MGA-53589

50MHz to 3GHz High Linear Amplifier

Data Sheet

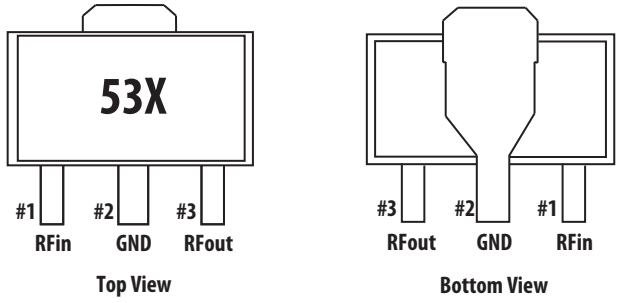
Description

Avago Technologies' MGA-53589 is a highly dynamic range low noise amplifier MMIC, housed in a SOT-89 standard plastic package.

MGA-53589 is especially ideal for Cellular/PCS/W-CDMA basestation, wireless LAN, WLL and other systems in the 50MHz to 3GHz frequency range applications. With high IP3 and low noise figure, the MGA-53589 may be utilized as a driver amplifier in the transmit chain and as a second stage LNA in the receive chain.

MGA-53589 is a versertile component and allows circuit designers to put suitable external matching elements to suit its intended application such as max OIP3, lowest NF, highest return loss and etc.

Pin connections and Package Marking



Note:
Top View : Package marking provides orienation and identification
"53" = Device Code
"X" = Date Code character indentifies month of manufacturing

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model = 40 V
ESD Human Body Model = 250 V
Refer to Avago Application Note A004R:
Electrostatic Discharge, Damage and Control.

Features

- Lead-free Option Available
- Very high linearity at low DC bias power
- Low noise figure
- High OIP3
- Advanced enhancement mode PHEMT Technology
- Excellent uniformity in product specification
- SOT-89 standard package

Specifications

At 1.9GHz, Vdd=5V, Idd=52mA (typ) @ 25°C

- OIP3 = 37dBm
- Noise Figure = 1.66dB
- Gain = 15.8 dB
- P1dB = 18.2dBm
- IRL = 14.4 dB, ORL = 15.7 dB

Application

- Base station radio card
- High linearity LNA for base stations, WLL, WLAN and other applications in the 50MHz to 6GHz range.

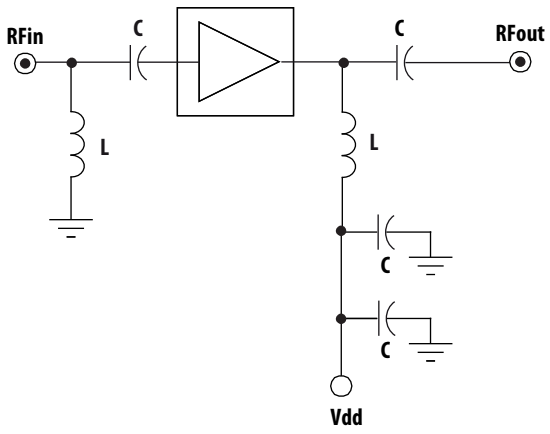


Figure 1. Simplified Schematic Diagram

MGA-53589 Absolute Maximum Rating [1]

Symbol	Parameter	Units	Absolute Maximum
Vin	Max input voltage	V	0.8
V_d	Supply Voltage (Id=52mA)	V	5.5
P_d	Power Dissipation [2]	mW	400
P_{in}	CW RF Input Power	dBm	13
T_j	Junction Temperature	°C	150
T_{stg}	Storage Temperature	°C	-65 to 150

Thermal Resistance [3]
(V_d=5.0V) θ_{jc} = 62.5°C/W

Notes:
1. Operation of this device is excess of any of these limits may cause permanent damage.
2. Source lead temperature is 25°C. Derate 7.7mW/°C for TL > 125°C.
3. Thermal resistance measured using150°CInfra-RedMicroscopy Technique.

MGA-53589 Electrical Specification

T_C = 25°C, Z_o = 50 , V_d = 5V, unless noted

Symbol	Parameter and Test Condition	Frequency	Units	Min.	Typ.	Max.	stdev(4)
I_d	Current Drawn	N/A	mA	40	52	70	0.001
NF	Noise Figure	0.9GHz[1]		-	1.24	-	-
		1.9GHz[1]	dB	-	1.66	2	0.02
		2.4GHz[1]		-	1.61	-	-
Gain	Gain	0.9GHz[1]		-	18.2	-	-
		1.9GHz[1]	dB	14	15.8	17	0.07
		2.4GHz[1]			15.3	-	-
OIP3	Output Third Order Intercept Point[2]	0.9GHz[1]		-	36.8	-	-
		1.9GHz[1]	dBm	34	37	-	0.66
		2.4GHz[1]		-	37.2	-	-
P1dB	Output Power at 1dB Gain Compression	0.9GHz[1]		-	18.6	-	-
		1.9GHz[1]	dBm	16.5	18.2	20.5	0.12
		2.4GHz[1]		-	17.6	-	-
PAE	Power Added Efficiency at P1dB	0.9GHz[1]		-	24.7	-	-
		1.9GHz[1]	%	-	27.3	-	0.21
		2.4GHz[1]		-	22.7	-	-
IRL	Input Return Loss	0.9GHz[1]		-	13.6	-	-
		1.9GHz[1]	dB	-	14.4	-	0.29
		2.4GHz[1]		-	11.6	-	-
ORL	Output Return Loss	0.9GHz[1]		-	20.3	-	-
		1.9GHz[1]	dB	-	15.7	-	0.31
		2.4GHz[1]		-	14.1	-	-
ISO	Isolation	0.9GHz[1]		-	22.1	-	-
		1.9GHz[1]	dB	-	22.4	-	0.09
		2.4GHz[1]		-	22.3	-	-

