Surface Mount Low Barrier X-Band Schottky Diode

Features

- Low I_R (<100nA @ 1V, <500nA @ 3V)
- Designed for High Volume, Low Cost Detector and Mixer Applications
- Low Noise Figure: 5.7 dB (SSB) at X-Band
- High Detector Sensitivity: -55 dBm TSS
- Low Capacitance: 0.30 pF
- Low 1/F Noise
- Single, Series Pair, and Unconnected Pair Configurations
- Available in four package styles
- Tape and Reel

Description

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 at frequencies from VHF through low Ku band.

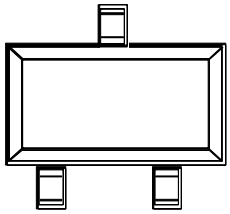
The MA4E2054-1141T (SOD-323), and the MA4E2054A and the MA4E2054C (available in both the SOT-23 and SOT-323 packages) are single element Schottky diodes characterized for use as single ended mixers and detectors. The MA4E2054B and MA4E2054D (available in both the SOT-23 and SOT-323 packages) incorporate 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.

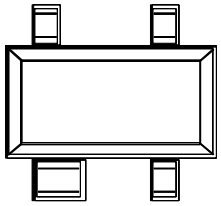
The MA4E2054-1141T is available only in the SOD-323 package style. The MA4E2054A , B, C, D are available in both the SOT-23 and SOT-323 package styles. The MA4E2054E is available only in the SOT-143 package style.

Package Outlines

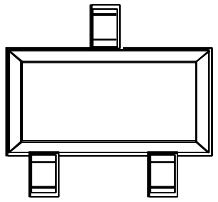
SOT-23 (287)



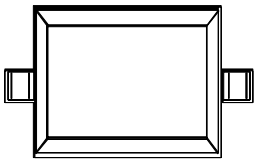
SOT-143 (1068)



SOT-323 (1146)

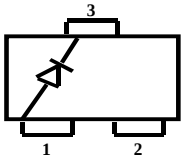


SOD-323 (1141)

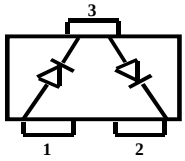


Configurations

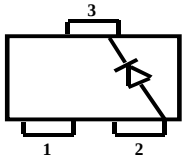
TOP VIEW



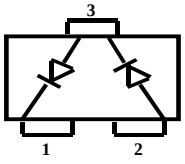
SINGLE
MA4E2054A-287T
MA4E2054A-1146T



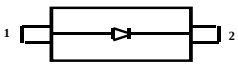
SERIES PAIR
MA4E2054B-287T
MA4E2054B-1146T



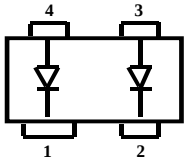
SINGLE
MA4E2054C-287T
MA4E2054C-1146T



SERIES PAIR
MA4E2054D-287T
MA4E2054D-1146T



SINGLE
MA4E2054-1141T



UNCONNECTED PAIR
MA4E2054E-1068T

Specifications subject to change without notice.

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Maximum Ratings

Parameter	Unit	Values
Operating Temperature	ºC	-65 to +125
Storage Temperature	ºC	-65 to +125
Incident RF Power (CW)	mW	75[1]
Reverse Voltage @ 25ºC	V	3
Forward Current	mA	20
Soldering Temperature	ºC	+260 for 5 sec.

1. At 25°C junction temperature. Derate linearly to zero watts at 125°C case temperature.

Electrical Specifications @ +25°C

Parameter	Condition	Symbol	Specification
Breakdown Voltage	I_R = 10 mA	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	C_T	0.30 pF max.
Dynamic Resistance[2]	I_F = 10 mA	R_D	17 Ohms max.
Forward Voltage	I_F = 1 mA	V_F	250 mV min.
Forward Voltage Difference[1]	I_F = 1 mA	ΔV_F	20 mV max.

1. Applies to MA4E2054B, MA4E2054D and MA4E2054E configurations.

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

Typical RF Performance @ +25°C

Parameter	Conditions	Typical Value
Mixer Noise Figure[1]	f = 9.375 GHz	5.7 dB (SSB)
IF Impedance	I_F = 30 MHz	200 ohms
Tangential Signal Sensitivity[2]	I_F = 20 mA BW = 2 MHz	-55 dBm
Detector Output Voltage at -30 dBm[2]	R_L = 100K Ohms I_F = 20 μA	20 mV
Detector Output	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.

