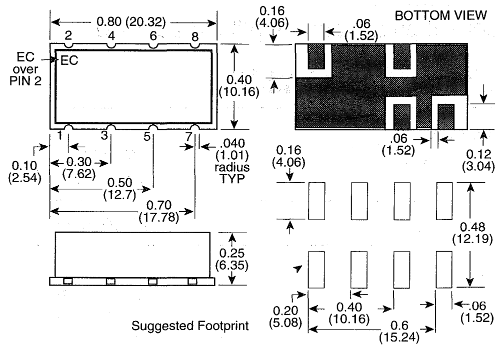
Operating Characteristics

Impedance	50 Ohms Nom
IF Power (1 dB Compression)	+3 dBm

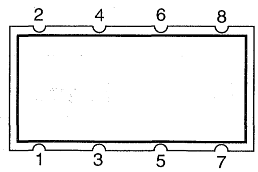
Absolute Maximum Ratings

Operating Tempature	0˚C to +70 °C
Storage Tempature	-40 °C to +85 °C

SM-25



Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
IF (in)	8
I (0°)	5
Q (90°)	6
Not used	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

E-Series I/Q Demodulator
70.2 MHz

EQKS8-70DI

Features
- Surface mount
- Excellent phase and amplitude balance

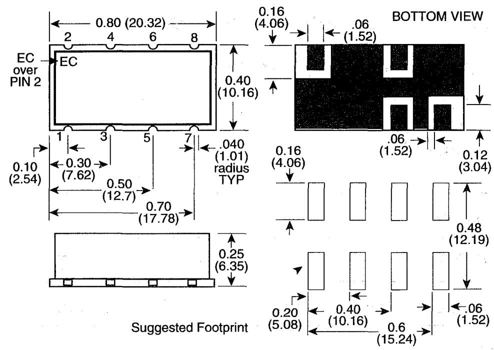
Specifications @ 25˚C

Frequency Range	
(LO) Carrier, IF	70.2 MHz
I/Q	DC–1 MHz
Insertion Loss	10 dB Max
Isolation	
LO to IF	40 dB Min
LO to I/Q	30 dB Min
Amplitude Unbalance	±0.5 dB Max
Phase Unbalance	±1 ° Max
(LO) Carrier Power	10±2 dBm

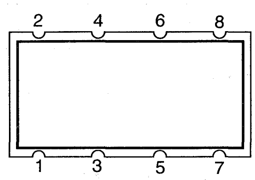
Operating Characteristics

Impedance	50 Ohms Nominal
IF Power (1 dB Compression)	+3 dBm

SM-25



Pin Configuration (Top View)



Function	Pin No.
(LO) Carrier	1
IF (in)	8
I (0°)	5
Q (90°)	6
Not used	2
Case Ground	3,4,7

Specifications Subject to Change Without Notice

Power Dividers/Splitters/Combiner

Overview

Introduction

A power divider is ideally a lossless reciprocal device which can also perform vector summation of two or more signals and thus is sometimes called a power combiner or summer. Two forms of power dividers are considered in this discussion; binary and N-way. A binary power divider is composed of one or more terminated 180° hybrids and may have 2, 4, 8, 16, --- 2N outputs. An N-way power divider has an odd number of outputs, generally 3, and utilizes a unique patented transformer circuit for frequencies below 1 GHz. Although power dividers could be composed of 90° hybrids, the term normally refers to a device that splits an input signal into two or more in-phase outputs. The purpose of this article is to provide the designer with basic information describing the function of these devices and to define the performance parameters and trade-offs critical to specifying a power divider.

Functional Description

Binary Power Dividers

A binary power divider is in fact an internally terminated 180° hybrid. **Figure 1** shows the standard diagram for a 180° hybrid with a termination at Port A.

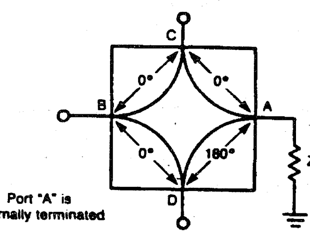


Figure 1. *2-Way, In-Phase (0°) Power Divider/Summer, or ISO-T*

Physically, the 2-way power divider appears to be a three terminal device, since the Z_O termination at Port A is normally mounted inside the package. Also, although a conventional 180° hybrid can be used as a power divider, the usual form of 2-way power divider does not have a Z_O impedance level at all four ports. **Figure 2** shows a simplified, schematic for a transformer design realization of a 2-way power divider together with impedance, voltage and current levels. Elements such as shunt capacitors, used to tune out the parasitic elements of non-ideal transformers, are not shown.

The internal termination shown as Z_O to ground on Port A in **Figure 2** is actually realized by connecting a termination equal to 2 Z_O between ports C and D. This structure is utilized because of its greater simplicity and the fact Port A,

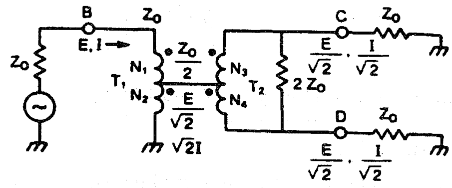


Figure 2.

the difference port, does not need to be used externally. Port A can be thought of as a balanced output of impedance 2 Z_O which has been terminated. T1 is an autotransformer which steps the Z_O impedance at Port B down to $Z_O/2$ at its tap. Its turns ratio must be equal to the square root of the desired impedance ratio. Thus,

$$\frac{N_2}{N_1 + N_2} = \sqrt{\frac{Z_O/2}{Z_O}} = \frac{1}{\sqrt{2}}$$

In practice a turns ratio approximating this value is used. T2 is a center tapped transformer; therefore N3 = N4 and thus,

$$Z_{C-D} = \left(\frac{N_3 + N_4}{N_4}\right)^2 \frac{Z_O}{2} = \frac{2^2 Z_O}{2} = 2\,Z_O$$

The use of an internal termination of 2 Z_O satisfies the required conditions for impedance match at all ports.

Higher order binary power dividers, such as 4-way and 8-way power dividers, are realized by cascading 2-way dividers of various circuit configurations. The functional diagram for a 4-way divider is shown in **Figure 3** while the 8-way diagram would simply have the "B" port of additional 2-way dividers connected at ports 1, 2, 3, and 4.

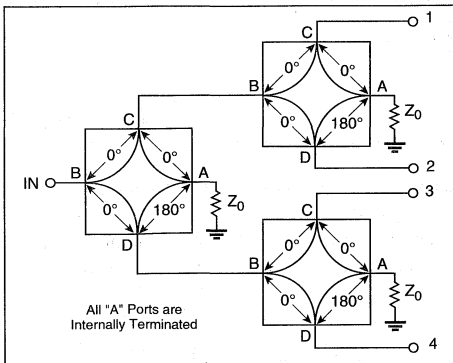


Figure 3. 4-Way Divider Functional Diagram

N-Way Dividers

Power dividers having an odd number of outputs (3, 5, 7, etc.) are sometimes classified as N-way power dividers. Because of the complexity of higher order circuits, the 3-way power divider is the only type of this class of divider normally used. The circuit actually used to realize a true 3-way divider, as opposed to a terminated 4-way power divider, is a unique transformer circuit covered by U.S. patent number 3,428,920. It is beyond the scope of this article to review in detail the transformer operation of this circuit, however, **Figure 4** shows a functional diagram of a 3-way power divider.

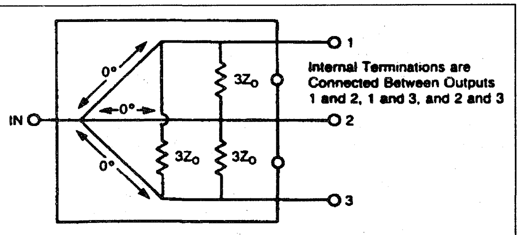


Figure 4. 3-Way Power Divider Functional Diagram

The transformer circuit is interconnected in such a manner as to produce three mutually isolated outputs. Three internal terminations of value 3 Z_O must be connected between ports 1 and 2, 1 and 3, and 2 and 3 in order to maintain port match and port-to-port isolation. We can see the operation of the divider by considering signals injected at two ports.

First, if we inject a signal at the input with outputs 1, 2, and 3 loaded in ZO, three equal phase and amplitude outputs appear at ports 1, 2, and 3. Since all signals are equal, no voltage differential appears across the internal terminations and thus no power is dissipated in them.

In the second case, if we inject a signal at output 1 with all other ports terminated in Z_O, 1/3 of the current will flow in the 3 Z_O internal terminations connected between ports 1 and 2, and 1 and 3, and 1/3 will flow directly into the transformer connection at port 1. The power injected is I2 Z_O, while the power dissipated in each of the internal terminations is (I/3)2 (3 Z_O) = 1/3 I2 Z_O. Thus 2/3 of the power is lost in the internal loads and 1/3 appears at the input. This satisfies the requirement for a lossless reciprocal device.

Performance Parameters

The critical parameters in selecting a power divider are normally frequency range, insertion loss, isolation and VSWR. In addition to these parameters the following two parameters are often specified and are related to the power rating of the internal load resistors.

Matched Power Rating or Input Power

This is the highest power level that can be applied to the input and still maintain other performance limits. It is stated with Z_O terminations on all outputs to avoid reflected signals from unbalanced loads which may exceed the limit for power dissipation in the internal terminations.

Internal Load Dissipation

This is simply the power rating of any one of the internal terminations. These two parameters are related and the input power rating is normally several times larger than the internal load dissipation. The reason for this is intuitively obvious since most of the input power is delivered to the output loads, not the internal termination.

There are three considerations affecting the amount of input power that a power divider can withstand.

I. Insertion Loss

The first consideration is the total power dissipated in the power divider. Total power dissipation in a power divider under matched conditions can be determined to a reasonable approximation from the insertion loss and the known input power as follows:

Insertion Loss (dB) = 10 log PinPout
Therefore:

$$P_{OUT} = \frac{P_{IN}}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}$$

$$P_{Dissipated} = P_{IN} - P_{OUT}$$

$$= P_{IN} - \frac{P_{IN}}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}$$

$$= P_{IN}\left(1 - \frac{1}{10^{\left(\frac{\text{Ins. Loss}}{10}\right)}}\right)$$

As an example, consider a power divider with the following conditions

$$\text{Ins. Loss} = 0.5\ \text{dB}$$

$$P_{IN} = 2\ \text{Watts}$$

$$P_{Dissipated} = 2\left(1 - \frac{1}{10^{\frac{.5}{10}}}\right)$$

$$= .218\ \text{Watts}$$

Most of this power will be dissipated in the wire and ferrite cores making up the transformer circuits and not in the internal load.

II. Amplitude Balance

In a power divider operating under matched conditions, a second consideration for input power dissapation is the dissapated power in the internal load. If we consider a 2-Way power divider similar to that shown in **Figure 1**, we observe that ideally no power would be dissipated in the 2 Z_O load between Ports C and D, because the voltages at C and D would be equal. In practice, a small differential may occur because of imperfect Amplitude Balance. The approximate dissipation due to this unbalance can be calculated from the following:

Let Voltage at Port C = VC
Let Voltage at Port D = VD
Let Power at Port C = PC
Let Power at Port D = PD

If we make the simplifying assumption:

$$P_D = \frac{V_D^2}{Z_O} \cong \frac{P_{OUT}}{2}$$

then 1)

$$V_D \cong \sqrt{\frac{P_{OUT\,(Z_O)}}{2}}$$

The relationship for Amplitude Balance is as follows:

$$\text{Amp Bal (dB)} = 10\ \text{Log}\ \frac{P_C}{P_d} = 20\ \text{Log}\ \frac{V_C}{V_d}$$

$$\text{Therefore } V_C = V_D\, 10^{\left(\frac{\text{Amp Bal}}{20}\right)}$$

$$\text{and } V_C - V_D = V_D\, 10^{\left(\frac{\text{Amp Bal}}{20}\right)} - V_D$$

$$= V_D\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)$$

Substituting from 1)

2)
$$V_C - V_D \cong \sqrt{\frac{P_{OUT\,(Z_O)}}{2}}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)$$

This gives the voltage drop across the internal termination of 2 Z_O between C and D. The power dissipated in this load is then given by the following:

$$P_{INT\ LOAD} = \frac{(V_C - V_D)^2}{2\,Z_O}$$

$$\cong \frac{1}{2\,Z_O}\left[\sqrt{\frac{P_{OUT\,(Z_O)}}{2}}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)\right]^2$$

or 3)

$$P_{INT\ LOAD} \cong \frac{P_{OUT}}{4}\left(10^{\left(\frac{\text{Amp Bal}}{20}\right)} - 1\right)^2$$

A very small amount of power normally is dissipated due to this effect. Consider the following example:
Let

$$P_{OUT} = 2 \text{ Watts}$$
$$\text{Amp Bal} = .25 \text{ dB}$$
$$P_{INT\ LOAD} \cong \tfrac{1}{2}\left(10^{\frac{.25}{20}} - 1\right)^2$$
$$= 0.4 \text{ mW}$$

III. When determining input power limits, the third and perhaps most important case to consider is the condition of mismatched loads at the outputs of the power divider. Reflections from these mismstches can cause a considerably larger voltage differential to appear across the internal load. If the VSWR of the two loads is K_1, and K_2, the limit on input heat power P_{IN}, is given in the following:

$$P_{IN} \leqslant \frac{\text{Internal Load Rating (Watts)}}{\left[\frac{K_1 - 1}{K_1 + 1}\right]^2 + \left[\frac{K_2 - 1}{K_2 + 1}\right]^2}$$

As an example, if the internal load rating is 0.5 Watts and the VSWR of K_1 and K_2 is 2.0:1 then:

$$P_{IN} \leqslant \frac{0.5}{\left[\frac{2 - 1}{2 + 1}\right]^2 + \left[\frac{2 - 1}{2 + 1}\right]^2}$$
$$\leqslant 2.25 \text{ Watts}$$

This is the worst case formula, which assumes that the two load reflections are out of phase at the output port. If they are identical impedances, P_{IN} may be several times larger without causing damage.

From the preceeding discussion of power divider input power ratings, we can draw two conclusions:

1. Under matched loading conditions (Z_O terminations at all ports) the input power is limited by heating effects in the ferrite transformers, not by the internal load dissipation. Absolute maximum temperatures for ferrite core transformers are limited by the curie temperature of the ferrite, generally in 130°C to 500°C range, and the temperature rating of the magnet wire which is usually 130°C. It is advisable to stay well below these temperature limits (20°C or more) to avoid performance degradation, particularly increased insertion loss. The actual temperature rise in the ferrite core is dependent on the heat transfer path from the core to the heat sink or surrounding air. This determination involves measuring or calculating the thermal resistance, q, expressed in °C/Watt of this path. Thermal resistance will be highly dependent on the mounting of the power divider as well as its internal construction. For this reason, manufacturers normally provide a very conservative maximum input power rating that applies under absolute worst case conditions with no specific heatsinking of the unit. In many instances powers several times higher than this rating can be applied with little, if any, performance degradation.

2. Under conditions where mismatches are present at the power divider output, the internal load power dissipation rating may limit the input power that can be applied. A simple worst case calculation can be performed to determine if this is the case using the formula provided.

A final point relative to power ratings that should be considered is the application as a power summer. In this case signals are applied to the ports we have been calling outputs (for example Ports C and D in **Figure 2**) with the vector sum appearing at the input or S port (Port B in Figure 6). In this case equal signals are normally applied, and little if any power is dissipated in the internal load. A possible condition may occur where one or more of the signal sources fails or is removed. For example, if two equal sources are applied at Ports C and D and the source at D fails, 50% of the power supplied by the source at C will be dissipated in the 2 Z_O internal load. Thus the power injected at each port should not exceed twice the rating of the internal load to avoid this condition.

Performance Trade-offs

Since power dividers are low loss passive devices, few trade-offs in performance are possible once the frequency range is selected. One trade-off that is sometimes possible is between isolation and VSWR. If we consider the 2-way divider schematic of **Figure 2**, we see that an internal load of 2 Z_O is shown between Ports C and D. This is correct for an ideal lossless transformer circuit, however the actual transformers have parasitic dissipative and reactive elements. For this reason the value of the 2 Z_O load is sometimes varied and additional small amounts of shunt capacitance and series inductance are added in an attempt to optimize VSWR and isolation. The optimum compensation for isolation is often slightly different than that required for VSWR. In fact, it is possible over limited frequency ranges to improve isolation by in effect "balancing the bridge" while VSWR may be slightly degraded.

Conclusions

Power dividers are often considered the simplest of the many RF devices that may be required in designing a system, and in some respects this is true. Despite the functional simplicity of power dividers and generally rugged and reliable components used in their construction, their specification and application in systems can still lead to unexpected problems.

In this article we have presented some basic information to give the system designer insight into the internal construction of power dividers and how this influences the operation of the device and its function in the real world of imperfect matches and less than ideal physical installation. On this latter point, the consideration of power dividers was dealt with both analytically and in terms of expected results in the normally mounted configuration. The devices described in this article are generally intended for receive rather than transmit applications and are thus quite conservatively rated for power handling. Care must be taken, however, in using them at higher powers because both internal designs and external mounting provisions are not optimally suited for transfer.

Many of the points made and expressions derived for the operation of 180° hybrids can be applied to power dividers, particularly 2-way power dividers, and questions that may arise pertaining to points not covered in this article, such as isolation in the presence of mismatch or other signal flow relationships, can be analyzed by reference to the tables contained in that article.

E-Series 2-Way 0° Power Splitter
0.1 – 400 MHz

ES-2-1

Features

- 2-Way
- 0 Degree
- Wide band

Specifications @ 25˚C

Frequency Range		0.1–400 MHz
Insertion Loss		
0.1–1 MHz	0.2 dB Typ	0.6 dB Max
1–200 MHz	0.4 dB Typ	0.75 dB Max
200–400 MHz	0.6 dB Typ	1.0 dB Max
Isolation		
0.1–1 MHz	20 dB Typ	15 dB Min
1–200 MHz	25 dB Typ	20 dB Min
200–400 MHz	25 dB Typ	20 dB Min
Amplitude Unbalance		
0.1–1 MHz		0.15 dB Max
1–200 MHz		0.2 dB Max
200–400 MHz		0.4 dB Max
Phase Unbalance		
0.1–1 MHz		2° Max
1–200 MHz		3° Max
200–400 MHz		4° Max

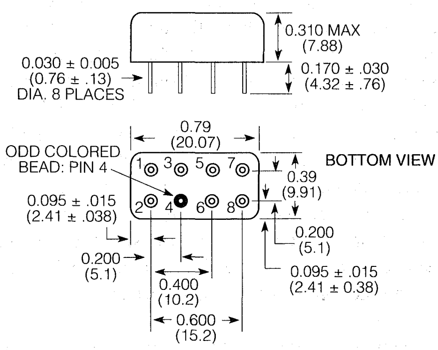
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

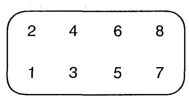
Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C
Pin Temp (10 sec)	260˚C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View



Function	Pin No.
Sum Port	1
Port 1	5
Port 2	6
Ground	2,3,4,7,8

Specifications Subject to Change Without Notice

E-Series 2-Way 0° Power Splitter
0.1 – 450 MHz

ESM-2-1

Features
- 2-Way
- 0 Degree
- Wide band

Specifications @ 25˚C

Frequency Range		0.1–450 MHz
Insertion Loss		
0.1–1 MHz	0.3 dB Typ	0.5 dB Max
1–225 MHz	0.4 dB Typ	0.75 dB Max
225–450 MHz	0.6 dB Typ	1.0 dB Max
Isolation		
0.1–1 MHz	20 dB Typ	15 dB Min
1–225 MHz	30 dB Typ	20 dB Min
225–450 MHz	30 dB Typ	20 dB Min
Amplitude Unbalance		
0.1–1 MHz		0.15 dB Max
1–225 MHz		0.2 dB Max
225–450 MHz		0.3 dB Max
Phase Unbalance		
0.1–1 MHz		2° Max
1–225 MHz		3° Max
225–450 MHz		4° Max

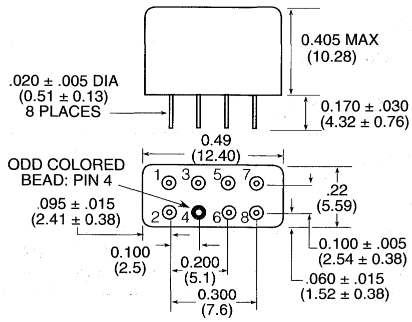
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

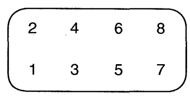
Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C
Pin Temp (10 sec)	260˚C

R-6



WEIGHT(APPROX.): 0.06 OUNCES 1.6 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Sum Port	1
Port 1	5
Port 2	6
Ground	2,3,4,7,8

Specifications Subject to Change Without Notice

E-Series 2-Way 0° Power Splitter
1 – 400 MHz

EST-2-1

Features

- 2 Way
- 0 Degree
- Minature package

Specifications @ 25˚C

Frequency Range		1–400 MHz
Insertion Loss		
1–10 MHz	0.25 dB Typ	0.5 dB Max
10–200 MHz	0.4 dB Typ	0.75 dB Max
200–400 MHz	0.8 dB Typ	1.0 dB Max
Isolation		
1–10 MHz	30 dB Typ	25 dB Min
10–200 MHz	30 dB Typ	25 dB Min
200–400 MHz	30 dB Typ	20 dB Min
Amplitude Unbalance		
1–10 MHz		0.15 dB Max
10–200 MHz		0.2 dB Max
200–400 MHz		0.6 dB Max
Phase Unbalance		
1–10 MHz		2 ° Max
10–200 MHz		3 ° Max
200–400 MHz		4 ° Max

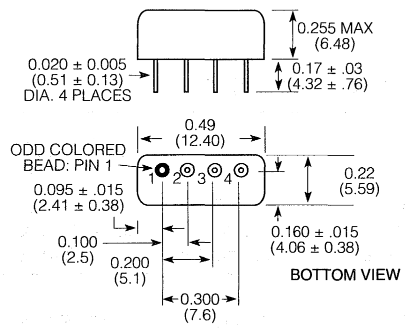
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

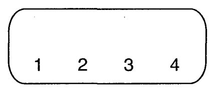
Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C
Pin Temp (10 sec)	260˚C

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Sum Port	1
Port 1	2
Port 2	4
Case Ground	3

Specifications Subject to Change Without Notice

E-Series 2-Way 0° Power Splitter 0.1 – 400 MHz

ES-2-1X1

Features

- 2-Way
- 0 Degree
- Wide band
- Surface Mount

Specifications @ 25˚C

Frequency Range		0.1–400 MHz
Insertion Loss		
0.1–1 MHz	0.2 dB Typ	0.6 dB Max
1–200 MHz	0.4 dB Typ	0.75 dB Max
200–400 MHz	0.6 dB Typ	1.0 dB Max
Isolation		
0.1–1 MHz	20 dB Typ	15 dB Min
1–200 MHz	25 dB Typ	20 dB Min
200–400 MHz	25 dB Typ	20 dB Min
Amplitude Unbalance		
0.1–1 MHz		0.15 dB Max
1–200 MHz		0.2 dB Max
200–400 MHz		0.3 dB Max
Phase Unbalance		
0.1–1 MHz		2° Max
1–200 MHz		3° Max
200–400 MHz		4° Max

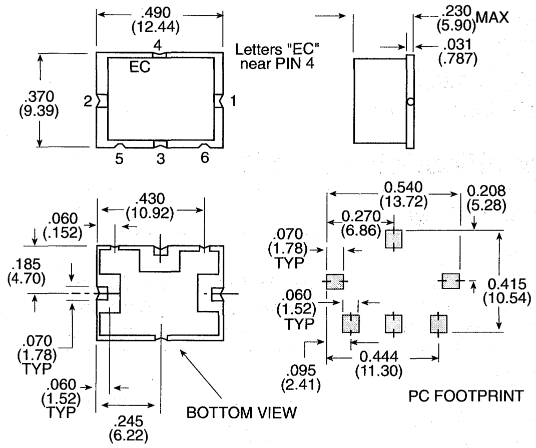
Operating Characteristics

Impedance	50 Ohms Nominal

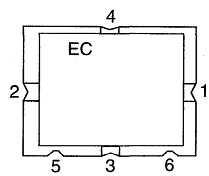
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C

SM-2



Pin Configuration (Top View)



Function	Pin No.
Sum Port	1
Port 1	3
Port 2	2
Ground	4,5,6

Specifications Subject to Change Without Notice

E-Series 2-Way 0° Power Splitter
10 – 1000 MHz

ES-2-4X1

Features
- 2-Way
- 0 Degree
- Wide band
- Surface Mount

Specifications @ 25°C

Frequency Range		10–1000 MHz
Insertion Loss		
10–100 MHz	0.6 dB Typ	0.8 dB Max
100–500 MHz	0.6 dB Typ	1.0 dB Max
500–1000 MHz	0.7 dB Typ	1.2 dB Max
Isolation		
10–100 MHz	25 dB Typ	20 dB Min
100–500 MHz	22 dB Typ	18 dB Min
500–1000 MHz	19 dB Typ	15 dB Min
Amplitude Unbalance		
10–100 MHz		0.15 dB Max
100–500 MHz		0.2 dB Max
500–1000 MHz		0.4 dB Max
Phase Unbalance		
10–100 MHz		2° Max
100–500 MHz		3° Max
500–1000 MHz		4° Max

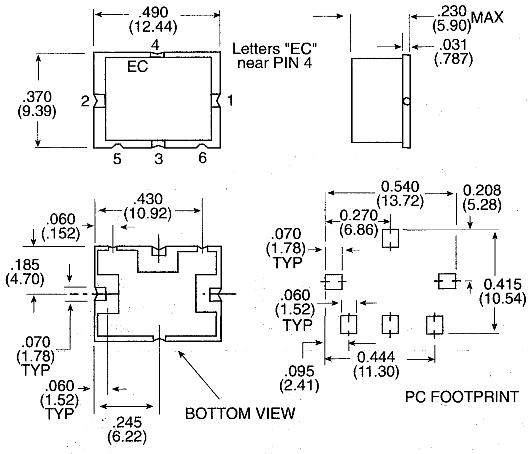
Operating Characteristics

Impedance	50 Ohms Nominal

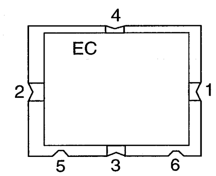
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0°C to 70°C

SM-2



Pin Configuration (Top View)



Function	Pin No.
Sum Port	3
Port 1	2
Port 2	1
Ground	4,5

Specifications Subject to Change Without Notice

E-Series 2-Way 90° Power Splitter
40 – 70 MHz

ESQ-2-70

Features

- 2-Way
- 90 Degree

Specifications @ 25˚C

Frequency Range		40–70 MHz
Insertion Loss	0.3 dB Typ	0.7 dB Max
Isolation	30 dB Typ	20 dB Min
Amplitude Unbalance		1.5 dB Max
Phase Unbalance		3° Max

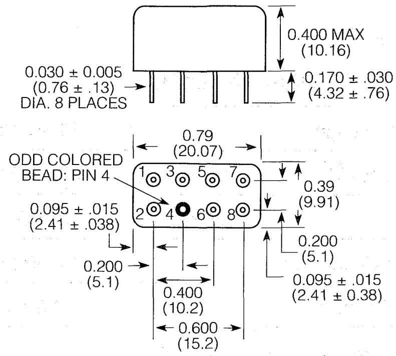
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

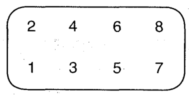
Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C
Pin Temp (10 sec)	260˚C

R-2



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Sum Port	1
Port 1	2
Port 2	5
Ground	3,4,7,8
Terminated	6

Specifications Subject to Change Without Notice

M/A-COM

E-Series 2-Way 90° Power Splitter 55 – 90 MHz

ESQ-2-90

Features

- 2 Way
- 90 Degree

Specifications @ 25˚C

Frequency Range		55–90 MHz
Insertion Loss (1)	0.3 dB Typ	0.7 dB Max
Isolation	30 dB Typ	20 dB Min
Amplitude Unbalance		1.2 dB Max
Phase Unbalance		3.0 ° Max

Note (1): average of coupled outputs less 3 dB

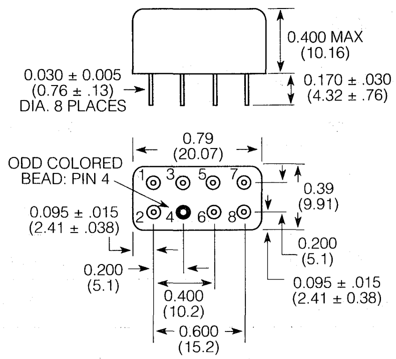
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

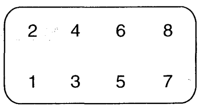
Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C
Pin Temp (10 sec)	260˚C

R-2



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Sum Port	1
Port 1	2
Port 2	5
Ground	3,4,7,8
Terminate	
50 Ohms	6

Specifications Subject to Change Without Notice

E-Series 2-Way 90° Power Splitter
40 – 70 MHz

ESQ-2-70X1

Features

- 2-Way
- 90 Degree
- Surface Mount

Specifications @ 25˚C

Frequency Range		40–70 MHz
Insertion Loss	0.3 dB Typ	0.7 dB Max
Isolation	30 dB Typ	20 dB Min
Amplitude Unbalance		0.15 dB Max
Phase Unbalance		3˚ Max

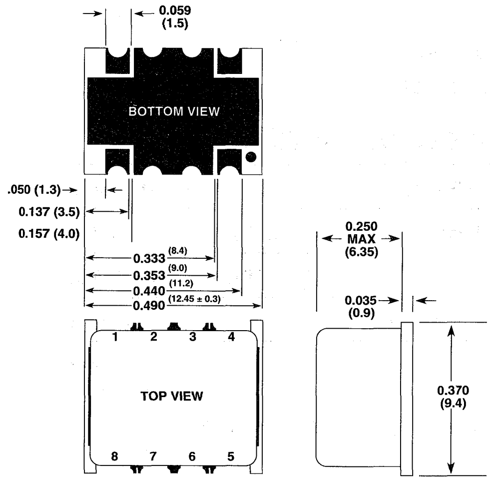
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C

SM-4



Pin Configuration (Top View)

Function	Pin No.
Sum Port	1
Port 1	5
Port 2	8
Ground	2,3,6,7
50 Ω Terminated	4

Specifications Subject to Change Without Notice

![M/A-COM]

E-Series 2-Way 90° Power Splitter
120 – 180 MHz
ESQ-2-180X1

Features
- 2-Way
- 90 Degree
- Surface Mount

Specifications @ 25˚C

Frequency Range		120–180 MHz
Insertion Loss	0.3 dB Typ	0.7 dB Max
Isolation	23 dB Typ	15 dB Min
Amplitude Unbalance		1.2 dB Max
Phase Unbalance		4° Max

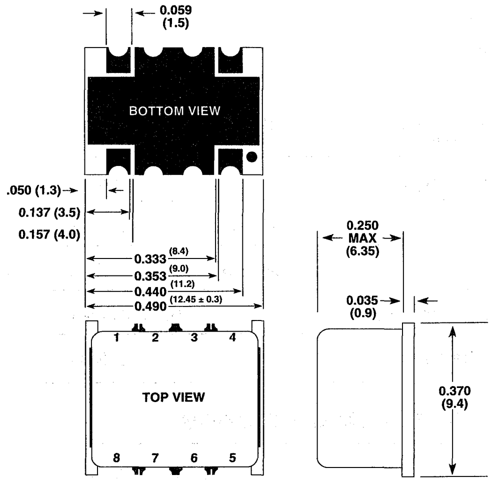
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C

SM-4



Pin Configuration (Top View)

Function	Pin No.
Sum Port	1
Port 1	5
Port 2	8
Ground	2,3,6,7
50 Ω Terminated	4

Specifications Subject to Change Without Notice

E-Series 2-Way 90° Power Splitter
820 – 980 MHz

ESQ-2-900X1

Features

- 2-Way
- 90 Degree
- Surface Mount

Specifications @ 25˚C

Frequency Range		820–980 MHz
Insertion Loss	0.6 dB Typ	1.0 dB Max
Isolation	18 dB Typ	14 dB Min
Amplitude Unbalance		1.2 dB Max
Phase Unbalance		4° Max

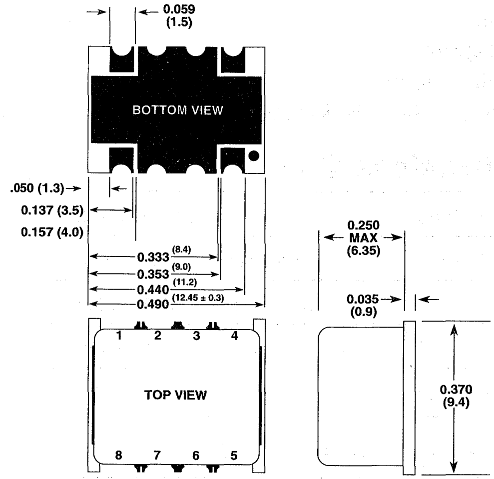
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C

SM-4



Pin Configuration (Top View)

Function	Pin No.
Sum Port	1
Port 1	5
Port 2	8
Ground	2,3,6,7
50 Ω Terminated	4

Specifications Subject to Change Without Notice

E-Series 2-Way 90° Power Splitter
820 – 980 MHz

EQSM-2-900

Features
- 2 Way
- 90 Degree
- Surface mount
- Tape and Reel Packaging Available

Specifications @ 25˚C

Frequency Range		820–980 MHz
Insertion Loss	0.7 dB Typ	1.0 dB Max
Isolation	20 dB Typ	12.5 dB Min
Amplitude Unbalance		1.0 dB Max
Phase Unbalance		7 ° Max

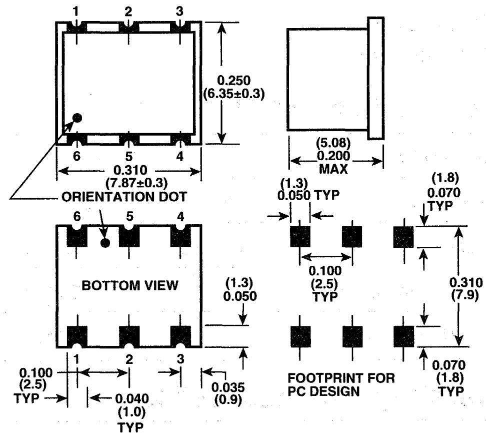
Operating Characteristics

Impedance	50 Ohms Nominal

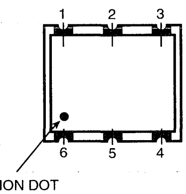
Absolute Maximum Ratings

Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0˚C to 70˚C
Pin Temp (10 sec)	260˚C

SM-1



Pin Configuration (Top View)



Function	Pin No.
Input	1
Port 1	4
Port 2	6
External 50 Ohms	3
Ground	2,5

Specifications Subject to Change Without Notice

M/A-COM

E-Series 3-Way 0° Power Splitter 1– 200 MHz

ES-3-1

Features

- 3-Way
- 0 Degree
- Wideband

Specifications @ 25°C

Frequency Range		1–200 MHz
Insertion Lossr		
1–10 MHz	0.6 dB Typ	1.0 dB Max
10–100 MHz	0.4 dB Typ	0.7 dB Max
100–200 MHz	0.6 dB Typ	1.0 dB Max
Isolations		
1–10 MHz	45 dB Typ	30 dB Min
10–100 MHz	40 dB Typ	30 dB Min
100–200 MHz	40 dB Typ	25 dB Min
Amplitude Imbalance		
1–10 MHz		0.15 dB Min
10–100 MHz		0.2 dB Min
100–200 MHz		0.3 dB Min
Phase Unbalance		
1–10 MHz		1° Max
10–100 MHz		2° Max
100–200 MHz		4° Max

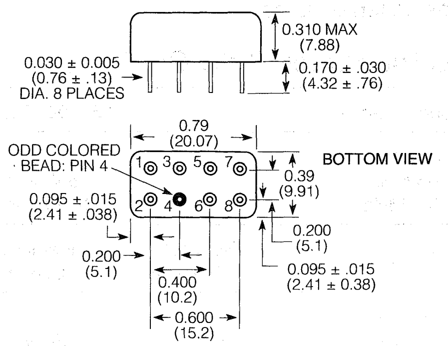
Operating Characteristics

Impedance	50 Ohms Nominal

Absolute Maximum Ratings

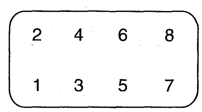
Parameter	Absolute Maximum
Maximum Power Rating	1 watt
Internal Load Dissapation	0.125w
Operating Storage Temp	0°C to 70°C
Pin Tempature	260°C

R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Sum Port	6
Port 1	1
Port 2	2
Port 3	5
Ground	3,4,7,8

Specifications Subject to Change Without Notice

E-Series Coupler
0.5 – 500 MHz

EPDC-10-1

Features
- Wideband
- Low Insertion Loss

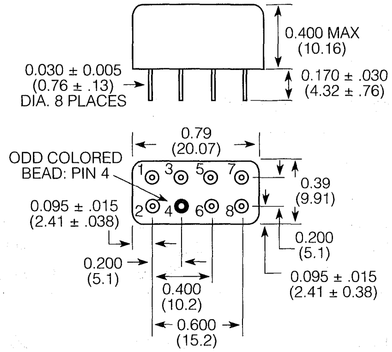
Specifications @ 25˚C

Frequency Range		0.5–500 MHz
Input Power		
0.5–5 MHz		1.5 W Max
5–500 MHz		3.0 W Max
Coupling	Nominal	Flatness
	11.5±0.5 dB	±0.6 dB
Main Line Loss		
0.5–5 MHz	0.85 dB Typ	1.3 dB Max
5–250 MHz	0.65 dB Typ	1.0 dB Max
250–500 MHz	0.85 dB Typ	1.3 dB Max
Directivity		
0.5–5 MHz	32 dB Typ	25 dB Min
5–250 MHz	32 dB Typ	25 dB Min
250–500 MHz	22 dB Typ	15 dB Min
VSWR		1.2 : 1 Typ

Operating Characteristics

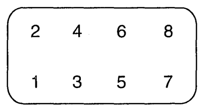
Impedance	50 Ohms Nominal

R-2



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
In	1
Out	4
Coupled	3
Case Gnd	2,5,7,8
Not Used	6

Specifications Subject to Change Without Notice

E-Series Directional Coupler
1 – 400 MHz

ETDC-10-1

Features
• Small size

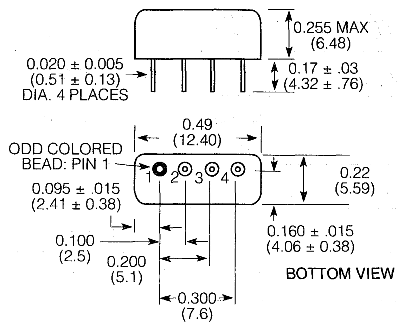
Specifications @ 25˚C

Frequency Range		1–400 MHz
Input Power		
1–10 MHz		1.0 W Max
10–400 MHz		2.0 W Max
Coupling	Nominal	Flatness
	10±0.5 dB	±0.6 dB
Main Line Loss		
1–10 MHz	1.2 dB Typ	1.5 dB Max
10–200 MHz	1.0 dB Typ	1.3 dB Max
200–400 MHz	1.2 dB Typ	1.5 dB Max
Directivity		
1–10 MHz	35 dB Typ	25 dB Min
10–200 MHz	30 dB Typ	20 dB Min
200–400 MHz	20 dB Typ	15 dB Min
VSWR		1.5 : 1 Typ

Operating Characteristics

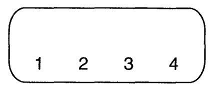
Impedance	50 Ohms Nominal

R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

Pin Configuration (Top View)



Function	Pin No.
In	1
Out	2
Coupled	4
Case Gnd	3

E-Series Directional Coupler
930 – 960 MHz

ESDC-10-1

Features

- Surface mount

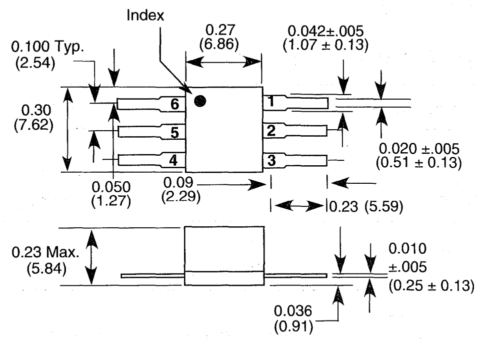
Specifications @ 25°C

Frequency Range		930–960 MHz
Coupling	Nominal 10 dB	Flatness ±0.2 dB
Main Line Loss		2.7 dB Max
Directivity		16 dB Min
VSWR		1.5 : 1 Typ

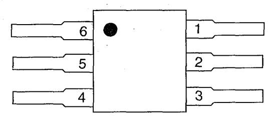
Operating Characteristics

Impedance	50 Ohms Nominal

SM-5



Pin Configuration (Top View)



Function	Pin No.
In	6
Out	1
Coupled	4
Case Gnd	2
Not Used	5
External 50 Ohms	3

Specifications Subject to Change Without Notice

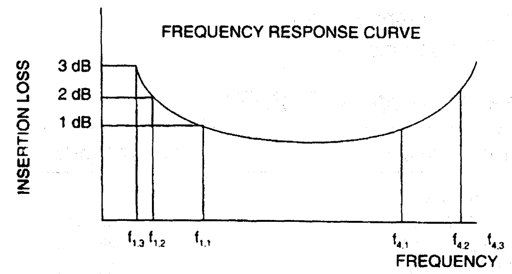
R/F Transformer Applications

Overview

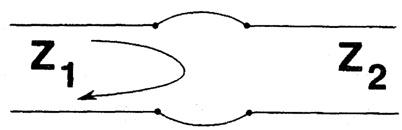
KHz to 1000 MHz
M/A-COM transformers provide a variety of impedance transformations over the frequency band 3 KHz to 1000 MHz.

The impedance ratios are always specified as step-up, i.e., the secondary impedance is greater than the primary impedance. Although the primary side is nominally 50 ohms these transformers can be operated as low as 12.5 ohms at the primary side with about the same impedance matching ratio. Frequency response will show a slight change .

A typical frequency response curve of a transformer is shown opposite.



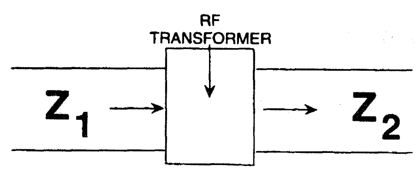
The 1 dB bandwidth of each transformer implies that the insertion loss of the transformer (for the specified ohms ratio) over this frequency range is less than 1 dB. 1 dB is the guaranteed maximum insertion loss but, in most cases, it will be less, typically 0.5dB for many devices. Similarly, the 2dB bandwidth implies that the insertion loss is less than 2dB over this frequency range, and so on for the 3dB bandwidth



LARGE REFLECTIONS WHEN $Z_2 \neq Z_1$ IF NO TRANSFORMER

The primary application of RF transformers is "impedance matching." This means that, if the user desires to send an RF signal from a source (of impedance Z1) to a load of impedance Z2, then the appropriate RF transformer will ensure that the signal will reach the load with minimal reflection.

For the majority of RF transformers, DC isolation is also provided between primary and secondary.



WITH TRANSFORMER, MAX INSERTION LOSS = 1 dB OVER DESIRED FREQUENCY RANGE

Specifications Subject to Change Without Notice

E-Series 1:1 Transformer
0.003 – 300 MHz

ET1-6T Series

Features
- 1:1 Impedance Ratio
- CT on secondary

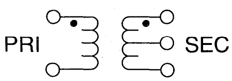
Specifications @ 25˚C

Frequency Range	0.003–300 MHz
Insertion Loss	
0.003–300 MHz	3 dB Max
0.010–150 MHz	2 dB Max
0.020–50 MHz	1 dB Max
Amplitude Imbalance	
0.02-50 MHz	0.1 dB Max
0.003–300 MHz	0.5 dB Max
Phase Imbalance	
0.02-50 MHz	1 ° Max
0.003–300 MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

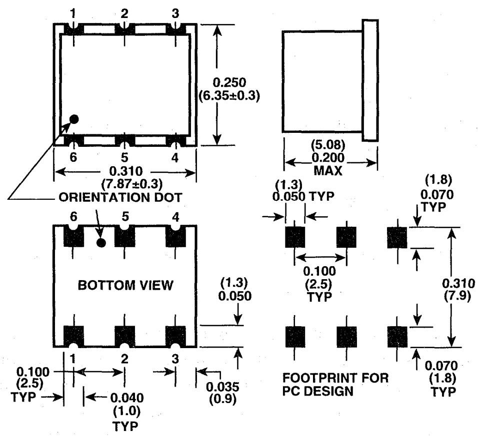


Ordering Information

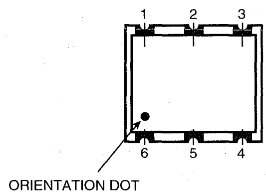
Part No.	Package
ET1-6T-SM1*	SM-1
ET1-6T-SM5	SM-5
ET1-6T-SM20	SM-20
ET1-6T-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

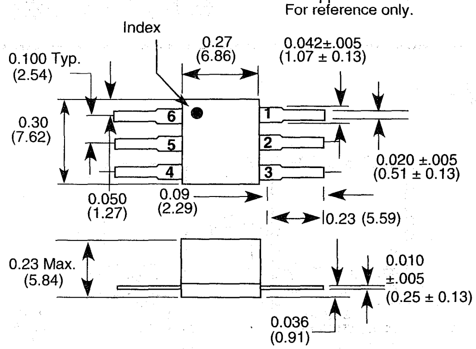


Pin Configuration (Typical)

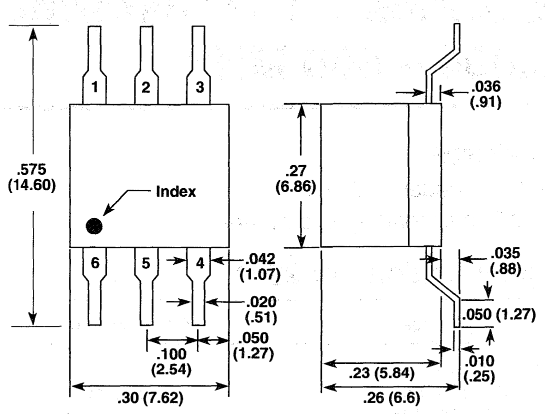
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

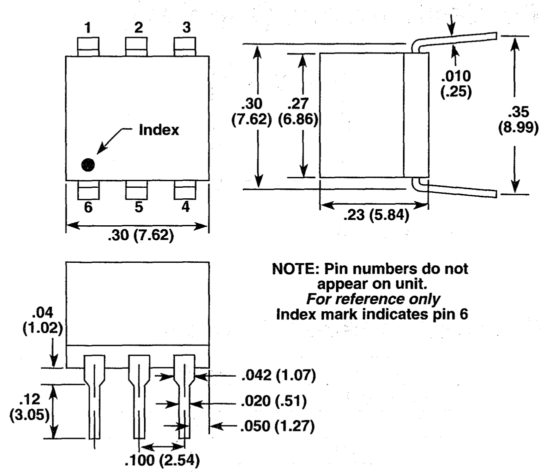


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 1:1 Transformer
0.004 – 500 MHz

ETT1-6 Series

Features

- 1:1 Impedance Ratio
- CT on secondary and primary

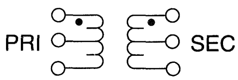
Specifications @ 25˚C

Frequency Range	0.004–500 MHz
Insertion Loss	
0.004–500 MHz	3 dB Max
0.020–200 MHz	2 dB Max
0.100–50 MHz	1 dB Max
Amplitude Imbalance	
0.1–50 MHz	0.1 dB Max
0.004–500 MHz	0.5 dB Max
Phase Imbalance	
0.1–50 MHz	1 ° Max
0.004–500MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

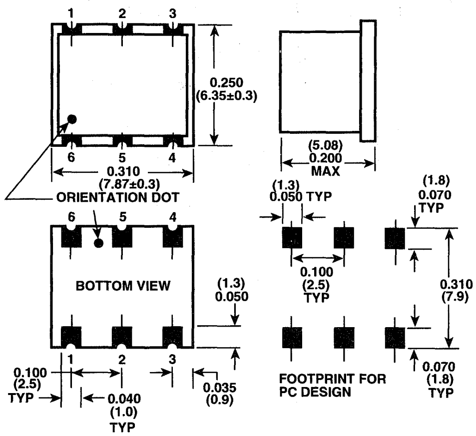


Ordering Information

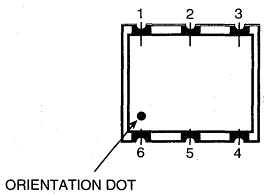
Part No.	Package
ETT1-6-SM1*	SM-1
ETT1-6-SM5	SM-5
ETT1-6-SM20	SM-20
ETT1-6-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

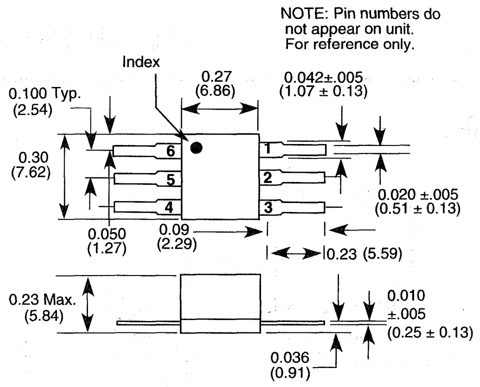


Pin Configuration (Typical)

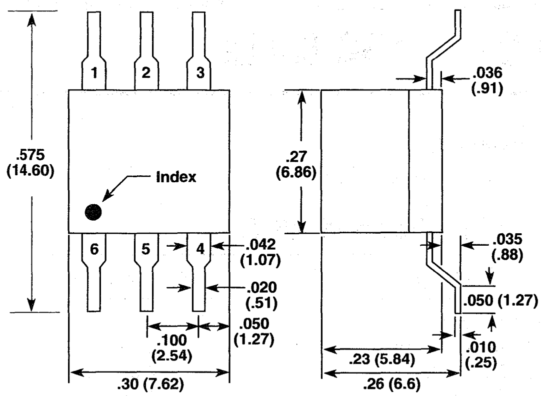
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	5
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

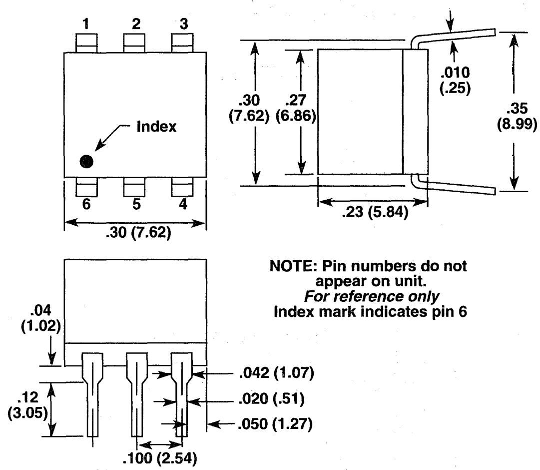


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 1:1 Transformer
0.01 – 150 MHz

ET1-6 Series

Features

- 1:1 Impedance Ratio

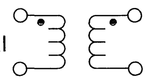
Specifications @ 25˚C

Frequency Range	0.01–150 MHz
Insertion Loss	
0.010–150 MHz	3 dB Max
0.020–100 MHz	2 dB Max
0.050–50 MHz	1 dB Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

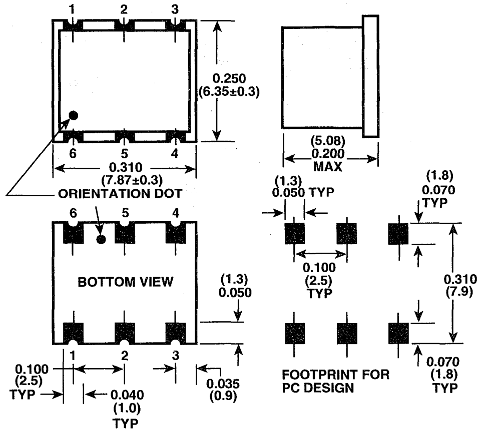


Ordering Information

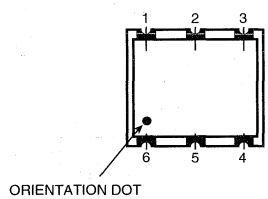
Part No.	Package
ET1-6-SM-1*	SM-1
ET1-6-SM5	SM-5
ET1-6-SM20	SM-20
ET1-6-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

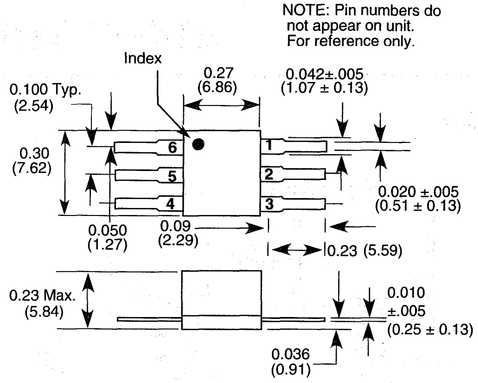


Pin Configuration (Typical)

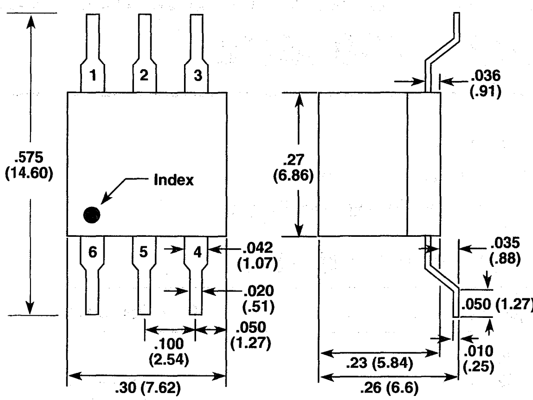
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	–
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

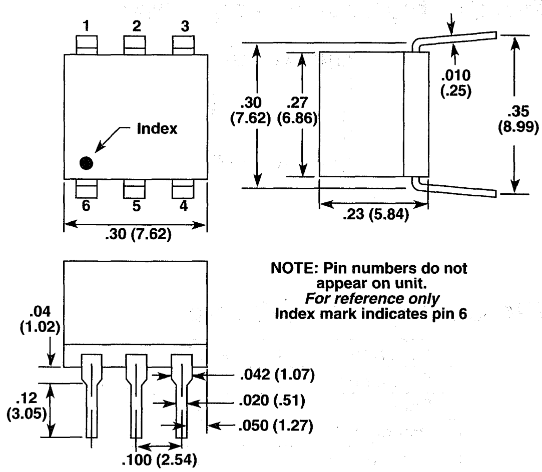


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

Specifications Subject to Change Without Notice

E-Series 4:1 Transformer
0.02 – 250 MHz

ET4-6T Series

Features

- 4:1 Impedance Ratio
- Phase and Amplitude Balance

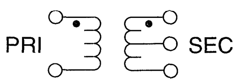
Specifications @ 25˚C

Frequency Range	0.02–250 MHz
Insertion Loss	
0.02–250 MHz	3 dB Max
0.05–150 MHz	2 dB Max
0.10–100 MHz	1 dB Max
Amplitude Imbalance	
0.10-100 MHz	0.1 dB Max
0.02–250 MHz	0.5 dB Max
Phase Imbalance	
0.10-100 MHz	1 ° Max
0.02–250 MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

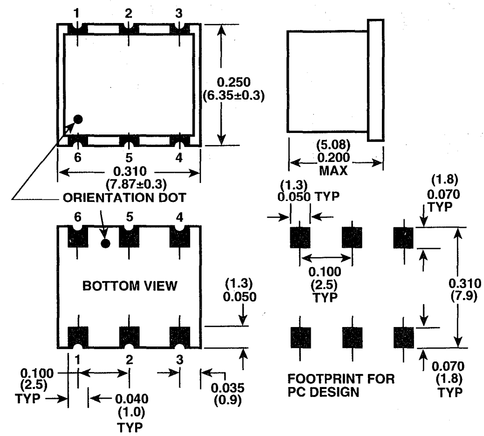


Ordering Information

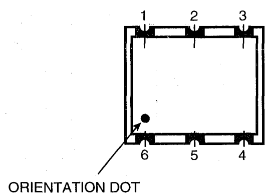
Part No.	Package
ET4-6T-SM-1*	SM-1
ET4-6T-SM5	SM-5
ET4-6T-SM20	SM-20
ET4-6T-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

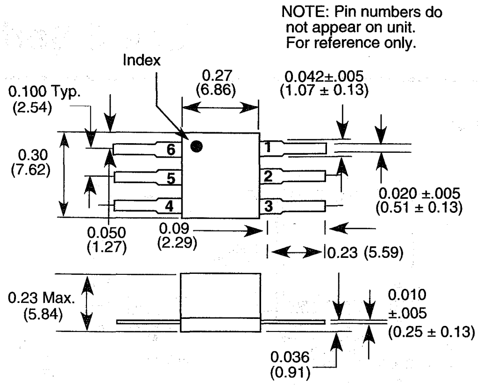


Pin Configuration (Typical)

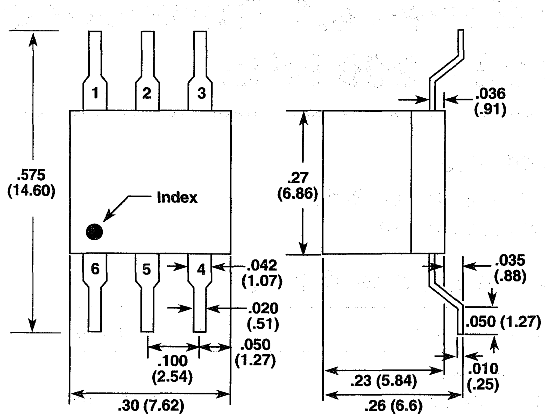
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

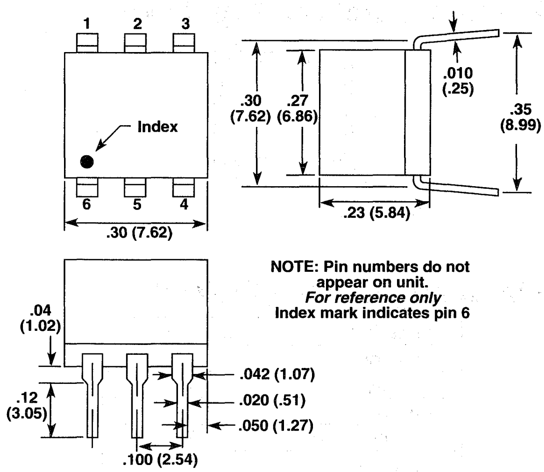


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 4:1 Transformer
0.02 – 200 MHz

ET4-6 Series

Features

- 4:1 Impedance Ratio
- Surface Mount

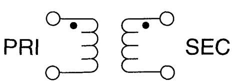
Specifications @ 25°C

Frequency Range	0.02–200 MHz
Insertion Loss	
0.15–400 MHz	3 dB Max
0.35–200 MHz	2 dB Max
2–50 MHz	1 dB Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

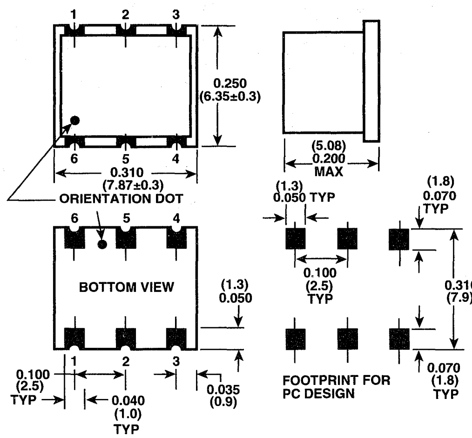


Ordering Information

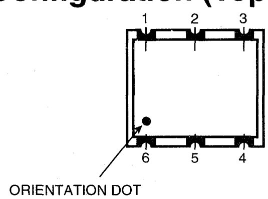
Model No.	Package
ET4-6-SM-1*	SM-1
ET4-6-SM5	SM-5
ET4-6-SM20	SM-20
ET4-6-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

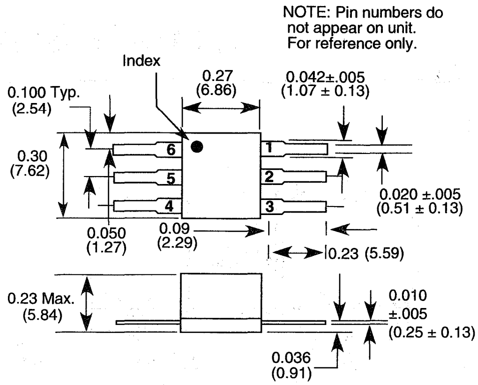


Pin Configuration (Typical)

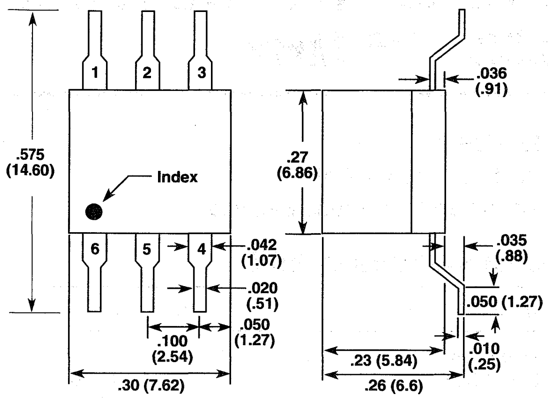
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	–
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

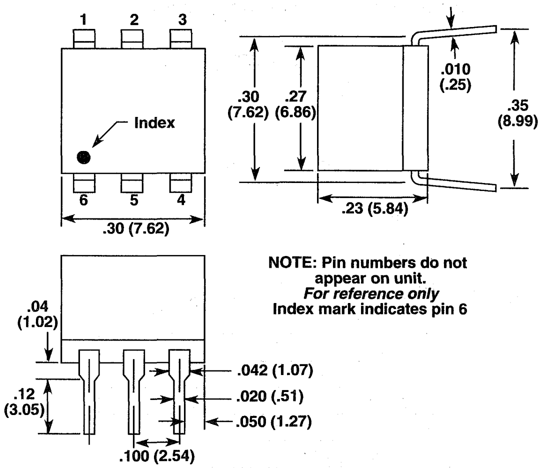


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 16:1 Transformer
0.03 – 75 MHz

ET16-6T Series

Features

- 16:1 Impedance Ratio
- Phase and Amplitude Balance

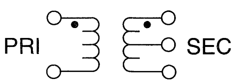
Specifications @ 25˚C

Frequency Range	0.03–75 MHz
Insertion Loss	
0.03–75 MHz	3 dB Max
0.06–30 MHz	2 dB Max
0.10–20 MHz	1 dB Max
Amplitude Imbalance	
0.10–20 MHz	0.1 dB Max
0.03–75 MHz	0.5 dB Max
Phase Imbalance	
0.10–20 MHz	1 ° Max
0.03–75 MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

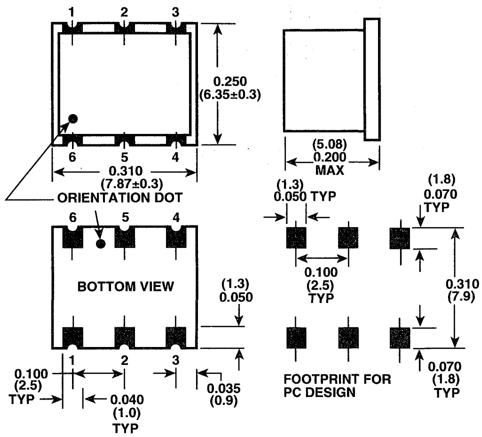


Ordering Information

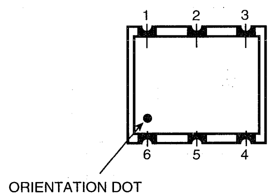
Part No.	Package
ET16-6T-SM-1*	SM-1
ET16-6T-SM5	SM-5
ET16-6T-SM20	SM-20
ET16-6T-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



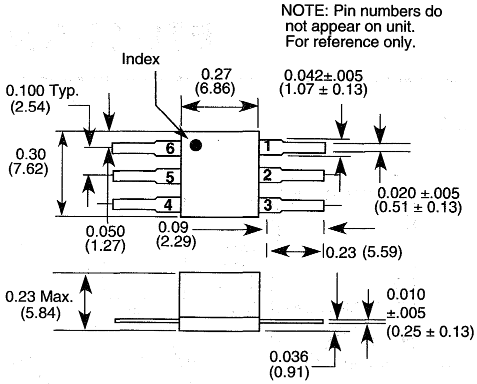
Pin Configuration (Top View)



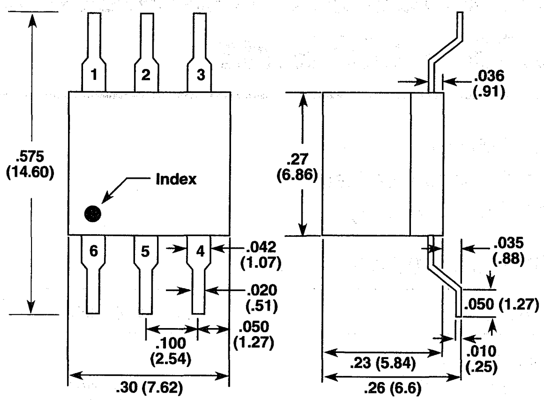
Pin Configuration (Typical)

Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

SM-5

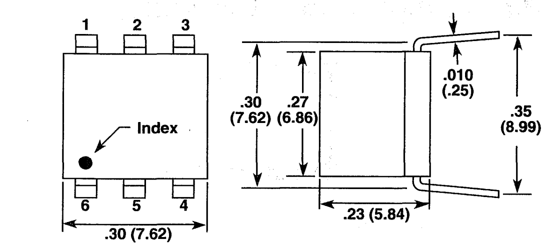


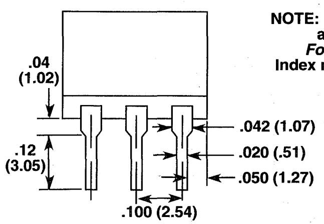
SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21





NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 8:1 Transformer
0.03 – 140 MHz

ET8-1T Series

Features
- 8:1 Impedance Ratio
- CT on secondary

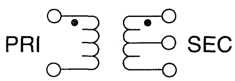
Specifications @ 25˚C

Frequency Range	0.03–140 MHz
Insertion Loss	
0.030–140 MHz	3 dB Max
0.100–90 MHz	2 dB Max
1–60 MHz	1 dB Max
Amplitude Imbalance	
1–60 MHz	0.1 dB Max
0.03–140 MHz	0.5 dB Max
Phase Imbalance	
1–60 MHz	1 ° Max
0.03–140 MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

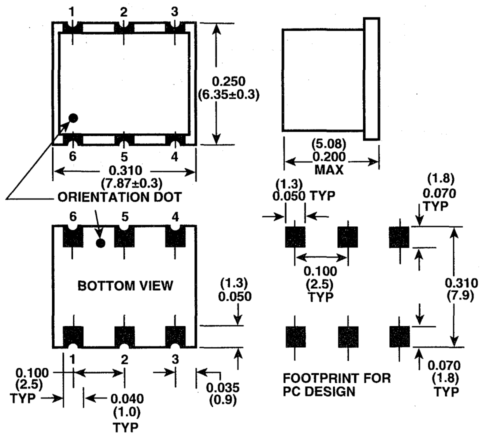


Ordering Information

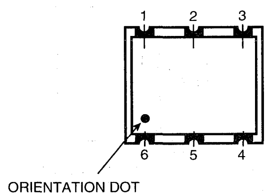
Part No.	Package
ET8-1T-SM1*	SM-1
ET8-1T-SM5	SM-5
ET8-1T-SM20	SM-20
ET8-1T-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

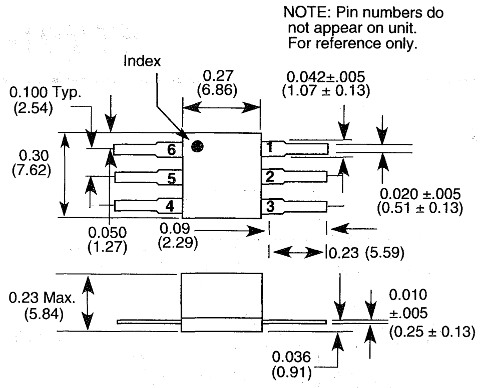


Pin Configuration (Typical)

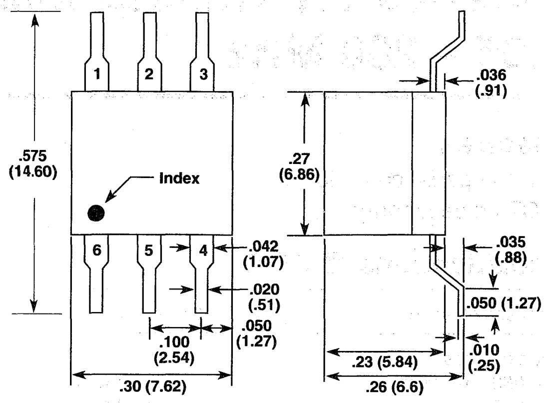
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

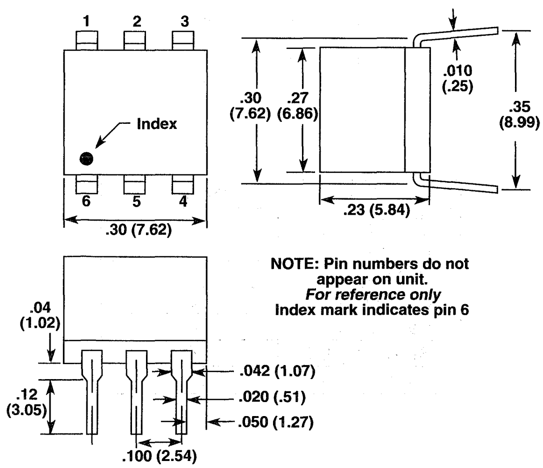


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 1:1 Transformer
0.05 – 200 MHz

ETM01-1T

Features

- 1:1 Impedance Ratio
- CT on secondary

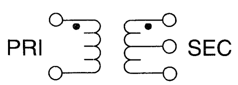
Specifications @ 25°C

Frequency Range	0.05–200 MHz
Insertion Loss	
0.050–200 MHz	3 dB Max
0.080–150 MHz	2 dB Max
0.200–80 MHz	1 dB Max
Amplitude Imbalance	
0.2–80 MHz	0.1 dB Max
0.05–200 MHz	0.5 dB Max
Phase Imbalance	
0.2–80 MHz	1 ° Max
0.05–200 MHz	5 ° Max

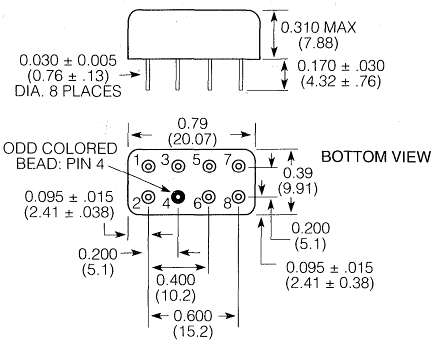
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

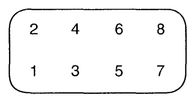


R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Primary dot	1
Primary	5
Primary CT	–
Secondary dot	2
Secondary	6
Secondary CT	4
Case Ground	7,8

Specifications Subject to Change Without Notice

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

E-Series 1:1 Transformer
0.05 – 200 MHz

ET1-1T Series

Features
- 1:1 Impedance Ratio
- CT on secondary

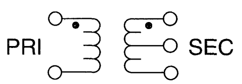
Specifications @ 25˚C

Frequency Range	0.05–200 MHz
Insertion Loss	
0.05–200 MHz	3 dB Max
0.08–150 MHz	2 dB Max
0.20–80 MHz	1 dB Max
Amplitude Imbalance	
0.2-80 MHz	0.1 dB Max
0.050–200 MHz	0.5 dB Max
Phase Imbalance	
0.2-80 MHz	1 ° Max
0.050–200 MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

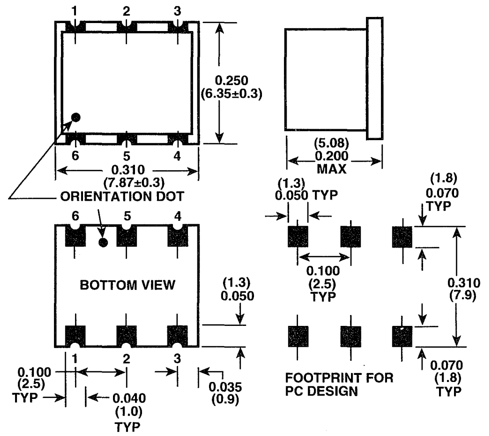


Ordering Information

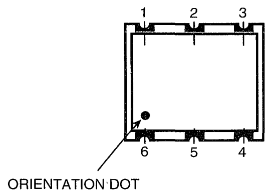
Part No.	Package
ET1-1T-SM-1*	SM-1
ET1-1T-SM5	SM-5
ET1-1T-SM20	SM-20
ET1-1T-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)



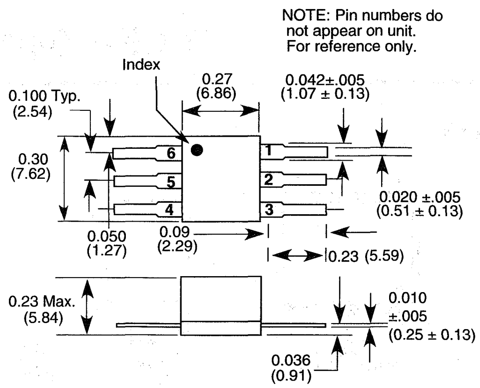
Pin Configuration (Typical)

Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

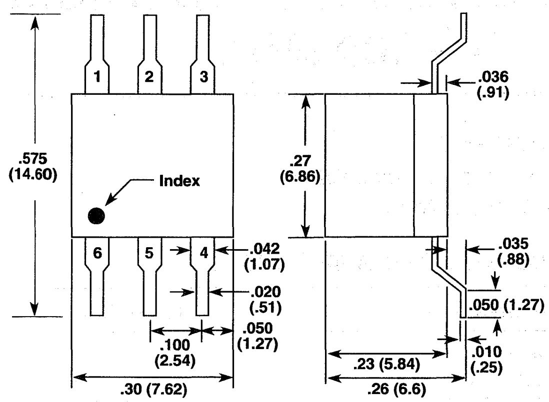
Specifications Subject to Change Without Notice

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

SM-5

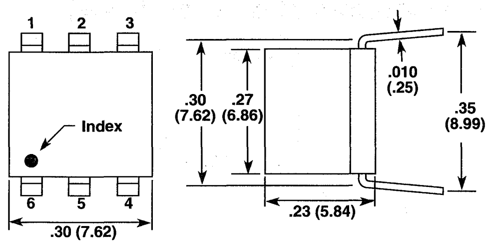


SM-20

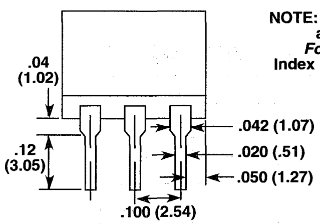


NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6



E-Series 1.5:1 Transformer
0.15 – 300 MHz

ET1.5-1 Series

Features
- 1.5:1 Impedance Ratio
- Surface Mount

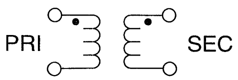
Specifications @ 25˚C

Frequency Range	0.15–300 MHz
Insertion Loss	
0.1–300 MHz	3 dB Max
0.2–150 MHz	2 dB Max
0.5–80 MHz	1 dB Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

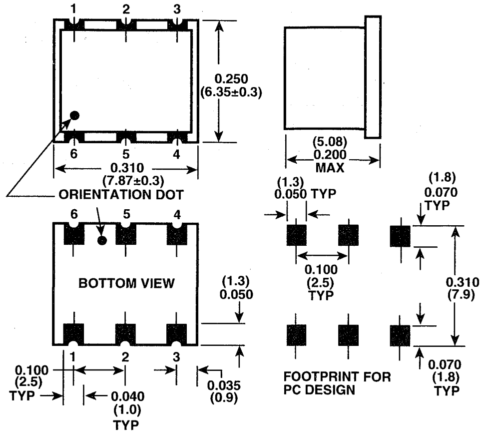


Ordering Information

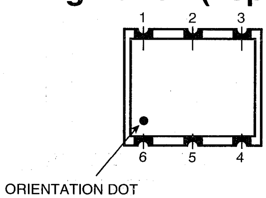
Part No.	Package
ET1.5-1-SM-1*	SM-1
ET1.5-1-SM5	SM-5
ET1.5-1-SM20	SM-20
ET1.5-1-SM21	SM-211

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

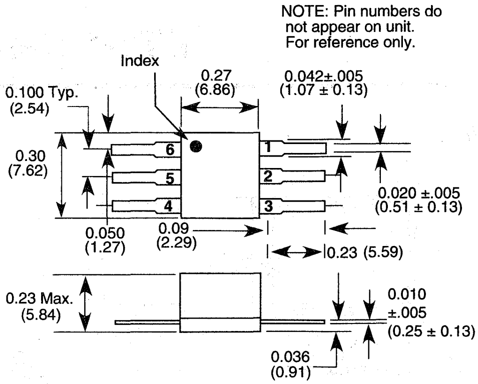


Pin Configuration (Typical)

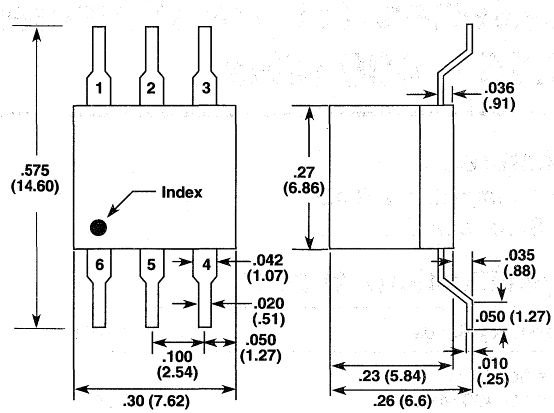
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	–
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

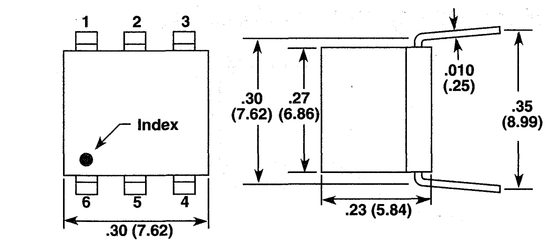


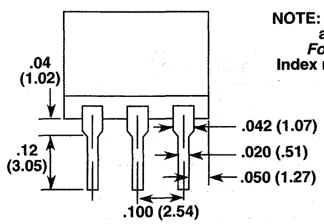
SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21





NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 1:1 Transformer
0.15 – 400 MHz

ET1-1 Series

Features
- 1:1 Impedance Ratio
- Surface Mount

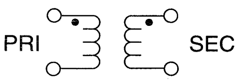
Specifications @ 25˚C

Frequency Range	0.15–400 MHz
Insertion Loss	
0.15–400 MHz	3 dB Max
0.35–200 MHz	2 dB Max
2–50 MHz	1 dB Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

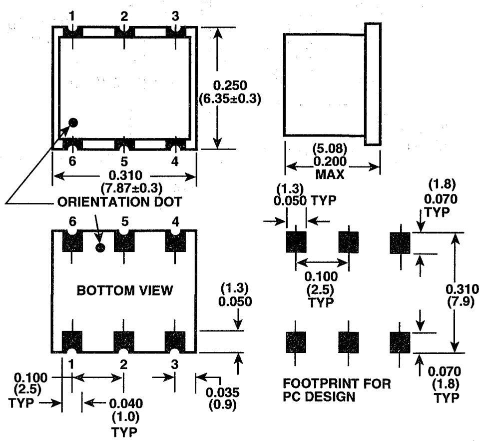


Ordering Information

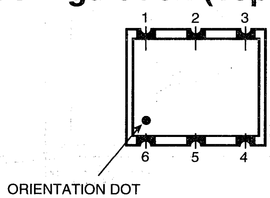
Part No.	Package
ET1-1-SM-1*	SM-1
ET1-1-SM5	SM-5
ET1-1-SM20	SM-20
ET1-1-SM21	SM-21

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

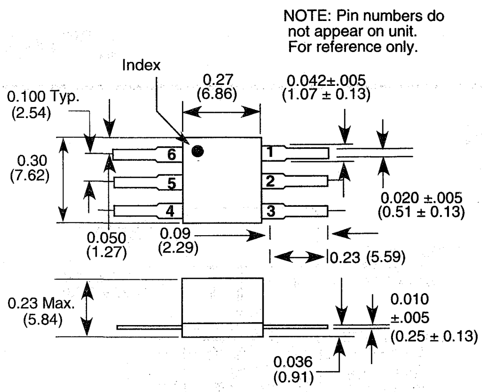


Pin Configuration (Typical)

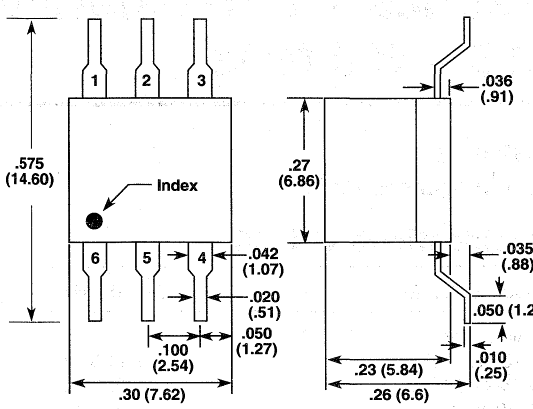
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	–
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

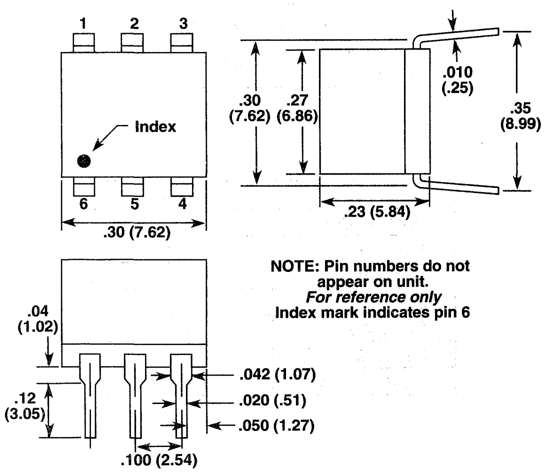


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 1:1 Transformer
0.15 – 400 MHz

ETMO1-1

Features
- 1:1 Impedance Ratio

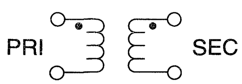
Specifications @ 25˚C

Frequency Range	0.15–400 MHz
Insertion Loss	
0.15–400 MHz	3 dB Max
0.35–200 MHz	2 dB Max
2–50 MHz	1 dB Max

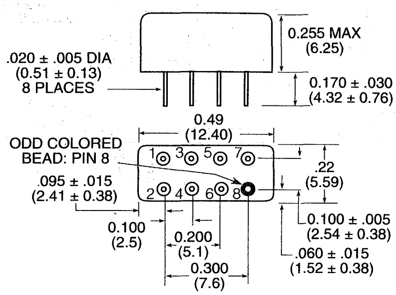
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

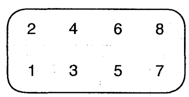


R-7



WEIGHT(APPROX.): 0.06 OUNCES 1.6 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Primary dot	1
Primary	5
Primary CT	–
Secondary dot	2
Secondary	6
Secondary CT	–
Case Ground	7

Specifications Subject to Change Without Notice

![M/A-COM logo]

E-Series 4:1 Transformer
0.2 – 350 MHz

ETM04-1

Features

- 4:1 Impedance Ratio
- CT on secondary

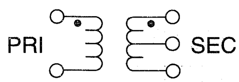
Specifications @ 25˚C

Frequency Range	0.2–350 MHz
Insertion Loss	
0.20–350 MHz	3 dB Max
0.350–300 MHz	2 dB Max
2–100 MHz	1 dB Max
Amplitude Imbalance	
2–100 MHz	0.1 dB Max
0.2–350 MHz	0.5 dB Max
Phase Imbalance	
2–100 MHz	1 ° Max
0.2–350 MHz	5 ° Max

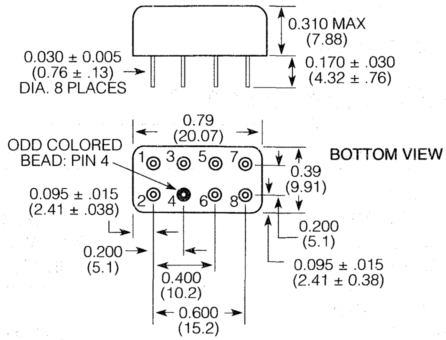
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

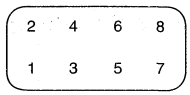


R-1



WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

Pin Configuration (Top View)



Function	Pin No.
Primary dot	1
Primary	5
Primary CT	–
Secondary dot	2
Secondary	6
Secondary CT	4
Case Ground	7,8

Specifications Subject to Change Without Notice

E-Series 4:1 Transformer
0.2 – 350 MHz

ET4-1 Series

Features

- 4:1 Impedance Ratio
- CT on secondary
- Surface Mount

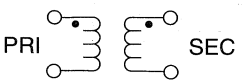
Specifications @ 25˚C

Frequency Range	0.2–350 MHz
Insertion Loss	
0.200–350 MHz	3 dB Max
0.350–300 MHz	2 dB Max
2–100 MHz	1 dB Max
Amplitude Imbalance	
2–100 MHz	0.1 dB Max
0.2–350 MHz	0.5 dB Max
Phase Imbalance	
2–100 MHz	1 ° Max
0.2–350 MHz	5 ° Max

Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

Schematic

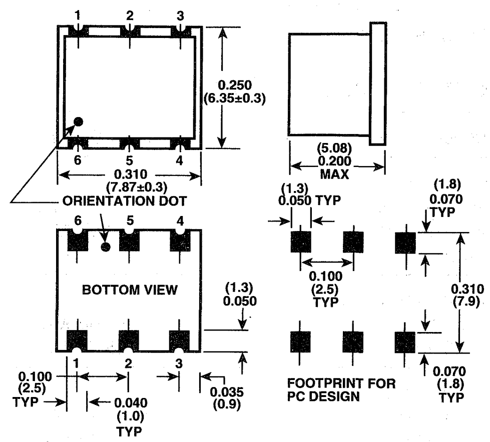


Ordering Information

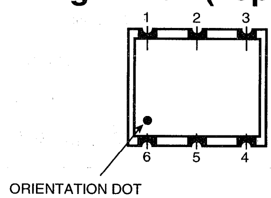
Part No.	Package
ET4-1-SM-1*	SM-1
ET4-1-SM5	SM-5
ET4-1-SM20	SM-20
ET4-1-SM21	SM-211

*Tape and reel packaging available. Contact factory.

SM-1



Pin Configuration (Top View)

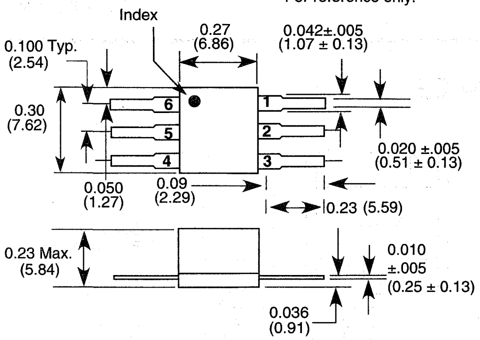


Pin Configuration (Typical)

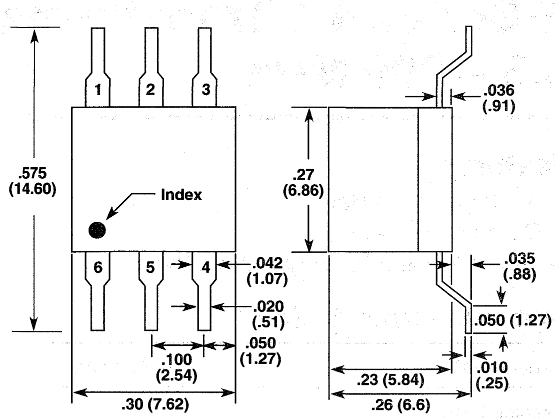
Function	Pin No.
Primary dot	4
Primary	6
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	–
Case Ground	–

Specifications Subject to Change Without Notice

SM-5

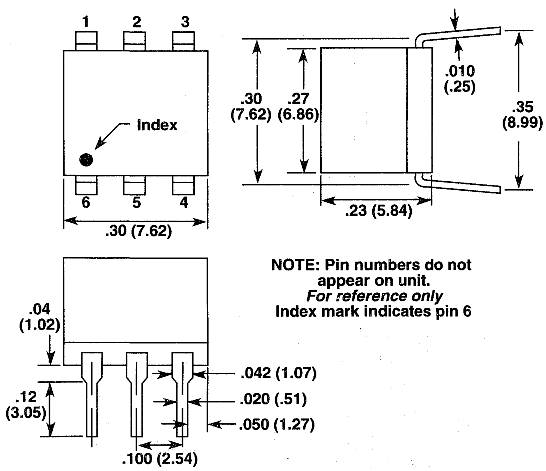


SM-20



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21



NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

E-Series 4:1 Transformer
0.5 – 800 MHz

ETC-4-1-2

Features

- 4:1 Impedance Ratio
- CT on secondary
- Tape and Reel Packaging Available

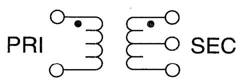
Specifications @ 25˚C

Frequency Range	0.5–800 MHz
Insertion Loss	
0.500–800 MHz	3 dB Max
1.5–600 MHz	2 dB Max
7–100 MHz	1 dB Max

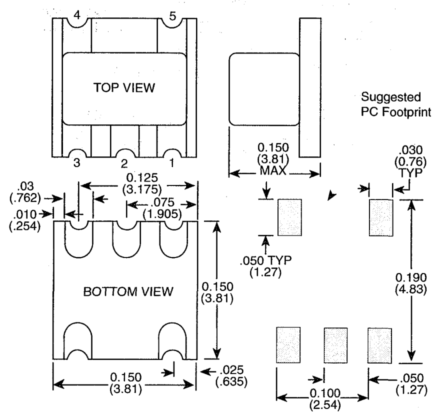
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	-20 °C to +85 °C

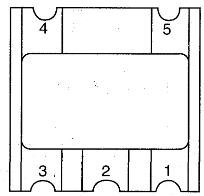
Schematic



SM-22



Pin Configuration (Top View)



Function	Pin No.
Primary dot	4
Primary	5
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

Specifications Subject to Change Without Notice

E-Series 4:1 Transformer
500 – 2500 MHz

ETC1.6-4-2-3

Features

- 4:1 Impedance Ratio
- Transmission Line Transformer
- Tape and Reel Packaging Available

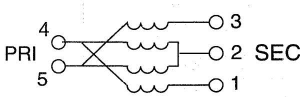
Specifications @ 25˚C

Frequency Range	500–2500 MHz
Insertion Loss	
500–2500 MHz	3 dB Max
750–1200 MHz	1 dB Max

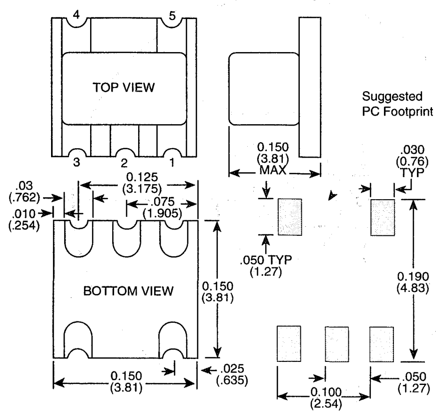
Absolute Maximum Ratings

Parameter	Absolute Maximum
RF Power	250 mW
DC Current	30 mA
Operating/Storage Temperature	--20 °C to +85 °C

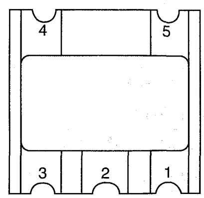
Schematic



SM-22



Pin Configuration (Top View)

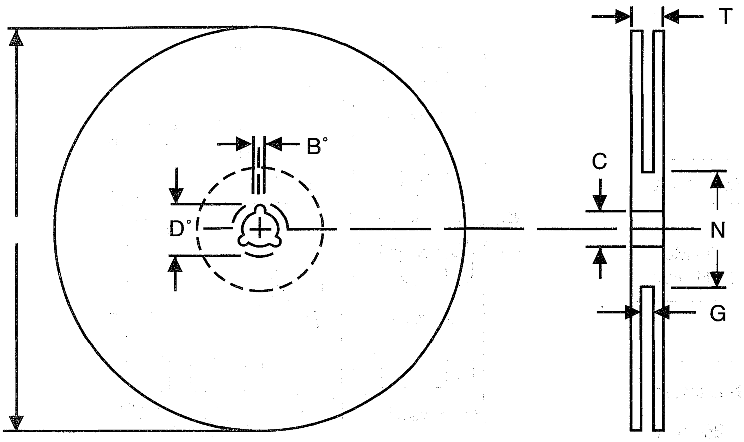


Function	Pin No.
Primary dot	4
Primary	5
Primary CT	–
Secondary dot	3
Secondary	1
Secondary CT	2
Case Ground	–

Specifications Subject to Change Without Notice

Tape and Reel Packaging for Surface Mount Components

M513



SO-8

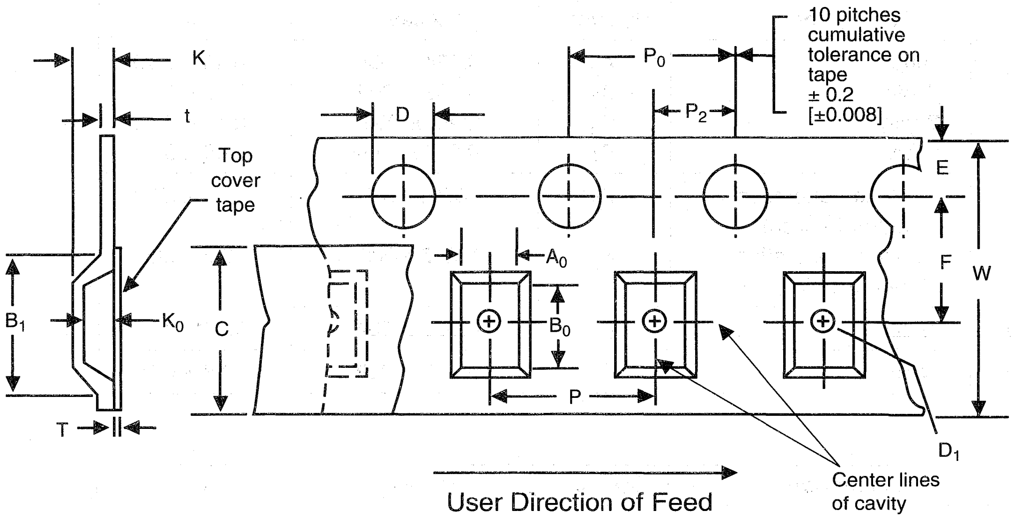
			13" Reel	
	Items	**Symbol**	**Size (mm)**	**Size (in)**
Flange	Diameter	A	330 ± 2.0	13.0 ± .079
	Thickness	T	18.4 Max	0.724 Max
	Space Between Flange	G	12.4 ± 2.0, -0.0	0.488 ± .08, -0.0
Hub	Outer Diameter	N	63 Min	2.48 Min
	Spindle Hole Diameter	C	13.0 ± 0.2	0.512 ± .008
	Keyslit Width	B	1.5 Min	0.059 Min
	Keyslit Diameter	D	20.2 Min	0.795 Min

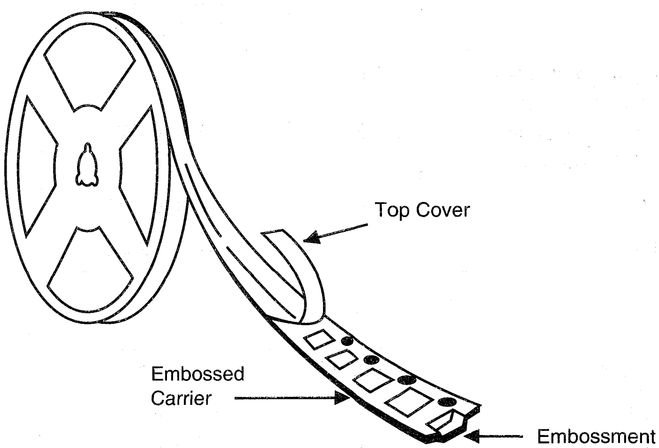
SO-14, SO-16

			13" Reel	
	Items	**Symbol**	**Size (mm)**	**Size (in)**
Flange	Diameter	A	330 ± 2.0	13.0 ± .079
	Thickness Maximum	T	22.4 Max	0.882 Max
	Space Between Flange	G	16.4 ± 2.0, -0.0	0.646 ± .08, -0.0
Hub	Outer Diameter	N	63 Min	2.48 Min
	Spindle Hole Diameter	C	13.0 ± 0.2	0.512 ± .008
	Keyslit Width	B	1.5 Min	.059 Min
	Keyslit Diameter	D	20.2 Min	0.795 Min

Specifications Subject to Change Without Notice

12, 16, 24mm Tape Only





Fixed Dimensions

Description		Symbol	Inches	mm
Cavity	Bottom hole diameter	D_1	.059 +.004, -.000	1.5 ± 0.10
Perforation	Diameter Pitch Position	D P_0 E	.059 +.004, -.000 .157 ±.004 .069 ±.004	1.5 ± 0.10 4.0 ± 0.10 1.75 ± 0.10
Cover tape	Width	T	.003 ± .004	.065 ± 0.01
Carrier tape	Width	t	0.12 ± .002	0.30 ± 0.05

Specifications Subject to Change Without Notice

SO-8

Description		Symbol	Inches	mm
Cavity	Length Width Depth Pitch	A_0 B_0 K_0 P_1	0.254 ± .004 0.202 ± .004 .083 ± .004 0.315 ± .004	6.45 ± 0.10 5.13 ± 0.10 2.11 ± 0.10 8.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction) Cavity to Perforation (Width Direction)	P_2 F	.079 ± .002 0.217 ±.002	2.0 ± .05 5.5 ± .05
Cover tape	Width	C	0.366 ± .004	9.30 ± 0.10
Carrier tape	Width	W	0.472 ± .002	12.0 ± 0.20

SO-16

Description		Symbol	Inches	mm
Cavity	Length Width Depth Pitch	A_0 B_0 K_0 P_1	0.256 ± .004 0.404 ± .004 .084 ± .004 0.315 ± .004	6.50 ± 0.10 10.26 ± 0.10 2.13 ± 0.10 8.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction) Cavity to Perforation (Width Direction)	P_2 F	.079 ± .002 0.295 ±.002	2.0 ± .05 7.5 ± .05
Cover tape	Width	C	0.524 ± .004	13.30 ± 0.10
Carrier tape	Width	W	0.630 ± .012	16.0 ± 0.20

SO-14

Description		Symbol	Inches	mm
Cavity	Length Width Depth Pitch	A_0 B_0 K_0 P_1	0.258 ± .004 0.351 ± .004 .083 ± .004 0.315 ± .004	6.55 ± 0.10 8.92 ± 0.10 2.11 ± 0.10 8.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction) Cavity to Perforation (Width Direction)	P_2 F	.079 ± .002 0.295 ±.002	2.0 ± .05 7.5 ± .05
Cover tape	Width	C	0.524 ± .004	13.30 ± 0.10
Carrier tape	Width	W	0.630 ± .008	16.0 ± 0.20

SOT-143

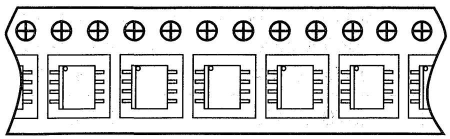
Description		Symbol	Inches	mm
Cavity	Length	A_0	0.120 ± .004	3.05 ± 0.10
	Width	B_0	0.104 ± .004	2.64 ± 0.10
	Depth	K_0	.049 ± .004	1.24 ± 0.10
	Pitch	P_1	0.158 ± .004	4.00 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.138 ±.002	3.5 ± .05
Cover tape	Width	C	0.217 ± .004	5.5 ± 0.10
Carrier tape	Width	W	0.315 ± .008	8.0 ± 0.20

SOW-16

Description		Symbol	Inches	mm
Cavity	Length	A_0	0.428 ± .004	10.87 ± 0.10
	Width	B_0	0.423 ± .004	10.74 ± 0.10
	Depth	K_0	0.120 ± .004	3.05 ± 0.10
	Pitch	P_1	0.472 ± .004	11.99 ± 0.10
Distance between centerline	Cavity to Perforation (Length Direction)	P_2	.079 ± .002	2.0 ± .05
	Cavity to Perforation (Width Direction)	F	0.295 ±.002	7.5 ± .05
Cover Tape	Width	C	0.524 ± .004	13.30 ± 0.10
Carrier tape	Width	W	0.630 ± .012	16.0 ± 0.20

Typical Component Orientation For Tape and Reel

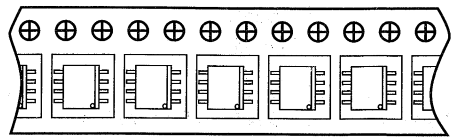
example: SW-239TR



User Direction of Feed

Forward Tape and Reel

example: SW-239RTR



User Direction of Feed

Reverse Tape and Reel

Ordering Information on Reel Size and Number of Units Per Reel

Package Type	Max. Qty. – 7" Reel	Max. Qty. – 13" Reel
SO-8	1000	2500
SO-14	1000	2500
SO-16	1000	2500
SOW-16	Not Recommended	1000
SO-20	Not Recommended	1000
SO-24	Not Recommended	1000
SOT-143	3000	10,000

Products ordered on tape and reel require adding a suffix of TR or RTR to part number (e.g., SW-239 becomes SW-239TR or SW-239RTR when on tape and reel).

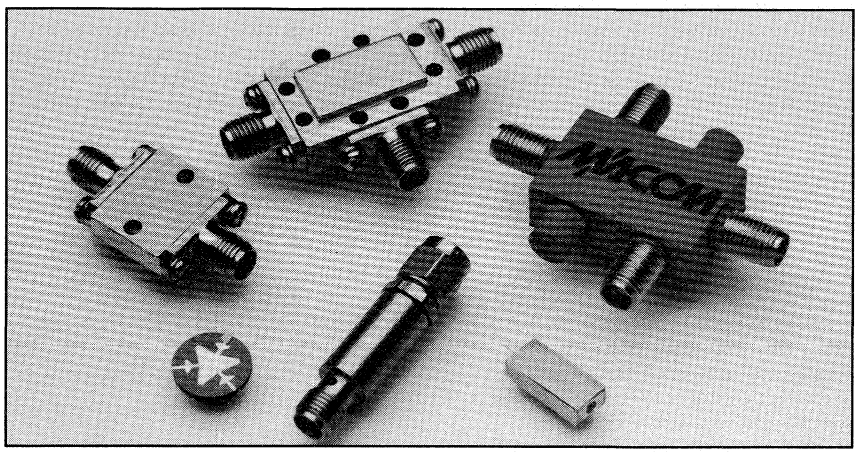
Products using the SO-8, SO-14, and SO-16 designations should sell standard TR and RTR in quantities of 500, 1000, 2500, or any multiple thereof.

Products using the SOW-16, SO-20, and SO-24 designations should sell standard TR and RTR in quantities of 500, 1000, or any multiple thereof.

Products using the SOT-143 should sell standard TR and RTR in quantities of 1000, 5000, 10,000, or any multiple thereof.

Note: A ½ meter leader and ½ meter trailer tape will be provided with each reel. Other lengths may be specified by the customer.

Microwave Components



M/A-COM

Custom Multi-Function Packages

In addition to components, M/A-COM can provide custom multi-function devices to meet your system needs. By integrating more than one component, assemblies are produced that exhibit superior RF performance in a reduced package size at a lower system cost than a collection of discrete components. Lower transmission loss, improved frequency flatness and VSWR are the direct result of eliminating excess line lengths and multiple mismatches.

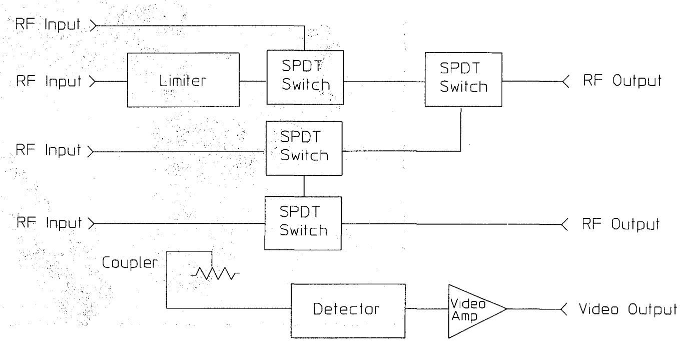
A key element in the success of an integrated package is total control of the devices that comprise the package. M/A-COM has an extensive product capability in active components such as switches, limiters , variable attenuators, amplifiers, mixers and detectors, as well as passive components including couplers, power dividers and attenuators. By applying this specific component experience, M/A-COM produces an effective integrated package.

As with standard components, multi-function packages are designed, fabricated and tested to operate in the most severe military and aerospace environments.

Consult the factory to discuss your specific requirements.

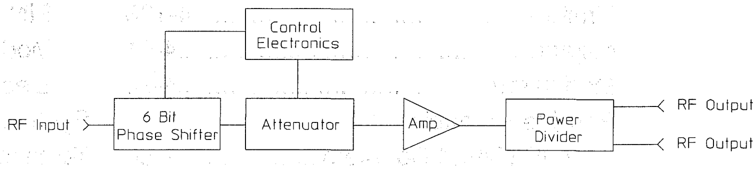
Switch Limiter

This device includes four broadband high speed SPDT switches, a broadband high power CW limiter, a broadband directional coupler and a detector with a video amplifier to provide the desired output level. Hybrid switch drivers provide TTL-compatible control of the RF switches. The device is hermetically sealed and screened for military applications.



Phase Shifter/Amplifier

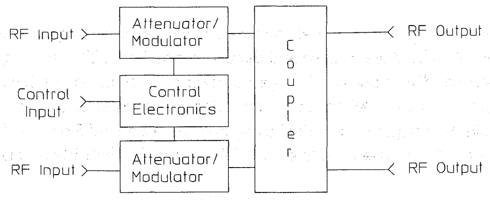
This integrated package includes four RF functions with the associated control electronics. The electronics section consists of twelve switch drivers and an attenuator driver. The RF section provides a six bit switched line phase shifter with 12 nS switching speed. An absorptive attenuator provides temperature compensation for the linear RF amplifier. A Wilkinson power divider provides two amplitude and phase matched outputs. The device is hermetically sealed using laser welding techniques.



Specifications Subject to Change Without Notice.

Dual Modulator Coupler

This device incorporates two linearized absorptive attenuators with the required control electronics and a tandem coupler configuration in a single hermetic package. The attenuators provide up to 63 dB of linear attenuation to a customer-required transfer curve. Since the attenuator is realized in an absorptive configuration, low VSWR is maintained over the entire attenuation range. The tandem coupler provides dual output of a common input.



Specifications Subject to Change Without Notice.

PIN Diode Switch

Overview

Broadband Switches Ideally Suited for a Variety of Applications

A complete series of solid state, PIN diode switches is offered covering the frequency range from 0.5 to 18 GHz in suboctave, octave and decade bandwidths. These units are available in module or connectorized versions and feature microstrip construction utilizing M/A- COM's own chip or beam lead diodes. All bonds are gold ribbon attached by thermal compression. M/A-COM, Inc. is in the unique position of having complete control from the fabrication of the semiconductors and machined housings, as well as the RF & hybrid circuits.

Broadband 50 ohm PIN diode switches are obtained by carefully integrating chip diodes into a low pass filter design. Center conductor dimensions are controlled to yield the required series inductance to resonate with the inherent shunt PIN junction capacitance. Low capacitance diodes can be designed into a filter with cut-off frequencies well above 18 GHz.

M/A-COM's switch modules have physical configurations which are ideally suited for mounting into stripline or microstrip circuits. Our connectorized versions offer SMA interfaces for RF and a variety of interfaces for logic and bias voltages.

Miniature "Stop sign" switches feature removable SMA female connectors allowing use as drop-ins for stripline assemblies. In addition, the field replaceable connectors allow replacement of a damaged connector without violating the hermetic seal.

Most switches achieve their signal isolation by reflecting the RF energy back to the source. Because of this fact, they are classified as "reflective"; that is, the switches have optimum VSWR in the conducting state only. It is possible to design switches with good VSWR in the isolation state, but such designs are more limited in operating power levels and switching speeds. Such units are called "absorptive" switches. Customer-selected options such as optimized performance in the areas of ...

- bandwidth
- power
- switching speed
- integrated drivers
- logic TTL/ECL
- isolation/loss/VSWR
- package style and size

...are readily available. Contact the factory with your requirements.

The principal use of all types of switches is in signal routing and signal control. Multi-throw switches may be used to route a signal to one of many outputs or several signals into one output channel. Single-pole single-throw switches are often used in active protection circuits where a delicate receiver channel, for example, is shut off from an unwanted, but anticipated, high power signal. M/A-COM's PIN diode switches are ideally suited for radar, ECM, E.W., communications and other applications in both the military and commercial markets.

Attenuator

Overview

Variable Attenuators Designed to Meet Specific Requirements

PIN diode attenuators are used in applications where a designer wishes to have analog or digital control over signal power levels. Such devices can be reflective; that is, they attenuate by reflecting a percentage of the power back to the source. Alternately, these devices can be absorptive whereby the reflected power is terminated within the unit itself.

Attenuators are primarily octave bandwidth devices. While they do function outside the design band, the dynamic range of attenuation is greatly restricted. Also, the flatness of attenuation versus frequency variation is degraded, requiring different control curves when operated beyond their normal band of operation.

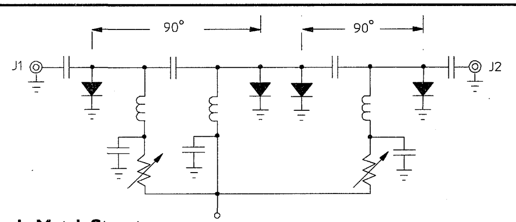
The attenuators in this catalog are presented as a brief introduction to M/A-COM's overall capability in the variable attenuator area. These units represent only a small part of the units available. M/A-COM offers many options to the user. Units are available as reflective or absorptive devices, with or without linearizers and in digital or voltage variable configurations.

Attenuators tend to require more precise specifications than switches. Because of their dynamic nature, parameters such as linearity, flatness and temperature compensation are of interest to most designers. To assure that all parameters have been considered, use the Glossary of Terms in the Appendix as a quick checklist, and for more technical information, refer to Application Note M502, PIN Diode Attenauator.

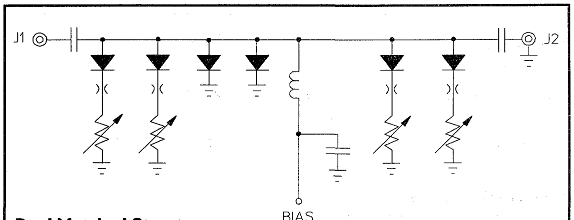
Design Considerations

There are many tradeoffs in the design of custom attenuators, and they are not just limited to the type of driver. Variations in the type of matching circuits can have a profound effect on the attenuation flatness, RF power stability, VSWR and settling speed.

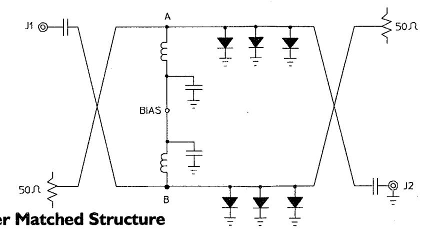
For instance, low power octave devices can be developed with a very basic matching circuit, a single PIN diode spaced 90° from the attenuation diodes, and can function extremely well. Broadening the bandwidth, reducing the required VSWR or increasing the RF power will require a more elaborate circuit. The following illustrates three of the circuits utilized in M/A-COM's attenuators:



Single Match Structure



Dual Matched Structure



Coupler Matched Structure

To minimize the time required for an attenuator to reach the desired level of attenuation, one must have a thorough understanding of the individual circuits within the attenuator. Traditionally one looks to the driver as the source of all "time" issues ... switching speed, settling speed, delay, etc. Not always true. Diode lifetime, matching and bias circuits, and the mechanical layout in general play a more significant role in the design of the high speed attenuators.

M/A-COM's engineering team is prepared to satisfy your most demanding attenuator requirements. For additional information, refer to Application Note M502, PIN Diode Attenauator.

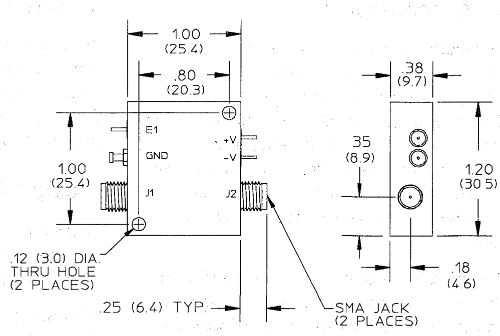
SPST Reflective Switches With Drivers

SPST Reflective Switches With Drivers

2660 Series

Features

- Broadband Frequency Ranges
- Environmentally Sealed
- TTL Compatible
- Small Size



Description

M/A-COM 's diode switches cover instantaneous multi-octave bandwidths from UHF to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. Typical insertion loss, VSWR, and isolation curves are shown below.

Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Specifications Subject to Change Without Notice.

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[5]
0.5-2.0	0.6	1.40:1	40	5	30	0.1	2660-1001-XY
	0.7	1.40:1	60	100	200	5.0	2660-1004-XY
2-8	0.8	1.50:1	40	100	200	5.0	2660-1006-XY
	1.0	1.50:1	60	5	30	0.1	2660-1007-XY
				100	200	5.0	2660-1008-XY
6-18	2.0	1.90:1	55	5	30	0.1	2660-1011-XY
				100	200	5.0	2660-1012-XY
2-18	2.0	2.00:1	40	5	30	0.1	2660-1013-XY
	2.2	2.00:1	55	5	30	0.1	2660-1015-XY

Notes:
1. Driver current req. ±60mA typ.
2. Logic "0" for low loss.
3. Transition Time measured from 10% to 90% of detected RF.
4. Switch Speed measured from 50% TTL to 10%/90% detected RF.
5. Specify voltage and logic connector from option table.

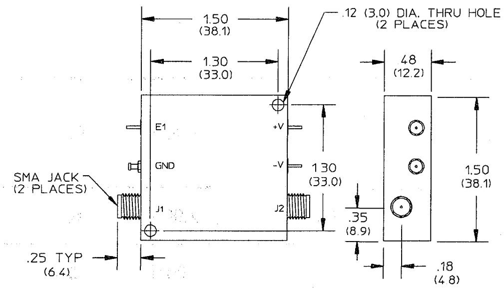
- XY Option Table

	X Bias Voltage		Y Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V	1	SMC Conn.
2	+15V/-15V	2	SMA Conn.
3	+12V/-12V		
4	+5 V/-15V		

SPST Absorptive Switches With Drivers

2661 Series

Features
- Broadband Frequency Ranges
- Environmentally Sealed
- TTL Compatible
- Constant VSWR



Description
M/A-COM 's diode switches cover instantaneous multi-octave bandwidths from UHF to Ku-band. These devices offer the ability to absorb RF energy internally when in the isolation state. This matching characteristic is achieved by incorporating a diode-resistor network to provide a 50 Ohm impedance to the system. Lower RF power and increased switching time are the tradeoffs for absorptive switches. Typical insertion loss, VSWR, and isolation curves are shown below.

Environmental
These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

2661-Series

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[5]
0.5-2.0	1.2	1.50:1	60	20	50	0.1	2661-1001-XY
				150	200	0.2	2661-1002-XY
2-8	2.0	1.70:1	60	20	50	0.1	2661-1003-XY
				150	200	0.2	2661-1004-XY
6-18	2.6	2.00:1	60	20	50	0.1	2661-1005-XY
				150	200	0.2	2661-1006-XY
2-18	2.8	2.20:1	60	20	50	0.1	2661-1007-XY

Notes:
1. Driver current req. ± 90mA typ.
2. Logic "0" for low loss.
3. Transition Time measured from 10% to 90% of detected RF.
4. Switch Speed measured from 50% TTL to 10%/90% detected RF.
5. Specify voltage and logic connector from option table.

- XY Option Table

	X Bias Voltage		Y Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V	1	SMC Conn.
2	+15V/-15V	2	SMA Conn.
3	+12V/-12V		
4	+5 V/-15V		

Specifications Subject to Change Without Notice.

SPST ECL Switches With Drivers

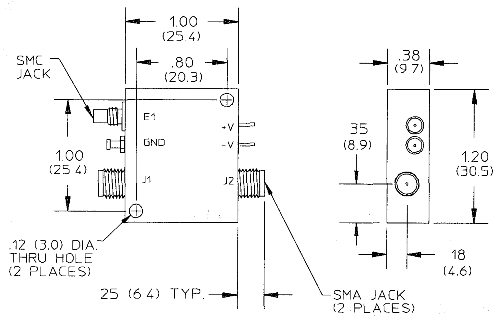
2662 Series

Features

- Broadband Frequency Ranges
- Environmentally Sealed
- ECL Compatible

Description

M/A-COM 's Emitter Coupled Logic (ECL) PIN diode switches offer multi-octave bands from UHF to Ku-band. Advantages of an ECL switch are narrow pulse width (25 nS) and high pulse repetition rates (20 MHz). These devices typically have lower RF power characteristics due to the thin I-region needed for fast transition times. Standard options for bias voltages are not available on ECL switches. Typical insertion loss, VSWR, and isolation curves are shown below.



Environmental

These devices are designed to meet the following conditions:

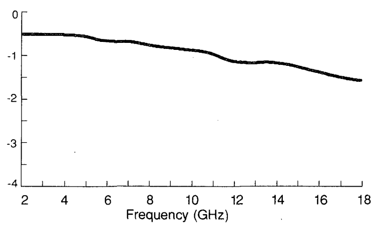
Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

Maximum Ratings

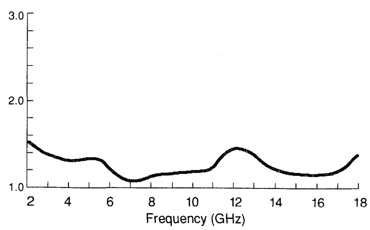
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2662-1008-XY

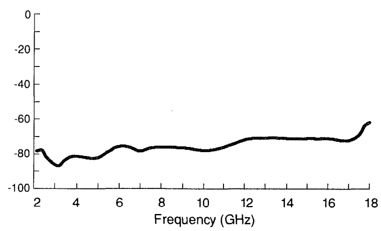
Insertion Loss (dB)



VSWR



Isolation (dB)



Specifications Subject to Change Without Notice.

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[9]
0.5-2.0	0.7	1.40:1	40	5	15	0.02	2662-1001-XY
2-8	1.0	1.50:1	40	5	15	0.02	2662-1003-XY
	1.2	1.50:1	60	5	15	0.02	2662-1004-XY
6-18	2.0	1.90:1	40	5	15	0.02	2662-1005-XY
	2.2	1.90:1	55	5	15	0.02	2662-1006-XY
2-18	2.5	2.00:1	55	5	15	0.02	2662-1008-XY

Notes:
1. Driver current req. ± 90mA typ.
2. Logic "1" for low loss.
3. Transition Time measured from 10% to 90% of detected RF.
4. Switch Speed measured from 50% TTL to 10%/90% of detected RF.
5. Nominal ECL levels are:
   "1" -0.8V
   "0" -1.8V
6. Minimum pulse width 25 nS.
7. Maximum PRF 20 MHz.
8. Logic input impedance: 75 ohms.
9. Specify voltage and logic connector from option table.

- XY Option Table

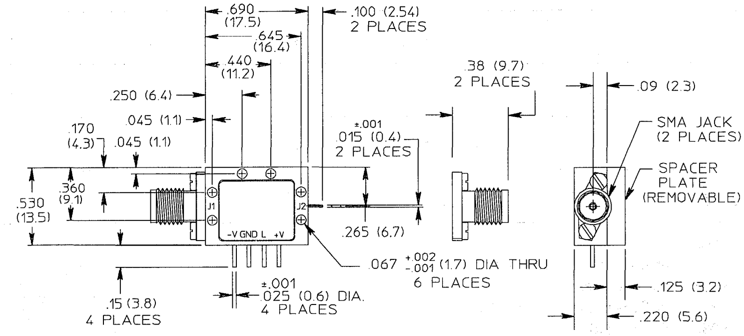
	X Bias Voltage		Y Logic Conn.
0	+12V/-5.2V	0	N/A
1	+5V/-5.2V	1	SMC Conn.
2	+15V/-5.2V	2	SMA Conn.

SPST Reflective Switches With TTL Drivers
SPST Reflective Switches With TTL Drivers and Removable Connectors

2680 Series

Features

- Broadband Frequency Ranges
- Hermetically Sealed
- TTL Drivers
- Removable SMA Connectors



Description

M/A-COM's diode switches cover multi-octave bandwidths from S to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. These switches may be used as drop-ins on stripline assemblies by removing the SMA connectors.The removable mounting plate allows clearance when using the device with cable assemblies. The SMA connector seals are integrated in the housing to allow connector removal without violating the hermetic seal. Typical swept insertion loss, return loss, and isolation curves are shown below.

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +125°C
Input Power	0.5 W CW/Avg.

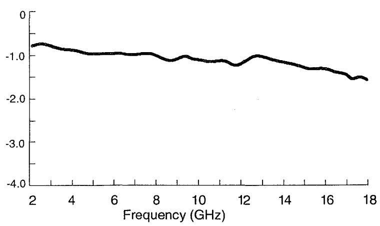
Environmental

These devices are designed to meet the following screening conditions:

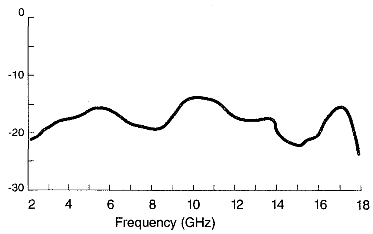
Test		Method	Cond
Non-Destructive Bond Pull		2023	
Internal Visual Inspection		2017	
Stabilization Bake		1008	B
Thermal Cycle		1010	B
Constant Acceleration		2001	A (Y1 Axis)
Burn-in		1015	+125°C
Seal	Fine	1014	A1
	Gross	1014	C1
External Visual		2009	

Typical Performance Data 2680-1003

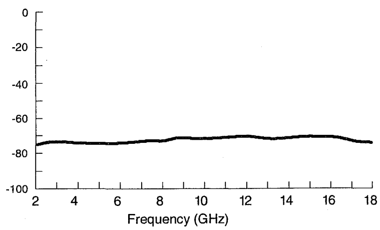
Insertion Loss (dB)



Return Loss (dB)



Isolation (dB)



Specifications Subject to Change Without Notice.

Specifications 25˚C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Part Number
2-8	1.4	1.50:1	70	10	20	2680-1001
8-18	2.4	2.00:1	75	10	20	2680-1002
2-18	2.5	2.10:1	70	10	20	2680-1003

Notes:

1. Driver current req. +5.0 ± .25V @ +40mA typ.
   -11.0 - 15V @ -50mA typ.
2. Transition Time measured from 10% to 90% of detected RF.
3. Switch Speed measured from 50% TTL to 10%/90% of detected RF.
4. Other logic options are available, consult factory.

Logic Table

TTL Control Input	
L1	
0	Insertion Loss
1	Isolation

TTL Logic: "0" =0 to 0.8V @ -1.6 mA Max. Sink.
"1" =2.0 to 5.0V @ 40μA Max. Source.

Specifications Subject to Change Without Notice.

SPDT Reflective Switches With Drivers

SPDT Reflective Switches With Drivers

2664 Series

Features

- Broadband Frequency Ranges
- Environmentally Sealed
- TTL Compatible
- Small Size

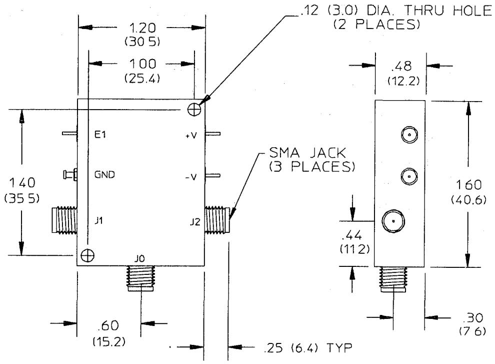
Description

M/A-COM's diode switches cover instantaneous multi-octave bandwidths from UHF to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. Typical insertion loss, VSWR, and isolation curves are shown below.

Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

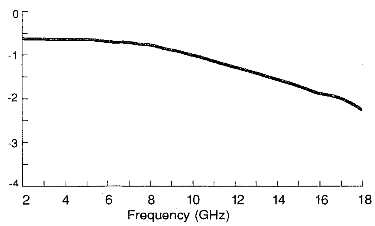


Maximum Ratings

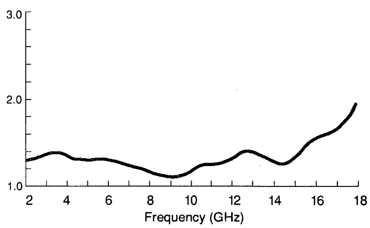
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2664-1015-XY

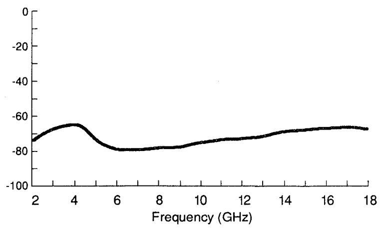
Insertion Loss (dB)



VSWR



Isolation (dB)



Specifications Subject to Change Without Notice.

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Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[7]
0.5-2.0	0.9	1.40:1	40	15	30	0.1	2664-1001-XY
				150	200	0.5	2664-1002-XY
	1.1	1.40:1	60	15	30	0.1	2664-1003-XY
				150	200	0.5	2664-1004-XY
2-8	1.5	1.60:1	60	15	30	0.1	2664-1007-XY
				150	200	0.5	2664-1008-XY
6-18	2.4	2.00:1	40	15	30	0.1	2664-1009-XY
				150	200	0.5	2664-1010-XY
	2.6	2.00:1	55	15	30	0.1	2664-1011-XY
2-18	2.8	2.00:1	55	15	30	0.1	2664-1015-XY
				150	200	0.5	2664-1016-XY

Notes:
1. Driver current req. ± 90mA typ.
2. Logic "0" for low loss J_0-J_1.
3. Transition Time measured from 10% to 90% of detected RF.
4. Switch Speed measured from 50% TTL to 10%/90% detected RF.
5. Single input control.
6. Separate input control available as special.
7. Specify voltage and logic connector from option table.

- XY Option Table

	X Bias Voltage		Y Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V	1	SMC Conn.
2	+15V/-15V	2	SMA Conn.
3	+12V/-12V		
4	+5 V/-15V		

Specifications Subject to Change Without Notice.

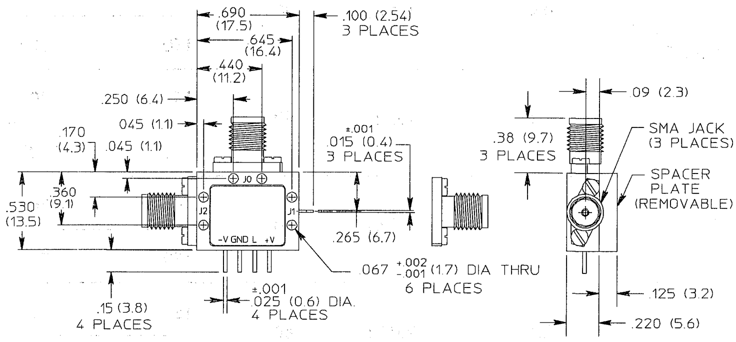
SPDT Reflective Switches With TTL Drivers and Removable Connectors — 2681 Series

SPDT Reflective Switches With TTL Drivers and Removable Connectors

2681 Series

Features

- Broadband Frequency Ranges
- Hermetically Sealed
- TTL Drivers
- Removable SMA Connectors



Description

M/A-COM's diode switches cover multi-octave bandwidths from S to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. These switches may be used as drop-ins on stripline assemblies by removing the SMA connectors.The removable mounting plate allows clearance when using the device with cable assemblies. The SMA connector seals are integrated in the housing to allow connector removal without violating the hermetic seal. Typical swept insertion loss, return loss, and isolation curves are shown below.

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +125°C
Input Power	0.5 W CW/Avg.

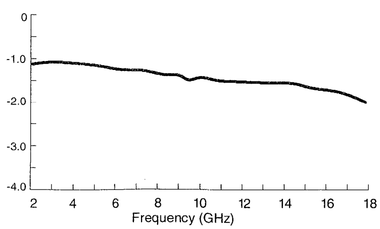
Environmental

These devices are designed to meet MIL-STD-883 screening conditions :

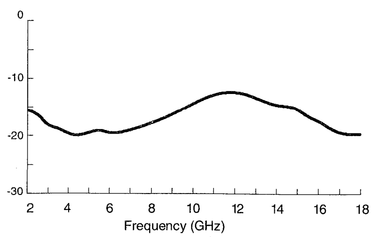
Test		Method	Cond
Non-Destructive Bond Pull		2023	
Internal Visual Inspection		2017	
Stabilization Bake		1008	B
Thermal Cycle		1010	B
Constant Acceleration		2001	A (Y1 Axis)
Burn-in		1015	+125°C
Seal	Fine	1014	A1
	Gross	1014	C1
External Visual		2009	

Typical Performance Data 2681-1003

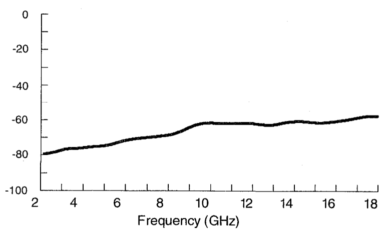
Insertion Loss (dB)



Return Loss (dB)



Isolation (dB)



Specifications Subject to Change Without Notice.

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Part Number
2-8	1.5	1.50:1	60	10	20	2681-1001
8-18	2.2	2.00:1	55	10	20	2681-1002
2-18	2.5	2.10:1	55	10	20	2681-1003

Notes:
1. Driver current req. +5.0 ± .25V @ +50mA typ.
   -11.0 - 15V @ -50mA typ.
2. Transition Time measured from 10% to 90% of detected RF.
3. Switch Speed measured from 50% TTL to 10%/90% of detected RF.
4. Other logic options are available, consult factory.

Logic Table

TTL Control Input L	J0 -J1	J0 -J2
0	Insertion Loss	Isolation
1	Isolation	Insertion Loss

TTL Logic: "0" =0 to 0.8V @ -1.6 mA Max. Sink.
"1" =2.0 to 5.0V @ 40μA Max. Source.

Specifications Subject to Change Without Notice.

SPDT Medium Power Switches With Drivers

2665 Series

Features
- Octave Bands to 18 GHz
- 10 Watts CW
- TTL Compatible
- Environmentally Sealed

Description
M/A-COM 's medium power PIN diode switches cover octave bandwidths from 2 to 18 GHz. All diodes are shunt-mounted to the housing for superior heat sinking. The circuit and bias structure are designed to withstand higher signal levels without compromising RF performance. All solder construction and thermal compression bonding techniques ensure reliable operation in hostile environments. Typical insertion loss, VSWR, and isolation curves are shown below.

Environmental
These devices are designed to meet the following conditions:

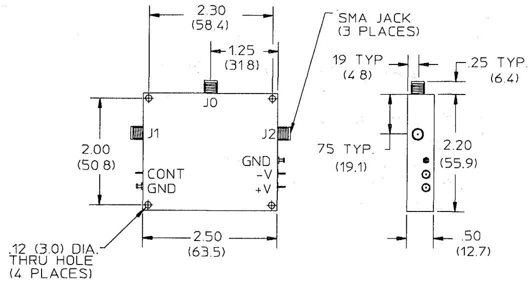
Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

Maximum Ratings

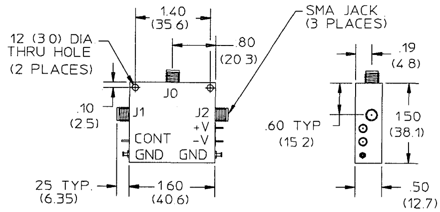
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Mechanical Outline

2-4 and 4-8 GHz



8-12 and 12-18 GHz



2665-Series

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[5]
2-4	1.6	1.70:1	55	150	200	10	2665-1002-XY
4-8	2.0	1.90:1	55	150	200	10	2665-1004-XY
8-12	2.5	2.00:1	55	150	200	10	2665-1006-XY
12-18	2.4	2.20:1	40	150	200	10	2665-1007-XY

Notes:

1. Driver current req. ± 90mA typ.
2. Logic "0" for low loss.
3. Transition Time measured from 10% to 90% of detected RF.
4. Switch Speed measured from 50% TTL to 10%/90% detected RF.
5. Specify voltage and logic connector from option table.

- XY Option Table

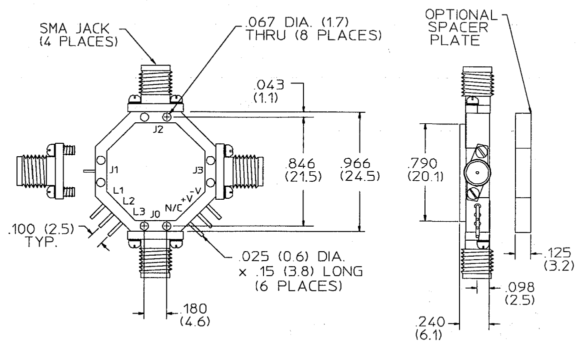
	X Bias Voltage		Y Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V	1	SMC Conn.
2	+15V/-15V	2	SMA Conn.
3	+12V/-12V		
4	+5 V/-15V		

Specifications Subject to Change Without Notice.

![M/A-COM logo]

SP3T Reflective Switches With Drivers and Removable Connectors

2682 Series



RF Connector (4 Places): .015 ±.001 Dia. (0.4), .100 Long (2.5)

Features

- Broadband Frequency Ranges
- Hermetically Sealed
- TTL Compatible
- Removable SMA Connectors

Description

M/A-COM's diode switches cover multi-octave bandwidths from UHF to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. These switches may be used as drop-ins in stripline assemblies simply by removing the SMA connectors. In addition, the field replaceable connectors allow replacement of a damaged connector without violating the hermetic seal. Typical insertion loss, return loss, and isolation curves are shown below.