Notes:
1. Measurements obtained from a test circuit described in Figure 34. Input and output matching components are tuned for consistent OIP3; while keeping VSWR better than 2:1. Data obtained are minus board losses.
2. I) Output power level and frequency of two fundamental tones at 0.9GHz; F1 & F2 =-0.38dB; F1=0.905GHz and F2=0.915GHz
   II) Output power level and frequency of two fundamental tones at 1.9GHz; F1 & F2 =5.49dB; F1=1.905GHz and F2=1.915GHz
   III) Output power level and frequency of two fundamental tones at 2.4GHz; F1 & F2 =5dB; F1=2.405GHz and F2=2.415GHz
3. Standard deviation data are based on at least 500 pieces samples size taken from 2 wafer lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower specification limits.

MGA-53589 Consistency Distribution Chart at 1900MHz [4,5]

T_C = 25°C, V_d=5V (in production test board tuned for optimum OIP3)

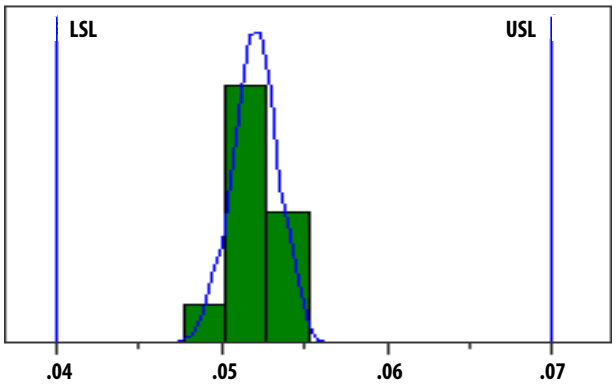


Figure 2. Idd Distribution

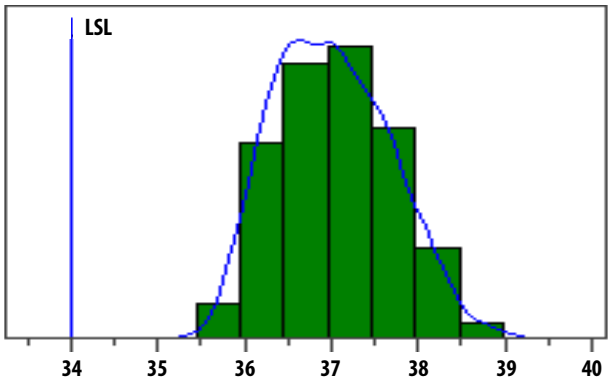


Figure 3. OIP3 Distribution

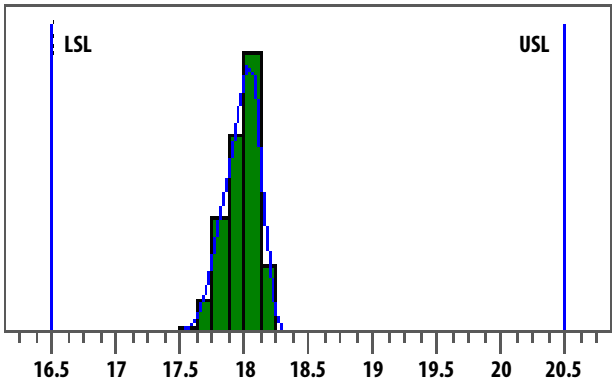


Figure 4. P1dB Distribution

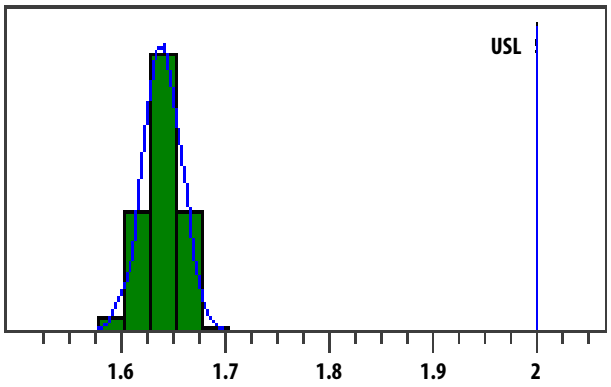


Figure 5. NF Distribution

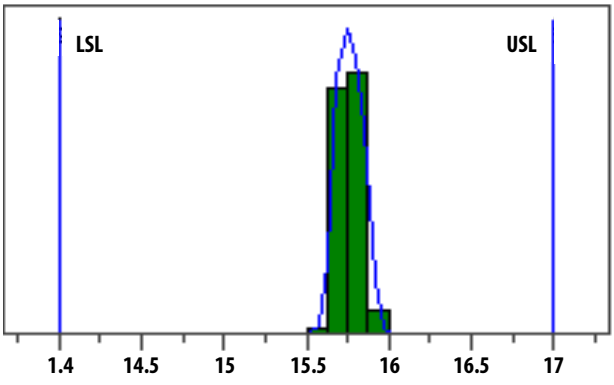


Figure 6. Gain Distribution

Note:

4. Data sample size is 500 samples taken from 2 different wafers and 2 different lots. Future wafers allocated to this product may have nominal values anywhere between the upper and lower limits
5. 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.

Application Circuit : 900MHz (for optimum OIP3 across temperature)

