PRELIMINARY

RFuW Engineering Ltd.

MSW5T-0310-505

SP5T High Power T Configuration Switch Module - SMT

Features:

- Surface Mount SP5T Switch Module: 12mm x 12mm x 2.5mm
- Frequency Range: 30 MHz to 1.0 GHz
- High Average Power Handling: 50dBm (CW)
- High Peak Power Handling: TBD dBm
- Low Insertion Loss: < 0.80 dB
- Return Loss (Ant-Tx) : > 11 dBm
- Isolation: > 40 dB
- 2^{nd} Harmonic: > 80 dBc
- RoHS Compliant

Description:

The MSW5T-0310-505 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-0310-505 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 (12mm x 12mm x 2.5mm) offer world class power handling, low insertion loss, and superior isolation performance in a single device. The MSW5T-0310-505 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 TBD dBm peak RF incident power while operating at the T_{amb} (MAX) = +85^{o}C.

ESD and Moisture Sensitivity Rating

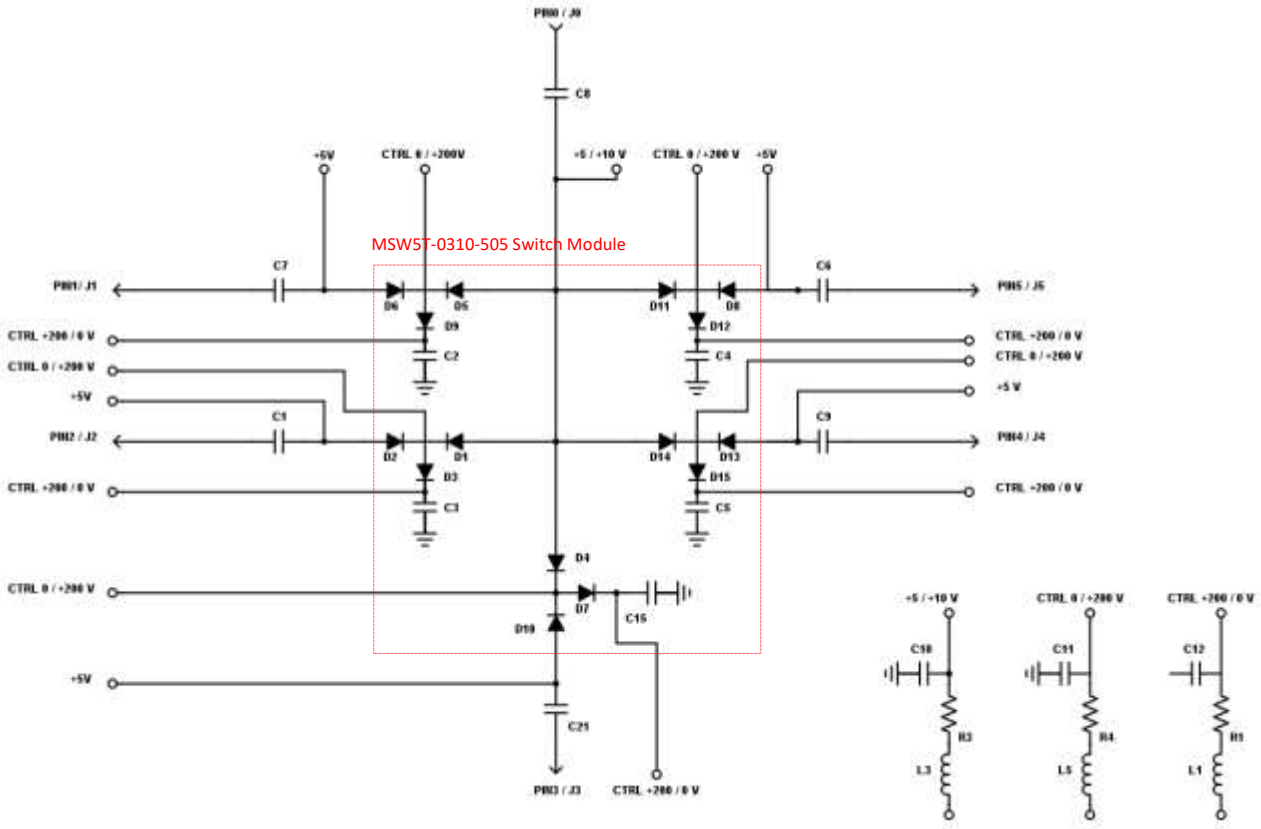
The MSW5T-0310-505 Switch Module carries a Class 1 ESD rating (HBM) and an MSL 1 moisture rating.

