

# MGA-16216

Dual LNA for Balanced Application 1440 – 2350 MHz



## Data Sheet

### Description

Avago Technologies' MGA-16216 is an ultra low-noise high linearity amplifier pair with built-in active bias and shutdown features for balanced applications in the 1950 MHz band. Shutdown functionality is achieved using a single DC voltage input pin. High linearity is achieved through the use of Avago Technologies' proprietary GaAs Enhancement-mode pHEMT process [1]. It is housed in a miniature 4.0 x 4.0 x 0.85 mm<sup>3</sup> 16-pin Quad Flat No-lead (QFN). The compact footprint coupled with ultra low noise and high linearity makes MGA-16216 an ideal choice for basestation transmitters and receivers.

For applications > 1950 MHz, it is recommended to use MGA-16316 1950-4000 MHz. For applications < 1450 MHz, it is recommended to use MGA-16116 450-1450 MHz. All 3 products share the same package and pin out configuration.

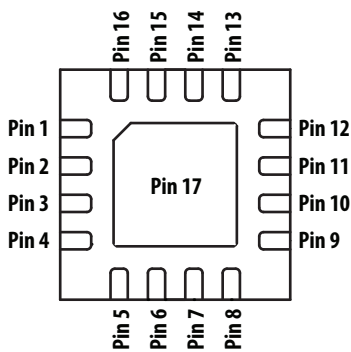
### Component Image

4.0 x 4.0 x 0.85 mm<sup>3</sup> 16-Lead QFN



Note:  
Package marking provides orientation and identification  
"16216" = Device Code  
"YYWW" = Date Code identifies year and work week of manufacturing  
"XXXX" = Last 4 digit of assembly lot number

### Pin Configuration



VIEW FROM THE TOP

Pin	Use	Pin	Use
1	RFIN1	10	GND
2	GND	11	GND
3	GND	12	RFOUT1
4	RFIN2	13	Not used
5	Bias_out2	14	Bias_in1
6	Vsd2	15	Vsd1
7	Bias_in2	16	Bias_out1
8	Not used	17	GND
9	RFOUT2	-	-

### Features

- Ultra Low Noise Figure
- Variable Bias and Shutdown functionality
- High IIP3: +17 dBm typ.
- GaAs E-pHEMT Technology [1]
- Small package size: 4.0 x 4.0 x 0.85 mm<sup>3</sup>
- RoHS and MSL1 compliant.

### Typical Performances

1950 MHz @ 4.8 V, 52.5 mA (typ per amplifier)

- Gain: 18.4 dB
- NF: 0.32 dB [2]
- IIP3: 17.1 dBm
- P1dB: 19.5 dBm
- Shutdown voltage Vsd range > 1.5 V
- Total shutdown current (Vsd1, Vsd2 = 3 V): 4.8 mA

### Applications

- Basestation Transmitter and Receivers requiring balanced configuration
- Ultra low-noise RF amplifiers.

Notes:

1. Enhancement mode technology employs positive Vgs, thereby eliminating the need of negative gate voltage associated with conventional depletion mode devices.
2. Measured at RFin pin of packaged part, other losses deembedded.
3. Good RF practice requires all unused pins to be grounded.



**Attention: Observe precautions for handling electrostatic sensitive devices.**  
ESD Machine Model = 60V  
ESD Human Body Model = 300V  
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

**Absolute Maximum Rating**<sup>[1]</sup>  $T_A = 25^\circ\text{C}$ 

Symbol	Parameter	Units	Absolute Maximum
V <sub>dd</sub>	Drain Voltage, RF output to ground	V	5.5
I <sub>dd</sub>	Drain Current	mA	100
V <sub>sd</sub>	Shutdown Voltage	V	5.5
P <sub>in</sub>	CW RF Input Power with LNA On	dBm	27
P <sub>in</sub>	CW RF Input Power with LNA Off	dBm	27
P <sub>d</sub>	Power Dissipation	mW	550
T <sub>j</sub>	Junction Temperature	°C	150
T <sub>stg</sub>	Storage Temperature	°C	-65 to 150

**Thermal Resistance**<sup>[3]</sup>

(V<sub>d</sub> = 4.8V, I<sub>dd</sub> = 52.5 mA, T<sub>c</sub> = 100° C)  
 $\theta_{jc} = 43.1^\circ\text{C/W}$

Notes:

1. Operation of this device in excess of any of these limits may cause permanent damage.
2. Source lead temperature is 25° C. Derate 23 mW/°C for T<sub>c</sub> > 126° C.
3. Thermal resistance measured using 150° C Infra-Red Microscopy Technique.

**Electrical Specifications**

T<sub>A</sub> = 25° C, V<sub>dd1</sub> = V<sub>dd2</sub> = 4.8 V, V<sub>sd1</sub> = V<sub>sd2</sub> = 0 V at R<sub>bias</sub> = 1 Kohm, RF performance at 1950 MHz, CW operation unless otherwise stated.

Symbol	Parameter and Test Condition	Units	Min.	Typ.	Max.
V <sub>dd</sub>	Supply Voltage	V		4.8	
I <sub>dd</sub>	Total Supply Current per amplifier (I <sub>dq</sub> +I <sub>bias</sub> )	mA	44	52.5	65
Gain	Gain	dB	17.2	18.4	19.4
NF <sup>[1]</sup>	Noise Figure	dB		0.32	0.55
OP1dB	Output Power at 1dB Gain Compression	dBm		19.5	
IIP3 <sup>[2]</sup>	Input Third Order Intercept Point	dBm	14	17.1	
S11	Input Return Loss, 50 Ω source	dB		-9.0	
S22	Output Return Loss, 50 Ω load	dB		-4.4	
S12	Reverse Isolation	dB		-30	
S31	Isolation between R <sub>Fin1</sub> and R <sub>Fin2</sub>	dB		-41.6	
V <sub>sd1,2</sub> <sup>[3]</sup>	Maximum Shutdown voltage required to turn ON LNA	V		0.5	
V <sub>sd1,2</sub> <sup>[3]</sup>	Minimum Shutdown voltage required to turn OFF LNA	V		2.0	
I <sub>dq</sub> <sup>[4]</sup>	Current at V <sub>dd</sub> with V <sub>sd</sub> = 0 V	mA		48.5	
	Current at V <sub>dd</sub> with V <sub>sd</sub> = 3 V	mA		0.378	
I <sub>sd</sub> <sup>[4]</sup>	Current at V <sub>sd</sub> with V <sub>sd</sub> = 0 V	μA		4	
	Current at V <sub>sd</sub> with V <sub>sd</sub> = 3 V	mA		0.176	
I <sub>bias</sub> <sup>[4]</sup>	Current at V <sub>bias</sub> with V <sub>sd</sub> = 0 V	mA		3.0	
	Current at V <sub>bias</sub> with V <sub>sd</sub> = 3 V	mA		4.542	

Notes:

1. Noise figure at the DUT RF Input pin, board losses are deembedded.
2. IIP3 test condition: FRF1-FRF2 = 1 MHz with input power of -20 dBm per tone.
3. V<sub>sd1</sub> and V<sub>sd2</sub> are active LOW.
4. Refer to Figure 6 for more details.

