

## Surface Mount Low Barrier Schottky Diode

Rev. V9

### 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

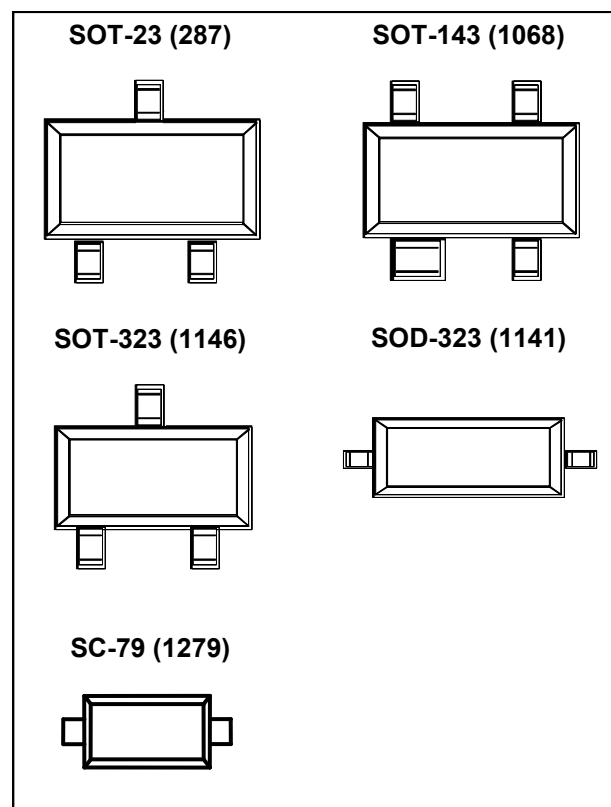
### Description and Applications

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.

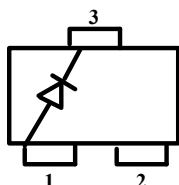
These parts are offered with Sn/Pb plating, as well as with 100 % matte Sn plating on the RoHS compliant part numbers.

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.

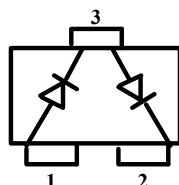
The part number consists of the base chip (MA4E2054), followed by the wiring configuration (A, B, C, D, E, omit for SOD-323), the package style (287, 1068, 1141, 1146) and a "T" for tape and reel.



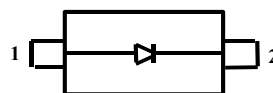
### Configurations (Topviews)



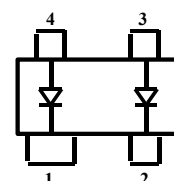
**SINGLE**  
MA4E2054A-287T  
MA4E2054A-1146T



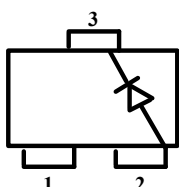
**SERIES PAIR**  
MA4E2054B-287T  
MA4E2054B-1146T



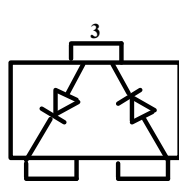
**Single**  
MA4E2054-1141T  
MA4E20541-1279T



**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

## Surface Mount Low Barrier Schottky Diode

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### 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	$V_R = 0 V$ $f = 1 MHz$	$C_T$	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. 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

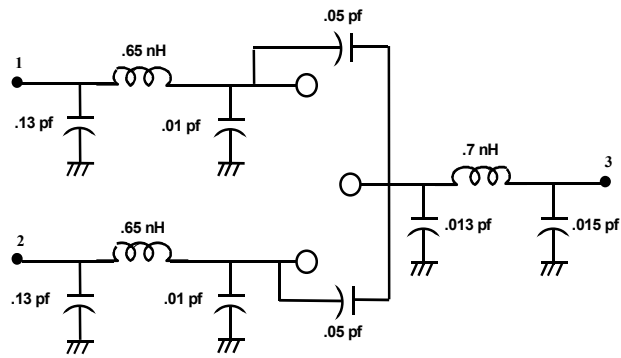
Parameter	Conditions	Typical Value
Mixer Noise Figure <sup>1</sup>	$f = 9.375 GHz$ $LO = 0 dBm$	5.7 dB (SSB)
IF Impedance	$I_F = 30 MHz$	200 ohms
Tangential Signal Sensitivity <sup>2</sup>	$I_F = 20 mA$ $BW = 2 MHz$ Video NF = 1.5 dB	-55 dBm
Detector Output, Voltage at -30 dBm <sup>2</sup>	$R_L = 100K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

1. Fixture tuned to 9.375 GHz.

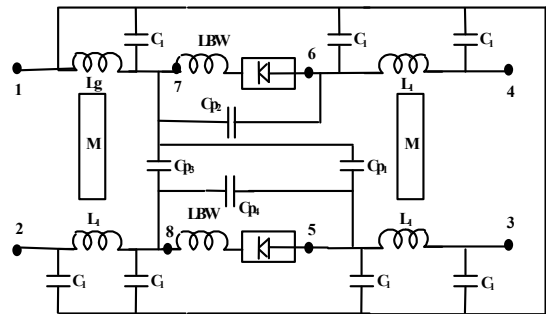
2. Fixture tuned to 2.5 GHz. See figures on page 3 for untuned fixture performance.

