MGA-13316

High Gain, High Linearity Low Noise Amplifier

Data Sheet

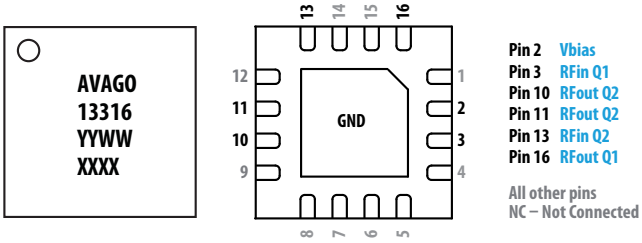
Description

Avago Technologies' MGA-13316 is a two stage, easy-to-use GaAs MMIC Low Noise Amplifier (LNA). The LNA has low noise with good input return loss and high linearity achieved through the use of Avago Technologies' proprietary 0.25 µm GaAs Enhancement-mode pHEMT process. Minimum matching needed for input, output and the inter-stage between the two LNA.

It is designed for optimum use between 2.2 GHz to 4 GHz. For optimum performance at lower frequency from 400 MHz to 1.5 GHz, MGA-13116 is recommended. For optimum performance at frequency from 1.5 GHz to 2.5 GHz, the MGA-13216 is recommended. All these 3 products, MGA-13116, MGA-13216 and MGA-13316 share the same package and pinout configuration.

Pin Configuration and Package Marking

4.0 x 4.0 x 0.85 mm³ 16-lead QFN



Top View Bottom View

Note:
Package marking provides orientation and identification
"13316" = Product Code
"YYWW" = Year and Work Week of Manufacture
"XXXX" = Lot Number



Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model = 90 V
ESD Human Body Model = 600 V
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Features

- Low noise figure
- High gain
- High linearity performance
- Excellent isolation
- GaAs E-pHEMT Technology [1]
- Low cost small package size: 4.0 x 4.0 x 0.85 mm³
- Excellent uniformity in product specifications
- Meets MSL1, Lead-free and halogen free

Specifications

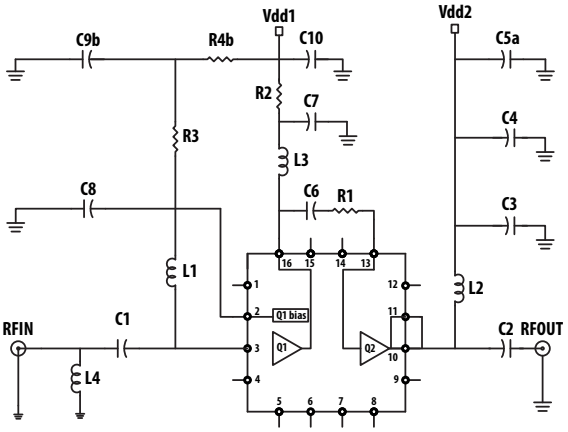
2.5 GHz; Q1: 5 V, 53 mA (typ) Q2: 5 V, 116 mA (typ)

- 0.76 dB Noise Figure
- 34.3 dB Gain
- 50.3 dB RFout Q1 to RFin Q2 Isolation
- 41.8 dBm Output IP3
- 23.5 dBm Output Power at 1dB gain compression

Applications

- Low noise amplifier for cellular infrastructure including GSM, CDMA, TD-LTE, and W-CDMA.
- Other very low noise applications.

Simplified Schematic



Notes: Enhancement mode technology employs positive gate bias, thereby eliminating the need of negative gate voltage associated with conventional depletion mode devices.

MGA-13316 Absolute Maximum Rating [1] $T_A = 25°$ C

Symbol	Parameter	Units	Absolute Maximum
Vdd1	Device Voltage	V	5.5
Vdd2	Device Voltage	V	5.5
Idd1	Q1 Drain Current	mA	90
P_d	Power Dissipation [2]	W	1.19
$P_{in,max}$	CW RF Input Power	dBm	20
$T_{j,max}$	Junction Temperature	°C	150
T_{stg}	Storage Temperature	°C	-65 to 150

Thermal Resistance

Thermal Resistance [3]
($V_{dd1} = 5.0$ V, $I_{dd1} = 53$ mA, $V_{dd2} = 5.0$ V, $I_{dd2} = 116$ mA), $\theta_{jc} = 39.59°$ C/W

Notes:
1. Operation of this device in excess of any of these limits may cause permanent damage.
2. This is limited by maximum Vd and Id. Board temperature (T_c) is 25°C. For T_c >103°C, derate the device power at 25 mW per °C rise in board temperature adjacent to package bottom.
3. Thermal resistance measured using Infra-Red Microscopy Technique.

Electrical Specifications [1]

RF performance at Vdd1 = 5 V, Vdd2 = 5 V, 2.5 GHz, T_A = 25° C, measured on the demo board.

Symbol	Parameter and Test Condition	Units	Min.	Typ.	Max.
Idd1	Current at Q1	mA	40	53	68
Idd2	Current at Q2	mA	96	116	138
NF	Noise Figure	dB	–	0.76	1.1
Gain	Gain	dB	33	34.3	36.3
OIP3[2]	Output Third Order Intercept Point	dBm	37	41.8	–
OP1dB	Output Power at 1 dB Gain Compression	dBm	22.1	23.5	–
IRL	Input Return Loss, 50 Ω source	dB	–	-19.5	–
ORL	Output Return Loss, 50 Ω load	dB	–	-10.5	–
|S12|	Reverse Isolation	dB	–	50	–
$\|ISOL_{1-2}\|$	Isolation between Output pin to Input pin	dB	–	50.3	–

Notes:
1. Measurements obtained using demo board described in Figure 7 with component list in Table 1. Input and Output trace loss is not de-embedded from the measurement.
2. OIP3 test condition: f_{tone1} = 2500 MHz, f_{tone2} = 2501 MHz with input power of -27 dBm per tone.
3. Use proper bias, heatsink and derating to ensure maximum channel temperature is not exceeded. See absolute maximum ratings and application note for more details.

