

# Surface Mount PIN Diode SP3T Switches MSW3100-310 & MSW3101-310 Series Datasheet



## Features

- Surface Mount SP3T Switch in Compact Outline:  
8mm L x 8mm W x 2.5 mm H
- Higher Average Power Handling than Plastic ( 100 W C.W.)
- Higher Voltage > 1000 Volts for Higher RF Peak Power ( 500 W )
- Lower Insertion Loss ( 0.45 dB ) & Higher IIP3 ( 65 dBm )
- Operates From + Voltage Only (+5V, & +28V to + 125V)
- RoHS Compliant



## Description

The MSW3100-310 and MSW3101-310 Surface Mount Silicon PIN Diode SP3T Switches are 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, (8 mm L x 8 mm W x 2.5 mm H) offers superior low and high signal performance to comparable MMIC devices in QFN packages. The SP3T switches are designed in a symmetrical topology to optimize Insertion Loss and Isolation performance.

Using PIN Diodes with lower thermal resistance ( < 8 °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 ( < 1.0  $\Omega$  ), coupled with the longer minority carrier lifetime, ( > 2  $\mu$ S ), provides better IIP3 distortion values > +65 dBm .

## Applications

These MSW3100-310 and MSW3101-310 SP3T Switches are designed to be used in higher average and peak power switch applications, operating from 20 MHz to 4000 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 MSW3100-310 and MSW3101-310 SP3T 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.



## MSW3100-310 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          |
| J0-J1, J0-J2 or J0-J3<br>Insertion Loss (Note 3) | IL        | dB            | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)                                                      |               | -0.4                                         | -0.6          |
| J0-J1, J0-J2 or J0-J3<br>Return Loss (Note 3)    | RL        | dB            | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)                                                      | -18           | -20                                          |               |
| J0-J1, J0-J2 or J0-J3<br>Isolation (Note 3)      | Isol      | dB            | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)                                                      | -50           | -53                                          |               |
| C.W. Incident Power<br>(Note 3)                  | Pinc (CW) | dBm           | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)<br>1.5:1 Source & Load VSWR                          |               | +50                                          |               |
| Peak. Incident Power<br>(Note 3)                 | Pinc (Pk) | dBm           | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)<br>1.5:1 Source & Load VSWR                          |               | +57 @<br>10 $\mu\text{S}$ Pulse,<br>1 % Duty |               |
| Switching Speed                                  | Ts        | $\mu\text{S}$ | (10% -90% RF Voltage)<br>TTL Rep rate = 100 kHz                                              |               | 2                                            | 3             |
| Input 3rd Order<br>Intercept Point               | IIP3      | dBm           | F1 = 500 MHz<br>F2 = 510 MHz<br>P1 = P2 = +40 dBm<br>0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF) | 60            | 65                                           |               |

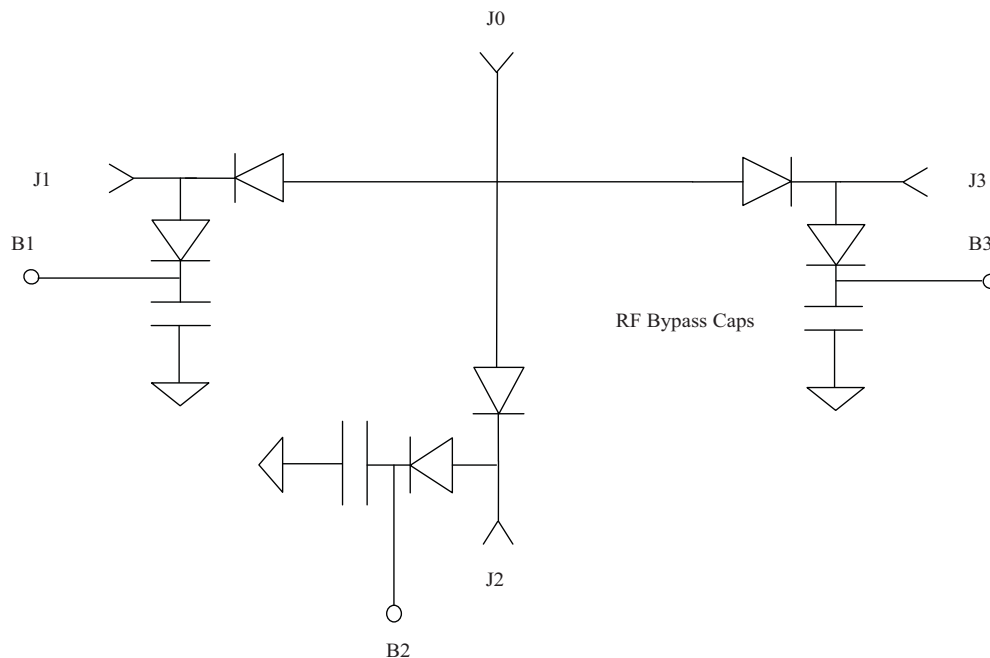
## MSW3101-310 Electrical Specifications

