



## MSW2T-2040-193

# SP2T Surface Mount High Power PIN Diode Switch

### Features:

- Wide Operating Frequency Band: 50 MHz to 4 GHz
- Surface Mount SP2T Switch: 5mm x 8mm x 2.5mm
- Industry Leading Average Power (CW) Handling: 160 W
- High RF Peak Power: 550 W
- Low Insertion Loss: 0.25 dB
- High IIP3: 65 dBm
- High Linearity
- RoHS Compliant

### Description:

The MSW2T-2040-193 symmetrical SP2T surface mount High Power PIN Diode switch offers an exceptionally broadband range of frequency operating from 50 MHz to 4 GHz. The MSW2T-2040-193 high power switches leverage 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 (8mm x 5mm x 2.5mm) offers world class power handling, low insertion loss, and superior intermodulation performance exceeding all competitive technologies. The MSW2040-193 symmetrical switches 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 52 dBm CW power and up to 57 dBm peak RF incident power while operating at the  $T_{amb (MAX)} = +85^{\circ}\text{C}$ .

### Typical Applications:

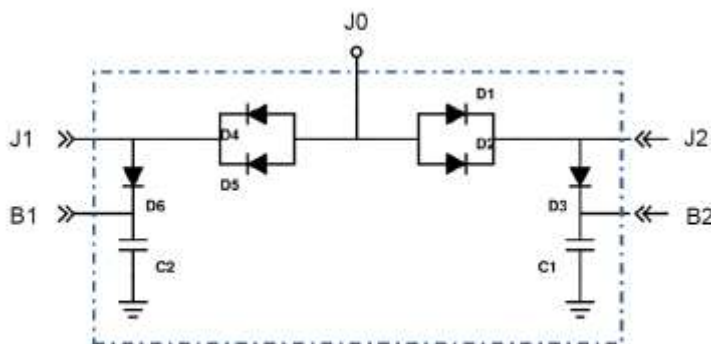
- Radar T/R Modules
- High Power Transmit/Receive Switching
- Switch Bank Filters
- Mil-Com Radios

The MSW2T-2040-193 series of High Power SP2T switches are intended for use in high power, high reliability, mission critical applications from 50 MHz to 4 GHz. The manufacturing process has been proven through decades of extensive use in high reliability applications.

## **ESD and Moisture Sensitivity Level Rating:**

The MSW2T-2040-193 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-2040-193 Schematic**



### **MSW2T-2040-193 Electrical Specifications @ $Z_0 = 50\Omega$ ; $T_a = +25^\circ\text{C}$**

Parameter	Symbol	Test Condition	Min Value	Typ Value	Max Value	Units
Frequency	F		50		4,000	MHz
Insertion Loss	IL	State 1: J0 to J1 & State 2: J0 to J2 50 MHz to 1 GHz		0.15	0.25	dB
Insertion Loss	IL	State 1: J0 to J1 & State 2: J0 to J2 1.0 GHz to 2.0 GHz		0.25	0.4	dB
Insertion Loss	IL	State 1: J0 to J1 & State 2: J0 to J2 2.0 GHz to 4.0 GHz		0.5	0.75	dB
Return Loss	RL	50 MHz to 1 GHz	22	30		dB
Return Loss	RL	1.0 GHz to 2.0 GHz	14	13		dB
Return Loss	RL	2.0 GHz to 4.0 GHz	13	16		dB
Isolation	ISO	State 1: J0 to J1 & State 2: J0 to J2 50 MHz to 1 GHz	45	50		dB
Isolation	ISO	State 1: J0 to J1 & State 2: J0 to J2 1.0 GHz to 2.0 GHz	43	47		dB
Isolation	ISO	State 1: J0 to J1 & State 2: J0 to J2 2.0 GHz to 4.0 GHz	30	40		dB
CW Incident Power (Note 2)	$P_{inc}(CW)$	Source & Load VSWR = 1.5:1			52	dBm
Peak Incident Power (Note 2)	$P_{inc}(Pk)$	Source & Load VSWR = 1.5:1 Pulse width = 10 $\mu\text{s}$ , Duty Cycle = 1%			57	dB
Switching Time	$t_{sw}$	10% to 90% RF Voltage, TTL rep rate = 100 kHz		1	2	usec
Input 3 <sup>rd</sup> Order Intercept Point	IIP3	$F_1=500\text{ MHz}$ , $F_2=510\text{ MHz}$ , $P_1=P_2=10\text{ dBm}$ Measured on path biased to low loss state	60	65		dBm

