Semiconductor Products Master Catalog

M/A-COM

INTRODUCTION

M/A-COM Semiconductor Products is the world's leading manufacturer and custom designer of microwave semiconductor devices. For over 35 years our company has been developing and manufacturing state of the art semiconductor products for commercial, telecommunications and military applications. Our established product lines include both silicon and gallium arsenide diodes. Our broad selection of diodes include:

SILICON PRODUCTS

SCHOTTKY BARRIER DIODES
(Packaged, Chips, Beam Leads)
- Detectors • Mixers • Bridge Quads • Ring Quads
- Dual Barrier Quads • Anti-Parallel Beam Leads
- Dual and Single Tees

PIN DIODES
- Packaged • Axial Lead Package • Hermetic Chips
- Beam Leads • Surface Mount (MELF, SOT)
- RF Multithrow Switch Modules • Stripline • Limiters

MULTIPLIER DIODES
- Variable Capacitance Diodes • Step Recovery Diodes
- Bimode/Dualmode Diodes • Pulse Multipliers
- Stackpack/Series Pack Multipliers • Packaged • Chips

TUNING VARACTORS
- Abrupt • Hyperabrupt • Packaged • Chips

POINT CONTACT DIODES
- Detectors • Mixers

MNS Capacitors

BIPOLAR TRANSISTORS
- Low Noise Transistors • Oscillator Transistors

SILICON EPITAXIAL WAFERS

BULK WINDOWS™ Arrays

GaAs PRODUCTS

SCHOTTKY BARRIER DIODES
(Packaged, Chips, Beam Leads)
- Mixers • Anti-Parallel Beam Leads • Single Beam Leads • MM Mixer Diodes • Ring Quads • Tees
- Bridge Quads

GaAs PIN DIODES
- Packaged • Chips • Beam Leads

MULTIPLIER DIODES
- MM Multiplier Diodes • Packaged • Chips

PARAMETRIC AMPLIFIER VARACTORS
- Packaged • Chips

TUNING VARACTORS
- Abrupt • Hyperabrupt • Constant Gamma
- Beam Lead • Packaged • Chips

GUNN DIODES
- CW Gunn Diodes • Pulse Gunn Diodes

IMPATT DIODES
- CW IMPATT Diodes • Pulse IMPATT Diodes

MMIC (FET based)
- GaAs FET MMIC RF & Microwave • Control Products

M/A-COM Semiconductor Products Operation's well equipped facilities, advanced processing techniques and highly skilled technical specialists provide the basis for outstanding technological leadership and expertise. We have a highly qualified multinational team of product specialists, application engineers and sales/marketing professionals to assist our customers.

Our charter is to provide a reliable, high quality product at a reasonable price. To achieve this, our technical staff is continually at work developing new device concepts and products, and our sales and applications personnel are available to serve the demands of the fast growing semiconductor industry.

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PIN Diodes

SILICON BEAM LEAD PIN DIODES
Specifications @ T_A = 25°C

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs (ohms)	NOMINAL CARRIER LIFETIME (ns)	NOMINAL REVERSE RECOVERY TIME (ns)
MA4P800	100	.025	3.5 @ 50 mA	100	10
MA4P801	100	.030	3.3 @ 50 mA	100	10
MA4P802	100	.040	3.0 @ 50 mA	100	10
MA4P803	100	.050	2.8 @ 50 mA	100	10
MA4P461	50	.070	2.2 @ 10 mA	30	3
MA4P462	30	.120	1.7 @ 10 mA	20	2

For more specific information see page 1-19.

SILICON PIN DIODE CHIPS

LOW CAPACITANCE PIN CHIPS

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs @ 10 mA (ohms)	NOMINAL CHIP SIZE (mils)	NOMINAL CARRIER LIFETIME (ns)
MA4P150	20	.10	1.5	15X15	10
MA4P151	30	.05	2.0	15X15	10
MA4P152	30	.10	1.5	15X15	10
MA4P153	30	.15	1.2	15X15	10
MA4P154	30	.20	1.0	15X15	10
MA4P155	40	.05	2.0	15X15	15
MA4P156	40	.10	1.5	15X15	15
MA4P157	60	.10	1.5	15X15	50
MA4P158	60	.15	1.2	15X15	60
MA4P159	60	.20	1.0	15X15	65
MA4P160	100	.05	1.9	15X15	80
MA4P161	100	.10	1.5	15X15	90
MA4P162	100	.15	1.2	15X15	100
MA4P163	100	.20	1.2	15X15	120
MA4P165	200	.05	2.5	15X15	170
MA4P166	200	.10	2.0	15X15	190
MA4P167	200	.15	1.5	15X15	220

For more specific information see page 1-23.

GENERAL PURPOSE PIN CHIPS

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs @ 10 mA (ohms)	NOMINAL CHIP SIZE (mils)	NOMINAL CARRIER LIFETIME (ns)
MA47420-132	35	.85	0.5	20X20	300
MA4P102-134	50	.05	2.0	15X15	20
MA4P202-134	100	.05	2.5	15X15	100
MA4P203-134	100	.15	1.5	15X15	100
MA4P303-134	200	.15	1.5	15X15	200
MA4P404-132	250	.60	0.6	20X20	1000

For more specific information see page 1-23.

PIN CHIPS FOR ATTENUATOR CIRCUITS

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs @ 10 mA (ohms)	NOMINAL CHIP SIZE (mils)	NOMINAL CARRIER LIFETIME (μs)
MA47418	200	.15	3	20X20	1.0
MA47416	200	.15	6	20X20	2.0
MA47406	200	.15	8	20X20	2.5

For more specific information see page 1-23.

HIGH VOLTAGE PIN CERMACHIP™

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs @ 100 mA (ohms)	NOMINAL CHIP SIZE (mils)	NOMINAL CARRIER LIFETIME (μs)
MA4P504-132	500	0.20	0.60	20X20	1
MA4P505-131	500	0.35	0.45	30X30	2
MA4P506-131	500	0.70	0.30	30X30	3
MA4P604-131	1000	0.30	1.00	30X30	3
MA4P606-131	1000	0.60	0.70	30X30	4
MA4P607-210	1000	1.30	0.40	65X65	5
MA4P608-130	1000	2.50	0.35	85X85	5
MA4P709-223	1500	3.30	0.25	110X110	10
MA4P902-223	2000	3.50	0.30	115X115	20

For more specific information see page 1-23.

LIMITER PIN DIODES
Specifications @ T_A = 25°C

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM JUNCTION CAPACITANCE (pF)	MAXIMUM Rs @ 10 mA (ohms)	RATED THERMAL RESISTANCE (C/W)
MA4L011	20	.20	2.0	70
MA4L021	30	.20	1.5	60
MA4L022	30	.15	2.0	60
MA4L031	40	.20	1.5	40
MA4L032	40	.15	2.0	40
MA4L101	100	.15	2.0	30
MA4L301	200	.20	2.0	25
MA4L302	200	.25	1.2	30
MA4L401	250	.30	1.5	25
MA47089-54*	30	.3 (Ct0)	2.0	500

*Glass Limiter diode (case style 54)

For more specific information see page 2-3.

STRIPLINE PIN DIODE SWITCHES

MODEL NUMBER	VOLTAGE RATING (volts)	TEST FREQUENCY (GHz)	MAXIMUM REVERSE BIAS INSERTION LOSS (dB)	MAXIMUM THERMAL RESISTANCE (C/W)
MA47208	1000	1.0	0.25 @ -20V	10
MA47200	500	1.0	0.25 @ -20V	10
MA47202	500	6.0	0.50 @ -20V	15
MA47204	500	8.0	0.60 @ -20V	20
MA47206	100	10.0	0.50 @ -10V	30
MA47201	500	1.0	0.25 @ -20V	10
MA47203	500	6.0	0.50 @ -20V	15
MA47205	115	10.0	0.50 @ -20V	20
MA47207	100	10.0	0.50 @ -20V	30
MA47223	500	4-8	0.50 @ 0V	20
MA47222	150	8.0	0.50 @ 0V	20
MA47220*	150	10.0	0.50 @ 0V	30
MA47221	70	4-8	1.00 @ 20V	20

*Anode heat sink diode

For more specific information see page 1-59.

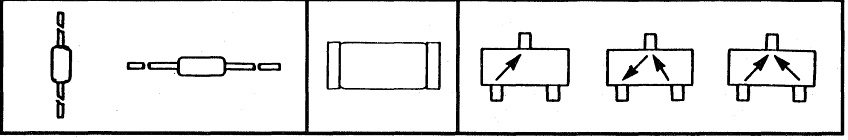
RF MULTITHROW SWITCH MODULES

MODEL NUMBER	CASE STYLE	MAXIMUM CW INPUT POWER (watts)	SWITCH TYPE	FREQUENCY RANGE (MHz)
MA8334-100	506	10	SP2T	20-600
MA8334-101	506	10	SP2T	20-600
MA8334-001	844	100	SP2T	20-1000
MA8334-004	844	100	SP3T	20-1000
MA8334-200	946	1000	SP2T	20-200

For more specific information see page 1-63.

AXIAL LEAD AND SURFACE MOUNT PIN DIODES FOR UHF AND VHF FREQUENCIES

Specifications @ T_A = 25°C

MAXIMUM RATING (volts)	MAXIMUM CAPACITANCE (pF)	SERIES RESISTANCE (ohms @ mA)	AXIAL LEAD PACKAGES*		SURFACE MOUNT PACKAGES**			
			ODS-54	DOUBLE PLUG	HERMETIC MELF	SOT-23 PACKAGES		
						SINGLE DIODE	SERIES TEE	COMMON TEE
								

General Purpose Diodes

35	1.00	0.5 @ 10 mA	MA47120	—	—	—	—	—
35	1.20	0.5 @ 10 mA	—	MA4PH270	MA47058	MAP275	MA4P275ST	MA4P275CK
50	0.30	1.5 @ 10 mA	MA4PH401	—	MA4PH101	MA4P789	MA4P789ST	MA4p789CK
100	1.20	0.6 @ 10 mA	—	MA4PH151	MA4PH152	MA4P282	—	—
100	0.25	1.5 @ 50 mA	1N5719	—	—	—	—	—
200	0.30	3.0 @ 10 mA	MA47047	—	—	—	—	—
200	0.50	3.0 @ 10 mA	—	MA47123	MA47055	MA4P274	MA4P274ST	MA4P274CK
200	0.40	2.5 @ 100 mA	1N5767	—	—	—	—	—

Large Signal Switch Diodes

100	2.00	0.4 @ 50 mA	—	MA4PH201	—	—	—	—
200	1.50	0.6 @ 50 mA	—	MA47266	MA47059	—	—	—
200	1.10	1.0 @ 50 mA	—	MA4PH301	—	—	—	—

Fast Switching and Low Capacitance Diodes

100	0.10	2.5 @ 30 mA	MA40741	—	—	—	—	—
100	0.20	1.5 @ 10 mA	MA47053	—	—	—	—	—
100	0.25	1.2 @ 10 mA	MA47054	—	—	—	—	—

Low Distortion Attenuator Diodes

200	0.30	6.0 @ 10 mA	MA47600	—	—	—	—	—
200	0.50	6.0 @ 10 mA	—	MA47110	MA47057	MA4P277	—	MA4P277CK
200	0.30	8.0 @ 10 mA	MA47100	—	MA47056	MA4P278	—	—
100	0.25	20.0 @ 10 mA	MA4PH001	—	—	—	—	—
100	0.35	20.0 @ 10 mA	—	MA4P208	—	—	—	—
100	1.00	8.0 @ 10 mA	—	MA4PH451	—	—	—	—
200	0.80	25.0 @ 10 mA	—	MA47111	MA4PH601	—	—	—

For more specific information see page 1-39.

PACKAGED AND CHIP GaAs PIN DIODES

GaAs PIN DIODES
Specifications @ T_A = 25°C

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs @ 20 mA (ohms)	NOMINAL CARRIER LIFETIME (mils)	NOMINAL SWITCHING SPEED (ns)
MA4GP022	50	0.15	1.00	5.0	4.0
MA4GP025	75	0.35	0.85	10.0	4.0
MA4GP030	100	0.06	2.00	20.0	10.0
MA4GP032	100	0.12	1.50	25.0	10.0

For more specific information see page 1-11.

GaAs BEAM LEAD PIN DIODES
Specifications @ T_A = 25°C

MODEL NUMBER	VOLTAGE RATING (volts)	MAXIMUM CAPACITANCE (pF)	MAXIMUM Rs @ 10 mA (ohms)	NOMINAL CARRIER LIFETIME (ns)	NOMINAL SWITCHING SPEED (ns)
MA4GP901	50	.07	2.0	5	2-4

For more specific information see page 1-15.

PACKAGED SILICON PIN DIODE SELECTION GUIDE

CHARACTERISTICS/SPECIFICATIONS

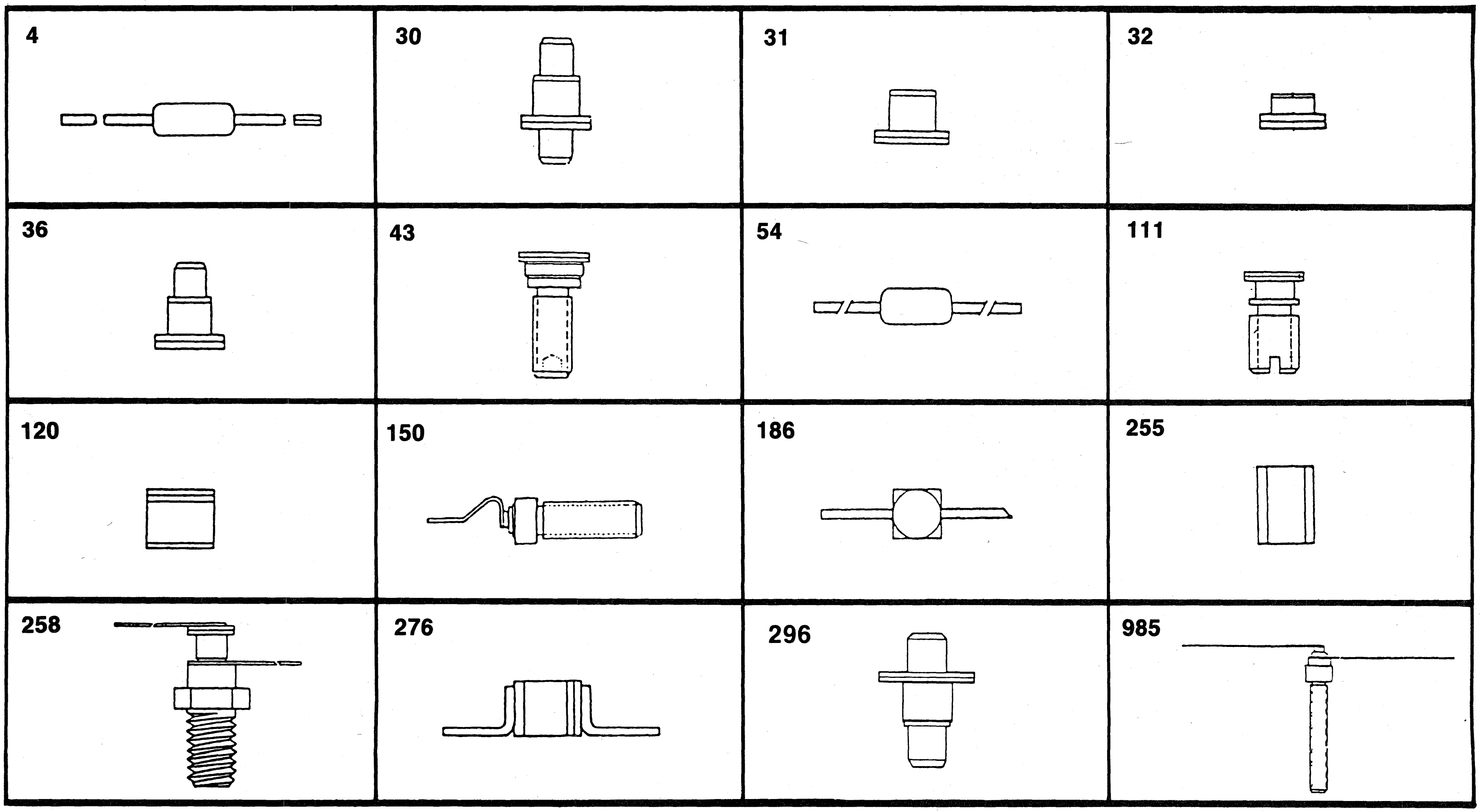
ELECTRICAL CHARACTERISTICS	4P102	4P202	4P203	4P303	4P404	4P504	4P505	4P506	4P604	4P606	4P607	4P608	4P709	4P902	UNITS
Voltage Rating	50	100	100	200	250	500	500	500	1000	1000	1000	1000	1500	2000	volts
Max. Capacitance CT @ volts	0.30pF @ 10V	0.25pF @ 10V	0.35pF @ 10V	0.35pF @ 10V	0.40pF @ 10V	0.40pF @ 100V	0.55pF @ 100V	0.90pF @ 100V	0.50pF @ 100V	0.80pF @ 100V	2.00pF @ 100V	3.20pF @ 100V	3.30pF @ 100V	3.50pF @ 100V	pF @ volts
Max Rs mA	2.0 @ 10 mA	2.5 @ 10 mA	1.5 @ 10 mA	1.5 @ 10 mA	0.6 @ 50 mA	0.6 @ 100 mA	0.45 @ 100 mA	0.30 @ 100 mA	1.00 @ 100 mA	0.70 @ 100 mA	0.40 @ 100 mA	0.35 @ 150 mA	0.25 @ 200 mA	0.30 @ 200 mA	Ohms @ mA
Nominal Carrier Lifetime (μs)	20	100	200	1000	1.0	1.0	2.0	3.0	3.0	4.0	5.0	5.0	10	15	μs @ 10 mA
Max. Thermal Resistance	60	60	30	30	20	20	15	10	20	10	7	5	2	2	°C/W

AVAILABLE CASE STYLES[2]

Case Style #	Nom. CP (pF)	Nom. LP (nH)	Refer to Outline Drawings of Available Case Styles													
4	0.25	2.5	—	—	—	—	—	X	X	X	X	X	—	—	—	—
30	0.18	0.40	X	X	X	X	X	X	X	X	X	X	—	—	—	—
31	0.18	0.60	X	X	X	X	X	X	X	X	X	X	—	—	—	—
32	0.30	0.40	X	X	X	X	X	X	X	X	X	X	—	—	—	—
36	0.18	0.40	X	X	X	X	X	X	X	X	X	X	—	—	—	—
43	0.75	0.80	—	—	—	—	—	—	—	—	—	—	X	X	—	—
54	0.10	1.0	—	—	X	X	X	—	—	—	—	—	—	—	—	—
111	0.27	0.30	—	—	—	—	X	X	X	X	X	X	—	—	—	—
120	0.13	0.40	X	X	X	X	X	—	—	—	—	—	—	—	—	—
150	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	X
186	0.15	0.40	X	X	X	X	—	—	—	—	—	—	—	—	—	—
255	0.20	0.40	—	—	—	—	—	X	X	X	X	X	—	—	—	—
258	0.25	0.60	—	—	—	—	—	X	X	X	X	X	—	—	—	—
276	0.13	0.40	X	X	X	X	X	—	—	—	—	—	—	—	—	—
985	1.0*	—	—	—	—	—	—	—	—	—	—	—	—	—	X	X

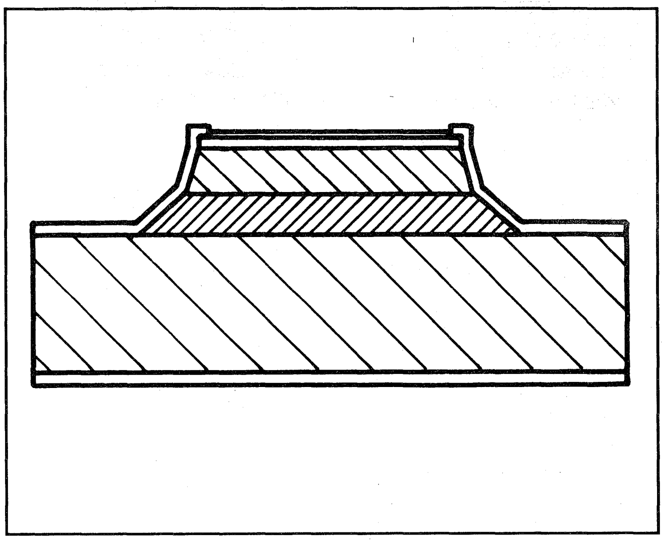
* Capacitance to Ground X Available Package — Package Not Available For This Part

Packaged Silicon PIN Diode
Outline Drawings of Available Case Styles



MA4GP Series

GaAs PIN Diodes



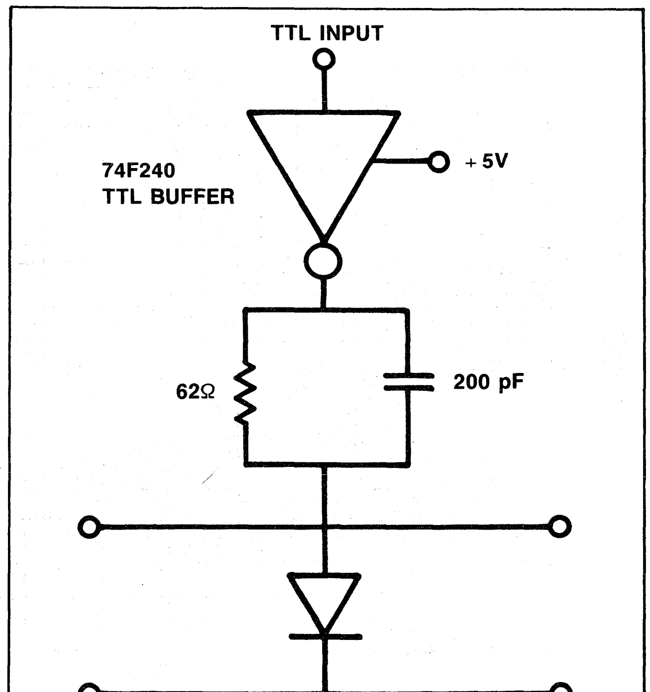
Features

- MAY BE DRIVEN DIRECTLY FROM TTL SIGNALS
- LOW SERIES RESISTANCE
- FAST SWITCHING SPEED
- NO REVERSE BIAS REQUIRED
- AVAILABLE AS PASSIVATED CHIPS

Description

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

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



TYPICAL DRIVER CIRCUIT

Specifications $T_A = 25° C$

ELECTRICAL SPECIFICATIONS

Nominal Characteristics

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

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

MAXIMUM RATINGS

Temperature	
Operating	−65° C to +175° C
Storage	−65° C to +175° C
Voltage	Breakdown Voltage
Power Dissipation Rating	.25W @ 25° C

ENVIRONMENTAL RATINGS PER MIL-STD-750

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

Typical Performance Curves

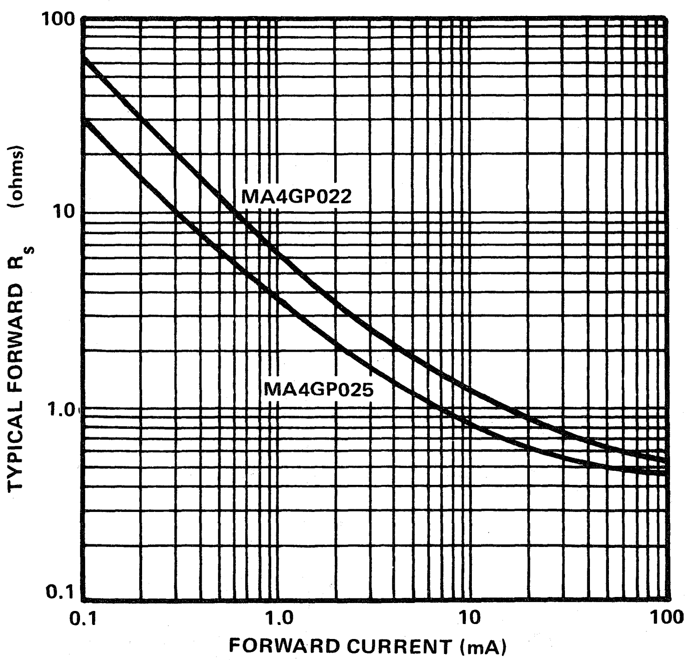


FIGURE 1. Typical Forward R_S vs. Forward Current at 1 GHz

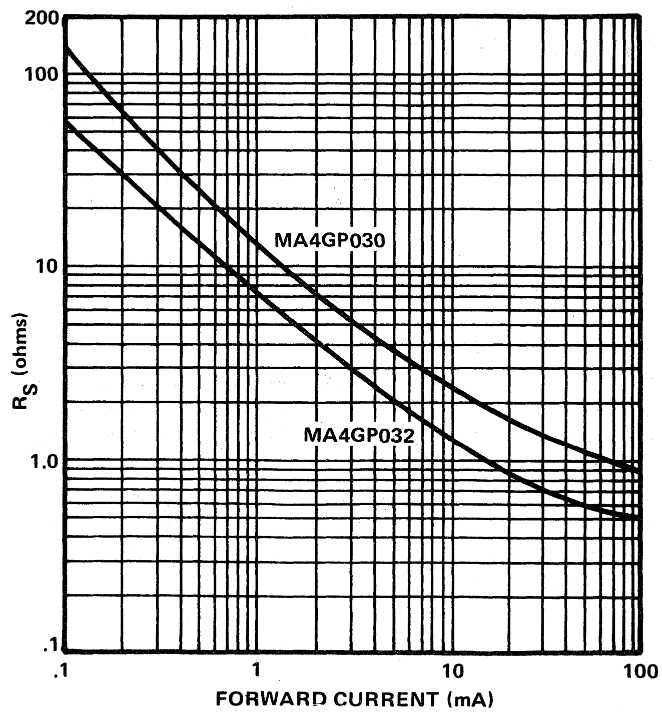


FIGURE 2. Typical Forward R_S vs. Forward Current at 1 GHz

Typical Performance Curves (Cont'd)

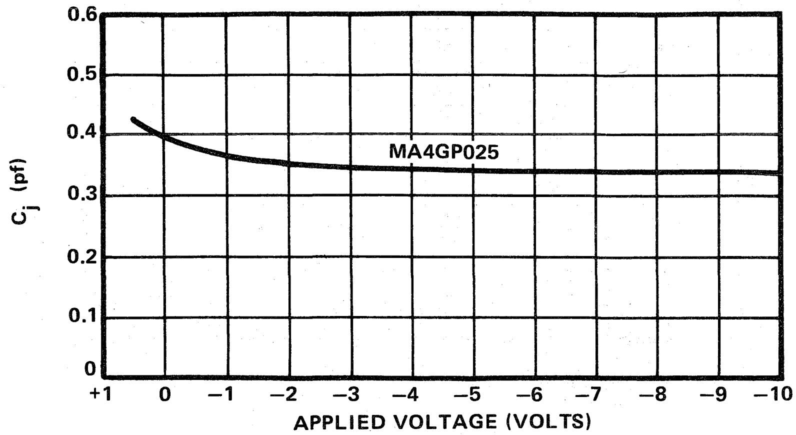


FIGURE 3. Capacitance Voltage Characteristics at 1 GHz

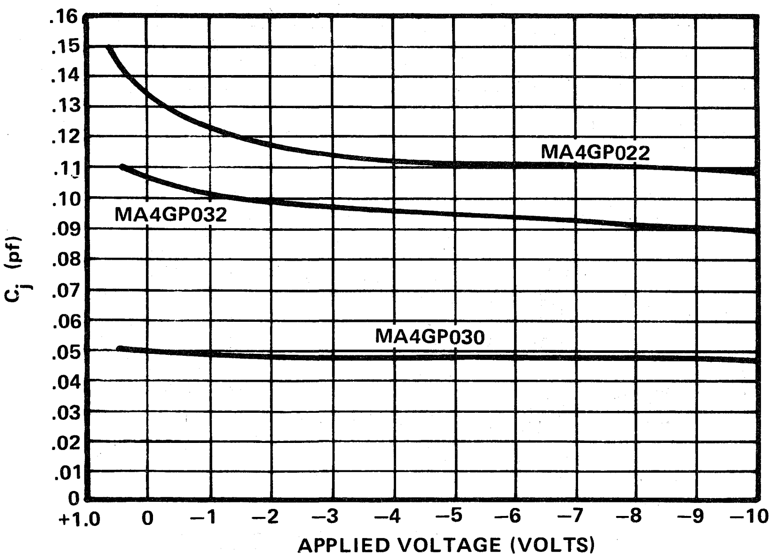


FIGURE 4. Capacitance Voltage Characteristics at 1 GHz

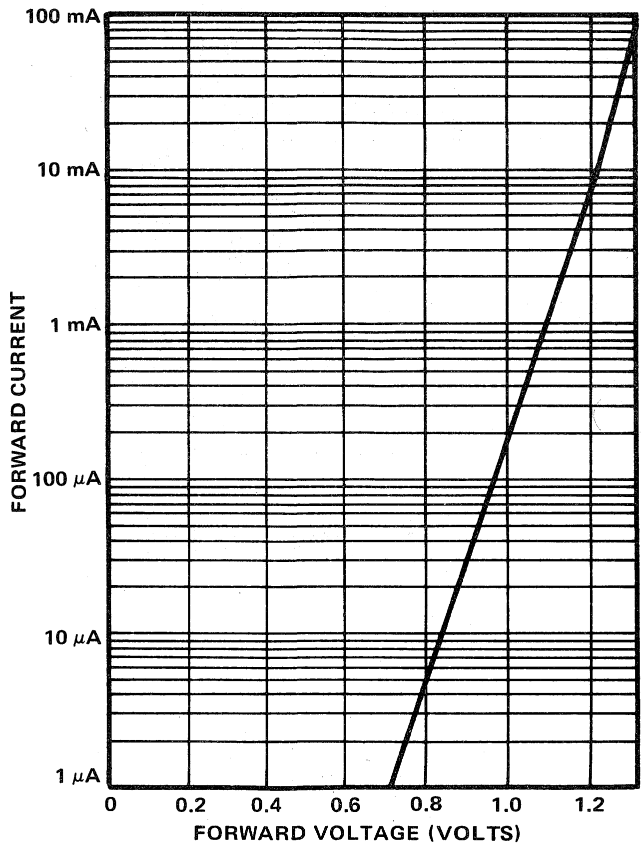
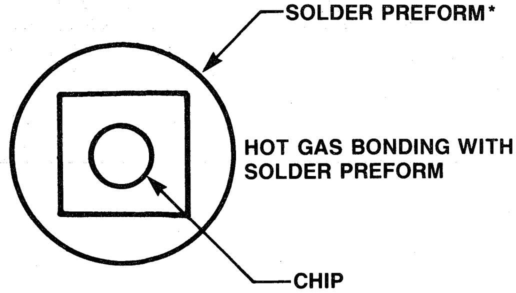


FIGURE 5. Typical Characteristics at 25° C Forward Current vs. Forward Voltage (All GaAs PIN Diodes)

DIE BONDING

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



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

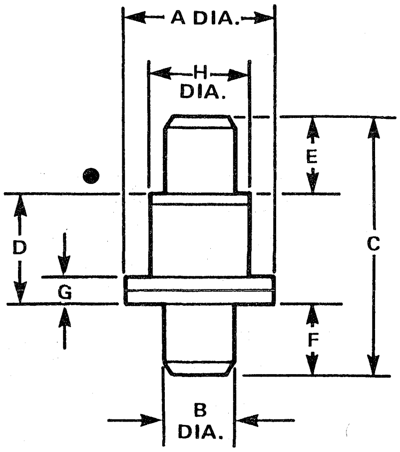
The heating stage should be set at 240° C. An 80% N_2, 20% H_2 forming gas is effective as the hot gas jet. The temperature at the tip should be approximately 400° C.

RIBBON AND WIRE ATTACHMENT

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

Case Styles

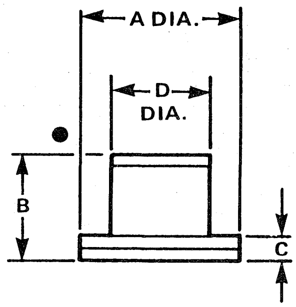
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

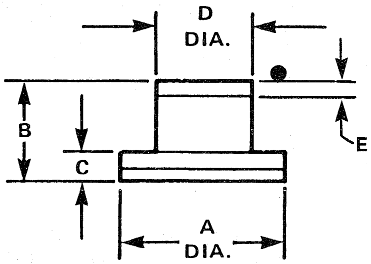
31



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

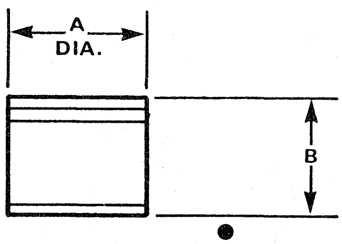
94



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35
E	0.004	0.010	0,10	0,24

C_P = 0.15 pF Typical
L_S = 0.40 nH Typical

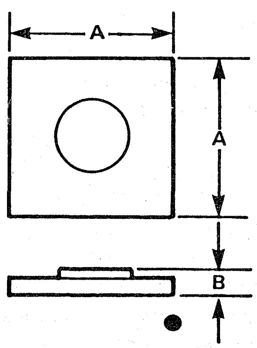
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,29	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

277 (CHIP STYLE)

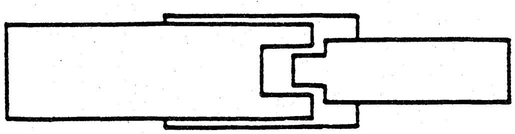


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.012	0,25	0,31
B	0.004	0.005	0,10	0,13

● DENOTES CATHODE

All specifications are subject to change without notice.

GaAs Beam Lead PIN Diodes



992

Features

- NANOSECOND SWITCHING SPEED
- MAY BE SWITCHED DIRECTLY FROM TTL SIGNALS
- LOW CAPACITANCE
- LOW FORWARD R_S TO 2 OHMS
- LOW REVERSE BIAS REQUIREMENTS

Description

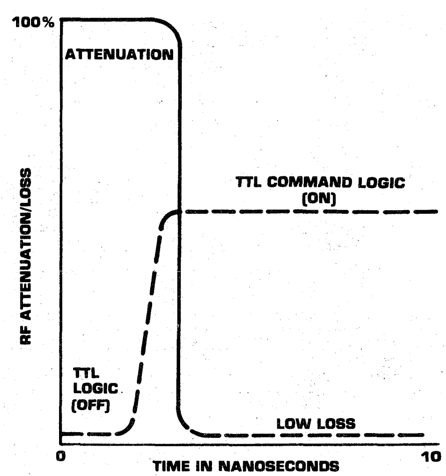
The MA4GP900 family of Gallium Arsenide Beam Lead PIN diodes offers improved microwave characteristics for many switching applications. The high carrier mobility of Gallium Arsenide results in low series resistance and fast switching. The low carrier density in the intrinsic region results in zero bias punch through and high off impedance at zero bias. Air bridge technology reduces the beam parasitic capacitance and helps to achieve very small total capacitance.

This series of GaAs Beam Lead PIN diodes may be switched directly using TTL signals.

Switching speeds in the low nanosecond range are achieved with GaAs Beam Lead PIN diodes.

Applications

The MA4GP900 series of PIN diodes are useful for fast MIC switches through 18 GHz.



Fast Series Switch

Specifications @ T_A = 25°C

	Electrical Specifications			Nominal Characteristics	
Model[1] Number	Maximum[2] Forward R_S @ 10 mA, 10 GHz (Ohms)	Minimum Voltage V_b @ 10 μA (Volts)	Maximum Capacitance @ 1 MHz @ −10 Volts (pF)	Switching[3] Speed (ns)	Carrier[4] Lifetime (ns)
MA4GP901	2.0	50	.07	2-4	5

NOTES:
1. Case Style for the MA4GP series is the ODS 992, a nitride passivated beam lead.
2. Forward R_S measured at 10 mA and 10 GHz in a 50 ohm transmission line.
3. Switching speed is measured between 10% and 90% loss in a series mounted 10 GHz switch.
4. Carrier lifetime (τ) is measured at 10 mA. It is derived from the stored charged where: $Q = \tau I_{dc}$

MAXIMUM RATINGS

Temperature

Operating	−65°C to +175°C
Storage	−65°C to +175°C
Voltage	Breakdown Voltage
Power Dissipation Rating	.10W at 25°C

ENVIRONMENTAL RATINGS PER MIL STD 750

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

Typical Performance Curves

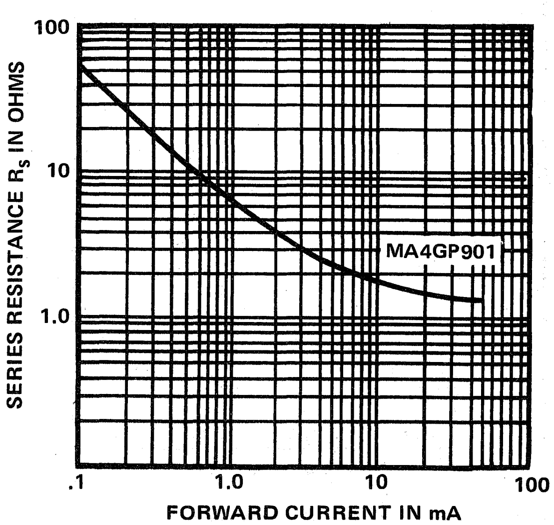


FIGURE 1. Typical Forward R_S vs. Forward Current in mA at 10 GHz

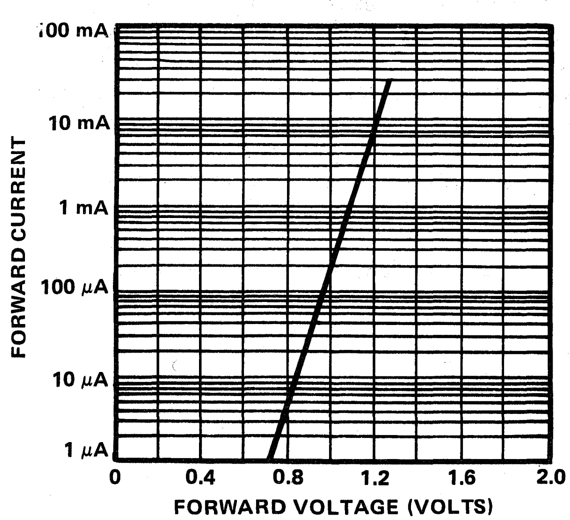
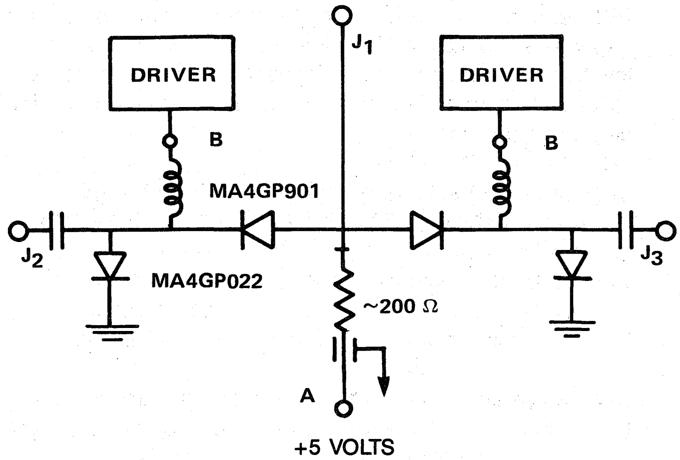


FIGURE 2. Typical Characteristics at 25°C Forward Current vs. Forward Voltage (All GaAs PIN Diodes).

Application Note

GaAs PIN DIODE DRIVER CIRCUIT

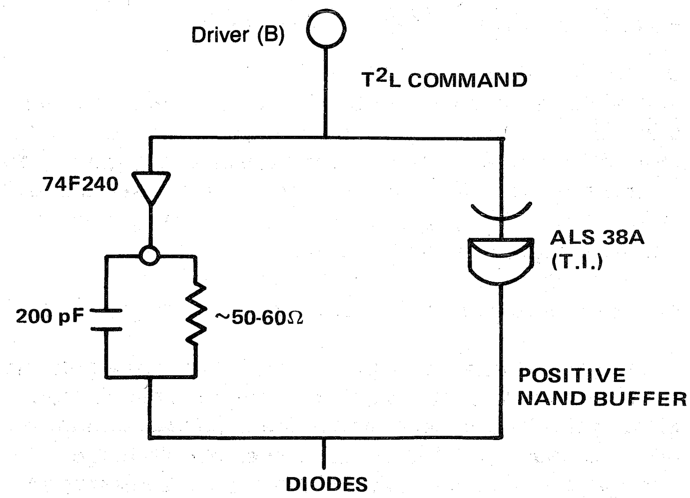
Gallium Arsenide PIN diodes have high impedance at zero bias. They can be driven to low impedance by using 5-20 mA forward current.This can normally be supplied directly by an inexpensive TTL "buffer" logic such as the 74F240 family. The following circuit is an example of a simple inexpensive driver circuit which can be used for either a SPDT or a series shunt diode SPST switch (using the MA4GP901 in series and MA4GP022 PIN diodes in shunt). It is quite fast. See page 1-12 for MA4GP022.



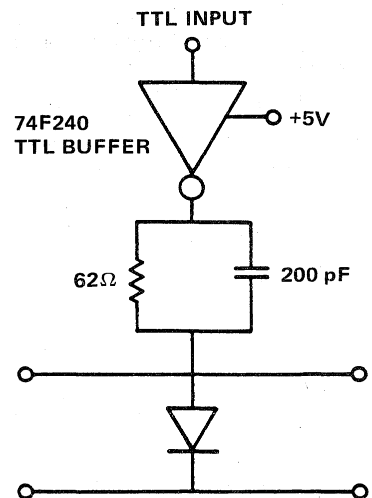
SPST/SPDT DRIVER

The common +5 volt supply is used to forward bias one or the other of the series diodes. The current should be controlled at the common input (A). A suitable current is ~5-20 mA. The forward biased diode will allow RF power to flow from J1 to either of the opposing arms (J2 or J3).

The driver connection (B) must provide a TTL (zero) which will zero bias the shunt diode and allow a low resistance "sink" for the series connected diode's current. (See driver schematic.) The one state will cause current to pass through the ~50 ohm resistor (~10-20 mA) to forward bias the shunt diode. The voltage drop across this diode will zero or slightly reverse bias the series diode and shut it off. This arm will then isolate.

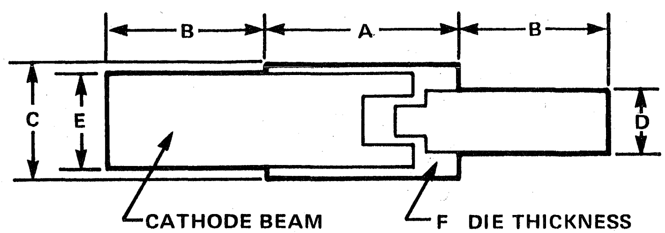


The 74F240 logic buffer can be used to drive a series or shunt GaAs PIN diode. It is the driver M/A-COM Semiconductor Operations uses to RF characterize GaAs PIN diodes (see figure below). The ALS38A (T.I.) is a positive nand buffer with open collector output. It supplies a high impedance output when the 74F240 is forward biasing the shunt diode and a current sink when the 5 volt source is biasing the series diode.



TYPICAL DRIVER CIRCUIT

Case Style
992



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.012	0.014	0,305	0,356
B	0.010	— —	0,254	— —
C	0.006	0.008	0,152	0,203
D	0.004	0.006	0,102	0,152
E	0.007	0.009	0,178	0,229
F	— —	0.004	— —	0,102

Bonding Procedures

BONDING BEAM LEAD DIODES

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

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

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

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

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

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

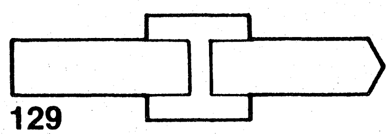
BONDING TO SOFT CIRCUITS

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

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

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

Silicon Beam Lead PIN Diodes



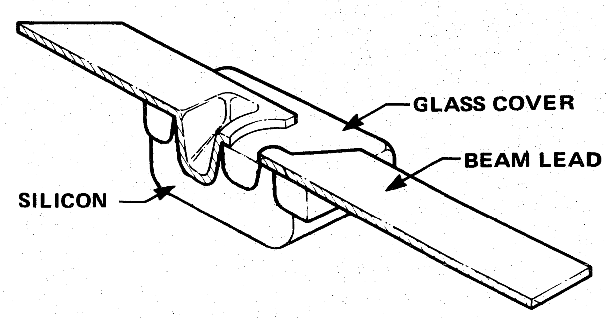
Features

- HIGH PERFORMANCE MICROWAVE CHARACTERISTICS
- FAST SWITCHING SPEEDS
- GLASS ENCAPSULATED CONSTRUCTION
- HERMETICALLY SEALED
- MECHANICALLY RUGGED — 6 GRAMS MINIMUM BEAM STRENGTH

Description

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

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



Specifications @ T_A = 25°C

Model[5] Number	Maximum Capacitance @ 10 Volts 1 MHz (Volts)	Maximum R_S @ 500 MHz (Ohms)	Minimum[1] Voltage Rating, V_b (Volts)	Nominal[2] Carrier Lifetime (ns)	Nominal[3] Reverse Recovery Time (ns)
MA4P800	.025	3.5 @ 50 mA	100	100	10
MA4P801	.030	3.3 @ 50 mA	100	100	10
MA4P802	.040	3.0 @ 50 mA	100	100	10
MA4P803	.050	2.8 @ 50 mA	100	100	10
MA4P461	.070	2.2 @ 10 mA	50	30	3
MA4P462	.120	1.7 @ 10 mA	30	20	2

NOTES:
1. The reverse current will not exceed 10 μA at the minimum voltage rating.
2. Nominal carrier lifetime measured at 10 mA.
3. Nominal reverse recovery time measured at I_F = 20 mA, I_R = 200 mA.
4. Lower capacitance values with correspondingly higher series resistance are available on request.
5. Standard case style is ODS-129

ABSOLUTE MAXIMUM RATINGS

Voltage	Voltage Rating
Operating Temperature	−65°C to +150°C
Storage Temperature	−65°C to +175°C
Power Dissipation at 25°C	
Lead Temperature	250 mW
Beam Strength	6 grams

Typical Performance Curves

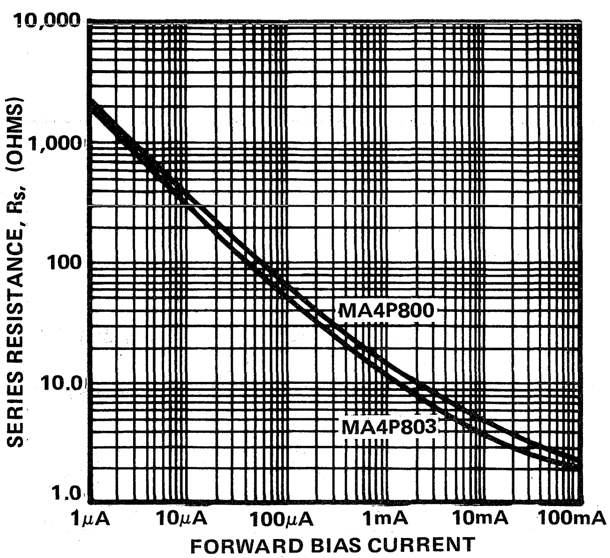


FIGURE 1. Typical Resistance at 500 MHz

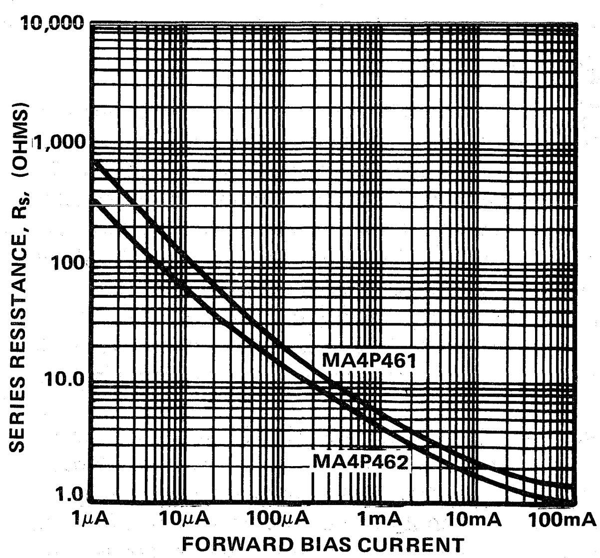


FIGURE 2. Typical Resistance at 500 MHz

Bonding Procedures

BONDING BEAM LEAD DIODES

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

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BONDING TO SOFT CIRCUITS

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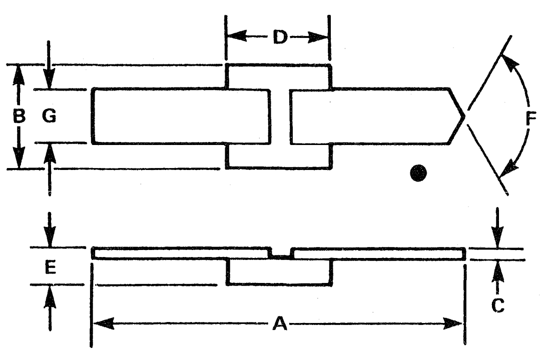
Conductive solder paste such as high conducting silver filled epoxy will also result in good low loss bonds. Care should be taken to ensure that the wet paste does not run up the beam lead and short it.

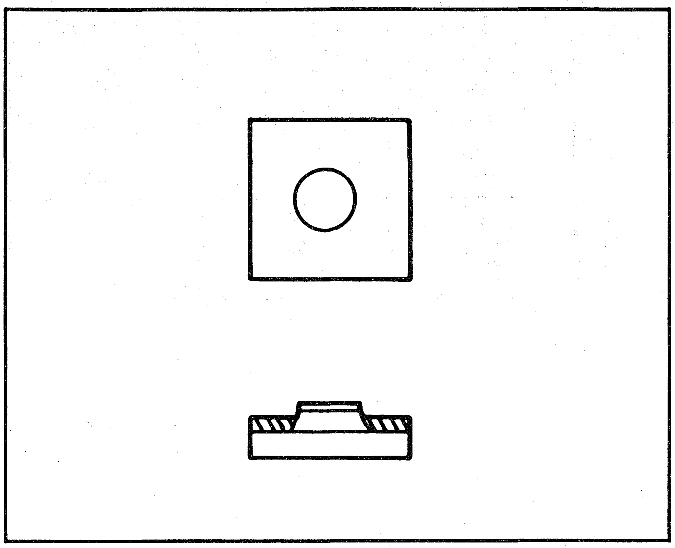
Case Style

129



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

Silicon PIN Diode Chips



Features

- **GLASS OR SILICON DIOXIDE PASSIVATION**
- **HERMETICALLY SEALED CERMACHIP™ DESIGN**
- **FAST SPEED, LOW LOSS MICROWAVE CHIPS**
- **ATTENUATOR CHIPS**
- **VOLTAGE RATINGS TO 2000 VOLTS**
- **WIDE RANGE OF PIN CHARACTERISTICS**

Description

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

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

M/A-COM's PIN diode chips have gold contact surfaces, with the cathode surface as the bottom contact. Equivalent NIP structures are available for many of the products described in this bulletin.

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

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

The General Purpose PIN diode chips are silicon dioxide passivated mesa structures. They are also available in hermetically sealed packages as described in the standard packaged PIN diode Bulletin 4325. These diodes encompass a wide range of characteristics with voltage ratings from 50 to 250 volts.

M/A-COM's CERMACHIP™ PIN diode chips employ M/A-COM's unique hard glass passivation, covering the entire active surface of the PIN diode junction. This results in an hermetically sealed chip that has been qualified for many high reliability military and space programs. The CERMACHIP™ PIN chips are available with voltage ratings up to 2,000 volts and are capable of controlling kilowatts of power.

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

				Nominal Characteristics		
Model[1] Number	Voltage[2] Rating (volts)	Maximum[3] C_j @ 10V (pF)	Maximum[4] R_S @ 10 mA (ohms)	Carrier[5] Lifetime (ns)	Reverse[6] Recovery Time (ns)	Contact Diameter (mils)
MA4P150	20	.10	1.5	10	2	1.5
MA4P151	30	.05	2.0	10	2	1.5
MA4P152	30	.10	1.5	10	2	2.0
MA4P153	30	.15	1.2	10	2	2.0
MA4P154	30	.20	1.0	10	2	2.0
MA4P155	40	.05	2.0	15	4	1.5
MA4P156	40	.10	1.5	15	4	1.5
MA4P157	60	.10	1.5	50	6	2.0
MA4P158	60	.15	1.2	60	6	2.5
MA4P159	60	.20	1.0	65	7	2.5
MA4P160	100	.05	1.9	80	8	2.0
MA4P161	100	.10	1.5	90	9	2.5
MA4P162	100	.15	1.2	100	10	3.0
MA4P163	100	.20	1.2	120	15	3.5
MA4P165	200	.05	2.5	170	20	2.0
MA4P166	200	.10	2.0	190	20	3.0
MA4P167	200	.15	1.5	220	30	5.0

NOTES:
1. Nominal chip size is 15 X 15 mil (ODS 134)
2. Maximum reverse current is 10 μA at the specified voltage rating.
3. Maximum capacitance is specified at 1 MHz at the indicated voltage.
4. Maximum series resistance is at the specified current and a frequency of 500 MHz.
5. Nominal carrier lifetime is specified at If = 10 mA.
6. Nominal reverse recovery time is specified at If = 20 mA, Ir = 200 mA.

ATTENUATOR PIN DIODE CHIPS
Specifications @ T_A = 25°C

				Nominal Characteristics				
Model[1] Number	Voltage[2] Rating (volts)	Maximum[4] R_S @ 10 mA (ohms)	Maximum[3] Cj @ 100V @ 100 V (pF)	R_S for I_F = 1 mA (ohms)	R_S for I_F = 10 μA (ohms)	Carrier Lifetime (μS)	I-Region Width (mils)	Equivalent[6] M/A-COM Axial Lead PIN Diode
MA47418	200	3	.15	8	500	1.0	2	MA47047
MA47416	200	6	.15	30	2000	2.0	4	MA47600
MA47406	200	8	.15	50	3000	2.5	7	MA47100

NOTES
1. Nominal chip size is 20 X 20 mil (ODS 132)
2. Maximum reverse current is 10 μA at specified voltage rating.
3. Capacitance is specified at 1 MHz.
4. Resistance is specified at 100 MHz.
5. Carrier Lifetime is specified at 10 mA.
6. See Bulletin 4323 for more information.

GENERAL PURPOSE PIN CHIPS
Specifications @ T_A = 25° C

Model[1] Number	Voltage[2] Rating (volts)	Maximum R_S @ 10 mA (ohms)	Maximum[4] C_j @ V_R (pF)	Nominal Characteristics Carrier[5] Lifetime (ns)	I-Region Width (μm)	Contact Diameter (mils)	Thermal Resistance (°C/W)	Chip Size (mils X mils)
MA47420	35	0.5	.85 @ 20	300	10	6.0	60	20 X 20
MA4P102-134	50	2.0	.05 @ 10	20	7	1.5	60	15 X 15
MA4P202-134	100	2.5	.05 @ 10	60	12	1.5	60	15 X 15
MA4P203-134	100	1.5	.15 @ 10	100	12	2.5	30	15 X 15
MA4P303-134	200	1.5	.15 @ 10	200	20	4.0	30	15 X 15
MA4P404-132	250	0.6*	.20 @ 50	1000	30	4.0	20	20 X 20

* AT 50 mA, 100 MHz

NOTES:
1. Packaged diodes listing these chips are described in Bulletin 4325.
2. Maximum reverse current is 10 μA at specified voltage rating.
3. Resistance is specified at 500 MHz unless indicated.
4. Capacitance is specified at 1 MHz at the indicated voltage.
5. Nominal carrier lifetime is specified at 10 mA.

PIN CERMACHIPS™
Specifications @ T_A = 25°C

Model[1] Number	Voltage[2] Rating (volts)	Maximum R_S@100 mA (ohms)	Maximum[4] C_j @ 100V (pF)	Nominal Characteristics Carrier[5] Lifetime (μs)	I-Region Width (mils)	Chip Size (mils X mils)	Contact Diameter (mils)	Thermal Resistance (°C/W)
MA4P504-132	500	0.60	0.20	1	2	20 X 20	5	20
MA4P505-131	500	0.45	0.35	2	2	30 X 30	8	15
MA4P506-131	500	0.30	0.70	3	2	30 X 30	12	10
MA4P604-131	1000	1.00	0.30	3	4	30 X 30	12	15
MA4P606-131	1000	0.70	0.60	4	4	30 X 30	18	10
MA4P607-210	1000	0.40	1.30	5	4	65 X 65	28	7
MA4P608-130	1000	0.35*	2.50	5	4	85 X 85	38	5
MA4P709-223	1500	0.25**	3.30	10	7	110 X 110	50	2
MA4P902-223	2000	0.30**	3.50	15	8	115 X 115	55	2

* AT 150 mA
** AT 300 mA

NOTES:
1. Packaged diodes using these chips are described in Bulletin 4325.
2. Maximum reverse current is 10 μA at specified voltage ratings.
3. Capacitance is specified at 1 MHz
4. Resistance is specified at 100 MHz.
5. Nominal Carrier Lifetime is specified at 10 mA.

MAXIMUM RATINGS

STORAGE TEMPERATURE	−65°C TO +200°C
OPERATING TEMPERATURE	−65°C TO +175°
VOLTAGE	VOLTAGE RATING

POWER DISSIPATION:

LOW CAPACITANCE AND ATTENUATOR CHIPS	0.5 WATTS @ 25°C (derate to zero watts at 175°C)

GENERAL PURPOSE CHIPS AND CERMACHIPS™

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

Typical Resistance Curves

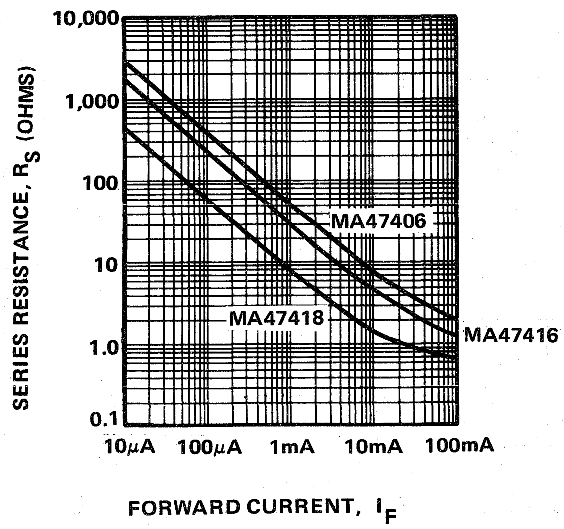


FIGURE 1.

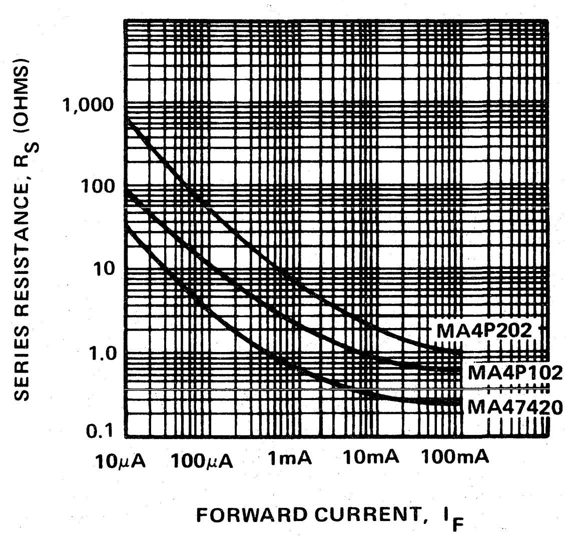


FIGURE 2.

Typical Resistance Curves (Cont'd)

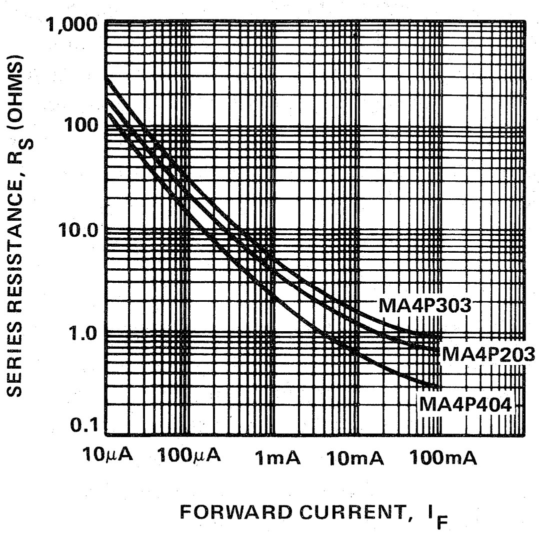


FIGURE 3.

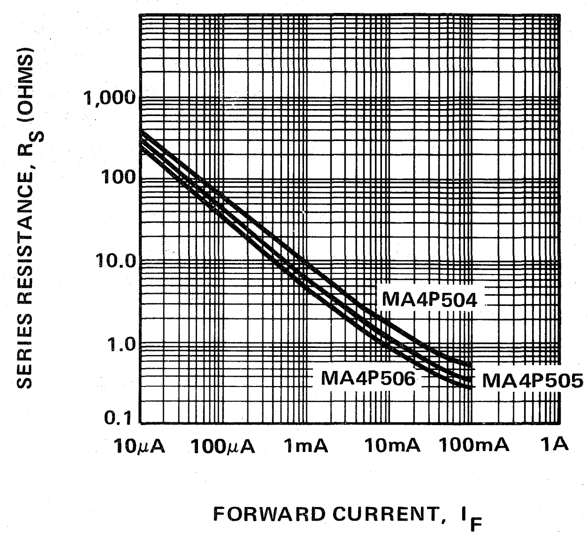


FIGURE 4.

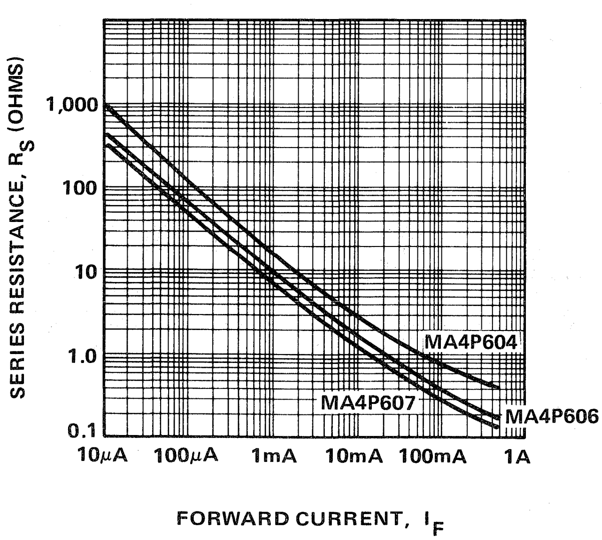


FIGURE 5.

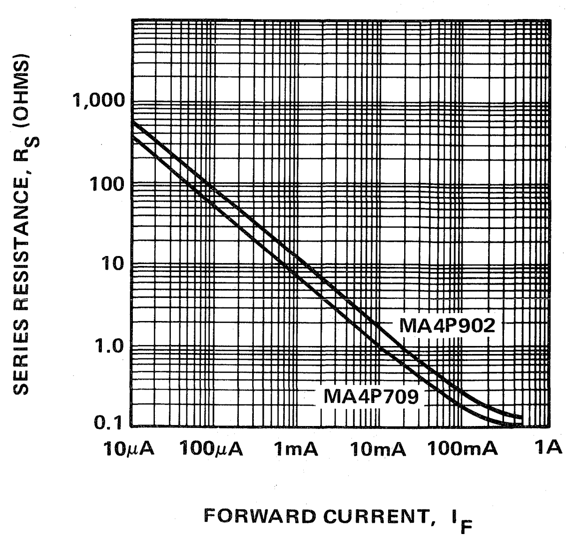


FIGURE 6.

BONDING AND HANDLING CONSIDERATIONS FOR SILICON PIN DIODE CHIPS

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

DIE BONDING

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

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

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

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

LEAD BONDING

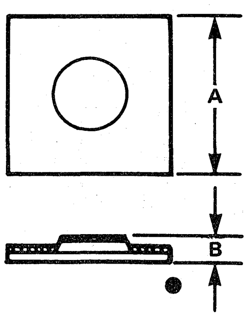
Thermocompression and thermocompression ultrasonic lead bonding techniques may be employed for PIN diode chips. Wire bonds using 0.7 mil and 1 mil gold wire may be ball or wedge bonded; ribbons from 0.25 mil X 3.0 mil to 1 mil X 10 mil maybe wedge bonded. The choice depends on the application and the contact size. During lead bonding, it is preferrable that the substrate be raised to approximately 150°C. The bonding tip temperature and pressure depends on the wire or ribbon size and contact area. The resulting bond strength should exceed the specification in MIL-STD-883, Method 2011.3 for gold wire or ribbon leads.

CHIPS ON CARRIERS

Many of M/A-COM Semiconductor Products Operation's PIN diode chips are available on carriers with attached leads. These devices share the low parasitic characteristics of the PIN diode chip, but they are easier to handle and require less complicated bonding procedures. The style 280 package as shown can accommodate the MA4P504 through MA4P606 chips. Other designs are also available.

Chip Styles

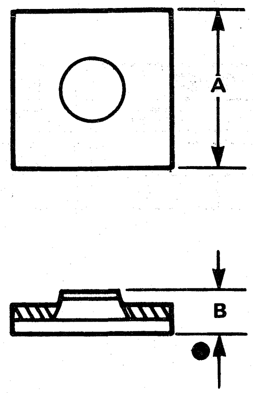
130



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.075	0.095	1,90	2,41
B	0.0085	0.0105	0,021	0,026

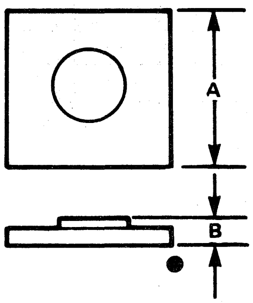
Chip Styles

131



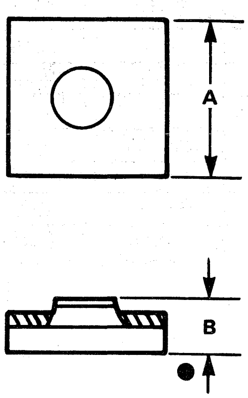
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.030	0.035	0,76	0,89
B	0.0085	0.0105	0,216	0,267

132



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.020	0.024	0,51	0,61
B	0.003	0.006	0,08	0,15

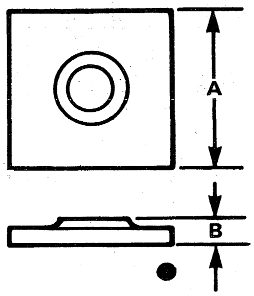
134



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0135	0.0165	0,34	0,42
B	0.0035	0.0065	0,09	0,17

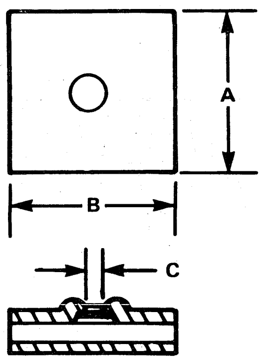
Chip Styles (Cont'd)

210



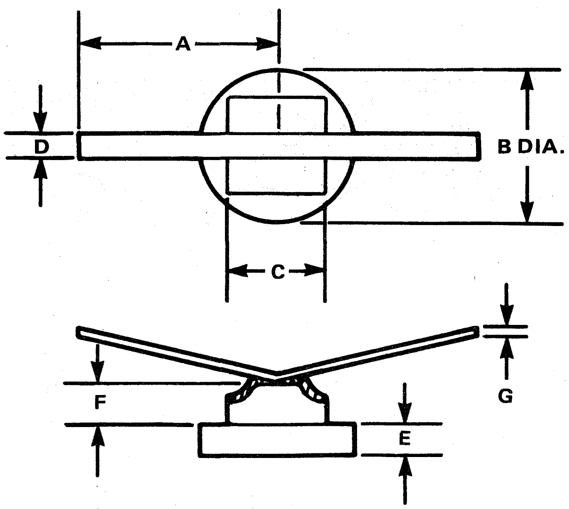
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.024	0.028	0,61	0,71
B	0.004	0.007	0,10	0,18

223



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.110	0.130	2,79	3,30
B	0.110	0.130	2,79	3,30
C	0.008	0.012	,20	,30

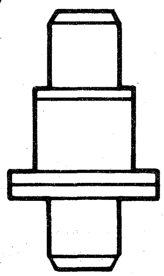
280



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.125	— —	3,18	— —
B	0.090	0.100	2,29	2,54
C	0.063	0.067	1,60	1,70
D	0.0095	0.0105	0,241	0,267
E	— —	0.015	— —	0,38
F	0.010	0.014	0,25	0,36
G	0.0008	0.0013	0,019	0,032

Packaged Silicon PIN Diodes

ODS-30



Features

- HIGH POWER PIN DIODES
- FAST SPEED PIN DIODES
- VOLTAGE RATINGS TO 2000 VOLTS
- LONG CARRIER LIFETIME DESIGNS
- WIDE VARIETY OF HERMETIC PACKAGES
- HIGH RELIABILITY FOR SPACE/MILITARY APPLICATIONS

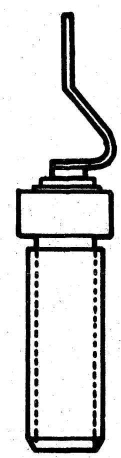
Description

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

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

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

ODS-150



FAST SWITCHING PIN DIODES

Specifications T_A = 25°C

Model[1] Number	Voltage[2] Rating (volts)	Maximum[3] Capacitance Ct @ 100V (pF)	Maximum[4] R_S @ 10 mA 500 MHz (ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics: Carrier[5] Lifetime (ns)	T_{rr}[6] (ns)	I-Region Width (microns)
MA4P102-30	50	.30	2.0	60	20	3	7
MA4P202-30	100	.25	2.5	60	60	5	12
MA4P203-30	100	.35	1.5	30	100	20	12
MA4P303-30	200	.35	1.5	30	200	60	20
MA4P404-30	250	.40*	0.6**	20	1000	100	30

* at 50 volts
** at 50 mA, 100 MHz.

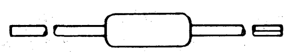
The standard case style is ODS-30.
These diodes are available in the following packages:
Case style 30, 31, 32, 36, 54, 94, 111, 120, 186, 255, and 276.

500 VOLT CERMACHIP™ PIN DIODES

Specifications T_A = 25°C

Model[1] Number	Voltage[2] Rating (volts)	Maximum[3] Capacitance C_t @ 100V (pF)	Maximum[4] R_S @ 100 mA (ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics: Carrier[5] Lifetime (μs)	I-Region Width (mils)
MA4P504-30	500	.40	.60	20	1.0	2
MA4P505-30	500	.55	.45	15	2.0	2
MA4P506-30	500	.90	.30	10	3.0	2

The standard case style is ODS-30.
These diodes are available in the following packages:
Case style 4, 30, 31, 32, 36, 111, 255, 258. (Isolated heatsink)

4


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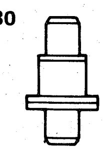
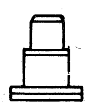


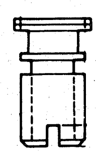
31


32

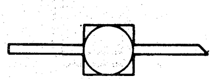

36


54


94


111


120


186


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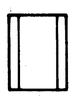

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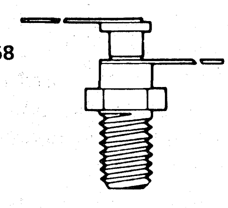

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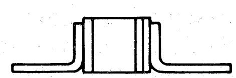


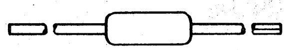
See outline drawings for nominal case capacitance values.

1000 VOLT CERMACHIP™ PIN DIODES

Specifications T_A = 25°C

Model[1] Number	Voltage[2] Rating (volts)	Maximum[3] Capacitance C_t @ 10V (pF)	Maximum[4] R_S at forward current (ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics: Carrier[5] Lifetime (μs)	Nominal Characteristics: I-Region Width (mils)
MA4P604-30	1000	0.50	1.00 @ 100	20	3.0	4
MA4P606-30	1000	0.80	0.70 @ 100	10	4.0	4
MA4P607-43	1000	2.00	0.40 @ 100	7	5.0	4
MA4P608-43	1000	3.20	0.35 @ 150	5	5.0	4

The standard case styles are indicated as a suffix to the model number.
The MA4P604 and MA4P606 are not available in case style 43.
The MA4P607 is only available in case styles 43 and 296.
The MA4P608 is only available in case style 43.

4


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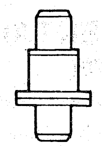
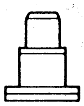


31


36


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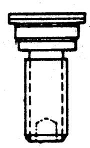

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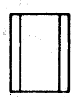

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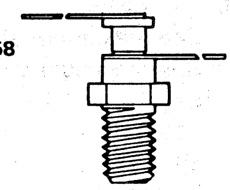
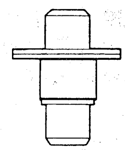


296


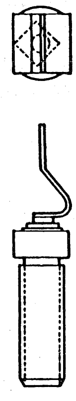
See outline drawings for nominal case capacitance values.

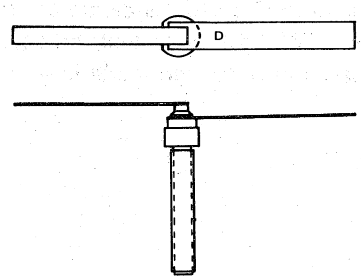
1500 VOLT AND 2000 VOLT CERMACHIP™ PIN DIODE

Specifications T_A = 25°C

Model[1] Number	Voltage[2] Rating (volts)	Maximum[3] Capacitance C_t @ 100V (pF)	Maximum[4] R_S at forward current (ohms)	Maximum Thermal Resistance (°C/W)	Nominal Characteristics: Carrier[5] Lifetime (μs)	Nominal Characteristics: I-Region Width (mils)
MA4P709-150	1500	3.3	.25 @ 200	2	10	7
MA4P902-150	2000	3.5	.30 @ 200	2	15	9

The standard case style is ODS-150.
The diodes are available in the following packages:
Case style 150, 985. (Isolated heatsink)

150


985


NOTES:
1. The devices are available in chip form for integrated circuits. For more information, see Bulletin 4326.
2. The maximum reverse current is 10 μA at voltage rating.
3. Capacitance is specified at 1 MHz.
4. Resistance is specified at 100 MHz unless otherwise indicated.
5. Nominal carrier lifetime is specified at 10 mA.
6. Reverse recovery time is specified at the 90% recovery with I_F = 20 mA and I_R = 100 mA.

MAXIMUM RATINGS

VOLTAGE	VOLTAGE RATING
OPERATING TEMPERATURE	−65°C TO +175°C
STORAGE TEMPERATURE	−65°C TO +200°C

POWER DISSIPATION

CATHODE HEAT SINKED PACKAGES (ODS 30, 150 etc).

$$P_{diss.} = \frac{T_{operating} - 25°C}{\theta jc}$$

LEADED PACKAGES @ 25°C (ODS 54,186, etc). $P_{diss.}$ = .25W

ODS 4 $P_{diss.}$ = .50w

MAXIMUM SOLDERING TEMPERATURE

CASE STYLE 4, 54, 150,186, 258, 985 200°C for 5 seconds.

CASE STYLE 120, 255, 276 200°C for 5 seconds — cathode only.

CASE STYLE 30, 31, 32, 36, 43, 94, 111, 296 225°C for 5 seconds.

ENVIRONMENTAL RATINGS

PER MIL-STD 750

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

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

SCREENED DIODES

(MIL-STD 750)

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

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

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

Ordering Information

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

Typical Resistance Curves

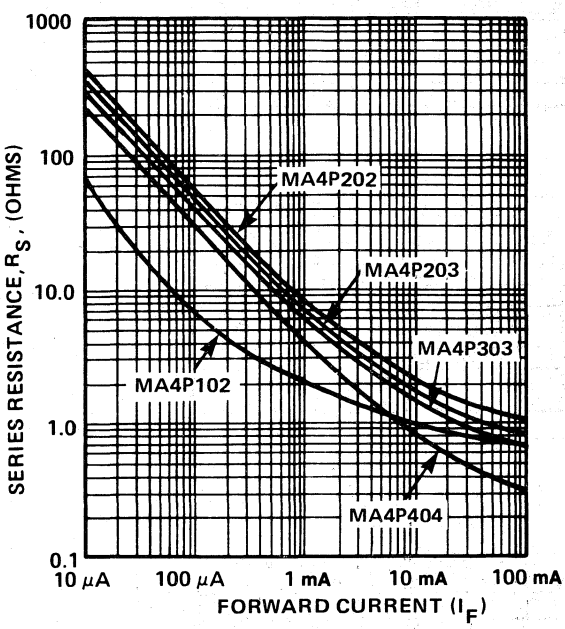


FIGURE 1. Forward Current vs. Series Resistance for MA4P202, MA4P203, MA4P303, MA4P404 and MA4P102

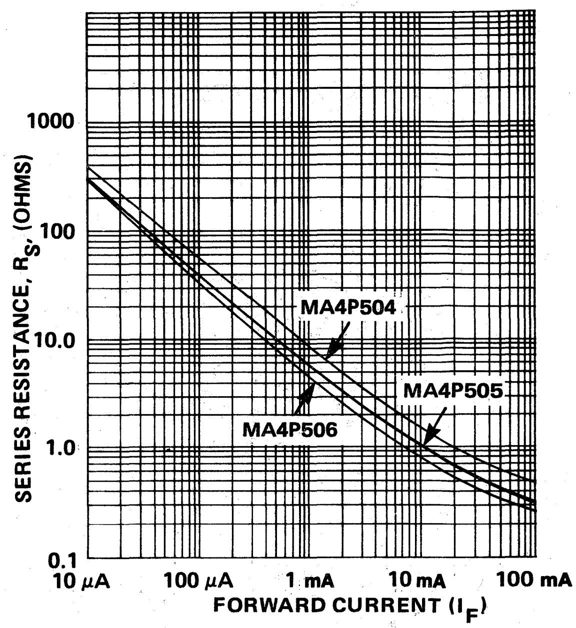


FIGURE 2. Forward Current vs. Series Resistance for MA4P504, MA4P505, MA4P506

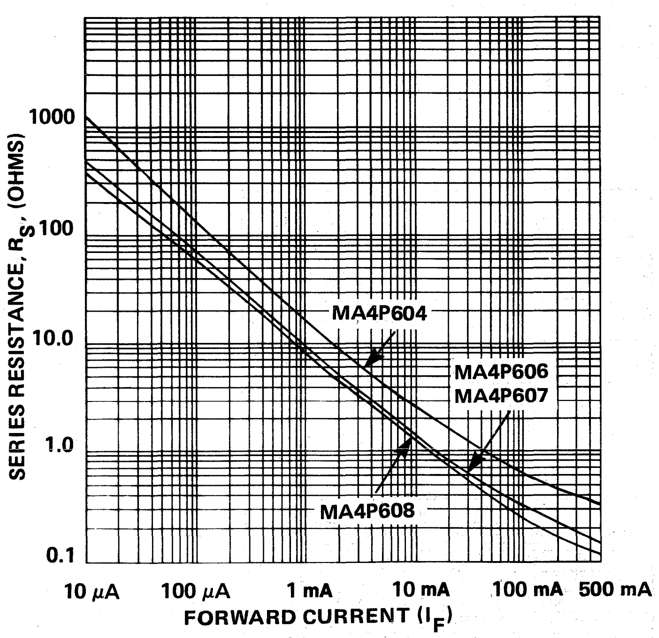


FIGURE 3. Forward Current vs. Series Resistance for MA4P604, MA4P606, MA4P607, MA4P608

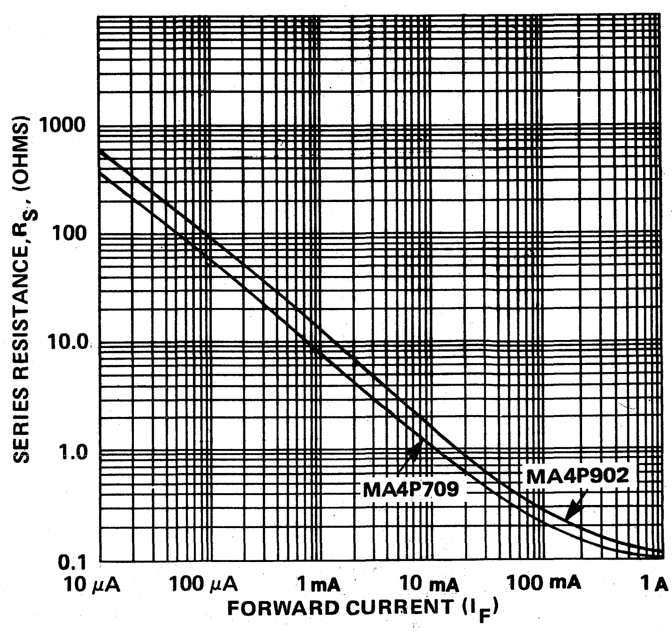
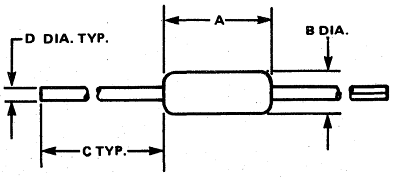


FIGURE 4. Forward Current vs. Series Resistance for MA4P709, MA4P902

Case Styles (• indicates cathode and heat sink terminal)

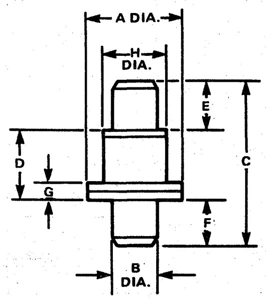
4



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.230	0.300	5,84	7,62
B	0.085	0.107	2,16	2,72
C	1.000	— —	25,40	— —
D	0.018	0.022	0,46	0,56

C_P = 0.15 pF Typical

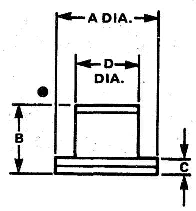
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

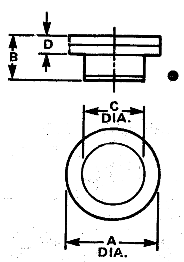
31



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

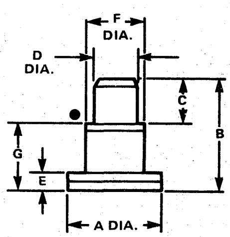
32



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3,02	3,18
B	0.055	0.065	1,40	1,65
C	0.077	0.083	1,96	2,11
D	— —	0.025	— —	0,64

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

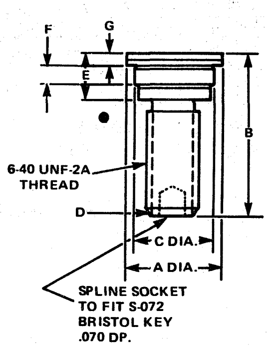
36



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3,02	3,18
B	0.143	0.163	3,63	4,14
C	0.060	0.064	1,52	1,63
D	0.060	0.064	1,52	1,63
E	— —	0.025	— —	0,64
F	0.077	0.083	1,96	2,11
G	0.086	0.096	2,18	2,44

Silicon: C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

43

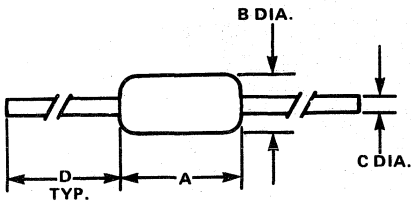


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.255	0.265	6,48	6,73
B	0.440	0.460	11,18	11,68
C	0.208	0.212	5,28	5,38
D	.020 x 45° REF.		0,51 x 45° REF.	
E	0.119	0.131	3,02	3,33
F	50 REF.		1.27 REF.	
G	0.025	0.035	0,64	0,89

C_P = 0.75 pF Typical
L_S = 0.60 nH Typical

Case Styles (Cont'd)

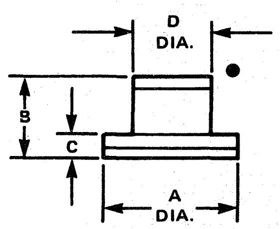
54



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

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

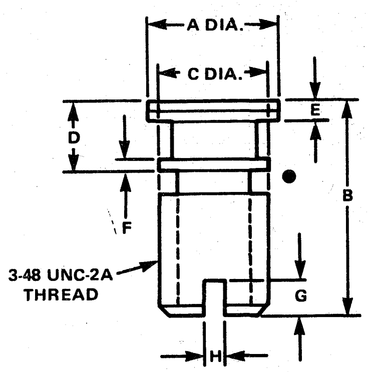
94



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35
E	0.004	0.010	0,101	0,254

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

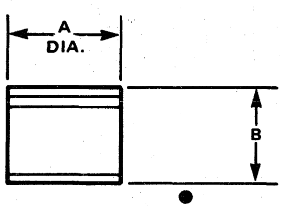
111



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.188	0.208	4,78	5,28
C	0.098	0.102	2,49	2,59
D	0.057	0.071	1,45	1,80
E	0.016	0.024	0,41	0,61
F	0.009	0.011	0,23	0,28
G	0.025	0.045	0,64	1,14
H	0.015	0.025	0,38	0,64

C_P = 0.27 pF Typical
L_S = 0.30 nH Typical

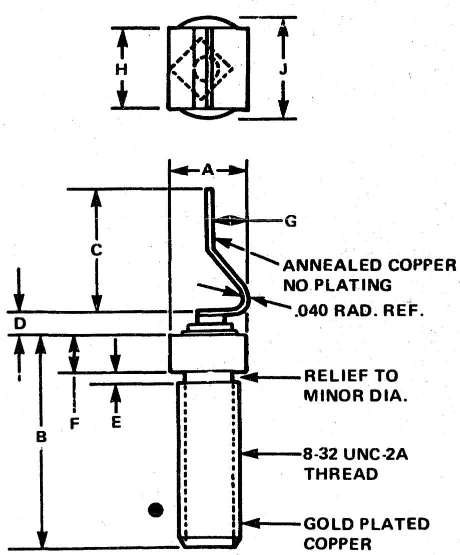
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

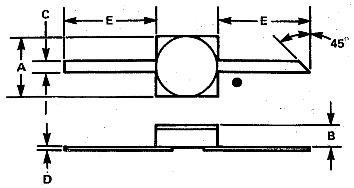
150



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.180	0.190	4,57	4,83
B	0.730	0.770	18,54	19,56
C	0.300	0.360	7,62	9,14
D	0.048 REF.		0,89	1,40
E	0.020	0.040	0,51	1,02
F	0.095	0.105	2,41	2,67
G	0.070	0.110	1,78	2,79
H	0.190	0.210	4,83	5,34
J	0.245	0.255	6,22	6,48

Case Styles (Cont'd)

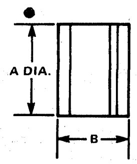
186



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0,76	0,15
E	0.130	0.170	3,30	4,32

C_P = 0.15 pF Typical
L_S = 0.40 nH Typical

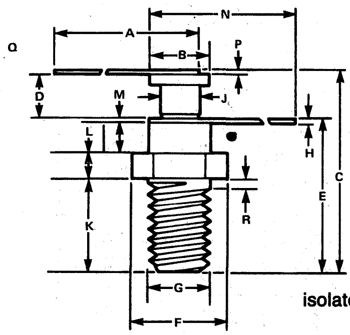
255



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.075	0.085	1,90	2,16
B	0.045	0.055	1,14	1,40

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

258

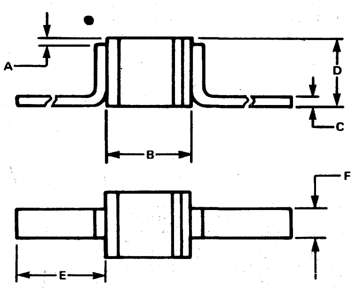


isolated heat sink package

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.975	1.025	24,77	26,04
B	0.119	0.127	3,02	3,23
C	0.385	0.430	9,78	10,92
D	0.085	0.097	2,16	2,46
E	0.190	0.230	4,83	5,84
F	0.202	— —	5,13	— —
G	0.090	0.105	2,28	2,67
H	0.005	0.013	0,13	0,33
J	0.077	0.083	1,96	2,11
K	0.183	0.193	4,65	4,90
L	0.055	0.060	1,40	1,52
M	0.057	0.067	1,45	1,70
N	0.695	0.705	17,65	17,91
P	0.002	0.004	0,05	0,10
Q	0.090	0.105	2,28	2,67
R	0.020	Typ	0,051	Typ

C_P = 0.25 pF Typical
L_S = 0.60 nH Typical
C_{grd} = 0.30 pF Typical

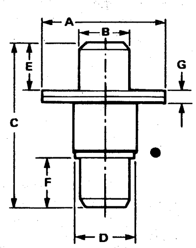
276



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.020	0,254	0,508
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

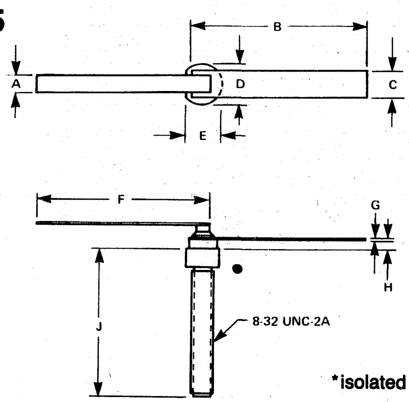
C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

296



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.156	0.164	3,96	4,17
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.120	0.128	3,05	3,25
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	2,01	2,11

985

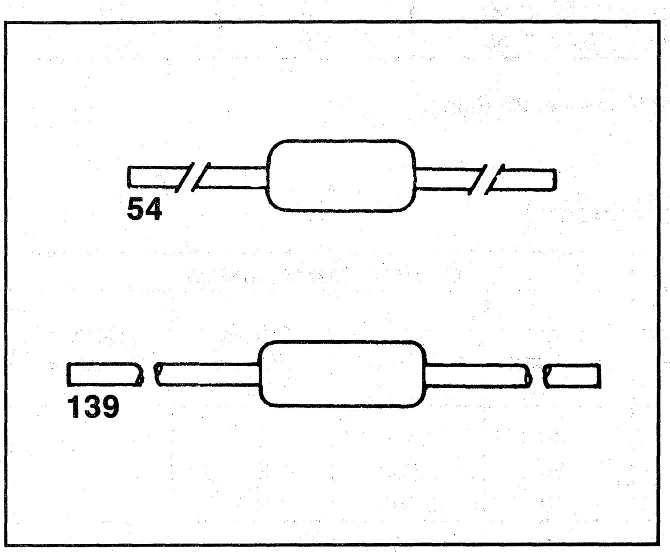


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.095	0.105	2,41	2,67
B	0.500	0.750	12,70	19,05
C	0.148	0.152	3,75	3,86
D	0.245	0.255	6,22	6,48
E	0.180	0.190	4,57	4,83
F	0.500	0.750	12,70	19,05
G	0.003	0.005	0,076	,127
H	0.050	0.060	1,27	1,52
J	0.730	0.770	18,54	19,56

C_{grd} = 1.0 pF Typical

*isolated heat sink package

Axial Lead PIN Diodes



Features

- GLASS HERMETIC SEALED PACKAGES
- SCREENABLE TO JANTXV AND MILITARY SPECIFICATIONS
- LARGE SIGNAL SWITCH DESIGN
- LOW CAPACITANCE (0.1 pF) PIN DIODES
- HIGH VOLUME MANUFACTURING CAPABILITY
- TAPE AND REEL PACKAGING AVAILABLE

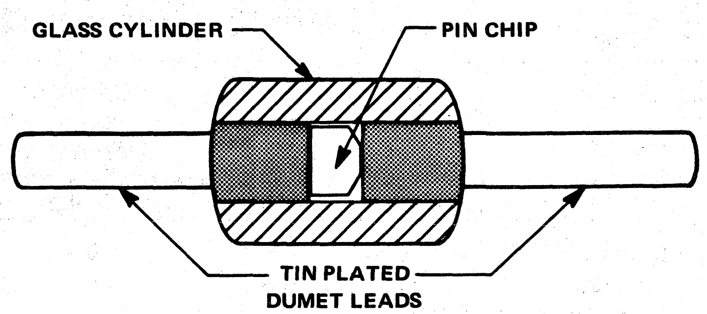
Description

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

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

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

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



Specifications @ $T_A = 25°C$

General Purpose PIN Diodes

Model Number	Case Style	Voltage[1] Rating (Volts)	Maximum[2] Series Resistance R_S @ I_F (mA) (Ohms)	Maximum[3] Total Capacitance C_t @ V_R (Volts) (pF)	Nominal Characteristics: Carrier Lifetime[4] (μs)	Nominal Characteristics: I-Region Thickness (mils)
MA47120	54	35	0.5 @ 10	1.00 @ 20	0.3	0.4
MA4P270	139	35	0.5 @ 10	1.20 @ 20	0.3	0.4
MA4PH401	54	50	1.5 @ 10	0.30 @ 20	0.2	0.4
MA4PH151	139	100	0.6 @ 10	1.20 @ 50	1.0	0.8
1N5719	54	100	1.5 @ 50	0.25 @ 50	1.0	2.0
MA47047	54	200	3.0 @ 10	0.30 @ 50	1.0	2.0
MA47123	139	200	3.0 @ 10	0.50 @ 50	1.0	2.0
1N5767*	54	200	2.5 @ 100	0.40 @ 50	1.0	4.0

*Additional specifications for 1N5767: R_S@20 mA = 8Ω (Max.); R_S@10 mA = 400Ω (Min.)

Low Distortion Attenuator PIN Diodes

Model Number	Case Style	Voltage[1] Rating (Volts)	Maximum[2] Series Resistance R_S@I_F = 10 mA (Ohms)	Maximum[3] Total Capacitance C_t @ 50V (pF)	Nominal Characteristics: R_S I_F = 1 mA (Ohms)	Nominal Characteristics: R_S I_F = 10 μA (Ohms)	Nominal Characteristics: Carrier Lifetime (μs)	Nominal Characteristics: I-Region Thickness (mils)
MA47600	54	200	6	.30	30	2,000	2	4
MA47110	139	200	6	.50	30	2,000	2	4
MA47100	54	200	8	.30	50	3,000	2.5	7
MA4PH001	54	100	20	.25	100	6,500	1.5	9
MA4P208	139	100	20	.35	100	6,500	1.5	9
MA4PH451	146	100	8	1.00	50	2,500	3	9
MA47111	146	200	25	.80	75*	4,000	4	14

* I_F = 1.5-2.5 mA

Large Signal Switch PIN Diodes

Model Number	Case Style	Voltage[1] Rating (Volts)	Maximum[2] Series Resistance R_S @ I_F = 50 mA (Ohms)	Maximum[3] Total Capacitance C_t @ 50V (pF)	Nominal Characteristics: Carrier Lifetime[4] (μs)	Nominal Characteristics: I-Region Thickness (mils)
MA4PH201	146	100	0.4	2.0	2.0	1.0
MA47266	146	200	0.6	1.5	3.0	3.0
MA4PH301	146	200	1.0	1.1	5.0	5.0

Specifications @ $T_A = 25°C$
Fast Switching and Low Capacitance PIN Diodes

Model Number	Case Style	Voltage[1] Rating (Volts)	Maximum[2] Series Resistance R_S @ I_F (mA) (Ohms)	Maximum[3] Total Capacitance C_t @ 10 Volts (pF)	Nominal Characteristics Carrier Lifetime[4] (ns)	Switching[5] Time (ns)
MA47041	54	100	2.5 @ 30	0.10	200	20
MA47053	54	100	1.5 @ 10	0.20	100	10
MA47054	54	100	1.2 @ 10	0.25	150	15

NOTES:
1. The reverse current is specified not to exceed 10 μA at the designated voltage rating.
2. Series resistance is measured at 100 MHz at the indicated forward current.
3. Total capacitance is measured to 1 MHz at the indicated reverse voltage.
4. Carrier lifetime is measured at 10 mA.
5. See Bulletin 4325, Packaged Silicon PIN Diodes, for additional Axial Lead PIN Diodes.

MAXIMUM RATINGS

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

ENVIRONMENTAL CAPABILITY (Per MIL-STD-750 and MIL-S-202)

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

Screened Diodes

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

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

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

Typical Resistance Curves at 100 MHz

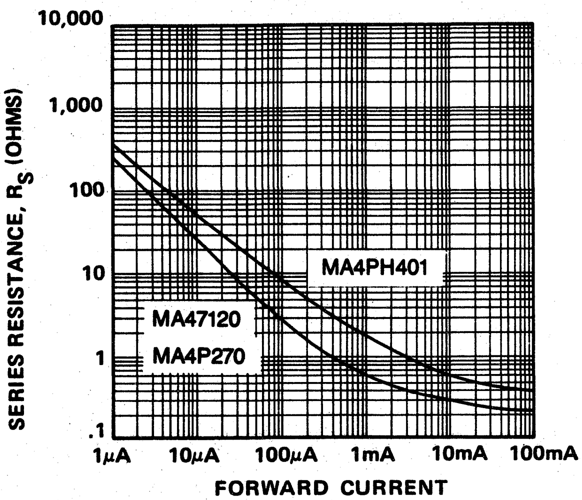


FIGURE 1. Series Resistance vs. Forward Current for General Purpose PIN Diodes

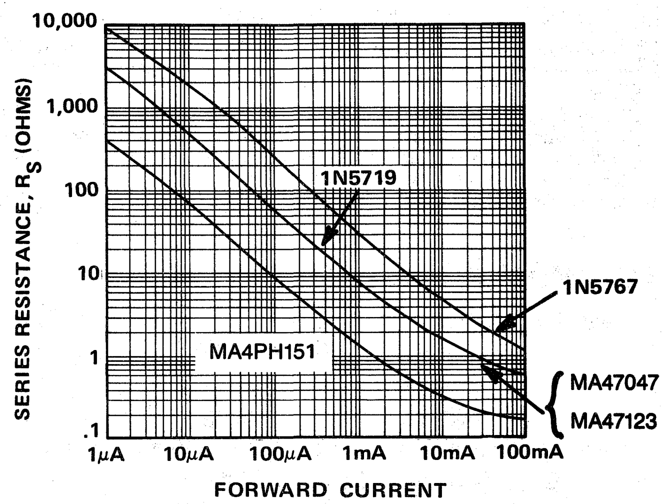


FIGURE 2. Series Resistance vs. Forward Current for General Purpose PIN Diodes

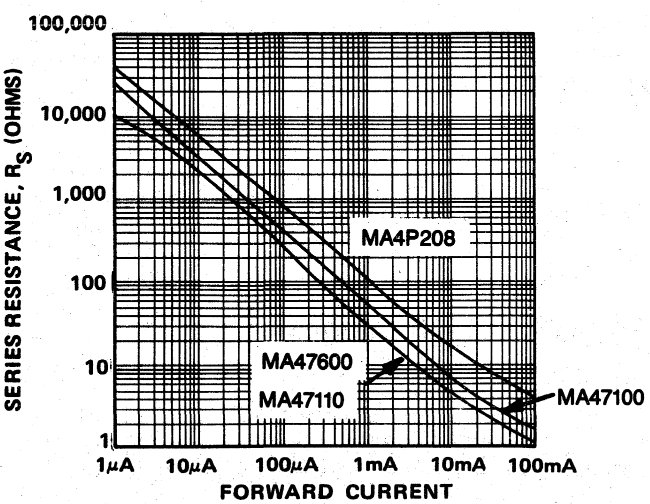


FIGURE 3. Series Resistance vs. Forward Current for Low Distortion Attenuator PIN Diodes

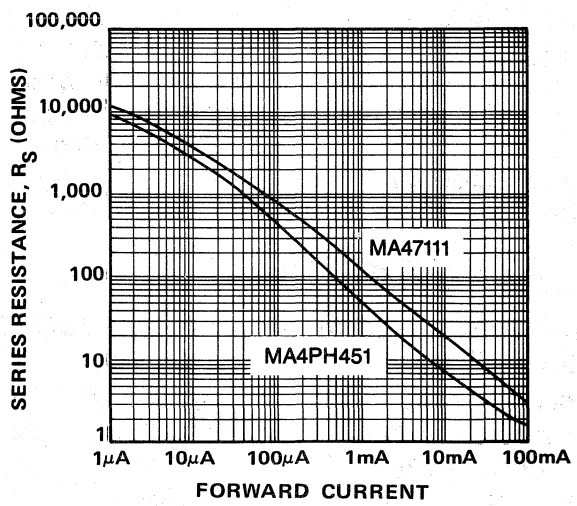


FIGURE 4. Series Resistance vs. Forward Current for Low Distortion Attenuator PIN Diodes

Typical Resistance Curves at 100 MHz

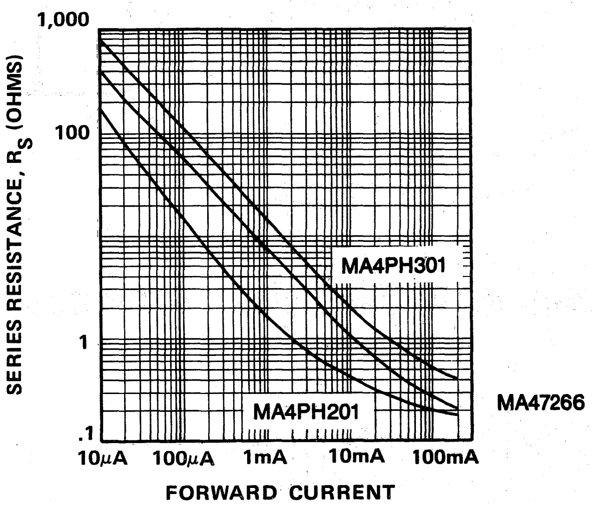


FIGURE 5. Series Resistance vs. Forward Current for Large Signal Switch PIN Diodes

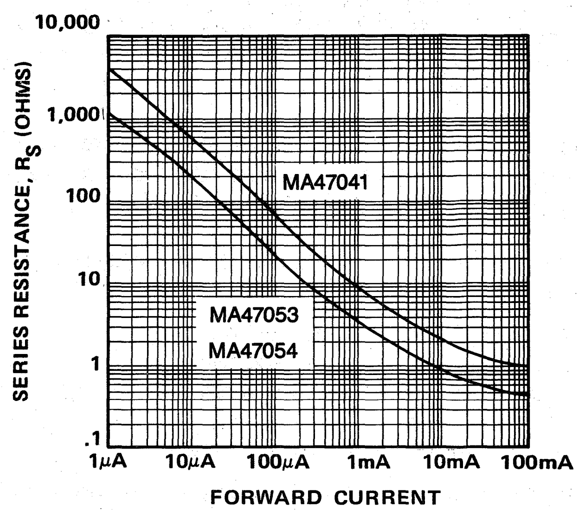


FIGURE 6. Series Resistance vs. Forward Current for Fast Switching PIN Diodes

Cross Reference

Many of M/A-COM's axial lead hermetic surface mount (MELF) and SOT-23 PIN diodes use similar chips and have the same electrical characteristics.

The following table lists the axial lead PIN diode by model number and the equivalent hermetic surface mount PIN and SOT-23 PIN diode counterparts.

Axial Lead Glass Diode	Hermetic Surface Mount	SOT-23
MA47100	MA47056	MA4P278
MA47110	MA47057	MA4P277
MA47111	MA4PH601	—
MA47123	MA47055	MA4P274
MA47266	MA47059	—
MA4P270	MA47058	MA4P275
MA4PH151	MA4PH152	MA4P282
MA4PH401	MA4PH101	MA4P789

Applications Information

PIN DIODE FUNDAMENTALS

The PIN diode is a current controlled resistor at radio and microwave frequencies. It is a silicon semiconductor diode in which a high resisitivity intrinsic I-region is sandwiched between a P-type and N-type region. When the PIN diode is forward biased, holes and electrons are injected into the I-region. These charges do not immediately annihilate each other; instead they stay alive for an average time called the carrier lifetime. This results in an average stored charge, Q, which lowers the effective resistance of the I-region to a value, R_S.

When the PIN diode is at zero or reverse bias there is no stored charge in the I-region and the diode appears as a virtually lossless capacitor.

PIN diodes are specified in this bulletin for the following parameters:

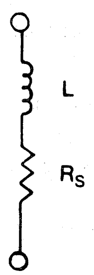
R_S — series resistance under forward bias
C_t — total capacitance at reverse bias
V_r — maximum allowable DC reverse bias voltage
τ — carrier lifetime
P_d — maximum average power dissipation

By varying the I-region width and diode area it is possible to construct PIN diodes of different geometrics to result in the same R_S and C_t characteristics. However, the thicker I-region diode would have a higher bulk or RF breakdown voltage and better distortion properties in attenuator circuits. The thinner I-region diodes are generally faster with lower values of forward resistance (R_S).

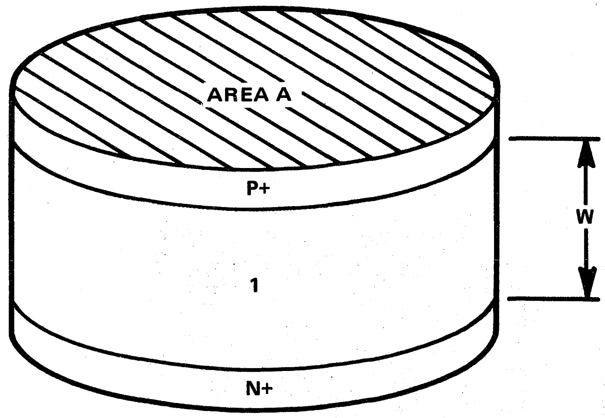
FORWARD BIASED PIN DIODE

$$R_S = \frac{W^2}{(\mu_n + \mu_p)\, Q}$$

where:
$Q = I_F \times \tau$
W = I-region width
I_F = forward bias current
τ = carrier lifetime
μ_n = electron mobility
μ_p = hole mobility



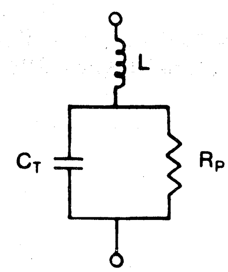
NOTES:
1. In a practical diode, the parasitic resistance of the diode package limits the lowest resistance value.
2. The lowest impedance will be affected by the parasitic inductance, L, which is generally less than 1 nHy.
3. The equation is valid at frequencies higher than the I region transit time frequency i.e.,
$$f > \frac{1300}{W^2}$$



ZERO OR REVERSE BIAS PIN DIODES

$$C_T = \frac{\varepsilon A}{W}$$

where:
ε = dielectric constant of silicon
A = area of diode junction



NOTES:
1. The above equation which is independent of the reverse bias voltage is valid at frequencies above the dielectric relaxation frequency of the I-region i.e.
$$f > \frac{1}{2\pi\varrho\varepsilon}$$
where ϱ is the resisitivity of the I-region. At lower frequencies the PIN diode acts like a varactor.
2. The value Rp is proportional to the reverse bias voltage and inversely proportional to frequency. In most RF applications its value is higher than the reactance of the capacitance Ct and is less significant.

PIN Diode Switch Performance Equations*

SWITCH TYPE*	ISOLATION (dB)	INSERTION LOSS (dB)
SERIES CONNECTED	$10\log_{10}\left[1+\left(\frac{X_C}{2Z_o}\right)^2\right]$	$20\log_{10}\left[1+\frac{R_S}{2Z_o}\right]$
SHUNT CONNECTED	$20\log_{10}\left[1+\frac{Z_o}{2R_S}\right]$	$10\log_{10}\left[1+\left(\frac{Z_o}{2X_C}\right)^2\right]$
SERIES-SHUNT	$10\log_{10}\left[\left(1+\frac{Z_o}{2R_S}\right)^2+\left(\frac{X_C}{2Z_o}\right)^2\left(1+\frac{Z_o}{R_S}\right)^2\right]$	$10\log_{10}\left[\left(1+\frac{R_S}{2Z_o}\right)^2+\left(\frac{Z_o+R_S}{2X_C}\right)^2\right]$
TEE CONNECTED	$10\log_{10}\left[1+\left(\frac{X_C}{Z_o}\right)^2\right]+10\log_{10}\left[\left(1+\frac{Z_o}{2R_S}\right)^2+\left(\frac{X_C}{2R_S}\right)^2\right]$	$20\log_{10}\left[1+\frac{R_S}{Z_o}\right]+10\log_{10}\left[1+\left(\frac{Z_o+R_S}{2X_C}\right)^2\right]$

*Above equations are for SPST swithches. Add 6 dB to isolation values for SPNT switches.

DISTORTION IN PIN DIODE CIRCUITS
The distortion generated in a forward biased PIN diode circuit has been analyzed[1] and shown not to be dependent solely on causing lifetime, but related to the ratio of stored charge, Q, to diode resistance, Rs, and the operating frequency. In a PIN diode switch the values of Rs and Q are determined by the particular diode selected and the forward bias current.

FOR A SERIES CONNECTED DIODE IN A 50 OHM SWITCH
Prediction equations for the second order intermodulation interept point (IP2) and the third order intermodulation intercept point (IP3) have been developed from PIN semiconductor analysis and are presented as follows:

$$\text{IP2} = 34 + 20\log\frac{FQ}{R_S}\ \text{dBm}$$

$$\text{IP3} = 24 + 15\log\frac{FQ}{R_S}\ \text{dBm}$$

where:
F = Frequency in MHz
R_S = PIN diode resistance in ohms
Q = Stored charge in nC ($I_F \times \tau$)

To use these equations the resistance Rs of the PIN diode is determined from the enclosed curves and the stored charge is computed from the product of the forward current and the nominal carrier lifetime.

In most applications, the distortion generated by a reverse biased diode is smaller than forward biased generated distortion for small or moderate signal size. This is particularly the case when the reverse bias applied to the PIN diode is larger than the peak RF voltage preventing any instantaneous swing into the forward bias direction.

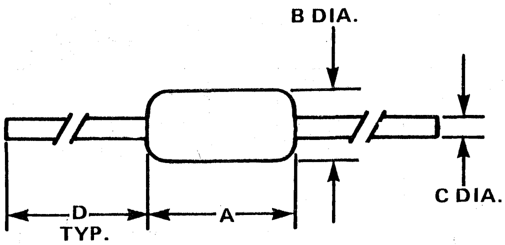
In an attenuator circuit, the PIN diode acts as a variable resistor. The distortion generated at any resistance value is minimized only be maximizing the stored charge required to maintain this resistance. It can be demonstrated that the primary contributor to stored charge at any PIN diode resistance is the I-region width and the the carrier lifetime has virtually no impact on distortion in a PIN diode attenuator. The thicker I-region the larger the stored charge and the lower the distortion. The carrier lifetime, however, will determine the amount of the forward current needed to achieve a specific resistance value.

1). R.H. Caverly and G. Hiller, "Distortion in PIN Diode Control Circuits," IEEE Trans. Microwave Theory Tech, VOL MTT-35, No.5 p.492, May 1987.

Note: For additional information request, "Design With PIN Diodes," M/A-COM SPO, Marketing Department, Burlington, MA 01803.

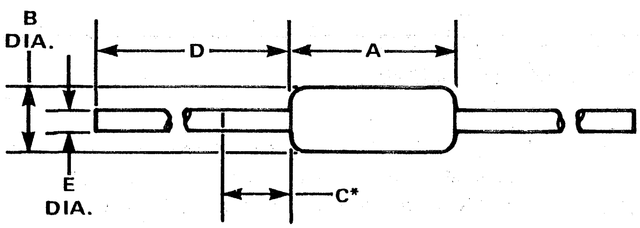
Case Styles

54



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

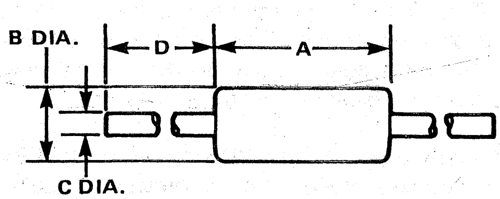
139



*LEAD DIA. UNCONTROLLED IN THIS AREA

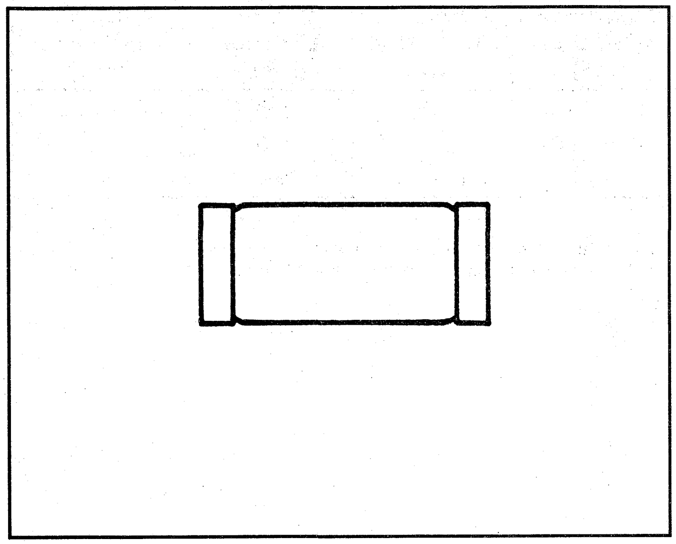
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.135	0.165	3,43	4,19
B	0.050	0.070	1,27	1,78
C	— —	0.050	— —	1,27
D	1.000	1.250	25,40	31,75
E	0.017	0.023	0,43	0,58

146



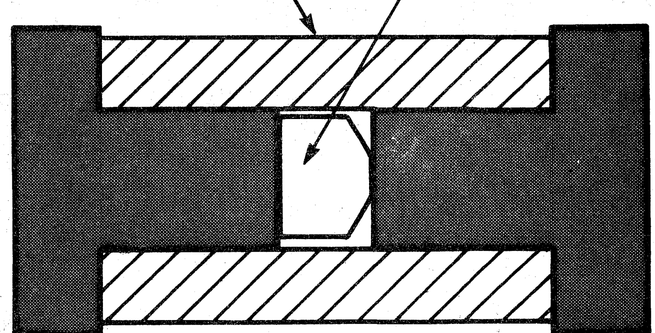
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.200	0.240	5,08	6,10
B	0.085	0.105	2,16	2,67
C	0.027	0.033	0,69	0,84
D	1.000	1.250	25,40	31,75

Hermetic Surface Mount PIN Diodes



Features

- SURFACE MOUNT DESIGN
- HERMETICALLY SEALED PACKAGES
- POWER DISSIPATION TO 1 WATT
- LOW LOSS SWITCHING DIODES
- LOW DISTORTION ATTENUATOR DIODES
- SCREENABLE TO MILITARY SPECIFICATIONS
- HIGH VOLUME MANUFACTURING CAPABILITY



Description

This series of PIN diodes is encapsulated in metal electrode faced (MELF) bond packages resulting in hermetically sealed devices suitable for surface mount applications. This glass to metal seal construction results in a rugged device designed to meet the environmental requirements of MIL-STD-750 and MIL-STD-202. The metallic contact surfaces are tin plated for good solder wetting and are designed for adhesion to circuit boards using wave solder or solder reflow techniques. MELF PIN diodes contain no small ribbons or whisker wires, resulting in low parasitic inductance and capacitance. M/A-COM's MELF PIN diodes are designed for switch and attenuator circuits from HF through S-Band. A wide range of PIN characteristics are available including devices with 1 watt power rating, long carrier lifetime, and low resistance for high power antenna and filter switches (MA47059). Thick I-region PIN diodes suitable for low distortion VHF attenuators are also offered (MA4PH601). This class of PIN diodes has never been obtainable in surface mount packages. Also available are general purpose PIN diodes, useful in a broad range of control circuit applications.

Specifications @ T_A = 25 °C

GENERAL PURPOSE AND SWITCH PIN DIODES

Model Number	Case Style	Minimum[2] Voltage Rating V_r (Volts)	Maximum R_S @ I = 10 mA 100 MHz (Ohms)	Maximum[3] Total Capacitance @ Volts (pF)	Nominal Characteristics	
					Carrier[4] Lifetime (μsec)	I-Region Thickness (mils)
MA47058	983	35	0.5	1.2 @ 20V	0.3	0.4
MA4PH101	983	50	1.5	0.5 @ 20V	0.3	0.4
MA4PH152	983	100	0.6	1.4 @ 20V	1.0	0.8
MA47055	983	200	3.0	0.5 @ 50V	1.5	2.0
MA47059	984	200	0.6[1]	1.5 @ 50V	3.0	3.0

LOW DISTORTION ATTENUATOR PIN DIODES

Model Number	Case Style	Minimum[2] Voltage Rating V_r (Volts)	Maximum R_S @I = 10 mA 100 MHz (Ohms)	Maximum[3] Capacitance @ 50 Volts (pF)	Nominal Characteristics		
					I_F for R_S = 75Ω (mA)	Carrier[4] Lifetime (μsec)	I-Region Thickness (mils)
MA47057	983	200	6.0	0.5 @ 50V	.3-.6	2.0	4.0
MA47056	983	200	8.0	0.5 @ 50V	.5-1.0	3.0	7.0
MA4PH601	984	200	25.0	0.8 @ 50V	1.2-2.4	6.0	14.0

NOTES
1. Rs for the MA47059 is measured at 50 mA.
2. The reverse current will not exceed 10 microamperes at the minimum voltage rating.
3. Maximum total capacitance is measured at 1 MHz.
4. Nominal minority lifetime is measured at I_F = 10 mA.

MAXIMUM RATINGS

Voltage	Voltage Rating
Operating Temperature	−65°C to +150°C
Storage Temperature	−65°C to +175°C
Power Dissipation at 25°C ambient:	Case 983 = 500 mW Case 984 = 1.0 W
Maximum Soldering Temperature	275°C for 10 seconds

SCREENED DIODES (MIL-STD-750)

Suggested 100% Preconditioning and Screening Program for TX Level Screening

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

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

Specifications (Cont'd)

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

ENVIRONMENTAL RATINGS PER MIL-STD 750

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

Cross Reference

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

Hermetic Surface Mount	Glass Axial Lead	SOT-23
MA47055	MA47123	MA4P274
MA47056	MA47100	MA4P278
MA47057	MA47110	MA4P277
MA47058	MA4P270	MA4P275
MA47059	MA47266	Not Applicable
MA4PH101	MA4PH401	MA4P789
MA4PH152	MA4PH151	MA4P282
MA4PH601	MA47111	Not Applicable

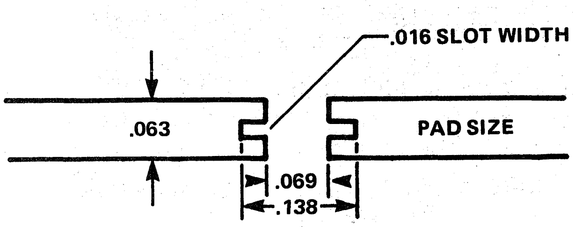
Mounting Information

Mounting MELF PIN Diodes to Circuit Boards

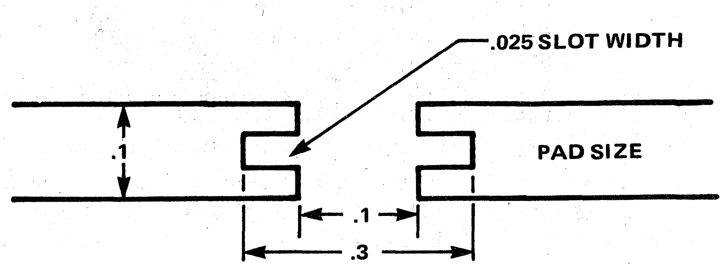
Wave soldering or reflow soldering techniques may be used to mount M/A-COM's MELF PIN diodes to circuit boards. The MELF construction, due to its volume, cylindrical shape and mass has shown less tendency to lift up on end (tombstone) or skew than lighter, four sided surface mount components. Wave soldering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

Recommended Pad Drawings

PAD FOR CASE STYLE 983



PAD FOR CASE STYLE 984



Dimensions in Inches

Typical Resistance Curves at 100 MHz

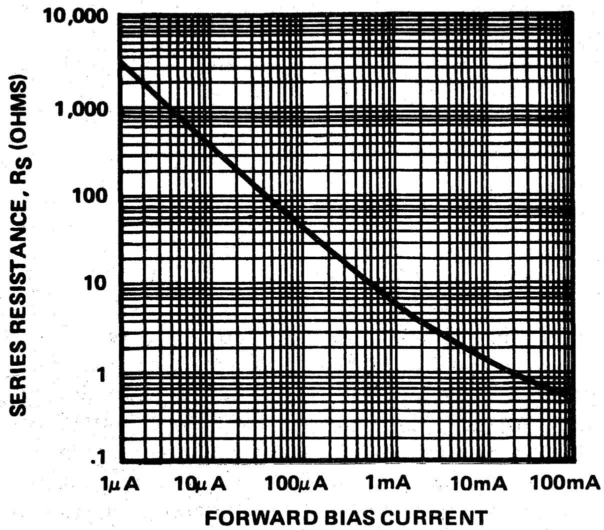


FIGURE 1. MA47055 Series Resistance vs. Forward Current

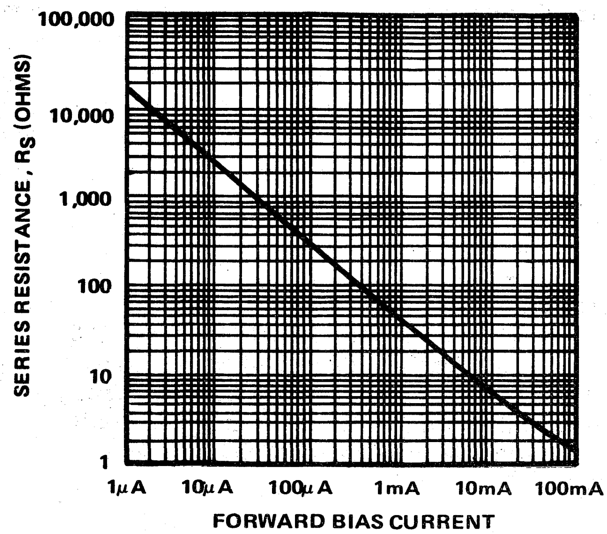


FIGURE 2. MA47056 Series Resistance vs. Forward Current

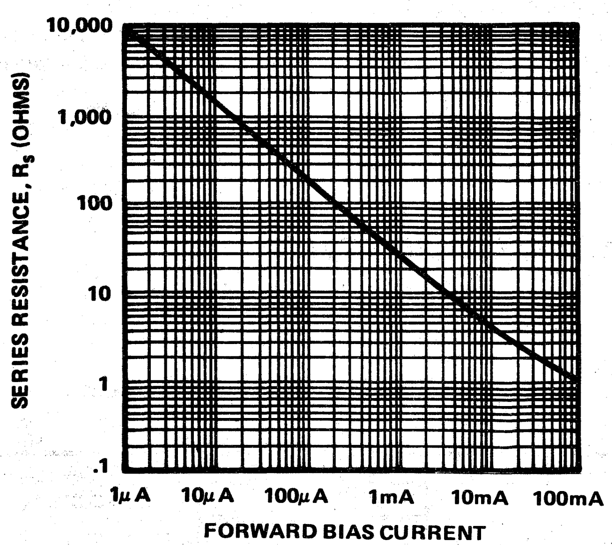


FIGURE 3. MA47057 Series Resistance vs. Forward Current

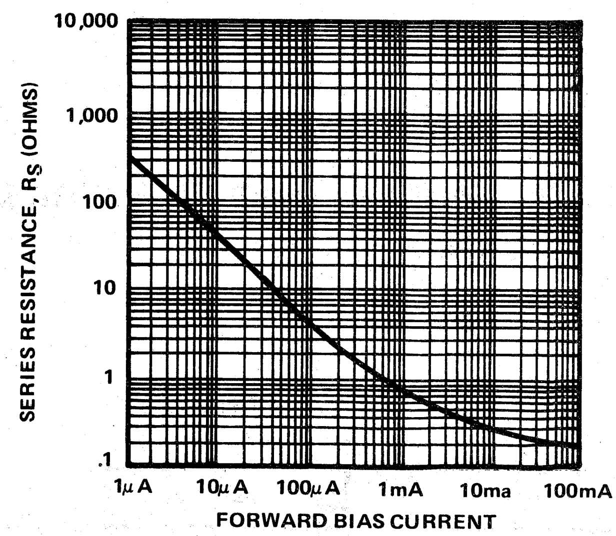


FIGURE 4. MA47058 Series Resistance vs. Forward Current

Typical Resistance Curves at 100 MHz (Cont'd)

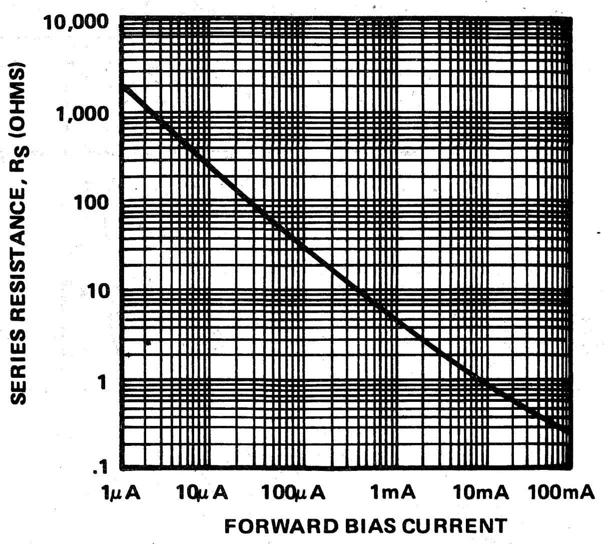


FIGURE 5. MA47059 Series Resistance vs. Forward Current

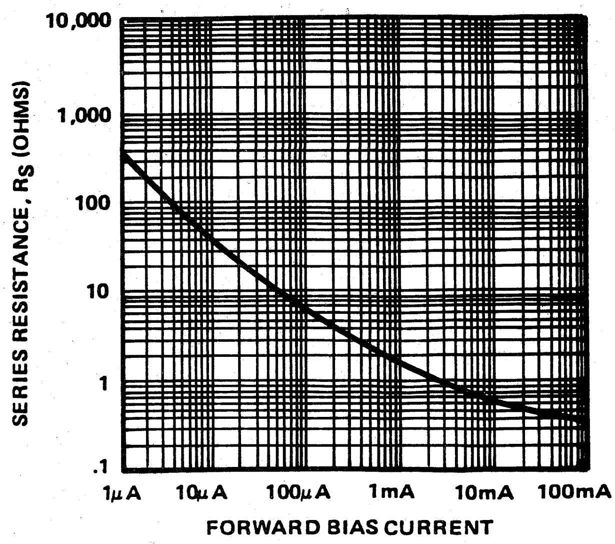


FIGURE 6. MA4PH101 Series Resistance vs. Forward Current

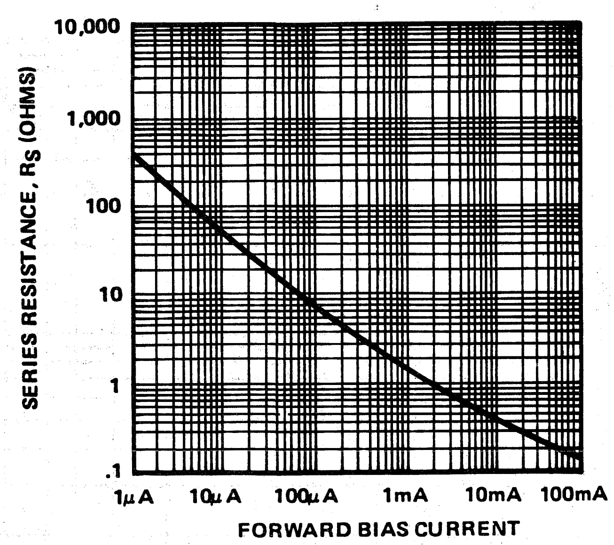


FIGURE 7. MA4PH152 Series Resistance vs. Forward Current

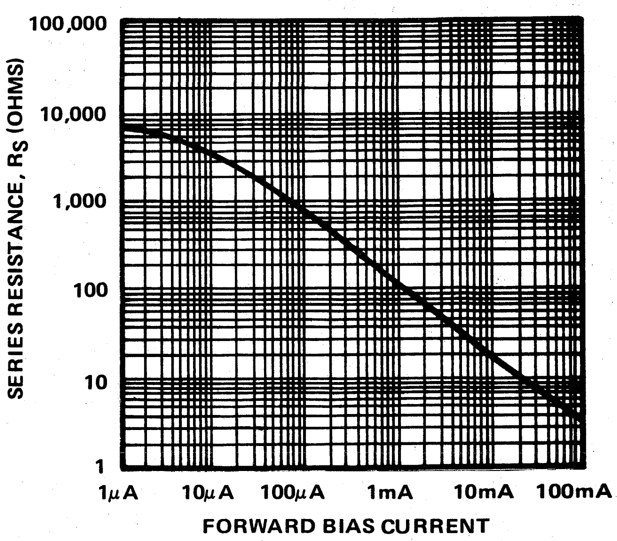


FIGURE 8. MA4PH601 Series Resistance vs. Forward Current

Application Notes*

TYPE	ISOLATION (dB)	INSERTION LOSS (dB)
SERIES	$10\log_{10}\left[1+\left(\frac{X_C}{2Z_o}\right)^2\right]$	$20\log_{10}\left[1+\frac{R_S}{2Z_o}\right]$
SHUNT	$20\log_{10}\left[1+\frac{Z_o}{2R_S}\right]$	$10\log_{10}\left[1+\left(\frac{Z_o}{2X_C}\right)^2\right]$
SERIES-SHUNT	$10\log_{10}\left[\left(1+\frac{Z_o}{2R_S}\right)^2 + \left(\frac{X_C}{2Z_o}\right)^2\left(1+\frac{Z_o}{R_S}\right)^2\right]$	$10\log_{10}\left[\left(1+\frac{R_S}{2Z_o}\right)^2 + \left(\frac{Z_o+R_S}{2X_C}\right)^2\right]$
TEE	$10\log_{10}\left[1+\left(\frac{X_C}{Z_o}\right)^2\right] + 10\log_{10}\left[\left(1+\frac{Z_o}{2R_S}\right)^2+\left(\frac{X_C}{2R_S}\right)^2\right]$	$20\log_{10}\left[1+\frac{R_S}{Z_o}\right] + 10\log_{10}\left[1+\left(\frac{Z_o+R_S}{2X_C}\right)^2\right]$

FIGURE 9. Summary of formulas for SPST switches. (Add 6 dB to isolation to obtain value for single-pole multiple throw switch.)

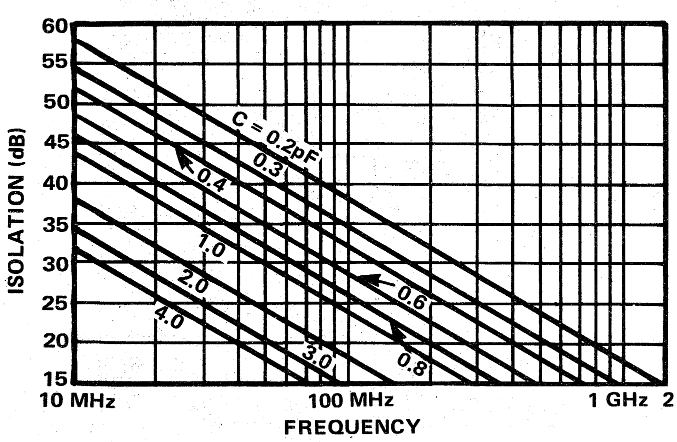


FIGURE 10. Isolation for SPST diode series switch in 50Ω system. Add 6 dB to isolation for multi-throw switches (SPNT).

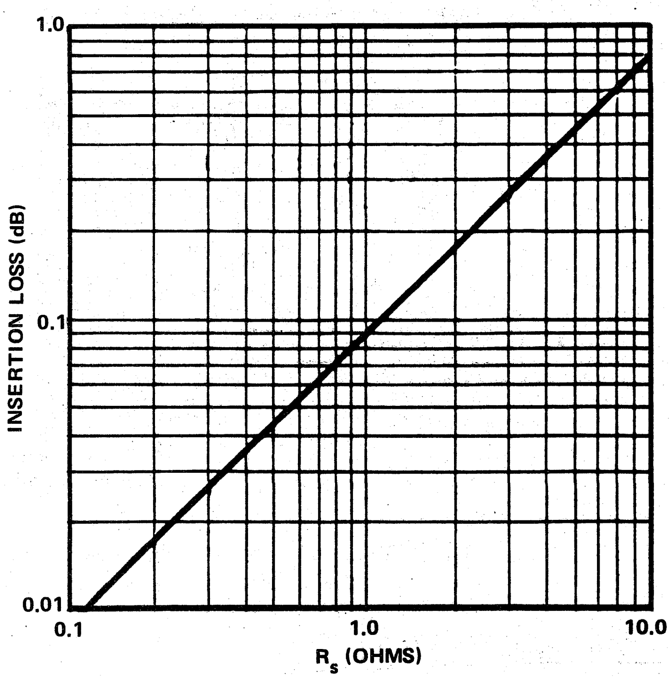


FIGURE 11. Insertion loss for PIN diode series switch in 50Ω system.

*From Design with PIN Diodes, G. Hiller, M/A-COM SPO, Application Article AG312.

Application Notes (Cont'd)

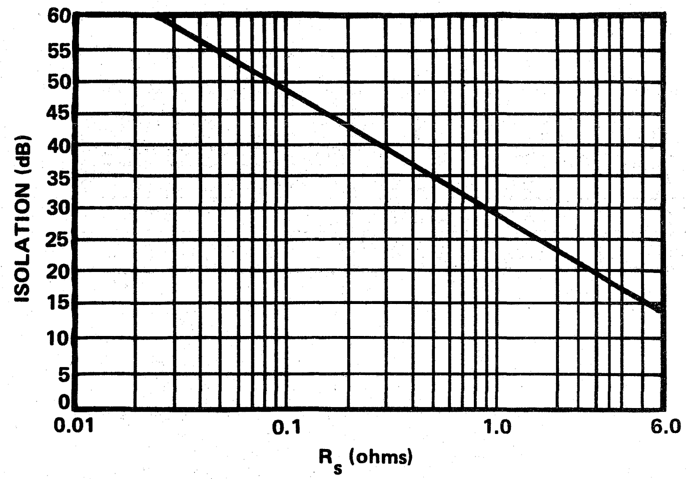


FIGURE 12. Isolation for SPST shunt PIN switches in 50Ω system. Add 6 dB to isolation for multi-throw switches (SPNT).

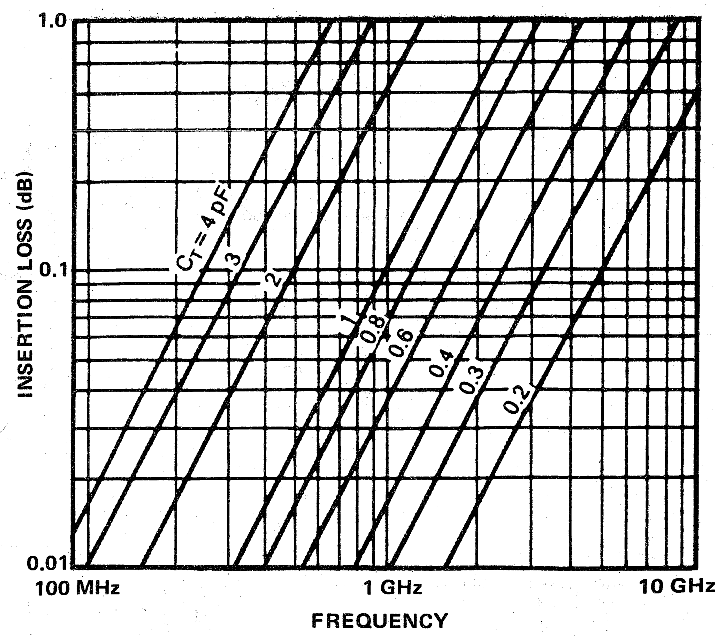


FIGURE 13. Insertion loss for shunt PIN switch in 50Ω system.

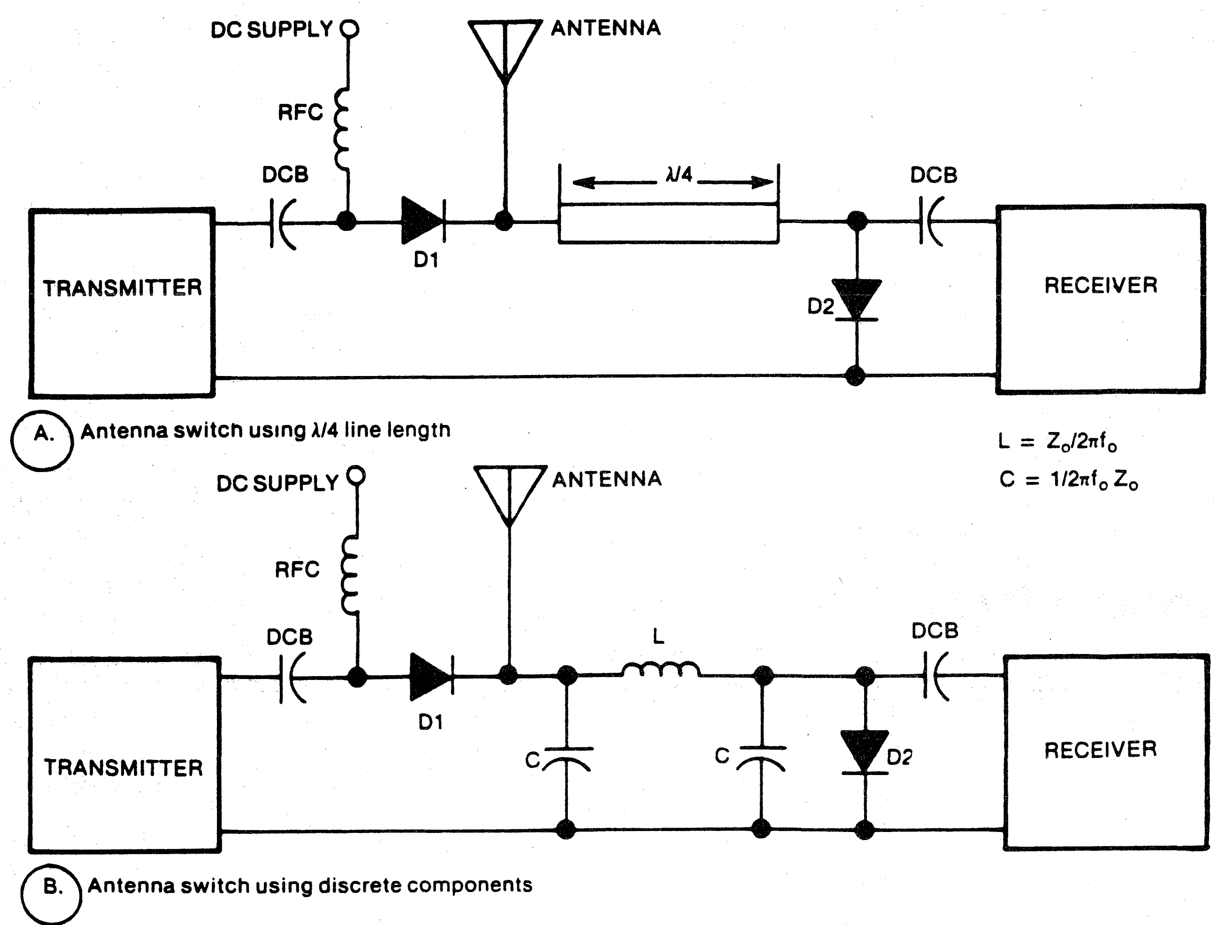
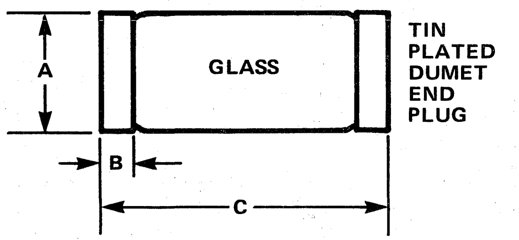


FIGURE 14. Quarter wave antenna switches.

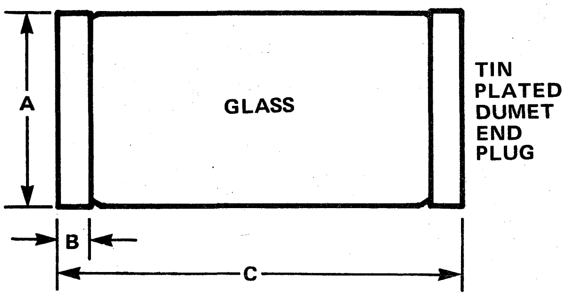
Case Styles

983



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.057	0.067	1,45	1,70
B	0.011	0.019	0,280	0,482
C	0.130	0.150	3,30	3,81

984

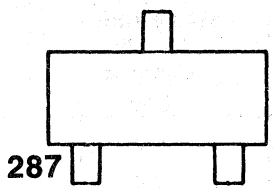


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.095	0.100	2,41	2,54
B	0.010	0.020	0,280	0,482
C	0.185	0.205	0,469	0,520

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

SOT-23 PIN Diodes



Description

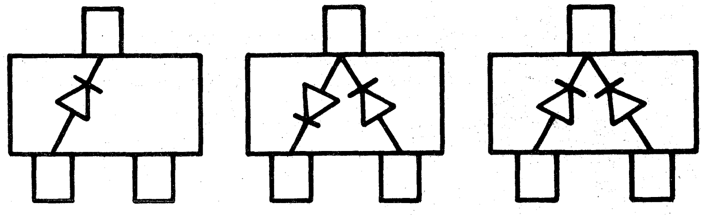
The SOT-23 is a widely used low cost semiconductor package that may be supplied in tape and reel for automated pick and place assembly on surface mount circuit boards. The semiconductor chips in the SOT-23 package are completely encapsulated with molded silicone plastic. This results in a rugged package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

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

Features

- SURFACE MOUNT PACKAGE
- LOW CAPACITANCE DIODES
- LOW LOSS SWITCH DIODES
- LOW DISTORTION ATTENUATOR DIODES
- FAST SWITCHING DIODES
- SINGLE AND DUAL DIODE CONFIGURATIONS
- TAPE AND REEL PACKAGING AVAILABLE

TOP VIEW



(SINGLES) (SERIES TEE) (COMMON CATHODE TEES)

Specifications @ $T_A = 25°C$

Single Diodes

Model[5] Number	Voltage[1] Rating (Volts)	Maximum Total[2] Capacitance (pF)	Maximum[3] R_S @ 10 mA (Ohms)	Nominal Characteristics: Carrier Lifetime[4] (μs)	Nominal Characteristics: I-Region Thickness (mils)
MA4P275	35	1.00 @ 20V	0.5	0.2	0.4
MA4P789	50	0.35 @ 20V	1.5	0.2	0.4
MA4P282	100	1.20 @ 20V	0.6	1.0	0.8
MA4P274	100	0.35 @ 50V	3.0	1.0	2.0
MA4P277	200	0.35 @ 50V	6.0*	2.0	4.0
MA4P278	200	0.35 @ 50V	10.0**	3.0	7.0

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

Series TEEs

Model[5] Number	Single Chip[1] Voltage Rating (Volts)	Single Chip[2] Maximum Total Capacitance (pF)	Single Chip[3] Maximum R_S @ 10 mA (Ohms)	Nominal Characteristics: Single Chip[4] Carrier Lifetime (μs)	Nominal Characteristics: Single Chip I-Region Thickness (mils)
MA4P275ST	35	1.00 @ 20V	0.5	0.2	0.4
MA4P789ST	50	0.35 @ 20V	1.5	0.2	0.4
MA4P274ST	100	0.35 @ 50V	3.0	1.0	2.0

Common Cathode TEEs

Model[5] Number	Single Chip[1] Voltage Rating (Volts)	Single Chip[2] Maximum Total Capacitance (pF)	Single Chip[3] Maximum R_S @ 10 mA (Ohms)	Nominal Characteristics: Single Chip[4] Carrier Lifetime (μs)	Nominal Characteristics: Single Chip I-Region Thickness (mils)
MA4P275CK	35	1.00 @ 20V	0.5	0.2	0.4
MA4P789CK	50	0.35 @ 20V	1.5	0.2	0.4
MA4P274CK	100	0.35 @ 50V	3.0	1.0	2.0
MA4P277CK	200	0.35 @ 50V	6.0*	2.0	4.0

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

The connections for the SOT-23 diodes are as illustrated.

