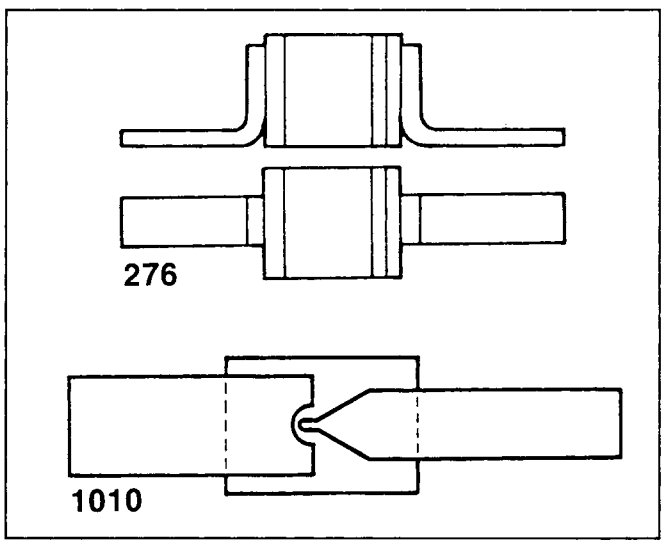
## MA40401/MA40422 Series

# 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<br>75 mW/Junction |
| **Soldering Temperature (Packaged Diodes)** | 235°C for<br>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 CHARACTER-TERISTICS |
|---|---|---|---|---|---|---|---|---|
| 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 $\Delta C_j$ (pF) | Minimum[5] Breakdown Voltage $V_B$ (Volts) | Maximum[2] Forward Voltage Difference $\Delta V_F$ (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 $\Delta C_j$ (pF) | Minimum[5] Breakdown Min./Max. $V_B$ (Volts) | Maximum[2] Forward Voltage Difference $\Delta V_F$ (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 $\Delta C_j$ (pF) | Minimum[5] Breakdown Min./Max. $V_B$ (Volts) | Maximum[2] Forward Voltage Difference $\Delta V_F$ (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 $\Delta C_j$ (pF) | Maximum[2] Forward Voltage Difference $\Delta V_F$ (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 |

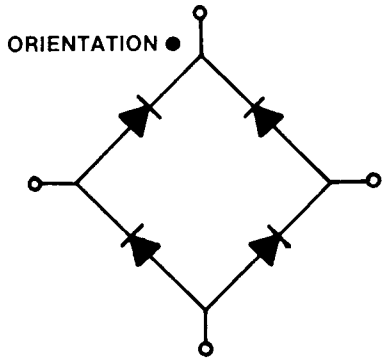
   $f_{if}$ = 30 MHz
   $R_l$ = 22 ohms

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.