### Circuit Models

**SOT-23**

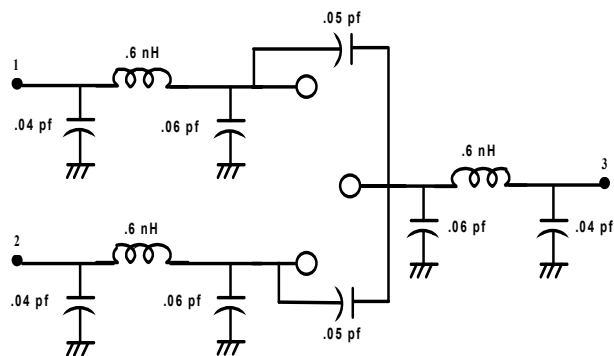


**SOT-143**

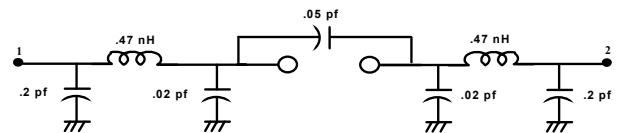


LBW = 0.08nH, Lg = 0.36nH, L1 = 0.31nH, M = 0.12nH, C1 = 0.01pF, Cp1 = 0.05pF, Cp2 = 0.10pF, Cp3 = 0.05pF, Cp4 = 0.03pF

**SOT-323**

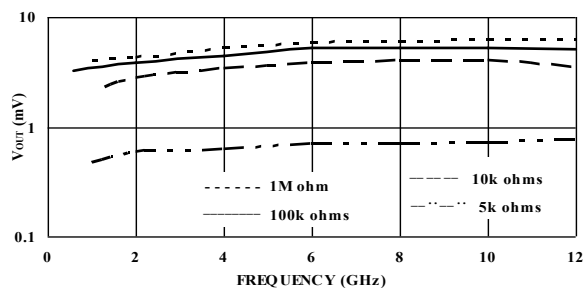


**SOD-323**

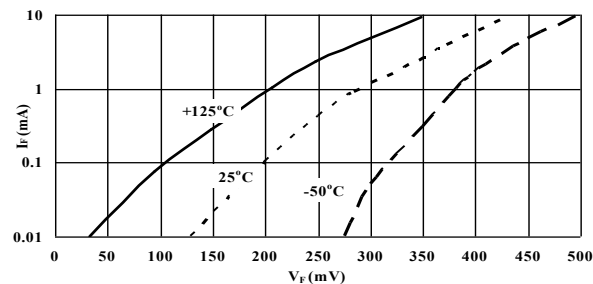


### Typical Performance Curves @ 25°C in Chip Form, Mounted on a Microstrip Fixture

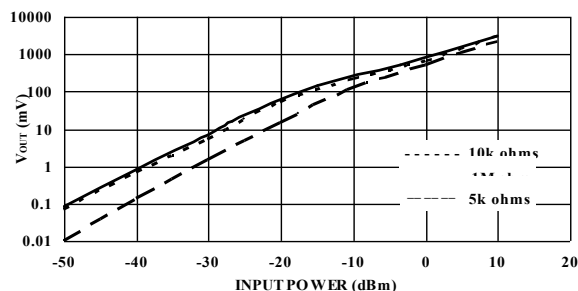
**Detector Output Voltage vs Frequency and Load Resistance at -30 dBm. Diode Forward Biased at 20  $\mu$ A. Untuned Fixture (50  $\Omega$ )**



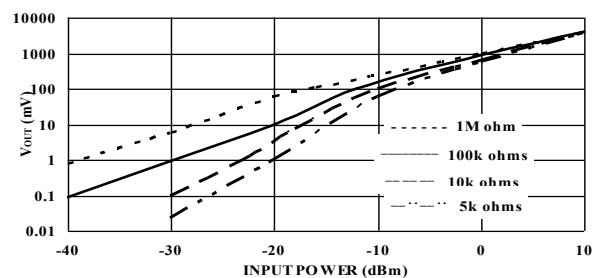
**Forward Current vs Forward Voltage and Temperature**



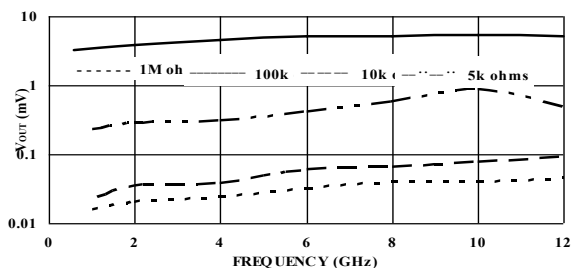
**Detector Output Voltage vs Input Power and Load Resistance. Diode Forward Biased at 20  $\mu$ A. Untuned Fixture at 9.375 GHz.**



