

HMIC™ Silicon PIN Diode SP2T Switch with Integrated Bias Network, 2 - 18 GHz



MASW-011052

Rev. V4

Features

- Broad Bandwidth Specified up to 18 GHz
- Usable up to 26 GHz
- Integrated Bias Network
- Low Insertion Loss / High Isolation
- Fully Monolithic
- Glass Encapsulate Construction
- RoHS Compliant* and 260°C Reflow Compatible

Applications

- Aerospace & Defense

Description

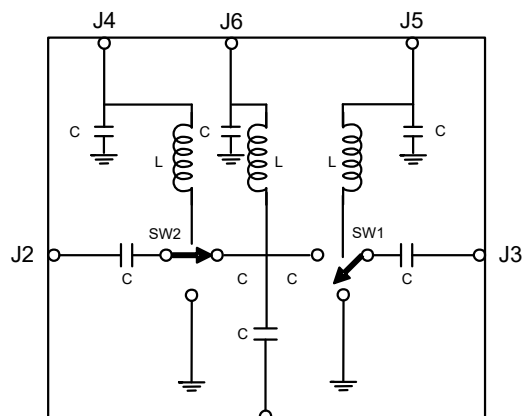
The MASW-011052 device is a SP2T broad band switch die with integrated bias networks utilizing MACOM's patented HMIC (Heterolithic Microwave Integrated Circuit) process. This process allows the incorporation of silicon pedestals that form series and shunt diodes or vias by imbedding them in low loss, low dispersion glass. By using small spacing between elements, this combination of silicon and glass gives HMIC devices low loss and high isolation performance with exceptional repeatability through low millimeter frequencies. Large bond pads facilitate the use of low inductance ribbon bonds, while gold backside metallization allows for manual or automatic chip bonding via 80/20 - Au/Sn, 62/36/2 - Sn/Pb/Ag solders or electrically conductive silver epoxy.

Ordering Information¹

Part Number	Package
MASW-011052-14220G	Die in Gel Pack
MASW-011052-14220W	Die in Waffle Pack

1. Die quantity varies.

Functional Diagram



Pin Configuration²

Pin	Function
J1	Antenna
J2	RF _{IN}
J3	RF _{IN}
J4	Bias of J2
J5	Bias of J3
J6	Bias Antenna

2. The exposed metallization on the chip bottom must be connected to RF, DC and thermal ground.

* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

HMIC™ Silicon PIN Diode SP2T Switch with Integrated Bias Network, 2 - 18 GHz



MASW-011052

Rev. V4

Electrical Specifications:

$T_A = +25^\circ\text{C}$, $Z_0 = 50\ \Omega$, $P_{IN} = 0\ \text{dBm}$, DC Control Current = 20 mA (unless otherwise noted)

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	2 GHz	dB	—	1.20	1.80
	6 GHz			0.55	1.00
	12 GHz			0.80	1.20
	18 GHz			1.15	1.80
Input to Output Isolation	2 GHz	dB	55	70	—
	6 GHz		47	64	
	12 GHz		40	59	
	18 GHz		36	48	
Input Return Loss	2 GHz	dB	—	15	—
	6 GHz			23	
	12 GHz			18	
	18 GHz			15	
Input/Output IP3 @ 5 dBm	2 GHz	dBm	—	42.2	—
	6 GHz			41.6	
	9 GHz			44.6	
	12 GHz			44.5	
	15 GHz			43.4	
	18 GHz			40.5	
Input/Output IP2 @ 5 dBm	2 GHz	dBm	—	75.0	—
	6 GHz			68.1	
	9 GHz			67.2	
	12 GHz			66.6	
	15 GHz			76.3	
	18 GHz			80.3	
Switching Speed ³	—	ns	—	75	—

3. Typical Switching speed measured from (50% Control - 90% RF Voltage), in commutating mode at 10 kHz repetition rate, using the MACOM MADR-011022 driver at -10 V @ -20 mA and +5 V @ +20 mA.

