



## MSW2T-2040X-198

# SP2T SMT Extended High Power PIN Diode Switch

### Features:

- Wide Operating Frequency Band: 100 MHz to 2.0 GHz
- Peak Power: +60 dBm
- Average Power: +56 dBm
- Low Insertion Loss: 0.6 dB
- High IIP3: 65 dBm
- Surface Mount SP2T Switch: 10.1mm x 6.2mm x 2.5mm
- High Linearity
- RoHS Compliant

### Description:

The MSW2T-2040X-198 SP2T surface mount Extra High Power PIN Diode switch operates across the frequency band from 100 MHz to 2.0 GHz. The MSW2T-2040X-198 Extra High Power switch leverages high reliability hybrid manufacturing processes which yield both superior RF and thermal characteristics performance 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 factor (10.1mm x 6.2mm x 2.5mm) offers world class power handling, low insertion loss, and superior intermodulation performance exceeding all competitive technologies. The MSW2040X-198 symmetrical switch is tailored to minimize Transmit-to-Antenna loss while maximizing Transmit-to-Receive isolation and to enable maximum flexibility as the designer can assign either port as Transmit Port and the other as the Receive Port. The extremely low thermal resistance of the hybrid assembly permits reliably handling up to +56 dBm CW power and up to +60 dBm peak RF incident power while operating at the  $T_{CASE (MAX)} = +85^{\circ}C$ .

### Typical Applications:

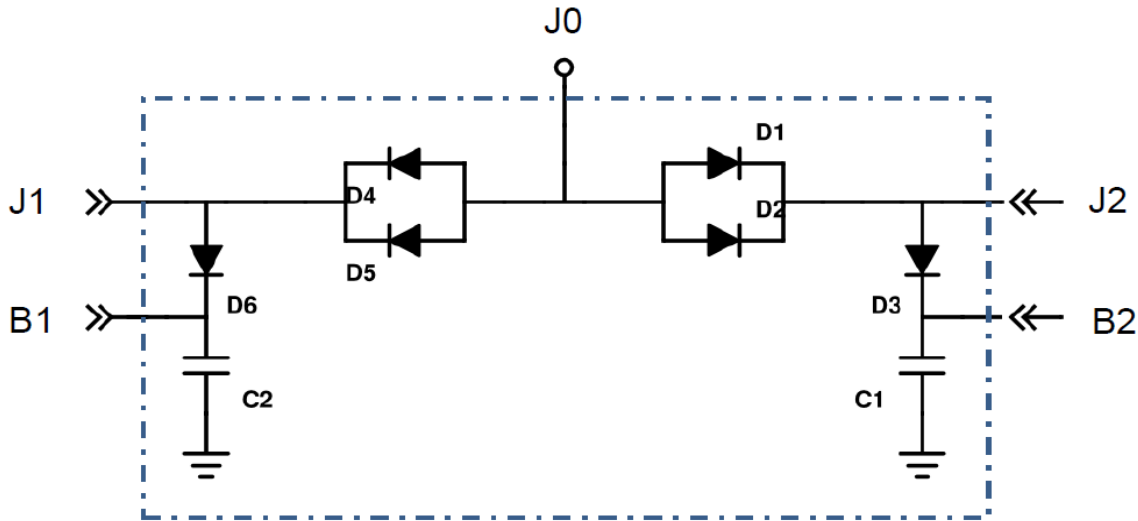
- Radar T/R Modules
- IFF Systems
- High Power Transmit/Receive Switching
- Switch Bank Filters
- Mil-Com Radios

The MSW2T-2040X-198 Extra High Power SP2T switch is intended for use in high power, high reliability, mission critical applications from 100 MHz to 2.0 GHz. The manufacturing process has been proven through decades of extensive use in high reliability application and is capable of being screened to industry HIREL standards.

**ESD and Moisture Sensitivity Level Rating:**

The MSW2T-2040X-198 SP2T switch is fully RoHS compliant and carries an ESD rating of Class 1C, Human Body Model (HBM) with a moisture sensitivity rating of MSL 1.

**MSW2T-2040X-198 Schematic**



**MSW2T-2040X-198 Electrical Specifications @ Zo = 50Ω; Ta = +25°C**

Parameter	Symbol	Test Condition	Min Value	Typ Value	Max Value	Units
Frequency	F		100		2,000	MHz
Insertion Loss	IL	Bias State 1: port J0 to J1 Bias State 2: port J0 to J2 Freq: 100 MHz to 1.0 GHz		0.4	0.5	dB
Insertion Loss	IL	Bias State 1: port J0 to J1 Bias State 2: port J0 to J2 Freq: 1.0 GHz to 2.0 GHz		0.6	0.7	dB
Return Loss	RL	Bias State 1: port J0 to J1 Bias State 2: port J0 to J2	13	15		dB
Isolation	ISO	Bias State 1: port J0 to J1 Bias State 2: port J0 to J2	40	45		dB
CW Incident Power (Note 2)	P <sub>inc</sub> (CW)	Source & Load VSWR = 1.5:1			+56	dBm
Peak Incident Power (Note 2)	P <sub>inc</sub> (Pk)	Source & Load VSWR = 1.5:1 Pulse width = 10 us, Duty Cycle = 1%			+60	dB
Switching Time	t <sub>sw</sub>	10% to 90% RF Voltage, TTL rep rate = 100 kHz		2		usec
Input 3 <sup>rd</sup> Order Intercept Point	IIP3	F <sub>1</sub> =500 MHz, F <sub>2</sub> =510 MHz, P <sub>1</sub> =P <sub>2</sub> =10dBm Measured on path biased to low loss state	60	65		dBm