Spice Model Parameters

IS = 3 x 10^{-8} A	M = 0.50
RS = 11Ω	EG = 0.69 eV
N = 1.05	BV = 5.0 V
TT = 0 S	IBV = 1 x 10^{-5} A
Cj(0) = 0.10 x 10^{-12} pF	
Cpar = 0.11 x 10^{-12} pF	
VJ = 0.40 V	

Specifications subject to change without notice.

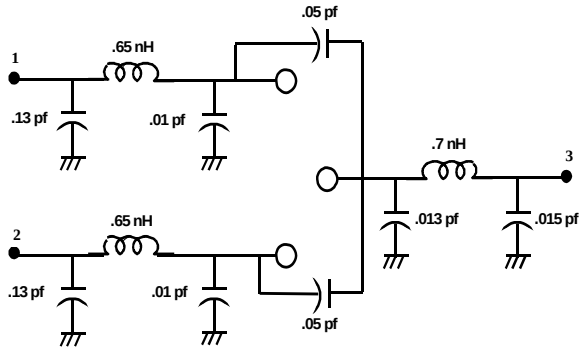
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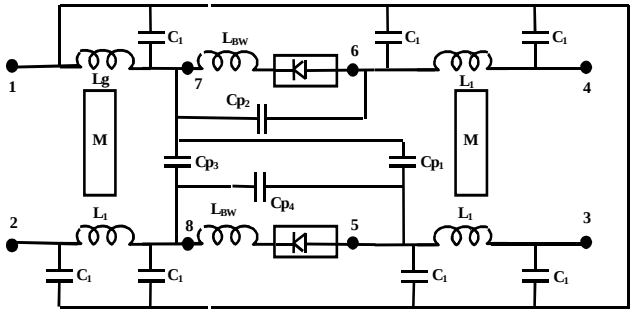
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Circuit Models

SOT-23

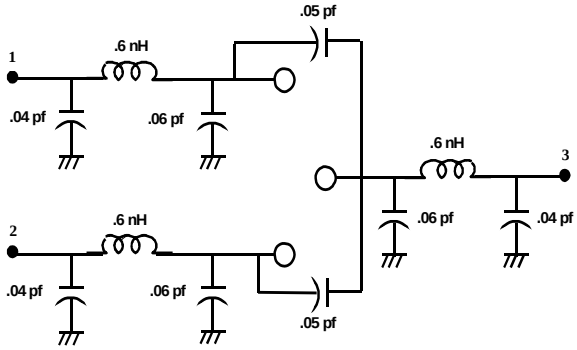


SOT-143

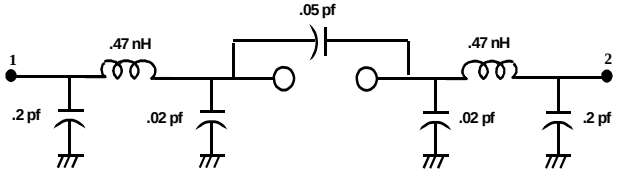


LBW = 0.08nH, Lg = 0.36nh, L1 = 0.31nH, M = 0.12nH, C1 = 0.01pF, Cp1 = 0.05pF, CP2 = 0.10pF, Cp3 = 0.05pF, Cp4 = 0.03pF

SOT-323

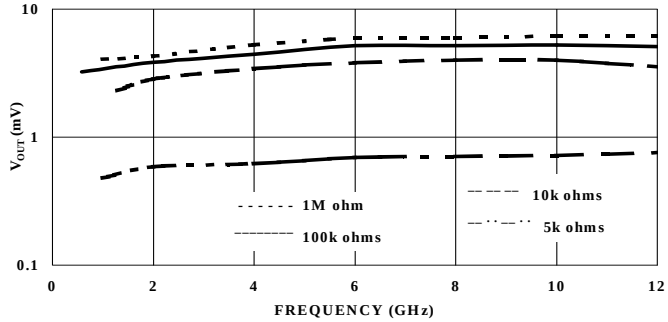


SOD-323

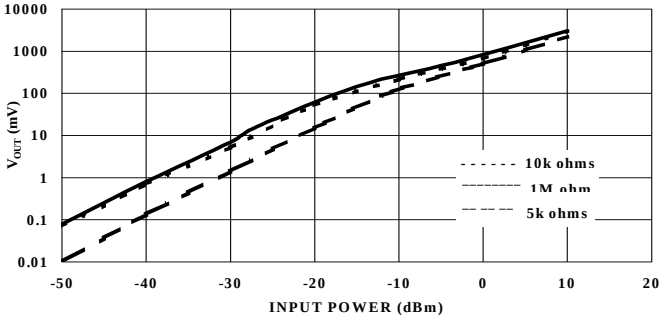


Typical Performance Curves @ 25°C (MA4E2054-287T)