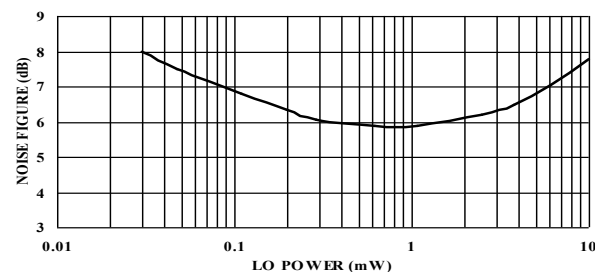
**Detector Output Voltage vs Input Power and Load Resistance. Diode at Zero Bias. Untuned Fixture at 9.375 GHz (50  $\Omega$ )**



**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**



## Surface Mount Low Barrier Schottky Diode

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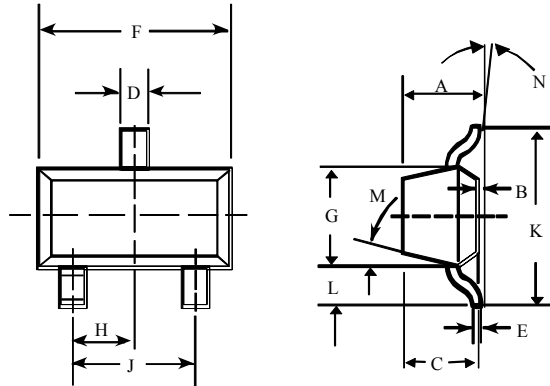
### Typical Scattering Parameters (S11)

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

Freq. 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

$L_s = 1.4 \text{ nH}$

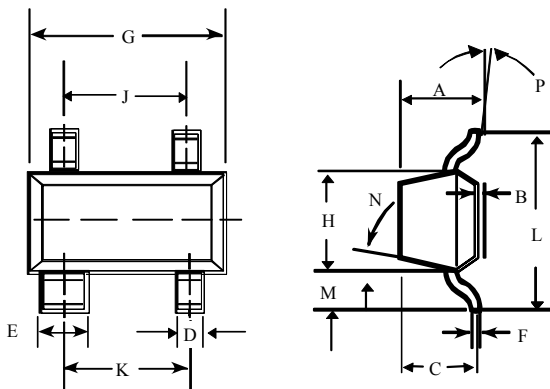
$C_p = .12 \text{ pF}$

#### 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

$L_s = 1.2 \text{ nH}$

$C_p = .14 \text{ pF}$

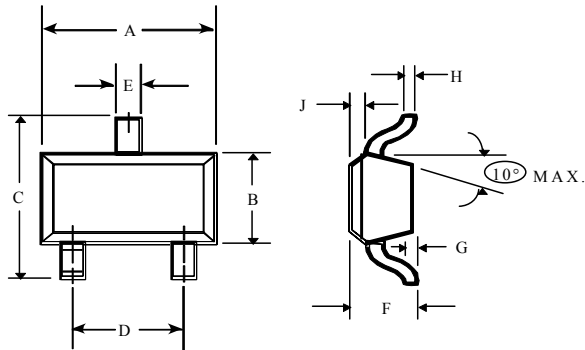
#### SOT-143 (Case Style 1068)

	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

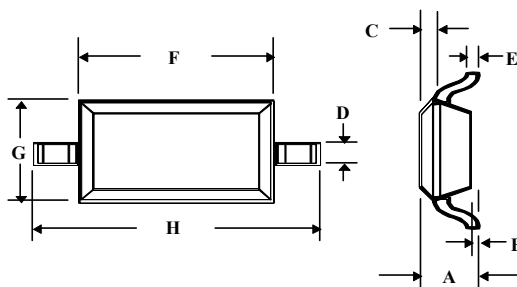
$L_s = 1.2 \text{ nH}$

$C_p = .11 \text{ pF}$

#### 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

$L_s = 1.2 \text{ nH}$

$C_p = .11 \text{ pF}$

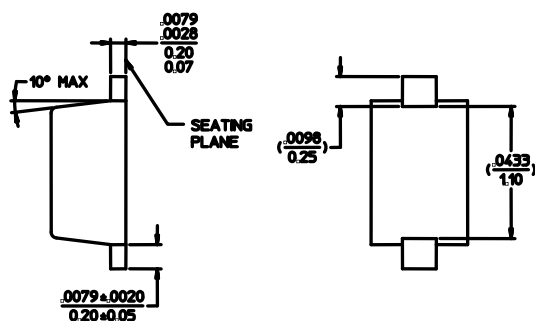
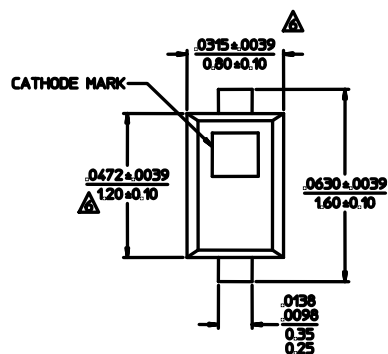
#### SOD-323 (Case Style 1141)

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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