## Product Consistency Distribution Charts

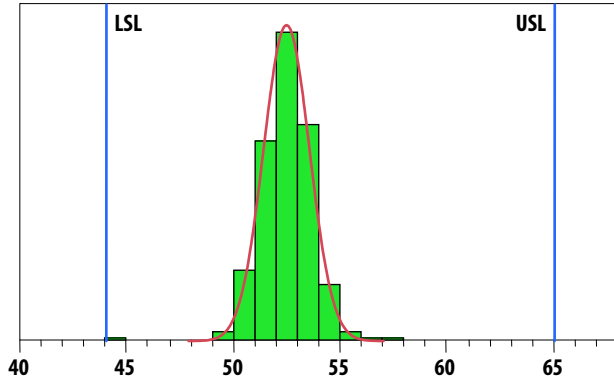


Figure 1. Idd, LSL = 44 mA, nominal = 52.5 mA, USL = 65 mA

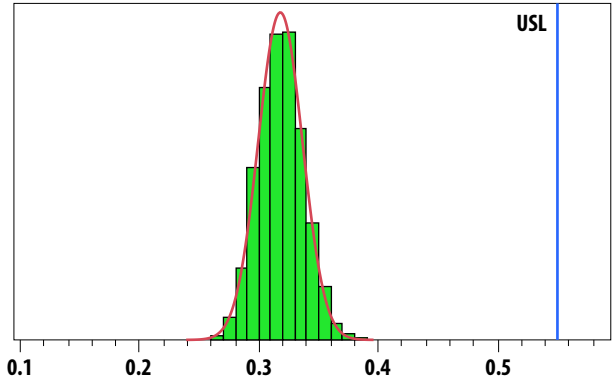


Figure 2. NF, nominal = 0.32 dB, USL = 0.55 dB

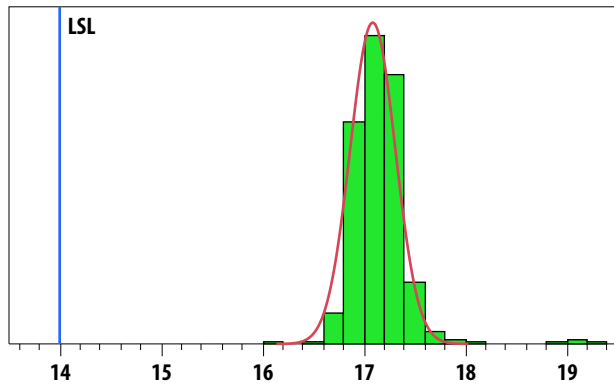


Figure 3. IIP3, LSL = 14 dBm, nominal = 17.1 dBm

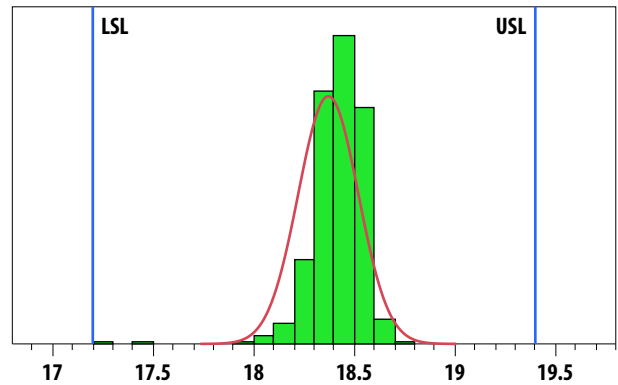


Figure 4. Gain, LSL = 17.2 dB, nominal = 18.4 dB, USL = 19.4 dB

### Notes:

1. Distribution data sample size is 3000 samples taken from 6 different wafer lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
2. Circuit trace losses for NF have been de-embedded from measurements above.

## Demo Board Layout

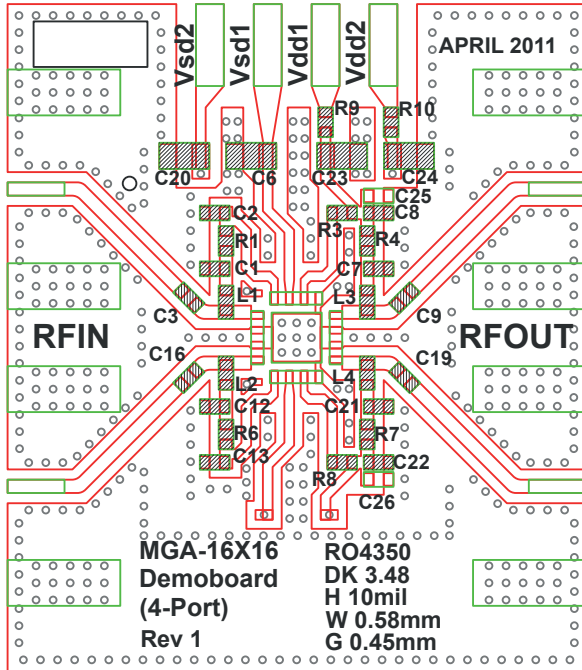


Figure 5. Demo Board Layout Diagram

### Notes:

1. Recommended PCB material is 10 mils Rogers RO4350.
2. Suggested component values may vary according to layout and PCB material.
3. Input board loss at 1950 MHz is 0.11dB
4. The schematic is shown with the assumption that similar PCB is used for all MGA-16116, MGA-16216 and MGA-16316.
5. Detail of the components needed for this product is shown in Table 1.
6. R1 and R6 are for low frequency stability.
7. Bias to each LNA is adjustable using R3 and R8 (see Figure 6). Increasing R3 and R8 will reduce bias current (I<sub>dd</sub>) and vice-versa.
8. R9/R10 are stability improvement resistors that may not be needed in actual application. They are included in the demoboard to provide isolation from power supply noise.
9. Center Paddle is grounded.

## Demo Board Schematic

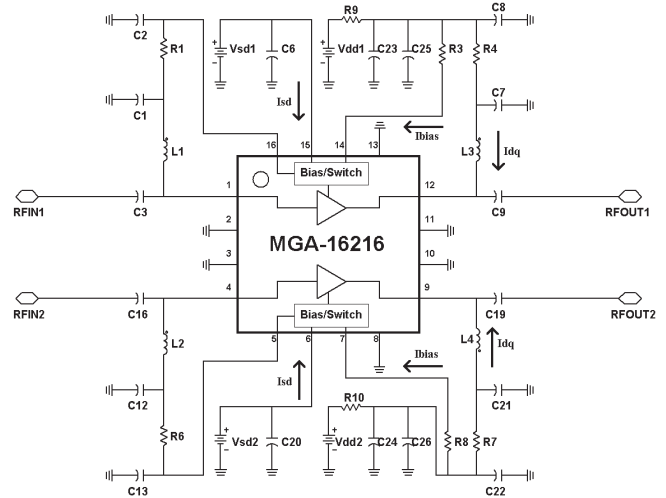


Figure 6. Demo Board Schematic Diagram

Table 1. Component list for 1950 MHz matching

PART	Size	Value	Detail Part Number
C1, C12	0201	10 pF	GRM0335C1E100JD01D
C3, C16	0402	18 pF	GJM1555C1H180JB01D
C9, C19	0201	1000 pF	GRM033R71C102KA01D
C2, C8, C13, C22	0402	0.1 $\mu$ F	GRM155R71C104KA88D
C6, C20, C23, C24	0805	4.7 $\mu$ F	GRM21BR60J475KA11L
C7, C21	0201	22 pF	GRM0335C1E200GD01D
C25, C26	0402	NOT USED	-
L1, L2	0603	12 nH	LQW18AN12NG00D
L3, L4	0603	6.2 nH	LQW18AN6N2C00D
R1, R4, R6, R7	0402	0 ohm	RK73B1ETTP0R0J
R3, R8	0402	1 kohm	RK73B1ELTP102J
R9, R10	0402	10 ohm	RK73B1ETTP100J

**Table 2.** Below is the table showing the MGA-16216 Reflection Coefficient Parameters tuned for Maximum OIP3. Vdd = 4.8 V, Idd = 35 mA per amplifier. Input gamma is tuned for Fmin. The reflection coefficients are for single amplifier.

Frequency (MHz)	Gamma Load Position		IIP3 (dBm) <sup>[1]</sup>	Gain (dB)
	Magnitude	Angle		
1440	0.514	100.8	13.70	22.36
1750	0.514	115.2	15.14	20.82
1950	0.771	145.9	20.92	16.48
2350	0.643	162.6	19.70	16.12

**Table 3.** Below is the table showing the MGA-16216 Reflection Coefficient Parameters tuned for Maximum OIP3. Vdd = 4.8 V, Idd = 55 mA per amplifier. Input gamma is tuned for Fmin. The reflection coefficients are for single amplifier.

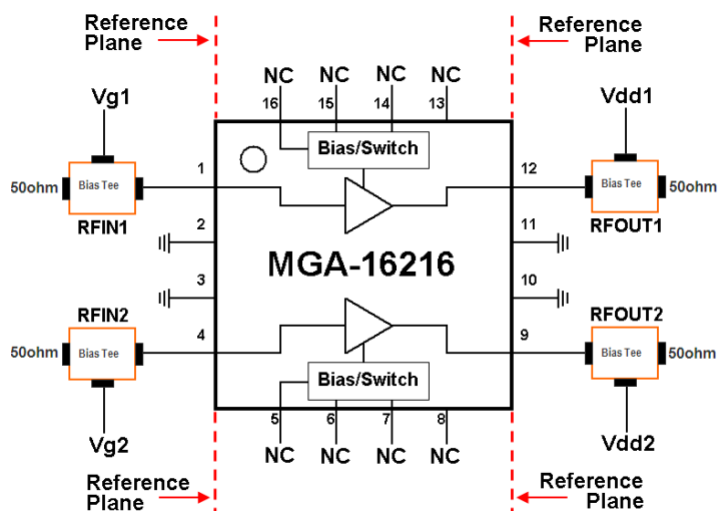
Frequency (MHz)	Gamma Load Position		IIP3 (dBm) <sup>[1]</sup>	Gain (dB)
	Magnitude	Angle		
1440	0.643	104.5	18.23	22.33
1750	0.385	80.0	19.16	21.01
1950	0.771	145.9	23.25	16.60
2350	0.514	143.9	21.07	17.94

**Table 4.** Below is the table showing the MGA-16216 Reflection Coefficient Parameters tuned for Maximum OIP3. Vdd = 4.8 V, Idd = 75 mA per amplifier. Input gamma is tuned for Fmin. The reflection coefficients are for single amplifier.

