Features

- Exceptional Broadband Performance
- Low Loss:
  \[ T_X = 0.33 \text{ dB} @ 2010 \text{ MHz}, \ 5 \text{ V} / 20 \text{ mA} \]
  \[ T_X = 0.38 \text{ dB} @ 3.5 \text{ GHz}, \ 5 \text{ V} / 20 \text{ mA} \]
- High Isolation:
  \[ R_X = 44 \text{ dB} @ 2010 \text{ MHz}, \ 20 \text{ mA} / 5 \text{ V} \]
  \[ R_X = 36 \text{ dB} @ 3.5 \text{ GHz}, \ 20 \text{ mA} / 5 \text{ V} \]
- High \(T_X\) RF Input Power:
  50 W CW @ 2010 MHz
- High \(T_X\) RF Input Peak Power:
  >1000 W
- Suitable for Very High Power TD-SCDMA & WiMAX Applications
- Surface Mount 4 mm PQFN Package
- RoHS* Compliant

Description and Applications

The MASW-000834-13560T is a SPDT broadband, high linearity, common anode, PIN diode T/R switch, for 0.05 - 6.0 GHz applications, including WiMAX & WiFi. The device is provided in industry standard 4 mm PQFN plastic packaging. This device incorporates a PIN diode die fabricated with MACOMs' patented silicon-glass HMIC™ process. This chip features two silicon pedestals embedded in a low loss, low dispersion glass. The diodes are formed on the top of each pedestal. The topside is fully encapsulated with silicon nitride and has an additional polymer passivation layer that prevents damage and contamination during handling and assembly.

This compact SPDT switch offers wideband performance with excellent isolation to loss ratio for both \(T_X\) and \(R_X\) states. The PIN diode provides 50 W typical CW power handling and 65 dBm IIP3 at 2010 MHz for maximum switch performance.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASW-000834-13560T</td>
<td>1000 piece reel</td>
</tr>
<tr>
<td>MASW-000834-001SMB</td>
<td>Sample Board</td>
</tr>
<tr>
<td>MADR-008851-001TB1</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

1. Sample board with recommended external driver & MASW-000834-13560T switch.

Electrical Specifications:\(^3\):
\(T_A = +25^\circ\text{C}, 20\ \text{mA} / 5\ \text{V}, \ P_{\text{INC}} = 0\ \text{dBm}, \ Z_0 = 50\ \Omega\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
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<tbody>
<tr>
<td><strong>F = 900 MHz</strong></td>
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<tr>
<td>Insertion Loss, (R_X)</td>
<td>(R_X)</td>
<td>dB</td>
<td>—</td>
<td>0.34</td>
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<td>dB</td>
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<tr>
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<td>(R_X)</td>
<td>dB</td>
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<tr>
<td>Isolation, ANT To (T_X)</td>
<td>(T_X)</td>
<td>dB</td>
<td>21.7</td>
<td>27.1</td>
<td>—</td>
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<tr>
<td><strong>F = 1800 MHz</strong></td>
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<tr>
<td>Insertion Loss, (R_X)</td>
<td>(R_X)</td>
<td>dB</td>
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<td>Insertion Loss, (T_X)</td>
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<td>dB</td>
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<td>0.49</td>
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<td>Isolation, ANT To (R_X)</td>
<td>(R_X)</td>
<td>dB</td>
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<td>48.9</td>
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<tr>
<td>Isolation, ANT To (T_X)</td>
<td>(T_X)</td>
<td>dB</td>
<td>18.4</td>
<td>21.4</td>
<td>—</td>
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<tr>
<td><strong>F = 2010 MHz</strong></td>
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<tr>
<td>Insertion Loss, (R_X)</td>
<td>(R_X)</td>
<td>dB</td>
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<td>0.42</td>
<td>0.75</td>
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<td>dB</td>
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<td>0.5</td>
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<td>Isolation, ANT To (R_X)</td>
<td>(R_X)</td>
<td>dB</td>
<td>43.2</td>
<td>44.6</td>
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<tr>
<td>Isolation, ANT To (T_X)</td>
<td>(T_X)</td>
<td>dB</td>
<td>17.7</td>
<td>19.9</td>
<td>—</td>
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<tr>
<td>Input Return Loss, (T_X)</td>
<td>(T_X)</td>
<td>dB</td>
<td>—</td>
<td>32.1</td>
<td>—</td>
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<tr>
<td>Input Return Loss, (R_X)</td>
<td>(R_X)</td>
<td>dB</td>
<td>—</td>
<td>24.2</td>
<td>—</td>
</tr>
</tbody>
</table>

