AlGaAs SP4T Reflective PIN Diode Switch
14 - 38 GHz

MASW-011087-DIE
Rev. V4

Features

- Low Loss: 0.9 dB, 16 to 35 GHz
- High Isolation: 32 dB, 16 to 35 GHz
- 30 dBm CW Power Handling @ +85°C
- Switching Speed <34 ns
- Integrated DC Blocks and RF Bias Networks
- Die with G-S-G RF Pads and DC Bias Pads
- RoHS* Compliant

Applications

- Test Equipment
- Radiometers
- Switching Arrays of Radar Systems
- Point-to-Point Communications
- Multi-Assembly Components

Description

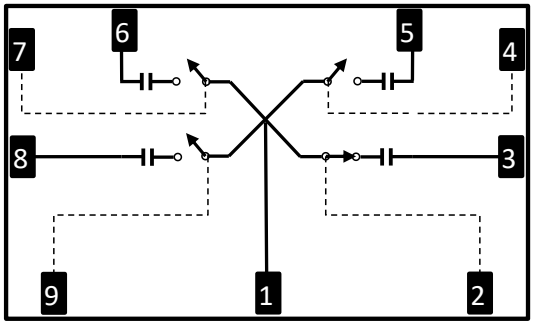
The MASW-011087 is a high power, symmetrical SP4T switch. This broadband, reflective switch was developed for Ka-Band applications that require up to 30 dBm (1 W) power handling while maintaining low insertion loss, high isolation, and fast switching speed. These switches are used in switching arrays of radars systems, radiometers, test equipment, Point-to-Point communications systems and other high frequency applications.

The SP4T MMIC utilizes MACOM's proven AlGaAs PIN diode technology. The switch is fully passivated with silicon nitride and has an added polymer layer for scratch protection. The protective coating prevents damage to the junction and the air-bridges during handling and assembly. The die has backside metallization to facilitate an epoxy die attach process.

Ordering Information

Part Number	Package
MASW-011087-DIE	Die in Waffle Tray
MASW-011087-SMB	Sample Board

Functional Schematic



Pin Configuration
(Backside metal is RF, DC, and thermal ground.)

Pin #	Function
1	RF_{COMMON}
2	B1 (Bias 1)
3	RF1
4	B2 (Bias 2)
5	RF2
6	RF3
7	B3 (Bias 3)
8	RF4
9	B4 (Bias 4)

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

Electrical Specifications: T_A = 25°C, V_R = -10 V, I_{SH} = +5 mA , I_{SE} = +5 mA, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss (RF_{COMMON} to RF_X ON state)	20.0 GHz 28.5 GHz 35.0 GHz	dB	—	0.8 0.8 0.9	— 1.1 —
Isolation (RF_{COMMON} to RF_X OFF state)	20.0 GHz 28.5 GHz 35.0 GHz	dB	— 30 —	40 34 31	—
Return Loss (RF_{COMMON})	20.0 GHz 28.5 GHz 35.0 GHz	dB	—	18 22 18	—
Return Loss (RF_X ON state)	20.0 GHz 28.5 GHz 35.0 GHz	dB	—	18 22 20	—
CW Power Handling (ON state)	28.5 GHz	dBm	—	30	—
Switching Speed T_{RISE} / T_{FALL}	10% - 90% RF, 26.5 GHz	ns	—	10 / 18	—
Switching Speed T_{ON} / T_{OFF}	50% control to 90% RF, 26.5 GHz	ns	—	26 / 34	—
IIP3	27 - 32 GHz, P_{IN} = 10 dBm, Tone Spacing 10 MHz	dBm	—	43	—
P 0.1dB	29.5 GHz	dBm	—	31	—

Absolute Maximum Ratings @ +85°C[1,2,3]

Parameter	Absolute Maximum
Incident Power (ON path)	30 dBm
I_{SE}	20 mA
I_{SH}	20 mA
V_R	-50 V
Junction Temperature	+150°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +150°C

1. Exceeding any one or combination of these limits may cause permanent damage to this device.
2. MACOM does not recommend sustained operation near these survivability limits.
3. Operating at nominal conditions with junction temperature less than 150°C will ensure MTTF >10^6 hours.