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

| Parameter                                        | Symbol    | Units         | Test Conditions                                                                                | Minimum Value | Typical Value                                | Maximum Value |
|--------------------------------------------------|-----------|---------------|------------------------------------------------------------------------------------------------|---------------|----------------------------------------------|---------------|
| Frequency                                        | F         | MHz           |                                                                                                | 200           | 400 – 4000                                   | 4500          |
| J0-J1, J0-J2 or J0-J3<br>Insertion Loss (Note 3) | IL        | dB            | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)                                                        |               | -0.6                                         | -0.8          |
| J0-J1, J0-J2 or J0-J3<br>Return Loss (Note 3)    | RL        | dB            | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)                                                        | -14           | -15                                          |               |
| J0-J1, J0-J2 or J0-J3<br>Isolation (Note 3)      | Isol      | dB            | 0 V @ 100 mA (ON)<br>28 V @ 25 mA (OFF)                                                        | -32           | -34                                          |               |
| C.W. Incident Power<br>(Note 3)                  | Pinc (CW) | dBm           | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)<br>1.5:1 Source & Load VSWR                            |               | +50                                          |               |
| Peak. Incident Power<br>(Note 3)                 | Pinc (Pk) | dBm           | 0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF)<br>1.5:1 Source & Load VSWR                            |               | +57 @<br>10 $\mu\text{S}$ Pulse,<br>1 % Duty |               |
| Switching Speed                                  | Ts        | $\mu\text{S}$ | (10% -90% RF Voltage)<br>TTL Rep rate = 100 kHz                                                |               | 1.5                                          | 2             |
| Input 3rd Order<br>Intercept Point               | IIP3      | dBm           | F1 = 2000 MHz<br>F2 = 2010 MHz<br>P1 = P2 = +40 dBm<br>0 V @ 100 mA (ON)<br>28 V @ 50 mA (OFF) | 60            | 65                                           |               |

# SP3T PIN Diode Switches

*MSW3100-310 and MSW3101-310 SP3T 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 MPD3T28125-701 is the recommended Driver to interface with the MSW3100-310 and MSW3101-310 SP3T 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 5 of this datasheet. +28V values shown in these specification tables are utilized for small signal testing ~0 dBm.

The schematic diagram illustrates a TTL PIN Diode Driver (6 X). It features six identical driver units, each consisting of a 28V supply, a 1.1K resistor, a 5V supply, a 39 ohm resistor, a 1V supply, and various diodes and capacitors. The units are labeled J1, J2, J3, B1, B2, and B3. The circuit is designed to drive a PIN diode, which is represented by a diode symbol with a horizontal line through it. The 28V supply is connected to the anode of the PIN diode. The 1.1K resistor is connected to the cathode of the PIN diode. The 5V supply is connected to the anode of the PIN diode. The 39 ohm resistor is connected to the cathode of the PIN diode. The 1V supply is connected to the anode of the PIN diode. The circuit is designed to drive a PIN diode, which is represented by a diode symbol with a horizontal line through it. The 28V supply is connected to the anode of the PIN diode. The 1.1K resistor is connected to the cathode of the PIN diode. The 5V supply is connected to the anode of the PIN diode. The 39 ohm resistor is connected to the cathode of the PIN diode. The 1V supply is connected to the anode of the PIN diode.

# SP3T PIN Diode Switches



## RF Bias Network Values

| Part Number | F ( MHz )   | DC Blocking Capacitors | Inductors   | RF Bypass Capacitors |
|-------------|-------------|------------------------|-------------|----------------------|
| MSW3100-310 | 50 – 1,000  | 0.1 $\mu$ F            | 4.7 $\mu$ H | 0.1 $\mu$ F          |
| MSW3101-310 | 400 – 4,000 | 27 pF                  | 82 nH       | 270 pF               |

