



MSW5T-0310-515

SP5T High Power Series-Shunt Switch Module - SMT

Features:

- Surface Mount SP5T Switch Module: 10mm x 10mm x 2.5mm
- Frequency Range: 30 MHz to 1.0 GHz
- High Average Power Handling: +50 dBm (CW)
- High Peak Power Handling: +53 dBm
- Low Insertion Loss: < 0.40 dB
- Return Loss (Ant-Tx): > 15 dBm
- Isolation: > 30 dB

Description:

The MSW5T-0310-515 SP5T surface mount High Power silicon PIN Diode switch was designed for transmit/receive functions or selected switched filter bank applications operating in the 30 MHz to 1.0 GHz frequency range. The MSW5T-0310-515 high power switch leverages proven high reliability hybrid manufacturing processes which yield both superior RF and thermal characteristics performance when compared to MMIC or Glass Carrier based technologies. The hybrid design approach permits precise PIN Diode selection to optimize RF performance while maintaining competitive cost targets. The small form factors (10mm x 10mm x 2.5mm) offer world class power handling, low insertion loss, and superior isolation performance in a single device. The MSW5T-0310-515 symmetrical switch is tailored to minimize Transmit to Antenna loss while maximizing Transmit to Receive isolation. The extremely low thermal resistance of the hybrid assembly permits reliably handling up to +50 dBm CW power and up to +53 dBm peak RF incident power while operating at the $T_{amb} (MAX) = +85^{\circ}C$.

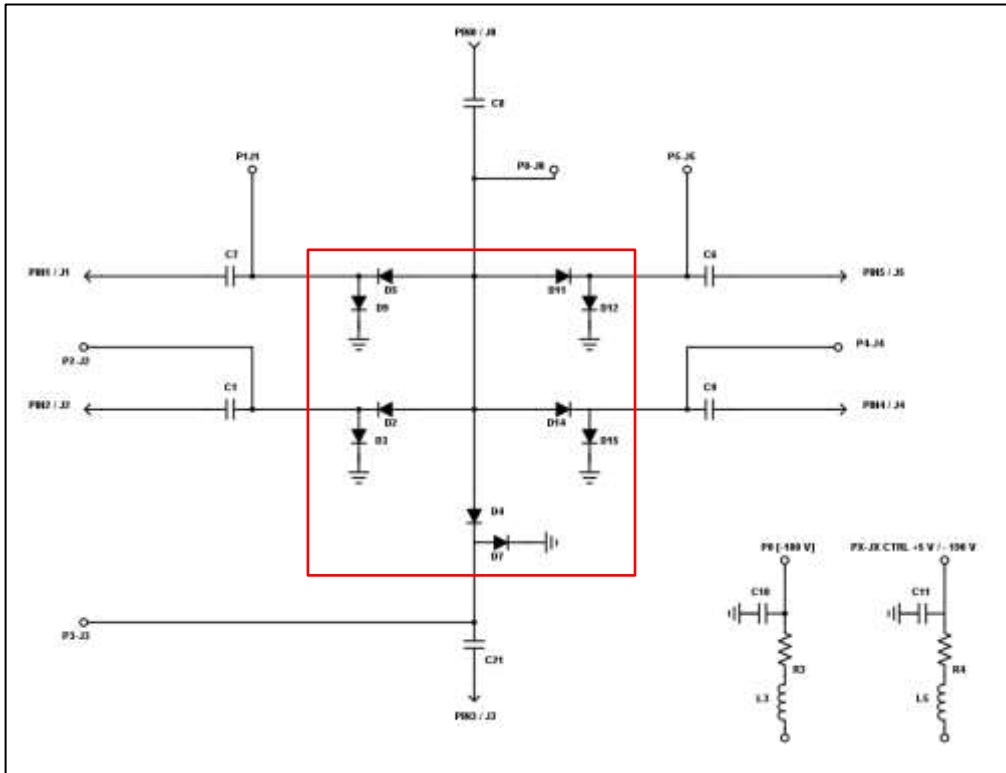
ESD and Moisture Sensitivity Rating

The MSW5T-0310-515 Switch Module carries a Class 1 ESD rating (HBM) and an MSL 1 moisture rating.

Thermal Management Features

A proprietary design methodology minimizes thermal resistance from the PIN Diode junction to base plate (RTHJ-A) to the customer's substrate and associated heat sink. This circuit topology coupled with the thermal characteristic of the substrate design enables reliably handling High Input RF Power up to +50 dBm CW and RF Peak Power levels up to +53 dBm with the base plate temperature at 85°C. The MSW5T-0310-515 has been design to offer superior long term reliability in the customer's application by utilizing ultra-thin Au plating to combat Au embrittlement concerns.