Frequency (MHz)	Gamma Load Position		IIP3 (dBm) <sup>[1]</sup>	Gain (dB)
	Magnitude	Angle		
1440	0.257	89.9	18.09	22.04
1750	0.514	129.6	20.21	20.33
1950	0.128	119.6	20.48	18.31
2350	0.257	149.9	21.39	16.88

Notes:

1. IIP3 test condition: FRF1-FRF2 = 1 MHz with input power of -20 dBm per tone.
2. Idd can be obtained by varying the Vg1/Vg2. Refer to figure 7.



**Figure 7.** RFinut and RFoutut Reference Plane

Note:

1. Maximum OIP3 is measured on coplanar waveguide made on 0.010 inch thick ROGER 4350.

## Typical 1950 MHz RF Performance Plots For Single Amplifier

RF performance at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 4.8\text{ V}$ ,  $I_{dd} = 52\text{ mA}$ , LNA mode, measured on demo board in Figure 5. Signal is CW unless stated otherwise. Application Test Circuit is shown in Figure 6 and Table 1. IIP3 test condition: FRF1-FRF2 = 1 MHz with input power of -20 dBm per tone.

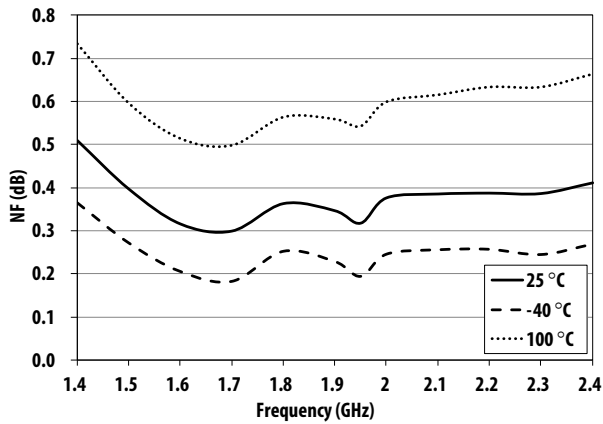


Figure 8. NF vs Frequency vs Temperature [1]

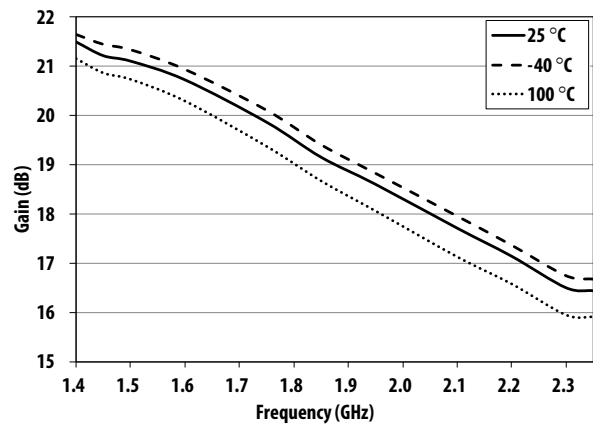


Figure 9. Gain vs Frequency vs Temperature

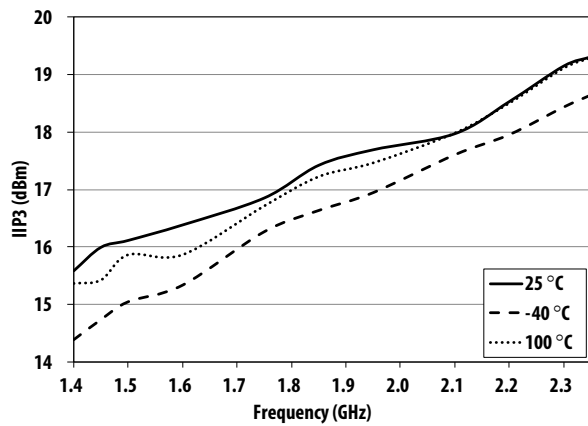


Figure 10. IIP3 vs Frequency vs Temperature

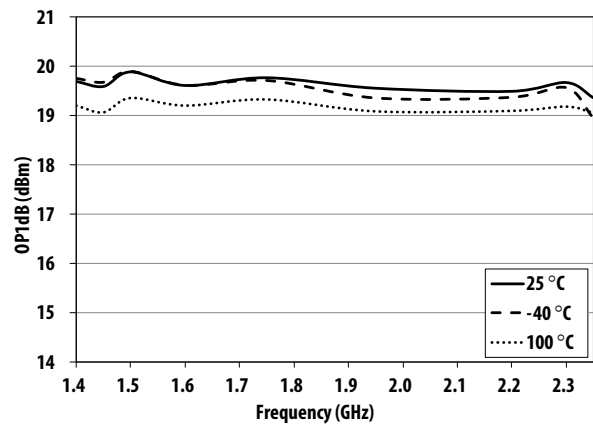


Figure 11. OP1dB vs Frequency vs Temperature

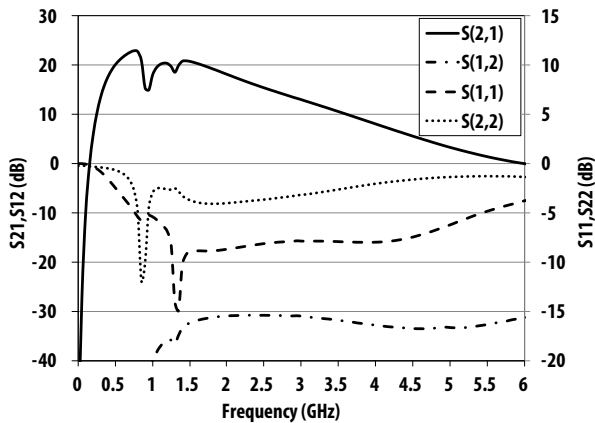


Figure 12. Input Return Loss, Output Return Loss, Gain, Reverse Isolation vs Frequency

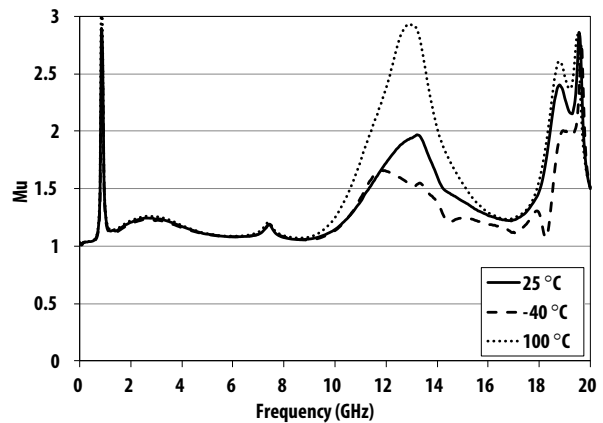


Figure 13. Mu stability factors vs Frequency vs Temperature

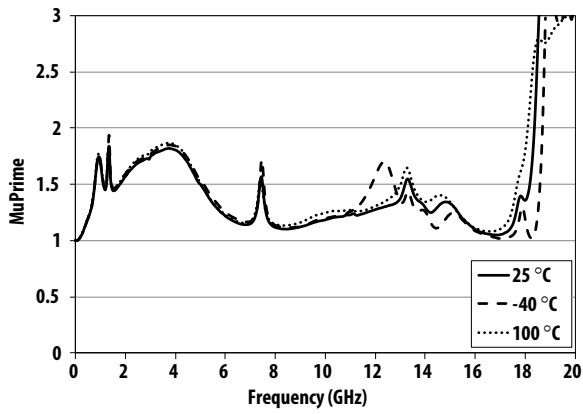


Figure 14. Mu' stability factors vs Frequency vs Temperature

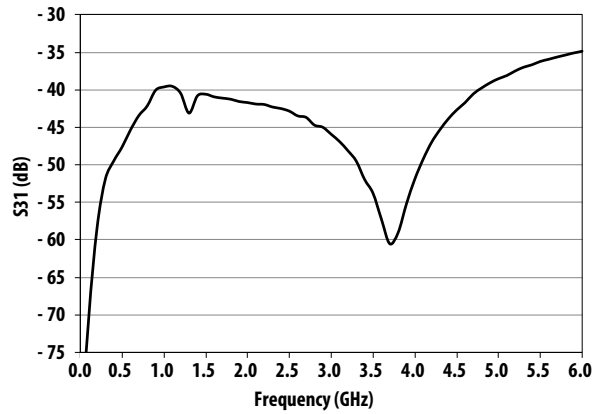


Figure 15. Input Ports Isolation (S31) vs Frequency

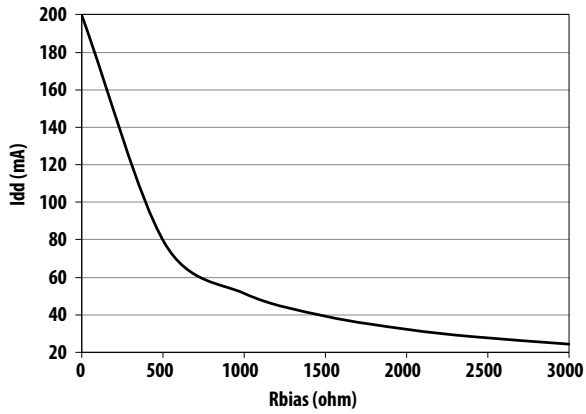


Figure 16. Idd vs Rbias [2]