**MSW2T-2040X-198 Absolute Maximum Ratings @ T<sub>A</sub> = +25 °C (unless otherwise denoted)**

Parameters	Conditions	Absolute Maximum Value
Forward Current –Ant, Tx or Rx Port		300mA
Forward Current – DC Bias Port		100mA
Reverse Voltage – Tx or Rx Port		250V
Reverse Voltage – DC Bias Port		250V
Forward Diode Voltage	I <sub>F</sub> = 250mA	1.2V
Operating Temperature		-65°C to + 125°C
Storage Temperature		-65°C to + 150°C
Junction Temperature		+175°C
Assembly Temperature		260°C for 10 sec
CW Incident Power Handling – J0-J1 or J0-J2 ( Note 1)	Source & Load VSWR = 1.5:1, T <sub>CASE</sub> = +85°C, cold switching	+56 dBm
Peak Incident Power Handling – J0-J1 or J0-J2 (Note 1)	Source & Load VSWR = 1.5:1, T <sub>CASE</sub> = +85°C, cold switching, Pulse Width = 10 us, Duty Cycle = 1%	+60 dBm

Notes:

- 1) Backside RF, DC and Thermal Ground area of device must be completely soldered attached to RF circuit board vias for proper electrical and thermal circuit grounding.

**Control Conditions Table**

	State 1	State 2
Test Condition	J0-J1 in Low Insertion Loss J0-J2 in Isolation	J0-J1 in Isolation J0-J2 in Low Insertion Loss
B1	V <sub>HIGH</sub> , 0 mA	0 V, -25 mA
B2	0 V, -25 mA	V <sub>HIGH</sub> (note 2), 0 mA
J0	~0.9 V, +150 mA	~0.9 V, +150mA
J1	0 V, -150 mA	V <sub>HIGH</sub> (note 2), +25 mA
J2	V <sub>HIGH</sub> (note 2), 25 mA	0 V, -150 mA

Notes:

- 1) Switching time from 50% TTL to 10% or 90% RF Voltage is a function of the PIN diode driver circuit performance as well as the characteristic of the PIN diode. An RC (current spiking network) is used on the driver circuit output to provide a large transient current spike to rapidly remove stored charge from the PIN diode's intrinsic layer. Typical component values are : R = 50 to 220Ω and C = 470 to 1,000 pF.
- 2) PIN diode minimum reverse DC voltage (V<sub>HIGH</sub>) is used to maintain high resistance in the OFF PIN diode state and is determined by RF frequency, incident power, duty cycle, characteristic impedance and VSWR as well by the characteristics of the PIN diode. The recommended minimum value of the reverse bias voltage (V<sub>HIGH</sub>) value is provided in the Minimum Reverse Bias Voltage Table shown below.

### Control Truth Table for MSW2T-2040X-198

J0 – J1 Path	J0-J2 Path	J1 Bias (notes 1 & 2)	J2 Bias (notes 1 & 2)
Low Loss	Isolation	$V_{LOW}$ @, $I = -100$ mA	$V = +1V$ $I = +25$ mA
Isolation	Low Loss	$V = +1V$ , $I = +25$ mA	$V = V_{LOW}$ , $I = -100$ mA

Notes:

- 1)  $V_{LOW}$  determined by frequency of operation.
- 2) PIN diode min reverse DC voltage ( $V_{HIGH}$ ) to maintain high resistance state in the OFF PIN diode is determined by RF frequency. Incident power, duty cycle, characteristic impedance and VSWR as well as by characteristics of the diode. The recommended min reverse bias voltage ( $V_{HIGH}$ ) values are provided in the Min Reverse Bias Voltage Table of this data sheet.

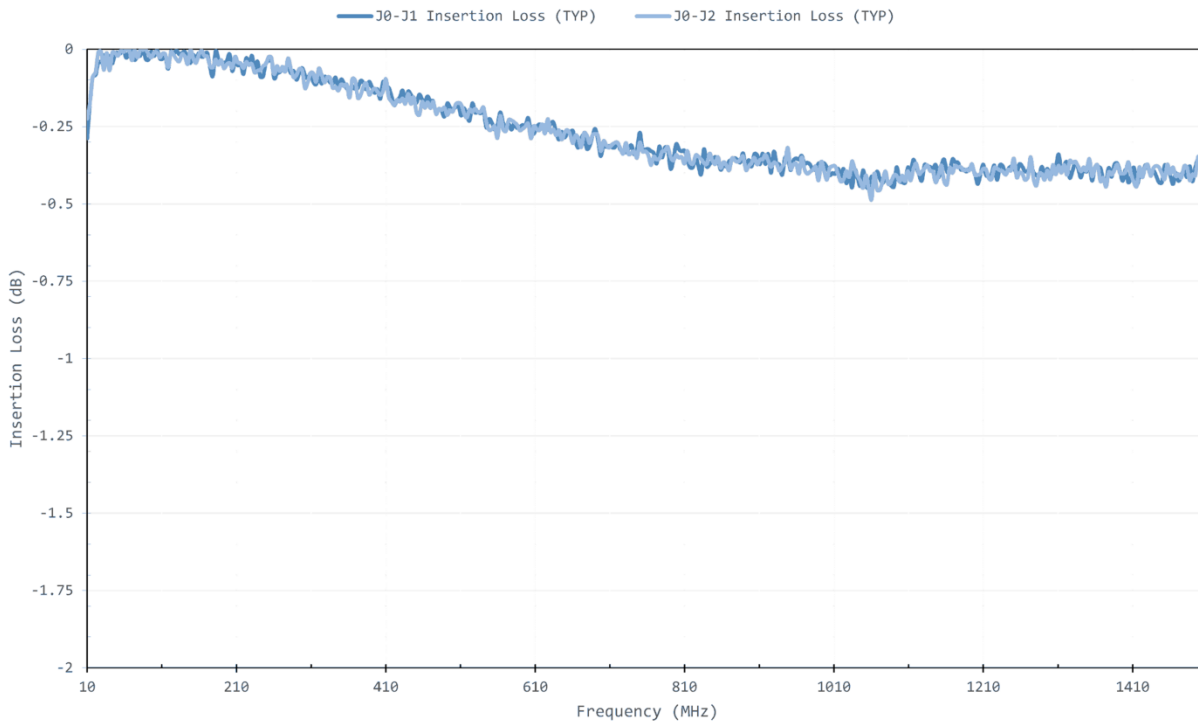
### MSW2T-2040X-198 Minimum Reverse Bias Voltage Table

