

Optical Node RF Amplifier 50 - 1200 MHz

Rev. V5

Features

- -8 dBm to +2 dBm Optical Input Range
- Low Equivalent Input Noise (EIN): 3.2 pA/rtHz
- Single +5 V Bias
- 29 dB Gain at 55 MHz; 34 dB Gain at 1000 MHz
- 27 dB Gain Control Range
- +24 dBmV/ch Output at 550 MHz
- Lead-Free 4 mm PQFN-24LD Plastic Package
- Halogen-Free “Green” Mold Compound
- RoHS* Compliant

Description

The MAAM-010333 provides high gain, low noise and low distortion amplification for optical node applications.

The MAAM-010333 is fabricated using MACOMs' low noise GaAs pHEMT technology in a lead-free 4 mm 24-lead package. The amplifier requires a minimal number of off-chip components resulting in a highly integrated low cost solution.

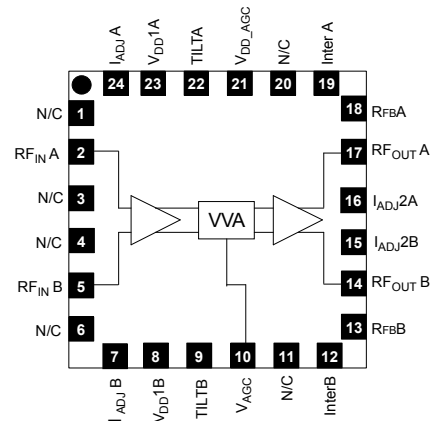
Ordering Information^{1,2}

Part Number	Description
MAAM-010333-TR1000	1000 Piece Reel
MAAM-010333-TR3000	3000 Piece Reel
MAAM-010333-001SMB	Sample Test Board
MAMU-011089-SMBPPR	Reference design PCB including 2 nd stage MAAM-007807 amplifier

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 Configuration³

Pin No.	Pin Name	Description
1	N/C	No Connection
2	RF _{IN} A	RF Input A
3	N/C	No Connection
4	N/C	No Connection
5	RF _{IN} B	RF Input B
6	N/C	No Connection
7	I _{ADJ} B	Current Adjust
8	V _{DD} 1B	+ 5V Bias Voltage
9	TiltB	Tilt Connection
10	V _{AGC}	AGC Control Voltage: 0V to 3V
11	N/C	No Connection
12	InterB	Interstage Pin
13	R _{FB} B	Feedback Resistor
14	RF _{OUT} B	RF Output B
15	I _{ADJ} 2B	Current Adjust
16	I _{ADJ} 2A	Current Adjust
17	RF _{OUT} A	RF Output A
18	R _{FB} A	Feedback Resistor
19	InterA	Interstage Pin
20	N/C	No Connection
21	V _{DD} _AGC	+ 5V AGC Bias Voltage
22	TiltA	Tilt Connection
23	V _{DD} 1A	+ 5V Bias Voltage
24	I _{ADJ} A	Current Adjust
25	Paddle	RF & DC Ground

3. The exposed pad centered on the package bottom must be connected to RF and DC ground.

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Electrical Specifications⁴: $V_{DD} = +5$ V Regulated Supply⁵, $T_A = 25^\circ\text{C}$, $Z_0 = 75 \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Trans-Impedance Gain ^{6,7}	50 MHz 870 MHz 1 GHz	dB	26.5 31.0 31.5	29.0 33.0 34.0	30.5 35.0 35.5
Gain Tilt ⁸	$V_{AGC} = +3$ V $V_{AGC} = 0$ V	dB	-	5 7	-
Gain Flatness ⁹	V_{AGC} : 0 to 3 V	dB		0.7	
Gain Control Range	50 MHz 870 MHz 1 GHz	dB	25.5 23.0 24.0	29.0 26.0 27.0	32.0 29.0 30.0
AGC Control Voltage Range	50 MHz - 1 GHz	V	0	-	+3
EIN ⁷	50 MHz - 1 GHz	pA/rtHz	-	3.2	-
Output Return Loss	50 MHz - 1 GHz	dB	-	18	-
CTB ¹⁰	79 channels	dBc	-	-68	-
CSO ¹⁰	79 channels	dBc	-	-65	-
Current	$V_{DD} = +5$ V	mA	225	260	295

