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

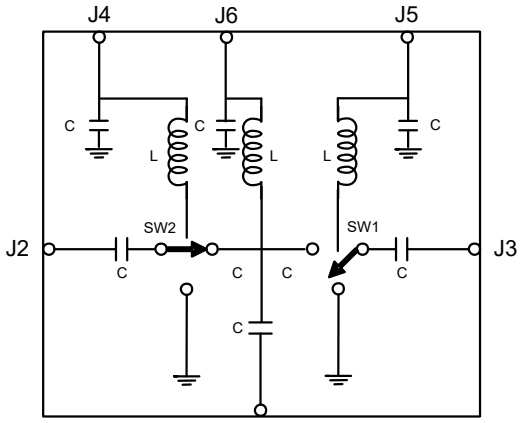
The MASW-011052 device is a SP2T broad band switch die with integrated bias networks utilizing MACOM's patented HMIC (Heterolithic Microwave Integrated Circuit) process. This process allows the incorporation of silicon pedestals that form series and shunt diodes or vias by imbedding them in low loss, 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 Information[1]

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

1. Die quantity varies.

Functional Diagram



Pin Configuration[2]

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.

Electrical Specifications:

T_A = +25°C, Z_0 = 50 Ω, P_{IN} = 0 dBm, DC Control Current = 20 mA (unless otherwise noted)

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

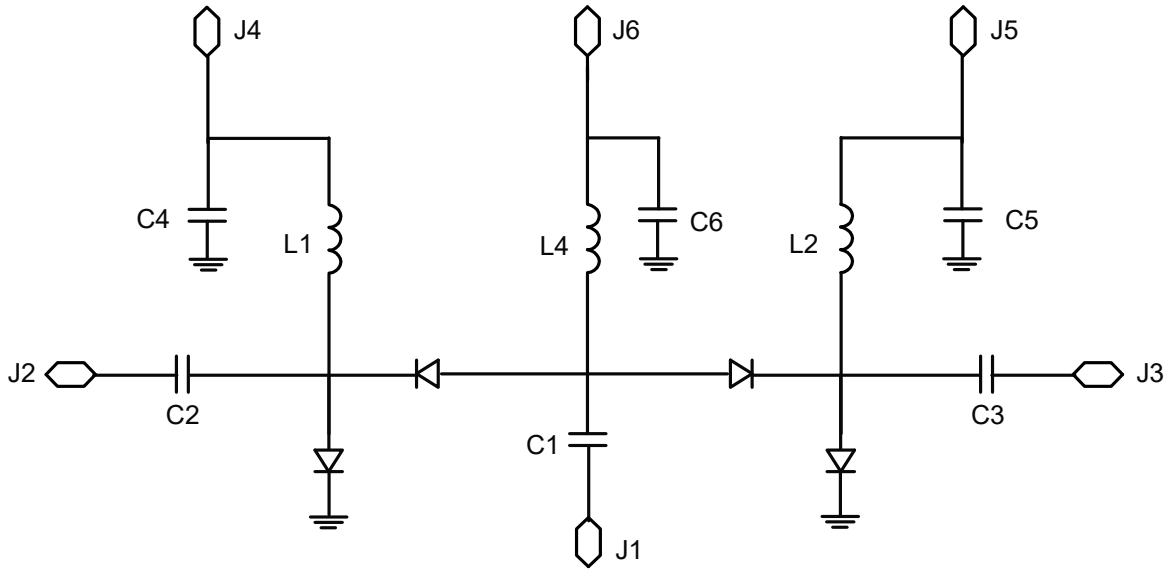
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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.

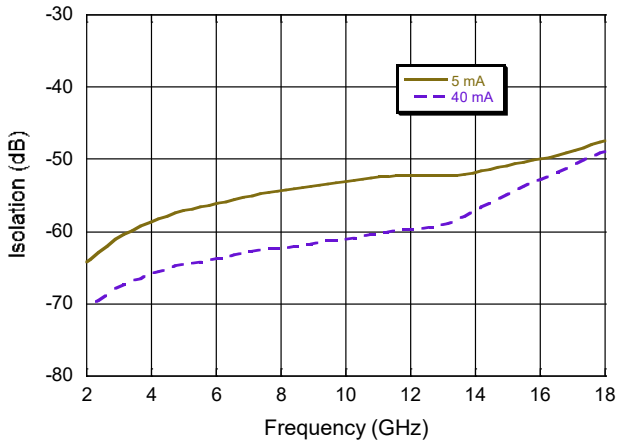
Circuit Schematic[7]