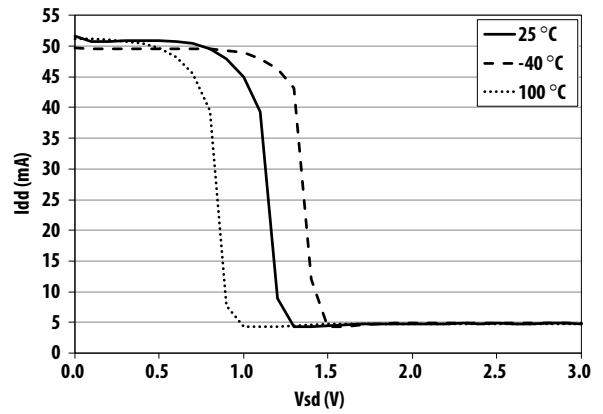


Figure 17. Idd vs Vsd

Notes:

1. Circuit trace losses for NF have been de-embedded from measurements above.
2. Rbias is R3 and R8 from Figure 6.

**Table 5. Typical Scattering Parameters, Vdd = 4.8 V, Idd = 35 mA**

LNA SPAR (100 MHz – 20 GHz). The S-parameter is for single amplifier.

Freq (GHz)	S11 (dB)	S11 (ang)	S21 (dB)	S21 (ang)	S12 (dB)	S12 (ang)	S22 (dB)	S22 (ang)
0.1	-0.256	-11.004	29.400	161.000	-54.136	69.450	-1.119	-5.967
0.5	-3.272	-38.907	25.700	110.000	-41.500	67.641	-1.411	-27.507
0.7	-4.480	-44.800	23.600	94.579	-39.100	62.952	-1.541	-37.021
0.9	-5.414	-48.213	22.200	81.787	-37.300	59.100	-1.649	-46.227
1.0	-5.760	-49.321	21.285	76.115	-36.600	57.374	-1.661	-51.112
1.45	-6.970	-53.422	18.700	53.457	-34.100	47.978	-1.812	-73.622
1.7	-7.300	-58.425	17.500	41.375	-33.000	42.475	-1.970	-85.851
1.95	-7.493	-63.400	16.500	29.771	-32.200	36.900	-2.100	-99.158
2.0	-7.527	-64.400	16.300	27.370	-32.100	35.560	-2.143	-102.000
2.5	-7.560	-74.037	14.300	4.565	-31.262	24.825	-2.320	-131.000
3.0	-7.326	-84.245	12.255	-17.490	-31.200	15.200	-2.230	-161.449
3.5	-6.920	-94.352	10.248	-37.352	-31.600	11.600	-1.930	172.000
4.0	-6.420	-105.000	8.414	-55.260	-31.800	13.660	-1.644	150.000
4.5	-5.780	-116.000	6.673	-71.667	-31.400	18.900	-1.427	132.000
5.0	-5.130	-124.753	5.155	-87.649	-30.100	23.400	-1.340	112.502
5.5	-4.520	-134.000	3.324	-103.000	-28.600	24.900	-1.120	96.135
6.0	-4.209	-143.000	1.392	-116.000	-28.300	12.149	-0.899	84.300
7.0	-3.740	-168.000	-1.690	-144.000	-25.600	10.395	-0.701	60.390
8.0	-2.716	165.000	-4.532	-171.000	-23.100	-4.646	-0.802	34.880
9.0	-1.690	149.000	-7.183	164.000	-21.200	-20.900	-0.608	9.433
10.0	-1.250	135.000	-8.970	141.000	-19.300	-37.200	-0.071	-8.985
11.0	-0.532	105.000	-10.400	114.000	-17.000	-54.965	-0.248	-19.965
12.0	-0.971	62.400	-12.780	85.720	-16.200	-71.880	-0.114	-17.700
13.0	-0.171	46.500	-15.500	63.700	-16.000	-86.995	-0.594	-29.595
14.0	-0.099	43.890	-17.300	40.790	-15.800	-98.010	-0.426	-46.110
15.0	-0.413	38.975	-15.700	14.775	-14.400	-110.000	-0.402	-74.425
16.0	-0.689	6.360	-14.200	-53.400	-8.934	-140.400	-0.828	-93.840
17.0	-1.565	-42.955	-10.800	-85.965	-7.439	-167.550	-1.120	-104.000
18.0	-3.827	-82.300	-12.700	-150.000	-6.623	137.000	-2.507	-109.000
19.0	-10.485	-85.000	-14.000	-167.000	-15.500	114.000	-4.484	-86.815
20.0	-12.300	19.900	-19.300	143.000	-13.600	68.800	-4.230	-132.000

**Table 6. Typical Noise Parameters for single amplifier, Vdd = 4.8 V, Idd = 35 mA**

Freq MHz	Fmin dB	$\Gamma_{opt}$ Mag.	$\Gamma_{opt}$ Ang.	$R_{n/50}$
1440	0.31	0.245	56.3	0.05
1750	0.28	0.256	76.2	0.04
1950	0.34	0.236	103.5	0.03
2350	0.4	0.229	136.6	0.03

Notes:

1. The Fmin values are based on noise figure measurements at multiple input impedances using Focus source pull test system. From these measurements a true Fmin is calculated.
2. Scattering and noise parameters are measured on coplanar waveguide made on 0.010 inch thick ROGER 4350. The input reference plane is at the end of the RFinput pin and the output reference plane is at the end of the RFoutput pin as shown in Figure 7.
3. Idd can be obtained by varying the Vg1/Vg2. Refer to figure 7.



**Table 7. Typical Scattering Parameters, Vdd = 4.8 V, Idd = 55 mA**

LNA SPAR (100 MHz – 20 GHz). The S-parameter is for single amplifier.

Freq	S11	S11	S21	S21	S12	S12	S22	S22
(GHz)	(dB)	(ang)	(dB)	(ang)	(dB)	(ang)	(dB)	(ang)
0.1	-0.305	-11.605	30.899	160.000	-55.471	80.373	-1.229	-5.557
0.5	-3.623	-36.915	26.493	106.926	-41.700	68.726	-1.511	-27.015
0.7	-4.759	-41.300	24.290	91.579	-39.200	64.259	-1.622	-36.510
0.9	-5.503	-44.100	22.600	79.487	-37.287	60.213	-1.710	-45.727
1.0	-5.779	-44.891	21.771	74.030	-36.515	58.345	-1.720	-50.612
1.45	-6.710	-48.722	19.000	52.235	-34.000	48.500	-1.852	-73.043
1.7	-6.940	-53.725	17.900	40.549	-32.900	42.600	-2.010	-85.351
1.95	-7.060	-58.829	16.800	29.171	-32.100	36.671	-2.140	-98.658
2.0	-7.084	-59.830	16.600	26.840	-32.000	35.440	-2.176	-101.299
2.5	-7.030	-69.937	14.600	4.379	-31.200	24.088	-2.360	-131.000
3.0	-6.750	-80.445	12.555	-17.390	-31.100	13.855	-2.280	-161.000
3.5	-6.330	-90.952	10.600	-36.952	-31.700	10.005	-1.980	173.000
4.0	-5.846	-102.000	8.714	-54.660	-32.100	12.320	-1.686	151.000
4.5	-5.250	-113.000	6.967	-70.867	-31.800	18.667	-1.460	132.000
5.0	-4.637	-122.502	5.445	-86.674	-30.400	23.900	-1.372	112.753
5.5	-4.060	-132.000	3.602	-102.000	-28.800	26.200	-1.150	96.518
6.0	-3.780	-142.000	1.642	-115.000	-28.500	13.339	-0.931	84.510
7.0	-3.350	-166.049	-1.440	-142.000	-25.700	11.500	-0.721	60.595
8.0	-2.430	167.000	-4.292	-169.000	-23.100	-3.906	-0.809	35.180
9.0	-1.500	150.000	-6.943	166.000	-21.200	-20.400	-0.623	9.603
10.0	-1.090	136.000	-8.740	144.000	-19.400	-36.600	-0.069	-8.655
11.0	-0.375	106.000	-10.165	118.351	-17.100	-53.965	-0.236	-19.565
12.0	-0.841	63.880	-12.500	90.600	-16.300	-70.980	-0.105	-17.500
13.0	-0.083	48.000	-15.300	69.705	-16.100	-86.195	-0.593	-29.695
14.0	-0.047	45.110	-17.300	47.900	-16.000	-97.000	-0.467	-46.010
15.0	-0.362	40.675	-15.900	22.375	-14.700	-108.000	-0.417	-73.925
16.0	-0.498	9.996	-15.100	-46.340	-8.894	-138.000	-0.777	-93.400
17.0	-1.335	-37.255	-11.200	-77.565	-7.159	-163.000	-0.945	-104.000
18.0	-3.070	-78.700	-13.400	-141.000	-6.203	140.000	-2.370	-110.000
19.0	-9.429	-85.315	-14.000	-165.000	-14.500	113.000	-4.523	-86.900
20.0	-12.900	16.200	-19.700	147.000	-13.000	69.700	-4.250	-132.000

