

## Switch, SP2T 100 Watt Reflective 0.5 - 6.0 GHz

Rev. V1

### Features

- Suitable for Large Signal Broadband Applications
- Power Handling: 100 W @ 85°C
- Insertion Loss: 0.5 dB @ 4 GHz
- Isolation: 35 dB @ 4 GHz
- Lead-Free 4 mm HQFN-20LD Package
- RoHS\* Compliant

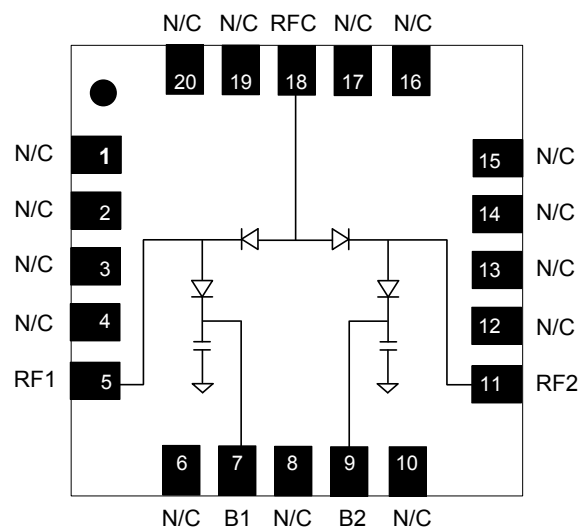
### Description

The MASW-011060 is a high power PIN diode SP2T switch in a common anode configuration, operating from 0.5 to 6.0 GHz. It features low insertion loss and excellent linearity. This device is capable of handling 100 Watts CW of incident power at a base plate temperature of 85°C.

This high power switch is ideal for use on broadband, MIL-COM, IED, and cellular applications that require higher CW and pulsed power operation.

The MASW-011060 is manufactured using MACOM's hybrid manufacturing process featuring high voltage PIN diodes and passive devices integrated in a 4 mm HQFN 20-lead plastic package.

### Functional Schematic



### Pin Configuration<sup>3</sup>

| Pin | Function      | Pin                 | Function      |
|-----|---------------|---------------------|---------------|
| 1   | No Connection | 11                  | RF2 / V2 Bias |
| 2   | No Connection | 12                  | No Connection |
| 3   | No Connection | 13                  | No Connection |
| 4   | No Connection | 14                  | No Connection |
| 5   | RF1 / V1 Bias | 15                  | No Connection |
| 6   | No Connection | 16                  | No Connection |
| 7   | B1 Bias       | 17                  | No Connection |
| 8   | No Connection | 18                  | RFC / V3 Bias |
| 9   | B2 Bias       | 19                  | No Connection |
| 10  | No Connection | 20                  | No Connection |
|     |               | Paddle <sup>4</sup> | Ground        |

3. MACOM recommends connecting unused package pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

### Ordering Information<sup>1,2</sup>

| Part Number        | Package        |
|--------------------|----------------|
| MASW-011060-TR0500 | 500 piece reel |
| MASW-011060-SMB    | Sample Board   |

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

\*Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

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Electrical Specifications:  $T_A = 25^\circ\text{C}$ , Bias = +5 / -5 V<sup>5</sup>, 50 mA / 100 mA

