

## Differential CATV Variable Gain Amplifier 50 - 1200 MHz

Rev. V2

### Features

- 28 dB Gain
- 25 dB Attenuation Range
- -62 dBc ACPR @ 67 dBmV Output  
-1 channel 256 QAM
- -60 dBc ACPR @ 59 dBmV/channel  
-4 channel 256 QAM
- 6 V, 900 mA
- Differential Input and Output
- Low Harmonics
- Single Control Voltage
- Lead-Free 5 x 7 mm PQFN-40LD
- Halogen-Free "Green" Mold Compound
- RoHS\* Compliant

### Description

The MAAM-010399 is an integrated 3 stage differential amplifier with embedded voltage variable attenuator. This part is intended as the output amplifier in a downstream Edge QAM RF modulator. The module provides excellent linearity and ACPR at output levels greater than 7 dB above Cable Labs DRFI requirements. The voltage variable attenuator (VVA) is implemented with PIN diodes to provide continuous power level control with high linearity and is controlled with a single voltage. The part is packaged in a 5 x 7 mm PQFN package.

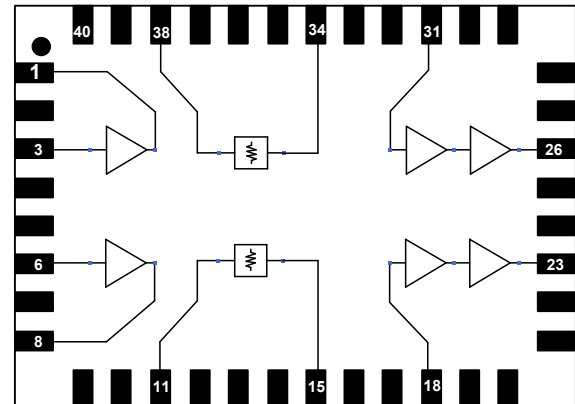
### Ordering Information<sup>1,2</sup>

| Part Number        | Package           |
|--------------------|-------------------|
| MAAM-010399-TR1000 | 1000 piece reel   |
| MAAM-010399-TR3000 | 3000 piece reel   |
| MAAM-010399-001SMB | Sample Test Board |

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

\* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

### Functional Schematic



### Pin Configuration<sup>3,4</sup>

| Pin No.    | Pin Name  | Description            |
|------------|-----------|------------------------|
| 1          | RF_OUT1+  | Stage 1 Output (+)     |
| 2          | FB1+      | Stage 1 Feedback (+)   |
| 3          | RF_IN+    | Stage 1 Input (+)      |
| 5          | IADJ1     | Stage 1 Current Adjust |
| 6          | RF_IN1-   | Stage 1 Input (-)      |
| 7          | FB1-      | Stage 1 Feedback (-)   |
| 8          | RF_OUT1-  | Stage 1 Output (-)     |
| 9,17,32,40 | VREF      | VVA reference voltage  |
| 11         | VVA_IN-   | VVA Input (-)          |
| 13,36      | V_CONTROL | VVA Control Voltage    |
| 15         | VVA_OUT-  | VVA Output (-)         |
| 18         | RF_IN2-   | Stage 2 Input (-)      |
| 19         | FB2-      | Stage 2 Feedback (-)   |
| 20         | V_DD2-    | Stage 2 Drain Bias (-) |
| 23         | RF_OUT-   | Output of VGA (-)      |
| 24         | IADJ2     | Stage 2 Current Adjust |
| 25         | IADJ3     | Stage 3 Current Adjust |
| 26         | RF_OUT+   | Output of VGA (+)      |
| 29         | V_DD2+    | Stage 2 Drain Bias (+) |
| 30         | FB2+      | Stage 2 Feedback (+)   |
| 31         | RF_IN2+   | Stage 2 Input (+)      |
| 34         | VVA_OUT+  | VVA Output (+)         |
| 38         | VVA_IN+   | VVA Input (+)          |
| 41         | Paddle    | RF & DC Ground         |

3. Do not ground pins 10,12,14,16,33,35,37 and 39 (all are "No Connection").
4. Pins 4, 21, 22, 27 and 28 may or may not be grounded (all are "No Connection").

