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Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

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Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



## 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.

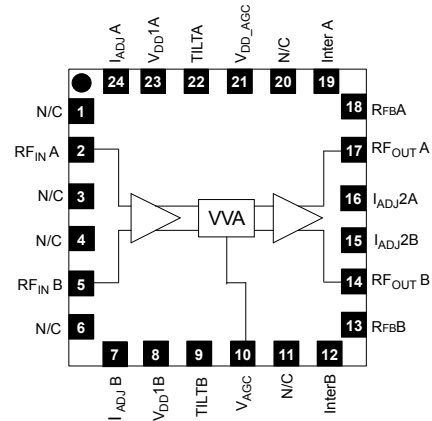
### Ordering Information<sup>1,2</sup>

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 <sup>nd</sup> 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 Configuration<sup>3</sup>

Pin No.	Pin Name	Description
1	N/C	No Connection
2	RF <sub>IN</sub> A	RF Input A
3	N/C	No Connection
4	N/C	No Connection
5	RF <sub>IN</sub> B	RF Input B
6	N/C	No Connection
7	I <sub>ADJ</sub> B	Current Adjust
8	V <sub>DD</sub> 1B	+ 5V Bias Voltage
9	TiltB	Tilt Connection
10	V <sub>AGC</sub>	AGC Control Voltage: 0V to 3V
11	N/C	No Connection
12	InterB	Interstage Pin
13	R <sub>FB</sub> B	Feedback Resistor
14	RF <sub>OUT</sub> B	RF Output B
15	I <sub>ADJ</sub> 2B	Current Adjust
16	I <sub>ADJ</sub> 2A	Current Adjust
17	RF <sub>OUT</sub> A	RF Output A
18	R <sub>FB</sub> A	Feedback Resistor
19	InterA	Interstage Pin
20	N/C	No Connection
21	V <sub>DD</sub> _AGC	+ 5V AGC Bias Voltage
22	TiltA	Tilt Connection
23	V <sub>DD</sub> 1A	+ 5V Bias Voltage
24	I <sub>ADJ</sub> 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 Specifications<sup>4</sup>: $V_{DD} = +5\text{ V}$ Regulated Supply<sup>5</sup>, $T_A = 25^\circ\text{C}$ , $Z_0 = 75\ \Omega$

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Trans-Impedance Gain <sup>6,7</sup>	50 MHz	dB	26.5	29.0	30.5
	870 MHz		31.0	33.0	35.0
	1 GHz		31.5	34.0	35.5
Gain Tilt <sup>8</sup>	$V_{AGC} = +3\text{ V}$ $V_{AGC} = 0\text{ V}$	dB	-	5 7	-
Gain Flatness <sup>9</sup>	$V_{AGC}$ : 0 to 3 V	dB		0.7	
Gain Control Range	50 MHz	dB	25.5	29.0	32.0
	870 MHz		23.0	26.0	29.0
	1 GHz		24.0	27.0	30.0
AGC Control Voltage Range	50 MHz - 1 GHz	V	0	-	+3
$EIN$ <sup>7</sup>	50 MHz - 1 GHz	pA/rtHz	-	3.2	-
Output Return Loss	50 MHz - 1 GHz	dB	-	18	-
CTB <sup>10</sup>	79 channels	dBc	-	-68	-
CSO <sup>10</sup>	79 channels	dBc	-	-65	-
Current	$V_{DD} = +5\text{ V}$	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.  $\text{Gain} = 20 \cdot \log(Z_T/75)$ , where  $Z_T = \text{Transconductance } (\Omega)$ .
7. Specified at maximum gain ( $V_{AGC} = +3.0\text{ V}$ ).
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:  
 $OMI = 3.5\%$ ;  $P_{out} = +24\text{ dBmV/ch}$  at 550 MHz  
 $P_{out} = +22.5\text{ dBmV/ch}$  at 55 MHz;  $+24\text{ dBmV/ch}$  at 550 MHz

### Absolute Maximum Ratings<sup>11,12,13</sup>

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 <sup>14</sup>	+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  $MTTF > 1 \times 10^6$  hours.
14. Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} \cdot ((V \cdot I) - (P_{OUT} - P_{IN}))$   
 Typical thermal resistance ( $\Theta_{jc}$ ) = 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

