HMIC™ Silicon PIN Diode SP3T Switch
50 MHz - 20 GHz

MASW-003103
Rev. V4

Features

- Operates 50 MHz to 20 GHz
- Usable up to 26 GHz
- Low Insertion Loss
- High Isolation
- Low Parasitic Capacitance and Inductance
- RoHS Compliant Surmount Package
- Rugged, Fully Monolithic
- Glass Encapsulated Construction
- Up to +38 dBm CW Power Handling @ +25°C
- Silicon Nitride Passivation
- Polymer Scratch Protection
- Solderable

Applications

- Aerospace & Defense
- ISM

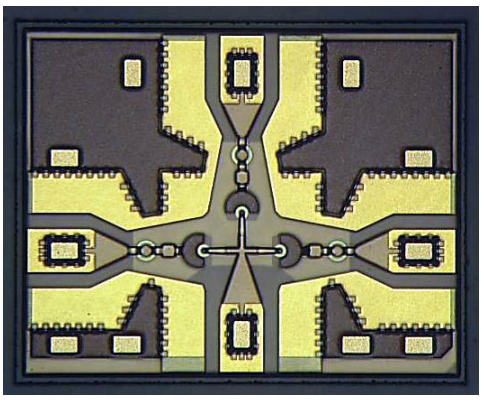
Description

The MASW-003103-1364 is a SP3T, surmount, broadband, monolithic switch using series and shunt connected silicon PIN diodes. This device is designed for use in broadband, moderate signal, high performance, switch applications up to 20 GHz. It is a surface mountable switch configured for optimized performance and offers a distinct advantage over MMIC, beamlead and chip and wire hybrid designs. Because the PIN diodes of the MASW-004103-1365 are integrated into the chip and kept within close proximity, the parasitics typically associated with other designs that use individual components are kept to a minimum.

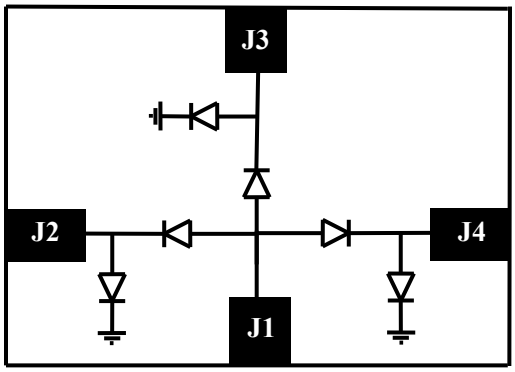
To minimize the parasitics and achieve high performance the MASW-003103-1364 is fabricated using MACOMs' patented HMIC™ (Heterolithic Microwave Integrated Circuit) process. This process allows the silicon pedestals, which form the series and shunt diodes or vias, to be imbeded in low loss, low dispersion glass. The combination of low loss glass and using tight spacing between elements results in an HMIC device with low loss and high isolation through low millimeter wave frequencies.

The topside is fully encapsulated with silicon nitride and also has an additional layer of polymer for scratch and impact protection. The protective coating guards against damage to the junction and the anode airbridges during handling and assembly.

On the backside of the chip gold metalized pads have been added to produce a solderable surmount device.



Functional Schematic



Pin Configuration

Pin	Function
J1	RFC
J2	RF1
J3	RF2
J4	RF3

Ordering Information

Part #	Package
MASW-003103-13640G	50 piece gel pack
MASW-003103-13645P	500 piece reel
MASW-003103-13640P	3000 piece reel
MASW-003103-001SMB	Sample Test Board

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

Electrical Specifications: T_A = 25°C, P_{IN} = 0 dBm, Z_0 = 50 Ω, 20 mA, -12 V

Parameter	Conditions	Units	Min.	Typ.	Max.
Insertion Loss	6 GHz 13 GHz 20 GHz	dB	—	0.5 0.8 1.2	0.6 1.1 1.4
Isolation	6 GHz 13 GHz 20 GHz	dB	50 37 25	54 40 31	—
Input Return Loss	6 GHz 13 GHz 20 GHz	dB	19 14 14	25 22 21	—
Output to Output Isolation	6 GHz 13 GHz 20 GHz	dB	—	57 42 30	—
Input 0.1 dB Compression Point	2 GHz	dBm	—	36	—
Switching Speed[1]	—	ns	—	75	—
Voltage Rating[2]	—	V	—	—	80

1. Typical Switching speed measured from (50% Control - 90% RF Voltage), in commutating mode at 10 kHz repetition rate, using the MACOM MADR-011022 Driver at -12 V @ -20 mA and +5 V @ +20 mA.
2. Maximum reverse leakage current in either the shunt or series PIN diodes shall be 0.5 µA maximum @ -80 volts.