Maximum Operation Ratings @ +25°C

Parameter	Maximum
Incident Power (ON path)	30 dBm
I_{SE}	10 mA
I_{SH}	10 mA
V_R	-50 V

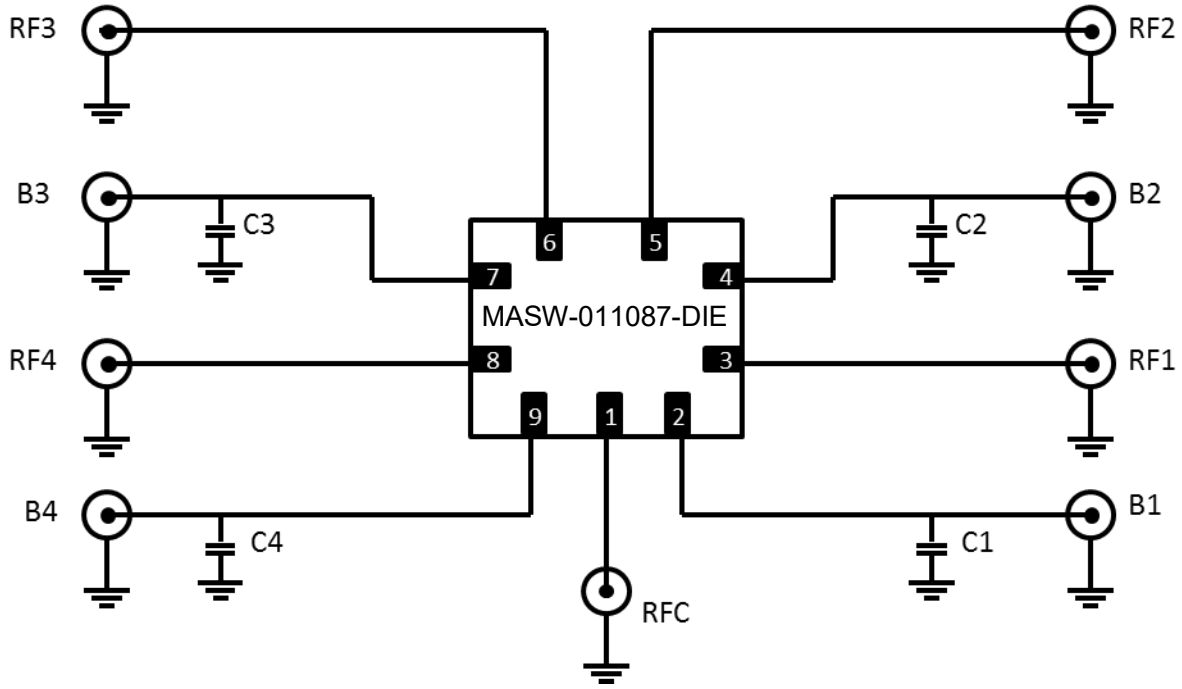
Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM class 1A devices.