NOTES:
1. Voltage rating is measured at a reverse bias current of 10 μA.
2. Maximum total capacitance is measured at 1 MHz at the indicated voltage.
3. Maximum series resistance is measured at the specified current and a frequency of 100 MHz.
4. Nominal minority lifetime is measured at I_F = 10 mA.
5. Standard case style is ODS-287.

MAXIMUM RATINGS

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

Typical Resistance Curves at 100 MHz

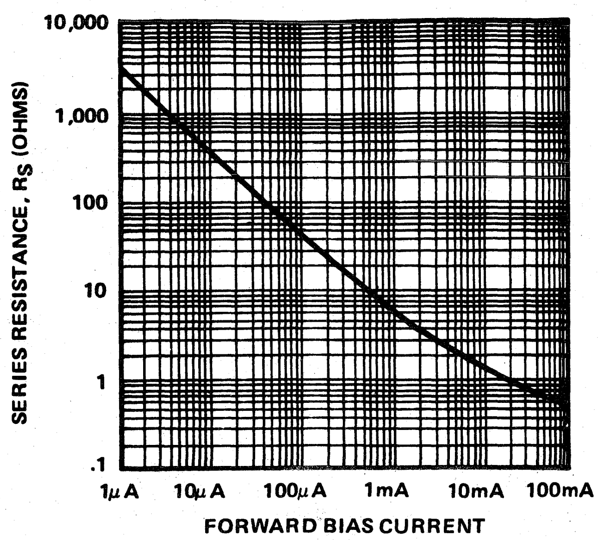


FIGURE 1. MA4P274 Series Resistance vs. Forward Current

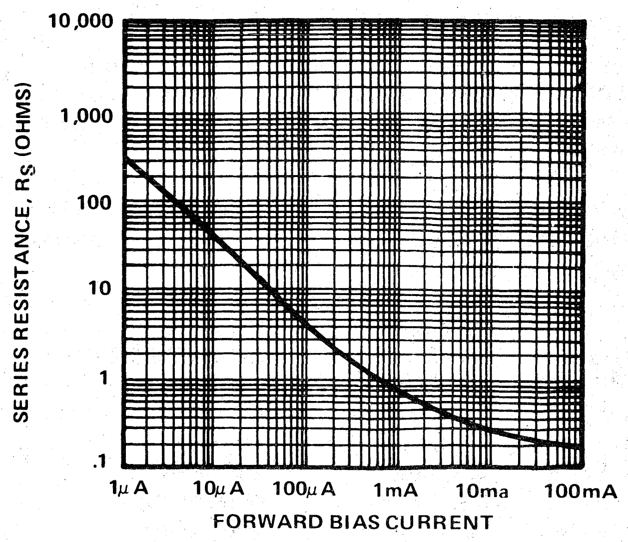


FIGURE 2. MA4P275 Series Resistance vs. Forward Current

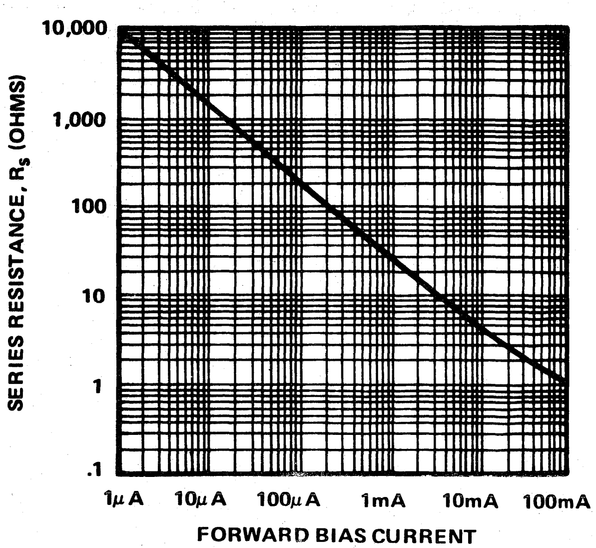


FIGURE 3. MA4P277 Series Resistance vs. Forward Current

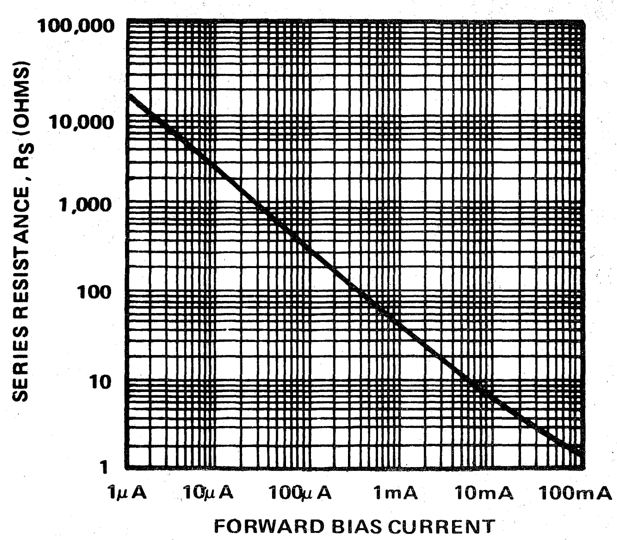


FIGURE 4. MA4P278 Series Resistance vs. Forward Current

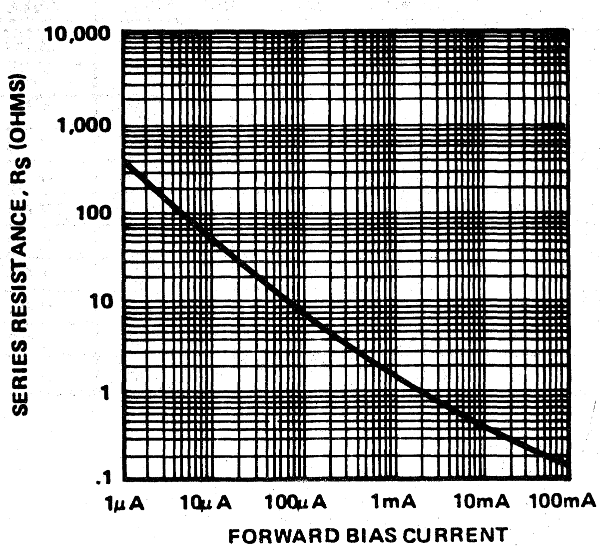


FIGURE 5. MA4P282 Series Resistance vs. Forward Current

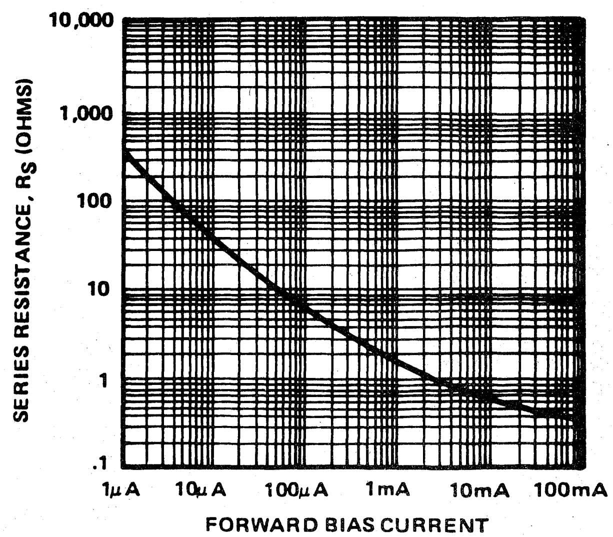


FIGURE 6. MA4P789 Series Resistance vs. Forward Current

SOT-23 Packaged PIN Diodes

CROSS REFERENCE

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

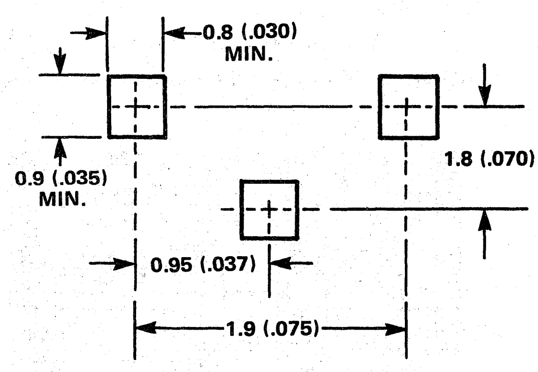
The following table lists the SOT-23 PIN diode by model number and standard axial lead PIN diode and hermetic surface mount PIN counterparts.

SOT-23	AXIAL LEAD GLASS DIODE	HERMETIC SURFACE MOUNT
MA4P274	MA47123	MA47055
MA4P275	MA4P270	MA47058
MA4P277	MA47110	MA47057
MA4P278	MA47100	MA47056
MA4P282	MA4PH151	MA4PH152
MA4P789	MA4PH401	MA4PH101

Mounting Information

Figure 7 indicates the recommended mounting pad configuration for the SOT-23 package. Solder paste containing flux should be screened onto the pads to a thickness of 0.005 inches. The SOT-23 device is placed in position firmly adhering to the solder paste.

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

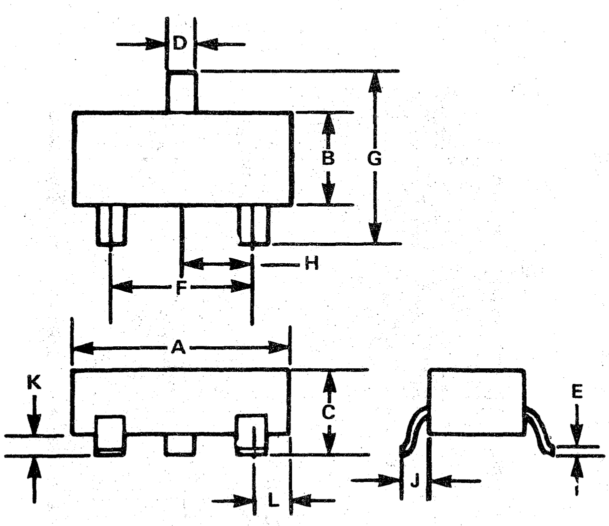


DIMENSIONS MILLIMETERS (INCHES)

FIGURE 7.

Case Style

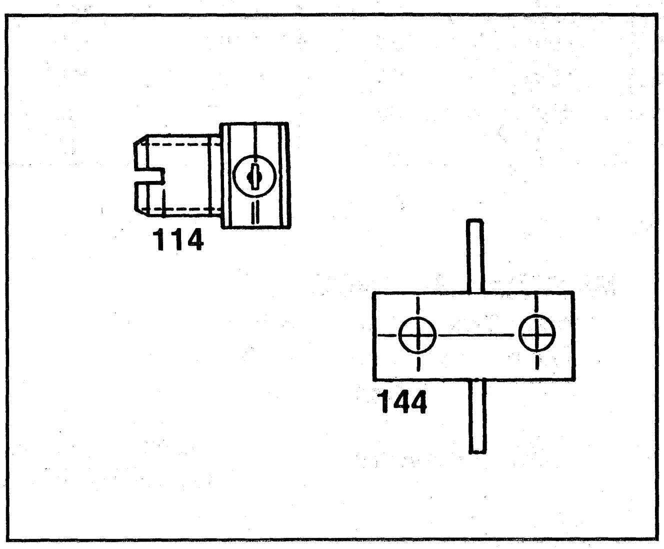
287



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.110	0.120	2,80	3,50
B	0.047	0.055	1,20	1,40
C	0.034	0.017	0,85	1,20
D	0.014	0.017	0,37	0,43
E	0.003	0.005	0,08	0,13
F	0.070	0.081	1,78	2,06
G	0.083	0.098	2,19	2,50
H	0.035	0.043	0,89	1,09
J	0.018	0.024	0,45	0,61
K	0.006	0.009	0,13	0,23
L	0.018	0.022	0,45	0,56

MA47200 Series

Stripline PIN Diode Switch Modules



Description

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

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

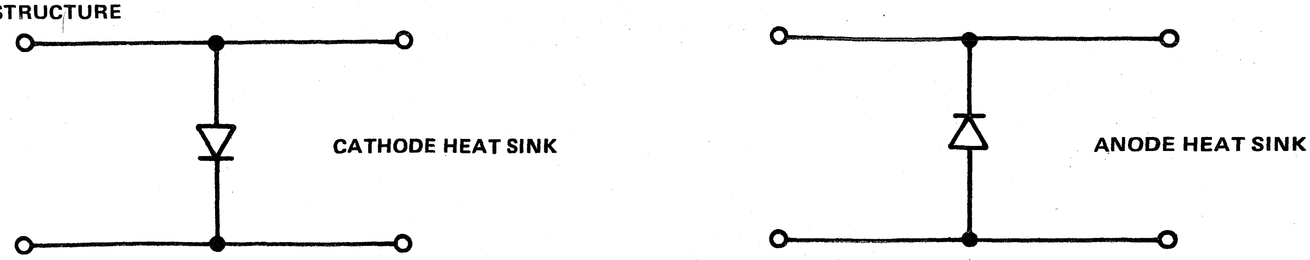
Features

- BROADBAND 50 OHM DESIGNS THROUGH X BAND
- CIRCUIT CHARACTERIZED
- HIGH POWER CAPABILITY
- VOLTAGE RATINGS TO 1000 VOLTS
- FAST SWITCHING SPEED TO 10 NANOSECONDS
- HERMETICALLY SEALED PACKAGES

Applications

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

DIODE STRUCTURE



Specifications @ $T_A = 25°C$

Model[1] Number	Case Style	Test Frequency (GHz)	Maximum[2] Insertion Loss (dB) @ V_R	Minimum Isolation (dB) @ I_F	Minimum[3] Voltage Rating (Volts)	Maximum Thermal Resistance (C/W°)	Nominal Switching Speed (ns) RF Off to RF On	RF On to RF Off
MA47208	114	1.0	0.25 @ 20V	30 @ 25 mA	1000	10	300	150
MA47200	114	1.0	0.25 @ 20V	30 @ 25 mA	500	10	200	60
MA47202	114	6.0	0.50 @ 20V	25 @ 25 mA	500	15	150	30
MA47204	114	8.0	0.60 @ 20V	20 @ 25 mA	500	20	100	30
MA47206	114	10.0	0.50 @ 10V	20 @ 10 mA	100	30	10	10
MA47201	115	1.0	0.25 @ 20V	30 @ 25 mA	500	10	200	60
MA47203	115	6.0	0.50 @ 20V	25 @ 25 mA	500	15	150	30
MA47205	115	10.0	0.50 @ 20V	20 @ 25 mA	500	20	100	30
MA47207	115	10.0	0.50 @ 10V	20 @ 10 mA	100	30	10	10
MA47223	144	4-8**	0.50 @ 0V	20 @ 100 mA	500	20	150	30
MA47222	144	8.0	0.50 @ 0V	20 @ 100 mA	150	20	100	30
MA47220*	144	10.0	0.50 @ 0V	20 @ −100 mA	150	30	100	30
MA47221	144	4-8**	1.00 @ 0V	20 @ 20 mA	70	20	10	10

* Anode heat sink
** Swept frequency measurement

NOTES:
1. Cathode heat sink all models except where indicated.
2. Maximum SWR is 1.5 at specified insertion loss condition.
3. Maximum reverse current is 10 microamperes at specified voltage rating.

MAXIMUM RATINGS

Storage Temperature	−65°C to +175°C
Operating Temperature	−65°C to +150°C
Voltage	Voltage Rating
Power Dissipation	$P_{diss} = \frac{150°C - T\ ambient}{Thermal\ Resistance}$

Environmental Performance

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

ENVIRONMENTAL RATINGS (PER MIL-STD-750)

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

Screened Diodes

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

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

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

Typical Performance Curves

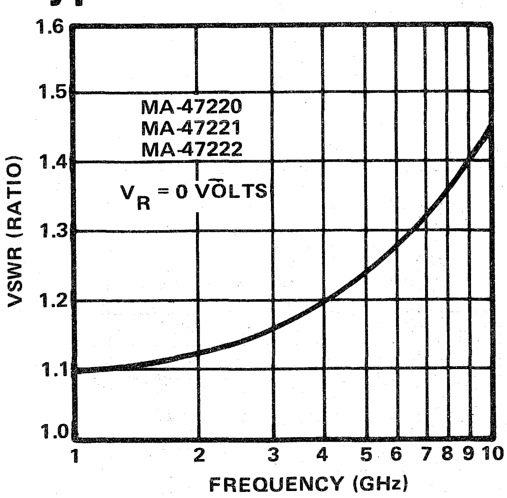


FIGURE 1. Typical VSWR vs Frequency for MA47200 Series

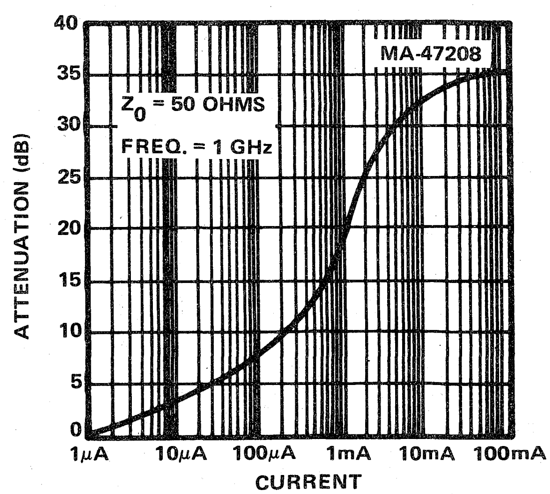
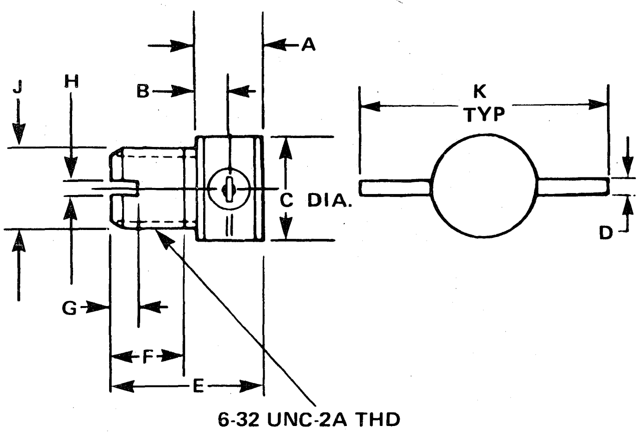


FIGURE 2. Typical Attenuation vs. Forward Current for MA47200 Series

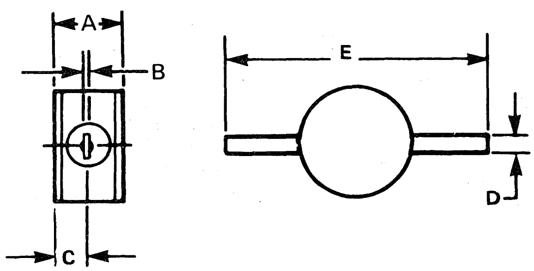
Case Styles

114



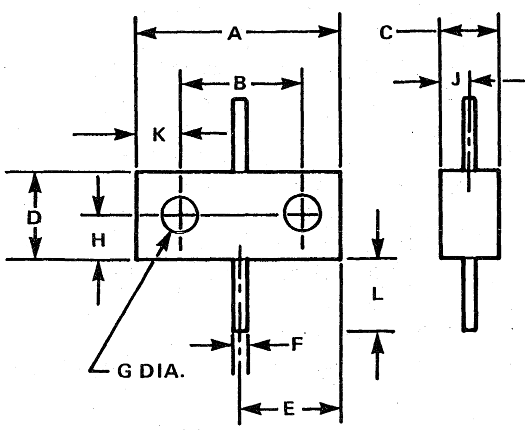
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.120	.140	3,04	3,55
B	.058	.072	1,47	1,82
C	—	.255	—	6,47
D	.011	.013	,76	1,52
E	.380	.400	9,65	10;16
F	.205	—	5,20	—
G	—	—	—	—
H	—	—	—	—
J	.1312	.1372	3,33	3,48
K	—	—	—	—

115



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.118	.140	3,00	3,55
B	.002	.006	,051	,152
C	.058	.072	1,47	1,82
D	.011	.013	1,76	1,52
E	—	—	—	—

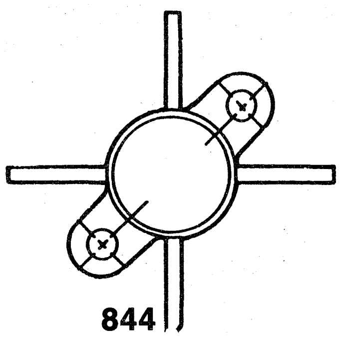
144



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.405	0.415	10,16	10,67
B	0.240	0.260	6,10	6,60
C	0.120	0.130	3,05	3,30
D	0.155	0.165	3,94	4,19
E	0.195	0.215	4,95	5,46
F	0.015	0.035	0,38	0,89
G	0.092	0.100	2,34	2,54
H	0.075	0.085	1,91	2,16
J	0.056	0.066	1,42	1,68
K	0.075	0.085	1,91	2,16
L	0.120	— —	3,05	— —

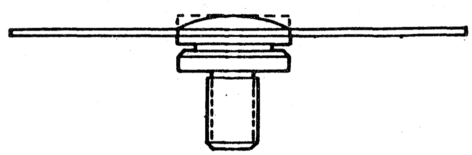
MA8334 Series

RF Multithrow PIN Diode Switch Modules



Features

- SP2T AND SP3T DESIGNS
- HIGH POWER CAPABILITY (UP TO 1 kW OF CW)
- LOW DISTORTION
- HIGH RELIABILITY
- FREQUENCY RANGE FROM 10 MHz TO 1 GHz
- LOW INSERTION LOSS
- HIGH ISOLATION



Description

M/A-COM's MA8334 series Multithrow Switch Modules are SP2T and SP3T switches designed for use from 20 MHz to 1000 MHz. They are rated to handle 10, 100 or 1000 watts CW RF power.

These switch modules are constructed using advanced hybrid technology and utilize PIN diode chips distinguished by their low loss and high reliability. The 1000 watt switch modules employ M/A-COM's Cermachip PIN diodes.

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

Specifications @ $T_A = 25°C$

Model Number	Case Style	Maximum[5] CW Input Power (Watts)	Switch[6] Type	Frequency[4] Range (MHz)	Minimum[1,2,3] Isolation (dB)	Maximum[1,2,3] Insertion Loss (dB)	Diode Voltage Rating (Volts)
MA8334-100	506	10	SP2T	20-600	25	.35	250
MA8334-101	506	10	SP2T	20-600	25	.35	250
MA8334-001	844	100	SP2T	20-1000	24	.35	900
MA8334-004	844	100	SP3T	20-1000	24	.35	900
MA8334-200	946	1000	SP2T	20-200	24	.20	1000

NOTES:
1. For the MA8334-1000 and MA8334-101 the isolation and insertion loss is specified at 450 MHz with the "ON" branch forward biased at 20 mA and the "OFF" branch at zero bias.
2. For the MA8334-001 and the MA8334-004 the isolation and insertion loss is specified at 450 MHz with the "ON" branch forward biased at 50 mA and the "OFF" branch at zero bias.
3. For the MA8334-200 the isolation and insertion loss is specified at 100 MHz with the "ON" branch forward biased at 600 mA and the "OFF" branch is reversed biased at 400 volts.
4. Maximum SWR for all switches is 1.35 at specified frequency.
5. Nominal thermal resistance is 100 C/W per diode for 10 watt switches, 10 C/W per diode for 100 watt switches and 3 C/W per diode for 1000 watt switches.
6. Other configurations available upon request.

ABSOLUTE MAXIMUM RATINGS

TEMPERATURE	STORAGE	OPERATING
10 watt switch	−65°C to +150°C	−55°C to +150°C
100 watt switch	−65°C to +125°C	−55°C to +100°C
1000 watt switch	−65°C to +150°C	−55°C to +150°C

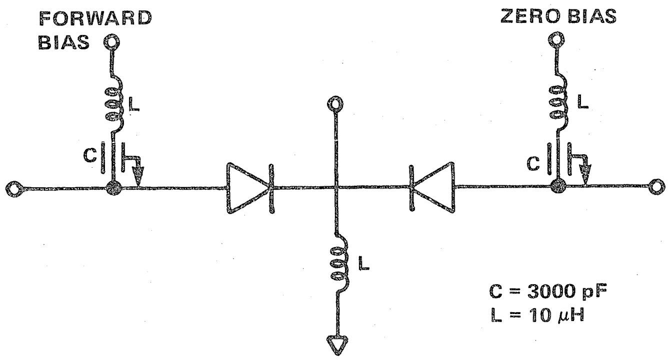
POWER

Power rating derated to zero watts at maximum operating temperature.

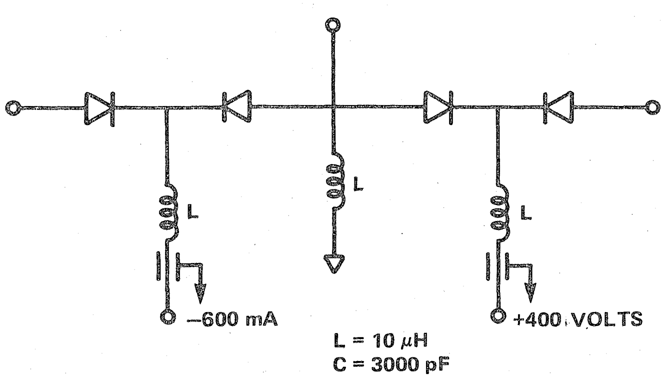
VOLTAGE Voltage Rating

Application Notes

APPLICATIONS CIRCUITS

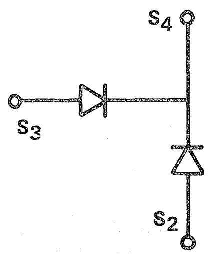


Suggested Bias Circuit for 10 Watt and 100 Watt SP2T Switches

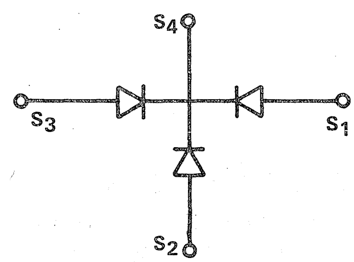


Suggested Bias Circuit for 1000 Watt Switch

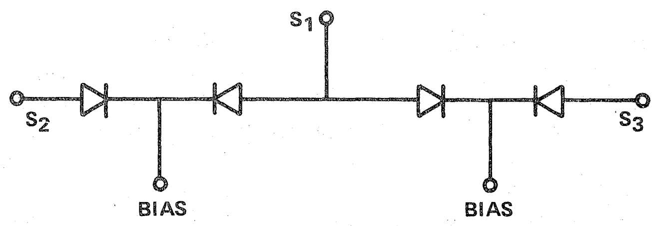
INTERNAL WIRING DIAGRAMS



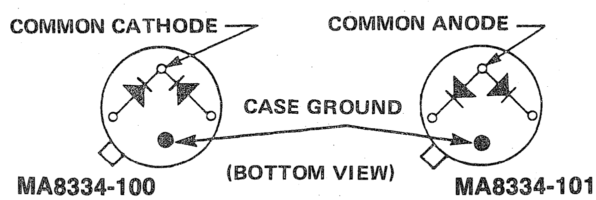
MA8334-001



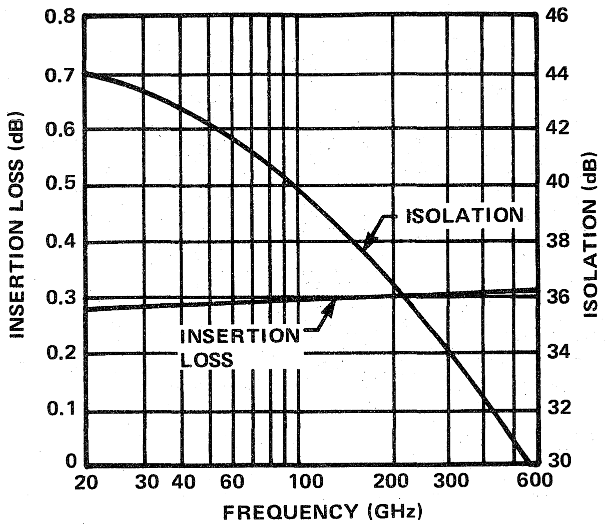
MA8334-004



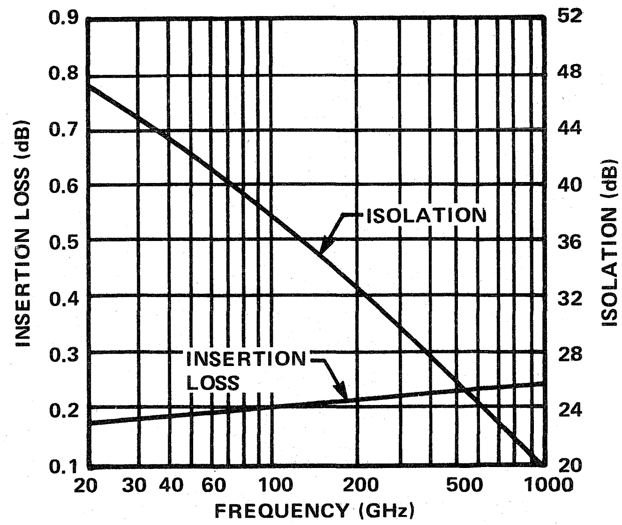
MA8334-200



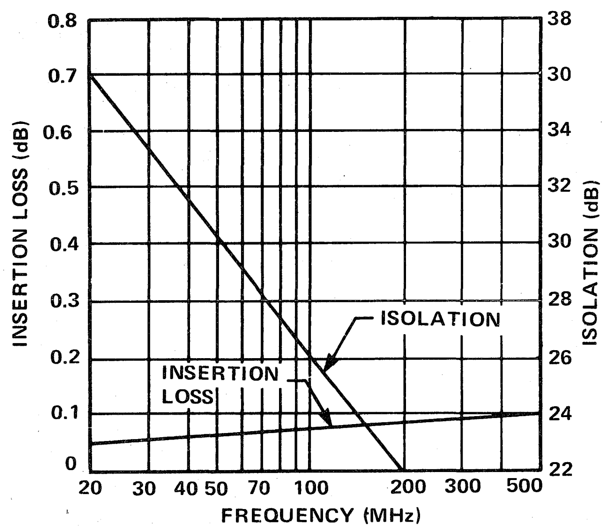
Typical Performance Curves



Typical Isolation and Insertion Loss vs. Frequency for 10 Watt Switches



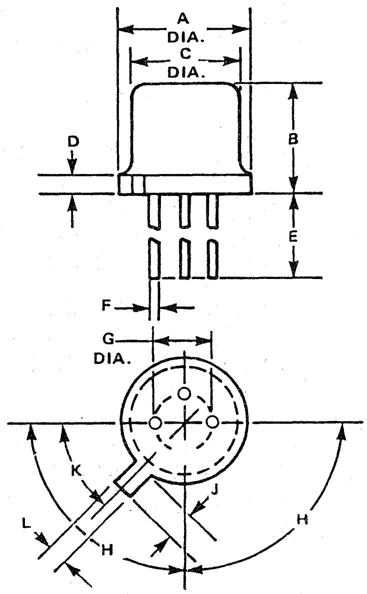
Typical Insertion Loss and Isolation vs. Frequency for 100 Watt Switches



Typical Insertion Loss and Isolation vs. Frequency for 1 kW Switch

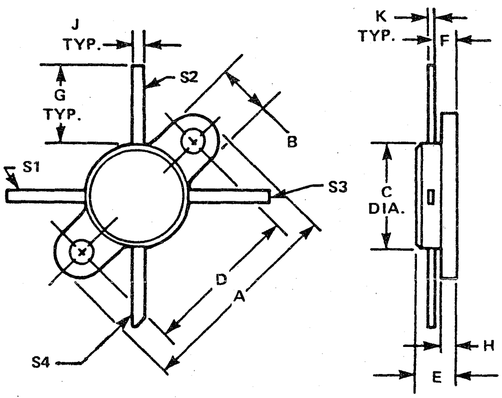
Case Styles

506



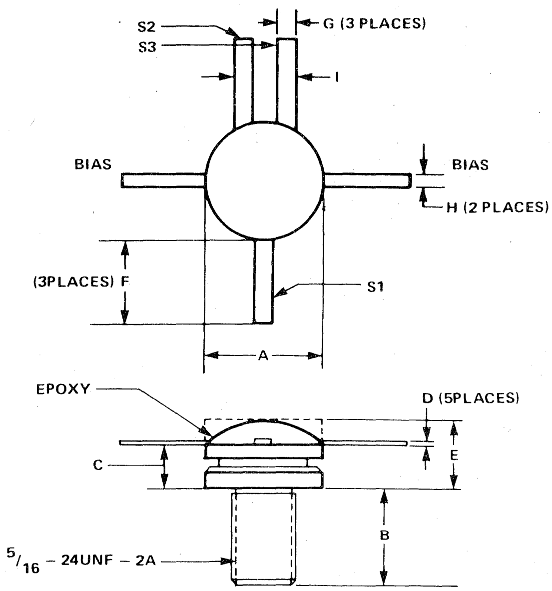
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.350	0.370	8,89	9,40
B	0.240	0.260	6,11	6,60
C	0.315	0.335	8,00	8,51
D	— —	0.040	— —	1,02
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.190	0.210	4,83	5,33
H	89°	91°	89°	91°
J	0.029	0.043	0,74	1,09
K	43°	47°	43°	47°
L	0.028	0.034	0,71	0,86

844



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.970	0.980	24,64	24.89
B	0.240	0.260	6,10	6.60
C	0.460	0.500	11,68	12.70
D	0.720	0.730	18,29	18.54
E	0.250	0.290	6,35	7.37
F	0.150	0.190	3,81	4.83
G	0.350	0.390	8,89	9.91
H	0.080	0.120	2,03	3.05
J	0.045	0.055	1,14	1.40
K	0.010	— —	0,25	— —

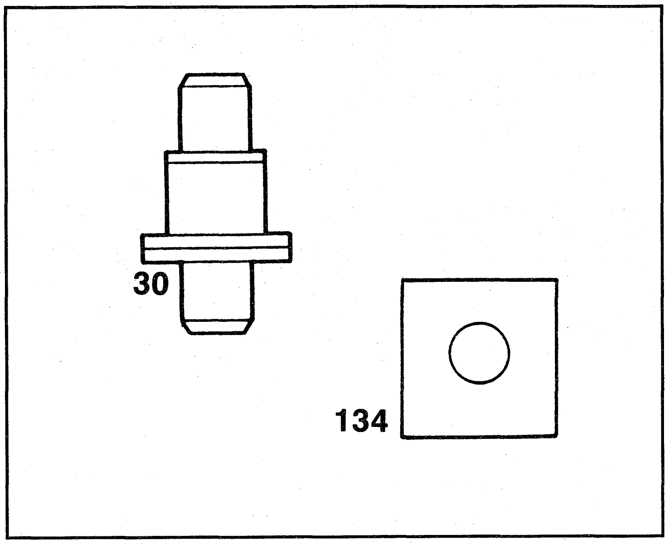
946



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.740	.760	18,80	19,30
B	.552	.577	14,02	14,65
C	.210	.220	5,33	5,59
D	.007	.014	0,17	0,35
E	— —	.155	— —	3,93
F	.485	.750	12,31	19,05
G	.095	.110	2,41	2,80
H	.035	.045	0,90	1,14
I	.305	.345	7,74	8.77

Limiter Diodes

Limiter PIN Diodes



Features

- LOW TURN ON POWER
- HIGH PEAK POWER DEVICES
- CHIPS AND PACKAGED DEVICES

Description

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

Applications

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

Specifications @ $T_A = 25°C$

ELECTRICAL SPECIFICATIONS

Model[1] Number	Minimum[2] Breakdown Voltage, V_b (Volts)	Maximum[3] Cj @ 0 Volts (pF)	Maximum[4] Rs @ 10 mA (Ohms)	Nominal Characteristics: Carrier Lifetime @ 10 mA (ns)	I-Region Width (μm)	Contact Diameter (mils)	Thermal[5] Resistance (°C/W)
MA4L011-134	20	.20	2.0	7	2	1.5	70
MA4L021-134	30	.20	1.5	10	3	2.0	60
MA4L022-134	30	.15	2.0	10	3	2.0	60
MA4L031-134	40	.20	1.5	15	5	1.5	40
MA4L032-134	40	.15	2.0	15	5	1.5	40
MA4L101-134	100	.15	2.0	90	10	2.5	30
MA4L301-134	200	.20	2.0	200	20	3.0	30
MA4L302-134	200	.25	1.5	250	20	5.0	30
MA4L401-132	250	.30	1.2	800	25	4.0	25
MA47089*	30	.30	2.0	10	3	—	500

*Glass Limiter Diode (case style 54)

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

NOTES:
1. The passivated chip, case style 134, (15X15 mils) or case style 132 (20X20 mils) are the standard case style for the MA4L series. The devices are available in the standard package, case style 30 (model number MA4L011-30) and other ceramic packages.
2. Breakdown voltage is specified at 10 microamperes reverse current.
3. Capacitance is specified at 1 MHz. For diodes in case style 30, add 0.20 pF.
4. Resistance is specified at 500 MHz.
5. Nominal thermal resistance is derived from diode geometry and is equivalent to case style 30 diode mounted to a heat sink.
6. Nominal microwave performance is the expected performance of the MA4L series shunt connected in a 6 GHz, 50 ohm transmission line.
7. The nominal maximum incident peak power is the suggested maximum safe operation peak power for a 1 microsecond pulse width and at 1% duty cycle.
8. The nominal recovery time is to 3 dB of the insertion loss state.

Specifications (Cont'd)

MAXIMUM RATINGS

Temperature Range

Storage	−65°C to +200°C
Operating	−65°C to + 125°C

Power Dissipation

$$\textbf{Pdiss} = \frac{175°C - T\ \text{ambient}}{\text{Thermal Resistance}}$$

Environmental Performance

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

ENVIRONMENTAL RATINGS (PACKAGED DIODES) (PER MIL-STD-750)

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

Screening Diodes (Packaged Diodes)

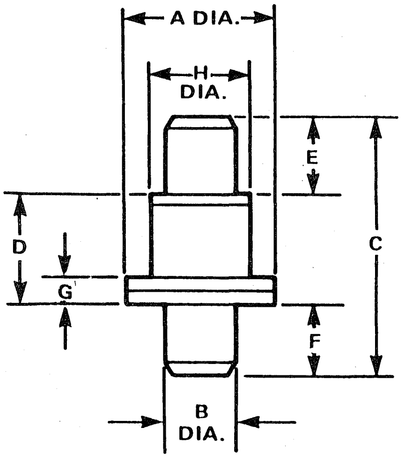
TABLE 1. Typical 100% Preconditioning and Screening Program for TX Level Screening

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

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

Case Styles

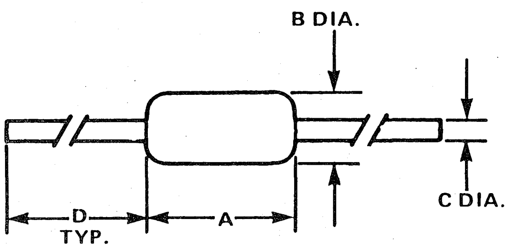
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

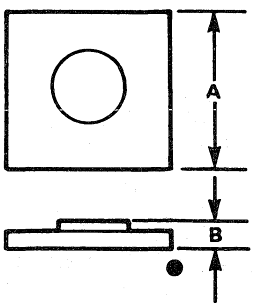
54



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

C_P = 0.05 pF Typical
L_S = 1.00 nH Typical

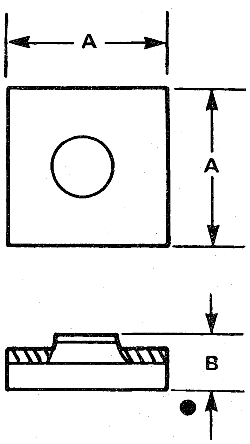
132



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.020	0.024	0,51	0,61
B	0.003	0.006	0,08	0,15

Chip Style

134

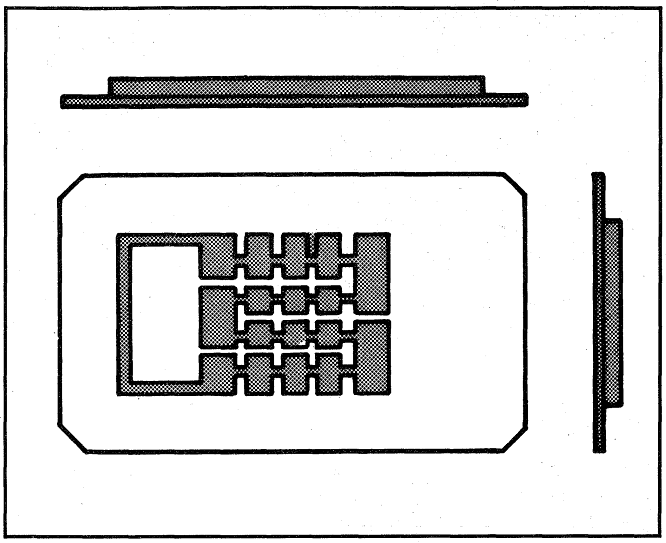


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0135	0.0165	0,34	0,42
B	0.0035	0.0065	0,09	0,17

All specifications are subject to change without notice.

Bulk Window™ Switch Arrays

Bulk Window™ Waveguide Switch Elements



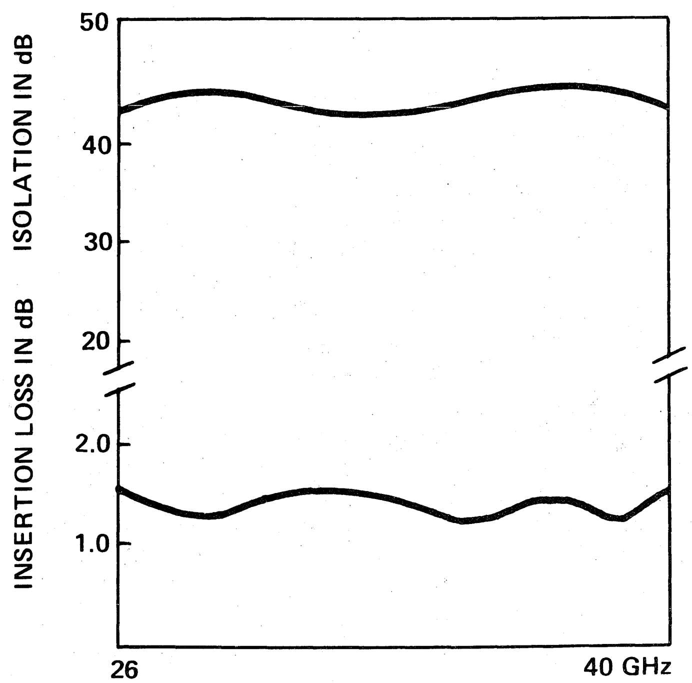
Features

- HIGH PEAK POWER
- HIGH AVERAGE POWER
- LOW LOSS
- HIGH ISOLATION
- SMALL SIZE
- LIGHT WEIGHT

Description

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 typically 25 dB of isolation.

The high isolation and low insertion loss of these high power PIN diode switch elements make them suitable for controlling high power radars and communication systems.



Application and Usage of "Bulk Window"™ as a Switch

BASIC STRUCTURE OF SEMICONDUCTOR ELEMENT

The diode array switch uses a semiconductor window element which is placed across the opening of the waveguide as shown in Figure 1. Fabricated onto this semiconductor window is an array of diodes. This series parallel array of diodes has a significant performance advantage over that of a single, conventionally packaged diode.

A pictorial of a diode array on a semiconductor window support element is shown in Figure 2. The "a" and "b" dimensions indicated in Figure 2 are essentially the "a" and "b" dimensions of the waveguide utilized.

In the pictorial, the diodes are in the center region. There are four diodes stacked in each of the four columns for a total of 16 diodes. The actual devices have a much greater number of diodes. A bias pad is provided on the left to facilitate the application of control bias current to each of the diodes.

The metallization to the left and right of the central diode region functions as an inductive iris. A metal flange is provided on the periphery of the semiconductor window to facilitate mounting into the waveguide holder.

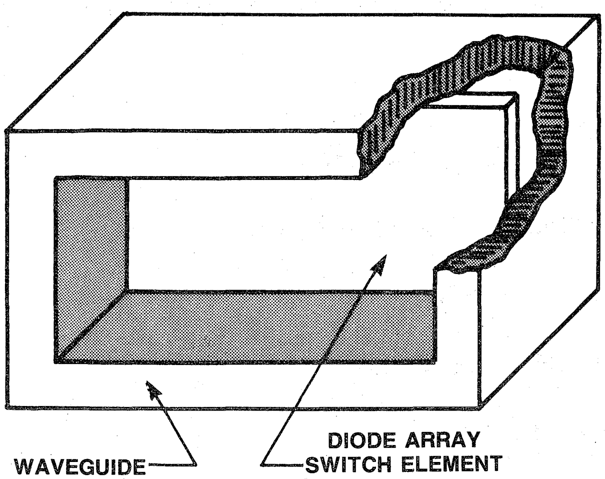


FIGURE 1. Switch Element Placement in Waveguide

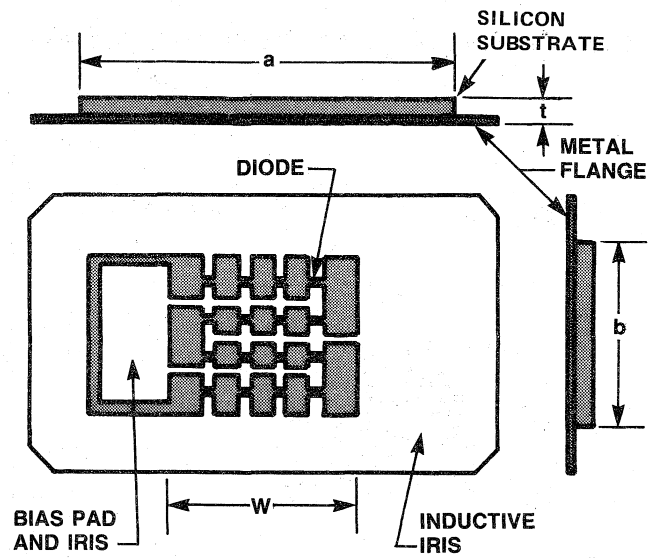


FIGURE 2. Semiconductor Diode Array Element

Representative Circuit of Diode Array Element

The semiconductor diode array element appears to the waveguide as a lumped element placed in shunt across the waveguide. The predominant characteristic of this lumped element is that of a capacitor. The capacitance results from several contributions. The most significant of which are the capacitance of the diode array, the capacitance of the bias structure and the capacitance of the substrate silicon. For switching applications, it is desirable that this capacitance be tuned so as to provide a nonreactive admittance at the frequency of interest when the diodes are unbiased.

Tuning can be done in several ways. The simplest technique is to provide inductive iris elements at the sides of the array as shown in Figure 2. At frequencies around 10 GHz, inductance added in this manner, is adequate to compensate for the capacitance of the semiconductor structure. At higher frequencies, it is necessary to use additional tuning elements, as described in the following section on Single-Pole Single-Throw Switch applications. At 35 GHz, it is possible to have full waveguide bandwidth operation with appropriate tuning.

To complete the representative circuit, a resistance is placed in parallel with the capacitance and iris inductance as shown in Figure 3(C). This resistance is a function of the forward bias current flowing in the diodes. With adequate forward bias current, this resistance is sufficiently low such that a single element single throw switch will provide 20 dB of isolation. At other bias levels, the resistance varies as the reciprocal of the current in accordance with semiconductor theory.

The representative circuit of Figure 3(c) can be used to model the RF performance for various tuning methods and for various application circuits.

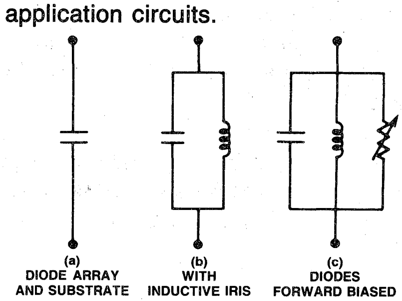


FIGURE 3. Representative Circuit of Diode Array Element

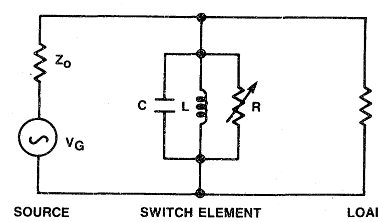


FIGURE 4. Representative Circuit of Untuned Switch Elemen

Application Notes (Cont'd)

SINGLE THROW SWITCH EXAMPLES

REPESENTATIVE CIRCUIT:

This application note will show the use of the representative circuit for the diode array element in predicting the performance of two different single throw switch configurations.

The representative circuit of the semiconductor window element is a parallel RLC combination connected in shunt across the transmission medium. (See also Figure 5).

Values for R,L and C are computed from RF insertion loss measurements at various frequencies and bias currents. The pertinent equations are given below:

(1) $$IL = |1 + (G + j\bar{B})(Z_0/2)|^2$$

where:

- IL = Insertion loss (defined to be >1)
- G = $1/R$ = Shunt conductance (a function of bias current)
- $\bar{B} = \omega C - \frac{1}{\omega L}$ = Shunt susceptance
- ω = Angular Frequency in radians/second
- R,L,C = Resistive, Inductive, Capacitive components of representative circuit

(2) $$Z_0 = \frac{\sqrt{\mu/\varepsilon}\,(b/a)}{\sqrt{1-(f_c/f)^2}}$$ Waveguide impedance

- μ, ε = Permeability and permittivity of transmission medium, respectively
- b, a = Height and width of waveguide transmission medium, respectively
- f_c, f = Cutoff and operating frequency

The shunt conductance (G) is a function of the control bias current (I). For the zero bias current case, the value of G can be ignored, leaving only (L) and (C) remaining in the representative circuit. Values for (L) and (C) are determined from (IL) measurements taken at two frequencies, the top and bottom of the frequency band.

The RF loss with zero bias is quite low (under 1 dB) such that reverse bias is generally not required. Applications of reverse bias of 5 to 10 volts will reduce the midband insertion loss 1 or 2 tenths of a dB.

For operations with forward bias, the shunt resistance (R) will increase inversely with the bias current (I).

(3) $$R = K_1 + K_2/I$$

where K_1 and K_2 are constants (Typical values are $K_1 = 3$, $K_2 = 2.8$)

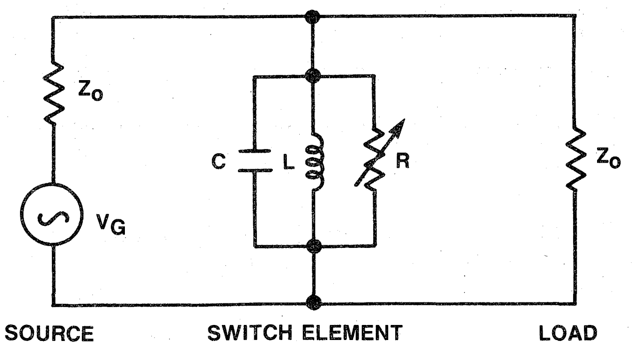


FIGURE 5. Representative Circuit of Untuned Switch Element

Single Window Tuning

For a single window array which is tuned for minimum VSWR at f_0 with the use of two tuning capacitors each spaced λg/8 from the window array (see figure 6), the following relationship between the normalized capacitive susceptance of the window array and of the tuning capacitors can be derived:

(4) $$\bar{B}_C = \frac{\bar{B}_W \pm \sqrt{\bar{B}_W(4-\bar{B}_W)}}{\bar{B}_W - 2}$$

where:

$\bar{B}_C$, $\bar{B}_W$ = the normalized capacitive susceptances of the tuning capacitors and the window array, respectively, at f_0.

From the above relation, if the negative radical is chosen, $2 \leq B_W \leq 4$ and $1 \leq B_C \leq 2$. If the positive radical is chosen, $2 \leq B_C \leq \infty$. The negative radical should be employed since it yields physically realizable values of tuning capacitance and broader bandwidth tuning.

A curve of the above expression is shown in Figure 7 for negative values of the radical.

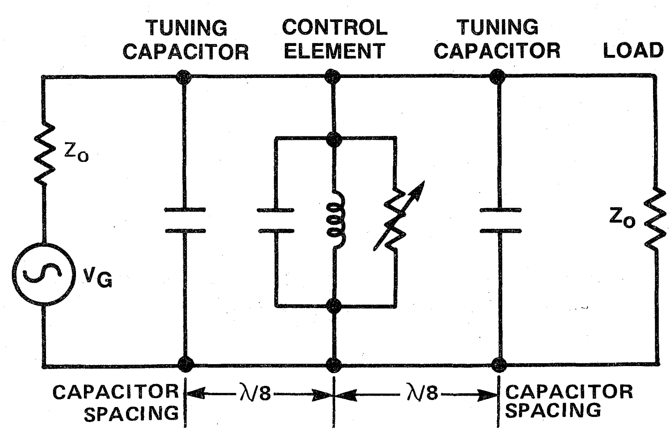


FIGURE 6. Representative Circuit of Broadband Switch

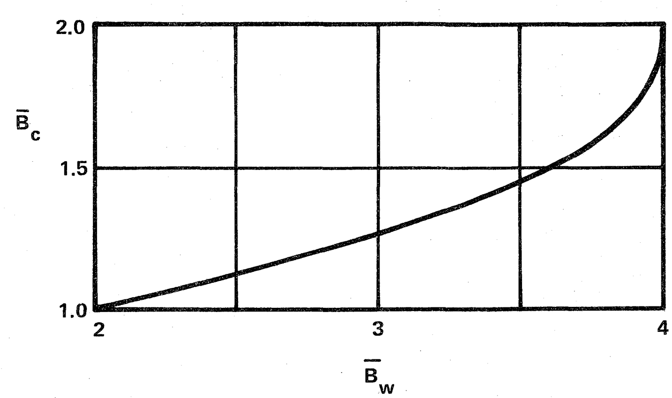


FIGURE 7. $\bar{B}_C$ (Normalized Tuning Capacitor Susceptance) vs. $\bar{B}_W$ (Normalized Capacitive Susceptance of Window Array)

Application Notes (Cont'd)

Figures 8, 9, and 10 show the calculated loss, SWR and isolation for the lossless case. They represent the purely reactive loss only. This model uses a tuning capacitor of 25 fF and a spacing of .055 inches (1.38 mm) from the window. The window model is L = 0.72 nH., C = 82 fF. The switch design was centered at 33 GHz.

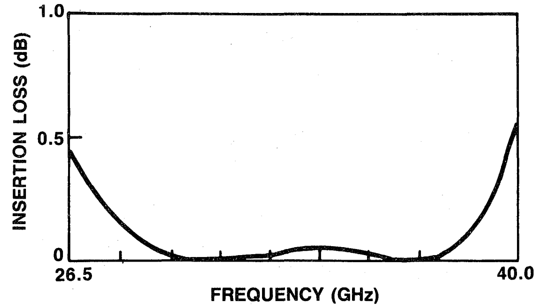
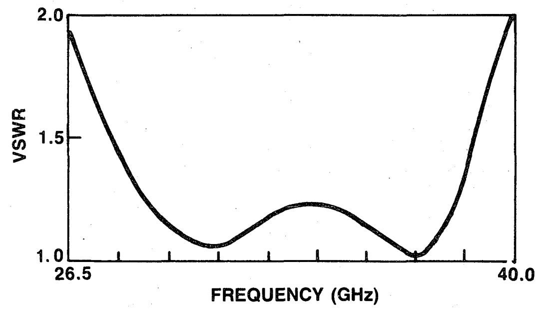


FIGURE 8. Calculated Insertion Loss vs. Frequency



b) VSWR VS. FREQUENCY

FIGURE 9. Calculated SWR vs. Frequency for the Broad Band Switch Base Line Design

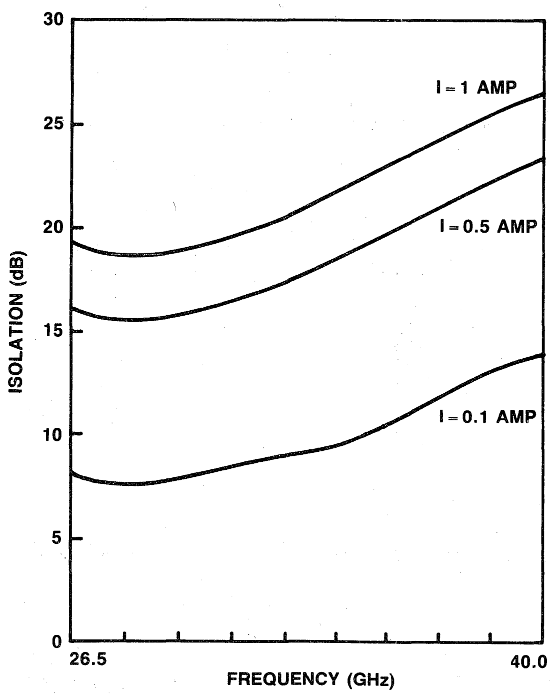


FIGURE 10. Calculated Isolation vs. Frequency for Single Window Switch Element as a Function of Bias Current

Dual Window Tuning

For dual window tuning, the following relationship between the optimum spacing and the normalized capacitive susceptance of the window arrays which provides a matched condition at f_O can be derived (see Figure 11):

$$\theta = \arctan\left(\frac{2}{\bar{B}}\right) \qquad (5)$$

where:

θ = electrical length or $\frac{2\pi l}{\lambda g}$

$\bar{B} = \frac{B}{Yo}$ (the normalized capacitive susceptance of the window array at f_O)

$\bar{B}$ can be expressed in terms of its insertion loss as:

$$\bar{B} = 2\,(10^{IL/10} - 1)^{1/2} \qquad (6)$$

where:

IL = insertion loss in dB at f_O (defined to be >1)

A curve of the optimum spacing expressed as θ versus the insertion loss of the window array for normalized capacitive susceptances of $2 \leq B \leq 4$ is shown in Figure 12.

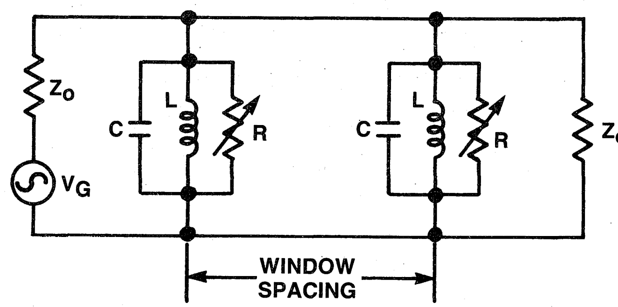


FIGURE 11. Representative Circuit of Dual Window Switch

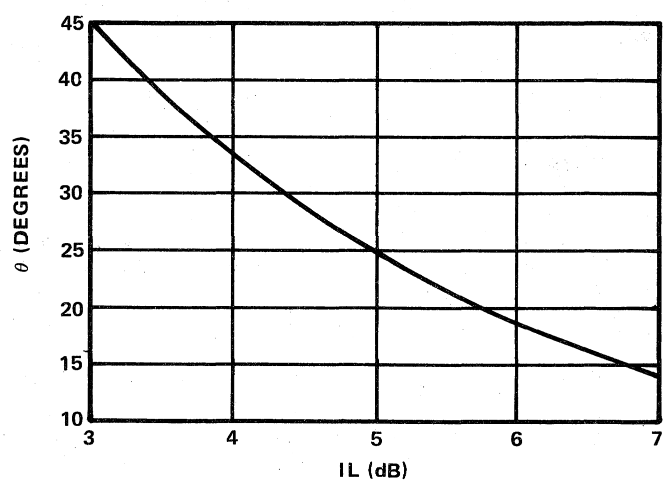


FIGURE 12. Electrical Spacing (θ) vs. the Insertion Loss of the Window Array at f_O

Application Notes (Cont'd)

DUAL WINDOW SWITCH ELEMENT EXAMPLE

The insertion loss versus frequency computed for a dual window switch is presented in Figure 13. The insertion loss curves presented are for the lossless case and represent a purely reactive loss. The window inductance and capacitance were calculated from loss measurements. The center curve is for a spacing of 0.051 inches (0.138 mm).

The two other curves are for spacings 20 percent larger and smaller. Smaller spacing shifts the passband upward in frequency. Typical isolation computed for the application of forward bias to the switch elements is presented in Figure 14. A shunt resistance which varies with current as expressed in Equation 3 has been added to the window model for this case. Results with actual switches have been in close agreement with the expected results from the model.

Broad Band Tuning

BROAD BAND DUAL WINDOW TUNING

Two window tuning bandwidth can be further optimized by employing two tuning capacitors as is done for single window tuning. For more information on Broad Band Tuning, request "The Design of Millimeter Frequency Bulk Window™ Arrays and Their Usage in Ka Band High Power Switches", 1987 by Charles M. Howell and Sam Parisi

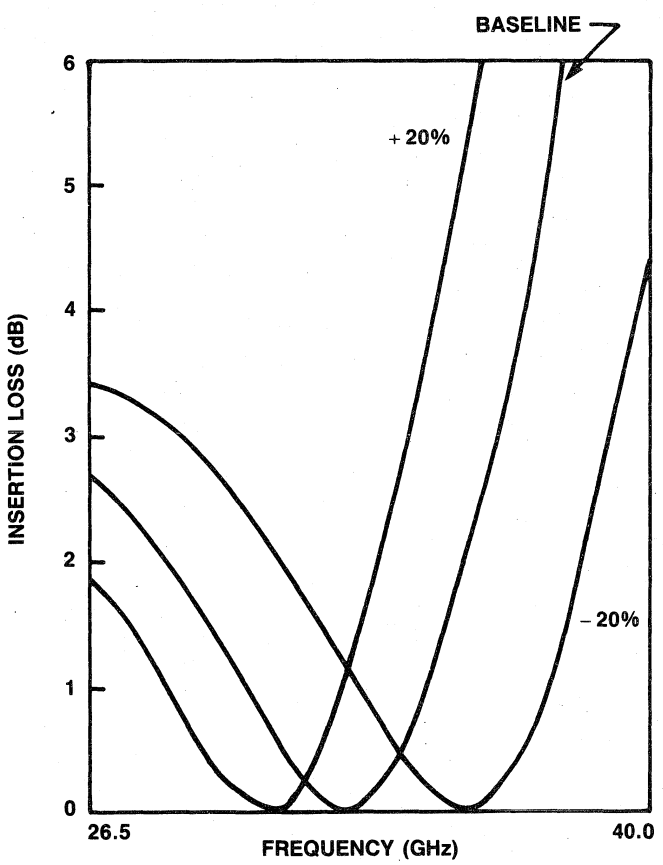


FIGURE 13. Insertion Loss vs. Frequency for the Base Line Design (.051 inch spacing) and ±20% Spacing Variation

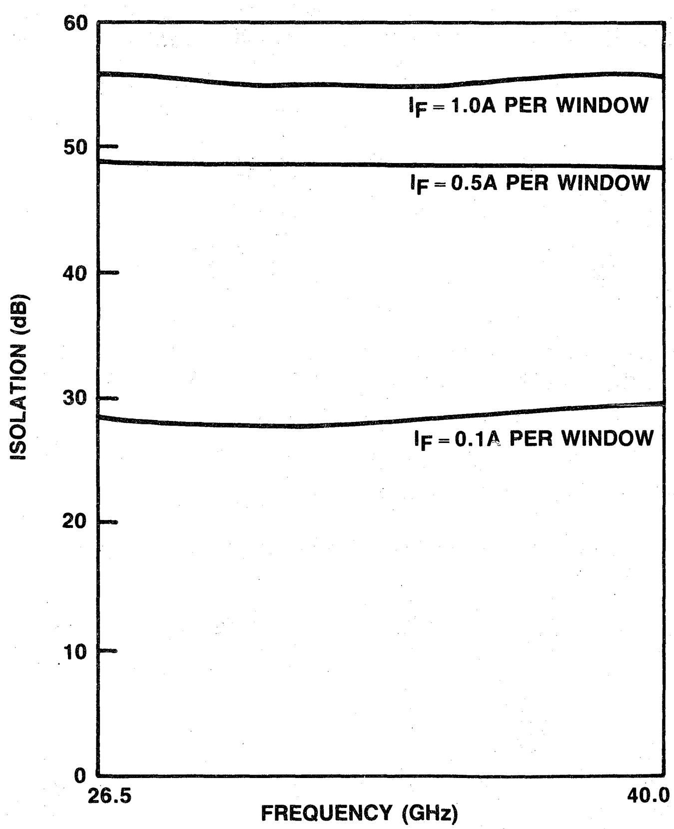


FIGURE 14. Calculated Isolation vs. Frequency for the Dual Window Switch Element for Three Different Current Levels

Application Notes (Cont'd)

TUNING CAPACITORS

Tuning capacitors are simply slabs of silicon which are supported by metal beam leads. The height and width of the silicon are equivalent to the "a" and "b" dimensions of the rectangular waveguide into which the capacitor is mounted (see outline drawing). The thickness of the silicon determines the capacitance values.

The capacitor can be modeled as a dielectric loaded waveguide to determine its capacitive susceptance. The waveguide impedance is expressed as

$$Z_g = \frac{\sqrt{\mu_o/\varepsilon_o}\,(b/a)}{\sqrt{\varepsilon_R - (f_c/f)^2}} \qquad (7)$$

where:

μ_o, ε_o = are the permeability and the permittivity of free space, respectively

b, a = are the height and width of the waveguide, respectively

ε_R = is the relative dielectric constant (ε_R = 11.8 for silicon)

f_c, f = the cutoff frequency of the waveguide and the operating frequency, respectively

The ABCD matrix of the capacitor is the following:

$$\begin{bmatrix} A & B \\ C & D \end{bmatrix} = \begin{bmatrix} \cos\theta & j\bar{Z}_g \sin\theta \\ j\bar{Y}_g \sin\theta & \cos\theta \end{bmatrix} \qquad (8)$$

where $\bar{Z}_g$, $\bar{Y}_g$ are the normalized waveguide impedance and admittance, respectively.

$$\theta = \frac{2\pi L}{\lambda_g} \text{ where } \lambda_g = \frac{\lambda_o}{\sqrt{\varepsilon_R - (\lambda_o/\lambda_c)^2}}$$

where L = the thickness of the silicon

If the silicon thickness is electrically short, then the ABCD matrix is approximated by

$$\begin{bmatrix} 1 & 0 \\ j\,B/y_o & 1 \end{bmatrix}$$

which is the matrix for a shunt susceptance.

where Yo is the characteristic admittance of unloaded waveguide.

$$\frac{B}{Y_o} \approx \frac{2\pi\,\bar{Y}_g}{\lambda_g} \qquad \text{since } \sin\theta = \theta \text{ for small angles}$$

$$\text{or } C = \frac{Y_o\,\bar{Y}_g\,L}{f\,\lambda_g}$$

Figure 15 shows the capacitance vs. silicon thickness in Ka band.

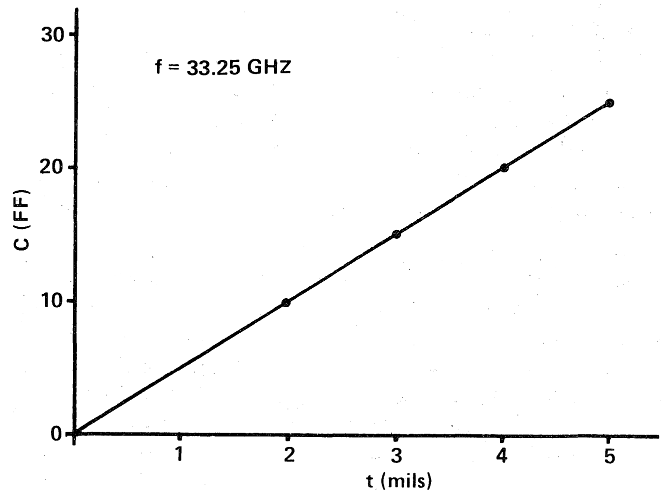
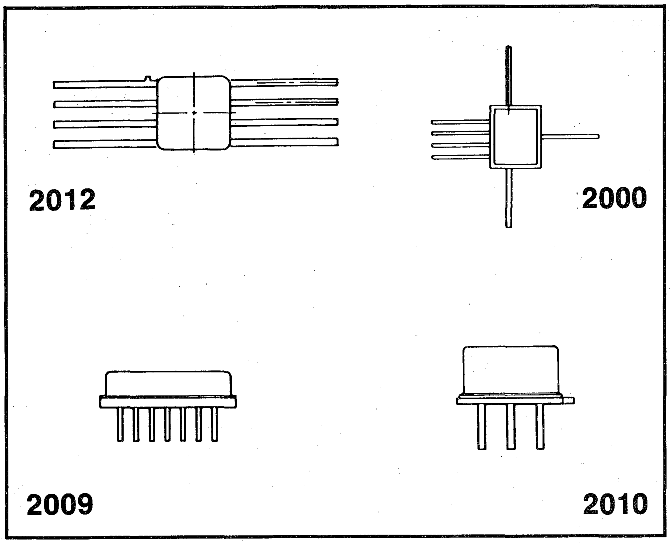


FIGURE 15. Capacitance verses silicon thickness for WR 28 capacitors at 33.25 GHz

GaAs FET MMIC Broadband Control Products

GaAs FET MMIC Broadband Control Products Capability Guide



Features

- DC TO 18 GHz OPERATION
- EXTREMELY LOW DC POWER CONSUMPTION
- NANOSECOND SWITCHING
- EXCELLENT INTERMODULATION
- LOW INSERTION LOSS
- EXCELLENT TEMPERATURE STABILITY

Description

M/A-COM Semiconductor Products Operation offers a broad range of fast FET MMIC switches and attenuators. The switch line includes Single Pole-Single Throw, Single Pole-Double Throw switches and transfer switches covering the range from DC to 18 GHz. The attenuator line includes matched variable voltage absorptive attenuators as well as digital attenuators. Also available are switched line phase shifters and switches with TTL or CMOS compatible drivers. All of these MMIC broad band products are available in chip form, several microwave packages and some devices are offered with built in drivers. This Capability Guide lists the standard GaAs MMIC products as well as the custom products that are available. The specifications for the standard control products are listed in this capability guide.

For more detailed specifications and device characterizations, request the "GaAs FET MMIC RF & MICROWAVE CONTROL PRODUCTS" catalog. M/A-COM also offers custom MMIC Broadband Control Products. For more information on this product line, contact your M/A-COM sales representative or the M/A-COM Semiconductor Products Operation Sales Department - Burlington, MA.

Standard and Custom MMIC RF & Microwave Control Products

- SPST REFLECTIVE/NON-REFLECTIVE SWITCHES
- SPDT REFLECTIVE/NON-REFLECTIVE SWITCHES
- MULTITHROW SWITCHES
- TRANSFER SWITCHES
- VOLTAGE VARIABLE ABSORPTIVE ATTENUATORS
- DIGITAL ATTENUATORS
- SWITCHED LINE PHASE SWITCHES
- SWITCHES WITH TTL/CMOS COMPATIBLE DRIVERS
- SP4T GaAs SWITCH

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION • Burlington, MA 01803 • (617) 272-3000 • TWX 710-332-6789 • TELEX 94-9464

GaAs MMIC SPST REFLECTIVE SWITCHES
Specifications @ T_A = 25°C

ELECTRICAL CHARACTERISTICS					Nominal Characteristics		
Model[3] Number	Frequency[4] Range (GHz)	Maximum I/O SWR Range Low/High	Maximum Input Power (dBM)	Case Style	Insertion[2] Loss Range Low/High (dB)	Isolation[2] Range Low/High (dB)	Control Voltage (volts)
MA4GM201-2000	DC-2	1.3:1	33	2000	0.30-0.60	65-35	−7
MA4GM201-T5	DC-2	1.2-1.3:1	33	2010	0.30-0.60	65-35	−7
MA4GM201-500	DC-2	1.0-1.1:1	33	500A	0.28-0.30	65-40	−7
MA4GM211-500	DC-12	1.5-2.0:1	25	500B	1.00-2.50	65-17	−7

NOTES:
1. Switching transition time specification for GaAs MMIC SPST switches is 3 nanoseconds.
2. Nominal values of insertion loss and isolation may vary from data sheet specifications. The Low/High values are at the low end and high end of the specified frequency band. Values given in capability guide supercede.
3. For more detailed information on GaAs MMIC SPST switches request a copy of the "GaAs FET MMIC RF & MICROWAVE CONTROL PRODUCTS" catalog.
4. For measurement to the specification at D.C. a 300 KHz test condition is used.

GaAs MMIC SPDT SWITCHES
Specifications @ T_A = 25°C

ELECTRICAL CHARACTERISTICS					Nominal Characteristics		
Model[7] Number	Frequency[4] Range (GHz)	Maximum I/O SWR Range Low/High	Maximum Input Power (dBM)	Case Style	Insertion[5] Loss Range Low/High (dB)	Isolation[5] Range Low/High (dB)	Control Voltage (volts)
MA4GM202-2000	DC-2	1.3-1.6:1	33	2000	0.7-0.9	70-37	−7
MA4GM202-T5	DC-2	1.3-1.6:1	33	2010	0.7-1.0	70-32	−7
MA4GM202-500	DC-2	1.2-1.5:1	33	500C	0.6-0.9	70-45	−7
MA4GM202L-2000	DC-2	1.5-1.8:1	33	2000	0.4-0.8	60-35	−7
MA4GM202L-T5	DC-2	1.5-1.8:1	33	2010	0.4-0.8	60-30	−7
MA4GM202L-500	DC-2	1.5-1.8:1	33	500D	0.4-0.8	60-35	−7
MA4GM202-D14S(2)	DC-2	1.4-1.6:1	33	2009	1.1-1.4	40-32	TTL (6)
MA4GM202-D14(3)	DC-2	1.4-1.6:1	33	2009	1.1-1.4	40-32	TTL (6)
MA4GM202M-D14(3)	DC-2	1.4-1.6:1	27	2009	1.1-1.4	46-38	TTL (6)
MA4GM212-500	DC-12	1.4-2.0:1	25	500E	1.0-2.7	60-16	−7
MA4GM222-500	DC-18	1.8-2.0:1	20	500G	1.3-2.7	70-13	−7
MA4GM202M-2000	DC-2	1.3-1.8:1	27	2015	1.0-1.2	70-55	−7

NOTES:
1. The switching transition time specification for the GaAs MMIC SPDT switches is 3 nanoseconds, unless otherwise indicated.
2. The switching time specification for this device is 70 nanoseconds and the driver supply voltage is + 5 volts nominal single supply.
3. The switching time specification for this device is 70 nanoseconds and the driver supply voltage is − 8 volts and +12 volts nominal.
4. For measurement to the specification at D.C. a 300 KHz test condition is used.
5. Nominal values of insertion loss and isolation vary from data sheet specifications. Values given in capability guide supercede. The Low/High values are at the low end and the high end of the specified frequency range.
6. Driver supply voltage logic can be configured to customer specifications. Contact the factory.
7. For more information on the GaAs MMIC SPDT switches, request a copy of the "GaAs FET MMIC RF & MICROWAVE CONTROL PRODUCTS" catalog.

GaAs MMIC TRANSFER SWITCHES Specifications @ T_A = 25°C

ELECTRICAL CHARACTERISTICS

					Nominal Characteristics		
Model[3] Number	Frequency[4] Range (GHz)	Maximum I/O SWR Range Low/High	Maximum Input Power (dBM)	Case Style	Insertion[2] Loss Range Low/High (dB)	Isolation[2] Range Low/High (dB)	Control Voltage (volts)
MA4GM316-500*	DC-12	1.3-1.8:1	27	500F	1.0-3.0	70-32	−7

*This device is available as an attenuator. When used as an attenuator the maximum input power for 1 dB compression is 0 dB.

NOTES:
1. The GaAs MMIC transfer switches have a switching transition time specification of 3 nanoseconds.
2. Nominal values of insertion loss and isolation vary from data sheet specifications. Values given in capability guide supercede. The Low/High values are at the low end and the high end of the specified frequency range.
3. For more information, request a copy of the "GaAs FET MMIC RF & MICROWAVE CONTROL PRODUCTS" catalog.
4. For measurement to the specification at D.C. a 300 KHz test condition is used.

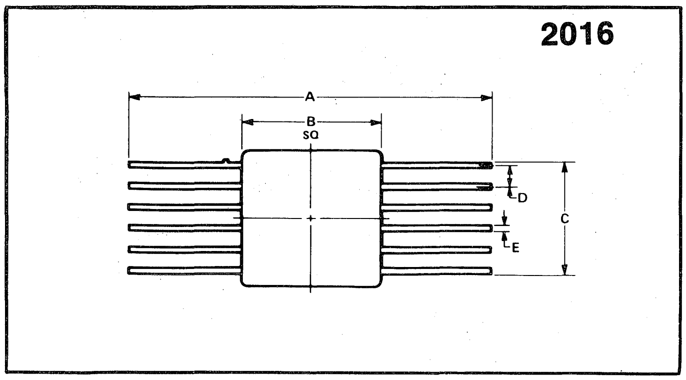
GaAs MMIC VOLTAGE VARIABLE ABSORPTIVE ATTENUATORS Specifications @ T_A = 25°C

ELECTRICAL CHARACTERISTICS

					Nominal Characteristics		
Model[4] Number	Frequency[4] Range (GHz)	Maximum I/O SWR Range Low/High	Maximum[2] Input Power (dBM)	Case Style	Insertion[3] Loss Range Low/High (dB)	Maximum[3] Linear Attenuation (dB)	Control Voltage (volts)
MA4GM301-500	DC-2	1.2:1	0	500H	1.1-1.3	20.5-19.8	0 to −5
MA4GM301-T5	DC-2	1.4:1	0	2010	1.2-1.4	20.3-19.8	0 to −5
MA4GM301-2000	DC-2	1.4:1	0	2000	1.15-1.35	20.5-19.8	0 to −5
MA4GM311-500	DC-12	1.2-1.3:1	0	500H	1.1-1.3	20-10	0 to −5
MA4GM321-500	DC-18	1.4-1.7:1	0	500H	1.1-1.8	20-7	0 to −5

NOTES:
1. The GaAs MMIC voltage variable absorptive attenuators have a switching time specifications of 3 nanoseconds.
2. The maximum input power for 1 dB compression is 0 dBm.
3. Nominal values of insertion loss, isolation and attenuation may vary from data sheet specifications. Values given in capability guide supercede. The Low/High values are at the low end and the high end of the specified frequency range.
4. For measurement to the specification at D.C. a 300 KHz test condition is used.
5. For more information on GaAs MMIC Voltage Variable Absorptive Attenuators, request a copy of the "GaAs FET MMIC RF and MICROWAVE CONTROL PRODUCTS" catalog.

GaAs MMIC SP4T SWITCH — MA4GM204 SERIES



Features

- DC TO 2 GHz
- SWITCHING SPEED TO 70 NANOSECONDS
- LOW INSERTION LOSS TO 2 GHz
- AVAILABLE WITH TTL COMPATIBLE DRIVER

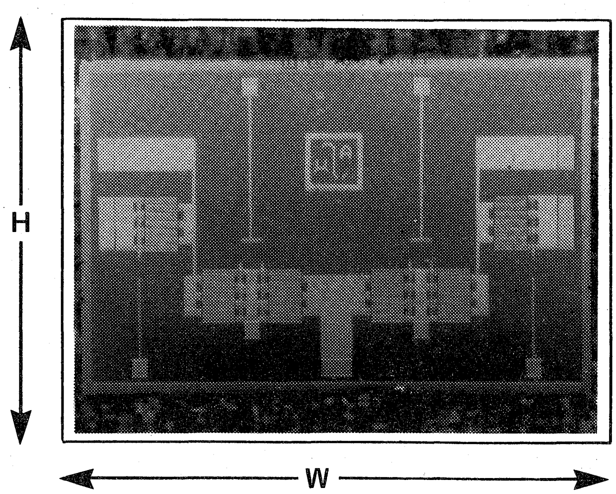
Description

This monolithic SP4T switch device is available in chip form (MA4GM204-500J), as well as a packaged unit containing the driver (MA4GM204D-2016). The packaged device utilizes a 12 PIN microstrip mounted package — ODS2016. The ODS2016 package offers excellent RF performance up to 2 GHz and is compatible with printed circuited board and stripline topologies.

Specifications @ T_A = 25°C

Insertion Loss — 2.3 dB maximum (Freq. .5 to 2 GHz)
Return Loss Greater Than 14 dB
Isolation at 2 GHz is 32 dB minimum
Package Configuration ODS2016 (12 PIN)
Driver Control Logic is TTL compatible
Switching Speed — 70 nanoseconds

GaAs FET CHIP STYLES*



*SPDT GaAs Switch

CHIP STYLES

MODEL NUMBER	CHIP STYLE	NOMINAL DIMENSIONS (Height X Width) (mils)	NOMINAL DIMENSIONS (Height X Width) (millimeters)
MA4GM201-500A		52 x 72	1.30 x 1.80
MA4GM211-500B		41 x 60	1.00 x 1.50
MA4GM202-500C		72 x 101	1.80 x 2.60
MA4GM202L-500D		60 x 90	1.50 x 2.30
MA4GM212-500E		42 x 42	1.10 x 1.10
MA4GM316-500F		62 x 65	1.60 x 1.70
MA4GM222-500G		48 x 60	1.20 x 1.50
MA4GM301-500H		37 x 44	0.95 x 1.10
MA4GM311-500H		37 x 44	0.95 x 1.10
MAGM321-500H		37 x 44	0.95 x 1.10
MA4GM204-500J		48 x 60	1.20 x 1.30

NOTE: All chips are nominal .010 mils (0.23 mm) thick.

CUSTOM MMIC PRODUCTS — MA4GM400 SERIES

DIGITAL STEP ATTENUATORS
(0.3 MHz TO 2.0 GHz)

SWITCHED LINE PHASE SHIFTERS
(500 MHz — 2.0 GHz)

CAN BE SUPPLIED WITH CMOS DRIVERS

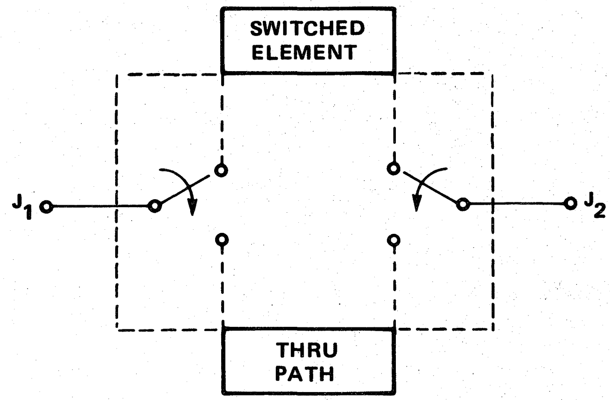


FIGURE 1. Dual Double Throw Switch

Description

The MA4GM400 series custom control circuits consist of one to five dual SPDT switches placed in series, creating a multi-purpose switching function. These functions can include switched attenuators, multi-step attenuators, and multi-bit switched line phase shifters. Because of the low insertion loss of the dual SPDT switches, cascading of up to five devices is possible.

The following sections detail custom digital step attenuators (one to five steps) and switch line phase shifters (one to four elements).

These products are based on our low loss dual SPDT GaAs FET monolithic switch chips which have low input and output SWR allowing them to be cascaded.

These attenuators and phase shifters can be supplied with −8 and + 12 volt CMOS drivers.

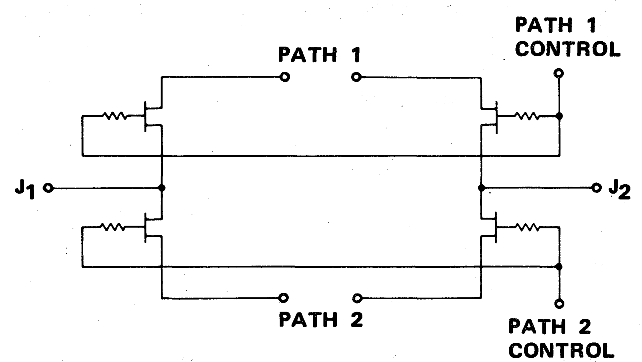


FIGURE 2. Dual Double Throw FET Switch Schematic

Circuit Description

SWITCHED ATTENUATORS

A digital attenuator can be built by placing a known attenuation pad in Path 1 between J1 or J2 (Figure 1) and switching the 'pad' "in and out". A switched line phase shifter may be built in the same manner by switching "in and out" a predetermined line length between J1 or J2 (Figure 1). The circuit of the MA4GM400 switch is illustrated in Figure 2 as a Dual SPDT Switch. (The signal path of the switch is determined by providing bias to the desired transmission arm). The GaAs FET switch requires −7 volts nominal and 0 volts (ground) for controi.

These Dual SPDT Switches have excellent SWR and can be cascaded to form digital attenuators with up to 5 bits of attenuation (Figure 3). (See following page for the available specifications).

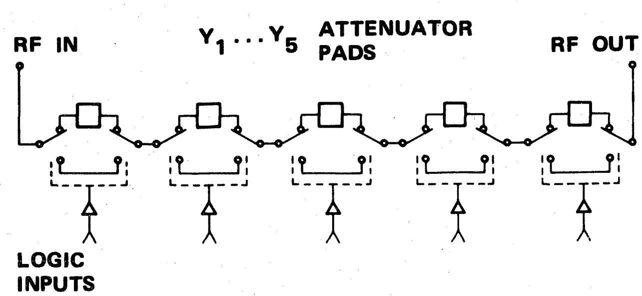


FIGURE 3. Typical Block Diagram of 5-Section Attenuator/Phase Shifter

CUSTOM MMIC PRODUCTS — MA4GM400 SERIES

Circuit Description (Cont'd)

SWITCH LINE PHASE SHIFTERS

The Dual SPDT switch previously discussed, may also be used for switch line phase shifters utilizing a switched transmission line technique. For detailed specifications, see next page.

DRIVER OPTIONS

M/A-COM Semiconductor Products Operation offers a CMOS driver for switching the MA4GM400 with −8 and +12 volts. The switching time with this CMOS driver is less than one microsecond.

An individual driver can be added to each section for independent control of each bit. Figures 3 illustrates a representative schematic of a five bit attenuator. (This driver will operate with negative and positive voltages from 5 to 12 volts, but switching performance may be decreased). The Dual SPDT Switch unit can also be supplied without the driver.

For more information on Custom Control Product specifications, contact your local M/A-COM sales Representative or the M/A-COM Semiconductor Products Operation Sales Department, Burlington, Massachusetts.

SWITCHED DIGITAL STEP ATTENUATORS

Description

The MA4GM400 switched digital attenuator consists of one to five cascaded Dual SPDT FET switches with a precision pad on each arm of the switch. The customer may choose the attenuation values and the number of steps (up to five). Each pads' attenuation value can be specified from +1.0 to 24 dB and with an accuracy of +0.5 to −0.25 dB per step. The schematic of the attenuator is illustrated in Figure 3.

The following section describes the available specifications and a standard step attenuator — MA4GM954.

Specifications @ T_A = 25°C

MA4GM954 STANDARD 5 BIT ATTENUATOR

Frequency Range — 0.3 MHz to 1600 MHz
Insertion Loss — 5.0 dB maximum (measured at 1 GHz)
Attenuation Steps — (1 to 30 dB for the full 5 bit attenuator)
Attenuation Pad Values = 1,2,4,8 and 16 dB
Attenuation Accuracy per step — +0.5/-0.25 dB/bit
Return Loss — 20 dB
Phase tracking — 5 degrees maximum for each bit
Switching Speed — 200 nanoseconds maximum
Package Configuration Module — Consult factory for details
Driver Control Logic — TTL compatible
Custom CMOS driver requires −8 volts and +12 volts supply. (This driver will operate with negative and positive voltages from 5 to 12 volts, but the switching performance may be decreased.)

Ordering Information/ Custom Options

NOTE: The following custom options are available for 1 to 5 bit attenuators as follows:

FREQUENCY RANGE — from .3 mHz to 2 GHz is available with 1 to 5 attenuation steps possible. The values of the individual attenuation pads can vary from 0.5 dB minimum to 24 dB maximum per step.

ATTENUATION — The maximum attenuation of the packaged multi bit attenuator is approximately 50 dB at 2 GHz.

SINGLE STEP ATTENUATORS — are available in chip form or packaged in T05 (ODS-2010) or T08 (ODS-2019) in the attenuation range of +1.0 to 24 dB.

PACKAGE CONFIGURATION - Available packages for 2-5 bit attenuators: DIPS (ODS-2009, ODS-2019) and Modules. Not all attenuator circuits will fit all available packages. For more information, contact the factory.

DRIVER CONTROL — CMOS driver requires −8 and +12 volts supplies. (This driver will operate with negative and positive voltages from 5 to 12, but the switching performance may be decreased.)

All the above specifications must be defined by the customer when ordering a custom device.

CUSTOM MMIC PRODUCTS — MA4GM400 SERIES

SWITCHED LINE PHASE SHIFTERS

Description

Switch line phase shifters are also available using the Dual SPDT switches (See Figure 1). The options are 1 to 4 bits and the center frequency 500 mHz to 2 GHz. Each bit can vary from 22.5 to 180 degrees with a each bit having a tolerance of ±5% (or ±5 degrees which ever is greater) at the design frequency. Loss per bit is approximately 1 dB. The following is a list of the available specifications for the Switch Line Phase Shifters.

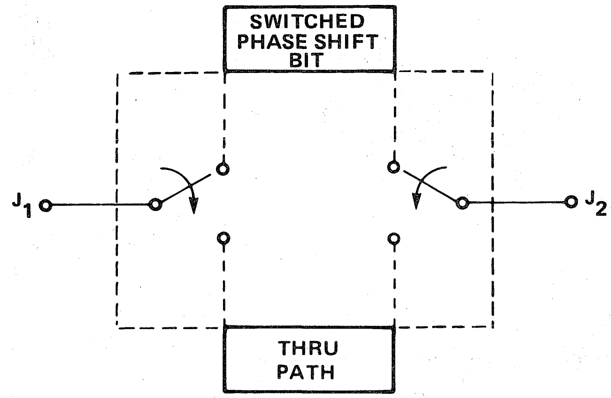


FIGURE 1. Phase Shifter Schematic

Specifications @ T_A = 25°C

The available custom product capability is as follows:

Phase Shift Bits available 22.5 to 180 degrees with tolerance of ±5% or ±5 degrees whichever is greater.

Insertion loss to 2 GHz — 1 dB per bit nominal

Return Loss — 20 dB maximum at design frequency.

Frequency Range — 500 mHz to 2 GHz (Frequency to be specified).

One to four bit phase shifter models available, with or without driver.

Driver Control Logic is TTL compatible.

Switching Speeds Up to 200 nanoseconds maximum.

Ordering Information/ Custom Options

NOTE: All the following specifications must be defined when when ordering custom devices.

DESIGN FREQUENCY — from 500 mHz to 2 GHz

BITS — 1 to 4 bits available per switched line phase shifter

PHASE SHIFTER — Selected bits can vary from 22.5 to 180 degrees with a tolerance of ±5% or ±5 degrees which ever is greater.

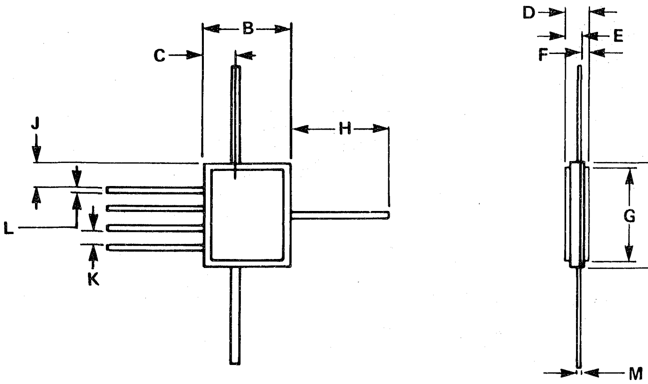
DRIVER CONTROL — A CMOS driver requries +8 and −12 volt supply. (This driver will operate with negative and positive voltages from 5 to 12 volts, but the switching performance may be decreased).

PACKAGE CONFIGURATIONS — 14 PIN DIP (ODS-2009) or 24 PIN DIP (ODS-2019) and MODULES. Not all devices are available in all packages. Consult the factory.

Driver Options

M/A-COM Semiconductor Products Operation offers a CMOS driver for switching the MA4GM400 with −8 and +12 volts. The switching time with this CMOS driver is less than one microsecond. A driver is required for each bit of the phase shifter.

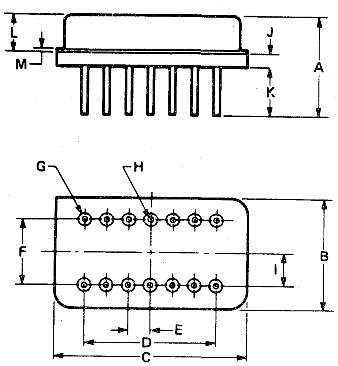
2000



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.252	.268	6,40	6,80
B	.207	.223	5,25	5,66
C	.080	.090	2,03	2,29
D	.047	.055	1,19	1,39
E	.027	0.035	,685	,889
F	.017	.023	,431	,584
G	.242	.258	6,14	6,55
H	.225	.255	5,71	6,47
J	.053	.063	1,34	1,60
K	.032	.038	,812	,965
L	.008	.012	,203	,304
M	.004	.007	,101	,177

NOTES:
1. Lid is Nickel Plated
2. Other metal areas are Au Plated

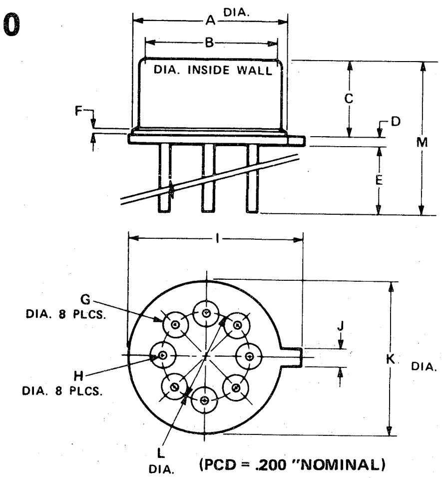
2009



14 PIN Dip

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.445	.455	11,30	11,55
B	.501	.495	12.72	12,57
C	.873	.867	22,17	22,02
D	.595	.605	15,11	15,36
E	.095	.105	2,41	2,66
F	.295	.305	7,49	7,74
G	.051	.061	1,29	1,54
H	.016	.020	0,40	0,50
I	.145	.155	3,68	3,93
J	.055	.065	1,39	1,65
K	.200	.240	5,08	6,09
L	.164	.174	4,16	4,41
M	.008	.012	0,20	0,30

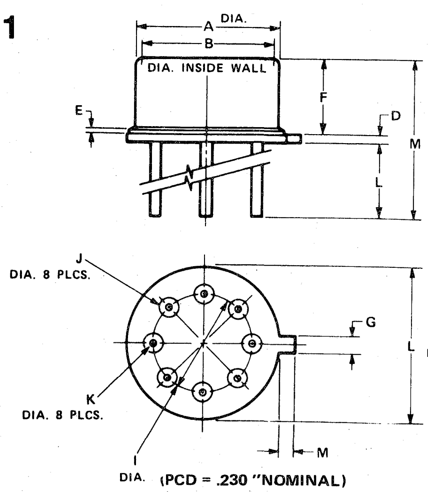
2010



TO 5

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.347	.351	8,81	8,91
B	.302	.306	7,67	7,77
C	.170	.180	4,31	4,57
D	.013	.017	0,33	0,43
E	.500	.560	12,70	14,22
F	.009	.012	0,22	0,30
G	.054	.058	1,37	1,47
H	.015	.019	0,38	0,48
I	.390	.398	9,90	10,10
J	.027	.034	0,68	0,86
K	.358	.362	9,09	9,19
L	.195	.205	4,95	5,20
M	.683	.757	17,34	19,22

2011

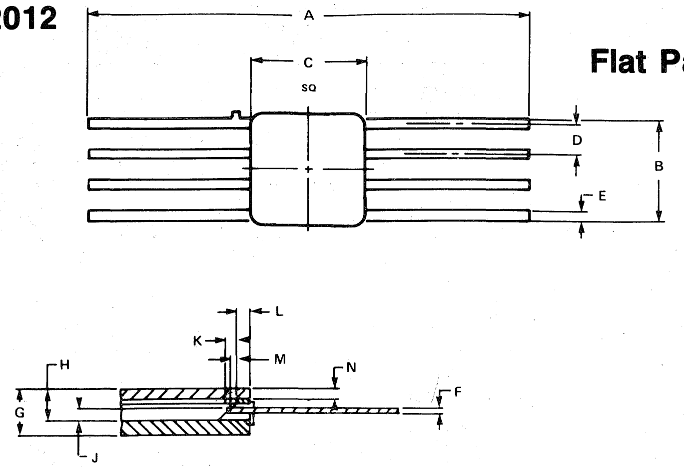


TO 77

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.347	.351	8,81	8,91
B	.302	.306	7,67	7,77
C	.500	.560	12,70	14,22
D	.013	.017	0,33	0,43
E	0,09	.012	0,22	0,30
F	.170	.180	4,31	4,57
G	.028	.034	0,71	0,86
H	.030	.040	0,76	1,01
I	.225	.235	5,71	5,96
J	.040	.050	1,01	1,27
K	.015	.019	0,38	0,48
L	.358	.362	9,09	9,19
M	.683	.757	17,34	19,22

2012

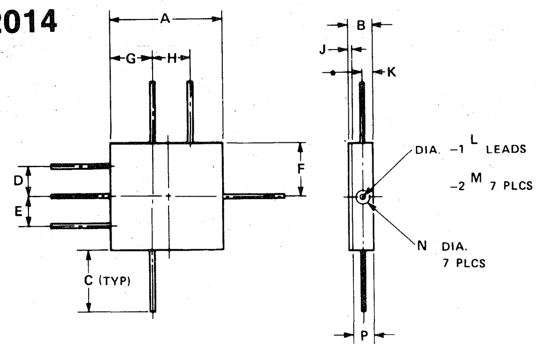
Flat Pack



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.695	.705	17,65	17,90
B	.160	.170	4.06	4,31
C	.175	.180	4,44	4,57
D	.045	.055	1,14	1,39
E	.010	.020	0,25	0,50
F	.003	.007	0,07	0,17
G	.072	.075	1,83	1,90
H	.032	.037	0,81	0.93
J	.015	.025	0,38	0,63
K	.013	.023	0,33	0,58
L	0.15	.025	0,38	0,63
M	.006	.010	0,15	0,25
N	.010	.020	0,25	0,50

2014

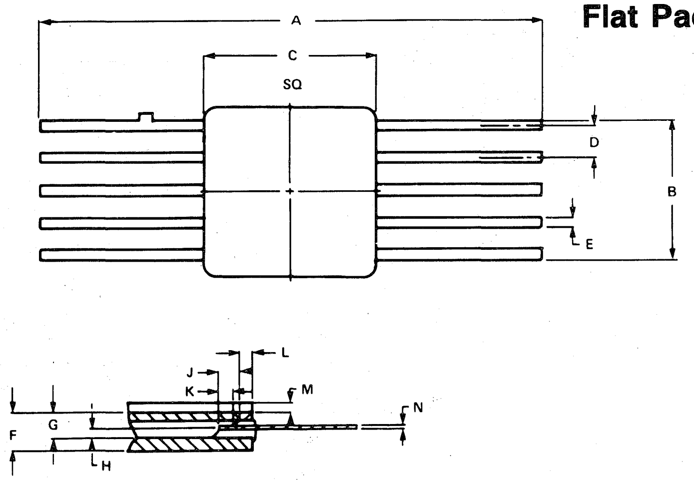
Module



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.623	.627	15,82	17,06
B	.130	.140	3,30	3,55
C	.350	.335	8,89	9,01
D	.170	.180	4,31	4,57
E	.170	.180	4,31	4,57
F	.308	.318	7,82	8,07
G	.230	.240	5,84	6,09
H	.440	.450	11,17	11,43
J	.007	.013	0,17	0,33
K	.060	.066	1,52	1,67
L	.145	.155	0,35	0,39
M	.115	.125	0,27	0,30
N	.077	.079	1,95	2,00
P	.123	.127	3,12	3,22

2015

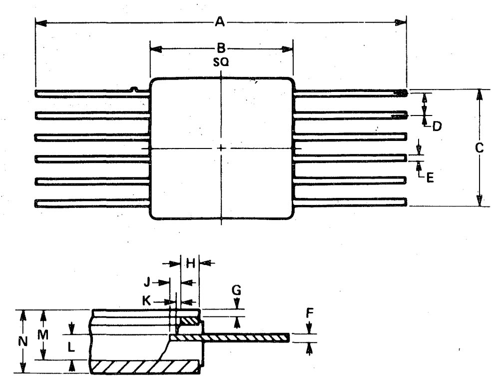
Flat Pack



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.260	.270	6,60	6,85
B	.210	.220	5,33	5,58
C	.265	.270	6,73	6,85
D	.045	.055	1,14	1,39
E	.010	.020	0,25	0,50
F	.075	.080	1,90	2,03
G	.040	.045	1,01	1,14
H	.015	.025	0,38	0,63
J	.015	.025	0,38	0,63
K	.010	.015	0,25	0,38
L	.017	.027	0,43	0,68
M	.010	.020	0,25	0,50
N	.002	.008	0,05	0,20

2016

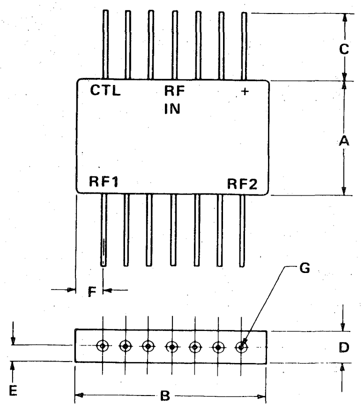
Flat Pack



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.525	.535	13,33	13,58
B	.635	.640	16,12	16,25
C	.525	.535	13,33	13,58
D	.095	.105	2,41	2,66
E	.010	.020	0,25	0,53
F	.007	.013	0,17	0,33
G	.010	.020	0,25	0,53
H	.037	.047	0,93	1,19
J	.020	.030	0,53	0,76
K	.010	.015	0,25	0,38
L	.050	.060	1,27	1,52
M	.095	.100	2,41	2,54
N	.120	.125	3,04	3,17

2017

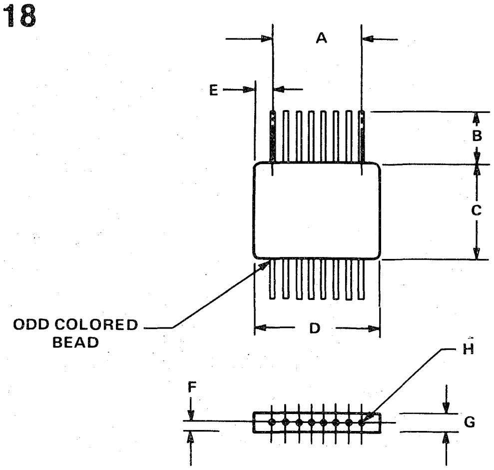
Module



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A		.500		12,7
B		.820		20,828
C	.325		8,255	
D		.138		3,5052
E		.069		1,7526
F		.110		2,794
G	.013	.017	,3302	,4318

2018

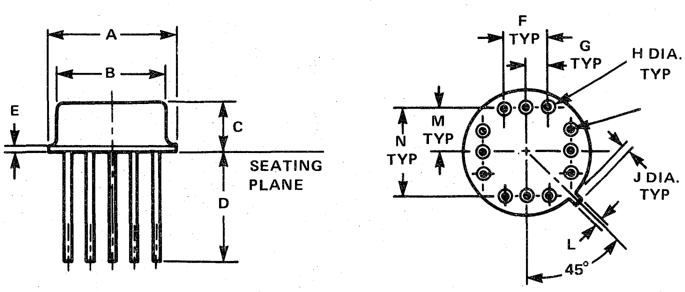
Module



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.100 Nominal		2,54 Nominal	
B	.325	—	8,26	—
C	.790	.810	20,1	20,6
D	.980	1.020	24,9	25,9
E	0.150 Nominal			
F	—	0.69	—	1,75
G	—	.138	—	3,50
H	—	.017	,33	,43

2019

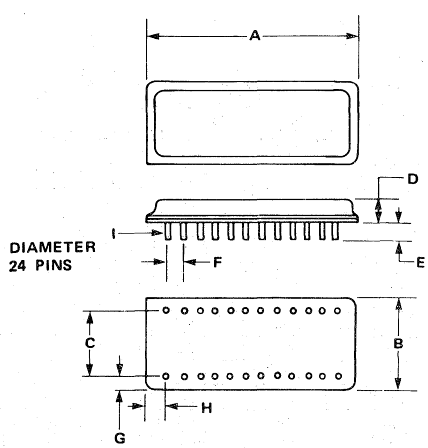
T08



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.598	.602	15,18	15,29
B	.545	.555	13,84	14,10
C	.185	.195	4,69	4,95
D	.500	.560	12,70	14,22
E	.013	.016	0,33	0,40
F	.195	.205	4,93	5,20
G	.095	.105	2,41	2,66
H	.055	.065	1,39	1,65
J	.0183	.0188	0,44	0,48
K	.026	.036	0,66	0,91
L	.026	.036	0,66	0,91
M	.193	.207	4,90	5,25
N	.393	.407	9,98	10,33

2021

Module



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	1.350	1.390	34,3	35,3
B	0.780	0.820	19,8	20,8
C	0.595	0.605	15,1	15,3
D	—	0.200	—	5,1
E	0.120	—	3,0	—
F	0.100	Nominal	2,4	Nominal
G	0.080	0.120	2,0	3,0
H	0.120	0.160	3,1	4,1
I	0.013	0.023	0,38	0,42

GaAs FET MMIC Control Product Process Screening and Quality Procedures

GaAs FET MMIC Control Product Process Screening and Quality Procedures

In processing GaAs FET MMIC Control Products, consistency and reproducibility is ensured by measuring key electrical parameters on each wafer at the main steps and using the results for statistical process control. If a process goes out of control, the inspected wafers are rejected and the problem quickly corrected. The measurements are made automatically at multiple test sites on the wafer. This procedure provides circuits manufactured with the same process, under the same controlled conditions and therefore comparable in quality and reliability. A typical process sequence with test points is presented in Figure 1. When processing is complete, each circuit is DC tested to select the good dies and determine the yield. Control circuits can generally be extensively tested at this level, due to their simplicity, to estimate the functional yield.

Next the wafer is diced and undergoes qualification by evaluating sample dies for electrical functional performance, temperature stability, mechanical die attach strength and wire bond strength.

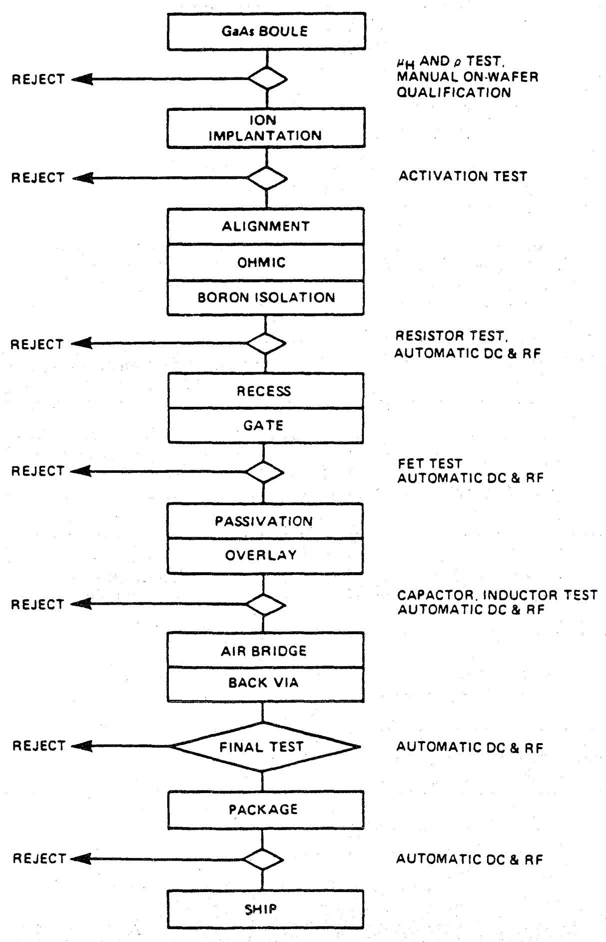


FIGURE 1. Typical Process Sequence with Test Points

Following wafer qualification, the chips are assembled into packages and tested according to Figure 2 for commercial applications.

M/A-COM can also provide higher levels of product assurance, the most common being a qualification following the requirements of MIL-M-38510 level B, as outlined in Figure 3. A typical sceening scheme for this qualification level is presented in Figure 4 along with test methods and typical test conditions. This screening sequence follows method 5004 of MIL-STD-883. The lot qualification follows method 5005 of MIL-STD-883, a typical sequence of which is shown in Figure 5. The electrical tests performed and LTPDs are determined with consideration of the device type and its intended application.

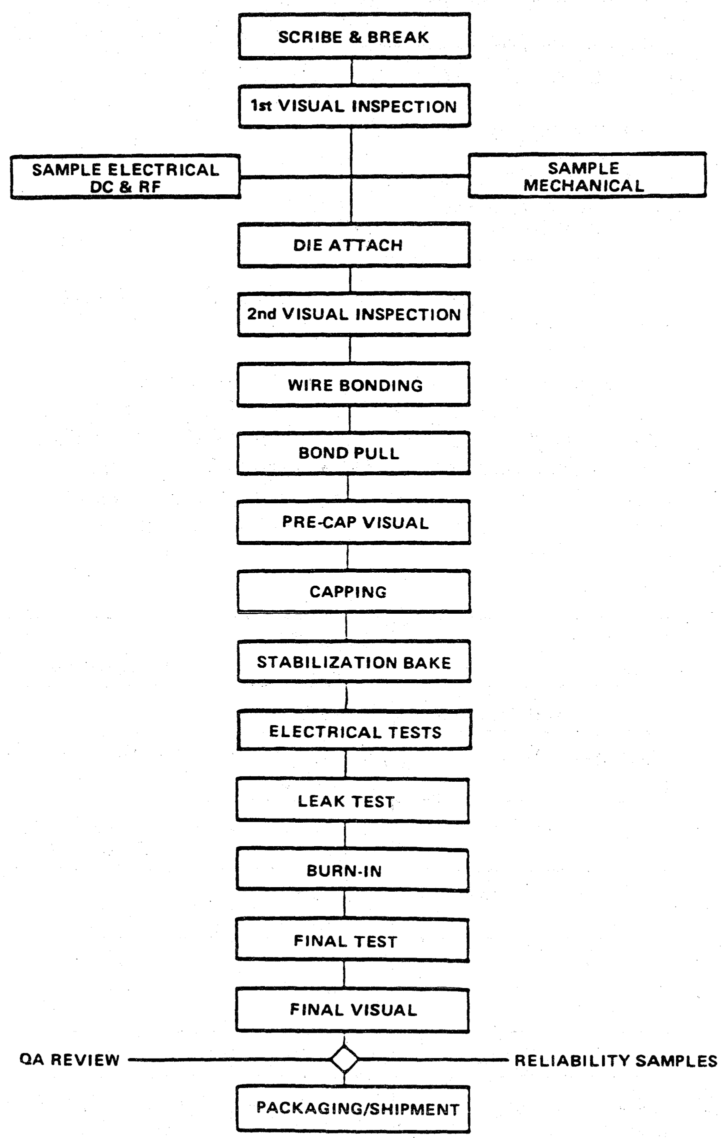


FIGURE 2. Assembly and Screening Steps for Packaged Devices

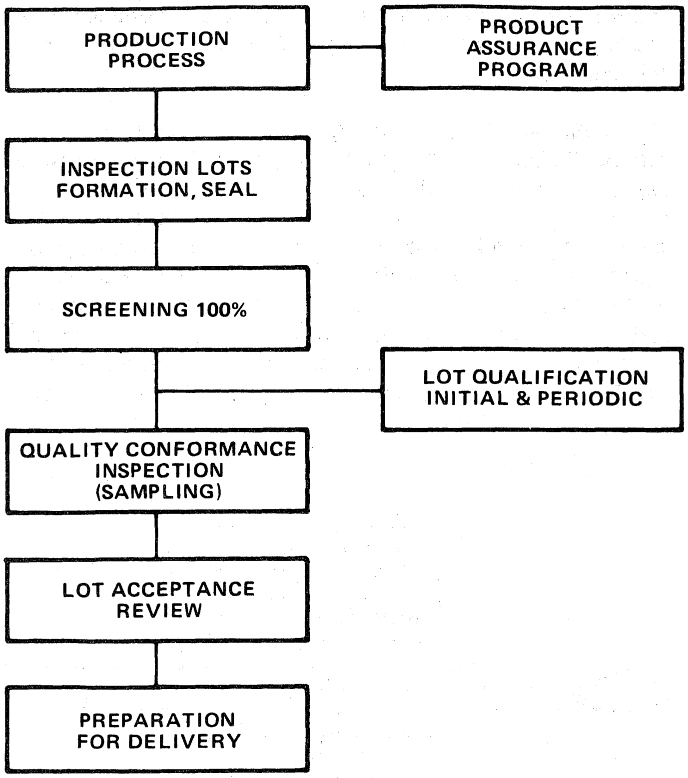


FIGURE 3. Typical Product Flow for Qualified Parts

M/A-COM has shipped thousands of parts qualified at a level equivalent to MIL-M-38510, level B. This experience has provided us with an understanding of device qualification methods and procedures. Requests for additional or alternate testing programs can be complied with, as can customer requests for screening equivalent to S level requirements.

Test	MIL-STD-883 Method	Test Conditions
Pre-Cap Visual Inspection	2010B	—
Stabilization Bake	1008 Cond. C	150°C for 24 hours
Temp. Cycling/Thermal Shock	1010 Cond. C	10 Cycles – 65°C to 150°C
Constant Acceleration	2001 Cond. B	—
Leak Test: Fine Gross	1014 Cond. A Cond. C	—
Pre Burn-In Electrical	—	—
Burn-In	1015 Cond. B	160 Hours @ $T_A = 125°C$
Final Electrical	—	—
External Visual Inspection	2009	—

FIGURE 4. MIL-M-38510 Class B Screening Sequence

Product reliability can be expected from our carefully planned and controlled design, development and manufacturing efforts, but still this needs to be tested and proved. Life time experiments are performed under a variety of stress conditions.

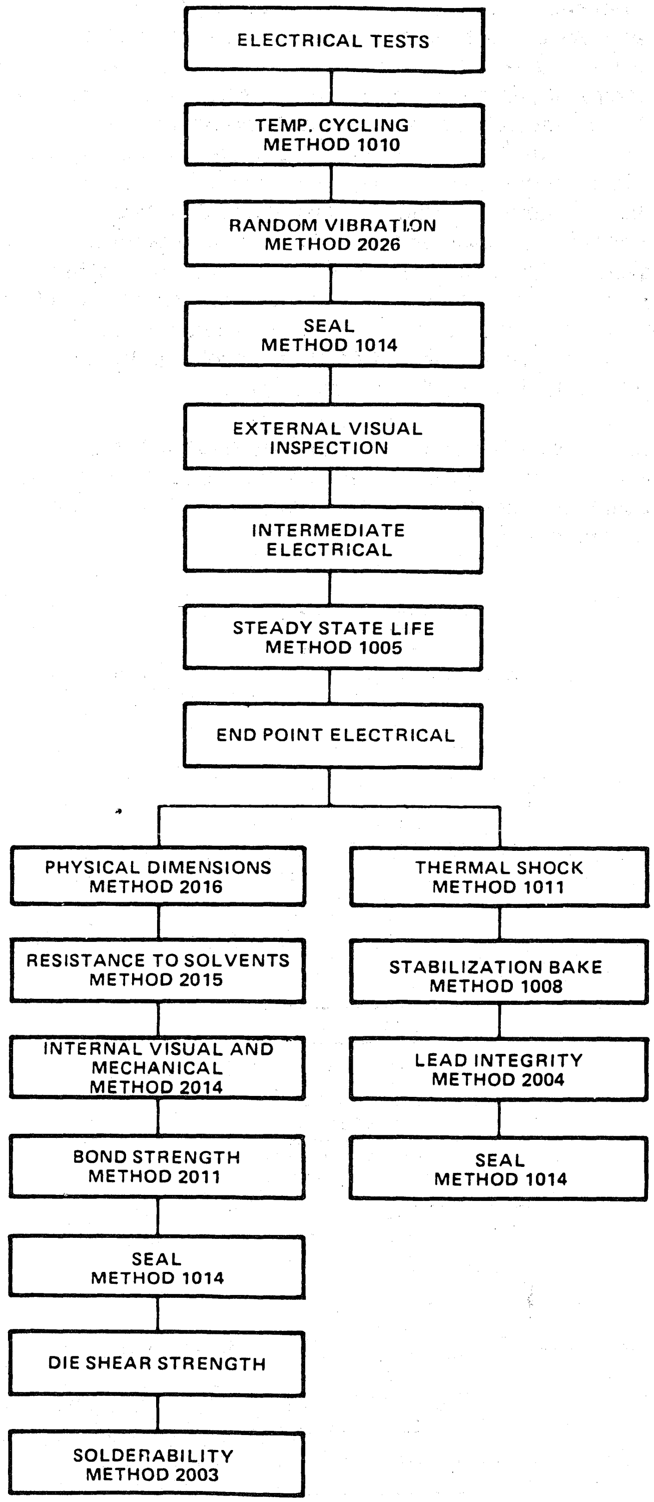


FIGURE 5. MIL-M-38510 Level B Equivalent Lot Qualification Steps

Reliability may be defined as the probability that a component will perform a required function under stated conditions for a given period of time. A failure occurs when the ability of an item to perform its required function is terminated. Failures can be classified as catastrophic, i.e., complete and sudden, or as degradation failures, i.e., gradual and partial.

When life test experiments are run, the times to failure for each component are determined. We then can graphically analyze the results to estimate the reliability R(t). This function R(t) can be seen either as the probability that a random unit drawn from the population will survive at least t hours or as the fraction of all units in the population that will survive at least t hours. It is useful to express this reliability function by an analytical formula, thus providing a theoretical model for describing the way the population values are distributed. The functional form taken by R(t) will be based on the actual distribution on considerations of the prevalent failure mechanisms.

The most common distributions for semiconductor device failures are the log-normal and the Weibull distributions. The log-normal distribution is very suitable for degradation failure mechanisms. The model that leads to this distribution is a multiplicative growth model, assuming that at any instant in time, the item undergoes a random increase in degradation that is proportional to its present state. The multiplicative effect of all these random and assumed independent growths builds up to failure. This model is preferred in order to hypothesize if a multiple degradation process is going on, like a corrosion migration or diffusion phenomenon.

If there are many identical and independent coupling processes leading to failure, and the first to reach a critical stage determines the failure time, then an extreme value distribution can be derived, and the Weibull distribution is expected to apply.

The main functions related to life distributions are:

The Probability Density Function (PDF)

f(t), where f(t)dt is the fraction of failures from the population occurring during the time interval dt. This function can be found experimentally from a histogram of the number of failures versus time.

The Cumulative Distribution Function

f(t) is the integral of the PDF from time = 0 to time = t; it is the probability of a failure to occur before or at a time t in a single random draw from the population. It is alternatively the fraction of all units in the population which fail by t hours, its graphical representation from experimental data being straight forward with this definition:

Using the above distributions, the reliability function R(t) can be expressed as:

$$R(t) = 1 - f(t)$$

The hazard function h(t), or failure rate, is then given by:

$$h(t) = \frac{f(t)}{R(t)} = \frac{f(t)}{1 - F(t)}$$

Figure 6 shows a visual comparison of the probability density function, the cumulative distribution function, and the failure rate for both log-normal and Weibull distribtions.

To obtain reliability results for a given product, several accelerated life tests are performed on that product, each at a different test temperature. The results of these life tests are analyzed both as individual experiments and, upon completion of several life tests, as a group.

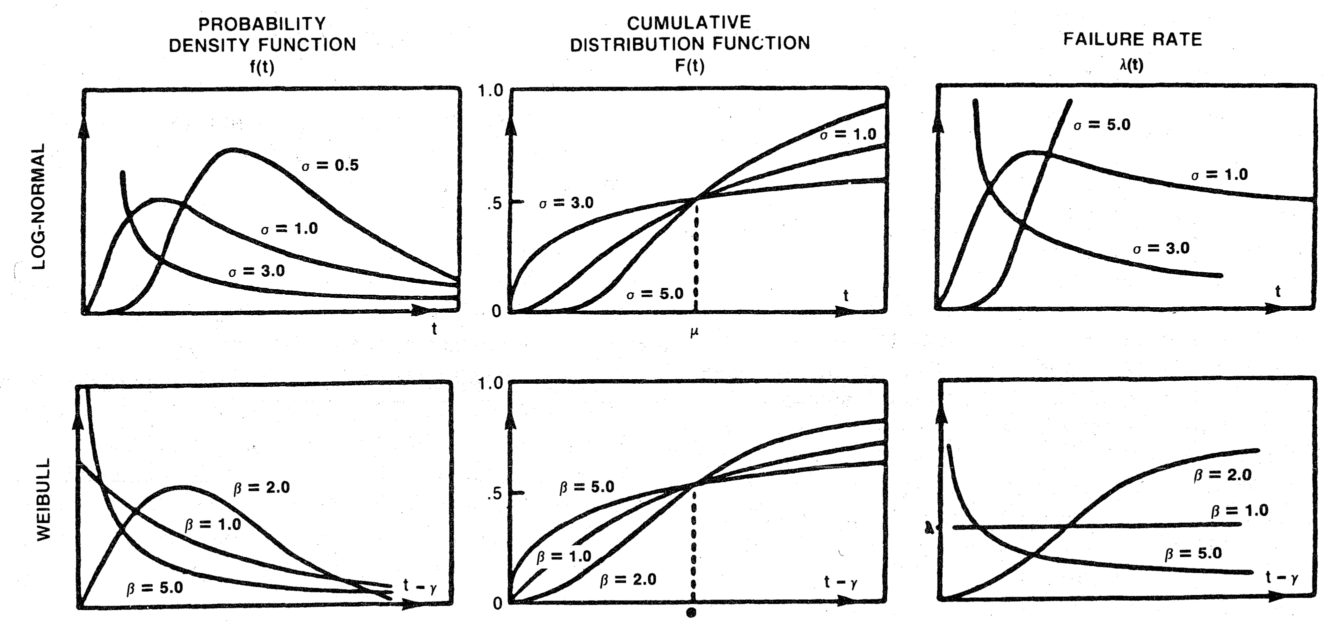


FIGURE 6. Visual Comparison of Log-Normal and Weibull Distributions

Three types of analysis are performed upon completion of every life test. A statistical analysis yields information on the test lot as a whole, such as the type of distribution and the standard deviation of the distribution, Figure 7 shows a typical device failure distribution plotted on a log-normal graph. Here the cumulative percentage of failures is plotted as a function of the time under test. This specific plot is from a life test on 0.5 watt FETs performed at a temperature of 225°C. An electrical analysis comparing device parameter measurements before and after the life test indicates how the device has changed and suggests specific physical degradation that may have occured during the life test. During a physical failure analysis, we actually research the device for the physical phenomenon that has led to failure.

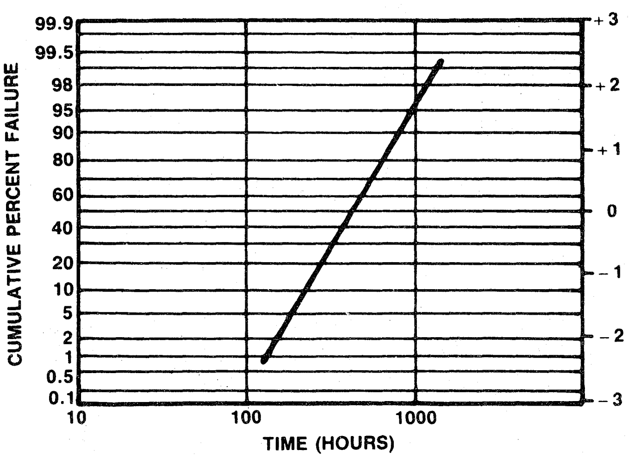


FIGURE 7. Typical FET Device Lifetime Distribution — Log-Normal Plot (HTRB Conditions During 225°C Test)

Once life tests at several different temperatures have been performed, the Arrhenius equation is evoked to extrapolate reliability results at high temperatures to predict device reliability at operating temperatures. The Arrenius equation, which relates reaction rate to temperature may be written as:

$$R = R_O \exp[-Ea/kT]$$

where: R_O = a constant
E_a = activation energy in eV
k = Boltzman's constant
T = absolute temperature (°K)

Since the time to failure is directly related to the reaction rate of the degradation mechanism, the mean time to failure (MTTF) is directly proporational to R. Using this proportionality, the Arrenhius equation shows that the natural log of MTTF is inversely proportional to the test temperature. Figure 8 shows a typical plot of the natural log of MTTF versus the inverse of the test temperature for several life tests on 0.5 watt FETs. The scale on the right side of the graph indicates an activiation energy of 1.35 eV for the failure mechanism observed. Life tests have begun and are continuing on SPST switches such as the MA4GM201 and the MA4GM211. These devices are representative of the entire family of more complex control devices, which are essentially various combinations of the design used for the SPST switch. These life tests are performed under two different bias conditions. High temperature reverse bias (HTRB) test utilize the schematic shown in Figure 9. For this test, all of the FETs in the switch are pinched off and no RF signal is applied. During a power life test, a 1 MHz signal is applied at the RF input of the device and DC control pins are biased as they would be under normal operating conditions. Figure 10 shows the schematic for this type of test.

An HRTB test performed using 20 devices at a temperature of 250°C for 592 hours resulted in no catastrophic failures. During this time, the average insertion loss degraded from 0.4 dB to 0.6 dB. Using a value for insertion loss of 0.75 dB as a failure criteria and extrapolating this degradation to that point yields an MTTF of approximately 1100 hours for a 250°C temperature (see Figure 11).

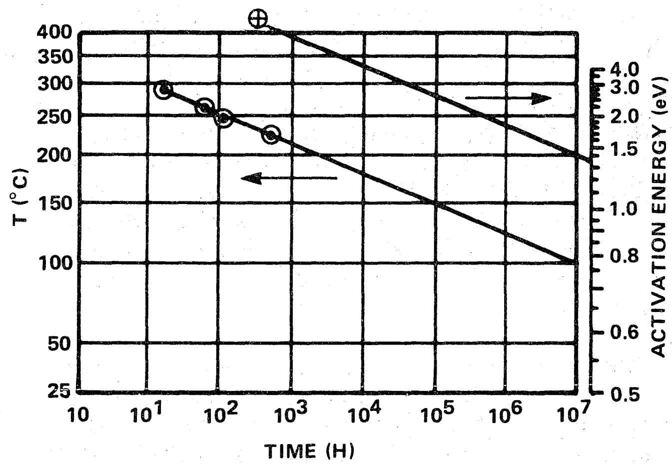


FIGURE 8. Typical Plot of Median Lifetime vs. 1/Temperature (Measured Data and Extrapolated MTTF)

A second HRTB test on 30 devices at a temperature of 225°C has been running for more than 1300 hours with no catastrophic failures.

Electrostatic Discharge

Most microwave FET MMIC broad band control circuits use FET transistors with small gate lengths. These are susceptible to electrostatic discharge (ESD) damage or burn out due to improper biasing. M/A-COM's FET MMIC control products are more resistant to ESD damage because the inputs are either (1) low impedance paths to ground through the source drain path of the FET; or (2) the gate control is protected by a five kilohm series resistor. Although these circuit characteristics result in improved resistance to ESD damage, the normal precautions when handling FET based microwave semiconductors should be taken.

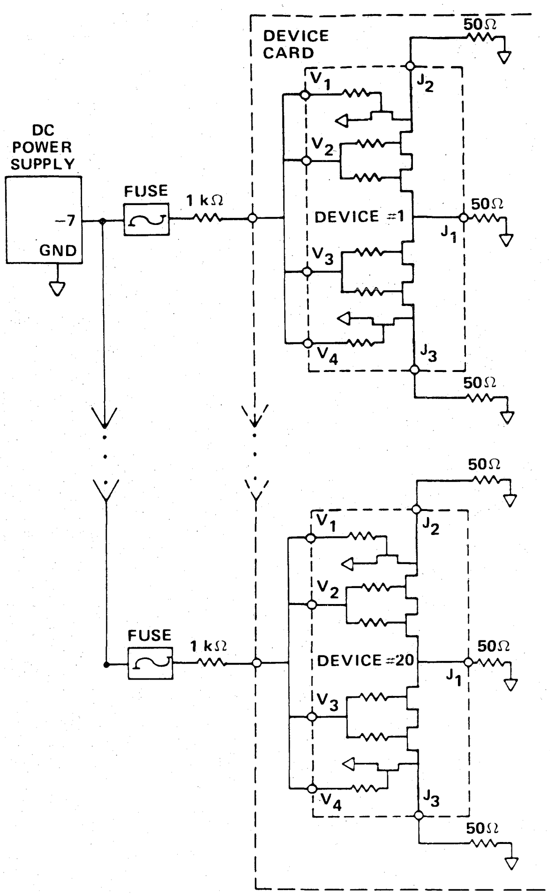


FIGURE 9. HTRB Burn-in Electrical Schematic for SPDT Switch

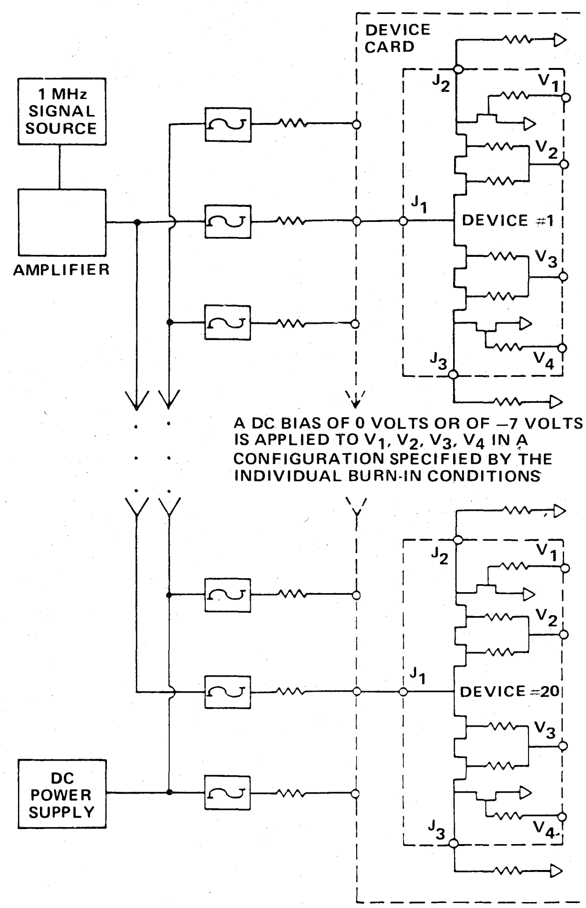


FIGURE 10. Power Burn-in Electrical Schematic for SPDT Switch

The FET MMIC control products should only be handled by personnel at ESD equipped workstations. This equipment should be grounded and include wrist straps and conductive mats. Care should be taken that the maximum specified electrical ratings are not exceeded.

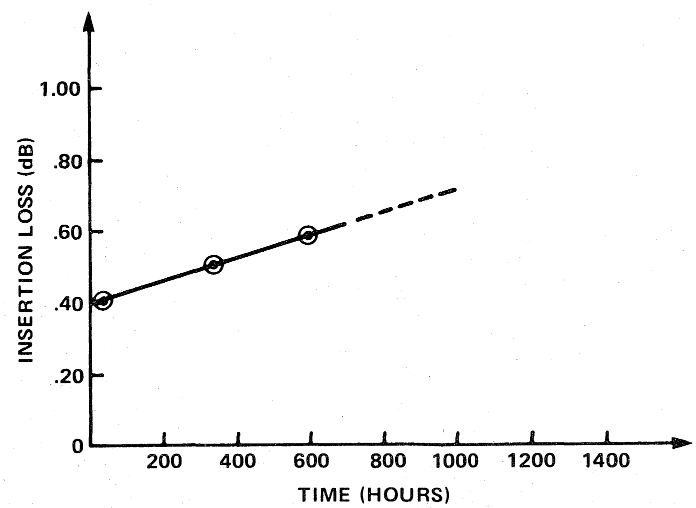


FIGURE 11. Evolution of Average Insertion Loss for Switches HTRB Stressed at T = 250°C

Chip Mounting and Handling of GaAs MMIC Chips

Chip Mounting and Handling of GaAs MMIC Chips

CHIP DIE DOWN BONDING TECHNIQUES (Die Attach)

The important considerations for die attach are to have low thermal resistance, strong mechanical bond over the desired temperature range, and no damage occurring to the chip during assembly. Two techniques are discussed for successfully attaching the die; namely, hot gas bonding using a solder and bonding utilizing a conductive epoxy.

HOT GAS BONDING OF CHIPS

The hot gas bonder is one of the most convenient ways to bond chips onto a metal ground plane or circuit. The circuit should be plated with a metal such as gold that enhances wetting and should be thoroughly cleaned. It is usually a good idea to remove all grease and dirt from the circuit parts by boiling them in reagent grade trichloroethylene and drying them with methanol. The cleaned parts should be stored in a dry atmosphere (relative humidity $\sim$ 25% maximum). After cleaning, they can be stored for a few days.

Either gold-tin eutectic, (80% Au, 20% Sn) with a melting point of approximately 280°C or tin-antimony eutectic, (97% Sn, 3% Sb) with a melting point of approximately 232°C solder preforms are very satisfactory with chips that have gold metallization. For higher temperature operation, a gold-germanium eutectic solder can also be used.

The temperature of the heating stage should be set such that the bonding area quickly rises to within 50-75°C of the melting point of the solder preform. A preform which is 0.001 inch thick is recommended.

Forming gas (80% N_2, 20% H_2) is effective as the gas jet. The gas temperature at the tip should be approximately 100°C above the solder melting point. The solder should melt in a few seconds after starting the bonding step.

It is a good practice to observe the wetting of the die through a microscrope (a 5-15X microscope will provide enough magnification). The solder should flow evenly forming a smooth shiny surface with no meniscus at the edge. It should cover at least 90-95% of the area.

DIE BONDING WITH CONDUCTIVE EPOXIES

Although some military and space systems do not allow the use of conductive epoxies for many circuits, very satisfactory die down results can be obtained this way. To obtain consistently strong bonds, the following precautions should be observed.

1. Cleanliness
   Everything should be clean and degreased. It is a good idea to clean the circuit in an alkaline solution to remove any traces of plating solutions and then degrease the circuit.
2. Shelf Life
   The conductive epoxy must be within the warranty shelf and/or pot life. Because manufacturers tend to be optimistic on pot life estimates, it is advisable to use one-half the given pot life. Thus, if the pot life is stated to be 2 days, it is much safer to use new epoxy every day.
3. Curing
   The epoxy must be cured in air or in an oxidizing atmosphere. This reaction requires oxygen. The epoxy curing oven should be kept clean and not used for other purposes. A good air flow must be provided to carry off any carrier fumes. The epoxy will not cure well if there are other solvent fumes in the atmosphere.
4. Carrier Fluid
   The carrier fluid must not be allowed to get on top of the chip. Not only will it make the chip unbondable, but it will be impossible to detect under a normal bonding microscope. If a vacuum tip is used to put the chip in place, remove the vacuum when the chip is 10-13 mils from the epoxy. Static charge will hold the chip to the tip. If the vacuum tip touches the epoxy, it will become coated with the epoxy carrier and will then coat the next chip with the carrier material. The same problem can occur with the use of tweezers. If they touch the epoxy, they should be cleaned before picking up another chip.
5. Reliability Problems
   Silver conductive epoxies should not be used where they will come into contact with lead-tin solders or high tin solders. There can be an anodic reaction, which can cause failure of the bond.
6. Bond Strength
   The shear bond strength of a good epoxy joint can approach that of solder, 50-100 kgms/cm^2. The thickness of the conductive epoxy should be kept to 0.001" or less.

   Weak bonds are usually caused by the use of old epoxy, bonds that are too thick, or lack of cleanliness.
7. Thermal Resistance
   The thermal resistance of silver conductive epoxy bonds are a little higher than those of gold-tin eutectic solder. They can be satisfactory for all but the highest power applications if kept thin.

WIRE BONDING

It is very difficult to give definite parameters for the force (pressure), time and temperature for an optimum bonding schedule. Different wire, bonding surfaces or semiconductor die characteristics require different bonding conditions. In general, the bonding parameters should be adjusted to maximize reproduceability at a high bond pull strength. Top bonds to the contact pads are best made using a thermal compression wedge bonder with a heated stage and tip. A stage temperature of 240°C and a tip temperature of 120°C is recommended. Typical bonding force should be in the region of 30 grams but less than 40 grams. It is recommended that dead soft gold be used, wire or ribbon, depending on the size of the bonding pads and the parasitic inductance or capacitance requirements of the circuit.

Most problems are caused by improper bonding machine and tool settings and improper maintenance and lack of cleanliness. It is important to control the movement of the part being bonded, maintaining proper alignment of tools and work as well as proper tool height, angle and tool condition.

In general, the die will crack if too hard a wire, excessive pressure or ultrasonics are used. Too small a pressure results in small, weak bonds.

A good bond should be stronger than the wire and 2 to 3 times the wire diameter. The deformed width of the wire should be about 1.3 to 1.8 times the wire thickness. If the deformed width is too small, the bond will tend to lift off. If it is too large, (greater than 1.8 times the wire thickness), the wire tends to break.

When using a bond puller during sampling destruct testing, the wire or ribbon should break before the bond breaks. Acceptable top bonds exhibit: no nicks or tears on the wire; no metallization lifting off die or fracture in bond; slight amount of slack in wire to guard against cold temperature contraction.

Bonding equipment should be regularly checked for sources of surge voltage and be properly ground at all times. All test handling equipment should be grounded to minimize the possibilities for static discharge.

MMIC CHIP HANDLING
GaAs MMIC chips are substantially larger in dimension than individual semiconductor devices varying in size from 40 mils X 40 mils to over 100 mils square. Therefore, even though the thickness for control devices is 10 mils, cracking of the somewhat brittle GaAs die can occur if not carefully handled. M/A-COM recommends the use of a vacuum pencil with plastic-tip for any manual handling of chips. Chips usually require specialized equipment for die attachment and for wire and ribbon bonding to top of the chip. These operations require a clean work area and equipment such as vacuum pick and place, hot gas bonders and wedge bonders as previously discussed.

The MMICs are subject to damage caused by switching transients, inductive pickup and static discharge, and so must be handled with care.

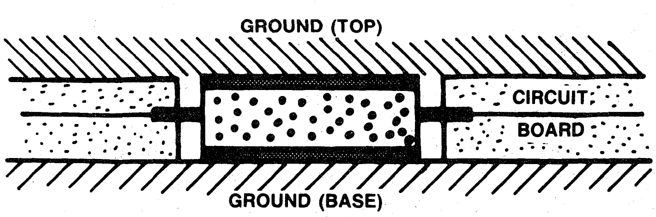
PACKAGE MOUNTING RECOMMENDATION FOR GaAs MMIC CONTROL DEVICES

INTRODUCTION
When using packaged control devices, it is extremely important to ensure that proper shielding and grounding is applied in order to maintain the inherent isolation characteristics of the MMIC device. The following package mounting techniques are suggestions for accomplishing the desired results.

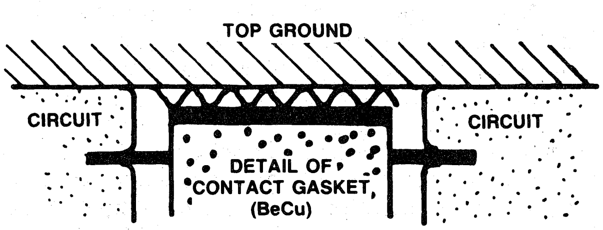
FLAT PACK CONFIGURATIONS 2000 SERIES
The 2000 series and the flat packs are primarily designed for microstrip or stripline interfaces (see Figure 1). In addition, by providing a surface ground it is possible to achieve a totally compatible surface mount configuration. In the latter, careful grounding is crucial. (see Figure 2 for a recommended detail).

TO-5 PACKAGE
The TO-5 represents a versatile low cost package. If optimum performance is desired, then it is essential to maintain good shielding and grounding. This is especially true at frequencies above 250 megahertz. See Figure 3 for suggested mounting configurations.

DIP STYLE PACKAGE
The DIP packages require mounting precautions similar to those for the TO-5 package. Because of the close proximity of pin outs, it is critical to shield and ground the package adequately. As a secondary precaution in critical high isolation applications, measurements should be performed on the circuit board prior to package installation to ensure that adequate isolation exists between adjacent transmission lines and/or the DIP socket interface. Figure 4 shows suggested mounting configurations.



SOLDER OR CONDUCTIVE EPOXY TO BASE, USE SPRING GASKET ON TOP TO INSURE ADEQUATE CONTACT (SEE DETAIL).



(b) STRIPLINE APPLICATION

FIGURE 1. Microstrip and Stripline Mounting Recommendations

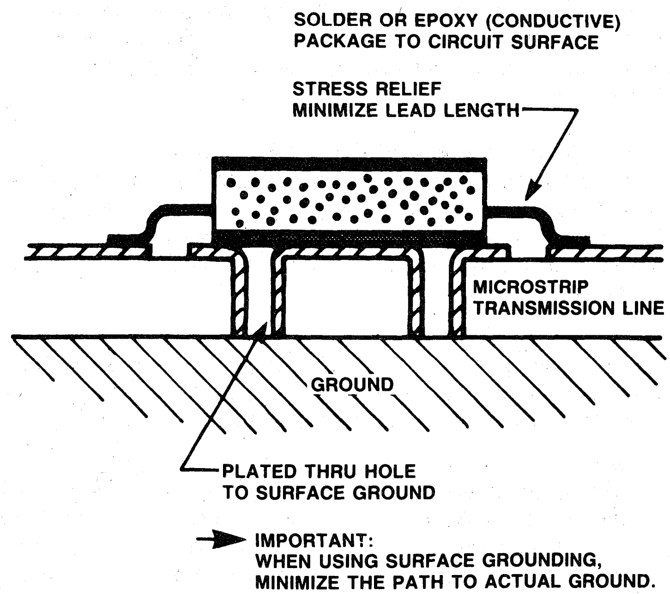


FIGURE 2. Surface Mounting 2000 or Flat Pack Packages

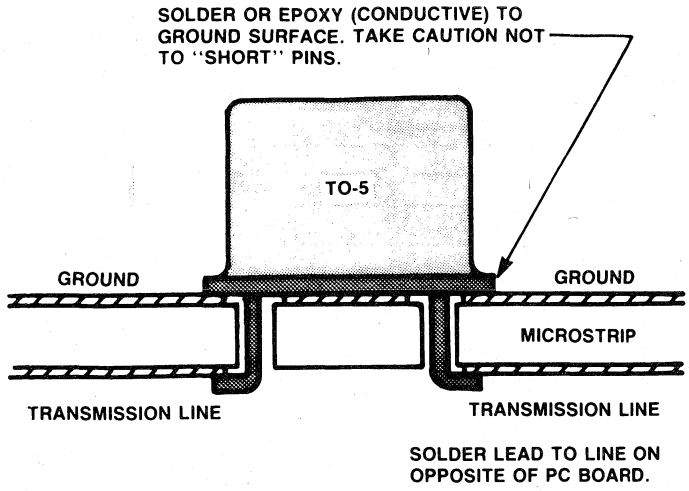
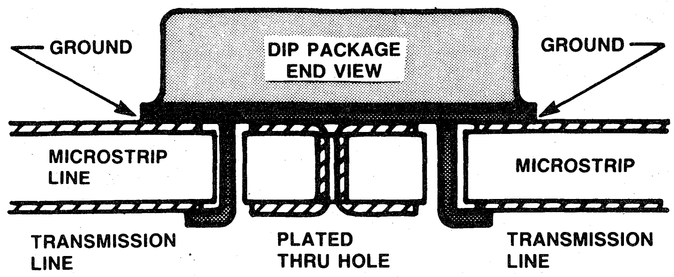


FIGURE 3. TO-5 Mounting Recommendation



DIRECTIONS

1. SOLDER OR CONDUCTIVE EPOXY PACKAGE TO GROUND SIDE OF PC BOARD.
2. SOLDER OR EPOXY RF AND CONTROL PINS TO OPPOSITE SIDE.
3. WHERE POSSIBLE, USE PLATED THRU HOLES BETWEEN TRANSMISSION AND CONTROL LINE FOR ADDITIONAL SHIELDING. THIS WILL IMPROVE ISOLATION.

