# AlGaAs SP2T PIN Diode Switch with integrated bias circuits Wideband, 80 - 100 GHz

**MASW-011111-DIE**
**Rev. V2**

## Features

- 80 - 100 GHz Broadband Operating Frequency
- 0.8 dB Insertion Loss
- 25 dB Isolation
- Silicon Nitride Passivation
- BCB Scratch Protection
- Lead-Free AlGaAs MMIC Die
- Die Size: 1.33 x 1.055 x 0.1 mm
- RoHS* Compliant

## Applications

- ISM / MM

## Description

The MASW-011111-DIE is a wideband SP2T switch manufactured using MACOM's patented AlGaAs PIN Diode MMIC process on a semi-insulating GaAs substrate. The device is fully passivated with silicon nitride and has an additional layer of BCB for scratch protection. This protective coating prevents damage to the circuit during automated or manual handling. These devices are suitable for pick and place insertion.

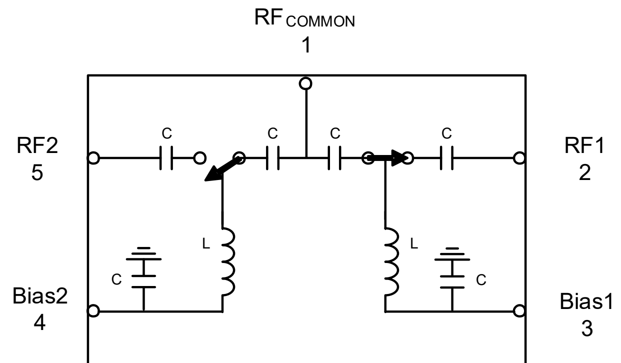
Each RF port contains DC blocking capacitors and a DC bias circuit consisting of high impedance lines and RF radial stubs. This device has gold plated bonding pads at all RF and DC ports. RF and DC ground backside gold plating allows conventional chip bonding techniques using 80Au/20Sn solder, Indalloy solder, or electrically conductive silver epoxy.

Applications include satellite communications, millimeter-wave radar, and 94 GHz imaging in astronomy, defense, and security applications.

## Ordering Information

| Part Number | Package |
|---|---|
| MASW-011111-DIE | Waffle Pak |

## Functional Schematic




## Pin Configuration[1]

| Pin # | Function |
|---|---|
| 1 | $RF_{COMMON}$ |
| 2 | RF1 |
| 3 | Bias1 |
| 4 | Bias2 |
| 5 | RF2 |

1. The die backside must be connected to RF, DC and thermal ground.

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



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## Electrical Specifications: $T_A$ = 25°C, +10 mA / -4.5 V, $Z_0$ = 50 Ω

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| Insertion Loss | 80 - 100 GHz | dB | — | 0.8 | — |
| Isolation | 80 - 100 GHz | dB | — | 25 | — |
| $RF_{COMMON}$ Return Loss | 80 - 100 GHz | dB | — | 16 | — |
| RF1, RF2 Return Loss | 80 - 100 GHz | dB | — | 20 | — |
| Forward Bias | 10 mA | V | — | 1.34 | — |
| Switching Speed | 10% - 90% RF Voltage | ns | — | 20 | — |

## Truth Table & Bias Conditions

| RF Inputs | Bias1 | Bias2 |
|---|---|---|
| $RF_{COMMON}$ to RF1 | -4.5 V[2] | 10 mA[3] |
| $RF_{COMMON}$ to RF2 | 10 mA[3] | -4.5 V[2] |

2. Minimum reverse bias voltage ($V_R$) should be determined based on working conditions. For example, $V_R$ = -4.5 V @ 23 dBm 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 PIN Diode in a High Power Switch,” IEEE Transactions on Microwave Theory and Techniques, Vol.38,No.12, December 1990. For higher linearity the $V_R$ may be increased to -25 V.
3. Forward bias current ($I_F$) is set using external bias resistors ($R_{BIAS}$) placed at pins Bias1 and Bias2, where $R_{BIAS}$ = ($V_{CC}$ - 1.32 V) / $I_F$.

## Absolute Maximum Ratings[4,5]

| Parameter | Absolute Maximum |
|---|---|
| Input Power | 30 dBm |
| Forward Bias Current | 15 mA |
| Reverse Bias Voltage | -50 V |
| Junction Temperature[6] | +150°C |
| Operating Temperature | -55°C to +85°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.
6. Operating at nominal conditions with $T_J \leq$ +150°C will ensure MTBF > 1 x $10^6$ hours.

