HMIC Silicon PIN Diode SP3T Switch with Integrated Bias Network, 2 - 18 GHz

MASW-011053
Rev. V3

Features

- Broad Bandwidth Specified up to 18 GHz
- Usable up to 26 GHz
- Integrated Bias Network with External Bias Resistors
- Low Insertion Loss / High Isolation
- Fully Monolithic
- Glass Encapsulate Construction
- RoHS* Compliant

Applications

- Aerospace & Defense
- EW
- ISM
- Radar
- Test & Measurement

Description

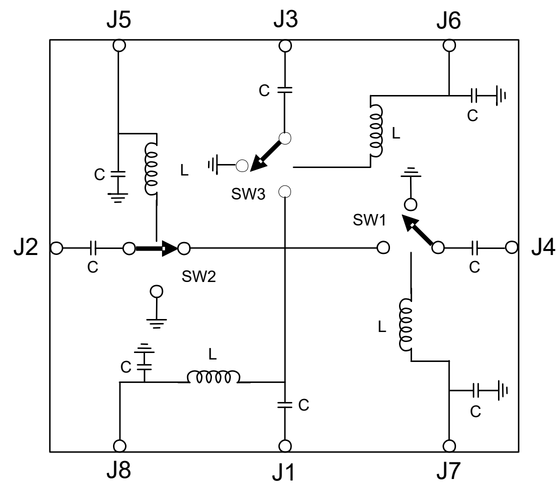
The MASW-011053 device is a SP3T broad band switch with integrated bias networks utilizing MACOM's patented HMIC (Heterolithic Microwave Integrated Circuit) process. This process allows the incorporation of silicon pedestals that form series and shunt diodes or vias by imbedding them in low loss, low 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-011053-47300G	Die in Gel Pack
MASW-011053-47300W	Die in Waffle Pack

1. Die quantity varies.

Functional Diagram



Pin Configuration[2]

Pin	Function
J1	Antenna
J2	RF_{IN}
J3	RF_{IN}
J4	RF_{IN}
J5	Bias of J2
J6	Bias of J3
J7	Bias of J4
J8	Bias of Antenna

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

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

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	—	1.0 0.6 0.8 1.1	2.0 1.1 1.3 1.9
Input to Output Isolation	2 GHz 6 GHz 12 GHz 18 GHz	dB	54 47 40 36	62 55 50 47	—
Input Return Loss	2 GHz 6 GHz 12 GHz 18 GHz	dB	—	14 15 16 14	—
Input/Output IP3 @ 5 dBm	2 GHz 6 GHz 12 GHz 18 GHz	dBm	—	46.0 48.8 50.8 45.0	—
Input/Output IP2 @ 5 dBm	2 GHz 6 GHz 12 GHz 18 GHz	dBm	—	66.3 66.8 66.0 68.3	—
Switching Speed[3]	—	ns	—	50	—

3. Typical switching speed measured from 10% to 90% of detected RF signal driven by TTL compatible drivers using RC output spiking network, R = 50 – 200 Ω , C = 390 – 560 pF.

Nominal Operating Conditions

Parameter	Value
Forward Bias Current	20 mA
Reverse Bias Voltage	12 V
RF Incident Power	31 dBm CW
Junction Temperature	+175°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

Absolute Maximum Ratings[4,5]

Parameter	Absolute Maximum
Forward Bias Current	60 mA
Reverse Bias Voltage (RF & DC)	50 V
RF Incident Power	33 dBm CW
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.