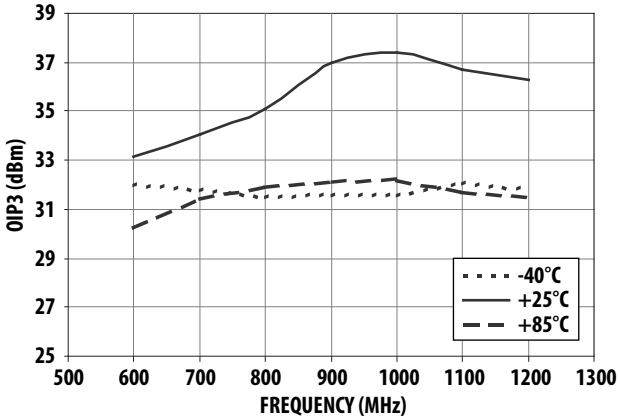


Figure 7. OIP3 vs Frequency and Temperature

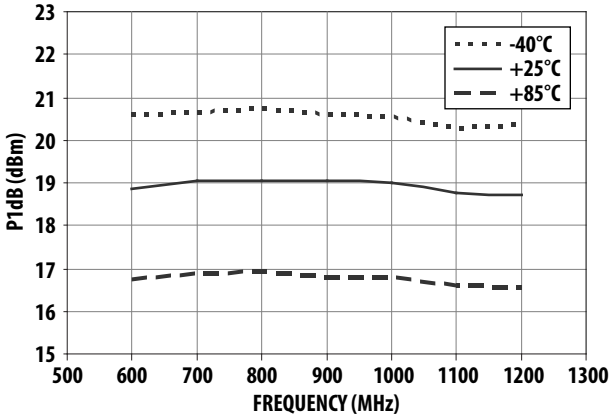


Figure 8. P1dB vs Frequency and Temperature

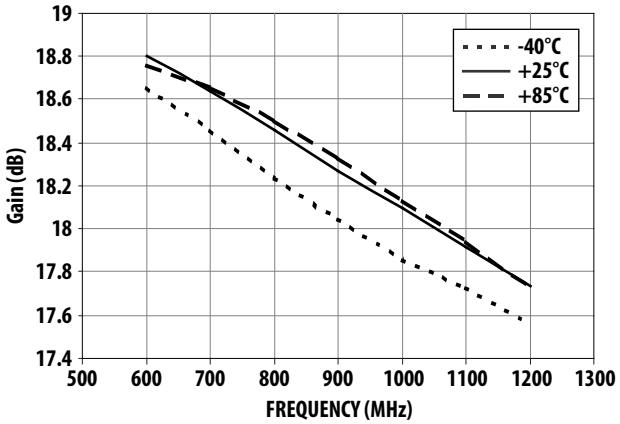


Figure 9. Gain vs Frequency and Temperature

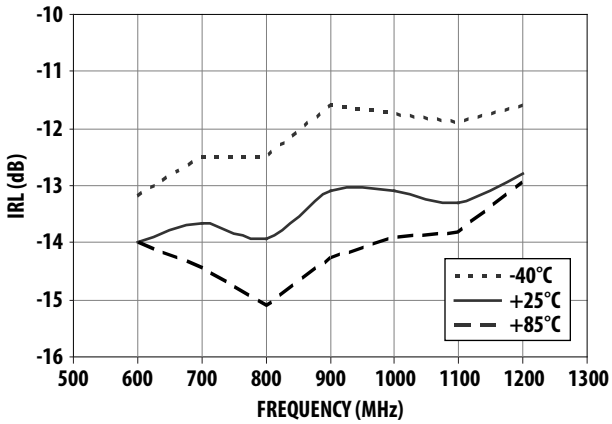


Figure 10. IRL vs Frequency and Temperature

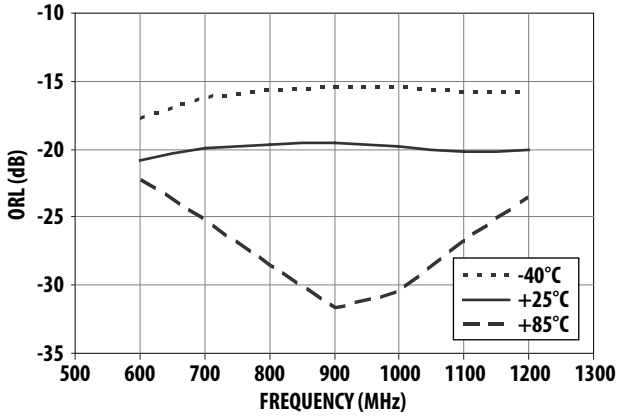


Figure 11. ORL vs Frequency and Temperature

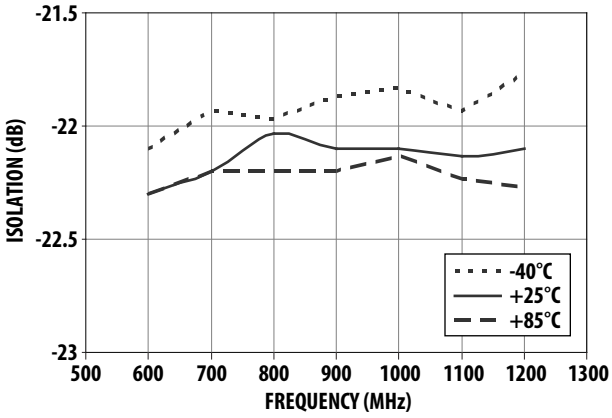


