MGA-12516
High Gain, Matched-Pair Dual,
Very Low Noise Amplifier

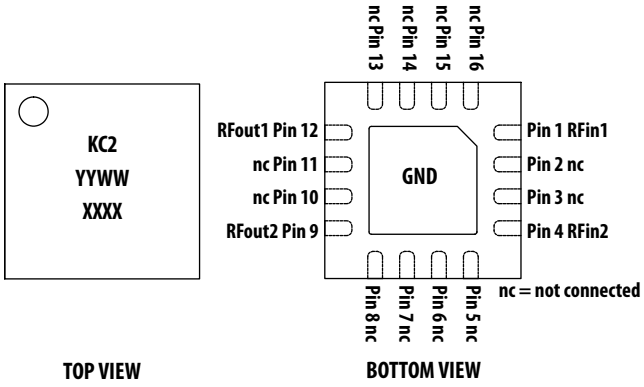
Data Sheet

Description

Avago Technologies' MGA-12516 is an economical, easy-to-use GaAs MMIC matched-pair dual Low Noise Amplifier (LNA). The LNA has very low noise, high gain and excellent isolation achieved through the use of Avago Technologies' proprietary 0.25um GaAs Enhancement-mode pHEMT process. It is housed in a miniature 4.0 x 4.0 x 0.85mm 16-pin Small Leadless Package (SLP) package. The compact footprint and low profile coupled with ultra-low noise and high gain make the MGA-12516 an ideal choice as a low noise amplifier for cellular infrastructure for GSM, CDMA ,TD-SCDMA and WiMAX applications.

Pin Configuration and Package Marking

4.0 x 4.0 x 0.85 mm^3 16-lead SLP



Notes:
Package marking provides orientation and identification
"KC2" = Product Code
"YYWW" = Work Week and Year of manufacture
"XXXX" = Last 4 digit of Lot number

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model = 70 V
ESD Human Body Model = 200 V
Refer to Avago Application Note A004R:
Electrostatic Discharge, Damage and Control.

Features

- Dual, matched-pair LNAs
- Optimum frequency of operation 800MHz-3GHz
- Very low noise figure
- High gain
- Excellent isolation
- GaAs E-pHEMT Technology[1]
- Low cost small package size: 4.0x4.0x0.85 mm^3
- Excellent uniformity in product specifications

Specifications

1.95GHz; 4V, 50mA per channel (typ)

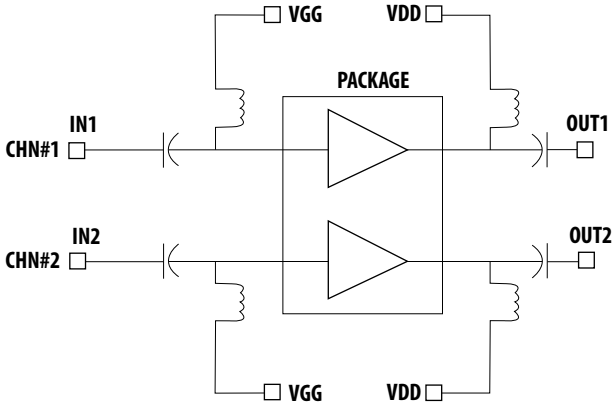
- 0.58 dB Noise Figure
- 24 dB Gain
- 38.6 dB Isolation
- 33.3 dBm Output IP3
- 18.4 dBm Output Power at 1dB gain compression

Applications

- Balanced dual low noise amplifier for cellular infrastructure for GSM, CDMA, TD-SCDMA and WiMAX used with 3-dB hybrid couplers at inputs and outputs

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

Simplified Schematic



MGA-12516 Absolute Maximum Rating [1]

Symbol	Parameter	Units	Absolute Max.
VDD	Device Voltage, RF output to ground	V	6
VGG	Gate Voltage	V	0.8
$P_{in,max}$ (ON)	CW RF Input Power (at V_{DD}=4V, V_{GG}=0.58V).	dBm	18
$P_{in,max}$ (OFF)	CW RF Input Power(at V_{DD}=4V, V_{GG}=0V)	dBm	28
P_{diss}	Total Power Dissipation [2]	W	1.2
T_j	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to 150

Thermal Resistance [3], θ_{jc} = 34 °C/Wat VDD= 4V, IDD=50mA per channel

Notes:
1. Operation of this device in excess of any of these limits may cause permanent damage.
2. Power dissipation with both channels turned on. Board temperature T_B is 25 °C. Derate 29.5mW/ °C for T_B>109 °C.
3. Thermal resistance measured using Infra-red measurement technique, with both channels turned on, hence IDDtotal=100mA.

Electrical Specifications

RF performance at 4V, 50mA,1.95 GHz, T_A = 25 °C, given for each RF channel, measured on the demo board in Fig. 28 with component list in Table 1, for 1.95GHz matching.

Symbol	Parameter and Test Condition	Units	Min.	Typ.	Max.
VGG	Operational Gate Voltage (to adjust for given IDD)	V	0.43	0.58	0.7
NF[4]	Noise Figure	dB		0.58	0.9
Gain	Gain	dB	22.3	24	25.8
OIP3[5]	Output Third Order Intercept Point	dBm		33.3	
OP1dB	Output Power at 1dB Gain Compression	dBm		18.4	
IRL	Input Return Loss, 50Ω source	dB		13.5	
ORL	Output Return Loss, 50Ω load	dB		4.6	
|S12|	Reverse Isolation	dB		38.6	
$\|ISOL_{1-2}\|$	Isolation between IN1 and IN2	dB		43	

Notes:
4. Board transmission line losses have been deembedded.
5. 1.95GHz IP3 test condition: f_{tone1} = 1.950 GHz, f_{tone2} = 1.951 GHz with input power of -20dBm per tone.

Product Consistency Distribution Charts [1]

T_A = 25 °C, 1.95GHz, Vdd = 4V, Idd = 50mA, F_{RF}=1.95GHz, unless stated otherwise.

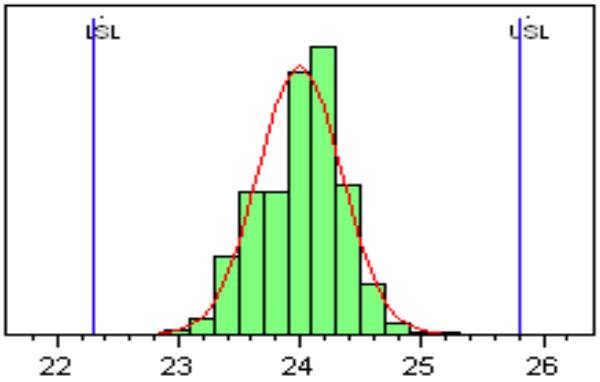


Figure 1. Gain at 1.95 GHz , VDD=4V; IDD=50mA

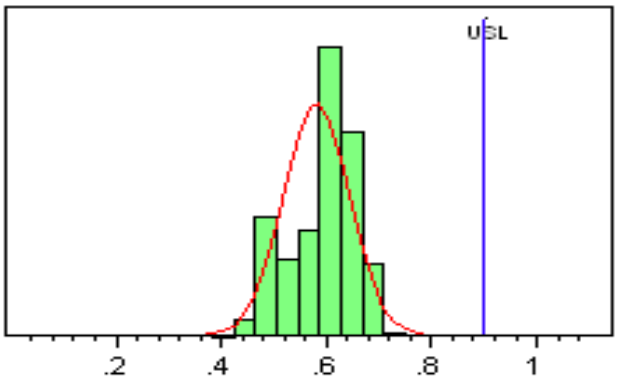


Figure 2. NF at 1.95 GHz , VDD=4V; IDD= 50mA

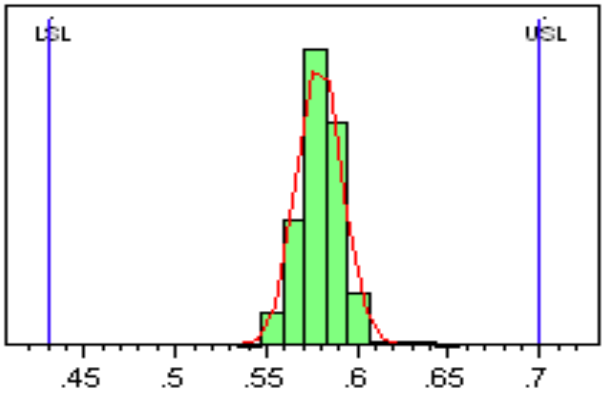


Figure 3. VGG at 1.95 GHz , VDD=4V; IDD= 50mA

Notes:

1. Distribution data sample size are 500 samples taken from 3 different wafer lots, measured on a production test board with contactor. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limit.