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 TBD dBm with the base plate temperature at 85°C. The MSW5T-0310-505 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-0310-505 Switch Module Schematic



[Comment – The choice of T-Junction Diode Configuration is driven by the available positive only voltages, the isolation requirement, and also the linearity (2nd Harmonic) requirement. WBA has also conducted simulations based on Series-Shunt Diode Configuration. The isolation is at least 6dB off from requirement with uncertain linearity performance. The T-Junction gives the best chance of compliance, even though the biasing configurations are rather sophisticated. The inductors are the biasing constraint element, for its high inductance, high current required for 30Mhz, and high enough SRF to work up to 1Ghz. Please note that the +5V biasing source could be shared, but the RF blocking inductors and additional biasing capacitors (not shown) should be placed at the module RF and biasing ports. For example, this design would need six L3 inductors for the respective +5 V bias.]

[Comment II – the +5V might need to be changed to +10V. To be confirmed.]

Absolute Maximum Ratings

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

Parameter	Conditions	Absolute Maximum Value
DC Forward Current @ Bias Ports		~ 500 mA (TBD)
DC Reverse Voltage @ B1		~ 200 V (TBD)
DC Forward Diode Voltage @ B1 or B2	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
Peak Incident Power Handling	10 usec pulse width, 1 % duty cycle source and load VSWR = 1.2 : 1 (max); T_{case} = 85°C	TBD dBm

Note 1: T_{CASE} is defined as the temperature of the bottom ground surface of the device.

MSW5T-0310-505 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)	See Figure 1		< 0.8		dB
Return Loss	RL (Tx)	See Figure 1		> 11		dB
Isolation	ISO	See Figure 1		> 40		dB
CW Incident Power (Note 1)	P_{inc} (CW)	Source & Load VSWR = 1.5:1		50	TBD	dBm
Peak Incident Power (Note 2)	P_{inc} (Peak)	(See Note 2)			TBD	dBm
Switching Time (Note 3)	t_{SW}	10% to 90% RF Voltage		5	TBD	usec
Input 3rd Order Intercept Point	IIP3			TBD		dBm
2nd Harmonics	dBc	RF Input 0dBm (J0); Measured at J1 (Low Loss) and J2 (Isolation)	TBD	82		dBc

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.
2. The diode used in the switch module could meet minimum 1000 Vbr (10uA) requirement. The Peak Incident Power for this module, however, depends on the bias currents at the 30 Mhz frequency range.
3. 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-0310-505 Operating Truth Table:

(Truth Table To Be Furnished). The operating concept is as follow: For J0-J1 in low loss, series Control is put at 0V, and shunt control is put at +200V (*). Meanwhile, for J0-J2 (J2-J5) to be in Isolation Mode, series control is pulled up to +200V (*) and shunt control is put at 0V (current sinking). Resistors will be used to control current sinking and sourcing. (*) Exact voltage to be confirmed upon 2nd Harmonics compliance.