4. Performance is specified using JDSU Photodiode EPM-745 or equivalent (EPM705) and output balun # MABA-009210-CT1760.

5. MACOM recommends use of a regulated supply voltage in order to limit performance variation.

6. Gain = $20 \cdot \log(Z_T/75)$, where Z_T = Transconductance (Ω).

7. Specified at maximum gain ($V_{AGC} = +3.0$ V).

8. Positive gain slope from 50 MHz to 1 GHz (tilt of best fit straight line from 50 MHz to 1 GHz).

9. Flatness defined as peak-peak deviation from best fit straight line.

10. Optical Input Power Range: -8 dBm to +2 dBm; 79 channels:

OMI = 3.5%; P_{out} = +24 dBmV/ch at 550 MHz

P_{OUT} = +22.5 dBmV/ch at 55 MHz; +24 dBmV/ch at 550 MHz

Absolute Maximum Ratings^{11,12,13}

Parameter	Absolute Maximum
Input Power	+3 dBm Optical
Operating Voltage	+15 volts
AGC Voltage	+5 volts
Operating Temperature	-40°C to +85°C
Junction Temperature ¹⁴	+150°C
Storage Temperature	-65°C to +150°C

11. Exceeding any one or combination of these limits may cause permanent damage to this device.

12. M/A-COM Technology Solutions does not recommend sustained operation near these survivability limits.

13. Operating at nominal conditions with $T_J \leq +150^\circ\text{C}$ will ensure MTTF > 1×10^6 hours.

14. Junction Temperature (T_J) = $T_C + \Theta_{jc} \cdot ((V \cdot I) - (P_{OUT} - P_{IN}))$

Typical thermal resistance (Θ_{jc}) = 19° C/W.

a) For $T_C = 25^\circ\text{C}$, $T_J = 53^\circ\text{C}$ @ 5 V, 295 mA

b) For $T_C = 85^\circ\text{C}$, $T_J = 112^\circ\text{C}$ @ 5 V, 295 mA

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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The schematic diagram illustrates the internal circuitry of the 4mm x 4mm 24LD PQFN module. The central component is a 24-pin package with pins 1-12 on the left and 13-24 on the right. The schematic shows various components connected to these pins, including resistors (R1-R24), capacitors (C1-C19), inductors (L1-L15), and a photodiode (VSENSE). The output is taken from pin 1 through a network of components to RFOUT (75Ω). Power is supplied to VDD (+5V) and VAGC. A photodiode reverse bias of +12V is applied to the photodiode.

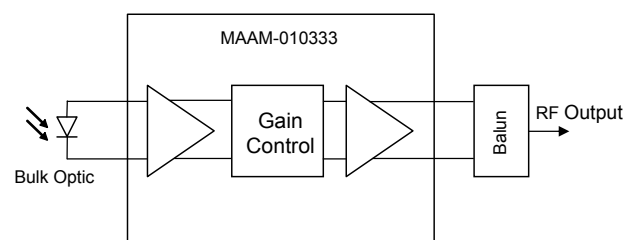
Parts List for 1GHz Matching

Component	Value	Case Style
L1 - L8 ¹⁵	Ferrite Bead	0402
L9 - L10	12 nH w/w	0402
L11	8.2 nH	0402
L12	33 nH	0402
L13 - L14	10 nH	0402
C1 - C12	10 nF	0402
C13 - C14	2.7 pF	0402
C15	3.0 pF	0402
C16 - C17	2.0 pF	0402
C18 - C22	1.0 μ F	0603
R1 - R4	1 k Ω	0402
R5 - R7	680 Ω	0402
R8	200 Ω	0402
R9 - R10	120 Ω	0402
R11 - R12	39 Ω	0402
R13	82 Ω	0402
R14	180 Ω	0402
R15 - R16	12 Ω	0402
R17 - R18	47 Ω	0402
R19 - R20	62 Ω	0402
R21	6.2 Ω	0402
R22	1 k Ω	0603
R23	470 Ω	0402
T1 ¹⁶	1:1 Balun	SM-118A