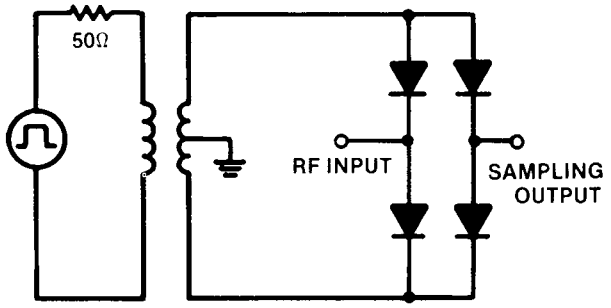
# Packaged Quad and Tee Configurations

## BRIDGE QUAD CIRCUIT

TOP VIEW PACKAGE



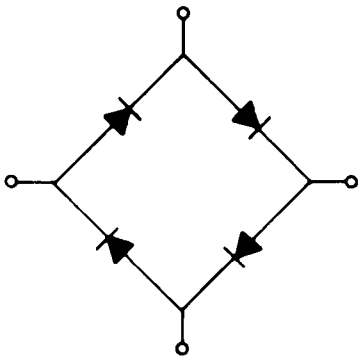

Diode Bridge Circuit



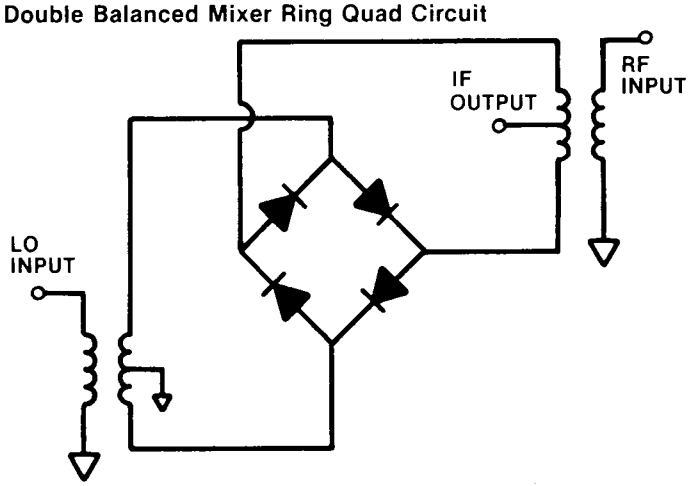

Sampling Circuit Bridge Quad

## RING QUAD CIRCUIT

TOP VIEW PACKAGE

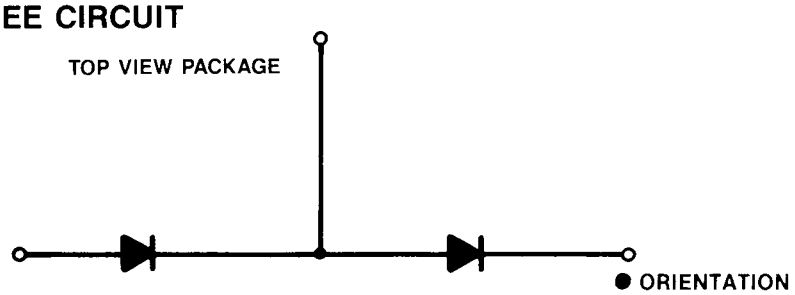


Double Balanced Mixer Ring Quad Circuit

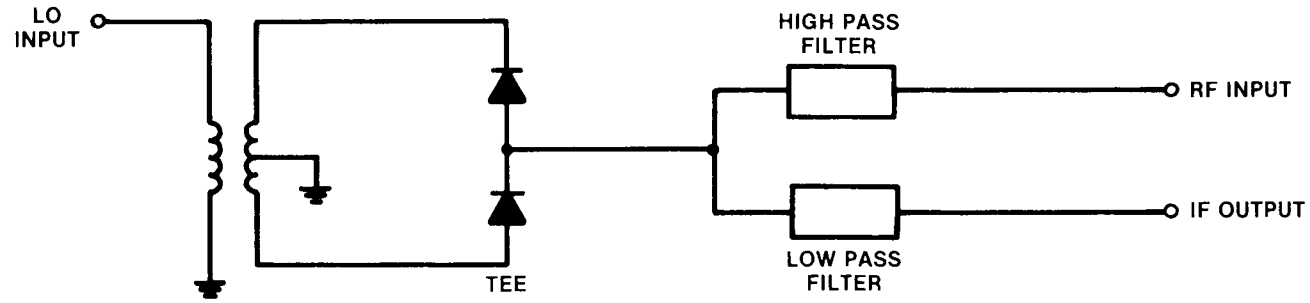



## TEE CIRCUIT

TOP VIEW PACKAGE

