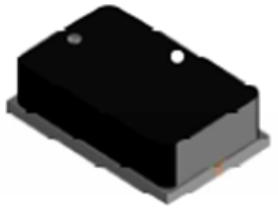
MSW206x-206
Rev. V2

Features

- Wide Frequency Range:
  50 MHz to 6 GHz in 3 Bands
- Surface Mount SP2T Switch in Compact Outline:
  8 x 5 x 2.5 mm (L x W x H)
- Higher Average Power Handling than Plastic Packaged
- MMIC Switches: 100 W CW
- High RF Peak Power: 500 W
- Low Insertion Loss: 0.3 dB
- High IIP3: 65 dBm
- Operates From: 5 V & -180 V
- RoHS* Compliant

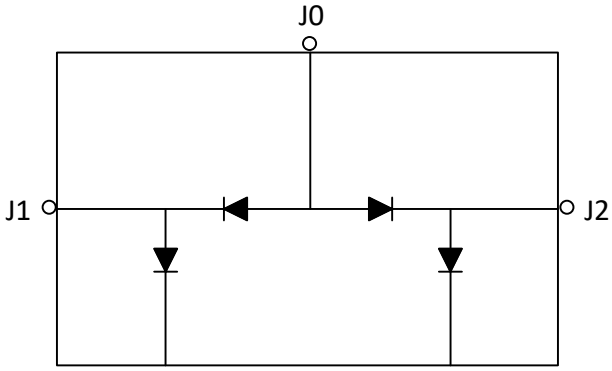


CS206

Applications

- High Power Transmit/Receive (TR) Switching
- Active Receiver Protection

Functional Schematic



Description

The MSW206x-206 series of SP2T TR silicon PIN diode switches are manufactured using a proven hybrid manufacturing process incorporating high voltage PIN diodes and passive devices integrated within a ceramic substrate. This low profile, compact, surface mount component, offers superior low and high signal performance to comparable MMIC devices in QFN packages. The SP2T switches are designed in an asymmetrical series & series-shunt topology to optimize Tx & Rx performance. .

Using PIN diodes with lower thermal resistance (<10ºC/W), RF CW incident power levels of +50 dBm and RF peak incident power levels of +57 dBm are very achievable in higher power cold and hot switching applications @ +85ºC. The lower PIN diode series resistance (<1 Ω), coupled with the longer minority carrier lifetime, (>3 µs), provides better IIP3 distortion values >+65 dBm.

These MSW206x-206 SP2T switches are designed to be used in higher power switch applications, operating from 20 MHz to 6000 MHz, requiring high volume, surface mount, solder re-flow manufacturing. These products are durable, reliable, and capable of meeting all military, commercial, and industrial environments.

Ordering Information

Part #[1]	Package
MSW206x-206-T	tube
MSW206x-206-R	250 or 500 piece reel
MSW206x-206-W	waffle pack
MSW206x-206-E	RF evaluation board

1. x determines frequency, replace x with:
   0 = 20 - 1200 MHz
   1 = 200 - 4500 MHz
   2 = 1.5 - 6.5 GHz

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

MSW2060-206
Electrical Specifications: Freq. = 20 - 1200 MHz, T_A = +25°C, P_{IN} = 0 dBm, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	—	0.25	0.35
Return Loss	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	20	23	—
Isolation	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	49	53	—
CW Incident Power[2]	Source & Load VSWR = 1.5:1	dBm	—	50	—
Peak Incident Power[2]	Source & Load VSWR = 1.5:1, Pulse Width = 10 µs, Duty Cycle = 1%	dBm	—	57	—
Switching Time[3]	10% - 90% RF Voltage, TTL rep rate = 100	µs	—	2	3
Input IP3	F1 = 500 MHz, F2 = 510 MHz, P1=P2=40 dBm Measured on path biased to low loss state	dBm	60	65	—

MSW2061-206
Electrical Specifications: Freq. = 200 - 4500 MHz, T_A = +25°C, P_{IN} = 0 dBm, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	—	0.5	0.7
Return Loss	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	14	16	—
Isolation	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	32	35	—
CW Incident Power[2]	Source & Load VSWR = 1.5:1	dBm	—	50	—
Peak Incident Power[2]	Source & Load VSWR = 1.5:1, Pulse Width = 10 µs, Duty Cycle = 1%	dBm	—	57	—
Switching Time[3]	10% - 90% RF Voltage, TTL rep rate = 100	µs	—	1	2
Input IP3	F1 = 2000 MHz, F2 = 2010 MHz, P1=P2=40 dBm Measured on path biased to low loss state	dBm	60	65	—

