MASW-011094

Ka-Band High Power Terminated SPDT PIN Switch
24 - 37 GHz

Features
- Low Loss: 0.6 dB, 28 to 34 GHz
- High Isolation: >26 dB
- >40 W CW Power Handling @ +85°C
- Switching Speed: <65 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-011094 is a high power SPDT with 50 Ω terminated RF ports. This broadband, high linearity, SPDT switch was developed for Ka-Band applications that require up to 40 Watts CW power handling at an environmental temperature of +85°C while maintaining low insertion loss and high isolation.

The SPDT 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.

These switches are ideally suited for satellite and Point-to-Point communications systems, radar systems, radiometers, test and instrumentation equipment and other high frequency applications.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MASW-011094-DIE0G</td>
<td>Die in Gel Pack</td>
</tr>
<tr>
<td>MASW-011094-DIERI</td>
<td>Die, Inked on Wafer Ring</td>
</tr>
</tbody>
</table>

1. Die quantity varies.

Ka-Band High Power Terminated SPDT PIN Switch
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**Electrical Specifications:** $T_A = 25^\circ$C, $V_R^2 = -5$ V, $V_F = +7.5$ V, $Z_0 = 50$ Ω

<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><strong>Insertion Loss</strong>&lt;br&gt;($RF_{COMMON}$ to $RF_x$ ON state)</td>
<td>26 - 28 GHz &lt;br&gt;28 - 32 GHz &lt;br&gt;32 - 36 GHz &lt;br&gt;36 - 37 GHz</td>
<td>dB</td>
<td>—</td>
<td>0.8</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Isolation</strong>&lt;br&gt;($RF_{COMMON}$ to $RF_x$ OFF state)</td>
<td>26 - 28 GHz &lt;br&gt;28 - 32 GHz &lt;br&gt;32 - 36 GHz &lt;br&gt;36 - 37 GHz</td>
<td>dB</td>
<td>—</td>
<td>26</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>27</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>28</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>28</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>29</td>
<td>—</td>
</tr>
<tr>
<td><strong>Return Loss</strong>&lt;br&gt;($RF_{COMMON}$)</td>
<td>26 - 28 GHz &lt;br&gt;28 - 32 GHz &lt;br&gt;32 - 36 GHz &lt;br&gt;36 - 37 GHz</td>
<td>dB</td>
<td>—</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Return Loss</strong>&lt;br&gt;($RF_x$ ON state)</td>
<td>26 - 28 GHz &lt;br&gt;28 - 32 GHz &lt;br&gt;32 - 36 GHz &lt;br&gt;36 - 37 GHz</td>
<td>dB</td>
<td>—</td>
<td>14</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td>12</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Return Loss</strong>&lt;br&gt;($RF_x$ OFF state)</td>
<td>26 - 28 GHz &lt;br&gt;28 - 32 GHz &lt;br&gt;32 - 36 GHz &lt;br&gt;36 - 37 GHz</td>
<td>dB</td>
<td>—</td>
<td>10.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15.0</td>
<td>11.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CW Power Handling (ON state)</td>
<td>28.5 GHz, -60 V @ +85°C</td>
<td>dBm</td>
<td>—</td>
<td>46</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>16 / 34</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>42 / 65</td>
<td>—</td>
</tr>
<tr>
<td>$I_R$ - Reverse Bias Current</td>
<td>$V_R = -60$ V</td>
<td>nA</td>
<td>—</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>$I_F$ - Forward Bias Current</td>
<td>$V_F = +7.5$ V</td>
<td>mA</td>
<td>30</td>
<td>38</td>
<td>45</td>
</tr>
</tbody>
</table>

2. Reverse bias voltage should be determined based on working conditions. For example, -60 V @ 46 dBm input power. For lower power applications, a less negative voltage can be used. R. Caverly and G. Hiller, “Establishing the Minimum Reverse Bias for a P-I-N Diode in a High Power Switch,” IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.

3. Isolation defined with 1 port in low loss state.

4. Forward bias voltage should be determined based on working conditions.
Absolute Maximum Ratings$^{5,6,7}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse Bias Voltage</td>
<td>-100 V</td>
</tr>
<tr>
<td>Forward Bias Current</td>
<td>83 mA</td>
</tr>
<tr>
<td>Forward Bias Voltage</td>
<td>11 V</td>
</tr>
<tr>
<td>Incident Power (ON path)</td>
<td>47 dBm</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>

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with junction temperature less than 150°C will ensure MTTF >1 x 10⁶ hours.