Nominal Operating Conditions[3]

Parameter	Nominal Value
RF CW Incident Power 2 GHz 2 GHz 2 GHz 20 GHz 20 GHz 20 GHz	 36 dBm @ +25°C 33 dBm @ +85°C 31 dBm @ +125°C 31 dBm @ +25°C 28 dBm @ +85°C 25 dBm @ +125°C
DC Reverse Voltage	40 V
Bias Current	±20 mA @ +25°C ±20 mA @ +85°C
Junction Temperature	+175°C
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

3. Operating at nominal conditions with T_J < 175°C will ensure MTTF > 1 x 10^6 hours.

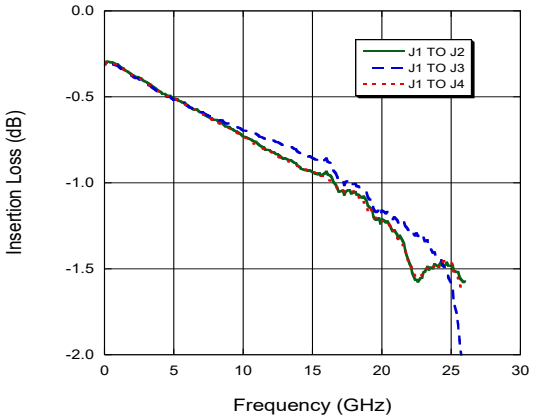
Absolute Maximum Ratings[4,5]

Parameter	Absolute Maximum
RF CW Incident Power 2 GHz 2 GHz 2 GHz 20 GHz 20 GHz 20 GHz	 38 dBm @ +25°C 35 dBm @ +85°C 33 dBm @ +125°C 33 dBm @ +25°C 30 dBm @ +85°C 27 dBm @ +125°C
DC Reverse Voltage	80 V
Bias Current	±50 mA @ +25°C ±25 mA @ +85°C
Junction Temperature	+175°C
Operating Temperature	-65°C to +125°C
Storage Temperature	-65°C to +150°C

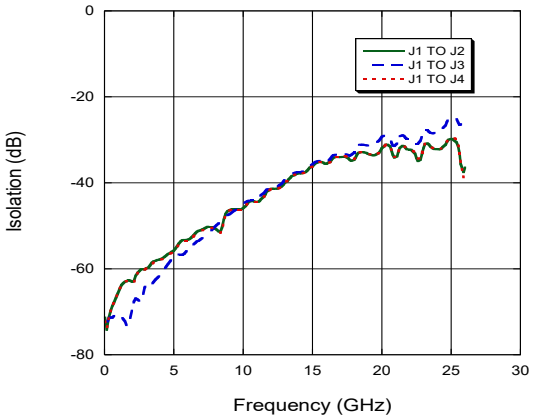
4. Exceeding any one or combination of these limits may cause permanent damage to this device.
5. MACOM does not recommend sustained operation near these survivability limits.

Typical Performance Curves: 20 mA, -10 V (On-Wafer Probed)