FIGURE 4. DIP Package Mounting Recommendation

Tuning Varactors

(Continued on next page)

TUNING VARACTORS (Cont'd)

TABLE 1

CHOICE OF TUNING VARACTOR BY TYPE OF VOLTAGE CONTROLLED OSCILLATOR

	Silicon Abrupt	Silicon Hyperabrupt	GaAS Abrupt	GaAS Hyperabrupt
(1) ECM VCO with Post Tuning Drift Requirements				
(A) to 10 GHz	Good	Best	Fair	Fair
(B) above 12 GHz	Fair	Good	Good	Best
(2) Telecommunication Phase Locked Oscillator	Fair	Good	Good	Best
(3) VCO's for Tuned Synthesizers				
(A) Instruments & Telecommunication	Best	Good	****	****
(B) Radar Synthesizers	Good	****	Best	Good
(4) Radar Local Oscillators				
(A) Frequency Agile Radar (using Synthesizer)	Good	Good	Good	Best
(B) Frequency Agile Radar (using Tuned Exciter)	Good	Best	Good	Very Good
(C) Marine/Weather Radar Local Oscillator	Good	Fair-Good	Best	Good
(5) Telecommunications Transmitter VCO's	Gcod	Good	Good	Best
(6) Missile Seeker	Good	Fair	Good	Best
(7) Doppler Radar/Motion Detector VCO	Good	Good	Good	Best
(8) Instrument VCO	Good	Best	****	****
(9) Police Radar Detectors				
(A) 11.5 GHz VCO	****	****	Best	Good
(B)1 GHz VCO	Good	Good	****	Best

**** Denotes not normal usage for this type of varactor

The charts should be used in this order:

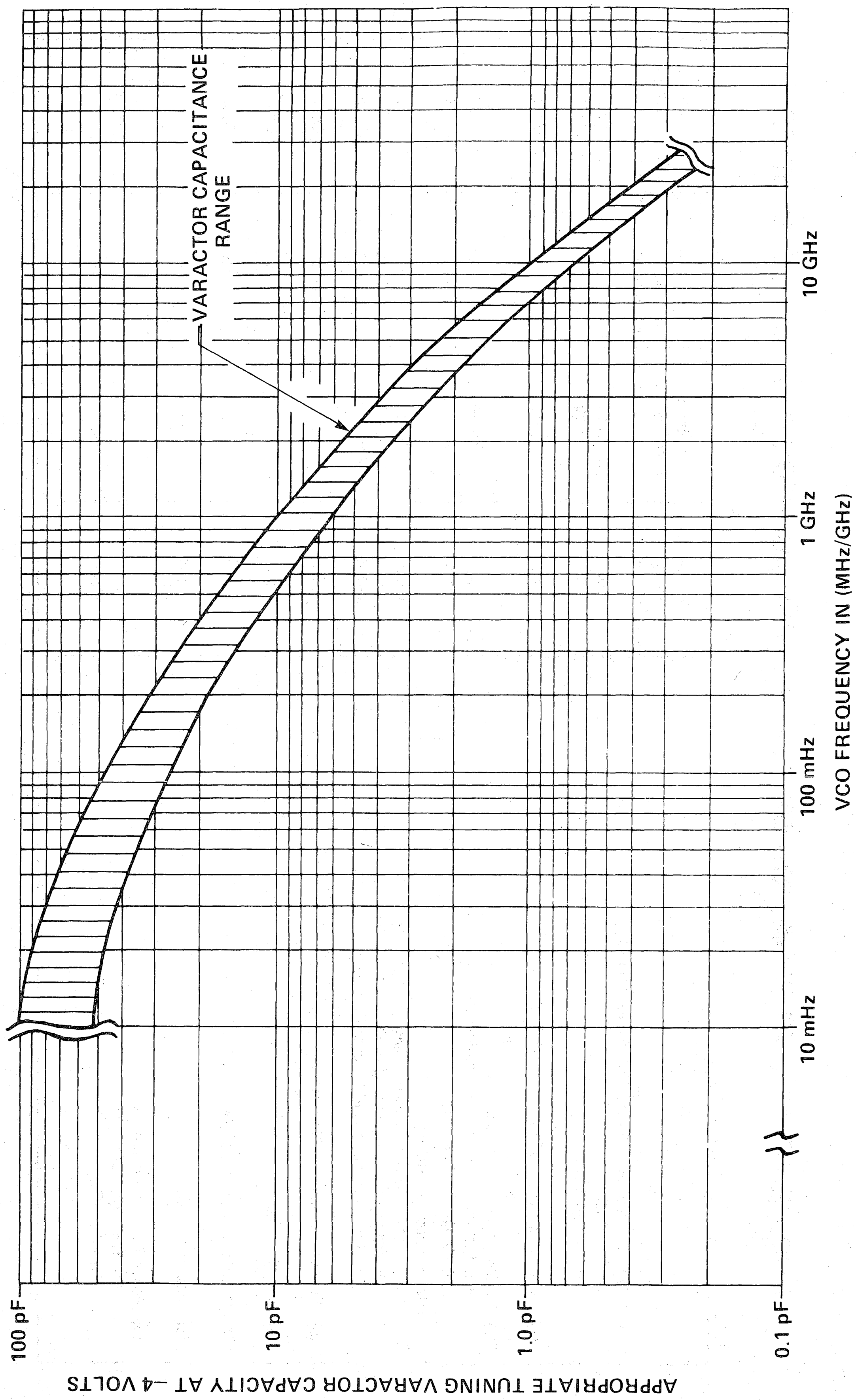
Table 1: From the type of VCO select a type of varactor, i.e., Silicon Hyperabrupt or GaAs Varactor.

Graph 1: From the frequency, select the approximate capacitance.

Next, select the proper diode from the Selection Guide, and from the data sheet indicated, give package, check Q, etc.

GRAPH 1

SUGGESTED APPROXIMATE VARACTOR CAPACITANCE VALUES AT −4 VOLTS FOR VCOs WITH LOW POWER



GaAs and SILICON ABRUPT JUNCTION TUNING VARACTOR SELECTION GUIDE IN MICROWAVE PACKAGES, AXIAL LEAD PACKAGES & CHIPS

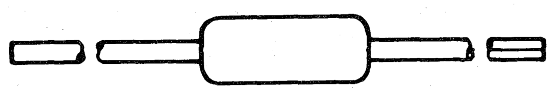
JUNCTION CAPACITANCE	GaAs ABRUPT VARACTORS CERAMIC PACKAGES & CHIPS		SILICON ABRUPT TUNING VARACTORS CERAMIC PACKAGES & CHIPS				SI ABRUPT TUNING VARACTORS IN AXIAL LEAD GLASS PACKAGES		
@ −4 VOLTS pF	Bv = 30V	Bv = 45V	Bv = 30V	Bv = 45V	Bv = 60V	Bv = 90V	Bv = 30V	Bv = 45V	Bv = 60V
0.3	46600	—	—	—	—	—	—	—	—
0.4	46601	—	—	—	—	—	—	—	—
0.5	46602	46610	45225	45245	—	—	—	—	—
0.6	46603	46611	45226	45246	45260	—	—	—	—
0.8	46604	46612	45227	45247	45621	—	—	—	—
1.0	46605	46613	45228	45248	45262	45290	—	—	—
1.2	46606	46614	45229	45249	45263	45291	—	—	—
1.5	46607	46615	45230	45250	45264	45292	—	—	—
1.8	46608	46616	45231	45251	45265	45293	—	—	—
2.2	46609	46617	45232	45252	45266	45294	—	—	—
2.7	—	46618	45233	45253	45267	45295	—	—	—
3.3	—	46619	45234	45254	45268	45296	—	—	—
3.9	—	—	45235	45255	45269	45297	—	—	—
4.7	—	—	45236	45256	45270	45298	45330	45345	45360
5.6	—	—	45237	45257	45271	45299	45331	45346	45361
6.8	—	—	45238	45258	45272	—	45332	45347	45362
8.2	—	—	45239	45259	45273	—	45333	45348	45363
10	—	—	45240	—	45274	—	45334	45349	45364
12	—	—	45241	—	45275	—	45335	45350	45365
15	—	—	45242	—	45276	—	45336	45351	45366
18	—	—	—	—	45277	—	45337	45352	45367
22	—	—	—	—	45278	—	45338	45353	45368
27	—	—	—	—	45279	—	45339	45354	45369
33	—	—	—	—	45280	—	45340	45355	45370
39	—	—	—	—	—	—	45341	45356	45371
47	—	—	—	—	—	—	45342	45357	45372
56	—	—	—	—	—	—	45343	45358	—
	See Bulletin 4601D For Detail Specs. of GaAs Abrupt Tuning Varactors		See Bulletin 4610 For Detail Specs. of Microwave Packages For Silicon				See Bulletin 4602D For Detail Specs of SI Axial Lead Tuning Varactors		

HYPERABRUPT TUNING VARACTORS IN CERAMIC PACKAGES OR CHIP DIODES SELECTION GUIDE

NOMINAL JUNCTION CAPACITANCE @ −4 VOLTS pF	SILICON HYPERABRUPT	GaAs HYPERABRUPT GAMMA = 1.0	GaAs HYPERABRUPT GAMMA = 1.25	GaAs BEAM LEAD DIODE	
				GAMMA = 1.0	GAMMA = 1.25
0.5	—	46450	46470	46580	46585
0.7	—	46451	46471	46581	46586
0.8	4ST551	—	—	—	—
1.0	4ST552	46452	46472	46582	46587
1.2	4ST553	46453	46473	—	—
1.5	4ST554	46454	46474	46583	46588
1.8	4ST555	46455	46475	—	—
2.0	—	56456	46476	46584	46589
2.2	4ST556	46457	46477	—	—
2.7	4ST557	46458	46478	—	—
3.3	4ST558	46459	46479	—	—
3.9	4ST559	46460	46489	—	—
4.7	4ST560	46461	46481	—	—
5.6	4ST561	46462	46482	—	—
6.8	4ST562	46463	46483	—	—
8.2	4ST563	46464	46484	—	—
10	—	46465	46485	—	—
	See Bulletin No. 4611 Specs	See Bulletin No. 4609 Specs	See Bulletin No. 4609 Specs	See Bulletin No. 4608A Specs	See Bulletin No. 4608A Specs
UHF - VHF — AXIAL LEAD & CHIP HYPERABRUPT TUNING VARACTORS					
10	4ST533	—	—	—	—
20	4ST520	—	—	—	—
22	4ST534	—	—	—	—
50	4ST522	—	—	—	—
110	4ST523	—	—	—	—
155	4ST524	—	—	—	—
	See Bulletin No. 4406				

MA4ST520/MA4ST530 Series

UHF, VHF Silicon Hyperabrupt Tuning Varactors



CASE STYLE
4

Description

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

Standard product (MA4ST520 Series) is available in 4 ranges from 20- 155 pF (nominal) (C_T 4V), in a variety of capacitance windows. The diodes are offered in glass axial packages and as unpackaged chips.

Standard product (MA4ST530 Series) is available in 2 ranges from 11.5 - 28.0 pF (nominal) (C_T 3V), in a variety of capacitance windows. The diodes are offered in glass axial packages and as unpackaged chips.

Features

- **A SUPERIOR ION IMPLANTATION PROCESS RESULTS IN MORE REPEATABLE C-V CHARACTERISTICS WITHIN SPECIFIED CAPACITANCE TOLERANCES.**
- **THERMALLY GROWN SILICON OXIDE PASSIVATION FOR LOW LEAKAGE AND RELIABLE LONG-TERM OPERATION.**
- **HIGH Q**
- **USABLE CAPACITANCE CHANGE RATIOS AS HIGH AS 8:1. (MA4ST520 Series)**
- **USABLE CAPACITANCE CHANGE RATIOS AS HIGH AS 7:1. (MA4ST530 Series)**

Applications

The MA4ST520 series was developed for VCO tuning in the VHF through UHF ranges. Ideal applications are high volume fixed and frequency hopping military radios where low cost and lot-to-lot C-V repeatability are critical.

The MA4ST530 series hyperabrupt tuning varactors are particularly appropriate for usage in wide-band low noise oscillators such as occur in signal generators and frequency measurement instrument VCOs within the 100 MHz to 2 GHz range.

MAXIMUM RATINGS

Temperature Range	
Operating	–65°C to +125°C
Storage	–65°C to +150°C
Power Dissipation (Max.)	(derate linearly to zero at 150°C)
Case Style 4	250 mW
Max. Reverse Voltage	22 Volts
Forward Current	50 mAdc

Specifications @ T_A = 25°C

Min. Reverse Breakdown Voltage V_{BR} 22V @ 10μA. **Max. Reverse Leakage Current I_R @ 18V = 100n/Amps.**

Symbol	C_T				T_R		Q		
Parameter	Diode Capacitance				Tuning Ratio		Figure of Merit	Package Style	Chip Style
Unit	pF								
Test Conditions	F = 1 MHz Vr = 2.5 Vdc	Vr = 4.0 Vdc	Vr = 8.0 Vdc	Vr = 20 Vdc	F = 1 MHz C (4V)/C (8V)	C (4V)/C (20V)	F = 50 MHz Vr = 4 Vdc		
Part Number	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min.		
MA4ST520	25/29	18/22					150	4	132
MA4ST520A		18/22	7.5/10.5		1.7/2.9		300	4	132
MA4ST520B		18/22	7.5/10.5	3.1/3.9		4.6/7.1	300	4	132
MA4ST520C		19/21	7.8/9.2		2.0/2.7		300	4	132
MA4ST520D		19/21	7.8/9.2	3.1/3.9	2.0/2.7	4.8/6.8	300	4	132
MA4ST522	62/72	45/55					100	4	132
MA4ST522A		45/55	18/25		1.8/3.1		200	4	132
MA4ST522B		45/55	18/25	7.3/9.2		4.9/7.5	200	4	132
MA4ST522C		47.5/52.5	18.4/21.6		2.2/2.8		200	4	132
MA4ST522D		47.5/52.5	18.4/21.6	7.3/9.2	2.2/2.8	5.2/6.9	200	4	132
MA4ST523	135/160	100/120					65	4	200
MA4ST523A		100/120	39/55		1.8/3.1		125	4	200
MA4ST523B		100/120	39/55	16/20		5.0/7.5	125	4	200
MA4ST523C		104.5/115.5	41.4/48.6		2.15/2.8		125	4	200
MA4ST523D		104.5/115.5	41.4/48.6	16/20	2.15/2.8	5.2/7.3	125	4	200
MA4ST524	195/225	140/170					50	4	200
MA4ST524A		140/170	55/80		1.7/3.1		100	4	200
MA4ST524B		140/170	55/80	22.5/28		5.0/7.6	100	4	200
MA4ST524C		147/163	59.8/70.2		2.1/2.8		100	4	200
MA4ST524D		147/163	59.8/70.2	22.5/28	2.1/2.8	5.2/7.2	100	4	200

Specifying Part Numbers

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

Note

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

MAXIMUM RATINGS

Temperature Range	
Operating	−65°C to +125°C
Storage	−65°C to +150°C
Power Dissipation (Max.)	(derate linearly to zero at 150°C)
Case Style 4	250 mW
Forward Current	50 mAdc
Reverse Voltage	Same as V_B

Specifications @ T_A = 25°C

Symbol	V_B	C_T				T_R		Q
Parameter	Reverse Breakdown Voltage	Diode Capacitance				Tuning Ratio		Figure of Merit
Unit	Vdc	pF						
Test Conditions	@ 10 μAdc	F = 1 MHz Vr = 1.25 Vdc	Vr = 3.0 Vdc	Vr = 8.0 Vdc	Vr = 20 Vdc	F = 1 MHz C (3V)/C (8V)	C (3V)/C (20V)	F = 50 MHz Vr = 3 Vdc
Model Number	Min.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min./Max.	Min.
MA4ST533	15	14/17.5	10.5/12.5					200
MA4ST533A	15		10.5/12.5	4.3/5.7		1.8/2.9		300
MA4ST533B	22		10.5/12.5	4.3/5.7	2.0/2.4		4.4/6.3	300
MA4ST533C	22		10.5/12.5	4.3/5.7	2.0/2.3		4.6/6.3	450
MA4ST533D	15		10.9/12.5	4.6/5.4		2.0/2.6		300
MA4ST533E	22		10.9/12.1	4.6/5.4	2.0/2.4	2.0/2.6	4.5/6.1	300
MA4ST534	15	34/42	25/31					150
MA4ST534A	15		25/31	10/13.5		1.8/3.1		200
MA4ST534B	22		25/31	10/13.5	4.5/5.3		4.7/6.9	200
MA4ST534C	22		25/31	10/13.5	4.5/5.1		4.9/6.9	300
MA4ST534D	15		26.5/29.5	11/13		2.0/2.7		200
MA4ST534E	22		26.5/29.5	11/13	4.5/5.3	2.0/2.7	5.0/6.6	200

NOTES

REVERSE LEAKAGE CURRENT
For all model numbers listed above, the Reverse Leakage Current at 80% V_B Max. is 100 nAmps.

CASE AND CHIP STYLE
All model numbers are available in Axial Lead Case Style 4 and Chip Style 132.

Specifying Model Numbers

When ordering diodes, use the appropriate M/A-COM model number and add case style suffix where appropriate. (For example, MA4ST533B is a 10.5-12.5 pF (@ 3V) varactor in the standard glass package, case style 4. The MA4ST533B-132 is the unpackaged chip version.

Typical Performance Curves — MA4ST520

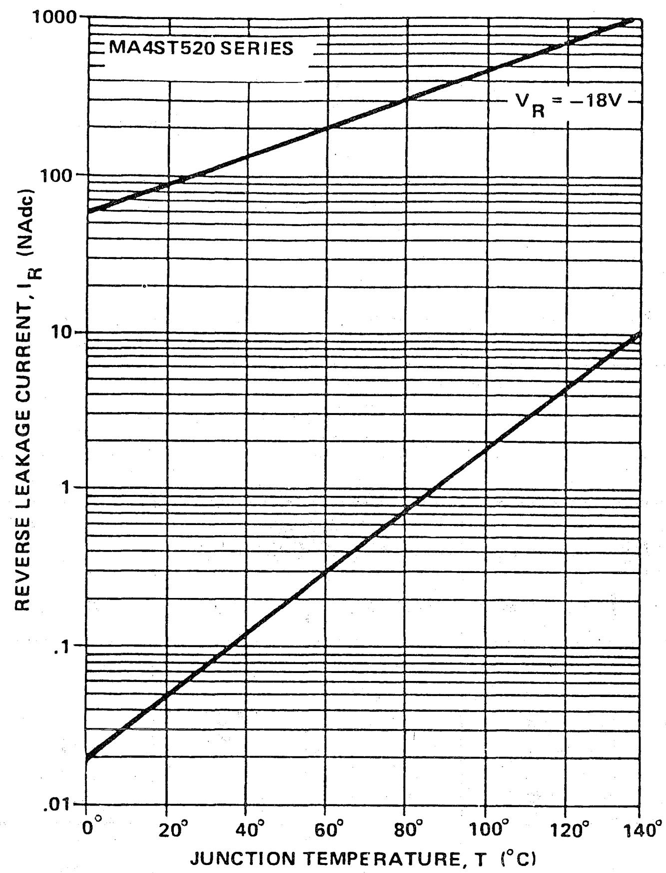


FIGURE 1. Reverse Leakage Current @ −18V vs. Junction Temperature

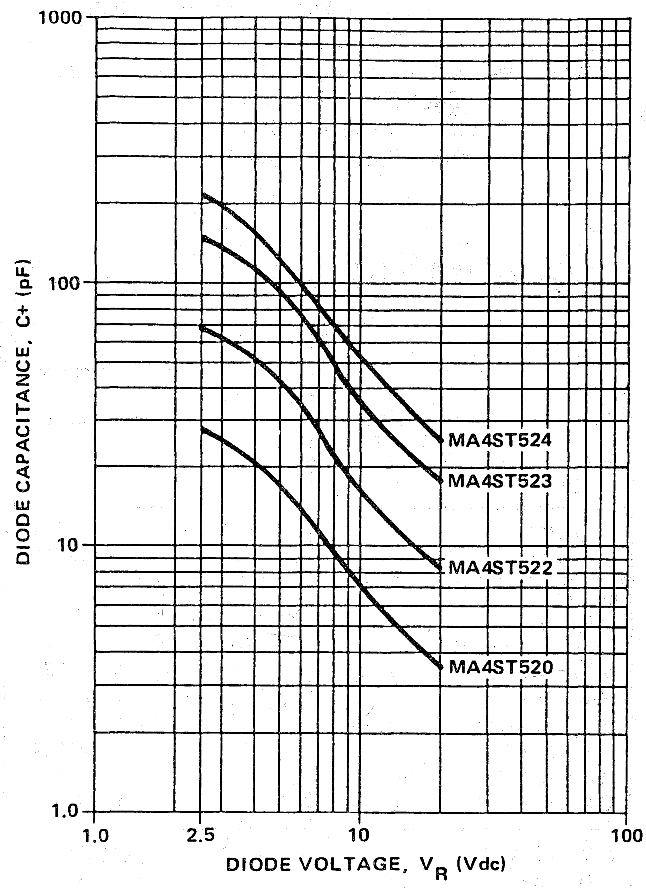


FIGURE 2. Nominal Capacitance vs. Tuning Voltage $T_A = 25°C$ FOR MA4ST520 Series

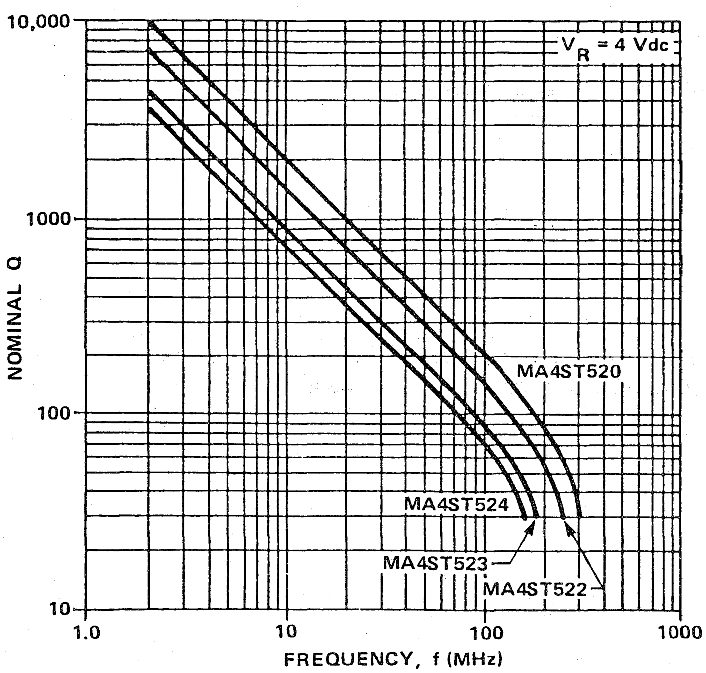


FIGURE 3. Nominal Q vs. Frequency for MA4ST520 Series

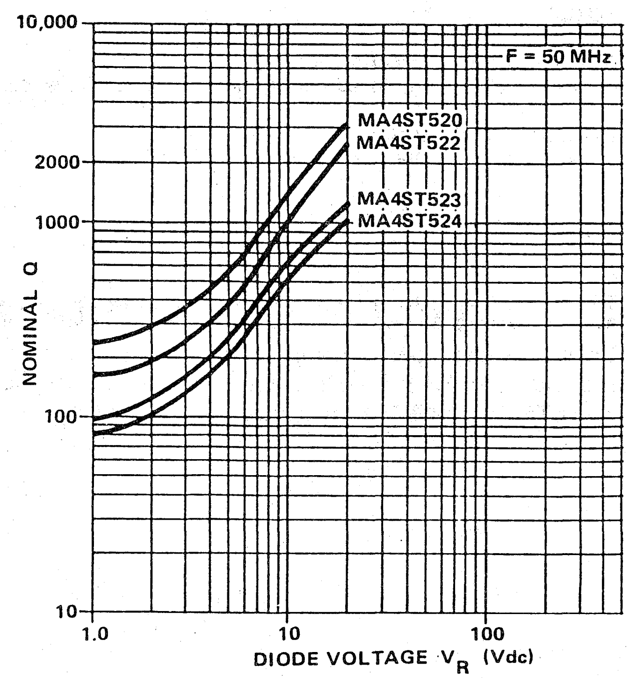


FIGURE 4. Nominal Q vs. Tuning Voltage for MA4ST520 Series

Typical Performance Curves — MA4ST520 (Cont'd)

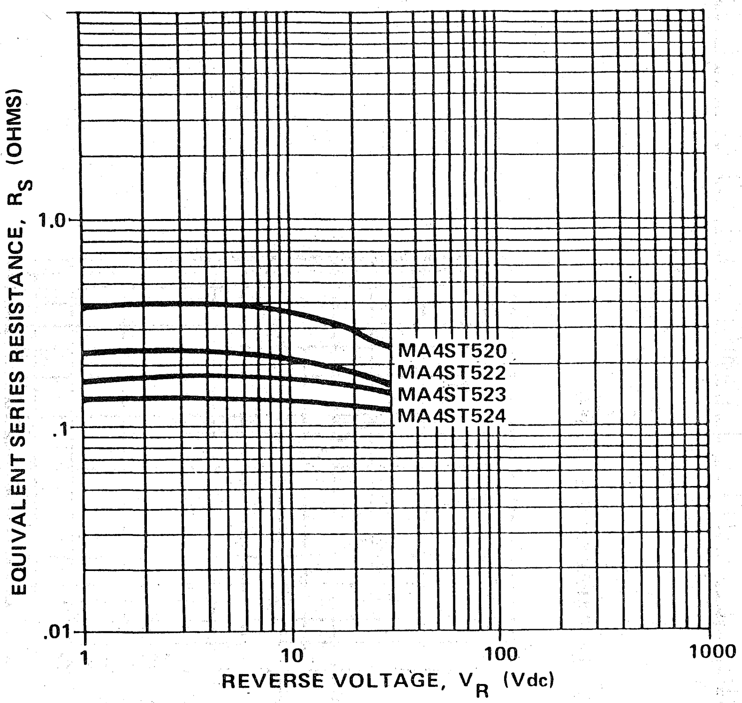


FIGURE 5. Equivalent Series Resistance vs. Varactor Voltage ($T_A = 25°C$) for MA4ST520 Series

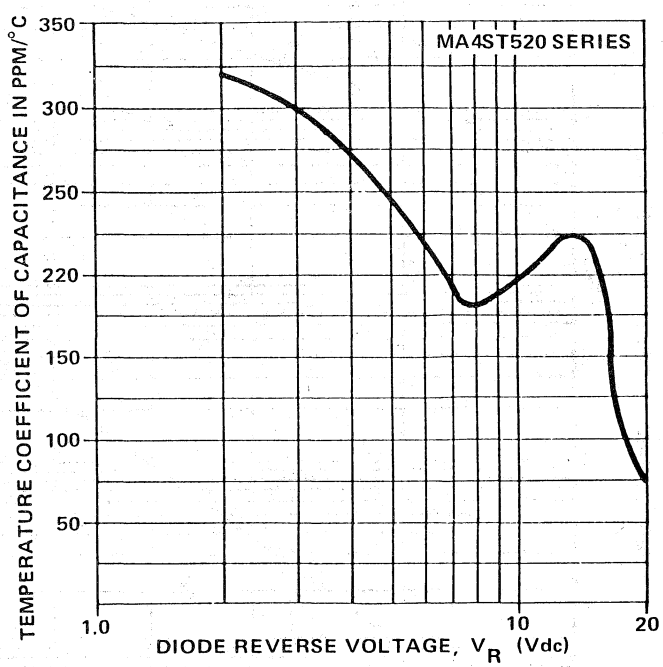


FIGURE 6. Temperature Coefficient of Capacitance in PPM/°C vs. Tuning Voltage for MA4ST520 Series

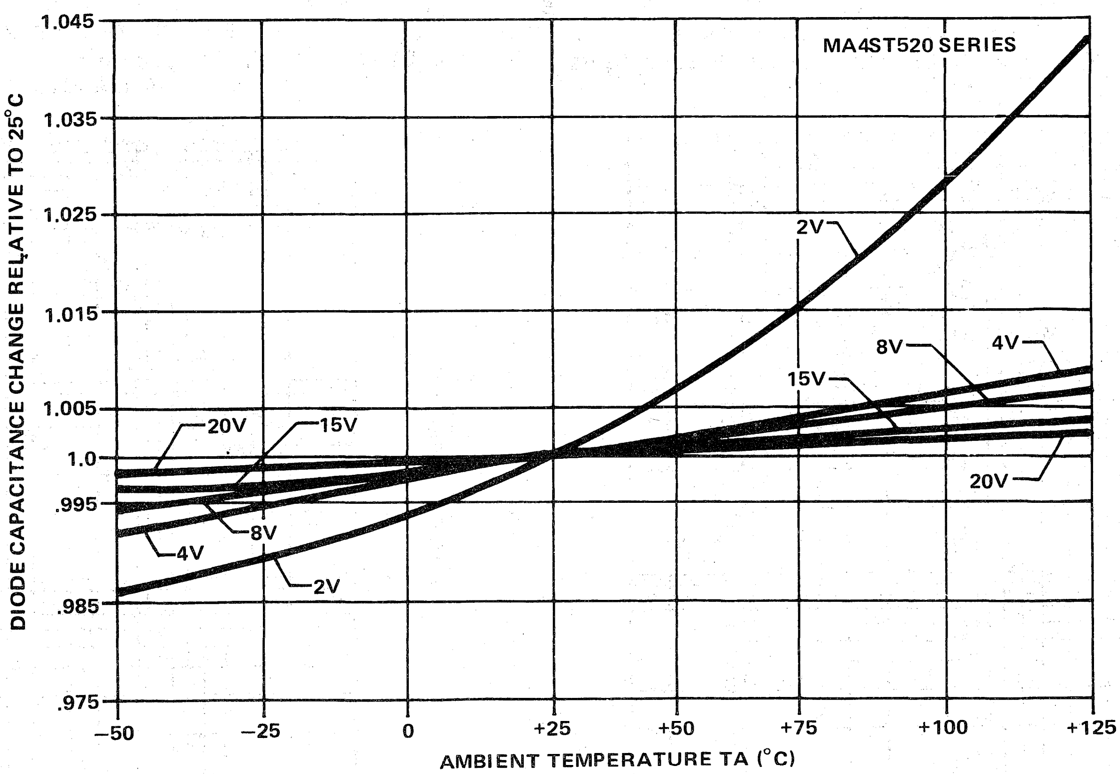


FIGURE 7. Capacitance Change vs. Ambient Temperature for MA4ST520 Series

Typical Performance Curves — MA4ST530

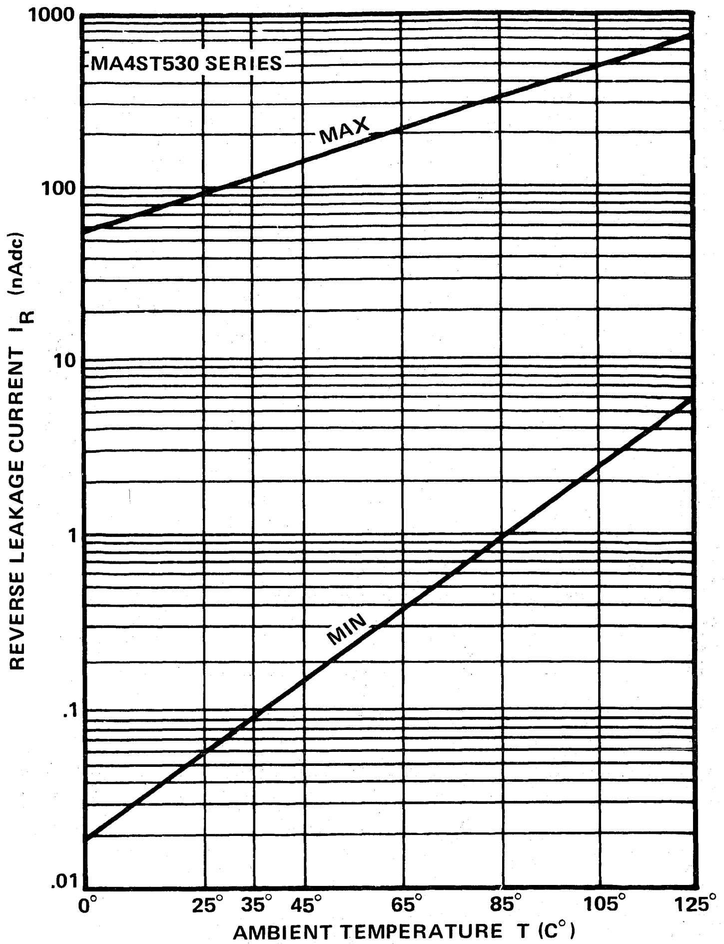


FIGURE 8. Reverse Leakage Current @ 80% V_B vs. Ambient Temperature

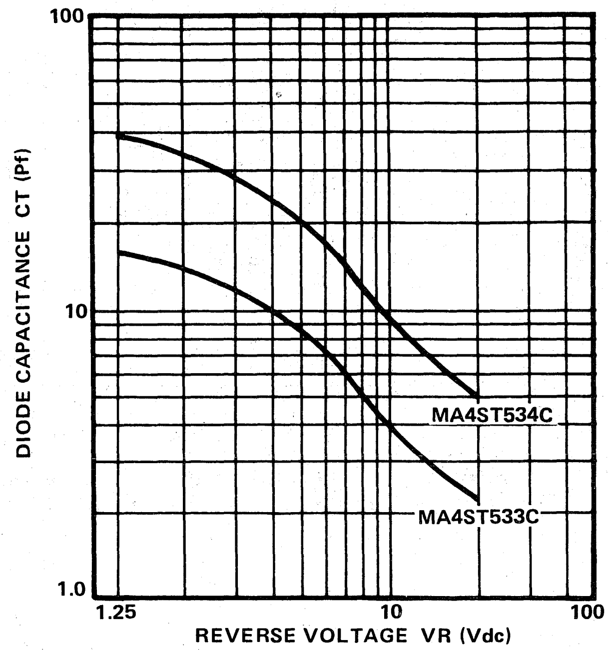


FIGURE 9. Nominal Capacitance vs. Tuning Voltage T_A = 25°C for MA4ST530 Series

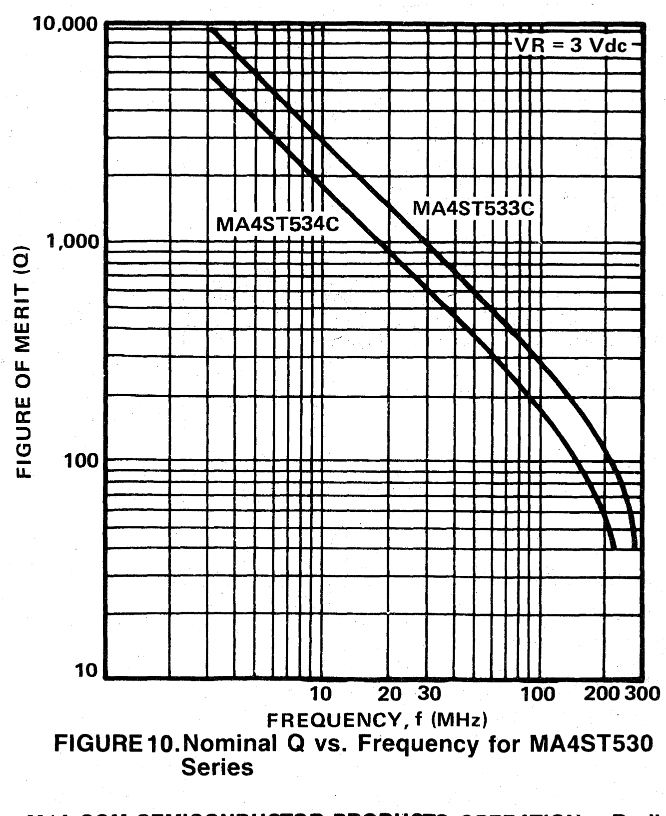


FIGURE 10. Nominal Q vs. Frequency for MA4ST530 Series

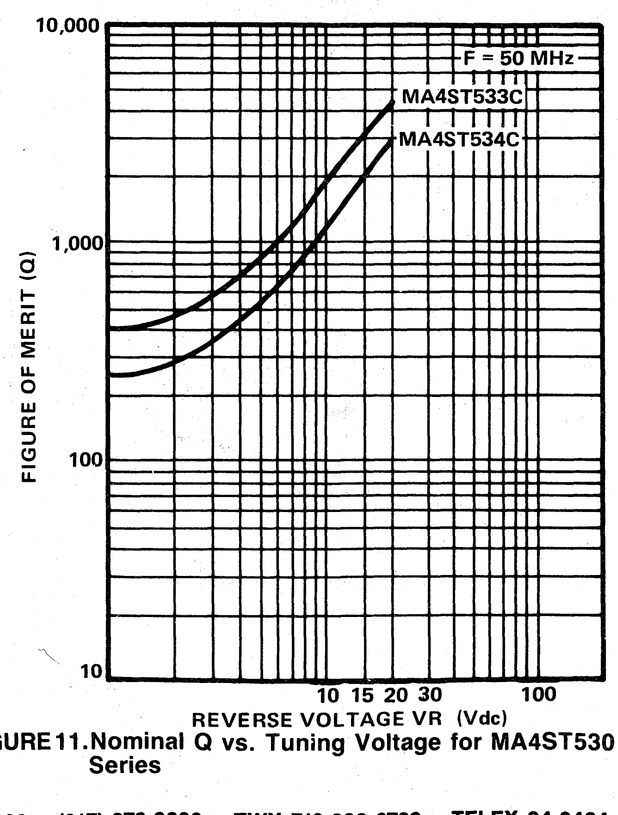


FIGURE 11. Nominal Q vs. Tuning Voltage for MA4ST530 Series

Typical Performance Curves — MA4ST530 (Cont'd)

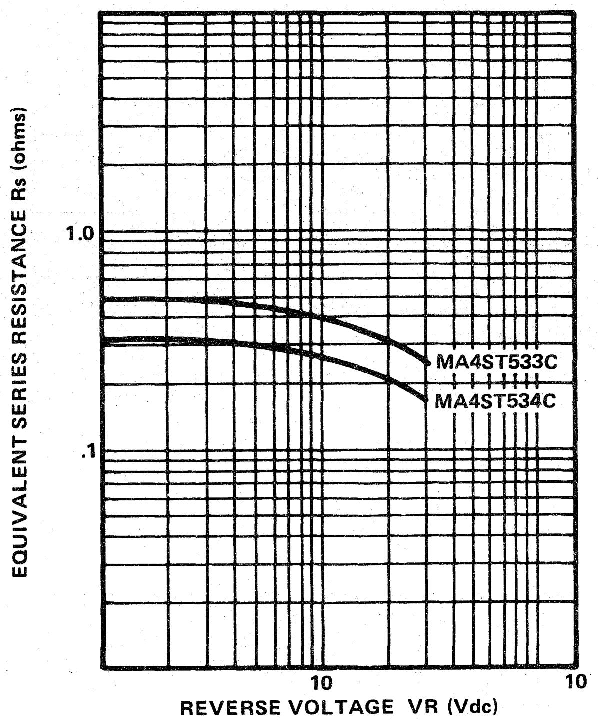


FIGURE 12. Equivalent Series Resistance vs. Varactor Voltage (T_A = 25°C) for MA4ST530 Series

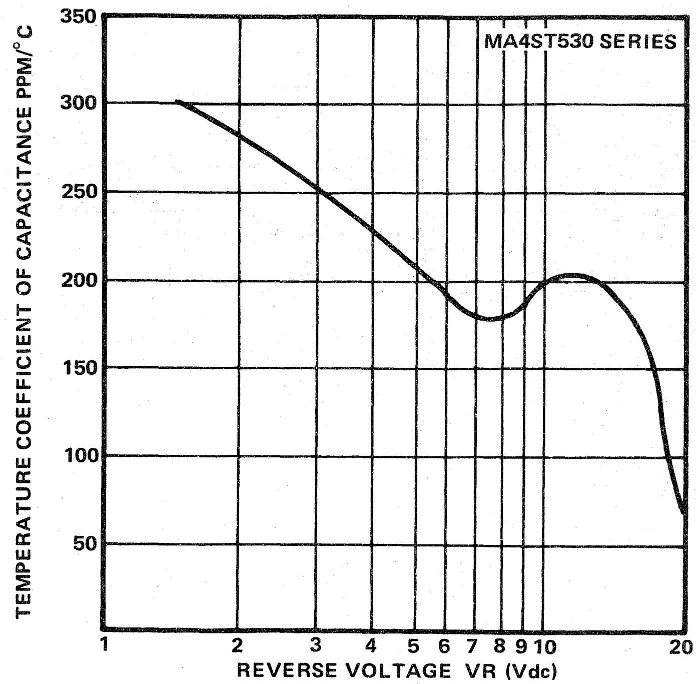


FIGURE 13. Temperature Coefficient of Capacitance in PPM/°C vs. Tuning Voltage for MA4ST530 Series

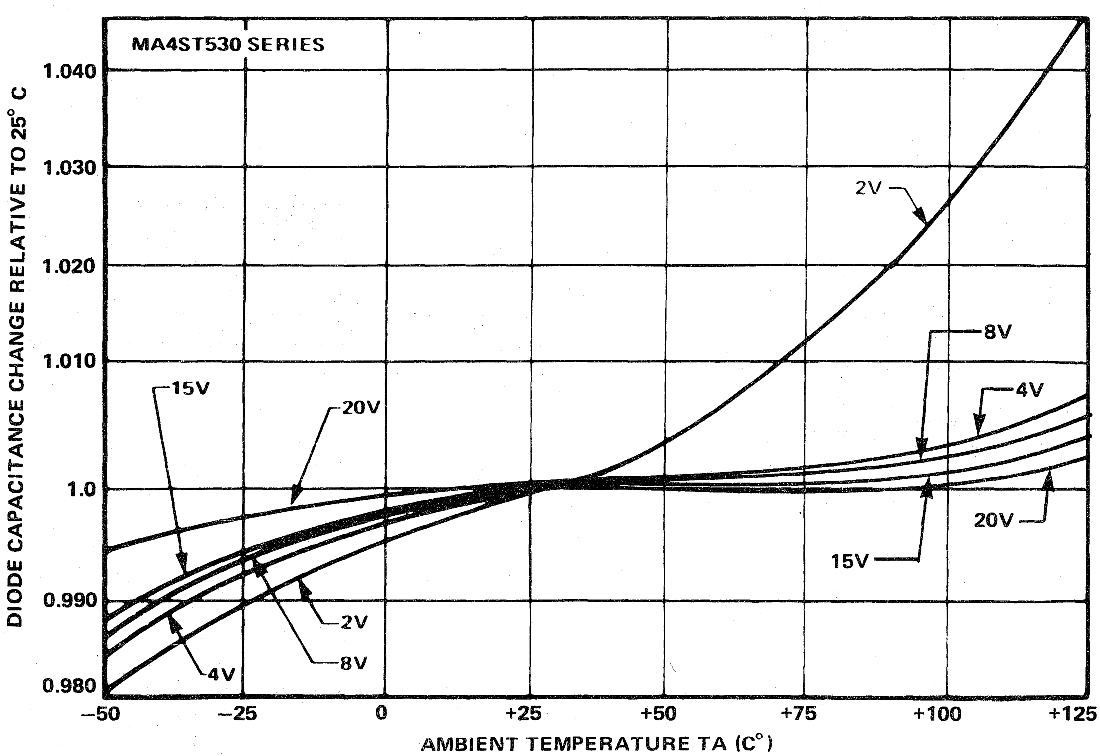
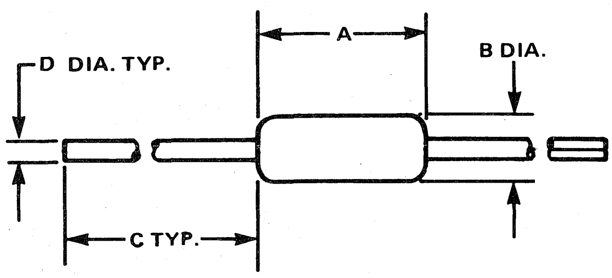


FIGURE 14. Capacitance Change vs. Ambient Temperature for MA4ST530 Series

Case Styles

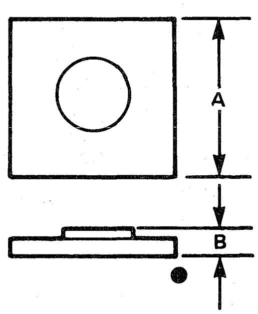
4



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.230	0.300	5,84	7,62
B	0.085	0.107	2,16	2,72
C	1.000	— —	25,40	— —
D	0.018	0.022	0,46	0,56

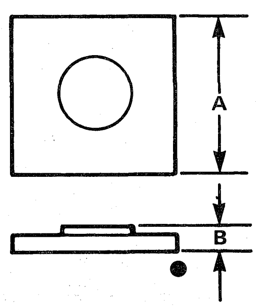
C_P = 0.15 pF Typical
L_S = 2.50 nH Typical

132



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.020	0.024	0,51	0,61
B	0.003	0.006	0,08	0,15

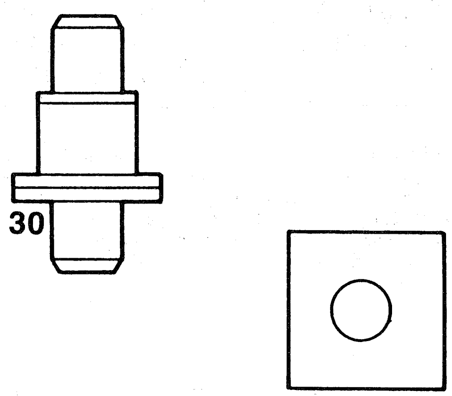
200



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.037	0.041	0,94	1,04
B	0.004	0.005	0,10	0,13

MA4ST550 Series

High Q Silicon Hyperabrupt Tuning Varactors



Features

- HIGH Q
- USABLE CAPACITANCE CHANGE OF 7:1
- LOW REVERSE LEAKAGE FOR GOOD POST TUNING DRIFT CHARACTERISTICS
- REPRODUCIBLE C-V CURVES

Description

The MA4ST550 family of high Q Silicon Hyperabrupt Tuning Varactors is available in a series of low parasitic capacitance microwave packages or in chip form. The MA4ST550 series of diodes is available in a RETMA series with junction capacitances of approximately 0.8 pF to 8.2 pF at −4 volts. All junctions are made with an ion implantation process which assures repeatable C-V characteristics from lot to lot. These devices have capacitance change ratios as high as 7:1.

Applications

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

Specifications @ T_A = 25°C

Breakdown Voltage = 22 volts minimum at 10 microamps
Reverse Current = 50 nAmps maximum @ 20 volts and 25°C

Model Number	Case[1] Style	Total Capacitance[2,3] @ –4V (pF) Min./Max.	Total Capacitance[2,3] @ –20V (pF) Min./Max.	Minimum Q[4] @ –4 Volts 50 MHz
MA4ST551	30	.72-.88	0.30-0.38	650
MA4ST552	30	.90-1.10	0.34-0.42	650
MA4ST553	30	1.08-1.32	0.38-0.48	600
MA4ST554	30	1.35-1.65	0.43-0.58	600
MA4ST555	30	1.62-1.98	0.51-0.68	550
MA4ST556	30	1.98-2.42	0.58-0.78	550
MA4ST557	30	2.43-2.97	0.68-0.88	500
MA4ST558	30	2.97-3.63	0.82-1.02	500
MA4ST559	30	3.51-4.29	0.93-1.18	450
MA4ST560	30	4.23-5.16	1.13-1.43	450
MA4ST561	30	5.04-6.16	1.33-1.63	450
MA4ST562	30	6.12-7.48	1.58-1.98	400
MA4ST563	30	7.38-9.02	1.88-2.38	400

NOTES

1. The standard case style is 30. Other packages and chips, shown at the back of this bulletin are available upon request. When ordering, specify the desired case style by adding the case designation as a suffix to the model number, i.e. MA4ST552-134 is a 15 X 15 mil chip diode.
2. Capacitance is measured at 1 MHz using a shielded test holder. The normal tolerance at –4 volts is ±10%. Closer tolerances are available upon request, at an additional charge. By adding the suffix A to the model number, a tolerance of ±5% can be obtained.
3. The total capacitance values shown are for devices housed in case style 30. Other case styles will result in different values due to different case parasitics. Case parasitics (C_p and L_s) are given for available case styles along with the outline drawings in this bulletin. The C_p values listed typically have tolerances of ±.02 pF.
4. Diode Q is measured by the DeLoach technique at –4 volts and extrapolated to 50 MHz.

MAXIMUM RATINGS

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

HIGH RELIABILITY

All diodes in the MA4ST550 series may be screened to TX, TXV specifications. For further high reliability information contact the factory.

ENVIRONMENTAL PERFORMANCE

All tuning varactors in the MA4ST550 series are capable of meeting the performance tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

Typical Performance Curves

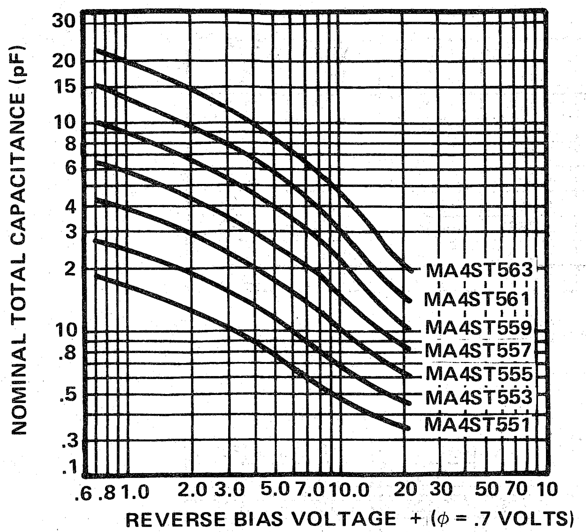


FIGURE 1. Capacitance vs. Reverse Bias Voltage (MA4ST551-563) in ODS-30.

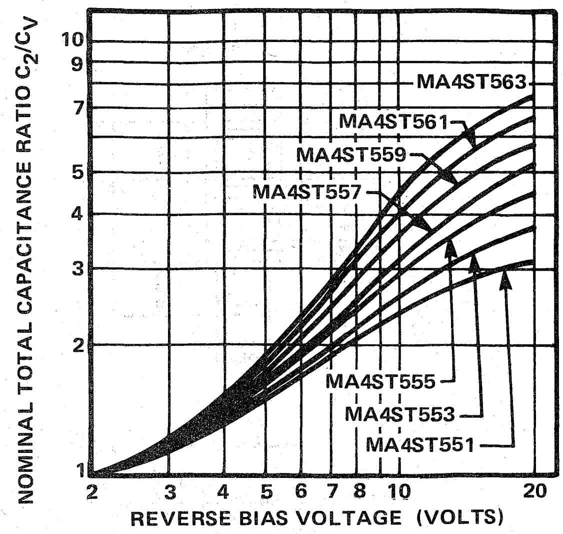


FIGURE 2. Capacitance Ratio C_2/C_V vs. Reverse Bias Voltage (MA4ST551-563) in ODS-30.

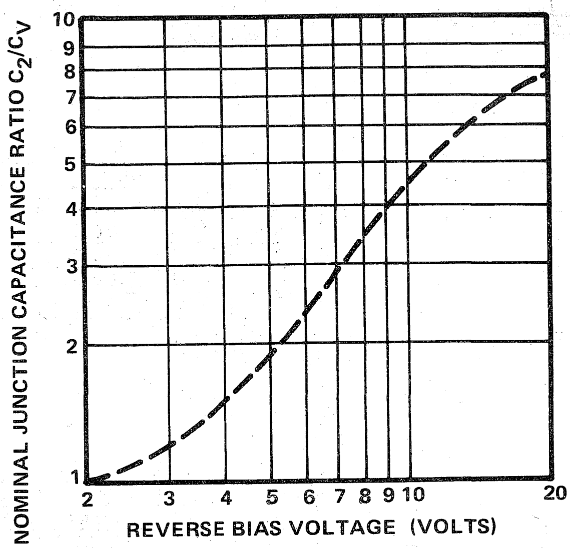


FIGURE 3. Capacitance Ratio C_2/C_V vs. Reverse Bias (MA4ST551-563) Chip Diodes (ODS-134).

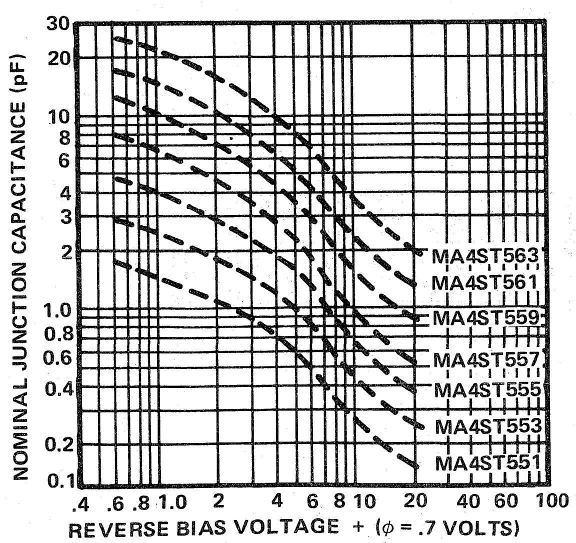


FIGURE 4. Capacitance vs. Reverse Bias Voltage (MA4ST551-563) Chips (ODS-134).

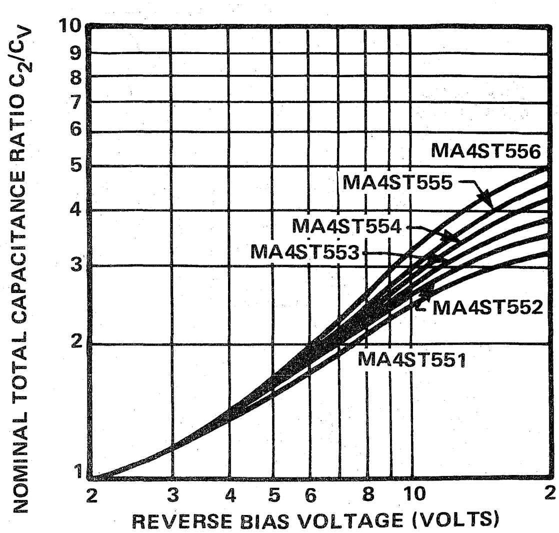
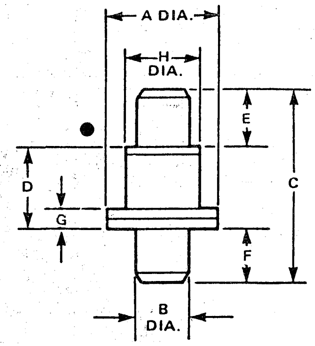


FIGURE 5. Capacitance Ratio C_2/C_V vs. Reverse Bias (MA4ST551-556) in ODS-30.

Case Styles

● DENOTES CATHODE   NOT TO SCALE

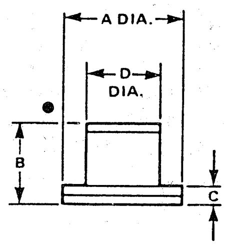
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

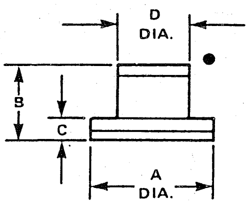
31



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P - 0.15 pF Typical
L_S - 0.40 nH Typical

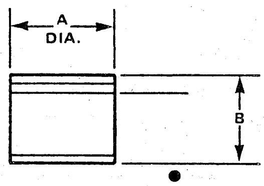
94



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

120

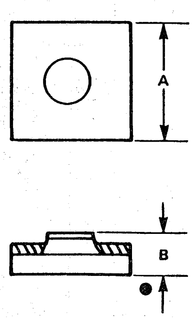


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

Chip Style

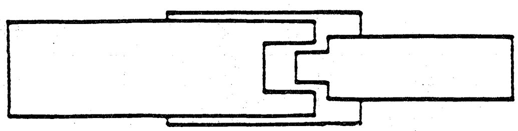
134



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0135	0.0165	0,34	0,42
B	0.0035	0.0065	0,09	0,17

MA46580 through 46589 Series (Gamma 1.0 & 1.25)

Beam Lead Constant Gamma Gallium Arsenide Tuning Varactors



992

Features

- GAMMA OF 1.0 AND 1.25 AVAILABLE
- CONSTANT GAMMA FOR LINEAR TUNING
- STRONG BEAM CONSTRUCTION
- LOW PARASITIC CAPACITANCE
- HIGH Q
- CLOSE CAPACITANCE TRACKING
- MINIMUM 10 GRAM BEAM STRENGTH

Description

The MA46580-84 series of beam lead constant gamma tuning varactors are hyperabrupt junction gallium arsenide diodes with a constant gamma of 1.0 or 1.25. The high Q values and elimination of package parasitics make these varactors very attractive for voltage controlled oscillators that require linear tuning. These tuning diodes are useful at frequencies as high as 40 GHz.

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

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

Applications

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

Specifications @ $T_A = 25°C$

BEAM LEAD CONSTANT GAMMA GALLIUM ARSENIDE TUNING VARACTORS

Minimum Voltage Rating 18 Vdc[5] Gamma = 1.25 ± 10% From 2-12 Volts						
Model Number[2]	**MA46580**	**MA46581**	**MA46582**	**MA46583**	**MA46584**	**Units**
Q at 4 Volts[4,6]	3000	3000	2500	2000	2000	(Min.)
Cj at 4 Volts[1,2]	0.5	0.7	1.0	1.5	2.0	pF (±20%)
$\frac{CT_2}{CT_{12}}$	$\frac{4.5:1}{6.5:1}$	$\frac{4.5:1}{6.5:1}$	$\frac{4.5:1}{6.5:1}$	$\frac{4.5:1}{6.5:1}$	$\frac{4.5:1}{6.5:1}$	Min. / Max.

Minimum Voltage Rating 18 Vdc[5] Gamma = 1.0 ± 10% From 2-12 Volts						
Model Number[2]	**MA46585**	**MA46586**	**MA46587**	**MA46588**	**MA46589**	**Units**
Q at 4 Volts[4,6]	3000	3000	2500	2000	2000	(Min.)
Cj at 4 Volts[1,2]	0.5	0.7	1.0	1.5	2.0	pF (±20%)
$\frac{CT_2}{CT_{12}}$	$\frac{3.2:1}{5.2:1}$	$\frac{3.2:1}{5.2:1}$	$\frac{3.2:1}{5.2:1}$	$\frac{3.2:1}{5.2:1}$	$\frac{3.2:1}{5.2:1}$	Min. / Max.

NOTES:

1. Capacitance is measured at 1 MHz on a bridge which has been balanced with a shielded test holder connected in place, but open circuited. Tested in M/A-COM's microstrip test fixture.
2. Capacitance tolerances are available on request for ±5%, ±10%, ±20%. MA type number will be supplied with the following tolerance for Cj4:

   MA46XXX = ±20%
   MA46XXX/A = ±10%
   MA46XXX/B = ±5%
3. All junctions are hyperabrupt with nominal γ = 1.0 or 1.25 where:

   $$Cj(V) = \frac{Cjo}{(1 + \frac{V}{\phi})^{\gamma}}$$

   and

   Cj (V) = voltage dependent junction capacitance
   V = applied voltage
   ϕ = built-in potential (1.3 volts for GaAs)
   γ = capacitance-voltage slope exponent — gamma
   K = constant
4. Diode Q is measured at 3 GHz and at −4 volts and extrapolated to 50 MHz. Tested in M/A-COM's microstrip test fixture.
5. Maximum leakage current: IR = 20 nA Max. at −14V and 25°C
   IR = 10 μA Max. at −18V and 25°C
6. Q is a nominal specification.

MAXIMUM RATINGS

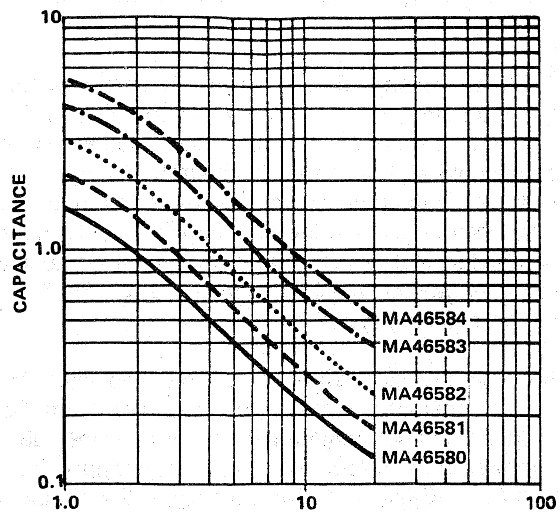
Operating Temperature	−65° to 150°C
Storage Temperature	−65° to 150°C
Max. Voltage Rating	18 Volts
Power Dissipation	25 mW at 25°C
Beam Strength	10 Grams Min.

ENVIRONMENTAL RATINGS PER MIL-STD-750

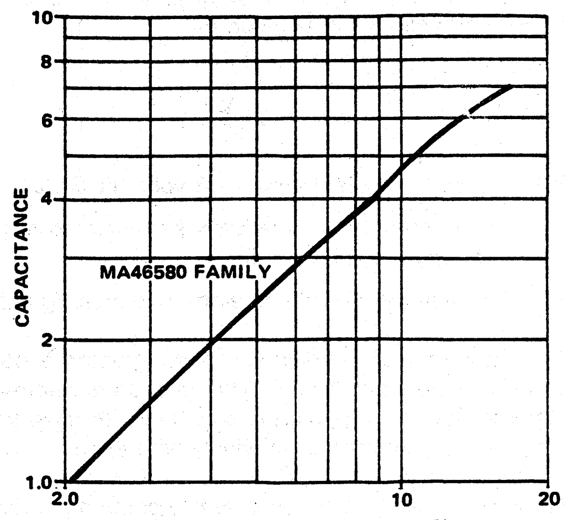
	MIL Method	Level
Storage Temp.	1031	See maximum ratings
Operating Temp.		See mamimum ratings
Temperature Cycle	1051	10 cycles, −65° to +175°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

Typical Performance Curves

Gamma = 1.25 ± 10% from 2-12 Volts (MA 46580 Series)

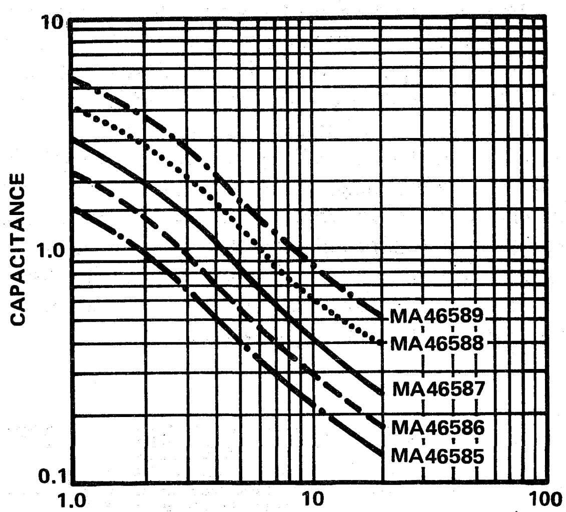


MA46580-46584 Capacitance vs. Voltage

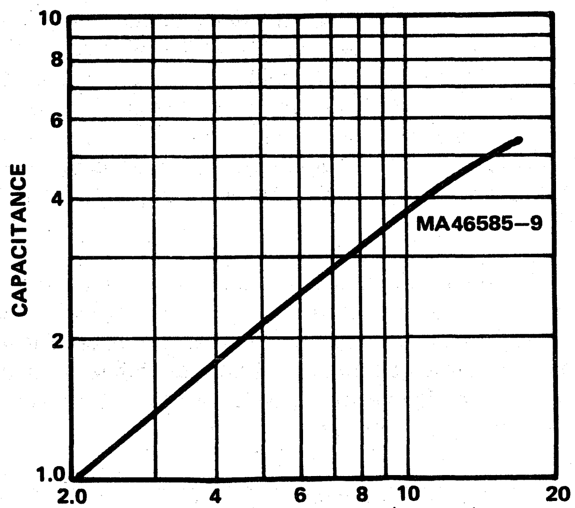


Capacitance Ratio $C_{T\text{-}2}/C_{TV}$ for MA46580 Series

Gamma = 1.0 ± 10% from 2-12 Volts (MA 46580 Series)



MA46585-46589 Capacitance vs. Voltage



Capacitance Ratio $C_{T\text{-}2}/C_{TV}$ for MA46585-46589 Series

Application Notes

SELECTION OF CONSTANT GAMMA HYPERABRUPT TUNING VARACTORS

For varactors, the dependence of junction capacitance, C_j, on applied voltage, V, is given by:

$$C_j = \frac{C_O}{\left(1 + \frac{V_R}{\theta}\right)^{\gamma}} \qquad (1)$$

Φ = the built in potential ($\Phi = 1.3$ volts for GaAs)

C_O = a constant (mathematically extrapolated to junction capacitance at V = 0)

γ = the capacitance-voltage slope exponent (gamma)

For simple abrupt junction varactors, gamma is constant and nominally equal to 0.5. The junction is referred to as hyperabrupt when gamma is >0.5 and for most varactors, the value of gamma varies widely with applied voltage.

From Equation (1), we observe that gamma is graphically determined as the slope of junction capacitance, C_j, as a function of total voltage (applied voltage plus built-in potential) plotted on log-log paper A typical plot of the constant gamma hyperabrupt tuning varactor C-V characteristics is illustrated in Figure A, where the slope of the curve is a constant gamma = 1.25 over the applied voltage range of 2—20 volts. Notice that constant gamma is not maintained at low applied voltages, so C_O = 6.6 pF is a mathematical value determined by extending the constant slope to V = 0 (or V + Φ) = 1.3). The capacitance versus applied voltage, Curve 2, is also shown in Figure A for the chip, and Curve 3 illustrated the C-V curve when the chip is mounted in a style 30 package having a package capacitance of ~0.18 pF.

The primary purpose of the constant gamma hyperabrupt varactors is to permit the designer to approach linear frequency tuning without the use of a linearizer. For a simple resonant circuit comprised of an inductance, L, and a varactor with junction capacitance C_j (V), the frequency-voltage relationship is given by:

$$fr\,(V) = \frac{1}{2\pi\sqrt{LC_j\,(V)\,1}} = \frac{1}{2\pi\sqrt{LC_O}}\left(1 + \frac{V_R}{\theta}\right)^{\gamma/2}$$

and the desired gamma value for linear tuning is 2.0

In all microwave oscillator circuits, the varactor is not the only capacitor in the resonant circuit. Instead, this capacitance makes up only a portion of the total resonant capacitive element. An analysis has been performed of the simple series circuit illustrated in Figure B where a fixed capacitor, C_S, is in series with the varactor junction. The results of this analysis provides guidance to the selection of a suitable gamma. The total capacitance, C_t of the resonant circuit can be expressed in terms of a coupling factor, K_S, as:

$$\frac{1}{C_t\,(V)} = \frac{1}{C_{to}}\left[1 - K_S + K_S\left(1 + \frac{V}{\theta}\right)^{\gamma}\right]$$

where:
K_S = C_{to} = total capacitance of resonator at V = 0
C_O = varactor junction capacitance at V = 0

when K_S = 1, the varactor is fully coupled and the value for linear tuning is 2.0.

As K_S approaches 0, the varactor becomes decoupled and the optimum gamma for linear tuning approaches 1.0. An optimum value of gamma for linear frequency tuning is predictable and the result is illustrated in Figure C. In this illustration, the optimum gamma value is plotted versus the frequency f_{max}/f_{min}, the coupling factor, K_S, as a parameter. Notice that linear tuning can be achieved for constant gamma within the limits $1.0 < \gamma < 2.0$ depending on the coupling factor.

A circuit designer can use this simplified analysis for selection of constant gamma hyperabrupt varactors. For example, suppose a circuit requirement is for a tuning ratio of 2:1, the designer could select γ = 2 and fully couple the varactor with $C_{max}/C_{min} < 4$. Alternatively, if the circuit is decoupled to K_S = 0.6 where γ = 1.6 and $C_{max}/C_{min} > 6$. The further decoupling can also be considered with correspondingly lower optimum γ. The decoupling limit occurs when the C_{max}/C_{min} is not available in the varactor. It has been empirically found that to obtain the best noise and bandwidth characteristics, most moderate bandwidth voltage controlled oscillators will have varactor coupling factors (K_S) of 0.2-0.4. Most moderate power C and X band bipolar or FET oscillator transistors will have a C_C of approximately 0.25 pF. 50-100mW Gunn diodes have similar capacitances. (For further discussion on varactor coupling refer to M/A-COM SPI's article "Tuning Varactor Diode Selection Guide," 1986). These broadband tuning requirements are optimized in circuits with $1.2 < \gamma < 1.4$, while circuits with narrow tuning bandwidth need to utilize a value of gamma approaching 1.0. Linearity improvement with these varactors is frequently a factor of 10 or more in comparison to conventional abrupt junction varactors.

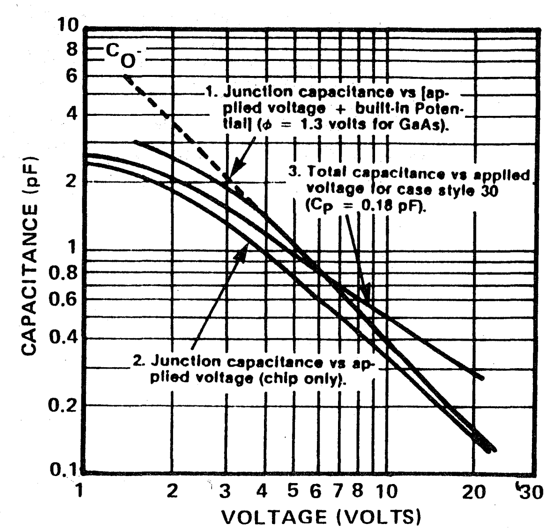


FIGURE A. Typical GaAs Hyperabrupt C-V Characteristics for Beam Lead (992), Chip (276) and Packaged Diodes (30).

Application Notes (Cont'd)

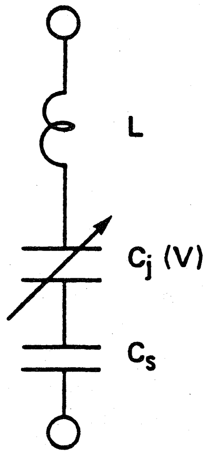


FIGURE B. Resonant Circuit with Decoupled Tuning Varactor

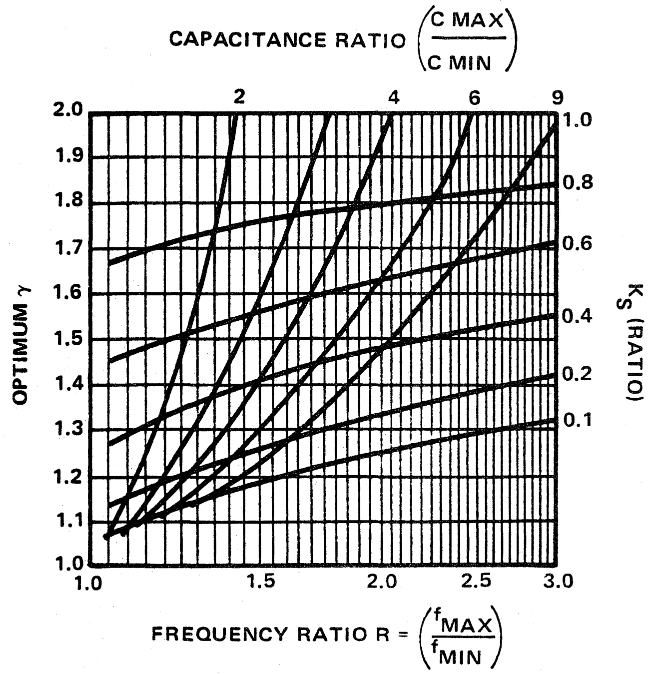
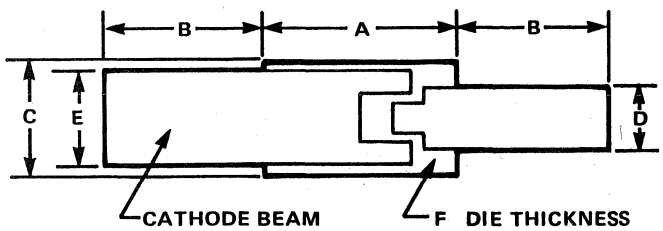


FIGURE C. Optimum γ Selection for Linear Tuning

Case Style

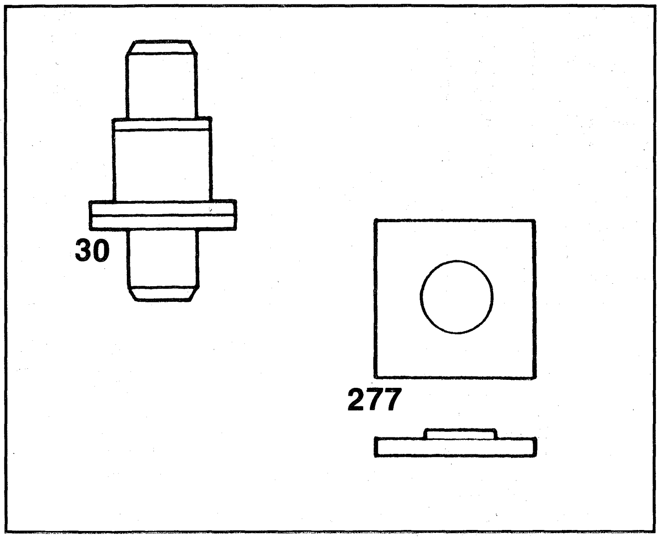
992



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.012	0.014	0,305	0,356
B	0.010	— —	0,254	— —
C	0.006	0.008	0,152	0,203
D	0.004	0.006	0,102	0,152
E	0.007	0.009	0,178	0,229
F	— —	0.004	— —	0,102

MA46450 through MA46480 Series — 1.00 and 1.25 Gamma

GaAs Hyperabrupt Tuning Varactors



Features

- CONSTANT GAMMA = 1.0 OR 1.25
- HIGH Q (UP TO 4000 AT −4 VOLTS)
- LARGE CAPACITANCE CHANGE WITH VOLTAGE
- MORE LINEAR FREQUENCY TUNING
- HIGH AND NEARLY CONSTANT MODULATION SENSITIVITY

Description

The MA46450 series and the MA46470 series of tuning varactors are hyperabrupt junction Gallium Arsenide devices featuring constant gamma of 1.0 (MA46450 series) and 1.25 (MA46470 series). These series offer high "Q" (up to 4000) that permit excellent tuning performance from VHF through Ka-band. Each device in these series exhibits the large capacitance change with voltage of hyperabrupt tuning varactors. Standard capacitance matching is ±10%, with closer matching available on request. All diode types are available in a wide selection of ceramic packages and in chip form.

Applications

The constant gamma value of 1.0 or 1.25 available from these diodes permits significant circuit performance improvements for the circuit designer. Constant gamma tuning varactors permits more linear VCO frequency tuning with bias voltage than conventional varactors. These varactors are also useful for tunable filters and can improve the frequency tuning linearity of these circuits. These diodes are an excellent choice for modulator applications where excellent linearity and constant modulation sensitivity is desired.

Specifications @ T_A = 25°C

MA46450 Series
GaAs Constant Gamma Hyperabrupt Tuning Varactors
Gamma = 1.0

Breakdown Voltage = 22 Volts Minimum
Gamma Constant = 1.0 ± 10% 2 – 20 volts
Capacitance Tolerance[3] = ± 10%

Model[1] Number	Case Style	Total[9, 2, 5] Capacitance @ –4 Volts (±10%) (pF)	Capacitance[3, 9] Ratio (2/20) Min./Max.	Q at[6] –4 Volts Minimum
MA46450	30	0.5	2.0/2.7	4000
MA46451	30	0.7	2.9/4.1	4000
MA46452	30	1.0	3.6/5.2	3000
MA46453	30	1.2	3.6/5.2	3000
MA46454	30	1.5	3.8/5.5	3000
MA46455	30	1.8	4.1/6.1	3000
MA46456	30	2.0	4.1/6.1	3000
MA46457	30	2.2	4.1/6.1	3000
MA46458	30	2.7	4.5/6.7	2000
MA46459	30	3.3	4.5/6.7	2000
MA46460	30	3.7	4.7/7.1	2000
MA46461	30	4.7	4.8/7.2	1500
MA46462	30	5.6	4.9/7.4	1500
MA46463	30	6.8	4.9/7.4	1500
MA46464	30	8.2	5.0/7.6	1500
MA46465	30	10.0	5.0/7.6	1500

MA46470 Series
GaAs Constant Gamma Hyperabrupt Tuning Varactors
Gamma = 1.25

Breakdown Voltage = 22 Volts Minimum
Gamma Constant = 1.25 ± 10% 2 – 20 Volts Minimum
Capacitance Tolerance[3] = ± 10%

Model[1] Number	Case Style	Total[9, 2, 5] Capacitance @ –4 Volts (±10%) (pF)	Capacitance[3, 9] Ratio (2/20) Min./Max.	Q at[6] –4 Volts 50 MHz
MA46470	30	0.5	2.2/3.2	4000
MA46471	30	0.7	3.6/5.3	4000
MA46472	30	1.0	4.8/7.1	3000
MA46473	30	1.2	4.8/7.1	3000
MA46474	30	1.5	5.0/7.4	3000
MA46475	30	1.8	6.6/8.7	3000
MA46476	30	2.0	6.6/8.7	3000
MA46477	30	2.2	6.6/8.7	3000
MA46478	30	2.7	6.4/10.0	2000
MA46479	30	3.3	6.4/10.0	2000
MA46480	30	3.7	6.8/11.0	2000
MA46481	30	4.7	6.9/11.1	1500
MA46482	30	5.6	7.2/11.5	1500
MA46483	30	6.8	7.2/11.5	1500
MA46484	30	8.2	7.2/11.5	1500
MA46485	30	10.0	7.5/12.0	1500

NOTES:
1. All GaAs tuning varactors are available upon special request in chip form as well as any other case style and the standard ODS – 30 package. When ordering, specify the desired case by adding the case designation as a suffix to the type number.
2. Case parasitics (C_p and L_s) are given for most case styles along with case outlines in this bulletin. The C_p values listed typically have tolerances of ± 0.02 pF.
3. The nominal tolerance at – 4 volts is ± 10%. Closer tolerances are available upon request. By adding the suffix A to the part number, a tolerance of ± 5% can be obtained.
4. Gamma is within the limits of 0.90 < γ < 1.10 over the voltage range of 2 – 20 volts for the MA46450 series. Gamma is within the limits of 1.13 < γ < 1.40, over the range of 2 – 20 volts for the MA46470 series. Total capacitance of the packaged diodes will deviate from constant gamma characteristics due to differences in case capacitance (C_p). Figures 1 and 4 illustrate typical total capacitance versus applied voltage for these series when case style 30 is selected. Figure 3 illustrates the typical range of γ versus voltage when case style 30 is selected. Figures 2 and 5 illustrate typical capacitance ratios versus applied voltage in case style 30.
5. Capacitance is measured at 1 MHz using a shielded test holder.
6. Diode Q is measured by the DeLoach technique at – 4 volts and extrapolated to 50 MHz.
7. Parasitic inductance (L_s) has been determined at X band using the DeLoach method measurement.
8. Breakdown voltage (V_b) is measured at 10 microamps.
9. The total capacitance and capacitance ratios shown are for devices housed in case style 30. Other case styles will result in different values.

Electrical Characteristics (at 25°C)

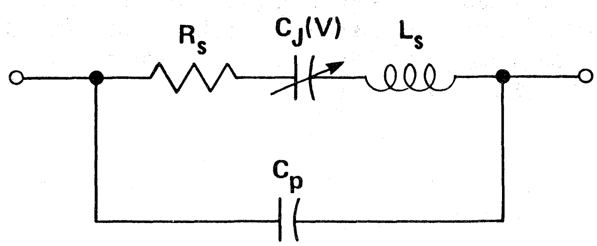
MAXIMUM RATINGS

Operating Temperature	– 65°C to + 200°C
Storage Temperature	– 65°C to + 200°C
Reverse Voltage	Breakdown Voltage

ENVIRONMENTAL RATINGS PER MIL-STD-750

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

TUNING VARACTOR EQUIVALENT CIRCUIT



Typical Performance Curves

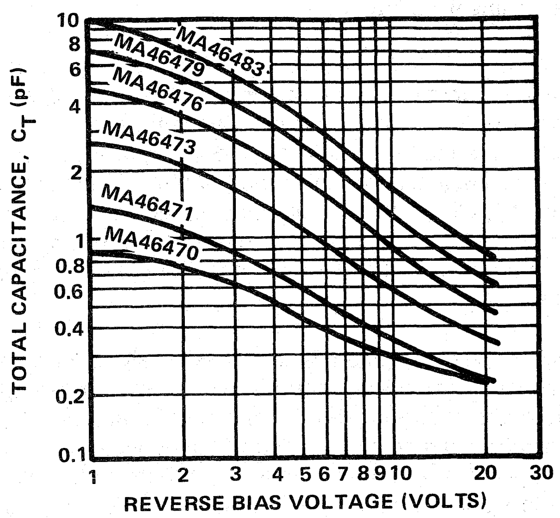


FIGURE 1. Total Capacitance vs. Reverse Bias Voltage (Case Style 30)

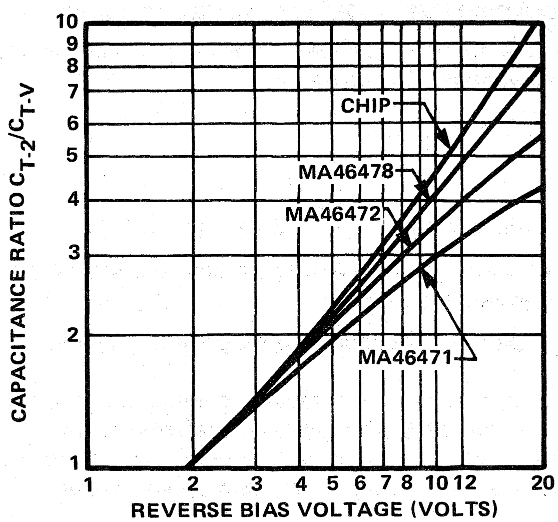


FIGURE 2. Capacitance Ratio vs. Reverse Bias Voltage (Case Style 30)

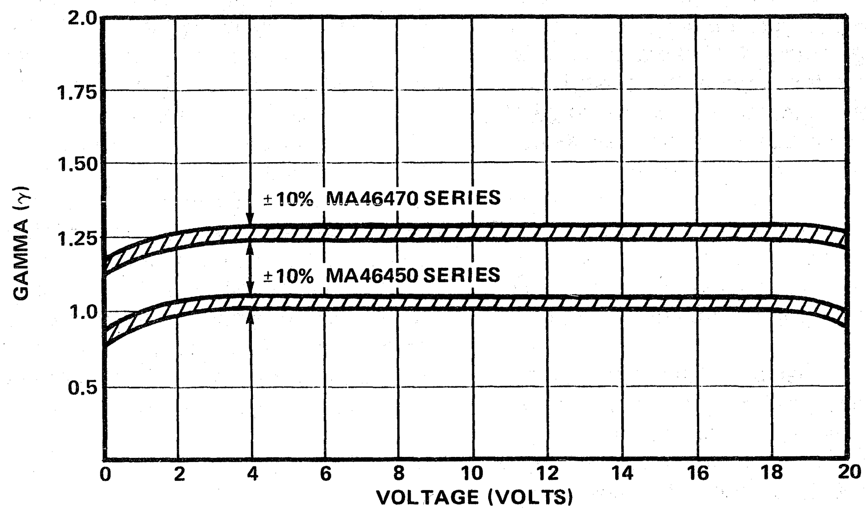


FIGURE 3. Gamma vs. Voltage

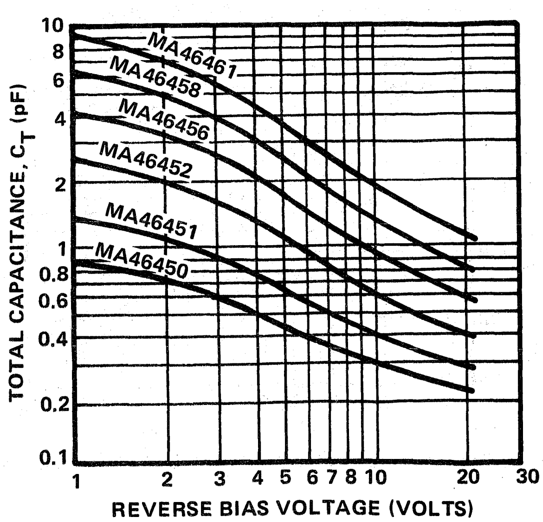


FIGURE 4. Total Capacitance vs. Reverse Bias Voltage (Case Style 30)

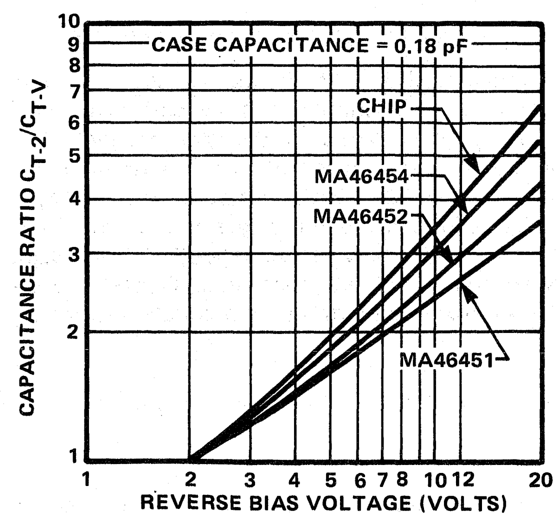


FIGURE 5. Capacitance Ratio vs. Reverse Bias Voltage (Case Style 30)

Application Notes

SELECTION OF CONSTANT GAMMA HYPERABRUPT TUNING VARACTORS

For varactors, the dependence of junction capacitance, C_j, on applied voltage, V, is given by:

$$C_j = \frac{C_O}{\left(1 + \frac{V_R}{\theta}\right)^{\gamma}} \qquad (1)$$

Φ = the built in potential (Φ = 1.3 volts for GaAs)

C_O = a constant (mathematically extrapolated to junction capacitance at V = 0)

γ = the capacitance-voltage slope exponent (gamma)

For simple abrupt junction varactors, gamma is constant and nominally equal to 0.5. The junction is referred to as hyperabrupt when gamma is >0.5 and for most varactors, the value of gamma varies widely with applied voltage.

From Equation (1), we observe that gamma is graphically determined as the slope of junction capacitance, C_j, as a function of total voltage (applied voltage plus built-in potential) plotted on log-log paper. A typical plot of the constant gamma hyperabrupt tuning varactor C-V characteristics is illustrated in Figure A, where the slope of the curve is a constant gamma = 1.25 over the applied voltage range of 2-20 volts. Notice that constant gamma is not maintained at low applied voltages, so C_O = 6.6 pF is a mathematical value determined by extending the constant slope to V=0 or (V + Φ = 1.3). The capacitance versus applied voltage, Curve 2, is also shown in Figure A for the chip, and Curve 3 illustrates the C-V curve when the chip is mounted in a style 30 package having a package capacitance of ~0.18 pF.

The primary purpose of the constant gamma hyperabrupt varactors is to permit the designer to approach linear frequency tuning without the use of a linearizer. For a simple resonant circuit comprised of an inductance, L, and a varactor with junction capacitance C_j (V), the frequency-voltage relationship is given by:

$$fr\,(V) = \frac{1}{2\pi\sqrt{LC_j\,(V)_1}} = \frac{1}{2\pi\sqrt{LC_O}}\left(1 + \frac{V_R}{\theta}\right)^{\gamma/2}$$

and the desired gamma value for linear tuning is 2.0.

In all microwave oscillator circuits, the varactor is not the only capacitor in the resonant circuit. Instead, this capacitance makes up only a portion of the total resonant capacitive element. An analysis has been performed of the simple series circuit illustrated in Figure B where a fixed capacitor, C_S, is in series with the varactor junction. The results of this analysis provides guidance to the selection of a suitable gamma. The total capacitance, C_t of the resonant circuit can be expressed in terms of a coupling factor, K_S, as:

$$\frac{1}{C_t\,(V)} = \frac{1}{C_{to}}\left[1 - K_S + K_S\left(1 + \frac{V}{\theta}\right)^{\gamma}\right]$$

where:

K_S = C_{to} = total capacitance of resonator at V = 0
C_O = varactor junction capacitance at V = 0

when K_S = 1, the varactor is fully coupled and the value of gamma for linear tuning is 2.0.

As K_S approaches 0, the varactor becomes decoupled and the optimum gamma for linear tuning approaches 1.0. An optimum value of gamma for linear frequency tuning is predictable and the result is illustrated in Figure C. In this illustration, the optimum gamma value is plotted versus the frequency f_{max}/f_{min}, the coupling factor, Ks, as a parameter. Notice that linear tuning can be achieved for constant gamma within the limits $1.0 < \gamma < 2.0$ depending on the coupling factor.

A circuit designer can use this simplified analysis for selection of constant gamma hyperabrupt varactors. For example, suppose a circuit requirement is for a tuning ratio of 2:1. The designer could select $\gamma = 2$ and fully couple the varactor with $C_{max}/C_{min} < 4$. Alternatively, if the circuit is decoupled to $K_S = 0.6$ where $\gamma = 1.6$ and $C_{max}/C_{min} > 6$. The further decoupling can also be considered with correspondingly lower optimum γ. The decoupling limit occurs when the C_{max}/C_{min} is not available in the varactor. It has been empirically found that to obtain the best noise and bandwidth characteristics, most moderate bandwidth voltage controlled oscillators will have varactor coupling factors (K_S) of 0.2-0.4. Most moderate power C and X band bipolar or FET oscillator transistors will have a C_C of approximately 0.25 pF. 50-100 mW Gunn diodes have similar capacitances. (For further discussion on varactor coupling refer to M/A-COM SPO's article "Tuning Varactor Diode Selection Guide", 1986). These broadband tuning requirements are optimized in circuits with $1.2 < \gamma < 1.4$, while circuits with narrow tuning bandwidth need to utilize a value of gamma approaching 1.0. Linearity improvement with these varactors is frequently a factor of 10 or more in comparison to conventional abrupt junction varactors.

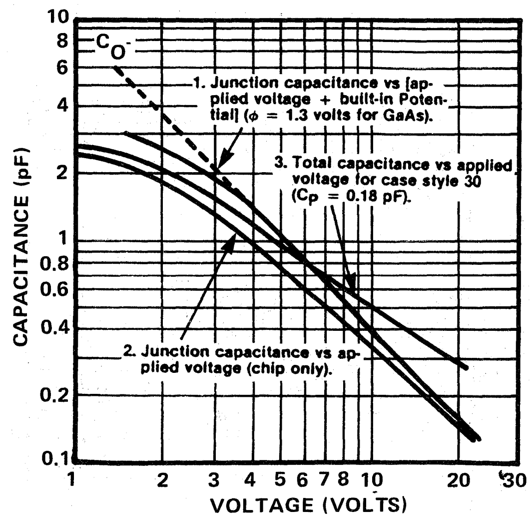


FIGURE A. Typical GaAs Hyperabrupt C-V Characteristics

Application Notes (Cont'd)

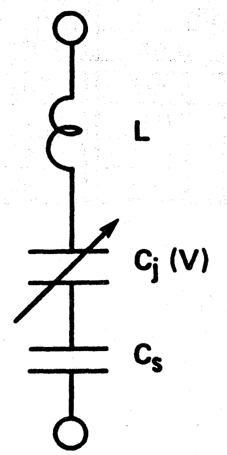


FIGURE B. Resonant Circuit With Decoupled Tuning Varactor

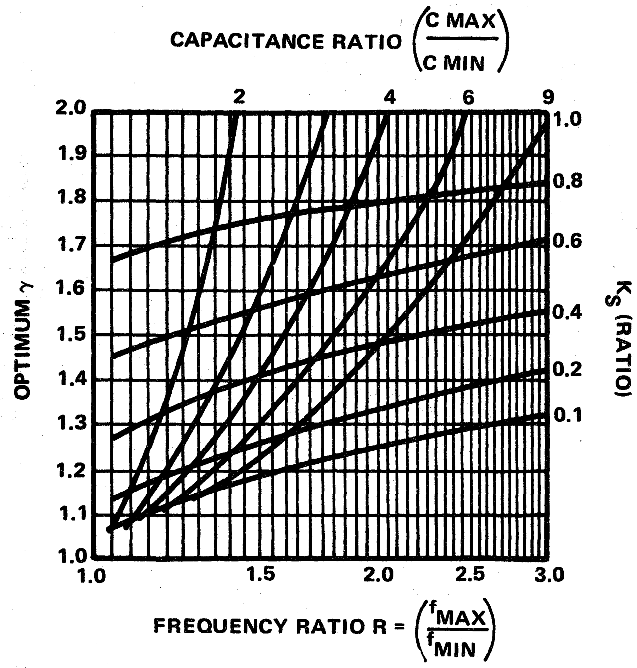
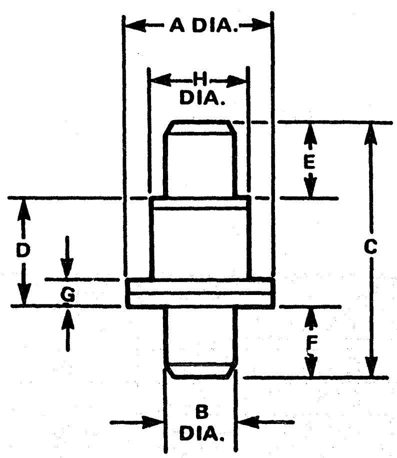


FIGURE C. Optimum γ Selection for Linear Tuning

Case Styles

30

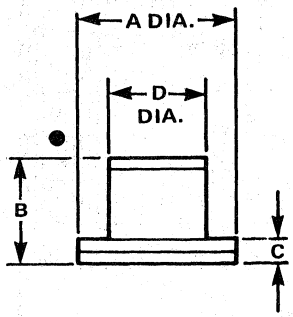


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

Case Styles (Cont'd)

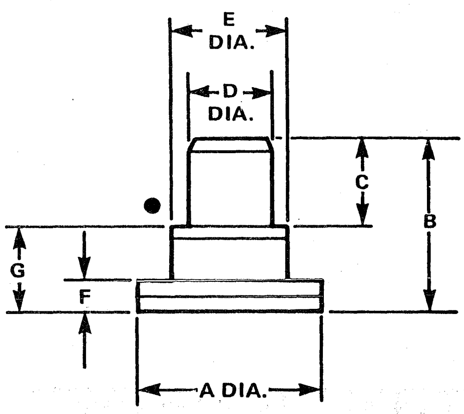
31



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

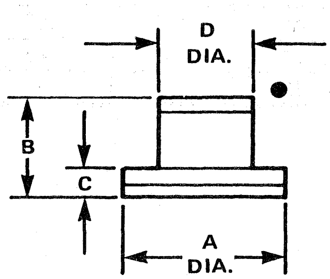
91



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.115	0.129	2,92	3,28
C	0.060	0.064	1,52	1,63
D	0.060	0.062	1,52	1,57
E	0.077	0.083	1,96	2,11
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

94

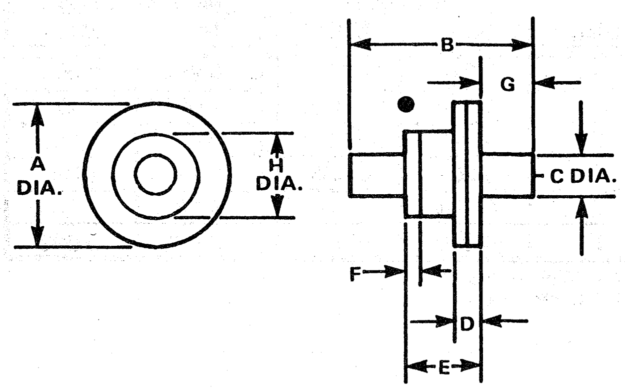


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

Case Styles (Cont'd)

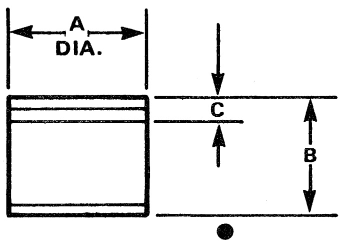
97



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.100	0.110	2,54	2,79
C	0.024	0.026	0,61	0,66
D	— —	0.015	— —	0,38
E	0.040	0.050	1,02	1,27
F	0.004	0.010	0,10	0,25
G	0.029	0.031	0,74	0,79
H	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

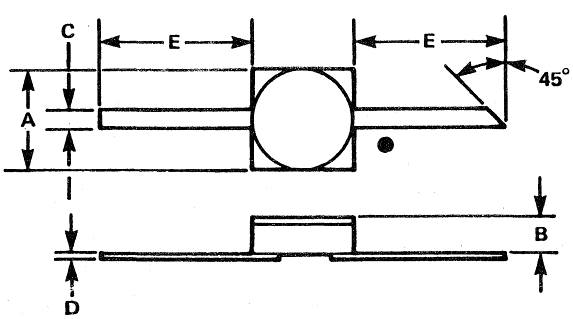
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

186

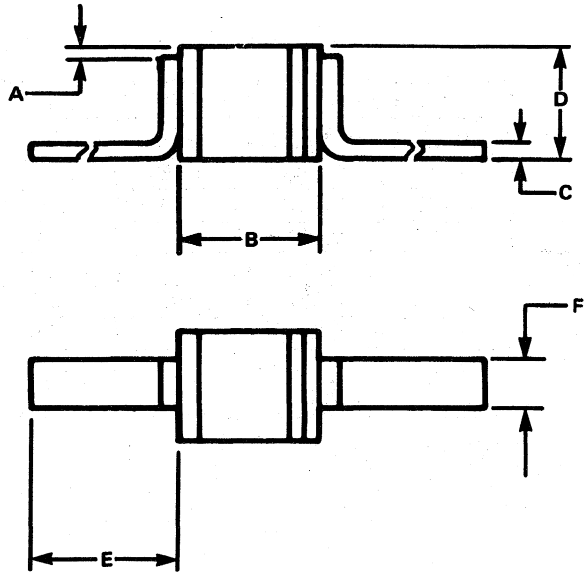


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0,76	0,15
E	0.130	0.170	3,30	4,32

C_P = 0.15 pF Typical
L_S = 0.40 nH Typical

Case Styles (Cont'd)

276

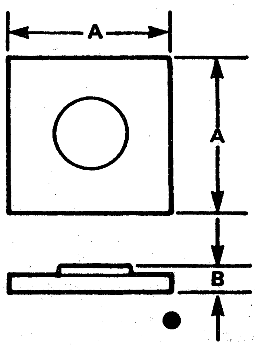


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.020	0,254	0,508
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

Chip Style

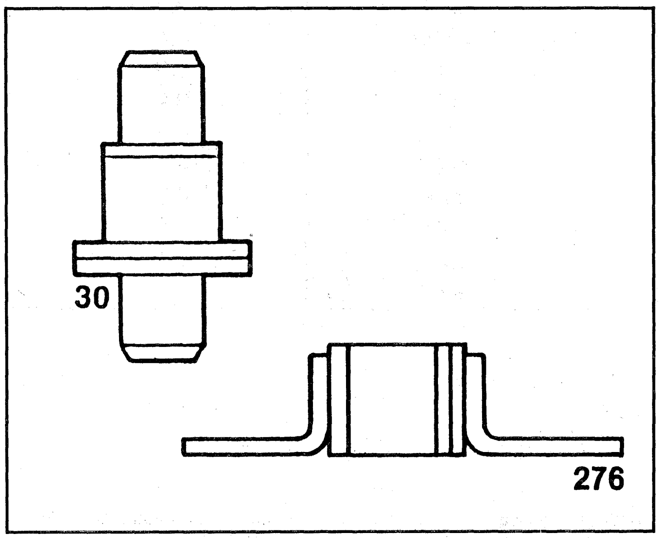
277



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.012	0,25	0,31
B	0.004	0.005	0,10	0,13

MA46600 Series

GaAs Tuning Varactors



Features

- HIGHEST Q
- LARGE CAPACITANCE VARIATION WITH VOLTAGE (ABRUPT JUNCTION)
- CUSTOM TAILORED DESIGNS AVAILABLE ON REQUEST

Description

The MA46600 series of microwave tuning varactors is a family of abrupt junction gallium arsenide devices featuring "Q factors" in excess of 8000. This series is specifically designed for broadband high Q tuning performance (up to 8000 at -4 volts and 50 MHz) from L through Ka band. Characteristics such as high reliability, low leakage and close capacitance tracking between diodes are typical of these devices. Standard capacitance matching is ± 10%, but closer matching is available upon request. All diode types are available in a wide selection of ceramic packages as well as in chip form. The series is available in minimum breakdown voltage ranges of 30 volts and 45 volts.

Applications

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

Specifications @ T_A = 25°C

Model Number	Voltage[7] Breakdown (Volts)	C_{t4}[1,3] ± 10% (pF)	Q@ −4 Volts[2] Minimum	Ratio[1,3] C_{t0}/C_tV_B (pF) (Typical)
MA46600	30	0.3	8000	1.9
MA46601	30	0.4	7500	2.1
MA46602	30	0.5	7000	2.5
MA46603	30	0.6	6500	2.8
MA46604	30	0.8	6000	3.2
MA46605	30	1.0	5700	3.4
MA46606	30	1.2	5300	3.6
MA46607	30	1.5	5000	3.8
MA46608	30	1.8	4500	3.9
MA46609	30	2.2	4000	4.0
MA46610	45	0.5	6000	2.7
MA46611	45	0.6	5500	3.1
MA46612	45	0.8	5000	3.6
MA46613	45	1.0	4600	3.9
MA46614	45	1.2	4300	4.2
MA46615	45	1.5	4000	4.5
MA46616	45	1.8	3800	4.7
MA46617	45	2.2	3600	4.9
MA46618	45	2.7	3300	5.1
MA46619	45	3.3	3000	5.3

NOTES

1. Capacitance is measured at 1 MHz on a bridge which has been balanced with shielded test holders connected in place but open circuited.
2. Diode Q is measured by the DeLoach technique and extrapolated to −4 volts and 50 MHz.
3. All GaAs tuning varactors are available in any case style shown in this bulletin as well as in chip form. When ordering, specify the desired case by adding the case designation as a suffix to the type number. For example, a MA46601-30 specifies a 30 volt tuning diode in a case style 30 with a C_{t14} between .36 and .44 pF and a Q at −4 volts and 50 MHz ≥7500. The capacitance values and capacitance ratios are for case style 30. Other case styles or chips will have slightly different values.
4. All junctions are abrupt i.e., γ = 0.50 ± .03 where

$$C_j(v) = \frac{C_o}{\left(1 + \frac{V_R}{\Phi}\right)^{\gamma}}$$

5. Total capacitance ratios will vary with case choice due to differences in case capacitance (C_p). Figure 1 shows the ratio for the 30 case style.
6. Case parasitics (C_p and L_s) are given for most case styles.
7. Breakdown voltage (V_b) is measured at −10 μA.

MAXIMUM RATINGS

Temperature:	
Operating	−65°C to +200°C
Storage	−65°C to +200°C
Voltage	Breakdown Voltage
Power Dissipation	Cj = 1.0 pF max. @ 50mW
(derate linearly to zero at 200°C)	Cj = 1.0 pF min. @100mW

ENVIRONMENTAL RATINGS

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

Typical Performance Curve

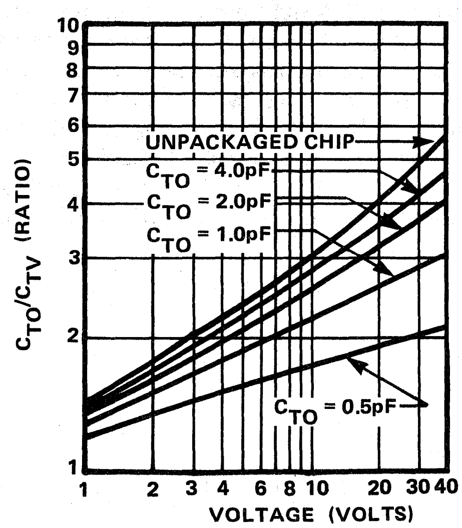
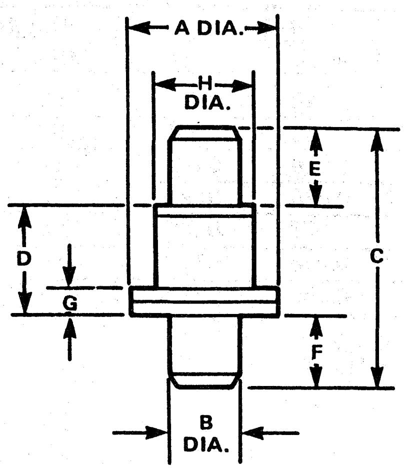


FIGURE 1. Capacitance Change Ratios for GaAs Tuning Varactors in Case Style 30

Case Styles

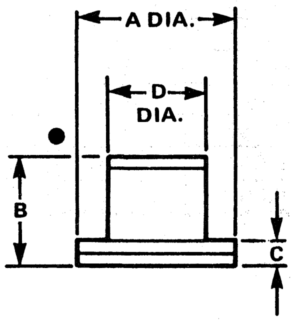
30



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.127	0.119	3,22	3,02
B	0.064	0.060	1,63	1,52
C	0.225	0.205	5,72	5,21
D	0.097	0.085	2,46	2,16
E	0.064	0.060	1,63	1,52
F	0.064	0.060	1,63	1,52
G	0.024	0.016	0,61	0,41
H	0.083	0.079	2,11	2,01

GaAs: C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

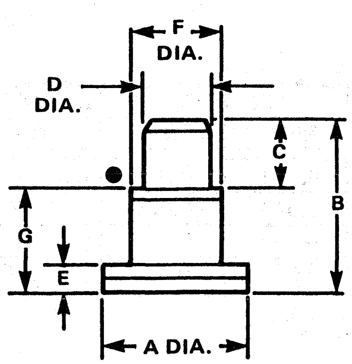
31



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

36

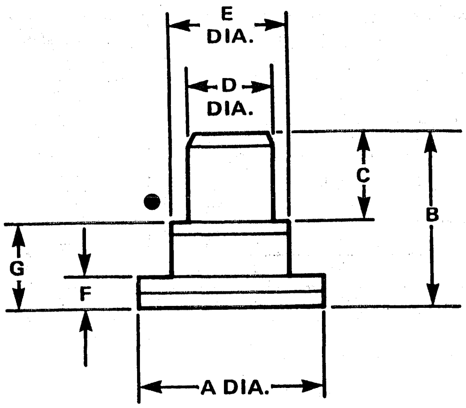


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.125	3,02	3,18
B	0.143	0.163	3,63	4,14
C	0.060	0.064	1,52	1,63
D	0.060	0.064	1,52	1,63
E	— —	0.025	— —	0,64
F	0.077	0.083	1,96	2,11
G	0.086	0.096	2,18	2,44

GaAs: C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

Case Styles (Cont'd)

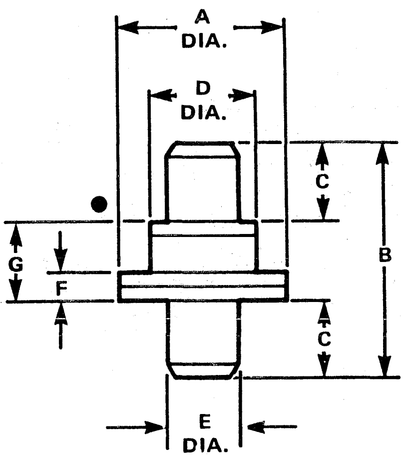
91



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.115	0.129	2,92	3,28
C	0.060	0.064	1,52	1,63
D	0.060	0.062	1,52	1,57
E	0.077	0.083	1,96	2,11
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

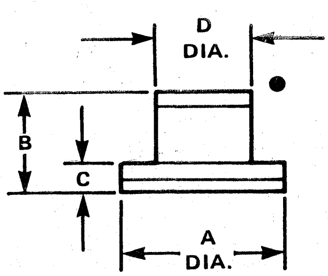
92



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.174	0.194	4,42	4,93
C	0.060	0.064	1,52	1,63
D	0.077	0.083	1,96	2,11
E	0.060	0.062	1,52	1,57
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

94

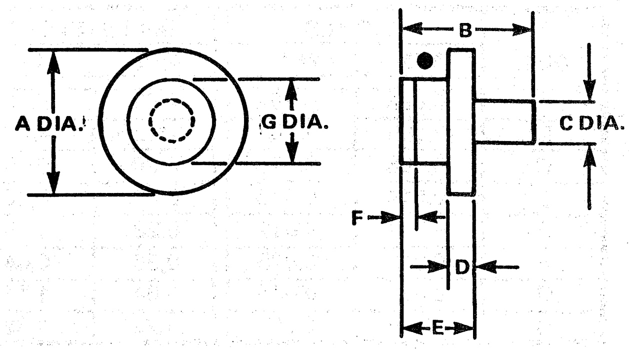


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

Case Styles (Cont'd)

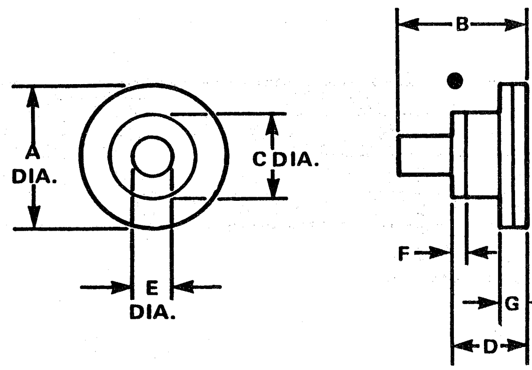
95



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.070	0.080	1,78	2,03
C	0.024	0.026	0,61	0,66
D	— —	0.015	— —	0,38
E	0.040	0.050	1,02	1,27
F	0.004	0.010	0,10	0,25
G	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

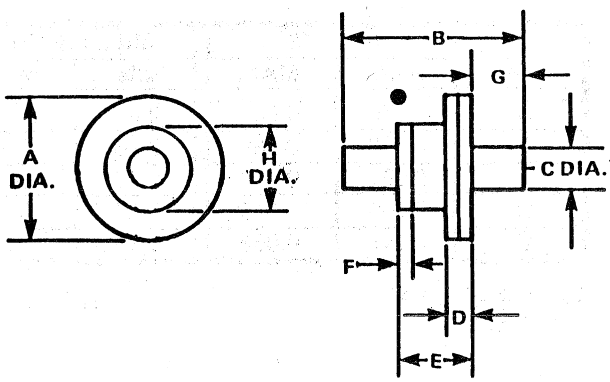
96



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.070	0.080	1,78	2,03
C	0.047	0.053	1,19	1,35
D	0.040	0.050	1,02	1,27
E	0.024	0.026	0,61	0,66
F	0.004	0.010	0,10	0,25
G	— —	0.015	— —	0,38

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

97

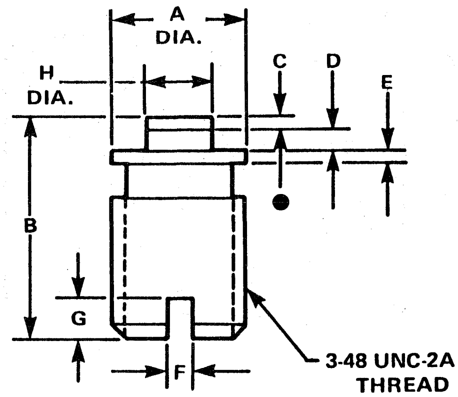


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.100	0.110	2,54	2,79
C	0.024	0.026	0,61	0,66
D	— —	0.015	— —	0,38
E	0.040	0.050	1,02	1,27
F	0.004	0.010	0,10	0,25
G	0.029	0.031	0,74	0,79
H	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

Case Styles (Cont'd)

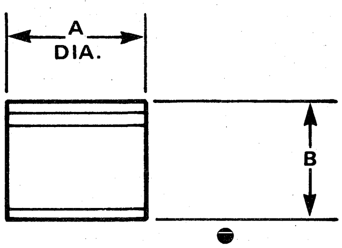
118



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.098	0.102	2,49	2,59
B	0.165	0.185	4,19	4,70
C	0.008	0.012	0,20	0,30
D	0.014	0.018	0,36	0,46
E	0.009	0.011	0,23	0,28
F	0.015	0.025	0,38	0,64
G	0.025	0.045	0,64	1,14
H	0.048	0.052	1,22	1,32

C_P = 0.22 pF Typical
L_S = 0.16 nH Typical

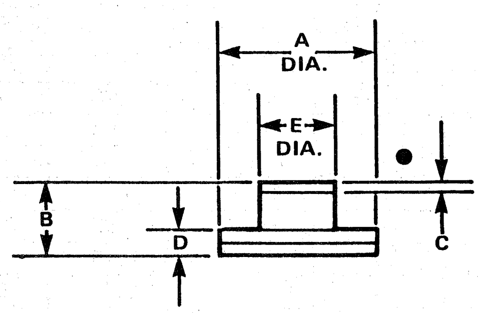
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

126

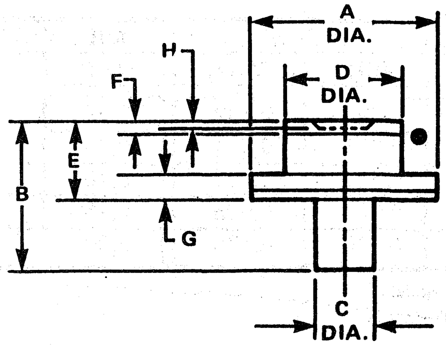


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.079	0.087	2,01	2,21
B	0.030	0.038	0,76	0,97
C	0.002	0.006	0,05	0,15
D	0.009	0.015	0,23	0,38
E	0.047	0.053	1,19	1,35

C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

Case Styles (Cont'd)

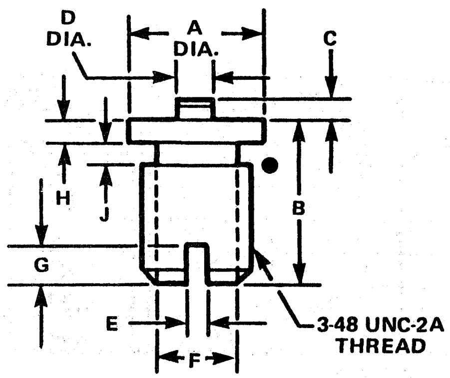
128



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.077	0.083	1,96	2,11
B	0.0545	0.0675	1,384	1,715
C	0.022	0.028	0,56	0,71
D	0.047	0.053	1,19	1,35
E	0.0295	0.0325	0,749	0,826
F	0.002	0.007	0,05	0,18
G	0.010	0.015	0,25	0,38
H	0.0015	0.0030	0,038	0,076

C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

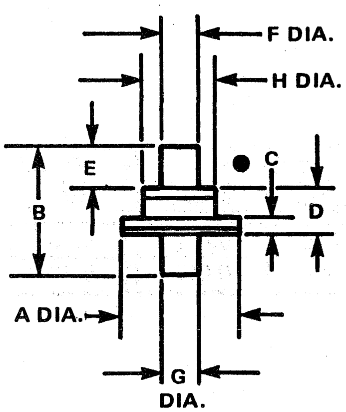
138



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.113	0.118	2,87	3,00
B	0.140	0.145	3,56	3,68
C	0.016	0.019	0,41	0,48
D	0.027	0.034	0,69	0,86
E	0.015	0.025	0,38	0,64
F	0.068	0.070	1,73	1,78
G	0.025	0.045	0,64	1,14
H	0.018	0.022	0,46	0,56
J	0.015	0.025	0,38	0,64

C_P = 0.18 pF Typical
L_S = 0.10 nH Typical

168

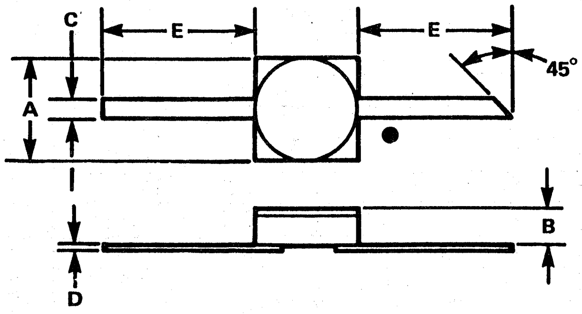


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.079	0.081	2,01	2,06
B	0.084	0.096	2,13	2,49
C	0.008	0.010	0,20	0,25
D	0.028	0.032	0,71	0,81
E	0.028	0.032	0,71	0,81
F	0.024	0.026	0,61	0,66
G	0.024	0.026	0,61	0,66
H	0.049	0.051	1,24	1,30

C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

Case Styles (Cont'd)

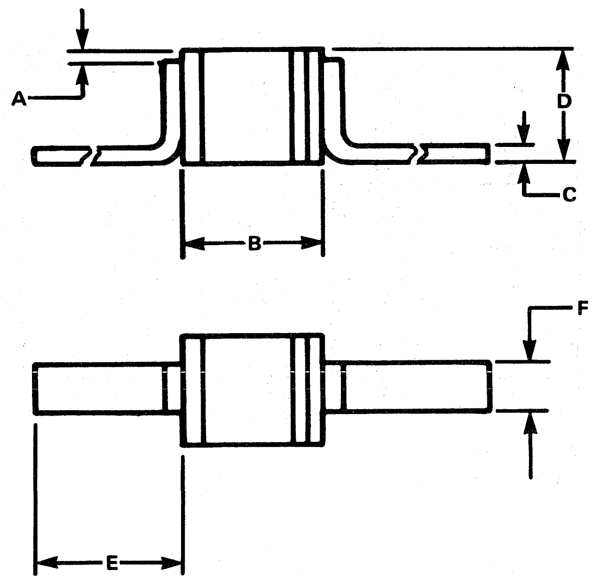
186



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0,76	0,15
E	0.130	0.170	3,30	4,32

$C_P \approx 0.15$ Typical
$L_S \approx 0.40$ nH Typical

276

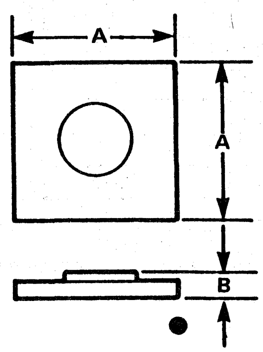


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.020	0.025	0,058
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

Chip Style

277

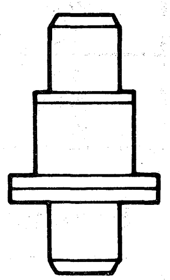


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.012	0,25	0,31
B	0.004	0.005	0,10	0,13

MA45200 Series

Silicon Abrupt Junction Tuning Varactors

30



Features

- HIGH Q
- LOW LEAKAGE
- AVAILABLE IN CHIP FORM
- AVAILABLE IN CERAMIC PACKAGES
- CUSTOM DESIGNS AVAILABLE
- LOW POST TUNING DRIFT
- FREQUENCY RANGE VHF — Ku-BAND
- CAN BE SCREENED TO TX, TXV SPECIFICATIONS

Description

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

Applications

The MA45200 series of silicon tuning diodes is ideally suited for frequency tuning applications through Ku band. These devices are designed for use in solid state electronic tuning of transistor, Gunn and IMPATT oscillators.

Specifications @ $T_A = 25°C$

30 Volt Silicon Abrupt Junction Tuning Varactors — Nominal Characteristics

Model[1] Number	Minimum[6] V_b (Volts)	Total[2,7] Capacitance (pF)	Minimum[3,7] Capacitance Ratio Ct_0/Ct_{Vb}	Minimum[4] "Q"	Frequency Range (GHz)	Available[1,7] Case Style (Chip)
MA45225	30	0.5	2.7	5500	10-12	132
MA45226	30	0.6	2.9	5500	9-11	132
MA45227	30	0.8	2.9	5000	8-10	132
MA45228	30	1.0	3.0	4800	7-9	132
MA45229	30	1.2	3.2	4800	6-8	132
MA45230	30	1.5	3.3	4500	6-8	132
MA45231	30	1.8	3.5	4000	5-7	132
MA45232	30	2.2	3.6	4000	5-7	132
MA45233	30	2.7	3.7	4000	4-6	132
MA45234	30	3.3	3.7	3500	4-6	132
MA45235	30	3.9	3.8	3500	3-5	132
MA45236	30	4.7	3.8	3000	2-4	132
MA45237	30	5.6	3.9	3000	2-4	132
MA45238	30	6.8	3.9	3000	2-4	132
MA45239	30	8.2	3.9	2700	1-2	132
MA45240	30	10.0	4.0	2500	1-2	132
MA45241	30	12.0	4.0	2200	.5-1.0	132
MA45242	30	15.0	4.0	2000	.5-1.0	132

45 Volt Silicon Abrupt Junction Tuning Varactors — Nominal Characteristics

Model[1] Number	Minimum[6] V_b (Volts)	Total[2,7] Capacitance (pF)	Minimum[3,7] Capacitance Ratio Ct_0/Ct_{Vb}	Minimum[4] "Q"	Frequency Range (GHz)	Available[1,7] Case Style (Chip)
MA45245	45	0.5	3.3	4000	9-11	132
MA45246	45	0.6	3.7	4000	8-10	132
MA45247	45	0.8	3.9	3800	5-7	132
MA45248	45	1.0	4.0	3500	5-7	132
MA45249	45	1.2	4.2	3500	4-6	132
MA45250	45	1.5	4.4	3300	4-6	132
MA45251	45	1.8	4.6	3000	3-5	132
MA45252	45	2.2	4.8	2700	3-5	132
MA45253	45	2.7	5.5	2700	2-3	132
MA45254	45	3.3	5.2	2400	2-3	132
MA45255	45	3.9	5.3	2200	1.5-2.5	132
MA45256	45	4.7	5.4	2000	1.0-1.5	132
MA45257	45	5.6	5.4	2000	1.0-1.5	132
MA45258	45	6.8	5.4	1800	1.0-1.5	132
MA45259	45	8.2	5.4	1700	1.0-1.5	132

NOTES

1. Case style 30 is the standard enclosure for this series. On special order, these devices are also available in other case styles including 31, 94, 96, 108, and in chip form. To order the MA45200 series in chip form or other case styles, add the designated available case number as a suffix to the model number, i.e., MA45229-132 is a chip or MA45229-96 is in the 96 case style.
2. Total capacitance is measured at 1 MHz and −4 volts. The standard capacitance is ± 10%. A tighter tolerance ±5% may be obtained, at an additional cost, by adding the suffix "A" to the basic model number.
3. The total capacitance ratio will vary with different packages due to differences in package parasitic capacitance.
4. Diode Q at −4 volts is determined at 1.0 GHz and extrapolated to 50 MHz by:

$$Q_{-4} = \frac{1}{2\pi f \, C_{j-4} R_s}$$

5. Reverse leakage current is measured at 80% of the minimum breakdown voltage and will be 20 nanoamperes maximum.
6. Reverse leakage is 10 microamperes maximum at minimum breakdown voltage.
7. The total capacitance and capacitance ratios shown are for diodes housed in case style 30. Other cases and chip styles will result in slightly different values.

Specifications @ T_A = 25°C (Cont'd)

60 Volt Silicon Abrupt Junction Tuning Varactors — Nominal Characteristics

Model[1] Number	Minimum[6] V_b (Volts)	Total[2,7] Capacitance (pF)	Minimum[3,7] Capacitance Ratio Ct_0/Ct_{V_b}	Minimum[4] "Q"	Frequency Range (GHz)	Available[1,7] Case Style (Chip)
MA45260	60	0.6	4.5	2500	4-6	132
MA45261	60	0.8	4.5	2300	4-6	132
MA45262	60	1.0	4.8	2200	4-6	132
MA45263	60	1.2	5.2	2000	2-4	132
MA45264	60	1.5	5.6	1800	2-4	132
MA45265	60	1.8	5.9	1800	2-4	132
MA45266	60	2.2	6.0	1700	1.5-2.0	132
MA45267	60	2.7	6.2	1700	1.5-3.0	132
MA45268	60	3.3	6.3	1600	1.5-3.0	132
MA45269	60	3.9	6.4	1500	1.0-2.0	132
MA45270	60	4.7	6.5	1400	1.0-2.0	132
MA45271	60	5.6	6.5	1400	1.0-2.0	132
MA45272	60	6.8	6.5	1200	0.5-1.0	132
MA45273	60	8.2	6.8	1200	0.5-1.0	132
MA45274	60	10.0	7.0	1000	0.5-1.0	132
MA45275	60	12.0	7.0	1000	0.5-1.0	131
MA45276	60	15.0	7.2	900	0.25-0.50	131
MA45277	60	18.0	7.2	900	0.25-0.50	131
MA45278	60	22.0	7.4	800	0.25-0.50	131
MA45279	60	27.0	7.4	800	0.10-0.25	131
MA45280	60	33.0	7.4	700	0.10-0.25	131

90 Volt Silicon Abrupt Junction Tuning Varactors — Nominal Characteristics

Model[1] Number	Minimum[6] V_b (Volts)	Total[2,7] Capacitance (pF)	Minimum[3,7] Capacitance Ratio Ct_0/Ct_{V_b}	Minimum[4] "Q"	Frequency Range (GHz)	Available[1,7] Case Style (Chip)
MA45290	90	1.0	6.0	1500	2.0-4.0	132
MA45291	90	1.2	6.5	1200	2.0-4.0	132
MA45292	90	1.5	7.0	1100	2.0-4.0	132
MA45293	90	1.8	7.3	1000	2.0-4.0	132
MA45294	90	2.2	7.5	900	1.5-3.0	132
MA45295	90	2.7	7.8	900	1.5-3.0	132
MA45296	90	3.3	8.0	800	1.0-2.0	132
MA45297	90	3.9	8.3	800	1.0-2.0	132
MA45298	90	4.7	8.5	700	1.0-2.0	132
MA45299	90	5.6	8.8	600	0.5-1.0	132

See notes on previous page.

MAXIMUM RATINGS

Reverse Voltage	Same as rated breakdown V_b
Operating Temperature	−65°C to +150°C
Storage Temperature	−65°C to +200°C
Temperature Coefficient	300 ppm/°C at −4 Volts
Power Dissipation	Cj = 1.0 pF max. @100mW
(derate linearly to zero at 150°C)	Cj = 1.0 pF min. @200mW

ENVIRONMENTAL PERFORMANCE

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

HIGH RELIABILITY PARTS

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

Typical Performance Curves

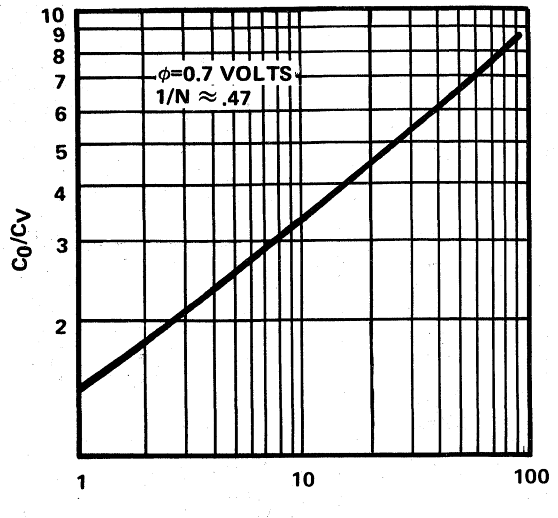


FIGURE 1. Typical Capacitance Change Ratios for Silicon Tuning Varactor Chips

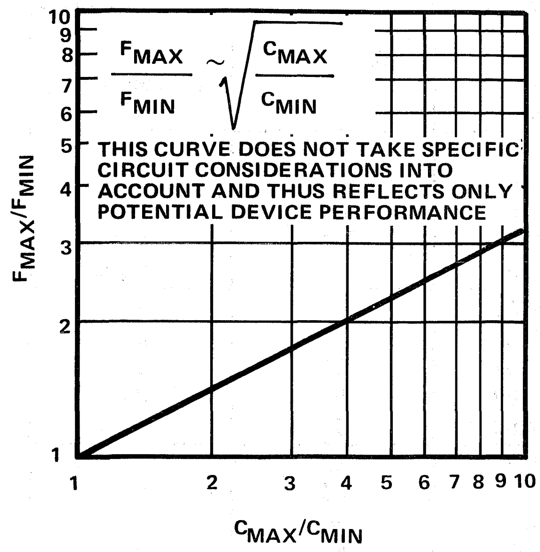


FIGURE 2. Frequency Tuning Ratio as a Function of Capacitance Change Ratio

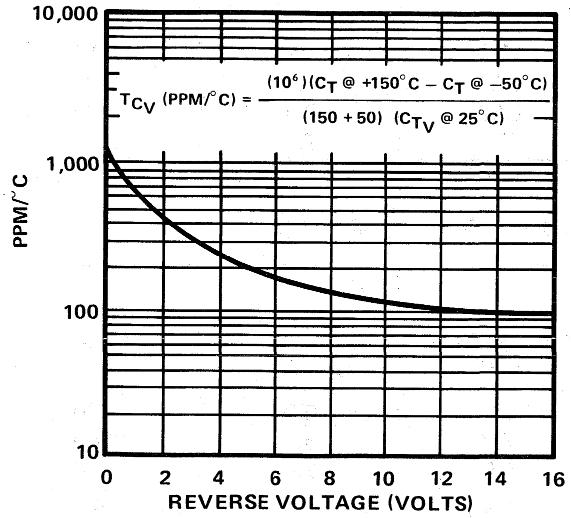


FIGURE 3. Typical Temperature Coefficient of Silicon Varactors

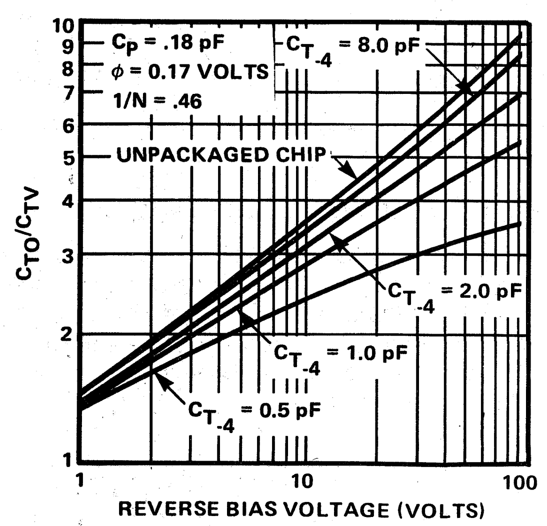


FIGURE 4. Typical Capacitance Change Ratios for Silicon Tuning Varactors in Case Styles 30, 31 & 108

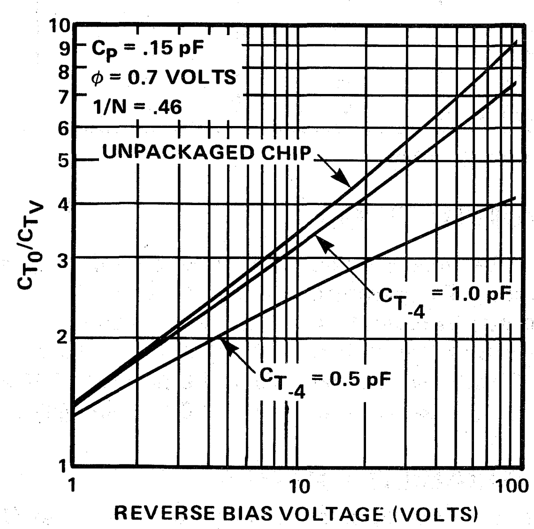


FIGURE 5. Typical Capacitance Change Ratios for Silicon Tuning Varactors in Case Styles 94 and 96

Application Notes

Capacitance Change Ratio

The capacitance change between any two reverse bias voltages for a silicon abrupt junction tuning varactors in chip form is given by:

(1)

$$\frac{C_{jV_1}}{C_{jV_2}} = \left(\frac{V_2 + \theta}{V_1 + \theta}\right)^{\gamma}$$

where:

C_{jV_1} = Junction capacitance at reverse voltage (V_1)
C_{jV_2} = Junction capacitance at reverse voltage (V_2)
θ = Contact potential (0.7 volts for silicon)
V_1 = Reverse bias voltage at point 1
V_2 = Reverse bias voltage at point 2
γ = Gamma (exponential of the C-V curve)
$\gamma \cong .47$ for MA45200 series

The junction capacitance ratio for a chip, between zero volts and any reverse bias voltage (V) simplifies to:

(2)

$$C_{j0}/C_{jV} = 1 + \frac{V}{\theta}^{\gamma}$$

The diode capacitance ratio given in Equation 1 diminishes when the semiconductor chip is enclosed in a hermetic package. The amount of decrease depends on the value of case capacitance (C_p) and its relative magnitude with respect to the chip junction capacitance (C_j). The total capacitance (C_T) of the packaged diode at any reverse voltage (V) is given by:

(3)

$$C_{TV} = C_P + C_{jV}$$

The total capacitance tuning ratio from zero to any reverse bias voltage is shown in Figures 1 and 2 and for all the standard tuning diode packages as a function of reverse bias and total capacitance at −4 volts (C_{t-4}). From these plots, the total capacitance ratio between any two voltage levels can be obtained by dividing (C_{t0}/C_{TV_2}) by (C_{t0}/C_{TV_1}) to yield (C_{jV_1}/C_{jV_2}). Figures 1 and 2 show the typical total capacitance vs ($V_R + \theta$) for each device in this series. For a more in-depth discussion on capacitance change ratio see M/A-COM Semiconductor Products Inc., SPI-MISER article, "Tuning Varactor Diode Selection Guide," 1986.

Varactor Q

The Q of tuning varactors is historically given at a frequency of 50 MHz and a reverse bias voltage of -4 volts. This is determined by using the 1 GHz series resistance and a 1 MHz capacitance measure, Q @ 50 MHz is:

$$Q_{50}\ \text{MHz} = \frac{3183}{(R_{S-4})\,(C_{j-4})}$$

where:

R_S = series resistance (ohms) measured at −4 volts
C_{j-4} = junction capacitance at −4 volts (pF).

1 GHz R_S MEASUREMENT

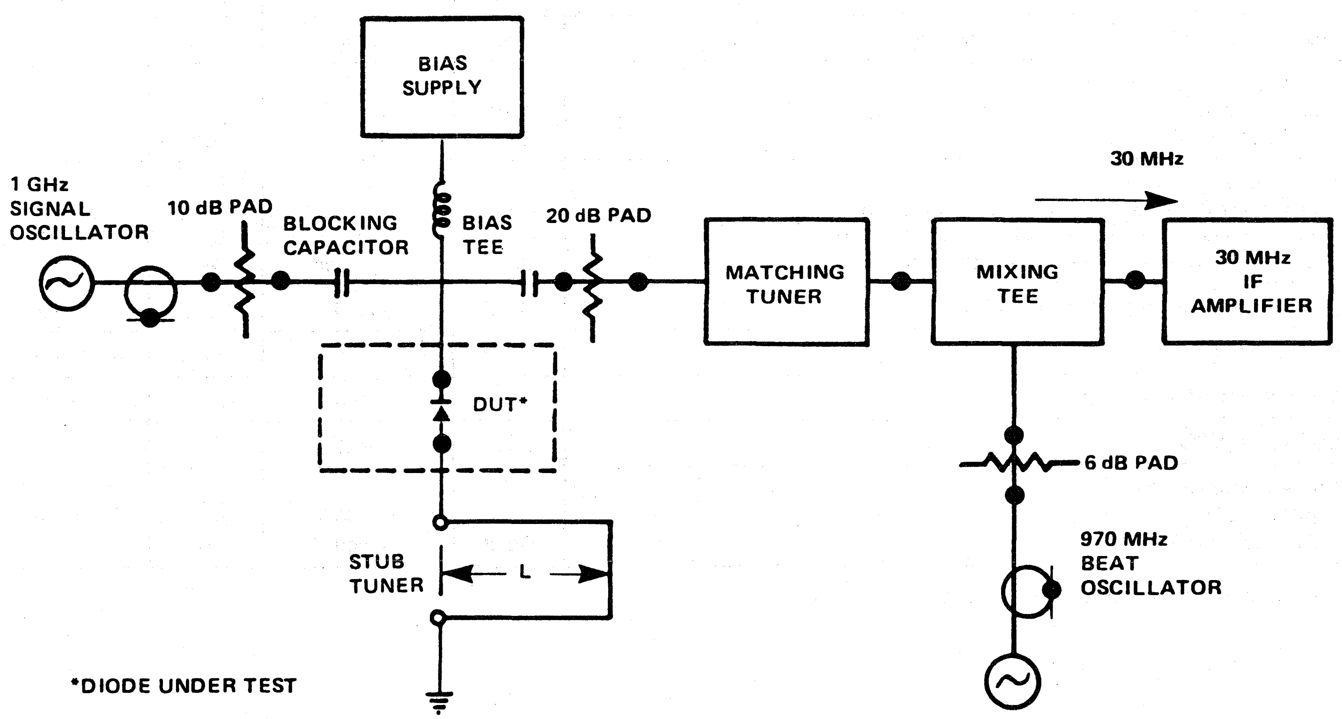


TABLE 1. COMPARISON OF RELATIVE PERFORMANCE OF DIFFERENT TUNING VARACTOR CHARACTERISTICS

Varactor Type	Linear Tuning	Harmonic Content	Q or Loss	Post Tuning Drift Charac.	Settle Time	Temp. Stability	Phase Noise	Residual FM	Normal (Max) Useful Tun. Range (Volts)	Noise Performance When Osc. Is Overdriven	Useful Cap. Change Obtainable (Maximum)
Si Abrupt	Fair	Good	Good	Very-Good	Good	Good-Best	Best	Best	0-60	Good	~6/1
Si Hyperabrupt	Good	Good	Fair	Very-Good	Best	Fair	Fair-Good	Fair-Good	2-20	Good	~12/1 to 15/1
GaAs Abrupt	Fair	Good	Best	Fair	Fair	Best	Good	Good	1-30	Poor	~5/1
GaAs Hyperabrupt	Good-Best	Good	Good	Fair	Fair	Fair	Fair-Good	Fair-Good	2-20	Poor	~6/1 to 12/1

TABLE II. CHOICE OF TUNING VARACTOR BY TYPE OF VOLTAGE CONTROLLED OSCILLATOR

	Silicon Abrupt	Silicon Hyperabrupt	GaAs Abrupt	GaAs Hyperabrupt
ECM VCO With Post Tuning Drift Requirements				
A) To 10 GHz	Good	Best	Fair	Fair
B) Above 12 GHz	Fair	Good	Good	Best
Telecommunication Phase Locked Oscillator	Fair	Good	Good	Best
VCOs for Tuned Synthesizers				
A) Instruments and Telecommunication	Best	Good	— —	— —
B) Radar Synthesizers	Good	— —	Best	Good
Radar Local Oscillators				
A) Frequency Agile Radar (Using Synthesizer)	Good	Good	Good	Best
B) Frequency Agile Radar (Using Tuned Exciter)	Good	Best	Good	Very Good
C) Marine/Weather Radar Local Oscillator	Good	Fair-Good	Best	Good
Telecommunications Transmitter VCOs	Good	Good	Good	Best
Missile Seeker	Good	Fair	Good	Best
Doppler Radar/Motion Detector VCOs	Good	Good	Good	Best
Instrument VCO	Good	Best	— —	— —
Police Radar Detectors				
A) 11.5 GHz VCO	— —	— —	Best	Good
B) 1 GHz VCO	Good	Good	— —	Best

— — Denotes not normal usage for this type of varactor.

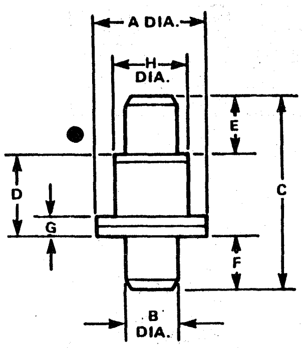
TABLE III.

		Suggested Tuning Varactor By Type of VCO			
	Frequency	Silicon Abrupt	Silicon Hyperabrupt	GaAs Abrupt	GaAs Hyperabrupt
ECM VCO With Post Tuning Drift Specification	C		4ST554		
	X		4ST551		
	Ku		—		46580
Telecommunication P.L.O.	L	45238	4ST533		46485
	C	45230	4ST554		46476
	X	45350	4ST551	46602	46471
VCO For Tuned Synthesizer	UHF	45350	4ST533		
	VHF	45355	4ST522		
Radar LO					
A) Frequency Agile Radar Synthesizer	VHF	45351	4ST522		
B) Tuned Exciter	X	45226	4ST551	46602	46471
	Ku	45225	—	46601	46470
C) Marine/Weather Radar LO	X	45226	4ST551	46602	
Telecommunications Transmitter (VCO)	C	45230	4ST554	46609	46456
	X		4ST551	46602	46451
	Ku		—	46601	46450-94
	K		—	46600	46450-94
Missile Seeker	X	45227C	4ST551	46602	46581
	Ku	45226C	—	46601	46580
Doppler Radar/Motion Detection	X		—	46602	
Instrument VCO	UHF	45350	4ST533		
	VHF	45355	4ST522		
PRD Radar Detector					
11 GHz VCO	X		4ST551	46602	46471
1 GHz VCO	L	45346	4ST533		
UHF/Mobile Radio VCO			4ST533		
VHF/Mobile Radio VCO			4ST522		

Case Styles

● DENOTES CATHODE NOT TO SCALE

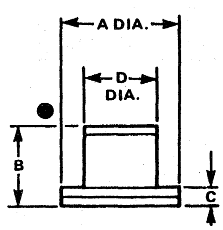
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

31

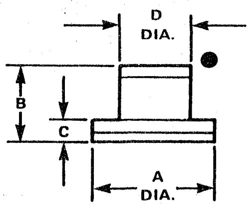


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

Case Styles (Cont'd)

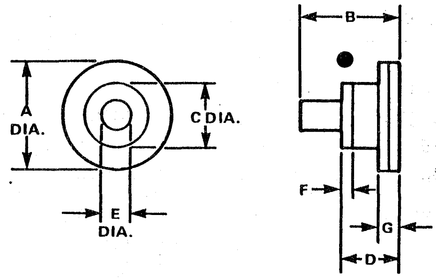
94



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

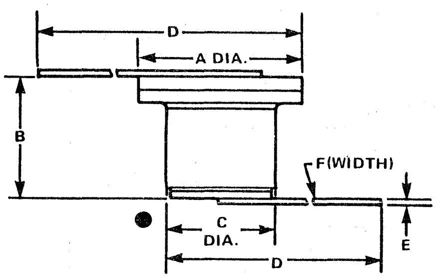
96



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.070	0.080	1,78	2,03
C	0.047	0.053	1,19	1,35
D	0.040	0.050	1,02	1,27
E	0.024	0.026	0,61	0,66
F	0.004	0.010	0,10	0,25
G	— —	0.015	— —	0,38

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

108

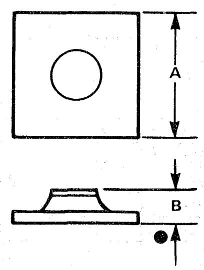


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.077	0.083	1,96	2,11
D	0.975	1.025	24,77	26,04
E	0.002	0.004	0,05	0,09
F	0.077	0.083	1,96	2,11

$C_P \approx$ 0.18 pF Typical
L_S = 0.60 nH Typical

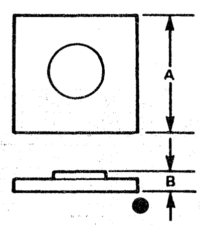
Chip Styles

131



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.030	0.035	0,76	0,89
B	0.003	0.006	0,08	0,15

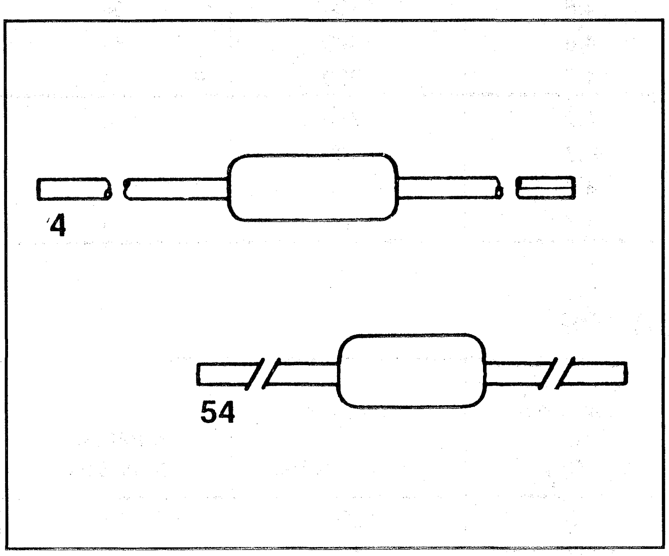
132



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.020	0.024	0,51	0,61
B	0.003	0.006	0,08	0,15

MA45300 Series

Axial Lead Silicon Planar Abrupt Tuning Varactors



Description

The MA45300 series of silicon planar abrupt junction tuning varactors has been designed to obtain the highest Q possible. All devices in this series have a high density silicon dioxide passivation which results in exceptionally low leakage currents and low post tuning drift. These diodes are available in axial lead glass packages, case style 4 or 54 as designated.

