MAAM-010399

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.

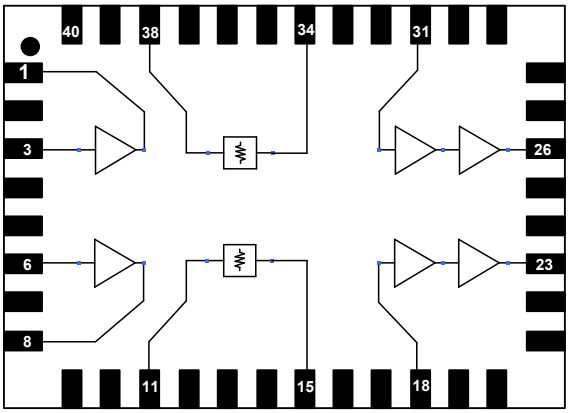
Ordering Information[1,2]

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[3,4]

Pin No.	Pin Name	Description
1	$RF_{OUT}1+$	Stage 1 Output (+)
2	FB1+	Stage 1 Feedback (+)
3	$RF_{IN}+$	Stage 1 Input (+)
5	IADJ1	Stage 1 Current Adjust
6	$RF_{IN}1-$	Stage 1 Input (-)
7	FB1-	Stage 1 Feedback (-)
8	$RF_{OUT}1-$	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	$RF_{IN}2-$	Stage 2 Input (-)
19	FB2-	Stage 2 Feedback (-)
20	$V_{DD}2-$	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	$V_{DD}2+$	Stage 2 Drain Bias (+)
30	FB2+	Stage 2 Feedback (+)
31	$RF_{IN}2+$	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").

Electrical Specifications[5]: Freq. = 981 MHz, T_A = 25°C, V_{DD} = +6 Volts, V_{REF} = 1.3 Volts, Z_0 = 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[6]	200 - 1000 MHz, VVA Control = 5.5 V 50 - 200 MHz, VVA Control = 5.5 V	dB	—	5.0 6.5	—
Input Return Loss	—	dB	—	20	—
Output Return Loss	—	dB	—	20	—
Reverse Isolation	—	dB	—	60	—
Attenuation Range	—		—	25	—
Maximum Output	Level N = 1 Level N = 2 Level N = 4	dBmV	— — 57	67 63 59	—
ACPR[7]	@ max output N = 1 @ max output N = 2 @ max output N = 4	dBc	—	—	-62 -60 -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	—
2nd Harmonic	Single Channel, P_{OUT} = 67 dBmV	dBc	—	-65	—
3rd Harmonic	Single Channel, P_{OUT} = 67 dBmV	dBc	—	-65	—
I_{DD}	—	mA	—	900	1050
$I_{DD}3$	—	mA	—	520	600
$I_{CONTROL}$	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)

Absolute Maximum Ratings [8,9,10]

Parameter	Absolute Maximum
RF Input Power	-2 dBm
Voltage	9 volts
Operating Temperature	-40°C to +100°C
Junction Temperature[11]	+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°C will ensure MTTF > 1 x 10^6 hours.
11. Junction Temperature (T_J) = T_C + Θ_{JC} * (V * I)
    Typical thermal resistance (Θ_{JC}) = 14.9°C/W.
    a) For T_C = 25°C,
    T_J = 63 °C @ 6 V, 420 mA (output stage)
    b) For T_C = 100°C,
    T_J = 138 °C @ 6 V, 420 mA (output stage)

