

SURMOUNT PIN Diode Switch Element with Thermal Terminal

V3

Features

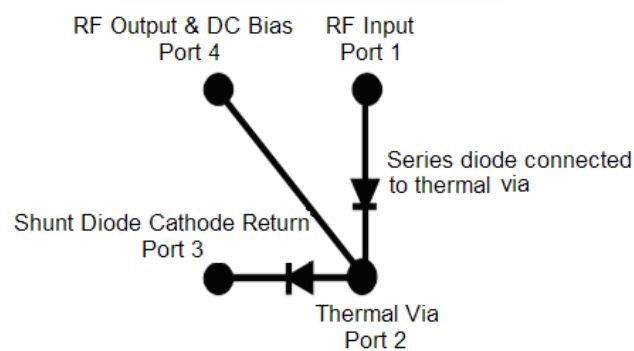
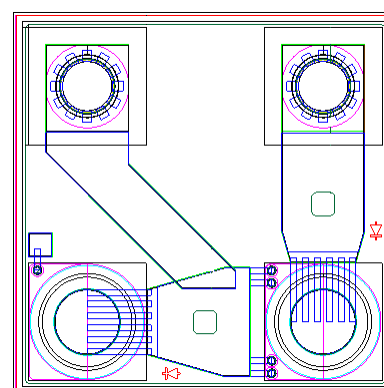
- ◆ Specified Bandwidth: 30MHz—2.5GHz
- ◆ Useable to 3.0GHz
- ◆ Low Loss <0.5dB
- ◆ High isolation >40dB
- ◆ High C.W. Incident Power, 50W at 500MHz
- ◆ Unique Thermal Terminal for Series Diode
- ◆ Surface Mount Device (No Wire Bonds)
- ◆ Rugged Silicon-Glass Construction
- ◆ Silicon Nitride Passivation
- ◆ Protective Polymer Scratch Protection
- ◆ RoHS Compliant

Description

This device is a PIN diode series-shunt switch element with a unique integrated thermal terminal for dissipating heat in the series diode created by the DC and RF input power. The thermal terminal allows for optimum heat dissipation by providing a direct thermal path from the series diode to circuit thermal ground while also being electrically isolated. The chip is designed to provide a heat transfer conduit that does not interfere with the PIN diode anode (input) and cathode (output) electrical terminals, especially with respect to RF performance. The silicon-glass PIN diode chip is fabricated using M/A-COM Technology Solutions patented HMIC™ process. This device features silicon pedestals embedded in a low loss, low dispersion glass. Selective backside metallization is applied producing a surface mount device. The topside is fully encapsulated with silicon nitride and has an additional polymer layer to protect against damage during handling and assembly.

Applications

This PIN diode series-shunt switch element is particularly advantageous in higher average power, 50W switch applications from 30MHz – 3000GHz. In addition, the backside RF, D.C., and thermal I/O ports allow for direct solder re-flow attachments to the micro-strip circuit for surface mount assembly. Of particular interest, is the thermal terminal which provides the power dissipating series diode a direct connection to the circuit thermal ground for unprecedented heat transfer. This thermal terminal is electrically isolated from the other I/O ports. The chip can be configured as either a reflective or an absorptive switch.



Ordering Information ²

Part Number	Package
MASW-001150-13160W	WAFFLE PACK
MASW-001150-13160P	POCKET TAPE

2. Reference Application Note M513 for reel size information.

Absolute Maximum Ratings

Parameter	Absolute Maximum
Forward Current	100mA
Reverse Voltage	- 180V
Operating Temperature	-55°C to +125°C
Storage Temperature	-55°C to +150°C
Junction Temperature	+175°C
Dissipated RF & DC Power	500MHz, 4W
RF C.W. Incident Power	500MHz, 50W
Mounting Temperature	+260°C for 30 seconds
ESD	Class 1A — HBM
ESD	Class M3 — MM
ESD	Class C3 — CDM

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PRELIMINARY: Data Sheets contain information regarding a product M/A-COM Technology Solutions has under development. Performance is based on engineering tests. Specifications are typical. Mechanical outline has been fixed. Engineering samples and/or test data may be available. Commitment to produce in volume is not guaranteed.