| Parameter                          | Test Conditions   | Units         | Min. | Typ.      | Max. |
|------------------------------------|---|---------------|------|-----------|------|
| Insertion Loss<br>$P_{IN} = 0$ dBm | 0.5 GHz   | dB            | —    | 0.15      | —    |
|                                    | 1.0 GHz   |               |      | 0.25      | —    |
|                                    | 2.0 GHz   |               |      | 0.30      | 0.45 |
|                                    | 3.0 GHz   |               |      | 0.35      | —    |
|                                    | 4.0 GHz   |               |      | 0.50      | —    |
|                                    | 5.0 GHz   |               |      | 0.75      | —    |
|                                    | 6.0 GHz   |               |      | 0.80      | —    |
| Isolation<br>$P_{IN} = 0$ dBm      | 0.5 GHz   | dB            | —    | 47        | —    |
|                                    | 1.0 GHz   |               | —    | 47        |      |
|                                    | 2.0 GHz   |               | 40   | 44        |      |
|                                    | 3.0 GHz   |               | —    | 40        |      |
|                                    | 4.0 GHz   |               | —    | 35        |      |
|                                    | 5.0 GHz   |               | —    | 32        |      |
|                                    | 6.0 GHz   |               | —    | 28        |      |
| Input Return Loss                  | $P_{IN} = 0$ dBm  | dB            | —    | >15       | —    |
| CW Input Power <sup>6</sup>        | 25°C Base plate, 2 GHz<br>$V_{DC} = 0$ V / 28 V                               | dBm<br>W      | —    | 52<br>158 | —    |
| CW Input Power <sup>6</sup>        | 85°C Base plate, 2 GHz<br>$V_{DC} = 0$ V / 28 V                               | dBm<br>W      | —    | 50<br>100 | —    |
| P0.1dB <sup>6</sup>                | 25°C Base plate, 2 GHz<br>$V_{DC} = 0$ V / 28 V                               | dBm           | —    | 52        | —    |
| Input IP3                          | F1 = 3000 MHz, F2 = 3010 MHz<br>$P_{IN} = 40$ dBm/Tone, $V_{DC} = 0$ V / 28 V | dBm           | —    | 75        | —    |
| $T_{ON}$ , $T_{OFF}$               | 50% control to 90% RF,<br>50% control to 10% RF                               | $\mu\text{s}$ | —    | 1.5       | —    |
| $T_{RISE}$ , $T_{FALL}$            | 10% to 90% RF,<br>90% to 10% RF   | $\mu\text{s}$ | —    | 1.1       | —    |

5. See Bias table and Application Schematic.

6. DC reverse bias of a PIN Diode operating at a high power is dependent on RF Frequency, Incident Power, and VSWR. See Minimum Reverse DC Voltage table for high power operation.

### Absolute Maximum Ratings<sup>7,8</sup>

| Parameter             | Absolute Maximum |
|-----------------------|------------------|
| Forward Current       | 150 mA           |
| Reverse DC Voltage    | -150 V           |
| Operating Temperature | -40°C to +85°C   |
| Storage Temperature   | -55°C to +150°C  |
| Junction Temperature  | +175°C           |

7. Exceeding any one or combination of these limits may cause permanent damage to this device.  
8. MACOM does not recommend sustained operation near these survivability limits.

### Minimum Reverse DC Voltage<sup>9</sup>

| Frequency (MHz) | Minimum Reverse DC Voltage |
|-----------------|----------------------------|
| 500             | -41 V                      |
| 1000            | -22 V                      |
| 2000            | -11 V                      |
| 3000            | -8 V                       |
| 4000            | -6 V                       |

9. Required to maintain low loss under 100 W of incident power with 1.5:1 VSWR.

## Bias Tables for small signal operation

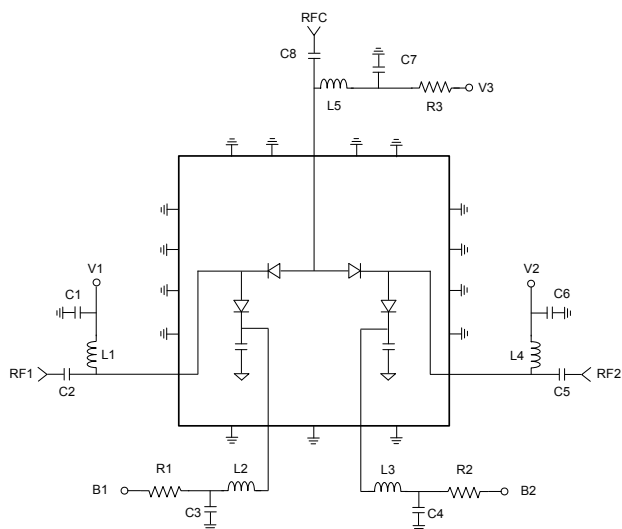
### Positive / Negative DC Bias, +5 / -5 V

| RF State  | V1 Bias (V)   | V2 Bias (V)   | V3 Bias (V) | B1 Bias (V) | B2 Bias (V) |
|---|---------------|---------------|-------------|-------------|-------------|
| Pin No.   | Pin 5         | Pin 11        | Pin 18      | Pin 7       | Pin 9       |
| RFC – RF1 Insertion Loss<br>RFC – RF2 Isolation | -5 V @ 100 mA | +5 V @ 50 mA  | GND         | GND         | GND         |
| RFC – RF2 Insertion Loss<br>RFC – RF1 Isolation | +5 V @ 50 mA  | -5 V @ 100 mA | GND         | GND         | GND         |