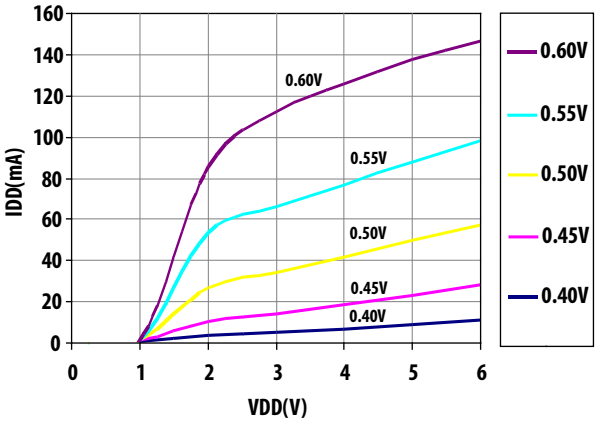


Figure 4. IDD vs VDD vs VGG, All Channels Terminated at 50ohm (both Channels turn on)

MGA-12516 Typical Performance

Measured on demo board in Fig. 28 with component list in Table 1, for 1.95GHz matching. T_A = +25 ºC, VDD = 4V, IDD = 50mA per channel, Frequency=1.95GHz, unless stated otherwise.

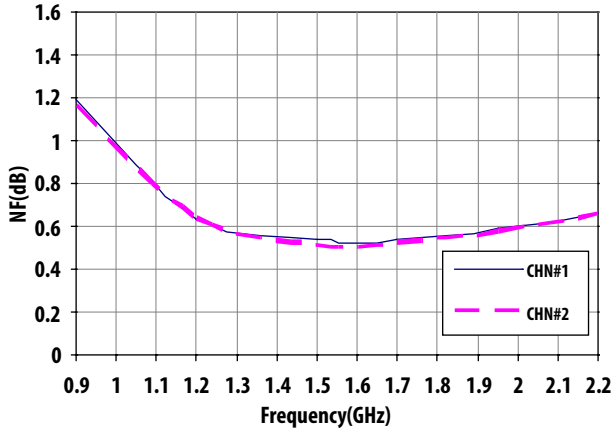


Figure 5. Noise Figure vs Frequency vs Channel

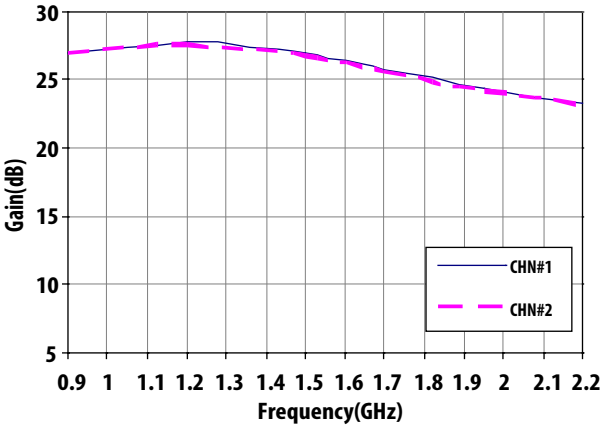


Figure 6. Gain vs Frequency vs Channel

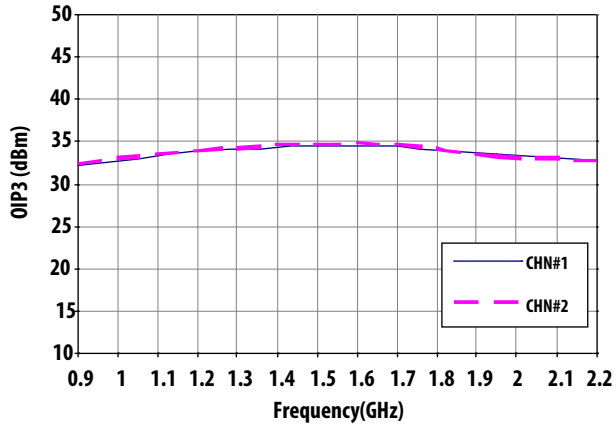


Figure 7. OIP3 vs Frequency vs Channel

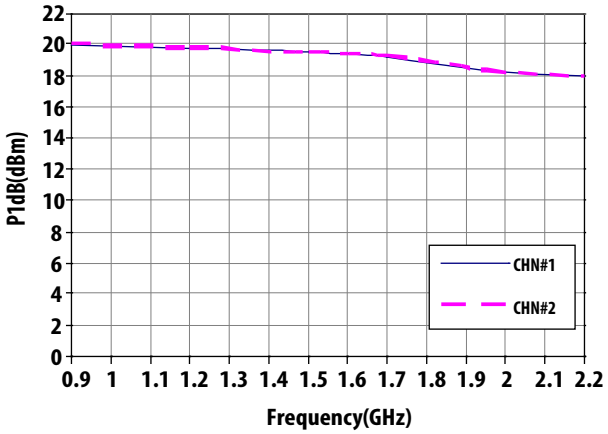


Figure 8. OP1dB vs Frequency vs Channel

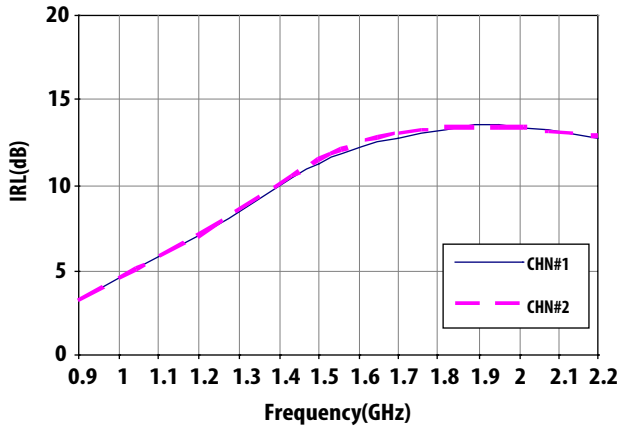


Figure 9. IRL vs Frequency vs Channel

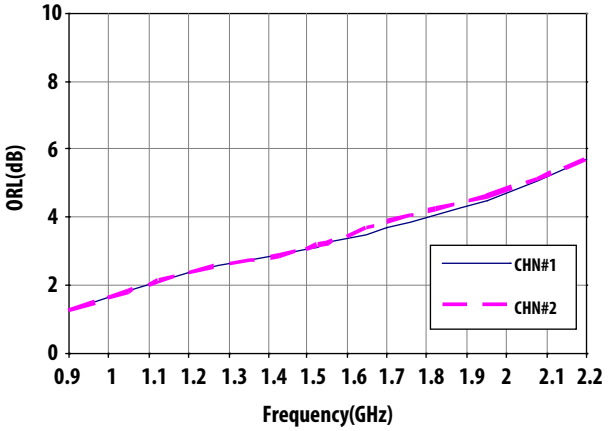


Figure 10. ORL vs Frequency vs Channel

MGA-12516 Typical Performance

Measured on demo board in Fig. 28 with component list in Table 1, for 1.95GHz matching. T_A = +25 ºC, VDD = 4V, IDD = 50mA per channel, Frequency=1.95GHz, unless stated otherwise.