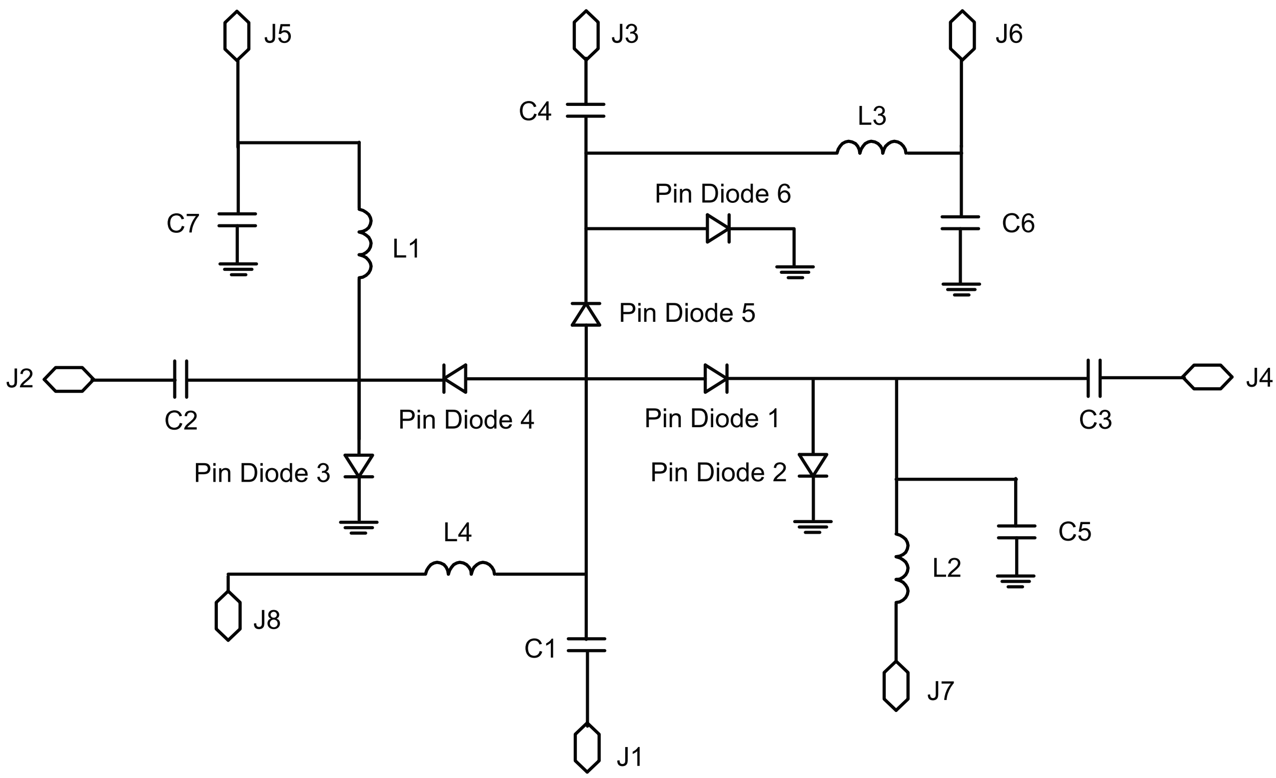
Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

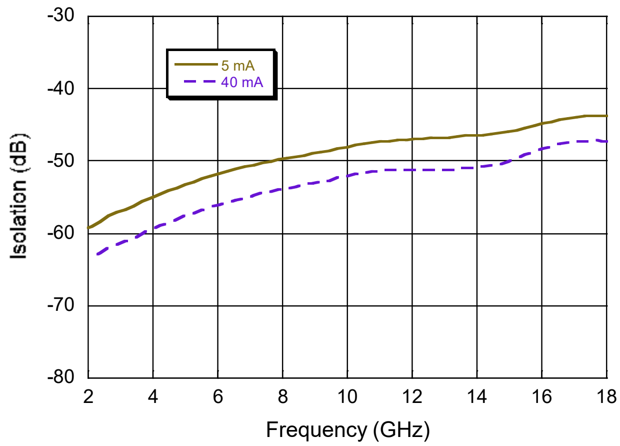
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