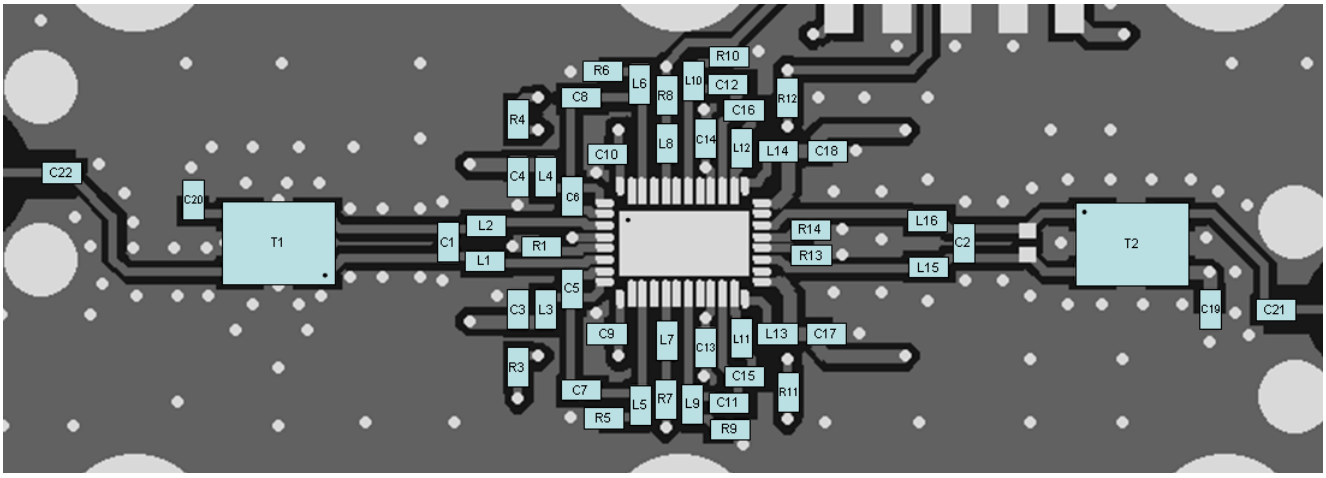
Handling Procedures

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.