MSW2062-206
Electrical Specifications: Freq. = 1.5 - 6.5 GHz, T_A = +25°C, P_{IN} = 0 dBm, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	—	0.7	0.9
Return Loss	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	11	13	—
Isolation	Condition 1:port J0 to J1 Condition 2: port J0 to J2	dB	31	34	—
CW Incident Power[2]	Source & Load VSWR = 1.5:1	dBm	—	50	—
Peak Incident Power[2]	Source & Load VSWR = 1.5:1, Pulse Width = 10 µs, Duty Cycle = 1%	dBm	—	57	—
Switching Time[3]	10% - 90% RF Voltage, TTL rep rate = 100	µs	—	1	2
Input IP3	F1 = 2000 MHz, F2 = 2010 MHz, P1=P2=40 dBm Measured on path biased to low loss state	dBm	60	65	—

Bias State Conditions:

State 1 (J0 - J1 in low insertion loss state):
a. J1: -50 mA, 180 V (ON)

State 2 (J0 - J2 in low insertion loss state):
a. J2: +25 mA, 1 V (OFF)

2. PIN diode DC reverse voltage to maintain high resistance in the OFF PIN diode is determined by RF frequency, incident power, and VSWR as well as by the characteristics of the diode. The minimum reverse bias voltage values are provided in this datasheet. The input signal level applied for small signal testing is approximately 0 dBm.
3. Switching time (50% TTL - 10/90% RF Voltage) is a function of the PIN diode driver performance as well as the characteristics of the diode. An RC “current spiking network” is used on the driver output to provide a transient current to rapidly remove stored charge from the PIN diode. Typical component values are: R = 50 to 220 Ω and C = 470 to 1,000 pF. Monzite’s MDD050N181Q16A or 99235 (https://monzite.com/) is the recommended PIN diode driver to interface with the MSW206x-206 series SP2T switches.

Truth Table

Port J0 - J1	Port J0 - J2	Bias: J1	Bias: J2
Low Loss	Isolation	-180 V, -50 mA	+1 V, +25 mA
Isolation	Low Loss	+1 V, +25 mA	-180 V, -50 mA

RF Bias Network Component Values

Part #	Frequency (MHz)	Inductors	DC Blocking Capacitors	RF Bypass Capacitors
MSW2060-206	50 - 1000	4.7 µH	0.1 µF	0.1 µF
MSW2061-206	400 - 4000	82 nH	27 pF	270 pF
MSW2062-206	2000 - 6000	33 nH	22 pF	33 pF

Minimum Reverse Bias Voltage: P_{INC} = 100 W CW, Z_0 = 50 Ω with 1.5:1 VSWR

Part #	F = 20 MHz	F = 100 MHz	F = 200 MHz	F = 400 MHz	F = 1 GHz	F = 4 GHz
MSW2060-206	-180 V	-150 V	-110 V	-75 V	-35 V	N/A
MSW2061-206	N/A	N/A	-150 V	-110 V	-55 V	-25 V
MSW2062-206	(F = 1 GHz) -55 V	(F = 2 GHz) -28 V	(F = 3 GHz) -28 V	(F = 4 GHz) -28 V	(F = 5 GHz) -28 V	(F = 6 GHz) -28 V

The minimum reverse bias voltage required to maintain a PIN diode out of conduction in the presence of a large RF signal is given by:

$$|V_{DC}| = \frac{|V_{RF}|}{\sqrt{1+\left[\left(\frac{0.0142 \times f_{MHz} \times W_{mils}^2}{V_{RF} \times \sqrt{D}}\right) \times \left(1+\sqrt{1+\left(\frac{0.056 \times V_{RF} \times \sqrt{D}}{W_{mils}}\right)^2}\right)\right]^2}}$$

Where:

$|V_{DC}|$ = magnitude of the minimum DC reverse bias voltage
$|V_{RF}|$ = magnitude of the peak RF voltage (including the effects of the VSWR)
F_{MHz} = lowest RF signal frequency expressed in MHz
D = duty factor of the RF signal
W_{MILS} = thickness of the diode I layer, expressed in mils (thousands of an inch)