### Positive Only DC Bias 0 / +10 V

| RF State  | V1 Bias (V)    | V2 Bias (V)    | V3 Bias (V)   | B1 Bias (V)  | B2 Bias (V)  |
|---|----------------|----------------|---------------|--------------|--------------|
| Pin No.   | Pin 5          | Pin 11         | Pin 18        | Pin 7        | Pin 9        |
| RFC – RF1 Insertion Loss<br>RFC – RF2 Isolation | 0 V            | +10 V @ 100 mA | +5 V @ 100 mA | +10 V @ 0 mA | 0 V          |
| RFC – RF2 Insertion Loss<br>RFC – RF1 Isolation | +10 V @ 100 mA | 0 V            | +5 V @ 100 mA | 0 V          | +10 V @ 0 mA |

## Application Schematic



## Off-Chip Component Values<sup>10</sup>

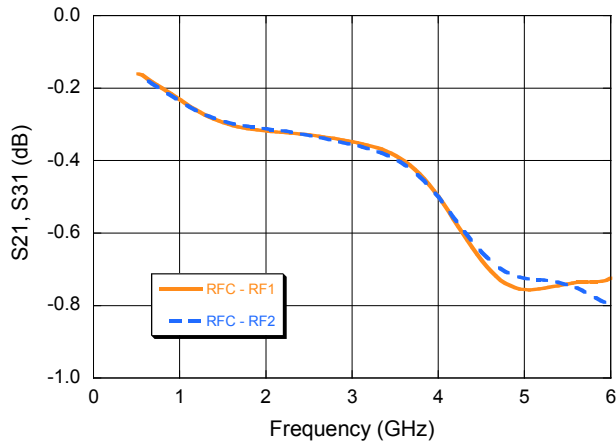
| Component             | Value              | Size |
|-----------------------|--------------------|------|
| C1, C3, C4,<br>C6, C7 | 47 pF              | 0402 |
| C2, C5, C8            | 18 pF              | 0402 |
| L1 - L5               | 47 nH              | 0402 |
| R1 - R2               | 82 Ω <sup>11</sup> | 1210 |
| R3                    | 39 Ω               | 1210 |

10. Off-chip component values are used for small signal testing under +5 / -5 V and 0 / +10 V bias conditions. These must be rated appropriately to ensure safe performance under high power operation.

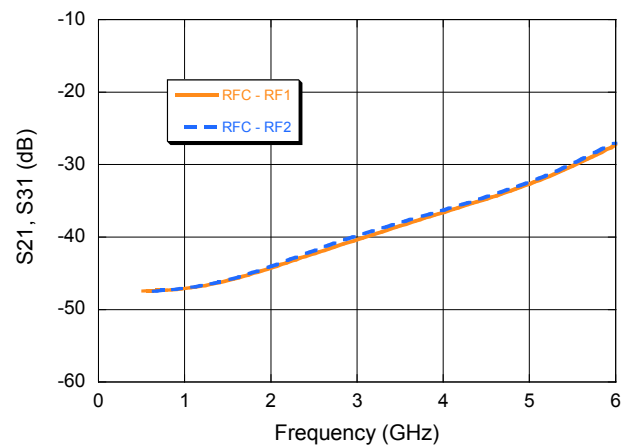
11. Shunt resistor (R1, R2) values can be adjusted using the following formula:  $R = (V-1) / I_{SHUNT}$  where R is the shunt resistor value, V is the DC voltage applied to the reverse-biased series PIN diode, and  $I_{SHUNT}$  is the current through the forward-biased shunt PIN diode.