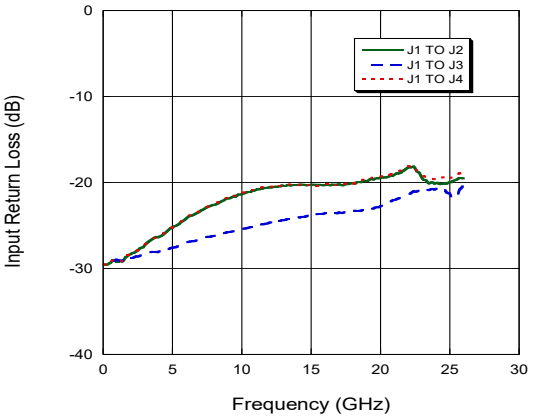
Insertion Loss



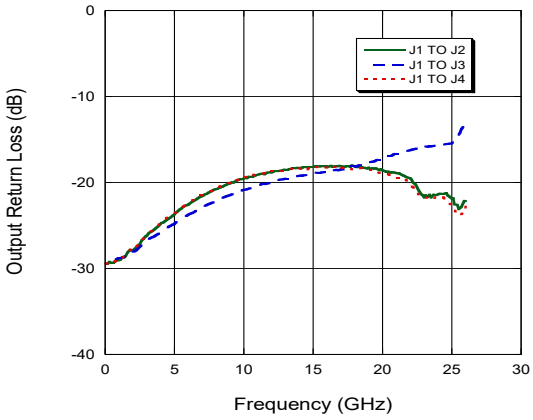
Isolation



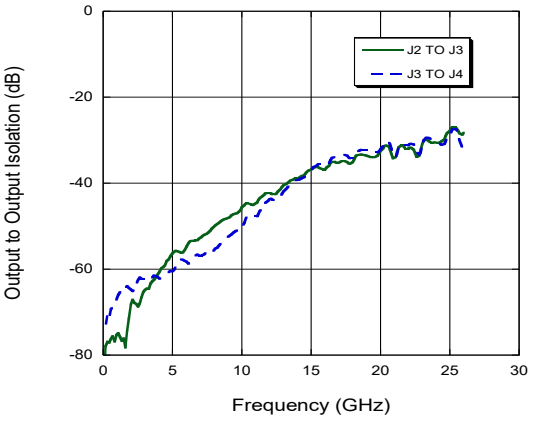
Input Return Loss



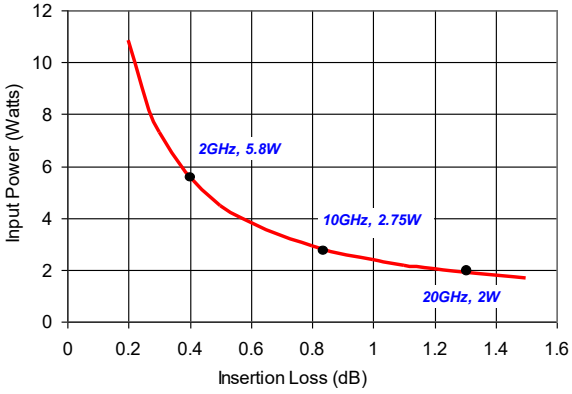
Output Return Loss



Output to Output Isolation



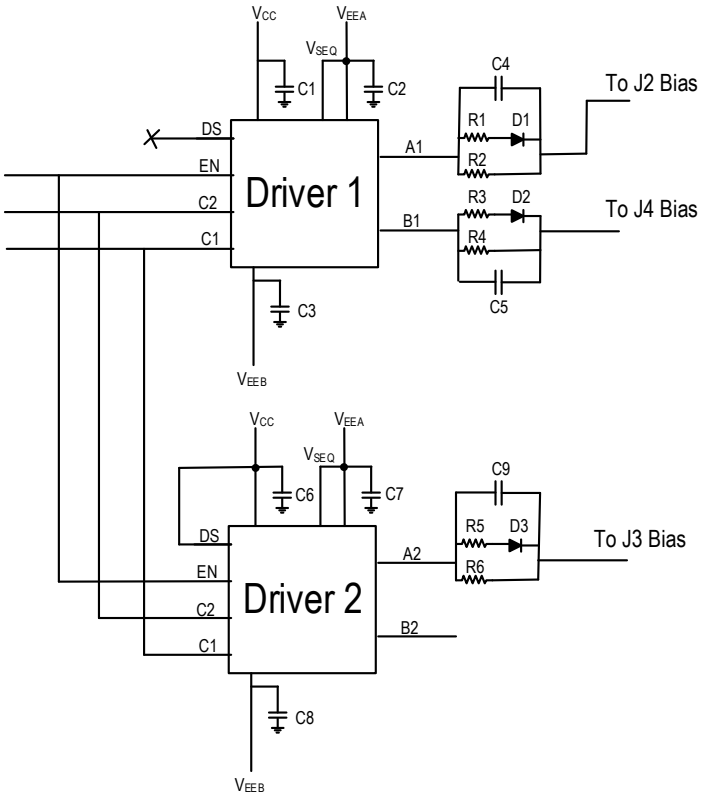
Maximum Input Power, Baseplate Temperature fixed @ +25°C