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

Absolute Maximum Ratings

Parameter	Conditions	Absolute Maximum
Forward Current	J1 or J2 Port	250 mA
Reverse Voltage	J1 or J2 Port	300 V
Forward Diode Voltage	I_F = 250 mA	1.2 V
CW Incident Power Handling[4]	Source & Load VSWR = 1.5:1, T_C = 85°C, cold switching	50 dBm
Peak Incident Power Handling[4]	RX or Ant Port Source & Load VSWR = 1.5:1, T_C = 85°C, cold switching Pulse Width = 10 µs, Duty Cycle = 1%	57 dBm
Total Dissipated RF & DC Power[5]	T_C = 85°C, cold switching	12 W
Junction Temperature	—	+175°C
Operating Temperature	—	-65°C to +125°C
Storage Temperature	—	-65°C to +150°C
Assembly Temperature	t = 10 s	+260°C

4. For hot switching, PIN diode driver must transition from forward bias to reverse bias and reverse bias to forward bias within 100 ns with a parallel RC spiking network at the driver output.
5. Backside RF and DC grounding area of device must be completely solder attached to the RF circuit board vias for proper electrical and thermal circuit grounding.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

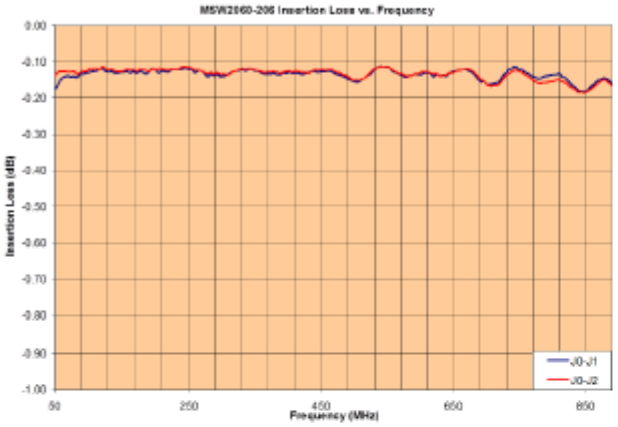
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 1C (HBM) devices. The moisture sensitivity level (MSL) rating for this part is MSL 2.

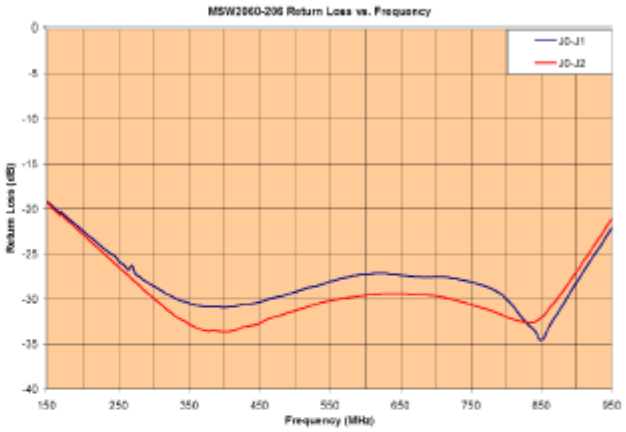
Environmental Capabilities

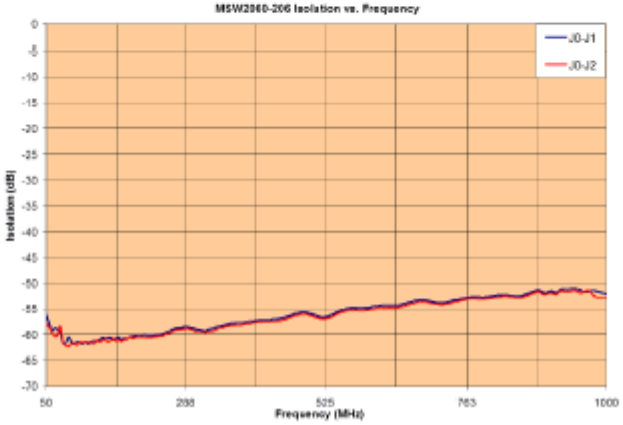
The MSW206x-206 series diodes are capable of meeting the environmental requirements of MIL-STD -202 and MIL-STD-750.