Absolute Maximum Ratings^{4,5}

Parameter	Absolute Maximum
Forward Bias Current	60 mA
DC Reverse Bias Voltage	50 V
RF Incident Power CW	33 dBm @ +85°C
Junction Temperature	+175°C
Operating Temperature	-65°C to +125°C
Storage Temperature	-65°C to +150°C

4. Exceeding any one or combination of these limits may cause permanent damage to this device.

5. MACOM does not recommend sustained operation near these survivability limits.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

HMIC™ Silicon PIN Diode SP2T Switch with Integrated Bias Network, 2 - 18 GHz



MASW-011052

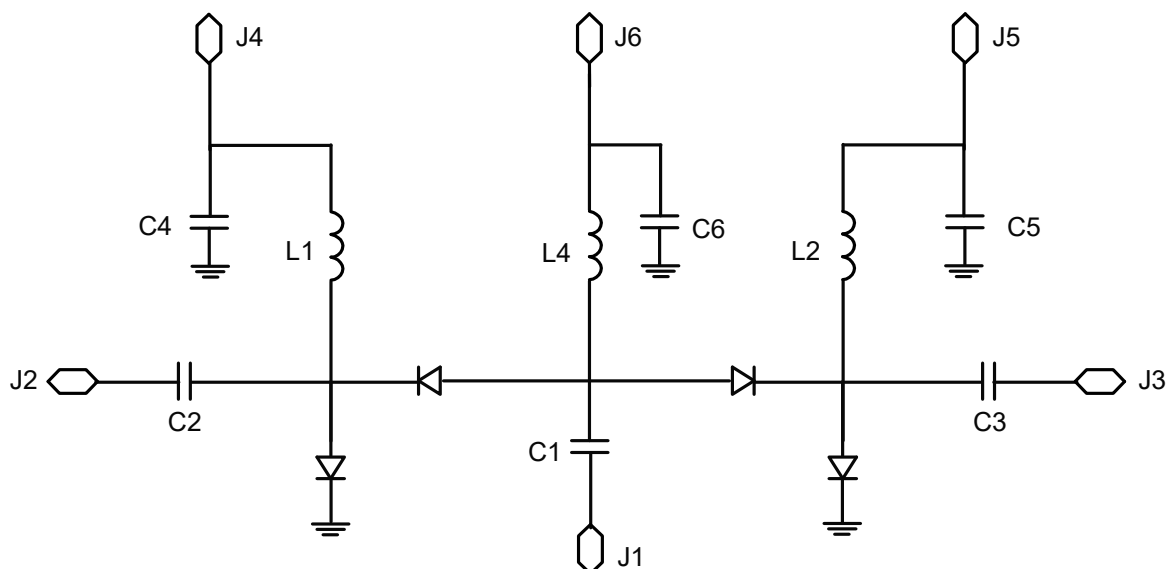
Rev. V4

Truth Table

DC Control Current ⁶			Condition of RF Output	
J4	J5	J6	J1-J2	J1-J3
-20 mA	+20 mA	GND	Low Loss	Isolation
+20 mA	-20 mA	GND	Isolation	Low Loss

6. The forward diode voltage drop between:
J6 to J4 or J6 to J5 is 1.0 V typical.
J4 to GND or J5 to GND is 0.9 V typical.

