

### Features

- Low  $I_R$  (<100 nA @ 1 V, <500 nA @ 3 V)
- Designed for High Volume, Low Cost Detector & Mixer Applications
- High Detector Sensitivity: -55 dBm TSS
- Low Capacitance: 0.30 pF
- Low 1/F Noise
- Single, Series Pair, and Unconnected Pair Configurations
- Lead Free
- RoHS\* Compliant
- Tape and Reel

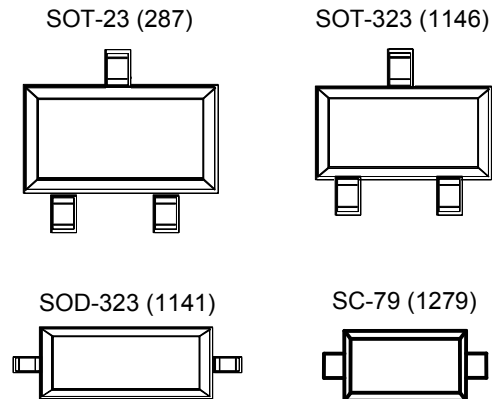
### Description and Applications

The MA4E2054 series are low barrier N-type silicon Schottky diodes assembled in surface mount plastic packages. They are designed for use as high performance mixer and detector diodes.

The MA4E20541-1141T (SOD-323), MA4E20541-1279T (SC-79) and MA4E2054A1(SOT-23) are single element Schottky diodes characterized for use as single ended mixers and detectors. The MA4E2054B1 and MA4E2054D1 (available in both the SOT-23 and SOT-323 packages) incorporate two Schottky chips in series pair configurations. These diodes are useful for balanced mixer and detector voltage doubler circuits.

Applications for the MA4E2054 series include VSAT and DBS mixers. The small diode package size and low cost make them attractive for use in RF tag applications for identification and toll collection.

### Package Outlines

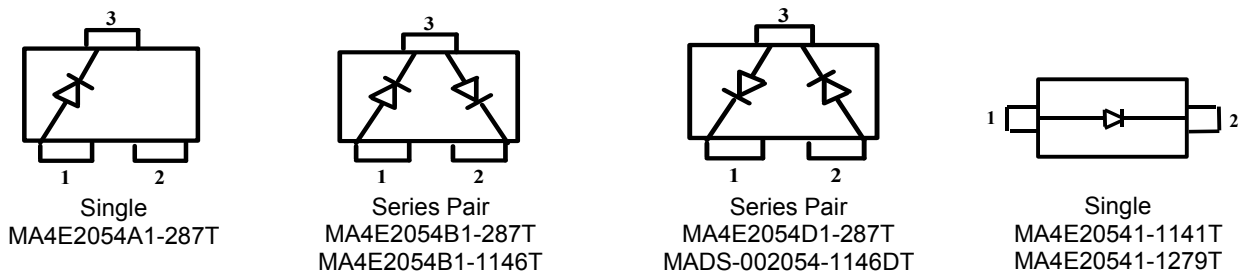


### Part Numbers

| Part Number        | Package Style |
|--------------------|---------------|
| MA4E2054A1-287T    | SOT-23        |
| MA4E2054B1-287T    | SOT-23        |
| MA4E2054B1-1146T   | SOT-323       |
| MA4E2054D1-287T    | SOT-23        |
| MADS-002054-1146DT | SOT-323       |
| MA4E20541-1141T    | SOD-323       |
| MA4E20541-1279T    | SC-79         |

1. The part number consists of the base chip (MA4E2054), followed by the wiring configuration (A, B, D, omit for SOD-323), the package style (287, 1141, 1146) and a "T" for tape and reel.

### Configurations (Top View)



\* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

## Surface Mount Low Barrier Schottky Diode

Rev. V13

### Electrical Specifications @ +25°C<sup>2,3</sup>

| Parameter                                 | Condition                  | Specification              |
|---|----------------------------|----------------------------|
| Breakdown Voltage ( $V_B$ )               | $I_R = 10 \mu A$           | 3.0 V min.                 |
| Reverse Leakage Current ( $I_R$ )         | $V_R = 1 V$<br>$V_R = 3 V$ | 100 nA max.<br>500 nA max. |
| Total Capacitance ( $C_T$ )               | $V_R = 0 V, F = 1 MHz$     | 0.3 pF max.                |
| Dynamic Resistance ( $R_D$ ) <sup>2</sup> | $I_F = 10 mA$              | 17 $\Omega$ max.           |
| Forward Voltage ( $V_F$ )                 | $I_F = 1 mA$               | 250 mV min.<br>350 mV max. |
| Delta Forward Voltage ( $\Delta V_F$ )    | $I_F = 1 mA$               | 20 mV max.                 |