Product consistency Distribution Charts [1,2]

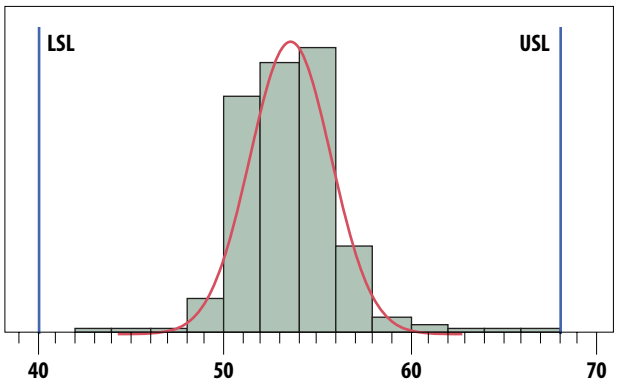


Figure 1. Idd1 @ 2.5 GHz, Vdd1 = 5 V, LSL = 40 mA, Nominal = 53 mA, USL = 68 mA

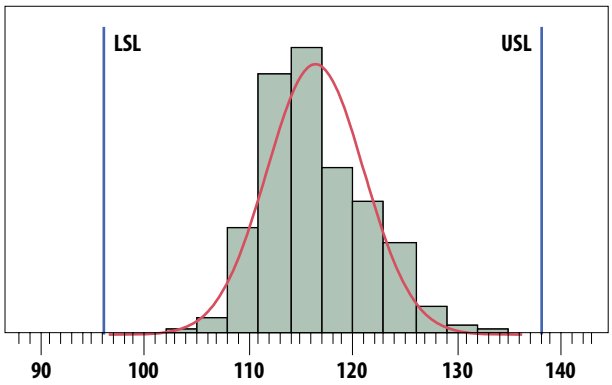


Figure 2. Idd2 @ 2.5 GHz, Vdd2 = 5 V, LSL = 96 mA, Nominal = 116 mA, USL = 138 mA

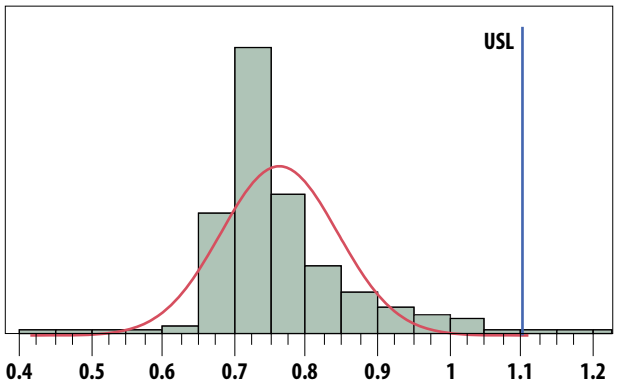


Figure 3. Noise Figure @ 2.5 GHz, Vdd1 = 5 V, Vdd2 = 5 V, Nominal = 0.76 dB, USL = 1.1 dB

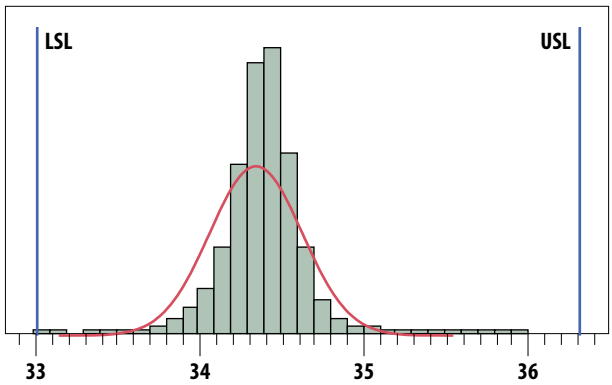


Figure 4. Gain @ 2.5 GHz, Vdd1 = 5 V, Vdd2 = 5 V, LSL = 33 dB, Nominal = 34.3 dB, USL = 36.3 dB

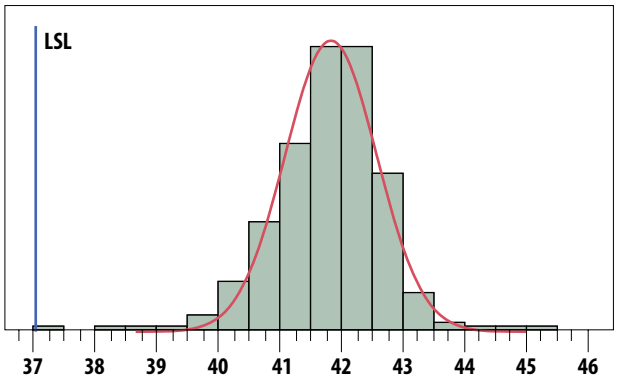


Figure 5. OIP3 @ 2.5 GHz, Vdd1 = 5 V, Vdd2 = 5 V, LSL = 37 dBm, Nominal = 41.8 dBm

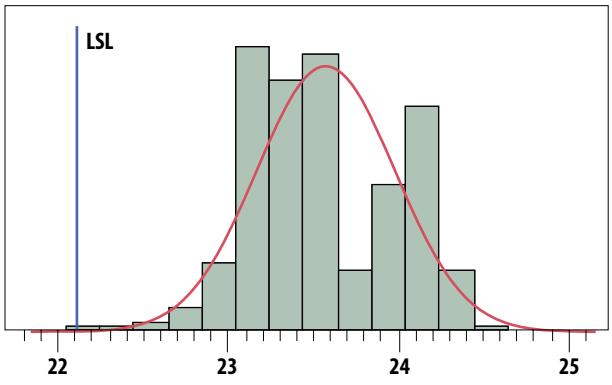


Figure 6. OP1dB @ 2.5 GHz, Vdd1 = 5 V, Vdd2 = 5 V, LSL = 22.1 dBm, Nominal = 23.5 dBm

Notes:
1. Data sample size is 11 Kpcs samples taken from 3 different wafers. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits.
2. Measurements are made on production test board which represents a trade-off between optimal Gain, NF, OIP3 and OP1dB. Circuit losses have been de-embedded from actual measurements.

Demo Board Layout

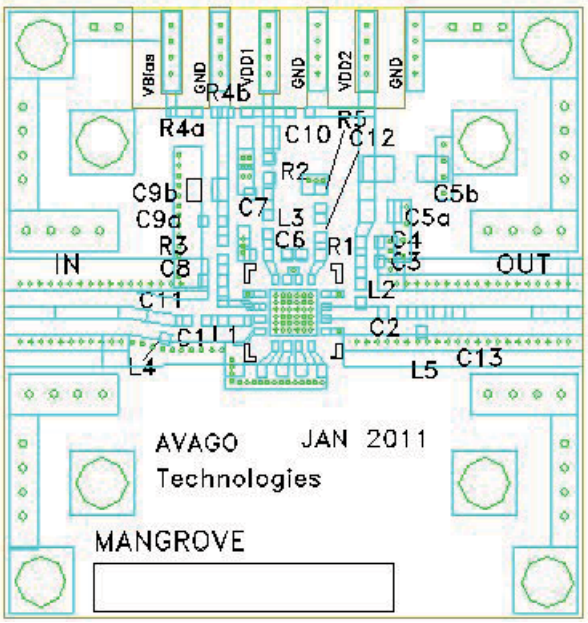


Figure 7. Demo Board layout diagram.

