

# MGA-17516

## Low Noise, High Linearity Match Pair Low Noise Amplifier

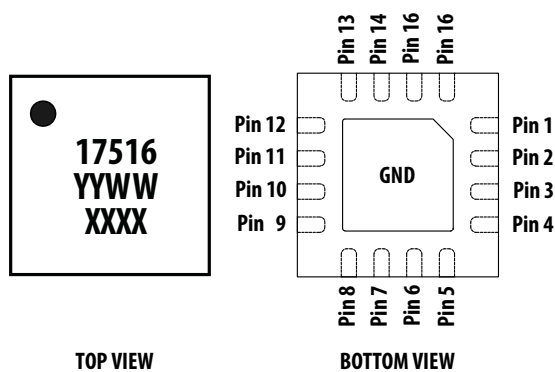


### Data Sheet

#### Description

Avago Technologies' MGA-17516 is an economical, easy-to-use GaAs MMIC match pair Low Noise Amplifier (LNA). The LNA has low noise and high linearity 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<sup>3</sup> 16-pin Quad-Flat-Non-Lead (QFN) package. The compact footprint and low profile coupled with low noise, high gain and high linearity make the MGA-17516 an ideal choice as a low noise amplifier for cellular infrastructure for GSM, CDMA and TDS-CDMA applications. This device is applicable to both Single and Balance mode. It is designed for optimum use from 1.7GHz to 2.7GHz. For optimum performance at lower frequency from 500MHz to 1.7GHz, the MGA-16516 is recommended. Both MGA-17516 and MGA-16516 share the same package and pinout.

#### Pin Configuration and Package Marking



Note:  
Package marking provides orientation and identification  
"17516" = Device Code  
"YYWW" = Year and Work Week  
"XXXX" = Last 4 digit of Device Lot Number

#### Features

- 4.0 x 4.0 x 0.85 mm<sup>3</sup> 16-lead QFN
- Low noise figure
- High linearity performance
- GaAs E-pHEMT Technology<sup>[1]</sup>
- Low cost small package size: 4.0x4.0x0.85 mm<sup>3</sup>
- Excellent uniformity in product specifications
- Tape-and-Reel packaging option available

#### Specifications

##### 1.85GHz; 5V, 50mA (typ) per section

- 17.4 dB Gain
- 0.46 dB Noise Figure
- 16.2 dBm Input IP3
- 21 dBm Output Power at 1dB gain compression

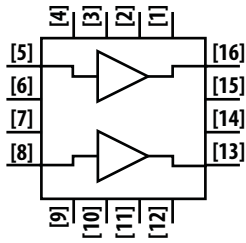
#### Applications

- Low noise amplifier for cellular infrastructure for GSM, CDMA and TDS-CDMA.
- Other ultra low noise application.



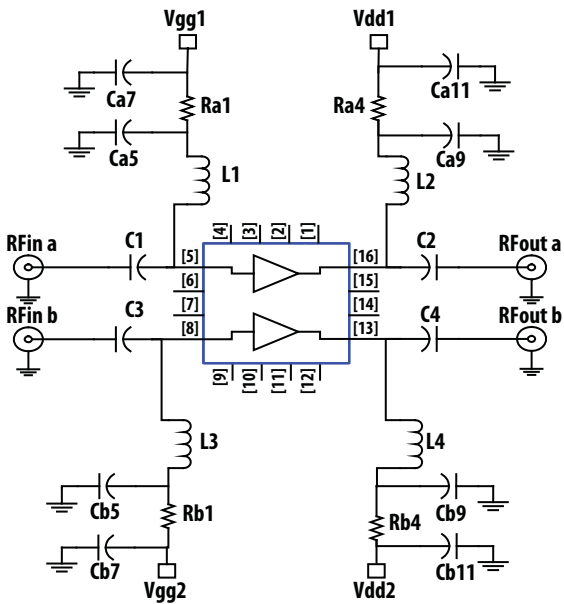
**Attention: Observe precautions for handling electrostatic sensitive devices.**  
ESD Machine Model = 40V  
ESD Human Body Model = 350V  
Refer to Avago Application Note A004R:  
*Electrostatic Discharge, Damage and Control.*

## Pin Configuration



Pin	Use
1	Not Used
2	Not Used
3	Not Used
4	Not Used
5	RFin1
6	Not Used
7	Not Used
8	RFin2
9	Not Used
10	Not Used
11	Not Used
12	Not Used
13	RFout2
14	Not Used
15	Not Used
16	RFout1

## Simplified Schematic



Note:

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

## Absolute Maximum Rating <sup>[2]</sup> $T_A = 25^\circ\text{C}$

Symbol	Parameter	Units	Absolute Max.
$V_{dd}$	Device Voltage, RF output to ground	V	5.5
$V_{gg}$	Gate Voltage	V	1
$P_{in}$	CW RF Input Power ( $V_{dd} = 5.0$ , $I_{dd} = 50\text{mA}$ )	dBm	15
$I_{dd}$	Device Current, RFout to ground per channel	mA	100
$P_{diss}$	Total Power Dissipation <sup>[4]</sup>	W	1
$T_j$	Junction Temperature	$^\circ\text{C}$	150
$T_{STG}$	Storage Temperature	$^\circ\text{C}$	-65 to 150

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

( $V_{dd} = 5.0\text{V}$ ,  $I_{dd} = 50\text{mA}$  per channel),  
 $\theta_{jc} = 49.4^\circ\text{C/W}$  per channel

Notes:

- Operation of this device in excess of any of these limits may cause permanent damage.
- Thermal resistance measured using Infra-Red Measurement Technique with both channels turned on hence  $I_{dd\_total}=100\text{mA}$ .
- Power dissipation with both channels turned on. Board temperature  $T_B$  is  $25^\circ\text{C}$ . Derate at  $20\text{mW}/^\circ\text{C}$  for  $T_B > 100^\circ\text{C}$ .

## Electrical Specifications <sup>[7-10]</sup>

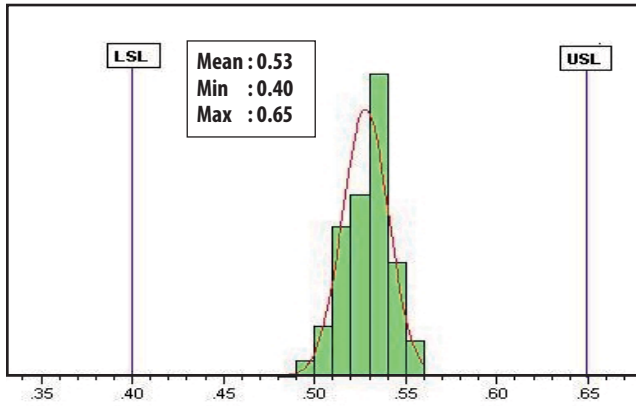
RF performance at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $I_{dd} = 50\text{mA}$ , 1.85 GHz and 1.95 GHz given for each RF channel, measured on demo board in Figure 5 with component list in Table1 for 1.85GHz matching.