Recommended Board Schematic



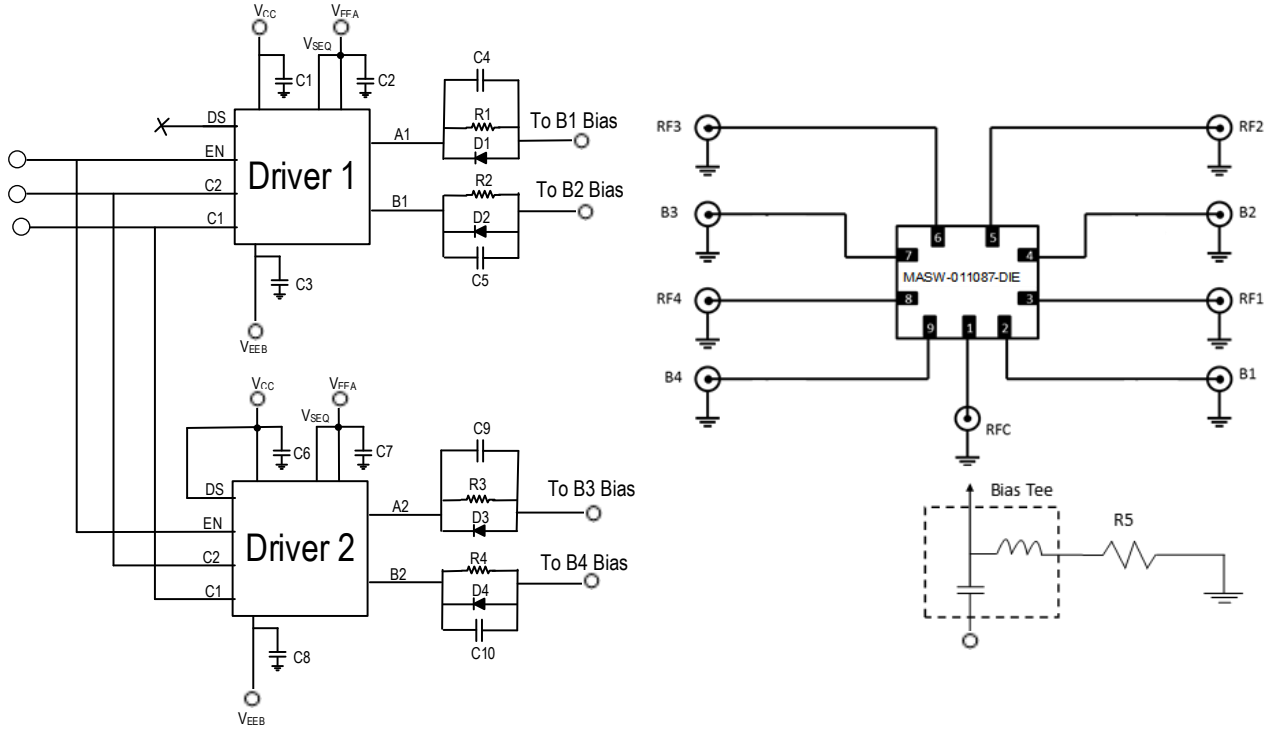
Recommended Board Component List

Component Designator	Description	P/N
RFC, RF1, RF2, RF3, RF4	2.4 mm - Southwest Microwave connector	1492-04A-5
B1, B2, B3, B4	Johnson/Emerson RF connector Or SSMA - Southwest Microwave connector	142-0761-821 292-06A
C1, C2, C3, C4	22 pF High Frequency Capacitor	ATC600L220

Truth Table

State	B1	B2	B3	B4
RF_{COMMON} to RF1 ON	-10 V (-5 mA)	+5 mA	+5 mA	+5 mA
RF_{COMMON} to RF2 ON	+5 mA	-10 V (-5 mA)	+5 mA	+5 mA
RF_{COMMON} to RF3 ON	+5 mA	+5 mA	-10 V (-5 mA)	+5 mA
RF_{COMMON} to RF4 ON	+5 mA	+5 mA	+5 mA	-10 V (-5 mA)

MADR-011022 Driver with MASW-011087 Switch Application Schematic



Parts List

Part	Value
C1,C3,C6,C8	0.1 µF
C2,C7	47 pF
C4,C5,C9,C10	470 pF
R1 - R4	650 Ω
R5	1.2 KΩ
D1 - D4	1N4148WS

To calculate off-chip bias resistors:

$R5 = (| V_{EEB} | - 2.64\ V - 0.7\ V - 0.4\ V) / I_{SE})$
$R1 - 4 = (V_{CC} - 1.32\ V - 0.4\ V) / (I_{SH})$

For example, with V_{CC} = +5 V and V_{EEB} = -10 V:

R5 = (10 V - 2.64 V - 1.1 V) / 0.005 A = 1.25 kΩ
R1 - R4 = (5 V - 1.32 V - 0.4 V) / (0.005 A) = 656 Ω

Voltage drop of D1 - D4 is 0.7 V and voltage drop at driver output is 0.4 V.

Switch Minimum Reverse DC Voltage[4]

Frequency (GHz)	Minimum Reverse DC Voltage at B1 - B4
14	-6.5
20	-5
25	-4
30	-4
35	-4
38	-4

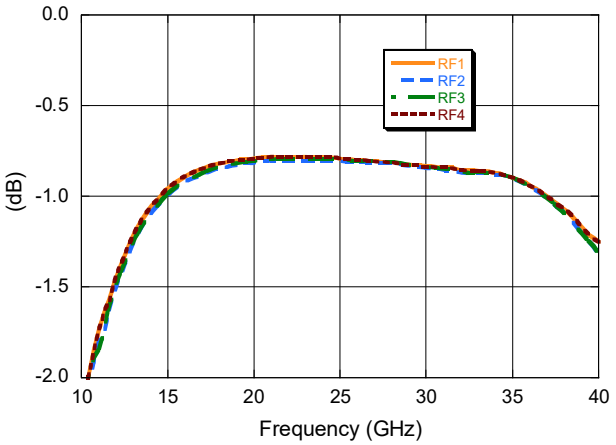
4. Calculated minimum reverse bias voltage to maintain low loss under 1 W of incident power with 1.5:1 VSWR. R. Caverly and G. Hiller, "Establishing the Minimum Reverse Bias for a P-I-N Diode in a High Power Switch," IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.

