PIN Diode SPDT 120 W Switch for 0.05 - 6 GHz High Power Applications

Features
- Exceptional Broadband Performance
- Low Insertion Loss: $T_X = 0.20$ dB @ 2.7 GHz
- High Isolation: $R_X = 50$ dB @ 2.7 GHz
- High $T_X$ RF Input Power = 120 W CW @ 2.0 GHz, +85°C
- High $T_X$ RF Input Peak Power: 1000 W
- Positive DC Bias Only Required
- Surface Mount 4 mm PQFN Package
- RoHS* Compliant and 260°C Reflow Compatible

Applications
- Suitable for High Power LTE, TD-SCDMA, WiMAX, and Military Radio Applications

Description
The MASW-000936 is a SPDT high power, broadband, high linearity, PIN diode T/R switch for 0.05 - 6.0 GHz applications, including WiMAX & WiFi. The device is provided in an industry standard lead free 4 mm PQFN plastic package.

This device incorporates PIN diode die fabricated with a low loss, high isolation switching diode

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASW-000936-14000T</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MASW-000936-001SMB</td>
<td>Sample Board</td>
</tr>
<tr>
<td>MASW-000936-DRVSM</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.

Pin Configuration

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Pin Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,8,11,13</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>ANT</td>
<td>Antenna</td>
</tr>
<tr>
<td>3,6,15</td>
<td>N/C</td>
<td>Connect to Ground</td>
</tr>
<tr>
<td>4,5,10,16</td>
<td>N/C</td>
<td>No Connection</td>
</tr>
<tr>
<td>7</td>
<td>R_X</td>
<td>Receive</td>
</tr>
<tr>
<td>9</td>
<td>ShD R_X Bias</td>
<td>ShD R_X Bias</td>
</tr>
<tr>
<td>12</td>
<td>Tx Tune</td>
<td>Tx Tune$^3$</td>
</tr>
<tr>
<td>14</td>
<td>T_X</td>
<td>Transmit</td>
</tr>
</tbody>
</table>

2. The exposed pad centered on the package bottom must be connected to RF, DC and Thermal ground.
3. Optional tuning pin. See note 6 for details.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
### Electrical Specifications

**Freq.** = 2.0, 2.7, 3.5 GHz, **T<sub>A</sub>** = 25°C, Bias = 100 mA / 28 V

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insertion Loss&lt;sup&gt;4&lt;/sup&gt;</td>
<td>RX 0.8 GHz</td>
<td>dB</td>
<td>0.20</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>TX 0.8 GHz</td>
<td></td>
<td>0.07</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>RX 2.0 GHz</td>
<td></td>
<td>0.35</td>
<td>—</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>TX 2.0 GHz</td>
<td></td>
<td>0.15</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>RX 2.7 GHz</td>
<td></td>
<td>0.50</td>
<td>—</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>TX 2.7 GHz</td>
<td></td>
<td>0.20</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>RX 3.5 GHz</td>
<td></td>
<td>0.70</td>
<td>—</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>TX 3.5 GHz</td>
<td></td>
<td>0.25</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Isolation&lt;sup&gt;4&lt;/sup&gt;</td>
<td>RX to Antenna, 2.0 GHz</td>
<td>dB</td>
<td>41</td>
<td>45</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>TX to Antenna, 2.0 GHz</td>
<td></td>
<td>—</td>
<td>16</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>RX to Antenna, 2.7 GHz</td>
<td></td>
<td>40</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>TX to Antenna, 2.7 GHz</td>
<td></td>
<td>—</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>RX to Antenna, 3.5 GHz</td>
<td></td>
<td>33</td>
<td>40</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>TX to Antenna, 3.5 GHz</td>
<td></td>
<td>—</td>
<td>11</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss&lt;sup&gt;4&lt;/sup&gt;</td>
<td>RX</td>
<td>dB</td>
<td>—</td>
<td>23</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>TX</td>
<td></td>
<td>—</td>
<td>34</td>
<td>—</td>
</tr>
<tr>
<td>TX Input P0.1 dB</td>
<td>TX to Antenna</td>
<td>dBm</td>
<td>—</td>
<td>&gt;50</td>
<td>—</td>
</tr>
<tr>
<td>TX IIP3</td>
<td>F1 = 2010 MHz, F2 = 2020 MHz</td>
<td>dBm</td>
<td>—</td>
<td>72</td>
<td>—</td>
</tr>
<tr>
<td>TX CW Input Power</td>
<td>85°C Base plate</td>
<td>dBm / W</td>
<td>50.8 / 120</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2.0 GHz</td>
<td></td>
<td>50 / 100</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2.7 GHz</td>
<td></td>
<td>49 / 80</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>3.5 GHz</td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>RX CW Input Power</td>
<td>85°C Base plate</td>
<td>dBm / W</td>
<td>41.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>2.0 GHz</td>
<td></td>
<td>14</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>TX RF Switching Speed</td>
<td>(10 - 90% RF Voltage)</td>
<td>ns</td>
<td>—</td>
<td>200</td>
<td>—</td>
</tr>
</tbody>
</table>

4. See Bias Table
PIN Diode SPDT 120 W Switch for 0.05 - 6 GHz High Power Applications

Bias Schematic

![Bias Schematic Diagram]