3. See Bias Table 1.
### Electrical Specifications

For operation over different frequency ranges:

- **F = 2.3 - 2.7 GHz**
  - Insertion Loss, $R_X$: $R_{XIL}$ dB, Min. 0.46, Typ. 0.84
  - Insertion Loss, $T_X$: $T_{XIL}$ dB, Min. 0.35, Typ. 0.525
  - Isolation, ANT To $R_X$: $R_{XISO}$ dB, Min. 40.2, Typ. 41.2
  - Isolation, ANT To $T_X$: $T_{XISO}$ dB, Min. 16.2, Typ. 18.6
  - Input Return Loss, $T_X$: $T_{XRL}$ dB, Min. 30.5
  - Input Return Loss, $R_X$: $R_{XRL}$ dB, Min. 22.9

- **F = 3.3 - 3.8 GHz**
  - Insertion Loss, $R_X$: $R_{XIL}$ dB, Min. 0.56, Typ. 1.0
  - Insertion Loss, $T_X$: $T_{XIL}$ dB, Min. 0.38, Typ. 0.575
  - Isolation, ANT To $R_X$: $R_{XISO}$ dB, Min. 33.7, Typ. 35.9
  - Isolation, ANT To $T_X$: $T_{XISO}$ dB, Min. 13.6, Typ. 16.1
  - Input Return Loss, $T_X$: $T_{XRL}$ dB, Min. 27.4
  - Input Return Loss, $R_X$: $R_{XRL}$ dB, Min. 21.9

- **F = 4.9 - 5.9 GHz**
  - Insertion Loss, $R_X$: $R_{XIL}$ dB, Min. 0.78
  - Insertion Loss, $T_X$: $T_{XIL}$ dB, Min. 0.52
  - Isolation, ANT To $R_X$: $R_{XISO}$ dB, Min. 26.4
  - Isolation, ANT To $T_X$: $T_{XISO}$ dB, Min. 11.8
  - Input Return Loss, $T_X$: $T_{XRL}$ dB, Min. 20.3
  - Input Return Loss, $R_X$: $R_{XRL}$ dB, Min. 24.2
### Electrical Specifications:

\[ T_A = +25°C, \ 50 \text{ mA} / 25 \text{ V}, \ P_{\text{INC}} = 0 \text{ dBm}, \ Z_0 = 50 \Omega \]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
<th>Min.</th>
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<tr>
<td>F = 900 MHz</td>
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<tr>
<td>Insertion Loss, R&lt;sub&gt;x&lt;/sub&gt;</td>
<td>R&lt;sub&gt;x&lt;/sub&gt;</td>
<td>IL</td>
<td>dB</td>
<td></td>
<td>0.27</td>
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<tr>
<td>Insertion Loss, T&lt;sub&gt;x&lt;/sub&gt;</td>
<td>T&lt;sub&gt;x&lt;/sub&gt;</td>
<td>IL</td>
<td>dB</td>
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<td>ISO</td>
<td>dB</td>
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<td>F = 1800 MHz</td>
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<td>Insertion Loss, R&lt;sub&gt;x&lt;/sub&gt;</td>
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<td>IL</td>
<td>dB</td>
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<td>IL</td>
<td>dB</td>
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<td>0.27</td>
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<tr>
<td>Isolation, ANT To R&lt;sub&gt;x&lt;/sub&gt;</td>
<td>R&lt;sub&gt;x&lt;/sub&gt;</td>
<td>ISO</td>
<td>dB</td>
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<td>50.2</td>
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<td>Isolation, ANT To T&lt;sub&gt;x&lt;/sub&gt;</td>
<td>T&lt;sub&gt;x&lt;/sub&gt;</td>
<td>ISO</td>
<td>dB</td>
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<td>21.6</td>
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<tr>
<td>F = 2010 MHz</td>
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<tr>
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<td>R&lt;sub&gt;x&lt;/sub&gt;</td>
<td>IL</td>
<td>dB</td>
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<td>Insertion Loss, T&lt;sub&gt;x&lt;/sub&gt;</td>
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<td>dB</td>
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<td>ISO</td>
<td>dB</td>
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<td>45.5</td>
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<td>Isolation, ANT To T&lt;sub&gt;x&lt;/sub&gt;</td>
<td>T&lt;sub&gt;x&lt;/sub&gt;</td>
<td>ISO</td>
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<td>R&lt;sub&gt;x&lt;/sub&gt;</td>
<td>RL</td>
<td>dB</td>
<td></td>
<td>24.1</td>
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</table>