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**Electrical Specifications<sup>5</sup>: Freq. = 981 MHz, T<sub>A</sub> = 25°C, V<sub>DD</sub> = +6 Volts, V<sub>REF</sub> = 1.3 Volts, Z<sub>0</sub> = 75 Ω, (Performance specified with input/output Balun MABA-010321-CT1A42)**

| Parameter                 | Test Conditions                                                          | Units | Min.         | Typ.           | Max.              |
|---------------------------|--------------------------------------------------------------------------|-------|--------------|----------------|-------------------|
| Gain                      | VVA Control = 5.5 V                                                      | dB    | 26           | 28             | —                 |
| Gain Flatness             | —                                                                        | dB    | —            | 0.25           | —                 |
| Gain Slope                | —                                                                        | dB    | —            | 0.5            | —                 |
| Noise Figure <sup>6</sup> | 200 - 1000 MHz, VVA Control = 5.5 V<br>50 - 200 MHz, VVA Control = 5.5 V | dB    | —            | 5.0<br>6.5     | —                 |
| Input Return Loss         | —                                                                        | dB    | —            | 20             | —                 |
| Output Return Loss        | —                                                                        | dB    | —            | 20             | —                 |
| Reverse Isolation         | —                                                                        | dB    | —            | 60             | —                 |
| Attenuation Range         | —                                                                        |       | —            | 25             | —                 |
| Maximum Output            | Level N = 1<br>Level N = 2<br>Level N = 4                                | dBmV  | —<br>—<br>57 | 67<br>63<br>59 | —                 |
| ACPR <sup>7</sup>         | @ max output N = 1<br>@ max output N = 2<br>@ max output N = 4           | dBc   | —            | —              | -62<br>-60<br>-60 |
| P1dB                      | —                                                                        | dBm   | —            | 28             | —                 |
| OIP2                      | 2-tone, 5 dBm/tone, 6 MHz spacing, 500 MHz                               | dBm   | —            | 80             | —                 |
| OIP3                      | 2-tone, 5 dBm/tone, 6 MHz spacing, 500 MHz                               | dBm   | —            | 48             | —                 |
| CTB                       | 77 Channels, 39 dBmV/ch.                                                 | dBc   | —            | -78            | —                 |
| CSOL                      | 77 Channels, 39 dBmV/ch.                                                 | dBc   | —            | -78            | —                 |
| CSOH                      | 77 Channels, 39 dBmV/ch.                                                 | dBc   | —            | -81            | —                 |
| 2 <sup>nd</sup> Harmonic  | Single Channel, P <sub>OUT</sub> = 67 dBmV                               | dBc   | —            | -65            | —                 |
| 3 <sup>rd</sup> Harmonic  | Single Channel, P <sub>OUT</sub> = 67 dBmV                               | dBc   | —            | -65            | —                 |
| I <sub>DD</sub>           | —                                                                        | mA    | —            | 900            | 1050              |
| I <sub>DD3</sub>          | —                                                                        | mA    | —            | 520            | 600               |
| I <sub>CONTROL</sub>      | VVA Control = 5.5 V                                                      | mA    | —            | 35             | —                 |

5. N = number of channels

6. Includes Balun Loss.

7. Adjacent Channel (750 kHz from channel block edge to 6 MHz from channel block edge)

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### Absolute Maximum Ratings<sup>8,9,10</sup>

| Parameter                          | Absolute Maximum |
|------------------------------------|------------------|
| RF Input Power                     | -2 dBm           |
| Voltage                            | 9 volts          |
| Operating Temperature              | -40°C to +100°C  |
| Junction Temperature <sup>11</sup> | +155°C           |
| Storage Temperature                | -65°C to +150°C  |