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



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



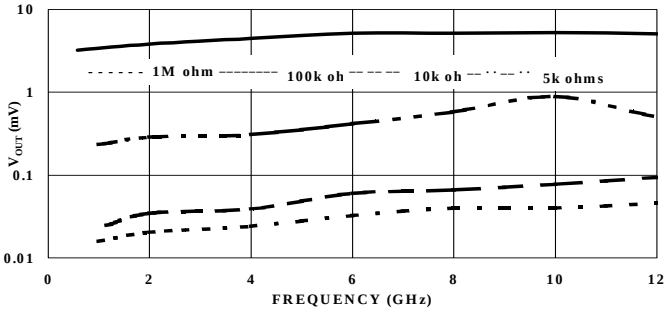
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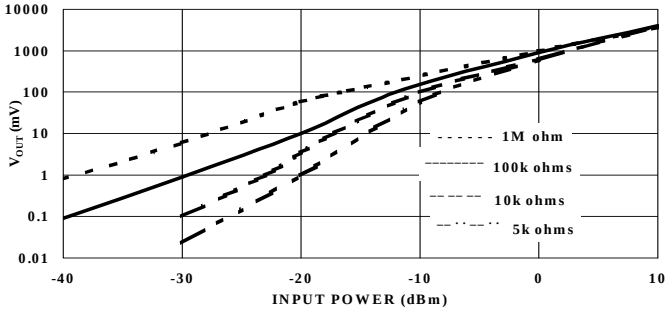
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Typical Performance Curves @ 25°C (Cont'd) (MA4E2054-287T)

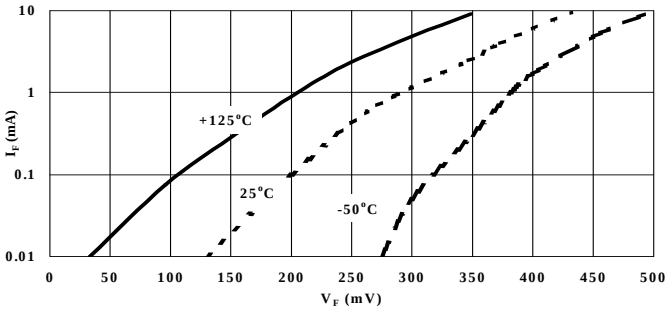
Detector Output Voltage vs Frequency and Load Resistance at -30 dBm. Diode at Zero Bias. Untuned Fixture (50Ω)



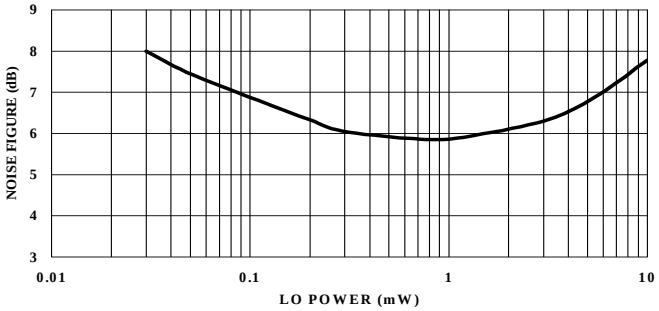
Detector Output Voltage vs Input Power and Load Resistance. Diode at Zero Bias. Untuned Fixture at 9.375 GHz (50Ω)



Forward Current vs Forward Voltage and Temperature



Tuned Fixture



Typical Scattering Parameters (S_{11})

MA4E2054A (packaged in SOT-23), Using a 50 Ohm Intercontinental Test Fixture (no DC bias)

Freq.	-30 dBm		-3 dBm		0 dBm		3 dBm	
GHz	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

Specifications subject to change without notice.