4. See Bias Table 2.
**Electrical Specifications**

\[ T_A = +25^\circ C, \ 50 \ mA / 25 \ V, \ P_{INC} = 0 \ dBm, \ Z_0 = 50 \ \Omega \]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
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<tbody>
<tr>
<td><strong>F = 2.3 - 2.7 GHz</strong></td>
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<tr>
<td>Insertion Loss, ( R_X )</td>
<td>( R_{X \ IL} )</td>
<td>dB</td>
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<td>Insertion Loss, ( T_X )</td>
<td>( T_{X \ IL} )</td>
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<tr>
<td>Isolation, ANT To ( R_X )</td>
<td>( R_{X \ ISO} )</td>
<td>dB</td>
<td>—</td>
<td>41.8</td>
<td>—</td>
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<tr>
<td>Isolation, ANT To ( T_X )</td>
<td>( T_{X \ ISO} )</td>
<td>dB</td>
<td>—</td>
<td>18.7</td>
<td>—</td>
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<tr>
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<td>( T_{X \ RL} )</td>
<td>dB</td>
<td>—</td>
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<tr>
<td>Input Return Loss, ( R_X )</td>
<td>( R_{X \ RL} )</td>
<td>dB</td>
<td>—</td>
<td>22.8</td>
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<tr>
<td><strong>F = 3.3 - 3.8 GHz</strong></td>
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<tr>
<td>Insertion Loss, ( R_X )</td>
<td>( R_{X \ IL} )</td>
<td>dB</td>
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<tr>
<td>Insertion Loss, ( T_X )</td>
<td>( T_{X \ IL} )</td>
<td>dB</td>
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<tr>
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<td>( R_{X \ ISO} )</td>
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<td>—</td>
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<td><strong>F = 4.9 - 5.9 GHz</strong></td>
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<td>( R_{X \ IL} )</td>
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<td>( T_{X \ ISO} )</td>
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<td>( T_{X \ RL} )</td>
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<td>20.5</td>
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<tr>
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<td>( R_{X \ RL} )</td>
<td>dB</td>
<td>—</td>
<td>24.2</td>
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</table>
Electrical Specifications:
$T_A = +25^\circ \text{C}$, 50 mA / 25 V, $Z_0 = 50 \, \Omega$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Units</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
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<tbody>
<tr>
<td>$T_X$ Input P1dB</td>
<td>$T_X$</td>
<td>$P_{1dB}$</td>
<td>dBm</td>
<td>—</td>
<td>&gt;45.5</td>
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<td></td>
<td>$P_{1dB}$</td>
<td>2010 MHz, $T_X$ to Antenna 3.5 GHz, $T_X$ to Antenna</td>
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<tr>
<td>$T_X$ 2$^\text{nd}$ Harmonic</td>
<td>$T_X$</td>
<td>$2F_0$</td>
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<td>—</td>
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<td></td>
<td>$2F_0$</td>
<td>2010 MHz, $P_{IN} = +30$ dBm</td>
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<td>$T_X$ 3$^\text{rd}$ Harmonic</td>
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<td>$3F_0$</td>
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<td>2010 MHz, $P_{IN} = +30$ dBm 3.5 GHz, $P_{IN} = +30$ dBm</td>
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<td>$T_X$ Input IP3</td>
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<td>$IIP3$</td>
<td>dBm</td>
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<td>&gt;64</td>
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<td>$IIP3$</td>
<td>$P_{IN} = +10$ dBm, $F_1 = 2010$ MHz, $F_2 = 2020$ MHz $P_{IN} = +10$ dBm</td>
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<tr>
<td>$T_X$ CW Input Power</td>
<td>$T_X$</td>
<td>$P_{INC}$</td>
<td>dBm / W</td>
<td>—</td>
<td>47 / 50</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>$P_{INC}$</td>
<td>$F = 2010$ MHz</td>
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<tr>
<td>$R_X$ CW Input Power</td>
<td>$R_X$</td>
<td>$P_{INC}$</td>
<td>dBm / W</td>
<td>—</td>
<td>41.5 / 14</td>
<td>40.5 / 11</td>
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<td>$P_{INC}$</td>
<td>$F = 2010$ MHz $F = 3.5$ GHz</td>
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</tr>
<tr>
<td>$T_X$ RF Switching Speed</td>
<td>$t_{RF}$</td>
<td>$F = 2010$ MHz (10-90% RF Voltage) $F = 3.5$ GHz (10-90% RF Voltage) 1 MHz Rep Rate in Modulating Mode</td>
<td>ns</td>
<td>—</td>
<td>200</td>
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Absolute Maximum Ratings$^{5,6}$
@ $T_A = +25^\circ \text{C}$ (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
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<tbody>
<tr>
<td>Forward Current</td>
<td>100 mA</td>
</tr>
<tr>
<td>RF &amp; DC Reverse Voltage</td>
<td>-200 V</td>
</tr>
<tr>
<td>$T_X$ Incident CW Power</td>
<td>50 W (47 dBm)$^7$</td>
</tr>
<tr>
<td></td>
<td>@ 2010 MHz</td>
</tr>
<tr>
<td>$T_X$ Peak Incident Power</td>
<td>&gt;300 W, 5 μs, 1% duty</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>+175°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55°C to +150°C</td>
</tr>
</tbody>
</table>