MSW2060-206 Small Signal Typical Performance

Z_0 = 50 Ω, T_A = +25 °C (Unless Otherwise Defined)

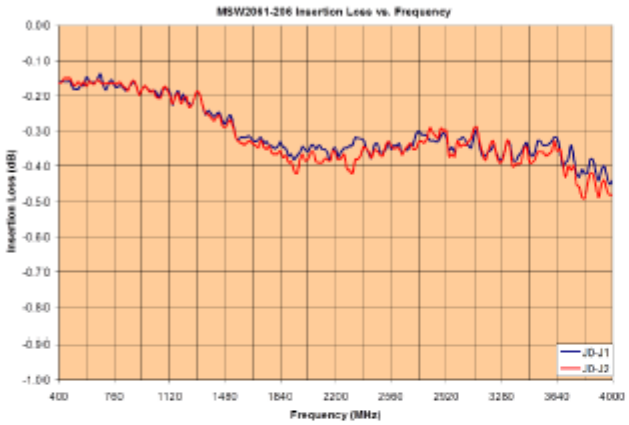


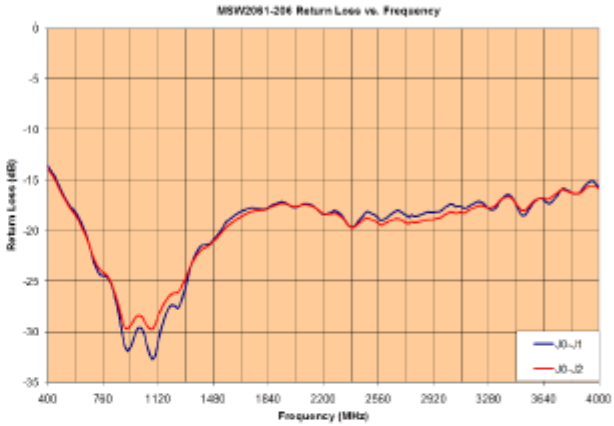


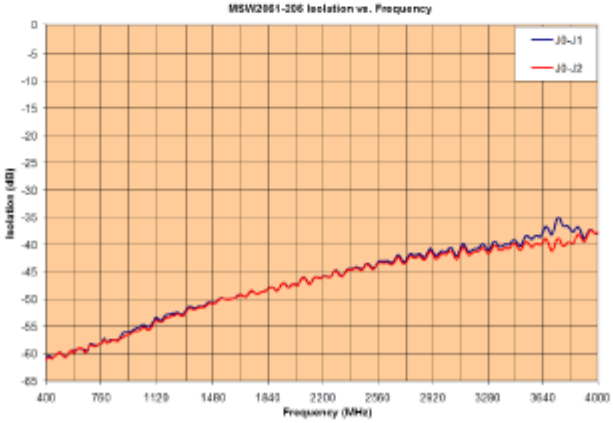


MSW2061-206 Small Signal Typical Performance

Z_0 = 50 Ω, T_A = +25 °C (Unless Otherwise Defined)