Operation of MASW-003103

The simultaneous application of a negative DC current to the low loss port and positive DC current to the isolated port is required for proper operation of the MASW-003103. The backside area of the die is the RF and DC ground return and the DC return is through the common Port J1. A constant current source should be used to supply the DC control currents. The control voltages at these points will not exceed ±1.5 V for supply currents up to ±20 mA. In the low loss state, the series diode must be forward biased and the shunt diode reverse biased. On all isolated ports, the shunt diode is forward biased and the series diode is reverse biased.

Application Schematic with MADR-011022



Parts List[6]

Part	Value	Part	Value
C1, C3, C6, C8	0.1 µF	R2, R4, R6	390 Ω
C2, C7	47 pF	R7	560 Ω
C4, C5, C9	470 pF	D1, D2, D3	1N4148WS
R1, R3, R5	270 Ω		

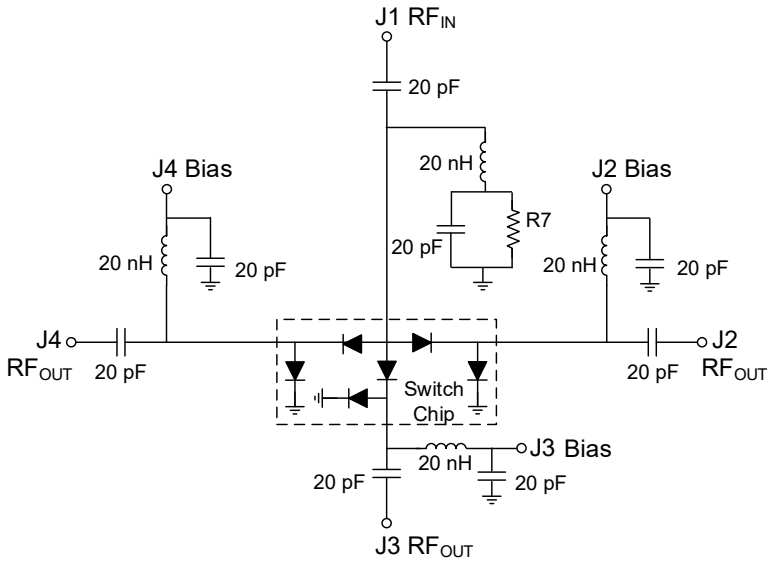
6. Resistor values calculated to provide ~20 mA of bias current and ~-12 V reverse bias voltage at the anode of the shunt diode given V_{CC} = 5 V, V_{EEB}= -20 V, voltage drop at driver output 0.4 V, V_F of D1 0.7 V and V_F of switch diodes ~1 V.

Driver Connections

Two drivers are needed to drive a SP3T or SP4T switch. The DS pin of the first driver can be left open due to the internal active pull-down. Connect the DS pin of the second driver to V_{CC}. The combined truth table is below:

Control Logic			DC Control Current (mA)			RF Output States		
EN	C2	C1	J2	J3	J4	J1-J2	J1-J3	J1-J4
1	x	x	20	20	20	Isolation	Isolation	Isolation
0	0	0	-20	20	20	low loss	Isolation	Isolation
0	0	1	20	-20	20	Isolation	low loss	Isolation
0	1	0	20	20	-20	Isolation	Isolation	low loss

Bias Connections[7]



7. RLC values are for an operation frequency of 2 - 18 GHz and bias current of ±20 mA per port.

Minimum Reverse Bias Voltage[8]

Frequency (GHz)	DC Voltage (V)	Power (W)
0.05	40	11.0
2	23	5.8
10	5	2.8
20	2	2.0

8. Minimum DC bias voltage to maintain low loss under power with 1.5:1 VSWR.

Handling Procedures

Please observe the following precautions to avoid damage:

Attachment to a circuit board is made simple through the use of standard 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 attachment onto hard and soft substrates. The use of 80Au/20Sn, or RoHS compliant solders is recommended. For applications where the average power is ≤ 1W, conductive silver epoxy may also be used. Cure per manufacturers recommended time and temperature. Typically 1 hour at 150°C.