Circuit Schematic

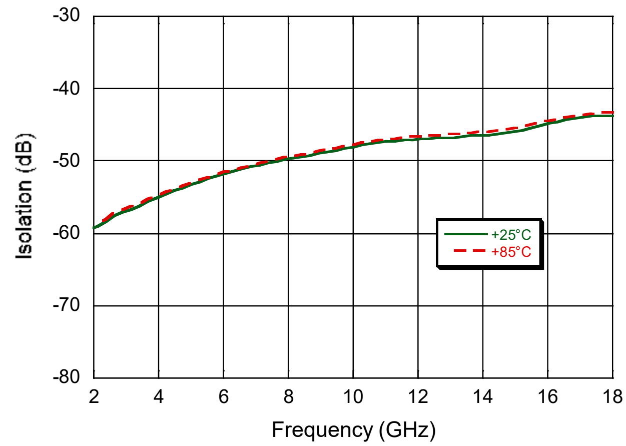


Typical Performance Curves

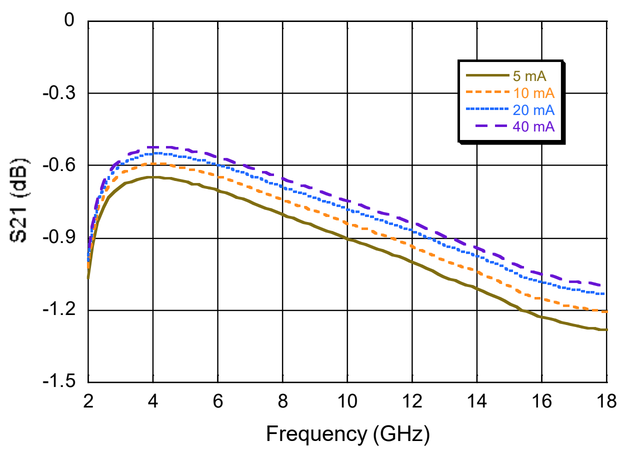
Isolation @ 5 V, +25°C



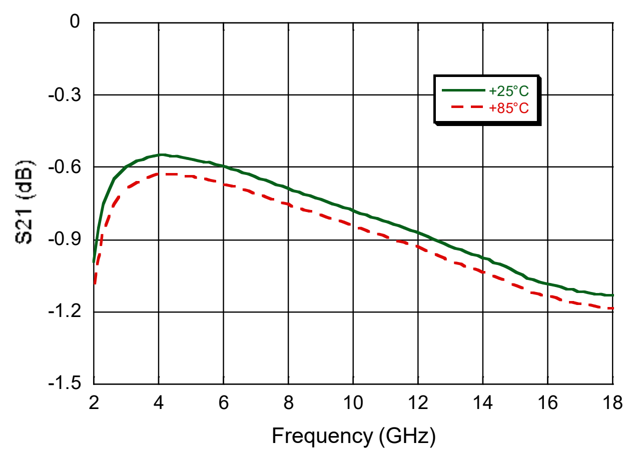
Isolation @ 5 V, 5 mA



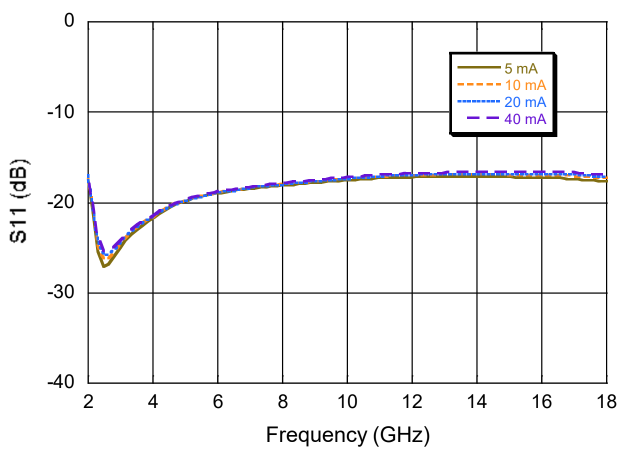
Insertion Loss @ 5 V, +25°C



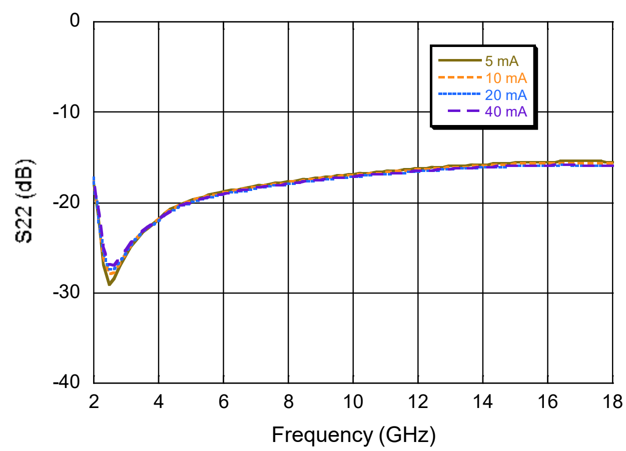
Insertion Loss @ 5 V, 20 mA



