

# AlGaAs SP4T PIN Diode Switch

## MA4AGSW4

### Features

- Ultra Broad Bandwidth: 50 MHz to 50 GHz
- Functional bandwidth : 50 MHz to 70 GHz
- 1.0 dB Insertion Loss, 32 dB Isolation at 50 GHz
- Low Current consumption:
  - 10 mA for Low Loss State
  - +10 mA for Isolation
- M/A-COM's unique patent pending AlGaAs hetero-junction anode technology
- Silicon Nitride Passivation
- Polyimide Scratch protection

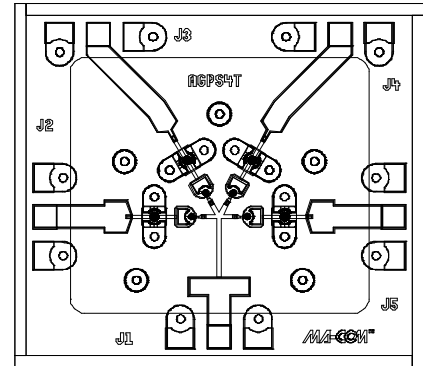
### Description

M/A-COM's MA4AGSW4 is an Aluminum-Gallium-Arsenide anode enhanced, SP4T PIN diode switch. AlGaAs anodes, which utilize M/A-COM's patent pending hetero-junction technology, which produce less loss than conventional GaAs processes, as much as 0.3 dB reduction in insertion loss at 50 GHz. These devices are fabricated on a OMCVD epitaxial wafer using a process designed for high device uniformity and extremely low parasitics. The diodes themselves exhibit low series resistance, low capacitance, and fast switching speed. They are fully passivated with silicon nitride and have an additional layer of a polymer for scratch protection. The protective coating prevents damage to the junction and the anode airbridges during handling. Off-chip bias circuitry is required and allows maximum design flexibility.

### Applications

The low capacitance of the PIN diodes used makes it ideal for use in microwave multi-throw switch designs, where the series capacitance in each off-arm will load the input. Also, the low series resistance of the diodes helps the total insertion loss of the devices at microwave frequencies. These AlGaAs PIN switches are used as the switching arrays for radar systems, radiometers, and other multi-assembly components.

### MA4AGSW4 Layout



### Absolute Maximum Ratings<sup>1</sup>

@ TA = +25 °C (Unless otherwise specified)

Parameter	Maximum Rating
Operating Temperature	-55 °C to +125 °C
Storage Temperature	-65 °C to +150 °C
Incident C.W. RF Power	+ 23 dBm C. W.
Reverse Voltage	25 V
Bias Current	+/- 30 mA

1. Exceeding any of these values may result in permanent damage

### Nominal Chip Dimensions

Chip Dimensions (µm)		
	X	Y
Chip	1725	1530
Pad Dimensions (µm)		
	X	Y
RF	100	100
Pad Locations (µm)		
	X	Y
J1	0	0
J2	-736	+506
J3	-511	+1277
J4	-511	+1277
J5	+736	+506
Pad Locations Relative to J1		

## Electrical Specifications @ $T_A = 25\text{ }^\circ\text{C}$ , +/- 10 mA Bias Current (On-Wafer Measurements)

RF Specifications					
Parameters	Frequency	Minimum	Typical	Maximum	Units
Insertion Loss	0.05 - 18 GHz	-	0.7	0.8	dB
	18 - 50 GHz	-	1.0	1.4	
Isolation	0.05 - 18 GHz	25	41	-	dB
	18 - 50 GHz	25	32	-	
Input Return Loss	0.05 - 18 GHz	10	21	-	dB
	18 - 50 GHz	10	22	-	
Output Return Loss	0.05 - 18 GHz	10	26	-	dB
	18 - 50 GHz	10	17	-	
Switching Speed	10 GHz	-	20	-	ns