## 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 HBM Class 0 devices.



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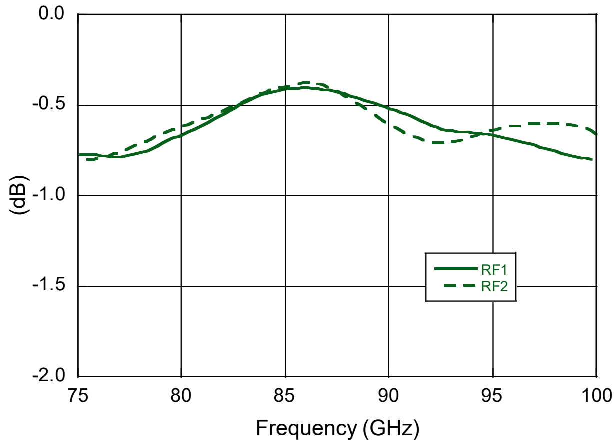
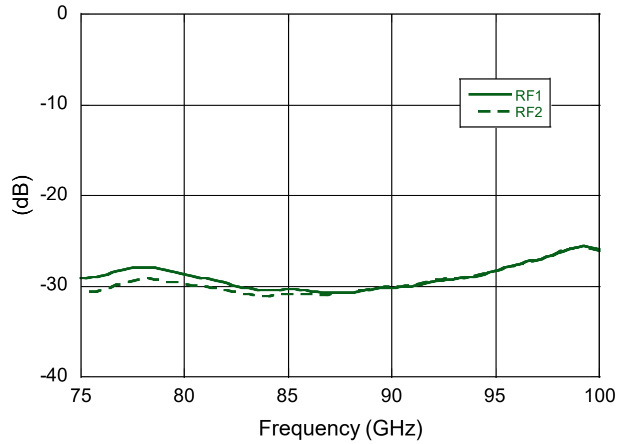
## Typical Performance Curves