MSW5T-0310-515 Series-Shunt SP5T Switch Module Schematic



[Design Comment: This design is based on +5V / -190V, and -180V bias voltages. With the negative and positive voltages being available, the shunt capacitors can be removed. The -180V and -190V selections are due to 2nd Harmonics consideration. We need to measure to confirm the final linearity spec. The bias voltages could be changed accordingly; the current limiting resistors and power ratings need to be taken into consideration as well (e.g. R3 and R4...etc.)]

Absolute Maximum Ratings

@ $Z_0=50\Omega$, $T_A= +25^\circ\text{C}$ as measured on the base ground surface of the device.

| Parameter | Conditions | Absolute Maximum Value |
|------------------------------------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------|
| DC Forward Current @ Bias Ports | | 250 mA |
| DC Reverse Voltage | | 300 V |
| DC Forward Diode Voltage | 150 mA | 1.2 V |
| Operating Temperature | | -54°C to 80°C |
| Storage Temperature | | -65°C to +150°C |
| Junction Temperature | | +175°C |
| Assembly Temperature | T = 10 sec | +260°C for 10 sec |
| CW Incident Power Handling Source & Load VSWR = 1.5 : 1 (Cold Switching) See Notes below: 1 & 2 | | +50 dBm @ +85 °C Case Temp |
| Peak Incident Power Handling Source & Load VSWR = 1.5 : 1 (Cold Switching) See Notes below: 1 & 2 | | +53 dBm @ 10 usec pulse, 1% duty cycle $T_{\text{case}} = 85^\circ\text{C}$ |

Notes:

- 1) For Hot Switching, PIN Diode Drivers must transition between states in less than 100 nsec with a parallel RC spiking network at the Driver Output.
- 2) Backside RF and DC grounding area must be completely solder attached to the RF Circuit board for proper electrical and thermal circuit grounding.

MSW5T-0310-515 Electrical Specifications

@ Zo=50Ω, TA= +25°C as measured on the base ground surface of the device.

| Parameter | Symbol | Test Condition | Min Value | Typ Value | Max Value | Units |
|---------------------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-------|
| Frequency | F | | 30 | | 1,000 | MHz |
| Insertion Loss | IL (Tx) | Bias State 1: J0 to J1 Bias State 2: J0 to J2 Bias State 3: J0 to J3 Bias State 4: J0 to J4 Bias State 5: J0 to J5 | | 0.4 | 0.5 | dB |
| Return Loss | RL (Tx) | Bias State 1: J0 to J1 Bias State 2: J0 to J2 Bias State 3: J0 to J3 Bias State 4: J0 to J4 Bias State 5: J0 to J5 | 15 | 17 | | dB |
| Isolation | ISO | Bias State 1: J0 to J1 Bias State 2: J0 to J2 Bias State 3: J0 to J3 Bias State 4: J0 to J4 Bias State 5: J0 to J5 | 30 | 35 | | dB |
| CW Incident Power (note 1) | P _{inc} (CW) | Source & Load VSWR = 1.5:1 | | | 50 | dBm |
| Peak Incident Power Note 1) | P _{inc} (Peak) | Source & Load VSWR = 1.5 : 1, Pulse Width = 10 usec, Duty Cycle = 1% | | | 53 | dBm |
| Switching Time (note 2) | t _{sw} | 10% to 90% RF Voltage | | 1 | 2 | usec |
| Input 3 rd Order Intercept Point | IIP3 | F1 = 500 MHz, F2 = 510 MHz, P1 = P2 = 10 dBm, measured on path biased to low loss state | | 65 | | dBm |

Conditions:

1. The PIN Diode minimum reverse DC Voltage (VHIGH) is used to maintain the High Resistance state in the OFF PIN Diode is determined by the RF Frequency, Incident power, duty cycle, characteristic impedance and VSWR in addition to the RF characteristics of the PIN Diodes.
2. Switching time defined to be from 50% TTL signal to 10/90% RF Voltage is controlled by the PIN Diode Driver circuit performance as well as the RF characteristics of the PIN Diode

