

Surface Mount PIN Diode SP2T Switches MSW2000-200, MSW2001-200 & MSW2002-200 Series Datasheet



Features

- Surface Mount SP2T Switch in Compact Outline:
8mm L x 5mm W x 2.5 mm H
- Higher Average Power Handling than Plastic (125 W C.W.)
- Higher Voltage > 500 Volts for Higher RF Peak Power (500 W)
- Lower Insertion Loss (0.25 dB) & Higher IIP3 (65 dBm)
- Operates From + Voltage Only (+5V, & +28V to +125V)
- RoHS Compliant



Description

The MSW2000-200, MSW2001-200, and MSW2002-200 Series of Surface Mount Silicon PIN Diode SP2T T-R Switches is manufactured using Aeroflex / Metelics proven hybrid manufacturing process incorporating High Voltage PIN Diodes and passive devices integrated within a ceramic substrate. This low profile, compact, surface mount component, (8mm L x 5mm W x 2.5 mm H) offers superior low and high signal performance to comparable MMIC devices in QFN packages. The SP2T switches are designed in an asymmetrical topology to optimize Tx-Ant Loss and Tx-Rx Isolation performance.

Using PIN Diodes with lower thermal resistance ($< 10 \text{ }^\circ\text{C/W}$), RF C.W. incident power levels of +50 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 ($< 0.8 \text{ } \Omega$), coupled with the longer minority carrier lifetime, ($> 2 \text{ } \mu\text{S}$), provides better IIP3 distortion values $> +65 \text{ dBm}$.

Applications

The MSW2000-200, MSW2001-200, and MSW2002-200 Series SP2T Switches are designed to be used in higher average and peak power switch applications, operating from 20 MHz to 6000 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. The devices are fully RoHS compliant.

Environmental Capabilities

The MSW2000-200, MSW2001-200, and MSW2002-200 Series SP2T Switches are capable of meeting the environmental requirements of MIL-STD-202 and MIL-STD-750.

ESD and Moisture Sensitivity Level Rating

PIN Diode Switches are susceptible to ESD conditions as with all semiconductors. The ESD rating for this device is Class 1C, HBM. The moisture sensitivity level rating for this device is MSL 2



MSW2000-200 Electrical Specifications

@ $Z_0 = 50 \Omega$, $T_A = +25^\circ\text{C}$ (Unless Otherwise Defined)

Parameter	Symbol	Units	Test Conditions	Minimum Value	Typical Value	Maximum Value
Frequency	F	MHz		20	50 – 1000	1500
Tx-Ant Insertion Loss	$I_L(\text{Tx})$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)		-0.15	-0.25
Ant-Rx Insertion Loss	$I_L(\text{Rx})$	dB	0V @ 100 mA (Rx) 28V @ 0 mA (Tx)		-0.25	-0.35
Tx-Ant Return Loss	$R_L(\text{Tx})$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)	-20	-22	
Ant-Rx Return Loss	$R_L(\text{Rx})$	dB	0 V @ 100 mA (Rx) 28V @ 0 mA (Tx)	-20	-23	
Tx-Rx Isolation	$I_{\text{sol}}(\text{Rx})$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)	-48	-52	
Rx-Tx Isolation	$I_{\text{sol}}(\text{Tx})$	dB	0 V @ 100 mA (Rx) 28V @ 0 mA (Tx)	-22	-26	
C.W. Incident Power $I_L(\text{Tx})$ (Note 3)	$P_{\text{inc}}(\text{CW})$	dBm	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx) 1.5:1 Source & Load VSWR		+50	
C.W. Incident Power $I_L(\text{Rx})$ (Note 3)	$P_{\text{inc}}(\text{CW})$	dBm	0V @ 100 mA (Rx) 28V @ 0mA(Tx) 1.5:1 Source & Load VSWR		+43	
Peak. Incident Power $I_L(\text{Tx})$ (Note 3)	$P_{\text{inc}}(\text{Pk})$	dBm	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx) 1.5:1 Source & Load VSWR		+57 @ 10 μs Pulse, 1 % Duty	
Switching Speed	T_s	μs	(10% -90% RF Voltage)		2	3
Input 3rd Order Intercept Point	IIP3	dBm	F1 = 500 MHz F2 = 510 MHz P1 = P2 = +40 dBm	60	65	

SP2T PIN Diode Switches



MSW2001-200 Electrical Specifications

@ $Z_0 = 50 \Omega$, $T_A = +25 \text{ }^\circ\text{C}$ (Unless Otherwise Defined)

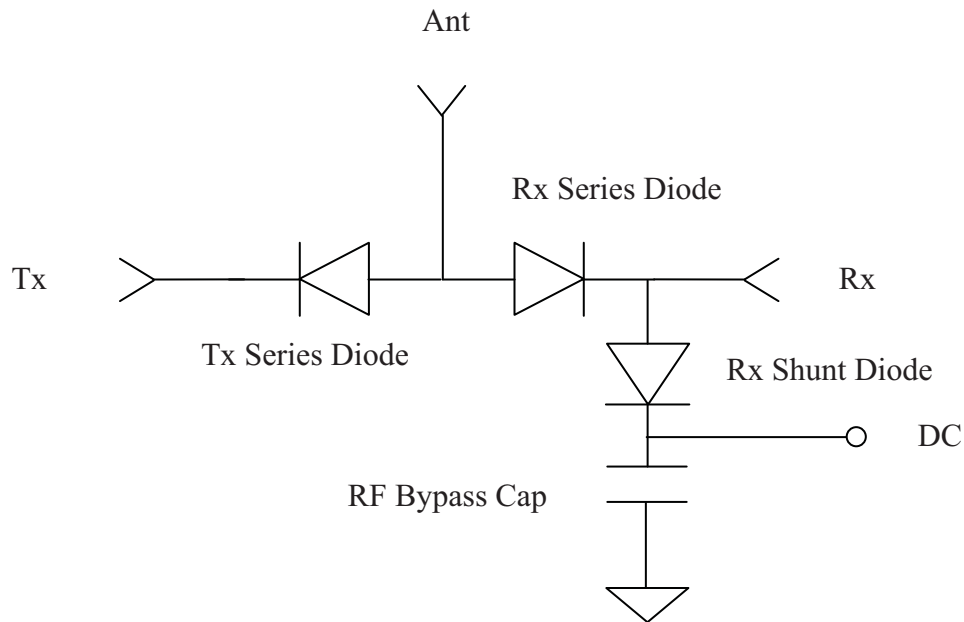
Parameter	Symbol	Units	Test Conditions	Minimum Value	Typical Value	Maximum Value
Frequency	F	MHz		200	400 – 4000	4500
Tx-Ant Insertion Loss	$I_L(Tx)$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)		-0.3	-0.4
Ant-Rx Insertion Loss	$I_L(Rx)$	dB	0V @ 100 mA (Rx) 28V @ 0 mA (Tx)		-0.4	-0.5
Tx-Ant Return Loss	$R_L(Tx)$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)	-15	-18	
Ant-Rx Return Loss	$R_L(Rx)$	dB	0 V @ 100 mA (Rx) 28V @ 0 mA (Tx)	-15	-17	
Tx-Rx Isolation	$I_{sol}(Rx)$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)	-32	-36	
Rx-Tx Isolation	$I_{sol}(Tx)$	dB	0 V @ 100 mA (Rx) 28V @ 0 mA (Tx)	-12	-14	
C.W. Incident Power $I_L(Tx)$ (Note 3)	$P_{inc}(CW)$	dBm	0 V @ 100 mA (Tx) 28V @ 0 mA (Rx) 1.5:1 Source & Load VSWR		+50	
C.W. Incident Power $I_L(Rx)$ (Note 3)	$P_{inc}(CW)$	dBm	0V @ 100 mA (Rx) 28V @ 0mA(Tx) 1.5:1 Source & Load VSWR		+43	
Peak. Incident Power $I_L(Tx)$ (Note 3)	$P_{inc}(Pk)$	dBm	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx) 1.5:1 Source & Load VSWR		+57 @ 10 μ S Pulse, 1 % Duty	
Switching Speed	T_s	μ S	(10% -90% RF Voltage)		1.5	2
Input 3rd Order Intercept Point	IIP3	dBm	F1 = 1000 MHz F2 = 1010 MHz P1 = P2 = +40 dBm	60	65	

