AlGaAs SP4T Reflective PIN Diode Switch
14 - 38 GHz

Features
- Low Loss: 0.9 dB, 16 to 35 GHz
- High Isolation: 32 dB, 16 to 35 GHz
- 30 dBm CW Power Handling @ +85°C
- Switching Speed <34 ns
- Integrated DC Blocks and RF Bias Networks
- Die with G-S-G RF Pads and DC Bias Pads
- RoHS* Compliant

Description and Applications
The MASW-011087 is a high power, symmetrical SP4T switch. This broadband, reflective switch was developed for Ka-Band applications that require up to 30 dBm (1 W) power handling while maintaining low insertion loss, high isolation, and fast switching speed. These switches are used in switching arrays of radars systems, radiometers, test equipment, Point-to-Point communications systems and other high frequency applications.

The SP4T MMIC utilizes MACOM’s proven AlGaAs PIN diode technology. The switch is fully passivated with silicon nitride and has an added polymer layer for scratch protection. The protective coating prevents damage to the junction and the air-bridges during handling and assembly. The die has backside metallization to facilitate an epoxy die attach process.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASW-011087-DIE</td>
<td>Die in Waffle Tray</td>
</tr>
<tr>
<td>MASW-011087-SMB</td>
<td>Sample Board</td>
</tr>
</tbody>
</table>

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Electrical Specifications:  \( T_A = 25°C, V_R = -10\ V, I_{SH} = +5\ mA, I_{SE} = +5\ mA, Z_0 = 50\ \Omega \)

<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 (RF_COMMON to RF_X ON state)</td>
<td>20.0 GHz, 28.5 GHz, 35.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Isolation (RF_COMMON to RF_X OFF state)</td>
<td>20.0 GHz, 28.5 GHz, 35.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>Return Loss (RF_COMMON )</td>
<td>20.0 GHz, 28.5 GHz, 35.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Return Loss (RF_X ON state)</td>
<td>20.0 GHz, 28.5 GHz, 35.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>CW Power Handling (ON state)</td>
<td>28.5 GHz</td>
<td>dBm</td>
<td>—</td>
<td>30</td>
<td>—</td>
</tr>
<tr>
<td>Switching Speed ( T_{RISE} / T_{FALL} )</td>
<td>10% - 90% RF, 26.5 GHz</td>
<td>ns</td>
<td>—</td>
<td>10 / 18</td>
<td>—</td>
</tr>
<tr>
<td>Switching Speed ( T_{ON} / T_{OFF} )</td>
<td>50% control to 90% RF, 26.5 GHz</td>
<td>ns</td>
<td>—</td>
<td>26 / 34</td>
<td>—</td>
</tr>
<tr>
<td>IIP3</td>
<td>27 - 32 GHz, ( P_{IN} = 10\ dBm, ) Tone Spacing 10 MHz</td>
<td>dBm</td>
<td>—</td>
<td>43</td>
<td>—</td>
</tr>
<tr>
<td>( P_{0.1dB} )</td>
<td>29.5 GHz</td>
<td>dBm</td>
<td>—</td>
<td>31</td>
<td>—</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings\(^1,2,3\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident Power (ON path)</td>
<td>30 dBm</td>
</tr>
<tr>
<td>( I_{SE} )</td>
<td>20 mA</td>
</tr>
<tr>
<td>( I_{SH} )</td>
<td>20 mA</td>
</tr>
<tr>
<td>( V_R )</td>
<td>-50 V</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>(+150°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>

Handling Procedures

Please observe the following precautions to avoid damage:

**Static Sensitivity**

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 HBM class 1A devices.

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1. Exceeding any one or combination of these limits may cause permanent damage to this device.
2. MACOM does not recommend sustained operation near these survivability limits.
3. Operating at nominal conditions with junction temperature less than 150°C will ensure MTTF >10^6 hours.
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Recommended Board Schematic

Recommended Board Component List

<table>
<thead>
<tr>
<th>Component Designator</th>
<th>Description</th>
<th>P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC, RF1, RF2, RF3, RF4</td>
<td>2.4 mm - Southwest Microwave connector</td>
<td>1492-04A-5</td>
</tr>
<tr>
<td>B1, B2, B3, B4</td>
<td>Johnson/Emerson RF connector Or SSMA - Southwest Microwave connector</td>
<td>142-0761-821</td>
</tr>
<tr>
<td>C1, C2, C3, C4</td>
<td>22 pF High Frequency Capacitor</td>
<td>ATC600L220</td>
</tr>
</tbody>
</table>

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**Recommended Board Application Schematic**

The schematic shown below depicts the switch in ON state of the RF\_COMMON to RF1 and all remaining RF inputs in OFF state.

![](schematic.png)

- $I_{SE}$ - the forward bias current of a series diode
- $I_{SH}$ - the forward bias current of a shunt diode
- $V_R$ - the voltage of a reverse biased shunt diode as well as the voltage of a forward biased series diode
- $V_{CC}$ - the voltage of forward biased shunt diodes

To calculate off-chip bias resistors required:

\[
R_1 = (|V_R| - 2.64\, \text{V}) / I_{SE}
\]

\[
R_2 = (V_{CC} - 1.32\, \text{V}) / (3 * I_{SH})
\]

For example, using standard resistor values with $V_{CC} = +5\, \text{V}$ and $V_R = -10\, \text{V}$:

\[
R_1 = (10\, \text{V} - 2.64\, \text{V}) / 0.005\, \text{A} = 1470\, \text{k}\Omega
\]

\[
R_2 = (5\, \text{V} - 1.32\, \text{V}) / (3 * 0.005\, \text{A}) = 246\, \Omega
\]

**Truth Table**

<table>
<thead>
<tr>
<th>State</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$RF_COMMON$ to RF1</td>
<td>-10 V (-5 mA)</td>
<td>+5 mA</td>
<td>+5 mA</td>
<td>+5 mA</td>
</tr>
<tr>
<td>$RF_COMMON$ to RF2</td>
<td>+5 mA</td>
<td>-10 V (-5 mA)</td>
<td>+5 mA</td>
<td>+5 mA</td>
</tr>
<tr>
<td>$RF_COMMON$ to RF3</td>
<td>+5 mA</td>
<td>+5 mA</td>
<td>-10 V (-5 mA)</td>
<td>+5 mA</td>
</tr>
<tr>
<td>$RF_COMMON$ to RF4</td>
<td>+5 mA</td>
<td>+5 mA</td>
<td>+5 mA</td>
<td>-10 V (-5 mA)</td>
</tr>
</tbody>
</table>
Typical Performance Curves

**Insertion Loss**

**RF 1, 2, 3, 4 Return Loss in On State**

**Insertion Loss over Temperature**

**RF\_COMMON Return Loss in ON State**

**Insertion Loss over Bias Current**

**RF\_COMMON Return Loss in ON State over Bias Current**
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Typical Performance Curves

**Isolation RF\textsubscript{COMMON} to RF2, RF3 over Temperature**

- Frequency (GHz)
- Isolation in dB

**Isolation RF\textsubscript{COMMON} to RF1, RF4 over Temperature**

- Frequency (GHz)
- Isolation in dB

**Compression over Reverse-Bias Voltage @ 29.5 GHz**

- Input Power (dBm)
- Normalized Insertion Loss in dB

**IIP3 over Temperature @ 5 V / 5 mA**

- Frequency (GHz)
- Input IP3 in dBm

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NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS SHOWN AS um WITH A TOLERANCE OF ±5um.
2. DIE THICKNESS IS 100 ±12.5um