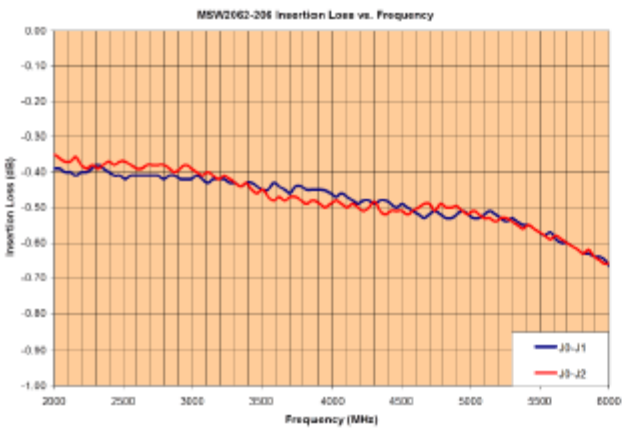


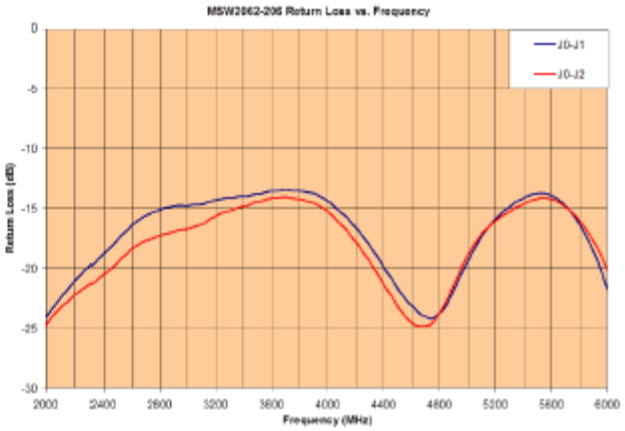


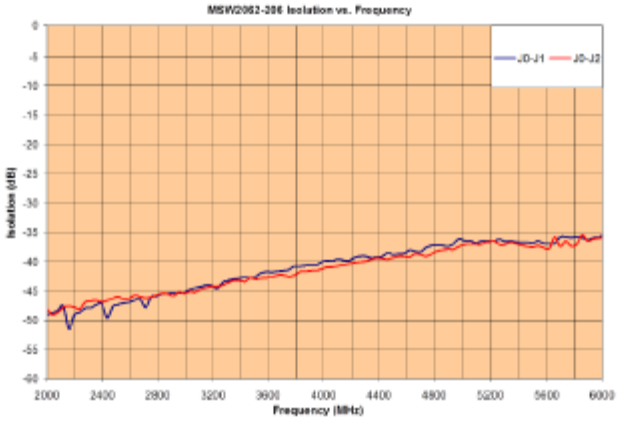


MSW2062-206 Small Signal Typical Performance

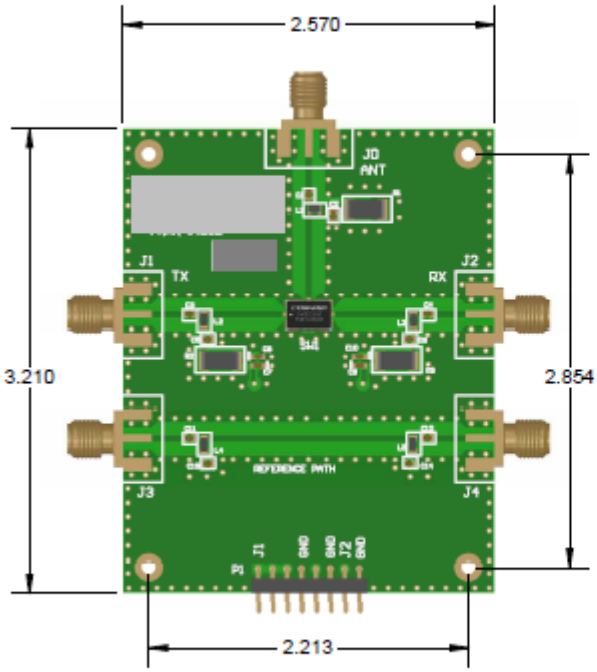
Z_0 = 50 Ω, T_A = +25 °C (Unless Otherwise Defined)



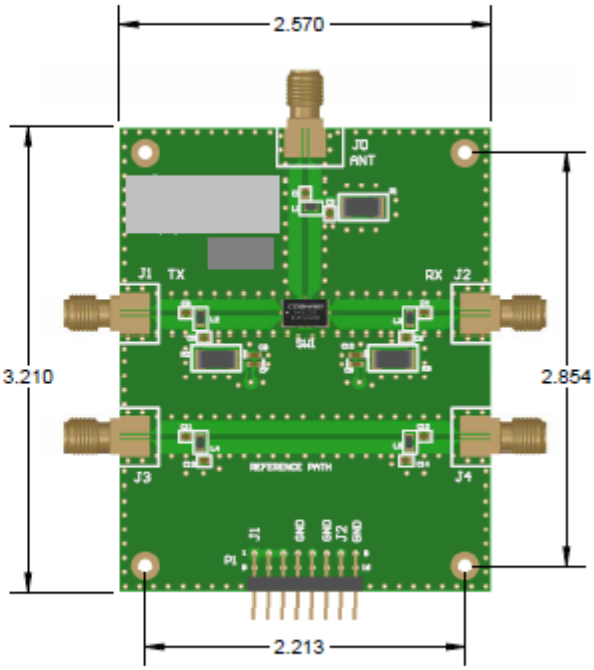




SP2T Switch Evaluation Board Layouts



APPLIES TO THE FOLLOWING EVAL BOARDS:
CS206 - BAND 1 / BAND 2



APPLIES TO THE FOLLOWING EVAL BOARDS:
CS206 - BAND 3

Evaluation Board Parts List

MSW2060-206 Band 1		
Part	**Value**	**Case Style**
C1, C3, C4, C11, C12	470 pF	0603
C2, C5, C6, C13, C14	470 pF	0603
[6]C7, C8, C9, C10	470 pF	0603
L1 - L7	600 Ω	0603
R1	130 Ω	2512
R2, R3	150 Ω	2512