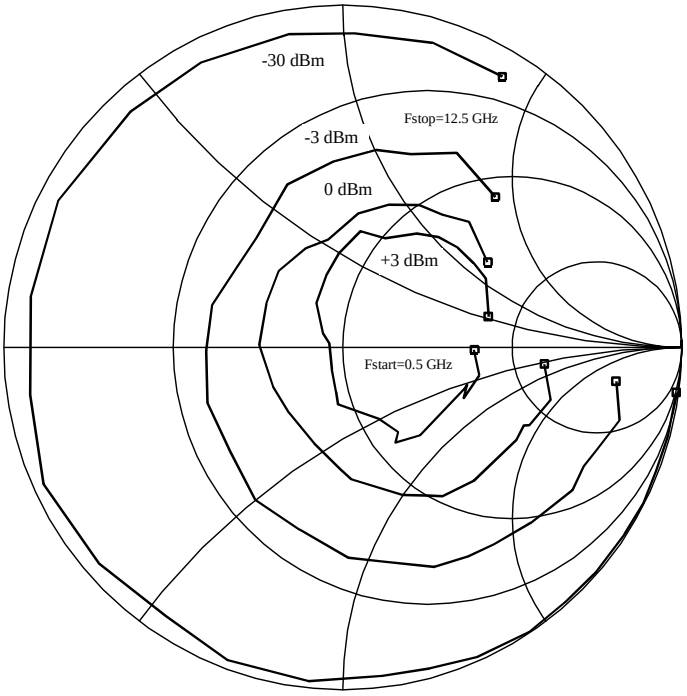
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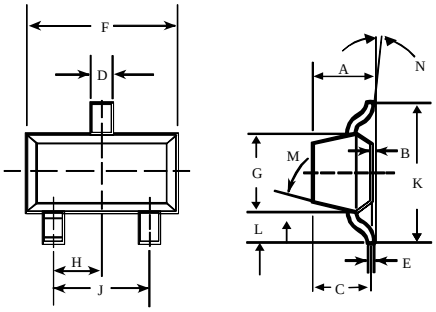
Impedance Plot

MA4E2054A (packaged in SOT-23)
Using a 50 Ohm Intercontinental Test Fixture (no DC bias)



Case Styles

SOT-23



SOT-23 (Case 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.[1]
N	2° . . .30°

Note:
1. Applicable on all sides

Specifications subject to change without notice.

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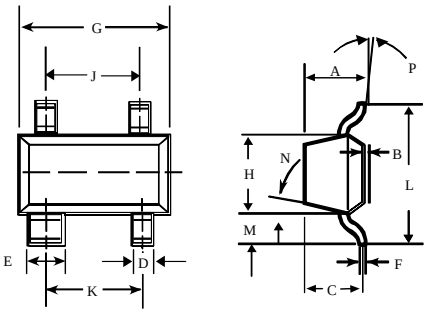
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Case Styles

SOT-143



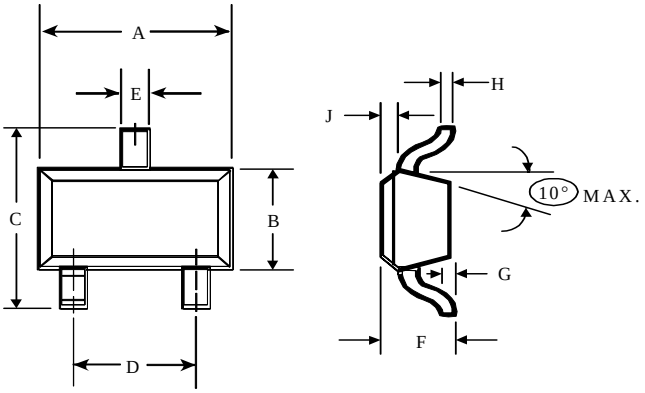
SOT-143 (Case 1068)

DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	—	0.044	—	1.10
B	—	0.044	—	1.10
C	—	0.040	—	1.00
D	0.030	0.035	0.75	0.90
E	0.013	0.020	0.35	0.50
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.[1]
P	2° . . .30°

