

## Features

- Low  $I_R$  (<100nA @ 1V, <500nA @ 3V)
- Designed for High Volume, Low Cost Detector and 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) Equivalents Available With 260 Deg. C Reflow Capability
- Tape and Reel

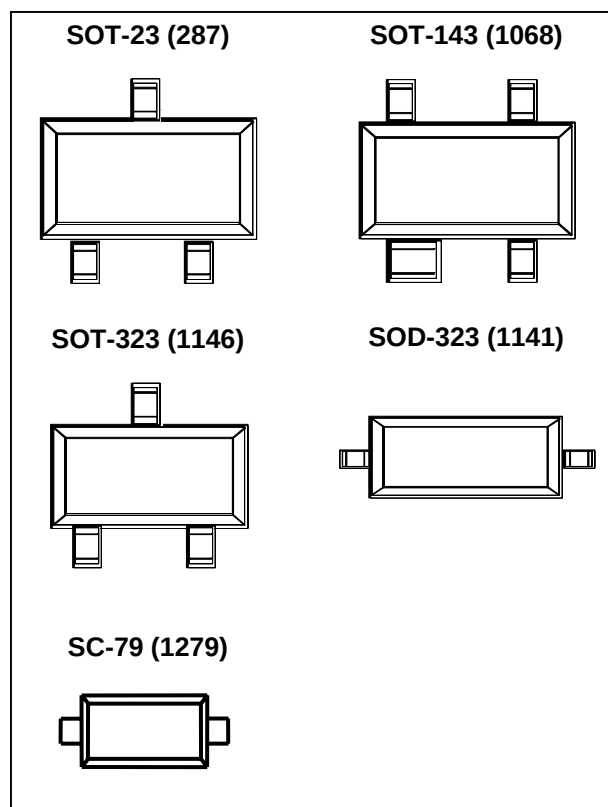
## Description and Applications

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

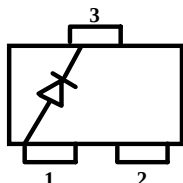
These parts are offered with Sn/Pb plating, as well as with 100 % matte Sn plating on the RoHS compliant part numbers.

The MA4E2054 -1141T (SOD-323), MA4E20541 -1279 (SC-79) and the MA4E2054A and MA4E2054C (available in both the SOT-23 and SOT-323 packages) are single element Schottky diodes characterized for use as single ended mixers and detectors. The MA4E2054B and MA4E2054D (available in both the SOT-23 and SOT-323 packages) incorporate two Schottky chips in series pair configurations. The MA4E2054E-1068T consists of two Schottky chips in the SOT-143 package in an unconnected pair configuration. 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.

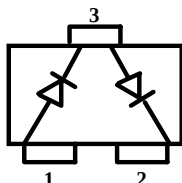
The part number consists of the base chip (MA4E2054), followed by the wiring configuration (A, B, C, D, E, omit for SOD-323), the package style (287, 1068, 1141, 1146) and a "T" for tape and reel.



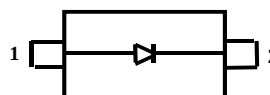
## Configurations (Topviews)



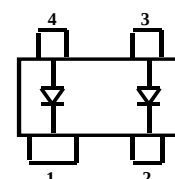
**SINGLE**  
MA4E2054A-287T  
MA4E2054A-1146T



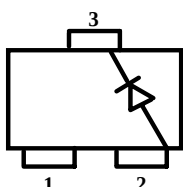
**SERIES PAIR**  
MA4E2054B-287T  
MA4E2054B-1146T



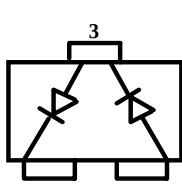
**Single**  
MA4E2054-1141T  
MA4E20541-1279T