Environmental

These devices are designed to meet the following screening conditions:

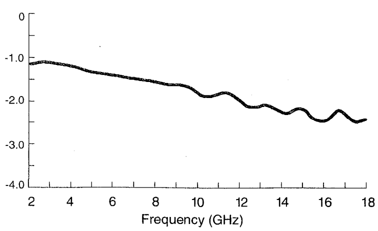
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		883	2017	
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

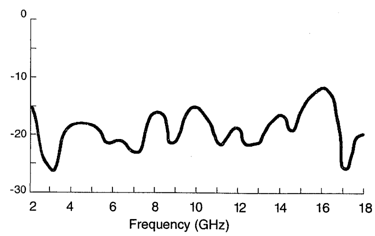
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2682-1004-XY

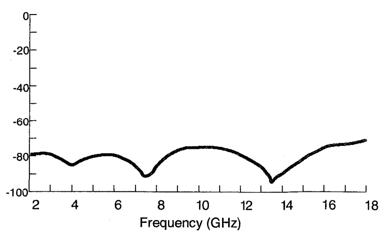
Insertion Loss (dB)



Return Loss (dB)



Isolation (dB)



Specifications Subject to Change Without Notice.

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[4]
0.5-2.0	1.2	1.50:1	70	10	25	0.1	2682-1001-XY
2-8	1.8	1.80:1	70	10	25	0.1	2682-1002-XY
6-18	2.5	2.00:1	70	10	25	0.1	2682-1003-XY
2-18	2.8	2.00:1	65	10	25	0.1	2682-1004-XY

Notes:

1. Driver current req. +5.0 ±. 25V @ +115mA typ.
   -12.0 ±. 75V @ -55mA typ.

   Alternate bias options are available.
2. Transition Time measured from 10% to 90% of detected RF.
3. Switch Speed measured from 50% TTL to 10%/90% of detected RF.
4. Specify voltage from option table. To designate option spacer plate, change 5th digit of part number to "2", i.e. 2682-2001-XY.

-XY Option Table

X	Bias Voltage	Y	Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V		
4	+5V/-15V		

Logic Table

TTL Control Input L1	L2	L3	J0-J1	J0-J2	J0-J3
0	1	1	Insertion Loss	Isolation	Isolation
1	0	1	Isolation	Insertion Loss	Isolation
1	1	0	Isolation	Isolation	Insertion Loss

TTL Logic: "0" =0 to 0.8V @ -1.6 mA Max. Sink.
"1" =2.0 to 5.0V @ 40µA Max. Source.

SP4T Reflective Switches With Drivers and Removable Connectors

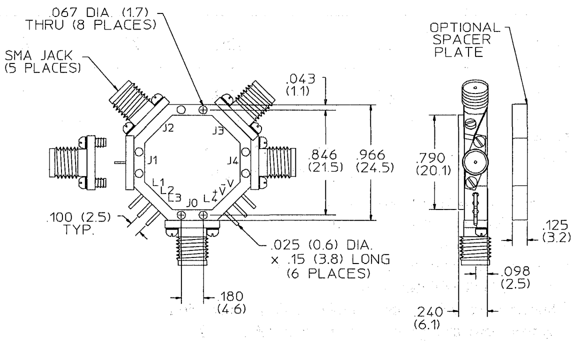
2683 Series

Features

- Broadband Frequency Ranges
- Hermetically Sealed
- TTL Compatible
- Removable SMA Connectors

Description

M/A-COM's diode switches cover multi-octave bandwidths from UHF to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. These switches may be used as drop-ins in stripline assemblies simply by removing the SMA connectors. In addition, the field replaceable connectors allow replacement of a damaged connector without violating the hermetic seal. Typical insertion loss, return loss, and isolation curves are shown below.



RF Connector (5 Places): .015 ±.001 Dia. (0.4), .100 Long (2.5)

Environmental

These devices are designed to meet the following screening conditions:

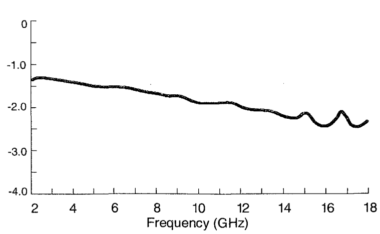
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		883	2017	
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

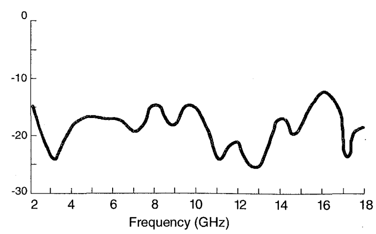
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2683-1004-XY

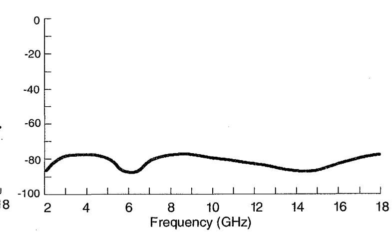
Insertion Loss (dB)



Return Loss (dB)



Isolation (dB)



Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed (nS)	Operating Power (W)	Part Number[4]
0.5-2.0	1.4	1.50:1	70	10	25	0.1	2683-1001-XY
2-8	2.0	1.80:1	70	10	25	0.1	2683-1002-XY
6-18	2.9	2.00:1	70	10	25	0.1	2683-1003-XY
2-18	3.2	2.00:1	65	10	25	0.1	2683-1004-XY

Notes:

1. Driver current req. +5.0 ±. 25V @ +145mA typ.
   -12.0 ±. 75V @ -75mA typ.

   Alternate bias options are available.
2. Transition Time measured from 10% to 90% of detected RF.
3. Switch Speed measured from 50% TTL to 10%/90% of detected RF.
4. Specify voltage from option table. To designate option spacer plate, change 5th digit of part number to "2", i.e. 2683-2001-XY.

-XY Option Table

X	Bias Voltage	Y	Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V		
4	+5V/-15V		

Logic Table

TTL Control Input L1	L2	L3	L4	J0-J1	J0-J2	J0-J3	J0-J4
0	1	1	1	Insertion Loss	Isolation	Isolation	Isolation
1	0	1	1	Isolation	Insertion Loss	Isolation	Isolation
1	1	0	1	Isolation	Isolation	Insertion Loss	Isolation
1	1	1	0	Isolation	Isolation	Isolation	Insertion Loss

TTL Logic: "0" =0 to 0.8V @ -1.6 mA Max. Sink.
"1" =2.0 to 5.0V @ 40μA Max. Source.

SP5T Reflective Switches With Drivers and Removable Connectors

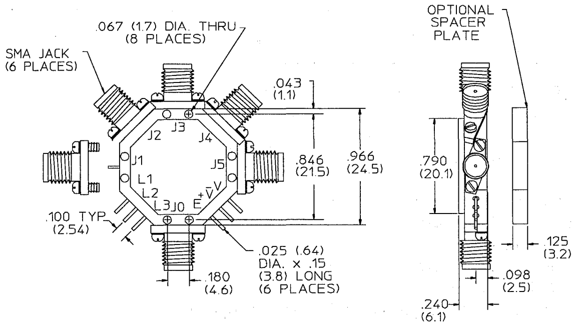
SP5T Reflective Switches With Drivers and Removable Connectors — 2684 Series

Features

- Broadband Frequency Ranges
- Hermetically Sealed
- TTL Compatible
- Removable SMA Connectors

Description

M/A-COM's diode switches cover multi-octave bandwidths from UHF to Ku-band. M/A-COM's capability in both semiconductor and digital circuit technology allows considerable flexibility in the tradeoffs of power, speed, RF parameters and drivers. These switches may be used as drop-ins in stripline assemblies simply by removing the SMA connectors. In addition, the field replaceable connectors allow replacement of a damaged connector without violating the hermetic seal. Typical insertion loss, return loss, and isolation curves are shown below.



RF Connector (6 Places): .015 ±.001 Dia. (0.4), .100 Long (2.5)

Environmental

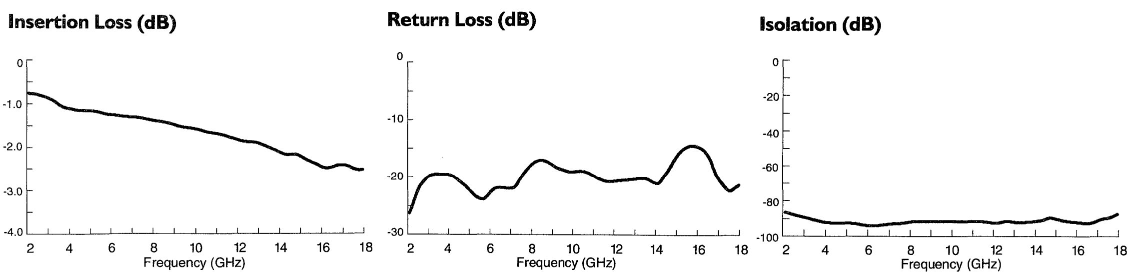
These devices are designed to meet the following screening conditions:

Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		883	2017	
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2684-1004-XY



Specifications Subject to Change Without Notice.

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Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Transition Time (nS)	Switching Speed(nS)	Operating Power (W)	Part Number[4]
0.5-2.0	1.5	1.50:1	70	10	25	0.1	2684-1001-XY
2-8	2.2	1.80:1	70	10	25	0.1	2684-1002-XY
6-18	3.1	2.00:1	70	10	25	0.1	2684-1003-XY
2-18	3.3	2.00:1	65	10	25	0.1	2684-1004-XY

Notes:
1. Driver current req. +5.0 ±.25V @ +175mA typ.
   -12.0 ±.75V @ -90mA typ.

   Alternate bias options are available.
2. Transition Time measured from 10% to 90% of detected RF.
3. Switch Speed measured from 50% TTL to 10%/90% of detected RF.
4. Specify voltage from option table. To designate optional spacer plate, change 5th digit of part number to "2", i.e. 2684-2001-XY.

-XY Option Table

	X Bias Voltage		Y Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V		
4	+5V/-15V		

Logic Table

TTL Control Input L1	L2	L3	E	J0-J1	J0-J2	J0-J3	J0-J4	J0-J5
1	0	0	1	Insertion Loss	Isolation	Isolation	Isolation	Isolation
0	1	0	1	Isolation	Insertion Loss	Isolation	Isolation	Isolation
1	1	0	1	Isolation	Isolation	Insertion Loss	Isolation	Isolation
0	0	1	1	Isolation	Isolation	Isolation	Insertion Loss	Isolation
1	0	1	1	Isolation	Isolation	Isolation	Isolation	Insertion Loss
X	X	X	0	Isolation	Isolation	Isolation	Isolation	Isolation

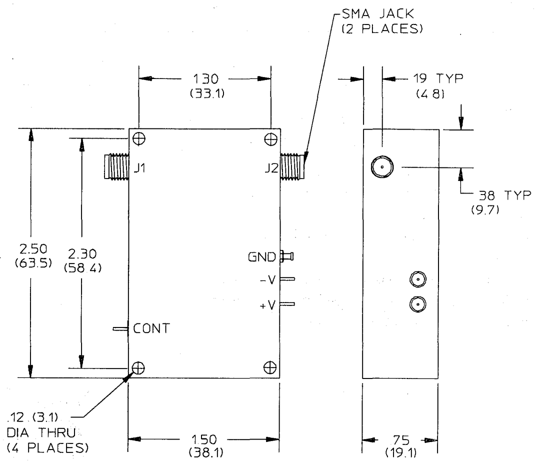
TTL Logic: "0" =0 to 0.8V @ -1.6 mA Max. Sink.
"1" =2.0 to 5.0V @ 40μA Max. Source.
"X"= "0" or "1"

Absorptive Linearized Attenuators

2694 Series

Features
- Standard Bandwidths up to 18 GHz
- Environmentally Sealed
- Linear Operation

Description
M/A-COM 's 2694 series voltage variable attenuators operate over wide dynamic range and octave bandwidths. The circuit for the device is built using PIN diode chips in a broadband microstrip design. The linearized driver uses hybrid IC's and offers transfer functions that produce linear RF attenuation with input voltage.



Environmental
These devices are designed to meet the following conditions:

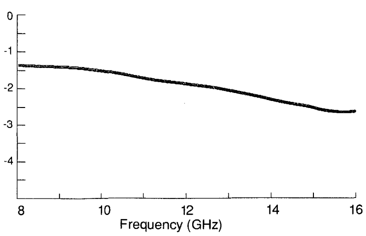
Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

Maximum Ratings

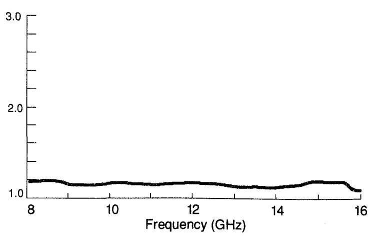
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2694-1006

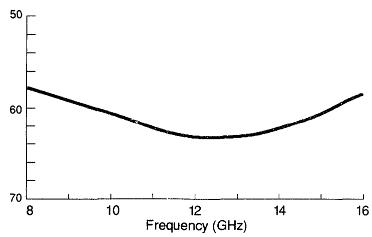
Insertion Loss (dB)



VSWR



Attenuation (dB)



Specifications Subject to Change Without Notice.

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR Low Loss State	VSWR Any State	Dynamic Range (dB)	Switching Time (nS)	Operating Power (W)	Part Number[7]
2.0-4.0	1.8	1.50:1	2.00:1	45	1000	0.100	2694-1001-XY
	2.0	1.50:1	2.00:1	60	1000	0.100	2694-1002-XY
4.0-8.0	2.2	1.60:1	2.00:1	45	1000	0.100	2694-1003-XY
	2.5	1.60:1	2.00:1	60	1000	0.100	2694-1004-XY
8.0-16.0	3.0	2.00:1	2.20:1	45	1000	0.100	2694-1005-XY
	3.4	2.00:1	2.20:1	60	1000	0.100	2694-1006-XY

Notes:
1. Driver current req. ± 125mA typ.
2. Switching Time measured from 50% control voltage to 10% or 90% of detected RF.
3. Linearity: ± 1.0 dB or ± 4% (whichever is greater) deviation from best fit straight line.
4. Flatness: ± 1.0 dB or ± 8% whichever is greater.
5. Temperature variation: ± 1.0dB or ± 3% whichever is greater.
6. Transfer function: 0 to +10V typ.
7. Specify voltage and logic connector from option table.

- XY Option Table

	X Bias Voltage		Y Logic Conn.
0	N/A	0	Solder Pin
1	N/A	1	SMC Conn.
2	+15V/-15V	2	SMA Conn.
3	+12V/-12V		

Specifications Subject to Change Without Notice.

Switch Modules Easily Integrated Into Printed Microwave Circuit Boards

Microwave modules consist of microelectronic circuits inside a hermetically sealed metal package. The transition into and out of the housing is accomplished by using coaxial bead structures. These bead structures have Kovar center pins making the construction ideal for integration into printed microwave circuit boards. The internal construction requires a soldered connection from the circuit board to the leads and a mechanical connection from circuit board ground to the case.

Standard modules are designed to be integrated into 1/8-inch-ground-plane-spacing stripline circuits. Such stripline circuitry provides the important balanced "coaxial" ground connection. Mounting modules in microstrip circuits is more complex because the single-sided ground system does not continue the ground currents symmetrically into the coaxial bead connector of the module. This asymmetry may affect performance. Applications information on module design considerations follows.

Switches Without Internal Drivers

Switching time for devices without drivers is defined as the elapsed time required for the switch to transition between the insertion loss and isolation states. In order to provide a consistent framework for measuring these transitions, the 10% and 90% RF voltage points have been selected as standard reference points. Figure 1 illustrates the RF envelope, as displayed on a sampling oscilloscope, showing the transitions from isolation to insertion loss and back again. The switching speeds listed in the specification section are specified with M/A-COM standard drivers.

Switches With Internal Drivers

Switching times for devices equipped with logic compatible drive circuitry can be specified by the use of several different reference points. The conventional definition of switching speed is the total time required from the input of the logic signal to the completion of the RF transition. The actual points chosen are the 50% transition point of the logic input and either the 10% or 90% points of the RF voltage envelope. This method of measurement includes all delays in the driver portion of the device as well as the actual transition times of the RF circuitry. Figure 2 illustrates the relation between the logic input signal and the resultant RF transition, as it would be displayed on a sampling oscilloscope.

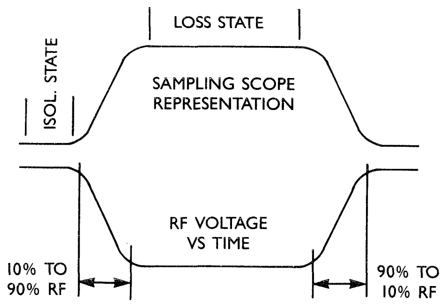


Figure 1

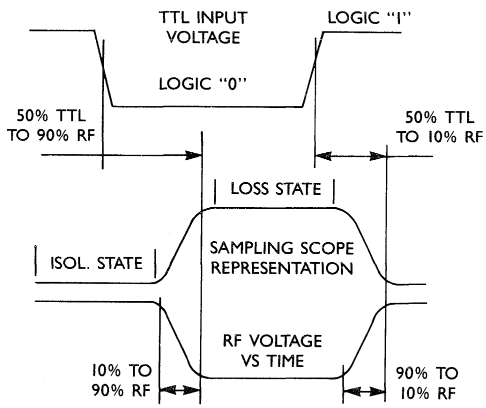


Figure 2

The switching speed parameter limits listed in the specifications section are for the modulating mode only. The modulating mode is defined as switching one arm of a switch on and off while holding all other arms in the isolated state. The other method of using a switch is called the commutating mode which is defined as switching between any two arms on a given switch. Commutating and modulating modes are the same for a single-pole single-throw switch. When measuring any parameter on a switch requiring biasing, make sure the bias supply voltage and current outputs are the correct value and polarity. Switches with internal drivers have some reverse polarity and over voltage protection but they are protected only to a certain point and can be permanently damaged if the protection limits are exceeded.

A typical test set-up used to measure switching speed is shown in Figure 3.

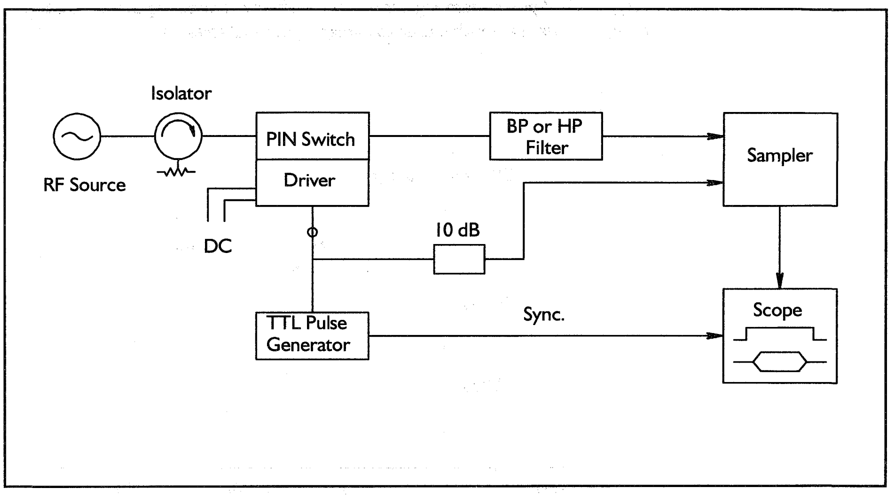


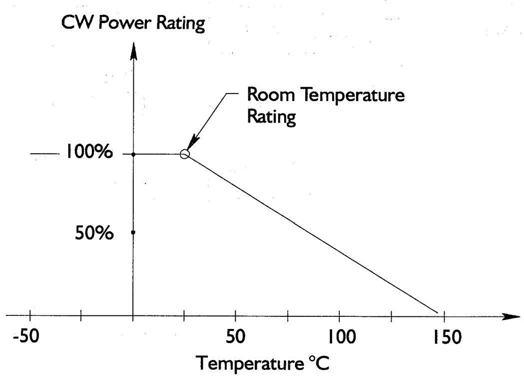
Figure 3

Power Considerations

For most switches, the power is either transmitted to the output load or reflected back to the source. The percentage absorbed by the switch in either state is typically small. Problems arise when the requirement is to switch states while the high power is applied (a condition called "hot switching"). Up to 50% of the incident power may be absorbed during switching. For this reason, most power ratings are under "cold switching" conditions. The problem with "hot switching" requirements is that diodes must be thick enough to withstand RF line power, yet be thin enough to switch fast and minimize duration of absorbed energy during the transition state.

Some advantage can be obtained under pulsed operation. If RF pulse lengths are short compared to thermal time constants for PIN diodes, the diode will not have time to heat up. Thermal time constants are typically a few microseconds long. Hence, pulse widths of 10 or more microseconds are virtually CW conditions for most devices. Duty cycle/average power computations are no longer useful under these long pulse conditions.

A typical CW power derating curve is shown below. Increasing the ambient temperature brings a diode that much closer to damaging thermal stresses.



Power Derating Curve

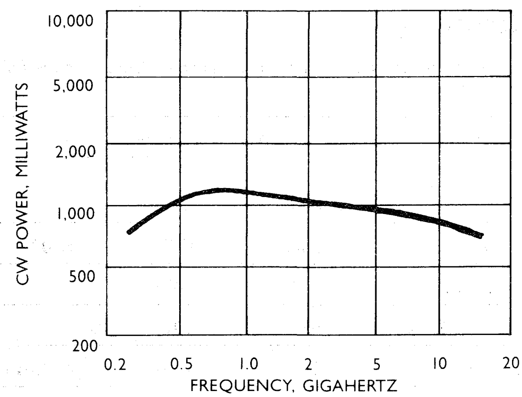
Additional Power Considerations

Another type of problem encountered at high power levels is limiting. Limiting occurs when charges injected by the RF currents become comparable to the charges stored in the diodes by the dc control currents. This occurs most frequently in fast switching, thin I-Region diodes which will accommodate a smaller dc charge. High power signals will induce a current which may modulate the control signal, causing performance degradation.

There are several solutions to this problem, among them:

- Increase the thickness of the diode (slow the switching speed) so that the diode will store more dc charges in the isolation state.
- Apply a higher reverse voltage at insertion loss to sweep out any RF injected charges.
- Make the driver output impedance high so that there is little chance of the RF forcing rectified current back through the driver.

The above considerations show that there is a trade-off between high power and fast switching speed. The curves below show typical effects on loss for increased CW and pulsed power.



Typical CW Power at which Insertion Loss Increases by 0.1 dB Over Loss at 0 dBm.

M/A-COM

SPST Reflective Switch Modules

2951 Series

Features

- Broadband Frequency Ranges
- Hermetic Package
- Stripline Compatible
- Compact Size

Description

M/A-COM 's switch modules cover multi-octave bandwidths from UHF to Ku-band. M/A-COM's expertise in semiconductor technology and design techniques results in devices having unique advantages that allow them to satisfy a variety of microwave system requirements.

Screening

Optional screening can be performed in accordance with the following sequence:

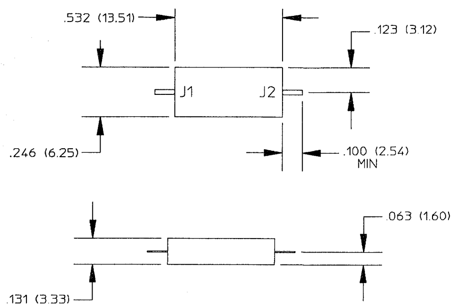
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		M/A-COM	QCP	QAP409
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Mechanical Outline (Top View)

Without Internal Bias Circuitry



±.002
Leads are .012 (.31) diameter (std.).
±.010 ±.002
May be supplied as tabs: .025 (.64) Wide, .006 (.15) Thick (opt.).
Contact factory.

Specifications Subject to Change Without Notice.

Typical Specifications 25°C

Without Internal Bias Circuitry

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Switching Speed (nS)	Power Handling (W)	Part Number
0.5-2.0	0.6	1.5:1	40	15	1.0	2951-2001
2.0-8.0	0.9	1.7:1	50	15	1.0	2951-2002
6.0-18.0	1.4	1.9:1	55	15	1.0	2951-2003

Notes:
1. Bias: -10V for specified loss
   +30mA for specified isolation
2. Switching speed is measured from 10%-90% and 90%-10% of the detected RF with a 2 MHz maximum switching rate.
3. Switching speed is measured with a standard M/A-COM driver.
4. Operating power is 100 mW maximum.

SPDT Reflective Switch Modules

2954 Series

Features
- Broadband Frequency Ranges
- Hermetic Package
- Stripline Compatible
- Compact Size

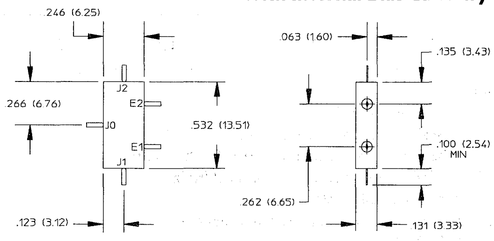
Description
M/A-COM 's switch modules cover multi-octave bandwidths from UHF to Ku-band. M/A-COM's expertise in semiconductor technology and design techniques results in devices having unique advantages that allow them to satisfy a variety of microwave system requirements.

Screening
Optional screening can be performed in accordance with the following sequence:

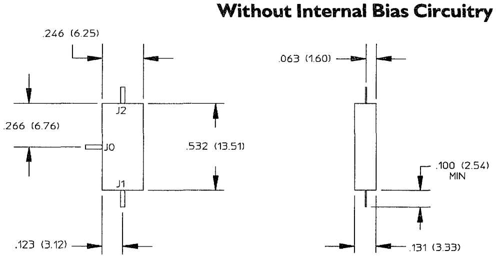
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		M/A-COM	QCP	QAP 409
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Mechanical Outline (Top View)

With Internal Bias Circuitry



Without Internal Bias Circuitry



Leads are .012 (.31) diameter (std.). ±.002

May be supplied as tabs: .025 (.64) Wide, ±.010, .006 (.15) Thick (opt.). ±.002

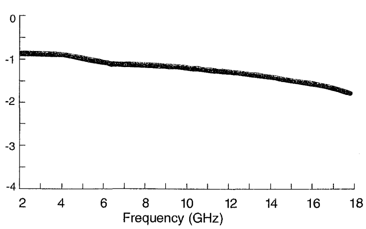
Contact factory.

Maximum Ratings

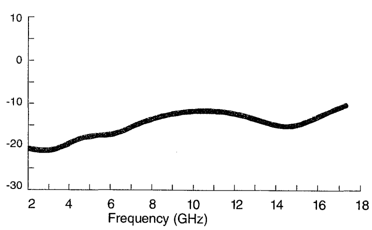
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2954-1004

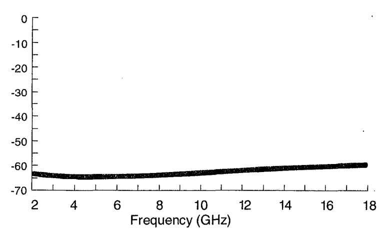
Insertion Loss (dB)



Return Loss (dB)



Isolation (dB)



Specifications Subject to Change Without Notice.

Typical Specifications 25°C

With Internal Bias Circuitry

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Switching Speed (nS)	Power Handling (W)	Part Number
0.5-2.0	0.8	1.5:1	40	20	0.5	2954-1001
2.0-8.0	1.5	1.7:1	45	20	0.5	2954-1002
2.0-18.0	2.6	2.0:1	35	20	0.5	2954-1004

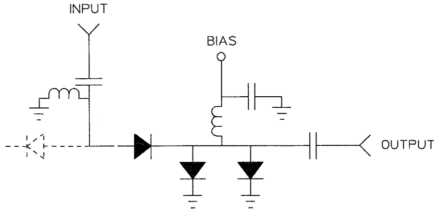
Without Internal Bias Circuitry

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Switching Speed (nS)	Power Handling (W)	Part Number
0.5-2.0	0.8	1.5:1	40	20	0.5	2954-2001
2.0-8.0	1.5	1.7:1	45	20	0.5	2954-2002
6.0-18.0	2.0	2.0:1	35	20	0.5	2954-2003

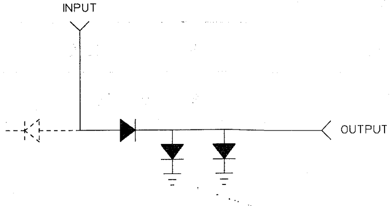
Notes:
1. Bias: -30V for specified loss
   +30mA for specified isolation
2. Switching speed is measured from 10%-90% and 90%-10% of the detected RF with a 2 MHz maximum switching rate.
3. Switching speed is measured with a standard M/A-COM driver.
4. Operating power is 100 mW maximum.

Typical Schematic

With Internal Bias Circuitry
Part Number 2954-1004



Without Internal Bias Circuitry
Part Number 2954-2003



Specifications Subject to Change Without Notice.

SPDT Reflective Modules With TTL Compatible Drivers

2956 Series

Features
- Broadband Frequency Ranges
- Hermetic Package
- Stripline Compatible
- Compact Size
- TTL Compatible Driver

Description
M/A-COM 's switch modules with TTL compatible drivers have been designed to incorporate broad bandwidth (0.5-18.0 GHz) design techniques with integral hybrid driver circuitry. The results are multi-octave bandwidth devices which retain the stripline compatibility feature of a module while also incorporating a low power consumption driver capable of switching the RF circuitry in less than 50 nS. Construction techniques allow these devices to be used in today's most stringent military environments.

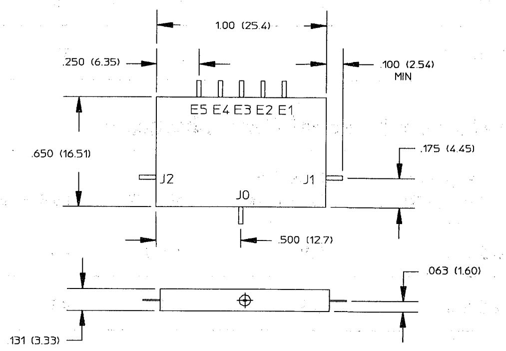
Screening
Optional screening can be performed in accordance with the following sequence:

Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		M/A-COM	QCP	QAP 409
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Mechanical Outline (Top View)



Leads are .012 (.31) diameter (std.). ±.002
May be supplied as tabs: .025 (.64) Wide, .006 (.15) Thick (opt.). ±.010 ±.002
Contact factory.

Terminal Assignments

Terminal	Assignment	Terminal	Assignment
J0	RF Common Arm	E3	Ground
J1	RF Port 1	E4	+5 Volts
J2	RF Port 2	E5	TTL Logic
E1	TTL Logic	Case	Ground
E2	-12 Volts		

RF Assignment

TTL E5	TTL E1	J0-J2	J0-J1
0	1	Loss	Isolation
1	0	Isolation	Loss

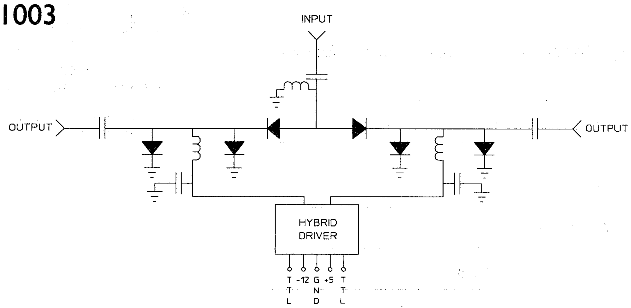
Specifications Subject to Change Without Notice.

Typical Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Switching Speed (nS)	Power Handling (W)	Part Number
0.5-2.0	1.2	1.5:1	50	50	0.5	2956-1001
2.0-8.0	1.8	1.8:1	50	50	0.5	2956-1002
6.0-18.0	2.5	2.0:1	45	50	0.5	2956-1003

Notes:
1. Bias: +5V ± 5%@ 75mA maximum
   -12V ± 5% @ 50mA maximum
2. Switching speed is measured from 10%-90% and 90%-10% of the detected RF with a 2 MHz maximum switching rate.
3. Operating power is 100 mW maximum.

Typical Schematic 2956-1003



Specifications Subject to Change Without Notice.

SP4T Reflective Switch Modules

2959 Series

Features

- Broadband Frequency Ranges
- Hermetic Package
- Stripline Compatible
- Compact Size

Description

M/A-COM 's switch modules cover multi-octave bandwidths from UHF to Ku-band. M/A-COM's expertise in semiconductor technology and design techniques results in devices having unique advantages that allow them to satisfy a variety of microwave system requirements.

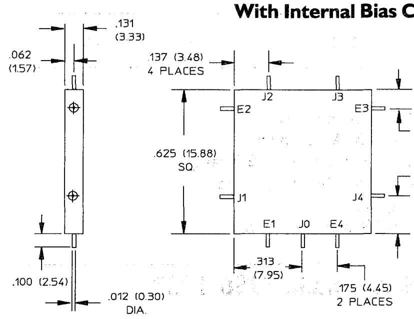
Screening

Optional screening can be performed in accordance with the following sequence:

Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		M/A-COM	QCP	QAP 409
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Mechanical Outline (Top View)

With Internal Bias Circuitry



Notes:
1. Finish: Gold plate
2. Case is ground.

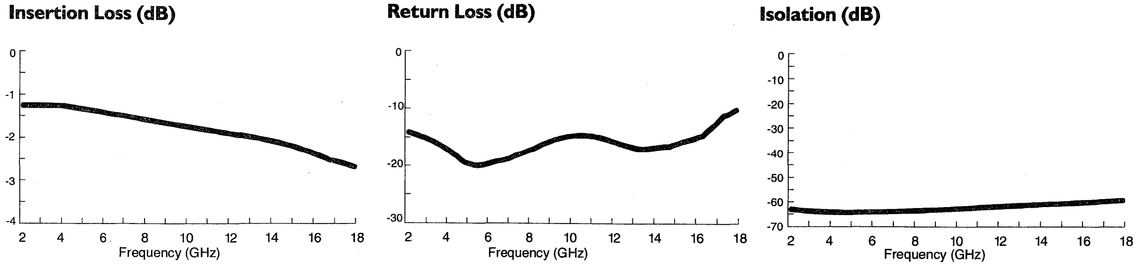
Leads are .012 (.31) diameter (std.). ±.002

May be supplied as tabs: .025 (.64) Wide ±.010, .006 (.15) Thick ±.002 (opt.).
Contact factory.

Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2959-1004



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Typical Specifications 25°C

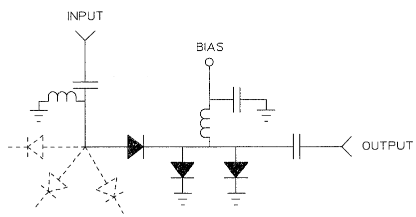
With Internal Bias Circuitry

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Isolation (dB)	Switching Speed (nS)	Power Handling (W)	Part Number
0.5-2.0	1.2	1.5:1	40	20	0.5	2959-1001
2.0-8.0	1.8	1.8:1	50	20	0.5	2959-1002
6.0-18.0	2.7	2.0:1	40	20	0.5	2959-1003
2.0-18.0	2.9	2.0:1	40	20	0.5	2959-1004

Notes:
1. Bias: -30mA for specified loss
   +30mA/Arm for specified isolation
2. Switching speed is measured from 10%-90% and 90%-10% of the detected RF with a 2 MHz maximum switching rate.
3. Switching speed is measured with a standard M/A-COM driver.
4. Operating power is 100 mW maximum.

Typical Schematic

With Internal Bias Circuitry
Part Number 2959-1004



M/A-COM

Electromechanical Switch

Overview

M/A-COM's electromechanical switches are designed to produce an optimum combination of RF performance and proven reliability as well as excellent repeatability and a uniform impedance match over all frequency ranges.

The following pages contain detailed information on a representation of the M/A-COM electromechanical switch line. The complete standard product line is represented by these coaxial and waveguide selection charts. Custom designs are also available through M/A-COM's extensive design engineering capability.

STANDARD FEATURES AND OPTIONS

- Actuators: 28V (12VDC)
  Failsafe (Latching)
  (Manual)
- Power Connections: Solder Terminals
- Indicator (Auxiliary) Contacts
- Traditional Mounting Configurations
- Switching Action: Break-Before-Make
  Non-Hot Switched

WAVEGUIDE EM SWITCHES*

FUNCTION	POWER	FREQUENCY RANGE (GHz)
WR-90	500W	8.2 - 12.4
WR-62	300W	12.4 - 18.0
WR-62Y ROTOR	100W	14.5 - 18.0
WR-28	100W	26.5 - 40.0
WAVEGUIDE SHUTTERS	100W	8.5 - 9.6 31.2 - 40.0

* Contact factory for details.

COAXIAL EM SWITCHES

FUNCTION	SIZE	POWER (CW)	FREQUENCY RANGE (GHz)	CONNECTOR TYPE
SPDT	MINIATURE	60W 2W	DC - 26.5 DC - 50.0*	SMA (OSM)® OS-50™
	STANDARD	100W 175W	DC - 12.4 DC - 18.0	N,TNC,BNC,SMA (OSM) N,TNC,SMA (OSM)
4 PORT TRANSFER	MINIATURE STANDARD	60W 100W	DC - 18.0 DC - 12.4	SMA (OSM) N,TNC,BNC,SMA (OSM)
MULTI-THROW	MINIATURE STANDARD	60W 100W	DC - 18.0 DC - 12.4	SMA N,TNC,BNC,SMA (OSM)
ROTARY COAXIAL*	STANDARD	200W	DC - 11.0	N,TNC

* Contact factory for details.
OSM & OS-50 are trademarks of M/A-COM

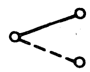
Specifications Subject to Change Without Notice.

This section provides the definition of commonly used terms and some basic application notes to assist in the selection and use of electromechanical switches.

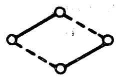
FUNCTIONS:

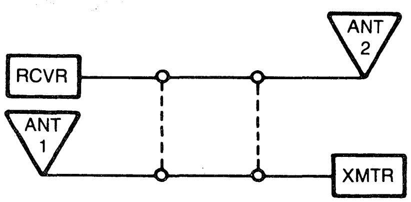
The switching configurations of M/A-COM's Switches include:

SPDT: Single Pole Double Throw is the most common 3-port arrangement used to switch a common input to two outputs or two inputs to a common output.



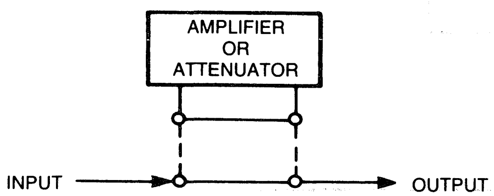
Transfer: This four port function is like two SPDT arrangements with opposed common switched outputs and provides two separate paths for each state. This versatile function is used to transfer connections between common equipment.



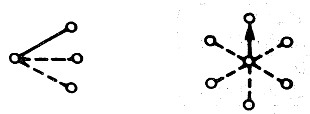


It can also be used as a building block for a multiple input/output switching matrix.

Circuit Insertion: Is similar to a transfer function but is simply used to insert a device or circuit in a transmission line.



Multiposition: Refers to a common input with many outputs or many inputs with a common output. Used for selecting or combining signals, this function in combination with the others identified can provide any switching arrangement desired.



Normally Closed/Open: Is the condition of the switch contacts when a remotely controlled switch (relay) is unenergized (no power applied to the actuator).

ACTUATORS:

M/A-COM provides both remote electromagnetic (linear, rotary) and manual (rotary, toggle) actuators.

Failsafe: An actuator which requires continous power to hold an energized state and returns to its normal state when de-energized.

Latching: This actuator will remain in the last selected state whether power is applied or not and change states only when the opposite state is energized. They may be actuated with "pulsed" or continuous power.

Manual: The mechanical actuation (rotary knob or toggle lever) when offered is the simplest actuation for direct or "override" (in the case of some waveguide remote switches) operation. Unless indicated, (example Miniature SPDT) auxiliary contacts are not normally provided with manual switches.

Operating Voltage: The nominal voltage to operate a remote switch, usually with a minimum range of $\pm 15\%$.

Pull in Voltage: The voltage at which the switch actuates.

Holding Current: The current necessary to maintain actuation (failsafe only).

FEATURES:

A few of the popular features M/A-COM provides routinely - refer to other special options within each series specification.

Auxiliary Contacts: Also referred to as indicator contacts because they are commonly used to indicate (lights, electronic signal, etc.) the position of the RF contacts. They are a separate set of switching contacts - electric, magnetic or electronic actuated - which change states along with the RF contacts. Except for the Miniature SPDT, they are normally offered only with remotely (latching, failsafe) actuated switches.

Suppression Diodes: An optional feature which connects a diode across the actuation coil to reduce transient line noise (spikes) when the switch is de-energized. In most cases a reverse polarity protection diode can also be provided.

Power Connectors: In place of standard solder terminals, multi-pin power connectors (standard and miniature) can be supplied for shielding and quick installation and maintenance.

PERFORMANCE:

Typical characteristics to consider when specifying electromechanical switches. Their best applications are when low loss, high isolation, medium and high power, and broad operating band requirements exist. Unless otherwise specified, RF performance is measured with a 50 ohm characteristic impedance test system to match that of M/A-COM E/M switches.

RF Characteristics:

Insertion Loss: The measure of power loss (in dB below input level) resulting from the reflected and absorbed power when inserting the switch in a transmission line.

VSWR: Voltage Standing Wave Ratio is the ratio of voltages obtained (max. to min.) of a standing wave passing through a switch terminated in a matching 50 ohm load. It is related to return loss in that it measures relative reflected losses due to characteristic impedance discontinuities.

Isolation: The measure of RF signal leakage (in dB below input level) from a selected switch path to any unselected path.

Power Ratings: M/A-COM switches are designed to carry the continuous wave (CW) or average power specified under typical conditions. Contact the factory for deration due to extended conditions.

Hot Switching: High performance RF switches are designed to carry rated power and can have performance degradation in RF and cycle life if switched with power on, depending on power levels. Hot switching above milliwatt levels is not recommended.

Switching Time: The time between application of actuation voltage and stabilized closure of the selected switch contacts (including bounce) or the reclosure of normally closed contacts when the actuation voltage is removed.

Actuation Power: For remote switches, the product of nominal coil voltage and current required to operate the switch. This can vary up to 10% depending on coil resistance, which is temperature dependent (coil losses) and can vary further depending on ambient temperatures, but not usually more than another 10%.

Switching Action: Is the sequence of contact closures as the switch is actuated. M/A-COM switches are classified as "break-before-make" (meaning closed contacts open before open contacts close) unless otherwise specified.

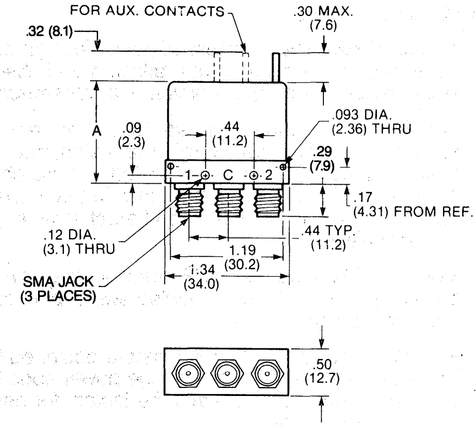
Life: The number of mechanical cycles (usually greater than one million) before operation or contact closure ceases.

Environmental: Special conditions such as temperature extremes, shock, vibration, moisture, solvents, explosive atmospheres, acceleration, vacuum, etc. in which switches must operate. Most M/A-COM switches are designed to meet the general environmental requirements of MIL-S-3928 or MIL-S-55041; however, many are supplied to specific customer requirements.

Miniature SPDT Electromechanical Switches

7530 Series

These miniature coaxial switches feature an outstanding combination of high RF performance and proven reliability in a very small package. Accurately positioned rigid contacts provide excellent repeatability and a uniform impedance match over the DC to 18.0 or 26.5 GHz frequency range.



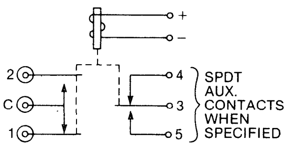
Metric equivalents are given in parentheses for general information.

FEATURES:

Life: >1,000,000 Cycles
Weight: 1.4 oz. Nom.
Construction: Aluminum Body and Housing
Finish: Chemical Film per MIL-C-5541
RF Connectors: (SMA) Jack per MIL-C-39012
Passivated Stainless Steel
Switching Time: 15 ms Typ. (20 ms Max.)
Switching Action: Break-Before-Make
Actuating Voltage: 20-30 Vdc, 28 Vdc Nom.
Actuating Current: 104 mA @ 28 Vdc and 20° C (Failsafe)
80 mA @ 28 Vdc and 20° C (Latching)
Coil Resistance: 270 Ohms ±10% @ 20° (Failsafe)
350 Ohms± 10% @ 20° (Latching)

PART NUMBER	FREQUENCY (GHz)	ACTUATION	AUX. CONTACTS	DIM. A INCHES (MM)
7530-6412-00	DC-18.0	FAILSAFE	No	1.12 (28.4)
7530-6412-10		FAILSAFE	Yes	1.25 (31.5)
7530-6414-00		LATCHING	No	1.70 (43.2)
7530-6414-10		LATCHING	Yes	1.70 (43.2)
7530-6422-00	DC-26.5	FAILSAFE	No	1.12 (28.4)
7530-6422-10		FAILSAFE	Yes	1.25 (31.5)
7530-6424-00		LATCHING	No	1.70 (43.2)
7530-6424-10		LATCHING	Yes	1.70 (43.2)

FAILSAFE SCHEMATIC
DEENERGIZED



SPECIFICATIONS:

FREQUENCY RANGE (GHz)	DC TO 4.0	4.0 TO 8.0	8.0 TO 12.4	12.4 TO 18.0	18.0 TO 26.5
VSWR (MAX.)	1.10:1	1.15:1	1.20:1	1.40:1	1.50:1
ISOLATION (NOM. dB)	80	80	70	70	55
INSERTION LOSS (MAX., dB)	0.15	0.30	0.40	0.50	0.60
CW POWER (MAX., WATTS)	60	50	35	25	20

OPTIONS: (Contact Factory)

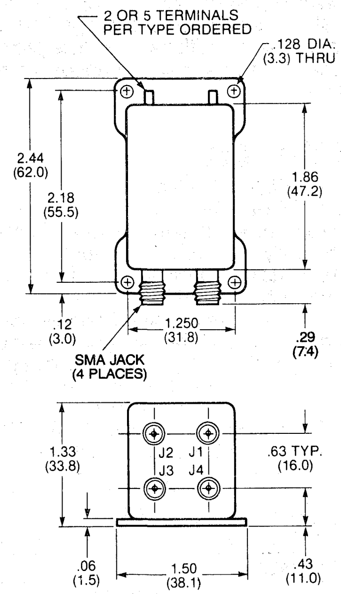
- Manual Actuation
- Special Finish or Marking
- Special Coil Voltages
- Arc Suppression Diodes
- Differential Drive Input (RS 422)
- Environmental & Hermetic Sealing
- Multi-Pin Power Connectors
- Alternate Solder Terminals/ Locations
- Alternate Mounting Configurations
- Self De-energizing Circuits
- Special High Reliability (Temp., Alt., Pres., Life)
- TTL Drivers

Specifications Subject to Change Without Notice.

Miniature 4-Port Transfer Electromechanical Switches

7531 Series

These electromechanical switches feature excellent RF performance coupled with new standards of reliability. Accurately positioned rigid contacts provide consistent repeatability and a uniform impedance match over the complete frequency range. Compact construction with all connectors emerging from a common plane at one end provides an ideal unit suited for matrix applications. Individual switches are commonly used for series insertion of RF components, such as: attenuators, filters, amplifiers, etc.



Metric equivalents are given in parentheses for general information.

FEATURES:

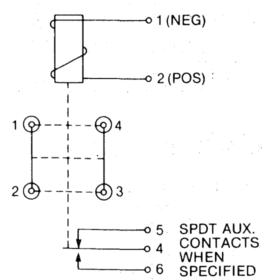
Life: >1,000,000 Cycles
Weight: 6 oz. Nom.
Construction: Aluminum Body and Housing
Finish: Chemical Film per MIL-C-5541
RF Connectors: OSM® (SMA) Jack per MIL-C-39012
Passivated Stainless Steel
Switching Time: 15 ms Typ. (20 ms Max.)
Switching Action: Break-Before-Make
Actuating Voltage: 20-30 Vdc, 28 Vdc Nom.
Actuating Current: 142mAmax @ 28 Vdc and 20°C

PART NUMBER	FREQUENCY (GHz)	ACTUATION	AUX. CONTACTS
7531-6200-00	DC - 18.0	FAILSAFE	NO
7531-6210-00		FAILSAFE	YES

SPECIFICATIONS:

FREQUENCY RANGE (GHz)	DC TO 4.0	4.0 TO 8.0	8.0 TO 12.4	12.4 TO 18.0
VSWR (MAX.)	1.2:1	1.3:1	1.4:1	1.5:1
ISOLATION (NOM., dB)	80	70	65	60
INSERTION LOSS (MAX., dB)	0.2	0.3	0.4	0.5
CW POWER (MAX., WATTS)	60	50	35	25

FAILSAFE SCHEMATIC
DEENERGIZED
1-2, 3-4 CONNECTED (SOLID LINES)
ENERGIZED
1-4, 2-3 CONNECTED (DOTTED LINES)



OPTIONS: (Contact Factory)

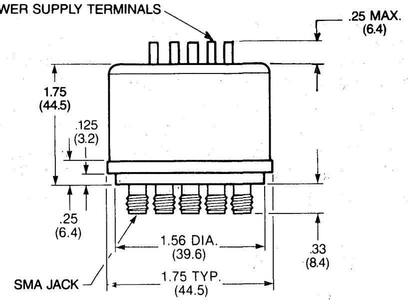
- Latching or Manual Actuation
- Special Finish or Marking
- Special Coil Voltages
- Arc Suppression Diodes
- Differential Drive Input (RS 422)
- Environmental & Hermetic Sealing
- Multi-Pin Power Connectors
- DC - 26.5 GHz
- Alternate Solder Terminals/ Locations
- Alternate Mounting Configurations
- Pulse Latching Activation (Not Disconnect)
- Special High Reliability (Temp., Alt., Pres., Life)
- TTL Drivers

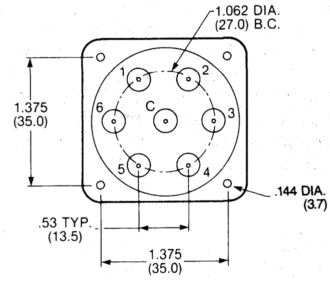
Specifications Subject to Change Without Notice.

Miniature SPMT Electromechanical Switches

7533 Series

This switch provides SP6T operation from DC to 18.0 or 26.5 GHz in a very small package (1.75 x 1.75 inches). The accurately positioned contacts provide excellent repeatability and a uniform impedance match for all positions.





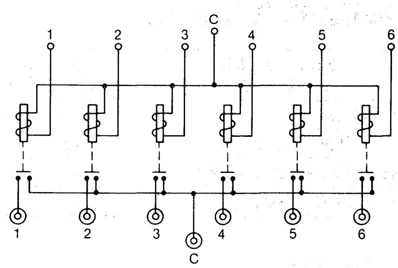
Metric equivalents are given in parentheses for general information.

FEATURES:

Life: >1,000,000 Cycles
Weight: 6.4 oz. Nom.
Construction: Aluminum Body and Housing
Finish, Body: Chemical Film per MIL-C-5541
Finish, Housing: Black Anodize Per MIL-A-8625
RF Connectors: OSM® (SMA) Jack per MIL-C-39012
Passivated Stainless Steel
Switching Time: 15 ms Typ. (20 ms Max.)
Switching Action: All positions normally open. Can be either make-before-break or break-before-make.
Actuating Voltage: 20-30 Vdc, 28 Vdc Nom.
Actuating Current: 118 mA @ 28 Vdc and 20°C

PART NUMBER	FREQUENCY (GHz)	ACTUATION	TYPE
7533-6622-00	DC - 26.5	FAILSAFE	SP6T
7533-6522-00		FAILSAFE	SP5T
7533-6422-00		FAILSAFE	SP4T
7533-6322-00		FAILSAFE	SP3T

FAILSAFE SCHEMATIC
(DEENERGIZED)



SPECIFICATIONS:

FREQUENCY RANGE (GHz)	DC TO 4.0	4.0 TO 8.0	8.0 TO 12.4	12.4 TO 18.0	18.0 TO 26.5
VSWR (MAX.)	1.10:1	1.15:1	1.20:1	1.40:1	1.45:1
ISOLATION (NOM. dB)	80	70	60	60	60
INSERTION LOSS (MAX., dB)	0.1	0.2	0.3	0.4	0.6
CW POWER (MAX., WATTS)	60	50	35	25	20

OPTIONS: (Contact Factory)

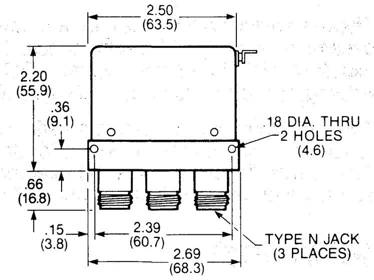
- Latching Actuation
- Special Finish or Marking
- Special Coil Voltages
- Arc Suppression Diodes
- Auxiliary Indicator Contacts
- Environmental & Hermetic Sealing
- Multi-Pin Power Connectors
- Alternate Solder Terminals/ Locations
- Alternate Mounting Configurations
- TTL Drivers
- Special High Reliability (Temp., Alt., Pres., Life)
- Auxilliary Indicator Contacts

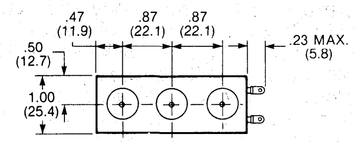
Specifications Subject to Change Without Notice.

Standard SPDT Electromechanical Switches

7524-6132 Series

These switches feature compact packaging for Type N connectors. Many years of production and design refinement have resulted in a switch of good electrical performance and proven reliability. SPDT operation from DC to 12.4 or 18.0 GHz.





Metric equivalents are given in parentheses for general information.

FEATURES:

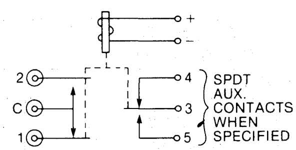
Life: >1,000,000 Cycles
Weight: 9.5 oz. Nom.
Construction: Aluminum Body and Housing
Finish, Body: Chemical Film per MIL-C-5541
Finish, Housing: Black Anodize per MIL-A-8625
RF Connectors: Type N Jack per MIL-C-39012
Switching Time: 25 ms Max.
Switching Action: Break-Before-Make
Actuating Voltage: 20-30 Vdc, 28 Vdc Nom.
Actuating Current: 122 mA Max @ 28 Vdc and 20° C

PART NUMBER	FREQUENCY (GHz)	ACTUATION	AUX. CONTACTS
7524-6132-00	DC - 12.4	FAILSAFE	NO
7524-6132-10		FAILSAFE	YES

SPECIFICATIONS:

FREQUENCY RANGE (GHz)	DC TO 4.0	4.0 TO 8.0	8.0 TO 12.4
VSWR (MAX.)	1.3:1	1.4:1	1.5:1
ISOLATION (NOM., dB)	70	65	60
INSERTION LOSS (MAX., dB)	0.3	0.4	0.5
CW POWER (MAX., WATTS)	100	80	75

FAILSAFE SCHEMATIC
DEENERGIZED



OPTIONS: (Contact Factory)

- Latching Actuation
- Special Finish or Marking
- Special Coil Voltages
- Arc Suppression Diodes
- TNC, BNC or SMA Connectors
- Environmental & Hermetic Sealing
- DC - 18.0 GHz
- Multi-Pin Power Connectors
- Alternate Solder Terminals/Locations
- Alternate Mounting Configurations
- Normally Open (Both Ports)
- High Power Configurations
- TTL Drivers

Specifications Subject to Change Without Notice.

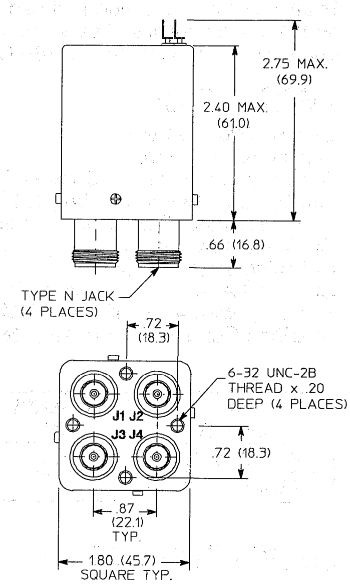
M/A-COM

Standard 4-Port Transfer Electromechanical Switches

7525 Series

These transfer switches combine a compact, lightweight assembly with high RF performance. This series features excellent VSWR and isolation from DC to 12.4, easy cabling, fast operation and high reliability.

They are designed for use in a variety of switching functions including matrices and tandem substitution. Typical installations include the interchanging of two antennas on two receivers or transmitters.

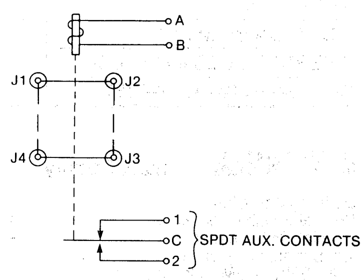


FEATURES:

Life: 1,000,000 Cycles
Weight: 14 oz. Nom.
Construction: Aluminum Body and Housing
Finish: Chemical Film per MIL-C-5541
RF Connectors: Type N Jack per MIL-C-39012
Switching Time: 25 ms Max.
Switching Action: Break-Before-Make
Actuating Voltage: 20-30 Vdc, 28 Vdc Nom.
Actuating Current: 160 mA Max @ 28 Vdc and 20° C.

PART NUMBER	FREQUENCY (GHz)	ACTUATION	AUX. CONTACTS
7525-6320-00	DC - 12.4	FAILSAFE	NO
7525-6321-00		FAILSAFE	YES

SCHEMATIC
DE-ENERGIZED 1-2 3-4 CONNECTED (SOLID LINES)
ENERGIZED 1-4 2-3 CONNECTED (DOTTED LINES)



SPECIFICATIONS:

FREQUENCY RANGE (GHz)	DC TO 4.0	4.0 TO 8.0	8.0 TO 12.4
VSWR (MAX.)	1.3:1	1.4:1	1.5:1
ISOLATION (NOM., dB)	70	65	60
INSERTION LOSS (MAX., dB)	0.3	0.4	0.5
CW POWER (MAX., WATTS)	100	80	75

OPTIONS: (Contact Factory)

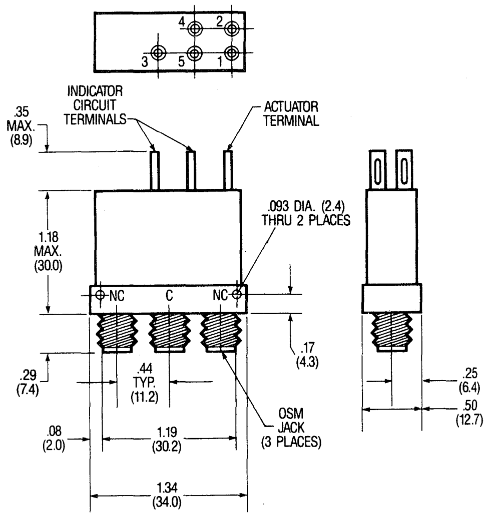
- Multi-Pin Power Connectors
- Special Finish or Marking
- Special Coil Voltages
- Arc Suppression Diodes
- Environmental Sealing
- Alternate Solder Terminals/ Locations
- Alternate Mounting Configurations
- TNC, BNC or SMA Connectors

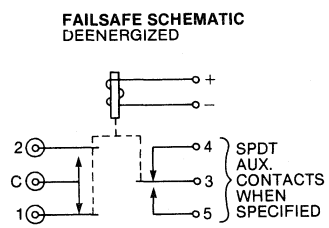
Specifications Subject to Change Without Notice.

QPL Electromechanical Switches

7530 Series

MIL-S-3928/15





Military Part Number	M/A-COM Part Number	Type	Frequency (GHz)	Commercial Alternate
-03	7530-4179-00	SPDT	dc - 18.0	**7530-6412-00**
-04	7530-4178-00	SPDT	dc - 18.0	**7530-6412-10**

Mixers

Overview

Standard and Custom Designs Provided For Specific Requirements

Standard Features

- Frequency Coverage 1-20 GHz
- IF Bandwidths dc - 10 GHz
- Multiple Package Configurations
- Guaranteed Specifications
- Hi-Rel Screening Options Available
- Dedicated Technical Customer Support

Custom Design Capability

As the world's largest manufacturer of microwave components and subsystems, M/A-COM has extensive experience in the development and production of custom components for specific applications. This custom design capability includes:

- special or "extended" frequency ranges
- high performance on selected electrical parameters
- custom package outlines
- special reliability or environmental requirements
- low cost drop-in models
- custom integrated packages which may include limiters, isolators, couplers, power dividers, etc.
- phase and amplitude matched sets of mixers and mixer assemblies
- multi-channel mixer assemblies with integrated LO power distribution

Please contact the factory or your local field office or representative with your specific needs. A professional engineering staff is always available to discuss specific requirements and provide technical support as necessary.

Double Balanced Mixers With Removable Connectors

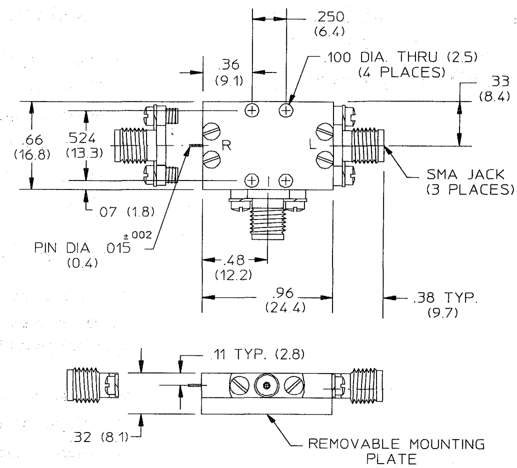
290X Series

Features

- Double-Balanced 2-18 GHz
- Removable Connectors
- Ideal for Drop-in Applications
- High Reliability
- Hermetic Seal

Description

Broadband, high reliability, hermetically sealed double-balanced mixers feature SMA jack removable connectors and mounting plate for applications requiring drop-in modules. Units are also available with SMA plug connectors.



Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D
Moisture Resistance	202	106E	-
Salt Spray	202	101D	A
Solvent Resistance	883	2015	-
Hermeticity	883	1014	Fine & Gross

Maximum Ratings

Parameter	LO Drive Level Low Medium (L,M Suffix)	High (H Suffix)
Operating Temp. Max.	-55°C to +100°C	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C	-65°C to +125°C
RF Input Power Max.	100 mW	200 mW

Specifications Subject to Change Without Notice.

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	L-I Isolation (dB min.)	3 dB IF Bandwidth (GHz min.)	LO Range (dBm) Min./Max.	Conversion Loss (dB) Max./Typ.	Input 1dB Compression Pt. (dBm Min.)	Input 3rd Order Intercept Pt. (dBm Min.)	Part Number
2.0-18.0	20	12	dc-1.0	+7/+11	10.0/7.0	+2	+12	2901-04-DBL
				+11/+15	10.0/7.0	+5	+15	2901-04-DBM
				+15/+18	10.5/7.5	+8	+18	2901-04-DBH
	20	15	.01-6.0	+7/+11	9.5/6.5	+2	+12	2902-04-DBL†
				+11/+15	9.5/6.5	+5	+15	2902-04-DBM
				+15/+18	10.0/7.0	+8	+18	2902-04-DBH
	20	15	.5-8.0	+7/+11	10.0/7.0	+3	+12	2903-04-DBL
				+11/+15	10.0/7.0	+6	+15	2903-04-DBM
				+15/+18	10.5/7.0	+8	+18	2903-04-DBH

Notes:
1. All measurements performed in a 50 ohm system.
2. Available in phase and amplitude matched sets; consult factory for details.

* Consult the factory for typical performance over frequency.

†**Available from stock at local authorized distributors.**

Specifications Subject to Change Without Notice.

Double Balanced Mixer
Miniature Drop-In

3601 Series

Features

- Double-Balanced 4-18 GHz
- Ruggedized Construction Techniques
- Hermetic Seal

Description

Miniature broadband double-balanced mixers in a drop-in module configuration for direct integration into stripline or microstrip circuitry. Designed for use in high-rel military system environments.

Environmental

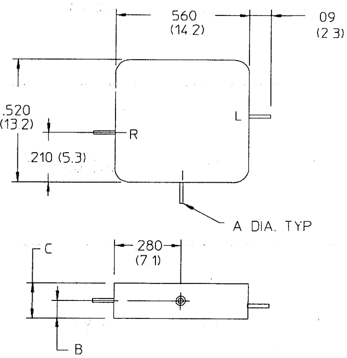
These devices are designed to meet the following screening conditions:

Test	MIL-STD	Method	Cond
Non-Destructive Bond Pull	883	2023	
Internal Visual	M/A-COM	QCP	H076
Stabilization Bake	883	1008	B
Thermal Cycle	883	1010	B
Constant Acceleration	883	2001	A (Y1 Axis)
Burn-in	883	1015	125°C
Seal Fine	883	1014	A1
Gross	883	1014	C1
External Visual	883	2009	

High-rel screening is available. See Appendix at the end of this section for options.

Maximum Ratings

Parameter	LO Drive Level Low Medium (L, M Suffix)	High (H Suffix)
Operating Temp. Max.	-55°C to +100°C	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C	-65°C to +125°C
RF Input Power Max.	100 mW	200 mW



Dim. Inches (mm)			
	A ±.002	B	C
-05- Series	.012 (0.3)	.075 (1.9)	.150 (3.8)
-07- Series	.015 (0.4)	.095 (2.4)	.190 (4.8)

Specifications Subject to Change Without Notice.

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	L-I Isolation (dB min.)	3 dB IF Bandwidth (GHz min.)	LO Range (dBm) Min./Max.	Conversion Loss (dB) Max./Typ.	Input 1 dB Compression Pt. (dBm Min.)	Input 3rd Order Intercept Pt. (dBm Min.)	Part Number
4.0-18.0	18	15	dc-1.0	+7/+11	9.5/6..5	+2	+12	3601-05-DBL†
				+11/+15	9.5/6.5	+5	+15	3601-05-DBM
				+15/+18	10.0/7.0	+8	+18	3601-05-DBH
	18	15	dc-1.0	+7/+1i	9.5/6.5	+2	+12	3601-07-DBL
				+11/+15	9.5/6.5	+5	+15	3601-07-DBM
				+15/+18	10.0/7.0	+8	+18	3601-07-DBH

Notes:
1. All measurements performed in a 50 ohm system.
2. Available in phase and amplitude matched sets; consult factory for details.
3. Low-cost test fixture available. Consult factory for details.

* Consult the factory for typical performance over frequency.
† **Available from stock at local authorized distributors.**

Integration of Drop-In Mixers

Drop-in mixers support the continual trend toward smaller, more reliable systems. The mixer modules are typically installed directly on a stripline or microstrip circuit board, adding the following advantages:

- Space savings (no connectors or cables)
- Mixer can be tested outside the system, as a stand-alone device
- Connector and cable losses are eliminated

To ensure proper correlation between the mixer manufacturer's test results and the user's evaluation data on the same device, it is important that both parties use the same type of test fixture and test methods. It is recommended that the test fixture itself closely resemble the conditions the mixer will see in the actual system. For example, a mixer to be used in a stripline medium with a ground plane spacing of .062 and an effective dielectric constant of 2.32, should be tested in a fixture of similar construction.

M/A-COM offers the following interface guidelines:

1) Attention must be paid to proper electrical interface as the operating frequency increases, especially above 8 GHz.
2) Ground plane contact between the motherboard and the mixer should be smooth and continuous. Solid ground contact is absolutely necessary.
3) Minimize gaps or other discontinuities at all RF launches. This usually requires tight mechanical tolerances.
4) Use radiation shielding techniques at least comparable to the isolation performance of the mixer.
5) Use 50 ohm "dummy" modules to evaluate and troubleshoot the motherboard assembly. These "dummy" modules are mechanically identical to the mixer modules, but contain 50 ohm transmission lines instead of mixer circuitry. This is often particularly useful in conjunction with time-domain reflectometer measurements to troubleshoot the mixer module interface. Consult factory for price, availability and options on "dummy" modules.

The contact pins on microwave modules are fragile. They are usually made of Kovar and are about .015" in diameter in order to achieve 50 ohm impedance through the glass bead. Assembly personnel should be trained to work with drop-in modules. Bending may weaken the lead or degrade the quality of the glass seal. The use of anti-static work stations and approved personnel grounding straps are required since these are ESD sensitive devices.

M/A-COM's engineering staff has extensive experience in integrating drop-in modules as part of complex microwave subsystems. Please contact the factory with your specific integration requirements.

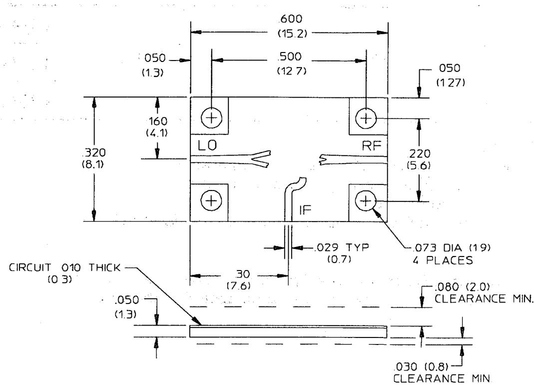
![M/A-COM]

Miniature Open Substrate Mixers

2902 Series

Features
- Triple-Balanced 4-18 GHz
- Miniature Drop-In Carrier
- High Reliability

Description
Miniature broadband triple-balanced mixers on an open substrate configuration for direct integration into microstrip circuitry. Rugged construction designed for use in high-rel military system environments. Contact factory for mounting details.



Environmental
These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D

Maximum Ratings

Parameter	LO Drive Level Low Medium (L, M Suffix)	High (H Suffix)
Operating Temp. Max.	-55°C to +100°C	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C	-65°C to +125°C
RF Input Power Max.	100 mW	200 mW

Specifications Subject to Change Without Notice.

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	L-I Isolation (dB min.)	3 dB IF Bandwidth (GHz min.)	LO Range (dBm) Min./Max.	Conversion Loss (dB) Max./Typ.	Input 1dB Compression Pt. (dBm Min.)	Input 3rd Order Intercept Pt. (dBm Min.)	Part Number
2.0-18.0	20	15	0.5-8.0	+7/+11	10.0/7.0	+2	+12	2902-10-DBL
				+11/+15	10.0/7.0	+5	+15	2902-10-DBM
				+15/+18	10.5/7.5	+8	+18	2902-10-DBH

Notes:
1. All measurements performed in a 50 ohm system.
2. Available in phase and amplitude matched sets; consult factory for details.
3. Low-cost test fixture available. Consult factory for details.

* Consult the factory for typical performance over frequency.

Specifications Subject to Change Without Notice.

Miniature Open Substrate Mixers

2901 Series

Features

- Double-Balanced 6-18 GHz
- Miniature Drop-In Carrier
- High Reliability

Description

Miniature broadband double balanced mixers on an open substrate configuration for direct integration into microstrip circuitry. Low cost rugged construction designed for high volume commercial and high-rel military applications.

Environmental

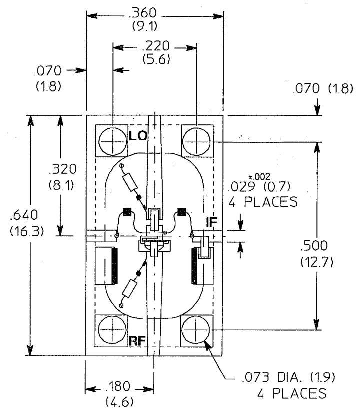
These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D

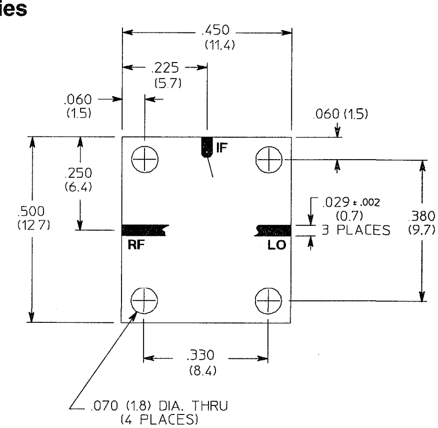
Maximum Ratings

	LO Drive Level	
Parameter	Low Medium (L,M Suffix)	High (H Suffix)
Operating Temp. Max.	-55°C to +100°C	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C	-65°C to +125°C
RF Input Power Max.	100mW	200mW

2901-10 Series



2901-11 Series



Dimension tolerances are ±.005.
For mounting details, request Application Note No. 101.

Specifications Subject to Change Without Notice.

Specifications over Operating Temperature Range of -55°C to +100°C

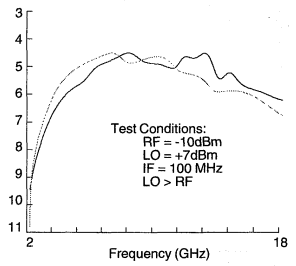
IF/LO Frequency Range (GHz)	3 dB IF Bandwidth (GHz min.)	L - R Isolation (dB min.)	L - I Isolation (dB min.)	Conversion Loss (dB) Typ./Max.	Lo Range (dBm) Min./Max.	Input 1 dB Compression Pt. (dBm min.)	Input 3rd Order Intercept Pt. (dBm min.)	Part Number
4-18	dc-1	20	15	6.0/9.0	+7/+11	+2	+12	2901-10-DBL
4-18	dc-1	20	15	6.0/9.0	+11/+15	+5	+15	2901-10-DBM
4-18	dc-1	20	15	6.5/9.5	+15/+18	+8	+18	2901-10-DBH
6-18	dc-1	20	15	6.0/9.0	+7/+11	+2	+12	2901-11-DBL
6-18	dc-1	20	15	6.0/9.0	+11/+15	+5	+15	2901-11-DBM
6-18	dc-1	20	15	6.5/9.5	+15/+18	+8	+18	2901-11-DBH

Typical Performance 25°C

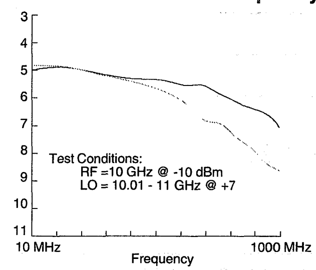
2901-10 Series

2901-11 Series

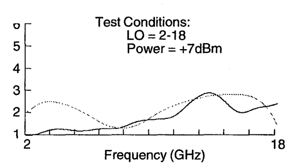
Conversion Loss vs. Frequency



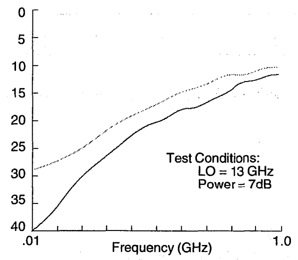
Conversion Loss vs. IF Frequency



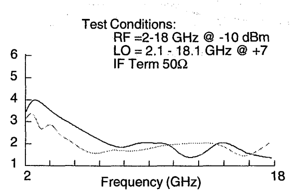
LO VSWR vs. Frequency



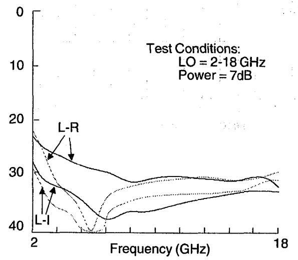
IF Return Loss vs. Frequency



RF VSWR vs. Frequency



Isolation vs. Frequency



Single tone intermodulation matrixes shown (in dBc) at RF bandwidth extremes with LO and IF held constant. In actual practice, these levels are frequency-dependent and vary approximately ± 5 dB across RF/IF bandwidths.

Test Conditions:
LO = 6 GHz, @ +7 dBm
IF = 200 MHz
RF = -10 dBm

LO Harmonics	RF Harmonics 1	2	3
3	20.7	35.2	46.6
2	27.3	45.3	–
1	–	–	–

Test Conditions:
LO = 17 GHz, @ +7 dBm
IF = 200 MHz
RF = -10 dBm

LO Harmonics	RF Harmonics 1	2	3
3	20.7	35.2	46.6
2	27.3	45.3	>60.0
1	–	–	–

Specifications Subject to Change Without Notice.

Flange Mounted Double-Balanced Mixers

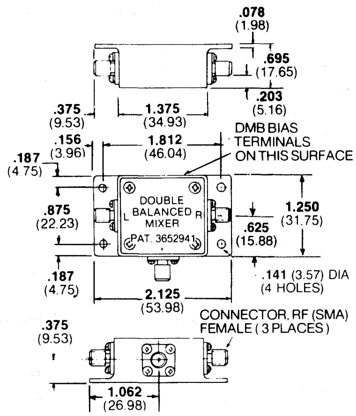
DM Series

Features

- 5.0 dB Midband Conversion Loss
- 28 dB Midband L-R Isolation

Description

This series of mixers is typically specified as down converters. They also function well as up converters, third harmonic mixers or phase detectors.



Environmental

Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	95% non-condensing
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

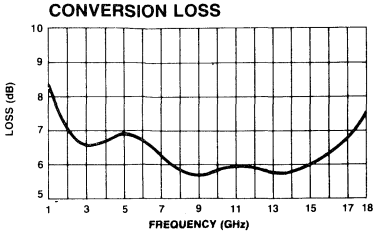
Specifications 25°C[1]

RF Frequency Range(GHz)	L-R Isolation (dB)	L-I Isolation (dB)	3dB IF Bandwidth (GHz)	LO Range (dBm) Min.\Max.	Conversion Loss (dB)[2] Typ./Max.	Input 1dB Compr. Pt. (dBm)	Noise Figure SSB (dB Max.)	Part Number
1.0-18.0	22	18	dc-0.5	7/11	6.0/9.5	+3	10.0	DM1-18A

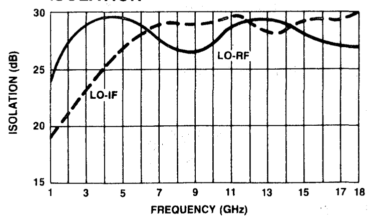
Notes:
1. Specifications apply when operated at +8 dBm available LO power with 50 ohm source and load impedance.
2. For IF frequencies of 100 MHz and RF power of -10 dBm or lower.

Typical Performance 25° DM1-18A

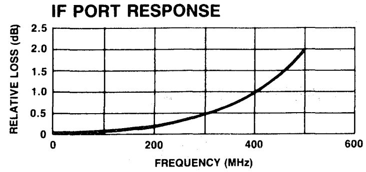
CONVERSION LOSS



ISOLATION



IF PORT RESPONSE



Specification Subject to Change Without Notice

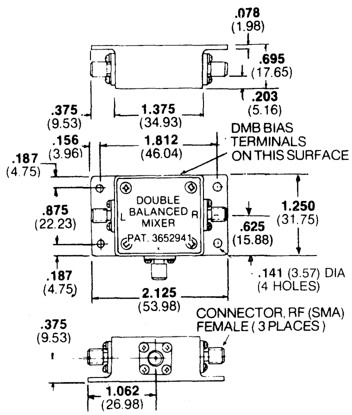
Flange Mounted Double-Balanced Biasable Mixers

DMB Series

Description

Part Number DMB1-12A is a two-port mixer utilizing bridge diode quad. RF and IF are diplexed into the same port via an internal diplexer. At crossover frequency (RF=IF), response for each is down 3 dB. Self-adjusting biasing automatically reduces dc bias level as the LO power is increased. Available with options such as built-in PIN limiter on the RF port. Contact factory.

Part Number DMB2-18A is a one-port design utilizing a bridge quad of Schottky diodes. RF and IF are directed into separate ports via an internal diplexer. The LO port uses a self-adjusting biasing circuit which automatically decreases the dc voltage as the LO power is increased.



Environmental

Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	95% non-condensing
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

Specifications 25°C

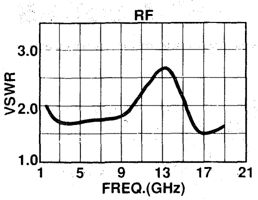
RF/LO Frequency Range(GHz)	L-R Isolation (dB)	L-I Isolation (dB)	3dB IF Bandwidth (GHz)	LO Range (dBm)	Conversion Loss (dB) Typ./Max.	Input 1dB Compr. Pt. (dBm)	Part Number
1.0-12.0	16	15	.001-.3	-10/+10[1]	8/10 LO Drive = +10 dBm 9/12 LO Drive = 0 dBm 10/16 LO Drive = -10 dBm	-5	DMB1-12A
2.0-18.0	20	15	.01-0.5	-10/+10[1]	8/10 LO Drive = +10 dBm 9/12 LO Drive = 0 dBm 10/16 LO Drive = -10 dBm	-10[1]	DMB2-18A

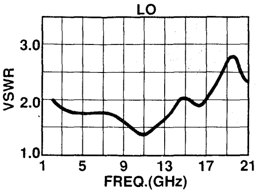
Notes:
1. Tested with 0 dBm LO.
2. dc Power: +12/8 Volts/mA. +15 V available.

Specifications Subject to Change Without Notice

Typical Performance 25° C DMB2-18A

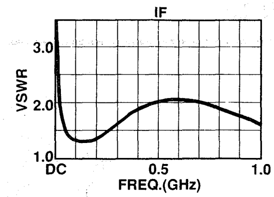
INPUT

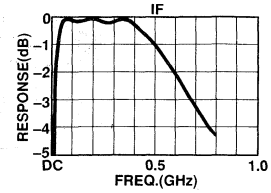




RF = −10dBm

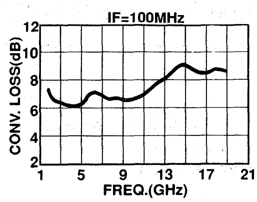
OUTPUT

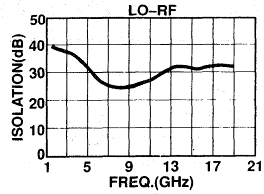




LO = 0dBm

TRANSFER CHARACTERISTICS





(IF=100MHz, LO=8GHz)*

LO HARMONICS	RF HARMONICS 1	2	3
3	23	53	50
2	26	48	52
1	0	55	52

(IF=0.1GHz, LO=16GHz)*

LO HARMONICS	RF HARMONICS 1	2	3
3	N/A	N/A	55
2	N/A	55	61
1	0	49	48

*Single tone intermodulation matrixes shown (in dBc) at RF bandwidth extremes with LO and IF held constant. In actual practice, these levels are frequency-dependent and vary approximately ±5dB across RF/IF bandwidths.

Specifications Subject to Change Without Notice.

M/A-COM

Mixer Preamps With Removable Connectors

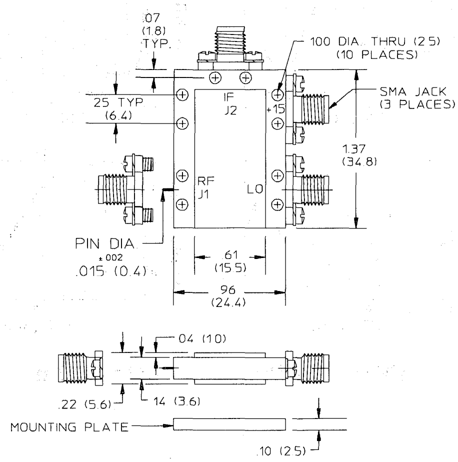
2912 Series

Features

- 10-500 MHz IF Range
- Integrated IF Preamp
- Double-Balanced 2-18 GHz
- Removable SMA Connectors
- High Reliability
- Hermetic Seal

Description

Broadband, high reliability, hermetically sealed, double-balanced mixers with integrated low noise IF preamplifier. Ideal for drop-in applications where size is a primary concern.



Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D
Moisture Resistance	202	106E	-
Salt Spray	202	101D	A
Solvent Resistance	883	2015	-
Hermeticity	883	1014	Fine & Gross

Maximum Ratings

Parameter	
Operating Temp. Max.	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C
RF Input Power Max.	100mW
dc Voltage (Bias Terminal) Max.	+20 Volts

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	RF-IF Gain (dB)	3 dB IF Bandwidth (MHz)	LO Range (dBm) Min./Max.	Noise Fig. (dB) Max./Typ.	Output 1dB Compression Pt. (dBm Min.)	Output 3rd Order Intercept Pt. (dBm Min.)	Part Number
2.0-18.0	20	18 ± 2.5	10-500	+7/+11	10.5/8.5	+5	+18	2912-12-MBL

Notes:

1. All measurements performed in a 50 ohm system.
2. Available in phase and amplitude matched sets; consult factory for details.
3. Narrow IF band available; consult factory for details.
4. dc bias + 15 VDC at 60 milliamps max.

* Consult the factory for typical performance over frequency.

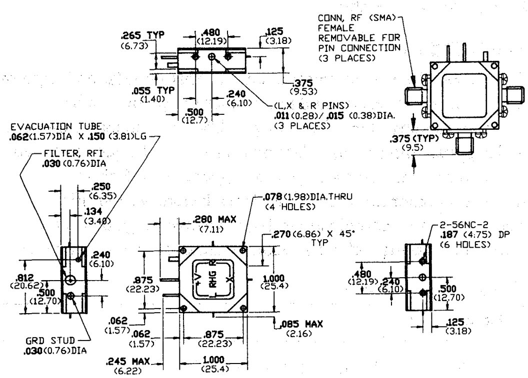
Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Ultra-miniature Mixer Preamps With Removable Connectors

DML Series

Features
- Double-Balanced
- Hermetic Seal
- Ideal For Drop-in Applications



Description
These mixer preamps incorporate a built-in microwave diode limiter. The hermetically sealed package can be used either cabled or as a drop-in unit. Preliminary tests can be made with the connectors in place, and then removed for final assembly, when used as a drop-in.

Environmental

Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	100% with condensation
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

Specifications 25°C

RF/LO Frequency Range(GHz)	L-R Isolation (dB)	3dB IF Bandwidth (MHz)	LO Range (dBm) Min./Max.	Conversion Gain (dB Min.)	Noise Figure SSB (dBMax.)	Output 1 dB Compression Pt. (dBm Min.)	Input 3rd Order Intercept Pt. (dBm)	Part Number
2.0-18.0	23	50-70	7/11	20	11	0	+10	DML2-18/10B

Notes:
1. DC Power = +12 Volts @ 40 mA max.

Specification Subject to Change Without Notice

Image Rejection Mixer Preamps

IRMP Series

Features

- Integrated Mixer and Preamp
- Low Noise Figure
- High Image Rejection

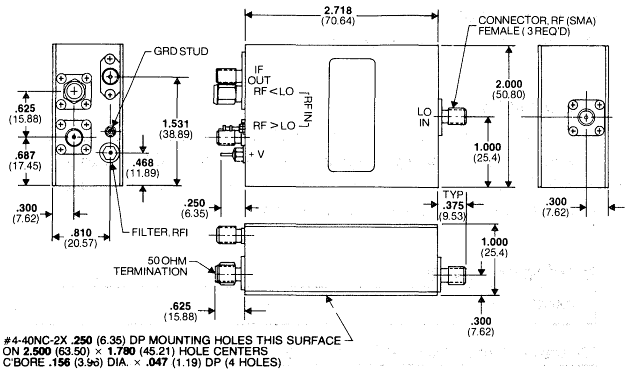
Description

This series offers an integrated package that includes an image rejection down converter and IF amplifier to complete a basic receiver building block. Following an LNA, this supercomponent will suppress the double sideband noise of the frequency conversion and provide sufficient gain to support most IF signal processing schemes. Options available include various IF frequency and gain combinations, high dynamic range units and custom packaging including reduced size drop-in hermetic units.

Environmental

Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	95% non-condensing
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

IRMP2-18/XX



Specifications Subject to Change Without Notice.

Specifications 25°C

RF Coverage (GHz)	Noise Figure[2] (dB Max.)	Image Rejection[3] (dB Min.)	RF VSWR (Max.)	Part No.[1]
2.0-18.0	13.0	16	1.75	IRMP2-18/XX
2.0-26.0	16.5	15	1.75	IRMP2-26/XX

Preamp Options[6]

IF (MHz)	Bandwidth (MHz Min.)	Overall RF-IF Gain (dB)	IF Output Capability @ -1dB[4] (dBm)	xx Suffix[1] Part No.
Fixed Gain				
60	10	25	0	01
60	20	25	0	02
30	10	25	0	03
160	50	25	+13	04

Notes:
1. To select IF, choose desired value from the Preamp Options table and use the corresponding XX suffix for the desired preamp. For example: 5969-1006-03 for 30 MHz IF, fixed gain.
2. Noise figures shown are with +12 dBm nominal LO injection and pre amp types -01, -02 and -03. Contact the factory for noise figures on other preamps.
3. Image rejection shown applies for both lower or upper sideband (LO > RF or LO < RF). A 2 dB improvement in image rejection can be obtained if optimized for only one sideband.Contact the factory for units that always use the lower sideband or upper sideband.
4. Variable gain preamp types have a 20 dB gain control range for 0 to -3 V (nominal) applied gain control voltage. Output capability is shown for 0 V applied gain control.
5. For biasable models which operate with LO injection of 0 dBM, contact the factory.
6. Contact the factory for any preamp not shown.

Common Specifications

LO to RF Isolation	20dB min.
LO Input VSWR	2.5:1 typ.
dc Power	+12 Vdc at 20 mA typ. (45 mA typ. for -04 preamp types) +15 Vdc available, contact factory.

M/A-COM

Miniature Image Rejection Mixers With Removable Connectors 25XX/26XX/27XX Series

Features

- Broadband Double-Balanced 6-18 GHZ
- Hermetic Seal
- Removable SMA Connectors
- Small 1.30 x 1.30 x .31 Inch Thick

Description

Miniature Image Rejection Mixers utilizing reliable planar construction. Ideal for drop-in applications where size, weight and reliability are prime concerns.

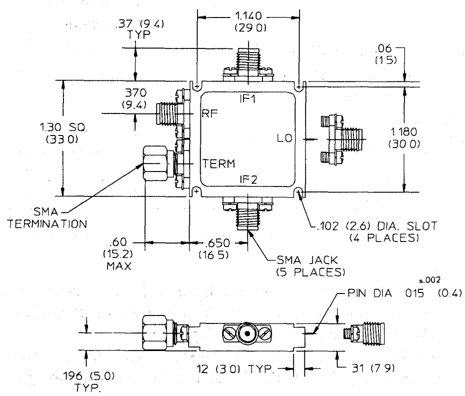
Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D
Moisture Resistance	202	106E	-
Salt Spray	202	101D	A
Solvent Resistance	883	2015	-
Hermeticity	883	1014	Fine & Gross
Non-Destructive Bond Pull	883	2023	

Maximum Ratings

Parameter	
Operating Temp. Max.	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C
RF Input Power Max.	400 mW to any port 500 mW to all ports



IF Output Selection		
RF>LO	IF1 Desired	IF2 Image
RF<LO	IF2 Desired	IF1 Image

Specifications Subject to Change Without Notice.

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	L-I Isolation (dB min.)	VSWR R, L,I Typical	Image Rejection (dB min.)	Conversion Loss (dB) Max./Typ.	Input 1dB Compression Pt. (dBm Min.)	LO Range (dBm) Min./Max.	Part Number[4]
8.0-12.0	20	23	1.5, 2.0, 1.5	18	8.0/6.5	+3	+9/+13	25XX-09-IRL
					8.0/6.5	+9	+13/+17	25XX-09-IRM
					8.5/7.0	+13	+17/+21	25XX-09-IRH
12.0-18.0	20	23	1.8, 2.5, 1.5	18	8.5/7.0	+3	+9/+13	26XX-09-IRL
					8.5/7.0	+9	+13/+17	26XX-09-IRM
					9.0/7.5	+13	+17/+21	26XX-09-IRH
6.0-18.0	20	23	1.8, 2.5, 1.5	16	8.5/7.0	+3	+9/+13	27XX-09-IRL
					8.5/7.0	+9	+13/+17	27XX-09-IRM
					9.0/7.5	+13	+17/+21	27XX-09-IRH

Notes:
1. All measurements performed in a 50 ohm system.
2. Image rejection measured at center IF frequency.
3. Alternate IF ranges are also available. Consult factory for details.
4. Specify IF frequency range from selection table.

* Consult the factory for typical performance over frequency.

IF Selection Table

XX	IF Frequency Range
05	20-40 MHz
06	40-80 MHz
07	80-160 MHz
08	100-200 MHz

Miniature Quadrature IF Mixers With Removable Connectors

2713 Series

Features

- Broadband Double-Balanced 6-18 GHZ
- Hermetic Seal
- Removable SMA Connectors
- Small 1.30 x 1.30 x .31 Inch Thick

Description

Miniature Quadrature IF Mixers utilizing reliable planar construction. Two IF outputs in quadrature are provided, making these devices ideal for use in Doppler or QPSK applications.

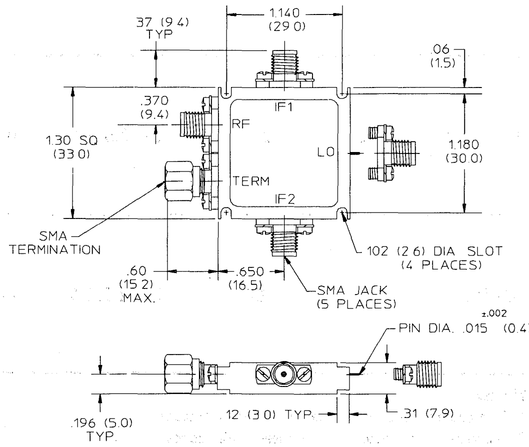
Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D
Moisture Resistance	202	106E	-
Salt Spray	202	101D	A
Solvent Resistance	883	2015	-
Hermeticity	883	1014	Fine & Gross
Non-Destructive Bond Pull	883	2023	

Maximum Ratings

Parameter	
Operating Temp. Max.	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C
RF Input Power Max.	400 mW to any port 500 mW to all ports



IF Output Selection

	IF1	IF2
RF > LO	-90°	0°
RF < LO	0°	-90°

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	L-I Isolation (dB min.)	VSWR R, L, I	Phase Accuracy From 90°	Conversion Loss[2] (dB) Max./Typ.	Input 1dB Compression Pt. (dBm Min.)	LO Range (dBm) Min./Max.	Part Number
					11.5/9.5	+3	+9/+13	2713-09-QML
6.0-18.0	20	23	1.5, 2.0, 1.5	±12	11.5/9.5	+9	+13/+17	2713-09-QMM
					12.0/10.0	+13	+17/+21	2713-09-QMH

Notes:
1. All measurements performed in a 50 ohm system.
2. Conversion loss figures include loss of internal 3 dB power divider.
3. Quadrature IF outputs will be amplitude balanced within ±0.8 dB.
4. IF frequency range dc-300 MHz. Wider bandwidths available on some models; consult factory.

* Consult the factory for typical performance over frequency.

Quadrature IF Mixers

(QIFM) M503

A quadrature IF mixer is used when it is necessary to determine the relative positions of two signals in the frequency domain, that is, whether one signal is above or below the other in frequency. It can also be used as a phase detector when both signals are at the same frequency. Figure 1 below shows a block diagram of a typical quadrature IF mixer.

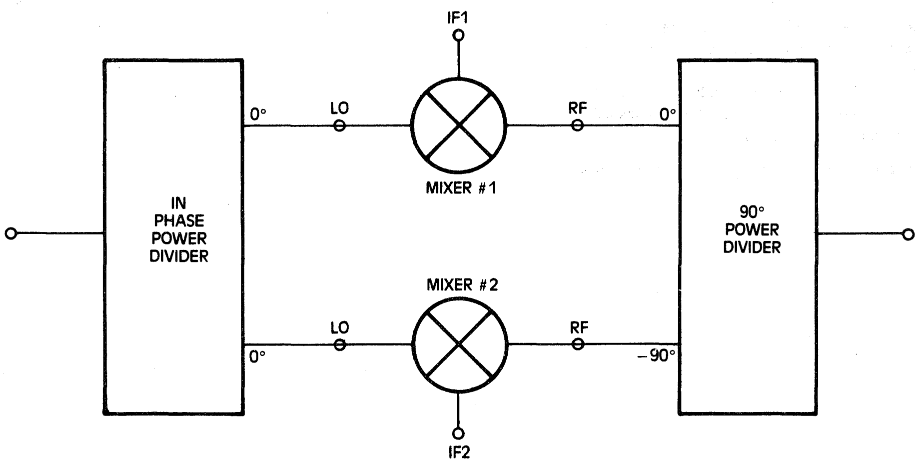


FIGURE 1. Block Diagram of the Quadrature IF Mixer.

An LO signal is fed to two mixers through an in-phase power divider. A 90°, 3 dB power divider or hybrid is used to provide quadrature signals to the two mixer RF ports. The two mixers have IF port bandwidth that usually extends down to dc, especially for a phase detector. Sufficient LOS power must be provided to drive the mixer diodes into a high conduction state (3 dB is lost in the LO power divider due to the power split).

Theory of Operation

Assume that the LO signal is sinusoidal and COS $\omega_{LO}t$ represents the voltage at the LO port of each mixer. Also, assume that the RF signal is sinusoidal and let COS $\omega_{RF}t$ represent the voltage at the RF port of mixer #1. Since the RF power divider has a 90° phase difference between the outputs, the voltage at mixer #2 can be represented as sin $\omega_{RF}t$. Each mixer performs a multiplication on the input signals such that the outputs appear as:

MIXER 1:

$$(\cos \omega_{LO}t)(\cos \omega_{RF}t) = \tfrac{1}{2}\,[\,\cos(\omega_{LO} + \omega_{RF})\,t + \cos(\omega_{LO} - \omega_{RF})\,t\,]$$

MIXER 2:

$$(\cos \omega_{LO}t)(\sin \omega_{RF}t) = \tfrac{1}{2}\,[\,\sin(\omega_{LO} - \omega_{RF})\,t + \sin(\omega_{RF} + \omega_{LO})\,t\,]$$

Since we are only interested in the difference frequency, the IF outputs are:

$$IF_1 \propto \tfrac{1}{2}\cos(\omega_{LO} - \omega_{RF})\,t$$
$$IF_2 \propto \tfrac{1}{2}\sin(\omega_{RF} - \omega_{LO})\,t$$

Theory of Operation (cont'd.)

When we evaluate these two expressions with either the RF signal frequency above or below the LO signal frequency, we see that the IF output from mixer #2 is either leading or lagging the IF output from mixer #1 by 90°, since:

$$\cos(\omega_{LO} - \omega_{RF})\,t = \cos(\omega_{RF} - \omega_{LO})\,t$$

and

$$\sin(\omega_{RF} - \omega_{LO})\,t = -\sin(\omega_{LO} - \omega_{RF})\,t$$

Therefore, when: RF < LO, Mixer #2 leads Mixer #1
and when: RF > LO, Mixer #2 lags Mixer #1

If the RF and LO signals are at the same frequency, the IF outputs are dc signals proportional to the sine and cosine of the phase angle between the RF and LO signals.

Application of the Quadrature IF Mixer

There are many uses of this particular mixer configuration. The major applications are in phase detection and Doppler Radar Systems, as well as in digital Quadrature Phase Shift Keying (QPSK) demodulators. When the QIFM is used as a phase detector, the IF outputs are proportional to the sine and cosine of the phase difference of the two input signals, and if they are fed to the horizontal and vertical inputs of an oscilloscope, the result will be a polar display of the magnitude and phase difference.

When used in a Doppler Radar System, the QIFM will indicate the direction of movement of a target, since on an approaching target, the return signal is higher in frequency than the LO and lower in frequency when the target is receding.

Another use of the Quadrature IF Mixer is as a demodulator for digital QPSK signals. A sample of the carrier signal is injected into the LO port as a reference. The digital QPSK signal is applied to the RF port. The original bi-phase digital signals, 0°, 180° and 90°, 270° are extracted from the two IF output ports.

Ultra-low Noise QUIET® Mixers

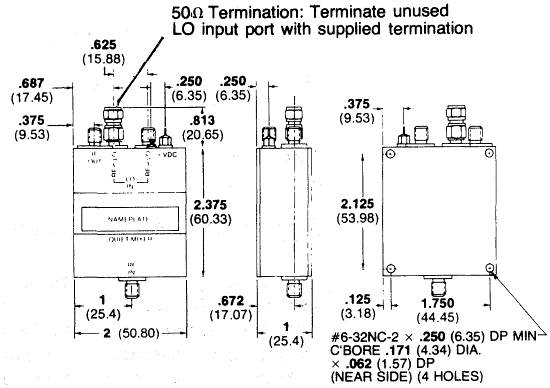
IRR Series

Features

- Built-in Preamp
- 20 dB Image Rejection

Description

The QUIET® mixers have gained worldwide acceptance as the ultimate in low noise front-ends. They are superior to any presently available low noise microwave device, considering noise figure, dynamic range, stability, size and cost on an overall basis. QUIET mixers are also available in matched 3-channel versions in the most popular frequencies. Single and multi-channel units can also be supplied at any frequency between 1 and 10 GHz. Phase and amplitude drift are virtually non-existent. And, the low noise figure coupled with low VSWR result in system sensitivities much greater than the noise figure would indicate.



Environmental

Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	95% non-condensing
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

QUIET is a registered trademark of M/A-COM

Specifications 25°C

RF Coverage (GHz)	IF Center Freq./Bandwidth (MHz)	Noise Figure* (dB Max.)	Image Rejection (dB Min.)	Part No.[1]
Single Channel				
5.4-5.9	30/10	5.5	20	IRR5.9/30
5.4-5.9	60/20	5.5	20	IRR5.9/60
8.5-9.6	30/10	5.7	20	IRR9.6/30
8.5-9.6	60/20	5.7	20	IRR9.6/60

* Specified noise figure is for +7 dBm nominal LO injection (+13 dBm for 3-channel models).

Common Specifications

IF Output @ 1 dB comp.	0 dBm
RF-IF Gain, typ.	20 dB
LO/RF Isolation, min./typ.	20 dB/25 dB
RF VSWR, typ.	2:1
LO VSWR, typ.	1.5:1
Power	+12 Vdc @ 35 mA (typ.) per channel For +15 Vdc, contact factory
RF Input, max.	+23 dBm CW 0.4 ergs for <2 nsec. pulses
Gain/Phase Tracking	±0.5 dB/±5°

Options: (Contact Factory)

1. +15 dBm RF output (adds 1.5 dB increment to noise figure and reduces gain to 15 dB typ.).

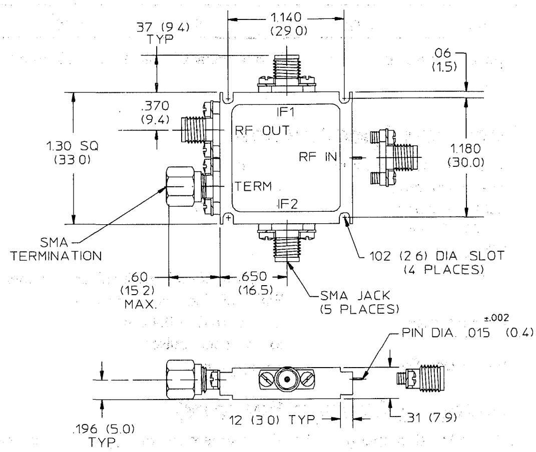
Specification Subject to Change Without Notice

Miniature Single Sideband Modulators With Removable Connectors

27XX Series

Features

- Broadband Double-Balanced 6-18 GHZ
- Hermetic Seal
- Removable SMA Connectors
- Small 1.30 x 1.30 x .31 Inch Thick



Description

Miniature Single Sideband Modulators utilizing reliable planar construction. Ideal for drop-in applications where size, weight and reliability are prime concerns.

Sideband Selection		
IF1 in	RF out > RF in	IF2 Term 50 Ω
IF2 in	RF out < RF in	IF1 Term 50 Ω

(IF termination not supplied)

Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Cond
Mechanical Shock	202	213B	C
Constant Acceleration	883	2001	A
Thermal Cycle	883	1010	B
Vibration, HF	202	204D	D
Moisture Resistance	202	106E	-
Salt Spray	202	101D	A
Solvent Resistance	883	2015	-
Hermeticity	883	1014	Fine & Gross
Non-Destructive Bond Pull	883	2023	

Maximum Ratings

Parameter	
Operating Temp. Max.	-55°C to +100°C
Storage Temp. Max.	-65°C to +125°C
RF Input Power Max.	400 mW to any port 500 mW to all ports

Specifications* 25°C

RF/LO Frequency Range (GHz)	L-R Isolation (dB min.)	L-I Isolation (dB min.)	VSWR R, L, I Typical	Sideband Suppression[3] (dB min.)	Conversion Loss[2] (dB) Max./Typ.	Input 1dB Compression Pt. (dBm Min.)	LO Range (dBm) Min./Max.	Part Number[5]
6.0-18.0	20	23	1.5,2.0,1.5	16	9.5/8.0	+3	+9/+13	27XX-09-SSL
					9.5/8.0	+9	+13/+17	27XX-09-SSM
					10.0/8.5	+13	+17/+21	27XX-09-SSH

Notes:
1. All measurements performed in a 50 ohm system.
2. Conversion loss measured relative to IF input level.
3. Sideband suppression measured relative to desired sideband output level.
4. Alternate IF ranges are also available. Consult factory for details.
5. Specify IF frequency range from selection table.

* Consult the factory for typical performance over frequency.

IF Selection Table

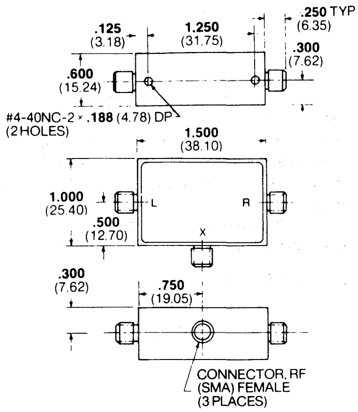
XX	IF Frequency Range
05	20-40 MHz
06	40-80 MHz
07	80-160 MHz
08	100-200 MHz

Wide Band Bi-Phase Modulator

DMK2-18

Features

- 2-18 GHz (Usable 1-26 GHz)
- 3 nsec. Max. Switching Speed
- Low Cost



Description

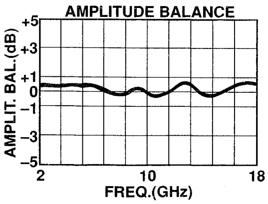
This wide band bi-phase modulator is a special version of a standard double-balanced mixer. It employs a special diode quad with diodes selected for switching rather than mixing capability, and special IF decoupling networks to produce superior performance as a bi-phase modulator.

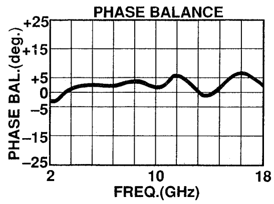
Environmental

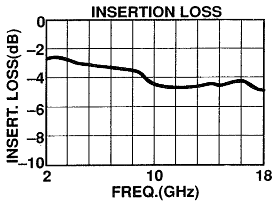
Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	95% non-condensing
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

Frequency Range (GHz)	Carrier Suppression (dB)	dc Current Required (mA)	LO Injection (dBm)	RF/LO VSWR (Typ.)	LO/RF Isolation (dBMin)	IF Response (MHz)	Part Number Model No.
2.0-18.0	20	±10	+7/+10	2.5	20	dc-500	DMK2-18

Typical Performance 25°C







Specifications Subject to Change Without Notice.

TTL Controlled Bi-Phase Modulator With Removable Connectors

DMK2-18TTL

Features

- Integrated Bi-Phase Modulator/TTL Driver
- Multi-octave Bandwidth
- 8 nanosecond Rise and Fall Time
- Hermetic Seal
- Ideal for Drop-in Applications

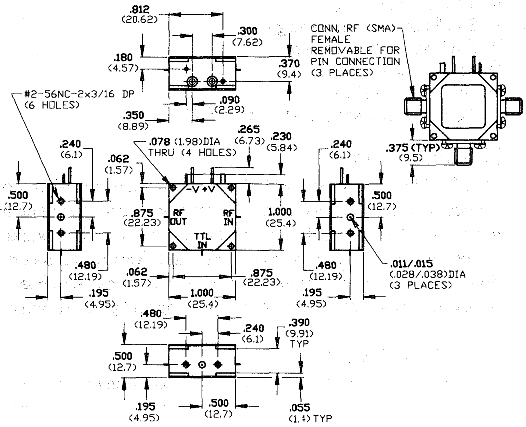
Description

These modulators are designed for systems where bi-phase modulation of an RF source is required. Integration of a TTL driver and RF mixer simplifies the task of the user's designers.

Environmental

Parameter	
Operating Temp. Max.	-55°C to +85°C
Storage Temp. Max.	-65°C to +125°C
Humidity	100% with condensation
Vibration	7G's rms, 50 to 2000 cps, per MIL-STD-810-B, Method 514, Proced. 5

Mechanical Outline

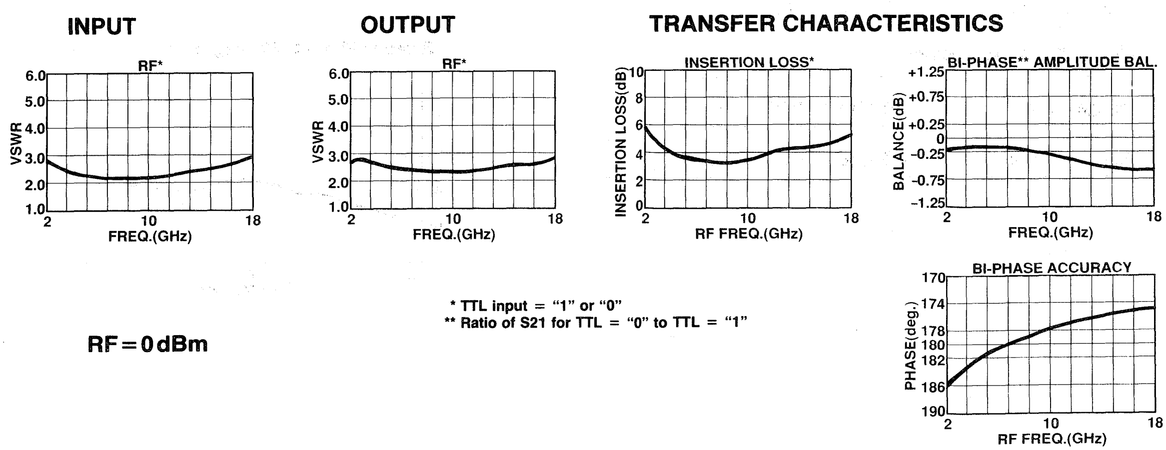


WEIGHT: 1.4 oz. (40 g)

Specifications 25°C

RF Frequency Range (GHz)	IF Modulation Frequency (MHz)	RF Power Isolation (dBm Max.)	dc Power (mA)	RF Power @ 1 dB Compr. Pt. (dBm)	Part Number
2.0 - 18.0	dc-30	+20	+5V/33 -10V/-23	+9	DMK2-18TTL

Typical Performance 25°C



* TTL input = "1" or "0"
** Ratio of S21 for TTL = "0" to TTL = "1"

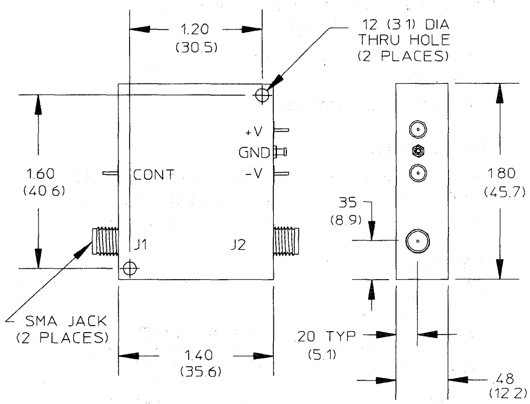
RF = 0 dBm

Specifications Subject to Change Without Notice.

Bi-Phase PIN Diode Modulators With Drivers

2696 Series

Features
- Broadband Performance
- TTL Compatibility
- Small Lightweight Package
- Environmentally Sealed
- Solder Construction
- Low Insertion Loss
- Temperature Range: -40° to +95°C



Description
M/A-COM's miniature 0-180° phase shifter is a vectorial phase shifting network utilizing PIN diodes together with broadband quadrature hybrid coupler circuits. It is driven by a hybrid-IC, TTL-compatible driver for convenient system applications. It features balanced insertion loss in both states, as well as broadband phase response. Applications include antenna beam steering and phase modulation.

Environmental
These devices are designed to meet the following conditions:

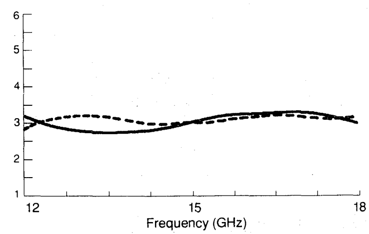
Test	MIL-STD	Method	Cond
Temperature Cycle	883	1010	C
Const. Acceleration	883	2001	A
Vibration	202	214	
Solvent Resistance	883	2015	
Salt Spray	202	101	A
Moisture Resistance	202	106	

Maximum Ratings

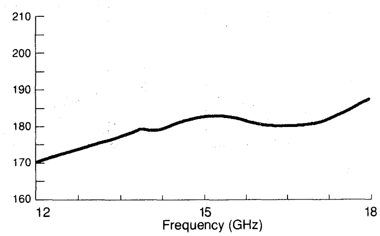
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +95°C

Typical Performance Data 2696-0109

Insertion Loss (dB)



Relative Phase Shift (degrees)



Specifications Subject to Change Without Notice.

2696-Series
Specifications 25°C

Frequency Range (GHz)	VSWR	Insertion Loss (dB)	Phase Delta (Degrees)	Transition Time (nS)	Switching Time (nS)	Operating Power (W)	Part Number[5]
2.0-4.0	1.60:1	1.8	180 ± 8	20	50	0.100	2696-0101-XY
	1.60:1	1.8	180 ± 8	300	500	0.500	2696-0102-XY
4.0-8.0	1.80:1	2.2	180 ± 10	20	50	0.100	2696-0103-XY
	1.80:1	2.2	180 ± 10	300	500	0.500	2696-0104-XY
8.0-12.0	1.80:1	2.8	180 ± 10	20	50	0.100	2696-0105-XY
	1.80:1	2.8	180 ± 10	300	500	0.500	2696-0106-XY
8.0-16.0	2.00:1	3.3	180 ± 15	20	50	0.100	2696-0107-XY
	2.00:1	3.3	180 ± 15	300	500	0.500	2696-0108-XY
12.0-18.0	2.00:1	3.8	180 ± 15	20	50	0.100	2696-0109-XY
	2.00:1	3.8	180 ± 15	300	500	0.500	2696-0110-XY

Notes:
1. All units include TTL drivers.
2. Driver current required: ±75 mA (typical).
3. Transition Time measured from 10% to 90% of detected RF.
4. Switching Time measured from 50% TTL to 10% or 90% of detected RF.
5. Specify voltage and logic connector from option table.

- XY Option Table

	X Bias Voltage		Y Logic Conn.
0	+5V/-12V	0	Solder Pin
1	+5V/-5V	1	SMC Conn.
2	+15V/-15V	2	SMA Conn.
3	+12V/-12V		
4	+5 V/-15V		

Specifications Subject to Change Without Notice.

Phase Modulator

Overview

Custom Designed Phase Shifters for ECM, Radar and Communications

M/A-COM has designed and developed numerous phase shifters for ECM, radar and communications applications. Nearly all of the multi-bit units are specifically designed to customer specification. Thus, in this portion of the control device world, custom design is generally the rule, versus the exception.

Phase shifters are specified with a wide variety of performance criteria and trade-off considerations. Therefore, consultation with the factory is recommended when specifying custom devices. M/A-COM has constructed units in VHF bands through Ku-Band frequencies, whether one bit or six bits, whether 10 milliwatts or 10 kW power handling, and speeds of 5 nS or 5 µS.

The bi-phase modulators on the preceeding pages represent typical performance for 180° phase shifters. As additional bits (90°, 45°, etc.) are added, the insertion loss increases, size increases and bandwidth becomes more limited.

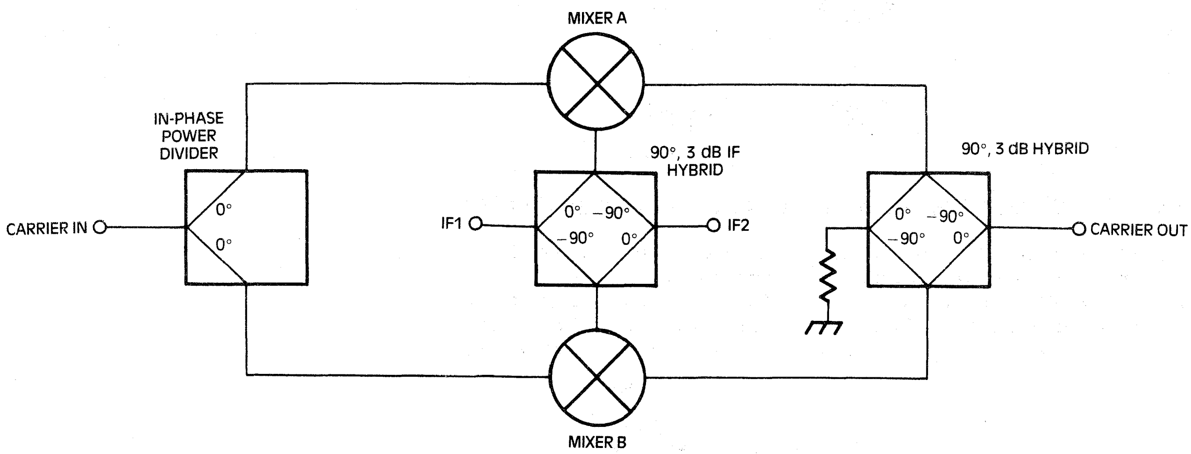
There are two fundamental types of phase shifters. One type is a true "constant-over-frequency" phase shifter, and the other is a "linear-with-frequency" time delay shifter. Contact the factory with your requirements or for applications assistance.

Single Sideband Modulators

M504

Single Sideband Modulators are used to modulate a carrier signal with a low frequency baseband signal and transmit only one sideband.

A Single Sideband Modulator can be constructed as shown in Figure 1. The input carrier signal is applied to an in-phase, 3 dB power divider selected for the frequency band of interest. The outputs of this power divider feed two double balanced mixers (with dc coupled IF ports for audio modulation). The modulating signal is applied to the IF ports of the mixers through an IF 90°, 3 dB hybrid. The outputs of the two mixers are combined by a 90°, 3 dB hybrid covering the carrier signal band.



Theory of Operation

Assume that the carrier input signal is sinusoidal and appears at the LO input of mixer A and mixer B as COS ($\omega_c t$). Suppose that the modulating signal is also sinusoidal and is applied to the IF1 input. Assuming that the IF input signal to mixer A is COS ($\omega_m t$), then the signal at the IF of mixer B will be SIN ($\omega_m t$), since the signals are applied through a 90° IF hybrid.

Each mixer performs a multiplication of the input signals and, therefore, the outputs are proportional to:

MIXER A:

$$[\,\cos(\omega_c t)\,]\,[\,\cos(\omega_m t)\,] = \tfrac{1}{2}\,[\,\cos(\omega_c + \omega_m)\,t + \cos(\omega_c - \omega_m)\,t\,]$$

MIXER B:

$$[\,\cos(\omega_c t)\,]\,[\,\sin(\omega_m t)\,] = \tfrac{1}{2}\,[\,\sin(\omega_c + \omega_m)\,t - \sin(\omega_c - \omega_m)\,t\,]$$

When these two signals are added in the 90°, 3 dB hybrid, the upper sideband results:

$$\text{carrier out} \propto \sin(\omega_c + \omega_m)\,t$$

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Using Microwave Mixers As Phase Modulators

M505

A simple bi-phase modulator can be made from a microwave mixer as shown in Figure 1. The only requirement for the mixer is that it must have a dc coupled IF port.

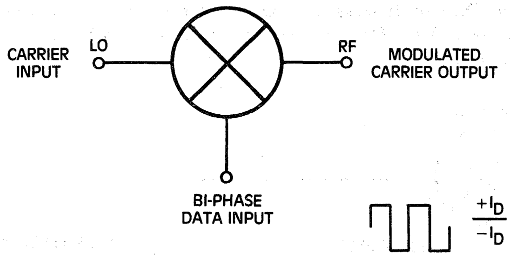


FIGURE 1. Using a Microwave Mixer as a Bi-Phase Modulator.

Figure 2 shows an equivalent schematic diagram of the mixer. Current flowing into the IF port from the data generator turns on diodes 1 and 2, thereby connecting the LO balun transformer to the RF balun transformer with a phase shift equal to Φ degrees. As the data input current changes direction, diodes 3 and 4 are turned on, while diodes 1 and 2 are turned off. The connection between the LO and RF baluns is now reversed and is equal to Φ + 180°.

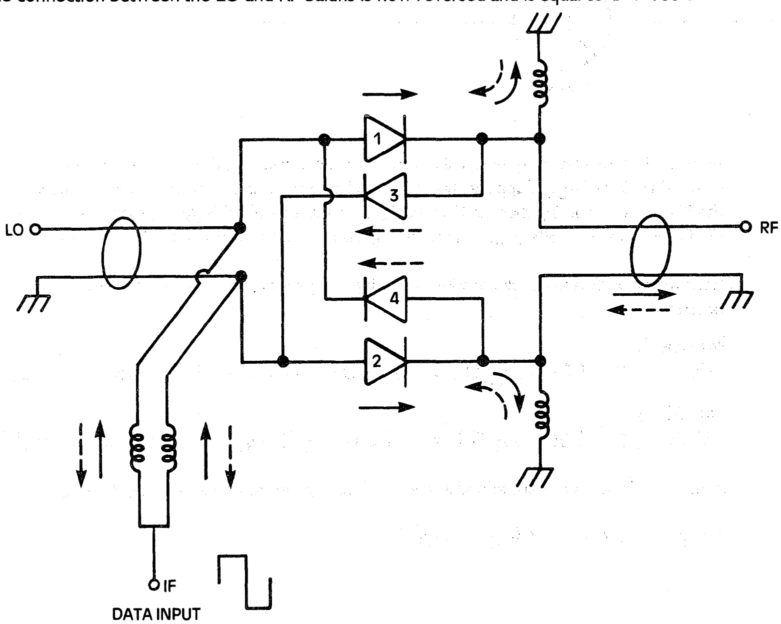


FIGURE 2. Microwave Mixer Schematic Showing Current Direction.

Usually, 20 milliamperes is sufficient to drive the diodes into a high conductance state, but less current may be used for low level carrier signals (< 0 dBm) with a slight degradation in signal transmission. Typically, the insertion loss is in the order of 2.5 to 3 dB with an amplitude balance of 0.25 dB and phase balance of 180 ± 5°. The maximum data rate that can be used depends on the bandwidth of the IF port of the mixer. Most of M/A-COM's dc IF mixers have bandwidths of up to 1.0 GHz. For critical applications or for specific design information, consult with M/A-COM engineering.

A quadrature phase modulator can be formed as shown in Figure 3 by using two Bi-Phase modulators, a quadrature hybrid and an in-phase power combiner. In this application, two separate data inputs are used to modulate the carrier signal to produce the 0°, 90°, 180° and 270° states.

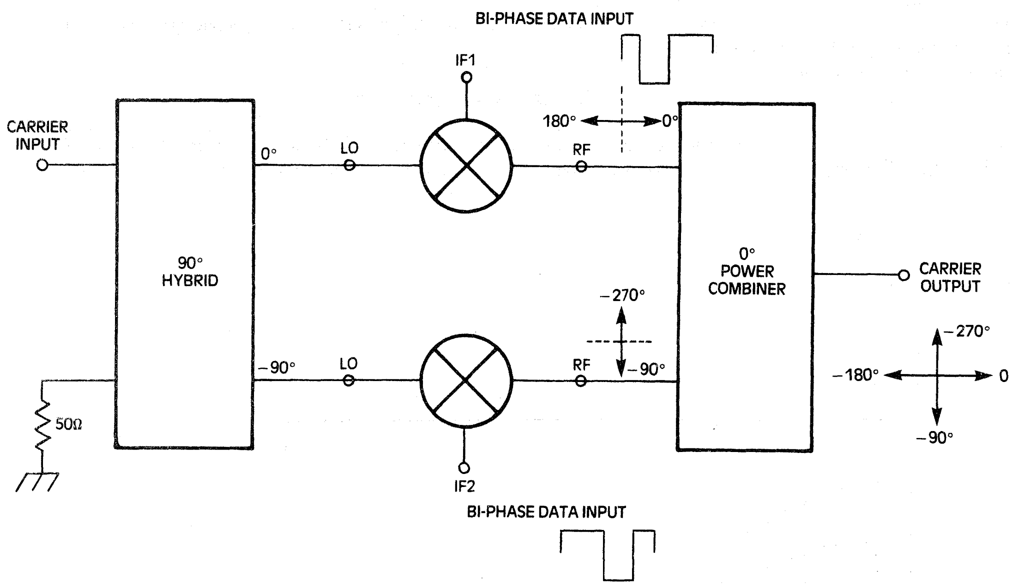


FIGURE 3. Quadrature Phase Modulator Block Diagram.

Using Microwave Mixers As Phase Detectors

M506

For microwave systems that require detection of the phase difference between two signals, a double balanced mixer is often used. Many of M/A-COM's double balanced mixers can be used in this application, provided that the IF frequency range extends down to dc.

This application note will discuss some of the general theory behind the use of microwave mixers as phase detectors, and will provide some useful information for the system designer attempting to use a mixer in this application.

How Mixers Detect Phase

When a mixer is used as a phase detector, signals of the same frequency are applied to the RF and LO ports. The mixer performs a multiplication on the two signals providing products of the form:

$$IF = \pm mRF \pm nLO$$

where m = 0, 1, 2, 3 ... etc.
n = 0, 1, 2, 3 ... etc.

The output products for which m and n = 1 are dominant and are in the range of 6 to 10 dB below the RF input level. In the case of the phase detector, the dominant products are at dc and 2RF (or 2LO) since the signals are at the same frequency.
Observing this output on a low frequency mixer with an oscilloscope, one would see a signal similar to the output of a full wave rectifier. When the phase difference is varied between 0 and 180°, the oscilloscope trace shifts above and below the 0 volts position on the screen. When the signals are 90° out of phase, the signal trace is vertically centered such that the average area above and below the center is equal.

The offset voltage observed while varying the phase between the input signals can be expressed as:

$$V_{IF} = K \cos(\beta_{LO} \rightarrow \beta_{RF})$$

where K is a function of the diode characteristics and the conversion loss of the mixer. Figure 1 shows a plot of the output voltage as a function of the phase difference between the LO and RF signals.

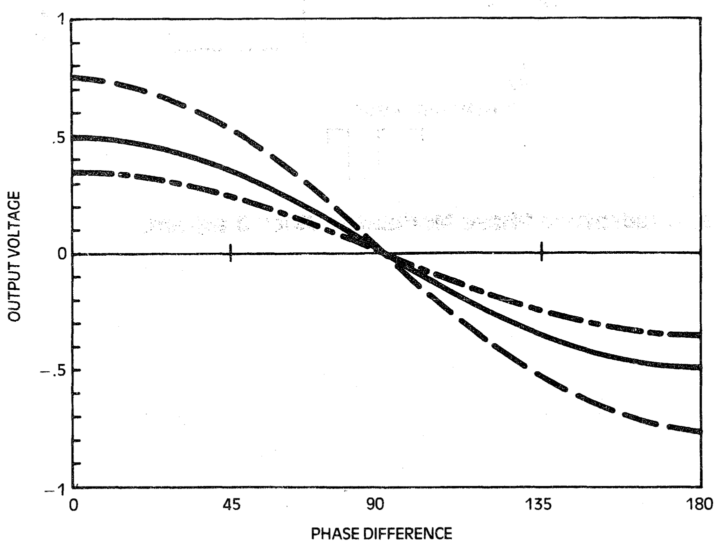


FIGURE 1. Phase Detector Output Voltage vs. Phase Difference Between LO and RF Signals.

How Mixers Detect Phase (cont'd.)

Three different plots are shown indicating variations in the value of "K". The value of K depends on three main factors: (1) the relative LO and RF power levels, (2) the IF load resistance and (3) the conversion efficiency of the mixer at the frequency of operation.

(1) Variation in LO and RF Power Levels
Assuming that the mixer is operating with the prescribed LO power level and the IF load resistance is 50 ohms, the output level will be determined by the RF signal level and the mixer conversion loss at the frequency of operation. Increasing the RF signal level up to the 1 dB compression point will also increase the output voltage level dB for dB. Since the LO power level is already sufficiently high enough to turn the diodes on, variations in LO power will have a somewhat reduced effect on the output voltage level. M/A-COM offers microwave mixers in three different LO power level ranges, from +7 dBm to +18 dBm, providing a broad range of operation levels.

(2) Variations in IF Load Resistance
Most microwave mixers are designed to operate in a 50 ohm system, but in some applications it is desirable to operate with an IF impedance other than 50 ohms. Figure 2 shows a plot of a phase detector with 50, 100 and 1000 ohms connected to the IF output. Notice that the maximum output voltage, as well as the slope of the curve at 90°, increases with a higher resistance connected. The higher output level and corresponding increase in sensitivity with higher output load resistance can sometimes be offset by a degradation in offset errors, or by poor intermodulation performance.

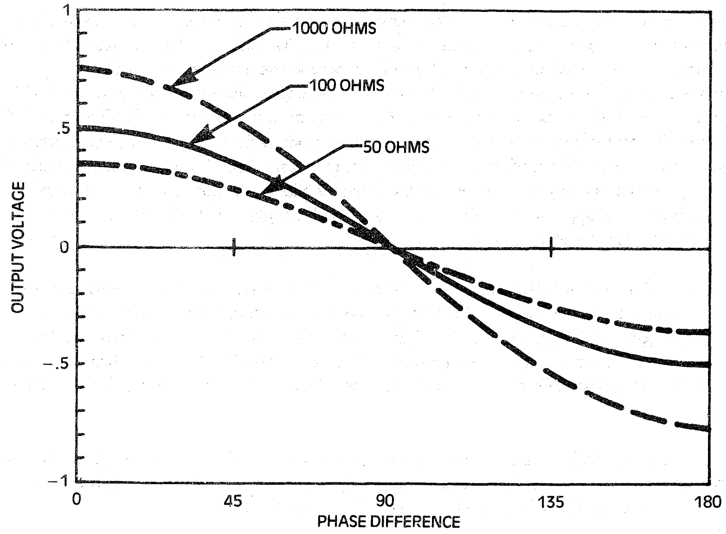


FIGURE 2. Phase Detector Output Voltage vs. IF Load Resistance.

(3) Output Voltage vs. Conversion Efficiency
The output voltage of a microwave mixer, when used as a phase detector, will depend on several factors. Using a broadband mixer at the upper end of its operating frequency range will yield a lower output voltage than when using a narrow band mixer optimized for the same frequency band. The same effect will be found when using a high level mixer in a "starved" LO condition, when there is insufficient LO power to drive the diodes into a high conductance state. As a general rule, choose a mixer with an RF and LO frequency range optimized for the band you are using.

Another factor relating the output voltage with conversion efficiency is the IF output load impedance level. Most microwave mixers are designed to operate in a 50 ohm system. When using an IF load impedance other than 50 ohms, the conversion loss of the mixer may increase due to the mismatch.

In some cases, this increase in conversion loss may nullify any anticipated benefit of increasing the IF load impedance.

Non-Ideal Performance

There are three non-ideal electrical parameters that the system designer should be aware of when using microwave mixers as phase detectors. The first one, dc offset, is caused by an unbalance in the mixer, either from the slight differences in the diode characteristics or unbalanced balun transformers, or both. Ideally, when signals are applied to the LO and RF ports of a mixer with a phase difference of 90°, the dc output appearing at the IF port should be zero. In some cases, the actual output may be as much as several millivolts. The polarity of this voltage may also be random in a particular lot of mixers. This dc offset is usually measured directly by applying only the LO signal to the mixer, while the RF port is terminated with 50 ohms. For critical applications, an offset current may be applied to the IF port as a means of adjusting the offset voltage to zero.

The second non-ideal parameter of concern to the system designer is Mixer-Induced Phase Shift. Some mixers have internal circuitry that is non-symmetrical with respect to the LO and RF ports. Because of this, the effective phase lag between the RF input connector and the diodes may be different than the corresponding points of the LO side of the mixer. When signals with a 90° phase difference are applied to the mixer, the IF output will not be zero volts dc.

The solution to this problem is to externally adjust either the LO or RF path lengths to achieve a null when the RF and LO signals are 90° apart. This amount of adjustment may be determined experimentally, or by consulting the M/A-COM factory.

The third non-ideal parameter in a microwave phase detector is the dc output vs. input phase difference. The dc output voltage of a phase detector resembles a cosine wave when plotted against the relative phase difference between RF and LO signals. This output voltage can be expressed as:

$$V_{OUT} = V_{MAX} \cos(\Delta\Phi)$$

where Φ is in radians and V_{MAX} is in volts.

Then, the sensitivity is the derivative of V_{OUT} vs. phase difference or is given by:

$$\frac{dV_{OUT}}{d\Phi} = V_{MAX} \sin(\Delta\Phi)$$

A straight line can be drawn through the point where $\Phi = \pi/2$ (90°) and $V_{OUT} = 0$ volts with the same slope as V_{OUT} vs. Φ. The equation of this line can be found from the familiar:

$$y = mx + b$$

where m is the slope at $y = 0$ volts and x is $\pi/2$. Solving for b:

$$b = V_{MAX} (\pi/2)$$

The equation of the line is then:

$$y = V_{MAX} \Delta\Phi + V_{MAX} (\pi/2)$$

Converting $\Delta\Phi$ from radians to degrees:

$$V_{OUT} = V_{MAX} \cos\left(\frac{\Delta\Phi\pi}{180}\right)$$

and

$$y = -V_{MAX} \frac{\Delta\Phi\pi}{180} + V_{MAX} (\pi/2)$$

or

$$y = V_{MAX} \left(\pi/2 - \frac{\Delta\Phi\pi}{180}\right)$$

Non-Ideal Performance (cont'd.)

Figure 3 shows a plot of these two equations vs. $\Delta\Phi$ in degrees when V_{MAX} equals 1 volt.