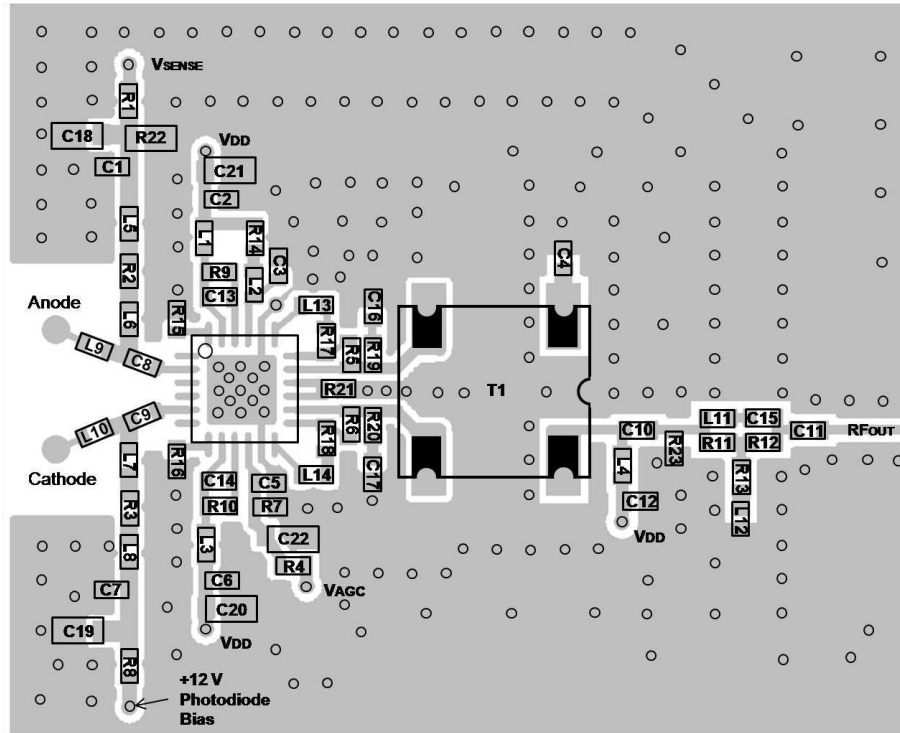
Please observe the following precautions to avoid damage:

### Static Sensitivity

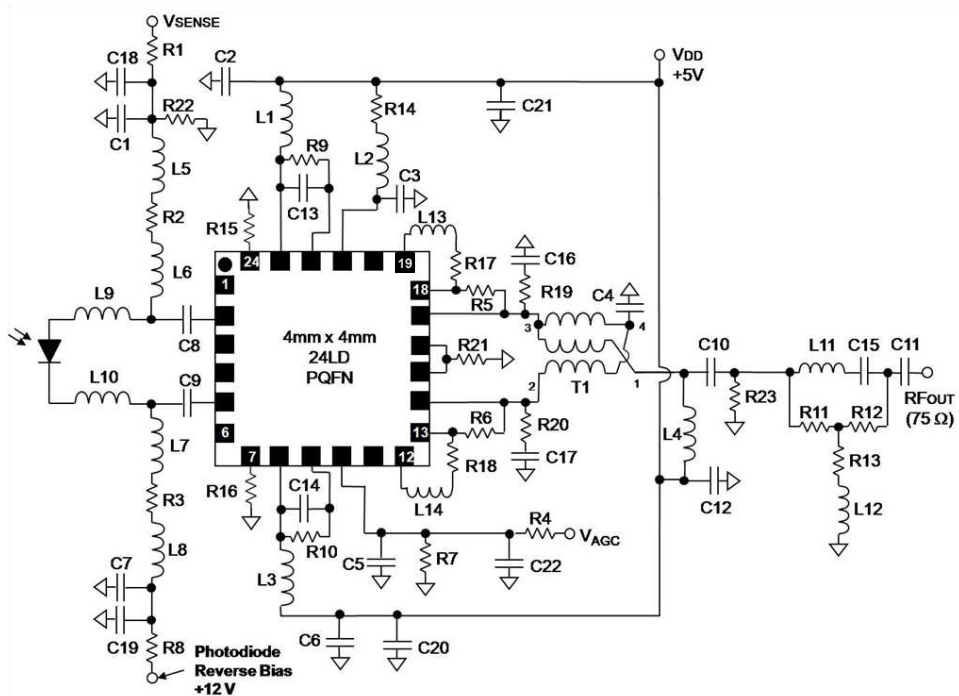
Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.