Part Number	Frequency of Operation (MHz)				
	100	200	400	1,000	2,000
MSW2T-2040X-198	150V	115V	85V	35V	28V

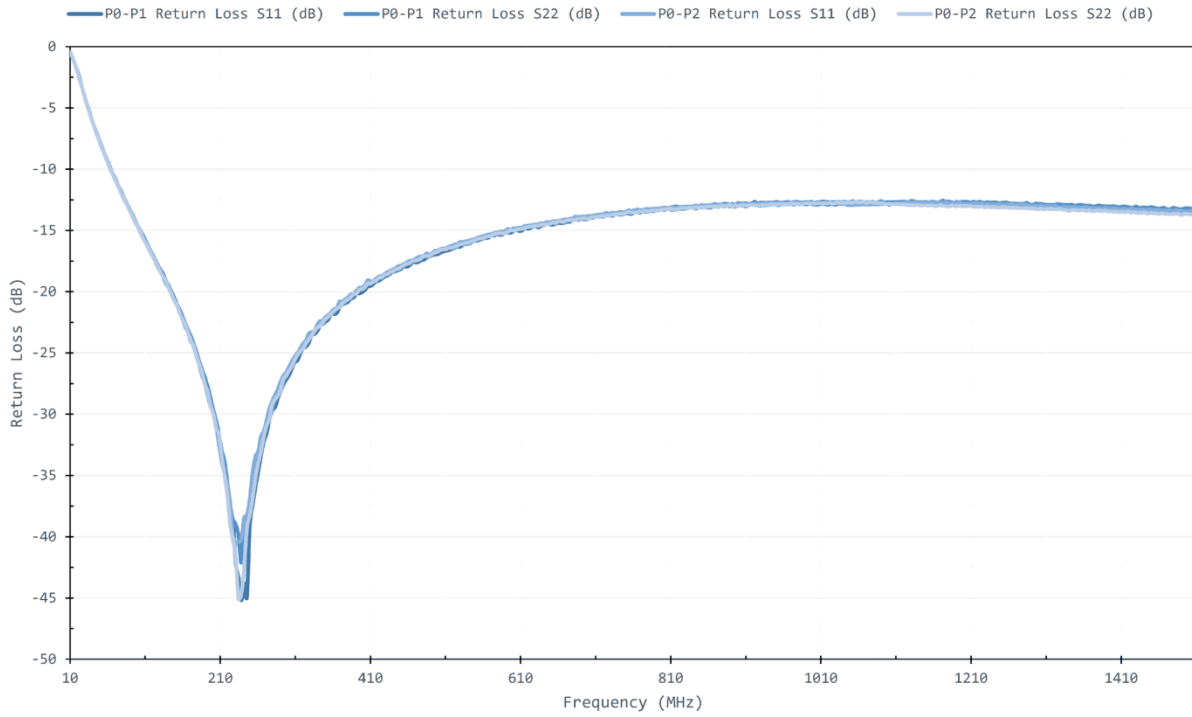
Note: N/A denotes an operating frequency outside the normal switch operating frequency range.

### MSW2T-2040X-198 Small Signal Parametric Performance:

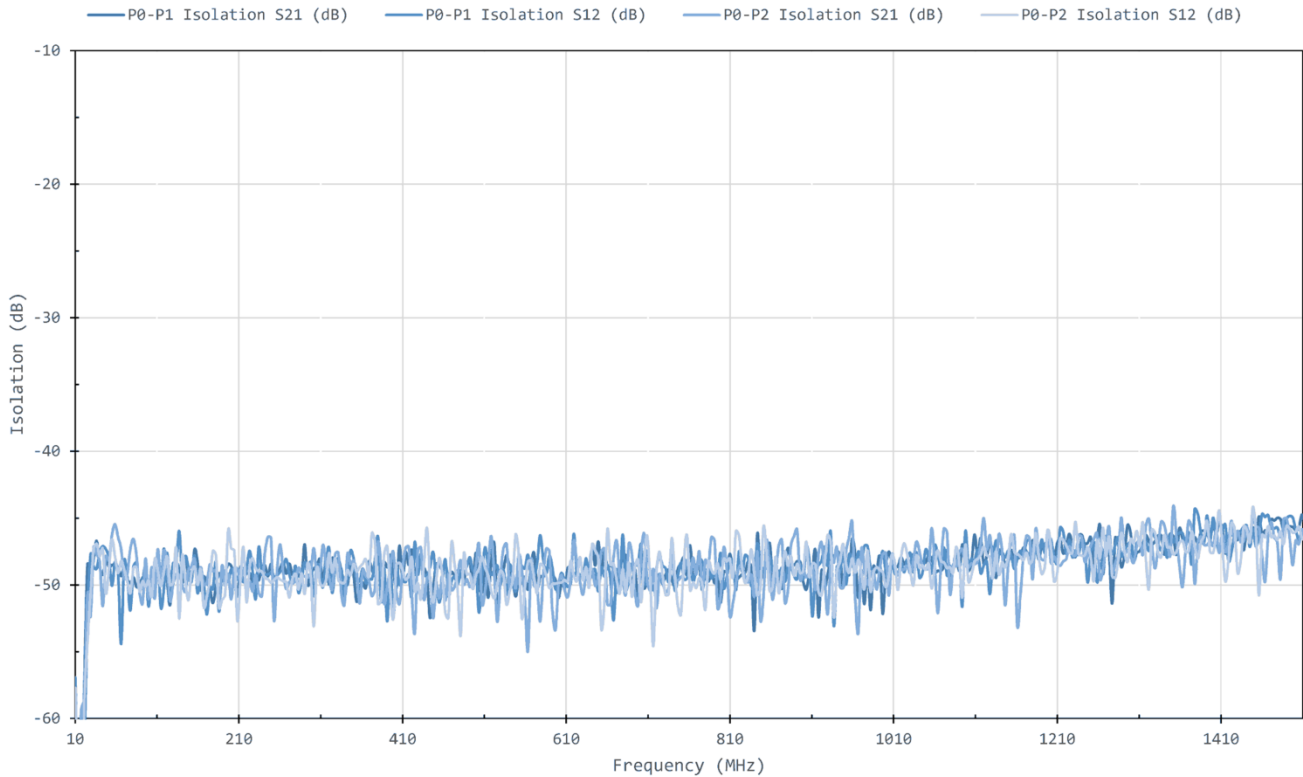
#### MSW2T-2040X-198 Insertion Loss (tuned for 1 GHz)