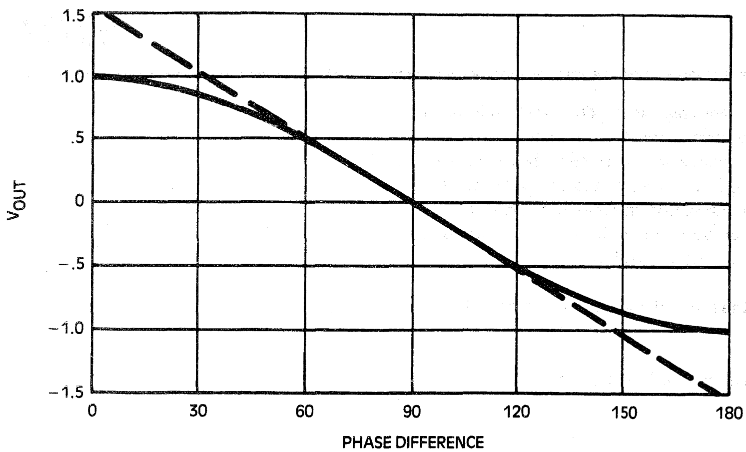


FIGURE 3. Plot of V_{OUT} and Y vs. $\Delta\Phi$.

The nonlinearity of the output can be expressed as:

$$P = \left(\frac{Y - V_{OUT}}{y}\right) \times 100\,\%$$

Figure 4 shows a plot of this nonlinearity vs. $\Delta\Phi$ in degrees. From this plot it can be seen that nonlinearity increases as the phase deviates from 90° with a maximum at 0° and 180°. In the equations for V_{OUT} and y, the voltage V_{MAX} is a common factor and therefore, the non-linearity is independent of V_{MAX}.

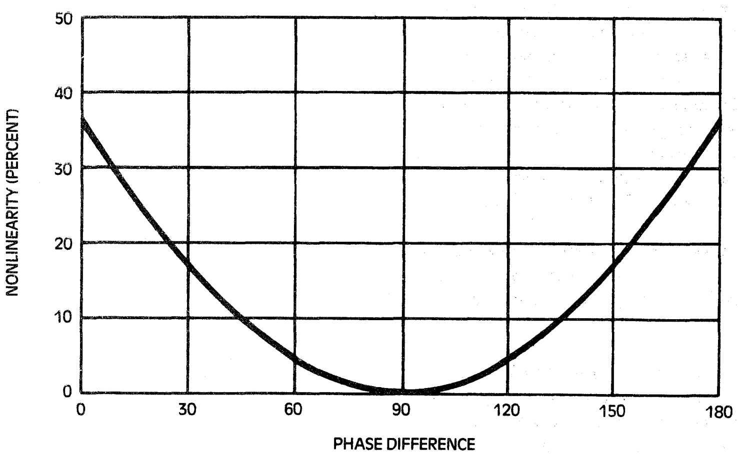


FIGURE 4. Nonlinearity of V_{OUT} vs. Phase Difference $\Delta\Phi$

Intermodulation Performance of Microwave Mixers

M507

Because of the non-linear properties of mixer diodes, many spurious products are produced in a microwave mixer along with the desired sum or difference products. The relative output levels of these various "unwanted" products, as well as their relative position in the frequency spectrum, depends on the type of mixer used (e.g., single vs. double balanced), the LO and RF power levels involved, and the frequency of the LO and RF signals. In addition, the circuit in which the mixer is embedded can also influence the spurious response because some products may be reflected back into the mixer to be reconverted to other products.

There are two types of mixer products generated by the mixer diodes. The first type, called single-tone products, can be described by:

$$f = m f_{RF} \pm n f_{LO} \qquad \text{where } m, n = 0, 1, 2, 3, \ldots\text{etc.}$$

The primary outputs occur when m and n equal 1.

The second type of mixer products are due to multiple RF input frequencies and are called multiple-tone. These spurious products have the form:

$$f = \pm m_1 f_{RF1} \pm m_2 f_{RF2} \pm \ldots \pm n f_{LO} \qquad \text{where } m_1, m_2 \ldots n = 0, 1, 2, \ldots$$

The multiple-tone product of greatest concern to the system designer is usually the two-tone, third order product; when $m_1 = 2$, $m_2 = 1$ or $m_1 = 1$, $m_2 = 2$ and $n = 1$. The reason for this is that this product can appear at the IF output port along with the desired IF signal and may be so close in frequency that it cannot be effectively filtered out.

Single-Tone Intermodulation Products

The power level of the various single-tone intermodulation products produced by the mixer diodes that appear at the RF, LO and IF ports of a mixer depends on the type of mixer construction. The most popular type is the double balanced mixer because it offers low conversion loss, high isolation, broad bandwidth and good spurious rejection. Its one drawback is poor VSWR characteristics which may lead to phase and amplitude ripple, especially in multiple channel systems. The double balanced mixer is constructed with two transmission line balun transformers feeding a matched set of four Schottky diodes. The two transformers convert the single-ended transmission line at the RF and LO inputs to a balanced transmission line at the diodes., The IF output is extracted from the diodes through an unbalanced filter network. Because of this mixed excitation mode of operation, cancellation of all even order terms is provided at the IF output, that is, when m and n = 0, 2, 4, etc. Since the even order products are suppressed, only the odd numbered products of the LO and RF appear at the IF output.
This same cancellation scheme causes some of the single-tone intermodulation to appear at either the RF or LO ports. At the RF port, cancellation suppresses all products except for odd order RF and even order LO terms. At the LO port, just the opposite occurs. Appearing at the LO port are even order RF and odd order LO products.

Many of these single-tone products are of little concern, mainly because they may fall outside the pass band of the IF, or because they are at a level that does not adversely affect the performance of the mixer in the system. Some of these single-tone products, such as the term 2LO-RF (sometimes called the image signal), can be a problem. In a double balanced mixer, this product appears at the RF port. If at some frequency this signal is reflected back into the mixer, or if it "leaks" through a common RF power divider connected to another mixer, it can recombine with the LO and produce an error signal at the IF frequency.

Single-Tone Intermodulation Products (cont'd.)

Because of the many product combinations that can occur in a mixer, complicated by variations in power levels, frequency and the circuits that the mixer is embedded in, an accurate prediction of spurious levels is nearly impossible. Because of this problem, it is recommended that the system designer consult the M/A-COM factory for guidance in selecting the right mixer for the intended application. Using state-of-the-art equipment, M/A-COM engineers can simulate your system operating conditions and provide you with comprehensive data so that you may predict the mixer's performance before committing to production purchases.

Multiple-Tone Intermodulation Products

Multiple-tone intermodulation products are produced in mixers because of the non-linear I-V characteristics of the diodes. These products, of which the third order is the most significant, are generated during the on-off transition time of the diodes as well as during the on-time of the diodes, due to non-linear series resistance. Multiple-tone products, as are the single-tone products, are subject to the same variations due to the power levels, frequency and the surrounding circuitry. Mixers are usually characterized for intermodulation performance over the operating frequency band with the LO power level set to the optimum value for the mixer under test, and the RF power level set low enough so that the mixer is operating in the linear region. From this test data, a figure of merit is calculated called the Intercept Point. This number describes the point at which the desired IF output power would equal the intermodulation product output power if the mixer was capable of operating at these levels. Careful attention is paid to the test set-up when making intermodulation measurements. Generators are well isolated to eliminate cross-talk, and the test port VSWR is minimized by using low VSWR cables and attenuators.

Figure 1 illustrates the relationship between the fundamental IF output and multiple-tone intermodulation products. The Intercept Point in dBm referenced to the input power level can be found by the expression:

$$I_{PIN}^{n} = \frac{\text{I.M.R. (dBc)}}{n-1} + RF_{IN}\ \text{(dBm)}$$

where:

n = the order of the product (the sum of the multipliers of each input tone)

I.M.R. = Intermodulation Ratio. The difference in power levels between the measured IF output and the intermodulation product output.

I_{PIN}^{n} = the input intercept point.

The intercept point referred to the output, I_{POUT}^{n}, can be found by subtracting the mixer conversion loss (or by adding the mixer conversion gain).

The intermodulation performance of a mixer is mainly dependent on the diode characteristics. Other than paying close attention to the embedding circuit matching and minimizing the operating RF input level, the only other alternative for the system designer is to specify a higher level mixer. At the sacrifice of conversion loss and with increased LO power levels, mixers can be constructed with either multiple diodes in the usual ring configuration, or with resistor or resistor-capacitor networks in series with each diode. These added components tend to minimize the non-linear effects of the diodes. At microwave frequencies, multiple diodes are usually dictated because of ease of fabrication and minimized parasitic effects. M/A-COM supplies a complete line of microwave mixers available in a choice of "levels". Please consult the factory for guidance in selecting a mixer for your particular application.

Multiple-Tone Intermodulation Products (cont'd.)

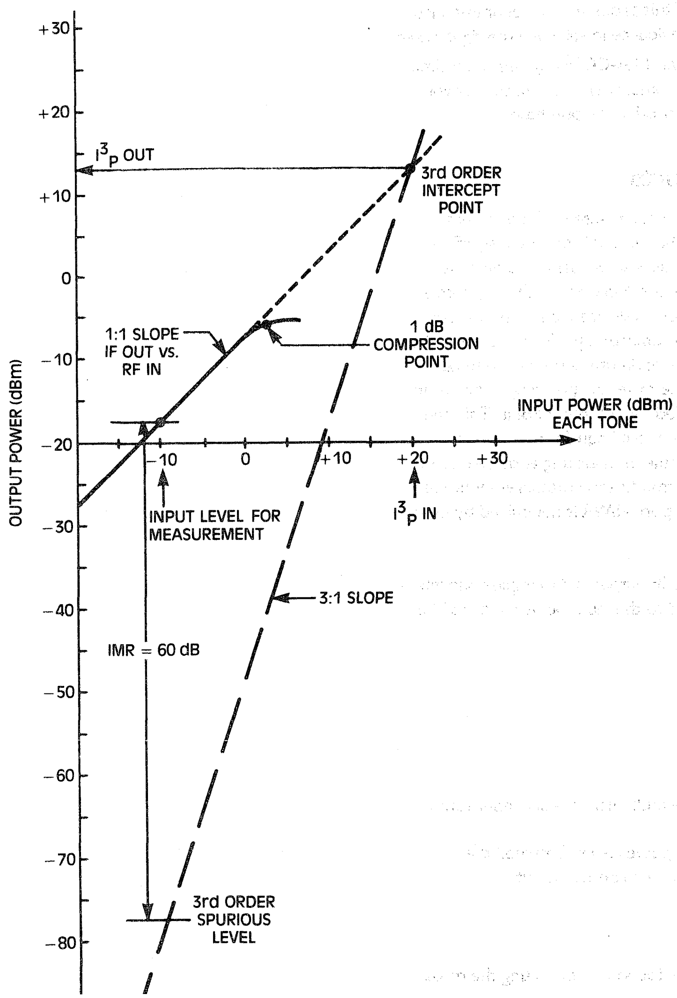


FIGURE 1. Plot of Mixer IF Output Power vs. Input Power Showing 3rd Order Intercept Point

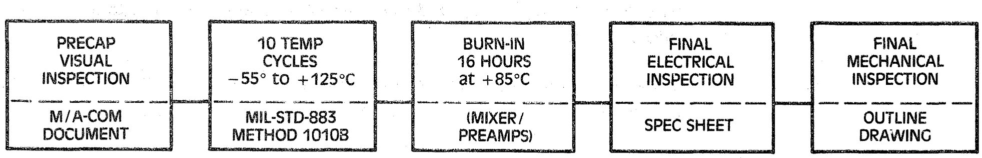
Application Note

Reliability & Screening Considerations for Microwave Mixers M508

All products offered in this catalog are suitable for use in military environments as well as commercial applications where the use of a high quality device is indicated. M/A-COM also has the in-house capability to perform various levels of reliability screening. Screening plans may be selected from the recommended plans described below or tailored to the specific application requirements. Three recommended plans are offered: STANDARD, HIGH-REL LEVEL I and HIGH-REL LEVEL 2.

Standard Screening

Unless otherwise specified, all mixer products in this catalog are subjected to the standard screening and inspection cycle shown below:



Standard Screening Plan

High-Rel Screening

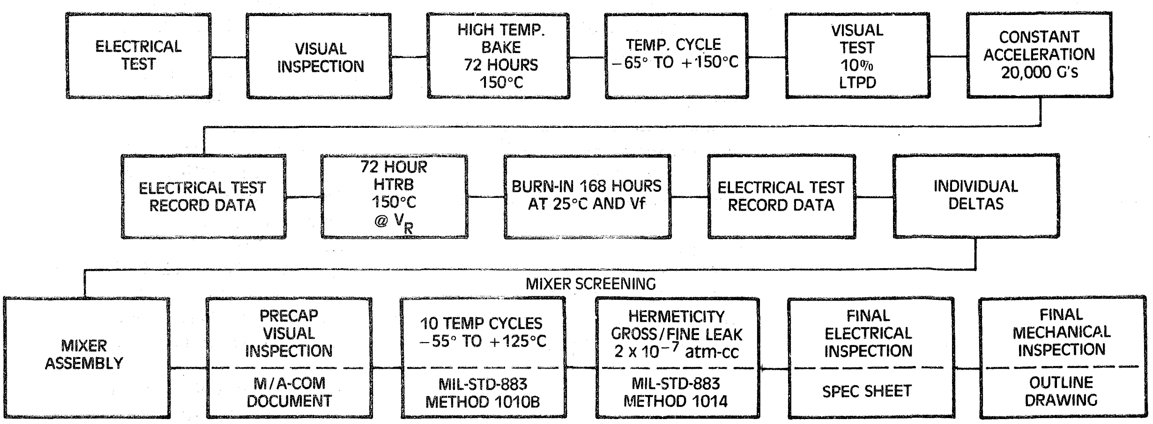
High-Rel screening can be performed for applications requiring enhanced reliability. M/A-COM routinely manufactures mixers and other microwave components for military aircraft, missile, naval and ground support equipment.

Modern defense weapon systems typically invoke specifications such as MIL-M-38510, MIL-STD-883 and MIL-M-28837 to detail the construction and screening requirements for microwave mixers. These specifications treat the mixer as a hybrid microcircuit device containing unpackaged semiconductors. M/A-COM's High-Rel mixers are designed to be processed and screened to meet the intent of these specifications. Two High-Rel screening options are offered as described below.

High-Rel Level I Screening

In this case, the Schottky diodes are individually screened to a JANTX level except that hermeticity testing is omitted since the diodes themselves are not hermetic. (Hermetic packages for Schottky diode quads are not practical for high frequency microwave mixers due to the lead inductance and package capacitance.) The mixer itself is then subjected to temperature cycling and hermeticity testing. This screening plan is summarized in the block diagram below:

SCHOTTKY DIODE SCREENING (PER MIL-STANDARD 750 AND THE APPROPRIATE METHOD.)



Level 1 Screening Plan

Specifications Subject to Change Without Notice.

Reliability Considerations

High-Rel Screening (cont'd.)

High-Rel Level 2 Screening

In this case, the entire mixer is treated as a hybrid microcircuit device and screened per Table VIII of MIL-STD-883, Method 5008. This screening plan is outlined below:

PRECAP VISUAL INSPECT	STABILIZATION BAKE 24 HOURS 125°C	10 TEMP CYCLES −55° TO +125°C	CONSTANT ACCEL 5000 G	BURN-IN 168 HOURS +125°C	HERMETICITY FINE/GROSS 2 x 10^{-7} atm-cc	FINAL ELECTRICAL INSPECT	FINAL MECHANICAL INSPECT
M/A-COM DOCUMENT	883 1008B	883 1010B	883 2001A	883 1015B	883 1014A1, C	SPEC SHEET	OUTLINE DRAWING

Level 2 Screening Plan

Alternate screening plans can be accommodated as required by the specific application. M/A-COM's Design and Quality Assurance engineers would be happy to discuss your individual needs.

Screening costs depend on device type and lot size. Please consult the factory for current pricing.

MTBF For Microwave Mixers

MTBF (Mean Time Between Failures) is usually calculated as specified in MIL-HDBK-217, which provides the formula for the MTBF calculation as well as the failure rates for the individual components inside the mixer. Important factors such as stress ratings, operating environment and screening level are also part of the calculation.

The component which most affects mixer MTBF is the Schottky diode itself. Since this is the limiting factor, calculated MTBF for a mixer depends heavily on the assumptions made regarding the reliability factor of the diodes. An example of a typical MTBF calculation is given below:

Mixer MTBF Calculation #1
Part #3601-07-DBL
Paragraph References from MIL-HDBK-217D

Components:

Qty	Description
1	Housing
2	Covers
1	Diode Quad
2	Capacitors

Conditions:
- LO input power level = 10 milliwatts
- Operating temperature = +85°C
- Environment = Ground benign
- Mixer screened per High-Rel Level 2

Construction:
- # of solder joints = 18
- # of glass feedthroughs = 3
- Area of substrate = 0.159 square inches
- Seal perimeter = 4.32 inches

Component Failure Rate Calculations:

a) Silicon Schottky Diode Quad

Formula: $\lambda_p = (\lambda_b \times \pi_E \times \pi_Q)$ failures/10^6 hours

Rating = 144 milliwatts at +85°C
Stress = 10 milliwatts
Ratio = 0.069
$\lambda_b = 0.054$ per Table 5.1.3.7-3
$\pi_E = 1.0$ per Table 5.1.3.7-1
$\pi_Q = 1.0$ per Table 5.1.3.7-2

SO $\lambda_p = (0.054 \times 1.0 \times 1.0)$
$\lambda_p = 0.054$

b) Ceramic Capacitor

Formula: $\lambda_p = \lambda_b (\pi_E \times \pi_Q \times \pi_{CV})$ failures/10^6 hours

Rating = 50 volts
Stress = 0.7 volts
Ratio = 0.014
$\lambda_b = 0.00085$ per Table 5.1.7.4-4
$\pi_E = 1.0$ per Table 5.1.7.4-1
$\pi_Q = 0.1$ per Table 5.1.7.4-2
$\pi_{CV} = 0.3$ per Table 5.17.4-3

SO $\lambda_p = 0.00085\ (1.0 \times 0.1 \times 0.3)$
$\lambda_p = 0.0000255$

Reliability Considerations

MTBF For Microwave Mixers (cont'd.)

c) Package Failure Rate
$\lambda_S = 0.0218$ per Table 5.1.2.7-7

d) Interconnections
N_I = number of interconnections
$N_I = 18$
λ_I = temperature dependent failure rate
$\lambda_I = 0.00170$ per Table 5.1.2.7-3

e) Density Factor
Formula: $\pi_D = 0.2 + 0.15\,(\sqrt{\text{Density}})$

$$\text{Density} = \frac{\text{Number of Interconnections}}{\text{Substrate Area} + 0.1}$$

$$\text{Density} = \frac{18}{0.159 + 0.1} = 69.5$$

so $\pi_D = 0.2 + 0.15\,(\sqrt{69.5})$
$\pi_D = 1.45$

Mixer Failure Rate Calculation per 5.1.2.7-1:

Formula: $\lambda_p = \{\Sigma N_C\lambda_C\pi_G + [N_R\lambda_R + \Sigma N_I\lambda_I + \lambda_S]\,\pi_F\pi_E\}\,\pi_Q\pi_D$ failures/10^6 hours

where:
$\lambda_S = 0.0218$ per 5.1.2.7-7
$\pi_D = 1.45$ per 5.1.2.7-11
$\pi_E = 0.20$ per 5.1.2.7-5
$\pi_F = 1.25$ per 5.1.2.7-1
$\pi_G = 0.2$ per 5.1.2.7-1 (diodes)
$\pi_G = 0.8$ per 5.1.2.7-1 (capacitors)

so:
$\lambda_p = \{(0.054 \times 0.2) + (2 \times .0000255 \times 0.8) + [(18 \times .0017) + 0.0218]\,(1.25 \times 0.2)\}\ 1.0 \times 1.45$
$\lambda_p = 0.0347$ failures/10^6 hours

or MTBF = 28,818,444 hours for this double balanced mixer in a Ground Benign environment.

Component failure rates given in MIL-HDBK-217 for harsher environments yield much lower MTBF figures than shown in the example above. To illustrate, the same calculation is performed for an Airborne Uninhabited Fighter environment:

MIXER MTBF CALCULATION #2
Part #
Paragraph References from MIL-HDBK-217D

Components:

QTY	DESCRIPTION
1	Housing
2	Covers
1	Diode Quad
2	Capacitors

Conditions:
LO input power level = 10 milliwatts
Operating temperature = 85°C
Environment = Airborne uninhabited fighter
Mixer screened to High-Rel Level 2

Construction:
# of solder joints = 18
# of glass feedthroughs = 3
Area of substrate = 0.159 square inches
Seal perimeter = 4.32 inches

Component Failure Rate Calculations:
a) Silicon Schottky Diode Quad
Formula: $\lambda_p = (\lambda_b \times \pi_E \times \pi_Q)$ failures/10^6 hours
Rating = 144 milliwatts at +85° C
Stress = 10 milliwatts
Ratio = 0.069
$\lambda_b = 0.054$ per Table 5.1.3.7-3
$\pi_E = 110$ per Table 5.1.3.7-1
$\pi_Q = 1.0$ per Table 5.1.3.7-2

so $\lambda_p = (0.054 \times 110 \times 1.0)$
$\lambda_p = 5.94$

Specifications Subject to Change Without Notice.

Reliability Considerations   MTBF For Microwave Mixers (cont'd.)

b) Ceramic Capacitor

Formula: $\lambda_p = \lambda_b\ (\pi_E \times \pi_Q \times \pi_{CV})$ failures/10^6 hours

Rating = 50 volts

Stress = 0.7 volts

Ratio = 0.014

$\lambda_b = 0.00085$ per Table 5.1.7.4-4

$\pi_E = 15$ per Table 5.1.7.4-1

$\pi_Q = 0.1$ per Table 5.1.7.4-2

$\pi_{CV} = 0.3$ per Table 5.17.4-3

so $\lambda_p = 0.00085\ (15 \times 0.1 \times 0.3)$

$\lambda_p = 0.0000383$

c) Package Failure Rate

$\lambda_S = 0.0218$ per Table 5.1.2.7-7

d) Interconnections

N_I = number of interconnections

$N_I = 18$

λ_I = temperature dependent failure rate

$\lambda_I = 0.00170$ per Table 5.1.2.7-3

e) Density Factor

Formula: $\pi_D = 0.2 + 0.15\ (\sqrt{\text{Density}})$

$$\text{Density} = \frac{\text{Number of Interconnections}}{\text{Substrate Area} + 0.1}$$

$$\text{Density} = \frac{18}{0.159 + 0.1} = 69.5$$

so $\pi_D = 0.2 + 0.15\ (\sqrt{69.5})$

$\pi_D = 1.45$

Mixer Failure Rate Calculation per 5.1.2.7-1:

Formula: $\lambda_p = \{\ \Sigma N_C \lambda_C \pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S]\ \pi_F \pi_E\}\ \pi_Q \pi_D$ failures/10^6 hours

where:
$\lambda_S = 0.0218$ per 5.1.2.7-7
$\pi_D = 1.45$ per 5.1.2.7-11
$\pi_E = 4.0$ per 5.1.2.7-5
$\pi_F = 1.25$ per 5.1.2.7-1
$\pi_G = 0.2$ per 5.1.2.7-1 (diodes)
$\pi_G = 0.8$ per 5.1.2.7-1 (capacitors)

so: $\lambda_p = \{(5.94 \times 0.2) + (2 \times .0000383 \times 0.8) + [(18 \times .0017) + 0.0218]\ (1.25 \times 4.0)\}\ 1.0 \times 1.45$

$\lambda_p = 2.103$ failures/10^6 hours

or MTBF = 475,511 hours for this double balanced mixer in an Airborne Uninhabited Fighter environment

As the example shows, the calculated MTBF of a typical mixer screened to Level 2 (as previously defined) is 475,511 hours for operation in an Airborne Uninhabited Fighter environment. This type of number is typical when the failure rates given in MIL-HDBK-217 for Schottky diodes are used in the calculation.

Schottky diode manufacturers generally claim that the reliability of their diodes is actually much higher than specified in MIL-HDBK-217. Depending on the application , data may exist to support a higher diode reliability factor, and therefore a higher calculated mixer MTBF. Please consult factory for further information.

Detector

Overview

General Information

RF detection is achieved through utilization of the nonlinear, current-voltage characteristics of a semiconducting junction. Two fundamental detector diode types are used; silicon-based, Schottky barrier and germanium-based, tunnel (or back) diodes.

In Schottky barrier devices, semiconduction results from a contact potential established between a metal and an ion enriched (doped) non-metal (silicon). With "N" type material, electron-rich negative ions flow forward current from the non-metal/semiconducting material into metal. With "P" type material, electron-deficient, positive ions flow forward current from the non-metal/semiconducting material into the metal. The junction has an inherent potential difference of 0.3 to 0.8 volts. Additionally, a "barrier" potential must be overcome, in the order of 0.15 volts more or less depending upon which type is selected; low, medium or high barrier Schottky.

The tunnel diode consists of a P-N junction formed between two heavily "doped" semiconductor materials (no metal within this junction). The term "tunnelling" refers to the possibility of some electrons passing through, rather than over, a potential energy barrier. This tunnelling probability increases with size reduction of the junction. The junction barrier potential in germanium material is in the order of 0.6 volts. Tunnel diodes require no external dc bias and are several orders of magnitude more stable over temperatures between -55°C and +100°C.

Definition of Parameters

Frequency Range

The frequency range is selected based on voltage output response or VSWR limits. Detectors are usable beyond the specified frequency range with some degradation of minimum voltage output or maximum VSWR.

VSWR

Matching networks are required to obtain low VSWR values on detectors. The Octave Band Back Detectors and Point Contact Detectors use these techniques. Standard Schottky Detectors have medium to high input VSWR values, but have other desirable characteristics such as high output voltage. Schottky Detectors can have low input VSWR values when the bias is 200 microamperes or more with some sacrifice in voltage sensitivity. They should be used with components that present a low source VSWR to maintain the specified flatness.

Flatness

Flatness, across the RF frequency band, is defined as 10 log of the ratio of maximum to minimum output voltage with a constant RF input power. This is applicable in the square law range. For example, a flatness of ±0.5 dB is a voltage ratio of 1.26:1.

A source VSWR of 1.25:1 or less is recommended to drive the detector input. An SMA coupler, attenuator, or power divider can be used to achieve this result.

Output Voltage Sensitivity

The output voltage sensitivity is the ratio of output voltage to input RF power. The output voltage is measured across an open circuit with a known RF input power. An open circuit is a load that is greater than 50 times the video output resistance. This is a square law function, so the output voltage is directly proportional to input power. The square law range is typically between -20 dBm and the lowest signal sensitivity. The symbol "K" is used to indicate the ratio of this open circuit output voltage to this input power and is usually expressed in millivolts/milliwatt.

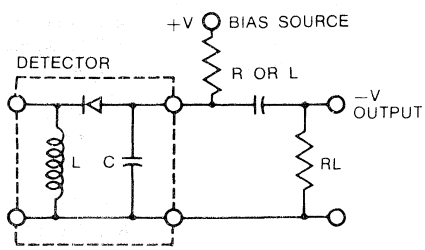
Tangential Signal Sensitivity

The tangential signal sensitivity (TSS) level is defined as that RF input signal power which produces an 8 dB video output-to-noise voltage ratio. Since the output voltage is so low, on the order of 4 microvolts at the TSS level, a video amplifier should be used to perform the measurement. To obtain the TSS value using a video amplifier, the amplifier noise figure and video bandwidth must be known.

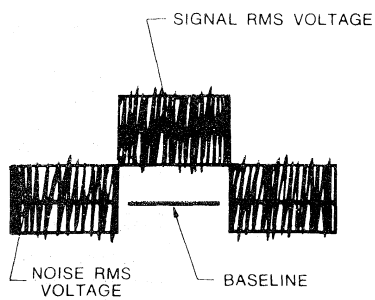
To obtain tangential sensitivity at a video bandwidth (BW) other than 1 MHz, or noise figure (NF) other than 2 dB, use the following formula:

$$\text{TSS} = \text{TSS (2 MHz BW amp. value)} + 5 \log_{10}\left(\frac{\text{BW in MHz}}{1\text{ MHz}}\right) + .5\ (\text{NF in dB -3 dB})$$

Typical Bias Circuit



Typical TSS Display



Definition of Parameters (cont'd.)

Custom Considerations

- Narrow bandwidth, improved sensitivity
- Special testing and documentation
- Special connector configuration
- Matched pairs available
- Directional detectors
- Limiter detectors

Special application detectors which require custom design of RF bandwidths, input VSWR, and output capacitance are available.

M/A-COM also maintains complete facilities required for testing and documenting requirements necessary for "High-Reliability aerospace" applications.

Selection Guidelines

M/A-COM offers a wide range of detectors which are available with three types of detector diodes:

- Back Diode
- Schottky Barrier Diode
- Point Contact Diode

These three basic diode types are used in various configurations to offer optimum performance for a wide range of applications, at the lowest cost.

Back Diode Detectors

Back Diode Detectors offer the best temperature stability. The low video resistance of back diodes also provides the widest video bandwidth and fastest rise time. Back Diode Detectors also offer the best inherent RF match, without special input matching.

Back diodes tend to be somewhat mechanically and electrically fragile due to the minute geometrics of the device.

Schottky Barrier Diode Detectors

Schottky Detectors are generally chosen over other types of detectors due to their mechanical and electrical ruggedness, highest output voltage and best tangential sensitivity.

Biased Schottky Detectors offer additional advantages over the unbiased equivalent by providing higher burnout levels, lower video resistance and improved temperature stability.

Point Contact Diode Detectors

Sometimes called crystal detectors, these units are built with diodes formed by a tungsten wire pressing against a silicon chip. Still popular after many years of use in the field, the Point Contact Detectors offer a cost effective alternative with a good overall combination of operating characteristics. The 2087-6001 Point Contact Detectors are constructed with a resistive pad at the RF input to provide a lower VSWR than otherwise possible, due to the high video resistance inherent with point contact types.

Due to the mechanical structure of the point contact, they tend to be the least rugged electrically and mechanically.

M/A-COM

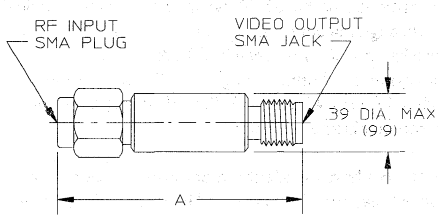
Back Diode Detector With Replaceable Diodes

2085 Series

Specifications

Bias Current	0
Output Polarity	Negative[4]
Video Resistance	80 Ohms Nominal[2]
Maximum Power	40 mW CW or 3 erg spike (except 2085-6018-00) 2085-6018, 25 mW CW or 2 erg spike
Temperature Stability	±1 dB over operating range of -65°C to +100°C
Tracking	0.5 dB (Matched Pair) per octave band (except 2085-6018-00) 2085-6018-00, 0.8 dB (Matched Pair) per octave band[5]
Temperature Range	-65°C to +100°C
Finish	Passivated Stainless Steel

Mechanical Outline



Frequency Range (GHz)	Flatness[1] Typical (± dB)	VSWR[1] Typical	Open Circuit Voltage Sensitivity[2] (mV/mW) Typ.	Min.	Tangential Sensitivity[3] (-dBm) Typ.	Min.	Output Capacitance Typical (pF)	Dimension A Inches	(mm)	Replacement Diode Part Number	Detector Part Number
1.0-18.0	1.5	4.0	500	400	47.0	46.0	12	1.35	(34.3)	9999-4018-00	2085-6010-00
1.0-2.0	0.2	2.5	780	700	53.0	52.0	18	1.35	(34.3)	9999-4018-00	2085-6013-00
2.0-4.0	0.3	1.8	840	750	53.5	52.5	18	1.55	(39.4)	9999-4028-00	2085-6014-00
4.0-8.0	0.4	2.5	610	525	52.0	51.0	12	1.55	(39.4)	9999-4029-00	2085-6015-00
8.0-12.4	0.5	2.0	640	550	52.5	51.5	12	1.55	(39.4)	9999-4030-00	2085-6016-00
12.4-18.0	0.5	2.5	600	500	52.0	51.0	9	1.55	(39.4)	9999-4031-00	2085-6017-00
18.0-26.0	0.8	4.0	600	350	52.0	49.5	6	1.35	(34.3)	9999-4032-00	2085-6018-00

Typical Extended Band Performance

Frequency Range (GHz)	Flatness[1] Typical (± dB)	VSWR[1] Typical	Open Circuit Voltage Sensitivity[2] Typical (mV/mW)	Tangential Sensitivity[3] (-dBm)	Output Capacitance Typical (pF)	Detector Part Number
.85-6.0	1.0	3:1	500	50.0	18	2085-6013-00
1.4-5.0	1.0	3:1	500	50.0	18	2085-6014-00
3.9-9.5	1.0	3:1	500	50.0	12	2085-6015-00
6.5-14.0	1.0	3:1	400	49.0	12	2085-6016-00
2.7-18.5	1.0	3:1	400	49.0	9	2085-6017-00
4.0-26.5	1.5	5:1	300	48.0	6	2085-6018-00

Notes:

1. For RF power levels below -20 dBm and with 1,000 ohm load.
2. For RF power levels below -20 dBm.
3. With video amplifier of 1 MHz bandwidth, and 2 dB noise figure.
4. For positive output, change last two digits in part number to -13. On part number 2085-6018 severe degradation results with positive output.
5. For negative output matched pairs, change last two digits in part number to -28. For positive output matched pairs, change last two digits in part number to -29.

Specifications Subject to Change Without Notice.

Modular Tunnel Diode Detectors

7700J Series

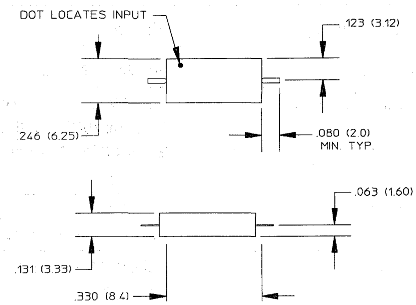
Description

The 7700J series provides a minimized, hermetically sealable, 50 ohm module designed especially for TEM stripline and microstrip media. These detectors are ideal components for dense packaging requirements.

These detectors provide a usable 67 dB dynamic range from nominal T_{SS} of -50 dBm, through maximum saturation at + 17dBm. Within this range, square law transfer response is -50 dBm through -15 dBm, linear region is -15 dBm through +5 dBm and saturation + 5dBm through + 17 dBm. Above + 17 dBm RF input power diode damage and subsequent burnout occurs.

Tunnel diode detectors have excellent temperature stability, very fast pulse response time, good RF match and broadband frequency flatness. Open circuit voltage sensitivity (K) and high power burnout are less than silicon based Schottky detectors, but the tunnel detector's relatively low video impedance with no dc bias requirement enables dc and ac coupling with video and log video post amplifiers.

Mechanical Outline (Top View)



Dimensions in ()'s are mm. Tolerance: .xxx= ± .005

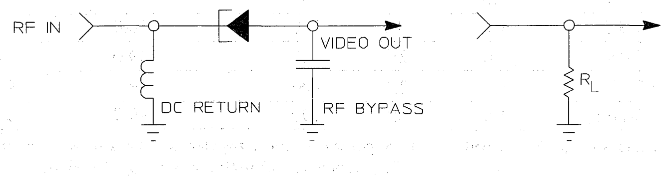
±.002
Leads are .012 (.31) diameter (std.).
± .010 ±.002
May be supplied as tabs: .025 (.64) Wide, .006 (.15) Thick (opt.).
Contact factory.

Specifications*

Frequency Range (GHz)	Voltage[2] Sensitivity (K) Min. (mV/mW)	VSWR[3] Typ.	Flatness Max. (dB)	T_{SS}[4] Typ. (-dBm)	RF Bypass Capacitance Typ. (pF)	Rise[5] Time Typ. (nS)	Video[6] Resistance Typ. (Ohms)	Part Number[1]
0.1-2.0	700	2.5:1	± 0.7	50	100	13	120	7700J-0020
2.0-8.0	800	2.0:1	± 0.6	50	20	4	120	7700J-0021
8.0-18.0	600	2.3:1	± 1.0	50	12	3	100	7700J-0022
2.0-18.0	500	2.5:1	± 1.5	50	20	4	100	7700J-0023

Notes:

1. Detectors are normally supplied with negative (-) output voltage polarity, referenced to case ground. Positive (+) output polarity is available for most parts. To designate, add suffix "P" to end of part numbers.
2. Minimum open circuit voltage sensitivity (K) in mV/mW is measured at -20 dBm RF input power into 30K ohm, external video load resistance (R_L).
3. VSWR measured at -20 dBm RF power input into 100 ohm, external video load resistance.
4. Tangential signal sensitivity (T_{SS}) is measured using a video amplifier restricted to 2 MHz bandwidth and having a noise contribution of 3 dB maximum.
5. Pulse rise time (t_r) in nanoseconds, is measured into an external load (R_L) of 100 ohms with 12 picofarads in parallel.
6. Video resistance is measured at -20dBm.



Specifications Subject to Change Without Notice.

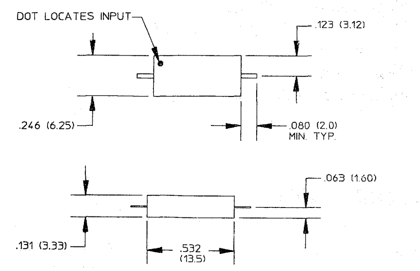
Modular Limiter-Tunnel Diode Detectors

7718N Series

Description

The 7718N series provide extended RF input power range while maintaining the desirable characteristics of a broadband tunnel diode detector. Dependent upon video load resistance, CW limiting starts at +10 to +17 dBm input power with pulsed power limiting up to +30 dBm. Limiting is reflective rather than absorptive.

Mechanical Outline (Top View)



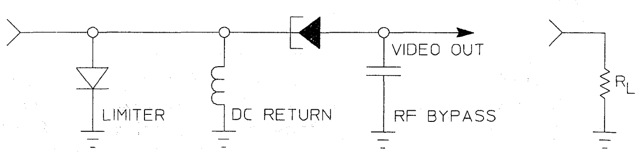
±.002
Leads are .012 (.31) diameter (std.). Dimensions in ()'s are mm. Tolerance: .xxx= ±.005
±.010 ±.002
May be supplied as tabs: .025 (.64) Wide, .006 (.15) Thick (opt.).
Contact factory.

Specifications

Frequency Range (GHz)	Voltage[2] Sensitivity (K) Min. (mV/mW)	Flatness Max. (dB)	T_{SS}[3] Typ. (-dBm)	RF Bypass Capacitance Typ. (pF)	Rise[4] Time Typ. (nS)	Video[5] Resistance Typ. (Ohms)	Part Number[1]
0.1-2.0	700	±0.7	48	100	15	120	7718N-0025
2.0-8.0	800	±0.6	48	20	10	120	7718N-0026
8.0-18.0	500	±1.2	48	12	6	100	7718N-0027

Notes:

1. Detectors are normally supplied with negative (-) output voltage polarity, referenced to case ground. Positive (+) output polarity is available for most parts. To designate, add suffix "P" to end of part numbers. Other package styles available. Consult factory.
2. Minimum open circuit voltage sensitivity (K) in mV/mW is measured at -20 dBm RF input power into 30K ohm, external video load resistance (R_L).
3. Tangential signal sensitivity (T_{SS}) is measured using a video amplifier restricted to 2 MHz bandwidth and having a noise contribution of 3 dB maximum.
4. Pulse rise time (t_r) in nanoseconds, is measured into an external load (R_L) of 100 ohms with 12 picofarads in parallel.
5. Video resistance is measured at -20dBm.



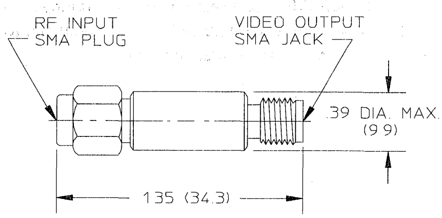
Specifications Subject to Change Without Notice.

Biased Schottky Detectors With Replaceable Diodes

Biased Schottky Detectors With Replaceable Diodes

2086 Series

Features
- High Output Sensitivity
- Flat Frequency Response to 18 GHz
- Burnout Rating 200 mW
- Available in Matched Pairs[4]
- Field Replaceable Diodes



Specifications

Video Resistance	700 Ohms Typical[1]
Output Polarity	Negative[3]
Bias Current	50 µA Nominal
Temperature Range	-65°C to +125°C
Temperature Stability	±2.0 dB
Maximum Power	200 mW CW
Finish	Passivated Stainless Steel

Tracking/Octave[4]

Frequency Band (GHz)	Tracking (dB)
1.0-2.0	0.5
2.0-4.0	0.5
4.0-8.0	0.75
8.0-12.4	1.0
12.4-18.0	2.0

Frequency Range (GHz)	Flatness[1] Max. (± dB)	Open Circuit Voltage Sensitivity[1] (mV/mW) Min.	Tangential Sensitivity[2] (-dBm) Min.	Output Capacitance Typical (pF)	Replacement Diode Part Number	Detector Part Number
1.0-18.0	1.25	1500	52.0	12	9999-4050-00	2086-6010-00

Notes:
1. For RF power levels below -20 dBm, and with an open circuit load.
2. With video amplifier of 1 MHz bandwidth and 2 dB noise figure.
3. For positive output, order part number 2086-6010-13.
4. For negative output matched pairs, order part number 2086-6010-28.
   For positive output matched pairs, order part number 2086-6010-29.

Specifications Subject to Change Without Notice.

Modular Biased Schottky Detectors

7709J Series

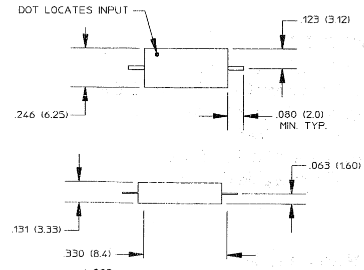
Description

The 7709J series provides a minimized, hermetically sealable, 50 ohm module designed especially for TEM stripline and microstrip media. These detectors are ideal components for dense packaging requirements.

The usable input power range is from T_{SS} to +20 dBm. Square law response is from T_{SS} to approximately -15dBm, linear range is between -15dBm and approximately +6 dBm with saturation through +20 dBm and burnout occuring beyond +23dBm. For higher RF input power handling, see the 7715 series of limiter-detectors. Extension/shift of the square law and linear regions is accomplished with multiple diode circuits, available on special order.

The high sensitivity (K) and RF power handling of these detectors makes them particularly useful in signal processing and RF power monitors in receivers, exciters, radar, guidance and broadband countermeasure equipment.

Mechanical Outline (Top View)



±.002
Leads are .012 (.31) diameter (std.).
±.010 ±.002
May be supplied as tabs: .025 (.64) Wide, .006 (.15) Thick (opt.).
Contact factory.

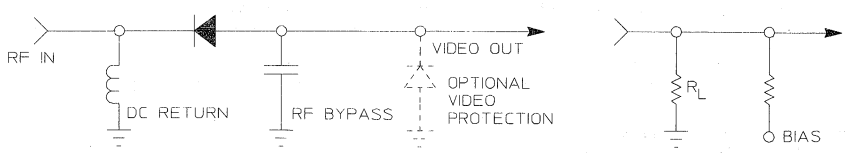
Specifications*

Frequency Range (GHz)	Voltage[2] Sensitivity (K) Min. (mV/mW)	Flatness Max. (dB)	T_{SS}[3] Typ. (-dBm)	RF Bypass Capacitance Typ. (pF)	Rise[4] Time Typ. (nS)	Video[5] Resistance Typ. (Ohms)	Part Number[1]
0.1-2.0	1700	±0.7	51	100	50	300	7709J-0020
2.0-8.0	1900	±0.6	51	20	15	300	7709J-0021
8.0-18.0	2000	±1.0	51	12	10	300	7709J-0022
2.0-18.0	1800	±1.5	51	20	15	300	7709J-0023

Notes:

1. Detectors are normally supplied with negative (-) output voltage polarity, referenced to case ground. Positive (+) output polarity is available for most parts.
2. Minimum open circuit voltage sensitivity (K) in mV/mW is measured with 100 microamps forward bias applied via video port, with -20 dBm RF input power into 30K ohm, external video load resistance (R_L).
3. Tangential signal sensitivity (T_{SS}) is measured using a video amplifier restricted to 2 MHz bandwidth and having a noise contribution of 3 dB maximum.
4. Pulse rise time (t_r) in nanoseconds, is measured into an external load (R_L) of 1.0K ohms with 12 picofarads in parallel, and 100 microamps bias applied.
5. Video resistance is measured at -20dBm with 100 μA bias.
6. Video protection against ESD and transients is available. One or more shunt diodes clamp any reverse voltages present at video output port. RF input is generally protected via dc return.

* Performance curves can be found at the end of the Detector section.

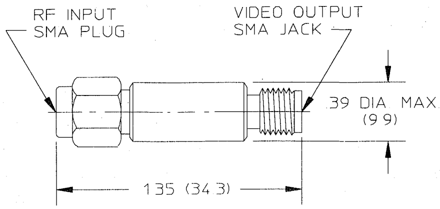


Zero Biased Schottky Detectors With Replaceable Diodes

2086 Series

Features

- High Output Sensitivity
- Flat Frequency Response to 15 GHz
- Burnout Rating 100 mW
- No Bias Required
- Available in Matched Pairs[4]
- Field Replaceable Diodes



Specifications

Video Resistance	1200 Ohms Typical[1]
Output Polarity	Negative[3]
Temperature Range	-50°C to +125°C
Maximum Power	100 mW CW
Finish	Passivated Stainless Steel

Tracking/Octave[4]

Frequency Band (GHz)	Tracking (dB)
1.0-2.0	0.5
2.0-4.0	0.5
4.0-8.0	0.75
8.0-12.4	1.0
12.4-15.0	2.0

Frequency Range (GHz)	Flatness[1] Max. (± dB)	Open Circuit Voltage Sensitivity[1] (mV/mW) Min.	Tangential Sensitivity[2] (-dBm) Min.	Output Capacitance Typical (pF)	Replacement Diode Part Number	Detector Part Number
1.0-15.0	1.25	1500	52.0	12	9999-4033-00	2086-6000-00

Notes:
1. For RF power levels below -20 dBm, and with an open circuit load.
2. With video amplifier of 1 MHz bandwidth and 2 dB noise figure.
3. For positive output, order part number 2086-6000-13.
4. For negative output matched pairs, order part number 2086-6000-28.
   For positive output matched pairs, order part number 2086-6000-29.

Modular Zero Bias Schottky Detectors

7744J Series

Description

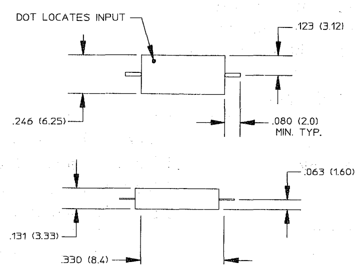
The 7744J series provides a minimized, hermetically sealable, 50 ohm module designed especially for TEM stripline and microstrip media. These detectors are ideal components for dense packaging requirements.

The usable RF input power range is from T_{SS} through +20 dBm, above which the detector is in saturation with permanent degradation or burn-out occuring at +23 dBm CW. Square law response falls between T_{SS} and -21dBm with the linear response from -21dBm through +20 dBm.

These zero bias Schottky detectors offer generally higher voltage sensitivities (K) over greater RF bandwidths, as compared with biased Schottky detectors, and require no external dc bias. However, RF impedance of the ZBD diode is substantially higher than biased Schottky or tunnel diodes resulting in diminished input match to 50 ohms. Further, these detectors are more temperature sensitive and performance severely degrades below -20°C.

Performance characteristics can be modified with certain trade-offs. RF input match can be enhanced with a reduction of sensitivity, T_{SS} and K. Consult factory for recommendations and specifics.

Mechanical Outline (Top View)



±.002
Leads are .012 (0.3) diameter (std.). May be supplied as optional tabs. Contact factory.
Dimensions in ()'s are mm. Tolerance: .xxx= ±.005

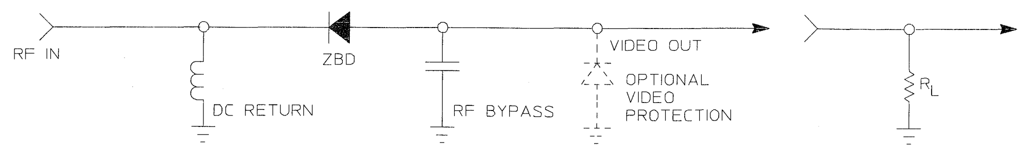
Specifications*

Frequency Range (GHz)	Voltage[2] Sensitivity (K) Min. (mV/mW)	Flatness Max. (dB)	T_{SS}[3] Typ. (-dBm)	RF Bypass Capacitance Typ. (pF)	Rise[4] Time Typ. (nS)	Video[5] Resistance Typ. (Ohms)	Part Number[1]
0.1-2.0	1700	±0.7	52	100	20	3000	7744J-0020
2.0-8.0	2000	±0.6	52	20	10	3000	7744J-0021
8.0-18.0	1800	±1.0	52	12	10	3000	7744J-0022
2.0-18.0	1800	±1.5	52	20	10	3000	7744J-0023

Notes:

1. Detectors are normally supplied with negative (-) output voltage polarity, referenced to case ground. Positive (+) output polarity is available for most parts. To designate, add suffix "P" to end of part numbers.
2. Minimum open circuit voltage sensitivity (K) in mV/mW is measured with -20 dBm RF input power into 30K ohm, external video load resistance (R_L).
3. Tangential signal sensitivity (T_{SS}) is measured using a video amplifier restricted to 2 MHz bandwidth and having a noise contribution of 3 dB maximum.
4. Pulse rise time (t_r) in nanoseconds, is measured into an external load (R_L) of 100 ohms with 12 picofarads in parallel, and 0 dBm RF power applied.
5. Video resistance is measured at -20dBm.
6. Video protection against ESD and transients is available. One or more shunt diodes clamp any reverse voltages present at video output port.

* Performance curves can be found at the end of the Detector section.



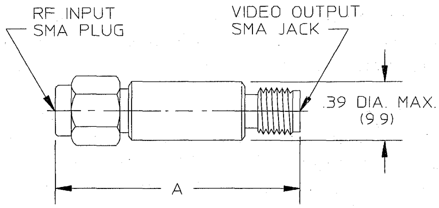
Specifications Subject to Change Without Notice.

Point Contact Detectors With Replaceable Diodes

2087 Series

Features

- Broadband Frequency Ranges
- No Bias Required
- Flat Frequency Response
- Available in Matched Pairs[5]
- Field Replaceable Diodes
- Passivated Stainless Steel Finish



Specifications

Flatness (Maximum)	±0.5 dB, 10 MHz to 4 GHz ±1.0 dB, 10 MHz to 8 GHz ±1.5 dB, 10 MHz to 12 GHz ±2.5 dB, 10 MHz to 18 GHz
VSWR (Maximum)	1.5:1, 10 MHz to 4 GHz 2.0:1, 10 MHz to 8 GHz 3.0:1, 10 MHz to 12 GHz 3.5:1, 10 MHz to 18 GHz
Tracking	0.8 dB (Matched Pair)[5]
Maximum Power	100 mW
Output Polarity	Negative[4]
Video Resistance	6K Ohms Typical[2]
Temperature Range	-65°C to +100°C

Frequency Range[1] (GHz)	Open Circuit Voltage Sensitivity[2] (mV/mW) Min.	Tangential Sensitivity[3] (-dBm) Min.	Output Capacitance Typical (pF)	Dimension A Inches (mm)	Replacement Diode Part Number	Detector Part Number
.01-18.0	400	45	12	1.55 (39.4)	9999-4019-00	2087-6001-00

Notes:
1. Usable to 20 GHz.
2. For RF power levels below -20 dBm, and with an open circuit load.
3. With video amplifier of 1 MHz bandwidth and 2 dB noise figure.
4. For positive output, change the last two digits of the part number to -13.
5. For negative output matched pairs, change the last two digits of the part number to -28.
   For positive output matched pairs, change the last two digits of the part number to -29.

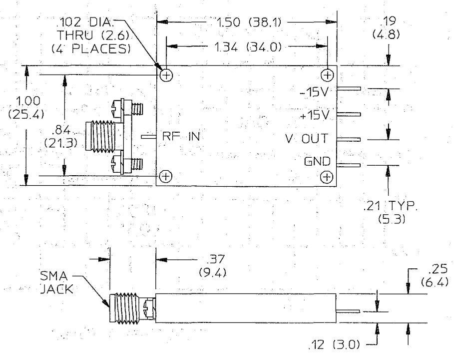
Detector Video Amplifiers With Removable Connectors 7770V Series

Description

The 7770V series of detector video amplifiers combine excellent CW and pulse performance with low standby current drain in a stripline-microstrip compatible package, exhibiting square law performance from T_{SS} to the -10 dBm region, and linear performance beyond. These DVA's are useful for accurate power and signal monitoring as well as pulse timing applications.

The low mass drop-in package facilitates motherboard subsystem integration of multiplexed and diversity power measurement, threshold detection, direction finding and communications schemes.

Mechanical Outline (Top View)

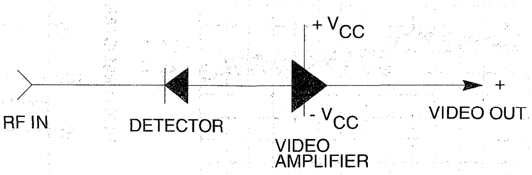


Dimensions in ()'s are mm. Tolerance: .xxx= ± .005
.xx= ± .02

Specifications*

Frequency Range (GHz)	Video[2,4] Output Typ. (mV)	VSWR[3] Typ.	Flatness Max. (dB)	T_{SS}[4] Typ. (-dBm)	Video[4] Output Max. (Volts)	Video[5] Rise Time Typ. (nS)	Current[6] Drain (Standby) Max. (mA)	Part Number[1]
1.0-2.0	200	2.0:1	±0.5	36	10	50	±35	7770V-0020
2.0-18.0	200	3.0:1	±1.5	35	10	50	±35	7770V-0023

Notes:
1. Normally supplied with positive (+) voltage output.
2. Video output at -20 dBm RF power input. Other video amplifier gain options available. Consult factory.
3. VSWR measured at -20 dBm RF power input.
4. Measured into 100 ohm external video load resistance (R_L).
5. Video pulse rise time measured at -20 dBm RF power input into 100 ohm, external load resistance (R_L).
6. Power supply, dc ±15 volts.

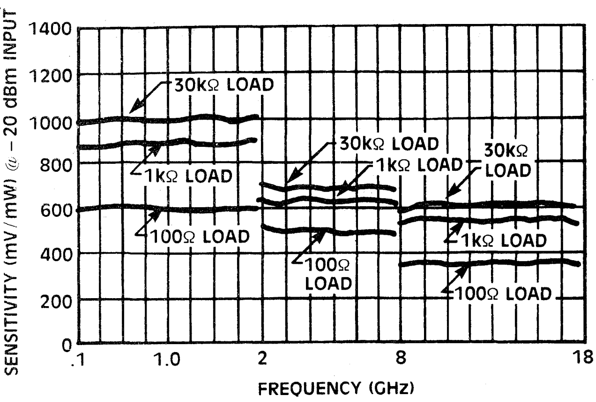


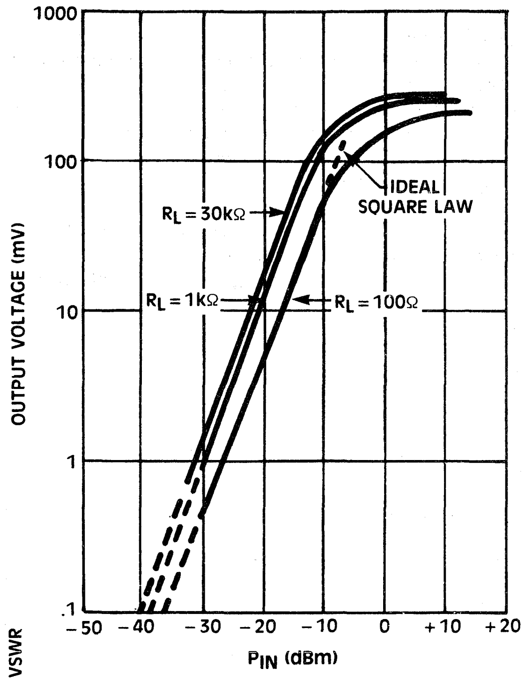
Specifications Subject to Change Without Notice.

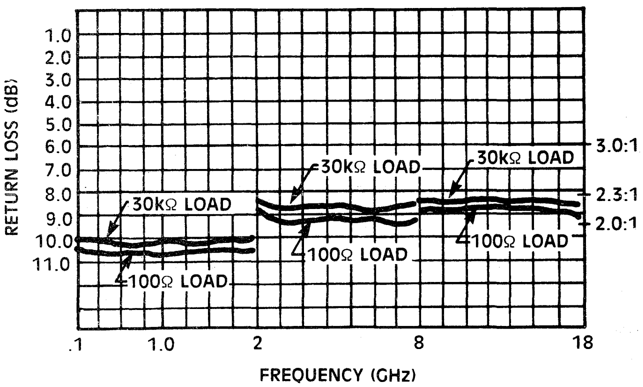
M/A-COM

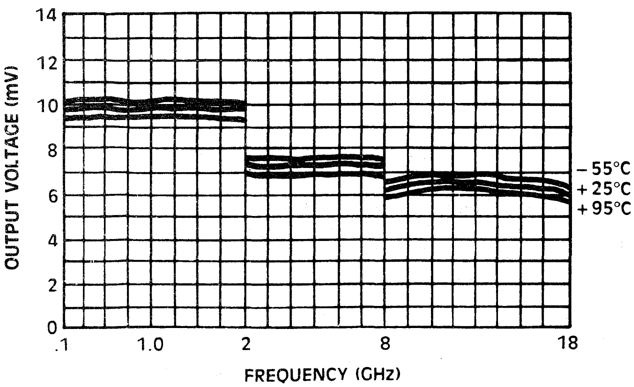
7700 Series Tunnel Diode Detector

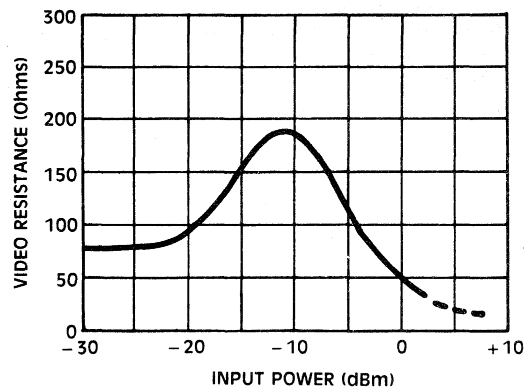
Performance







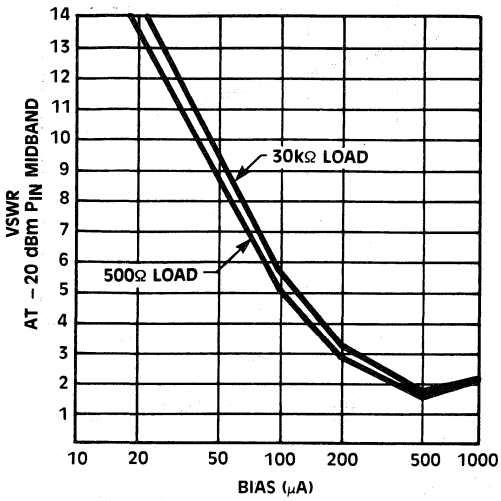


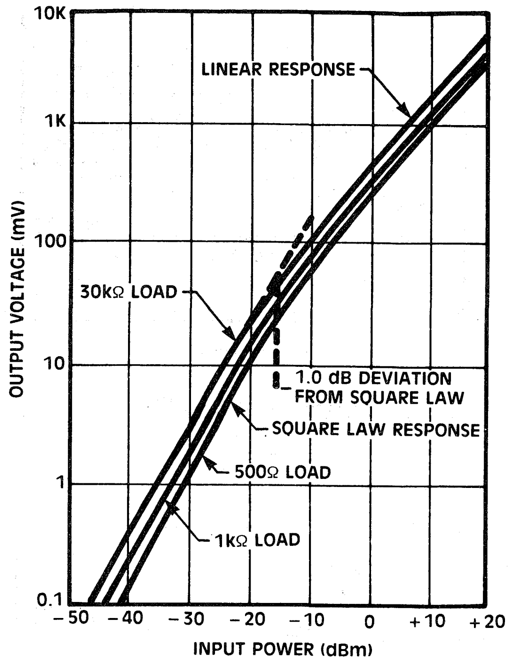


Specifications Subject to Change Without Notice.

7709 Series Biased Schottky Detector

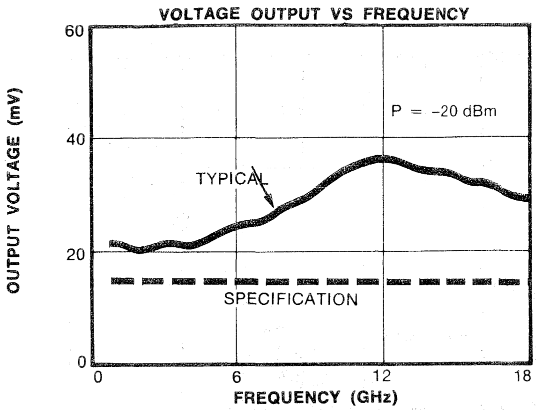
Performance

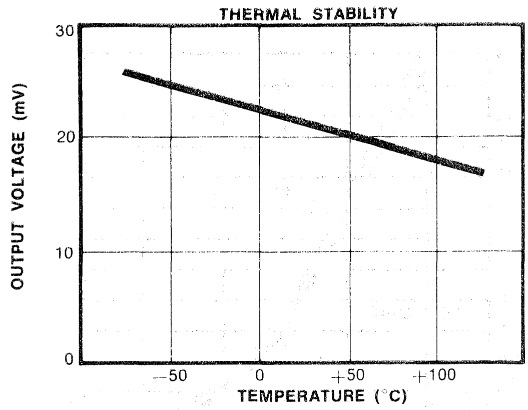


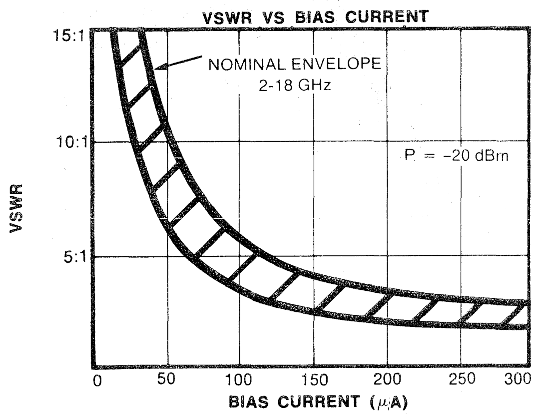


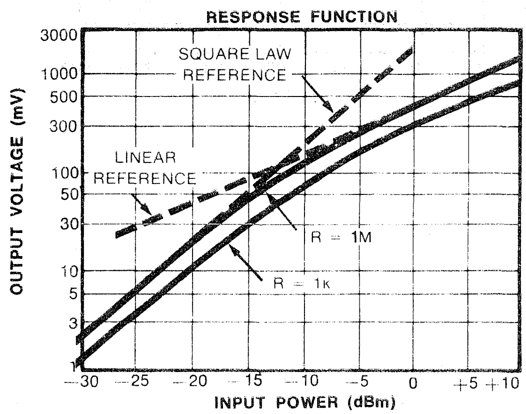
2086 Series Biased Schottky Detector

Performance



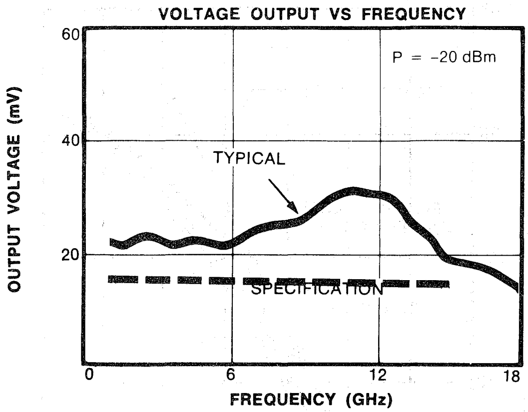


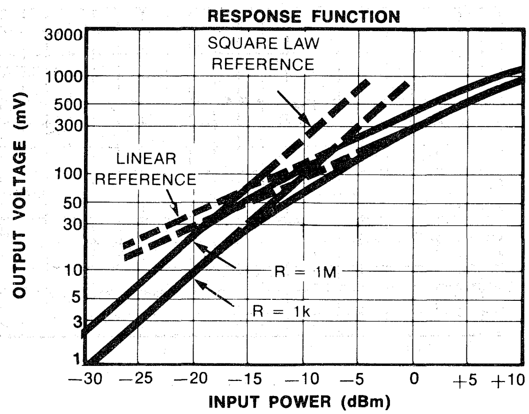




2086 Series Zero Biased Schottky

Performance

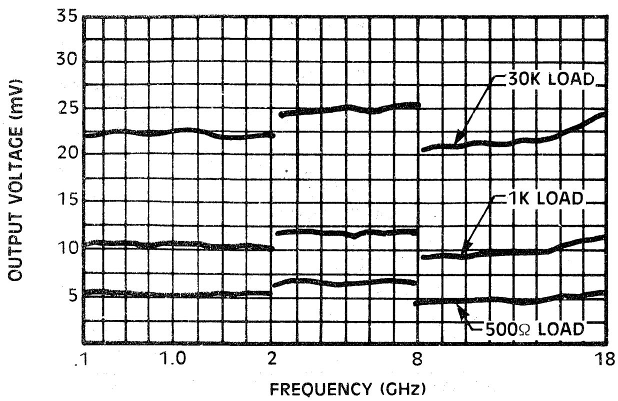


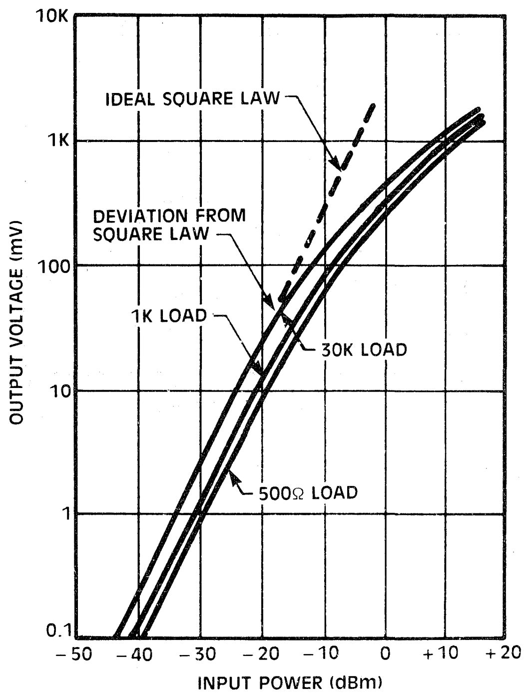


Specifications Subject to Change Without Notice.

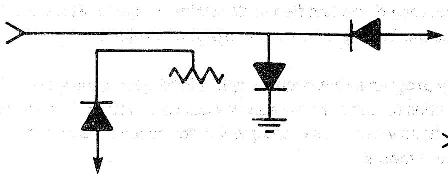
7744 Series Zero Biased Schottky Detector

Performance

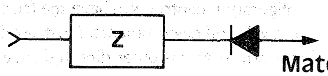




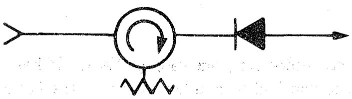
Detector Custom Capabilities



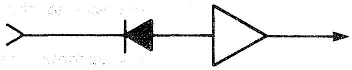
Coupler, Limiter, Dual Detector



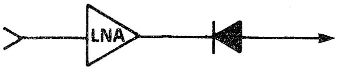
Matched Detector



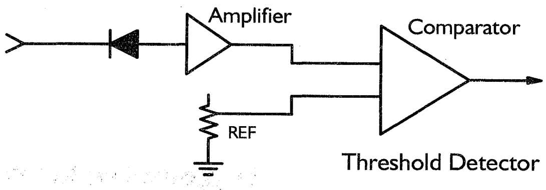
Isolator-Detector



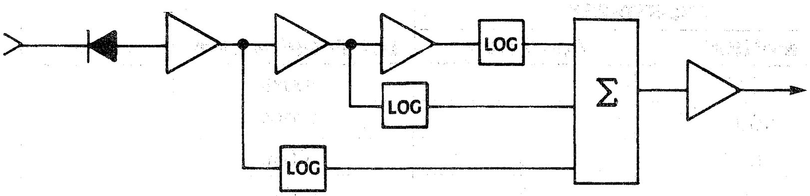
Detector Video Amplifier



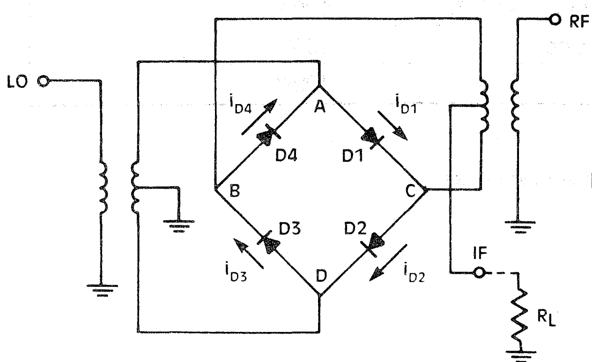
Amplifier-Detector



Threshold Detector



Detector-Log Video Amplifier



Phase Detector

Appendix

Reliability and Parts Screening

All detector products are manufactured, tested and handled under stringent electrostatic discharge protection. Each detector leaves the factory in its own anti-static envelope.

M/A-COM continually supplies to many programs that require high reliability/screening and configuration control. We have the facilities to build and screen devices to various rigid military standards and environments. Most products within this catalog will meet military standards consistent with customer directed requirements.

Please consult the factory with your specific requirements. Costs are determined by the type of device, lot size and screening required.

For customers that require high reliability within a cost-effective price range, M/A-COM has developed an appropriate high-rel screening and test plan. This procedure was patterned after MIL-M-38510 and MIL-STD-883C method 5008.2 for a class "B" device.

Suggested Hi-Rel Product Testing

Test Description	MIL-STD-883		Lot Requirement	Notes
	Method	Condition		
Internal Visual	2017		100%	
Stabilization Bake	1008	B	100%	1
Temperature Cycling	1010	B	100%	1
Constant Acceleration	2001	A	100%	2
Seal: a. Fine b. Gross	1014	A C	100%	3
Burn-In	1015	160 hrs. +125°C	100%	1
Electrical Test	Per Product Spec		100%	
External Visual	2009		100%	

NOTES:
1. Selected tunnel devices reduce T_A to +110°C.
2. Y1 axis.
3. Seal tests are limited to internal module or pill package containing the active devices.

Hi-Rel Quality Conformance (Lot Acceptance)

Additional Screening and Process Verification Done on a Sample Basis and at Added Cost

GROUP A ELECTRICAL TESTS

Subgroups	Description	LTPD
4	Dynamic Test at $T_A = +25°C$	5
5	Dynamic Test at $T_A = +85°C$	7
6	Dynamic Test at $T_A = -55°C$	7

NOTE: Dynamic test requirements are per product spec.

GROUP B ELECTRICAL TESTS

Subgroups	Description	MIL-STD-883		Min. Device Sample Size
		Method	Condition	
1	Physical Dimensions	2016	Note 1	2
3	Resistance to Solvents	2015	Note 1	3
4	Internal Visual and Mechanical	2014	Note 1	1
5	Bond Strength	2011	C	2
6	Die Shear Strength	2019		2
7	Solderability	2003	Temp 245 ±5°C	1

NOTE 1: No failures allowed.

GROUP C ELECTRICAL TESTS (First lot only)

Subgroups	Description	MIL-STD-883		Min. Device Sample Size
		Method	Condition	
1	External Visual	2009		5
1	Temp. Cycling	1010	10 Cycles—Note 1	5
1	Constant Acceleration	2001	A Y1 Axis	5
1	Seal: a. Fine b. Gross	1014	A C	5
1	Visual Examination	2009		5
1	End Point Electrical	Product Spec		5
2	Steady State Life	1005	1000 hrs.—Note 1	5
2	End Point Electrical	Product Spec		5

NOTE 1: High temperature $T_A = +110°C$ for tunnel devices.

Hi-Rel Quality Conformance (Lot Acceptance) cont'd.

GROUP D ELECTRICAL TESTS (Package only)

Subgroups	Description	MIL-STD-883 Method	MIL-STD-883 Condition	Min. Device Sample Size
1	Physical Dimensions	2016	Note 1	5
2	Solderability	2003 or 2004	Temp 245 ±5°C	3
3	Thermal Shock	1011	C	3
3	High Temperature Bake	1008	C 1 Hr.	3
3	Lead Integrity	2004	B_2 (Lead Fatigue) D (Leadless Carriers)	3
3	Seal (Unlidded cases)	1014	A_4	3
4	Metal Package Isolation	1003	600 VDC 100 NA Max.	3
5	Moisture Resistance	1004		3
6	Salt Atmosphere	1009		3

NOTE: Consult factory for specific product limitations and pricing for screening to Group A, B, C and D tests.

NOTE 1: Per outline drawing.

Mean Time Between Failures (MTBF)

The MTBF is usually calculated using procedures set forth in MIL-Handbook 217, revision D. The formulas and circuit device failure rates are obtained from the book with stress ratings, operating environment and screening levels user selected/specified.

The semiconductors contribute the greater impact having the most critical limitations. The MTBF for an RF detector is dependent on the assumptions made as to the reliability factor of the diodes. Examples of MTBF predictions for a typical Schottky barrier detector in ground benign and airborne uninhabited environments are presented below. Note, that while the procedures used are actual, the detector model is representative of catalog/standard parts. User-specific requirements may result in great variance with those MTBF numbers below.

Model Calculation #1, ground benign environment.
Detector 7709J-0023
Paragraph headings are from MIL-HDBK-217.

COMPONENTS:

Quantity	Description	Conditions
1	Diode, Schottky	Operating Temperature = +90°C
1	Capacitor, MNS	Environment = Ground Benign
1	Coil, Gold	Screening = MIL-STD-883, Class B
1	Housing	
1	Cover	

CONSTRUCTION:

\# of Solder Joints = 2
\# of Gold-to-Gold Bonds = 3
\# of Conductive Epoxy Joints = 2
Area of Substrate = 0.115 Square Inches
Perimeter Seal = 1.556 Inches

Component Failure Rate Calculations:

a) Schottky Diode

Formula: $\lambda_p = \lambda_b \times \pi_E \times \pi_Q$ Failures/10^6 Hours
Rating = 50 mW
Stress = 20 mW
Ratio = .40
$\lambda_b = 0.10$ Per table 5.1.3.7-3
$\pi_E = 1.0$ Per table 5.1.3.7-1
$\pi_Q = 1.0$ Per table 5.1.3.7-2
$\lambda_p = 0.10 \times 1.0 \times 1.0$
$\lambda_p = 0.10$

b) MNS Capacitor

Formula: $\lambda_p = \lambda_b (\pi_E \times \pi_Q \times \pi_{CV})$ Failures/10^6 Hours
Rating = 50 mW
Stress = 20 mW
Ratio = .40
$\lambda_b = .0025$ Per table 5.1.7.3-5
$\pi_E = 1.0$ Per table 5.1.7.3-1
$\pi_Q = 0.03$ Per table 5.1.7.3-3
$\pi_{CV} = 1.04$ Per table 5.1.7.3-4
$\lambda_p = .0025 (1.0 \times 0.03 \times 1.04)$
$\lambda_p = .000078$

Mean Time Between Failures (MTBF) cont'd.

c) Gold Coil (15 Turn)

Formula: $\lambda_p = \lambda_b\,(\pi_E \times \pi_Q \times \pi_C)$ Failures/10^6 Hours

$\lambda_b = 0.024$ Per table 5.1.8.2-5

$\pi_E = 1.0$ Per table 5.1.8.2-3

$\pi_Q = 0.03$ Per table 5.1.8.2-2

$\pi_C = 1.0$ Per table 5.1.8.2-4

$\lambda_p = 0.0024\ (1.0 \times .03 \times 1.0)$

$\lambda_p = .000072$

d) Package Failure Rate

$\lambda_S = .0261$ Per table 5.1.2.7-4

e) Interconnections Per para 5.1.2.7.3

N_I = Number of Interconnections

$N_I = 7$

λ_I = Temperature dependent failure rate

$\lambda_I = .00367$ (Bonds)

$\lambda_I = .00199$ (Solder)

f) Density Factor

Formula: $\pi_D = 0.2 + 0.15\,(\sqrt{\text{Density}})$ per table 5.1.2.7-7

$$\text{Density} = \frac{\text{Number of Interconnections}}{\text{Substrate Area} + 0.1}$$

$$\text{Density} = \frac{7}{.115 + 0.1} = 32.6$$

so $\pi_D = 0.2 + 0.15\,(\sqrt{32.6})$

$\pi_D = 1.06$

Detector Failure Rate Calculation per 5.1.2.7-1

Formula: $\lambda_p \left[\Sigma\, N_C\lambda_C\pi_C + (N_R\lambda_R + \Sigma N_I\lambda_I + \lambda_S)\,\pi_F\pi_E\right]\pi_Q\pi_D$ Failures/10^6 Hours

where: λ_S = .0261 Per 5.1.2.7-4

π_D = 1.06 Per 5.1.2.7-7

π_E = 0.20 Per 5.1.2.7-5

π_F = 1.25 Per 5.1.2.7-1

π_C = 0.2 (Diodes) Per 5.1.2.7-1

π_C = 0.8 (Capacitors) Per 5.1.2.7-1

π_Q = 1.0 Per 5.1.2.7-6

So: $\lambda_p = \left[(0.10 \times 0.2) + (.000078 \times 0.8) + (.000072) + ((3 \times .00367) + (2 \times .00199) + (2 \times .00199) + .0261)\ 1.25 \times 0.20\right] 1.0 \times 1.06$

$\lambda_p = .0264$ Failures/10^6 Hours

Or: MTBF = 37,878,788 Hours

Mean Time Between Failures (MTBF) cont'd.

Model Calculation #2, uninhabited airborne, fighter. Detector 7709J-0023

COMPONENTS:

Quantity	Description	Conditions
1	Diode, Schottky	Operating Temperature = +90°C
1	Capacitor, MNS 40 pF	Environment = Airborne Uninhabited Fighter
1	Gold Coil, 15 Turn	Screening = Class B, MIL-STD-883
1	Housing	
1	Cover	

CONSTRUCTION:

# of Solder Joints = 2
# of Gold-to-Gold Bonds = 3
# of Conductive Epoxy Joints = 2
Area of Substrate = 0.115 Square Inches
Perimeter Seal = 1.556 Inches

Component Failure Rate Calculations:

a) Schottky Diode
Formula: $\lambda_p = \lambda_b \times \pi_E \times \pi_Q$ Failures/10^6 Hours
Rating = 50 mW
Stress = 20 mW
Ratio = .40
$\lambda_b = 0.10$ Per table 5.1.3.7-3
$\pi_E = 110$ Per table 5.1.3.7-1
$\pi_Q = 1.0$ Per table 5.1.3.7-2
$\lambda_p = 0.10 \times 110 \times 1.0$
$\lambda_p = 11.0$

b) MNS Capacitor
Formula: $\lambda_p = \lambda_b (\pi_E \times \pi_Q \times \pi_{CV})$ Failures/10^6 Hours
Rating = 50 mW
Stress = 20 mW
Ratio = .40
$\lambda_b = .0025$ Per table 5.1.7.3-5
$\pi_E = 40$ Per table 5.1.7.3-1
$\pi_Q = 0.03$ Per table 5.1.7.3-3
$\pi_{CV} = 1.04$ Per table 5.1.7.3-4
$\lambda_p = .0025 (40 \times 0.03 \times 1.04)$
$\lambda_p = .003$

Mean Time Between Failures (MTBF) cont'd.

c) Gold Coil (15 Turn)
Formula: $\lambda_p = \lambda_b (\pi_E \times \pi_Q \times \pi_C)$ Failures/10^6 Hours
$\lambda_b = 0.024$ Per table 5.1.8.2-5
$\pi_E = 10$ Per table 5.1.8.2-3
$\pi_Q = 0.03$ Per table 5.1.8.2-2
$\pi_C = 1.0$ Per table 5.1.8.2-4
$\lambda_p = 0.0024\ (10 \times .03 \times 1.0)$
$\lambda_p = .00072$

d) Package Failure Rate
$\lambda_S = .0261$ Per table 5.1.2.7-4

e) Interconnections Per para 5.1.2.7.3
N_I = Number of Interconnections
$N_I = 7$
λ_I = Temperature dependent failure rate
$\lambda_I = .00367$ (Bonds)
$\lambda_I = .00199$ (Solder)

f) Density Factor
Formula: $\pi_D = 0.2 + 0.15\ (\sqrt{\text{Density}})$ per table 5.1.2.7-7

$$\text{Density} = \frac{\text{Number of Interconnections}}{\text{Substrate Area} + 0.1}$$

$$\text{Density} = \frac{7}{.115 + 0.1} = 32.6$$

so $\pi_D = 0.2 + 0.15\ (\sqrt{32.6})$
$\pi_D = 1.06$

Detector Failure Rate Calculation per 5.1.2.7-1
Formula: $\lambda_p \left[\Sigma N_C \lambda_C \pi_C + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \pi_F \pi_E\right] \pi_Q \pi_D$ Failures/10^6 Hours

where: λ_S = .0261 Per 5.1.2.7-4
π_D = 1.06 Per 5.1.2.7-7
π_E = 4.0 Per 5.1.2.7-5
π_F = 1.25 Per 5.1.2.7-1
π_G = 0.2 (Diodes) Per 5.1.2.7-1
π_G = 0.8 (Capacitors) Per 5.1.2.7-1
π_Q = 1.0 Per 5.1.2.7.-6

So: $\lambda_p = \left[(11.0 \times 0.2) + (.003 \times 0.8) + (.00072) + [(3 \times .00367) + (2 \times .00199) + (2 \times .00199) + .0261]\ 1.25 \times 4.0\right] 1.0 \times 1.06$

$\lambda_p = 2.436$ Failures/10^6 Hours

Or: MTBF = 410,509 Hours

Limiter

Overview

Protection for Power Sensitive Microwave Components

PIN diode limiters are primarily used in passive limiting applications to protect power sensitive components . PIN diodes are used because their high breakdown voltage enables them to withstand moderate peak power levels, and their large junction volume enables them to withstand moderate pulse lengths. The compact size and reliable all-solid state construction make them ideal for airborne and ECM applications.

At the present time, passive PIN diode limiters are restricted in pulse length capabilities if peak power is high. Pulse lengths of several microseconds are virtually CW conditions, and the devices will not survive the first pulse unless peak power specifications are relatively low. For long pulse/high power conditions, an active device such as a switch is recommended.

PIN diode limiter power ratings are typically derated above 25˚C. M/A-COM catalog limiters derate linearly to zero at 150˚C. This occurs because increased ambient temperatures of semiconductor devices bring those devices closer to failure temperature levels.

A class of broadband PIN diode limiters is being offered by integrating the PIN diode chip directly into an MIC circuit. As the packageless diode chip displays only a fundamentally required junction capacitance and minimum circuit degrading parasitic capacitance, optimum high frequency operation can be achieved. By carefully controlling the dimensions of the bonding attachment to the junction, the proper series inductance is obtained resulting in a matched 50 ohm impedance over very broad bandwidths.

In order to achieve passive low level limiting unaided by external biasing, it is necessary to use high resistivity silicon (thin base width) PIN diodes of optimum carrier lifetime. To achieve high power handling, the PIN diode must be optimized for maximum volume consistent with the requirement of passive self-limiting, a constraint which restricts the range of permissable junction thickness. Mounting the silicon junction diode directly to the ground plane of the MIC structure considerably enhances heat sinking and allows a significant amount of RF power to be absorbed within the PIN junction without causing thermal failure. Further technical discussion on the design and application can be found in the Appendix.

Three varieties are offered . . .the fixed connectorized limiter, the field replaceable connectorized limiter and the modular limiter. Each type is presented in specification tables with various customer-selected operating parameters. Whether the requirement is the handling of 1000 W peak power, 100 W CW power or exhibiting 20 mW maximum flat leakage, M/A-COM has a limiter available. Because the design matrix of peak power (arcing), average power (thermal failure), and pulse width (thermal time constant) is literally three dimensional, M/A-COM can offer only a small number of the total limiter selections in this catalog. Contact the factory with your requirements or for applications assistance.

Coaxial Limiters

2690 Series

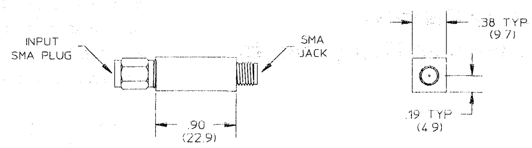
Features
- Broadband Frequency Ranges
- Environmentally Sealed
- Feedback Leveling
- Small Size
- Reduced VSWR

Description
M/A-COM's standard limiter series 2690 is a line of completely passive solid state receiver protectors. They exhibit octave and multi-octave performance using a unique construction technique involving PIN diodes in broadband microstrip circuits. Careful diode selection allows a variety of device performance, trading off peak and average power handling, spike leakage and recovery time. Typical insertion loss and VSWR curves are shown below.

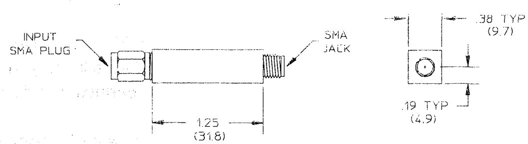
Environmental
These devices are designed to meet the following screening conditions:

Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		883	2017	
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Outline 1



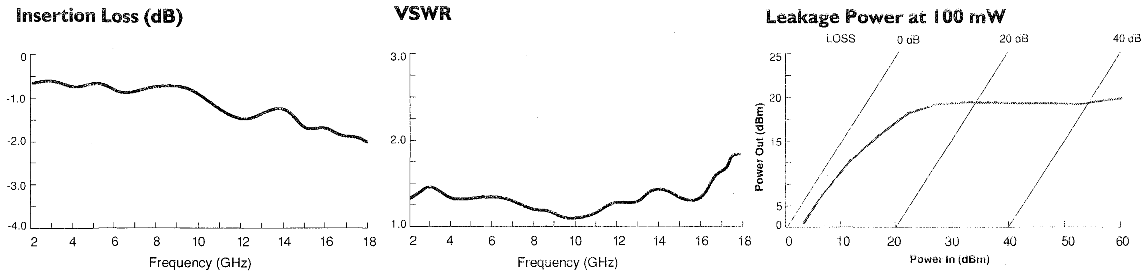
Outline 2



Maximum Ratings

Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +85°C

Typical Performance Data 2690-1015



Specifications Subject to Change Without Notice.

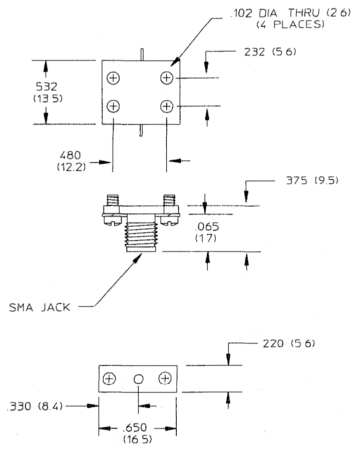
Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Average Power (W)	Peak Power (W)	Recovery Time (nS)	Leakage Power (mW)	Outline Drawing	Part Number
1.0-2.0	0.7	1.5:1	1.0	100	100	75	1	2690-1001
	0.8	1.5:1	2.0	500	250	75	1	2690-1002
	0.9	1.5:1	3.0	1000	1000	100	2	2690-1003
2.0-8.0	1.1	1.6:1	1.0	100	100	50	1	2690-1005
	1.2	1.6:1	2.0	500	250	75	1	2690-1006
	1.3	1.6:1	3.0	1000	1000	100	2	2690-1007
8.0-18.0	1.8	2.0:1	1.0	100	100	50	1	2690-1009
	2.0	2.0:1	2.0	500	250	75	1	2690-1010
	2.3	2.0:1	3.0	1000	1000	100	2	2690-1011
2.0-18.0	2.0	2.0:1	1.0	100	100	50	1	2690-1013
	2.2	2.0:1	2.0	500	250	75	1	2690-1014
	2.3	2.0:1	3.0	1000	1000	100	2	2690-1015

Notes:
1. Insertion loss and VSWR measured at 0 dBm input power.
2. Peak input power rated at 1 microsecond pulse width, 1% duty into 1.5:1 source VSWR and 1.15 load VSWR.
3. Spike leakage energy: 0.5 ergs max.
4. 1 dB compression: +7 dBm min.

Low-Frequency Coaxial Limiters

2691 Series



Features

- .001 to 2.0 GHz Frequency Coverage
- Low Insertion Loss
- 5 Watts CW
- Removable SMA Connectors

Description

M/A-COM's low frequency limiters offer circuit protection up to 5 watts CW and, due to an innovative design, feature small overall size. Equipped with field replaceable SMA connectors, they may be utilized as a connectorized or drop-in package. These devices may be tested with connectors, eliminating costly fixturing, and then mounted in a stripline circuit.

Environmental

These devices are designed to meet the following screening conditions:

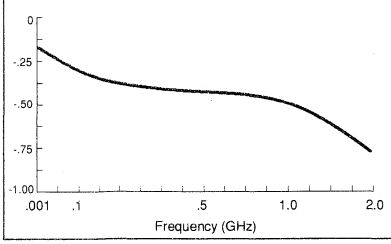
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		883	2017	
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

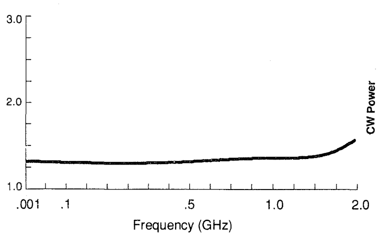
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +85°C

Typical Performance Data

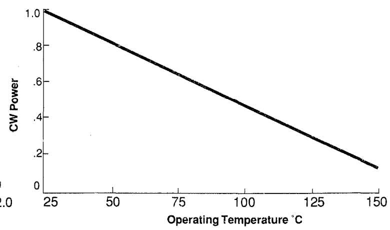
Insertion Loss (dB)



VSWR



Power vs. Operating Temperature



Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	CW Power (W)	Leakage Power (mW)	Part Number
.001-.1	0.5	1.3:1	5	50	2691-2001
.1-.5	0.6	1.3:1	5	100	2691-2002
.5-1.0	0.6	1.4:1	5	100	2691-2003
1.0-2.0	0.8	1.5:1	5	100	2691-2004

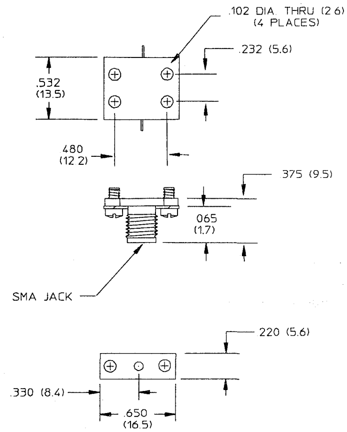
Notes:
1. Insertion loss and VSWR measured at 0 dBm input power.
2. 1 dB compression: +7 dBm min.

![M/A-COM]

Coaxial Limiters With Removeable Connectors

2691 Series

2691-Series



Features

- Broadband Frequency Ranges
- Environmentally Sealed
- Feedback Leveling
- Small Size
- Supplied with RF Connectors (SMA female)

Description

M/A-COM's 2691 series is a line of completely passive solid state receiver protectors. They exhibit octave and multi-octave performance using a unique construction technique involving PIN diodes in broadband microstrip circuits. These limiters may be used as drop-ins in stripline assemblies. In addition, the field-replaceable connectors allow replacement of a damaged connector without violating the hermetic seal. Typical insertion loss and VSWR curves are shown below.

Environmental

These devices are designed to meet the following screening conditions:

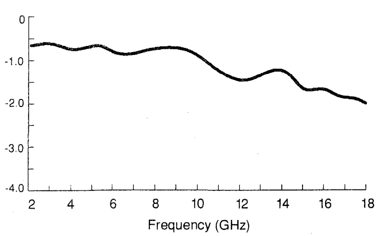
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		883	2017	
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (YI Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	AI
	Gross	883	1014	CI
External Visual		883	2009	

Maximum Ratings

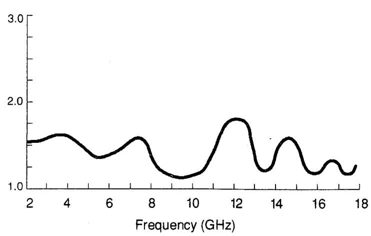
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +85°C

Typical Performance Data 2691-1015

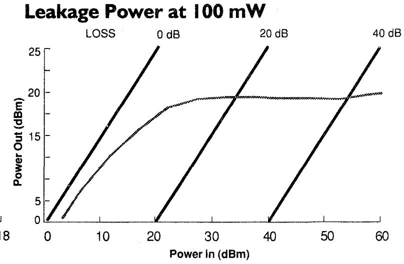
Insertion Loss (dB)



VSWR



Leakage Power at 100 mW



Specifications Subject to Change Without Notice.

Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	Average Power (W)	Peak Power (W)	Recovery Time (nS)	Leakage Power (mW)	Part Number
1.0-2.0	0.8	1.5:1	2.0	500	250	75	2691-1002
2.0-8.0	1.1	1.6:1	1.0	100	100	50	2691-1005
	1.3	1.6:1	3.0	1000	1000	100	2691-1007
8.0-18.0	1.8	2.0:1	1.0	100	100	50	2691-1009
2.0-18.0	2.0	2.0:1	1.0	100	100	50	2691-1013
	2.2	2.0:1	2.0	500	250	75	2691-1014
	2.3	2.0:1	3.0	1000	1000	100	2691-1015

Notes:

1. Insertion loss and VSWR measured at 0 dBm input power.
2. Peak input power rated at 1 microsecond pulse width, 1% duty into 1.5:1 source VSWR and 1.15 load VSWR.
3. Spike leakage energy: 0.5 ergs max.
4. 1 dB compression: +7 dBm min.

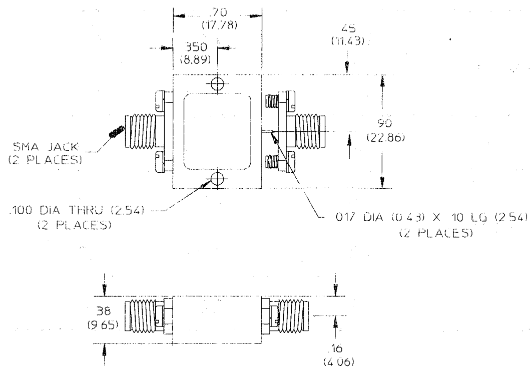
Specifications Subject to Change Without Notice.

High-Power Limiter Modules With Removeable Connectors

2692 Series

Features

- 100 Watt Average Power
- 1,000 Watt Peak Power
- Environmentally Sealed
- Internal dc Block and Return
- Removable SMA Female Connectors



Description

M/A-COM's limiter modules are ideally suited for broadband passive receiver protection, guaranteed in the most hostile environments. They exhibit multi-octave performance using M/A-COM's unique Schottky Enhanced Limiter technology. These limiter modules have been developed to allow easy and efficient testing prior to insertion in stripline circuits. Test the modules, remove the SMA connectors and insert the limiters in the stripline circuit.

Environmental

These devices are designed to meet the following screening conditions:

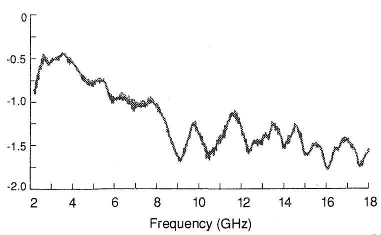
Test	MIL-STD	Method	Cond
Non-Destructive Bond Pull	883	2023	
Internal Visual	883	2017	
Stabilization Bake	883	1008	B
Thermal Cycle	883	1010	B
Constant Acceleration	883	2001	A (Y1 Axis)
Burn-in	883	1015	125°C
Seal Fine	883	1014	A1
Seal Gross	883	1014	C1
External Visual	883	2009	

Maximum Ratings

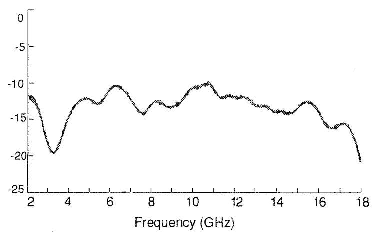
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +85°C

Typical Performance Data 2692-1004

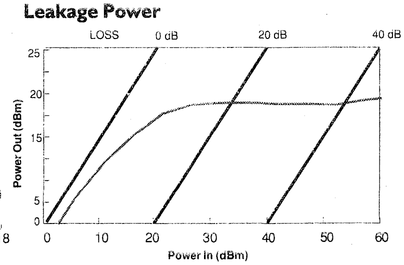
Insertion Loss (dB)



Return Loss (dB)



Leakage Power



Specifications Subject to Change Without Notice.

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2692-Series
Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	CW Power (W)	Peak Power (W)	Recovery Time (µS)	Leakage Power (mW)	Part Number
0.5-2.0	1.2	1.5:1	100	1000	5.0	125	2692-1001
2.0-8.0	1.6	2.0:1	100	1000	5.0	50	2692-1002

Notes:
1. Insertion loss and VSWR measured at 0 dBm input power.
2. Peak input power rated at 1 microsecond pulse width, 1% duty into 1.5:1 source VSWR and 1.15 load VSWR.
3. Spike leakage energy: 0.5 ergs max.
4. 1 dB compression: +7 dBm min.
5. Consult factory for 2.0 - 18.0 GHz and 8.0 - 18.0 GHz units.

Limiter Modules

2970 Series

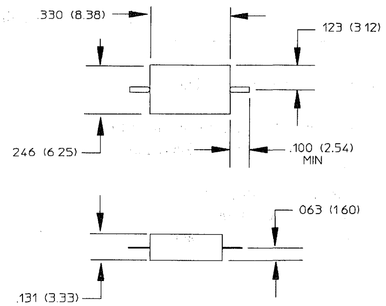
Features

- Broadband Frequency Ranges
- Environmentally Sealed
- Stripline Compatible
- Small Size
- High Power, Low Loss

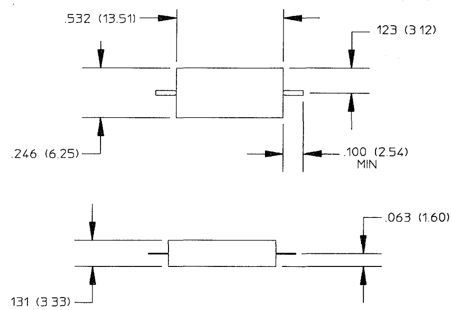
Description

M/A-COM's limiter modules offer exceptional performance over a broad frequency range (0.5-18.0 GHz). This performance results from our internal diode manufacturing capabilities and circuit design experience. The stripline compatibility of these modules allows them to be integrated into higher level assemblies to protect a wide range of power sensitive devices from excessive RF power or voltage levels.

Part Number 2970-1XXX



Part Number 2970-2XXX



Leads are .012 ±.002 (.31) diameter (std.).
May be supplied as tabs: .025 ±.010 (.64) Wide, .006 ±.002 (.15) Thick (opt.).

Environmental

These devices are designed to meet the following screening conditions:

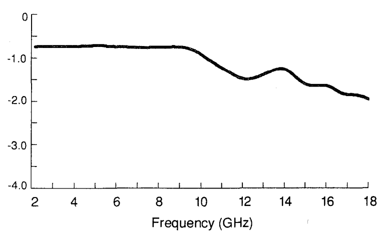
Test		MIL-STD	Method	Cond
Non-Destructive Bond Pull		883	2023	
Internal Visual		M/A-COM	QCP	H076
Stabilization Bake		883	1008	B
Thermal Cycle		883	1010	B
Constant Acceleration		883	2001	A (Y1 Axis)
Burn-in		883	1015	125°C
Seal	Fine	883	1014	A1
	Gross	883	1014	C1
External Visual		883	2009	

Maximum Ratings

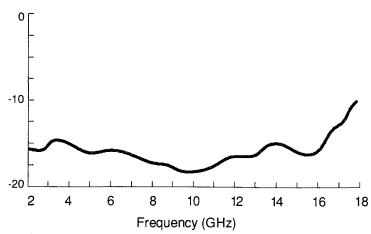
Storage Temp.	-65°C to +125°C
Operating Temp.	-55°C to +85°C

Typical Performance Data 2970-2004

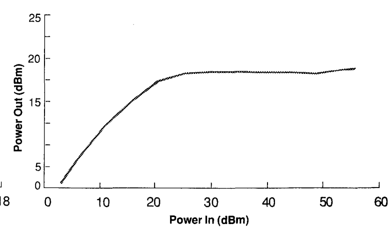
Insertion Loss (dB)



Return Loss (dB)



Leakage Power



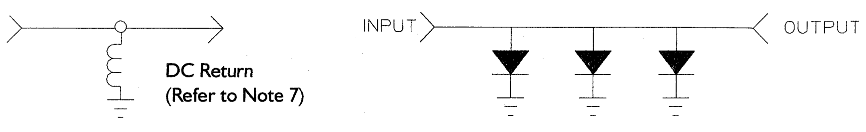
Specifications Subject to Change Without Notice.

2970-Series
Specifications 25°C

Frequency Range (GHz)	Insertion Loss (dB)	VSWR	CW Power (W)	Peak Power (W)	Leakage Power (mW)	Part Number
0.5-2.0	0.7	1.5:1	3.0	200	150	2970-1001
	0.9	1.5:1	5.0	1500	150	2970-2001
2.0-8.0	1.0	1.7:1	2.0	200	125	2970-1002
	1.3	1.7:1	3.0	1000	125	2970-2002
8.0-18.0	1.6	1.9:1	2.0	200	100	2970-1003
	2.2	2.0:1	3.0	600	100	2970-2003
2.0-18.0	1.7	2.0:1	2.0	200	125	2970-1004
	2.2	2.0:1	3.0	600	125	2970-2004

Notes:
1. Insertion loss and VSWR measured at -20 dBm input power.
2. Peak input power rated at 1 microsecond pulse width, .001 duty cycle.
3. 1 dB compression point: +7 dBm min.
4. Spike leakage: 0.1 erg. max.
5. Recovery time: (3 dB point) 100W pulse or max. input for pulses less than 100W:
   1000 nS max. 2970-2XXX series
   500 nS max. 2970-1XXX series.
6. Risetime of RF input pulse 100 nS min.
7. All models require external dc returns (less than 1Ω).

Typical Schematic 2970-2004



Specifications Subject to Change Without Notice.

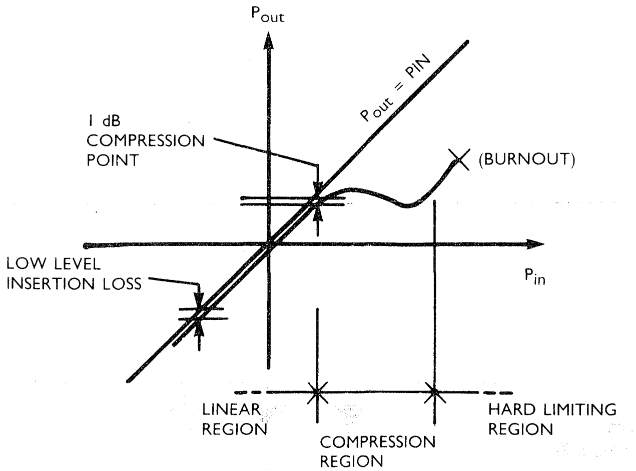
Protection for Power Sensitive Microwave Components

M509

PIN diode limiters are designed to protect power sensitive microwave components against a variety of high power CW and pulsed microwave signals. Basic PIN limiters utilize diodes resulting in low insertion loss at low power levels. As the power level increases, the incident signal causes conductivity modulation of the diode I-region resulting in a progressive increase in total attenuation, until the diode reaches its saturated series resistance. At this point, the power output will increase until the diode reaches its burnout temperature. The typical response of a PIN limiter is shown in a power output versus power input curve as shown in Figure 1. There are three operating regions. In the linear region (low incident power), the incident signal is passed with relatively little power loss. "Insertion Loss" and "VSWR" are defined in this region. As the incident power level increases, the limiter enters the compression region where the incident RF power starts to self bias the PIN diodes (via conductivity modulation of the I-region). The "1 dB Compression Point" is usually used to mark the onset of the compression region. With continued increase in RF power, relative attenuation will increase as the conductivity modulation/self bias decreases the diode resistance to its saturation point. At this point, the limiter provides an essentially constant attenuation and power output will begin to increase with input power, but again with relatively high attenuation. This is defined as the hard limiting region. Eventually, thermal stresses on the PIN diodes will lead to burnout.

With pulsed input signals, additional parameters are needed to fully describe the operation of PIN limiters. These parameters are shown in Figure 2. Of particular interest is the relationship of the input pulse parameters to the output pulse parameters and the dynamic nature of a pulsed input. The output consists of a pulse with a spike of energy on the leading edge. This is due to a short but finite "turn-on time" of the PIN diodes. The actual turn-on time is difficult to measure since it depends on the rise time of the incident pulse as well as on the characteristics of the PIN diodes. The usual procedure is to specify a "spike leakage" measured in ergs (watts x sec. x 10^{-7}). Observed spike leakage levels are a subjective measurement unless particular attention is given to controlling the risetime of the incident pulse and the linearity of

Figure 1



Typical Limiter Transfer Characteristics

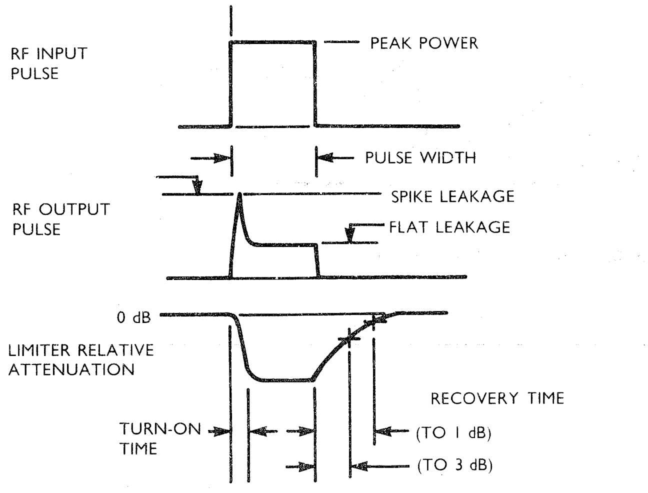
the detection system. After the limiter has fully turned on, the output pulse reaches a constant level defined as the "flat leakage" level. The power output remains at this level for the duration of the pulse. After the pulse is removed, it takes some time for the limiter to return to its low loss condition. This characteristic is due to the intrinsic recovery time of the PIN diodes.

During the recovery period, the system will experience a marked increase in overall insertion loss (resulting in a decreased dynamic range). The recovery time is normally longer than the turn-on time, and a specification of recovery time should always include a test method. Unless specified otherwise, it is referenced to the 3 dB point.

The power handling capability of a PIN limiter is ultimately a thermal consideration, as shown in Figure 3. In the presence of a CW signal (high enough to cause limiting to occur), the diode temperature increases with time until it reaches a steady state. The time-temperature profile depends on the thermal properties of the PIN diodes and the magnitude of the incident signal. If the diode temperature (temperature rise pulse ambient) exceeds the maximum junction temperature, burnout will occur. For pulsed signals, it is essential to consider both the short term temperature rise caused by the pulse, and long term or average temperature rise due to the average power of the pulsed signal. Figure 3 clearly demonstrates the possibility of cumulative heating effects from successive pulses as the junction temperature cannot "cool off" to the ambient temperature between pulses. This consideration is particularly important if the signal has a high duty cycle. For this reason, it is essential that the operational pulse power parameters be completely specified for limiters.

There is one factor often overlooked when calculating the maximum input power a limiter will see in a given circuit. That factor is the source VSWR. When a limiter is fully saturated, its input impedance is essentially a short circuit. The majority of the power is reflected back toward the source. If the source does not present a good match to this reflected power, standing waves will be established between the source and the limiter. Depending on the phase relationship between the source and the limiter, a current maximum could occur at the limiter resulting in significantly higher power dissipated.

Figure 2



Typical Limiter Pulse Response

The relationship between potential dissipated power and source VSWR is close to linear for any VSWR up to 2.0:1, i.e. a 2.0:1 source VSWR has the potential to increase the dissipation power at the limiter by a factor of two. For any VSWR above 2.0:1, the following formula must be used:

$$P_A = \frac{P_S}{[1 \pm LS]^2}$$

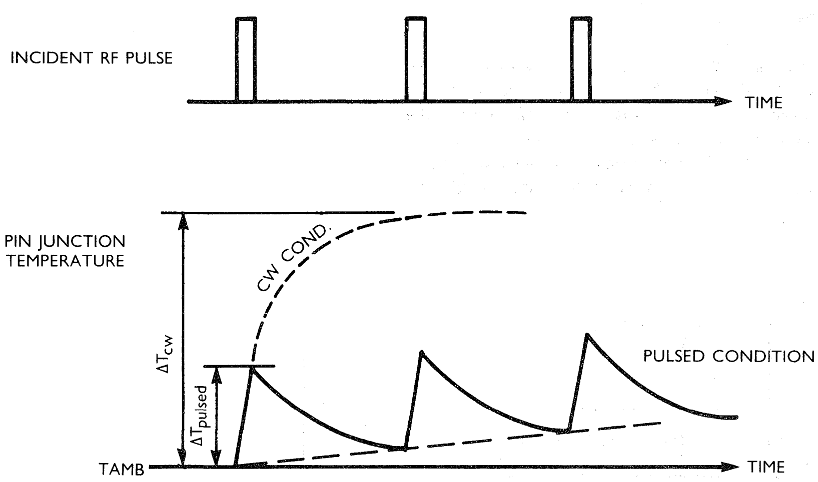
Where: P_A = Actual Power

P_S = Source Power

L = Load (Limiter) Power Factor, 0.96 Typical

S = Source Power Factor

Figure 3



Thermal Characteristics of PIN Limiters

Fixed Coaxial Attenuators

Overview

- dc - 4, dc - 12.4, dc - 18 and dc - 26.5 GHz Performance
- Temperature Range: −54° to +125°C
- Temperature Coefficient: 10^{-4} dB/dB/°C
- Average Power: Up to 20 Watts
- Connectors: OSM, Type N, TNC
- Meets MIL-E-5400 and MIL-E-16400 Environmental Requirements

Attenuators are linear, passive transmission line components designed to reduce the input power in a matched system by a predetermined amount. M/A-COM offers a complete line of fixed coaxial attenuators designed for laboratory, production, testing and system use. Typical applications include VSWR reduction at the insertion point of measurement setups, range extension of power meters, RF path loss simulation, and isolation or power level reduction of signal sources. The attenuator characteristics of primary concern are:

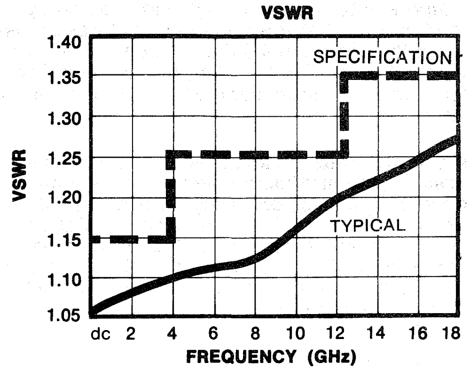
a. frequency range
b. attenuation
c. average and peak power handling capability
d. operating temperature range
e. size
f. weight

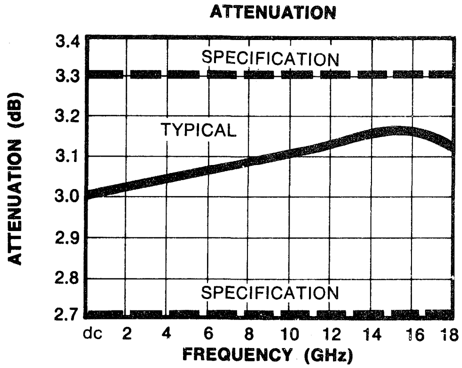
All attenuators are production tested to ensure proper operation within published specifications. Therefore, over-specification by the user is unnecessary and reduces cost-effectiveness. For example, if the frequency range requirements are 2 to 4 GHz, over-specifying flat performance to 12.4 GHz will increase component cost with no performance advantage.

Catalog attenuators are available in a variety of package sizes and connector configurations as shown on the following pages. The attenuator elements are designed to provide broad-band operation with low frequency sensitivity and extremely stable operation at temperature extremes.

OSM is a registered trademark of M/A-COM

TYPICAL PERFORMANCE PART NO. 2082-6191-03





Specifications Subject to Change Without Notice.

ATTENUATION — The term *attenuation* is generally used rather loosely and often means *insertion loss* or, to be even more specific *characteristic insertion loss.* Insertion loss is the ratio of the power delivered to a matched load by a matched generator before and after the insertion of a component in the line. Insertion loss is actually a combination of two losses: mismatch loss (reflective) and attenuation (dissipative). Mismatch loss is the ratio of power that would be absorbed by the device if it were perfectly matched to the actual power absorbed by the device with its mismatch in impedance. Attenuation is the ratio of power into a component to the power out under perfectly matched conditions and represents the actual power dissipated within the component. Where a component is perfectly matched to the line and the load, the mismatch loss is zero, and the attenuation and insertion loss are the same.

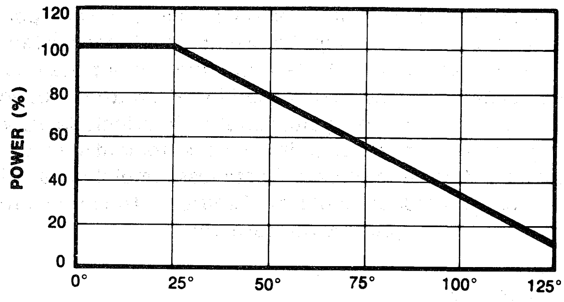
AVERAGE POWER — The maximum average power is the maximum specified input power applied for a minimum of one hour at a specified operating temperature (25°C for OSM fixed coaxial attenuators) with the output terminated in the characteristic impedance which will not permanently change the specified properties of the attenuator after return to ambient temperature at a power level 20 dB below the maximum specified input power.

Derating is necessary if the attenuator is operated at higher temperatures. See derating curve and specifications.

PEAK POWER — The maximum peak power at a specified pulse width and average power which when applied for a minimum of one hour while the output is terminated in the characteristic impedance will not permanently change the specified properties of the attenuator. The pulse width used to test OSM attenuators is 5 microseconds.

TEMPERATURE COEFFICIENT — The maximum change of insertion loss in dB per °C from 20°C over the maximum operating temperature range. To obtain ΔdB, multiply the temperature coefficient by the value in dB and by the temperature change from 20°C in °C.

POWER DERATING



SPECIFICATIONS

Impedance: 50 ohms
Temperature Range: —54 to +125°C
Temperature Coefficient: 10^{-4} dB/dB/°C

CUSTOM CONSIDERATIONS

In addition to the standard models described in this section, M/A-COM can supply special attenuators to suit your particular needs. Some typical specials are listed below. Complete facilities are maintained for the testing and documentation requirements of high reliability aerospace applications.

- Extended frequency operation to 50 GHz
- Attenuation values greater than 20 dB
- In-between dB values — .5 dB steps
- High power units
- Narrow bandwidth, tight specification applications
- Special connectors and mounting configurations
- Drop-in chip attenuators

M/A-COM

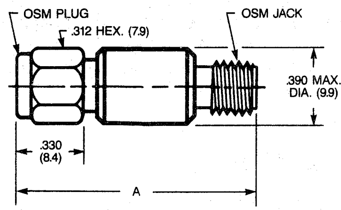
OSM (SMA) Fixed Coaxial Attenuators Miniature

2082 Series

dc-18 GHz • Round Body

- Thin Film Technology
- Complete In-House Capability
- Broadband Operation

SMA(OSM) miniature series fixed Attenuators offer precision reliable performance in a compact package. Maximum electrical flexibility can be achieved by choosing the proper unit from the series listed below. Rugged construction and thermal stability assure high performance in military and space applications.



dB	DIM. A	WEIGHT
0 - 30	1.24 (31.5mm)	.30 oz. max. (8g)
31 - 60	1.80 (45.7mm)	.40 oz. max. (11g)

PART NUMBER PLUG-JACK	ATTENUATION (dB)
2082-6191-00	0.0 ±0.30
2082-6197-00	0.5 ±0.30
2082-6191-01	1.0 ±0.30
2082-6197-01	1.5 ±0.30
2082-6191-02	2.0 ±0.30
2082-6197-02	2.5 ±0.30
2082-6191-03	3.0 ±0.30
2082-6197-03	3.5 ±0.30
2082-6192-04	4.0 ±0.30
2082-6198-04	4.5 ±0.30
2082-6192-05	5.0 ±0.30
2082-6198-05	5.5 ±0.30
2082-6192-06	6.0 ±0.30
2082-6198-06	6.5 ±0.50
2082-6193-07	7.0 ±0.50
2082-6199-07	7.5 ±0.50
2082-6193-08	8.0 ±0.50
2082-6199-08	8.5 ±0.50
2082-6193-09	9.0 ±0.50
2082-6199-09	9.5 ±0.50
2082-6193-10	10.0 ±0.50
2082-6199-10	10.5 ±0.75
2082-6194-11	11.0 ±0.75
2082-6194-12	12.0 ±0.75
2082-6194-13	13.0 ±0.75
2082-6194-14	14.0 ±0.75
2082-6194-15	15.0 ±0.75
2082-6194-16	16.0 ±0.75
2082-6194-17	17.0 ±0.75
2082-6194-18	18.0 ±0.75
2082-6194-19	19.0 ±0.75
2082-6194-20	20.0 ±0.50
2082-6195-30	30.0 ±0.75
2082-6196-40	40.0 ±1.00
2082-6196-50	50.0 ±2.00
2082-6196-60	60.0 ±2.00

Frequency:
dc - 18.0 GHz
Also available:
dc - 4, dc - 12.4

VSWR:
dc - 4 GHz 1.15
4 - 12.4 GHz 1.25
12.4 - 18 GHz 1.35

Power:
2 Watts Average
500 Watts Peak
See Derating Curve

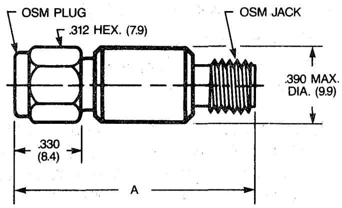
Finish:
Passivated Stainless Steel

Specifications Subject to Change Without Notice.

OSM (SMA) Fixed Coaxial Attenuators
Miniature
2082/2782 Series

Round Body

Any standard attenuator shown below is available with any combination of plug and jack connectors, as well as attenuation values as identified in part number table on previous page. Contact factory for part numbers and complete specifications.



dB	DIM. A	WEIGHT
0 - 30	1.24 (31.5mm)	.30 oz. max. (8g)
31 - 60	1.80 (45.7mm)	.40 oz. max. (11g)

Power:
2 Watts Average
500 Watts Peak
See Derating Curve
Finish:
Passivated Stainless Steel

Low Cost

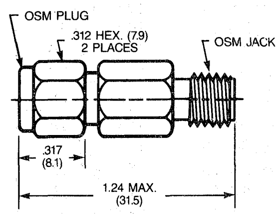
PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
2082-6145-03		3.0 ±0.60	
2082-6146-06		6.0 ±0.75	dc to 4 GHz 1.20
2082-6147-10	dc - 18.0	10.0 ±1.25	4 to 12.4 GHz 1.40
2082-6148-20		20.0 ±1.50	12.4 to 18 GHz 1.60
2082-6148-30		30.0 ±2.00	

PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
2082-6181-03		3.0 ±0.30	
2082-6182-06		6.0 ±0.30	
2082-6183-10	dc - 12.4	10.0 ±0.50	dc to 4 GHz 1.15
2082-6184-20		20.0 ±0.50	4 to 12.4 GHz 1.25
2082-6185-30		30.0 ±0.75	
2082-6186-40		40.0 ±1.00	
2082-6171-03		3.0 ±0.30	
2082-6172-06		6.0 ±0.30	
2082-6173-10	dc - 4.0	10.0 ±0.5	dc to 4 GHz 1.15
2082-6174-20		20.0 ±0.50	
2082-6175-30		30.0 ±0.75	
2082-6176-40		40.0 ±1.00	

dc-26.5 GHZ • Hex Body

- Thin Film Technology
- Complete In-House Capability
- dc - 26.5 GHz

The extended frequency OSM(SMA) allows coaxial system operation to 26.5 GHz when mated with connectors from the same family. This extended frequency range design is higher order mode free and mates with the standard SMA(OSM) series with negligible effects on performance.



Power:
2 Watts Average
500 Watts Peak
See Derating Curve

Finish:
Passivated Stainless Steel
Weight:
.23 oz. max. (6.4g)

PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
2782-6251-03		3.0 ±0.30	dc to 4 GHz 1.15
2782-6251-06	dc - 26.5	6.0 ±0.30	4 to 12.4 GHz 1.25
2782-6251-10		10.0 ±0.50	12.4 to 18 GHz 1.35
2782-6251-20		20.0 ±0.75	18 to 26.5 GHz 1.50

Specifications Subject to Change Without Notice.

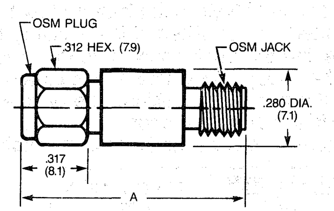
OSM (SMA) Fixed Coaxial Attenuators Subminiature

2082 Series

dc-18 GHz • Round Body

- Small Size, .86 and 1.02 Overall Length
- Light Weight
- Broadband Operation
- Rugged Construction
- Thin Film Technology
- Complete In-House Capability

SMA(OSM) subminiature series attenuators are extremely compact; as small as 0.28 inches in diameter and 0.86 inches long. This series was designed for broadband precision operation where flat frequency response and minimum size and weight are necessary. The rugged construction and thermal stability assure high performance in military and space applications.



PART NUMBER PLUG-JACK	ATTENUATION (dB)
2082-6040-00	0.0 ±0.30
2082-6130-00	0.5 ±0.30
2082-6040-01	1.0 ±0.30
2082-6130-01	1.5 ±0.30
2082-6040-02	2.0 ±0.30
2082-6130-02	2.5 ±0.30
2082-6040-03	3.0 ±0.30
2082-6130-03	3.5 ±0.30
2082-6041-04	4.0 ±0.30
2082-6131-04	4.5 ±0.30
2082-6041-05	5.0 ±0.30
2082-6131-05	5.5 ±0.30
2082-6041-06	6.0 ±0.30
2082-6131-06	6.5 ±0.50
2082-6042-07	7.0 ±0.50
2082-6132-07	7.5 ±0.50
2082-6042-08	8.0 ±0.50
2082-6132-08	8.5 ±0.50
2082-6042-09	9.0 ±0.50
2082-6132-09	9.5 ±0.50
2082-6042-10	10.0 ±0.50
2082-6132-10	10.5 ±0.75
2082-6043-11	11.0 ±0.75
2082-6043-12	12.0 ±0.75
2082-6043-13	13.0 ±0.75
2082-6043-14	14.0 ±0.75
2082-6043-15	15.0 ±0.75
2082-6043-16	16.0 ±0.75
2082-6043-17	17.0 ±0.75
2082-6043-18	18.0 ±0.75
2082-6043-19	19.0 ±0.75
2082-6043-20	20.0 ±0.50
2082-6044-30	30.0 ±0.75

dB	DIM. A	WEIGHT
0 - 12	0.86 (21.8mm)	.18 oz. max. (5g)
13 - 30	1.02 (25.9mm)	.21 oz. max. (6g)

Frequency:
dc - 18.0 GHz
Also available:
dc - 4, dc - 12.4

VSWR:
dc - 4 GHz 1.15
4 - 12.4 GHz 1.25
12.4 - 18 GHz 1.35

Power:
2 Watts Average
500 Watts Peak
See Derating Curve

Finish:
Passivated Stainless Steel

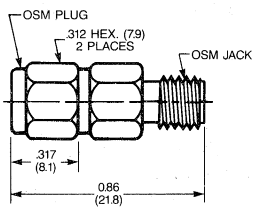
Specifications Subject to Change Without Notice.

OSM (SMA) Fixed Coaxial Attenuators
Subminiature 2082 Series

dc-18 GHz • Hex Body

- Small Size
- Light Weight
- Broadband Operation
- Rugged Construction
- Thin Film Technology
- Complete House Capability

This series of SMA subminiature hex body attenuators is designed for use where it is difficult to hold the unit while tightening the SMA connectors to the required torque levels. The hex body allows use of a standard SMA nut wrench to hold the body into position. The units are designed for broadband precision operation where flat frequency response and minimum size and weight are necessary.



dB	DIM. A	WEIGHT
0 - 12	0.86 (21.8mm)	0.18 oz. max. (5g)
13 - 30	1.02 (25.9mm)	0.21 oz. max. (6g)

PART NUMBER PLUG-JACK	ATTENUATION (dB)
2082-6240-00	0.0 ±0.30
2082-6240-01	1.0 ±0.30
2082-6240-02	2.0 ±0.30
2082-6240-03	3.0 ±0.30
2082-6241-04	4.0 ±0.30
2082-6241-05	5.0 ±0.30
2082-6241-06	6.0 ±0.30
2082-6242-07	7.0 ±0.50
2082-6242-08	8.0 ±0.50
2082-6242-09	9.0 ±0.50
2082-6242-10	10.0 ±0.50
2082-6243-11	11.0 ±0.75
2082-6243-12	12.0 ±0.75
2082-6243-13	13.0 ±0.75
2082-6243-14	14.0 ±0.75
2082-6243-15	15.0 ±0.75
2082-6243-16	16.0 ±0.75
2082-6243-17	17.0 ±0.75
2082-6243-18	18.0 ±0.75
2082-6243-19	19.0 ±0.75
2082-6243-20	20.0 ±0.50
2082-6244-30	30.0 ±0.75

Frequency:
dc - 18.0 GHz
Also available:
dc - 4, dc - 12.4

Power:
2 Watts Average
500 Watts Peak
See Derating Curve

VSWR:
dc - 4 GHz 1.15
4 - 12.4 GHz 1.25
12.4 - 18 GHz 1.35

Finish:
Passivated Stainless Steel

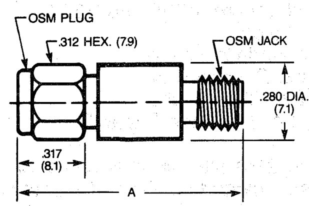
Specifications Subject to Change Without Notice.

M/A-COM

OSM (SMA) Fixed Coaxial Attenuators
Subminiature — 2082/2782 Series

Round Body

Any standard attenuator shown below is available with any combination of plug and jack connectors, as well as attenuation values as identified in part number table on previous page. Contact factory for part numbers and specifications.



dB	DIM. A	WEIGHT
0 - 12	0.86 (21.8mm)	.18 oz. max. (5g)
13 - 30	1.02 (25.9mm)	.21 oz. max. (6g)

Power:
2 Watts Average
500 Watts Peak
See Derating Curve

Finish:
Passivated Stainless Steel

Low Cost

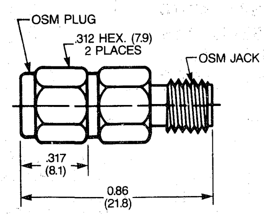
PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
2082-6141-03 2082-6142-06 2082-6143-10 2082-6144-20 2082-6144-30	dc - 18.0	3.0 ±0.60 6.0 ±0.75 10.0 ±1.25 20.0 ±1.50 30.0 ±2.00	dc to 4 GHz 1.20 4 to 12.4 GHz 1.40 12.4 to 18 GHz 1.60

PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
2082-6020-03 2082-6021-06 2082-6022-10 2082-6023-20 2082-6024-30	dc - 12.4	3.0 ±0.30 6.0 ±0.30 10.0 ±0.50 20.0 ±0.50 30.0 ±0.75	dc to 4 GHz 1.15 4 to 12.4 GHz 1.25
2082-6010-03 2082-6011-06 2082-6012-10 2082-6013-20 2082-6014-30	dc - 4	3.0 ±0.30 6.0 ±0.30 10.0 ±0.50 20.0 ±0.50 30.0 ±0.75	dc to 4 GHz 1.15

dc-26.5 GHz • Hex Body

- Small Size
- Light Weight
- Thin Film Technology
- Complete In-House Capability
- dc - 26.5 GHz

The extended frequency OSM(SMA) allows coaxial system operation to 26.5 GHz when mated with connectors from same family. This extended frequency range design is higher order mode free and mates with the standard OSM(SMA) series with negligible effects on performance.



dB	DIM. A	WEIGHT
0 - 12	0.86 (21.8mm)	0.18 oz. max. (5g)
13 - 30	1.02 (25.9mm)	0.21 oz. max. (6g)

Power:
2 Watts Average
500 Watts Peak
See Derating Curve

Finish:
Passivated Stainless Steel

Weight:
.23 oz. max. (6.4g)

PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
2782-6051-03 2782-6051-06 2782-6051-10 2782-6051-20	dc - 26.5	3.0 ±0.30 6.0 ±0.30 10.0 ±0.50 20.0 ±0.75	dc to 4 GHz 1.15 4 to 12.4 GHz 1.25 12.4 to 18 GHz 1.35 18 to 26.5 GHz 1.50

Specifications Subject to Change Without Notice.

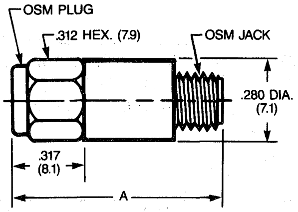
OSM (SMA) Fixed Coaxial Attenuators Ultra Miniature

2082 Series

dc-18 GHz • Round Body

- Overall Length: 0.75″ and 0.86″
- Light Weight
- Broadband Operation
- Rugged Construction
- Thin Film Technology
- Complete In-House Capability

This new SMA ultra short series of attenuators utilizes the latest technology to achieve the shortest length available. These units are designed for use where space is limited, yet broadband precision operation and flat frequency response are necessary.



dB	DIM. A	WEIGHT
1 - 12	0.75 (19.0mm)	.18 oz. max. (5g)
13 - 30	0.86 (21.8mm)	.19 oz. max. (5g)

PART NUMBER PLUG-JACK	ATTENUATION (dB)
2082-6340-01	1.0 ±0.30
2082-6340-02	2.0 ±0.30
2082-6340-03	3.0 ±0.30
2082-6340-04	4.0 ±0.30
2082-6340-05	5.0 ±0.30
2082-6340-06	6.0 ±0.30
2082-6340-07	7.0 ±0.50
2082-6340-08	8.0 ±0.50
2082-6340-09	9.0 ±0.50
2082-6340-10	10.0 ±0.50
2082-6340-11	11.0 ±0.75
2082-6340-12	12.0 ±0.75
2082-6340-13	13.0 ±0.75
2082-6340-14	14.0 ±0.75
2082-6340-15	15.0 ±0.75
2082-6340-16	16.0 ±0.75
2082-6340-17	17.0 ±0.75
2082-6340-18	18.0 ±0.75
2082-6340-19	19.0 ±0.75
2082-6340-20	20.0 ±0.75
2082-6340-30	30.0 ±1.00

Frequency:
dc - 18 GHz

VSWR:
dc - 4 GHz 1.15
4 - 12.4 GHz 1.25
12.4 - 18 GHz 1.35

Power:
2 Watts Average
200 Watts Peak
See Derating Curve

Finish:
Passivated Stainless Steel

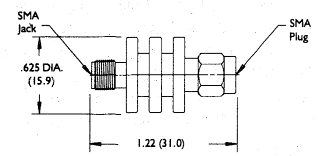
Specifications Subject to Change Without Notice.

Fixed Coaxial Attenuators
5 & 10 Watt

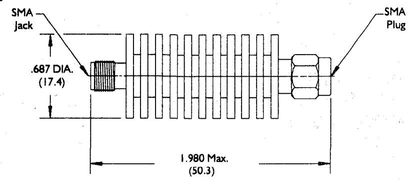
2082 Series

Features
- Low VSWR
- dc - 18.0 GHz Operation
- Flat Attenuation Response
- Precision SMA Connectors
- No Hazardous Beryllium Oxide
- N Custom Capability

5 Watt



10 Watt



Description
M/A-COM Control Components Division introduces its new 5 and 10 watt SMA attenuators. These units have been designed for use where stable, broadband, medium power units are required. They feature stainless steel connectors and black anodized aluminum heat sink bodies. Standard connector configuration is plug-jack. Contact the factory for part numbers and specifications on plug-plug and jack-jack configurations.

5 Watt SMA

Frequency Range (GHz)	Attenuation (dB)	Part Number
dc - 18.0	3.0 ± 0.30	2082-6524-03
	6.0 ± 0.30	2082-6524-06
	10.0 ± 0.50	2082-6524-10
	20.0 ± 0.75	2082-6524-20
	30.0 ± 0.75	2082-6524-30

Power
(Avg.): 5 Watts CW (25°C)*
(Peak): 500 Watts Max.
Temperature Range
-55 to 125°C
Weight
0.5 oz. (14g) Max.
VSWR

dc to 4 GHz	1.15
4 to 12.4 GHz	1.25
12.4 to 18 GHz	1.35

10 Watt SMA

Frequency Range (GHz)	Attenuation (dB)	Part Number
dc - 18.0	3.0 ± 0.30	2082-6502-03
	6.0 ± 0.30	2082-6502-06
	10.0 ± 0.50	2082-6502-10
	20.0 ± 0.75	2082-6502-20

Power
(Avg.): 10 Watts CW (25°C)*
(Peak): 500 Watts Max.
Temperature Range
-55 to 125°C
Weight
1.0 oz. (28g) Max.
VSWR

dc to 8 GHz	1.20
8 to 12.4 GHz	1.30
12.4 to 18 GHz	1.40

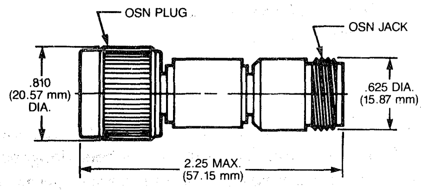
*Power derates linearly to 10% at 125°C.

Specifications Subject to Change Without Notice.

Type N Fixed Coaxial Attenuators

3082 Series

Type N series attenuators have been designed for use where stable, broadband, medium power units are required. Any combination of precision stainless steel type N plug and jack connectors is available on these units. Contact the factory for part numbers and specifications. Standard configuration is one Type N plug and one Type N jack.