**MSW2T-2040-193 Absolute Maximum Ratings @  $T_A = +25^\circ\text{C}$  (unless otherwise denoted)**

Parameters	Conditions	Absolute Maximum Value
Forward Current – Ant, Tx or Rx Port		250mA
Forward Current – DC Bias Port		100mA
Reverse Voltage – Tx or Rx Port		125V
Reverse Voltage – DC Bias Port		125V
Forward Diode Voltage	$I_F = 250\text{mA}$	1.2V-
Operating Temperature		$-65^\circ\text{C}$ to $+125^\circ\text{C}$
Storage Temperature		$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Junction Temperature		$+175^\circ\text{C}$
Assembly Temperature		$260^\circ\text{C}$ for 10 sec
CW Incident Power Handling – J0-J1 or J0-J2 ( Note 1)	Source & Load VSWR = 1.5:1, $T_{\text{CASE}} = 85^\circ\text{C}$ , cold switching	52 dBm
Peak Incident Power Handling – J0-J1 or J0-J2 (Note 1)	Source & Load VSWR = 1.5:1, $T_{\text{CASE}} = 85^\circ\text{C}$ , cold switching, Pulse Width = 10 us, Duty Cycle = 1%	57 dBm
Total Dissipated RF & DC Power (note 1)	$T_{\text{CASE}} = 85^\circ\text{C}$ , cold switching	6 W

Notes:

- 1) Backside RF, DC and Thermal Ground area of device must be completely solder 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	$V_{\text{HIGH}}$ , 0 mA	0 V, -25 mA
B2	0 V, -25 mA	$V_{\text{HIGH}}$ (note 2), 0 mA
J0	$\sim 0.9\text{ V}$ , +150 mA	$\sim 0.9\text{ V}$ , +150mA
J1	0 V, -150 mA	$V_{\text{HIGH}}$ (note 2), +25 mA
J2	$V_{\text{HIGH}}$ (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 220 $\Omega$  and C = 470 to 1,000 pF.
- 2) PIN diode minimum reverse DC voltage ( $V_{\text{HIGH}}$ ) 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 ( $V_{\text{HIGH}}$ ) value is provided in the Minimum Reverse Bias Voltage Table shown below.

**Control Truth Table for MSW2T-2040-193**+ $V_{\text{cc1}} = 5\text{V}$  and + $V_{\text{cc2}} = 28\text{V}$  ( unless otherwise noted)

Ant – Tx Path	Ant – Rx Path	Bias J1 (notes 1 & 2)	Bias J2 (notes 1 & 2)	B1 Bias (notes 1 & 2)	B2 Bias (notes 1 & 2)	J0 (notes 1 & 2)
Low Loss	Isolation	$V = 0\text{ V}$ , $I = -150\text{ mA}$	$V = V_{\text{HIGH}}$ , $I = +100\text{ mA}$	$V = V_{\text{HIGH}}$ $I = 0\text{ mA}$	$V = 0\text{ V}$ $I = -25\text{ mA}$	$V \sim 0.9\text{ V}$ $I = +100\text{mA}$
Isolation	Low Loss	$V = V_{\text{HIGH}}$ , $I = +25\text{ mA}$	$V = 0\text{ V}$ , $I = -150\text{ mA}$	$V = 0\text{ V}$ , $I = -25\text{ mA}$	$V_{\text{HIGH}} + 28\text{ V}$ $I = 0\text{ mA}$	$V \sim 0.9\text{ V}$ $I = +100\text{mA}$

## Notes:

- 1)  $28\text{ V} \leq V_{\text{HIGH}} \leq 125\text{ V}$
- 2) PIN diode min reverse DC voltage ( $V_{\text{HIGH}}$ ) 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 ( $V_{\text{HIGH}}$ ) values are provided in the Min Reverse Bias Voltage Table of this data sheet.