Figure 12. Isolation vs Frequency and Temperature

Application Circuit : 900MHz (for optimum OIP3 across temperature) – continue

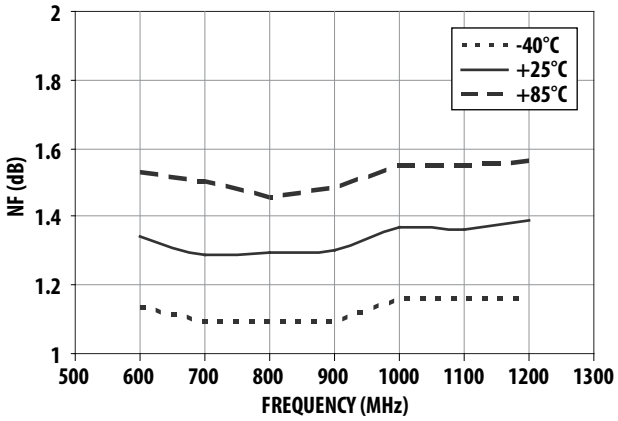


Figure 13. Noise Figure vs Frequency vs Temperature

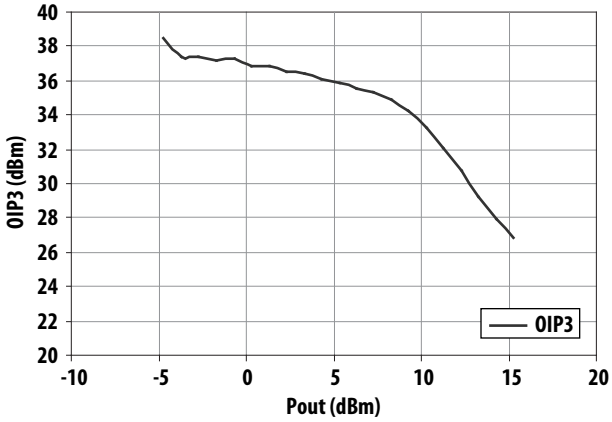


Figure 14. OIP3 vs Output Power at 900MHz

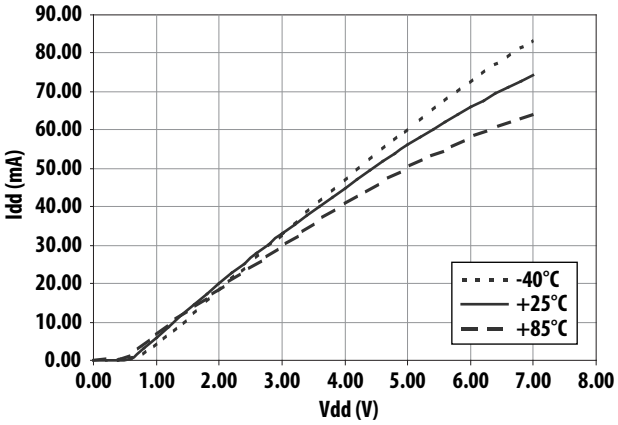


Figure 15. Current vs Voltage and Temperature

Application Circuit : 1900MHz (for optimum OIP3 across temperature)