Demo Board Schematic

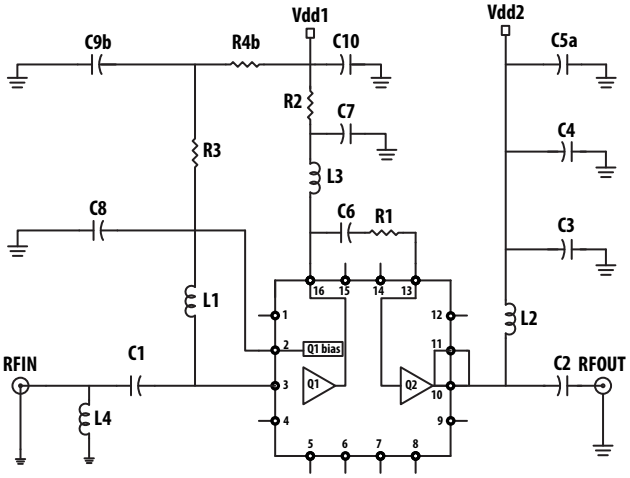


Figure 8. Demo Board schematic diagram.

- Recommended PCB material is 10 mils Rogers R04350.
- Suggested component values may vary according to layout and PCB material.

Table 1. Component list for 2.5 GHz matching

Part	Size	Value	Detail Part Number	Notes
C1	402	1.8 pF (Murata)	GRM1555C1H1R8CZ01D	DC Blocking Capacitor
C2	402	100 pF (Murata)	GRM1555C1H101JD01E	DC Blocking Capacitor
C3	402	2.7 pF (Murata)	MCH155A2R7JK	Bypass Capacitor
C4	402	0.1 uF (Murata)	GRM155R61A104KA01D	Bypass Capacitor
C5a	603	2.2 uF (Murata)	GRM188R61A225KE34D	Bypass Capacitor
C5b	N/A	N/A	N/A	Not Used
C6	402	1000 pF (Murata)	GRM155R71H102KA01E	DC Blocking Capacitor
C7	402	10 pF (Murata)	GRM1555C1H100JZ01E	Bypass Capacitors
C8	402	10 pF (Murata)	GRM1555C1H100JZ01E	Bypass Capacitors
C9a	N/A	N/A	N/A	Not Used
C9b	402	4.7 µF (Murata)	GRM155R60E475ME760	Bypass Capacitors
C10	402	4.7 µF (Murata)	GRM155R60E475ME760	Bypass Capacitors
C11	N/A	N/A	N/A	Not Used
C12	N/A	N/A	N/A	Not Used
C13	N/A	N/A	N/A	Not Used
L1	402	6.8 nH (Coilcraft)	0402CS-6N8XJBW	Input match for NF
L2	402	3.3 nH (Toko)	LL1005-FHL3N3S	Output match for Q2
L3	402	6.8 nH (Toko)	LL1005-FHL6N8J	Output match for Q1
L4	402	3.6 nH (Coilcraft)	0402CS-3N6XJBW	Input match for Q1
L5	N/A	N/A	N/A	Not Used
R1, R2	402	0 ohm (Koa)	RK73Z1ELTP	Bridging Resistors
R3	402	49.9 ohm (Koa)	RK73H1ELTP49R9F	Stabilizing Resistor for Q1
R4a	N/A	N/A	N/A	Not Used
R4b	402	3.6 Kohm (Rohm)	MCR01J362	Biasing Resistor for Q1
R5	N/A	N/A	N/A	Not Used