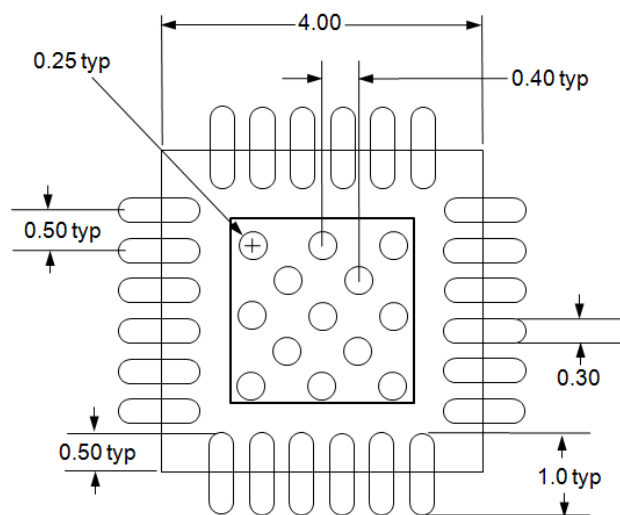
15. Ferrite Bead from Murata, part number BLM15HD182SN.

16. MACOM's MABA-009210-CT1760 1:1 T_x Line Balun.

Application Functional Schematic

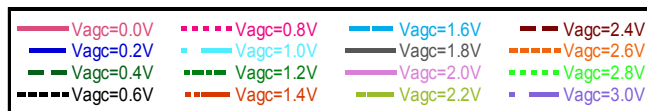


PCB Land Pattern

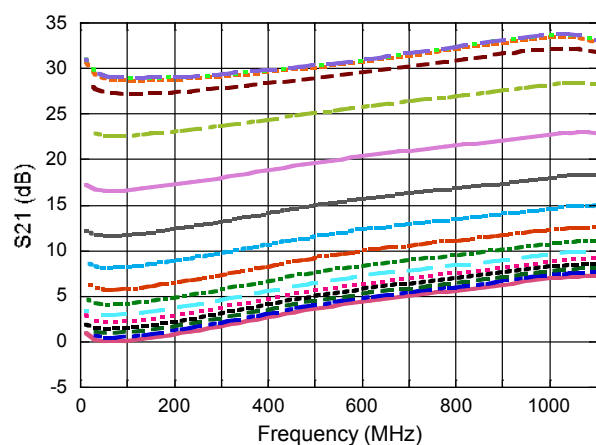


All dimension are in mm

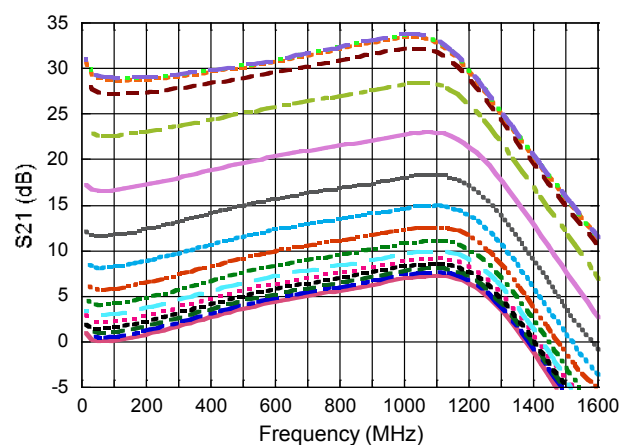
Typical Performance Curves with 1 GHz Matching: +25°C, $V_{AGC} = 0$ V to 3 V in 0.2 V Steps