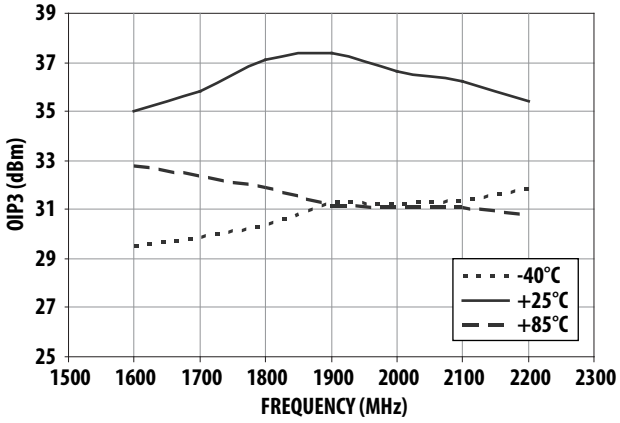


Figure 16. OIP3 vs Frequency and Temperature

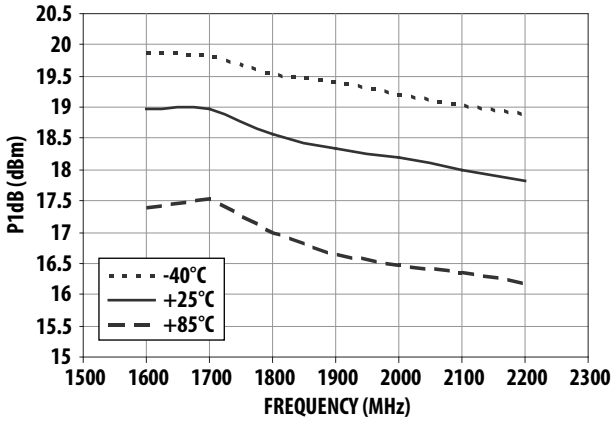


Figure 17. P1dB vs Frequency and Temperature

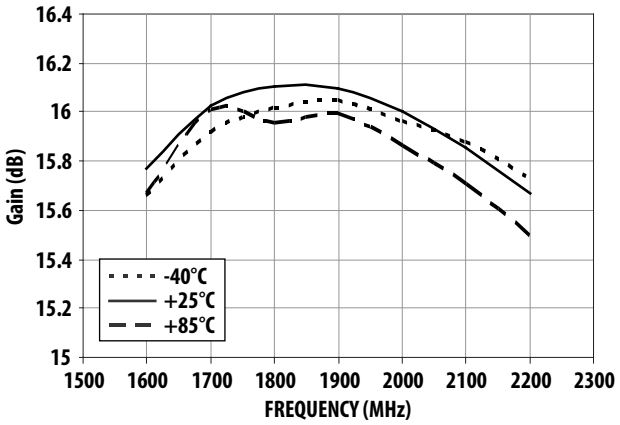


Figure 18. Gain vs Frequency and Temperature

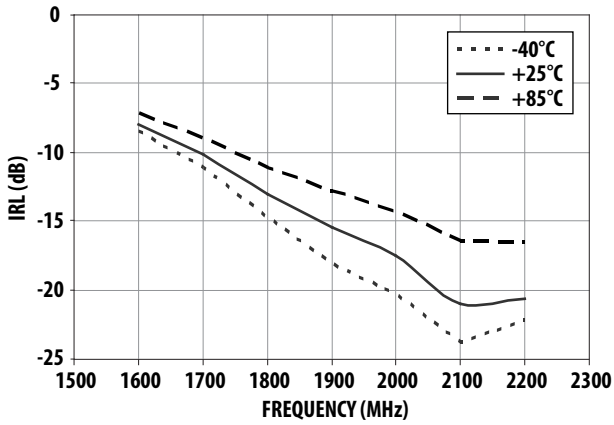


Figure 19. IRL vs Frequency and Temperature

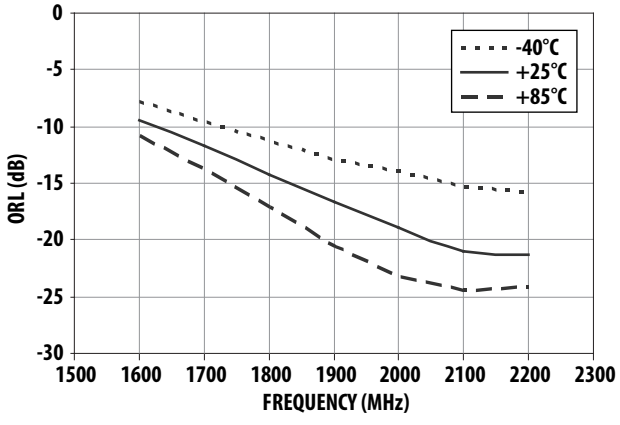


Figure 20. ORL vs Frequency and Temperature

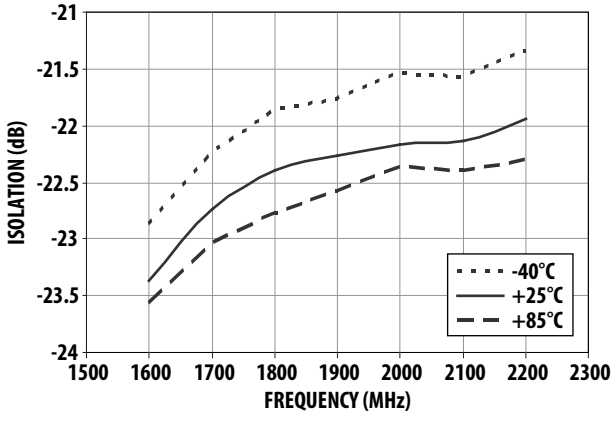