8. Exceeding any one or combination of these limits may cause permanent damage to this device.
9. MACOM does not recommend sustained operation near these survivability limits.
10. Operating at nominal conditions with  $T_J < 155^\circ\text{C}$  will ensure  $\text{MTTF} > 1 \times 10^6$  hours.
11. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{JC} * (V * I)$   
 Typical thermal resistance ( $\Theta_{JC}$ ) =  $14.9^\circ\text{C/W}$ .  
 a) For  $T_C = 25^\circ\text{C}$ ,  
 $T_J = 63^\circ\text{C @ 6 V, 420 mA (output stage)}$   
 b) For  $T_C = 100^\circ\text{C}$ ,  
 $T_J = 138^\circ\text{C @ 6 V, 420 mA (output stage)}$

### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

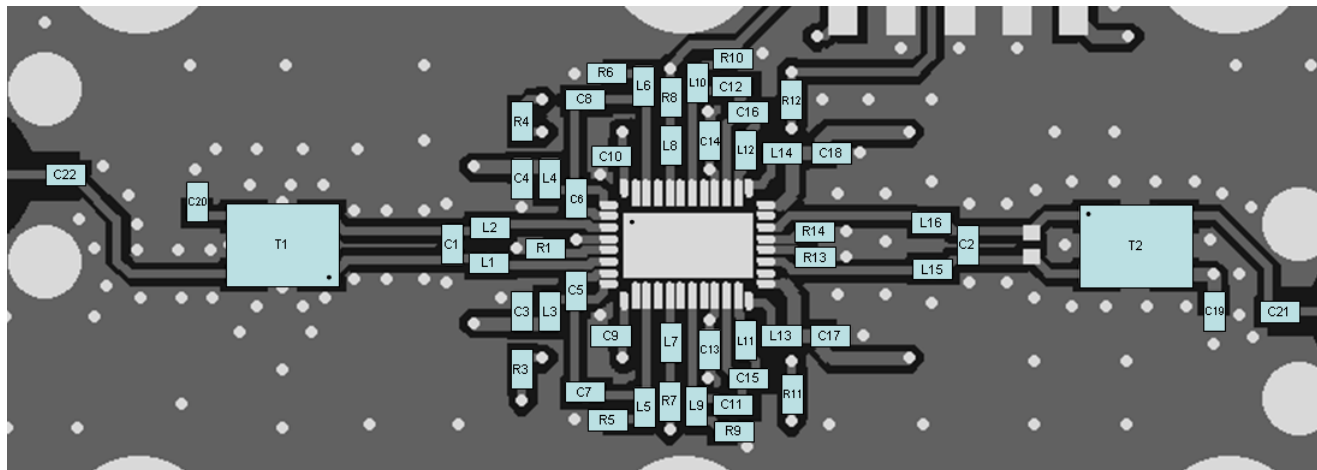
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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### Recommended PCB



### Parts List

| Component                            | Value                                        | Package |
|--------------------------------------|----------------------------------------------|---------|
| C1                                   | 0.5 pF                                       | 0402    |
| C2                                   | 1.8 pF                                       | 0402    |
| C3, C4, C9, C10, C13, C14, C17 - C22 | 0.01 $\mu$ F                                 | 0402    |
| C5 - C8, C11, C12, C15, C16          | 1000 pF                                      | 0402    |
| L1, L2, L15, L16                     | 0 $\Omega$                                   | 0402    |
| L3 - L8, L13 - L14 <sup>12</sup>     | 1 k $\Omega$                                 | 0402    |
| L9, L10                              | 68 nH                                        | 0402    |
| L11, L12                             | 12 nH                                        | 0402    |
| R1                                   | 50 $\Omega$                                  | 0402    |
| R2                                   | 330 $\Omega$                                 | 0402    |
| R3 - R6, R9 - R12                    | 200 $\Omega$                                 | 0402    |
| R7, R8, R13                          | 150 $\Omega$                                 | 0402    |
| R14                                  | 82 $\Omega$                                  | 0402    |
| R15                                  | 1 k $\Omega$                                 | 0402    |
| T1, T2                               | 1:1 Baluns (MACOM part # MABA-010321-CT1A42) |         |

12. The 1 k $\Omega$  ferrite bead (part number BLM15HD102SN) is from Murata.

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Top view of a microelectronic package showing a central die with a grid of vias, surrounded by a thermal pad and a package outline. Dimensions are provided in inches and millimeters.