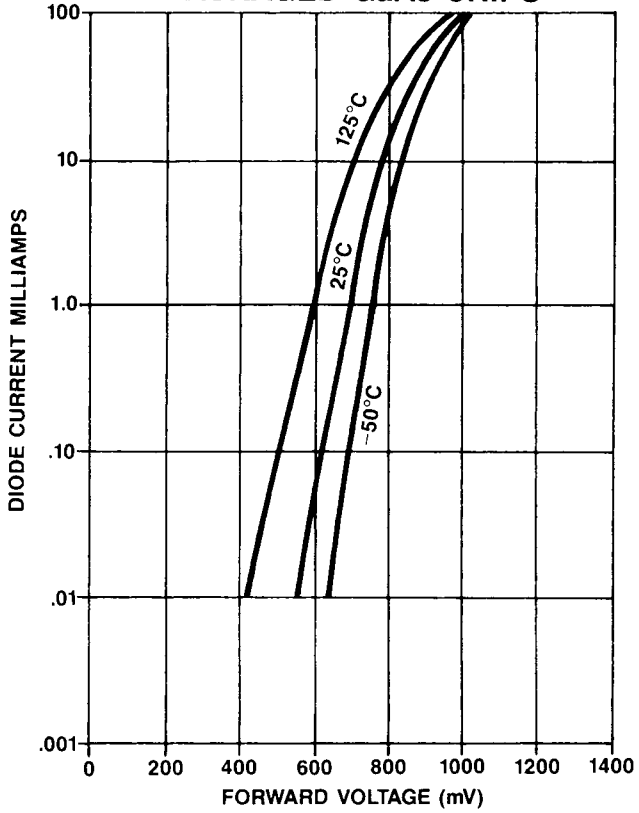



## BALANCED MIXER

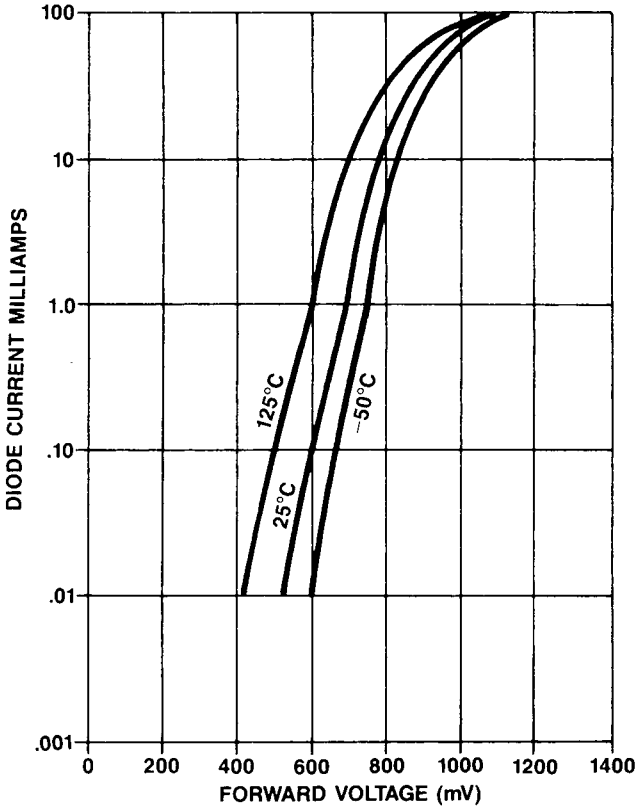


# Typical Performance Curves

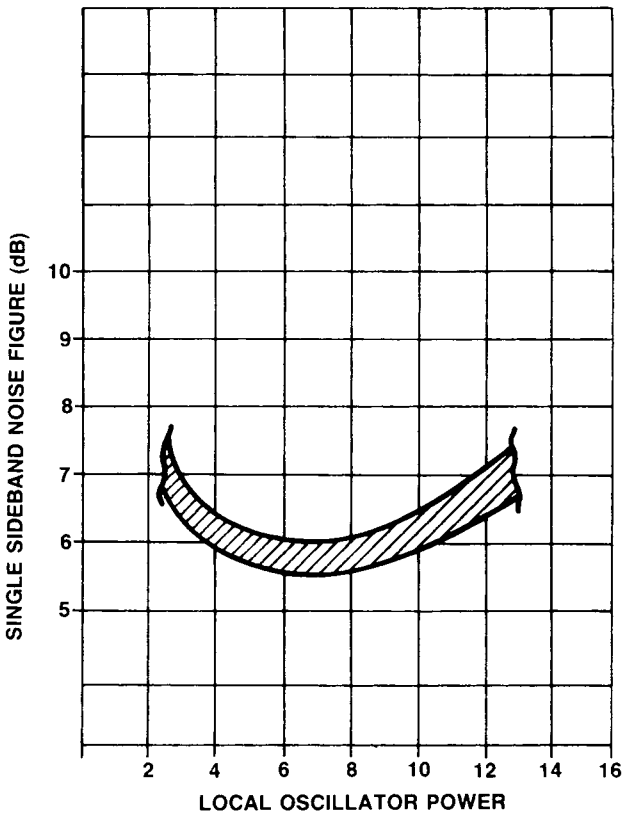
## MA40401-40412 PACKAGED GaAs CHIPS




## MA40413 GaAs BEAM LEAD

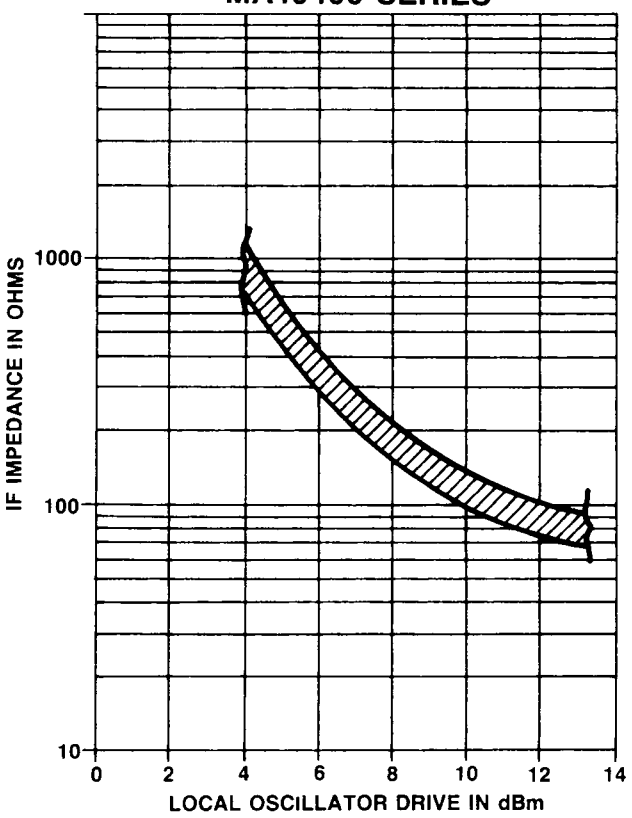



## MA-40400 SERIES




NOISE FIGURE VS. LOCAL OSCILLATOR POWER

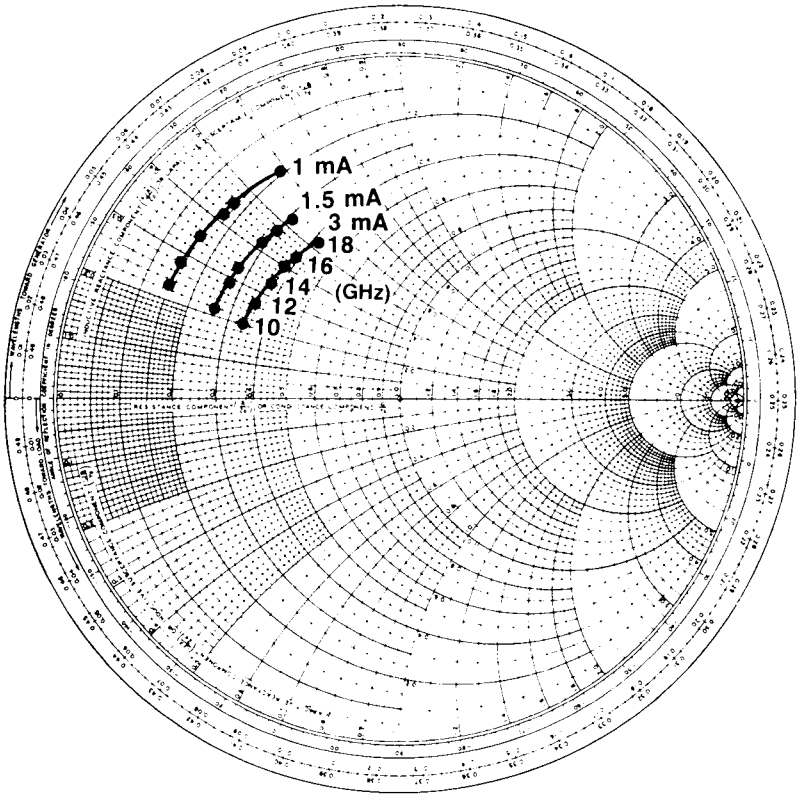
## MA40400 SERIES



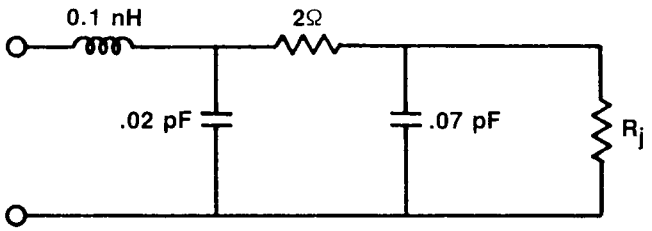

IF IMPEDANCE VS. LOCAL OSCILLATOR DRIVE WITH $R_L$ = 10 OHMS