Figure 21. Isolation vs Frequency and Temperature

Application Circuit : 1900MHz (for optimum OIP3 across temperature) – continue

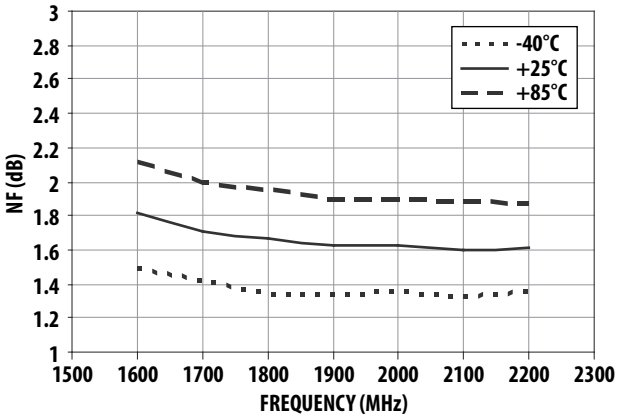


Figure 22. Noise Figure vs Frequency vs Temperature

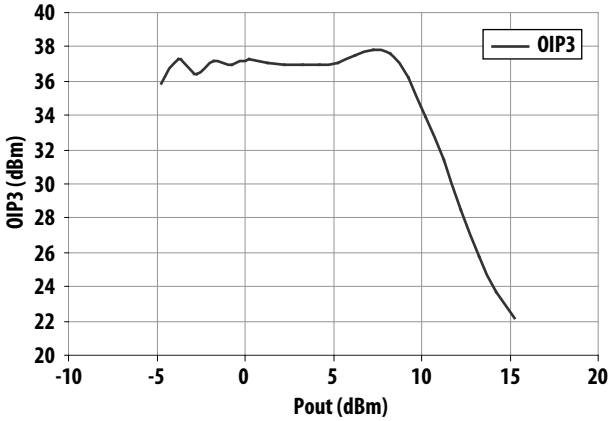


Figure 23. OIP3 vs Output Power at 1900MHz

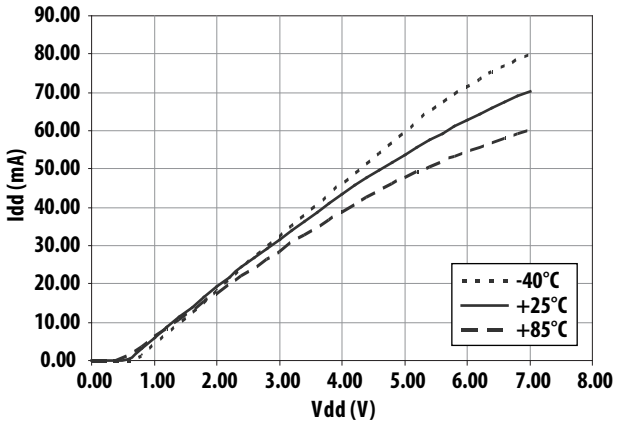


Figure 24. Current vs Voltage and Temperature

Application Circuit : 2400MHz (for optimum OIP3 across temperature)