Symbol	Parameter and Test Condition	Frequency (GHz)	Units	Min.	Typ.	Max.
$V_{gg}$	Operational Gate Voltage, $I_{dd}=50\text{mA}$		V	0.40	0.53	0.65
Gain	Gain	1.85	dB		17.4	
		1.95	dB	15.5	16.8	18.5
IIP3 <sup>[8]</sup>	Input Third Order Intercept Point	1.85	dBm		16.2	
		1.95	dBm	13.5	17	
NF <sup>[9]</sup>	Noise Figure	1.85	dB		0.46	
		1.95	dB		0.50	0.75
OP1dB	Output Power at 1dB Gain Compression	1.85	dBm		21	
		1.95	dBm		21	
IRL	Input Return Loss, $50\Omega$ source	1.85	dB		6	
		1.95	dB		6.3	
ORL	Output Return Loss, $50\Omega$ load	1.85	dB		15	
		1.95	dB		15	
REV ISOL	Reverse Isolation	1.85	dB		26	
		1.95	dB		26	
ISOL <sub>1-2</sub>	Isolation between RFin1 and RFin2	1.85	dB		38	
		1.95	dB		38	

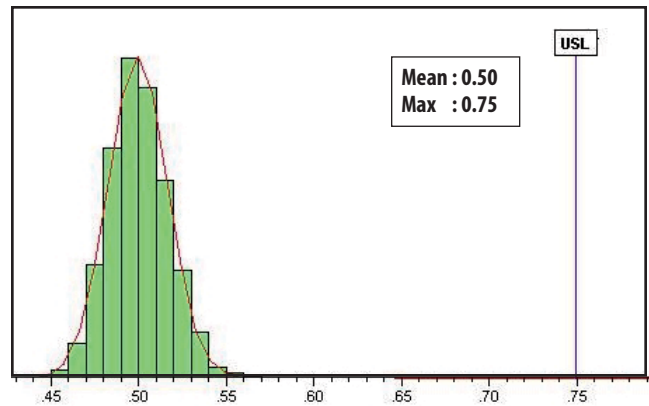
Notes:

- Measurements at 1.85 GHz obtained using demo board described in Figure 1.
- IIP3 test condition:
  - $F_{RF1} = 1.85\text{ GHz}$ ,  $F_{RF2} = 1.851\text{ GHz}$  with input power of  $-15\text{dBm}$  per tone.
  - $F_{RF1} = 1.95\text{ GHz}$ ,  $F_{RF2} = 1.951\text{ GHz}$  with input power of  $-15\text{dBm}$  per tone.
- For NF data, board losses of the input have not been de-embedded.
- Use proper bias, heatsink and derating to ensure maximum channel temperature is not exceeded. See absolute maximum ratings and application note for more details.

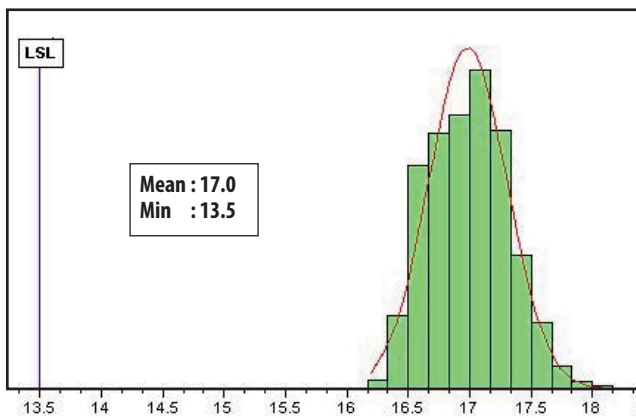
## Product Consistency Distribution Charts



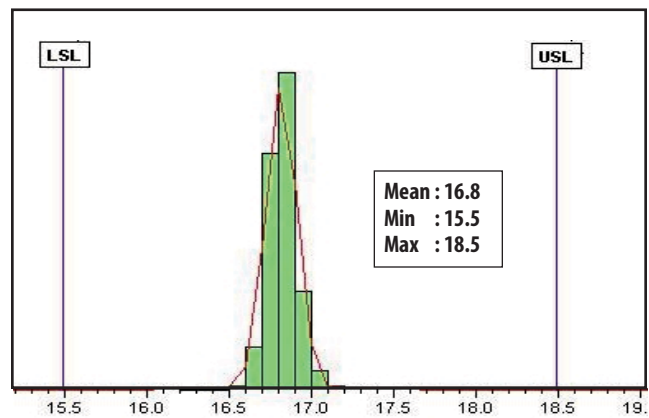
**Figure 1. V<sub>gg</sub> @ 1.95GHz, 5V, 50mA**  
**Mean = 0.53**



**Figure 2. Noise Figure @ 1.95GHz, 5V, 50mA**  
**Mean = 0.50**



**Figure 3. IIP<sub>3</sub> @ 1.95GHz, 5V, 50mA**  
**Mean = 17.0**



**Figure 4. Gain @ 1.95GHz, 5V, 50mA**  
**Mean = 16.8**

### Notes:

1. Distribution data samples size is 500 samples taken from 4 different wafers. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits. Circuit losses have not been de-embedded from actual measurement.

## Demo Board Layout

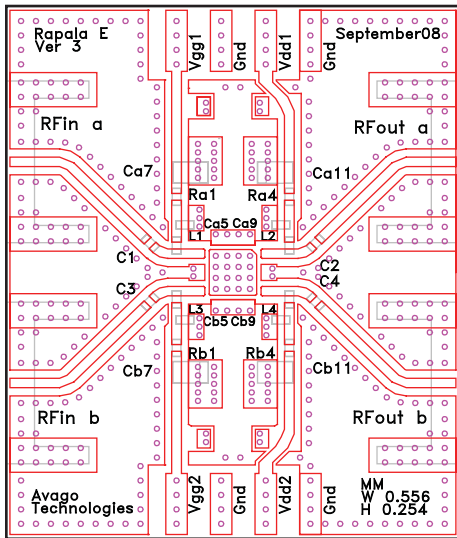


Figure 5. Demo Board Layout Diagram

- Recommended PCB material is 10 mils Rogers RO4350.
- Suggested component values may vary according to layout and PCB material.

## Demo Board Schematic

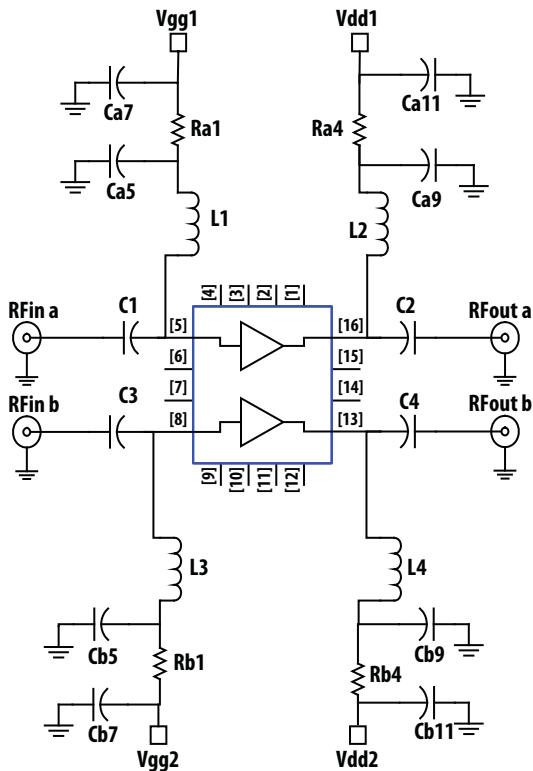


Figure 6. Demo Board Schematic Diagram

Table 1. Component list for 1.85GHz matching.

Part	Size	Value	Part Number
C1, C2	0402	1000pF (Murata)	GRM155R71H102KA01
C3, C4	0402	1000pF (Murata)	GRM155R71H102KA01
Ca7, Ca11	0805	4.7uF (Murata)	GRM21BR60J475KA11L
Cb7, Cb11	0805	4.7uF (Murata)	GRM21BR60J475KA11L
Ca5, Ca9	0402	9pF (Murata)	GJM1555C1H9R0CB01
Cb5, Cb9	0402	9pF (Murata)	GJM1555C1H9R0CB01
Ra1, Rb1	0402	4.3Ω (Rohm)	MCR01MZSJ4R3
Ra4, Rb4	0402	9.1Ω (Rohm)	MCR01MZSJ9R1
L1, L3	0402	9nH (Coilcraft)	0402CS-9N0XJLU
L2, L4	0402	8.2nH (Toko)	LLP1005-FH8N2C

## MGA-17516 Typical Performance

RF performance for each RF channel at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $I_{dd} = 50\text{mA}$  unless otherwise stated. OIP3 is measured with input power of  $-15\text{dBm}$  per tone.