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Electrical Specifications @ $T_{AMB} = +25^{\circ}\text{C}$

Symbol	Parameter	Conditions	Units	Typical	Maximum
$C_{T \text{ Series}}$	Total Capacitance	-25V, 30MHz	pF	0.52	—
$C_{T \text{ Series}}$	Total Capacitance	-25V, 1800MHz	pF	0.37	—
$C_{T \text{ Shunt}}$	Total Capacitance	-25V, 30MHz	pF	0.54	—
$C_{T \text{ Shunt}}$	Total Capacitance	-25V, 1800MHz	pF	0.39	—
$R_{S \text{ Series}}$	Series Resistance	20mA, 30MHz	Ω	1.13	—
$R_{S \text{ Series}}$	Series Resistance	20mA, 1800MHz	Ω	1.25	—
$R_{S \text{ Series}}$	Series Resistance	50mA, 30MHz	Ω	0.93	—
$R_{S \text{ Series}}$	Series Resistance	50mA, 1800MHz	Ω	1.07	—
$R_{S \text{ Shunt}}$	Series Resistance	10mA, 30MHz	Ω	1.00	—
$R_{S \text{ Shunt}}$	Series Resistance	10mA, 1800MHz	Ω	0.99	—
V_F	Forward Voltage	20mA	V	0.82	0.85
V_F	Forward Voltage	50mA	V	0.88	0.90
I_R	Reverse Leakage Current	-180V	μA	—	-10.0
R_{qJL}	Thermal Resistance _{Series}	Steady State	$^{\circ}\text{C/W}$	36.0	—
T_L^{-1}	Minority Carrier Lifetime	I_F 10mA/ I_R 6mA	μs	8.5	—

1. Measured from 50% of control voltage to 90% of output voltage

Parameter	Units	Port 1	Port 2	Conditions	Minimum	Typical	Maximum
Insertion Loss	dB	- 50mA	-25V	30MHz	—	0.07	0.10
		- 50mA	-25V	1000MHz	—	0.30	0.45
		- 50mA	-25V	2500MHz	—	0.60	0.80
Return Loss	dB	- 50mA	-25V	30MHz	36	39	—
		- 50mA	-25V	1000MHz	18	20	—
		- 50mA	-25V	2500MHz	11	13	—
Isolation	dB	+ 50mA	+25V	30MHz	60	63	—
		+ 50mA	+25V	1000MHz	40	42	—
		+ 50mA	+25V	2500MHz	29	33	—
Input IP3	dBm	- 50mA	-25V	-50mA / -25V F1 = 500MHz F2 = 505MHz $P_{IN} = +40\text{dBm}$ (each tone)	—	-66	—
2 nd Harmonic	dBc	- 50mA	-25V	50mA / -25V 500MHz / +35dBm	—	-46	—
3 rd Harmonic	dBc	- 50mA	-25V	50mA / -25V 500MHz / +35dBm	—	-60	—