## Recommended PCB



## Schematic Including Off-Chip Components



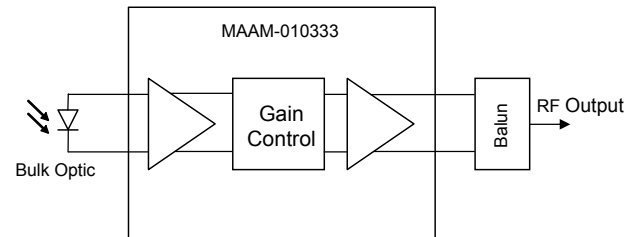
## Parts List for 1GHz Matching

Component	Value	Case Style
L1 - L8 <sup>15</sup>	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 $\mu$ F	0603
R1 - R4	1 k $\Omega$	0402
R5 - R7	680 $\Omega$	0402
R8	200 $\Omega$	0402
R9 - R10	120 $\Omega$	0402
R11 - R12	39 $\Omega$	0402
R13	82 $\Omega$	0402
R14	180 $\Omega$	0402
R15 - R16	12 $\Omega$	0402
R17 - R18	47 $\Omega$	0402
R19 - R20	62 $\Omega$	0402
R21	6.2 $\Omega$	0402
R22	1 k $\Omega$	0603
R23	470 $\Omega$	0402
T1 <sup>16</sup>	1:1 Balun	SM-118A

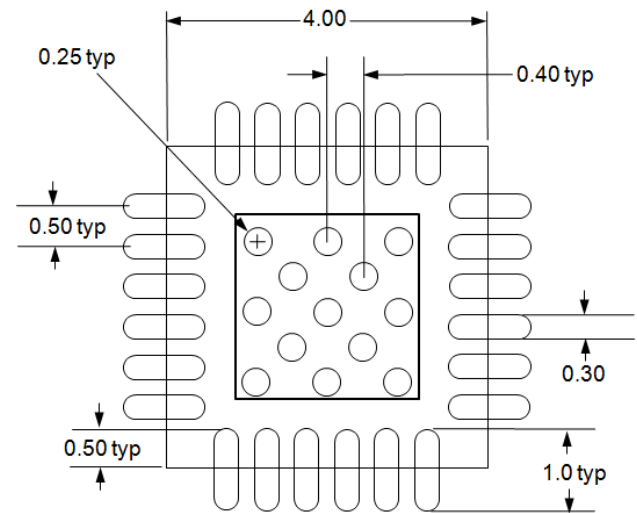
15. Ferrite Bead from Murata, part number BLM15HD182SN.