Power:
2 Watts Average
500 Watts Peak
See Derating Curve

Finish:
Passivated Stainless Steel

Weight:
2.5 oz. (70.9g)

Low Cost

PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
3082-6141-03		3.0 ±0.60	
3082-6142-06	dc - 18.0	6.0 ±0.75	dc to 4 GHz 1.20
3082-6143-10		10.0 ±1.25	4 to 12.4 GHz 1.40
3082-6144-20		20.0 ±1.50	12.4 to 18 GHz 1.60

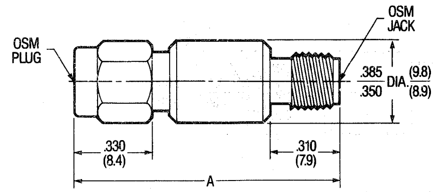
PART NUMBER PLUG-JACK	FREQUENCY (GHZ)	ATTENUATION (dB)	VSWR
3082-6191-03		3.0 ±0.30	
3082-6192-06	dc - 18.0	6.0 ±0.30	dc to 4 GHz 1.15
3082-6193-10		10.0 ±0.50	4 to 12.4 GHz 1.25
3082-6194-20		20.0 ±0.75	12.4 to 18 GHz 1.35
3082-6195-30		30.0 ±1.00	
3082-6181-03		3.0 ±0.30	
3082-6182-06		6.0 ±0.30	dc to 4 GHz 1.15
3082-6183-10	dc - 12.4	10.0 ±0.50	4 to 12.4 GHz 1.25
3082-6184-20		20.0 ±0.75	
3082-6185-30		30.0 ±1.00	
3082-6171-03		3.0 ±0.30	
3082-6172-06		6.0 ±0.30	
3082-6173-10	dc - 4	10.0 ±0.50	dc to 4 GHz 1.15
3082-6174-20		20.0 ±0.75	
3082-6175-30		30.0 ±1.00	

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2082 Series

MIL-A-3933/14



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Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-01	2082-4135-03N	1	1.24 (31.5)	3	dc - 12.4	**2082-6181-03**
-02	2082-4135-06N	1	1.24 (31.5)	6	dc - 12.4	**2082-6182-06**
-03	2082-4135-10N	1	1.24 (31.5)	10	dc - 12.4	**2082-6183-10**
-04	2082-4135-20N	1	1.24 (31.5)	20	dc - 12.4	**2082-6184-20**
-05	2082-4135-15N	1	1.24 (31.5)	15	dc - 12.4	**2082-6184-15**
-06	2082-4135-01N	1	1.24 (31.5)	1	dc - 12.4	**2082-6181-01**
-07	2082-4135-02N	1	1.24 (31.5)	2	dc - 12.4	**2082-6181-02**
-08	2082-4135-04N	1	1.24 (31.5)	4	dc - 12.4	**2082-6182-04**
-09	2082-4135-05N	1	1.24 (31.5)	5	dc - 12.4	**2082-6182-05**
-10	2082-4135-07N	1	1.24 (31.5)	7	dc - 12.4	**2082-6183-07**
-11	2082-4135-08N	1	1.24 (31.5)	8	dc - 12.4	**2082-6183-08**
-12	2082-4135-09N	1	1.24 (31.5)	9	dc - 12.4	**2082-6183-09**
-13	2082-4135-30N	1	1.85 (47.0)	30	dc - 12.4	**2082-6185-30**
-17	2082-4135-28N	1	1.85 (47.0)	28	dc - 12.4	**2082-6185-28**
-18	2082-4135-16N	1	1.24 (31.5)	16	dc - 12.4	**2082-6184-16**
-19	2082-4135-14N	1	1.24 (31.5)	14	dc - 12.4	**2082-6184-14**
-20	2082-4135-13N	1	1.24 (31.5)	13	dc - 12.4	**2082-6184-13**
-21	2082-4135-12N	1	1.24 (31.5)	12	dc - 12.4	**2082-6184-12**
-22	2082-4135-11N	1	1.24 (31.5)	11	dc - 12.4	**2082-6184-11**
-23	2082-4135-23N	1	1.24 (31.5)	1.5	dc - 12.4	**2082-6185-23**

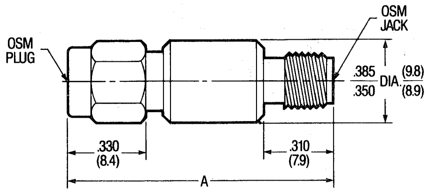
M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2082 Series

MIL-A-3933/16



2

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-01	2082-4137-03N	2	1.24 (31.5)	3	dc - 18.0	**2082-6191-03**
-02	2082-4137-06N	2	1.24 (31.5)	6	dc - 18.0	**2082-6192-06**
-03	2082-4137-10N	2	1.24 (31.5)	10	dc - 18.0	**2082-6193-10**
-04	2082-4137-20N	2	1.24 (31.5)	20	dc - 18.0	**2082-6194-20**
-05	2082-4137-01N	2	1.24 (31.5)	1	dc - 18.0	**2082-6191-01**
-06	2082-4137-02N	2	1.24 (31.5)	2	dc - 18.0	**2082-6191-02**
-07	2082-4137-04N	2	1.24 (31.5)	4	dc - 18.0	**2082-6192-04**
-08	2082-4137-05N	2	1.24 (31.5)	5	dc - 18.0	**2082-6192-05**
-09	2082-4137-07N	2	1.24 (31.5)	7	dc - 18.0	**2082-6193-07**
-10	2082-4137-08N	2	1.24 (31.5)	8	dc - 18.0	**2082-6193-08**
-11	2082-4137-09N	2	1.24 (31.5)	9	dc - 18.0	**2082-6193-09**
-12	2082-4137-30N	2	1.85 (47.0)	30	dc - 18.0	**2082-6195-30**
-16	2082-4137-00N	2	1.24 (31.5)	0	dc - 18.0	**2082-6191-00**
-17	2082-4385-01N	2	1.24 (31.5)	.5	dc - 18.0	—
-18	2082-4385-02N	2	1.24 (31.5)	1.5	dc - 18.0	—
-19	2082-4385-03N	2	1.24 (31.5)	2.5	dc - 18.0	—
-20	2082-4385-04N	2	1.24 (31.5)	3.5	dc - 18.0	—
-21	2082-4385-05N	2	1.24 (31.5)	4.5	dc - 18.0	—
-22	2082-4385-06N	2	1.24 (31.5)	5.5	dc - 18.0	—
-23	2082-4385-07N	2	1.24 (31.5)	6.5	dc - 18.0	—
-24	2082-4385-08N	2	1.24 (31.5)	7.5	dc - 18.0	—
-25	2082-4385-09N	2	1.24 (31.5)	8.5	dc - 18.0	—
-26	2082-4385-10N	2	1.24 (31.5)	9.5	dc - 18.0	—
-27	2082-4385-11N	2	1.24 (31.5)	10.5	dc - 18.0	—
-28	2082-4137-11N	2	1.24 (31.5)	11	dc - 18.0	**2082-6194-11**

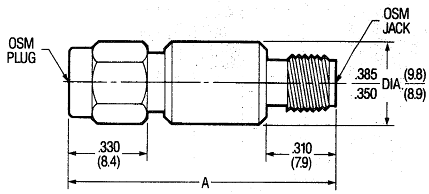
M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2082 Series

MIL-A-3933/16



2

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-29	2082-4385-12N	2	1.24 (31.5)	11.5	dc - 18.0	—
-30	2082-4137-12N	2	1.24 (31.5)	12	dc - 18.0	**2082-6194-12**
-31	2082-4385-13N	2	1.24 (31.5)	12.5	dc - 18.0	—
-32	2082-4137-13N	2	1.24 (31.5)	13	dc - 18.0	**2082-6194-13**
-33	2082-4385-14N	2	1.24 (31.5)	13.5	dc - 18.0	—
-34	2082-4137-14N	2	1.24 (31.5)	14	dc - 18.0	**2082-6194-14**
-35	2082-4385-15N	2	1.24 (31.5)	14.5	dc - 18.0	—
-36	2082-4137-15N	2	1.24 (31.5)	15	dc - 18.0	**2082-6194-15**
-37	2082-4385-16N	2	1.24 (31.5)	15.5	dc - 18.0	—
-38	2082-4137-16N	2	1.24 (31.5)	16	dc - 18.0	**2082-6194-16**
-39	2082-4385-17N	2	1.24 (31.5)	16.5	dc - 18.0	—
-40	2082-4137-17N	2	1.24 (31.5)	17	dc - 18.0	**2082-6194-17**
-41	2082-4385-18N	2	1.24 (31.5)	17.5	dc - 18.0	—
-42	2082-4137-18N	2	1.24 (31.5)	18	dc - 18.0	**2082-6194-18**
-43	2082-4385-19N	2	1.24 (31.5)	18.5	dc - 18.0	—
-44	2082-4137-19N	2	1.24 (31.5)	19	dc - 18.0	**2082-6194-19**
-45	2082-4385-20N	2	1.24 (31.5)	19.5	dc - 18.0	—
-46	2082-4385-21N	2	1.24 (31.5)	20.5	dc - 18.0	—
-47	2082-4137-21N	2	1.24 (31.5)	21	dc - 18.0	**2082-6195-21**
-48	2082-4385-22N	2	1.24 (31.5)	21.5	dc - 18.0	—
-49	2082-4137-22N	2	1.24 (31.5)	22	dc - 18.0	**2082-6195-22**
-50	2082-4385-23N	2	1.24 (31.5)	22.5	dc - 18.0	—
-51	2082-4137-23N	2	1.24 (31.5)	23	dc - 18.0	**2082-6195-23**
-52	2082-4385-24N	2	1.24 (31.5)	23.5	dc - 18.0	—
-53	2082-4137-24N	2	1.24 (31.5)	24	dc - 18.0	**2082-6195-24**
-54	2082-4385-25N	2	1.24 (31.5)	24.5	dc - 18.0	—
-55	2082-4137-25N	2	1.24 (31.5)	25	dc - 18.0	**2082-6195-25**
-56	2082-4137-28N	2	1.24 (31.5)	28	dc - 18.0	**2082-6195-28**

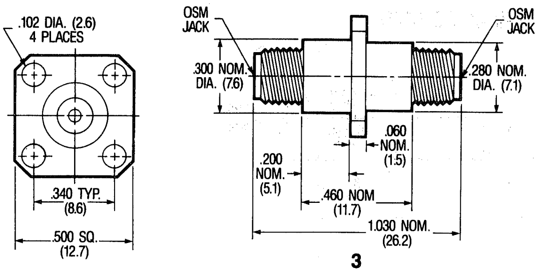
M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2084/2082 Series

MIL-A-3933/24

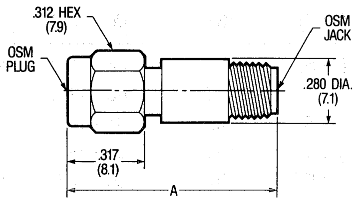


3

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-01	2084-4012-10N	3	1.03 (26.2)	10	2.0 - 12.4	—
-02	2084-4012-15N	3	1.03 (26.2)	15	2.0 - 12.4	—
-03	2084-4012-20N	3	1.03 (26.2)	20	2.0 - 12.4	—

M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

MIL-A-3933/25



4

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-01	2082-4384-01N	4	.87 (22.1)	1	dc - 2.0	**2082-6010-01**
-02	2082-4384-02N	4	.87 (22.1)	2	dc - 2.0	**2082-6010-02**
-03	2082-4384-03N	4	.87 (22.1)	3	dc - 2.0	**2082-6010-03**
-04	2082-4384-04N	4	.87 (22.1)	4	dc - 2.0	**2082-6011-04**
-05	2082-4384-05N	4	.87 (22.1)	5	dc - 2.0	**2082-6011-05**
-06	2082-4384-06N	4	.87 (22.1)	6	dc - 2.0	**2082-6011-06**
-07	2082-4384-07N	4	.87 (22.1)	7	dc - 2.0	**2082-6012-07**
-08	2082-4384-08N	4	.87 (22.1)	8	dc - 2.0	**2082-6012-08**
-09	2082-4384-09N	4	.87 (22.1)	9	dc - 2.0	**2082-6012-09**
-10	2082-4384-10N	4	.87 (22.1)	10	dc - 2.0	**2082-6012-10**
-11	2082-4384-11N	4	.87 (22.1)	11	dc - 2.0	**2082-6013-11**
-12	2082-4384-12N	4	.87 (22.1)	12	dc - 2.0	**2082-6013-12**
-13	2082-4384-13N	4	1.03 (26.2)	13	dc - 2.0	**2082-6013-13**
-14	2082-4384-14N	4	1.03 (26.2)	14	dc - 2.0	**2082-6013-14**
-15	2082-4384-15N	4	1.03 (26.2)	15	dc - 2.0	**2082-6013-15**

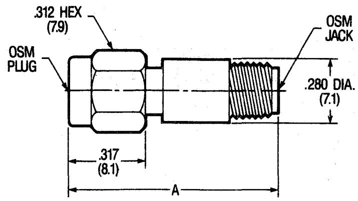
M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2082 Series

MIL-A-3933/25



4

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-16	2082-4384-16N	4	1.03 (26.2)	16	dc - 2.0	**2082-6013-16**
-17	2082-4384-17N	4	1.03 (26.2)	17	dc - 2.0	**2082-6013-17**
-18	2082-4384-18N	4	1.03 (26.2)	18	dc - 2.0	**2082-6013-18**
-19	2082-4384-19N	4	1.03 (26.2)	19	dc - 2.0	**2082-6013-19**
-20	2082-4384-20N	4	1.03 (26.2)	20	dc - 2.0	**2082-6013-20**
-21	2082-4384-21N	4	1.03 (26.2)	21	dc - 2.0	**2082-6014-21**
-22	2082-4384-22N	4	1.03 (26.2)	22	dc - 2.0	**2082-6014-22**
-23	2082-4384-23N	4	1.03 (26.2)	23	dc - 2.0	**2082-6014-23**
-24	2082-4384-24N	4	1.03 (26.2)	24	dc - 2.0	**2082-6014-24**
-25	2082-4384-25N	4	1.03 (26.2)	25	dc - 2.0	**2082-6014-25**
-26	2082-4384-30N	4	1.03 (26.2)	30	dc - 2.0	**2082-6014-30**
-27	2082-4383-01N	4	.87 (22.1)	1	dc - 12.4	**2082-6020-01**
-28	2082-4383-02N	4	.87 (22.1)	2	dc - 12.4	**2082-6020-02**
-29	2082-4383-03N	4	.87 (22.1)	3	dc - 12.4	**2082-6020-03**
-30	2082-4383-04N	4	.87 (22.1)	4	dc - 12.4	**2082-6021-04**
-31	2082-4383-05N	4	.87 (22.1)	5	dc - 12.4	**2082-6021-05**
-32	2082-4383-06N	4	.87 (22.1)	6	dc - 12.4	**2082-6021-06**
-33	2082-4383-07N	4	.87 (22.1)	7	dc - 12.4	**2082-6022-07**
-34	2082-4383-08N	4	.87 (22.1)	8	dc - 12.4	**2082-6022-08**
-35	2082-4383-09N	4	.87 (22.1)	9	dc - 12.4	**2082-6022-09**
-36	2082-4383-10N	4	.87 (22.1)	10	dc - 12.4	**2082-6022-10**
-37	2082-4383-11N	4	.87 (22.1)	11	dc - 12.4	**2082-6023-11**
-38	2082-4383-12N	4	.87 (22.1)	12	dc - 12.4	**2082-6023-12**
-39	2082-4383-13N	4	.94 (23.9)	13	dc - 12.4	**2082-6023-13***
-40	2082-4383-14N	4	.94 (23.9)	14	dc - 12.4	**2082-6023-14***

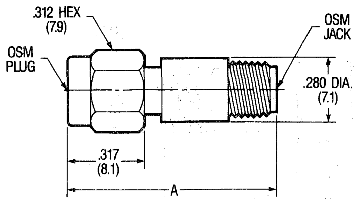
M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2082 Series

MIL-A-3933/25



4

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-41	2082-4383-15N	4	.94 (23.9)	15	dc - 12.4	**2082-6023-15***
-42	2082-4383-16N	4	.94 (23.9)	16	dc - 12.4	**2082-6023-16***
-43	2082-4383-17N	4	.94 (23.9)	17	dc - 12.4	**2082-6023-17***
-44	2082-4383-18N	4	.94 (23.9)	18	dc - 12.4	**2082-6023-18***
-45	2082-4383-19N	4	.94 (23.9)	19	dc - 12.4	**2082-6023-19***
-46	2082-4383-20N	4	1.04 (26.4)	20	dc - 12.4	**2082-6023-20**
-47	2082-4383-21N	4	1.04 (26.4)	21	dc - 12.4	**2082-6024-21**
-48	2082-4383-22N	4	1.04 (26.4)	22	dc - 12.4	**2082-6024-22**
-49	2082-4383-23N	4	1.04 (26.4)	23	dc - 12.4	**2082-6024-23**
-50	2082-4383-24N	4	1.04 (26.4)	24	dc - 12.4	**2082-6024-24**
-51	2082-4383-25N	4	1.04 (26.4)	25	dc - 12.4	**2082-6024-25**
-52	2082-4383-30N	4	1.04 (26.4)	30	dc - 12.4	**2082-6024-30**
-58	2082-4381-00N	4	.87 (22.1)	0	dc - 18.0	**2082-6040-00**
-59	2082-4382-01N	4	.87 (22.1)	.5	dc - 18.0	—
-60	2082-4381-01N	4	.87 (22.1)	1	dc - 18.0	**2082-6040-01**
-61	2082-4382-02N	4	.87 (22.1)	1.5	dc - 18.0	—
-62	2082-4381-02N	4	.87 (22.1)	2	dc - 18.0	**2082-6040-02**
-63	2082-4382-03N	4	.87 (22.1)	2.5	dc - 18.0	—
-64	2082-4381-03N	4	.87 (22.1)	3	dc - 18.0	**2082-6040-03**
-65	2082-4382-04N	4	.87 (22.1)	3.5	dc - 18.0	—
-66	2082-4381-04N	4	.87 (22.1)	4	dc - 18.0	**2082-6041-04**
-67	2082-4382-05N	4	.87 (22.1)	4.5	dc - 18.0	—
-68	2082-4381-05N	4	.87 (22.1)	5	dc - 18.0	
-69	2082-4382-06N	4	.87 (22.1)	5.5	dc - 18.0	—

M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

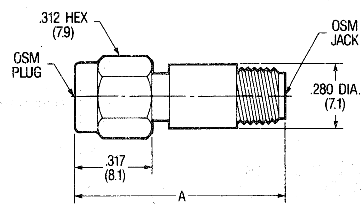
* Commercial Alternate has overall length of 1.02 (25.9).

Specifications Subject to Change Without Notice.

QPL Fixed Coaxial Attenuators

2082 Series

MIL-A-3933/25



4

Military Part Number	M/A-COM Part Number	Outline	Dim. A Max. Inches (mm)	Attenuation Value (dB) Nom.	Frequency Range (GHz)	Commercial Alternate
-70	2082-4381-06N	4	.87 (22.1)	6	dc - 18.0	**2082-6041-06**
-71	2082-4382-07N	4	.87 (22.1)	6.5	dc - 18.0	—
-72	2082-4381-07N	4	.87 (22.1)	7	dc - 18.0	**2082-6042-07**
-73	2082-4382-08N	4	.87 (22.1)	7.5	dc - 18.0	—
-74	2082-4381-08N	4	.87 (22.1)	8	dc - 18.0	**2082-6042-08**
-75	2082-4382-09N	4	.87 (22.1)	8.5	dc - 18.0	—
-76	2082-4381-09N	4	.87 (22.1)	9	dc - 18.0	**2082-6042-09**
-77	2082-4382-10N	4	.87 (22.1)	9.5	dc - 18.0	—
-78	2082-4381-10N	4	.87 (22.1)	10	dc - 18.0	**2082-6042-10**
-79	2082-4381-11N	4	.87 (22.1)	11	dc - 18.0	**2082-6043-11**
-80	2082-4381-12N	4	.87 (22.1)	12	dc - 18.0	**2082-6043-12**
-81	2082-4381-13N	4	.94 (23.9)	13	dc - 18.0	**2082-6043-13***
-82	2082-4381-14N	4	.94 (23.9)	14	dc - 18.0	**2082-6043-14***
-83	2082-4381-15N	4	1.04 (26.4)	15	dc - 18.0	**2082-6043-15**
-84	2082-4381-16N	4	1.04 (26.4)	16	dc - 18.0	**2082-6043-16**
-85	2082-4381-17N	4	1.04 (26.4)	17	dc - 18.0	**2082-6043-17**
-86	2082-4381-18N	4	1.04 (26.4)	18	dc - 18.0	**2082-6043-18**
-87	2082-4381-19N	4	1.04 (26.4)	19	dc - 18.0	**2082-6043-19**
-88	2082-4381-20N	4	1.04 (26.4)	20	dc - 18.0	**2082-6043-20**
-89	2082-4381-25N	4	1.04 (26.4)	25	dc - 18.0	**2082-6044-25**
-90	2082-4381-30N	4	1.04 (26.4)	30	dc - 18.0	**2082-6044-30**

M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S."

* Commercial Alternate has overall length of 1.02 (25.9).

Specifications Subject to Change Without Notice.

Termination

Overview

- dc - 12.4, dc - 18, dc - 26.5 and dc - 50 GHz Performance
- Temperature Range : −54° to +125° C
- Average Power: .5 to 10 Watts
- Connectors: OSM, OSSM, Type N, TNC, 7mm, BNC, OS-50, OSP, OSSP and OS-50P
- Meets MIL-E-5400 and MIL-E-16400 Environmental Requirements

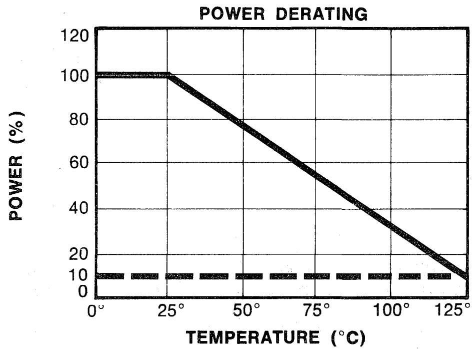
Terminations are power absorbing loads properly matched to the characteristic impedance of a transmission line. M/A-COM offers a complete line of miniature fixed coaxial terminations designed for laboratory, testing and system use. The termination characteristics of primary concern are:

a. operating frequency range	d. VSWR
b. average power handling capability	e. size
c. operating temperature range	f. weight

All terminations are production tested to ensure proper operation within published specifications. Hence, over-specification by the user is unnecessary.

Catalog OSM terminations are available in a variety of package sizes and connector configurations as shown on the following pages. The resistance elements are aged to ensure stable operation at temperature extremes.

TYPICAL TEMPERATURE DERATING



All OSM standard model terminations are 50 ohms and are derated linearly to 10% power at 125°C. Operating temperature range is −54 to +125°C.

CUSTOM CONSIDERATIONS

In addition to the standard terminations shown on the following pages M/A-COM can supply special units to suit your particular needs.

- Heat sinks for higher power dissipation
- Characteristic impedance other than 50 ohms
- Custom connectors and mounting configurations

Specifications Subject to Change Without Notice.

Metallized Substrates For Microwave Integrated Circuits

M/A-COM offers a wide selection of metallized 99.5+% alumina (Al_2O_3) substrates and aluminum nitride ceramic which is an attractive alternative where power and thermal conductivity are a concern. Polished surfaces of less than one microinch are offered with exacting tolerances for maximum control of electrical parameters at frequencies to 50 GHz. For most applications, a fine grained 99.5+% alumina ceramic is available with an as-fired surface of approximately 3 microinches. As-fired surfaces offer maximum adhesion of the conductors to the ceramic and are very cost effective while giving excellent performance at frequencies through 26.5 GHz.

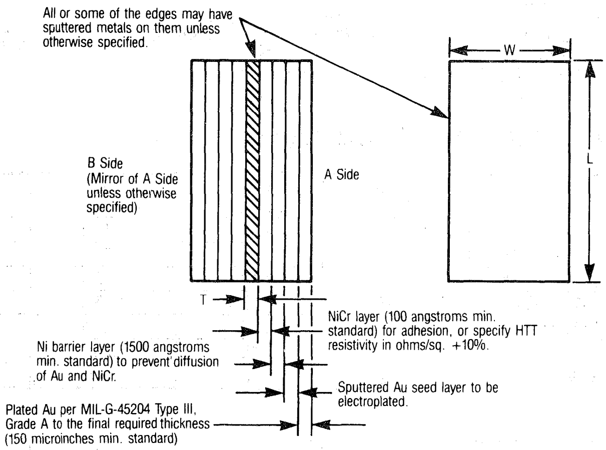
Custom Services and Substrates

Custom etch services are available for prototype or production quantities on most substrates. These can be provided to your circuit and size requirements with edge metallization.

Other customer services can be provided on request.

When specifying custom substrates, the following information should be provided:

- Length and tolerance (±.0005 to ±1% is available)
- Width and tolerance (±.0005 to ±1% is available)
- Thickness
- Camber (alumina is .001 inch/inch max. standard, or specify)
- Metallization - thickness
- Special requirements for edges or holes in substrate
- Substrate material (99.5+% alumina, aluminum nitride, or specify)



Specifications Subject to Change Without Notice.

OSM (SMA) Plug Terminations

2001/2003 Series

OSM Miniature Plug Terminations are compact, fixed coaxial loads for terminating miniature coaxial lines at frequencies up to 26.5 GHz. Small size and weight and low VSWR allow numerous applications in both measurement and system use.

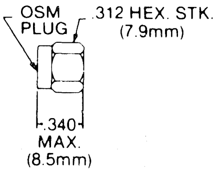


Fig. 1

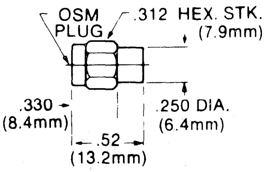


Fig. 2

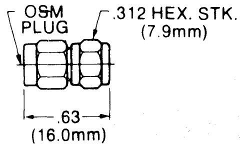
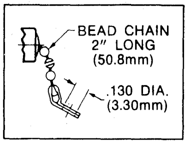


Fig. 3



Ultra Short Plug Terminations

Part Number	Frequency (GHz)	VSWR dc-4 GHz	VSWR 4-12.4 GHz	VSWR 12.4-18 GHz	VSWR 18-26.5 GHz	Fig.	Power Watts Avg.[1]
2003-6110-00	dc - 26.5	1.05:1	1.10:1	1.20:1	1.30:1	1	
2003-6117-00		1.05:1	1.05:1	1.10:1	-	1	
2003-6111-00		1.10:1	1.10:1	1.10:1	-	1	
2003-6112-00	dc - 18.0	1.05:1	1.15:1	1.20:1	-	1	0.5
2003-6113-00		1.10:1	1.20:1	1.30:1	-	1	
2003-6115-00		1.10:1	1.20:1	1.30:1	-	1[5]	
2003-6116-00	dc - 12.4	1.05:1	1.05:1	-	-	1	

Part Number	Frequency (GHz)	VSWR dc-4 GHz	VSWR 4-12.4 GHz	VSWR 12.4-18 GHz	VSWR 18-26.5 GHz	Fig.	Power Watts Avg.[1]
2001-6110-00	dc - 26.5	1.05:1	1.10:1	1.20:1	1.30:1	2	0.5
2001-6105-00		1.05:1	1.15:1	1.15:1	-	3[5]	
2001-6100-00		1.05:1	1.15:1	1.15:1	-	3	1.0
2001-6101-00		1.05:1	1.15:1	1.20:1	-	2	
2001-6143-00		1.09:1[2]	1.17:1[2]	1.23:1[2]	-	2	
2001-6118-00[4]	dc - 18.0	1.05:1	1.05:1	1.05:1	-	2	
2001-6117-00		1.05:1	1.05:1	1.10:1	-	2	
2001-6111-00		1.10:1	1.10:1	1.10:1	-	2	
2001-6112-00		1.05:1	1.15:1	1.20:1	-	2	0.5
2001-6113-00		1.10:1	1.20:1	1.30:1	-	2	
2001-6115-00		1.10:1	1.20:1	1.30:1	-	2[5]	
2001-6116-00	dc - 12.4	1.05:1	1.05:1	-	-	2	
2001-6500-00	dc - 4.0	dc-2 1.10:0[3] 2-4 1.15:1	-	-	-	2	0.5
2001-6501-00		dc-2 1.10:1[3] 2-4 1.15:1	-	-	-	2	1.0

[1] See Derating Curve
[2] VSWR based on 1.05 + 0.01 f(GHz) Max.
[3] Optimized VSWR units available. 1.05:1 to 2.0 GHz and 1.10:1 to 4.0 GHz. Change last two digits of part number to 94.
[4] Calibrated termination supplied with data identifying actual VSWR values at 2.0, 4.0, 12.4 and 18.0 GHz. Finish is gold.
[5] With Bead Chain.
Standard finish is gold. For passivated stainless steel, change the part number suffix from -00 to -02. Part Number 2001-6143-00 available in gold only.

Specifications Subject to Change Without Notice.

OSM (SMA) Jack Terminations

2002/2004 Series

OSM Miniature Jack Coaxial Terminations feature models offering extremely low VSWR at frequencies up to 26.5 GHz. The small size of these models makes them ideal for high-density system application and laboratory use.

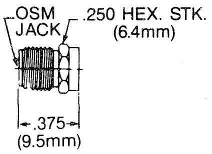


Fig. 1

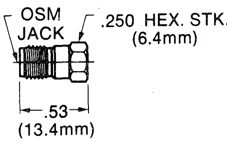


Fig. 2

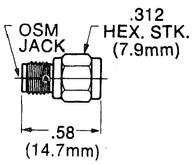
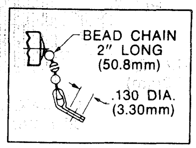


Fig. 3



Ultra Short Jack Terminations

Part Number	Frequency (GHz)	VSWR dc-4 GHz	VSWR 4-12.4 GHz	VSWR 12.4-18 GHz	VSWR 18-26.5 GHz	Fig.	Power Watts Avg.[1]
2004-6110-00	dc - 26.5	1.05:1	1.10:1	1.20:1	1.30:1	1	
2004-6117-00		1.05:1	1.05:1	1.10:1	-	1	
2004-6111-00		1.10:1	1.10:1	1.10:1	-	1	
2004-6112-00	dc - 18.0	1.05:1	1.15:1	1.20:1	-	1	0.5
2004-6113-00		1.10:1	1.20:1	1.30:1	-	1	
2004-6115-00		1.10:1	1.20:1	1.30:1	-	1[4]	
2004-6116-00	dc - 12.4	1.05:1	1.05:1	-	-	1	

Part Number	Frequency (GHz)	VSWR dc-4 GHz	VSWR 4-12.4 GHz	VSWR 12.4-18 GHz	VSWR 18-26.5 GHz	Fig.	Power Watts Avg.[1]
2002-6110-00	dc - 26.5	1.05:1	1.10:1	1.20:1	1.30:1	2	0.5
2002-6105-00		1.05:1	1.15:1	1.15:1	-	3[4]	
2002-6100-00		1.05:1	1.15:1	1.15:1	-	3	1.0
2002-6101-00		1.05:1	1.15:1	1.20:1	-	2	
2002-6118-00[3]		1.05:1	1.05:1	1.05:1	-	2	
2002-6117-00	dc - 18.0	1.05:1	1.05:1	1.10:1	-	2	
2002-6111-00		1.10:1	1.10:1	1.10:1	-	2	
2002-6112-00		1.05:1	1.15:1	1.20:1	-	2	0.5
2002-6113-00		1.10:1	1.20:1	1.30:1	-	2	
2002-6114-00		1.10:1	1.20:1	1.30:1	-	2[4]	
2002-6116-00	dc - 12.4	1.05:1	1.05:1	-	-	2	
2002-6500-00	dc - 4.0	dc-2 1.10:0[2] 2-4 1.15:1	-	-	-	2	0.5

[1] See Derating Curve
[2] Optimized VSWR units available. 1.05:1 to 2.0 GHz and 1.10:1 to 4.0 GHz. Change last two digits of part number to 94.
[3] Calibrated termination supplied with data identifying actual VSWR values at 2.0, 4.0, 12.4 and 18.0 GHz. Finish is gold.
[4] With Bead Chain.
Standard finish is gold. For passivated stainless steel, change the part number suffix from -00 to -02. Part Number 2002-6118-00 available in gold only.

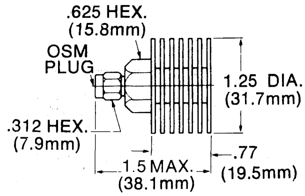
Specifications Subject to Change Without Notice.

M/A-COM

High Power Terminations and OS-50 (2.4mm) Terminations

2001/8501 Series

High Power Terminations



PLUG PART NO.	Power Avg. (Watts)	FIG.	VSWR dc-4 GHz	VSWR 4-12.4 GHz	VSWR 12.4-18 GHz
2001-6005-00	5	9	1.05:1	1.15:1	1.25:1
2001-6010-00	10	9	1.05:1	1.15:1	1.25:1

Connector finish is passivated stainless steel, with stainless coupling nut and black anodized aluminum body.
See Derating Curve.

OS-50 (2.4mm)

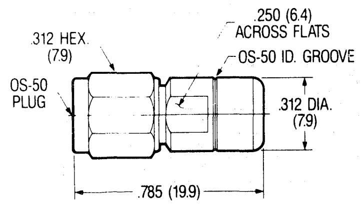


Fig. 1

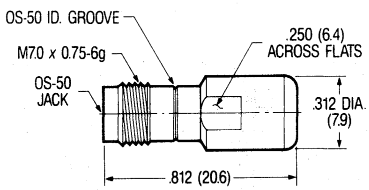


Fig. 2

Part Number Plug	Fig.	Part Number Jack	Fig.	VSWR dc-18 GHz	VSWR 18-26.5 GHz	VSWR 26.5-50 GHz
8501-6119-02	1	**8502-6119-02**	2	1.10	1.15	1.30

Frequency:
dc - 50.0 GHz

Power:
0.5 Watts Average
See Derating Curve

Finish:
Passivated stainless steel

Specifications Subject to Change Without Notice.

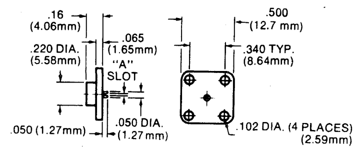
OSM (SMA), OSSM (SSMA) and Type N Terminations

OSM (SMA) Flange Mount

Part Number	Frequency (GHz)	VSWR (max.)	A Slot
2068-6101-00	dc - 18	dc to 4 GHz 1.10	.015 (.4mm)
2068-6102-00		4 to 12.4 GHz 1.20	.020 (.5mm)
2068-6103-00		12.4 to 18 GHz 1.30	.030 (.8mm)

Power:
0.5 Watts Average
See Derating Curve

Weight:
.05 oz. (1.4g)



OSSM (SSMA) Subminiature

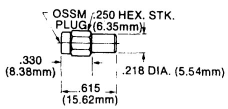


Fig. 1

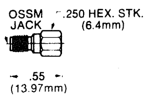
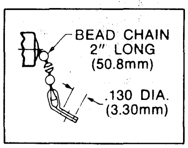


Fig. 2



Part Number Plug	Fig.	Part Number Jack	Fig.	Frequency (GHz)	VSWR	Weight	
						Plug	Jack
1001-6113-00	1	**1002-6113-00**	2	dc - 18	dc to 4 GHz 1.10 4 to 12.4 GHz 1.15 12.4 to 18 GHz 1.25	.08 oz.(2.3g)	.06 oz.(1.6g)
1001-6115-00	1*	**1002-6114-00**	2*			.11 oz.(3.0g)	.09 oz.(2.5g)

* With Bead Chain.

Power:
0.5 Watts Average
See Derating Curve

Finish:
Standard finish is gold.
For passivated stainless steel, change the part number suffix from -00 to -02.

Type N

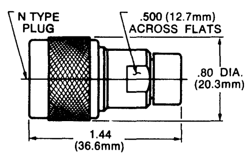


Fig. 1

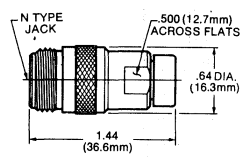


Fig. 2

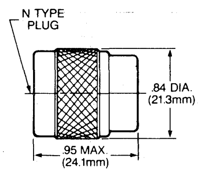
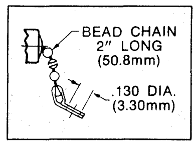


Fig. 3



Part Number Plug	Fig.	Part Number Jack	Fig.	Frequency (GHz)	VSWR	Weight	
						Plug	Jack
3001-6113-00	1	**3002-6113-00**	2	dc - 12.4	dc to 8 GHz 1.15 8 to 12.4 GHz 1.20	1.5 oz.(41.7g)	1.4 oz.(38.5g)
3001-6121-02	3	-	-	dc - 12.4	dc to 12.4 GHz 1.15	1.3 oz. (37g)	-
3001-6125-02	3*	-	-			1.3 oz. (37g)	-
3001-6100-00	1	**3002-6100-00**	2	dc - 18	dc to 12.4 GHz 1.15 12.4 to 18 GHz 1.20	1.5 oz.(41.7g)	1.4 oz.(38.5g)
3001-1316-00	1*	-	-			1.5 oz (41.7g)	-
3001-6120-02	3	-	-			1.3 oz. (37g)	-
3001-6124-02	3*	-	-			1.3 oz. (37g)	-

* With Bead Chain.

Power:
2.0 Watts Average
See Derating Curve

Finish:
Passivated Stainless Steel

Specifications Subject to Change Without Notice.

Plug Short Circuit Terminations

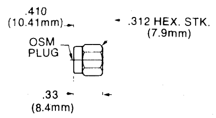


Fig. 1

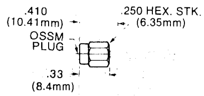


Fig. 2

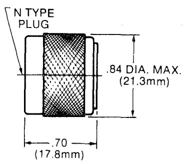


Fig. 3

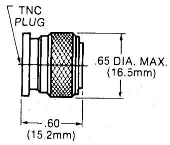


Fig. 4

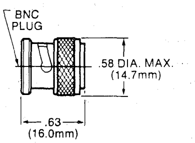
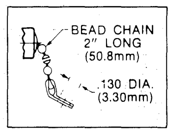


Fig. 5



Type	Part Number	Fig.	Finish	Weight
OSM (SMA)	**2021-1314-00★**	1	1	.12 oz. (3.4g)
	2021-1312-00★	1*	1	.13 oz. (3.7g)
OSSM (SSMA)	**1021-1314-00★**	2	1	.09 oz. (2.6g)
	1021-1312-00★	2*	1	.1 oz. (2.9g)
Type N	**3001-1314-02★**	3	2	.9 oz. (25.2g)
	3001-1312-02★	3*	2	.91 oz. (25.5g)
TNC	**3101-1314-02★**	4	2	.5 oz. (14.0g)
	3101-1312-02★	4*	2	.51 oz. (14.3g)
BNC	**3201-1314-02★**	5	2	.4 oz. (11.2g)
	3201-1312-02★	5*	2	.41 oz. (11.5g)

* With Bead Chain.

Finish:
1 Gold plated. For passivated stainless steel, change the part number suffix from -00 to -02.
2 Passivated stainless steel.

Jack Short Circuit Terminations

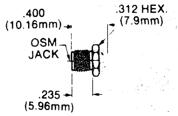


Fig. 1

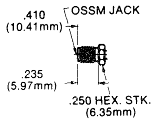


Fig. 2

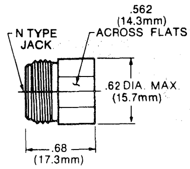


Fig. 3

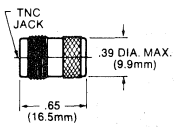


Fig. 4

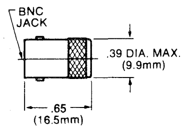
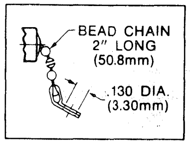


Fig. 5



Type	Part Number	Fig.	Finish	Weight
OSM (SMA)	2020-1314-00	1	1	.09 oz. (2.6g)
	2020-1312-00	1*	1	.1 oz. (2.9g)
OSSM (SSMA)	1020-1314-00	2	1	.07 oz. (2.0g)
	1020-1312-00	2*	1	.08 oz. (2.3g)
Type N	3002-1314-02	3	2	.75 oz. (21.1g)
	3002-1312-02	3*	2	.76 oz. (21.3g)
TNC	3102-1314-02	4	2	.22 oz. (6.3g)
	3102-1312-02	4*	2	.23 oz. (6.4g)
BNC	3202-1314-02	5	2	.21 oz. (6.0g)
	3202-1312-02	5*	2	.22 oz. (6.3g)

* With Bead Chain.

Finish:
1 Gold plated. For passivated stainless steel, change the part number suffix from -00 to -02.
2 Passivated stainless steel.

Specifications Subject to Change Without Notice.

Plug Dust Cap Terminations

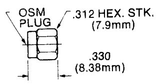


Fig. 1

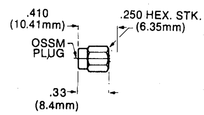


Fig. 2

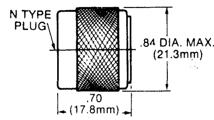


Fig. 3

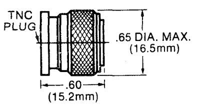


Fig. 4

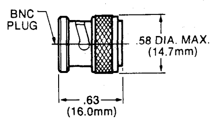
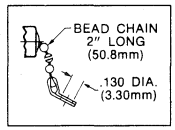


Fig. 5



Standard 2 inch Bead Chain

Type	Part Number	Fig.	Finish	Weight
OSM (SMA)	**2021-1311-00**	1	1	.12 oz. (3.4g)
	2021-1310-00	1*	1	.13 oz. (3.6g)
OSSM (SSMA)	**1021-1311-00**	2	1	.09 oz. (2.6g)
	1021-1310-00	2*	1	.1 oz. (2.8g)
Type N	**3001-1315-02**	3	2	.9 oz. (25.7g)
	3001-1310-02	3*	2	.1 oz. (2.8g)
TNC	**3101-1315-02**	4	2	.5 oz. (14.0g)
	3101-1310-02	4*	2	.51 oz. (14.3g)
BNC	**3201-1315-02**	5	2	.4 oz. (11.4g)
	3201-1310-02	5*	2	.41 oz. (11.5g)

* With Bead Chain.

Finish:
1 Gold plated. For passivated stainless steel, change the part number suffix from -00 to -02.
2 Passivated stainless steel.

Jack Dust Cap Terminations

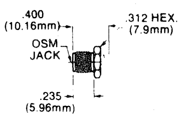


Fig. 1

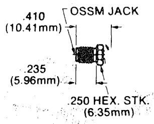


Fig. 2

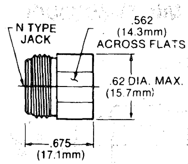


Fig. 3

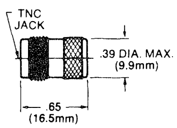


Fig. 4

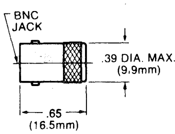
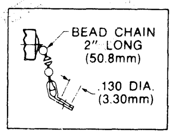


Fig. 5



Type	Part Number	Fig.	Finish	Weight
OSM (SMA)	**2020-1311-00**	1	1	.08 oz. (2.2g)
	2020-1310-00	1*	1	.09 oz . (2.6g)
OSSM (SSMA)	**1020-1311-00**	2	1	.07 oz. (2.0g)
	1020-1310-00	2*	1	.08 oz. (2.2g)
Type N	**3002-1315-02**	3	2	.7 oz. (20.0g)
	3002-1310-02	3*	2	.71 oz. (20.0g)
TNC	**3102-1315-02**	4	2	.21 oz. (6.0g)
	3102-1310-02	4*	2	.22 oz. (6.2g)
BNC	**3202-1315-02**	5	2	.21 oz. (6.0g)
	3202-1310-02	5*	2	.22 oz. (6.2g)

* With Bead Chain.

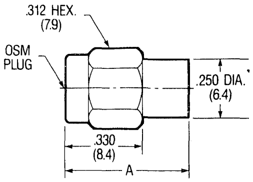
Finish:
1 Gold plated. For passivated stainless steel, change the part number suffix from -00 to -02.
2 Passivated stainless steel.

![M/A-COM]

QPL (Dummy Load) Terminations

2001/2002 Series

MIL-D-39030/3



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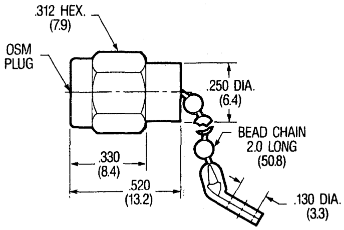

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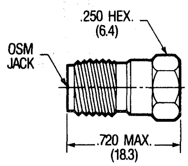

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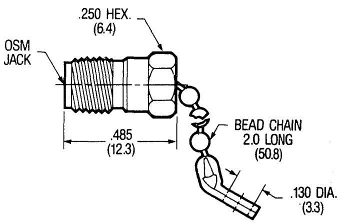

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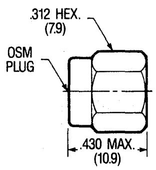


42

Military Part Number	M/A-COM Part Number	Outline	Dim. A Inches	(mm)	Commercial Alternate
-01	2001-4178-00N	38	.520	(13.2)	**2001-6112-00**
-02	2001-4182-02N	38	.520	(13.2)	**2001-6112-02**
-03	2001-4173-00N	39	—		—
-04	2001-4173-02N	39	—		—
-05	2002-4065-00N	40	—		**2002-6112-00**
-06	2002-4065-02N	40	—		**2002-6112-02**
-07	2002-4066-00N	41	—		—
-08	2002-4066-02N	41	—		—
-09	2001-4302-00N	38	.520	(13.2)	**2001-6111-00**
-10	2001-4303-00N	38	.520	(13.2)	—
-11	2001-4301-00N	42	—		**2003-6117-00**
-12	2001-4294-00N	38	.550 Max.	(14.0)	**2001-6110-00**
-13	2001-4304-00N	39	—		—
-15	2001-4305-00N	38	.520	(13.2)	**2001-6116-00**

M/A-COM part number reflects non-screened unit. For screened unit, change "N" to "S"

3 dB Hybrid Coupler

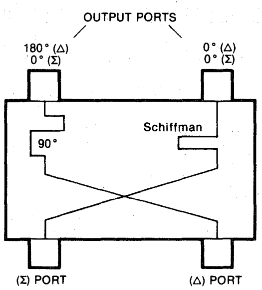
Selection Guide

Hybrid Type	Crossover 90° Stripline	Non-crossover 90° Air Dielectric	Crossover 180° Stripline
Part Number Series	2032	2035	2031
Frequency Range (GHz)	Octave and Multi-Octave .06-18.0	Octave 1.0-18.0	Octave 1.0-18.0
VSWR[1]	1.25	1.25	1.35
Insertion Loss (dB)[1]	0.25	0.20	0.7
Isolation(dB)[1]	22	18	22
Amplitude Balance (dB)[1]	±0.5	±0.5	±0.5
Input Power (Avg. Watts)[1]	30	50	30
Major Features	Small Size	Low Loss	0° and 180° Outputs

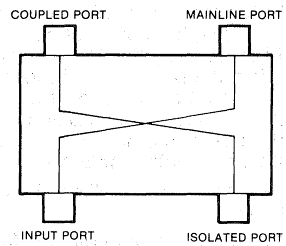
[1] Representative specifications for 3 dB hybrid in 2.0 - 4.0 GHz frequency range for part numbers shown in Table I.

TABLE I

For 2032 series, part number 2032-6345-00
For 2035 series, part number 2035-6365-00
For 2031 series, part number 2031-6332-00



180° CROSSOVER HYBRID



90° CROSSOVER HYBRID

Specifications Subject to Change Without Notice.

Coupler

Overview

- 60 MHz to 50 GHz Performance
- Octave and Multi-Octave Bands
- High Directivity
- Subminiature Size
- OSM (SMA) Connectors Standard. Other connector types available upon request
- Meets MIL-E-5400 Environments

A directional coupler is a 4-port device in which two transmission lines pass close enough to each other for energy propagating on one line to couple to the other line. All four ports are matched to the characteristic impedance (usually 50 ohms). A schematic of a directional coupler is shown below.

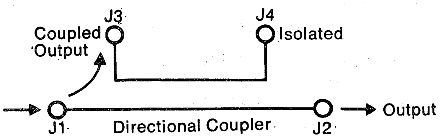


FIGURE 1.

Power incident upon port 1 is partially coupled to port 3. In a 10 dB coupler, for example, the power at port 3, referenced to the input, will be down by 10 dB (1/10 the power). The remaining 9/10 of the power (.46 dB loss) will pass through the coupler to the output port (port 2). Port 4, the "isolated" port, will receive no power in an ideal coupler. Similarly, power incident to port 2 would couple to port 4 with port 3 being isolated.

Practical couplers, however, are more involved. They have the following limitations:

1. **Frequency:** Directional couplers exhibit useful coupling characteristics over finite frequency bands.
2. **Coupling:** Coupling is not constant, but varies a finite amount with frequency. The amount of this variation or ripple can be controlled. A perfectly flat coupler (i.e. a coupler with no variation in coupling) theoretically cannot be built. Furthermore, due to manufacturing tolerances, there will be some variation of coupling from coupler to coupler even on couplers of the same design.

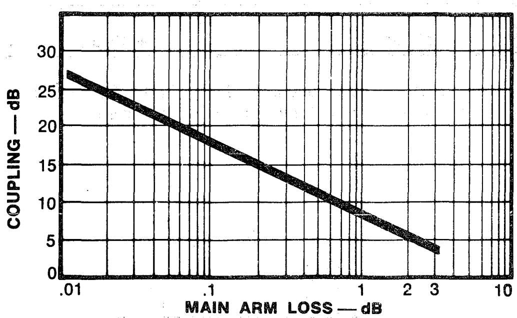
   Coupling is defined as follows:

   $$\text{Coupling (dB)} = -10 \text{ Log} \left(\frac{P3}{P1}\right)$$

   where P3 and P1 are the RF power levels at ports 3 and 1 respectively.
3. **Loss:** In an ideal dissipationless coupler, the main line loss (J1-J2) due to power coupled to the coupled output port is:

   $$\text{Insertion Loss (dB)} = 10 \text{ Log} \left(1-\frac{P3}{P1}\right)$$

   The effect of dissipation in the circuit will be to raise the insertion loss by the power dissipation in dB. A graph of the theoretical insertion loss (dB) vs coupling (dB) for a dissipationless coupler is shown below.



4. **Directivity:** In actual directional couplers, the isolated port is never completely isolated. Some RF power will always be present at the isolated port. If the power out of the isolated port is 20 dB below the power out of the coupled port, the coupler is said to have 20 dB directivity. Referring to the

diagram of Figure 1, directivity is defined as follows:

$$\text{Directivity (dB)} = -10 \text{ Log } \left(\frac{P4}{P3}\right)$$

where power is incident to port 1. The terms P4 and P3 represent the power at ports 4 and 3 respectively. The negative sign in the equation results in the directivity always being a positive number.

5. **Isolation:** Isolation is another term which measures how much leakage gets to the isolated port.

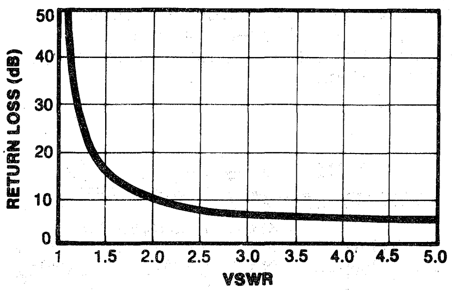
$$\text{Isolation (dB)} = -20 \text{ Log } \left(\frac{P4}{P1}\right)$$

where P4 and P1 are the power levels at ports 4 and 1 respectively. Isolation and directivity measure the same characteristic.

Isolation (dB) = Coupling (dB) + Directivity (dB)

For example, a 10 dB coupler with 20 dB directivity would have 30 dB isolation. Directivity, rather than isolation, is usually specified on directional couplers. For 3 dB hybrid couplers, which are described later, isolation is usually specified.

6. **VSWR :** Like all microwave components, directional couplers are plagued with reflections from mismatches and discontinuities within the circuitry. In directional couplers, a mismatch on the output port or coupled output port (ports 2 and 3 respectively in Figure 1) reduces directivity by an amount equal to the return loss (in dB) of the mismatch. It makes no difference whether the mismatch is actually inherent in the coupler circuit itself or is connected to the output port of the coupler. It is this property of couplers which makes them useful in reflectometer set-ups to measure VSWR. By measuring the directivity of a coupler which otherwise has very high directivity and good VSWR, the VSWR of the load connected to the output port can be determined. The relation between return loss (dB) and VSWR is shown by the following graph and equation:



$$\text{Return loss (dB)} = -10 \text{ Log } \left(\frac{VSWR-1}{VSWR+1}\right)^2$$

FIGURE 1.

There are a few other directional coupler terms which are frequently used:

Main Line — The circuit between the input and output ports (ports 1 and 2) is called the main line. This is usually the line on which the signal to be sampled propagates.

Coupled Line — The transmission line to which the mainline signal is coupled is called the coupled arm or coupled line. Usually the isolated port on the coupled line is terminated with a 50 ohm load.

90° HYBRIDS

Hybrid or hybrid-couplers are basically 3 dB directional couplers in which the phase of the coupled output signal and the output signal are 90° apart.

Since −3 dB represents half power, a 3 dB coupler divides the power equally (within a certain tolerance) between the output and coupled output ports. The 90° phase difference between the outputs makes hybrids useful in the design of electronically variable attenuators, microwave mixers, modulators and many other microwave components and systems.

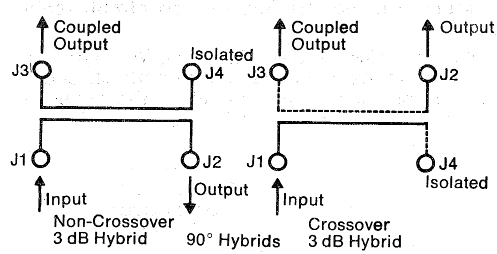


FIGURE 2.

Hybrids are available in non-crossover and the crossover configuration (see Figure 2). The crossover configuration has both the output and the coupled output ports on the same side of the circuit while the outputs of the non-crossover circuit are on opposite sides. The differences are purely mechanical.

Ninety degree hybrids are also called quadrature hybrids because the phase of the two outputs are a quadrant (90°) apart. Note also that it does not make any difference which port is the input port as long as the relationship between ports remains. This is because both electrically and mechanically the 90° hybrids are symmetrical about both the X and Y axes.

180° HYBRIDS

In addition to the quadrature hybrids, Omni Spectra offers a line of 180° hybrid couplers. The 180° hybrid circuit consists of a 90° hybrid coupler with a Schiffman phase shifter connected as shown in Figure 3.

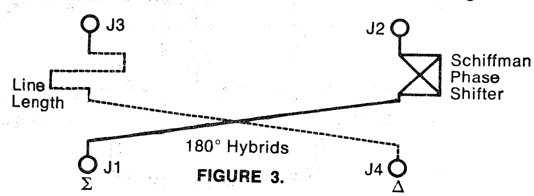


FIGURE 3.

A signal incident to port 1 splits equally between ports 2 and 3 with equal phase with port 4 being isolated. With port 4 as an input, equal amplitude outputs occur at ports 2 and 3 with a 180° phase difference while port 1 is isolated.

When coherent inputs are applied to ports 2 and 3 simultaneously, port 1 yields a signal that is the sum (Σ) of the two inputs while port 4 yields a signal that is the difference (Δ) of the two inputs. Ports 2 and 3 are isolated from each other.

Applications of 180° hybrids include monopulse comparitors (in monopulse radar systems), mixers, power combiners, power dividers, modulators and phased array radar antenna systems.

COUPLER CIRCUITS

There are a variety of ways to construct directional couplers. Many of Omni Spectra's standard couplers are constructed using stripline printed circuit techniques.

Single Section Couplers — The simplest type of coupler circuit is the single section directional coupler. This type of coupler may be either the offset or overlap configurations shown in Figure 4.

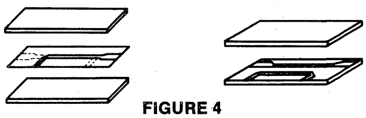


FIGURE 4

The offset coupler circuit is typically etched on a printed circuit board, over which is placed the blank dielectric board. The overlap coupler is usually etched on both sides of a thin sheet of dielectric material and sandwiched between sections of dielectric. The construction used is based on coupling, frequency and other requirements. Generally, overlap couplers are used for coupling values from 3 to 10 dB; a 3 dB coupler being almost a complete overlap. All stripline coupler circuits are constructed in solid, completely enclosed aluminum housings. This provides complete EMI and environmental sealing.

Multi-Section Couplers — Most octave bandwidth low frequency couplers up to 4 GHz are single section couplers. Multi-section couplers are used in place of single section couplers to increase the bandwidth and flatten out the frequency response. Some of the sections may be overlap couplers and some may be offset. Multi-section couplers may be either symmetric or asymmetric.

Asymmetric couplers may have any number of sections. For a given overall length they result in greater bandwidth and/or flatter frequency response than corresponding symmetric couplers. Two, three and four section asymmetric couplers are used in most dog-bone, mini and internally loaded couplers from 4 to 18 GHz.

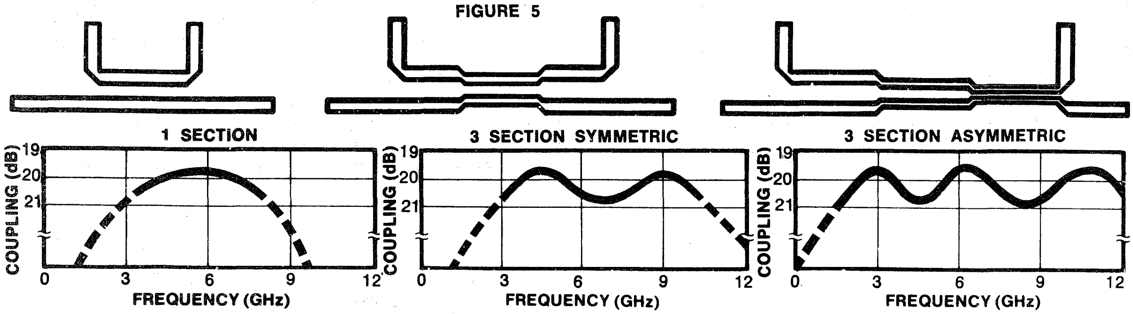
Symmetric couplers must be an odd number of sections and usually are 1, 3, or 5 sections (note that a single section coupler is symmetric). Symmetric couplers are quadrature and thus must be used for all hybrids. Low frequency octave band hybrids up to 4 or 8 GHz are single section symmetric couplers. Three section symmetric couplers are used on higher frequency models.

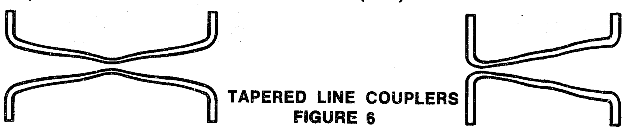
Shown, for comparison, are coupler circuits for single section, three section symmetric and three section asymmetric couplers together with their theoretical coupling curves. All couplers have their operating frequencies centered at 6 GHz (see Figure 5).

Tapered Line Couplers — A tapered line coupler is a coupler in which the coupling varies continuously along the coupling region. Tapered line couplers usually are either symmetric or asymmetric as shown in Figure 6.

Symmetric tapered line couplers have theoretical coupling curves similar to the multi-section symmetric couplers after which they are patterned. They also have quadrature coupling like other symmetric couplers. They usually have better VSWR and directivity, but are most difficult to construct and require more room than symmetric stepped couplers. The (2032-6370-00) utilizes two symmetric tapered line couplers connected in tandem.

FIGURE 5





TAPERED LINE COUPLERS
FIGURE 6

Asymmetric tapered line couplers represent the ultimate for broad bandwidth. Since they are high pass coupler circuits, there is no theoretical limit to the upper frequency at which any asymmetrical coupler will function properly. Practical limits to the upper operational frequency include losses in the stripline circuit, moding in the coupler cavity and the VSWR of discontinuities in the circuit.

Tandem Couplers — In many instances, especially in the design of very broad band 3 dB couplers, the previously mentioned couplers have some deficiencies. In such instances, these deficiencies may be overcome by using a tandem inter-connection of couplers as shown in Figure 7.

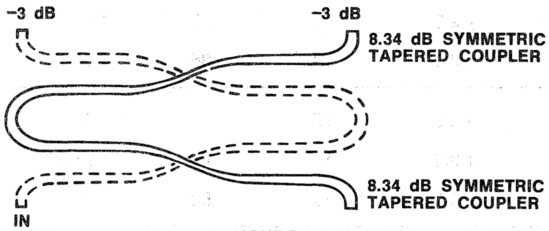


FIGURE 7
TANDEM COUPLER

Such a configuration was used in the design of the (2032-6370-00) 2 to 12.4 GHz hybrid. The hybrid consists of two tandemly connected 8.34 dB symmetric tapered line couplers. The end result is a 3 dB hybrid with ±.5 dB frequency sensitivity and typically 20 dB isolation from 2 to 12 GHz.

Computer Aided Design — M/A-COM is currently building both types of state-of-the-art tapered line couplers and have developed a number of computer programs with which to facilitate the design of a wide variety of directional couplers. Also available, are a number of other programs which can be used for microwave analysis as well as computer simulation of microwave networks.

Coupler Specifications — All couplers in this catalog are specified as follows:

Part Number	2020-6621-10
Frequency Range (GHz)	7-12.4
Coupling (includes Frequency Sensitivity) (dB)	10 ± .75
Frequency Sensitivity (dB)	± .4
Insertion Loss (dB) max.)	.4
Directivity (dB) min.)	20
VSWR (max.)	1:30:1

The part number and frequency range are self-explanatory.

Coupling, as specified, includes frequency sensitivity (which is specified separately). There are 3 requirements placed on the coupling characteristics:

1. The coupling of a 2020-6621-10 must be between 9.25 and 10.75 dB over the frequency range. Coupling is referenced to the input port.
2. The frequency sensitivity of the coupling is ±.4. Thus, the coupling cannot vary more than 0.8 dB over the frequency range even though the coupling curve can be anywhere within a 10 ±.75 dB window.
3. The insertion loss is the maximum amount which the mainline loss will exceed the theoretical loss of a dissipationless coupler.

Special Units — The factory should be consulted on couplers to meet special requirements such as extended or narrow bandwidths; non-standard frequency bands and coupling levels connectors other than OSM (SMA) or tighter toleranced couplers.

M/A-COM's inventory of standard and special coupler designs, together with rapid and accurate computer-aided design procedures, gives M/A-COM a fast turn-around time for design of special purpose assemblies, such as monopulse comparitors, quadrature feed networks, and sub-systems incorporating filters, attenuators and power dividers.

Specifications Subject to Change Without Notice.

Commercial Equivalent Couplers
MIL-P-23971/2 — 203X Series

Military Dash Number	M/A-COM Part Number	Frequency Range (GHz)	Coupling (dB) (Mid.-Frequency)	Output To Output Amplitude Equality (dB Max.)	Output To Output Phase Equality (Max.)[1]	Isolation (dB Min.)	Insertion Loss (dB Max.)[2]	VSWR (Max.) Primary Line
-06	2030-4006-00	.5-1.0	$3.0^{+0.2}_{-0.0}$	±0.5	±1.5	18	.25	1.25:1
-07	2035-4002-00	1.0-2.0	$3.0^{+0.2}_{-0.0}$	±0.5	±1.5	18	.25	1.25:1
-08	2035-4003-00	2.0-4.0	$3.0^{+0.2}_{-0.0}$	±0.5	±2.0	18	.25	1.25:1
-09	2035-4004-00	4.0-8.0	$3.0^{+0.35}_{-0.0}$	±0.5	±2.0	18	.35	1.30:1
-10	2032-4041-00	7.0-11.0	$3.0^{+0.5}_{-0.0}$	±0.5	±2.0	17	-	1.45:1
-11	2035-4005-00	8.0-12.4	$3.0^{+0.4}_{-0.0}$	±0.5	±3.0	15	.40	1.35:1
-12	2035-4006-00	12.4-18.0	$3.0^{+0.5}_{-0.0}$	±0.5	±5.0	15	.50	1.45:1

Notes:
Para. 3.4.6 MIL-C-22750 Epoxy paint will be used.
Para. 3.11 Units will be humidity sealed.

1. Phase Equality is defined as the difference in phase between the outputs from the nominal phase difference. For example, the quadrature coupler has a 90° nominal phase difference, so a typical measurement would be 90 ±3°.
2. Insertion Loss is defined as the net unrecovered power, in dB, based on one-way transmission through the device at any particular frequency.

M/A-COM

3 dB 90° Crossover Hybrid Couplers
Broadband, High Power

2032/3132 Series

- **90° Quadrature Phase**
- **Small Package Size**
- **Low Insertion Loss**
- **High Isolation**
- **SMA or TNC Female Connectors**
- **Temperature Range: −54° to +100°C**
- **Meets MIL-E-5400 Environments**

These 3dB quadrature mini-hybrid couplers are the ultimate in compact, rugged, broadband, high power components. These stripline devices incorporate new design features for high thermal conductivity that allow the highest power rating available for components with SMA connectors.

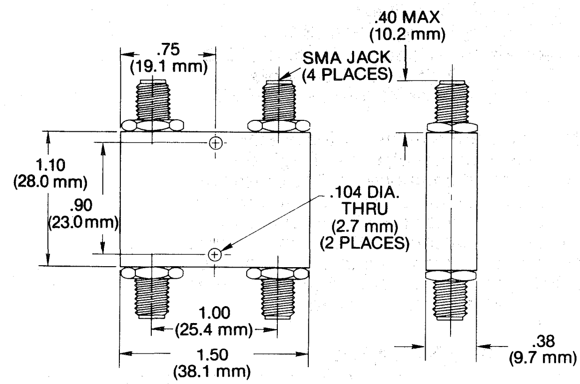


FIG. 1

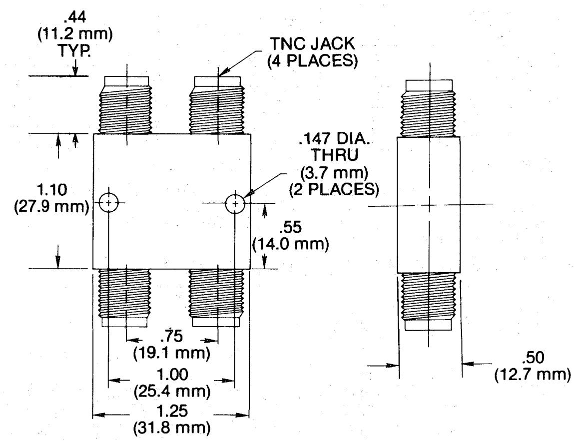


FIG. 2

NOTE: All dimensions are ±.020, except mounting hole diameters (±.005) and mounting hole location (±.010).

SPECIFICATIONS

PART NO.	FIG.	FREQUENCY RANGE (GHz)	AMPLITUDE BALANCE (dB)	INSERTION LOSS max. (dB)	ISOLATION min. (dB)	VSWR (max.)	POWER AVG. (W)	POWER PK. (kW)	WEIGHT oz.	WEIGHT g
2032-6375-00	1	4.0-18.0	±0.50	1.0	18	1.45	100	5	1.41	40
3132-6375-00	2	6.0-18.0	±0.75	.60	15	1.60	100	5	1.76	50

Specifications Subject to Change Without Notice.

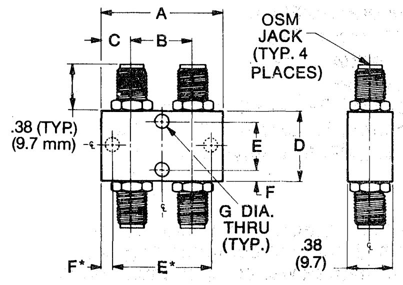
M/A-COM

3 dB 90° Crossover Hybrid Couplers

2032 Series

- **90° Quadrature Phase**
- **Frequency Range: .06 to 18 GHz**
- **Temperature Range: —65° to +125°C**
- **Meets MIL-E-5400 Environments**
- **Non-crossover Versions Available**

3dB quadrature mini-hybrids are the ultimate in compact, rugged high stress environment components. The crossover feature of the location of both outputs on one side allows simplicity in system or subsystem design. Multi-octave coverage of the complete frequency spectrum, along with high isolation performance, qualifies them as an asset to any system.



NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole location (± .010).

SPECIFICATIONS

PART NO.	CASE STYLE	FREQUENCY RANGE (GHz)	AMPLITUDE BALANCE (dB)	INSERTION LOSS max. (dB)	ISOLATION min. (dB)	VSWR (max.)	POWER AVG. (W)	POWER PK. (kW)
2032-6344-00	3	1.0-2.0	±0.5	.20	22	1.20	30	3
2032-6345-00	4	2.0-4.0	±0.5	.25	22	1.25	30	3
2032-6347-00	5	4.0-8.0	±0.5	.30	20	1.25	30	3
2032-6348-00	5	8.0-12.4	±0.5	.50	18	1.35	30	3
2032-6349-00	5	12.4-18.0	±0.5	.50	18	1.45	30	3
2032-6350-00	6	.5-2.0	±0.5	.60	24	1.20	30	3
2032-6352-00	7	2.0-8.0	±0.5	.50	20	1.30	30	3
2032-6354-00	8	4.0-12.4	±0.5	.60	20	1.25	50	3
2032-6371-00	10	2.0-18.0	±1.0	.60***	20****	1.45	50	3
2032-6374-00	5	6.5-18.0	±0.5	.60	18	1.35	30	3
2032-6375-00	11	4.0-18.0	±0.5	.80	18	1.45	100	5

MULTI-OCTAVE

HIGH POWER

*These dimensions apply only to part nos. 2032-6350-00 and 2032-6354-00.
**Insertion loss is 0.8dB from 8.0 to 12.4 GHz.
***Insertion loss is 1.2dB from 6.0 to 12.4 GHz and 1.5dB from 12.4 to 18.0 GHz.
****Isolation is 15dB from 12.4 to 18.0 GHz.

MECHANICAL SPECIFICATIONS

CASE STYLE	SIZE. INCHES (mm) A	B	C	D	E	F	G	WEIGHT oz.	WEIGHT g
3	1.78 (45.2)	1.28 (32.5)						.84	24
4	1.16 (29.4)	.66 (16.7)	.25 (6.35)	.50 (12.7)	.31 (7.9)	.09 (2.4)	.104 (2.6)	.65	19
5	1.0 (25.4)	.50 (12.7)						.60	17
6	5.58 (141.7)	5.0 (127)	.29 (7.3)	.70 (17.9)	5.42 (137.7)	.08 (2.0)	.093 (2.4)	2.35	67
7	1.71 (43.4)	1.21 (30.7)	.25 (6.33)	.50 (12.7)	.31 (7.9)	.09 (2.4)	.104 (2.6)	.82	23
8	1.72 (43.7)	1.22 (31)		1.07 (27.2)	.58 (14.7)	.57 (14.5)		1.40	40
10	1.88 (47.6)	1.41 (35.9)	.23 (5.7)	1.3 (33)	1.06 (26.9)	.12 (3.1)	.14 (3.6)	1.76	50
11	1.50 (38.1)	1.00 (25.4)	.25 (6.4)	1.10 (28.0)	.90 (23.0)	.10 (2.5)	.104 (2.6)	1.41	40

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

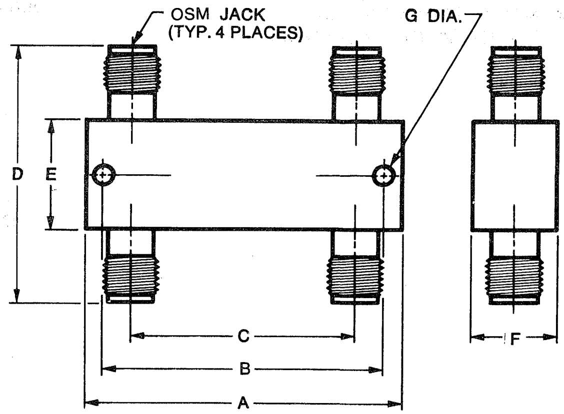
3 dB 90° Non-Crossover Hybrid Couplers Air Dielectric

2035 Series

- 90° Quadrature Phase
- Frequency Range: 1.0 to 18 GHz
- Temperature Range: −50° to +110°C
- Meets MIL-E-5400 and MIL-E-16400 Environments
- MIL-C-15370/8 Equivalent

These 3dB coaxial hybrids are ultra-compact. A signal applied into any terminal appears at both outputs with one-half the amplitude and shifted 90 degrees out of phase.

The units mount four OSM jack, low VSWR connectors. These couplers may be used in mixers, duplexers and other applications requiring equal power division.



NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole location (± .010).

SPECIFICATIONS

PART NO.	MODEL NO.	CASE STYLE	FREQUENCY RANGE (GHz)	AMPLITUDE BALANCE (dB)	INSERTION LOSS max.(dB)	ISOLATION min.(dB)	VSWR (max.)	POWER AVG. (W)	POWER PK. (kW)
2035-6364-00	20153-3	1	1.0-2.0	±0.4	0.20	20	1.25	50	3
2035-6365-00	20154-3	2	2.0-4.0	±0.5	0.20	18	1.25	50	3
2035-6366-00	201545-3	3	2.6-5.2	±0.5	0.20	18	1.25	50	3
2035-6367-00	20155-3	4	4.0-8.0	±0.5	0.30	18	1.25	50	3
2035-6368-00	20156-3	5	8.0-12.4	±0.5	0.35	15	1.30	50	3
2035-6369-00	20157-3	5	12.4-18.0	±0.5	0.35	15	1.35	50	3

MECHANICAL SPECIFICATIONS

CASE STYLE	SIZE. INCHES (mm) A	B	C	D	E	F	G	WEIGHT oz.	WEIGHT g
1	2.55 (64.8)	2.39 (60.8)	1.97 (50.1)					1.80	52
2	1.69 (42.7)	1.52 (38.7)	1.11 (28.2)					1.10	32
3	1.41 (35.6)	1.24 (31.5)	.82 (20.8)	1.16 (29.5)	.50 (12.7)	.38 (9.7)	.093 (2.4)	0.99	28
4	1.13 (28.7)	.97 (24.7)	.55 (14)					0.89	26
5	1.08 (27.4)	.92 (23.4)	.50 (12.7)	1.28 (32.5)	.63 (15.9)			0.93	27

Specifications Subject to Change Without Notice.

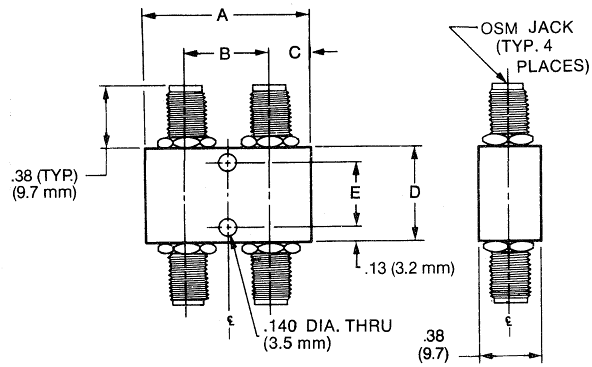
M/A-COM

3 dB 180° Crossover Hybrid Couplers

2031 Series

- 0° or 180° Phase Difference
- High Isolation
- Low VSWR
- Multi-Octave Frequency Range
- Temperature Range: −65° to +125°C
- Meets MIL-E-5400 and MIL-E-16400 Environments

These 3dB 180° mini-hybrids are highly reliable rugged stripline-constructed units that can be used either to divide or combine R.F. power. A signal incident at the sum (Σ) port will yield in-phase amplitude balanced signals at the output ports. Conversely, a signal applied to the difference (Δ) port will yield amplitude balanced and 180° out of phase signals at the output ports.



NOTE: All dimensions are ±.020, except mounting hole diameters (±.005) and mounting hole location (±.010).

SPECIFICATIONS

PART NO.	CASE STYLE	FREQUENCY RANGE (GHz)	AMPLITUDE BALANCE (dB)	INSERTION LOSS max. (dB)	ISOLATION min.(dB)	VSWR (max.)	PHASE BALANCE (DEGREES)	POWER AVG. (W)	POWER PK. (kW)
2031-6330-00	1	0.5-1.0	±0.5	0.4	25	1.30	±4	30	3
2031-6331-00	2	1.0-2.0	±0.5	0.5	25	1.35	±4	30	3
2031-6332-00	3	2.0-4.0	±0.5	0.7	22	1.35	±5	30	3
2031-6333-00	4	2.6-5.2	±0.5	0.7	20	1.35	±5	30	3
2031-6334-00	4	4.0-8.0	±0.5	0.7	20	1.35	±6	30	3
2031-6335-00	7	8.0-12.4	±0.5	0.8	17	1.45	±6	30	3
2031-6336-00	7	12.4-18.0	±0.6	1.2	12	1.70	±6	30	3
2031-6338-00	6	4.0-12.4	±0.6	1.0	17	1.50	±8	30	3
2031-6339-00	7	7.0-18.0	±0.6	1.2	14	1.70	±8	20	2

} MULTI-OCTAVE

MECHANICAL SPECIFICATIONS

<table>
<tr><th rowspan="2">CASE STYLE</th><th colspan="5">SIZE, INCHES (mm)</th><th colspan="2">WEIGHT</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>oz.</th><th>g</th></tr>
<tr><td>1</td><td>3.25 (82.6)</td><td>2.5 (63.5)</td><td rowspan="3">.50 (12.7)</td><td rowspan="4">1.25 (31.8)</td><td rowspan="4">1.0 (25.4)</td><td>2.8</td><td>70</td></tr>
<tr><td>2</td><td>2.0 (50.8)</td><td>1.25 (31.8)</td><td>2.0</td><td>47</td></tr>
<tr><td>3</td><td>1.44 (36.5)</td><td>.69 (17.5)</td><td>1.5</td><td>38</td></tr>
<tr><td>4</td><td>1.25 (31.8)</td><td>.50 (12.7)</td><td>.38 (9.7)</td><td>1.5</td><td>38</td></tr>
<tr><td>6</td><td>1.5 (38.1)</td><td>.75 (19.1)</td><td rowspan="2">.38 (9.7)</td><td rowspan="2">1.0 (25.4)</td><td rowspan="2">.75 (19.1)</td><td>1.2</td><td>34</td></tr>
<tr><td>7</td><td>1.25 (31.8)</td><td>.50 (12.7)</td><td>1.1</td><td>31</td></tr>
</table>

Specifications Subject to Change Without Notice.

M/A-COM

Directional Coupler

Selection Guide

Directional Coupler Type	**Mini Stripline**	**Multi-Octave**	**Ultra Broadband**
Part Number Series	2020	2025	2026
Frequency Range (GHz)	Octave .5-18.0	Octave .5-18.0	1.0-12.4 2.0-18.0 1.0-18.0
Terminated Isolated Port	Internal	Internal	Internal
Coupling Range (dB)	6-30	6-20	10-20
VSWR[1]	1.15	1.20[2]	1.30[3]
Insertion Loss (dB Max.)[1]	0.2	0.3[2]	0.85[3]
Directivity (dB)[1]	22	18[2]	18[3]
Freq. Sensitivity (dB)[1]	± 0.75	± 0.4[2]	± 0.4[3]
Coupling Variation[1]	± 1.0	± 1.0[2]	± 1.0[3]
Major Features	Smallest Size Low Cost	Bandwidth	Bandwidth

[1] Representative specifications for 10 dB coupler in 2.0 - 4.0 GHz frequency range for part numbers shown in Table I.
[2] Representative specifications for 10 dB coupler in 1.0 - 4.0 GHz frequency range for part numbers shown in Table I.
[3] Representative specifications for 10 dB coupler in 1.0 - 12.4 GHz frequency range for part numbers shown in Table I.

TABLE I

For 2020 series, part number 2020-6609-10
For 2025 series, part number 2025-6006-10 (1.0 - 4.0 GHz)
For 2026 series, part number 2026-6001-10 (1.0 - 12.4 GHz)

M/A-COM

Commercial Equivalent Couplers
MIL-C-15370/9

202X Series

Military Dash Number	M/A-COM Part Number	Frequency Range (GHz)	Coupling (dB) (Mid.-Frequency)	Coupling Variation (dB Max.)	Effective Directivity (dB Min.)	Insertion Loss (dB Max.)	VSWR (Max.) Primary Line	Secondary Line
-001	2020-4015-06	1.0-2.0	6.0 $^{+0.5}$	1.2	25	.20	1.15:1	1.15:1
-002	2020-4015-10	1.0-2.0	10.0 $^{+0.5}$	1.5	25	.20	1.10:1	1.10:1
-003	2020-4015-20	1.0-2.0	20.0 $^{+0.5}$	1.5	25	.20	1.10:1	1.10:1
-004	2020-4015-30	1.0-2.0	30.0 $^{+0.5}$	1.5	25	.20	1.10:1	1.10:1
-005	2020-4016-06	2.0-4.0	6.0 $^{+0.5}$	1.2	22	.20	1.15:1	1.15:1
-006	2020-4016-10	2.0-4.0	10.0 $^{+0.5}$	1.5	22	.20	1.15:1	1.15:1
-007	2020-4016-20	2.0-4.0	20.0 $^{+0.5}$	1.5	22	.20	1.15:1	1.15:1
-008	2020-4016-30	2.0-4.0	30.0 $^{+1.0}$	1.5	22	.20	1.15:1	1.15:1
-009	2020-4017-06	4.0-8.0	6.0 $^{+0.5}$	1.2	20	.25	1.25:1	1.25:1
-010	2020-4017-10	4.0-8.0	10.0 $^{+0.5}$	1.5	20	.25	1.20:1	1.20:1
-011	2020-4017-20	4.0-8.0	20.0 $^{+0.5}$	1.5	20	.25	1.20:1	1.20:1
-012	2020-4018-06	7.0-12.4	6.0 $^{+0.5}$	1.0	17	.40	1.30:1	1.30:1
-013	2020-4018-10	7.0-12.4	10.0 $^{+0.75}$	1.0	17	.40	1.30:1	1.30:1
-014	2020-4018-20	7.0-12.4	20.0 $^{+0.5}$	1.0	17	.40	1.30:1	1.30:1
-015	2020-4114-06	12.4-18.0	6.0 $^{+0.5}$	1.0	12	.50	1.35:1	1.45:1
-016	2020-4114-10	12.4-18.0	10.0 $^{+0.5}$	1.0	12	.50	1.30:1	1.45:1
-017	2020-4114-20	12.4-18.0	20.0 $^{+0.5}$	1.0	12	.50	1.30:1	1.45:1
-018	2020-4018-30	7.0-12.4	30.0 $^{+1.0}$	1.0	17	.40	1.30:1	1.30:1
-019	2024-4044-10	11.0-17.0	10.0 $^{+0.5}$	1.0	15	.30	1.30:1	1.30:1
-020	2024-4044-20	11.0-17.0	20.0 $^{+0.5}$	1.0	20	.50	1.30:1	1.30:1
-021	2024-4044-30	11.0-17.0	30.0 $^{+0.5}$	1.0	20	.50	1.30:1	1.30:1
-022	2020-4115-06	7.5-16.0	6.0 $^{+1.10}$	0.6	12	.60	1.35:1	1.40:1
-023	2020-4115-10	7.5-16.0	10.0 $^{+1.50}$	0.75	12	.60	1.35:1	1.40:1
-024	2020-4115-20	7.5-16.0	20.0 $^{+1.25}$	0.75	12	.50	1.35:1	1.40:1
-025	2020-4115-30	7.5-16.0	30.0 $^{+1.25}$	0.75	12	.50	1.35:1	1.40:1
-026	2026-4015-16	1.0-18.0	16.0* $^{+1.00}$	1.50	15, 1.0-12.4 GHz 12, 12.4-18.0 GHz	.80	1.40:1	1.50:1

Notes:
Para. 3.4.6 MIL-C-22750 Epoxy paint will be used.
Para. 3.11 Units will be humidity sealed.

* Referenced to output port for use as leveling coupler.

Specifications Subject to Change Without Notice.

Commercial Equivalent Couplers
MIL-C-15370/10 — 202X Series

Military Dash Number	M/A-COM Part Number	Frequency Range (GHz)	Coupling (dB) (Mid.-Frequency)	Coupling Variation (dB Max.)	Effective Directivity (dB Min.)	Insertion Loss (dB Max.)	VSWR (Max.) Primary Line	Secondary Line
-001	2021-4009-06	.5-1.0	6.0	1.0	20	.20	1.25:1	1.25:1
-002	2021-4010-10	.5-1.0	10.0	1.5	20	.20	1.25:1	1.25:1
-003	2021-4011-20	.5-1.0	20.0	2.0	20	.20	1.25:1	1.25:1
-004	2023-4011-06	1.0-2.0	6.0	1.5	20	.20	1.25:1	1.25:1
-005	2023-4012-10	1.0-2.0	10.0	2.0	20	.20	1.25:1	1.25:1
-006	2023-4013-20	1.0-2.0	20.0	2.0	20	.20	1.20:1	1.20:1
-007	2023-4014-06	2.0-4.0	6.0	1.5	18	.20	1.20:1	1.20:1
-008	2023-4015-06	4.0-8.0	6.0	1.5	18	.25	1.25:1	1.25:1
-009	2023-4016-10	8.0-12.4	10.0	1.5	15	.35	1.30:1	1.30:1
-010	2023-4017-20	8.0-12.4	20.0	2.0	15	.35	1.30:1	1.30:1
-011	2023-4085-06	12.4-18.0	6.0	1.5	12	.40	1.35:1	1.35:1
-012	2020-4112-10	7.0-11.0	10.0	1.0	15	.35	1.30:1	1.30:1
-013	2020-4113-20	7.0-11.0	20.0	1.0	15	.40	1.30:1	1.30:1

Notes:
Para. 3.4.6 MIL-C-22750 Epoxy paint will be used.
Para. 2.11 Units will be humidity sealed.

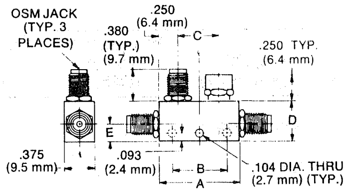
Specifications Subject to Change Without Notice.

M/A-COM

Directional Couplers
Mini, Octave Bandwidth

2020 Series

- **Smallest and Lightest Couplers Available**
- **.5 Through 18 GHz Including Wideband Units**
- **High Directivity — Low VSWR**
- **Meets MIL-E-5400 Environments**



NOTE: All dimensions are ±.020, except mounting hole diameters (±.005) and mounting hole location (±.010).

SPECIFICATIONS

PART NO.	CASE STYLE	FREQUENCY RANGE (GHz)	COUPLING (INCLUDES FREQUENCY SENSITIVITY) (dB)	FREQUENCY SENSITIVITY (dB)	INSERTION LOSS max. (dB)	DIRECTIVITY min. (dB)	VSWR (max.)		POWER (INPUT)		
							PRI. LINE	SEC. LINE	AVG. IN. (W)	AVG. REFL. (W)	PK. (kW)
2020-6600-06	7	0.5-1.0	6 ±1.0	±0.60	0.15	25	1.10	1.10	50	4	4
2020-6601-10	7		10 ±1.0	±0.75	0.15	25	1.10	1.10	50	10	4
2020-6602-20	7		20 ±1.0	±0.75	0.15	25	1.10	1.10	50	50	4
2020-6603-30	7		30 ±1.0	±0.75	0.15	25	1.10	1.10	50	50	4
2020-6604-06	5	1.0-2.0	6 ±1.0	±0.60	0.20	25	1.15	1.15	50	4	4
2020-6605-10	5		10 ±1.0	±0.75	0.20	25	1.15	1.15	50	10	4
2020-6606-20	5		20± 1.0	±0.75	0.20	25	1.15	1.15	50	50	4
2020-6607-30	6		30 ±1.0	±0.75	0.20	25	1.15	1.15	50	50	4
2020-6608-06	3	2.0-4.0	6 ±1.0	±0.60	0.20	22	1.15	1.15	50	4	4
2020-6609-10	3		10 ±1.0	±0.75	0.20	22	1.15	1.15	50	10	4
2020-6610-20	3		20 ±1.0	±0.75	0.20	22	1.15	1.15	50	50	4
2020-6611-30	4		30 ±1.0	±0.75	0.20	22	1.15	1.15	50	50	4
2020-6612-06	2	2.6-5.2	6 ±1.0	±0.60	0.25	20	1.25	1.25	50	4	4
2020-6613-10	2		10 ±1.0	±0.75	0.25	20	1.25	1.25	50	10	4
2020-6614-20	2		20 ±1.0	±0.75	0.25	20	1.25	1.25	50	50	4
2020-6615-30	1		30 ±1.0	±0.75	0.25	20	1.25	1.25	50	50	4
2020-6616-06	2	4.0-8.0	6 ±.75	±0.50	0.25	22	1.25	1.25	50	4	4
2020-6617-10	2		10 ±.75	±0.50	0.25	20	1.25	1.25	50	10	4
2020-6618-20	2		20 ±.75	±0.50	0.25	20	1.25	1.25	50	50	4
2020-6619-30	1		30 ±.75	±0.50	0.25	20	1.25	1.25	50	50	4
2020-6620-06	2	7.0-12.4	6 ±1.0	±0.40	0.40	15	1.35	1.35	50	4	4
2020-6621-10	1		10 ±.75	±0.40	0.40	20	1.30	1.35	50	10	4
2020-6622-20	1		20 ±.75	±0.50	0.30	18	1.35	1.35	50	50	4
2020-6623-30	1		30 ±1.0	±0.50	0.30	17	1.35	1.35	50	50	4
2020-6624-06	2	7.0-18.0	6 ±1.0	±0.50	0.50	15	1.35	1.35	50	4	3
2020-6625-10	1		10 ±1.0	±0.50	0.40	20	1.30	1.40	50	10	3
2020-6626-20	1		20 ±1.0	±0.75	0.50	15**	1.45	1.45	50	50	3
2020-6627-30	8		30 ±1.0	±0.75	0.50	15**	1.45	1.45	50	50	3
2020-6628-06	2	12.4-18.0	6 ±.75	±0.40	0.50	15	1.40	1.40	50	4	2
2020-6629-10	1		10 ±.75	±0.40	0.40	20	1.30	1.40	50	10	2
2020-6630-20	1		20 ±.75	±0.50	0.50	17	1.45	1.45	50	50	2
2020-6631-30	8		30 ±1.0	±0.50	0.50	12	1.45	1.45	50	50	2

MECHANICAL SPECIFICATIONS

CASE STYLE	A	B	C	D	E	WEIGHT	
						oz.	g
1	1.00 (25.4 mm)	N/A	.50 (12.7 mm)	.55 (13.9 mm)	.22 (5.6 mm)	0.62	17.6
2				.50 (12.7 mm)		0.60	17.0
3	1.16 (29.4 mm)	.34 (8.7 mm)	.66 (16.7 mm)	.50 (12.7 mm)		0.64	18.2
4				.55 (13.9 mm)		0.67	19.0
5	1.78 (45.2 mm)	.94 (23.8 mm)	1.28 (32.5 mm)	.50 (12.7 mm)		0.82	23.2
6				.55 (13.9 mm)		0.87	23.3
*7	3.00 (76.2 mm)	1.00 (25.4 mm)	2.50 (63.5 mm)	.75 (19.1 mm)	.31 (7.9 mm)	1.50	43.0
8	1.00 (25.4 mm)	N/A	.50 (12.7 mm)	.63 (15.9 mm)	.22 (5.6 mm)	0.67	19.0

*NOTE Case style seven has four mounting holes located symmetrically to the two shown dotted in figure.
**12dB from 12.4 to 18.0 GHz.

Specifications Subject to Change Without Notice.

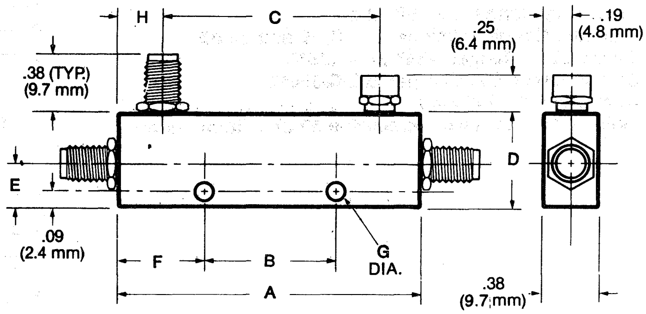
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Directional Couplers Multi-Octave

2025 Series

- **Flat Frequency Response**
- **Frequency Range: 0.5-18 GHz**
- **Multi-Octave Bandwidths**
- **Temperature Range: −54 to +125°C**
- **Meets MIL-E-5400 Environments**



NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole location (± .010).

SPECIFICATIONS

PART NO.	CASE STYLE	FREQUENCY RANGE (GHz)	COUPLING (INCLUDES FREQUENCY SENSITIVITY) (dB)	FREQUENCY SENSITIVITY (dB)	INSERTION LOSS max. (dB)	DIRECTIVITY min. (dB)	VSWR (max.) PRI. LINE	VSWR (max.) SEC. LINE	POWER (INPUT PORT) AVG. IN. (W)	POWER (INPUT PORT) AVG. REFL. (W)	POWER (INPUT PORT) PK. (kW)	
2025-6001-06	1	.50-2.0	6 ±1	±0.4	0.3	18	1.15	1.15	50	4	4	
2025-6002-10	1		10 ±1	±0.4	0.3	18	1.15	1.15	50	10	4	
2025-6003-16	1		16 ±1*	±0.4	0.3	22	1.15	1.15	50	40	4	IMPROVED
2025-6004-20	1		20 ±1	±0.4	0.3	22	1.15	1.15	50	50	4	IMPROVED
2025-6005-06	2	1.0-4.0	6 ±1	±0.4	0.35	18	1.20	1.20	50	4	4	
2025-6006-10	2		10 ±1	±0.4	0.3	18	1.20	1.20	50	10	4	
2025-6007-16	2		16 ±1*	±0.4	0.3	22	1.20	1.20	50	40	4	IMPROVED
2025-6008-20	2		20 ±1	±0.4	0.3	22	1.20	1.20	50	50	4	IMPROVED
2025-6009-06	3	2.0-8.4	6 ±1	±0.3	0.4	18	1.25	1.25	50	4	4	
2025-6010-10	3		10 ±1	±0.3	0.35	18	1.25	1.25	50	10	4	
2025-6011-16	3		16 ±1*	±0.3	0.35	18	1.25	1.25	50	40	4	
2025-6012-20	3		20 ±1	±0.3	0.35	20	1.25	1.25	50	50	4	
2025-6013-06	4	4.0-12.4	6 ±1	±0.4	0.5	15	1.30	1.30	50	4	4	
2025-6014-10	4		10 ±1	±0.4	0.5	15	1.30	1.30	50	10	4	
2025-6015-16	4		16 ±1*	±0.4	0.5	15	1.30	1.30	50	40	4	
2025-6016-20	4		20 ±1	±0.4	0.5	15	1.30	1.30	50	50	4	
2025-6017-06	5	6.0-18.0	6 ±1	±0.4	0.7	15	1.40	1.40	50	4	2	
2025-6018-10	5		10 ±1	±0.4	0.6	16	1.40	1.40	50	10	2	
2025-6019-16	5		16 ±1*	±0.4	0.6	16	1.40	1.40	50	40	2	
2025-6020-20	5		20 ±1	±0.4	0.6	15	1.40	1.40	50	50	2	

*Reference to output port for use as leveling coupler.

MECHANICAL SPECIFICATIONS

CASE STYLE	SIZE, INCHES (mm) A	B	C	D	E	F	G	H	WEIGHT oz.	g
1	4.92 (125)	3.5 (89)	4.42 (112)	.60 (15.2)	.27 (6.73)	.71 (18.1)	.143 (3.63)	.25 (6.4)	2.10	58.8
2	2.66 (67.6)	1.48 (37.6)	2.22 (56.4)	.60 (15.2)	.27 (6.73)	.59 (15)	.143 (3.63)	.22 (5.59)	1.26	35.3
3	1.99 (50.5)	.88 (22.2)	1.44 (36.6)	.63 (15.9)	.28 (7.11)	.56 (14.2)	.143 (3.63)	.28 (7.06)	1.05	29.4
4	1.21 (30.7)	.38 (9.7)	.69 (17.6)	.60 (15.2)	.22 (5.56)	.42 (10.6)	.104 (2.64)	.26 (6.55)	0.74	20.7
5	1.16 (29.5)	.50 (12.7)	.65 (16.5)	.57 (14.4)	.25 (6.35)	.33 (8.33)	.104 (2.64)	.25 (6.45)	0.69	19.3

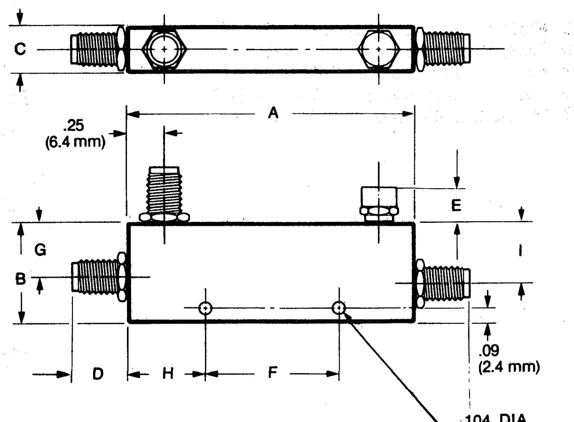
Specifications Subject to Change Without Notice.

M/A-COM

Directional Couplers
Ultra-Broadband

2026/8526 Series

- Frequency Range: 0.5 - 50 GHz
- Standard Coupling Values: 10, 13, 16 and 20 dB
- Temperature Range: −54° to + 125°C
- Connectors: OSM/SMA per MIL-C-39012, 3.5mm or OS-50 (2.4mm)
- Isolated Port with Non-removable 50 ohm Termination



NOTE: All dimensions are ±.020, except mounting hole diameters (±.005) and mounting hole location (±.010).

SPECIFICATIONS

PART NO.	CASE STYLE	FREQUENCY RANGE (GHz)	COUPLING (INCLUDES FREQUENCY SENSITIVITY)	FREQUENCY SENSITIVITY (dB)	INSERTION LOSS (dB) max.	DIRECTIVITY min. (dB)	VSWR (max.) PRI. LINE	POWER (INPUT PORT) AVG. IN. (W)	AVG. REFL. (W)	PK. (kW)
2026-6001-10	1	1.0-12.4	10 ± 1	± 0.4	.35 + .04fGHz	18[1]	1.30	50	10	3
2026-6002-16	1		16 ± 1[3]	± 1.0	.35 + .04fGHz	18	1.30	50	40	3
2026-6003-20	1		20 ± 1	± 0.6	.35 + .04fGHz	20	1.30	50	50	3
2026-6004-10	2	2.0-18.0	10 ± 1	± 0.5	.30 + .03fGHz	15[2]	1.35	50	10	3
2026-6005-16	2		16 ± 1[3]	± 0.5	.30 + .03fGHz	18[4]	1.35	50	40	3
2026-6006-20	2		20 ± 1	± 0.5	.30 + .03fGHz	18[4]	1.35	50	50	3
2026-6007-10	1	1.0-18.0	10 ± 1	± 0.5	.30 + .05fGHz	15[2]	1.40	50	10	3
2026-6008-16	1		16 ± 1[3]	± 1.0	.30 + .05fGHz	18[4]	1.40	50	40	3
2026-6009-20	1		20 ± 1	± 0.6	.30 + .05fGHz	18	1.40	50	50	3
2026-6010-10	3	0.5-18.0	10 ± 1	± 1.0	.90 + .03fGHz	15[2]	1.50	50	10	3
2026-6011-16	3		16 ± 1.5[3]	± 1.5	.90 + .03fGHz	15	1.50	50	40	3
2026-6012-20	3		20 ± 1	± 1.0	.90 + .03fGHz	15	1.50	50	50	3
2026-6013-10	3	0.5-26.5[6]	10 ± 1.5	± 1.5	.90 + .06fGHz	15[5]	1.60	50	10	3
2026-6014-16	3		16 ± 2[3]	± 2.0	.90 + .06fGHz	15[5]	1.60	50	40	3
2026-6015-20	3		20 ± 1.5	± 1.5	.09 + .06fGHz	15[5]	1.60	50	50	3
8526-6002-13	4	2.0-50.0[7]	13 ± 1.5[3]	± 1.0 (2-40) ± 1.5 (40-50)	2.0	15 (2-26) 12 (26-40) 10 (40-50)	1.3 (2-26) 1.7 (26-40) 1.8 (40-50)	10	5	.5
8526-6050-13	5	2.0-50.0[7]	13 ± 1.5[3]	± 1.0 (2-40) ± 1.5 (40-50)	2.0	15 (2-26) 12 (26-40) 10 (40-50)	1.3 (2-26) 1.7 (26-40) 1.8 (40-50)	10	5	.5

[1] 15 dB from 8.0 to 12.4 GHz
[2] 12 dB from 12.4 to 18 GHz
[3] Reference to output port for use as leveling coupler.
[4] 15 dB from 12.4 to 18 GHz
[5] 12 dB from 12.4 to 26.5 GHz
[6] Connectors are 3.5mm.
[7] Connectors are OS-50 (2.4mm).

MECHANICAL SPECIFICATIONS

CASE STYLE	SIZE INCHES (mm) A	B	C	D	E	F	G	H	I	WEIGHT oz.	g
1	3.8 (97)	.69 (17.5)	.38 (9.7)	.38 (9.7)	.25 (6.4)	2.31 (58.7)	.39 (9.9)	.75 (19)	.44 (11.1)	2.0	56
2	2.0 (50.8)	.69 (17.5)	.38 (9.7)	.38 (9.7)	.25 (6.4)	.95 (24.2)	.38 (9.7)	.53 (13.5)	.42 (10.7)	1.3	37
3	4.4 (111.8)	.73 (18.5)	.38 (9.7)	.38 (9.7)	.25 (6.4)	2.90 (73.7)	.48 (12.2)	.75 (19)	.48 (12.2)	2.5	71
4	2.36 (59.9)	.61 (15.5)	.51 (13)	.53 (13.5)	.56 (13.2)	1.175 (29.9)	.25 (6.4)	.588 (14.9)	2.5 (6.4)	2.1	60
5	1.75 (44.5)	.50 (12.7)	.40 (10.2)	.38 (9.7)	.40 (10.2)	1.00 (25.4)	.25 (6.4)	.375 (9.5)	2.5 (6.4)	1.0	29

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Power Divider/Combiner

Overview

POWER DIVIDERS/COMBINERS are passive components that split an input signal into two or more identical output signals, or combine multiple signals into one output signal. The number of output ports available in standard models is 2, 3, 4, and 8 outputs, but combinations of these power divisions are available in special models.

The basic measure of quality of a power divider is in terms of its ability to provide identical outputs. However, achievement of equal outputs is also a function of the impedance match between the divider and the external system and of the intrinsic isolation of the divider. The advantage of this characteristic is that the output at one port is not severely affected by an impedance mismatch at another output port. In principle, the isolated power dividers is the ideal power divider for any application. It functions as a hybrid or magic tee with the difference port internally terminated, with the exception that the outputs are in phase.

Practical isolated power dividers are built in octave bandwidth and also extremely wide bandwidth, even decades and greater. Octave band units are of the Wilkinson type, using discrete lumped resistors. VSWR increases outside of the band specified. The broadband units are of a tapered design which provide semi-infinite bandwidth in principle. That is, there is no upper frequency limit to operation, however, in practice there is an actual upper limit due to increasing VSWR and loss.

M/A-COM high performance isolated power dividers offer significant advantages when used in phased array antennas, test instrumentation, reflectometer or leveling setups, L.O. feed networks, network analyzers, phase bridges, and any other wideband power splitting applications.

POWER DIVIDER SELECTION GUIDE

Power Divider Type	Unmatched Coaxial	Wilkinson Stripline	Tapered Line Stripline	Microwave Integrated Circuit
Part Number Series	2041	2089	2090	2091 2092
Frequency Range (GHz)	n/a	Octave & Multi-Octave 1.0-18.0	Multi-Octave 0.5-26.0	Octave & Multi-Octave 0.9-18.0
Input VSWR[1]	n/a	1.35:1	1.35:1[2]	1.35:1
Insertion Loss (dB Max.)[1]	n/a	0.25	0.48[2]	0.60
Isolation (dB Min.)[1]	n/a	20	20[2]	20
Output Imbalance (Max.)[1] Phase (degrees) Amplitude (dB)	n/a	4.0 0.2	5.0[2] 0.3[2]	4.0 0.2
Input Power (Avg. Watt) (Max.)[1]	50	2.0	40.0[2]	5.0
Major Features	Low Cost	Size and Performance	Isolation, Power, Bandwidth and Price	Smallest Size
Configurations Available	2-way	2-way 4-way	2-way, 3-way 4-way, 8-way	2-way

TABLE I

[1] Representative specifications for 2-way power dividers in 2.0 - 4.0 GHz frequency range for part numbers shown in Table I.
[2] Representative specifications for 2-way power dividers in 2.0 - 18.0 GHz frequency range for part numbers shown in Table I.

For 2089 series, part number 2089-6202-00
For 2090 series, part number 2090-6205-00 (2.0 - 18.0 GHz)
For 2091 series, part number 2091-6202-00

Specifications Subject to Change Without Notice.

M/A-COM

Unmatched Tees
Non-Isolated

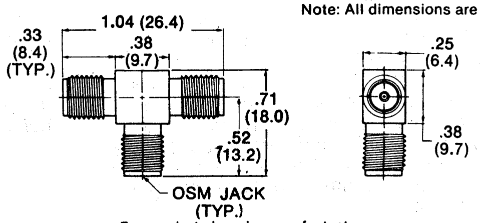
2041 Series

- **Small Size**
- **Broad Band**
- **Economical Power Divider**

Miniature Unmatched Coaxial Tees provide a convenient means of separating an input signal into two components. The units are used where isolation between the outputs and VSWR are not primary considerations. Temperature range is −54°C to +125°C.

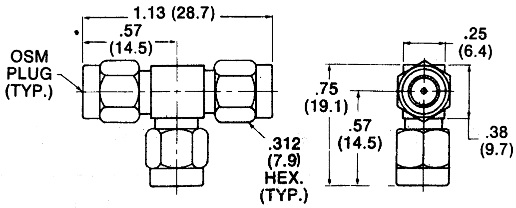
Note: All dimensions are ± .020.

PART NUMBER	**2041-6201-00**
MODEL NUMBER	20200-1
JACK-JACK-JACK ADAPTER	



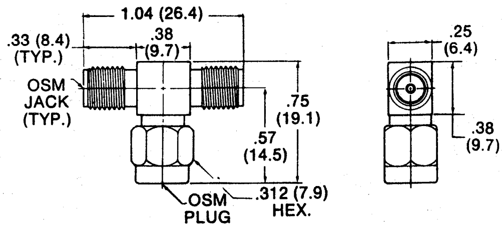
For passivated version, see footnote.

PART NUMBER	**2041-6202-00**
MODEL NUMBER	20200-4
PLUG-PLUG-PLUG ADAPTER	



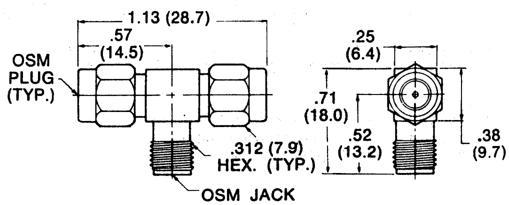
For passivated version, see footnote.

PART NUMBER	**2041-6203-00**
MODEL NUMBER	20200-2
JACK-PLUG-JACK ADAPTER	



For passivated version, see footnote.

PART NUMBER	**2041-6204-00**
MODEL NUMBER	20200-3
PLUG-JACK-PLUG ADAPTER	



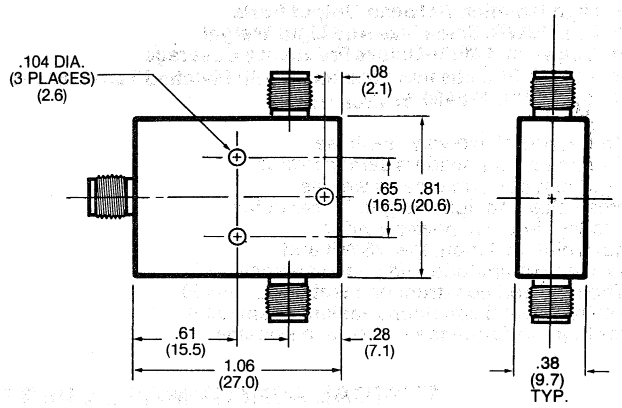
For passivated version, see footnote.

All unmatched coaxial tees have OSM connectors. For OSSM connectors, simply change the first digit in the part number from "2" to "1". For example, 1041-6201-00.
Standard units have gold-plated connectors ("-00" suffix). For passivated stainless steel finish connectors, simply change the "-00" to "-02" in the part number.

Two-Way Isolated Power Dividers
Microstrip

2091/2092 Series

- Excellent Amplitude and Phase Balance
- High Isolation Between Output Ports
- Wideband Frequency Coverage
- Low Insertion Loss
- Low VSWR
- Power: 5.0 — 20 Watts Input Maximum, with Matched Terminations
- Temperature Range: −54°C to +125°C
- Meets MIL-E-5400 Environments

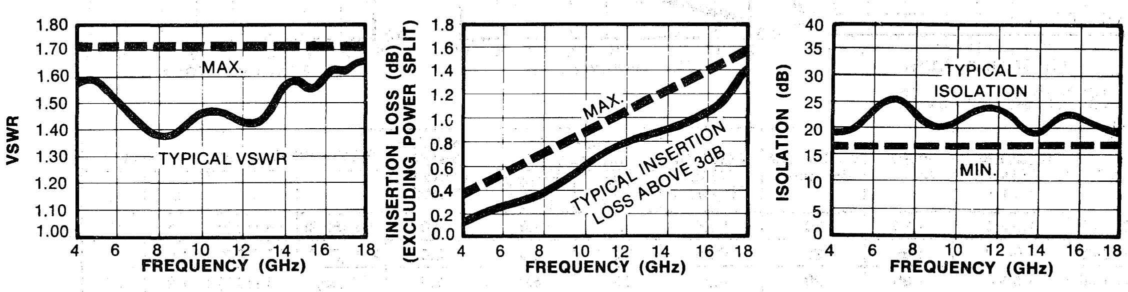


NOTE: All dimensions are ±.020, except mounting hole diameters (±.005) and mounting hole location (±.010).

Ceramic microstrip construction techniques are utilized to achieve small size and high performance. Sliding contact connectors ensure high reliability over the temperature range. This type of construction can handle higher power when proper heat sinking is used.

These high performance units operate over octave and multi-octave bandwidths.

TYPICAL PERFORMANCE PART NO. 2092-6209-00



SPECIFICATIONS

PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION (dB min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE		MAXIMUM INPUT POWER* (watts)	WEIGHT	
					AMP. (dB)	PHASE (deg.)		oz.	g
2091-6204-00	0.9-4.0	1.50	18	1.0	0.3	5.0	5.0	1.3	37
2091-6201-00	1.0-2.0	1.30	20	0.4	0.2	2.0	5.0	1.3	37
2091-6202-00	2.0-4.0	1.35	20	0.6	0.2	4.0	5.0	1.3	37
2092-6209-00	4.0-18.0	1.70	16	0.1+.08f (GHz)	0.3	1.0f (GHz)	20.0	1.3	37

*Maximum input power with output loads of VSWR ≤ 2.0:1.
Derate to 10% of listed value when arbitrarily terminated.

Specifications Subject to Change Without Notice.

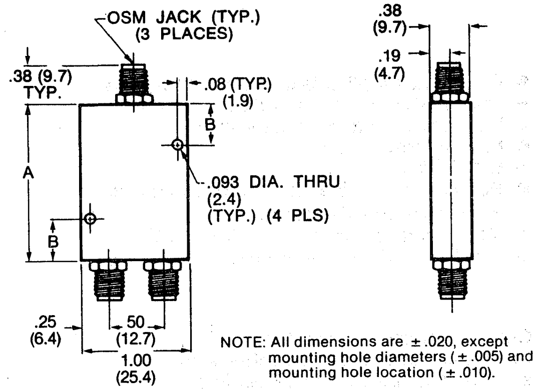
M/A-COM

Two-Way Isolated Power Dividers Wilkinson

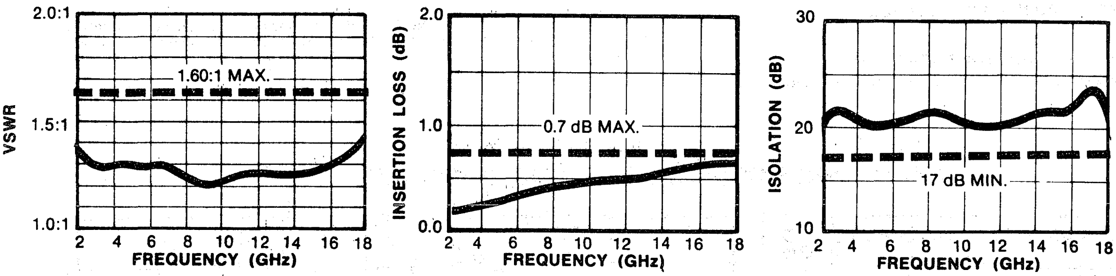
2089 Series

- **Excellent Amplitude And Phase Balance**
- **High Isolation Between Output Ports**
- **Low VSWR, Small Size And Light Weight**
- **Octave and Multi-Octave Frequency Coverage.**
- **Power: 10 Watts Input Maximum with Matched Terminations**
- **Meets MIL-E-5400 Environments**

This series of two-way, in-phase stripline power dividers demonstrates excellent performance as well as small size and light weight. These octave and multi-octave power dividers have high isolation, low VSWR and excellent amplitude and phase balance. Their rugged construction meets MIL-E-5400 environmental conditions, making them ideal for high performance microwave systems.



TYPICAL PERFORMANCE PART NO. 2089-6208-00



SPECIFICATIONS

PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION dB (min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE		MAXIMUM INPUT POWER* (watts)	SIZE, INCHES (mm)		WEIGHT	
					AMP. (dB)	PHASE (deg.)		A	B	oz.	g
2089-6201-00	1.0-2.0	1.25	20	0.25	0.2	4.0	2.0	2.0 (50.8)	0.5 (12.7)	1.5	43
2089-6202-00	2.0-4.0	1.35	20	0.25	0.2	4.0	2.0	2.0 (50.8)	0.5 (12.7)	1.5	43
2089-6203-00	4.0-8.0	1.35	20	0.3	0.2	6.0	2.0	1.38 (35)	0.4 (10.2)	1.2	35
2089-6204-00	8.0-12.4	1.60	20	0.4	0.25	6.0	2.0	1.38 (35)	0.4 (10.2)	1.2	35
2089-6205-00	12.4-18.0	1.70	17	0.6	0.25	6.0	3.0	1.38 (35)	0.4 (10.2)	1.2	35
2089-6206-00	0.5-2.0	1.30	20	0.4	0.2	4.0	4.0	2.8 (71.2)	0.5 (12.7)	2.0	57
2089-6207-00	2.0-8.0	1.50	18	0.4	0.25	8.0	4.0	2.25 (57.2)	0.5 (12.7)	1.3	37
2089-6208-00	2.0-18.0	1.60	17	1.0	0.25	8.0	10.0	2.25 (57.2)	0.5 (12.7)	1.3	37
2089-6209-00	4.0-18.0	1.60	17	0.6	0.25	8.0	4.0	1.63 (41.4)	0.5 (12.7)	1.3	37
2089-6210-00	7.0-18.0	1.70	17	0.6	0.25	8.0	3.0	1.38 (35)	0.4 (10.2)	1.2	35

*Maximum input power with output loads of VSWR ≤ 2.0:1.
Derate to 10% of listed value when arbitrarily terminated.

Specifications Subject to Change Without Notice.

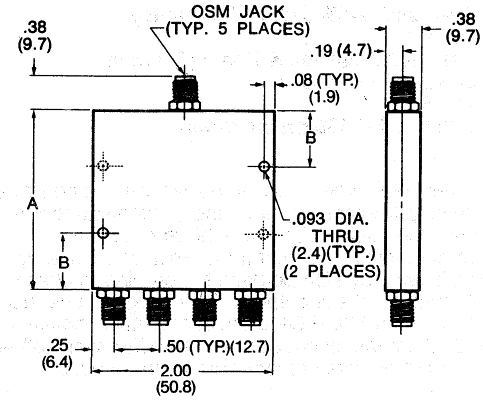
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Four-Way Isolated Power Dividers Wilkinson

2089 Series

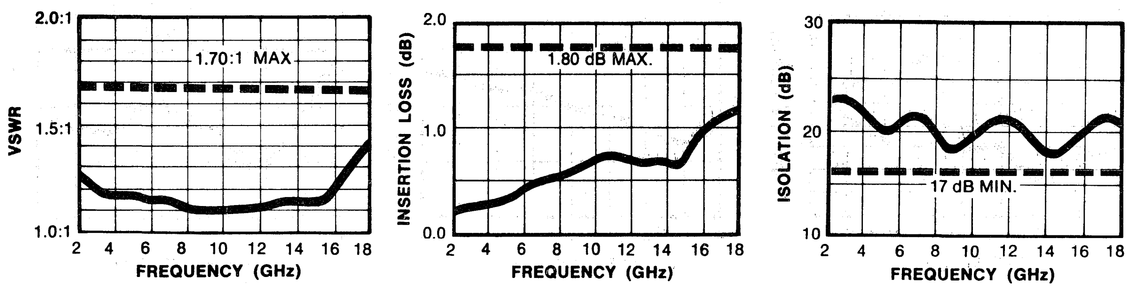
- Octave And Multi-Octave Frequency Coverage.
- Low Insertion Loss
- Excellent Phase Balance
- High Isolation Between Output Ports.
- Low VSWR.
- Power: 20 Watts Maximum
- Meets MIL-E-5400 Environments

These four-way in-phase power dividers combine excellent strip transmission line design techniques with small size and light weight and still achieve superb performance over wide multi-octave frequency ranges as well as over single octave bandwidths. These units may be used in reverse to combine in-phase signals applied to them. They are also available in a variety of "n" way output ports as well as custom designed to your particular application.



NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole location (± .010).

TYPICAL PERFORMANCE PART NO. 2089-6408-00



SPECIFICATIONS

PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION dB (min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE AMP. (dB)	OUTPUT UNBALANCE PHASE (deg.)	MAXIMUM INPUT POWER* (watts)	SIZE, INCHES (mm) A	SIZE, INCHES (mm) B	WEIGHT oz.	WEIGHT g
2089-6401-00**	1.0-2.0	1.35	20	0.50	0.40	6	4.0	3.0 (76.2)	0.63 (15.9)	4.0	115
2089-6402-00	2.0-4.0	1.35	20	0.50	0.40	6	4.0	2.0 (50.8)		2.8	80
2089-6403-00	4.0-8.0	1.50	20	0.50	0.40	8	4.0	2.0 (50.8)		2.8	80
2089-6404-00	8.0-12.4	1.70	18	0.75	0.50	8	4.0	2.0 (50.8)		2.8	80
2089-6405-00	12.4-18.0	1.70	15	1.20	0.50	8	6.0	2.0 (50.8)		2.8	80
2089-6406-00**	0.5-2.0	1.45	20	0.70	0.40	6	4.0	2.92 (74.2)		4.0	115
2089-6407-00**	2.0-8.0	1.60	18	0.80	0.50	12	8.0	4.0 (102)		5.2	149
2089-6408-00	2.0-18.0	1.70	17	1.80	0.50	12	20.0	3.0 (76.2)		4.0	115
2089-6409-00	4.0-18.0	1.70	15	1.20	0.50	12	8.0	2.0 (50.8)		2.8	80
2089-6410-00	7.0-18.0	1.60	15	1.20	0.50	12	6.0	2.0 (50.8)		2.8	80

*Maximum input power with output loads of VSWR ≤ 2.0:1.
Derate to 10% of listed value when arbitrarily terminated.
**These units have four mounting holes symmetrically located as shown.

Specifications Subject to Change Without Notice.

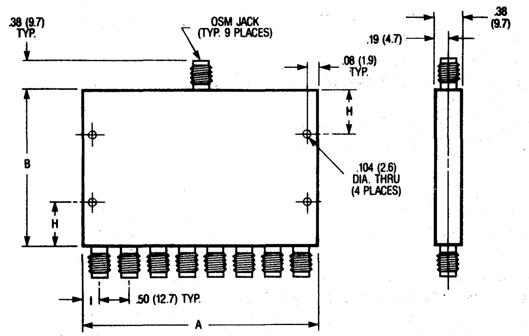
M/A-COM

Eight-Way Isolated Power Dividers Wilkinson

2089 Series

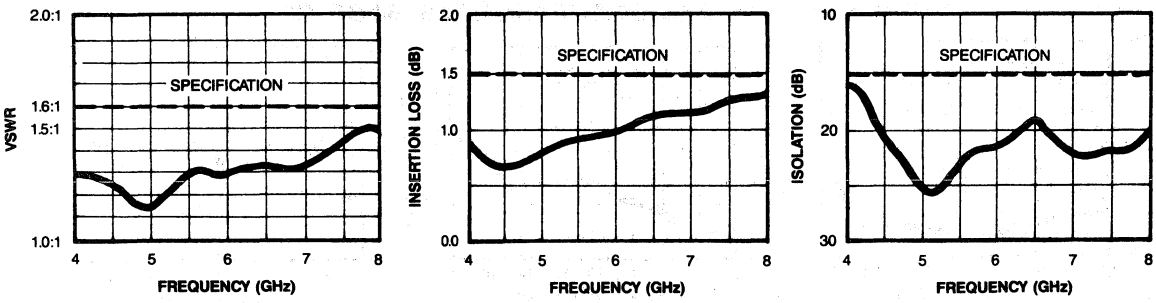
- **Octave and Multi-Octave Frequency Coverage**
- **Excellent Amplitude & Phase Balance**
- **Low Insertion Loss**
- **Low VSWR**
- **Meets MIL-E-5400 Environments**

These new eight-way in-phase power dividers combine reliable strip transmission line design techniques with small size and light weight to achieve excellent performance over octave and multi-octave frequency ranges. They may also be used to combine in-phase signals applied at the outputs. Their rugged construction meets stringent MIL-E-5400 environmental conditions. OSM/SMA female connectors are standard while other common connectors are available upon request.



NOTE: All dimensions are ± .020 except mounting hole diameters (± .005) and mounting hole locations (± .010).

Typical Performance Part No. 2089-6803-00



SPECIFICATIONS

PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION dB (min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE		MAXIMUM INPUT POWER* (watts)	SIZE, INCHES				WEIGHT (NOM.) oz.
					AMP. (dB)	PHASE (deg.)		A	B	H	I	
2089-6801-00	1.0-2.0	1.5:1	20	1.0	0.8	8	6.0	4.5	5.0	1.0	0.50	15
2089-6802-00	2.0-4.0	1.5:1	18	1.0	0.8	10	6.0	4.0	2.0	0.5	0.25	12
2089-6803-00	4.0-8.0	1.6:1	15	1.5	0.8	16	6.0	4.0	2.0	0.5	0.25	12
2089-6804-00	8.0-12.4	1.7:1	15	1.7	0.8	16	6.0	4.0	2.0	0.5	0.25	12
2089-6805-00	12.4-18.0	1.7:1	15	2.2	0.8	24	10.0	4.0	2.0	0.5	0.25	12
2089-6806-00	0.5-2.0	1.5:1	20	1.5	0.8	8	12.0	4.5	5.0	1.0	0.50	15
2089-6807-00	2.0-8.0	1.6:1	15	2.0	1.2	16	12.0	4.0	2.0	0.5	0.25	12
2089-6808-00	2.0-18.0	1.8:1	15	3.3	1.8	24	30.0	4.5	5.0	1.0	0.50	15
2089-6810-00	7.0-18.0	1.8:1	15	2.5	1.5	24	10.0	4.0	2.0	0.5	0.25	12

*Maximum input power with output of VSWR ≤ 2.0:1
Derate to 10% of listed value when arbitrarily terminated.

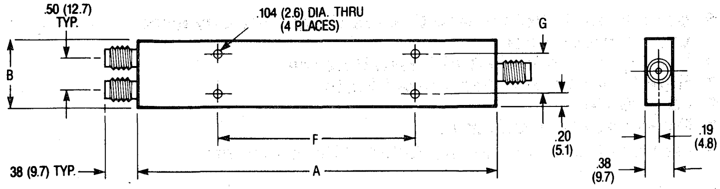
Specifications Subject to Change Without Notice.

M/A-COM

Two-, Four- & Eight-Way Isolated Power Dividers Tapered

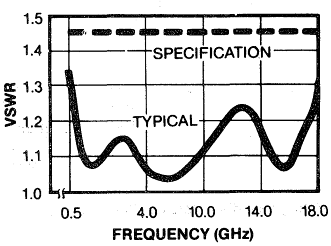
2090 Series

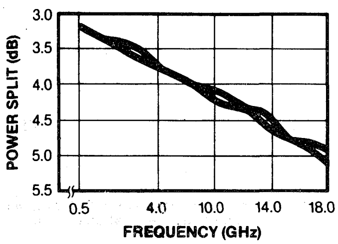
- **Broadband Performance 0.5-18.0 GHz**
- **Low Insertion Loss**
- **Excellent Amplitude and Phase Balance**
- **Power: 50 Watts Maximum**
- **Meets MIL-E-5400 Environments**

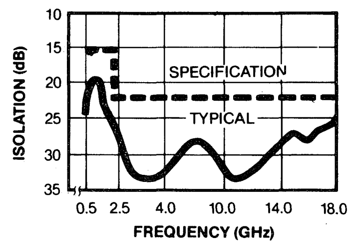


These are the smallest in-phase isolation 0.5-18.0 GHz power dividers available. Rugged stripline construction, housed in sealed lightweight packages insure reliable operation in the roughest environments. OSM/SMA stainless steel connectors are standard. Contact the factory for other connector designs.

Typical Performance Part No. 2090-6214-00







SPECIFICATIONS

PART NO.	NO. OF OUTPUTS	FREQUENCY RANGE (GHz)	VSWR (max.)		ISOLATION (dB min.) FREQUENCY (GHz)		INSERTION LOSS dB (max.)	OUTPUT UNBALANCE AMP. (dB) FREQUENCY (GHz)		OUTPUT UNBALANCE PHASE (deg.) FREQUENCY (GHz)		MAXIMUM INPUT POWER* (watts)
			Input	Ouput	0.5-2.5	2.5-18.0		0.5-2.5	2.5-18.0	0.5-2.5	2.5-18.0	
2090-6214-00	2	0.5-18.0	1.40	1.35	15	22	0.25 + 0.11f	0.4	0.4	5	5	50
2090-6414-00	4	0.5-18.0	1.6	1.4	15	20	0.7 + 0.21f	0.6	1.0	8	12	50
2090-6814-00	8	0.5-18.0	1.7	1.5	15	18	1.0 + 0.25f	0.8	1.4	10	16	50

*50 Watts with 1.2:1 max. load VSWR.
25 Watts with 2:1 max. load VSWR.

MECHANICAL SPECIFICATIONS

PART NO.	SIZE, INCHES (mm) A	B	F	G	WEIGHT oz.	g
2090-6214-00	5.50 (139.7)	1.00 (25.4)	4.00 (101.6)	.60 (15.2)	3.4	96.6
2090-6414-00	5.20 (132.1)	2.00 (50.8)	3.20 (81.3)	1.60 (45.7)	16	448
2090-6814-00	5.20 (132.1)	4.00 (101.6)	3.20 (81.3)	3.60 (91.4)	30	840

Specifications Subject to Change Without Notice.

M/A-COM

Two-Way Isolated Power Dividers Tapered, Ultra Broadband

2090 Series

- Octave, Multi-Octave And Decade Frequency Coverage
- Low Insertion Loss
- Excellent Amplitude And Phase Balance
- High Isolation Between Output Ports
- Low VSWR
- Power: 80 Watts Maximum
- Meets MIL-E-5400 and MIL-E-16400 Environments

New designs include operation through 26 GHz and retain the performance of lower frequency units. These units are ideal for multi-octave ECM systems. These units function as either dividers or combiners to facilitate system performance.

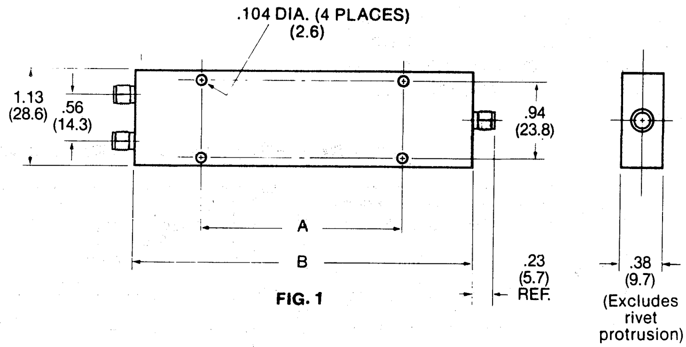


FIG. 1

NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole location (± .010).

SPECIFICATIONS

PART NO.	MODEL NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION dB (min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE AMP. (dB)	OUTPUT UNBALANCE PHASE (deg.)	MAX. INPUT POWER** (watts)	SIZE, INCHES (mm) A	SIZE, INCHES (mm) B	WEIGHT FIG.	WEIGHT oz. g
2090-6204-00	204927	0.5-18.0	1.35 (0.5 to 11) GHz 1.70 (11 to 18) GHz	20 (0.5 to 3) GHz 23 (3 to 18) GHz	0.2 +.17f	0.3	5	80	9.40 (239)	11.02 (291)	1	8.0 226
2090-6205-00	204947	2.0-18.0	1.35 (2 to 11) GHz 1.50 (11 to 18) GHz	20 (2 to 3) GHz 23 (3 to 18) GHz	0.2 +.07f	0.3	5	40	2.40 (61.1)	4.02 (102)	1	2.9 83

*To 18 GHz
**Maximum input power with output loads of VSWR ≤ 2.0:1.
Derate to 10% of listed value when arbitrarily terminated.
Note: f is frequency in GHz.

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

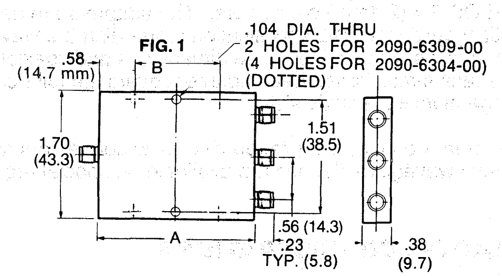
Three-Way Isolated Power Dividers Tapered

2090 Series

- Good Amplitude And Phase Balance
- High Isolation Between Output Ports
- Low VSWR, Small Size And Light Weight
- Octave, Multi-Octave And Decade Frequency Coverage
- Low Insertion Loss
- Power: 80 Watts Maximum
- Meets MIL-E-5400 Environments

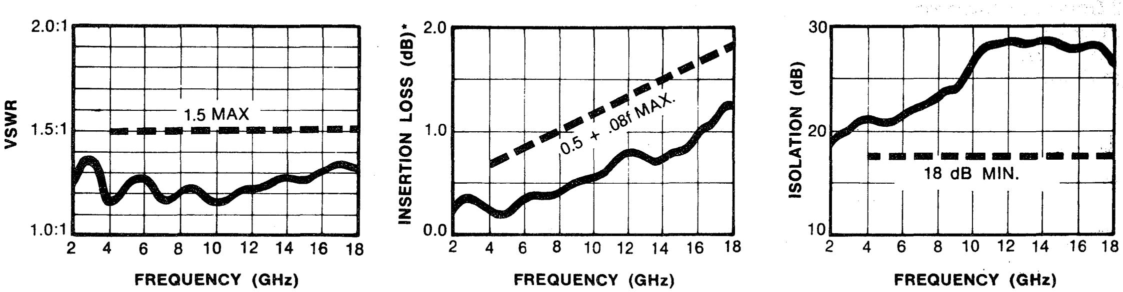
Power Dividers are compact stripline units with wide bandwidth and multiple outputs. Tapered line transformers and internal terminations provide low VSWR at all ports and high isolation between all output ports. Phase and amplitude tracking of all outputs is excellent due to the symmetrical designs. Combinations of three-way and two-way power dividers in one package are available for custom applications.

FIG. 1



NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole location (± .010). Height dimension excludes rivet protrusion.

TYPICAL PERFORMANCE PART NO. 2090-6309-00



SPECIFICATIONS

PART NO.	MODEL NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	ISOLATION dB (min.)	INSERTION LOSS dB (max.)	OUTPUT UNBALANCE AMP. (dB)	OUTPUT UNBALANCE PHASE (deg.)	MAXIMUM INPUT POWER** (watts)	FIG.	SIZE, INCHES (mm) A	SIZE, INCHES (mm) B	WEIGHT oz.	WEIGHT g
2090-6304-00	204827	0.5-18.0	1.6	18	0.4 + .24f	0.5†	*	80	1	11.0 (280)	9.84 (250.0)	11.4	322
2090-6309-00	204857	4.0-18.0	1.5	18	0.5 + .08f	0.5	*	40	1	2.02 (51.3)	—	2.1	60

*Not phase matched.
**Maximum input power with output loads of VSWR ≤ 2.0:1. Derate to 10% of listed value when arbitrarily terminated.
†0.5 dB (0.5 to 10 GHz), 1.0 dB (10 to 18 GHz)

Note: f is frequency in GHz.

Specifications Subject to Change Without Notice.

Waveguide Adapter

Overview

A broad range of waveguide to coaxial adapters are offered for rectangular waveguide transmission lines with SMA, SSMA, N and OS-2.4 (2.4mm) connectors. The adapters are designed to satisfy applicable MIL specifications regarding the waveguide dimensions, waveguide flange dimensions and coaxial connector interface dimensions. Each adapter covers the full frequency range of its waveguide size.

Either jack connectors (standard) or plug connectors are available Choke waveguide flanges are available on special request.

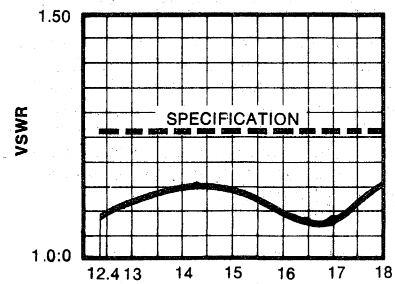
CUSTOM CONSIDERATIONS

- Matched pairs
- Special flanges
- Extra low VSWR over narrow band
- Hermetically sealed
- High Power

- **Full Octave Bandwidths**
- **Compact Size**
- **Lower VSWR**
- **High Power**

TYPICAL PERFORMANCE

TYPICAL VSWR
RECTANGULAR W/G



Specifications Subject to Change Without Notice.