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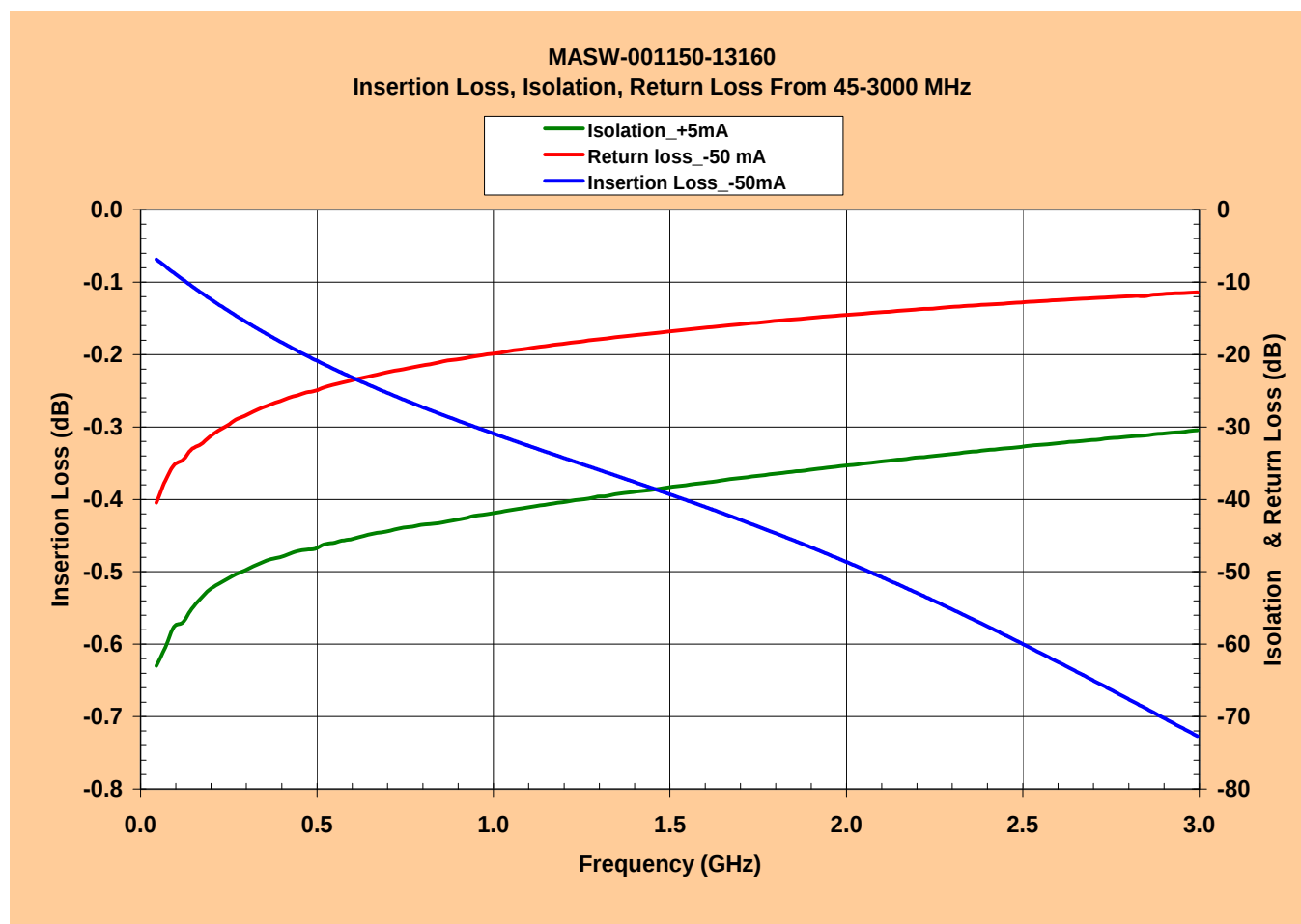