Parts List

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 - C3</td>
<td>22 pF</td>
<td>0603</td>
</tr>
<tr>
<td>C4 - C7</td>
<td>27 pF</td>
<td>0603</td>
</tr>
<tr>
<td>L1 - L4</td>
<td>68 nH</td>
<td>0603</td>
</tr>
<tr>
<td>R1^5</td>
<td>39 Ω</td>
<td>0603</td>
</tr>
<tr>
<td>R2^5</td>
<td>480 Ω</td>
<td>See note 5</td>
</tr>
</tbody>
</table>

Suggested Switch Driver
MADR-009150 or MADR-010574

Bias Table

<table>
<thead>
<tr>
<th>Switch State</th>
<th>TX Bias</th>
<th>RX Bias</th>
<th>ShD RX Bias</th>
<th>ANT Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX-ANT Isolation</td>
<td>(+28 V), 0 mA</td>
<td>(GND), -100 mA</td>
<td>(+28 V), 0 mA</td>
<td>+5 V</td>
</tr>
<tr>
<td>TX-ANT Insertion Loss</td>
<td>(GND), -100 mA</td>
<td>(+28 V), +56 mA</td>
<td>(GND), -56 mA</td>
<td>+5 V</td>
</tr>
<tr>
<td>RX-ANT Isolation</td>
<td>(GND), -100 mA</td>
<td>(+28 V), +56 mA</td>
<td>(GND), -56 mA</td>
<td>+5 V</td>
</tr>
<tr>
<td>RX-ANT Insertion Loss</td>
<td>(+28 V), 0 mA</td>
<td>(GND), -100 mA</td>
<td>(+28 V), 0 mA</td>
<td>+5 V</td>
</tr>
</tbody>
</table>

Note:
5. R1 and R2 values equal to ((Applied Bias Voltage) - (Forward Voltage of Diode)) / (Ibias) where the Forward Voltage of Diode (Vf) can be approximated as 1 V. The size of the package will depend on the power rating needed.
6. Not shown, adding an LC network to pin 12 can improve RX performance between 2.0 and 2.7 GHz but may limit performance above 3.0 GHz. For broadband applications MACOM recommends not using pin 12 and not connecting it to any metal trace.
PIN Diode SPDT 120 W Switch for 0.05 - 6 GHz High Power Applications

Absolute Maximum Ratings\(^7,8,9\)
@ \(T_A = +25^\circ C\) (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Current</td>
<td>150 mA</td>
</tr>
<tr>
<td>DC Reverse Voltage</td>
<td>130 V</td>
</tr>
<tr>
<td>(T_X) Incident CW Power</td>
<td>See Power De-rating Curve</td>
</tr>
<tr>
<td>(T_X) Incident Peak Power</td>
<td>1000 W</td>
</tr>
<tr>
<td>(R_X) Incident CW Power</td>
<td>41.5 dBm (14 W) @ 2 GHz, +85°C</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>+175°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +100°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55°C to +150°C</td>
</tr>
</tbody>
</table>

7. Exceeding these limits may cause permanent damage.
8. MACOM does not recommend sustained operation near these survivability limits.
9. Operating at nominal conditions with \(T_J \leq +175^\circ C\) will ensure MTTF > 1 \(\times 10^6\) hours.
10. Measured with 4 ms pulse period, up to +100°C case temperature.

Minimum Reverse Bias Voltage\(^11\)

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>DC Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>130(^12)</td>
</tr>
<tr>
<td>500</td>
<td>91(^12)</td>
</tr>
<tr>
<td>1000</td>
<td>57(^12)</td>
</tr>
<tr>
<td>2000</td>
<td>31</td>
</tr>
<tr>
<td>4000</td>
<td>16</td>
</tr>
<tr>
<td>6000</td>
<td>11</td>
</tr>
</tbody>
</table>

11. Minimum DC bias voltage to maintain low loss under 120 W of Tx power with 1.5:1 VSWR
12. The MADR-009150 switch driver has a maximum output voltage of 55 V. If a higher output voltage is desired, then one may want to consider using the MADR-010574 switch driver.

Handling Procedures
Please observe the following precautions to avoid damage:

Static Sensitivity
Silicon Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 1C Human Body devices.
PIN Diode SPDT 120 W Switch for 0.05 - 6 GHz High Power Applications

Typical Performance Curves (RF-probed parts), $T_X$ (100 mA Bias Current)

**Insertion Loss, $T_X$**

**Isolation, $T_X$**

**Input Return Loss, $T_X$**

**Output Return Loss, $T_X$**
PIN Diode SPDT 120 W Switch for 0.05 - 6 GHz High Power Applications

Typical Performance Curves (RF-probed parts), $R_X$ (100 mA Bias Current)

**Insertion Loss, $R_X$**

![Insertion Loss Plot](Image)

**Isolation, $R_X$**

![Isolation Plot](Image)

**Input Return Loss, $R_X$**

![Input Return Loss Plot](Image)

**Output Return Loss, $R_X$**

![Output Return Loss Plot](Image)
PIN Diode SPDT 120 W Switch for 0.05 - 6 GHz High Power Applications

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PCB Footprint

![PCB Footprint Diagram]

Lead Free 4 mm 16-Lead PQFN†

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