Input Return Loss @ 5 V, +25°C

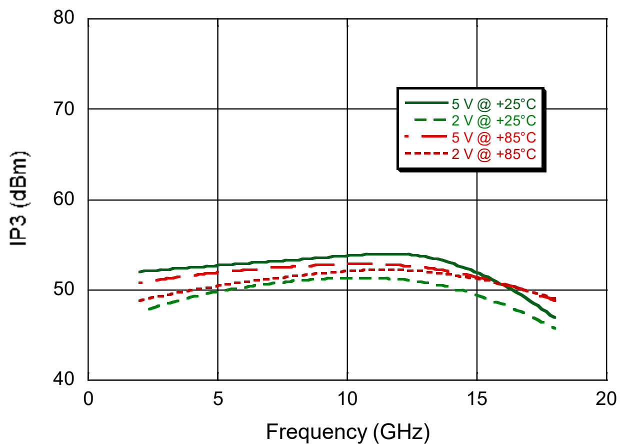


Output Return Loss @ 5 V, +25°C

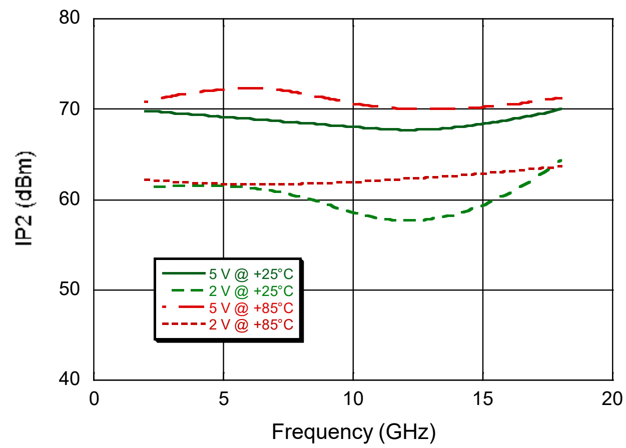


Typical Performance Curves @ T_A = 25°C

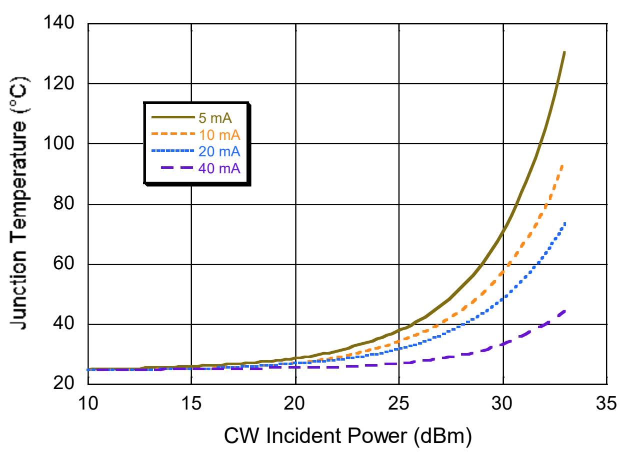
IP3



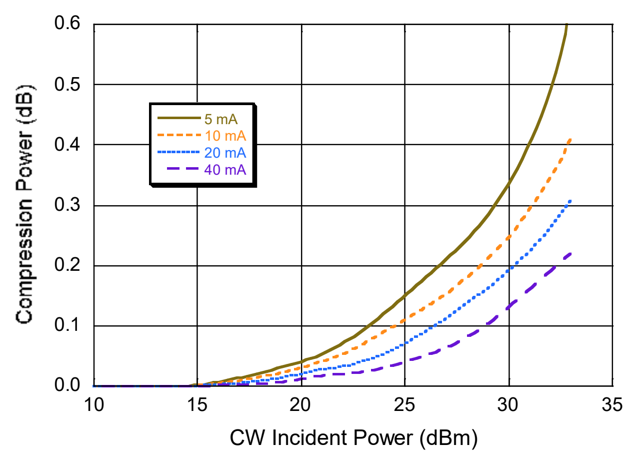
IP2



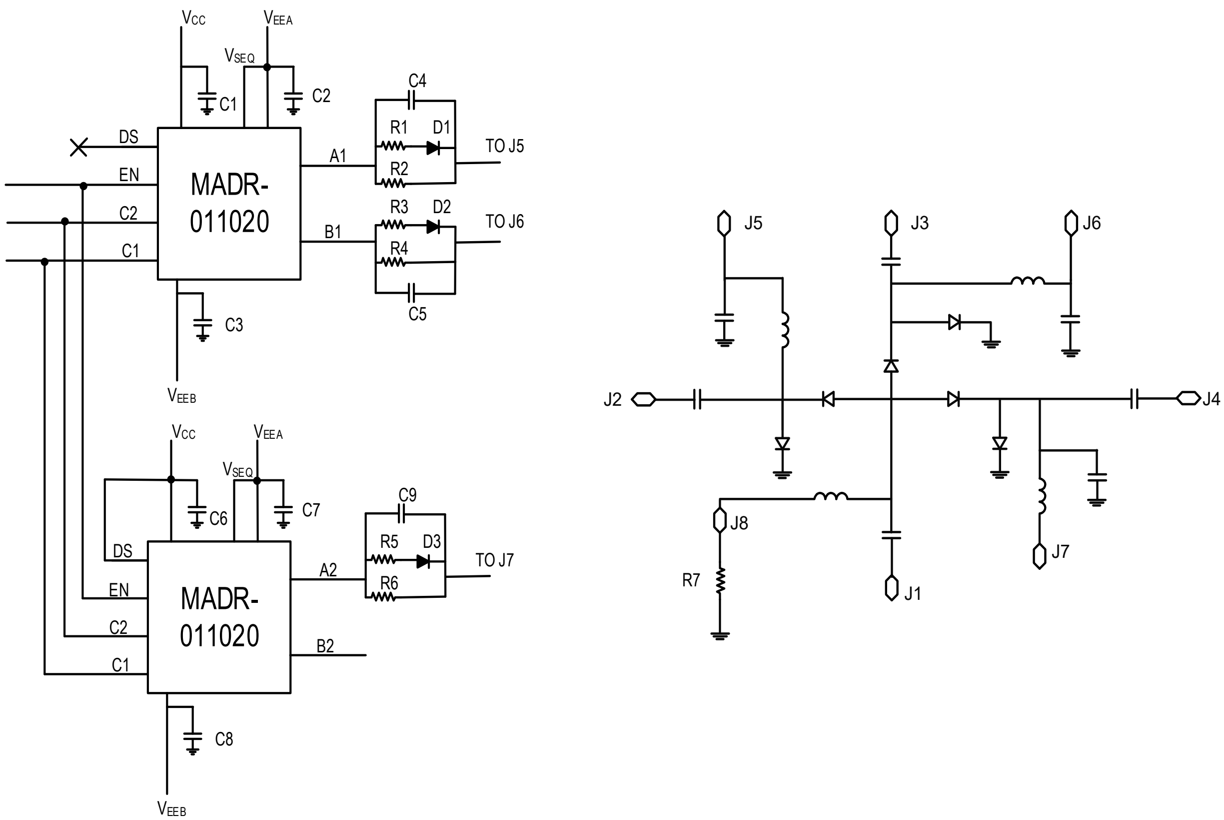
Junction Temperature



Compression Power



MASW-011053 with MADR-011020 Driver Application Schematic



Parts List[6]

Part	Value
C1, C3, C6, C8	0.1 µF
C2, C7	47 pF
C4, C5, C9	470 pF
R1, R3, R5	270 Ω
R2, R4, R6	390 Ω
R7	560 Ω
D1 - D3	1N4148WS

6. 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[7]

Frequency (GHz)	DC Voltage (V) J5, J6 & J7
2	-12
5	-7
10	-5
15	-5
18	-5

7. 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.

