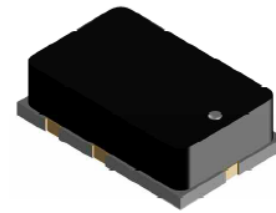


Features

- Wide Frequency Range: 10 MHz to 1 GHz
- 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: 158 W CW
- High RF Peak Power: 500 W
- Low Insertion Loss: 0.3 dB
- High IIP3: 60 dBm
- Operates From: 5 V & -200 V
- RoHS* Compliant



CS202

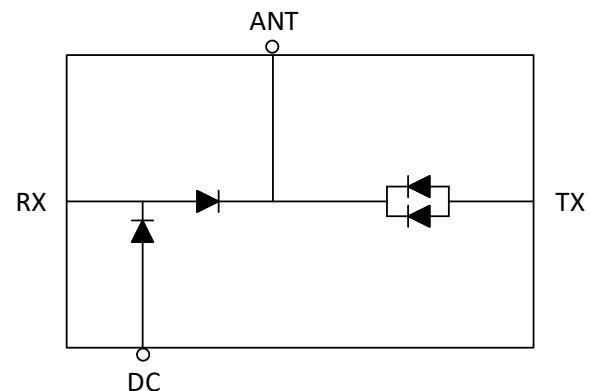
Description

The MSW2020-202 silicon PIN diode, surface mount SP2T T-R Switch is 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. The MSW2020-202 operates from 10 - 1,000 MHz to provide broadband performance for low and high signal superior operation.

Using PIN diodes with lower thermal resistance (<8°C/W), RF CW incident power levels of +52 dBm and RF peak incident power levels of +57 dBm are very achievable in higher power cold and hot switching applications @ +85°C. The lower PIN Diode series resistance (<1 Ω), coupled with the longer minority carrier lifetime, (>4 μs), provides better IIP3 distortion values >+60 dBm.

These MSW2020-202 SP2T switches are designed to be used in higher power switch applications, operating from 10 MHz to 1000 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.

Functional Schematic



Ordering Information

| Part Number | Package |
|---------------|-----------------------|
| MSW2020-202-T | tube |
| MSW2020-202-R | 250 or 500 piece reel |
| MSW2020-202-W | Waffle pack |
| MSW2020-202-E | RF evaluation board |

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

Electrical Specifications: Freq. = 10 - 1000 MHz, T_A = +25°C, P_{IN} = 0 dBm, Z₀ = 50 Ω

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|-------------------------------------|--|-------|------|------|------|
| TX-Ant Insertion Loss | Condition 1 | dB | — | 0.2 | 0.3 |
| Ant-RX Insertion Loss | Condition 2 | dB | — | 0.3 | 0.4 |
| TX-Ant Return Loss | Condition 1 | dB | 18 | 20 | — |
| Ant-RX Return Loss | Condition 2 | dB | 18 | 20 | — |
| TX-RX Isolation | Condition 1 | dB | 40 | 45 | — |
| RX-TX Isolation | Condition 2 | dB | 20 | 23 | — |
| TX CW Incident Power ¹ | Condition 1, 1.5:1 Source & Load VSWR | dBm | — | — | 52 |
| RX CW Incident Power ¹ | Condition 2, 1.5:1 Source & Load VSWR | dBm | — | — | 40 |
| TX Peak Incident Power ¹ | Condition 1, 10 μs Pulse Width, 1% Duty Cycle, 1.5:1 Source & Load VSWR (IL) | dBm | — | — | 57 |
| Switching Time ² | 10% - 90% RF Voltage | μs | — | 2 | 3 |
| Input IP3 | F1 = 500 MHz, F2 = 510 MHz, P1=P2=40 dBm | dBm | 60 | 65 | — |

Bias State Conditions:
Transmit State

(TX - ANT in low insertion loss state):

- a. TX: +100 mA, +5 V
- b. ANT: -100 mA, 0 V
- c. RX: -25 mA, -200 V
- d. DC: +25 mA, +5 V

Small Signal Receive State

(ANT - RX in low insertion loss state):

- a. TX: 0 mA, -200 V
- b. ANT: -100 mA, 0 V
- c. RX: +100 mA, +5 V
- d. DC: 0 mA, -200 V

1. 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.
2. 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 MDD050N151Q12A (<https://monzite.com/>) is the recommended PIN diode driver to interface with the MSW2020-202 SP2T switch.