MSW2002-200 Electrical Specifications

@ $Z_0 = 50 \Omega$, $T_A = +25 \text{ }^\circ\text{C}$ (Unless Otherwise Defined)

Parameter	Symbol	Units	Test Conditions	Minimum Value	Typical Value	Maximum Value
Frequency	F	GHz		1.5	2 - 6	6.5
Tx-Ant Insertion Loss	$I_L(\text{Tx})$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)		-0.6	-0.7
Ant-Rx Insertion Loss	$I_L(\text{Rx})$	dB	0V @ 100 mA (Rx) 28V @ 0 mA (Tx)		-0.9	-1.0
Tx-Ant Return Loss	$R_L(\text{Tx})$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)	-13	-15	
Ant-Rx Return Loss	$R_L(\text{Rx})$	dB	0 V @ 100 mA (Rx) 28V @ 0 mA (Tx)	-11	-13	
Tx-Rx Isolation	$I_{\text{SOI}}(\text{Rx})$	dB	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx)	-32	-34	
Rx-Tx Isolation	$I_{\text{SOI}}(\text{Tx})$	dB	0 V @ 100 mA (Rx) 28V @ 0 mA (Tx)	-11	-13	
C.W. Incident Power $I_L(\text{Tx})$ (Note 3)	$P_{\text{inc}}(\text{CW})$	dBm	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx) 1.5:1 Source & Load VSWR		+50	
C.W. Incident Power $I_L(\text{Rx})$ (Note 3)	$P_{\text{inc}}(\text{CW})$	dBm	0V @ 100 mA (Rx) 28V @ 0mA(Tx) 1.5:1 Source & Load VSWR		+43	
Peak. Incident Power $I_L(\text{Tx})$ (Note 3)	$P_{\text{inc}}(\text{Pk})$	dBm	0 V @ 100 mA (Tx) 28V @ 25 mA (Rx) 1.5:1 Source & Load VSWR		+57 @ 10 μS Pulse, 1 % Duty	
Switching Speed	T_s	μS	(10% -90% RF Voltage)		1.0	1.5
Input 3rd Order Intercept Point	IIP3	dBm	F1 = 2000 MHz F2 = 2010 MHz P1 = P2 = +40 dBm	60	65	

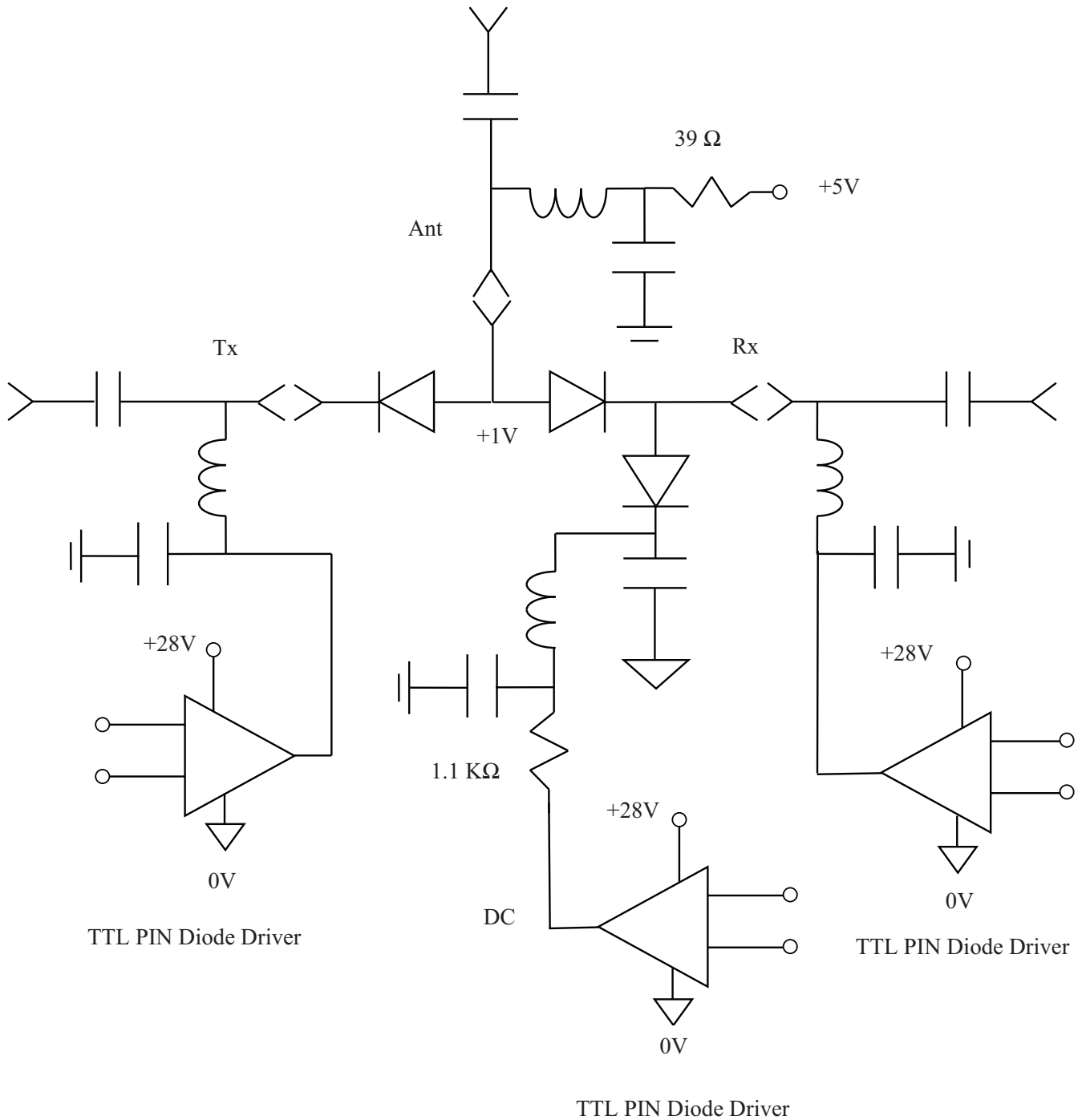
MSW2000-200, MSW2001-200 & MSW2002-200 SP2T Schematic