MADR-011022 Driver with Switch Logic Table

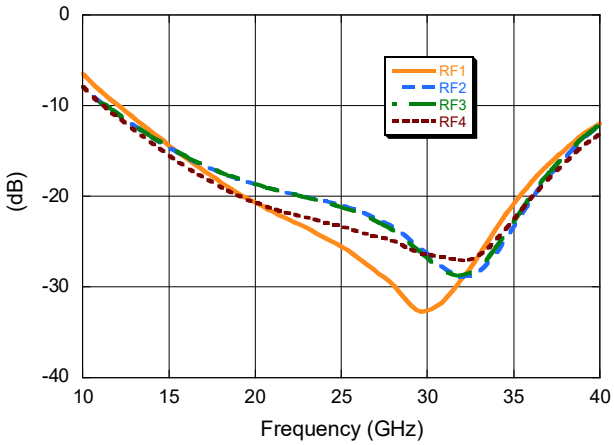
Inputs			Outputs				RF OUTPUT
EN	C2	C1	A1	B1	A2	B2	
1	X	X	H	H	H	H	ALL OFF
0	0	0	L	H	H	H	RF1 - ON
0	0	1	H	L	H	H	RF2 - ON
0	1	0	H	H	L	H	RF3 - ON
0	1	1	H	H	H	L	RF4 - ON