Note:
1. Applicable on all sides

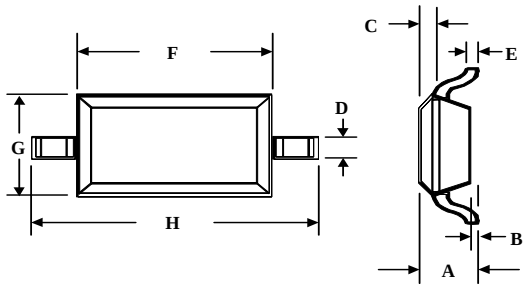
SOT-323



SOT-323 (Case 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

SOD-323



SOD-323 (Case 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

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Low Barrier Schottky Single Junction Chip

Features

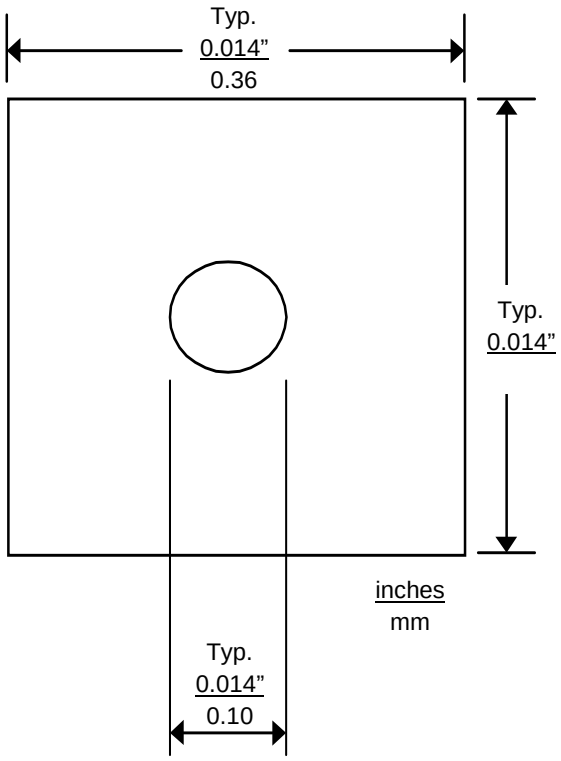
- Low I_R (<100 nA @ 1V, <500 nA @ 3V)
- Designed for High Volume, Low Cost Detector and Mixer Applications
- Low Noise Figure: 5.7 dB (SSB) at X-Band
- High Detector Sensitivity: -55 dBm TSS
- Low Capacitance: 0.13 pF
- Low 1/F Noise

Description

The MA4E2054 diode is a low barrier, n-type, silicon Schottky device. It is useful as a high performance mixer or detector diode at frequencies from VHF through X-band. The 0.004-inch diameter gold bond pads and sturdy construction allow you to use these chips in automatic assembly processes.

Package Outlines

MA4E2054



Maximum Ratings

Parameter	Symbol	Unit	Values
Operating Temperature	T_{OP}	ºC	-65 to
Storage Temperature	T_{STG}	ºC	-65 to
Incident RF Power (CW)	P_T	mW	75[1]
Reverse Voltage @ 25ºC	V_R	V	3
Forward Current @ 25°C	I_F	mA	20

1. At 25°C die temperature. Derate linearly to zero watts at 150°C.

Electrical Specifications @ +25°C

Parameter	Condition	Symbol	Specification
Breakdown Voltage	I_R = 10 µA	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 f = 1 MHz	C_T	0.13 pF max.
Dynamic Resistance[1]	I_F = 10 mA	R_D	17 Ohms max.
Forward Voltage	I_F = 1 mA	V_F	250 mV min. 350 mV max.

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

Typical RF Performance @ +25°C

SOT-23 Package

Parameter	Conditions	Typical Value
Mixer Noise Figure[1]	f = 9.375 GHz LO = 0 dBm	5.7 dB (SSB)
IF Impedance	I_F = 30 MHz	200 ohms
Tangential Signal Sensitivity[2]	I_F = 20 µA BW = 2 MHz Video NF = 1.5 dB	-55 dBm
Detector Output Voltage at -30 dBm[2]	R_L = 100K Ohms I_F = 20 µA	20 mV
Detector Output Voltage at -30 dBm[2]	R_L = 1M Ohm Zero Bias	20 mV

Specifications subject to change without notice.