5. Exceeding these limits may cause permanent damage.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Baseplate Temperature must be controlled to a constant +25°C. See derating curve.

Static Sensitivity
These devices are rated Class 1B Human Body. Proper ESD control techniques should be used when handling these devices.
Note that this part must be held to a constant baseplate temperature to achieve the power handling results specified above. Adding a heatsink to the baseplate will improve performance to values greater than shown here. The increase in maximum input power from using a heatsink depends on the specific heatsink design.

With a sample board mounted onto a heatsink of dimensions and fins shown below, this switch can handle up to 35 W CW of incident power.
HMIC™ PIN Diode SPDT 50 Watt Switch for 0.05 - 6.0 GHz Higher Power Applications

**T<sub>x</sub> Performance Curves @ +25°C, Z<sub>0</sub> = 50 Ω**

**T<sub>x</sub> Insertion Loss, 20 mA & 50 mA**

![Graph showing T<sub>x</sub> Insertion Loss at 20 mA and 50 mA](image)

**T<sub>x</sub> Isolation, 5 V & 25 V**

![Graph showing T<sub>x</sub> Isolation at 5 V and 25 V](image)

**R<sub>x</sub> Performance Curves @ +25°C, Z<sub>0</sub> = 50 Ω**

**R<sub>x</sub> Insertion Loss, 20 mA & 50 mA**

![Graph showing R<sub>x</sub> Insertion Loss at 20 mA and 50 mA](image)

**R<sub>x</sub> Isolation, 5 V & 25 V**

![Graph showing R<sub>x</sub> Isolation at 5 V and 25 V](image)
Bias Diagrams & Tables

**T<sub>x</sub>-ANT Insertion Loss, R<sub>x</sub>-ANT Isolation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pin 14</th>
<th>Pin 7</th>
<th>DC2</th>
<th>ANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;x&lt;/sub&gt;-ANT Insertion Loss</td>
<td>-20 mA</td>
<td>+5 V, +20 mA</td>
<td>-20 mA</td>
<td>0 V, +20 mA</td>
</tr>
<tr>
<td>R&lt;sub&gt;x&lt;/sub&gt;-ANT Isolation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;x&lt;/sub&gt;-ANT Insertion Loss</td>
<td>+5 V, 0 mA</td>
<td>-20 mA</td>
<td>+5 V, 0 mA</td>
<td>0 V, +20 mA</td>
</tr>
<tr>
<td>T&lt;sub&gt;x&lt;/sub&gt;-ANT Isolation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**R<sub>x</sub>-ANT Insertion Loss, T<sub>x</sub>-ANT Isolation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pin 14</th>
<th>Pin 7</th>
<th>DC2</th>
<th>ANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&lt;sub&gt;x&lt;/sub&gt;-ANT Insertion Loss</td>
<td>-50 mA</td>
<td>+25 V, +50 mA</td>
<td>-50 mA</td>
<td>0 V, +50 mA</td>
</tr>
<tr>
<td>R&lt;sub&gt;x&lt;/sub&gt;-ANT Isolation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;x&lt;/sub&gt;-ANT Insertion Loss</td>
<td>+25 V, 0 mA</td>
<td>-50 mA</td>
<td>+25 V, 0 mA</td>
<td>0 V, +50 mA</td>
</tr>
<tr>
<td>T&lt;sub&gt;x&lt;/sub&gt;-ANT Isolation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. Diode Based Products require different minimum reverse bias voltages depending on the frequency and incident power levels. More details can be found on page 10 of this datasheet.
Minimum Required Reverse Bias Voltage