## RF Bias Network Recommended Component Values

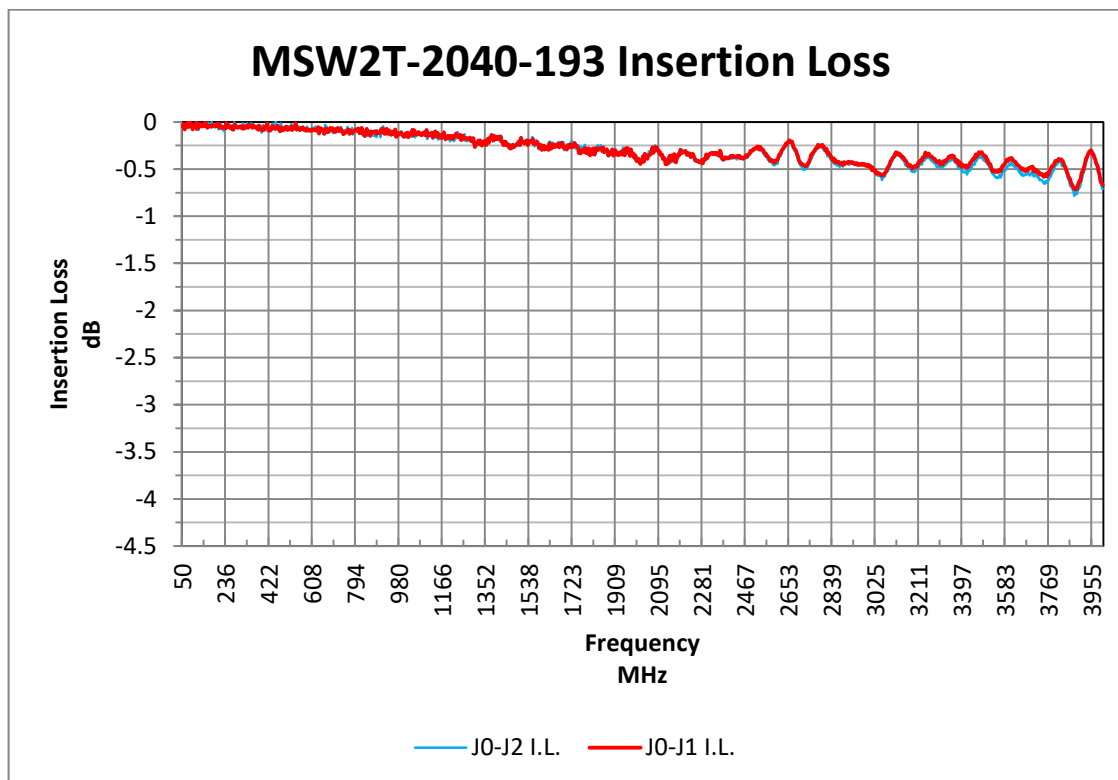
Part Number	Operating Frequency (MHz)	DC Blocking Capacitors	Inductors	RF Bypass Capacitors
MSW2T-2040-193	50 – 1,000	0.1 $\mu\text{F}$	4.7 $\mu\text{H}$	0.1 $\mu\text{F}$

## MSW2T-204X-193 Minimum Reverse Bias Voltage Table

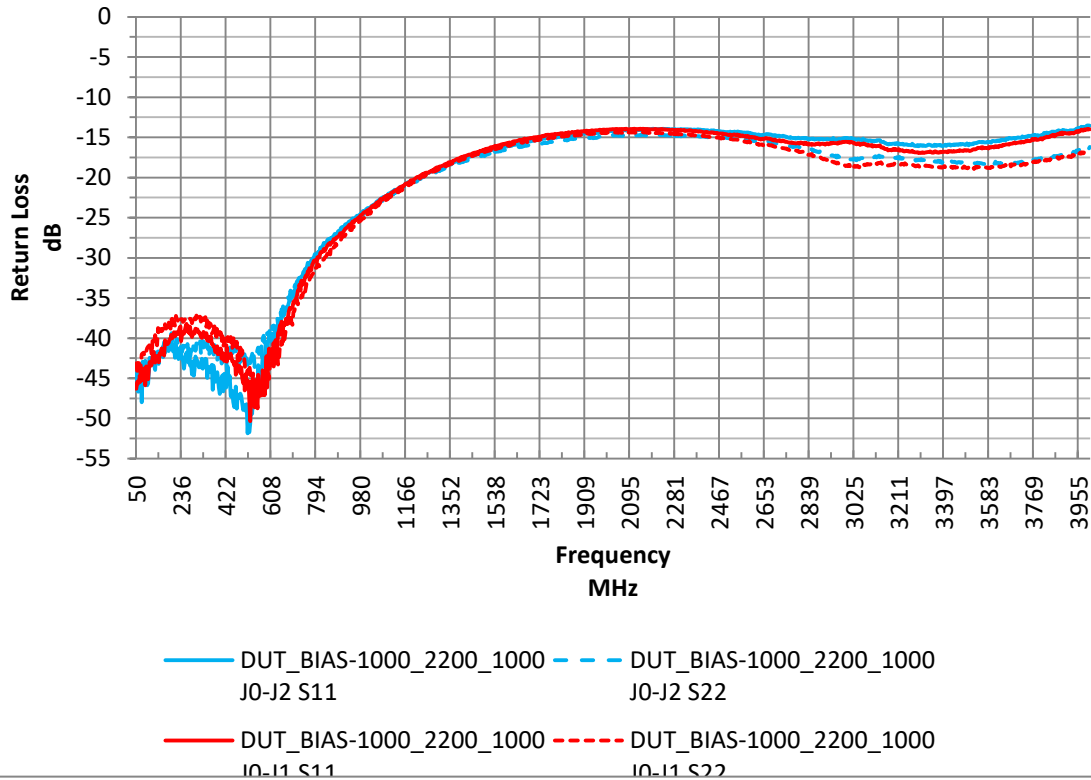
Part Number	Frequency of Operation (MHz)					
	50	100	200	400	1,000	4,000
MSW2T-2040-193	125V	125V	85V	55V	28V	N/A