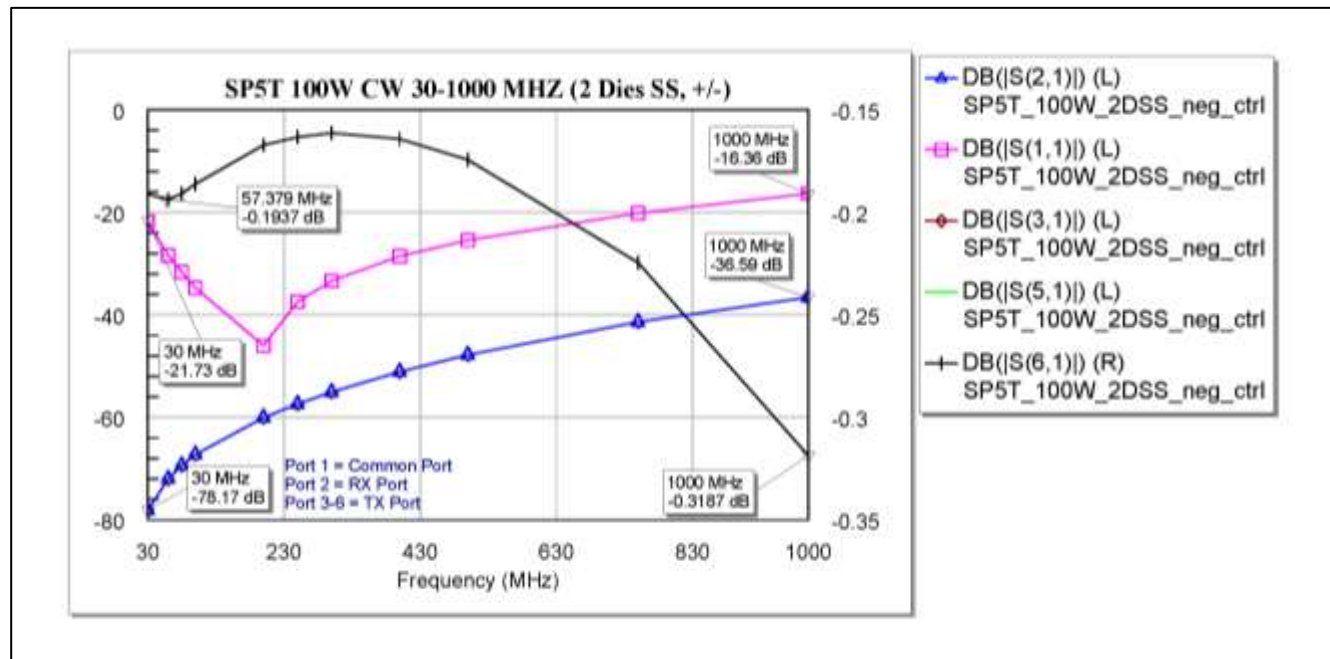
MSW5T-0310-515 Operating Truth Table:

| | ON Channel | B1 | B2 | B3 | B4 | B5 |
|---------|------------|---------------|---------------|---------------|---------------|---------------|
| State 1 | J0-J1 "ON" | -180V @ -50mA | +1 V @ +25mA | +1 V @ +25mA | +1 V @ +25mA | +1 V @ +25mA |
| State 2 | J0-J2 "ON" | +1 V @ +25mA | -180V @ -50mA | +1 V @ +25mA | +1 V @ +25mA | +1 V @ +25mA |
| State 3 | J0-J3 "ON" | +1 V @ +25mA | +1 V @ +25mA | -180V @ -50mA | +1 V @ +25mA | +1 V @ +25mA |
| State 4 | J0-J4 "ON" | +1 V @ +25mA | +1 V @ +25mA | +1 V @ +25mA | -180V @ -50mA | +1 V @ +25mA |
| State 5 | J0-J5 "ON" | +1 V @ +25mA | +1 V @ +25mA | +1 V @ +25mA | +1 V @ +25mA | -180V @ -50mA |

Note:

1. The PIN Diode minimum reverse DC Voltage (VHIGH) is used to maintain the High Resistance state in the OFF PIN Diode is determined by the RF Frequency, Incident power, duty cycle, characteristic impedance and VSWR in addition to the RF characteristics of the PIN Diodes.