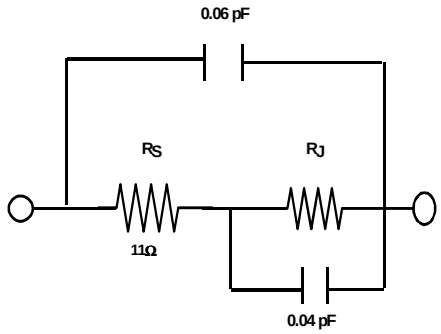
■ **North America:** Tel. (800) 366-2266, Fax (800) 618-8883
■ **Asia/Pacific:** Tel.+81-44-844-8296, Fax +81-44-844-8298
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Circuit Model (Chip)



Spice Model Parameters

IS = 3 x 10-^{8} A	M = 0.50
RS = 11Ω	EG = 0.69 eV
N = 1.05	BV = 5.0 V
TT = 0 S	IBV = 1 x 10 -^{5} A
Cj(0) = 0.10 x 10 -^{12} pF	
VJ = 0.40 V	

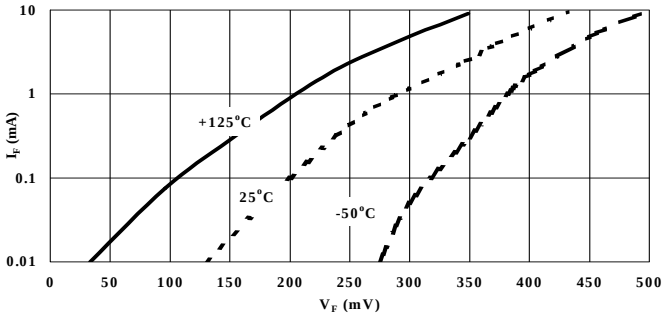
Recommended Assembly

1. One mil diameter gold wire.
2. Ball bond
3. Conductive silver epoxy for die mounting.

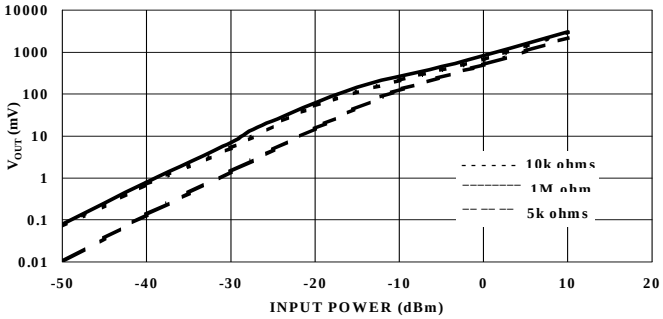
Typical Performance Curves @ +25°C

(Packaged in SOT-23)

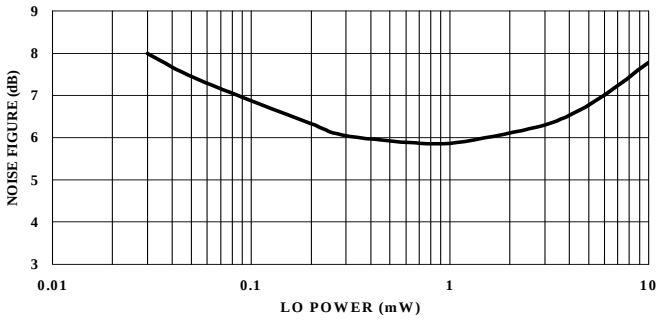
Forward Current vs Forward Voltage and Temperature



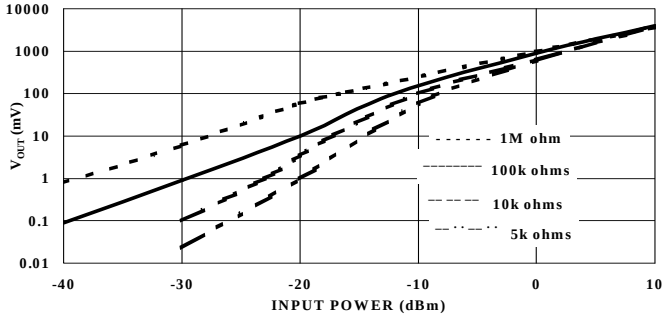
Detector Output Voltage vs Input Power and Load Resistance. Diode Forward Biased at 20µA. Untuned Fixture at 9.375 GHz



Noise Figure vs LO Power at 9.375 GHz, Tuned Fixture



Detector Output Voltage vs Input Power and Load Resistance. Diode at Zero Bias. Untuned Fixture at 9.375 GHz



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