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

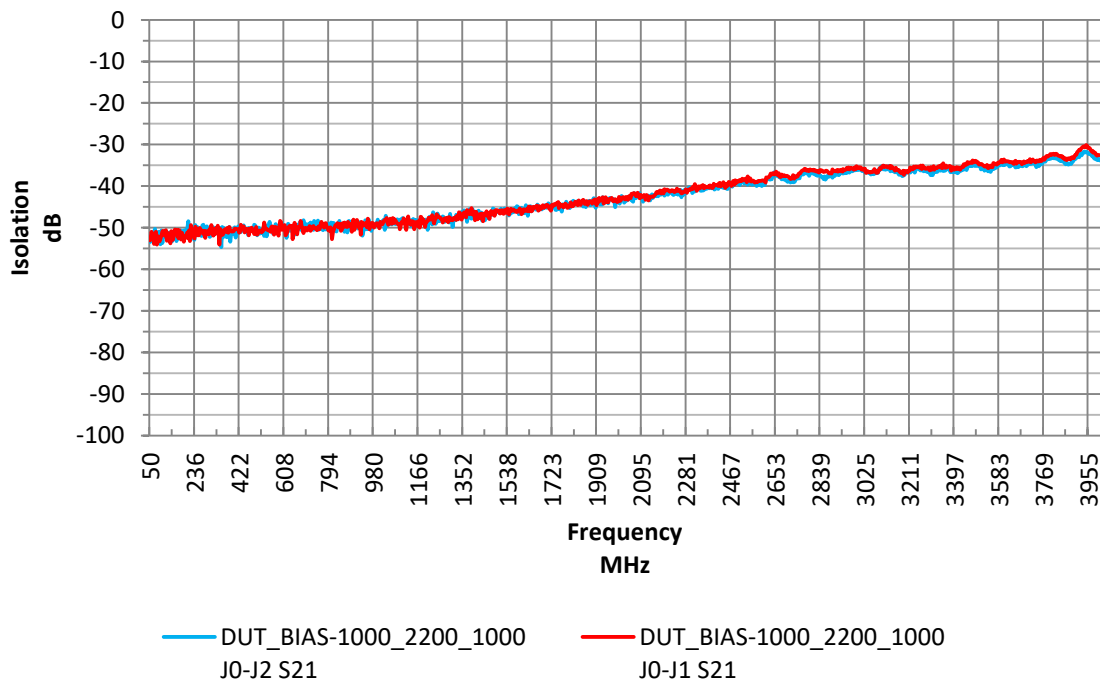
## MSW2T-2040-193 Small Signal Parametric Performance:



### MSW2T-2040-193 Return Loss



### MSW2T-2040-193 Isolation

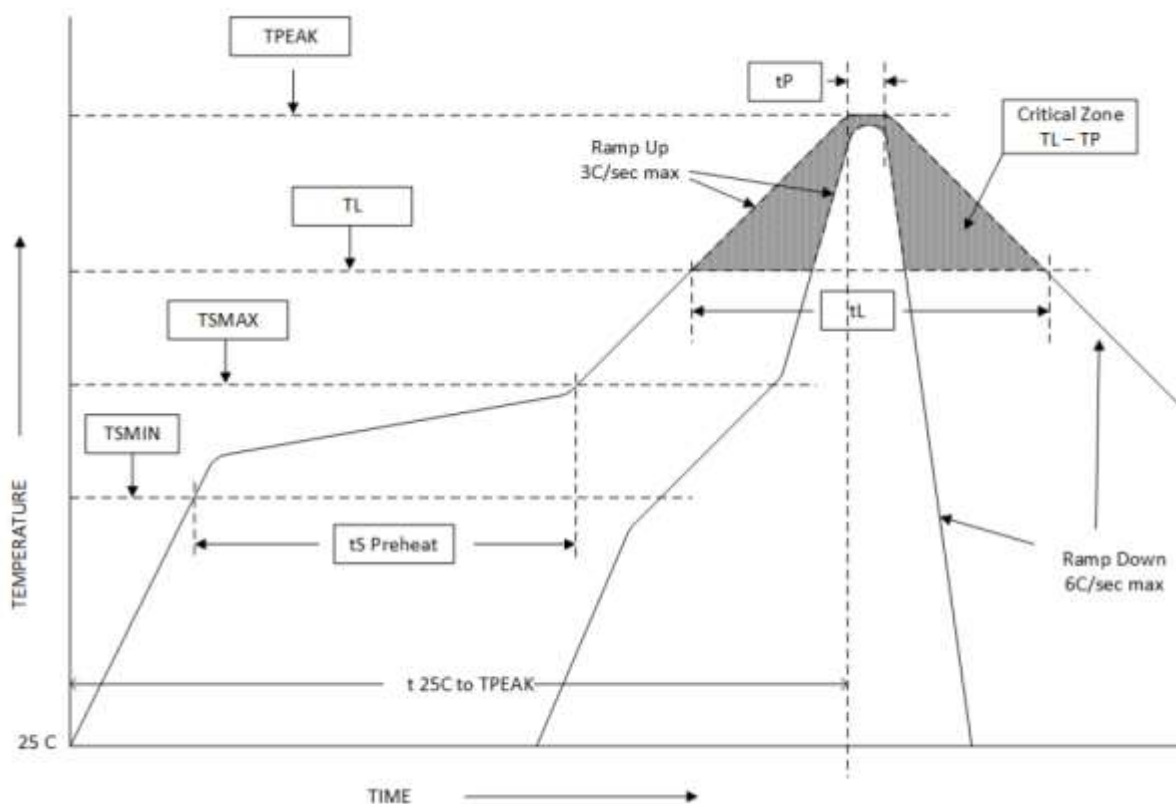


## Assembly Instructions

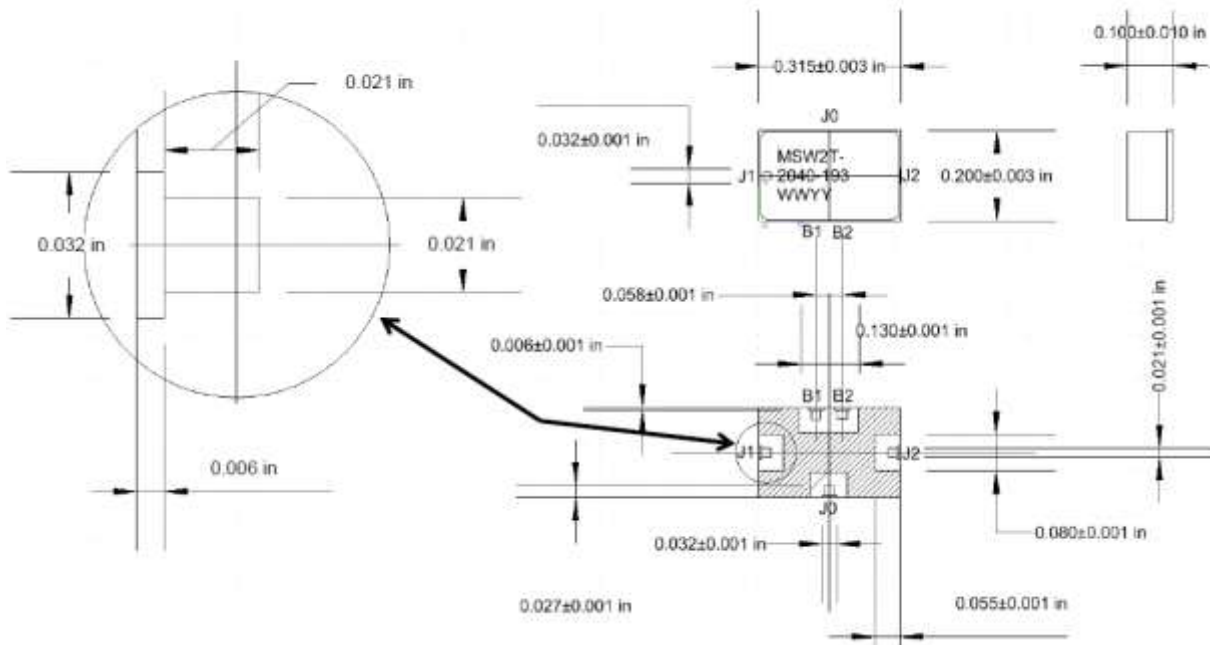
The MSW2T-204X-193 may be attached to the printed circuit card using solder reflow procedures using either RoHS or Sn63/ Pb37 type solders per the Table and Temperature Profile Graph shown below:

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 – 120 sec
$T_{smax}$ to $T_L$ Ramp up Rate		3°C/sec (max)
Peak Temp ( $T_P$ )	225°C +0°C / -5°C	245°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



## MSW2T-2040-193 SP2T Package Outline Drawing

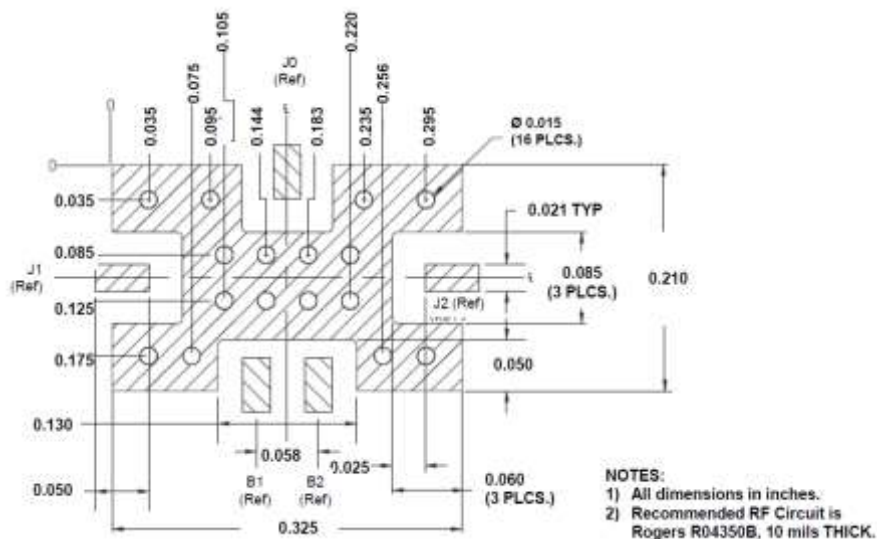


Note: Metalized area on backside is the RF, DC and Thermal ground. In user's end application this surface temperature must be managed to meet the power handling requirements.