MGA-13316 Typical Performance in Demoboard for 2.5 GHz

T_A = 25° C, V_{dd1} = 5.0 V, V_{dd2} = 5.0 V, I_{dd1} = 53 mA, I_{dd2} = 116 mA

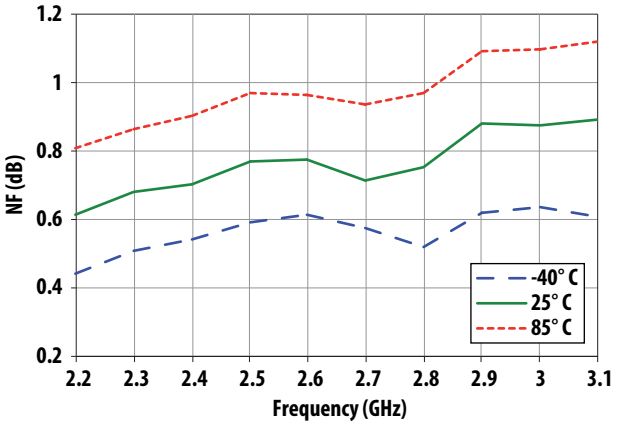


Figure 9. NF vs Frequency and Temperature

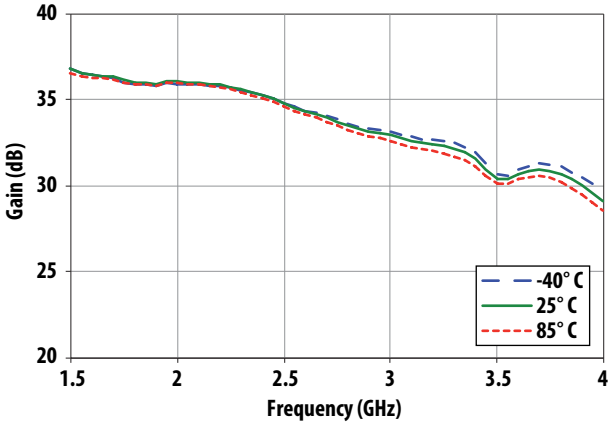


Figure 10. Gain vs Frequency and Temperature

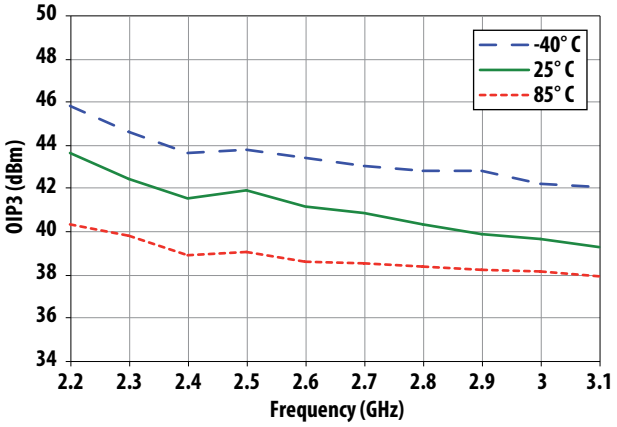


Figure 11. OIP3 vs Frequency and Temperature

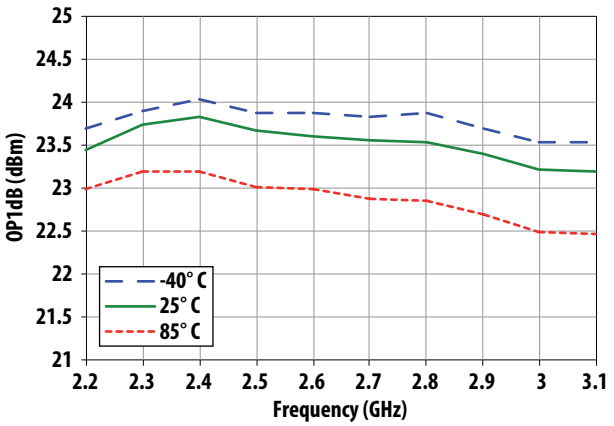


Figure 12. OP1dB vs Frequency and Temperature

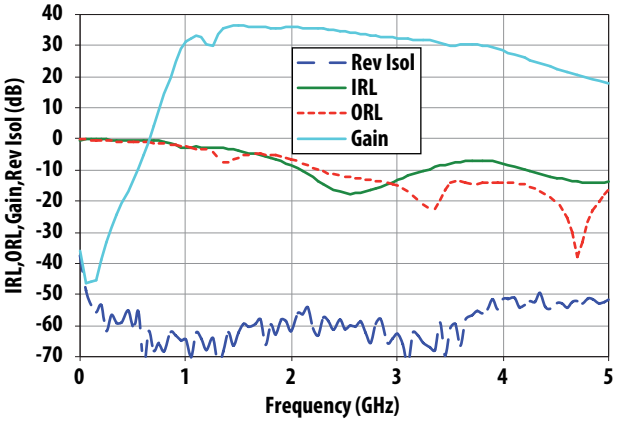


Figure 13. Input Return Loss, Output Return Loss, Gain, & Reverse Isolation vs Frequency