Recommended PCB

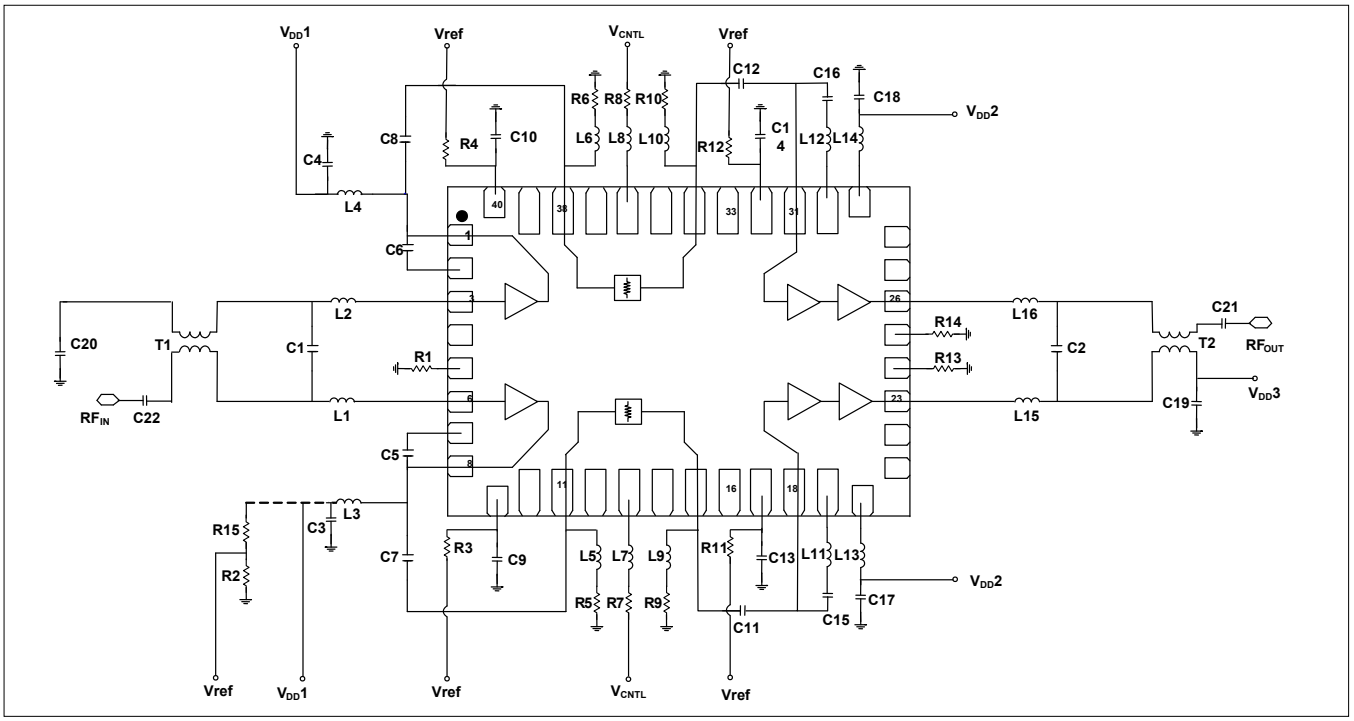


Parts List

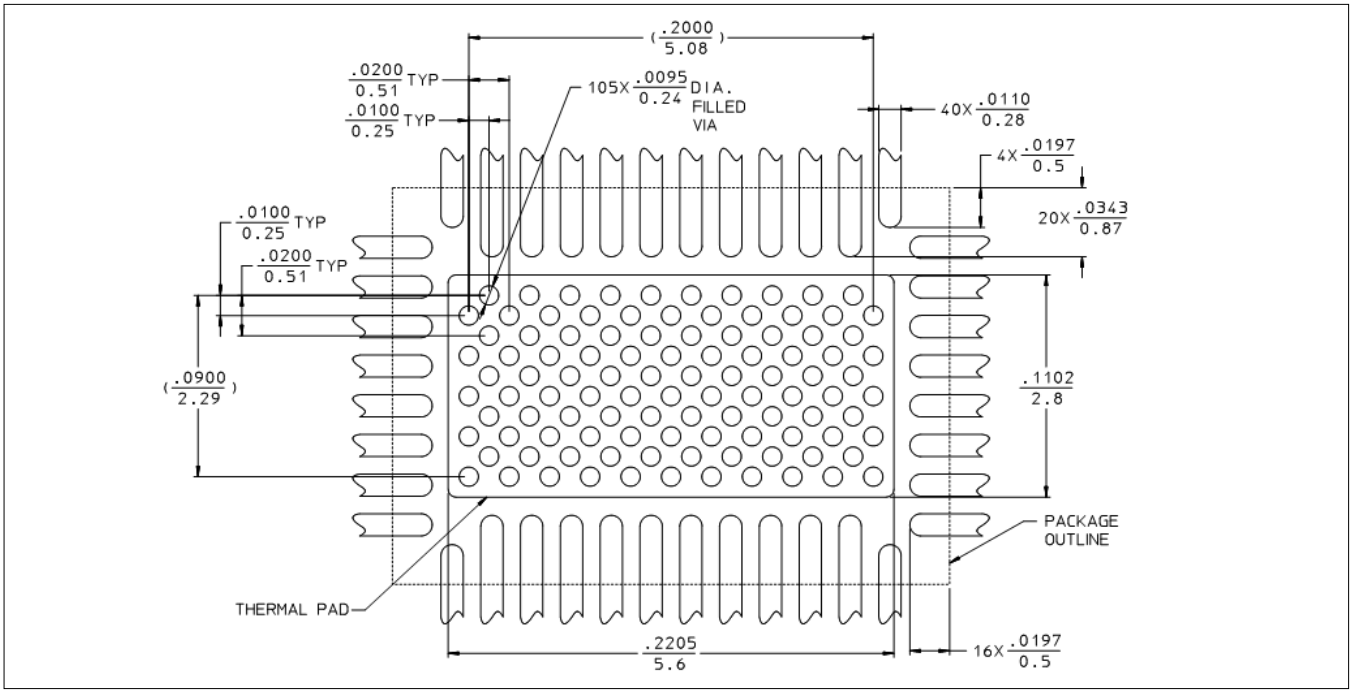
Component	Value	Package
C1	0.5 pF	0402
C2	1.8 pF	0402
C3, C4, C9, C10, C13, C14, C17 - C22	0.01 µF	0402
C5 - C8, C11, C12, C15, C16	1000 pF	0402
L1, L2, L15, L16	0 Ω	0402
L3 - L8, L13 - L14[12]	1 kΩ	0402
L9, L10	68 nH	0402
L11, L12	12 nH	0402
R1	50 Ω	0402
R2	330 Ω	0402
R3 - R6, R9 - R12	200 Ω	0402
R7,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

