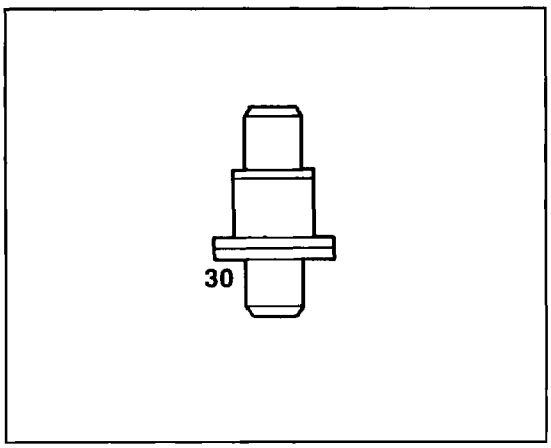
MA49000 Series

# Gallium Arsenide Gunn Diodes




## 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[6] 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 (Volts) |
|---|---|---|---|---|---|
| MA49618* | 30 | 9.0/12.0 | 5.0 | 80 | 8.0 |
| MA49508* | 30 | 9.0/12.0 | 10.0 | 160 | 8.0 |
| MA49628* | 30 | 18.0/26.0 | 10.0 | 200 | 5.0 |

* 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 (Tc) 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[1,4,8] 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:

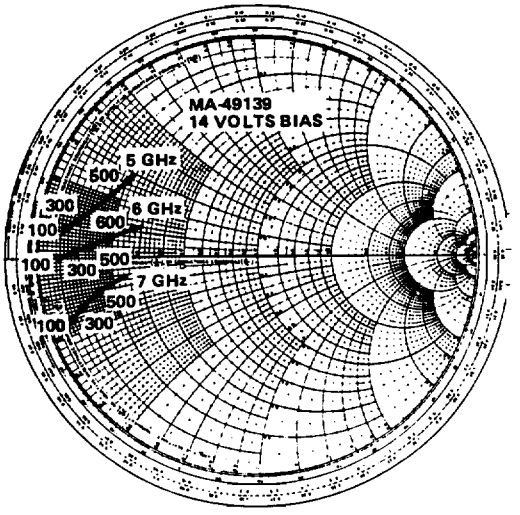
$$T_{AL} = T_A + \Delta T_{CA} + (P_{in} - P_{out})\, R_\theta$$

where: $T_A$ = Ambient temperature
$\Delta T_{CA}$ = Temperature difference between the diode case and the ambient at operating power.
$R_\theta$ = Thermal resistance
$T_{AL}$ = Active region temperature

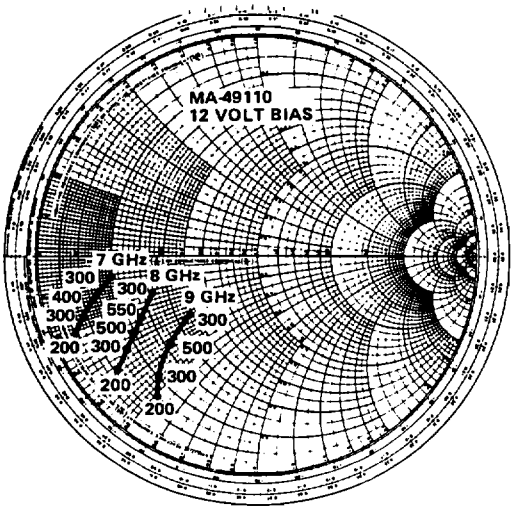
In well designed heat sinks, the thermal difference $\Delta T_{CA}$ is usually less than 30°C for a power input of about 15 watts. This is an important factor in the design of Gunn oscillators and must be carefully considered.

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

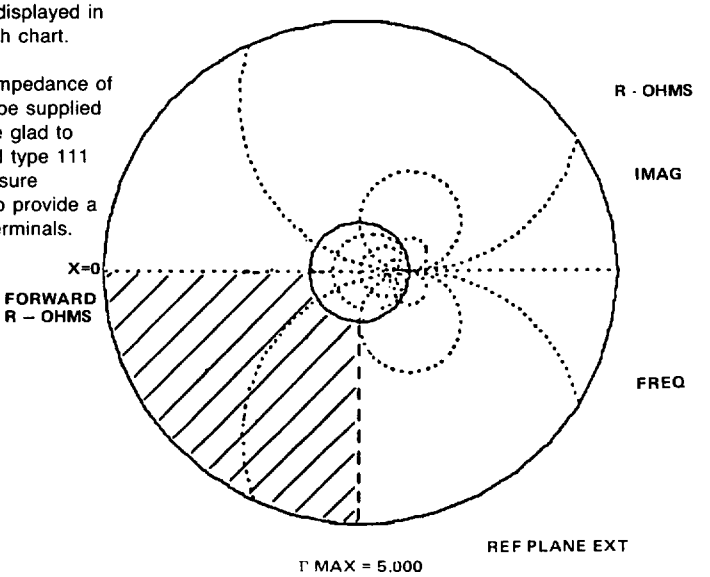
NOTE
1. Power levels on Smith charts are in mW.