Rectangular Waveguide Adapters

FREQUENCY RANGE (GHz)	WAVEGUIDE TYPE	INSIDE WAVEGUIDE SIZE INCHES (mm)	WAVEGUIDE FLANGE SIZE INCHES (mm)
2.6-3.95	WR-284	2.840 x 1.340 (72.1 x 34.0)	5.31 dia. (134.9)
3.95-5.85	WR-187	1.872 x 0.872 (47.5 x 22.2)	3.62 dia. (92.0)
5.85-8.20	WR-137	1.372 x 0.622 (34.9 x 15.8)	3.12 dia. (79.3)
7.05-10.0	WR-112	1.122 x 0.497 (28.5 x 12.6)	1.87 sq. (47.5)
7.0-11.0	WR-102	1.020 x 0.510 (25.9 x 13.0)	1.69 sq. (42.9)
8.2-12.4	WR-90	0.900 x 0.400 (22.9 x 10.2)	1.62 sq. (41.2)
10.0-15.0	WR-75	0.750 x 0.375 (19.1 x 9.5)	1.50 sq. (38.1)
12.4-18.0	WR-62	0.622 x 0.311 (15.8 x 7.9)	1.31 sq. (33.3)
18.0-26.5	WR-42	0.420 x 0.170 (10.7 x 4.3)	0.88 sq. (22.4)
26.5-40.0	WR-28	0.280 x 0.140 (7.1 x 3.6)	0.75 sq. (19.1)
33.0-50.0	WR-22	0.112 x 0.224 (2.8 x 5.7)	1.125 dia. (32.1)

COMMON SPECIFICATIONS ALL CONNECTOR TYPES

Impedance: 50 ohms
VSWR: 1.25:1 max. (most models)
Power Rating: 50 watts average
Temperature Range: −50° to +125° C.
Connectors: Passivated Stainless Steel
Housing: Aluminum with gray epoxy paint (most models)
Waveguide Adapters: Meets general requirements of MIL-A-22641
Flange: MIL-F-3922
Waveguide: MIL-W-85

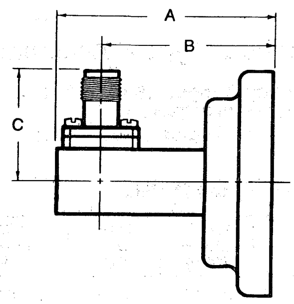
Waveguide to OSM(SMA) Adapters

- **Frequency Range: 2.6 to 40.0[1] GHz**
- **Connector: OSM Miniature Jack[2]**
- **VSWR 1.1:1 Typical, 1.25: 1 Max.**

SPECIFICATIONS

PART[3] NUMBER	MODEL NUMBER	FREQ. RANGE (GHz)	FITS W/G SIZE	W/G FLANGE TYPE	MAX. SIZE, INCHES (mm) DIM. A	DIM. B	DIM. C
2000-6250-00	20184J	2.6-3.95	WR-284	UG-584/U	2.49 (63.2)	1.37 (34.7)	1.22 (30.9)
2000-6251-00	201845J	3.95-5.85	WR-187	UG-407/U	1.89 (48.0)	1.17 (29.7)	.97 (24.6)
2000-6252-00	20185J	5.85-8.2	WR-137	UG-441/U	1.51 (38.3)	1.01 (25.6)	.84 (21.3)
2000-6253-00	201856J	7.05-10.0	WR-112	UG-138/U	1.29 (32.7)	0.91 (23.1)	.78 (19.8)
2000-6258-00	—	7.0-11.0	WR-102	No UG Desig.	1.41 (35.8)	0.91 (23.1)	.78 (19.8)
2000-6254-00	20186AJ	8.2-12.4	WR-90	UG-135/U	1.29 (32.7)	0.92 (23.3)	.72 (18.2)
2000-6257-00	201867AJ	10.0-15.0	WR-75	No UG Desig.	1.26 (32.0)	0.90 (22.8)	.70 (17.7)
2000-6255-00	20187AJ	12.4-18.0	WR-62	UG-1665/U	1.26 (32.0)	.98 (24.9)	.66 (16.7)
2000-6256-00[4]	20188AJ	18.0-26.5	WR-42	UG-597/U	1.01 (25.6)	.73 (18.5)	.59 (14.9)
1000-6259-00[1]	30189AJ	26.5-40.0	WR-28	UG-599/U	.82 (20.8)	.59 (14.9)	.54 (13.7)

1. Uses OSSM(SSMA) connector, VSWR 1.5:1 max.
2. Also available with OSM plug conn. as part nos. 2001-6250, etc. (C dimension will vary).
3. Also available with choke flange as part nos. 2000-6260 thru 2000-6268.
4. VSWR 1.35:1, 25 to 26.5 GHz



APPLICABLE MIL-SPECIFICATIONS
Adapter: MIL-A-22641, Class 5
Connector: MIL-C-39012/57

Specifications Subject to Change Without Notice.

M/A-COM

Rectangular Waveguide Adapters

3000/850X Series

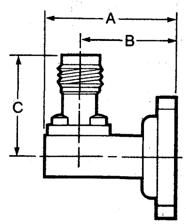
Waveguide to OS-50(2.4mm) Adapters

- **Frequency Range: 18.0 to 40.0 GHz**
- **Connector: OS-50**

APPLICABLE MIL-SPECIFICATIONS
Adapter: MIL-A-22641 where applicable
Connector: MIL-C-39012 where applicable

SPECIFICATIONS

PART NUMBER	COAXIAL CONNECTOR	FREQ. RANGE (GHz)	FITS W/G SIZE	W/G FLANGE TYPE	VSWR		MAX. SIZE, INCHES (mm)		
					TYP.	MAX.	DIM. A	DIM. B	DIM. C
8501-6256-00	OS-50 PLUG	18.0-26.5	WR-42	UG-597/U	1.20:1	1.30:1	1.02 (25.9)	.71 (18.0)	.77 (19.6)
8500-6256-00	OS-50 JACK						1.02 (25.9)	.71 (18.0)	.74 (18.8)
8501-6259-00	OS-50 PLUG	26.5-40.0	WR-28	UG-599/U	1.25:1	1.35:1	.84 (21.3)	.61 (15.5)	.69 (17.5)
8500-6259-00	OS-50 JACK						.84 (21.3)	.61 (15.5)	.66 (16.8)



Waveguide to Type N Adapters

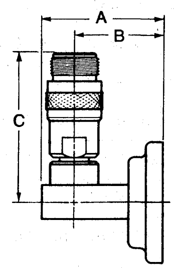
- **Frequency Range: 2.6 to 18.0 GHz**
- **Connector: "N" Type Jack****
- **VSWR 1.1:1 Typical, 1.25: 1 Max.**

APPLICABLE MIL-SPECIFICATIONS
Adapter: MIL-A-22641, class 1
Connectors: MIL-C-39012/1

SPECIFICATIONS

PART NUMBER*	FREQ. RANGE (GHz)	FITS W/G SIZE	W/G FLANGE TYPE	MAX. SIZE, INCHES (mm)		
				DIM. A	DIM. B	DIM. C
3000-6250-00	2.6-3.95	WR-284	UG-584/U	2.49 (63.2)	1.36 (34.5)	2.18 (55.4)
3000-6251-00	3.95-5.85	WR-187	UG-407/U	1.89 (48.0)	1.17 (29.7)	1.93 (49.1)
3000-6252-00	5.85-8.2	WR-137	UG-441/U	1.81 (45.9)	1.45 (36.8)	1.80 (45.8)
3000-6253-00	7.05-10.0	WR-112	UG-138/U	1.39 (35.3)	1.01 (25.6)	1.74 (44.2)
3000-6258-00	7.0-11.0	WR-102	No UG Desig.	1.45 (36.8)	.96 (24.3)	1.75 (44.5)
3000-6254-00	8.2-12.4	WR-90	UG-135/U	1.29 (32.7)	.91 (23.1)	1.68 (42.7)
3000-6257-00	10.0-15.0	WR-75	No UG Desig.	1.26 (32.0)	.96 (24.3)	1.66 (42.2)
3000-6255-00	12.4-18.0	WR-62	UG-1665/U	1.26 (32.0)	.96 (24.3)	1.63 (41.4)

*Also available with choke flanges as part nos. 3000-6260 thru 3000-6268.
**Also available with N type plug connector as part nos. 3001-6250, etc. (C dimension will vary).



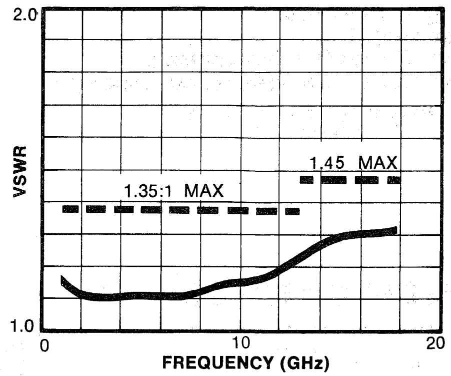
Specifications Subject to Change Without Notice.

dc Block/Monitor Tee

Overview

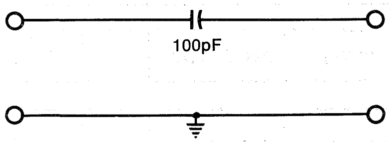
- Broadband Performance
- Low Insertion Loss
- Rugged Construction
- Small Size
- Light Weight
- Meets MIL-E-5400

TYPICAL PERFORMANCE
PART NO. 2044-6010-00



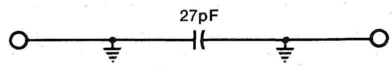
INSIDE dc BLOCK

OSM Inside dc Block has capacitance in-series with the center conductor which prevents the flow of dc current, while permitting RF power to flow without interruption.



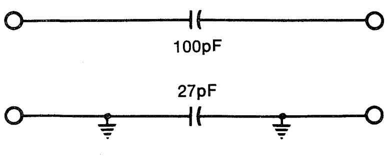
OUTSIDE dc BLOCK

OSM Outside dc Block has a capacitance in-series with the outer conductor, which prevents the flow of dc current while permitting RF power to flow without interruption.



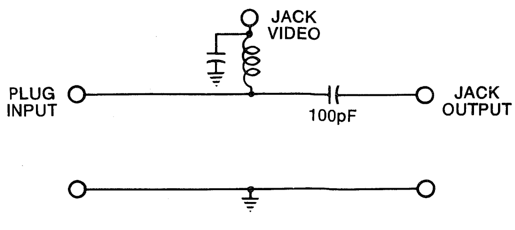
INSIDE/OUTSIDE dc BLOCK

OSM Inside/Outside dc Block has a capacitance in-series with the inner and outer conductors which prevents the flow of dc current, while permitting RF power to flow without interruption.



INSIDE dc BLOCK/MONITOR TEE

OSM Inside dc Block/Monitor Tee performs the dual function of an Inside dc Block and a Monitor Tee. The dc connection is between the OSM Plug and the shunt arm OSM Jack.



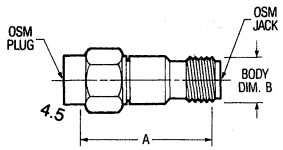
Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

Inside, Outside and Inside/Outside dc Blocks

204X Series

- Small Size
- Broadband Performance 0.01 to 50 GHz
- Low Insertion Loss
- Rugged Construction
- Light Weight
- Meets MIL-E-5400 Environments
- Connectors: OSM/SMA per MIL-C-39012
- Power: Average 20 Watts CW
  Peak 1000 Watts



NOTE: All dimensions are ± .020.

SPECIFICATIONS

PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	INSERTION LOSS dB (max.)	MAIN LINE MAXIMUM VOLTAGE (Vdc)	SIZE, INCHES (mm) A	SIZE, INCHES (mm) B	WEIGHT oz.	WEIGHT g
Inside dc Block								
2046-6010-00[1]	.01-2.0	1.15	0.2	200	1.375 (35)	.31 SQ. (7.9)	.25	7
2046-6020-00[1]	0.5-18.0	1.25 (0.5-8.0) 1.35 (8.0-12.4) 1.45 (12.4-18.0)	0.4 (0.5-8.0) 0.5 (8.0-12.4) 0.6 (12.4-18.0)	600	1.10 (28)	.300 DIA. (7.6)	.21	6
2046-6030-00[2]	.25-18.0	1.35	0.5	300	.88 (22.4)	.25 DIA. (6.4)	.18	5.1
Outside dc Block								
2045-6010-00[1]	1.0-18.0	1.35 (1.0-12.4) 1.45 (12.4-18.0)	0.5	400	1.10 (28)	.300 DIA. (7.6)	.21	6
Inside/Outside dc Block								
2044-6010-00[1]	1.0-18.0	1.35 (1.0-12.4) 1.45 (12.4-18.0)	0.4 (1.0-18.0) 0.6 (8.0-12.4) 0.8 (12.4-18.0)	300	1.10 (28)	.300 DIA. (7.6)	.21	6

Finish: Passivated Stainless Steel

[1] Temperature Range: −54° to +71° C
[2] Temperature Range: −54° to +125° C

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

M/A-COM

Monitor Tee/dc Blocks

2047 Series

- Broadband Performance .75 to 50 GHz
- Power: Average 20 Watts CW
  Peak 1000 Watts
- Temperature Range: −54° to +71°C
- Connectors: OSM/SMA per MIL-C-39012, 3.5mm

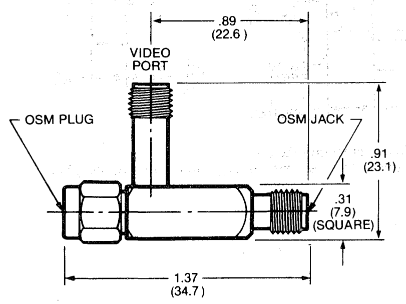


FIG. 1

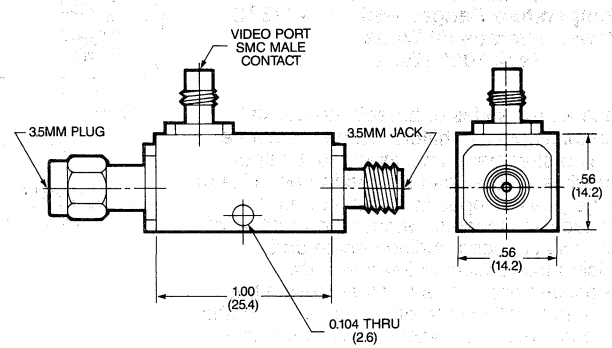


FIG. 2

NOTE: All dimensions are ± .020.

SPECIFICATIONS

PART NO.	FIG. NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	INSERTION LOSS dB (max.)	MAIN LINE MAXIMUM VOLTAGE (Vdc)	MAXIMUM CURRENT (Adc)	WEIGHT	
							oz.	g
2047-6010-00	1	0.75-2.0	1.30	0.3	600	.25	0.5	14.2
2047-6011-00	1	1.5-4.0	1.35	0.4	600	.25	0.5	14.2
2047-6012-00	1	2.6-5.2	1.40	0.5	600	.25	0.5	14.2
2047-6013-00	1	4.0-11.0	1.45	0.7	600	.25	0.5	14.2
2047-6014-00	1	8.0-12.4	1.45	0.7	600	.25	0.5	14.2
2047-6015-00	1	11.0-18.0	1.50	0.7	600	.25	0.5	14.2
2047-6016-00	2	2.0-18.0	1.35	1.0	250	.50	.62	17.6

Finish: Gold plate for Figure 1.
Epoxy paint for Figures 2 and 3.

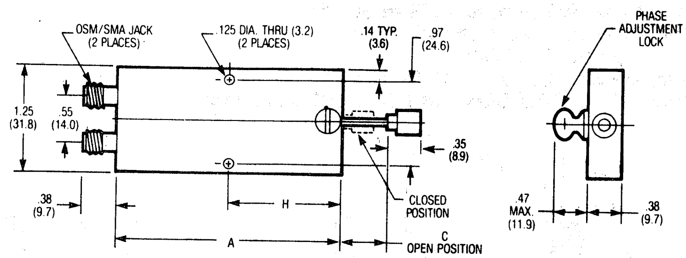
Specifications Subject to Change Without Notice.

![M/A-COM]

Phase Shifters

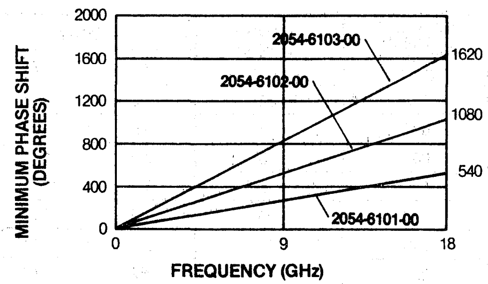
- **Fixed Connector Positions**
- **Low Loss**
- **Broadband**
- **Choice of Minimum Phase Shift**
- **Temperature Range: −65° to +125°C**
- **Power: Average 50 Watts**
  Peak 1000 Watts

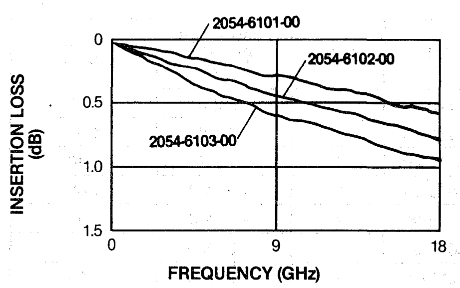
This is a new series of broadband coaxial mechanical phase shifters. These trombone style line stretchers have fixed input/output connectors so they can be used to equalize or change phase slopes in a chain of hard mounted components, without the addition of cable service loops. Airline design and precision tolerancing of internal slide connections allow for a low loss device that can be manually set to precise phase lengths and, once locked in place, remains stable in the roughest shock, vibration and thermal environments (meets MIL-E-5400 and MIL-E-16400 environments). Three different phase slope units are offered so that insertion loss is minimized. Other connectors, phase slopes and configurations are available upon request.



Finish: Medium gray paint. Passivated stainless steel connectors.
NOTE: All dimensions are ± .020, except mounting hole diameters (± .005) and mounting hole locations (± .010).

TYPICAL PERFORMANCE





SPECIFICATIONS

PART NO.	PHASE SHIFT (min.)	INSERTION LOSS (dB)	VSWR (Ratio)	SIZE,INCHES(mm) A	C	H	WEIGHT oz.	g
2054-6101-00	30 Deg./GHz	0.5 + .025 f(GHz)	1.5, dc-10 GHz 1.7, 10-18 GHz	2.50 (63.5)	.50 Nom. (12.7)	1.25 (31.8)	2.5	71.4
2054-6102-00	60 Deg./GHz	0.5 + .035 f(GHz)	1.6, dc-10 GHz 1.8, 10-18 GHz	3.50 (88.9)	1.00 Nom. (25.4)	1.75 (44.5)	3.5	100.0
2054-6103-00	90 Deg./GHz	0.5 + .045 f(GHz)	1.6, dc-10 GHz 1.8, 10-18 GHz	4.50 (114.3)	1.50 Nom. (38.1)	2.25 (57.2)	4.5	128.6

Specifications Subject to Change Without Notice.

M/A-COM

Line Stretchers

2054 Series

- **Constant Impedance**
- **Quick Adjusting**
- **Secure Locking**
- **Captured Contacts**
- **Temperature Range: −65° to +125°C**
- **Meets MIL-E-5400 Environments**

Line Stretchers are used to adjust the electrical separation of other components. The length of travel is .500 inch (12.7 mm), both mechanically and electrically. They are bi-directional. The design is such that at all times the impedance is 50 ohms. A locking device is provided to adjust sliding tension and to lock the desired adjustments.

FIG. 1

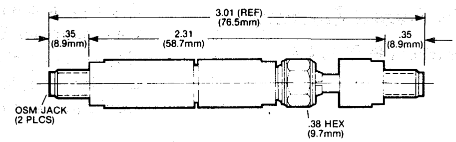


FIG. 2

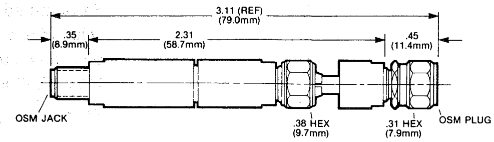
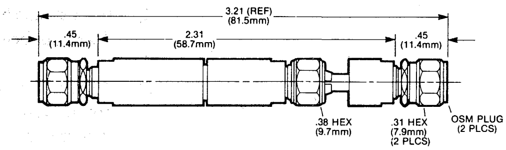


FIG. 3



NOTE: All dimensions are ± .020.

SPECIFICATIONS

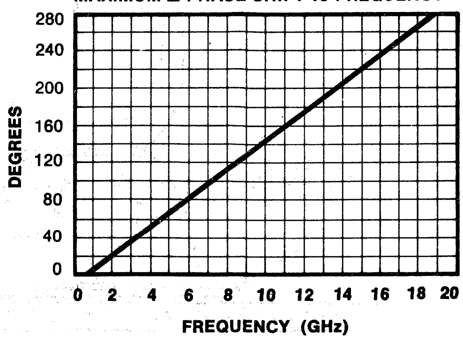
PART NO.	FREQUENCY RANGE (GHz)	VSWR (max.)	INSERTION LOSS (dB)	TIME DELAY (nanoseconds) (min.) (max.)	POWER AVG. (W)	POWER PK. (kW)	FIG.
2054-6001-00	dc-18.0	1.30 (dc-10.0) 1.40 (10.0-18.0)	.20 + .03f	.30 - .38	20	1.0	1
2054-6002-00	dc-18.0	1.30 (dc-10.0) 1.40 (10.0-18.0)	.20 + .03f	.31 - .39	20	1.0	2
2054-6003-00	dc-18.0	1.30 (dc-10.0) 1.40 (10.0-18.0)	.20 + .03f	.31 - .39	20	1.0	3

MECHANICAL SPECIFICATIONS

FIG.	CONNECTORS	LENGTH (L) EXTENDED (max.) in.	LENGTH (L) EXTENDED (max.) mm	DIAMETER (max.) in.	DIAMETER (max.) mm	WEIGHT oz.	WEIGHT g
1	OSM Jacks	3.5	88.9	.385	9.78	1.30	36.5
2	OSM Plug OSM Jack	3.6	91.5	.385	9.78	1.35	38.0
3	OSM Plug OSM Plug	3.7	94.0	.385	9.78	1.40	39.5

Finish: Passivated Stainless Steel

MAXIMUM Δ PHASE SHIFT vs FREQUENCY



Specifications Subject to Change Without Notice.

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ESD (Electrostatic Discharge) Precautions

M510

Steps To Avoid Damaging ESD-Sensitive Parts

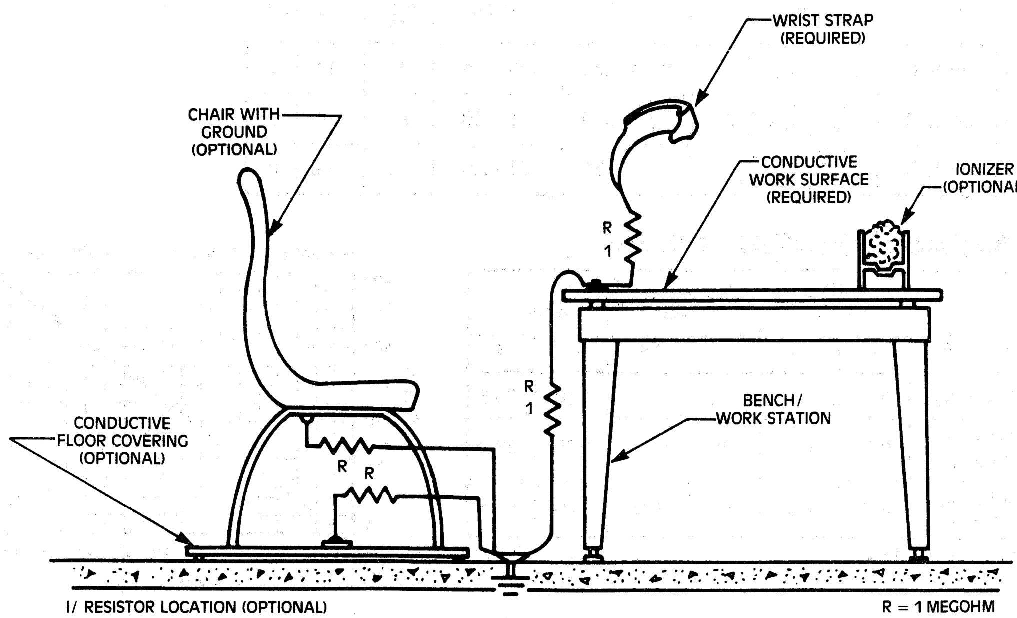
Detector diodes have very small junctions and are therefore quite sensitive to electrostatic discharge. ESD-induced damage is a major contributor to component failures at all levels of system assembly and test. Connectorless drop-in detector modules are particularly susceptible since the pins are completely exposed. The following precautions should be taken to avoid damage to microwave detectors or any other ESD-sensitive parts:

1) Parts should be transported in static-free containers at all times. M/A-COM detectors are shipped in appropriate static-free packing material and we recommend that this packaging be used up to the system assembly stage. Should it be necessary to return a detector to M/A-COM for evaluation or repair, the original packing material (or equivalent) should be used.

2) Parts should be handled only at static-controlled work stations where the operator, bench surface and other equipment are suitably grounded.

3) All test equipment, cables and power supplies should be checked to insure that there are no "ground loops" or excess voltages (AC or DC) present that would damage the detector diodes.

A typical static-free workstation is shown below.



Application Note

PIN Diode Attenuator

M502

Obtaining Controllable Attenuation Functions at Microwave Frequencies

PIN diode attenuators are designed to provide a controllable attenuation function at microwave frequencies. Simple PIN attenuators consist of one or more shunt mounted diodes. In this configuration, the attenuation versus control current is non-linear and temperature dependent. Usually, a linearized and temperature-compensated driver is incorporated to provide a specific transfer characteristic usually specified as X dB per volt. The temperature compensation circuits are included to minimize attenuation versus temperature variations.

Most PIN attenuators exhibit an inherent variation of attenuation with frequency (flatness). This characteristic usually limits the operating bandwidth to approximately one octave. Attenuation errors due to flatness cannot be compensated for with driver circuitry. More sophisticated designs include RF matching circuits for applications requiring low VSWR over the entire dynamic range of attenuator.

For digital control, a D/A converter can be added to convert a digital input to an analog level to drive the attenuator. Figures 1, 2 and 3 illustrate these concepts. The linearized driver results in an essentially linear transfer function (attenuation vs. control voltage). This type of driver is aligned and temperature compensated at the factory with a unique PIN attenuator.

In general, the attenuator/driver combinations are non-interchangeable. The alignment process must be performed at a specific frequency within the specified operating range. The normal procedure is to select the frequency that results in the nominal attenuation curves as shown in Figure 1 (linearization frequency). This procedure results in the frequency variation (flatness) error being equally distributed about the desired or nominal attenuation. Addition of the linearizer "corrects" the Figure 1 nonlinearity to within a specified value (note tolerance on Figure 2).

Figure 1

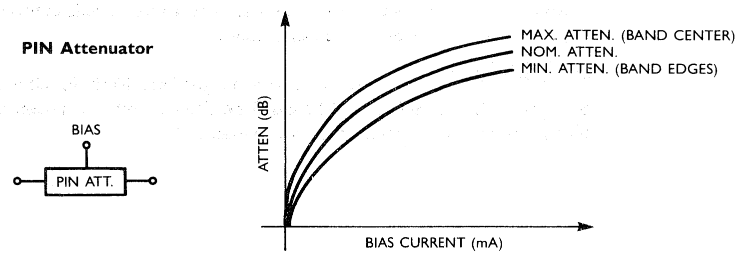
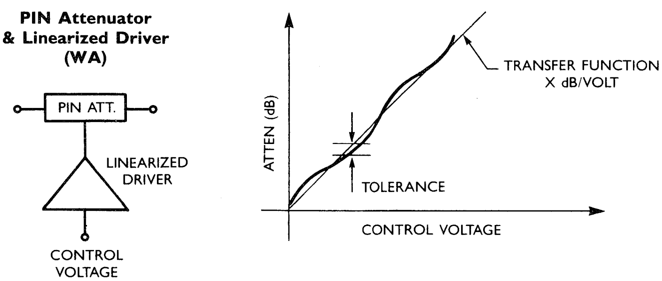


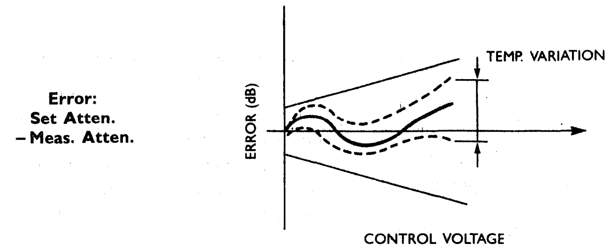
Figure 2



Specifications Subject to Change Without Notice.

Once the desired attenuation and linearity have been achieved at room ambient, the device is subjected to temperature evaluation. At the specified temperature extremes, the attenuation drift is electronically compensated to obtain minimum attenuation error as shown in Figure 3.

Figure 3



Drive Circuitry

To interface microwave components with today's digital and linear control systems, M/A-COM manufactures a variety of TTL, ECL and linear drivers.

TTL Drivers

TTL drivers are available with optional supply voltages, logic, phase and switching speeds. Voltages are optimized for power consumption and performance.

Switching speed is the major consideration in TTL driver design. The PIN diodes and filter elements in the microwave switch have to be chosen carefully to avoid compromising the driver circuitry. Higher RF power requires thicker PIN diodes, resulting in slower switching speeds. Frequencies below 1 GHz require bias filters that begin to roll off the high speed leading edges of the driver output. M/A-COM's fast switches are capable of toggle rates of 20 MHz and transition times of less than 3 nanoseconds.

ECL Drivers

ECL drivers are designed specifically for ultra high speed applications. The voltages are fixed at +12 and -5.2V. These switches will operate at toggle rates of 80 MHz and transition times less than 1 nanosecond.

Design Considerations For General Microwave Module Usage

M511

Circuit Installation

The recommended method of installation is shown in Figure 1. The foil above and below conformally wraps over the module. In this way, continuity in RF ground currents at the module interfaces is assured. The compression gasket maintains contact between the circuit board ground metallization and the module case ground (top and bottom). In addition, it provides proper compression of the circuit board around the leads to eliminate air gaps at the leads. Note that primary ground is on the circuit board metallization and not the metal plates.

Modules are typically designed to fit in 0.125 inch ground plane spacing stripline circuits. The standard height of a module is, by design, 0.130 inches. This guarantees that ground foils will make contact with the body first, assuring a good module ground. The rubber/foil accommodates the difference between circuit board ground and body ground.

Biasing Requirements

Some M/A-COM modules require external biasing circuits. A typical example of a schematic is shown in Figure 2. Current or voltage is fed through the bias coil to the diodes and back through the case to ground. It is, therefore, usually necessary to ground the power supply or driver to the RF ground. The external bypass capacitor provides additional filtering (RF rejection) in the bias circuit, but if the capacitance value is too large, it will degrade the switching speed. dc blocks are required to prevent leakage of bias current into the remaining RF circuitry.

For the noted circuit, forward bias causes the diodes to show R_S thereby shorting out the RF line. This necessarily produces a mismatch, reflecting the input power back to the RF source. Absorptive units are presented for most M/A-COM products in this catalog. This option is an enhanced design which exhibits low VSWR in both switch states. For insertion loss, the diodes are normally reverse biased with a voltage, typically 10 volts. This reverse voltage ensures that the diodes are completely off and improves the switching speed.

Figure 1

Typical Module Installation into Stripline Geometry

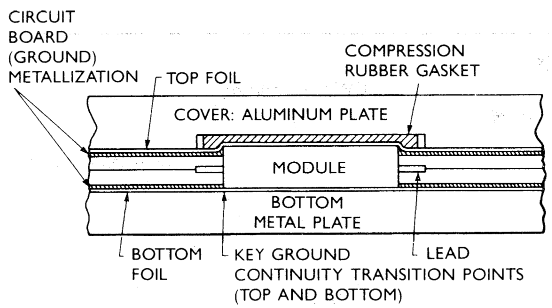
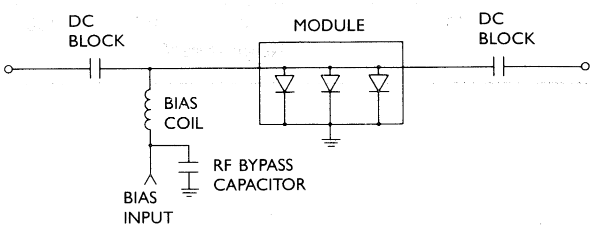


Figure 2



Specifications Subject to Change Without Notice.

Power Considerations

For most switches, the power is either transmitted to the output load or reflected back to the source. The percentage absorbed by the switch in either state is typically small. Problems arise when the requirement is to switch states while the high power is applied (a condition called "hot switching"). In shunt diode switches, up to 50% of the incident power may be absorbed during switching. For this reason, most switches are power rated under "cold switching" conditions. The problem with "hot switching" requirements is that diodes must be thick enough to withstand RF line power, yet be thin enough to switch fast and minimize duration of absorbed energy during the transition state.

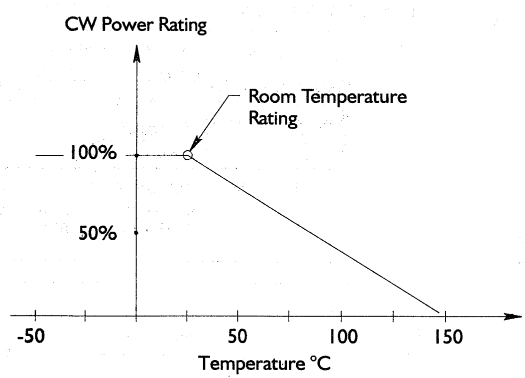
Some advantage can be obtained under pulsed operation. If RF pulse lengths are short compared to thermal time constants for PIN diodes, the diode will not have time to heat up. Thermal time constants are typically a few microseconds long. Hence, pulse widths of 10 or more microseconds are virtually CW conditions for most devices. Duty cycle/average power computations are no longer useful under these long pulse conditions.

A typical CW power derating curve is shown in Figure 3. Increasing the ambient temperature brings a diode that much closer to damaging thermal stresses.

Another type of problem encountered at high power levels is limiting. Limiting occurs when charges injected by the RF currents become comparable to the charges stored in the diodes by the dc control currents. This occurs in fast switching, thin I-Region diodes which are incapable of strong sufficient dc charge. A rectified current is set up which modifies the control bias.

Figure 3

Power Derating Curve



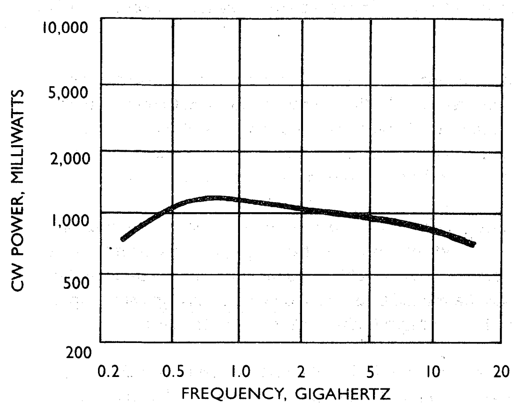
Power Considerations (cont'd.)

The solution to this problem consists of three strategies:

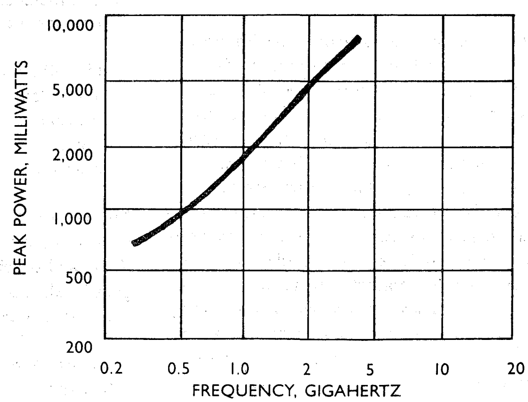
- Increase the thickness of the diode (slow the switching speed) so that the diode is saturated with dc charges in the isolation state.
- Apply a reverse voltage at insertion loss to sweep out any RF injected charges.
- Make the driver output impedance high so that there is little chance of the RF forcing rectified current back through the driver.

The above considerations show that there is a trade-off between high power and fast switching speed. The curves in Figure 4 show typical effects on loss for increased CW and pulsed power.

Figure 4



Typical CW Power at which Insertion Loss Increases by 0.1 dB Over Loss at 0 dBm.



Typical Peak Power at which Insertion Loss Increases by 0.1 dB Over Loss at 0 dBm.

Integration of Drop-In Microwave Components

M512

The growing popularity of drop-in components is a result of the continual trend toward smaller, more reliable systems. Drop-in modules are typically installed directly on a stripline or microstrip circuit board. Advantages of this approach to system design are:

- Space savings (no connectors or cables)
- Components can be tested outside the system, as a stand-alone device
- Components can be screened for enhanced reliability
- Connector and cable losses are eliminated

There are drawbacks associated with the use of drop-in module devices, however. The first is a potential correlation problem between the component manufacturer's test results and the user's evaluation data on the same device. It is important that both parties use the same type of test fixture and test methods and we recommend that the test fixture itself closely resemble the conditions the component will see in the actual system. For example, a component to be used in a stripline medium with a ground plane spacing of .062 and an effective dielectric constant of 2.32 should be tested in a fixture of similar construction.

The second drawback occurs in the system design stage. The designer who elects to use drop-ins abandons the relative safety of standard 50 ohm connectors and assumes the electrical and mechanical problems involved in interfacing the drop-in module with the system's motherboard. Removable-connector-type modules may eliminate correlation problems, but performance with connectors is no guarantee that the same can be achieved in a system unless the interface is correct. Due to the wide variety of designs, materials and construction techniques, there are no "standard" interface rules, but we offer the following guidelines:

1) The difficulty of maintaining a proper electrical interface increases with the operating frequency. This deserves serious attention for frequencies above 8 GHz.

2) Ground plane contact between the motherboard and the module should be smooth and continuous. Solid ground contact is absolutely necessary.

3) Minimize gaps or other discontinuities at all RF launches. This usually requires tight mechanical tolerances.

4) Use radiation shielding techniques at least comparable to the isolation performance of the component.

5) Use 50 ohm "dummy" modules to evaluate and troubleshoot the motherboard assembly. These "dummy" modules are mechanically identical to the modules, but contain 50 ohm transmission lines instead of component circuitry. This is often particularly useful in conjunction with time-domain reflectometer measurements to troubleshoot the module interface. Consult factory for price, availability and options on "dummy" modules.

The last serious consideration involves the handling of drop-in modules in the manufacturing area. The contact pins on microwave modules are somewhat fragile; they are usually made of Kovar and are about .015" in diameter in order to achieve 50 ohm impedance through the glass bead. Assembly personnel must be trained to use caution when working with drop-in modules. Bending may weaken the lead or degrade the quality of the glass seal.

Static discharge is another handling problem which should be addressed in manufacturing. Schottky diodes are very sensitive and the unprotected leads make the module quite susceptible to static discharge damage. The use of anti-static work stations and approved personnel grounding straps is highly recommended.

M/A-COM's engineering staff has had extensive experience in integrating drop-in modules as part of complex microwave subsystems. Our engineers would be happy to consult with you regarding your specific integration requirements.

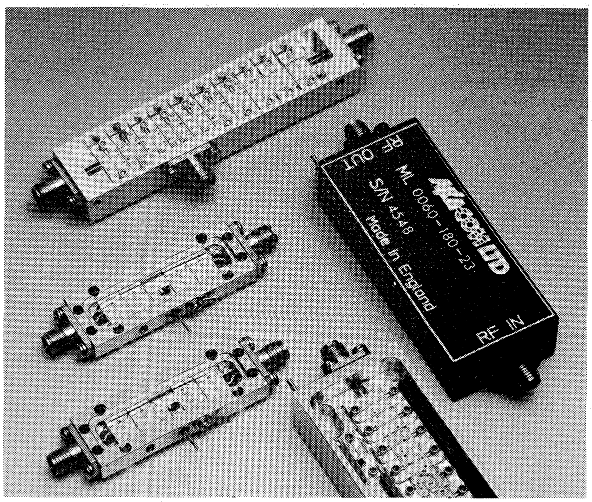
M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

GaAs FET Amplifiers, Broadband
0.5-18 GHz

MLA 2000 Series

FEATURES

- Broad Frequency Ranges
- Low Noise Figures
- Wide Dynamic Ranges
- Temperature Compensation
- Miniature Outlines



DESCRIPTION

The MLA 2000-000 series of broadband GaAs FET Amplifiers from M/A-COM Ltd is a comprehensive range of devices for octave and multi-octave applications from 0.5 to 18 GHz. The range includes standard low noise and medium power gain blocks available with or without temperature compensation as well as limiting amplifiers for output power compression. All amplifiers are available in either a standard or optional miniature package style.

The designs are based on a balanced hybrid approach giving excellent gain flatness and VSWR over very wide bandwidths. Construction of the amplifiers is by integration of the FET or MMIC devices into either a conventional alumina MIC or a glass MIC (GMIC) with the complete amplifier assembly then hermetically sealed by laser welding. GMIC is a proprietary pseudo-monolithic MIC fabrication technique established by M/A-COM Ltd using a thin glass substrate bonded directly to a high conductivity silicon carrier. All the passive components are then photolithographically defined with the discrete FET devices mounted in via holes. The compact, rugged construction of these amplifiers makes them suitable for the most severe environmental conditions encountered in military and hi-rel applications.

Low noise amplifiers have a wide variety of uses in broadband EW and radar receivers and test equipment applications while medium power units can be used as driver amplifiers for high power TWTA's or as output amplifiers for ECM, decoy and target transmitters. Limiting amplifiers are used where an input signal with wide dynamic range is to be compressed to an output signal with very narrow dynamic range for subsequent signal processing and detection. Advances in solid state technology make these amplifiers suitable as direct replacements for TWTAs in many applications giving improved reliability at lower cost.

As well as the basic amplifiers described M/A-COM Ltd also manufactures devices with additional components integrated within the same housing. Available options include input limiters for passive high power protection, integral PIN attenuators for gain/sensitivity control, coupled outputs for successive detection and filters. For details of these options and to discuss other custom requirements please contact the factory for applications assistance.

Specifications Subject to Change Without Notice.

GaAs FET Low Noise Amplifiers 0.5-18 GHz

MLA 2100 Series

SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
0.5 - 2.0	+12	18	±1.00	0.020	3.5	2.0	65	A1. A3	MLA 2130-101
		36	±2.00	0.040	3.5	2.0	130	A1, A3	MLA 2130-102
		54	±3.00	0.060	3.5	2.0	200	A1, A3	MLA 2130-103
	+22	10	±0.50	0.010	5.0	2.0	100	A1, A3	MLA 2130-201
		28	±1.25	0.030	4.0	2.0	150	A1, A3	MLA 2130-202
		46	±1.50	0.040	4.0	2.0	225	A1, A3	MLA 2130-203
2.0 - 8.0	+10	18	±1.50	0.025	3.5	2.0	130	A1, A3	MLA 2140-101
		27	±1.50	0.035	3.5	2.0	200	B1, B3	MLA 2140-102
		36	±1.75	0.050	3.5	2.0	270	B1, B3	MLA 2140-103
	+15	18	±1.50	0.025	4.0	2.0	150	A1, A3	MLA 2140-201
		27	±1.50	0.035	4.0	2.0	220	B1, B3	MLA 2140-202
		36	±1.75	0.050	4.0	2.0	300	B1, B3	MLA 2140-203
	+18	18	±1.50	0.025	5.0	2.0	180	A1, A3	MLA 2140-301
		27	±1.50	0.035	5.0	2.0	280	B1, B3	MLA 2140-302
		36	±1.75	0.050	5.0	2.0	350	B1, B3	MLA 2140-303
6.0 - 12.0	+10	12	±1.00	0.025	4.0	2.0	100	A1, A2	MLA 2150-101
		23	±1.25	0.050	4.0	2.0	200	B1, B2	MLA 2150-102
		34	±1.75	0.075	4.0	2.0	300	B1, B2	MLA 2150-103
		46	±2.00	0.100	4.0	2.0	400	C1, C2	MLA 2150-104
		52	±2.00	0.120	4.0	2.0	450	D1, D2	MLA 2150-105
	+15	11	±1.25	0.025	5.0	2.0	150	A1, A2	MLA 2150-201
		22	±1.50	0.050	5.0	2.0	250	B1, B2	MLA 2150-202
		33	±1.75	0.075	5.0	2.0	350	B1, B2	MLA 2150-203
		44	±2.00	0.100	5.0	2.0	450	C1, C2	MLA 2150-204
		50	±2.00	0.120	5.0	2.0	500	D1, D2	MLA 2150-205
	+18	10	±1.25	0.025	7.0	2.0	175	A1, A2	MLA 2150-301
		21	±1.50	0.050	6.0	2.0	275	B1, B2	MLA 2150-302
		32	±1.75	0.075	6.0	2.0	400	B1, B2	MLA 2150-303
		42	±2.00	0.100	6.0	2.0	500	C1, C2	MLA 2150-304
		48	±2.00	0.120	6.0	2.0	550	D1, D2	MLA 2150-305
12.0 - 18.0	+10	11	±1.00	0.025	5.5	2.0	100	A1, A2	MLA 2160-101
		22	±1.25	0.050	5.5	2.0	200	B1, B2	MLA 2160-102
		33	±1.75	0.075	5.5	2.0	300	B1, B2	MLA 2160-103
		44	±2.00	0.100	5.5	2.0	400	C1, C2	MLA 2160-104
		50	±2.00	0.120	5.5	2.0	450	D1, D2	MLA 2160-105
	+15	10	±1.00	0.025	6.0	2.0	150	A1, A2	MLA 2160-201
		21	±1.25	0.050	6.0	2.0	250	B1, B2	MLA 2160-202
		32	±1.75	0.075	6.0	2.0	350	B1, B2	MLA 2160-203
		43	±2.00	0.100	6.0	2.0	450	C1, C2	MLA 2160-204
		49	±2.00	0.120	6.0	2.0	500	D1, D2	MLA 2160-205
	+18	9	±1.00	0.025	8.0	2.0	175	A1, A2	MLA 2160-301
		20	±1.25	0.050	7.0	2.0	275	B1, B2	MLA 2160-302
		30	±1.75	0.075	7.0	2.0	400	B1, B2	MLA 2160-303
		40	±2.00	0.100	7.0	2.0	500	C1, C2	MLA 2160-304
		46	±2.00	0.120	7.0	2.0	550	D1, D2	MLA 2160-305

Specifications Subject to Change Without Notice.

SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
6.0 - 18.0	+10	11	±1.00	0.025	5.5	2.0	100	A1, A2	MLA 2170-101
		22	±1.50	0.050	5.5	2.0	200	B1, B2	MLA 2170-102
		33	±1.75	0.075	5.5	2.0	300	B1, B2	MLA 2170-103
		44	±2.00	0.100	5.5	2.0	400	C1, C2	MLA 2170-104
		50	±2.00	0.120	5.5	2.0	450	D1, D2	MLA 2170-105
	+15	10	±1.25	0.025	6.0	2.0	150	A1, A2	MLA 2170-201
		21	±1.50	0.050	6.0	2.0	250	B1, B2	MLA 2170-202
		32	±1.75	0.075	6.0	2.0	350	B1, B2	MLA 2170-203
		43	±2.00	0.100	6.0	2.0	450	C1, C2	MLA 2170-204
		49	±2.00	0.120	6.0	2.0	500	D1, D2	MLA 2170-205
	+18	9	±1.50	0.025	8.0	2.0	175	A1, A2	MLA 2170-301
		20	±1.50	0.050	7.0	2.0	275	B1, B2	MLA 2170-302
		30	±1.75	0.075	7.0	2.0	400	B1, B2	MLA 2170-303
		40	±2.00	0.100	7.0	2.0	500	C1, C2	MLA 2170-304
		46	±2.00	0.120	7.0	2.0	550	D1, D2	MLA 2170-305
2.0 - 18.0	+12	6	±0.50	0.015	6.5	2.2	100	A1, A2	MLA 2180-101
		12	±1.00	0.030	7.0	2.2	200	A1, A2	MLA 2180-102
		24	±1.50	0.060	7.0	2.2	400	B1, B2	MLA 2180-103
		36	±2.00	0.120	7.0	2.2	600	B1, B2	MLA 2180-104
	+17	6	±0.75	0.015	8.0	2.2	150	A1, A2	MLA 2180-201
		12	±1.25	0.030	8.5	2.2	250	A1, A2	MLA 2180-202
		24	±1.50	0.060	8.5	2.2	450	B1, B2	MLA 2180-203
		36	±2.00	0.120	8.5	2.2	650	B1, B2	MLA 2180-204

NOTES

1) Maximum input power without damage +20dBm (cw)
2) Third order intercept point is typically 10dB above P1dB
3) All amplifiers have reverse polarity and over voltage power supply protection
4) Alternative +8V and +12V power supplies are available on selected amplifiers, please contact the factory
5) All amplifiers are unconditionally stable for any input or output VSWR, any phase
6) Case operating temperature -55°C to +95°C
   Storage temperature -55°C to +125°C
7) Amplifiers are supplied in standard package styles (A1, B1, C1, D1) unless miniature option (A2, B2 etc) is specified.

Specifications Subject to Change Without Notice.

GaAs FET Low Noise Amplifiers 0.5-18 GHz, Temp. Compensated

MLA 2200 Series

SPECIFICATIONS (guaranteed –55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
2.0 - 8.0	+10	17	±2.00	±0.75	4.5	2.0	130	A1. A3	MLA 2240-101
		25	±2.00	±1.00	4.5	2.0	200	B1, B3	MLA 2240-102
		34	±2.25	±1.25	4.5	2.0	270	B1, B3	MLA 2240-103
	+15	17	±2.00	±0.75	5.0	2.0	150	A1. A3	MLA 2240-201
		25	±2.00	±1.00	5.0	2.0	220	B1, B3	MLA 2240-202
		34	±2.25	±1.25	5.0	2.0	300	B1, B3	MLA 2240-203
	+18	17	±2.00	±0.75	6.0	2.0	180	A1. A3	MLA 2240-301
		25	±2.00	±1.00	6.0	2.0	280	B1, B3	MLA 2240-302
		34	±2.25	±1.25	6.0	2.0	350	B1, B3	MLA 2240-303
6.0 - 12.0	+10	10	±1.00	±0.75	6.5	2.0	100	A1. A2	MLA 2250-101
		19	±1.25	±1.00	5.5	2.0	200	B1, B2	MLA 2250-102
		28	±1.75	±1.50	5.5	2.0	300	B1, B2	MLA 2250-103
		38	±2.00	±2.00	5.5	2.0	400	C1. C2	MLA 2250-104
		44	±2.00	±2.00	5.5	2.0	500	D1, D2	MLA 2250-105
	+15	10	±1.25	±0.75	6.5	2.0	150	A1. A2	MLA 2250-201
		19	±1.50	±1.00	5.5	2.0	250	B1, B2	MLA 2250-202
		28	±1.75	±1.50	5.5	2.0	350	B1, B2	MLA 2250-203
		38	±2.00	±2.00	5.5	2.0	450	C1. C2	MLA 2250-204
		44	±2.00	±2.00	5.5	2.0	500	D1, D2	MLA 2250-205
	+18	9	±1.25	±0.75	7.5	2.0	175	A1. A2	MLA 2250-301
		18	±1.50	±1.00	6.5	2.0	275	B1, B2	MLA 2250-302
		27	±1.75	±1.50	6.5	2.0	400	B1, B2	MLA 2250-303
		36	±2.00	±2.00	6.5	2.0	500	C1. C2	MLA 2250-304
		42	±2.00	±2.00	6.5	2.0	550	D1, D2	MLA 2250-305
12.0 - 18.0	+10	9	±1.00	±0.75	8.0	2.0	100	A1. A2	MLA 2260-101
		18	±1.25	±1.00	7.0	2.0	200	B1, B2	MLA 2260-102
		27	±1.75	±1.50	7.0	2.0	300	B1, B2	MLA 2260-103
		36	±2.00	±2.00	7.0	2.0	400	C1. C2	MLA 2260-104
		41	±2.00	±2.00	7.0	2.0	500	D1, D2	MLA 2260-105
	+15	9	±1.00	±0.75	8.0	2.0	150	A1, A2	MLA 2260-201
		18	±1.25	±1.00	7.0	2.0	250	B1, B2	MLA 2260-202
		27	±1.75	±1.50	7.0	2.0	350	B1, B2	MLA 2260-203
		36	±2.00	±2.00	7.0	2.0	450	C1, C2	MLA 2260-204
		41	±2.00	±2.00	7.0	2.0	500	D1, D2	MLA 2260-205
	+18	8	±1.00	±0.75	9.0	2.0	175	A1, A2	MLA 2260-301
		17	±1.25	±1.00	8.0	2.0	275	B1, B2	MLA 2260-302
		26	±1.75	±1.50	7.0	2.0	400	B1, B2	MLA 2260-303
		34	±2.00	±2.00	7.0	2.0	500	C1, C2	MLA 2260-304
		39	±2.00	±2.00	7.0	2.0	550	D1, D2	MLA 2260-305

Specifications Subject to Change Without Notice.

SPECIFICATIONS (guaranteed –55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
6.0 - 18.0	+10	9	±1.00	±0.75	8.0	2.0	100	A1, A2	MLA 2270-101
		18	±1.50	±1.00	7.0	2.0	200	B1, B2	MLA 2270-102
		27	±1.75	±1.50	7.0	2.0	300	B1, B2	MLA 2270-103
		36	±2.00	±2.00	7.0	2.0	400	C1, C2	MLA 2270-104
		41	±2.00	±2.00	7.0	2.0	500	D1, D2	MLA 2270-105
	+15	9	±1.25	±0.75	8.0	2.0	150	A1, A2	MLA 2270-201
		18	±1.50	±1.00	7.0	2.0	250	B1, B2	MLA 2270-202
		27	±1.75	±1.50	7.0	2.0	350	B1, B2	MLA 2270-203
		36	±2.00	±2.00	7.0	2.0	450	C1, C2	MLA 2270-204
		41	±2.00	±2.00	7.0	2.0	500	D1, D2	MLA 2270-205
	+18	8	±1.50	±0.75	9.0	2.0	175	A1, A2	MLA 2270-301
		17	±1.50	±1.00	8.0	2.0	275	B1, B2	MLA 2270-302
		26	±1.75	±1.50	7.0	2.0	400	B1, B2	MLA 2270-303
		34	±2.00	±2.00	7.0	2.0	500	C1, C2	MLA 2270-304
		39	±2.00	±2.00	7.0	2.0	550	D1, D2	MLA 2270-305

NOTES

1) Maximum input power without damage +20dBm (CW)
2) Third order intercept point is typically 10dB above P1dB
3) All amplifiers have reverse polarity and over voltage power supply protection
4) Alternative +8V and +12V power supplies are available on selected amplifiers, please contact the factory
5) All amplifiers are unconditionally stable for any input or output VSWR, any phase
6) Case operating temperature –55°C to +95°C
   Storage temperature –55°C to +125°C
7) Amplifiers are supplied in standard package styles (A1, B1, C1, D1) unless miniature option (A2, B2 etc) is specified.

GaAs FET Medium Power Amplifiers
0.5-18 GHz

MLA 2100 Series

SPECIFICATIONS (guaranteed @25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
2.0 - 8.0	+21	17	±2.00	0.025	7.5	2.0	300	A1. A3	MLA 2140-401
		26	±2.00	0.035	6.0	2.0	400	B1, B3	MLA 2140-402
		35	±2.00	0.050	6.0	2.0	480	B1, B3	MLA 2140-403
	+26	15	±2.00	0.025	8.0	2.0	350	A1. A3	MLA 2140-501
		24	±2.00	0.035	7.0	2.0	450	B1, B3	MLA 2140-502
		33	±2.00	0.050	6.0	2.0	550	B1, B3	MLA 2140-503
6.0 - 12.0	+21	10	±1.00	0.025	9.0	2.0	200	A1. A2	MLA 2150-401
		21	±1.25	0.050	8.0	2.0	300	B1, B2	MLA 2150-402
		31	±1.50	0.075	8.0	2.0	450	B1, B2	MLA 2150-403
		42	±1.75	0.100	8.0	2.0	600	C1. C2	MLA 2150-404
	+25	9	±1.00	0.025	9.0	2.0	300	A1. A2	MLA 2150-501
		20	±1.25	0.050	8.0	2.0	450	B1, B2	MLA 2150-502
		29	±1.50	0.075	8.0	2.0	600	B1, B2	MLA 2150-503
		40	±1.75	0.100	8.0	2.0	800	C1. C2	MLA 2150-504
12.0 - 18.0	+21	9	±1.00	0.025	10.0	2.0	200	A1. A2	MLA 2160-401
		20	±1.25	0.050	9.0	2.0	300	B1, B2	MLA 2160-402
		30	±1.50	0.075	9.0	2.0	450	B1, B2	MLA 2160-403
		40	±1.75	0.100	9.0	2.0	600	C1. C2	MLA 2160-404
	+25	8	±1.00	0.025	10.0	2.0	300	A1, A2	MLA 2160-501
		19	±1.25	0.050	9.0	2.0	450	B1, B2	MLA 2160-502
		28	±1.50	0.075	9.0	2.0	600	B1, B2	MLA 2160-503
		38	±1.75	0.100	9.0	2.0	800	C1, C2	MLA 2160-504
6.0 - 18.0	+21	9	±1.25	0.025	10.0	2.0	200	A1, A2	MLA 2170-401
		20	±1.50	0.050	9.0	2.0	300	B1, B2	MLA 2170-402
		30	±1.75	0.075	9.0	2.0	450	B1, B2	MLA 2170-403
		40	±2.00	0.100	9.0	2.0	600	C1, C2	MLA 2170-404
	+25	8	±1.25	0.025	10.0	2.0	300	A1, A2	MLA 2170-501
		19	±1.50	0.050	9.0	2.0	450	B1, B2	MLA 2170-502
		28	±1.75	0.075	9.0	2.0	600	B1, B2	MLA 2170-503
		38	±2.00	0.100	9.0	2.0	800	C1, C2	MLA 2170-504

NOTES

1) Higher output powers of up to +30dBm are available in non-standard outlines, please contact the factory
2) Maximum input power without damage +20dBm (CW)
2) Third order intercept point is typically 10dB above P1dB
3) All amplifiers have reverse polarity and over voltage power supply protection
4) Alternative +8V and +12V power supplies are available on selected amplifiers, please contact the factory
5) All amplifiers are unconditionally stable for any input or output VSWR, any phase
6) Case operating temperature -55°C to +95°C
Storage temperature -55°C to +125°C
7) Amplifiers are supplied in standard package styles (A1, B1, C1, D1) unless miniature option (A2, B2 etc) is specified.

Specifications Subject to Change Without Notice.

M/A-COM

GaAs FET Medium Power Amplifiers
0.5-18 GHz, Temp. Compensated MLA 2200 Series

SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
2.0 - 8.0	+21	16	±2.00	±0.75	8.0	2.0	300	A1. A3	MLA 2240-401
		24	±2.00	±1.00	7.0	2.0	400	B1, B3	MLA 2240-402
		33	±2.00	±1.25	7.0	2.0	480	B1, B3	MLA 2240-403
	+26	14	±2.00	±0.75	9.0	2.0	350	A1. A3	MLA 2240-501
		22	±2.00	±1.00	8.0	2.0	450	B1, B3	MLA 2240-502
		31	±2.00	±1.25	7.0	2.0	550	B1, B3	MLA 2240-503
6.0 - 12.0	+21	9	±1.00	±0.75	10.0	2.0	200	A1. A2	MLA 2250-401
		20	±1.25	±1.00	9.0	2.0	300	B1, B2	MLA 2250-402
		29	±1.50	±1.50	9.0	2.0	450	C1, C2	MLA 2250-403
		40	±1.75	±2.00	9.0	2.0	600	D1. D2	MLA 2250-404
	+25	8	±1.00	±0.75	10.0	2.0	300	A1. A2	MLA 2250-501
		19	±1.25	±1.00	9.0	2.0	450	B1, B2	MLA 2250-502
		27	±1.50	±1.50	9.0	2.0	600	C1, C2	MLA 2250-503
		36	±1.75	±2.00	9.0	2.0	800	D1. D2	MLA 2250-504
12.0 - 18.0	+21	8	±1.00	±0.75	12.0	2.0	200	A1. A2	MLA 2260-401
		18	±1.25	±1.00	10.0	2.0	300	B1, B2	MLA 2260-402
		27	±1.50	±1.25	10.0	2.0	450	C1, C2	MLA 2260-403
		36	±1.75	±2.00	10.0	2.0	600	D1. D2	MLA 2260-404
	+25	7	±1.00	±0.75	12.0	2.0	300	A1, A2	MLA 2260-501
		17	±1.25	±1.00	10.0	2.0	450	B1, B2	MLA 2260-502
		25	±1.50	±1.25	10.0	2.0	600	C1, C2	MLA 2260-503
		34	±1.75	±2.00	10.0	2.0	800	D1, D2	MLA 2260-504
6.0 - 18.0	+21	8	±1.25	±0.75	12.0	2.0	200	A1, A2	MLA 2270-401
		18	±1.50	±1.00	10.0	2.0	300	B1, B2	MLA 2270-402
		27	±1.75	±1.50	10.0	2.0	450	C1, C2	MLA 2270-403
		36	±2.00	±2.00	10.0	2.0	600	D1, D2	MLA 2270-404
	+25	7	±1.25	±0.75	12.0	2.0	300	A1, A2	MLA 2270-501
		17	±1.50	±1.00	10.0	2.0	450	B1, B2	MLA 2270-502
		25	±1.75	±1.50	10.0	2.0	600	C1, C2	MLA 2270-503
		34	±2.00	±2.00	10.0	2.0	800	D1, D2	MLA 2270-504

NOTES

1) Higher output powers of up to +30dBm are available in non-standard outlines, please contact the factory
2) Maximum input power without damage +20dBm (CW)
2) Third order intercept point is typically 10dB above P1dB
3) All amplifiers have reverse polarity and over voltage power supply protection
4) Alternative +8V and +12V power supplies are available on selected amplifiers, please contact the factory
5) All amplifiers are unconditionally stable for any input or output VSWR, any phase
6) Case operating temperature -55°C to +95°C
Storage temperature -55°C to +125°C
7) Amplifiers are supplied in standard package styles (A1, B1, C1, D1) unless miniature option (A2, B2 etc) is specified.

![M/A-COM]

GaAs FET Limiting Amplifiers 0.5-18 GHz

MLA 2300 Series

SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Saturated Output Power (dBm) Min.	Saturated Output Power (dBm) Max.	Saturated Power Flatness (dB) Max.	Input Power for Saturation (dBm) Min.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
2.0 - 8.0	+14	+17	±1.0	-10	5.0	2.0	250	B1. B3	MLA 2340-101
				-20	5.0	2.0	300	B1, B3	MLA 2340-102
				-30	5.0	2.0	350	C1, C3	MLA 2340-103
	+17	+20	±1.0	-10	5.0	2.0	300	B1. B3	MLA 2340-201
				-20	5.0	2.0	350	B1, B3	MLA 2340-202
				-30	5.0	2.0	400	C1, C3	MLA 2340-203
	+20	+23	±1.0	-10	5.0	2.0	350	B1, B3	MLA 2340-301
				-20	5.0	2.0	400	B1, B3	MLA 2340-302
				-30	5.0	2.0	450	C1, C3	MLA 2340-303
6.0 - 12.0	+14	+17	±1.0	-10	6.0	2.0	300	C1. C2	MLA 2350-101
				-20	6.0	2.0	350	C1, C2	MLA 2350-102
				-30	6.0	2.0	400	D1, D2	MLA 2350-103
	+17	+20	±1.0	-10	6.0	2.0	350	C1. C2	MLA 2350-201
				-20	6.0	2.0	400	D1, D2	MLA 2350-202
				-30	6.0	2.0	450	D1, D2	MLA 2350-203
	+20	+23	±1.0	-10	6.0	2.0	500	C1, C2	MLA 2350-301
				-20	6.0	2.0	550	D1, D2	MLA 2350-302
				-30	6.0	2.0	600	D1, D2	MLA 2350-303
12.0 - 18.0	+14	+17	±1.0	-10	8.0	2.0	350	C1, C2	MLA 2360-101
				-20	8.0	2.0	400	C1, C2	MLA 2360-102
				-30	8.0	2.0	450	D1, D2	MLA 2360-103
	+17	+20	±1.0	-10	8.0	2.0	400	C1, C2	MLA 2360-201
				-20	8.0	2.0	450	D1, D2	MLA 2360-202
				-30	8.0	2.0	500	D1, D2	MLA 2360-203
	+20	+23	±1.0	-10	8.0	2.0	550	C1, C2	MLA 2360-301
				-20	8.0	2.0	600	D1, D2	MLA 2360-302
				-30	8.0	2.0	650	D1, D2	MLA 2360-303
6.0 - 18.0	+14	+17	±1.0	-10	8.0	2.0	350	C1, C2	MLA 2370-101
				-20	8.0	2.0	400	C1, C2	MLA 2370-102
				-30	8.0	2.0	450	D1, D2	MLA 2370-103
	+17	+20	±1.0	-10	8.0	2.0	400	C1, C2	MLA 2370-201
				-20	8.0	2.0	450	D1, D2	MLA 2370-202
				-30	8.0	2.0	500	D1, D2	MLA 2370-203
	+20	+23	±1.0	-10	8.0	2.0	550	C1, C2	MLA 2370-301
				-20	8.0	2.0	600	D1, D2	MLA 2370-302
				-30	8.0	2.0	650	D1, D2	MLA 2370-303

NOTES

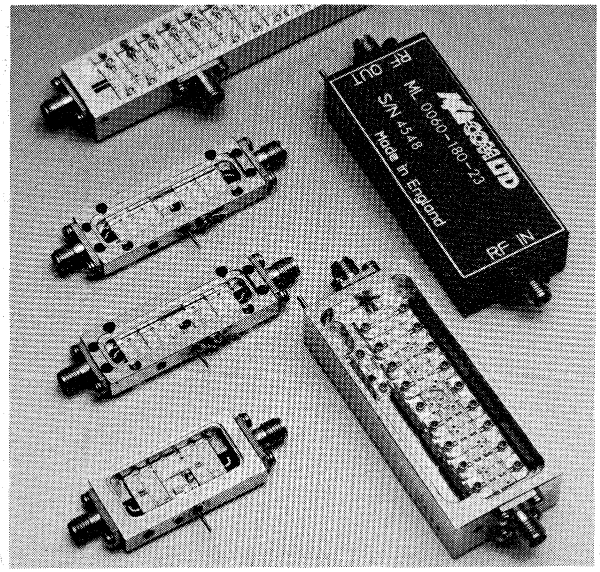
1) Amplifiers saturating from lower input powers are available in non-standard outlines, please contact the factory.
2) Power output for 1dB gain compression is typically 4dB below saturated output power.
3) Maximum input power without damage +20dBm (CW)
4) Harmonic outputs are typically -12dBc
5) All amplifiers have reverse polarity and over voltage power supply protection
6) Alternative +8V and +12V power supplies are available on selected amplifiers, please contact the factory
7) All amplifiers are unconditionally stable for any input or output VSWR, any phase
8) Case operating temperature -55°C to +95°C. Storage temperature -55°C to +125°C
9) Amplifiers are supplied in standard package styles (A1, B1, C1, D1) unless miniature option (A2, B2 etc) is specified.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

GaAs FET Amplifiers, Narrowband
0.5-18 GHz MLA 2500/2600 Series

FEATURES

- Radar & Communications Bands
- Low Noise Figures
- Wide Dynamic Ranges
- Temperature Compensation
- Miniature Outlines



DESCRIPTION

The MLA 2500-000 series of coaxial GaAs FET amplifiers from M/A-COM Ltd are designed for specific narrowband applications in the 0.5 to 18 GHz frequency range. Each frequency band includes a wide range of gain levels for both low noise and medium power amplifiers which are available with or without temperature compensation. All amplifiers are available in either a standard or optional miniature outline.

The designs are based on a balanced hybrid approach giving excellent gain flatness and VSWR as well as load independent stability. Construction of the amplifiers is by integration of the FET, MMIC or low noise HEMT devices into either a conventional alumina MIC or a glass MIC (GMIC) with the complete amplifier assembly then hermetically sealed by laser welding. GMIC is a proprietary pseudo-monolithic MIC fabrication technique established by M/A-COM Ltd using a thin glass substrate bonded directly to a high conductivity silicon carrier. All the passive components are then photolithographically defined with the discrete FET devices mounted in via holes. The compact, rugged construction of these amplifiers makes them suitable for the most severe environmental conditions encountered in military and hi-rel applications.

These amplifiers cover a wide variety of the most commonly used microwave frequency bands. Applications include airborne, naval and ground based radar receivers and transmitters, radar altimeters, military and commercial up and down links for satellite communications and terrestrial communications. Advances in solid state technology make these amplifiers suitable as direct replacements for TWTAs giving improved reliability at lower cost in such applications as airborne targets and transmitter drivers.

As well as the basic amplifiers described M/A-COM Ltd also manufactures devices with additional components integrated within the same housing. Available options include input limiters for passive high power protection, integral PIN attenuators for gain/sensitivity control, coupled outputs, filters, pulsed power supplies and waveguide inputs for LNAs. For details of these options and to discuss other custom requirements, please contact the factory for applications assistance.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
2.7 - 3.1	+12	12	±0.20	0.012	1.5	1.8	80	A1, A3	MLA 2543-101
		24	±0.40	0.024	1.5	1.8	160	A1, A3	MLA 2543-102
		36	±0.50	0.036	1.5	1.8	240	B1, B3	MLA 2543-103
		48	±0.50	0.050	1.5	1.8	320	B1, B3	MLA 2543-104
	+18	11	±0.20	0.012	3.0	1.6	100	A1, A3	MLA 2543-201
		23	±0.40	0.024	2.0	1.6	180	A1, A3	MLA 2543-202
		35	±0.50	0.036	2.0	1.6	260	B1, B3	MLA 2543-203
		46	±0.50	0.050	2.0	1.6	340	B1, B3	MLA 2543-204
	+21	10	±0.30	0.012	4.0	1.6	120	A1, A3	MLA 2543-301
		22	±0.40	0.024	3.0	1.6	220	A1, A3	MLA 2543-302
		34	±0.50	0.036	2.0	1.6	300	B1, B3	MLA 2543-303
		45	±0.50	0.050	2.0	1.6	380	B1, B3	MLA 2543-304
	+26	9	±0.30	0.012	6.0	1.8	200	A1, A3	MLA 2543-401
		20	±0.40	0.024	4.0	1.8	320	A1, A3	MLA 2543-402
		31	±0.50	0.036	3.0	1.8	420	B1, B3	MLA 2543-403
		43	±0.50	0.050	3.0	1.8	500	B1, B3	MLA 2543-404
	+29	7	±0.50	0.012	7.0	1.8	400	A1, A3	MLA 2543-501
		16	±0.75	0.024	6.0	1.8	600	A1, A3	MLA 2543-502
		26	±1.00	0.036	5.0	1.8	700	B1, B3	MLA 2543-503
		36	±1.00	0.050	4.0	1.8	800	B1, B3	MLA 2543-504

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
2.7 - 3.1	+12	10	±0.30	±0.50	2.5	1.8	80	A1, A3	MLA 2643-101
		21	±0.50	±0.75	2.2	1.8	160	A1, A3	MLA 2643-102
		32	±0.60	±1.00	2.2	1.8	240	B1, B3	MLA 2643-103
		43	±0.60	±1.50	2.2	1.8	320	B1, B3	MLA 2643-104
	+18	9	±0.30	±0.50	4.0	1.6	100	A1, A3	MLA 2643-201
		20	±0.50	±0.75	3.0	1.6	180	A1, A3	MLA 2643-202
		31	±0.60	±1.00	3.0	1.6	260	B1, B3	MLA 2643-203
		42	±0.60	±1.50	3.0	1.6	340	B1, B3	MLA 2643-204
	+21	8	±0.30	±0.50	5.0	1.6	120	A1, A3	MLA 2643-301
		19	±0.50	±0.75	4.0	1.6	220	A1, A3	MLA 2643-302
		30	±0.60	±1.00	3.0	1.6	300	B1, B3	MLA 2643-303
		41	±0.60	±1.50	3.0	1.6	380	B1, B3	MLA 2643-304
	+26	7	±0.30	±0.50	6.0	1.8	200	A1, A3	MLA 2643-401
		18	±0.50	±0.75	5.0	1.8	320	A1, A3	MLA 2643-402
		28	±0.60	±1.00	4.0	1.8	420	B1, B3	MLA 2643-403
		37	±0.60	±1.50	4.0	1.8	500	B1, B3	MLA 2643-404
	+29	6	±0.50	±0.50	8.0	1.8	400	A1, A3	MLA 2643-501
		15	±0.75	±0.75	7.0	1.8	600	A1, A3	MLA 2643-502
		25	±1.00	±1.00	6.0	1.8	700	B1, B3	MLA 2643-503
		33	±1.00	±1.50	5.0	1.8	800	B1, B3	MLA 2643-504

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
3.1 - 3.5	+12	12	±0.20	0.012	1.5	1.8	80	A1, A3	MLA 2544-101
		24	±0.40	0.024	1.5	1.8	160	A1, A3	MLA 2544-102
		36	±0.50	0.036	1.5	1.8	240	B1, B3	MLA 2544-103
		48	±0.50	0.050	1.5	1.8	320	B1, B3	MLA 2544-104
	+18	11	±0.20	0.012	3.0	1.6	100	A1, A3	MLA 2544-201
		23	±0.40	0.024	2.0	1.6	180	A1, A3	MLA 2544-202
		35	±0.50	0.036	2.0	1.6	260	B1, B3	MLA 2544-203
		46	±0.50	0.050	2.0	1.6	340	B1, B3	MLA 2544-204
	+21	10	±0.30	0.012	4.0	1.6	120	A1, A3	MLA 2544-301
		22	±0.40	0.024	3.0	1.6	270	A1, A3	MLA 2544-302
		34	±0.50	0.036	2.0	1.6	300	B1, B3	MLA 2544-303
		45	±0.50	0.050	2.0	1.6	380	B1, B3	MLA 2544-304
	+26	9	±0.30	0.012	6.0	1.8	200	A1, A3	MLA 2544-401
		20	±0.40	0.024	4.0	1.8	320	A1, A3	MLA 2544-402
		31	±0.50	0.036	3.0	1.8	420	B1, B3	MLA 2544-403
		43	±0.50	0.050	3.0	1.8	500	B1, B3	MLA 2544-404
	+29	7	±0.50	0.012	7.0	1.8	400	A1, A3	MLA 2544-501
		16	±0.75	0.024	6.0	1.8	600	A1, A3	MLA 2544-502
		26	±1.00	0.036	5.0	1.8	700	B1, B3	MLA 2544-503
		36	±1.00	0.050	4.0	1.8	800	B1, B3	MLA 2544-504

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed –55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
3.1 - 3.5	+12	10	±0.30	±0.50	2.5	1.8	80	A1, A3	MLA 2644-101
		21	±0.50	±0.75	2.2	1.8	160	A1, A3	MLA 2644-102
		32	±0.60	±1.00	2.2	1.8	240	B1, B3	MLA 2644-103
		43	±0.60	±1.50	2.2	1.8	320	B1, B3	MLA 2644-104
	+18	9	±0.30	±0.50	4.0	1.6	100	A1, A3	MLA 2644-201
		20	±0.50	±0.75	3.0	1.6	180	A1, A3	MLA 2644-202
		31	±0.60	±1.00	3.0	1.6	260	B1, B3	MLA 2644-203
		42	±0.60	±1.50	3.0	1.6	340	B1, B3	MLA 2644-204
	+21	8	±0.30	±0.50	5.0	1.6	120	A1, A3	MLA 2644-301
		19	±0.50	±0.75	4.0	1.6	220	A1, A3	MLA 2644-302
		30	±0.60	±1.00	3.0	1.6	300	B1, B3	MLA 2644-303
		41	±0.60	±1.50	3.0	1.6	380	B1, B3	MLA 2644-304
	+26	7	±0.30	±0.50	6.0	1.8	200	A1, A3	MLA 2644-401
		18	±0.50	±0.75	5.0	1.8	320	A1, A3	MLA 2644-402
		29	±0.60	±1.00	4.0	1.8	420	B1, B3	MLA 2644-403
		40	±0.60	±1.50	4.0	1.8	500	B1, B3	MLA 2644-404
	+29	6	±0.50	±0.50	8.0	1.8	400	A1, A3	MLA 2644-501
		15	±0.75	±0.75	7.0	1.8	600	A1, A3	MLA 2644-502
		25	±1.00	±1.00	6.0	1.8	700	B1, B3	MLA 2644-503
		33	±1.00	±1.50	5.0	1.8	800	B1, B3	MLA 2644-504

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
4.0 - 4.6	+12	11	±0.30	0.012	1.5	1.8	80	A1, A3	MLA 2546-101
		22	±0.40	0.024	1.5	1.8	160	A1, A3	MLA 2546-102
		33	±0.50	0.036	1.5	1.8	240	B1, B3	MLA 2546-103
		44	±0.50	0.050	1.5	1.8	320	B1, B3	MLA 2546-104
	+18	10	±0.30	0.012	4.0	1.6	100	A1, A3	MLA 2546-201
		20	±0.40	0.024	3.0	1.6	180	A1, A3	MLA 2546-202
		30	±0.50	0.036	3.0	1.6	260	B1, B3	MLA 2546-203
		40	±0.50	0.050	3.0	1.6	340	B1, B3	MLA 2546-204
	+21	9	±0.40	0.012	5.0	1.6	120	A1, A3	MLA 2546-301
		19	±0.50	0.024	4.0	1.6	220	A1, A3	MLA 2546-302
		29	±0.50	0.036	3.0	1.6	300	B1, B3	MLA 2546-303
		39	±0.50	0.050	3.0	1.6	380	B1, B3	MLA 2546-304
	+26	8	±0.40	0.012	6.0	1.8	200	A1, A3	MLA 2546-401
		17	±0.50	0.024	5.0	1.8	320	A1, A3	MLA 2546-402
		27	±0.50	0.036	4.0	1.8	420	B1, B3	MLA 2546-403
		37	±0.50	0.050	3.0	1.8	500	B1, B3	MLA 2546-404
	+29	7	±0.50	0.012	7.0	1.8	400	A1, A3	MLA 2546-501
		16	±0.75	0.024	6.0	1.8	600	A1, A3	MLA 2546-502
		26	±1.00	0.036	5.0	1.8	700	B1, B3	MLA 2546-503
		36	±1.00	0.050	4.0	1.8	800	B1, B3	MLA 2546-504

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
4.0 - 4.6	+12	9	±0.40	±0.50	2.5	1.8	80	A1, A3	MLA 2646-101
		18	±0.50	±0.75	2.5	1.8	160	A1, A3	MLA 2646-102
		27	±0.50	±1.00	2.5	1.8	240	B1, B3	MLA 2646-103
		36	±0.50	±1.50	2.5	1.8	320	B1, B3	MLA 2646-104
	+18	8	±0.40	±0.50	5.0	1.6	100	A1, A3	MLA 2646-201
		17	±0.50	±0.75	4.0	1.6	180	A1, A3	MLA 2646-202
		26	±0.50	±1.00	4.0	1.6	260	B1, B3	MLA 2646-203
		35	±0.50	±1.50	4.0	1.6	340	B1, B3	MLA 2646-204
	+21	8	±0.40	±0.50	6.0	1.6	120	A1, A3	MLA 2646-301
		17	±0.50	±0.75	5.0	1.6	220	A1, A3	MLA 2646-302
		26	±0.50	±1.00	4.0	1.6	300	B1, B3	MLA 2646-303
		35	±0.50	±1.50	4.0	1.6	380	B1, B3	MLA 2646-304
	+26	7	±0.50	±0.50	7.0	1.8	200	A1, A3	MLA 2646-401
		16	±0.50	±0.75	6.0	1.8	320	A1, A3	MLA 2646-402
		25	±0.50	±1.00	5.0	1.8	420	B1, B3	MLA 2646-403
		34	±0.50	±1.50	4.0	1.8	500	B1, B3	MLA 2646-404
	+29	6	±0.50	±0.50	8.0	1.8	400	A1, A3	MLA 2646-501
		15	±0.75	±0.75	7.0	1.8	600	A1, A3	MLA 2646-502
		23	±1.00	±1.00	6.0	1.8	700	B1, B3	MLA 2646-503
		30	±1.00	±1.50	5.0	1.8	800	B1, B3	MLA 2646-504

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
5.5 - 6.5	+12	11	±0.30	0.012	1.5	1.8	80	A1, A3	MLA 2549-101
		22	±0.40	0.024	1.5	1.8	160	A1, A3	MLA 2549-102
		33	±0.50	0.036	1.5	1.8	240	B1, B3	MLA 2549-103
		44	±0.50	0.050	1.5	1.8	320	B1, B3	MLA 2549-104
	+18	10	±0.30	0.012	4.0	1.6	100	A1, A3	MLA 2549-201
		20	±0.40	0.024	3.0	1.6	180	A1, A3	MLA 2549-202
		30	±0.50	0.036	3.0	1.6	260	B1, B3	MLA 2549-203
		40	±0.50	0.050	3.0	1.6	340	B1, B3	MLA 2549-204
	+21	9	±0.40	0.012	5.0	1.6	120	A1, A3	MLA 2549-301
		19	±0.50	0.024	4.0	1.6	220	A1, A3	MLA 2549-302
		29	±0.50	0.036	3.0	1.6	300	B1, B3	MLA 2549-303
		39	±0.50	0.050	3.0	1.6	380	B1, B3	MLA 2549-304
	+26	8	±0.40	0.012	6.0	1.8	200	A1, A3	MLA 2549-401
		17	±0.50	0.024	5.0	1.8	320	A1, A3	MLA 2549-402
		27	±0.50	0.036	4.0	1.8	420	B1, B3	MLA 2549-403
		37	±0.50	0.050	3.0	1.8	500	B1, B3	MLA 2549-404
	+29	7	±0.50	0.012	7.0	1.8	400	A1, A3	MLA 2549-501
		16	±0.75	0.024	6.0	1.8	600	A1, A3	MLA 2549-502
		26	±1.00	0.036	5.0	1.8	700	B1, B3	MLA 2549-503
		36	±1.00	0.050	4.0	1.8	800	B1, B3	MLA 2549-504

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
5.5 - 6.5	+12	9	±0.40	±0.50	2.5	1.8	80	A1, A3	MLA 2649-101
		18	±0.50	±0.75	2.5	1.8	160	A1, A3	MLA 2649-102
		27	±0.50	±1.00	2.5	1.8	240	B1, B3	MLA 2649-103
		36	±0.50	±1.50	2.5	1.8	320	B1, B3	MLA 2649-104
	+18	8	±0.40	±0.50	5.0	1.6	100	A1, A3	MLA 2649-201
		17	±0.50	±0.75	4.0	1.6	180	A1, A3	MLA 2649-202
		26	±0.50	±1.00	4.0	1.6	260	B1, B3	MLA 2649-203
		35	±0.50	±1.50	4.0	1.6	340	B1, B3	MLA 2649-204
	+21	8	±0.40	±0.50	6.0	1.6	120	A1, A3	MLA 2649-301
		17	±0.50	±0.75	5.0	1.6	220	A1, A3	MLA 2649-302
		26	±0.50	±1.00	4.0	1.6	300	B1, B3	MLA 2649-303
		35	±0.50	±1.50	4.0	1.6	380	B1, B3	MLA 2649-304
	+26	7	±0.50	±0.50	7.0	1.8	200	A1, A3	MLA 2649-401
		16	±0.50	±0.75	6.0	1.8	320	A1, A3	MLA 2649-402
		25	±0.50	±1.00	5.0	1.8	420	B1, B3	MLA 2649-403
		34	±0.50	±1.50	4.0	1.8	500	B1, B3	MLA 2649-404
	+29	6	±0.50	±0.50	8.0	1.8	400	A1, A3	MLA 2649-501
		15	±0.75	±0.75	7.0	1.8	600	A1, A3	MLA 2649-502
		24	±1.00	±1.00	6.0	1.8	700	B1, B3	MLA 2649-503
		32	±1.00	±1.50	5.0	1.8	800	B1, B3	MLA 2649-504

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
7.9 - 8.4	+12	10	±0.30	0.012	1.5	1.8	80	A1, A2	MLA 2554-101
		20	±0.40	0.024	1.5	1.8	160	A1, A2	MLA 2554-102
		30	±0.50	0.036	1.5	1.8	240	B1, B2	MLA 2554-103
		40	±0.50	0.050	1.5	1.8	320	B1, B2	MLA 2554-104
	+18	10	±0.30	0.012	4.0	1.6	100	A1, A2	MLA 2554-201
		20	±0.40	0.024	4.0	1.6	180	A1, A2	MLA 2554-202
		30	±0.50	0.036	4.0	1.6	260	B1, B2	MLA 2554-203
		40	±0.50	0.050	4.0	1.6	340	B1, B2	MLA 2554-204
	+21	10	±0.30	0.012	5.0	1.6	120	A1, A2	MLA 2554-301
		20	±0.40	0.024	4.0	1.6	220	A1, A2	MLA 2554-302
		30	±0.50	0.036	4.0	1.6	300	B1, B2	MLA 2554-303
		40	±0.50	0.050	4.0	1.6	380	B1, B2	MLA 2554-304
	+26	8	±0.30	0.012	6.0	1.8	280	A1, A2	MLA 2554-401
		18	±0.40	0.024	5.0	1.8	400	A1, A2	MLA 2554-402
		28	±0.50	0.036	4.0	1.8	480	B1, B2	MLA 2554-403
		38	±0.50	0.050	4.0	1.8	560	B1, B2	MLA 2554-404
	+29	7	±0.50	0.012	8.0	1.8	400	A1, A2	MLA 2554-501
		16	±0.75	0.024	6.0	1.8	600	A1, A2	MLA 2554-502
		26	±1.00	0.036	5.0	1.8	700	B1, B2	MLA 2554-503
		36	±1.00	0.050	4.0	1.8	800	B1, B2	MLA 2554-504

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed –55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
7.9 - 8.4	+12	8	±0.30	±0.50	2.5	1.8	80	A1, A2	MLA 2654-101
		17	±0.40	±0.75	2.5	1.8	160	A1, A2	MLA 2654-102
		26	±0.50	±1.00	2.5	1.8	240	B1, B2	MLA 2654-103
		35	±0.50	±1.50	2.5	1.8	320	B1, B2	MLA 2654-104
	+18	8	±0.30	±0.50	6.0	1.6	100	A1, A2	MLA 2654-201
		17	±0.40	±0.75	5.0	1.6	180	A1, A2	MLA 2654-202
		26	±0.50	±1.00	5.0	1.6	260	B1, B2	MLA 2654-203
		35	±0.50	±1.50	5.0	1.6	340	B1, B2	MLA 2654-204
	+21	7	±0.30	±0.50	7.0	1.6	120	A1, A2	MLA 2654-301
		16	±0.40	±0.75	6.0	1.6	220	A1, A2	MLA 2654-302
		25	±0.50	±1.00	5.0	1.6	300	B1, B2	MLA 2654-303
		34	±0.50	±1.50	5.0	1.6	380	B1, B2	MLA 2654-304
	+26	6	±0.30	±0.50	8.0	1.8	280	A1, A2	MLA 2654-401
		15	±0.40	±0.75	7.0	1.8	400	A1, A2	MLA 2654-402
		24	±0.50	±1.00	6.0	1.8	480	B1, B2	MLA 2654-403
		33	±0.50	±1.50	5.0	1.8	560	B1, B2	MLA 2654-404
	+29	5	±0.50	±0.50	9.0	1.8	400	A1, A2	MLA 2654-501
		14	±0.75	±0.75	7.0	1.8	600	A1, A2	MLA 2654-502
		22	±1.00	±1.00	6.0	1.8	700	B1, B2	MLA 2654-503
		30	±1.00	±1.50	5.0	1.8	800	B1, B2	MLA 2654-504

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
8.5 - 9.5	+12	10	±0.30	0.012	1.5	1.8	80	A1, A2	MLA 2555-101
		20	±0.40	0.024	1.5	1.8	160	A1, A2	MLA 2555-102
		30	±0.50	0.036	1.5	1.8	240	B1, B2	MLA 2555-103
		40	±0.50	0.050	1.5	1.8	320	B1, B2	MLA 2555-104
	+18	10	±0.30	0.012	4.0	1.6	100	A1, A2	MLA 2555-201
		20	±0.40	0.024	4.0	1.6	180	A1, A2	MLA 2555-202
		30	±0.50	0.036	4.0	1.6	260	B1, B2	MLA 2555-203
		40	±0.50	0.050	4.0	1.6	340	B1, B2	MLA 2555-204
	+21	10	±0.30	0.012	5.0	1.6	120	A1, A2	MLA 2555-301
		20	±0.40	0.024	4.0	1.6	220	A1, A2	MLA 2555-302
		30	±0.50	0.036	4.0	1.6	300	B1, B2	MLA 2555-303
		40	±0.50	0.050	4.0	1.6	380	B1, B2	MLA 2555-304
	+26	8	±0.30	0.012	6.0	1.8	280	A1, A2	MLA 2555-401
		18	±0.40	0.024	5.0	1.8	400	A1, A2	MLA 2555-402
		28	±0.50	0.036	4.0	1.8	480	B1, B2	MLA 2555-403
		38	±0.50	0.050	4.0	1.8	560	B1, B2	MLA 2555-404
	+28	7	±0.50	0.012	8.0	1.8	400	A1, A2	MLA 2555-501
		16	±0.75	0.024	7.0	1.8	600	A1, A2	MLA 2555-502
		26	±1.00	0.036	6.0	1.8	700	B1, B2	MLA 2555-503
		36	±1.00	0.050	5.0	1.8	800	B1, B2	MLA 2555-504

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed −55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
8.5 - 9.5	+12	8	±0.30	±0.50	2.5	1.8	80	A1, A2	MLA 2655-101
		17	±0.40	±0.75	2.5	1.8	160	A1, A2	MLA 2655-102
		26	±0.50	±1.00	2.5	1.8	240	B1, B2	MLA 2655-103
		35	±0.50	±1.50	2.5	1.8	320	B1, B2	MLA 2655-104
	+18	8	±0.30	±0.50	6.0	1.6	100	A1, A2	MLA 2655-201
		17	±0.40	±0.75	5.0	1.6	180	A1, A2	MLA 2655-202
		26	±0.50	±1.00	5.0	1.6	260	B1, B2	MLA 2655-203
		35	±0.50	±1.50	5.0	1.6	340	B1, B2	MLA 2655-204
	+21	7	±0.30	±0.50	7.0	1.6	120	A1, A2	MLA 2655-301
		16	±0.40	±0.75	6.0	1.6	220	A1, A2	MLA 2655-302
		25	±0.50	±1.00	5.0	1.6	300	B1, B2	MLA 2655-303
		34	±0.50	±1.50	5.0	1.6	380	B1, B2	MLA 2655-304
	+26	6	±0.30	±0.50	8.0	1.8	280	A1, A2	MLA 2655-401
		15	±0.40	±0.75	7.0	1.8	400	A1, A2	MLA 2655-402
		24	±0.50	±1.00	6.0	1.8	480	B1, B2	MLA 2655-403
		33	±0.50	±1.50	5.0	1.8	560	B1, B2	MLA 2655-404
	+28	6	±0.50	±0.50	9.0	1.8	400	A1, A2	MLA 2655-501
		14	±0.75	±0.75	8.0	1.8	600	A1, A2	MLA 2655-502
		24	±1.00	±1.00	7.0	1.8	700	B1, B2	MLA 2655-503
		32	±1.00	±1.50	6.0	1.8	800	B1, B2	MLA 2655-504

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
9.5 - 10.5	+12	10	±0.30	0.012	1.5	1.8	80	A1, A2	MLA 2556-101
		20	±0.40	0.024	1.5	1.8	160	A1, A2	MLA 2556-102
		30	±0.50	0.036	1.5	1.8	240	B1, B2	MLA 2556-103
		40	±0.50	0.050	1.5	1.8	320	B1, B2	MLA 2556-104
	+18	10	±0.30	0.012	4.0	1.6	100	A1, A2	MLA 2556-201
		20	±0.40	0.024	4.0	1.6	180	A1, A2	MLA 2556-202
		30	±0.50	0.036	4.0	1.6	260	B1, B2	MLA 2556-203
		40	±0.50	0.050	4.0	1.6	340	B1, B2	MLA 2556-204
	+21	10	±0.30	0.012	5.0	1.6	120	A1, A2	MLA 2556-301
		20	±0.40	0.024	4.0	1.6	220	A1, A2	MLA 2556-302
		30	±0.50	0.036	4.0	1.6	300	B1, B2	MLA 2556-303
		40	±0.50	0.050	4.0	1.6	380	B1, B2	MLA 2556-304
	+26	9	±0.30	0.012	6.0	1.8	280	A1, A2	MLA 2556-401
		18	±0.40	0.024	5.0	1.8	400	A1, A2	MLA 2556-402
		28	±0.50	0.036	4.0	1.8	480	B1, B2	MLA 2556-403
		38	±0.50	0.050	4.0	1.8	560	B1, B2	MLA 2556-404

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
9.5 - 10.5	+12	10	±0.30	±0.50	2.5	1.8	80	A1, A2	MLA 2656-101
		20	±0.40	±0.75	2.2	1.8	160	B1, B2	MLA 2656-102
		27	±0.50	±1.00	2.2	1.8	240	B1, B2	MLA 2656-103
		35	±0.50	±1.50	2.2	1.8	320	B1, B2	MLA 2656-104
	+18	8	±0.30	±0.50	6.0	1.6	100	A1, A2	MLA 2656-201
		17	±0.40	±0.75	5.0	1.6	180	B1, B2	MLA 2656-202
		26	±0.50	±1.00	5.0	1.6	260	B1, B2	MLA 2656-203
		35	±0.50	±1.50	5.0	1.6	340	B1, B2	MLA 2656-204
	+21	7	±0.30	±0.50	7.0	1.6	120	A1, A2	MLA 2656-301
		16	±0.40	±0.75	6.0	1.6	220	B1, B2	MLA 2656-302
		25	±0.50	±1.00	5.0	1.6	300	B1, B2	MLA 2656-303
		34	±0.50	±1.50	5.0	1.6	380	B1, B2	MLA 2656-304
	+26	7	±0.30	±0.50	8.0	1.8	280	A1, A2	MLA 2656-401
		15	±0.40	±0.75	7.0	1.8	400	B1, B2	MLA 2656-402
		24	±0.50	±1.00	6.0	1.8	480	B1, B2	MLA 2656-403
		33	±0.50	±1.50	5.0	1.8	560	B1, B2	MLA 2656-404

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
13.5 - 14.5	+12	13	±0.30	0.024	2.5	1.8	100	A1, A2	MLA 2564-101
		20	±0.40	0.036	2.5	1.8	150	A1, A2	MLA 2564-102
		33	±0.50	0.060	2.5	1.8	250	B1, B2	MLA 2564-103
		40	±0.50	0.072	2.5	1.8	300	C1, C2	MLA 2564-104
	+18	11	±0.30	0.024	6.0	1.6	150	A1, A2	MLA 2564-201
		18	±0.40	0.036	5.0	1.6	200	A1, A2	MLA 2564-202
		31	±0.50	0.060	5.0	1.6	300	B1, B2	MLA 2564-203
		38	±0.50	0.072	5.0	1.6	400	C1, C2	MLA 2564-204
	+21	10	±0.40	0.024	7.0	1.6	200	A1, A2	MLA 2564-301
		17	±0.50	0.036	6.0	1.6	250	A1, A2	MLA 2564-302
		30	±0.50	0.060	5.0	1.6	350	B1, B2	MLA 2564-303
		37	±0.50	0.072	5.0	1.6	450	C1, C2	MLA 2564-304
	+26	9	±0.40	0.024	8.0	1.8	250	A1, A2	MLA 2564-401
		16	±0.50	0.036	7.0	1.8	300	A1, A2	MLA 2564-402
		29	±0.50	0.060	6.0	1.8	400	B1, B2	MLA 2564-403
		36	±0.50	0.072	5.5	1.8	500	C1, C2	MLA 2564-404

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed -55°C to +95°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
13.5 - 14.5	+12	11	±0.40	±0.50	3.5	1.8	100	A1, A2	MLA 2664-101
		17	±0.50	±1.00	3.5	1.8	150	B1, B2	MLA 2664-102
		29	±0.50	±1.50	3.5	1.8	250	C1, C2	MLA 2664-103
		40	±0.50	±2.00	3.5	1.8	300	C1, C2	MLA 2664-104
	+18	9	±0.40	±0.50	8.0	1.6	150	A1, A2	MLA 2664-201
		14	±0.50	±1.00	7.0	1.6	200	B1, B2	MLA 2664-202
		25	±0.50	±1.50	6.0	1.6	300	C1, C2	MLA 2664-203
		36	±0.50	±2.00	6.0	1.6	400	C1, C2	MLA 2664-204
	+21	8	±0.40	±0.50	9.0	1.6	200	A1, A2	MLA 2664-301
		13	±0.50	±1.00	8.0	1.6	250	B1, B2	MLA 2664-302
		24	±0.50	±1.50	7.0	1.6	350	C1, C2	MLA 2664-303
		35	±0.50	±2.00	6.0	1.6	450	C1, C2	MLA 2664-304
	+26	7	±0.40	±0.50	10.0	1.8	250	A1, A2	MLA 2664-401
		12	±0.50	±1.00	9.0	1.8	300	B1, B2	MLA 2664-402
		23	±0.50	±1.50	8.0	1.8	400	C1, C2	MLA 2664-403
		34	±0.50	±2.00	7.0	1.8	500	C1, C2	MLA 2664-404

Specifications Subject to Change Without Notice.

UNCOMPENSATED SPECIFICATIONS (guaranteed @ +25°C)

Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB/°C)	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
16.5 - 17.5	+12	11	±0.40	0.025	4.0	1.8	100	A1, A2	MLA 2567-101
		22	±0.50	0.050	4.0	1.8	200	B1, B2	MLA 2567-102
		33	±0.50	0.075	4.0	1.8	300	B1, B2	MLA 2567-103
		44	±0.50	0.100	4.0	1.8	400	C1, C2	MLA 2567-104
	+18	10	±0.40	0.025	7.0	1.6	150	A1, A2	MLA 2567-201
		21	±0.50	0.050	6.0	1.6	250	B1, B2	MLA 2567-202
		32	±0.50	0.075	6.0	1.6	350	B1, B2	MLA 2567-203
		43	±0.50	0.100	6.0	1.6	450	C1, C2	MLA 2567-204
	+21	10	±0.50	0.025	8.0	1.6	200	A1, A2	MLA 2567-301
		21	±0.50	0.050	7.0	1.6	300	B1, B2	MLA 2567-302
		32	±0.50	0.075	6.0	1.6	400	B1, B2	MLA 2567-303
		43	±0.50	0.100	6.0	1.6	500	C1, C2	MLA 2567-304
	+26	9	±0.50	0.025	9.0	1.8	300	A1, A2	MLA 2567-401
		19	±0.50	0.050	8.0	1.8	400	B1, B2	MLA 2567-402
		30	±0.50	0.075	7.0	1.8	500	B1, B2	MLA 2567-403
		40	±0.50	0.100	6.0	1.8	600	C1, C2	MLA 2567-404

TEMPERATURE COMPENSATED SPECIFICATIONS (guaranteed –55°C to +95°C)

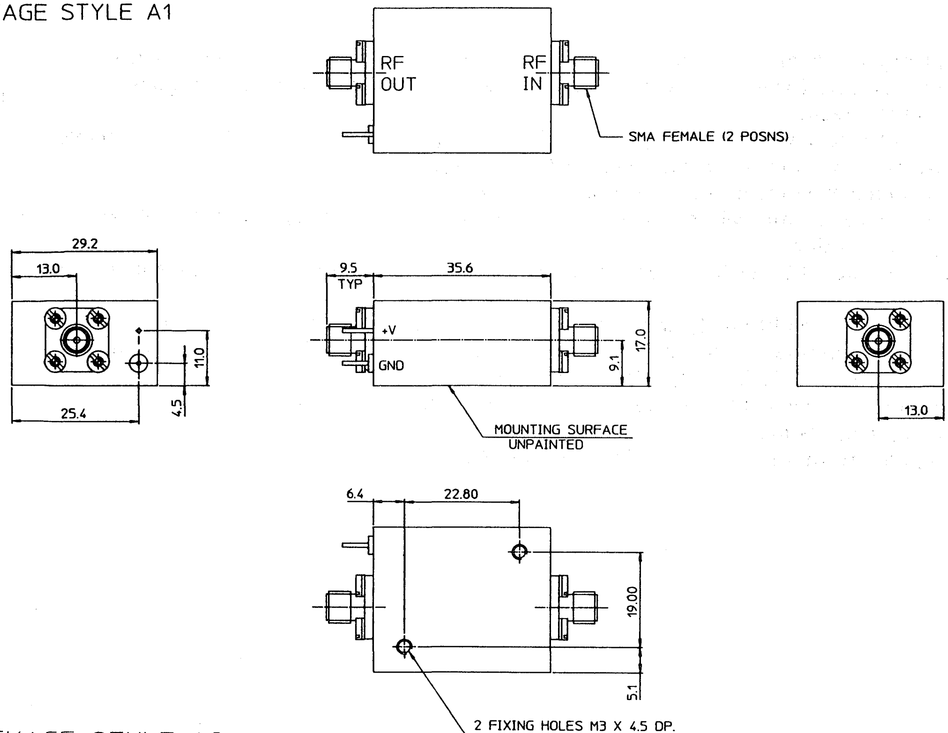
Frequency Range (GHz)	Output Power at 1dB Gain Comp (dBm) Min.	Gain (dB) Min.	Gain Flatness (dB) Max.	Gain Variation with Temp (dB) Max.	Noise Figure (dB) Max.	Input and Output VSWR Max.	DC Current at +15V (mA)	Package Styles	Part Number
16.5 - 17.5	+12	9	±0.40	±0.50	5.0	1.8	100	A1, A2	MLA 2667-101
		18	±0.50	±1.00	5.0	1.8	200	B1, B2	MLA 2667-102
		28	±0.50	±1.50	5.0	1.8	300	C1, C2	MLA 2667-103
		38	±0.50	±2.00	5.0	1.8	400	C1, C2	MLA 2667-104
	+18	8	±0.40	±0.50	8.0	1.6	150	A1, A2	MLA 2667-201
		17	±0.50	±1.00	7.0	1.6	250	B1, B2	MLA 2667-202
		27	±0.50	±1.50	7.0	1.6	350	C1, C2	MLA 2667-203
		37	±0.50	±2.00	7.0	1.6	450	C1, C2	MLA 2667-204
	+21	8	±0.50	±0.50	9.0	1.6	200	A1, A2	MLA 2667-301
		17	±0.50	±1.00	8.0	1.6	300	B1, B2	MLA 2667-302
		27	±0.50	±1.50	7.0	1.6	400	C1, C2	MLA 2667-303
		36	±0.50	±2.00	7.0	1.6	500	C1, C2	MLA 2667-304
	+26	7	±0.50	±0.50	10.0	1.8	300	A1, A2	MLA 2667-401
		16	±0.50	±1.00	9.0	1.8	400	B1, B2	MLA 2667-402
		25	±0.50	±1.50	8.0	1.8	500	C1, C2	MLA 2667-403
		34	±0.50	±2.00	7.0	1.8	600	C1, C2,	MLA 2667-404

Specifications Subject to Change Without Notice.

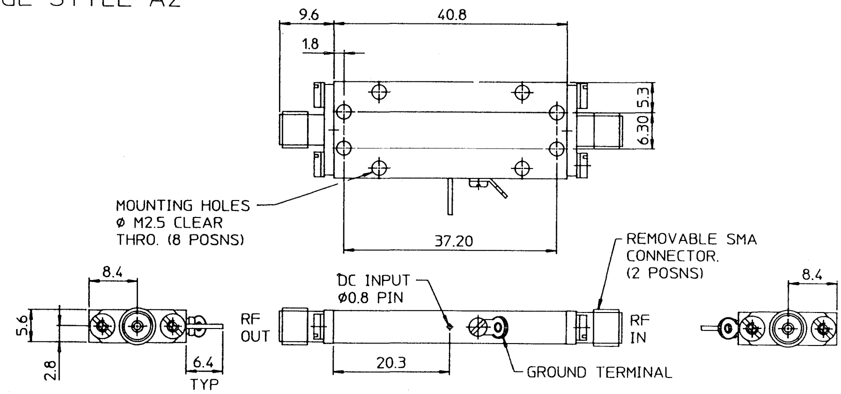
NOTES

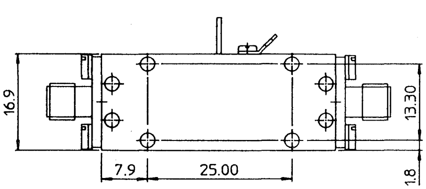
1) Other frequency bands are available, please contact the factory with your requirements.
2) Higher output powers for each frequency band are available in non-standard outlines, please contact the factory.
3) Maximum input power without damage is +20dBm (CW), higher power handling is available with an optional input limiter, please contact the factory.
4) Third order intercept point is typically 10dB above P1dB.
5) All amplifiers have an integral voltage regulator giving reverse polarity and over voltage power supply protection.
6) Alternative +8V and +12V power supplies are available on selected amplifiers, please contact the factory.
7) All amplifiers are unconditionally stable for any input or output VSWR, any phase.
8) All amplifiers are supplied in the standard coaxial outline (A1, B1, C1) unless the optional miniature outline (A2, A3, B2, B3, C2) is specified.
9) Waveguide inputs are available on selected amplifiers, please contact the factory.
10) Case operating temperature -55°C to +95°C
Storage temperature range -55°C to +125°C.

PACKAGE STYLE A1



PACKAGE STYLE A2





DRAWING NOTES

Third Angle Projection

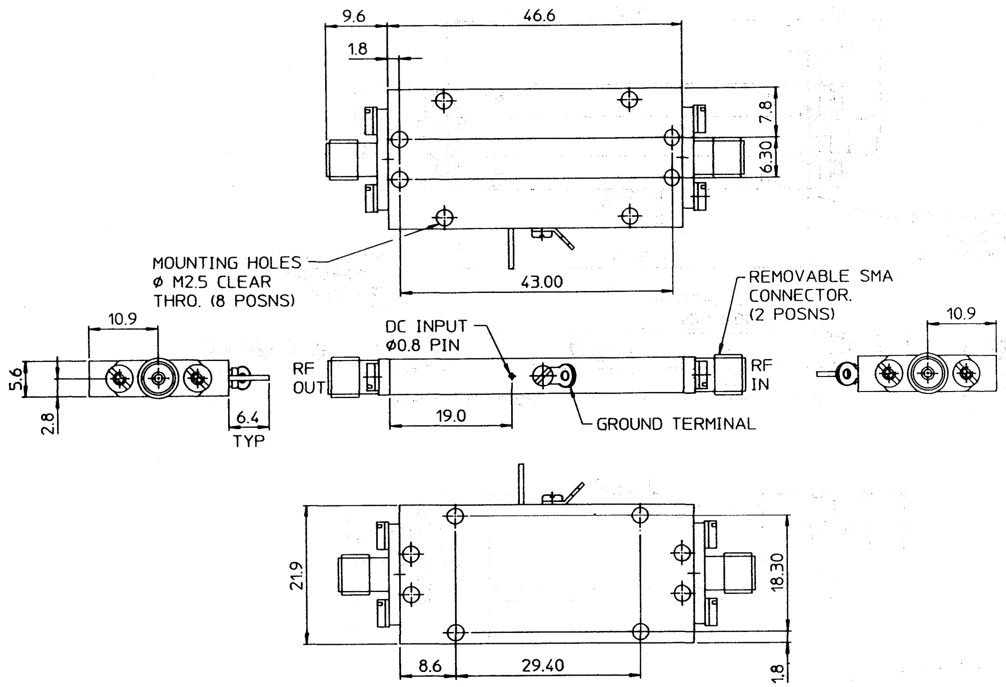
All dimensions in mm

Tolerances x.x = ±0.5mm
x.xx = ±0.1mm

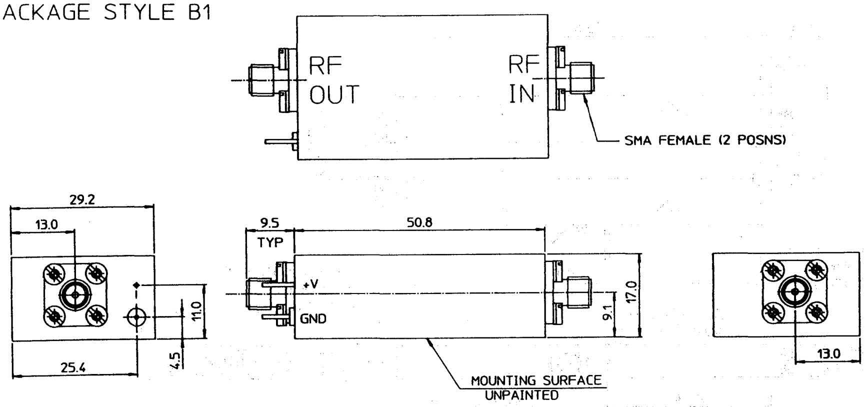
Standard Finish:
Standard packages:
Matt black paint to DTD 5555A (A1, B1, C1)
Miniature packages:
Nickel plate (A2, A3, B2, B3, C2, C3)

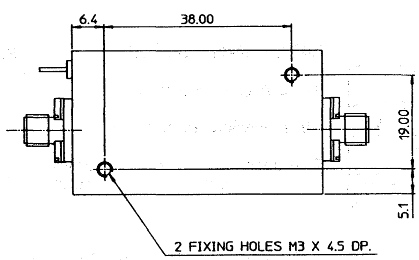
Specifications Subject to Change Without Notice.

PACKAGE STYLE A3



PACKAGE STYLE B1





Drawing Notes

Third Angle Projection

All dimensions in mm

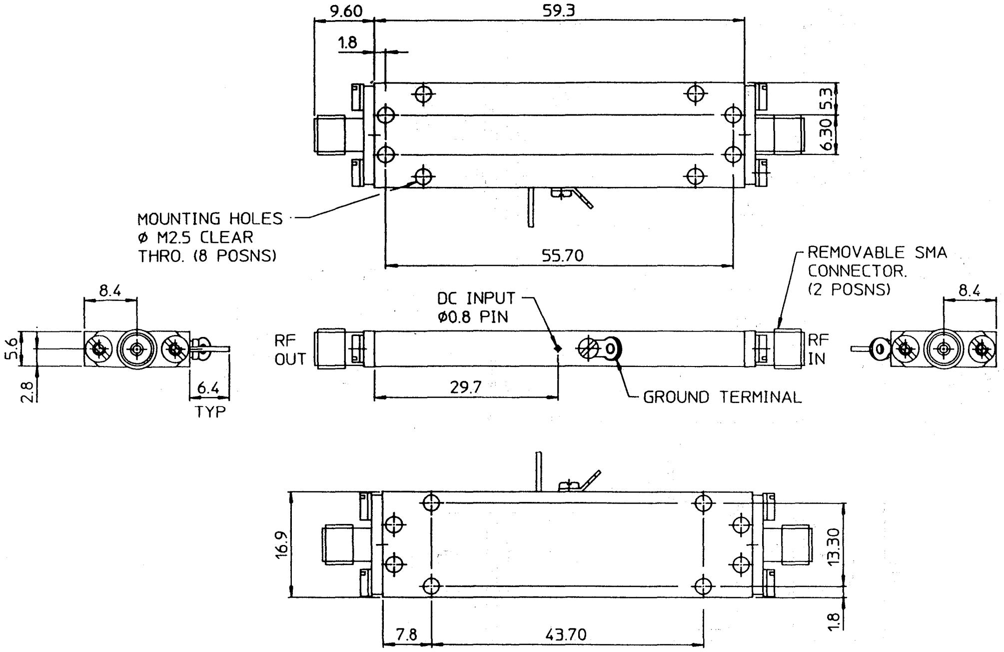
Tolerances x.x = ±0.5mm
x.xx = ±0.1mm

Standard Finish:

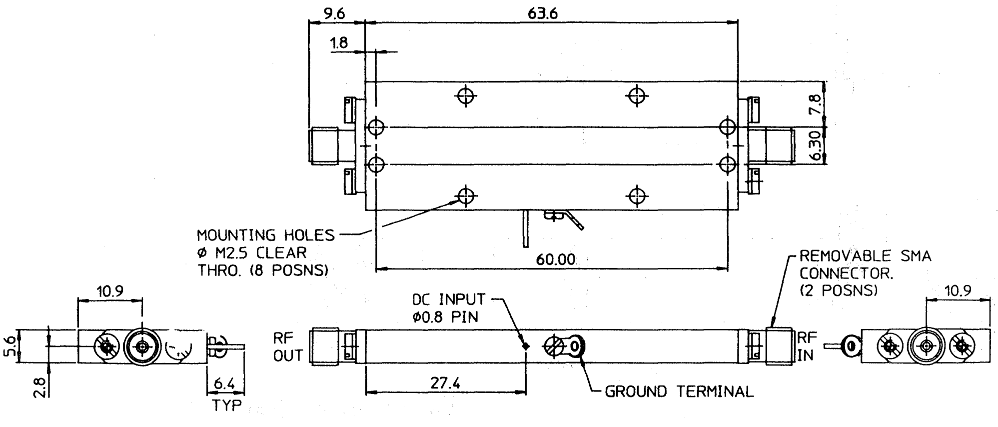
Standard packages:	Matt black paint to DTD 5555A (A1, B1, C1, D1)
Miniature packages:	Nickel Plate (A2, A3, B2, B3, C2, C3, D2)

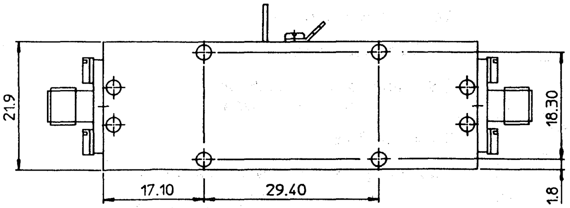
Specifications Subject to Change Without Notice.

PACKAGE STYLE B2



PACKAGE STYLE B3





DRAWING NOTES

Third Angle Projection

All dimensions in mm

Tolerances	x.x	=	±0.5mm
	x.xx	=	±0.1mm

Standard Finish:

Standard packages:

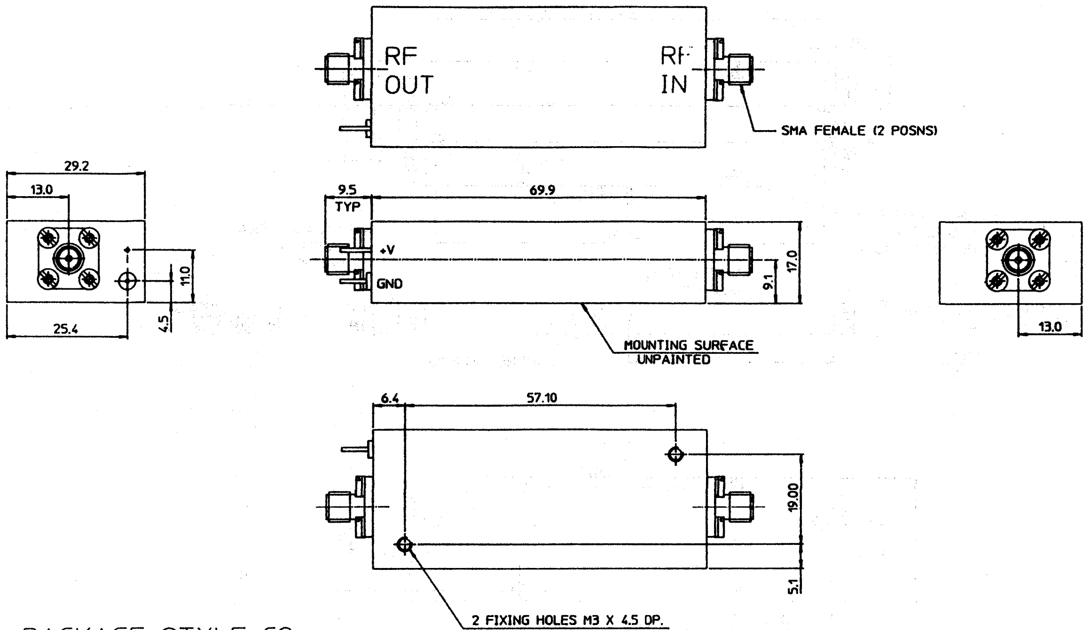
Matt black paint to DTD 5555A (A1, B1, C1)

Miniature packages:

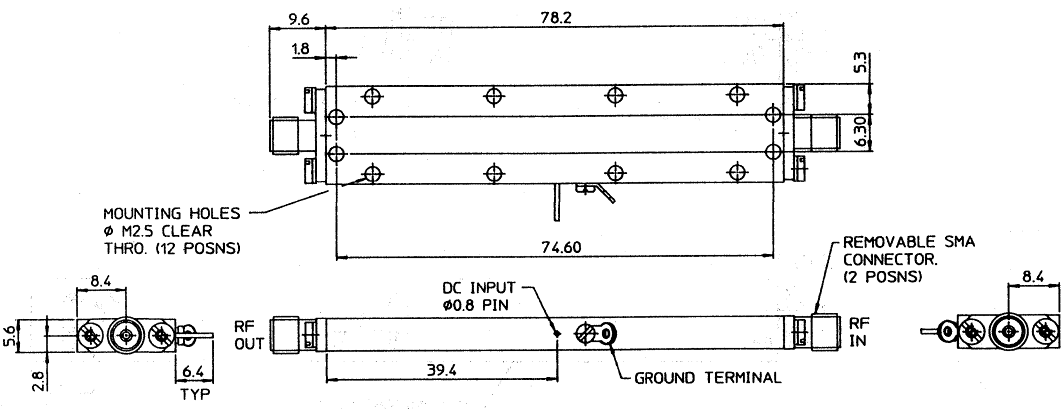
Nickel plate (A2, A3, B2, B3, C2, C3)

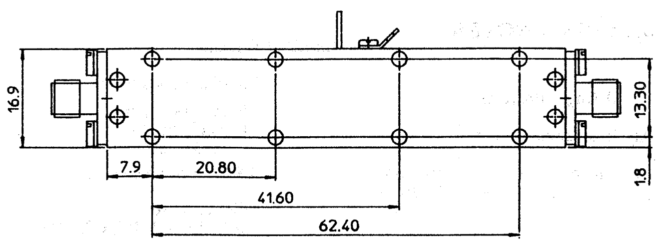
All specifications subject to change without notice

PACKAGE STYLE C1



PACKAGE STYLE C2





DRAWING NOTES

Third Angle Projection

All dimensions in mm

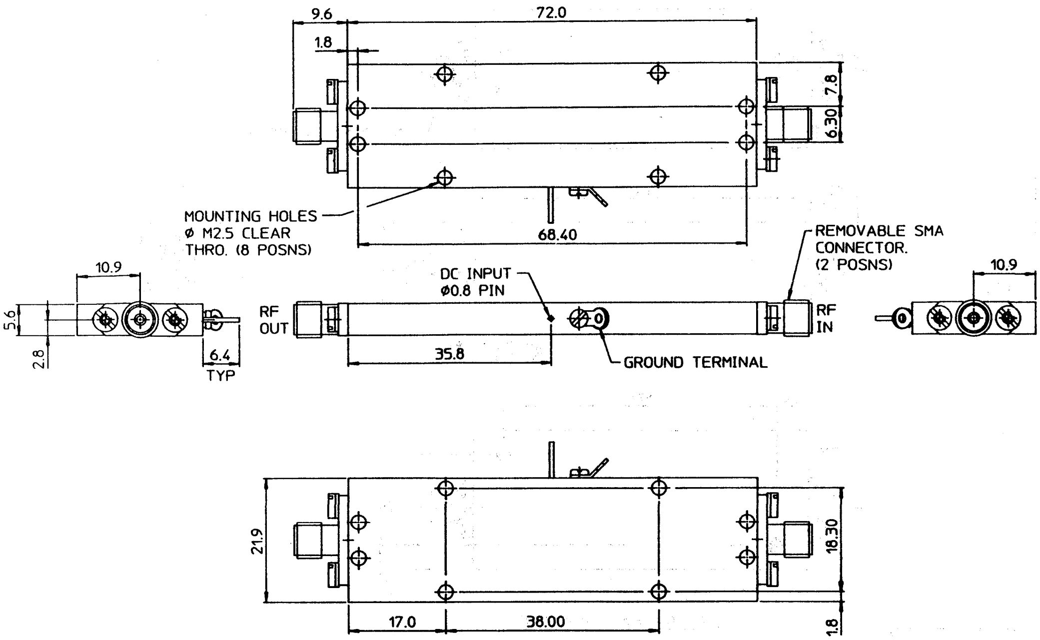
Tolerances	x.x	=	±0.5mm
	x.xx	=	±0.1mm

Standard Finish:

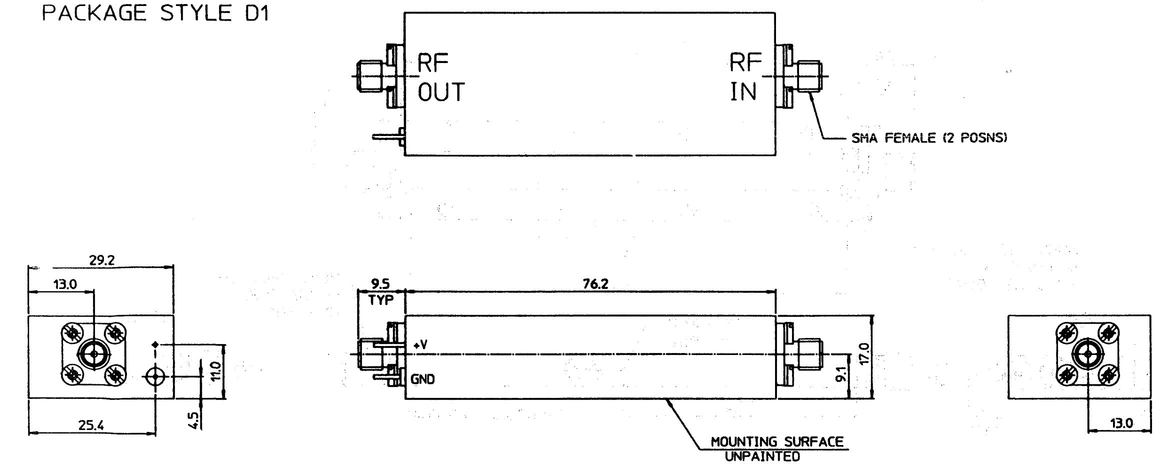
Standard packages:	Matt black paint to DTD 5555A (A1, B1, C1)
Miniature packages:	Nickel plate (A2, A3, B2, B3, C2, C3)

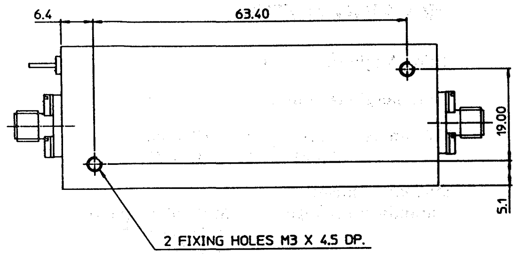
Specifications Subject to Change Without Notice.

PACKAGE STYLE C3



PACKAGE STYLE D1





DRAWING NOTES

Third Angle Projection

All dimensions in mm

Tolerances x.x = ±0.5mm
x.xx = ±0.1mm

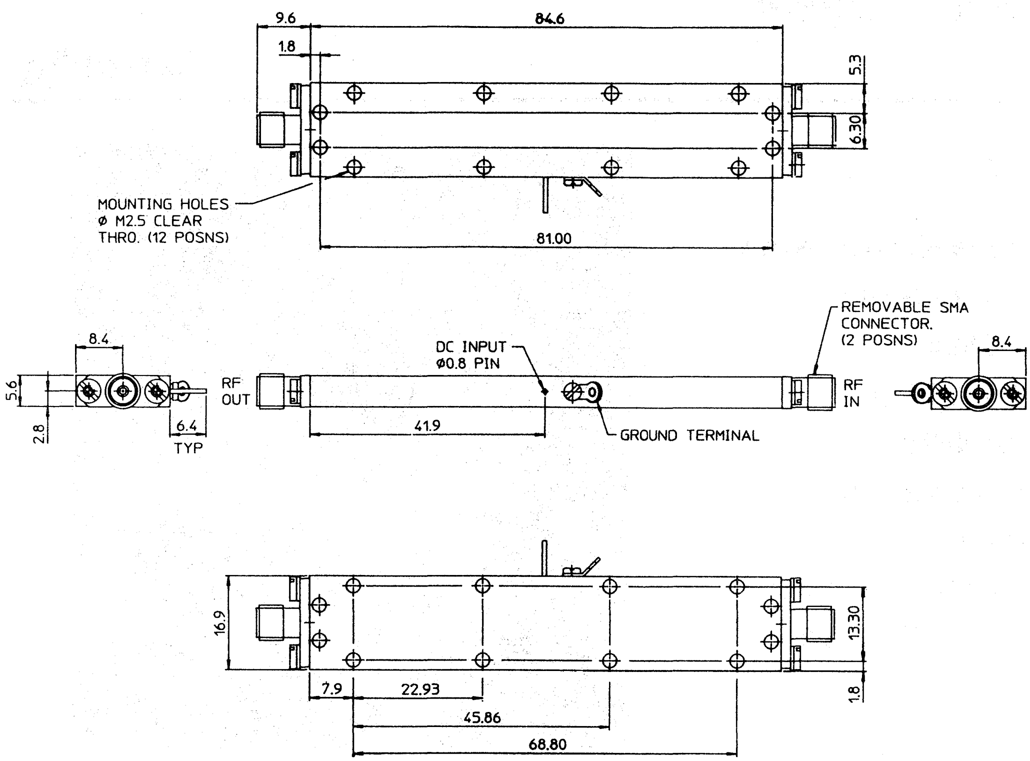
Standard Finish:

Standard packages:
Matt black paint to DTD 5555A (A1, B1, C1)

Miniature packages:
Nickel plate (A2, A3, B2, B3, C2, C3)

All specifications subject to change without notice

PACKAGE STYLE D2



DRAWING NOTES

Third Angle Projection

All dimensions in mm

Tolerances	x.x	=	±0.5mm
	x.xx	=	±0.1mm

Standard Finish:

Standard packages:	Matt black paint to DTD 5555A (A1, B1, C1)
Miniature packages:	Nickel plate (A2, A3, B2, B3, C2, C3)

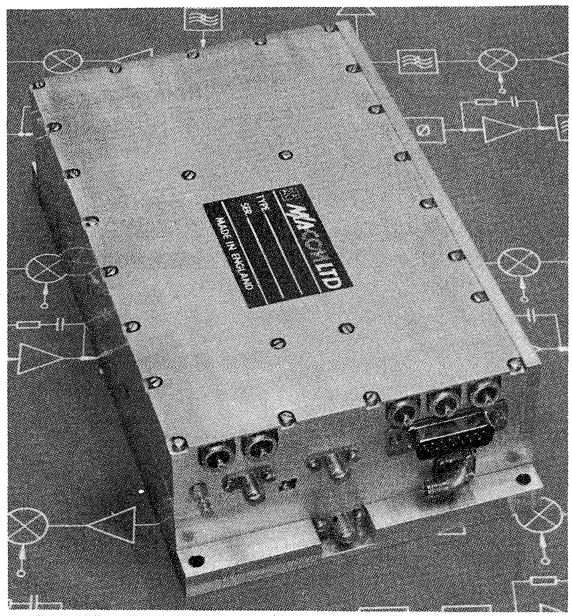
All specifications subject to change without notice

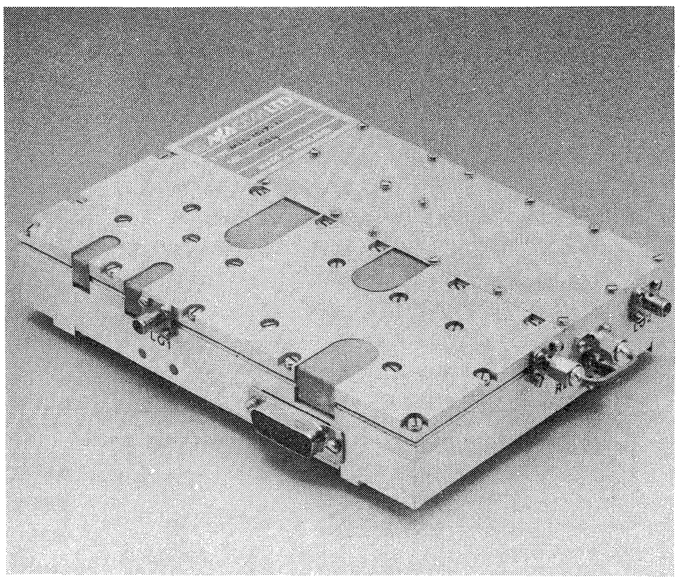
Radar Synthesiser

Capability

CAPABILITY

- UHF to Millimetre Wave
- Low Phase Noise
- Small Steps
- Fast Switching
- High Stability
- Direct Modulation
- Custom Design
- Systems Understanding
- Special-to-Type Test Equipment





TECHNIQUES

- Indirect
- Multiloop
- Phase Locked Direct
- Sampling
- Direct Digital
- Anti Vibration
- Temperature Stabilization
- Hybrid Assembly
- Nuclear Hardening

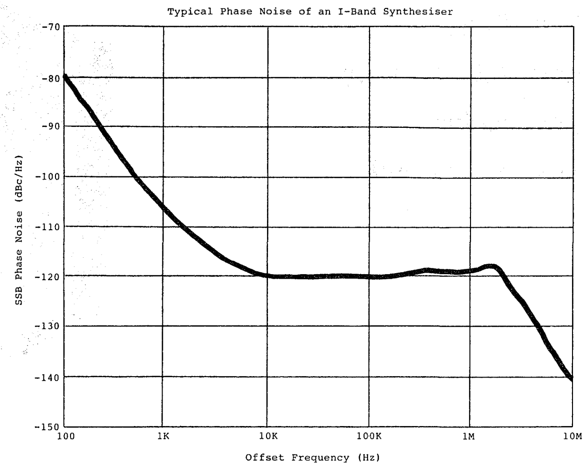
Specifications Subject to Change Without Notice.

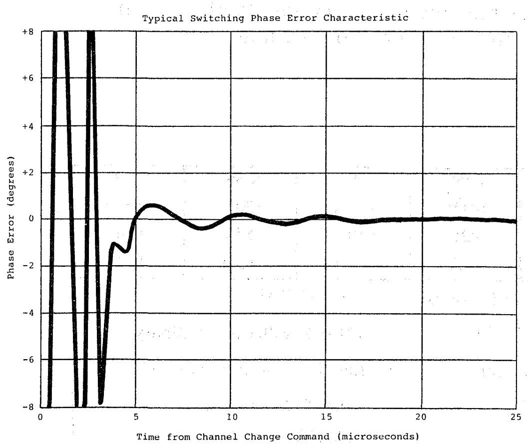
Radar synthesisers are almost invariably custom designs for performance or environmental reasons. After 20 years of close liaison with its customers, M/A-COM has the experience to employ the most appropriate synthesiser design and integration techniques to satisfy stringent system requirements in a cost-effective way.

Beyond the design stage, M/A-COM's strength lies in its depth of production capability which has helped to make it a world leader in the design, development and timely supply of reliable radar synthesisers for sea, land and air systems.

ACHIEVEMENTS

- **-120dBc/Hz Phase Noise at 10KHz Offset at I Band**
- **1Hz Steps with -70dBc Spurious**
- **Missile Control Radar Synthesisers Qualified from -35 to +85°C**
- **Reliable Operation Under High Shock, Vibration and Radiation Levels**



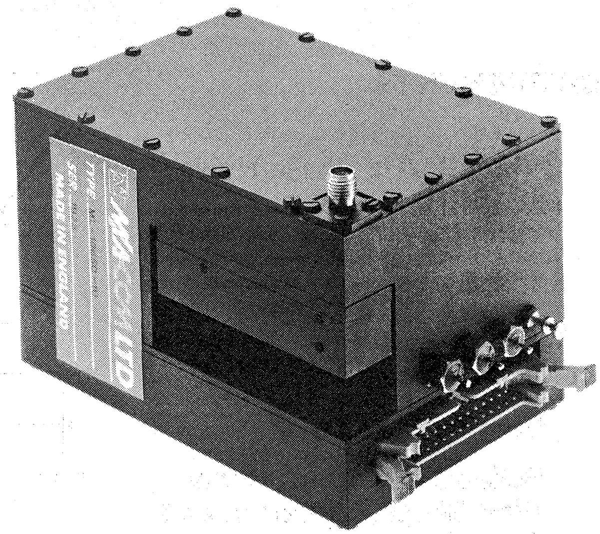


- **Airborne Synthesisers with Under 5uS Switching**
- **Direct Modulation of Airborne Synthesisers**
- **Battlefield Manpack Radar Synthesiser Measuring Only 170 x 125 x 70mm**
- **Supply of First, Second and Third Line Rugged Test Equipment**

Microstrip Low-Noise Synthesiser
4 to 15 GHz MLS-2000

FEATURES

- Low Cost
- Low Microphony
- Low Noise
- Low Phase Hits



DESCRIPTION

MLS-2000 synthesisers are non-cavity, hard mountable, variable frequency crystal stabilised units designed for low cost, high quality Digital Data and FM Communications applications.