12. The 1 KΩ ferrite bead (part number BLM15HD102SN) is from Murata.

Application Schematic



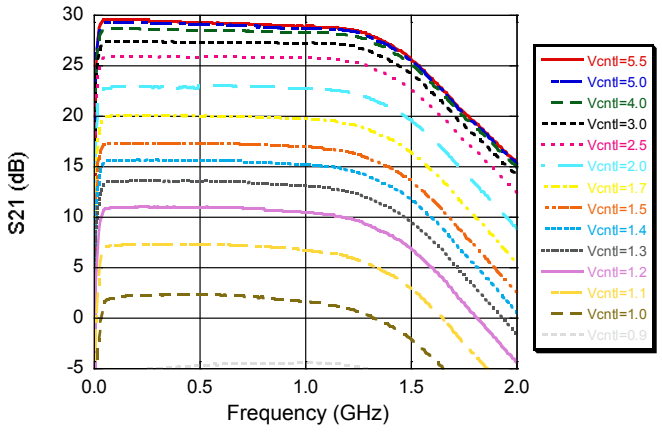
Land Pattern[13]



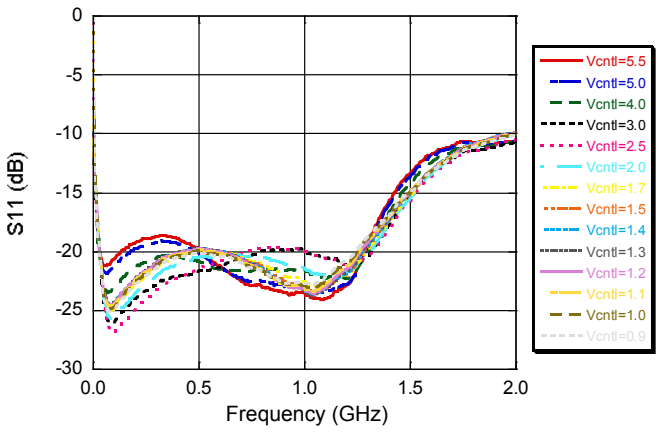
13. Vias to be plated solid copper.