**Table 8. Typical Noise Parameters for single amplifier, Vdd = 4.8 V, Idd = 55 mA**

Freq	Fmin	$\Gamma_{opt}$	$\Gamma_{opt}$	$R_{n/50}$
MHz	dB	Mag.	Ang.	
1440	0.31	0.226	50	0.04
1750	0.27	0.236	70.7	0.04
1950	0.34	0.161	109	0.03
2350	0.38	0.215	139.4	0.03

Notes:

1. The Fmin values are based on noise figure measurements at multiple input impedances using Focus source pull test system. From these measurements a true Fmin is calculated.
2. Scattering and noise parameters are measured on coplanar waveguide made on 0.010 inch thick ROGER 4350. The input reference plane is at the end of the RFinput pin and the output reference plane is at the end of the RFOutput pin as shown in Figure 7.
3. Idd can be obtained by varying the Vg1/Vg2. Refer to figure 7.

**Table 9. Typical Scattering Parameters, Vdd = 4.8 V, Idd = 75 mA**

LNA SPAR (100 MHz – 20 GHz). The S-parameter is for single amplifier.

Freq	S11	S11	S21	S21	S12	S12	S22	S22
(GHz)	(dB)	(ang)	(dB)	(ang)	(dB)	(ang)	(dB)	(ang)
0.1	-0.369	-11.807	31.797	159.986	-54.599	73.714	-1.269	-5.048
0.5	-3.752	-35.407	26.800	105.000	-41.885	69.437	-1.550	-26.707
0.7	-4.818	-39.200	24.500	90.279	-39.290	64.910	-1.633	-36.210
0.9	-5.473	-41.713	22.800	78.573	-37.400	60.947	-1.720	-45.427
1.0	-5.706	-42.406	21.971	73.215	-36.615	58.915	-1.730	-50.312
1.45	-6.510	-46.322	19.200	51.757	-34.000	48.800	-1.860	-72.743
1.7	-6.710	-51.400	18.000	40.275	-32.975	42.875	-2.010	-85.025
1.95	-6.790	-56.500	17.000	29.071	-32.100	36.729	-2.143	-98.258
2.0	-6.817	-57.600	16.800	26.740	-32.000	35.370	-2.183	-101.000
2.5	-6.730	-67.737	14.763	4.525	-31.200	23.837	-2.380	-130.374
3.0	-6.446	-78.445	12.700	-17.090	-31.200	13.700	-2.290	-160.449
3.5	-6.030	-89.000	10.700	-36.552	-31.852	9.524	-2.000	173.000
4.0	-5.560	-99.900	8.874	-54.160	-32.300	11.940	-1.704	151.000
4.5	-4.990	-112.000	7.123	-70.200	-32.000	18.835	-1.480	132.000
5.0	-4.397	-120.753	5.592	-85.874	-30.625	24.700	-1.392	113.502
5.5	-3.840	-131.000	3.742	-101.000	-29.000	27.182	-1.170	96.735
6.0	-3.579	-140.899	1.781	-114.000	-28.600	14.149	-0.946	84.800
7.0	-3.160	-165.000	-1.300	-141.000	-25.800	12.495	-0.735	60.795
8.0	-2.308	168.000	-4.132	-168.000	-23.180	-3.146	-0.829	35.280
9.0	-1.410	151.000	-6.790	168.000	-21.300	-19.700	-0.629	9.803
10.0	-1.005	137.000	-8.585	146.000	-19.400	-35.950	-0.093	-8.550
11.0	-0.290	108.000	-9.996	121.000	-17.100	-53.165	-0.261	-19.465
12.0	-0.776	65.400	-12.400	93.600	-16.300	-69.980	-0.110	-17.300
13.0	-0.029	49.400	-15.200	73.300	-16.200	-85.295	-0.570	-29.490
14.0	-0.009	46.290	-17.300	52.180	-16.010	-96.010	-0.460	-45.810
15.0	-0.339	41.900	-16.000	26.875	-14.800	-107.000	-0.420	-73.625
16.0	-0.400	12.420	-15.600	-41.700	-8.880	-136.000	-0.745	-93.040
17.0	-1.229	-33.355	-11.500	-71.965	-7.019	-160.000	-0.836	-104.000
18.0	-2.610	-76.070	-13.800	-133.000	-5.943	143.000	-2.250	-110.000
19.0	-8.858	-85.300	-13.985	-163.000	-13.900	113.000	-4.543	-86.900
20.0	-13.300	14.000	-19.800	149.000	-12.600	70.300	-4.270	-132.000

**Table 10. Typical Noise Parameters for single amplifier, Vdd = 4.8 V, Idd = 75 mA**

Freq	Fmin	$\Gamma_{opt}$	$\Gamma_{opt}$	$R_{n/50}$
MHz	dB	Mag.	Ang.	
1440	0.33	0.207	50.2	0.04
1750	0.28	0.221	67.2	0.05
1950	0.34	0.134	109.3	0.03
2350	0.4	0.205	146.5	0.03

Notes:

1. The Fmin values are based on noise figure measurements at multiple input impedances using Focus source pull test system. From these measurements a true Fmin is calculated.
2. Scattering and noise parameters are measured on coplanar waveguide made on 0.010 inch thick ROGER 4350. The input reference plane is at the end of the RFinput pin and the output reference plane is at the end of the RFoutput pin as shown in Figure 7.
3. Idd can be obtained by varying the Vg1/Vg2. Refer to figure 7.

## BALANCED MODE APPLICATION

### Electrical Specifications

$T_A = 25^\circ\text{C}$ ,  $V_{dd1} = V_{dd2} = 4.8\text{V}$ ,  $V_{sd1} = V_{sd2} = 0\text{V}$  at  $R_{bias} = 1\text{Kohm}$ , RF performance at 1950 MHz, CW operation unless otherwise stated.

Symbol	Parameter and Test Condition	Units	Typ.
Vdd	Supply Voltage per amplifier	V	4.8
Idd	Supply Current per amplifier	mA	50
Gain	Gain	dB	18.6
NF	Noise Figure	dB	0.489
OP1dB	Output Power at 1dB Gain Compression	dBm	21.6
IIP3	Input Third Order Intercept Point	dBm	20.2
S11	Input Return Loss, 50 $\Omega$ source	dB	-28.8
S22	Output Return Loss, 50 $\Omega$ load	dB	-23.2
S12	Reverse Isolation	dB	-30.3

### Balanced Amplifier Demo Board Layout

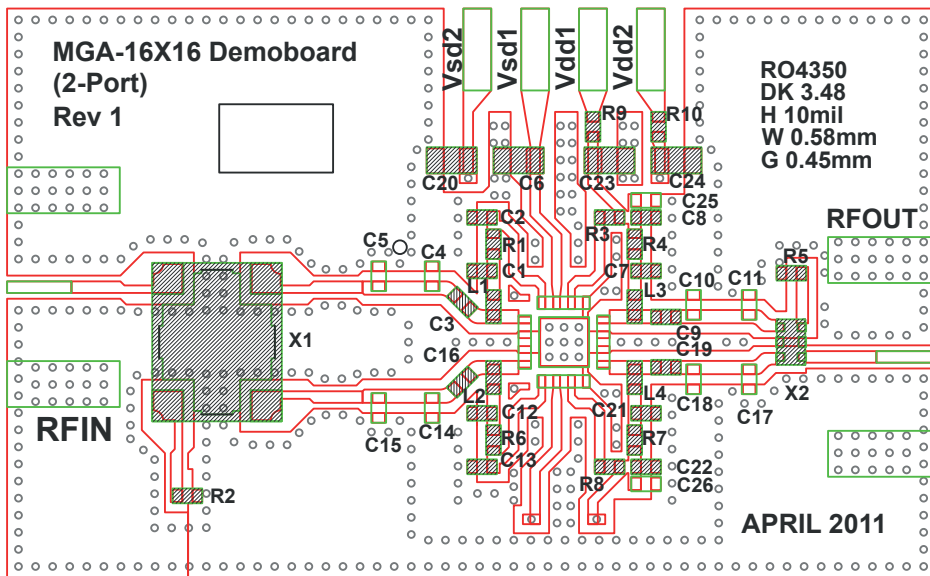


Figure 18. Balanced Amplifier Demo Board Layout Diagram

#### Notes:

1. Recommended PCB material is 10 mils Rogers RO4350.
2. Suggested component values may vary according to layout and PCB material.
3. Input board loss at 1950 MHz is 0.18 dB.