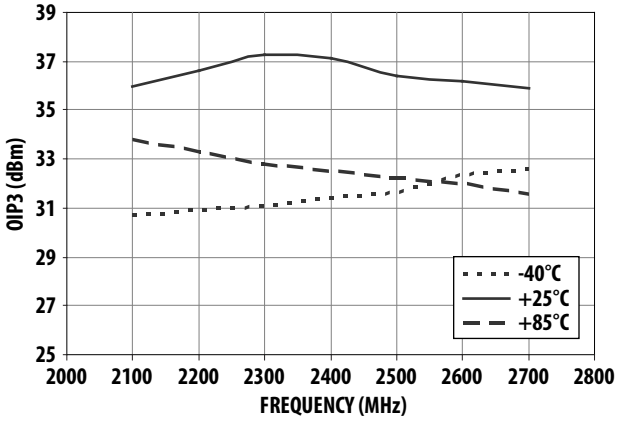


Figure 25. OIP3 vs Frequency and Temperature

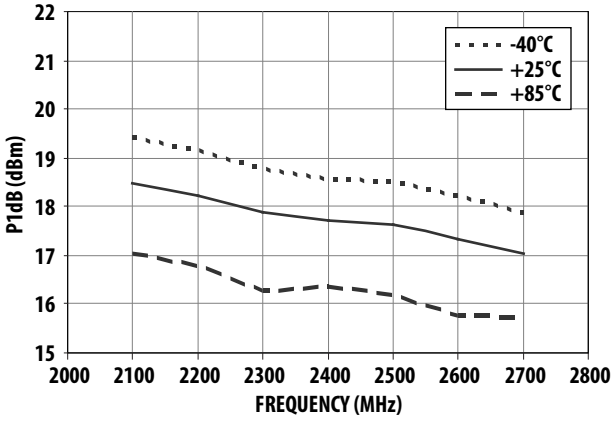


Figure 26. P1dB vs Frequency and Temperature

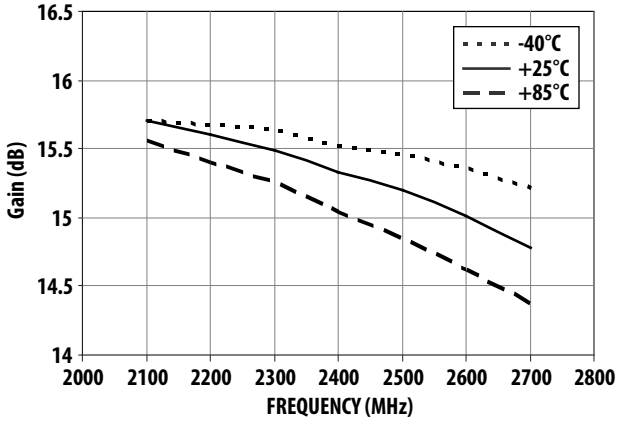


Figure 27. Gain vs Frequency and Temperature

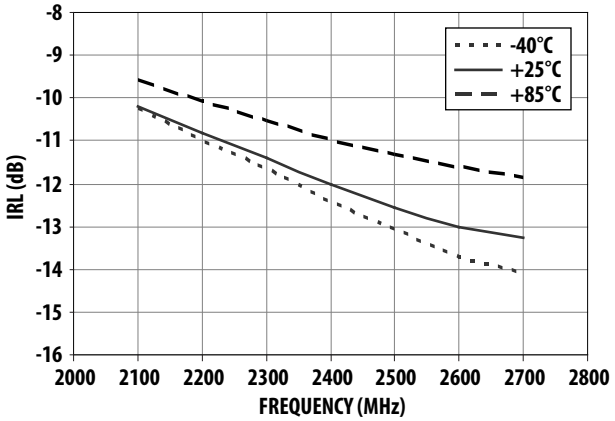


Figure 28. IRL vs Frequency and Temperature

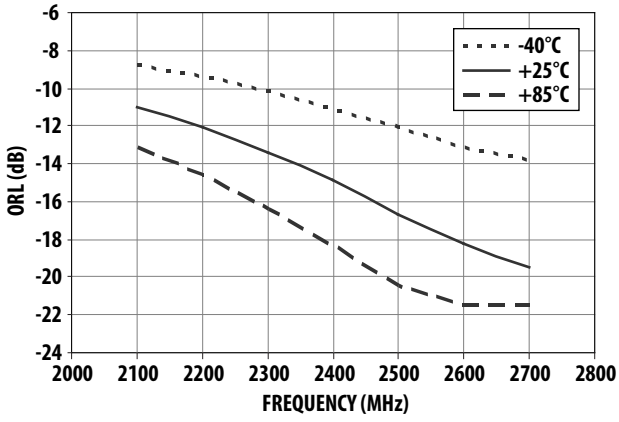


Figure 29. ORL vs Frequency and Temperature

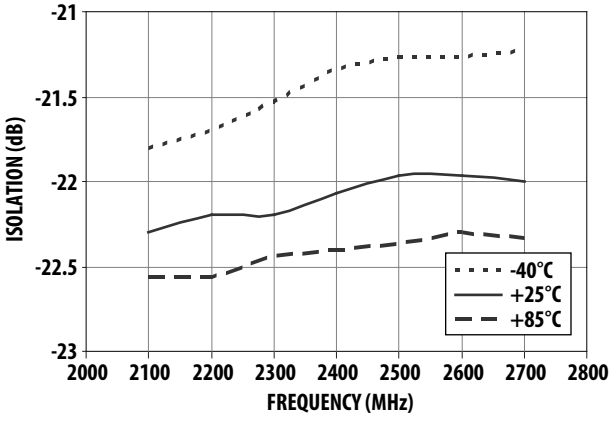


Figure 30. Isolation vs Frequency and Temperature

Application Circuit : 2400MHz (for optimum OIP3 across temperature) – continue

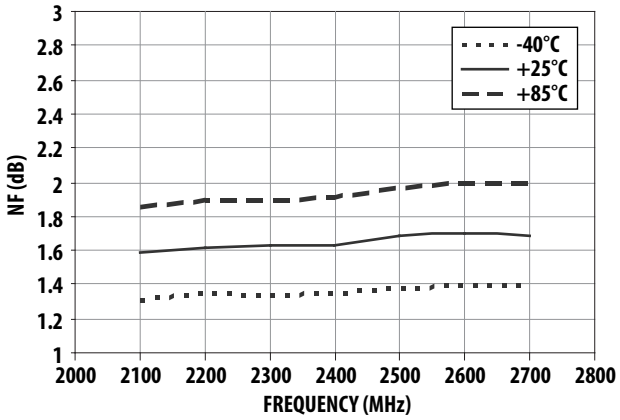


Figure 31. Noise Figure vs Output Power at 1900MHz