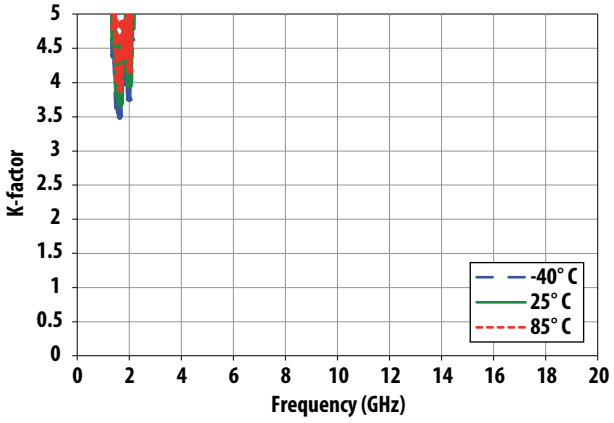


Figure 14. K-factor vs Frequency and Temperature

MGA-13316 Typical Performance in Demoboard for 2.5GHz

T_A = 25° C, V_{dd1} = 5.0 V, V_{dd2} = 5.0 V, I_{dd1} = 53 mA, I_{dd2} = 116 mA

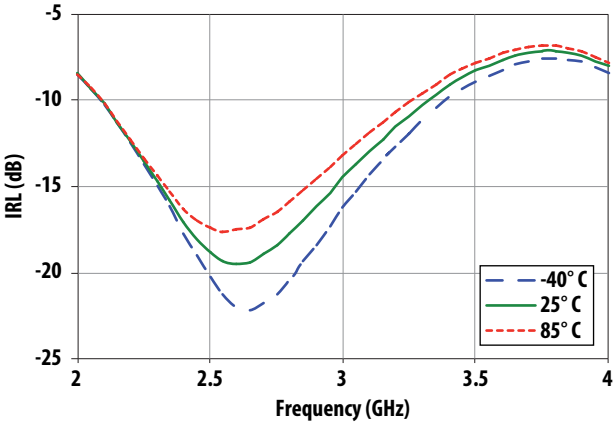


Figure 15. IRL vs Frequency and Temperature

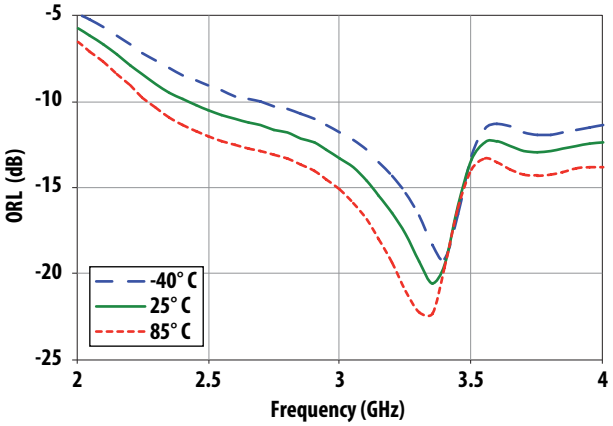


Figure 16. ORL vs Frequency and Temperature

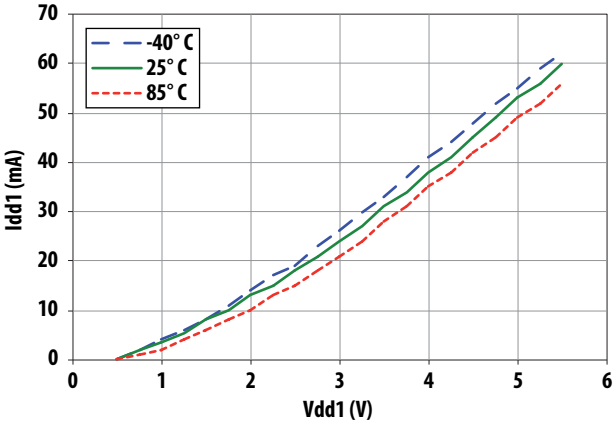


Figure 17. Idd1 vs Vdd1 and Temperature

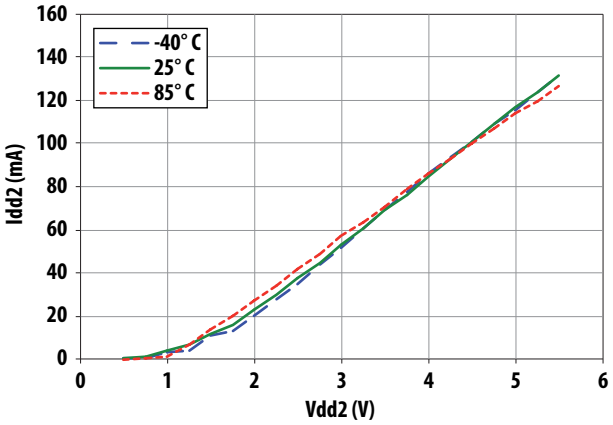


Figure 18. Idd2 vs Vdd2 and Temperature

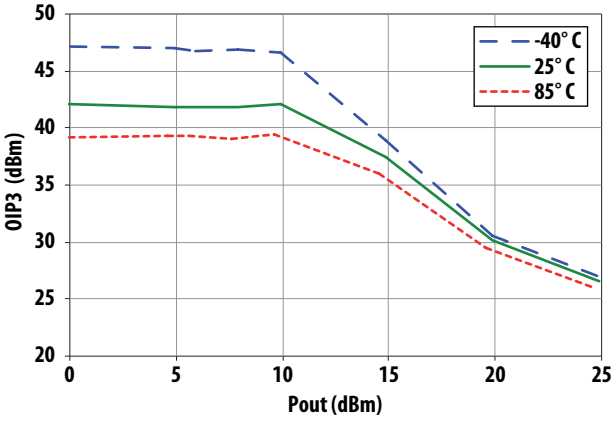


Figure 19. OIP3 vs Output Power and Temperature at 2.5 GHz

MGA-13316 Q1 Typical Scattering Parameters, Vdd1 = 5 V, Idd1 = 50 mA

Freq	S11		S21		S12		S22	
GHz	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
0.1	0.9476	-12.2632	34.5057	160.7532	0.0047	11.7831	0.5890	-19.3593
0.5	0.7044	-47.1391	21.9467	122.3275	0.0042	57.5859	0.3650	-23.2918
0.9	0.5242	-68.5640	15.4283	98.9990	0.0082	67.2825	0.3377	-27.1103
1.0	0.4951	-72.7375	14.2599	94.3046	0.0090	71.7130	0.3295	-28.6361
1.5	0.3999	-90.7648	10.3743	74.9007	0.0135	73.4180	0.2990	-38.7699
1.7	0.3773	-97.0091	9.3573	68.1636	0.0156	74.2662	0.2845	-44.4387
1.9	0.3628	-102.5217	8.5296	61.7988	0.0171	73.3113	0.2709	-51.0121
2.0	0.3568	-105.3332	8.1756	58.6806	0.0185	74.7631	0.2648	-54.4426
2.5	0.3462	-117.1978	6.7358	43.8914	0.0241	73.9083	0.2413	-74.2707
3.0	0.3480	-125.6487	5.7740	29.9534	0.0300	72.3617	0.2386	-96.7672
4.0	0.3658	-137.1290	4.5433	3.0393	0.0458	66.7425	0.2715	-139.7999
5.0	0.4085	-153.2931	3.7927	-25.8685	0.0650	56.1926	0.3428	176.4105
6.0	0.4702	-176.1741	3.1671	-57.5236	0.0866	40.6304	0.4772	127.2305
7.0	0.5235	160.4259	2.4253	-89.2923	0.1022	22.5904	0.6697	93.7068
8.0	0.5567	142.9302	1.7724	-117.9984	0.1099	6.0176	0.7884	71.4942
9.0	0.5652	128.2157	1.3338	-143.5986	0.1175	-9.2834	0.8651	53.9815
10.0	0.5764	112.2267	1.0609	-169.8542	0.1303	-26.3840	0.9135	33.9307
11.0	0.6110	94.0142	0.8212	162.0386	0.1380	-46.0835	0.9153	9.5407
12.0	0.6359	74.4400	0.5789	137.9581	0.1302	-62.5887	0.9319	-4.7026
13.0	0.6909	61.5493	0.4055	119.0601	0.1192	-74.3752	1.0008	-6.4422
14.0	0.7561	55.5470	0.2934	102.1102	0.1122	-85.6306	0.9811	-8.8053
15.0	0.7687	49.0968	0.2247	82.2629	0.1099	-100.4473	0.9427	-20.3955
16.0	0.7709	25.7908	0.1633	55.9850	0.0967	-125.5991	0.9539	-37.7405
17.0	0.7710	-16.0165	0.0954	39.5175	0.0439	-147.7475	0.9593	-46.7449
18.0	0.1200	-24.7870	0.1282	27.9369	0.1451	-96.9288	0.9194	-57.6137
19.0	0.6142	21.6007	0.0644	10.0400	0.1137	-170.9741	0.9265	-68.6984
20.0	0.6121	-12.3158	0.0749	-32.7215	0.0722	-140.1984	0.8915	-78.5449

MGA-13316 Q1 Typical Noise Parameters, Vdd1= 5 V, Idd1 = 50 mA

Freq	NFMin	GammaOpt	PhiOpt	
GHz	dB	mag	deg	Rn/50
1.50	0.46	0.29	43.20	0.06
1.70	0.45	0.30	63.30	0.06
1.90	0.58	0.27	66.60	0.06
2.00	0.54	0.26	84.50	0.06
2.20	0.53	0.21	88.20	0.05
2.50	0.60	0.17	112.90	0.05
2.70	0.67	0.17	160.50	0.04
2.90	0.68	0.17	157.80	0.05
3.30	0.68	0.24	-172.20	0.05
3.50	0.72	0.29	170.90	0.05
4.00	0.78	0.40	179.40	0.03

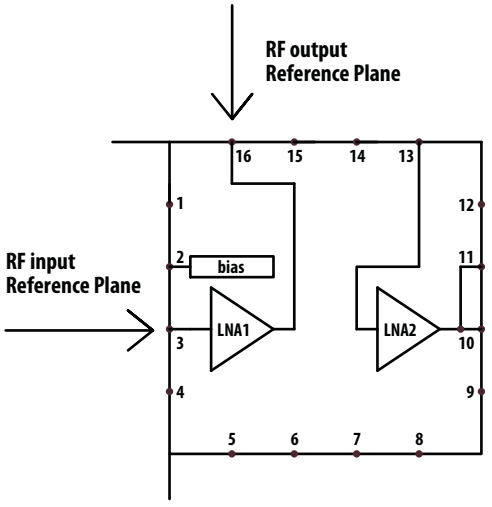


Figure 20.