## D.C. Bias to RF Truth Table

| RF State                                           | J1 Bias       | J2 Bias       | J3Bias        | B1 Bias      | B2 Bias      | B3 Bias      |
|----------------------------------------------------|---------------|---------------|---------------|--------------|--------------|--------------|
| J1-J0 Low Loss & J2-J0 Isolation & J3-J0 Isolation | 0 V @ 100 mA  | +28 V @ 25 mA | +28 V @ 25 mA | +28 V @ 0 mA | +0 V @ 25 mA | +0 V @ 25 mA |
| J2-J0 Low Loss & J1-J0 Isolation & J3-J0 Isolation | +28 V @ 25 mA | +0 V @ 100 mA | +28 V @ 25 mA | +0 V @ 25 mA | +28 V @ 0 mA | +0 V @ 25 mA |
| J3-J0 Low Loss & J1-J0 Isolation & J2-J0 Isolation | +28 V @ 25 mA | +28 V @ 25 mA | +0 V @ 100 mA | +0 V @ 25 mA | +0 V @ 25 mA | +28 V @ 0 mA |

Minimum Reverse Bias Voltage @ J1, J2, J3, B1, B2,B3 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 |
|-------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| MSW3100-310 | 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        |
| MSW3101-310 | 20 MHz NA           | 100 MHz NA          | 200 MHz   -110 V    | 400 MHz   -85 V     | 1,000 MHz   -55 V   | 4,000 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 )

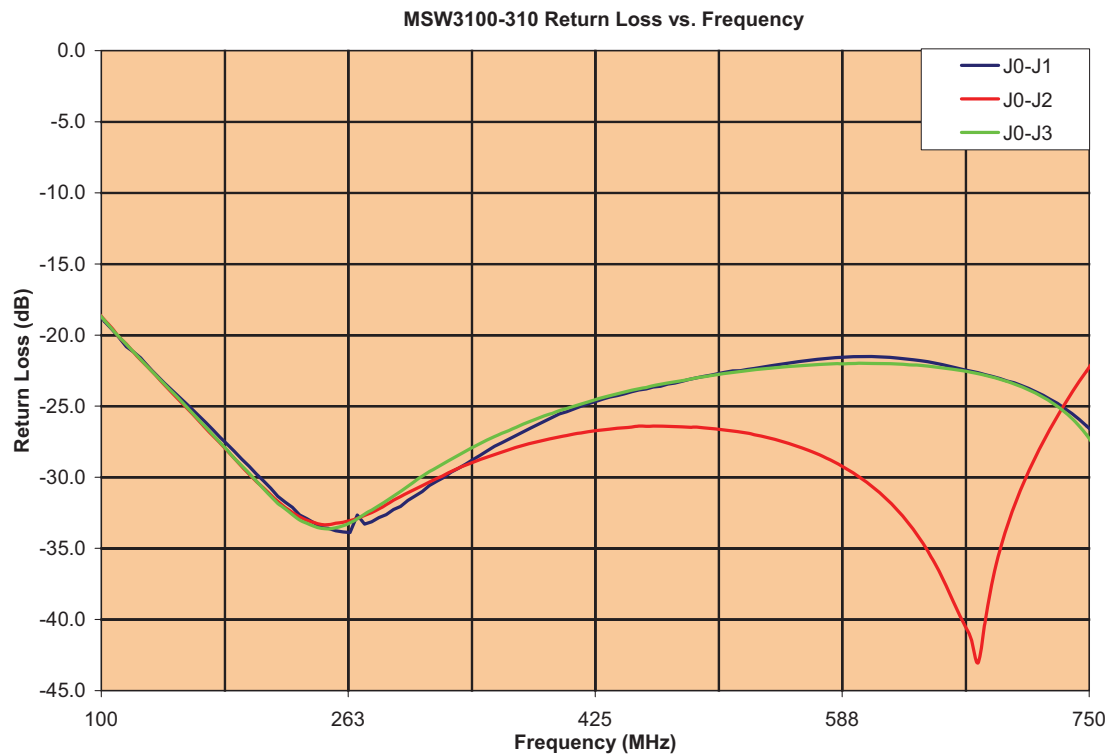
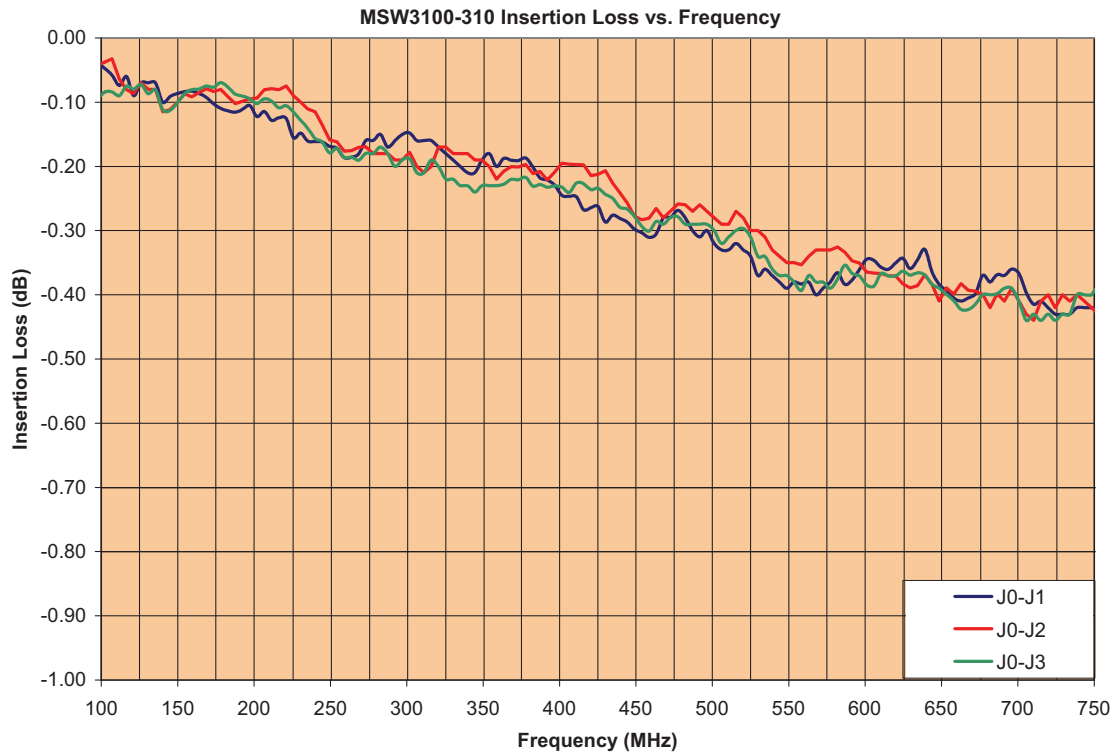
| Parameter                                                                                                       | Absolute Maximum Value                                                              |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Forward Diode Current @ J0, J1, J2 or J3                                                                        | 250 mA                                                                              |
| Reverse Voltage @ J0, J1, J2 or J3                                                                              | -125   V                                                                            |
| Reverse Voltage @ B1, B2 or B3                                                                                  | -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<br>Source & Load VSWR = 1.5 :1<br>( Cold Switching & Hot Switching )<br>Notes 1, 2 | +50 dBm @ +85 $^{\circ}\text{C}$ Case Temperature                                   |
| Peak Incident Power Handling<br>Source & Load VSWR = 1.5 :1<br>( Cold Switching & Hot Switching )<br>Notes 1, 2 | +57 @ 10 $\mu\text{s}$ Pulse, 1 % Duty<br>@ +85 $^{\circ}\text{C}$ Case Temperature |
| Total Dissipated RF & D.C. Power<br>( Cold Switching )<br>Notes 1, 2                                            | 5.0 W @ +85 $^{\circ}\text{C}$ Case Temperature                                     |