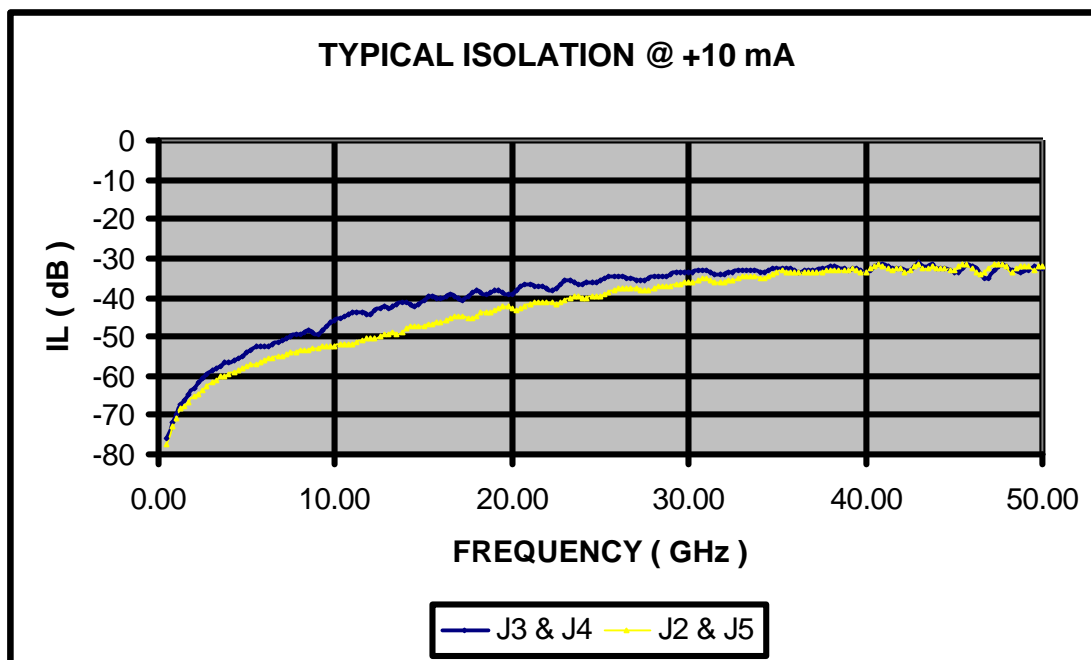
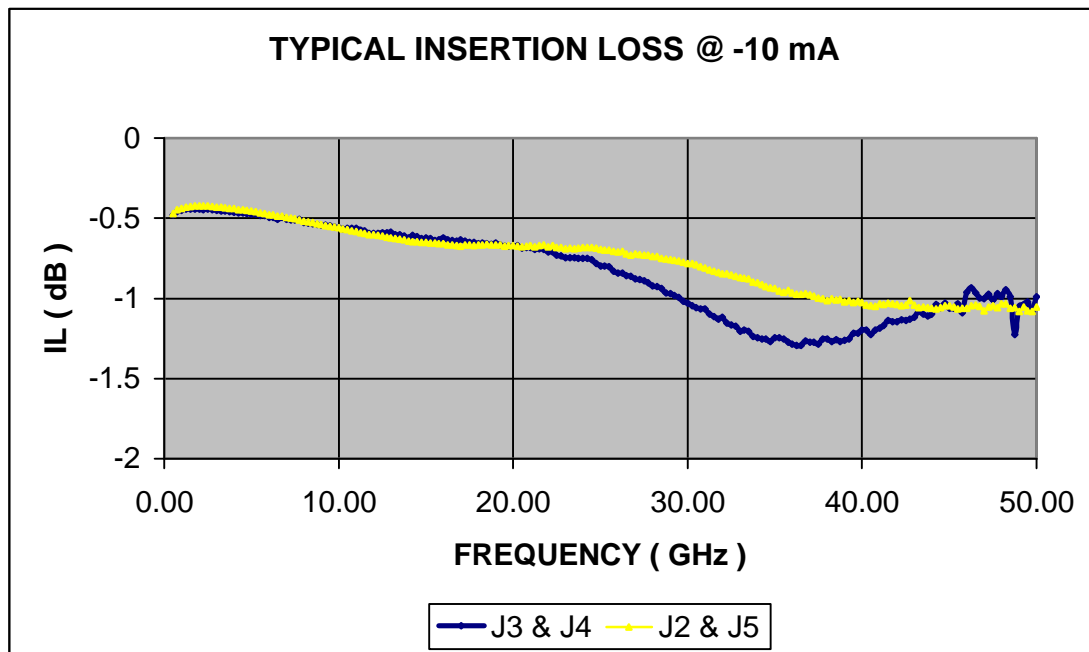
### NOTES:

1. Typical switching speed is measured from 10% to 90% of the detected RF voltage driven by a TTL compatible driver. Driver output parallel RC network uses a capacitor between 390 pF - 560 pF and a resistor between 150 - 220 Ohms to achieve 20 ns rise and fall times.