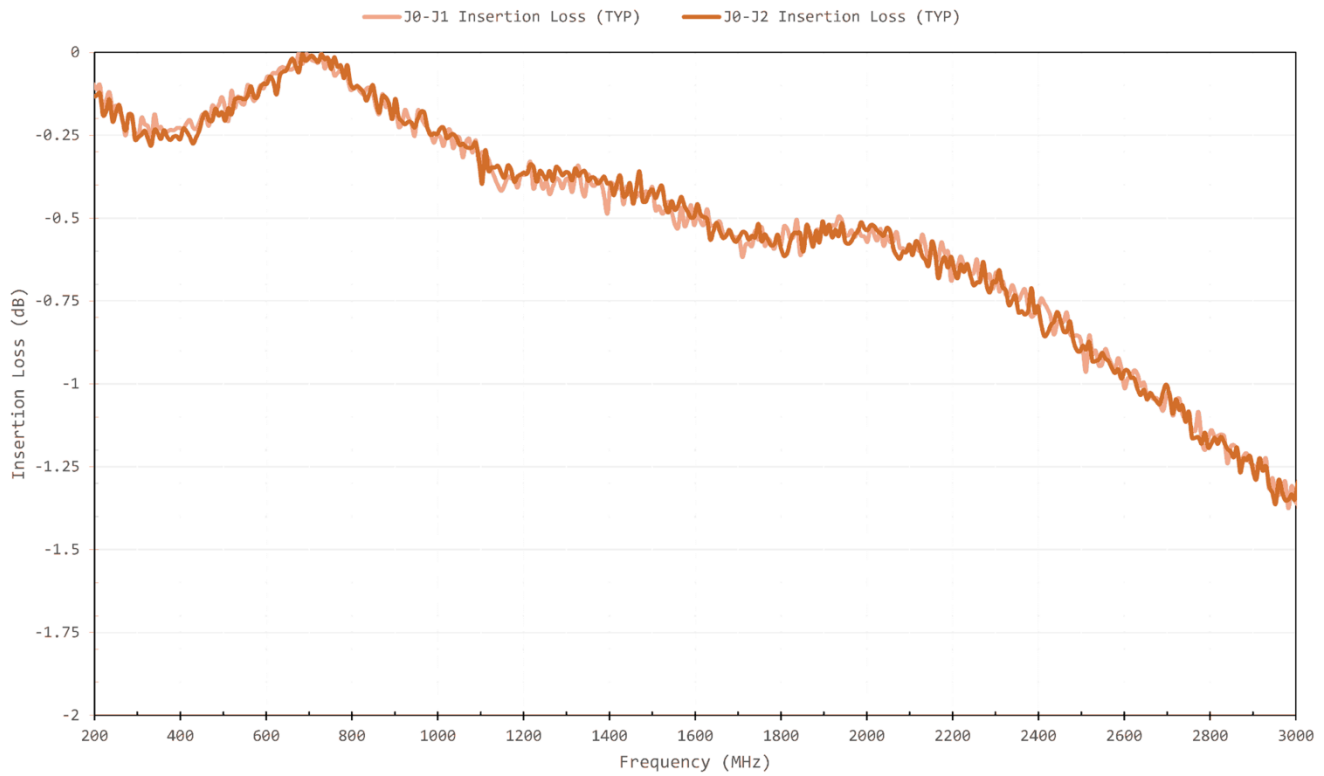
### MSW2T-2040X-198 Return Loss (tuned for 1 GHz)