### Notes:

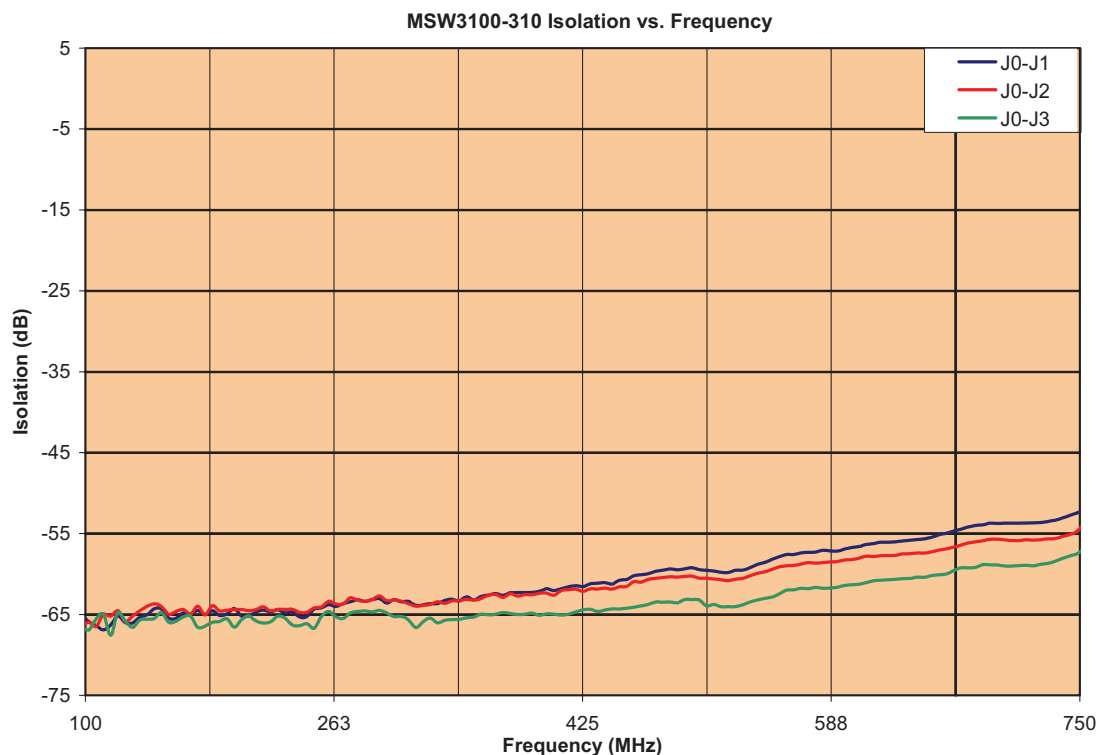
1. For Hot Switching, PIN Diode Driver must Transition from Forward Bias to Reverse Bias and Reverse Bias to Forward Bias within 100 ns with a parallel RC spiking network at the Driver Output.
2. Backside RF and D.C. Grounding Area of Device must be Completely Solder Attached to RF Circuit Board Vias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