MSW2061-206 Band 2		
Part	**Value**	**Case Style**
C1, C3, C4, C11, C12	47 pF	0603
C2, C5, C6, C13, C14	220 pF	0603
[6]C7, C8, C9, C10	1000 pF	0603
L1 - L5	43 nH	0603
R1	130 Ω	2512
R2, R3	150 Ω	2512

MSW2062-206 Band 3		
Part	**Value**	**Case Style**
C1, C3, C4, C11, C12	10 pF	0603
C2, C5, C6, C13, C14	33 pF	0603
[6]C7, C8, C9, C10	1000 pF	0603
L1 - L5	8.2 nH	0603
R1	130 Ω	2512
R2, R3	150 Ω	2512

6. Second bypass capacitor is optional.

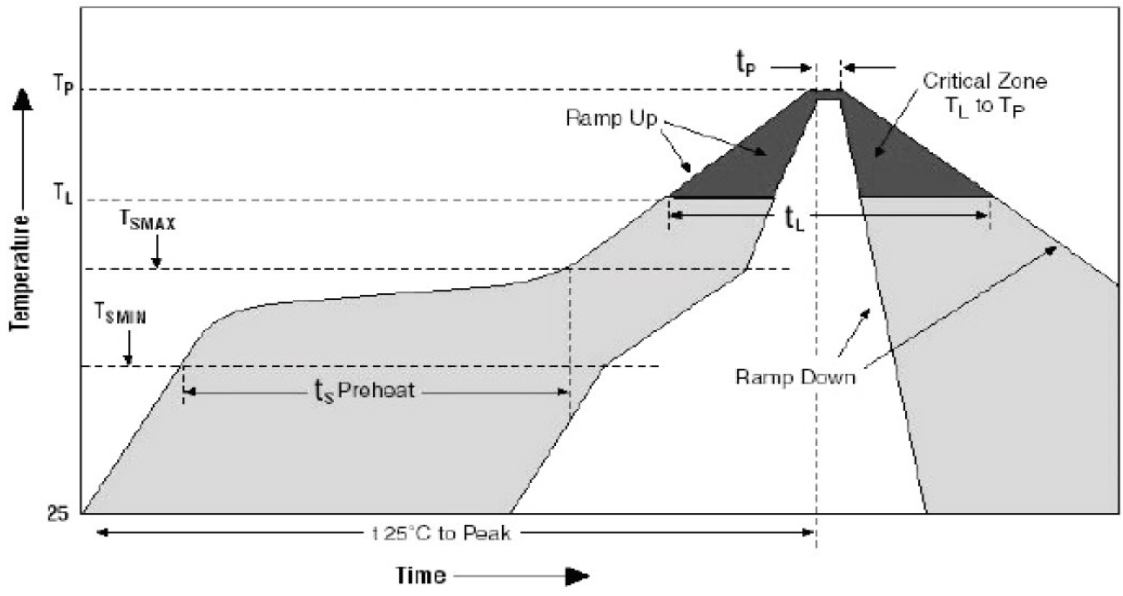
Assembly Instructions

SP2T PIN Diodes may be placed onto circuit boards with pick and place manufacturing equipment from tape and reel. The devices are attached to the circuit using conventional solder re-flow or wave soldering procedures with RoHS type or Sn 60 / Pb 40 type solders.