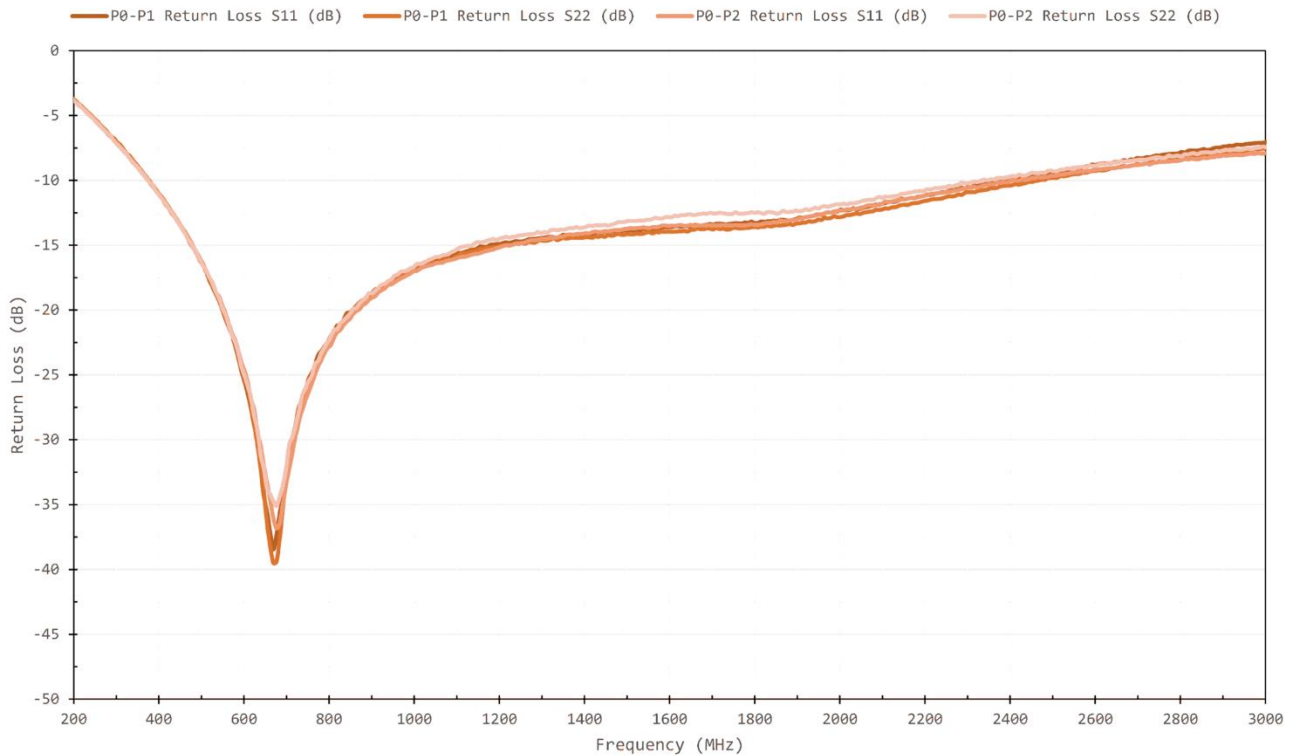
### MSW2T-2040X-198 Isolation (tuned for 1 GHz)



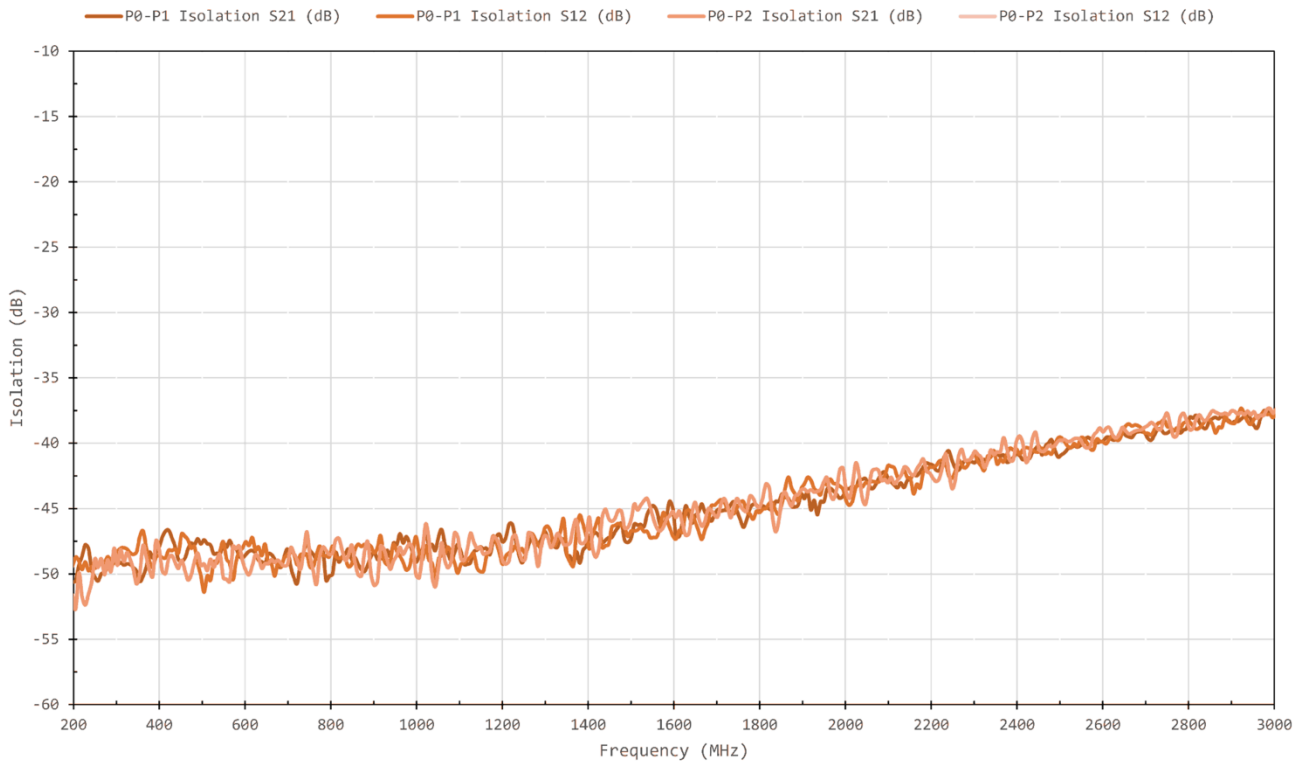
### MSW2T-2040X-198 Insertion Loss (tuned for 2 GHz)