Electrical Specification Notes:

1. Switching Speed (50 % TTL – 10/90 % RF Voltage) is a Function of the PIN Diode Driver Performance. A RC “ Current Spiking Network” is used on the Driver output to provide a $I_c = C \, dV/dt$ transient current to move Stored charge through the PIN Diode, typical values are: $R = 50 - 220 \, \Omega$ and $C = 470 - 1,000 \, pF$.
2. Aeroflex/Metelics MPD2T28125-700 is the recommended PIN Diode Driver to interface with the MSW2000- 200, MSW2001- 200, and MSW2002-200 SP2T Switches and its data sheet may be found at <http://www.aeroflex.com/metelics>.
3. PIN Diode D.C. Reverse Voltage to maintain High Resistance in the OFF PIN diode is determined by RF Frequency, Incident Power, and VSWR. The Minimum D.C. Reverse Voltage values are provided on page 7 of this datasheet. +28V values shown in these specification tables are utilized for small signal testing ~0 dBm.

SP2T Switch Schematic with RF Bias Network and Truth Table



SP2T PIN Diode Switches



RF Bias Network Values

Part Number	F (MHz)	DC Blocking Capacitors	Inductors	RF Bypass Capacitors
MSW2000-200	50 – 1,000	0.1 μ F	4.7 μ H	0.1 μ F
MSW2001-200	400 – 4,000	27 pF	82 nH	270 pF
MSW2002-200	2,000 - 6,000	22 pF	33 μ H	33 pF

D.C. Bias to RF Truth Table

RF State	Ant Bias	Tx Bias	Rx Bias	DC Bias
Tx-Ant Low Loss & Tx-Rx Isolation	+5V @ +100 mA	0 V @ 100 mA	+28V @ 25 mA	0 V @ 25 mA
Ant-Rx Low Loss & Rx – Tx Isolation	+5 V @ +100 mA	+28V @ 0 mA	0 V @ 100 mA	+28 V @ 0 mA

Minimum Reverse Bias Voltage @ Tx, Rx, DC ports vs. Frequency for 100 W C.W. Power with 1.5:1 VSWR

Part Number	F (MHz) & - Vdc	F (MHz) & - Vdc	F (MHz) & - Vdc	F (MHz) & - Vdc	F (MHz) & - Vdc	F (MHz) & - Vdc
MSW2000-200	20 MHz -120 V	100 MHz -110 V	200 MHz -85 V	400 MHz -55 V	1,000 MHz -28 V	4,000 MHz NA
MSW2001-200	20 MHz NA	100 MHz NA	200 MHz -110 V	400 MHz -85 V	1,000 MHz -55 V	4,000 MHz -28 V
MSW2002-200	1,000 MHz -55 V	2,000 MHz -28 V	3,000 MHz -28 V	4,000 MHz -28 V	5,000 MHz -28 V	6,000 MHz -28 V

Notes:

1. " NA " denotes the Switch is not defined for that Frequency Band.