16. MACOM's MABA-009210-CT1760 1:1 T<sub>x</sub> Line Balun.

## Application Functional Schematic

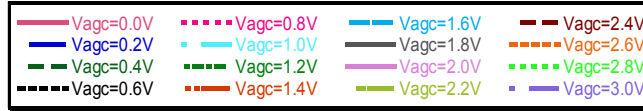


## PCB Land Pattern

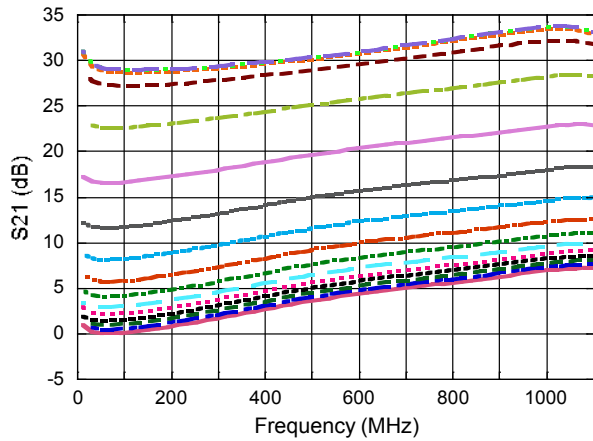


All dimension are in mm

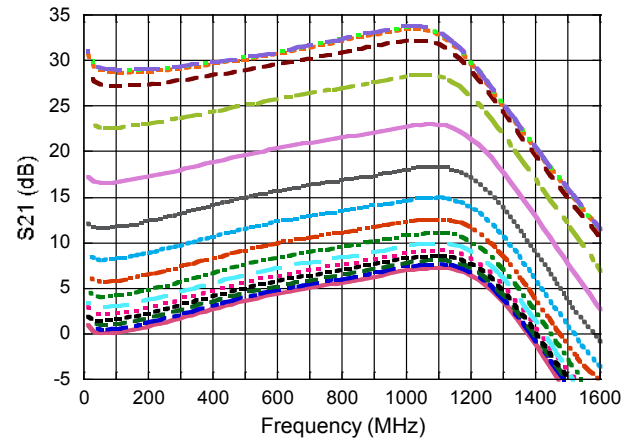
**Typical Performance Curves with 1 GHz Matching: +25°C,  $V_{AGC} = 0\text{ V}$  to  $3\text{ V}$  in  $0.2\text{ V}$  Steps**



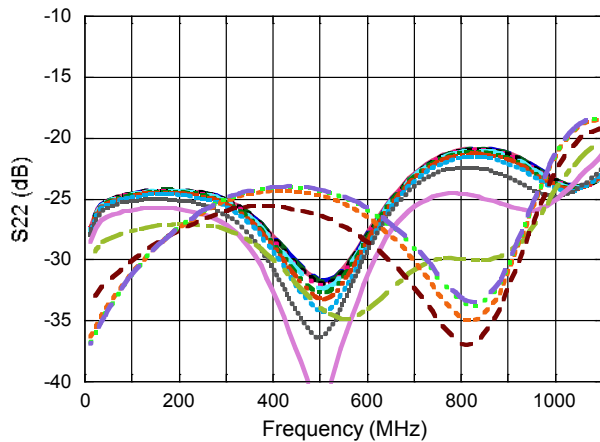
**Receiver Gain vs. Frequency to 1.1 GHz**



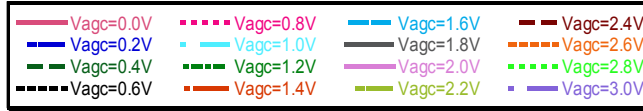
**Receiver Gain vs. Frequency to 1.6 GHz**



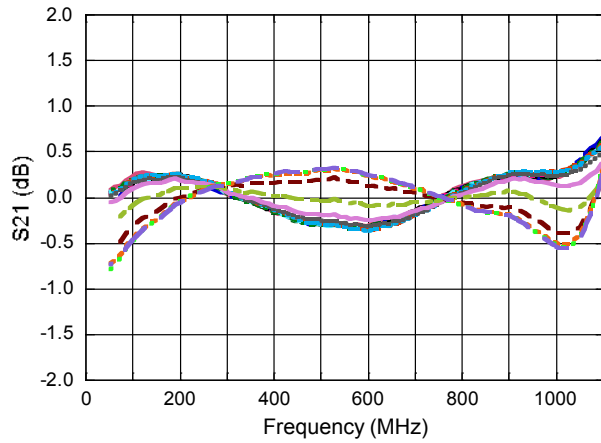
**Output Return Loss vs. Frequency**



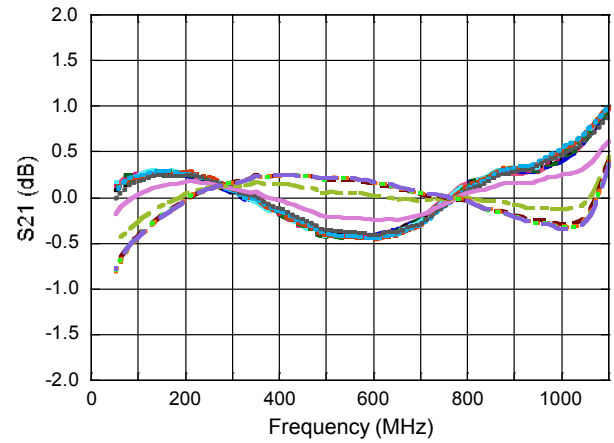
Typical Performance Curves with 1 GHz Matching:  $V_{AGC} = 0\text{ V to }3\text{ V}$  in 0.2 V Steps