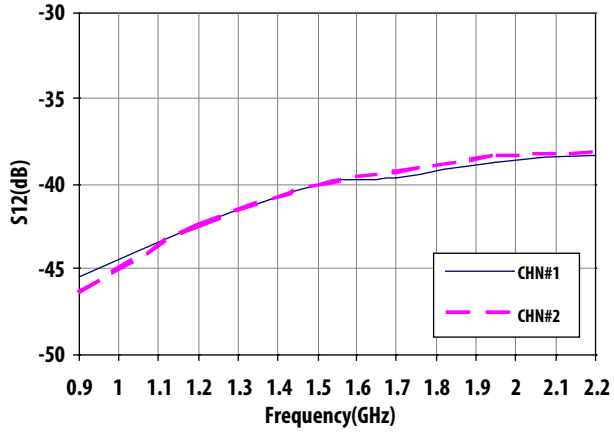


Figure 11. S12 vs Frequency vs Channel

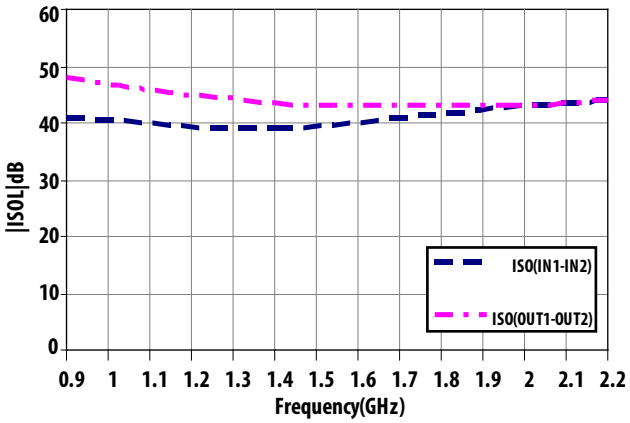


Figure 12. Channel Isolation vs Frequency, at Inputs and Outputs

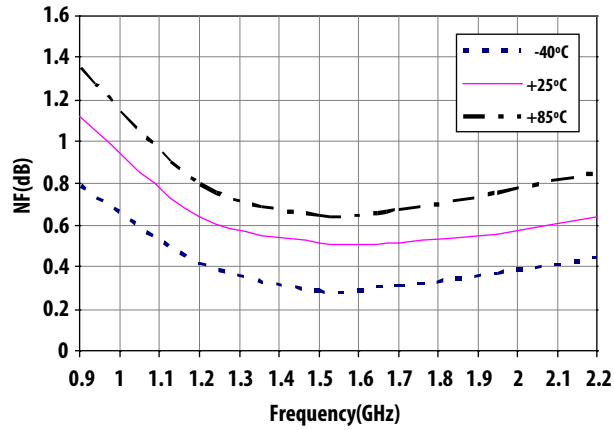


Figure 13. Noise Figure vs Frequency vs Temperature

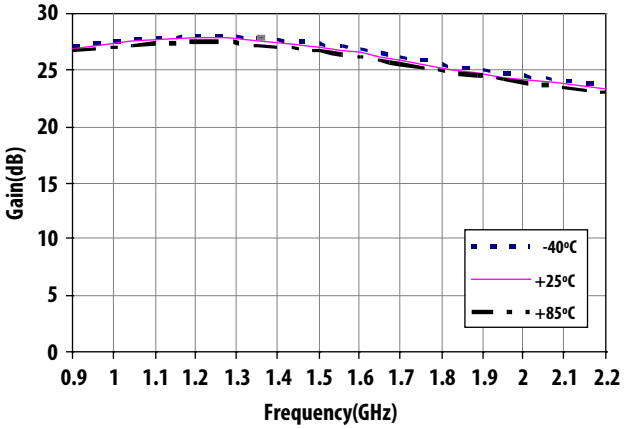


Figure 14. Gain vs Frequency vs Temperature

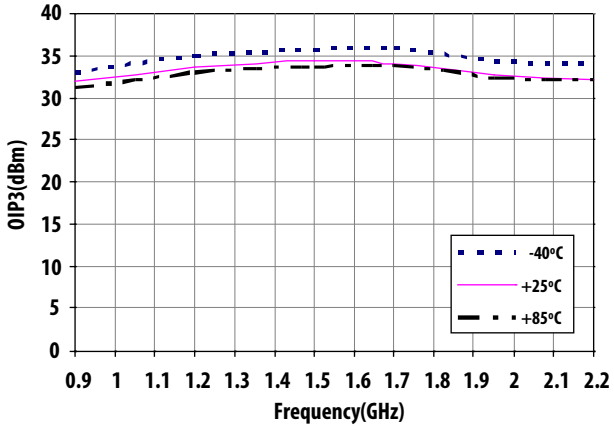


Figure 15. OIP3 vs Frequency vs Temperature

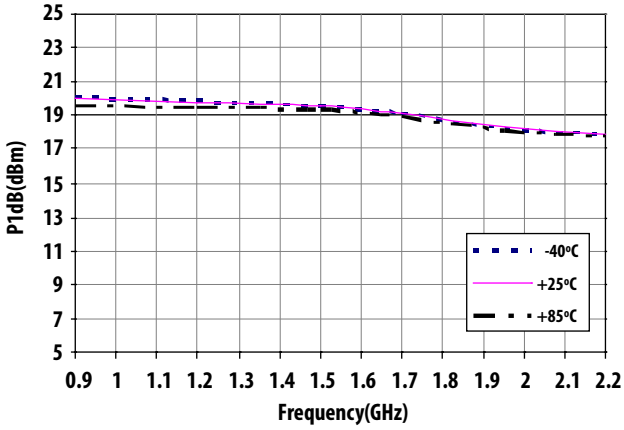


Figure 16. OP1dB vs Frequency vs Temperature

MGA-12516 Typical Performance

Measured on demo board in Fig. 28 with component list in Table 1, for 1.95GHz matching. T_A = +25 ºC, VDD = 4V, IDD = 50mA per channel, Frequency=1.95GHz, unless stated otherwise.