Key dimensions and features:

- Overall width:  $(.2000)$  / 5.08
- Overall height:  $(.0900)$  / 2.29
- Die width:  $.2205$  / 5.6
- Die height:  $.1102$  / 2.8
- Thermal pad width:  $.0200$  / 0.51 (typical)
- Thermal pad height:  $.0100$  / 0.25 (typical)
- Via diameter:  $105 \times .0095$  DIA. FILLED VIA
- Via pitch:  $.0100$  / 0.25 (typical)
- Package outline width:  $.2205$  / 5.6
- Package outline height:  $.1102$  / 2.8
- Lead width:  $40 \times .0110$  / 0.28
- Lead pitch:  $4 \times .0197$  / 0.5
- Lead length:  $20 \times .0343$  / 0.87
- Lead width (bottom):  $16 \times .0197$  / 0.5

5

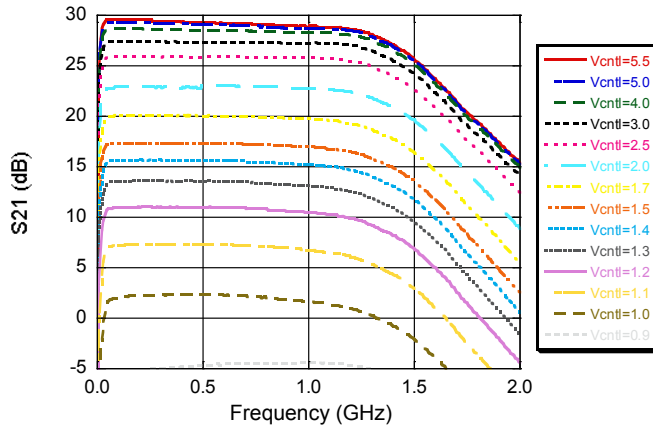
For further information and support please visit:  
<https://www.macom.com/support>