Notes: Measurements are made on 10 mils Rogers R04350 TRL Board. Figure 20 shows the input and output reference plane for Q1.

MGA-13316 Q2 Typical Scattering Parameters, Vdd2 = 5 V, Idd2 = 116 mA

Freq	S11		S21		S12		S22	
GHz	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
0.1	0.8724	172.0353	0.1413	-112.7154	0.0036	65.3831	0.8292	174.6930
0.5	0.8474	140.1052	1.5607	-80.8803	0.0085	97.0757	0.7645	149.3051
0.9	0.6825	97.0606	5.6920	-123.6645	0.0248	87.8937	0.5485	118.0392
1.0	0.5865	84.1827	7.0773	-139.4571	0.0314	80.4474	0.4499	109.9115
1.5	0.1423	121.2420	9.6368	140.8404	0.0481	30.1766	0.2033	151.0622
1.7	0.2352	127.2011	9.0963	118.4115	0.0478	15.1099	0.2422	152.5525
1.9	0.2848	115.3972	8.5861	99.9577	0.0472	3.1298	0.2483	147.5974
2.0	0.2958	108.3752	8.3840	91.7925	0.0461	-2.5589	0.2433	145.1175
2.5	0.2456	63.8963	7.8317	54.1684	0.0418	-32.2292	0.1619	141.3232
3.0	0.1638	-29.4140	7.7532	16.1359	0.0323	-73.1124	0.1204	-176.1177
4.0	0.6964	177.8403	6.1643	-73.8377	0.0279	140.3060	0.2679	173.3761
5.0	0.9402	119.6485	2.6318	-158.0828	0.0383	76.6959	0.2333	-125.8671
6.0	0.9483	86.9076	0.8464	145.2466	0.0472	52.2933	0.4868	-153.4601
7.0	0.9468	63.6793	0.3393	111.7191	0.0506	33.7091	0.4904	-173.3753
8.0	0.9714	46.0950	0.1877	77.8816	0.0547	20.9620	0.5367	176.2551
9.0	0.9301	27.7972	0.1149	41.1122	0.0547	4.2118	0.6319	162.5823
10.0	0.8606	17.9019	0.0705	16.9907	0.0470	-5.3221	0.7125	149.2561
11.0	0.9721	14.0126	0.0539	1.3504	0.0437	-13.1746	0.7438	137.7980
12.0	0.9895	1.8829	0.0390	-18.8103	0.0355	-30.2990	0.7126	120.6736
13.0	0.9504	-6.3036	0.0253	-32.1307	0.0244	-43.2860	0.7159	94.6400
14.0	0.9976	-15.2859	0.0102	-36.7154	0.0105	-59.8362	0.7653	74.7833
15.0	1.0065	-24.3699	0.0098	103.9489	0.0089	122.0001	0.7641	64.9085
16.0	0.9938	-32.7298	0.0351	103.0363	0.0351	107.6657	0.7375	50.6656
17.0	0.9802	-44.7104	0.0714	86.2511	0.0713	88.0832	0.7318	25.3774
18.0	0.9647	-57.3892	0.1406	55.3523	0.1406	55.7281	0.7347	-9.4297
19.0	0.9158	-61.5557	0.1291	-26.7187	0.1285	-26.7652	0.2011	-33.2109
20.0	0.9422	-62.6624	0.1319	50.0625	0.1307	49.6143	0.5420	4.8232

MGA-13316 Q2 Typical Noise Parameters, Vdd2 = 5 V, Idd2 = 116 mA

Freq	NFMin	GammaOpt	PhiOpt	
GHz	dB	mag	deg	Rn/50
1.50	2.17	0.31	-87.10	0.30
1.70	2.11	0.21	-89.90	0.27
1.90	2.09	0.21	-95.10	0.25
2.00	2.00	0.19	-94.70	0.24
2.20	1.93	0.16	-105.80	0.23
2.50	2.06	0.14	-112.40	0.22
2.70	2.08	0.16	-129.40	0.21
2.90	2.08	0.15	-148.20	0.20
3.50	2.15	0.34	178.80	0.13
4.00	2.42	0.57	-163.60	0.09

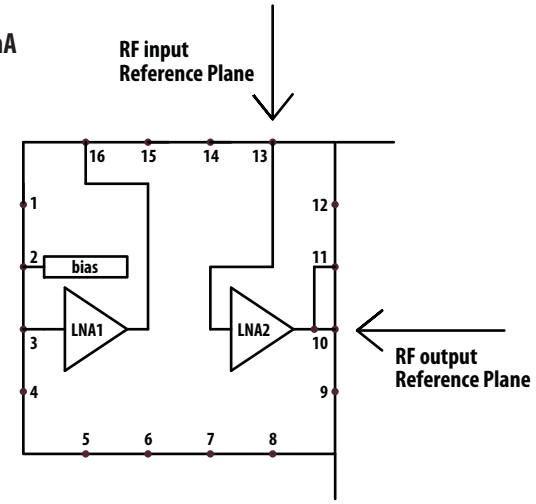
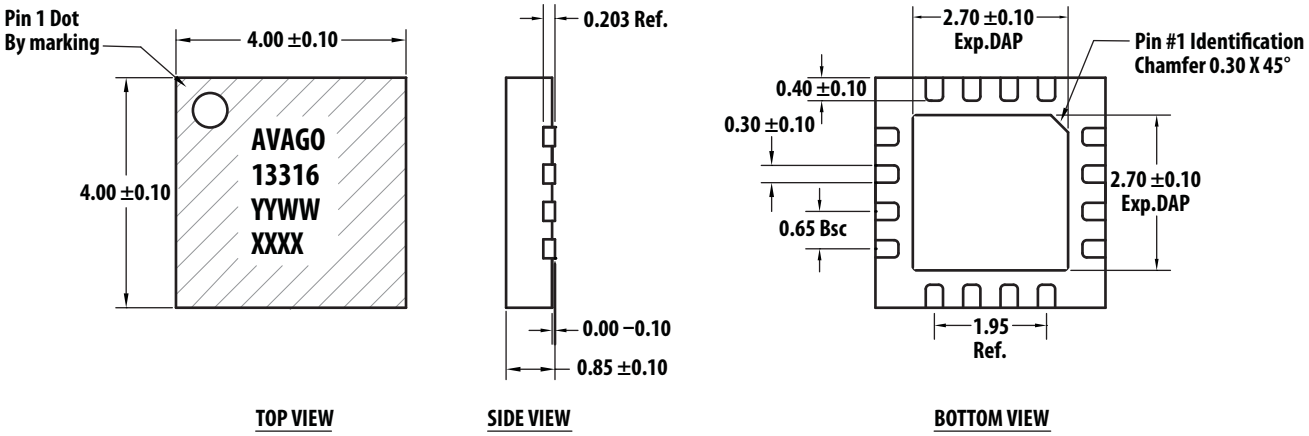