Circuit Schematic⁷



7. J6 junction is node for external bias resistor.

HMIC™ Silicon PIN Diode SP2T Switch with Integrated Bias Network, 2 - 18 GHz

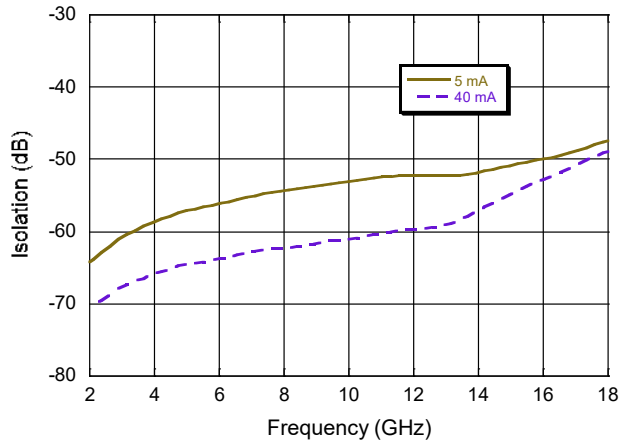


MASW-011052

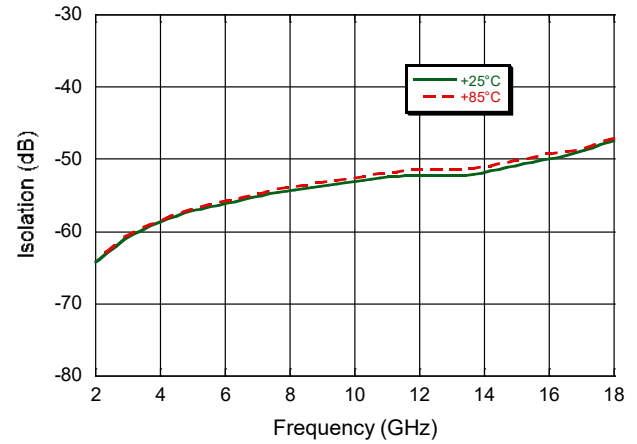
Rev. V4

Typical Performance Curves

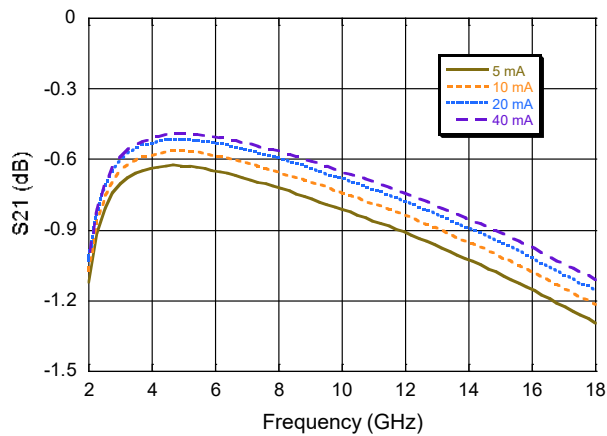
Isolation @ 5 V, +25°C



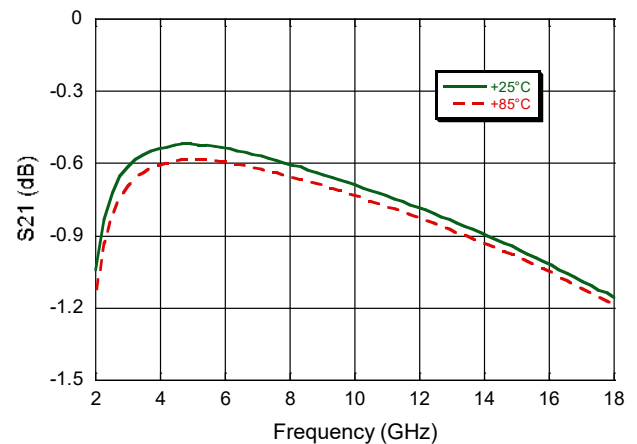
Isolation @ 5 V, 5 mA



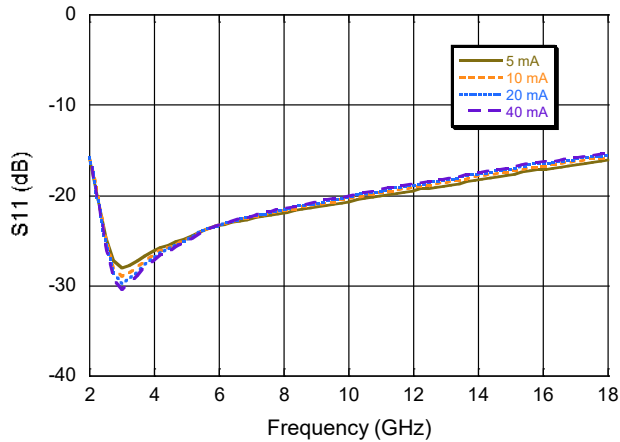
Insertion Loss @ 5 V, +25°C



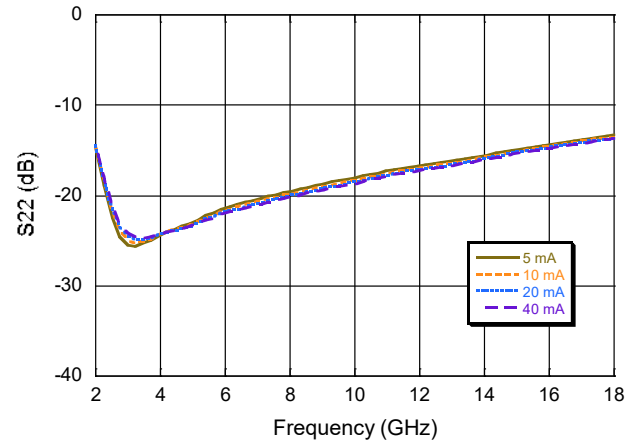
Insertion Loss @ 5 V, 20 mA



Input Return Loss @ 5 V, +25°C

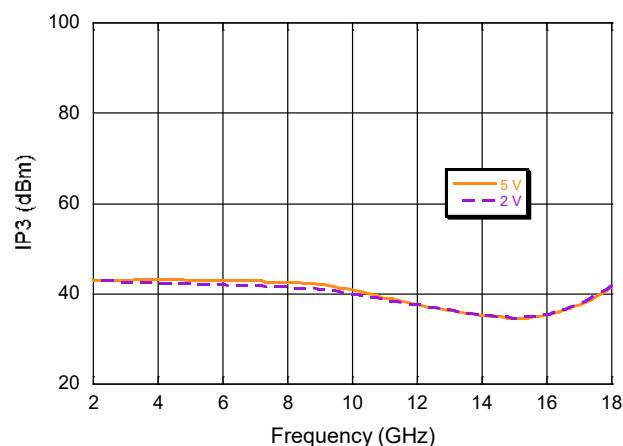


Output Return Loss @ 5 V, +25°C

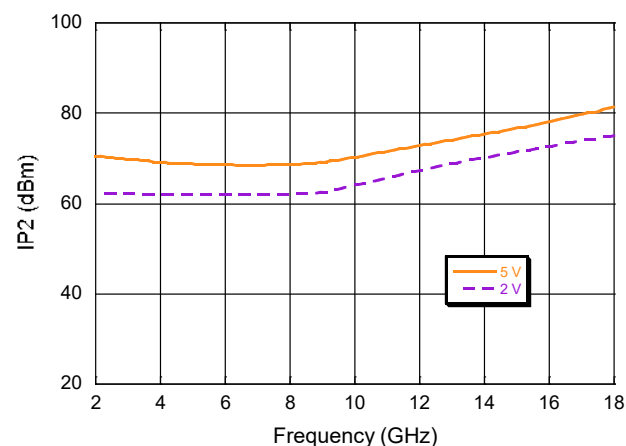


Typical Performance Curves