# 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

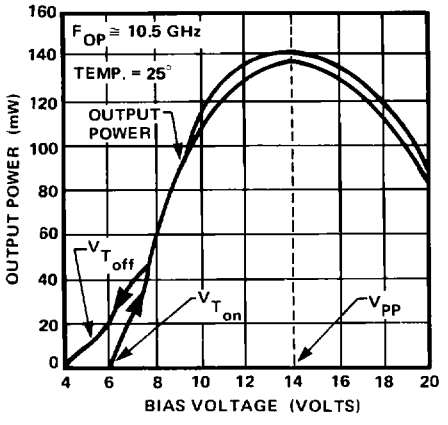



FIGURE 1. Output Power vs. Bias Voltage of a Typical X-Band Gunn Diode

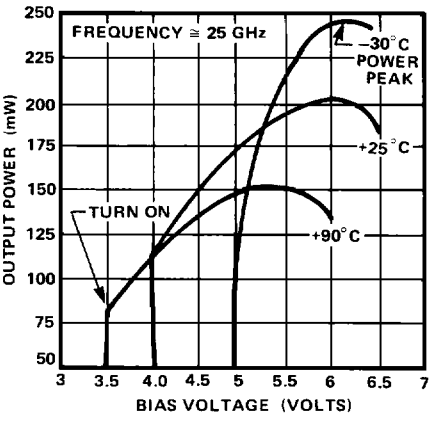



FIGURE 2. Output Power vs. Bias Voltage and Temperature of Typical K-Band Gunn Diode

# Typical Performance Curves (General)

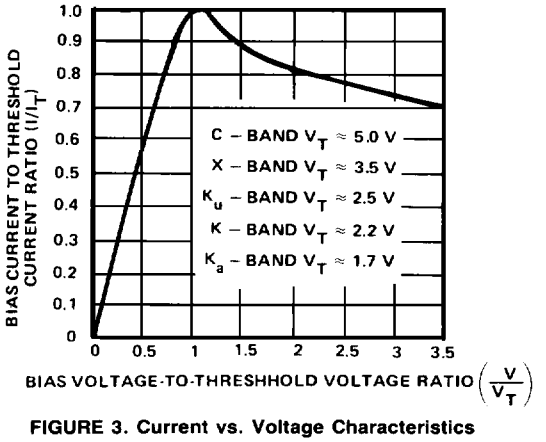



FIGURE 3. Current vs. Voltage Characteristics

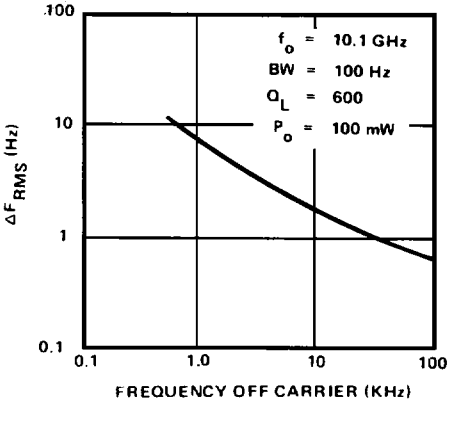



FIGURE 4. FM Noise Spectrum

# Typical Performance Curves (High-Power Diodes)

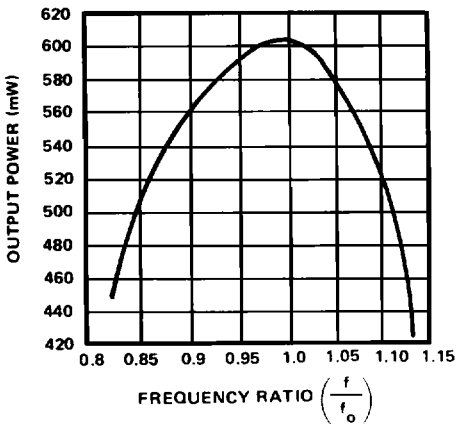



FIGURE 5. Output Power vs. Frequency for MA49139 and MA49110

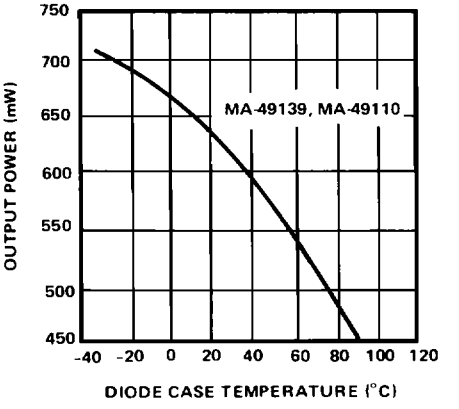
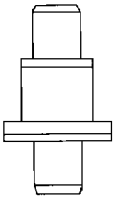



FIGURE 6. Output Power vs. Diode Case Temperature for MA49139 and MA49110

**All the typical performance curves were measured using M/A-COM SPO test cavities.**

## Case Styles



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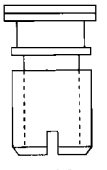

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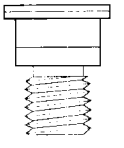

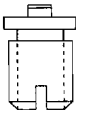

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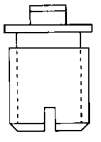

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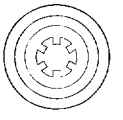

171