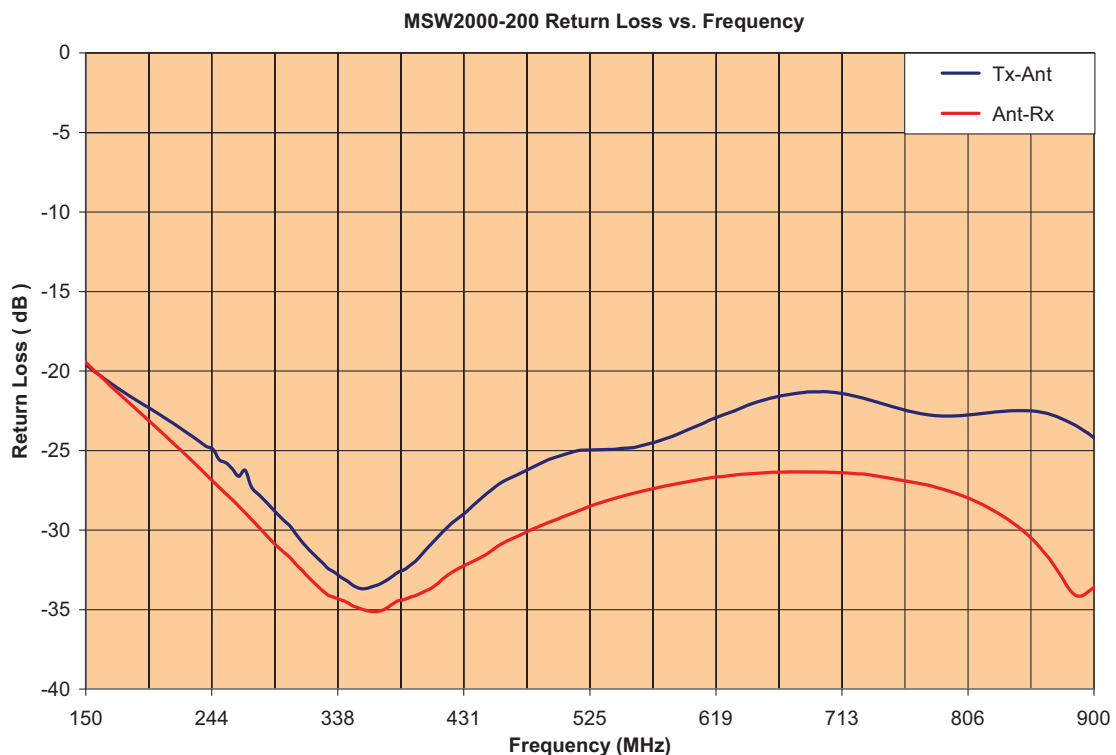
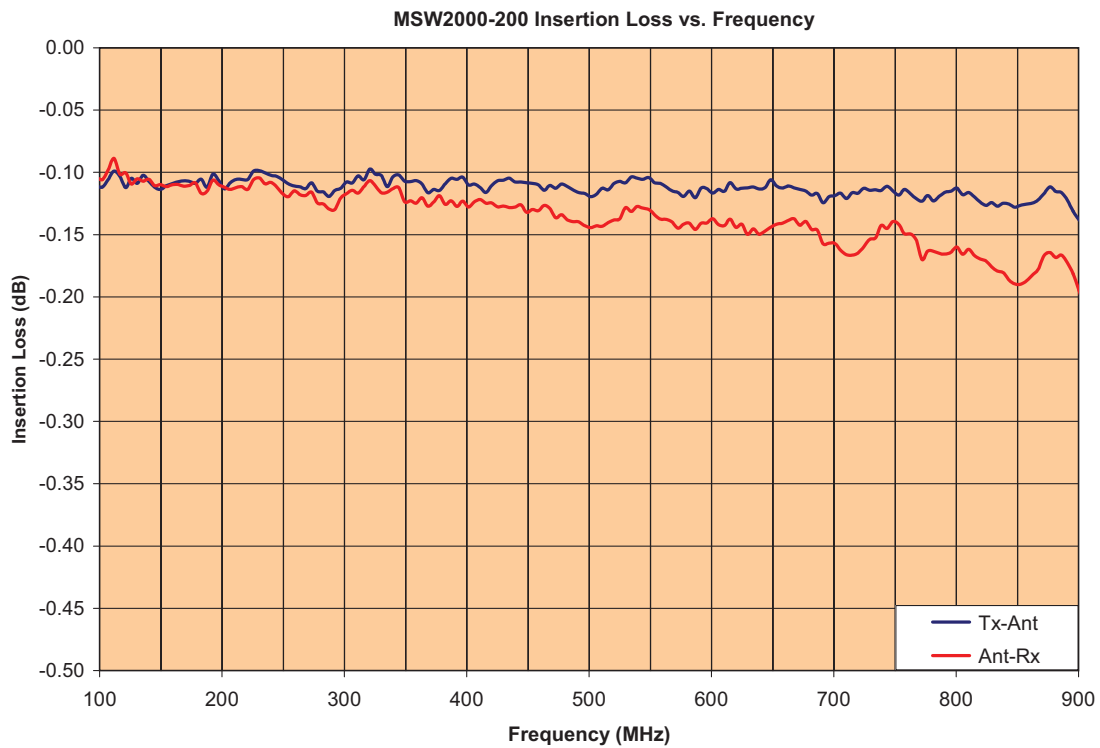
Absolute Maximum Ratings @ $T_A = + 25 \text{ }^\circ\text{C}$ (Unless Otherwise Defined)

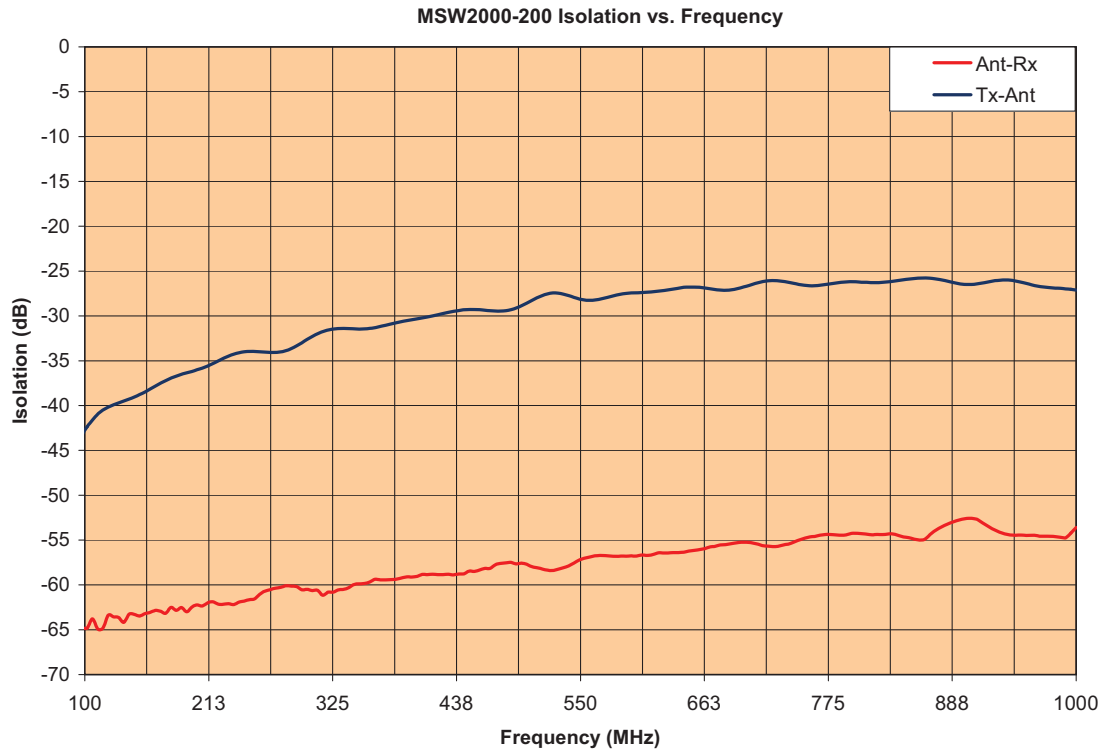
Parameter	Absolute Maximum Value
Forward Current @ Tx or Rx	250 mA
Reverse Voltage @ Tx or Rx	-125 V
Reverse Voltage @ DC	-125 V
Forward Diode Voltage	1.2 V @ 250 mA
Operating Temperature	- 65 $^\circ\text{C}$ to +125 $^\circ\text{C}$
Storage Temperature	- 65 $^\circ\text{C}$ to +150 $^\circ\text{C}$
Junction Temperature	+175 $^\circ\text{C}$
Assembly Temperature	+260 $^\circ\text{C}$ for 10 Seconds
C.W. Incident Power Handling Source & Load VSWR = 1.5 :1 (Cold Switching & Hot Switching) Notes 1, 2	+50 dBm @ +85 $^\circ\text{C}$ Case Temperature
Peak Incident Power Handling Source & Load VSWR = 1.5 :1 (Cold Switching & Hot Switching) Notes 1, 2	+57 @ 10 μs Pulse, 1 % Duty @ +85 $^\circ\text{C}$ Case Temperature
Total Dissipated RF & D.C. Power (Cold Switching) Notes 1, 2	8.0 W @ +85 $^\circ\text{C}$ Case Temperature

Notes:

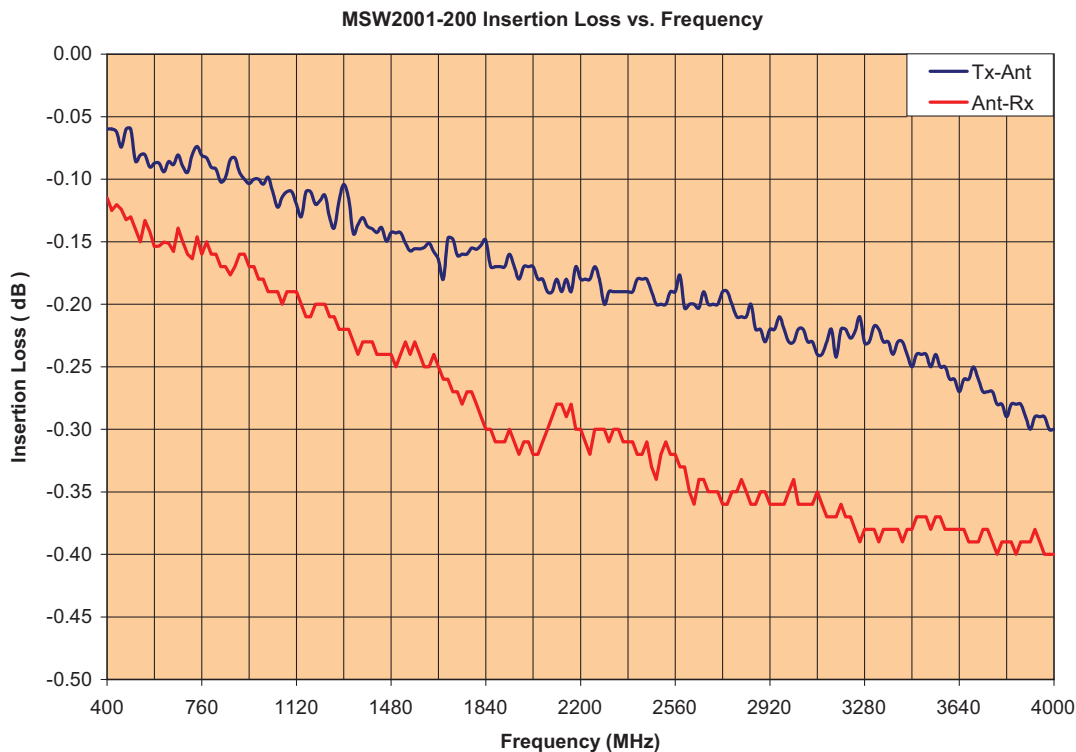
1. For Hot Switching, PIN Diode Driver must Transition from Forward Bias to Reverse Bias and Reverse Bias to Forward Bias within 100 ns with a parallel RC spiking network at the Driver Output.
2. Backside RF and D.C. Grounding Area of Device must be Completely Solder Attached to RF Circuit Board Vias for Proper Electrical and Thermal RF Circuit Grounding.

MSW2000-200 Small Signal Parametric Performance

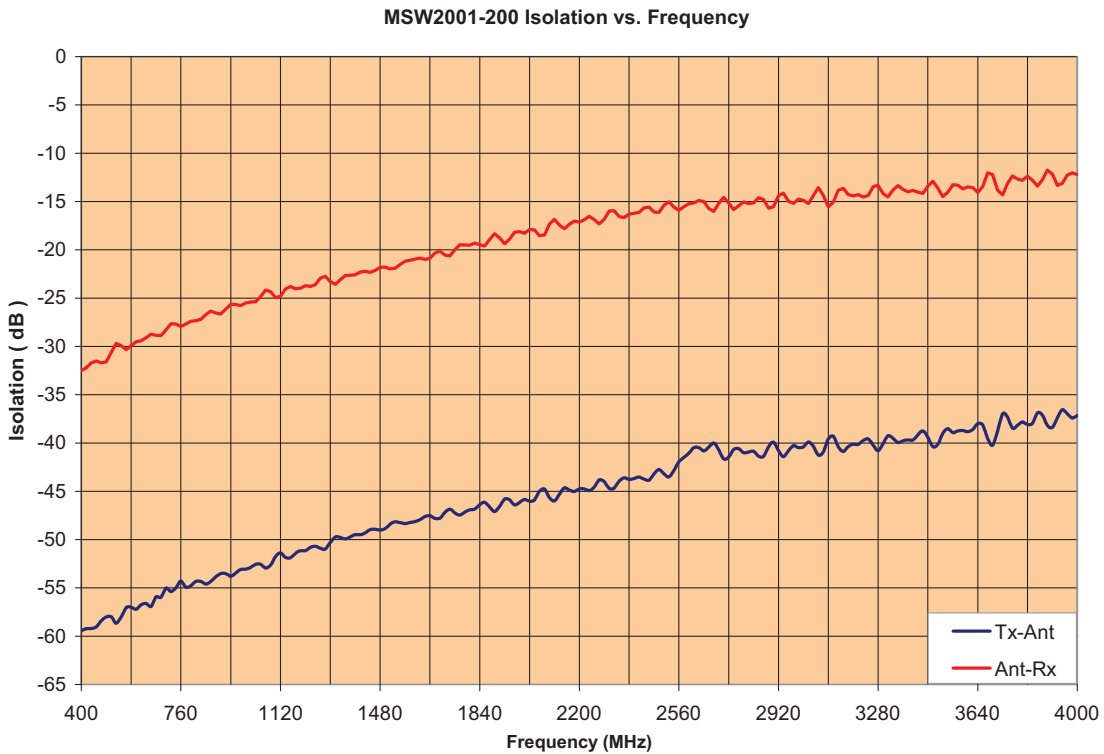
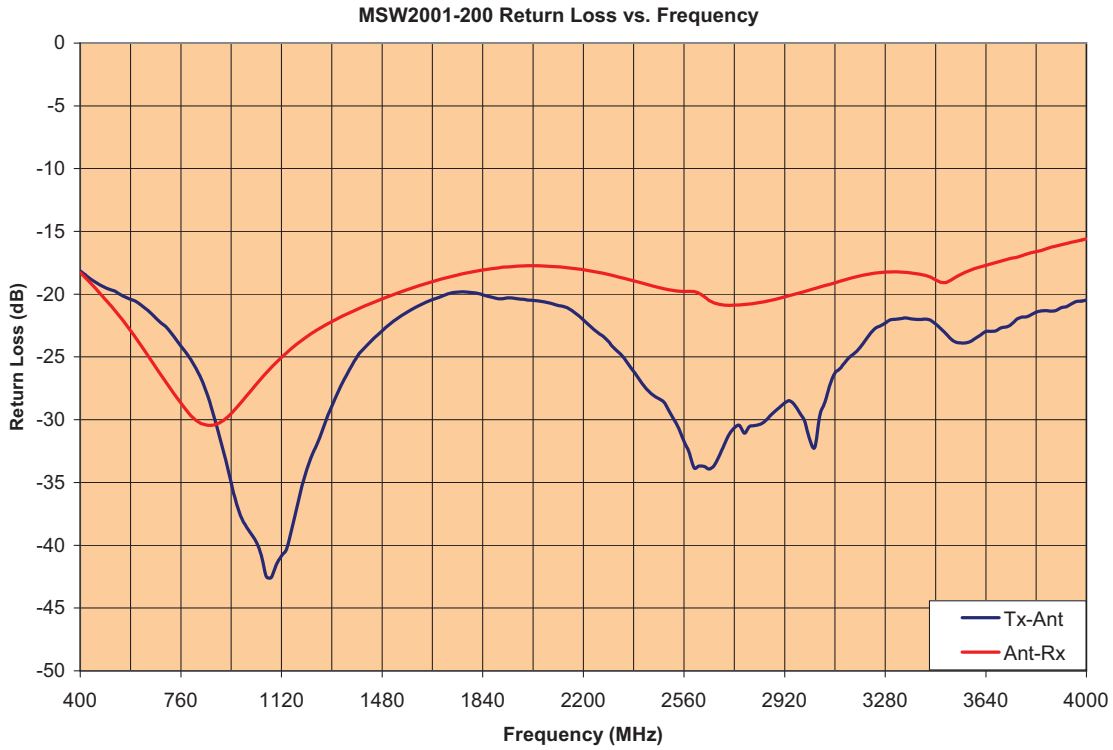