When soldering these devices to a hard substrate, a solder re-flow method is preferred. A vacuum tip pick -up tool and a force of 60 to100 grams applied to the top surface of the device while placing the chip is recommended.

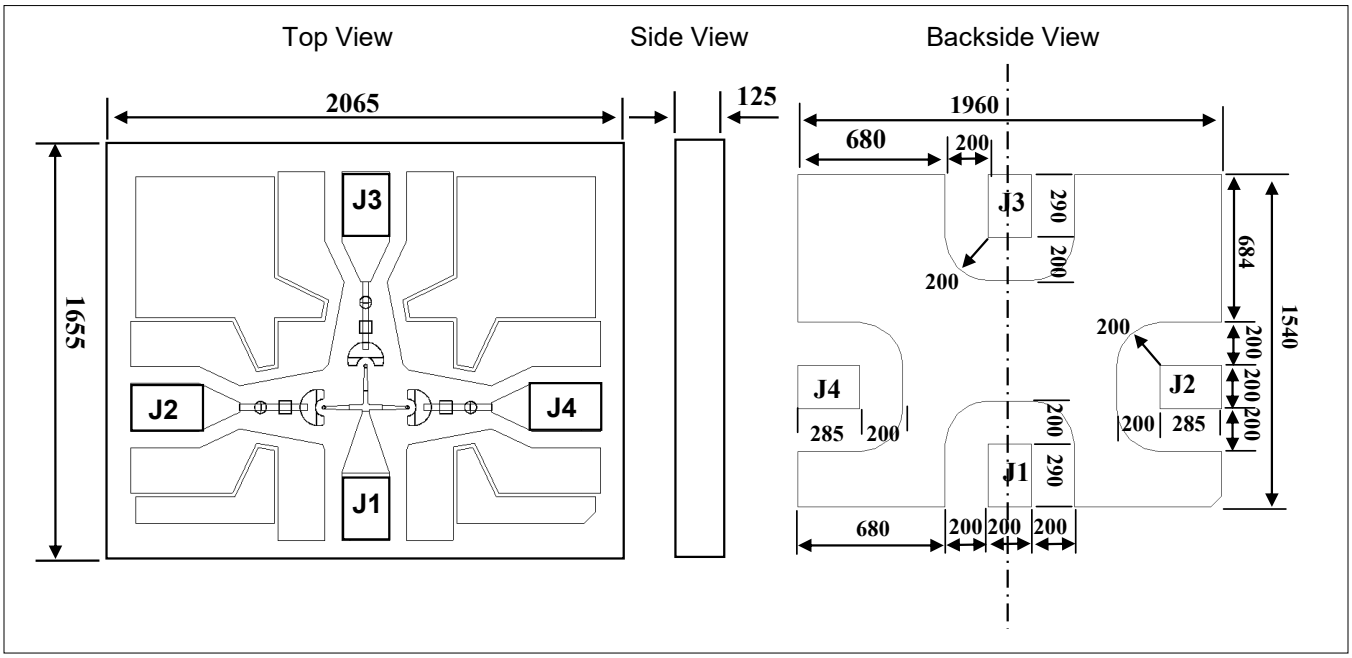
When soldering to soft substrates, such as Duroid, it is recommended to use a soft solder at the circuit board to mounting pad interface to minimize stress due to any TCE mismatches that may exist. Position the die so that its mounting pads are aligned with the circuit board mounting pads.

Solder reflow should not be performed by causing heat to flow through the top surface of the die to the back. Since the HMIC glass is transparent, the edges of the mounting pads can be visually inspected through the die after attachment is completed. Typical re-flow profiles for Sn60/Pb40 and RoHS compliant solders is provided in Application Note M538, “Surface Mounting Instructions“ and can viewed on the MACOM Technology Solutions website @ www.macom.com

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 Class 1A HBM devices.