### MSW2T-2040X-198 Return Loss (tuned for 2 GHz)

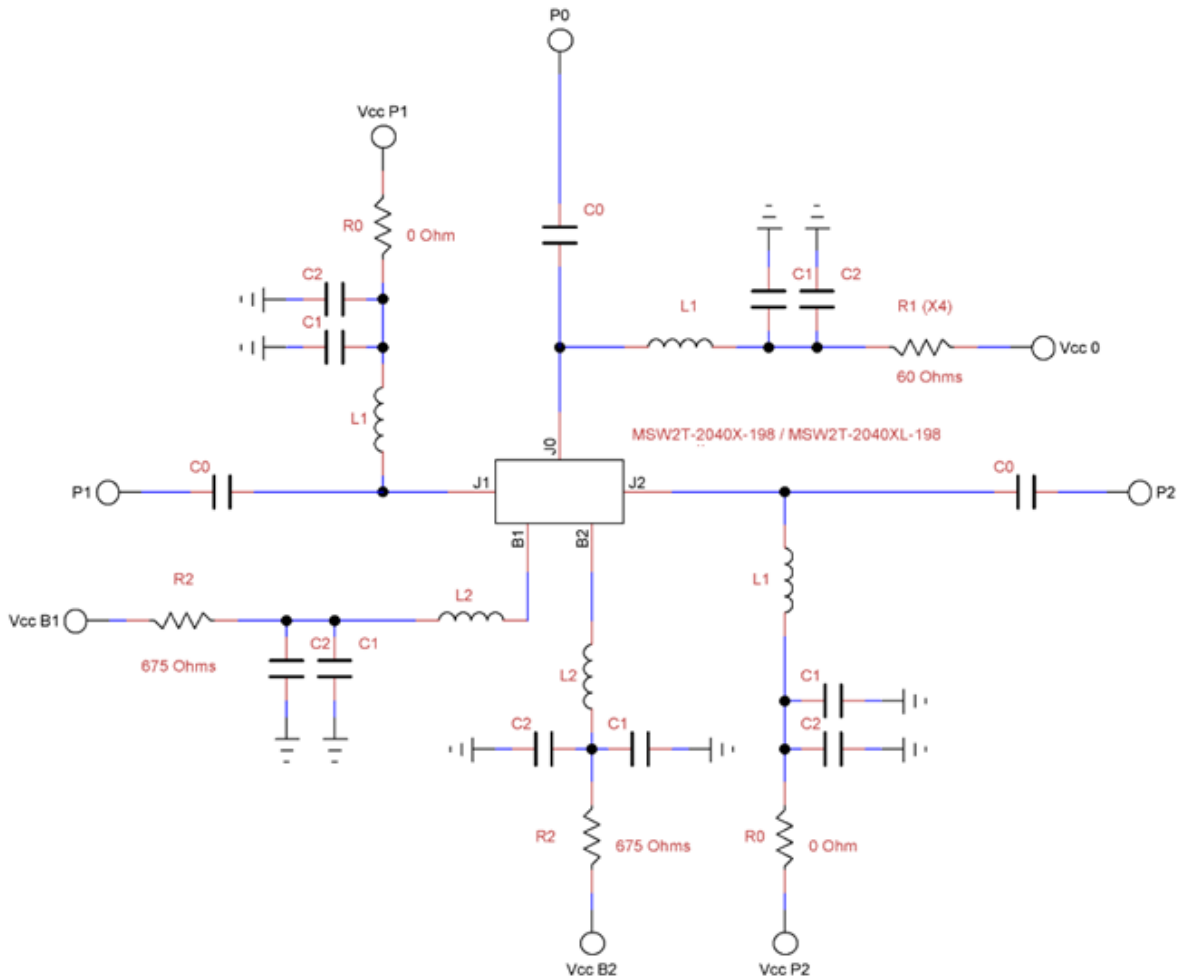


### MSW2T-2040X-198 Isolation (tuned for 2 GHz)



Note: Tuning is accomplished via the external biasing network.