2. Applies to MA4E2054B and MA4E2054D configurations.

3.  $R_D = R_S + R_J$  where  $R_J = \frac{26}{I_F}$  (in mA)

### Typical RF Performance @ +25°C in Chip Form, Mounted on a Microstrip Fixture

| Parameter                           | Condition  | Specification |
|-------------------------------------|--|---------------|
| Mixer Noise Figure                  | $F = 9.375 GHz, LO = 0 dBm$                                    | 5.7 dB (SSB)  |
| IF Impedance                        | $I_F = 30 MHz$   | 200 ohms      |
| Tangential Signal, Sensitivity      | $F = 2.5 GHz, I_F = 20 mA,$<br>$BW = 2 MHz, Video NF = 1.5 dB$ | -55 dBm       |
| Detector Output, Voltage at -30 dBm | $R_L = 100 k\Omega, I_F = 20 mA$                               | 20 mV         |
| Detector Output, Voltage at -30 dBm | $R_L = 1 M \Omega, Zero Bias$                                  | 20 mV         |

4. See Performance Curves on page 4 for untuned fixture performance.

### Maximum Ratings @ 25°C (unless otherwise specified)<sup>5,6</sup>

| Parameter              | Values             |
|------------------------|--------------------|
| Operating Temperature  | -65°C to +125°C    |
| Storage Temperature    | -65°C to +125°C    |
| RF Incident Power (CW) | 75 mW <sup>7</sup> |
| Forward Current        | 20 mA              |
| Reverse Voltage        | 3 V                |
| Soldering Temperature  | +260°C for 5 sec.  |

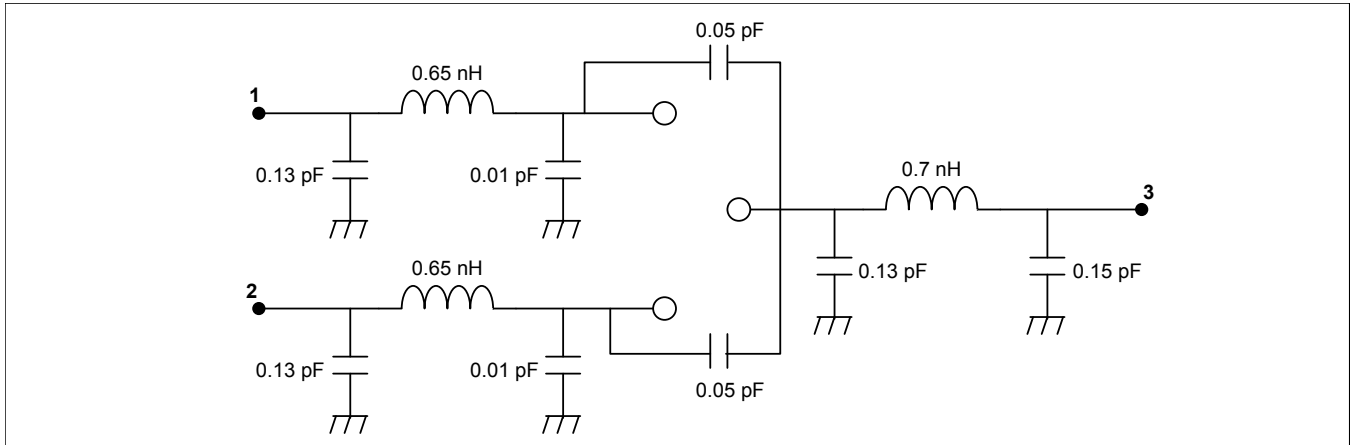
5. Operation of this device above any one of the Maximum Rated parameters may cause permanent damage.