## Typical Driver Connections

Control Level (DC Current)				RF Output Conditions			
J2	J3	J4	J5	J2-J1	J3-J1	J4-J1	J5-J1
-10 mA	+10 mA	+10 mA	+10 mA	Low Loss	Isolation	Isolation	Isolation
+10 mA	-10 mA	+10 mA	+10 mA	Isolation	Low Loss	Isolation	Isolation
+10 mA	+10 mA	-10 mA	+10 mA	Isolation	Isolation	Low Loss	Isolation
+10 mA	+10 mA	+10 mA	-10 mA	Isolation	Isolation	Isolation	Low Loss

Microwave and Millimeter Wave Performance

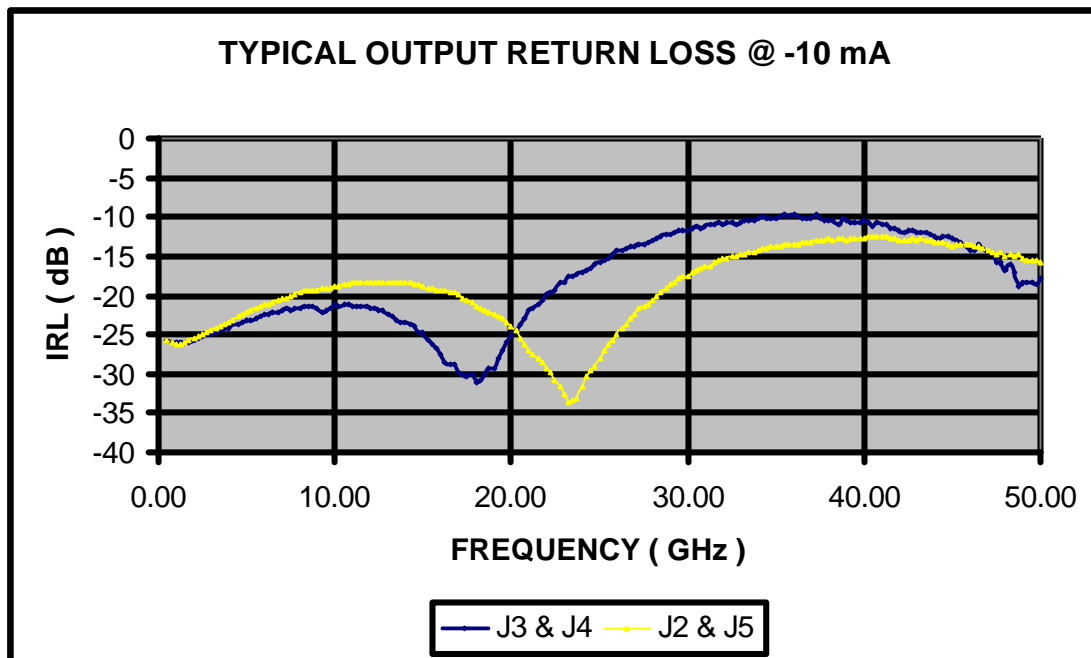
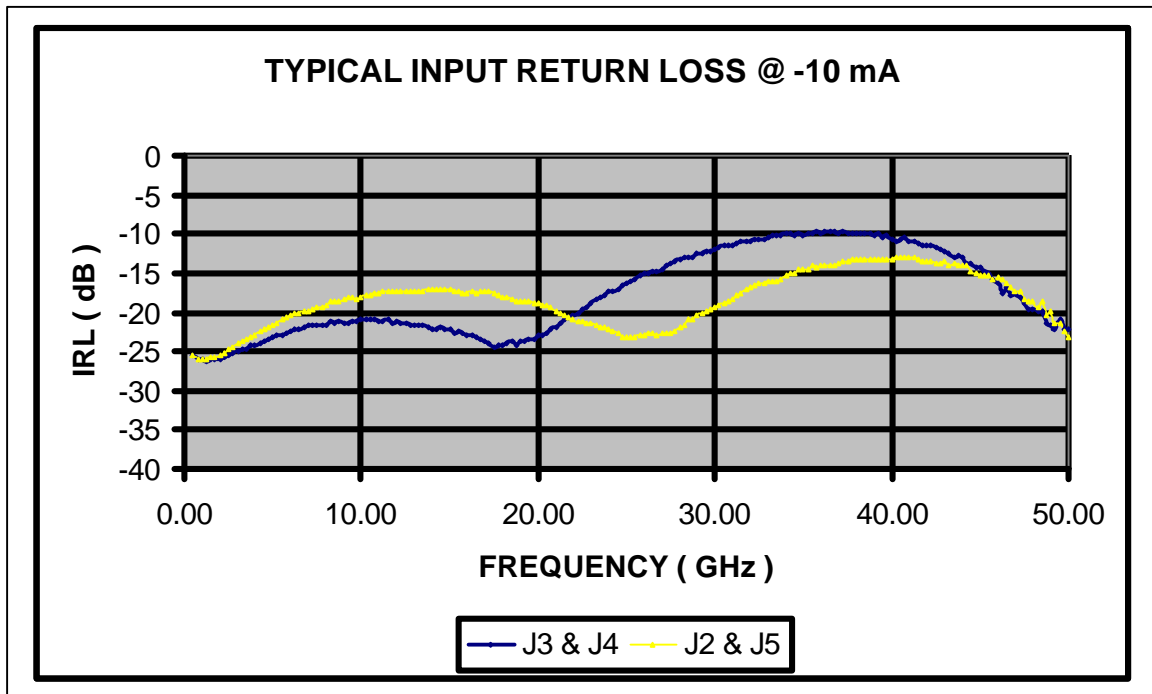