Truth and Bias Table using MADR-011020 Driver[8]

Two drivers are needed to drive a SP3T or SP4T switch. The DS pin of the first driver can be left open due to the internal active pull-down. Connect the DS pin of the second driver to V_{CC}. The combined truth table is below:

EN	C1	C2	A1	B1	A2	B2	J5	J6	J7	J1-J2	J1-J3	J1-J3
1	X	X	H	H	H	H	+20 mA	+20 mA	+20 mA	Isolation	Isolation	Isolation
0	0	0	L	H	H	H	-20 mA	+20 mA	+20 mA	Low Loss	Isolation	Isolation
0	0	1	H	L	H	H	+20 mA	-20 mA	+20 mA	Isolation	Low Loss	Isolation
0	1	0	H	H	L	H	+20 mA	+20 mA	-20 mA	Isolation	Isolation	Low Loss

8. The forward diode voltage drop between:
J8 to J5, J6 or J7 is 1.0 V typical.
J5, J6 or J7 to GND is 0.9 V typical.

Wire/Ribbon and Die Attachment Recommendations

Wire 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.

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.

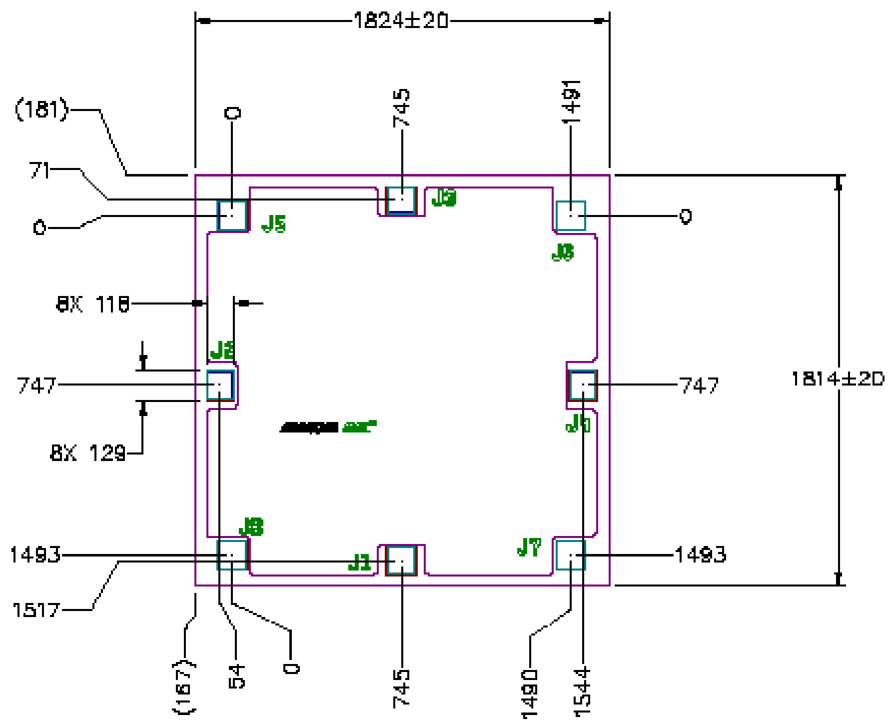
Eutectic Die Attachment:

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 3 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[9,10,11]



9. Unless otherwise specified, all dimensions shown as µm, with tolerance ±5 µm.
10. Die thickness is 125 ±10 µm.
11. Topside and backside metallization is gold, 2.5 µm thick typical.