Truth Table

<table>
<thead>
<tr>
<th>State</th>
<th>B1</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$RF_{COMMON}$ to $RF1$</td>
<td>-5 V</td>
<td>+7.5 V</td>
</tr>
<tr>
<td>$RF_{COMMON}$ to $RF2$</td>
<td>+7.5 V</td>
<td>-5 V</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.
**Ka-Band High Power Terminated SPDT PIN Switch**

**Typical Performance Curves**

**Insertion Loss**

- **Frequency (GHz)**
  - 20
  - 25
  - 30
  - 35
  - 40

- **(dB)**
  - 0.0
  - -0.5
  - -1.0
  - -1.5
  - -2.0

**Insertion Loss over Reverse Bias Voltage**

- **Frequency (GHz)**
  - 20
  - 25
  - 30
  - 35
  - 40

- **(dB)**
  - 0.0
  - -0.5
  - -1.0
  - -1.5
  - -2.0

**Isolation RF_{COMMON} to RF_{x}**

- **Frequency (GHz)**
  - 20
  - 25
  - 30
  - 35
  - 40

- **(dB)**
  - 0
  - -10
  - -20
  - -30
  - -40

**RF_{COMMON} Return Loss in On State**

- **Frequency (GHz)**
  - 20
  - 25
  - 30
  - 35
  - 40

- **(dB)**
  - 0
  - -10
  - -20
  - -30
  - -40

**RF_{x} Return Loss in On State**

- **Frequency (GHz)**
  - 20
  - 25
  - 30
  - 35
  - 40

- **(dB)**
  - 0
  - -10
  - -20
  - -30
  - -40

**Return Loss of Terminated Port RF_{x}**

- **Frequency (GHz)**
  - 20
  - 25
  - 30
  - 35
  - 40

- **(dB)**
  - 0
  - -10
  - -20
  - -30
  - -40

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Outline Drawing

Notes:
Unless otherwise specified, all dimensions shown as µm with a tolerance of ±5 µm.
Die thickness is 100 µm ± 12.5 µm.
Pad 1 = 178 x 101 µm.
Pads 2 & 5 = 88 µm sq.
Pads 3 & 4 = 101 x 208 µm.
Applications Section

Sample Board Layout

Sample Board Layout - Detailed View

Sample Board Schematic

<table>
<thead>
<tr>
<th>Component Designator</th>
<th>Description</th>
<th>P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC, RF1, 2, 3, and 4</td>
<td>2.4 mm - Southwest Microwave connector</td>
<td>1492-03A</td>
</tr>
<tr>
<td>B1, B2</td>
<td>Johnson/Emerson RF connector</td>
<td>142-0761-821</td>
</tr>
<tr>
<td></td>
<td>Or SSMA - Southwest Microwave connector</td>
<td>292-06A</td>
</tr>
<tr>
<td>C1, C2</td>
<td>22 pF High Frequency Capacitor</td>
<td>ATC600L220</td>
</tr>
</tbody>
</table>

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DC-0012385
Applications Section

Sample Board Application Schematic

The schematic shown below depicts the switch in ON state of the RF\text{COMMON} to RF2 and RF1 input in OFF state. The switch bias conditions are set for high power (40 W) application.

![Sample Board Application Schematic](image)

Truth Table

<table>
<thead>
<tr>
<th>State</th>
<th>B1</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF\text{COMMON} to RF1 ON</td>
<td>-60 V</td>
<td>+7.5 V</td>
</tr>
<tr>
<td>RF\text{COMMON} to RF2 ON</td>
<td>+7.5 V</td>
<td>-60 V</td>
</tr>
</tbody>
</table>

Typical Forward Current vs. Forward Voltage

[Graph showing typical forward current vs. forward voltage]
Applications Section

Typical Sample Board Performance (Not De-embedded)

**Insertion Loss**

-2.0
-2.5
-3.0
-3.5
-4.0
-4.5
-5.0

Frequency (GHz)

**RF1 and RF2 Return Loss in On State**

-40
-30
-20
-10
0

Frequency (GHz)

**Isolation RF1 and RF2**

-40
-30
-20
-10
0

Frequency (GHz)

**RF\textsubscript{COMMON} Return Loss in ON State**

-40
-30
-20
-10
0

Frequency (GHz)