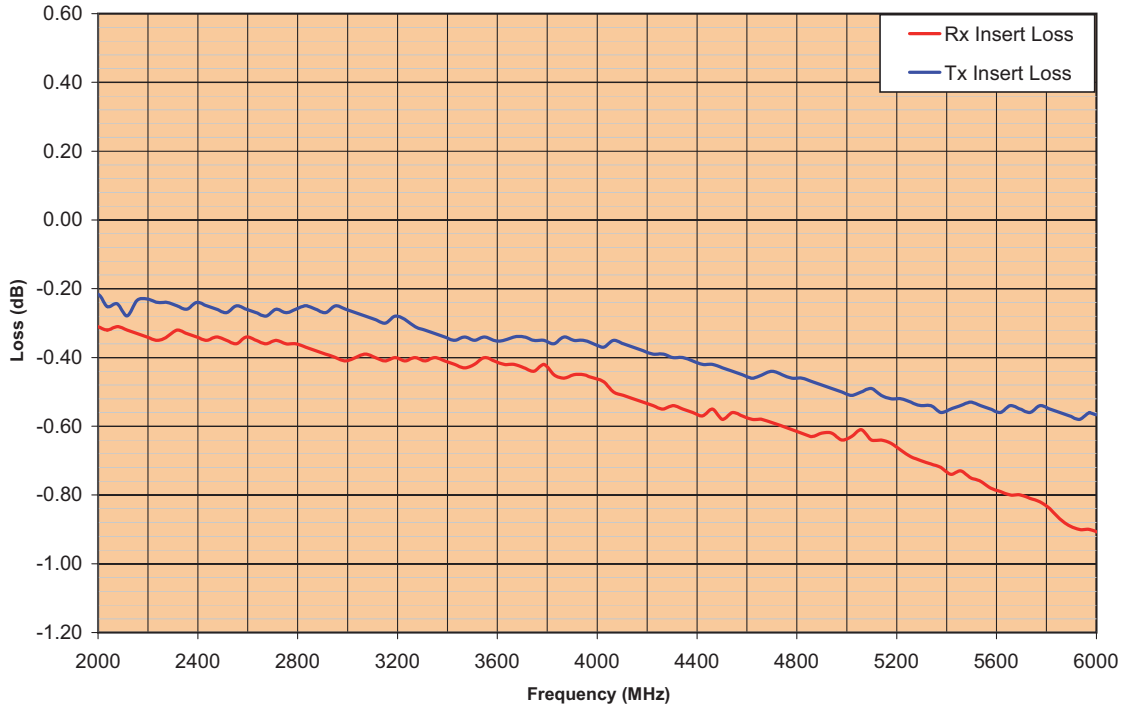
MSW2001-200 Small Signal Parametric Performance