## Differential CATV Variable Gain Amplifier 50 - 1200 MHz

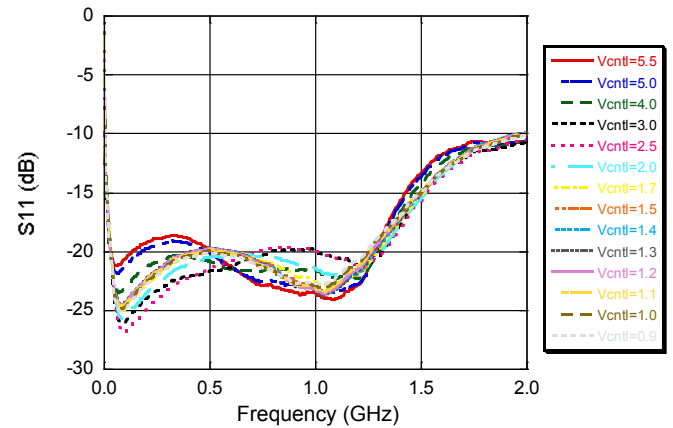
Rev. V2

Typical Performance Curves:  $V_{DD} = +6$  Volts,  $V_{REF} = 1.3$  Volts

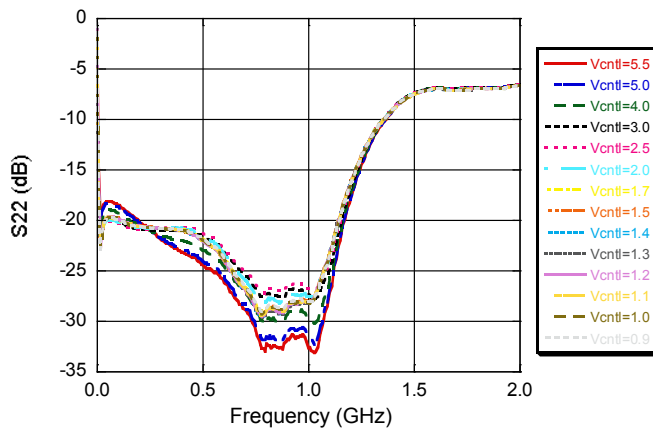
Gain vs. Frequency & VGA Control



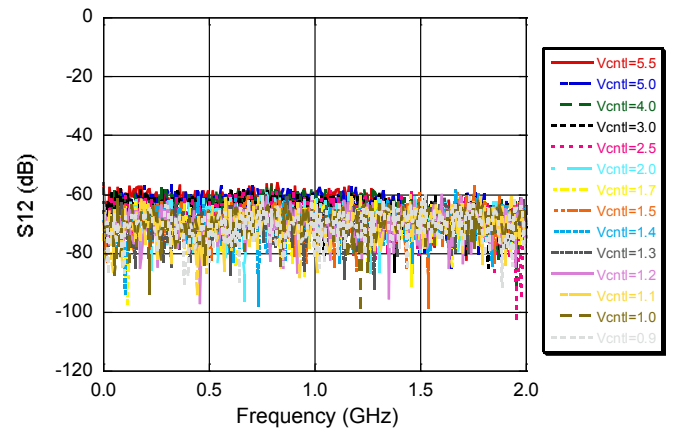
Input Return Loss vs. Frequency & VGA Control



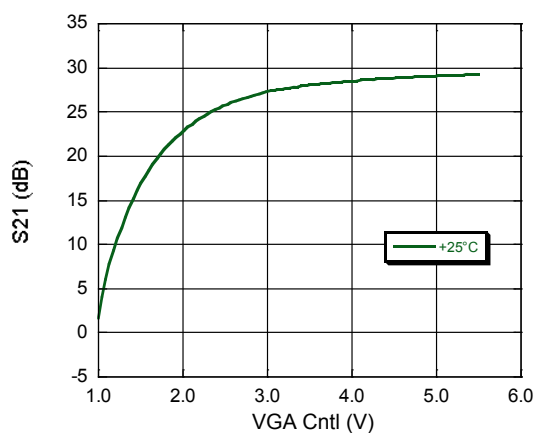
Output Return Loss vs. Frequency & VGA Control