**Unconnected Pair**  
MA4E2054E-1068T



**SINGLE**  
MA4E2054C-287T  
MA4E2054C-1146T



**SERIES PAIR**  
MA4E2054D-287T  
MA4E2054D-1146T

## 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                       |                            |

## Standard Part Numbers and RoHS Equivalents

| Standard Part Number | RoHS Compliant Part Number | Package Style |
|----------------------|----------------------------|---------------|
| MA4E2054A-287T       | MA4E2054A1-287T            | SOT-23        |
| MA4E2054A-1146T      | MA4E2054A1-1146T           | SOT-323       |
| MA4E2054B-287T       | MA4E2054B1-287T            | SOT-23        |
| MA4E2054B-1146T      | MA4E2054B1-1146T           | SOT-323       |
| MA4E2054C-287T       | MA4E2054C1-287T            | SOT-23        |
| MA4E2054C-1146T      | MADS-002054-1146CT         | SOT-323       |
| MA4E2054D-287T       | MA4E2054D1-287T            | SOT-23        |
| MA4E2054D-1146T      | MADS-002054-1146DT         | SOT-323       |
| MA4E2054-1141T       | MA4E20541-1141T            | SOD-323       |
| MA4E2054E-1068T      | MA4E2054E1-1068T           | SOT-143       |
| N/A                  | MA4E20541-1279T            | SC-79         |

### Maximum Ratings

| Parameter                                | Unit | Maximum Ratings |
|------------------------------------------|------|-----------------|
| Operating Temperature                    | °C   | -65 to +125     |
| Storage Temperature                      | °C   | -65 to +125     |
| Incident RF Power (CW)                   | mW   | 75*             |
| Reverse Voltage @ 25 °C                  | V    | 3               |
| Forward Current                          | mA   | 20              |
| Soldering Temperature (Standard Part #)  | °C   | +235 for 5 sec. |
| Soldering Temperature (Lead Free Part #) | °C   | +260 for 5 sec. |

\* At 125 °C case temperature. Derate linearly to zero watts at 125 °C case temperature.

### Electrical Specifications @ +25 °C

| Parameter                               | Condition                  | Symbol | Specification              |
|-----------------------------------------|----------------------------|--------|----------------------------|
| Breakdown Voltage                       | $I_R = 10 \mu A$           | $V_B$  | 3.0 V min.                 |
| Reverse Leakage Current                 | $V_R = 1 V$                | $I_R$  | 100 nA max.                |
| Reverse Leakage Current                 | $V_R = 3 V$                | $I_R$  | 500 nA max.                |
| Total Capacitance                       | $V_R = 0 V$<br>$f = 1 MHz$ | $C_T$  | 0.30 pF max.               |
| Dynamic Resistance <sup>2</sup>         | $I_F = 10 mA$              | $R_D$  | 17 Ohms max.               |
| Forward Voltage                         | $I_F = 1 mA$               | $V_F$  | 250 mV min.<br>350 mV min. |
| Forward Voltage Difference <sup>1</sup> | $I_F = 1 mA$               | $V_F$  | 20 mV max.                 |

1. Applies to MA4E2054B, MA4E2054D and MA4E2054E configurations.

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

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

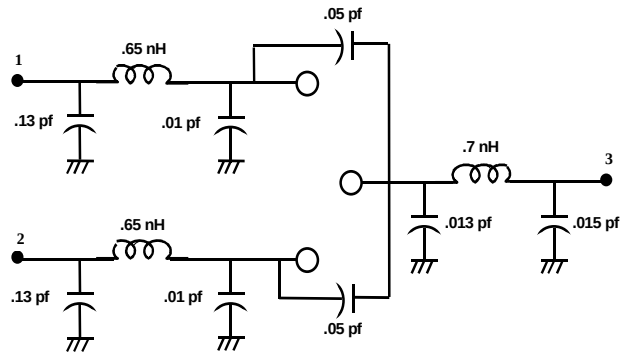
| Parameter                                        | Conditions                                         | Typical Value |
|--------------------------------------------------|----------------------------------------------------|---------------|
| Mixer Noise Figure <sup>1</sup>                  | $f = 9.375 GHz$<br>$LO = 0 dBm$                    | 5.7 dB (SSB)  |
| IF Impedance                                     | $I_F = 30 MHz$                                     | 200 ohms      |
| Tangential Signal Sensitivity <sup>2</sup>       | $I_F = 20 mA$<br>$BW = 2 MHz$<br>Video NF = 1.5 dB | -55 dBm       |
| Detector Output, Voltage at -30 dBm <sup>2</sup> | $R_L = 100K Ohms$<br>$I_F = 20 \mu A$              | 20 mV         |
| Detector Output, Voltage at -30 dBm <sup>2</sup> | $R_L = 1M Ohm$                                     | 20 mV         |

1. Fixture tuned to 9.375 GHz.

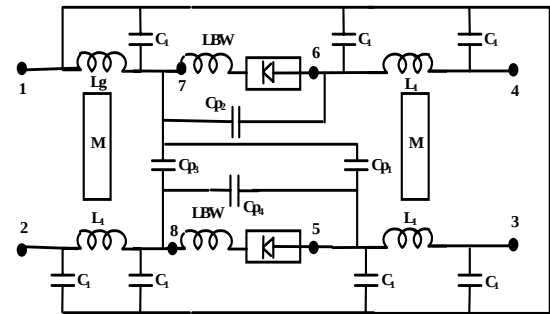
2. Fixture tuned to 2.5 GHz. See figures on page 3 for untuned fixture performance.