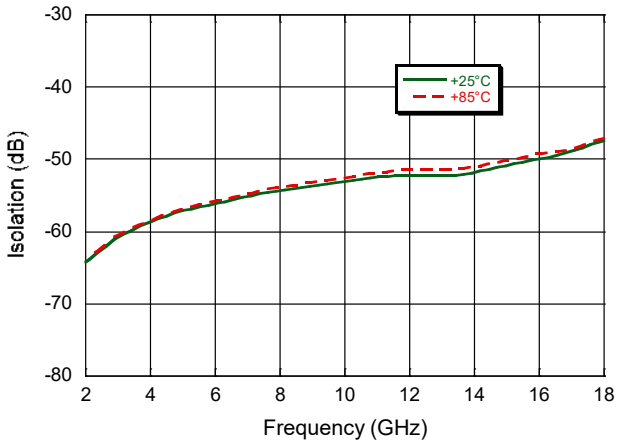
7. J6 junction is node for external bias resistor.

Typical Performance Curves

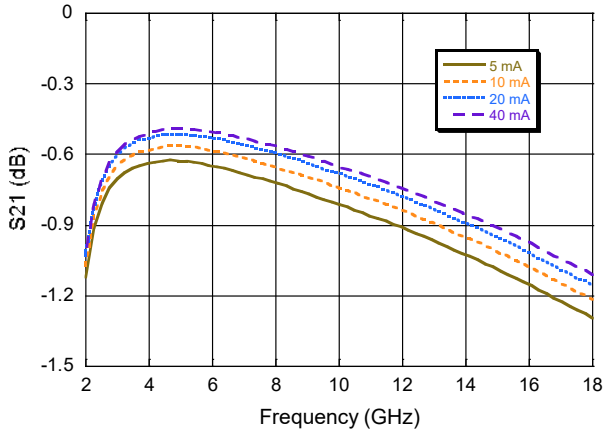
Isolation @ 5 V, +25°C



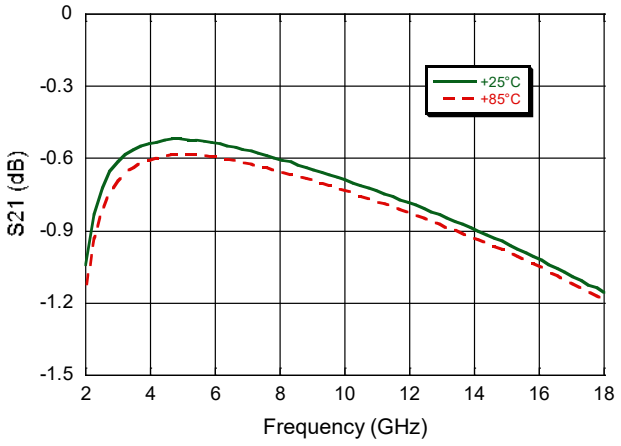
Isolation @ 5 V, 5 mA



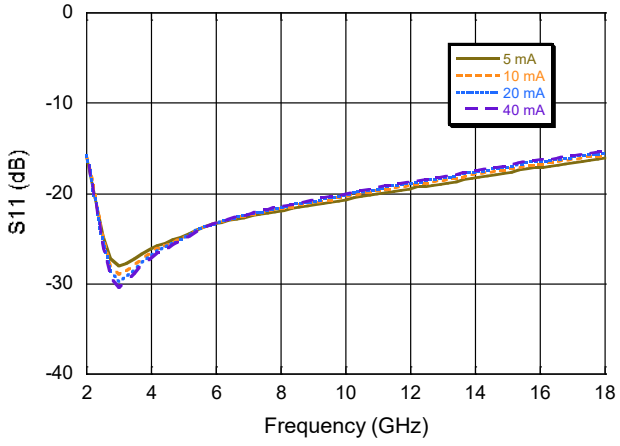
Insertion Loss @ 5 V, +25°C



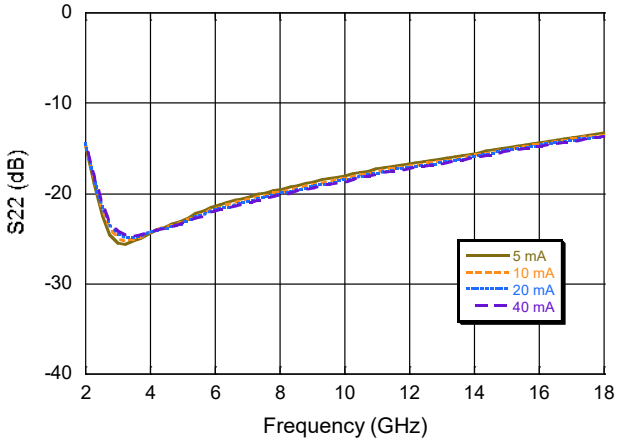
Insertion Loss @ 5 V, 20 mA



Input Return Loss @ 5 V, +25°C