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

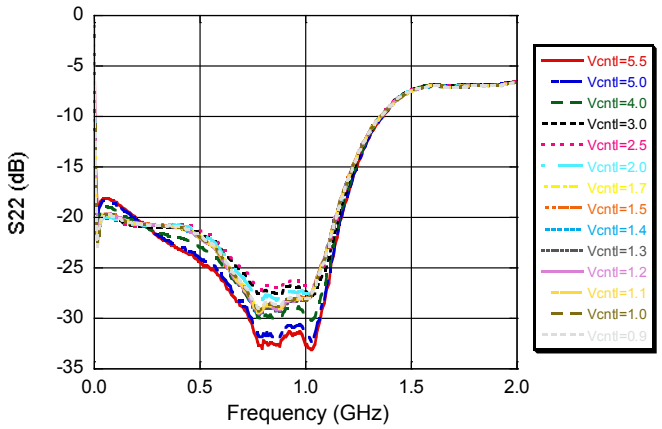
Gain vs. Frequency & VGA Control



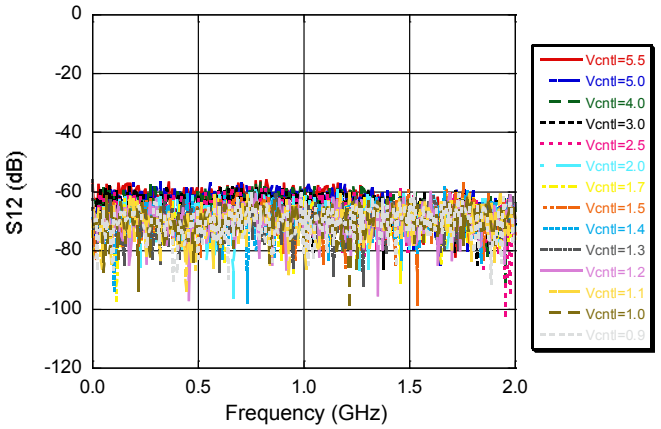
Input Return Loss vs. Frequency & VGA Control



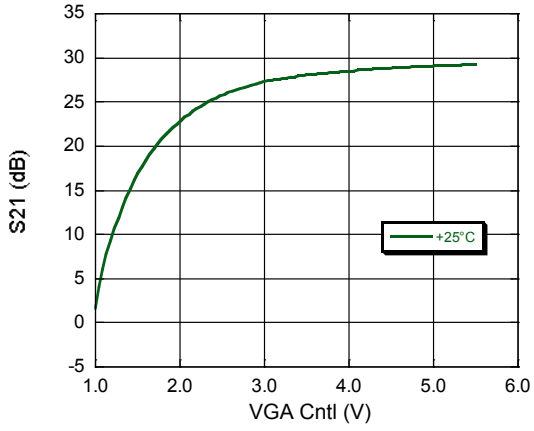
Output Return Loss vs. Frequency & VGA Control