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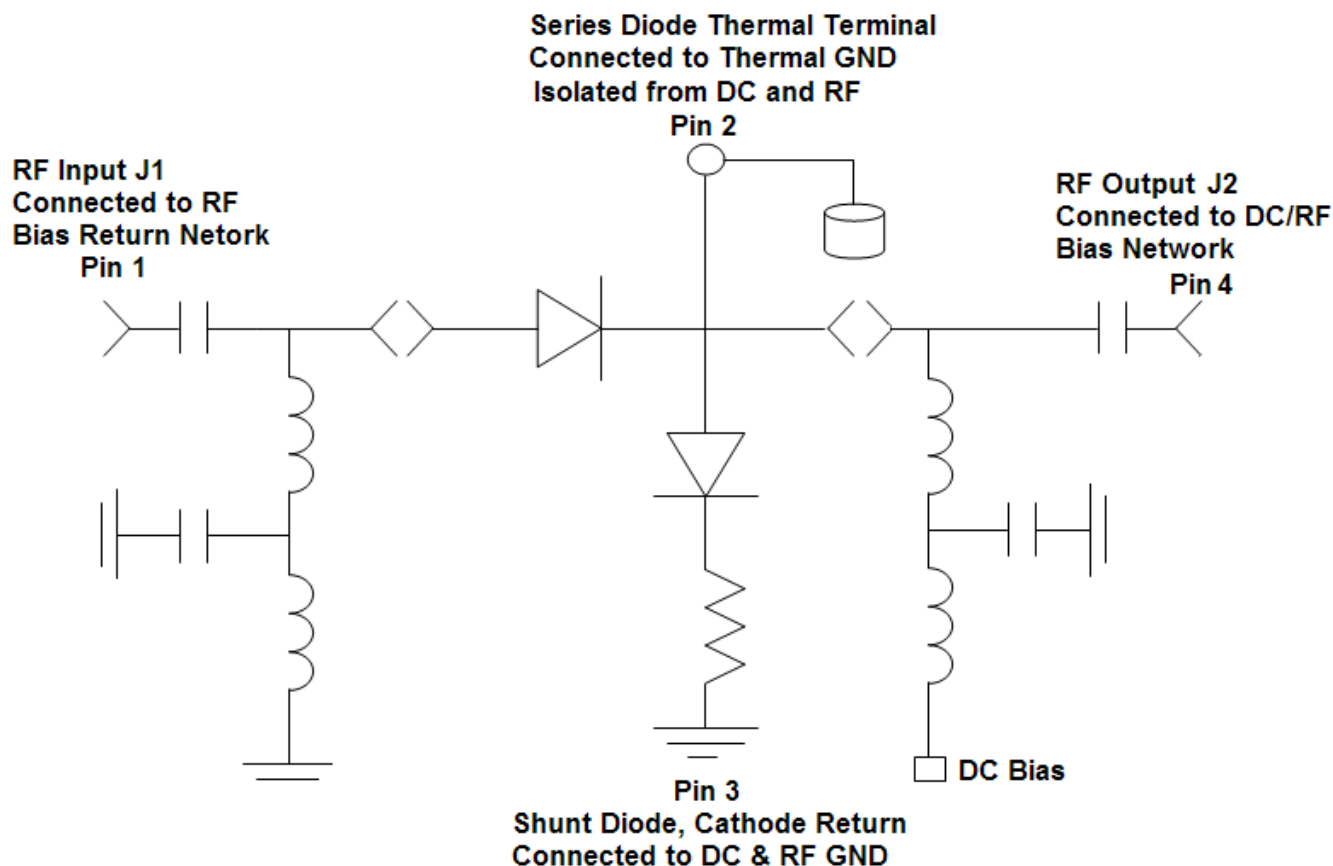
Typical RF Small Signal Performance



