Voltage Variable Attenuator
5 - 45 GHz

Features

- 5 - 45 GHz Frequency Range
- 1.5 dB Insertion Loss @ 20 GHz
- >30 dB Attenuation Range
- High Linearity, 30 dBm IIP3
- Lead-Free 3 mm, 16-Lead QFN Package
- RoHS* Compliant

Description

The MAAV-011013 is a voltage variable attenuator with analog control and greater than 30 dB of attenuation. Excellent linearity is maintained over the full attenuation range. The attenuation level is set by two control voltages of 0 to -2 V. This device is assembled in a lead free 3 mm 16 lead PQFN plastic package.

Applications include transceivers for cellular infrastructure.

Functional Block Diagram

Pin Configuration

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Connection</td>
</tr>
<tr>
<td>2</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>RF Input</td>
</tr>
<tr>
<td>4</td>
<td>Ground</td>
</tr>
<tr>
<td>5</td>
<td>No Connection</td>
</tr>
<tr>
<td>6</td>
<td>VC1</td>
</tr>
<tr>
<td>7</td>
<td>VC2</td>
</tr>
<tr>
<td>8</td>
<td>No Connection</td>
</tr>
<tr>
<td>9</td>
<td>Ground</td>
</tr>
<tr>
<td>10</td>
<td>RF Output</td>
</tr>
<tr>
<td>11</td>
<td>Ground</td>
</tr>
<tr>
<td>12 - 16</td>
<td>No Connection</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.
3. It is recommended to connect unused pins to ground.
4. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.

Voltage Variable Attenuator
5 - 45 GHz

Electrical Specifications: \( T_a = +25^\circ C, Z_0 = 50 \, \Omega, P_{IN} = -10 \, \text{dBm} \)

<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 ((V_{C1} = -2 , \text{V}))</td>
<td>5.9 - 15.5 GHz, 17.6 - 20 GHz, 20 - 30 GHz, 30 - 34 GHz, 37 - 40 GHz</td>
<td>dB</td>
<td>—</td>
<td>1.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Attenuation ((V_{C1} = 0 , \text{V})^5)</td>
<td>5.9 - 8.5 GHz, 10 - 11.7 GHz, 12.75 - 15.35 GHz, 17.6 - 20 GHz, 20 - 30 GHz, 30 - 34 GHz, 37 - 40 GHz</td>
<td>dB</td>
<td>22.5</td>
<td>25.0</td>
<td>—</td>
</tr>
<tr>
<td>Input P1dB^6</td>
<td>5 - 25 GHz, 25 - 40 GHz</td>
<td>dBm</td>
<td>24</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>IIP3 (any attenuation)</td>
<td>( P_{IN} = 12 , \text{dBm/tone} @ 5.0 - 15.0 , \text{GHz} ) ( P_{IN} = 12 , \text{dBm/tone} @ 15.0 - 26.5 , \text{GHz} ) ( P_{IN} = 12 , \text{dBm/tone} @ 26.5 - 40.0 , \text{GHz} )</td>
<td>dBm</td>
<td>29.0</td>
<td>31.0</td>
<td>—</td>
</tr>
<tr>
<td>IIP3 ((V_{C1} = V_{C2} = -2 , \text{V})^6)</td>
<td>( P_{IN} = 12 , \text{dBm/tone} @ 5 - 40 , \text{GHz} )</td>
<td>dBm</td>
<td>—</td>
<td>42</td>
<td>—</td>
</tr>
<tr>
<td>Input Return Loss ((any , \text{attenuation}))</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Output Return Loss ((any , \text{attenuation}))</td>
<td>—</td>
<td>dB</td>
<td>—</td>
<td>10</td>
<td>—</td>
</tr>
</tbody>
</table>

5. To increase attenuation from minimum attenuation state \((V_{C1} = -2 \, \text{V} \) and \( V_{C2} = -2 \, \text{V})\) to max attenuation state \((V_{C1} = 0 \, \text{V} \) and \( V_{C2} = 0 \, \text{V})\), \( V_{C1} \) increases to full range prior to adjusting \( V_{C2} \).
6. Guaranteed on MACOM Sample Board only