Truth Table

| Port TX - ANT | Port ANT - RX | P1-TX | P1-ANT | P1-RX | P1-DC |
|---------------|---------------|---------------|--------------|----------------|--------------|
| Low Loss | Isolation | +5 V, +100 mA | 0 V, -100 mA | -200 V, -25 mA | +5 V, +25 mA |
| Isolation | Low Loss | -200 V, 0 mA | 0 V, -100 mA | +5 V, 100 mA | -200 V, 0 mA |

RF Bias Network Component Values

| Part # | Frequency (MHz) | Inductors | DC Blocking Capacitors | RF Bypass Capacitors |
|-------------|-----------------|-------------|------------------------|----------------------|
| MSW2020-202 | 30 - 1000 | 4.7 μ H | 0.1 μ F | 0.1 μ F |

Minimum Reverse Bias Voltage: $P_{INC} = 125$ W CW, $Z_0 = 50$ Ω with 1.5:1 VSWR

| Frequency (MHz) | DC Voltage RX-ANT (V) |
|-----------------|-----------------------|
| 10 | -135 |
| 100 | -120 |
| 200 | -95 |
| 500 | -50 |
| 1000 | -25 |

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 | TX or RX Port | 250 mA |
| Reverse Voltage | TX, RX or B1 Port | 300 V |
| Forward Diode Voltage | $I_F = 250 \text{ mA}$ | 1.2 V |
| CW Incident Power Handling ³ | Source & Load VSWR = 1.5:1, $T_C = 85^\circ\text{C}$ | 51 dBm |
| Peak Incident Power Handling ³ | RX or Ant Port Source & Load VSWR = 1.5:1, $T_C = 85^\circ\text{C}$, Pulse Width = 10 μs , Duty Cycle = 1% | 57 dBm |
| Total Dissipated RF & DC Power ³ | $T_C = 85^\circ\text{C}$, cold switching | 8 W |
| Junction Temperature | — | +175°C |
| Operating Temperature | — | -65°C to +125°C |
| Storage Temperature | — | -65°C to +150°C |
| Assembly Temperature | $t = 10 \text{ s}$ | +260°C |

3. 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:

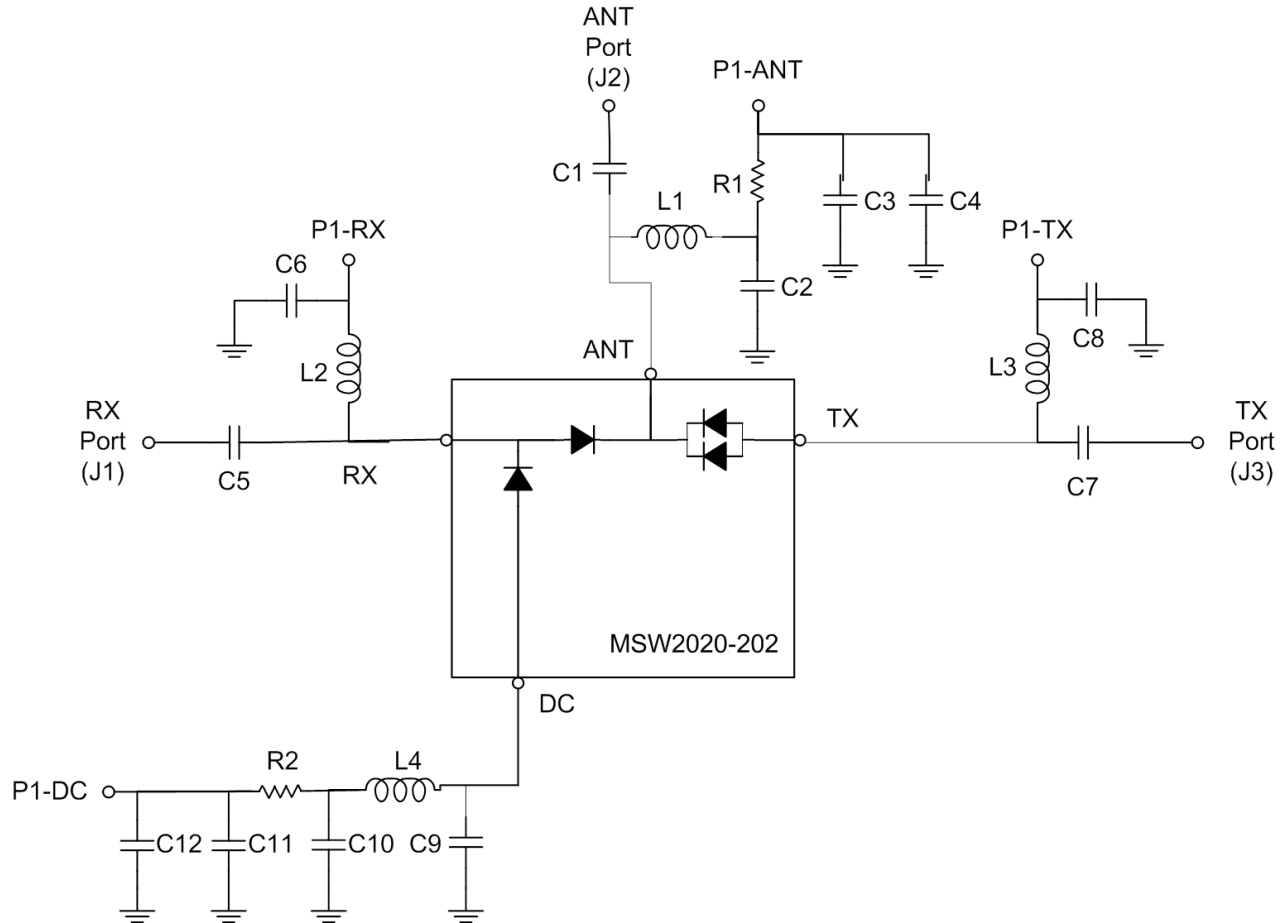
Static Sensitivity

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 MSW2020-202 diode is capable of meeting the environmental requirements of MIL-STD-202 and MIL-STD-750.

SP2T Switch Evaluation Board Schematic



The MSW2020-202 surface mount silicon PIN diode SP2T T-R switch can be controlled using external bias sources to fully exercise the switch for small signal performance analysis and for large signal operation with maximum input signal power of 45 dBm (CW or peak power). The MSW2020-202 SP2T schematic with RF bias network shows the appropriate DC blocking capacitors at each RF port and bias decoupling networks at each RF port and DC bias port of the switch.

Three complementary control signals are required for proper operation. Bias voltages are applied to the TX bias port, RX bias port and the DC bias port to control the state of the switch. A bias voltage of 5 V must be applied to the Ant Bias port whenever the switch is in operation.

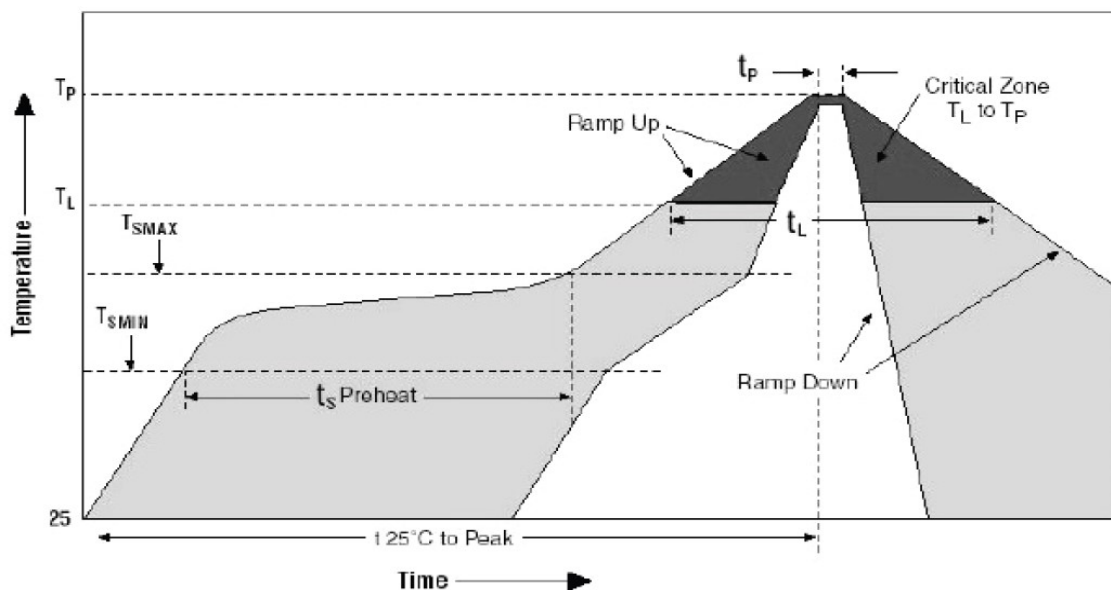
Assembly Instructions

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.