6. Please refer to Application Note M538 for surface mounting instructions.

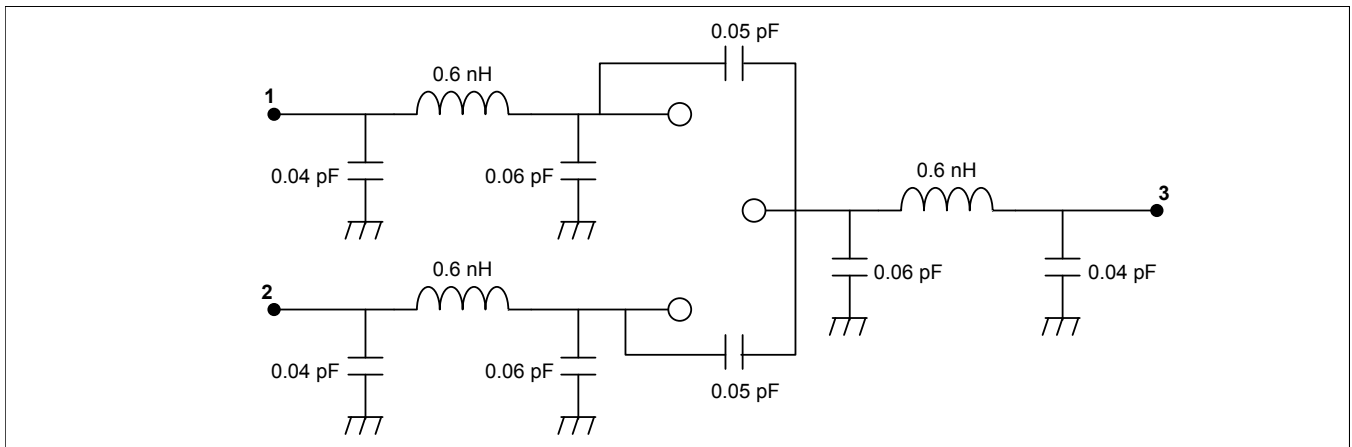
7. Derate linearly to 0 W @ 125°C case temperature.