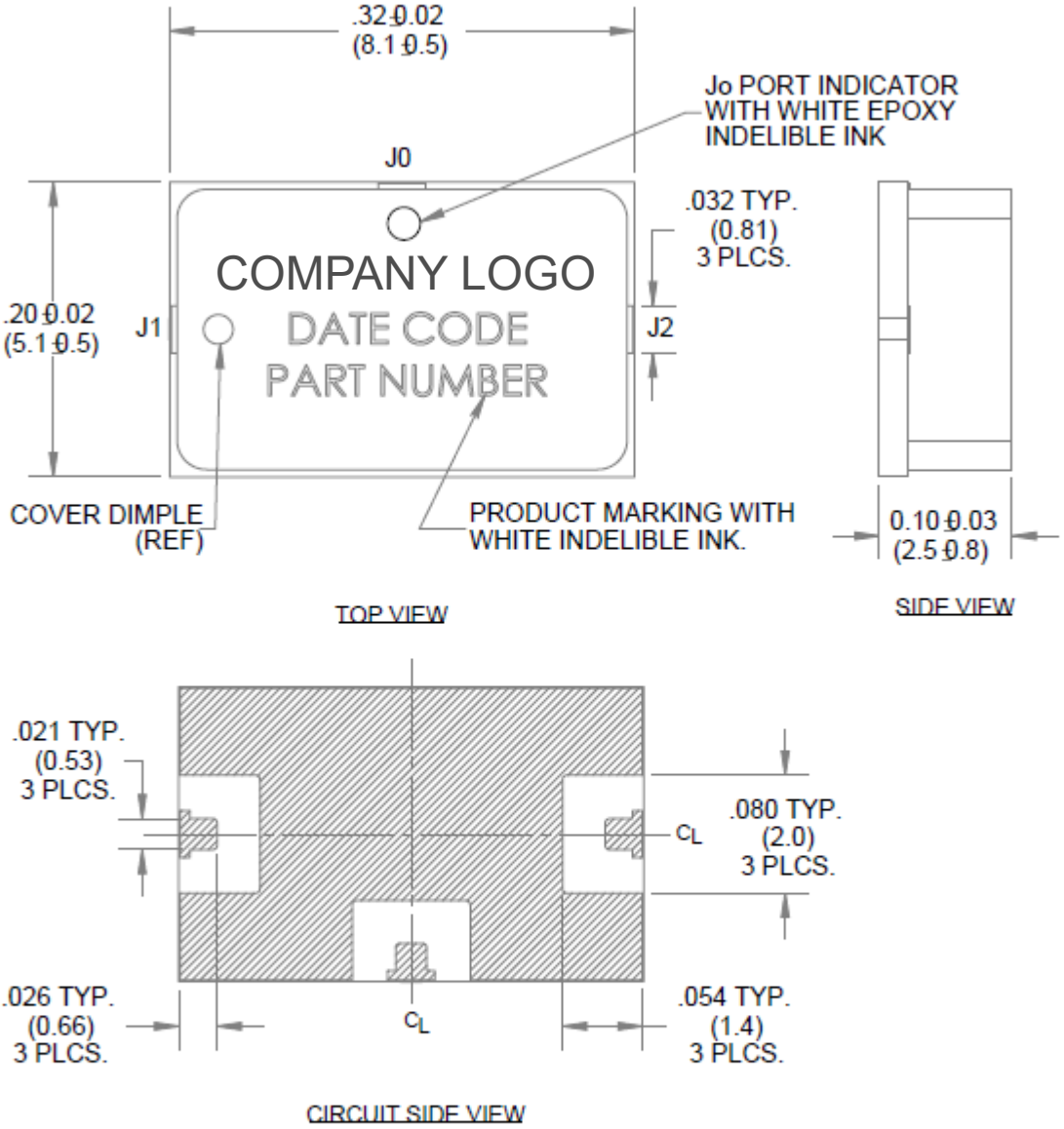
Table 1. Time-Temperature Profile for Sn60/Pb40 or RoHS Type Solders

Profile Feature	SnPb Solder Assembly	Pb-Free Solder Assembly
Average Ramp-Up Rate (T_L to T_P)	3°C /second maximum	3°C /second maximum
Preheat: - Temperature Min (T_{SMIN}) - Temperature Max (T_{SMAX}) - Time (min to max)(t_S)	 100°C 150°C 60-120 s	 150°C 200°C 60-180 s
T_{SMAX} to T_L - Ramp-Up Rate		3°C/s maximum
Time Maintained Above: - Temperature (T_L) - Time (t_L)	 183°C 60-150 s	 217°C 60-150 s
Peak temperature (T_P)	225 +0/-5°C	260 +0/-5°C
Time Within 5°C of Actual Peak Temperature (t_P)	10 – 30 s	20 – 40 s
Ramp-Down Rate	6°C /s maximum	6°C /s maximum
Time 25°C to Peak Temperature	6 minutes maximum	8 minutes maximum

