Digital Attenuator, 1-Bit, Single Control
21 dB, 0.8 - 8.0 GHz

Features
- 21 dB Step Attenuator
- Positive Control: 2.5 V typical
- Insertion Loss: 0.75 dB typical @ 2.0 GHz
- Current Consumption: 40 µA typical
- IP3: >42 dBm typical @ 2.0 GHz
- Lead-Free 2mm 8-Lead PDFN Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant and 260°C Re-flow Compatible

Description
M/A-COM’s MAADSS0012 is a 1-bit, 21 dB step attenuator. This GaAs MMIC digital attenuator is packaged in an ultra small lead free 2 mm 8-Lead PDFN surface mount package.

The MAADSS0012 digital attenuator will work with any power source operating between 2.8 and 5.0 volts. This single bit attenuator is ideally suited for use in wide band systems, up to 8.0 GHz where good linearity and low insertion loss are required.

Typical applications for the MAADSS0012 attenuator include WiMAX (802.16), Mesh Networks, Multi-band repeaters and other linear systems.

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAADSS0012TR-3000</td>
<td>3000 piece reel</td>
</tr>
<tr>
<td>MAADSS0012SMB</td>
<td>Sample Test Board</td>
</tr>
</tbody>
</table>

1. Reference Application Note M513 for reel size information.
2. All sample boards include 5 loose parts.

Functional Schematic

VDD

GND

VC

RF1

RF2

3. Blocking capacitors are required on all RF ports.

Pin Configuration

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Function</th>
<th>Pin No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VC</td>
<td>5</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>Ground</td>
<td>6</td>
<td>RF In/Out</td>
</tr>
<tr>
<td>3</td>
<td>RF In/Out</td>
<td>7</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>Ground</td>
<td>8</td>
<td>VDD</td>
</tr>
</tbody>
</table>

Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Power 0.8 - 8.0 GHz</td>
<td>+33 dBm</td>
</tr>
<tr>
<td>VDD = 2.8 - 5.0 V</td>
<td></td>
</tr>
<tr>
<td>Control Voltage</td>
<td>-0.5 V ≤ VC ≤ 5.0 V</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>

Digital Attenuator, 1-Bit, Single Control
21 dB, 0.8 - 8.0 GHz

Electrical Specifications: $T_A = 25^\circ C$, $Z_0 = 50 \, \Omega$, $V_C = 2.5 \, V$, $V_{DD} = 2.8 \, V$

<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>Reference Insertion Loss</td>
<td>2.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>0.75</td>
<td>1.0</td>
</tr>
<tr>
<td>Attenuation</td>
<td>2.0 GHz</td>
<td>dB</td>
<td>20</td>
<td>21</td>
<td>22</td>
</tr>
<tr>
<td>Return Loss</td>
<td>2.0 - 8.0 GHz</td>
<td>dB</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Trise, Tfall</td>
<td>10% to 90% RF, 90% to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td>Ton, Toff</td>
<td>50% Control to 90% RF, 50% Control to 10% RF</td>
<td>ns</td>
<td>—</td>
<td>200</td>
<td>—</td>
</tr>
<tr>
<td>Transients</td>
<td>In Band</td>
<td>mV</td>
<td>—</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>1 dB Compression</td>
<td>Input Power, 0.8 - 8.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>25</td>
<td>—</td>
</tr>
<tr>
<td>$I_{P2}$</td>
<td>2.0 - 8.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>70</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Measured Relative to Input (for two-tone Input Power up to +5 dBm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{P3}$</td>
<td>2.0 - 8.0 GHz</td>
<td>dBm</td>
<td>—</td>
<td>42</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Measured Relative to Input (for two-tone Input Power up to +5 dBm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{C}$</td>
<td>$V_C = 2.5 , V$</td>
<td>$\mu A$</td>
<td>—</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>$I_{DD}$</td>
<td>$V_{DD} = 2.8 , V$</td>
<td>$\mu A$</td>
<td>—</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

6. External DC blocking capacitors are required on all RF ports. Loss varies at 0.003 dB/°C.

Recommended Configuration

Parts List

<table>
<thead>
<tr>
<th>Part</th>
<th>Value</th>
<th>Case Style</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C4</td>
<td>15 pF</td>
<td>0402</td>
<td>Murata</td>
</tr>
<tr>
<td>C2, C3</td>
<td>47 pF</td>
<td>0201</td>
<td>Murata</td>
</tr>
<tr>
<td>R1, R2</td>
<td>10K $\Omega$</td>
<td>0201</td>
<td>Panasonic</td>
</tr>
</tbody>
</table>

Truth Table:

<table>
<thead>
<tr>
<th>VC</th>
<th>Attenuation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Reference IL</td>
</tr>
<tr>
<td>1</td>
<td>21</td>
</tr>
</tbody>
</table>

7. $0 = 0 \pm 0.2 \, V$, $1 = +2.5$ to $5 \, V$, minimum $2.5 \, V$ delta.
Digital Attenuator, 1-Bit, Single Control
21 dB, 0.8 - 8.0 GHz

Typical Performance Curves

**Insertion Loss**

-2.0  -1.5  -1.0  -0.5  0.0  2  3  4  5  6  7  8
Frequency (GHz)

**Relative Attenuation**

-20.0  -20.5  -21.0  -21.5  -22.0  2  3  4  5  6  7  8
Frequency (GHz)

**Input Return Loss, Insertion Loss State**

-30  -25  -20  -15  -10  2  3  4  5  6  7  8
Frequency (GHz)

**Input Return Loss, Attenuation State**

-30  -25  -20  -15  -10  2  3  4  5  6  7  8
Frequency (GHz)

**Output Return Loss, Insertion Loss State**

-30  -25  -20  -15  -10  2  3  4  5  6  7  8
Frequency (GHz)

**Output Return Loss, Attenuation State**

-30  -25  -20  -15  -10  2  3  4  5  6  7  8
Frequency (GHz)
Digital Attenuator, 1-Bit, Single Control
21 dB, 0.8 - 8.0 GHz

Typical Performance Curves

**IP3**

![IP3 Graph]

**IP2**

![IP2 Graph]

Handling Procedures

Please observe the following precautions 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 devices.

**Lead-Free 2 mm 8-Lead PDFN†**

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

Meets JEDEC moisture sensitivity level 1 requirements.

Plating is 100% matte tin over copper.
Applications Section—Low Frequency Measurement

**Insertion Loss**

![Insertion Loss Graph](image)

**Relative Attenuation**

![Relative Attenuation Graph](image)

**Input Return Loss—Insertion Loss State**

![Input Return Loss—Insertion Loss State Graph](image)

**Input Return Loss—Attenuation State**

![Input Return Loss—Attenuation State Graph](image)

**Output Return Loss—Insertion Loss State**

![Output Return Loss—Insertion Loss State Graph](image)

**Output Return Loss—Attenuation State**

![Output Return Loss—Attenuation State Graph](image)

This data shows the MAADSS0012 with the board and connector loss removed.

M/A-COM recommends using DC-Blocking capacitors large enough that their $X_c$ is insignificant at the frequency of use. At 800 MHz a capacitor value greater than 1000 pF is recommended.
Digital Attenuator, 1-Bit, Single Control
21 dB, 0.8 - 8.0 GHz

M/A-COM Products
Rev. V2

M/A-COM Technology Solutions Inc. All rights reserved.
Information in this document is provided in connection with M/A-COM 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 estoppels 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.

For further information and support please visit:
https://www.macom.com/support