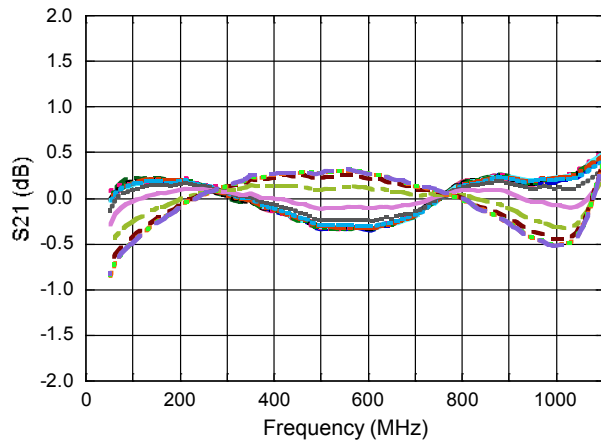
Gain Flatness Deviation From Best Fit Line @ +25°C



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

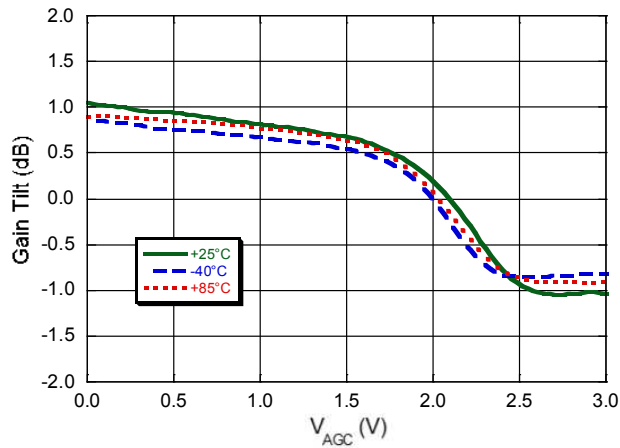


Gain Flatness Deviation From Best Fit Line @ +85°C

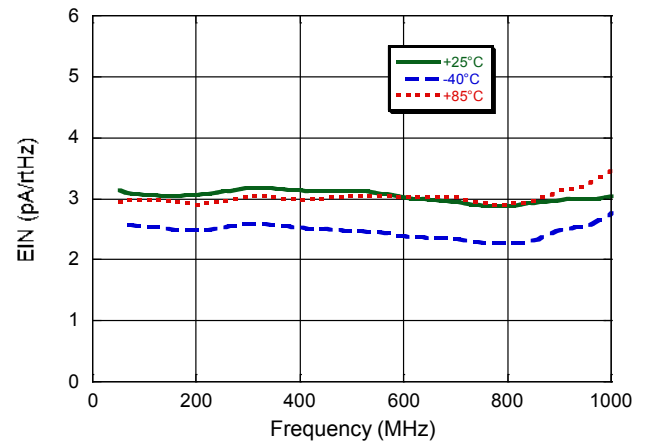


## Typical Performance Curves with 1 GHz Matching:

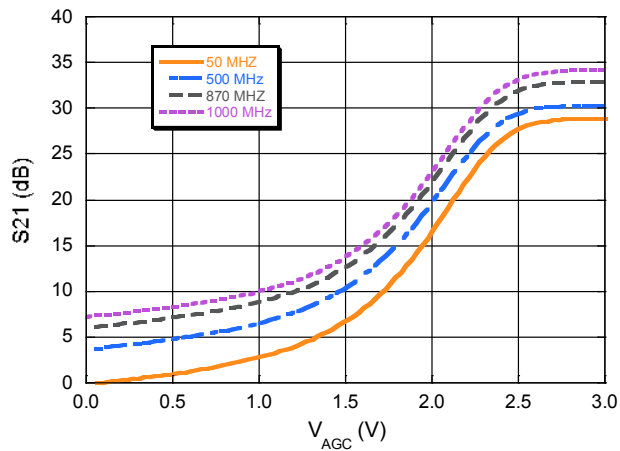
**Gain Tilt Deviation from Average Tilt**