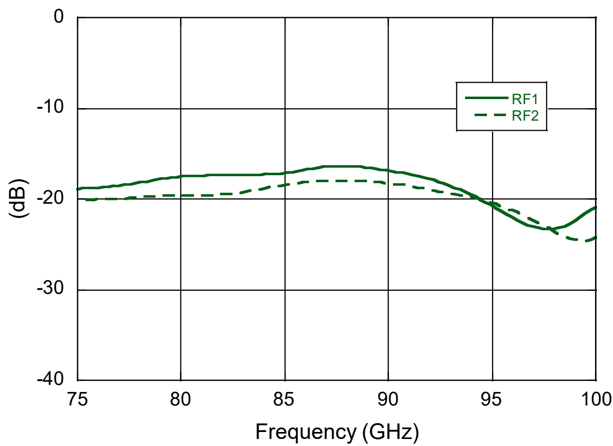
*Insertion Loss $RF_{COMMON}$ to RFx*



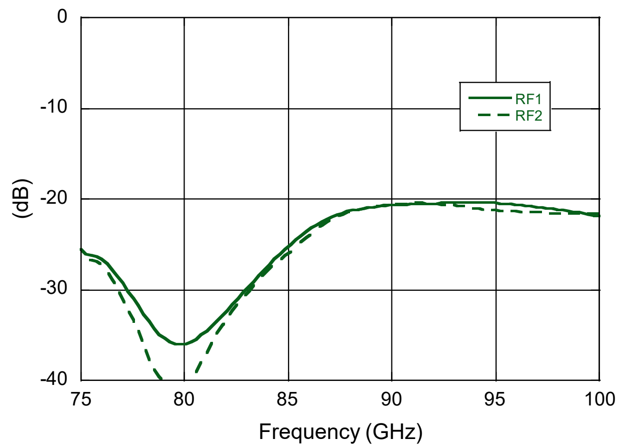

*Isolation $RF_{COMMON}$ to RFx*




*$RF_{COMMON}$ Return Loss in ON State*




*RFx Return Loss in On State*



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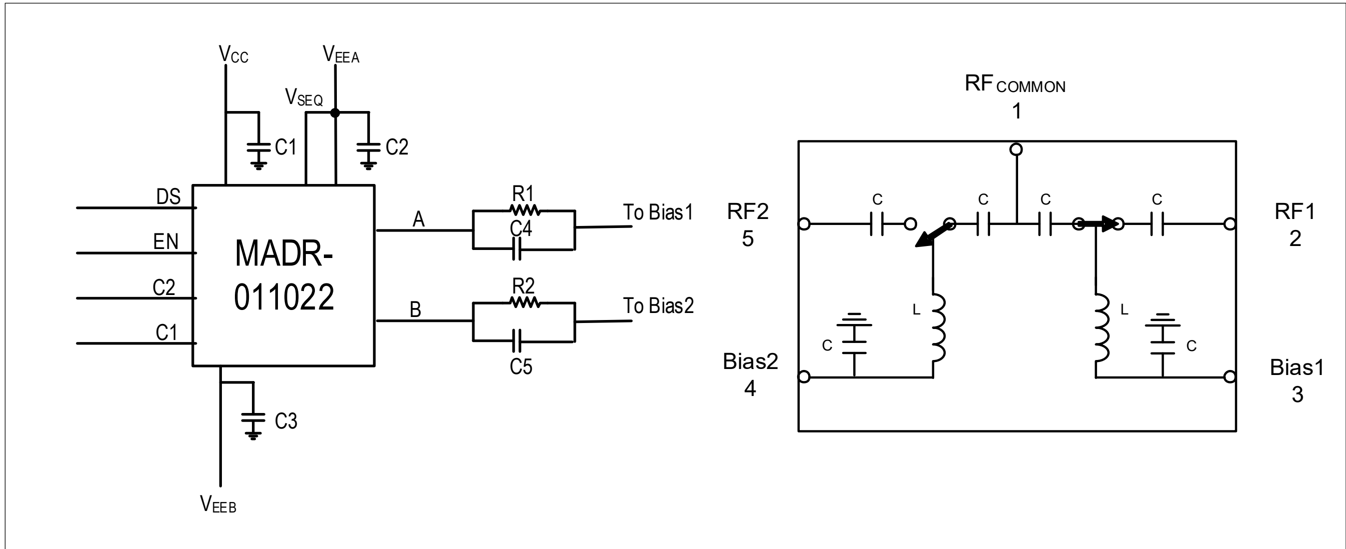
## MASW-011111-DIE with MADR-011022 Driver Application Schematic




## Parts List[7]

| Part | Value |
|---|---|
| C1,C3 | 0.1 µF |
| C2 | 47 pF |
| C4,C5 | 470 pF |
| R1,R2 | 360 Ω |

7. Resistor values calculated to provide ~10 mA of bias current given $V_{CC}$ = 5 V, $V_{EEB}$ = -10 to -25 V, voltage drop at driver output 0.4 V, Vf of switch diodes 1.32 V and $V_R$ at Bias1 and Bias2 equal to $V_{EEB}$ minus 0.4 V.



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## Solder Die Attach

All die attach and bonding methods should be compatible with gold metal. Solder which does not scavenge gold, such as 80 Au/20 Sn or Indalloy #2, is recommended. Do not expose die to a temperature greater than 300°C for more than 10 seconds.

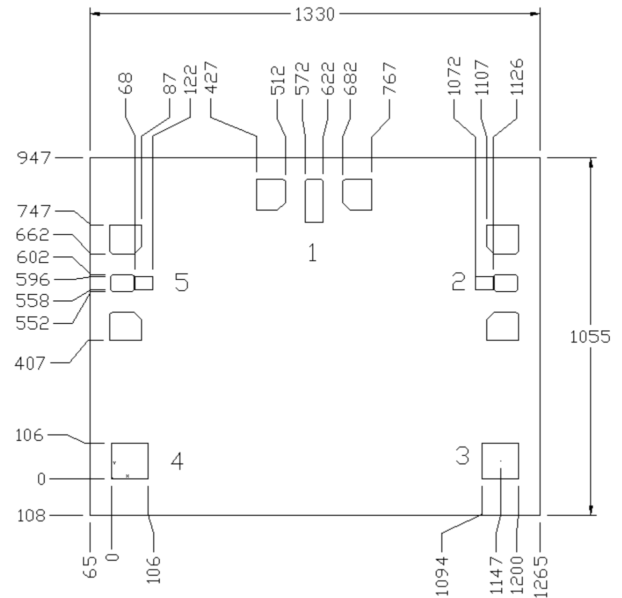
## Electrically Conductive Epoxy Die Attach

Assembly can be preheated to approximately 125°C. Use a controlled thickness of approximately 1 mils for best electrical conductivity and lower thermal resistance. A thin epoxy fillet should be visible around the perimeter of the chip after placement. Cure epoxy per manufacturer's schedule. For extended cure times, temperatures should be kept below 150°C.

## Wire / Ribbon Bonding

Wedge thermo compression bonding may be used to attach ribbons to the RF bonding pads. Gold ribbons should be at least 1/4 by 2 mil for lowest inductance. The same gold ribbon or 1 mil dia. gold wire is recommended for all DC pads.

## Outline Drawing




Dimensions are in µm.



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