AlGaAs SP2T Switch with Integrated Bias Network
2 - 22 GHz

Features
- Broad Bandwidth Specified up to 22 GHz
- Integrated DC Blocks and RF Bias Networks
- Low Insertion Loss / High Isolation
- Fast Switching Speed
- Fully Monolithic
- Low Current Consumption:
  - -10 mA for Low Loss State
  - +10 mA for Isolation State
- Die Size: 2.07 mm X 1.48 mm
- RoHS* Compliant

Applications
- Test & Measurement
- Broadband Communication Systems

Description
The MASW-011129-DIE is an SPDT PIN diode switch with integrated bias networks offered as bare die part. This broadband, reflective switch operates from 2 - 22 GHz and provides less than 1 dB insertion loss and 35 dB isolation.

The combination of broadband performance along with very fast switching (<10 ns) and excellent settling time make this device ideal for many applications, including test & measurement, and broadband communication systems.

The switch is fully passivated with silicon nitride and has an added polymer layer for scratch protection. The protective coating prevents damage to the junctions and the anode 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-011129-DIE</td>
<td>Die in Gel Pack</td>
</tr>
</tbody>
</table>

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.
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MASW-011129-DIE
Rev. V2

Electrical Specifications: $T_A = +25^\circ C$, $I_{DC}=+/-10$ mA, $Z_0 = 50$ 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>Insertion Loss</td>
<td>2 GHz, 6 GHz, 12 GHz, 18 GHz</td>
<td>dB</td>
<td>-1.8</td>
<td>-1.1</td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-1</td>
<td>-0.5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-1.1</td>
<td>-0.6</td>
<td>-0.1</td>
</tr>
<tr>
<td>Input to Output Isolation</td>
<td>2 GHz, 6 GHz, 12 GHz, 18 GHz</td>
<td>dB</td>
<td>—</td>
<td>-60</td>
<td>-50</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-50</td>
<td>-40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-45</td>
<td>-35</td>
</tr>
<tr>
<td>RF Common Return Loss</td>
<td>2 GHz, 6 GHz, 12 GHz, 18 GHz</td>
<td>dB</td>
<td>—</td>
<td>-14</td>
<td>-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-16</td>
<td>-12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-19</td>
<td>-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-27</td>
<td>-23</td>
</tr>
<tr>
<td>RF1, RF2 Return Loss</td>
<td>2 GHz, 6 GHz, 12 GHz, 18 GHz</td>
<td>dB</td>
<td>—</td>
<td>-14</td>
<td>-10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-16</td>
<td>-12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-19</td>
<td>-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>-20</td>
<td>-16</td>
</tr>
<tr>
<td>$P_{IN}$ at 0.1 dB Compression</td>
<td>$V_R = -2$ V, @ 2 GHz $V_R = -5$ V, @ 2 GHz $V_R = -10$ V, @ 2 GHz</td>
<td>dBm</td>
<td>—</td>
<td>22.0</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>26.5</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td>28.0</td>
<td>—</td>
</tr>
<tr>
<td>Input IP3</td>
<td>2 Tone, 5 dBm/Tone, 5 MHz spacing, 2 - 18 GHz</td>
<td>dBm</td>
<td>—</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>$T_{RISE}$, $T_{FALL}$</td>
<td>10% to 90% RF &amp; 90% to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>$T_{ON}$, $T_{OFF}$</td>
<td>50% control to 90% RF &amp; 50% control to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>7</td>
<td>—</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings\(^1,2\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident CW RF Power</td>
<td>30 dBm @ $V_R = -10$ V</td>
</tr>
<tr>
<td>Forward Bias Current</td>
<td>20 mA</td>
</tr>
<tr>
<td>Reverse DC Bias Voltage</td>
<td>-50 V</td>
</tr>
<tr>
<td>Junction Temperature(^3)</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>-65°C to +150°C</td>
</tr>
</tbody>
</table>

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 HBM Class 1A devices.

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 $T_J \leq +150^\circ C$ will ensure MTTF $> 1 \times 10^6$ hours.

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DC-0023987
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Truth Table & Bias Conditions

<table>
<thead>
<tr>
<th>RF Common Path</th>
<th>Bias 1</th>
<th>Bias 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF1 Low Loss</td>
<td>$V_R = -10 \text{ V}$</td>
<td>$I_F = +10 \text{ mA}$</td>
</tr>
<tr>
<td>RF2 Isolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RF1 Isolation</td>
<td>$I_F = +10 \text{ mA}$</td>
<td>$V_R = -10 \text{ V}$</td>
</tr>
<tr>
<td>RF2 Low Loss</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Reverse bias voltage should be determined based on working conditions. For example, -10 V @ 2 GHz, 28 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 PIN Diode in a High Power Switch,” IEEE Transactions on Microwave Theory and Techniques, Vol. 38, No. 12, December 1990. See Compression Power and Junction Temperature Performance curves for guidance.

RF Common Bias Configuration:

**Option #1:** Biased using internal resistance
- J7 to ground
- J6 un-connected
- Set $V_R$ to -2 V
- $R_1$ value is 57 $\Omega$

**Option #2:** Biased using external resistance
- J6 to external resistor ($R_{BIAS}$) to ground
- J7 un-connected
- $R_{BIAS} = (V_R - 1.4 \text{ V})/I_{DC}$

5. 22 dBm input power maximum.

Circuit Schematic
AlGaAs SP2T Switch with Integrated Bias Network
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Typical RF Performance Curves, On-Wafer (RF1, RF2 Symmetrical):
Test Conditions: \( V_R = -2 \) V, \( I_F = +10 \) mA, \( P_{IN} = -10 \) dBm

**Insertion Loss over Temperature**

**Return Loss**

**Isolation (RF Common to RF2)**

**Isolation (RF1 to RF2)**
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Typical RF Performance Curves, On-Board (RF1, RF2 Symmetrical)

**IP3 over Temperature, \( P_{IN} = 5 \text{ dBm per tone} \)**

**Junction Temperature over \( V_R \) @ 2 GHz, +85°C**

**Compression Power, over Temperature @ 2 GHz, \( V_R \) -2 V**

**Compression Power, over Temperature @ 18 GHz, \( V_R \) -2 V**

**Compression Power, over \( V_R \) @ 2 GHz, +25°C**

**Compression Power, over \( V_R \) @ 18 GHz, +25°C**

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Solder Die Attach
All die attach and bonding methods should be compatible with gold metal. Solder which does not scavenge gold, such as 80 Au/20 Sn or Indalloy #2, is recommended. Do not expose die to a temperature greater than 300°C for more than 10 seconds.

Electrically Conductive Epoxy
Die Attach
Assembly can be preheated to approximately 125°C. Use a controlled thickness of approximately 1 mils for best electrical conductivity and lower thermal resistance. A thin epoxy fillet should be visible around the perimeter of the chip after placement. Cure epoxy per manufacturer's schedule. For extended cure times, temperatures should be kept below 150°C.

Wire / Ribbon Bonding
Wedge thermo compression bonding may be used to attach ribbons to the RF bonding pads. Gold ribbons should be at least 1/4 mil by 2 mil for lowest inductance. The same gold ribbon or 1 mil dia. gold wire is recommended for all DC pads.

Die Outline Drawing

6. Bond pad dimensions 1 - 7, 100 µm x 100 µm.
7. Unless otherwise specified, all dimensions shown are µm with a tolerance of ±5 µm.
8. Die thickness is 100 µm, ±10 µm.
9. Bond pad / backside metallization: Gold
10. Die size reflects sawn dimensions.
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