**MSW2T-2040X-198 Biasing Network**

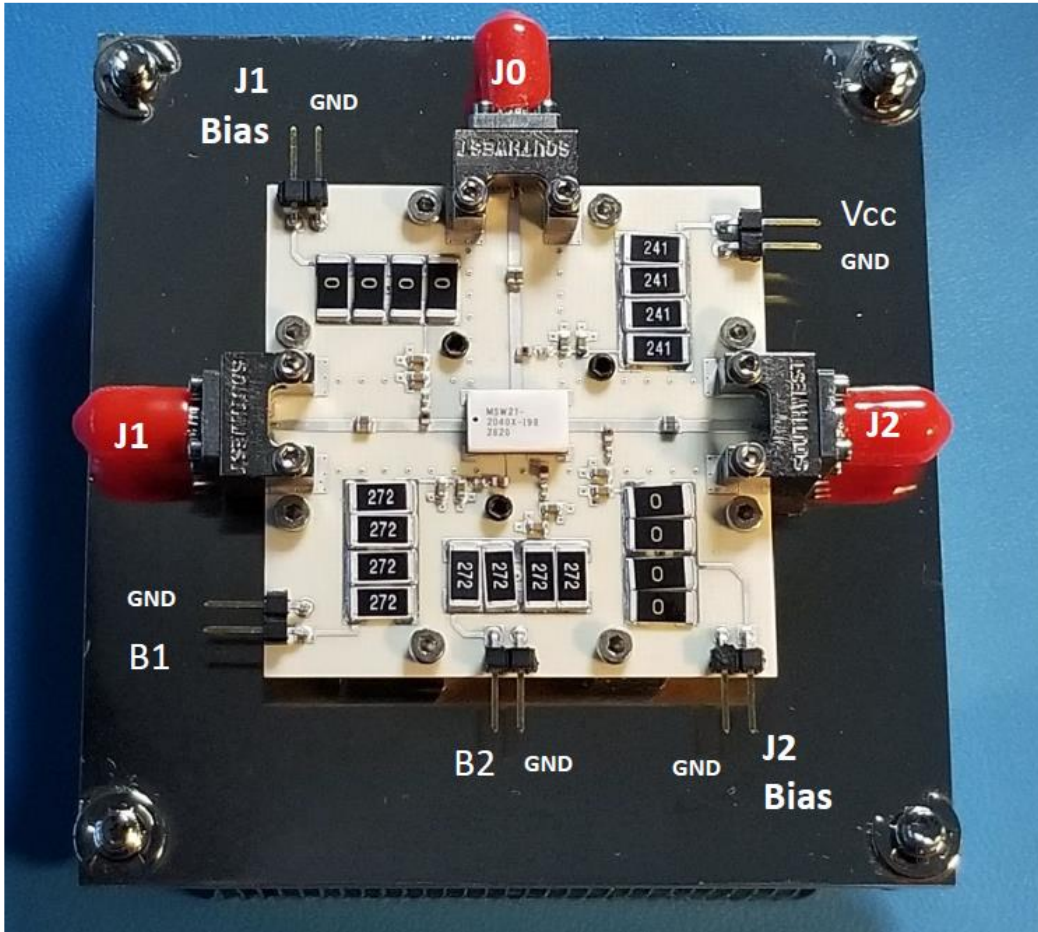


**Biasing Network Bill of Material**

Components and Designation	Usage	MFG	PN	Size (IN)	Value	Remark
RF High Impedance Inductor L1	3	Coilcraft	0603CS-39NXJLW	0603	39 nH	600 mA
RF Inductor Jumper (NOT SHOWN ON THE RIGHT)	3	Coilcraft	0603CS-1N6XJLW	0603	1.6 nH	700 mA
Cap: RF Coupling C0	6	KEMET	CBR06C390J5GAC	0603	39 PF	250 VDC
Cap: RF Bypass/LPF C1	5	KEMET	C0603V102KBRAC7867	0603	1000 PF	630 V
Cap: RF Bypass/LPF C2	5	KEMET	C0805C272KDRAUTO	0805	2700 PF	1000 V
Control Inductor (B1, B2) L2	2	Coilcraft	0603CS-47NXJLW	0603	47 nH	600 mA
Control Inductor Jumper (NOT SHOWN ON THE RIGHT)	2	Coilcraft	0603CS-1N6XJLW	0603	1.6 nH	700 mA