## Balanced Amplifier Demo Board Schematic

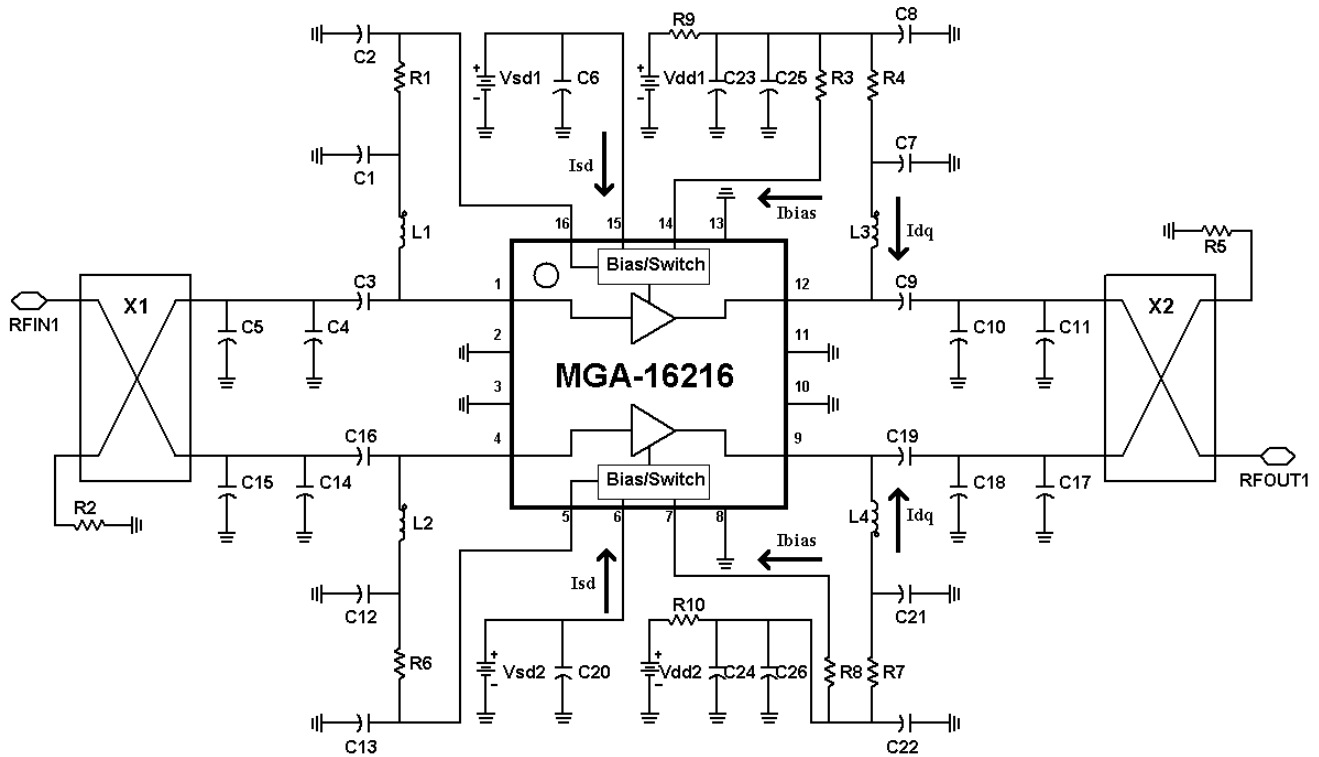


Figure 19. Balanced Amplifier Demo Board Schematic

Table 11. Component list for 1950 MHz Balanced Amplifier Matching

PART	Size	Value	Detail Part Number
C1, C12	0201	10 pF	GRM0335C1E100JD01D
C3, C9, C16, C19	0402	18 pF	GJM1555C1H180JB01D
C2, C8, C13, C22	0402	0.1 $\mu$ F	GRM155R71C104KA88D
C6, C20, C23, C24	0805	4.7 $\mu$ F	GRM21BR60J475KA11L
C7, C21	0201	15 pF	GJM0336C1E150JB01D
C4, C5, C10, C11, C14, C15, C17, C18, C25, C26	0402	NOT USED	
L1, L2	0603	10 nH	LQW18AN10NG00D
L3, L4	0603	4.7 nH	LQW18AN4N7D00D
R1, R4, R6, R7	0402	0 ohm	RK73B1ETTP0R0J
R3, R8	0402	1 kohm	RK73B1ELTP102J
R9, R10	0402	10 ohm	RK73B1ETTP100J
R2, R5	0402	51 ohm	RK73B1ETTP510J
X1	-	-	X3C19P1-03S
X2	-	-	C1720J5003AHF

### Typical 1950 MHz RF Performance Plots for Balanced Amplifier

RF performance at  $T_A = 25^\circ\text{C}$ ,  $V_{dd1} = V_{dd2} = 4.8\text{V}$ ,  $I_{dd1} = I_{dd2} = 50\text{mA}$ , LNA mode, measured on demo board in Figure 18. Signal is CW unless stated otherwise. Application Test Circuit is shown in Figure 19 and Table 11. IIP3 test condition:  $\text{FRF1-FRF2} = 1\text{MHz}$  with input power of  $-20\text{dBm}$  per tone.