# SP3T PIN Diode Switches

## MSW3100-310 Small Signal Parametric Performance

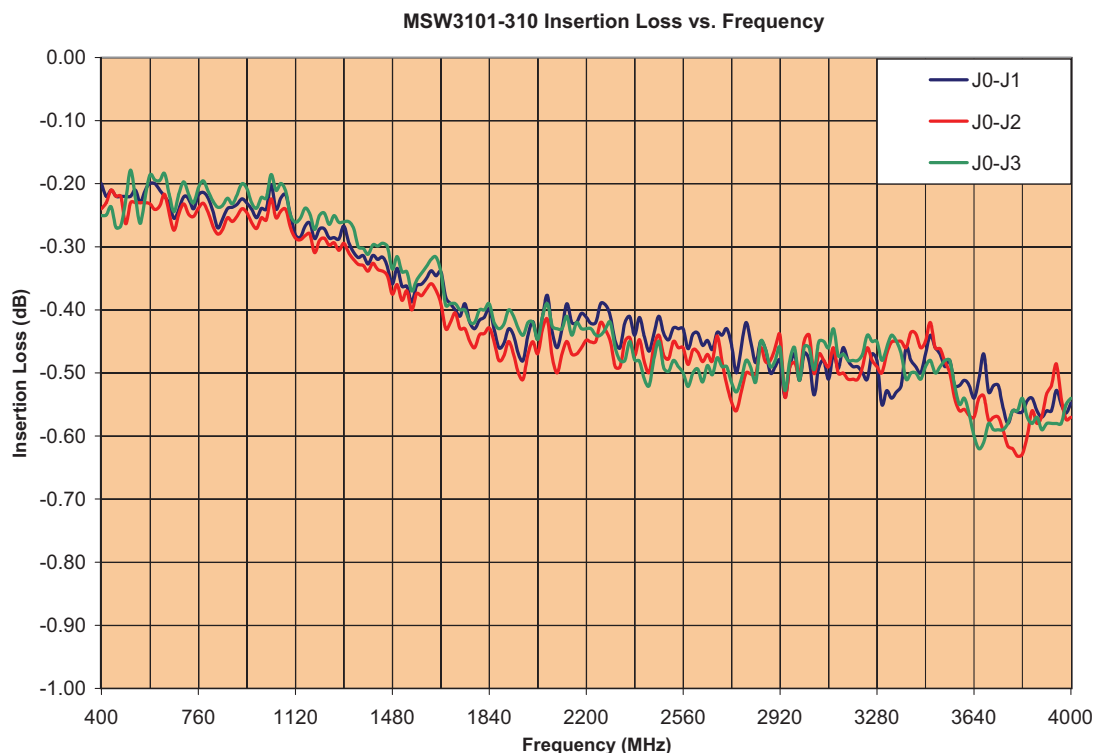


Notes: Data is only shown from 100 - 750 MHz due to bandwidth of RF Bias network.