**MSW2T-2040X-198 Evaluation Board**

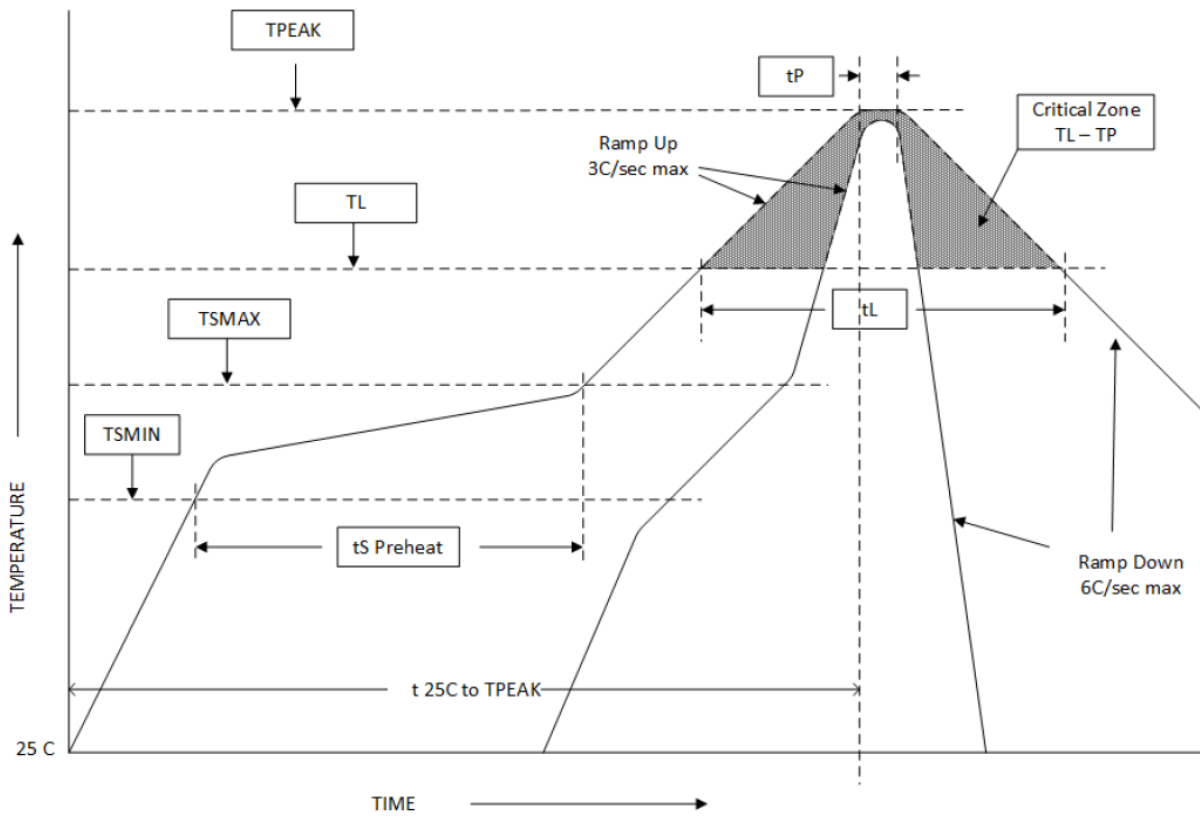


**Assembly Instructions**

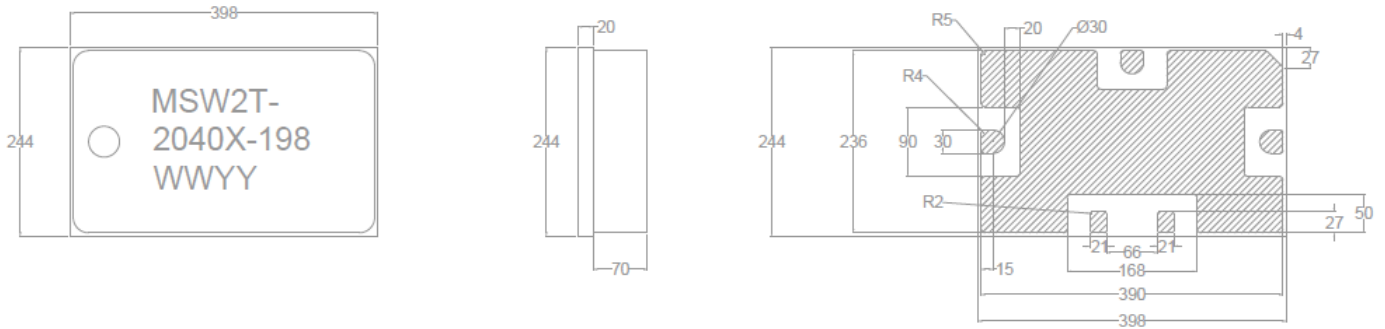
The MSW2T-2040X-198 may be attached to the printed circuit card using solder reflow procedures using either RoHS or Sn63/ Pb37 type solders per the Table and Temperature Profile Graph shown below:

Profile Parameter	Sn-Pb Assembly Technique	RoHS Assembly Technique
Average ramp-up rate (T <sub>L</sub> to T <sub>P</sub> )	3°C/sec (max)	3°C/sec (max)
Preheat		
Temp Min (T <sub>smin</sub> )	100°C	100°C
Temp Max (T <sub>smax</sub> )	150°C	150°C
Time ( min to max) (t <sub>s</sub> )	60 – 120 sec	60 – 120 sec
T <sub>smax</sub> to T <sub>L</sub>		
Ramp up Rate		3°C/sec (max)
Peak Temp (T <sub>P</sub> )	225°C +0°C / -5°C	245°C +0°C / -5°C
Time within 5°C of Actual Peak Temp (T <sub>P</sub> )	10 to 30 sec	20 to 40 sec
Time Maintained Above:		
Temp (T <sub>L</sub> )	183°C	217°C
Time (t <sub>L</sub> )	60 to 150 sec	60 to 150 sec
Ramp Down Rate	6°C/sec (max)	6°C/sec (max)
Time 25°C to T <sub>P</sub>	6 minutes (max)	8 minutes (max)

### Solder Re-Flow Time-Temperature Profile



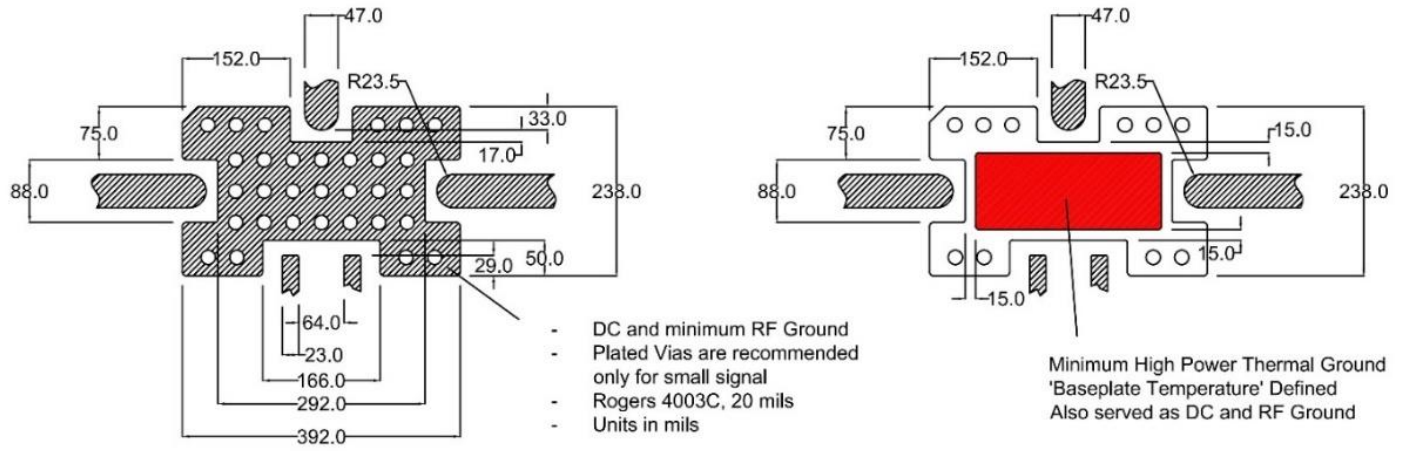
### MSW2T-2040X-198 SP2T Package Outline Drawing



Note: Dimensions in mils

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.

### MSW2T-2040X-198 Suggested Solder Foot Print



Note: Dimensions in mils

### Thermal Design Considerations

The design of the MWT-2040X-198 High Power Switch permits the maximum efficiency in thermal management of the PIN Diodes while maintaining extremely high reliability. Optimum switch performance and reliability of the switch can be achieved by the maintaining the base ground surface temperature of less than +85°C.

### Part Number Ordering Details

The MSW2T-2040X-198 High Power Switch is available in the following format.

Part Number	Description	Packaging
MSW2T-2040X-198	SMT Limiter	Gel-Pack
MSW2T-2040X-198 SS EVB	Small Signal Evaluation Board	Box
MSW2T-2040X-198 HP EVB	High Power Evaluation Board	Box