## Circuit Models

**SOT-23**

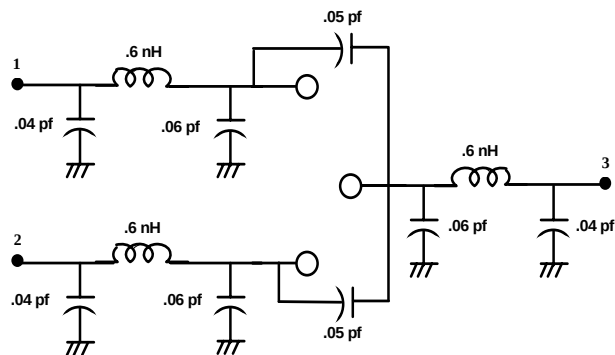


**SOT-143**

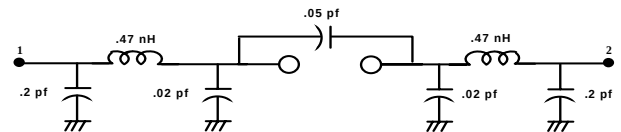


LBW = 0.08nH, Lg = 0.36nH, L1 = 0.31nH, M = 0.12nH, C1 = 0.01pF, Cp1 = 0.05pF, CP2 = 0.10pF, Cp3 = 0.05pF, Cp4 = 0.03pF

**SOT-323**

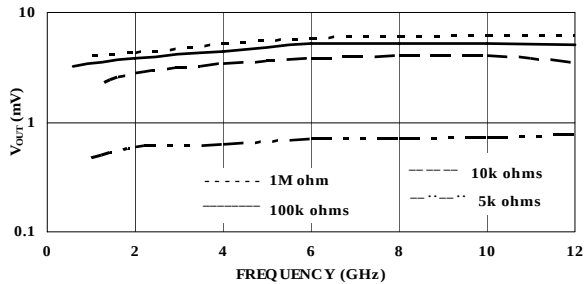


**SOD-323**

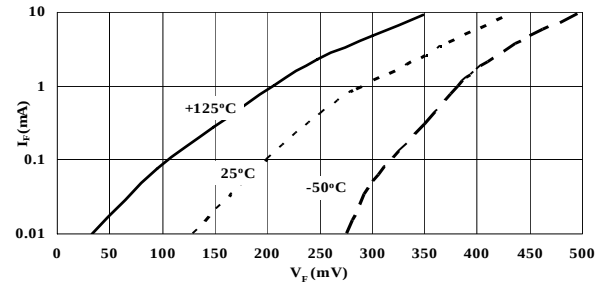


## Typical Performance Curves @ 25°C in Chip Form, Mounted on a Microstrip Fixture

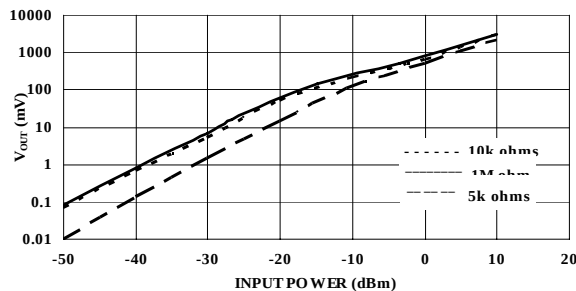
**Detector Output Voltage vs Frequency and Load Resistance at -30 dBm. Diode Forward Biased at 20  $\mu$ A. Untuned Fixture (50  $\Omega$ )**