TYPICAL SPECIFICATION

Frequency Start	(MHz)	4600	5750	6900	8050	9200	10350	11500
Frequency End	(MHz)	5800	7250	8700	10150	11600	13050	14500
Step Size (min)	(KHz)	250	300	375	425	500	550	600
Output Power (Typ)	(dBm)	18.0	17.5	17.0	16.0	15.0	13.0	11.0

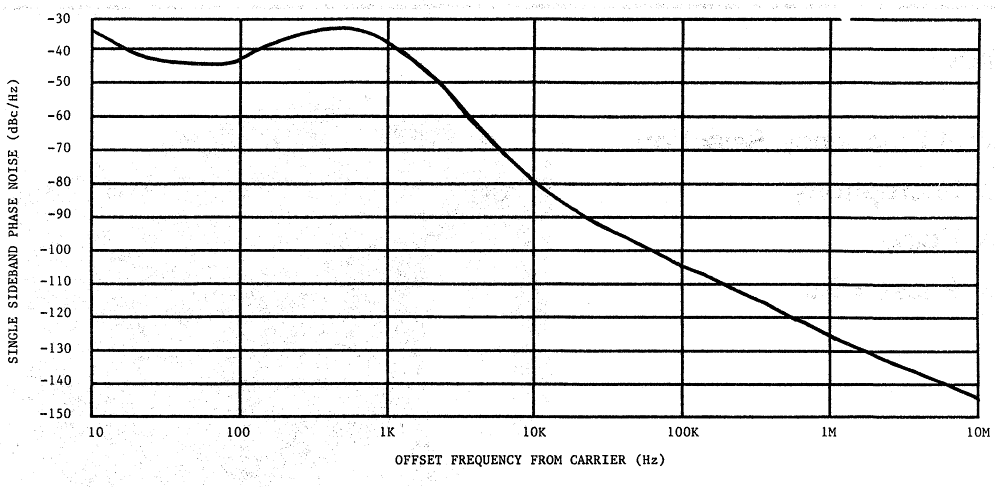
Tuning Range	:	500 MHz max.	Non Harmonic Spurious	:	-60 dBc max
Frequency Stability	:	±20 p.p.m. max.	Channel Selection	:	12Bit Parallel Input Binary
Output Power Variation	:	±2 dB max.	Lock Failure Alarm	:	Low Impedance to Ground
Noise Performance	:	See Over	Power Supply	:	+20V DC, 300mA max.
Harmonic Spurious	:	-40 dBc max.			+5V DC, 100mA max.

Specifications Subject to Change Without Notice.

M/A-COM Inc. ■ 1011 Pawtucket Boulevard, Lowell, MA 01853 USA ■ Telephone: 800-366-2266

NOISE PERFORMANCE

Typical Noise Performance for a 10.5 GHz Synthesiser



Integrated Phase Jitter	:	56 degrees rms
PAL Video Signal/Noise in 10 KHz – 5 MHz Bandwidth	:	67dB Lum. wtd.
Telephony Signal/Noise at 10 KHz Offset	:	68 dB weighted

MECHANICAL CHARACTERISTICS

Size	:	102 x 70 x 64mm
RF Connectors	:	SMA
D.C. Connectors	:	Solder Pin
Control Connector	:	Ribbon Cable Header Socket

Other Connector configurations available

ENVIRONMENTAL CHARACTERISTICS

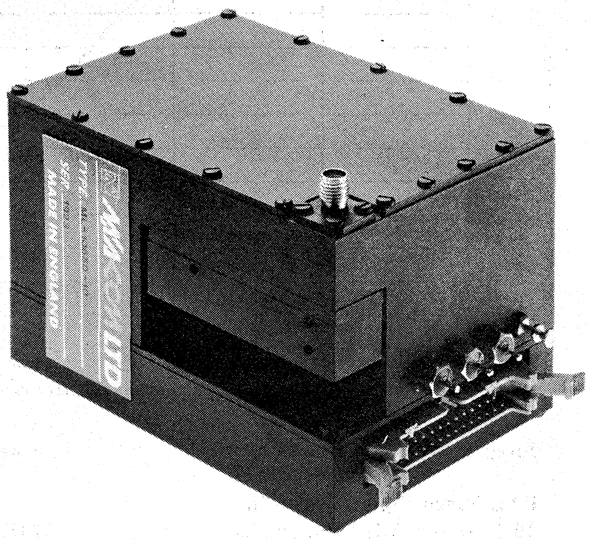
Operating Temperature Range	:	-30°C to +70°C
Storage Temperature Range	:	-40°C to +85°C

Improved Phase Noise Synthesiser 5 to 15 GHz

MLS-3000

FEATURES

- Digital Frequency Selection
- Low Microphony
- Low Noise
- Low Phase Hits



DESCRIPTION

MLS-3000 synthesisers are non-cavity, hard mountable, variable frequency crystal stabilised units featuring "Mix and Divide" technology for Digital Data, FM Communications and Radar applications where low close-to-carrier phase noise is critical.

TYPICAL SPECIFICATION

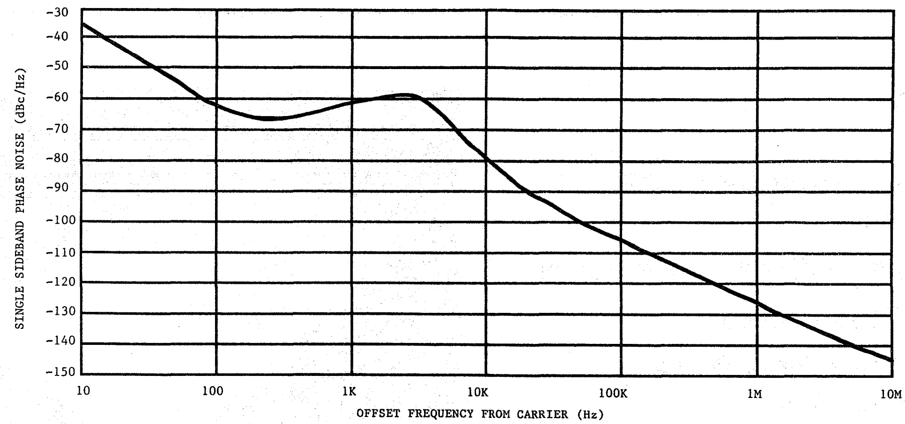
Frequency Start	**(MHz)**	5060	6325	7590	8855	10120	11385	12650
Frequency End	**(MHz)**	5800	7250	8700	10150	11600	13050	14500
Step Size (Min)	**(KHz)**	400	500	600	700	800	900	1000
Output Power (Typ)	**(dBm)**	18.0	17.5	17.0	16.0	15.0	13.0	11.0

Tuning Range	:	500 MHz max.	Non Harmonic Spurious	:	-60 dBc max.
Frequency Stability	:	±20 p.p.m. min.	Channel Selection	:	12Bit Parallel Input Binary
Output Power Variation	:	±2 dB max.	Lock Failure Alarm	:	Low Impedance to Ground.
Noise Performance	:	See Over	Power Supply	:	+20V DC, 400mA
Harmonic Spurious	:	-40 dBc max.			+5V DC, 50mA

Specifications Subject to Change Without Notice.

NOISE PERFORMANCE

Typical Noise Performance for a 10.5 GHz Synthesiser



Integrated Phase Jitter	:	15 degrees rms
PAL Video Signal/Noise in 10 KHz – 5 MHz Bandwidth	:	67dB Lum. wtd.
Telephony Signal/Noise at 10 KHz Offset:	:	68 dB weighted

MECHANICAL CHARACTERISTICS

Size	:	102 x 70 x 64mm
RF Connectors	:	SMA
D.C. Connectors	:	Solder Pin
Control Connector	:	Ribbon Cable Header Socket

Other Connector configurations available

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature Range	:	–30°C to +70°C
Storage Temperature Range	:	–40°C to +85°C

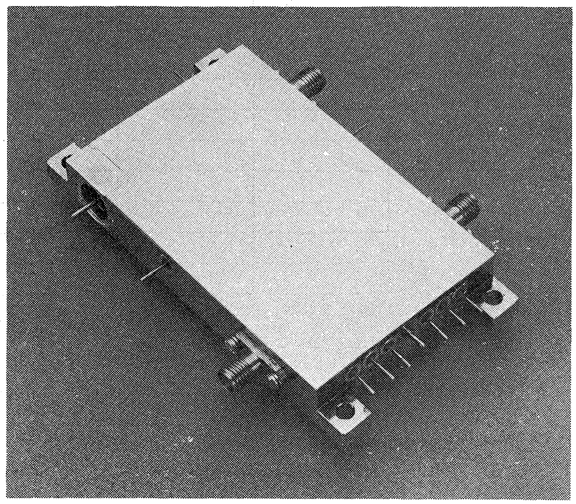
Specifications Subject to Change Without Notice.

Dual Output Sampling Synthesiser
4 to 18 GHz

MLS-4000

FEATURES

- Independently Selectable Outputs
- Internal or External Reference
- Low Phase Noise
- Small Size/Low Power Consumption
- Hermetically Sealed



DESCRIPTION

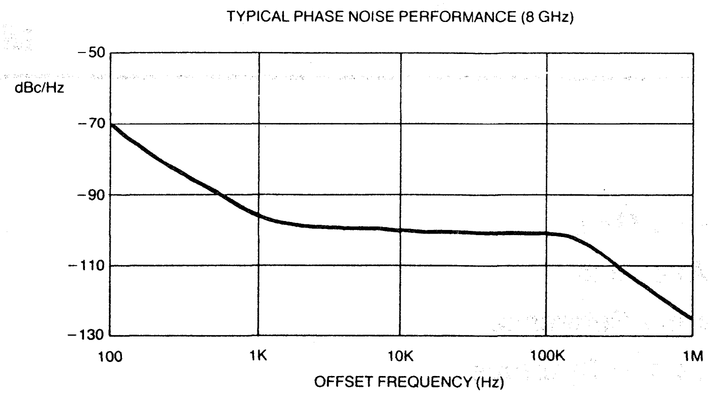
Designed for man portable applications, MLS-4000 synthesisers provide dual independent outputs to drive both transmitter and receiver in communications and radar applications.

SPECIFICATION

Frequency Range	:	4 to 18 GHz	Output VSWR	:	1.5:1 max.
Bandwidth	:	500 MHz	External Reference	:	5, 10 or 20 MHz @ 0dBm nominal
Step Size	:	50 MHz min.	Monitor Output	:	Lock Alarm
Output Power	:	+10dBm nom.	Control Interface	:	2 x 3 bit binary TTL
Phase Noise SSB	:	See Over	D.C. Supply Voltage	:	+12 ±0.25V
Spurious Outputs	:	-70dBc max.	Current Consumption	:	500mA max.

Specifications Subject to Change Without Notice.

PHASE NOISE PERFORMANCE



The internal voltage controlled oscillator defines the phase noise performance at offset frequencies above approximately 100 Hz, irrespective of external reference performance.

MECHANICAL CHARACTERISTICS

Size	:	**80 x 50 x 10mm**
Weight	:	**100g max.**
RF/Ref. Connectors	:	**SMA Female**
D.C. Connectors		**Solder Pin**
Control Connectors	:	**Solder Pin**

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature Range	:	**–30°C to +60°C**
Storage Temperature Range	:	**–40°C to +85°C**
Housing Seal	:	**Hermetic**

M/A-COM

Broadband Low-Noise Synthesiser 1 to 18 GHz

MLS-5000

FEATURES

- Bandwidth up to 1 GHz
- 1Hz Step Size Available
- Internal or External Reference
- Low Phase Noise and Spurious
- Optional Digital Modulation

DESCRIPTION

The low cost, general purpose MLS-5000 series synthesiser is designed to give low phase noise performance while providing a 1 GHz bandwidth and very small step size. These devices are ideal for SATCOM and Radar applications.

SPECIFICATION

Frequency Range	:	1 to 18 GHz	External Reference	:	5 or 10 MHz @ 0 dBm nominal
Bandwidth	:	1 GHz max.	Modulation Options	:	FSK, PSK
Step Size	:	1 Hz min.	Monitor Outputs	:	Power/Lock Alarm
Switching Speed	:	10 ms (100 us Option)	Control Interface	:	RS232, Thumbwheel or Custom Design
Output Power	:	+20 dBm max.	D.C. Supply Voltage	:	+15V, +5V
Phase Noise SSB	:	See Over	Current Consumption	:	1.0A, 0.8A
Spurious Outputs	:	-70 dBc max.			

Specifications Subject to Change Without Notice.

PHASE NOISE PERFORMANCE

For designs using an external reference, the SSB phase noise will, for offsets less than approximately 100Hz from carrier, depend on the phase noise of the external reference.

TYPICAL SSB PHASE NOISE (dBc/Hz)
(For 1 Hz Step Size)

Offset	At 3 GHz	At 10 GHz	At 15 GHz
200 Hz	-85	-74	-70
1 KHz	-98	-93	-90
10 KHz	-112	-106	-100
100 KHz	-110	-105	-100
1 MHz	-121	-119	-115

MECHANICAL

RF/Ref. Connectors	:	SMA Female
D.C. Connectors	:	D-Type
Control Connectors	:	D-Type or Custom
Size (Approx.)	:	186 x 141 x 65mm
Weight (Typical)	:	1.8Kg

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature Range	:	-25°C to +75°C
Storage Temperature Range	:	-40°C to +85°C

Ferrodisc® and Drop-In* Devices

Overview

Ferrodisc and Drop-In circulators and isolators manufactured by M/A-COM are extremely well suited for all types of microwave integrated circuits (MIC's). The rapidly growing awareness and utilization of these devices in microwave systems of all types has resulted in a need for information with regard to their technical applications and practical installation features of these devices.

The purpose of this Overview is to provide technical information for these devices in the areas of basic features and characteristics, key mechanical and thermal parameters and recommended practical procedures for installation into microstrip circuits.

The Ferrodisc Concept and Application

M/A-COM's Ferrodisc and Drop-In devices are 3-port microstrip junction circulators. Ferrodiscs are constructed on a ferrite substrate, while the Drop-Ins are constructed in a magnetic stainless steel enclosure. They are both designed to be directly compatible with microstrip circuits with a simple tab connection. These ferrite devices can also be used in strip transmission line applications in a suitable mounting arrangement. When one port is suitably terminated, either internally or externally, the device can be used as an isolator.

In contrast to the convention strip transmission line ferrite circulator, which requires two ground planes and two ferrite elements, the Ferrodisc is a true microstrip device using a single ferrite substrate with the circuit pattern on one face and the ground plane on the other. With a permanent magnet structure included on the substrate, a Ferrodisc is a complete, self-contained and fully-functional ferrite circulator.

Ferrodisc and Drop-In ferrite isolators and circulator feature:

- **Small size and weight**
  The elimination of mechanical structure for Ferrodiscs and simplified structure of Drop-Ins, coupled with the elimination of connectors permits the design of more compact light weight microwave circuits with greatly reduced weight.
- **Low cost**
  The simplicity of the devices make them inherently low cost ferrite devices. This is especially true for large volume applications.
- **Variety**
  The self-contained feature permits users to economically obtain Ferrodisc devices directly from the factory in a wide variety of frequency ranges and configurations. No user functions or adjustment is required at installation.

Ferrodisc and Drop-In devices are currently in use in a multitude of microwave circuit applications such as amplifiers, receivers, converters, multipliers, synthesizers, voltage-controlled oscillators and many other multi-function assemblies. System applications cover a wide range of uses from commercial applications to high performance military systems to satellite uses. M/A-COM Ferrodisc and Drop-In circulators and isolators are currently in use in the following types of systems:

- Digital Microwave Telecommunications
- Airborne Radar
- Electronic Countermeasures
- Fuses
- Missiles
- Satellites—Military & Commercial

Ferrodisc is a registered trademark of M/A-COM.
* For the purpose of this document, a Drop-In device is defined as a unit with tab connectors.

Technical Description

Substrate Material

The ferrite substrate materials used in Ferrodisc devices are sintered magnetic ceramics. The type and composition, which is a factory design choice, varies with the required frequency, power level and operating temperature.

Table I lists selected mechanical and thermal properties of typical Ferrodisc substrate materials. The parameters listed are those of most relevance to users in terms of applications and installation. Alumina is a familiar ceramic substrate material which is included in the table for comparison purposes.

Circuit Design

Ferrodisc and Drop-In circuit designs follow the established principles of symmetrical ferrite junction circulators. With Ferrodiscs, advantage is taken of the microstrip configuration to utilize quasi-lumped element techniques which permit greater design flexibility in the relationship between frequency bandwidth and size. One face of the ferrite substrate carries the circuit pattern while the other face is completely metallized to form the ground plane. In Drop-In designs significant reduction in size is attained through the use of high permittivity materials and quasi-lumped circuit elements. The center conductors are fabricated using EDM techniques to ensure the close tolerances necessary.

Metallization

Ferrodiscs are available in either thin film or thick film metallization.

The thin film Ferrodisc metallization process is similar to that used on ceramic microstrip substrates and is based on vacuum sputtering. After proper preparation of the ferrite substrate surfaces, a chromium adhesion layer is applied followed by copper and gold. There is sufficient copper thickness to allow for subsequent soldering and there is sufficient soft gold for compatibility with MIC connection techniques such as soldering and ultrasonic or thermal compression bonding. The desired circuit patterns are obtained by conventional photo-etching techniques.

The thick film Ferrodisc metallization process is essentially the standard screen and fire thick film technology. The circuit patterns are screened directly on the ferrite substrates using either silver or gold inks and fired to form the metallization circuit patterns. While the thick film technology is more limited in circuit definition, it offers a considerable price advantage and performance equivalent to thin film designs at frequencies up to 7.0 GHz.

Magnet Structure

A fixed magnetic field is required to obtain the nonreciprocal circulator properties of these devices. The necessary field is provided by ceramic, rate earth or metal permanent magnets which are saturated and then degaussed to the proper level as part of the factory tuning procedure.

Magnet configuration varies as a function of frequency. In general, the low frequency Ferrodiscs have a single magnet on the ground plane (lower) side. At higher frequencies, an additional magnet is frequently used on the circuit (upper) side. The dividing line between these two cases is approximately 7.0 GHz.

Substrate Configuration

Both devices are available in round, square and rectangular configurations, depending on customer requirements. Triangular or spacial asymmetrical shapes are also available. Ferrodisc technology can also be applied to custom requirements such as multi-junction circulator configurations and multi-function microwave integrated circuits.

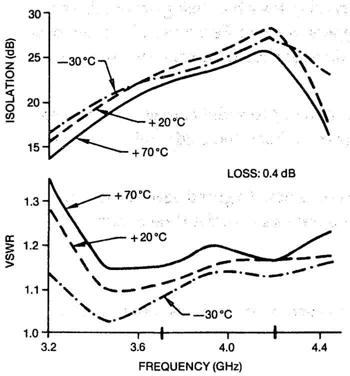
Ferrodisc size and thickness is a function of frequency. A typical range of substrata dimensions between 2.0 GHz and 17.5 GHz shows the surface varying from a 2.0 inch (50.8 mm) diameter to 0.25 x 0.30 inch (6.4 x 7.6 mm) and thickness varying from 0.15 inch (3.81 mm) to 0.015 inch (0.38 mm) The smaller sizes correspond to the higher frequencies. Consult the product pages for specific dimensions.

Parameter	Units	*Ferrodisc* Substrates	Alumina
Density	gm. cm^{-3}	4.9 — 5.4	3.8 — 3.9
Compressive Strength	$x10^3$. lb. in^{-2}	50 — 100	300 — 375
Tensile Strength	$x10^3$. lb. in^{-2}	5 — 6	28 — 35
Young's Modulas	$x10^7$. lb. in^{-2}	1.5 — 2.1	4.4 — 5.2
Coefficient of Linear Expansion	$x10^{-6}$. $°C^{-1}$	8 — 9	5 — 7
Thermal Conductivity	cal. cm^{-1}. sec^{-1}. $°C^{-1}$	.01 — .02	.05 — .07
Specific Heat	cal. $gm.^{-1}$ $°C^{-1}$	=.15	.20
Thermal Diffusivity	cm^2. sec^{-1}	=.02	=.08
Relative Dielectric Constant	—	12 — 16	9.9

Table I. Selected Properties of Ferrodisc and Alumina Microstrip Substrate Materials

Electrical Performance Characteristics

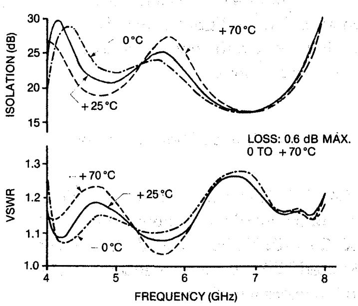
Standard catalog Ferrodisc devices are currently available from 1.7 GHz to 17.5 GHz with bandwidths ranging from 5 to 13%. Standard catalog Drop-In devices are available from .4 GHz to 15.5 GHz with bandwidths ranging from 5 to 10%. Both types are also available in broad and octave-band versions. Special frequency bands and temperature ranges are also available.



SIZE: 0.75 in. (19,0mm) DIA

Figure 1. Performance of 3.7-4.2 GHz Ferrodisc Isolator (S4355)

Figure 1. Performance of 3.7-4.2 GHz Ferrodisc Isolator (S4355)



SIZE: 1.0 in. (25,4 mm) DIA

Figure 2. Performance of 4.8 GHz Octave Ferrodisc Isolator (S4486)

Figure 2. Performance of 4.8 GHz Octave Ferrodisc Isolator (S4486)

Figure 1 shows typical performance data for the S4355 Ferrodisc isolator over the frequency range 3.7 to 4.2 GHz and an extended temperature range from -30 to +70°C. This data illustrates that reasonable performance is maintained over a frequency bandwidth appreciably wider than the 12.7% design band. Figure 2 shows the performance of the S4486 Ferrodisc isolator over the 4 to 8 GHz octave and the temperature range of 0 to +70°C.

Relationship Between Ferrodisc and MIC Substrate Thicknesses

It is not necessary that the Ferrodisc and the connecting MIC microstrip substrate have the same thickness. It has been found that satisfactory operation is obtained with the Ferrodisc either thicker or thinner than the connecting MIC provided that the thickness ratio does not exceed 2. The upper surfaces, or circuit side, of the Ferrodisc and the connecting MIC must be coplanar. This confines thickness differences to the lower, or ground plane, surfaces. Coplanarity and mounting details are discussed in the product section.

Direction of Circulation

The standard circulation direction (i.e. the low loss direction) is clockwise (to the right) when viewed from the top or circuit side of the device. Reverse circulation is available and is designated by adding the suffix "L" to the Model Number. It is essential to properly specify and to check for proper circulation direction before final installing of the device into a microwave circuit.

RF Enclosure and Cover Proximity

In terms of the effect of enclosures and cover plates, the RF behavior of Ferrodisc devices is much the same as conventional microstrip line. RF operation is generally unaffected by an adjacent cover or object, provided that approximately 0.25 inch (6.4 mm) air space is maintained on the circuit side. Due to the magnetically shielded stripline construction of the Drop-In ferrite devices, their RF performance is essentially unaffected by the proximity of the enclosure walls and cover. Proximity effects though will affect VSWR in microstrip enclosures as in any component interface.

Terminations for Ferrodisc Isolators

Ferrodisc isolators are internally terminated by means of a 50 ohm chip resistor soldered on the circuit side of the ferrite substrate. Connection to the ground plane is typically via a metallized strip on the ferrite edge.

In the standard catalog isolators, the chip termination is nominally rated at 100 mW. In reverse power overload situations, the power handling capability of the 100 mW chip resistor depends on the heat transfer efficiency between the Ferrodisc and the base plate. This, in turn, depends on the size and shape of the Ferrodisc and the method of mounting.

For isolator applications at higher reverse power ratings, higher voltage terminations up to 12 watts can be provided. Consultation with the factory is advised before final commitment to this type of termination.

For the maximum reverse power handling, the termination resistor should be mounted off the ferrite substrate and directly on the carrier ground plane. This provides lowest thermal resistance.

Another approach for high power handling would be to use a circulator and have an external termination provided within the customer's circuitry.

Standard chip resistors are installed using soft-solder at a maximum temperature of 200°C. For special applications, a higher temperature soldering process for the chip resistor is available.

The thermal data in Table I for Ferrodisc substrate materials is of value in calculating temperature gradients and distributions associated with heat dissipation both in the chip termination and in the Ferrodisc itself.

Precautions

There are certain basic precautions that should be considered in the handling, installation and use of all Ferrodisc and Drop-In devices. The most important of these are listed below.

Temperature Exposure

An upper temperature limit is imposed by the epoxy adhesive used in Ferrodisc magnet structure assembly and by the solder systems used to attach the termination to the substrate and the substrate to the carrier (if used). Upper temperature limits for Drop-Ins are imposed by the solder used to secure the cover. Table II shows the maximum long term temperature exposure for each generic type of Ferrodisc. Peak temperatures up to 200°C for no more than 10 seconds are allowable for interconnections. Higher temperature solders are available from the factory.

Ferrodisc Substrate	Maximum Temperature Allowed
Thin Film	160° C
Gold Thick Film	145° C
Silver Thick Film	160° C
All Carrier Mounted	145° C

Table II

Magnetic Fields and Materials

Ferrodiscs typically exhibit a fringing magnetic field which is less than one gauss at a distance of 0.5 inch (12.7 mm). Electrical performance may be affected if the device is mounted on or very close to magnetic materials or exposed to strong magnetic fields from nearby magnetic devices. Usually Ferrodisc devices are mounted to non-magnetic surfaces (e.g. a Kovar or steel carrier plate or close to a microwave tube) It is recommended that the Ferrodisc be tuned at the factory in an equivalent magnetic environment to achieve optimum electrical performance. Due to the magnetic shielding employed in Drop-In devices, RF performance is not adversely affected by adjacent magnetic materials. In applications where very high magnetic field strengths may be encountered, contact the factory.

RF Power Level

The rated RF power of a given ferrite device should not be exceeded. Excessive peak power may induce limiting with attendant high insertion loss. Excessive average power may overheat the device. In isolator versions, excessive reverse power may damage the internal termination.

Test Fixtures

If Ferrodisc devices are to be tested in a test fixture prior to final circuit installation, care must be taken to ensure that the test fixture itself does not damage the Ferrodisc. Specifically, test fixture methods based on localized mechanical contact pressure may introduce the risk of damaging the metallization and/or the ferrite substrate unless very carefully implemented. Similarly, test fixture methods that require soldering to the Ferrodisc must be carefully controlled to avoid damage.

Mechanical Handling

Some simple mechanical handling precautions are appropriate in handling these devices prior to installation. The ferrite substrate is a brittle ceramic material which is liable to crack or shatter if the unmounted Ferrodisc suffers severe mechanical shock such as being dropped. The magnet(s) will be strongly attracted to steel, other magnets or other Ferrodiscs. To avoid possible damage from violent magnetic contact, Ferrodisc devices should be kept well-separated from each other and from magnetic materials.

Tab connections are very fragile and careful handling is required to avoid damage. Cleanliness is essential to ensure successful final connection into the MIC. Tabs and solderable metallized surfaces should not be handled or contaminated.

M/A-COM's ferrite devices are packaged in protective containers to guard against the above hazards. It is recommended that they be kept in these containers until the time of actual circuit installation.

Cleaning

The use of chlorinated solvents is strictly prohibited. The recommended solvent/cleaner is isopropyl alcohol per MIL-TT-I-375.

Adhesive and Solder Materials

This section contains information on adhesive and solder materials which are suitable for installation of M/A-COM's ferrite devices into microstrip circuits. The materials listed are a sampling of those most commonly used.

Conductive Epoxy (Substrate Attachment)

In certain applications, the use of conductive epoxy is favored for mounting and to enhance the electrical connection between the base plate and device ground plane surfaces. Recommended conductive epoxy materials suitable for this purpose include Ecco-Bond No. 56C (Emerson & Cummings), Cho-Bond No. 589-29 (Chomerics, Inc.) or Epo-Tek No. 417 (Epoxy Technology, Inc.). In each case the surface to be bonded and the epoxy material itself should be prepared in accordance with the manufacturer's instructions.

Tin-Lead Solders & Fluxes (Interconnections)

The upper temperature limitation of ferrite devices restricts the choice of tin-lead solder allows to those with melting points bellow 200°C.

In accordance with the Federal Qualified Product List QQ-S-571, soft-solder alloys with tin content in the range of 60% to 63% are recommended for standard applications except thick film gold. These have melting points in the range of 188°C to 183°C. For use with this type of solder, a mildly active rosin flux per MIL-F-14256 designated "RMA" is recommended. Suitable cored solders are manufactured by Alpha Metals, Ersin Multicore and Kester.

CAUTION: The use of thin lead solders on a gold thick film Ferrodisc is strictly prohibited. We recommend an indium alloy solder for all interconnections to a gold thick film Ferrodisc. (See Indium Solders and Fluxes).

An alternative solder material is Multicore Oxide-Free Solder Cream which is a paste consisting of powdered solder and flux. This preparation is coated on the surface to be soldered prior to heating. Again, the flux should be "RMA" type. A suitable Multicore solder cream with the proper flux is XCM 27330/SN62PRMAB3.

Material	Expansion[1] Coefficient
Invar	1.6
Alumina	5 — 7
NiFe & NiCoFe Low-Expansion Alloys Including Kovar	5 — 8
Rhodium	8 — 9
Ferrodisc Materials	8 — 9
Platinum	9
Woven Glass Fiber PTFE Laminate (TFG-Keene Di-Clad 522/527)[2]	9 — 10
Stainless Steel (400 Series)	9 — 12
Non-Woven Glass Fiber PTFE Laminate (Rogers RT/Duroid 5870)[2,3]	10 — 60
Iron	12
Nickel	13 — 15
Gold	14
Steel (1020)	15
Stainless Steel (300 Series)	15 — 17
Copper	17 — 18
Silver	19 — 20
Aluminum (6061)	23 — 25
Tin	23 — 27
Soft Solder (60/40)	24
Magnesium	26 — 27
Indium	33 — 42
PTFE (Teflon)	90 — 110
	$X10^{-6}$. $°C^{-1}$

NOTES:
1. Mean value for range +25 to +200 °C from various sources.
2. Data shown is for length and width directions. Expansion coefficient for thickness direction is approximately 200.
3. Substantial differences exist between length and width directions and with temperature. Consult manufacturer's data sheet.

Table III. Linear Coefficients of Thermal Expansion

Indium Solders and Fluxes (Substrate and Housing Attachments & Interconnections)

Indium solder alloys are popular as a means of reducing soldering temperatures and minimizing differential thermal expansion problems when mounting MIC ceramic substrates. A range of indium solders is available, for example, from Indium Corporation of America. Most suitable for Ferrodisc installation are Indalloy No. 4 (Pure In) with a melting point of 157°C, Indalloy No. 2 (In, Pb, Ag) with a melting point of 149°C or Indalloy No. 1 (In, Sn) with a melting point of 125°C. For use with these indium solder alloys, fluxes such as Kester 135 or 197 are suitable.

Flux Residue Removal

In keeping with good soldering practice, it is essential to remove flux residues after soldering. A suitable solvent/cleaner for this purpose is isopropyl alcohol per MIL-TT-I-375.

CAUTION: The use of chlorinated solvents is strictly prohibited.

Mechanical Mounting

General Mounting Considerations

The most critical aspect of mechanical mounting in terms of proper electrical performance is the fit of the Ferrodisc substrate or the Drop-In housing to the microstrip line. The gap between the ferrite device and the adjacent microstrip substrate to which it is to be connected must be tightly controlled and becomes very critical at the higher frequencies. Coplanarity of the upper surfaces of the Ferrodisc and the connecting MIC must also be controlled to avoid additional impedance discontinuities.

It is essential to achieve a good electrical contact between the ferrite device's ground plane and the MIC base plate, especially in the vicinity of the tab connections. Failure to achieve this good ground contact may result in erratic insertion loss and VSWR characteristics.

Each Ferrodisc unit has a specified magnet envelope. The actual magnet dimensions and location will be well within this envelope. It is only necessary to provide reasonable clearance around this envelope when designing the Ferrodisc mounting configuration.

Further mechanical factors to be considered in Ferrodisc mounting relate to thermal expansion effects which become of particular importance if the Ferrodisc is to be rigidly attached to a carrier or base plate. Table III lists linear thermal expansion coefficients in ascending order for those materials which are most relevant to the mounting and connection of Ferrodisc devices. This information, coupled with the mechanical parameters listed in Table I, permits detailed theoretical analysis of proposed Ferrodisc mounting arrangements.

Common to all mounting methods is the obvious necessity to check for the proper direction of circulation and, before final fastening, to check that the Ferrodisc and MIC microstrip lines are accurately aligned.

The final general comment to be made is the mounting arrangements must be dimensioned and toleranced to accept the Ferrodisc and its magnet structure without mechanical interference. The brittle ferrite substrate will not survive being mechanically forced into an improperly dimensioned recess.

Circuit Mounting Requirements

A frequently used, and representative method, of mounting these Ferrodisc devices into microstrip circuits is shown in the product section. A machined recess is provided in the base plate to accept the ferrite substrate and ensure coplanarity of the tab and interconnecting line.

The minimum shoulder width of 0.025 inch (0.64 mm) specified in Detail A, along with restrictions on surface and corner finishes, are all steps to ensure a proper ground contact to the underside of the Ferrodisc. Restrictions on surface and corner finishes ensure a proper ground contact to the underside of the Drop-In device.

Detail B indicates that the base plate recess can be made slightly oversize with the outer edge located under the connecting microstrip substrate. This provides some relief to the tight inside corner radius requirement at the bottom of the recess. However, this can be done only if the MIC has its only metallized ground plane. In cases where the base plate is also the ground plane, an oversized recess should not be used. The objective is to ensure that the ferrite device rests on the flat shoulder and not on the corner radius.

For Ferrodisc devices, the lower magnet recess can be any convenient diameter ranging from dimension D minimum to dimension A—0.05 inch (1.27 mm) maximum. It is optional whether this hole extends completely through the base plate as noted. It is generally easier to drill through, but there may be mechanical or electrical reasons that preclude this in some cases. This location of the cover should be at least 0.25 inch (6.4 mm) above the circuit. This spacing is sufficient to accommodate Ferrodiscs that have an upper magnet since the F dimension is usually smaller than this.

Mechanical Clamp Mounting Methods

Ferrodisc devices are frequently clamped into place by means of screws located around the periphery. Rectangular Ferrodisc configurations are clamped in a similar way, but the screws should be located along the sides of the rectangle rather than at the corners to avoid possible stress concentration and ferrite cracking. The use of resilient clamping washers is recommended to limit the mechanical pressure applied to the Ferrodisc by the screws. Suitable washer materials include Nylor and Deirin. Most users employ stainless steel screws, although some have used Nylon screws both with and without washers. Thread sizes typically range of 2-56 to 6-32.

In the case of mechanical clamp mounting, the achievement of a good ground contact to the Ferrodisc is critically dependent on proper seating in the bottom of the recess. Cleanliness is important, since dust or lint particles will prevent proper seating. The clamping screws should be sequentially tightened to avoid uneven stresses that may result in cracking of the ferrite substrate.

M/A-COM's Drop-In ferrite devices are frequently clamped into place be means of screws in flange configurations (allow for two 0-80 screws to secure the device to the housing). The case of mechanical mounting, a good ground contact to the isolator is critically dependent on proper seating in the bottom of the recess. Cleanliness is important since dust or lint particles will prevent proper seating.

Conductive Epoxy Mounting Methods

An alternate method of mounting Ferrodisc and Drop-In devices into microstrip circuits is conductive epoxy bonding. The difficulty is to confine the epoxy to the ground plane side of the ferrite device and to prevent it from flowing onto the edge of the ferrite or into the port openings. Electrical performance may be seriously impaired if this occurs. Any of the conductive epoxy materials recommended earlier may be used. Either device may be held by a temporary clamp during the epoxy curing process.

Solder Mounting Methods

In considering the soldering of Ferrodisc devices to metal surfaces, the mechanical and thermal properties listed in Tables I and III are important factors. Also relevant, is the fact that there will be differences in the ground plane solder are depending on the size and shape of the Ferrodisc and its magnet geometry.

The temperature limitations suggest that soldering operations are best performed on a hot plate with accurate temperature control. Solder must not be permitted to flow onto the edge of the ferrite substrate or into the port openings.

To make a comparison with related ceramic substrate MIC technology, it is known that thin alumina substrates can be successfully soldered directly to plated aluminum using indium solder at 160°C. Despite the disparity in expansion coefficients, the strength of alumina, combined with the mechanical softness of the indium solder layer gives a successful technique.

Mixed results have been obtained in soldering Ferrodisc substrate directly to plated aluminum, both with tin-lead and indium solders. Due to its crystal structure, ferrite is weaker than alumina and is much more prone to cracking. The variability of results is related to the size and shape of the ferrite substrate and aluminum base plate, the solder area, the solder type and temperature and the method of cooling after soldering. Because of this variability, the factory can make no firm recommendations with regard to soldering Ferrodisc devices directly to alumina base plates. User experimentation is suggested to evaluate each particular situation.

The above situation can be overcome by soldering the Ferrodisc to a carrier plate, which, in turn, may be soldered (or sometime attached by screws) to the MIC base plate. Table II indicates that Kovar and steel are suitable carrier materials because their expansion coefficients are reasonably close to that of Ferrodisc substrate materials.

Ferrodisc devices are routinely soldered to plated cold-rolled steel carriers using an indium allow solder paste.

As noted in the discussion on Magnetic Fields and Materials, the presence of a magnetic carrier, such as Kovar or steel, may modify Ferrodisc electrical performance. This presents no problems provided that final factory tuning is done with the Ferrodisc either soldered to, or at least located on, a replica of the carrier.

Soldering of the Drop-In housing to the chassis is most easily accomplished by using a solder preform .001 inch (.025 mm) to .002 inch (0.51 mm) thick. The preform, stamped to the size of the device, provides a uniform solder joint with minimum labor.

Conductive Tape

Conductive tape (Ablefilm 570) can also be used to secure Drop-In circulators and isolators to base plates. This method has the advantage of minimum labor to install and clean.

Electrical Connections

General Connection Considerations

Microstrip circuits are usually interconnected by means of metal ribbons or wires which may be soldered, welded or bonded to the adjacent microstrip lines. Most of the standard techniques commonly used with ceramic substrates are suitable for Ferrodisc devices. Since Ferrodiscs are relatively large devices compared with, say semiconductor elements, very fine bonding wires are neither necessary nor desirable.

The gold plated beryllium copper tabs provided on Drop-In devices provide straightforward interconnections to microstrip lines. Tabs are generally soldered to interconnection transmission line. Alternatively, ribbon bonding has been utilized in applications subject to extreme environmental stress.

The most common connection methods chosen by Ferrodisc users are based on metal ribbons. The ribbon width is comparable with the microstrip lines to be connected. The thickness is in the range of 0.001 (0.03 mm) to 0.002 (0.05) inch and the length is sufficient to give an adequate connection area on each substrate.

Depending on the bonding method, the ribbon material may be copper or gold. A ribbon material suitable for soldering is Cusil, manufactured by Western Gold and Platinum Company in a variety of widths and thicknesses. It is necessary to cut the ribbon to proper size tabs. Suitable tabs are available from the factory and, on special order. Ferrodiscs can be supplied with the tabs already soldered to the ferrite circuit.

To allow for thermal expansion over side environmental temperature ranges, most users prefer to bend the tabs slightly.

Soldering

The solder and flux combinations recommend previously should be used. Pencil-tip soldering irons in the range of 20 to 35W and cored solder wires of 0.03 inch (0.76 mm) diameter are typically used.

The tab soldering operation should be done quickly and neatly using the minimum of solder necessary to make the connection. Excessive time my overheat the Ferrodisc or the MIC line with the risk of thermal damage to the metallization or the substrates. Excessive solder may low onto the ferrite edge under the tab with serious electrical performance consequences.

After soldering, flux residue should be removed by cleaning with isopropyl alcohol or equivalent.
CAUTION: The use of chlorinated solvents is strictly prohibited.

An alternate to the above hand soldering process is the reflow solder technique. A small solder preform is placed under the tab and local mechanical pressure and heat applied via a wire loop pressed onto the top side of the tab. Sufficient heat is required to melt the preform and accomplish a solder connection under the tab. A machine suitable for this purpose is the Hughes MCW-550 welder.

Welding

Parallel gap welding of the tab connections is a widely used MIC technique which has also been found suitable for use on Ferrodisc devices. Machines such as the Unitek Model 127 Welding Head with Model 1-124-05 Power Supply have been successfully used to weld gold tabs to ferrite substrates.

Ultrasonic Bonding

This process uses a cold ultrasonic tip, but requires that the Ferrodisc and the connecting MIC must be heated to 150°C. This bonding process is restricted to gold only. A trial run is recommended to ensure that the ultrasonic vibration does not damage the ferrite substrate.

Thermal Compression Bonding

This process, commonly used with alumina substrates, is restricted to gold connections is not recommended for tab connections to Ferrodisc devices. Thermal compression bonding requires that the tip of the microstrip lines must be heated to approximately 300°C which exceeds the maximum permissible Ferrodisc exposure temperature.

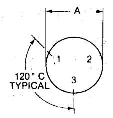
Ferrodisc Microstrip Circulators & Isolators

Features

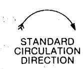
- Small Size, Light Weight
- Low Cost
- Broad Offering
- Standard and Octave Bandwidths
- MIL-Temperature Magnetically Shielded Options

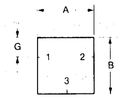
Description

Ferrodisc is a 3-port microstrip junction circulator constructed on a ferrite substrate. This is a true microstrip device using a single ferrite element with a circuit pattern on one face and the ground plane on the other. With a permanent magnet structure included on the ferrite substrate, a Ferrodisc is a complete, self-contained and fully functional ferrite circulator. Ferrodisc devices can also be used in strip transmission line applications in a suitable mounting arrangement. When one port is suitably terminated, the device can be used as an isolator.

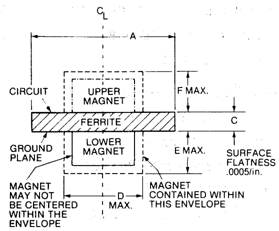


CONFIGURATION 1





CONFIGURATION 2



See end of Model Number Section for Mounting Detail

Electrical Specifications

		Standard Bandwidth	Octave Bandwidth
Insertion Loss dB Max.	<14 GHz	0.4	0.6
	≥ 14 GHz	0.5	
Isolation dB Min.		20	16
VSWR Max.		1.3	1.4
Temperature Range °C		0 to +50	

Notes
1. Performance as measured in factory test fixture with pressure contacat direct to SMA female connectors.
2. Minimum forward power rating 5W CW for both circulators and isolators when mounted to a heat conducting base plate.
3. Internal termination in standard isolator versions rated at 100 mW nominal dissipation.

Specifications

Freq. (GHz)	Config.	Dimensions Inches (mm) A ±.002	B ±.002	C ±.001	D Max.	E Max.	F Max.	G ±.010	Weight Ounces Max. (Grams)	Circulator Model No.*	Isolator Model No.*
1.7-1.8	1	1.15 (29.2)	-	.09 (2.3)	.94 (23.9)	.20 (5.1)	0	-	.56 (16.0)	S4240	-
1.7-2.0	1	1.15 (29.2)	-	.09 (2.3)	.92 (23.3)	.27 (6.9)	.10 (2.5)	-	.76 (21.5)	S4250[1]	-
1.7-2.07	1	1.15 (29.2)	-	.09 (2.3)	.94 (23.9)	.23 (5.8)	.10 (2.5)	-	.76 (21.5)	-	S4247[1]

Notes
1. Insertion loss 0.5 dB, isolation 18 dB, VSWR 1.3:1 max.
* Standard circulation direction is clockwise. For reverse circulation, and other frequency options, contact factory.
Standard metallization is thin film. For thick film gold or thick film silver, contact factory.
suffix "ST" after the Model Number.

Specifications Subject to Change Without Notice.

Specifications

Freq. (GHz)	Config.	Dimensions Inches (mm) A ±.002	B ±.002	C ±.001	D Max.	E Max.	F Max.	G ±.010	Weight Ounces Max. (Grams)	Circulator Model No.*	Isolator Model No.*
1.9-2.0	1	1.15 (29.2)	-	.09 (2.3)	.94 (23.9)	.20 (5.1)	0	-	.56 (16.0)	S4241	-
2.0-2.2	1	.997 (25.3)	-	.08 (2.0)	.94 (23.9)	.20 (5.1)	0	-	.46 (13.0)	S4349	-
2.1-2.3	1	.997 (25.3)	-	.08 (2.0)	.94 (23.9)	.25 (6.4)	0	-	.46 (13.0)	S4393	S4392
2.2-2.3	1	.997 (25.3)	-	.08 (2.0)	.94 (23.9)	.20 (5.1)	0	-	.46 (13.0)	S4350	S4358
2.3-2.5	1	.997 (25.3)	-	.08 (2.0)	.94 (23.9)	.20 (5.1)	0	-	.67 (19.0)	S4395	S43103
2.4-2.7	1	.997 (25.3)	-	.08 (2.0)	.79 (20.1)	.22 (5.6)	0	-	.35 (10.0)	S4367	S4398
2.7-2.95	1	.81 (20.6)	-	.06 (1.5)	.74 (18.8)	.25 (6.4)	0	-	.25 (7)	S4353	S4352
2.8-3.2	1	.81 (20.6)	-	.06 (1.5)	.74 (18.8)	.20 (5.1)	0	-	.25 (7)	-	S43107
2.9-3.1	1	.81 (20.6)	-	.06 (1.5)	.74 (18.8)	.20 (5.1)	0	-	.25 (7)	S43123	S4389
3.1-3.5	1	.748 (19.0)	-	.045 (1.2)	.54 (13.7)	.25 (6.4)	0	-	.18 (5)	S4354	S43116
3.7-4.2	1	.748 (19.0)	-	.045 (1.2)	.54 (13.7)	.20 (5.1)	0	-	.18 (5)	S4356	S4355
3.7-4.2	2	.75 (19.1)	.75 (19.1)	.045 (1.2)	.54 (13.7)	.20 (5.1)	0	.25 (6.4)	.21 (6)	S4382	S4357
4.2-4.4	2	.75 (19.1)	.75 (19.1)	.045 (1.2)	.54 (13.7)	.20 (5.1)	0	.25 (6.4)	.21 (6)	S44103	S44100
4.4-5.0	1	.62 (15.8)	-	.04 (1.0)	.54 (13.7)	.20 (5.1)	0	-	.18 (5)	S4440	S4439
5.0-5.3	1	.62 (15.8)	-	.04 (1.0)	.49 (12.4)	.20 (5.1)	0	-	.18 (5)	S4441	S4442
5.4-5.9	1	.62 (15.8)	-	.04 (1.0)	.49 (12.4)	.20 (5.1)	0	-	.18 (5)	S4444	S4443
5.9-6.45	1	.62 (15.8)	-	.04 (1.0)	.31 (7.9)	.20 (5.1)	0	-	.14 (4)	S4445	S4446
6.4-7.125	1	.62 (15.8)	-	.04 (1.0)	.40 (10.2)	.24 (6.1)	0	-	.08 (2)	S44102	S44114
6.0-8.0	1	.62 (15.8)	-	.04 (1.0)	.50 (12.7)	.175 (4.4)	0	-	.11 (3)	-	S44120[2]
7.25-7.75	1	.45 (11.4)	-	.03 (.8)	.26 (6.6)	.20 (5.1)	.20 (5.1)	-	.11 (3)	S4447	S4448
7.125-7.725	2	.45 (11.4)	.45 (11.4)	.025 (.8)	.28 (7.1)	.13 (3.3)	.13 (3.3)	.125 (3.3)	.03 (1)	-	S44124
7.9-8.4	2	.45 (11.4)	.45 (11.4)	.03 (.8)	.32 (8.1)	.23 (5.8)	0	-	.03 (1)	-	S44115
7.9-8.4	1	.45 (11.4)	-	.03 (.8)	.26 (6.6)	.20 (5.1)	.20 (5.1)	-	.11 (3)	S4452	S4449
8.5-9.6	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.20 (5.1)	.20 (5.1)	.125 (3.3)	.07 (2)	S4565	S4566

Notes
1. Insertion loss 0.5 dB, isolation 18 dB, VSWR 1.3:1 max.
2. Insertion loss 1.0 dB, isolation 18 dB VSWR 1.3:1.
3 Insertion loss 1.0 dB, isolation 15 dB, VSWR 1.5:1 max.
4. Insertion loss 0.6 dB, isolation 18 dB, VSWR 1.5:1 max.
5. Insertion loss 0.5 dB, isolation 17 dB, VSWR 1.4:1 max.

* Standard circulation direction is clockwise. For reverse circulation and other frequency options, contact factory.
Standard metallization is thin film. For thick film gold or thick film silver, contact factory.

Specifications

Freq. (GHz)	Config.	A ±.002	B ±.002	C ±.001	D Max.	E Max.	F Max.	G ±.010	Weight Ounces Max. (Grams)	Circu-lator Model No.*	Iso-lator Model No.*
		Dimensions Inches (mm)									
9.0-10.1	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.20 (5.1)	.20 (5.1)	.125 (3.3)	.07 (2)	S4567	S4568
9.5-10.5	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.20 (5.1)	.20 (5.1)	.125 (3.3)	.07 (2)	S4596	S45114
10.6-11.7	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.20 (5.1)	.20 (5.1)	.125 (3.3)	.07 (2)	S4571	S4572
11.4-12.4	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.20 (5.1)	.20 (5.1)	.125 (3.3)	.07 (2)	S4577	S4573
11.8-13.0	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.12 (3.0)	.09 (2.3)	.125 (3.3)	.04 (1)	-	S4651[1]
12.0-13.0	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.25 (6.4)	.12 (3.0)	.09 (2.3)	.125 (3.3)	.04 (1)	-	S4657
12.2-16.9	2	.40 (10.2)	.40 (10.2)	.015 (.5)	.17 (4.3)	.09 (2.3)	.09 (2.3)	.06 (1.5)	.04 (1)	-	S4652[3]
12.5-14.5	2	.25 (6.4)	.30 (7.6)	.015 (.5)	.17 (4.3)	.10 (2.5)	.10 (2.5)	.10 (2.5)	.04 (1)	S4645[5]	-
12.8-13.8	2	.35 (8.9)	.40 (10.2)	.025 (.8)	.275 (7.0)	.125 (3.0)	.10 (2.5)	.125 (3.3)	.04 (1)	-	S4658
14.0-14.5	2	.25 (6.4)	.30 (7.6)	.015 (.5)	.18 (4.6)	.09 (2.3)	.09 (2.3)	.10 (2.5)	.04 (1)	S4636	S4635
14.5-15.5	2	.25 (6.4)	.30 (7.6)	.015 (.5)	.18 (4.6)	.09 (2.3)	.09 (2.3)	.10 (2.5)	.04 (1)	S4633	S4643
15.5-17.5	2	.25 (6.4)	.30 (7.6)	.015 (.5)	.18 (4.6)	.09 (2.3)	.09 (2.3)	.10 (2.5)	.04 (1)	S4662[4]	-
15.5-17.5	2	.25 (6.4)	.30 (7.6)	.015 (.5)	.17 (4.3)	.09 (2.3)	.07 (1.8)	.10 (2.5)	.04 (1)	-	S4641[4]

Notes
1. Insertion loss 0.5 dB, isolation 18 dB, VSWR 1.3:1 max.
2. Insertion loss 1.0 dB, isolation 18 dB VSWR 1.3:1.
3. Insertion loss 1.0 dB, isolation 15 dB, VSWR 1.5:1 max.
4. Insertion loss 0.6 dB, isolation 18 dB, VSWR 1.5:1 max.

* Standard circulation direction is clockwise. For reverse circulation and other frequency options, contact factory.
Standard metallization is thin film. For thick film gold or thick film silver, contact factory.

Circuit Mounting Details

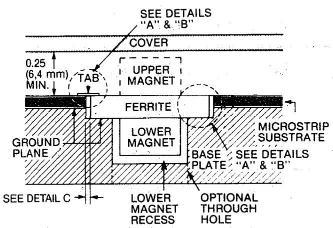
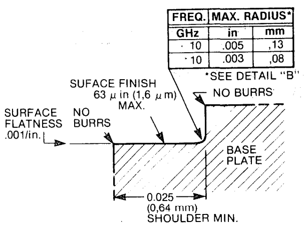
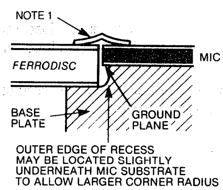


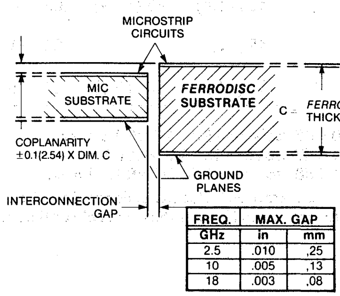
FIGURE 1.



DETAIL A.



DETAIL B.



DETAIL C. Interconnection Gap & Coplanarity Requirements

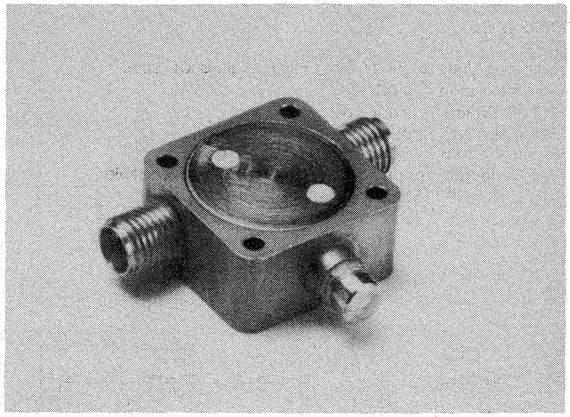
NOTES:
1. Tab should be bent slightly to allow for thermal expansion effects.
2. Linear coefficient of thermal expansion for *Ferrodisc* substrate 8-9 ppm/°C.

Specifications Subject to Change Without Notice.

Magnetically Shielded Circulators & Isolators

Features

- Magnetically Shielded
- Small Size, Light Weight
- Low Cost
- Miniature Coaxial Packages Available
- Choice of Round, Flange, Square or Drop-in Package
- Standard, Octave and Multi-octave Bandwidths from 0.4 to 18 GHz

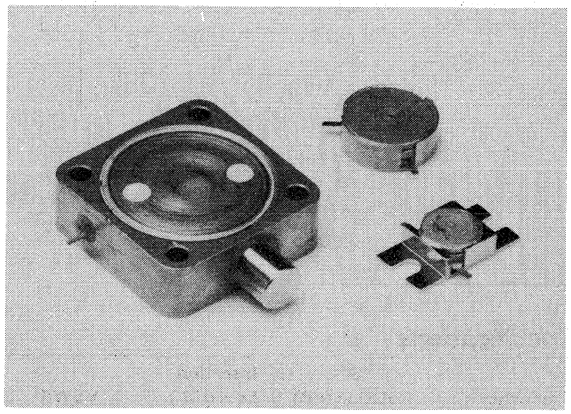


Description

M/A-COM's magnetically shielded circulators and isolators are miniaturized rugged components. The solid magnetic stainless steel housing provides unique ruggedness and reliability as well as exceptional magnetic shielding. Ferrodisc frequencies, octave, multi-octave and custom 5% bandwidths are available. Contact factory for details.

Drop-in circulators and isolators, manufactured by M/A-COM are well suited for all types of microwave integrated circuits (MIC's). These devices are available in square, flanged and round configurations for direct integration into microstrip or stripline circuits. The various packages facilitate mounting using mounting screws, soft solder or conductive epoxy.

Contact factory for complete specifications and outline drawings.



Specifications Subject to Change Without Notice.

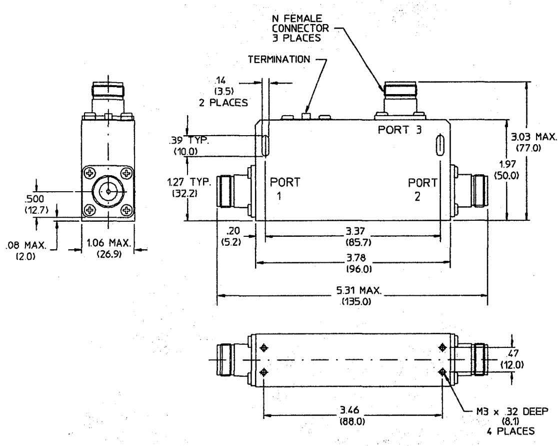
4-Port Cellular Circulators & Isolators

Features

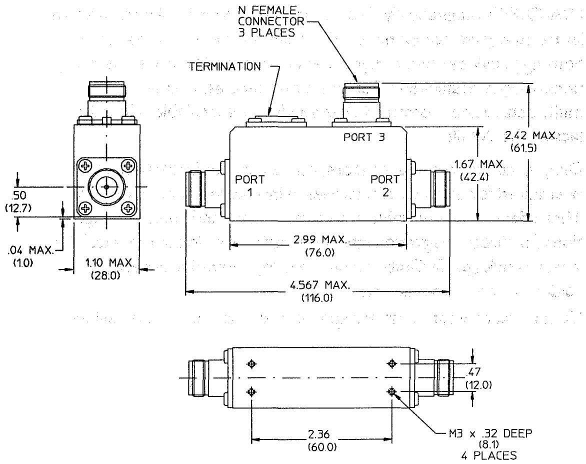
- Standard Units to 200W CW[5]. Higher values available.
- 60 dB Isolation Typical
- 0.3 dB Typical Insertion Loss
- SMA, N, TNC, SMB Connectors and Drop-In Configurations Available
- 3rd Order Intermodulation As Low As -75 dBc Available
- -10°C to +60°C Standard Temperature.[6]

Description

M/A-COM's circulators and isolators designed for cellular applications feature high performance at low cost. In addition to the products shown, M/A-COM offers specific designs to meet difficult harmonic and intermodulation distortion specifications. Consult the factory for engineering assistance in this critical area.



Config. 1



Config. 2

Specifications

Frequency Range (MHz)[8]	Isolation (dB) Typ./Min.	Insertion Loss (dB) Typ./Max.	VSWR Typ./Max.	Power[7] W CW	Config.	Conn. Type[1]	Circulator[2] Model No.
400-500[4]	60/55	.20/.40	1.10/1.15	200	1	N	7R192
405-455	55/50[3]	.35/.50	1.20/1.25	200	1	N	7R190
450-500	55/50[3]	.35/.50	1.20/1.25	200	1	N	7R191
800-1000	50/40	.5/.6	1.20/1.25	200	2	N	7R193
860-960	60/55[3]	.30/.40	1.10/1.20	200	2	N	7R195
1790-1900	60/55[3]	.30/.40	1.15/1.25	200	2	N	7R196

1. These configurations are standard. Connectors are female type. Many combinations of connectors and tabs are available. Consult the factory for specifications and part numbers.
2. Contact the factory for isolator part numbers and specifications.
3. Isolation: 45 dB Min. at temperature extremes.
4. 5% Bandwidth
5. Higher CW power levels available with special heat sink and termination options.
6. Contact the factory for other temperature ranges.
7. Power level subject to connector type.
8. Contact factory for other frequency ranges.

Specifications Subject to Change Without Notice.

3-Port Cellular Circulators and Isolators

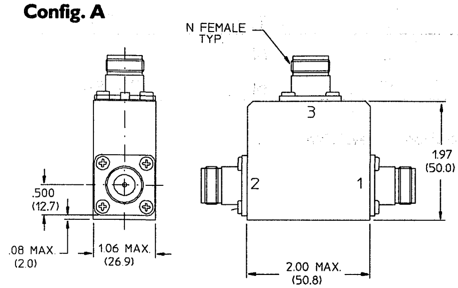
Features

- Standard Units to 200W CW[4]. Higher values available.
- 0.2 dB Typical Insertion Loss
- SMA, N, TNC, SMB Connectors and Drop-In Configurations Available
- 3rd Order Intermodulation As Low As -75 dBc Available
- -10°C to +60°C Standard Temperatures.[5]

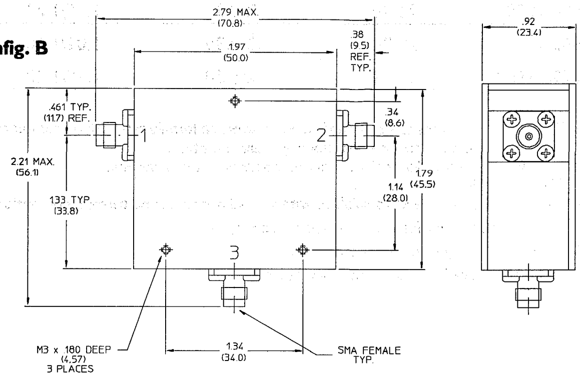
Description

M/A-COM's circulators and isolators designed for cellular applications feature high performance at low cost. In addition to the products shown, M/A-COM offers specific designs to meet difficult harmonic and intermodulation distortion specifications. Consult the factory for engineering assistance in this critical area.

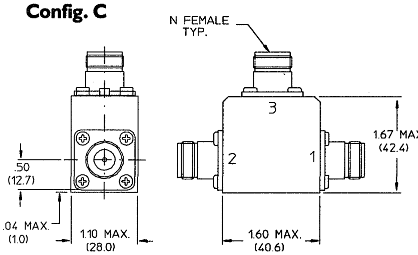
Config. A



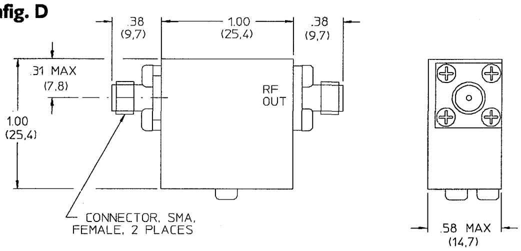
Config. B



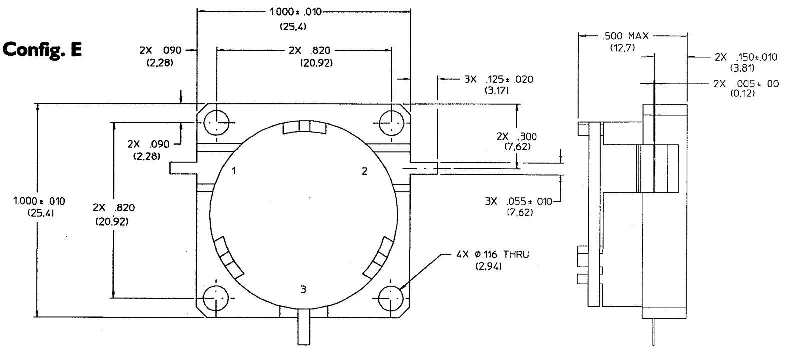
Config. C



Config. D



Config. E



Specifications Subject to Change Without Notice.

Specifications

Frequency Range (MHz)[7]	Isolation (dB) Typ./Min.	Insertion Loss (dB) Typ./Max.	VSWR Typ./Max.	Power[6] W CW	Outline	Conn. Type[1]	Circulator[2] Model No.
367-400	23/20	.3/.4	1.15/1.20	200	A	N	7N189
400-500[3]	30/26	.20/.25	1.10/1.15	200	A	N	7N192
405-455	26/24	.25/.3	1.10/1.20	200	A	N	7N190
450-500	26/24	.25/.3	1.10/1.20	200	A	N	7N191
760-960	25/20	.40/.50	1.20/1.25	200	B	SMA	7N197
800-1000	25/20	.25/.30	1.15/1.20	200	C	N	7N193
800-1000[3]	28/25	.15/.20	1.08/1.10	200	C	N	7N194
850-1000[3]	24/20	.25/.35	1.15/1.20	50	D	SMA	7N205
850-1000[3]	24/20	.25/.35	1.15/1.20	50	E	Tab	7N256
860-960	28/24	.20/.30	1.01/1.20	200	C	N	7N195
1790-1900	28/24	.20/.30	1.15/1.20	200	C	N	7N196

1. These configurations are standard. Connectors are female type. Many combinations of connectors and tabs are available Consult the factory for specifications and part numbers.
2. Contact the factory for isolator part numbers and specifications.
3. 5% Bandwidth
4. Higher CW power levels available. with special heat sink and termination options.
5. Contact the factory for other temperature ranges.
6. Power level subject to connector type.
7. Contact factory for other frequency ranges.

M/A-COM

3-Port Coaxial Circulators & Isolators

Features

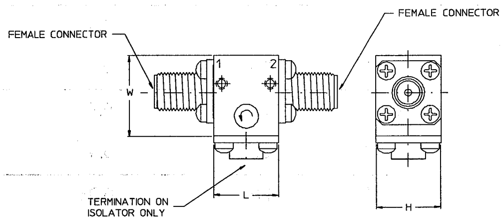
- Narrow and Broadband Designs
- SMA, N, TNC Connectors and Drop-in Configurations Available

Description

The standard units have female connectors. When used as an isolator, and internal 60 W peak, 1 W average termination is employed. Options such as termination type and location, temperature performance, RF and magnetic shielding and direction of circulation are available. Consult the factory with your requirements.

Outline Drawing Dimensions

Outline	Dimensions Inches (mm) L	W	H
A	2.00 (50.8)	2.00 (50.8)	0.75 (19.1)
B	1.38 (35.1)	1.38 (35.1)	0.75 (19.1)
C	1.00 (25.4)	1.00 (25.4)	0.50 (12.7)
D	0.75 (19.1)	0.75 (19.1)	0.50 (12.7)
E	0.50 (12.7)	0.63 (41.3)	0.50 (12.7)
F	1.77 (45.0)	1.97 (50.0)	1.18 (30.0)
G	2.00 (50.8)	2.00 (50.8)	1.00 (25.4)
H	1.81 (46.0)	2.31 (58.7)	1.22 (31.0)
I	3.00 (76.2)	3.00 (7.62)	1.13 (28.7)
J	2.75 (69.9)	2.85 (72.4)	0.88 (22.4)
L	1.63 (41.4)	1.63 (41.4)	0.75 (19.1)
N	1.78 (45.2)	1.78 (45.2)	0.84 (21.3)
O	1.00 (25.4)	1.00 (25.4)	0.50 (12.7)



Narrow Band Specifications

Frequency (GHz)	Temp. (°C)	Isolation (dB) Min.	Insertion Loss (dB)Max.	VSWR Max.	Outline	Conn. Type	Circulator Model No.	Isolator Model No.
.50-.56	-30° to +71°	20	0.4	1.25	A	SMA	M3A-530	M2A-530
.53-.60	-30° to +71	20	0.4	1.25	A	SMA	M3A-565	M2A-565
.570-.645	-30° to +71	20	0.4	1.25	A	SMA	M3A-605	M2A-605
.61-.69	-30° to +71	20	0.4	1.25	A	SMA	M3A-650	M2A-650
.655-.745	-30° to +71	20	0.4	1.25	A	SMA	M3A-700	M2A-700
.695-.795	-30° to +71	20	0.4	1.25	A	SMA	M3A-745	M2A-745

Specifications Subject to Change Without Notice.

Narrow Band Specifications

Frequency (GHz)	Temp. (°C)	Isolation (dB) Min.	Insertion Loss (dB) Max.	VSWR Max.	Outline	Conn. Type	Circulator Model No.	Isolator Model No.
.755-.865	-30° to +71°	20	0.4	1.25	A	SMA	M3A-810	M2A-810
.82-.96	-30° to +71°	20	0.4	1.25	A	SMA	M3A-890	M2A-890
.91-1.05	-30° to +71°	20	0.4	1.25	A	SMA	M3A-980	M2A-980
.96-1.10	-30° to +71°	20	0.4	1.25	B	SMA	M3B-1030	M2B-1030
1.045-1.200	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1122	M2B-1122
1.14-1.32	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1230	M2B-1230
1.2-1.4	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1300	M2B-1300
1.295-1.500	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1395	M2B-1395
1.425-1.650	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1537	M2B-1537
1.57-1.80	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1685	M2B-1685
1.65-1.85	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1750	M2B-1750
1.7-1.9	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1800	M2B-1800
1.7-2.3	*	20	0.3	1.20	H	N	7K233	-
1.7-2.4	*	20	0.3	1.20	I	N	7K125	-
1.8-2.0	-20° to +71°	20	0.4	1.25	B	SMA	M3B-1900	M2B-1900
1.9-2.3	*	20	0.4	1.25	B	SMA	M3B-2100	M2B-2100
2.0-2.3	*	20	0.35	1.25	C	SMA	M3C-2150	M2C-2150
2.1-2.4	-20° to +71°	20	0.35	1.25	C	SMA	M3C-2250	M2C-2250
2.3-2.6	-20° to +71°	20	0.35	1.25	C	SMA	M3C-2450	M2C-2450
2.5-2.9	-20° to +71°	20	0.35	1.25	C	SMA	M3C-2700	M2C-2700
2.7-3.1	-20° to +71°	20	0.35	1.25	C	SMA	M3C-2900	M2C-2900
2.9-3.5	-20° to +71°	20	0.35	1.25	C	SMA	M3C-3200	M2C-3200
3.2-4.0	-20° to +71°	20	0.35	1.25	C	SMA	M3C-3600	M2C-3600

* Contact factory.

Narrow Band Specifications

Frequency (GHz)	Temp. (°C)	Isolation (dB) Min.	Insertion Loss (dB) Max.	VSWR Max.	Outline	Conn. Type	Circulator Model No.	Isolator Model No.
3.7-4.5	-20° to +71°	20	0.3	1.25	D	SMA	M3D-4100	M2D-4100
4.0-5.0	-20° to +71°	20	0.3	1.25	D	SMA	M3D-4500	M2D-4500
4.4-5.5	-20° to +71°	20	0.3	1.25	D	SMA	M3D-4950	M2D-4950
5.0-6.0	-20° to +71°	20	0.3	1.25	D	SMA	M3D-5500	M2D-5500
5.0-6.0	-20° to +71°	20	0.35	1.25	E	SMA	M3E-5500	M2E-5500
5.7-6.8	-20° to +71°	20	0.35	1.25	E	SMA	M3E-6250	M2E-6250
6.55-7.85	-20° to +71°	20	0.35	1.25	E	SMA	M3E-7200	M2E-7200
7.5-9.0	-20° to +71°	20	0.35	1.25	E	SMA	M3E-8250	M2E-8250
8.4-10.0	-20° to +71°	20	0.35	1.25	E	SMA	M3E-9200	M2E-9200
9.5-12.0	-20° to +71°	20	0.4	1.25	E	SMA	M3E-10750	M2E-10750
12.4-15.0	-20° to +71°	18	0.7	1.40	E	SMA	M3E-13700	M2E-13700
14.0-16.5	-20° to +71°	18	0.7	1.40	E	SMA	M3E-15250	M2E-15250
15.0-18.0	-20° to +71°	18	0.7	1.40	E	SMA	M3E-16500	M2E-16500

Broadband Specifications

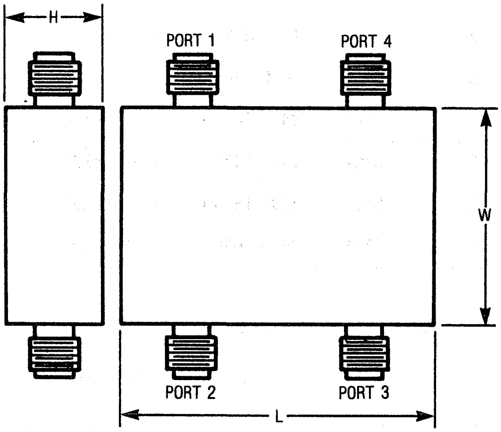
Frequency (GHz)	Temp. (°C)	Isolation (dB) Min.	Insertion Loss (dB) Max.	VSWR Max.	Outline	Conn. Type	Circulator Model No.	Isolator Model No.
	0°	15	0.6	1.40				
1.0-2.0	+25°	16	0.5	1.30	J	SMA[1]	M3G-1500	M2G-1500
	+71°	15	0.5	1.50				
	0°	17	0.5	1.35				
2.0-4.0	+25°	18	0.4	1.25	L	SMA[1]	M3G-3000	M2G-3000
	+71°	17	0.4	1.35				
	-20°	17	0.6	1.35				
2.6-5.2	+25°	20	0.4	1.25	N	SMA[1]	M3G-4400	M2G-4400
	+71°	18	0.4	1.30				
	-20°	17	0.4	1.30				
4.0-8.0	+25°	18	0.4	1.25	O	SMA[1]	M3G-6000	M2G-6000
	+71°	17	0.4	1.30				
	-20°	17	0.6	1.35				
8.0-16.0	+25°	18	0.6	1.35	Q	SMA[1]	M3G-12000	M2G-12000
	+85°	17	0.6	1.35				

1. Contact factory for TNC and N connector options.

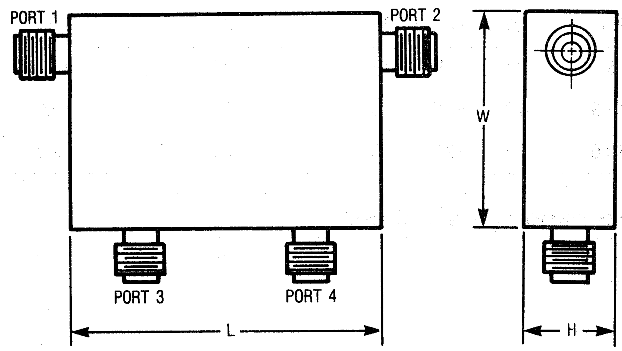
4-Port Coaxial Circulators

Features

- High Isolation
- 396 MHz to 12.0 GHz
- 0° to +60°C Temperature Range
- 50 Watt Average Power
- Female Connectors Standard - SMA, N or TNC



"H" CONFIGURATION



"π" CONFIGURATION

Specifications

Frequency (GHz)	Isolation (dB Min.) 2-1 4-3	3-2 1-4	Insertion Loss (dB Max.) 1-2 3-4	2-3 4-1	VSWR Max.	Dimensions Inches (mm) L	W	H	Config.	Conn. Type	Circulator Model No.
.39-.41	26	40	0.4	0.8	1.15	4.25 (108.0)	2.19 (114.3)	1.25 (31.8)	H	SMA	7M478
.95-1.22	40	—	0.8	—	1.25	3.45 (87.6)	1.86 (47.2)	.90 (22.9)	π	SMA	7M392
1.0-2.0	18	35	0.4	0.8	1.30	7.00 (177.8)	3.50 (88.9)	1.23 (31.2)	H	SMA	7M034

Specifications Subject to Change Without Notice.

Specifications Continued

Frequency (GHz)	Isolation (dB Min.) 2-1 4-3	3-2 1-4	Insertion Loss (dB Max.) 1-2 3-4	2-3 4-1	VSWR Max.	Dimensions Inches (mm) L	W	H	Config.	Conn. Type	Circulator Model No.
1.42-1.65	—	37	—	0.8	1.20	3.62 (91.9)	2.10 (53.3)	1.20 (30.5)	π	SMA	7M406
1.48-1.61	37	—	0.8	—	1.20	3.37 (88.6)	1.75 (44.5)	1.00 (25.4)	π	SMA	7M518
1.48-1.61	40	—	0.8	—	1.20	3.37 (88.6)	1.75 (44.5)	1.00 (25.4)	π	SMA	7M414
1.60-1.72	37	—	0.8	—	1.20	2.25 (57.6)	1.17 (29.7)	1.00 (25.4)	π	SMA	7M421
1.64-1.72	40	—	0.8	—	1.20	3.37 (85.6)	1.75 (44.5)	1.00 (25.4)	π	SMA	7M515
1.70-1.80	37	—	0.8	—	1.20	2.25 (57.6)	1.17 (29.7)	1.00 (25.4)	π	SMA	7M399
1.78-1.99	37	—	0.8	—	1.20	2.25 (5.76)	1.17 (29.7)	1.00 (25.4)	π	SMA	7M386
1.97-2.15	—	40	—	0.8	1.25	2.75 (69.9)	1.38 (35.1)	0.80 (20.3)	π	TNC	7M384
1.97-2.26	37	—	0.8	—	1.20	2.25 (57.6)	1.17(29.7)	1.00 (25.4)	π	SMA	7M394
2.15-2.30	—	40	—	0.8	1.25	2.75 (69.9)	1.38 (35.1)	0.80 (20.3)	π	TNC	7M400
2.19-2.37	37	—	0.8	—	1.20	2.25 (57.6)	1.17(29.7)	1.00 (25.4)	π	SMA	7M395
3.7-4.2	20	40	0.3	0.5	1.10	4.25 (108.0)	2.19 (55.6)	1.25 (31.8)	H	N	H-415-421
4.0-8.0	37	—	0.8	—	1.30	3.06 (77.7)	2.06 (52.3)	1.25 (31.8)	H	N	R-411-354
8.0-12.0	37	—	0.8	—	1.30	2.12 (53.8)	1.56 (39.6)	1.25 (31.8)	π	N	R-422-355

Specifications Subject to Change Without Notice.

M/A-COM

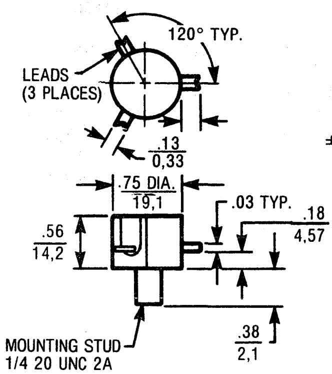
Low Frequency Gyrators

Features

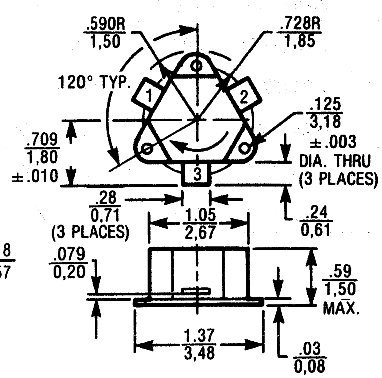
- 200 Ohm Impedance
- 50 Watts Average Power
- -50°C to +70°C Operating Temperature
- 3% to 5% Standard Bandwidth Within Specified Frequency Range

Description

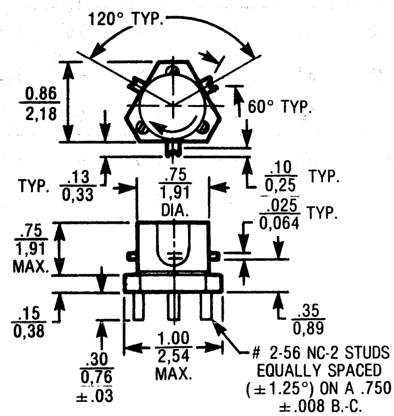
Gyrators are inexpensive non-reciprocal circuit elements which perform as circulators in the appropriate matching network.



OUTLINE A



OUTLINE B



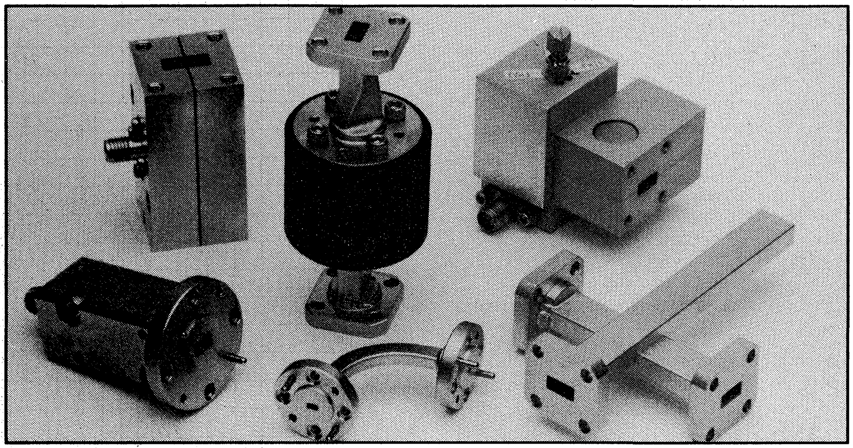
OUTLINE C

Specifications

Frequency (MHz)	Isolation (dB)	Insertion Loss (dB Max.)	Outline Drawing	Model No.
100-200	20	1.5	A	G2
200-400	20	1.0	A	G1
300-600	20	1.2	A	G3
570-770	20	.8	B	7A230
350-367	20	1.2	C	7A203

Specifications Subject to Change Without Notice.

Millimeter Wave Components



Title | Page

Millimeter Wave Components

Overview

Millimeter Wave Capabilities and Facilities

Specialized millimeter wave components covering a wide variety of devices, including oscillators, attenuators, terminations, couplers, as well as standard catalog devices, are developed by a fully staffed engineering department supported by the latest automated design equipment.

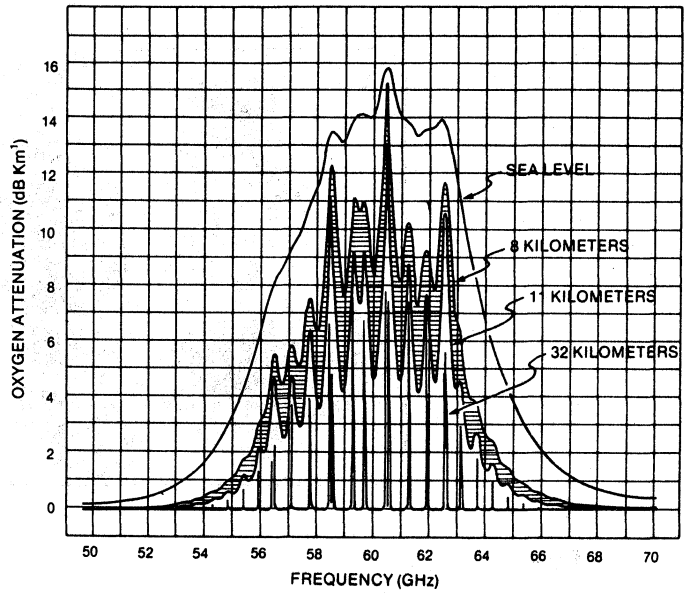
The vertically integrated state-of-the-art facility has the capability to produce the industry's broadest lines of millimeter wave components, covering the frequency spectrum from 18 to 325 GHz.

Vertical integration provides complete in-house control of every operation from design and development to fabrication, assembly and test.

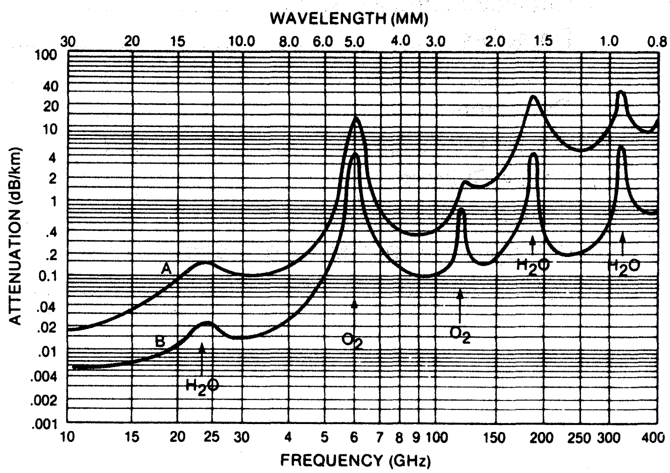
This capability enables M/A-COM to produce a range of low-cost, high quality products for commercial applications through High Reliability products produced to withstand the severe environmental conditions associated with space flight.

R&D/Engineering

The sophistication of present-day systems places an ever-increasing demand on engineering for the definition and mechanization of state-of-the-art techniques and products. M/A-COM's fully staffed engineering and design department is constantly engaged in the development of new products as well as improvements on present products.



OXYGEN ATTENUATION FOR VARIOUS ELEVATIONS IN THE EARTH'S ATMOSPHERE



AVERAGE ATMOSPHERIC ABSORPTION OF MILLIMETER WAVES.

A: SEA LEVEL
T = 20°C
P = 760 MM
P_{H_2O} = 7.5 GR/M^3

B: 4 KM
T = 0°C
P_{H_2O} = 1 GR/M^3

Specifications Subject to Change Without Notice.

Millimeter Wave Subassemblies

Overview

Choice of Transmission Line Media

In millimeter wave integrated circuit assemblies as in conventional integrated circuit assemblies, the choice of media is a major factor in terms of technical success and cost effectiveness. M/A-COM has a long history of working with all transmission line media and incorporating multi-media techniques when this is appropriate to improve the performance of an integrated subassembly. Millimeter wave subassemblies are currently being built using suspended substrate stripline, solid microstrip and dielectric stripline, ceramic and low dielectric microstrip, as well as planar integrated waveguide techniques in what we refer to as WIP (Waveguide Integrated Package). Examples of millimeter wave integrated subassemblies using all of these techniques are shown in the accompanying photographs.

Figure 1 shows a block diagram of a compact high-performance 24 GHz FM CW radar transceiver assembly which has been developed at M/A-COM for a commercial automotive application. The design approach taken enabled the transceiver to be compact in size, adaptive, and highly reliable, with the potential for low cost in high volume production runs like those required by the automotive industry. Critical components were the balanced mixer, Gunn VCO, and the LO feed network. These components are designed to minimize AM distortion in the system and allow for the customer processing circuitry to eliminate the small linearly varying portions of AM distortion produced within the radar. The next generation transceiver design will further improve the FM CW performance, reduce the overall parts count and greatly reduce the unit cost.

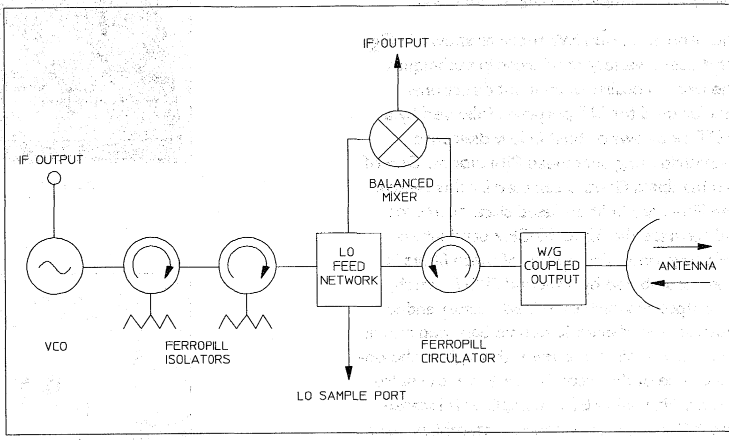


Figure 1. System Block Diagram

Scanning Transceiver

Figure 2 shows a 2 by 64 element scanning transceiver. This unit takes 128 separate radiating outputs and switches them in a scanning sequence. This unit is an excellent example of M/A-COM's multi-faceted technical ability since it includes logic, control circuits, microwave switches with drivers and the distribution network driving the 35 GHz radiating elements.

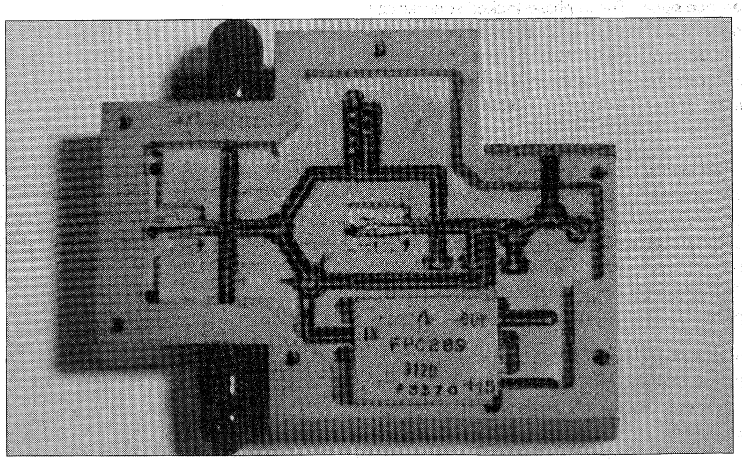


Figure 2. 2 x 64 Element Ka-Band Scanning Transceiver

35 GHz Beacon Transceiver

Figure 3 is a good example of a microstrip transceiver used as an airborne beacon. This unit includes switched outputs, local oscillator, BITE detector/filter, balanced mixer, switched load, circulator, isolators and a miniature IF amplifier. Again, this is an example of a multi-function circuit that utilizes printed circuit technology and a simple housing for low cost.

The band extension EW receiver shown in Figure 4 uses a variety of microstrip techniques. The circuit consists of an input directional coupler used for BIT purposes followed by a SPDT diode switch built in low dielectric microstrip using beam lead PIN diodes. One of two bandpass filters is selected by this switch. The filters are built on fused silica microstrip and separate the 32 to 40 GHz band into 4 GHz segments. The output of these filters is then recombined by a second SPDT switch, the output of which then feeds a suspended substrate low dielectric double balanced mixer. The IF from this mixer feeds through to the opposite side of the assembly where a low noise 4 to 8 GHz GaAs FET preamplifier is located. This MIC illustrates wideband assemblies being built for EW applications.

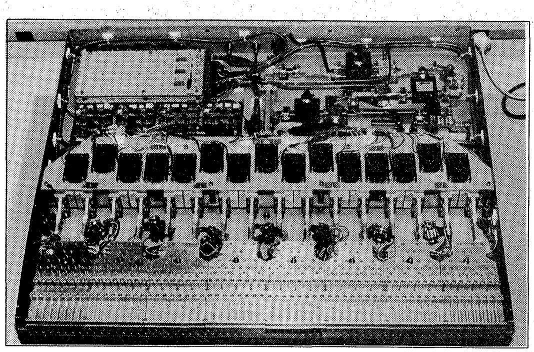


Figure 3. 35 GHz Beacon Transceiver

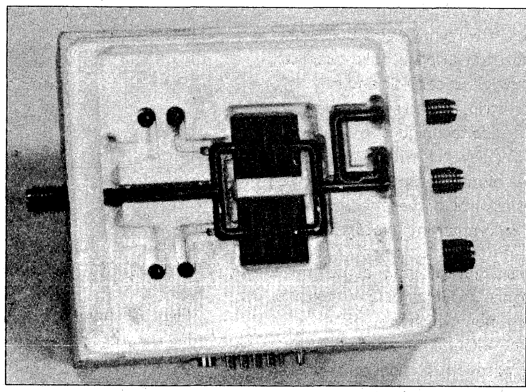


Figure 4. EW Receiver (Band Extension Front-End)

Phased Locked Oscillators

M/A-COM's millimeter wave phase-locked sources utilize state-of-the-art design approaches yielding superior performance while minimizing size and reducing cost.

These units consist of a GaAs or InP Gunn diode oscillator and all the necessary circuitry for locking them to a low frequency crystal reference signal. These phase-locked sources can provide 200 mW of output power at 35 GHz and up to 60 mW at 94 GHz. The phase noise is determined by the integral reference oscillator, or by an external customer supplied source.

Used in local oscillators for receivers, coherent systems, multi-channel communication synthesizers and instrumentation, or any other application between 18 and 140 GHz that requires high stability and/or low phase noise. These sources can be made extremely compact.

In addition to the phase-locked sources, M/A-COM also offers a wide range of custom millimeter wave injection-locked sources and amplifiers.

Summary

These brief examples of millimeter wave integrated subassemblies have been chosen to illustrate the breadth of techniques and resources available at M/A-COM and our dedication to subassembly and integrated circuit fabrication. Our experience in complex microwave and millimeter wave subassemblies is unparalleled in the industry. Let us put it to work for you.

Millimeter Wave Antennas

Overview

M/A-COM designs, builds and tests specialty antennas that are characterized by their thin profiles and usually printed circuit or miniature waveguide feeds. These antennas are usually part of a transceiver or custom circuit and are an integral part of the system's packaging concept; i.e. conformal designs that blend in with the user's required structure (bumper, grill, aircraft skin, etc.). Examples include:

- 35 GHz Patch Array
- 24 GHz Patch Array
- 77 GHz Tri Beam Array
- 35 GHz Flat Plate Antennas
- 35 GHz Monopulse Waveguide Integrated Package
- 94 GHz Monopulse Front End

Millimeter wave antennas from Ka- to D-band have also been developed. These include a V-band waveguide slot array in a 4" x 4" configuration, a Ka-band offset fed reflector with adjustable beam widths and low side lobes, as well as W-band and D-band high gain cassegrain reflectors with spinning sub-reflectors for tracking purposes. Additional Ka-band slot arrays include a 5.4 inch diameter antenna with four subarrays as well as an 8 inch diameter antenna with 16 subarrays. This type of slot array has many advantages for millimeter wave applications because of its low profile, high efficiency, very low loss and flat construction.

Low dielectric microstrip was the medium of choice for the 35 GHz FM CW antenna and transceiver assembly. The printed circuit array antenna is fed by a microstrip feed network connected to Gunn oscillator, ferrite circulator, and single ended mixer transceiver assembly mounted to the edge of the antenna. The antenna is only .005" thick and is backed up by a foam core support for lightweight construction.

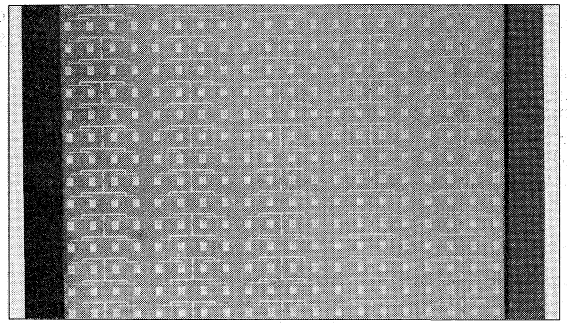


Figure 1. 24 GHz Patch Array

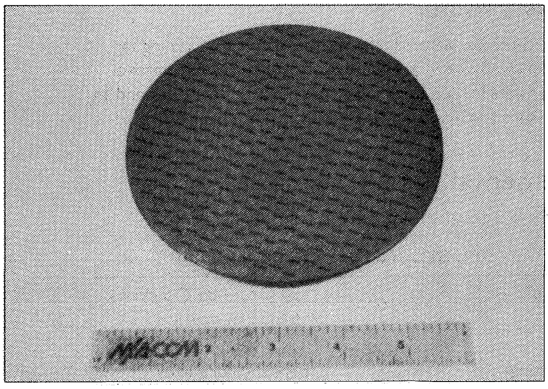


Figure 2. 35 GHz Flat Plate Antenna

Electronically Tuned Gunn Oscillators 18-140 GHz

6 (WG) V Series

Features

- GaAs or InP
- Electronic Tuning to 4 GHz
- Excellent Linearity
- Output Power to 200 mW
- Small and Lightweight
- Optional Mechanical Tuning
- 15 or 28 Vdc Temperature Controller Available

Description

These varactor tuned Gunn oscillators are designed to generate RF power in the 18 to 140 GHz range while allowing electronic tuning by suitably coupling an abrupt or hyberabrupt GaAs varactor with a Gunn diode (GaAs or InP) in a single cavity. Standard models achieving 1% linearity, while producing 200 mW at 35 GHz and over 50 mW at 94 GHz, are used in FMCW radar transceivers, communication links, collision avoidance radars, AFC loops and phase locked systems. Broadband models used for instrumentation and laboratory testing allow electronic tuning of over 4 GHz with center frequencies up to 100 GHz.

Options with these oscillators include some mechanical tuning for course frequency adjustment, temperature controller to improve the frequency stability due to change in ambient temperature and an isolator to reduce the frequency pulling caused by changes in load VSWR.

Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Condition
Temperature Cycle	202	102A	-50°C to +85°C 5 cycles, ½ hour per cycle
Acceleration (Non-Operating)	202	212	11G, three mutually perpendicular axes
Vibration (High Freq.)	202	204B	10G Peak, 10-2000 Hz

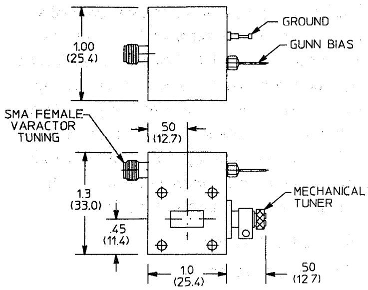
Maximum Ratings

Storage Temp.	-50°C to +85°C
Operating Temp.[1]	-30°C to +70°C

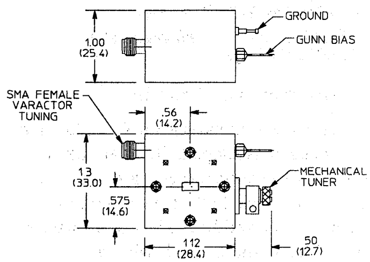
Notes:

1. Units will operate from -30°C to +70°C although specifications listed above are guaranteed only between 0°C and +50°C. Broader temperature units are available. Test data measured at a case temperature of 30 ± 5°C is provided with each unit.

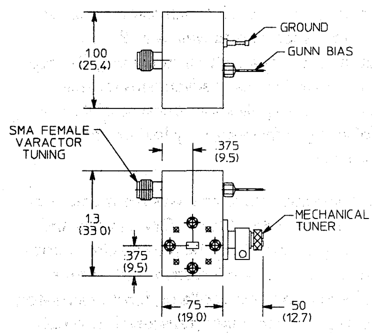
6-42V & 6-28V Series



6-22V & 6-19V Series



6-15V, 6-12V, 6-10V, 6-08V Series



Dimensions apply to standard models only. Consult factory regarding other models.

Specifications at T_C 30°C[1,3]

Frequency (GHz)[2]	Output Power (mW) Standard	Output Power (mW) Broadband	Frequency Stability[10] (MHz/°C Max.)	Power Stability (dB/°C Max.)	dc Power (V/A Max.) GaAs	dc Power (V/A Max.) InP	Model No.†
18-26.5	150	70	2.0	0.03	8/1.5	N/A	6-42V-XXX-XX**
26.5-40	200	70	2.5	0.03	8/1.5	13/0.3	6-28V-XXX-XX**
33-50	150	50	3.5	0.03	7/1.5	13/0.3	6-22V-XXX-XX
40-60	100	50	4.0	0.03	7/1.5	12/0.3	6-19V-XXX-XX
50-60	100	30	5.0	0.03	6/1.5	11/0.4	6-15V-XXX-XX
60-75	70	30	5.0	0.03	6/1.5	11/0.4	
60-75	70	30	5.0	0.03	6/1.4	11/0.4	6-12V-XXX-XX
75-90	50	20	5.0	0.03	6/1.4	11/0.4	
75-95	50	20	5.0	0.03	6/1.4	11/0.4	6-10V-XXX-XX
95-110	30	10	5.0	0.03	6/1.4	11/0.4	
90-110	20	*	*	*	*	*	6-08V-XXX-XX
110-140	*	*	*	*	*	*	

*Consult factory.
**Specify tapped or thru holes for flange.

Tuning Range Options

Standard	Broadband
1: ± 100 MHz	3: ± 500 MHz
2: ± 250 MHz	4: ± 750 MHz
	5: ± 1000 MHz
	6: ± 1500 MHz
	7: ± 2000 MHz

Output Power Options

01: 10mW	07: 70mW
02: 20mW	10: 100mW
03: 30mW	12: 125mW
04: 40mW	15: 150mW
05: 50mW	20: 200mW

Other Options

F: Integrated Ferrite Isolator[6]
H: Temperature Controller[7] (15 or 28Vdc)
M: Mechanical Tuning

†How to Order

6 — (WR)V — X XX X — XX

Output Waveguide[4]
Tuning Range
Output Power
Other Options (if applicable)
Center Frequency[2]

Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-08
RF Mating Flange[4] MIL-F-3922/	54-001-M	68-001 68-002	67B-006	67B-007	67B-008	67B-009	67B-010	67B-010 MOD
UG Reference	595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M	387/U-M
Gunn Bias Connector	Feed Thru							
Tuning Port Connector	SMA Female							
Cooling	Conduction[5]							

Notes:

1. This table lists the maximum power available in the frequency ranges specified. For a specific combination of tuning range and output power, consult the factory.
2. All oscillators are supplied with a center frequency tolerance of ± 50 MHz unless otherwise stated.
3. Units will operate from -30°C and +70°C although specifications listed above are guaranteed only between 0°C to +50°C. Broader temperature units are available. Test data measured at a case temperature of 30 ± 5°C is provided with each unit.
4. Other waveguide flange patterns and custom designs are available.
5. Heat sink can be provided. Consult factory.
6. When ordered with ferrite isolator, the output power will be reduced by the isolator loss.
7. When temperature controller is ordered, the units are stabilized at 55 ± 2°C and the output power is reduced by approximately 1.0 dB.
8. For most units, the varactor tuning voltage is from 0 to +25 Vdc (max.) with respect to ground. Some designs, though, require the tuning supply to be isolated from the case ground because the varactor voltage is referenced to the Gunn bias.
9. Modulation rate is 0-80 MHz.
10. Frequency stability is improved typically by a factor of 2 with temperature compensated units.

Specifications Subject to Change Without Notice.

Mechanically Tuned Gunn Oscillators 18-140 GHz

6 (WG) M Series

Features

- GaAs or InP
- Excellent Frequency Stability
- High Output Power
- Low AM and FM Noise
- Small and Lightweight
- Standard and Broadband Tuning
- Multi-diode Combining
- 15 or 28 Vdc Temperature Controller Available

Description

These mechanically tuned Gunn oscillators are specially designed for low AM and FM noise characteristics. They combine either GaAs or InP Gunn diodes with high Q waveguide cavities to generate RF power from 28 to 140 GHz. Standard models can be provided with temperature compensation techniques that translate to superior frequency stability necessary for local oscillators in radio communications, doppler radars and many receiver sytsems. Broadband models are designed to produce the highest possible power with reliable and repeatable mechanical tuning ideally suited for laboratory use or drivers for wideband high frequency multipliers. An optional micrometer-driven tuning mechanism further enhances these oscillators by allowing convenient and reliable frequency resetting.

Other options include a temperature controller to improve the frequency stability of these oscillators due to changes in ambient temperature and an isolator which reduces the frequency pulling caused by changes in load VSWR.

Environmental

These devices are designed to meet the following conditions:

Test	MIL-STD	Method	Condition
Temperature Cycle	202	102A	-50˚C to +85˚C 5 cycles, ½ hour per cycle
Acceleration (Non-Operating)	202	212	11G, three mutually perpendicular axes
Vibration (High Freq.)	202	204B	10G Peak, 10-2000 Hz

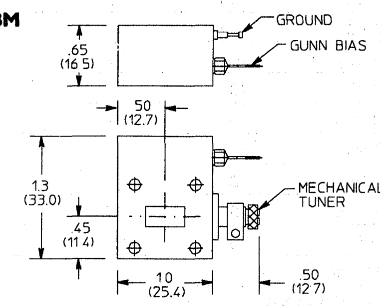
Maximum Ratings

Storage Temp.	-50˚C to +85˚C
Operating Temp.[1]	-30˚C to +70˚C

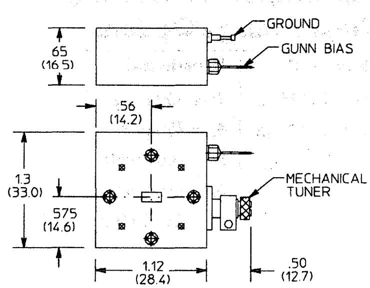
Notes:

1. Units will operate from -30˚C to +70˚C although specifications listed above are guaranteed only between 0˚C and +50˚C. Broader temperature units are available. Test data measured at a case temperature of 30 ± 5˚C is provided with each unit.

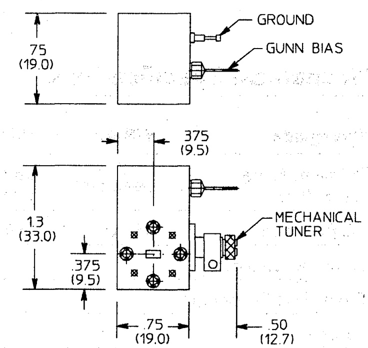
6-42M & 6-28M Series



6-22M & 6-19M Series



6-15M, 6-12M, 6-10M, 6-08M Series



Dimensions apply to standard models only. Consult factory regarding other models.

Specifications at T_C 30°C[1,3]

Frequency (GHz)[2]	Output Power (mW) Standard	Output Power (mW) Broadband	Frequency Stability[8] (MHz/°C Max.)	Power Stability (dB/°C Max.)	dc Power (V/A Max.) GaAs	dc Power (V/A Max.) InP	Model No.†
18-26.5	250	150	1.0	0.03	8/1.5	N/A	6-42M-XXX-XX**
26.5-40	300	150	1.0	0.03	8/1.5	13/0.3	6-28M-XXX-XX**
33-50	250	125	2.0	0.03	7/1.5	13/0.3	6-22M-XXX-XX
40-60	200	100	2.0	0.03	7/1.5	12/0.3	6-19M-XXX-XX
50-60	200	100	3.5	0.03	6/1.5	11/0.4	6-15M-XXX-XX
60-75	100	70	3.5	0.03	6/1.5	11/0.4	
60-75	100	70	4.0	0.03	6/1.4	11/0.4	6-12M-XXX-XX
75-90	70	40	4.0	0.03	6/1.4	11/0.4	
75-95	70	40	5.0	0.03	6/1.4	11/0.4	6-10M-XXX-XX
95-110	50	20	5.0	0.03	6/1.4	11/0.4	
90-110	30	20	*	*	*	*	6-08M-XXX-XX
110-140	*	*	*	*	*	*	

*** Consult factory.**
****Specify tapped or thru holes for flange.**

Tuning Range Options

Standard	Broadband
0: Fixed Frequency	3: ±500 MHz
1: ± 100 MHz	4: ±750 MHz
2: ±250 MHz	5: ± 1000 MHz
	6: ± 1500 MHz
	7: ± 2000 MHz

Output Power Options

01: 10mW	10: 100mW
02: 20mW	12: 125mW
03: 30mW	15: 150mW
04: 40mW	20: 200mW
05: 50mW	25: 250mW
07: 70mW	30: 300mW

Other Options

F: Integrated Ferrite Isolator[6]
H: Temperature Controller[7] (15 or 28Vdc)
M: Micrometer Tuner

†How to Order

6 — (WR)M — X XX X — XX

Output Waveguide[4]
Tuning Range
Output Power
Other Options (if applicable)
Center Frequency[2]

Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-08
RF Mating Flange[4] MIL-F-3922/	54-001-M	68-001 68-002	67B-006	67B-007	67B-008	67B-009	67B-010	67B-010 MOD
UG Reference	595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M	387/U-M
dc Connector	Feed Thru							
Cooling	Conduction[5]							

Notes:

1. This table lists the maximum power available in the frequency ranges specified. For a specific combination of tuning range and output power, consult the factory.
2. All oscillators are supplied with a center frequency tolerance of ± 50 MHz unless otherwise stated.
3. Units will operate from -30°C to +70°C although specifications listed above are guaranteed only between 0°C and +50°C. Broader temperature units are available. Test data measured at a case temperature of 30 ± 5°C is provided with each unit
4. Other waveguide flange patterns and custom designs are available.
5. Heat sink can be provided. Consult factory.
6. When ordered with ferrite isolator, the output power will be reduced by the isolator loss.
7. When temperature controller is ordered, the units are stabilized at 55 ± 2°C and the output power is reduced by approximately 1.0 dB.
8. Frequency stability is improved typically by a factor of 2 with temperature compensated units.

Pulsed Gunn Oscillators
18-60 GHz

6 (WG) P Series

Features

- Small and Lightweight
- Peak Output Power to 500mW
- Fast Rise Time

Description

The high output power, excellent frequency and power stability of these Millimeter Wave Pulsed Gunn Diode Oscillators make them ideally suited for radar transmitters, point to point digital communications links, industrial control systems as well as laboratory applications. With pulse widths of 0.05 to 2.0 microseconds and duty cycles of 0.001 to 0.01, a broad range of radar and telecommunications requirements can be satisfied from 18.0 to 60.0 GHz. Custom options include: pulse modulator with TTL command pulse input, isolators, voltage regulators, frequency stabilizing circuits, special diode screening criteria, higher power outputs, wider tuning bandwidths, waveguide sizes, chip compensation etc. Contact the factory with your requirements.

Environmental

These devices are designed to meet the following conditions:

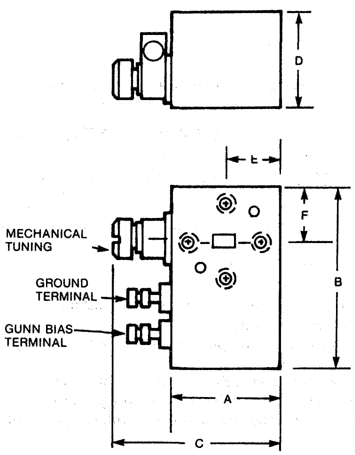
Test	MIL-STD	Method	Condition
Temperature Cycle	202	102A	-50°C to +85°C 5 cycles, ½ hour per cycle
Acceleration (Non-Operating)	202	212	11G, three mutually perpendicular axes
Vibration (High Freq.)	202	204B	10G Peak, 10-2000 Hz

Maximum Ratings

Storage Temp.	-50°C to +85°C
Operating Temp.[1]	-30°C to +70°C

Notes:
1. The operating temperature range is defined as the range of temperature over which application of the bias dc voltage will cause no degradation of the RF performance. The electrical parameters specified in the table on next page are guaranteed from 0°C to +50°C.

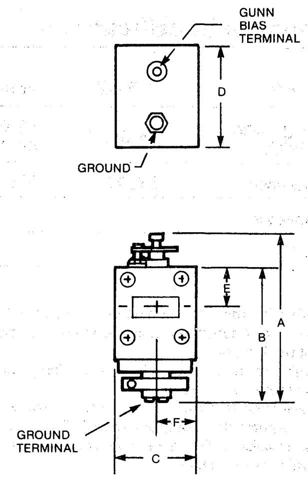
WR-42, WR-28



DIM. (Max.)	MODEL NUMBERS 6-22-808 IN	6-22-808 MM	6-15-808 IN	6-15-808 MM
A	1.12	28,4	0.76	19,3
B	1.30	33,0	1.30	33,0
C	1.65	41,9	1.30	33,0
D	0.67	17,0	0.67	17,0
E	0.56	14,2	0.38	9,7
F	0.56	14,2	0.38	9,7

DIMENSIONS. (Max.)	MODEL NUMBERS 6-42-818 6-42-819 IN	6-42-818 6-42-819 MM	6-28-818 6-28-819 IN	6-28-818 6-28-819 MM
A	1.82	46,2	1.76	43,2
B	1.50	38,1	1.36	34,5
C	0.80	20,3	0.76	19,3
D	0.93	23,6	0.75	19,1
E	0.45	11,4	0.38	9,7
F	0.40	10,2	0.38	9,7

WR-22, WR-15



Specifications Subject to Change Without Notice.

Specifications at T_C 30°C[5]

Waveguide	Frequency (GHz)[1]	Mechanical Tuning Range (MHz Min.)	Peak Power Output[2] mW	Input Current (Peak Amps. Max.)	Frequency Chirp (MHz Min)	Frequency Deviation[4] (MHz/°C Max.)	Model No.[1]
WR-42	18.0-26.5	±100	250	1.5	100	-0.4	6-42P-818XX*
WR-42	18.0-26.5	±100	500	2.5	100	-0.4	6-42P-819XX*
WR-28	26.5-40.0	±150	250	1.5	100	-0.7	6-28P-818XX*
WR-28	26.5-40.0	±150	500	2.0	100	-0.7	6-28P-819XX*
WR-22	40.0-50.0	±200	250	1.5	200	-2.0	6-22P-808XX
WR-15	50.0-60.0	±200	250	1.5	200	-3.5	6-15P-808XX

***Specify tapped or thru holes for flange.**

Common Specifications

Pulse Width	0.05 to 2.0 µsec.
Duty Cycle	0.01 to 1.0 percent
Peak Input Voltage	+20V Max.[3]
Power Deviation	-.05 dB/°C Max.[4]

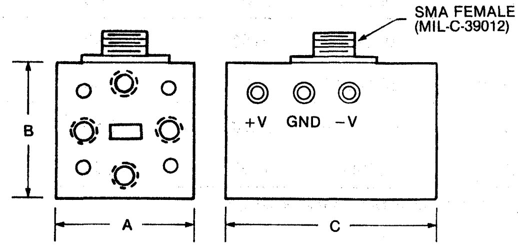
Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-15
RF Mating Flange MIL-F-3922/	54-001-M	68-001 68-002	67B-006	67B-008
UG Reference	595/U	599/U	383/U	385/U
Bias Input	Solder Terminal			

Notes:
1. Replace "XX" in model number with desired center frequency.
2. Higher output power and operating temperature ranges available. The maximum output power is guaranteed into a 1.2:1.0 VSWR. The pulsed oscillator will not be damaged by an RF load from a short to an open circuit.
3. Exact operating voltage is factory set. All bias dc voltages are positive.
4. Frequency and power stability are measured between 0°C and 50°C. For further frequency or voltage stability information, consult factory.
5. Test data measured at a case temperature of 30 ±5°C is provided with each unit.

Specifications Subject to Change Without Notice.

SPST and SPDT PIN Diode Switches
18-110 GHz
7(WG) 231/232 Series



Features

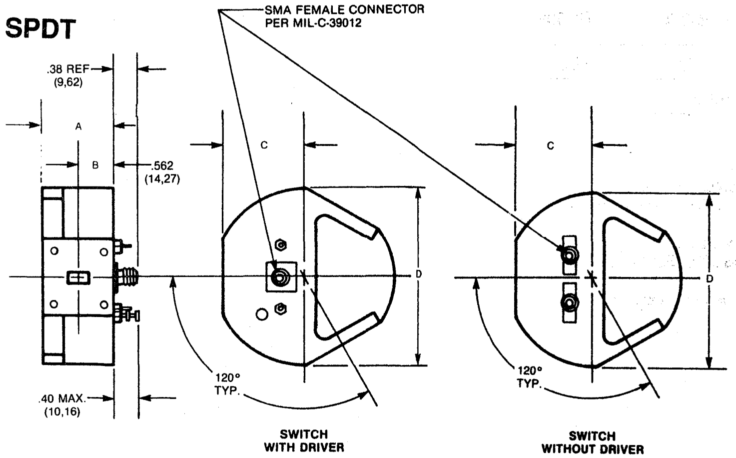
- Low Loss
- High Isolation
- Fast Switching
- Compact Package
- Optional Integral Driver

Description

This series of SPST and SPDT PIN diode switches is available in seven waveguide bands from 18 to 110 GHz, achieving high isolation and low insertion loss over the specified frequency bandwidth. These PIN diode switches have numerous applications as solid state modulators and attenuators due to their unique characteristics of broadband frequency coverage, high isolation, low insertion loss and fast switching speeds. An integral driver for direct control from TTL logic levels is available.

When used in conjunction with a circulator, the SPST switches can be used as SPDT switches. When used with an isolator they can provide a matched device in both high and low loss states. Consult the factory for specifications on alternate PIN diode switches of SPDT designs from 18 to 110 GHz. Multi-throw options are also available.

SPDT



Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
RF Mating Flange MIL-F-3922/	54-001-M	68-001 68-002	67B-006	67B-007	67B-008	67B-009	67B-010
UG Reference	595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M
Bias Connector	Feed Thru						
Control Connector	SMA Female						
Control Logic	TTL						

Specifications Subject to Change Without Notice.

Specifications at 25°C

Waveguide	Frequency (GHz)	RF Bandwidth (GHz)	Insertion Loss[2] (dB Typ.)		Isolation[2] (dB Min.)		Part Number[2]	
			SPST	SPDT	SPST	SPDT	SPST	SPDT
WR-42	18-26.5	18-26.5	1.2	1.8	30	30	7-42-231	7-42-232
WR-28	26.5-40	26.5-40	1.5	2.0	30	30	7-28-231	7-28-232
WR-22	33-50	33-50	1.5	2.0	30	30	7-22-231	7-22-232
WR-19	40-60	40-60	1.8	2.5	25	25	7-19-231	7-19-232
WR-15	50-75	50-75	2.0	2.5	20	25	7-15-231	7-15-232
WR-12	60-90	±5.0	2.0	2.5	20	20	7-12-231-XX[1]	7-12-232-XX1
WR-10	75-110	±5.0	2.0	2.5	20	20	7-10-231-XX[1]	7-10-232-XX[1]

Common Specifications

VSWR	2.0:1 Max.
Average Power Rating	1.0 W
Switching Speed[3]	
Loss to Isolation	10 nsec. Typ.
Isolation to Loss	50 nsec. Typ.
Isolation State Current	+10 mA Typ.
Low Loss State Voltage	-12V Typ.
dc Bias	
With Driver	+5/-12V, +20 mA
Without Driver	+12/-12V, +20 mA
Operating Temperature	0°C to +60°C

Notes:
1. Replace "XX" in model number with desired center frequency.
2. Contact factory for driver availability and Lower Loss and insulation
3. Switching speed including driver delay, add 20 nsec. The specifications noted are for RF detected transition time (10%-90% — 90%-10%). Switching speeds as fast as 2 nsec. available. Consult factory.

Mechanical Specifications

Waveguide		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
SPST Dim (Max.) Inch (mm)	A	.88 (22.2)	.75 (19.1)	1.13 (28.7)	1.13 (28.7)	.75 (19.1)	.75 (19.1)	.75 (19.1)
	B	1.50 (38.1)	1.50 (38.1)	1.50 (38.1)	1.50 (38.1)	1.25 (31.8)	1.25 (31.8)	1.25 (31.8)
	C	2.30 (58.3)	2.00 (50.8)	1.75 (44.5)	1.75 (44.5)	1.75 (44.5)	1.75 (44.5)	1.75 (44.5)
SPDT Dim (Max.) Inch (mm)	A	1.13 (28.7)	1.13 (28.7)	1.13 (28.7)	1.13 (28.7)	.75 (19.1)	.75 (19.1)	.75 (19.1)
	B	.56 (14.3)	.56 (14.3)	.56 (14.3)	.56 (14.3)	.375 (9.5)	375 (9.5)	375 (9.5)
	C	1.25 (31.8)	1.25 (31.8)	.67 (17.0)	.67 (17.0)	.67 (17.0)	67 (17.0)	67 (17.0)
	D	2.80 (71.1)	2.80 (71.1)	1.75 (44.5)	1.75 (44.5)	1.75 (44.5)	1.75 (44.5)	1.75 (44.5)

Specifications Subject to Change Without Notice.

M/A-COM

Monolithic PIN Diode Switches High Power

Features

- 26.5 to 40.0 GHz (WR-28)
- 75.0 to 110.0 GHz (WR-10)
- High Peak Power
- High Average Power
- Low Loss
- High Isolation
- Small and Lightweight
- 0°C to 60°C Operating Temperature

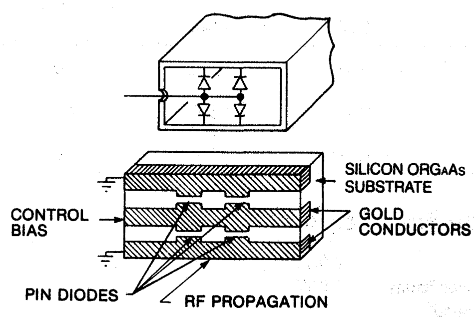
Description

This series of SPST and SPDT switches offers solid state control of high power microwave energy at millimeter frequencies, which previously has been available only through the use of gaseous or ferrite devices. Their high isolation and low insertion loss make them suitable for controlling up to 1.0 kW peak millimeter wave power at fast rates for high power radars and communications systems. These solid state, monolithic PIN diode array switches provide high power switching by placing a GaAs or silicon semiconductor window element across the waveguide aperture.

A matrix of PIN diodes is fabricated on one surface of the window element. In the unbiased state, the PIN diodes appear as a shunt capacitance across the waveguide. The effect of this capacitance can be minimized by the use of a second window or by appropriate tuning devices. In the biased or conducting state, the diodes produce a large admittance across the waveguide which provides a minimum of 35 dB of isolation for a window-pair.

SPST switches are available with 10% and full bandwidth in the 26.5 to 40 GHz frequency range and with 3% bandwidth in the 75 to 110 GHz range. A SPDT configuration is available with 10% bandwidth in the 26.5 to 40 GHz range. They are available with driver for direct control from TTL logic levels.

Conceptual Design



Waveguide	WR-28	WR-10
RF Mating Flange MIL-F-3922/	68-001 68-002	67B-010
UG Reference	559/U	387/U-M
Bias Connector	SMA Female	
Control Connector	SMA Female	
Control Logic	TTL	

Typical Specifications at +25°C

Insertion Loss	1.0 to 1.6 dB Typ.
Isolation	20 to 30 dB Typ.
Switching Speed	10 nS (loss to isolation)
	50 to 100 nS (isolation to loss)
Isol. State Current	-1.0 or -0.6 Amp Max.
VSWR	1.6:1 Max.
Peak Power	1.0 kW Max.

Specifications Subject to Change Without Notice.

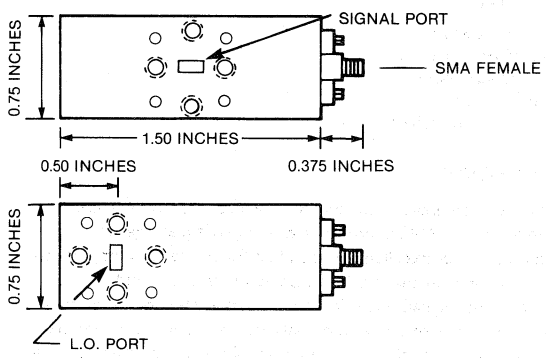
M/A-COM

Balanced Mixers
26.5-110 GHz

Features

- Low Noise Figure
- Beam Lead Diodes
- Broad IF Bandwidth
- Low Conversion Loss
- Low LO Drive Power
- Small Size and Lightweight

DIMENSIONS OF MIXER/IF AMPLIFIER ON REQUEST.



Description

This series of balanced mixers achieves a low SSB noise figure with the utilization of M/A-COM proprietary beam lead diodes. The overall SSB noise figure is optimized over a ± 1.0 GHz bandwidth. Additional features include a high LO to RF isolation and high LO noise suppresion. These mixers are supplied with an IF amplifier in various IF bandwidths from 0.01 to 1.0 GHz. The local oscillator power required can be supplied by M/A-COM Gunn diode oscillators. When low noise M/A-COM Gunn diode oscillators and isolators are purchased with these balanced mixers, they are tested as an integrated Mixer-LO Subassembly. Special mixer performance and features to meet specific system requirements are available.

Mechanical Specifications

Waveguide	WR-28	WR-22	WR-15	WR-10
RF Mating Flange MIL-F-3922/	68-002	67B-006	67B-008	67B-010
UG Reference	599/U	383/U	385/U	387/U-M

Specifications at 25°C

Waveguide	Frequency (GHz)	SSB Conversion Loss (dB)	LO Drive Power (dBm Max.)	IF Frequency[2] With IF Amplifier (MHz)	SSB Noise[3] Figure (dB Max.)	Model No.[1] With IF Amplifier	Model No.[1] Without IF Amplifier
WR-28	26.5-40	6.5	+10	10-110	8.5	5-28-701-XX	5-28-700-XX
WR-22	33-50	6.5	+10	10-110	8.5	5-22-701-XX	5-22-700-XX
WR-15	50-75	7.0	+10	10-110	9.0	5-15-700-XX	5-15-700-XX
WR-10	75-110	8.0	+14	10-110	10.0	5-10-701-XX	5-10-700-XX

Common Specifications

RF Bandwidth	±1.0 GHz	RF to IF Gain	20 dB Typ.	dc Input Voltage	1.5V
LO to RF Isolation	20 dB	IF Output Impedance	50 Ohms	dc Input Current	30-50 mA
LO Noise Suppression	20 dB	IF Output VSWR	1.5	Operating Temperature	-54°C to +85°C
RF Input Level	100 mW Max.	IF Output Power (1 dB Compression)	0 dBm		
RF VSWR	2.0 Typ.				

Notes:

1. Replace "XX" in model number with desired center frequency.
2. Consult factory for other frequency bands.
3. SSB noise figure for 100-600 MHz IF will degrade 0.3 dB and 0.5 dB for 100-1000 MHz IF options.

Specifications Subject to Change Without Notice.

Double Balanced Mixers 18-40 GHz

5 (WG) 790 Series

Features

- Broad Bandwidth
- Planar Construction
- Beam Lead Diodes
- High Reliability
- Small and Lightweight

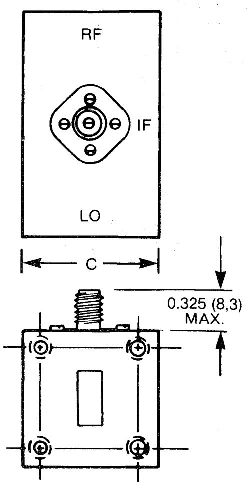
Description

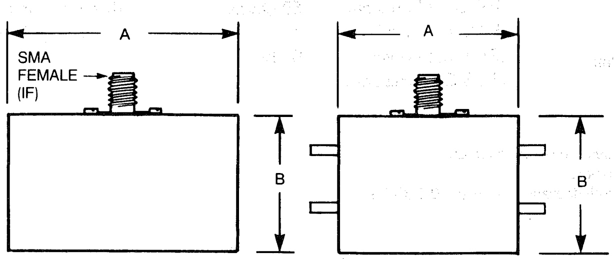
These mixers are broadband, double-balanced downconverters utilizing a unique planar MIC approach in a waveguide package. This technique provides excellent electrical performance in a compact format. Operation over the specified instantaneous bandwidth is provided for the Signals and LO simultaneously. The double-balanced feature provides inherent isolation between ports due to symmetry without the necessity of filtering which results in a wide instantaneous IF bandwidth. The four diodes required provide yet another advantage by lowering the IF impedance to the desirable 50 ohm level during normal operation. These diodes are glass passivated to provide a positive seal against humidity as well as to add mechanical strength to the beam leads. Each mixer is thoroughly screened to further enhance reliability and longevity. Another fundamental advantage of this mixer approach is that the Signal and LO ports are co-planar. This feature enables other devices to be readily integrated with the mixer either as discrete, individual components or as an integrated assembly, custom designed on the same substrate. Special performance or custom features can be provided on request.

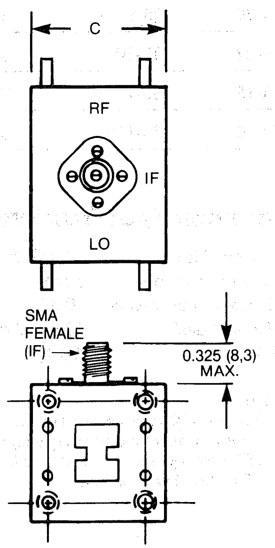
Model Numbers
5-42-790
5-28-790

Dimensions Inches (mm)	Model Number		
	5-42-790	5-28-790	5-00-790
A	1.68(42.7)	1.14(28.9)	1.16(29.5)
B	0.88(22.4)	0.75(19.1)	0.88(22.4)
C	0.88(22.4)	0.75(19.1)	0.88(22.4)

Model Number
5-00-790







Specifications Subject to Change Without Notice.

Specifications at 25°C

Instantaneous Bandwidth (GHz) Signal/LO	IF	SSB Conversion Loss (dB Typ/Max.)	Conversion Loss Flatness (dB)	VSWR (Max.) Signal/LO	IF[1]	Model No.
18-26.5	0-6	6.0/7.0	±1.0	2.2	2.0	5-42-790
26.5-40	0-8	6.2/7.5	±1.0	2.2	2.0	5-28-790
18-40	0-8	7.5/9.5	±1.5	2.5	2.0	5-00-790

Common Specifications

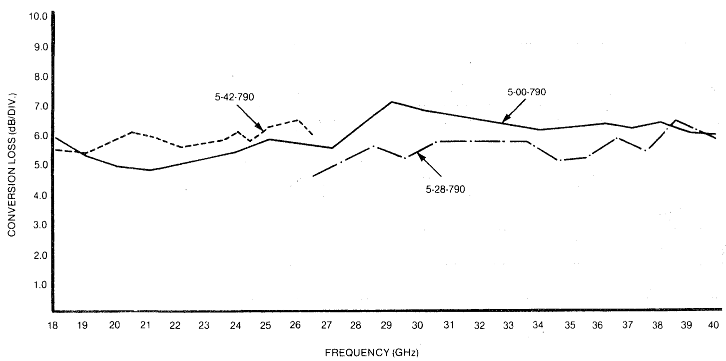
Optimum LO Drive	+10 dBm
1 dB Compression Point	+4 dBm
3rd Order IM Intercept	+14 dBm
Signal to LO Isolation	20 dB
Operating Temperature	-55°C to +70°C

Mechanical Specifications

Waveguide	5-42-790 WR-42	5-28-790 WR-28	5-00-790 WRD-180
RF Mating Flange	MIL-F-3922/54-001M	MIL-F-3922/68-002	MIL-F-39000/3B-088
UG Reference	595/U	599/U	1586/U

Notes:
1. Z_o = 50 Ohms
2. All units can be sealed.
3. Optimization for narrow bandwidth available.
4. Higher IF frequencies available.

Typical Performance



AVERAGE CONVERSION LOSS VS. FREQUENCY FOR VARIOUS IFs and LO FREQUENCIES

Harmonic Mixers
18-110 GHz

5 (WG) 7XX Series

Features

- Full Waveguide Bandwidth
- Low Conversion Loss
- Beam Lead Diodes
- Small Size and Lightweight
- Reliability Suitable for Military Applications

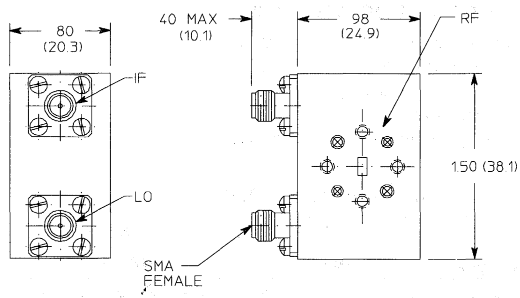
Description

Harmonic mixers provide a direct method of downconverting millimeter wave frequencies with a lower frequency local oscillator. Downconversion is achieved by mixing the millimeter wave signal with the appropriate harmonic content of the LO generated by the mixer.

These broad band harmonic mixers are tuned for low conversion loss operation over a full waveguide bandwidth. They are ideally suited for application in millimeter frequency measurements by downconverting the signal to a lower frequency counter, and in phase lock loops where millimeter wave sources need to be referenced to a crystal-controlled oscillator.

M/A-COM'S highly reliable beam lead diodes are capable of handling up to 100 mW of RF and LO power. A preamplifier is offered as an option with a nominal gain of 25 dB over a 50 to 500 MHz bandwidth. Special performance or customer features are available.

WR-10, WR-15*



*Consult factory for dimensions of other waveguide types.

Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-10
RF Mating Flange MIL-F-3922/	54-001-M	68-002	67B-006	67B-007	67B-008	67B-010
UG Reference	595/U	599/U	383/U	383/U	385/U-M	387/U-M
Preamp Bias Input			Solder Terminal			
IF Connector			SMA Female			
LO Output			SMA Female			

Specifications Subject to Change Without Notice.

Specifications at 25°C

Waveguide	Frequency (GHz)	Conversion Loss[1] (dB Typ.)	LO Frequency (GHz)	Model No.
WR-42	18-26.5	17.0	2.0-4.0	5-42-745
		17.0	4.0-8.0	5-42-750
		17.0	8.0-12.4	5-42-760
WR-28	26.5-40	20.0	2.0-4.0	5-28-745
		20.0	4.0-8.0	5-28-750
		20.0	8.0-12.4	5-28-760
WR-22	33-50	23.0	2.0-4.0	5-22-745
		23.0	4.0-8.0	5-22-750
		23.0	8.0-12.4	5-22-760
WR-19	40-60	26.0	2.0-4.0	5-19-745
		26.0	4.0-8.0	5-19-750
		26.0	8.0-12.4	5-19-760
WR-15	50-75	28.0	2.0-4.0	5-15-745
		28.0	4.0-8.0	5-15-750
		28.0	8.0-12.4	5-15-760
WR-10	75-110	35.0	2.0-4.0	5-10-745
		35.0	4.0-8.0	5-10-750
		35.0	8.0-12.4	5-10-760

Common Specifications

LO Power:	20 mW Typ.
IF Frequency:	1-1500 MHz
RF/LO VSWR:	2.0
IF VSWR:	1.5
Bias For Preamp:	15V/50mA
RF/LO Power:	100 mW Max.

Notes:
1. For harmonic numbers of 8 or less. Conversion Loss measured at mid-band frequency.
2. Models with IF amplifiers are available.

Coaxial Schottky Barrier Detectors
18-40 GHz

4-00-715

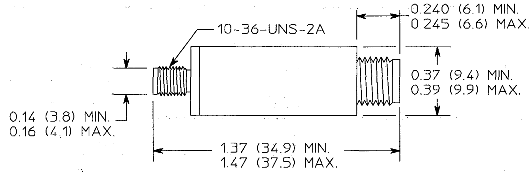
Features

- Wideband Response
- High Sensitivity
- Compact Size
- SSMA Input Connector Standard
  Available with OS-2.9 (2.92mm) or OS-2.4 (2.4mm)
- SMA Output Connector Standard

Description

The high sensitivity of these detectors, when coupled with low video resistance, results in a detector that is ideally suited for signal monitoring and detecting in broadband and multi-channel ECM receiving systems, missile guidance systems, radar and all-purpose laboratory instrumentation.

These detectors are specially designed for high voltage sensitivity over the entire band. The use of a Schottky diode enables this device to achieve superior environmental levels. A square law characteristic is maintained for power levels below -20 dBm.



Environmental

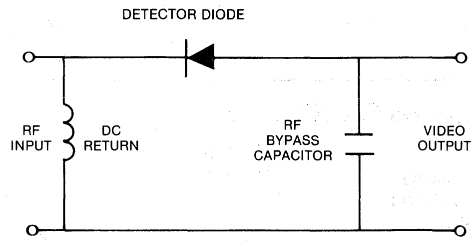
These devices are designed to meet the following conditions of MIL - STD - 750:

Test	Method	Condition
Shock	2016	2500g's, 5 ms
Vibration	2056	25 g's
Constant Acceleration	2006	20,000 g's

Maximum Ratings

Storage Temp.	-65°C to +150°C
Operating Temp.	-65°C to +85°C
Temp. Cycling	-65°C to +150°C (5 cycles)

Equivalent Circuit



Upper Limit on Video Response

The high frequency video response is limited by the amplifier input impedance and the RF bypass capacitance. The upper frequency, 3 dB roll off point is given by:

$$f_{3dB} = \frac{R_v + R_a}{2\pi R_v R_a C_T}$$

where: R_a = amplifier input resistance
R_v = video resistance
C_T = sum of amplifier input capacitance and rf bypass capacitance.

Specifications Subject to Change Without Notice.