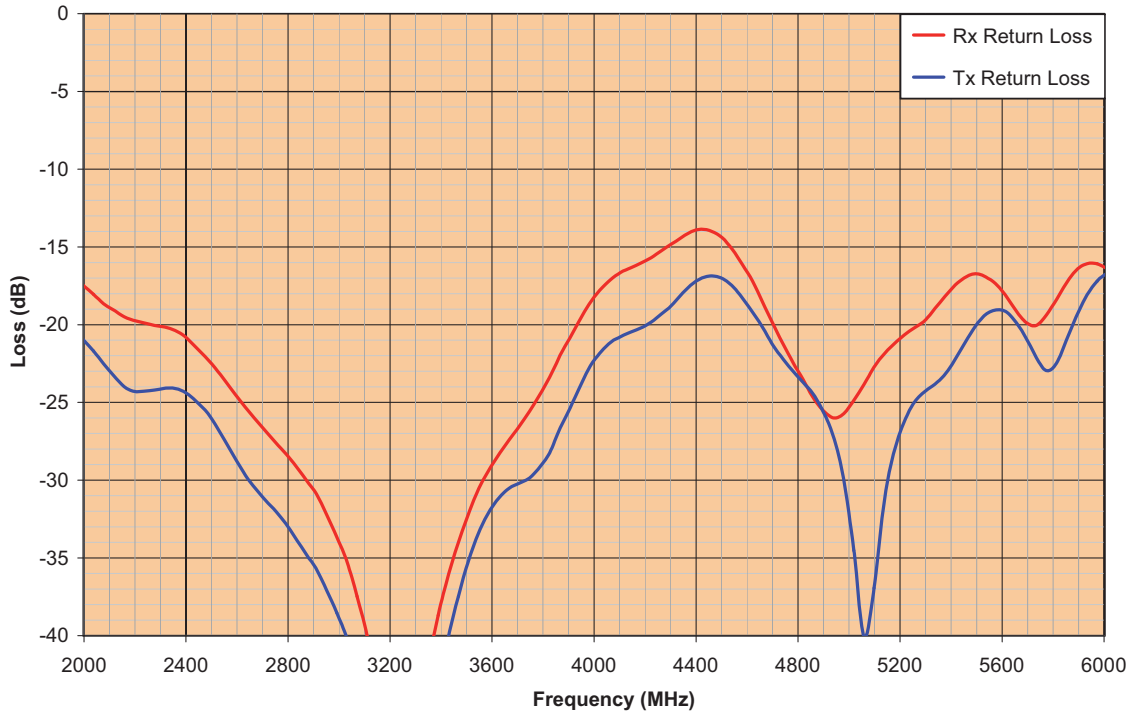
SP2T PIN Diode Switches

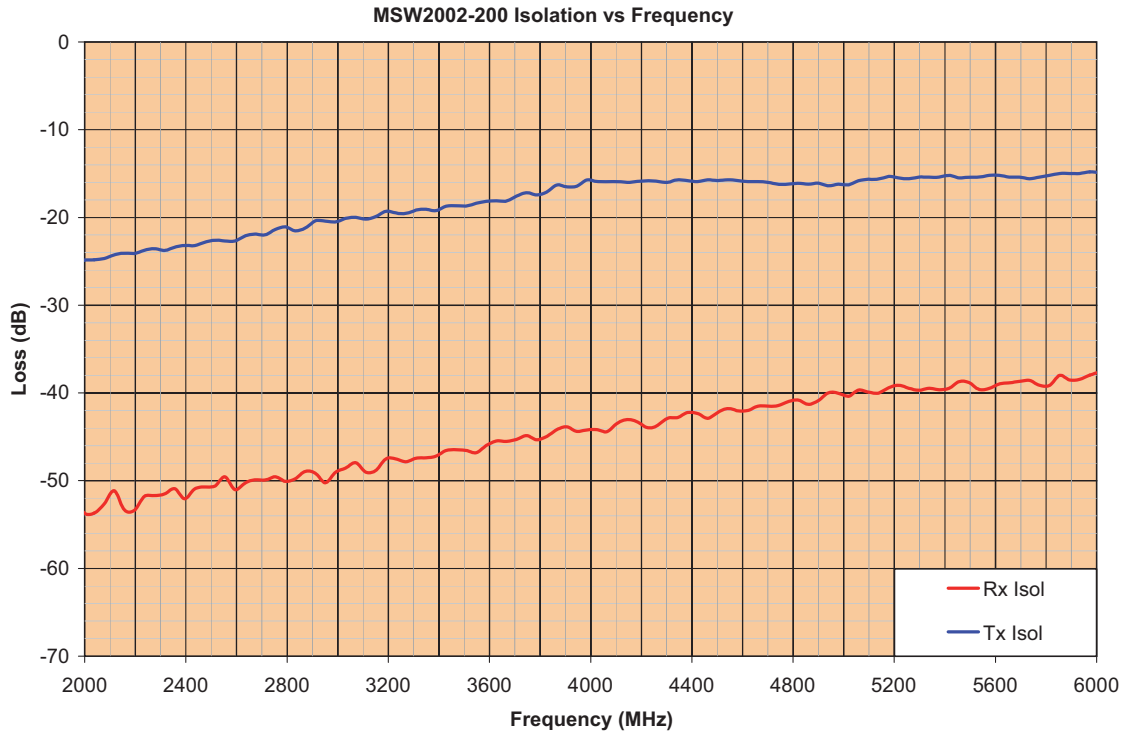


MSW2002-200 Insertion Loss vs Frequency

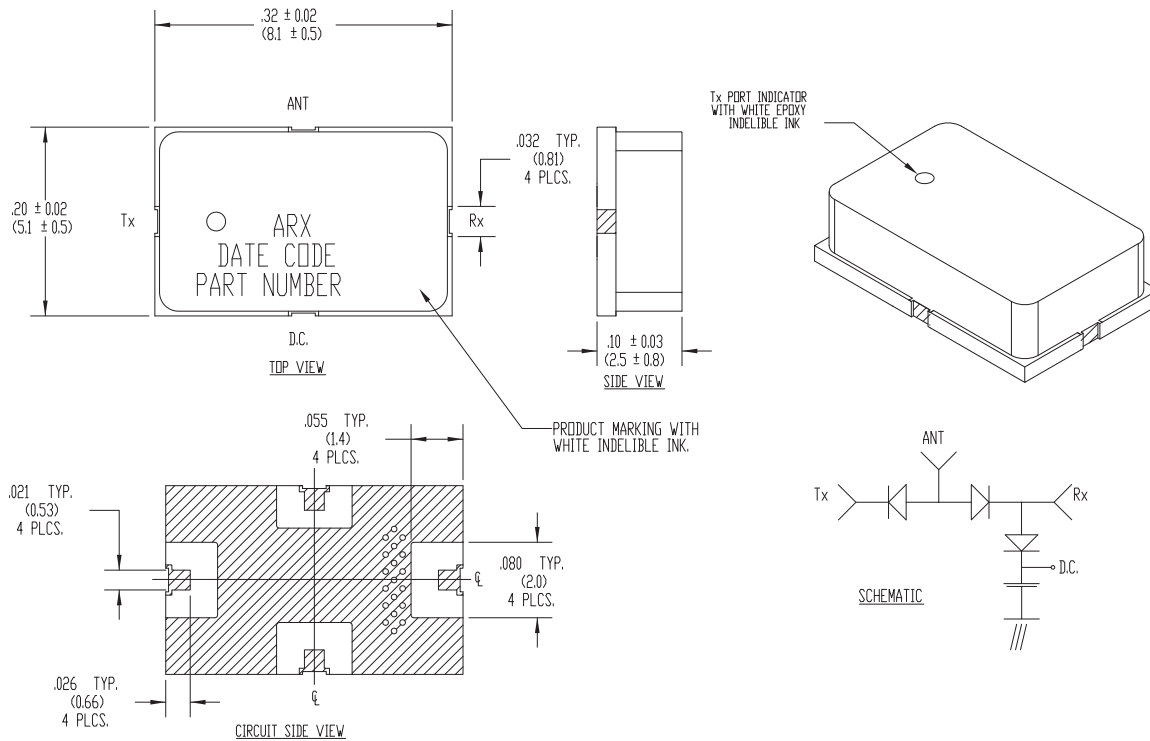


MSW2002-200 Return Loss vs Frequency





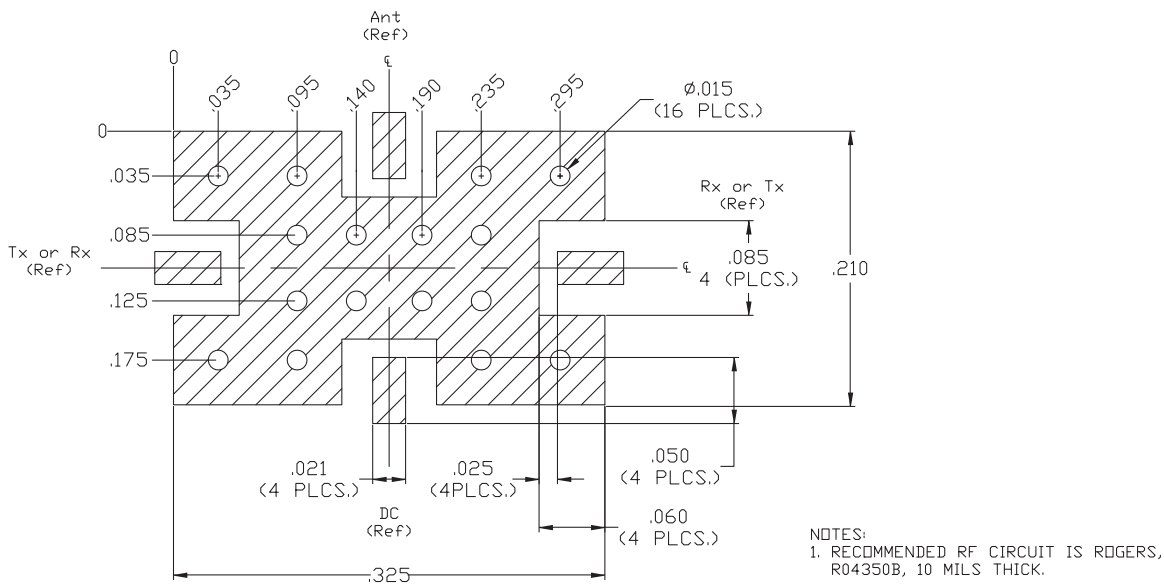
MSW2000-200, MSW2001-200 & MSW2002-200 SP2T Switch Outline (Case Style 200)



NOTES:
1. SUBSTRATE MATERIAL: 20 MIL THICK ALUMINA NITRIDE (AND RF COVER: BLACK CERAMIC).
2. TOP SIDE AND BACKSIDE METALLIZATION: 40μ IN PLATED Au, 60μ IN PLATED Ni OVER Ti-Pd-Au.
3. DIMENSION IN PARENTHESES ARE IN MM.

Note: Thatched Metal Area on Circuit Side of Device is RF, D.C. and Thermal Ground.

RF Circuit Solder Footprint for Case Style 200 (CS200)



Thatched Area is RF, D.C., and Thermal Ground. 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.

SP2T PIN Diode Switches

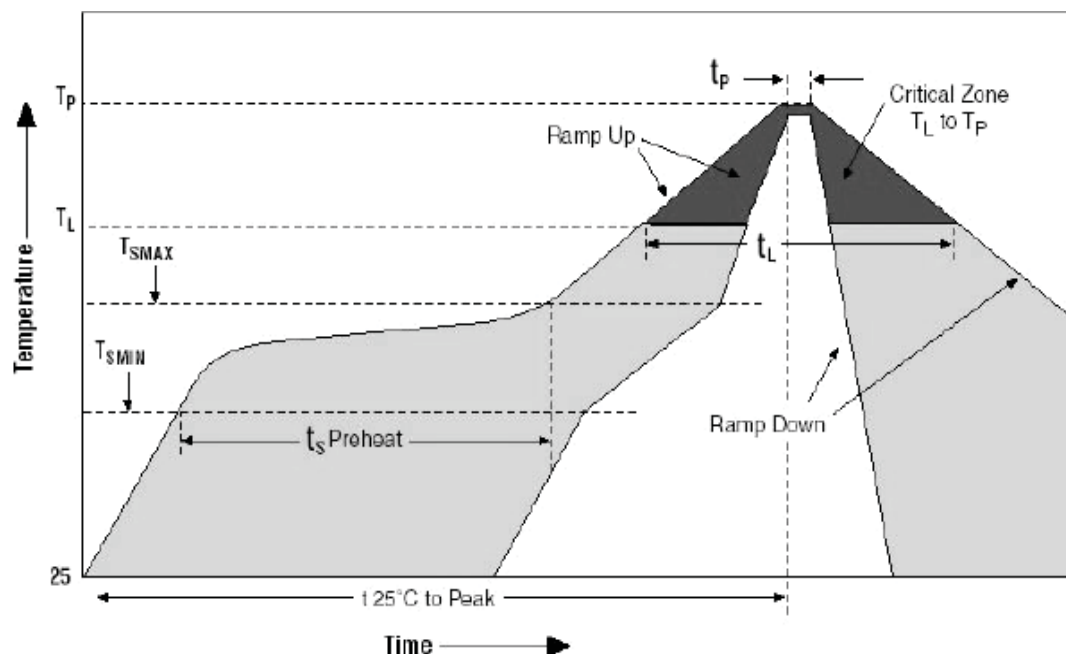
Assembly Instructions

The MSW2000-200, MSW2001-200, SW2002-200 Switches are capable of being placed onto circuit boards with pick and place manufacturing equipment from tube or tape-reel dispensing. The devices are attached to the circuit board using conventional solder re-flow or wave soldering procedures with RoHS type or Sn 63 / Pb 37 type solders per Table I and Graph I Time-Temperature recommended profile.

Table 1: Time-Temperature Profile for Sn 60/Pb40 or RoHS Type Solders