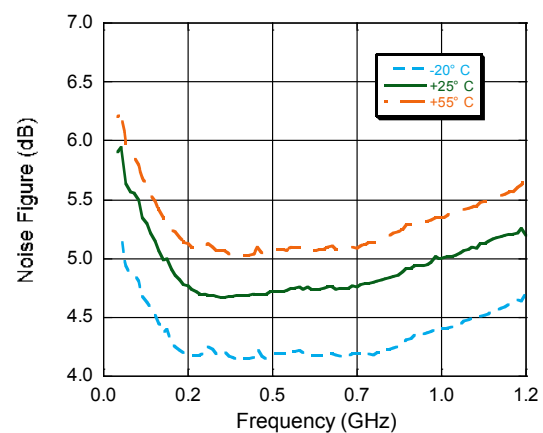
Reverse Isolation



Gain vs. VVA Control @ 500 MHz



Noise Figure

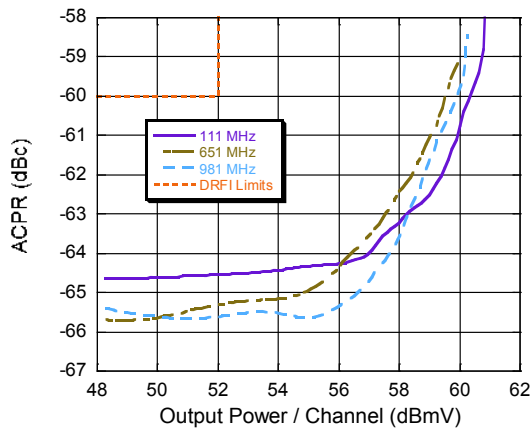


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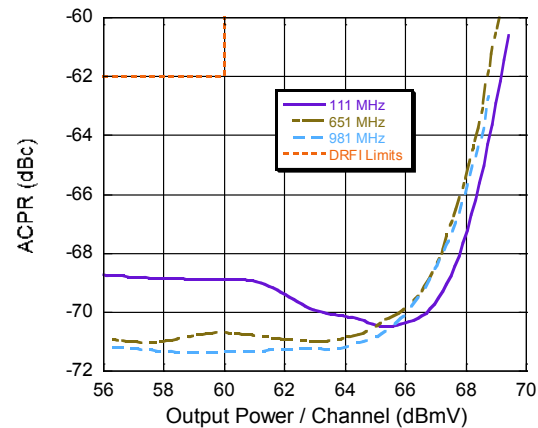
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Typical Performance Curves:  $V_{DD} = +6$  Volts,  $V_{REF} = 1.3$  Volts