Specifications at T_A 25°C

Frequency (GHz)	Flatness (dB TYP.)	Open Circuit Voltage Sensitivity[1] (mV/mW TYP.)	Tangential Sensitivity[4] (dBm TYP.)	Pulse Power[2] (dBm Max.)	CW Power (dBm)	Video Resistance[1] (Ohms Typ.)	Output Capacitance (pF Typ.)	Model No.
18-40	±2.5	1000	-47.2	+30	+20	360	15	4-00-715-XX[3]

Notes:
1. Diode bias current 100 μA.
2. Duty cycle 0.001. Pulse width 3 ns.
3. Replace "XX" in model number with 01 for positive output and 02 for negative output.
4. Tss calculated using:
   Tss(dBm) = -35 + 5 log (BXF) - 10 log M
   B = Video Amplifier Bandwidth = 7 MHz
   F = Video Amplifier Noise Figure = 1.4 dB
   $M = \frac{\text{Open Circuit Voltage Sensitivity}}{\sqrt{R}}$
   R = Video Impedance

Typical Performance

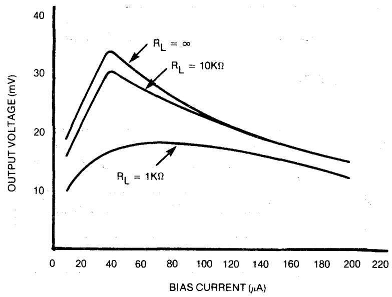


FIGURE 1. Typical Sensitivity vs Bias Current

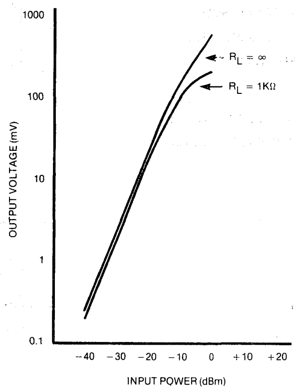


FIGURE 2. Typical Transfer Characteristics

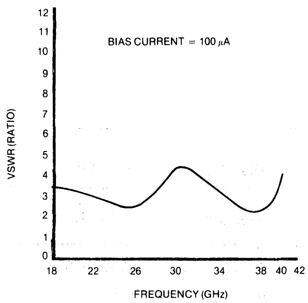


FIGURE 3. VSWR vs Frequency

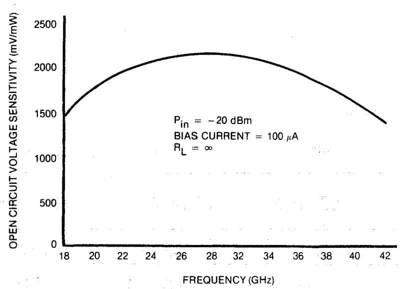


FIGURE 4. Open Circuit Voltage Sensitivity vs Frequency

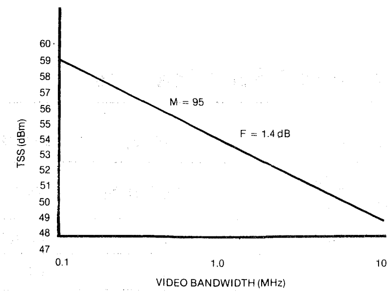


FIGURE 5. TSS vs Video Amplifier Bandwidth for Detector Diode Figure of Merit (M).

Specifications Subject to Change Without Notice.

Zero Biased Waveguide Detectors 18-110 GHz

4 (WG) 720 Series

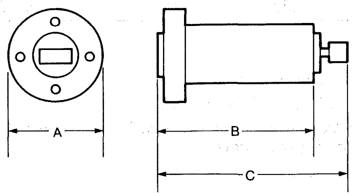
Features

- High Output Sensitivity
- Full Bandwidth Coverage
- Beam Lead Diodes
- High Reliability
- Compact Package

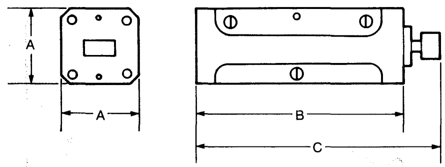
Description

These zero biased detectors are low cost units available in seven bands from 18 to 110 GHz. The high sensitivity of these full waveguide bandwidth detectors makes them ideally suited for signal monitoring and detecting of broad band receiving systems, missile guidance systems, communications systems and radar equipment. In addition, these detectors are used extensively in millimeter wave test set-ups to detect, monitor and measure CW or modulated signals.

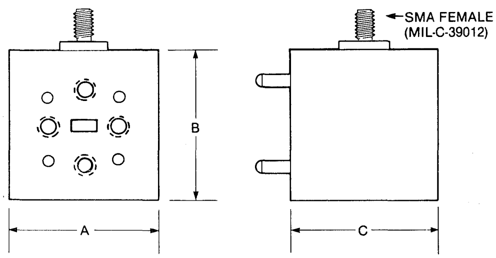
The rugged beam lead diode developed by M/A-COM for use in the millimeter frequency bands is employed as the detecting element. Options include narrow band and hermetically sealed units.



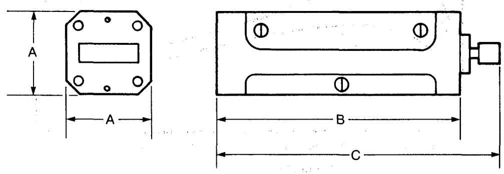
MODEL WR-19 & MODEL WR-22



MODEL WR-28



MODEL WR-15 & MODEL WR-10



MODEL WR-42

Mechanical Specifications

Waveguide		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
RF Mating Flange MIL-F-3922/		54-001-M	68-001	67B-006	67B-007	67B-008	67B-009	67B-010
UG Reference		595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M
Dim. Inches (mm)	A	0.87 (22.2)	0.75 (19.1)	1.12 (28.6)	1.12 (28.6)	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)
	B	2.25 (57.2)	2.03 (51.6)	1.50 (39.8)	1.50 (39.8)	0.75 (19.1)	0.75 (19.1)	0.75 (19.1)
	C	2.62 (66.5)	2.41 (61.2)	1.88 (47.8)	1.88 (47.8)	1.10 (27.9)	1.10 (27.9)	1.10 (27.9)
Output Connector		SMA Female						
Operating Temp.		0°C to + 60°C						

Specifications Subject to Change Without Notice.

Specifications 25°C

Waveguide	Frequency (GHz)	Voltage Sensitivity[3] (mV/mW Min.)	Flatness (dB Max.)	VSWR (Max.)	Input Power (mW Max.)	Model No.[1]
WR-42	18-26.5	600	±2.0	3.0	50	4-42-720-XX
WR-28	26.5-40	400	±2.0	3.0	50	4-28-720-XX
WR-22	33-50	300	±2.0	3.0	50	4-22-720-XX
WR-19	40-60	250	±2.0	3.0	50	4-19-720-XX
WR-15	50-75	200	±2.0	3.0	50	4-15-720-XX
WR-12	60-90	150	±2.5	3.0	50	4-12-720-XX
WR-10	75-95	125[2]	±2.5	3.0	50	4-10-720-XX

Notes:

1. Replace "XX" in the model number with 01 for positive output and 02 for negative output
2. 80 mV/mW min. from 95-110 GHz.
3. Into a 1 megohm video load.

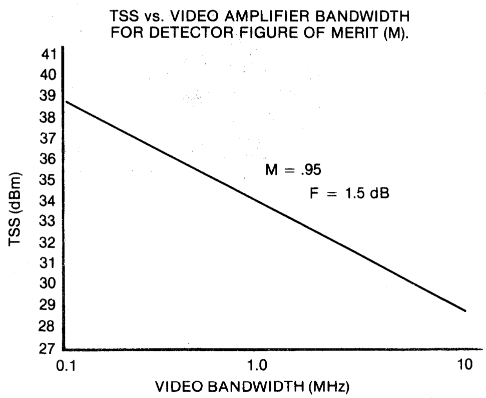
The voltage sensitivity (γ) of a detector is the ratio of the open circuit video signal voltage to the RF input power.

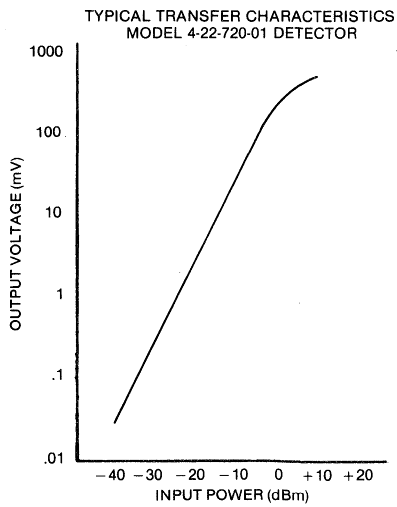
$$\gamma = \frac{Vocv}{Pin}$$

Where: Vocv = open circuit video voltage (1 megohm load)
Pin = RF power incident on the detector

Voltage sensitivity is usually expressed in units of millivolts per milliwatt. To assure that the detector diode is in the square law range, voltage sensitivity is usually measured at -20 to -30 dBm .

Typical Performance





Specifications Subject to Change Without Notice.

Waveguide Isolators
18-110 GHz

2 (WG) 250 Series

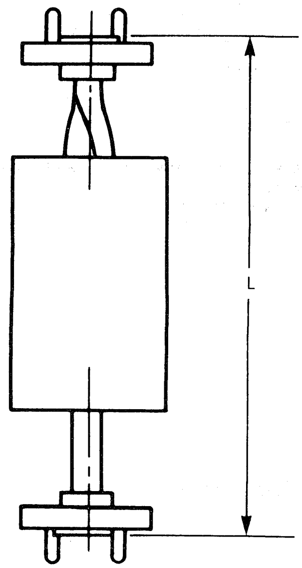
Features

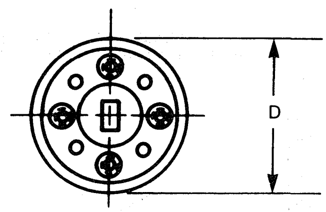
- 25 dB Isolation
- Full Waveguide Bandwidth
- Low Insertion Loss

Description

This series of waveguide isolators uses the Faraday rotation principle of design, where the forward signal is transmitted through the ferrite area with low insertion loss. The reverse signal is absorbed by rotation into the plane of a resistive element incorporated into the isolator's structure. By virtue of an optimal broadband Faraday rotation section, high isolation is maintained through the entire waveguide band.

These isolators are ideally suited for use in conventional low power systems and broadband sweep frequency measurement applications.





Specifications Subject to Change Without Notice.

Specifications

Waveguide	Frequency (GHz)	Isolation (dB Min.)	Insertion Loss (dB Max.)	VSWR Max.	Dimensions Inches (mm) D	L	Isolator Model No.
WR-42	18.0-26.5	25	1.5	1.5	1.25 (31.8)	4.26 (108.2)	2-42-250
WR-28	26.5-40.0	25	1.5	1.5	1.25 (31.8)	2.86 (72.6)	2-28-250
WR-22	33.0-50.0	25	1.5	1.5	1.25 (31.8)	2.86 (72.6)	2-22-250
WR-19	40.0-60.0	25	1.8	1.5	1.25 (31.8)	2.78 (70.6)	2-19-250
WR-15	50.0-75.0	25	1.8	1.5	.88 (22.4)	2.78 (70.6)	2-15-250
WR-12	60.0-90.0	25	2.0	1.5	.88 (22.4)	2.78 (70.6)	2-12-250
WR-10	75.0-110.0	25	2.5	1.5	.88 (22.4)	2.78 (70.6)	2-10-250

Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
RF Mating Flange MIL-F-3922/	54-001-M	68-002	67B-006	67B-007	67B-008	67B-009	67B-010
UG Reference	595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M

M/A-COM

3-Port Waveguide Junction Circulators & Isolators 18-110 GHz

2 (WG) 400 Series

Features

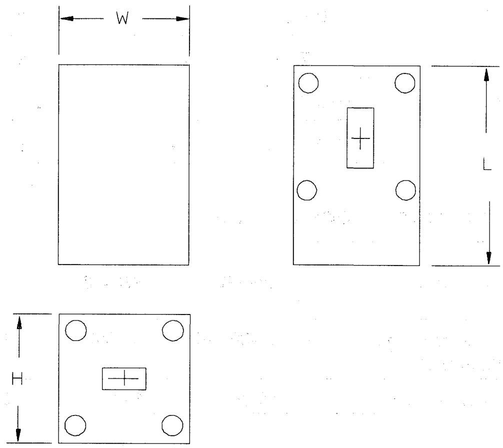
- 20 dB Isolation Typical
- Full Waveguide Bandwidth
- Low Insertion Loss
- 3 GHz RF Bandwidth
- -30°C to +70°C Operating Temperature

Description

These junction circulators are 3-port modified Y-junction ferrite devices. Junction isolators are used for testbench or system applications where high isolation is required between circuit components in order to isolate a signal source from variable or unmatched loads.

Junction circulators are used as ferrite duplexers in transmitter-receiver systems, and in the construction of SPST and SPDT switches. Multijunction circulators are also commonly used in amplifier chains to provide coupling to and isolation from tandem stages.

The devices shown represent only a sampling of M/A-COM's product capability. Contact the factory for custom options such as power, bandwidth, optimized performance, waveguide size, multijunction units, etc.



Mechanical Specifications

Waveguide		WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10
RF Mating Flange MIL-F-3922/		54-001-M	68-002	67B-006	67B-007	67B-008	67B-009	67B-010
UG Reference		595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M
Dim (Max.) Inch (mm)	W	1.00 (25.4)	.75 (19.1)	1.14 (28.9)	1.14 (28.9)	.75 (19.1)	.75 (19.1)	.75 (19.1)
	H	.88 (22.4)	.75 (19.1)	1.14 (28.9)	1.14 (28.9)	.75 (19.1)	.75 (19.1)	.75 (19.1)
	L	1.63 (41.4)	1.28 (32.5)	1.40 (35.6)	1.40 (35.6)	1.20 (30.5)	1.20 (30.5)	1.20 (39.5)

Specifications Subject to Change Without Notice.

Specifications

Waveguide	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB) Min.	VSWR	Power Peak (kW)	Power Avg. (W)	Circulator Model No.[1]	Isolator Model No.[1]
WR-42	18.0-26.5	0.3	20	1.20	1.0	10	2-42-700-XX	2-42-400-XX
WR-28	26.5-40.0	0.4	20	1.20	1.0	10	2-28-700-XX	2-28-400-XX
WR-22	33.0-50.0	0.4	20	1.20	1.0	1	2-22-700-XX	2-22-400-XX
WR-19	40.0-60.0	0.5	20	1.20	1.0	1	2-19-700-XX	2-19-400-XX
WR-15	50.0-75.0	0.7	20	1.25	.5	1	2-15-700-XX	2-15-400-XX
WR-12	60.0-90.0	0.8	20	1.25	.5	1	2-12-700-XX	2-12-400-XX
WR-10	75.0-110.0	0.8	18	1.25	.5	1	2-10-700-XX	2-10-400-XX

Notes:
1. Replace "XX" in model number with desired center frequency.

Specifications Subject to Change Without Notice.

M/A-COM

Variable Attenuators and Phase Shifters 18-325 GHz

3(WG) 103/112 Series

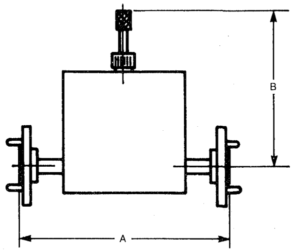
Dial Variable Phase Shifter Features

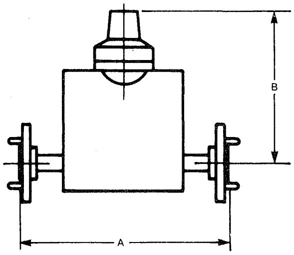
- 0°-180° Phase Shift
- Accurate Repeatability
- Minimum Insertion Loss
- Frequency Calibration Available

Description

Variable waveguide phase shifters provide a simple and convenient means of varying the electrical length of a transmission line. Principal usage is in a bridge circuit where it is possible to compare a known phase shift to some unknown phase shift of a device under test. Differential phase shifts of production units can be tested quickly by this null test and accurate numbers can be assigned to phase differences from unit to unit. Single frequency operation is recommended, but calibrations can be provided over a range of frequencies.

In this series of phase shifters, a dielectric vane traverses the center of the waveguide broadwall through a non-radiating waveguide slot. The positioning mechanism is controlled by a locking dial counter driving a differential screw. This allows fine definition of the phase shift angle and assures repeatability of any selected position. The design provides for a minimum of 180° of phase shift at the lowest frequency in any of the waveguide bands from 18 to 325 GHz.





Variable Attenuator Features

- Dial Variable
- Calibrated and Uncalibrated
- Low and High Power
- Full Waveguide Bandwidths
- Accurate Resetability
- Minimum VSWR

Description

This series of dial adjustable attenuators provides an inexpensive method of making measurements in fixed frequency laboratory or production test set-ups. They consist of a section of waveguide into which an adjustable resistive vane is inserted. The mechanical drive is designed to reduce backlash and provide positive definition for attenuation settings of up to 30 dB. A calibration chart will be provided with model number series 103.

Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-08	WR-06	WR-05	WR-04	WR-03
RF Mating Flange MIL-F-3922/	54-001-M	68-001	67B-006	67B-007	67B-008	67B-009	67B-010	74-001	74-002	74-003	74-004	74-005
UG Reference	595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M	Pin Contact	Pin Contact	Pin Contact	Pin Contact	Pin Contact
Dim. (Max) Inch (mm) A	3.50 (88.9)	3.00 (76.2)	3.00 (76.2)	3.00 (76.2)	2.75 (69.9)	2.75 (69.9)	2.75 (69.9)	2.50 (63.5)	2.50 (63.5)	2.50 (63.5)	2.50 (63.5)	2.50 (63.5)

Specifications Subject to Change Without Notice.

Specifications at 25°C Variable Attenuators[2]

Waveguide	Frequency (GHz)	VSWR (Max.)	Power (W)	Knob Variable Model No.	Dial Variable Model No.	Dial Calibrated[1] Model No.
WR-42	18-26.5	1.15	0.7	3-42-101	3-42-102	3-42-103-XX
WR-28	26.5-40	1.15	0.6	3-28-101	3-28-102	3-28-103-XX
WR-22	33-50	1.15	0.6	3-22-101	3-22-102	3-22-103-XX
WR-19	40-60	1.15	0.5	3-19-101	3-19-102	3-19-103-XX
WR-15	50-75	1.15	0.4	3-15-101	3-15-102	3-15-103-XX
WR-12	60-90	1.15	0.4	3-12-101	3-12-102	3-12-103-XX
WR-10	75-110	1.15	0.3	3-10-101	3-10-102	3-10-103-XX
WR-08	90-140	1.17	0.1	3-08-101	3-08-102	3-08-103-XX
WR-06	110-170	1.19	.08	3-06-101	3-06-102	3-06-103-XX
WR-05	140-220	1.21	.05	3-05-101	3-05-102	-
WR-04	170-260	1.25	.03	3-04-101	3-04-102	-
WR-03	220-325	1.30	.01	3-03-101	3-03-102	-

Notes:
1. Replace "XX" in model number with desired center frequency.
2. Variable to 30 dB Max.

Specifications 25°C Phase Shifters

Waveguide	Frequency (GHz)	VSWR (Max.)	Insertion Loss (dB)	Power Handling (W)	Model No.
WR-42	18-26.5	1.15	0.5	.5	3-42-112
WR-28	26.5-40	1.15	0.5	.5	3-28-112
WR-22	33-50	1.15	0.5	.5	3-22-112
WR-19	40-60	1.15	0.7	.3	3-19-112
W5-15	50-75	1.15	0.7	.3	3-15-112
WR-12	60-90	1.15	1.0	.3	3-12-112
WR-10	75-110	1.15	1.0	.3	3-10-112
WR-08	90-140	1.20	0.9	.3	3-08-112
WR-06	110-170	1.25	0.9	.2	3-06-112
WR-05	140-220	1.30	1.0	.2	3-05-112
WR-04	170-260	1.35	1.2	.1	3-04-112
WR-03	220-325	1.40	1.5	.1	3-03-112

Specifications Subject to Change Without Notice.

Fixed Attenuators 18-325 GHz

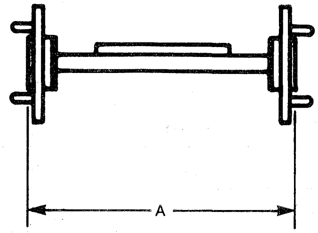
3(WG) 109 Series

Features

- Low and High Power
- Full Waveguide Bandwidths
- Minimum VSWR

Description

This series of attenuators provides an inexpensive method of making measurements in fixed frequency laboratory or production test set-ups. Fixed attenuators are generally designed into a system at a given frequency for a specific purpose such as detector protection. These units consist of a section of waveguide into which a fixed resistive vane is inserted.



Mechanical Specifications

Waveguide	WR-42	WR-28	WR-22	WR-19	WR-15	WR-12	WR-10	WR-08	WR-06	WR-05	WR-04	WR-03
RF Mating Flange MIL-F-3922/	54-001-M	68-001	67B-006	67B-007	67B-008	67B-009	67B-010	74-001	74-002	74-003	74-004	74-005
UG Reference	595/U	599/U	383/U	383/U-M	385/U	387/U	387/U-M	Pin Contact	Pin Contact	Pin Contact	Pin Contact	Pin Contact
Dim. (Max.) Inch (mm) **A**	3.50 (88.9)	3.00 (76.2)	3.00 (76.2)	3.00 (76.2)	2.00 (50.8)	2.00 (50.8)	2.00 (50.8)	1.50 (38.1)	1.50 (38.1)	1.50 (38.1)	1.50 (38.1)	1.50 (38.1)

Specifications at 25°C
Low Power

Waveguide	Frequency (GHz)	VSWR (Max.)	Power (W)	Model No.
WR-42	18-26.5	1.15	0.70	3-42-109-XX-YY
WR-28	26.5-40	1.15	0.60	3-28-109-XX-YY
WR-22	33-50	1.15	0.60	3-22-109-XX-YY
WR-19	40-60	1.15	0.50	3-19-109-XX-YY
WR-15	50-75	1.15	0.40	3-15-109-XX-YY
WR-12	60-90	1.15	0.40	3-12-109-XX-YY
WR-10	75-110	1.15	0.30	3-10-109-XX-YY
WR-08	90-140	1.17	0.10	3-08-109-XX-YY
WR-06	110-170	1.19	0.08	3-06-109-XX-YY
WR-05	140-220	1.21	0.05	3-05-109-XX-YY
WR-04	170-260	1.25	0.03	3-04-109-XX-YY
WR-03	220-325	1.30	0.01	3-03-109-XX-YY

Notes:
1. Replace "XX" in model number with desired center frequency.
   Replace "YY" in the model number with attenuation value in 1 dB steps to 30 dB max. for series 109, to 20 dB max. for series 110.

Contact factory for high-power options.

Specifications Subject to Change Without Notice.

Passive Millimeter Wave Products 18.0- 325.0 GHZ

Overview

Features

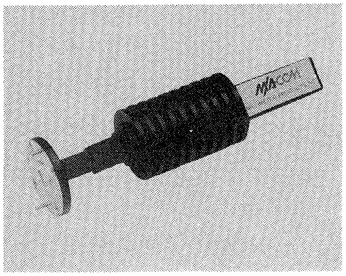
- Full Waveguide Bandwidths (WR-03 through WR-42)
- Minimum VSWR
- High Directivity
- High & Low Power Options
- Minimum Insertion Loss
- Small Sizes
- MIL-Spec Flanges
- Flange Material Brass per QQ-B-6266

Description

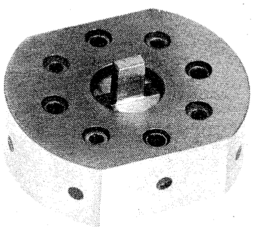
M/A-COM possesses an extensive capability and piece part inventory from which we can assemble almost any passive configuration, including:

- Terminations
- Top Wall Directional Couplers
- Cross-Guide Directional Couplers
- Pick-Up and Gain Horns
- Hybrid Rings
- Tees: E, H & E-H
- Flange Adapters
- Tapered Transitions
- O-Ring Adapters & Pressurizing Units
- Waveguide Straights, Bends & Twists
- Waveguide Flanges & Hardware
- Waveguide Tubing
- Flange Drill Jigs
- Test Benches & Accessories

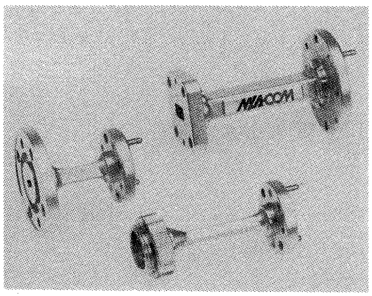
We offer extensive options for these components. The following pages show examples of our passive millimeter product families. Please contact M/A-COM for the options that will meet your needs.



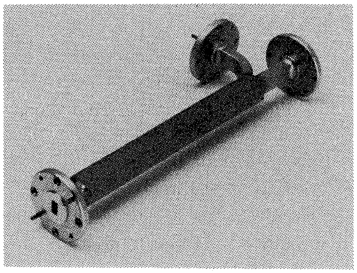
Terminations
18.0 - 325.0 GHz



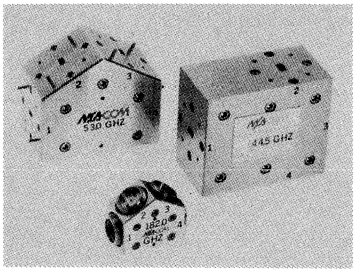
Flange Drill Jigs
18.0 - 110.0 GHz



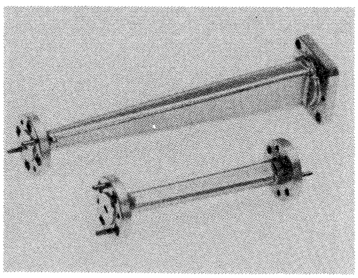
Flange Adapters
18.0 - 325.0 GHz



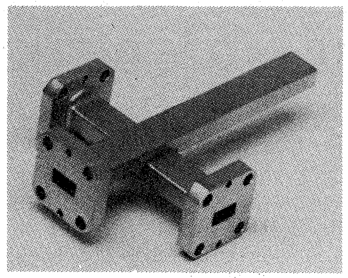
Top Wall Directional Couplers
18.0 - 325.0 GHz



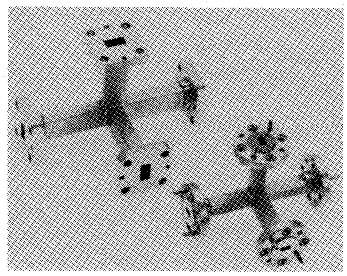
Hybrid Rings
18.0 - 325.0 GHz



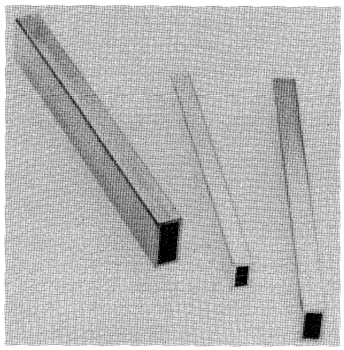
Tapered Transitions
8.0 - 325.0 GHz



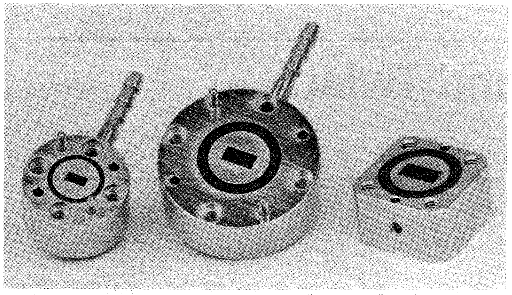
Cross-Guide Directional Couplers
18.0 - 110.0 GHz



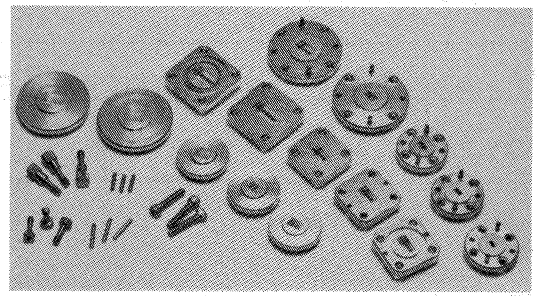
Tees: E, H, & E-H



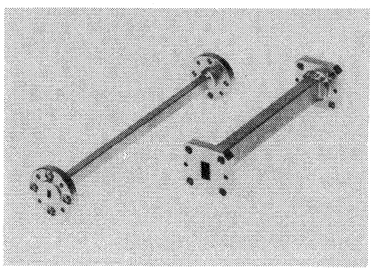
Waveguide Tubing
18.0 - 325.0 GHz

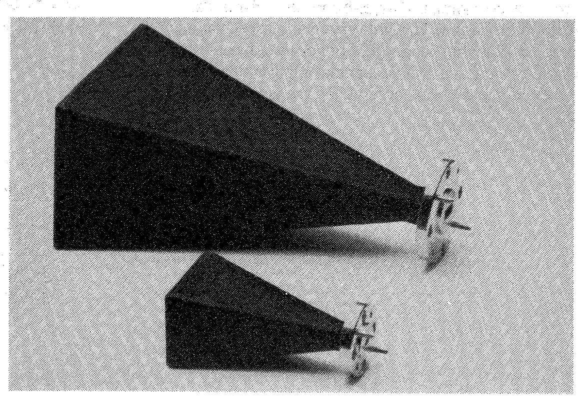


O-Ring Adapters and Pressurizing Units
18.0 - 110.0 GHz

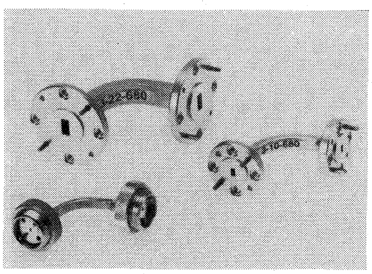


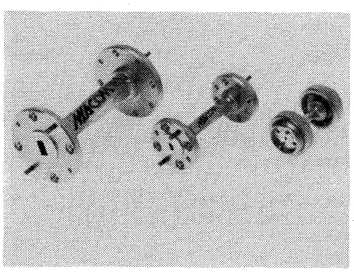
Waveguide Flanges and Hardware
18.0 - 110.0 GHz



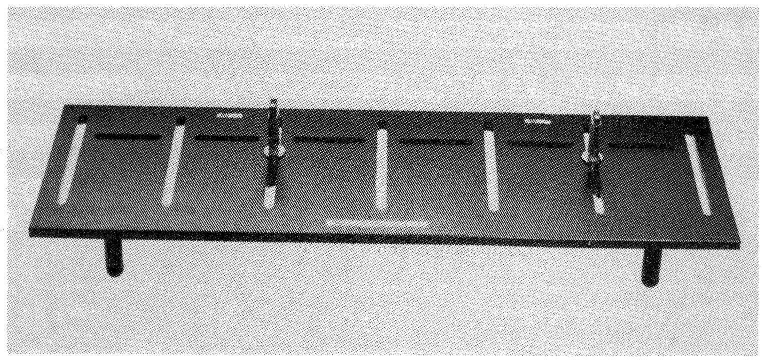


Pick-Up and Gain Horns
26.5 - 325.0 GHz





Waveguide Straights,
Bends & Twists
18.0 - 325.0 GHz
(See catalog listing for more details)



Test Bench and Accessories
18.0 - 325.0 GHz

Waveguide Straights, Bends and Twists 18-325 GHz

Features

- Full Waveguide Bandwidths
- Minimum Loss
- MIL-Spec Flanges
- Low VSWR

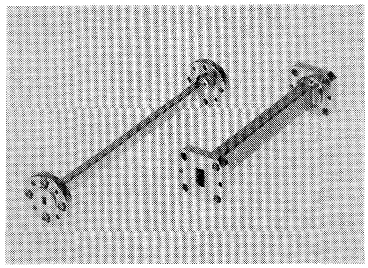
Description

This series of flanged waveguide configurations takes the form of straights, twists, E-bends and H-bends. The standard flanged straight waveguides are available up to 12 inches in length. Longer lengths are available on special request. Special angular bends or complex E- and H-bend assemblies are also available.

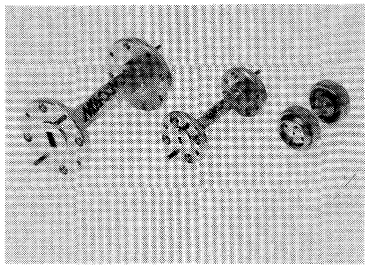
Straight Flanged Length Model No.†

3-(WG)-60 X
3-(WG)-600/XX

07 through 12 (XX)
1 through 6 (X)

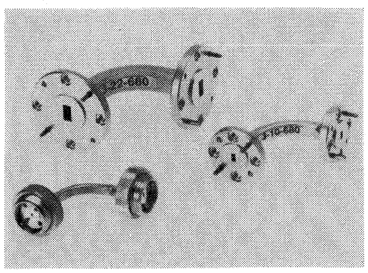


Twist Model No.	
3-(WG)-670	90°
3-(WG)-671	60°
3-(WG)-672	45°
3-(WG)-673	30°



E - Bend Model No.†	
3-(WG)-680	90°
3-(WG)-681	60°
3-(WG)-682	45°
3-(WG)-683	30°

H - Bend Model No.†	
3-(WG)-690	90°
3-(WG)-691	60°
3-(WG)-692	45°
3-(WG)-693	30°



† How to Order

3-(WG)-XXX

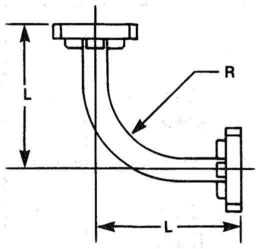
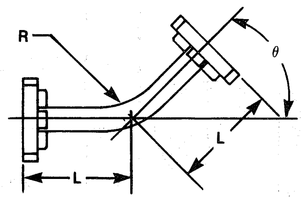
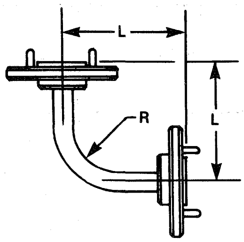
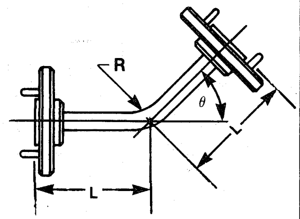
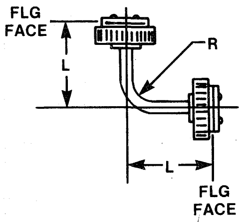
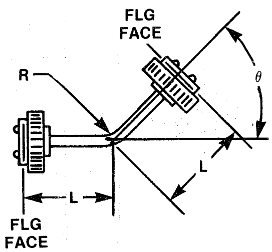
Waveguide WR-Number 42 Through 03 (WG)

Component Number (XXX)

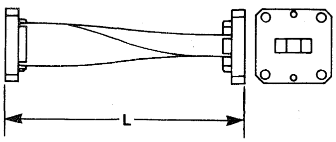
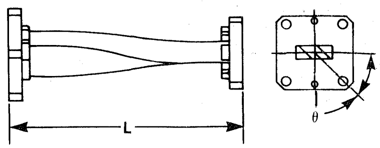
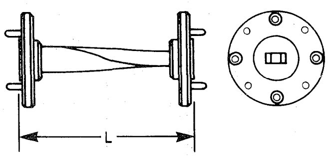
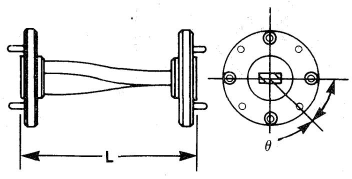
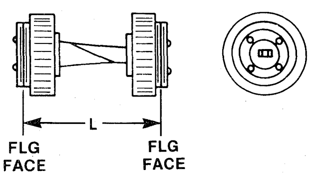
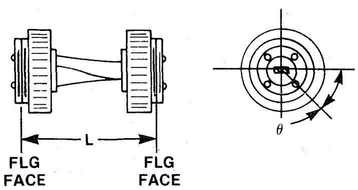
Notes

1. Twists are normally supplied as right handed. If left handed twists are required, add "L" to the model number.
2. WR-42 and WR-28 are supplied with square flange. WR-22 , WR-15, WR-12 and WR-10 are supplied with round flanges. WR-8 through WR-3 are supplied with pin contact flanges. Consult the factory for alternate flange configurations.

Specifications Subject to Change Without Notice.

BEND OUTLINE DRAWINGS: 90° E-Plane & H-Plane	BEND OUTLINE DRAWINGS: 30°, 45°, 60° E-Plane & H-Plane	WR	Freq. (GHz)	L (E & H) in, (mm): θ = 90°	L (E & H) in, (mm): θ = 30°, 45°, 60°	R	Typical VSWR (Max.)
		42	18-26.5	1.50 (38.1)	1.12 (28.4)	.75 (19.1)	1.1
		28	26.5-40	1.25 (31.8)	.87 (22.1)	.75 (19.1)	1.1
		22	33-50				1.1
		19	40-60				1.13
		15	50-75	1.00 (25.4)	.75 (19.1)	.50 (12.7)	1.13
		12	60-90				1.15
		10	75-110				1.15
		08	90-140	1.00 (25.4)	1.00 (25.4)	.25 (6.4)	1.15
		06	110-170				1.15
		05	140-220				1.15
		04	170-260				1.18
		03	220-325				1.18

Specifications Subject to Change Without Notice.

TWIST OUTLINE DRAWINGS (Right Hand Twists Shown) 90° Right Hand & Left Hand	 θ = 30°, 45°, 60° Right Hand & Left Hand	WR	Freq. (GHz)	L (R & L) in, (mm) (90°, 30°, 45°, 60°) Right & Left	Typical VSWR (Max.)
		42	18-26.5	2.75 (69.9)	1.1
		28	26.5-40	2.00 (50.8)	1.1
		22	33-50	2.00 (50.8)	1.1
		19	40-60		1.1
		15	50-75	1.50 (38.1)	1.1
		12	60-90		1.1
		10	75-110		1.13
		08	90-140	1.00 (25.4)	1.13
		06	110-170		1.13
		05	140-220		1.13
		04	170-260		1.15
		03	220-325		1.15

Specifications Subject to Change Without Notice.

Gunn Diode/Oscillator

M514

Description

The Gunn diode is a gallium arsenide (GaAs) device capable of converting direct current (dc) power into radio frequency (RF) power when inserted in an appropriate cavity.

This RF power is the result of a bulk negative resistance property associated with Gunn diodes.

Applications

Typical applications for Gunn diode oscillators are local oscillators, paramp pumps, and voltage control oscillators for radar and communication transmitters, Doppler motion detectors, intrusion alarms, police radars, police radar detectors and collision avoidance systems.

Diode Burn In

Every Gunn diode is "burned in," that is, it is operated both at an elevated temperature and voltage for a period of time. This is to insure that most or all of the "infant" failures are eliminated. Extensive experience has shown that a large portion of burn-in failures occur in the first few hours and that after 24 hours all but a few percent of the initial failures occur. After 48 hours burn-in failures are quite rare. Field service data have shown that the mean time between failure (MTBF) for M/A-COM Gunn diodes is in excess of thirty years.

The GaAs Gunn diodes that are used in the millimeter oscillators are subjected to a DC burn-in for 24 hours at 5.0 Volts, 75°C case temperature. Experiments done at M/A-COM indicate that this type of process conditioning will gives a failure rate of less than 3%.

Extended DC burn-in experiments indicate that a 168 hour burn-in, available upon request, give a projected MTBF of 260,000 hours.

Protective Measure

As a protective measure against damage to the Gunn diode under test, minimizing or eliminating low frequency oscillations is necessary. Large amplitude low frequency oscillation will destroy the Gunn diode and a small amplitude low frequency oscillation will modulate the RF oscillation. A bypass capacitor C, which is attached as close as physically possible to the test cavity, serves this purpose.

"Turn On" Properties Of a Gunn Oscillator

Only those properties which are characteristics of the Gunn diode by itself have been discussed. When the diode is placed in a high frequency cavity and the bias voltage is gradually increased from zero, initially there is either no output power or there is noisy, low-level output. At the turn-on voltage, there will be an abrupt change to a significant amount of output power at a well defined high RF frequency. As the voltage is increased further, the output power increases, while the active region temperature increases. At the power peak voltage, the output power begins to decrease because the active region temperature begins to dominate the effect of the increased voltage. In the case of pulsed Gunn diodes, there is much less heat than in the CW case so that far greater peak powers can be obtained. This competition between temperature and bias voltage explains why the power peak voltage decreases as the ambient temperature is increased as illustrated in Figure 1. Because a given bias voltage yields a certain temperature rise, a higher ambient temperature means the active layer is correspondingly hotter.

The turn-on voltage is affected inversely by temperature in that higher ambient temperatures produce lower turn-on voltages. This means that if an oscillator is to operate at low temperatures, provisions must be made for increasing the bias voltage as temperature is reduced or else the bias voltage must be high enough to ensure turn-on at low temperature. The latter choice can result in a substantial reduction in output power at the highest ambient temperature as illustrated in Figure 2. In order that the oscillator turn on at −30 degrees C, a fixed operating voltage has to be 3.5 volts or greater with 5.5. volts optimum. However, at +50 degrees C the output power at 5.5 volts is considerably less than that attainable at 4.5 volts, for example, the +90 degree C power peak voltage is approximately 4.2 Vdc.

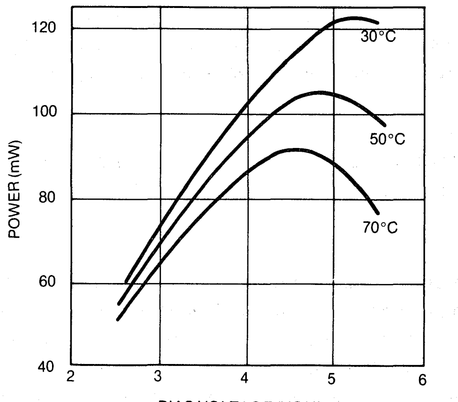


FIGURE 1 TYPICAL OUTPUT POWER vs. BIAS VOLTS

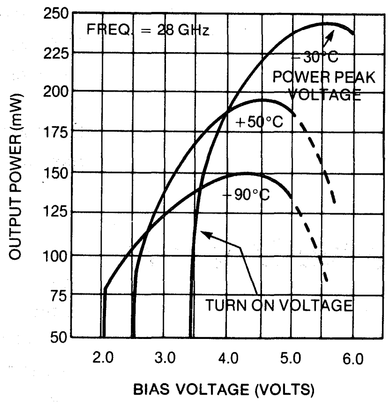


FIGURE 2 OUTPUT POWER vs. BIAS VOLTAGE

Temperature Stability

In many oscillator applications, it is desirable or necessary to control the frequency change with temperature. The frequency of oscillation is controlled mainly by the oscillator cavity; however, in cavities that have a low Q-factor the Gunn diode can play a significant role. It has been found that the diode effects are related to the voltage pushing, which is defined as the ratio of the change in frequency to the corresponding change in bias voltage. A diode with positive pushing will generally have a positive temperature coefficient and vice versa. Since the temperature coefficient of a high frequency cavity is generally negative as indicated in Figures 3a and 3b, it is possible to have compensation between the diode and cavity effects to minimize the frequency change over the temperature range.

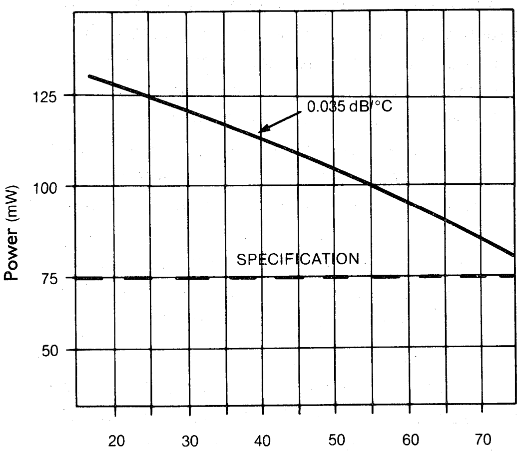


FIGURE 3a OUTPUT POWER vs. TEMPERATURE

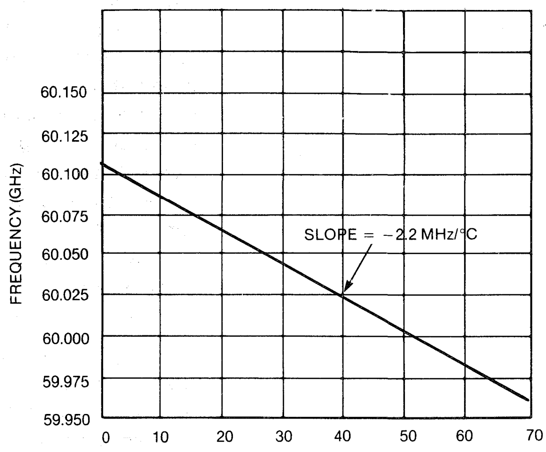


FIGURE 3b TYPICAL FREQUENCY vs. TEMPERATURE

Biasing and Biasing Stability
(Power Supply)

The ripple content of the power supply should be low to minimize AM and FM noise. Since the Gunn diode frequency varies with the bias voltage, any ripple in the dc line will appear as FM noise. When the specifications on the noise spectrum are rigid, the ripple content should be reduced to microvolt levels. For these applications it is usually necessary to perform experiments which ensure that the power supply does not contribute to the output noise. To achieve a low noise content it may be desirable to optimize the operating voltage of individual diodes to obtain the minimum pushing factor and hence minimum AM and FM noise. Such a power supply may consist of a voltage equal to the maximum rated voltage of the Gunn diodes with adjustable voltage dropping resistors in series and/or in shunt with the diode.

AM and FM Noise Spectra
Of Gunn Oscillators

When designing a high frequency, RF system, various sources of noise must be considered and the total noise must be kept within specified limits. Separate allocations of noise to the local oscillator and the transmitter, either AM or FM or both, are made. This section summarizes the results that can typically be obtained from high frequency oscillators using a Gunn diode and suggests what can be done to minimize the output noise level.

Figure 4 shows frequency and power plotted versus bias voltage for a typical Gunn diode in a high frequency microwave cavity.

The output power is maximum at 4.5 volts, while the maximum frequency occurs at 3.5 volts. The voltage corresponding to these points are called "power turnover" and "frequency turnover" voltage points respectively. These "turnover" characteristics of output power and frequency are not fixed but vary from diode to diode, cavity to cavity, and are functions of device to circuit matching. These points also shift as the operating temperature changes. Operation at the power or frequency turnover points results in the lowest AM and FM noise power output. These points represent the operating voltage at which amplitude and frequency variations versus voltage are minimal. Therefore, in the presence of ripple, or noise on the power supply line, minimum AM or FM noise will occur when the Gunn diode is biased at these turnover voltages. Although "power turnover" and "frequency turnover" voltages are usually close, they are rarely the same.

Under dynamic conditions, i.e., by injecting a modulation signal onto the dc bias line, it may be found that these voltages where the AM or FM noise is minimum, vary slightly with frequency as the cavity is tuned. The following discussion shows the effect of bias voltage, cavity Q and diode selection on the noise spectra of a representative Gunn oscillator.

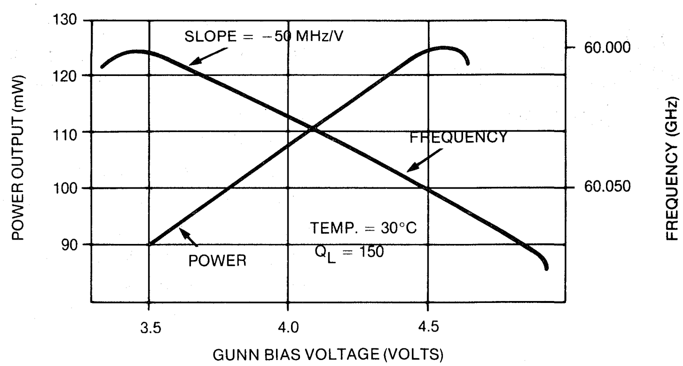


FIGURE 4 OUTPUT POWER AND FREQUENCY vs. GUNN DIODE BIAS VOLTAGE

Bias Voltage Variation

The AM and FM noise spectra of a typical Gunn diode oscillator are shown in Figure 5 and 6 respectively for bias voltages of 4 and 5 volts. AM noise has improved by 8-10 dB at 4 volts while the FM noise has improved by about 6 dB. A small improvement in FM noise alone would have been possible by operating the diode at the "frequency turnover" voltage of 5 volts for this diode in this circuit. The FM noise can be minimized by operating the diodes at the "frequency turnover" voltage. The AM noise power spectrum will, then, be degraded at this new bias voltage.

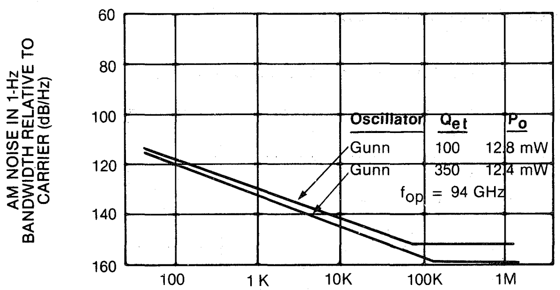


FIGURE 5 TYPICAL AM NOISE SPECTRA OF GUNN DIODE OSCILLATORS

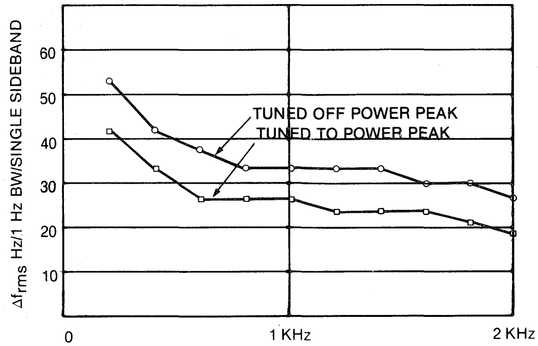


FIGURE 6 GUNN OSCILLATOR SINGLE SIDEBAND FM NOISE DEVIATION VS. FREQUENCY OFF CARRIER f_{op} = 94.15 GHz

Cavity Loading Effect

Both AM and FM noise spectra of the Gunn oscillator are affected by the loaded Q(Q_L) of the cavity. Figures 7 and 8 show the effect of Q_L on AM and FM noise respectively.

It is seen that both the AM and FM noise spectra show an improvement as Q_L is increased from 500 to 3500. The AM noise had improved by 7 to 10 dB while the FM noise had improved by about 14 dB. Notice also that the diode is operated at the "power turnover" voltage.

The FM noise close to the carrier will exhibit 1/f type behavior typical of semiconductor diodes. This 1/f behavior is best illustrated by plotting noise to signal ratio (in dB) as a function of frequency off the carrier. Figure 9, containing the same data as Figure 8, illustrates 1/f like behavior close to the carrier. Near the carrier the power spectra figure falls off at the rate of 9 to 11 dB per octave. Far from the carrier, the rate approaches 6 dB per octave.

Cavity Loading Effect (Cont'd)

Noise Improvement of Gunn Oscillators

Several methods of reducing the AM and FM noise spectra of a Gunn oscillator have been described in this Section. In summary, these are:

- Biasing at or near the frequency turnover voltage where

$$\frac{\Delta F}{\Delta V} = 0,$$

- Increasing the cavity quality factor Q,
- Careful selection of diodes, and
- Minimizing the ripple on the power supply voltage.

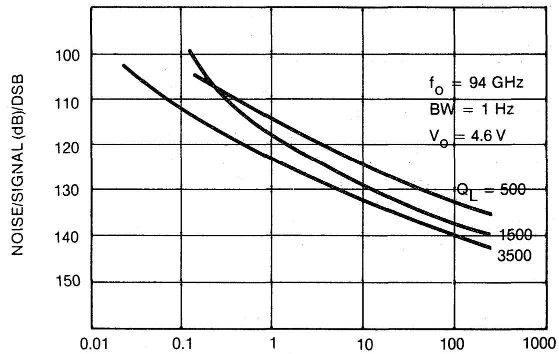


FIGURE 7 AM NOISE SPECTRUM OF A GUNN DIODE OSCILLATOR WITH VARIOUS CAVITY Q'S

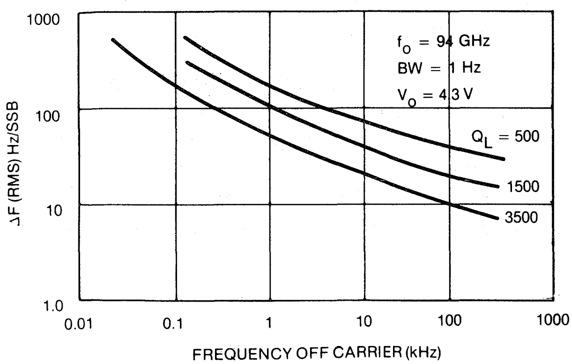


FIGURE 8 FM NOISE SPECTRUM OF A GUNN DIODE OSCILLATOR WITH VARIOUS CAVITY Q'S.

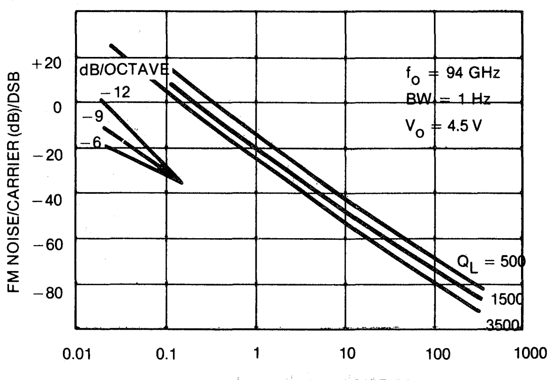


FIGURE 9 BEHAVIOR OF FM NOISE OF A GUNN DIOD OSCILLATOR WITH DIFFERENT CAVITY Q'S.

Electronic Tuning

Electronic tuning of high frequency microwave Gunn oscillators is often required in systems where either frequency modulation, automatic frequency control, or frequency sweep is needed. Techniques for video and pulse modulation of Gunn oscillators are discussed in more detail in another section. Two basic means of electronic tuning discussed here are:

- Pushing of the Gunn diode (variable bias voltage)
- Tuning diode, such as varactor (variable varactor bias)

Electronic Tuning by Pushing the Gunn Diode

Electronic tuning may be achieved by varying the Gunn diode bias. The cavity in which the diode is placed must have sufficiently low Q to allow coverage of the desired band. Up to 100 MHz per volt sensitivity is possible in low Q circuits compared to 1 MHz per volt in a high Q structure (Q_L = 1000).

A typical pushing characteristic encountered is illustrated in Figure 4. For a cavity having a loaded Q_L = 150, the frequency is plotted for a bias voltage varied between 3.5 to 4.5 volts. The frequency monotonically decreases with increasing bias voltage. In the range of 3.5 to 4.5 volts, the frequency is almost a linear function of bias voltage with a slope of −50.0 MHz per volt. In this voltage range, good tuning characteristics may be expected. However, the output power will also vary as shown in Figure 4 for the same cavity and diode. This may be undesirable for some applications (heavy loading of mixer, FM to AM conversion).

Figure 10 shows the measured modulation sensitivity as a function of the modulation rate. Modulating frequencies up to several MHz can be achieved without any deterioration of the sensitivity. There are several disadvantages to this simple electronic tuning. The pushing factor strongly depends on the diode used. Thus, wide variations in modulation sensitivity may be expected with different diodes in the same circuit. The modulators must be designed to operate at the high current levels of the Gunn diode. Typical modulation circuits are shown in Figure 11.

Electronic Tuning (Cont'd)

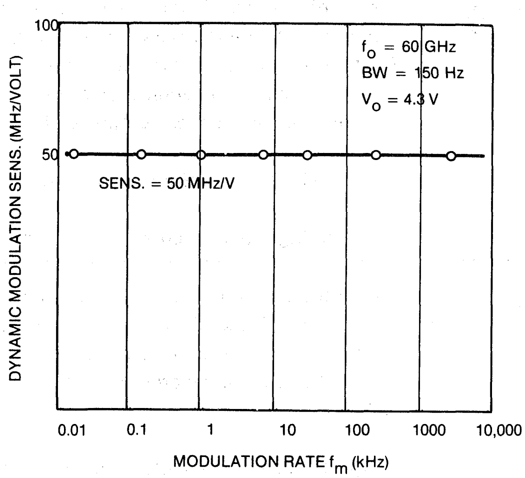


FIGURE 10 DYNAMIC MODULATION SENSITIVITY OF A GUNN DIODE OSCILLATOR TUNED BY THE "PUSHING" EFFECT OF BIAS VOLTAGE VARIATION.

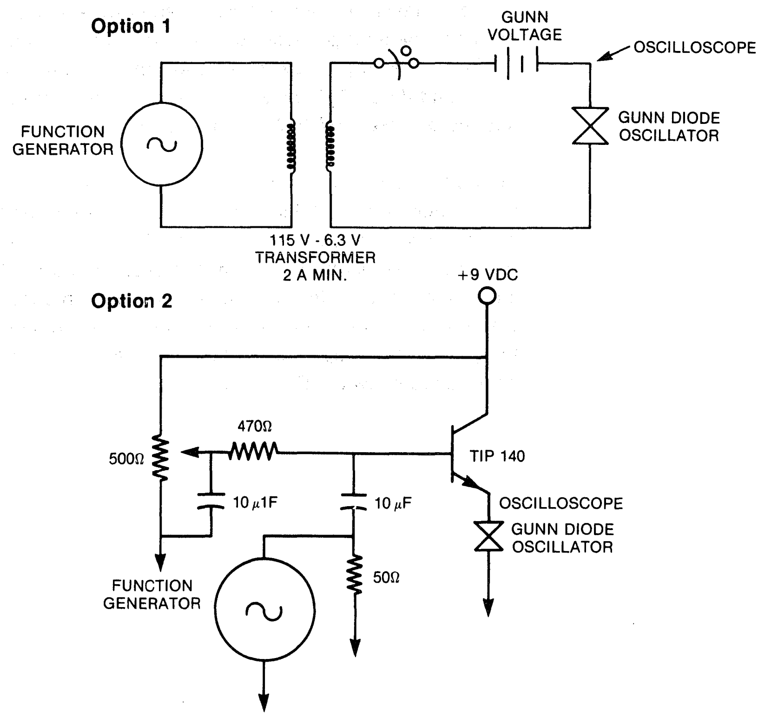


FIGURE 11 TYPICAL GUNN BIAS TUNABLE OSCILLATOR MODULATION CIRCUITS

Frequency Tuning Using Semiconductor Diodes

Electronic tuning may be achieved by placing a suitable tuning diode in the cavity along with the Gunn diode. The tuning is similar to mechanical tuning obtained by dielectric loading of the cavity.

Varactor diodes have a capacitance which is continuously variable with bias from a small value C_{min} at large reverse bias, to a large value approaching infinity under forward bias. The series resistance is usually nearly constant for reverse bias. The Q of the diode is maximum at high reverse bias, decreasing steadily towards zero as the bias is reduced and reversed.

An equivalent circuit of a series resonant cavity with a varactor diode coupled to it is shown in Figure 12. The varactor post is an inductive element with the diode in series with it. Coupling is through mutual inductance in that the RF magnetic fields of the cavity partly encircle the post. The Gunn diode itself is also coupled inductively to the cavity in a similar way. Figure 13 shows a "main tank" (cavity) resonator with an inductance L_C, a capacitance C_C and the copper loss resistance R_C, all in series. There are three inductive elements, L_V, L_L, L_G coupled by mutual inductances, M_V, M_L, and M_G, for the varactor, load and Gunn diodes respectively. These elements, referred to the cavity, all appear connected in series as shown in Figure 13. Figure 14 shows how the tuning characteristics change with different varactors. Figure 15 shows the electronic tuning of a Gunn oscillator at different temperatures.

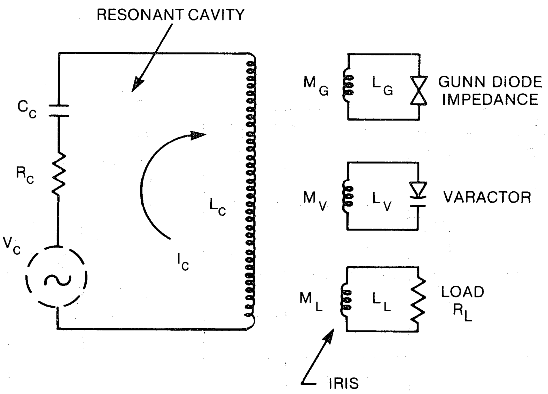


FIGURE 12 EQUIVALENT CIRCUIT FOR A GUNN DIODE OSCILLATOR TUNED BY A VARACTOR. THE GUNN DIODE, THE LOAD, AND THE VARACTOR ARE INDUCTIVELY COUPLED TO THE CAVITY.

Frequency Tuning (Cont'd)

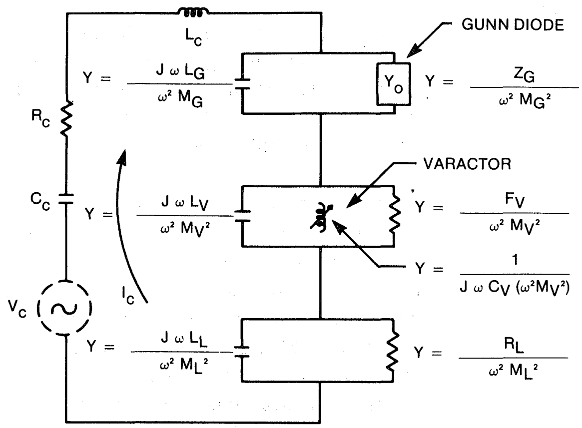


FIGURE 13 SINGLE-LOOP SERIES EQUIVALENT CIRCUIT FOR THE VARACTOR-TUNED GUNN DIODE OSCILLATOR

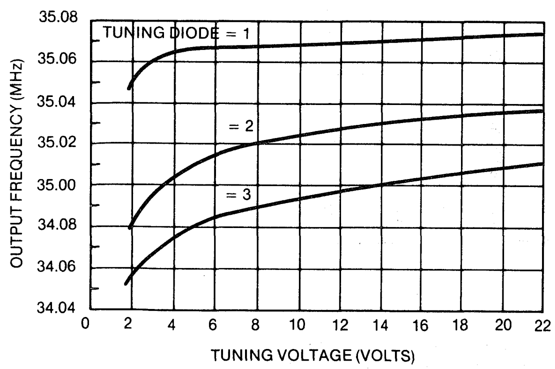


FIGURE 14 TUNING CHARACTERISTICS OF THE GUNN OSCILLATOR OBTAINED WITH A VARACTOR DIODE COUPLED TO THE CAVITY. THESE ARE THREE TYPICAL CASES FOR DIFFERENT DIODES AND DIFFERENT DEGREES OF COUPLING.

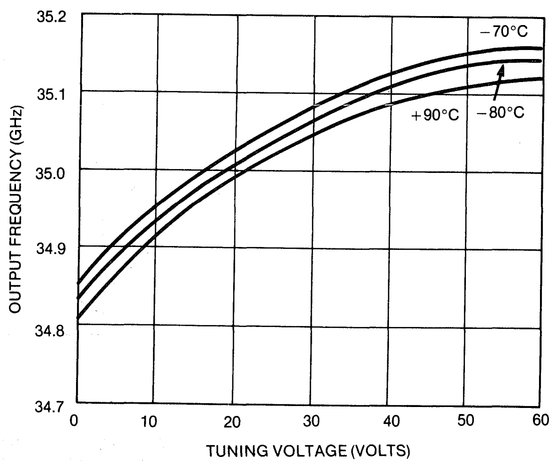


FIGURE 15 TUNING CHARACTERISTICS OF A MICROWAVE INTEGRATED CIRCUIT GUNN OSCILLATOR TUNED WITH A VARACTOR DIODE.

Video and Pulse Modulation Techniques

Gunn-effect oscillators can be directly pulse modulated or frequency modulated to generate useful high-information rate RF signals of modest power levels. Analog amplitude modulation, and phase shift keying, are normally accomplished with an external modulator operating on the output signal.

There are two standard FM deviation techniques for Gunn oscillators. In one type, a varactor tuning diode is coupled into the resonator cavity. A lower-cost technique involves varying the bias voltage on the Gunn diode itself. The ac video voltages are simply added to the dc bias supply. This "pushes" the frequency of the oscillator at the video rate. No fall-off in frequency response of the FM deviation has been observed at rates up to 10 MHz. At present, the chief drawback to these approaches is that frequency tuning is not a linear function of the applied voltage. There is a gradual curvature of the frequency versus voltage curve. Also, in the case of "pushing," the slope may even reverse near one end of the permissible bias range. For television signals, this causes a measurable distortion of the light-level to video voltage relationship. For multiplex telephone, this class of distortion causes intermodulation effects which produce low-level cross-talk between channels. One well-known technique for solving this problem is to use a predistortion network with a nonlinear input-output relationship which can precisely cancel the nonlinearity in the tuning curve. Many such networks using one or more diodes have been devised in the past for correcting similar nonlinearities in amplifiers and other devices.

Examples of Video FM Modulation

M/A-COM has conducted a number of tests with FM oscillators which have been modulated with video signals. In these tests a Gunn oscillator was modulated with standard video test signals; then the signal was attenuated and applied to a test receiver, which amplified and demodulated the signals. The test waveforms were displayed and analyzed with no distortion apparent.

In the multi-burst test, the deviation was 8 MHz peak-to-peak. In the linearity test, the deviation was also 8 MHz peak-to-peak, using a varactor biased at 7.5 V, with 5 V peak-to-peak swing.

The noise performance is outstandingly good in the varactor-tuned oscillators. The most important apparent problem is deviation linearity and this can be minimized by an optimum choice of the bias point for the varactor. Another important consideration in oscillators of this type is long-term frequency stability. Cavity Q cannot be as high in these oscillators as in stable local oscillators. For maximum stability, it may prove necessary to enclose the oscillator cavity in a temperature-controlled oven.

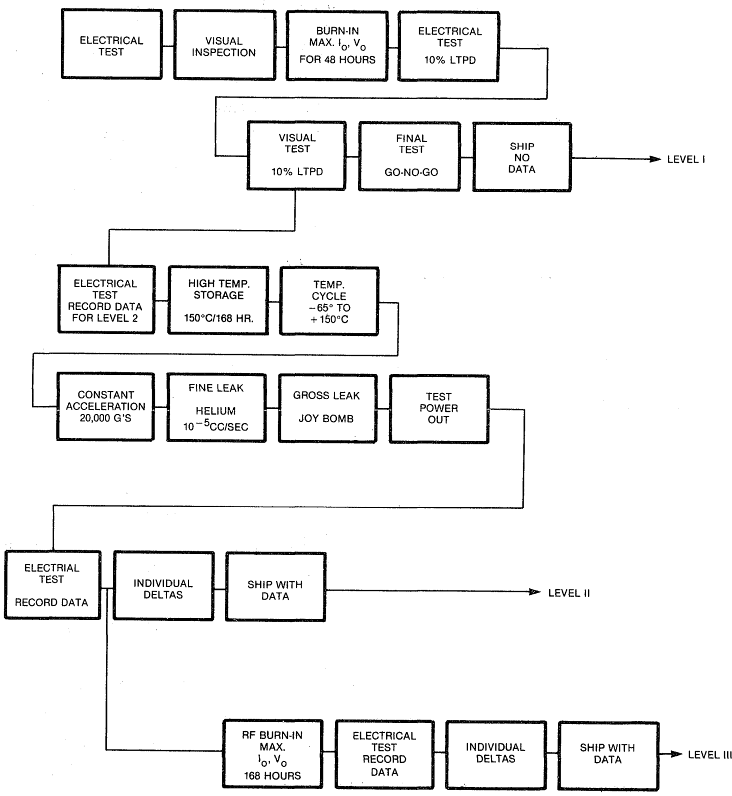
Pulsed Oscillations

Gunn-effect oscillators may be pulse-modulated by pulsing the bias supply during short intervals with square waves. One of the problems with pulsed diode oscillators is a significant frequency swing during each pulse. This is caused by the rapid rise of temperature in the tiny diode chip after the pulse is applied. There is also sometimes a variation in amplitude during the pulse. For low power Gunn diodes capable of CW operation, these problems are less severe than for IMPATT diodes. For many applications, these pulse distortions are acceptable.

High Reliability Gunn Diode Screening

M/A-COM maintains active reliability programs to meet the needs of our customers for screened diodes. Many of the Gunn diodes can be purchased to the following 3 levels of MIL-STANDARD 750.

Screening Program for Gunn Diodes



Note:
1. All screening done per MIL-STANDARD 750 and by the appropriate method.

Reference Materials and Application Note Appendix

Title | **Page**

RF Amplifier, Switches, Attenuators and Hybrid Microwave Products

TABLE 1 - SCREENING [1]

(Reference Document MIL STD-883D)

TEST	SAMPLE SIZE	METHOD/CONDITION
Internal Visual	[2]	M/A-COM MED Workmanship Standard
Stabilization Bake	100%	1008/C, 150°C for 24 hrs
Temperature Cycling	100%	1010/C, -65°C, 150°C
Constant Acceleration	100%	2001/A, 5000G, Y1 Plane only
Burn in [3]	100%	1015, 125°C for 160 hrs
Final Electrical	100%	Product Data Sheet Guaranteed Parameters
Seal Test - Fine Leak	100%	1014/A
Seal Test - Gross Leak	100%	1014/C
External Visual [4]	100%	M/A-COM Workmanship Standard

NOTES: [1] This test does not apply to connectorized units. Connectorized units using hermetically sealed hybrid microcircuits will be screened to Table 1 at the hybrid level.
[2] Sample size for internal visual will be per MIL-STD-105, AQL 1%.
[3] Burn-in temperature will be reduced as necessary to keep the internal junction temperatures from exceeding their absolute maximum ratings.
[4] Parts will be marked with their standard marking, plus a screening date and "T1" to signify that they are screened.
[5] Not available on relay header and plastic packaged products
How to Order: Suffix part number with "-T1"

TABLE B - SCREENING

(Reference Document MIL-STD-883D)

Includes 100% Internal Visual

TEST	SAMPLE SIZE	METHOD/CONDITION
Internal Visual	100%	2017
Stabilization Bake	100%	1008/C, 150°C for 24 hrs
Temperature Cycling	100%	1010/C, -65°C, 150°C
Constant Acceleration	100%	2001/A, 5000G, Y1 Plane only
Burn-in [1]	100%	1015, 125°C for 160 hrs
Final Electrical	100%	Product Data Sheet Guaranteed Parameters
Seal Test - Fine Leak	100%	1014/A
Seal Test - Gross Leak	100%	1014/C
External Visual [2]	100%	2009

NOTES: 1) Burn-in temperature will be reduced as necessary to keep the internal junction temperatures from exceeding their absolute maximum ratings.
2) Parts will be marked with their standard marking, plus a "B" suffix.
3) Not available on relay header and plastic packaged products.
How to order: Suffix part number with "B", confirm availability with factory.

RF Passive and Mixer Products

TABLE 1A
SCREENING

(Reference Document MIL-STD-202)

TEST	SAMPLE SIZE	METHOD/CONDITION
Stabilization Bake [1]	100%	24 hours @ 125° C
Thermal Shock	100%	107/B 5 cycles
Electrical Test	100%	Product Data Sheet
Seal Test — Gross [1]	100%	112/D
External Visual	1% AQL	Divisional Workmanship Manual
External Mechanical	1% AQL	Device Outline Drawing

NOTE: [1] This test does not apply to connectorized units. Connectorized units using hermetically sealed products will be screened to Table 1 at that level.

[2] Not available on relay header and plastic packaged products.

TABLE 2A
QUALITY CONFORMANCE INSPECTION

(Reference Document MIL-STD-202)

SUBGROUP	SAMPLE SIZE	METHOD/CONDITION
Electrical over Temp.	1% AQL	Product Data Sheet
Solderability	1%, S-4 AQL	208
Resistance to Solvents	3 Devices	215
Vibration	1%, S-4 AQL	204/A or D
Electrical at Room	1%, S-4 AQL	Product Data Sheet
Seal Test — Gross [1]	1%, S-4 AQL	112/D

NOTE: [1] This test does not apply to connectorized units. Connectorized units using hermetically sealed products will be screened to Table 1 at that level.

[2] Not available on relay header and plastic packaged products.

TABLE 3
QUALIFICATION [1]

(Reference Document MIL-STD-202)

TEST	SAMPLE SIZE	METHOD/CONDITION
Subgroup 1		
Moisture Resistance	2.5%, S-4 AQL	106
Subgroup 2		
Salt Spray	2.5%, S-4 AQL	101
Subgroup 3		
Shock	2.5%, S-4 AQL	213/C
Terminal Strength	2.5%, S-4 AQL	211

NOTE [1]: Table 2, Quality Conformance Inspection is part of the qualification testing and is done prior to these tests.

[2] Not available on relay header and plastic packaged products.

TABLE 3B
QUALIFICATION [1]

(Reference Document MIL-STD-883)

TEST	SAMPLE SIZE	METHOD/CONDITION
Group C, Life Test [2]		
Subgroup 1	15 Devices	
Temperature Cycling		1010/C
Constant Acceleration		2001/E (Y 1 plane only)
Seal Test — Gross		1014/C
Seal Test — Fine		1014/A
External Visual		Device Outline Drawing
End Point Electrical		Product Data Sheet
Subgroup 2	10 Devices	
Steady State Life		1005 (125 °C for 1000 hrs)
End Point Electrical		Product Data Sheet
Subgroup 3	5 Devices	
Internal Water Vapor Content		1018
Group D, Package Testing		
Subgroup 1	5 Devices	
Thermal Shock		1011/C
Stabilization Bake		1008/C (1 hr)
Lead Integrity		2004/B2 (15 leads)
Seal Test — Gross [3]		1014/C
Seal Test — Fine [3]		1014/A

NOTES: [1] Table 2, Quality Conformance Inspection is part of the qualification testing and is done prior to these tests.
[2] No failures allowed.
[3] Not available on relay header and plastic packaged products.

Non-Hermetic Hybrid Screening

TABLE 1C
SCREENING

(Reference Document MIL-STD-883)

TEST	SAMPLE SIZE	METHOD/CONDITION
Temperature Cycling	100%	1010/A
Seal Test — Fine [1]	100%	1014/A
Seal Test — Gross [1]	100%	1014/C
Mechanical Shock [2]	100%	2002/A
Burn In	100%	1015/85 °C for 160 hrs

NOTES: [1] This test does not apply to non-hermetic connectorized units. Non-hermetic units using hermetically sealed hybrid microcircuits will be screened to Table 1 at the hybrid level.
[2] This test will be performed at manufacturer's option.
[3] Not available on relay header and plastic packaged products.

Selected S-Parameter Data

AM-103	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.13	-73.9	3.24	-164.5	0.12	-172.7	0.03	148.3
10.0	0.07	-64.3	3.25	-174.4	0.13	-178.4	0.04	162.1
20.0	0.04	-46.1	3.26	177.7	0.13	175.7	0.04	156.7
50.0	0.02	-9.1	3.26	164.2	0.13	164.3	0.05	133.9
100.0	0.04	36.4	3.18	147.0	0.13	148.9	0.06	92.7
200.0	0.09	34.5	3.15	114.2	0.13	117.1	0.11	25.1
300.0	0.14	12.0	3.09	82.2	0.14	89.8	0.13	-22.5
400.0	0.17	-7.8	3.05	49.8	0.14	62.9	0.15	-68.3
500.0	0.18	-18.4	3.04	23.5	0.15	36.9	0.17	-129.4

AM-105	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.05	-159.0	8.84	10.1	0.03	14.3	0.07	130.9
10.0	0.04	139.2	8.92	-2.6	0.03	4.1	0.05	134.9
20.0	0.03	-65.6	8.87	-17.4	0.03	-5.3	0.05	138.4
50.0	0.03	-41.2	8.72	-50.2	0.03	-24.7	0.05	122.6
100.0	0.04	-52.9	8.58	-102.8	0.03	-53.3	0.09	71.1
150.0	0.06	-80.0	8.32	-154.4	0.03	-80.9	0.15	19.8
200.0	0.07	-117.5	8.16	153.2	0.03	-109.8	0.22	-26.6
250.0	0.08	-169.2	8.06	99.6	0.03	-139.0	0.29	-69.4
300.0	0.08	-9.6	8.13	41.0	0.03	-173.0	0.28	-111.7

AM-109	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
0.5	0.01	36.2	3.47	14.2	0.13	5.9	0.07	18.8
1.0	0.01	160.9	3.41	5.8	0.14	1.7	0.04	12.2
2.0	0.01	169.6	3.41	0.5	0.14	-1.7	0.04	4.4
5.0	0.01	-153.3	3.40	-7.4	0.14	-7.9	0.04	-5.3
10.0	0.01	-112.8	3.39	-17.0	0.14	-16.6	0.04	-17.1
20.0	0.03	-105.2	3.36	-34.7	0.13	-33.8	0.04	-51.6
40.0	0.07	-129.1	3.38	-69.4	0.13	-67.7	0.08	-168.4
50.0	0.09	-145.9	3.42	-87.1	0.13	-84.9	0.11	162.0
60.0	0.10	-163.6	3.45	-106.4	0.12	-103.0	0.18	141.9

AM-110	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
0.5	0.11	-114.6	29.74	29.7	0.01	26.8	0.08	70.2
1.0	0.06	-138.4	30.01	14.3	0.01	13.8	0.04	56.9
2.0	0.04	-158.0	30.03	4.6	0.01	6.4	0.03	42.8
5.0	0.04	172.5	30.04	-5.8	0.01	0.5	0.02	9.9
10.0	0.04	145.1	29.52	-16.0	0.01	-3.3	0.02	-3.7
25.0	0.04	91.6	29.24	-42.7	0.01	-12.6	0.03	-31.5
50.0	0.05	39.6	28.81	-85.5	0.01	-27.8	0.06	-57.4
75.0	0.05	-31.0	29.00	-130.5	0.01	-44.0	0.11	-80.4
100.0	0.08	-152.5	29.00	-178.4	0.01	-61.8	0.20	-111.0

AM-112	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.14	37.9	6.80	-1.0	0.08	-0.8	0.12	101.8
20.0	0.15	26.5	6.75	-12.2	0.08	-10.1	0.11	88.9
50.0	0.17	12.1	6.70	-30.0	0.08	-31.8	0.15	57.0
75.0	0.19	6.7	6.64	-57.9	0.08	-48.5	0.19	36.7
100.0	0.20	-0.9	6.52	-78.0	0.08	-65.8	0.21	17.4
125.0	0.21	-9.0	6.46	-96.1	0.08	-80.7	0.23	-1.0
150.0	0.22	-19.5	6.37	-115.4	0.08	-96.7	0.22	-18.5
175.0	0.22	-29.1	6.32	-134.4	0.08	-112.7	0.20	-34.3
200.0	0.21	-41.4	6.24	-154.1	0.09	-129.0	0.17	-48.9

AM-113	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.05	-90.1	34.57	-176.6	0.01	6.0	0.13	104.0
20.0	0.08	-101.1	34.81	167.6	0.01	-5.4	0.08	101.9
30.0	0.12	-106.0	34.47	157.8	0.01	-10.2	0.06	81.8
40.0	0.17	-110.0	33.92	147.8	0.01	-16.2	0.04	53.7
50.0	0.20	-113.6	33.57	138.5	0.01	-22.9	0.04	24.8
60.0	0.23	-122.2	33.27	130.1	0.01	-29.4	0.07	1.6
70.0	0.25	-124.2	32.56	121.7	0.01	-33.8	0.09	-15.2
85.0	0.30	-129.9	31.84	109.7	0.01	-41.4	0.12	-32.8
100.0	0.33	-135.8	31.20	97.8	0.01	-48.4	0.14	-46.7

AM-117	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.04	-166.2	2.59	3.7	0.29	4.1	0.04	-172.2
20.0	0.03	-151.6	2.60	-1.5	0.29	-1.0	0.04	-170.2
50.0	0.03	-133.5	2.61	-9.6	0.29	-8.3	0.03	-163.4
75.0	0.04	-128.7	2.60	-15.2	0.29	-13.4	0.03	-164.6
100.0	0.06	-124.3	2.59	-20.9	0.29	-18.1	0.05	-167.0
125.0	0.08	-124.1	2.59	-26.3	0.29	-22.7	0.06	-168.0
150.0	0.11	-121.6	2.60	-31.4	0.29	-27.5	0.06	-169.3
175.0	0.13	-123.3	2.60	-36.8	0.29	-32.2	0.07	-170.0
200.0	0.14	-124.6	2.59	-42.2	0.28	-37.0	0.07	-171.1

AM-123	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.21	-69.6	3.15	-158.8	0.11	171.3	0.15	92.8
10.0	0.11	-81.5	3.17	-172.2	0.11	175.0	0.06	116.1
20.0	0.08	-88.5	3.18	-178.4	0.12	171.7	0.04	139.8
50.0	0.06	-108.4	3.17	162.9	0.13	159.9	0.03	174.7
100.0	0.05	-122.8	3.14	142.8	0.13	141.4	0.04	-163.9
200.0	0.05	-141.8	3.11	104.8	0.13	102.1	0.04	-119.4
300.0	0.07	-155.4	3.09	66.9	0.12	64.9	0.14	-114.6
400.0	0.15	177.2	3.08	26.7	0.11	27.3	0.22	-153.2
500.0	0.20	151.3	3.05	-21.9	0.09	-20.9	0.25	83.4

FREQUENCY IN MHz

AM-131

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.23	-71.9	3.15	-157.9	0.11	173.2	0.15	90.6
10.0	0.12	-65.2	3.16	-171.9	0.12	175.7	0.07	105.5
20.0	0.08	-55.5	3.17	178.4	0.13	172.0	0.04	124.1
50.0	0.05	-61.3	3.17	162.9	0.13	160.8	0.02	-178.6
100.0	0.04	-78.3	3.15	143.5	0.13	143.9	0.03	-103.7
200.0	0.02	41.9	3.12	106.2	0.13	108.1	0.12	-83.4
300.0	0.10	5.0	3.10	68.8	0.13	75.7	0.20	-108.0
400.0	0.15	-28.7	3.09	29.8	0.14	42.3	0.24	-144.5
500.0	0.20	-18.6	3.07	-16.4	0.14	5.3	0.27	15.0

AM-132

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.13	-73.5	3.32	-171.2	0.19	-177.7	0.06	-8.0
10.0	0.07	-58.3	3.31	179.9	0.20	177.7	0.05	-4.1
20.0	0.06	-12.3	3.31	171.0	0.21	170.8	0.05	29.2
50.0	0.06	24.2	3.24	152.6	0.23	146.6	0.07	54.3
75.0	0.07	16.6	3.22	138.1	0.28	124.9	0.09	37.0
100.0	0.08	8.3	3.17	124.5	0.29	117.5	0.09	32.4
125.0	0.10	-4.0	3.15	110.6	0.21	114.8	0.10	21.6
150.0	0.14	-20.2	3.15	97.3	0.21	106.2	0.10	14.7
200.0	0.17	-50.3	3.19	68.8	0.21	83.6	0.11	35.2

AM-134

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.16	-80.9	5.29	-165.4	0.08	-73.5	0.13	-21.8
10.0	0.10	-94.2	5.33	-177.2	0.08	179.6	0.09	-36.4
20.0	0.08	-104.1	5.37	172.3	0.09	171.0	0.09	-50.5
50.0	0.12	-122.4	5.35	150.7	0.09	151.7	0.12	-85.7
75.0	0.14	-133.6	5.26	134.8	0.08	137.8	0.15	-107.0
100.0	0.18	-143.5	5.24	120.3	0.08	122.8	0.17	-120.9
125.0	0.20	-153.4	5.17	105.8	0.08	108.5	0.19	-137.7
150.0	0.22	-164.9	5.23	90.2	0.08	91.7	0.21	-150.7
200.0	0.24	178.7	5.36	55.2	0.07	58.9	0.23	162.8

AM-138

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.20	-60.7	17.49	26.0	0.01	11.6	0.17	-7.2
10.0	0.14	-69.0	17.73	5.6	0.01	2.2	0.10	-25.6
20.0	0.10	-73.0	17.85	-12.4	0.02	10.3	0.07	-32.9
50.0	0.13	-96.4	17.91	-47.3	0.01	-35.8	0.05	-82.3
75.0	0.16	-112.3	17.76	-74.6	0.01	-58.0	0.04	-146.0
100.0	0.20	-130.9	17.63	-103.3	0.01	-82.4	0.06	149.3
125.0	0.22	-148.5	17.82	-131.8	0.01	-115.9	0.11	109.4
150.0	0.21	-168.4	17.91	-168.8	0.01	179.5	0.15	78.5
200.0	0.19	159.9	17.90	132.4	0.01	95.3	0.18	15.8

AM-140

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.20	-68.5	28.34	30.2	0.01	11.8	0.16	-17.7
10.0	0.13	-85.6	29.26	8.0	0.01	4.4	0.12	-41.0
20.0	0.12	-99.8	29.37	-10.2	0.01	-7.3	0.12	-63.3
50.0	0.19	-126.8	29.36	-45.4	0.01	-30.5	0.19	-109.6
75.0	0.25	-145.8	29.26	-71.6	0.01	-48.3	0.24	-136.5
100.0	0.29	-165.0	29.68	-97.9	0.01	-68.5	0.26	-161.0
125.0	0.30	174.9	29.71	-125.2	0.01	102.5	0.25	172.4
150.0	0.25	154.5	29.48	-156.3	0.01	89.0	0.18	143.1
200.0	0.14	143.4	29.12	133.2	0.01	64.8	0.13	-171.7

AM-142

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
200.0	0.24	41.0	3.95	175.9	0.18	160.6	0.25	34.6
300.0	0.12	16.0	3.93	156.0	0.18	147.1	0.28	7.4
400.0	0.08	-6.4	3.97	140.8	0.17	134.9	0.31	-15.4
500.0	0.07	142.1	3.98	126.6	0.17	112.7	0.33	-35.9
600.0	0.06	127.8	4.04	112.9	0.17	110.4	0.33	-54.7
700.0	0.12	109.4	4.07	99.1	0.17	98.2	0.34	-73.6
800.0	0.18	90.1	4.12	84.5	0.16	86.5	0.36	-92.0
900.0	0.24	69.4	4.20	68.9	0.15	74.7	0.37	-110.7
1000.0	0.31	47.9	4.15	50.4	0.15	63.9	0.38	-129.9

AM-143

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.20	-60.7	5.90	-161.0	0.09	-160.5	0.32	-24.9
10.0	0.12	-63.8	6.07	-171.8	0.09	-172.6	0.27	-24.9
20.0	0.09	-65.3	6.16	-179.8	0.10	178.9	0.26	-17.4
50.0	0.10	-82.7	6.08	167.5	0.10	166.3	0.25	-28.0
100.0	0.14	-101.0	6.06	153.3	0.10	150.5	0.26	-49.3
200.0	0.21	-130.6	6.00	126.7	0.10	119.8	0.26	-82.3
300.0	0.23	-149.2	6.01	100.9	0.10	93.6	0.24	-104.5
400.0	0.20	-155.5	6.09	70.7	0.10	67.4	0.22	-100.5
500.0	0.22	-142.9	6.11	36.8	0.10	43.3	0.20	-79.8

AM-145

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
10.0	0.03	59.0	3.53	-160.8	0.21	-168.6	0.05	60.4
20.0	0.02	107.8	3.42	-171.3	0.22	-175.4	0.04	94.5
50.0	0.03	81.9	3.43	179.0	0.22	177.3	0.04	83.4
100.0	0.04	55.5	3.47	171.3	0.22	170.1	0.05	61.5
200.0	0.07	30.2	3.48	157.2	0.22	157.5	0.08	36.2
400.0	0.10	-18.6	3.5	131.8	0.22	134.3	0.11	-1.5
600.0	0.14	-64.1	3.54	106.9	0.23	111.8	0.14	-32.1
800.0	0.17	-115.9	3.49	82.1	0.23	90.6	0.16	-62.0
1000.0	0.21	162.9	3.51	55.5	0.23	69.3	0.18	-89.9

AM-146

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
10.0	0.13	-118.5	11.44	16.8	0.02	7.1	0.14	164.6
20.0	0.12	-144.0	11.63	-1.0	0.02	-4.0	0.16	168.2
50.0	0.13	-175.5	11.56	-27.1	0.02	-25.3	0.15	155.9
75.0	0.14	169.0	11.49	-44.3	0.02	-41.3	0.13	143.8
100.0	0.15	163.8	11.45	-59.9	0.02	-55.7	0.08	132.5
200.0	0.16	121.4	11.24	-120.3	0.02	-113.3	0.05	160.6
300.0	0.18	86.3	11.34	176.4	0.02	-170.1	0.07	167.7
400.0	0.20	55.2	11.33	110.4	0.02	133.3	0.12	159.2
500.0	0.23	13.1	10.84	31.1	0.01	75.6	0.23	174.8

AM-147

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.19	-68.2	6.75	-153.1	0.09	-152.0	0.20	-21.0
10.0	0.11	-78.1	7.05	-167.3	0.09	-168.0	0.12	-22.9
20.0	0.07	-83.8	7.17	-176.4	0.10	-177.7	0.10	-13.5
50.0	0.06	-95.0	7.15	171.4	0.10	170.1	0.09	-1.9
100.0	0.07	-100.1	7.14	159.2	0.10	156.7	0.10	2.6
200.0	0.11	-122.1	7.17	136.3	0.11	130.3	0.13	3.8
300.0	0.14	-141.7	7.08	114.7	0.11	108.4	0.14	-5.5
400.0	0.15	-166.3	7.16	91.0	0.11	86.6	0.17	-19.9
500.0	0.17	164.6	7.24	67.9	0.12	66.5	0.19	-38.9

AM-149

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
5.0	0.08	-46.1	5.82	-173.6	0.11	8.4	0.06	50.8
10.0	0.05	-27.8	5.87	-177.9	0.11	4.3	0.06	28.4
20.0	0.04	-8.9	5.84	178.6	0.11	2.5	0.06	15.8
50.0	0.05	25.2	5.82	170.8	0.11	1.4	0.06	8.6
100.0	0.07	39.8	5.82	161.3	0.12	0.6	0.07	10.1
200.0	0.12	32.0	5.80	142.6	0.12	-0.6	0.07	15.1
300.0	0.13	13.6	5.75	124.4	0.13	-3.0	0.06	42.2
400.0	0.14	-13.7	5.74	103.8	0.14	-6.9	0.07	57.0
500.0	0.14	-66.1	5.73	84.0	0.15	-13.0	0.10	49.8

AM-154

FREQUENCY	S11 MAG	S11 ANG	S21 MAG	S21 ANG	S12 MAG	S12 ANG	S22 MAG	S22 ANG
20.0	0.25	62.1	2.72	-165.1	0.17	-165.3	0.37	163.8
50.0	0.22	28.6	2.86	-177.4	0.17	-177.2	0.34	160.0
100.0	0.21	2.7	2.94	173.5	0.18	173.5	0.30	151.0
150.0	0.20	-14.0	2.96	166.3	0.18	166.3	0.29	140.7
200.0	0.19	-27.7	2.97	159.4	0.19	159.4	0.27	130.4
400.0	0.19	-74.5	2.92	134.2	0.21	134.2	0.24	82.3
600.0	0.20	-117.3	2.85	109.3	0.22	109.3	0.27	17.8
800.0	0.23	-156.9	2.82	86.1	0.25	86.4	0.30	-54.0
1000.0	0.26	159.5	2.80	63.8	0.27	63.8	0.32	-107.7

FREQUENCY IN MHz

AM-155

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
300.0	0.30	42.3	4.05	166.3	0.18	173.3	0.36	87.8
350.0	0.26	12.9	4.12	153.2	0.18	161.3	0.33	80.5
400.0	0.24	-25.7	4.13	142.0	0.19	150.6	0.30	76.2
500.0	0.20	-88.2	4.03	122.0	0.20	131.8	0.28	73.4
600.0	0.23	-123.0	3.94	104.9	0.20	115.3	0.27	67.8
700.0	0.26	-144.7	3.88	89.4	0.21	100.1	0.28	51.3
800.0	0.29	-163.9	3.88	74.5	0.21	85.2	0.28	21.3
900.0	0.27	175.6	4.01	59.5	0.22	69.8	0.30	-20.2
1000.0	0.25	147.1	4.22	41.3	0.23	53.6	0.32	-63.0

AM-160

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0	0.14	126.3	28.21	-5.6	0.01	-18.0	0.07	-73.4
150.0	0.12	56.7	28.30	-53.5	0.01	-68.5	0.08	-144.7
200.0	0.08	-15.5	27.45	-93.3	0.01	-108.2	0.09	150.5
250.0	0.17	-67.8	26.79	-126.3	0.01	-143.8	0.10	101.3
300.0	0.18	-87.7	25.37	-155.5	0.01	-178.1	0.12	64.4
350.0	0.18	-96.1	25.42	172.0	0.01	149.5	0.14	34.6
400.0	0.23	-115.4	24.92	141.7	0.02	120.6	0.11	4.7
500.0	0.27	175.5	25.67	78.7	0.02	59.1	0.10	-101.1
600.0	0.32	19.1	25.58	0.7	0.02	-14.6	0.24	143.7

AM-162

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.07	165.0	4.06	6.6	0.16	6.8	0.11	169.1
20.0	0.09	-166.8	4.13	-6.5	0.17	-5.8	0.09	-158.2
30.0	0.08	-151.5	4.18	-15.8	0.17	-15.2	0.09	-129.5
40.0	0.10	-146.9	4.20	-24.0	0.17	-23.3	0.11	-120.3
50.0	0.11	-147.9	4.23	-32.2	0.17	-30.9	0.12	-117.7
60.0	0.11	-152.0	4.19	-39.8	0.17	-38.6	0.13	-118.5
70.0	0.12	-159.7	4.20	-47.7	0.17	-46.0	0.14	-120.3
85.0	0.12	-171.5	4.17	-59.5	0.16	-57.7	0.14	-122.6
100.0	0.12	174.1	4.15	-72.1	0.16	-69.8	0.15	-123.6

AM-175

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.14	-0.6	6.01	-177.2	0.09	3.0	0.05	177.7
10.0	0.13	-1.7	5.99	-179.9	0.09	1.7	0.04	-171.3
20.0	0.12	-2.9	5.92	178.2	0.09	0.6	0.04	-173.0
50.0	0.12	-2.9	5.92	173.7	0.09	-0.6	0.04	-169.0
100.0	0.12	-7.9	5.89	167.9	0.10	-1.9	0.04	-166.8
250.0	0.12	-17.0	5.83	149.3	0.10	-5.3	0.04	-167.4
500.0	0.12	-49.0	5.80	119.2	0.10	-11.9	0.04	163.7
750.0	0.13	-108.5	5.78	89.3	0.10	-21.6	0.05	94.4
1000.0	0.17	-175.3	5.82	57.4	0.11	-36.0	0.13	22.0

AM-176

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.14	151.3	4.59	-168.1	0.13	-0.9	0.12	144.6
10.0	0.14	168.4	4.67	-175.5	0.13	0.1	0.10	156.3
20.0	0.14	178.2	4.61	-179.6	0.13	0.0	0.09	166.5
50.0	0.14	167.9	4.61	174.5	0.13	-0.1	0.09	170.5
100.0	0.13	161.6	4.58	168.6	0.13	-1.0	0.08	166.8
250.0	0.12	132.4	4.56	150.1	0.14	-3.5	0.08	149.9
500.0	0.10	83.9	4.57	119.8	0.15	-9.0	0.07	121.3
750.0	0.08	39.7	4.52	89.1	0.16	-17.7	0.05	76.1
1000.0	0.04	-91.4	4.39	58.4	0.16	-28.4	0.07	-9.9

AM-180

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.20	-156.1	2.97	-173.1	0.17	8.6	0.24	166.9
20.0	0.21	-169.7	2.98	-177.4	0.17	4.4	0.23	170.3
40.0	0.22	-174.2	3.01	179.0	0.18	1.7	0.22	171.1
100.0	0.23	174.3	3.02	171.6	0.18	-1.4	0.21	166.1
200.0	0.18	170.9	3.01	162.0	0.18	-4.5	0.20	154.5
500.0	0.13	149.3	3.05	134.3	0.19	-14.1	0.18	113.3
1000.0	0.07	-140.6	3.12	86.4	0.20	-35.9	0.17	5.5
1500.0	0.18	-133.3	3.05	32.4	0.18	-59.6	0.20	-93.3
2000.0	0.24	-168.2	3.01	-23.7	0.17	-76.2	0.26	-147.3

AM-181

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.13	111.1	2.58	12.4	0.29	13.1	0.14	112.3
20.0	0.08	121.6	2.59	2.7	0.29	3.5	0.10	113.0
50.0	0.07	170.9	2.62	-9.0	0.29	-8.2	0.03	127.1
100.0	0.06	-128.6	2.63	-22.8	0.29	-21.7	0.05	-117.5
150.0	0.09	-131.5	2.64	-35.8	0.29	-34.2	0.09	-122.8
200.0	0.12	-136.6	2.64	-49.3	0.28	-46.8	0.13	-134.3
250.0	0.17	-141.8	2.64	-62.3	0.27	-59.3	0.15	-148.8
300.0	0.19	-146.8	2.65	-76.1	0.27	-72.6	0.16	-168.4
400.0	0.22	-151.6	2.68	-105.9	0.25	-102.4	0.17	116.1

AM-183

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
5.0	0.14	-148.3	31.43	17.9	0.01	1.9	0.20	177.2
10.0	0.13	170.1	32.36	6.3	0.01	1.6	0.12	92.7
20.0	0.13	-178.3	32.65	-2.6	0.01	1.3	0.09	69.8
50.0	0.12	179.2	33.31	-13.6	0.01	-0.5	0.06	-72.9
100.0	0.11	-178.0	33.09	-29.3	0.01	-2.1	0.05	-98.1
250.0	0.12	171.1	31.87	-71.9	0.01	-9.3	0.06	-123.4
500.0	0.12	129.7	29.37	-144.8	0.01	-22.1	0.17	-153.9
750.0	0.14	-44.0	27.01	145.8	0.01	-45.8	0.25	178.1
1000.0	0.23	150.0	30.09	65.9	0.01	-97.1	0.28	80.0

AM-184

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.13	-171.5	10.33	6.2	0.03	4.5	0.10	80.7
20.0	0.12	-175.9	10.18	0.3	0.03	2.8	0.08	47.2
40.0	0.12	174.9	10.48	-4.6	0.03	1.4	0.08	7.2
100.0	0.12	165.0	10.51	-15.7	0.03	-1.8	0.06	-38.9
200.0	0.12	149.1	10.42	-32.4	0.03	-4.8	0.05	-76.4
500.0	0.12	105.1	10.13	-79.8	0.03	-12.1	0.10	-131.1
1000.0	0.12	9.8	9.60	-156.4	0.03	-27.2	0.12	173.5
1500.0	0.14	-99.8	9.53	126.5	0.02	-51.5	0.14	-89.3
2000.0	0.28	176.9	9.63	53.4	0.01	-75.0	0.30	-142.7

AM-185

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
10.0	0.08	179.9	9.00	6.0	0.03	6.7	0.12	160.6
20.0	0.07	172.6	9.03	0.1	0.03	3.6	0.10	168.3
40.0	0.07	167.7	9.07	-5.0	0.03	1.8	0.08	178.4
100.0	0.07	161.8	9.07	-16.5	0.03	-1.3	0.09	-171.7
200.0	0.09	138.6	8.95	-34.4	0.03	-4.3	0.10	-163.8
500.0	0.11	91.0	8.71	-84.2	0.03	-10.3	0.17	-169.7
1000.0	0.16	20.4	8.73	-163.9	0.03	-22.7	0.18	155.3
1500.0	0.18	-80.6	8.32	116.8	0.03	-44.2	0.16	150.0
2000.0	0.25	157.6	8.59	34.4	0.02	-48.8	0.27	-158.9

AM-191

	S11		S21		S12		S22	
FREQUENCY	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
100.0	0.33	-115.7	14.54	-143.3	0.02	-143.4	0.20	-171.1
150.0	0.25	-128.6	15.35	167.9	0.02	-168.5	0.25	121.6
200.0	0.17	-148.7	15.32	133.1	0.02	-130.5	0.27	8.5
250.0	0.16	-165.8	15.47	103.0	0.01	96.3	0.29	-43.6
300.0	0.16	177.3	15.07	76.5	0.01	63.3	0.29	-79.5
350.0	0.17	165.0	14.37	51.7	0.01	30.8	0.26	-109.7
400.0	0.18	157.2	14.16	27.6	0.01	0.9	0.24	-140.3
500.0	0.21	176.3	14.33	-17.6	0.02	-44.7	0.21	-4.6
600.0	0.30	-174.0	15.11	-68.9	0.02	-86.9	0.23	-59.4

FREQUENCY IN MHz

Specifications Subject to Change Without Notice.

Application Note

RF Amplifier Flatpack Installation Data

M528

M/A-COM products come in a variety of package styles, but they can be separated into three general categories: flatpacks, plug-in packages, and connectorized packages. The flatpack units can further be separated into RF/IF flatpacks and microwave flatpacks. RF/IF flatpacks have ground leads for installation while microwave flatpacks require direct grounding to the case. Plug-in packages include TO-5 and TO-8 packages, relay headers and other types of dual-in-line packages.

The installation of plug-in packages, except for amplifiers, is self evident and follows conventional printed circuit board mounting practices. Information describing mounting and heat sinking amplifiers is presented below:

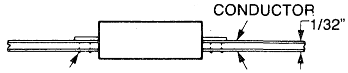
INSTALLING RF/IF FLATPACK DEVICES

The M/A-COM "AM-xxx" series of RF/IF flatpack signal processing components are designed for maximum RF performance plus convenient installation in microstrip, stripline or printed circuit board configurations. While they physically resemble familiar integrated circuit packages, the techniques used to achieve maximum performance are somewhat different and perhaps unfamiliar. Their interference to circuitry becomes increasingly important when operating at frequencies above several hundred Megahertz. Since all circuitry contained within the M/A-COM flatpacks is impedance matched, maximum performance is achieved by minimizing the discontinuities between the 50 ohm flatpack and associated circuitry. Three alternate methods of mounting and interfacing are described, categorized by their upper frequency limits of operation.

METHOD I	Specification performance over entire frequency range
METHOD II	Convenient installation-specification performance to 500 MHz
METHOD III	Lowest cost installation-specification performance to 100 MHz

METHOD I

This microstrip interface to the flatpack provides full performance over the unit's entire frequency range and requires no external compensation. The ground paths must be as direct as possible, using plated-through-holes or foil extending from the ground plane through the dielectric material to the lead attachment point as shown in Figure 1. Note that the flatpack is installed in a cut-out area of the circuit board. The purpose of this is to minimize discontinuities and also to provide the extremely low inductance ground paths necessary for good high frequency operation. Also observe the slight chamfer of the microstrip signal conductors that prevents their shorting to the flatpack case. This technique of interfacing to the flatpack allows high performance to above 3 GHz.

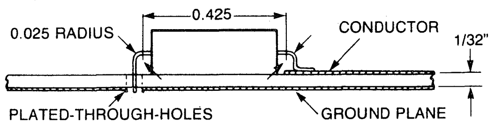


METHOD I — High performance microstrip installation in 1/32" glass teflon board, copper clad 2 sides

Figure 1

METHOD II

Method II is a microstrip interfacing technique for frequencies up to 500 MHz. The package installation is easier, but full performance to 500 MHz requires external compensation. The minimal lead inductance added by this method does not adversely affect performance below 250 MHz and requires no external compensation. For operation to 500 MHz, compensation is needed and is added in the form of a lumped capacitance of 1 to 2 pf from the signal leads to ground. This can be either a discrete capacitor or a distributed form using a stepped discontinuity in the connecting transmission lines to add the required capacitance. This technique transforms the undesirable signal lead inductance into an element of lowpass filter having a cutoff frequency of 1 GHz, if dimensions are followed closely. An excellent way to accomplish this compensation is to extend the microstrip conductors at right angles at the flatpack lead attachment point to form a lumped capacitance as in Figure 2, point A. This capacitance can be easily altered in prototyping by varying the area of the stepped discontinuity to achieve maximum performance.

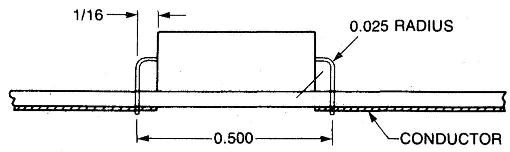


METHOD II – Installation in 1/32" glass teflon board, copper clad 2 sides

Figure 2

METHOD III

Method III consists of mounting the flatpack on a conventional PC board, using the low package profile to gain higher packaging densities that result from closer center-to-center spacing of the printed circuit boards. The leads are formed by a bending fixture to the dimensions shown in Figure 3 and the flatpack is then installed in the conventional manner. This technique is usable to 100 MHz covering the majority of IF signal processing requirements. When high frequency operation is desired, refer to Methods I and II.



METHOD III – Printed circuit board installation

Figure 3

491

Application Note

Plain Talk On Log Amps

M529

Understanding how the IF log amp relates to other components in a receiving system can clear up many questions surrounding anomalies in measured video output, bandwidth, pulse fidelity, and dynamic range.

THE ubiquitous logarithmic amplifier can be found in the IF sections of nearly all radar, ECM, and other receiving systems. But in spite of the amplifier's commonality, engineers are routinely misled when they apply linear reasoning to a nonlinear transfer characteristic, and fail to evaluate the impact of other components in the system on the performance of the log amp.

Apparent anomalies in video output level, dynamic range, bandwidth, and pulse response can often be traced to improper measurements or assumptions. For example, CW leakage from a test generator can make a log amp appear to have less dynamic range than it can actually deliver in a system. On the other hand, too much system preamplifier gain may restrict dynamic range and video output level to less than that measured in the lab. Questions of pulse fidelity are also important. Many designers forget that the amplifier's logging action also applies to the leading and trailing edges of pulses, not just to their peaks. Even simple tasks such as evaluating 3-dB bandwidth can be brainteasers with a log amp. (Think about it: Is the 3-dB point really 0.707 times the peak amplitude?)

Log amps translate a wide input range to a much narrower range by using a known logarithmic transfer function. This offers a major advantage over loop-type systems: a wide instantaneous dynamic range is available without the limitation of AGC time constants. A log amplifier typical of many of those used in today's systems might have the following specifications:

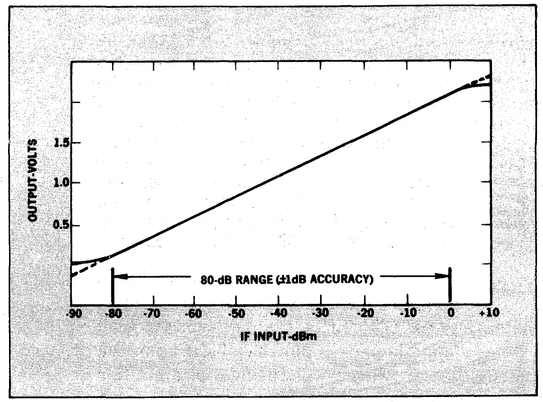
• Center frequency/bandwidth	60/20 MHz
• Input dynamic range	−80 to 0 dBm
• Log accuracy	±1 dB
• Rise time	50 ns
• Video output	0.1 to 2.1 V

These specifications will be used to illustrate four areas of concern to engineers today.

Lack of dynamic range

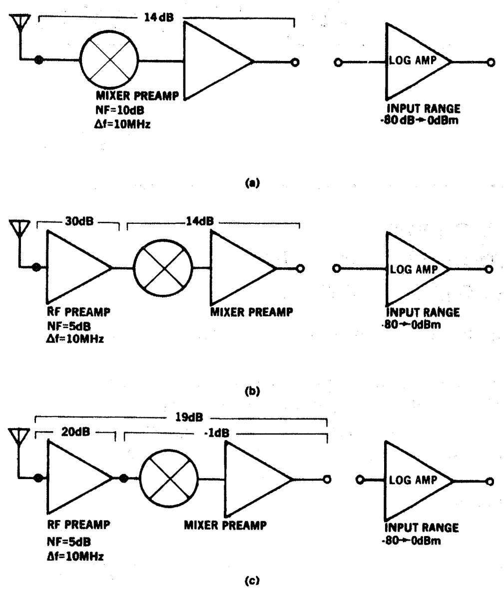
The transfer characteristic of a log amplifier is a straight line when the output, in volts, is plotted against the input, in dBm. As shown in Fig. 1, the slope of the reference amplifier is a constant and may be expressed as mV of output per dB change in input. Slope, therefore, defines dynamic range when related to output voltage. Generally, the gain of a log amplifier cannot be defined in conventional terms; the slope and the end points of the curve are specified instead. In the log amp defined above, the transfer slope is 25 mV/dB.

The dynamic range of a log amplifier can be checked easily enough by using a pulsed or CW source. However, avoid using a pulse generator that has a poor on/off signal ratio. When using a pulsed CW signal source, the turnoff characteristic of the source shows up as a video pedestal in the output. For example, if the generator is set at 0 dBm, the top of the log amp output pulse is at the 2.1-V level. If generator output was completely turned off, no pedestal would be seen since the pulse bottom at the log amp output would be at (or very near) 0 V.



1. A plot of a log amp transfer function reveals its accuracy; in this case ±1 dB over an 80-dB range.

But difficulties arise if the pulsed CW source doesn't turn off completely—for instance, if the output voltage dropped from 2.1 V to 0.85 V. This would indicate that the input signal had dropped by only 50 dB (2.1-0.85/0.025 = 50). Assuming the video output is DC-coupled, generator leakage appears as a DC pedestal. The AC component of this signal generator seen in the video output appears to remain constant from an output level of 0 dBm down to −30 dBm.



*2. **Don't provide too much gain** ahead of a log amp. Reduced dynamic range can result. In (a), equivalent input noise at the mixer preamp is −94 dBm and −80 dBm at the output. Usable dynamic range is 80 dB. In (b), an RF preamp with 30 dB gain precedes the mixer. Noise contributed by the preamp moves the dynamic gain range window upwards on the transfer curve. Net dynamic range has been reduced by 25 dB. A cure for reduced dynamic range is shown in (c). The preamp has less gain (20 dB) than in (b) (30 dB). By lowering preamp gain, system noise is reduced: the 80-dB range is restored.*

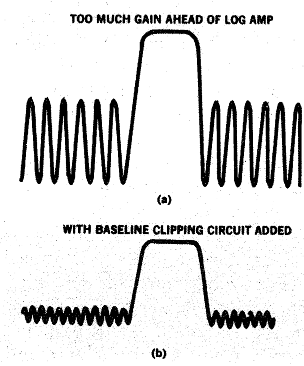
The important fact to remember is that the amplifier is logging over a wide dynamic range; the user sees this range displayed instantaneously. In a linear system, a voltage level 40 dB below the top of the pulse might be obscured in the base line of an oscilloscope display. But using a log amplifier with an 80-dB dynamic range, an output level 40 dB down (referenced to the top of a 0-dBm pulse) appears halfway down, or at the 50-percent point.

Providing too much gain ahead of the log amplifier also has the effect of reducing dynamic range. In most systems, the log amplifier is preceded by a mixer-preamplifier, as shown in Fig. 2(a). The equivalent noise at the mixer preamp input is −94 dBm and −80 dBm at the output. Note that the noise power (−80 dBm) presented into the log amp lies at the bottom end of its dynamic range (−80 dBm). The system, therefore, has a usable dynamic range of 80 dB.

In Fig. 2(b), an RF preamplifier with 30-dB gain is added. If the equivalent noise at the RF preamp input is −99 dBm, the noise presented into the log amp is −55 dBm. The input noise to the log amplifier is now 25 dB above the logging threshold of—80 dBm. As a result, net dynamic range has been reduced by 25 dB.

Figure 2(c) illustrates a possible cure for such a system where an RF preamplifier is involved. The use of a low-noise preamplifier will generally improve the sensitivity of the system by several dB since the noise figure of such a preamplifier will usually be less than the mixer preamplifier noise figure. However, the top end of the dynamic range is reduced by the use of an RF preamplifier and the overall system dynamic range will generally be less, unless a configuration such as that shown in Fig. 2(c) is considered.

The equivalent noise at the input to the RF amp is −99 dBm. To present noise at −80 dBm to the log amp requires an overall gain (RF preamp plus mixer preamp) of 19 dB.



*3. **Baseline clipping** is one method used to improve the apparent system signal-to-noise ratio. But a loss of dynamic range is one drawback of this technique.*

Since the RF preamp has 20 dB of gain, the mixer preamp must have −1 dB of gain. Based on a 7-dB mixer conversion loss, a preamp with 6-dB gain is required. Net mixer preamp gain is therefore −1 dB.

In a practical design, opt for approximately 10-dB gain, and adjust mixer preamp output with a resistive pad. Be sure the amplifier/pad combination has greater than 0-dBm output capability to preserve the top end of the dynamic range.

What happened to my SNR?

In a linear system, signal-to-noise ratio (SNR) is usually not affected by changes in gain level. The opposite is true of a system using a log amplifier. Consider the case of systems with and without an RF preamp, as shown in Figs. 2(a) and 2(b), respectively. In both, the signal level at the antenna is assumed to be −60 dBm. In Fig. 2(a), a −80-dBm noise level at the log amp input produces an output of 0.1 V; an input signal of −46 dBm (−60 dBm + 14 dB) yields an output of 0.9 V. System output SNR, therefore, is 9:1.

In Fig. 2(b), both the noise level at the input to the log amp and the signal level at the log amp have been increased by 30 dB. The signal produces a log amp output of 1.7 V; the noise floor, however, is at 0.8 V. So the apparent signal-to-noise ratio is now slightly over 2:1. The point here is to maintain the effective noise power at the log amp input as close to the bottom of the log transfer curve as possible.

If it is not practical to change the system ahead of the log amp, consider reducing the log amp sensitivity by either adding a resistive pad at the input, or modifying the basic design. Adding an input pad will move all signal levels down on the log curve. So, the output of the device ahead of the log amp must have a high enough output capability to reach the top end of the log amp input dynamic range (0 dBm) with the pad in place. For instance, if a 10-dB pad is inserted ahead of the log amp, the driving amplifier needs a top-end capability of at least +10 dBm.

Another method used to correct poor SNR is baseline clipping. However, this cures the symptom not the cause, and still results in a loss of usable dynamic range. If baseline clipping is used (Fig. 3), excess noise ("grass") can be sliced off the bottom. The signal-to-noise appears to be improved.

Bandwidth variation: Why?

In a typical log amp, the bandwidth often appears to broaden and be, at the same time, sensitive to signal level. Why? This is normal logging action.

The key factor is our definition of bandwidth: the 3-dB point is *not* 0.707 of the output. Remember, using the amplifier example chosen, the output slope is 25 mV/dB in the logging region. The 3-dB bandwidth is therefore represented by the frequencies where output is down 3 x 25=75 mV.

If the log amp incorporates an input filter to establish the desired bandwidth, the stages which follow generally have a much wider bandwidth than the input filter. This arrangement minimizes variations in bandpass and overall amplifier time delay. The latter is important when time-of-arrival information is critical. Typically, a log amp will exhibit delay variations of 25 percent of the rise time over its dynamic range.

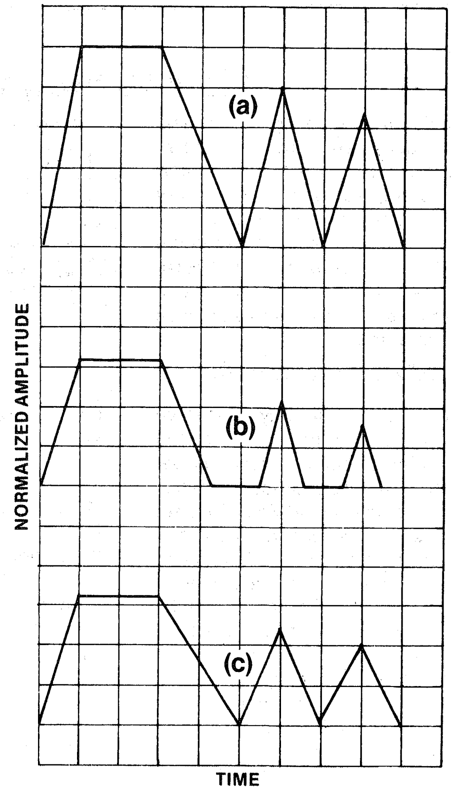
Watch pulse fall time

In a properly functioning log amplifier, the pulse fall time changes with signal level, and is apparently "stretched;" this shows that the amplifier is logging. In a linear system, fall time is the time interval for the pulse to fall from its 90 percent point to its 10 percent point, a level decrease of approximately 19 dB. Since the input pulse decays exponentially, it falls another 19 dB in the next "fall time." If the peak pulse level is 76 dB above the logging threshold, it takes 76/19, or 4 "fall times" to reach the baseline. Thus, if the input pulse has a fall time (amplitude declining from 90 percent to 10 percent) of 0.2 μs, it will take 0.8 μs to reach the logging threshold.

Pulse fidelity vs. junk

A properly designed log amplifier exhibits good transient response over the full dynamic range. The engineer can verify this with a lab bench evaluation, yet find that in the system the pulse contains spurious components ("junk"), usually on the trailing edge.

Figure 4(a) shows a typical example. Here, the junk reflects the true trailing edge of the pulsed IF signal being fed into the log amplifier. This was not visible before, but is seen now that a wide-dynamic-range signal is being viewed instantaneously.



*4. **Spurious components (junk) oftentimes** appear on the trailing edge of a pulse. These can lead the designer to diagnose faults either within the system or elsewhere. In (a), the true trailing edge of a pulsed IF signal is displayed. By reducing the IF level, the engineer can tell if the pulse is in the signal (b), or in the log amp/video processor (c).*

If the input signal is at a 0-dBm level, the 50-percent point of the log video output is 40 dB below the pulse top, and is probably invisible on a linear display. (Using an oscilloscope with a 4 cm/division display, a signal 35 dB-down is a scant 0.4 mm above the baseline.) But viewing the same pulse via a log amp offers an engineer the opportunity to see the pulse characteristics clearly over the full dynamic range.

To verify that garbage viewed is part of the pulse, and not in the system, reduce the input IF level by 30 dB. If the abnormality stays down the same number of milliwatts it's part of the signal (see Fig. 4(b)). But if it scales down (stays at the same percentage point), as in Fig. 4(c), it's introduced by the log amp and/or video processor.••

How to test, what to measure

Using the following techniques, most users are able to perform some basic tests of a log amplifier. There are essentially two primary measurements and two secondary ones. The primary measurements are log transfer function and pulse fidelity; the secondary measurements are bandwidth and noise power output.

Log transfer function

The most accurate way to observe the transfer function of a log amplifier is with a log amp test set such as the TSL series of instruments developed at RHG. The set consists of a crystal oscillator, which when switched off, provides a true exponential signal decaying down to noise. But you can make these measurements using readily available test equipment.

Equipment needed (a):
(a) CW signal source with built-in (or external) calibrated attenuator.
(b) Digital voltmeter.

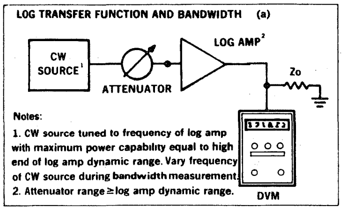
This procedure is valid for log amps with a direct coupled video output.

Procedure

(1) With the input terminated, and no signal input present and with a proper output load on the log amp, null the DC voltage appearing at the output connector using the log amp DC output adjustment. If a zero cannot be achieved, note the reading.
(2) Slowly increase the input IF signal level until the DC output starts to rise. Read the input IF level, and the output DC voltage. Record both these readings as the input signal level is raised in small (5 dB or so) increments. The accuracy of this plot is primarily determined by attenuator accuracy. The digital voltmeter should not contribute errors.

Pulse fidelity

Equipment needed (b):
(a) Pulsed IF generator (such as the Kay Radapulser)



(b) Suitably fast oscilloscope
(c) Attenuator, if not built into generator

Procedure

(1) Connect the IF source to the log amp.
(2) Connect the video output to a scope with proper load termination.
(3) View pulse fidelity over its dynamic range.
(4) Confirm the output level amplitude for pulsed vs. CW conditions at a mid-range power level. Some error is to be expected here due to generator power calibration errors.

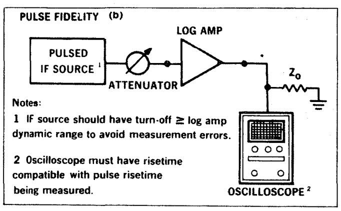
Bandwidth

This measurement (or parameter) is generally not important if the pulse fidelity noise measurements are satisfactory.

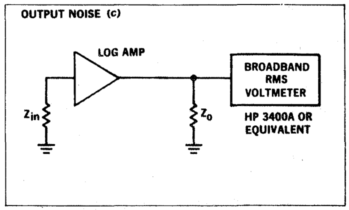
Equipment needed (a):
(a) Tunable IF signal source
(b) Digital voltmeter

Procedure

(1) Establish an output reference level somewhere in the middle of the dynamic range, with the signal generator set at center frequency.
(2) Take the log slope in mV/dB, and multiply by 3. Using the example log amp, 25 mV x 3= 75 mV.



(3) Hold the signal generator output constant and vary its frequency above and below center frequency to a frequency where the output is reduced by 75 mV. This point represents the 3-dB bandwidth.



Output noise

The noise output of a log amp is directly related to its bandwidth, noise figure, and of course, gain. Measuring noise figure is difficult at best, and generally not too meaningful; it does not provide a good indication of the noise power output.

A more important measurement is the output noise which is readily measured.

Equipment needed (c):
(a) RMS voltmeter with bandwidth compatible with video response of log amp. For the log amp example, a voltmeter with 10-MHz bandwidth is desirable such as a HP3400A or equivalent.

Procedure

(1)Terminate the log amp input and output appropriately. Measure the output noise. This noise measurement is now indicative of the log amp's contribution. To establish that this noise is not limiting the overall system, take the measurement again with the system ahead of the log amp connected. If the reading is not at least 3 dB higher, system parameters should be reviewed. Typical log amps with sensitivity and bandwidths of the type reviewed here will show 100 to 200 mV RMS output noise.••

Termination Insensitive Mixers (TIM)

M532

INTRODUCTION

How many times have you been frustrated by the failure of a mixer to provide expected or stated data sheet performance in system use? How does one design a system if, in the real world, component performance varies widely from unit to unit and measured system performance changes from day to day. For mixers, TIM (Termination Insensitive Mixers) solves that problem and provides data sheet performance in the real world environment. This article presents comparisons between TIM and other standard double balanced mixer types and explains what TIM is and why it outperforms conventional mixers in actual system applications.

This application note supports the following standard M/A-COM mixers:

- MD-160
- MD/MDC-161
- MD/MDC-162
- MD/MDC-163 (biasable)
- MD/MDC-164
- MD/MDC-169
- MD/MDC-174 (high-power +30 dBm IP^3)
- MD/MDC-179

CONVENTIONAL DOUBLE BALANCED MIXERS

Until now, there were essentially four types of double balanced mixers, all based on the same basic ring configuration (Figure 1).

Class I – The most common design consists of a pair (or more) of ferrite-core wideband transformers with four diodes connected in a "ring" configuration. Nominally, these components require about +7 dBm LO (local oscillator) drive power.

Class II, type 1 – This type also uses the ring topology with two series-connected diodes in each arm. The eight diodes may be similar or different. LO drive levels typically range from +13 to +17 dBm.

Class II, type 2 – These rely on a ring connection, but feature a precision resistor in series with a single diode in each arm. These four-diode designs are typically driven at +17 dBm.

Class III – These are essentially Class II, type 2 circuits with a large capacitor connected in parallel with the precision series resistor, and they are driven by an LO signal in the +20 to +30 dBm range.

The inclusion of additional series or parallel combinations of diodes does not alter the classification of a given mixer. Such modifications may allow the component to accept a higher LO drive level to reduce intermodulation distortion.

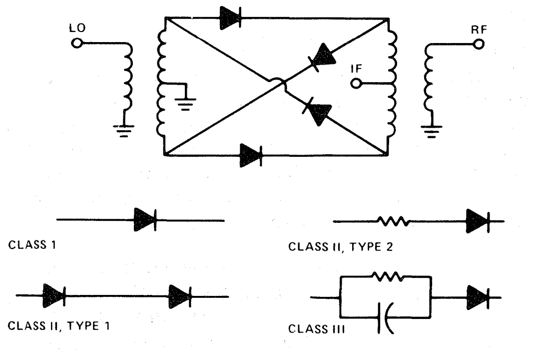


Figure 1. Standard double balanced mixer schematic

WHAT IS TIM?

TIM is a unique mixer circuit that allows flat intermodulation performance, flat conversion loss, and low spurious generation independent of system mismatch. This is achieved in a circuit which consists of a transmission line hybrid network driving two sets of diodes (Figure 2). Isolation between each hybrid's opposite ports allows the LO to independently control the switching action of alternately conducting diode sets. The reverse bias applied to the "off" diodes is determined only by available LO input power and not by the diode's forward potential as in the conventional "ring" type mixers. An internal resistor absorbs mixer-generated, even-order LO frequency terms, and improves LO VSWR by internally terminating the hybrid port opposite its LO input. These circuit features improve performance by allowing TIM to closely approximate a "square wave" LO drive condition with input powers of only ± 10 dBm.

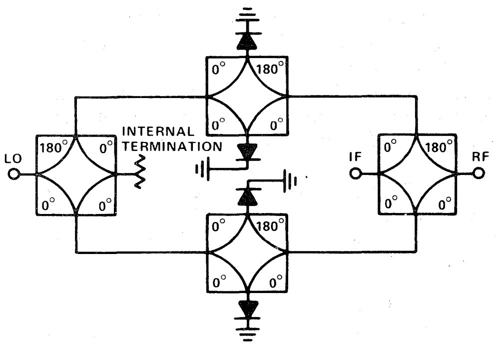


Figure 2. Termination insensitive mixer (TIM) schematic

TEST CONDITIONS UTILIZED FOR THESE COMPARISONS

To demonstrate TIM's superior performance in real system applications, several tests were run comparing TIM to other classes of double balanced mixers. Because several classes of mixers are available and an almost infinite number of frequency and impedance combinations are possible in a system environment, the measurements described in this article were limited to the following conditions:

- A single mixer was selected to represent each class.
- Mixer classes were compared at equal RF input powers, but used their respective recommended LO drive levels.
- All source and load impedances were matched except as specified.
- Impedance mismatched operation data was obtained for parameters which are most significantly affected by nonideal sources and loads.
- Commercially available mixers were used in all measurements.

Class III mixers have not been considered, except for intermodulation distortion, since their LO drive level requirements normally exceed +20 dBm making them a special case. However, a comparison of a high level TIM and a Class III mixer is expected to lead to similar improved performance and is presently under investigation.

INTERMODULATION DISTORTION

Study a data sheet for even the best low-distortion mixer and you will discover that the third-order IM response specified by the manufacturer is carefully qualified by a string of test conditions: tone separation, LO level, LO frequency, and termination impedances. Unfortunately, a system environment is not likely to provide these conditions, and, as the following measurements will show, the number that you see in the catalog is difficult to achieve in reality.
To actually see the reasons for these discrepancies, a swept intermodulation test stand is needed. (See Appendix for details.) Using this swept approach and varying specific parameters allows a clearer understanding of the mixers. For intermodulations distortion, two common problems faced by a system designer are analyzed:

1. IF difference frequency (F_{LO} - F_{RF}) is well matched while the termination to the sum frequency (F_{LO} + F_{RF}) is varied. This is the situation encountered when a narrow band filter is placed directly on the IF port of a mixer.
2. The return loss from both sum and difference frequencies are of equal magnitude but differ in phase angle. This is the case when a wideband amplifier is placed on the mixer IF port.

The third-order IM distortion performance of a typical Class I mixer (Figure 3) shows the effects of varying the sum frequency termination, while the difference frequency is terminated by 50 ohms (well matched). Observe that performance degrades significantly when only a moderate mismatch is created to the sum frequency. When the sum frequency is totally reflected, IM distortion has increased 25 dB, reducing the mixer's intercept point by more than 12.5 dB. Note also that, even in the matched case, the intercept point is not constant with frequency. Although other classes are not shown, similar results are obtained for the other classes of mixers.

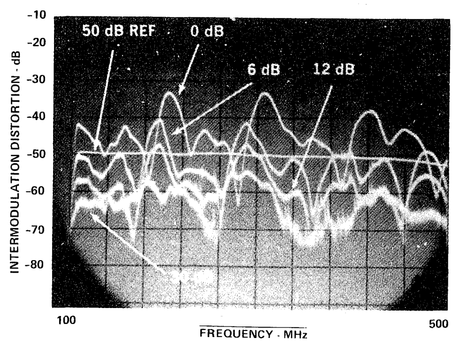


Figure 3. Class I mixer IM distortion
Difference frequency matched; sum frequency match varied.
P_{RF} = -15 dBm, P_{LO} = +7 dBm

Next, the effects of terminating the IF port with return-loss values of 30, 12, and 6 dB equal in magnitude but different in phase angle to sum and difference outputs were measured for each type of mixer. For a Class I mixer, Figure 4(A) shows significant variations in intermodulation performance as the RF is swept from 100-500 MHz. This example explains why padding each of the mixer's three ports – even by the accepted 10 dB value – does not necessarily guarantee 100 percent repeatable IM distortion measurements. In Figure 4(B), data for a Class II, type 1 mixer shows a slight improvement compared with Class I circuits, although the mixer's IM distortion still increases by approximately 12 dB under these same conditions. A Class II, type 2 mixer offers somewhat better performance, as shown in Figure 4(C), with only 7 dB more distortion than in a matched case. Note the comparatively smooth behavior even when the mixer is severely mismatched with a 6 dB return loss (3:1 VSWR). Series resistors are primarily responsible for this benign behavior, but not without a trade-off. The added resistance in each arm of the ring increases conversion loss 2 to 3 dB above that of a Class I design. Figure 4(D) illustrates the performance of a typical Class III mixer. The IM distortion behavior is ragged over the sweep range, with a peak of greater than 20 dB that is almost completely insensitive to changes in termination conditions. This characteristic is probably attributable to the combined reactances of the RF transformers and R-C diode biasing networks. The TIM unit in Figure 4(E) reveals a remarkably reduced susceptibility to IF port mismatch both in magnitude and phase. Note too that there is virtually no change in IM distortion under these conditions, and that the level of distortion is nearly constant with frequency. These comparisons show that TIM outperforms other mixers and provides the system designer with flat intermodulation distortion regardless of system match.

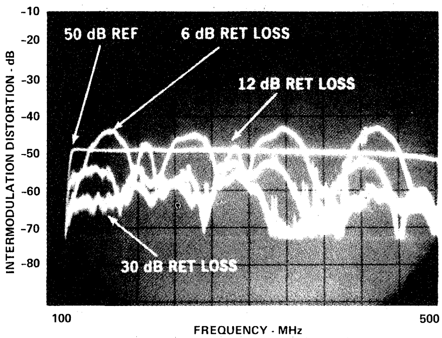


Figure 4(A) Class I
P_{RF} = -15 dBm, P_{LO} = +7 dBm

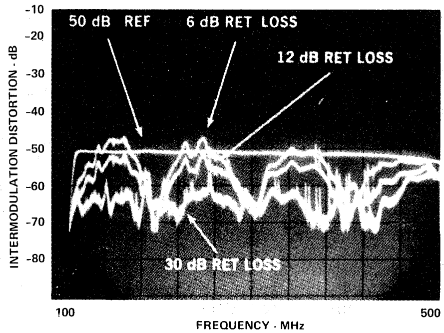


Figure 4(B) Class II, type 1
P_{RF} = -10 dBm, P_{LO} = +17 dBm

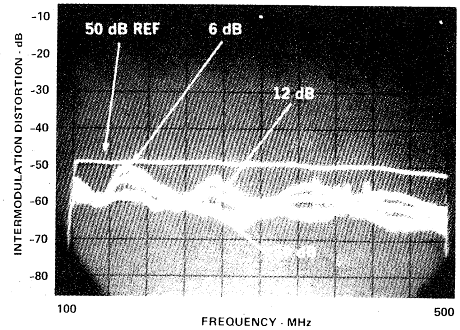


Figure 4(C) Class II, type 2
P_{RF} = -10dBm, P_{LO} = +17 dBm

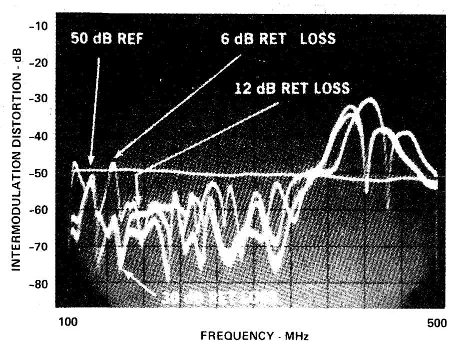


Figure 4(D) Class III
P_{RF} = 0 dBm, P_{LO} = +27 dBm

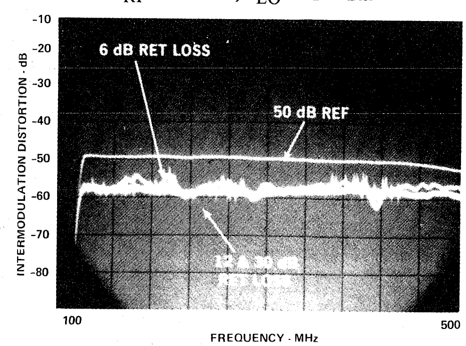


Figure 4(E) TIM
P_{RF} = -10 dBm, P_{LO} = +10 dBm

Figure 4. Intermodulation distortion return loss of equal magnitude but different phase angle at sum and difference frequencies

The TIM circuit was further tested to explore the effects of varying RF input level. All ports were terminated to provide a return loss of at least 20 dB, and the LO drive was fixed at + 10 dBm. Distortion data was taken at RF input levels of -15, -10, and -5 dBm. The results reveal that as the RF input level varies by ±5 dB, the IM distortion products change by nearly ±10 dB. This indicates that the mixer design has almost perfect linearity with respect to changes in RF input level, which implies a constant third-order intercept point.

Next, TIM was measured with the same termination conditions, but this time the RF input level was held constant at -10 dBm and the LO drive was varied from +7 to +17 dBm. The design responds predictably with a 2 dB change in IM distortion occurring for each 1 dB change in LO drive level.

Performance, for the particular TIM tested, over a 10 to 3500 MHz range, included 7 dB typical conversion loss and 30 dB typical isolation. This indicates that no penalties are incurred in these areas to obtain the advantage of reduced sensitivity to IF port mismatch.

To understand why we get these results we must look back to the construction of the different mixer types. In any of the conventional mixer circuits shown in Figure 1, the suppression of even-order frequency terms is dependent upon the symmetry and balance of the diodes and transformers used in the design. Cancellation effects can occur when one diode of an alternately conducting pair is biased at a slightly different level. The LO input current flows in series through each alternately conducting pair of diodes, while the RF input current passes through the same pair of diodes in parallel (Figure 5). The grounded center-tap LO transformer acts as a short circuit to even-order frequency terms which, in theory, prevents even-order voltages from appearing across the transformer's balanced secondary. However, the finite series resistance (R_S) of the diode allows even-order voltages to develop at the RF transformer connection node.

Obviously, it is possible to have different values of current flow in each diode, creating an unbalanced condition. If the RF input power is very small, these effects lead to negligible IM distortion cancellation. The relative RF input power levels where cancellation begins are approximately -15 dBm for a Class I mixer, -10 dBm for Class II types, and 0 dBm for a Class III design. Each class of mixer must be measured at or below these respective RF levels to accurately determine the third-order intercept point. Apparent improvements in IM distortion are sometimes seen when mixers are tested at higher RF input levels than their generic designs should allow.