### Circuit Models

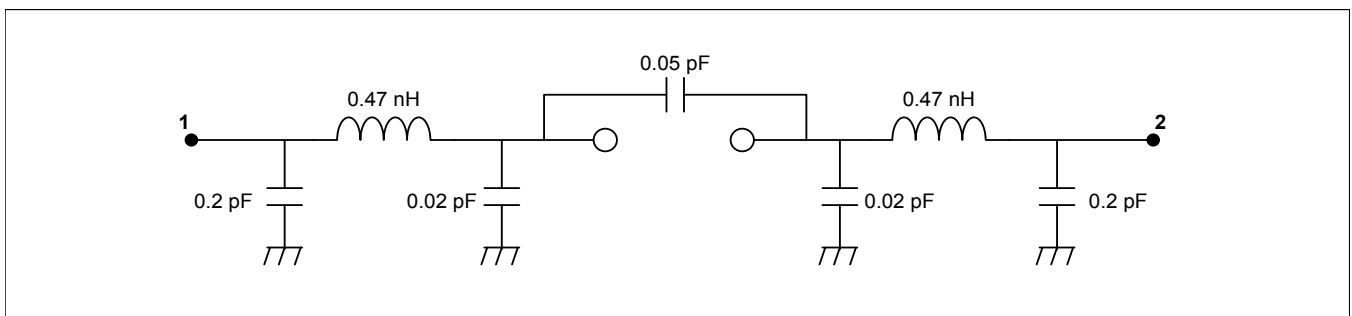
#### SOT-23



#### SOT-323



#### SOD-323

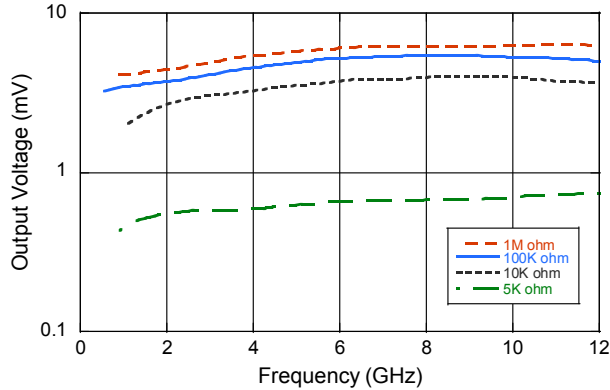


## Surface Mount Low Barrier Schottky Diode

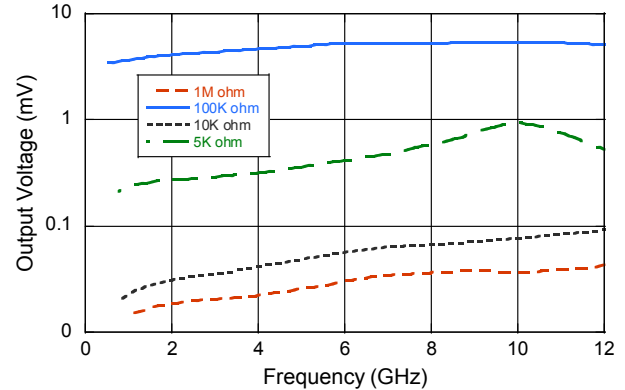
Rev. V13

### Typical Performance Curves @ +25°C in Chip Form, Mounted on a Microstrip Fixture

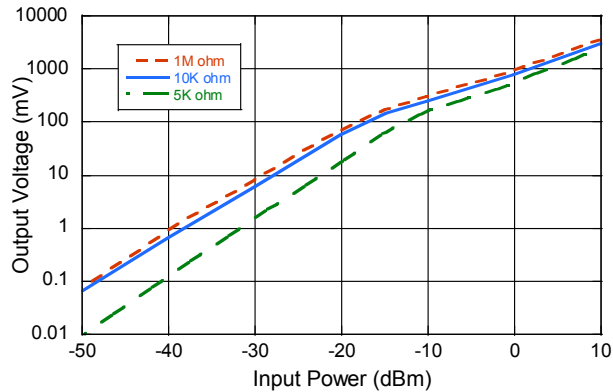
**Detector Output Voltage vs. Frequency and Load Resistance at -30 dBm. Diode Forward Biased at 20μA. Untuned Fixture (50 Ω)**



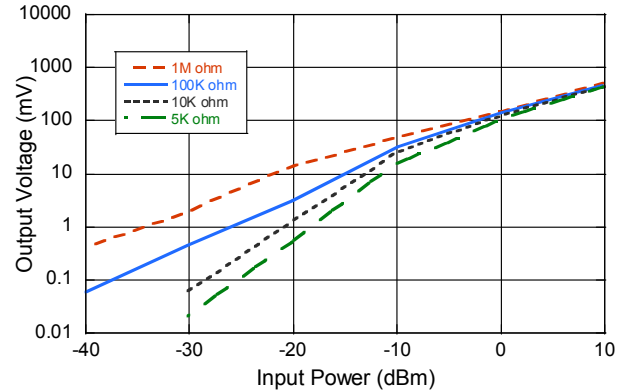
**Detector Output Voltage vs. Frequency and Load Resistance at -30 dBm. Diode at Zero Bias. Untuned Fixture.**



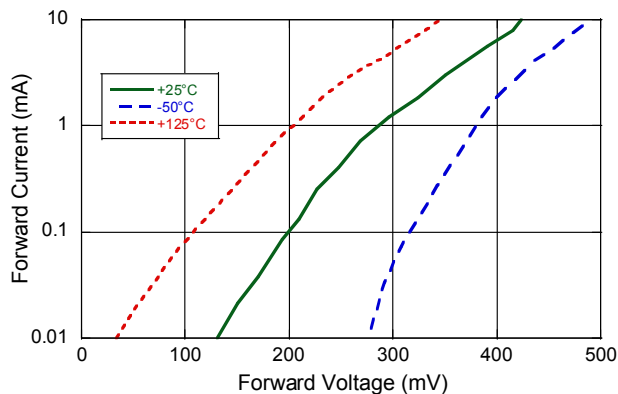
**Detector Output Voltage vs. Input Power and Load Resistance. Diode Forward Biased at 20μA. Untuned Fixture at 9.375 GHz.**



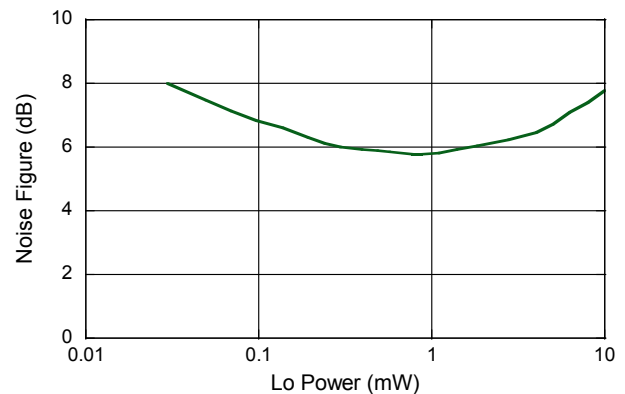
**Detector Output Voltage vs. Input Power and Load Resistance. Diode at Zero Bias. Untuned Fixture at 9.375 GHz (50Ω)**



