Wideband, 75 - 100 GHz, AlGaAs SP3T PIN Diode Switch with Integrated Bias Circuits

MASW-011029
Rev. V4

Features

- 60 - 110 GHz Broadband Operating Frequency
- 1.3 dB Insertion Loss
- 33 dB Isolation
- Silicon Nitride Passivation
- BCB Scratch Protection
- Lead-Free GaAs MMIC Chip
- RoHS* Compliant

Applications

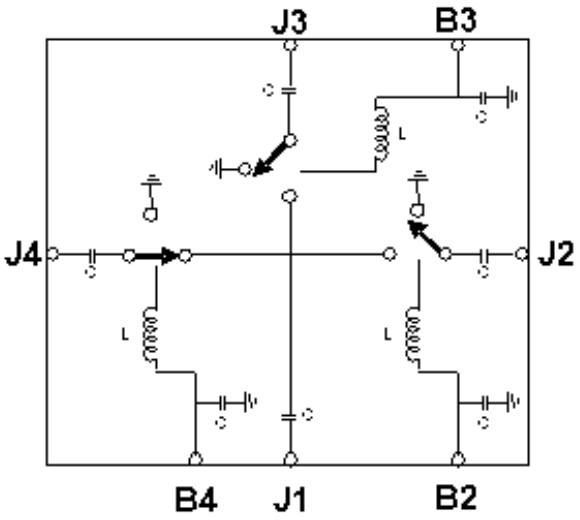
- SATCOM
- Millimeter-wave
- 77 GHz Automotive Cruise Control Radar
- 94 GHz Imaging in Astronomy, Defense, & Security

Description

The MASW-011029 is a wideband SP3T 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 bypass capacitors. This device has 100 um 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.

Functional Schematic



Bondpad Configuration[1,2]

Bondpad #	Function
J1	Common, RF1 (GSG)
J2	Output, RF2 (GSG)
B2	J2 Bias Control
J3	Output, RF3 (GSG)
B3	J3 Bias Control
J4	Output, RF4 (GSG)
B4	J4 Bias Control

1. Bondpad metal is gold and backside metal is gold.
2. The backside metal must be connected to RF and DC ground.

Ordering Information

Part Number	Package
MASW-011029-14140W	Waffle Pak

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

Electrical Specifications: Freq. = 75 - 100 GHz, T_A = 25°C, +10 mA / -25 V, Z_0 = 50 Ω

Parameter	Units	Min.	Typ.	Max.
Insertion Loss	dB	—	1.3	—
Isolation	dB	—	33	—
Forward Bias, 10 mA	V	1.15	—	1.40
Blocking Capacitor Leakage Current, -25 V	nA	—	—	50
Diode Leakage Current, -32 V	nA	—	—	50
Switching Speed, 10% - 90% RF Voltage	ns	—	2	—

Nominal Operating Conditions

Parameter	Value
Input Power	21 dBm
DC Current, per diode	10 mA
DC Voltage	-5 V
Junction Temperature[5]	+150°C
Operating Temperature	-25°C to +85°C
Storage Temperature	-65°C to +150°C

Absolute Maximum Ratings[3,4]

Parameter	Absolute Maximum
Input Power	23 dBm
DC Current, per diode	15 mA
DC Voltage	-25 V
Junction Temperature[5]	+150°C
Operating Temperature	-25°C to +85°C
Storage Temperature	-65°C to +150°C

3. Exceeding any one or combination of these limits may cause permanent damage to this device.
4. MACOM does not recommend sustained operation near these survivability limits.
5. Operating at nominal conditions with $T_J \leq$ +150°C will ensure MTBF > 1 x 106 hours.

Handling Procedures

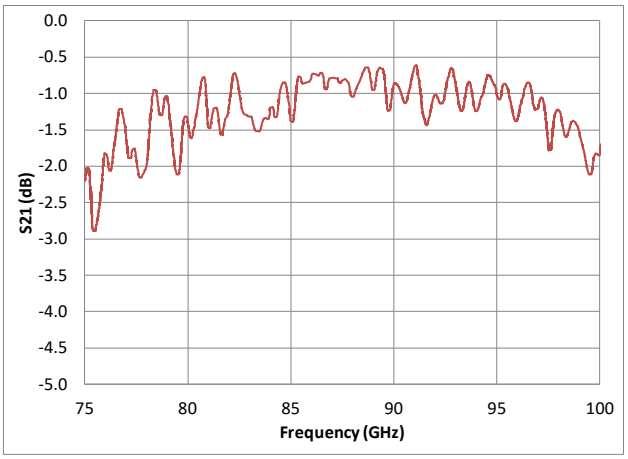
Please observe the following precautions to avoid damage:

Static Sensitivity

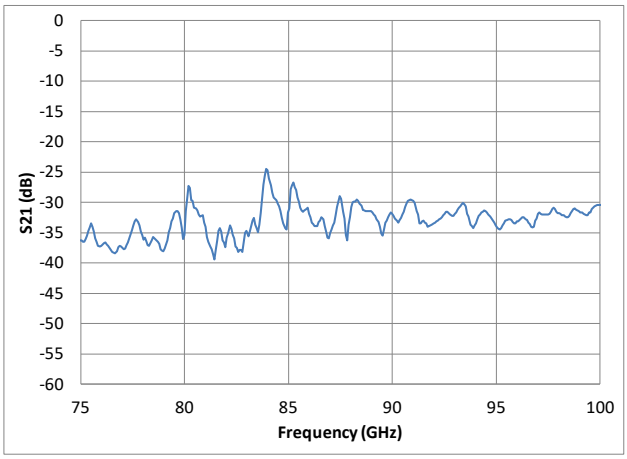
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

MASW-011029 Typical Performance Curves, 75 - 100 GHz[6]

Insertion Loss

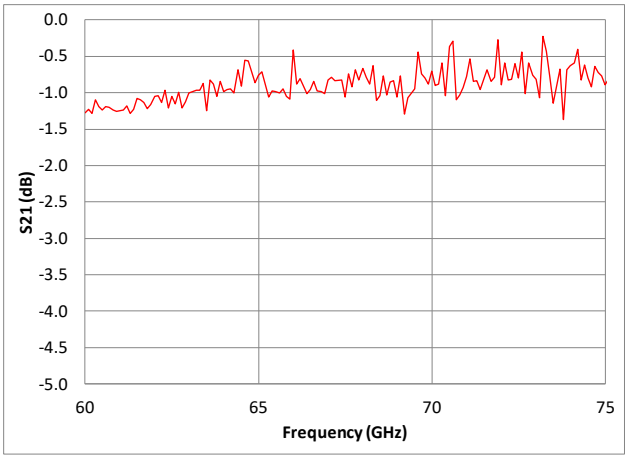


Isolation

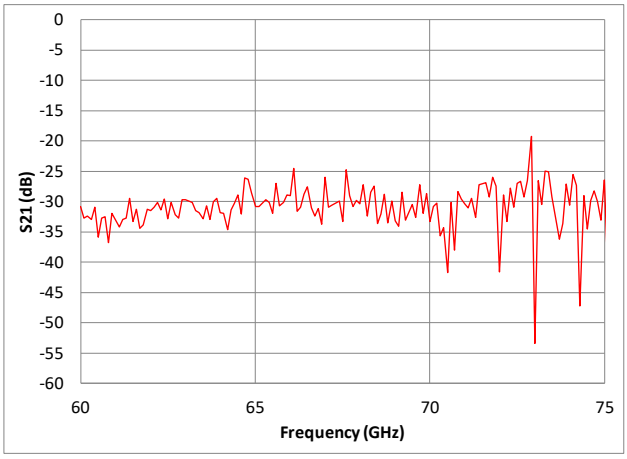


MA4GC6774 (Former Part Number) Reference Data, 60 - 75 GHz[6]