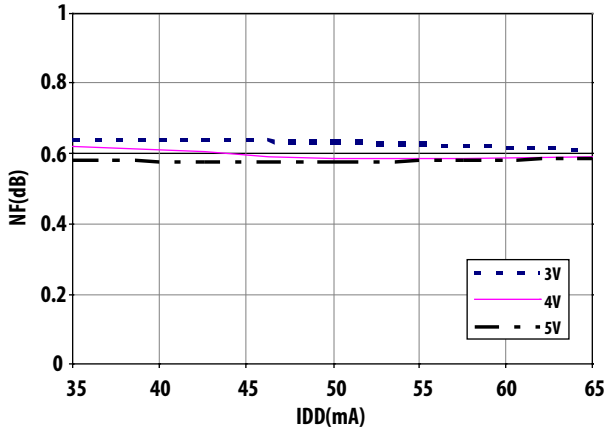


Figure 17. Noise Figure vs IDD vs VDD

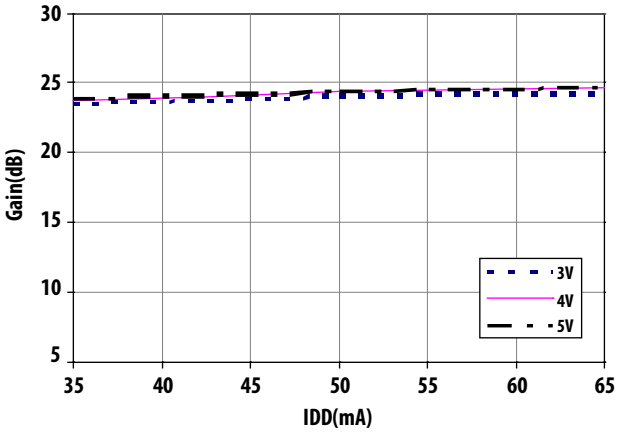


Figure 18. Gain vs IDD vs VDD

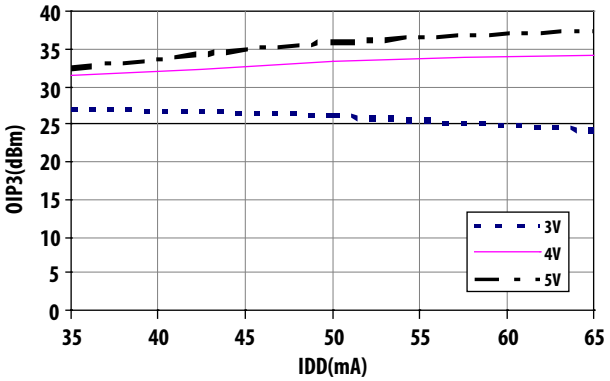


Figure 19. OIP3 vs IDD vs VDD

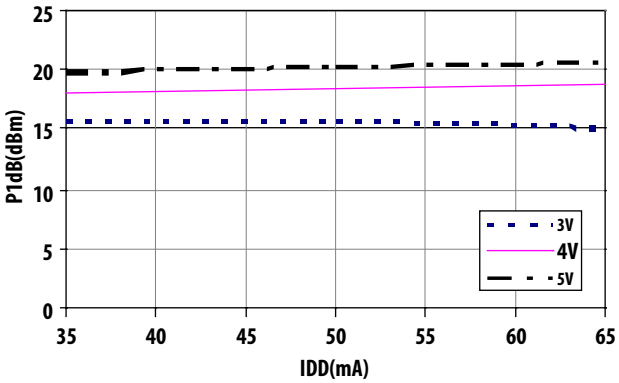


Figure 20. OP1dB vs IDD vs VDD

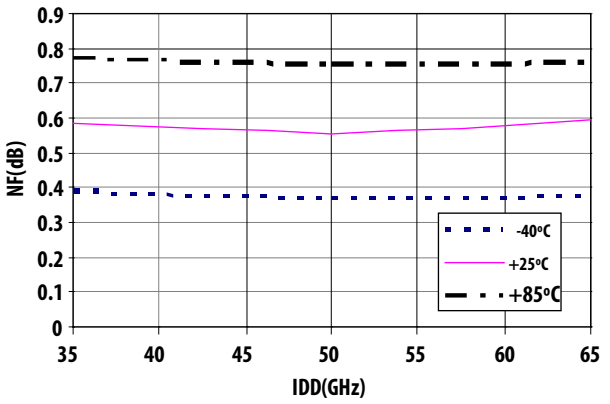


Figure 21. Noise Figure vs IDD vs Temperature

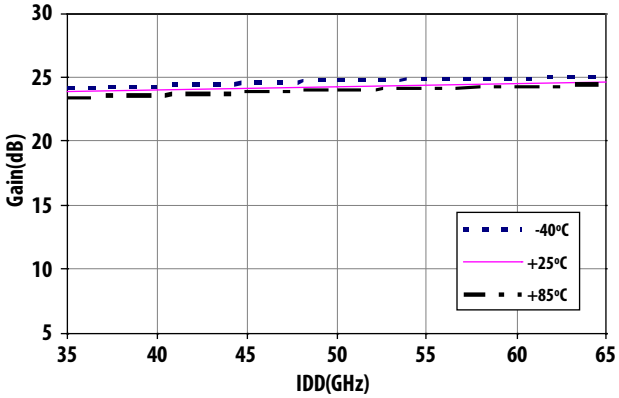


Figure 22. Gain vs IDD vs Temperature

MGA-12516 Typical Performance

Measured on demo board in Fig. 28 with component list in Table 1, for 1.95GHz matching. T_A = +25 ºC, VDD = 4V, IDD = 50mA per channel, Frequency=1.95GHz, unless stated otherwise.

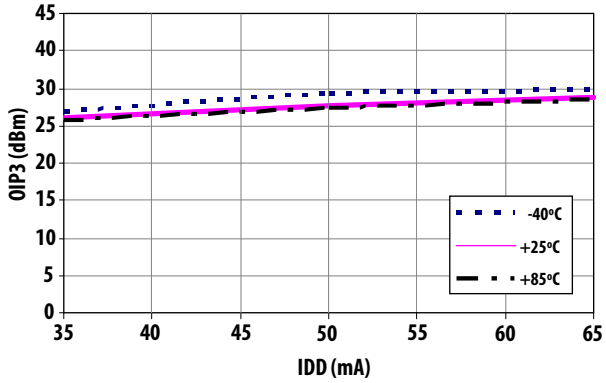


Figure 23. OIP3 vs IDD vs Temperature

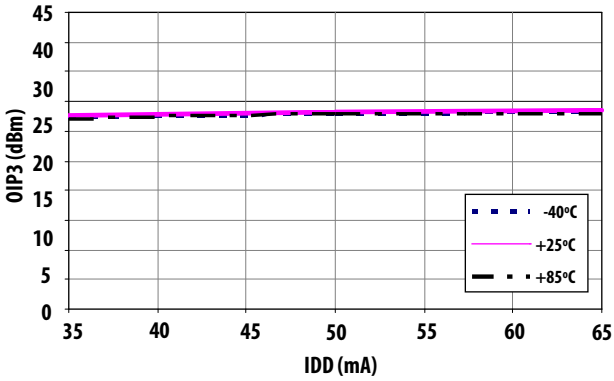


Figure 24. OP1dB vs IDD vs Temperature

MGA-12516 Typical Performance

Measured on demo board in Fig. 27 with component list in Table 1, for 2.4GHz matching. T_A = +25 ºC, VDD = 4V, IDD = 50mA per channel, Frequency=2.4GHz, unless stated otherwise.