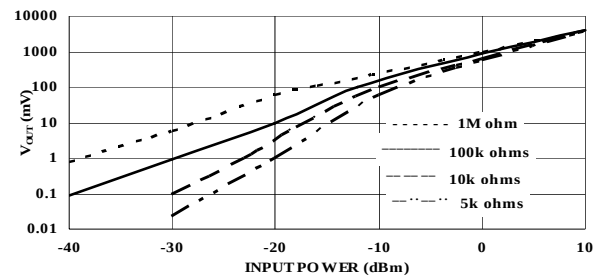
**Forward Current vs Forward Voltage and Temperature**



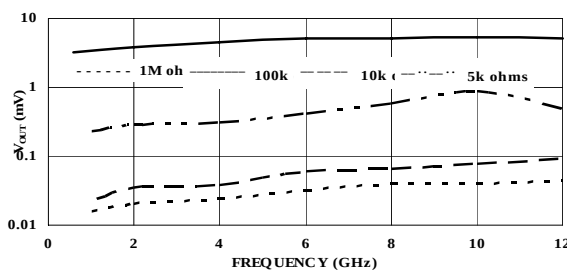
**Detector Output Voltage vs Input Power and Load Resistance. Diode Forward Biased at 20  $\mu$ A. Untuned Fixture at 9.375 GHz.**



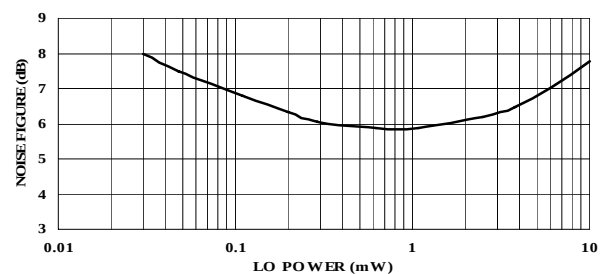
**Detector Output Voltage vs Input Power and Load Resistance. Diode at Zero Bias. Untuned Fixture at 9.375 GHz (50  $\Omega$ )**



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



**Tuned Fixture Noise Figure vs LO Power at 9.375 GHz**



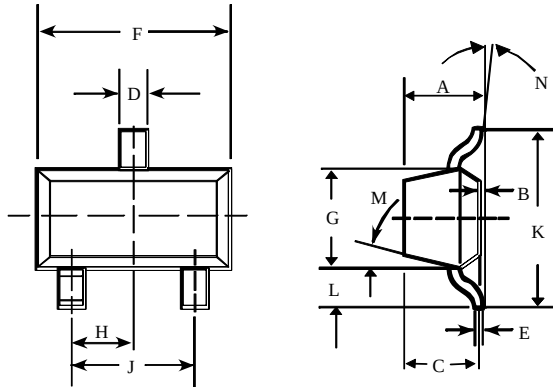
### Typical Scattering Parameters (S11)

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   |

### Case Styles

#### SOT-23



##### Package Parasitics

$L_s = 1.4 \text{ nH}$

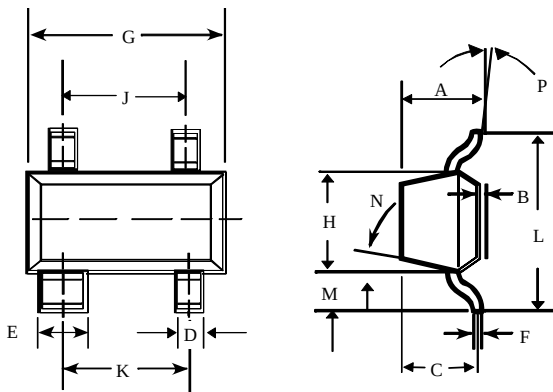
$C_p = .12 \text{ pF}$

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

|      | INCHES                |       | MILLIMETERS  |      |
|------|-----------------------|-------|--------------|------|
| DIM. | 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>1</sup> |       |              |      |
| N    | 2° ... 30°            |       |              |      |

Note: 1. Applicable on all sides

#### SOT-143



##### Package Parasitics

$L_s = 1.2 \text{ nH}$

$C_p = .14 \text{ pF}$

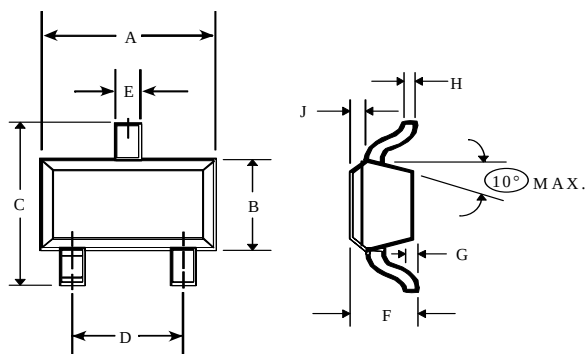
#### SOT-143 (Case Style 1068)