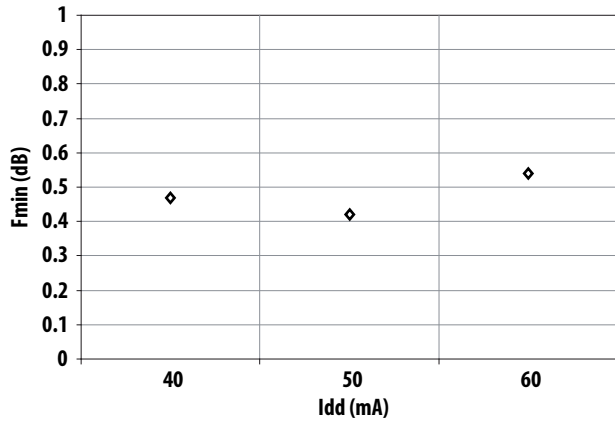


Figure 7.  $F_{min}$  vs  $I_{dd}$  at 5V at 1.85GHz

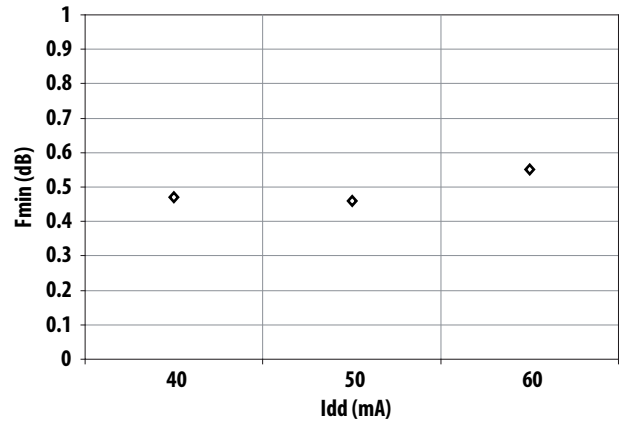


Figure 8.  $F_{min}$  vs  $I_{dd}$  at 5V at 2GHz

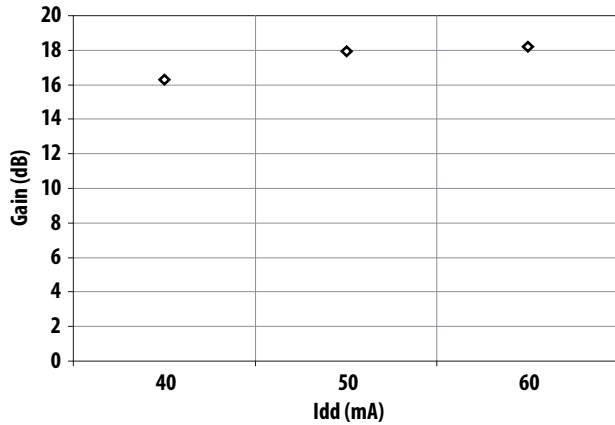


Figure 9. Gain vs  $I_{dd}$  at 5V Tuned for Optimum OIP3 and  $F_{min}$  at 1.85GHz

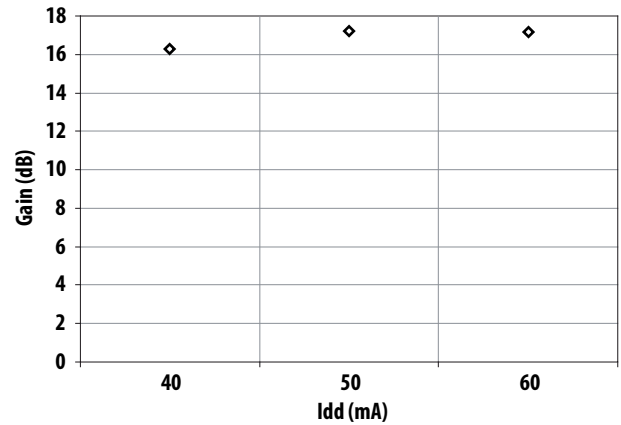


Figure 10. Gain vs  $I_{dd}$  at 5V Tuned for Optimum OIP3 and  $F_{min}$  at 2GHz

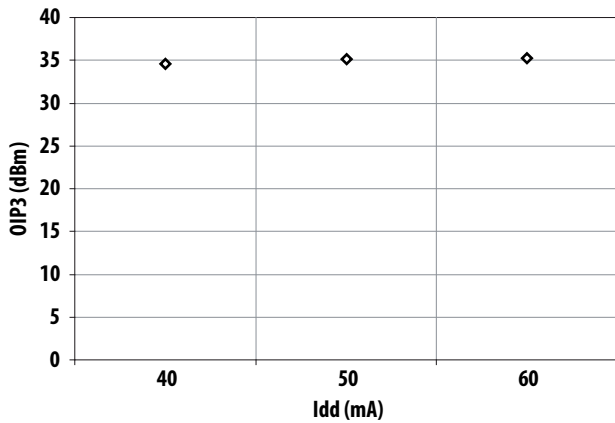


Figure 11. OIP3 vs  $I_{dd}$  at 5V Tuned for Optimum OIP3 and  $F_{min}$  at 1.85GHz

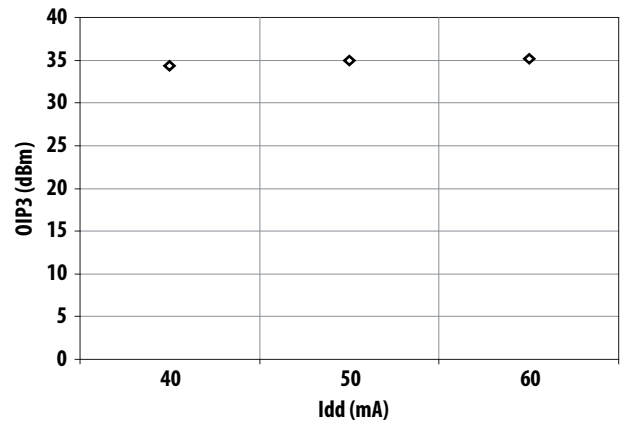


Figure 12. OIP3 vs  $I_{dd}$  at 5V Tuned for Optimum OIP3 and  $F_{min}$  at 2GHz

## MGA-17516 Typical Performance

RF performance for each RF channel at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $I_{dd} = 50\text{mA}$  unless otherwise stated. OIP3 is measured with input power of  $-15\text{dBm}$  per tone.