**Forward Current vs. Forward Voltage and Temperature**

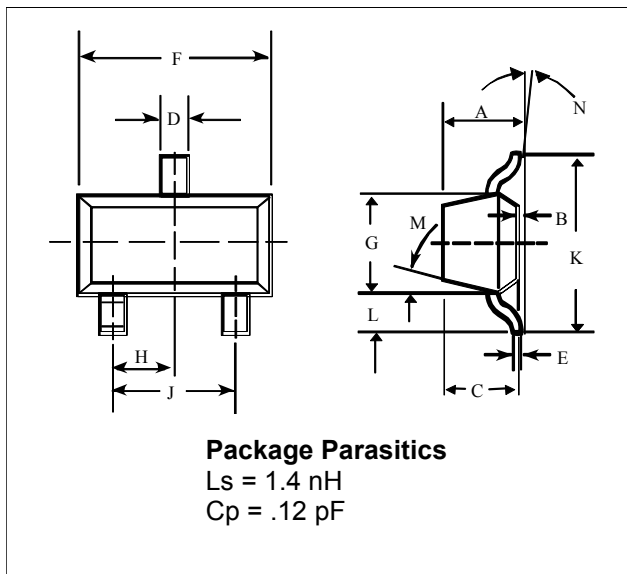


**Noise Figure vs. Lo Power at 9.375 GHz Tuned Fixture**



### Case Styles

#### SOT-23

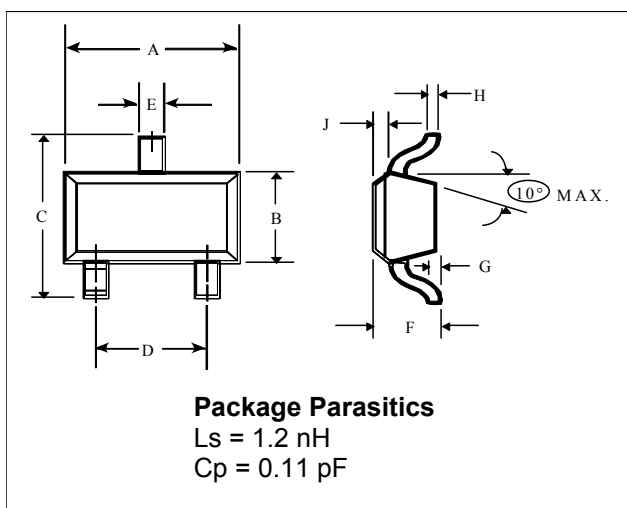


#### SOT-23 (Case Style 287)

| Dim. | Inches                |       | Millimeters  |      |
|------|-----------------------|-------|--------------|------|
|      | Min.                  | Max.  | Min.         | Max. |
| A    | —                     | 0.048 | —            | 1.22 |
| B    | —                     | 0.008 | —            | 0.20 |
| C    | —                     | 0.040 | —            | 1.00 |
| D    | 0.013                 | 0.020 | 0.35         | 0.50 |
| E    | 0.003                 | 0.006 | 0.08         | 0.15 |
| F    | 0.110                 | 0.119 | 2.80         | 3.00 |
| G    | 0.047                 | 0.056 | 1.20         | 1.40 |
| H    | 0.037 typical         |       | 0.95 typical |      |
| J    | 0.075 typical         |       | 1.90 typical |      |
| K    | —                     | 0.103 | —            | 2.60 |
| L    | —                     | 0.024 | —            | 0.60 |
| Dim. | Gradient              |       |              |      |
| M    | 10° max. <sup>3</sup> |       |              |      |
| N    | 2° . . . 30°          |       |              |      |