MSW5T-0310-515 **Simulated** RF Performance



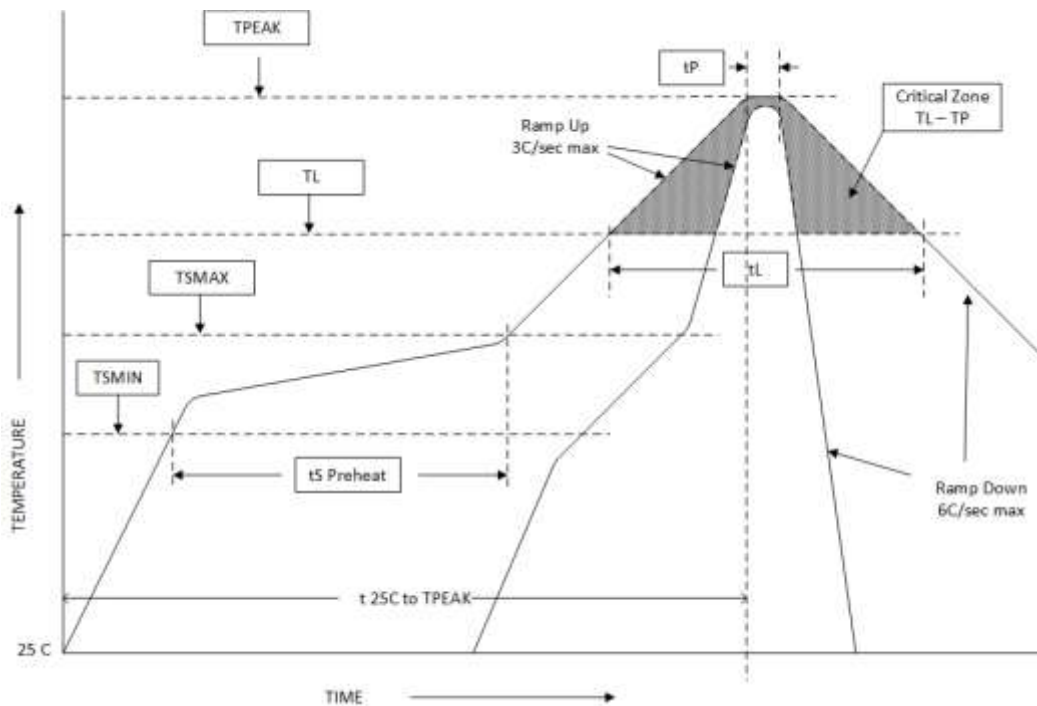
[Design Comment: the removal of shunt capacitor leads to the removal of the 3-4 uH inductor required for shunt diode biasing. This improved the isolation at 1GHz. No changes made on the diode characteristics.]

Assembly Instructions

The MSW5T-0310-515 may be attached to the printed circuit card using solder reflow procedures using either RoHS or Sn63/ Pb37 type solders per the Table and Temperature Profile Graph shown below:

| Profile Parameter | Sn-Pb Assembly Technique | RoHS Assembly Technique |
|----------------------------------------------------------|--------------------------|-------------------------|
| Average ramp-up rate (T _L to T _P) | 3°C/sec (max) | 3°C/sec (max) |
| Preheat | | |
| Temp Min (T _{smin}) | 100°C | 100°C |
| Temp Max (T _{smax}) | 150°C | 150°C |
| Time (min to max) (t _s) | 60 – 120 sec | 60 – 180 sec |
| T _{smax} to T _L | | |
| Ramp up Rate | | 3°C/sec (max) |
| Peak Temp (T _P) | 225°C +0°C / -5°C | 260°C +0°C / -5°C |
| Time within 5°C of Actual Peak Temp (T _P) | 10 to 30 sec | 20 to 40 sec |
| Time Maintained Above: | | |
| Temp (T _L) | 183°C | 217°C |
| Time (t _L) | 60 to 150 sec | 60 to 150 sec |
| Ramp Down Rate | 6°C/sec (max) | 6°C/sec (max) |
| Time 25°C to T _P | 6 minutes (max) | 8 minutes (max) |