Features

- HIGH Q
- LOW LEAKAGE
- LOW POST TUNING DRIFT
- CUSTOM DESIGNS AVAILABLE
- FREQUENCY RANGE THROUGH X-BAND
- CAN BE SCREENED TO TX, TXV SPECIFICATIONS

Applications

This series of silicon planar abrupt tuning varactors is specifically designed for low leakage applications through X-band for stripline, microstrip, waveguide, coaxial or lumped circuit environments. Silicon planar abrupt junction tuning varactors can be used in applications for the electronic tuning of transistor, Gunn or IMPATT oscillators as well as tunable filters, phase shifters and pre-selectors.

Specifications @ T_A = 25°C

30 VOLT AXIAL LEAD SILICON TUNING VARACTORS

Model[1] Number	Minimum[2] V_b (Volts)	Total[3] Capacitance (pF)	Minimum Capacitance Ratio $C_{t_0}/C_{t_{Vb}}$	Minimum[4] "Q" (@ −4 Volts)	Available Case Style
MA45330	30	4.7	4.5	1800	54
MA45331	30	5.6	4.5	1700	54
MA45332	30	6.8	4.5	1600	54
MA45333	30	8.2	4.5	1500	54
MA45334	30	10.0	4.6	1300	54
MA45335	30	12.0	4.6	1200	54
MA45336	30	15.0	4.6	1200	54
MA45337	30	18.0	4.6	1100	54
MA45338	30	22.0	4.6	1000	54
MA45339	30	27.0	4.7	900	4
MA45340	30	33.0	4.7	750	4
MA45341	30	39.0	4.7	500	4
MA45342	30	47.0	4.7	400	4
MA45343	30	56.0	4.7	300	4

45 VOLT AXIAL LEAD SILICON TUNING VARACTORS

Model[1] Number	Minimum[2] V_b (Volts)	Total[3] Capacitance (pF)	Minimum Capacitance Ratio $C_{t_0}/C_{t_{Vb}}$	Minimum[4] "Q" (@ −4 Volts)	Available Case Style
MA45345	45	4.7	5.6	1500	54
MA45346	45	5.6	5.7	1400	54
MA45347	45	6.8	5.8	1300	54
MA45348	45	8.2	5.8	1200	54
MA45349	45	10.0	5.9	1000	54
MA45350	45	12.0	5.9	1000	54
MA45351	45	15.0	5.9	800	4
MA45352	45	18.0	5.9	800	4
MA45353	45	22.0	5.9	600	4
MA45354	45	27.0	6.0	600	4
MA45355	45	33.0	6.0	400	4
MA45356	45	39.0	6.0	400	4
MA45357	45	47.0	6.0	300	4
MA45358	45	56.0	6.0	250	4

NOTES
1. All silicon planar abrupt junction varactors in this series are available as standard products in the axial lead glass package, case style 4 or 54 as designated.
2. Breakdown voltage is measured at 10 microamps of reverse bias current.
3. Standard capacitance tolerances are ±10%. A tighter tolerance (±5%) may be obtained by adding the suffix "A" to the diode model number.
4. Diode Q is calculated at −4 volts and 50 MHz using values of R_S measured at 500 MHz and values of junction capacitance measured at 1 MHz.

Specifications @ T_A = 25°C

60 VOLT AXIAL LEAD SILICON TUNING VARACTORS

Model[1] Number	Minimum[2] V_b (Volts)	Total[3] Capacitance (pF)	Minimum Capacitance Ratio $C_{t_0}/C_{t_{Vb}}$	Minimum[4] "Q" (@ −4 Volts)	Available Case Style
MA45360	60	4.7	7.2	1000	54
MA45361	60	5.6	7.2	900	54
MA45632	60	6.8	7.2	800	54
MA45263	60	8.2	7.2	750	54
MA45264	60	10.0	7.3	700	54
MA45365	60	12.0	7.3	650	4
MA45366	60	15.0	7.3	600	4
MA45367	60	18.0	7.3	500	4
MA45368	60	22.0	7.3	400	4
MA45369	60	27.0	7.4	350	4
MA45370	60	33.0	7.4	300	4
MA45371	60	39.0	7.4	250	4
MA45372	60	47.0	7.4	250	4

See notes on previous page

MAXIMUM RATINGS

Reverse Voltage	Same as rated breakdown V_b
Operating Temperature	−65° C to +150° C
Storage Temperature	−65° C to +150° C
Temperature Coefficient	300ppm/°C at −4 volts
Power Dissipation	Case Style 4 @ 250mW
(derate linearly to zero at 150°C)	Case Style 54 @ 200mW

HIGH RELIABILITY PARTS

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

ENVIRONMENTAL PERFORMANCE

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

Typical Performance Curves

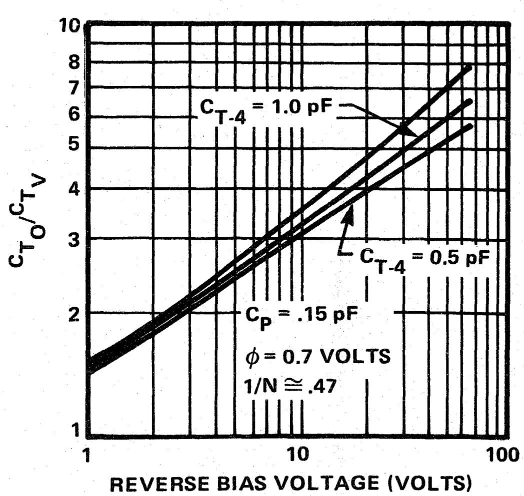


FIGURE 1. Typical Capacitance Change Ratio for Silicon Tuning Varactors in Case Style 4.

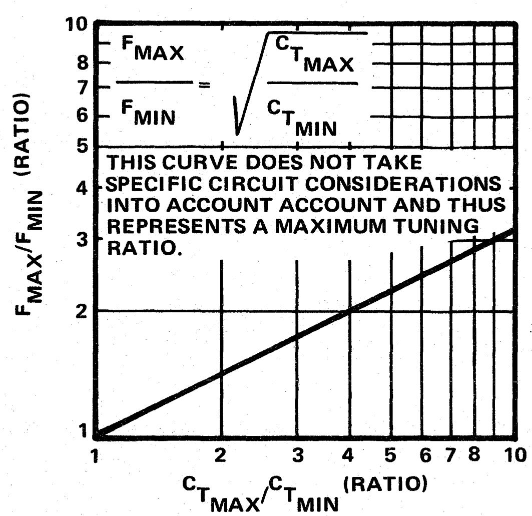


FIGURE 2. Frequency Tuning Ratio as a Function of Total Capacitance Change Ratio.

Application Notes

Capacitance Change Ratio

The capacitance change between any two reverse bias voltages for a silicon abrupt junction tuning varactor in chip form is given by:

$$\frac{C_{jV_1}}{C_{jV_2}} = \left(\frac{V_2 + \theta}{V_1 + \theta}\right)^{\gamma}$$

where:

C_{jV_1} = Junction capacitance at reverse voltage (V_1)
C_{jV_2} = Junction capacitance at reverse voltage (V_2)
θ = Contact potential (0.7 volts for silicon)
V_1 = Reverse bias voltage at point 1
V_2 = Reverse bias voltage at point 2
γ = Gamma (exponential of the C-V curve)
$\gamma \cong .47$ for MA45300 series

The junction capacitance ratio for a chip, between zero volts and any reverse bias voltage (V) simplifies to:

$$C_{j0}/C_{jV} = 1 + \left(\frac{V}{\theta}\right)^{\gamma}$$

The diode capacitance ratio given in Equation 1 diminishes when the semiconductor chip is enclosed in a hermetic package. The amount of decrease depends on the value of case capacitance (C_p) and its relative magnitude with respect to the chip junction capacitance (C_j). The total capacitance (C_T) of the packaged diode at any reverse voltage (V) is given by:

$$C_{TV} = C_P + C_{jV}$$

The total capacitance tuning ratio from zero to any reverse bias voltage is shown in Figures 1 and 2 and for the standard tuning diode packages as a function of reverse bias and total capacitance at −4 volts (C_{t-4}). From these plots, the total capacitance ratio between any two voltage levels can be obtained by dividing (C_{t0}/C_{TV_2}) by (C_{t0}/C_{TV_1}) to yield (C_{jV_1}/C_{jV_2}). Figures 1 and 2 show the typical total capacitance vs ($V_R + \theta$) for each device in this series. For a more in-depth discussion on capacitance change ratio see M/A-COM Semiconductor Products Inc., SPI-MISER article, "Tuning Varactor Diode Selection Guide," 1986.

Varactor Q

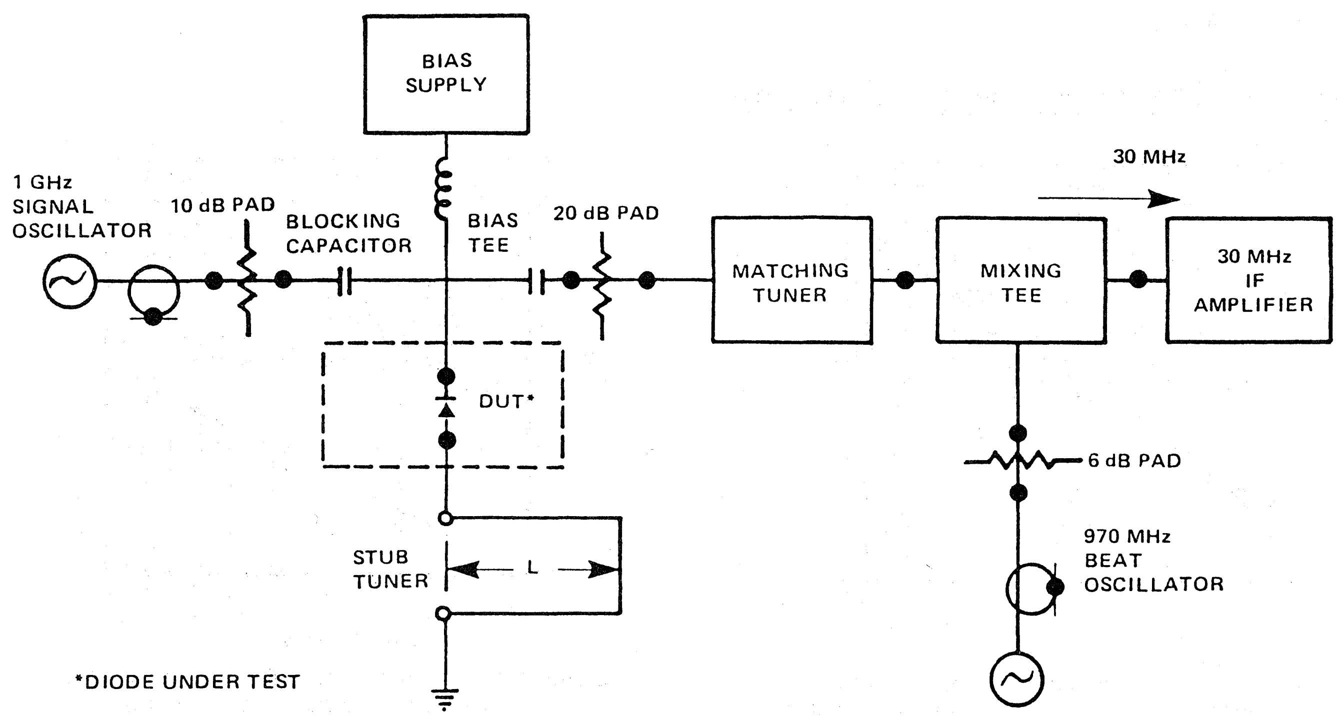
The Q of tuning varactors is historically given at a frequency of 50 MHz and a reverse bias voltage of -4 volts. This is determined by using the 1 GHz series resistance and a 1 MHz capacitance measure, Q @ 50 MHz is:

$$Q_{50}\text{ MHz} = \frac{3183}{(R_{S-4})\,(C_{j-4})}$$

where:

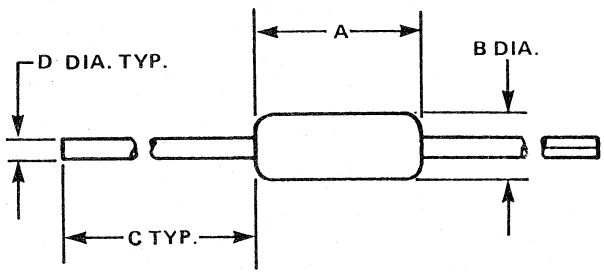
R_S = series resistance (ohms) measured at −4 volts
C_{j-4} = junction capacitance at −4 volts (pF).

1 GHz R_S MEASUREMENT



Case Styles

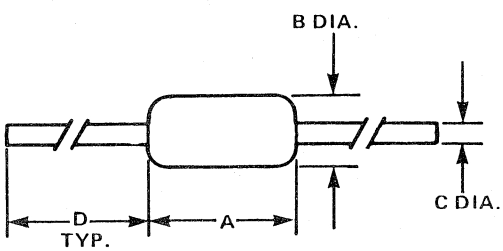
4



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.230	0.300	5,84	7,62
B	0.085	0.107	2,16	2,72
C	1.000	— —	25,40	— —
D	0.018	0.022	0,46	0,56

C_P = 0.15 pF Typical
L_S = 2.50 nH Typical

54



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

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

All specifications are subject to change without notice.

Schottky Diodes

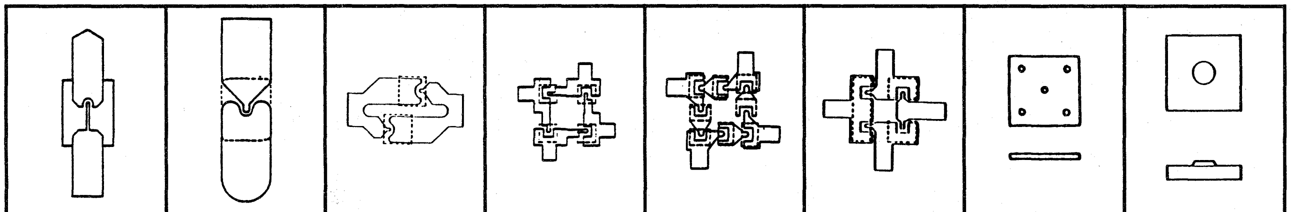
(Continued on next page)

SCHOTTKY DIODES (Cont'd)

(Continued on next page)

SCHOTTKY DIODES (Cont'd)

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION
SILICON SCHOTTKY MIXER DIODE
CHIP & BEAM LEAD SELECTION GUIDE

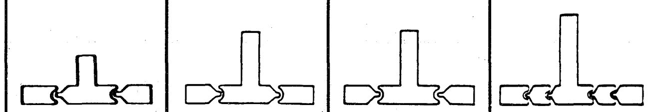


Frequency Band	ODS-990(1) Single Beam Lead (#4232)*	ODS-965(2) Single Beam Lead (#4232)*	ODS-942 Anti-Parallel (#4229)*	ODS-264 Quad (#4228)*	ODS-905 Dual Quad (High Barrier) (#4228)*	ODS-906 Bridge Quad (#4228)*	ODS-135 5 Dot Chip (#4228)*	ODS-902 Chip (#4236)*
100 MHz - 3 GHz								
Low Barrier						4E402L-906		4E968
Medium Barrier						4E402M-906		4E969
High Barrier						4E402H-906		4E970
					40482-905			
3 - 6 GHz								
Low Barrier	40297	40132		40437		4E402L-906		4E971
Medium Barrier	40298	40134		40448		4E402M-906		4E972
High Barrier	40299	40136		40487		4E402H-906		4E973
					40482-905			
6 - 12 GHz								
Low Barrier	40297	40132	40279L	40437		4E401L-906	40137	
Medium Barrier	40298	40134	40279M	40448		4E401M-906	40138	
High Barrier	40299	40136	40279H	40487		4E401H-906	40139	
					40483-905			
12 - 18 GHz								
Low Barrier	40287	40131	40278L	40438		4E400L-906	40120	
Medium Barrier	40288	40133	40278M	40450		4E400M-906	40170	
High Barrier	40289	40135	40278H	40488		4E400H-906	4E192	
					40484-905			
18 - 40 GHz								
Low Barrier			40278L				4E915	
Medium Barrier			40278M				4E921	
High Barrier			40278H				4E927	

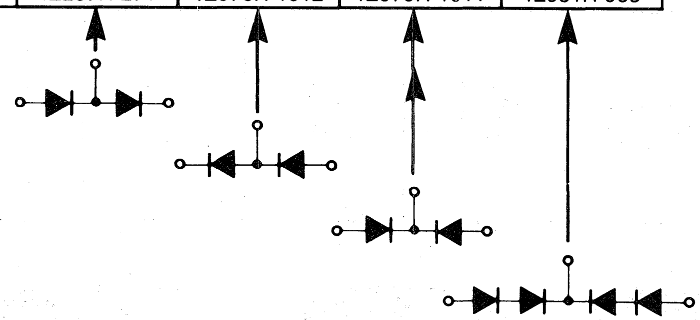
NOTES: 1) - Isoplanar Construction
2) - Planar Construction

*For more information request indicated Bulletin.

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION
SCHOTTKY BARRIER BEAM LEAD TEES
SELECTION GUIDE



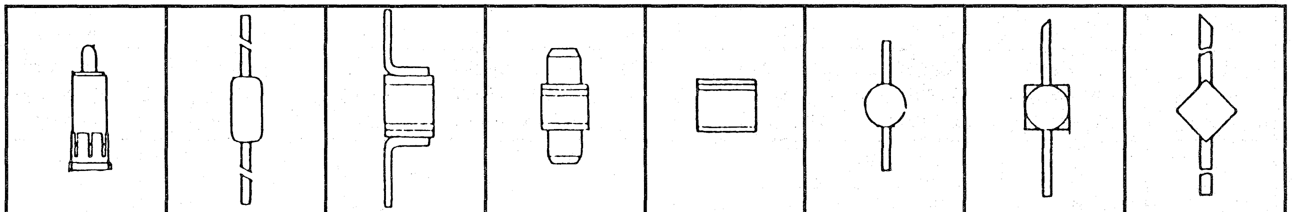
Frequency Band	ODS-271 Forward Tees	ODS-1012 Reverse Tees	ODS-1011 Common Cathode Tees	ODS-968 Dual Barrier Tees
100 MHz - 3.0 GHz				
Low Barrier	4E201L-271	4E974L-1012	4E977L-1011	
Medium Barrier	4E201M-271	4E974M-1012	4E977M-1011	
High Barrier	4E201H-271	4E974H-1012	4E977H-1011	
3.0 - 6.0 GHz				
Low Barrier	4E204L-271	4E975L-1012	4E978L-1011	
Medium Barrier	4E204M-271	4E975M-1012	4E978M-1011	
High Barrier	4E204H-271	4E975H-1012	4E978H-1011	4E980H-968
6.0 - 12.0 GHz				
Low Barrier	4E204L-271	4E975L-1012	4E978L-1011	
Medium Barrier	4E204M-271	4E975M-1012	4E978M-1011	
High Barrier	4E204H-271	4E975H-1012	4E978H-1011	4E980H-968
12.0 - 18.0 GHz				
Low Barrier	4E207L-271	4E976L-1012	4E979L-1011	
Medium Barrier	4E207M-271	4E976M-1012	4E979M-1011	
High Barrier	4E207H-271	4E976H-1012	4E979H-1011	4E981H-968



For more information request Bulletin 4219

SILICON PACKAGED SCHOTTKY MIXER DIODES SELECTION GUIDE

N-TYPE MIXERS



Frequency Band (GHz)	Nominal Noise Fig. (dB)	ODS-3 Waveguide (#4233)*	ODS-54 Gen. Purpose (#4235)*	ODS-276 Stripline (#4238)*	ODS-119 Waveguide (#4233)*	ODS-120 Waveguide (#4233)*	ODS-137 Stripline (#4238)*	ODS-186 Stripline (#4238)*	ODS-213 Stripline (#4238)*
0.1 - 1.0	6.5 5.5		4883(M) 4882(M)						
1.0 - 4.0	7.5 7.0	 40051E(M)	4851(M)						
	6.5		4852(M)		40016(L) 40019(M) 40022(H)				
	6.0	40051F(M)			40017(L) 40020(M) 40023(H)				
	5.5	40051G(M)	4853(M)		40018(L) 40021(M) 40055(H)				
4.0 - 8.0	7.0						40035(L) 40030(M) 40039(H)		40038(L) 40046(M) 40056(H)
	6.0		4856(M) 4E183(H)	40106-276(L) 40156-276(M) 4E186-276(H)					
8.0 - 12.0	7.5	40071E(M)	4856(M)						
	7.0	40071F(M)	40104(L) 40154(M) 4E184(H)		40102(L) 40152(M) 4E182(H)	40107(L) 40157(M) 4E187(H)	40076(L) 40084(M) 40091(H)	40128(L) 40178(M) 4E199(H)	40077(L) 40085(M) 40092(H)
	6.5	40071G(M) 40050(H)	40103(L) 40153(M)	40106-276(L) 40156-276(M) 4E186-276(H)	40101(L) 40151(M) 4E181(H)	40106(L) 40156(M) 4E186(H)	40078(L) 40086(M) 40093(H)	40127(L) 40177(M) 4E198(H)	40079(L) 40087(M) 40094(H)
	6.0	40071H(M)	40183H	40105-276(L) 40155-276(M) 4E185-276(H)	40100(L) 40150(M) 4E180(H)	40105(L) 40155(M) 4E185(H)	40080(L) 40088(M) 40095(H)	40126(L) 40176(M) 4E197(H)	40083(L) 40089(M) 40096(H)

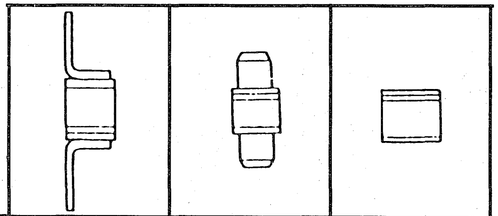
NOTE:
(L) = Low Barrier Diode
(M) = Medium Barrier Diode
(H) = High Barrier Diode

(*) — These letters are for information only; they are not part of the part number.

*For more information request indicated Bulletin.

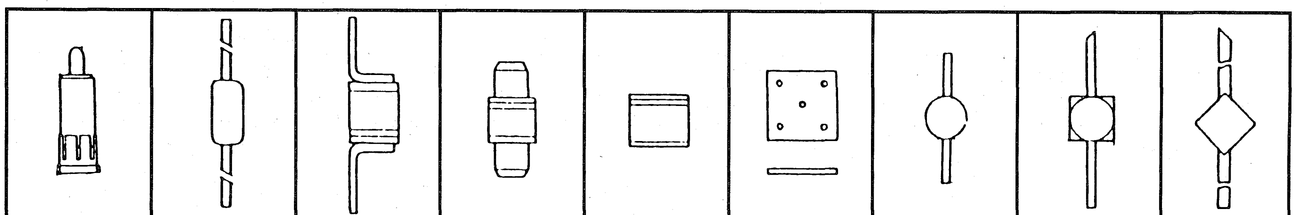
M/A-COM SEMICONDUCTOR PRODUCTS OPERATION
SILICON PACKAGED SCHOTTKY MIXER DIODES
SELECTION GUIDE (Cont'd)

N-TYPE MIXERS



Frequency Band (GHz)	Nominal Noise Fig. (dB)	ODS-276 Stripline (#4238)*	ODS-119 Waveguide (#4233)*	ODS-120 Waveguide (#4233)*
12.0 - 18.0	7.0	40116-276(L) 40166-276(M) 4E191-276(H)	40111(L) 40161(M) 4E189(H)	40116(L) 40166(M) 4E191(H)
	6.5	40115-276(L) 40165-276(M) 4E190-276(H)	40110(L) 40160(M) 4E188(H)	40115(L) 40165(M) 4E190(H)
18.0 - 26.0	8.0	4E911-276(L) 4E917-276(M) 4E923-276(H)	4E910(L) 4E916(M) 4E922(H)	4E911(L) 4E917(M) 4E923(H)
	7.5	4E914-276(L) 4E920-276(M) 4E926-276(H)	4E913(L) 4E919(M) 4E925(H)	4E914(L) 4E920(M) 4E926(H)

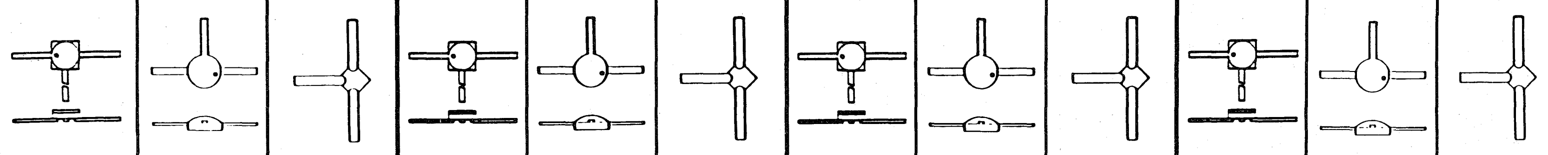
ZBD (LOW i/F NOISE) MIXERS
SELECTION GUIDE



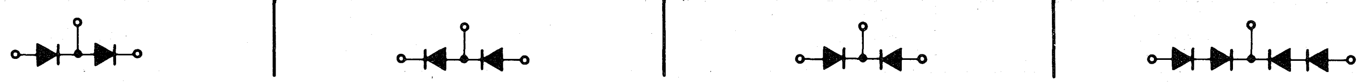
Frequency Band (GHz)	Nominal Noise Fig. (dB)	ODS-3 Waveguide (#4237)*	ODS-54 Gen. Purpose (#4237)*	ODS-276 Stripline (#4237)*	ODS-119 Waveguide (#4237)*	ODS-120 Waveguide (#4237)*	ODS-135 Chip (#4237)*	ODS-137 Stripline (#4237)*	ODS-186 Stripline (#4237)*	ODS-213 Stripline (#4237)*
6.0 - 12.0	12	40194	40192	40190-276	40191	40190	40193	40196	40197	40198
12.0 - 18.0	12			40182-276	40183	40182	40184			
18.0 - 26.0	12			40181-276	40181	40180				

*For more information request indicated Bulletin.

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION SILICON SCHOTTKY BARRIER PACKAGED TEES SELECTION GUIDE

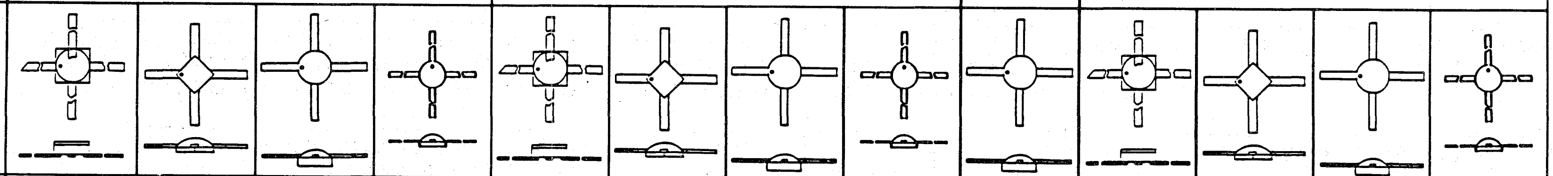


Frequency Band	Forward Tees			Reverse Tees			Common Cathode Tees			Dual Barrier Tees		
	ODS-270 Hermetic	ODS-272 Plastic	ODS-1000 Mini Tee	ODS-270 Hermetic	ODS-272 Plastic	ODS-1000 Mini Tee	ODS-270 Hermetic	ODS-272 Plastic	ODS-1000 Mini Tee	ODS-270 Hermetic	ODS-272 Plastic	ODS-1000 Mini Tee
100 MHz - 3 GHz												
Low Barrier	4E201L-270	4E201L-272	4E201L-1000	4E974L-270	4E974L-272	4E974L-1000	4E977L-270	4E977L-272	4E977L-1000			
Medium Barrier	4E201M-270	4E201M-272	4E201M-1000	4E974M-270	4E974M-272	4E974M-1000	4E977M-270	4E977M-272	4E977M-1000			
High Barrier	4E201H-270	4E201H-272	4E201H-1000	4E974H-270	4E974H-272	4E974H-1000	4E977H-270	4E977H-272	4E977H-1000			
3.0 - 6.0 GHz												
Low Barrier	4E204L-270	4E204L-272	4E204L-1000	4E975L-270	4E975L-272	4E975L-1000	4E978L-270	4E978L-272	4E978L-1000			
Medium Barrier	4E204M-270	4E204M-272	4E204M-1000	4E975M-270	4E975M-272	4E975M-1000	4E978M-270	4E978M-272	4E978M-1000			
High Barrier	4E204H-270	4E204H-272	4E204H-1000	4E975H-270	4E975H-272	4E975H-1000	4E978H-270	4E978H-272	4E978H-1000	4E980H-270	4E980H-272	4E980H-1000
6.0 - 12.0 GHz												
Low Barrier	4E204L-270	4E204L-272	4E204L-1000	4E975L-270	4E975L-272	4E975L-1000	4E978L-270	4E978L-272	4E978L-1000			
Medium Barrier	4E204M-270	4E204M-272	4E204M-1000	4E975M-270	4E975M-272	4E975M-1000	4E978M-270	4E978M-272	4E978M-1000			
High Barrier	4E204H-270	4E204H-272	4E204H-1000	4E975H-270	4E975H-272	4E975H-1000	4E978H-270	4E978H-272	4E978H-1000	4E980H-270	4E980H-272	4E980H-1000
12.0 - 18.0 GHz												
Low Barrier	4E207L-270	4E207L-272	4E207L-1000	4E976L-270	4E976L-272	4E976L-1000	4E979L-270	4E979L-272	4E979L-1000			
Medium Barrier	4E207M-270	4E207M-272	4E207M-1000	4E976M-270	4E976M-272	4E976M-1000	4E979M-270	4E979M-272	4E979M-1000			
High Barrier	4E207H-270	4E207H-272	4E207H-1000	4E976H-270	4E976H-272	4E976H-1000	4E979H-270	4E979H-272	4E979H-1000	4E981H-270	4E981H-272	4E981H-1000



For more information request Bulletin 4219

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION STRIPLINE SILICON PACKAGED BEAM LEAD QUADS SELECTION GUIDE

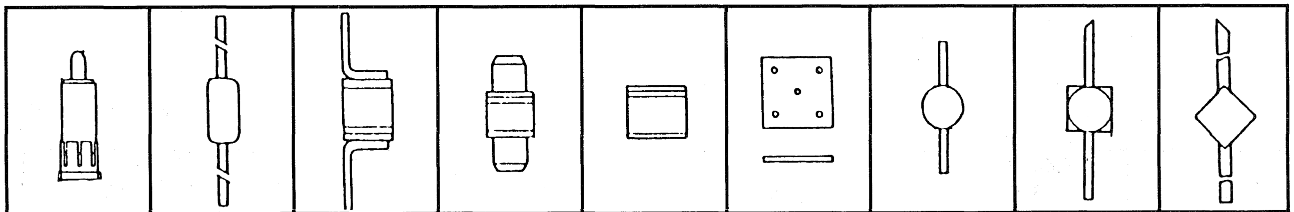
	Single Ring Quads				Dual Ring Quads				Cross Over Quad	Bridge Quads			
													
Frequency	ODS-226(3) Hermetic (#4228)*	ODS-227(4) Hermetic (#4228)*	ODS-228(4) Plastic (#4228)*	ODS-963 Mini Quad (#4228)*	ODS-226(3) Hermetic (#4228)*	ODS-227 Hermetic (#4228)*	ODS-228(4) Plastic (#4228)*	ODS-963 Mini Package (#4228)*	ODS-228(4) Hermetic (#4228)*	ODS-226(3) Hermetic (#4230)*	ODS-227 Hermetic (#4230)*	ODS-228(4) Plastic (#4230)*	ODS-963 Mini Quad (#4230)*
100 MHz - 3 GHz Low Barrier Medium Barrier High Barrier (Dual Barrier)	40430 40440 40490	40431 40441 40491	40432 40442 40492		40482-226	40482-227	40482-228		40472	4E402L-226 4E402M-226 4E402H-226	4E402L-227 4E402M-227 4E402H-227	4E402L-228 4E402M-228 4E402H-228	
3 - 6 GHz Low Barrier Medium Barrier High Barrier (Dual Barrier)	40433 40443 40493	40434 40444 40494	40445 40495		40482-226	40482-227	40482-228		40471	4E402L-226 4E402M-226 4E402H-226	4E402L-227 4E402M-227 4E402H-227	4E402L-228 4E402M-228 4E402H-228	
6 - 12 GHz Low Barrier Medium Barrier High Barrier (Dual Barrier)		40435 40446 40496		40284 40285 40486		40483-227		40483-963			4E401L-227 4E401M-227 4E401H-227		4E401L-963 4E401M-963 4E401H-963
12 - 18 GHz Low Barrier Medium Barrier High Barrier (Dual Barrier)		40436 40447 40497		40284 40285 40486		40484-227		40484-963			4E400L-227 4E400M-227 4E400H-227		4E400L-963 4E400M-963 4E400H-963

NOTES: 1) - Isoplanar Construction
2) - Planar Construction

*For more information request indicated Bulletin.

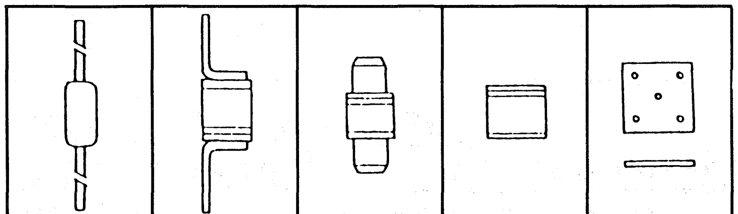
M/A-COM SEMICONDUCTOR PRODUCTS OPERATION PACKAGED SILICON SCHOTTKY DETECTOR DIODES SELECTION GUIDE

N-TYPE DETECTORS



Frequency Band (GHz)	Nominal Tss (-dBm)	ODS-3 Waveguide (#4234)*	ODS-54 Gen. Purpose (#4234)*	ODS-276 Stripline (#4234)*	ODS-119 Waveguide (#4234)*	ODS-120 Waveguide (#4234)*	ODS-135 Chip (#4234)*	ODS-137 Stripline (#4234)*	ODS-186 Stripline (#4234)*	ODS-213 Stripline (#4234)*
1.0 - 3.0	-50	40040L	40052L		40063L			40067L	40260L	40143L
	-55	40041L	40053L		40064L			40069L	40261L	40144L
3.0 - 12.0	-50	40042L	40072L		40065L			40070L	40262L	40145L
	-52	40043L	40204L	40208-276L	40203L	40208L	40220L	40108L	40263L	40146L
	-55		40202L	40207-276L	40201L	40207L		40114L	40264L	40147L
12.0 - 18.0	-48							40118L		40148L
	-50			40216-276L	40206L	40216L				40149L
	-52			40215-276L	40205L	40215L	40222L			
24.0 - 40.0	-48			40268-276L	40267	40268				

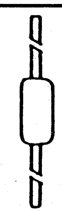
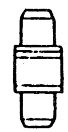
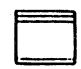
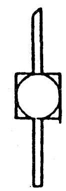
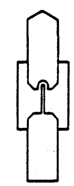
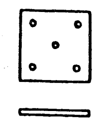
P-TYPE DETECTORS



Frequency Band (GHz)	Nominal Tss (-dBm)	ODS-54 Gen. Purpose*	ODS-276 Stripline*	ODS-119 Waveguide*	ODS-120 Waveguide*	ODS-135 Chip*
3.0 - 12.0	-52	40254	40258-276	40253	40258	
12.0 - 18.0	-55	40252	40257-276	40251	40257	40270
	-52		40265-276	40255	40265	40272
	-50		40266-276	40256	40266	

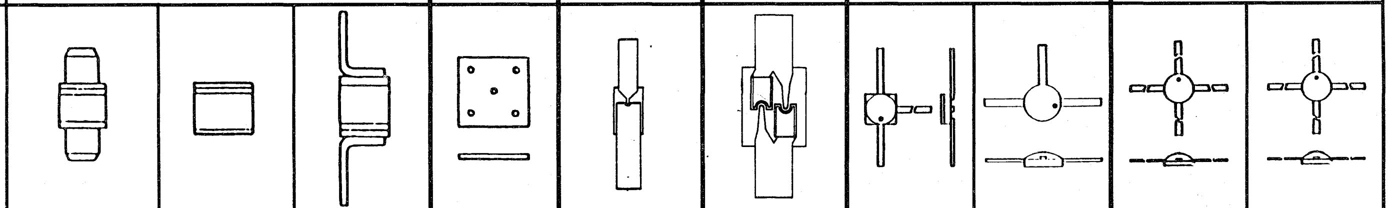
*For more information request Bulletin 4324.

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION PACKAGED, CHIP AND BEAM LEAD SILICON ZERO BIAS (ZBD) DETECTOR DIODES SELECTION GUIDE

Frequency Band (GHz)	Nominal Tss (-dBm)	Nominal Video Resistance (kilohms)	 ODS-54 Axial Lead	 ODS-119 Waveguide	 ODS-120 Waveguide	 ODS-186 Stripline	 ODS-990 Beam Lead	 ODS-135 Chip
1.0 - 12.0	-49	0.5 - 1.0	4E928	4E929	4E930	4E932	40188	4E931
	-52	1.0 - 2.0	4E928A	4E929A	4E930A	4E932A	40188A	4E931A
	-55	2.0 - 5.0	4E928B	4E929B	4E930B	4E932B	40188B	4E931B
	-56	5.0 - 10.0	4E928C	4E929C	4E930C	4E932C	40188C	4E931C
	-56	10.0 - 15.0	4E928D	4E929D	4E930D	4E932D	40188D	4E931D
12.0 - 18.0	-49	0.5 - 1.0					40189	
	-52	1.0 - 2.0					40189A	
	-55	2.0 - 5.0					40189B	
	-55	5.0 - 10.0					40189C	
	-56	10.0 - 15.0					40189D	

For more information request Bulletin 4327.

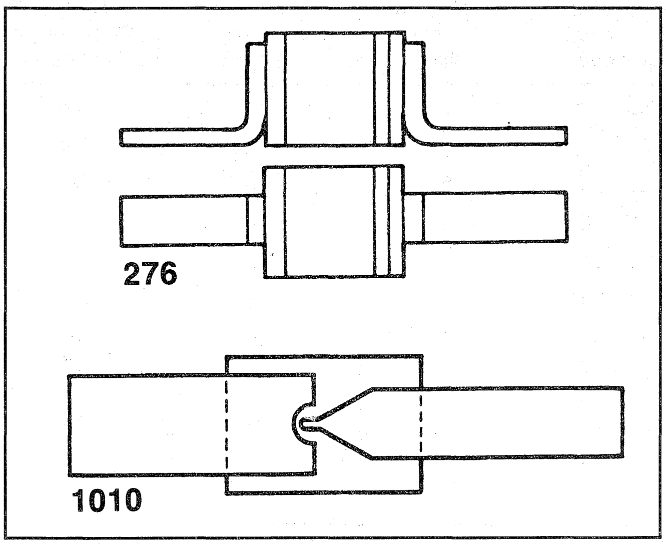
M/A-COM SEMICONDUCTOR PRODUCTS OPERATION GALLIUM ARSENIDE MIXER DIODE SELECTION GUIDE

	Single Packaged Diodes			Chips	Single Beam-Leads	Anti-Parallel Beam-Leads	Packaged Tee's		Packaged Quads Ring Quad	Packaged Quads Bridge
										
Frequency Band	ODS-119 Hermetic	ODS-120 Hermetic	ODS-276 Hermetic Stripline	ODS-135 Chip	ODS-1010	ODS-1013	ODS-270 Hermetic	ODS-272 Non-Hermetic	ODS-963 Hermetic Miniquad	ODS-963 Hermetic Miniquad
UHF-L Band										40418
8.0 - 12.0 GHz	40401	40405	40409	40413	40415		40420	40421	40419	40418
12.0 - 18.0 GHz	40402	40406	40410	40413	40415			40421	40419	40418
18.0 - 26.0 GHz	40403	40407	40411	40414	40415	40422			40419	
26.0 - 40.0 GHz	40404	40408	40412	40414	40416	40422				
40.0 - 100 GHz					40417					

For more information request Bulletin 4231

MA40401/MA40422 Series

GaAs Schottky Mixer Diodes



Description

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

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

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

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

Features

- VERY LOW NOISE FIGURE X, W-BAND
- LOW JUNCTION CAPACITANCE
- LOW SERIES RESISTANCE
- WIDE RANGE OF AVAILABLE PRODUCT
  - PACKAGED DIODES
  - CHIPS
  - BEAM LEADS
  - ANTI-PARALLEL BEAM LEADS
  - BRIDGE QUADS
  - RING QUADS
  - TEES
- SUPERIOR DYNAMIC RANGE TO SILICON DIODES
- MINIMUM BREAKDOWN VOLTAGE IS 5 VOLTS
- MINIMUM 10 GRAM BEAM STRENGTH FOR BEAM LEADS

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION • Burlington, MA 01803 • (617) 272-3000 • TWX 710-332-6789 • TELEX 94-9464

MAXIMUM RATINGS

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

Specifications @ $T_A = 25°C$

PACKAGED DIODES

SPECIFICATIONS						TYPICAL CHARACTERISTICS	
Model[9] Number	Case Style	L.O. Test Frequency (GHz)	Maximum[4] Noise Figure NF (dB)	IF[4] Impedance Min./Max. (Ohms)	Minimum[5] Breakdown Voltage V_B	Nominal[1,8] Junction Capacitance C_j (pF)	Nominal[3] Series Resistance R_S (Ohms)
MA40401	119	9.375	5.7	250 / 500	5	.10	3/6
MA40402	119	16.000	6.0	250 / 500	5	.10	3/6
MA40403	119	24.000	6.5	250 / 500	5	.07	3/6
MA40404	119	36.000	6.5	250 / 500	5	.06	3/6
MA40405	120	9.375	5.7	250 / 500	5	.10	3/6
MA40406	120	16.000	6.0	250 / 500	5	.10	3/6
MA40407	120	24.000	6.5	250 / 500	5	.07	3/6
MA40408	120	36.000	6.5	250 / 500	5	.06	3/6
MA40409	276	9.375	5.7	250 / 500	5	.10	3/6
MA40410	276	16.000	6.0	250 / 500	5	.10	3/6
MA40411	276	24.000	6.5	250 / 500	5	.07	3/6
MA40412	276	36.000	6.5	250 / 500	5	.06	3/6

BEAM LEADS AND CHIPS

SPECIFICATIONS						TYPICAL CHARACTERISTICS	
Model[9] Number	Case Style	Frequency Band	Series[3] Resistance Min./Max. (Ohms)	Junction[1] Capacitance Min./Max. (pF)	Minimum[5] Breakdown Voltage (Volts)	IF Impedance Min./Max. (Ohms)	Nominal Noise Figure (dB)
MA40413	135	X-K	3/6	.055 / .075	5	250 / 500	6.0
MA40414	135	Ka	3/6	.050 / .060	5	250 / 500	6.5
MA40415	1010	K	3/6	.055 / .075	5	250 / 500	6.5
MA40416	1010	Ka	3/6	.050 / .070	5	250 / 500	6.5
MA40417	1010	W	4/10	.030 / .055	5	250 / 500	7[10]

ANTI-PARALLEL BEAM LEADS

SPECIFICATIONS								TYPICAL CHARACTERISTICS
Model Number	Case Style	Frequency Band	Series[3] Resistance Min./Max. R_S (Ohms)	Junction[6] Capacitance Min./Max. C_j (pF)	Maximum[6] Junction Capacitance Difference ΔC_j (pF)	Minimum[5] Breakdown Voltage V_B (Volts)	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)
MA40422	1013	K-Ka	3/6	.10 / .20	.025	5.0	.015	.700

Specifications @ $T_A = 25°C$

PACKAGED TEES AND QUADS

Bridge Quad

SPECIFICATIONS								TYPICAL CHARACTERISTICS
Model Number	Case Style	Frequency Band	Maximum[3] Series Resistance Min./Max. R_S (Ohms)	Junction[7,8] Capacitance Min./Max. C_j (pF)	Maximum[7,8] Junction Capacitance Difference ΔC_j (pF)	Minimum[5] Breakdown Min./Max. V_B (Volts)	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)
MA40418	963	L-K	3/6	.05 / .10	.025	6	.020	.700

Ring Quad

SPECIFICATIONS								TYPICAL CHARACTERISTICS
Model Number	Case Style	Frequency Band	Maximum[3] Series Resistance Min./Max. R_S (Ohms)	Junction[7,8] Capacitance Min./Max. C_j (pF)	Maximum[7,8] Junction Capacitance Difference ΔC_j (pF)	Minimum[5] Breakdown Min./Max. V_B (Volts)	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)
MA40419	963	L-K	3/6	.05 / .10	.025	5.0	.020	.700

Tees

SPECIFICATIONS							TYPICAL CHARACTERISTICS		
Model Number	Case Style	Frequency Band	Maximum[3] Series Resistance Min./Max. R_S (Ohms)	Junction[7,8] Capacitance Min./Max. C_j (pF)	Maximum[7,8] Junction Capacitance Difference ΔC_j (pF)	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Nominal[2] Forward Voltage V_F (Volts)	Nominal[5] Breakdown Voltage V_B (Volts)	Nominal[4] Noise Figure N_f (dB)
MA40420	270	C-Ku	3/6	.05 / .10	.025	.020	.700	5	6
MA40421	272	C-Ku	3/6	.05 / .10	.025	.020	.700	5	6

NOTES:

1. C_j is measured at V_r = 0V and F = 1.0 MHz.
2. V_f is measured at I_f = 1.0 mA.
3. Series Resistance, R_S, is determined by subtracting the junction resistance R_j, from the measured value of 10 mA dynamic (slope) resistance, R_d:

   $R_S = R_d - R_j$ ohms

   Junction resistance is computed from:

   $R_j = 26/I_f$
   I_f = 10 mA
   I_f is the forward current in mA
4. Noise figure measurements are single sideband noise figure with N_{if} = 1.5 dB minimum. The noise figure of chips and beam lead types are performed on a sample of the lot. Chips are tested in a package. Beam leads are tested in a stripline holder. The test conditions are as follows:

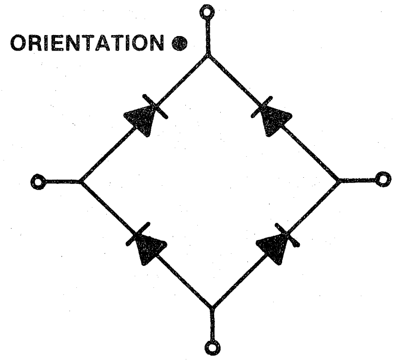
   L.O. Power 6.0 dBm
   L.O. Frequency 3.0 GHz
   9.375 GHz
   16.0 GHz
   24.0 GHz
   35.0 GHz

   f_{if} = 30 MHz
   R_l = 22 ohms
5. V_b is measured at I_r = 10 μA.
6. C_j is measured at V_r = 0V and F = 1.0 MHz. C_j of anti-parallel diodes is comprised of the capacitance of two diode junctions in parallel.
7. C_j is measured between adjacent leads of device at V_r = 0V and F = 1.0 MHz.
8. $C_t = C_j + C_p$
   C_t is total capacitance
   C_j is junction capacitance
   C_p is packaged capacitance
9. Match pairs are available by adding the suffix "M" to the part number.
10. Conversion loss at 94 GHz with Lo power ~ 8-12 dBm.

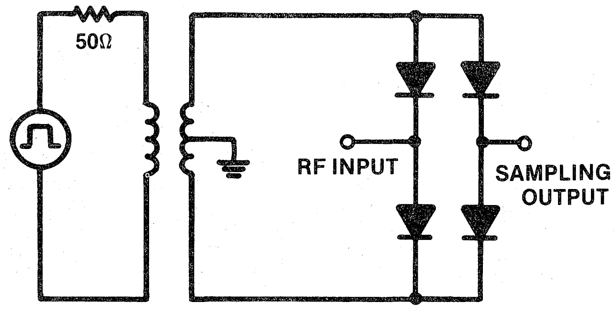
Packaged Quad and Tee Configurations

BRIDGE QUAD CIRCUIT

TOP VIEW PACKAGE



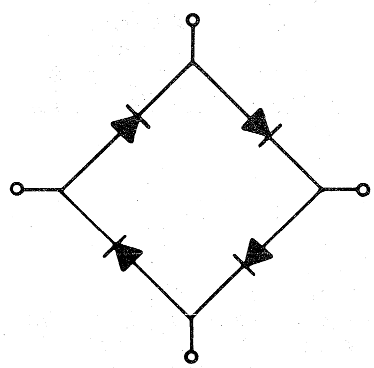
Diode Bridge Circuit



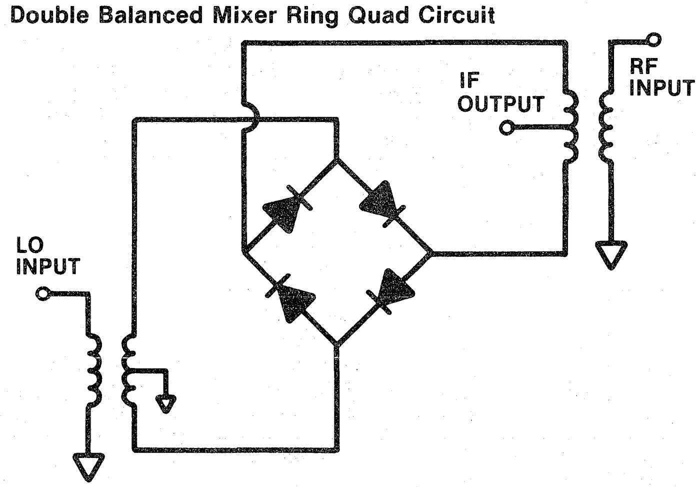
Sampling Circuit Bridge Quad

RING QUAD CIRCUIT

TOP VIEW PACKAGE

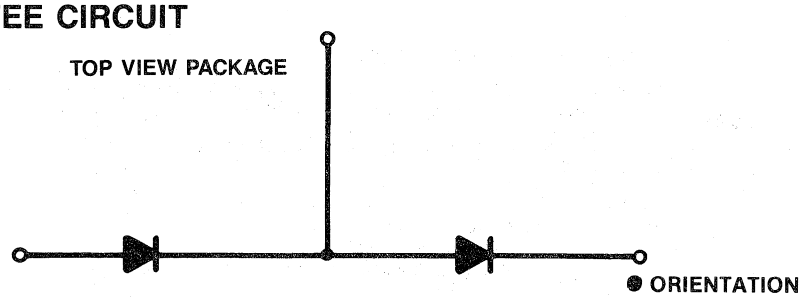


Double Balanced Mixer Ring Quad Circuit

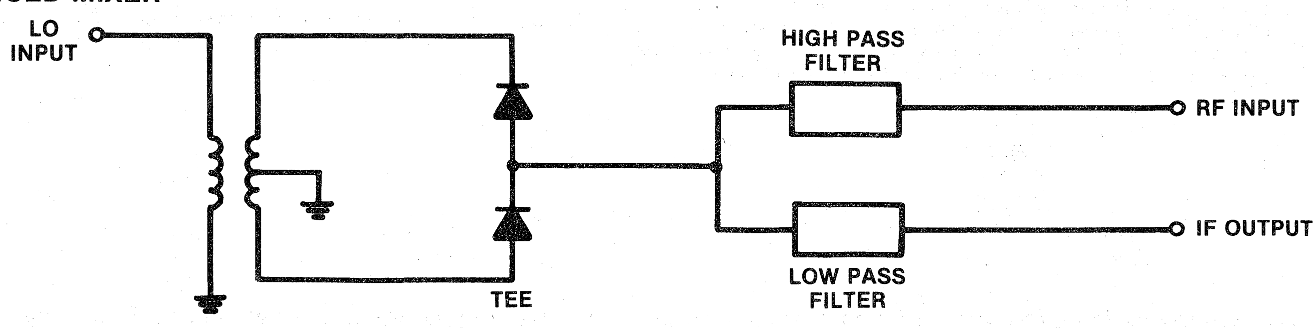


TEE CIRCUIT

TOP VIEW PACKAGE

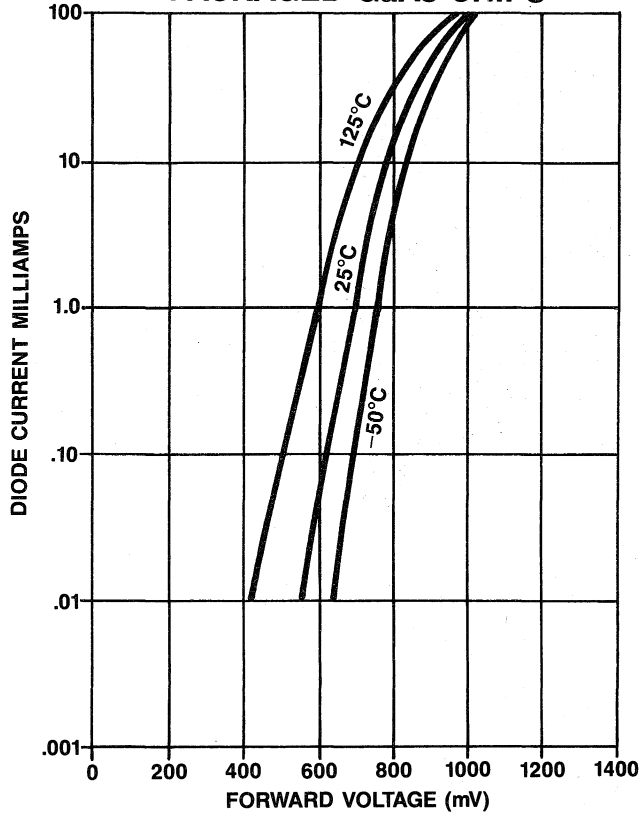


BALANCED MIXER

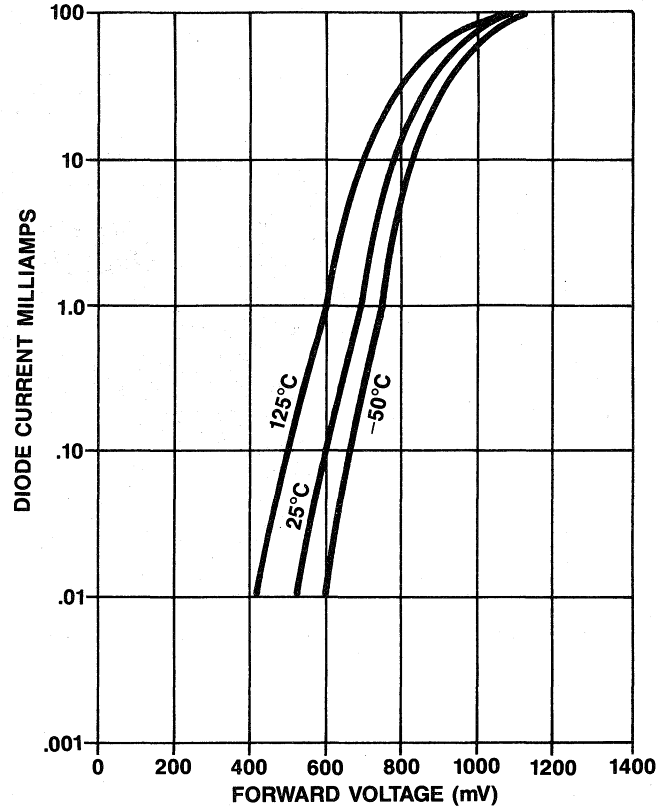


Typical Performance Curves

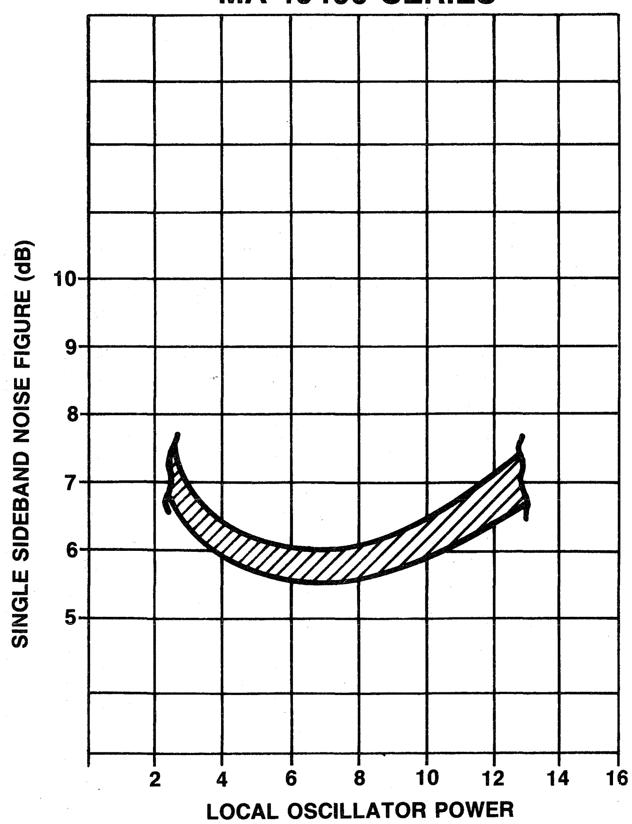
MA40401-40412
PACKAGED GaAs CHIPS



MA40413
GaAs BEAM LEAD

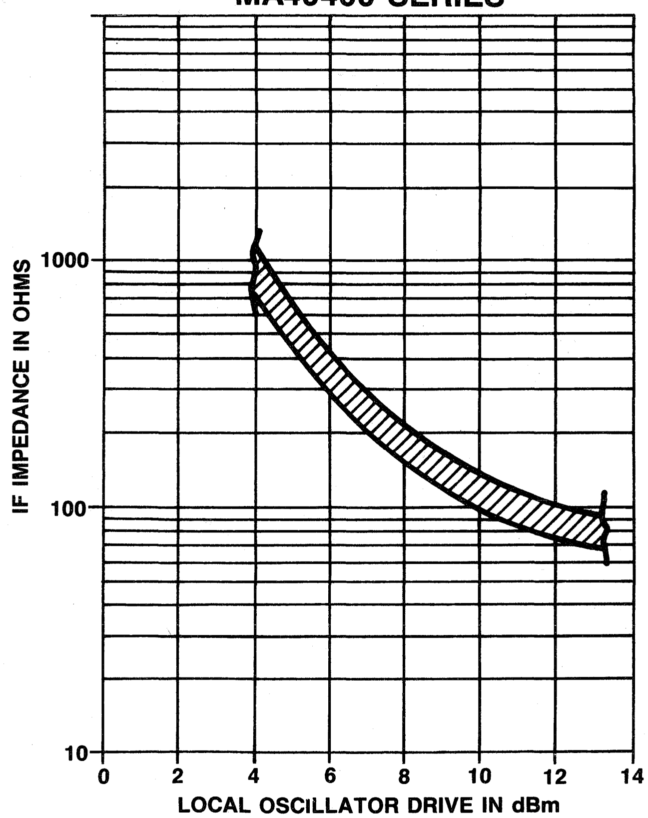


MA-40400 SERIES



NOISE FIGURE VS. LOCAL OSCILLATOR POWER

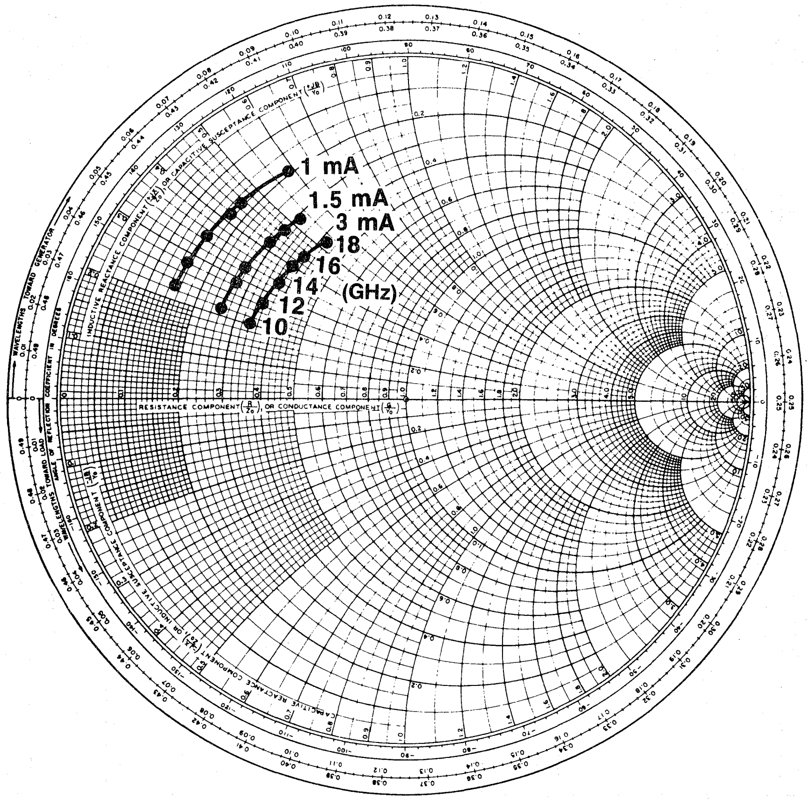
MA40400 SERIES



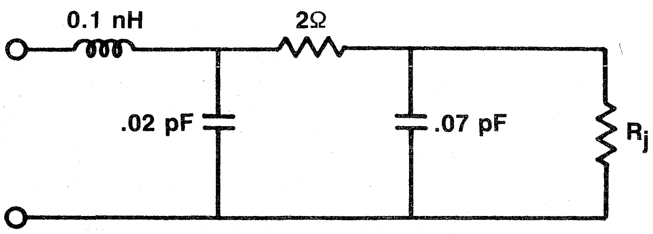
IF IMPEDANCE VS. LOCAL OSCILLATOR DRIVE WITH R_L = 10 OHMS

Typical Admittance Characteristics With Self Bias

MA40413 CHIP OR MA40415 BEAM LEAD



Approximate Equivalent Circuit of MA40415



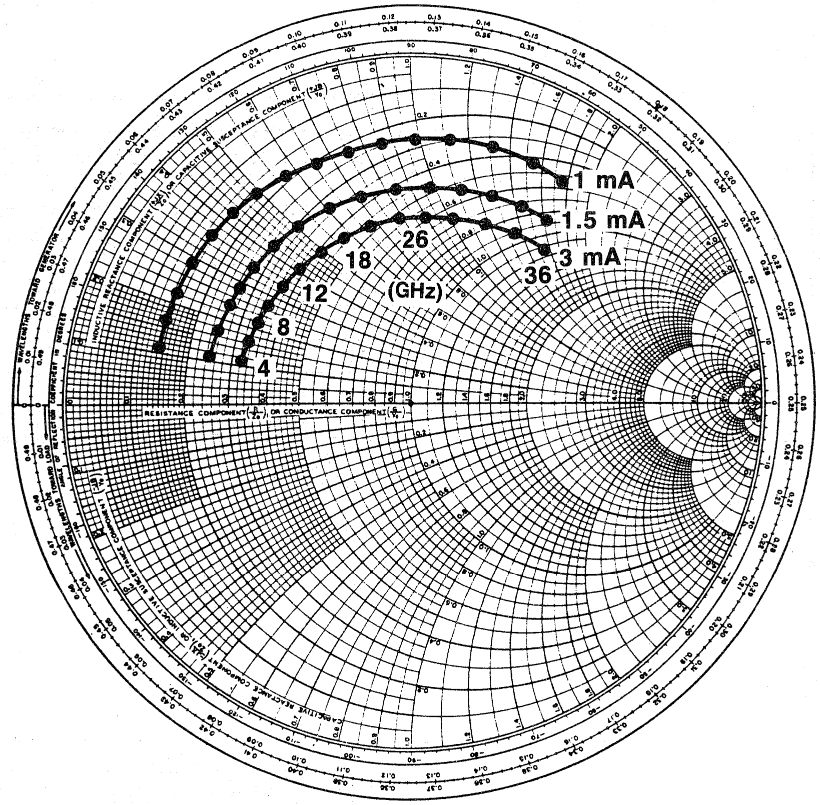
SELF BIAS (mA)	R_j (ohms)
1.0	350
1.5	200
3.0	150

Typical RF Impedance Data

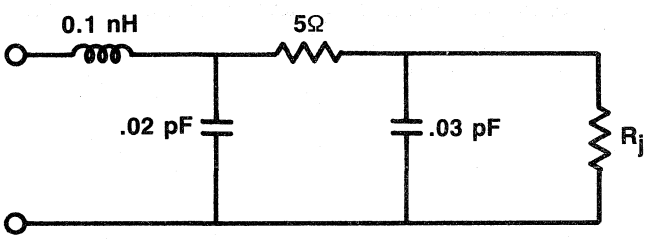
Frequency (GHz)	1.0 mA		1.5 mA		3.0 mA	
	Refl Mag	Coeff Ang	Refl Mag	Coeff Ang	Refl Mag	Coeff Ang
4	.751	– 13.0	.603	– 13.2	.505	– 13.6
6	.751	– 19.6	.603	– 19.9	.506	– 20.4
8	.751	– 26.1	.604	– 26.6	.506	– 27.2
10	.750	– 32.8	.604	– 33.4	.507	– 34.2
12	.750	– 32.8	.604	– 40.2	.508	– 41.2
14	.750	– 46.2	.606	– 47.1	.510	– 48.2
16	.750	– 53.1	.607	– 54.1	.512	– 55.4
18	.751	– 60.0	.609	– 61.1	.515	– 62.6
20	.751	– 67.0	.611	– 68.3	.519	– 69.9
22	.753	– 74.1	.614	– 75.5	.523	– 77.3
24	.754	– 81.3	.618	– 82.7	.529	– 84.7
26	.756	– 88.5	.623	– 90.1	.536	– 92.1
28	.759	– 95.7	.629	– 97.4	.543	– 99.5
30	.762	–103.0	.636	–104.7	.552	–107.0
32	.766	–110.3	.643	–112.1	.562	–114.3
34	.771	–117.5	.652	–119.3	.574	–121.6
36	.776	–124.7	.662	–126.6	.586	–128.8

Typical Admittance Characteristics With Self Bias

MA40417 BEAM LEAD



Approximate Equivalent Circuit of MA40417



SELF BIAS (mA)	R_j (ohms)
1.0	350
1.5	200
3.0	150

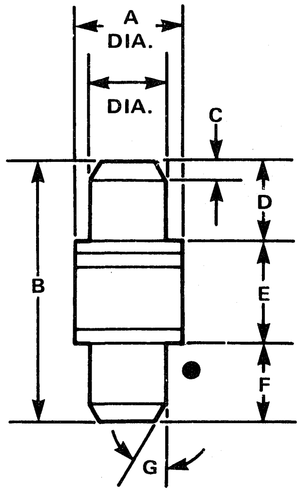
Typical RF Impedance Data

Frequency (GHz)	1.0 mA Refl Mag	1.0 mA Coeff Ang	1.5 mA Refl Mag	1.5 mA Coeff Ang	3.0 mA Refl Mag	3.0 mA Coeff Ang
4	.752	− 7.1	.607	− 7.1	.511	− 7.1
6	.751	−10.7	.606	−10.7	.510	−10.6
8	.750	−14.3	.604	−14.3	.508	−14.2
10	.749	−18.0	.602	−17.9	.506	−17.9
12	.747	−21.7	.600	−21.6	.503	−21.6
14	.744	−25.5	.597	−25.4	.500	−25.4
16	.742	−29.3	.593	−29.2	.496	−29.3
18	.739	−33.2	.590	−33.1	.492	−33.2
20	.735	−37.2	.586	−37.2	.488	−37.3
22	.732	−41.4	.581	−41.3	.483	−41.5
24	.728	−45.6	.577	−45.6	.478	−45.8
26	.724	−49.9	.572	−50.0	.472	−50.3
28	.720	−54.4	.567	−54.6	.467	−55.0
30	.716	−59.1	.562	−59.3	.462	−59.8
32	.711	−63.9	.557	−64.2	.456	−64.9
34	.707	−68.8	.552	−69.3	.451	−70.1
36	.703	−73.9	.547	−74.5	.447	−75.6

Case Styles

● DENOTES CATHODE

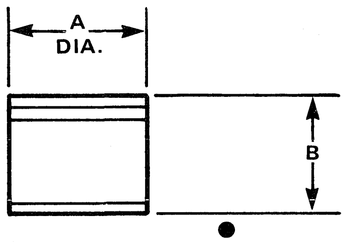
119



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.190	0.210	4,83	5,33
C	0.009	0.015	0,23	0,38
D	0.060	0.064	1,52	1,63
E	0.070	0.087	1,68	2,21
F	0.060	0.064	1,52	1,63
G	25°	35°	25°	35°
H	0.060	0.064	1,52	1,63

C_P = 0.15 pF Typical
L_S = 0.50 nH Typical

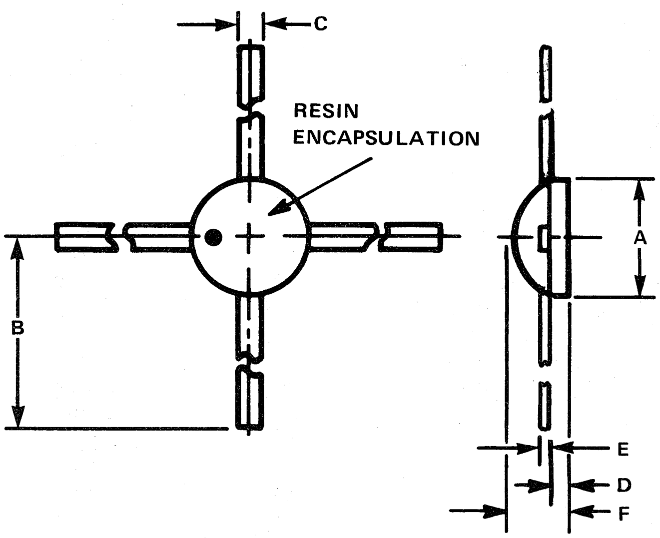
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

963 (MINI-QUAD)



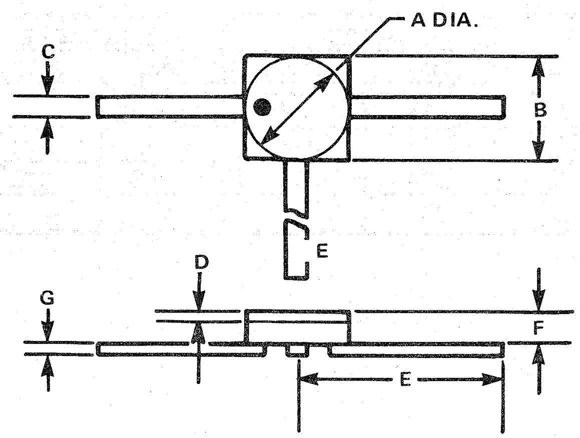
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.050	0.058	1,27	1,47
B	0.140	— —	3,55	— —
C	0.012	0.018	0,30	0,46
D	0.007	0.014	0,178	0,36
E	0.003	0.006	0,076	0,152
F	— —	0.035	— —	0,89

C_P ~ 0.04 pF Typical

Case Styles (Cont'd)

● DENOTES CATHODE

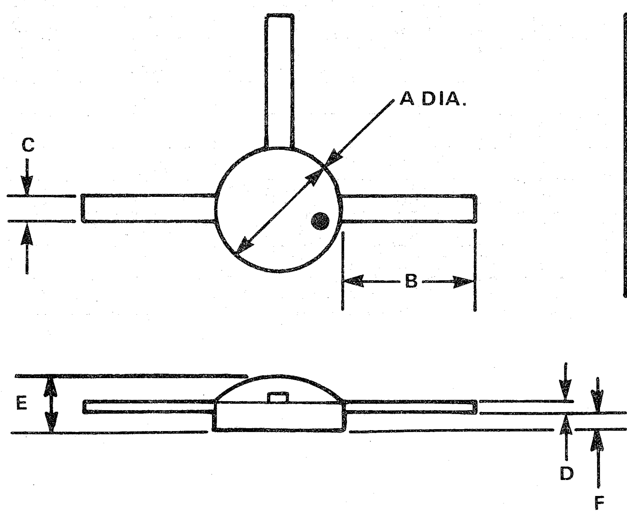
270



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0,094	0.102	2,39	2,59
C	0.018	0.022	0,46	0,56
D	0.005	0.008	0,13	0,20
E	0.200	— —	5,08	— —
F	0.030	0.040	0,75	1,02
G	0.003	0.006	0,08	0,15

$C_P \sim 0.12$ pF Typical

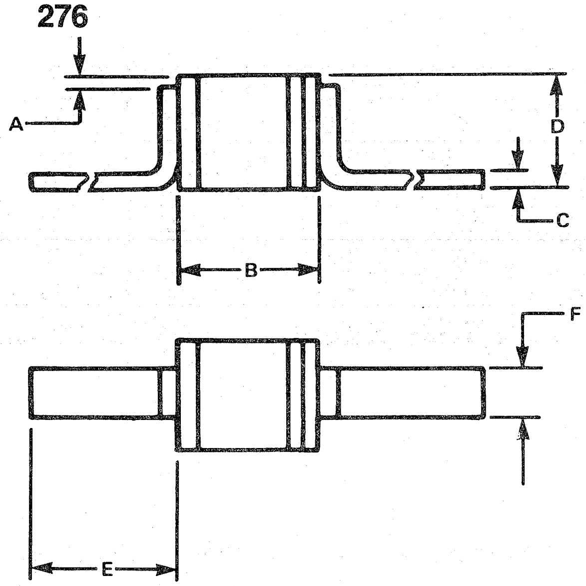
272



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2,29	2,75
B	0,090	0.110	2,29	2,75
C	0.018	0.022	0,46	0,56
D	0.003	0.006	0,08	0,15
E	— —	0.035	— —	0,09
F	— —	0.014	— —	0,36

$C_P \sim 0.10$ pF Typical

276



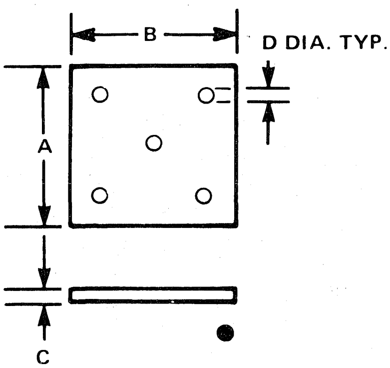
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.020	0,254	0,058
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

$C_P \approx 0.13$ pF Typical
$L_S \approx 0.40$ nH Typical

Chip Styles

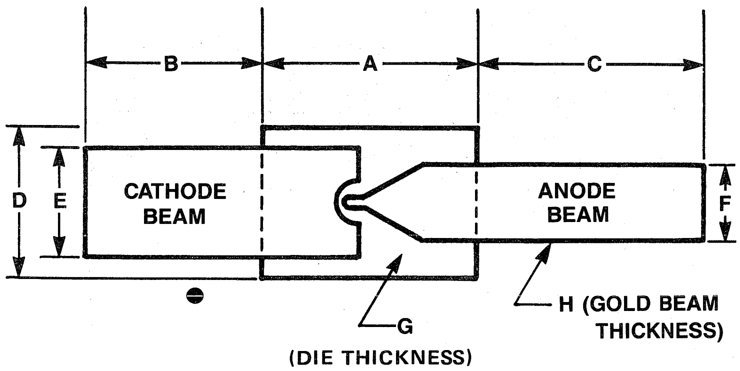
● DENOTES CATHODE

135



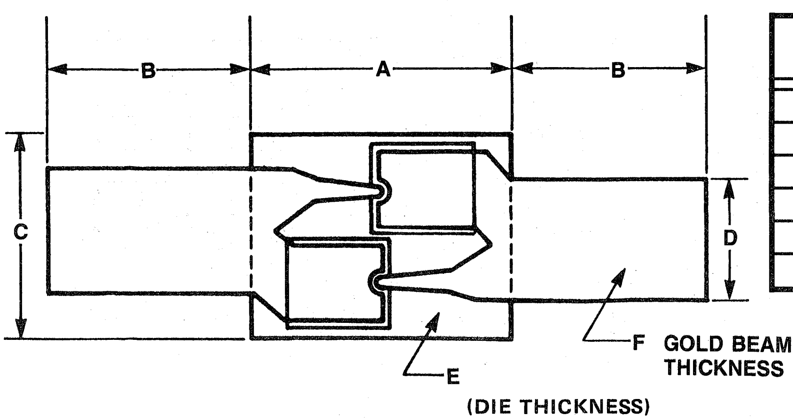
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.013	.017	,330	,431
B	.013	.017	,330	,431
C	.004	.006	,102	,152
D	.001	— —	,02	— —

1010



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.012	0,25	0,30
B	0.012	— —	0,30	— —
C	0.010	— —	0,25	— —
D	0.006	0.008	0,15	0,20
E	0.005	0.006	0,12	0,15
F	0.004	0.005	0,10	0,12
G	0.003	0.004	0,07	0,10
H	0.0003 Nominal		0.012 Nominal	

1013

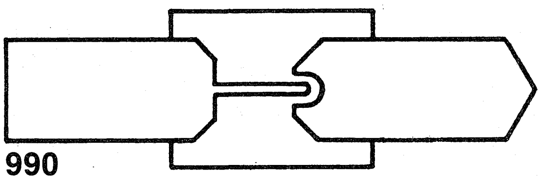


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0105	0.0125	0,26	0,32
B	0.007	— —	0,18	— —
C	0.0085	0.0105	0,22	0,26
D	0.005	0.006	0,13	0,15
E	0.003	0.004	0,07	0,10
F	0.0005 (Nominal)		0,012 (Nominal)	

MA40270, MA40290, MA40130 Series

Silicon Beam-Lead Schottky Barrier Diodes

Low, Medium and High Barrier Mixer and Detector Diodes



990

Features

- ISOPLANAR™ CONSTRUCTION (BEAM STRENGTH EXCEEDS 10 GRAMS)
- PLANAR CONSTRUCTION (SURFACE ORIENTED DIODE)
- EXTREMELY STRONG BEAM CONSTRUCTION
- HIGH PROCESS UNIFORMITY
- LOW NOISE FIGURE (MIXER DIODES)
- HIGH SENSITIVITY (DETECTOR DIODES)

Description

Isoplanar™

The M/A-COM MA40290 series Isoplanar™ Beam-Lead Schottky diodes represent an advanced departure from conventional beam-lead design; both anode and cathode beams are rigidly secured to a solid dielectric frame which encloses the active silicon region, providing strength and low parasitics. The dielectric frame also permits precise manufacturing limits on the dimensional tolerance and visual uniformity of the silicon body — across the entire wafer and from lot to lot. This dielectric material — which encapsulates the silicon — is tough and durable, providing scratch protection for the active silicon region; leading to increased assembly yield for the circuit manufacturers.

The M/A-COM Isoplanar™ Schottky diodes are offered in three drive levels (low, medium and high) each optimized for two frequency bands of operation (X-band and Ku-Band). Typical electrical performance data is listed in Table I. Beam strength is guaranteed to exceed 10 grams, measured in accordance with MIL-STD-883B "Push-Off Beam-Lead Test." The diodes meet the humidity and burn-in life tests as specified in MIL-STD-750 methods 1021 and 1038 respectively.

Planar

The MA40130 and MA40270 series diodes are planar devices in which both the Schottky contact and the ohmic contact are constructed in the same plane for convenient stripline and microstrip applications. The Schottky junction is passivated with silicon oxide and silicon nitride to give stable reliable performance. The diodes meet the moisture resistance as specified in MIL-STD-750 method 1021. These diodes are also capable of meeting burn-in life test to the same MIL-STDs above.

Specifications @ T_A = 25°C

ISOPLANAR™ N-TYPE SINGLE BEAM LEADS (990 CASE STYLE)

Model Number	Barrier Height	Freq. Band	Maximum[1] Junction Capacitance C_J (pF)	Typical[2] Forward Voltage V_F (Volts)	Minimum[5] Breakdown Voltage V_B (Volts)	Maximum[3] Series Resistance R_S (Ohms)	Maximum[4] Noise Figure NF (dB)
MA40297	Low	X	0.20	0.280	2	12	6.5
MA40287	Low	Ku	0.12	0.310	2	18	7.5
MA40298	Medium	X	0.20	0.385	3	12	6.5
MA40288	Medium	Ku	0.12	0.410	3	18	7.5
MA40299	High	X	0.20	0.580	5	12	6.5
MA40289	High	Ku	0.12	0.610	5	18	7.5

PLANAR N-TYPE SINGLE BEAM LEADS (965 CASE STYLE)

Model Number	Barrier Height	Freq. Band	Maximum[1] Junction Capacitance C_J (pF)	Typical[2] Forward Voltage V_F (Volts)	Minimum[5] Breakdown Voltage V_B (Volts)	Maximum[3] Series Resistance R_S (Ohms)	Maximum[4] Noise Figure NF (dB)
MA40132	Low	X	0.20	0.280	2	12	6.5
MA40131	Low	Ku	0.10	0.310	2	18	7.5
MA40134	Medium	X	0.20	0.385	3	12	6.5
MA40133	Medium	Ku	0.10	0.410	3	18	7.5
MA40136	High	X	0.20	0.580	5	12	6.5
MA40135	High	Ku	0.10	0.610	5	18	7.5

PLANAR P-TYPE SINGLE BEAM LEAD (965 CASE STYLE)

Model Number	Frequency Band	Minimum[6] Tangential Signal Sensitivity T_{SS} (dBm)	Typical[2] Forward Voltage V_F (Volts)	Maximum[1] Junction Capacitance C_J (pF)	Minimum[5] Breakdown Voltage V_B (Volts)
MA40273	X	–55	0.550	0.30	3.0

NOTES:

1. C_P is measured at V_R = 0V and F = 1.0 MHz.
2. V_F is measured at I_F = 1.0 mA.
3. Series Resistance, R_S, is determined by subtracting the junction resistance R_J, from the measured value of 10 mA dynamic (slope) resistance, R_D:

   $R_S = R_D - R_J$ ohms

   Junction resistance is computed from:

   $R_J = 26/I_F$

   I_F = 10 mA

   I_F is the forward current in mA.
4. Noise figure measurements are performed on single diodes sampled from every lot of beam-lead Schottky material. The noise figure specified is the maximum limit for lot approval. The test conditions are as follows:

   LO Power = 1.0 mW low and medium barrier, 2.0 mW for high barrier

   LO Frequency — 3.06 GHz (S-Band)
   9.375 GHz (X-Band)
   16 GHz (Ku-Band)

   IF = 30 MHz

   NF_{IF} = 1.5 dB
5. V_B is measured at I_R = 10μA
6. F = 10 GHz, BW = 2 MHz, R_L = 10 KΩ, I_{BIAS} = 20μA.

Applications

Both the Isoplanar™ and Planar series of Schottky barrier beam-lead diodes are specifically designed for stripline and microstrip mixer and detector applications in both X- and Ku-Band. The extremely strong beam-lead construction provides rugged devices with low parasitic elements. Precise process control insures repeatable RF performance between lots.

MAXIMUM RATINGS

Operating Temperature	−65°C to +150°C
Storage Temperature	−65°C to +150°C
Incident CW RF Power	75 mW
Incident Pulse RF Power (3ns pulse width, .001 duty cycle)	1W
Beam Strength	10g (Isoplanar) 2g (Planar)

Typical Performance Curves

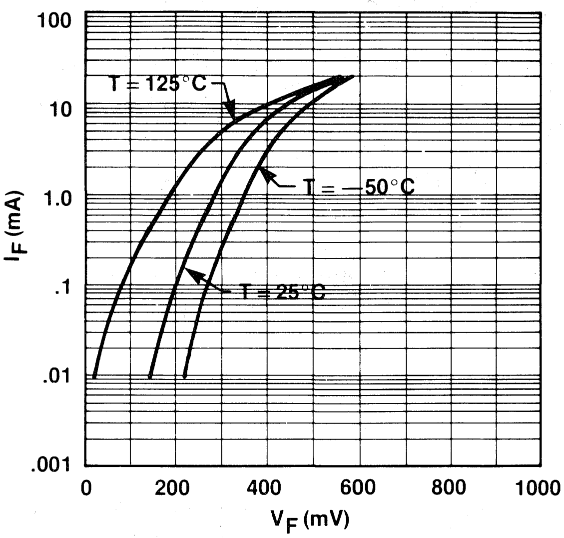


FIGURE 1. Low Barrier Schottky Diode Forward Characteristics vs. Temperature

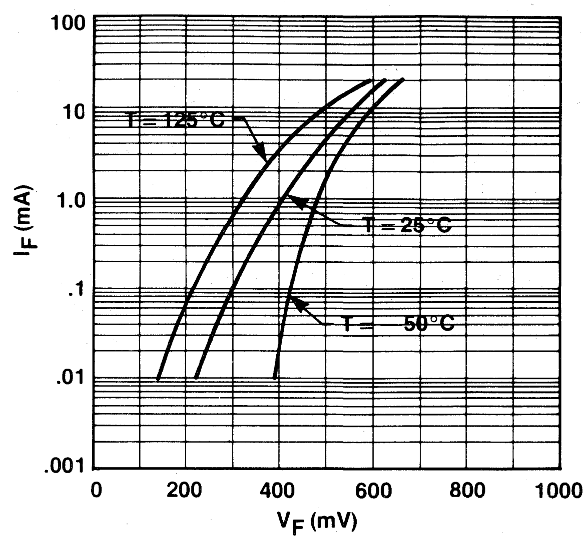


FIGURE 2. Medium Barrier Schottky Diode Forward Characteristics vs. Temperature

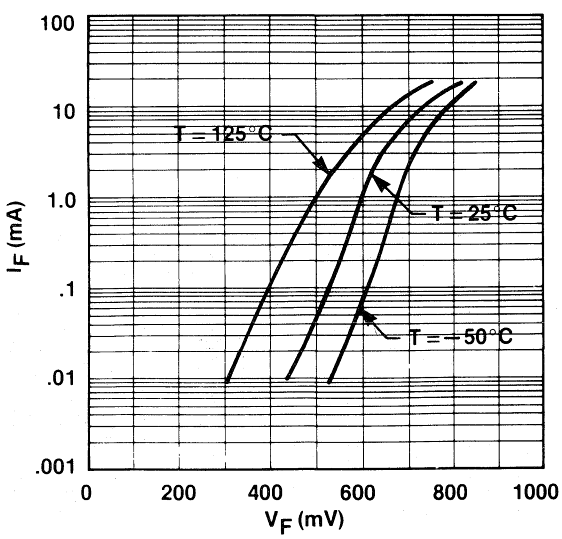


FIGURE 3. High Barrier Schottky Diode Forward Characteristics vs. Temperature

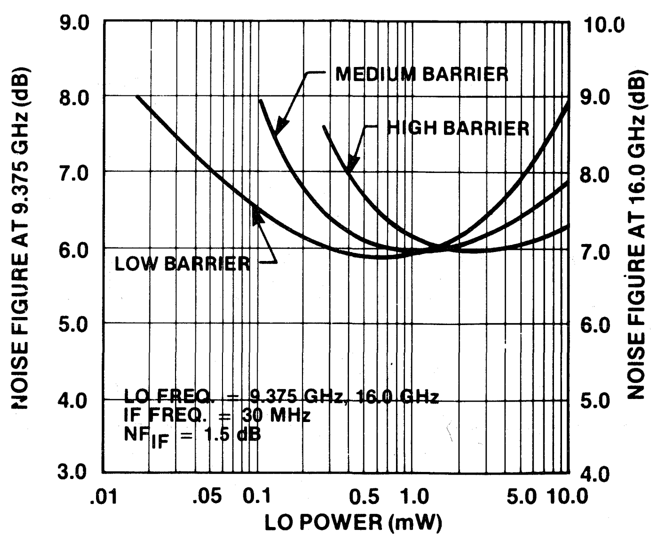
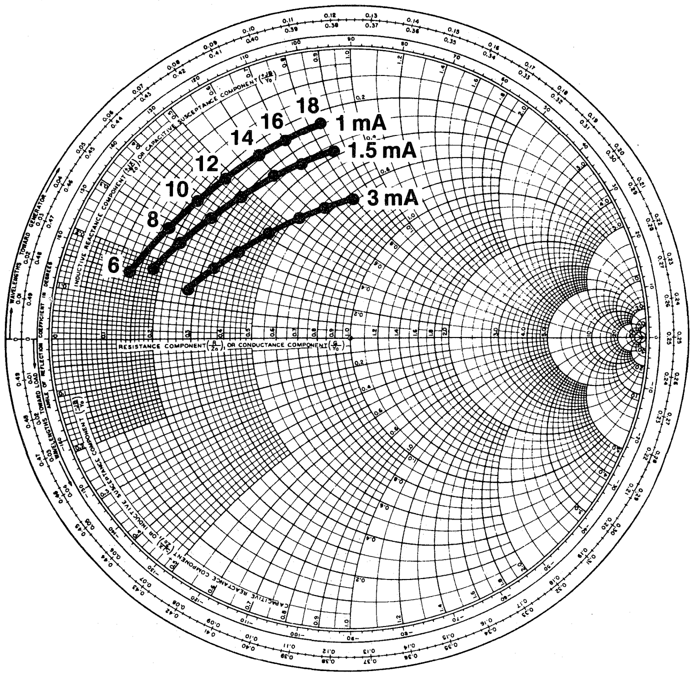
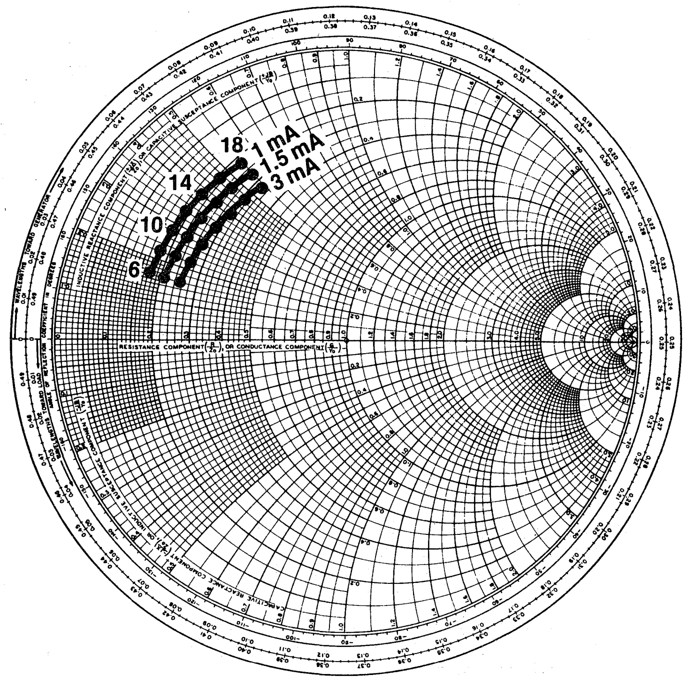


FIGURE 4. Noise Figure vs. Local Oscillator Power

Typical Admittance Characteristics With Self Bias



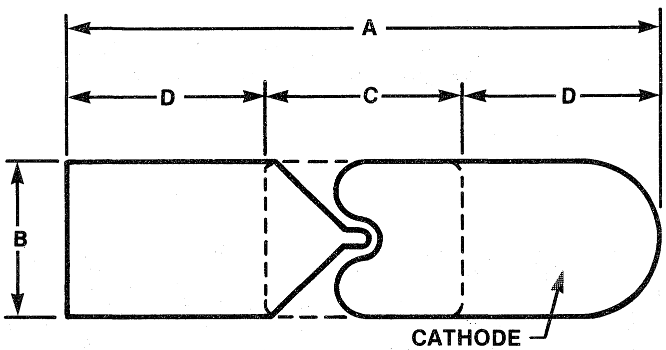
Medium and High Barrier Isoplanar Diodes
MA40288, MA40289, MA40298, MA40299



Medium Barrier and High Barrier Planar Diodes
MA40133, MA40134, MA40135, MA40136

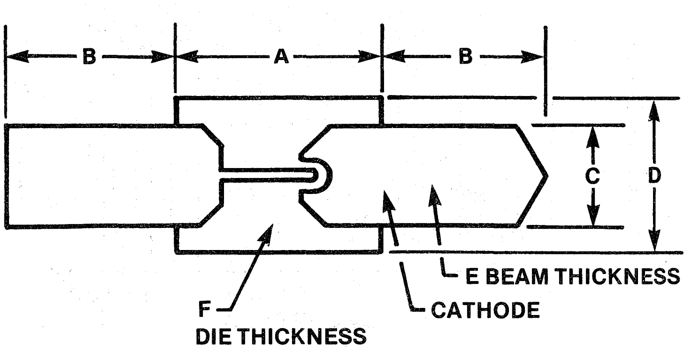
Case Styles

965



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0265	0.0275	0,673	0,699
B	0.0050	0.0060	0,127	0,152
C	0.0065	0.0075	0,165	0,191
D	0.009	0.0110	0,229	0,279

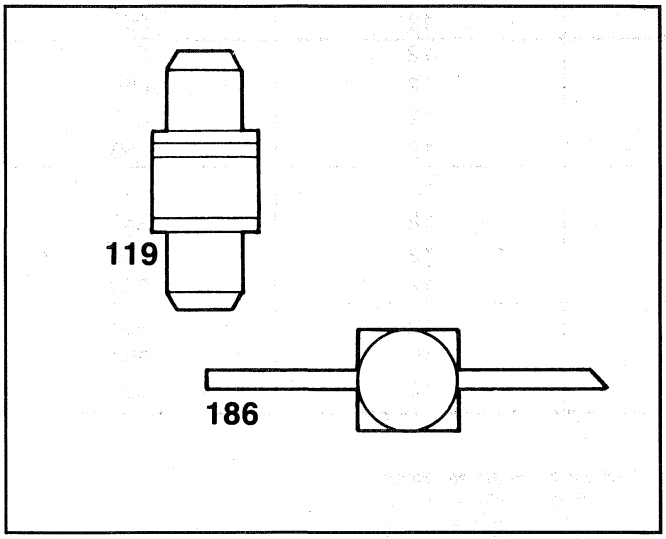
990



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0128	0.0132	0,325	0,335
B	0.010	0.011	0,254	0,279
C	0.0060	0.0062	0,152	0,157
D	0.0095	0.010	0,241	0,254
E	0.0003	0.0005	0,0076	0,0127
F	0.0014	0.0015	0,035	0,038

M/A-COM

Low 1/f Noise Low Barrier Schottky Doppler Mixer Diodes



Features

- LOW GUARANTEED 1/f NOISE AT 10 KHz
- LOW LOCAL OSCILLATOR REQUIREMENTS
- WIDE RANGE OF AVAILABLE PACKAGES
- USEFUL FOR STARVED LO MIXERS

Description

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

Applications

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

Specifications @ $T_A = 25°C$

Low IF/Low LO Drive Schottky Doppler Mixer Diodes

These low level silicon Schottky Doppler mixer diodes are suitable for use in waveguide, coaxial and stripline mixers. These diodes are intended for mixers using starved LO conditions (– 6 dBm). This family of diodes exhibits the specified noise figure without external dc bias.

Model[1] Nubmer	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Nominal[4] Z_{IF} (Ohms)
MA40198	213	9.375	12	250
MA40194	3	9.375	12	250
MA40192	54	9.375	12	250
MA40191	119	9.375	12	250
MA40193	135	9.375	12	250
MA40196	137	9.375	12	250
MA40197	186	9.375	12	250
MA40190	120	9.375	12	250
MA40190-276	276	9.375	12	250
MA40183	119	16.000	12	250
MA40184	135	16.000	12	250
MA40182	120	16.000	12	250
MA40182-276	276	16.000	12	250
MA40181	119	24.000	12	350
MA40180	120	24.000	12	350
MA40180-276	276	24.000	12	350

NOTES:

1. These diodes are available as matched pairs by adding the suffix "M" to the model number. The matching criteria is:
   ΔZ_{IF} = 25 ohms
   ΔN_F = 0.5 dBm
2. These diodes are thermocompression bonded in all case styles, except case styles 3, and 54. The maximum solder temperature for all cases, except case style 120 and 276, is 230°C for 5 seconds. For case styles 120 and 276 maximum solder temperature is 200°C for 5 seconds. The standard case style is listed for each model number. Case style 135 is a bondable chip. For other available case styles, contact the factory.
3. **Test conditions are as follows:**
   P_{LO} = – 10 dBm
   F_{IF} = 10 KHz
   R_L = 22 ohms
   N_{IF} = 1.5 dB
4. **The input impedance of the 10 KHz amplifier is approximately 10 Kohms. IF impedance is measured by modulating the specified test frequency with a 1000 Hz signal, R_L = 22 ohms.**

MAXIMUM RATINGS

TEMPERATURE RANGE

Storage Temperature	
(case style 3, 54, 119, 120 186, 276)	– 65°C to + 150°C
(case style 137)	– 65°C to + 125°C
Operating Temperature	
(case style 3, 54, 119, 120, 186, 276)	– 65°C to + 150°C
(case style 137)	– 65°C to + 125°C

POWER RATINGS

Maximum Incident Peak RF Power	0.5 watt for 1 μs maximum
Maximum Incident CW RF Power	X Band 100mW
	Ku-K Band 75 mW

SOLDER TEMPERATURE RATINGS

For case style 54, 186, 276	230°C for 5 seconds 1 mm from case
For case style 120	200°C for 5 seconds
For case style 137, 213	200°C for 5 seconds 1 mm from case

Typical Performance Curves

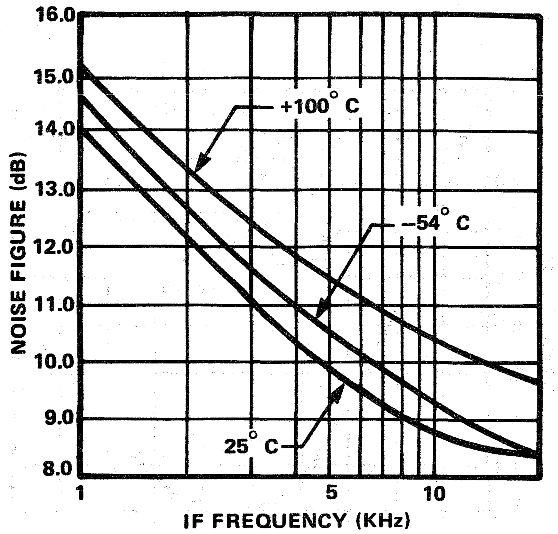


FIGURE 1. Noise Figure vs. IF Frequency Over Temperature

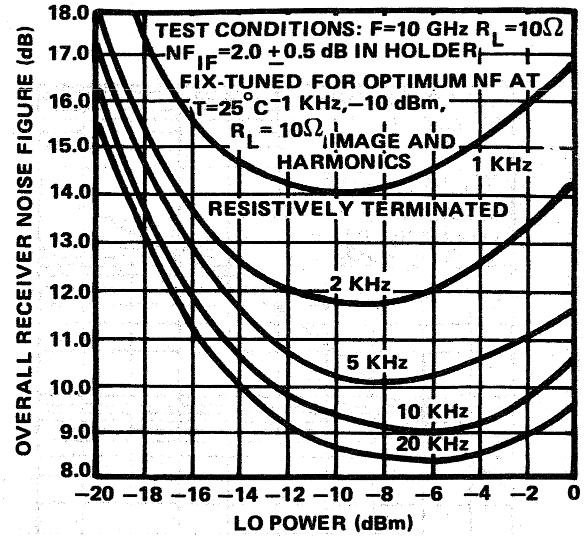


FIGURE 2. Single Sideband Noise Figure vs. Power

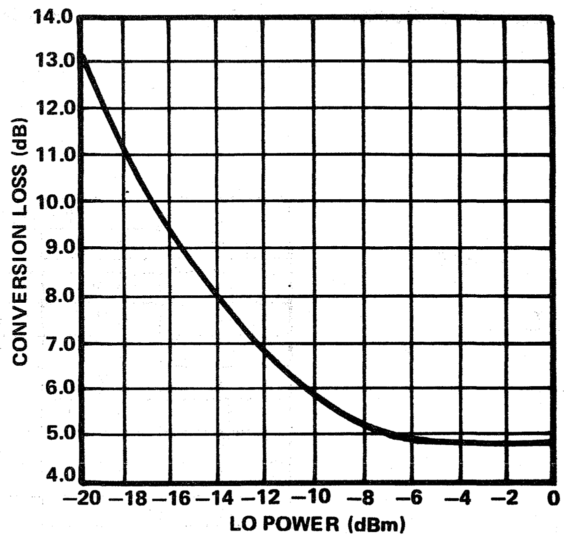


FIGURE 3. Conversion Loss vs. Power

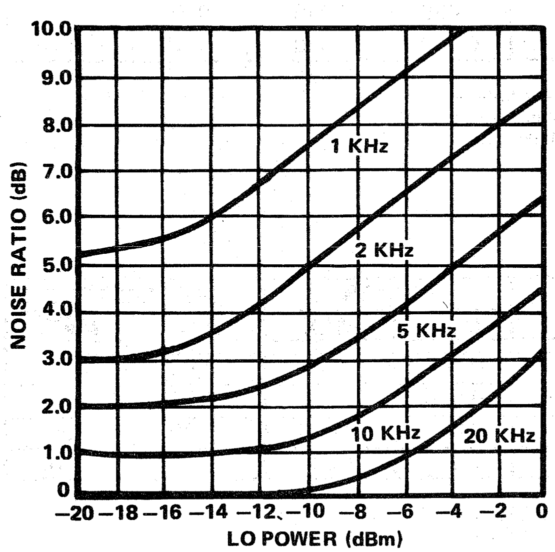


FIGURE 4. Noise Ratio vs. Power

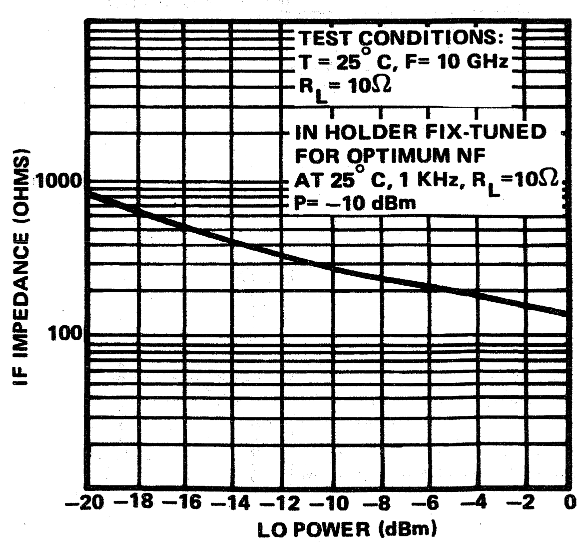


FIGURE 5. Z_{IF} vs. Power

Typical Performance Curves (Cont'd)

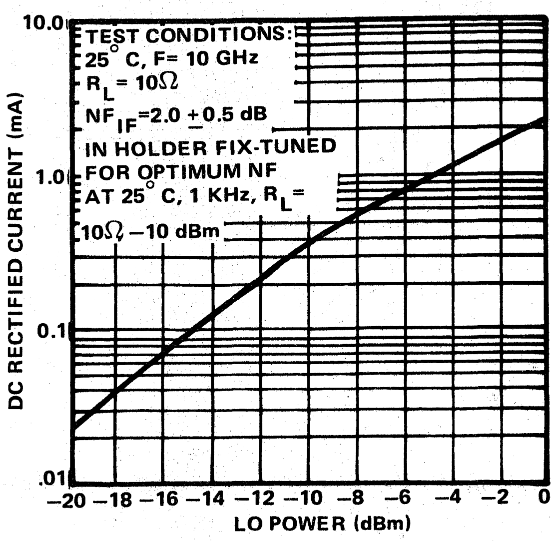


FIGURE 6. DC Rectified Current vs. Power

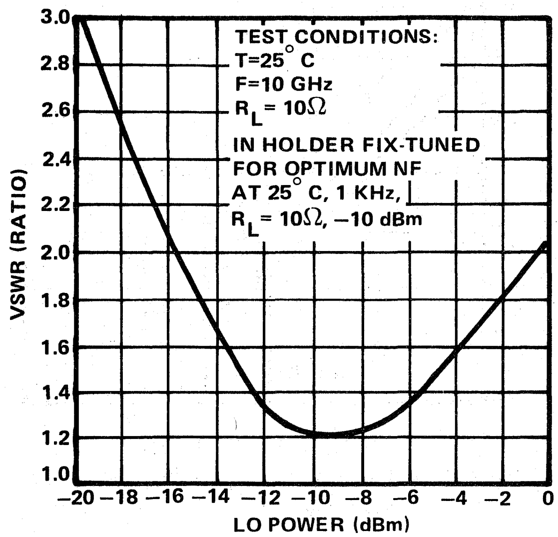
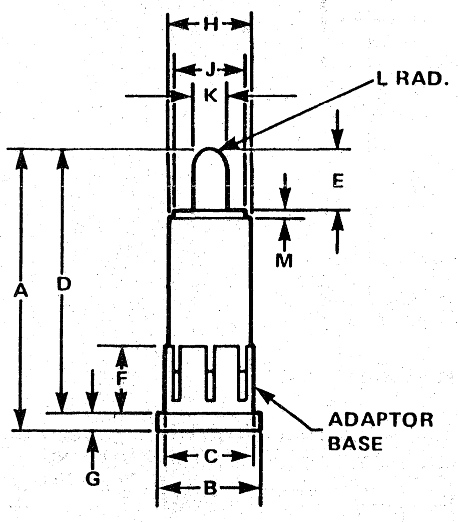


FIGURE 7. VSWR vs. Power

Case Styles

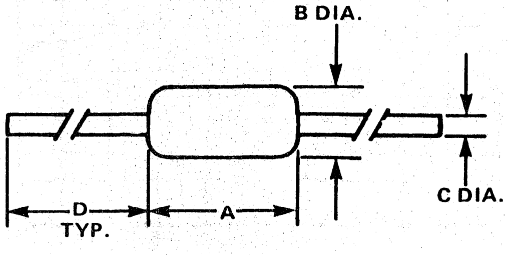
3



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.800	0.840	20,32	21,34
B	0.292	0.296	7,42	7,52
C	0.246	0.250	6,25	6,35
D	0.753	0.783	19,13	19,89
E	0.180	0.190	4,57	4,83
F	0.193	0.199	4,90	5,05
G	0.047	0.057	1,19	1,45
H	0.222	0.240	5,64	6,10
J	0.195	0.215	4,95	5,46
K	0.092	0.094	2,34	2,39
L	0.030	0.046	0,76	1,17
M	0.020	0.030	0,51	0,76

Adaptor base optional.
C_P = 0.12 pF Typical
L_S = 0.50 nH Typical

54

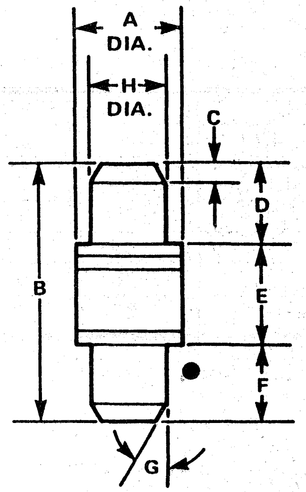


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.145	0.165	3,68	4,19
B	0.068	0.075	1,72	1,91
C	0.014	0.016	0,35	0,41
D	1.000	1.500	25,40	38,10

C_P = 0.05 pF Typical
L_S = 1.00 nH Typical

Case Styles (Cont'd)

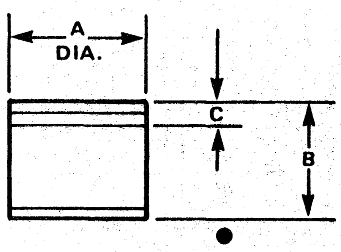
119



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.078	0.086	1,98	2,18
B	0.190	0.210	4,83	5,33
C	0.009	0.015	0,23	0,38
D	0.060	0.064	1,52	1,63
E	0.070	0.082	1,78	2,08
F	0.060	0.064	1,52	1,63
G	25°	35°	25°	35°
H	0.060	0.064	1,52	1,63

C_P = 0.15 pF Typical
L_S = 0.50 nH Typical

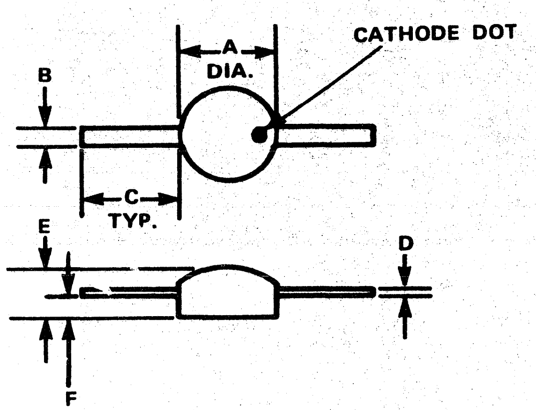
120



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

137

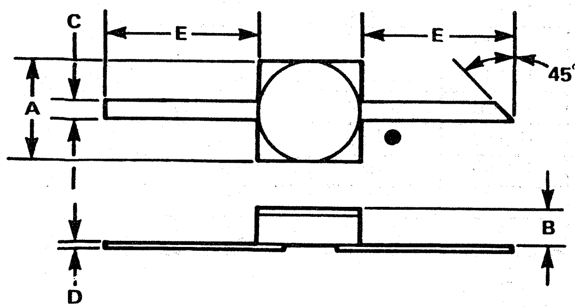


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.090	.110	2,29	2,54
B	.018	.022	,46	,56
C	.095	.105	2,41	2,67
D	.003	.005	,08	,13
E	— —	.050	— —	1,27
F	— —	.014	— —	,360

$C_P \cong$ 0.05 pF Typical
$L_S \cong$ 0.50 nH Typical

Case Styles (Cont'd)

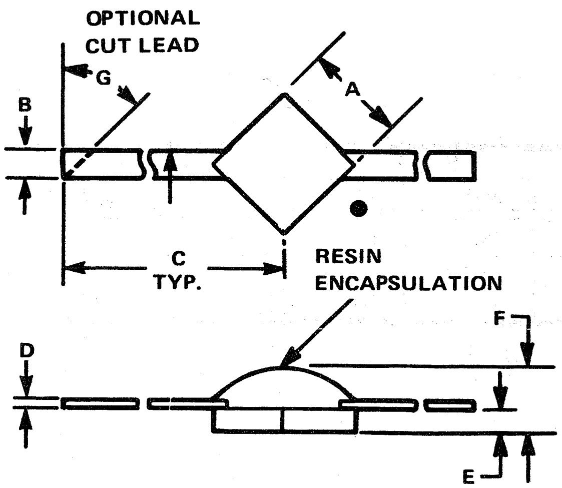
186



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0,76	0,15
E	0.130	0.170	3,30	4,32

$C_P \cong 0.15$ pF Typical
$L_S \cong 0.40$ nH Typical

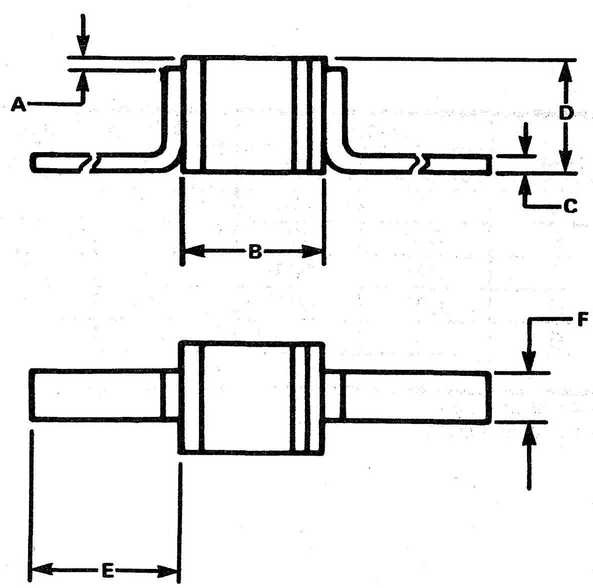
213



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.045	0.055	1,14	1,40
B	0.012	0.018	0,30	0,46
C	0.150	0.180	3,81	4,57
D	0.003	0.005	0,08	0,13
E	— —	0.014	— —	0,36
F	— —	0.035	— —	0,89
G	40°	50°	— —	— —

$C_P \approx 0.12$ pF Typical
$L_S \approx 0.30$ nH Typical

276

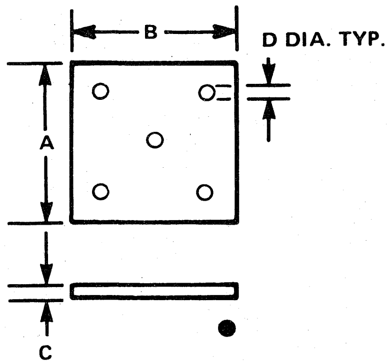


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.020	0,254	0,508
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

C_P - 0.13 pF Typical
L_S - 0.40 nH Typical

Chip Style

135



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.013	.017	,330	,431
B	.013	.017	,330	,431
C	.004	.006	,102	,152
D	.001	— —	,02	— —

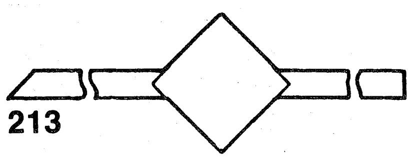
Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly at

M/A-COM Semiconductor Products Operation, 43 South Avenue, Burlington, MA 01803, (617) 272-3000, TWX 710-332-6789

Stripline Packaged Silicon Schottky Mixer Diodes

Stripline Packaged Silicon Schottky Mixer Diodes



213

Features

- LARGE CHOICE OF AVAILABLE PACKAGES
- UNIFORM RF CHARACTERISTICS
- SCREENING TO JANTXV LEVEL AVAILABLE
- LOW, MEDIUM AND HIGH BARRIER DIODES

Description

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

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

Applications

Stripline and microstrip mixers from 100 MHz.
Upconverters.

Stripline Packaged Silicon Schottky Mixer Diodes

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

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

Electrical characteristics and packaging other than the standard specifications listed, are available upon request at nominal charge. For more information, contact the factory.

Specifications @ $T_A = 25°C$

Low Barrier Stripline Packaged Schottky Diodes

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

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Frequency (dB)	Maximum[4] SWR (Volts)	Z_{IF} Range[5] Min./Max. (Ohms)
MA40033	137	6.000	5.5	1.5	200-500
MA40034	137	6.000	6.0	1.5	200-500
MA40035	137	6.000	7.0	2.0	200-500
MA40036	213	6.000	5.5	1.5	200-500
MA40037	213	6.000	6.0	2.0	200-500
MA40038	213	9.375	7.0	1.5	200-500
MA40080	137	9.375	6.0	1.5	200-500
MA40078	137	9.375	6.5	1.5	250-450
MA40076	137	9.375	7.0	2.0	250-450
MA40126	186	9.375	6.0	1.5	250-450
MA40127	186	9.375	6.5	2.0	250-450
MA40128	186	9.375	7.0	1.5	250-450
MA40083	213	9.375	6.0	1.5	250-450
MA40079	213	9.375	6.5	1.5	200-500
MA40077	213	9.375	7.0	2.0	200-500
MA40105-276	276	9.375	6.0	1.5	250-450
MA40106-276	276	9.375	6.5	1.5	250-450
MA40107-276	276	9.375	7.0	2.0	250-450
MA40115-276	276	16.000	6.5	2.0	250-450
MA40116-276	276	16.000	7.0	2.0	250-450
MA4E911-276	276	24.000	8.0	2.0	200-500
MA4E914-276	276	24.000	7.5	1.5	200-500

See notes on page 6-40.

Specifications (Cont'd)

Medium Barrier Stripline Schottky Diodes

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

Model[1] Number	Case[2] Style	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] SWR (Volts)	Z_{IF} Range[5] Min./Max. (Ohms)
MA40032	137	6.000	5.5	1.5	200-500
MA40031	137	6.000	6.0	1.5	200-500
MA40030	137	6.000	7.0	1.5	200-500
MA40048	213	6.000	5.5	1.5	200-500
MA40047	213	6.000	6.0	1.5	200-500
MA40046	213	6.000	7.0	1.5	200-500
MA40088	137	9.375	6.0	1.5	200-500
MA40086	137	9.375	6.5	1.5	200-500
MA40084	137	9.375	7.0	2.0	200-500
MA40176	186	9.375	6.0	1.5	250-450
MA40177	186	9.375	6.5	1.5	250-450
MA40178	186	9.375	7.0	2.0	250-450
MA40089	213	9.375	6.0	1.5	200-500
MA40087	213	9.375	6.5	1.5	200-500
MA40085	213	9.375	7.0	2.0	200-500
MA40155-276	276	9.375	6.0	1.5	250-450
MA40156-276	276	9.375	6.5	1.5	250-450
MA40157-276	276	9.375	7.0	2.0	250-450
MA40165-276	276	16.000	6.5	1.5	250-450
MA40166-276	276	16.000	7.0	2.0	250-450
MA4E920-276	276	24.000	7.5	1.5	200-500
MA4E917-276	276	24.000	8.0	2.0	200-500

See notes on page 6-40.

MAXIMUM RATINGS

TEMPERATURE RANGE

Operating	(case style 186, 276)	−65°C to +150°C
	(case style 137, 213)	−65°C to +125°C
Storage	(case style 186, 276)	−65°C to +150°C
	(case style 137, 213)	−65°C to +125°C

INCIDENT POWER RATINGS

Maximum Peak RF Incident Power	C-X Band 1 Watt for 1 microsecond maximum
	Ku-K Band 0.5 Watt for 1 microsecond maximum
Maximum CW RF Incident Power	C-X Band 150 mW
	Ku-K Band 100 mW

SOLDER TEMPERATURE RATINGS

(case style 137, 213)	200°C for 5 seconds, 1 mm from package
(case style 186, 276)	225°C for 5 seconds, 1 mm from package

Specifications (Cont'd)

High Barrier Stripline Schottky Diodes

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

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB	Maximum[4] SWR (Volts)	Z_{IF} Range[5] Min./Max. (Ohms)
MA40045	137	6.000	5.5	1.5	200-500
MA40044	137	6.000	6.0	1.5	200-500
MA40039	137	6.000	7.0	2.0	200-500
MA40060	213	6.000	5.5	1.5	200-500
MA40057	213	6.000	6.0	1.5	200-500
MA40056	213	6.000	7.0	2.0	200-500
MA40095	137	9.375	6.0	1.5	250-450
MA40093	137	9.375	6.5	1.5	250-450
MA40091	137	9.375	7.0	2.0	250-450
MA4E197	186	9.375	6.0	1.5	250-450
MA4E198	186	9.375	6.5	1.5	250-450
MA4E199	186	9.375	7.0	2.0	250-450
MA40096	213	9.375	6.0	1.5	250-450
MA40094	213	9.375	6.5	1.5	250-450
MA40092	213	9.375	7.0	2.0	250-450
MA4E185-276	276	9.375	6.0	1.5	250-450
MA4E186-276	276	9.375	6.5	1.5	250-450
MA4E187-276	276	9.375	7.0	2.0	250-450
MA4E190-276	276	16.000	6.5	1.5	250-450
MA4E191-276	276	16.000	7.0	2.0	250-450
MA4E926-276	276	24.000	7.5	1.5	200-500
MA4E923-276	276	24.000	8.0	2.0	200-500

NOTES:

1. All mixer diodes are available as matched pairs and can be ordered by adding the suffix "M" to the diode model number. Bin matching is available upon request. The matching criteria is as follows:
   Nf = 0.3 dB maximum   Zif = 25 ohms maximum
2. The maximum solder temperature is 230°C for 5 seconds. Case styles other than those indicated are available on request. Consult the factory.
3. Test conditions for noise figure:
   P_{LO} = 1 mW (for low and medium barrier)
   P_{LO} = 2 mW (for high barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB (minimum)
   R_L = 22 ohms
4. SWR for low and medium barrier diodes is tested at LO power of 1.0 mW. High barrier diodes are tested at a LO power level of 2.0 mW. RL = 22 ohms.
5. IF impedance is measured by modulating the specified test frequency with a 1000 Hz signal. RL = 22 ohms. Low and medium barrier diodes are tested at an incident power level of 1.0 mW. High barrier diodes are tested at an incident power level of 2.0 mW.

Specifications (Cont'd)

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

SCREENED DIODES MIL-STD-19500

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

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

Typical Performance Curves

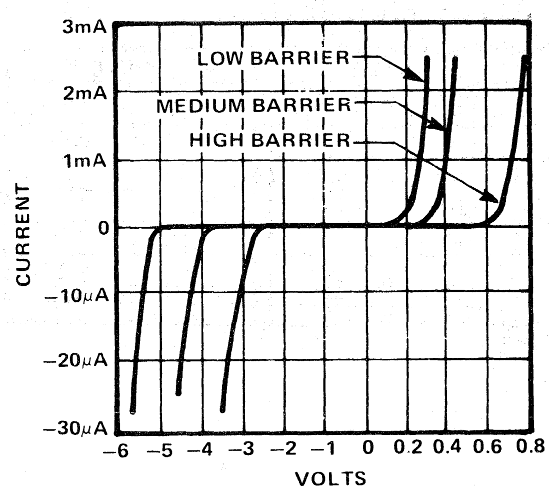


FIGURE 1. Nominal I-V Characteristics and Barrier Heights for Schottky Mixer Diodes

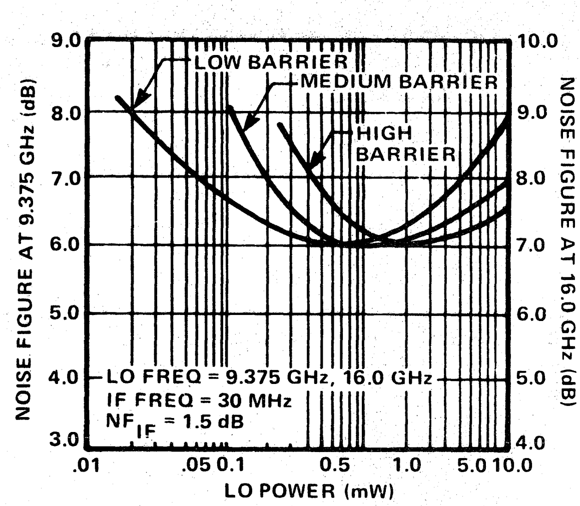


FIGURE 2. Nominal Schottky Barrier Noise Figure vs. LO Power

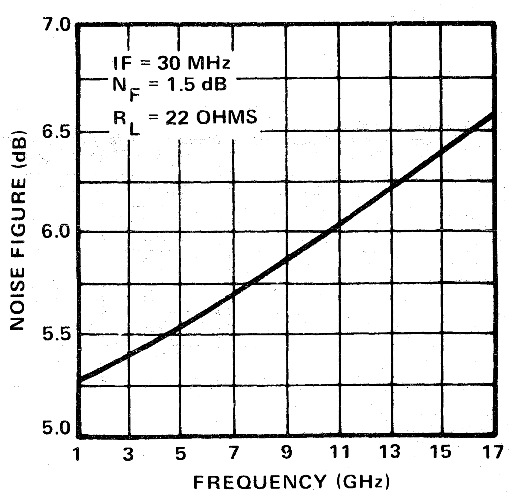


FIGURE 3. Nominal Noise Figure vs. Frequency

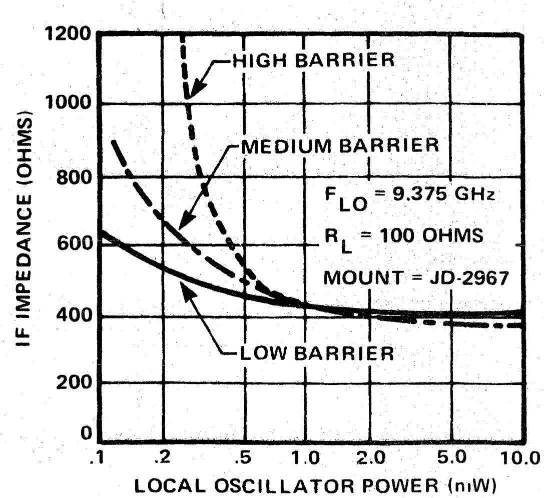
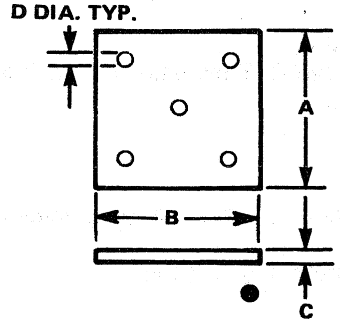


FIGURE 4. Nominal IF Impedance vs. Local Oscillator Drive

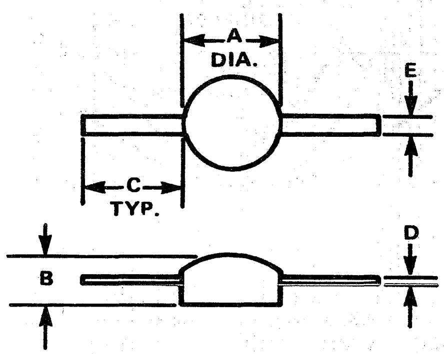
Case Styles

135



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.013	.017	,330	,431
B	.013	.017	,330	,431
C	.004	.006	,102	,152
D	.001	— —	,02	— —

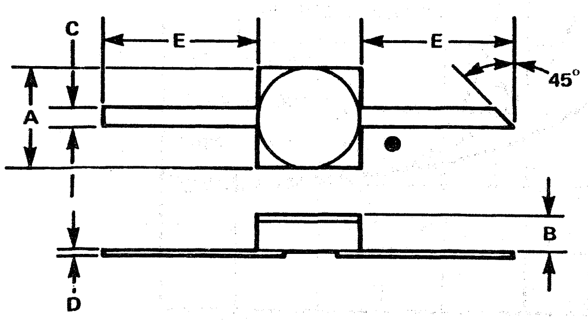
137



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.090	.110	2,29	2,54
B	.018	.022	,46	,56
C	.095	.105	2,41	2,67
D	.003	.005	,08	,13
E	— —	.050	— —	1,27
F	— —	.014	— —	,360

$C_P \approx 0.05$ pF Typical
$L_S \approx 0.50$ nH Typical

186

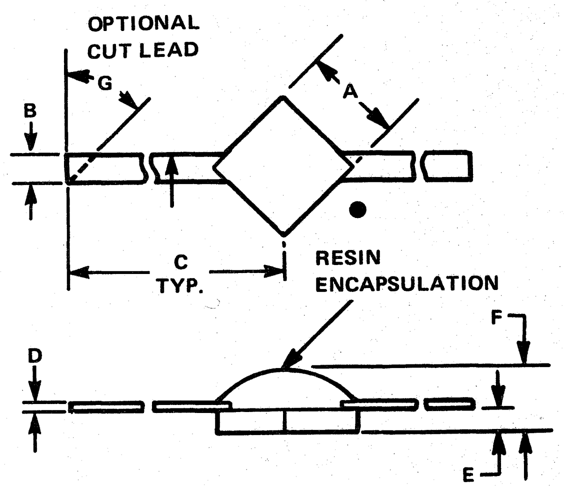


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0,76	0,15
E	0.130	0.170	3,30	4,32

$C_P \sim 0.15$ pF Typical
$L_S \sim 0.40$ nH Typical

Case Styles (Cont'd)

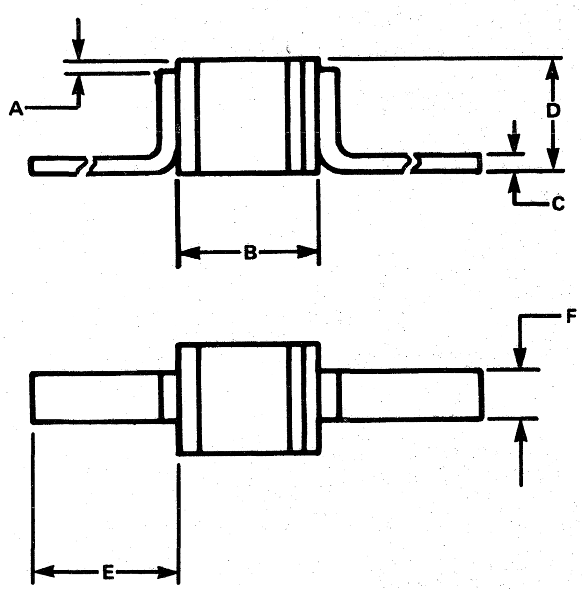
213



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.045	0.055	1,14	1,40
B	0.012	0.018	0,30	0,46
C	0.150	0.180	3,81	4,57
D	0.003	0.005	0,08	0,13
E	— —	0.014	— —	0,36
F	— —	0.035	— —	0,89
G	40°	50°	— —	— —

$C_P \approx$ 0.12 pF Typical
$L_S \approx$ 0.30 nH Typical

276



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.020	0,254	0,058
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

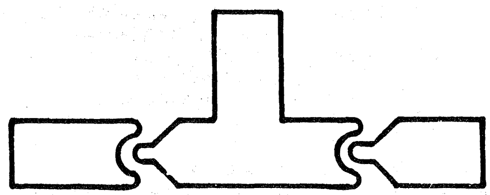
$C_P \approx$ 0.13 pF Typical
$L_S \approx$ 0.40 nH Typical

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

Schottky Barrier Packaged and Beam-Lead TEEs

For Balanced Mixers up to 18 GHz



Features

- SMALL PHYSICAL SIZE FOR MICROSTRIP MOUNTING
- HIGH RELIABILITY
- CLOSELY MATCHED JUNCTIONS FOR HIGH ISOLATION
- THREE DIODE BARRIER HEIGHTS ARE AVAILABLE ON REQUEST
- DEVICES 100% TESTED
- MINIMUM PARASITICS FOR BROADBAND DESIGNS

Description

Each Schottky barrier beam-lead TEE consists of two closely matched diodes connected in the classic TEE configuration. The diodes are formed monolithically to assure close matching of electrical characteristics such as capacitance, forward voltage and series resistance. The silicon that originally connected the diodes in slice form is etched away so that each diode in the configuration is in beam-lead form. The beam-lead construction assures minimum junction capacitance, minimum connecting lead inductance and permits the interconnection of the diodes into TEEs at the wafer level.

Three barrier levels are available for various levels of local oscillator drive power. The L series features a low barrier for applications which have low available local oscillator power. Both medium barrier (M series) and high barrier (H series) devices are available for applications with higher drive levels. The RF and local oscillator frequencies can range up to 18 GHz with selection of an appropriate junction capacitance. Each series is available in three case styles which are compatible with microstrip assembly techniques. The 270 case style is hermetically sealed and should be used in either harsh environments or very high reliability situations. The 272 case style is a low cost enclosure close to the physical size of the 270 case style. The 271 case style, specially designed for maximum bandwidth, features unpackaged diodes arranged in the TEE configuration. The case style 1000 is the smallest stripline package and has the lowest parasitic capacitance and inductance.

Specifications @ $T_A = 25°C$

Schottky Beam-Lead TEEs

Model[6,7] Number	Barrier Height	Frequency Band	Maximum[1] Junction Capacitance C_j (pF)	Maximum[1] Junction Capacitance Difference ΔC_j (pF)	Maximum[2] Series Resistance R_s (Ohms)	Nominal[3] Forward Voltage Vf (Volts)	Maximum[3] Forward Voltage Match Vf (Volts)	Nominal Noise Figure NF (dB)	Minimum[5] Break-down Voltage (Volts)
MA4E201L	Low	S	.50	.10	7	.250	.015	6.0	2.0
MA4E204L	Low	C-X	.35	.10	10	.270	.015	6.5	2.0
MA4E207L	Low	Ku	.20	.05	12	.300	.015	7.5	2.0
MA4E201M	Medium	S	.50	.10	7	.350	.015	6.0	3.0
MA4E204M	Medium	C-X	.35	.10	10	.370	.015	6.5	3.0
MA4E207M	Medium	Ku	.20	.05	12	.400	.015	7.5	3.0
MA4E201H	High	S	.50	.10	7	.550	.015	6.0	5.0
MA4E204H	High	C-X	.35	.10	10	.570	.015	6.5	5.0
MA4E207H	High	Ku	.20	.05	12	.600	.015	7.5	5.0

NOTES:

1. C_j and ΔC_j are measured at Vr = 0 volts and F = 1.0 MHz.
2. Vf is measured at IF = 1.0 mA.
3. Series resistance, R_s, is determined by subtracting the junction resistance, R_j, from the measured value of 10 mA dynamic (slope) resistance, R_d:

   $R_s = R_d - R_j$ ohms

   Junction resistance is computed from the following equation:

   $R_j = 26/IF$ ohms
   IF = 10 mA
   IF is the forward bias current in mA.
4. Noise figure measurements are performed on packaged diodes sampled from every lot of beam lead Schottky material. The noise figure specified is the maximum limit for lot approval. The test conditions are as follows:

   LO Power = 1.0 mW (low and medium barrier, 2.0 mW for high barrier)
   LO Frequency = 3.06 GHz (S-band)
   9.375 GHz (X-band)
   16.00 GHz (Ku-band)
   IF = 30 MHz
   NF_{IF} = 1.5 dB
5. Voltage breakdown is measured at Ir = 10 μA.
6. The standard case styles for the Schottky Beam-Lead Tees are 270, 271, 272 and 1000.
7. To order parts specify the package as a suffix, i.e., MA4E201L-270 is a S-Band Low Barrier Tee in ODS-270.

Schottky Beam Lead Reverse TEEs

Model[6,7] Number	Barrier Height	Frequency Band	Maximum[1] Junction Capacitance C_j (pF)	Maximum[1] Junction Capacitance Difference ΔC_j (pF)	Maximum[2] Series Resistance R_s (Ohms)	Nominal[3] Forward Voltage Vf (Volts)	Maximum[3] Forward Voltage Match Vf (Volts)	Nominal Noise Figure NF (dB)	Minimum[5] Break-down Voltage (Volts)
MA4E974L	Low	S	.50	.10	7	.250	.015	6.0	2.0
MA4E975L	Low	C-X	.35	.10	10	.270	.015	6.5	2.0
MA4E976L	Low	Ku	.20	.05	12	.300	.015	7.5	2.0
MA4E974M	Medium	S	.50	.10	7	.250	.015	6.0	3.0
MA4E975M	Medium	C-X	.35	.10	10	.270	.015	6.5	3.0
MA4E976M	Medium	Ku	.20	.05	12	.300	.015	7.5	3.0
MA4E974H	High	S	.50	.10	7	.250	.015	6.0	4.0
MA4E975H	High	C-X	.35	.10	10	.270	.015	6.5	4.0
MA4E976H	High	Ku	.20	.05	12	.300	.015	7.5	4.0

NOTES:

1. C_j and ΔC_j are measured at Vr = 0 volts and F = 1.0 MHz.
2. Vf is measured at IF = 1.0 mA.
3. Series resistance, R_s, is determined by subtracting the junction resistance, R_j, from the measured value of 10 mA dynamic (slope) resistance, R_d:

   $R_s = R_d - R_j$ ohms

   Junction resistance is computed from the following equation:

   $R_j = 26/IF$ ohms
   IF = 10 mA
   IF is the forward bias current in mA.
4. Noise figure measurements are performed on packaged diodes sampled from every lot of beam lead Schottky material. The noise figure specified is the maximum limit for lot approval. The test conditions are as follows:

   LO Power = 1.0 mW (low and medium barrier, 2.0 mW for high barrier)
   LO Frequency = 3.06 GHz (S-band)
   9.375 GHz (X-band)
   16.00 GHz (Ku-band)
   IF = 30 MHz
   NF_{IF} = 1.5 dB
5. Voltage breakdown is measured at Ir = 10 μA.
6. The standard case style for the Reverse Tee series of diodes is case style 1012. Reverse tee diodes available in case styles 270, 272, 1000 and 1012.
7. To order parts specify the package as a suffix, i.e., MA4E974L-270 is a S-Band Low Barrier Tee in ODS-270.

Specifications @ $T_A = 25°C$ (Cont'd)

Schottky Beam Lead Common Cathode TEEs

Model[6,7] Number	Barrier Height	Frequency Band	Maximum[1] Junction Capacitance C_j (pF)	Maximum[1] Junction Capacitance Difference ΔC_j (pF)	Maximum[2] Series Resistance R_S (Ohms)	Nominal[3] Forward Voltage Vf (Volts)	Maximum[3] Forward Voltage Match Vf (Volts)	Nominal Noise Figure NF (dB)	Minimum[5] Break-down Voltage (Volts)
MA4E977L	Low	S	.50	.10	7	.250	.015	6.0	2.0
MA4E978L	Low	C-X	.35	.10	10	.270	.015	6.5	2.0
MA4E979L	Low	Ku	.20	.05	12	.300	.015	7.5	2.0
MA4E977M	Medium	S	.50	.10	7	.250	.015	6.0	3.0
MA4E978M	Medium	C-X	.35	.10	10	.270	.015	6.5	3.0
MA4E979M	Medium	Ku	.20	.05	12	.300	.015	7.5	3.0
MA4E977H	High	S	.50	.10	7	.250	.015	6.0	4.0
MA4E978H	High	C-X	.35	.10	10	.270	.015	6.5	4.0
MA4E979H	High	Ku	.20	.05	12	.300	.015	7.5	4.0

NOTES:

1. C_j and ΔC_j are measured at Vr = 0 volts and F = 1.0 MHz.
2. Vf is measured at IF = 1.0 mA.
3. Series resistance, R_S, is determined by subtracting the junction resistance, R_j, from the measured value of 10 mA dynamic (slope) resistance, R_d:

   $R_S = R_d - R_j$ ohms

   Junction resistance is computed from the following equation:

   $R_j = 26/IF$ ohms
   IF = 10 mA
   IF is the forward bias current in mA.
4. Noise figure measurements are performed on packaged diodes sampled from every lot of beam lead Schottky material. The noise figure specified is the maximum limit for lot approval. The test conditions are as follows:

   LO Power = 1.0 mW (low and medium barrier, 2.0 mW for high barrier)
   LO Frequency = 3.06 GHz (S-band)
   9.375 GHz (X-band)
   16.00 GHz (Ku-band)
   IF = 30 MHz
   NF_{IF} = 1.5 dB
5. Voltage breakdown is measured at Ir = 10 μA.
6. The standard case style for the Beam Lead Schottky Common Cathode is case style 1011. Schottky common cathode is available in case styles 270, 272, 1000 and 1011.
7. To order parts specify the package as a suffix, i.e., MA4E977L-270 is a S-Band Low Barrier Tee in ODS-270.

Schottky Dual Barrier TEEs

Model[5,6] Number	Barrier Height	Frequency Band	Maximum[1] Junction Capacitance C_j (pF)	Maximum[1] Junction Capacitance Difference ΔC_j (pF)	Maximum[2] Series Resistance R_S (Ohms)	Nominal[3] Forward Voltage Vf (Volts)	Maximum[3] Forward Voltage Match Vf (Volts)	Minimum[4] Break-down Voltage (Volts)
MA4E980H	High	X	.20	.10	20	1.14	.020	8.0
MA4E981H	High	Ku	.12	.05	24	1.21	.020	8.0

NOTES:

1. C_j and ΔC_j are measured at Vr = 0 volts and F = 1.0 MHz.
2. Vf is measured at IF = 1.0 mA.
3. Series resistance, R_S, is determined by subtracting the junction resistance, R_j, from the measured value of 10 mA dynamic (slope) resistance, R_d:

   $R_S = R_d - R_j$ ohms

   Junction resistance is computed from the following equation:

   $R_j = 26/IF$ ohms
   IF = 10 mA
   IF is the forward bias current in mA.
4. Voltage breakdown is measured at Ir = 10 μA.
5. The standard case style for the Schottky Beam Lead Dual Barrier Tee is 968. Schottky dual barrier tee is available in case styles 270, 272, 968 and 1000.
6. To order parts specify the package as a suffix, i.e., MA4E980L-270 is a X-Band High Barrier Tee in ODS-270.

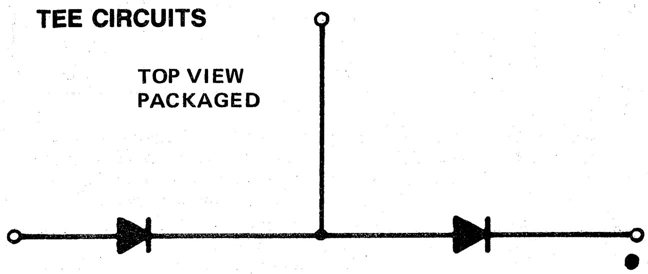
Applications

These diodes are intended primarily for use as balanced mixers. However, pairs of these TEE devices can be used as image rejection mixers. The small case sizes and minimal electrical parasitics are well suited for miniature broadband components. The low barrier (L series) should be used whenever optimum noise figure is required with −3 dBm or less of local oscillator drive power per diode. Medium barrier devices (M series) should be used where minimum noise figure is desired at LO drive levels between −3 dBm and +3 dBm per diode. Minimum noise figure can be obtained at LO drive levels in excess of +3 dBm per diode by using high barrier devices (H series). The diode configurations in the Tees are shown below.