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MASW-001150-13160W Configured As An Absorptive High Power SPDT Switch



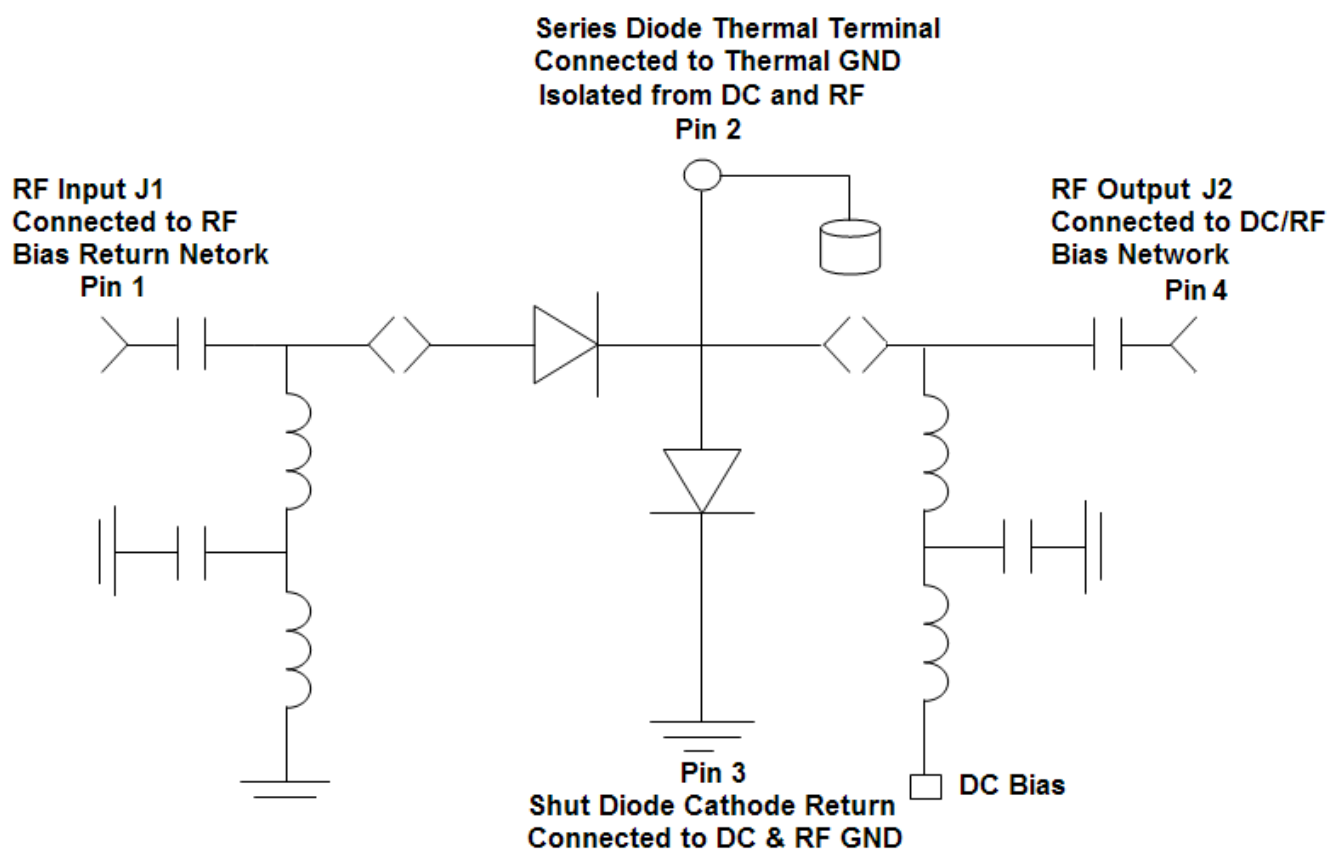
Note:

The bias circuits provided in the schematic above assumes current sources are available. If only voltage sources are available, a resistor will need to be added to the RF Input (J1) Bias Return Network. When using a D.C. voltage of 25V, a 500Ω resistor must be used to draw 50mA of current into the switch.