Absolute Maximum Ratings^7,8

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power</td>
<td>30 dBm</td>
</tr>
<tr>
<td>Voltage (RF pins)</td>
<td>30 V</td>
</tr>
<tr>
<td>Voltage (control pins)</td>
<td>+1 V to -6 V</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-55°C to +150°C</td>
</tr>
<tr>
<td>Case Temperature</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

Handling Procedures
The following precautions should be observed to avoid damage:

Static Sensitivity
Gallium Arsenide 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.

7. Exceeding any one or combination of these limits may cause permanent damage to this device.
8. MACOM does not recommend sustained operation near these survivability limits.
Typical Performance Curves: @ +25°C

**Gain**

![Gain Graph](image)

**Input Return Loss**

![Input Return Loss Graph](image)

**Output Return Loss**

![Output Return Loss Graph](image)
Typical Performance Curves: S-Parameters @ +25°C

S-Parameters $V_{C1} = -2.0$ V, $V_{C2} = -2.0$ V

S-Parameters $V_{C1} = 0$ V, $V_{C2} = -0.6$ V

S-Parameters $V_{C1} = -0.6$ V, $V_{C2} = -2.0$ V

S-Parameters $V_{C1} = -0.4$ V, $V_{C2} = -2.0$ V

S-Parameters $V_{C1} = -0.1$ V, $V_{C2} = -2.0$ V
Typical Performance Curves: Power Gain, Freq. 16 GHz

Power Gain @ $V_C1 = -2.0\ V$, $V_C2 = -2.0\ V$

Power Gain @ $V_C1 = 0\ V$, $V_C2 = -2.0\ V$

Power Gain @ $V_C1 = -0.4\ V$, $V_C2 = -2.0\ V$
Typical Performance Curves: Power Gain @ +25°C

**Power Gain @ \( V_{C1} = -2.0 \, V, V_{C2} = -2.0 \, V \)**

**Power Gain @ \( V_{C1} = -0.4 \, V, V_{C2} = -2.0 \, V \)**

**Power Gain @ \( V_{C1} = 0 \, V, V_{C2} = -2.0 \, V \)**

**Power Gain @ \( V_{C1} = 0 \, V, V_{C2} = -0.6 \, V \)**
Voltage Variable Attenuator
5 - 45 GHz

Typical Performance Curves: Input IP3

Input IP3 vs. Frequency
@ \( V_C1 = -2.0 \, \text{V}, \, V_C2 = -2.0 \, \text{V} \)

Input IP3 vs. SCL Input Power
@ \( V_C1 = -2.0 \, \text{V}, \, V_C2 = -2.0 \, \text{V} \)

Input IP3 vs. Attenuation, SCL \( P_{IN} = 6 \, \text{dBm} \)

Input IP3 vs. Attenuation, SCL \( P_{IN} = 12 \, \text{dBm} \)
**Voltage Variable Attenuator**

5 - 45 GHz

---

**Lead-Free 3 mm 16-Lead PQFN†**

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

Meets JEDEC moisture sensitivity level 1 requirements.

Plating is NiPdAuAg.

---

All DIMENSIONS SHOWN AS INCHES/MM.

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

Meets JEDEC moisture sensitivity level 1 requirements.

Plating is NiPdAuAg.
Voltage Variable Attenuator
5 - 45 GHz

MACOM Technology Solutions Inc. All rights reserved.
Information in this document is provided in connection with MACOM Technology Solutions Inc ("MACOM") products. These materials are provided by MACOM as a service to its customers and may be used for informational purposes only. Except as provided in MACOM’s Terms and Conditions of Sale for such products or in any separate agreement related to this document, MACOM assumes no liability whatsoever. MACOM assumes no responsibility for errors or omissions in these materials. MACOM may make changes to specifications and product descriptions at any time, without notice. MACOM makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED “AS IS” WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. MACOM FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. MACOM SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.