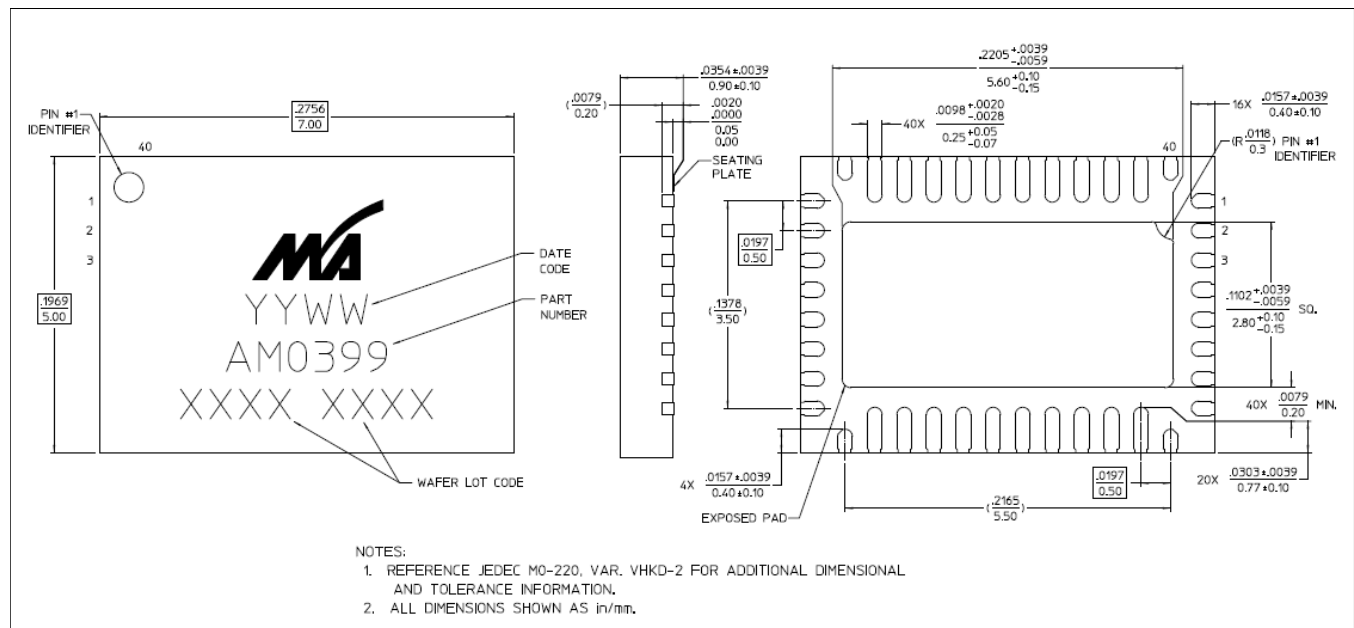
ACPR vs.  $P_{OUT}$ , 4 Channels



ACPR vs.  $P_{OUT}$ , Single Channel



### Lead-Free 5 x 7 mm 40-Lead PQFN<sup>†</sup>



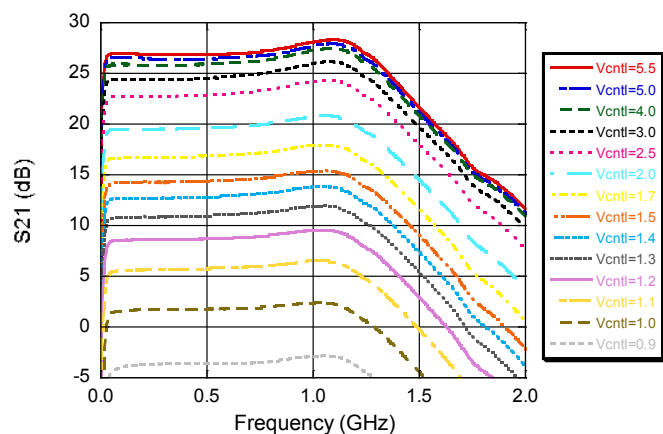
<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 1 requirements.  
Plating is NiPdAuAg.

### Applications Section - 1200 MHz

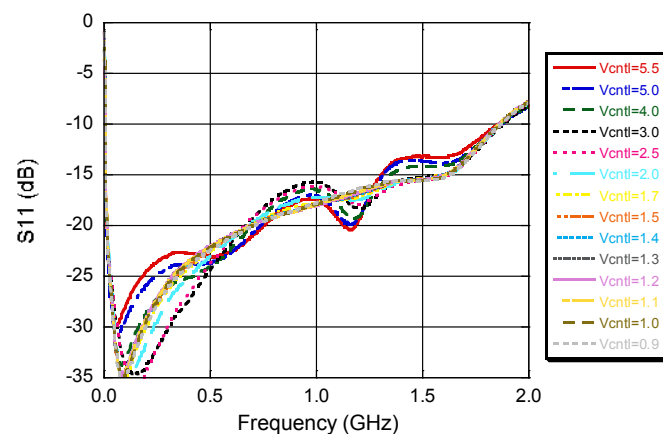
By using L1 and L2 = 15 nH, the MAAM-010399 may be operated up to 1200 MHz

### Typical Performance Curves: $V_{DD} = 6$ Volts, $V_{REF} = 1.3$ Volts

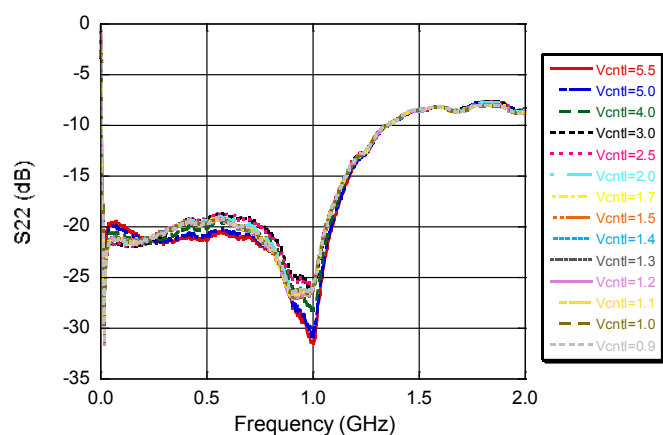
**Gain vs. Frequency & VGA Control**



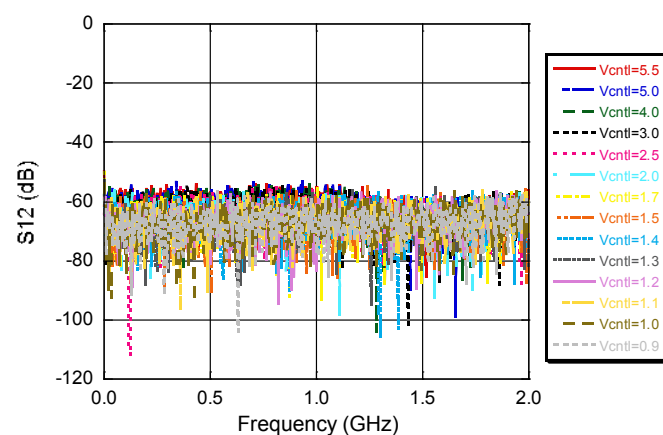
**Input Return Loss vs. Frequency & VGA Control**



**Output Return Loss vs. Frequency & VGA Control**



**Reverse Isolation**





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