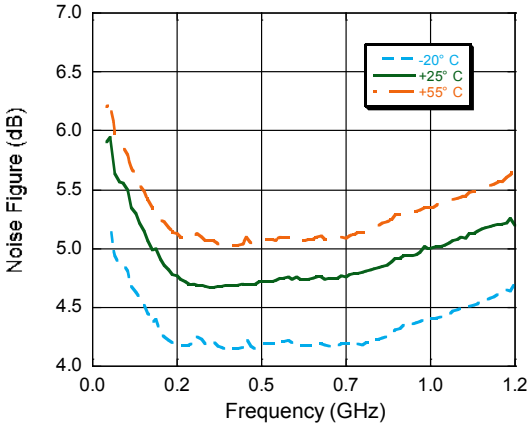
Reverse Isolation



Gain vs. VVA Control @ 500 MHz

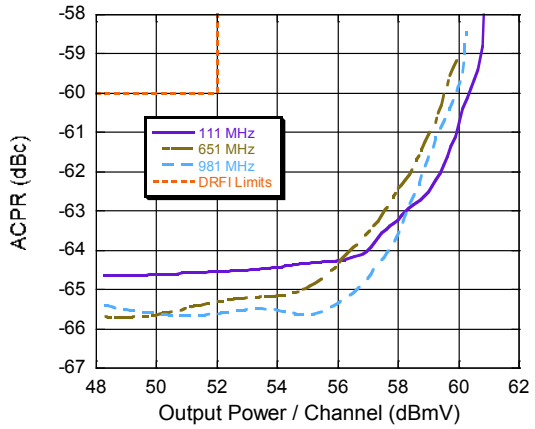


Noise Figure

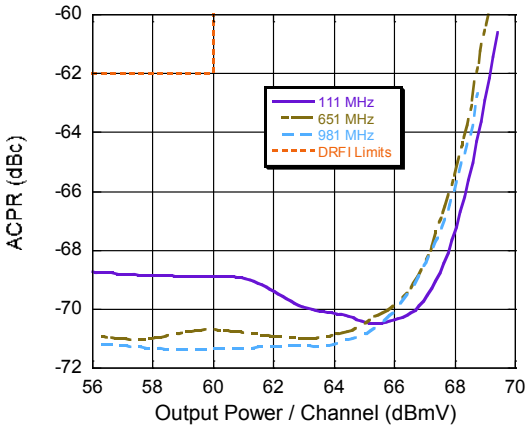


Typical Performance Curves: V_{DD} = +6 Volts, V_{REF} = 1.3 Volts

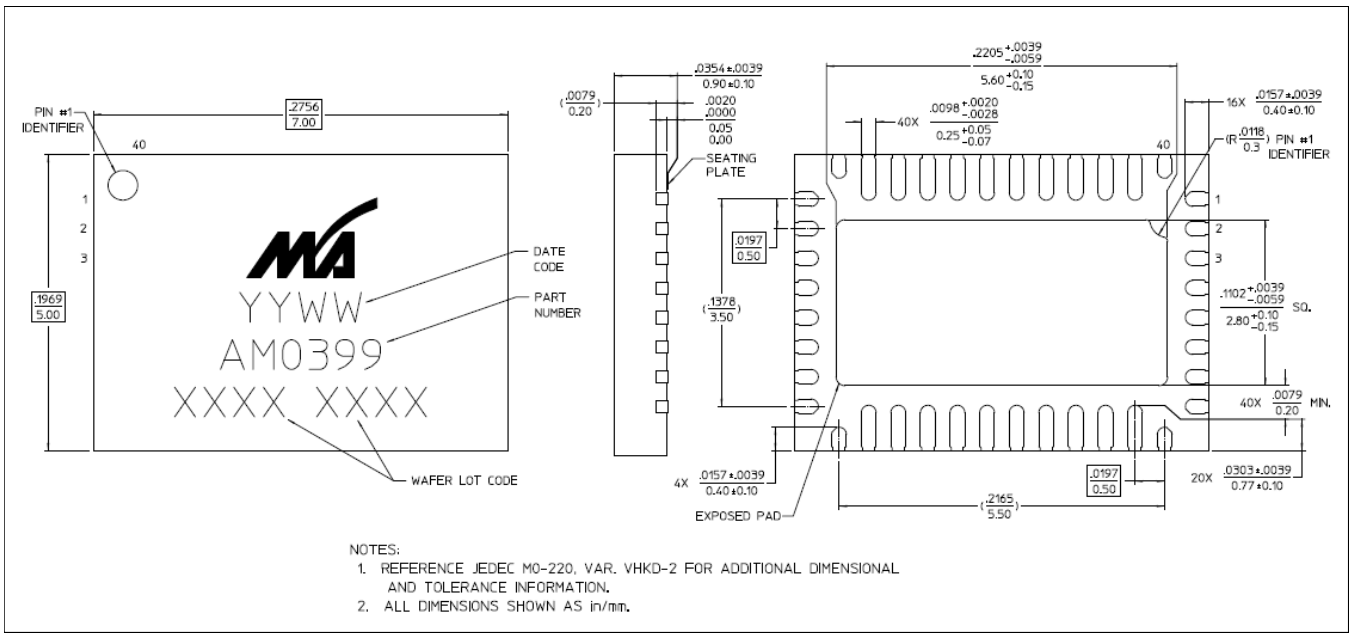
ACPR vs. P_{OUT}, 4 Channels



ACPR vs. P_{OUT}, Single Channel



Lead-Free 5 x 7 mm 40-Lead PQFN†



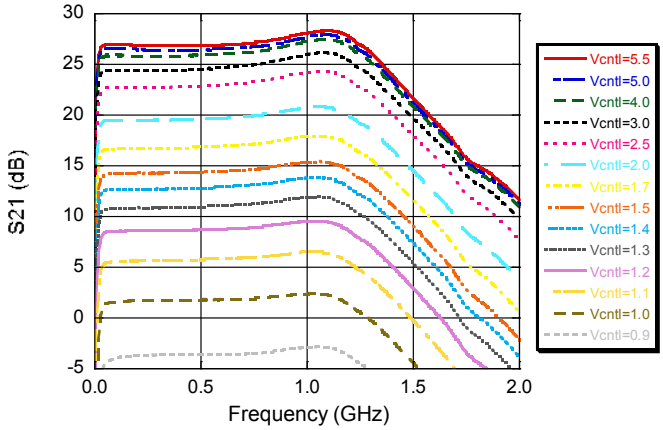
† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is NiPdAuAg.