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MASW-001150-13160W Configured As A Reflective High Power SPDT Switch



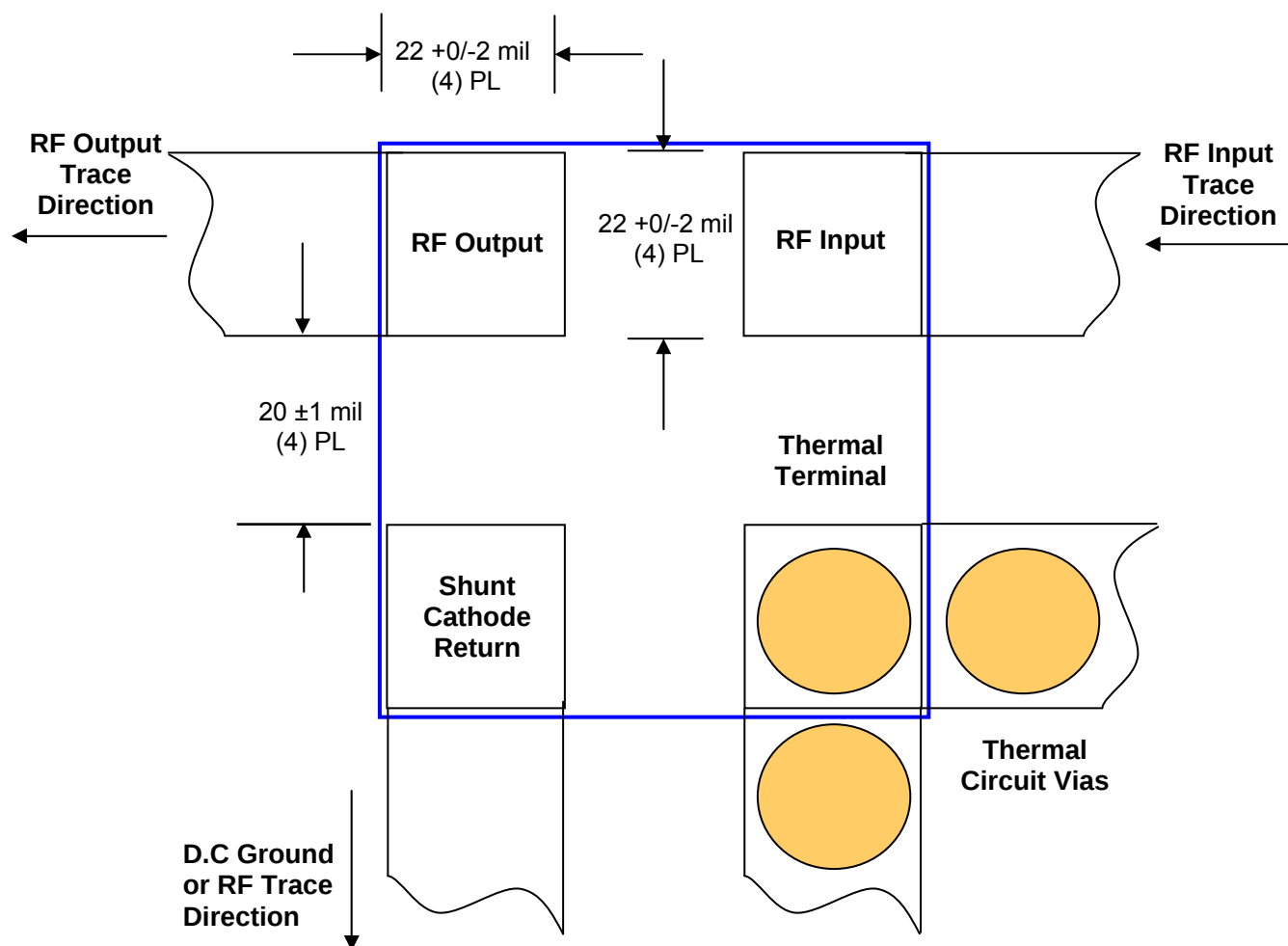
Note:

The bias circuits provided in the schematic above assumes current sources are available. If only voltage sources are available, a resistor will need to be added to the RF Input (J1) Bias Return Network. When using a D.C. voltage of 25V, a 500Ω resistor must be used to draw 50mA of current into the switch.