MAXIMUM RATINGS

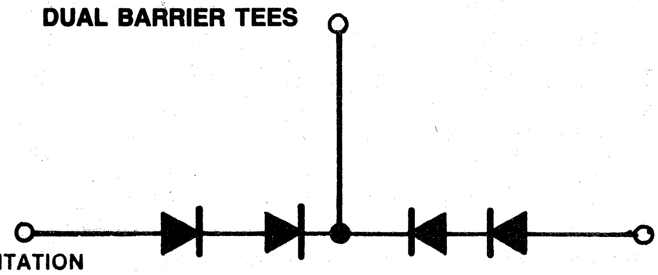
Operating and Storage Temperature Range	−65° to +150°C
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C	75 mW/junction
Soldering Temperature	235°C for 10 sec.
Beam Strength	2g (Case Style 271, 968, 1011, 1012)

TEE CIRCUITS

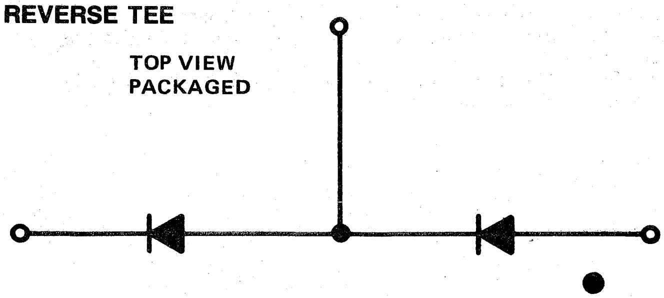


● ORIENTATION

DUAL BARRIER TEES



REVERSE TEE



COMMON CATHODE TEE

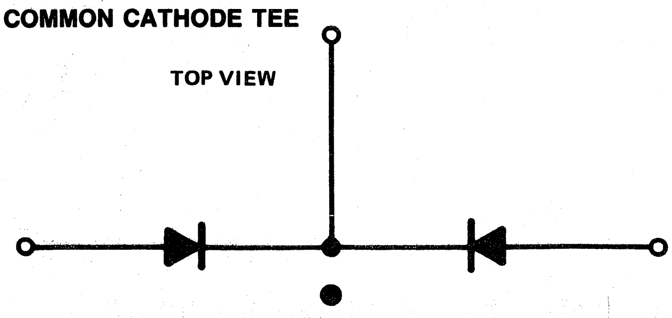
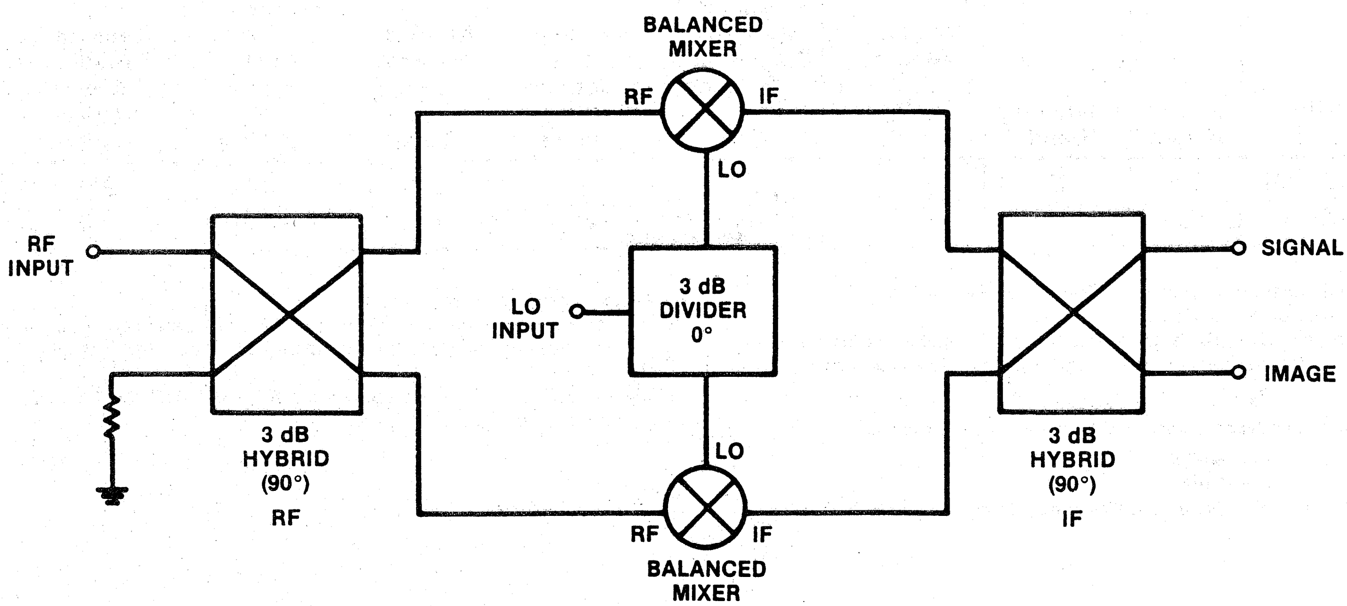
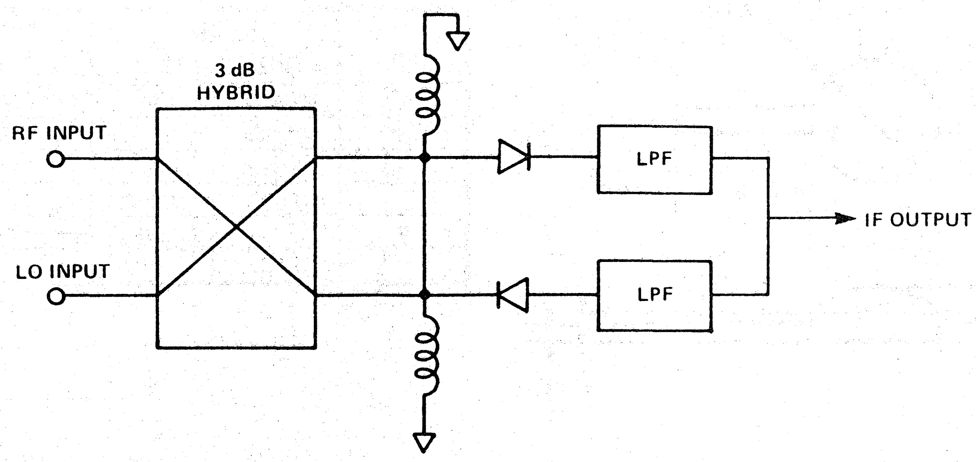


IMAGE REJECTION MIXER



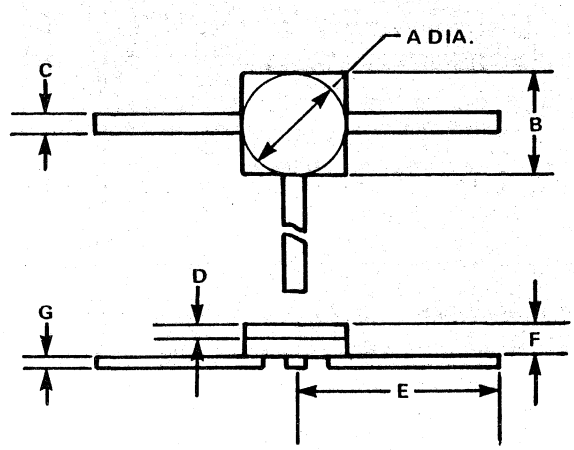
Applications (Cont'd)

BALANCED MIXER



Case Styles

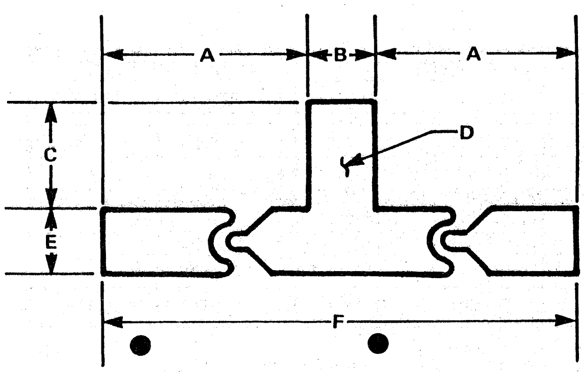
270



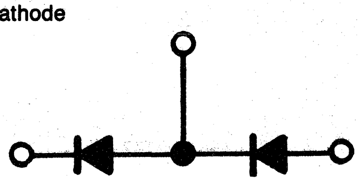
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0,094	0.102	2,39	2,59
C	0.018	0.022	0,46	0,56
D	0.005	0.008	0,13	0,20
E	0.200	— —	5,08	— —
F	0.030	0.040	0,75	1,02
G	0.003	0.006	0,08	0,15

Cp ~ 0.12 pF Typical

271



Cathode

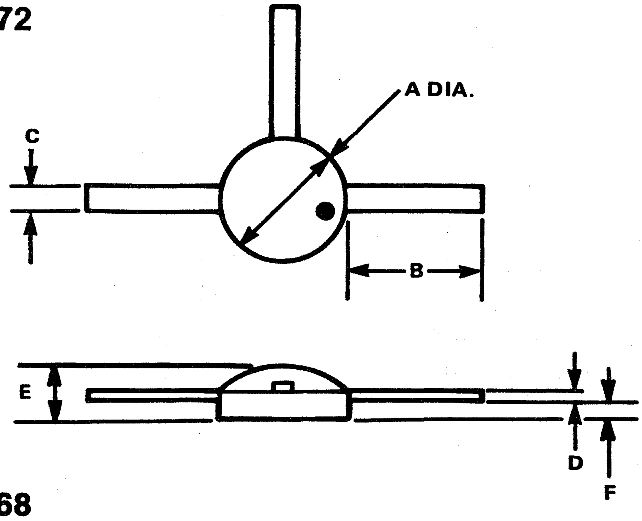


(Orientation)

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.020	0,46	0,508
B	0.0045	0.0065	0,114	0,165
C	0.017	0.019	0,43	0,48
D	0.0003	0.0005	0,008	0,013
E	0.0045	0.0065	0,114	0,165
F	0.044	0.054	1,118	1,372

Case Styles (Cont'd)

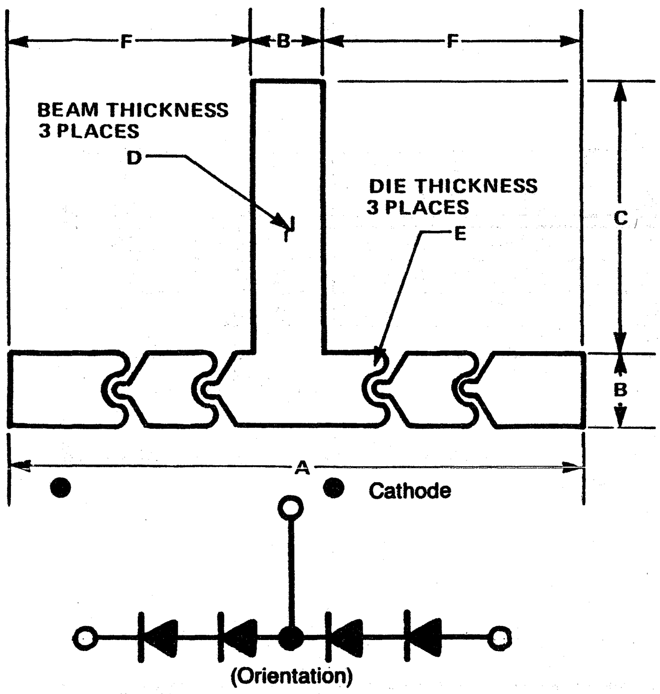
272



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2,29	2,75
B	0,090	0.110	2,29	2,75
C	0.018	0.022	0,46	0,56
D	0.003	0.006	0,08	0,15
E	— —	0.035	— —	0,09
F	— —	0.014	— —	0,36

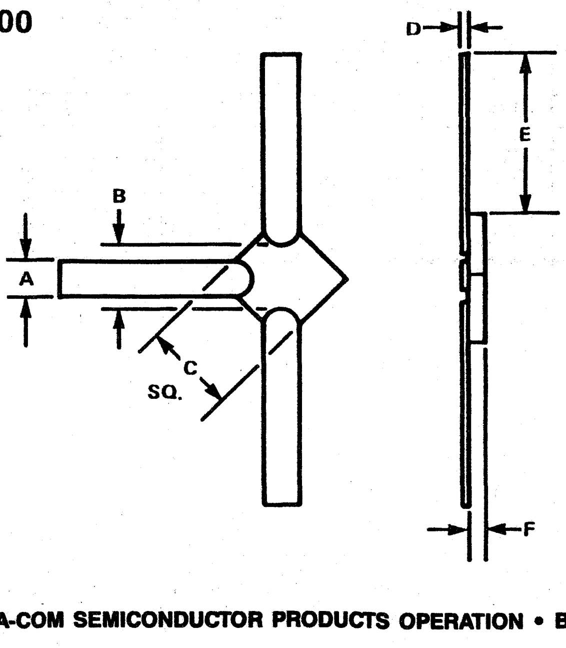
Cp ~ 0.10 pF

968



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.040	0.048	1,02	1,22
B	0.005	0.006	0,127	0,152
C	0.0230	0.0236	0,584	0,599
D	— —	0.005	— —	0,127
E	0.0002	0.0006	0,005	0,015
F	0.0185	0.0205	0,470	0,527

1000

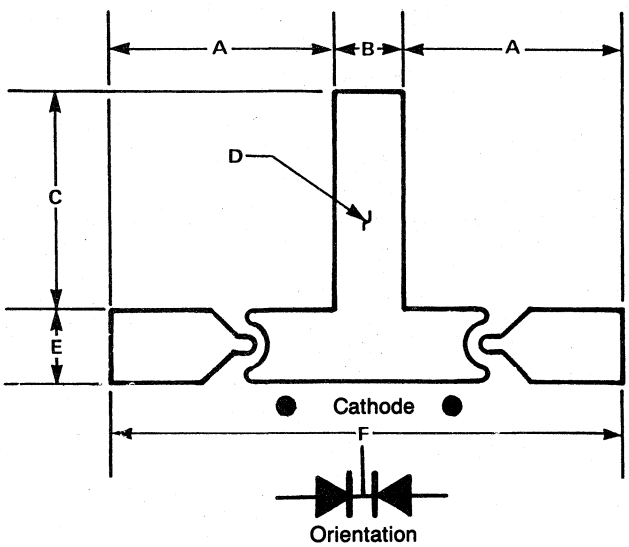


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.013	0.017	0,330	0,432
B	0.022	0.028	0,559	0,711
C	0.048	0.052	1,22	1,32
D	0.003	0.005	0,076	0,127
E	0.090	— —	2,29	— —
F	0.008	0.012	0,203	0,305

C_P ~ 0.05 pF

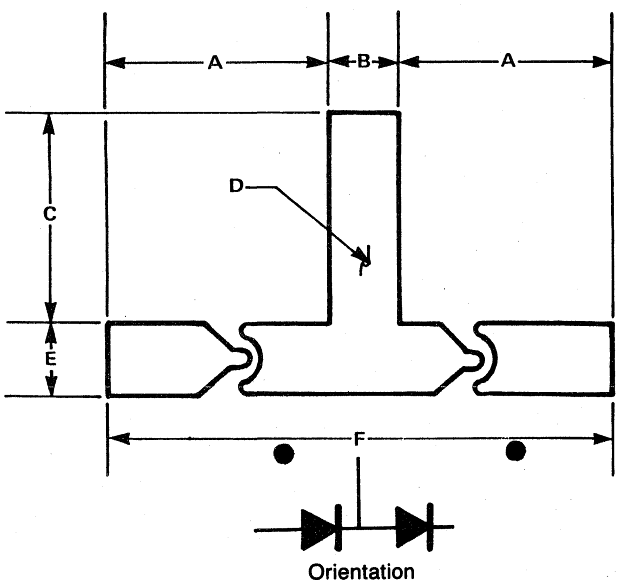
Case Styles (Cont'd)

1011



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.018	0.020	0,46	0,508
B	0.0045	0.0065	0,114	0,165
C	0.017	0.019	0,43	0,48
D	0.0003	0.0005	0,008	0,013
E	0.0045	0.0065	0,114	0,165
F	0.045	0.054	1,118	1,372

1012



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.018	0.020	0,46	0,508
B	0.0045	0.0065	0,114	0,165
C	0.017	0.019	0,43	0,48
D	0.0003	0.0005	0,008	0,013
E	0.0045	0.0065	0,114	0,165
F	0.044	0.054	1,118	1,372

Ordering Information

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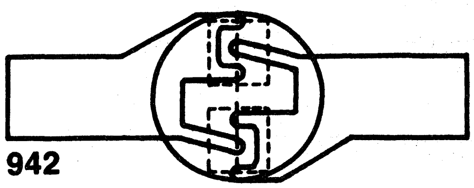
MA40278 and MA40279 Series

Schottky Barrier Beam-Lead Anti-Parallel Pairs



Description

Each Schottky barrier diode pair consists of two closely matched planar diodes connected in an anti-parallel pair configuration. The diodes are formed monolithically to assure close matching of electrical characteristics such as capacitance, forward voltage and series resistance. The silicon that originally connected the diodes in slice form is etched away so that each diode in the configuration is in beam-lead form. The beam-lead construction assures minimum junction capacitance, minimum connection lead inductance and permits the interconnection of the diodes in anti-parallel pairs at the wafer level.

Three barrier height levels are available for various amounts of local oscillator drive power. The MA40278L and MA40279L devices feature a low barrier for applications which have low available local oscillator power. Both medium barrier (MA40278M and MA40279M) and high barrier (MA40278H and MA40279H) devices are available for applications with higher drive levels.

Features

- SMALL PHYSICAL SIZE FOR MICROSTRIP MOUNTING
- HIGH RELIABILITY
- CLOSELY MATCHED JUNCTIONS
- THREE DIODE BARRIER HEIGHTS ARE AVAILABLE
- DEVICES 100% TESTED
- MINIMUM PARASITICS FOR BROADBAND DESIGNS
- SUITED FOR SUBHARMONICALLY PUMPED MIXERS

Specifications @ T_A = 25°C

ELECTRICAL CHARACTERISTICS (CASE STYLE 942)

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

NOTES:

1. C_J is measured at V_R = 0V and F = 1.0 MHz. C_J is comprised of the capacitance of two diode junctions in parallel.
2. Series Resistance, R_S, is determined by subtracting the junction resistance R_J, from the measured value of dynamic (slope) resistance, R_D:

   $R_S = R_D - R_J$ ohms

   Junction resistance is computed from the following equation:

   $R_J = 26/I_F$

   I_B = 10 mA

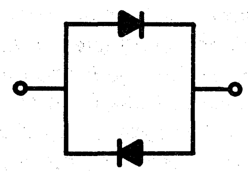
   I_B is the forward current in mA.
3. V_F and ΔV_F are measured at I_F = 1.0 mA.

Applications

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

MAXIMUM RATINGS

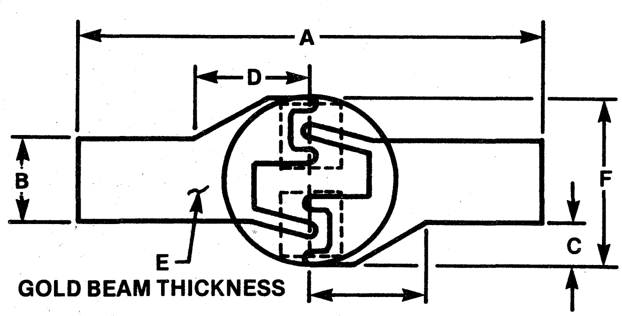
Operating and Storage Temperature Range of Junctions	−65°C to +150°C
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/junction
Beam Strength	2g



Diode Configuration

Case Style

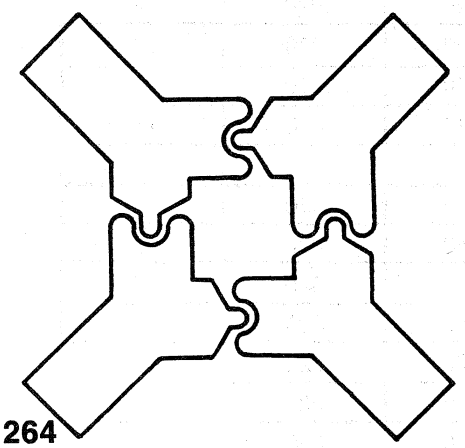
942



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.026	0.028	0,660	0,711
B	0.0045	0.0055	0,114	0,140
C	0.0019	0.0029	0,048	0,074
D	0.006	0.007	0,152	0,178
E	0.0002	0.0005	0,0051	0,0127
F	0.0085	0.010	0,216	0,254

Schottky Barrier Beam-Lead and Packaged Ring Quads

For Double Balanced Mixers up to 18 GHz



264

Features

- SMALL PHYSICAL SIZE FOR MICROSTRIP MOUNTING
- HIGH RELIABILITY
- CLOSELY MATCHED JUNCTION FOR HIGH ISOLATION
- HIGH BARRIERS FOR LO POWER LEVELS UP TO +27 dBm
- DEVICES 100% TESTED
- MINIMUM PARASITICS FOR BROAD-BAND DESIGNS

Description

Single Barrier Ring Quads

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

Dual Barrier Ring Quads

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

Cross-Over Quad

The cross-over quad is a single barrrier ring quad where the leads are crossed-over within the diode package. The diodes used are four closely matched medium barrier Schottky diode chips. M/A-COM's cross-over quads are constructed using hybrid integrated circuit technology.

M/A-COM's ring quads are available in five case styles which are compatible with microstrip assembly techniques. The 226 case style is hermetically sealed and should be used in either harsh environments or very high reliability situations. The 228 case style is a low-cost package close to the physical size of the 226 case style. The smaller case style, 227, is physically smaller than the others and should be used for either high frequency or maximum bandwidth applications. Case style 905, designed specifically for broadest bandwidth, features unpackaged beam-lead quads.

Specifications @ TA = 25°C

Model Number	Case Style	Freq. Band	Maximum[1] Capacitance C_j (pF)	Maximum[1] Capacitance Difference ΔC_T (pF)	Typical[2] Forward Voltage V_F (Volts)	Maximum[2] Forward Voltage Difference ΔV_F (Volts)	Maximum[3] Series Resistance R_S (Ohms)
Low Barrier Ring Quads							
MA40430	226	L-S	0.55	0.10	.250	.020	7
MA40431	227	L-S	0.40	0.10	.250	.020	7
MA40432	228	L-S	0.50	0.10	.250	.020	7
MA40439	228	L-S	0.50	0.20	.250	.020	7
MA40433	226	C	0.30	0.05	.270	.020	10
MA40434	227	C	0.30	0.10	.270	.020	10
MA40437	264	C-X	0.25	0.10	.270	.020	10
MA40435	227	X	0.20	0.05	.300	.020	12
MA40436	227	Ku	0.15	0.05	.300	.020	12
MA40438	264	X-Ku	0.15	0.05	.300	.020	12
MA40284	963	X-Ku	0.10	0.05	.310	.020	18
Medium Barrier Ring Quads							
MA40440	226	L-S	0.50	0.10	.350	.020	7
MA40441	227	L-S	0.45	0.10	.350	.020	7
MA40442	228	L-S	0.50	0.10	.350	.020	7
MA40449	228	L-S	0.50	0.20	.350	.020	7
MA40443	226	C	0.30	0.05	.370	.020	10
MA40444	227	C	0.30	0.10	.370	.020	10
MA40445	228	C	0.30	0.10	.370	.020	10
MA40448	264	C-X	0.25	0.10	.370	.020	10
MA40446	227	X	0.20	0.05	.410	.020	12
MA40447	227	Ku	0.15	0.05	.410	.020	12
MA40450	264	X-Ku	0.15	0.05	.410	.020	12
MA40285	963	X-Ku	0.10	0.05	.410	.020	18
High Barrier Ring Quads							
MA40490	226	L-S	0.50	0.10	.550	.020	7
MA40491	227	L-S	0.45	0.10	.550	.020	7
MA40492	228	L-S	0.50	0.10	.550	.020	7
MA40499	228	L-S	0.50	0.20	.550	.020	7
MA40493	226	C	0.30	0.05	.570	.020	10
MA40494	227	C	0.30	0.10	.570	.020	10
MA40495	228	C	0.30	0.10	.570	.020	10
MA40487	264	C-X	0.25	0.10	.570	.020	12
MA40496	227	X	0.20	0.05	.610	.020	12
MA40497	227	Ku	0.15	0.05	.610	.020	12
MA40488	264	X-Ku	0.15	0.05	.610	.020	12
MA40286	963	X-Ku	0.10	0.05	.610	.020	18

Notes: see top of next page

Specifications @ TA = 25°C (Cont'd)

NOTES:
1. C_T is measured across diagonal contacts. ΔC_T is measured across adjacent contacts. Capacitance is measured at zero bias and 1 MHz.
2. V_F and ΔV_F are measured across adjacent contacts at I_F – 1.0mA.
3. Series resistance, R_S, is determined by subtracting the junction resistance, R_J, from the measured value of dynamic (slope) resistance, R_D:

   $R_S = R_D - R_J$ ohms

   Junction resistance is computed from:

   $R_J = 26/I_F$ ohms

   I_F is the forward current in mA.

Dual High Barrier Beam-Lead Ring Quads

Model Number	Frequency Band	Junction Capacitance C_J (pF) Min.	Max.	Maximum[3] Junction Capacitance Difference ΔC_J (pF)	Typical[2] Series Resistance R_S (Ω)	Typical[4] Forward Voltage V_F (V)	Maximum[4] Forward Voltage Difference ΔV_F (V)
MA40482	S	0.20	0.30	0.10	14	1.10	0.020
MA40483	X	0.12	0.20	0.10	20	1.14	0.020
MA40484	Ku	0.05	0.12	0.05	24	1.21	0.020

NOTES:
1. C_J is measured across diagonal leads at V_R = 0V and F = 1.0 MHz. C_J is comprised of the capacitance of two diode junctions in series.
2. R_S is the diode series resistance which is the dynamic resistance, R_D, minus the junction resistance, R_J. The junction resistance is $R_J = 26/I_F$ where I_F is the DC bias current expressed in milliamperes. R_D is measured for I_F = 10 mA and the junction resistance, R_J, is subtracted from R_D to determine R_S. R_S is measured across adjacent quad leads and it is comprised of the series resistance of two diode junctions in series.
3. ΔC_J is measured across adjacent quad leads at V_R = 0V and F = 1.0 MHz.
4. V_F and ΔV_F are measured across adjacent quad leads at I_F = 1.0 mA. V_F is comprised of the forward voltage of two diode junctions in series.

Medium Barrier Crossover Quads

Model Number	Case Style	Frequency Band	Total[1] Capacitance C_T (pF)	Maximum[1] Total Capacitance Difference ΔC_T (pF)	Maximum[2] Series Resistance R_S (Ohms)	Typical[3] Forward Voltage V_F (Volts)	Maximum[3] Forward Voltage Difference ΔV_F (Volts)
MA40472	1008	L	1.20	0.10	7	.330	.020
MA40471	1008	S	0.60	0.10	7	.350	.020

NOTES:
1. C_T and ΔC_T are measured across adjacent leads 1-4 and 2-3 at V_R = 0V and F = 1.0 MHz
2. R_S is the diode series resistance which is the dynamic resistance R_D minus the junction resistance R_J. The junction resistance is $R_J = 26/I_F$ where I_F is the DC bias current expressed in milliamperes. R_D is measured for I_F = 10 mA and the junction resistance, R_J, is subtracted from R_D to determine R_S. R_S is calculated across leads 1-2, 2-4, 3-4 and 1-3.
3. V_F and ΔV_F are measured across adjacent leads at I_F = 1.0 mA.

MAXIMUM RATINGS

Operating and Storage Temperature Range of Junctions	–65°C to +150°C
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/junction
Soldering Temperature	235°C for 10 sec.
Beam Strength	2g (Case Styles 264 and 905)

Ordering Information

For ring quads and cross-over quads the model number indicates the case style. The case style for the dual barrier ring quad is specified by adding the case style number to the basic part number. For example, the MA40482-226 is the S-Band device in the 226 package.

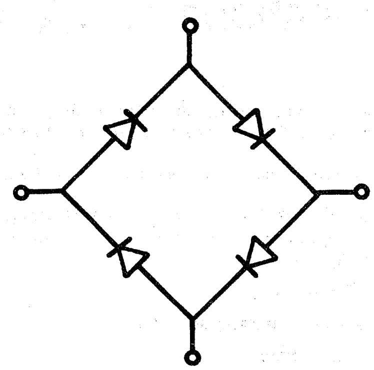
Applications

Single Ring Quads
These beam-lead Schottky barrier quads are intended primarily for use as double balanced mixers. However, the diode ring structure can also be used in phase detectors, AM modulators and pulse modulators. The small case sizes and minimal electrical parasitics are well suited for miniature broadband components. The low barrier series MA40430 device should be used whenever optimum noise figure is required with 0 dBm or less of local oscillator drive power per diode. The medium barrier series MA40440 devices will have an optimum noise figure at conventional local oscillator power levels of between 0 dBm and +3 dBm per diode. The high barrier series MA40490 devices have an optimum noise figure at local oscillator power levels of +3 dBm or higher per diode.

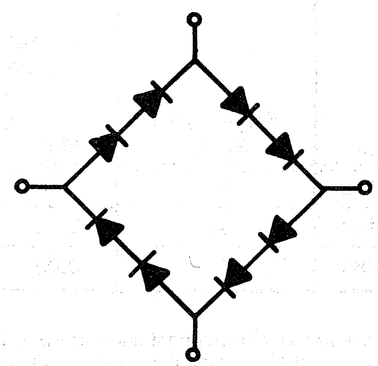
Dual, High Barrier Ring Quad
These beam-lead Schottky dual barrier quads are intended primarily for use as high level double balanced mixers. However, the diode ring structure can also be used in phase detectors, AM modulators and pulse modulators. The small case sizes and minimal electrical parasitics are well suited for miniature broadband components.

Minimum noise figures can be obtained at LO drive levels between +17 dBm and +27 dBm.

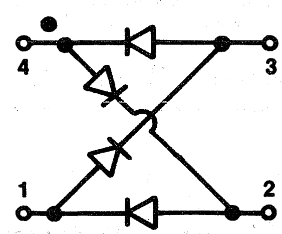
Cross-Over Quads
In a double balanced mixer using a conventional ring quad an external cross-over of leads is necessary which may adversely affect circuit symmetry. Using the cross-over quad external circuit symmetry is maintained.



Single Barrier Ring Quad Circuit Top View Packaged

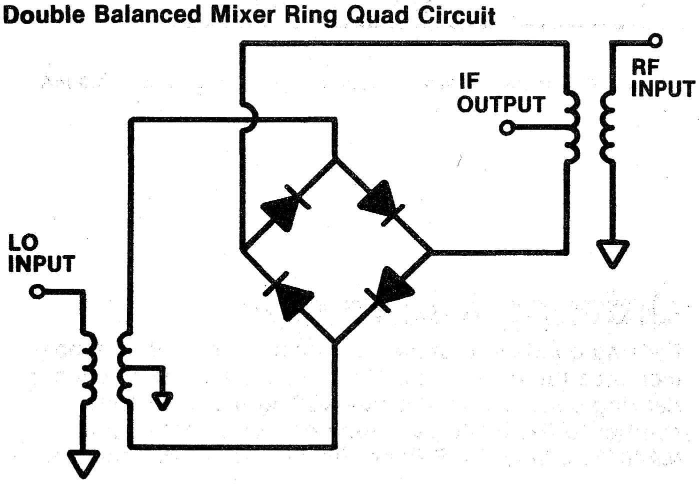


Dual Barrier Ring Quad Circuit Top View Packaged



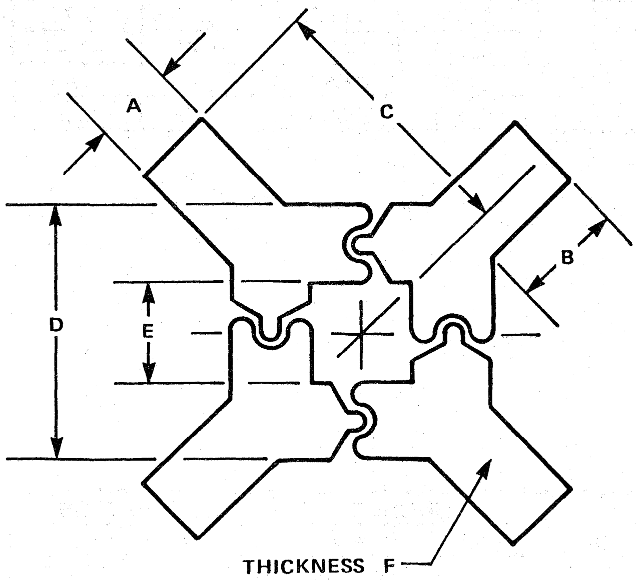
Cross-Over Ring Quad Circuit Top View Packaged

Double Balanced Mixer Ring Quad Circuit



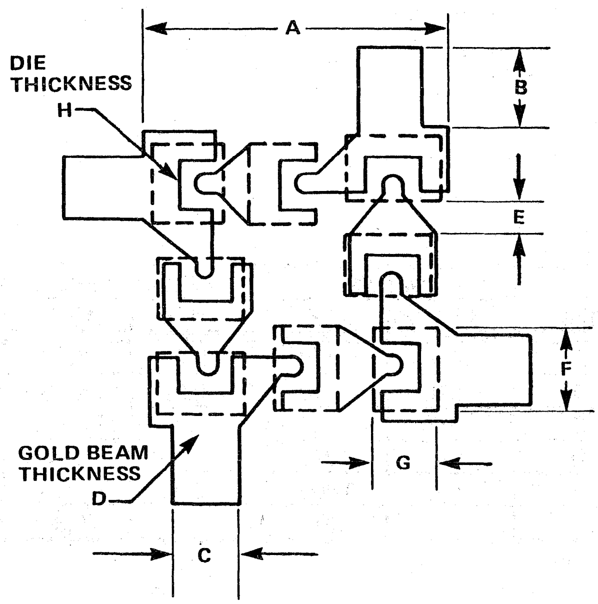
Case Styles

264



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0045	0.0065	0,114	0,165
B	0.007	0.009	0,178	0,229
C	0.0017	0.0019	0,43	0,48
D	0.008	0.010	0,203	0,254
E	0.006	0.008	0,152	0,203
F	0.0003	0.0005	0,008	0,013

905

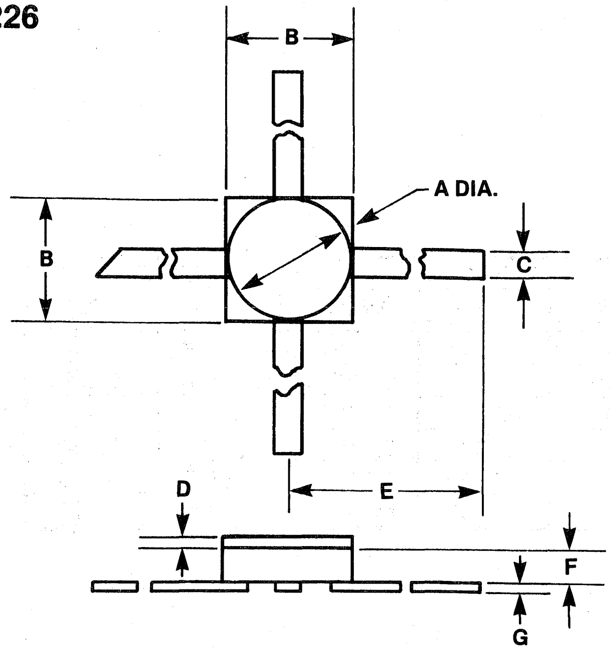


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.022	0.024	0,559	0,610
B	0.005	0.007	0,127	0,178
C	0.004	0.006	0,101	0,152
D	0.0002	0.0005	0,005	0,0127
E	0.002	0.003	0,051	0,076
F	0.006	0.007	0,152	0,177
G	0.0045	0.0055	0,114	0,139
H	0.0015	0.0025	0,0381	0,0635

NOTE: MEASUREMENT A, B, C & D 4 PLACES
MEASUREMENT E, F, G & H 8 PLACES

Case Styles (Cont'd)

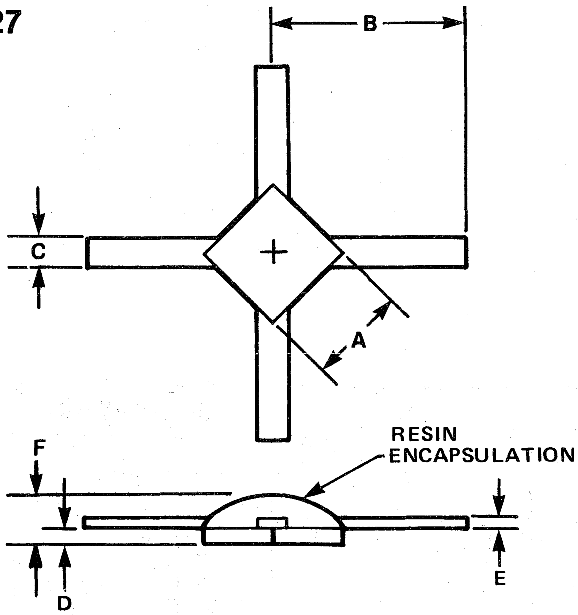
226



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.094	0.102	2,39	2,59
B	0.092	0.106	2,34	2,69
C	0.017	0.023	0,43	0,58
D	0.004	0.008	0,10	0,20
E	0.200	— —	5,08	— —
F	0.025	0.035	0,64	0,89
G	0.003	0.006	0,08	0,15

C_p = 0.12 pF

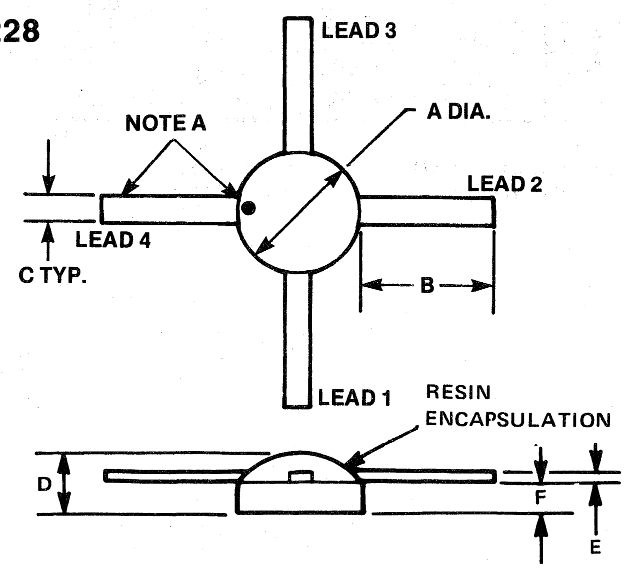
227



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.045	0.055	1,14	1,40
B	0.150	— —	3,81	— —
C	0.012	0.018	0,300	0,460
D	— —	0.014	— —	0,360
E	0.003	0.006	0,080	0,15
F	— —	0.035	— —	0,89

C_p = 0.05 pF

228



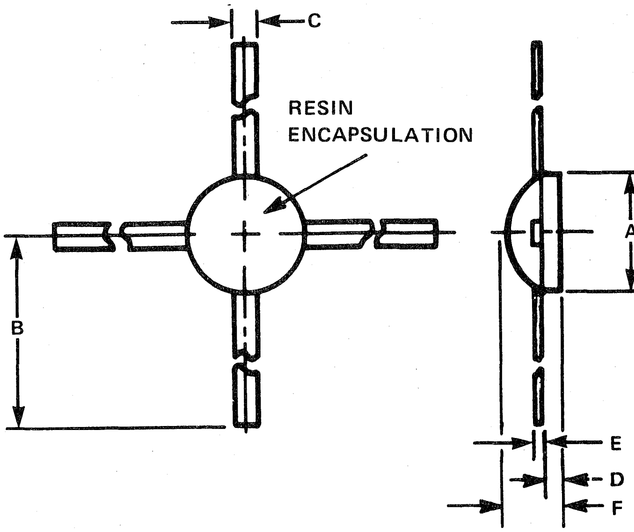
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.090	0.110	2,29	2,79
B	0.090	0.110	2,29	2,79
C	0.018	0.022	0,46	0,56
D	— —	0.035	— —	0,89
E	0.003	0.006	0,08	0,15
F	— —	0.014	— —	0,36

C_p = 0.10 pF

NOTE A
CROSS-OVER QUAD ORIENTATION MARK (•) ON LEAD 4.
SEE PAGE 12 FOR LEAD SCHEMATIC.
NO ORIENTATION MARK IS SUPPLIED ON RING QUADS.

Case Styles (Cont'd)

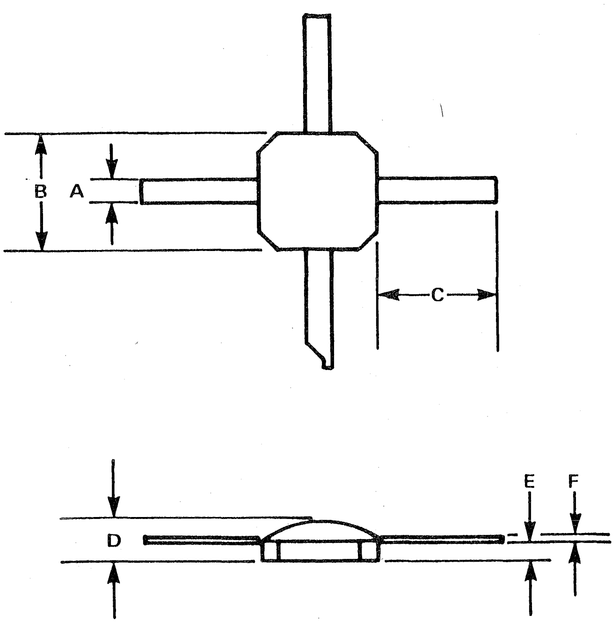
963



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.050	0.058	1,27	1,47
B	0.140	— —	3,55	— —
C	0.012	0.018	0,30	0,46
D	0.007	0.014	0,178	0,36
E	0.003	0.006	0,076	0,152
F	— —	0.035	— —	0,89

$C_P \sim 0.04$ pF Typical

1008



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.018	0.022	0,457	0,559
B	0.090	0.110	2,29	2,79
C	0.090	0.010	2,29	2,79
D	— —	0.05	— —	1,27
E	— —	0.015	— —	0,381
F	0.003	0.005	0,076	0,127

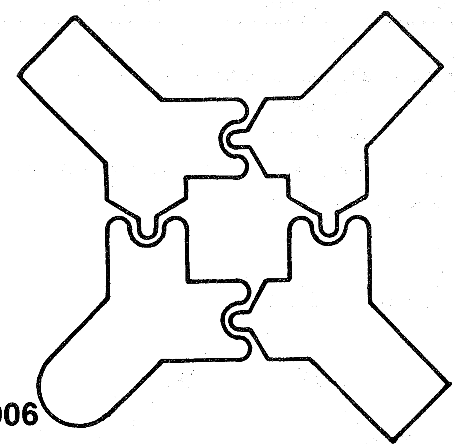
$C_P \sim 0.05$ pF Typical

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM.

MA4E400 Series

Schottky Barrier Beam-Lead and Packaged Bridge Quads



906

Description

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

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

Features

- SMALL PHYSICAL SIZE FOR MICROSTRIP MOUNTING
- HIGH RELIABILITY
- CLOSELY MATCHED JUNCTIONS FOR HIGH ISOLATION
- LOW, MEDIUM AND HIGH BARRIER DIODES AVAILABLE TO MATCH RF POWER
- DEVICES 100% TESTED
- MINIMUM PARASITICS FOR BROADBAND DESIGNS

Specifications @ T_A = 25°C

Model Number	Barrier Height	Band	Junction[1,2] Capacitance C_J (pF) Min.	Max.	Maximum[4] Junction Capacitance Difference ΔC_J (pF)	Maximum[3] Series Resistance R_S (Ohms)	Typical[4] Forward Voltage V_F (Volts)	Maximum Forward Voltage Difference ΔV_F (Volts)	Minimum[5] Breakdown Voltage V_B (Volts)
MA4E402L	Low	S	0.30	0.60	0.10	7	0.250	0.020	2.0
MA4E401L	Low	C-X	0.15	0.40	0.10	10	0.270	0.020	2.0
MA4E400L	Low	Ku	0.05	0.25	0.05	12	0.300	0.020	2.0
MA4E402M	Medium	S	0.30	0.60	0.10	7	0.350	0.020	3.0
MA4E401M	Medium	C-X	0.15	0.40	0.10	10	0.370	0.020	3.0
MA4E400M	Medium	Ku	0.05	0.25	0.05	12	0.410	0.020	3.0
MA4E402H	High	S	0.30	0.60	0.10	7	0.550	0.020	5.0
MA4E401H	High	C-X	0.15	0.40	0.10	10	0.570	0.020	5.0
MA4E400H	High	Ku	0.05	0.25	0.05	12	0.610	0.020	5.0

NOTES:
1. C_J is measured across diagonal leads at V_R = 0V and F = 1.0 MHz.
2. $C_T = C_J + C_P$ is the package capacitance.
3. Series resistance, R_S, is determined by subtracting the junction resistance R_J, from the measured value of 10 mA dynamic (slope) resistance, R_D:

   $R_S = R_D - R_J$ ohms

   Junction resistance is computed from the following equation:

   $R_J = 26/I_F$ ohms

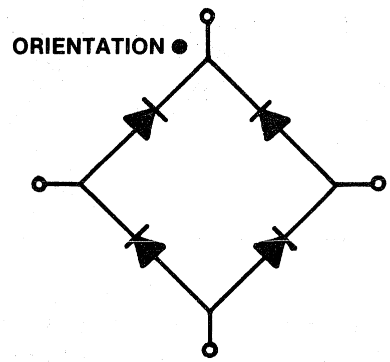
   I_F is the forward bias current in mA.
4. ΔC_J is measured across adjacent quad leads at V_R = 0V and F = 1.0 MHz.
5. V_B is measured at I_R = 10 μA

Applications

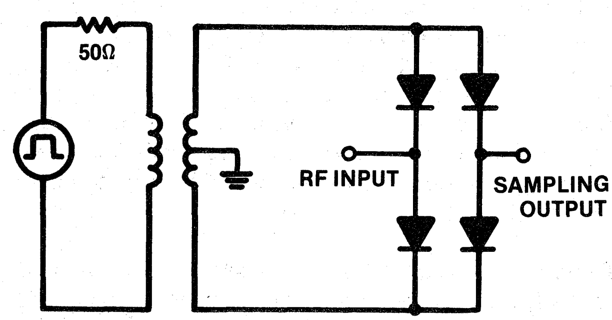
These beam-lead Schottky dual barrier bridge quads are primarily used in sampling and modulator applications. The small case sizes and minimal electrical parasitics are well suited for miniature broadband components.

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

The different barrier heights enable the designer to select a device with a high enough barrier so that the rf signal input to the sampler is not large enough to cause the diodes in the bridge to conduct. The diode circuit configuration is shown at the right.



Diode Bridge Circuit



Sampling Circuit Bridge Quad

MAXIMUM RATINGS

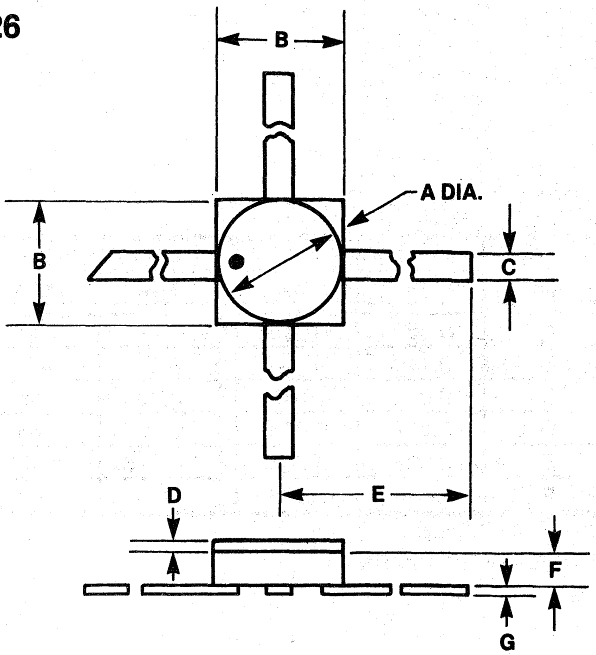
Operating and Storage Temperature Range of Junctions	−65°C to +150°C
Maximum Power Dissipation (derate linearly to zero allowable dissipation at 150°C)	75 mW/junction
Beam Strength (Case Style 906)	2g

Ordering Information

Case styles are specified by adding the case style number as a suffix to the basic part number. For example, an MA4E402L-228 is a low barrier bridge quad housed in the 228 case style.

Case Styles

226

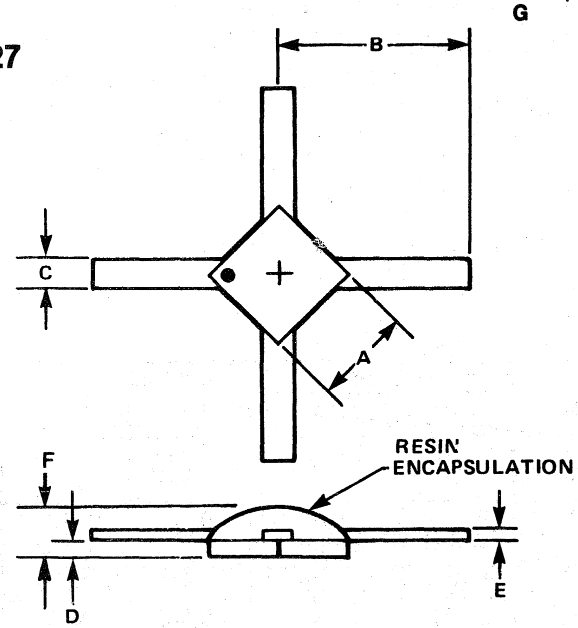


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.092	0.106	2,34	2,69
C	0.017	0.023	0,43	0,58
D	0.004	0.008	0,10	0,20
E	0.200	— —	5,08	— —
F	0.025	0.035	0,64	0,89
G	0.003	0.006	0,08	0,15

$C_P \sim 0.12$ pF

● ORIENTATION MARK

227

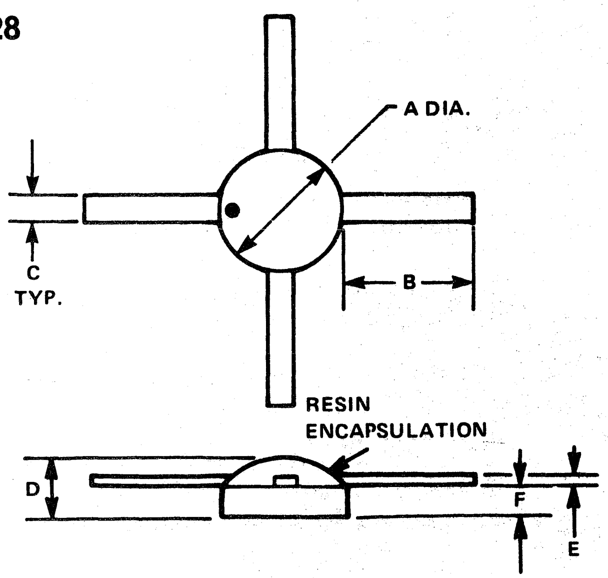


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.045	0.055	1,14	1,40
B	0.150	— —	3,81	— —
C	0.012	0.018	0,300	0,460
D	— —	0.014	— —	0,360
E	0.003	0.006	0,080	0,15
F	— —	0.035	— —	0,89

$C_P \sim 0.07$ pF

● ORIENTATION MARK

228



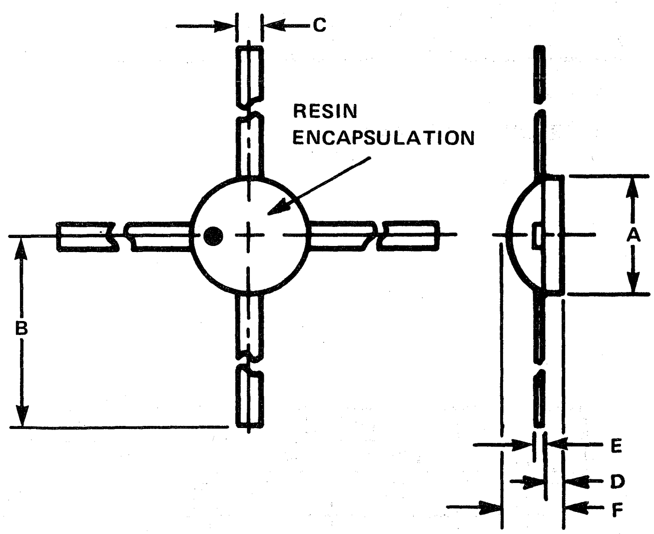
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2,29	2,79
B	0.090	0.110	2,29	2,79
C	0.018	0.022	0,46	0,56
D	— —	0.035	— —	0,89
E	0.003	0.006	0,08	0,15
F	— —	0.014	— —	0,36

$C_P \sim 0.10$ pF

● ORIENTATION MARK

Case Styles (Cont'd)

963 (MINI-QUAD)

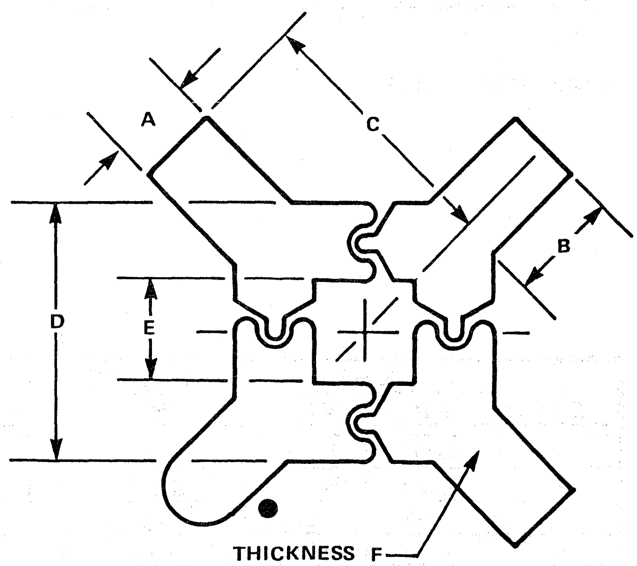


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.050	0.058	1,27	1,47
B	0.140	— —	3,55	— —
C	0.012	0.018	0,30	0,46
D	0.007	0.014	0,178	0,36
E	0.003	0.006	0,076	0,152
F	— —	0.035	— —	0,89

$C_P \sim 0.04$ pF Typical

● ORIENTATION MARK

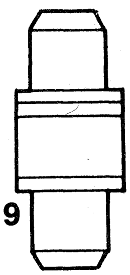
906



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.0045	0.0065	0,114	0,165
B	0.007	0.009	0,178	0,229
C	0.017	0.019	0,43	0,48
D	0.008	0.010	0,203	0,254
E	0.006	0.008	0,152	0,203
F	0.0003	0.0005	0,008	0,013

● ORIENTATION MARK

Ceramic Packaged Silicon Schottky Mixer Diodes



119

Features

- LARGE CHOICE OF AVAILABLE PACKAGES
- CAN BE SCREENED TO JANTXV LEVELS
- UNIFORM RF CHARACTERISTICS

Description

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

Applications

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

Ceramic Packaged Silicon Schottky Barrier Mixer Diodes

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

Low Barrier Mixer Diodes

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

Specifications @ T_A = 25°C

Model Number[1]	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] SWR	Z_{IF} Range[5] Min./Max. (Ohms)
MA40018	119	3.000	5.5	1.5	125-250
MA40017	119	3.000	6.0	1.5	125-250
MA40016	119	3.000	6.5	1.5	125-250
MA40100	119	9.375	6.0	1.5	250-450
MA40101	119	9.375	6.5	1.5	250-450
MA40102	119	9.375	7.0	2.0	250-450
MA40105	120	9.375	6.0	1.5	250-450
MA40106	120	9.375	6.5	1.5	250-450
MA40107	120	9.375	7.0	2.0	250-450
MA40110	119	16.000	6.5	1.5	250-450
MA40111	119	16.000	7.0	2.0	250-450
MA40115	120	16.000	6.5	1.5	250-450
MA40116	120	16.000	7.0	2.0	250-450
MA4E913	119	24.000	7.5	1.5	200-500
MA4E910	119	24.000	8.0	2.0	200-500
MA4E914	120	24.000	7.5	1.5	200-500
MA4E911	120	24.000	8.0	2.0	200-500

NOTES

1. All mixer diodes are available as matched pairs and can be ordered by adding the suffix "M" to the basic model number.
   Bin matching is available upon request. The matching criteria is as follows:
   ΔNF = 0.3 dB maximum
   ΔZ_{IF} = 25 ohms maximum.
2. The standard case style is given for each model number. For other case styles, contact the factory. The maximum solder temperature for all cases, except 120 and 276 is 230°C for 5 seconds. For case styles 120 and 276, the maximum solder temperature is 200°C for 5 seconds.
3. Test conditions are as follows:
   P_{LO} = 1.0 mW (Low or Medium Barrier)
   P_{LO} = 2.0 mW (High Barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB (minimum)
   R_L = 22 ohms
4. SWR is tested at a peak power of 1.0 mW for low and medium barrier and 2.0 mW for high barrier. R_L = 22 ohms.
5. IF impedance is measured by modulating the specified test frequency with a 1000 Hz signal, R_L = 22 ohms and an incident power level of 1.0 mW for low and medium barrier diodes, and 2.0 mW for high barrier diodes.

Medium Barrier Mixer Diodes

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

Specifications @ T_A = 25°C

Model Number[1]	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] SWR	Z_{IF} Range[5] Min./Max. (Ohms)
MA40051G	3	3.000	5.5	1.5	350-450
MA40051F	3	3.000	6.0	1.5	350-450
MA40051E	3	3.000	7.0	2.0	300-500
MA40021	119	3.000	5.5	1.5	125-250
MA40020	119	3.000	6.0	1.5	125-250
MA40019	119	3.000	6.5	1.5	125-250
MA40071H	3	9.375	6.0	1.5	250-450
MA40071G	3	9.375	6.5	1.5	325-475
MA40071F	3	9.375	7.0	1.5	325-475
MA40071E	3	9.375	7.5	2.0	300-500
MA40150	119	9.375	6.0	1.5	250-450
MA40151	119	9.375	6.5	1.5	250-450
MA40152	119	9.375	7.0	2.0	250-450
MA40155	120	9.375	6.0	1.5	250-450
MA40156	120	9.375	6.5	1.5	250-450
MA40157	120	9.375	7.0	2.0	250-450
MA40160	119	16.000	6.5	1.5	250-450
MA40161	119	16.000	7.0	2.0	250-450
MA40165	120	16.000	6.5	1.5	250-450
MA40166	120	16.000	7.0	2.0	250-450
MA4E919	119	24.000	7.5	1.5	200-500
MA4E916	119	24.000	8.0	2.0	200-500
MA4E920	120	24.000	7.5	1.5	200-500
MA4E917	120	24.000	8.0	2.0	200-500

* See notes on previous page.

MAXIMUM RATINGS

TEMPERATURE RATINGS

Storage Temperature	−65°C to +150°C
Operating Temperature	−65°C to +150°C

POWER RATINGS

Maximum Incident Peak RF Power	S-X Band 1 Watt for 1 μs maximum Ku – K Band 0.5 Watt for 1 μs maximum
Maximum CW RF Power	S Band 200 mW C-X Band 150 mW Ku-K Band 100 mW
Maximum Solder Temperature*	235°C for 5 seconds

* Except ODS 120 which has a maximum solder temperature for 200°C for 5 seconds.

High Barrier Mixer Diodes

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

Specifications @ T_A = 25°C

Model Number[1]	Case Style	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] SWR	Z_{IF} Range[5] Min./Max. (Ohms)
MA40055	119	3.000	5.5	1.5	125-250
MA40023	119	3.000	6.0	1.5	125-250
MA40022	119	3.000	6.5	1.5	125-250
MA40050	3	9.375	6.5	1.5	325-475
MA4E180	119	9.375	6.0	1.5	250-450
MA4E181	119	9.375	6.5	1.5	250-450
MA4E182	119	9.375	7.0	2.0	250-450
MA4E185	120	9.375	6.0	1.5	250-450
MA4E186	120	9.375	6.5	1.5	250-450
MA4E187	120	9.375	7.0	2.0	250-450
MA4E188	119	16.000	6.5	1.5	250-450
MA4E189	119	16.000	7.0	2.0	250-450
MA4E190	120	16.000	6.5	1.5	250-450
MA4E191	120	16.000	7.0	2.0	250-450
MA4E925	119	24.000	7.5	1.5	200-500
MA4E922	119	24.000	8.0	2.0	200-500
MA4E926	120	24.000	7.5	1.5	200-500
MA4E923	120	24.000	8.0	2.0	200-500

* See notes on previous page.

ENVIRONMENTAL RATINGS

All Ceramic Packaged Silicon Schottky Mixer diodes can be screened to TX or TXV levels.

Screened Diodes MIL-STD-19500

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

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

Typical Performance Curves

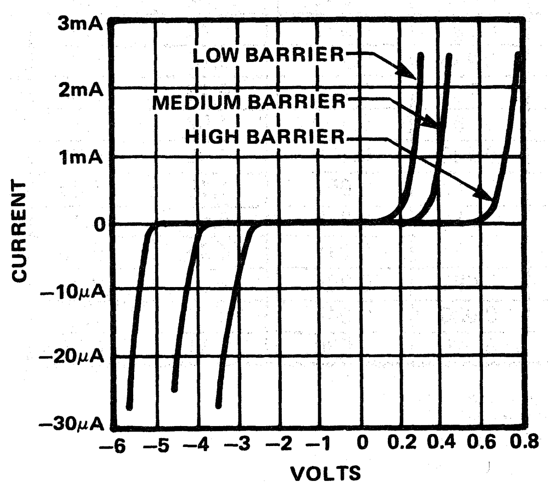


FIGURE 1. I-V Characteristics vs. Barrier Heights for Schottky Mixer Diodes

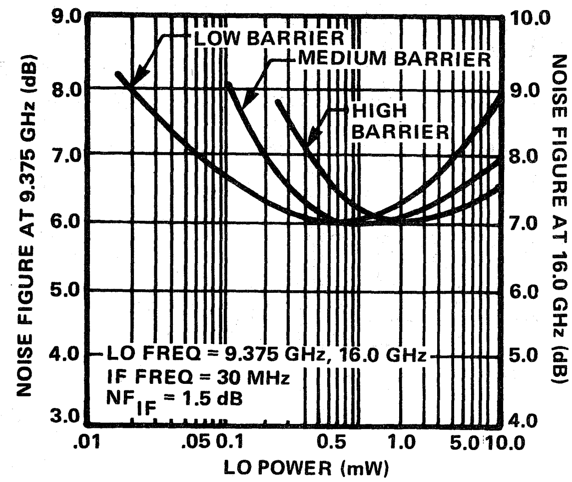


FIGURE 2. Schottky Barrier Noise Figure vs. LO Power

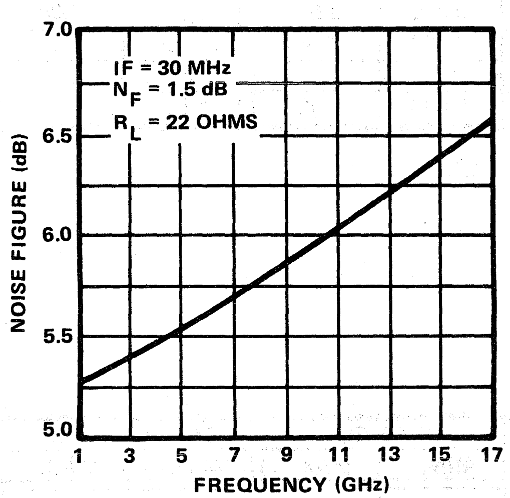


FIGURE 3. Nominal Noise Figure vs. Frequency

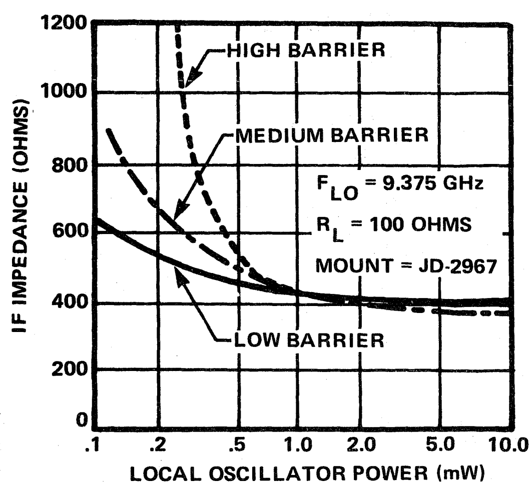
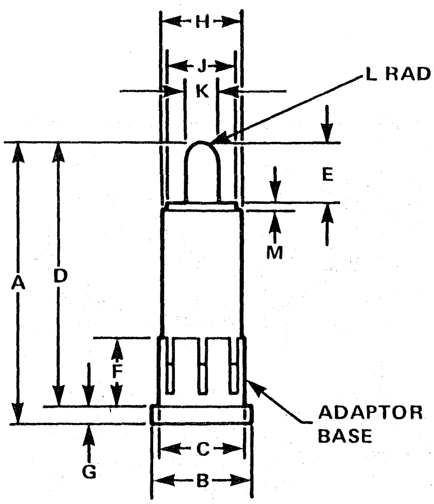


FIGURE 4. Nominal IF Impedance vs. Local Oscillator Drive

Case Styles

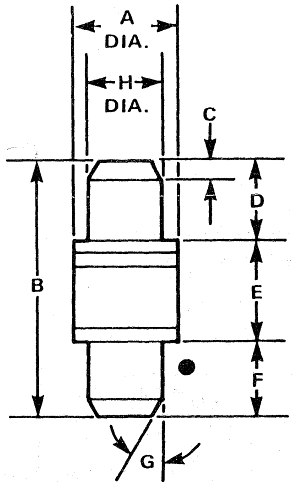
3



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.800	0.840	20,32	21,34
B	0.292	0.296	7,42	7,52
C	0.246	0.250	6,25	6,35
D	0.753	0.783	19,13	19,89
E	0.180	0.190	4,57	4,83
F	0.193	0.199	4,90	5,05
G	0.047	0.057	1,19	1,45
H	0.222	0.240	5,64	6,10
J	0.195	0.215	4,95	5,46
K	0.092	0.094	2,34	2,39
L	0.030	0.046	0,76	1,17
M	0.020	0.030	0,51	0,76

Adaptor base optional.
C_P = 0.12 pF Typical
L_S = 0.50 nH Typical

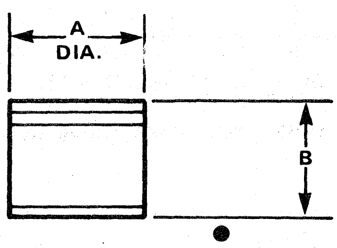
119



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.190	0.210	4,83	5,33
C	0.009	0.015	0,23	0,38
D	0.060	0.064	1,52	1,63
E	0.070	0.087	1,68	2,08
F	0.060	0.064	1,52	1,63
G	25°	35°	25°	35°
H	0.060	0.064	1,52	1,63

C_P = 0.15 pF Typical
L_S = 0.50 nH Typical

120

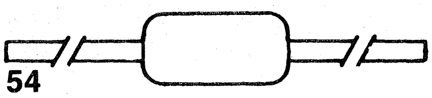


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

All specifications are subject to change without notice. **1/88 Printed in U.S.A.**

Axial Lead Glass Packaged Silicon Schottky Mixer Diodes



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Features

- HIGH RELIABILITY
- SCREENING TO JANTXV LEVEL AVAILABLE
- LOW, MEDIUM AND HIGH BARRIER DIODES AVAILABLE
- LOW NOISE FIGURE THROUGH 12 GHz

Description

Three families of axial lead Schottky diodes are offered with diodes optimized for 100 MHz through 12 GHz.

Low barrier diodes require the smallest local oscillator drive.

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

High barrier diodes are best for high dynamic range mixers and upconverters.

Applications

Stripline and coaxial mixers and upconverters through 12 GHz.

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Axial Lead Glass Packaged Silicon Schottky Mixer Diodes

Specifications @ T_A = 25°C

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

Low Barrier Mixer Diodes

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] SWR (Volts)	Z_{IF} Range[5] Min./Max. (Ohms)
MA40103	54	9.375	6.5	1.5	250-450
MA40104	54	9.375	7.0	2.0	250-450

Medium Barrier Mixer Diodes

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (db)	Maximum[4] SWR (Volts)	Z_{IF} Range[5] Min./Max. (Ohms)
MA4882	54	1.000	5.5	1.5	125-250
MA4883	54	1.000	6.5	1.6	125-250
MA4853	54	3.000	5.5	1.5	125-250
MA4852	54	3.000	6.5	1.5	125-250
MA4851	54	3.000	7.5	2.0	125-250
MA40153	54	9.375	6.5	1.5	250-450
MA40154	54	9.375	7.0	2.0	250-450
MA4856	54	9.375	7.5	2.0	200-400
MA4855	54	9.375	8.5	2.0	200-400

High Barrier Mixer Diodes

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dBm)	Maximum[4] SWR (Volts)	Z_{IF} Range[5] Min./Max. (Ohms)
MA4E183	54	9.375	6.5	1.5	250-450
MA4E184	54	9.375	7.0	2.0	250-450

NOTES

1. All mixer diodes are available as matched pairs and can be ordered by adding the suffix "M" to the diode model number. Bin matching is available upon request. The matching criteria is as follows:
   NF = 0.3 dB maximum
   Z_{IF} = 25 ohms maximum
2. The maximum solder temperature is 230°C for 5 seconds. Case styles other than those indicated are available upon request. Consult the factory.
3. Test conditions for noise figure:
   P_{LO} = 1 mW (for low and medium barrier)
   P_{LO} = 2 mW (for high barrier)
   F_{IF} = 30 MHz
   N_{IF} = 1.5 dB
   R_L = 22 Ohms
4. SWR for low and medium barrier diodes is tested at LO power of 1.0 mW. High barrier diodes are tested at LO power of 2.0 mW. RL = 22 ohms
5. IF impedance is measured by modulating the specified test frequency with a 1000 Hz signal. RL = 22 ohms. Low and medium barrier diodes are tested at an incident power level of 1.0 mW. High barrier diodes are tested at an incident power level of 2.0 mW.

MAXIMUM RATINGS

TEMPERATURE RATINGS

Storage Temperature – 65°C to + 150°C
Operating Temperature – 65°C to + 150°C

POWER RATINGS

Maximum Peak RF Power L-S band, 1 watt at 1 μs maximum C-X band, 0.5 watt at 1 μs maximum
Maximum CW RF Power (L-S Band) 250 mW (C-X Band) 150 mW

SOLDER TEMPERATURE RATINGS

Soldering Temperature 230°C for 5 seconds within 1 mm of package

Screened Diodes MIL-STD-19500

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

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

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

Typical Performance Curves

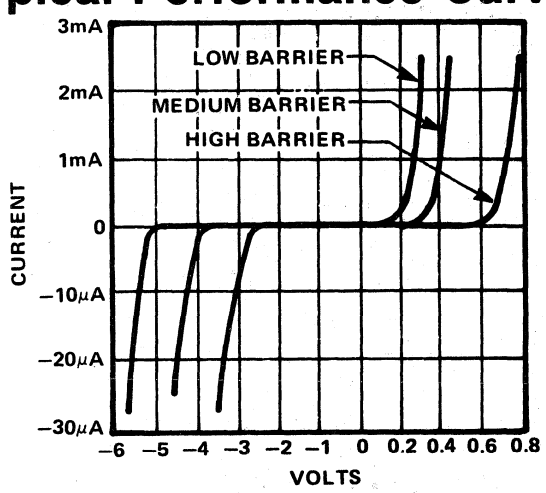


FIGURE 1. I-V Characteristics and Barrier Heights for Schottky Mixer Diodes

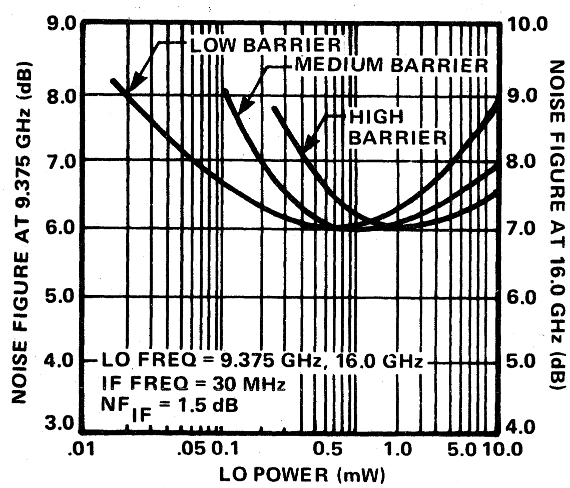


FIGURE 2. Schottky Barrier Noise Figure vs. LO Power

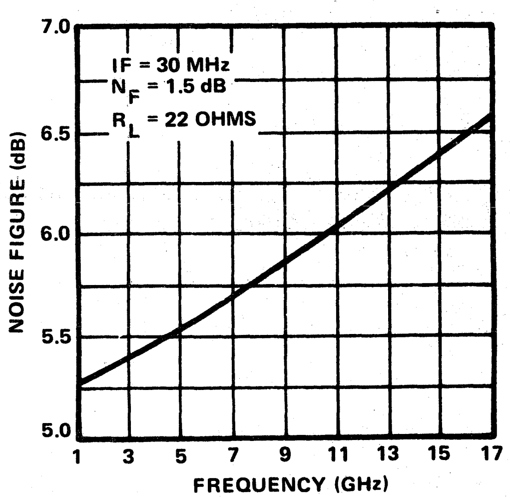


FIGURE 3. Nominal Noise Figure vs. Frequency

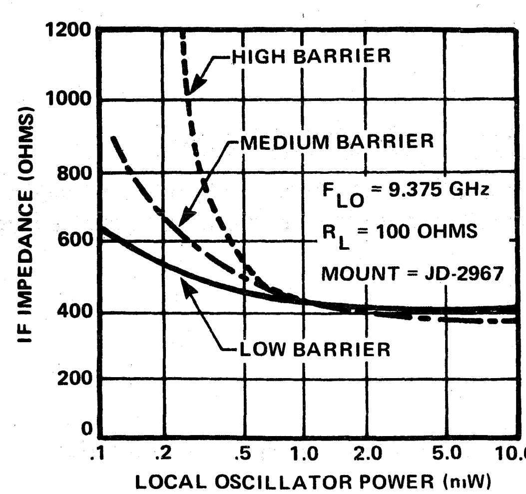
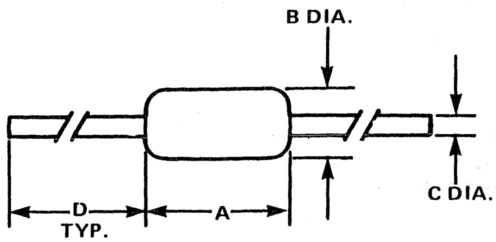


FIGURE 4. Nominal IF Impedance vs. Local Oscillator Drive

Case Style

54



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

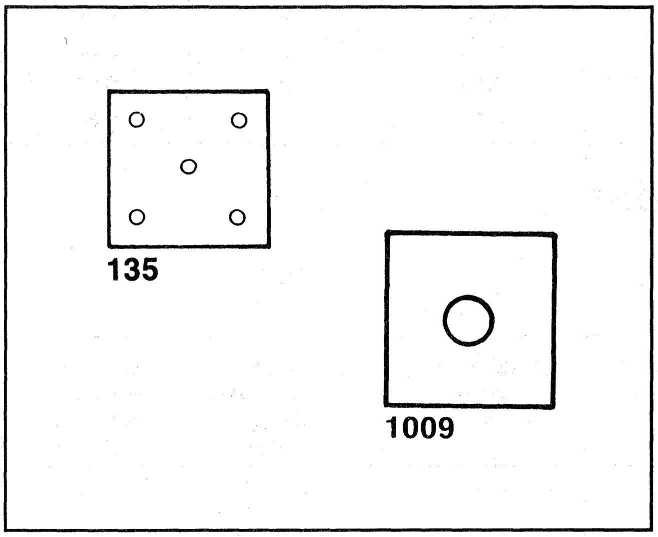
C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

All specifications are subject to change without notice.

Chip Silicon Schottky Mixer Diodes



Features

- MULTI-JUNCTION CHIP FOR HIGHER YIELD
- LOW NOISE FIGURE THROUGH 26 GHz
- GUARANTEED SMALL JUNCTION CAPACITANCE
- LOW, MEDIUM AND HIGH BARRIER DIODES

Description

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

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

Applications

Microstrip mixers 100 MHz to 26 GHz.

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Chip Silicon Schottky Mixer Diodes

Specifications @ $T_A = 25°C$

Chip devices are useful for stripline and microstrip mixers.
RF characteristics are tested on a sample basis.

Low Barrier Chip Mixer Diodes

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

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] Junction Capacitance (pF)	Minimum[5] Breakdown Voltage (Volts)	Nominal[6] Forward Voltage (Ohms)
MA4E968	1009	3.000	5.5	0.60	2	0.24
MA4E971	1009	6.000	5.5	0.45	2	0.26
MA40137	135	9.375	6.0	0.18	2	0.30
MA40120	135	16.000	6.5	0.15	2	0.30
MA4E915	135	24.000	7.5	0.10	2	0.31
MA4E912	135	24.000	8.0	0.10	2	0.31

Medium Barrier Chip Mixer Diodes

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

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] Junction Capacitance (pF)	Minimum[5] Breakdown Voltgage (Volts)	Nominal[6] Forward Voltage (Ohms)
MA4E969	1009	3.000	5.5	0.60	3	0.34
MA4E972	1009	6.000	5.5	0.45	3	0.36
MA40138	135	9.375	6.0	0.18	3	0.40
MA40170	135	16.000	6.5	0.15	3	0.40
MA4E921	135	24.000	7.5	0.10	3	0.41
MA4E918	135	24.000	8.0	0.10	3	0.41

High Barrier Chip Mixer Diodes

High barrier diodes are most suitable for applications where the local oscillator drive is between +6 dBM and +15 dBM per diode.

Model[1] Number	Case Style[2]	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Maximum[4] Junction Capacitance (pF)	Minimum[5] Breakdown Voltage (Volts)	Nominal[6] Forward Voltage (Ohms)
MA4E970	1009	3.000	5.5	0.60	5	0.44
MA4E973	1009	6.000	5.5	0.45	5	0.46
MA40139	135	9.375	6.0	0.18	5	0.55
MA4E192	135	16.000	6.5	0.15	5	0.55
MA4E927	135	24.000	7.5	0.10	5	0.56
MA4E924	135	24.000	8.0	0.10	5	0.56

Specifications (Cont'd)

NOTES:

1. Chip diodes are available as pairs or as matched sets. Matching criteria for chips:
   ΔC_j = 0.05 pF maximum @ 1 MHz and 0 volts
   ΔV_f = 10 mV maximum @ IF = 1.0 mA
2. These devices can be thermocompression bonded.
3. Test Conditions: (Chips are packaged for NF testing). Wafer lots are approved on a sample basis.
   P_{LO} = 1.0 mW (for low and medium barrier)
   P_{LO} = 2.0 mW (for high barrier)
   F_{IF} = 30.0 MHz
   N_{IF} = 1.5 dBM
   R_L = 22 ohms
4. Measurement frequency = 1 MHz; Voltage = 0 volts
5. Breakdown voltage is measured at 10 microamps of reverse bias.
6. Measured at forward current of 10 milliamps.

MAXIMUM RATINGS

TEMPERATURE RANGE

Storage Temperature	−65°C to +150°C
Operating Temperature	−65°C to +150°C

POWER RATINGS

Maximum Peak Incident RF Power	C-X Band 1 Watt for 1 microsecond Ku-K Band 0.5 Watt for 1 microsecond
Maximum CW Incident RF Power	C-X Band 150 mW Ku-X Band 100 mW

Typical Performance Curves

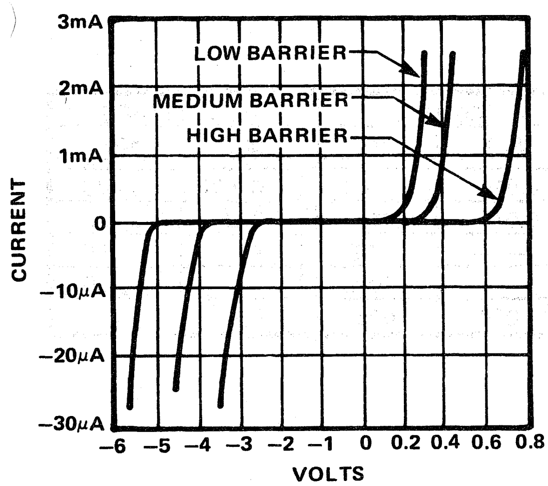


FIGURE 1. Nominal I-V Characteristics and Barrier Heights for Schottky Mixer Diodes

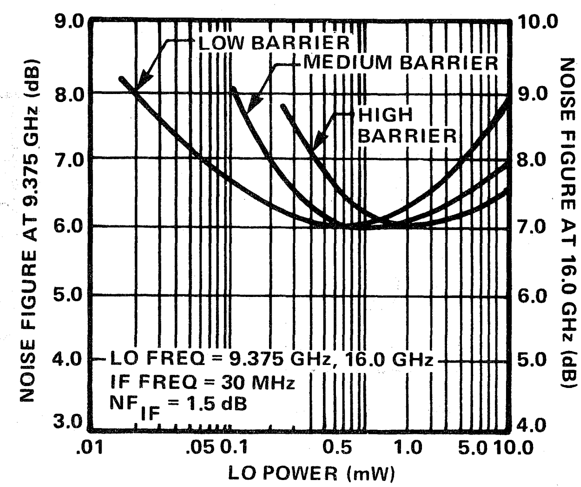


FIGURE 2. Nominal Schottky Barrier Noise Figure vs. LO Power

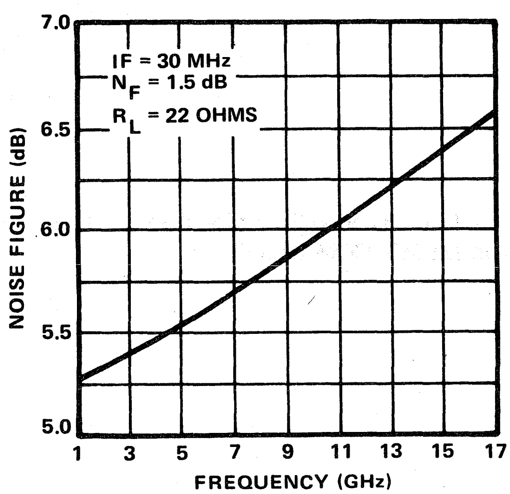


FIGURE 3. Nominal Noise Figure vs. Frequency

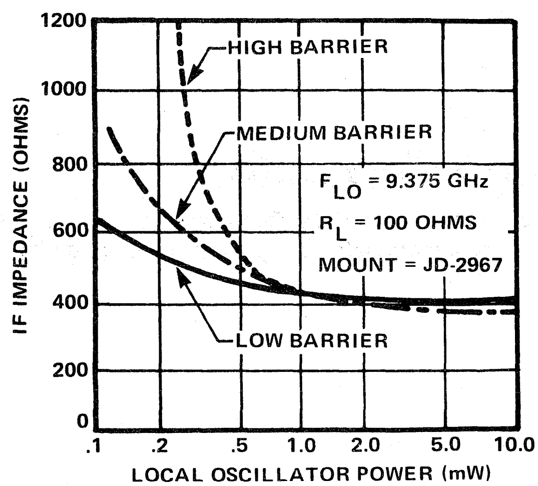
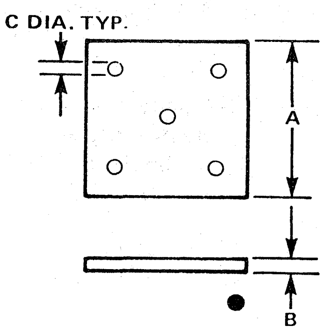


FIGURE 4. Nominal IF Impedance vs. Local Oscillator Drive

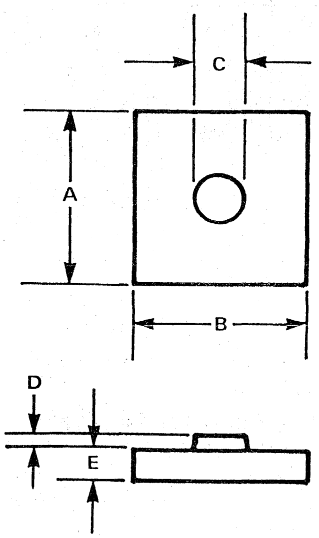
Case Styles

135



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.013	0.017	0,33	0,43
B	0.004	0.006	0,10	0,15
C	0.001	— —	0,03	— —

1009



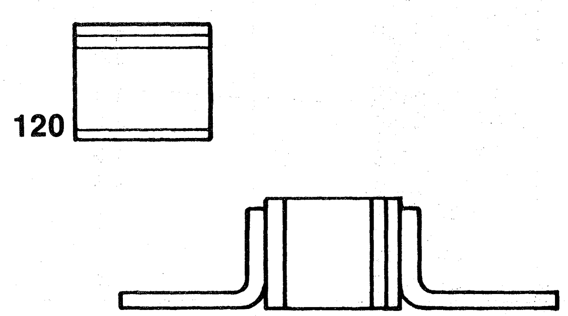
DIM.	INCHES		MILLIMETERS	
	MAX.	MIN.	MAX.	MIN.
A	0.014	0.016	0,355	0,406
B	0.014	0.016	0,355	0,406
C	— —	.002	— —	,056
D	— —	.0002	— —	,005
E	.004	.006	0,10	0,15

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

All specifications are subject to change without notice.

Chip and Packaged Silicon Schottky Detector Diodes



Features

- WIDE SELECTION OF PACKAGES FOR STRIPLINE, COAXIAL AND WAVEGUIDE DETECTORS
- CHIP DIODES AVAILABLE
- BOTH P AND N TYPE DIODES
- EXCELLENT SENSITIVITY THROUGH Ka-BAND
- LOW 1/f NOISE

Description

This family of low capacitance Schottky diodes is designed to give superior performance in video detectors and power monitors from 100 MHz through 40 GHz. They have low junction capacitance and repeatable video impedance. These diodes are available in a wide range of ceramic, stripline and axial lead packages and as bondable chips. Both P and N type diodes are offered.

Applications

Detectors and power monitors in stripline, coaxial and waveguide circuits through 40 GHz.

Packaged N Type Silicon Schottky Detector Diodes

These low barrier packaged detector diodes are suitable for use in stripline, waveguide and coaxial detectors. They feature high sensitivity and low l/f noise. These diodes are listed by increasing test frequency, grouped by packaged style and decreasing Tss. Other case styles than those specified are available upon request.

Specifications @ T_A = 25°C

Model Number[1]	Case Style	Test Frequency (GHz)	Minimum[2] Tang. Sig. Sens. T_{SS} (dBm)	Video Impedance[3] Range Min./Max. (K Ohms)
MA40041	3	3.0	−55	1-2
MA40040	3	3.0	−50	1-2
MA40053	54	3.0	−55	1-2
MA40052	54	3.0	−50	1-2
MA40064	119	3.0	−55	1-2
MA40063	119	3.0	−50	1-2
MA40043	3	10.0	−52	1-2
MA40042	3	10.0	−50	1-2
MA40202	54	10.0	−55	1-2
MA40204	54	10.0	−52	1-2
MA40072	54	10.0	−50	1-2
MA40201	119	10.0	−55	1-2
MA40203	119	10.0	−52	1-2
MA40065	119	10.0	−50	1-2
MA40207	120	10.0	−55	1-2
MA40208	120	10.0	−52	1-2
MA40205	119	16.0	−52	1-2
MA40206	119	16.0	−50	1-2
MA40215	120	16.0	−52	1-2
MA40216	120	16.0	−50	1-2
MA40267	119	36.0	−49	1-2
MA40268	120	36.0	−49	1-2

NOTES

1. Schottky barrier junction diodes are thermocompression bonded in case style 119 and 120. Case styles 3 and 54 use pressure contacts. The standard case style is given for each model number. Other case styles are available upon request. For additional information, contact the factory.
2. The video amplifier bandwidth is 2 MHz and the nominal amplifier noise figure is 3 dB. DC impedance is 10 K ohms. The dc bias is 20 μA.
3. RF Power = −30 dBM. The dc forward bias is +20 μA.
4. Measured at the indicated test frequency and at −30 dBm RF power with R_L = 10 K ohms and DC forward bias = 20μA.

MAXIMUM RATINGS

TEMPERATURE RATINGS

Storage Operating Temperature	−65°C to +150°C

POWER RATINGS at 25°C

Maximum Peak Incident RF Power	S-X Band 1 Watt-1 microsecond maximum pulse length Ku-K Band .5W-1 microsecond maximum pulse length
Maximum CW RF Power	S-X Band 150 mW (maximum) Ku-K band 100 mW (maximum)
Derate Linearly to Zero at 150°C	

SOLDER TEMPERATURE RATINGS

For case styles 54, 276, 186	230°C for 5 seconds, 1 mm from package
For case style 120	200°C for 5 seconds

Packaged P Type Silicon Schottky Detector Diodes

This series of low barrier P type detector diodes is suitable for use in waveguide, coaxial and stripline circuits. Each diode in this family features high sensitivity and lower 1/f noise than N type diodes. They are listed by test frequency, case style and descending Tss. These diodes are most appropriate for detectors with low video amplifier frequency.

Specifications @ T_A = 25°C

Model Number	Case Style	Test Frequency (GHz)	Minimum[1] Tang. Sig. Sens. T_{SS} (dBm)	Video Impedance[5] Range Min./Max. (Ohms)	Minimum[6] Sensitivity (mV/mW)
MA40252	54	10.0	−55	1.2-1.8	5000
MA40254	54	10.0	−52	1.2-1.8	3500
MA40251	119	10.0	−55	1.2-1.8	5000
MA40253	119	10.0	−52	1.2-1.8	3500
MA40257	120	10.0	−55	1.2-1.8	5000
MA40258	120	10.0	−52	1.2-1.8	3500
MA40257-276	276	10.0	−55	1.2-1.8	5000
MA40258-276	276	10.0	−52	1.2-1.8	3500
MA40255	119	16.0	−52	1.2-1.8	3500
MA40256	119	16.0	−50	1.2-1.8	3000
MA40265	120	16.0	−52	1.2-1.8	3500
MA40266	120	16.0	−50	1.2-1.8	3000
MA40265-276	276	16.0	−52	1.2-1.8	3500
MA40268-276	276	16.0	−50	1.2-1.8	3000

P Type Silicon Schottky Chip Detector Diodes

These low barrier P type chip detector diodes are suitable for use in microstrip or stripline circuits. These diodes are listed by increasing test frequency.

Specifications @ T_A = 25°C

Model Number	Case Style	Test Frequency (GHz)	Voltage[2] Breakdown V_b (Volts)	Nominal[1] T_{SS} (dBM)	Nominal[3] Forward Voltage (Volts)	Nominal[4] Total Capacitance (pF)
MA40270	135	10.0	4.0	−52	0.4	0.12
MA40272	135	16.0	4.0	−52	0.4	0.09

NOTES:
1. The video amplifier bandwidth is 2 MHz and the noise figure is 3 dB. Impedance is 10 Kilohms and dc bias is +20 μA.
2. Breakdown voltage is measured at 10 μA reverse bias current.
3. Forward voltage is measured at a forward current of 1 mA.
4. Capacitance is measured at 0 volts and 1 MHz.
5. RF power = −30 dBm. The DC forward bias is +20 μA.
6. Measured at the indicated test frequency and at −30 dBm RF power with R_L = 10 K ohms and DC forward bias +20 μA.

N Type Silicon Schottky Detector Diodes

These low barrier packaged detector diodes are suitable for use in stripline applications. They feature high sensitivity, and low I/f noise. These diodes are listed by increasing frequency, and grouped by package style and Tss. Case styles other than those specified are available on request for a nominal charge. For addtional information, contact the factory.

Model Number[1]	Case Style	Test Frequency (GHz)	Minimum[2] Tang. Sig. Sens. T_{SS} (dBm)	Video Impedance[3] Range Min./Max. (K Ohms)
MA40069	137	3.0	−55	1-2
MA40067	137	3.0	−50	1-2
MA40261	186	3.0	−55	1-2
MA40260	186	3.0	−50	1-2
MA40144	213	3.0	−55	1-2
MA40143	213	3.0	−50	1-2
MA40114	137	10.0	−55	1-2
MA40108	137	10.0	−52	1-2
MA40070	137	10.0	−50	1-2
MA40264	186	10.0	−55	1-2
MA40263	186	10.0	−52	1-2
MA40262	186	10.0	−50	1-2
MA40147	213	10.0	−55	1-2
MA40146	213	10.0	−52	1-2
MA40145	213	10.0	−50	1-2
MA40207-276	276	10.0	−55	1-2
MA40208-276	276	10.0	−52	1-2
MA40118	137	16.0	−48	1-2
MA40149	213	16.0	−50	1-2
MA40148	213	16.0	−48	1-2
MA40215-276	276	16.0	−52	1-2
MA40216-276	276	16.0	−50	1-2

NOTES
1. This series of Schottky barrier junction diodes are thermocompression bonded.
2. The video amplifier bandwidth is 2 MHz and the noise figure is 3 dB. The input impedance is 10 Kohms and dc bias is 20 μA.
3. Pinc = −30 dBM. The dc forward bias is +20 μA.

N Type Silicon Schottky Chip Detector Diodes

These low barrier N type detector diodes are suitable for use in stripline applications. They feature sensitivity, and low I/f noise. These diodes are listed by increasing frequency, and grouped according to case style and Tss. Other case styles are available upon request at a nominal charge. For additional information, contact the factory.

Model Number	Case Style	Test Frequency (GHz)	Minimum[1] T_{SS} (dBM)	Voltage[2] Breakdown V_b (Volts)	Nominal[3] Forward Voltage (Volts)	Nominal[4] Total Capacitance (pF)
MA40220	135	10.0	−52	2.0	0.3	0.12
MA40222	135	16.0	−52	2.0	0.3	0.09

NOTES:
1. The video amplifier bandwidth is 2 MHz and the noise figure is 3 dB. Impedance is 10 kilohms and dc bias is +20 μA. Wafers are evaluated on a sample basis for T_{SS}.
2. Breakdown voltage is measured at 10 μA reverse bias current.
3. Forward voltage is measured at a forward current of 1 mA.
4. Capacitance is measured at 0 volts and 1 MHz.

Typical Performance Curves

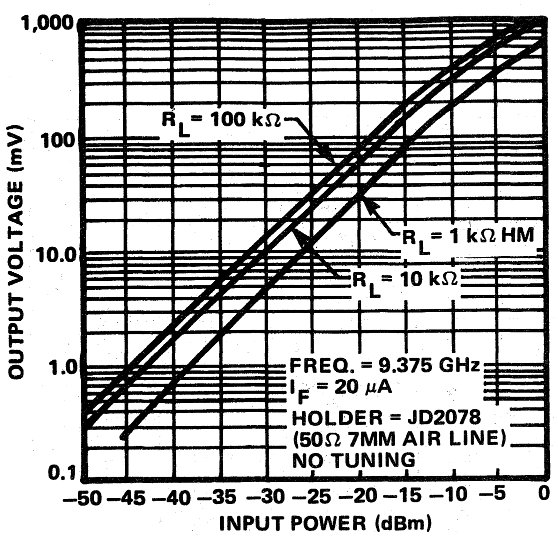


FIGURE 1. MA40250 Series Nominal Output Voltage at X-band (with Forward Bias)

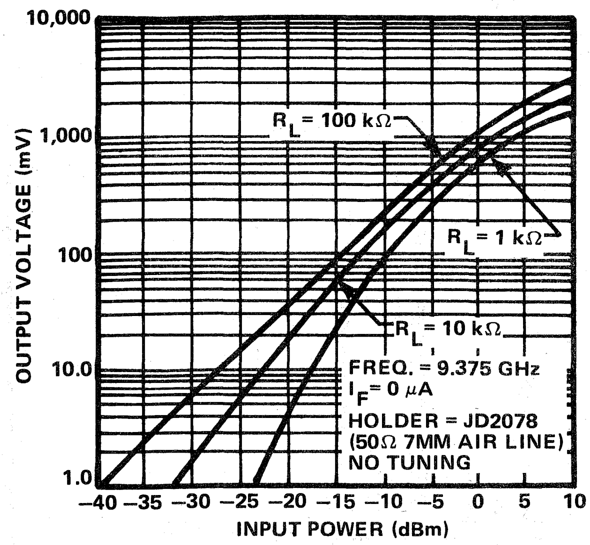


FIGURE 2. MA40250 Series Nominal Output Voltage at X-band (with Zero Bias)

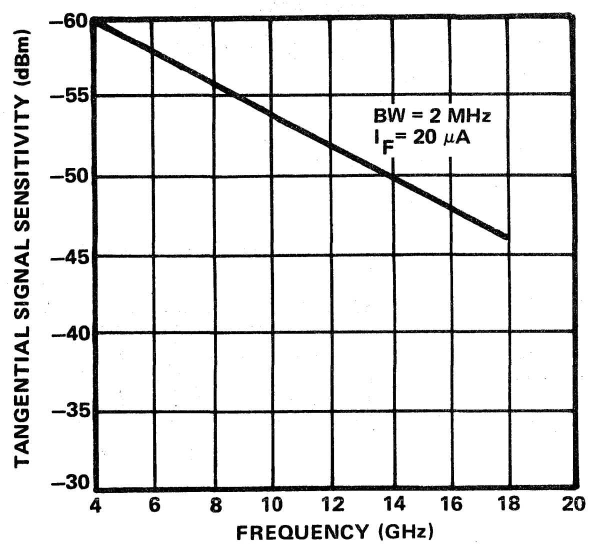


FIGURE 3. MA40250 Series Nominal Tangential Signal Sensitivity vs. Frequency

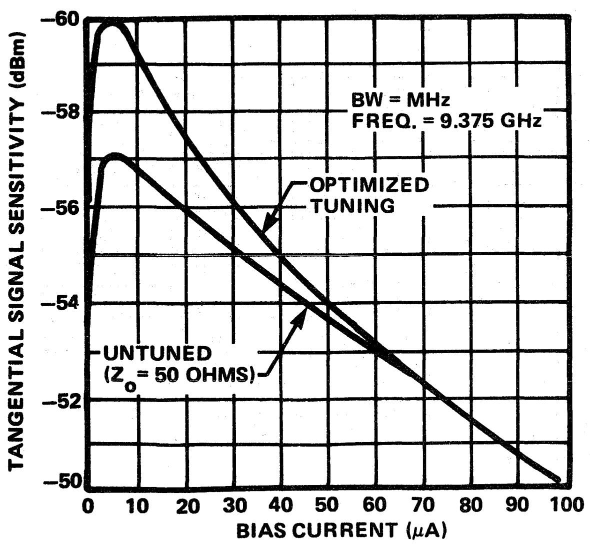


FIGURE 4. MA40250 Series Nominal Tangential Signal Sensitivity vs. Bias Current at X-band

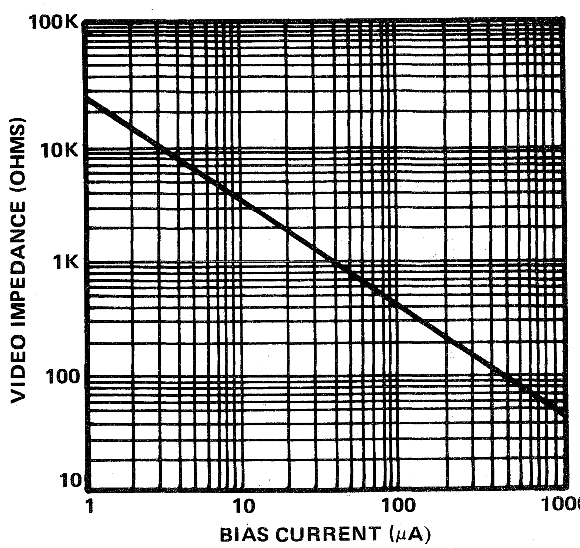
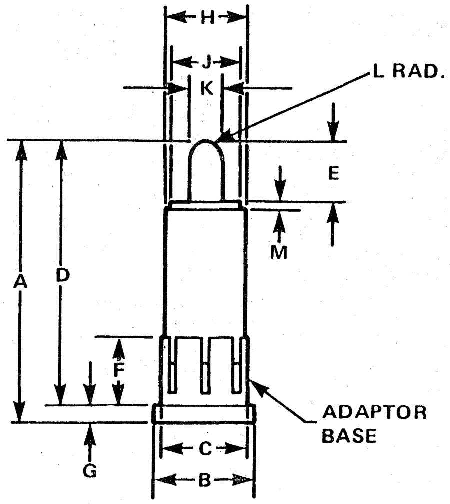


FIGURE 5. MA40250 Nominal Video Impedance vs. Bias Current

Case Styles

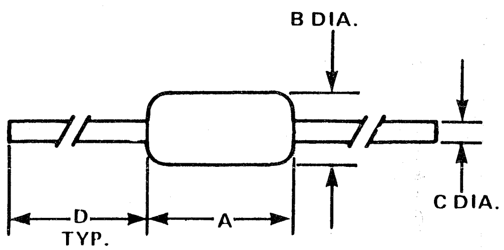
3



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.800	0.840	20,32	21,34
B	0.292	0.296	7,42	7,52
C	0.246	0.250	6,25	6,35
D	0.753	0.783	19,13	19,89
E	0.180	0.190	4,57	4,83
F	0.193	0.199	4,90	5,05
G	0.047	0.057	1,19	1,45
H	0.222	0.240	5,64	6,10
J	0.195	0.215	4,95	5,46
K	0.092	0.094	2,34	2,39
L	0.030	0.046	0,76	1,17
M	0.020	0.030	0,51	0,76

Adaptor base optional.
C_P = 0.12 pF Typical
L_S = 0.50 nH Typical

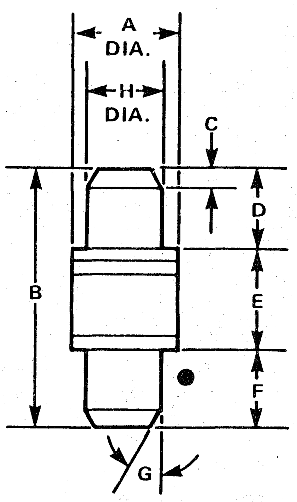
54



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

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

119

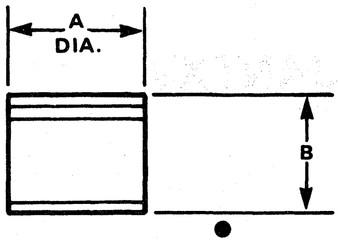


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.190	0.210	4,83	5,33
C	0.009	0.015	0,23	0,38
D	0.060	0.064	1,52	1,63
E	0.070	0.087	1,68	2,21
F	0.060	0.064	1,52	1,63
G	25°	35°	25°	35°
H	0.060	0.064	1,52	1,63

C_P = 0.15 pF Typical
L_S = 0.50 nH Typical

Case Styles (Cont'd)

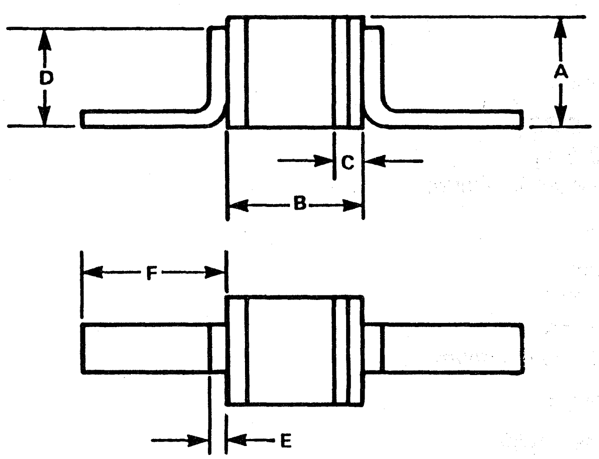
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

276

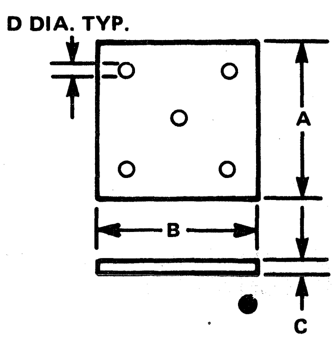


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.020	0,254	0,058
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

C_P = 0.13 pF Typical
$L_S \cong$ 0.40 nH Typical

Chip Style

135



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.013	.017	,330	,431
B	.013	.017	,330	,431
C	.004	.006	,102	,152
D	.001	— —	,02	— —

Suggested Screening for JANTX or JANTXV Equivalency for Packaged Diodes

INSPECTION	METHOD	CONDITION
Internal Visual	2074	See Note 1
High Temperature Life (Stabilization Bake)	1032	T = 24 Hours, T_A = 150°C
Thermal Shock	1051	20 cycles −65°C to +125°C, T extreme □10 minutes
Constant Acceleration	2006	20,000 g's, Y1 direction
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical		See Note 1
HTRB	1038	T_A = +150°C V_R = 80% V_b T = 48 Hours Minimum
Pre-Burn-In Electrical		See Note 1
Burn-In	1038	Condition B T_A = +25°C I_{pk} = 10 mA T≐96 Hours Minimum
Final Electricals and Delta		See Note 2
PDA		Less Than 10%

NOTES:
1. Chips may be screened by packaging and testing on a sample basis. Information is available upon request from the factory.
2. Conditions and details of test depend on the specific model number. Information is available from the factory upon request.

Ordering Information

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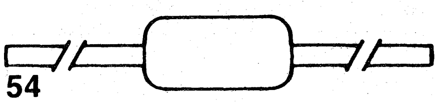
Axial Lead Glass Packaged Schottky Diodes



54

Features

- PICOSECOND SWITCHING
- JANTX/JANTXV SCREENING AVAILABLE
- LOW FORWARD VOLTAGE DROP
- LOW REVERSE LEAKAGE

Description

This family of planar Schottky diodes is designed to have picosecond switching speed. These diodes are housed in a hermetic axial lead glass package and can be screened to JANTX and JANTXV levels. Breakdown voltage of up to 30 volts is available. The MA4E2835 is designed to have very low forward drop.

Applications

This family of axial lead glass packaged Schottky diodes is designed for use as high level mixers, detectors, up-converters and fast switching and gating circuits. These diodes are also very useful in sampling circuits such as bridge quads and/or limiters in pulse shaping circuits and for gates in frequency discriminations.

Specifications @ $T_A = 25°C$

General Purpose Diodes

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

Model[1,2] Number	JEDEC Equivalent Part Number	Minimum[3] Breakdown Voltage, V_b (Volts)	Maximum Forward Voltage Vf @ 1 mA (Volts)	Minimum Forward Current Vf @ 1 V (mA)	Maximum Reverse Leakage Current, I_r (nA)	Maximum[4] Total Capacitance, C_t (pF)
MA4E2305		30.0	.400	75	300 @ −15V	1.0
MA4E2301	1N5165	30.0	.400	50	300 @ −15V	1.0
MA4E2302	1N5166	30.0	.400	35	200 @ −15V	1.0
MA4E2303	1N5167	20.0	.400	35	500 @ −15V	1.0
MA4E2810		20.0	.410	35	100 @ −15V	1.2
MA4E2812	1N5712	20.0	.550	35	150 @ −15V	1.2
MA4E2811	1N5713	15.0	.410	20	100 @ −8V	1.2
MA4E2835		8.0[6]	.340	10	100 @ −1V	1.0

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

MAXIMUM RATINGS

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

Typical Performance Curves

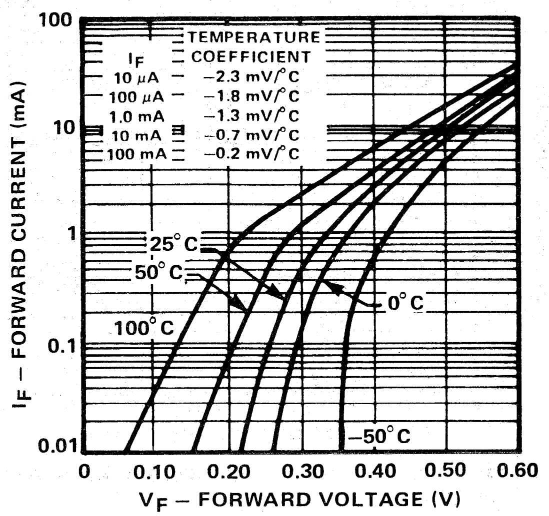


FIGURE 1. I-V Curve Showing Typical Temperature Variations for the MA4E2300-2305 Series Schottky Diodes.

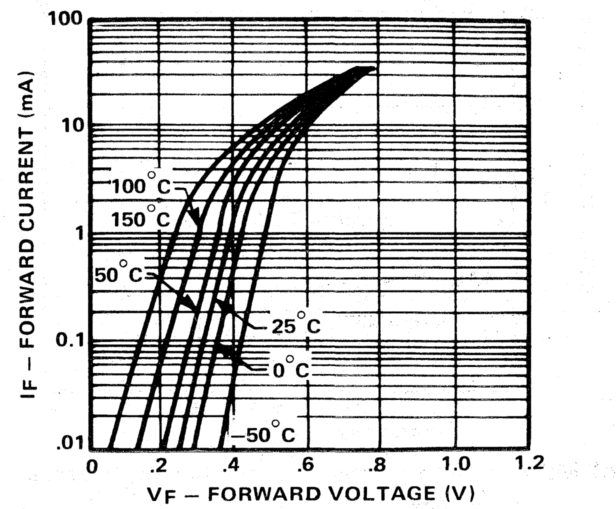


FIGURE 2. I-V Curve Showing Typical Temperature Variations for the MA4E2810-2812 Series Schottky Diodes.

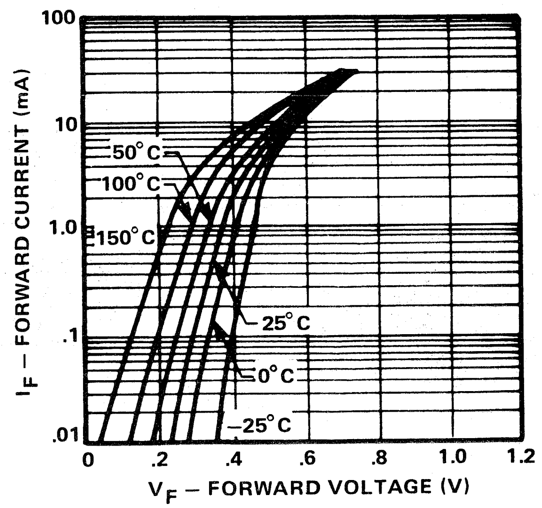


FIGURE 3. I-V Curve Showing Typical Temperature Variations for the MA4E2811 Series Schottky Diodes.

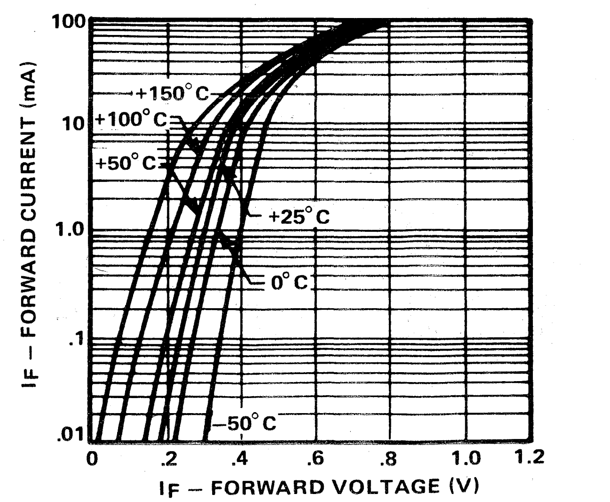


FIGURE 4. I-V Curve Showing Typical Temperature Variations for the MA4E2835 Series Schottky Diodes.

Typical Performance Curves (Cont'd)

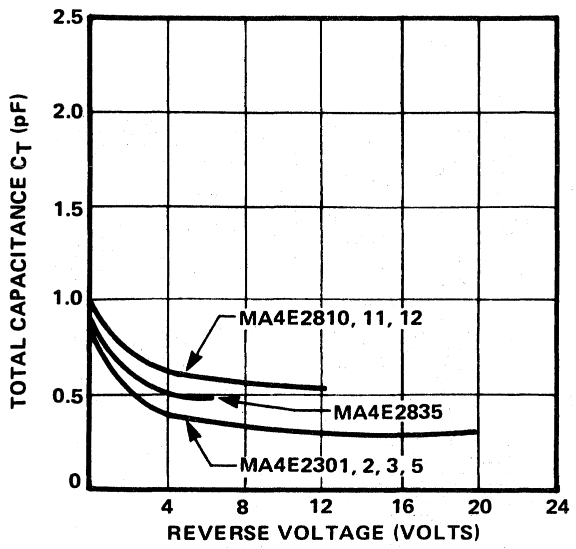


FIGURE 5. Nominal Total Capacitance vs. Reverse Voltage

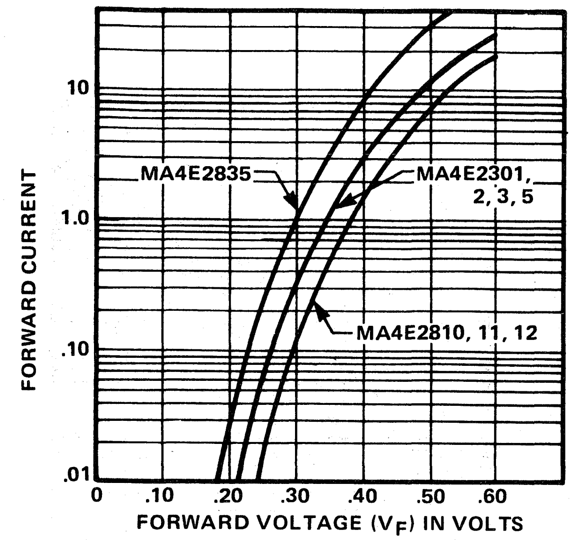
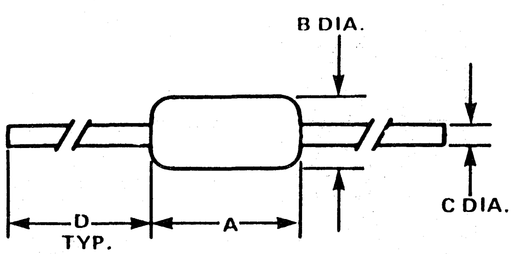


FIGURE 6. Nominal Forward Current vs. Forward Voltage (at 25°C)

Case Style

54

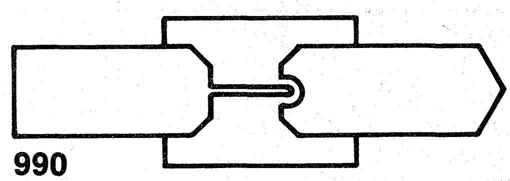


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.145	0.165	3,68	4,19
B	0.068	0.075	1,72	1,91
C	0.014	0.016	0,35	0,41
D	1.000	1.500	25,40	38,10

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

All specifications are subject to change without notice.

Zero Bias Detector Diodes



Features

- CAN BE USED WITHOUT EXTERNAL DC BIAS
- EXHIBIT UNIFORM Rv CHARACTERISTICS
- HIGH VOLTAGE SENSITIVITY
- AVAILABLE IN PACKAGES, CHIPS AND BEAM LEADS

Description

This family of Zero Bias Detector (ZBD) diodes is designed for use in video detectors and power monitors eliminating the need to provide external DC bias to the diode.

These diodes offer good output sensitivity and low junction capacitance.

M/A-COM's Zero Bias Detector diodes are available in a wide range of hermetic packages, and as bondable chips and beam lead diodes. This series of diodes are offered with video impedances of 0.5 to 15 kilohms at zero bias.

Applications

This series of diodes is useful as video detectors and power monitors through K band and do not require external DC bias.

Schottky Isoplanar ZBD Beam Lead Diodes

Model[6] Number	Test Frequency Band	Minimum[2] T_{SS} (−dBm)	Minimum[2] Eo, mV (Minimum)	R_V[3,4,5] (kilohms) (Minimum)	(Maximum)
MA40188	X	49	4.0	0.5	1.0
MA40189	Ku			0.5	1.0
MA40188A	X	52	8.0	1.0	2.0
MA40189A	Ku			1.0	2.0
MA40188B	X	55	12.0	2.0	5.0
MA40189B	Ku			2.0	5.0
MA40188C	X	56	15.0	5.0	10.0
MA40189C	Ku			5.0	10.0
MA40188D	X	56	15.0	10.0	15.0
MA40189D	Ku			10.0	15.0

Silicon Packaged and Chip ZBD Diodes

Model[1,7] Number	Case Style	Minimum[2,7] T_{SS} (−dBm)	Minimum[2] Eo, mV (Minimum)	R_V[3,4,5] (kilohms) (Minimum)	(Maximum)
MA4E928	54	49	4.0	0.5	1.0
MA4E928A	54	52	8.0	1.0	2.0
MA4E928B	54	55	12.0	2.0	5.0
MA4E928C	54	56	15.0	5.0	10.0
MA4E928D	54	56	15.0	10.0	15.0
MA4E929	119	49	4.0	0.5	1.0
MA4E929A	119	52	8.0	1.0	2.0
MA4E929B	119	55	12.0	2.0	5.0
MA4E929C	119	56	15.0	5.0	10.0
MA4E929D	119	56	15.0	10.0	15.0
MA4E930	120	49	4.0	0.5	1.0
MA4E930A	120	52	8.0	1.0	2.0
MA4E930B	120	55	12.0	2.0	5.0
MA4E930C	120	56	15.0	5.0	10.0
MA4E930D	120	56	15.0	10.0	15.0
MA4E931	135	49	4.0	0.5	1.0
MA4E931A	135	52	8.0	1.0	2.0
MA4E931B	135	55	12.0	2.0	5.0
MA4E931C	135	56	15.0	5.0	10.0
MA4E931D	135	56	15.0	10.0	15.0
MA4E932	186	49	4.0	0.5	1.0
MA4E932A	186	52	8.0	1.0	2.0
MA4E932B	186	55	12.0	2.0	5.0
MA4E932C	186	56	15.0	5.0	10.0
MA4E932D	186	56	15.0	10.0	15.0

NOTES:

1. Schottky barrier diodes are thermocompression bonded in case styles 119, 120 and 186. Case style 54 is pressure contact. Case style 135 is a bondable chip. Other case styles are available upon request. For additional information, contact the factory.
2. Test conditions:
   - For T_{SS}: Video Bandwidth = 2 MHz; Noise Amplifier = 3.5 dB
   - Test Frequency: X-Band = 10 GHz; Ku-Band = 16 GHz
   - Voltage Sensitivity: P_{IN} = −30 dBm; R_L = 1 M (ohms); Test Frequency = as stated
3. Higher R_V values are available on request. Contact the factory.
4. The nominal junction capacitance values are as follows:
   Diodes with R_V ~0.5 to 2.0 Kohms, C_j ~0.30 pF (maximum)
   Diodes with R_V ~2.0 to 5.0 Kohms, C_j ~0.25 pF (maximum)
   Diodes with R_V ~5.0 to 15.0 Kohms, C_j ~0.20 pF (maximum)
5. The nominal R_S is ~30 ohms maximum.
6. Case style is Beam Lead style in ODS 990
7. Test frequency band is X-Band

Specifications @ $T_A = 25°C$

MAXIMUM RATINGS

Temperature Ratings:	
Operating and Storage Temperature	−65°C to +150°C
Power Ratings:	
Maximum Peak Incident RF Power	0.5 Watts for 1 μsec maximum
Maximum Peak CW RF Power	100 mW
Both ratings at 25°C. Derate linearly to zero at maximum operating temperature.	
Solder Temperature Ratings:	
For case style 54, 186	230°C for 5 sec (1mm from package)
For case style 119, 120	200°C for 5 sec (maximum)

Suggested Screening for JANTX or JANTVX Equivalency for Packaged Diodes

SCREENED DIODES MIL-STD-19500

INSPECTION	METHOD	CONDITION
Internal Visual	2074	See note 1
High Temperature Life (stabilization bake)	1032	T = 24 hours, T_A = 150°C
Thermal Shock	1051	20 cycles −65°C to +125°C T extreme >10 minutes
Constant Acceleration	2006	20,000 g's, Y1 direction
Fine Leak	1071	H
Gross Leak	1071	C or E
Electrical		See note 1
HTRB	1038	T_A = +25°C V_r = 80% V_b T = 48 hours minimum
Pre Burn-In Electrical		See note 1
Burn-in	1038	Condition B T_A = +25°C I_{pk} = 10 mA T = 96 hours minimum
Final Electricals and Delta		See note 2
PDA		Less than 10%

NOTES:
1. Chips may be screened by packaging and testing on a sample basis. Information is available upon request from the factory.
2. Conditions and details of test depend on the specific model number. Information available from the factory upon request.

Typical Performance Curves

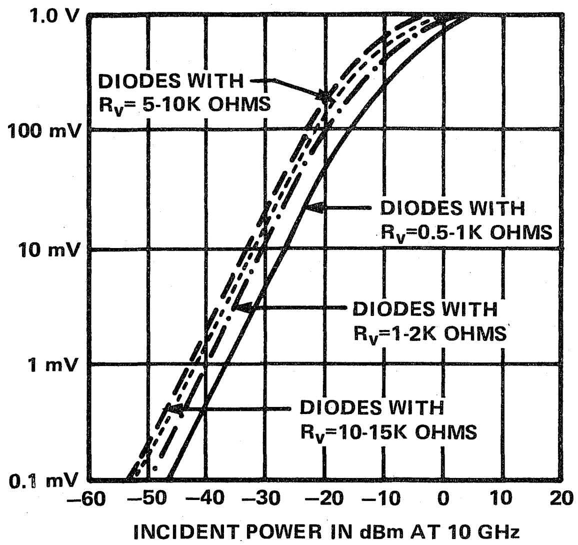


FIGURE 1. Zero Bias Silicon Schottky Detector Diode Nominal Output Voltage at 25°C and 10 GHz with a Fixed Tuned Holder an $R_L = 10K$ Ohms.

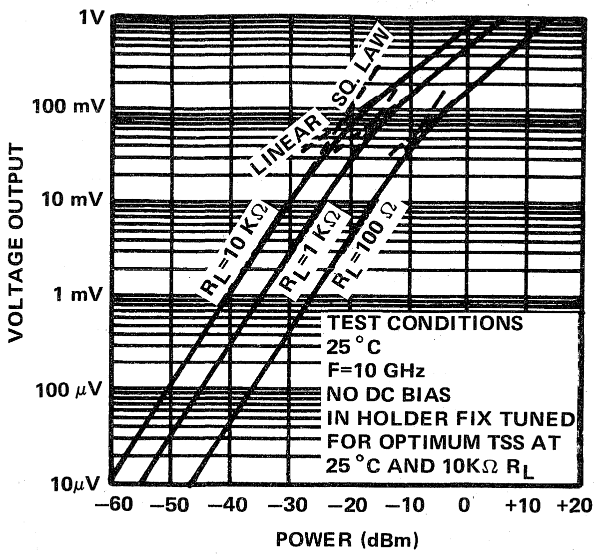


FIGURE 2. Zero Bias Schottky Detector Voltage Sensitivity for Diodes with 2-8K Ohm Video Impedance.

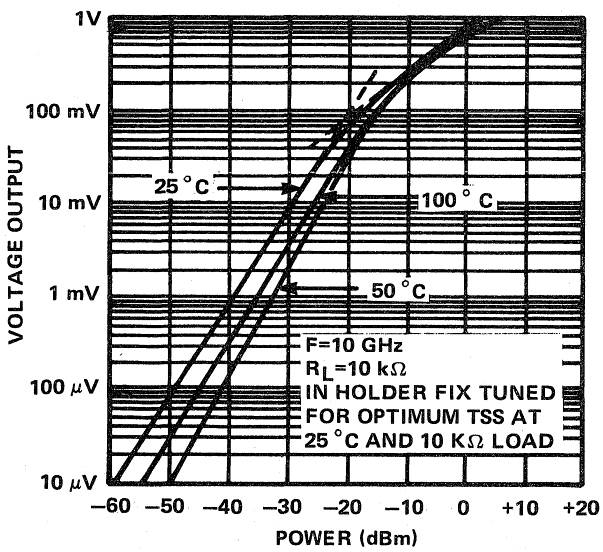


FIGURE 3. Zero Bias Schottky Detector Voltage Sensitivity Characteristics Under Temp for Diode with 2-8K Ohm Video Impedance.

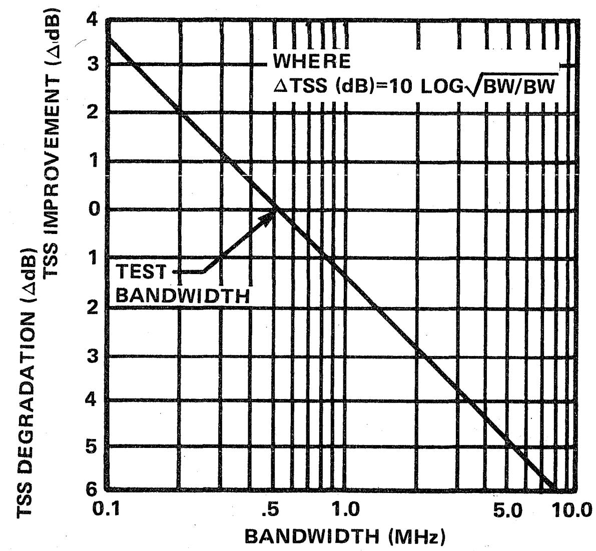


FIGURE 4. TSS Conversion for Bandwidths other than Test Bandwidth.

Typical Performance Curves (Cont'd)

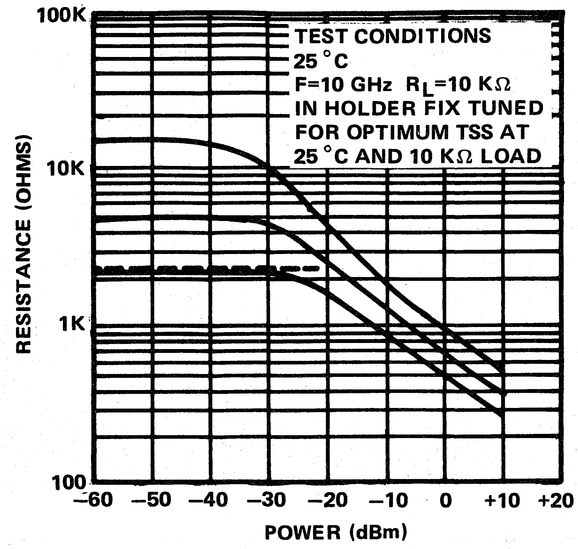
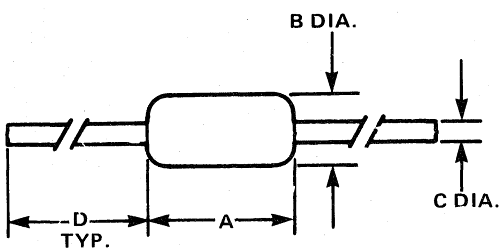


FIGURE 5. Zero Bias Schottky Detector Dynamic Resistance (R_V) vs. Power for Diodes of Different Impedance Ranges.

Case Styles

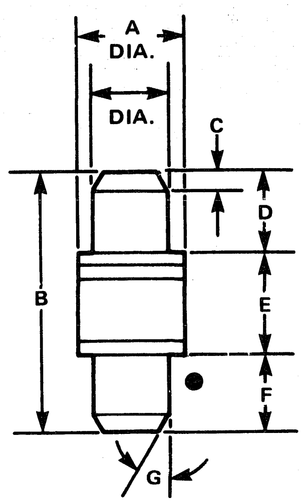
54



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

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

119

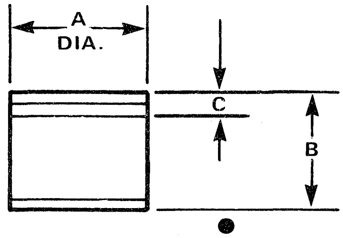


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.190	0.210	4,83	5,33
C	0.009	0.015	0,23	0,38
D	0.060	0.064	1,52	1,63
E	0.070	0.087	1,68	2,21
F	0.060	0.064	1,52	1,63
G	25°	35°	25°	35°
H	0.060	0.064	1,52	1,63

C_P = 0.15 pF Typical
L_S = 0.50 nH Typical

Case Styles (Cont'd)

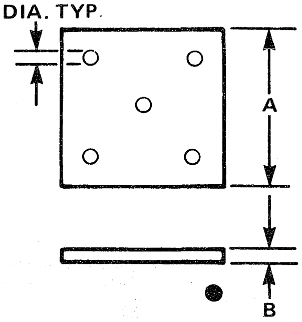
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38

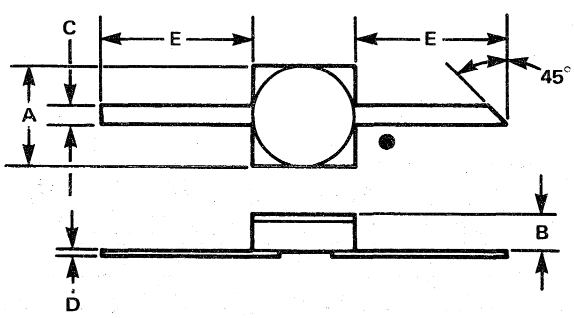
$C_P \approx$ 0.13 pF Typical
$L_S \approx$ 0.40 nH Typical

135



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.013	0.017	0,33	0,43
B	0.004	0.006	0,10	0,15
C	0.001	— —	0,03	— —

186

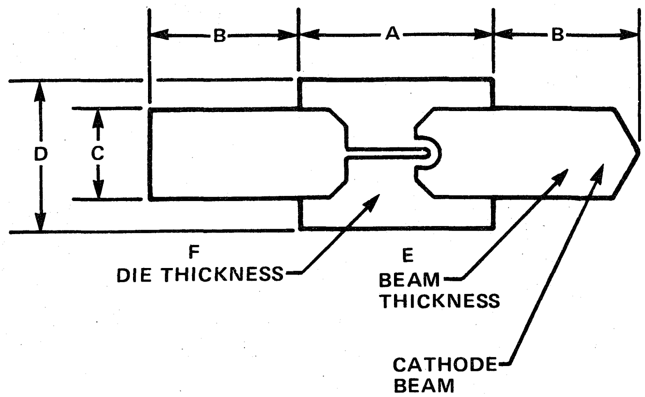


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0.0076	0,15
E	0.130	0.170	3,30	4,32

C_P = 0.15 pF Typical
L_S = 0.40 nH Typical

Case Styles (Cont'd)

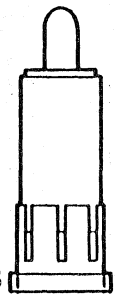
990



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0128	0.0132	0,325	0,335
B	0.010	0.011	0,254	0,279
C	0.0060	0.0062	0,152	0,157
D	0.0095	0.010	0,241	0,254
E	0.0003	0.0005	0,0076	0,0127
F	0.0014	0.0015	0,035	0,038

Point Contact Diodes

Point Contact Mixer and Detector Diodes



Features

- PACKAGED CARTRIDGE POINT CONTACT MIXER DIODES
- COAXIAL POINT CONTACT MIXER DIODES
- AXIAL LEAD GLASS PACKAGED POINT CONTACT MIXER DIODES
- AXIAL LEAD GLASS PACKAGED POINT CONTACT DETECTOR DIODES

Description

This series of point contact mixer and detector diodes features good mechanical reliability, low noise figure and is designed for use in stripline, waveguide and coaxial mixers, detectors and power monitors. This series of diodes is offered in axial lead, ceramic or coaxial packages.

Applications

These diodes are designed for mixer, detector and power monitors where good burnout and noise figure are major design criteria.

Packaged Cartridge Point Contact Mixer Diodes

Description

These packaged cartridge point contact mixer diodes feature low noise figure performance. Diodes in this series are available from S-band through X-band. JAN rated devices are also available. This special series of hermetically sealed point contact diodes has been carefully engineered for single or balanced mixer applications.

These diodes are useful for waveguide mixers from S-band through X-band, such as in marine radars, where good burnout resistance is required.

Features

- **LOW NOISE**
- **GOOD BURNOUT RESISTANCE TO SHORT NANOSECOND PULSES (i.e., TR TUBE LEAKAGE)**
- **SCREENABLE TO MILITARY SPECIFICATIONS**

Specifications @ $T_A = 25°C$

Model Number[1,2]	Case Style	Test Frequency (GHz)	Maximum[3] Noise Figure (dB)	Z_{IF} Range[4] (Ohms) Min./Max.	Maximum[5] SWR (Ratio)	MIL-STD-19500[6] Detail Specification Number
1N416G	3	3	5.5	350-450	1.3	
JAN1N21WG	3	3	5.5	350-450	1.3	321
1N416F	3	3	6.0	350-450	1.3	
1N416E	3	3	7.0	350-450	1.3	
JAN1N21WE	3	3	7.0	350-450	1.3	232A
JAN1N3655A	3	3	7.0	350-450	1.3	334
1N416D	3	3	7.5	325-475	1.5	
1N21G	7-1	3	5.5	350-450	1.3	
1N21F	7-1	3	6.0	350-450	1.3	
1N21E	7-1	3	7.0	350-450	1.3	
1N21D	7-1	3	7.5	325-475	1.5	
1N415H	3	9	6.0	335-465	1.3	
JAN1N23WG	3	9	6.5	335-465	1.3	322A
1N415G	3	9	6.5	335-465	1.3	
1N415F	3	9	7.0	335-465	1.3	
JAN1N23WE	3	9	7.5	335-465	1.3	322A
1N415E	3	9	7.5	335-465	1.3	
1N415D	3	9	8.2	325-475	1.3	
1N415C	3	9	9.5	325-475	1.5	
1N3745	3	9	9.5	325-475	1.5	
1N23H	7-1	9	6.0	335-465	1.3	
1N23G	7-1	9	6.5	335-465	1.3	
1N23F	7-1	9	7.0	335-465	1.3	
1N23E	7-1	9	7.5	335-465	1.3	
1N23D	7-1	9	8.2	325-475	1.3	
1N23C	7-1	9	9.5	325-475	1.5	

NOTES:

1. The 1N21D through G, and 1N23C through H series diodes are housed in the fixed base package, case style 7-1. All other diodes in this series are housed in case style 3. Case style 3 has a removable-reversible base adapter.
2. All diodes in this series are available as matched pairs for balanced mixer circuits. There are two types of matched pairs:

   To order two match pairs with the same polarity, "forward pairs" add the suffix "M" to the part number, i.e., 1N23EM

   To order two match diodes with opposite polarity, "reverse pairs" add the suffix "MR" to the part number, i.e., 1N23MR.
   The matching criteria is:
   ΔL_C = 0.3 dB maximum
   ΔZ_{IF} = 25 ohms maximum
3. Noise Figure Test Conditions:
   IRECT = 1.0 mA
   IF = 30 MHz
   NF_{IF} = 1.5 dB minimum
   R_L = 22 ohms
4. IF impedance is measured by modulating the specified test frequency with a 1000 Hz signal, $R_L = 22$ ohms, at an incident power level of 1.0 mW.
5. SWR is tested at a peak power of 1.0 mW, $R_L = 22$ ohms.
6. These diodes are available as JAN MIL qualified types.

Coaxial Point Contact Mixer Diodes

Description

This series of coaxial silicon point contact mixer diodes is especially designed for low noise figure performance. Two case styles are offered: case style 11 for X-, Ku- and K-band and case style 10 for Ka-band.

These diodes are used as waveguide mixers in X- through Ka-band.

Features

- **WIDER BANDWIDTH THAN CARTRIDGE DIODES IN X BAND**

Specifications @ $T_A = 25°C$

Model Number[1,2]	Case Style	Test[3] Frequency (GHz)	Maximum[3] Noise Figure (dB)	Z_{IF} Range[4] (Ohms) Min./Max.	Maximum SWR (Ratio)	MIL-STD-19500[6] Detail Specification Number
MA492F	11	9	7.0	250-450	1.3	
MA492E	11	9	7.5	250-450	1.3	
MA492D	11	9	8.5	250-450	1.7	
MA492C	11	9	9.5	250-450	1.7	
MA490G	11	16	7.0	400-565	1.5	
1N78G	11	16	7.0	400-565	1.5	
JAN1N78F	11	16	7.5	400-565	1.5	130C
1N78F	11	16	7.5	400-565	1.5	
MA490F	11	16	7.5	400-565	1.5	
MA490E	11	16	8.0	400-565	1.5	
1N78E	11	16	8.0	400-565	1.5	
1N78D	11	16	8.5	400-565	1.5	
MA490D	11	16	8.5	400-565	1.5	
1N78C	11	16	9.5	400-565	1.5	
MA490C	11	16	9.5	400-565	1.5	
JAN1N78C	11	16	9.5	400-565	1.5	130B
MA490B	11	16	10.0	365-565	1.6	
1N78B	11	16	10.0	365-565	1.6	
1N26C	11	24	9.5	400-600	1.6	
1N493C	11	24	9.5	400-600	1.5	
JAN1N26B	11	24	11.0	400-600	1.5	128A
1N26B	11	24	11.0	400-600	1.5	
1N53D(5)	10	35	9.0	400-800	1.6	
MA494C	10	35	9.0	400-800	1.6	
1N53C	10	35	9.0	400-800	1.6	
MA494D	10	35	9.0	400-800	1.6	
MA494B	10	35	10.0	400-800	1.6	
JAN1N53B	10	35	10.0	400-800	1.6	186B
1N53B	10	35	10.0	400-800	1.6	
MA494A	10	35	11.0	400-800	1.6	
1N53A	10	35	11.0	400-800	1.6	
MA494	10	35	13.0	400-800	1.6	
1N53	10	35	13.0	400-800	1.6	

NOTES:

1. These diodes are available in two polarities. One is a "forward" diode with a center conductor in the anode. To order a "forward" diode, specify the model number only, i.e. 1N78D.
   The other available polarity is a "reverse" diode. To order a "reverse" diode, add the suffix "R" to the basic model number, i.e., 1N78DR.
2. These diodes can be supplied in matched pairs for balanced mixer circuits. There are two types of pairs:
   (a) Two matched "forward" polarity diodes. To order a "forward" pair add the suffix "M" to the basic model number, i.e., 1N78DM.
   (b) Two matched, 1 "forward" and 1 "reversed" diodes. To order, a reverse pair add the suffix "MR" to the basic model number, i.e., 1N78DMR.
   The matching criteria for all pairs is:
   ΔL_C = 0.3 dBM maximum
   ΔZ_{IF} = 25 ohms maximum
3. The noise figure of these diodes are all measured in a fixed tuned "JAN" specified test holder at the following frequencies:
   F = 9.375 GHz
   F = 16.00 GHz
   F = 23.98 GHz
   F = 36.80 GHz
   Local oscillator power = 1.0 mW
   IF = 30 MHz
   R_L = 100 ohms
   NF_{IF} = 1.5 dB maximum
4. I_F impedance is measured by modulating the specified test frequency with a 1000 Hz signal. I_F impedance and SWR are tested at an incident power level of 1.0 mW, R_L = 100 ohms.
5. The 1N53D (MA494D) is rated for an operating temperature of 150°C vs. 70°C for other types.
6. These diodes are JAN MIL qualified types.

Axial Lead Glass Packaged Point Mixer Diodes

Description

This series of glass axial lead point contact mixer diodes features low capacitance, good mechanical reliability, low noise figure and is designed for use in stripline, microstrip and coaxial mixers from 500 MHz and 12.4 GHz. Each device in this series is housed in an axial lead glass package, case style 4.

These diodes are designed for usage where bandwidth, good burnout and noise figure are major design criteria.

Features

- HIGH SENSITIVITY
- UNIFORM AND REPEATABLE RF CHARACTERISTICS
- BROADBAND
- HIGH BURNOUT RESISTANCE

Specifications @T_A = 25°C

Model Number[1]	Case Style	Test Frequency (GHz)	Maximum[2,3] Noise Figure (dB)	Z_{IF}[2] Range (Ohms) Min./Max.	Nominal[2] Conversion Loss, L_C (dB)
1N831C	4	3	6.0	350-450	4.0
1N831B	4	3	6.5	350-550	4.5
1N831A	4	3	7.0	350-550	5.0
1N831	4	3	8.3	350-450	5.5
1N832C	4	9	6.5	335-465	4.5
1N832B	4	9	7.0	335-465	5.0
1N832A	4	9	7.5	335-465	6.0
1N832	4	9	9.5	325-475	7.0

NOTES:

1. All diode models are available as matched pairs. To order, add the suffix "M" to the model number.

   Matching criteria: ΔL_C = 0.3 dB maximum
   ΔZ_{IF} = 25 ohms maximum

2. The 1N831 series is tested at 3.06 GHz and LO power of 0.5 mW. The 1N832 series is tested at 9.375 GHz and LO power of 1.0 mW. Both series of diodes are tested in a fixed, tuned JAN holder with an appropriate fixed adapter. The other test conditions are:

   IF = 30 MHZ
   NF_{IF} = 1.5 dB minimum
   R_L = 100 ohms

MAXIMUM RATINGS

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

Axial Lead Glass Package Point Contact Detector Diodes

Description

This series of point contact detector diodes is offered in axial lead glass packages. These devices are useful as detectors and power monitors where bandwidth, high burnout resistance and sensitivity are the major design criteria. These diodes do not require DC bias to obtain the specified sensitivity.

These diodes are intended for coaxial and stripline detectors from VHF through X-band, where operation without external bias is required.

Features

- MODERATE VIDEO IMPEDANCE AT ZERO BIAS

Specifications @ $T_A = 25°C$

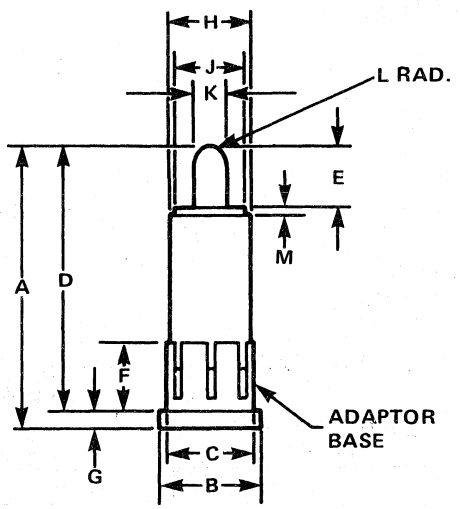
Model Number[1]	Case Style	Test Frequency (GHz)	Minimum T_{SS}[2,3,4] (dBm)	Video Resistance[4] Range (kilohms)
MA4123	4	3	−45	5.0-25.0
MA41511	54	3	−48	4.5-18.0
MA41512	54	3	−50	4.5-18.0
MA4123A	4	3	−48	5.0-25.0
MA4123B	4	3	−50	4.5-18.0
MA41510	54	3	−45	4.5-18.0
1N833A	4	9	−48	4.5-18.0
MA41515	54	9	−50	4.5-18.0
MA41513	54	9	−45	4.5-18.0
MA41514	54	9	−48	4.5-18.0
1N833	4	9	−45	4.5-18.0
1N833B	4	9	−50	4.5-18.0

NOTES:

1. Matched pairs are available by adding the suffix "M" to the model number. The matching criteria is:
   Output voltage is matched at a delta input power of 0.5 dBm maximum.
   Video resistance is matched to a delta to a percentage maximum of the incident power level.
   The matching is done at −30 dBm incident power.
2. Bandwidth of the video amplifier = 2 MHz; amplifier noise figure = 3.5 dB maximum with an input impedance of 10,000 ohms. Low frequency cut-off is approximately 10 kHz.
3. The test holders used to make the T_{SS} measurements are:
   Test holder JAN264 with adaptor for MA4123 through MA4123B
   Test holder JAN 1908 for MA41510 through MA41512
   Test holder JAN 105 (modified) for 1N833B
   Test holder JAN JD 2078 for MA41513 through MA41515.
4. T_{SS} is tested with no external bias current.