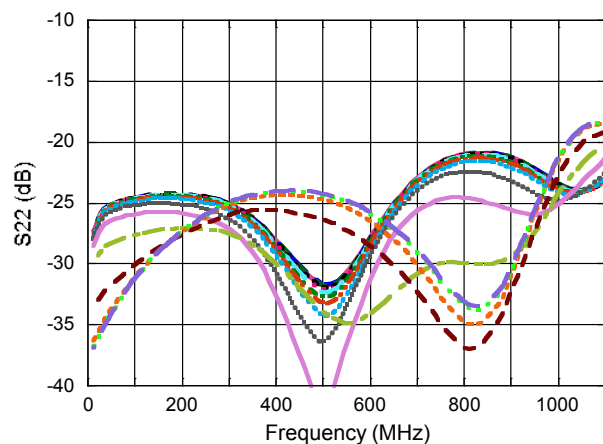
Receiver Gain vs. Frequency to 1.1 GHz



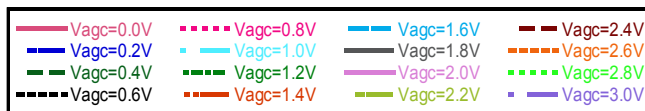
Receiver Gain vs. Frequency to 1.6 GHz



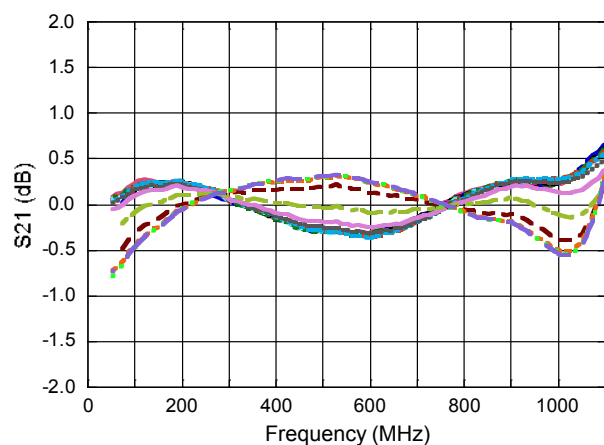
Output Return Loss vs. Frequency



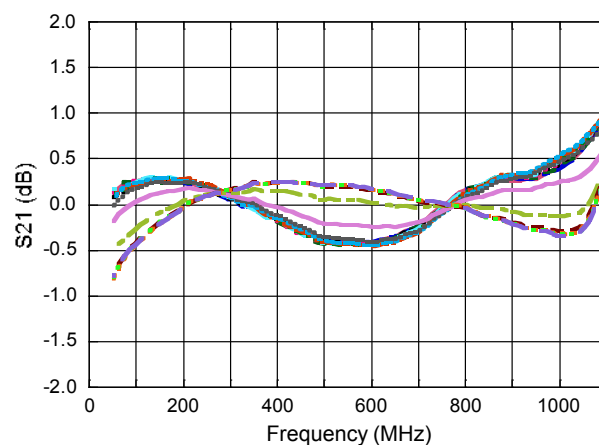
Typical Performance Curves with 1 GHz Matching: $V_{AGC} = 0\text{ V}$ to 3 V in 0.2 V Steps



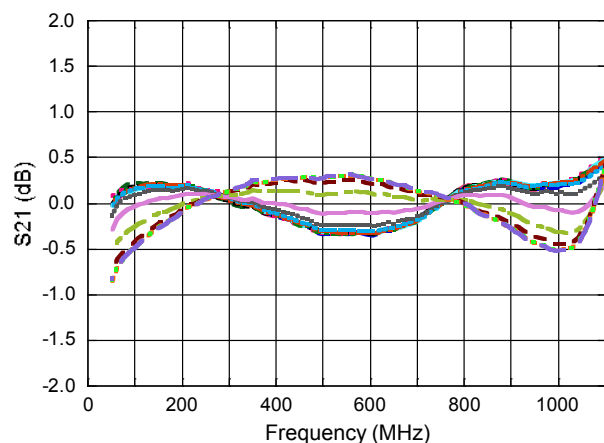
Gain Flatness Deviation From Best Fit Line @ $+25^{\circ}\text{C}$