Outline Drawing and Footprint (All dimensions in µm)[9,10,11,12]

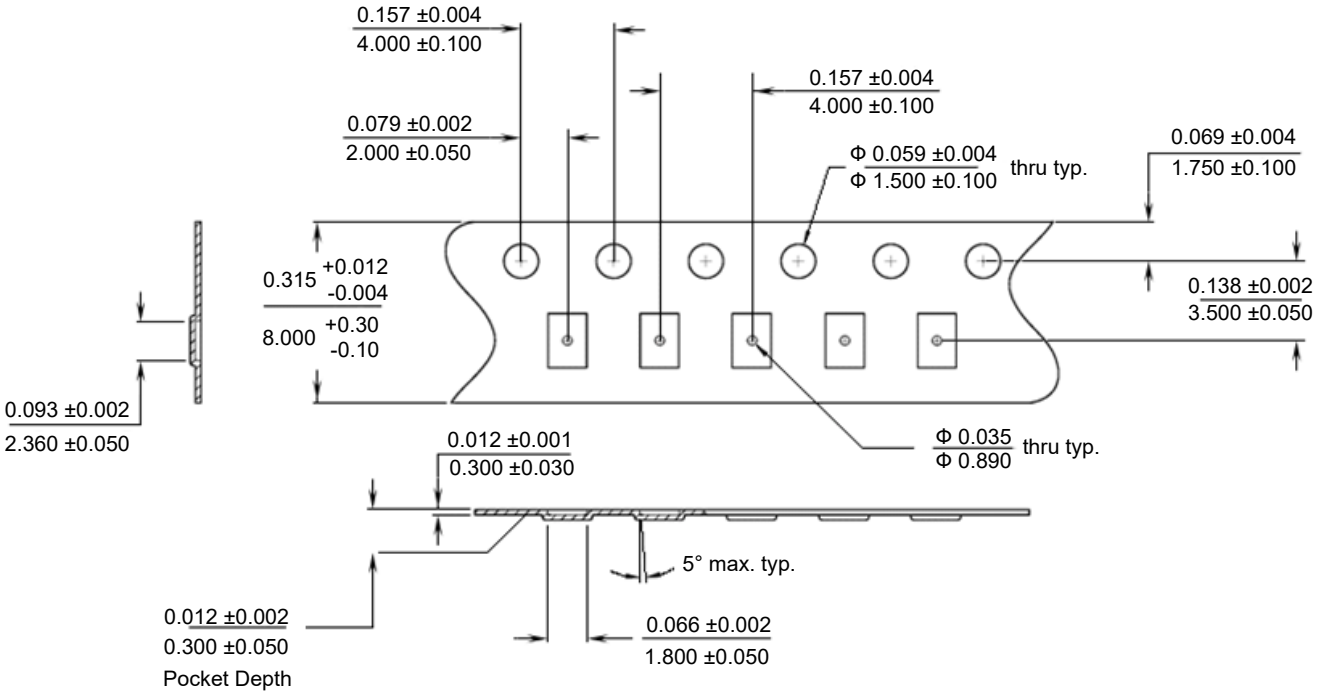


9. Bottom view shows the back metal foot print and mounting pads.
10. All dimension are +/-0.5 µm.
11. Ground radius is 200 µm and centered on the I/O Pad.
12. The center pad shown on the chip bottom view must be connected to RF and DC ground.