3. Applicable on all sides

#### SOT-323

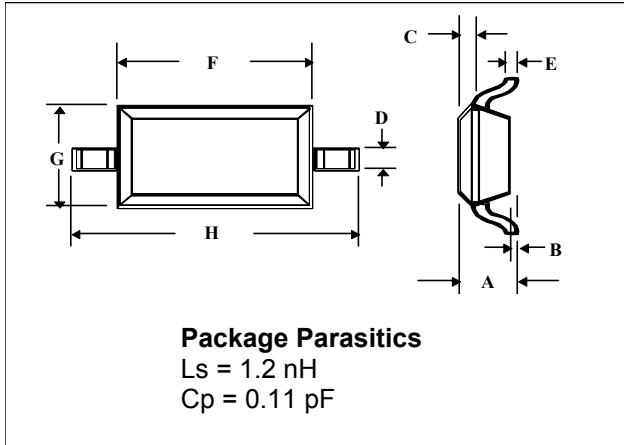


#### SOT-323 (Case Style 1146)

| Dim. | Inches |       | Millimeters |      |
|------|--------|-------|-------------|------|
|      | Min.   | Max.  | Min.        | Max. |
| A    | 0.063  | 0.087 | 1.6         | 2.2  |
| B    | 0.045  | 0.053 | 1.15        | 1.35 |
| C    | 0.079  | 0.087 | 2.0         | 2.2  |
| D    | 0.047  | 0.055 | 1.2         | 1.4  |
| E    | 0.008  | 0.016 | 0.2         | 0.4  |
| F    | 0.031  | 0.039 | 0.8         | 1.0  |
| G    | —      | 0.004 | —           | 0.1  |
| H    | 0.003  | 0.006 | 0.08        | 0.15 |
| J    | 0.004  | 0.010 | 0.1         | 0.25 |

### Case Styles (Cont'd)

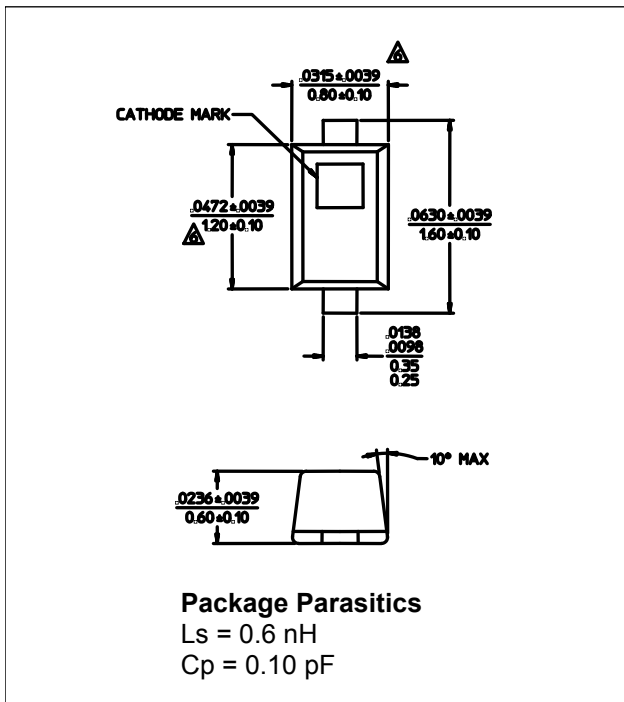
#### SOD-323



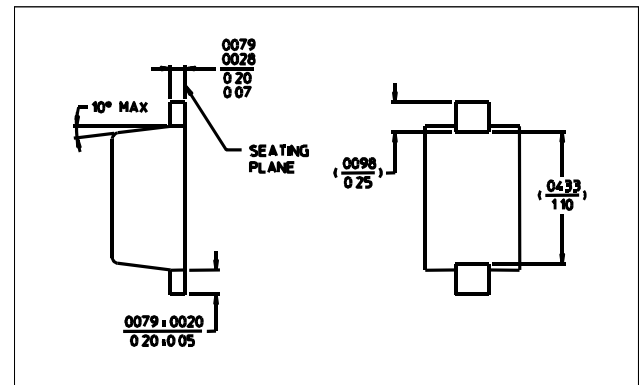
#### SOD-323 (Case Style 1141)

| Dim. | Inches |       | Millimeters |      |
|------|--------|-------|-------------|------|
|      | Min.   | Max.  | Min.        | Max. |
| A    | —      | 0.043 | —           | 1.1  |
| B    | —      | 0.004 | —           | 0.1  |
| C    | —      | 0.008 | —           | 0.2  |
| D    | 0.010  | 0.016 | 0.25        | 0.4  |
| E    | 0.003  | 0.006 | 0.08        | 0.15 |
| F    | 0.063  | 0.075 | 1.6         | 1.9  |
| G    | 0.045  | 0.057 | 1.15        | 1.45 |
| H    | 0.091  | 0.106 | 2.3         | 2.7  |