State	J0	B1	J1	B2	B3	J2	B4	B5	J3	B6	B7	J4	B8	B9	J5	B10
J0-J1																
J0-J2																
J0-J3																
J0-J4																
J0-J5																

Note:

1. V_{HIGH}: 0V to 200V
2. 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-0310-505: RF Performance (Simulation) vs Frequency

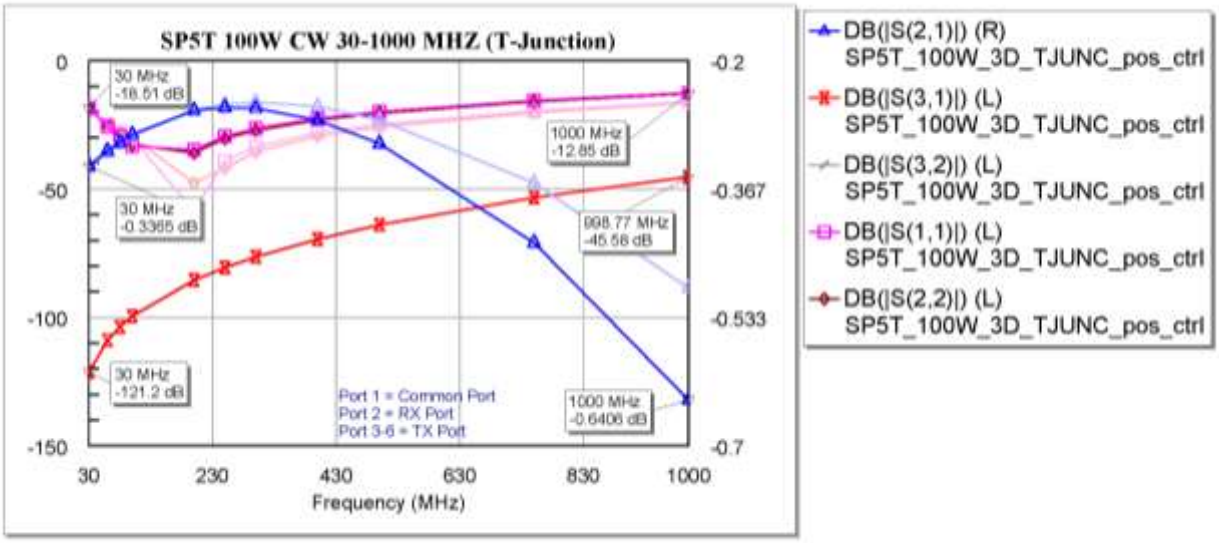


Figure 1 FMSW5T-0310-505 Simulation RF Performance

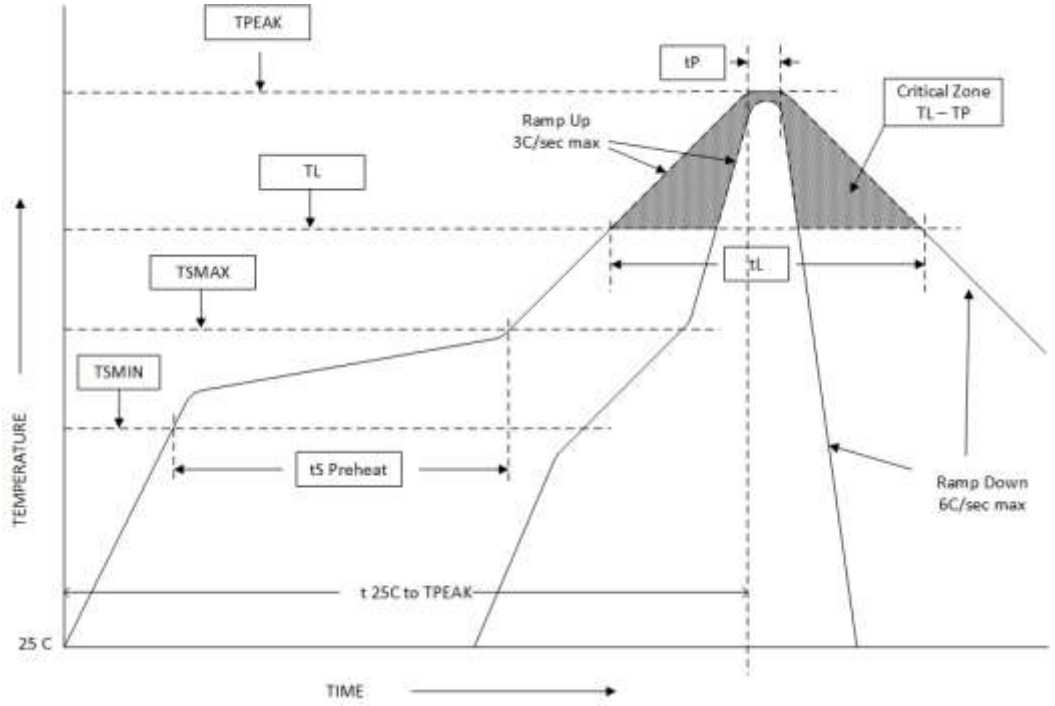
[Comment: Please take note of the change in RL and IL. The 'faded' traces were presented in preliminary datasheet revision A.3. This latest revision included the bond pads capacitance to ground for the TWO series diodes in the transmission path. At 1Ghz, the difference in IL is about 0.15dB whereas the RL is about 4dB difference.