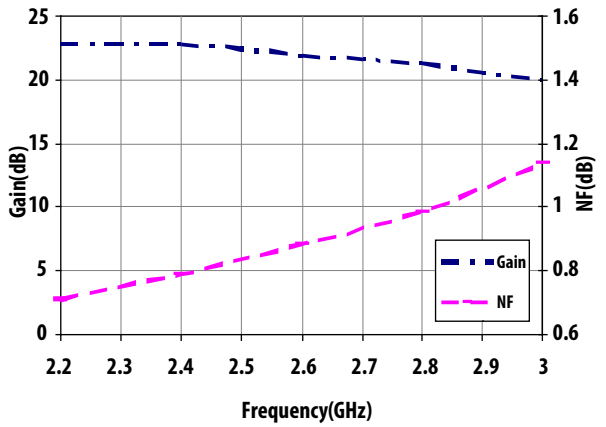


Figure 25. Gain/Noise Figure vs Frequency

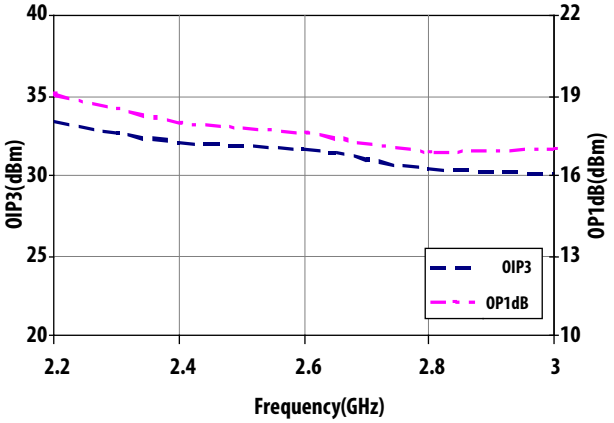


Figure 26. OIP3/OP1dB vs Frequency

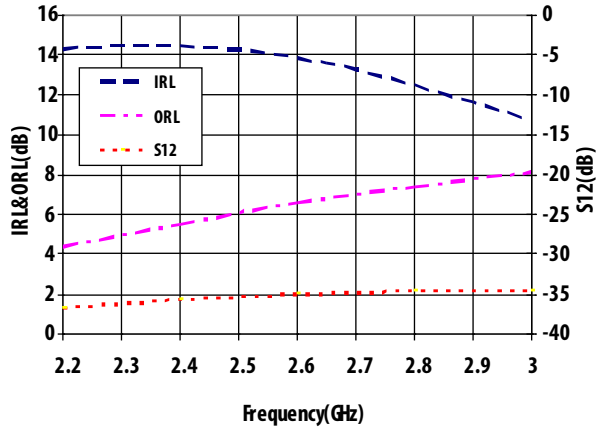


Figure 27. IRL/ORL/S12 vs Frequency

Demo Board Layout

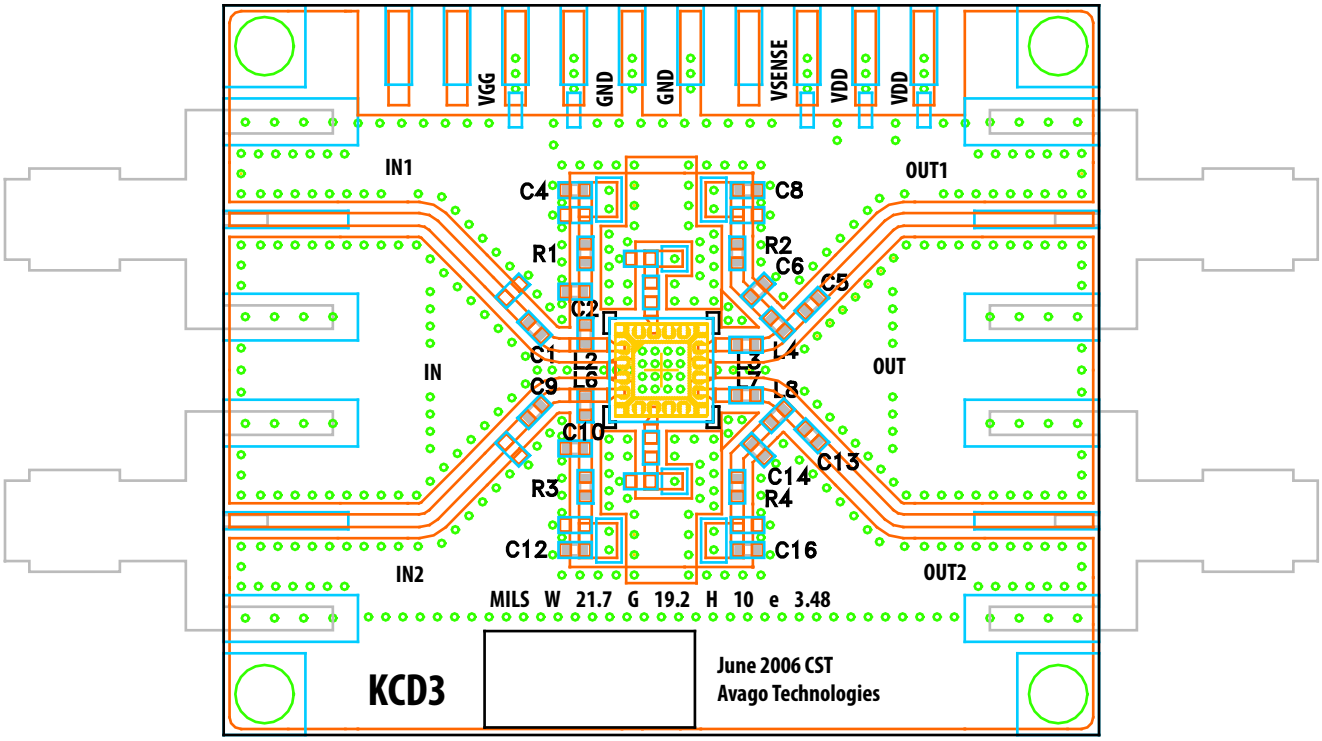


Figure 28. Demo board layout - for single-ended measurements. PCB uses 10 mils Rogers RO4350 material.

Demo Board Schematic

Note there are 2 different matchings, at 1.95GHz and 2.4GHz:

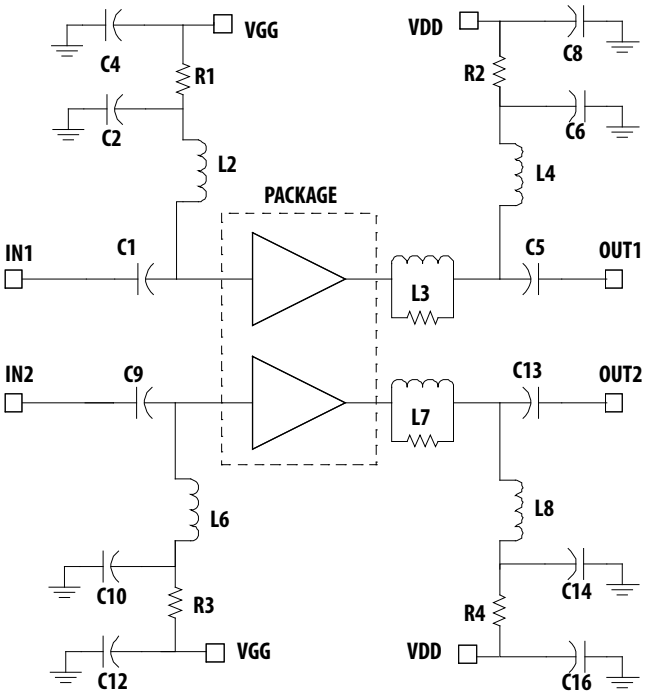


Figure 29. Demo board schematic diagram and SMT list.

Table 1. SMT Component list for 1.95GHz and 2.4GHz matching

		1.95GHz Matching	2.4GHz Matching
Component	**Size**	**Value**	**Value**
C1, C5, C9, C13	0402	100pF (Rohm MCH155A101JK)	100pF (Rohm MCH155A101JK)
C2, C10	0402	22pF (Rohm MCH155A220JK)	22pF (Rohm MCH155A220JK)
C6, C14	0402	1000pF (Rohm MCH155CN102KK)	1000pF (Rohm MCH155CN102KK)
C4, C8, C12, C16	0402	10nF (Murata GRM155R71E103KA01)	10nF (Murata GRM155R71E103KA01)
R1, R3	0402	33Ω (Rohm MCR01MZSJ330)	33Ω (Rohm MCR01MZSJ330)
R2, R4	0402	0Ω (Rohm MCR03EZHJ000)	0Ω (Rohm MCR03EZHJ000)
L2, L6	0402	6.2nH (Coilcraft 0402CS-6N2XJLU)	7.5nH (Coilcraft 0402CS-7N5XJLU)
L3, L7	0402	2.7nH (Toko LLP1005-FH2N7B) in parallel with 91Ω (Rohm MCR01MZSJ910)[8]	1.8nH (Toko LLP1005-FH1N8B) in parallel with 160Ω (Rohm MCR01MZSJ161)[1]
L4, L8	0402	82nH (Toko LL1005-FHL82NJ)	82nH (Toko LL1005-FHL82NJ)

Notes:
1. Inductor and resistor are stacked-up, in parallel.

MGA-12516 Typical Scattering and Noise parameters

Reference planes at package pins, measured at TA = +25 °C, VDD = 3V, IDD = 50mA per channel.

FREQ	S11		S21		S12		S22	
(GHz)	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.1	0.96	-8.89	33.30	169.67	0.00	67.40	0.85	-0.82
0.5	0.84	-38.37	27.23	128.05	0.00	64.80	0.79	-17.65
0.7	0.76	-49.14	23.89	113.62	0.01	64.38	0.77	-23.70
0.9	0.69	-57.95	20.88	100.85	0.01	61.57	0.76	-29.63
1.1	0.63	-64.99	18.38	89.91	0.01	59.42	0.77	-34.90
1.5	0.56	-77.36	14.76	70.72	0.01	57.53	0.76	-46.00
1.7	0.54	-82.96	13.35	62.29	0.01	56.12	0.77	-51.49
1.9	0.53	-87.96	12.31	54.31	0.01	54.76	0.77	-57.22
2.1	0.51	-89.34	11.20	45.85	0.02	50.47	0.75	-68.57
2.5	0.49	-100.62	9.78	30.68	0.02	47.24	0.75	-79.82
2.7	0.48	-106.20	9.08	23.56	0.02	46.17	0.75	-85.46
2.9	0.48	-111.65	8.63	16.18	0.02	45.81	0.74	-91.33
3.3	0.48	-124.37	7.77	2.10	0.02	43.47	0.73	-101.59
3.5	0.49	-131.55	7.53	-4.54	0.02	43.29	0.74	-106.66
3.9	0.49	-146.21	6.95	-18.97	0.03	41.99	0.73	-117.20
4.7	0.52	-178.01	6.24	-49.89	0.04	35.46	0.79	-145.24
5.5	0.59	148.00	5.45	-85.06	0.06	23.67	0.84	178.56
6.1	0.69	121.85	4.86	-111.59	0.07	10.90	0.89	148.54
6.5	0.73	104.32	4.28	-132.00	0.08	-2.94	0.89	128.09
7.1	0.73	85.10	3.18	-158.82	0.09	-19.63	0.90	102.85
7.5	0.76	76.76	2.61	-172.89	0.09	-27.68	0.90	88.75
8.1	0.82	61.68	2.00	167.29	0.09	-40.78	0.92	71.98
8.5	0.85	54.17	1.70	155.55	0.10	-47.97	0.92	63.00
9.1	0.87	41.85	1.29	138.15	0.10	-58.91	0.92	50.30
9.5	0.87	36.24	1.11	128.22	0.10	-65.09	0.93	42.50
10	0.87	28.87	0.91	116.99	0.10	-73.10	0.92	33.20

MGA-12516 Typical Scattering and Noise parameters

Reference planes at package pins, measured at TA = +25 °C, VDD = 4V, IDD = 50mA per channel.