Figure 1. Solder Re-Flow Time-Temperature Profile



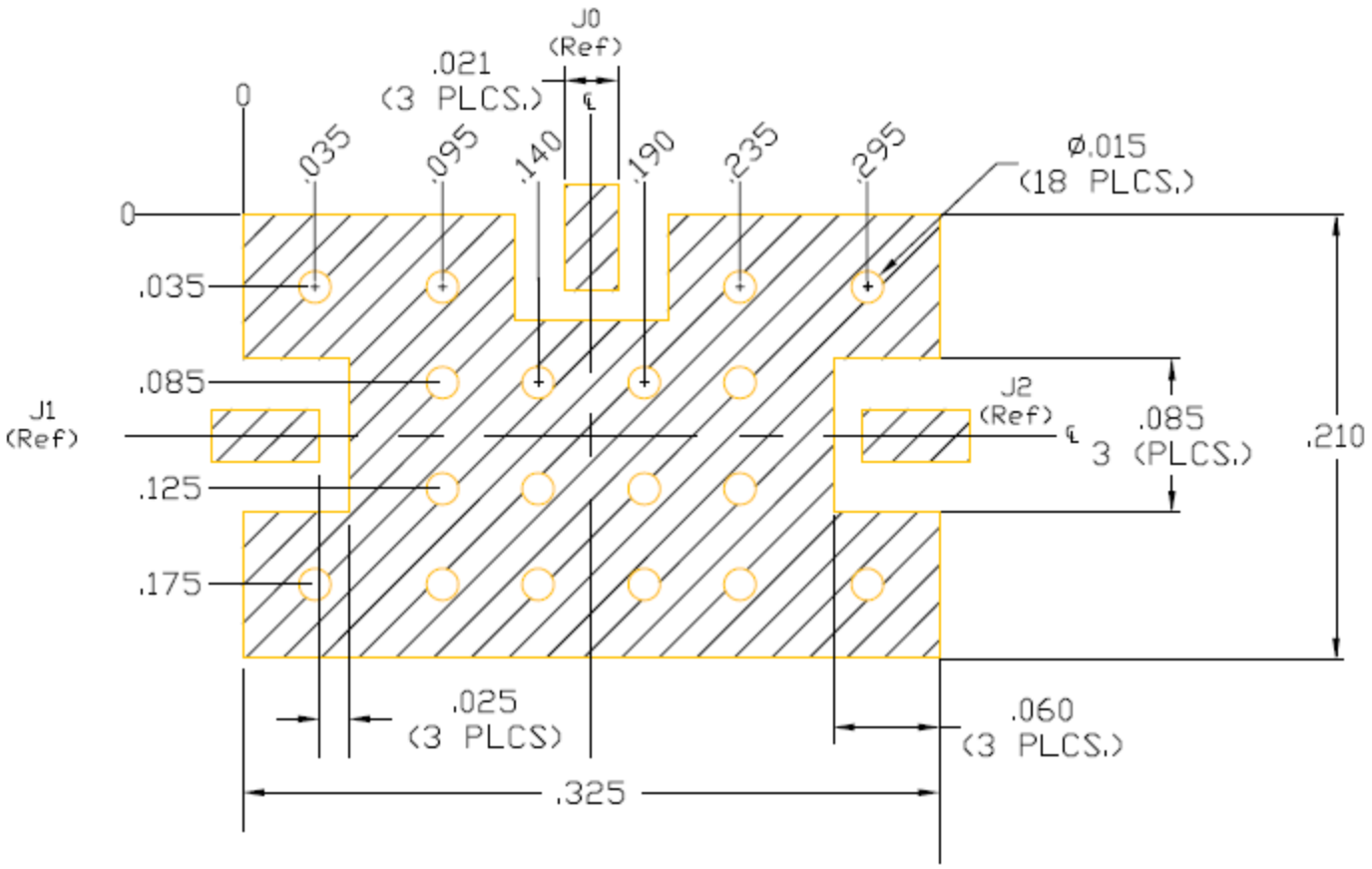
MSW2060-206, MSW2061-206, and MSW2062-206
SP2T Switch Outline (CS206)



Notes:

1. Hatched metal area on circuit side of device is RF, DC and thermal ground.

RF Circuit Solder Footprint for Case Style 206 (CS206)



Hatched area is RF, DC, and thermal Ground. Vias should be solid copper fill and gold plated for optimum heat transfer from backside of switch module through Circuit Vias to metal thermal ground.