Assembly Instructions

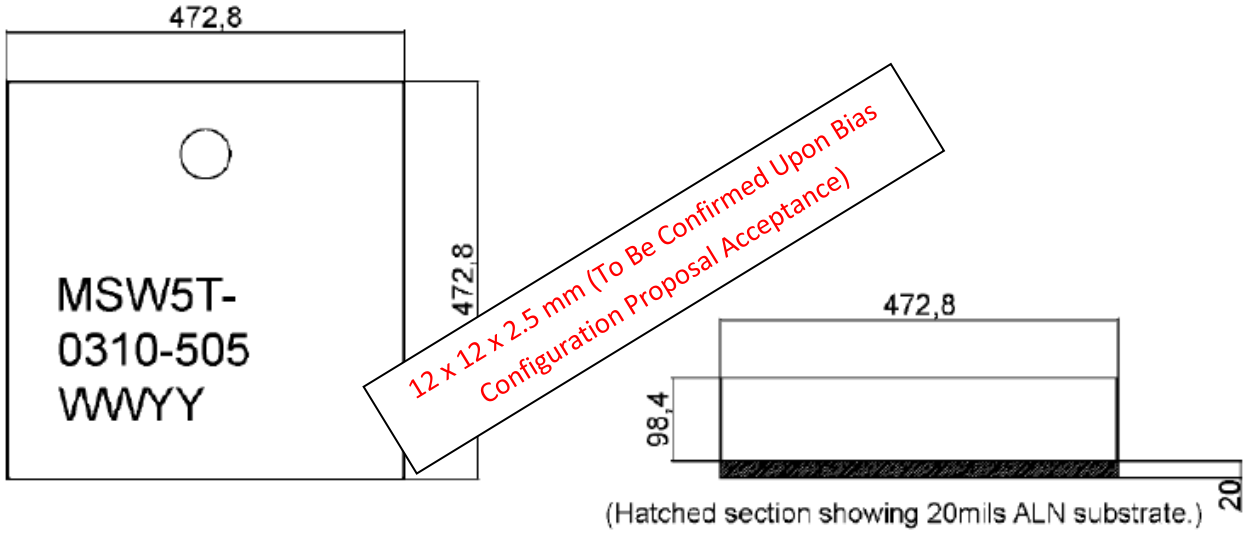
The MSW5T-0310-505/-197 may be attached to the printed circuit card using solder reflow procedures using either RoHS or Sn63/ Pb37 type solders per the Table and Temperature Profile Graph shown below:

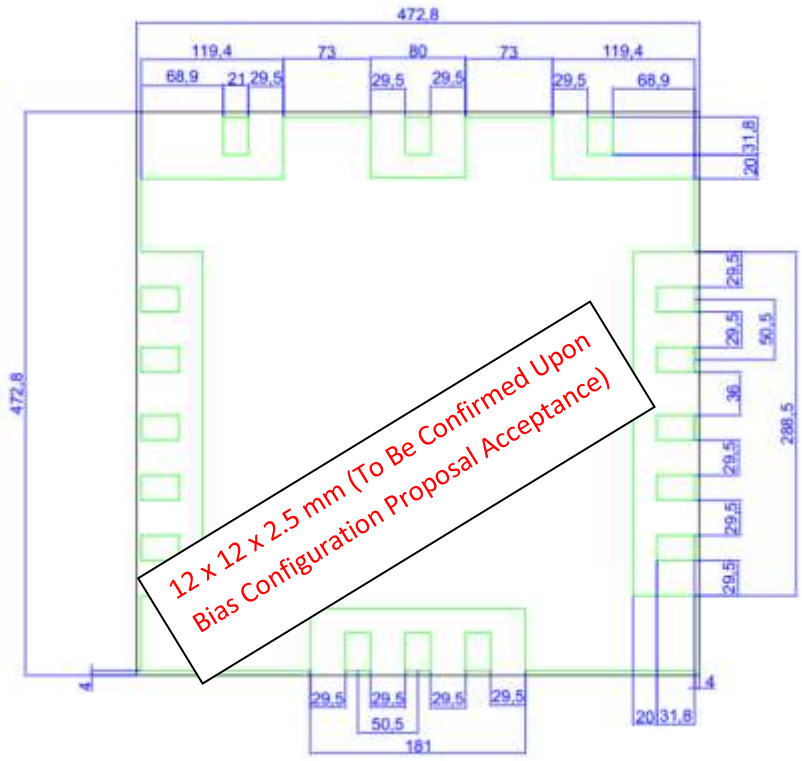
Profile Parameter	Sn-Pb Assembly Technique	RoHS Assembly Technique
Average ramp-up rate (T_L to T_P)	3°C/sec (max)	3°C/sec (max)
Preheat Temp Min (T_{smin}) Temp Max (T_{smax}) Time (min to max) (t_s)	 100°C 150°C 60 – 120 sec	 100°C 150°C 60 – 180 sec
T_{smax} to T_L Ramp up Rate	 	 3°C/sec (max)
Peak 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) Time (t_L)	 183°C 60 to 150 sec	 217°C 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-0310-505 Switch Module Outline Drawing





Notes:

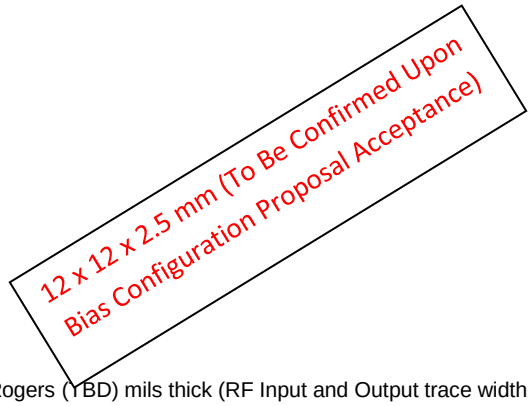
1) Metalized area on backside is the RF, DC and Thermal ground. In user's end application this surface temperature must be managed to meet the power handling requirements.
2) Back side metallization 10 – 20 Micro Inches (typ) Au termination plating to combat Au embrittlement (Au plated over Cu).
3) RF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

Thermal Design Considerations:

The design of the MSW5T-0310-505 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-0310-505



Notes:

1) Recommended PCB material is Rogers (TBD) 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 Limiter Module through circuit vias to thermal ground.

Part Number Ordering Detail:

The MSW5T-0310-505/-197 Switch Modules is available in either tube or Tape & Reel format.

Part Number	Description	Packaging
MSW5T-0310-505	SP5T 30 MHz – 2.5 GHz 12mm x 12mm	Tube
MSW5T-0310-505TR	SP5T 30 MHz – 2.5 GHz 12mm x 12mm	TR (250 pcs)