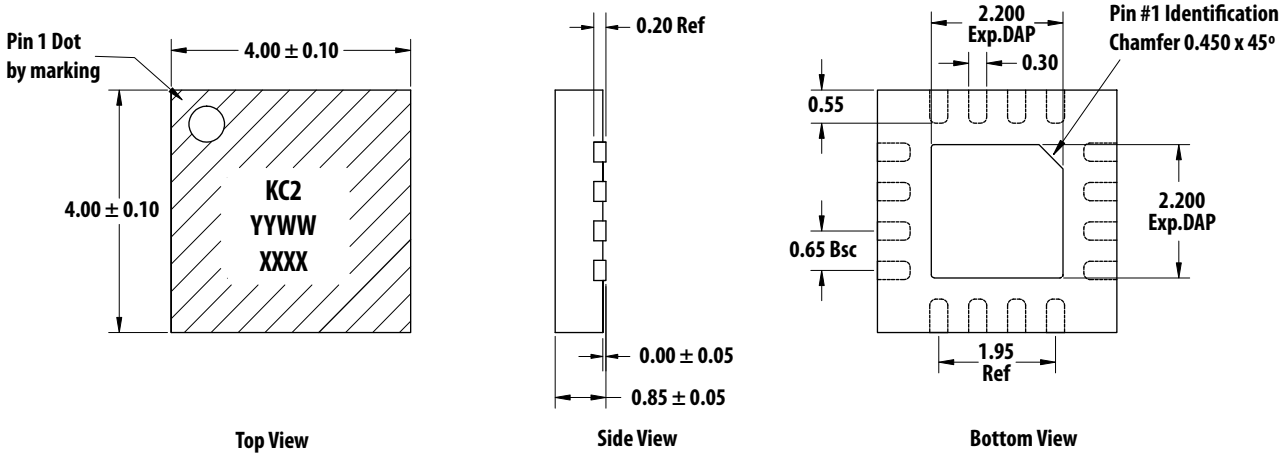
FREQ	S11		S21		S12		S22	
(GHz)	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.1	0.97	-8.41	35.51	168.94	0.00	70.66	0.88	-1.36
0.5	0.83	-37.03	28.17	128.32	0.00	59.52	0.82	-16.83
0.7	0.75	-47.45	24.62	114.02	0.01	64.80	0.81	-22.50
0.9	0.69	-55.83	21.50	101.47	0.01	64.04	0.80	-28.27
1.1	0.63	-62.45	18.87	90.84	0.01	62.26	0.80	-33.37
1.5	0.56	-74.23	15.09	72.01	0.01	57.56	0.80	-44.30
1.7	0.53	-79.16	13.69	63.70	0.01	57.67	0.80	-49.41
1.9	0.52	-83.93	12.61	56.02	0.01	56.32	0.80	-54.93
2.1	0.49	-84.50	11.48	47.68	0.01	53.32	0.78	-66.05
2.5	0.48	-94.89	10.02	32.89	0.01	51.44	0.78	-76.85
2.7	0.47	-100.24	9.34	25.97	0.02	50.02	0.78	-82.38
2.9	0.46	-105.13	8.89	18.85	0.02	49.37	0.78	-88.01
3.3	0.46	-116.94	8.03	5.22	0.02	49.61	0.76	-97.83
3.5	0.46	-123.70	7.76	-1.33	0.02	48.96	0.77	-102.56
3.9	0.46	-137.65	7.20	-15.34	0.02	48.73	0.76	-112.46
4.7	0.48	-168.07	6.53	-44.99	0.03	43.67	0.83	-138.95
5.5	0.54	157.80	5.90	-79.27	0.05	32.99	0.88	-173.86
6.1	0.64	130.77	5.37	-105.46	0.07	20.11	0.93	156.64
6.5	0.68	112.56	4.81	-126.29	0.08	6.11	0.93	136.03
7.1	0.70	92.09	3.66	-154.20	0.08	-11.43	0.94	109.41
7.5	0.74	82.58	3.05	-169.37	0.09	-20.19	0.93	94.31
8.1	0.80	66.61	2.35	169.71	0.09	-34.04	0.95	76.33
8.5	0.83	58.96	2.01	157.44	0.09	-41.68	0.94	67.03
9.1	0.86	45.63	1.53	138.63	0.10	-53.42	0.94	53.65
9.5	0.86	39.65	1.31	127.90	0.10	-59.94	0.94	45.44
10	0.86	31.95	1.08	115.89	0.10	-68.20	0.94	35.33

MGA-12516 Typical Scattering and Noise parameters

Reference planes at package pins, measured at TA = +25 °C, VDD = 5V, IDD =50mA per channel.

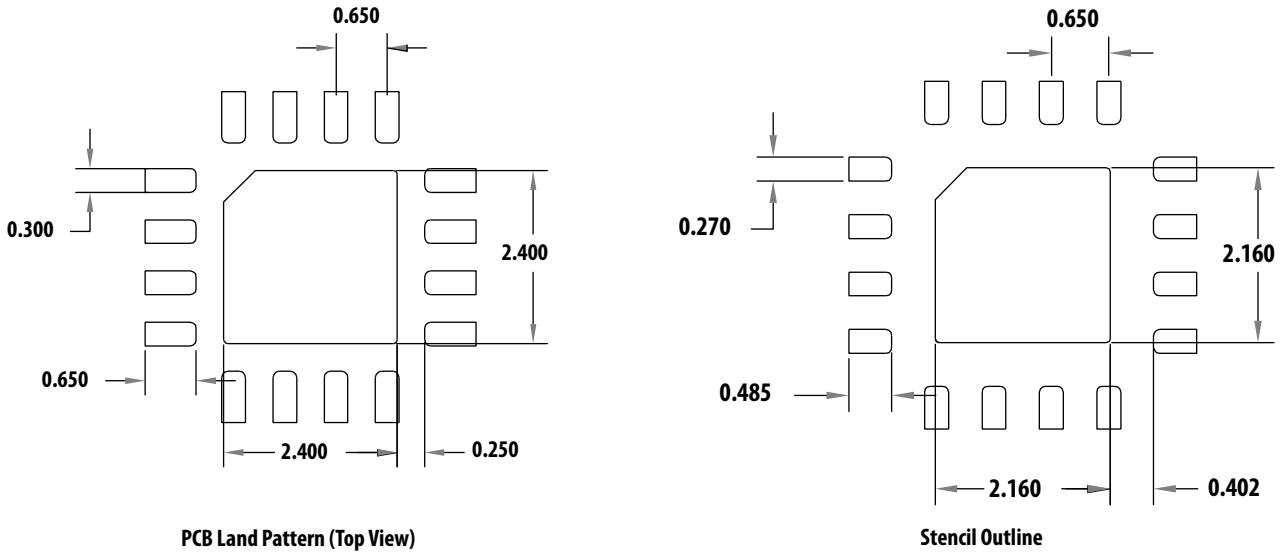
FREQ	S11		S21		S12		S22	
(GHz)	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.1	0.97	-8.30	35.83	168.76	0.00	112.69	0.89	-1.60
0.5	0.83	-37.22	28.27	128.38	0.00	66.07	0.84	-16.43
0.7	0.75	-47.40	24.78	114.23	0.00	63.18	0.82	-21.81
0.9	0.68	-55.80	21.53	101.54	0.01	61.61	0.82	-27.49
1.1	0.62	-62.65	18.91	90.90	0.01	62.92	0.82	-32.49
1.5	0.54	-73.90	15.16	72.40	0.01	59.20	0.82	-43.05
1.7	0.52	-78.64	13.72	64.13	0.01	58.37	0.82	-48.24
1.9	0.50	-83.19	12.59	56.52	0.01	56.71	0.82	-53.52
2.1	0.48	-83.51	11.50	48.39	0.01	58.16	0.81	-64.64
2.5	0.46	-93.34	10.04	33.96	0.01	53.84	0.80	-75.32
2.7	0.44	-98.41	9.30	26.98	0.01	54.40	0.80	-80.86
2.9	0.44	-102.90	8.91	19.98	0.01	52.62	0.79	-86.27
3.3	0.44	-114.12	8.04	6.61	0.02	52.71	0.78	-95.78
3.5	0.44	-120.51	7.79	0.37	0.02	52.33	0.79	-99.94
3.9	0.43	-133.87	7.23	-13.42	0.02	53.13	0.78	-109.76
4.7	0.45	-163.65	6.60	-42.62	0.03	48.59	0.85	-135.08
5.5	0.51	162.57	6.03	-76.07	0.05	39.22	0.90	-169.14
6.1	0.60	135.17	5.58	-102.32	0.06	26.22	0.95	161.74
6.5	0.64	117.25	5.09	-122.96	0.07	12.31	0.96	141.01
7.1	0.67	95.74	3.94	-151.73	0.08	-5.35	0.97	113.61
7.5	0.72	86.15	3.31	-166.87	0.08	-14.66	0.96	97.90
8.1	0.78	69.36	2.56	170.91	0.09	-29.24	0.97	78.93
8.5	0.81	61.39	2.19	158.29	0.09	-37.32	0.96	69.21
9.1	0.85	48.03	1.67	138.61	0.10	-49.19	0.96	55.44
9.5	0.85	41.90	1.45	127.69	0.10	-56.12	0.96	46.88
10	0.85	33.92	1.18	114.87	0.10	-64.59	0.95	37.11