Typical Performance Curves:  $T_A = 25^\circ\text{C}$ , Bias = +5 / -5 V<sup>5</sup>, 50 mA / 100 mA

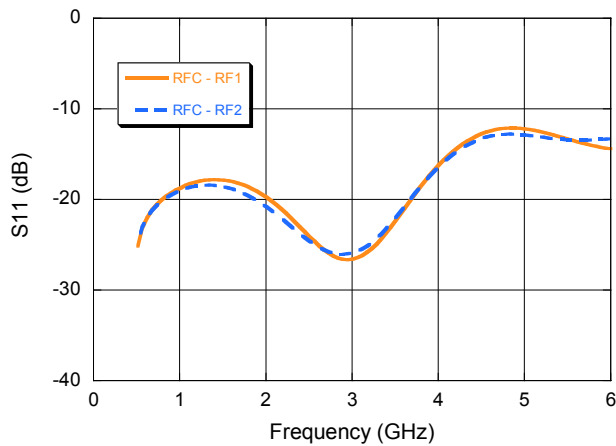
**Insertion Loss**



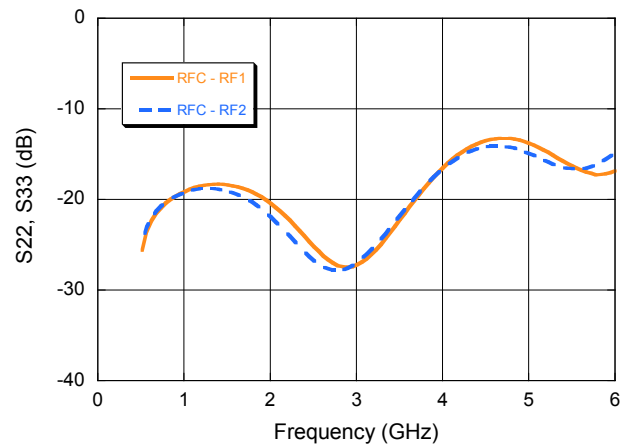
**Isolation**



**Input Return Loss**



**Output Return Loss**



## Switch, SP2T 100 Watt Reflective 0.5 - 6.0 GHz

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### Large Signal Operation @ 1 GHz

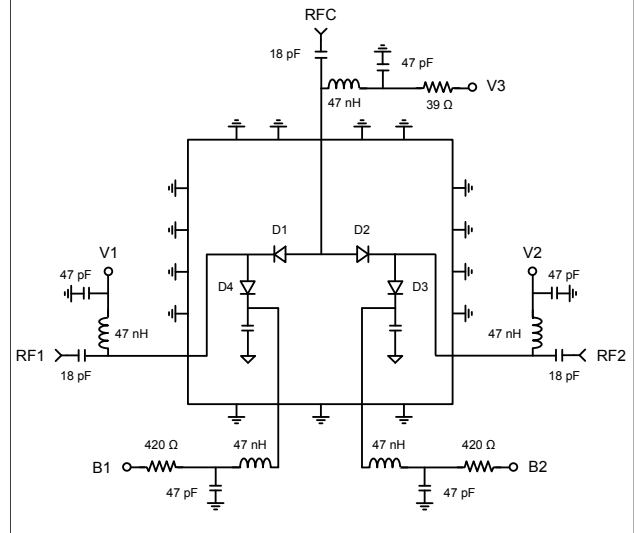
Operation of the MASW-011060 high power switch requires four complementary DC control signals. Bias voltages are applied to DC ports B1 and V1 (corresponding to RF port RF1), B2 and V2 (corresponding to RF port RF2), and static V3.

For positive-only DC bias at 1 GHz, 5 V and 22 V are required. A constant 5 V is applied at the V3 DC port at all times. To set the switch to a RFC-RF1 low loss state and RFC-RF2 in Isolation, D1 PIN diode must be forward biased, D2 PIN diode must be reversed biased, D3 PIN diode must be forward biased, and D4 PIN diode must be reversed biased.

D1 PIN diode is forward biased by setting V1 port to 0 V. A 39 Ω resistor sets the forward current to a nominal of 100 mA. D2 PIN diode is reverse biased by applying 22 V at V2 port. This is the minimum reverse bias voltage that is required to maintain the PIN diode in its non-conducting, high impedance state under 100 W incident power with a 1.5:1 VSWR. D3 PIN diode is forward biased by setting B2 to 0 V. To determine the forward current of the shunt PIN diode, equation listed on note 10 can be used. The resultant resistance is 420 Ω to achieve 50 mA nominal forward current. D4 PIN diode is reverse biased by applying 22 V to B1 port.