Gain Flatness Deviation From Best Fit Line @ -40°C

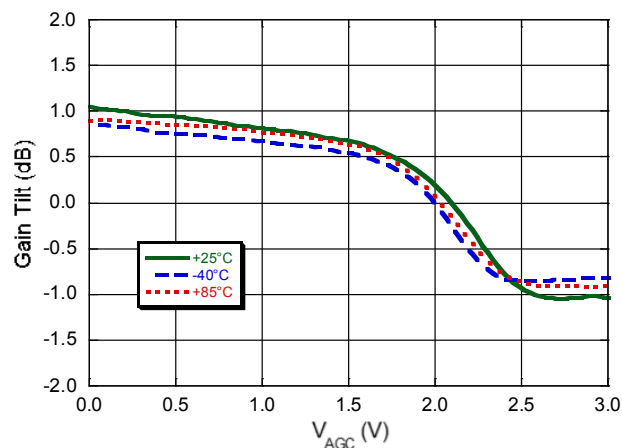


Gain Flatness Deviation From Best Fit Line @ $+85^{\circ}\text{C}$

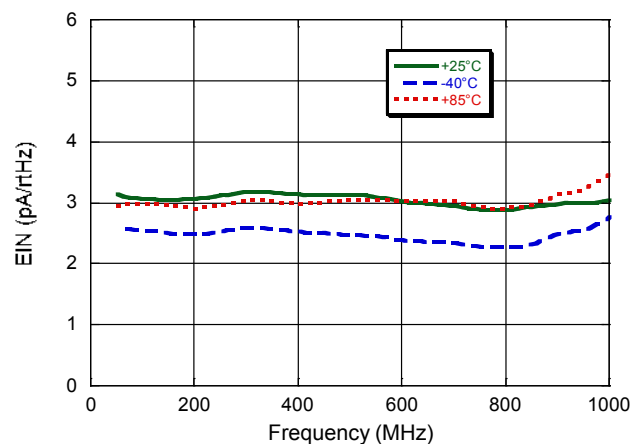


Typical Performance Curves with 1 GHz Matching:

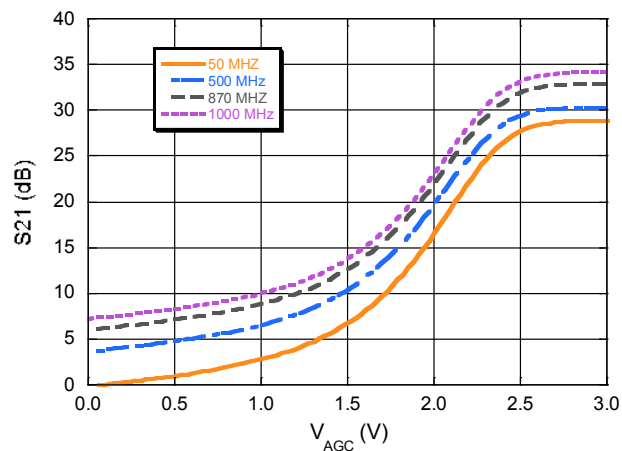
Gain Tilt Deviation from Average Tilt



Equivalent Input Noise @ Max Gain ($V_{AGC} = 3V$)



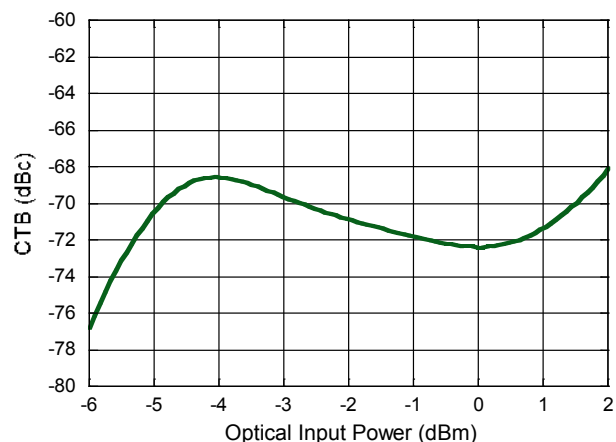
Receiver Gain vs. V_{AGC}



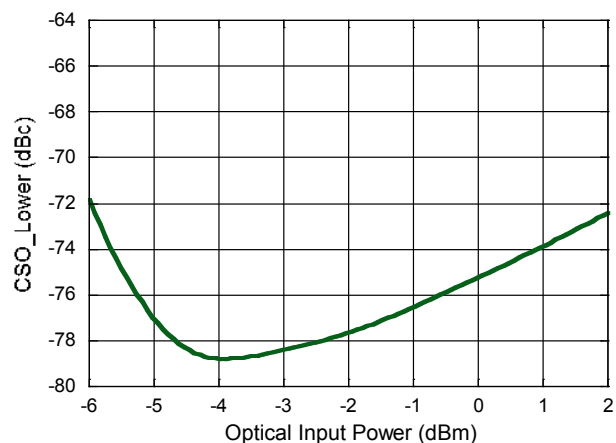
Typical Performance Curves with 1 GHz Matching:

79 Channels; NTSC Frequency Plan; $P_{out} = +22.5 \text{ dBmV/ch @ 55 MHz; } +24 \text{ dBmV @ 550 MHz}$

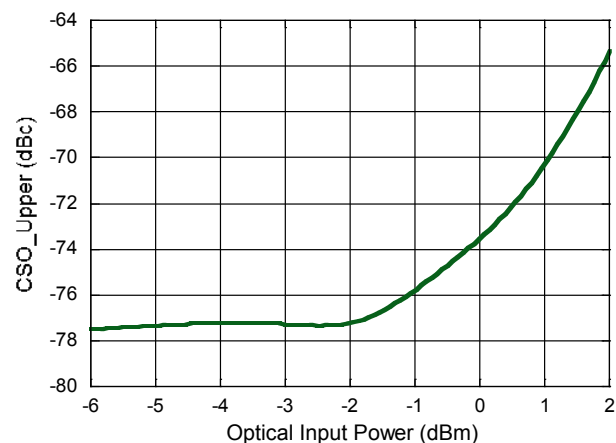
CTB vs. Optical Input Power



CSO_Lower vs. Optical Input Power



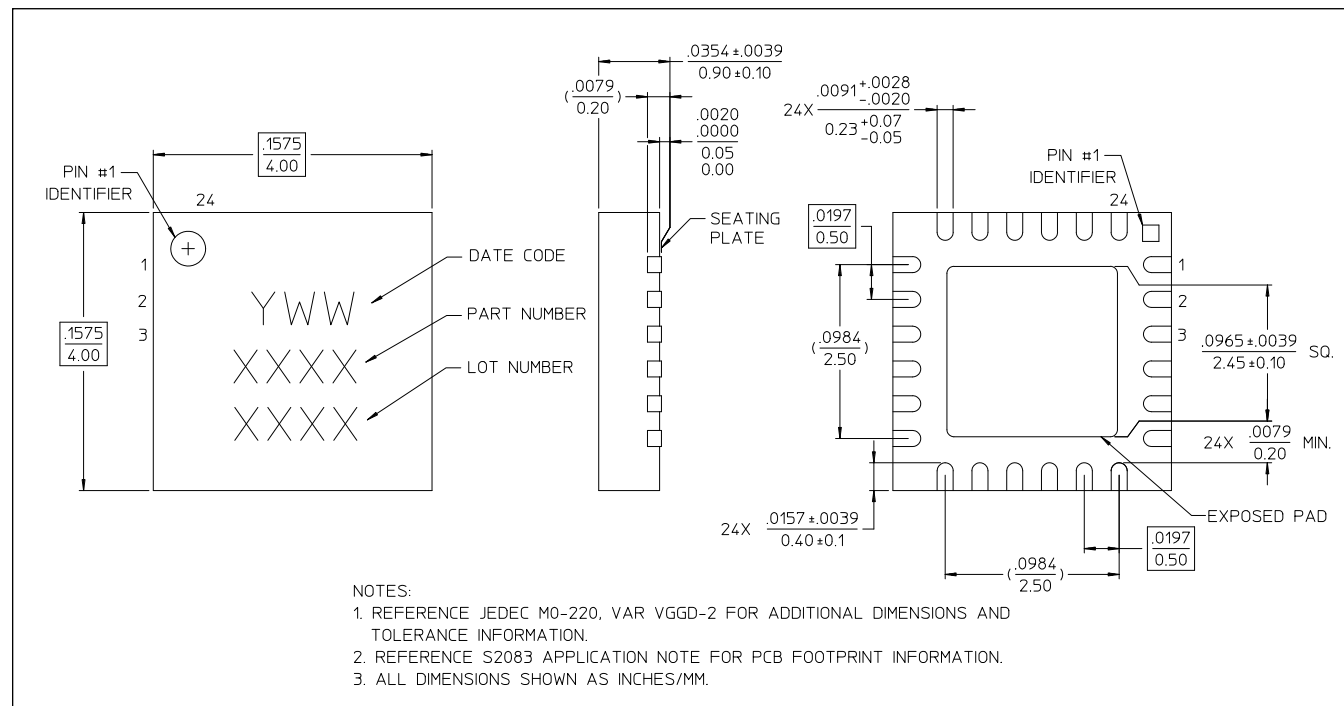
CSO_Upper vs. Optical Input Power



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Lead Free 4 mm 24-lead PQFN¹⁷