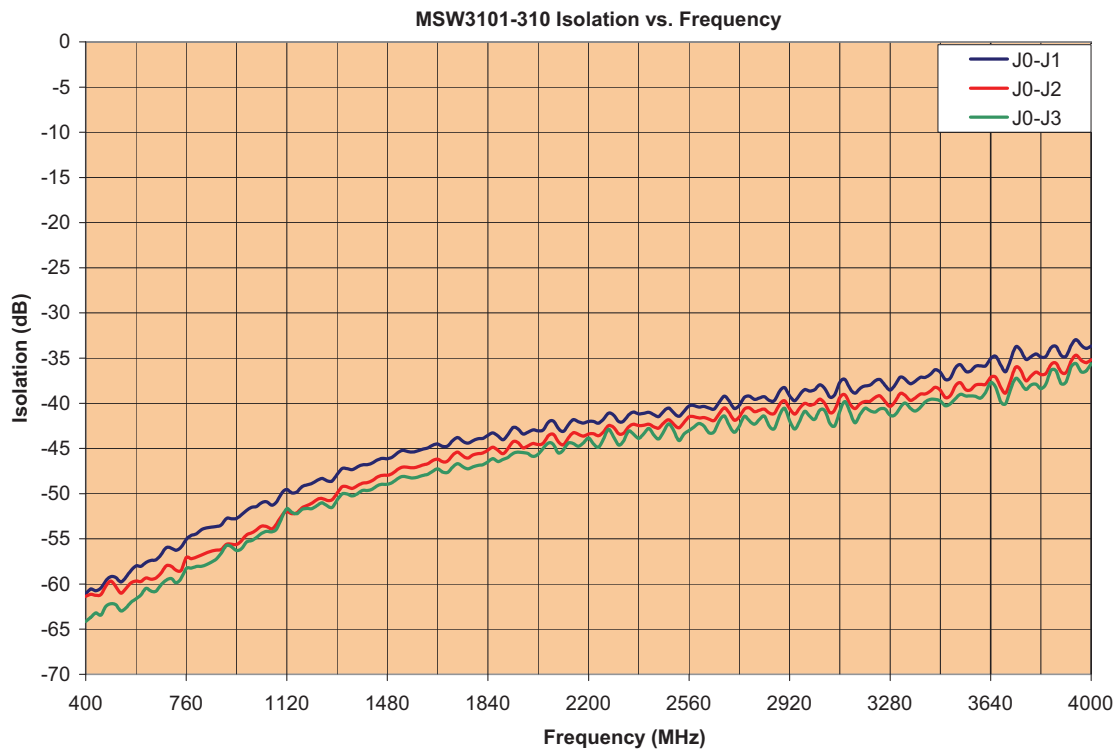
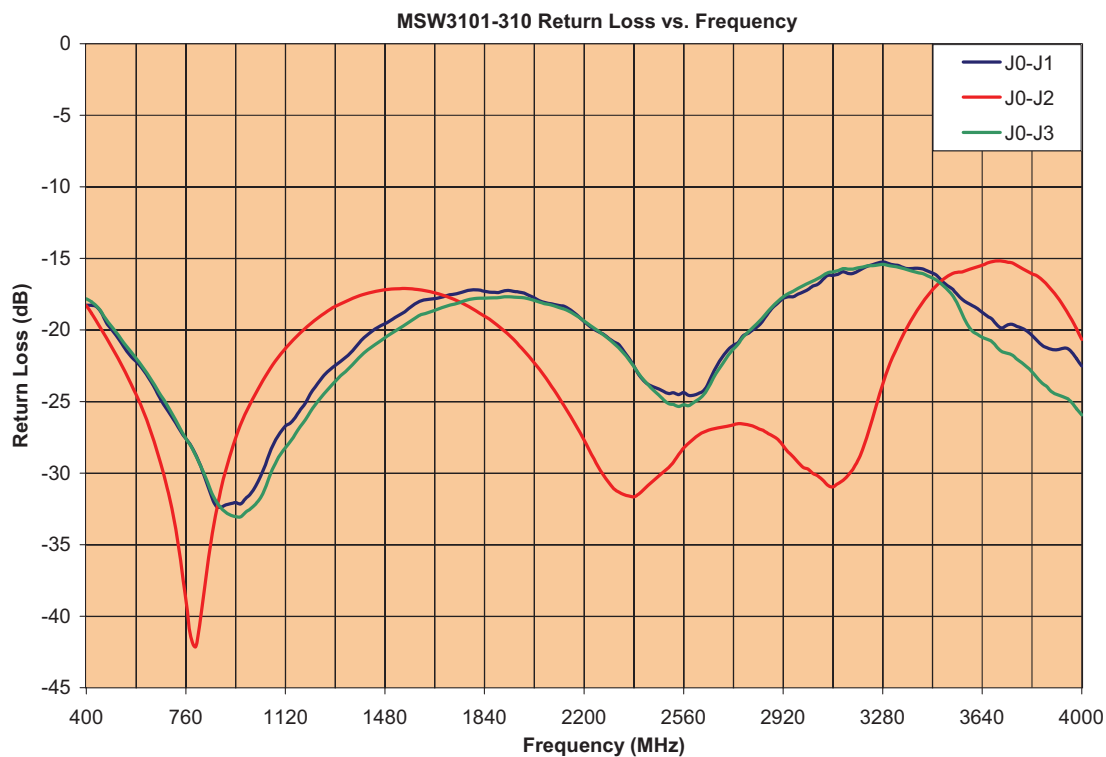


Notes: Data is only shown from 100 - 750 MHz due to bandwidth of RF Bias network.