To set the switch to a RFC-RF2 low loss state and RFC-RF1 in isolation, reverse 0 V and 22 V.

### Large Signal Operation @ 1 GHz, DC Bias 0 / +22V

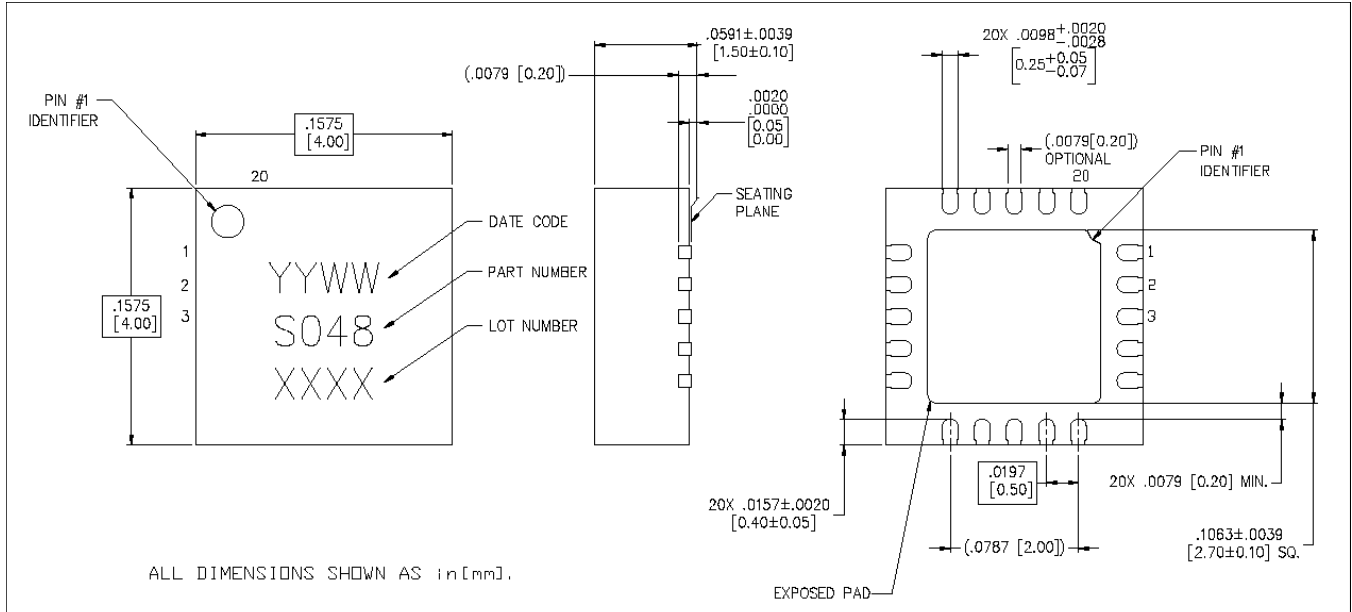


In order to safely operate at 100 W incident power, the values of the reactive components that make up the bias decoupling networks and DC blocking must be rated appropriately. Proper heat sinking is essential to safe operation under high incident power.

### Bias 0 / +22 V (Large Signal Operation @ 1 GHz)

| RF State  | V1 Bias (V)   | V2 Bias (V)   | V3 Bias (V)   | B1 Bias (V)  | B2 Bias (V)  |
|---|---------------|---------------|---------------|--------------|--------------|
| Pin No.   | Pin 5         | Pin 11        | Pin 18        | Pin 7        | Pin 9        |
| RFC - RF1 Insertion Loss<br>RFC - RF2 Isolation | 0 V           | +22 V @ 50 mA | +5 V @ 100 mA | +22 V @ 0 mA | 0 V          |
| RFC - RF2 Insertion Loss<br>RFC - RF1 Isolation | +22 V @ 50 mA | 0 V           | +5 V @ 100 mA | 0 V          | +22 V @ 0 mA |

## Lead Free 4 mm 20-Lead HQFN †



† Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 1 requirements.  
Plating is NiPdAuAg.

### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 1B HMB devices.

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