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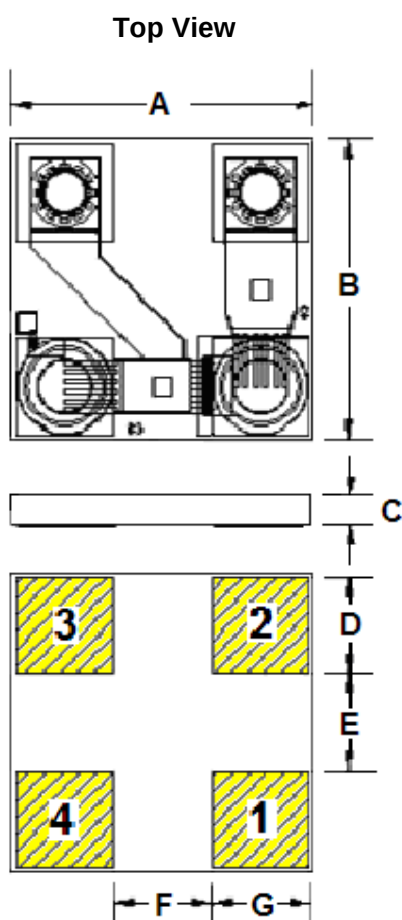
RF , DC, and Thermal Circuit Footprint (Topview)



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Chip Outline and Port Designations



Dimension	Inches		Millimeters	
	min.	max.	min.	max.
A	0.0665	0.0673	1.69	1.71
B	0.0665	0.0673	1.69	1.71
C	0.0045	0.0053	0.115	0.135
D	0.0195	0.0205	0.495	0.520
E	0.0195	0.0205	0.495	0.520
F	0.0195	0.0205	0.495	0.520
G	0.0195	0.0205	0.495	0.520

Ports	Function
1	RF Input
2	Thermal Terminal for Series Diode (Electrically isolated from other ports)
3	Shunt Diode (Cathode Return)
4	RF Output / D.C. bias

Notes:

Backside Metal: 2.5µm thick Au

Hatched yellow areas are I/O ports (die solder pads)