Case Styles

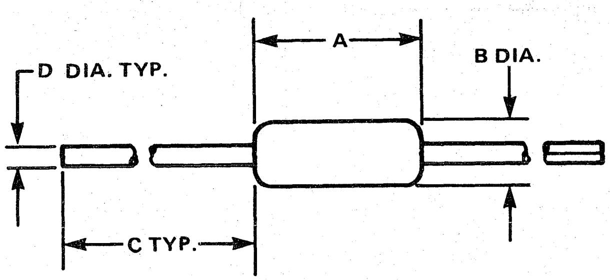
3



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.800	0.840	20,32	21,34
B	0.292	0.296	7,42	7,52
C	0.246	0.250	6,25	6,35
D	0.753	0.783	19,13	19,89
E	0.180	0.190	4,57	4,83
F	0.193	0.199	4,90	5,05
G	0.047	0.057	1,19	1,45
H	0.222	0.240	5,64	6,10
J	0.195	0.215	4,95	5,46
K	0.092	0.094	2,34	2,39
L	0.030	0.046	0,76	1,17
M	0.020	0.030	0,51	0,76

Adaptor base optional.
C_P = 0.12 pF Typical
L_S = 0.50 nH Typical

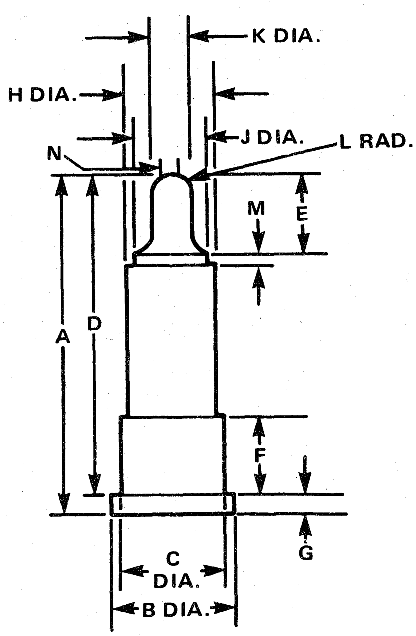
4



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.230	0.300	5,84	7,62
B	0.085	0.107	2,16	2,72
C	1.000	— —	25,40	— —
D	0.018	0.022	0,46	0,56

C_P = 0.15 pF Typical
L_S = 2.50 nH Typical

7-1



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.800	0.840	20,32	21,34
B	0.290	0.296	7,37	7,52
C	0.246	0.250	6,25	6,35
D	0.753	0.783	19,13	19,89
E	0.180	0.190	4,57	4,83
F	0.193	0.199	4,90	5,05
G	0.047	0.057	1,19	1,45
H	0.222	0.240	5,64	6,10
J	0.195	0.215	4,95	5,46
K	0.092	0.094	2,34	2,39
L	0.030	0.046	0,76	1,17
M	0.020	0.030	0,51	0,76
N	— —	0.030	— —	0,76

C_P = 0.12 pF Typical
L_S = 0.50 nH Typical

Case Styles (Cont'd)

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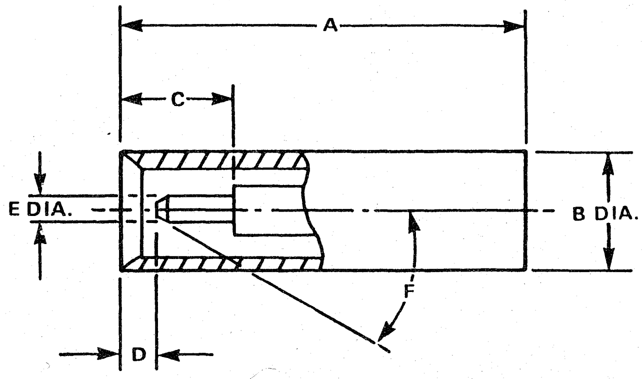
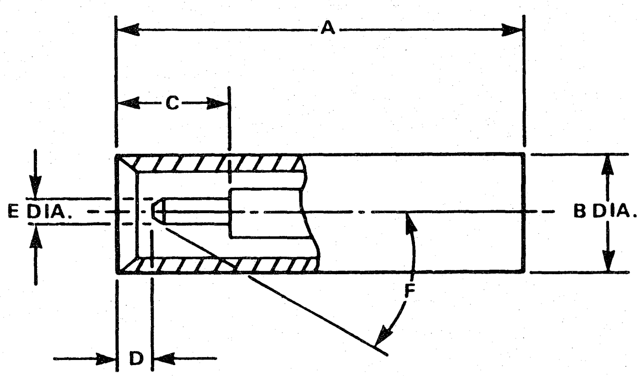


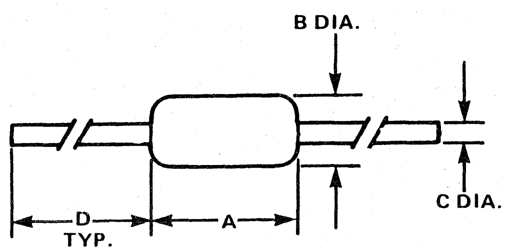
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.545	0.555	13,84	14,10
B	0.158	0.162	4,01	4,11
C	0.099	— —	2,51	— —
D	0.010	0.018	0,25	0,46
E	0.019	0.021	0,48	0,53
F	42°	48°	42°	48°

11



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.734	0.766	18,64	19,46
B	0.215	0.220	5,46	5,59
C	0.147	— —	3,73	— —
D	0.011	0.028	0,28	0,71
E	0.031	0.033	0,79	0,84
F	42°	48°	42°	48°

54



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

C_P = 0.05 pF Typical
L_S = 1.00 nH Typical

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

Multiplier Diodes

(Continued on next page)

MULTIPLIER DIODES (Cont'd)

SELECTION GUIDE FOR MULTIPLIER DIODES

When selecting SRD, Dual Mode or variable capacitance varactors for a multiplier, first determine the following for the multiplier circuit:

1) Output Frequency (f_o)
2) Input Frequency (f_{in})
3) Output Power (P)
4) Bandwidth (B)
5) Efficiency (E)

Use Table 1 to determine what type of diode to suggest. Then use the following tables and charts to determine the diode parameters.

A) Use Table II and Graphs 1,2,3,4 for a SRD or Dual Mode diode.

B) Use Table II and Graphs 1,5,6,7,8 for variable capacitance varactors.

Table I

The following Table I shows the type of multiplier diodes most commonly used in several widely used multipliers

MULTIPLIER DIODE SELECTION BY TYPE OF MULTIPLIER

TYPE OF MULTIPLIER	SUGGESTED TYPE OF MULTIPLIER DIODE		
	SRD	DUAL MODE™	VARACTOR
High Order Multiplier (4X-10X)	X		
Comb Generator (> 10X)	X		
High Power/Low Order (2X-3X)		X	
Pulsed High Power Multiplier (2X-3X)	X (Stacked)		
Millimeter Multiplier (2X-3X)			X
Usual Obtainable Instantaneous Bandwidth (2X-3X)	5-10%	10%	5%
Varactor Upconverter	X		X

Table II

Summary of SRD and Dual Mode Varactor Selection

Determine:

1) Capacitance from output reactance at the output frequency $x_c \cong 30 - 60$ ohms for all but high power multipliers then, $x_c \cong 10 - 30$ ohms

2) Snap Time $= \frac{1}{f_o}$ max.

3) Breakdown Voltage $V_{BR} = {}^*k \sqrt{\frac{2 P_o}{f_{(in)} C_{T-6}}}$

4) Lifetime $= \frac{10}{f_{in}}$ (min) $\frac{20-30}{f_{in}}$ preferred

5) Thermal Resistance $\Phi_{jc} = \frac{150 - T_A}{P_{in} - P_{out}}$

6) Bias Resistor $= R_b = \frac{5\, T_L}{N^2 C_{T-6}}$ (SRD Varactor)

$R_b = \frac{10\, T_L}{N^2 C_{T-6}}$ (Dual Mode™ Varactor)

7) Case style from the package inductance required. This is determined by output frequency, bandwidth and power dissipation.

*NOTE: K is a constant
= 0.8 for x3 or less
= 1.1 for x4
= 1.5 for greater than x4

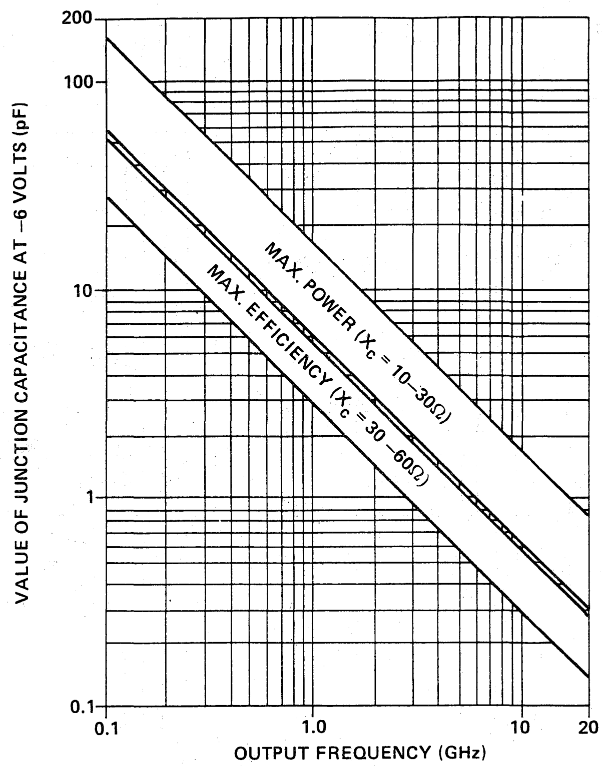


FIGURE 1 SUGGESTED JUNCTION CAPACITANCE FOR SRD AND DUAL MODE™ VARACTORS VS. MULTIPLIER OUTPUT FREQUENCY IN GHz.

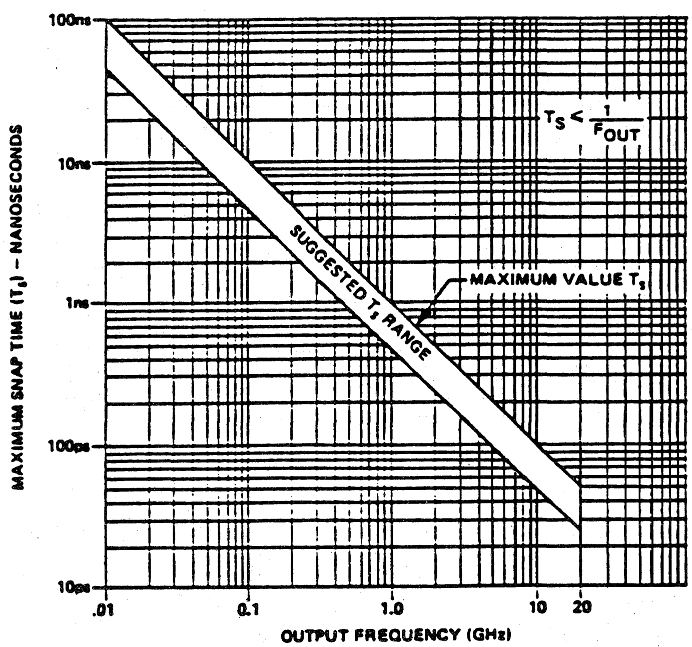


FIGURE 2 MAXIMUM AND SUGGESTED VALUES OF SNAPTIME (T_s) FOR SRD AND DUAL MODE VARACTORS VS. MULTIPLIER OUTPUT FREQUENCY IN GHz.

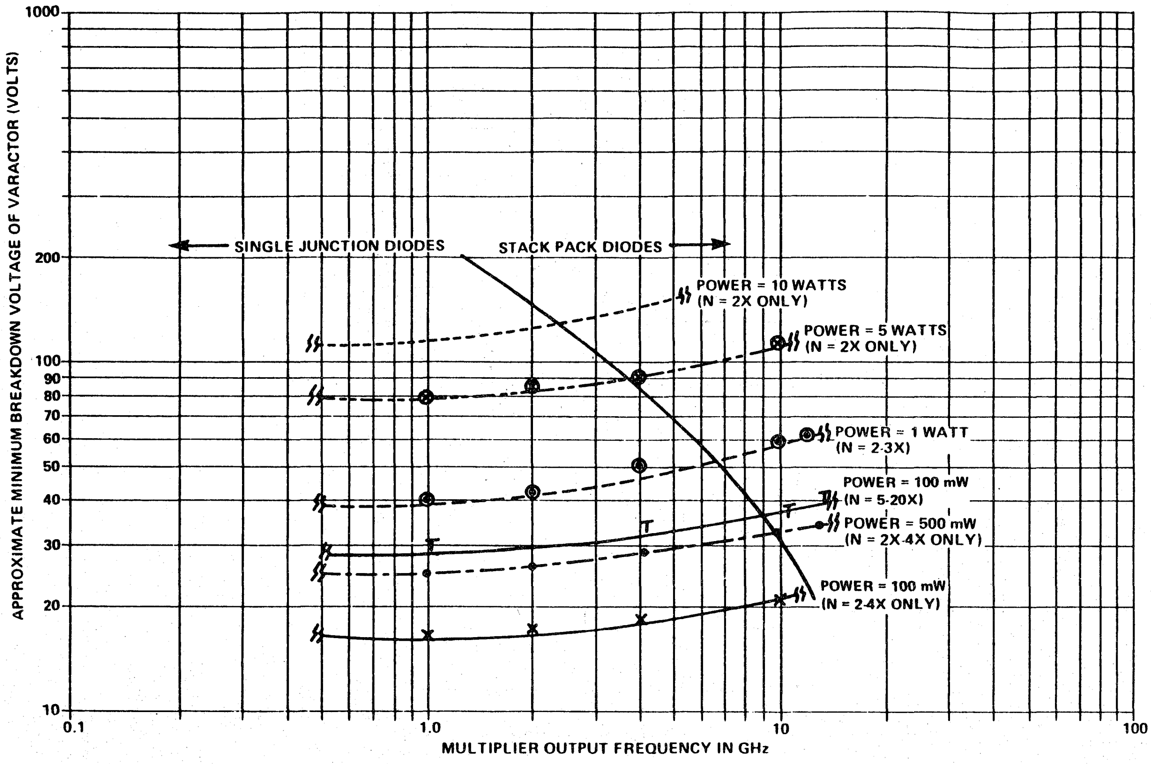


FIGURE 3 APPROXIMATE MINIMUM BREAKDOWN VOLTAGE REQUIRED FOR SRD AND DUAL MODE VARACTORS AT VARIOUS OUTPUT POWERS VS. OUTPUT FREQUENCY.

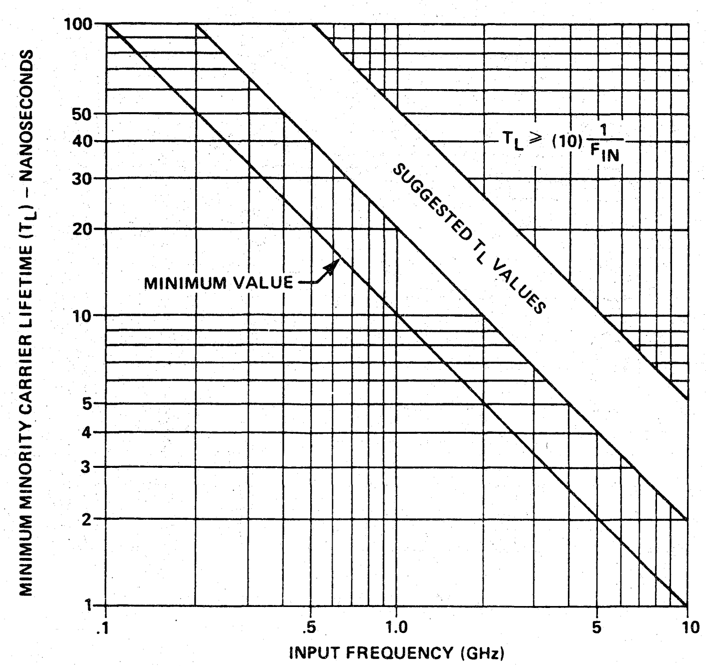


FIGURE 4 MINIMUM AND SUGGESTED VALUES OF MINORITY CARRIER LIFETIME (T_L) FOR SRD AND DUAL MODE VARACTORS VS. MULTIPLIER INPUT FREQUENCY IN GHz.

Table III

Summary of Variable Capacitance Varactor Selection

Determine:

1) Cutoff frequency from output frequency and efficiency required. See figures 5-7.

2) Junction and total capacity from capacitive reactance at output frequency — x_C = 30-60 ohms from C_j at $B_V/3$.

3) Breakdown Voltage from*

$$B_V = \sqrt{\frac{P_{out}}{(\beta)\,(C_{j\,min}) \times \omega_{(in)}}}$$

4) Theta from $\Phi_{jc} = \dfrac{150°C - T_A}{P_{in} - P_{out}}$

5) Case style or chip style from the inductance and package capacitance required by the output frequency and bandwidth.

*β = .0277 for x2
= .0241 for x3
= .0196 for x4

See M/A-COM Application Article AG313 "Application of Multiplier Diodes" for more information.

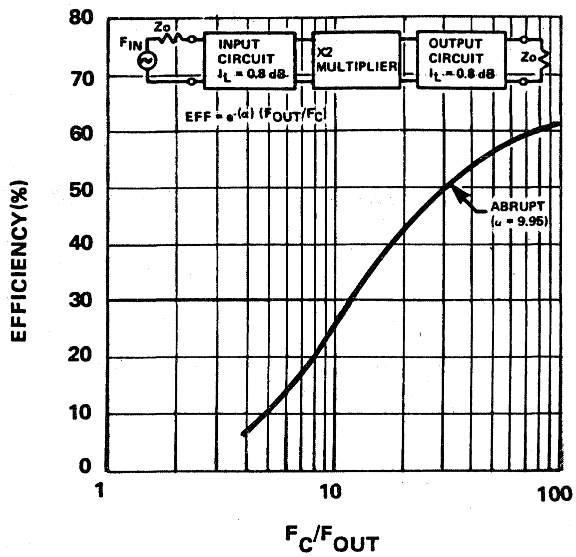


FIGURE 5. CALCULATED MAXIMUM EFFICIENCY OF X2 GaAs VARACTOR MULTIPLIERS

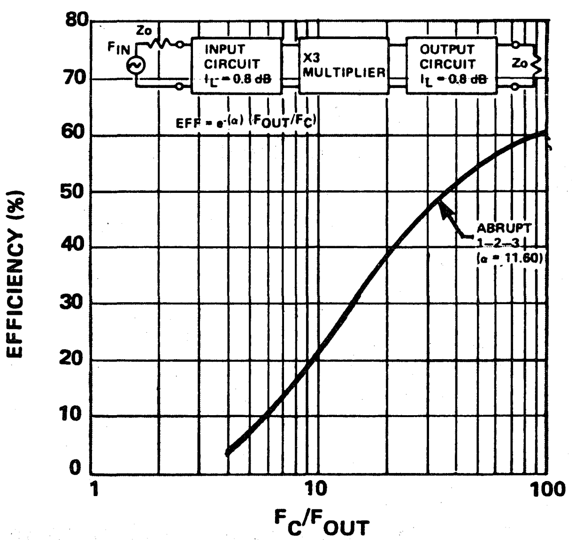


FIGURE 6. CALCULATED MAXIMUM EFFICIENCY OF X3 GaAs VARACTOR MULTIPLIERS

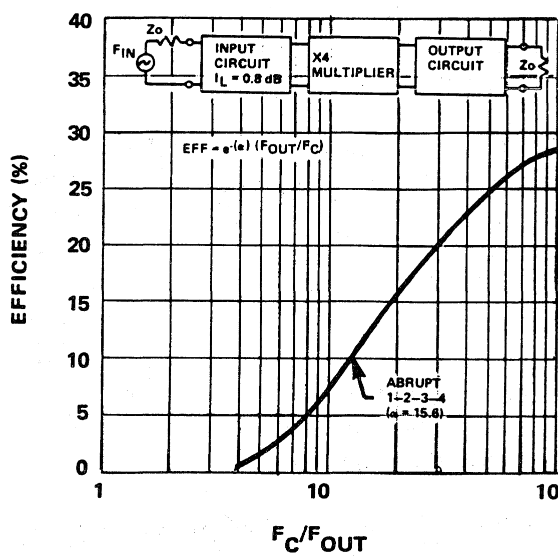


FIGURE 7. CALCULATED MAXIMUM EFFICIENCY OF X4 GaAs VARACTOR MULTIPLIERS

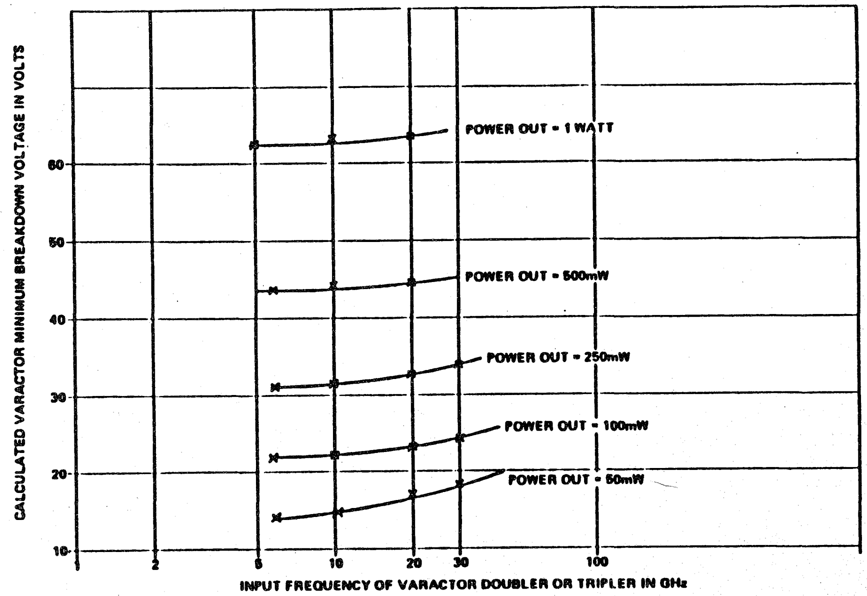
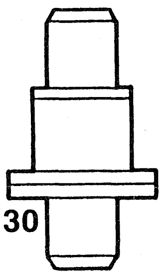


FIGURE 8 GRAPH OF THE CALCULATED MINIMUM VARACTOR BREAKDOWN VOLTAGE REQUIRED FOR ABRUPT VARACTOR DOUBLERS AND TRIPLERS VS. THE OUTPUT POWER OF THE MULTIPLIER.

MA44600 Series

Step Recovery Diodes



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Features

- LOW TRANSITION TIMES
- TIGHT CAPACITANCE RANGES
- HIGH VOLTAGE AND LOW THERMAL RESISTANCE FOR HIGHER INPUT POWER

Description

The MA44600 series of Step Recovery diodes is designed for use in low and moderate power multipliers with output frequencies of up to 20 GHz. These SRD diodes generate harmonics by storing a charge as the diode is driven to forward conductance by the positive voltage of the input signal. When the signal reverses polarity, this charge is extracted. The SRD diode will appear as a low impedance current source until all the charge is extracted, then it will "snap" to a higher impedance. This causes a voltage pulse to form in the impulse circuit of the multiplier. SRD diodes make excellent high order multipliers such as comb generators. They are also useful as efficient moderate power X2 – X4 multipliers. The MA44750 series of higher power step recovery multiplier diodes are higher voltage SRD diodes for use in multipliers with output frequencies of 200 MHz to ~8 GHz, where higher output power of 5 to 50 watts is required. These diodes are normally useful in multipliers with multiplication ratios of 2 to 6 times.

Applications

High Order Narrow Band Moderate Power Multipliers (MA44600 series)

Comb Generators (MA43592, MA43543)

High Power Narrow Band Multipliers (2 – 6 times) (MA44750 series)

High Power Circuit Tested Multipliers (MA43000 series)

Specifications @ T_A = 25° C

Model[1] Number	Voltage[2] Breakdown Minimum V_b (Volts)	Junction[3] Capacitance Range (C_j) Min./Max. (pF)	Minimum Lifetime 10 mA/6 mA TI (ns)	Transition Snap Time (ps)	
				Nominal	Max.
MA44611A	15	.2-.3	5	50	100
MA44611B	15	.3-.4	5	50	100
MA44611C	15	.4-.5	5	50	100
MA44612A	15	.5-.7	5	50	100
MA44612B	15	.7-.9	5	50	100
MA44612C	15	.9-1.1	5	50	100
MA44612D	15	1.1-1.5	5	50	100
MA44621A	20	.2-.3	7	50	100
MA44621B	20	.3-.4	7	50	100
MA44621C	20	.4-.5	7	50	100
MA44622A	20	.5-.7	7	50	100
MA44622B	20	.7-.9	7	50	100
MA44622C	20	.9-1.1	7	50	100
MA44622D	20	1.1-1.5	7	50	100
MA44631A	30	.3-.5	8	70	100
MA44631B	30	.5-.7	8	70	100
MA44631C	30	.7-.9	8	70	100
MA44631D	30	.9-1.1	8	70	100
MA44632A	30	.5-.7	8	70	120
MA44632B	30	.7-.9	8	70	120
MA44632C	30	.9-1.1	8	70	120
MA44632D	30	1.1-1.5	8	70	120
MA44641A	40	.4-.6	12	90	150
MA44641B	40	.6-.8	12	90	150
MA44641C	40	.8-1.1	12	90	150
MA44641D	40	1.1-1.5	12	90	150
MA44642A	40	.5-.7	12	150	200
MA44642B	40	.7-.9	12	150	200
MA44642C	40	.9-1.1	12	150	200
MA44642D	40	1.1-1.5	12	150	200
MA44643A	40	.7-.9	12	250	300
MA44643B	40	.9-1.1	12	250	300
MA44643C	40	1.1-1.5	12	250	300
MA44643D	40	1.5-2.0	12	250	300
MA44652A	50	.5-.7	15	150	200
MA44652B	50	.7-.9	15	150	200
MA44652C	50	.9-1.1	15	150	200
MA44652D	50	1.1-1.5	15	150	200
MA44653A	50	.7-.9	15	250	300
MA44653B	50	.9-1.1	15	250	300
MA44653C	50	1.1-1.5	15	250	300
MA44653D	50	1.5-2.0	15	250	300
MA44663A	60	.7-.9	20	250	300
MA44663B	60	.9-1.1	20	250	300
MA44663C	60	1.1-1.5	20	250	300
MA44663D	60	1.5-2.0	20	250	300

*The nominal chip size for the MA44600 series is 15 mils.

NOTES

1. When ordering, specify the desired case style by adding the case designation as a suffix to the model number. Case styles for the MA44600 series are 30, 31, 91, 92, 93, 111 and 113. To order in chip form, add the suffix "C" to the model number.
2. Breakdown voltage (V_b) is measured at a reverse bias current of 10 μA.
3. Junction capacitance is measured at a reverse voltage of 6 volts and a frequency of 1 MHz.
4. Transition time is measured between 20% and 80% points on the voltage recovery trace. These values are guaranteed for the A and B capacitance ranges only. Test conditions are +10 mA and −10 volts.

Specifications @ T_A = 25° C (Cont'd)

HIGH POWER CIRCUIT TESTED STEP RECOVERY DIODES

Model Number	Case[1] Style	Minimum Output Power (Watts)	Input Frequency (GHz)	Output Frequency (GHz)	Maximum Input Power (Watts)	Min./Max.[2] Breakdown Voltage Range, V_b (Volts)
MA4B300	43	8.0	0.400	2.0	30	100-145
MA43000	103	4.0	0.333	2.0	15	85-105
MA43002	91	1.5	2.000	6.0	5	45-70
MA43004	91	0.3	3.300	13.0	2	30-45

Model Number	Min./Max.[3] Junction Capacitance Range, C_j (pF)	Min./Max. Minor Carrier Lifetime, T_L 10 mA/6 mA (ns)	Maximum Snap Time, T_S −10V/10 mA (ps)	Maximum Thermal Resistance, jc (C/W)
MA4B300	5.00-8.00	300-800	750	7
MA43000	3.00-4.50	250-500	600	12
MA43002	1.60-2.40	75-225	250	25
MA43004	0.45-0.85	20-50	150	45

NOTES
1. The standard case styles are indicated for each model number. Other case styles are available. Consult the factory for information.
2. Breakdown voltage is measured at reverse bias current of 10 μA.
3. Junction capacitance is measured at a reverse bias of 6 volts and a frequency of 1 MHz.

MA44750 SERIES HIGH POWER STEP RECOVERY MULTIPLIER DIODES

Model[1] Number	Case Style	Minimum[5] Breakdown Voltage, V_b (Volts)	Min./Max.[6] Junction Capacitance, C_j (pF)	Maximum Thermal Resistance (C/W)	Maximum Transition Time, T_S −10V/10 mA (ps)	Output[2] Frequency Range (GHz)
MA44750	56	180	8.0-12.0	8	3000	0.2-0.5
MA44751	56	160	5.0-8.0	8	2000	0.5-1.0
MA44752	56	120	3.0-5.0	10	1500	1.0-2.0
MA44753	30	100	1.5-3.0	12	1000	2.0-4.0
MA44754	30	80	1.0-1.5	15	750	4.0-8.0

NOMINAL CHARACTERISTICS

Model Number	Output Power [3, 4] (Watts)	Minor Carrier Lifetime, T_L 10 mA/6 mA (ns)	X3 Efficiency[7] (%)	Chip Size[1] (mils)
MA44750	60	500	65	65
MA44751	20	400	60	50
MA44752	10	250	55	30
MA44753	8	150	50	20
MA44754	6	70	45	20

NOTES
1. Standard case styles are listed for each model number. For other case styles available, consult the factory. These diodes can be supplied in chip form. To order in chip form, add the suffix "C" to the model number.
2. This is an operable output frequency and does not imply instantaneous bandwidth.
3. Characteristic values are based on performance tests and include circuit losses amounting to about 1.5 dB. For special circuits, factors other than the diode may cause variations from the values shown. Contact the factory before using this information for equipment design.
4. These are nominal values at the midpoint of the specified frequency range. The MA44750 series of diodes can be operated at full efficiency over a broad range of drive power.
5. Breakdown voltage is measured at a reverse current of 10 μA.
6. Junction capacitance is measured at 1 MHz and −6 volts. The nominal tolerance is ±10%, but ±3% control is available at a nominal charge. Contact the factory. Nominal case capacitance are given with the case style outline drawings.
7. These are nominal values for narrow band circuits within the suggested frequency range and are to be used as guidelines in circuit designs. These values can vary substantially depending on the multiplier circuit design. These diodes are specifically designed for multiplication orders from 2 to 6.

Specifications @ T_A = 25° C (Cont'd)

HIGH ORDER SRD VARACTORS FOR USE IN COMB GENERATION

Model Number	Case[1] Style	Maximum[2] Input Power (Watts)	Min./Max.[3] Breakdown Voltage Range, V_b (Volts)	Min./Max.[4] Junction Capacitance C_j Range (pF)	Min./Max. Minor Carrier Lifetime, T_L Range (ps)	Maximum Snap Time, T_s – 10V/10 mA (ps)	Maximum Thermal Resistance jc (C/W)	Nominal[2] Output Frequency (GHz)
MA43592	30	1.0	25-40	0.2-0.30	9-27	90	70	1-12
MA43543	93	1.5	20-50	0.2-0.55	10-25	60	125	2-20

NOTES
1. The standard case styles are indicated for each model number. For other available case styles, consult the factory.
2. This is an operable output frequency range and does not imply instantaneous bandwidth.
3. Breakdown voltage is measured at a reverse bias voltage of 10 μA.
4. Junction capacitance is measured at a reverse bias voltage of 6 volts and a frequency of 1 MHz.

MAXIMUM RATINGS

Temperature Range

Operating Range	– 65° C to + 200° C
Storage Range	– 65° C to + 200° C

ENVIRONMENTAL PERFORMANCE

The MA44600 series of diodes is capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

ENVIRONMENTAL RATINGS (Per MIL-STD-750)

	Method	Level
Temperature:		
Storage	1031	– 65° C to + 200° C
Operating	— —	– 65° C to + 200° C
Cycling	1051	5 cycles
Solderability	2026	230° C as applicable
Thermal Shock	1056	5 cycles, 0-100° C
Moisture Resistance	1021	10 days 90-98% Relative Humidity
Shock	2016	5 blows (X, Y, Z @ 1500 g's)
Vibration Fatigue	2046	32 hours (X, Y, Z @ 20 g's min.)
Vibration Variable Frequency	2056	4 four minute cycles (X, Y, Z @ 20 min., 100-2000 Hz)
Constant Acceleration	2006	X, Y, Z @ 20,000 g's
Terminal Strength	2036	Package Dependent
Salt Atmosphere	1041	35° C for 24 hours

Selection of Multiplier Diodes

The following table and graphs will give an outline for selection of the appropriate snap recovery diode, depending on power, frequency and multiplication ratio desired.

TABLE I. Summary of SRD and Dual Mode Varactor Selection

Determine:

1) Capacitance from output reactance at the output frequency $x_c \cong$ 30-60 ohms for all but high power multipliers then, $x_c \cong$ 10-30 ohms

2) Snap Time $= \frac{1}{f_o}$ max.

3) Breakdown Voltage $V_{BR} = k \sqrt{\frac{2 P_o}{f_{(in)} C_{T-6}}}$

   (P_o = Output power)

4) Lifetime $= \frac{10}{f_{in}}$ (min) $\frac{20—30}{f_{in}}$ preferred

5) Thermal Resistance $\Phi_{jc} = \frac{150 - T_A}{P_{in} - P_{out}}$

6) Bias Resistor $= R_b = \frac{5 T_L}{N^2 C_{T-6}}$ (SRD Varactor)

   $R_b = \frac{10 T_L}{N^2 C_{T-6}}$ (Dual Mode™ Varactor)

   (N^2 = Multiplication ratio)

7) Case style from the package inductance required. This is determined by output frequency, bandwidth and power dissipation.

(*) k = Constant dependent on multiplication ratio

k = 0.8 for 3X or less

k ≈ 1.1 for 4X

k ≈ 1.5 for > 4X

Typical Performance Curves

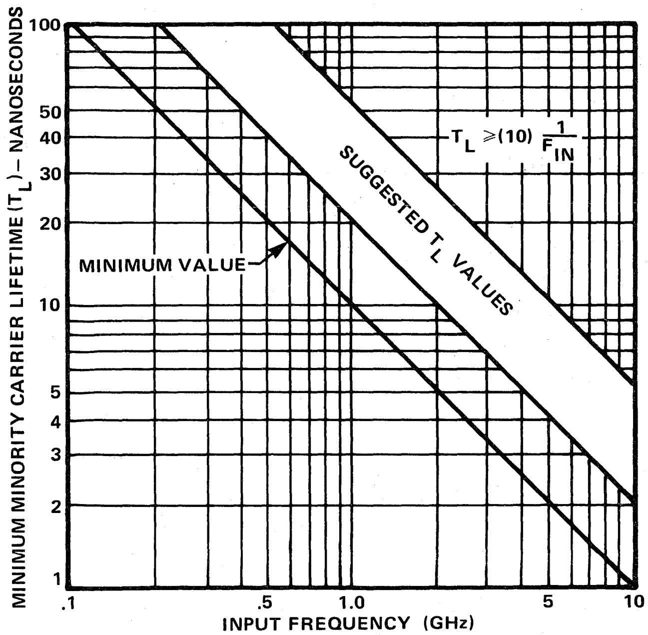


FIGURE 1. Minimum and Suggested Values of Miniority Carrier Lifetime (T_L) for SRD and Dualmode Varactors vs. Multiplier Input Frequency in GHz

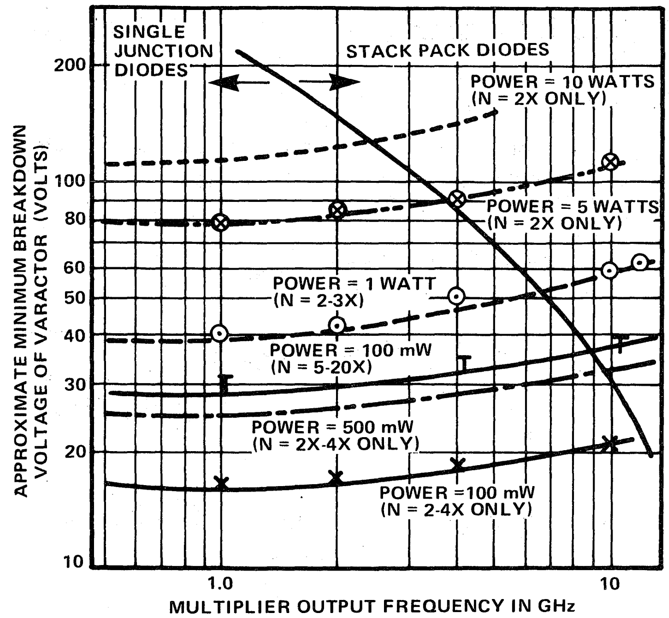


FIGURE 2. Approximate Minimum Breakdown Voltage Required for SRD and Dualmode Varactors at Various Output Power vs. Output Frequency

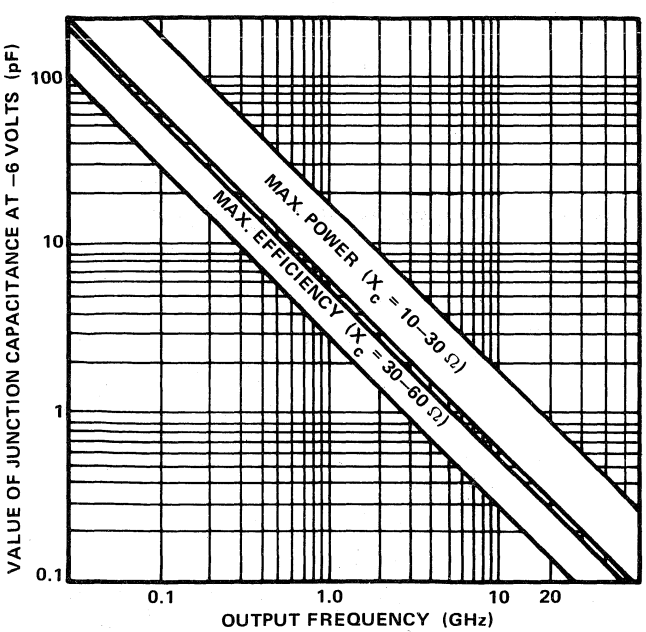


FIGURE 3. Suggested Junction Capacitance for SRD and Dualmode™ Varactors vs. Multiplier Output Frequency in GHz

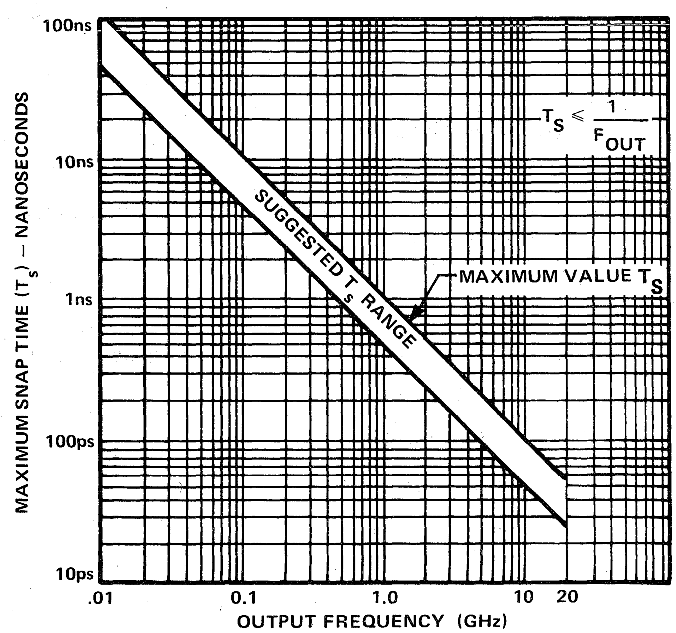
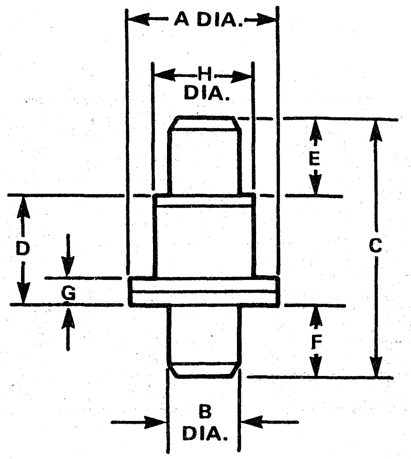


FIGURE 4. Maximum and Suggested Values of Snaptime (T_S) for SRD and Dualmode Varactors vs. Multiplier Output Frequency in GHz

Case Styles

● DENOTES CATHODE   NOT TO SCALE

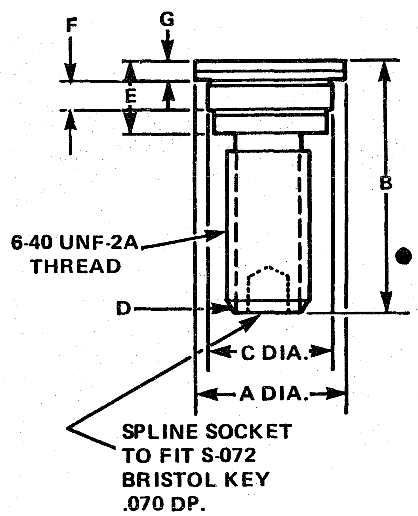
30



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

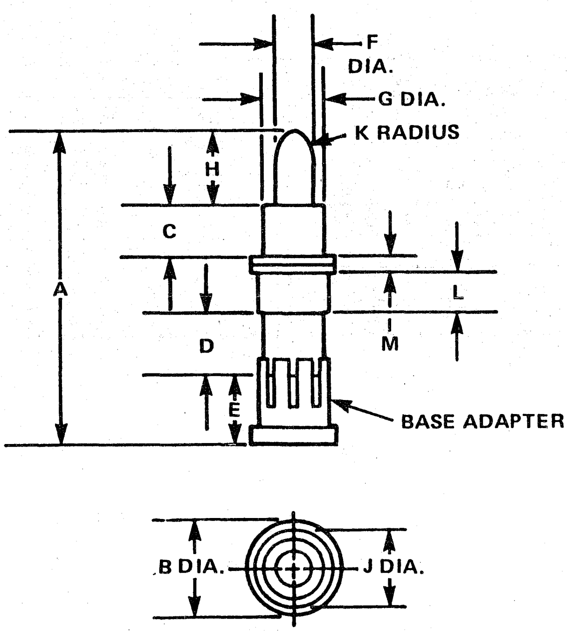
43



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.255	0.265	6,48	6,73
B	0.440	0.460	11,18	11,68
C	0.208	0.212	5,28	5,38
D	.020 x 45° REF.		0,51 x 45° REF.	
E	0.119	0.131	3,02	3,33
F	50 REF.		1.27 REF.	
G	0.025	0.035	0,64	0,89

C_P = 0.75 pF Typical
L_S = 0.60 nH Typical

56



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.766	0.792	19,46	20,12
B	— —	0.240	— —	6,10
C	0.130 REF.		3,30 REF.	
D	0.145	0.155	3,68	3,94
E	0.180	0.190	4,57	4,83
F	0.092	0.094	2,34	2,39
G	0.155	0.165	3,94	4,19
H	0.180	0.190	4,57	4,83
J	0.185	0.195	4,70	4,95
K	0.030	0.046	0,76	1,17
L	0.095	0.105	2,41	2,67
M	— —	0.030	— —	0,76

Base adaptor optional.
C_P = 0.35 pF Typical
L_S = 3.0 nH Typical

Case Styles (Cont'd)

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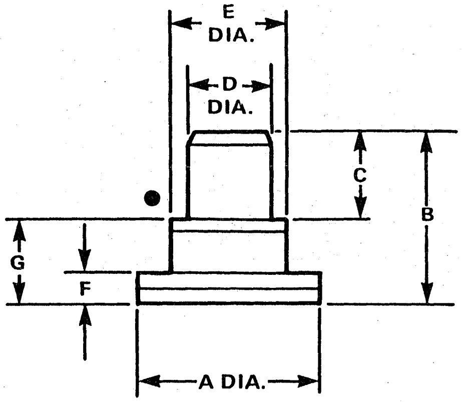

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.115	0.129	2,92	3,28
C	0.060	0.064	1,52	1,63
D	0.060	0.062	1,52	1,57
E	0.077	0.083	1,96	2,11
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

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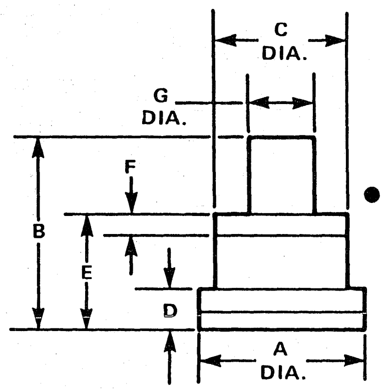

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.059	0.069	1,50	1,75
B	0.070	0.080	1,78	2,03
C	0.047	0.053	1,19	1,35
D	— —	0.015	— —	0,38
E	0.040	0.050	1,02	1,27
F	0.004	0.010	0,10	0,25
G	0.024	0.026	0,61	0,66

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

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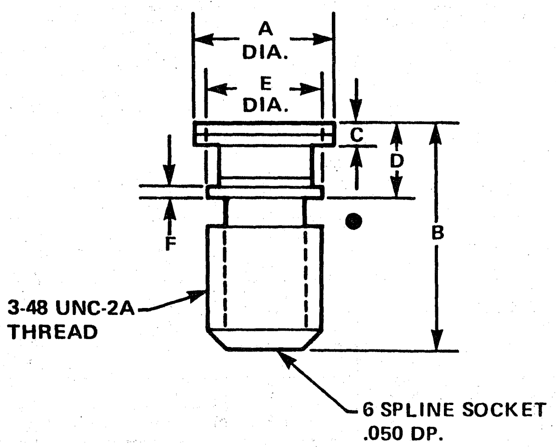
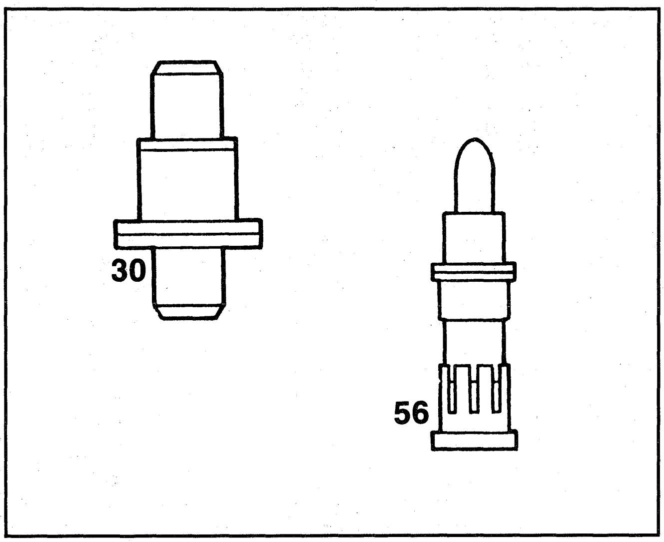


DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.188	0.208	4,78	5,28
C	0.016	0.024	0,41	0,61
D	0.058	0.071	1,47	1,80
E	0.098	0.102	2,49	2,59
F	0.009	0.011	0,23	0,28

MA44700 Series

Dualmode™ Multiplier Varactors



Features

- HIGHER EFFICIENCY IN HIGH POWER MULTIPLIER
- BETTER BANDWIDTH THAN STEP RECOVERY DIODES IN LOW ORDER MULTIPLIERS

Description

A Dualmode™ diode is specified in a combined variable reactance and time domain mode. The Dualmode™ varactor is specified for both time and frequency domain usage.

Normally, lifetime, snap time and capacitance are specified, and most Dualmode™ diodes will also have their Q or cut off frequency specified. The capacitance "punch through" voltage can affect impedance and may be specified also. Breakdown voltage is normally specified. It affects the power capability.

The Dualmode™ diode produces harmonics by two phenomena. It exhibits an abrupt change in capacitance versus bias voltage, as in a classical variable capacitance varactor, and it also exhibits a change in charge storage versus input drive level similar to a Step Recovery diode (SRD). The RF voltage where this transition from charge storage to variable reactance characteristic occurs is approximately the capacitance punch through voltage (the voltage at which the space charge extends across the varactor's active region). At this voltage, no more capacitance change will occur with additional reverse voltage. The effect of combining the stored charge and variable reactance change is to make the effective non-linearity larger than in either a SRD or variable capacitance diode.

In general, a properly designed Dualmode™ varactor will produce more power and be more efficient in a high power/low order multiplier than either a SRD or "varactor". These diodes are a very good choice for doublers and triplers with output frequency to 12 GHz where maximum power, efficiency and bandwidth are the major criteria. They have also been used in doublers with output frequencies as high as 20 GHz.

Specifications @ T_A = 25°C

Model[1] Number	Case Style	Minimum[2] Breakdown Voltage V_b (Volts)	Min./Max.[3] Junction Capacitance C_j (pF)	Minimum[4] Cutoff Frequency (GHz)	Maximum Transition Time T_S −10V/10 mA (ps)	Maximum Thermal Resistance (C/W)
MA44700	56	200	18.0-26.0	*	10000	5
MA44710	56	175	18.0-26.0	*	8000	5
MA44720	56	150	10.0-20.0	40.0	5000	6
MA44701	56	120	8.0-10.0	60.0	3000	7
MA44711	56	100	8.0-10.0	60.0	2000	7
MA44712	56	100	4.0-5.0	90.0	2000	11
MA44702	30	80	4.0-5.0	90.0	3000	10
MA44722	30	80	4.0-6.0	110.0	1500	10
MA44703	30	80	2.5-3.5	120.0	1000	13
MA44704	30	80	1.5-2.5	150.0	750	15
MA44714	30	60	1.5-2.5	150.0	400	15
MA44725	30	40	1.0-1.5	160.0	150	25
MA44705	30	40	0.5-0.7	175.0	150	50
MA44706	30	30	0.3-0.5	200.0	100	75
MA44707	30	30	0.15-0.20	350.0	—	300

* F_C not specified. R_S is measured at −6 volts and .5 GHz = 0.35 ohms maximum.

NOMINAL CHARACTERISTICS

Model[1] Number	Minority Carrier Lifetime, T_L 10 mA/6 mA (ns)	Available[7] Output Power Range (Watts)	X3[6] Efficiency (%)	Suggested[5] Output Frequency Range (GHz)
MA44700	450	3.0-20.0	55	0.3-0.75
MA44710	400	2.0-24.0	55	0.5-1.00
MA44720	350	2.0-16.0	55	0.6-1.20
MA44701	210	1.0-10.0	55	0.7-1.50
MA44711	180	1.0-10.0	55	1.0-2.50
MA44712	170	1.0-6.0	55	2.0-4.00
MA44702	200	1.0-8.0	55	1.5-3.00
MA44722	180	2.0-10.0	55	1.0-3.00
MA44703	100	0.5-4.0	50	3.0-5.00
MA44704	60	0.5-2.5	45	5.0-7.00
MA44714	60	0.3-1.5	45	5.0-8.00
MA44725	20	3.0-1.5	50	5.0-8.00
MA44705	18	0.1-0.6	40	8.0-12.00
MA44706	10	0.2-0.5	30	12.0-15.00
MA44707	—	0.1-0.2	15	15.0-25.00

NOTES

1. Standard case styles are listed for each model number. For other case styles available, consult the factory.
2. Breakdown voltage is measured at a reverse bias current of 10 μA.
3. Capacitance is measured at 1 MHz and −6 volts. The nominal tolerance is ±10%, but closer tolerances are available upon request at a nominal charge. Nominal case capacitances are given with the case style outline drawings.
4. R_S is measured at .5 GHz. Cutoff frequency is calculated at 1 GHz by this R_S and capacitance measurement at 1 MHz.
5. This is an operable output frequency range and does not imply instantaneous bandwidth.
6. These are nominal values for narrow band circuits within the suggested frequency range and are to be used as guidelines in circuit designs. These values can vary substantially depending on the multiplier circuit design. These diodes are specifically designed for multiplication orders of X2-X4.
7. These are nominal values at midpoint of the specified frequency range in a doubler. Dualmode diodes can operate at full efficiency over a broad range of power.

NOTE: Dualmode™ Multipliers were formerly called Bimode™ Varactors

MAXIMUM RATINGS

Reverse Voltage	Same as Rated Breakdown (V_b)
Operating Temperature	−65°C to +150°C
Storage Temperature	−65°C to +150°C

ENVIRONMENTAL PERFORMANCE

All varactors in the MA44700 series are capable of meeting the performance tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

Super Dualmode™ Diodes (For higher output power)

SPECIFICATIONS @ T_A = 25°C

Model[1] Number	Case Style	Minimum[2] Breakdown Voltage V_b (Volts)	Min./Max.[3] Junction Capacitance C_j (pF)	Minimum[4] Cutoff Frequency (GHz)	Maximum Transition Time T_S −10V/10 mA (ps)	Maximum Thermal Resistance (C/W)
MA44710A	56	140	18.0-26.0	*	5000	5
MA44711A	56	80	8.0-10.0	60	2000	9
MA44712A	56	80	4.0-5.0	90	2000	12
MA44713A	56	60	2.5-3.5	140	700	15
MA44714A	30	60	1.5-2.5	140	500	17
MA44724A	30	45	1.0-1.5	160	300	27

* F_c is not specified. R_S is measured at −6 volts and .5 GHz R_S = .35 ohms maximum.

NOMINAL CHARACTERISTICS

Model[1] Number	Minority Carrier Lifetime T_L 10 mA/6 mA (ns)	Available[7] Output Power Range (Watts)	X3[6] Efficiency (%)	Suggested[5] Output Frequency Range (GHz)
MA44710A	450	40.0	65	0.5-1.0
MA44711A	160	24.0	65	1.0-2.5
MA44712A	130	10.0	55	2.0-4.0
MA47713A	60	6.0	50	3.0-5.0
MA47714A	60	4.0	50	5.0-8.0
MA44724A	45	2.5	50	7.0-10.0

See notes on previous page.

Varactor Selection Guide

TABLE I. Summary of SRD and Dualmode™ Varactor Selection

The following table gives information for selecting an appropriate Dualmode™ varactor depending on the output frequencies and the power desired.

Determine:

1) Capacitance from output reactance at the output frequency $x_c \cong$ 30-60 ohms for all but high power multipliers then, $x_c \cong$ 10-30 ohms

2) Snap Time = $\frac{1}{f_o}$ max.

3) Breakdown Voltage $V_{BR} = k \sqrt{\frac{2 P_o}{f_{(in)} C_{T-6}}}$

4) Lifetime = $\frac{10}{f_{in}}$ (min) $\frac{20-30}{f_{in}}$ preferred

5) Thermal Resistance $\Phi_{jc} = \frac{150 - T_A}{P_{in} - P_{out}}$

6) Bias Resistor = $R_b = \frac{5\, T_L}{N^2\, C_{T-6}}$ (SRD Varactor) $R_b = \frac{10\, T_L}{N^2\, C_{T-6}}$ (Dual Mode™ Varactor)

7) Case style from the package inductance required. This is determined by output frequency, bandwidth and power dissipation.
k = 0.8 for 3X or less
k = 1.1 for 4X

Multiplier Diode Selection by Type of Multiplier

The following chart suggests the type of multiplier diodes that are used in several multiplier circuits.

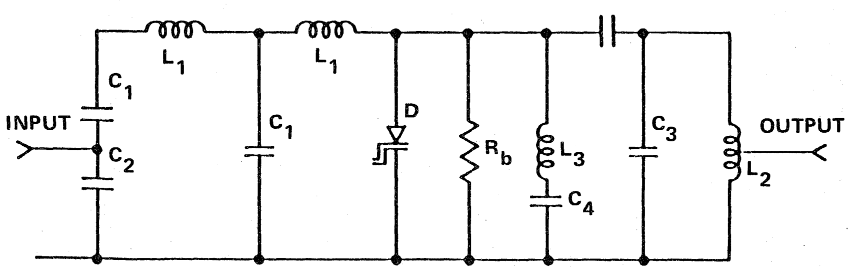
Type of Multiplier	Suggested Type of Multiplier Diode		
	SRD	Dualmode™	Varactor
High Order Multiplier (4X-10X)	X		
Comb Generator (>10X)	X		
High Power/Low Order (2X-3X)		X	
Pulsed High Power Multiplier (2-3X)	X (Stacked)		
Millimeter Multiplier (2-3X)			X
Instantaneous Bandwidth (2-3X)	5-10%	10%	5%
Varactor Upconverter	X		X

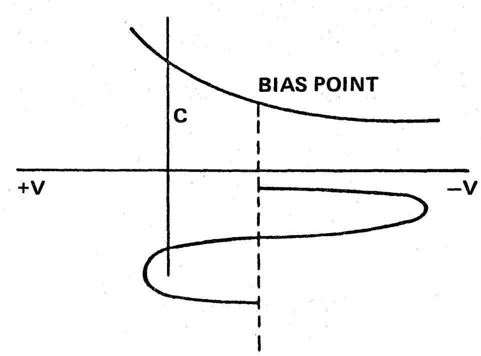
Dualmode™ Multiplier Circuits

Dualmode™ multiplier circuits are similar to SRD multiplier circuits, except that they require an idler circuit at unwanted harmonics to return them to ground.

Harmonics are generated by both the diode's voltage variable reactance and the charge storage (snap mechanism). In general, these circuits are most useful for low order high power multiplication. Normally, Dualmode™ multipliers will allow broader bandwidth than similar SRD multipliers. This better bandwidth characteristic is the result of easier broadband matching to the input signal. There is less change between the low impedance and high impedance states of Dualmode™ diode than a SRD.

The following is a typical Dualmode™ multiplier circuit. Its normal operating conditions are indicated.





Typical Performance Curves

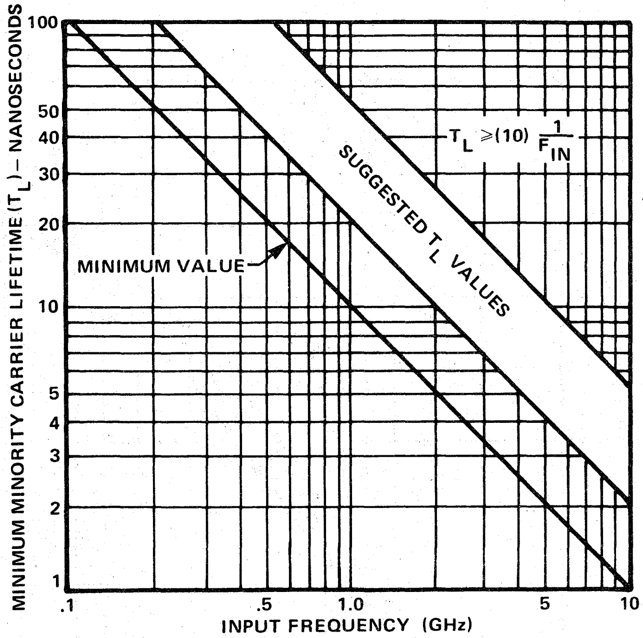


FIGURE 1. Minimum and Suggested Values of Miniority Carrier Lifetime (T_L) for SRD and Dualmode™ Varactors vs. Multiplier Input Frequency in GHz

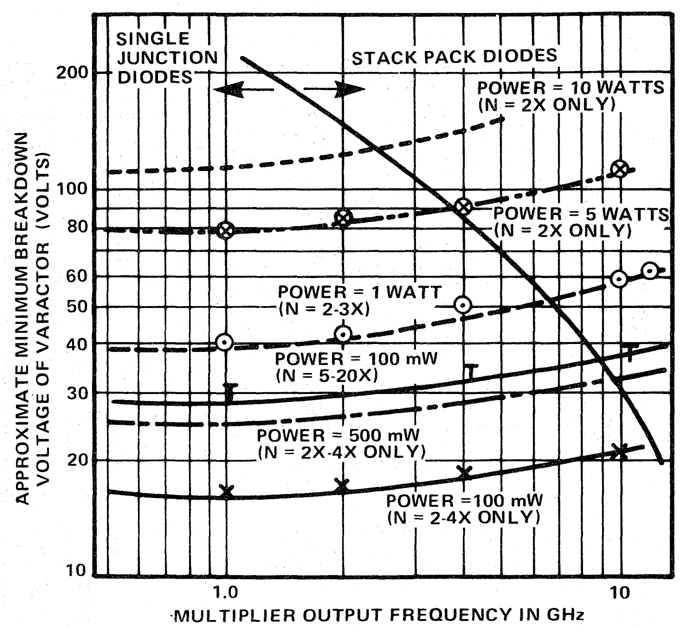


FIGURE 2. Approximate Minimum Breakdown Voltage Required for SRD and Dualmode™ Varactors at Various Output Power vs. Output Frequency

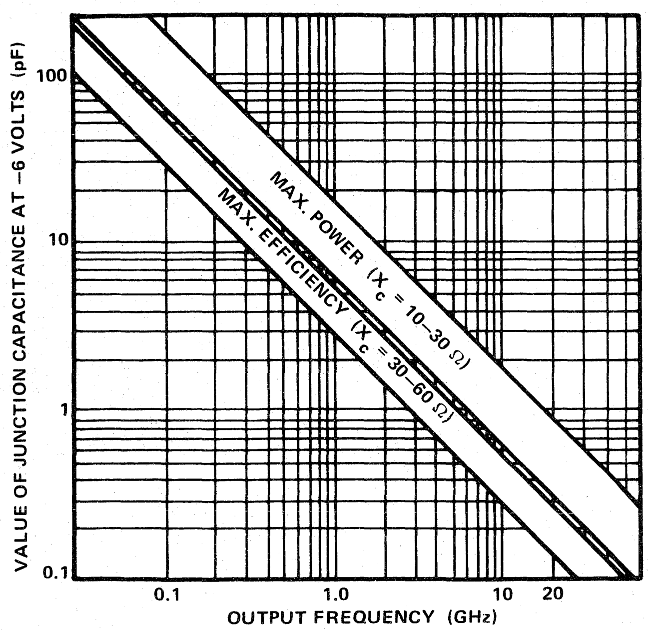


FIGURE 3. Suggested Junction Capacitance for SRD and Dualmode™ Varactors vs. Multiplier Output Frequency in GHz

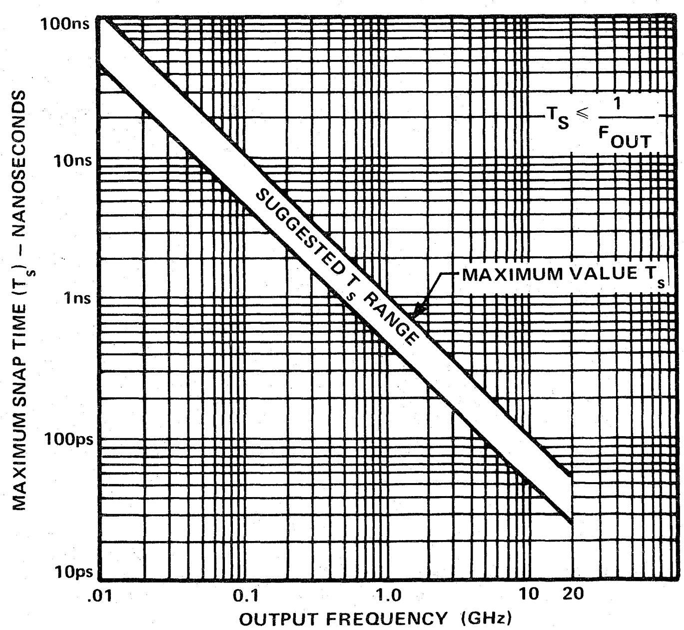


FIGURE 4. Maximum and Suggested Values of Snaptime (T_S) for SRD and Dualmode™ Varactors vs. Multiplier Output Frequency in GHz

Typical Performance Curves (Cont'd)

The following curves give a theoretical efficiency of silicon multipliers in simple doubles and triplers and include input and output circuit losses. These values are limit values.

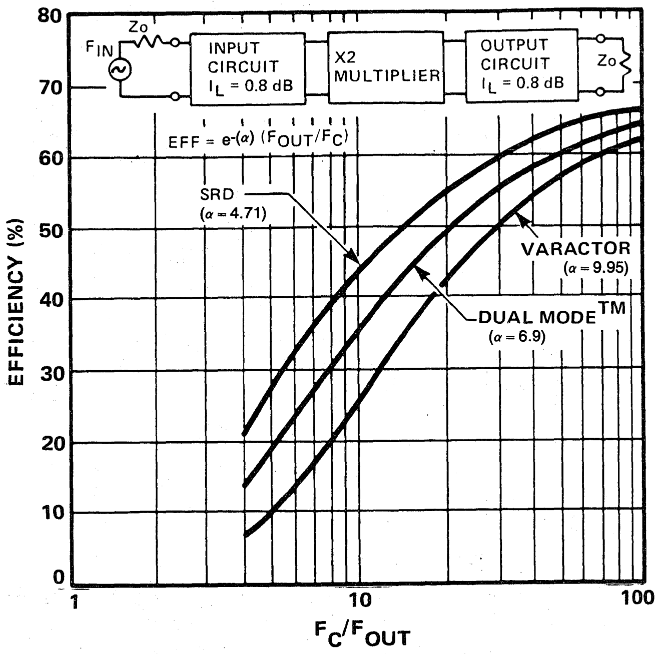


FIGURE 5. Theoretical Efficiency of X2 Silicon Diode Multipliers

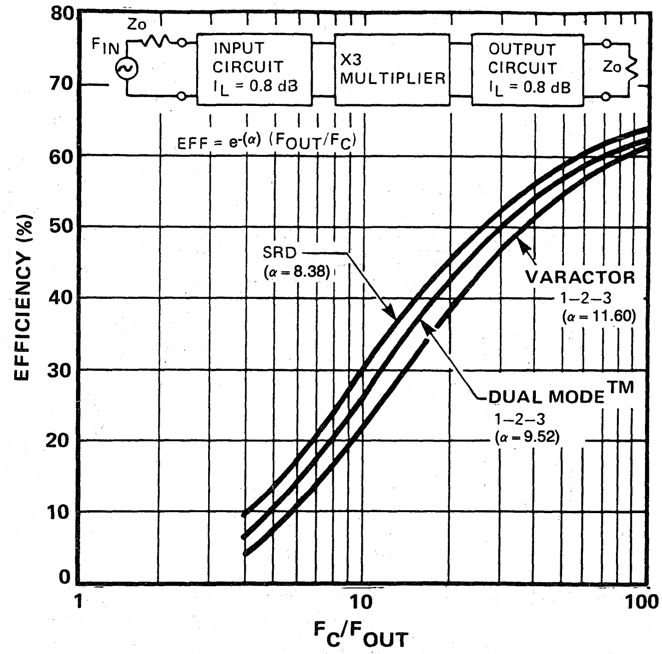
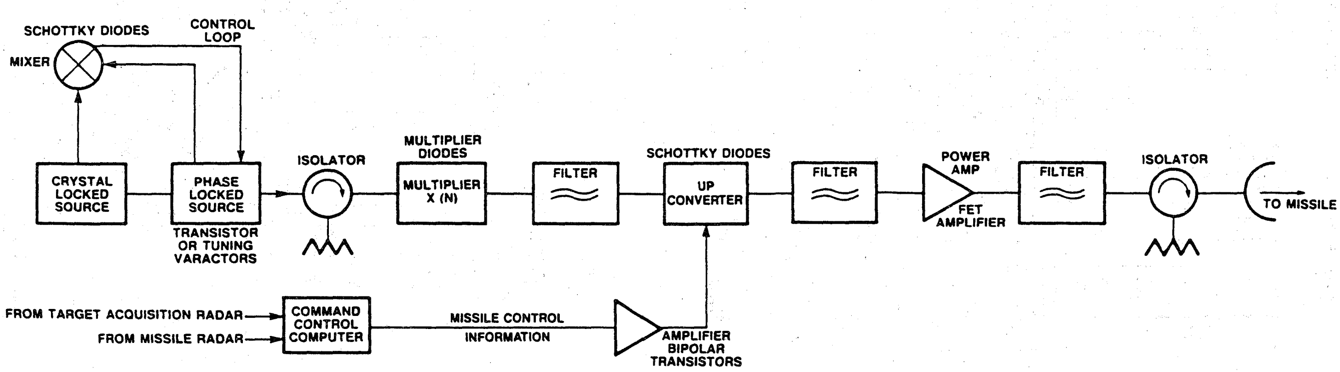


FIGURE 6. Theoretical Efficiency of Higher Order Diode Multipliers

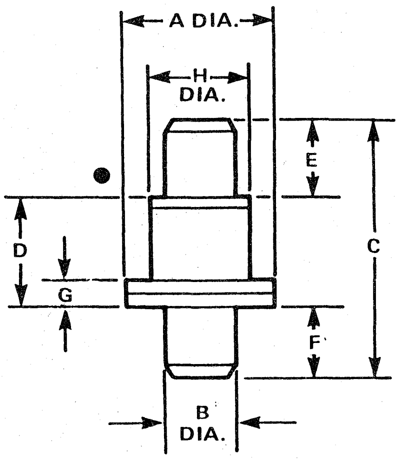
Typical Terminally Guided Missile Telemetry Link — Example of Dualmode™ Application



Case Styles

● DENOTES CATHODE NOT TO SCALE

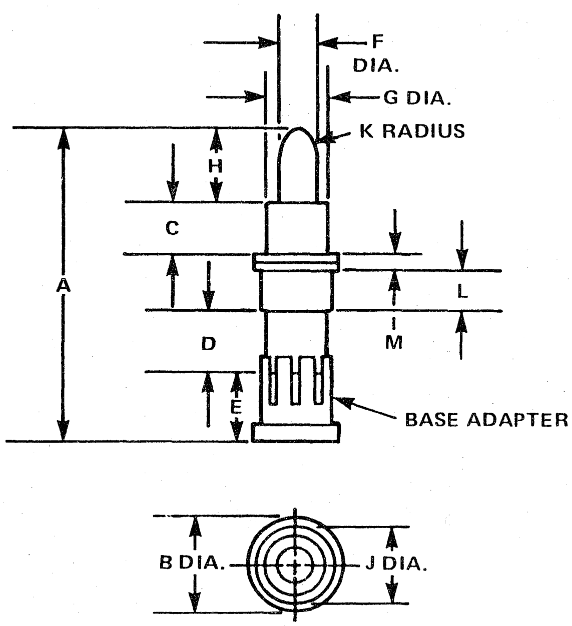
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

56



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.766	0.792	19,46	20,12
B	— —	0.240	— —	6,10
C	0.130 REF.		3,30 REF.	
D	0.145	0.155	3,68	3,94
E	0.180	0.190	4,57	4,83
F	0.092	0.094	2,34	2,39
G	0.155	0.165	3,94	4,19
H	0.180	0.190	4,57	4,83
J	0.185	0.195	4,70	4,95
K	0.030	0.046	0,76	1,17
L	0.095	0.105	2,41	2,67
M	— —	0.030	— —	0,76

Base adaptor optional.
C_P = 0.35 pF Typical
L_S = 3.0 nH Typical

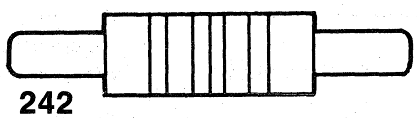
Ordering Information

Orders for products from M/A-COM Semiconductor Products, Inc. should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

M/A-COM

MA44700A Series

Stackpack™ & Super Stackpack™ Multiplier Diodes



Features

- HIGH REVERSE VOLTAGE
- LOW TRANSITION TIME
- LOW CAPACITANCE
- LOW THERMAL RESISTANCE

Description

M/A-COM Semiconductor Products' Stackpack™ and Super Stackpack™ Multiplier Diodes are a family of Step Recovery diodes with several junctions in series in the same package. These diodes have substantially higher reverse voltage than single junction diodes with the same transition time.

The Stackpack™ and Super Stackpack™ multiplier diodes are intended for use in high power, low multiplication ratio multipliers with output frequencies from L through X band.

The higher breakdown voltage allows for larger input power. This results in output power as large as 60 watts in L band and 5-7 watts in X band.

Each device in this family of diodes contains individually packaged Step Recovery diodes in a beryllia package. The individual diodes are soldered in series and encased in low loss packages. This assembly allows for closer matching of the individual chips. Each chip is then thermally heat sunk in parallel, resulting in a high voltage, low thermal resistance diode.

The Stackpack™ family of diodes has two junction chips in series per diode. The Super Stackpack family of diodes has three junction chips in series per diode.

Specifications $T_A = 25°C$

STACKPACK™ (2 CHIP DIODES)

Model Number[1]	Case Style	Minimum[2] Breakdown Voltage V_b (Volts)	Junction[3] Capacitance Min./Max. C_j (pF)	Minimum[4] Cutoff Frequency (GHz)	Maximum Transition Time Ts, −10V 10mA, (ps)	Maximum[7] Thermal Resistance (C/W)
MA44710A-2	242	280	18.0-26.0	*	6000	3
MA44711A-2	242	160	8.0-10.0	50	2000	7
MA44712A-2	242	160	4.0-4.5	70	2000	11
MA44713A-2	242	120	2.5-3.5	120	600	13
MA44714A-2	242	120	1.5-2.5	120	500	15
MA44715A-2	250	120	1.0-1.5	140	600	18
MA44716A-2	250	90	0.8-1.3	150	300	22
MA44724A-2	250	90	1.0-1.5	145	200	20
MA44725A-2	250	80	1.0-1.5	145	180	25
MA44705A-2	250	80	0.5-0.7	160	120	40
MA44706A-2	250	60	0.3-0.5	180	100	50

* Fc is not specified. Rs is measured at −12 volts and 1 GHz and is equal to .40 ohms maximum.

NOMINAL CHARACTERISTICS

Model Number[1]	Minor Carrier Lifetime T_L 10 mA/6 mA (ns)	Available[6] Output Power Range (Watts)	X3 Efficiency[6] (%)	Suggested Output[5] Frequency Range (GHz)
MA44710A-2	450	60	60	0.5-1.0
MA44711A-2	160	35	65	1.0-2.5
MA44712A-2	130	20	55	2.0-4.0
MA44713A-2	60	10	50	3.0-5.0
MA44714A-2	60	7	50	5.0-8.0
MA44715A-2	50	6	50	5.5-9.0
MA44716A-2	30	5	45	7.0-9.0
MA44724A-2	30	5	45	7.0-10.0
MA44725A-2	20	4	45	7.0-10.0
MA44705A-2	18	2	40	8.0-12.0
MA44706A-2	10	2[8]	50[8]	9.0-13.0

NOTES:
1. Standard case styles are listed for each model number. Other case styles can be furnished upon request. Consult the factory for additional information.
2. Breakdown voltage is specified at a reverse current of 10 microamperes.
3. Junction capacitance is specified at −12 volts bias and measured at a frequency of 1 MHz. Capacitance tolerance is nominally ±10%. Tolerances of ±5% are available on request at a nominal charge.
4. R_S is measured at 1 GHz. Cutoff frequency is calculated from R_S measurements at 1 GHz and capacitance measurements at −12 volts at a frequency of 1 MHz.
5. This is operable output frequency range and does not imply instantaneous bandwidth.
6. These are typical values at the midpoint of the specified frequency range. Stackpack diodes and Super Stackpack diodes can be operated at full efficiency over a broad range of drive power.
7. Thermal resistance is specified with an infinite heat sink on the cathode end only.
8. Typical power output and efficiency for the MA44706-A2 are specified in X2 multiplier.

Specifications $T_A = 25°C$

STACKPACK™ (3 CHIP DIODES)

Model Number[1]	Case Style	Minimum[2] Breakdown Voltage V_b (Volts)	Junction[3] Capacitance Min./Max. C_j (pF)	Minimum[4] Cutoff Frequency (GHz)	Maximum Transition Time Ts, −10V 10mA, (ps)	Maximum[7] Thermal Resistance (C/W)
MA44711A-3	243	240	8.0-10.0	50	2000	6
MA44712A-3	243	240	4.0-5.0	70	2000	10
MA44713A-3	243	180	1.5-2.5	120	700	11
MA44714A-3	243	180	1.5-2.5	120	500	13
MA44715A-3	247	180	1.0-1.5	140	400	16
MA44716A-3	247	135	0.8-1.3	150	300	19

NOMINAL CHARACTERISTICS

Model Number[1]	Minor Carrier Lifetime T_L 10 mA/6 mA (ns)	Available[6] Output Power Range (Watts)	X3 Efficiency[6] (%)	Suggested Output[5] Frequency Range (GHz)
MA44711A-3	160	50	65	1.0-2.5
MA44712A-3	130	30	55	2.0-4.0
MA44713A-3	60	15	50	3.0-5.0
MA44714A-3	60	10	50	5.0-8.0
MA44715A-3	50	8	50	5.5-9.0
MA44716A-3	30	7	45	7.0-9.0

NOTES:
1. Standard case styles are listed for each model number. Other case styles are available upon request. Consult the factory for additional information.
2. Breakdown voltage is specified at a reverse current of 10 microamperes.
3. Junction capacitance is specified at −18 volts bias and measured at a frequency of 1 MHz. Capacitance tolerance is nominally ± 10%. Tolerances of ± 5% are available upon request at a nominal charge.
4. Rs is measured at 1 GHz. Cutoff frequency is calculated from Rs measurements at 1 GHz and capacitance measurements at −18 volts at a frequency of 1 MHz.
5. This is an operable output frequency range and does not imply instantaneous bandwidth.
6. These are typical values at the midpoint of the specified frequency range. Stackpack diodes and Super Stackpack diodes can be operated at full efficiency over a broad range of drive power.
7. Thermal resistance is specified with an infinite heat sink on the cathode end only.

MAXIMUM RATINGS

Reverse Voltage Same as Breakdown Voltage

Operating Temperature −65°C to +150°C

Storage Temperature −65°C to +150°C

Temperature Coefficient of Capacitance 300 ppm/°C

HIGH RELIABILITY

All diodes in the MA44700 series may be screened to TX, TXV specifications. For further high reliability information, contact the factory.

ENVIRONMENTAL PERFORMANCE

All multiplier varactors in the MA44700 series are capable of meeting the performance tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

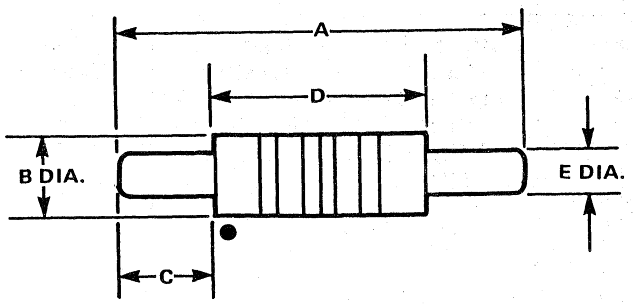
Ordering Information

Orders for products from M/A-COM Semiconductor Products, Inc. should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM .

Case Styles

● DENOTES CATHODE NOT TO SCALE

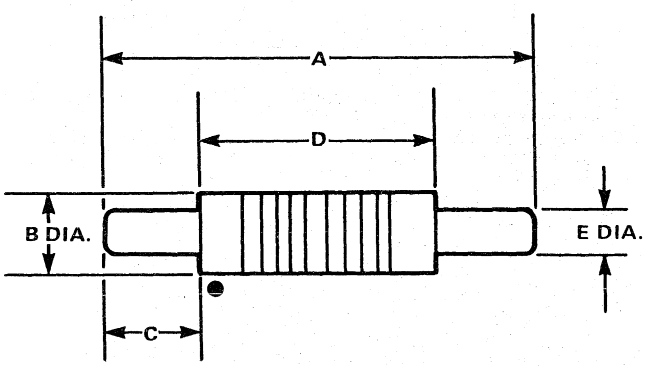
242



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.760	0.800	19,31	20,31
B	0.155	0.165	3,93	4,19
C	0.180	0.190	4,57	4,83
D	0.390	0.430	9,91	10,91
E	0.091	0.095	2,31	2,41

C_P = .18 pF Typical
L_S = .5 nH Typical

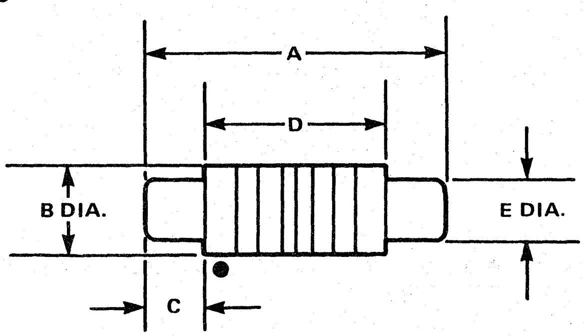
243



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.755	0.805	19,18	20,45
B	0.155	0.165	3,93	4,19
C	0.180	0.190	4,57	4,83
D	0.405	0.415	10,29	10,53
E	0.091	0.095	2,31	2,41

C_P = .18 pF Typical
L_S = .5 nH Typical

250



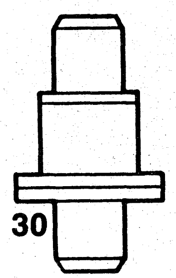
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.290	0.330	7,37	8,38
B	0.085	0.095	2,16	2,42
C	0.060	0.064	1,53	1,63
D	0.180	0.190	4,58	4,82
E	0.060	0.064	1,53	1,63

C_P = 0.21 pF Typical
L_S = 0.60 nH Typical

All specifications are subject to change without notice.

1N4386-88 and 1N5150-5157 Series

High Power Multiplier Varactors



Features

- HIGH POWER
- HERMETIC SEALS
- LOW THERMAL RESISTANCE
- HIGH EFFICIENCY

Description

These series of high power silicon multiplier diodes are designed for efficient frequency conversion at output frequencies 150 MHz to 10 GHz. These diodes are intended for use in either doublers or triplers.

Applications

These series of varactor diodes are intended for use in multipliers specifically designed as transmitters for communication and telemetry applications.

Specifications @ $T_A = 25°C$

Electrical Specifications									
Model[1] Number	Case Style	Input Frequency (MHz)	Output Frequency (MHz)	Maximum Input Power (Watts)	Minimum[2] Breakdown Voltage (Volts)	Series[3] Resistance R_S (Ohms)	Min./Max.[4] Junction Capacitance C_j (pF)	Maximum Thermal Resistance	Minimum Output Power (Watts)
1N4386	24	50	150	50.0	250	1.50	—/50.00	6	25.0
1N4387	24	150	450	30.0	150	0.70	—/35.00	5	15.0
1N4388	24	500	1000	20.0	100	0.25	—/20.00	9	11.0
1N5149	56	500	1000	20.0	80	0.25	5.00/20.00	9	11.0
1N5150	56	500	1000	35.0	80	0.25	5.00/20.00	9	24.0
1N5150A	56	500	1000	35.0	80	0.25	10.80/13.20	6	25.0
1N5151	32	1000	2000	12.0	75	0.50	5.00/7.50	23	6.0
1N5152	30	1000	2000	12.0	75	0.50	5.00/7.50	23	6.0
1N5153	56	1000	2000	12.0	75	0.50	5.00/7.50	23	6.0
1N5152A	30	1000	2000	12.0	75	0.50	5.40/6.60	15	7.0
1N5153A	56	1000	2000	12.0	75	0.50	5.40/6.60	15	7.0
1N5154	32	2000	6000	5.0	35	0.90	1.00/3.00	35	2.0
1N5155	30	2000	6000	5.0	35	0.90	1.00/3.00	35	2.0
1N5155A	30	2000	6000	5.0	35	0.90	1.71/2.09	20	2.0
1N5156	32	5000	10000	2.5	20	0.50	0.50/1.00	38	1.0
1N5157	30	5000	10000	2.5	20	1.00	0.50/1.00	38	1.0

NOTES:
1. Standard case styles are listed for each model number.
2. Breakdown voltage (V_b) is measured at a reverse bias current of 10 microamperes.
3. Series resistance (R_S) is measured at −6 volts and 500 MHz.
4. Junction capacitance is measured at a 1 MHz and −6 volts.

MAXIMUM RATINGS

Temperature Range	
Operating Range	−65°C to +200°C
Storage Range	−65°C to +200°C
Maximum Voltage	See breakdown voltage

ENVIRONMENTAL PERFORMANCE

These series of high power multiplier varactor diodes are capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

ENVIRONMENTAL RATINGS (Per MIL-STD-750)

	Method	Level
Temperature:		
Storage	1031	−65°C to +200°C
Operating	——	−65°C to +200°C
Cycling	1051	5 cycles
Solderability	2026	230°C as applicable
Thermal Shock	1056	5 cycles, 0-100°C
Moisture Resistance	1021	10 days 90-98% Relative Humidity
Shock	2016	5 blows (X,Y,Z @ 1500 g's)
Vibration Fatigue	2046	32 hours (X,Y,Z @ 20 g's min.)
Vibration Variable Frequency	2056	4 four minute cycles (X,Y,A @ 20 min., 100-2000 Hz)
Constant Acceleration	2006	X,Y,Z, @ 20,000 g's
Terminal Strength	2036	Package dependent
Salt Atmosphere	1041	35°C for 24 hours

Case Styles

● DENOTES CATHODE NOT TO SCALE

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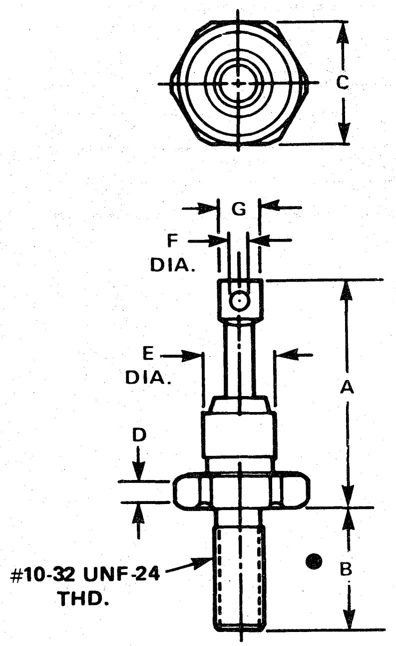
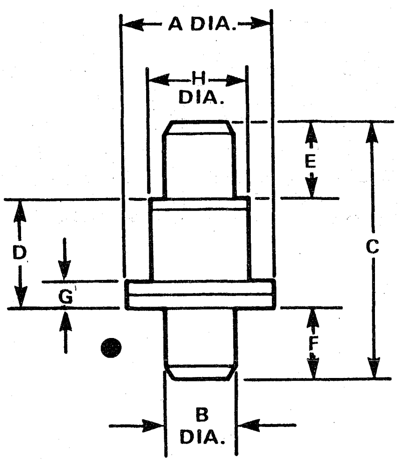


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	— —	0.800	— —	20,32
B	0.422	0.453	10,72	11,51
C	0.424	0.437	10,77	11,10
D	0.060	— —	1,52	— —
E	— —	0.290	— —	7,37
F	0.080	— —	2,03	— —
G	— —	0.160	— —	4,06

30

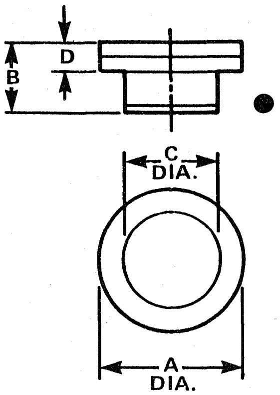


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

Case Styles (Cont'd)

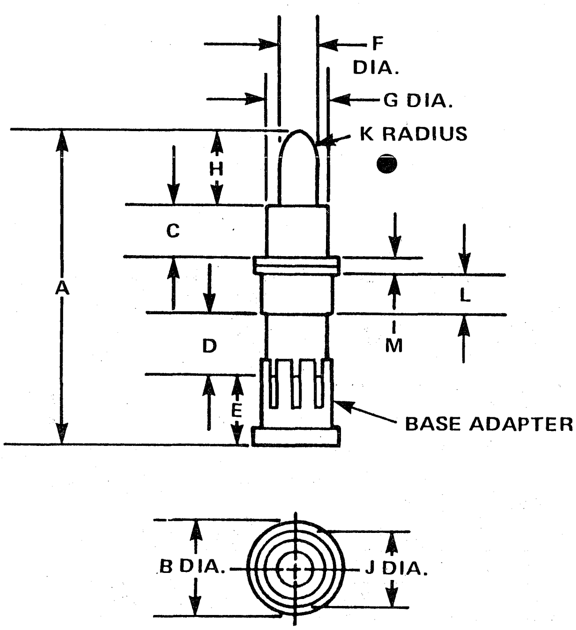
32



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3,02	3,18
B	0.055	0.065	1,40	1,65
C	0.077	0.083	1,96	2,11
D	— —	0.025	— —	0,64

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

56



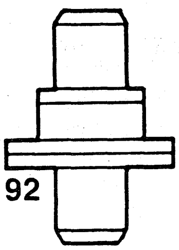
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.766	0.792	19,46	20,12
B	— —	0.240	— —	6,10
C	0.130 REF.		3,30 REF.	
D	0.145	0.155	3,68	3,94
E	0.180	0.190	4,57	4,83
F	0.092	0.094	2,34	2,39
G	0.155	0.165	3,94	4,19
H	0.180	0.190	4,57	4,83
J	0.185	0.195	4,70	4,95
K	0.030	0.046	0,76	1,17
L	0.095	0.105	2,41	2,67
M	— —	0.030	— —	0,76

Base adaptor optional.
C_P = 0.35 pF Typical
L_S = 3.0 nH Typical

M/A-COM

MA48700 Series

GaAs Multiplier Varactors



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Features

- HIGH CUTOFF FREQUENCY
- OPERATING TEMPERATURES FROM −65°C to +200°C
- GUARANTEED REPRODUCIBILITY

Description

The MA48700 series of Gallium Arsenide Abrupt Junction Multiplier Varactors is specifically designed to provide single state, high order multiplication at output frequencies extending to 100 GHz. All varactors in this series are available in either package or chip form. The cathode is the heat sink end of the package.

Applications

This series of Gallium Arsenide Multiplier Varactors is intended for medium power harmonic generation with high conversion efficiency. These diodes may be used to double or triple the frequency outputs of Gunn or IMPATT oscillators in millimeter wave radar and communications systems. They are also useful in local oscillators and in millimeter wave phase shifters, modulators and upconverters.

Specifications @ T_A = 25° C

ELECTRICAL CHARACTERISTICS

V_B = 15V (Min.)	C_{J0} Range[1] (pF)				
F_{C-6} (GHz)	.150 — .249	.250 — .349	.350 — .449	.450 — .549	.550 — .650
200				MA48704A	MA48705A
250			MA48703A	MA48704B	MA48705B
300		MA48702A	MA48703B	MA48704C	MA48705C
350	MA48701A	MA48702B	MA48703C	MA48704D	MA48705D
400	MA48701B	MA48702C	MA48703D	MA48704E	MA48705E
450	MA48701C	MA48702D	MA48703E		
500	MA48701D	MA48702E			
550	MA48701E				

V_B = 25V (Min.)	C_{J0} Range[1] (pF)				
F_{C-6} (GHz)	.150 — .249	.250 — .349	.350 — .449	.450 — .549	.550 — .650
200			MA48708A	MA48709A	MA48710A
250		MA48707A	MA48708B	MA48709B	MA48710B
300	MA48706A	MA48707B	MA48708C		
350	MA48706B	MA48707C			
400	MA48706C				

NOTES:

1. Junction capacitance (C_{j0}) is measured at 1 MHz and 0 volts on a bridge which has been balanced with a shielded test holder connnected in place, but open circuited.
2. Cutoff frequency measurements (F_{C0}) are made at 0 volts and then extropolated to −6 volts. See curve of Figure 1 showing typical F_{C-6} (cutoff at −6 volts) versus F_{C0} (cutoff at 0 volts) performance curve.
3. All GaAs multiplier diodes are available in any case style shown in this bulletin. When ordering, specify the desired case by adding the case designation as a suffix to the model number.
4. Nominal package parasitics (C_p and L_s) are given for each case style with the outline drawing. The C_p tolerances listed are typically ±0.02 pF.
5. The measured series resonant frequency of each varactor can be supplied with the diode or special order, at a nominal price.
6. $\Delta N_J = \frac{C_{J0} - C_{J6}}{C_{J0}} = 0.52$ typical $\quad \beta = \frac{C_J + 0.5}{C_J - 3} = 2.20$ typical
7. Breakdown voltage is measured at −10 μA. Other breakdown voltages are available on special request.

Typical Performance Curves

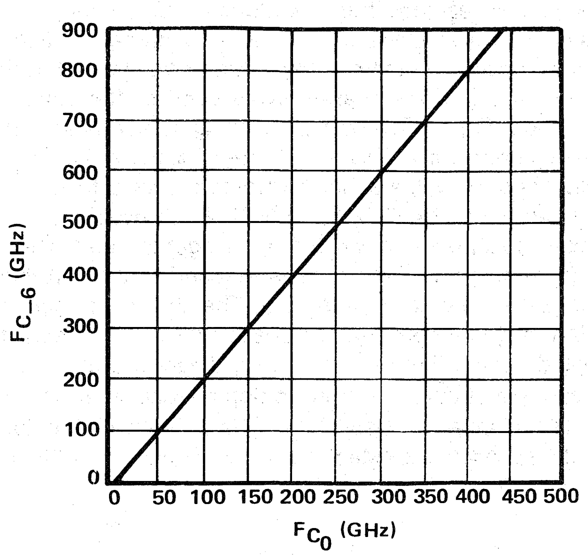


FIGURE 1. Relationship Between Cutoff Frequency at Zero and Six Volts in GaAs Varactor Diodes

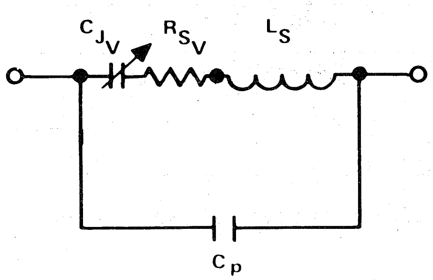


FIGURE 2. Varactor Diode Equivalent Circuit

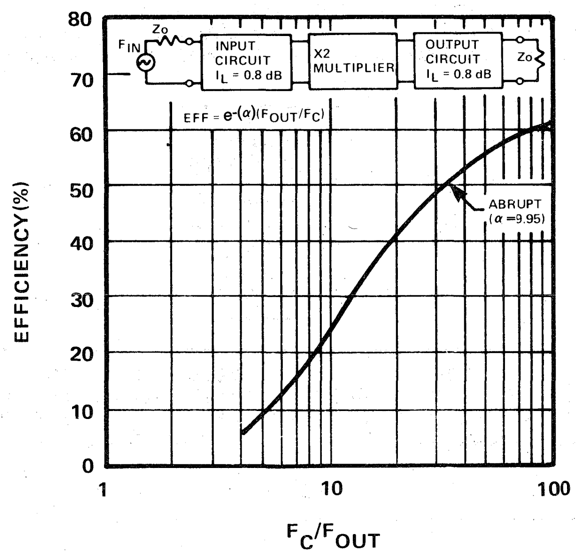


FIGURE 3. Theoretical Efficiency of x2 GaAs Varactor Multipliers

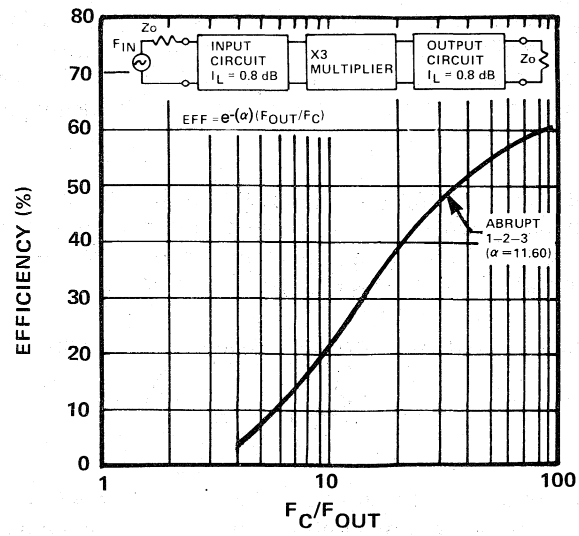


FIGURE 4. Theoretical Efficiency of x3 GaAs Varactor Multipliers

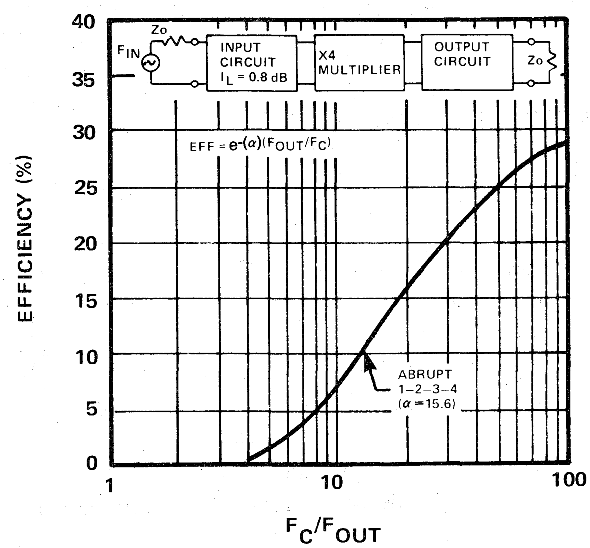


FIGURE 5. Theoretical Efficiency of x4 GaAs Varactor Multipliers

Application Notes

Many methods exist for measuring the quality factor or cutoff frequency (F_C) of varactor diodes. Among the most widely used methods are the reflection coefficient techniques of Houlding [1] and Harrison [2]. Unfortunately, at high microwave frequencies, varactor "parasitics" such as supporting structures, contacting straps, and case capacitance tend to make reflection test set calibrations difficult. Also, as varactor quality increases, the accuracy of these techniques decreases.

In 1964, DeLoach [3] devised a method for varactor characterization that avoided the above difficulties. This method involved the series resonance of a varactor diode and yielded not only series resistance but junction capacitance and parasitic inductance at any bias voltage. All of these parameters were determined at the self

Application Notes (Cont'd)

resonant frequency of the device and in a defined microwave environment. However, the case capacitance of DeLoach's packaged diodes was essentially non-existent thus simplifying certain mathematical solutions. Many widely used industrial varactor packages do have case capacitances that may in fact be larger than the device's junction capacitance.

A more recent analysis [4] has shown that the inclusion of case capacitance in the equivalent varactor circuit (shown in Figure 2) will modify the determination of cutoff frequency obtained by DeLoach's methods.

DeLoach's formula for diode resistance is as follows:

$$R_m = \left(\frac{Z_o}{2}\right)\left(\frac{1}{\sqrt{T_p} - 1}\right)$$

If we ignore the fringing capacitance (C_f), expansion of the expression for the real part of the total diode impedance, however, reveals that:

$$R_{SV} = \frac{(X_{CP})^2 - \sqrt{(X_{CP}{}^4 - (4)(R_m)^2 (X_{LS} + X_{CP} + X_{Cj})^2}}{2(R_m)}$$

It follows that: $F_{CV} = \dfrac{1}{2\pi R_{SV} C_{jV}}$

where:

T_p = power transmission loss ratio
Z_o = characteristic guide impedance at resonance
R_m = Re [Zv]
C_{jv} = junction capacitance at reverse bias voltage V
X_{Cj}, X_{Cp}, X_{Ls} = junction, package and inductive reactances respectively
R_{sv} = junction series resistance at voltage V
F_{cv} = varactor figure of merit or cutoff frequency at voltage V

DeLoach's method not only results in additional information for the circuit designer, but it produces a repeatable measurement that allows much greater accuracy in diode selection resulting in increased customer yields. DeLoach's measurements, however, are only as good as the diode holder used. Figure A shows a typical DeLoach holder in cross sectioned view. This is but one of several different holders used to evaluate GaAs varactors over a total frequency range of 4 GHz to 40 GHz. Each holder is computer designed to cover a full waveguide band. The waveguide height of each case is reduced to the ceramic height of the case style under test. The VSWR of each holder and choke combination is less than 1.1:1 across the waveguide band. Figure B is a block diagram of the DeLoach test circuit. For more in-depth discussion on varactor multipliers, consult M/A-COM's application note, AG312, "Application of Multipliers," C.M. Howell, 1986.

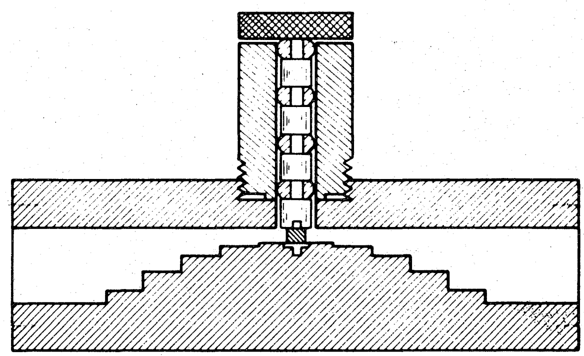


FIGURE A. Typical DeLoach Holder

[1] Houlding, N., "Measurement of Varactor Quality," Microwave Journal, Volume 3, No. 1, January 1960.
[2] Harrison, R., "Parametric Diode Q Measurements," Microwave Journal, Volume 3, No. 5, May 1960.
[3] DeLoach, B.C., "A New Microwave Measurement Technique to Characterize Diodes and an 800 Gc Cutoff Frequency Varactor at Zero Volts Bias," IEEE Transactions on MT&T, January 1964.
[4] Hapgood, D.W., "Determination of Varactor Parameters by a Modified DeLoach Method," Microwave Journal, Volume 24, No. 11, November 1981.

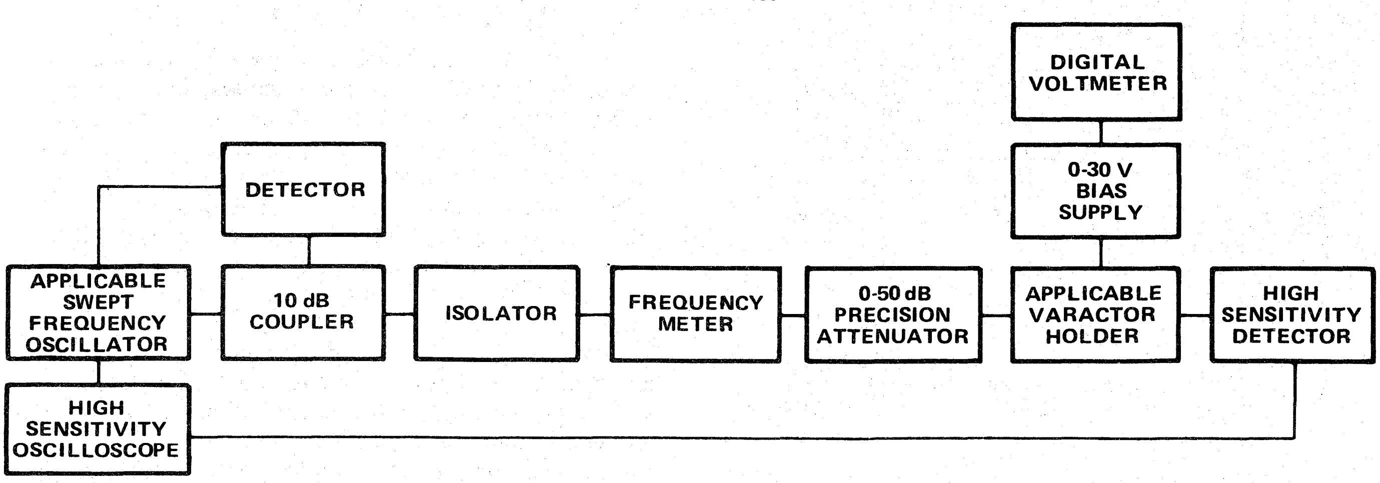
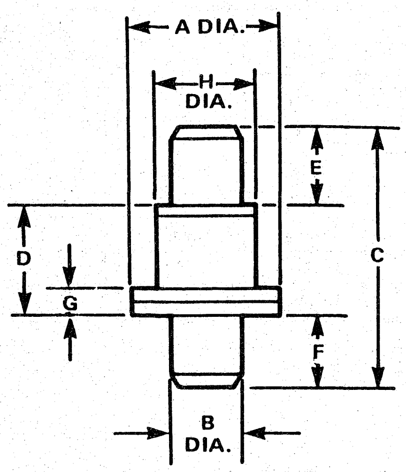


FIGURE B. Typical DeLoach Test Set

Case Styles

• DENOTES CATHODE NOT TO SCALE

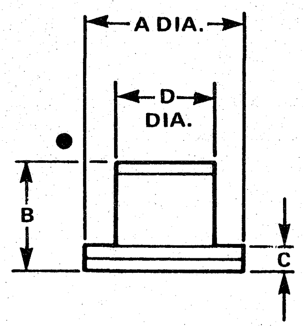
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

GaAs: C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

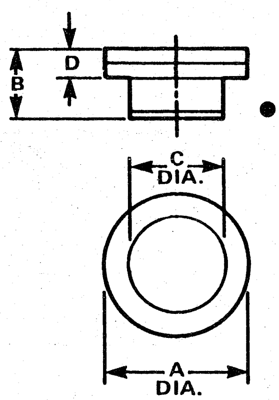
31



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

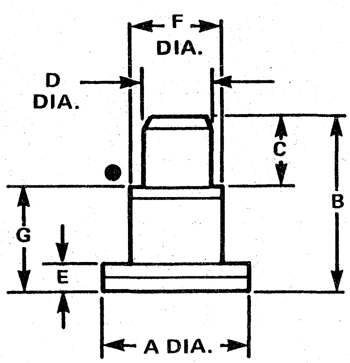
32



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3,02	3,18
B	0.055	0.065	1,40	1,65
C	0.077	0.083	1,96	2,11
D	— —	0.025	— —	0,64

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

36



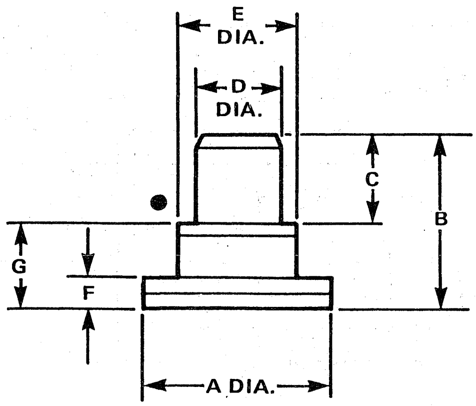
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3,02	3,18
B	0.143	0.163	3,63	4,14
C	0.060	0.064	1,52	1,63
D	0.060	0.064	1,52	1,63
E	— —	0.025	— —	0,64
F	0.077	0.083	1,96	2,11
G	0.086	0.096	2,18	2,44

GaAs: C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

Case Styles (Cont'd)

• DENOTES CATHODE NOT TO SCALE

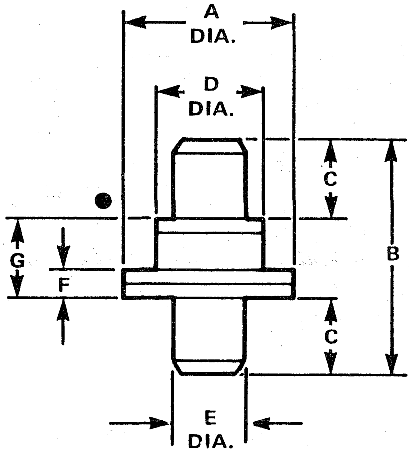
91



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.115	0.129	2,92	3,28
C	0.060	0.064	1,52	1,63
D	0.060	0.062	1,52	1,57
E	0.077	0.083	1,96	2,11
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

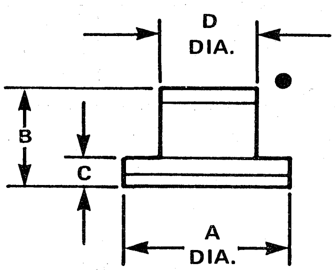
92



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.174	0.194	4,42	4,93
C	0.060	0.064	1,52	1,63
D	0.077	0.083	1,96	2,11
E	0.060	0.062	1,52	1,57
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

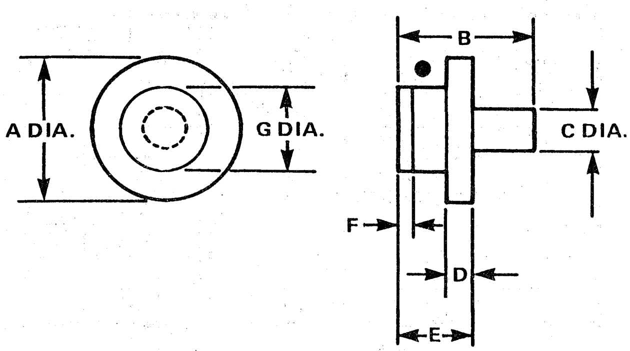
94



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

95



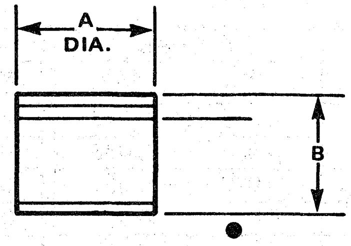
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.078	0.086	1,98	2,18
B	0.070	0.080	1,78	2,03
C	0.024	0.026	0,61	0,66
D	— —	0.015	— —	0,38
E	0.040	0.050	1,02	1,27
F	0.004	0.010	0,10	0,25
G	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

Case Styles (Cont'd)

• DENOTES CATHODE NOT TO SCALE

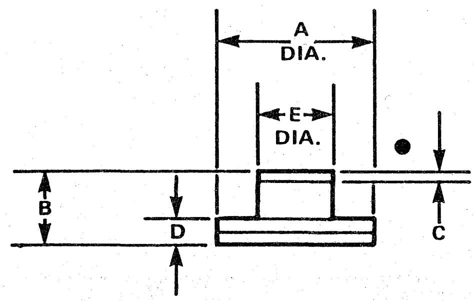
120



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

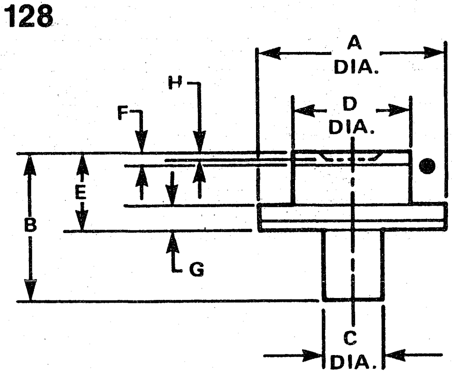
126



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.079	0.087	2,01	2,21
B	0.030	0.038	0,76	0,97
C	0.002	0.006	0,05	0,15
D	0.009	0.015	0,23	0,38
E	0.047	0.053	1,19	1,35

C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

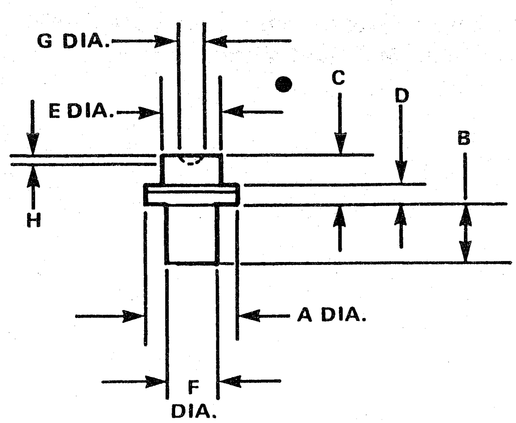
128



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.077	0.083	1,96	2,11
B	0.0545	0.0675	1,384	1,715
C	0.022	0.028	0,56	0,71
D	0.047	0.053	1,19	1,35
E	0.0295	0.0325	0,749	0,826
F	0.002	0.007	0,05	0,18
G	0.010	0.015	0,25	0,38
H	0.0015	0.0030	0,038	0,076

C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

155



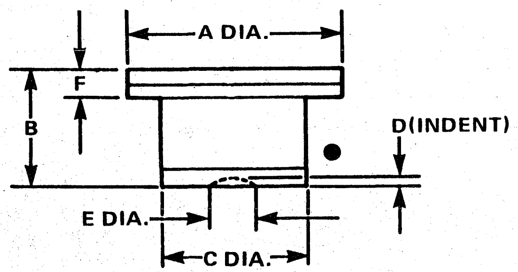
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.043	0.047	1,09	1,19
B	0.026	0.034	0,66	0,86
C	0.022	0.028	0,56	0,71
D	0.007	0.010	0,18	0,25
E	0.029	0.031	0,74	0,79
F	0.024	0.026	0,61	0,66
G	0.010	0.016	0,25	0,41
H	0.001	0.002	0,03	0,05

C_P = 0.13 pF Typical
L_S = 0.17 nH Typical

Case Styles (Cont'd)

• DENOTES CATHODE   NOT TO SCALE

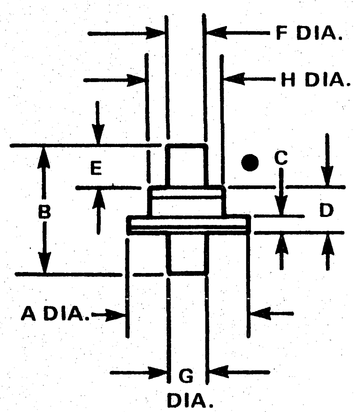
166



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.043	0.047	1,09	1,19
B	0.026	0.033	0,66	0,84
C	0.029	0.031	0,74	0,79
D	0.001	0.002	0,03	0,05
E	0.010	0.016	0,25	0,41
F	0.006	0.008	0,15	0,20

C_P = 0.13 pF Typical
L_S = 0.16 nH Typical

168



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.079	0.081	2,01	2,06
B	0.084	0.096	2,13	2,49
C	0.008	0.010	0,20	0,25
D	0.028	0.032	0,71	0,81
E	0.028	0.032	0,71	0,81
F	0.024	0.026	0,61	0,66
G	0.024	0.026	0,61	0,66
H	0.049	0.051	1,24	1,30

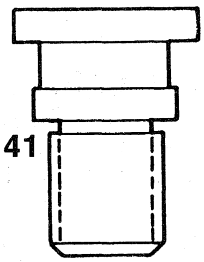
C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

MA44950 Series

Silicon Multichip Pulsed Multiplier Varactors



141

Features

- PEAK OUTPUT POWER TO 150 WATTS
- SIMPLE CIRCUITS
- PARTS CAN BE SCREENED TO MILITARY SPECIFICATIONS OR JANTX, TXV EQUIVALENT
- MULTIPLIER EFFICIENCY 30-50% IN DOUBLERS

Description

The MA44950 series of pulsed multiplier diodes is useful for higher peak power, low order multipliers used in solid state transmitters of marine, weather or aircraft radars. These devices will provide 50-150 watts output with a pulse length of 10 to 40 microseconds and a PPF of .001.

The MA44950 series consists of multiple snap junctions mounted in case style 141, a ceramic package. Diodes with breakdown voltages up to 400 volts are available.

Applications

The MA44950 series of multiple varactors is an excellent pulsed source for radar transponders, low power airborne weather radar and beacons requiring a high reliability pulsed transmitter with 50-150 watts peak power.

Specifications $T_A = 25°C$

Model[1] Number	Minimum[2] Breakdown Voltage (Vb) (Volts)	Total[3] Capacitance Ct_2 Range (pF)	Maximum[4] Leakage Current (na)	Nominal Characteristics: Output Frequency Range (GHz)	X2 Efficiency (%)	Peak[5] Power Output (Watts)
MA44951	400	6.0-7.0	20	1-2	50	175
MA44952	400	5.0-6.0	20	2-3	50	150
MA44953	400	4.0-5.0	20	3-4	48	125
MA44954	400	3.0-4.0	20	4-5	44	100
MA44955	300	2.5-3.0	20	5-6	40	80
MA44956	300	2.2-2.8	20	6-7	39	60
MA44957	300	2.0-2.5	20	7-8	38	50
MA44958	300	1.5-2.0	20	8-9	35	45
MA44959	300	1.0-1.5	20	9-10	30	40

NOTES:
1. The standard case style is 141, a metal ceramic package with a threaded stud.
2. Reverse current is 10 microamperes maximum at the rated voltage.
3. Capacitance is measured at a reverse bias voltage of 200 volts and at a frequency of 1 MHz.
4. Leakage current is measured at a reverse bias voltage of 200 volts.
5. Pulse length is between 10 and 40 microseconds with a duty cycle of .2%.

MAXIMUM RATINGS

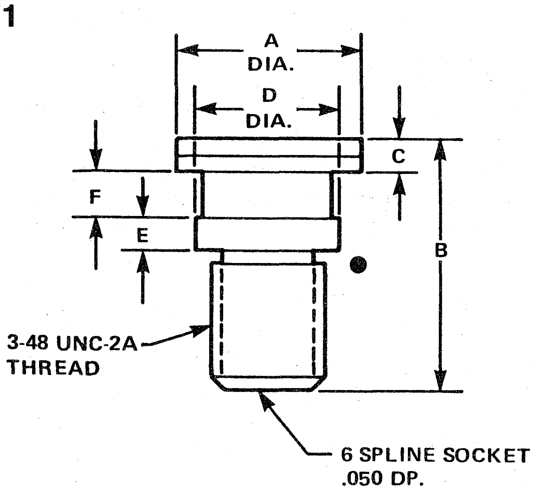
Reverse Voltage Same as rated breakdown (Vb)
Operating Temperature −65°C to +150°C
Storage Temperature −65°C to +150°C

ENVIRONMENTAL PERFORMANCE

All varactors in the the MA44950 series are capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductor products.

Case Style

141



● DENOTES CATHODE NOT TO SCALE

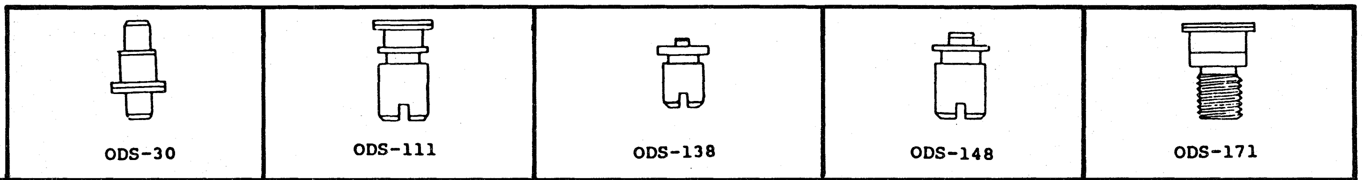
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.155	0.165	3,94	4,19
B	0.205	0.225	5,21	5,72
C	— —	0.030	— —	0,76
D	0.120	0.130	3,05	3,30
E	— —	0.030	— —	0,76
F	0.045 REF.		1,15 REF.	

Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

Gunn Diodes

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION
GUNN DIODE SELECTION GUIDE

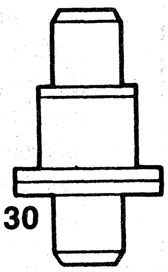


Frequency Range GHz	Case Style ODS #	FIXED FREQUENCY CW DIODES: Anode Heat Sink Diodes		Cathode Heat Sink Diodes						Broad Band Diodes	Pulse Gunn Diodes (Peak Power) 1% Duty Nominal			
		5 mW	10 mW	25 mW	50 mW	100 mW	250 mW	500 mW	1 W	100 mW	10 mW	5 W	10 W	20 W
5.0 - 8.0	30			49151	49152	49153	49154							
	111			49135	49136	49137	49138	49139				49260	49978[1]	49984[1]
	171								49145[1]	49140				
	148								49147[2]					
8.0 - 12.0	30	49618	49508	49156	49157	49158	49159				49870			
	111			49104	49106	49107	49109	49110				49265		
	148									49117				
12.0 - 18.0	30			49161	49162	49163	49164							
	111			49121	49122	49123	49124							
	138									49126				
	148									49126				
18.0 - 26.0	30		49628											
	138				49179	49180				49128				
	148		49190		49179	49180	49178							
26.0 - 40.0	138		49191		49172	49173 49177[4]	49837[8]							
40.0 - 60.0	138		49192		49181[5] 49182[6]	49838[5] 49839[6] 49193[7]								
94.0	138		49840[3]	49149[9]										

NOTES: 1. F = 5 - 6 GHz
2. F = 6.5 - 7.2 GHz
3. Cathode Heat Sink
4. Power = 150 mW
5. F = 40 - 50 GHz
6. F = 50 - 60 GHz
7. F = 40 - 50 GHz: Power = 75 mW
8. F = 26 - 35 GHz
9. Power = 30 mW at 94 GHz

MA49000 Series

Gallium Arsenide Gunn Diodes



30

Features

- HIGH RELIABILITY AND PERFORMANCE (SUITABLE FOR MILITARY APPLICATIONS)
- BROADBAND
- LOW NOISE CHARACTERISTICS FROM 5 TO 100 GHz
- EASILY INCORPORATED INTO WAVEGUIDE, COAXIAL, MICROSTRIP OR STRIPLINE TRANSMISSION ENVIRONMENTS
- AVAILABILITY/SUPPLY GUARANTEED
- CATALOG OR CUSTOM TAILORED DEVICES
- PULSE OR CW OPERATION

Description

The MA49000 series of Gallium Arsenide Gunn diodes is designed to operate at a fixed frequency under pulsed or CW conditions within a specified band. These devices feature low FM and AM noise characteristics while accomplishing a one step conversion from dc to microwave energy using a low voltage power supply, thereby eliminating complex circuitry. The polarity is cathode heat sink unless otherwise specified.

Applications

The devices are ideally suited for use in low noise sources such as local oscillators, locking oscillators, low and medium power transmitter applications and motion detection applications. The high power Gunn diodes in this series can be used in phase-locked oscillators or as reflection amplifiers in point-to-point communications links and telemetry systems.

These devices can be incorporated into microwave links, marine and weather radars, industrial measuring equipment, motion detectors, controls and instruments, as well as ground speed sensors, missiles, military and civilian radars and electronic warfare equipment.

Fixed Frequency CW Gunn Diodes (5-18 GHz)

This series of moderate frequency Gunn diodes features low noise (both AM and FM noise) good efficiency and one step conversion from dc to microwave energy using a simple dc power supply.

These devices are ideally suited for use in low noise oscillators such as telecommunication and radar local oscillators, exciters for radio links, radar, telecommunication transmitters and injection locked amplifiers.

The noise performance of these diodes is better than that of comparable reflex klystrons, thus making them attractive for use as local oscillators for noise measurements of mixer diodes.

Specifications @ $T_A = 25°C$

Model Number	Case[8] Style	Operating Frequency[3] Min./Max. (GHz)	Min. CW[1,4,5] Output Power (mW)	Operating Voltage Min./Max. (Volts)	Operating[6] Current Min./Max. (mA)	Maximum Thermal Resistance (°C/W)
MA49139	111	5.0/6.0	500	14.0		11
MA49145	171	5.0/6.0	1000	14.0		8
MA49135	111	5.0/8.0	25	10.0/14.0	150/250	45
MA49151	30	5.0/8.0	25	10.0/14.0	150/250	45
MA49136	111	5.0/8.0	50	10.0/14.0	250/350	35
MA49152	30	5.0/8.0	50	10.0/14.0	250/350	35
MA49153	30	5.0/8.0	100	10.0/14.0	350/500	17
MA49137	111	5.0/8.0	100	10.0/14.0	350/500	25
MA49138	111	5.0/8.0	250	10.0/14.0	500/700	24
MA49154	30	5.0/8.0	250	10.0/14.0	500/700	17
MA49147	171	6.5/7.2	1000	14.0		8
MA49104	111	8.0/12.4	25	8.0/12.0	200/300	45
MA49156	30	8.0/12.4	25	8.0/12.0	200/300	45
MA49157	30	8.0/12.4	50	8.0/12.0	300/450	35
MA49106	111	8.0/12.4	50	8.0/12.0	300/450	35
MA49107	111	8.0/12.4	100	8.0/12.0	450/650	24
MA49158	30	8.0/12.4	100	8.0/12.0	450/650	24
MA49159	30	8.0/12.4	250	8.0/12.0	750/1050	15
MA49109	111	8.0/12.4	250	8.0/12.0	750/1050	15
MA49110	111	8.0/12.4	500	12.0	850/1450	15
MA49161	30	12.4/18.0	25	6.0/10.0	200/300	45
MA49121	111	12.4/18.0	25	6.0/10.0	200/300	45
MA49162	30	12.4/18.0	50	6.0/10.0	300/500	35
MA49122	111	12.4/18.0	50	6.0/10.0	300/500	35
MA49123	111	12.4/18.0	100	6.0/10.0	500/750	24
MA49163	30	12.4/18.0	100	6.0/10.0	500/750	24
MA49124	111	12.4/18.0	250	6.0/10.0	850/1150	15
MA49164	30	12.4/18.0	250	6.0/10.0	850/1150	15

Fixed Frequency CW Gunn Diodes (18-94 GHz)

This series of high frequency Gunn diodes features low noise (both AM and FM) good efficiency and one step conversion from dc to microwave energy using a single, low voltage power supply.

These devices are ideally suited for use as paramp pump sources and as transmitters in point-to-point telecommunication links. The noise performance of these diodes makes them attractive for use as local oscillators for noise measurements of mixer diodes.

Specifications @ T_A = 25°C

Model Number	Case[8] Style	Operating Frequency[3] Min./Max. (GHz)	Min. CW[1,4,5] Output Power (mW)	Operating Voltage Min./Max. (Volts)	Maximum[6] Operating Current (mA)
MA49190*	148	18.0/26.5	10	4.0/7.0	250
MA49179	138	18.0/26.0	50	5.0/8.0	600
MA49179	148	18.0/26.5	50	5.0/8.0	600
MA49180	138	18.0/26.5	100	5.0/8.0	1000
MA49180	148	18.0/26.5	100	5.0/8.0	1000
MA49178	148	18.0/26.5	250	5.0/8.0	1600
MA49191*	138	26.5/40.0	10	3.0/6.0	250
MA49172	138	26.5/40.0	50	3.5/6.0	800
MA49173	138	26.5/40.0	100	3.5/6.0	1200
MA49177	138	26.5/35.0	150	4.0/8.0	1400
MA49837	138	26.5/35.0	250	4.0/8.0	1600
MA49838	138	40.0/50.0	100	2.5/4.5	1600
MA49192*	138	40.0/60.0	10	2.0/4.5	300
MA49181	138	40.0/50.0	50	2.5/4.5	1200
MA49193	138	40.0/50.0	75	2.5/4.5	1400
MA49182	138	50.0/60.0	50	2.5/4.5	1200
MA49839	138	50.0/60.0	100	2.5/4.5	1600
MA49840	138	94.0	10	2.5/4.5	1400
MA49149	138	94.0	30	2.5/4.5	1400

* These diodes are flip chip devices. The heat sink (threaded end) is the anode.

CW Broadband Gunn Diodes

These Gunn diodes are ideal for use in low power, fast tunable oscillators such as an ECM local oscillator or a broadband tunable source for an instrument. These diodes will deliver full rated power over the specified bandwidth.

Specifications @ T_A = 25° C

Model Number	Case Style	Frequency[10] Min./Max. (GHz)	Min. CW[10] Output Power (mW)	Maximum Operating Voltage (Volts)	Operating[6] Current Min./Max. (mA)	Nominal Operating Voltage (Volts)
MA49140	148	5.0/8.0	100	14.0	350/550	10.0
MA49117	148	8.0/12.4	100	12.0	450/600	8.0
MA49126	148	12.4/18.0	100	10.0	500/750	6.0
MA49126	138	12.4/18.0	100	10.0	500/750	6.0
MA49128	138	18.0/26.5	100	8.0	500/900	4.0

Commercial Fixed Frequency CW Gunn Diodes

These Gunn diodes are ideally suited for low power transmitters and local oscillators used in the detection of moving targets in such applications as speed control radars, radar detectors, intrusion alarm systems and navigational radar on fog bound shore lines. These low power diodes can also be used in control applications such as railroad crossings, traffic control, anti-skid braking systems for vehicles, and door openers.

Specifications @ T_A = 25°C

Model Number	Case Style	Frequency[3,4] Min./Max. (GHz)	Min. CW[1,4] Output Power (mW)	Maximum[6] Operating Current (mA)	Nominal Operating Voltage (Votls)
MA49618*	30	9.0/12.0	5.0	80	8.0
MA49508*	30	9.0/12.0	10.0	160	8.0
MA49628*	30	18.0/26.0	10.0	200	5.0

* The heat sink is the anode.

NOTES

1. This power is delivered at a specified single frequency in the specified band.
2. A bellows or prong cap for case style 111 is available upon special request.
3. The customer MUST specify the desired operating frequency within the indicated range.
4. Power is measured into a critically coupled load at a customer specified single frequency in the indicated range. Typical bandwidth is ±5%. The minimum indicated output power is guaranteed into a critically coupled load over the indicated bandwidth centered around the frequency specified by the customer. Higher power diodes are available on special request.
5. These diodes are designed to operate within a heat sink temperature −30°C to +70°C. However, for higher operating temperatures, please contact the factory.
6. The maximum threshold current is approximately 1.3 times the maximum operating current.
7. All diodes are burned in for a minimum period of 8 hours at diode case temperature (T_C) of 70 ± 5°C and a dc bias voltage of (V_{op} + 1.0 volts). Upon request and for an additional charge, these diodes can be burned in for longer periods.
8. The polarity is cathode heat sink, unless otherwise specified.
9. M/A-COM SPO, will provide technical assistance in specification, interpretation and selection of Gunn diodes.
10. These diodes will deliver the specified output power over the full frequency range, i.e., the MA49140 will deliver 100 mW minimum at 25°C ambient from 5-8 GHz.

Screening of Gunn Diodes for High Reliability

M/A-COM Semiconductor Products, Inc.'s Gunn diodes have proven to have a high reliability when operated properly in oscillator systems at junction temperatures not exceeding 260°C. The following prescreening procedure is suggested as a means of further guaranteeing Gunn diode reliability over long periods of time.

Available Procedures for JANTX Equivalency

100% Screening	MIL-STD-750 Method	Conditions/Comments
High Temperature Storage	1032	200°C for 24 hours
Temperature Cycle	1051	−65°C to +200°C, 20 Cycles for 30 minutes
Acceleration	2006	20,000 g's
Fine Leak	1071	5 x 10^{-8} cm^3/sec
Gross Leak	1071	Fluorocarbon or penetrative dye
Burn-In	1038	70°C heat sink temp. and V_{op} + 1 volt (or 10%) for 96 hours

Environmental and Lot Sampling Tests

The M/A-COM SPO Environmental Laboratory has complete capability for all Group B and C test requirements including life test as required by MIL-STD-19500 and MIL-STD-750.

Pulsed Gunn Diodes

These Gunn devices are specifically designed for high power pulsed operation such as a pulse transmitter for a radar transponder or missile beacon.

Specifications @ T_A = 25°C

Model Number	Case[2,8] Style	Frequency[3,9] Min./Max. (GHz)	Minimum[1,4,9] Peak Output (Watts)	Maximum Operating Voltage (Volts)	Maximum[10] Pulse Length (μs)	Maximum % Duty Cycle	Nominal Peak Current (Amps)
MA49260	111	5.0/8.0	5.0	45	1.0	1.0	6-8
MA49978	111	5.0/6.0	10.0	70	0.5	0.5	12
MA49984	111	5.0/6.0	20.0	90	0.5	0.5	24
MA49265	111	8.0/12.4	5.0	35	1.0	1.0	6-8

Commercial Pulsed Gunn Diodes

This series of pulsed Gunn diodes have very low average current drain and are used in motion detection systems, burglar alarms and door openers.

Specifications @ T_A = 25°C

Model Number	Case Style	Frequency[3,4,9] Min./Max. (GHz)	Minimum[1,4] Peak Power (mW)	Maximum Operating Voltage (Volts)	Maximum[6] Operating Current (mA)
MA49870*	30	9.0/11.0	10.0	8.5	120

* Heat sink is anode.

NOTES:
1. This power is delivered at a specified single frequency in the specified band.
2. A bellows or prong cap for case style 111 is available upon special request.
3. The customer MUST specify the desired operating frequency within the indicated range.
4. Power is measured into a critically coupled load at a customer specified single frequency in the indicated range. Typical bandwidth is ±5%. The minimum indicated output power is guaranteed into a critically coupled load over the indicated bandwidth centered around the frequency specified by the customer. Higher power diodes are available upon special request.
5. These diodes are designed to operate within a heat sink temperature −30°C to +70°C. However, for higher operating temperatures, please contact the factory.
6. The minimum threshold current is approximately 1.3 times the maximum operating current.
7. All diodes are burned in for a minimum period of 8 hours at diode case temperature (T_C) of 70 ±5°C and with CW dc bias.
8. The polarity is cathode heat sink unless otherwise specified.
9. Frequency chirp during 0.5 (μs) is typically less than 10 MHz in a waveguide cavity.
10. Maximum duty cycle is 1%. Maximum pulse width is 1 (μs).
11. M/A-COM SPO, will provide technical assistance in specification, interpretation and selection of Gunn diodes.

Gunn Diode Mounting and Heat Sink Considerations

The rise in temperature between the diode case and the active region is defined by $\Delta T = R_\theta (P_{in} - P_{out})$. In actual use the thermal drop between the ambient and the diode case must be taken into account in order to avoid exceeding the maximum active temperature of 260°C. The maximum active region temperature may be computed as follows:

Maximum active region temperature:

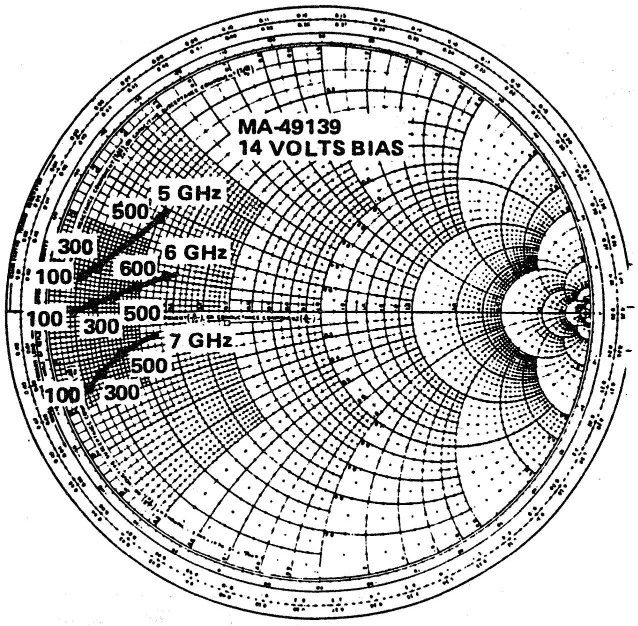
$$T_{AL} = T_A + \Delta T_{CA} + (P_{in} - P_{out}) R_\theta$$

where:
- T_A = Ambient temperature
- ΔT_{CA} = Temperature difference between the diode case and the ambient at operating power.
- R_θ = Thermal resistance
- T_{AL} = Active region temperature

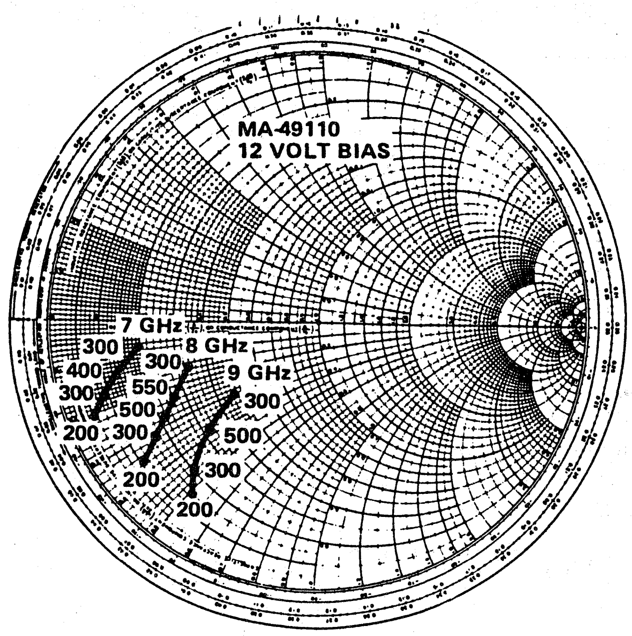
In well designed heat sinks, the thermal difference ΔT_{CA} is usually less than 30°C for a power input of about 15 watts. This is an important factor in the design of Gunn oscillators and must be carefully considered.

Our technique for measuring thermal resistance is available upon request.

Typical Load Impedance Required for Oscillation at Various Frequencies & Power[1]



C-BAND



X-BAND

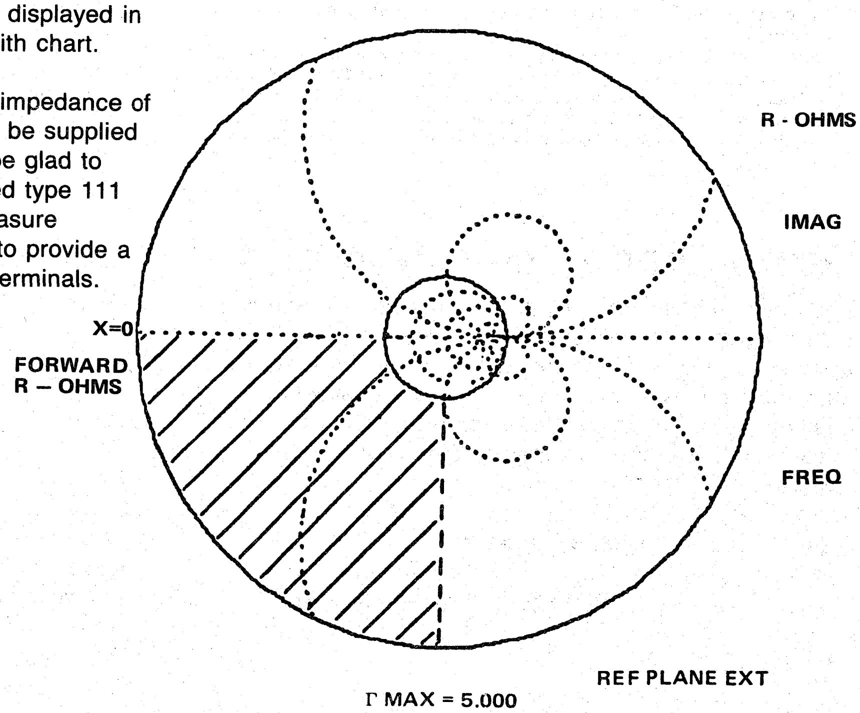
NOTE
1. Power levels on Smith charts are in mW.

Gunn Diode Impedance Measurements

Impedance measurements are made on Gunn diodes using the HP8542B system. By comparing the difference in the magnitude and the phase of the incident and the reflected signal, the impedance measurement should be displayed in the shaded region marked on the following Smith chart.

When used as oscillators, the high level diode impedance of these devices can be measured. This data can be supplied upon request at a nominal charge. We would be glad to provide, free of charge, open and short circuited type 111 case styles to customers who would like to measure package parasitics themselves in their circuits to provide a means of reducing the impedance to the chip terminals.

Typical Operating Region



Typical Performance Curves

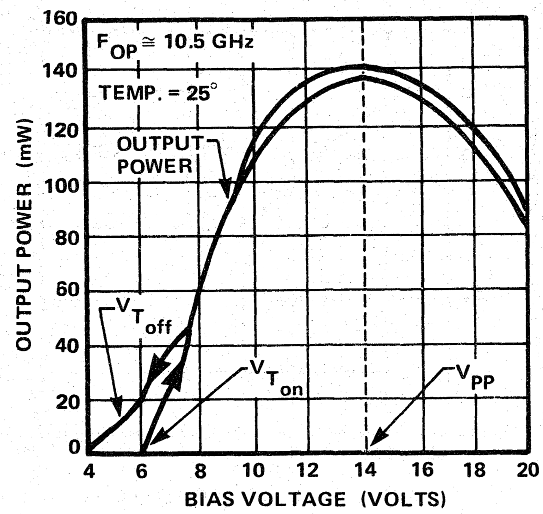


FIGURE 1. Output Power vs. Bias Voltage of a Typical X-Band Gunn Diode

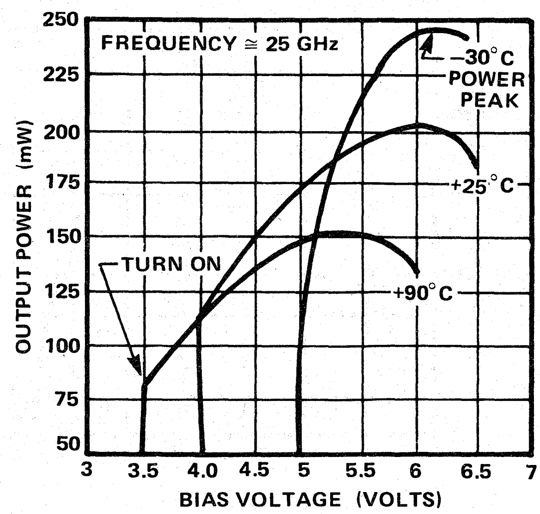


FIGURE 2. Output Power vs. Bias Voltage and Temperature of Typical K-Band Gunn Diode

Typical Performance Curves (General)

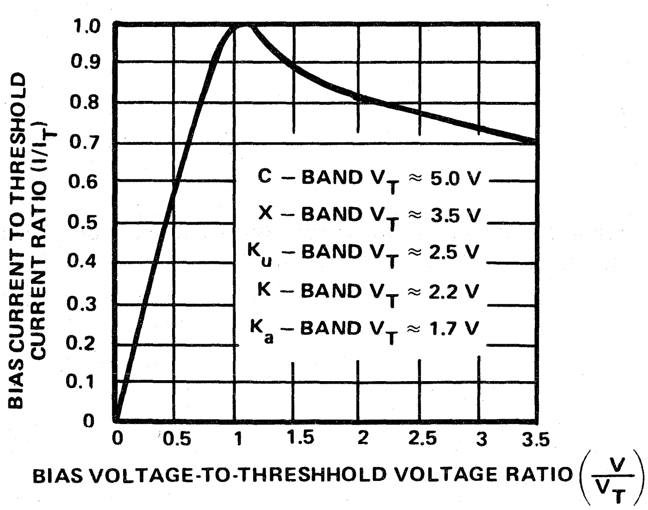


FIGURE 3. Current vs. Voltage Characteristics

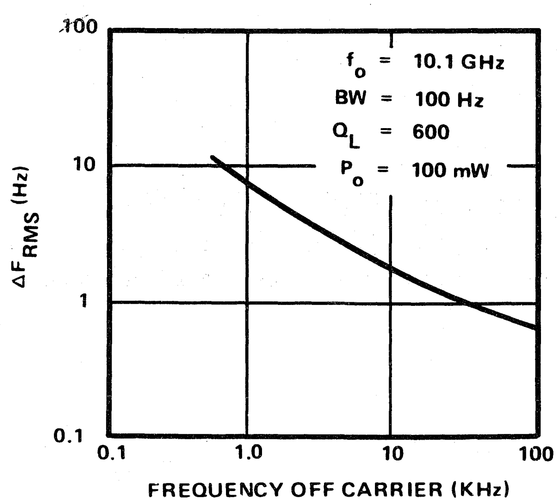


FIGURE 4. FM Noise Spectrum

Typical Performance Curves (High-Power Diodes)

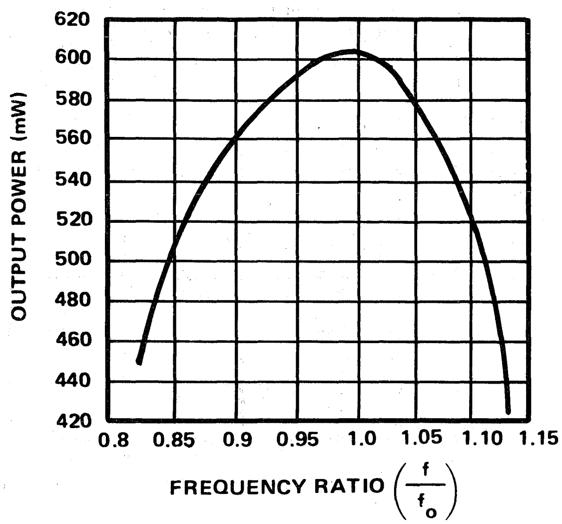


FIGURE 5. Output Power vs. Frequency for MA49139 and MA49110

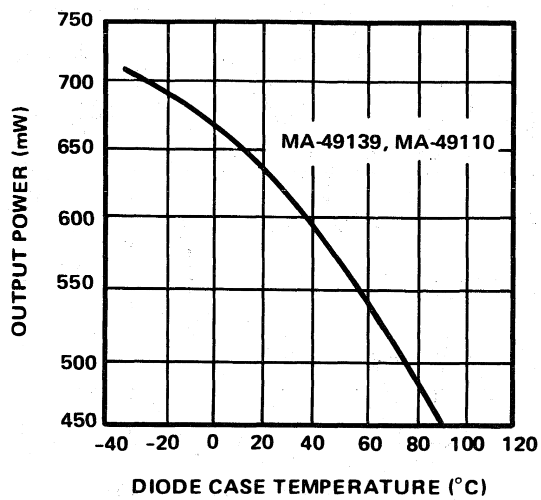


FIGURE 6. Output Power vs. Diode Case Temperature for MA49139 and MA49110

All the typical performance curves were measured using M/A-COM SPO test cavities.