Typical Performance Curves

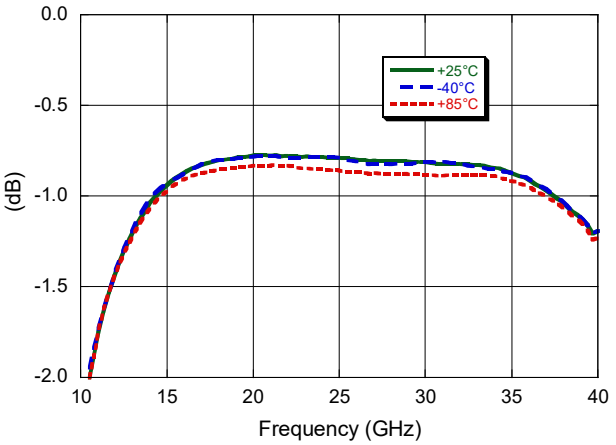
Insertion Loss



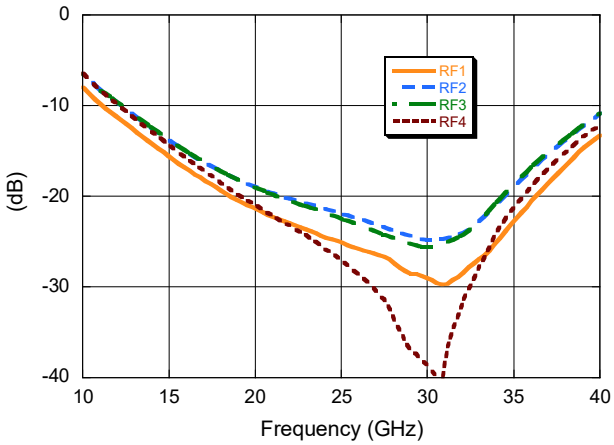
RF 1, 2, 3, 4 Return Loss in On State



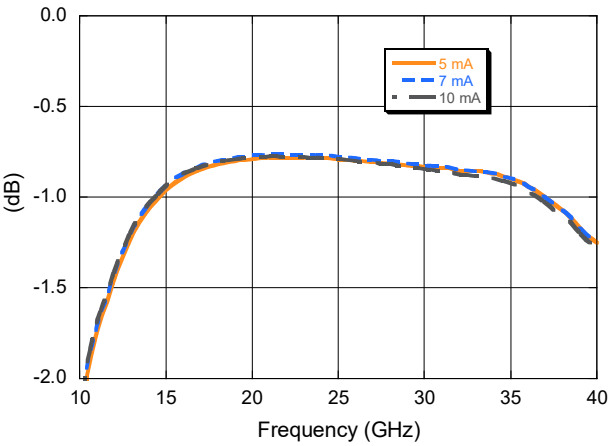
Insertion Loss over Temperature



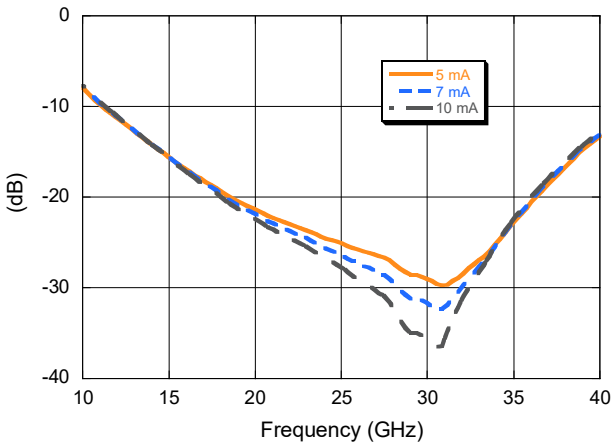
RF_{COMMON} Return Loss in ON State



Insertion Loss over Bias Current

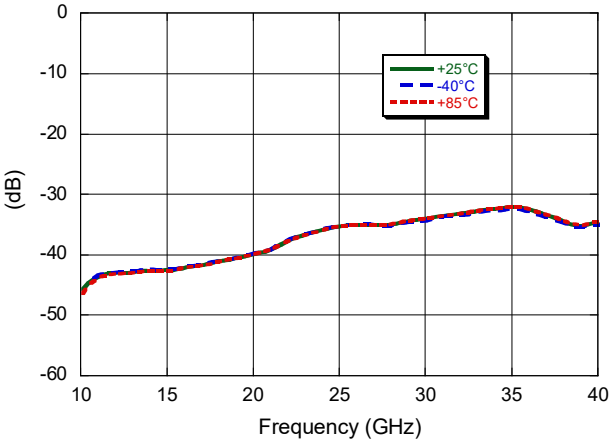


RF_{COMMON} Return Loss in ON State over Bias Current

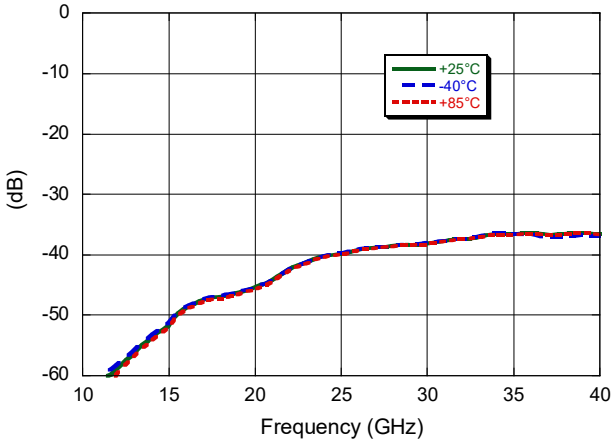


Typical Performance Curves

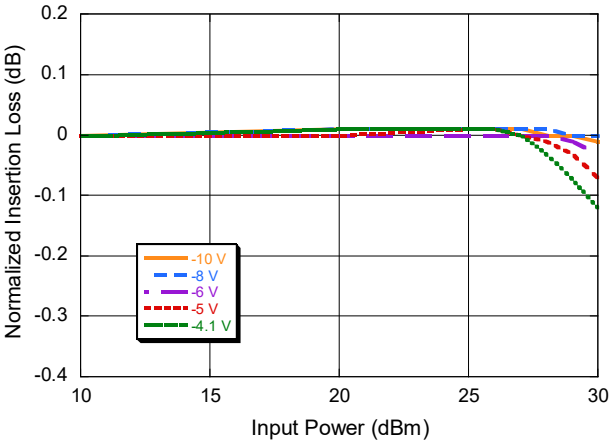
Isolation RF_{COMMON} to RF2, RF3 over Temperature



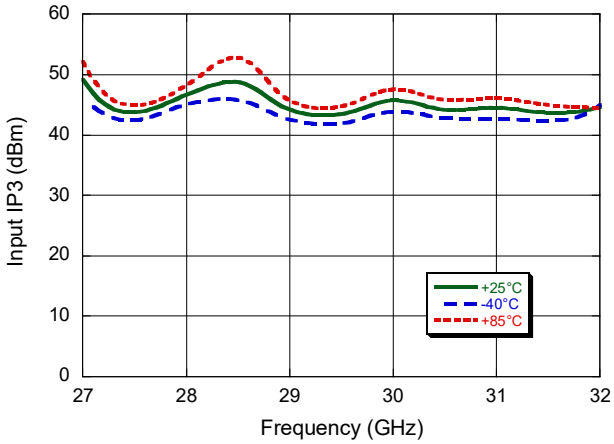
Isolation RF_{COMMON} to RF1, RF4 over Temperature