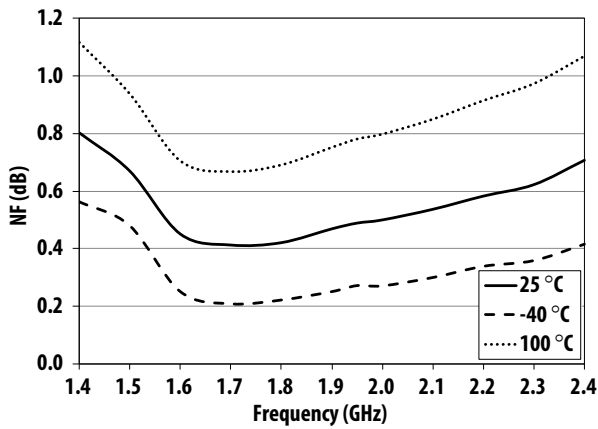


Figure 20. NF vs Frequency vs Temperature<sup>[1]</sup>

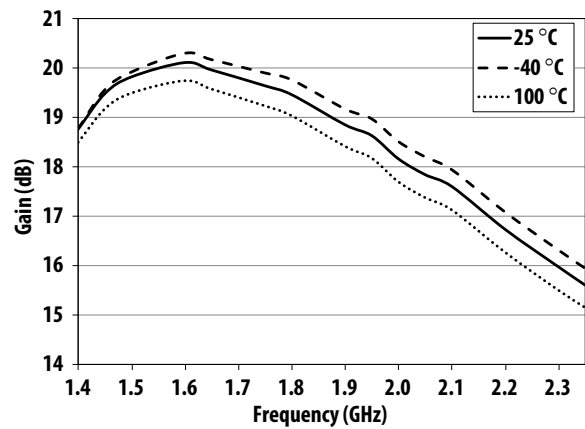


Figure 21. Gain vs Frequency vs Temperature

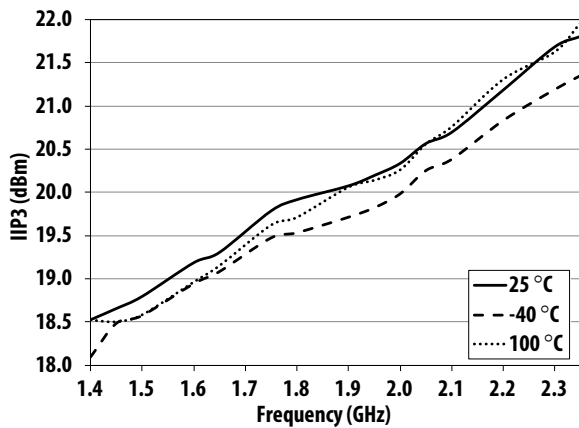


Figure 22. IIP3 vs Frequency vs Temperature

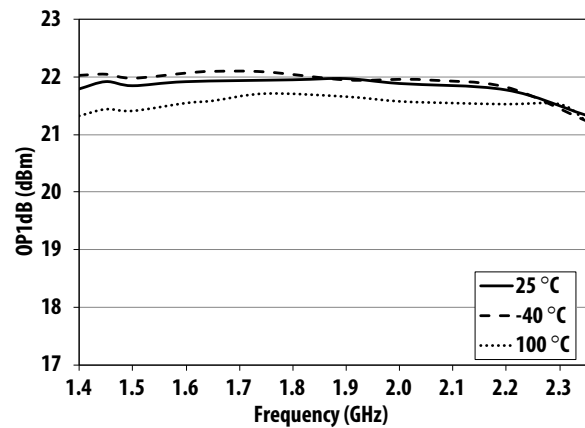


Figure 23. OP1dB vs Frequency vs Temperature

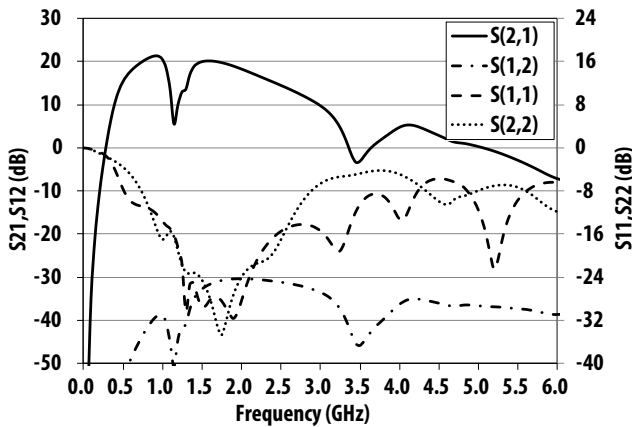


Figure 24. Input Return Loss, Output Return Loss, Gain, Reverse Isolation vs Frequency

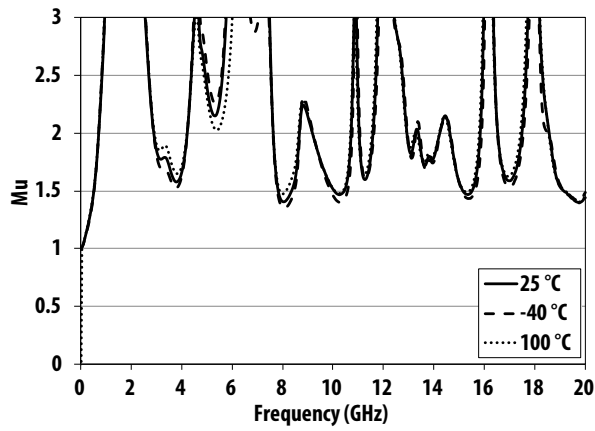


Figure 25. Mu stability factors vs Frequency vs Temperature

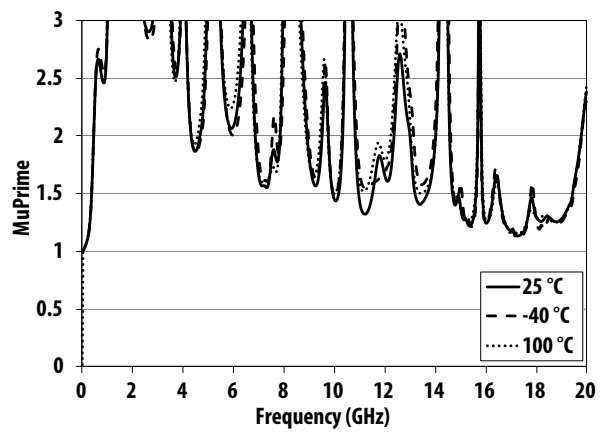


Figure 26. Mu' stability factors vs Frequency vs Temperature

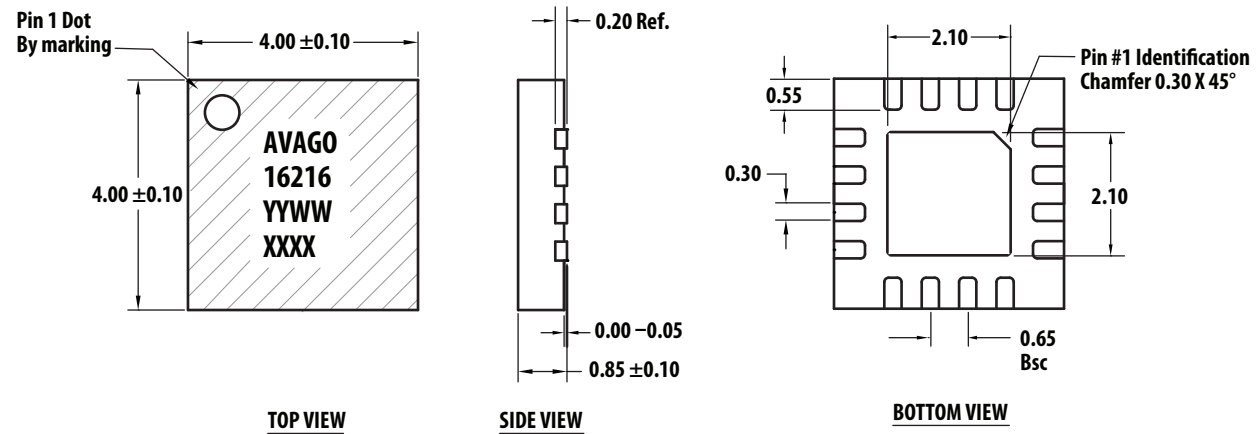
Note:

1. Circuit trace losses for NF have been de-embedded from measurements above.

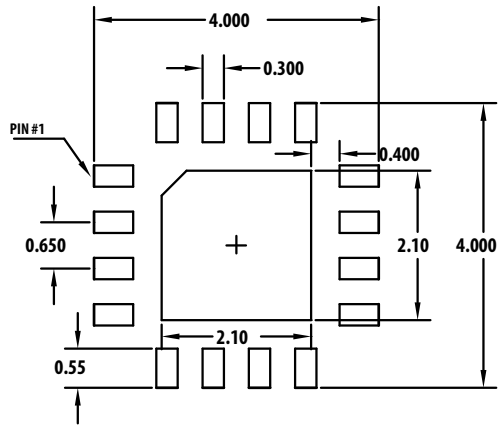
### Part Number Ordering Information

Part Number	No. of Devices	Container
MGA-16216-BLKG	100	Antistatic Bag
MGA-16216-TR1G	1000	7" Reel

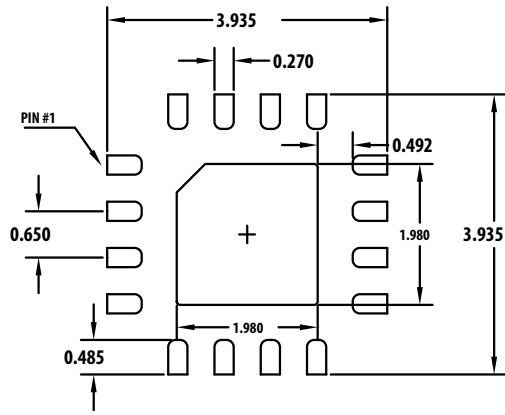
### Package Dimensions



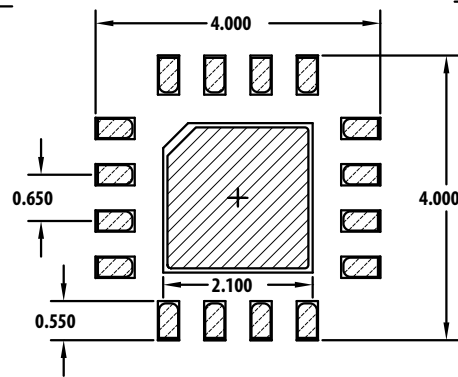
## Recommended PCB Land Pattern and Stencil Design