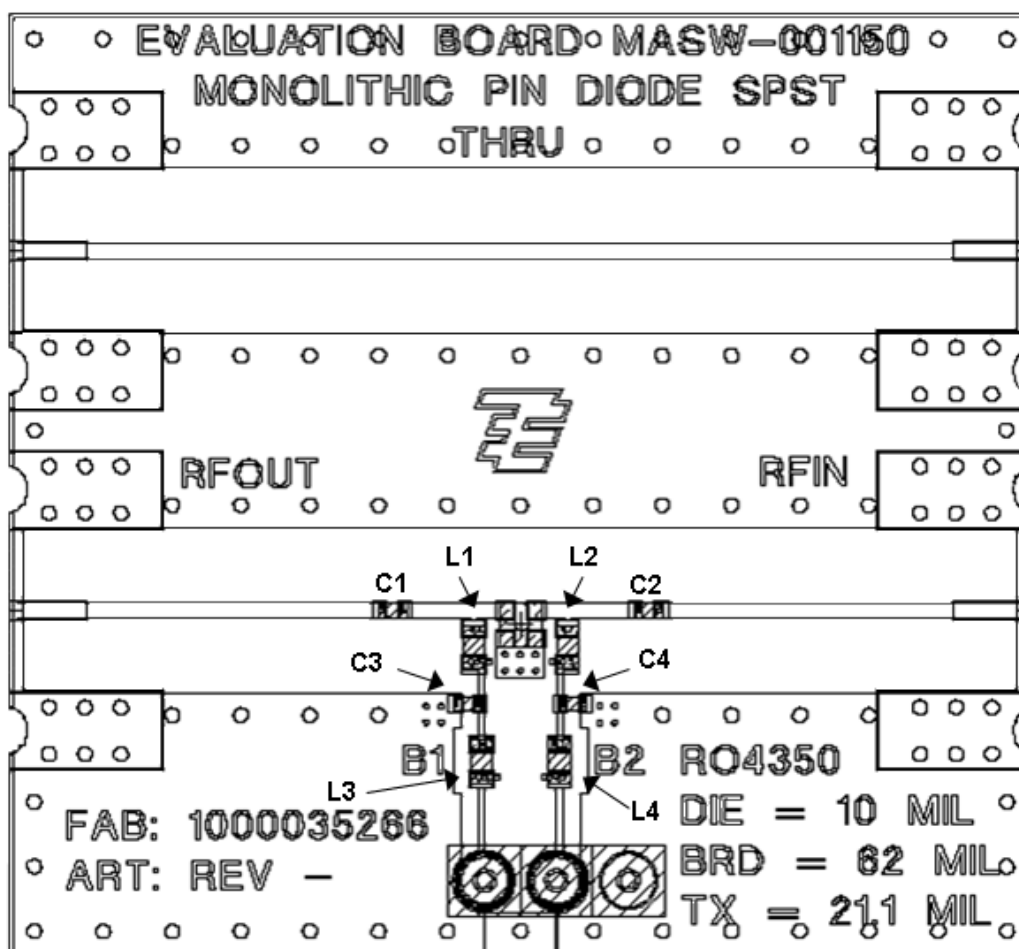
Ordering Information

Part Number	Packaging
MASW-001150-13160W	Waffle Tray
MASW-001150-13160P	Pocket Tape

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Sample Test Board for 300-3000 MHz



Component	Value	Case Size	Manufacturer
C1, C2	0.01 μ F	0402	Murata
C3, C4	100pF	0402	Murata
L1, L2, L3, L4	390nH	0603	Coilcraft

Ordering Information for Test Board

Part Number
MASW-001150-001SMB

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Assembly Guidelines

Handling

All semiconductor chips should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of plastic tipped tweezers or vacuum pickups is strongly recommended for individual components. Bulk handling should insure that abrasion and mechanical shock are minimized.

Bonding

Attachment to a circuit board is made simple through the use of surface mount technology. Mounting pads are conveniently located on the bottom surface of these devices and are removed from the active junction locations. These devices are well suited for solder or conductive epoxy attachment onto hard or soft substrates. The use of 60/40, Pb/Sn, 80/20, Au/Sn or any RoHS lead-free solder is recommended to achieve the lowest series resistance and optimum heat sink. The thermal terminal is not electrically conductive and may be soldered directly to any appropriate heat sink without affecting RF performance.

When soldering these devices to a hard substrate, hot gas die bonding is preferred. We recommend utilizing a vacuum tip and applying a force of 40 - 60 grams to the top surface of the device. When soldering, position the die so that its mounting pads are aligned with the circuit board mounting pads and reflow the solder by heating the circuit trace near the mounting pads while applying 40 to 60 grams of force perpendicular to the top surface of the die. All mounting pads should be heated simultaneously so that the solder under the pads flows at the same time. Avoid soldering the pads one at a time as doing so would produce an un-equal heat flow and potentially create thermal stress to the chip.

Solder reflow should not be performed by causing heat to flow through the top surface of the die. Die should be uniformly heated in a re-flow oven. Proper flow is easily determined looking down from the top since the HMIC glass is transparent and the edges of the mounting pads can be visually inspected through the die after attachment is complete. A typical soldering process profile and handling instructions are provided in Application Notes, [M538 Surface Mounting Instructions](#) and [M541 Bonding and Handling Procedures](#) on the MA-COM Technology Solutions website at www.macomtech.com

Conductive silver epoxy may also be used for die attachment, in lower Incident power applications where the average power is <1W. Apply a thin controlled amount approximately 1- 2 mils thick to minimize ohmic and thermal stresses. Take care not to bridge the gap between the chip pads with epoxy. A thin epoxy fillet should be visible around the perimeter of the pads after placement to ensure full coverage. Cure per epoxy per manufacturer's recommended schedule.