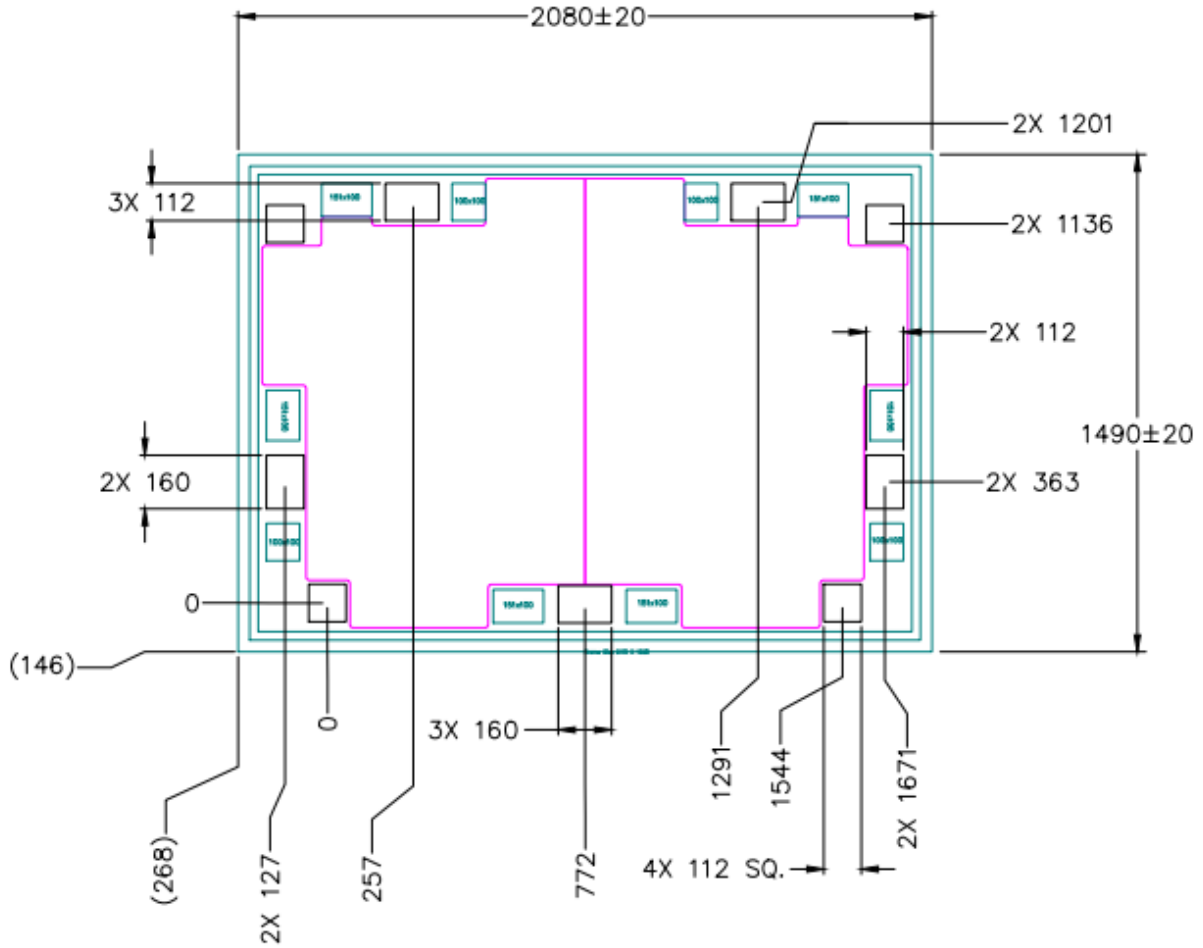
Compression over Reverse-Bias Voltage @ 29.5 GHz



IIP3 over Temperature @ 5 V / 5 mA



Outline Drawing



NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS SHOWN AS um WITH A TOLERANCE OF ±5um.
2. DIE THICKNESS IS 100 ±12.5um