Conditions similar to those responsible for IM distortion cancellation can also lead to serious increases in IM distortion. A double-balanced mixer can be viewed as a bi-phase modulator wherein the RF port is commutated to the IF port with a 180-degree phase reversal occurring during each half of the LO cycle. It follows then, that the mixer's RF input impedance is theoretically a direct function of its IF port termination impedance. If an RF source is connected to the RF port of a mixer that has a completely reflective IF port termination, the RF input voltage or current acting upon the diodes

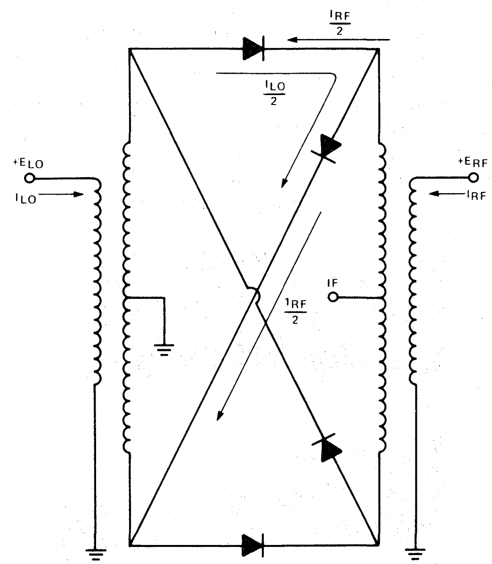


Figure 5. LO + RF Current Flow Class I Mixer

may be up to two times the matched RF voltage or current available to the mixer with a perfectly matched termination. Intermodulation products generated by each of the diode's higher-order (fourth and sixth) coefficients of a series expansion around an LO bias point are summed at the mixer's IF port. Two conclusions can be drawn from this fast analysis: the ratio of IM distortion products changes 2 dB per dB with respect to changes in the RF input level, and conditions are possible where voltage or current might be twice the values under matched conditions. Armed with these two concepts, it is easy to understand why IM distortion, in a typical double balanced mixer, might increase drastically as the termination, at the IF port, becomes more reflective.

The TIM circuit, however, consists of a network of hybrids driving two sets of diodes. The design allows the LO to independently control alternately conducting sets of diodes. Thus reverse bias is not limited by the forward potential across the conducting diode pair. An internal termination provides the required isolation between the alternately conducting diodes, and also absorbs the unwanted even-order frequency terms. Thus, TIM provides the insensitive characteristics for intermodulation distortion to IF mismatch.

The relationship between IM distortion and IF port VSWR is summarized in Figure 6 for the four classes of mixers described earlier. The data is averaged, and intended only as a comparative guideline; it does not take into account frequency effects or the extremely ragged peaks of IM distortion exhibited by some classes of mixers.

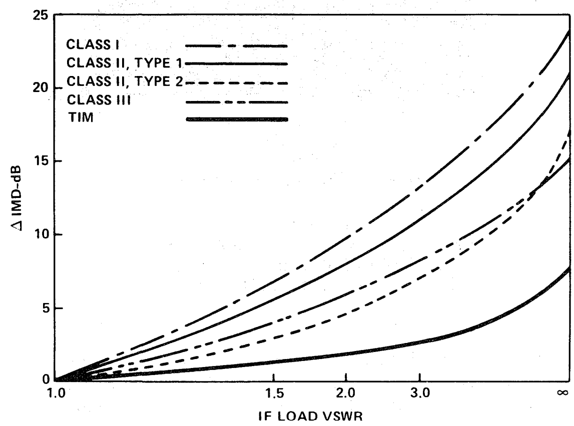


Figure 6
Intermodulation vs Mismatch
Average characteristics for different mixer types

CONVERSION LOSS

Manufacturers specify conversion loss in an ideal 50 or 75 ohm system for a very good reason: it varies greatly with port mismatches. Amplitude ripple, much larger than one would expect from a simple VSWR problem, can appear over the frequency range. During mismatch calculations, designers often fail to use the worst-case equivalent which is the cascade of two devices. This is determined by multiplying the adjacent device's VSWR by the mixer VSWR. A mixer VSWR of 2:1, a device VSWR of 2:1, and an electrical separation of one-quarter wavelength or more can produce a 4:1 system VSWR and about 1.95 dB conversion loss variation or ripple if the frequency band is an octave or more.

Figure 7(A) shows a Class I mixer's relative conversion loss from 100 to 600 MHz at a +10 dBm LO drive level and -10 dBm RF input. The LO and IF ports are terminated in 50 ohms. The RF source return loss is varied from 30 dB (a nearly perfect 50-ohm impedance) to values of 12 dB and 6 dB. By assuming a mixer RF input VSWR of 2:1 and multiplying the VSWRs, the 12 dB source termination should produce about 1.5 dB, and the 6 dB case should cause nearly 3 dB conversion loss ripple. The actual mixer performed a little better than theory predicts, particularly at lower frequencies, due to the fact that the Class I mixer VSWR measured closer to 1.5:1 than the assumed 2:1.

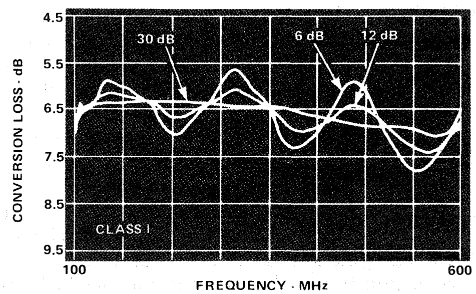


Figure 7(A)
Class I mixer
P_{RF} = -10 dBm, P_{LO} = +10 dBm

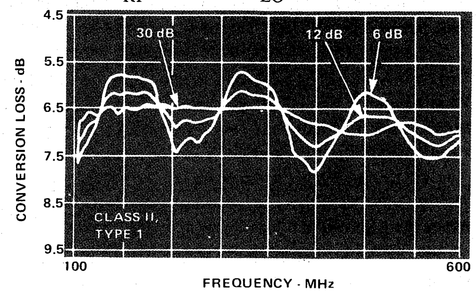


Figure 7(B)
Class II, type 1
P_{RF} = -10 dBm, P_{LO} = +17 dBm

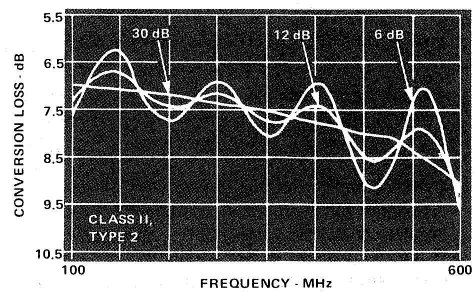


Figure 7(C)
Class II, type 2
P_{RF} = -10 dBm, P_{LO} = +17 dBm

The multidiode Class II, type 1 mixer is evaluated under the same test conditions, Figure 7 (B), except that the LO level is increased to +17 dBm. The test results show this type of mixer has more conversion loss ripple than a Class I type when terminated in a mismatched RF source impedance. Figure 7(C) shows the performance of the resistor-diode combination Class II, type 2 mixer under the same conditions. Again, no improvement is noted.

Now, TIM's relative conversion loss is measured with the LO drive level reduced to +10 dBm, Figure 7(D). The 12 dB RF source termination causes only about 0.4 dB ripple, and less than 1 dB variation for most of the frequency range in the 6 dB case. Since this performance approximates a 1.0:1 mixer VSWR for the 12 dB ripple and betters the theoretical 1.25 dB ripple possible in the 6 dB source example, other things must be happening.

An analysis was performed to find out exactly what occurs during the mixing process under RF and IF mismatch conditions. Again, using the analysis of double-balanced mixers as biphase modulators (which alternately commutate the RF and IF ports with a 180-degree phase reversal during each half-cycle of the LO), the desired mixing process predominantly produces the frequency term $F_{LO} \pm F_{RF}$. In a mixer having a totally reflective IF port termination, all of the IF signal, $F_{LO} \pm F_{RF}$, is reflected back into the mixer to remix with the LO input signal, giving a product of $F_{LO} \pm (F_{LO} \pm F_{RF})$. One of the frequency terms produced, $2F_{LO} \pm F_{RF}$, must exit at the mixer's RF input port. As it happens, $2F_{LO} - F_{RF}$ is the image frequency!

Because all double-balanced mixers are "double sideband" type modulators, both RF signal frequencies $F_{LO} + F_{IF}$ and $F_{LO} - F_{IF}$ are converted with equal efficiency. In conventional system designs, one of these terms would be the image frequency and its presence could cause phase cancellations of the desired signal. Measurements on Class I mixer confirm that this happens very efficiently, with only a 7 dB conversion loss to the $2F_{LO} \pm F_{RF}$ frequency term appearing at the RF port when the mixer's IF port is reflectively terminated (0 dB return loss). The Class II, types 1 and 2 exhibited very similar behavior. The TIM, however, showed a 10 dB conversion loss to this frequency term under the same conditions, indicating that 3 dB less RF input power is converted into image-producing frequency terms. As a result, the TIM's conversion loss remains more constant as its RF port is mismatched.

SPURIOUS SIGNAL GENERATION

Ideal mixers would generate only the desired IF output of $F_{LO} \pm F_{RF}$. Practical diode mixers, however, internally generate harmonics of their LO and RF input signals which mix and cause the harmonic modulation products $NF_{RF} \pm MF_{LO}$ in their output frequency spectrum. Double-balanced mixers have a reasonable (20 to 30 dB) suppression of internally generated, even-order harmonic modulation products compared to a single diode mixer.

An $NF_{RF} \pm MF_{LO}$ mixing product will be suppressed if it is caused by an even order RF harmonic, an even order LO harmonic, and obviously, even orders of both (if these products are being generated within the mixer). This cancellation is obtained by the symmetry of matched diodes coupled with phase and amplitude balanced transformers, but depends on frequency. The frequency dependence of "even order" suppression implies that only products caused by odd orders of

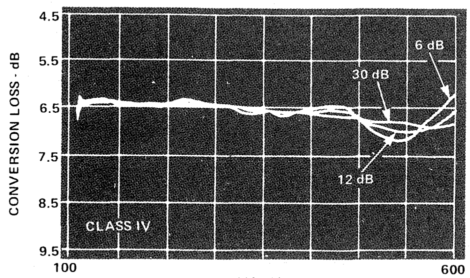


Figure 7(D)
TIM
P_{RF} = -10 dBm, P_{LO} = +10 dBm

Figure 7
Conversion Loss variation due to RF Match
(6, 12, 30 dB RF Return Loss plotted,
IF and LO terminated in 50 ohms)

RF and LO harmonics will be predictably suppressed by most high level mixer designs – a fact confirmed by our subsequent measurements. ("Odd order" suppression depends only on LO and RF power).

Most mixer manufacturers show N x M product data using fixed RF and LO frequencies of about 50 MHz for a very good reason. As frequency increases, even-order harmonic suppression degrades drastically because conventional mixers use flux-coupled transformers. The balance of these devices becomes 10 to 20 dB worse at higher frequencies due to their unavoidable leakage inductance and parasitic capacitances. Since single frequency specifications can be misleading, we used swept techniques to measure the various mixer classes over a more practical range of 300 to 500 MHz.

A full investigation of mixer N x M behavior would easily take many man-months, and even then, could not hope to include all specific system requirements. Therefore, only a few examples are presented here. The relative suppression of the product $2F_{RF} \times F_{LO}$ over the frequency range of 300 to 500 MHz is shown in Figure 8(A). A reference trace representing the mixer's conversion loss was obtained, the system gain increased by 30 dB, and the $2F_{RF} \times F_{LO}$ output measured. Class I suppression with +10 dBm LO drive varies from 50 to 25 dB, decreasing, as expected, at the higher frequencies because of the flux-coupled transformer's degrading balance. At +17 dBm LO input, the Class II, type 1 circuit exhibits nearly the same performance at 300 MHz, and a ragged 10-to-30dB improvement from 350 to 500 MHz. Since it has more diodes than the Class I, this design is more difficult to balance. The intermod suppression of the Class II, type 2, driven by a +17 dBm LO, starts out at 10 dB better than the Class I type, improves to 60 dB from 325 to 375 MHz, and then slowly degrades to 32 dB at 500 MHz. Flux-coupled transformers are again responsible for the unpredictable behavior of both Class II types. Finally, the TIM unit was evaluated with an LO input of +10 dBm and showed a nearly constant 49-to-57 dB suppression value. The well-balanced transmission line hybrids provide the improvement.

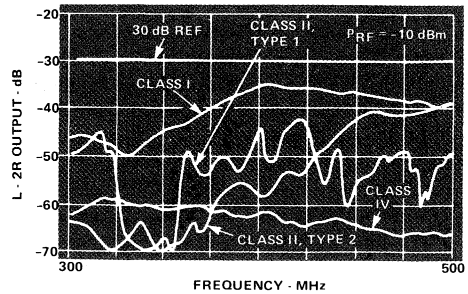


Figure 8(A)
$2F_{RF} \times F_{LO}$

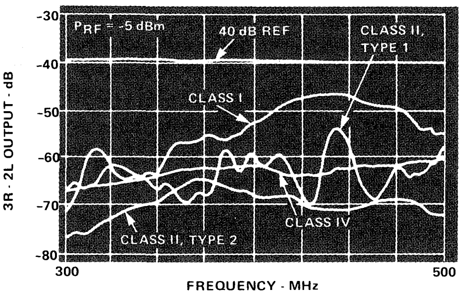


Figure 8(B)
$3F_{RF} \times 2F_{LO}$

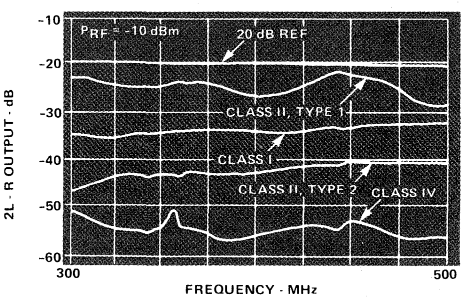


Figure 8(C)
$R_{RF} \times 2F_{LO}$

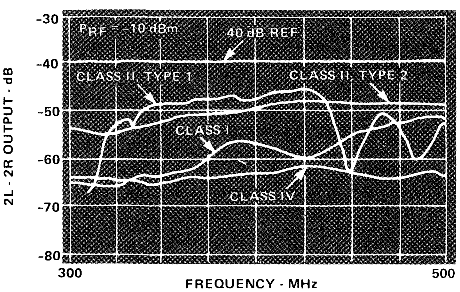


Figure 8(D)
$2F_{RF} \times 2F_{LO}$

Figure 8 (B) evaluates the suppression of the product $3F_{RF} \times 2F_{LO}$ from 300 to 500 MHz using a -5 dBm RF input and a 40 dB reference trace. The Class I mixer follows the same trend shown earlier: 65 dB suppression at 300 MHz degrades to 47 dB at 450 MHz. The Class II, type 1 mixer also repeats its frequency dependent suppression with a 20 dB variation observed in only 25 MHz. Class II, type 2 mixers clearly do best here, exhibiting a nearly constant $3F_{RF} \times 2F_{LO}$ suppression greater than 65 dB. (Their good performance should be expected because the series resistor-diode combination allows the use of a +17 dBm LO drive. This reduces the $3F_{RF} \times 2F_{LO}$ product by 2 dB for each 1 dB increase in LO input power over the Class I levels.) In this case, the Termination Intensive Mixer with +10 dBm Lo drive comes off second best, but still exhibits a fairly uniform $3F_{RF} \times 2F_{LO}$ suppression of 60 to 65 dB over the band. A TIM unit, such as M/A-COM model MD-174 designed for +17 dBm LO drive, will provide a nearly 14 dB improvement here.

The in-band $F_{RF} \times 2F_{LO}$ product can result in a system disaster because conventional mixers suppress it by only 30 dB or so. If that wasn't bad enough, the $F_{RF} \times 2F_{LO}$ product occurs independently of power level, and its suppression does not change with the ratio of RF to LO input power! Figure 8(C), with a 20 dB reference, confirms the Class I mixer's 30 dB suppression of R x 2L. The Class II, type 1 device actually performs less efficiently than the Class I, while the Class II, type 2 gives a good 10 dB better response. During our measurements, the TIM's suppression of $F_{RF} \times 2F_{LO}$ gave us a pleasant, but not totally unexpected surprise. It reduced $F_{RF} \times 2F_{LO}$ to levels that were 15 to 20 dB lower than the Class I and constant with frequency. The well-balanced transmission line hybrids and internal termination drastically reduce the amount of $2F_{LO}$ energy available at the diodes.

Finally, the mixers were evaluated for a N x M product suppression that depends on the combination of both RF and LO input symmetry or balance, Figure 8 (D). The trace shows a -10 dBm RF input with a 40 dB reference. The Class I mixer exhibits its expected decrease in suppression as frequency increases. The Class II, type 1 mixer does very badly because of the large $2F_{LO}$ term observed in Figure 8(C). The Class II, type 2 mixer also behaves poorly, probably because the series resistors inhibit the squaring of the LO drive waveform. Again, TIM comes through with uniform $2F_{RF} \times 2F_{LO}$ suppression because of its better overall transformer balance and the $2F_{LO}$ absorption by its internal termination.

Figure 8
N x M Intermodulation Products
(Suppression below desired IF output)
All ports terminated in 50 ohms)

CONCLUSION:

TIM can significantly simplify the system designer's task by relieving him of problems associated with other mixer types. The system designer can now expect "data sheet" performance on intermodulation distortion, conversion loss flatness, and spurious signal generation without the worries of interactive VSWRs, sum or difference match, and spurious signal recombination. Because the real world is never 50 ohms, TIM may be the mixer for your complex system requirements.

ACKNOWLEDGEMENT

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APPENDIX

Measurement system varies port mismatch

Third-order intermodulation distortion in a double-balanced mixer is, in general, dependent upon RF input power level, LO input power level, input frequencies, and source-load mismatches. Because of the many variables, a swept-frequency technique was used to obtain the data presented in this article. The original test setup (Figure A1) was modified to introduce variable source and load mismatches at any or all of the mixer's three ports.

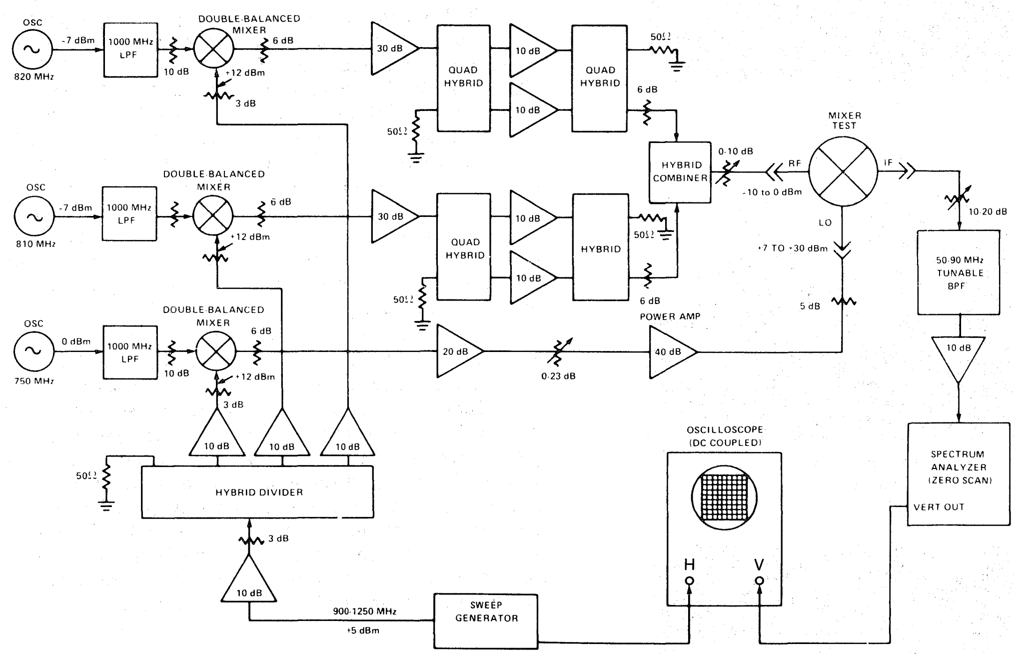


Figure A1. The swept-frequency mixer IM measurement setup is capable of testing mixers with as much as +30 dBm LO drive and 0 dBm RF power; dynamic range extends to 95 dB. See *Micro Waves* of May, 1978 for details.

It turns out that most of the mismatch manipulation is required at the IF port of the component under test. A convenient way of varying the IF load is to place a carefully designed diplexer, directional coupler, and variable-length transmission line at the mixer's IF port. With this configuration (Figure A2), the impedance presented to the IF port can be independently controlled for both sum and difference frequencies. The mixers used in the measurements presented here use a low (30 MHz) IF, so the electrical length from the IF port to the difference frequency variable mismatch (10 degrees) can be safely ignored. The electrical length to the sum frequency variable mismatch was purposely made long and adjustable, to simulate the effects of normal interconnect lengths that would be found in practical systems designs.

A simple way to obtain the needed magnitude of return loss at the IF port is to use different values of fixed attenuators; the return loss of the mismatch is two-times the attenuator value. The impedance can be adjusted up or down by cascading the fixed attenuator with an open or short circuit, as desired.

A similar technique is employed at the RF and LO ports using a 3 dB in-phase power splitter/combiner with the sum port connected to the mixer. By varying the mismatch at one of the divider's output ports, the mixer's source return loss may be varied from greater than 30 dB to approximately 6 dB (3:1 VSWR). The source return loss in this case becomes approximately 6 dB plus two-times the fixed attenuator value. Because most power dividers are not perfectly lossless and their losses increase with frequency, this is not only a first order approximation, but it is accurate enough to allow meaningful measurements.

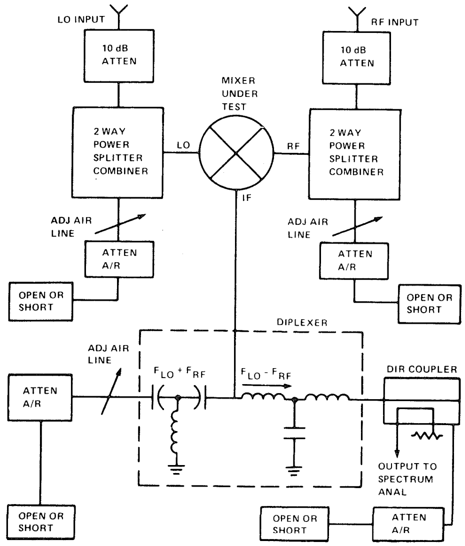


Figure A2. Diplexer, directional couplers, variable delay lines, and power dividers surround mixer to independently vary source and load impedances.

Note that $F_{LO} \pm F_{RF}$ terminations are adjustable separately.

Integration of Drop-In Components

Integration of Drop-In Components

The growing popularity of drop-in components is a result of the continual trend toward smaller, more reliable systems. Drop-in modules are typically installed directly on a stripline or microstrip circuit board. Advantages of this approach to system design are:

- Space savings (no connectors or cables)
- Components can be tested outside the system, as a stand-alone device
- Components can be screened for enhanced reliability
- Connector and cable losses are eliminated

There are drawbacks associated with the use of drop-in module devices, however. The first is a potential correlation problem between the component manufacturer's test results and the user's evaluation data on the same device. It is important that both parties use the same type of test fixture and test methods and we recommend that the test fixture itself closely resemble the conditions the component will see in the actual system. For example, a component to be used in a stripline medium with a ground plane spacing of .062 and an effective dielectric constant of 2.32 should be tested in a fixture of similar construction.

The second drawback occurs in the system design stage. The designer who elects to use drop-ins abandons the relative safety of standard 50 ohm connectors and assumes the electrical and mechanical problems involved in interfacing the drop-in module with the system's motherboard. Removable-connector-type modules may eliminate correlation problems, but performance with connectors is no guarantee that the same can be achieved in a system unless the interface is correct. Due to the wide variety of designs, materials and construction techniques, there are no "standard" interface rules, but we offer the following guidelines:

1) The difficulty of maintaining a proper electrical interface increases with the operating frequency. This deserves serious attention for frequencies above 8 GHz.

2) Ground plane contact between the motherboard and the module should be smooth and continuous. Solid ground contact is absolutely necessary.

3) Minimize gaps or other discontinuities at all RF launches. This usually requires tight mechanical tolerances.

4) Use radiation shielding techniques at least comparable to the isolation performance of the component.

5) Use 50 ohm "dummy" modules to evaluate and troubleshoot the motherboard assembly. These "dummy" modules are mechanically identical to the modules, but contain 50 ohm transmission lines instead of component circuitry. This is often particularly useful in conjunction with time-domain reflectometer measurements to troubleshoot the module interface. Consult factory for price, availability and options on "dummy" modules.

The last serious consideration involves the handling of drop-in modules in the manufacturing area. The contact pins on microwave modules are somewhat fragile; they are usually made of Kovar and are about .015" in diameter in order to achieve 50 ohm impedance through the glass bead. Assembly personnel must be trained to use caution when working with drop-in modules. Bending may weaken the lead or degrade the quality of the glass seal.

Static discharge is another handling problem which should be addressed in manufacturing. Schottky diodes are very sensitive and the unprotected leads make the module quite susceptible to static discharge damage. The use of anti-static work stations and approved personnel grounding straps is highly recommended.

M/A-COM's engineering staff has had extensive experience in integrating drop-in modules as part of complex microwave subsystems. Our engineers would be happy to consult with you regarding your specific integration requirements.

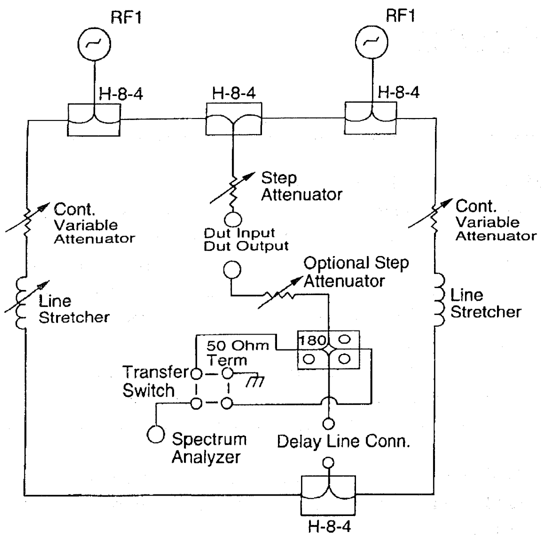
Intermodulation Test Procedure

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 sunmed 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 discoiinected, set the fundamental signals to top line reference on the spectrum analyzcr.
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 differnece 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.



Intermodulation Test Box Schematic

ESD Considerations for GaAs FET Switches

I Introduction

Military ESD control procedures have been established in MIL-HDBK-263 and MIL-STD-1686. Recent studies show that GaAs switches can be damaged by ESD voltages in the 250 volt range; this classifies these switches as Class O. When dealing with GaAs switch products, the elimination of electrostatic generators is necessary to protect against ESD voltages. Work procedures should be followed as outlined in the next section.

II 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 Mooring 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.

III Failure Analysis of ESD Damaged Devices

Failure of GaAs switches 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 IOOOX 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 (> 1OO%) 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.

IV 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 thc component surface for any nonstandard flow patterns. In this way the site of the ESD channel or blow hole can be detected.

V 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 powerlevel 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.

VI 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 prcsent, 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.

RF Mixer Terminology

1. Mixers

A mixer converts radio-frequency energy at one frequency to a second frequency. While the most common use for mixers is in the front end of radio receivers (**See Figure 1**), where they convert input signal frequencies to a lower "intermediate frequency," mixers are also used in up-converters, modulators, phase detectors, frequency synthesizers, etc.

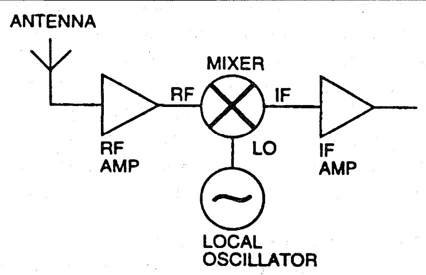


Figure 1: Standard Superheterodyne Radio Receiver Front End

2. Mixing Action

The mixing action of a mixer arises from two distinct processes acting in tandem. The input signal (designated "RF") is multiplied with a locally generated signal (the local oscillator, "LO"), thus generating two output signals at the sum and difference frequencies. The difference frequency is referred to as the intermediate (IF) frequency.

In a receiver, the sum frequency is normally rejected by a low pass IF filter leaving only the difference. Multiplication, however, is effected using non-linear elements (diodes) and these non-linearities are responsible for the generation of many additional frequencies other than the pure sum and difference frequencies.

3. Spurious Products

While we would wish all input signal power to be converted without loss to the IF frequency, mathematics tells us that the generation of both sum and difference frequencies is inevitable. Thus, even with an ideal mixer we will necessarily lose half the input signal power (or 3 dB) in the mixing process.

Other undesired or spurious products generated as a result of diode non-linearities will further increase the amount of signal power lost. In designing M/A-COM mixers, every effort is made to ensure that the generation of such spurious products is kept at a minimum.

4. Sum and Image Frequencies

We have seen above that an input RF signal and a local oscillator LO signal are multiplied to generate sum and difference IF frequencies. If another input frequency is found that, when mixed with the local oscillator, the correct IF frequency will be generated, then signal or noise power at this frequency will also be passed to the mixer IF terminals.

A frequency of 2LO-RF is such an input frequency. This particular frequency is called the image frequency (**See Figure 2**).

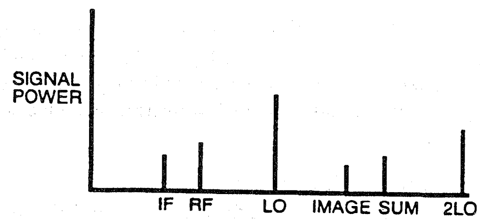


Figure 2: Mixer Frequency Spectrum

5. Conversion Loss

We have seen above that half the converted power is inevitably lost in the mixing process. Hence this loss (the SINGLE SIDEBAND CONVERSION LOSS) between RF input power and IF output power will have a minimum value of 3 dB. In practice, extra losses due to the generation of spurious products, resistive losses in the diodes, mismatches at the mixer ports, etc., will combine to increase this figure. Careful selection of local oscillator power to bias the diodes at their optimum operating points will minimize mixer conversion loss. All mixers have been designed with optimum diode/LO drive power combinations. Accordingly, our devices always should be operated with the LO drive power specified in this catalog.

6. Two-Tone Third Order Intercept

The generation of spurious output frequencies in a mixer is the result of using non-linear switching elements. Even for the single input frequency the number of such products that is generated as discernible power levels is quite large. The situation is further exacerbated when the input signal contains multitone components. A figure of merit indicative of the ability of a mixer to suppress such intermodulation products is the "two-tone third order intercept point" (usually measured in dBm). (See **Figure 3.**)

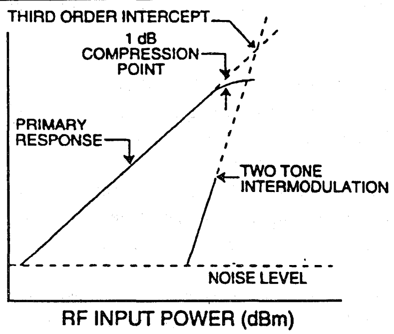


Figure 3.

The hypothetical intercept point is arrived at by extrapolating measured data to suggest an input RF power level at which IF power and intermodulation products would be equal. Mixers with high intercept points generate low intermodulation distortion products.

7. 1 dB Compression Point

The dynamic range of a mixer is the range of input RF power levels (in dBm) for which the mixer produces useful IF output power. Dynamic range is limited at the low end by the noise performance of the mixer devices. When the input power is such as to produce a discernible IF output signal a constant power ratio (equal to the conversion loss) is established between input RF power and output IF power.

As input power is increased, a point is reached where this constant power ratio is no longer maintained and conversion loss begins to increase. When conversion loss has increased by 1 dB, the upper limit of the mixers dynamic range is deemed to have been reached and this "1 dB COMPRESSION POINT" generally delineates the upper level of input power for which the mixer should be used. This catalog contains mixers with 1 dB compression points as high as +14 dBm.

The 1 dB compression point is tied in closely with the third order intercept point; as a rule of thumb, two-tone third order intercept point is 10-15 dB above the 1 dB compression point.

8. Voltage Standing Wave Ratio (VSWR)

Efficient operation of a mixer requires that maximum signal power transfer be effected at each of the three ports. The degree to which this ideal is met is indicated by the voltage standing wave ratio (VSWR) which quantifies the amount of mismatch at each port. A perfect match of a 50 ohm system implies a VSWR of 1:1 while a port with a VSWR of 2:1 means that approximately ten percent of the incident power would be reflected from that port. The importance of minimizing mixer VSWR to ensure efficient driving of the diodes and power transfer of RF/IF energies is, therefore, apparent.

9. Intercept Isolation

All references to the mixer so far have assumed that RF/LO/IF signal powers are present at their respective ports and at no other. In practice, a small portion of the power applied to any port will leak through to the other two ports. This is particularly undesirable in the case of the relatively high level LO signal. The degree to which the LO power is masked from the other two ports is specified by the L-R and L-I isolations (in dB). These are the insertion losses between the respective ports.

10. Double Balanced Mixers

It is evident from the foregoing that when designing a mixer our goals will be to minimize conversion loss, noise figure, VSWR and the generation of spurious products while maintaining interport isolation, 1 dB compression point and the third order intercept point.

Unfortunately, no single mixer type exists which will simultaneously satisfy all these requirements. The simplest mixer configuration, the "single-ended" mixer, uses a single diode as the switching element. Due to performance, single-ended mixers at frequencies in the RF and low microwave region are unsuitable for general use.

Improved performance is obtained from a "single-balanced" configuration where two diodes are used in a balanced arrangement.

However, further significant improvements in intermodulation suppression and dynamic range, as well as low VSWR, conversion loss and noise figure are possible with a "double-balanced" mixer configuration. This is the optimum configuration for most applications and so is the configuration used in all M/A-COM mixers. Figure 4 shows a typical M/A-COM implementation of a double-balanced mixer configuration. Optimum mixer operation requires the four diodes to have identical characteristics. This requirement is most closely met by a ring quad which contains the four Schottky-barrier ring diodes in a single package. Baluns at mixer ports are carefully designed to match the mixer over the broadest possible frequency ranges.

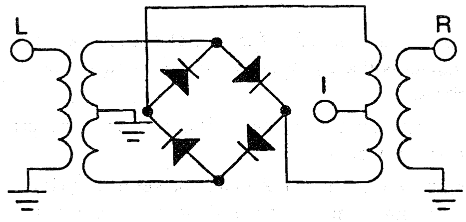


Figure 4: Schematic

11. Pulse Modulators

The principle of the current controlled attenuator outlined above can be extended to develop a pulse modulator. If the control current is pulsed, the unmodulated input carrier at the LO port will appear at the output RF port as a pulse modulated carrier. Because the switching elements of the mixer are Schottky diodes, very high switching speeds of about 1 nanosecond are possible. **Figure 5** shows the functional schematic of a pulse modulator.

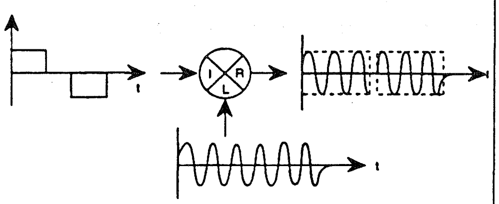


Figure 5: Pulse Modulator

Figure 8: Pulse Modulator

12. Phase Detectors

If the signals applied to the RF and LO ports of a mixer have the same frequency, then it can be shown that the resultant IF voltage will be DC and will vary as the cosine of the phase difference between the input signals. Accordingly, a double balanced mixer may be used as a phase detector. **Figure 6** shows the fundamental schematic of the phase detector and a plot of the DC output voltage vs. phase difference.

Theoretically, when DF is equal to $\pi/2$ the DC voltage at the IF port should be zero. In practice diode imbalance and transformer asymmetry may cause a DC offset. This offset can be counteracted by applying a DC bias to the IF port.

13. Quadraphase-Shift Keying (QPSK) Modulator

A QPSK modulator modulates the phase of a carrier with discrete 0°, 90°, 180°, or 270° phase shifts. A functional schematic of such a modulator is shown in **Figure 7**. The input carrier is passed through a 90° hybrid which provides quadrature signals to two double balanced mixers. Control signals to each mixer switch the transmission paths through the diodes causing a 0° or 180° relative phase shift. The mixer outputs are then combined yielding the required four equal amplitude phase states. An output amplifier restores the carrier signal to its original level. (See technical information on I/Q Modulators.)

14. Current Controlled Variable Attenuators

In normal operation, the LO and RF isolation is required to be a maximum. However, in some cases this isolation can be lessened by feeding the IF port with a negative bias current.

In this way a low level variable attenuator with a typical control range of about 50 dB can be constructed. With signal input at the LO port and output at the RF port, attenuation is maximum (and equal to LO-RF isolation) at zero bias current. Typically attenuations as low as 3 dB are attainable with maximum bias current. **Figure 8** shows the typical attenuation vs. IF port bias.

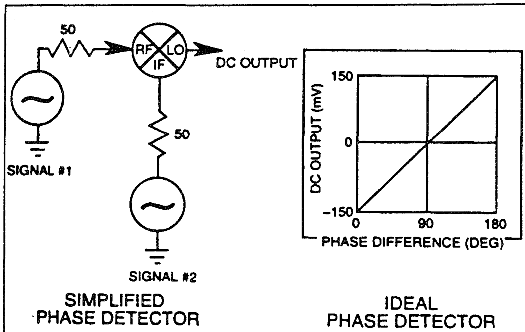


Figure 1: Phase Detector

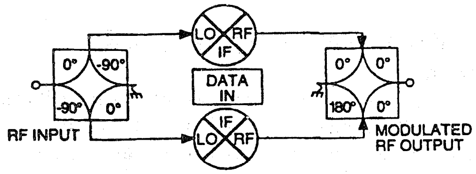


Figure 2: QPSK Modulator

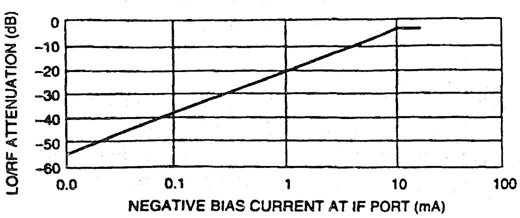


Figure 3: Current Controlled Variable Attenuator

15. Glossary of Terms

Conversion Loss (SSB) The ratio of RF input power to the IF output power of one sideband. (Either F_{LO}-F_{RF} or F_{LO} + F_{RF}.)

Noise Figure (SSB) The ratio of the signal-to-noise ratio at the mixer input divided by the signal-to-noise ratio of one mixer sideband.

Isolation The amount an input signal is attenuated when measured at another mixer port.

1 dB Compression Point The RF input power that causes a 1 dB increase above a mixer's small signal conversion loss.

1 dB Desensitization Level The RF input level of an interfering signal that causes a mixer's small signal conversion loss to increase by 1 dB.

Harmonic Intermodulation Products

Mixer output signals other than the desired $F_{LO} \pm F_{RF}$ which are harmonically related to either or both of the input signals. (Also termed $N_{RF} \pm M_{LO}$, NxM or "Spurs".)

Two-tone Intermodulation Products

Undesired mixer output products caused by the simultaneous presence of two RF input signals (3rd order IM consists of $[(2F_{RF1} \pm F_{RF2}) \pm (F_{LO})]$ and $[(F_{RF1} \pm 2F_{RF2}) \pm (F_{LO})]$.)

DC Polarity The mixer IF voltage polarity, either positive or negative when in phase LO and RF signals are applied.

DC Offset The IF output voltage measured with only the LO operating and the RF port terminated in 50 ohms.

Phase and Gain Matching Simplified

Specifying Phase and Gain Matched Microwave and IF Components

Introduction

Defining and interpreting specifications for multichannel devices, such as radars, direction finders, and guidance systems, where phase and gain matching parameters are important to system operation, historically has been an area of confusion and misunderstanding. Unfortunately, many of the requirements and ramifications are not fully understood. This article can reduce this confusion by discussing the pertinent areas and separating out the various ingredients.

Relevant Factors

Seven factors related to phase and gain matching are:

1. RF frequency variations
2. IF frequency variations
3. Dynamic signal range
4. Gain control variations in IF preamp (if preamp is not fixed gain)
5. Temperature variations
6. Signal nature
7. True matching, or tracking only required.

The detailed discussion of these variables indicates the impact and ramifications involved.

1. RF Frequency Variations

Systems are considerably simplified when a single (or fixed) RF frequency is involved. Differences in RF phase at the single frequency are readily "zeroed out" by a phase shifter, usually placed in the LO feed path. This "correction," is generally only valid over a small RF frequency range.

When it is necessary to phase match over a substantial RF/LO range, care must be taken to precisely match all cable lengths and components so that the phase slope in degrees/MHz is identical in all channels. (Note that 1 mm of cable at 18 GHz represents about 37 electrical degrees and at 1 GHz, 1 mm equals about 2 degrees). Implementation of this, and the measurement of phase vs. microwave frequency, is a difficult task. The HP network analyzer (or equal) is the only practical way to perform such measurements.

In general, "zeroing out" is done at the highest frequency of interest. In broadband situations, it must be done by accurately matching physical line lengths.

2. IF Frequency Variations

Most tracking measurements are made at the IF center frequency. For systems involving pulses, spectral energy is distributed over an IF bandwidth compatible with the pulse characteristics. Generally, merely aligning IF pass bands to be similar in their amplitude response level proves completely satisfactory to process the pulse spectrum and achieve pulse matching equal to the CW match which may have been achieved at center frequency.

When a signal may be shifting its frequency over the IF passband, it is important to hold matching over the entire frequency range.

In many instances, purchasers insist on a tight matching spec over the IF bandwidth where pulses are involved, and the IF frequency is fixed. The point to remember here is that the phase and amplitude tracking can be relaxed considerably as one moves farther from the carrier, since the energy distribution of a pulse decreases rapidly away from the carrier frequency. Experience has shown that for a system with a pulse width of T microseconds, requiring an IF bandwidth of 1/T MHz, phase tracking at the band edges can be relaxed by factors of 5 to 10 without noticeable pulse variations.

3. Dynamic Signal Range

As long as the system is performing linearly, dynamic range has essentially no effect on gain or phase performance. When signals strong enough to overload the IF preamp are involved, a gain controlled IF preamp must be used, or a controlled phase limiting preamp may also be considered.

4. Gain Control Variations

Varying the gain of the IF preamp is generally the largest contributor to gain and phase variations.

Obviously, since the gain is being changed, gain tracking variations will occur, as the networks used cannot exactly provide duplicate performance in two or more units. The use of matched diodes, etc., can reduce these variations to less than 1 dB in most cases and less than 0.5 dB in many cases.

The transfer phase characteristics through the preamplifier is also changed as the gain is changed. In general, the change in degrees/dB is reasonably small, so that good tracking can be achieved. The use of matched diodes readily provides phase tracking of $\pm 5°$ in preamp situations, including effects of temperature. Under fixed ambient conditions, it is not unusual to document $\pm 1°$ tracking between channels.

5. Temperature Variations

Temperature variations in general tend to produce offset errors in tracking. If a system is to be operated mostly in a particular segment of the temperature range, it may be advisable to optimize the initial performance in that range.

6. Signal Nature

RHG units are designed for pulse and CW operation, and in general, the nature of the signal will not affect the overall performance, except when nonlinear (overload) signal conditions are present. Clean overload is produced by the RHG designs, and recovery times are generally 1 μsec or less.

7. Matching vs Tracking

Although these two terms are frequently used interchangeably, there is a distinct difference between them.

A. Tracking refers to the ability of two or more devices whose parameters may change, to change together, within a preset tolerance.

B. Matching includes tracking, but also adds the ingredient of the initial starting values being the same.

For example:

If two amplifiers, one with 25 dB of gain and one with 28 dB of gain, were subjected to a temperature run, and the gain of one held at 25 dB and the other changed to 29 dB, they may be said to track within 1 dB. They only match to 4 dB however.

Usually in a system, these fixed increments of gain can be "zeroed out." In the above case, if a pad or other adjustment reduced the effective gain of the 29 dB unit to 25, they would now match and track to ± 1 dB (± is used, as the reference amp is not defined).

If a 4.5 pad were used in series with the 29 dB unit, they would now match and track to ± 0.5 dB.

Specifications Subject to Change Without Notice.

C. Phase tracking and matching enjoy the same privileges as the gain situation with the following precautions. Any phase trimming which is added will probably be frequency sensitive. The ratio of (F2/F1) relates the relative degrees. Generally, this is not a problem in the final system analysis.
D. Two channels vs. 3 (or 4) channel—In a two channel system, either channel may be considered as the reference without changing the specifications.

However, in a three channel system, one channel must be designated as the reference, or different performance results will occur.

EXAMPLE 1: Amp A 27 dB
Amp B 26 dB

matching is ± 1 dB regardless of which is referenced

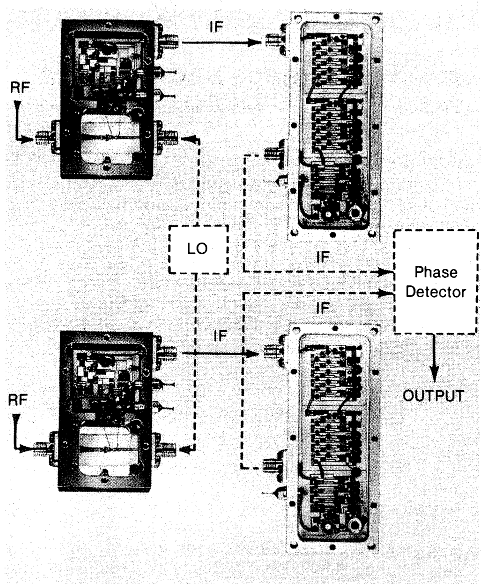
EXAMPLE 2: Amp A 27 dB
Amp B 26 dB
Amp C 25 dB

If B is reference, A and C are ± 1 dB. If C is reference, a 2 dB error will result.

RHG multichannel mixer preamps are generally specified and tested based on using an injected IF signal. Due to the relative transparency of the mixers, the matching and tracking specifications defined, relate to IF performance only. IF gain and phase trim adjustments are built into most units and are customer accessible. The HP vector voltmeter is used to measure IF gain and phase properties.

RHG has built thousands of matched mixer preamps, and have verified in all cases that test and measurement at IF is completely satisfactory for performance verification at a single RF frequency.

For all RHG matched mixer preamps and IF amps, the gain and phase tracking figures are applicable over the range of varying gain control, temperature, and dynamic signal range.



2 channel monopulse receiver using phase and gain matched mixer preamplifiers and IF limiters

TYPICAL REQUIRED COMBINATIONS FOR SEVERAL APPLICATIONS

It will be assumed that all applications reflect a dynamic range within the linear capability of the units in question and involve a temperature range of −30° to +71°C. If the ambient is restricted to essentially room temperature, improved specs can generally be achieved.

Case 1 Fixed RF Frequency
Fixed Gain Preamp

This is the easiest combination. In actual practice, it is usually unnecessary to purchase special matched devices, as two or more units of the same model number will probably track well enough without special attention. Fixed differences in gain and/or phase can be trimmed out in the system.

Case 2 Fixed RF Frequency
Gain Controlled Preamp

This combination requires a special preamp design where networks are carefully matched so that gain and phase tracking will occur when the two (or more) devices are varied in gain by a single control voltage.

Case 3 Varying RF Frequency
Fixed Gain Preamp

This requires mixers which are matched. Experience has shown that most good mixers will hold about ±5° and ±1 dB over their rated bandwidth. Multioctave devices may require looser tolerances. Where RF matching is critical, specially selected mixers and diodes may be used. Measurement of phase using microwave input signals is very complex and cannot generally be performed without a network analyzer.

Case 4 Varying RF Frequency
Gain Controlled Preamp

This is the most difficult combination, but is achievable using the elements of Case 2 and 3.

The most difficult aspect of this situation is not the mixer preamp, but the very close matching of the other microwave system elements. When the RF frequency is varying, very close matching is required for all RF cables, and other RF components. (*NOTE:* At 18 GHz, 5 electrical degrees is equivalent to a cable length of .005 inches emphasizing matching problems at high microwave frequencies). Matched broadband RF channels require special attention, and RHG engineers will be happy to discuss specific requirements and make recommendations which are optimum for your needs.

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.

$$VSWR = \frac{1 + |r|}{1 - |r|} \qquad |r| = \frac{P_{-1}}{P_R}^{½}$$

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:

$$|r| + |\tau| = 1$$

because energy is conserved in the network.

$$TL = 20 \log_{10} \frac{1}{|\tau|}$$

$$|\tau| = \frac{P_{-1}}{P_T}$$

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}]
$X_C = 2Z_0$ [{Antilog (ISO/20) -1 }]

Power Conversion dBm to Watts

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
										30.0	1000				

Specifications Subject to Change Without Notice.

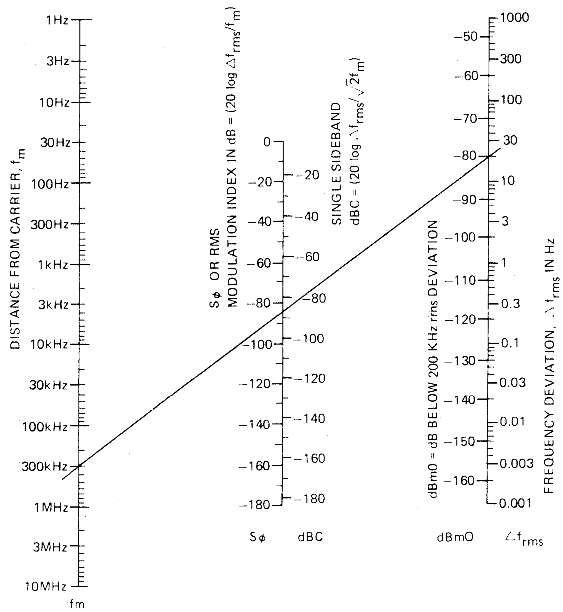
M/A-COM

VSWR, Return Loss and Transmission Loss vs. Transmitted Power

VSWR	RETURN LOSS (dB)	TRANS LOSS (dB)	VOLT REFL COEFF.	POWER TRANS. (%)	POWER REFL (%)
1.00	∞	.000	.00	100.0	.0
1.01	46.1	.000	.00	100.0	.0
1.02	40.1	.000	.01	100.0	.0
1.03	36.6	.001	.01	100.0	.0
1.04	34.2	.002	.02	100.0	.0
1.05	32.3	.003	.02	99.9	.1
1.06	30.7	.004	.03	99.9	.1
1.07	29.4	.005	.03	99.9	.1
1.08	28.3	.006	.04	99.9	.1
1.09	27.3	.008	.04	99.8	.2
1.10	26.4	.010	.05	99.8	.2
1.11	25.7	.012	.05	99.7	.3
1.12	24.9	.014	.06	99.7	.3
1.13	24.3	.016	.06	99.6	.4
1.14	23.7	.019	.07	99.6	.4
1.15	23.1	.021	.07	99.5	.5
1.16	22.6	.024	.07	99.5	.5
1.17	22.1	.027	.08	99.4	.6
1.18	21.7	.030	.08	99.3	.7
1.19	21.2	.033	.09	99.2	.8
1.20	20.8	.036	.09	99.2	.8
1.21	20.4	.039	.10	99.1	.9
1.22	20.1	.043	.10	99.0	1.0
1.23	19.7	.046	.10	98.9	1.1
1.24	19.4	.050	.11	98.9	1.1
1.25	19.1	.054	.11	98.8	1.2
1.26	18.8	.058	.12	98.7	1.3
1.27	18.5	.062	.12	98.6	1.4
1.28	18.2	.066	.12	98.5	1.5
1.29	17.9	.070	.13	98.4	1.6
1.30	17.7	.075	.13	98.3	1.7
1.32	17.2	.083	.14	98.1	1.9
1.34	16.8	.093	.15	97.9	2.1
1.36	16.3	.102	.15	97.7	2.3
1.38	15.9	.112	.16	97.5	2.5
1.40	15.6	.122	.17	97.2	2.8
1.42	15.2	.133	.17	97.0	3.0
1.44	14.9	.144	.18	96.7	3.3
1.46	14.6	.155	.19	96.5	3.5
1.48	14.3	.166	.19	96.3	3.7
1.50	14.0	.177	.20	96.0	4.0
1.52	13.7	.189	.21	95.7	4.3
1.54	13.4	.201	.21	95.5	4.5
1.56	13.2	.213	.22	95.2	4.8
1.58	13.0	.225	.22	94.9	5.1
1.60	12.7	.238	.23	94.7	5.3
1.62	12.5	.250	.24	94.4	5.6
1.64	12.3	.263	.24	94.1	5.9
1.66	12.1	.276	.25	93.8	6.2
1.68	11.9	.289	.25	93.6	6.4
1.70	11.7	.302	.26	93.3	6.7
1.72	11.5	.315	.26	93.0	7.0
1.74	11.4	.329	.27	92.7	7.3
1.76	11.2	.342	.28	92.4	7.6
1.78	11.0	.356	.28	92.1	7.9
1.80	10.9	.370	.29	91.8	8.2
1.82	10.7	.384	.29	91.5	8.5
1.84	10.6	.398	.30	91.3	8.7
1.86	10.4	.412	.30	91.0	9.0
1.88	10.3	.426	.31	90.7	9.3
1.90	10.2	.440	.31	90.4	9.6
1.92	10.0	.454	.32	90.1	8.9
1.94	9.9	.468	.32	89.8	10.2
1.96	9.8	.483	.32	89.5	10.5
1.98	9.7	.497	.33	89.2	10.8
2.00	9.5	.512	.33	88.9	11.1
2.50	7.4	.881	.43	81.6	18.4
3.00	6.0	1.249	.50	75.0	25.0
3.50	5.1	1.603	.56	69.1	30.9
4.00	4.4	1.938	.60	64.0	36.0
4.50	3.9	2.255	.64	59.5	40.5
5.00	3.5	2.553	.67	55.6	44.4
5.50	3.2	2.834	.69	52.1	47.9
6.00	2.9	3.100	.71	49.0	51.0
6.50	2.7	3.351	.73	46.2	53.8
7.00	2.5	3.590	.75	43.7	56.2
7.50	2.3	3.817	.76	41.5	58.5
8.00	2.2	4.033	.78	39.5	60.5
8.50	2.1	4.240	.79	37.7	62.3
9.00	1.9	4.437	.80	36.0	64.0
9.50	1.8	4.626	.81	34.5	65.5
10.00	1.7	4.807	.82	33.1	66.9
11.00	1.6	5.149	.83	30.6	69.4
12.00	1.5	5.466	.85	28.4	71.6
13.00	1.3	5.762	.86	26.5	73.5
14.00	1.2	6.040	.87	24.9	75.1
15.00	1.2	6.301	.88	23.4	76.6
16.00	1.1	6.547	.88	22.1	77.9
17.00	1.0	6.780	.89	21.0	79.0
18.00	1.0	7.002	.89	19.9	80.1
19.00	.9	7.212	.90	19.0	81.0
20.00	.9	7.413	.90	18.1	81.9
25.00	.7	8.299	.92	14.8	85.2
30.00	.6	9.035	.94	12.5	87.5

Noise Conversion Nomograph

Relationship between Modulating frequency (fm), Power spectral density of phase (Sϕ), Modulation Index, Sideband to carrier ratio (dBc), dBm0, and frequency deviation (frms).



Example:
20 Hz deviation in a 1 kHz band at 300 kHz from carrier gives single sideband dBC of −87 dB in a 1 kHz Bandwidth.

FREQUENCY CHARTS

ELECTRONIC WELFARE

Band	Frequency (MHz)
A	0 — 250
B	250 — 500
C	500 — 1,000
D	1,000 — 2,000
E	2,000 — 3,000
F	3,000 — 4,000
G	4,000 — 6,000
H	6,000 — 8,000
I	8,000 — 10,000
J	10,000 — 20,000
L	40,000 — 60,000
M	60,000 — 100,000

STANDARD RADAR

Band Designation	Nominal Frequency Range
HF	3-30 MHz
VHF	30-300 MHz
UHF	300-1,000 MHz
L	1,000-2,000 MHz
S	2,000-4,000 MHz
C	4,000-8,000 MHz
X	8,000-12,000 MHz
KU	12-18 GHz
K	18-27 GHz
Ka	27-40 GHz
mm	40-300 GHz

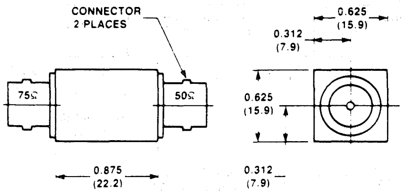
CONVERSION BETWEEN BITS AND HZ

There is an approximate relationship between the bit rate and the frequency band:

1 MHz bandwidth can handle at most a 0.7 x 1MBit bit stream.

MAXIMUM DATA RATE	APPROXIMATE FREQUENCY BANDWIDTH
155 MBit	110 MHz
622 MBit	450 MHz
2.0 GBit	1.5 GHz
2.4GBit	1.7 GHz

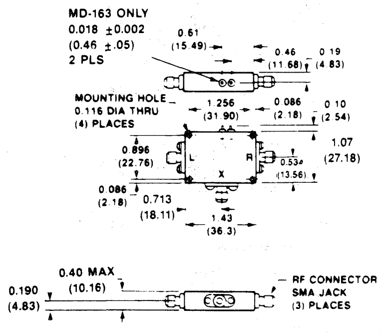
C-1



TOLERANCE = ±0.015
(.X = ±0.4)

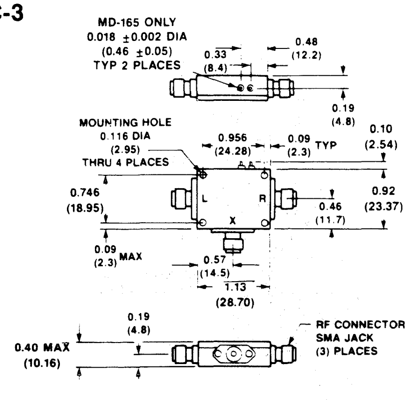
WEIGHT (APPROX.): 0.75 OUNCES 21 GRAMS

C-2



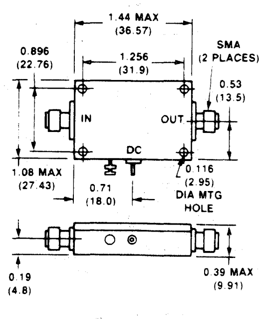
WEIGHT (APPROX): 1.2 OUNCES 34 GRAMS

C-3



WEIGHT (APPROX): 1.2 OUNCES 34 GRAMS

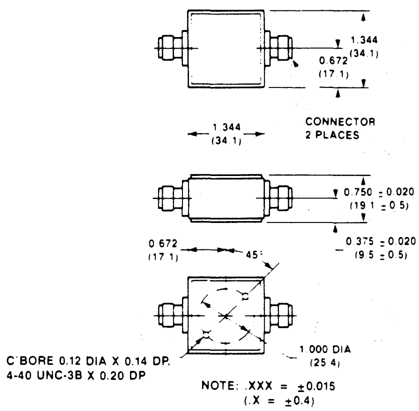
C-4



WEIGHT (APPROX.): 1.2 OUNCES 34 GRAMS

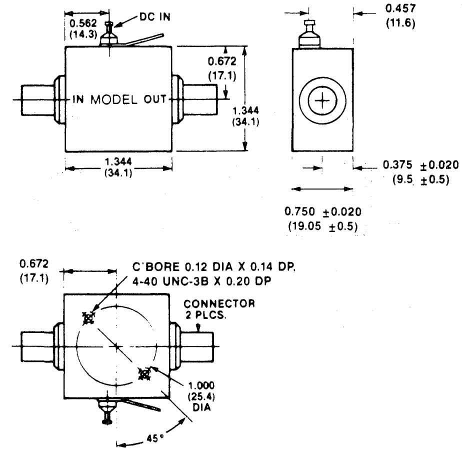
Specifications Subject to Change Without Notice.

C-5



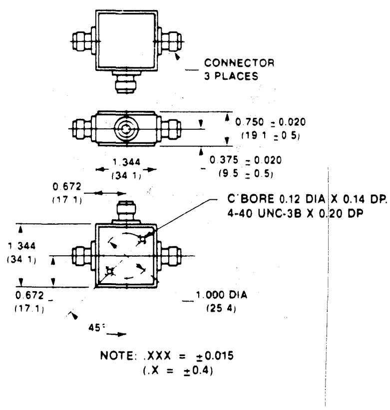
WEIGHT (APPROX.): 1.8 OUNCES 51 GRAMS

C-6



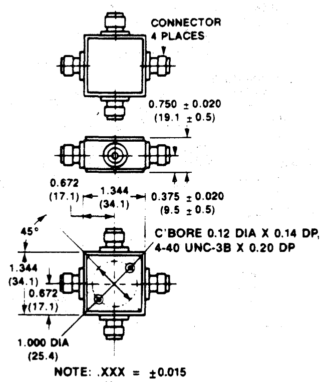
WEIGHT (APPROX.): 1.76 OUNCES 50 GRAMS

C-7



WEIGHT (APPROX.): 2.5 OUNCES 71 GRAMS

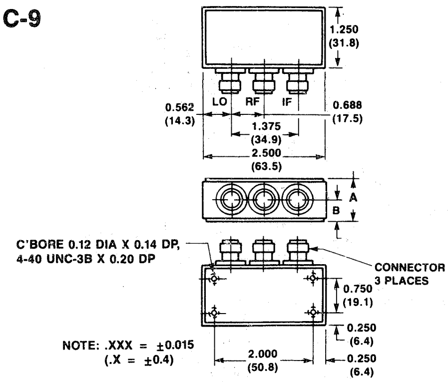
C-8



WEIGHT (APPROX.): 2.5 OUNCES 71 GRAMS

Specifications Subject to Change Without Notice.

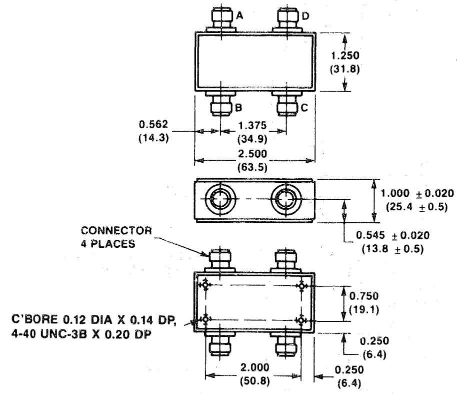
C-9



	MD-140	MD-141	MD-143	MD-150	MD-154	MD-174	MD-525-4
A	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)	1.000±0.020 (25.4±0.5)	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)	0.770±0.020 (19.6±0.5)
B	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)	0.485±0.020 (12.3±0.5)	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)	0.375±0.020 (9.5±0.5)

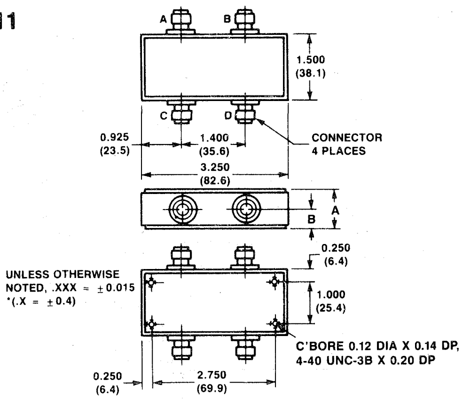
WEIGHT (APPROX): 3 OUNCES 85 GRAMS

C-10



WEIGHT (APPROX): 3.6 OUNCES 102 GRAMS

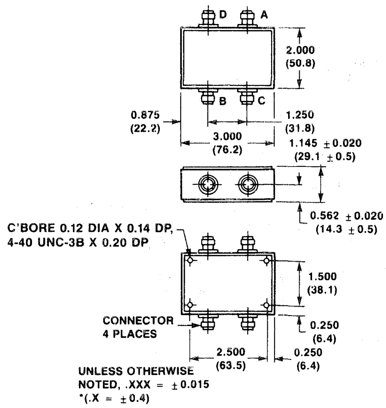
C-11



	A	B
HH-108	0.770±0.020 (19.6 ±0.5)	0.375 ±0.020 (9.5 ±0.5)
H-183	1.207 ±0.020 (30.6 ±0.5)	0.592 ±0.020 (15.03 ±0.5)

WEIGHT (APPROX): 7 OUNCES 198 GRAMS

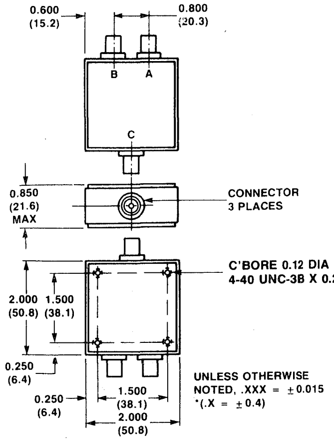
C-12



WEIGHT (APPROX): 10 OUNCES 283 GRAMS

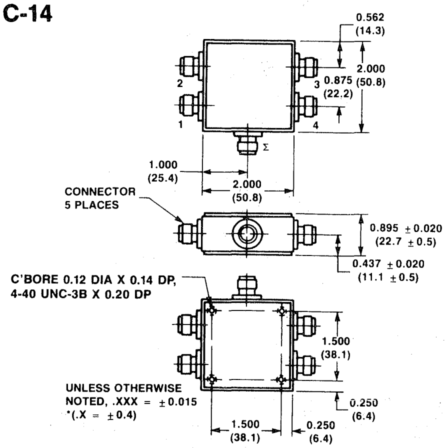
Specifications Subject to Change Without Notice.

C-13



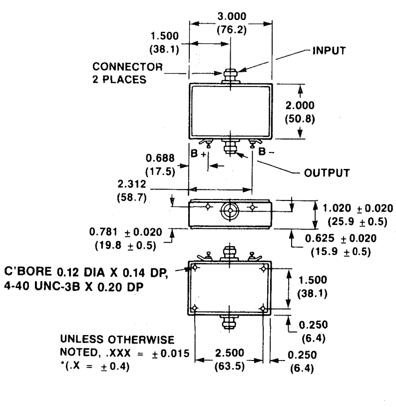
WEIGHT (APPROX): 3.28 OUNCES 93 GRAMS

C-14



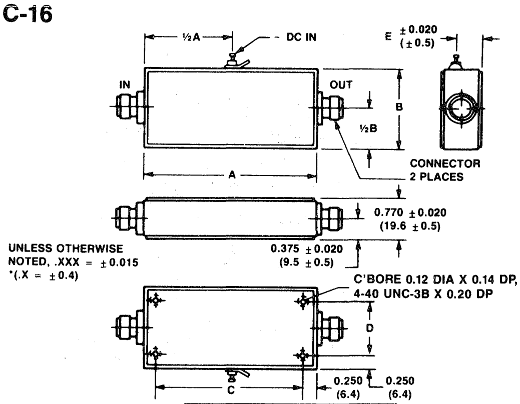
WEIGHT (APPROX): 4 OUNCES 113 GRAMS

C-15



WEIGHT (APPROX): 9 OUNCES 255 GRAMS

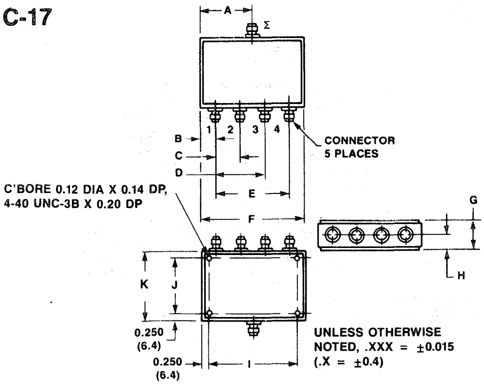
C-16



	A	B	C	D	E
AM-105 AM-112	2.500 (63.5)	1.250 (31.8)	2.000 (50.8)	0.750 (19.1)	0.437 (11.1)

WEIGHT (APPROX): 4.27 OUNCES 121 GRAMS

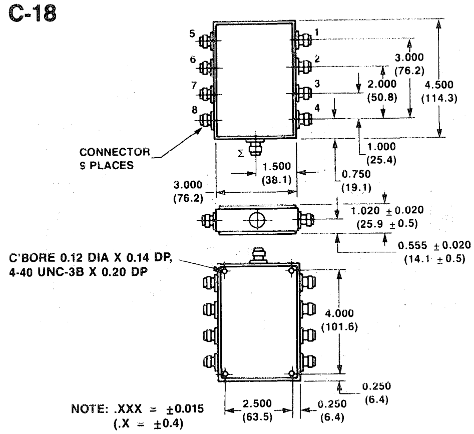
C-17



	A	B	C	D	E	F	G	H	I	J	K
DS-4-4	2.250 (57.2)	0.656 (16.7)	1.062 (27.0)	2.125 (54.0)	3.188 (8.10)	4.500 (114.3)	1.145±0.020 (29.1±0.5)	0.562±0.020 (14.3±0.5)	4.000 (101.6)	2.500 (63.5)	3.900 (76.1)
DS-409-4	1.625 (40.34)	0.593 (15.06)	0.688 (17.47)	1.376 (34.95)	2.064 (52.42)	3.250 (82.6)	0.770±0.020 (19.6±0.5)	0.375±0.020 (9.5±0.5)	2.750 (69.9)	1.000 (25.4)	1.500 (38.1)

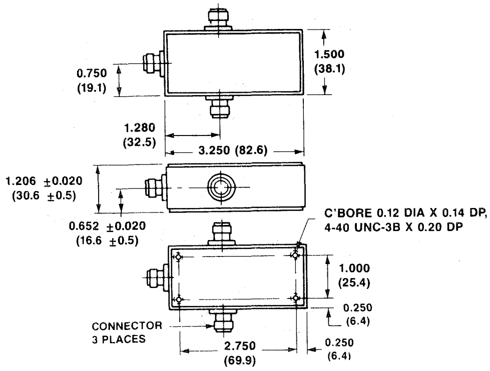
WEIGHT (APPROX): 10.58 OUNCES 300 GRAMS

C-18



WEIGHT (APPROX): 9 OUNCES 255 GRAMS

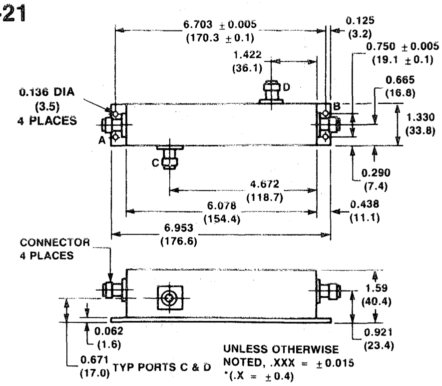
C-19



UNLESS OTHERWISE
NOTED, .XXX = ±0.015
*(.X = ±0.4)

WEIGHT (APPROX): 5.47 OUNCES 155 GRAMS

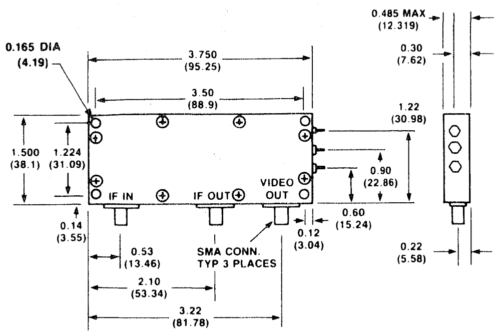
C-21



MOUNTING AREA:	9.25 SQ. IN.	60 SQ. CM.
VOLUME:	12.9 CU. IN.	211 CU. CM.
WEIGHT (APPROX):	8.7 OUNCES	247 GRAMS

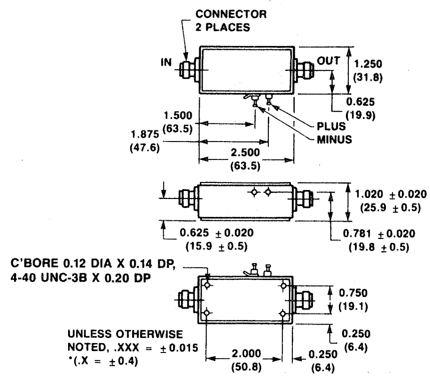
Specifications Subject to Change Without Notice.

C-22



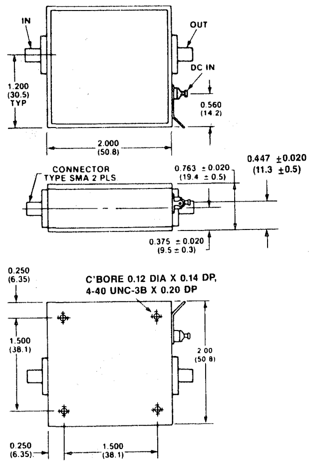
WEIGHT (APPROX): 3.5 OUNCES 99 GRAMS

C-23



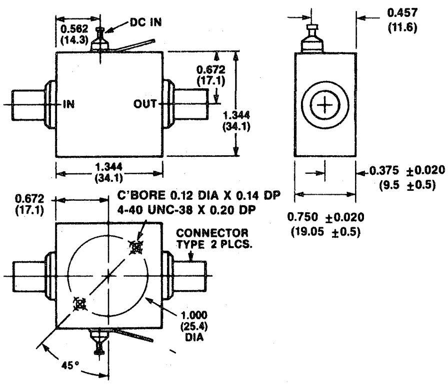
WEIGHT (APPROX): 5 OUNCES 142 GRAMS

C-25



WEIGHT (APPROX): 3.2 OUNCES 90 GRAMS

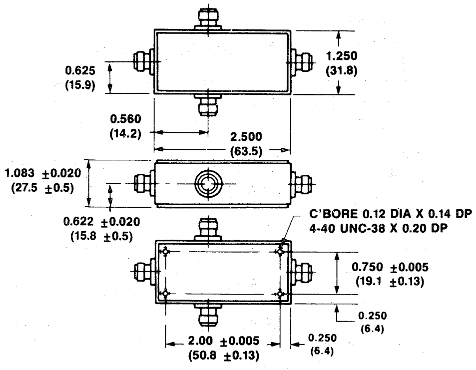
C-32



WEIGHT (APPROX): 1.62 OUNCES 46 GRAMS

Specifications Subject to Change Without Notice.

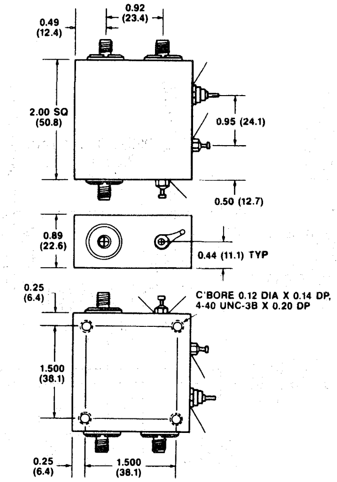
C-33



UNLESS OTHERWISE NOTED, .XXX = ±0.015 (.X = ±0.4)

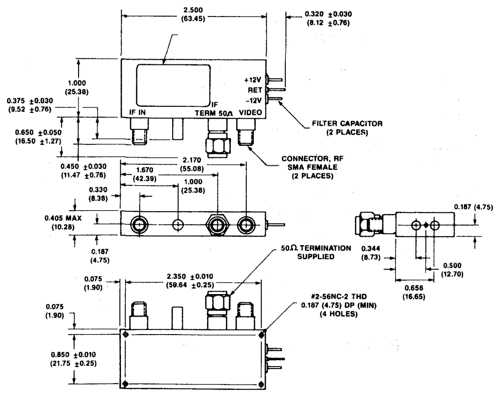
WEIGHT (APPROX): 5.47 OUNCES 155 GRAMS

C-34



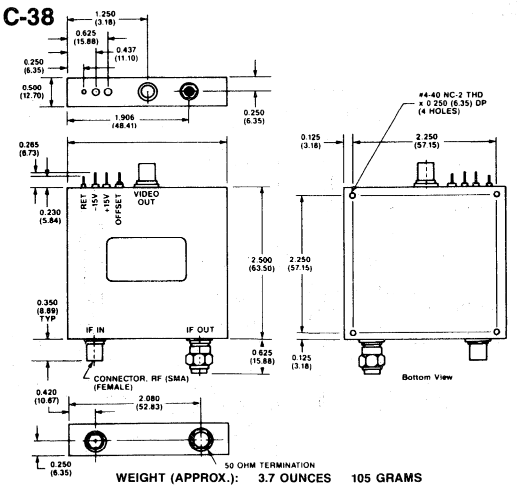
WEIGHT (APPROX): 4 OUNCES 114 GRAMS

C-36



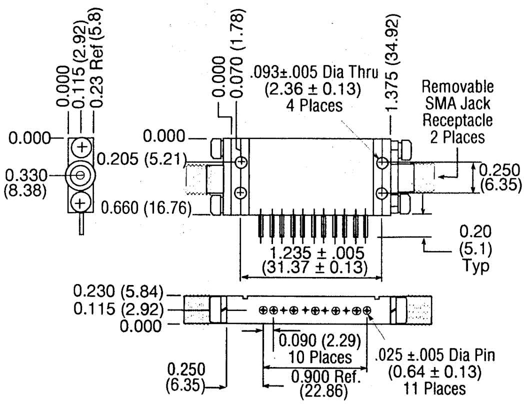
WEIGHT (APPROX.): 2.1 OUNCES 60 GRAMS

C-38



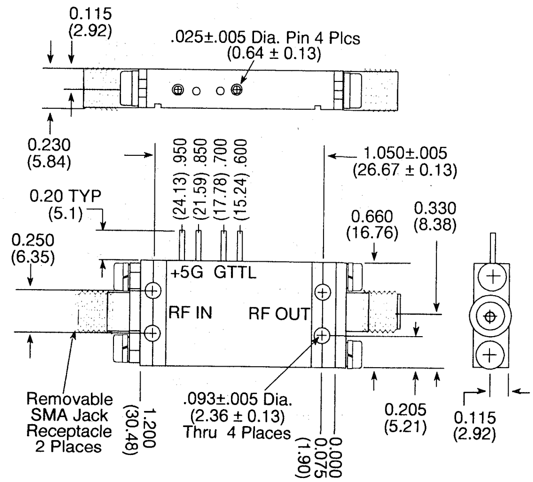
WEIGHT (APPROX.): 3.7 OUNCES 105 GRAMS

C-46



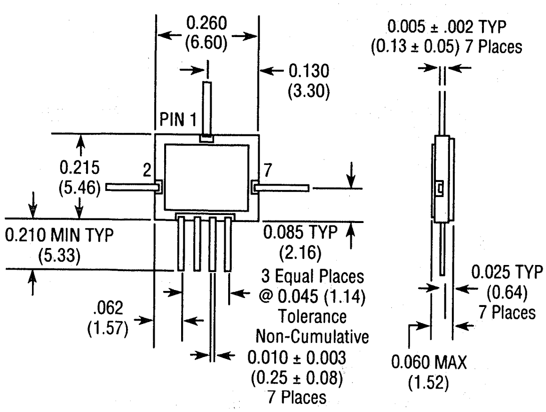
Bottom of case is AC ground.

C-47



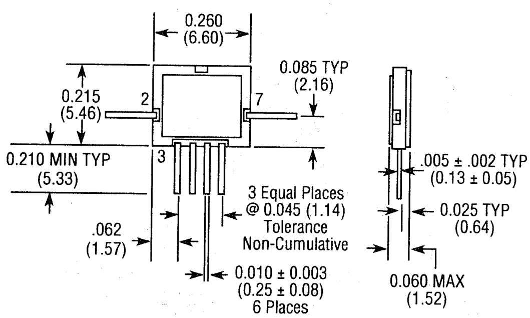
Bottom of case is AC ground.

CR-2



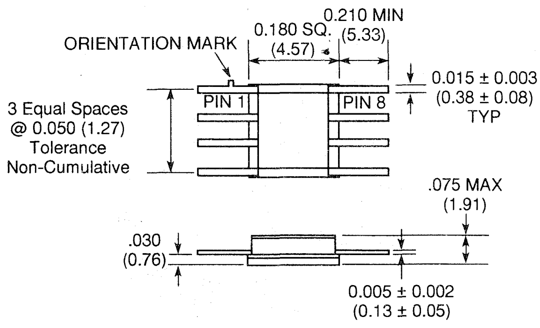
Bottom of Case is AC Ground

CR-2 w/o Pin 1



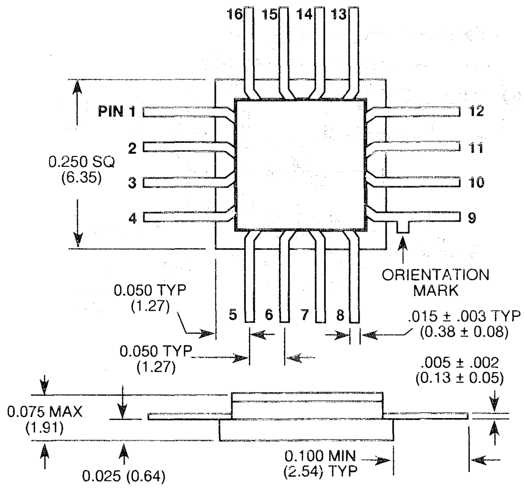
Bottom of case is AC ground.

CR-3



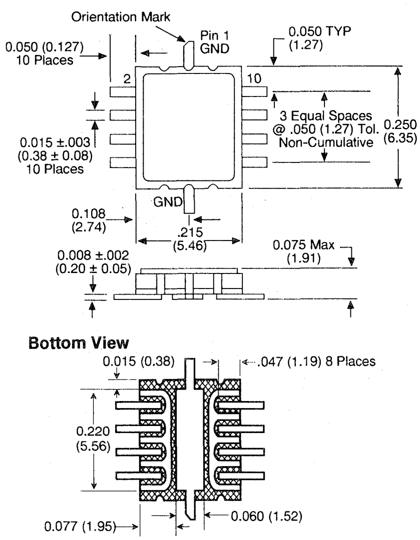
Bottom of case is AC ground.

CR-4

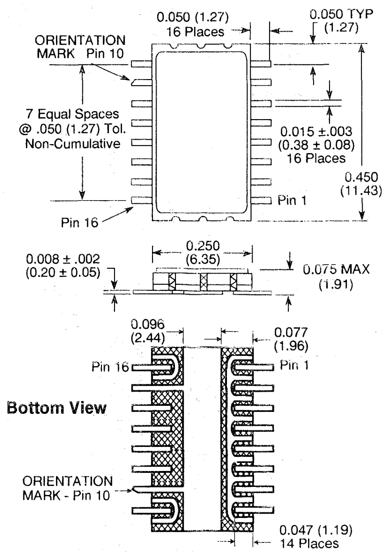


Bottom of case is AC ground.

CR-5



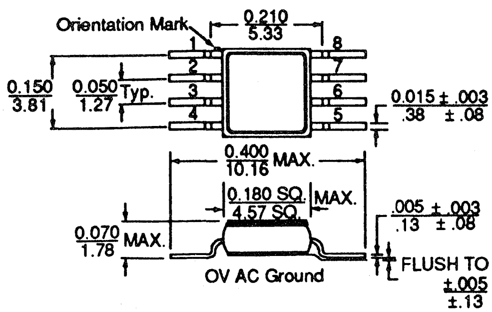
CR-6



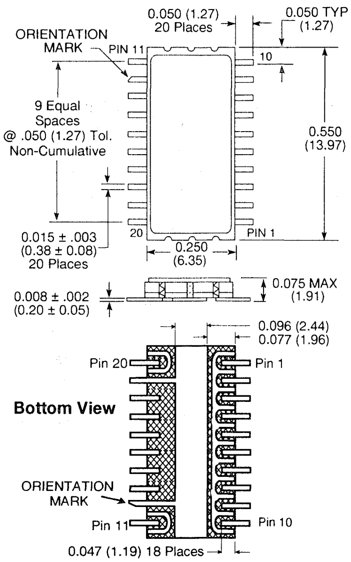
Bottom of case is AC ground.

Specifications Subject to Change Without Notice.

CR-7

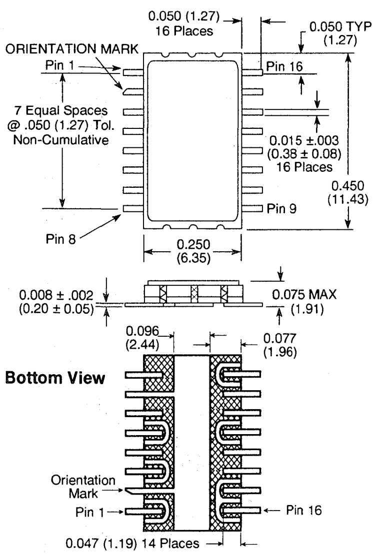


CR-8



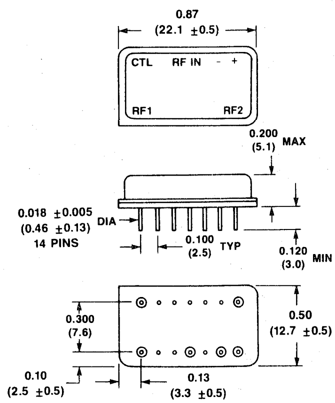
Bottom of case is AC ground.

CR-9



Bottom of case is AC ground.

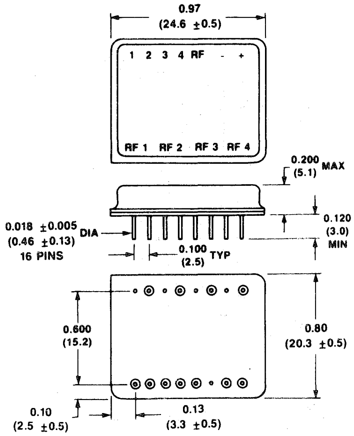
DI-1



(POSITIVE VOLTAGE ONLY SW-205 & 206, 207 & 208)

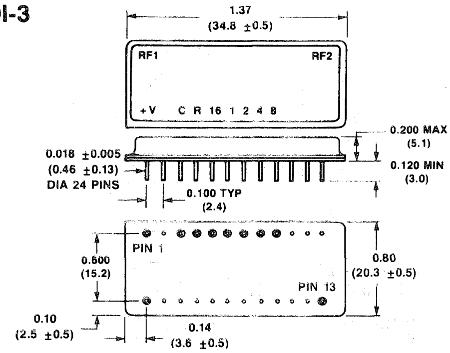
WEIGHT (APPROX.): 0.14 OUNCES 4 GRAMS

DI-2



WEIGHT (APPROX): 0.28 OUNCES 8 GRAMS

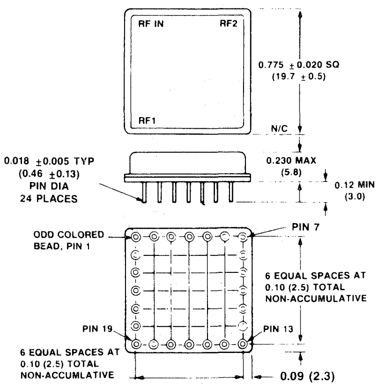
DI-3



	RF 1	RF2	+5V	-12V	C	R	16	1	2	4	8	0.5
AT-102	24	13	1	N/A	3	4	5	6	7	8	9	N/A
AT-103	24	13	1	N/A	3	4	N/A	6	7	8	9	5
AT-104	24	13	1	3	N/A	N/A	5	6	7	8	9	N/A
PINS UNMARKED ARE GROUND												

WEIGHT (APPROX): 0.39 OUNCES 11 GRAMS

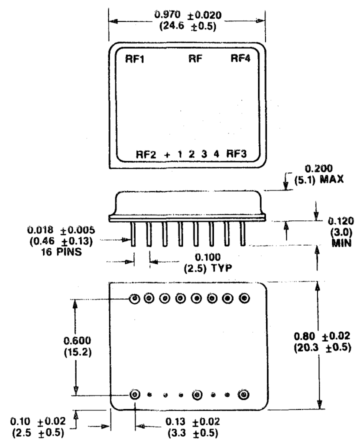
DI-4



	RF IN	RF 1	RF 2	RF 3	RF 4	+V	CTL
SW-118	19	1	13	N/A	N/A	3	4
SW-119	N/A	1	7	13	19	3	4
PINS UNMARKED ARE GROUND							

WEIGHT (APPROX): 0.21 OUNCES 6 GRAMS

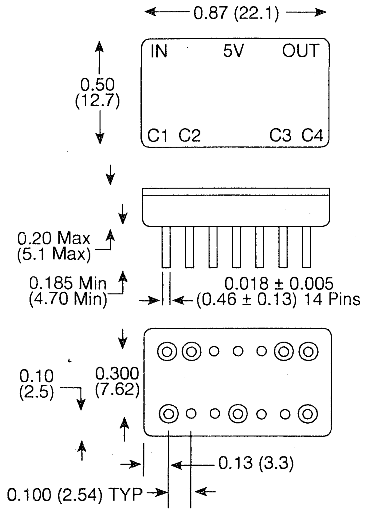
DI-5



WEIGHT (APPROX.): 0.26 OUNCES 73 GRAMS

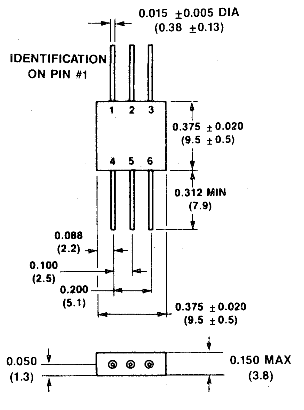
Specifications Subject to Change Without Notice.

DI-6



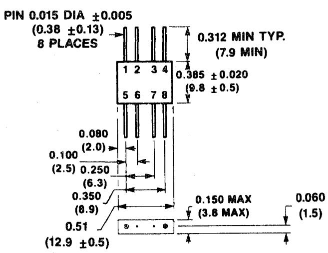
Bottom of case is AC ground.

FP-1



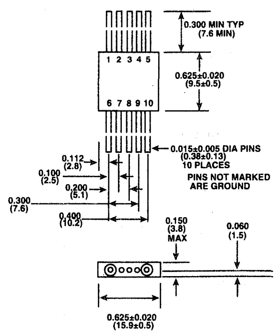
WEIGHT (APPROX.): 0.07 OUNCES 2 GRAMS

FP-2



WEIGHT (APPROX.): 0.09 OUNCES 2.5 GRAMS

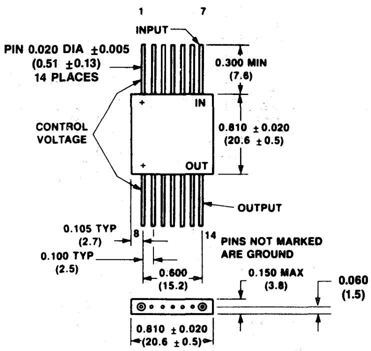
FP-3



WEIGHT (APPROX.): 0.12 OUNCES 3.4 GRAMS

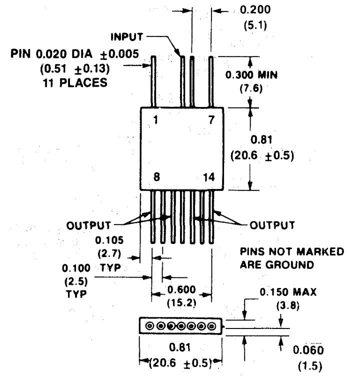
Specifications Subject to Change Without Notice.

FP-4



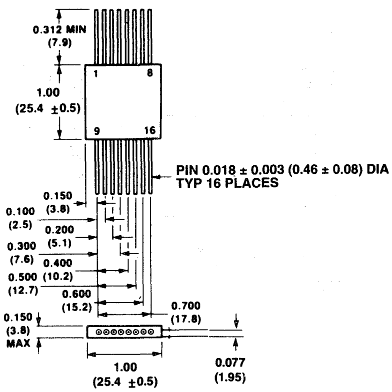
WEIGHT (APPROX.): 0.21 OUNCES 6 GRAMS

FP-5



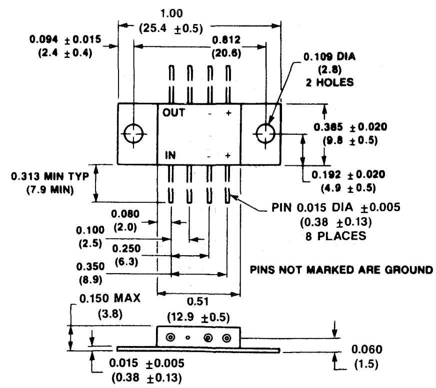
WEIGHT (APPROX.): 0.21 OUNCES 6 GRAMS

FP-6



WEIGHT (APPROX.): 0.24 OUNCES 6.8 GRAMS

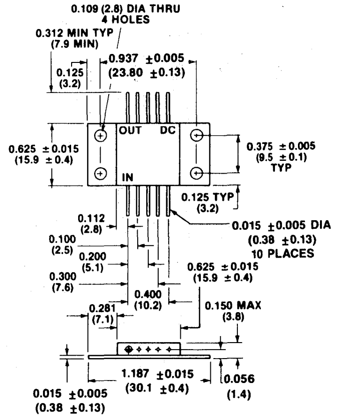
FP-7



(NOTE: AM-123 POSITIVE VOLTAGE ONLY.)

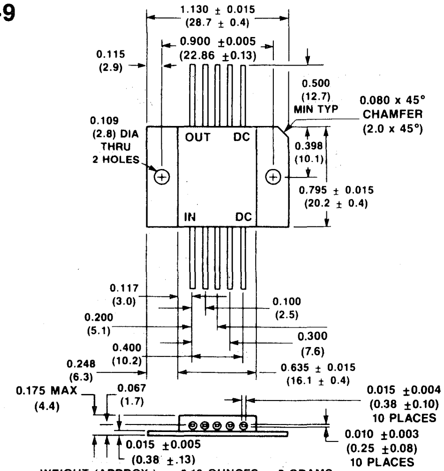
WEIGHT (APPROX.): 0.09 OUNCES 2.5 GRAMS

FP-8



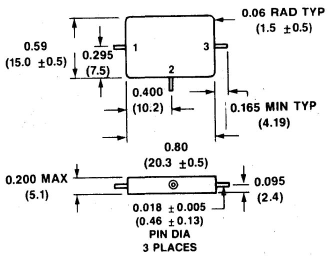
WEIGHT (APPROX.): 0.17 OUNCES 4.8 GRAMS

FP-9



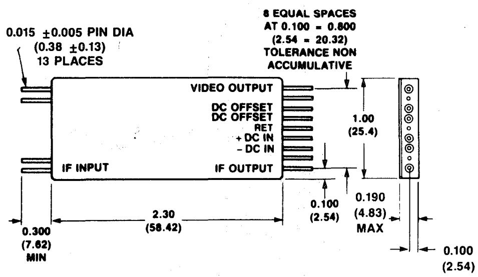
WEIGHT (APPROX.): 0.18 OUNCES 5 GRAMS

FP-10



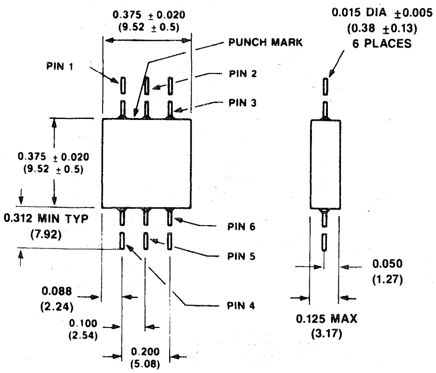
WEIGHT (APPROX.): 0.35 OUNCES 10 GRAMS

FP-12



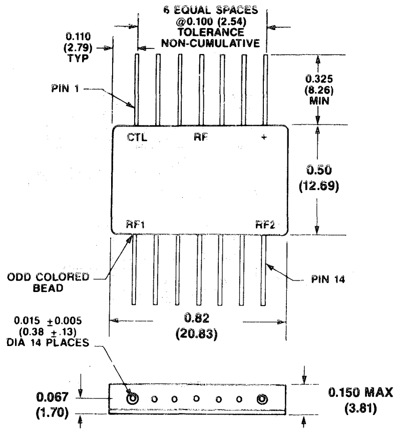
WEIGHT (APPROX.): 0.81 OUNCES 23 GRAMS

FP-13



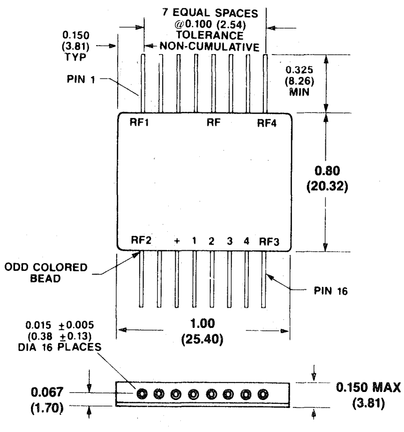
WEIGHT (APPROX.): 0.03 OUNCES 0.8 GRAMS

FP-16



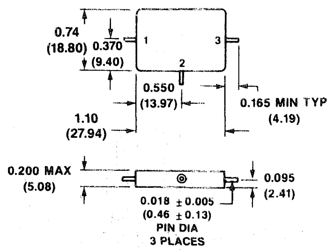
WEIGHT (APPROX): 0.14 OUNCES 4 GRAMS

FP-17



WEIGHT (APPROX): 0.21 OUNCES 6 GRAMS

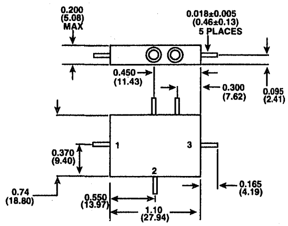
FP-18



WEIGHT (APPROX): 0.35 OUNCES 10 GRAMS

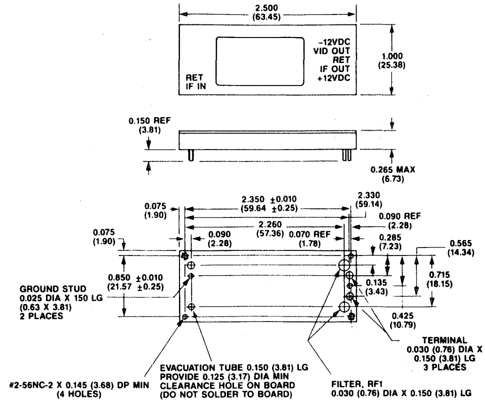
Specifications Subject to Change Without Notice.

FP-19



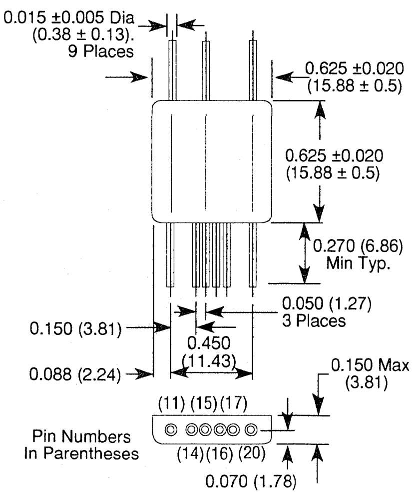
WEIGHT (APPROX.): 0.35 OUNCES 10 GRAMS

FP-21



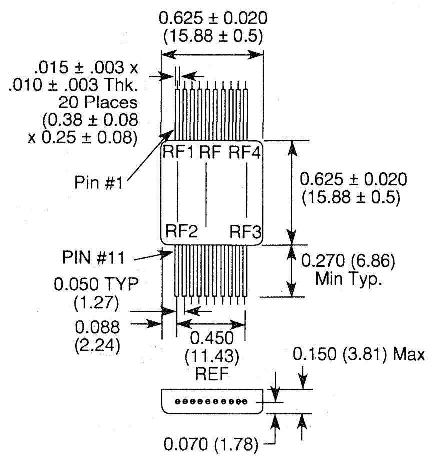
WEIGHT (APPROX.): 2.1 OUNCES 60 GRAMS

FP-25



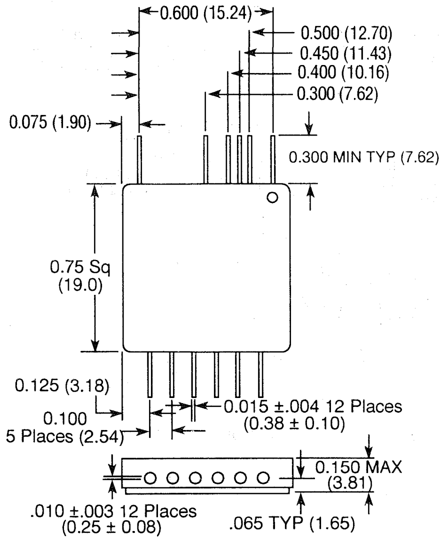
Weight (approx.): 0.12 Ounces 3.4 Grams
Bottom of case is AC ground.

FP-26



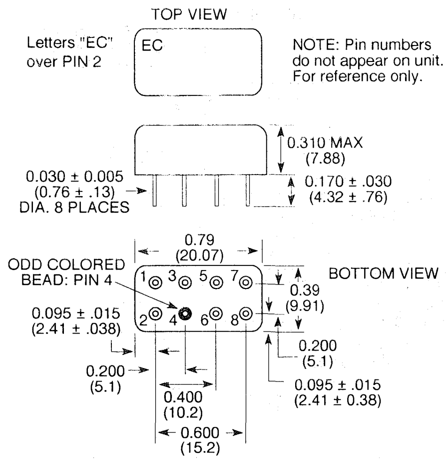
Bottom of case is AC ground.

FP-27



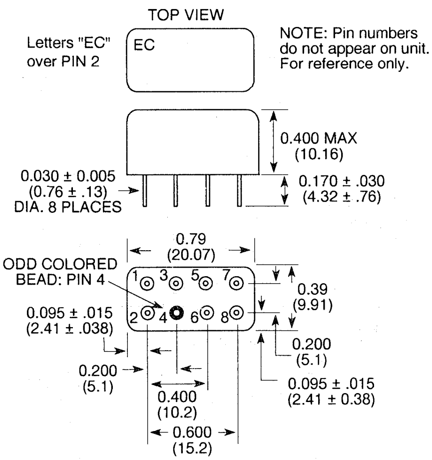
Bottom of Case is AC Ground

R-1



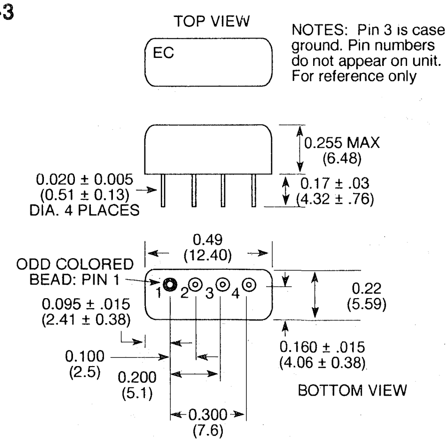
WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

R-2



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

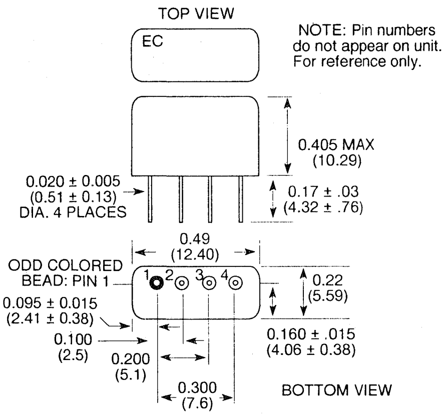
R-3



WEIGHT (APPROX.): 0.05 OUNCES 1.5 GRAMS

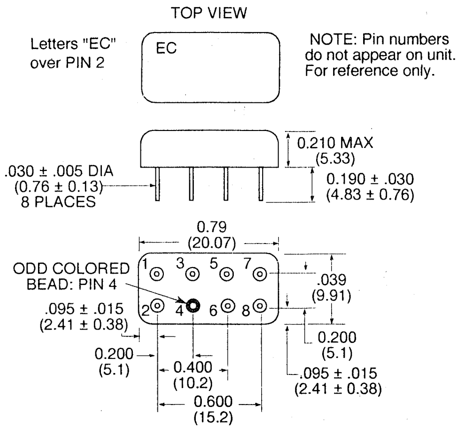
Specifications Subject to Change Without Notice.

R-4



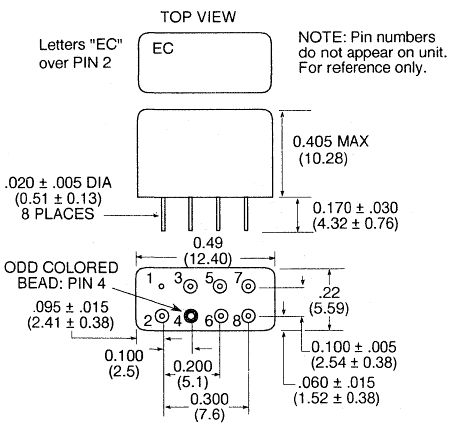
WEIGHT (APPROX.): 0.04 OUNCES 1.3 GRAMS

R-5



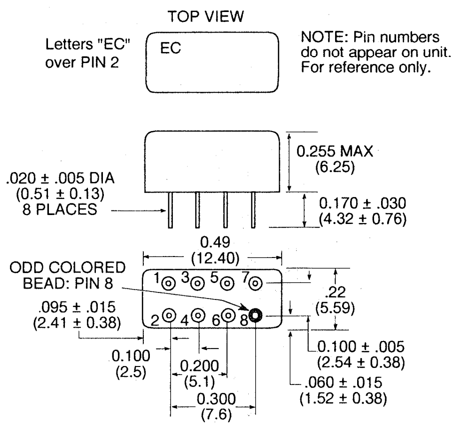
WEIGHT(APPROX.): 0.13 OUNCES 3.5 GRAMS

R-6



WEIGHT(APPROX.): 0.06 OUNCES 1.6 GRAMS

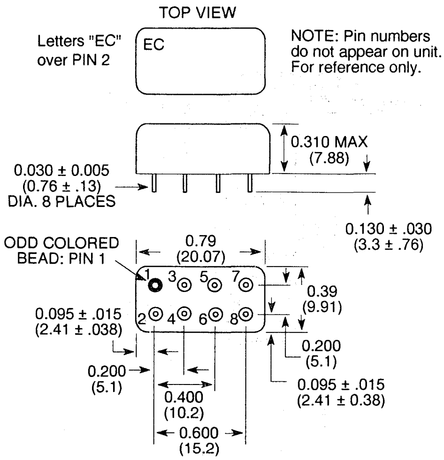
R-7



WEIGHT(APPROX.): 0.06 OUNCES 1.6 GRAMS

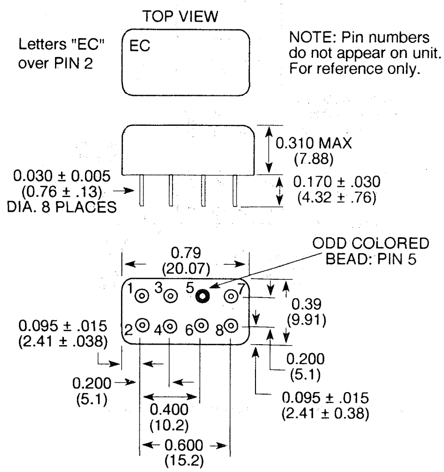
Specifications Subject to Change Without Notice.

R-11



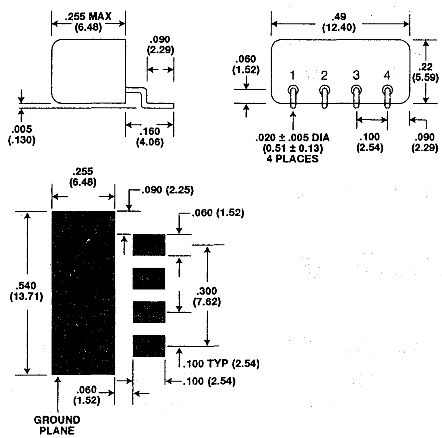
WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

R-14



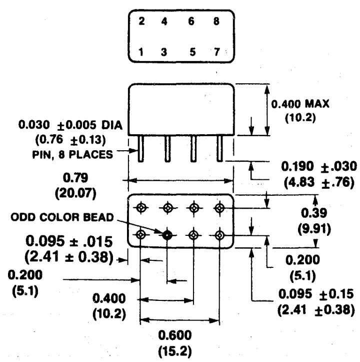
WEIGHT (APPROX.): 0.16 OUNCES 4.4 GRAMS

R-15



FOOTPRINT FOR P.C. DESIGN

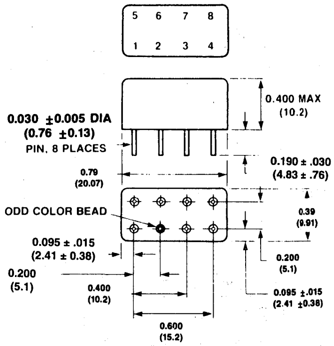
RH-1



WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

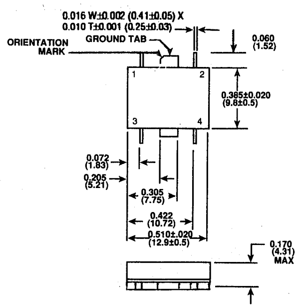
Specifications Subject to Change Without Notice.

RH-3



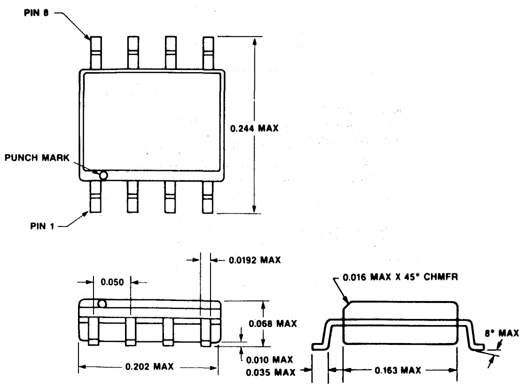
WEIGHT (APPROX.): 0.23 OUNCES 6.5 GRAMS

SF-1



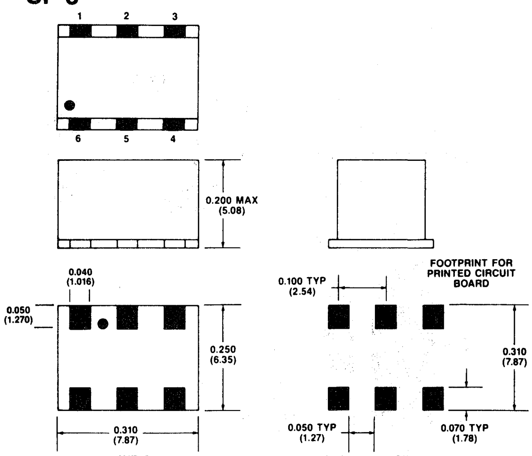
WEIGHT (APPROX.): 0.07 OUNCES 2 GRAMS

SF-2



WEIGHT (APPROX.): 0.003 OUNCES 0.08 GRAMS

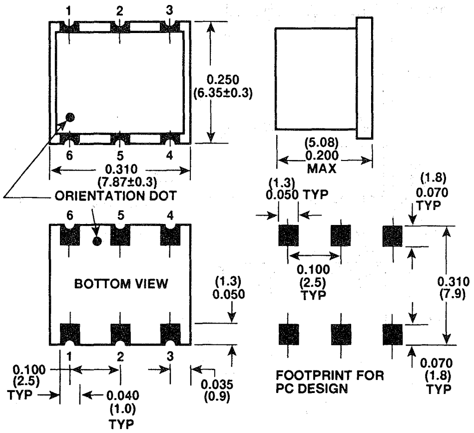
SF-3



WEIGHT (APPROX.): 0.011 OUNCES 0.31 GRAMS

Specifications Subject to Change Without Notice.

SM-1



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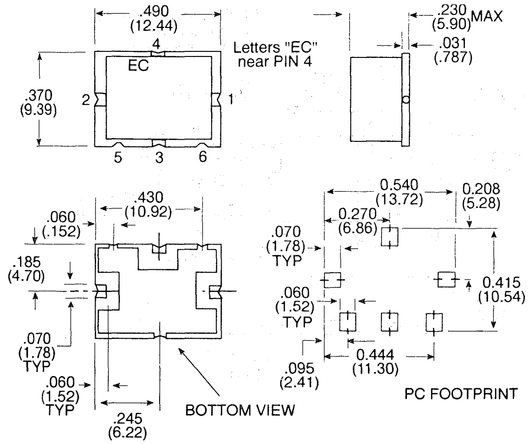
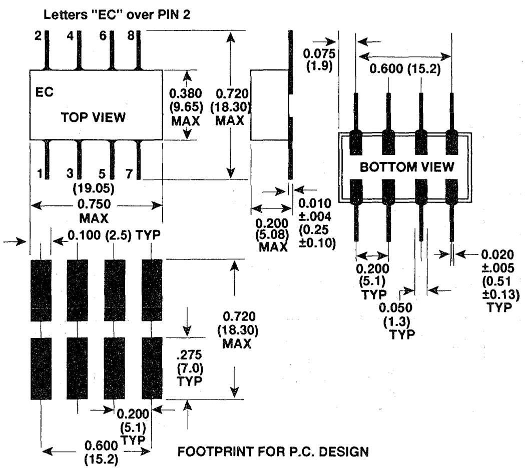
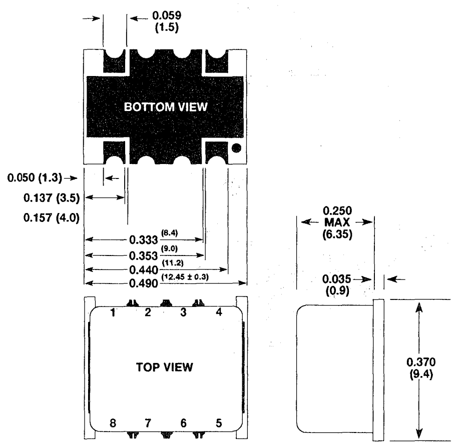


SM-3



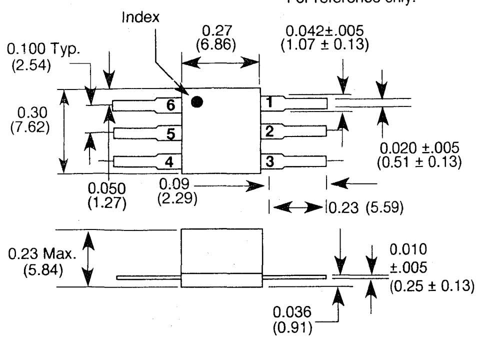
SM-4



Specifications Subject to Change Without Notice.

SM-5

NOTE: Pin numbers do not appear on unit. For reference only.



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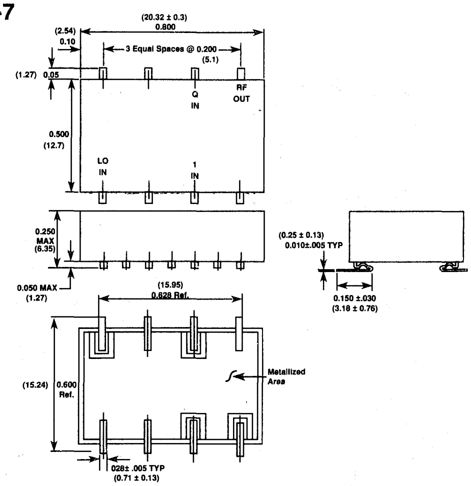
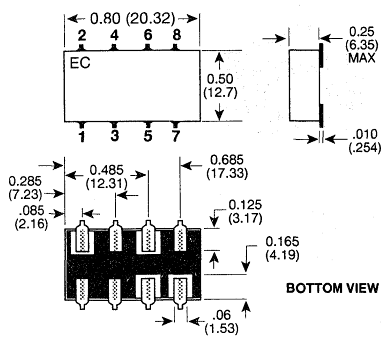
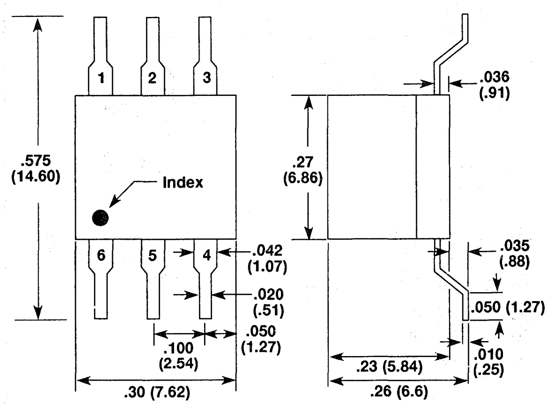


SM-7-1

Letters "EC" over PIN 2

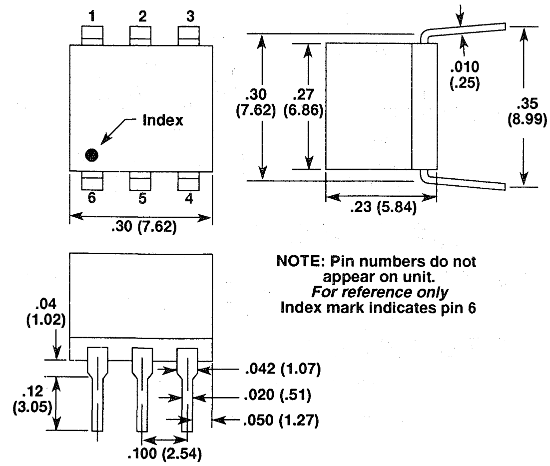


SM-20



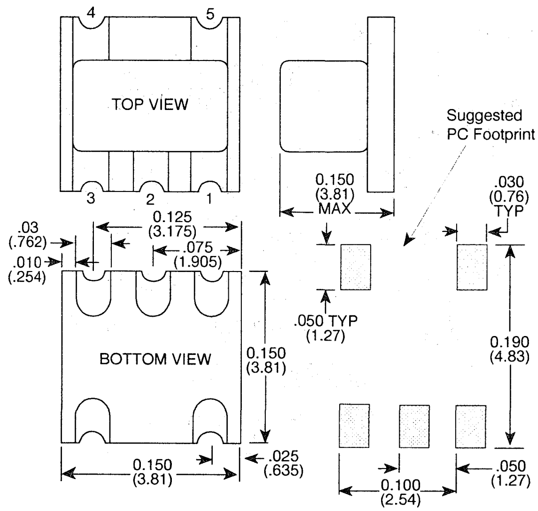
NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

SM-21

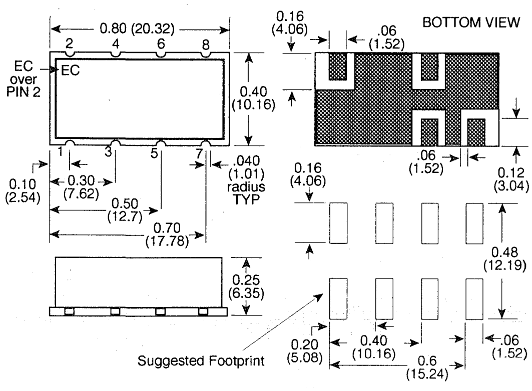


NOTE: Pin numbers do not appear on unit.
For reference only
Index mark indicates pin 6

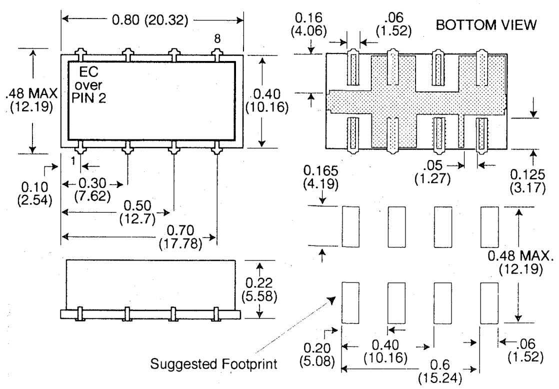
SM-22



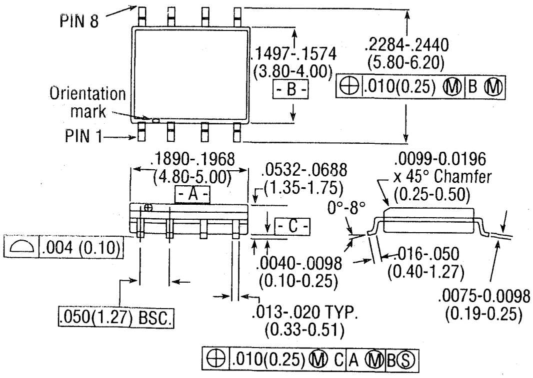
SM-25



SM-27

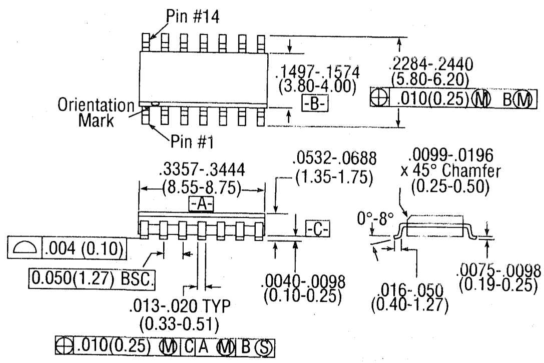


SO-8



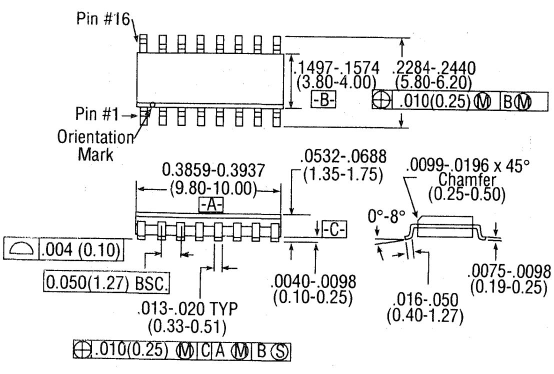
8- Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AA, Issue C)

SO-14



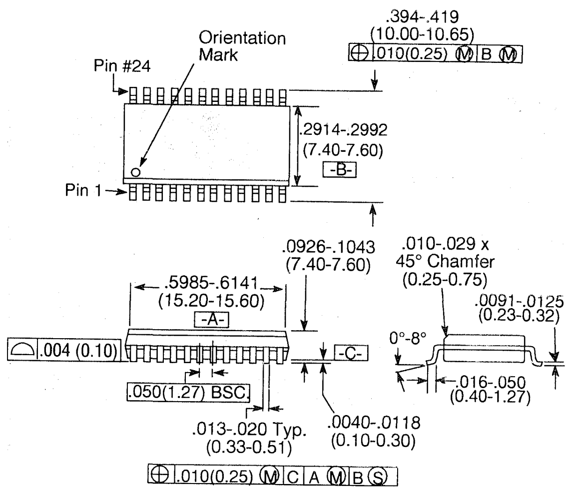
14-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AB, Issue C)

SO-16



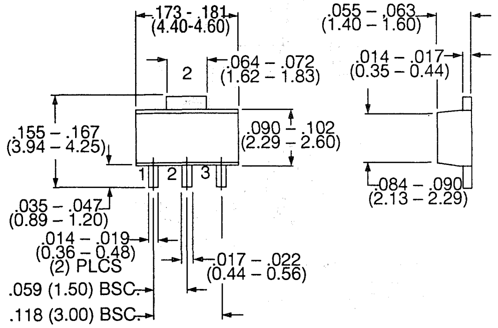
16-Lead SOP outline dimensions
Narrow body .150
(All dimensions per JEDEC No. MS-012-AC, Issue C)

SO-24

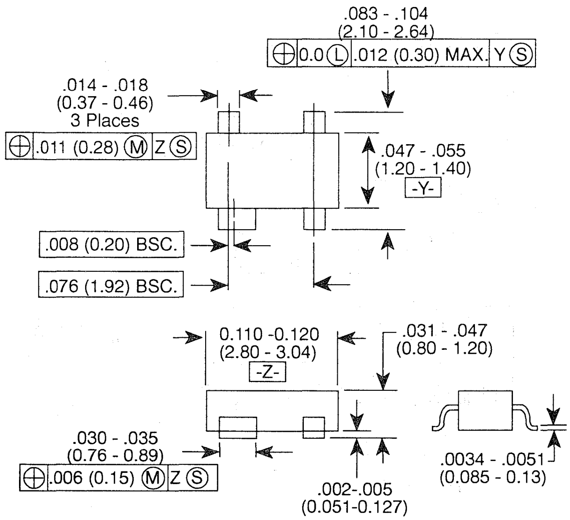


24-Lead SOP outline dimensions
Wide body .300
(All dimensions per JEDEC No. MS-013-AD, Issue C)

SOT-89

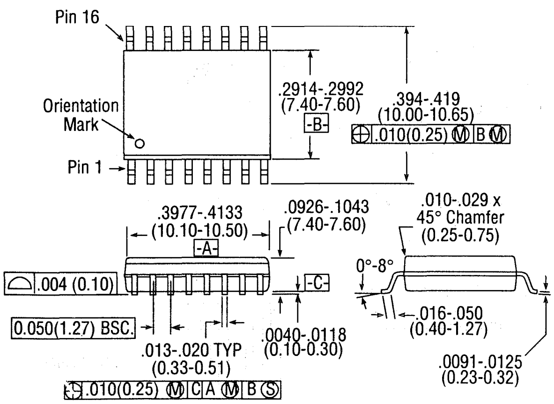


SOT-143



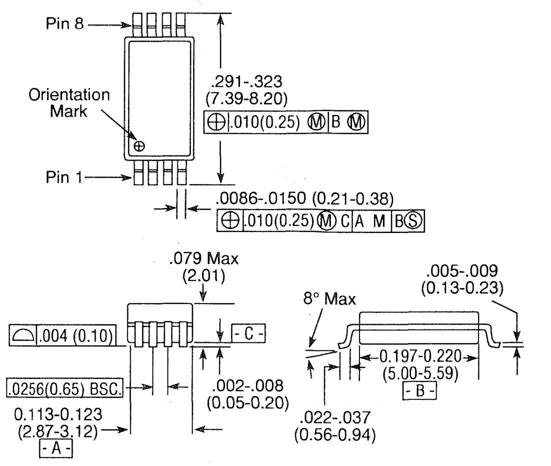
SOT-143 outline dimensions
(All dimensions per JEDEC No. TO-253 Issue C)

SOW-16



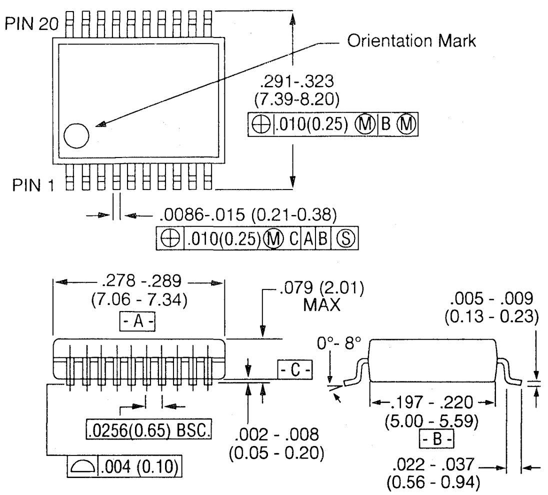
16-Lead SOP outline dimensions
Wide body (.300)
(All dimensions per JEDEC No. MS-013-AA, Issue C)

SSO-8

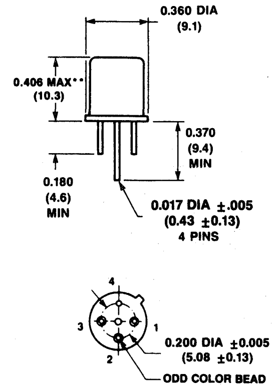


Specifications Subject to Change Without Notice.

SSOP-20



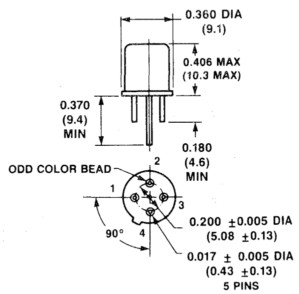
TO-5-1



**FOR MTH-50; 0.343"
MAX FOR MTV-50
(PIN 4 NOT ON ALL PACKAGES)

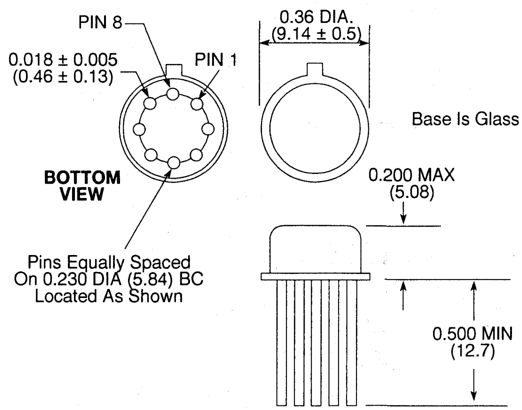
MOUNTING AREA:	0.1 SQ. IN.	0.6 SQ. CM.
WEIGHT (APPROX.):	0.11 OUNCES	3 GRAMS

TO-5-2



MOUNTING AREA:	0.1 SQ. IN.	0.6 SQ. CM.
WEIGHT (APPROX):	0.11 OUNCES	3 GRAMS

TO-5-3

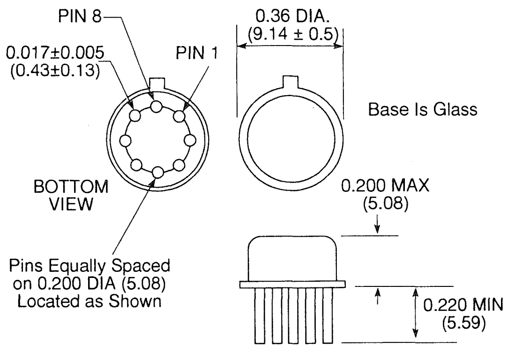


WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

Bottom of Case is AC Ground

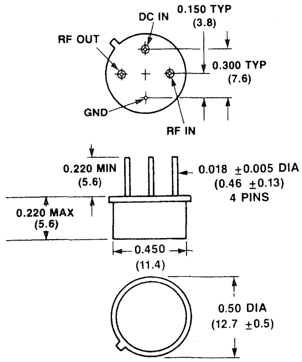
Specifications Subject to Change Without Notice.

TO-5-4



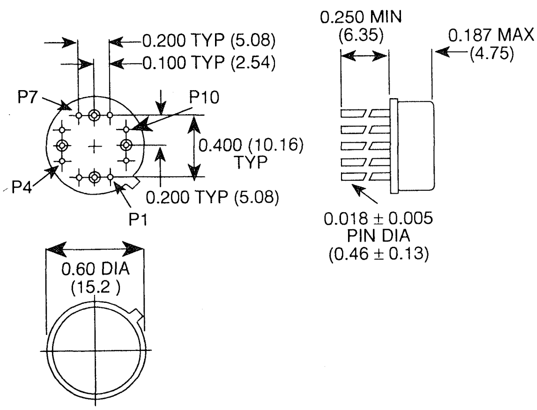
WEIGHT (APPROX.): 0.025 OUNCES 0.7 GRAMS

TO-8-1



WEIGHT (APPROX.): 0.10 OUNCES 2.8 GRAMS

TO-8-2



Bottom of Case is AC Ground

Specifications Subject to Change Without Notice.

Part Number Index

Part Number Index

Discontinued Part Number Cross Reference

Discontinued Part Number	Similar to * Replacement Part Number	Direct * Replacement Part Number
1101-SK		2951-2002
1308-SK	Contact Factory	
1508-SK	2664-1016-XY	
1557-SK	Contact Factory	
2103-SK	2954-2003	
2303-SK		2954-1004
2308-SK	2956-1003	
2404-1501-00	Contact Factory	
2404-1503-00	DM1-18A	
2404-1504-00	DM1-18A	
2404-1505-00		DM1-18A
2404-1506-00	DM1-18A	
2404-1507-00	DM1-18A	
2404-1508-00	DM1-18A	
2404-1509-00		Contact factory
2404-1510-00		Contact factory
2436-1501-00		DMB1-12A
2436-1502-00		DMB2-18A
2503-SK	2664-1016-XY	
2508-SK	2956-1003	
2696-1001-00		DMK2-18
2696-1002-00		DMK2-18TTL
2904-1010-00	2901-04-DBM	
2904-1011-00	Contact factory	
2904-1012-00	2903-04-DBH	
2904-1013-00	2903-04-DBH	
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2929-1002-00	Contact factory	
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4508-SK	Contact Factory	
4509-SK	2683-1004	
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8003-SK	2970-2004	
8109-SK	2692-1004	
9001-SK	2692-1004	
9003-SK	2692-1004	
9008-SK	2691-2004	
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AM-107	AMC-117	
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AM-156	AM-181	
AM-171	AM-181	
AM-173	AM-182	

Discontinued Part Number	Similar to * Replacement Part Number	Direct * Replacement Part Number
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AM-178	AM-180	
AM-179	AM-180	
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AM-211	AM-145	
AM-212	AM-181	
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AM-260	MAAM28000	
AM-261	MAAM28000-A1	
AM-280	MAAM12000	
AM-281	MAAM12000-A1	
AM-282	MAAM12000-A1	
AM-290	MAAM37000	
AM-291	MAAM37000-A1/AM-250	
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CH-139	CH-137	
CH-143	CH-140	
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DM1-12A	DM1-18A	
DM4-8A	DM1-18A	
DM8-12A	DM1-18A	
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DO-110	Contact Factory	
DO-120	Contact Factory	
DO-130	Contact Factory	
DS-329	DS-323	
DS-331	DS-313	

* Refer to part number index for page number of these parts or contact your local M/A-COM Field Office at 1-800-366-2266.

Discontinued Part Number Cross Reference

Discontinued Part Number	Similar to * Replacement Part Number	Direct * Replacement Part Number
DS-332	DS-313	
FM-105	FM-104	
JH-132	JH-115/JHS-115	
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JH-151	2032-6371-00	
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M-166C	2903-04-DBH	
M-167	3601-05-DBH	
M-167C	2903-04-DBH	
M-170	3601-05-DBH	
M-170C	2901-04-DBM	
M-171	3601-05-DBH	
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M-177C	2903-04-DBH	
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MD-402		EMT-4
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MD-404		EMT-2H
MD-405		EMT-3H
MD-406		EMT-4H
MD-407		EMT-15
MD-410		EMA-1
MD-411		EMA-1
MD-412		EMA-2
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MD-425		EMA-2000
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MD-427		EMS-1X
MD-428		EMS-1-1
MD-435		EMK-8
MD-440		EMM-2
MD-441		EMM-3
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MLLF-3	EMT-3	
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SW-245	SW-241	
SW-248	SW-241	
SW-252	SW-241	
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SW-300		MASW8000
SW-410		MASW4060
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TBM4-18	2903-04-DBH	
TBV2-18	2903-04-DBH	

* Refer to part number index for page number of these parts or contact your local M/A-COM Field Office at 1-800-366-2266.

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