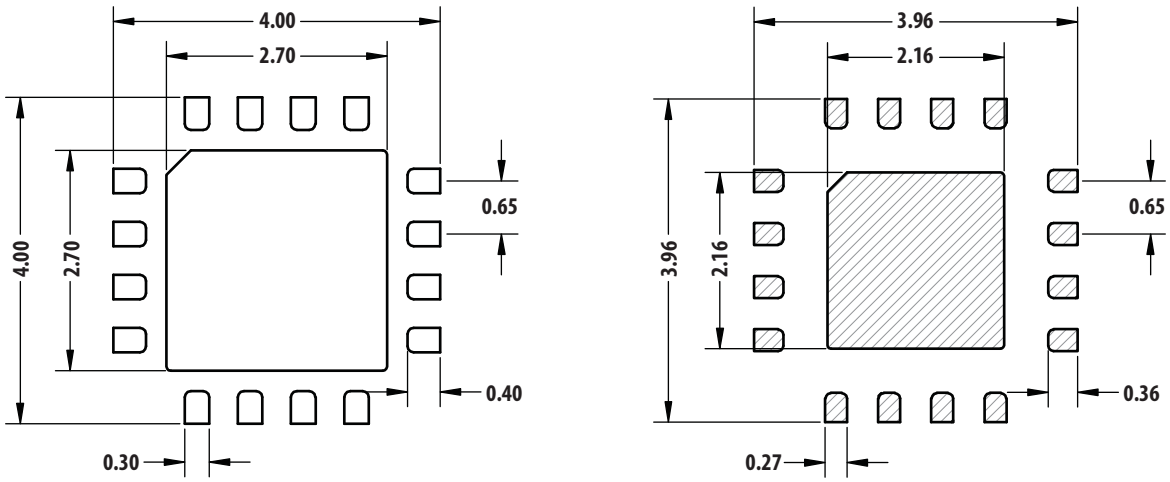
Figure 21.

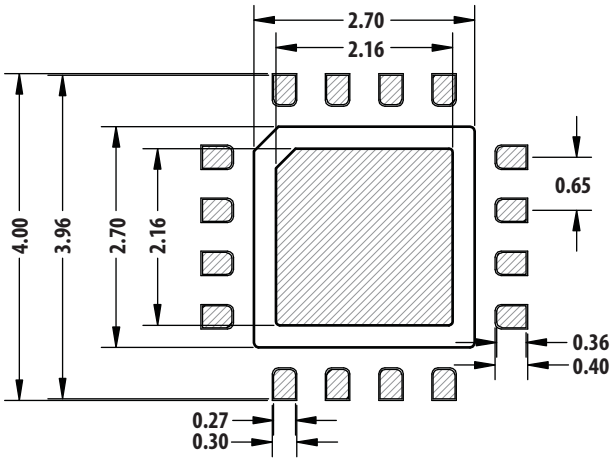
Notes: Measurements are made on 10 mils Rogers R04350 TRL Board. Figure 21 shows the input and output reference plane for Q2.