Solder Re-Flow Time-Temperature Profile



MSW5T-0310-515 Switch Module Package Outline Drawing

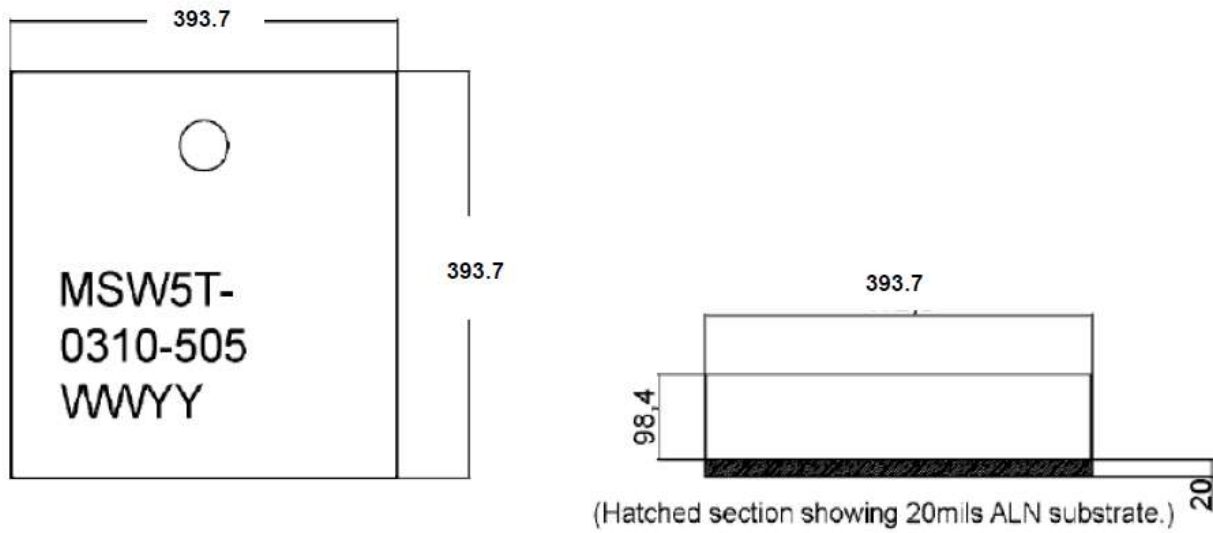


Figure 1 Module Outline and Markings; Units in mils

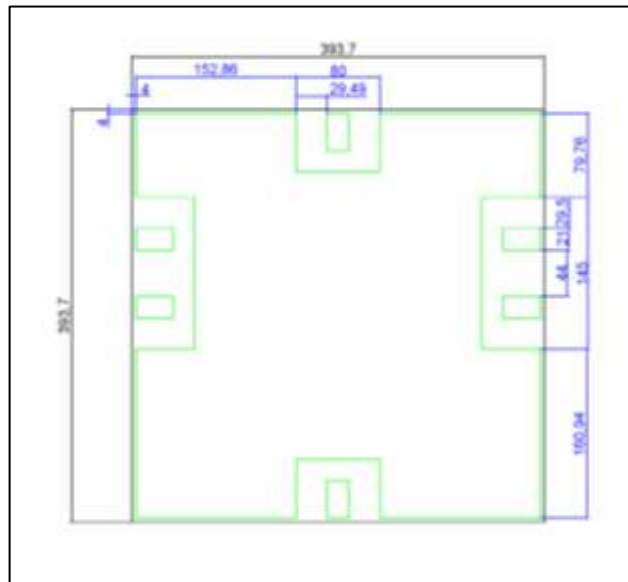


Figure 2 Module Backside / RF Ports and Ground; Units in mils

Notes:

- 1) Metalized area on backside is the RF, DC and Thermal ground. In user's end application this surface temperature must be managed to meet the power handling requirements.
- 2) Back side metallization 10 – 20 Micro Inches (typ) Au termination plating to combat Au embrittlement (Au plated over Cu).
- 3) RF Cover: White Ceramic
- 4) Substrate Material: 20 mils Aluminum Nitride (AlN)

Thermal Design Considerations:

The design of the MSW5T-0310-515 Switch Module permits the maximum efficiency in thermal management of the PIN Diodes while maintaining extremely high reliability. Optimum switch performance and reliability of the device can be achieved by the maintaining the base ground surface temperature of less than 80°C.

There must be a minimal thermal and electrical resistance between the limiter bottom surface and ground. Adequate thermal management is required to maintain a T_{JC} at less than +175°C and thereby avoid adversely affecting the semiconductor reliability. Special care must be taken to assure that minimal voiding occurs in the solder connection beneath the device.

Recommended RF Circuit Solder Footprint for the MSW5T-0310-515

(To Be Furnished)

Notes:

- 1) Recommended PCB material is Rogers 4003C, 25 mils thick (RF Input and Output trace width needs to be adjusted from the recommended footprint.)
- 2) Hatched area is RF, DC and Thermal Ground. Vias should be solid Cu filled and Au plated for optimal heat transfer from backside of Module through circuit vias to thermal ground.

Part Number Ordering Detail:

The MSW5T-0310-515 Switch Modules is available in the following formats:

| Part Number | Description | Packaging |
|----------------|-----------------------------------|-----------|
| MSW5T-0310-515 | SP5T 30 MHz – 2.5 GHz 10mm x 10mm | Gel Pack |