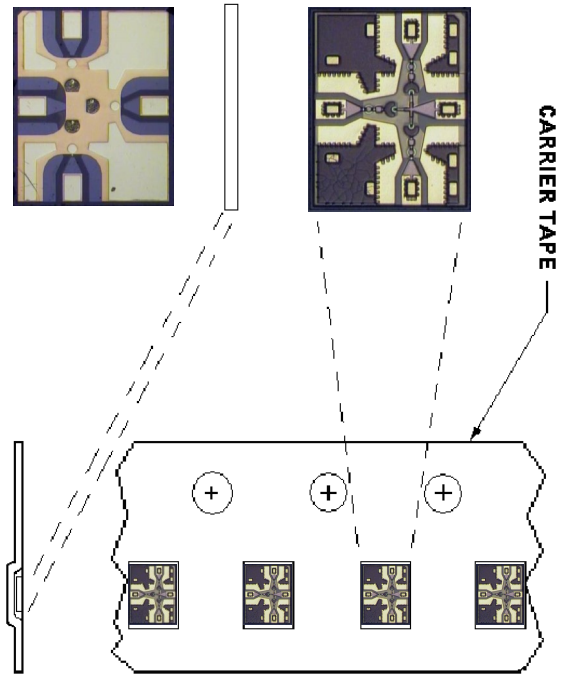
Dimensions

Dim.	Inches		mm	
	Min.	Max.	Min.	Max.
Width	0.06417	0.06614	1.630	1.680
Length	0.08031	0.08228	2.040	2.090
Thickness	0.00394	0.00591	0.100	0.150

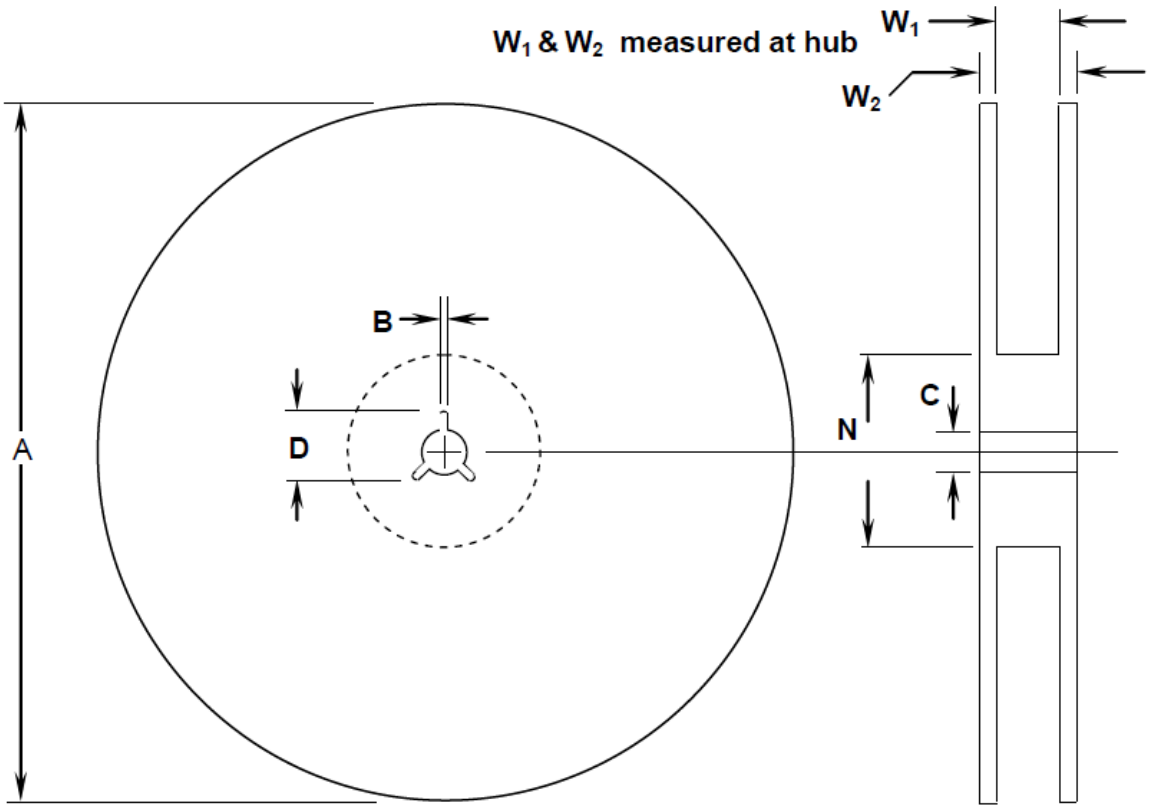
Carrier Tape Dimensions



Chip Orientation in Tape



Reel Information



Dim.	inches		mm	
	Min.	Max.	Min.	Max.
A	6.980	7.019	177.3	178.3
B	0.059	0.098	1.5	2.5
C	0.504	0.520	12.8	13.2
D	0.795	0.815	20.2	20.7
N	2.146	2.185	54.5	55.5
W_1	0.331	0.337	8.4	8.55
W_2	—-	0.567	—-	14.4