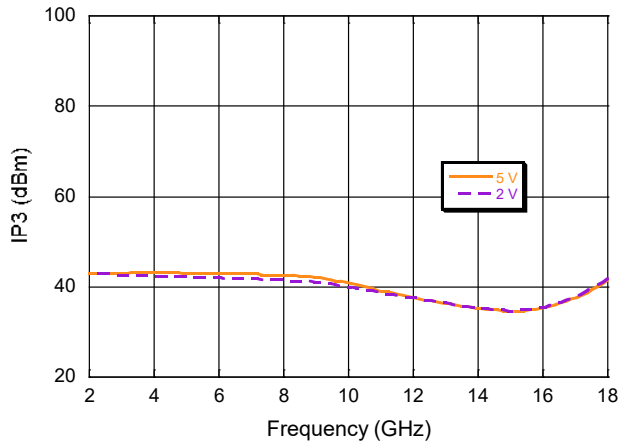


Output Return Loss @ 5 V, +25°C

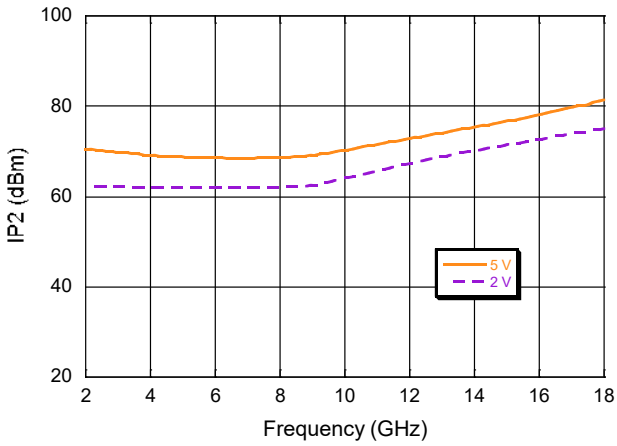


Typical Performance Curves

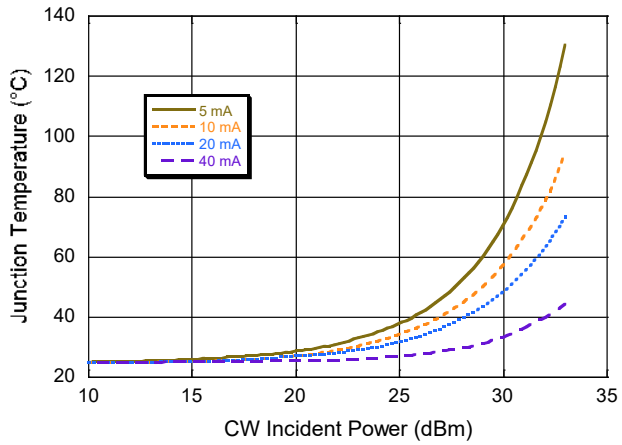
IP3



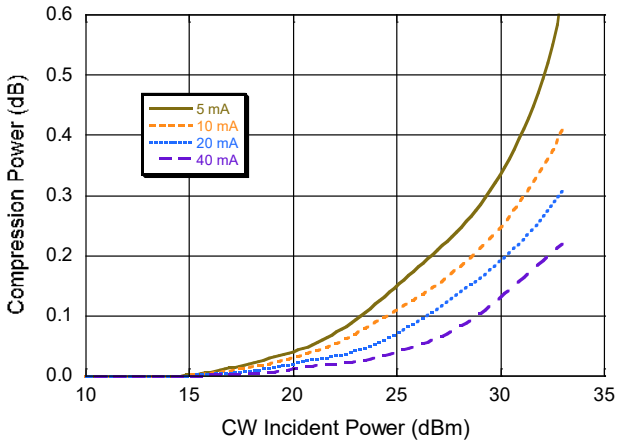
IP2



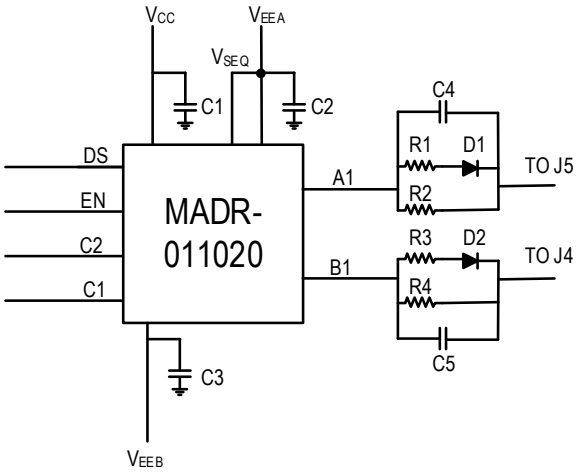
Junction Temperature

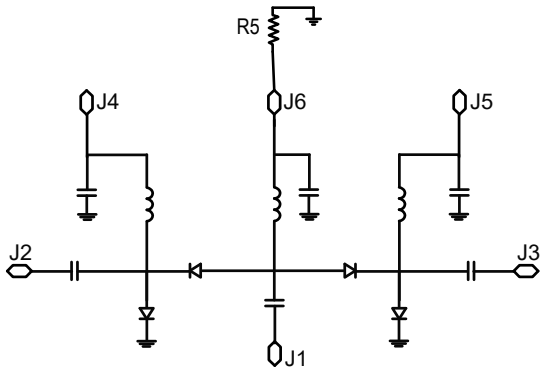


Compression Power



MASW-011052 with MADR-011020 Driver Application Schematic





Parts List[8]