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



**Receiver Gain vs.  $V_{AGC}$**

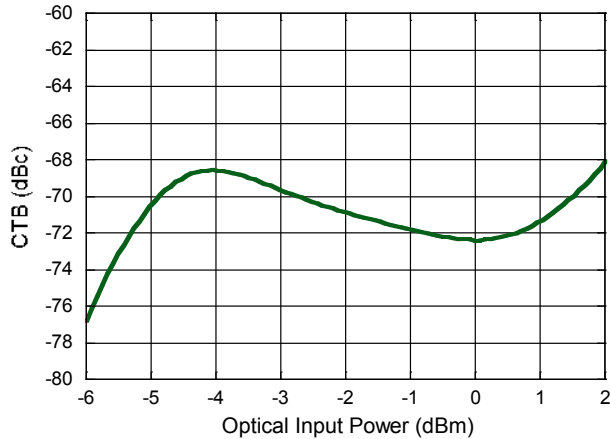




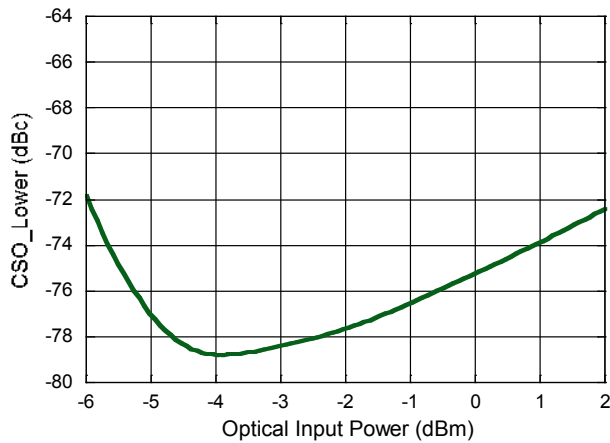
**Typical Performance Curves with 1 GHz Matching:**