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second maximum	3°C/second maximum
Preheat - Temperature Minimum (T_{SMIN}) - Temperature Maximum (T_{SMAX}) - Time (Minimum to maximum) (t_S)	100°C 150°C 60-120 seconds	150°C 200°C 60-180 seconds
T_{SMAX} to T_L - Ramp-up Rate		3°C/second maximum
Time Maintained above: - Temperature (T_L) - Time (t_L)	183°C 60-150 seconds	217°C 60-150 seconds
Peak Temperature (T_P)	225 +0 / -5°C	245 +0/-5°C
Time within 5°C of actual Peak Temperature (T_P)	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second maximum	6°C/second maximum
Time 25°C to Peak Temperature	6 minutes maximum	8 minutes maximum

Graph1: Solder Re-Flow Time-Temperature Function



Part Number Ordering Information:

Part Number	Packaging
MSW2000-200-T	Tube
MSW2000-200-R	Tape-Reel Quantities of 250 or 500
MSW2000-200-W	Waffle Pack
MSW2001-200-T	Tube
MSW2001-200-R	Tape-Reel Quantities of 250 or 500
MSW2001-200-W	Waffle Pack
MSW2002-200-T	Tube
MSW2002-200-R	Tape-Reel Quantities of 250 or 500
MSW2002-200-W	Waffle Pack
MSW2000-200-E	* RF Evaluation Board
MSW2001-200-E	* RF Evaluation Board
MSW2002-200-E	* RF Evaluation Board
* RF Evaluation boards are rated at +45 dBm C.W. or Peak Incident Power due to the RF power rating values of the Passive L,C Bias Elements	

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