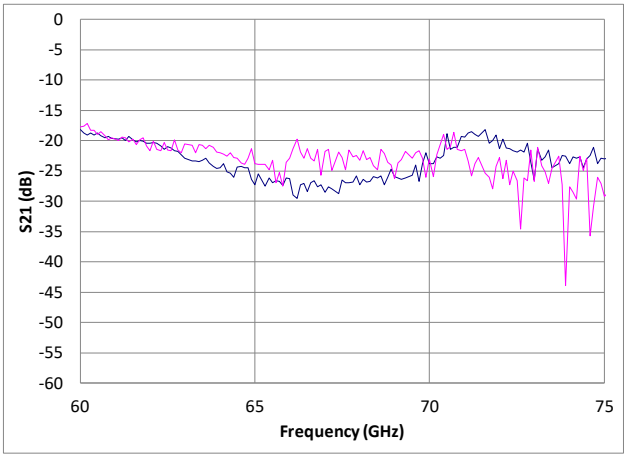
Insertion Loss



Isolation



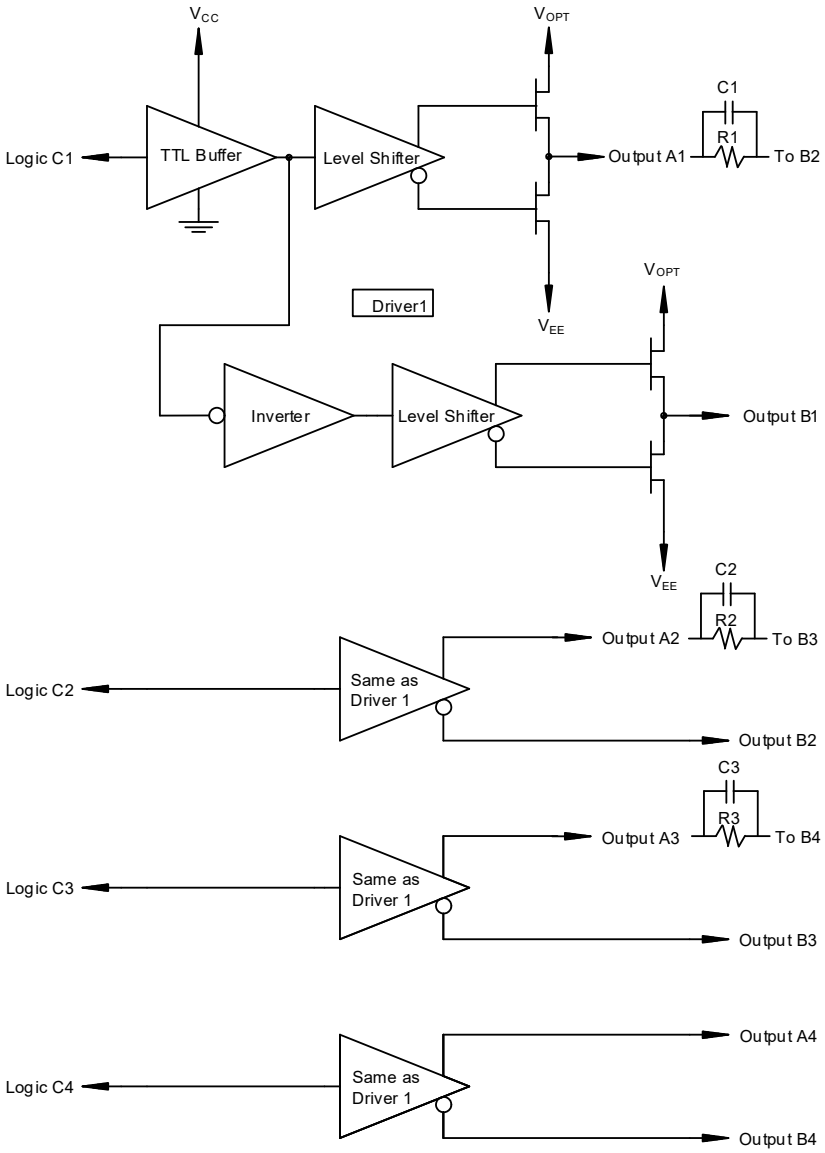
Return Loss, Input and Output



6. Measured data is highly dependent on fixturing and equipment setup.

Application Schematic with MADR-009190 Driver

Not shown in the schematic below, place 0.1 µF filter caps as close as possible to V_{CC}, V_{OPT} and V_{EE} pins. V_{CC} and V_{OPT} set to +5 V. V_{EE} set to -5 V.



Parts List

Part	Value
C1, C2, C3	470 pF
C4, C5, C6[7]	0.1 µF
R1, R2, R3	320 Ω

7. C4, C5 and C6 are the V_{CC}, V_{OPT} and V_{EE} filter capacitors and are not shown in schematic.

Truth Table and Bias Conditions with MADR-009190 Driver

RF Inputs	Driver C1	Driver C2	Driver C3	B2	B3	B4
J1 to J2 Isolation J1 to J3 Isolation J1 to J4 Isolation	1	1	1	10 mA[9]	10 mA[9]	10 mA[9]
J1 to J2 Insertion Loss J1 to J3 Isolation J1 to J4 Isolation	0	1	1	-5 V[8]	10 mA[9]	10 mA[9]
J1 to J2 Isolation J1 to J3 Insertion Loss J1 to J4 Isolation	1	0	1	10 mA[9]	-5 V[8]	10 mA[9]
J1 to J2 Isolation J1 to J3 Isolation J1 to J4 Insertion Loss	1	1	0	10 mA[9]	10 mA[9]	-5 V[7]

8. Minimum reverse bias voltage (V_R) should be determined based on working conditions. For example, V_R = -5 V @ 23 dBm input power. For lower 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 it may be as high as -25 V.
9. Forward bias current (I_F) is set using external bias resistors (R_{BIAS}) placed at pins B2, B3, and B4, where R_{BIAS} = ((V_{CC} - 1.32 V) / I_F - 50). 50 Ω is the approximate impedance of the MADR-009190 driver P-channel and N-channel FET's.

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 2 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 1/4 by 3 mil sq. for lowest inductance. The same 1/4 by 3 mil sq. gold ribbon or 1 mil dia. gold wire is recommended for all DC pads.

Outline Drawing