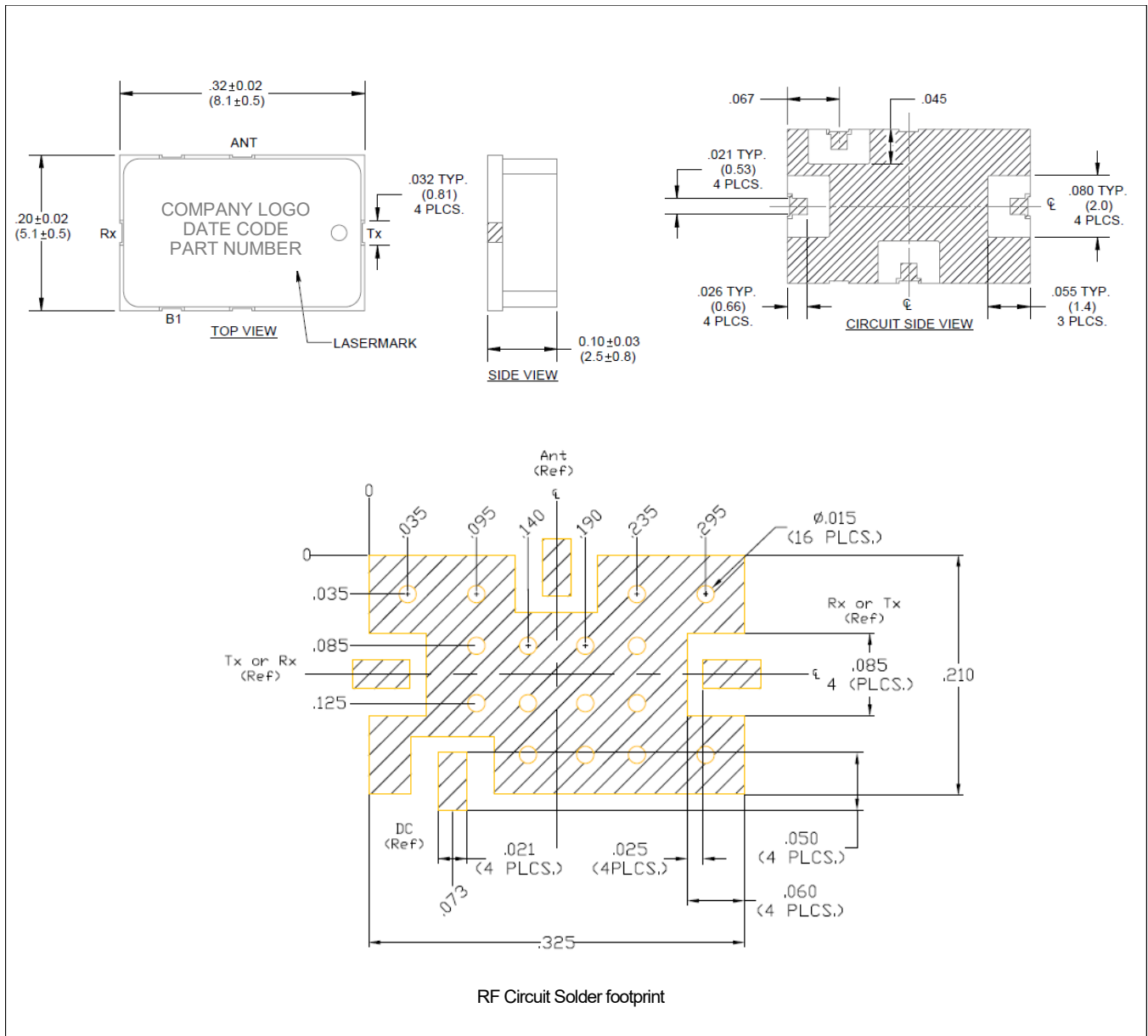
Table 1. Time-Temperature Profile for Sn60/Pb40 or RoHS Type Solders

| 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}) | 100°C | 150°C |
| - Temperature Max (T_{SMAX}) | 150°C | 200°C |
| - Time (min to max)(t_s) | 60-120 s | 60-180 s |
| T_{SMAX} to T_L | | |
| - Ramp-Up Rate | | 3°C/s maximum |
| Time Maintained Above: | | |
| - Temperature (T_L) | 183°C | 217°C |
| - Time (t_L) | 60-150 s | 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



Outline (CS204)^{4,5}



4. Hatched metal area on circuit side of device is RF, DC and thermal grounded.
5. 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.

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