Minimum reverse bias voltage on a PIN diode based product varies with frequency of operation and incident power levels. As a rule of thumb, a designer can always use the magnitude of the peak RF voltage or empirically locate lower bias values than the peak RF voltage magnitude. However, it has been shown that lower DC voltages can be used depending on the RF environment in which a diode is placed. In the plot below, the minimum required reverse voltage vs. frequency is shown for an incident RF power of 50 Watts. This trend line will shift lower if the incident RF power is decreased. The biasing values have not been verified through measurement at MACOM. As a result, please use the data below as a guide only for biasing requirements as this data is based solely on generic PIN diode equations. Please be cautious in that lower reverse bias levels can degrade isolation and distortion in a PIN diode based product.

MASW-000834 and Recommended Driver with +5 V & +28 V DC Power

MADR-008851 is the recommended driver for the MASW-000834 Switch.

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1-C3</td>
<td>27 pF, 100 V</td>
</tr>
<tr>
<td>C4</td>
<td>1000 pF</td>
</tr>
<tr>
<td>C5</td>
<td>0.022 µF</td>
</tr>
<tr>
<td>C6,C7</td>
<td>12 pF</td>
</tr>
<tr>
<td>C8</td>
<td>20 pF</td>
</tr>
<tr>
<td>L1, L2, L3,L4</td>
<td>27 nH</td>
</tr>
<tr>
<td>R1</td>
<td>see note 11</td>
</tr>
<tr>
<td>R2</td>
<td>see note 12</td>
</tr>
</tbody>
</table>

10. Forward Bias Diode Voltage: $D_{Vf}$ is $\sim 0.9 \text{ V}$ @ 22 mA; $D_{Vf}$ is $\sim 1.0 \text{ V}$ @ 35 mA
11. $R1$ is calculated by $(V_{CC} - 1.5 \text{ V})/I_{\text{SERIES}}$, where $I_{\text{SERIES}}$ is the desired bias current for the series diodes:
   - For 21 mA load current, $R1 = 165 \Omega @ V_{CC} = 5.0 \text{ V}$ and $82 \Omega @ V_{CC} = 3.3 \text{ V}$.
   - For 32 mA load current, $R1 = 110 \Omega @ V_{CC} = 5.0 \text{ V}$ and $56 \Omega @ V_{CC} = 3.3 \text{ V}$.
12. $R2$ is calculated by $(V_{DD} - 1.0 \text{ V})/I_{\text{SHUNT}}$, where $I_{\text{SHUNT}}$ is the desired forward bias current for the shunt diode. The power dissipation is calculated by $I_{\text{SHUNT}} \times 27 \text{ V}$. For 20 mA of $I_{\text{SHUNT}}$, $R2$ should use a 2511, 1W, 1.3kΩ resistor.
13. $C8$ is already built-in for MASW-000834-13560T switch.
14. The voltage at the common anode will be approximately 1.5 V.
15. The current in through the back-biased diodes will be the leakage current for the diodes.
16. C1-C5, L1-L4, R1, R2, and the switch are discrete components that should be installed on the users board. It is recommended that Coilcraft 0603CS-27NXJLW or equivalent be used for L1-L4 at 2 GHz (values may vary based on the frequency).
17. There are 33 pF bypass capacitors included in the driver for the $R_x$, $T_x$, and SH1 ports. There are cases (especially at higher frequencies), where the optional 12 pF bypass capacitors ($C6$ and $C7$) that are shown on the schematic are needed.
HMIC™ PIN Diode SPDT 50 Watt Switch for 0.05 - 6.0 GHz Higher Power Applications

Outline: 4 mm PQFN 16-Lead Saw Singulated

† Reference Application Note S2083 for lead-free solder reflow recommendations.

Meets JEDEC moisture sensitivity level 1 requirements.
HMIC™ PIN Diode SPDT 50 Watt Switch for 0.05 - 6.0 GHz Higher Power Applications

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