Package Dimensions

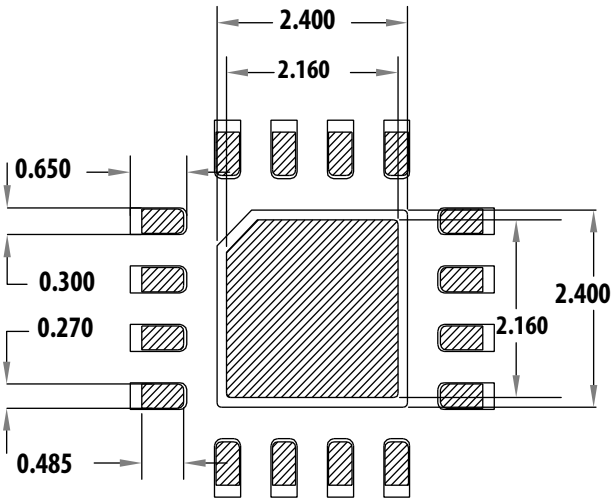


Top View | Side View | Bottom View

PCB Land Patterns and Stencil Design

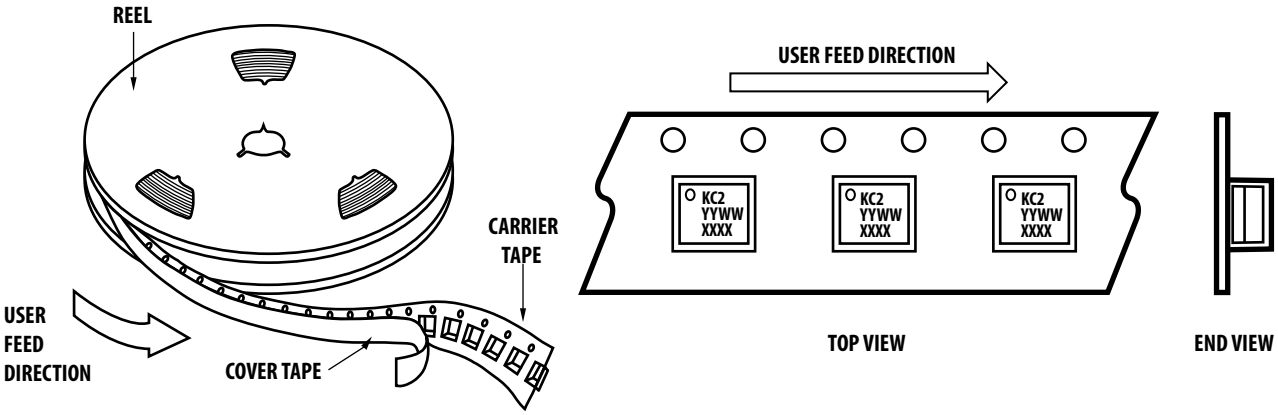


PCB Land Pattern (Top View) | Stencil Outline

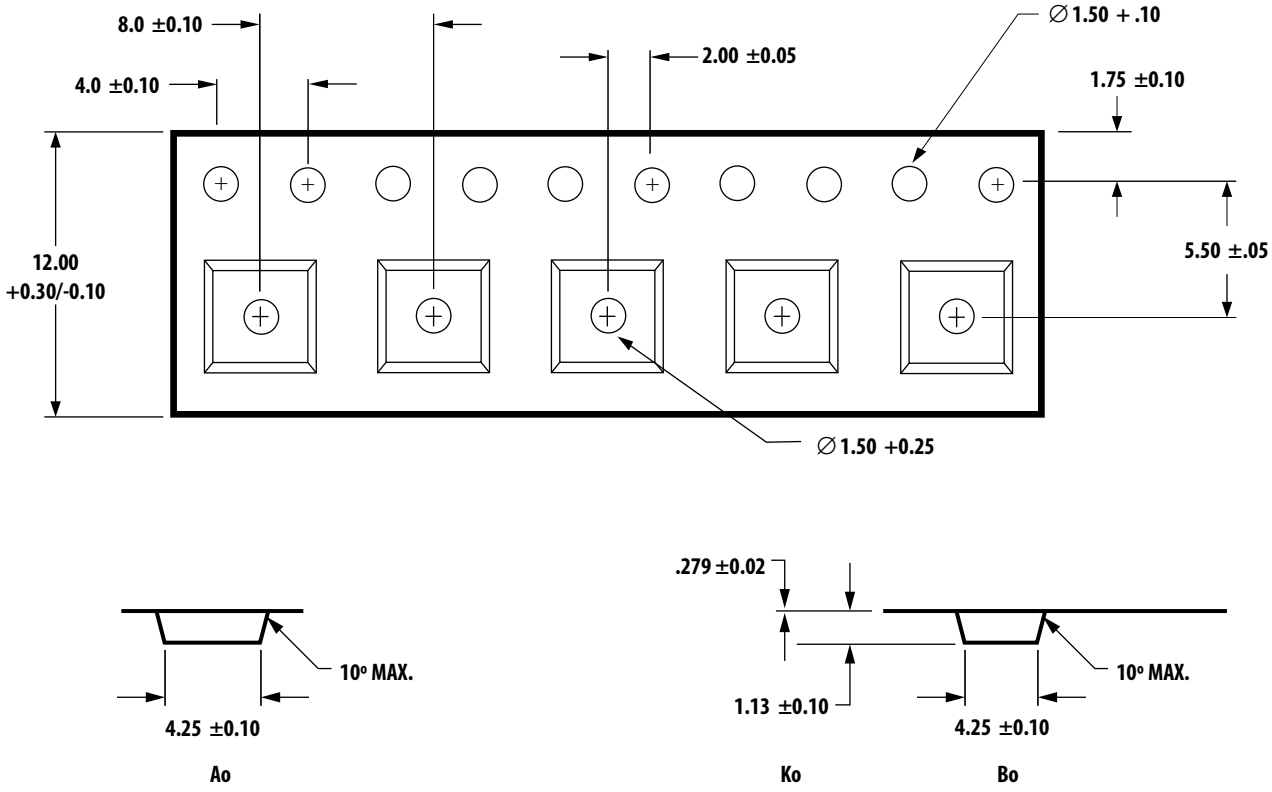


Combines PCB & Stencil Layouts
All Dimension are in MM

Device Orientation



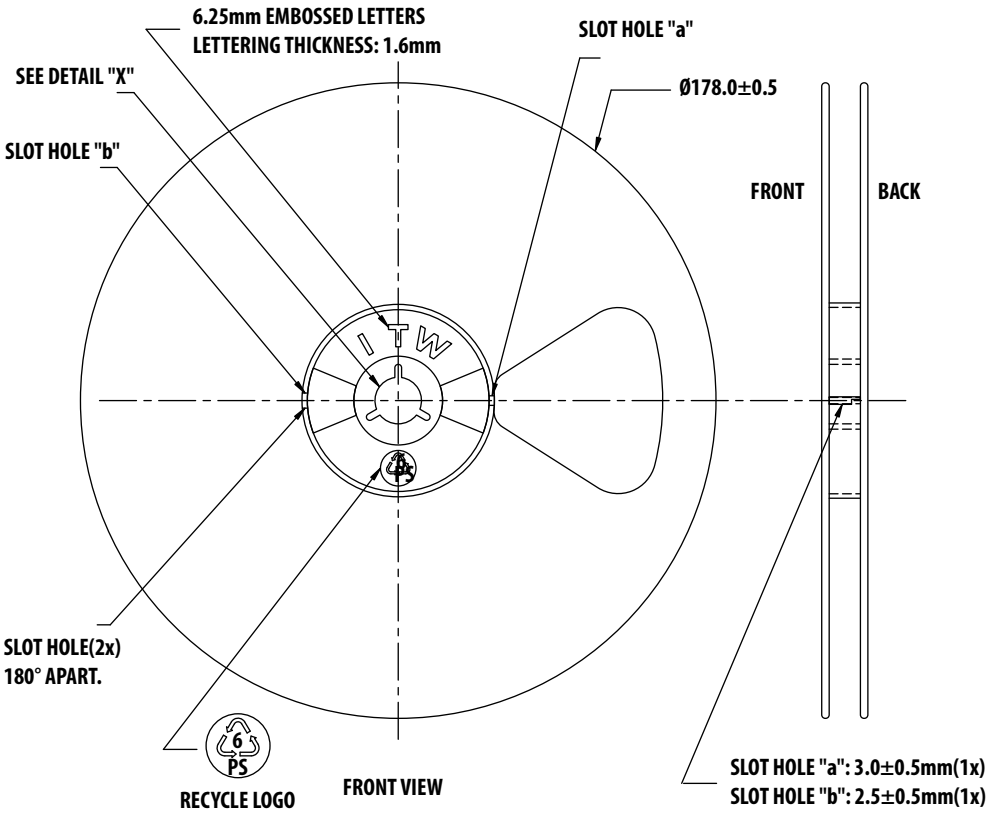
Tape Dimensions