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Microwave and Millimeter Wave Performance (cont'd)



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## Assembly Considerations

The following precautions should be observed to avoid damaging these chips.

## Cleanliness

These chips should be handled in a clean environment. Do not attempt to clean die after installation.

## Electro-Static Sensitivity

These Devices are considered ESD Class1. Proper ESD techniques should be used when handling these devices.

## General Handling

The protective polymer coating on the active areas of these die provides scratch and impact protection, particularly for the metal airbridge which contacts the diode's anode. Die should primarily be handled with vacuum pickups, or alternatively with plastic tweezers.

## Mounting Techniques

These AlGaAs devices are designed to be mounted with electrically conductive silver epoxy or with a lower temperature solder perform, which is not rich in Sn content.

## Operation of the MA4AGSW4

The Simultaneous Application of Negative DC Current to the Low Loss Port and Positive DC current to the Remaining Isolated Ports achieves operation of the MA4AGSW Series of AlGaAs PIN Switches. The Backside Area of the Die is the RF and DC Return Ground Plane. The DC Return is achieved on Common Port J1. Constant Current Sources should supply the DC Control Currents. The Diode voltages at these Bias Nodes will not exceed  $\pm 1.6$  volts ( $\pm 1.4$  volts typical for Supply Currents up to  $\pm 30$  mA). In the Low Loss State, the Series Diode must be Forward Biased and the Shunt Diode Reverse Biased. For All the Isolated Ports, the Shunt Diode is Forward Biased and the Series Diode is Reverse Biased. The Bias Network Design should yield  $> 30$  dB RF to DC Isolation.

Best Insertion Loss, P1dB, IP3, and Switching Speed is Achieved by using a Voltage Pull-up Resistor in the DC Return Path, (J1). A Minimum Value of  $-2$  V is recommended at this Return Node, which is achievable with a Standard,  $\pm 5$  V TTL Controlled PIN Diode Driver.

## Solder Die Attachment

All die attach and bonding methods should be compatible with gold metal. Solder which does not scavenge gold, such as 80Au/20Sn or Sn62/Pb36/Ag2 is recommended. Do not expose die to a temperature greater than 300 °C for more than 10 seconds.

## Electrically Conductive Epoxy Die Attachment

Assembly can be preheated to approximately 125 °C. Use a controlled thickness of approximately 2 mils for best electrical and thermal conductivity. Cure epoxy as per manufacturer's schedule. For extended cure times, temperatures should be kept below 150 °C.

## Ribbon/Wire Bonding

Wedge thermocompression bonding or ball bonding may be used to attach ribbons or wires to the RF bonding pads. Gold ribbons should be 1/4 x 3 mil sq. for all RF ports for lowest inductance and best microwave performance.

MA4AGSW4 Schematic with 2-18 GHz Bias Network