# Typical Admittance Characteristics With Self Bias

## MA40413 CHIP OR MA40415 BEAM LEAD




Approximate Equivalent Circuit of MA40415



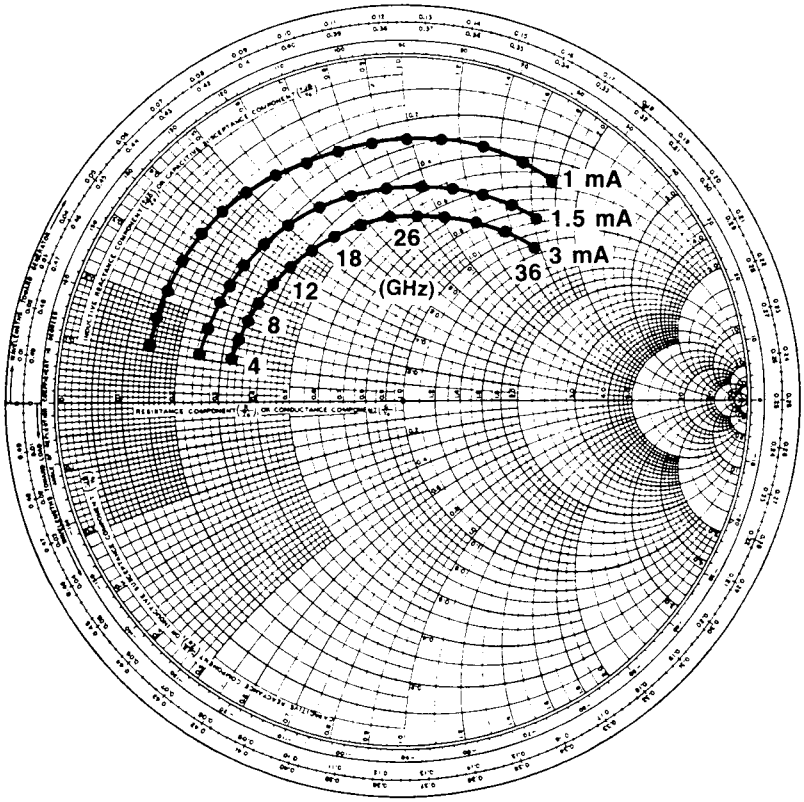

| SELF BIAS (mA) | $R_j$ (ohms) |
|---|---|
| 1.0 | 350 |
| 1.5 | 200 |
| 3.0 | 150 |

Typical RF Impedance Data

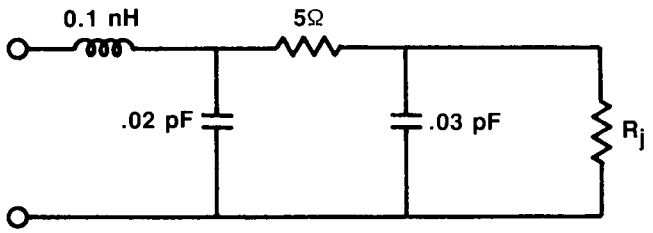
| Frequency (GHz) | 1.0 mA | | 1.5 mA | | 3.0 mA | |
|---|---|---|---|---|---|---|
| | Refl Mag | Coeff Ang | Refl Mag | Coeff Ang | Refl Mag | Coeff Ang |
| 4 | .751 | – 13.0 | .603 | – 13.2 | .505 | – 13.6 |
| 6 | .751 | – 19.6 | .603 | – 19.9 | .506 | – 20.4 |
| 8 | .751 | – 26.1 | .604 | – 26.6 | .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 |

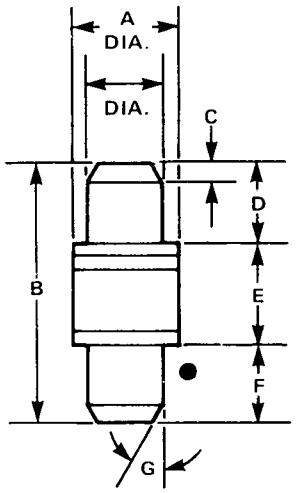
Typical RF Impedance Data

| Frequency (GHz) | 1.0 mA | | 1.5 mA | | 3.0 mA | |
|---|---|---|---|---|---|---|
| | Refl Mag | Coeff Ang | Refl Mag | Coeff Ang | Refl Mag | 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