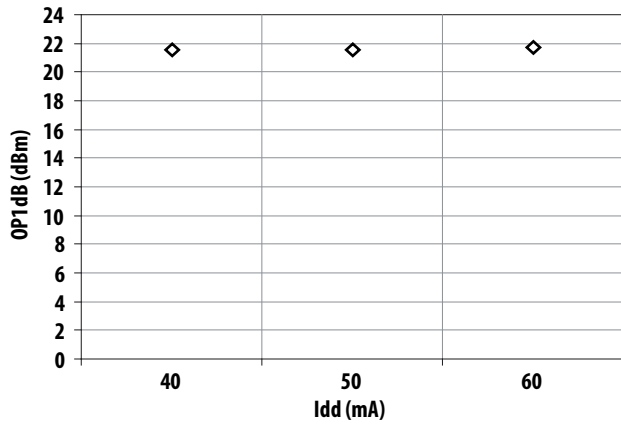


Figure 13. OP1dB vs Idd at 5V Tuned for Optimum OIP3 and Fmin at 1.85GHz

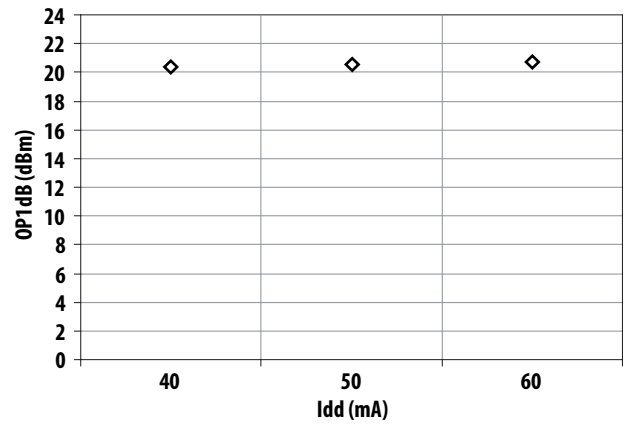


Figure 14. OP1dB vs Idd at 5V Tuned for Optimum OIP3 and Fmin at 2GHz

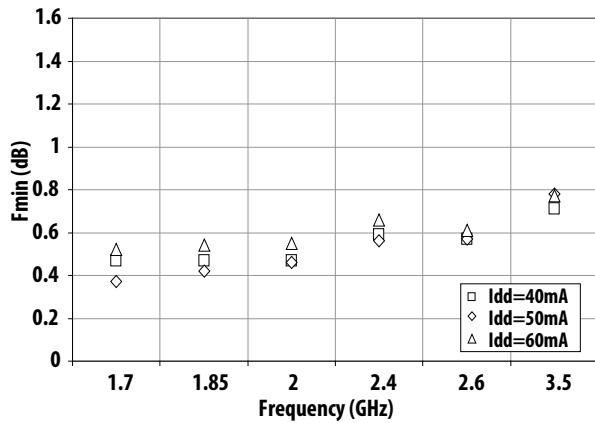


Figure 15. Fmin vs Frequency and Idd at 5V

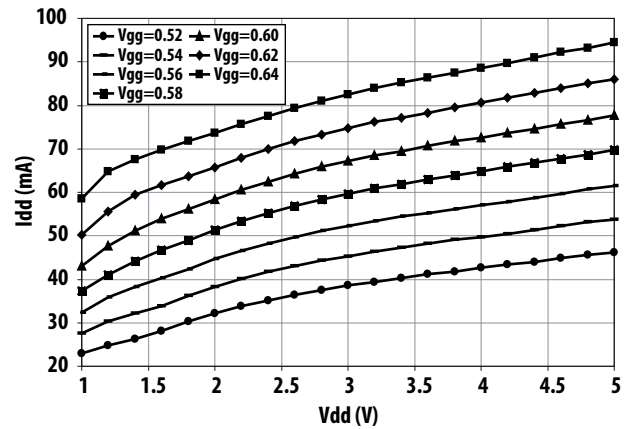


Figure 16. I-V curve

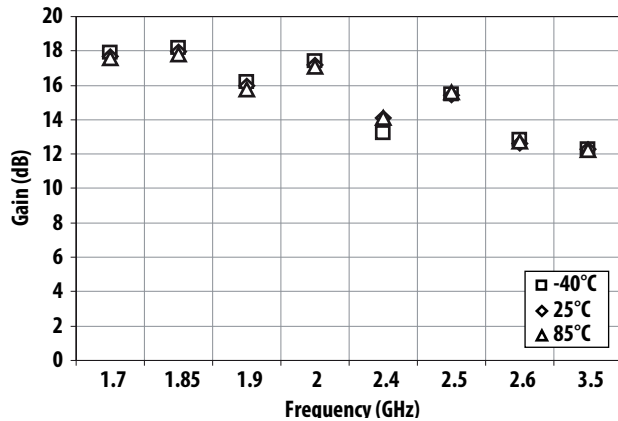


Figure 17. Gain vs Frequency and Temperature tuned for Optimum OIP3 and Fmin at 5V 50mA

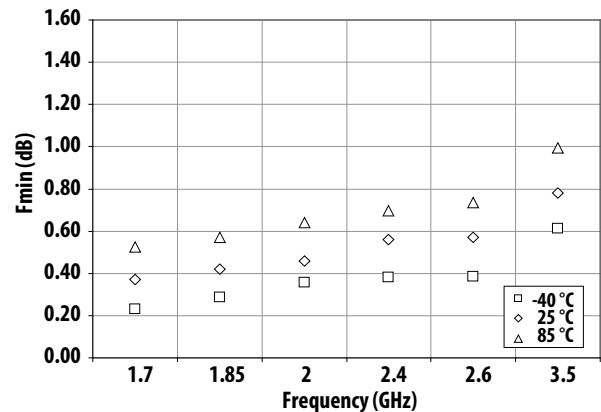


Figure 18. Fmin vs Frequency and Temperature tuned for Optimum OIP3 and Fmin at 5V 50mA

## MGA-17516 Typical Performance

RF performance for each RF channel at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $I_{dd} = 50\text{mA}$  unless otherwise stated. OIP3 is measured with input power of -15dBm per tone.

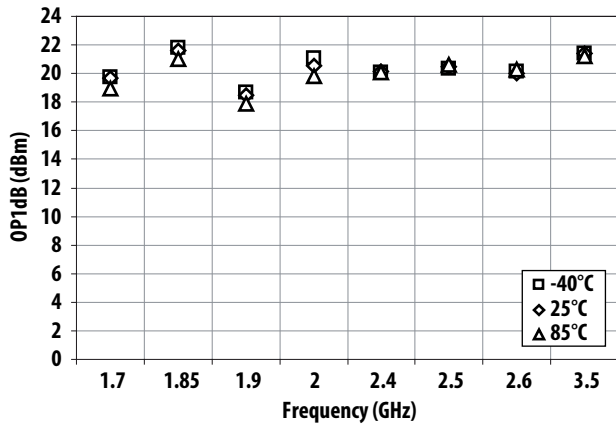


Figure 19. OP1dB vs Frequency and Temperature for Optimum OIP3 and Fmin at 5V 50mA

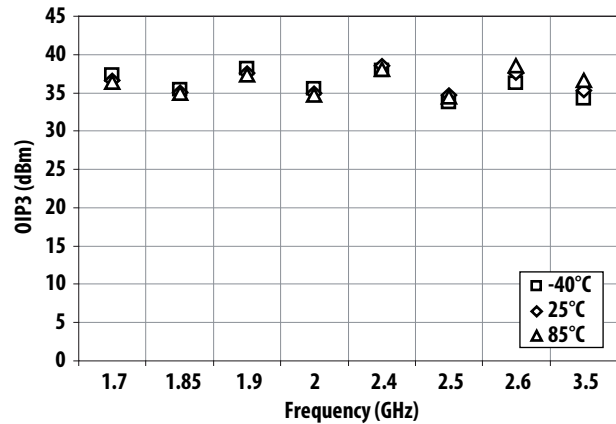


Figure 20. OIP3 vs Frequency and Temperature for Optimum OIP3 and Fmin at 5V 50mA

Below is the table showing the MGA-17516 Reflection Coefficient Parameters tuned for Maximum OIP3,  $V_{dd}=5\text{V}$ ,  $I_{dd}=50\text{mA}$ .

Frequency(GHz)	Gamma Load position		MAX OIP3 (dBm)	P1dB (dBm)
	Magnitude	Angle		
1.70	0.402	3.5	36.6	19.7
1.85	0.104	40.1	35.1	21.6
1.90	0.512	-9.4	37.6	18.5
2.00	0.153	44.0	34.9	20.5
2.40	0.369	3.5	38.5	20.1
2.50	0.170	143.3	34.7	20.5
2.60	0.566	40.0	37.5	20.0
3.50	0.352	178.8	35.3	21.4

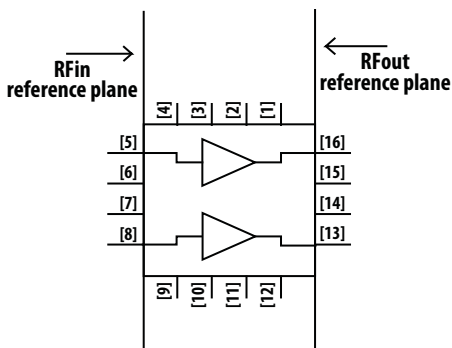


Figure 21.

### Notes:

1. The Maximum OIP3 values are calculated based on Load pull measurements on approximately 100 different impedances using Maury's Load pull test system.
2. Measurements are conducted on 0.010 inch thick ROGER 4350. The input reference plane is at the end of the RFin pin and the output reference plane is at the end of the RFout pin as shown in Figure 21.
3. Gamma Load for maximum OIP3 with biasing 3V50mA, 3.5V 50mA, 4V 50mA, 4.5V 50mA, 5V 40mA, 5V 50mA and 5V 60mA from 500 MHz to 3.5 GHz are available upon request.