Package Dimensions



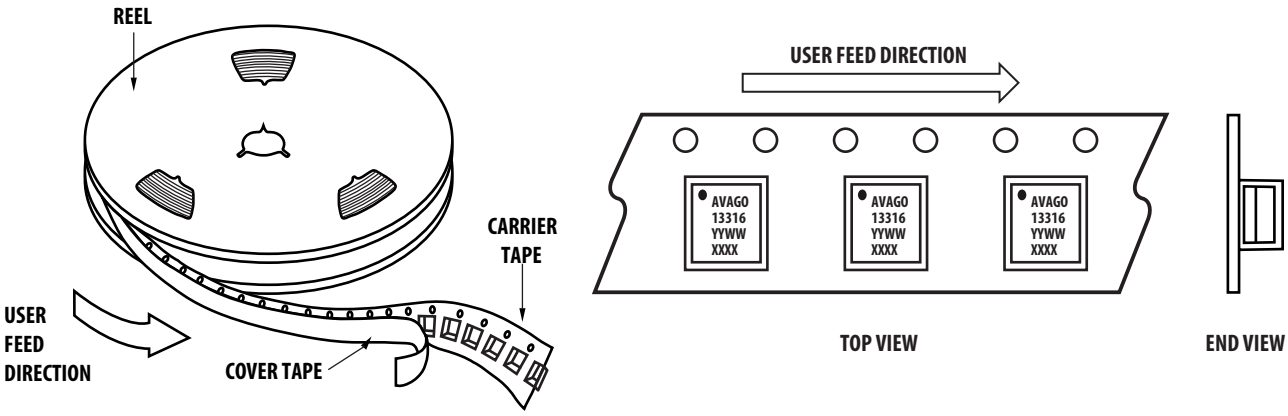
PCB Land Patterns and Stencil Design



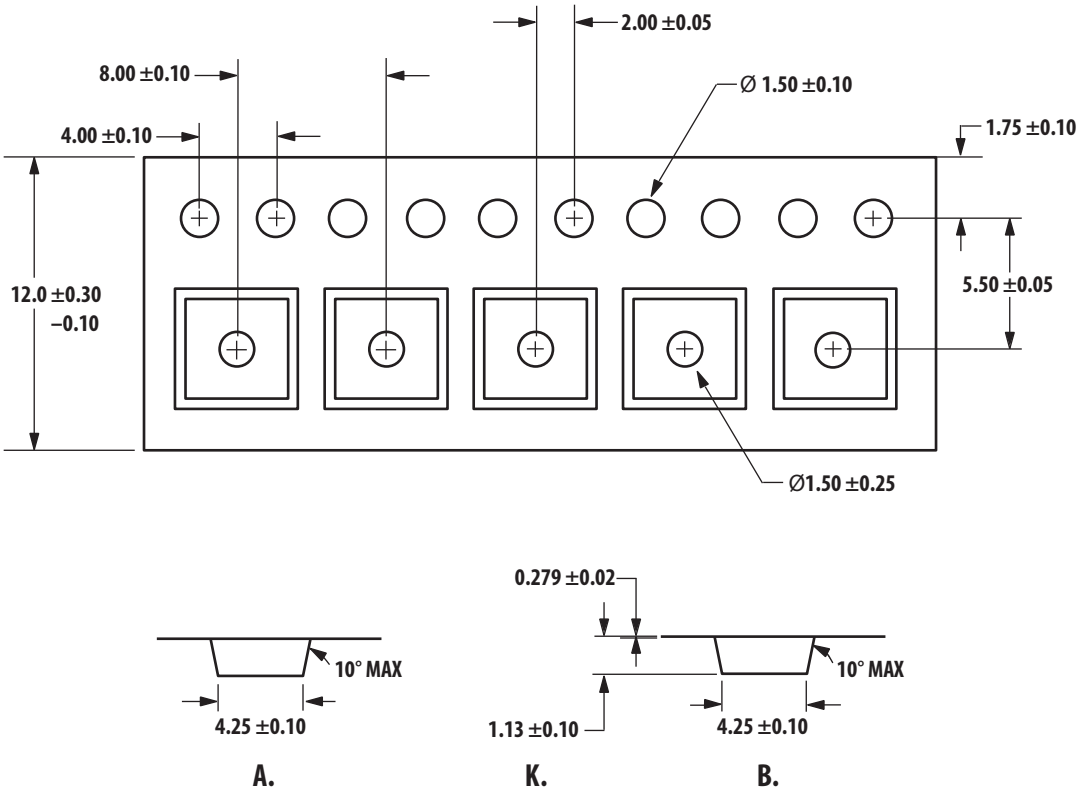


Notes:
1. All dimensions are in milimeters.
2. 4 mil stencil thickness recommended.

Device Orientation



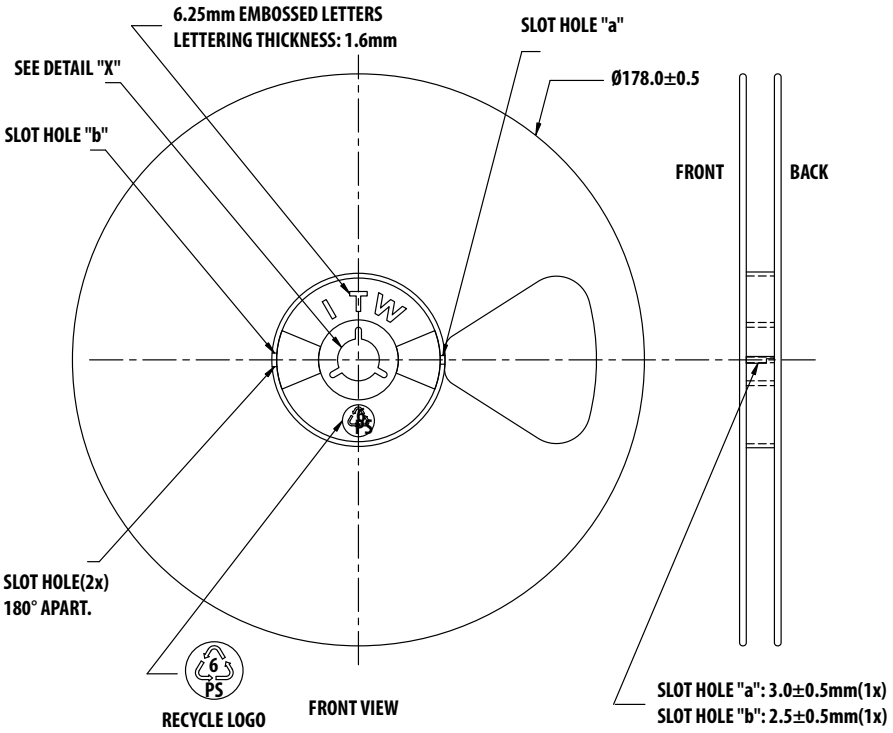
Tape Dimensions

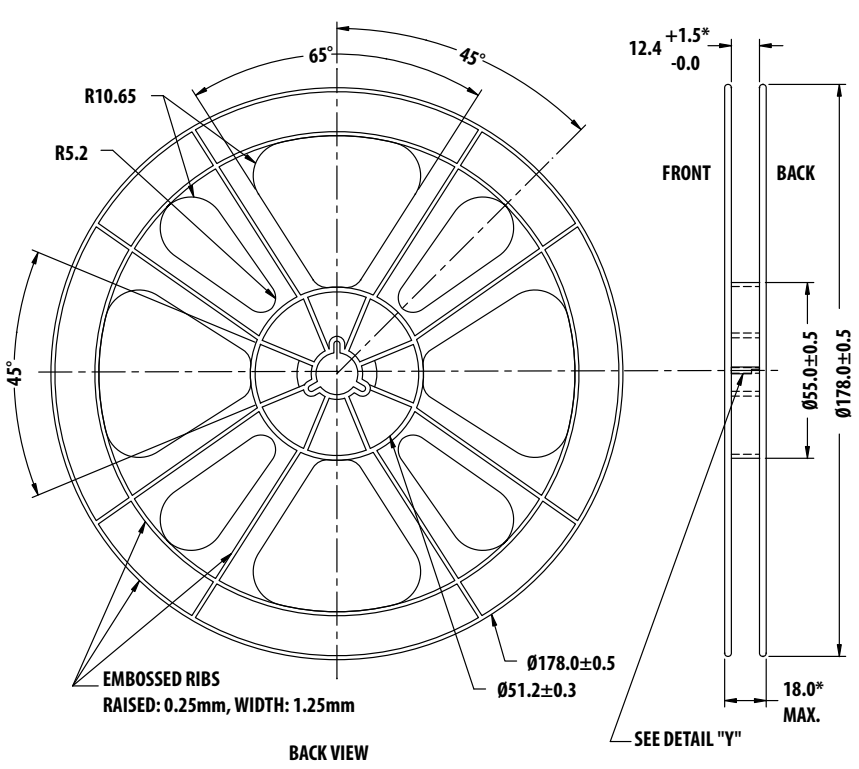


Part Number Ordering Information

Part Number	No. of Devices	Container
MGA-13316-TR1G	1000	7″ Reel
MGA-13316-BLKG	100	antistatic bag

Reel Dimensions (7 inch reel)





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AV02-3239EN - December 23, 2011