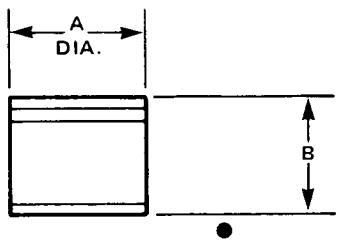
## 119




| 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

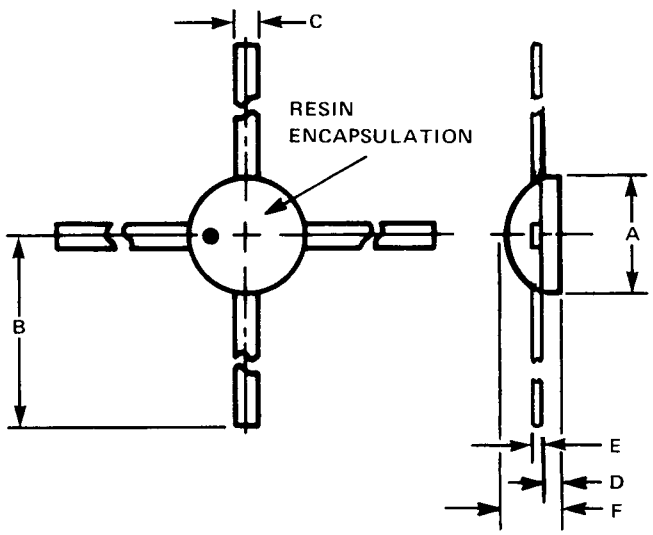
## 120




| 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)



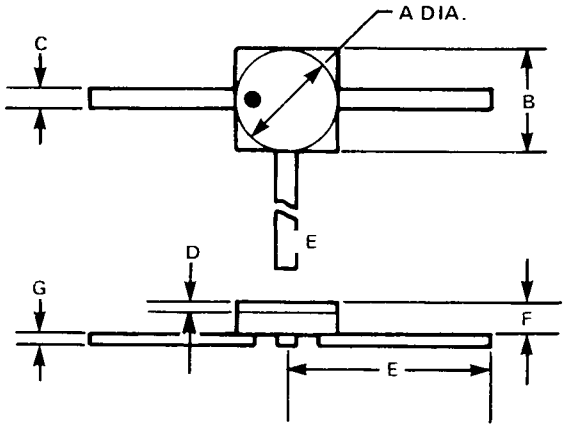

| DIM. | INCHES MIN. | INCHES MAX. | MILLIMETERS MIN. | MILLIMETERS MAX. |
|---|---|---|---|---|
| A | 0.050 | 0.058 | 1,27 | 1,47 |
| B | 0.140 | — — | 3,55 | — — |
| C | 0.012 | 0.018 | 0,30 | 0,46 |
| D | 0.007 | 0.014 | 0,178 | 0,36 |
| E | 0.003 | 0.006 | 0,076 | 0,152 |
| F | — — | 0.035 | — —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