#### SC-79



#### SC-79 (Case Style 1279)



### Spice Model Parameters

|                                   |                            |
|-----------------------------------|----------------------------|
| IS = $3 \times 10^{-8}$ A         | M = 0.50                   |
| RS = 11Ω                          | EG = 0.69 eV               |
| N = 1.05                          | BV = 5.0 V                 |
| TT = 0 S                          | IBV = $1 \times 10^{-5}$ A |
| Cj(0) = $0.13 \times 10^{-12}$ pF |                            |
| Cpar = $0.14 \times 10^{-12}$ pF  |                            |
| VJ = 0.40 V                       |                            |

### Typical Scattering Parameters (S11)

MA4E2054A Chip Form, Mounted on a Microstrip Fixture (no DC bias)

| Freq.<br>GHz | -30 dBm |        | -3 dBm |        | 0 dBm |        | 3 dBm |        |
|--------------|---------|--------|--------|--------|-------|--------|-------|--------|
|              | MAG     | PHASE  | MAG    | PHASE  | MAG   | PHASE  | MAG   | PHASE  |
| 0.50         | 0.993   | -7.6   | 0.812  | -7.0   | 0.597 | -4.6   | 0.387 | -0.9   |
| 1.00         | 0.994   | -15.1  | 0.843  | -14.7  | 0.632 | -13.9  | 0.411 | -11.3  |
| 1.50         | 0.993   | -21.4  | 0.807  | -21.7  | 0.596 | -22.3  | 0.386 | -22.4  |
| 2.00         | 0.997   | -27.1  | 0.791  | -26.0  | 0.580 | -23.1  | 0.383 | -16.4  |
| 2.50         | 0.994   | -33.2  | 0.795  | -31.5  | 0.579 | -27.6  | 0.378 | -18.5  |
| 3.00         | 0.994   | -41.3  | 0.755  | -42.7  | 0.548 | -45.2  | 0.342 | -48.6  |
| 3.50         | 0.992   | -48.6  | 0.727  | -52.2  | 0.524 | -55.8  | 0.318 | -60.8  |
| 4.00         | 0.997   | -56.5  | 0.713  | -58.9  | 0.502 | -59.5  | 0.296 | -56.3  |
| 4.50         | 0.987   | -66.4  | 0.696  | -67.1  | 0.464 | -67.7  | 0.235 | -62.6  |
| 5.00         | 0.971   | -74.7  | 0.634  | -79.8  | 0.386 | -86.2  | 0.167 | -94.9  |
| 5.50         | 0.965   | -83.1  | 0.614  | -88.6  | 0.354 | -91.4  | 0.131 | -98.7  |
| 6.00         | 0.980   | -96.0  | 0.547  | -103.5 | 0.292 | -107.0 | 0.072 | -117.2 |
| 6.50         | 0.974   | -110.3 | 0.514  | -120.1 | 0.248 | -129.5 | 0.041 | 163.9  |
| 7.00         | 0.941   | -123.7 | 0.450  | -137.4 | 0.235 | -150.8 | 0.070 | 145.2  |
| 7.50         | 0.957   | -138.9 | 0.430  | -158.1 | 0.247 | 178.0  | 0.152 | 120.6  |
| 8.00         | 0.969   | -155.6 | 0.404  | -178.8 | 0.260 | 150.1  | 0.218 | 102.5  |
| 8.50         | 0.933   | -171.5 | 0.405  | 162.2  | 0.294 | 129.9  | 0.278 | 92.0   |
| 9.00         | 0.932   | 170.9  | 0.391  | 143.1  | 0.310 | 110.8  | 0.344 | 84.4   |
| 9.50         | 0.943   | 152.8  | 0.410  | 128.2  | 0.318 | 97.9   | 0.343 | 68.7   |
| 10.00        | 0.931   | 132.2  | 0.504  | 108.9  | 0.394 | 83.3   | 0.399 | 56.9   |

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