Part	Value
C1, C3	0.1 µF
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 Voltage[9]

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.

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.

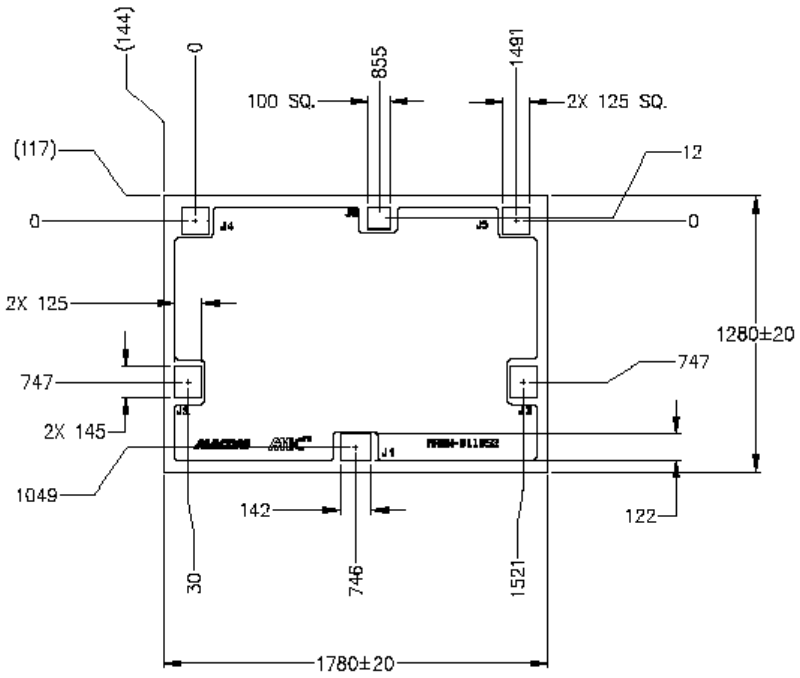
Eutectic Die Attachment

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 ±5 µm.
11. Die thickness is 125 ±10 µm.
12. Topside and backside metallization is gold, 2.5 µm thick typical.