## MGA-17516 Typical Performance

RF performance at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $I_{dd} = 50\text{mA}$ , given for each RF channel, measured on demo board in Figure 5 with component list in Table 1 for 1.85GHz matching. OIP3 is measured with input power of -15dBm per tone.

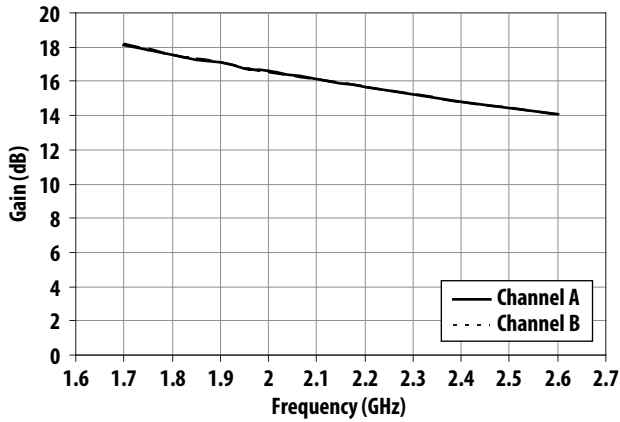


Figure 22. Gain vs Frequency and channel

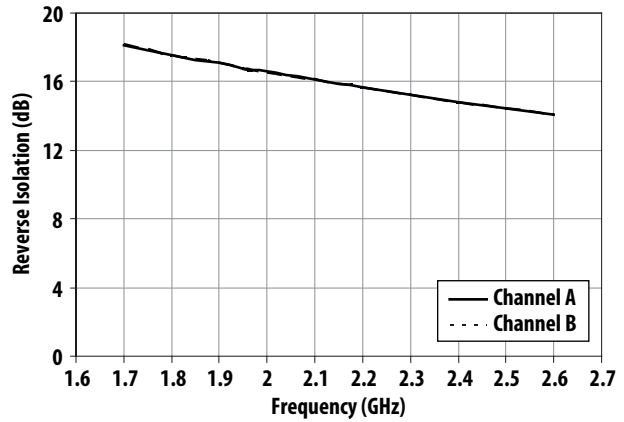


Figure 23. Reverse Isolation vs Frequency and channel

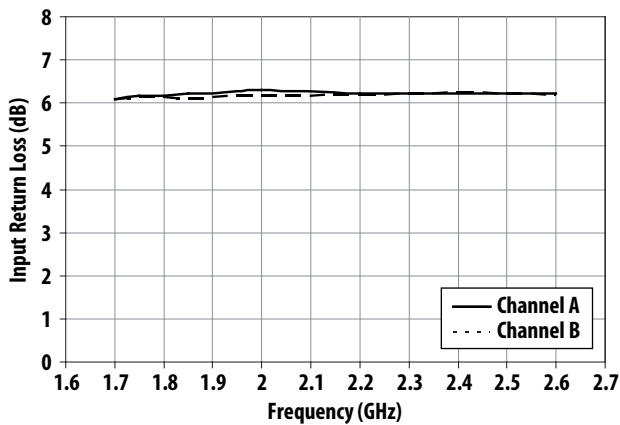


Figure 24. Input Return Loss vs Frequency and channel

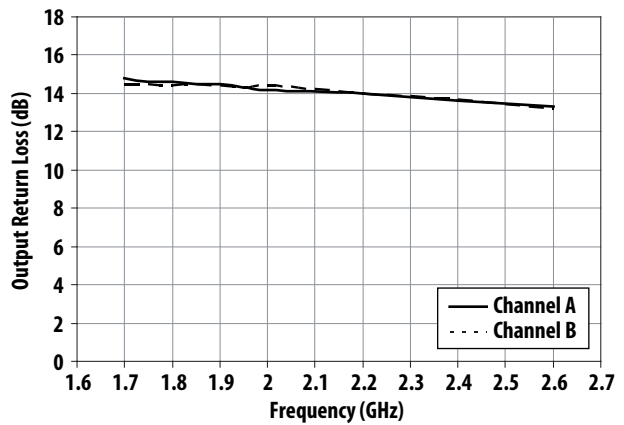


Figure 25. Output Return Loss vs Frequency and channel

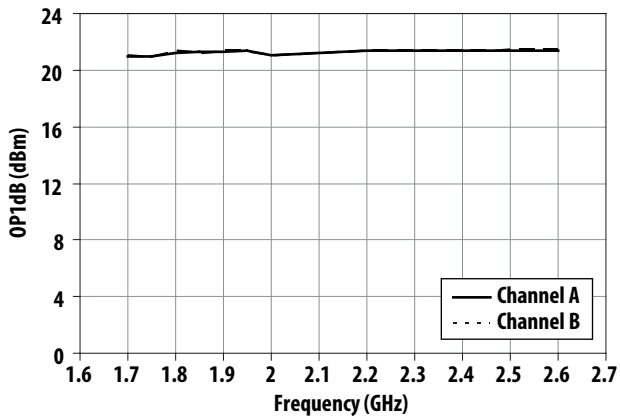


Figure 26. OP1dB vs Frequency and channel

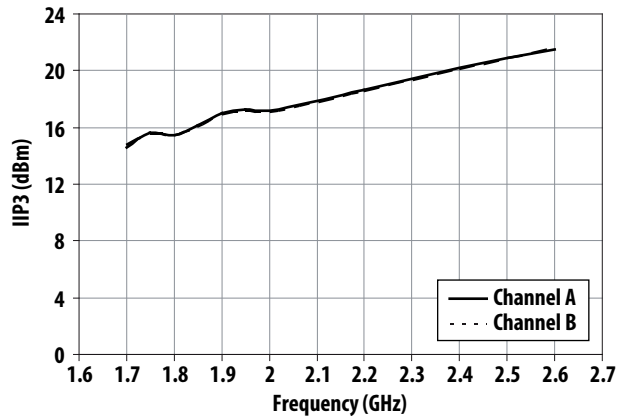


Figure 27. IIP3 vs Frequency and channel

## MGA-17516 Typical Performance

RF performance at  $T_A = 25^\circ\text{C}$ ,  $V_{dd} = 5\text{V}$ ,  $I_{dd} = 50\text{mA}$ , given for each RF channel, measured on demo board in Figure 5 with component list in Table1 for 1.85GHz matching. OIP3 is measured with input power of -15dBm per tone.

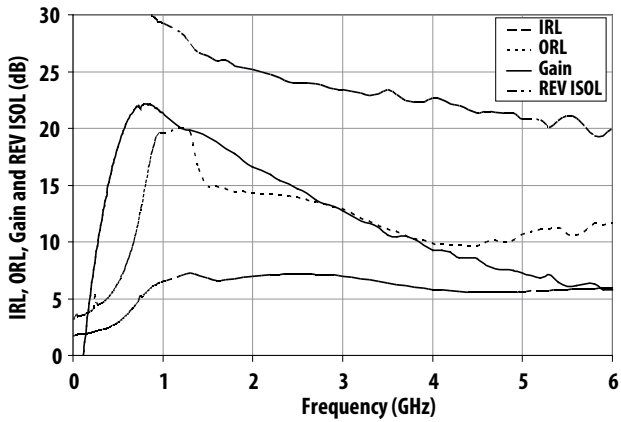


Figure 28. Input Return Loss, Output Return Loss, Gain, Reverse Isolation vs Frequency for channel A