Applications Section - 1200 MHz

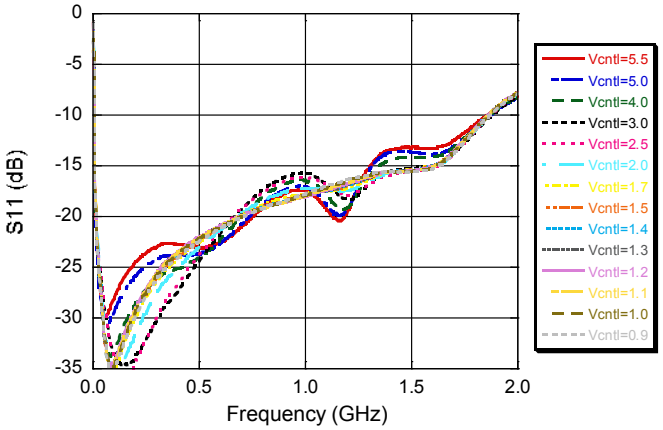
By using L1 and L2 = 15 nH, the MAAM-010399 may be operated up to 1200 MHz

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

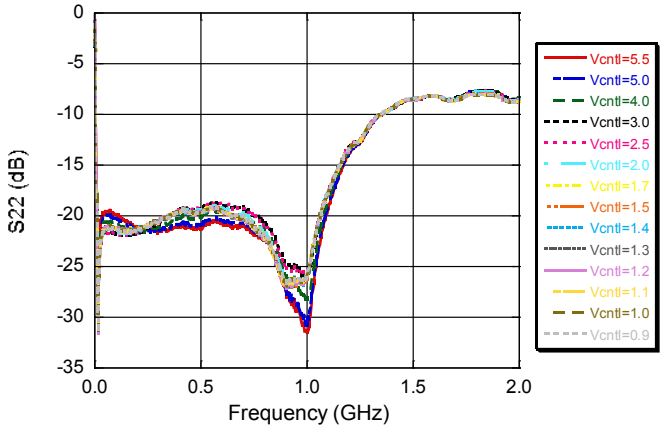
Gain vs. Frequency & VGA Control



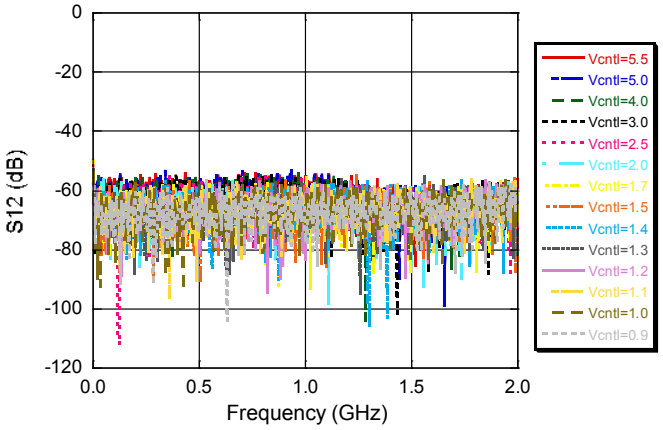
Input Return Loss vs. Frequency & VGA Control



Output Return Loss vs. Frequency & VGA Control



Reverse Isolation



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