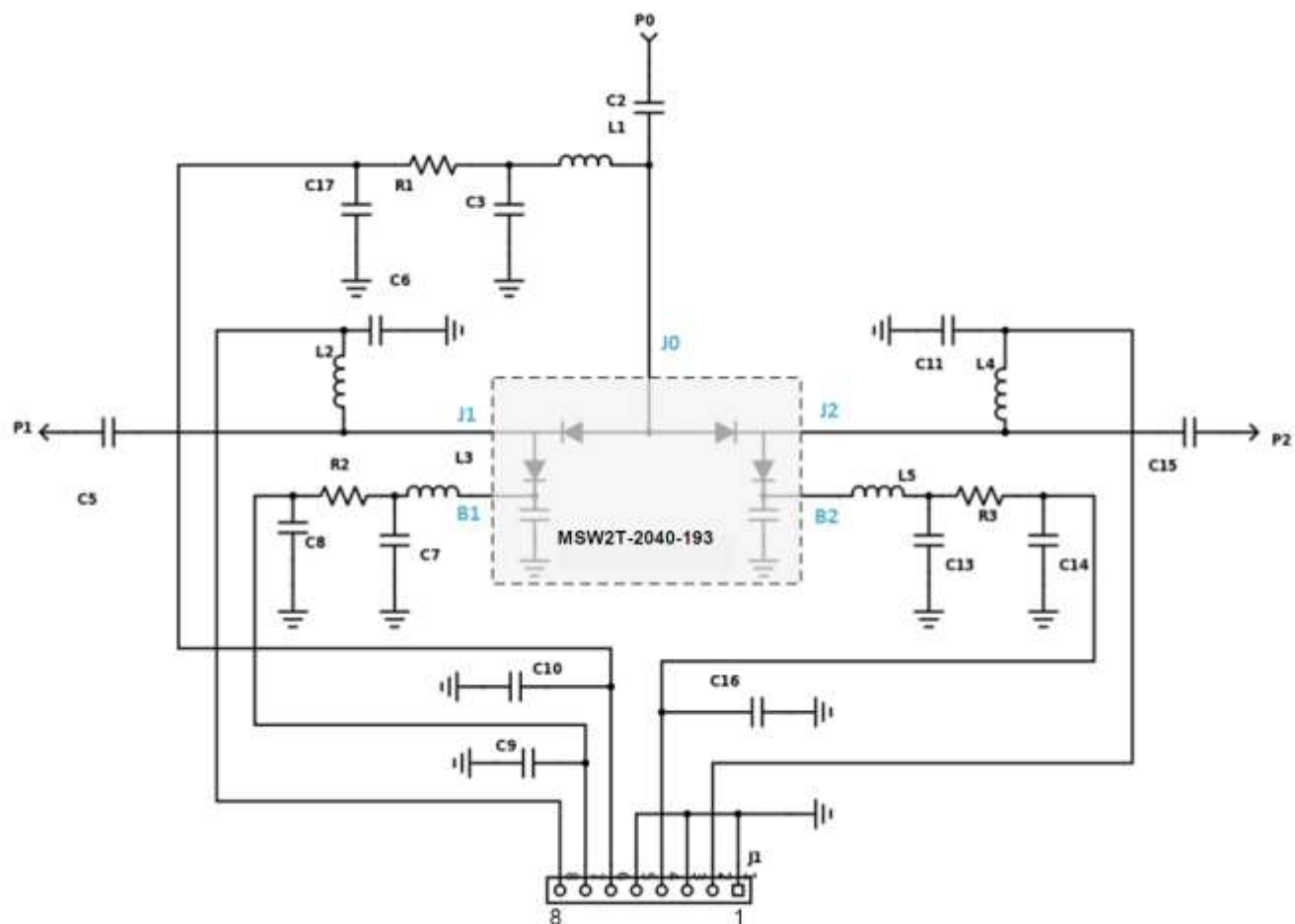
### Thermal Design Considerations:

The design of the MWT-2040-193 High Power Switches 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.