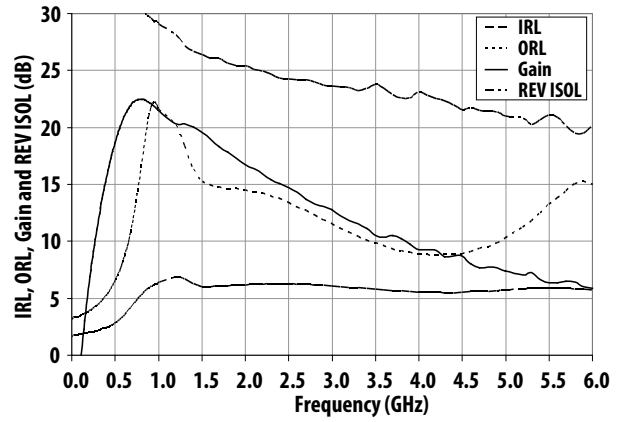


Figure 29. Input Return Loss, Output Return Loss, Gain, Reverse Isolation vs Frequency for channel B

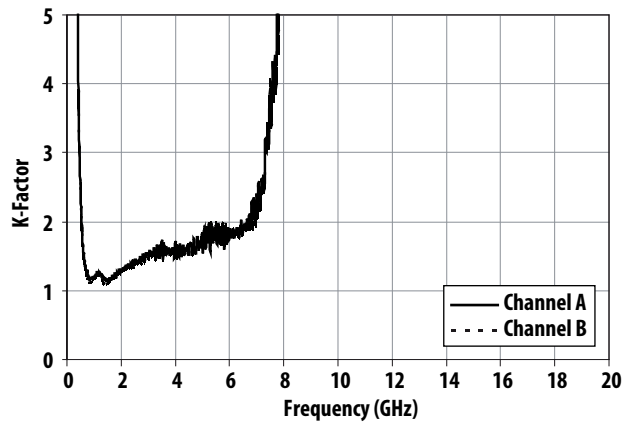


Figure 30. K-Factor vs Frequency and channel

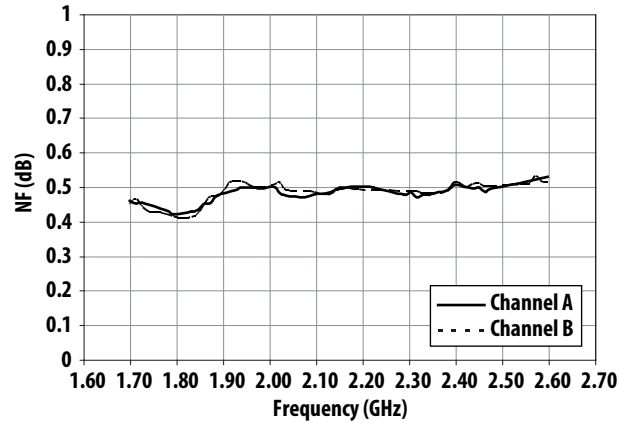


Figure 31. NF vs Frequency and channel

**MGA-17516 Typical Scattering Parameters, Vdd = 5V, Idd = 50mA**

Freq GHz	S11		S21			S12		S22	
	Mag.	Ang.	dB	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
0.1	0.98	-13.0	27.46	23.61	165.1	0.005	86.7	0.39	-25.4
0.5	0.80	-61.6	25.03	17.84	130.3	0.024	58.9	0.26	-57.7
0.9	0.66	-94.7	22.46	13.28	106.8	0.034	47.8	0.19	-87.4
1.0	0.64	-99.7	21.88	12.41	102.5	0.036	45.5	0.18	-90.8
1.5	0.548	-127.9	19.20	9.12	82.6	0.045	38.2	0.13	-125.0
1.9	0.52	-145.4	17.41	7.42	69.6	0.052	33.5	0.12	-155.1
2.0	0.51	-149.2	17.01	7.08	66.6	0.054	31.6	0.12	-162.2
2.5	0.49	-166.2	15.16	5.73	52.7	0.062	25.3	0.14	166.1
3.0	0.48	179.6	13.51	4.74	39.7	0.070	18.6	0.17	144.0
4.0	0.48	157.6	10.90	3.51	16.4	0.085	5.3	0.24	115.5
5.0	0.48	138.2	8.78	2.75	-6.4	0.099	-10.4	0.30	87.1
6.0	0.47	119.7	6.85	2.20	-26.9	0.111	-24.9	0.40	71.2
7.0	0.46	93.9	5.05	1.79	-49.2	0.119	-42.0	0.51	50.6
8.0	0.49	71.3	3.14	1.44	-70.0	0.122	-58.5	0.62	33.4
9.0	0.53	58.2	1.36	1.17	-87.5	0.123	-72.2	0.66	19.2
10.0	0.55	52.8	-0.10	0.99	-102.4	0.127	-84.0	0.69	6.6
11.0	0.56	47.2	-1.41	0.85	-116.8	0.129	-95.3	0.71	-5.9
12.0	0.54	35.1	-2.64	0.74	-131.9	0.131	-107.7	0.76	-15.2
13.0	0.55	18.1	-4.09	0.63	-146.8	0.127	-120.3	0.81	-21.5
14.0	0.59	4.6	-5.34	0.54	-160.4	0.126	-132.0	0.83	-26.4
15.0	0.63	3.3	-6.26	0.49	-172.8	0.127	-142.7	0.82	-36.3
16.0	0.65	7.5	-6.83	0.46	174.6	0.133	-153.4	0.80	-51.0
17.0	0.63	11.0	-7.35	0.43	162.7	0.139	-164.2	0.80	-64.3
18.0	0.62	4.9	-7.88	0.40	151.5	0.145	-174.1	0.82	-66.9
19.0	0.61	-7.4	-8.37	0.38	139.9	0.150	174.7	0.83	-65.0
20.0	0.65	-20.8	-9.02	0.35	126.5	0.150	162.4	0.81	-66.9

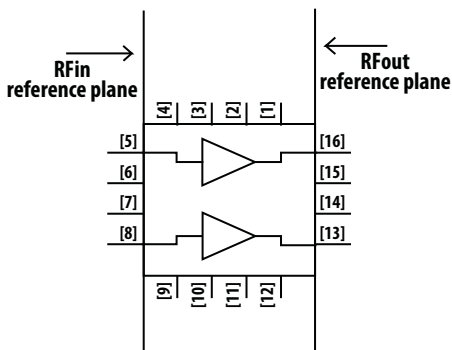


Figure 32.

### Typical Noise Parameters, Vdd = 5V, Idd = 50mA

Freq GHz	Fmin	$\Gamma_{opt}$	$\Gamma_{opt}$	$R_{n/50}$
	dB	Mag.	Ang.	
0.5	0.32	0.56	-18.64	0.069
0.7	0.32	0.48	-0.51	0.064
0.9	0.32	0.35	7.71	0.064
1.7	0.39	0.31	24.36	0.066
1.85	0.41	0.29	61.77	0.050
2.0	0.45	0.19	68.44	0.049
2.4	0.52	0.19	95.09	0.047
2.6	0.57	0.23	113.84	0.047
3.5	0.78	0.28	153089	0.037

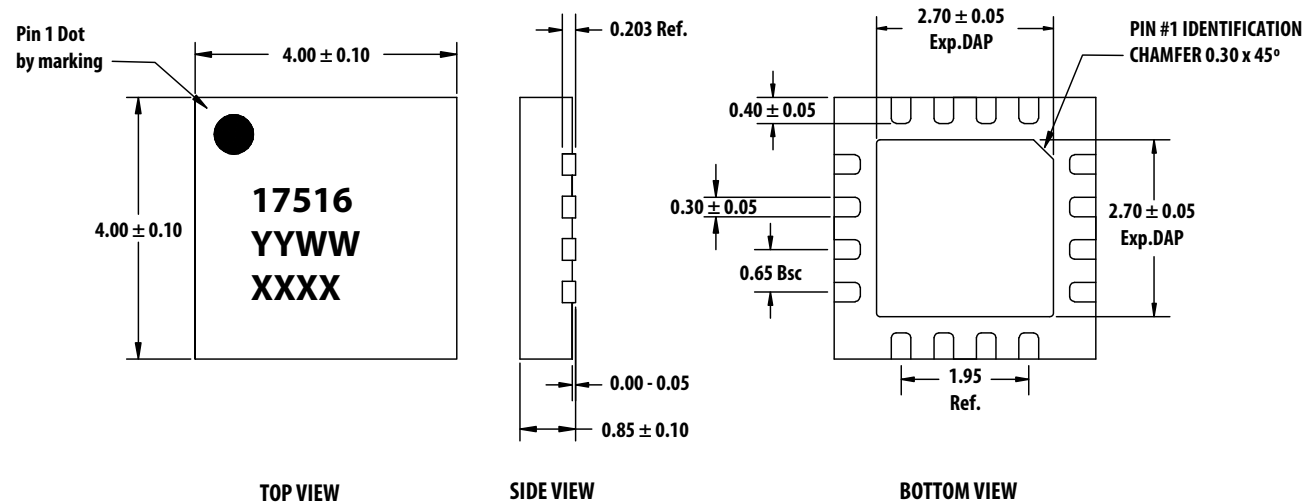
#### Notes:

1. The Fmin values are based on noise figure measurements at 100 different impedances using Focus source pull test system. From these measurements a true Fmin is calculated.
2. Scattering and noise parameters are measured on 10 mils thick ROGER 4350 with total board thickness of 62 mils. The input reference plane is at the end of the RFin pin and the output reference plane is at the end of the RFout pin as shown in Figure 32.
3. S2P file with scattering and noise parameters for biasing 3V 50mA, 3.5V 50mA, 4V 50mA, 4.5V 50mA, 5V 40mA and 5V 60mA are available upon request.

### Part Number Ordering Information

Part Number	No. of Devices	Container
MGA-17516-BLKG	100	Antistatic Bag
MGA-17516-TR1G	3000	Tape/reel

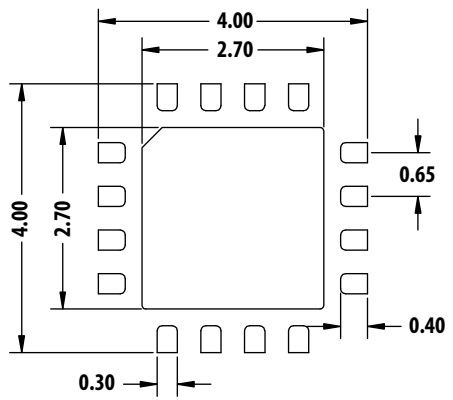
### SLP4X4 Package Dimension



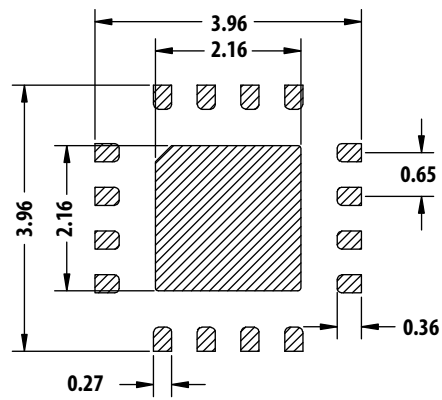
#### Notes:

1. All dimensions are in millimeters.
2. Dimensions are inclusive of plating.
3. Dimensions are exclusive of mold ash and metal burr.

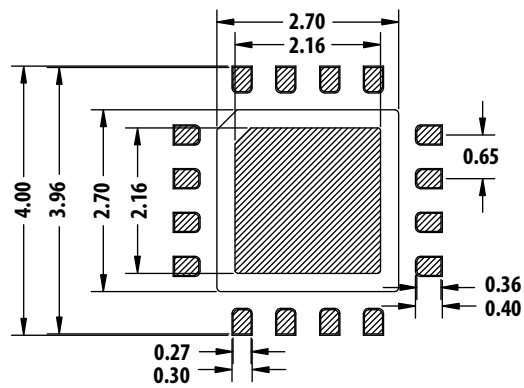
## PCB Land Pattern and Stencil Design



Land Pattern



Stencil Opening

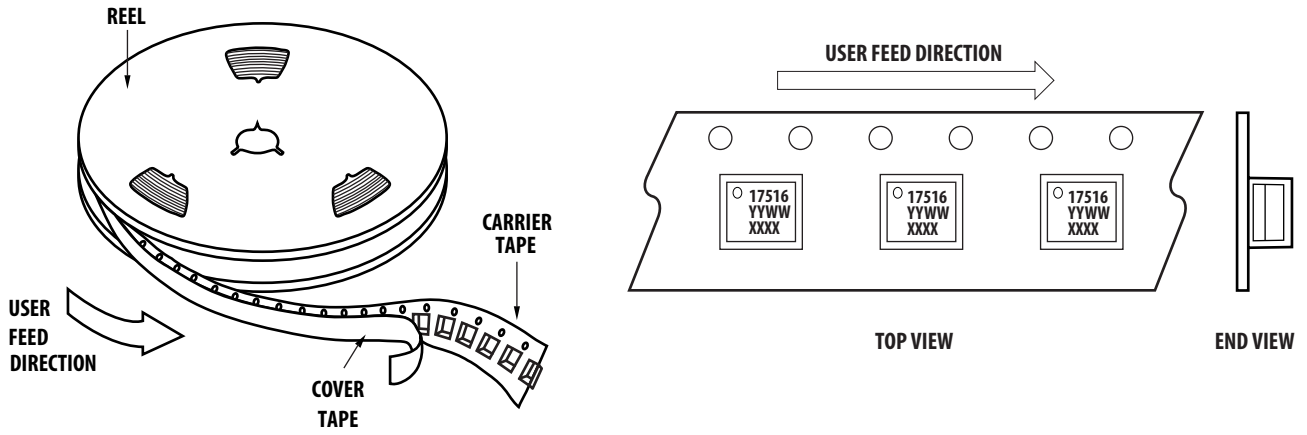


Combination of Land Pattern & Stencil Opening

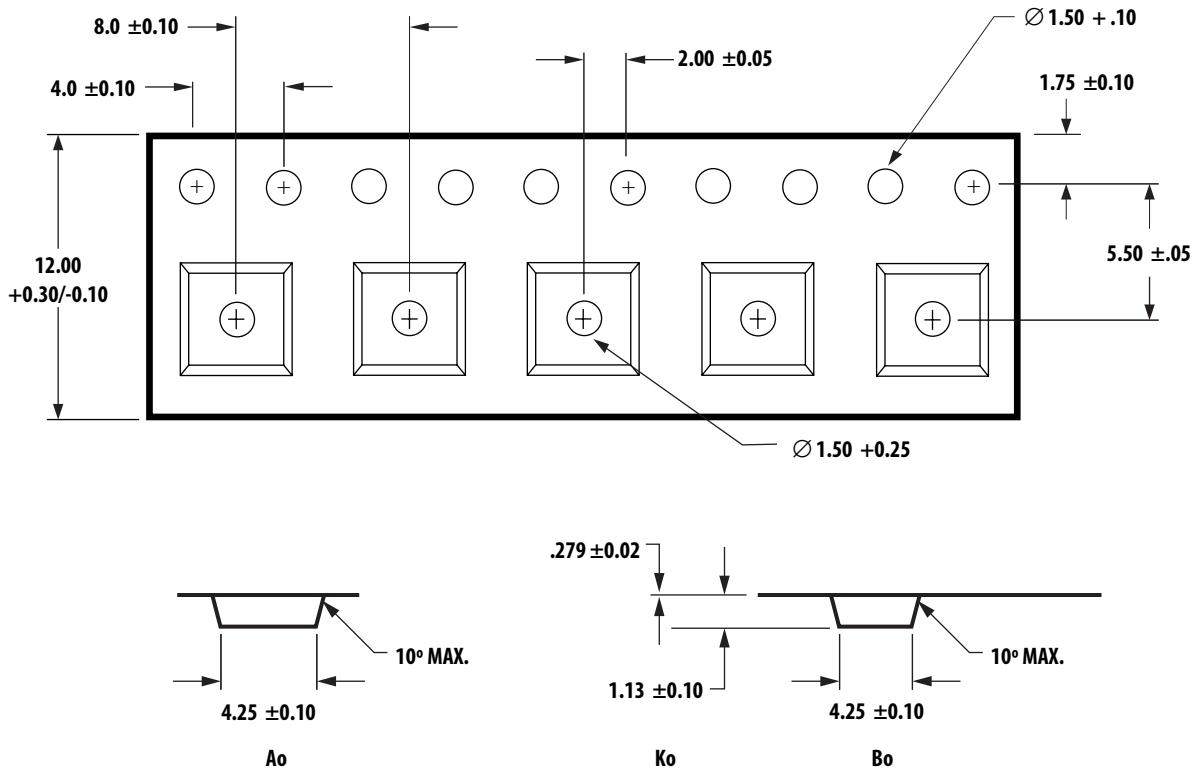
Notes:

1. All dimensions are in millimeters.
2. 4 mil stencil thickness recommended

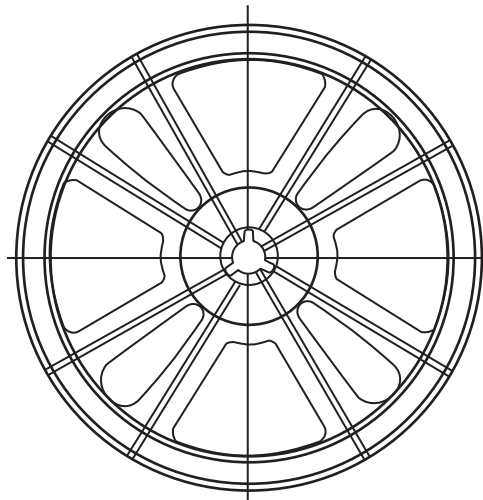
### Device Orientation



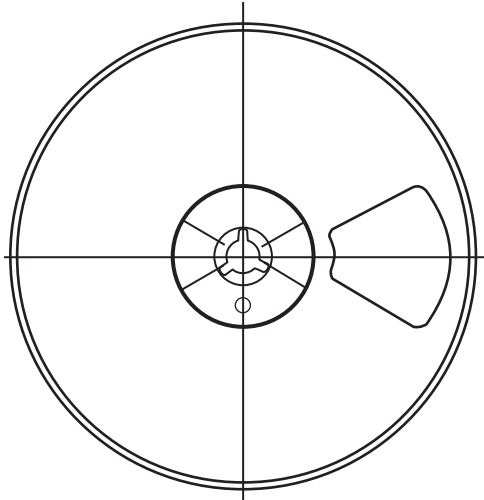
### Tape Dimensions



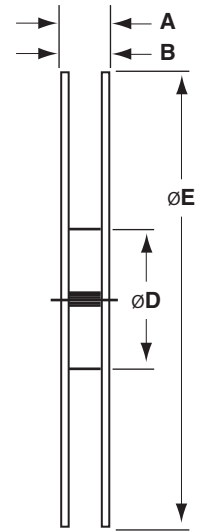
# Reel Dimension - 7 Inch



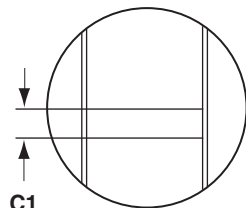
FRONT VIEW



BACK VIEW



SIDE VIEW

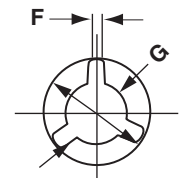


C1

TAPE SLOT  
PLANE VIEW

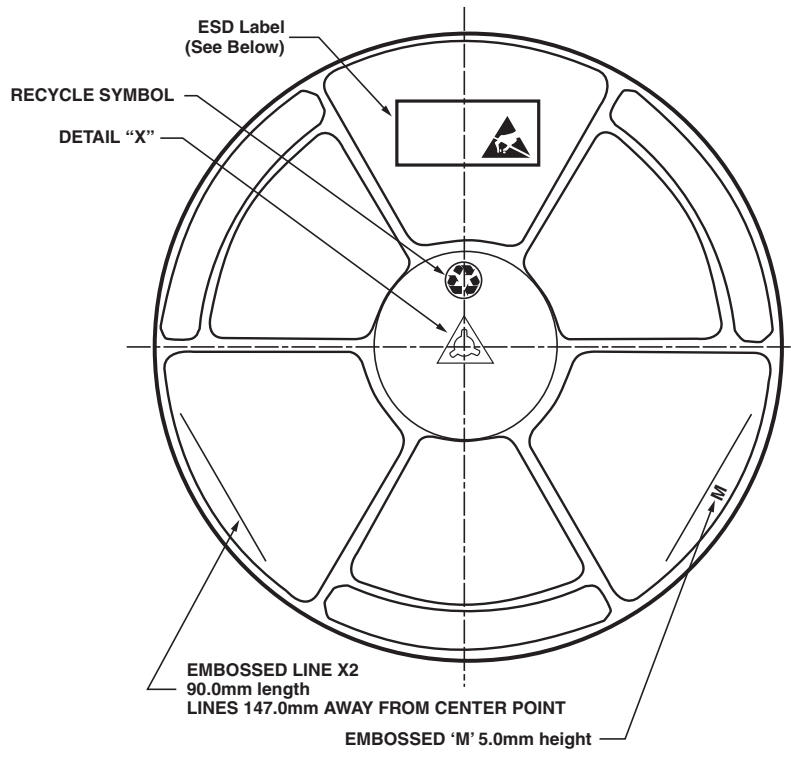
SPECIFICATION								
TAPE WIDTH	A MAX	B +1.5-0.0	C1 ±0.5	ØD ±0.5	ØE (max)	F (min)	ØG ±0.2	ØH (min)
12mm	18.00	12.4	4.40	55.0	178	1.50	13.50	20.20

Note: Surface resistivity to be  $<10^{12}$  Ohms/square

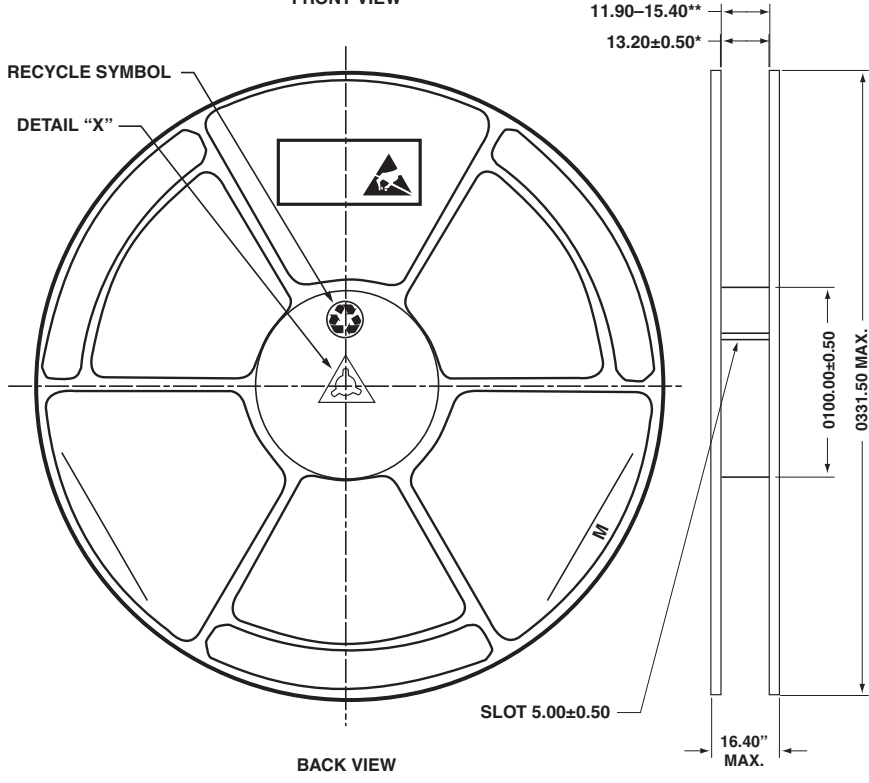


ARBOR HOLE

# Reel Dimension - 13 Inch



FRONT VIEW



BACK VIEW

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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