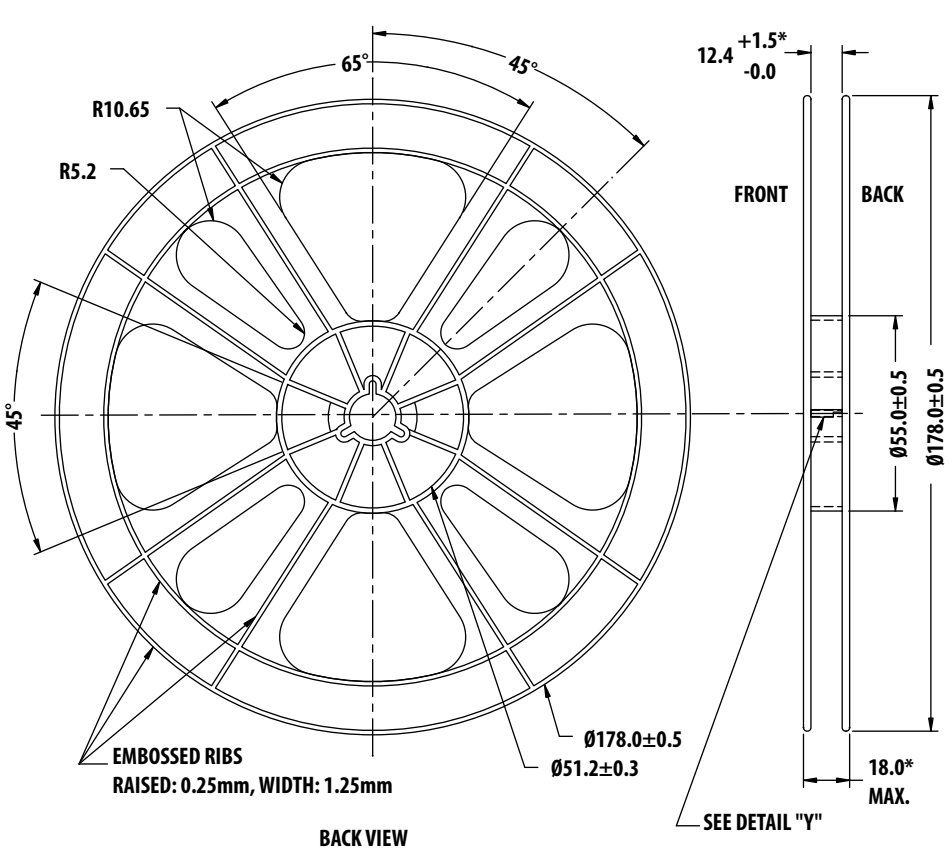


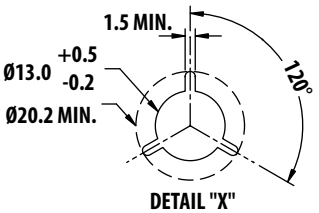
Part Number Ordering Information

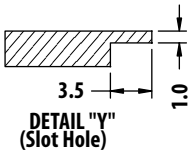
Part Number	No. of Devices	Container
MGA-12516-TR1G	1000	7″ Reel
MGA-12516-TR2G	3000	13″ Reel
MGA-12516-BLKG	100	antistatic bag

Reel Dimension - 7 inch

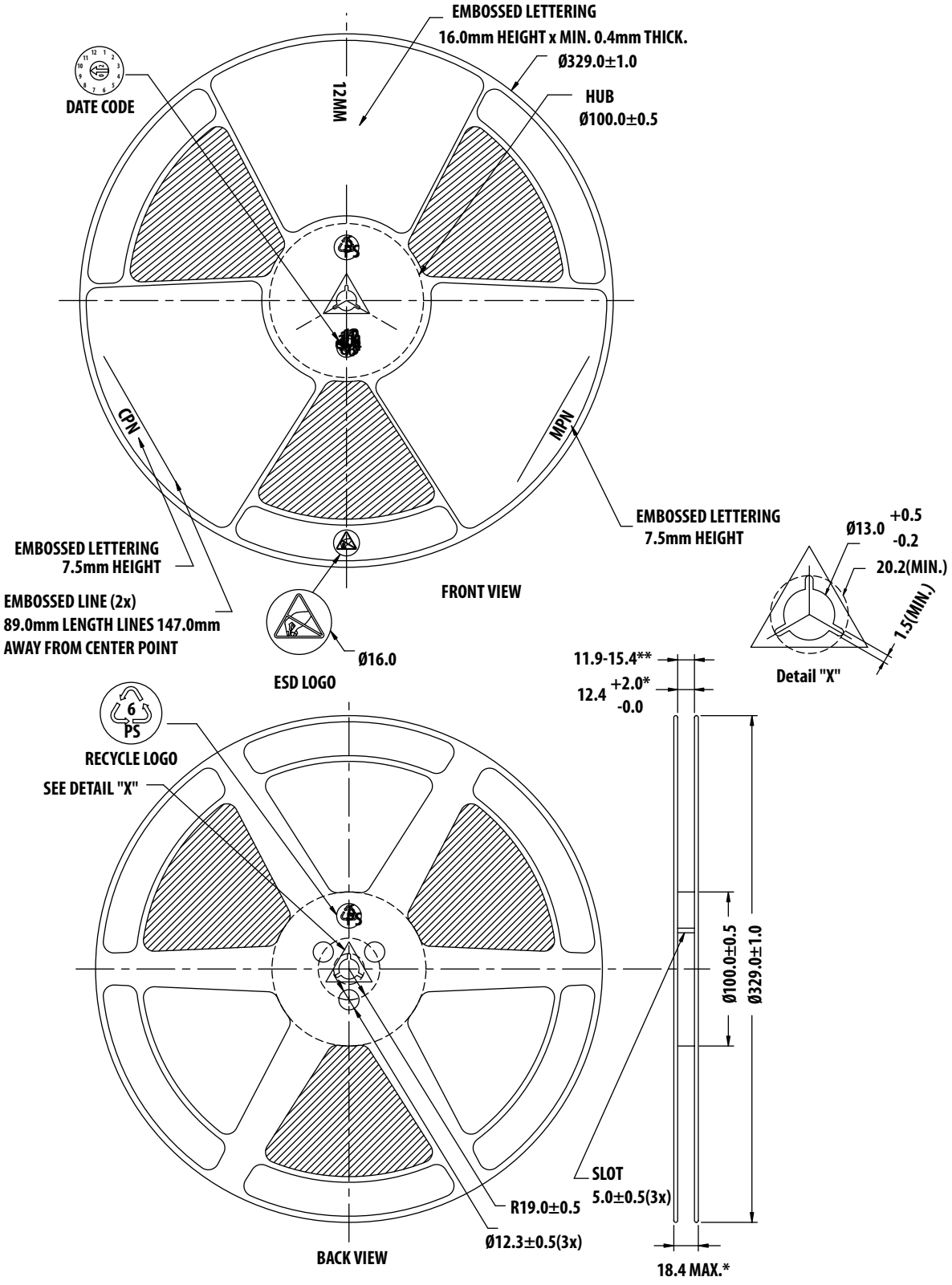








Reel Dimension - 13 inch



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