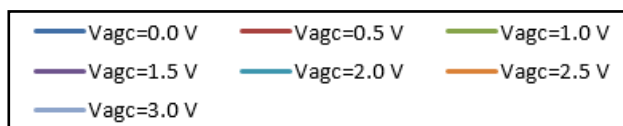


17. Reference Application Note 2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level 1 requirements.
Plating is 100% matte tin over copper.

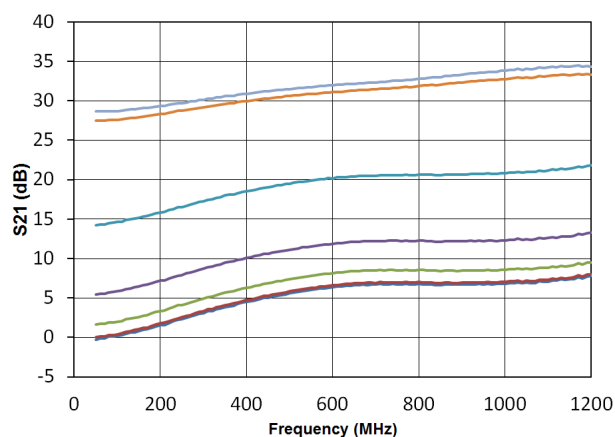
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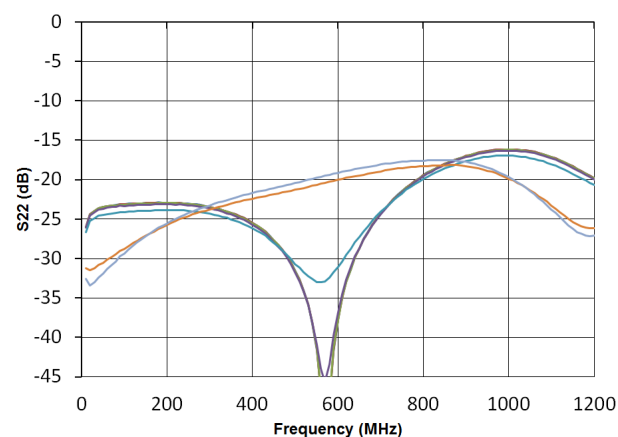
Application Section for 50 MHz to 1.2 GHz

Typical Performance Curves with 1.2 GHz Matching: $V_{AGC} = 0\text{ V to }3\text{ V}$ in 0.5 V Steps

Receiver Gain



Output Return Loss



Parts List for 1.2 GHz Matching

Component	Value	Case Style	Component	Value	Case Style
L1 - L8 ¹⁸	Ferrite Bead	0402	R8	200 Ω	0402
L9 - L10	8.2 nH w/w	0402	R9 - R10	120 Ω	0402
L11	8.2 nH	0402	R11 - R12	39 Ω	0402
L12	33 nH	0402	R13	82 Ω	0402
L13 - L14	10 nH	0402	R14	180 Ω	0402
C1 - C12	10 nF	0402	R15 - R16	12 Ω	0402
C13 - C14	3.9 pF	0402	R17 - R18	47 Ω	0402
C15	3.0 pF	0402	R19 - R20	62 Ω	0402
C16 - C17	0.5 pF	0402	R21	6.2 Ω	0402
C18 - C22	1.0 μF	0603	R22	1 k Ω	0603
R1 - R4	1 k Ω	0402	R23	470 Ω	0402
R5 - R7	680 Ω	0402	T1 ¹⁹	1:1 Balun	SM-118A

18. Ferrite Bead from Murata, part number BLM15HD182SN.

19. MACOM Technology Solutions MABA-009210-CT1760 1:1 T_x Line Balun.

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