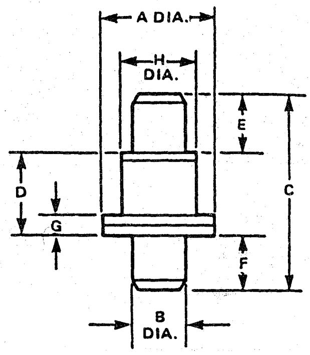
Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

Case Styles

● DENOTES CATHODE NOT TO SCALE

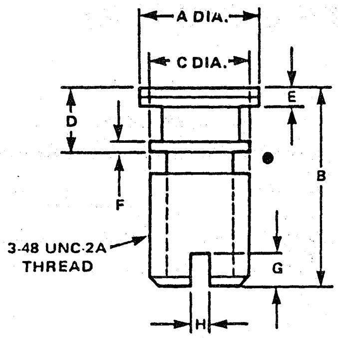
30



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

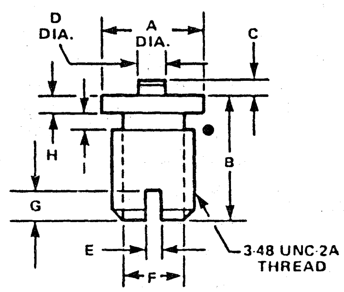
111



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.188	0.208	4,78	5,28
C	0.098	0.102	2,49	2,59
D	0.057	0.071	1,45	1,80
E	0.016	0.024	0,41	0,61
F	0.009	0.011	0,23	0,28
G	0.025	0.045	0,64	1,14
H	0.015	0.025	0,38	0,64

C_P = 0.27 pF Typical
L_S = 0.30 nH Typical

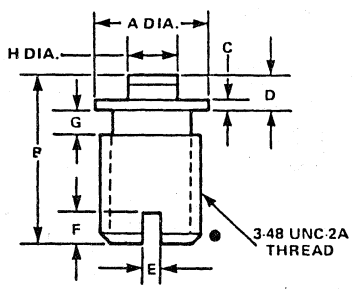
138



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.140	0.145	3,56	3,68
C	0.016	0.019	0,41	0,48
D	0.027	0.034	0,69	0,86
E	0.015	0.025	0,38	0,64
F	0.068	0.070	1,73	1,78
G	0.025	0.045	0,64	1,14
H	0.018	0.022	0,46	0,56
I	0.015	0.025	0,38	0,64

C_p = 0.18 pF Typical
L_s = 0.10 nH Typical

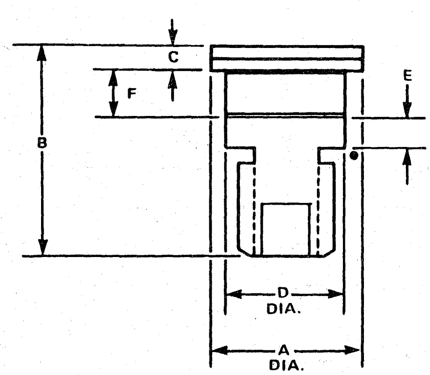
148



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.167	0.187	4,24	4,75
C	0.018	0.022	0,46	0,56
D	0.040	0.052	1,02	1,32
E	0.015	0.025	0,38	0,64
F	0.035	0.045	0,89	1,14
G	0.025	0.035	0,64	0,89
H	0.048	0.052	1,22	1,32

C_P = 0.26 pF Typical
L_S = 0.16 nH Typical

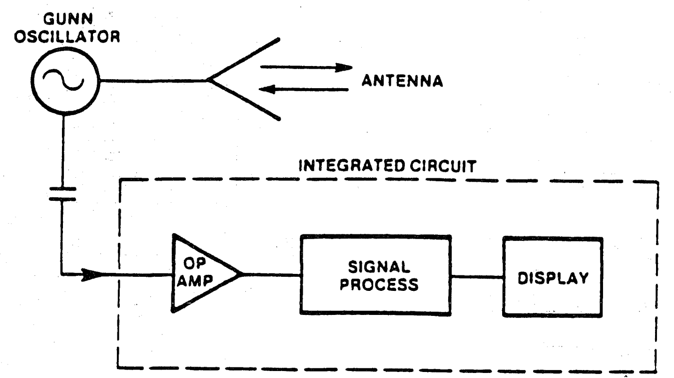
171



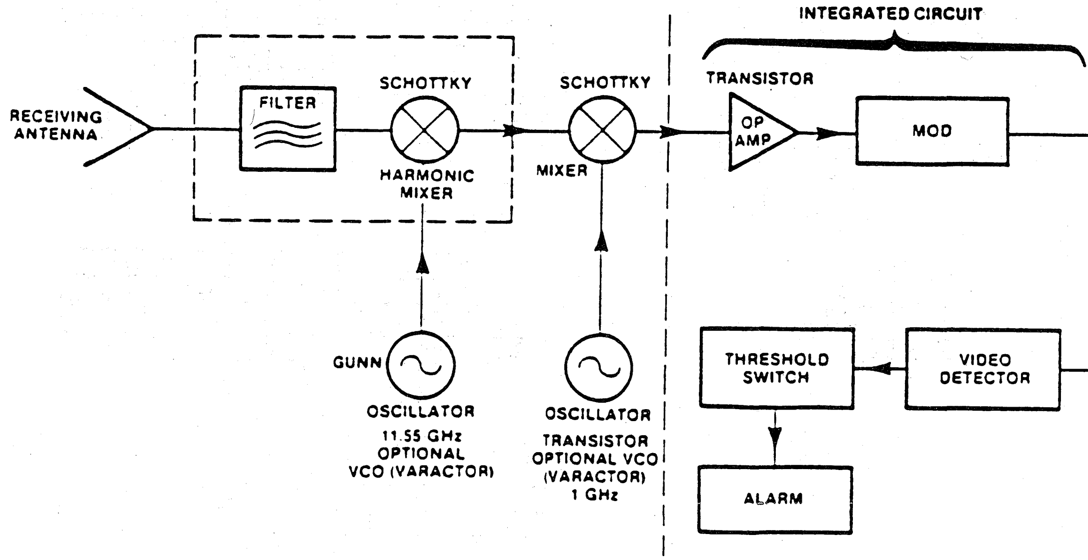
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.157	0.163	3,99	4,14
B	0.205	0.225	5,21	5,72
C	— —	0.025	— —	0,64
D	0.122	0.126	3,07	3,18
E	— —	0.030	— —	0,76
F	0.045	REF	1,15	REF

*Recommended torque for these case styles is 6 inch-ounces and should not be exceeded.

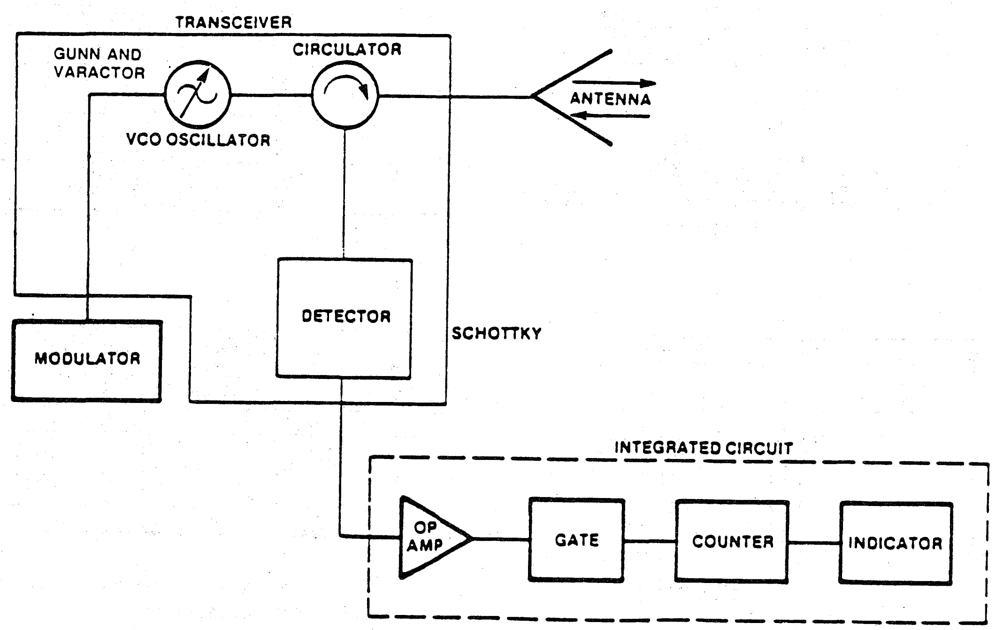
Application Section



SELF DETECT OSCILLATOR (BURGLAR ALARM)

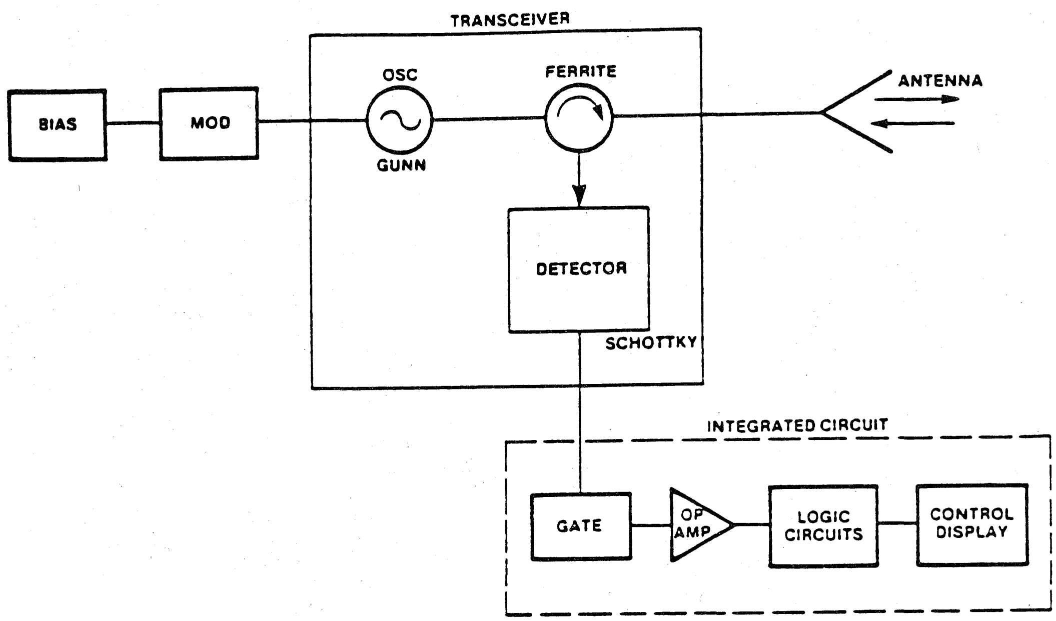


POLICE RADAR DETECTORS

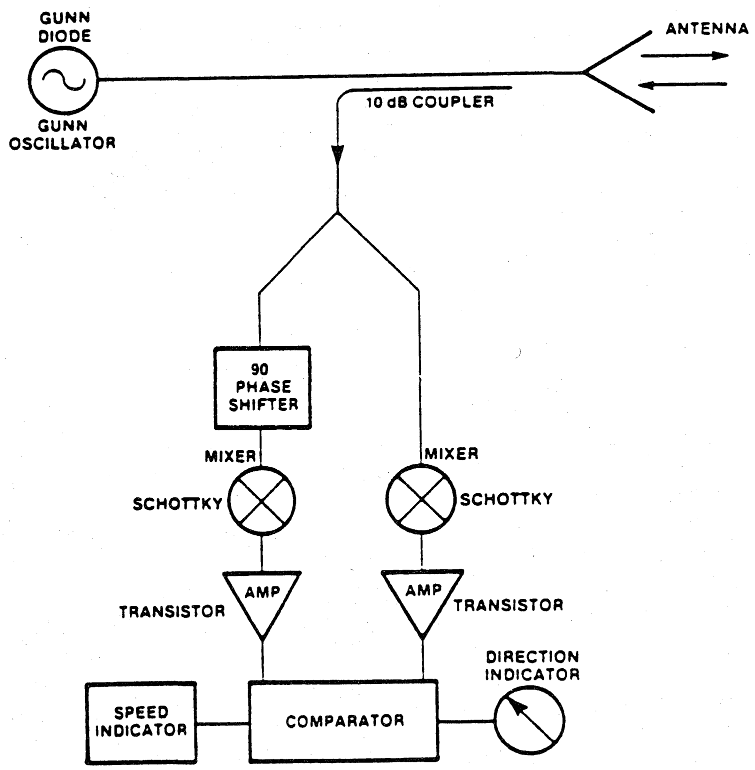


FREQUENCY MODULATED RADAR

Application Section (Cont'd)



PULSE MODULATED RADAR



DOPPLER SYSTEM WITH DIRECTION SENSOR

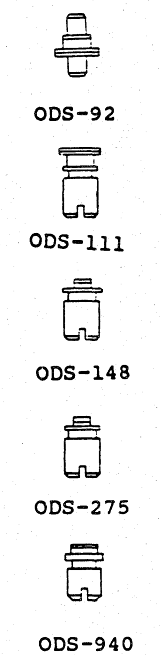
IMPATT Diodes

MODEL NUMBER	PAGE	MODEL NUMBER	PAGE
MA46019	10-5	MA46034	10-9
MA46020	10-5	MA46035	10-9
MA46021	10-9	MA46036	10-9
MA46022	10-9	MA46037	10-9
MA46023	10-9	MA46038	10-9
MA46024	10-9	MA46039	10-9
MA46025	10-9	MA46040	10-9
MA46026	10-9	MA46041	10-9
MA46027	10-9	MA46042	10-5
MA46028	10-9	MA46044	10-5
MA46029	10-9	MA46045	10-5
MA46030	10-9	MA46046	10-5
MA46031	10-9	MA46047	10-5
MA46032	10-9	MA46048	10-5
MA46033	10-9	MA46049	10-9

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION
GaAs IMPATT DIODE SELECTION GUIDE

Frequency Range GHz	Case Style ODS #	CW IMPATTS Minimum CW Output Power in Watts							PULSED IMPATT DIODES Min. Peak Pulse Power in Watts			
		0.5	1.0	1.5	2.0	2.5	3.8	4.0	10	12	24	30
5.5 - 6.0	111								46042			
6.0 - 8.0	111			46040				46037				
7.0 - 9.0	111					46033						
8.0 - 9.5	92 111	46021 46024	46027 46030									
8.0 - 10.0	111 275						46038			46045		
9.0 - 10.0	275								46046		46019[1]	46020
9.0 - 11.0	111				46034							
9.5 - 11.0	92 111	46022 46025	46028 46031									
10.0 - 12.0	111						46036					
11.0 - 12.5	92 111	46023 46026	46029 46032									
11.0 - 13.0	111				46035							
12.0 - 15.0	111					46039						
12.0 - 16.0	275								46044			
13.0 - 16.0	275								46047			
14.0 - 17.0	275					46049						
16.5 - 17.5	275								46048			
17.0 - 19.0	148	46041										

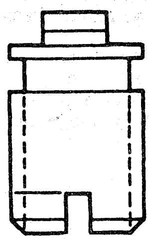
Case Style Illustrations



NOTE: 1. Case 940

MA46019-MA46048 Series

High Power Pulsed GaAs IMPATT Diodes



Features

- HIGH PEAK OUTPUT
  - 30W AT 9.0-10.0 GHz
  - 12W AT 8.0-10.0 GHz
  - 10W AT 5.5-17.5 GHz
- HIGH EFFICIENCY — TYPICALLY 20%
- BURNOUT RESISTANCE TO CIRCUIT MISMATCHES
- HIGH RELIABILITY
- HIGH & LOW DUTY CYCLE OPERATION
- CUSTOM DESIGNS AVAILABLE

Description

These single and double drift pulsed IMPATT diodes have a low-high low or high-low profile. These devices have been shown to be extremely rugged with respect to load mismatch. Short or open circuit loads in any phase can be tolerated indefinitely provided thermal dissipation limits are observed. Rugged and reliable diode construction is assured by using an epitaxial grown doping structure with a high temperature metallization process on Gallium Arsenide.

Applications

These pulsed IMPATT diodes are ideally suited for driver or final amplifier transmitter applications and are easily power combined in multiple diode oscillators. They are useful in radar systems and active missile seekers.

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION • Burlington, MA 01803 • (617) 272-3000 • TWX 710-332-6789 • TELEX 94-9464

Specifications @ T_A = 25° C

Model Number	Case Style	Operating Frequency Min./Max. (GHz)	Minimum Peak Output (Watts)	Minimum Efficiency (%)	Maximum Thermal Resistance (C/W)	Maximum Operating Current (Amps)
MA46042	111	5.5/ 6.5	10[8]	14	8.0	1.5
MA46045	275	8.0/10.0	12[7]	17	9.0	1.5
MA46020	275	9.0/10.0	30[6]	17	5.5	2.1
MA46019	940	9.0/10.0	24[5]	17	5.5	1.4
MA46046	111	9.0/11.0	10[8]	12	10.0	2.0
MA46044	275	12.0/16.0	10[7]	14	10.0	1.8
MA46047	275	13.0/16.0	10[8]	9	10.0	3.5
MA46048	275	16.5/17.5	10[8]	14	10.0	2.0

Model Number	Nominal[3] Operating Voltage (Volts)	Nominal Breakdown[3] Voltage (Volts)	Nominal[4] Junction Capacitance (pF)
MA46042	80	60	70
MA46045	70	45	60
MA46020	110	75	40
MA46019	110	75	35
MA46046	70	55	60
MA46044	60	35	60
MA46047	50	35	60
MA46048	40	30	40

NOTES:
1. The MA46046 is also available in case style 275.
2. The MA46045, MA46046 diodes are tested in a fixed tuned oscillator near the center of the frequency range, with a maximum average junction temperature rise of 200° C. Customer should specify the center frequency of operation, pulse width and duty cycle when ordering.
3. Breakdown voltage is measured with an Ir of 1 mA.
4. Junction capacitance is measured with a reverse voltage of zero volts at a frequency of 1 MHz.
5. Duty Cycle: 30%; Pulse Width: 1 to 2 μs.
6. Duty Cycle: 10%; Pulse Width: 1 to 4 μs.
7. Duty Cycle: 15 to 30%; Pulse Width: 1 to 5 μs.
8. Duty Cycle: 1 to 10%; Pulse Width: 5 to 15 μs.

MAXIMUM RATINGS

Junction Temperature	
Operating	−65°C to +225°C
Storage	−65°C to +225°C
Voltage	Breakdown Voltage
Soldering Temperature (for 5 second maximum)	230°C
Power Dissipation	$\frac{(225°C - T_A)}{R_\theta}$ °C/W

NOTE: Ratings should not be exceeded under either continuous or transient conditions. A single rating may be the limitation, and simultaneous operation at more than one rating, may damage the device. Equipment design should limit current and environmental variations so that the ratings will never be exceeded.

ENVIRONMENTAL RATINGS

Screen/Test Inspection	MIL-STD-750 Method	Conditions/Comments
Temperature, Storage	1031	−65°C to +225°C
Temperature, Operating	1031	−65°C to +225°C
Temperature Cycling	1051	5 Cycles −65°C to +150°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Moisture Resistance	1021	10 days

Typical Performance Curves

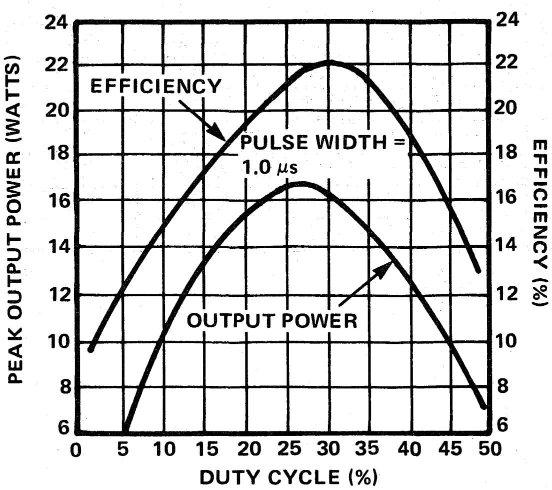


FIGURE 1. Output Power and Efficiency vs. Duty Cycle for an MA46045 Pulsed IMPATT Diode

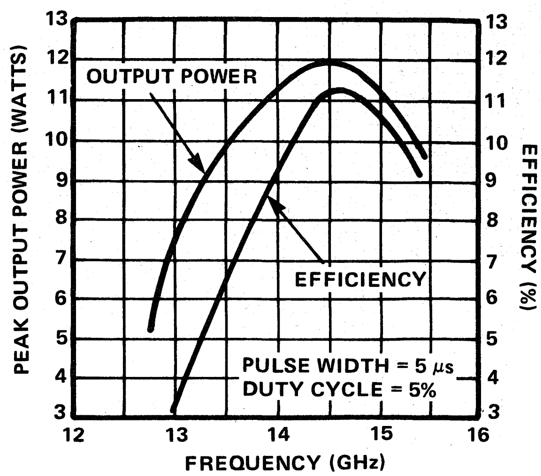


FIGURE 2. Output Power and Efficiency vs. Frequency for an MA46047 Pulsed IMPATT Diode (Diode and Circuit Have Been Optimized for 14.5 GHz)

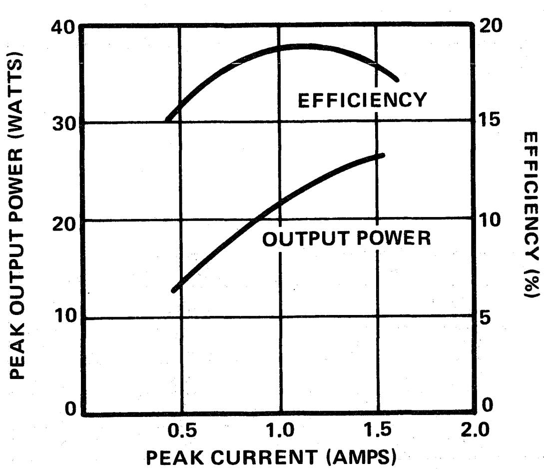


FIGURE 3. Double Drift IMPATT Output Power and Efficiency vs. Peak Current for an MA46019 Pulsed IMPATT Diode

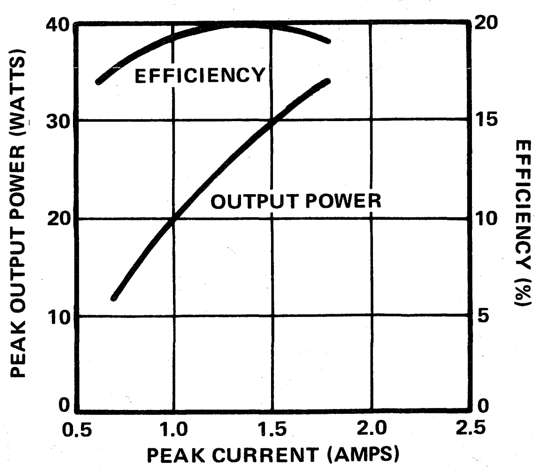
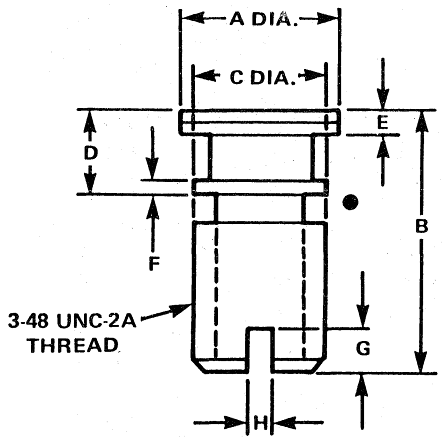


FIGURE 4. Double Drift IMPATT Output Power and Efficiency vs. Peak Current for an MA46020 Pulsed IMPATT Diode

Case Styles

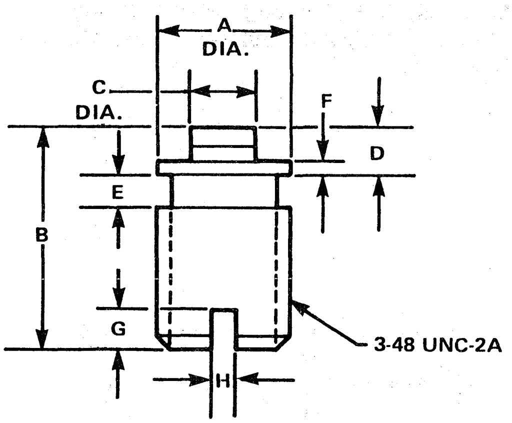
111



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.188	0.208	4,78	5,28
C	0.098	0.102	2,49	2,59
D	0.057	0.071	1,45	1,80
E	0.016	0.024	0,41	0,61
F	0.009	0.011	0,23	0,28
G	0.025	0.045	0,64	1,14
H	0.015	0.025	0,38	0,64

C_P = 0.27 pF Typical
L_S = 0.30 nH Typical

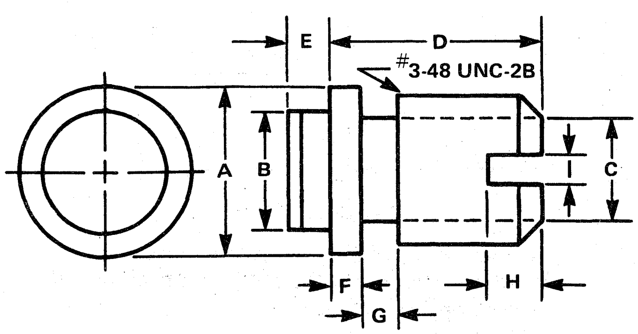
275



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.159	0.179	4,04	4,55
C	0.048	0.052	1,22	1,32
D	0.033	0.044	0,84	1,12
E	0.025	0.035	0,64	0,89
F	0.018	0.022	0,46	0,56
G	0.035	0.045	0,89	1,14
H	0.015	0.025	0,38	0,64

$C_P \sim$ .33 pF Typical
$L_S \sim$ .20 nH

940



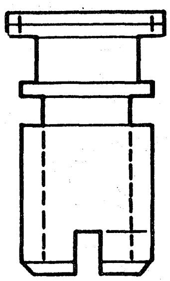
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.076	0.084	1,93	2,13
C	0.068	0.072	1,73	1,83
D	0.138	0.146	3,51	3,71
E	0.026	0.034	0,66	0,86
F	0.018	0.022	0,46	0,56
G	— —	0.020	— —	0,51
H	0.035	0.045	0,89	0,114
I	0.015	0.025	0,38	0,64

$C_P \sim$ .30 pF Typical
$L_S \sim$ .20 nH

MA46021-MA46049 Series

CW Gallium Arsenide IMPATT Diodes

0.5-4 Watts C,X, and Ku-Band



111

Features

- DIRECT CONVERSION FOR DC TO RF WITH >15% EFFICIENCY (LOW-HIGH-LOW)
- DIRECT CONVERSION FOR DC TO RF WITH >10% EFFICIENCY (FLAT PROFILE)
- LOW AM AND FM NOISE
- LOW COST

Description

These Gallium Arsenide IMPATT diodes (Impact Avalanche Transit Time) are junction devices that operate with a reverse bias sufficient to cause avalanche breakdown (typically 60 V and 125-150 mA). In such a diode, carriers are produced by avalanche multiplications. The negative resistance at microwave frequencies is the result of the avalanche phase delay between the voltage and the current. This is produced by both carrier generation and the circuit, causing the diodes to oscillate, producing a microwave output at an efficiency greater than 10% at the 0.5 and 1 watt levels. By use of a modified doping profile in the epitaxial layer (low-high-low profile), the efficiency can be increased to greater than 15% in the case of high output power devices (>2 watts). This series of IMPATT devices includes diodes that operate in C, X and Ku band.

Applications

These IMPATT diodes are useful as CW oscillators with up to 4 watts of output power. They are ideally suited as intermediate or final stage amplifiers for telecommunication systems. These diodes can be combined for high power if necessary.

Specifications @ T_A = 25°C

Model Number	Case[1] Style	Operating[2] Frequency Min./Max. (GHz)	Output[2] Power Min./Typ. (Watts)	Minimum[3] Efficiency (%)	Maximum[4] Thermal Resistance Theta (°C/W)	Breakdown[5] Voltage Min./Max. (Volts)	Operating[5] Voltage Min./Max. (Volts)	Maximum Operating Current (Amps)	Junction[1,6] Capacitance Min./Max. (pF)
MA46040	111	6.0/8.0	1.5	12	13	65/75	75/95	.150	7/10
MA46033	111	7.0/9.0	2.5/3.0	16	11	25/35	45/60	.350	10/14
MA46030	111	8.0/10.0	1.0/1.3	10	15	50/65	65/80	.125	5/8
MA46027	92	8.0/10.0	1.0/1.3	10	15	50/65	65/80	.125	5/8
MA46024	111	8.0/9.5	0.5/0.7	10	25	50/65	65/80	.100	4/7
MA46021	92	8.0/9.5	0.5/0.7	10	25	50/65	65/80	.100	4/7
MA46028	92	9.5/11.0	1.0/1.3	10	15	40/55	55/70	.150	4/7
MA46031	111	9.5/11.0	1.0/1.3	10	15	40/55	55/70	.150	4/7
MA46022	92	9.5/11.0	0.5/0.7	10	25	40/55	55/70	.100	3/6
MA46025	111	9.5/11.0	0.5/0.7	10	25	40/55	55/70	.100	3/6
MA46032	111	11.0/12.5	1.0/1.3	10	15	30/45	45/60	.150	3/5
MA46029	92	11.0/12.5	1.0/1.3	10	15	30/45	45/60	.150	3/5
MA46026	111	11.0/12.5	0.5/0.7	10	25	30/45	45/60	.100	2/4
MA46023	92	11.0/12.5	0.5/0.7	10	25	30/45	45/60	.100	2/4
MA46041	148	17.0/19.0	0.5/0.7	10	22	22/26	30/35	.240	2/3

Model Number	Case[1] Style	Operating[2] Frequency Min./Max. (GHz)	Output[2] Power Min./Typ. (Watts)	Minimum[3] Efficiency (%)	Maximum[4] Thermal Resistance Theta (°C/W)	Breakdown[5] Voltage Min./Max. (Volts)	Operating[5] Voltage Min./Max. (Volts)	Maximum Operating Current (Amps)	Junction[1,6] Capacitance Min./Max. (pF)
MA46037	111	6/8	4.0/4.50	20	11	35/50	60/75	.375	16/24
MA46038	111	8/10	3.8/4.10	20	11	25/35	50/60	.425	20/30
MA46034	111	9/11	2.0/2.50	15	11	20/30	40/50	.350	7/12
MA46036	111	10/12	3.8/4.10	20	11	20/30	40/50	.500	20/30
MA46035	111	11/13	2.0/2.50	12	10	17/25	35/45	.350	7/12
MA46039	111	12/15	2.5/3.00	18	13	17/25	30/40	.400	10/15
MA46049	275	14/17	2.5/2.75	15	12	13/23	30/40	.550	10/15

NOTES:
1. Package capacitance and inductance are shown with the case style drawing.
2. These diodes will deliver at least the minimum specified output power into a critically coupled load at a customer specified frequency in the indicated frequency range.
3. Efficiency = $\frac{\text{RF Power Out}}{\text{DC Power In}} \times 100$
4. Thermal resistance is obtained by measuring the change in breakdown voltage with dc current. Test method TM-372 describes this technique and is available upon request.
5. Breakdown voltage is specified at 1 mA.
6. Capacitance is measured at 1 MHz and 0 volts bias. The capacitance at breakdown is approximately 0.1 this value.

MAXIMUM RATINGS

Storage Temperature	−65°C to +200°C
Junction Operating Temperature	+225°C (For long term reliable operation)

ENVIRONMENTAL RATINGS

Screen/Test Inspection	MIL-STD-750 Method	Conditions/Comments
Storage Temperature	1031	−65°C to +200°C
Operating Temperature		+225°C
Temperature Cycle	1051	10 cycles, −65°C to +175°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days
Leak Tests:		
Fine and Gross	1071	Maximum leak rate: 1 X 10^{-8} atm cc/sec

ENVIRONMENTAL PERFORMANCE

The MA46021-MA46049 series of diodes is capable of meeting the tests dictated by the methods and procedures of the latest revisions of MIL-S-19500, MIL-STD-202 and MIL-STD-750 which specify mechanical, electrical, thermal and other environmental tests common to semiconductors.

Device Reliability

The reliability of these Schottky barrier IMPATTS has been established through long term operations and step stress testing. A four layer Schottky barrier metallization system eliminates potential problems arising from reaction of the Schottky metal with the semiconductor and from the penetration of metallization into the semiconductor during long term operation. Well established chip fabrication and mounting techniques further enhance device reliability by reducing the possibility of surface breakdown or chip damage in mounting.

Long term operating and step stress tests have indicated that a junction temperature of 220°C, MTTF will approach 10^6 hours. Long term operation and field service data in operating oscillators allow an estimate of the MTBF at a 200°C junction to be made. The data presently available places the MBTF at 40% confidence to be greater than 10^5 hours.

Devices of LHL type (output power greater than 1.5 watts) have been shown to be extremely rugged with respect to load mismatch. Short or open circuit loads may be tolerated indefinitely provided thermal dissipation limits are observed. Flat profile types should not be subjected to extreme mismatch while operating at full power.

The interaction of the microwave and bias port impedances represents a complex situation. A constant current regulated source is recommended for biasing the IMPATT diodes. Reference (1) describes the bias circuit instabilities that may occur, and recommends techniques for controlling the instabilities.

(1) C.A. Brackett, "The Elimination of Tuning-Induced Burnout and Bias Circuit Oscillations in IMPATT Oscillators." Bell Systems Technical Journal, Vol. 2, No. 3, March 1973, pp. 271-306.

Application Notes

Since all IMPATT devices are susceptible to tuning induced failures (burn-out), it is always necessary to reduce the bias voltage before tuning for maximum power.

Caution: A severe load mismatch should be avoided to minimize RF burn out.

The power supply should be carefully regulated to minimize voltage transients.

Low-High-Low diode types are more resistant to tuning induced burn out than flat profile types.

Applications assistance and engineering drawings of the test fixtures are available upon request.

Diode Mounting Procedure: Diodes in style 111 package should be securely tightened into a clean sharply tapped 3-48 UNC-2A threaded hole in copper diode holders or heat sinks. Diodes in style 92 package should be gripped securely in a collet assembly or soldered in place using a minimum thickness of 63-37 lead tin solder. Do not exceed 200°C for 20 seconds.

Small Signal Impedance Measurement: M/A-COM Gallium Arsenide IMPATT diodes are ideally suited for use in reflection amplifier applications. Small signal impedance data can be supplied for individual devices upon request at a nominal charge.

Typical Performance Curves

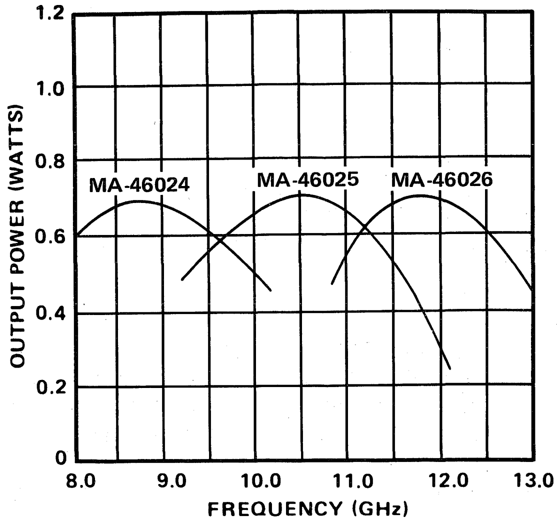


FIGURE 1. Output Power vs. Frequency

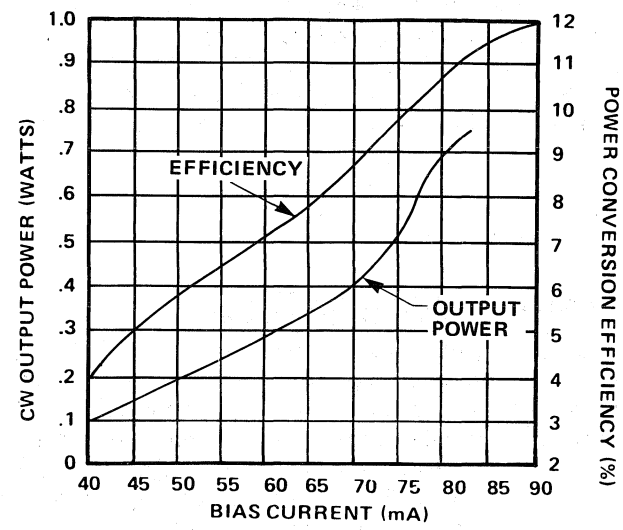


FIGURE 2. Output Power and Efficiency vs. Bias Curren for an MA46024 IMPATT Diode

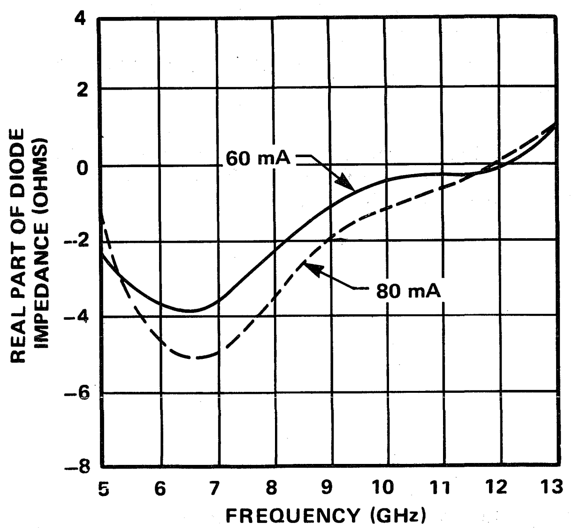


FIGURE 3. Real Part of the Small Signal Impedance for an MA46024 IMPATT Diode vs. Frequency and Bias Level

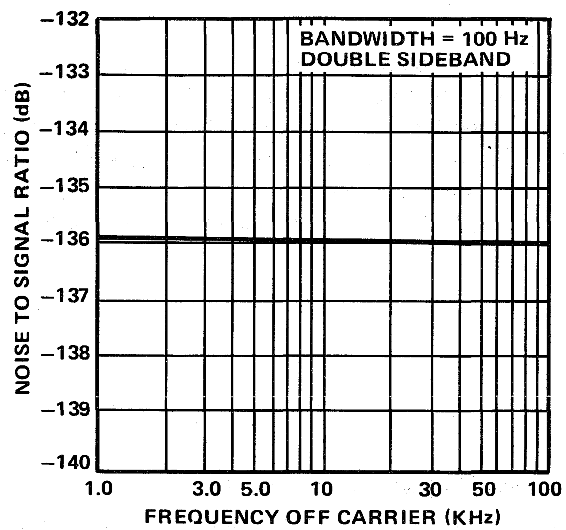


FIGURE 4. AM Noise vs. Frequency for 0.5 Watt Devices

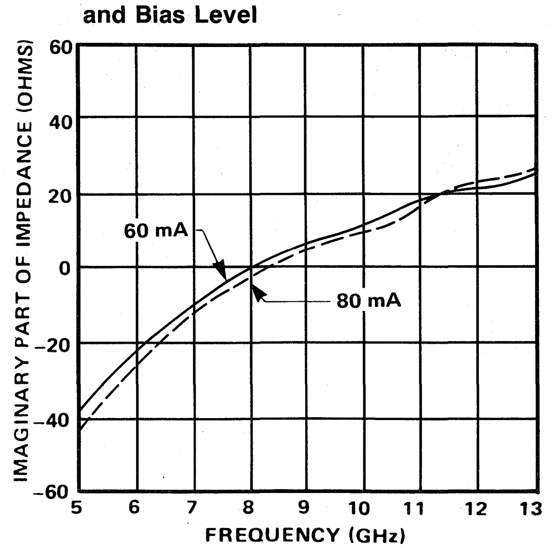


FIGURE 5. Imaginary Part of the Small Signal Impedance for an MA46024 IMPATT Diode vs. Frequency and Bias Level

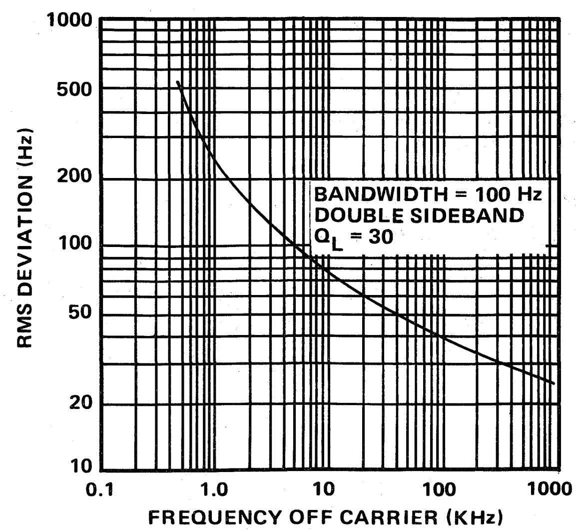


FIGURE 6. FM Noise vs. Frequency Off Carrier for 0.5 Watt Devices

Typical Performance Curves (Cont'd)

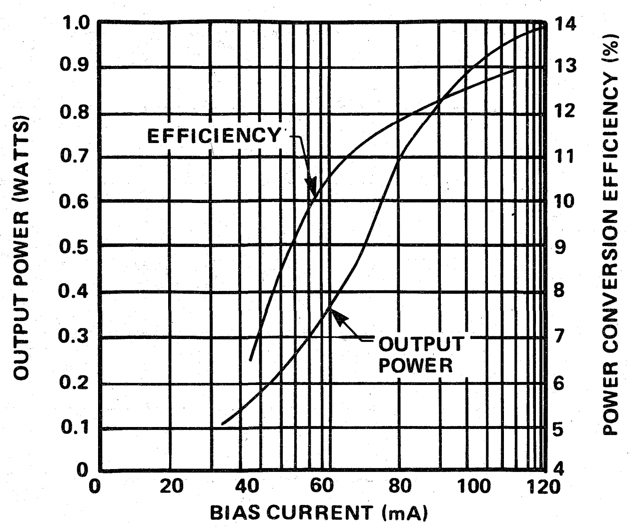


FIGURE 7. Output Power and Efficiency vs. Bias Current for and MA46030 IMPATT Diode

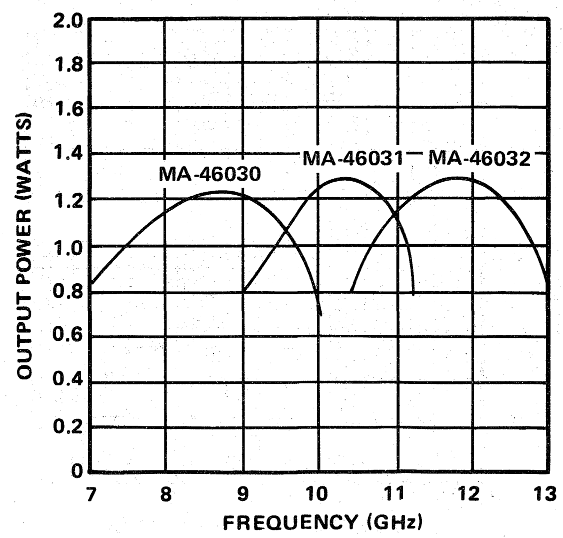


FIGURE 8. Output Power vs. Frequency

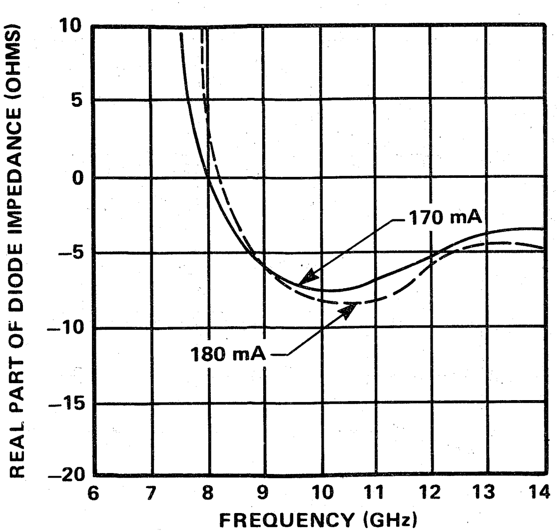


FIGURE 9. Real Part of the Small Signal Impedance for an MA46032 IMPATT Diode vs. Frequency and Bias Level

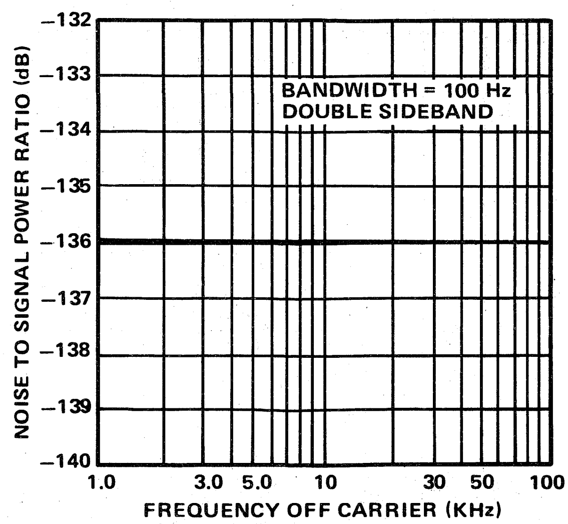


FIGURE 10. AM Noise vs. Frequency for 1 Watt Devices

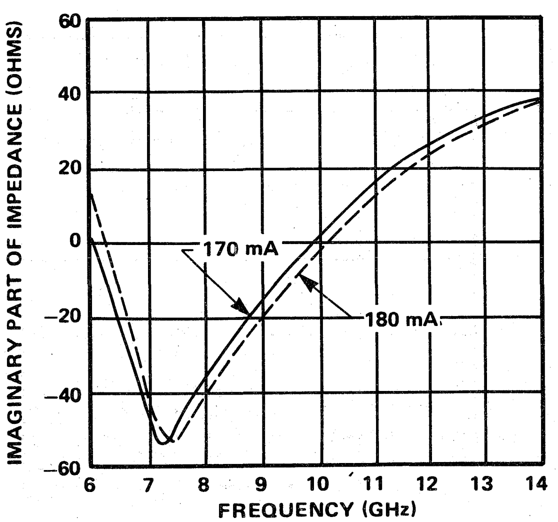


FIGURE 11. Imaginary Part of the Small Signal Impedance for an MA46032 IMPATT Diode vs. Frequency and Bias Level

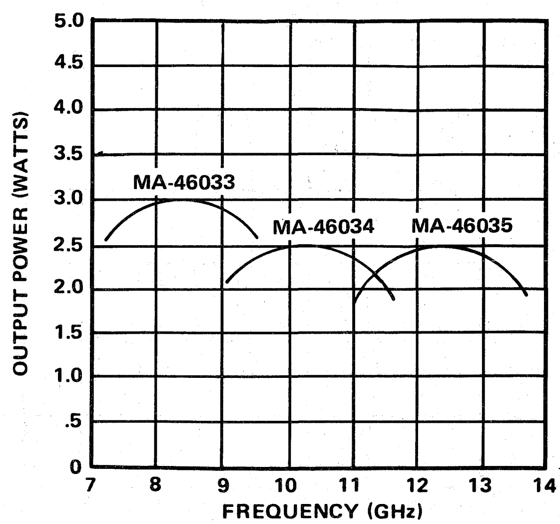


FIGURE 12. Output Power vs. Frequency for Low High Low IMPATT Diodes

Typical Performance Curves (Cont'd)

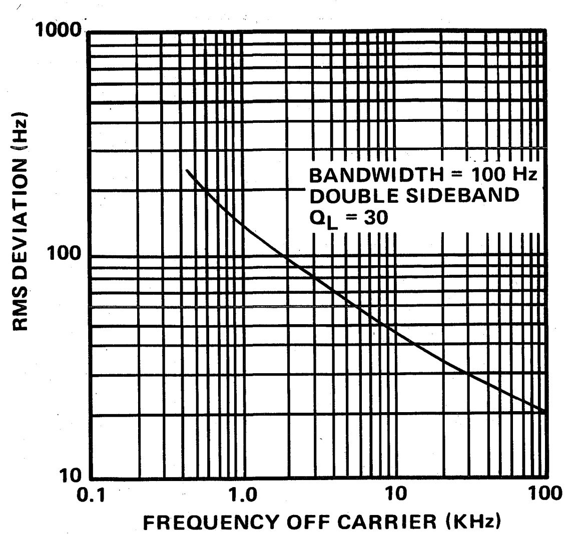


FIGURE 13. FM Noise vs. Frequency for 1 Watt Devices

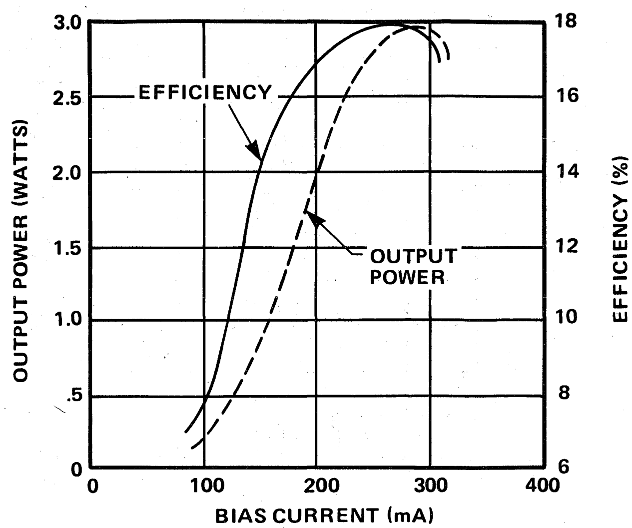


FIGURE 14. Output Power and Efficiency vs. Bias Current for an MA46033 IMPATT Diode

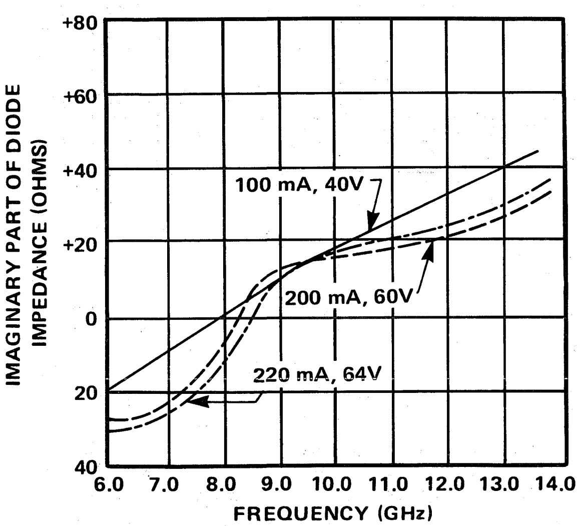


FIGURE 15. Imaginary Part of the Small Signal Impedance for an MA46033 IMPATT Diode vs. Frequency and Bias Level

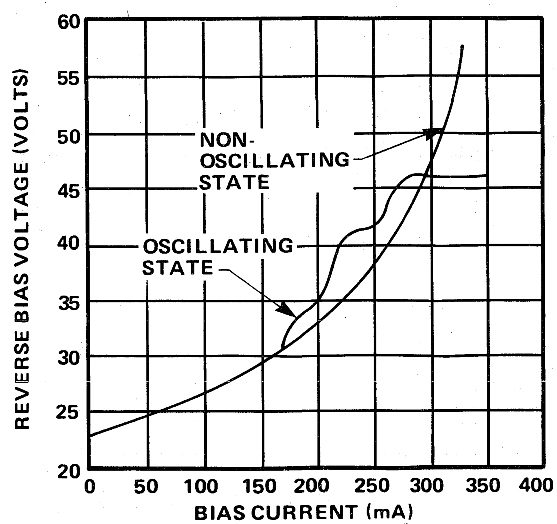


FIGURE 16. Bias Voltage Change with Current for an MA46033 IMPATT Diode

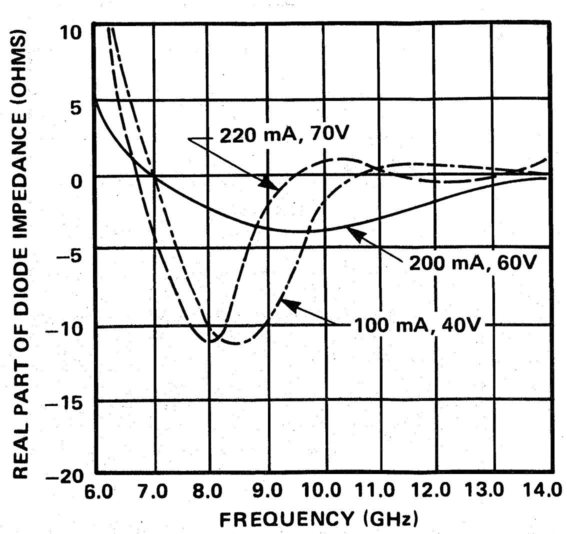


FIGURE 17. Real Part of the Small Signal Impedance for an MA46033 IMPATT Diode vs. Frequency and Bias Level

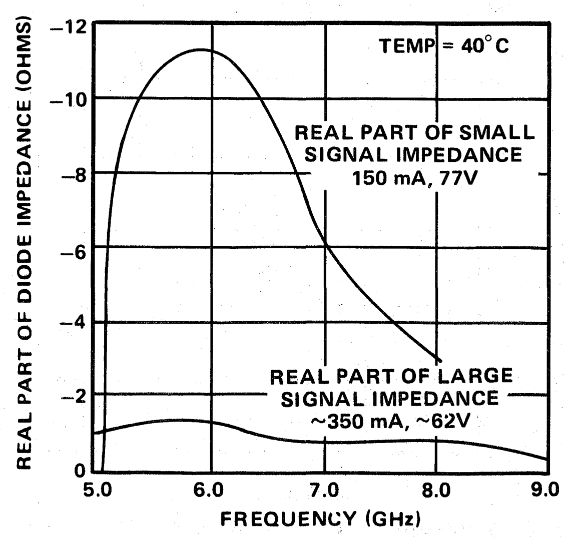


FIGURE 18. Typical Diode Resistance vs. Frequency for an MA46037 Gallium Arsenide IMPATT Diode

Typical Performance Curves (Cont'd)

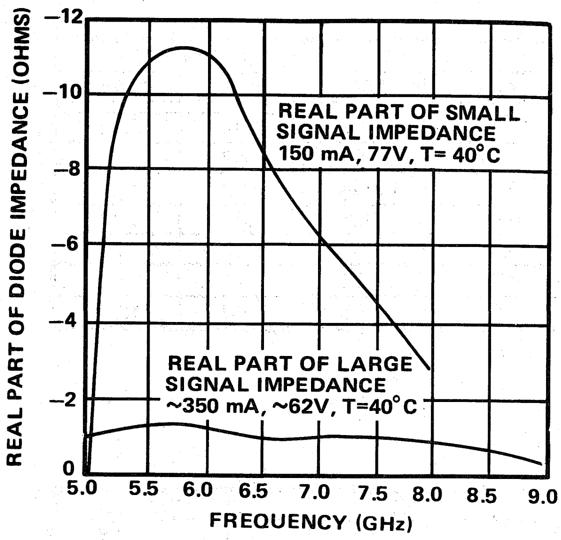


FIGURE 19. Typical Diode Resistance vs. Frequency for an MA46037 Gallium Arsenide IMPATT Diode

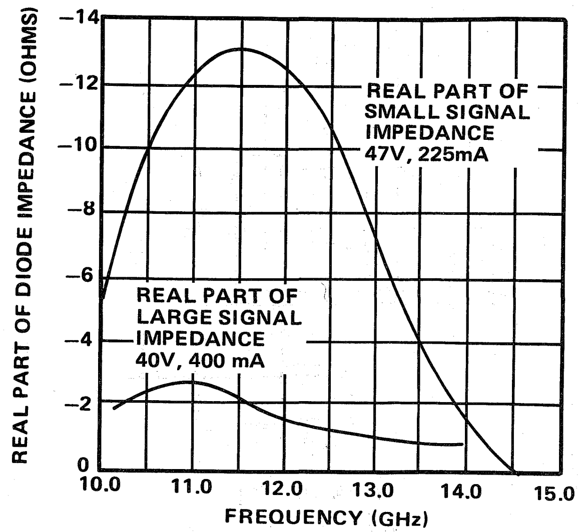


FIGURE 20. Diode Resistance vs. Frequency for an MA46039 Gallium Arsenide IMPATT Diode

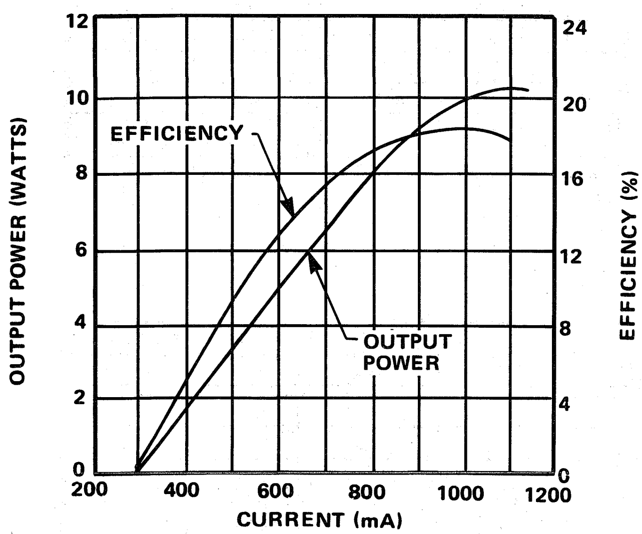


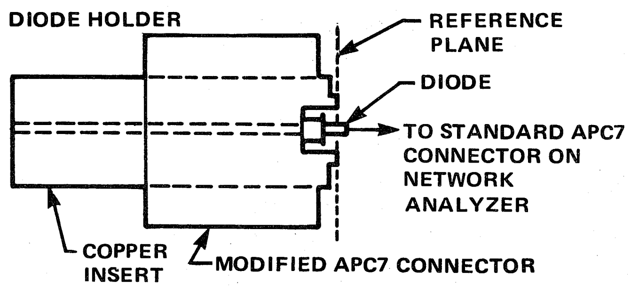
FIGURE 21. Typical Output Power and Efficiency vs. Current for an MA46048 Four Mesa High Power CW IMPATT Diode

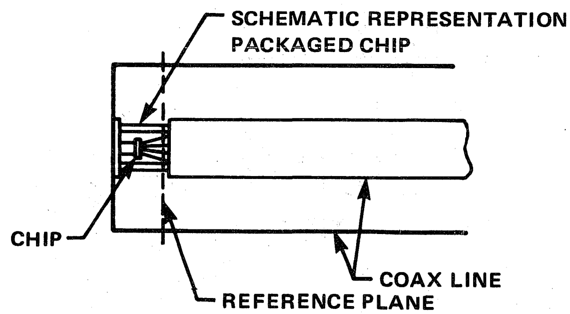
Ordering Information

Specify model number, desired frequency of operation, (e.g., MA46030, desired frequency of operation 8.5-9.0 GHz).

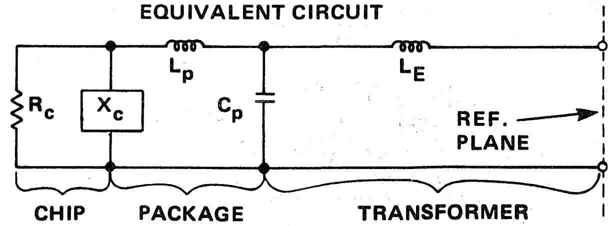
Test Circuits & Fixtures

MOUNTING AND EQUIVALENT CIRCUIT FOR IMPEDANCE MEASUREMENT





EQUIVALENT CIRCUIT



C_p (pF)	L_p (nH)	L_E (nH)	CASE STYLE
.33	.24	.36	92
.33	.24	.36	111

NOTE:

Drawings of test fixture for impedance measurement are available on request.

Case Styles

NOT TO SCALE

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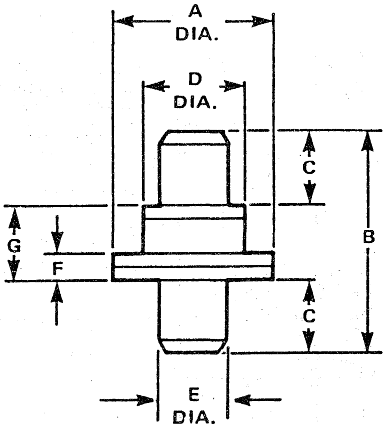

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.174	0.194	4,42	4,93
C	0.060	0.064	1,52	1,63
D	0.077	0.083	1,96	2,11
E	0.060	0.062	1,52	1,57
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

See previous page.

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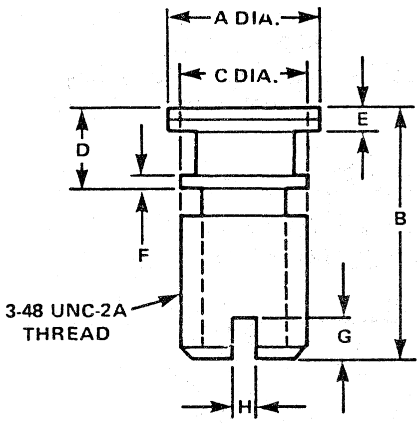

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.188	0.208	4,78	5,28
C	0.098	0.102	2,49	2,59
D	0.057	0.071	1,45	1,80
E	0.016	0.024	0,41	0,61
F	0.009	0.011	0,23	0,28
G	0.025	0.045	0,64	1,14
H	0.015	0.025	0,38	0,64

See previous page.

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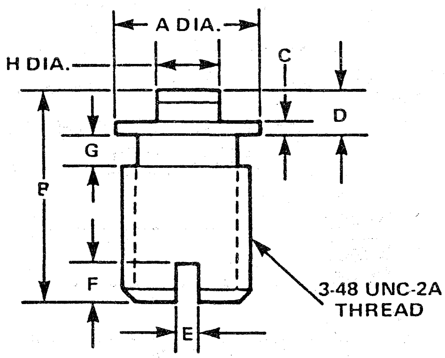

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.167	0.187	4,24	4,75
C	0.018	0.022	0,46	0,56
D	0.040	0.052	1,02	1,32
E	0.015	0.025	0,38	0,64
F	0.035	0.045	0,89	1,14
G	0.025	0.035	0,64	0,89
H	0.048	0.052	1,22	1,32

C_P = 0.33 pF
L_S = 0.20 nH

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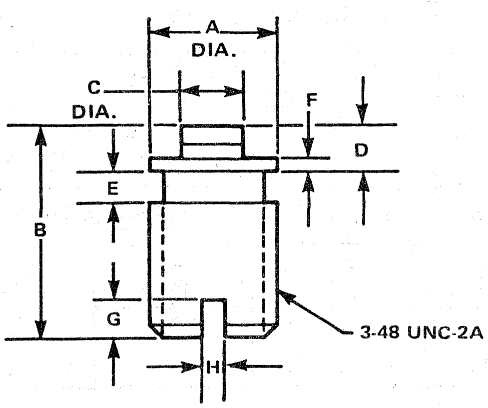
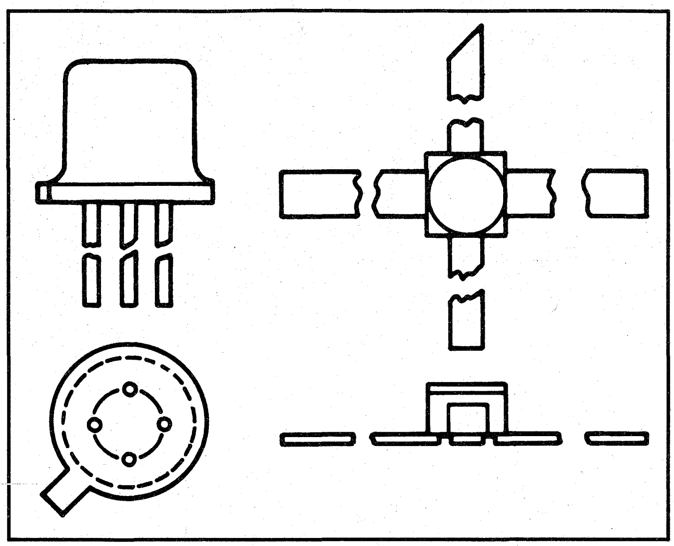


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.159	0.179	4,04	4,55
C	0.048	0.052	1,22	1,32
D	0.033	0.044	0,84	1,12
E	0.025	0.035	0,64	0,89
F	0.018	0.022	0,46	0,56
G	0.035	0.045	0,89	1,14
H	0.015	0.025	0,38	0,64

$C_P \approx$ 0.33 pF
$L_S \approx$ 0.20 nH

Silicon Low Noise Bipolar Transistors

Silicon Low Noise Bipolar Transistors



Features

- ■ LOW NOISE THROUGH 2.5 GHz
- ■ HERMETIC PACKAGE
- ■ CAN BE SCREENED TO JAN, JANTX, JANTXV LEVELS

Description

The series of Silicon NPN bipolar transistors are designed for low noise amplifiers in the frequency range of 60 MHz through 2 GHz. These devices are offered in several different families with different fT, Gain and dynamic range characteristics. They are offered in a series of hermetic, R.F. packages and as chips. Also offered are a family of low power, high fT oscillator transistors useful in applications up to 3 GHz.

M/A-COM SEMICONDUCTOR PRODUCTS OPERATION • Burlington, MA 01803 • (617) 272-3000 • TWX 710-332-6789 • TELEX 94-9464

Transistor Selection Guide

Series	Geometry	Nominal fT (GHz)	Nominal Optimum Noise Figure at Current (mA)	Nominal Current Range	I_C (Max.) (mA)	Useful Frequency Range (MHz)
42161	72	7.0	3	0.5-7.0	20	500-2500
42111	60	5.5	5	3.0-20.0	125	100-1500
42141	63	4.5	3	1.0-10.0	50	300-2000
42151	63	4.5	3	1.0-10.0	50	300-2000
42000	60	2.5	5	5.0-40.0	125	10-750
42197	60	1.2	5	5.0-40.0	125	10-750
42020	20	1.8	1	1.0-3.0	40	10-600
42051	55	1.8	2	1.0-5.0	50	10-600
42217	55	1.8	2	1.0-5.0	50	10-600
42120	70	1.5	1	0.9-3.0	80	10-600
42181	02	2.8	20	10.0-60.0	300	10-1600

NOTE: For more information and S-parameters request Bulletin #5220.

Typical Performance Curves

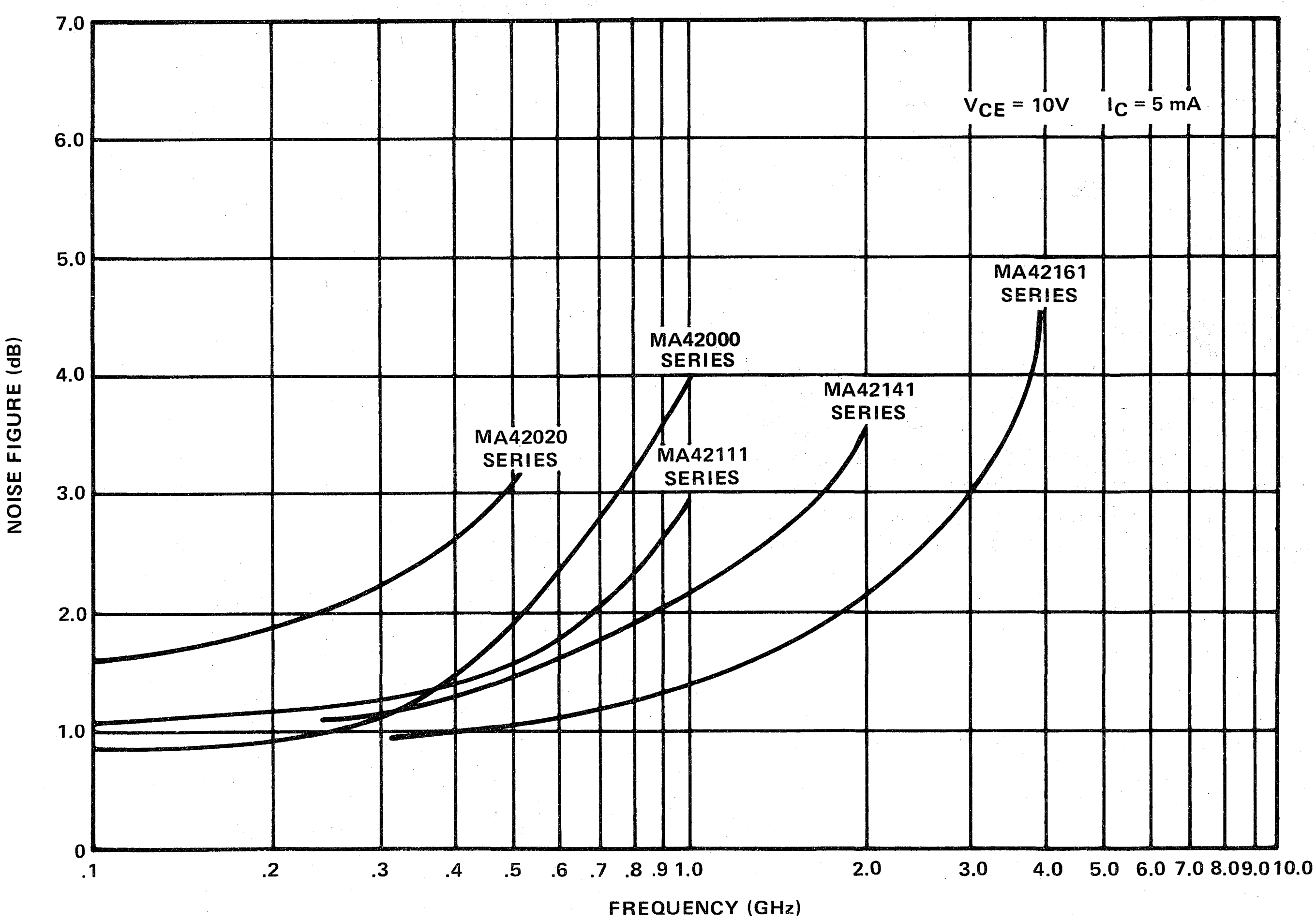


FIGURE A. Noise Figure vs. Frequency

Typical Performance Curves (Cont'd)

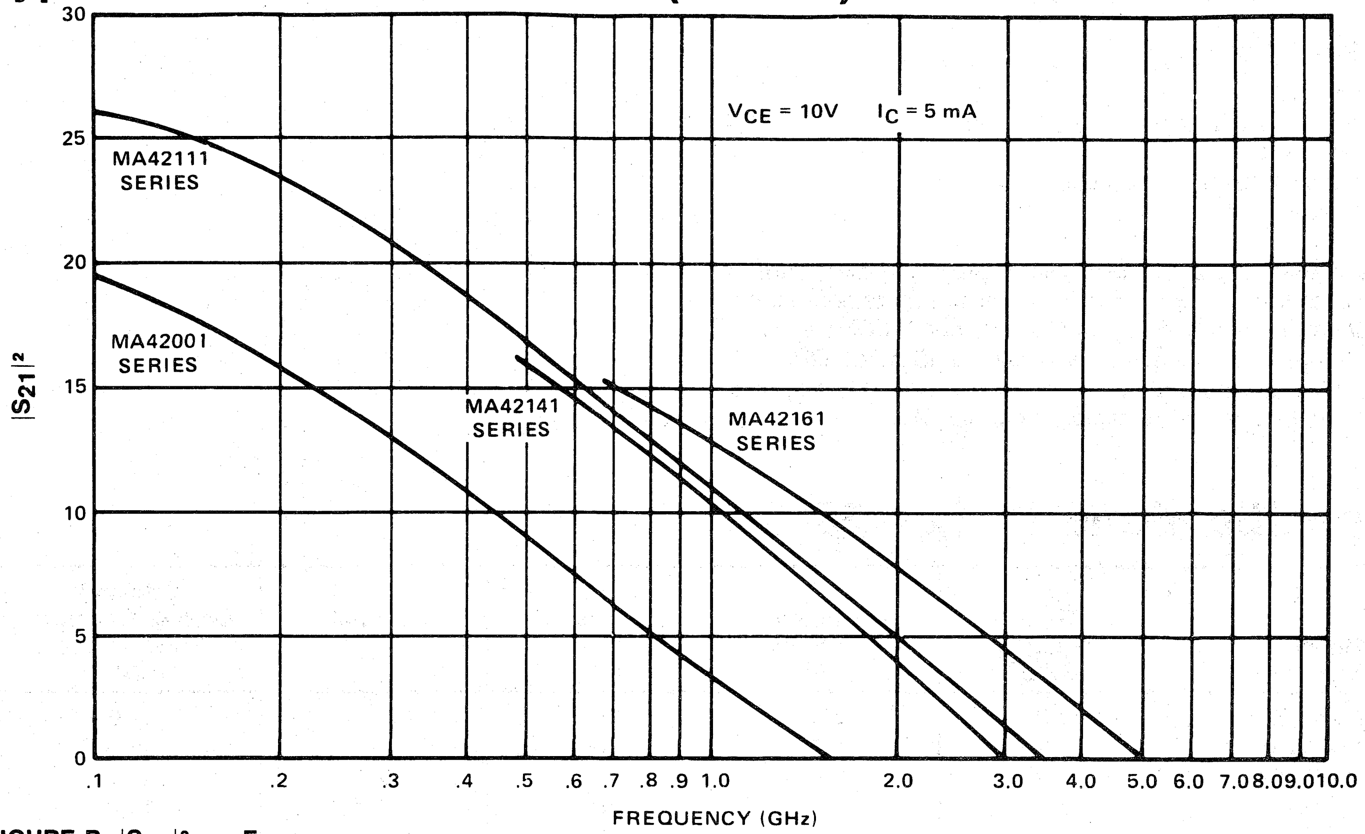


FIGURE B. $|S_{21}|^2$ **vs. Frequency**

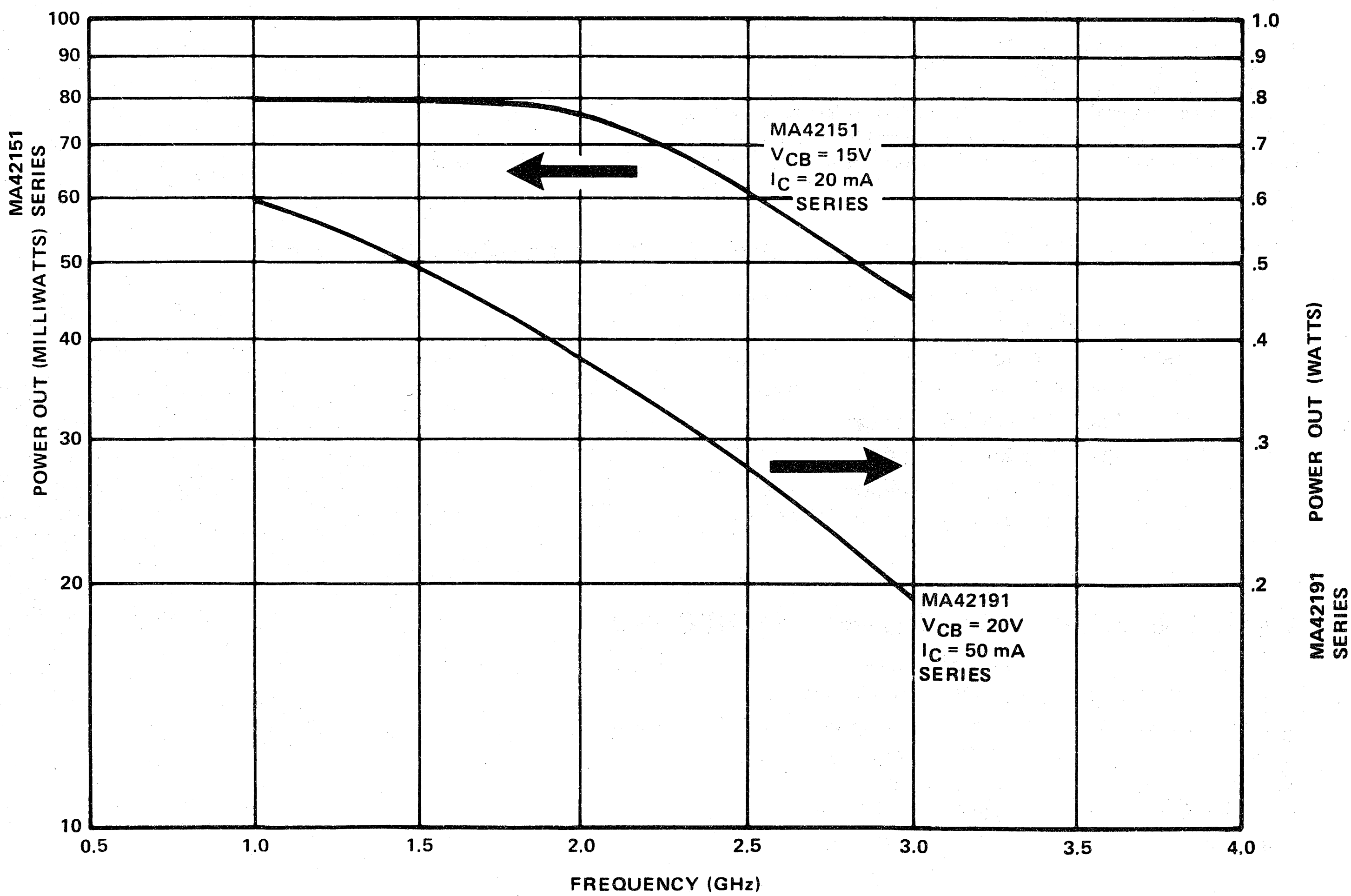


FIGURE C. Common-Base Power Out vs. Frequency

MA42160 Series

Description

Nominal fT = 7 GHz
Nominal Current Range = 0.5 to 7 mA
I_C Max. = 20 mA
Frequency Range = 500 MHz to 4 GHz
Geometry = 72

The MA42161 is a low noise silicon planar epitaxial transistor for.5 to 4.0 GHz amplifiers. These transistors feature high power gain, typically 14.0 dB gain at 2.0 GHz and a low intrinsic noise figure of typically 2.3 dB at 2.0 GHz. These transistors when housed in case style 511, may also be used in low level oscillators from 1-5 GHz.

Specifications @ $T_A = 25°C$

Model[1,6] Number	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum[2] Unilateral Gain (dB)	Nominal[2] $\lvert S_{21E}\rvert^2$ (dB)	Nominal[2] Gain @ Optimum Noise Figure (dB)
MA42161	2.0	2.5	12	8.0	11.0
MA42161	1.0	1.5	18	12.5	15.0
MA42162	2.0	3.0	12	8.0	11.0
MA42162	1.0	1.9	18	12.5	15.0
2N6618	2.0	2.2	12	8.0	11.0

NOTES:
1. 1 dB compression point is −5 dBm.
2. Test conditions I_C = 3mA, V_{CE} = 10 volts.
3. Nominal current transfer ratio is 80, I_C = 10μA.
4. The minimum collector to base breakdown voltage is 20 volts; I_C = 10μA.
5. The nominal collector to emitter sustaining voltage is 12 volts; I_C = 1.0 mA.
6. Available in ODS 511 & 535 packages. To order, add package as suffix to the model number i.e., MA42161-511

MAXIMUM RATINGS (Case Temperature 25°C unless otherwise noted)

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C
Lead Temperature (60 seconds)	250°C
Total Device Power Dissipation	(Case Style 511) - 0.25W
V_{cbo} Collector to Base Voltage	20 V
V_{ceo} Collector to Emitter Voltage	12 V
V_{ebo} Emitter to Base Voltage	1.5 V
I_C Continuous Collector Current	20 mA

ENVIRONMENTAL RATINGS PER MIL-STD 750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42140 Series

Description

Nominal fT = 4.5 GHz
Nominal Current Range = 1 to 10 mA
I_C Max. = 50 mA
Frequency Range = 300 MHz to 2.0 GHz
Geometry = 63

The MA42140 series of NPN silicon planar transistors features excellent high frequency current gain at medium current levels.

The MA42141 series has low noise figures from the frequency range of 0.5 to 2 GHz. These transistors are useful in RF amplifiers and low level oscillators from 100 MHz to 2 GHz.

Specifications @ $T_A = 25°C$

Model Number	Case Style	Test Frequency (GHz)	Maximum[2] Noise Figure (dB)	Maximum Unilateral Gain (dB)	Nominal[4] BV_{ebo} (Volts)
MA42141	509	1.00	2.5	17	1.5
MA42142	509	1.00	3.0	17	1.5
MA42143	509	0.45	1.7	18	1.5
2N5651	509	0.45	2.0	21	3.5
2N5662	509	0.45	2.5	21	3.5

NOTES:
1. The standard case style for all the MA42140 series is case style 509. The MA42141, MA42142 and MA42143 are also available in case styles 510 and 511. To order, add the case style as a suffix to the basic model number, i.e.: MA42142-510).
2. The collector current = 5 mA.
3. The minimum collector to base breakdown voltage is 27 volts, $I_C = 10\ \mu A$.
4. $I_E = 10\ \mu A$.
5. The minimum collector to emitter breakdown voltage is 20 volts $I_C = 500\ \mu A$.
6. The maximum collector cutoff current is 100 nA. $V_{CB} = 10$ volts.
7. Nominal current transfer ratio is 100, $I_C = 5$ mA, $V_{CE} = 10$ volts.

MAXIMUM RATINGS (Case Temperature 25°C unless otherwise noted)

Total Device Power Dissipation	509 Case — 400 mW 510 Case — 700 mW 511 Case — 700 mW
V_{cbo} Collector to Base Voltage	27 V
V_{ebo} Emitter to Base Voltage	3 V
I_C Collector Current	50 mA
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He
Lead Temperature (Soldering — 10 seconds each lead)	250°C

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42110 Series

Description

Nominal fT = 5.5 GHz
Nominal Current Range = 3 to 20 mA
I_C Max. = 125 mA
Frequency Range = 100 MHz to 1.5 GHz
Geometry = 60

The MA42110 series of silicon NPN bipolar transistors is designed to give a very low noise figure and wide dynamic range up to approximately 4 GHz. Gold metallization is employed in the construction of these devices resulting in rugged, highly reliable transistors.

Specifications @ $T_A = 25°C$

Model Number	Case Style	Test Frequency (MHz)	Maximum[2] Noise Figure (db @ mA)	Maximum[4] Unilateral Gain (dB)	Minimum $\|S_{21E}\|^2$	Nominal[2] Gain @ Opt. NF (dB)
MA42111	509	450	1.5	14	13.0	13
MA42111	510	450	1.5	17	15.5	15
MA42111	511	450	1.5	19	16.0	15
MA42112	509	450	1.8	14	13.0	13
MA42112	510	450	1.8	17	15.5	15
MA42112	511	450	1.8	19	16.0	15
MA42113	509	450	2.1	14	13.0	13
MA42113	510	450	2.1	17	15.5	15
MA42113	511	450	2.1	19	16.0	15

NOTES:

1. When ordering, specify the desired case style by adding it as a suffix to the basic model number, i.e., MA42111-510.
2. The maximum noise figure is measured as follows:
   V_{CE} = 10 volts
   I_C = 5 mA
   Frequency = 450 MHz.
3. For the maximum unilateral gain, 1 dB compression point is equal to 0 dBm.
4. $Gu\ (max)\ (dB) = 10 \log \frac{|S_{21E}|^2}{(1-|S_{11E}|^2)(1-|S_{22E}|^2)}$
5. Minimum $|S_{21E}|^2$ is: V_{CE} = 10 volts, I_C = 20 mA, and the frequency = 450 MHz.
6. The minimum collector current to base breakdown voltage is is 20 volts, where I_C = 10 μA.
7. The minimum emitter to base breakdown voltage is 1.5 volts, where I_E = 10 μA.
8. The maximum collector cutoff current is 10 μA, where V_{CB} = 10 volts.
9. The nominal current transfer ratio is 125 where V_{CE} = 10 volts, I_C = 5 mA.

MAXIMUM RATINGS (Case Temperature 25°C unless otherwise noted)

Total Device Power Dissipation	509 Case — 450 mW 510 Case — 1.2 W 511 Case — 750 mW
V_{cbo} Collector to Base Voltage	20 V
V_{ebo} Emitter to Base Voltage	2.5 V
Collector Current	125 mA
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He
Lead Temperature (Soldering — 10 seconds each lead)	250°C

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles, −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42000 Series
Description
NPN SILICON PLANAR TRANSISTORS

Nominal fT = 2.5 GHz
Nominal Current Range = 5 to 40 mA
I_C Max. = 125 mA
Frequency Range = 10 MHz to 750 GHz
Geometry = 60

This series of NPN silicon bipolar transistors is designed to provide low noise figures at frequencies from 10 to 750 MHz. These transistors have flat noise figures over a wide dynamic range. This series is recommended for such applications as IF and RF amplifiers from 10 to 750 MHz.

Specifications @ $T_A = 25°C$

Model Number	Case[1] Style	Test Frequency (MHz)	Maximum[2] Noise Figure (dB @ mA)	Maximum[3] Unilateral Gain (dB)	Maximum[4] cbo (nA)	Minimum[5] BV_{cbo} (Volts)	Minimum[6] BV_{ebo} (Volts)
2N6665	509	60	1.0 @ 5.0	28	10	20	2.5
MA42001	509	60	1.0 @ 5.0	28	10	20	2.5
MA42014	509	60	1.3 @ 5.0	28	10	20	2.5
MA42002	509	60	1.5 @ 5.0	28	10	20	2.5
MA42004	509	60	1.5 @ 15.0	30	10	20	2.5
MA42003	509	60	2.0 @ 5.0	30	10	20	2.5
MA42005	509	60	2.0 @ 20.0	30	10	20	2.5
MA42006	510	60	4.0 @ 40.0	35	10	20	2.5
MA42008	511	450	2.0 @ 5.0	18	10	20	2.5
MA42009	509	450	2.5 @ 5.0	14	10	20	2.5
MA42010	509	450	3.0 @ 20.0	15	10	20	2.5
MA42011	509	450	3.5 @ 20.0	15	10	20	2.5
MA42010	510	450	3.5 @ 40.0	20	10	20	2.5
MA42011	510	450	4.0 @ 40.0	20	10	20	2.5
MA42015	510	450	4.0 @ 60.0	20	10	20	2.5
MA42016	510	450	4.5 @ 60.0	20	10	20	2.5
MA42012	510	450	5.0 @ 60.0	20	10	20	2.5

NOTES:
1. The desired case style must be added as a suffix to the model number, i.e., MA42001-509.
2. VCE = 10 Volts.
3. Gu (MAX) (dB) = 10 LOG $\frac{|S21E|2}{|1\text{-}(S11E)2\ (1\text{-}|S22E|2)}$
4. VCB = 10 Volts.
5. Collector current = 10 μA.
6. Emitter current = 10 A.

MAXIMUM RATINGS (Case Temperature 25°C unless otherwise noted)

Total Device Power Dissipation	509 Case — 450 mW 510 Case — 1.2 W 511 Case — 750 mW
V_{cbo} Collector to Base Voltage	20 V
V_{ebo} Emitter to Base Voltage	3 V
Collector Current	125 mA
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He
Lead Temperature (Soldering — 10 seconds each lead)	250°C

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42197 Series
Description

Nominal FT = 2.5 GHz
Nominal Current Range = 5 to 40 mA
IC Max. = 100 mA
Frequency = 30 MHz to 600 MHz
Geometry = 60

The MA42197 NPN silicon planar bipolar transistor is designed to provide low noise figure and high gain at low cost. The high gain is due, in part, to the low lead inductance of the standard JEDEC TO-92 package (case style 524). This device exhibits excellent noise figure versus current characteristics which result in extremely low noise performance and wide dynamic range.

The chip used for this device is of planar interdigitated geometry, thermocompression bonded and encapsulated in this rugged package.

Specifications @ $T_A = 25°C$

Model Number	Test Frequency (MHz)	Collector[1] Current IC (mA)	Maximum Unilateral Power Gain GU (dB)	Nominal Noise Figures (dB)
MA42197	60	5.0	28	0.80
MA42197	100	5.0	26	0.95
MA42197	450	5.0	13	1.70

NOTES:
1. VCE = 10 volts.
2. (equation)
3. For performance curves, see MA42000 series

MA42020 Series and 2N2857

Description

Nominal fT = 1.8 GHz
Nominal Current Range = 1-5 mA
I_C Max. = 50 mA
Frequency = 10 MHz to 600 MHz
Geometry = 20

This series of NPN silicon planar transistors, packaged in the 509 case style are useful for low noise, high gain amplifiers from 10 to 600 MHz. All these transistors have gold metallization resulting in a rugged, highly reliable transistor.

Specifications @ $T_A = 25°C$

Model[1] Number	Test Frequency (MHz)	Maximum[4] Noise Figure (dB @ mA)	Maximum[5] Unilateral Gain (dB)	Minimum[6] BV_{cbo} (Volts)	Minimum[7] BV_{ebo} (Volts)
MA42020	60	1.6 @ 1.5	23	30	2.5
MA42021	60	2.0 @ 1.5	23	30	2.5
MA42022	60	2.5 @ 1.5	23	30	2.5
MA42023	60	2.0 @ 1.5	23	30	2.5
MA42024	60	3.0 @ 1.5	23	30	2.5
MA42025	450	2.5 @ 1.0	13	30	2.5
MA42026	450	3.0 @ 1.0	10	30	2.5
MA42027	450	3.5 @ 1.0	10	30	2.5
MA42028	450	4.0 @ 1.5	10	30	2.5
2N5031	450	2.5 @ 1.0	10	30	2.5
2N3570	450	2.5 @ 1.5	10	30	2.5
2N3953	450	3.0 @ 1.0	10	30	2.5
2N5032	450	3.0 @ 1.0	10	30	2.5
2N3880	450	3.5 @ 1.5	10	30	2.5
2N3839	450	3.9 @ 1.5	10	30	2.5
2N3571	450	4.0 @ 2.0	10	30	2.5
2N5054	450	4.0 @ 2.0	10	30	2.5
2N3683	450	4.5 @ 1.5	10	30	2.5
2N2857*	450	4.5 @ 1.5	10	30	2.5
2N5179	450	4.5 @ 2.0	10	30	2.5
2N5053	450	5.0 @ 2.0	10	30	2.5
2N3572	450	6.0 @ 2.0	10	30	2.5

NOTES:
1. This series of NPN silicon planar transistors is packaged in case style 509.
2. Maximum collector cutoff current is 10 μA, where V_{CB} = 15 volts.
3. The nominal current transfer ratio is 120 where V_{CE} = 1 volt, and I_C = 3 mA.
4. V_{CE} = 6 volts.
5. GU (max) can be derived from S-Parameter data:

$$\text{Gu (Max) (dB)} = 10 \log \frac{|S_{21E}|^2}{(1-|S_{11E}|^2)(1-|S_{22E}|^2)}$$

6. I_C = 1 μA.
7. I_E = 10 μA.

* This transistor can be screened to JAN level screening.

Silicon Low Noise Bipolar Transistors

MA42050 Series

Description

Nominal fT = 1.8 GHz
Nominal Current Range = 1 to 5 mA
I_C Max. = 40 mA
Frequency Range = 10 MHz to 600 GHz
Geometry = 55

The MA42050 series of NPN silicon planar transistors will give high gain and low noise figure characteristics in VHF amplifier applications. The refractory gold metallization techniques employed in the construction of these devices results in rugged, highly reliable transistors. This series is recommended for low power oscillators from 100 MHz to 16 GHz.

Specifications @ $T_A = 25°C$

Model[1] Number	Test Frequency (MHz)	Maximum[4] Noise Figure (dB @ mA)	Maximum[5] Unilateral Gain (dB)	Minimum[6] BV_{cbo} (Volts)	Minimum[7] BV_{ebo} (Volts)
MA42051	450	2.2 @ 3.0	18	20	2.5
MA42052	450	2.5 @ 3.0	18	20	2.5
MA42056	1000	4.5 @ 3.0	11	20	2.5

NOTES:

1. The MA42051 and MA42052 are available in the 509, 510, 511 case styles. The MA42056 is available in the 510 and 511 case styles. When ordering, specify the desired case style as a suffix to the basic model number, i.e., MA42051-510.
2. Gu (MAX) (dB) = 10 LOG $\frac{|S21E|2}{|1-|S11E|2\ (1-|S22E|2)}$
3. IC = 10 μA.
4. IE = 10 μA.
5. VCE = 1 Volts; IC = 3 mA; Nominal current transfer ratio = 75.
5. VCB = 10 Volts; Maximum collector current = 40.0 mA.

MAXIMUM RATINGS (Case Temperature 25°C unless otherwise noted)

Total Device Power	509 Case — 300 mW
	510 Case — 450 mW
	511 Case — 350 mW
V_{cbo} Collector to Base Voltage	20 V
V_{ebo} Emitter to Base Voltage	2.5 V
Collector Current	40 mA
Storage Temperature	−65°C to +200°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He
Operating Junction Temperature	+200°C
Lead Temperature (Soldering — 10 seconds each lead)	230°C

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42217 and MA42218 Series

Description

Nominal fT = 1.8 GHz
Nominal Current Range = 1 to 5 mA
I_C Max. = 50 mA
Frequency = 10 — 600 MHz
Geometry = 55

The MA42217 and MA42218 NPN silicon planar bipolar transistors are designed to provide low noise figure and high gain from 30 to 500 MHz at a moderate cost. The high gain is due, in part, to the low lead inductance of the standard JEDEC TO-92 package (case style 524). These devices exhibit excellent noise figure versus current characteristics which results in extremely low noise performance and wide dynamic range.

The transistor chips used are constructed with planar interdigitated geometry and are encapsulated in the rugged (case style 524) TO-92 package. These devices can be screened to JANTX, JANTXV, levels. Applications for these devices include UHF and VHF low noise amplifiers.

Specifications @ $T_A = 25°C$

Model Number	Test Frequency (MHz)	Collector Current I_C (mA)	Nominal Noise Figure (dB)
MA42217	60	1	1.0
MA42217	60	3	1.7
MA42217	100	1	1.0
MA42217	100	3	1.7
MA42218	450	1	2.3
MA42218	450	3	2.9

MA42120 Series

Description

Nominal fT = 1.5 GHz
Nominal Current Range = .4 to 3 mA
I_C Max. = 80 mA
Frequency = 100 to 600 MHz
Geometry = 70

This series of NPN epitaxial silicon planar transistors is designed for 100 MHz to 1 GHz amplifiers and low power oscillators up to 4 GHz. The high gain bandwidth products make the MA42122 and MA42123 useful to 1.0 GHz , while the MA42121 has the maximum frequency of oscillation of 4.2 GHz. Two case styles are offered, case stye 508 for low power oscillator applications and case style 509 for small signal IF and RF amplifiers.

Specifications @ $T_A = 25°C$

Model[1] Number	Case Style	Maximum[2] Noise Figure (dB)	Maximum[2] Unilateral Gain G_U (dB)	Minimum[4] Gain Bandwidth f_T (GHz)	Maximum[4] Available Gain G_A(dB)	Maximum[3,5] Frequency Oscillation (GHz)
MA42120	508	—	13	1.0	—	3.8
MA42121	508	—	13	1.3	12.8	4.2
MA42122	509	3.5	14	1.0	—	—
MA42123	509	3.0	14	1.3	13.8	

NOTES:
1. When ordering, specify the package, by adding the case style as a suffix to the basic model number, i.e, MA42120-508.
2. The test frequency for the MA42120 series is 450 MHz.
3. V_{CE} = 10 volts, I_C = 20 mA, Frequency = 500 MHz.
4. V_{CE} = 10 volts, I_C = 20 mA, Frequency = 1 GHz.
5. The maximum frequency of oscillation is calculated from S-parameters, Fmax is the frequency at which the extrapolated Ga (max) is 0 dB.
6. I_C = 10 μA., I_E = 0.
7. The minimum collector to base breakdown voltage is 30 volts.
8. The nominal neutralized power gain for the MA42123-509 is 17.0 dB.
9. The collector current for the MA42122 and MA42124 is 1.5 mA.

MAXIMUM RATINGS (Case temperature 25°C unless otherwise noted)

Total Power Dissipation	508 case — 1.0 W 509 case — .5 W
V_{cbo} Collector to Base Voltage	30 V
V_{ebo} Emitter to Base Voltage	4.0 V
V_{ces} Collector to Emitter Voltage	30 V
I_C Collector Current	80 mA
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering — 10 seconds each lead)	+250°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles, −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42151 and MA42191 Series

Description

Nominal fT — 4.5 GHz
Nominal Current Range = 1 to 10 mA
I_C Max. = 100 mA
Frequency = 300 MHz to 2.0 GHz
Geometry = 63

These NPN planar transistors are characterized for local oscillator use in to 1.0 to 3.0 GHz range. The MA42151 when mounted in a common base package (case style 510) exhibits a typical Fmax of 9.5 GHz at 20 mA collector current and at 3.0 GHz has a guaranteed power output. The MA42191 in case style 510 exhibits a typical Fmax of 6.0 GHz at 50 mA collector current and has a guaranteed power output at 2.0 GHz. This transistor is available in the hermetically sealed case style 510 stripline package and meets the MIL-S-19500 environmental ratings and test requirements of MIL-STD-750/883.

Specifications @ $T_A = 25°C$

Model[1] Number	Minimum[2] BV_{cbo} (Volts)	Minimum[3] BV_{ebo} (Volts)	Minimum[4] BV_{ceo} (Volts)	Minimum[5] Oscillator Power (mW)	Collector[6] Current (mA)	Nominal[7] Current Transfer Ratio
MA42151	27	1.5	20	20	50	60
MA42191	30	3.5	25	350	300	40

NOTES:
1. The standard case style for the MA42151 and MA42191 is case style 510. The MA42151 is also available in the hermetically sealed 511 stripline package and meets the MIL-S-19500 environmental ratings and tests requirements of MIL-STD-750/883.
2. I_C = 10 μA for MA42151; I_C = 100 μA for MA42191.
3. I_E = 10 μA.
4. I_C = 500 μA.
5. I_C = 100 μA.
6. V_{CE} = 10 volts; IC = 5 mA
7. V_{CE} = 5 volts: IC = 100 mA.

MAXIMUM RATINGS FOR MA42191 (Case temperature 25°C unless otherwise noted)

Total Device Power	510 case — 3.0 W
V_{cbo} Collector to Base Voltage	30V
V_{ebo} Emitter to Base Voltage	3.5 V
V_{ceo} Collector to Emitter Voltage	25 V
Collector Current	300 mA
Storage Temperature	−65°C to +200°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He
Operating Junction Temperature	+200°C
Lead Temperature (soldering — 10 seconds each lead)	+230°C

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200 °C
Temperature Cycle	1051	10 cycles, −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

MA42181 Transistors

Description

Nominal fT = 2.8 GHz
Nominal Current Range = 10 to 60 mA
I_C Max. = 300 mA
Frequency Range = 10 MHz to 1 GHz
Geometry = 02

The MA42181 transistor is designed for wide dynamic range amplifier applications from 100 MHz to 3 GHz. Other applications include second stage high dynamic range amplifiers and low level oscillators.

Specifications @ $T_A = 25°C$

Model Number	Case[1] Style	Minimum[1] BV_{cbo} (Volts)	Minimum[2] BV_{ebo} (Volts)	Minimum[3] BV_{ceo} (Volts)	Compress[5] Point 1 dB (dBm)	Maximum[8] Unilateral Gain (dB)
MA42181	510	30	3.5	25	+25	8.4

NOTES:
1. I_C = 100 μA.
2. I_E = 10 μA.
3. I_C = 100 μA.
4. Nominal current transfer ratio is 60; VCE = 15 Volts; IC = 100 mA.
5. VCE = 15 Volts; IC = 60 mA; ZG = ZL = 500 Ohms; Frequency = 1 GHz.
6. The nominal |S21E| 2 is 2.0 dB; VCE = 15 Volts; IC = 60 mA; Frequency = 2 GHz.
7. The nominal gain at optimum noise figure is 14.5 dB; VCE = 15 Volts; IC = 60 mA; Frequency = 1 GHz.
8. VCE = 15 Volts; IC = 60 mA; Frequency = 1 GHz.

MAXIMUM RATINGS (Case Temperature 25°C unless otherwise noted)

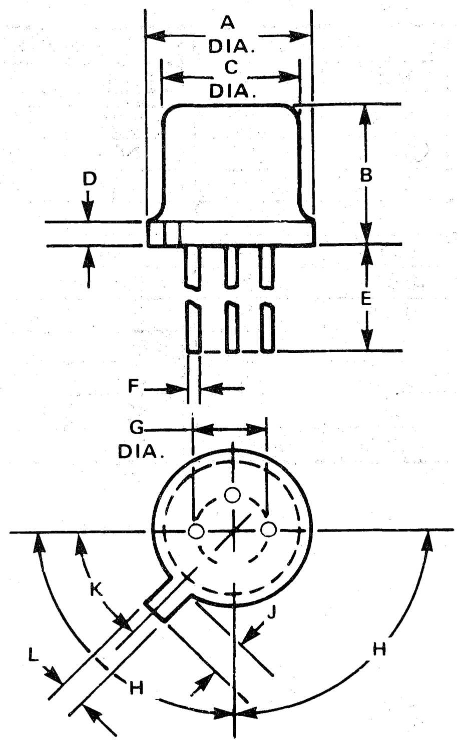
Total Device Power	510 Case — 3.0 mW
V_{cbo} Collector to Base Voltage	30 V
V_{ebo} Emitter to Base Voltage	25 V
Collector Current	300 mA
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Hermeticity	5 X $(10)^{-8}$ cc/sec of He
Lead Temperature (Soldering — 10 seconds each lead)	230°C

ENVIRONMENTAL RATINGS PER MIL-STD-750

	Method	Level
Storage Temperature	1031	−65°C to +200°C
Temperature Cycle	1051	10 cycles −65°C to +200°C
Shock	2016	500 g's
Vibration	2056	15 g's
Constant Acceleration	2006	20,000 g's
Humidity	1021	10 days

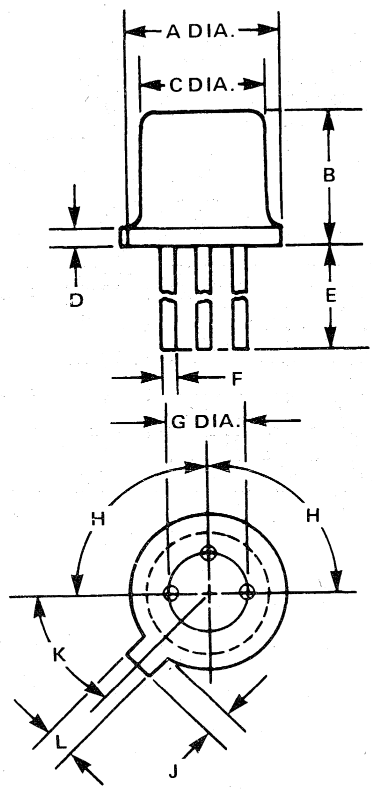
Case Styles

506



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.350	0.370	8,89	9,40
B	0.240	0.260	6,11	6,60
C	0.315	0.335	8,00	8,51
D	— —	0.040	— —	1,02
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.190	0.210	4,83	5,33
H	89°	91°	89°	91°
J	0.029	0.043	0,74	1,09
K	43°	47°	43°	47°
L	0.028	0.034	0,71	0,86

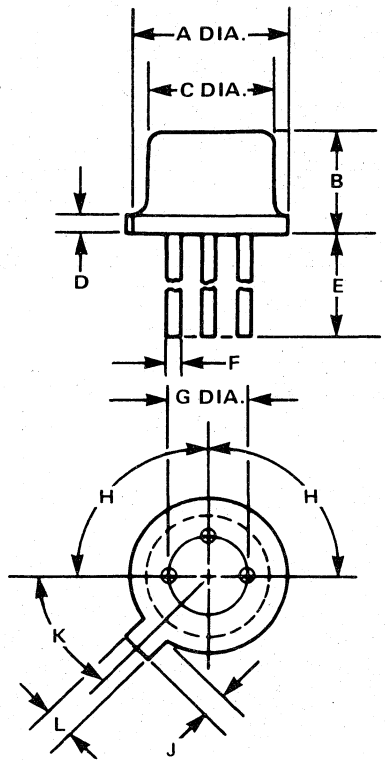
507



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.209	0.230	5,31	5,84
B	0.170	0.210	4,32	5,33
C	0.178	0.195	4,52	4,95
D	— —	0.030	— —	0,76
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.090	0.110	2,29	2,75
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

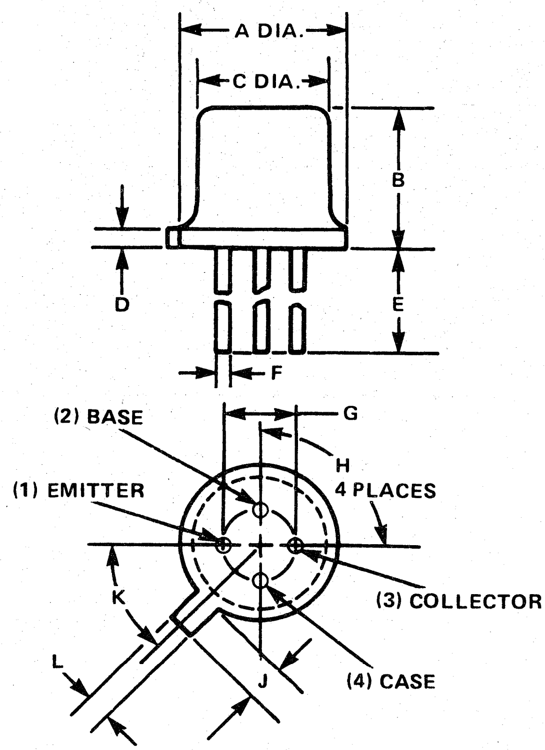
Case Styles (Cont'd)

508



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.209	0.230	5,31	5,84
B	0.065	0.085	1,65	2,16
C	0.178	0.195	4,52	4,95
D	— —	0.030	— —	0,76
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.090	0.110	2,29	2,75
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

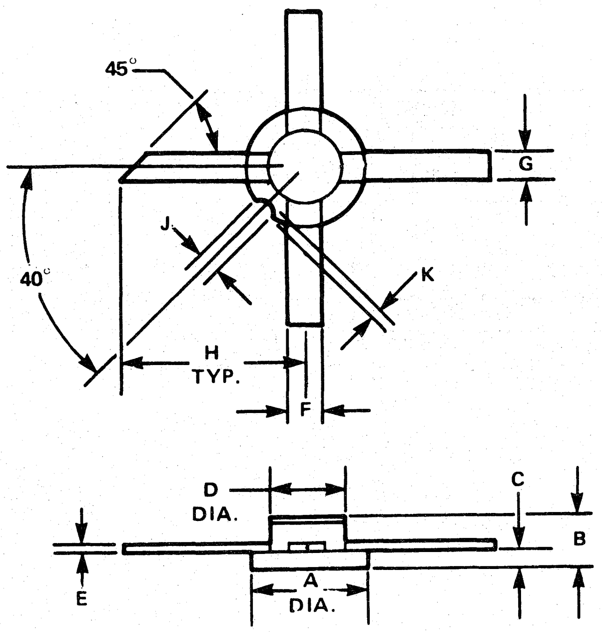
509



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.209	0.230	5,31	5,84
B	0.170	0.210	4,32	5,33
C	0.178	0.195	4,52	4,95
D	— —	0.020	— —	0,51
E	0.500	— —	12,70	— —
F	0.016	0.019	0,41	0,48
G	0.090	0.110	2,29	2,79
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

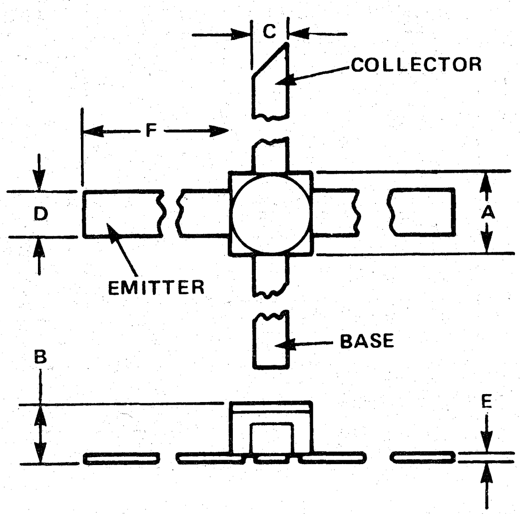
Case Styles (Cont'd)

510



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.195	0.215	4,95	5,46
B	0.043	0.063	1,09	1,60
C	0.016	0.024	0,41	0,61
D	0.129	0.141	3,28	3,58
E	0.0015	0.0045	0,04	0,11
F	0.054	0.066	1,37	1,68
G	0.024	0.036	0,61	0,91
H	0.279	0.321	7,09	8,15
J	0.030 REF.		0,76 REF.	
K	0.150 REF.		0,38 REF.	

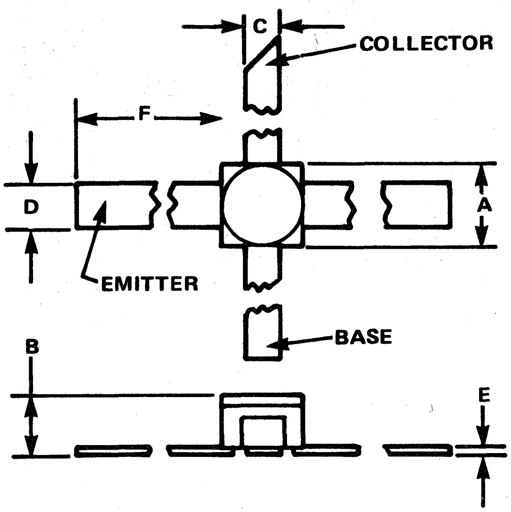
511



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.095	0.105	2,41	2,68
B	— —	0.050	— —	1,27
C	0.016	0.024	0,41	0,61
D	0.036	0.044	0,91	1,12
E	0.002	0.006	0,05	0,15
F	0.190	0.260	4,83	6,60

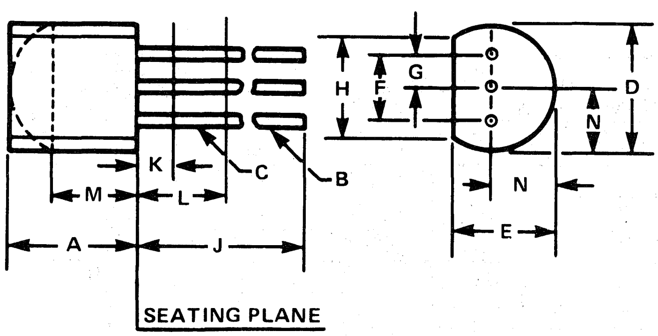
Case Styles (Cont'd)

512



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.065	0.075	1,65	1,91
B	— —	0.050	— —	1,27
C	0.016	0.024	0,41	0,61
D	0.036	0.044	0,91	1,12
E	0.002	0.006	0,05	0,15
F	0.230	0.280	5,84	7,11

524



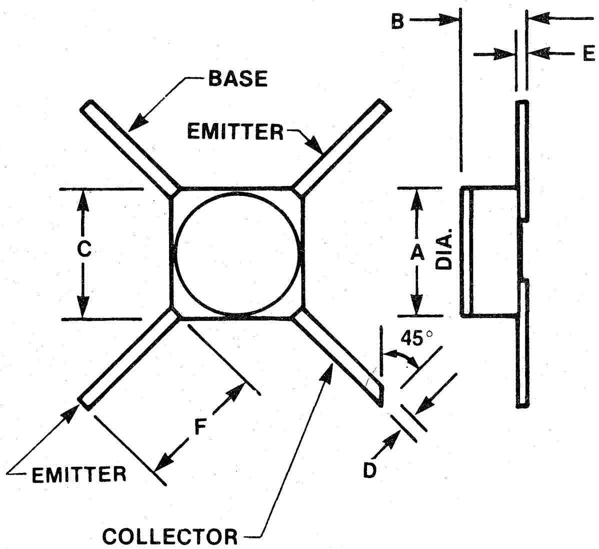
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.170	0.210	4,58	5,33
B[1,3]	0.016	0.021	0,407	0,533
C[3]	0.016	0.019	0,407	0,482
D	0.175	0.205	4,96	5,20
E	0.125	0.165	3,94	4,19
F	0.095	0.105	2,42	2,66
G	0.045	0.055	1,15	1,39
H	0.135	— —	3,43	— —
J[1,3]	0.500	— —	12,70	— —
K[3]	— —	0.050	— —	1,27
L[3]	0.250	— —	6,35	— —
M[2]	0.115	— —	2,93	— —
N	0.080	0.105	2,42	2,66

NOTES:

1. Three leads.
2. Contour of the package beyond this zone is uncontrolled.
3. (Three leads) dimension C applies between dimensions K and L. Dimension B applies between dimension L and .5" (12.70 mm) from seating plane. Diameter is uncontrolled in dimension K and beyond .5 (12.70 mm) from seating plane.

Case Styles (Cont'd)

535



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.082	0.092	2,08	2,37
B	0.040	0.058	1,02	1,47
C	0.090	0.100	2,29	2,45
D	0.018	0.022	0,46	0,56
E	0.003	0.005	0,08	0,13
F	0.090	0.125	2,29	3,17

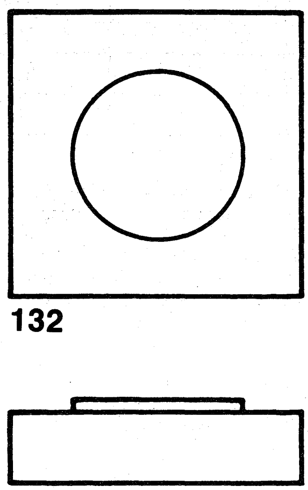
Ordering Information

Orders for products from M/A-COM Semiconductor Products Operation should be placed with our local sales office. Should there be a need for factory sales or applications engineering assistance, contact M/A-COM directly.

MNS Capacitor Chips

MA4M Series

MNS Microwave Chip Capacitors



132

Features

- EXCELLENT REPEATABILITY (WAFER TO WAFER AND LOT TO LOT)
- SMALL SIZE
- LOW LOSS
- AVAILABLE WITH ROUND AND SQUARE BONDING PADS

Description

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

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

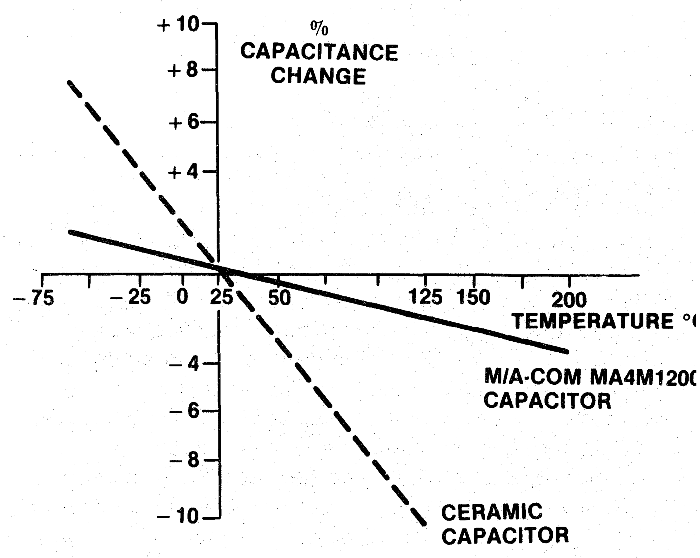
These chip capacitors are suited for applications requiring dc blocks, coupling capacitors, bypass capacitors, capacitive loads and tuning elements of oscillators, multipliers and filters.

Specifications

Chip Capacitors with Round Bonding Pads				
Model Number	Capaci-tance (pF)[1,2,3,4] ± 10%	Maximum Standoff Voltage Rating[2,5] Volts	Chip Style	Nominal Top Contact Diameter (mils)
MA4M2001	1	200	132	2.5
MA4M2002	2	200	132	3.5
MA4M2005	5	200	132	6.0
MA4M1010	10	100	132	6.0
MA4M2010	10	200	132	8.0
MA4M1020	20	100	132	9.0
MA4M2020	20	200	132	11.5
MA4M1030	30	100	132	11.0
MA4M2030	30	200	132	14.0
MA4M1040	40	100	132	13.0
MA4M2040	40	200	199	16.0
MA4M1050	50	100	132	14.0
MA4M2050	50	200	199	18.0
MA4M1060	60	100	199	16.0
MA4M2060	60	200	199	20.0
MA4M1080	80	100	199	18.0
MA4M2080	80	200	199	23.0
MA4M1100	100	100	199	20.0
MA4M2100	100	200	200	26.0
MA4M1125	125	100	199	22.0
MA4M2125	125	200	200	29.0
MA4M1150	150	100	200	25.0
MA4M2150	150	200	200	31.5
MA4M1200	200	100	200	28.0
MA4M2200	200	200	201	36.0
MA4M1250	250	100	200	32.0
MA4M2250	250	200	201	41.0
MA4M1300	300	100	201	35.0
MA4M2300	300	200	263	45.0
MA4M1600	600	100	263	48.0
MA4M2600	600	200	267	64.0

Chip Capacitors with Square Bonding Pads			
Model Number	Capacitance (pF)[1,2,3,4] ± 10%	Maximum Standoff Voltage Rating[2,5] Volts	Chip Style
MA4M3010	10	200	350
MA4M3020	20	200	351
MA4M3030	30	200	352
MA4M3040	40	200	353
MA4M3050	50	200	354
MA4M3060	60	100	355
MA4M3070	70	50	356
MA4M3080	80	100	357
MA4M3100	100	50	358
MA4M3150	150	50	359

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

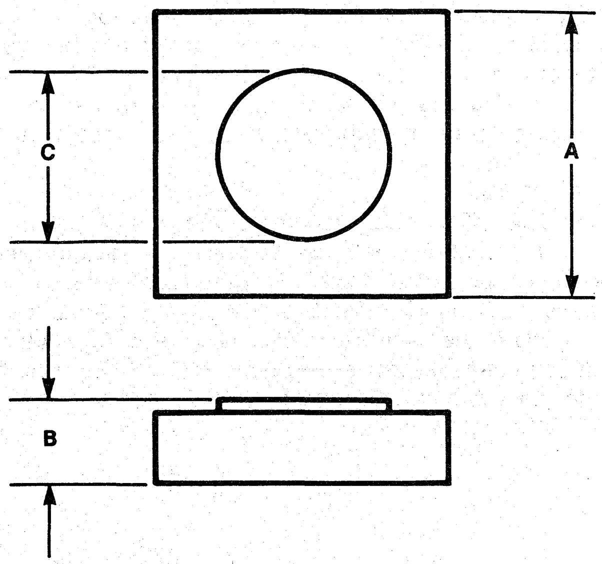


Typical Capacitance Change for MNS vs. Ceramic Capacitor with Temperature (200 pF Capacitor)

MAXIMUM RATINGS

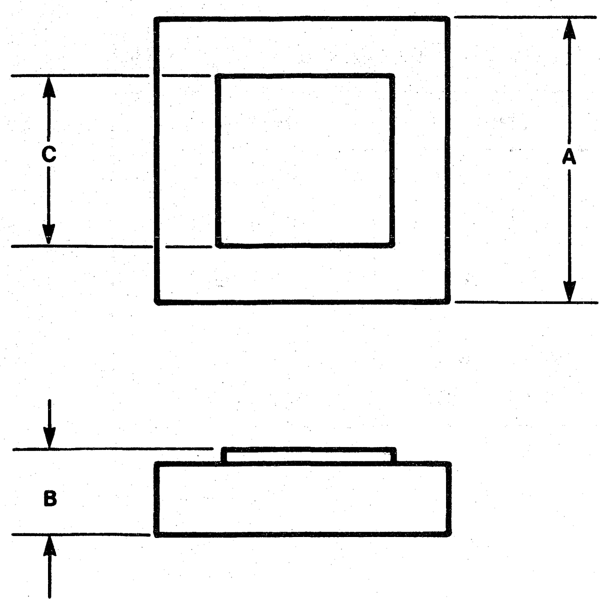
Applied Voltage	Specified standoff voltage
Operating Temperature	−55°C to +200°C
Storage Temperature	−55°C to +225°C

Chip Styles



CHIP STYLE	DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
132	A	0.020	0.024	0,51	0,61
	B	0.003	0.006	0,08	0,15
199	A	0.027	0.031	0,69	0,79
	B	0.004	0.005	0,10	0,13
200	A	0.037	0.041	0,94	1,04
	B	0.004	0.005	0,10	0,13
201	A	0.047	0.051	1,19	1,30
	B	0.004	0.005	0,10	0,13
263	A	— —	0.060	— —	1,52
	B	0.004	0.005	0,10	0,13
267	A	— —	0.070	— —	1,78
	B	0.004	0.005	0,10	0,13

NOTE: FOR "C" DIMENSION ON ABOVE CASE STYLES, SEE SPECIFICATIONS



CHIP STYLE	DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
350	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.009	— —	0,23
351	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.012	— —	0,30
352	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.015	— —	0,38
353	A	0.020	0.023	0,51	0,58
	B	— —	0.005	— —	0,13
	C	— —	0.017	— —	0,43
354	A	0.020	0.023	0,51	0,58
	B	— —	0.005	— —	0,13
	C	— —	0.018	— —	0,46
355	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.014	— —	0,36
356	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.011	— —	0,28
357	A	0.020	0.023	0,51	0,58
	B	— —	0.005	— —	0,13
	C	— —	0.017	— —	0,43
358	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.013	— —	0,33
359	A	0.018	0.021	0,46	0,53
	B	— —	0.005	— —	0,13
	C	— —	0.016	— —	0,41

Bonding and Handling Considerations for MNS Chip Capacitors

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

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

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

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

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

COMPARISON OF M/A-COM MNS CAPACITORS TO CERAMIC CHIP CAPACITORS

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

All specifications are subject to change without notice.

Quality and Reliability Section for Diodes and Transistors

Quality and Reliability

DIODE AND TRANSISTOR PRODUCTS

DISCUSSION

This section discusses the reliability of M/A-COM Semiconductor Products Operation diodes and transistors, how the reliability of a diode is defined, tested and demonstrated, and what reliability means to the user. However, prior to any reliability discussion, a review of quality control, key processing features, electrical and environmental screening is necessary.

QUALITY CONTROL

The quality control function at M/A-COM Semiconductor Products Operation is one of total involvement in the design, development, manufacturing and reliability assurance of our semiconductor devices. The key responsibilities of M/A-COM Semiconductor Products Operation, quality control are:

— Incoming inspection of all purchased materials to documented specifications.
— Calibration of manufacturing equipment on a regular basis against known standards.
— Q.C. on-line inspection of products at various key steps during the manufacturing process as shown in the process flow diagram of the individual part.
— Performance of all electrical and environmental screening, Group B and Group C testing and other reliability tests per the appropriate MIL-STD procedures or customer specifications.
— Final inspection of the product to customer specification prior to shipment.
— Responsibility for introduction, maintenance, review and adherence to documented specifications for all processes in the manufacturing of M/A-COM Semiconductor Products Operation devices.

M/A-COM Semiconductor Products Operation welcomes a customer review of our quality control procedures.

RELIABILITY

Product reliability is the culmination of a carefully planned design, development and manufacturing effort using the most up-to-date proven processing techniques. Reliability is defined as the probability of a device performing its function adequately for the period of time intended, under the operating conditions encountered. Three factors needed to define reliability are:

— Probability of survival
— Operating time period
— Operating conditions

These reliability factors are expressed as precise numerical quantities, and a statement of reliability that omits one, is of no value.

It is also important to note that a product which is a high quality device, may not have a high degree of reliability. However, a product which has a high degree of reliability is a high quality device. M/A-COM Semiconductor Products Operation provides high reliability and high quality products.

FAILURE RATE

For a single component series system (a system that fails when one component fails) a plot of system failure rate will be identical to the component failure rate. The graph (Figure 1) illustrates a typical failure rate curve, applicable to any semiconductor device. Initially, the failure rate is higher than allowed by system design. This is called the "early failure period." These "early" failures are the result of defects introduced into the manufacturing process and remain undetected despite the implementation of stringent processing controls.

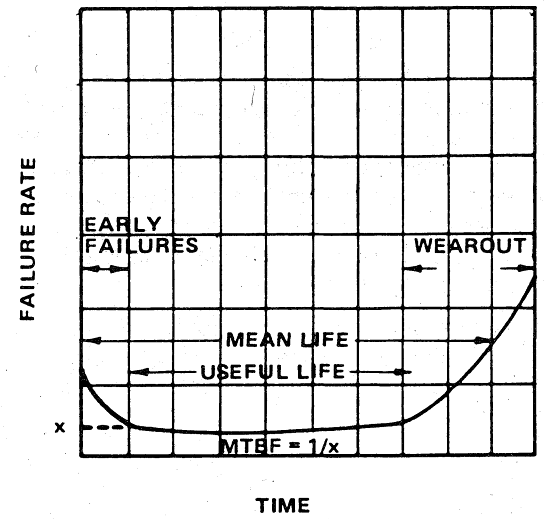


FIGURE 1. Component Failure Rate

These early failures can be brought to an acceptable level before installation of the device into a system by electrical and environmental screening. This process is referred to as "burn-in". After the initial early failure rate, the system will stabilize and exhibit a constant failure rate. M/A-COM Semiconductor Products Operation offers burn-in and screening services to eliminate early failures.

The period during which the failure rate remains constant is the "useful life" of the system. During this period, the component can be utilized to its greatest advantage. The failures that do occur are called "chance failures". The physical mechanism of "chance failures" is the sudden accumulation of stresses acting in and on the component. To minimize the chance failure rate, components should be operated at specified rated levels that have been conservatively selected. For mixer or detector diodes, operating levels should not exceed more than one tenth the rated CW or pulse burn-out levels.

For example, a Schottky diode operating at levels below the specified burn out ratings will be less prone to burn out than a similar device operating close to the maximum ratings should a sudden system overvoltage exceed specified safe operating conditions.

Customers and manufacturers must jointly evaluate reliability/cost trade offs, optimum selection of operating conditions and device features to ensure that reliability is achieved. Reliability is then the virtual elimination of field failures within the intended and useful life of the system.

The reliability, R (t) at time, t, in the useful life region is given by the expression:

$$R(t) = e^{-xt} \qquad (1)$$

where the function R (t) is the probability that the device, which has a constant failure rate, will not fail in the given operating time, t. The mean time between failures (MTBF) is the reciprocal of T:

$$MTBF = 1/x \qquad (2)$$

Specifying MTBF is the most common method of expressing a reliability, but it must be used with caution. Before MBTF can be applied to a situation, it is necessary to estimate the mean life of the component. The mean life is defined as the the time it takes for half of a given population to fail. Mean lifetime includes the failure from the wearout region. Wear out occurs at the end of a product's life cycle and is the result of the component's "age."

In most semiconductor circuit applications, the mean life is designed to be much greater than the actual intended life of the system. This is to prevent wear out from contributing to the failure rate.

To illustrate these concepts, consider purchasing 100,000 light bulbs. To establish an MTBF rating, each light bulb could simultaneously be operated for 100 hours. If ten bulbs failed, the determined MTBF would be:

$$MTBF = \frac{100,000 \times 100}{10} = 10^6 \text{ hours} = 114 \text{ yrs.}$$

This is an impressive number. However, this does not mean that the bulbs can be operated 10^6 hours. The mean life is probably no more than several thousand hours and the user must clearly understand this difference or he may be disappointed after a half year, that only half of the bulbs are operational. MTBF estimates are useless unless accompanied by an estimate of the products' mean life.

A component exhibiting a MBTF of 10^6 hours, by means of Equation 1, in all probability (99.99%) will not fail in any given 10 hour period. (Operation must be restricted to the useful life period of the component).

The major difference between the useful life period and the wear out region is that the failure rate is constant for chance failures. As the wear out increases and the operating time reaches the mean time, the failure rate increases. Extensive investigations of the failure region have been performed. The results indicate that characteristic failure mechanisms have been identified and in many cases, these can be reduced or eliminated.

The failure rate of these mechanisms is a strong function of temperature and follows the Arrhenius law:

$$FR = Ae^{\frac{Ea}{kT}}$$

where: FR = Failure Rate
A = Constant
Ea = Activation Energy
k = Boltzmann's Constant
T = Temperature (°K)

At room temperature, for well designed and thoroughly screened parts, the mean life of semiconductors can exceed 10^8 hours (more than 11,400 years). Experiments to determine failure rate at room temperature cannot be performed because of the long time span required. However, if the temperature is sufficiently raised, the failure rate will increase to a measurable level within a reasonable time frame (100 to 10,000 hours). Such testing, called "accelerated" or "step stress" testing, is used to assess the mean life of many semiconductor devices, despite the implicit assumption that the failing mechanisms are the same at all temperatures. Experimental care and analysis are needed before such extrapolations can be made.

Activation energies have been assigned to various isolated failure mechanisms. The failures have been determined by careful physical analysis of failed parts. Three of particular importance are given in Table 1.

Mechanism of Reaction	**Ea (eV)**
Oxide charge drift	≈1.02
Electromigration	
gold	≈ .61
nichrome	≈ .50
platinum	≈ .70
titanium	≈ .60
Diffusion into silicon	
gold	1.0
nichrome	1.5
platinum	1.6
titanium	2.1-2.6
Gold diffusion through a molybdenum blocking layer and refractory metal barrier	1.5-1.8

TABLE 1.

Oxide charge drift, which leads to leakage current and low frequency parameter drifts and noise, was an early problem with most semiconductor devices. However, the rapid advances made in metal oxide silicon (MOS) technology were brought about by the ability to control oxide charge drift through meticulous and clean processing schedules and today's microwave devices fully utilize these technological advances. Seldom, if ever, do they experience this problem, and wafers that do are eliminated through the use of screening procedures.

The very high activation energy of the gold molybdenum refractory metallization system, where diffusion of gold finally penetrates the barrier metal and diffuses into the silicon, means that at a normal system operating temperature of 150°C, the mechanism does not contribute to early failures.

As a consequence of these technology improvements, thoroughly screened M/A-COM Schottky diodes are estimated to meet the MTBF mean life and FIT/"failure in time" reliability levels shown.

M/A-COM Semiconductor Products Operation's Silicon Schottky diodes are made with a silicon dioxide and silicon nitride passivation and use pure gold contacts with refractory metal barriers and a molybdenum blocking layer. For such devices, at reasonable operating temperatures, the passivation failures are insignificant. The refractory metal contact scheme does not fail by diffusion, alloying or cracking until very high temperature time levels are reached (such as 250°C for 100 hours). This reliability results in an extremely long mean life for such devices. An approximate curve of mean life versus temperature for refractory metal barrier Schottky diodes is shown in Figure 2.

DEFINITION OF RELIABILITY LEVEL DATA (FAILURES IN TIME)

One "FIT" is the failure rate, if one diode failure occurs in 10^9 device hours of operation. A device hour can be obtained in any number of ways. It is one device operating for one hour, or two devices operating for 1/2 hours, etc.

Suggested screening sequences for several diode types are shown in Figures 3 through 6. The level of reliability is the customer's option.

PRECAUTION FOR HANDLING RECEIVING DIODES DURING TESTING AND INSERTION

Most mixer and detector diodes have very small junctions. They are sensitive to electrostatic shock and overvoltages.

The loss of expensive screened mixer diodes during testing and equipment assembly can be a major problem unless care is taken during these steps to avoid conditions which can lead to burnout. Care must be taken not to allow a static charge to come in contact with the diode. Proper bonding and handling procedures for chip diodes are discussed on in the bonding and handling section.

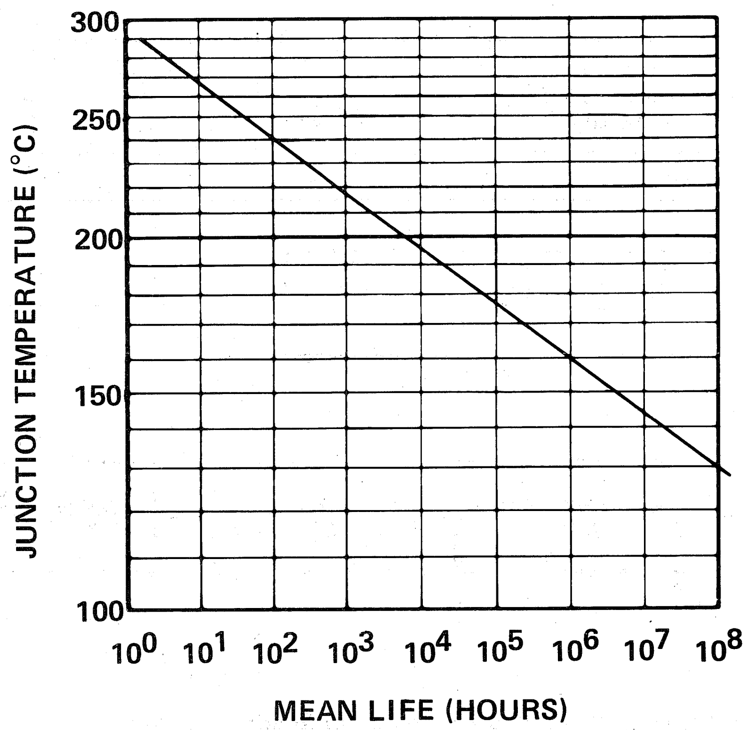


FIGURE 2. Mean Life vs. Junction Temperature for Silion Schottky Diodes Made With Refractory Metals for Barriers and Silicon Diodes with Silicon Nitride Passivation

The following pages indicate screening levels that can be applied to various SPO products. If screened products are required, they may be ordered by indicating the screening level on the purchase order.

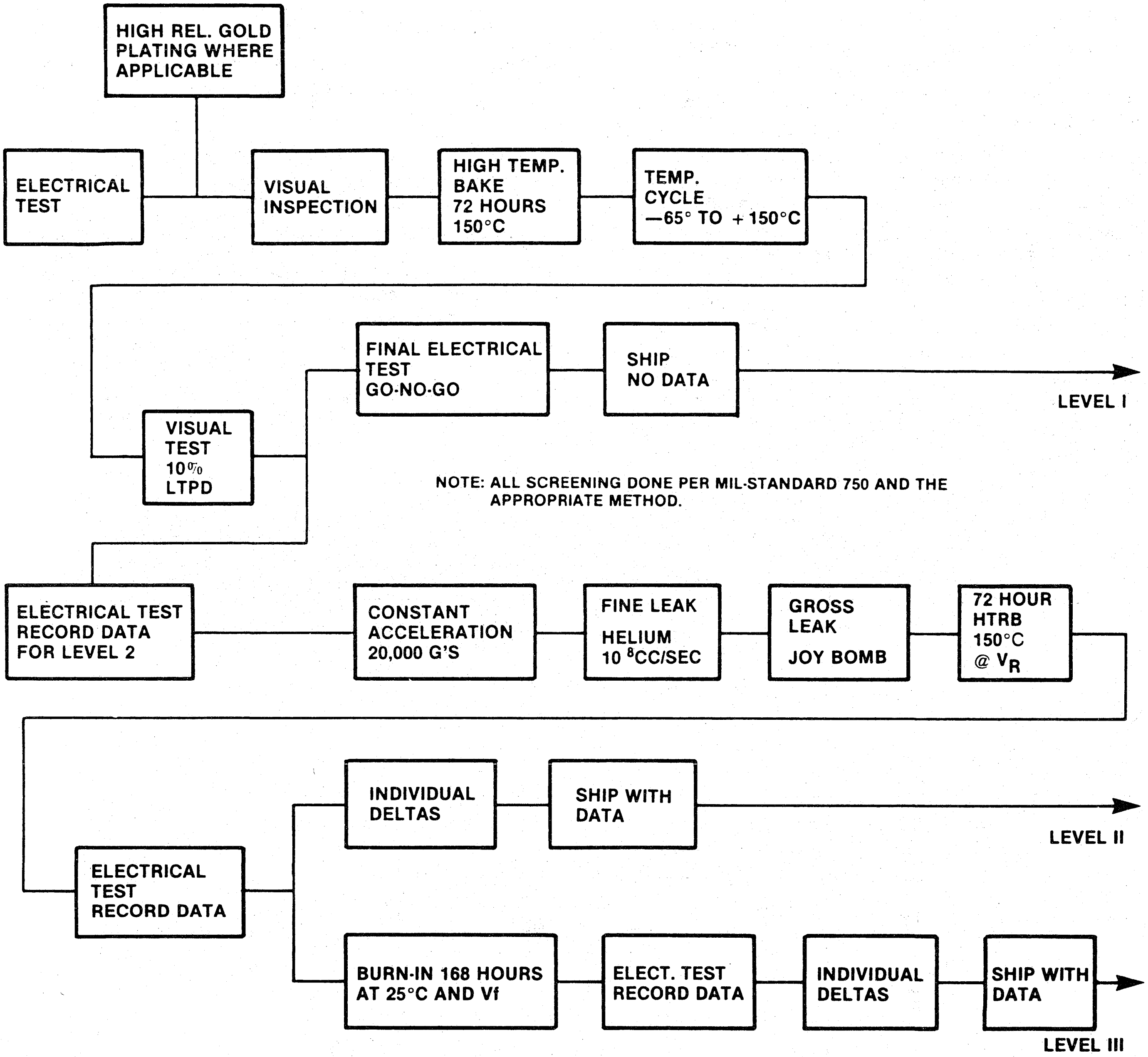


FIGURE 3. Screening Programs for Schottky Diodes

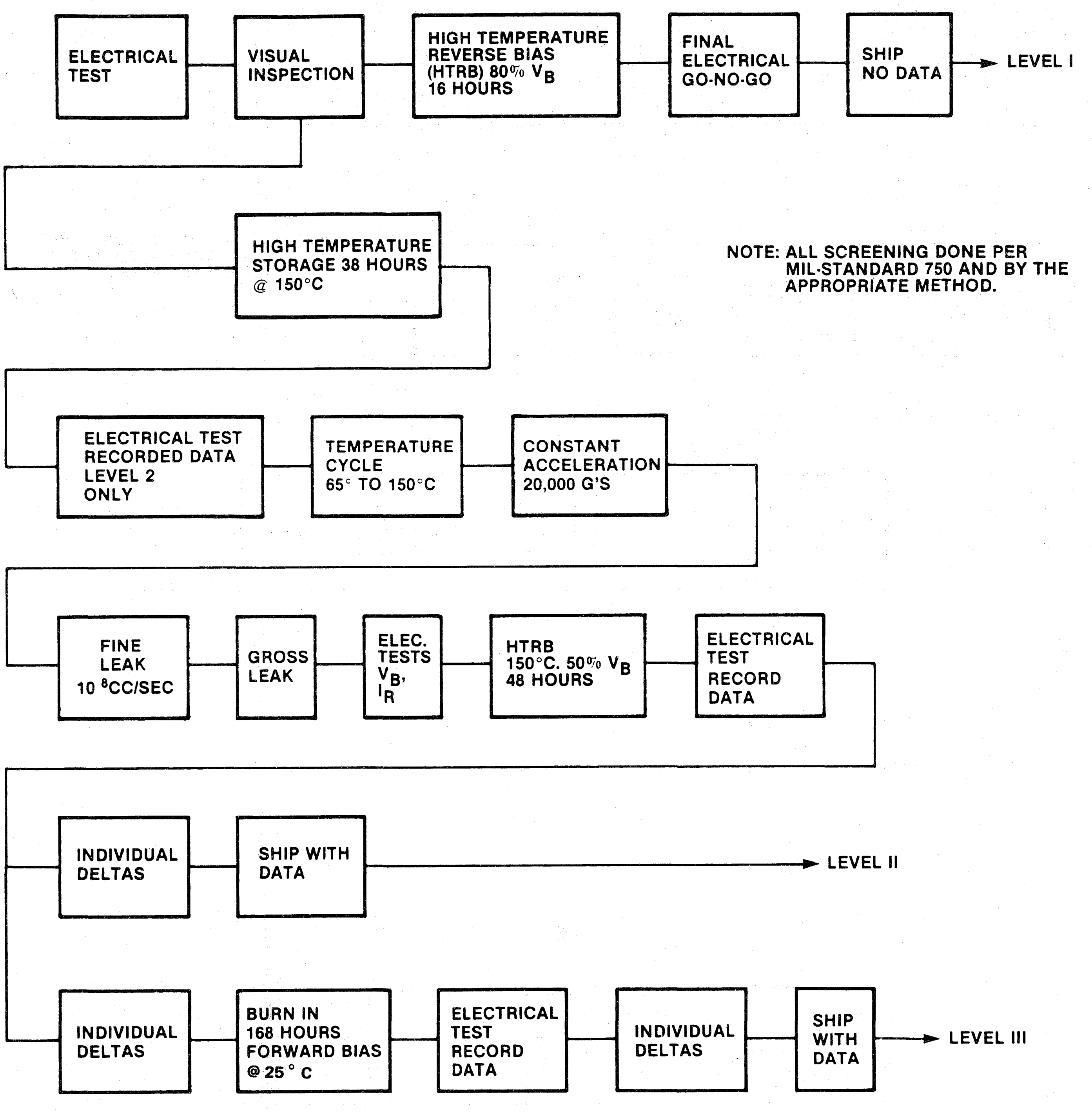
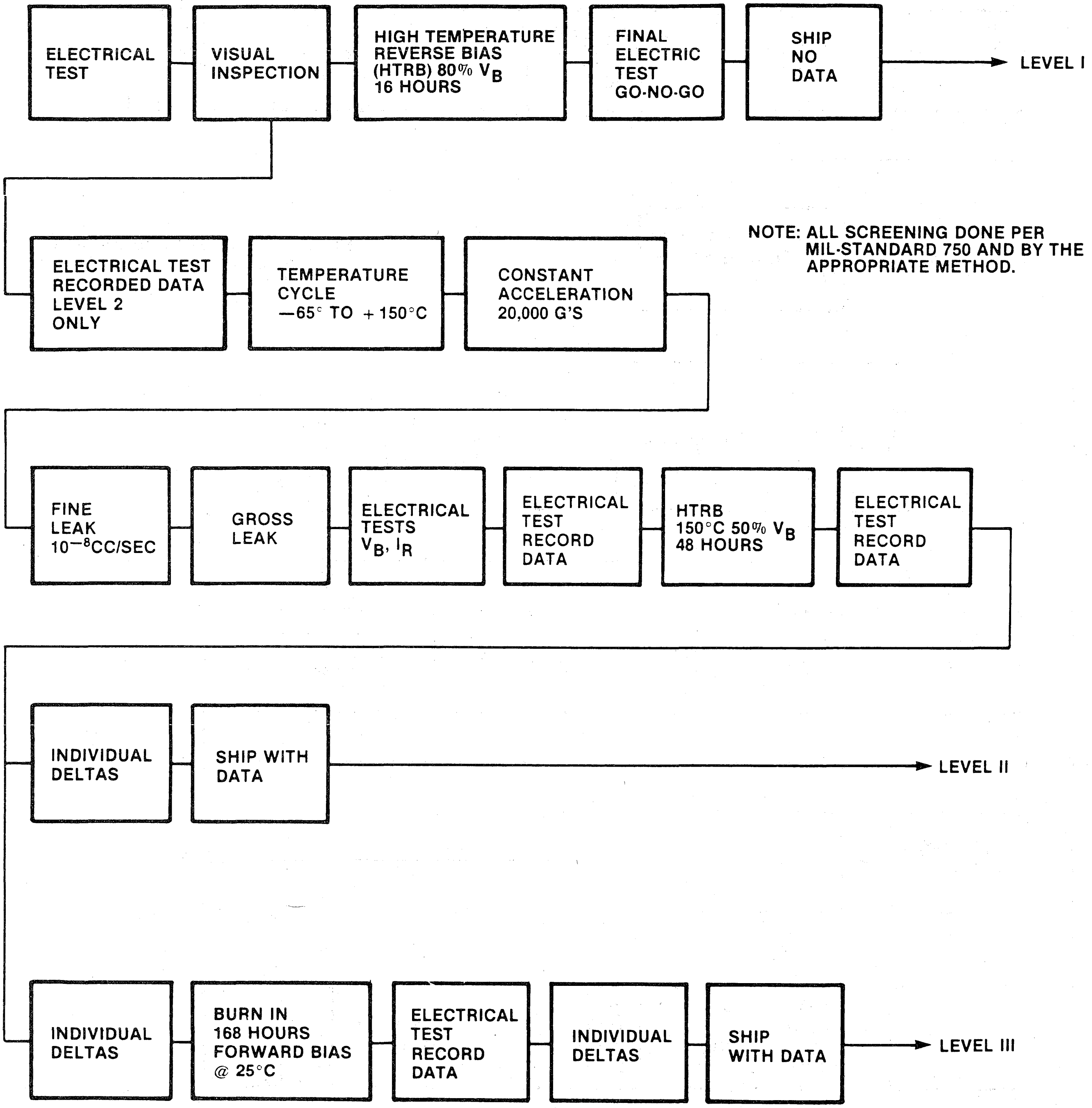


FIGURE 4. Screening Programs for PIN Diodes



NOTE: ALL SCREENING DONE PER MIL-STANDARD 750 AND BY THE APPROPRIATE METHOD.