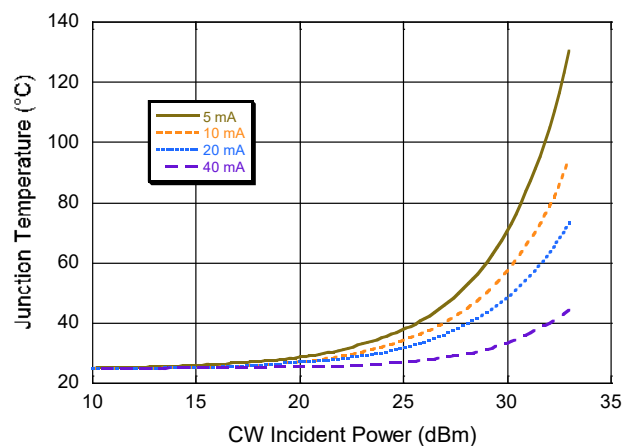
IP3



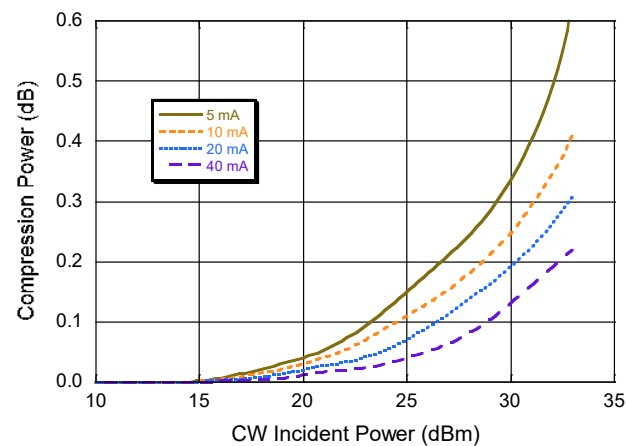
IP2



Junction Temperature



Compression Power



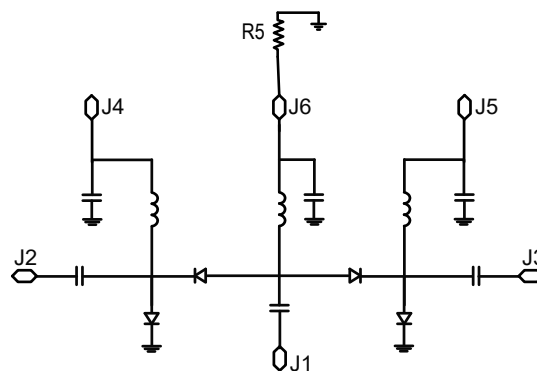
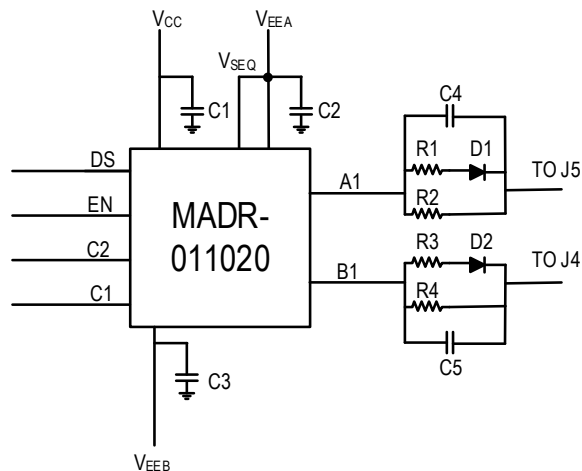
HMIC™ Silicon PIN Diode SP2T Switch with Integrated Bias Network, 2 - 18 GHz



MASW-011052

Rev. V4

MASW-011052 with MADR-011020 Driver Application Schematic



Parts List⁸

Part	Value
C1, C3	0.1 μ F
C2	47 pF
C4, C5	470 pF
R1, R3	270 Ω
R2, R4	390 Ω
R5	560 Ω
D1, D2	1N4148WS

8. Resistor values calculated to provide ~20 mA of bias current and ~12 V reverse bias voltage given $V_{CC} = 5$ V, $V_{EEB} = -20$ V, voltage drop at driver output 0.4 V, V_F of D1 and D2 0.7 V and V_F of switch diodes ~1 V (see note 6 for details).

Switch Minimum Reverse Bias Voltage⁹

Frequency (GHz)	DC Voltage (V) J4 & J5
2	-12
5	-7
10	-5
15	-5
18	-5

9. Calculated minimum DC bias voltage to maintain low loss under 2 W of power with 1.5:1 VSWR. Reverse bias voltage should be determined based on working conditions. For example, -12 V @ 2 GHz, 2 W input power. For lower power applications, a less negative voltage can be used. R. Caverly and G. Hiller, "Establishing the Minimum Reverse Bias for a P-I-N Diode in a High Power Switch," IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.

HMIC™ Silicon PIN Diode SP2T Switch with Integrated Bias Network, 2 - 18 GHz



MASW-011052

Rev. V4

Cleanliness

The chips should be handled in a clean environment free of dust and organic contamination.