$C_P \sim$ 0.04 pF Typical

# Case Styles (Cont'd)

● DENOTES CATHODE

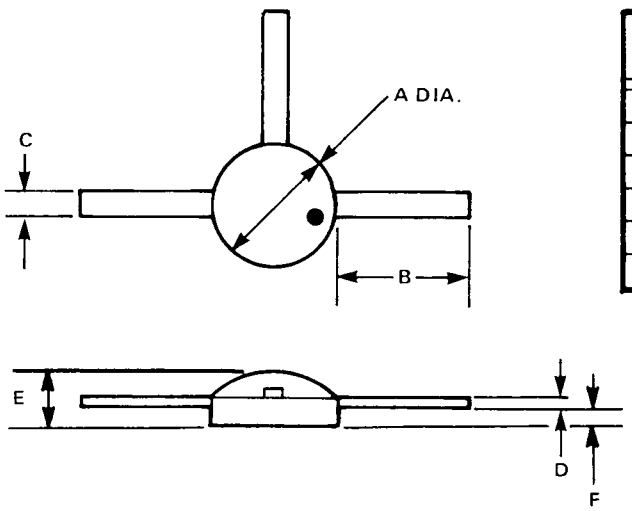
## 270




| 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

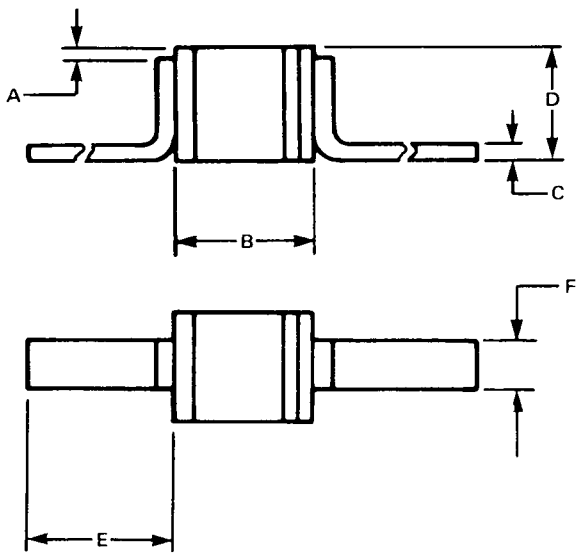
## 272




| 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



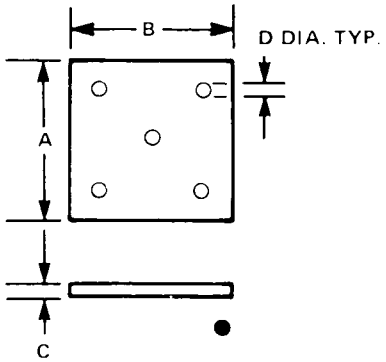

| DIM. | INCHES MIN. | INCHES MAX. | MILLIMETERS MIN. | MILLIMETERS MAX. |
|---|---|---|---|---|
| A | 0.010 | 0.020 | 0,254 | 0,058 |
| B | 0.040 | 0.050 | 1,02 | 1,27 |
| C | — — | 0.005 | — — | 0,127 |
| D | 0.051 | 0.055 | 1,29 | 1,39 |
| E | 0.200 | — — | 5,08 | — — |
| F | 0.019 | 0.021 | 0,483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

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

# Chip Styles

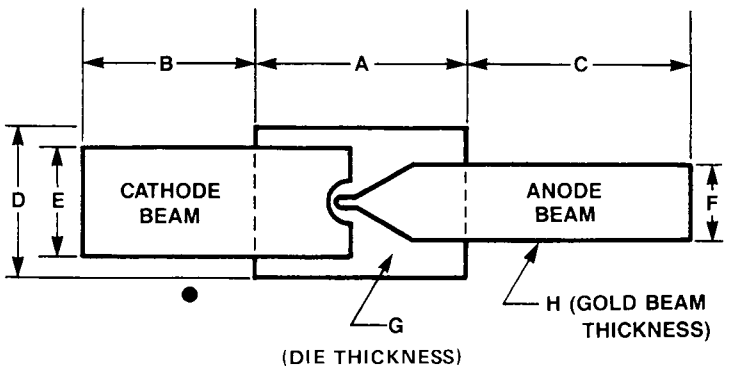
● DENOTES CATHODE

## 135



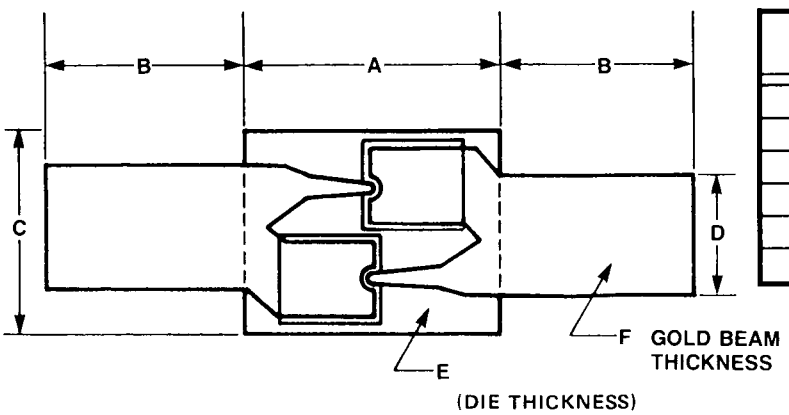

| DIM. | INCHES MIN. | INCHES MAX. | MILLIMETERS MIN. | MILLIMETERS MAX. |
|---|---|---|---|---|
| A | .013 | .017 | ,330 | ,431 |
| B | .013 | .017 | ,330 | ,431 |
| C | .004 | .006 | ,102 | ,152 |
| D | .001 | — — | ,02 | — — |

## 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) | |