FIGURE 5. Screening Programs for Varactor Diodes

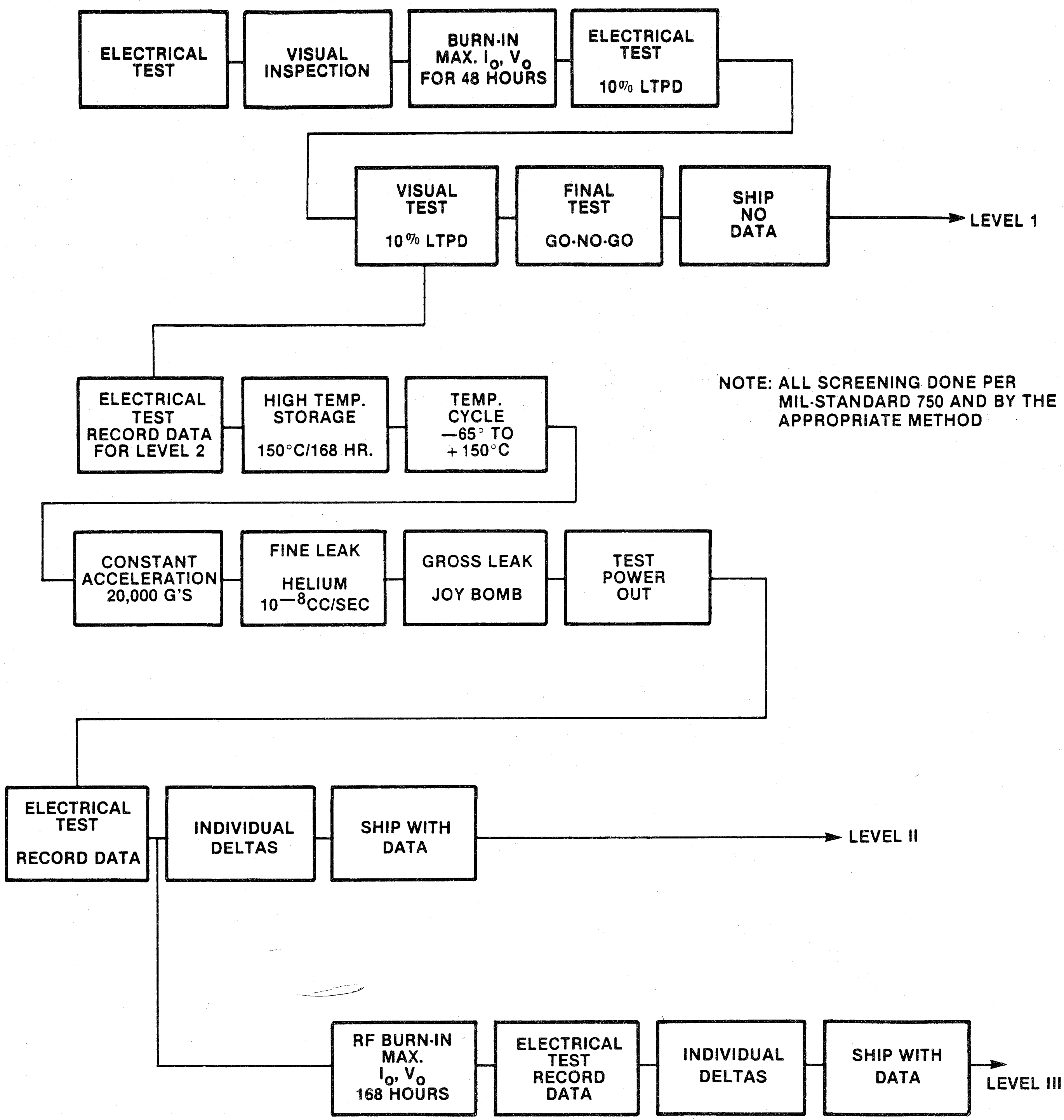


FIGURE 6. Screening Programs for Gunn Diodes

Bonding and Handling Procedures for Diodes and Transistors

Bonding and Handling Procedures for Chip Devices

DISCUSSION

Chip diode devices for use in integrated circuit and hybrid integrated circuits have proliferated in the last few years. Today's circuit designer is faced with a multiplicity of alternatives in the selection of diodes and packaging with each choice involving tradeoffs of particular advantages and disadvantages. The obvious advantages in the use of chip diodes in hybrid integrated circuit applications are their very small size and potentially lower cost. Small size and simplicity of structure give the benefit of minimal parasitics, but as the size of the diode becomes smaller, handling and production problems increase. By outlining our conclusions, we hope to help the designer overcome some of the difficulties encountered when using chips in MIC applications. M/A-COM Semiconductor Products Operation manufactures a large selection of chip and packaged diodes for hybrid integrated circuits. Obviously not all diode types are available in all configurations. Characteristics such as breakdown voltage or capacitance may limit the size of the chip or its form.

SILICON CHIP DEVICES
- CERMACHIP™ PIN diodes
- Oxide passivated PIN chips
- Beam Lead PINs
- Snap Varactor chips
- Tuning Varactor chips
- MNS Chip capacitors
- Schottky chips
- Beam Lead Schottky diodes
- RF Transistor Chips (low noise)

GaAs CHIP DEVICES
- Gunn Diodes
- GaAs Tuning Varactors
- Beam Lead GaAs Tuning Varactors
- GaAs Multipliers
- GaAs Schottky Mixers
- GaAs Abrupt and Hyperabrupt Tuning Varactors
- GaAs IMPATTs
- GaAs Beam Lead Schottky diodes

MICROSTRIP PACKAGES AND CHIP CARRIERS

Chip diodes usually require specialized equipment for die attachment to the circuit and for wire or strap bonding to the top of the chip. These operations require a clean work environment and special handling equipment such as vacuum pickups, hot gas bonders and/or thermal compression bonding equipment.

Not all MIC circuits require chips. In many cases (especially for conventional stripline circuits) a hybrid circuit package or carrier will give satisfactory results and can be handled much more easily without a large investment in fabrication equipment. M/A-COM Semiconductor Products Operation supplies a broad band of diodes in stripline or carrier packages.

HANDLING AND ASSEMBLING OF CHIPS INTO CIRCUITS

The problems of handling and assembling chips into packages can be best separated into two areas: putting the chip into the circuit (die down) and making top contact to the chip (top bonding). The following sections will discuss these problems.

CHIP BONDING METHODS

The biggest problem in using chip diodes is the damage encountered when assembling chips into circuits. In general, the value of the integrated circuits far exceeds the cost of the chip itself. When packaged diodes are used, the critical die attach and top contact operations are performed by M/A-COM Semiconductor Products Operation and all devices are RF tested after assembly into the packages. When the circuit fabricator performs the die attach and wire bonding operation on a complex substrate, he/she runs the risk of losing or damaging a chip during the bonding operation, which can result in the loss of the whole circuit or in an expensive rework cycle.

The most common problems that arise when bonding chips to the circuit are: the introduction of excessive series resistance, especially under forward bias conditions due to the improper bonding of the chip to the ground plane; poor reliability due to the entrapment of fluxes under the bond; and mechanical failure of the bond under thermal shock or temperature cycling. All three conditions are the result of improper wetting of the die to the ground plane and are usually caused by inadequate cleanliness or inadequate bonding conditions.

THE INFLUENCE OF THE CIRCUIT BOARD ON CHIP BONDING METHODS

Selection of the chip bonding method must take into consideration the characteristics of the circuit board material being used.

Stripline teflon-fiberglass circuits should be soft soldered. Most eutectic solders melt at temperatures too high (250-300°C) to be used with teflon fiberglass boards. Conductive epoxies can also be used, but the results may not be reliable. The use of either IMPATT or Gunn diodes on teflon fiberglass circuits is not recommended because the major problem in operating these diodes is the removal of heat. It is absolutely essential that eutectic solders or thermal compression bonding be used to bond these devices to achieve the best thermal resistance. Soft solders and conductive epoxies are not acceptable methods for bonding either Gunn or IMPATT diodes.The use of beam lead diodes with teflon fiberglass boards is not generally recommended. Because these boards are flexible, they may bend during or after bonding and cause the diode leads to break.

In many cases conductive epoxies will give good results with little or no complex equipment required. Although the high temperature and long term reliability of this type of bond is not generally as good as eutectic solders, the use of conductive epoxies is an acceptable and simple way to fabricate most circuits.

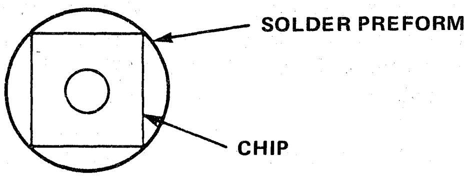
Soft solder, such as the eutectic composition of tin antimony or lead tin, give excellent reliability and good high temperature characteristics. The use of flux for soldering is not recommended at any time. Instead, a cover gas, such as a forming gas (80% N_2, 20% H_2, or 95% N_2, 5% H_2) should be used. When applicable, probably the best die down procedure is an ultrasonic silicon gold thermal compression bond or a high temperature eutectic solder (such as gold tin eutectic solder—80% Au, 20% Sn) with a melting point of approximately 280°C.

Chip Die Down Bonding Techniques

HOT GAS BONDING OF CHIPS

The hot gas bonder is one of the most convient ways of bonding chips onto a metal ground plane or circuit. Both silicon and GaAs chips may be bonded using similar techniques.

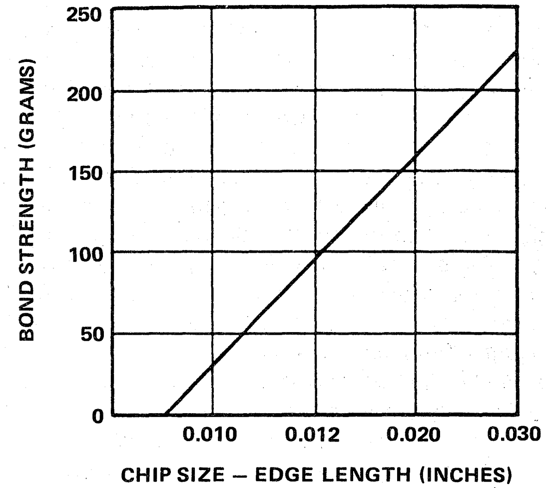
GaAs is brittle and softer than silicon. The use of gold tin solder preform (80% Au, 20% Sn) with an eutectic melting point of 280°C is recommended. A clean, gold plated surface is required to insure good wetting. The preform should be large enough to insure that the die fits within the areas shown. The preform should be ~1 mil thick.



The heating stage should be set at 250 ± 5°C. An 80% N_2, 20% H_2 forming gas is effective as the hot gas jet. The temperature at the tip should be approximately 400°C. The wetting time after the solder reflow is critical for strong bonding. It should be carefully controlled; 3 sec ± 1 sec. If done correctly, the shear strength of a 10 X 10 mil die will average 250-300 grams.

RIBBON AND WIRE ATTACHMENT

It is recommended that thermo-compression bonding be used. The bonding tip should be smaller than the anode contact. The exact conditions will depend on the tool types used. It is recommended that a half hard gold wire or strap be used. The wire or strap diameter should be smaller than the diameter of the anode contact. Typical bonding force should be 20 and 25 grams, and should not exceed 30 grams. When wire bonding, a thermal compression wedge bonder is recommended using a heated stage and heated tip. The stage temperature should be approximately 240°C ± 10°C and the recommended temperature for the tip is 120°C. Ultrasonic scrubbing is not recommended.



FURNACE SOLDER OF DICE

A moving belt furnace is also an excellent method for soldering chips. A belt furnace with an 80-20 forming gas atmosphere and nitrogen curtains on the ends of the furnace is recommended. All parts should be clean and free of oil and grease.

The temperature and speed of the belt should be adjusted so that the parts reach approximately 25-50°C over the melting point of the solder for a period of 2 to 5 minutes. Adequate tooling and furnace temperature are usually necessary to obtain good alignment. "Clean" gases are also very important. The criteria for acceptable solder die is shown on the following page.

TABLE 1. Selection Guide for Die Down Bonding Techniques

Die Down Method	Resultant Thermal Resistance	Temperature Required	High Temperature Capabilities	Power Handling Capability	Ease of Operation	Special Equipment Required	Potential Problems
Conductive Epoxy	Good with proper technique	Room temp. to 150°C	Good	Low to medium power	Easiest to apply	Little or none	High series or thermal resistance
Soft solder i.e., Pb-Sn-Ag (90, 5, 5) Pb-Sn (60, 40)	Good to very good	200-280°C 180-200°C	Good	Good to very good for low or high power	Simple application	Heated stage, hot gas bonder or gas curtain and furnace	Flux is usually required with lead solders. Cleaning of flux must be done carefully
Eutectic solder Au-Sn (80, 20) Sn-Sb (97, 3)	Very good	Approx. 300°C Approx. 230°C	Good	Very good	Simple application	Heated stage or hot gas bonder	Needs clean reducing atmosphere
Gold silicon Eutectic[1] (Thermal Compression Bond)	Very good	Approx. 380°C	Good	Very good	Most difficult	Ultrasonic bonder with heated stage & tip preferable	Cleanliness, proper bonding conditions

NOTE: 1. Excluded for Schottky diodes and some PIN limiter diodes. Consult factory for specific assistance.

ULTRASONIC THERMAL COMPRESSION BONDING OF DICE

In a small circuit, ultrasonic bonding gives a very reliable and strong bond. The die should be free of oxides and have no metallization. The bonding surface should have approximately 2.5 micrometers of a soft gold, preferably from a high cyanide gold bath.

The stage of the bonder should be set at approximately 200-250°C and the bond pressure approximately 400 grams/mm^2.

i.e.: ~ 50 grams for 0.010 X 0.010 inch die
~ 200 grams for 0.020 X 0.020 inch die
~ 300 grams for 0.030 X 0.030 inch die

These values can vary rather widely and some experimentation may be necessary to find the best results.

The criteria for a good thermal compression bond should be the same as for a soldered joint.

DIE BONDING WITH CONDUCTIVE EPOXIES

Although some military and telecommunications systems do not allow the use of conductive expoxies, satisfactory die down bonds may be obtained using these epoxies. The following precautions should be observed to obtain consistently strong bonds.

CLEANLINESS

Everything should be clean and degreased. It is a good idea to clean the circuit in an alkaline solution to remove any traces of plating solutions. The circuit should then be degreased.

SHELF LIFE

The conductive epoxy must be within the warranty shelf and/or pot life. It is advisable to use one half the listed pot life since manufacturers tend to be optimistic on pot life estimates. Thus, if the pot life is stated to be 2 days, it is much safer to use new epoxy every day.

CURING

The epoxy must be cured in air or in an oxidizing atmosphere. The reaction requires oxygen. The epoxy oven should be clean (not used for other functions) and should have a good air flow to carry fumes. The epoxy will not cure well if there are other solvent fumes in the atmosphere.

CARRIER FLUID

The carrier fluid must not be allowed to flow on the top of the chip. Not only will it make the chip unbondable, it will be almost virtually impossible to detect under normal bonding procedures. If a vacuum tip is used to put the chip in place, remove the vacuum when the chip is 10 to 30 mils

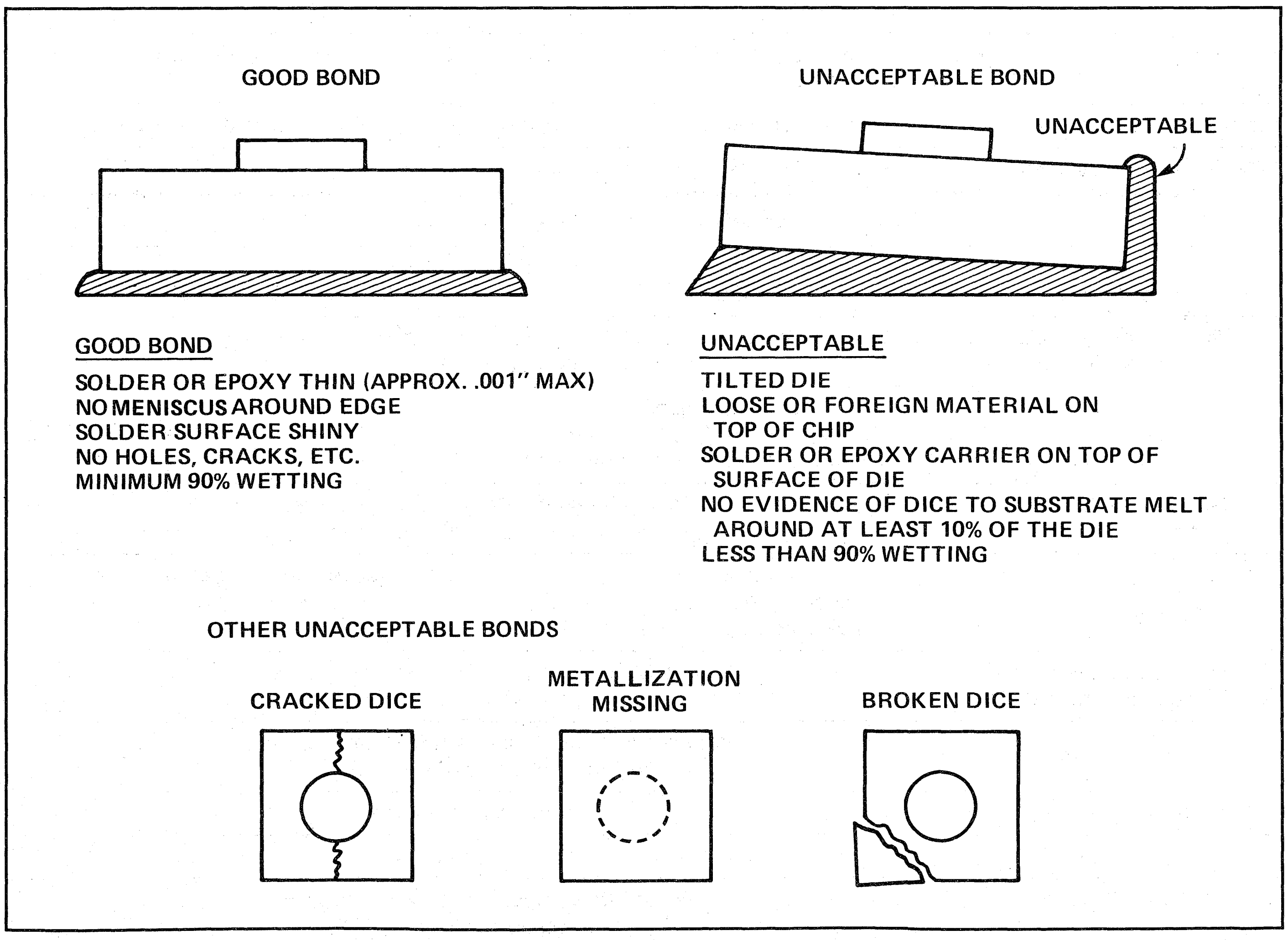


FIGURE 3. Die Bonding Criteria

from the epoxy. Static charge will hold the chip to the tip. If the vacuum tip touches the epoxy, it will become coated with the epoxy carrier fluid and contaminate the next chip with the carrier material. This same problem may occur with the use of tweezers. The tweezers should be cleaned before picking up another chip if they touch the epoxy.

RELIABILITY PROBLEMS

Silver conductive epoxies should not be used where they will come into contact with lead tin solders or high tin solder. There can be an anodic reaction which may cause failure of the bond.

BOND STRENGTH

The shear bond strength of a good epoxy joint can approach that of solder, 50-100 kgms/cm². The thickness of the conductive epoxy should be kept at 0.001″ or less.

The shear bond strength should be about:

40-60 grams for 0.010 X 0.010 inch chip
150-250 grams for 0.020 X 0.020 inch chip
350-500 grams for 0.030 X 0.030 inch chip

In general, the epoxy will shear before the chip breaks. Weak bonds are usually caused by the use of old epoxy, bonds that are too thick, or lack cleanliness.

THERMAL RESISTANCE

Although the thermal resistance of silver conductive epoxy bonds is a little higher than that of gold tin eutectic solder, it is still satisfactory for all but the highest power applications, as long as the epoxy is kept thin.

VISUAL INSPECTION

Die down bonds should be checked regularly using a 5-15X microscope and should meet the visual criteria shown in Table 2.

TABLE 2. Visual Inspection for Good Die-Down Bonds (Using a 5-15X Microscope)

Die Down Method	Visual (Good Bond Criteria)	Typical Bond Strength (In Stress)	Extra R_S From[1] Die Down (.020" Chip)
Conductive epoxy	Flat and maximum epoxy thickness approx. .001 inch. — 90% min. wetting	approx. 50-100 kgms/cm²	less than 0.15 ohms
Soft solder	Flat — maximum solder thickness 0.001 inch. — 90% minimum wetting	approx. 70-100 kgms/cm²	less than 0.1 ohms
Gold-tin eutectic solder	Flat — maximum solder thickness 0.001 inch. — 90% minimum wetting	approx. 100-150 kgms/cm²	less than 0.1 ohms
Thermal compression bond	Flat — 90% minimum wetting	approx. 1100 kgms/cm²	less than 0.1 ohms

NOTE: 1. This is the approximate extra RF series resistance from an ideal lossless bond of a .020" x .020" chip.

TABLE 3. Methods for Top-Bonding Diode Chips

Type of Chip	Type of Circuit Board: Ceramic	Type of Circuit Board: Teflon Fiberglass Metal Ground
Planar chip with gold metal on anode	Wedge bond 0.002 diameter gold wire or 0.001 x .005 strap. Bonding tool must be smaller than anode pad.	
Beam Lead	Ultrasonic bond. Bonding tip size 0.002 minimum. Special tools are available for beam leads.	NOT RECOMMENDED
Schottky diodes with planar contacts	Wedge bond 0.0007 diameter gold wire. Bonding tip size 0.001 maximum.	
Hermetic CERMACHIPS™	Wedge bond. 0.001 x 0.005 strap is best. Bonding tip size 0.005 maximum.	Wedge bond, or parallel gap or welded strap.
Planar chips with very small anode pads (less than 0.002)	Wedge bond 0.0007 to 0.001 diameter gold wire. Bonding tool size 0.001 maximum.	
Ministrip package	Wedge bond 0.0007 to 0.001 diameter gold wire. Bonding tool size 0.001 maximum.	
Stripline package	Solder or weld leads.	
Chip carrier	Wedge bond leads.	
Mesa diodes (small)	Wedge bond. Use 5 mil strap, if possible. Bonding tool tip size 0.001 to 0.002.	

TOP BONDING TO THE CHIP

Most chips can be bonded with a wedge bonder. The size and shape of the top contact will depend on the size of the bonding pads and the parasitic inductance or capacitance requirement of the circuit.

A gold strap is effective for the majority of applications.

Critical criteria in this procedure are cleanliness, bonding tip shape, tip pressure and stage temperature.

TOP CONTACTING METHODS

The usual criteria for choosing a specific top bonding technique are the size of the top contact of the chip, the type of chip, the sensitivity of the chip to temperature and pressure, the type of circuit board and the equipment available. The table shown (Table III) illustrates some of the suggested top bonding methods listed by type of chip and circuit applications. Usually the simplest contacts are a gold strap .001 X .005 inch or a 0.0007 to.001 inch diameter wedge bonded gold wire. The inductance of a 1 mil diameter wire will be ~0.5 nH for a 0.20 inch long lead. This inductance can be reduced considerably by using multiple contact wires, or by using straps (a technique which also increases reliability).

SELECTION OF BONDING EQUIPMENT, TOOLS & TIPS

The choice of bonding equipment and tools depends greatly on the type of circuit and chips to be used. Most bonding equipment manufacturers have useful literature available. A very good book on bonding is the "Semiconductor Bonding Handbook" by R. Elliett, of Small Precision Tools, 28 Paul Drive, San Rafael, California 94903.

WIRE BONDING

It is very difficult to give definite parameter values of force, pressure, time and temperature for an optimum bonding schedule. Different wire or strap sizes, bonding surfaces or semiconductor die characteristics require different bonding conditions. In general, the bonding parameters should be adjusted to maximize reproducibility at a high bond pull strength.

Most problems are caused by improper bonding machine and tool settings as well as improper maintenance and cleanliness. It is important to control the movement of the part being bonded, alignment of tools, tool height, angle, and tool condition.

In general, the die will crack or "crater" if too hard a wire or excessive pressure is used. Too little pressure results in small, weak bonds.

A good wire bond should be stronger than the wire and should also be two to three times the wire diameter as illustrated.

Also illustrated are drawings of another type of wire bond, the ball bond. As with all top bonds to planar die, the wire (or strap) should break during a pull test before the bond breaks.

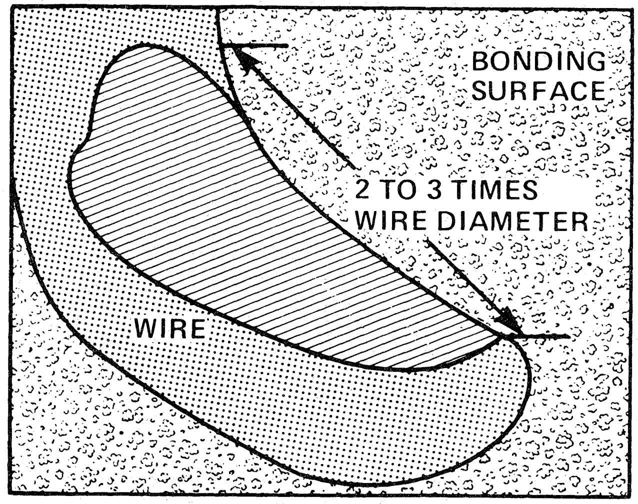


FIGURE 4. Typical Strong Wire Bond

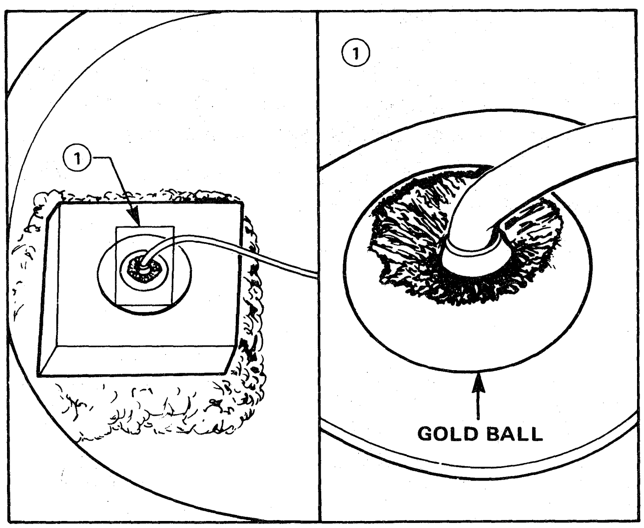


FIGURE 5. Sketch of a Good Nail Head Bond

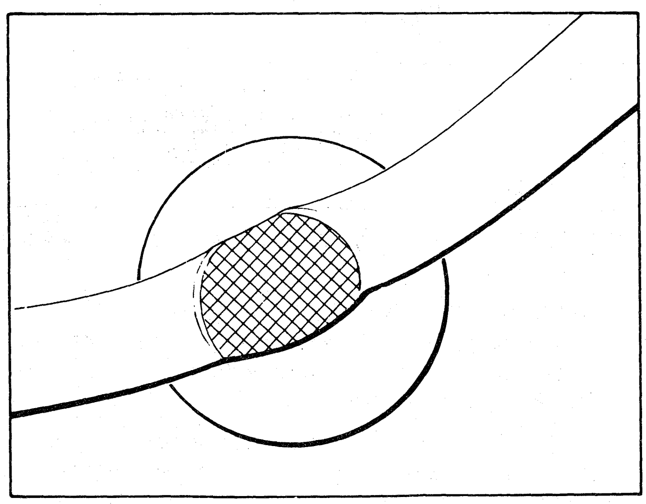


FIGURE 6. Single Strap Bond

When wire bonding, the deformed width of the wire should be about 1.3 to 1.8 times the wire thickness as shown in the wire bond sketch below.

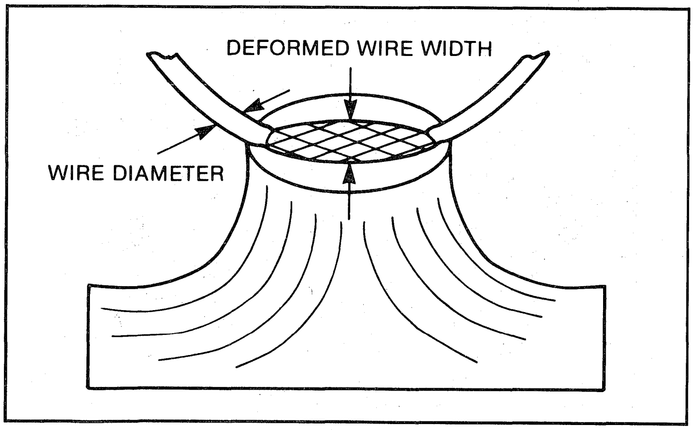


FIGURE 7. Appropriate Wire Bond Deformation for Maximum Strength

If the deformed width is too small, the bond will tend to lift off. If it is too large, (greater than 1.8 times the wire diameter) the wire tends to weaken and break.

Also shown is a curve of the pull strength vs. deformed width of ultrasonic bonded wire.

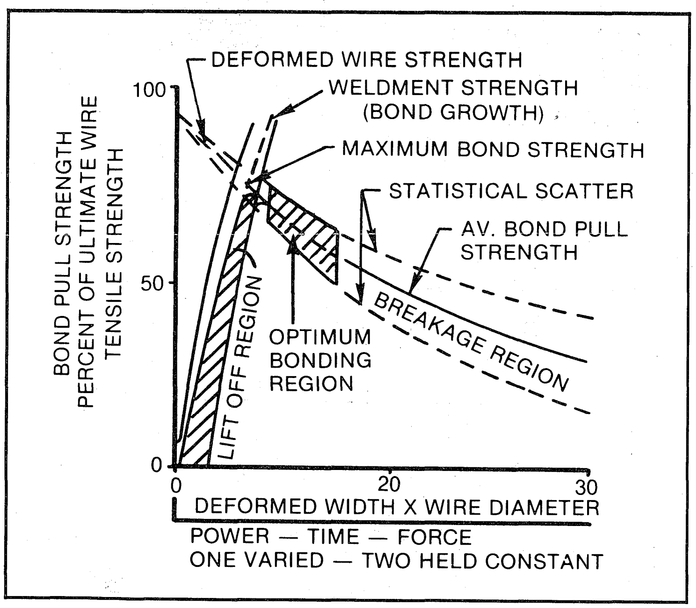


FIGURE 8. Pull Strength vs. Deformation for a Wirebond.

WIRE BONDING TO GaAs JUNCTIONS

GaAs is very brittle, and although the above mentioned procedures apply, the following extra precautions should be taken when wire bonding.

Wire bonds to the junctions are best made using a thermal compression wedge bonder with a heated stage and tip. A stage temperature of 240°C and a tip temperature of 120°C is recommended. Typical bonding force should be in the region of 20 grams for the smallest junctions but less than 40 grams for all other junctions. It is recommended that dead soft gold wire be used with a diameter of 0.0007 inches for the smallest mesa and 3 mil X .0005 ribbon for the largest mesa and 50 ohms attachment. For GaAs diodes, such as PIN diodes in parallel configuration, two ribbons are preferable.

STRAP BONDING

When bonding a strap, the bond should not deform the strap by more than 50%. The tool and conditions should be selected to provide a bond that has at least the same cross sectional area as the strap itself. For example, a 0.5 mil x 5 mil strap should have a bond cross section of 2.5 mils square or greater. The schematic shown illustrates a typically strong single strap bond to a large mesa. Cross strapping is used for low parasitic inductance. Careful heat and pressure control must be exercised in order to form a strong, damage free cross strap bond.

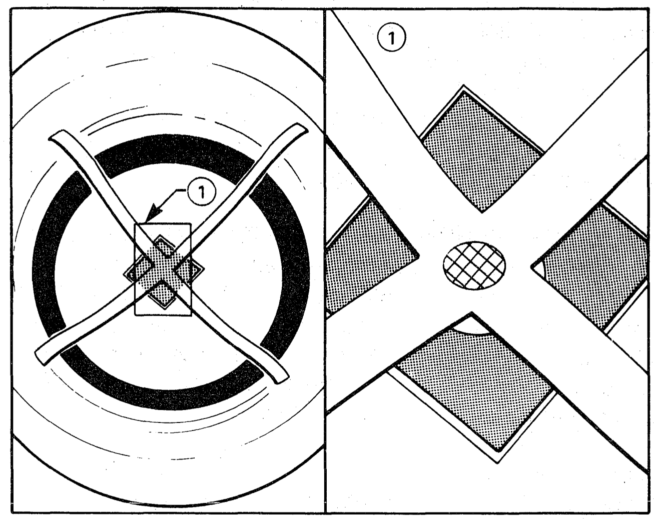


FIGURE 9. Cross Strap Bonding in a Packaged Device

BONDING TO SMALL MESAS

When bonding to a small mesa type diode, it is suggested to always use a strap. The strap, in many cases, may be larger than the top of the mesa (the larger the cross section area of the strap, the lower the parasitic inductance). In this case, it is advisable to bond all or as much of the entire top of the mesa as possible.

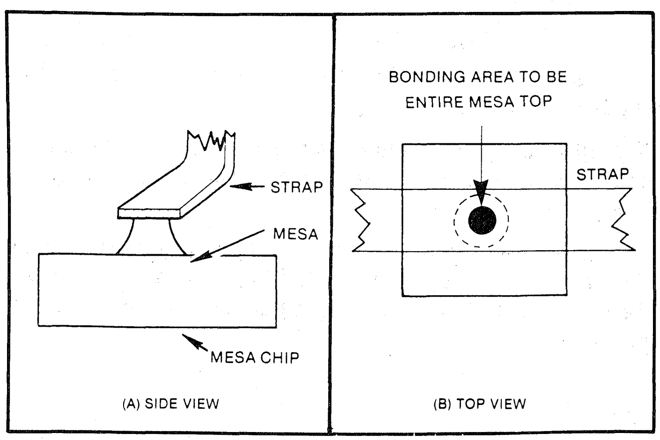


FIGURE 10. MESA BONDING

GOOD BONDING CRITERIA

When testing a mesa diode, if the bond is good, the mesa will usually break off before the bond or strap breaks. For all other bonds, the bonds should be as strong as the wire or strap when tested by pulling. Improper top bonding usually results in one of the following problems:

- Cracking or stressing the die through excessive pressure.
- Weak bonds from inadequate cleanliness or improper bonding conditions.
- Excessive parasitic capacitance from overlapping wire or straps.

ACCEPTABLE BONDS

Wire or strap does not separate when tested.
No fractures in bond.
No separation of metallization.
Wire breaks before bond.

BAD BONDS

Wire separates from bond.
Bond fractures at weld.
Separation of metallization from dice.

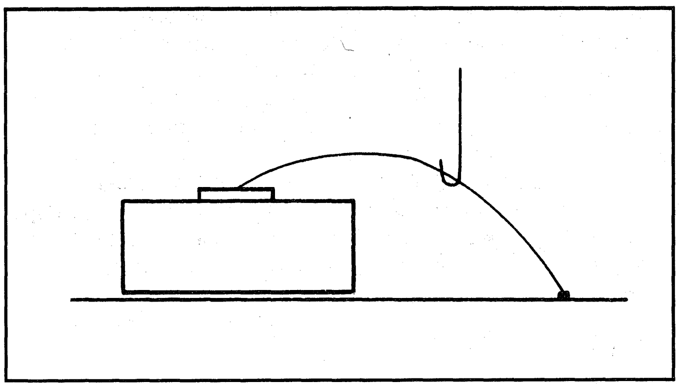


FIGURE 11.

BOND STRENGTH PULL TEST

It is extremely important to maintain good quality control procedures in order to ensure good bonding. The following figures and tables illustrate criteria for visual inspection and for testing of bond strength.

TABLE 4. Bond Strength Criteria (Gold Wire or Strap)

Wire or Ribbon Size (inches)	Minimum Pull Strength (grams)
0.0007 wire diameter	1.5
0.001 wire diameter	3.0
0.002 wire diameter	9.0
0.00025 X 0.002 strap	1.0
0.00025 X 0.005	4.0
0.00025 X 0.010 strap	6.5
0.001 X 0.005 strap	10.0
0.001 X 0.010 strap	16.0

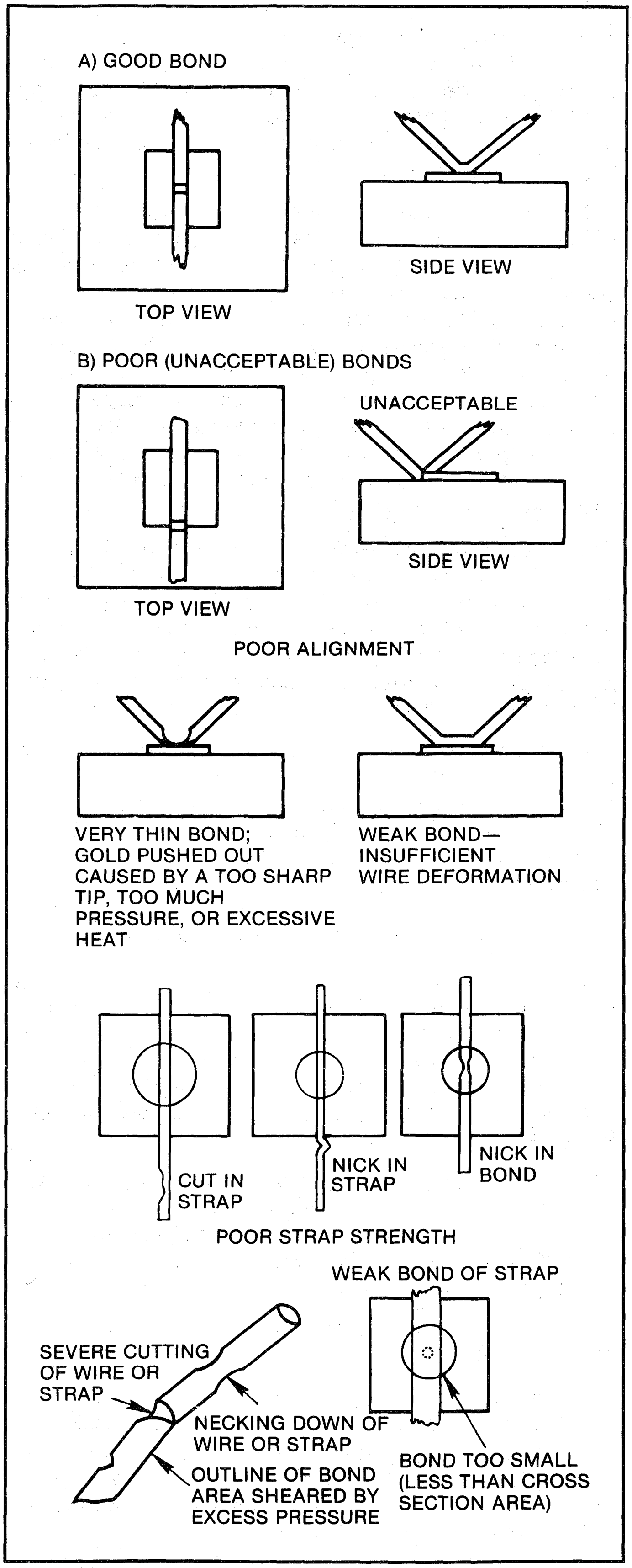


FIGURE 12. Visual Bond Inspection Criteria Gold Wire or Strap Bonds

BONDING BEAM LEAD DIODES

Selection of the beam lead bonding method must take into consideration the characteristics of the circuit board material used. Hard substrates such as alumina and quartz are recommended. Various bonding techniques are described below and may all be used on hard surfaces.

The beam lead diode is a silicon chip with planar gold leads which extend from the top surface of the chip (approximately 0.010 to 0.030 inch). Beam lead diodes are generally the smallest size chips available. They must be handled with care because the leads may easily be distorted or broken by the normal pressure of tweezer handling. Most vacuum tips are too large. A vacuum pencil with a #27 tip is recommended. A pointed wooden stick, such as a sharpened Q tip or toothpick, which has been dipped in isopropyl alcohol can also be used as a pick and place tool since the beam lead will adhere to the moistened point. This work should be performed under 10X to 30X magnification.

Beam lead diodes are easily damaged by static electricity and/or current from a small low impedance ground loop in the circuit. When mounting the diode in the circuit, contact should never be made across the gap. A static discharge from the operator may flow through the diode and destroy it. The circuit should always be grounded before the second lead of the diode is attached.

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

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

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

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

> To minimize the lead inductance, the wedge, or heated tips should be placed as close as possible to the edge of the chip without touching it. The chip is very easily damaged, and care must be taken that the bonding tip does not contact the chip at any time during the bonding process.
>
> The bonding tip must be perpendicular to the beam during bonding, to prevent a torsional force which will pull the beams apart. This is particularly important when bonding the second lead.

BONDING USING MICROSTRIP DIODES AND STRIPLINE PACKAGES

In many cases it is not necessary to use a diode as small in size as the beam lead diode. A small carrier makes handling much easier. M/A-COM Semiconductor Products Operation offers PIN diodes soldered to a small molybdenum tab with either one or two leads. The ministrip package is easily soldered to a circuit. A hot plate, a substrate heater, a belt furnace or a parallel gap welder can be used. (Conductive epoxy may be used for a prototype bonding). Thermal compression bonding or parallel-gap welding are the processes recommended for attaching the leads. (See the die down procedure).

Stripline packaged diodes can be used for shunt applications by placing the carrier on the ground plane and attaching the leads to the center conductor. In series application they can be mounted by soldering or welding the leads across the gap. The stripline packages, case style 137 or case style 213, are used in a similar way on conventional stripline boards. The leads should be welded for best results.

PIN DIODES ON CARRIERS

The microstrip carrier packages are well suited for shunt PIN diode switches and phase shifter circuits. Case style 162 and 163 are chip carriers. The chip is located in the center of the pedestal, as shown in the case style drawing illustrated. The pedestal allows the electrical and thermal resistance contact to extend up through the board, thus reducing inductance. The bottom of the carrier may be attached to the substrate or ground plane with low temperature solder without a large increase in the thermal resistance of the chip to the heat sink. While the pedestal is soldered to the ground plane, the temperature must be kept below 225°C. The wires or straps should be thermal compression bonded or parallel gap welded to the center conductor.

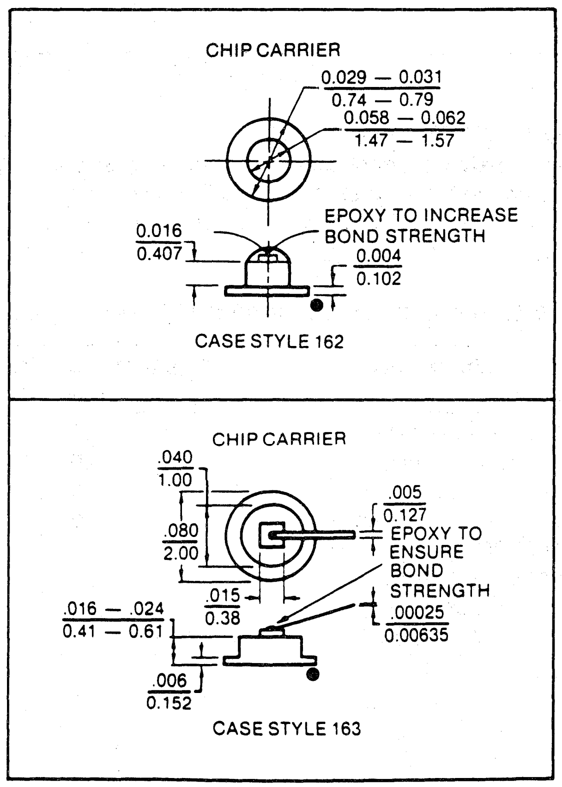


FIGURE 13. Chip Carriers

MOUNTING OF SURFACE MOUNT DEVICES

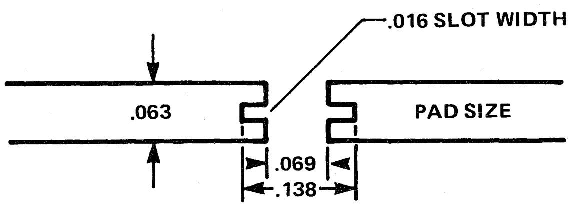
Mounting MELF PIN Diodes to Circuit Boards

Wave soldering or reflow techniques may be used to mount M/A-COM's MELF PIN diodes to circuit boards. The MELF construction, due to its volume, cylindrical shape and mass has shown less tendency to lift up on end (tombstone) or skew than lighter, four sided surface mount components. Wave soldering requires that the MELF devices be mechanically affixed to the circuit board with an epoxy adhesive prior to inverting the board. The subsequent solder wave will result in electrical adhesion of the devices to the circuit board. Reflow soldering requires the MELF diode to be temporarily secured to the circuit board by the solder paste to each bonding pad to prevent diode movement, which would result from unequal surface tension on the contacts of the diode. The solder reflow operation is then performed in a belt furnace or by vapor phase. The adhesion provided by solder paste is usually adequate to hold the MELF packaged in place for solder reflow. If additional resistance to rolling or skewing is desired, the pad patterns shown in Figure 14 are recommended.

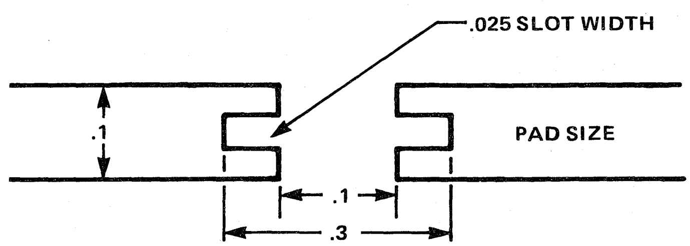
Figure 15 indicates the recommended mounting pad configuration for the SOT-23 package. Solder paste containing flux should be screened onto the pads to a thickness of 0.005 inches. The SOT-23 device is placed in position firmly adhering to the solder paste.

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

PAD FOR CASE STYLE 983

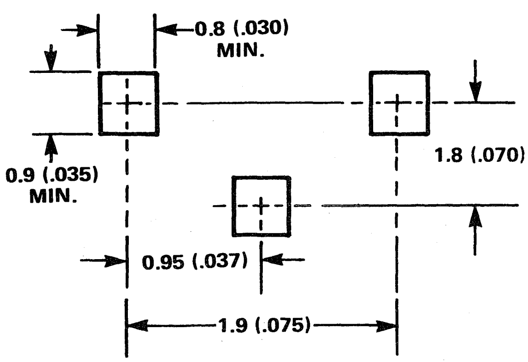


PAD FOR CASE STYLE 984



Dimensions in Inches

FIGURE 14. Recommended Pad Drawings for MELF Diodes.



DIMENSIONS MILLIMETERS (INCHES)

FIGURE 15. Mounting Pad Configuration for the SOT-23 Package.

Appendix

Ordering Information

Orders for M/A-COM Semiconductor Products Operation may be placed with either our sales representatives or directly with M/A-COM Semiconductor Products Operation Sales Department at the address indicated below. When ordering, use M/A-COM Semiconductor Products Operation model number (i.e. MA4P404-30) as indicated in the catalog.

M/A-COM Semiconductor Products Operation
Sales Department
43 South Avenue/Building 1
Burlington, Massachusetts 01803
Telephone 617-272-3000
TWX: 710-332-6789
Telex: 94-9464
FAX: 617-272-8861

INTERNATIONAL ORDERS

Customers outside the United States are served by both M/A-COM field offices and international sales representatives.

All international orders may be placed with either our M/A-COM field offices or international sales representatives depending on the country or directly with M/A-COM Semiconductor Products Operation International Sales Department.

M/A-COM Semiconductor Products Operation
International Sales
43 South Avenue/Building 1
Burlington, Massachusetts 01803
Telephone: 617-272-3000
TWX: 710-332-6789
Telex: 94-9464
FAX: 617-272-8861
Cable: MICROWAVE BURLINGTON

SHIPPING INSTRUCTIONS

Shipments will be made via United Parcel Service, unless other instructions are received. For rush services, we will ship by Air Freight or Air Express on request.

PRICE AND DELIVERY INFORMATION

The price and delivery of any item listed in this catalog is available from either our Burlington, MA sales department or any M/A-COM field office or international sales representative. Quotations are F.O.B., factory of origin, and are subject to change without notice. Terms are NET 30 days if credit has been extended.

SOURCE INSPECTION

Government source inspection may be performed on any item upon receipt of the complete written confirmation of purchase order items, including the prime government contract number. Government or customer source inspection with respect to some products increases unit price and extends delivery time because of repetitive requirements for standard final inspection and testing. It is recommended, wherever possible, that a Certificate of Compliance (supplied free of charge) be substituted in lieu of government or customer source inspection to minimize price and delivery impact.

RETURNED MATERIAL

When returning material for repair or replacement, it is necessary to first contact your local M/A-COM field office or representative for approval and authorization number if applicable. We require that complete information be included with the return shipment stating detailed description of the reason for return, the date and purchase order on which the product was originally purchased, the number of hours of operational use, and the exact address where the material is to be returned. All chip returns are on a lot-to-lot basis.

WARRANTY

We warrant to the original purchaser all products sold by us to be free of defects in material and workmanship for one year from the date of the original shipment. Our obligation under this warranty is, at M/A-COM's option, limited to repair, exchange or credit. The warranty does not apply to any product which has been subject to accident, alteration or abuse. Detailed warranty provisions appear on each sales order.

SALES AND TAXES

All quoted prices are exclusive of any federal, state or local taxes, and are the sole responsibility of the Buyer, unless an appropriate Certification of Exemption is furnished to M/A-COM with the written purchase order.

APPLICATION ENGINEERING

M/A-COM Semiconductor Products Operation maintains a large support staff of technical sales engineers, both domestically and internationally, who are experts in many areas of microwave technology. Each has a background which combines formal engineering education with training in microwave specialties — often with many years of product design experience. For further technical support, M/A-COM Semiconductor Products Operation offers the service of its engineering and scientific staff for consultation on advanced circuit designs or applications problems.

SPECIFICATIONS

We reserve the right to discontinue items and change specifications without notice.

FEDERAL SUPPLY CODE

M/A-COM Semiconductor Products Operation Federal Supply Code for Manufacturers assigned number is 96341.

Selection Guides and Application Notes

A list of M/A-COM Semiconductor application notes and selection guides is given below. All these are available upon request from your local M/A-COM Field Sales Office or Representative or from the M/A-COM SPO Marketing Department, Burlington, Massachusetts 01803.

SEMICONDUCTOR SELECTION GUIDES

GUNN DIODE SELECTION GUIDE — A selection chart designed to help the customer select the appropriate M/A-COM Gunn diode for a specific range. (SG210)

SILICON PIN DIODE SELECTION GUIDE — Useful reference table designed to assist the customer in the selection of M/A-COM PIN diodes. (SG211)

GaAs IMPATT DIODE SELECTION GUIDE — IMPATT diodes are designed for a specific application. This selection chart is a handy tool for selecting the appropriate M/A-COM IMPATT diode. (SG212)

GaAs SCHOTTKY DIODE SELECTION GUIDE — This selection table is designed to aid the customer in selecting the correct M/A-COM GaAs Schottky mixer diode for applications from X- through W-band. (SG213)

SCHOTTKY SELECTION GUIDE — This selection chart is designed to assist the customer in selecting packaged Schottky mixer and detector diodes, stripline packaged beam-lead Schottky mixer diodes and Schottky mixer chip and beam-lead diodes. (SG214)

MULTIPLIER SELECTION GUIDE — This selection chart, with curves and tables, is designed to help the customer determine the correct multiplier diode based on output, frequency, capacitance and snap time. (SG215)

TUNING VARACTOR SELECTION GUIDE — This selection table is designed to help the customer in selecting the appropriate tuning varactor diode for a VCO. (SG216)

TRANSISTOR SELECTION GUIDE — This selection chart and curves are designed to assist the customer in choosing silicon bipolar transistors for low noise amplifiers in the frequency range of 60 MHz through 2 GHz. (SG217)

APPLICATION ARTICLES

TUNING VARACTOR APPLICATIONS GUIDE — Designed to help the customer select the appropriate M/A-COM varactor diode for use in a voltage controlled oscillator. The guide includes short discussions on such topics as the factors that influence the choice of varactors for the major VCOs, characteristics of different tuning varactors, choice of varactors based on type of VCOs, suggested tuning varactor capacity and Q by VCO frequency, varactor capacitance versus frequency of the VCO and much more. (16 pages) (AG310)

GUNN DIODE FUNDAMENTALS AND DESIGN CONSIDERATIONS FOR STABLE GUNN OSCILLATORS — Discusses the Gunn diode's physical characteristics and oscillator design as it affects the choice of a Gunn diode. The article also deals with the following topics. (37 pages) (AG311)

- — Basic fundamentals of Gunn diode operation
- — Major consideration in designing a waveguide or coaxial oscillator
- — Techniques to determine oscillator frequency
- — Oscillator noise considerations
- — Gunn amplifier considerations

DESIGN WITH PIN DIODES — Describes the PIN model and the design of various RF switches. The article also describes the design of a PIN diode attenuator and a phase shifter circuit. The distortion model of the PIN diode is introduced and a discussion of techniques to reduce distortion in PIN diode circuits is presented. (20 pages) (AG312)

APPLICATIONS OF MULTIPLIER DIODES — This article is designed to assist customers in selecting the appropriate multiplier diode to use in a circuit. It is a condensation of some of the extensive literature available on the design and selection of diode frequency multipliers. The main focus is on the description and the design of multipliers using Step Recovery diodes, Dual Mode diodes and Varactor diodes. (44 pages) (AG313)

PRINCIPLES AND APPLICATIONS OF RECEIVING DIODES — This article is a survey of the physical and electrical characteristics of microwave receivers, mixer and detector diodes. It reviews the semiconductor and electrical properties of microwave diodes and illustrates how they are used in a number of receiving circuits. It also presents a number of tables and criteria for selecting the appropriate diode depending on the requirement of the mixer or receiving system. The article is written for a salesperson or engineer who is not an expert in receivers or mixer diodes. (60 pages) (AG314)

A NONDESTRUCTIVE MICROWAVE BEAM LEAD DIODE MEASUREMENT — Beam Lead PIN diodes are commonly measured at 1 MHz or, on a sample basis, destructively at microwave frequencies. This paper describes reproducible nondestructive microwave measurements using a vacuum hold down fixture. The article describes a beam lead vacuum test fixture useable at microwave frequencies and PIN diodes measurements of insertion loss and isolation made at 10 GHz. (~4 pages) (AG315)

PREDICT DISTORTION INTERCEPT POINTS IN PIN DIODE SWITCHES — Distortion caused by a PIN diode switch can be predicted and even controlled by circuit designers. This article presents material that is primarily applicable to forward biased PIN diodes. (~10 pages) (AG316)

HIGH POWER WAVEGUIDE BANDWIDTH DIODE ARRAY SWITCH ELEMENT — This paper describes "BULK WINDOWS,"™ switch devices for Ka band (26 to 40 GHz) which are capable of switching up to 1 kW peak power with of up to 25-50 dB for a single window. Loss is less than 1 dB in a 26-40 GHz switch. (~35 pages) (AG317)

GaAs MMIC Broadband Control Products

A list of M/A-COM technical articles on GaAs MMIC Broadband Control Products for RF and Microwave applications and accompanying summaries are given below.

DRIVING THE GaAs FET SWITCH — This application note presents information on driver requirements for a GaAs FET switch. The article also provides information on how to build new control circuit libraries based on FET switches. (~3 pages) (AGL410)

DRIVING GaAs FET MMIC SWITCHES WITH MONOLITHIC INTEGRATED CIRCUITS — This application note describes the current status of GaAs FETs based on voltage variable absorptive attenuators. Technical data is presented on the transfer functions and required control circuits. (~3 pages) (AGL411)

HOW TO USE GaAs FET BASED VOLTAGE VARIABLE ABSORPTIVE ATTENUATORS — This application note describes the current status of GaAs FETS based on voltage variable absorptive attenuators. Technical data is presented on the transfer functions and required control circuits. (~3 pages) (AGL412)

A GaAs FET AMPLIFER TEMPERATURE COMPENSATION TECHNIQUE USING A GaAs FET MMIC ATTENUATOR — This application article details a useful broadband technique to temperature compensate GaAs FET amplifiers with a FET attenuator. Data for experimental and calculated values of gate voltages for attenuation levels is presented. (~4 pages) (AGL413)

CHARACTERIZATION OF LINEAR AND NON-LINEAR PROPERTIES OF GaAs MESFETS FOR BROAD BAND CONTROL APPLICATIONS — This application article discusses GaAs MESFETS designed for control applications with their improved switching performance as compared to normal FETs designed for low noise or high power amplifiers. (~8 pages) (AGL414)

LOW COST, LOW DRAIN, HIGH SPEED, WIDEBAND GaAs MMIC SWITCHES — This article discusses the development of GaAs MMIC switches and the design approach using a building block concept based on monolithic SPST and monolithic SPDT switches. (~4 pages) (AGL415)

LIST OF SEMICONDUCTOR DATA SHEETS

PIN DIODES — BULLETIN#

LIMITER DIODES

GaAs FET MMIC BROADBAND CONTROL PRODUCTS

TUNING VARACTORS

MIXER DIODES

MIXER DIODES (Cont'd.) — BULLETIN

DETECTOR DIODES

POINT CONTACT DIODES

MULTIPLIER DIODES

GUNN DIODES

IMPATT DIODES

SILICON LOW NOISE BIPOLAR TRANSISTORS

MNS CAPACITOR CHIPS

Glossary — (Terms as used in this catalog)

ATTENUATOR — A PIN diode attenuator is a two terminal device capable of providing a prescribed RF attenuation based on the level of bias control applied.

BARRIER HEIGHT — The barrier height of a Schottky junction determines the voltage current characteristics of that diode. This can be important because it determines the local oscillator power necessary to bias the junction to its optimum non-linear operating point. As an approximation, the optimum local oscillator power will increase as the square of the barrier height, provided the same mixer circuit characteristics and junction capacitance values are used.

BIAS — The control voltage and/or current signals to the unit which provide proper unit operation.

BURNOUT — Most mixer diodes can be destroyed by static discharge or excessive RF power. Most Schottky diodes fail by becoming a short circuit. Burnout is defined as the maximum RF power which the diode can withstand without damage. It normally is in the range of 50-500 mW CW and up to 1-5 watts for pulses less than 2-5 nanoseconds long.

CAPACITANCE — The small signal capacitance measured between the terminals of the diode or detector under specified conditions of bias and frequency.

1 dB COMPRESSION POINT — The amount of power, measured in dBm, at which a device has reduced the output signal by 1 dB above the insertion loss state.

CONVERSION LOSS — The conversion loss of a mixer is defined as the loss of signal power during the conversion from the signal frequency to the IF frequency. It is defined as a power ratio:

$$L_C = \text{IF output power/signal input power}$$

It can also be expressed in dB:

$$L\ (\text{dB}) = \left[10 \log 10\ P_{if}/P_{rf}\right]$$

When referring to a mixer diode, it is the loss in an optimum single ended mixer carefully designed to minimize losses in the RF and LO coupling networks. Conversion loss normally includes power transferred to the image frequency which is resistively terminated.

DOWN CONVERTER (MIXER) — In a down converter (usually called a mixer) the desired IF output signal is obtained from the difference of the LO and signal frequency. Normally, the IF output signal is only a small fraction of the signal frequency.

DOPPLER RADAR — A typical Doppler radar system consists of an RF (i.e., microwave) section, a signal processing section and a bias supply.

In order to design a Doppler radar system, one must first know:

1. The maximum range at which the target is to be detected. (This determines the overall sensitivity required of the transceiver).
2. The maximum and minimum target speeds that the system is to measure. (This determines the frequency characteristics of the amplifier).

The commercial Doppler systems, such as police radars and intrusion alarms usually operate with a "zero IF" because the transmitter source (Gunn oscillator) is also used as the local oscillator for the mixer. Using this technique, the signal amplification will occur at the Doppler shift frequency. For example, if the transmitter frequency is 10.525 GHz, a vehicle traveling 50 mph will cause a Doppler shift of 1568 Hz. A police radar's IF amplifier bandpass frequency should be approximately 50 Hz to 5000 Hz.

The maximum range of a radar system can be determined by the following equation:

$$R_{max} \approx \left[\frac{P_t\, G_a\, K}{F}\right]^{1/4}$$

where P_t = transmitted power
G_a = antenna gain
F = receiver noise figure
K = constant

This expression shows that the effective range of a radar system is inversely proportional to the fourth root of the overall receiver noise figure.

DOPPLER SHIFT — Doppler radars utilize the fact that microwave energy reflected by a moving target is shifted in frequency. The amount of this frequency shift is directly proportional to the target's velocity relative to the radar's transmitter. A similar effect of audible frequencies occurs when an automobile horn is moving with respect to an observer. The sound pitch is higher when the horn is moving toward the observer and decreases as it moves away from him. The Doppler shift frequency f_d is given by:

$$f_d = 2V\left(\frac{f_o}{C}\right)\cos\Phi$$

where: f_o = transmitter frequency
C = velocity of light (3 X 10^8 meters per second)
V = velocity of the target (meters per second)
Φ = angle between microwave beam and target's path

NOTE: Cos Φ = 1, for moving directly forward or away from radar beam, velocity (v) in a vectorial sense will determine sign of Doppler shift frequency.

FLATNESS — The variation in attenuation at a given bias level over the frequency band.

1/f FLICKER NOISE — The effective noise temperature ratio (TM) of most Schottky diodes is normally close to thermal i.e., equal to that of a resistor of the same impedance at intermediate frequencies above 100 KHz-1MHz. However, as the IF frequency is reduced below 100 KHz, the noise temperature ratio begins to rise rapidly. It normally increases as the inverse of the IF frequency. This rise increases the noise figure of the diode at low frequency because $NF \geq 10 \log [LcTm + Lc (f_{IF} - 1)]$. Diodes designed for low audio frequencies normally will have 1/f noise specified at a specific frequency, i.e. 100 Hz or 1 KHz as required by the system.

FREQUENCY BAND — Frequency over which the unit needs to meet the specified performance.

GAIN — Gain is the ratio between the rated output power of an amplifier and its input power. It is normally expressed in decibels (dB) to determine the gain in dB if input and output is in milliwatts or watts.

$$\text{Gain (dB)} = 10 \log [P_{out}/P_{in}]$$

or in dBm:

$$\text{Gain (dB)} = \left[P_{out}\text{ (dBm)}\right] - \left[P_{in}\text{ (dBm)}\right]$$

In as much as a number of operating factors may affect the measured gain, it it often necessary to specify the conditions or methods of measurement.

HARMONICS — Frequency multiplication of the carrier signal due to non-linearities in the device under test. Normally expressed as THD (Total Harmonic Distortion) but can be specified for harmonics of interest in either a percentage or decibels below the carrier.

IF IMPEDANCE — This is the average of the time varying impedance of a mixer diode at a nominal IF frequency (usually 30 MHz). It is measured with an admittance bridge at a fixed rectified current (normally 1 mA) set up by the LO drive. Most Schottky diodes will have IF impedances in the range of 150-400 ohms at 1 mA.

IMAGE FREQUENCY — The image frequency is usually an unwanted frequency produced by the interaction of the second harmonic of the LO and the signal, i.e., (2 X $f_{LO} \pm f_{SIG}$) or (LO $\pm f_{IF}$). In most mixers, it is terminated in a broadband termination. Since most mixers have reciprocity, termination of the image causes loss of half the signal power. This is the reason that the minimum diode conversion loss is greater than or equal to 3.0 dB unless an image enhancement circuit is used.

INSERTION LOSS — The difference in power, measured in dB, between input level and output level when the unit is in low loss condition.

INTERMEDIATE FREQUENCY — The IF frequency is the desired output frequency from the mixing process and is normally the difference between the LO and signal frequencies, i.e., (L-RF) or (RF-LO). When an upconverter is used the IF is the modulated signal.

ISOLATION — The difference in power, measured in dB, between the input level and output level when unit is in high loss condition.

LIMITER — A receiver protector which does not require external control.

LINEARITY — For an attenuator, the variation from the best straight line of the attenuation vs. control signal transfer function at center frequency, measured in dB or percentage of attenuation.

LOCAL OSCILLATOR FREQUENCY — This is the RF or microwave signal which provides the RF bias to the mixer diode(s). It normally is at a higher power than the signal power. An optimum local oscillator power is required to obtain low conversion loss and good RF match to the mixer diode(s). Normally optimum local oscillator powers are in the range of -3 to 10 dBM for most common diodes.

MULTIPLIER — A device whose output frequency is a multiple of the input frequency and whose output is a representation of the input.

NOISE FIGURE — The noise factor and noise figure (NF) of a mixer diode are closely related to its conversion loss. They are usually measured as single sidebands in a single ended mixer and are:

$$\text{Noise Factor} = \frac{\text{Signal/noise ratio at mixer input}}{\text{Signal/noise ratio at mixer output}}$$

$$\text{N.F.} = 10 \log [L_c \times T_m + L_c (f_{IF} - 1)] = 10 \log (\text{noise figure})$$

where: L_c = diode conversion loss (expressed as a power ratio)
T_m = diode effective temperature ratio normally < 1.0
f_{IF} = IF amplifier noise figure (expressed as a ratio)

Normally this simplifies to $NF \sim 10 \log L_c (f_{IF} - 1)$. For a perfect mixer diode, NF in dB = 3.0 dB plus the IF amplifier noise figure and any circuit losses.

PIN DIODE — A PIN diodes is a semiconductor diode consisting of an intrinisic layer separated by P and N doped layers. It normally is used at a frequency above the dielectric relaxation frequency and has two states: (1) as a high "Q", low loss capacitance and (2) as a low resistance.

POST TUNING DRIFT — For a voltage controlled oscillator, it is the change in frequency of the oscillator after it has attained a frequency within the desired (new frequency) frequency band and after the tuning voltage has reached a stable state.

RECEIVER SENSITIVITY — The following equation for the sensitivity of a receiver shows the parameters which affect a receiving system's sensitivity:

$$S = -114\text{ dBm} + NF_O + 10 \log B + 10 \log S/N$$

where: S = receiver sensitivity in dBm
NF_O = receiver overall noise figure in dB
B = receiver bandwidth in MHz
S/N = minimum acceptable receiver signal to noise ratio in dB

RECOVERY TIME — The time interval required, after a sudden decrease in input signal amplitude to a system or transducer, to attain a stated percentage (usually 63 percent) of the ultimate change in amplification or attenuation due to this decrease.

RF FREQUENCY — The frequency in the portion of the electromagnetic spectrum that is between the audio-frequency portion and the infrared portion. It normally is 20 Hz to 110 GHz.

SERIES RESISTANCE — The real part of the impedance of a semiconductor device caused by the electrical resistance of the semiconductor and its leads.

SETTLE TIME — The time required for the device to attain 90% of the detected RF output referenced to the 10% level.

SIGNAL FREQUENCY — In a mixer or detector, this is the desired RF or microwave frequency containing AM or FM information. This is the frequency that is to be converted to a different (normally lower) frequency.

SNAP TIME — This is another term for a varactor's transition time. See definition of TRANSITION TIME.

SPURIOUS — The measured normalized fraction of signals present at the output of a device under test that are neither harmonics or intermodulation products. Can also be expressed as a percentage or decibels below the carrier.

SWR — The voltage standing wave ratio of unit when the in band signal is incident.

Glossary (Cont'd)

SWITCH — An N terminal device which requires external control and is capable of operating at the specified power level in any switch state.

SWITCHING TIME — The time required for the device to attain 90 percent of the detected RF output referenced to the 50 percent level of the command logic.

TEMPERATURE DRIFT — The variation in attenuation at any given bias level at a frequency over the temperature range, measured in dB.

THERMAL RESISTANCE — The temperature difference between two specified points or regions divided by the power dissipation under conditions of thermal equilibrium.

TRANSITION TIME — The transition or snap is the time required for a varactor diode to change from the conducting to non-conducting state under reverse bias. It is normally measured from the 90%-10% reverse current states.

TSS — Tangential Sensitivity — The tangential sensitivity is a direct measure of the signal to noise ratio of a detector and it will define the maximum sensitivity of a detector. It is defined as a signal to noise ratio of 2.5/1 and usually is measured on an oscilloscope. Because it is a noise measurement, the amplifier bandwidth must be defined. Usually this is 1 MHz. It is defined in dB below 0 dBM (i.e. −55 dBm).

VIDEO IMPEDANCE — The video impedance of a detector diode is the impedance looking into the diode from the video amplifier. It is essentially the (AC) slope of the diode at the bias level set up by external bias of the RF signal. The impedance is affected by the DC current flowing in the diode. It is normally specified at a specific (small) i.e., 1-100 microampere current and can range from 500 ohms to megohms. Some ZBDs are used without bias and R_V is specified at zero bias. The video impedance can affect the pulse fidelity of a video detector as the RC time constant depends on R_V and the bypass capacitor.

VOLTAGE BREAKDOWN — The reverse voltage at which avalanche breakdown occurs in a diode.

VOLTAGE CONTROLLED OSCILLATOR — An oscillator whose frequency is a function of the voltage of a control signal.

Case Style Index

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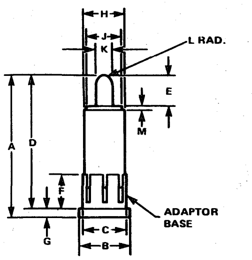

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.800	0.840	20.32	21.34
B	0.292	0.296	7.42	7.52
C	0.246	0.250	6.25	6.35
D	0.753	0.783	19.13	19.89
E	0.180	0.190	4.57	4.83
F	0.193	0.199	4.90	5.05
G	0.047	0.057	1.19	1.45
H	0.222	0.240	5,64	6.10
J	0.195	0.215	4.95	5.46
K	0.092	0.094	2,34	2.39
L	0.030	0.046	0,76	1.17
M	0.020	0.030	0,51	0,76

Adaptor base optional.
C_P = 0.12 pF Typical
L_S 0.50 nH Typical

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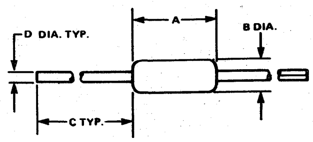

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.230	0.300	5,84	7,62
B	0.085	0.107	2,16	2,72
C	1.000	— —	25,40	— —
D	0.018	0.022	0,46	0,56

C_P - 0.15 pF Typical
L_S - 2.50 nH Typical

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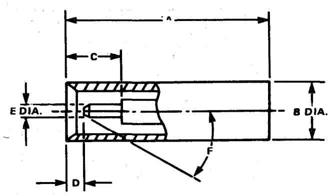

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.545	0.555	13,84	14,10
B	0.158	0.162	4,01	4,11
C	0.099	— —	2,51	— —
D	0.010	0.018	0,25	0,46
E	0.019	0.021	0,48	0,53
F	42°	48°	42°	48°

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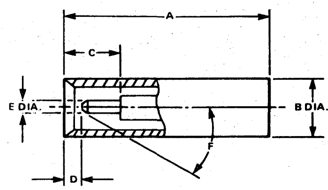

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.734	0.766	18,64	19,46
B	0.215	0.220	5,46	5,59
C	0.147	— —	3,73	— —
D	0.011	0.028	0.28	0,71
E	0.031	0.033	0.79	0,84
F	42°	48°	42°	48°

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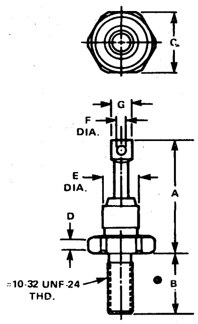

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	— —	0.800	— —	20,32
B	0.422	0.453	10,72	11,51
C	0.424	0.437	10,77	11,10
D	0.060	— —	1,52	— —
E	— —	0.290	— —	7,37
F	0.080	— —	2,03	— —
G	— —	0.160	— —	4,06

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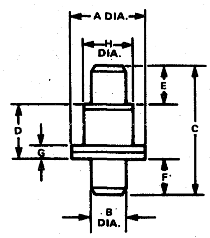

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,22
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.085	0.097	2,16	2,46
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	0,41	0,61
H	0.079	0.083	2,01	2,11

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

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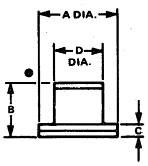

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.016	0.024	0,41	0,61
D	0.077	0.083	1,96	2,11

C_P = 0.18 pF Typical
L_S = 0.60 nH Typical

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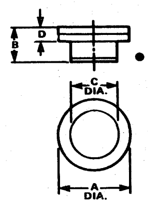

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.119	0.125	3,02	3.18
B	0.055	0.065	1.40	1.65
C	0.077	0.083	1.96	2.11
D	— —	0.025	— —	0.64

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

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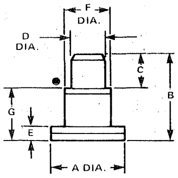

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.125	3,02	3,18
B	0.143	0.163	3,63	4,14
C	0.060	0.064	1,52	1,63
D	0.060	0.064	1,52	1,63
E	— —	0.025	— —	0,64
F	0.077	0.083	1,96	2,11
G	0.086	0.096	2,18	2,44

C_P = 0.18 pF Typical
L_S = 0.40 nH Typical

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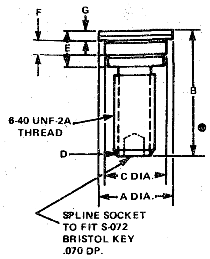

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.255	0.265	6,48	6,73
B	0.440	0.460	11,18	11,68
C	0.208	0.212	5,28	5,38
D	.020 x 45° REF.		0,51 x 45° REF.	
E	0.119	0.131	3,02	3,33
F	50 REF.		1.27 REF.	
G	0.025	0.035	0,64	0,89

C_P = 0.75 pF Typical
L_S = 0.60 nH Typical

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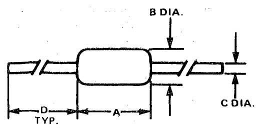

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.145	0.165	3,68	4,19
B	0.068	0.075	1,72	1,91
C	0.014	0.016	0,35	0,41
D	1.000	1.500	25,40	38,10

C_P = 0.10 pF Typical
L_S = 1.00 nH Typical

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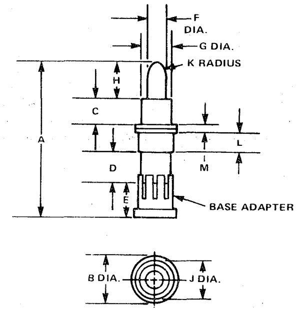

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.766	0.792	19,46	20,12
B	— —	0.240	— —	6,10
C	0.130 REF.		3.30 REF.	
D	0.145	0.155	3,68	3,94
E	0.180	0.190	4,57	4,83
F	0.092	0.094	2,34	2,39
G	0.155	0.165	3,94	4,19
H	0.180	0.190	4,57	4,83
J	0.185	0.195	4,70	4,95
K	0.030	0.046	0,76	1,17
L	0.095	0.105	2,41	2,67
M	— —	0.030	— —	0,76

Base adaptor optional.
C_P = 0.35 pF Typical
L_S = 3.0 nH Typical

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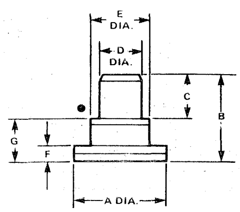

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.115	0.129	2,92	3,28
C	0.060	0.064	1,52	1,63
D	0.060	0.062	1,52	1,57
E	0.077	0.083	1,96	2,11
F	0.016	0.024	0,4[illegible]	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

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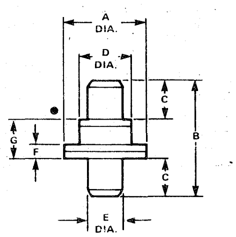

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.174	0.194	4,42	4,93
C	0.060	0.064	1,52	1,63
D	0.077	0.083	1,96	2,11
E	0.060	0.062	1,52	1,57
F	0.016	0.024	0,41	0,61
G	0.055	0.065	1,40	1,65

C_P = 0.30 pF Typical
L_S = 0.40 nH Typical

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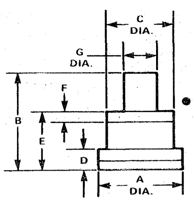

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.059	0.069	1,50	1,75
B	0.070	0.080	1,78	2.03
C	0.047	0.053	1.19	1.35
D	— —	0.015	— —	0.38
E	0.040	0.050	1,02	1.27
F	0.004	0.010	0.10	0.25
G	0.024	0.026	0.61	0.66

C_P ≈ 0.15 pF Typical
L_S ≈ 0.17 nH Typical

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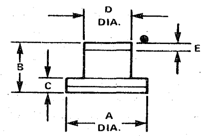

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.040	0.050	1,02	1,27
C	— —	0.015	— —	0,38
D	0.047	0.053	1,19	1,35
E	0.004	0.010	0.10	0,24

C_P - 0.15 pF Typical
L_S - 0.40 nH Typical

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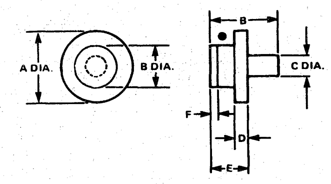

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.075	0.085	1,97	2,17
C	0.024	0.026	0,61	0,66
D	— —	0.018	— —	0,46
E	0.045	0.055	1,14	1,39
F	0.004	0.010	0,10	0,25
G	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

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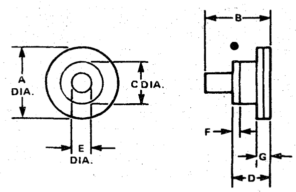

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.070	0.080	1,78	2,03
C	0.047	0.053	1,19	1,35
D	0.040	0.050	1,02	1,27
E	0.024	0.026	0,61	0,66
F	0.004	0.010	0,10	0,25
G	— —	0.015	— —	0,38

C_P 0.15 pF Typical
L_S 0.17 nH Typical

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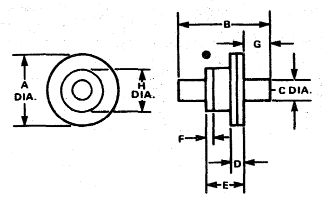

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.100	0.110	2,54	2,79
C	0.024	0.026	0,61	0,66
D	— —	0.015	— —	0,38
E	0.040	0.050	1,02	1,27
F	0.004	0.010	0,10	0,25
G	0.029	0.031	0,74	0,79
H	0.047	0.053	1,19	1,35

C_P = 0.15 pF Typical
L_S = 0.17 nH Typical

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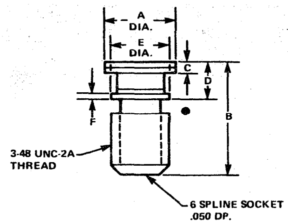

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3.02	3.23
B	0.188	0.208	4.78	5.28
C	0.016	0.024	0.41	0.61
D	0.058	0.071	1.47	1.80
E	0.098	0.102	2.49	2.59
F	0.009	0.011	0.23	0.28

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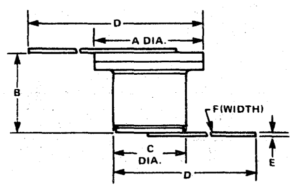

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.085	0.097	2,16	2,46
C	0.077	0.083	1,96	2,11
D	0.975	1.025	24,77	26,04
E	0.002	0.004	0,05	0,09
F	0.077	0.083	1,96	2,11

$C_P \approx$ 0.18 pF Typical
$L_S \approx$ 0.40 nH Typical

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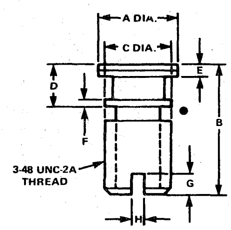

DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.119	0.127	3,02	3,23
B	0.188	0.208	4,78	5,28
C	0.098	0.102	2,49	2,59
D	0.057	0.071	1,45	1,80
E	0.016	0.024	0,41	0,61
F	0.009	0.011	0,23	0,28
G	0.025	0.045	0,64	1,14
H	0.015	0.025	0,38	0,64

C_P 0.27 pF Typical
L_S 0.30 nH Typical

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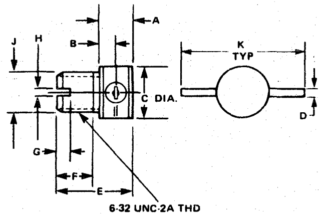
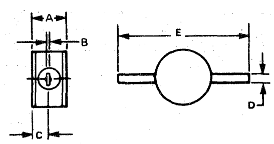


DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.120	.140	3,04	3,55
B	.058	.072	1,47	1.82
C	—	.255	—	6.47
D	.011	.013	.76	1.52
E	.380	.400	9.65	10.16
F	.205	—	5.20	—
G	—	—	—	—
H	—	—	—	—
J	.1312	.1372	3.33	3.48
K	—	—	—	—

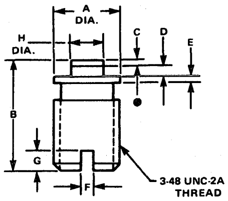
115



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.118	.140	3,00	3,55
B	.002	.006	.051	.152
C	.058	.072	1,47	1,82
D	.011	.013	1,76	1,52
E	—	—	—	—

Case Styles (Cont'd)

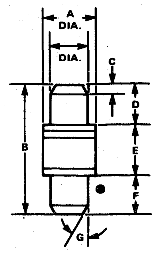
118



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.098	0.102	2,49	2,59
B	0.165	0.185	4,19	4,70
C	0.008	0.012	0,20	0,30
D	0.014	0.018	0,36	0,46
E	0.009	0.011	0,23	0,28
F	0.015	0.025	0,38	0,64
G	0.025	0.045	0,64	1,14
H	0.048	0.052	1,22	1,32

C_P = 0.22 pF Typical
L_S = 0.16 nH Typical

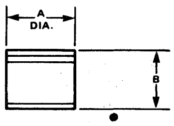
119



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.078	0.086	1,98	2,18
B	0.190	0.210	4,83	5,33
C	0.009	0.015	0,23	0,38
D	0.060	0.064	1,52	1,63
E	0.070	0.087	1,68	2,21
F	0.060	0.064	1,52	1,63
G	25°	35°	25°	35°
H	0.060	0.064	1,52	1,63

C_P - 0.15 pF Typical
L_S - 0.50 nH Typical

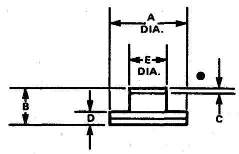
120



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.051	0.055	1,30	1,40
B	0.040	0.050	1,02	1,27

C_P = 0.13 pF Typical
L_S = 0.40 nH Typical

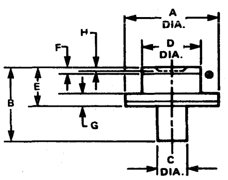
126



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.079	0.087	2,01	2,21
B	0.030	0.038	0,76	0,97
C	0.003	REF	0,76	REF
D	0.009	0.015	0,23	0,38
E	0.047	0.053	1,19	1,35

C_P - 0.23 pF Typical
L_S - 0.20 nH Typical

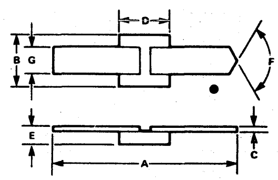
128



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.077	0.083	1,96	2,11
B	0.0545	0.0675	1,384	1,715
C	0.022	0.028	0,56	0,71
D	0.047	0.053	1,19	1,35
E	0.0295	0.0325	0,749	0,826
F	0.002	0.007	0,05	0,18
G	0.010	0.015	0,25	0,38
H	0.0015	0.0030	0,038	0,076

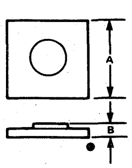
C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

129



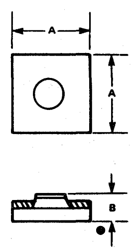
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.030	0.034	0,76	0,86
B	0.007	0.011	0,18	0,28
C	0.0004	0.0006	0,010	0,015
D	0.007	0.011	0,18	0,28
E	0.002	0.004	0,05	0,10
F	110°	130°	110°	130°
G	0.0045	0.0055	0,114	0,140

132



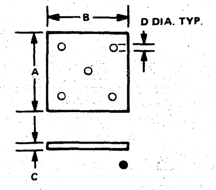
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.020	0.024	0,51	0,61
B	0.003	0.006	0,08	0,15

134



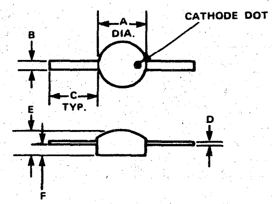
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0135	0.0165	0.34	0.42
B	0.0035	0.0065	0.09	0.17

135



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.013	.017	,330	,431
B	.013	.017	,330	,431
C	.004	.006	,102	,152
D	.001	— —	,02	— —

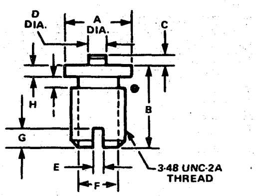
137



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.090	.110	2,29	2,54
B	.018	.022	,46	,56
C	.095	.105	2,41	2,67
D	.003	.005	,08	,13
E	— —	.050	— —	1,27
F	— —	.014	— —	,360

$C_P \approx 0.05$ pF Typical
$L_S \approx 0.50$ nH Typical

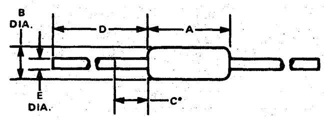
138



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.140	0.145	3,56	3,68
C	0.016	0.019	0,41	0,48
D	0.027	0.034	0,69	0,86
E	0.015	0.025	0,38	0,64
F	0.068	0.070	1,73	1,78
G	0.025	0.045	0,64	1,14
H	0.018	0.022	0,46	0,56
I	0.015	0.025	0,38	0,64

C_p = 0.18 pF Typical
L_S = 0.10 nH Typical

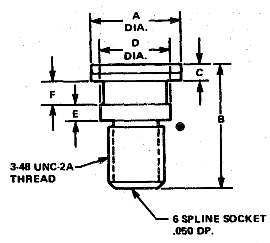
139



*LEAD DIA. UNCONTROLLED IN THIS AREA

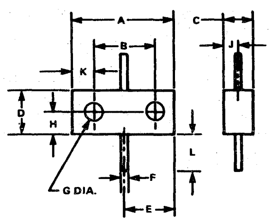
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.135	0.165	3,43	4,19
B	0.050	0.070	1,27	1,78
C	— —	0.050	— —	1,27
D	1.000	1.250	25,40	31,75
E	0.017	0.023	0,43	0,58

141



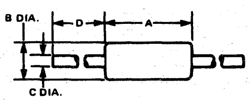
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.155	0.165	3,94	4,19
B	0.205	0.225	5,21	5,72
C	— —	0.030	— —	0,76
D	0.120	0.130	3,05	3,30
E	— —	0.030	— —	0,76
F	0.045 REF.		1.15 REF.	

144



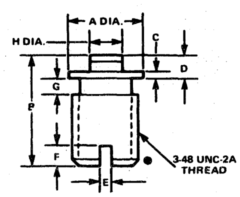
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.405	0.415	10,16	10,67
B	0.240	0.260	6,10	6,60
C	0.120	0.130	3,05	3,30
D	0.155	0.165	3,94	4,19
E	0.195	0.215	4,95	5,46
F	0.015	0.035	0,38	0,89
G	0.092	0.100	2,34	2,54
H	0.075	0.085	1,91	2,16
J	0.056	0.066	1,42	1,68
K	0.075	0.085	1,91	2,16
L	0.120	— —	3,05	— —
M	0.125	REF	3,18	REF

146



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.200	0.240	5,08	6,10
B	0.085	0.105	2,16	2,67
C	0.027	0.033	0,69	0,84
D	1.000	1.250	25,40	31,75

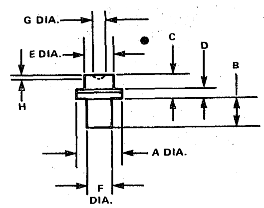
148



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.167	0.187	4,24	4,75
C	0.018	0.022	0,46	0,56
D	0.040	0.052	1,02	1,32
E	0.015	0.025	0,38	0,64
F	0.035	0.045	0,89	1,14
G	0.025	0.035	0,64	0,89
H	0.048	0.052	1,22	1,32

C_P = 0.26 pF Typical
L_S = 0.16 nH Typical

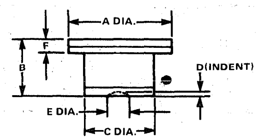
155



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.043	0.047	1,09	1,19
B	0.026	0.034	0,66	0,86
C	0.022	0.028	0,56	0,71
D	0.007	0.010	0,18	0,25
E	0.029	0.031	0,74	0,79
F	0.024	0.026	0,61	0,66
G	0.010	0.016	0,25	0,41
H	0.001	0.002	0,03	0,05

C_P = 0.13 pF Typical
L_S = 0.17 nH Typical

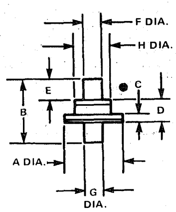
166



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.043	0.047	1,09	1,19
B	0.026	0.033	0,66	0,84
C	0.029	0.031	0,74	0,79
D	0.001	0.002	0,03	0,05
E	0.010	0.016	0,25	0,41
F	0.006	0.008	0,15	0,20

C_P = 0.13 pF Typical
L_S = 0.16 nH Typical

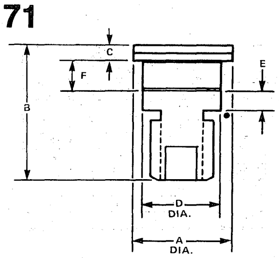
168



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.079	0.081	2,01	2,06
B	0.084	0.096	2,13	2,49
C	0.008	0.010	0,20	0,25
D	0.028	0.032	0,71	0,81
E	0.028	0.032	0,71	0,81
F	0.024	0.026	0,61	0,66
G	0.024	0.026	0,61	0,66
H	0.049	0.051	1,24	1,30

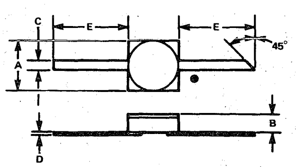
C_P = 0.23 pF Typical
L_S = 0.20 nH Typical

171



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.157	0.163	3,99	4,14
B	0.205	0.225	5,21	5,72
C	— —	0.025	— —	0,64
D	0.122	0.126	3,07	3,18
E	— —	0.030	— —	0,76
F	0.045	REF	1,15	REF

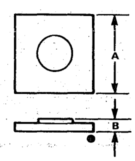
186



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.031	0.044	0,79	1,12
C	0.019	0.021	0,48	0,53
D	0.003	0.006	0.076	0,15
E	0.130	0.170	3,30	4,32

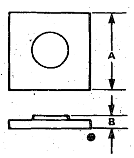
$C_P \approx$ 0.15 pF Typical
$L_S \approx$ 0.40 nH Typical

199



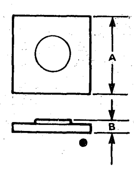
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.027	0.031	0,69	0,79
B	0.004	0.005	0,10	0,13

200



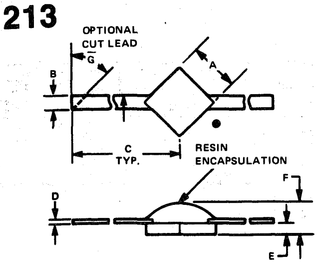
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.037	0.041	0,94	1,04
B	0.004	0.005	0,10	0,13

201



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.047	0.051	1,19	1,30
B	0.004	0.005	0,10	0,13

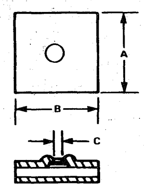
213



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.045	0.055	1,14	1,40
B	0.012	0.018	0,30	0,46
C	0.150	0.180	3,81	4,57
D	0.003	0.005	0,08	0,13
E	— —	0.014	— —	0,36
F	— —	0.035	— —	0,89
G	40°	50°	— —	— —

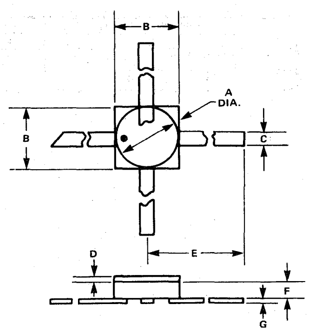
C_p ≈ 0.12 pF Typical
L_S ≈ 0.30 nH Typical

223



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.110	0.130	2,79	3,30
B	0.110	0.130	2,79	3,30
C	0.008	0.012	,20	,30

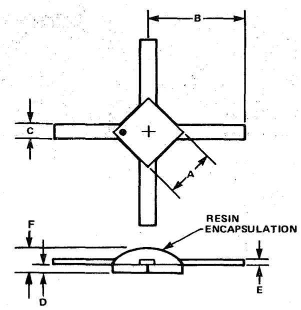
226



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0.092	0.106	2,34	2,69
C	0.017	0.023	0,43	0,58
D	0.004	0.008	0,10	0,20
E	0.200	— —	5,08	— —
F	0.025	0.035	0,64	0,89
G	0.003	0.006	0,08	0,15

C_p = 0.12 pF

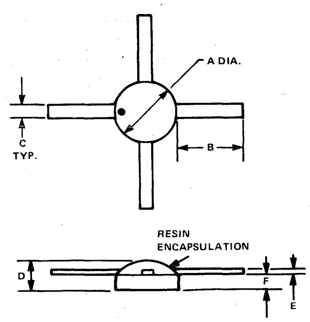
227



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.045	0.055	1,14	1,40
B	0.150	— —	3,81	— —
C	0.012	0.018	0,300	0,460
D	— —	0.014	— —	0,360
E	0.003	0.006	0,080	0,15
F	— —	0.035	— —	0,89

C_p = 0.05 pF

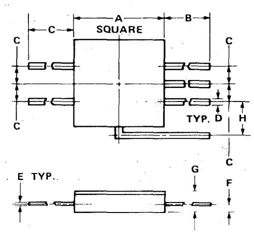
228



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2,29	2,79
B	0.090	0.110	2,29	2,79
C	0.018	0.022	0,46	0,56
D	— —	0.035	— —	0,89
E	0.003	0.006	0,08	0,15
F	— —	0.014	— —	0,36

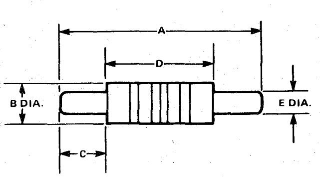
C_p = 0.10 pF

232



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.230	.270	5,84	6,86
B	.080	.120	2,03	3,05
C	.045	.055	1,14	1,40
D	.015	.020	,38	,51
E	.004	.006	,10	,15
F	.022	.032	,56	,81
G	.045	.065	1,14	1,65
H	.095	.105	2,41	2,67

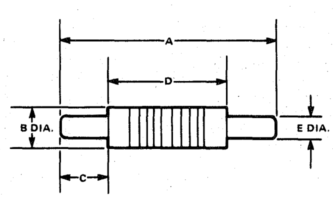
242



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.760	0.800	19,31	20,31
B	0.155	0.165	3,93	4,19
C	0.180	0.190	4,57	4,83
D	0.390	0.430	9,91	10,91
E	0.091	0.095	2,31	2,41

C_p ≈ 0.18 pF Typical
L_S ≈ 0.5 nH Typical

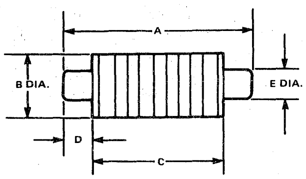
243



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.755	0.805	19,18	20,45
B	0.155	0.165	3,93	4,19
C	0.180	0.190	4,57	4,83
D	0.405	0.415	10,29	10,53
E	0.091	0.095	2,31	2,41

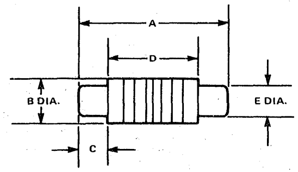
Case Styles (Cont'd)

247



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.368	0.408	9,35	10,37
B	0.128	0.134	3,25	3,41
C	0.250	0.270	6,35	6,85
D	0.060	0.064	1,53	1,63
E	0.060	0.064	1,53	1,63

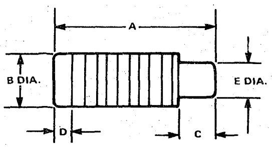
250



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.290	0.330	7,37	8,38
B	0.085	0.095	2,16	2,42
C	0.060	0.064	1,53	1,63
D	0.180	0.190	4,58	4,82
E	0.060	0.064	1,53	1,63

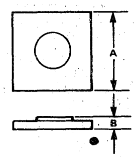
$C_p \approx$ 0.21 pF Typical
$L_S \approx$ 6 nH Typical

253



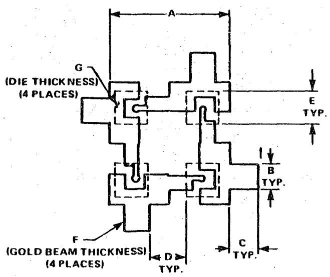
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.270	0.310	6,86	7,88
B	0.085	0.095	2,16	2,42
C	0.060	0.064	1,53	1,63
D	0.045	0.055	1,15	1,39
E	0.060	0.064	1,53	1,63

263



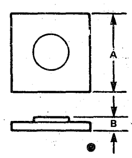
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	— —	0.060	— —	1,52
B	0.004	0.005	0,10	0,13

264



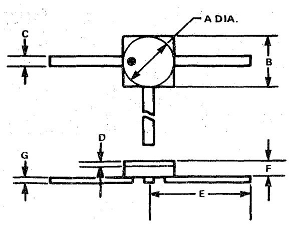
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.024	0.026	0,61	0,66
B	0.004	0.006	0,10	0,15
C	0.005	0.007	0,13	0,18
D	0.007	0.009	0,18	0,23
E	0.006	0.008	0,15	0,20
F	0.0002	0.0005	0,005	0,013
G	0.0015	0.0025	0,038	0,064

267



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	— —	0.070	— —	1,78
B	0.004	0.005	0,10	0,13

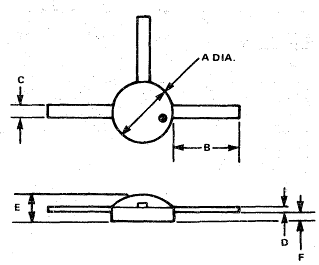
270



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.094	0.102	2,39	2,59
B	0,094	0.102	2,39	2,59
C	0.018	0.022	0,46	0,56
D	0.005	0.008	0,13	0,20
E	0.200	— —	5,08	— —
F	0.030	0.040	0,75	1,02
G	0.003	0.006	0,08	0,15

$C_p \sim$ 0.12 pF Typical

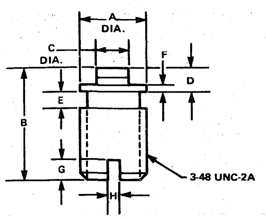
272



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.090	0.110	2,29	2,75
B	0.090	0.110	2,29	2,75
C	0.018	0.022	0,46	0,56
D	0.003	0.006	0,08	0,15
E	— —	0.035	— —	0,09
F	— —	0.014	— —	0,36

$C_p \sim$ 0.10 pF Typical

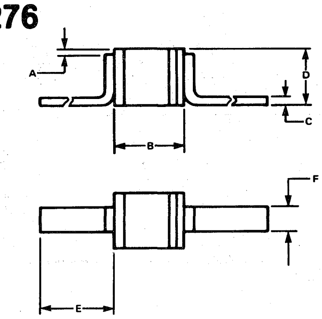
275



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.113	0.118	2,87	3,00
B	0.159	0.179	4,04	4,55
C	0.048	0.052	1,22	1,32
D	0.033	0.044	0,84	1,12
E	0.025	0.035	0,64	0,89
F	0.018	0.022	0,46	0,56
G	0.035	0.045	0,89	1,14
H	0.015	0.025	0,38	0,64

$C_P \approx 0.33$ pF Typical
$L_S \approx 0.20$ nH Typical

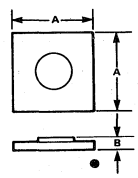
276



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.020	0,254	0,058
B	0.040	0.050	1,02	1,27
C	— —	0.005	— —	0,127
D	0.051	0.055	1,29	1,39
E	0.200	— —	5,08	— —
F	0.019	0.021	0,483	0,533

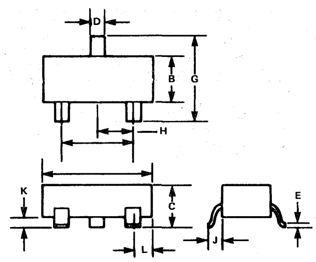
$C_P \approx 0.13$ pF Typical
$L_S \approx 0.40$ nH Typical

277



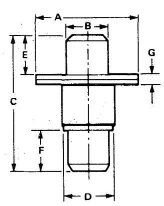
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.010	0.012	0,25	0,31
B	0.004	0.005	0,10	0,13

287



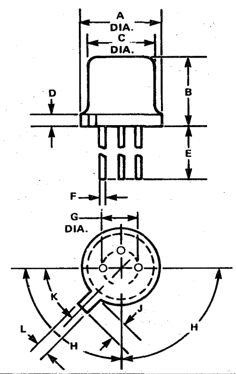
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.110	0.120	2,80	3,50
B	0.047	0.055	1,20	1,40
C	0.034	0.047	0,85	1,20
D	0.014	0.017	0,37	0,43
E	0.003	0.005	0,08	0,13
F	0.070	0.081	1,78	2,06
G	0.083	0.098	2,19	2,50
H	0.035	0.043	0,89	1,09
J	0.018	0.024	0,45	0,61
K	0.006	0.009	0,13	0,23
L	0.018	0.022	0,45	0,56

296



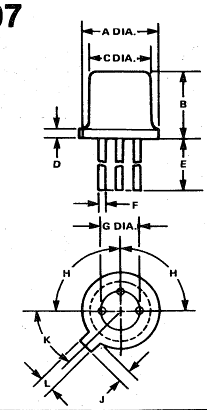
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.156	0.164	3,96	4,17
B	0.060	0.064	1,52	1,63
C	0.205	0.225	5,21	5,72
D	0.120	0.128	3,05	3,25
E	0.060	0.064	1,52	1,63
F	0.060	0.064	1,52	1,63
G	0.016	0.024	2,01	2,11

506



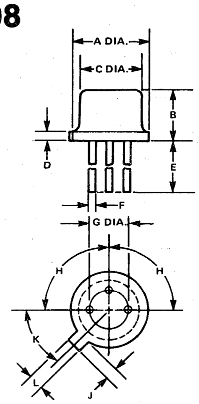
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.350	0.370	8,89	9,40
B	0.240	0.260	6,11	6,60
C	0.315	0.335	8,00	8,51
D	— —	0.040	— —	1,02
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.190	0.210	4,83	5,33
H	89°	91°	89°	91°
J	0.029	0.043	0,74	1,09
K	43°	47°	43°	47°
L	0.028	0.034	0,71	0,86

507



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.209	0.230	5,31	5,84
B	0.170	0.210	4,32	5,33
C	0.178	0.195	4,52	4,95
D	— —	0.030	— —	0,76
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.090	0.110	2,29	2,75
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

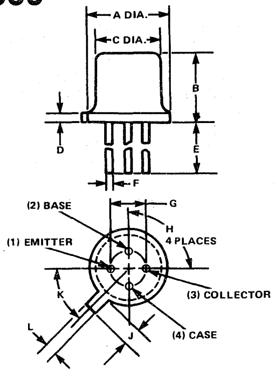
508



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.209	0.230	5,31	5,84
B	0.065	0.085	1,65	2,16
C	0.178	0.195	4,52	4,95
D	— —	0.030	— —	0,76
E	0.500	— —	12,70	— —
F	0.016	0.021	0,41	0,53
G	0.090	0.110	2,29	2,75
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

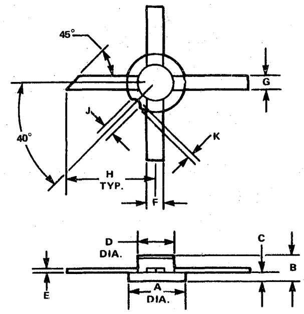
Case Styles (Cont'd)

509



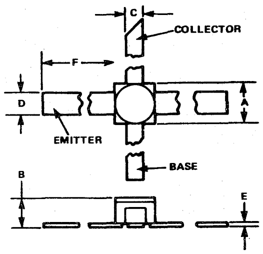
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.209	0.230	5,31	5,84
B	0.170	0.210	4,32	5,33
C	0.178	0.195	4,52	4,95
D	— —	0.020	— —	0,51
E	0.500	— —	12,70	— —
F	0.016	0.019	0,41	0,48
G	0.090	0.110	2,29	2,79
H	89°	91°	89°	91°
J	0.028	0.048	0,71	1,22
K	43°	47°	43°	47°
L	0.036	0.046	0,91	1,17

510



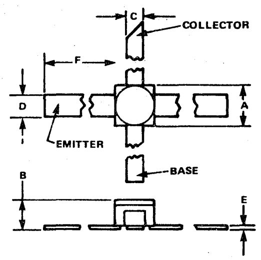
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.195	0.215	4,95	5,46
B	0.043	0.063	1,09	1,60
C	0.016	0.024	0,41	0,61
D	0.129	0.141	3,28	3,58
E	0.0015	0.0045	0,04	0,11
F	0.054	0.066	1,37	1,68
G	0.024	0.036	0,61	0,91
H	0.279	0.321	7,09	8,15
J	0.030 REF.		0,76 REF.	
K	0.150 REF.		0,38 REF.	

511



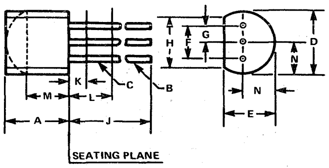
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.095	0.105	2,41	2,68
B	— —	0.050	— —	1,27
C	0.016	0.024	0,41	0,61
D	0.036	0.044	0,91	1,12
E	0.002	0.006	0,05	0,15
F	0.190	0.260	4,83	6,60

512



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.065	0.075	1,65	1,91
B	— —	0.050	— —	1,27
C	0.016	0.024	0,41	0,61
D	0.036	0.044	0,91	1,12
E	0.002	0.006	0,05	0,15
F	0.230	0.280	5,84	7,11

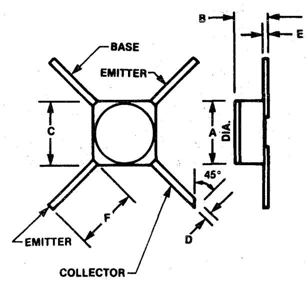
524



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.170	0.210	4,58	5,33
B[1,3]	0.016	0.021	0,407	0,533
C[3]	0.016	0.019	0,407	0,482
D	0.175	0.205	4,96	5,20
E	0.125	0.165	3,94	4,19
F	0.095	0.105	2,42	2,66
G	0.045	0.055	1,15	1,39
H	0.135	— —	3,43	— —
J[1,3]	0.500	— —	12,70	— —
K[3]	— —	0.050	— —	1,27
L[3]	0.250	— —	6,35	— —
M[2]	0.115	— —	2,93	— —
N	0.080	0.105	2,42	2,66

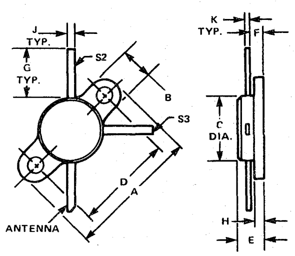
NOTES:
1. Three leads.
2. Contour of the package beyond this zone is uncontrolled.
3. (Three leads) dimension C applies between dimensions K and L. Dimension B applies between dimension L and .5" (12.70 mm) from seating plane. Diameter is uncontrolled in dimension K and beyond .5 (12.70 mm) from seating plane.

535



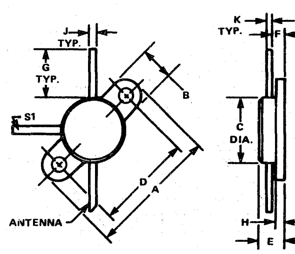
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.075	0.090	1,90	2,29
B	0.040	0.058	1,02	1,47
C	0.080	0.095	2,03	2,41
D	0.018	0.022	4,60	5,60
E	0.003	0.005	0,076	0,127
F	0.090	0.125	2,29	3,17

844-001



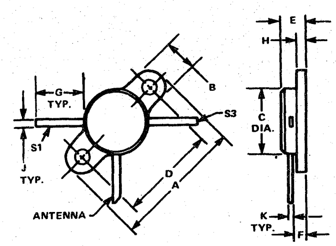
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.970	0.980	24,64	24,89
B	0.240	0.260	6,10	6,60
C	0.460	0.500	11,68	12,70
D	0.720	0.730	18,29	18,54
E	0.250	0.290	6,35	7,37
F	0.150	0.190	3,81	4,83
G	0.350	0.390	8,89	9,91
H	0.080	0.120	2,03	3,05
J	0.045	0.055	1,14	1,40
K	0.010	— —	0,25	— —

844-002



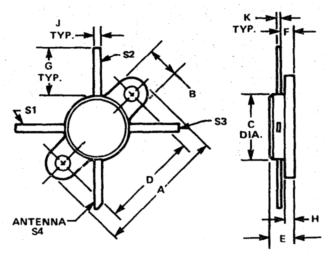
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.970	0.980	24,64	24,89
B	0.240	0.260	6,10	6,60
C	0.460	0.500	11,68	12,70
D	0.720	0.730	18,29	18,54
E	0.250	0.290	6,35	7,37
F	0.150	0.190	3,81	4,83
G	0.350	0.390	8,89	9,91
H	0.080	0.120	2,03	3,05
J	0.045	0.055	1,14	1,40
K	0.010	— —	0,25	— —

844-003



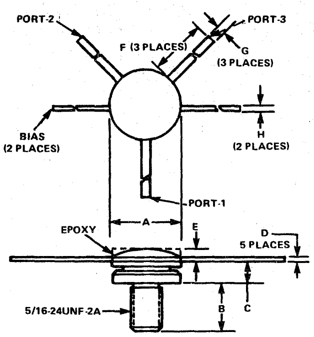
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.970	0.980	24,64	24,89
B	0.240	0.260	6,10	6,60
C	0.460	0.500	11,68	12,70
D	0.720	0.730	18,29	18,54
E	0.250	0.290	6,35	7,37
F	0.150	0.190	3,81	4,83
G	0.350	0.390	8,89	9,91
H	0.080	0.120	2,03	3,05
J	0.045	0.055	1,14	1,40
K	0.010	— —	0,25	— —

844-004



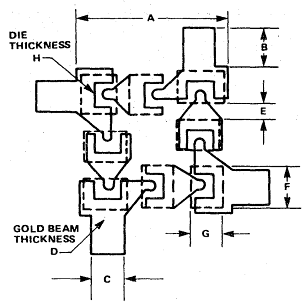
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.970	0.980	24,64	24,89
B	0.240	0.260	6,10	6,60
C	0.460	0.500	11,68	12,70
D	0.720	0.730	18,29	18,54
E	0.250	0.290	6,35	7,37
F	0.150	0.190	3,81	4,83
G	0.350	0.390	8,89	9,91
H	0.080	0.120	2,03	3,05
J	0.045	0.055	1,14	1,40
K	0.010	— —	0,25	— —

852



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	— —	0.775	— —	19,69
B	0.552	0.572	14,02	14,52
C	— —	0.250	— —	6,35
D	0.006	0.014	0,15	0,38
E	— —	0.250	— —	0,64
F	— —	0.750	— —	19,10
G	0.095	0.105	2,41	2,67
H	0.045	0.055	1,14	1,40

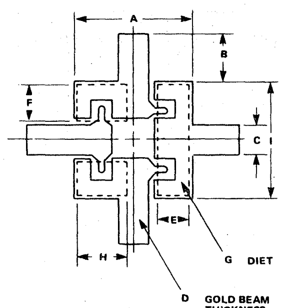
905



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.022	0.024	0,559	0,610
B	0.005	0.007	0,127	0,178
C	0.004	0.006	0,101	0,152
D	0.0002	0.0005	0,005	0,0127
E	0.002	0.003	0,051	0,076
F	0.006	0.007	0,152	0,177
G	0.0045	0.0055	0,114	0,139
H	0.0015	0.0025	0,0381	0,0635

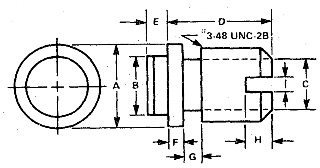
NOTE: MEASUREMENT A, B, C & D 4 PLACES
MEASUREMENT E, F, G & H 8 PLACES

906



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.019	0.021	0,483	0,533
B	0.007	0.009	0.178	0,229
C	0.004	0.006	0,102	0,152
D	0.0002	0.0005	0,0050	0,0127
E	0.006	0.007	0,152	0,127
F	0.006	0.007	0,152	0,127
G	0.0045	0.0055	0,114	0,139
H	0.009	0.010	0,229	0,254
I	0.019	0.021	0,483	0,533

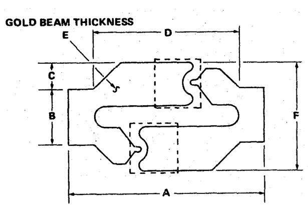
940



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.113	0.118	2,87	3,00
B	0.076	0.084	1,93	2,13
C	0.068	0.072	1,73	1,83
D	0.138	0.146	3,51	3,71
E	0.026	0.034	0,66	0,86
F	0.018	0.022	0,46	0,56
G	— —	0.020	— —	0,51
H	0.035	0.045	0,89	0,114
I	0.015	0.025	0,38	0,64

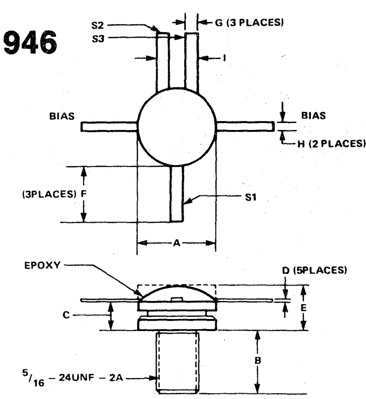
$C_P \sim$ .30 pF Typical
$L_S \sim$ .20 nH

942



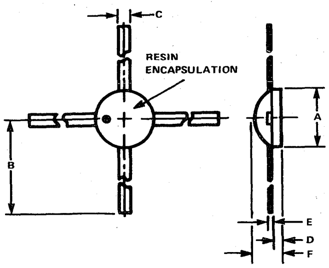
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.026	0.028	0,660	0,711
B	0.0045	0.0055	0,114	0,140
C	0.0019	0.0029	0,048	0,074
D	0.006	0.007	0,152	0,178
E	0.0002	0.0005	0,0051	0,0127
F	0.0085	0.010	0,216	0,254

946



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.740	.760	18,80	19,30
B	.552	.577	14,02	14,65
C	.210	.220	5,33	5,59
D	.007	.014	0,17	0,35
E	— —	.155	— —	3,93
F	.485	.750	12,31	19,05
G	.095	.110	2,41	2,80
H	.035	.045	0,90	1,14
I	.305	.345	7,74	8,77

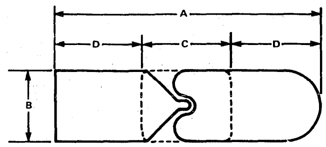
963



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.050	0.058	1,27	1,47
B	0.140	— —	3,55	— —
C	0.012	0.018	0,30	0,46
D	0.007	0.014	0,178	0,36
E	0.003	0.006	0,076	0,152
F	— —	0.035	— —	0,89

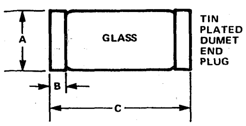
Cp ~ 0.04 pF Typical

965



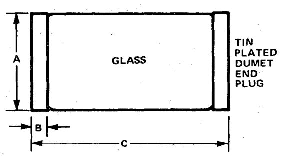
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0265	0.0275	0,673	0,699
B	0.0050	0.0060	0,127	0,152
C	0.0065	0.0075	0,165	0,191
D	0.009	0.0110	0,229	0,279

983



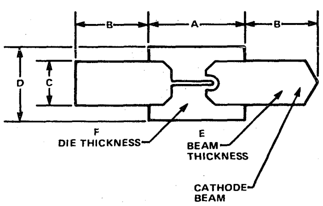
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.057	0.067	1,45	1,70
B	0.011	0.019	0,280	0,482
C	0.130	0.150	3,30	3,81

984



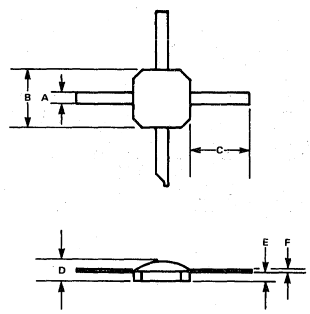
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.095	0.100	2,41	2,54
B	0.010	0.020	0,280	0,482
C	0.185	0.205	0,469	0,520

990



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0128	0.0132	0,325	0,335
B	0.010	0.011	0,254	0,279
C	0.0060	0.0062	0,152	0,157
D	0.0095	0.010	0,241	0,254
E	0.0003	0.0005	0,0076	0,0127
F	0.0014	0.0015	0,035	0,038

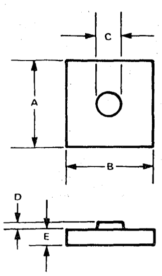
1008



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.018	0.022	0,457	0,559
B	0.090	0.110	2,29	2,79
C	0.090	0.110	2,29	2,79
D	— —	0.05	— —	1,27
E	— —	0.015	— —	0,381
F	0.003	0.005	0,076	0,127

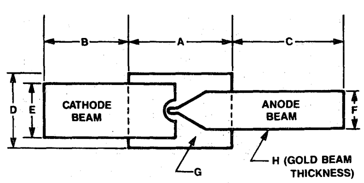
Cp ≈ 0.05 pF Typical

1009



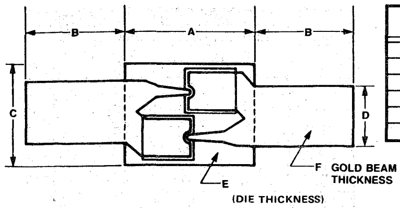
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.014	0.016	0,355	0,406
B	0.014	0.016	0,355	0,406
C	— —	.002	— —	,056
D	— —	.0002	— —	,005
E	.004	.006	0,10	0,15

1010



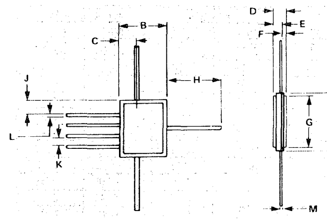
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.010	0.012	0,25	0,30
B	0.012	— —	0,30	— —
C	0.010	— —	0,25	— —
D	0.006	0.008	0,15	0,20
E	0.005	0.006	0,12	0,15
F	0.004	0.005	0,10	0,12
G	0.003	0.004	0,07	0,10
H	0.0003 Nominal		0.012 Nominal	

1013



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.0105	0.0125	0,26	0,32
B	0.007	— —	0,18	— —
C	0.0085	0.0105	0,22	0,26
D	0.005	0.006	0,13	0,15
E	0.003	0.004	0,07	0,10
F	0.0005 (Nominal)		0,012 (Nominal)	

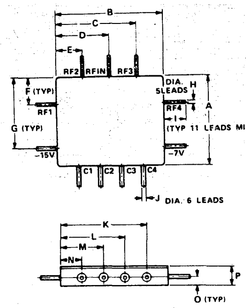
2000



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.252	.268	6,40	6,80
B	.207	.223	5,25	5,66
C	.080	.090	2,03	2,29
D	.047	.055	1,19	1,39
E	.027	0.035	,685	,889
F	.017	.023	,431	,584
G	.242	.258	6,14	6,55
H	.225	.255	5,71	6,47
J	.053	.063	1,34	1,60
K	.032	.038	,812	,965
L	.008	.012	,203	,304
M	.004	.007	,101	,177

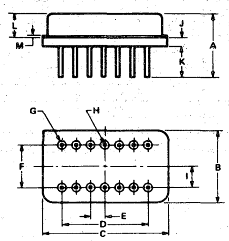
NOTES:
1. Lid is Nickel Plated
2. Other metal areas are Au Plated

2008



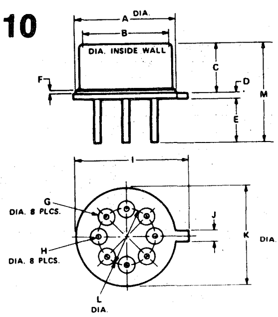
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.625	.635	15,87	16,13
B	.745	.755	18,92	19,17
C	.557	.567	14,14	14,40
D	.370	.380	9,39	9,65
E	.182	.192	4,62	4,87
F	.182	.192	4,62	4,87
G	.495	.505	12,57	12,82
H	.010	.014	0,12	0,38
I	.145	.155	3,68	3,93
J	.020	.030	0,38	0,63
K	.595	.605	15,11	15,36
L	.445	.455	11,30	11,55
M	.295	.305	7,49	7,74
N	.145	.155	3,68	3,93
O	.057	.067	1,44	1,70
P	.130	.140	3,30	3,55

2009



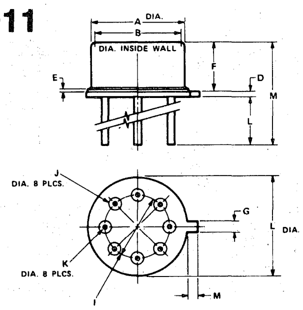
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.445	.455	11,30	11,55
B	.495	.501	12.72	12,57
C	.867	.873	22,17	22,02
D	.595	.605	15,11	15,36
E	.095	.105	2,41	2,66
F	.295	.305	7,49	7,74
G	.051	.061	1,29	1,54
H	.016	.020	0,40	0,50
I	.145	.155	3,68	3,93
J	.055	.065	1,39	1,65
K	.200	.240	5,08	6,09
L	.164	.174	4,16	4,41
M	.008	.012	0,20	0,30

2010



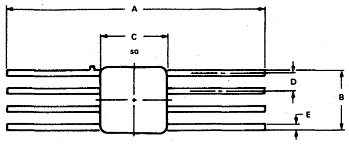
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.347	.351	8,81	8,91
B	.302	.306	7,67	7,77
C	.170	.180	4,31	4,57
D	.013	.017	0,33	0,43
E	.500	.560	12,70	14,22
F	.009	.012	0,22	0,30
G	.054	.058	1,37	1,47
H	.015	.019	0,38	0,48
I	.390	.398	9,90	10,10
J	.027	.034	0,68	0,86
K	.358	.362	9,09	9,19
L	.195	.205	4,95	5,20
M	.683	.757	17,34	19,22

2011



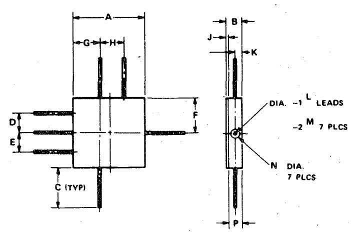
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.347	.351	8,81	8,91
B	.302	.306	7,67	7,77
C	.500	.560	12,70	14,22
D	.013	.017	0,33	0,43
E	0,09	.012	0,22	0,30
F	.170	.180	4,31	4,57
G	.028	.034	0,71	0,86
H	.030	.040	0,76	1,01
I	.225	.235	5,71	5,96
J	.040	.050	1,01	1,27
K	.015	.019	0,38	0,48
L	.358	.362	9,09	9,19
M	.683	.757	17,34	19,22

2012



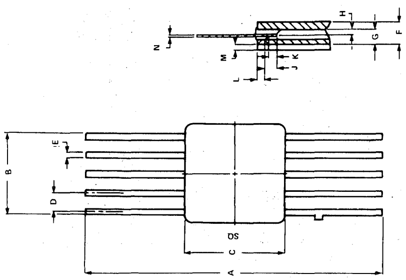
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.695	.705	17,65	17,90
B	.160	.170	4.06	4,31
C	.175	.180	4,44	4,57
D	.045	.055	1,14	1,39
E	.010	.020	0,25	0,50
F	.003	.007	0,07	0,17
G	.072	.075	1,90	1,83
H	.032	.037	0,81	0.93
J	.015	.025	0,38	0,63
K	.013	.023	0,33	0,58
L	0.15	.025	0,38	0,63
M	.006	.010	0,15	0,25
N	.010	.020	0,25	0,50

2014



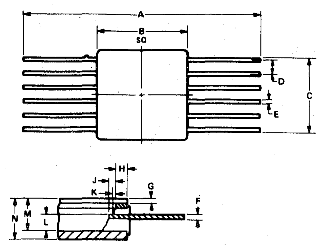
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.623	.627	15,82	17,06
B	.130	.140	3,30	3,55
C	.335	.350	8,89	9,01
D	.170	.180	4,31	4,57
E	.170	.180	4,31	4,57
F	.308	.318	7,82	8,07
G	.230	.240	5,84	6,09
H	.440	.450	11,17	11,43
J	.007	.013	0,17	0,33
K	.060	.066	1,52	1,67
L	.145	.155	0,35	0,39
M	.115	.125	0,27	0,30
N	.077	.079	1,95	2,00
P	.123	.127	3,12	3,22

2015



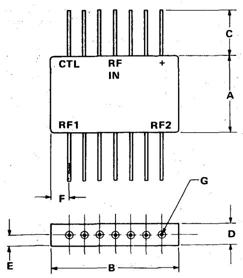
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.260	.270	6,60	6,85
B	.210	.220	5,33	5,58
C	.265	.270	6,73	6,85
D	.045	.055	1,14	1,39
E	.010	.020	0,25	0,50
F	.075	.080	2,03	1,90
G	.040	.045	1,01	1,14
H	.015	.025	0,38	0,63
J	.015	.025	0,38	0,63
K	.010	.015	0,25	0,38
L	.017	.027	0,43	0,68
M	.010	.020	0,25	0,50
N	.002	.008	0,05	0,20

2016



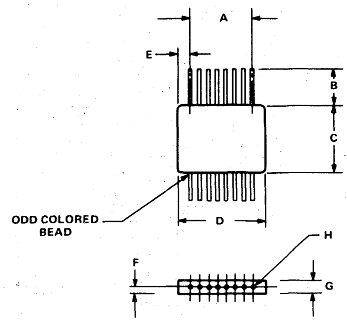
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.525	.535	13,33	13,58
B	.635	.640	16,12	16,25
C	.525	.535	13,33	13,58
D	.095	.105	2,41	2,66
E	.010	.020	0,25	0,53
F	.007	.013	0,17	0,33
G	.010	.020	0,25	0,53
H	.037	.047	0,93	1,19
J	.020	.030	0,53	0,76
K	.010	.015	0,25	0,38
L	.050	.060	1,27	1,52
M	.095	.100	2,41	2,54
N	.120	.125	3,04	3,17

2017



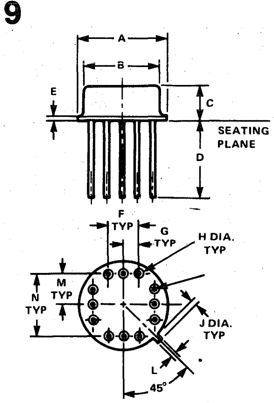
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A		.500		12,7
B		.820		20,828
C	.325		8,255	
D		.138		3,5052
E		.069		1,7526
F		.110		2,794
G	.013	.017	.3302	.4318

2018



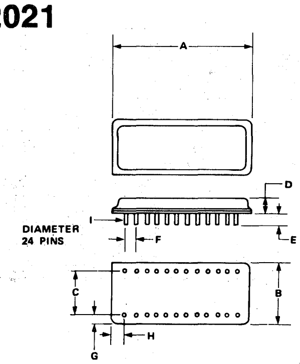
DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	0.100 Nominal		2,54 Nominal	
B	.325	—	8,26	—
C	.790	.810	20,1	20,6
D	.980	1.020	24,9	25,9
E	0.150 Nominal			
F	—	0.69	—	1,75
G	—	.138	—	3,50
H	—	.017	,33	,43

2019



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	.598	.602	15,18	15,29
B	.545	.555	13,84	14,10
C	.185	.195	4,69	4,95
D	.500	.560	12,70	14,22
E	.013	.016	0,33	0,40
F	.195	.205	4,93	5,20
G	.095	.105	2,41	2,66
H	.055	.065	1,39	1,65
J	.0183	.0188	0,44	0,48
K	.026	.036	0,66	0,91
L	.026	.036	0,66	0,91
M	.193	.207	4,90	5,25
N	.393	.407	9,98	10,33

2021



DIM.	INCHES MIN.	INCHES MAX.	MILLIMETERS MIN.	MILLIMETERS MAX.
A	1.350	1.390	34,3	35,3
B	0.780	0.820	19,8	20,8
C	0.595	0.605	15,1	15,3
D	—	0.200	—	5,1
E	0.120	—	3,0	—
F	0.100	Nominal	2,4	Nominal
G	0.080	0.120	2,0	3,0
H	0.120	0.160	3,1	4,1
I	0.013	0.023	0,38	0,42

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Field Sales Offices

Domestic Field Offices/Representatives

NORTHEASTERN REGION:

M/A-COM Components Marketing
New England Field Office
6 Omni Way
Suite 182
Chelmsford, MA 01824
Tel: (617) 256-4000
FAX: (617) 250-1095
TWX: 710-348-1339
EASYLINK: 62017597

M/A-COM Components Marketing
Syracuse Field Office
4713 Crossroads Park Drive
Suite 501
Liverpool, NY 13088
Tel: (315) 451-6774
FAX: (315) 451-2230
EASYLINK: 62017598

M/A-COM Components Marketing
Buffalo Satellite Office
Suite 230, Second Floor
Sidway Building
775 Main Street
Buffalo, NY 14203
Tel: (716) 855-1920

ERA, Inc.
354 Veterans Memorial Hwy.
Commack, NY 11725
Tel: (516) 543-0510
FAX: (516) 543-0758
TWX: 510-226-1485
EASYLINK: 62826324

M/A-COM Components Marketing
Philadelphia Field Office
2300 Computer Avenue, Suite H-42
Willow Grove, PA 19090
Tel.: (215) 784-9640
FAX: (215) 657-3550
TWX: 510-665-6533
EASYLINK: 62017599

M/A-COM Components Marketing
Baltimore Field Office
10280 Old Columbia Road, Suite D
Columbia, MD 21046
Tel: (301) 381-2230
TWX: 710-828-9819
FAX: (301) 381-2238
EASYLINK: 62017600

M/A-COM Components Marketing
Chicago Field Office
380 West Palatine Road, Suite 2
Wheeling, IL 60090
Tel: (312) 459-8440
FAX: (312) 459-8728
TWX: 910-651-3026
EASYLINK: 62017612

EASTERN CANADA:

M/A-COM Components Marketing
Toronto Field Office
6547 Mississauga Road, Suite B
Mississauga, Ontario, L5N 1A6
Tel: (416) 821-3548
FAX: (416) 821-0762
TWX: 610-492-2999
EASYLINK: 62017646

M/A-COM Components Marketing
Ottawa Field Office
190 Colonnade Road, Suite 204
Nepean, Ontario K2E 7J5
Tel: (613) 727-9800
(514) 848-7081 (Montreal)
Telex: 053-3507
FAX: (613) 727-1064

SOUTHEASTERN REGION:

M/A-COM Components Marketing
Atlanta Field Office
1640 Powers Ferry Road
Suite 350, Bldg. 17
Marietta, GA 30067
Tel: (404) 956-0351
FAX: (404) 953-9056
TWX: 810-751-0244
EASYLINK: 62017602

M/A-COM Components Marketing
Warner Robins Field Office
1532 B Watson Blvd.
Suite 1
Warner Robins, GA 31093
Tel: (912) 929-1000
FAX: (912) 929-9519
EASYLINK: 62017609

M/A-COM Components Marketing
Melbourne Field Office
P.O. Box 1419
Palm Bay, FL 32906
Tel: (407) 729-6400
FAX: (407) 723-8508
TWX: 810-848-0008
EASYLINK: 62017610

MA/COM Components Marketing
Tampa Field Office
10014 North Dale Mabry
Suite 101
Tampa, FL 33618
Tel.: (813) 960-4189
FAX: (813) 960-8405
Telex: 52-407

M/A-COM Components Marketing
Ft. Wayne Field Office
1502 Magnavox Way
Suite 240
Ft. Wayne, IN 46804
Tel: (219) 432-8424
FAX: (219) 432-3598
TWX: 810-332-1513
EASYLINK: 62017613

M/A-COM Components Marketing
DESC Field Office
Suite 2006
240 West Elmwood Drive
Centerville, OH 45459
Tel.: (513) 436-9024
FAX: (513) 436-9028
EASYLINK: 62017614

Seltec Sales Corp.
P.O. Box 2172
316 2nd St., SE Suite 416
Cedar Rapids, IA 52406
Tel: (319) 364-7660
FAX: (319) 364-7906
TWX: 910-525-1329
EASYLINK: 62824351

M/A-COM Components Marketing
St. Louis Field Office
5494 Brown Road
Suite 113
Hazelwood, MO 63042
Tel: (314) 731-0271
FAX: (314) 731-3604
EASYLINK: 62017614

WESTERN REGION:

M/A-COM Components Marketing
Dallas Field Office
800 E. Campbell Road, Suite 260
Richardson, TX 75081
Tel: (214) 234-2463
FAX: (214) 234-4267
TWX: 910-867-4769
EASYLINK: 62017616

M/A-COM Components Marketing
Denver Field Office
14 Inverness Drive — E
Building F, Suite 140
Englewood, CO 80112
Tel.: (303) 790-0538, 39, 42
FAX: (303) 799-6814
TWX: 910-935-0156
EASYLINK: 62035090

M/A-COM Components Marketing
Phoenix Field Office
3260 No. Hayden Rd., Suite 115
Scottsdale, AZ 85251
Tel: (602) 949-1642
FAX: (602) 941-1703
TWX: 910-950-1281
EASYLINK: 62017636

M/A-COM Components Marketing
Los Angeles Field Office
9800 Sepulveda Blvd., Suite 610
Los Angeles, CA 90045
Tel: (213) 641-5311
FAX: (213) 645-2090
TWX: 910-328-6132
EASYLINK: 62017638

M/A-COM Components Marketing
Gov't. R & D Liaison Office
108 Turquoise Ave.
Balboa Island, CA 92662
Tel: (714) 675-4211
FAX: (714) 675-1986
EASYLINK: 62047183

M/A-COM Components Marketing
Santa Barbara Field Office
5638 Hollister Ave., Suite 1
Goleta, CA 93117
Tel: (805) 964-4844
FAX: (805) 967-9642
TWX: 910-334-4840
EASYLINK: 62035091

M/A-COM Components Marketing
San Diego Field Office
3650 Clairemont Drive, Suite 5
San Diego, CA 92117
Tel: (619) 483-5099
FAX: (619) 483-2710
TWX: 910-335-1737
EASYLINK: 62035092

M/A-COM Components Marketing
Orange County Field Office
421 N. Brookhurst, Suite 108
Anaheim, CA 92801
Tel: (714) 758-1921
FAX: (714) 758-1921
TWX: 910-591-2908
EASYLINK: 62017639

M/A-COM Components Marketing
Northern California Field Office
1754 Technology Drive, Suite 129
San Jose, CA 95110
Tel: (408) 298-2525
FAX: (408) 294-7401
TWX: 910-338-2140
EASYLINK: 62017640

M/A-COM Components Marketing
Seattle Field Office
1495 Gilman Blvd., NW Suite 17
Issaquah, Washington 98027
Tel: (206) 392-4990
FAX: (206) 392-8780
TWX: 910-443-3038
EASYLINK: 62017645

International Field Offices/Representatives

ARGENTINA

Reycom Electronica SRL
Arcos 3631
1429-Buenos Aires
Argentina
Tel: 11-1721 or 701-4462
TELEX: 22122 PHOENI AR or
25133 REYCOM AR
FAX –: 54-(1)-11-1722

AUSTRALIA

MAA Pty. Limited
P.O. Box 128
Winmalee, N.S.W.
Australia 2777
Tel: 61-4-754-1877
TELEX: 71464

*MAA Pty. Limited
3/115 MacQuarie Road
Springwood N.S.W.
Australia 2777

BELGIUM, LUXEMBOURG

Microwave Associates, Int'l
92-94 Sq. E. Plasky
1040 Bruxelles
Belgium
Tel: 32-(2)-735-01-95
TELEX: 84623281
TELEFAX: 736.53.72
CABLE: MELABSA BRUSSELS
EASY LINK: 62028826

BRAZIL

Hitech Comercial E Industrial Ltda.
Av. Eng. Luiz Carlos Berrini, 801, cj. 121
Cidade Moncoes
04571 Sao Paulo, Brazil
Tel: (55-11) 531-9355
TELEX: 11-53288
FAX: 5511613770

CHINA (P.R.C.)

M/A-COM Hong Kong
Room 91, 9th Floor
New Henry House
10 Ice House Street
Central, Hong Kong
Tel.: 011-852-5-263362
TELEX: 63884 MACOM HX
FAX: 011-852-5-8680112

DENMARK

Tage-Olsen A/S
Ballerup BYVEJ 222
P.O. Box 225
DK-2750 Ballerup
Denmark
Tel: 45-(2)-65.81.11
TELEX: 35293
CABLE: TOAS DK
FAX: 452680300

EUROPE — EAST BLOC

M/A-COM France S.A.
6-8 Rue du 4-Septembre
92130 Issy Les Moulineaux
France
Attn: Alain Gobilliard
Tel.: 33-(1)-554.97.58
FAX: 33145573400
TELEX: 842202100
EASY LINK: 62036483

FINLAND

Carlo Casagrande Oy
Kalevankatu 4
Helsinki 10
Finland
Tel: 358-(0)-640-711, 641
TELEX: 857121677
CABLE: CARCAS HELSINKI
FAX: 3580644488

FRANCE

M/A-COM France S.A.
6-8 Rue Du 4 Septembre
92130 Issy Les Moulineaux
France
Tel: 33-(1)-554.97.58
TELEX: 842202100
FAX: 33145573400
EASY LINK: 62036483

HONG KONG

M/A-COM Hong Kong
Room 91, 9th Floor
New Henry House
10 Ice House Street
Central, Hong Kong
Tel.: 011-852-5-263362
TELEX: 63884 MACOM HX
FAX: 011-852-5-8680112

INDIA

Radelcom
11/3 Hayes Road Cross
Bangalore — 560025
India
Tel: 91-(0812)-51439
TELEX: 845-8466 NAAG IN
CABLE: RADELCOM BANGALORE

ISRAEL

ISCOM, Ltd.
3 Ta'as St.
Ramat-Gan, 52521
Israel
Tel: (3) 7518421
(3) 7510498
TELEX: 361456
FAX: 97237510498
EASY LINK: 62036482

ISCOM, Ltd.
*P.O. Box 1873
Ramat-Gan
Israel 52117

ITALY (SOUTHERN)

M/A-COM Italia, S.P.A.
Via Antonia Vivaldi, 9
00199 Roma, Italy
Tel: 39-(6)-83.95.148
TELEX: 843610105
FAX: 396834787
EASY LINK: 62036484

ITALY (NORTHERN)

M/A-COM Italia, S.P.A.
Via M. Macchi 28
20124, Milan, Italy
Tel: 2-669-6368
TELEX: 340564
FAX: 3926696974
EASY LINK: 62036485

JAPAN

Nihon M/A-COM K.K.
1, Yotsuya 4-Chome
Shinjuku-Ku, Tokyo 160
Japan
Tel.: 81-3-2261671
FAX: 81-3-2261451
E-Mail: 81-3-2261452
TELEX: 2325011
FAX: 8132261451
EASY LINK: 62028811

KOREA

Hanaro Corporation
Yoido P.O. Box. 286
Seoul, Korea
Tel.: (02) 784-1144
TELEX: K26878 HANARO
FAX: (02) 784-0157

MEXICO

Mexitek, S.A.
Eugenia No. 408, Deptos. 2 y 3
Col. Del Valle
Apdo. Postal 12-1012
03100 Mexico, D.F.
Tel: 52-536-09-10, 523-97-51,
543-03-77
TELEX: 1773239 MEXIME

NETHERLANDS (HOLLAND)

Microwave Associates
Components BV
Lelystraat 2
3601 BV Maarssen, The Netherlands
*P.O. Box 277
Tel: 31-(3465)-66024
TELEX: 84447808
FAX: 31346568124
EASY LINK: 62038286

NEW ZEALAND

AWA New Zealand, Ltd.
P.O. Box 50-248
Porirua, New Zealand
Tel: 64-(4)-375069
TELEX: 31001
FAX: 64-(4)-374201

NORWAY

EB Nortelco a.s.
P.O. Box 92 — Risloekka
0516 Oslo 5 Norway
Tel: 47-(2)-64-90-50
TELEX: 85676743
FAX: (02) 64 7400

SINGAPORE

S & T Enterprises, Ltd.
80 Genting Lane 903-02
Ruby Industrial Complex, Genting Block
Singapore 1334
Tel: 65-7459235
TELEX: 24784
CABLE: BRAPANSIN

SOUTH AFRICA

Fairmont Electronics (Pty.) Ltd.
4th Floor, 312 Kent Avenue
Ferndale
Randburg 2194
Transvaal, Republic of South Africa
Tel: 27-(11)-789-1230
TELEX: 424842
CABLE: FAIRTRONICS
FAX: 27118862929

Fairmont Electronics (Pty.) Ltd.
*P.O. Box 4556
Randburg 2125

SPAIN

Compelesa
Pza. Sta. Maria Soledad Torres Acosta –1
3rd Floor
28004 Madrid, Spain
Tel: (34)-1-5326403
(34)-1-2326156
TELEX: 48734 EMC E

Barcelona
Caspe, 116-2-3
08013 Barcelona, Spain
Tel: 34-(3)-93-231-59-61
TELEX: 98580 OMP E

SWEDEN

M/A-COM A/B
Wallingatan 38
S-111 24 Stockholm
Sweden
Tel: 46-(8)-14-03-50
TELEX: 10540 MACOM S
FAX: 468119116
EASY LINK: 62036486

SWITZERLAND

Walter-Electronic AG
Frauenfelderstrasse 49
CH-8370 SIRNACH
Switzerland
Tel: 073-264040
TELEX: 883448 WAELCH
FAX: 073-263717

TAIWAN

Taipei Office

Telestar International
13-1 Floor
540 Ming Shen E. Road
P.O. Box 58648
Taipei, Taiwan R.O.C.
Tel: (02)-5064194
TELEX: 10671
FAX: (02)-5064194

Los Angeles Office

Telestar International
849 Westchester Place
Los Angeles, CA 90005
U.S.A.
Tel: (213) 386-3385
TELEX: 181375 HTI LSA

TURKEY

Elektro
Sanayi Ve Ticaret Koll. Sti.
Ahmet Rasim Sokak No. 16 Hasanpasa
Kadikoy-Istanbul
Turkey
Tel.: 33.72.245
TELEX: 29569 ELTS TR.

UNITED KINGDOM

M/A-COM, Ltd.
Humphreys Road
Dunstable LU5 4SX
Bedfordshire, U.K.
Tel: 44-(582)-47.12.00
TELEX: 85182295
FAX: 582472277
CABLE: MICROWAVE DUNSTABLE

WEST GERMANY & AUSTRIA

M/A-COM GMBH
Fasanweg 4
8016 Feldkirchen
Fed. Rep. Germany
Tel: 49-(89)-903.80.34
TELEX: 841529103
FAX: 4989-903-0250
EASY LINK: 62036481

*Regular Mailing Addres

M/A-COM

M/A-COM Semiconductor Products Operation
South Avenue, Burlington, MA 01803
Telephone (617) 272-3000
Telex 94-9464
TWX 710-332-6789
FAX: (617) 272-8861