|      | INCHES                |       | MILLIMETERS  |      |
|------|-----------------------|-------|--------------|------|
| DIM. | MIN.                  | MAX.  | MIN.         | MAX. |
| A    | –                     | 0.044 | –            | 1.10 |
| B    | –                     | 0.044 | –            | 1.10 |
| C    | –                     | 0.040 | –            | 1.00 |
| D    | 0.013                 | 0.020 | 0.35         | 0.50 |
| E    | 0.030                 | 0.035 | 0.75         | 0.90 |
| F    | 0.003                 | 0.006 | 0.08         | 0.15 |
| G    | 0.110                 | 0.119 | 2.80         | 3.00 |
| H    | 0.047                 | 0.056 | 1.20         | 1.40 |
| J    | 0.075 typical         |       | 1.90 typical |      |
| K    | 0.075 typical         |       | 1.90 typical |      |
| L    | –                     | 0.103 | –            | 2.6  |
| M    | –                     | 0.024 | –            | 0.6  |
| DIM. | GRADIENT              |       |              |      |
| N    | 10° max. <sup>1</sup> |       |              |      |
| P    | 2° ... 30°            |       |              |      |

Note: 1. Applicable on all sides

## Case Styles (Cont'd)

### SOT-323



#### Package Parasitics

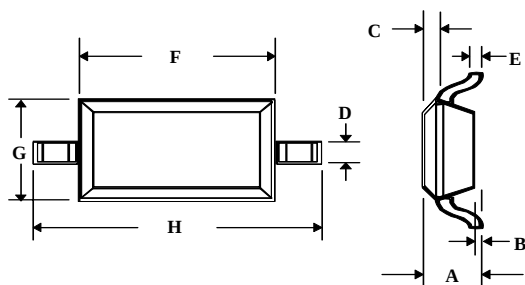
$L_s = 1.2 \text{ nH}$

$C_p = .11 \text{ pF}$

### 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 typical | 0.15 |
| J    | 0.004  | 0.010 | 0.1          | 0.25 |

### SOD-323



#### Package Parasitics

$L_s = 1.2 \text{ nH}$

$C_p = .11 \text{ pF}$

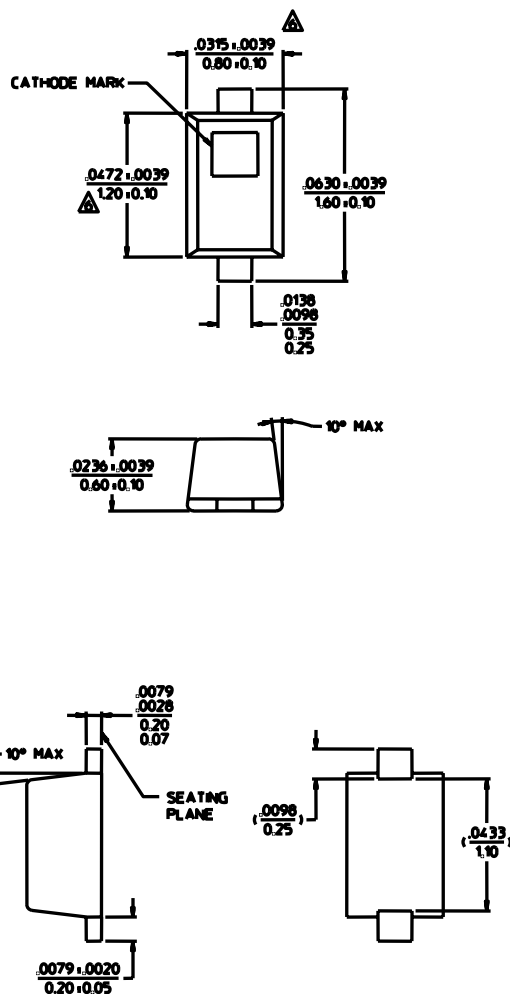
### SOD-323 (Case Style 1141)

| 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  |



## Case Styles (Cont'd)

### ODS-1279



#### Package Parasitics

$L_s = .6 \text{ nH}$

$C_p = .10 \text{ pF}$

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