## MSW3101-310 Small Signal Parametric Performance



# SP3T PIN Diode Switches



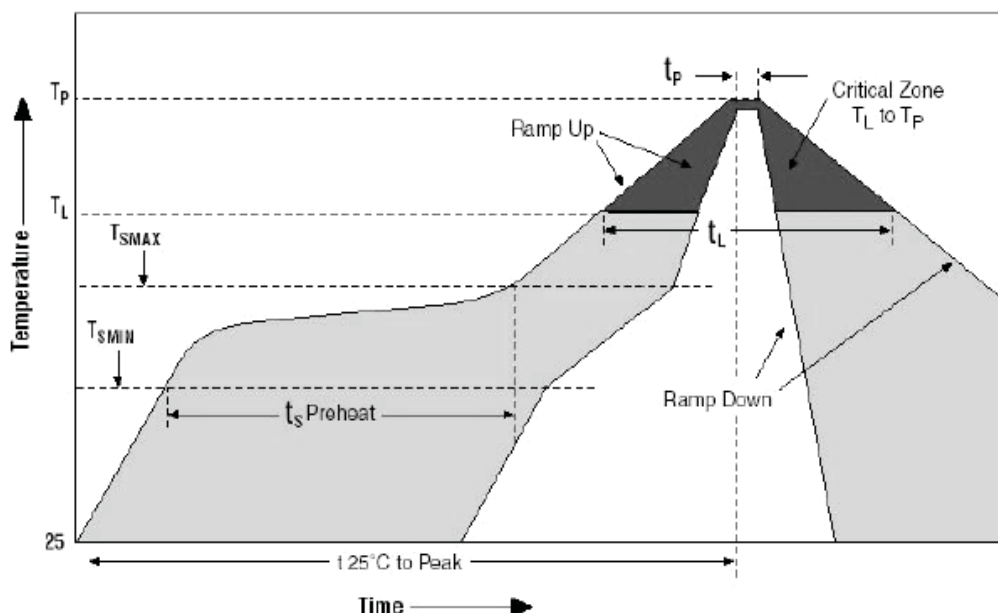
## Assembly Instructions

The MSW3100-310 and MSW3101-310 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