**Land Pattern**



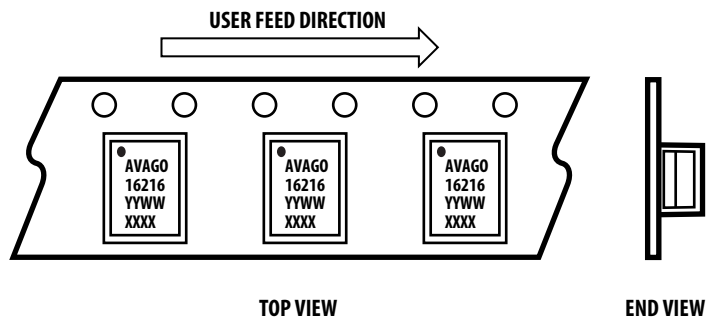
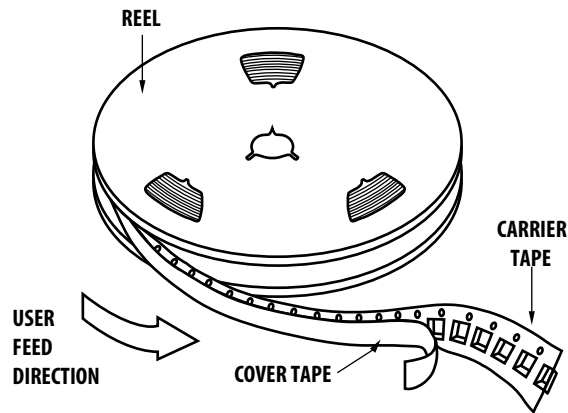
**Stencil Opening**



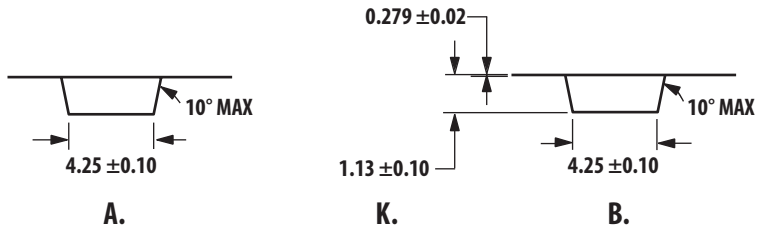
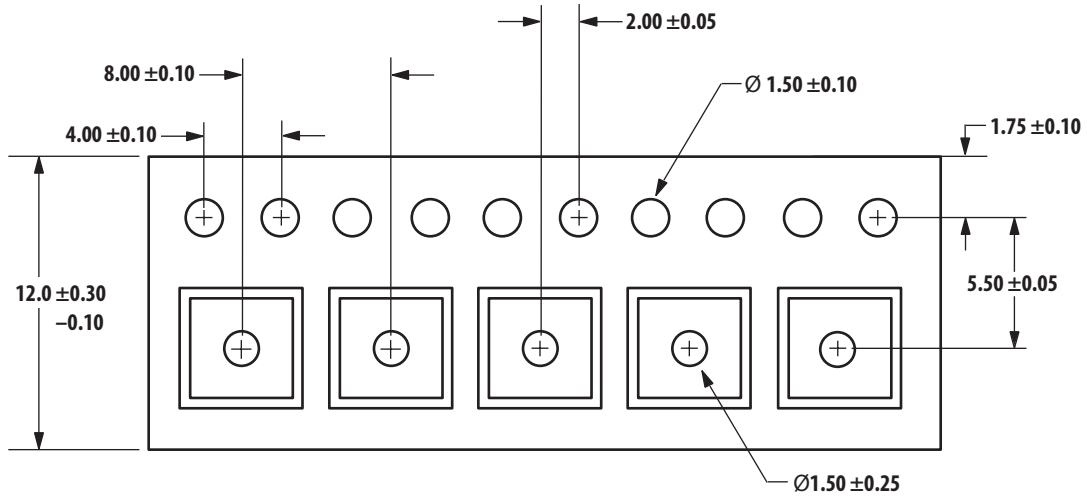
**Combination of Land Pattern & Stencil Opening**

Note:  
 1. ALL DIMENSIONS ARE IN MILLIMETERS  
 2. 4mil stencil thickness is recommended

## Device Orientation

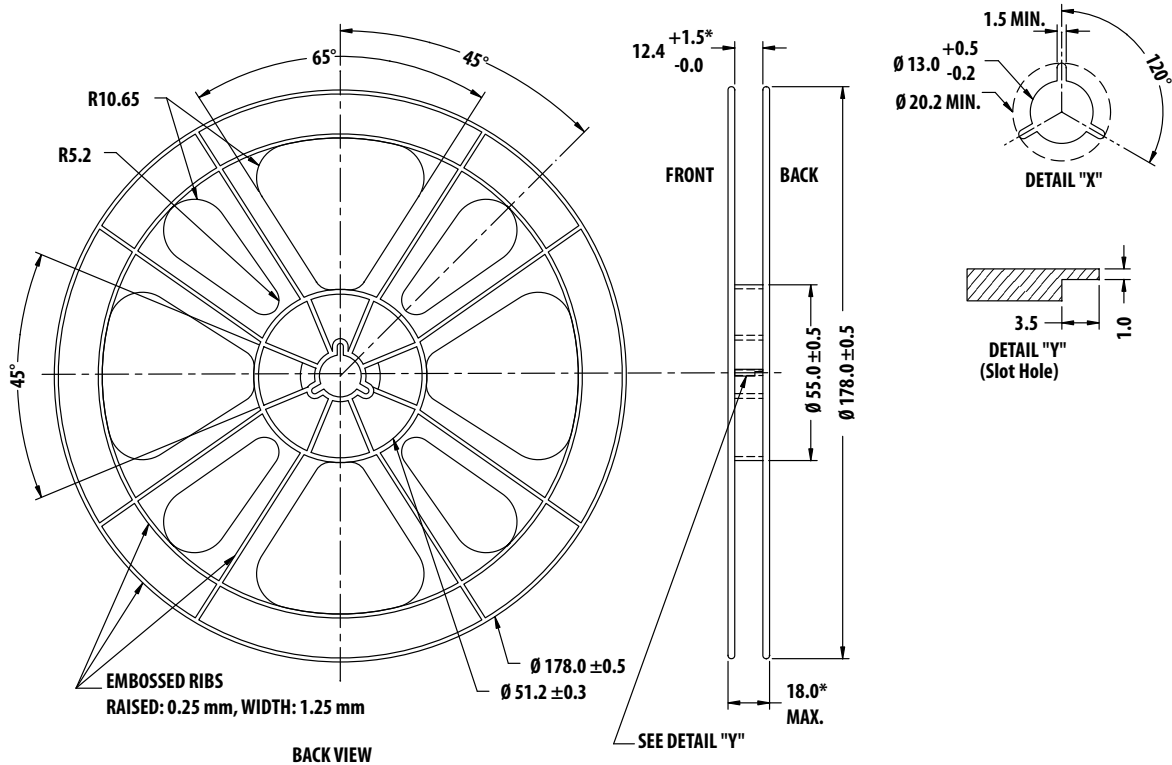
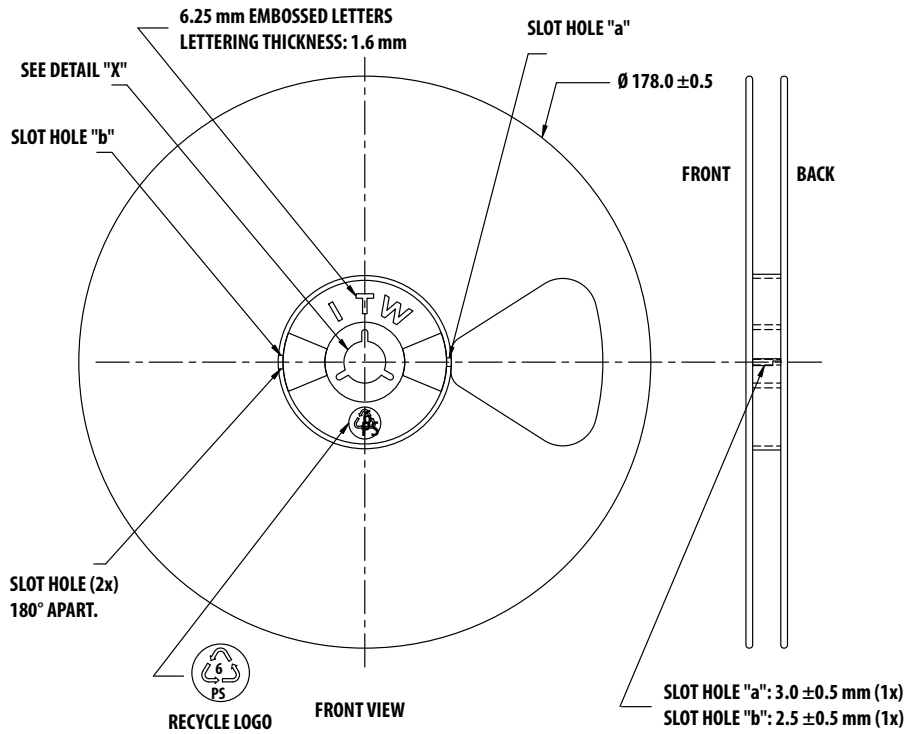


# Tape Dimensions





# Reel Dimensions – 7 inch



For product information and a complete list of distributors, please go to our web site: [www.avagotech.com](http://www.avagotech.com)

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