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

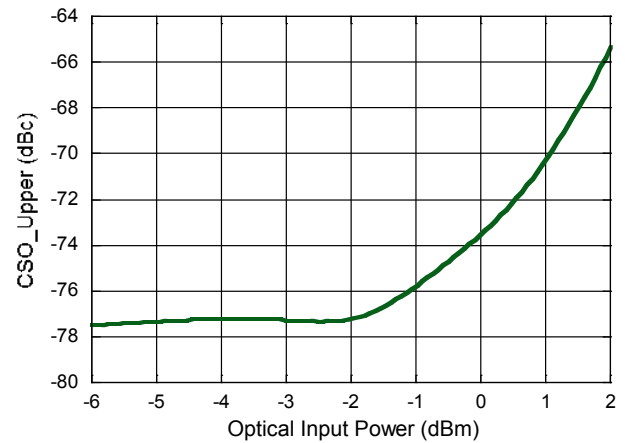
**CTB vs. Optical Input Power**



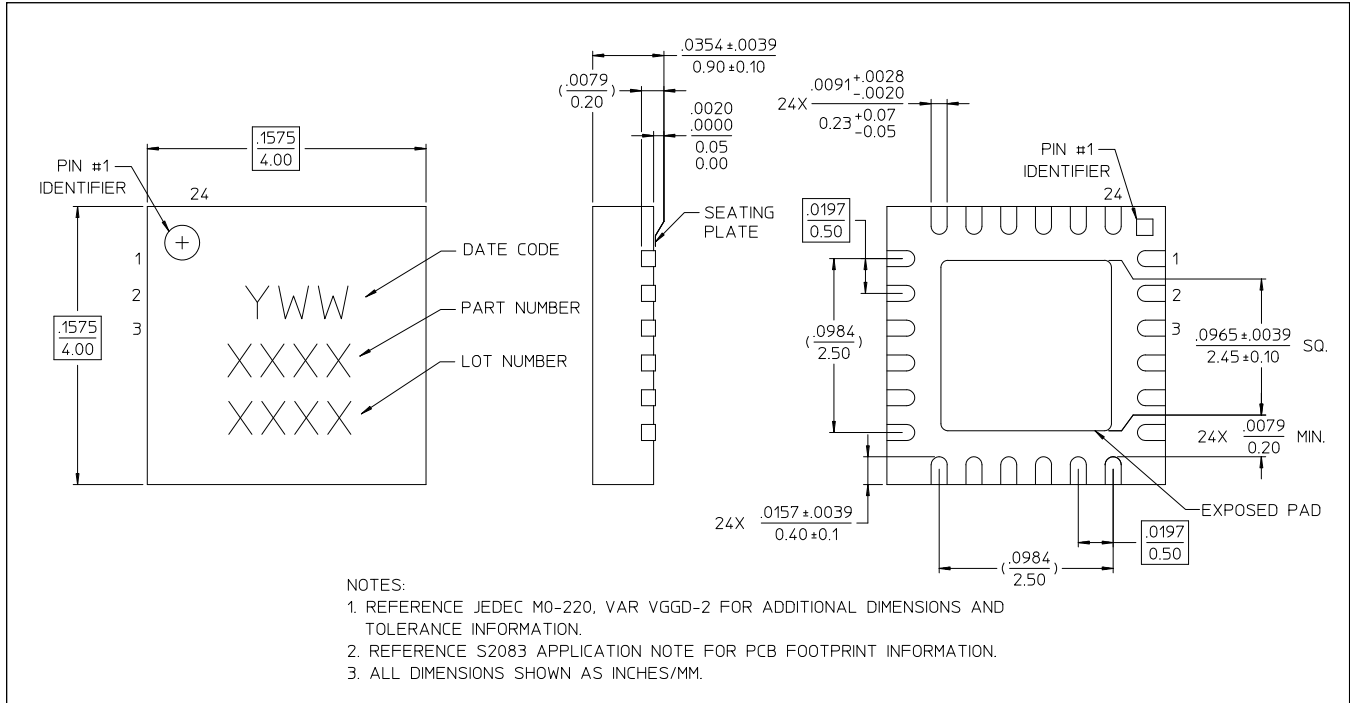
**CSO\_Lower vs. Optical Input Power**



**CSO\_Upper vs. Optical Input Power**



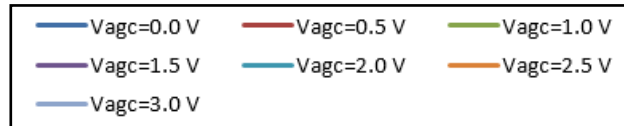
**Lead Free 4 mm 24-lead PQFN<sup>17</sup>**



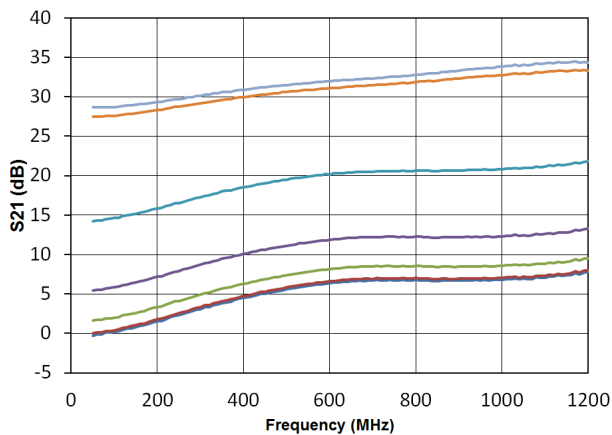
17. Reference Application Note 2083 for lead-free solder reflow recommendations.  
 Meets JEDEC moisture sensitivity level 1 requirements.  
 Plating is 100% matte tin over copper.

## Application Section for 50 MHz to 1.2 GHz

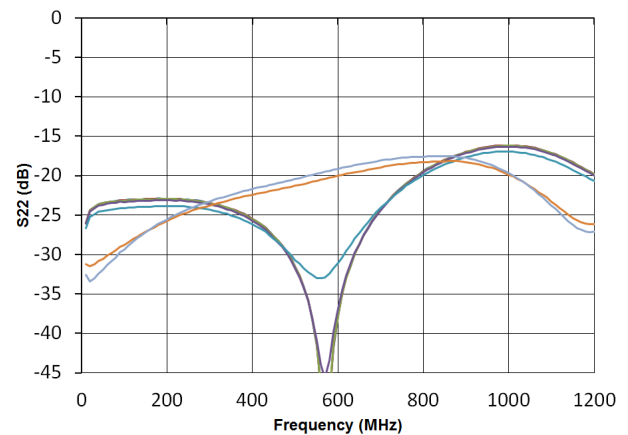
### Typical Performance Curves with 1.2 GHz Matching: $V_{AGC} = 0\text{ V to }3\text{ V}$ in 0.5 V Steps



**Receiver Gain**



**Output Return Loss**



### Parts List for 1.2 GHz Matching

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

18. Ferrite Bead from Murata, part number BLM15HD182SN.

19. MACOM Technology Solutions MABA-009210-CT1760 1:1 T<sub>x</sub> Line Balun.

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