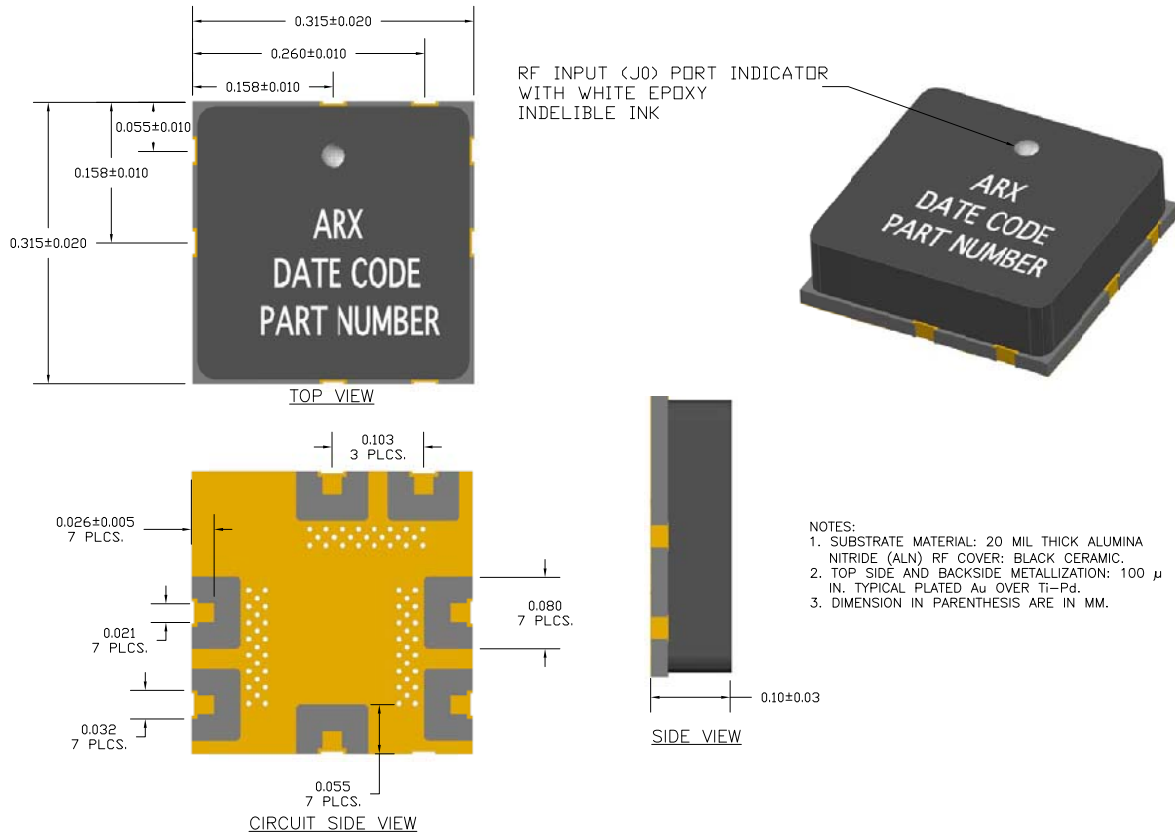
| Profile Feature                                                                                                                                                                                                        | Sn-Pb Eutectic Assembly          | Pb-Free Assembly                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------|
| Average ramp-up rate ( $T_L$ to $T_P$ )                                                                                                                                                                                | 3°C/second maximum               | 3°C/second maximum               |
| Preheat <ul style="list-style-type: none"> <li>- Temperature Minimum (<math>T_{SMIN}</math>)</li> <li>- Temperature Maximum (<math>T_{SMAX}</math>)</li> <li>- Time (Minimum to maximum) (<math>t_s</math>)</li> </ul> | 100°C<br>150°C<br>60-120 seconds | 150°C<br>200°C<br>60-180 seconds |
| $T_{SMAX}$ to $T_L$ <ul style="list-style-type: none"> <li>- Ramp-up Rate</li> </ul>                                                                                                                                   |                                  | 3°C/second maximum               |
| Time Maintained above: <ul style="list-style-type: none"> <li>- Temperature (<math>T_L</math>)</li> <li>- Time (<math>t_L</math>)</li> </ul>                                                                           | 183°C<br>60-150 seconds          | 217°C<br>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



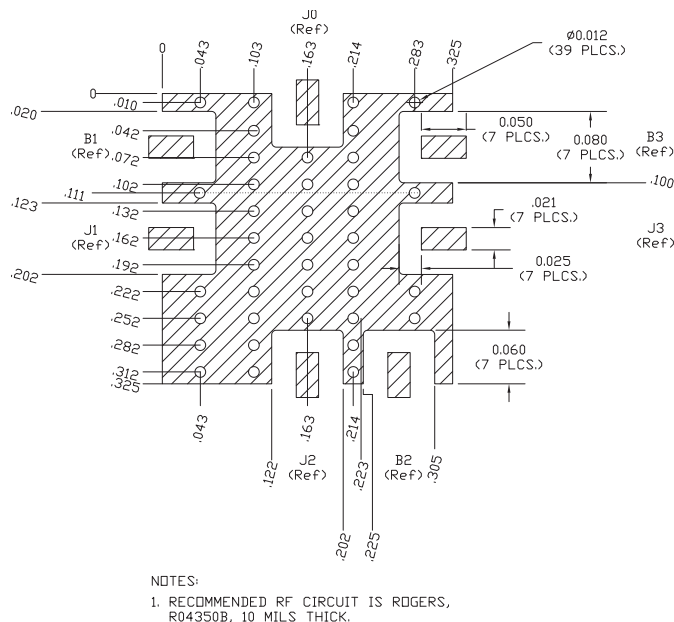
# SP3T PIN Diode Switches

## MSW3100-310 and MSW3101-310 SP3T Switch Outline ( Case Style 310 )



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

## RF Circuit Solderable Footprint for Case Style 310 ( CS310 )



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.

## Part Number Ordering Information:

| Part Number                                                                                                                                   | Packaging                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| MSW3100-320-T                                                                                                                                 | Tube                                    |
| MSW3100-320-R                                                                                                                                 | Tape-Reel<br>(Quantities of 250 or 500) |
| MSW3100-320-W                                                                                                                                 | Waffle Pack                             |
| MSW3101-320-T                                                                                                                                 | Tube                                    |
| MSW3101-320-R                                                                                                                                 | Tape-Reel<br>(Quantities of 250 or 500) |
| MSW3101-320-W                                                                                                                                 | Waffle Pack                             |
| MSW3100-320-E                                                                                                                                 | RF Evaluation Board                     |
| MSW3101-320-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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