### Recommended RF Circuit Solder Footprint for the MSW2T-2040-193



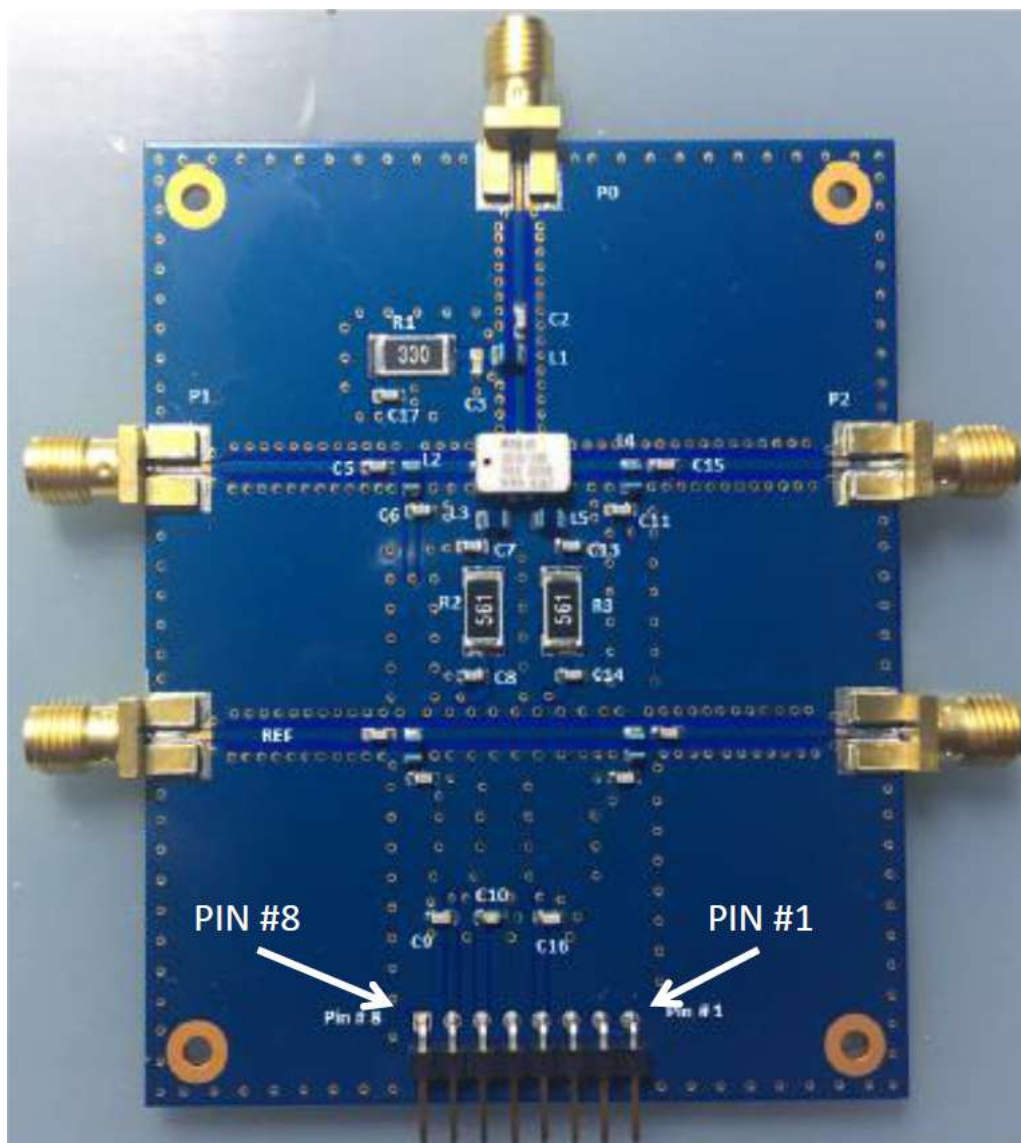
## MSW2T-2040-192 Evaluation Board Schematic & Bill-of-Materials



### Small Signal Bias Components

Component	Nominal Value	Manufacturer	Part Number	Description
C2, C5, C15	27 pF	Johanson Technology	251R14S270JV4T	27 pF $\pm 5\%$ , 250V, Ceramic Cap C0G NP0 0603 (IN)
L1, L2, L3, L4, L5	47 nH	Murata	LQW2BAS47NJ00L	47 nH, 500mA, 0805 (IN)
R1	33 $\Omega$	Panasonic	ERJ-1TYJ330U	RES SMD 33 $\Omega$ $\pm 5\%$ , 1W, 2512 (IN)
R2, R3	560 $\Omega$	Panasonic	ERJ-1TYJ561U	RES SMD 560 $\Omega$ $\pm 5\%$ , 1W, 2512 (IN)
C3, C6, C7, C8, C9, C10, C11, C13, C14, C16, C17	270 pF	TDK	C1608C0G2E271J080AA	CAP CER 270pF, 250V C0G 0603 (IN)

## MSW2T-2040-192 Evaluation Board



### Test Condition 1: P0-P1 Low Loss & P0-P2 ISOLATION

Header J1							
Pin #8	Pin #7	Pin #6	Pin #5	Pin #4	Pin #3	Pin #2	Pin #1
0V/GND -100mA	+20V 0mA	+5V ~100mA	GND	0V/GND -35mA	GND	+20V ~35mA	GND

### Test Condition 2: P0-P1 ISOLATION & P0-P2 LOW LOSS

Header J1							
Pin #8	Pin #7	Pin #6	Pin #5	Pin #4	Pin #3	Pin #2	Pin #1
+20V ~35mA	0V/GND -35mA	+5V ~100mA	GND	+20V 0mA	GND	0V/GND -100mA	GND

**Part Number Ordering Details:**

The MSW2T-2040-193 High Power Switch is available in the following format.

Part Number	Packaging
MSW2T-2040-193	Gel-Pack