Wire / Ribbon Bonding

Thermosonic wedge wire bonding using 0.00025" x 0.003" ribbon or 0.001" diameter gold wire is recommended. A heat stage temperature of 150°C and a force of 18 to 22 grams should be used. Ultrasonic energy should be adjusted to the minimum required to achieve a good bond. RF bond wires should be kept as short and straight as possible.

Chip Mounting

The HMIC switches have Ti-Pt-Au back metal. They can be die mounted with a gold-tin eutectic solder preform or conductive epoxy. Mounting surface must be clean and flat.

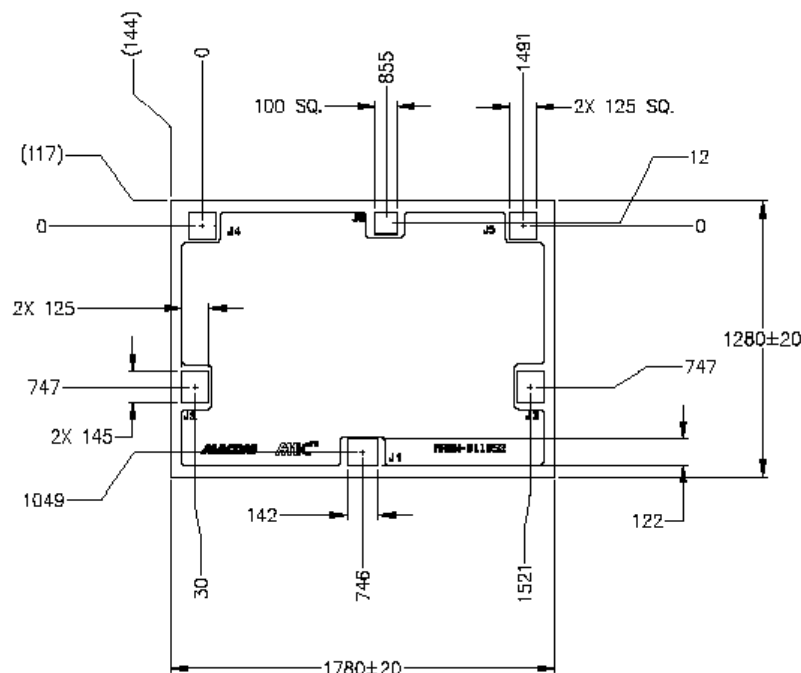
Eutectic Die Attachment

An 80/20, gold-tin, eutectic solder preform is recommended with a work surface temperature of 255°C and a tool tip temperature of 265°C. When hot gas is applied, the tool tip temperature should be 290°C. The chip should not be exposed to temperatures greater than 320°C for more than 20 seconds. No more than three seconds should be required for attachment. Solders containing tin should not be used.

Epoxy Die Attachment

A minimum amount of epoxy should be used. A thin epoxy fillet should be visible around the perimeter of the chip after placement. Cure epoxy per manufacturer's schedule (typically 125 - 150°C).

Outline Drawing^{10,11,12}



10. Unless otherwise specified, all dimensions shown as μm , with tolerance $\pm 5 \mu\text{m}$.

11. Die thickness is $125 \pm 10 \mu\text{m}$.

12. Topside and backside metallization is gold, 2.5 μm thick typical.

MACOM Technology Solutions Inc. ("MACOM"). All rights reserved.

These materials are provided in connection with MACOM's products as a service to its customers and may be used for informational purposes only. Except as provided in its Terms and Conditions of Sale or any separate agreement, MACOM assumes no liability or responsibility whatsoever, including for (i) errors or omissions in these materials; (ii) failure to update these materials; or (iii) conflicts or incompatibilities arising from future changes to specifications and product descriptions, which MACOM may make at any time, without notice. These materials grant no license, express or implied, to any intellectual property rights.

THESE MATERIALS ARE PROVIDED "AS IS" WITH NO WARRANTY OR LIABILITY, EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHT, ACCURACY OR COMPLETENESS, OR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.