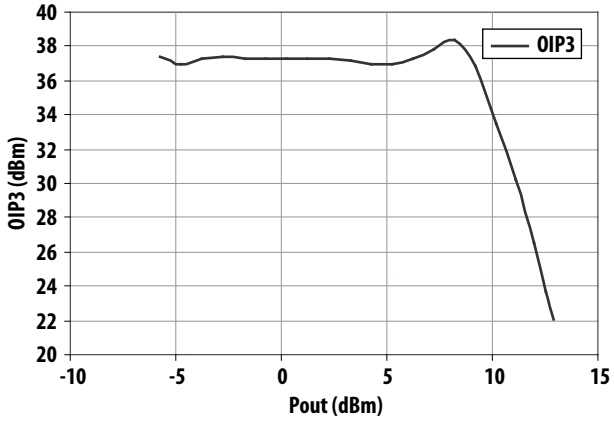


Figure 32. OIP3 vs Output Power at 2400MHz

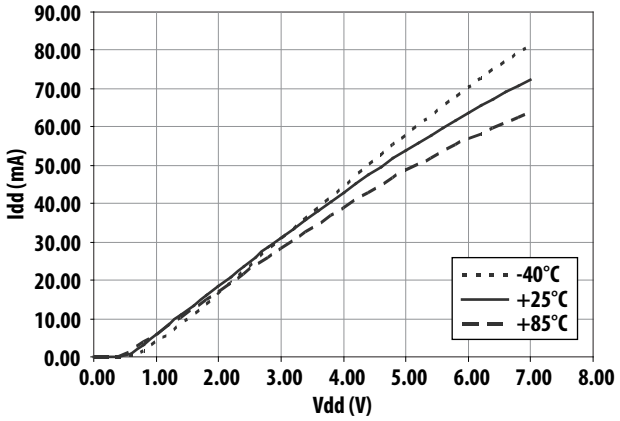
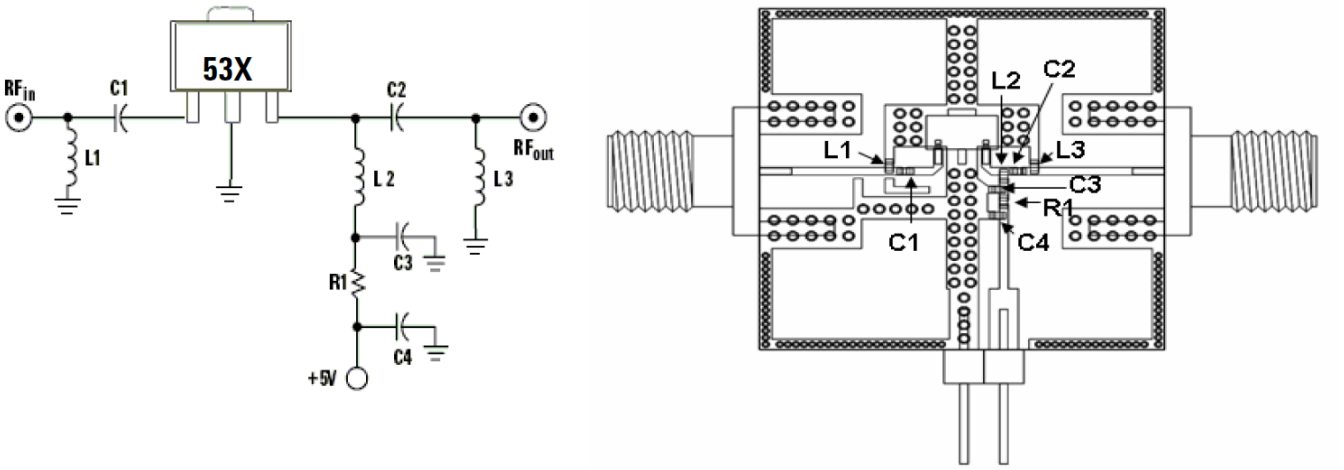


Figure 33. Current vs Voltage and Temperature

Circuit description (for optimum OIP3 across temperature)



Bill of Materials

		Description					
Circuit Symbol	Size	For 0.9GHz (1)		For 1.9GHz (2)		For 2.4GHz (3)	
L1	0402	22nH	Toko	4.3nH	Coilcraft	12nH	Toko
C1	0402	8.2pF	Kyocera	1.5pF	Murata	3.3pF	Murata
L2	0402	47nH	Toko	3.9nH	Toko	68nH	Toko
C2	0402	8.2pF	Kyocera	3.0pF	Kyocera	6.8pF	Murata
L3	0402	39nH	Toko	NA	Not in use	4.7nH	Coilcraft
C3	0402	150pF	Murata	150pF	Murata	100pF	Murata
C4	0402	0.1uF	Murata	0.1uF	Murata	0.1uF	Murata
R1	0402	0 R	KOA	0 R	KOA	0 R	KOA

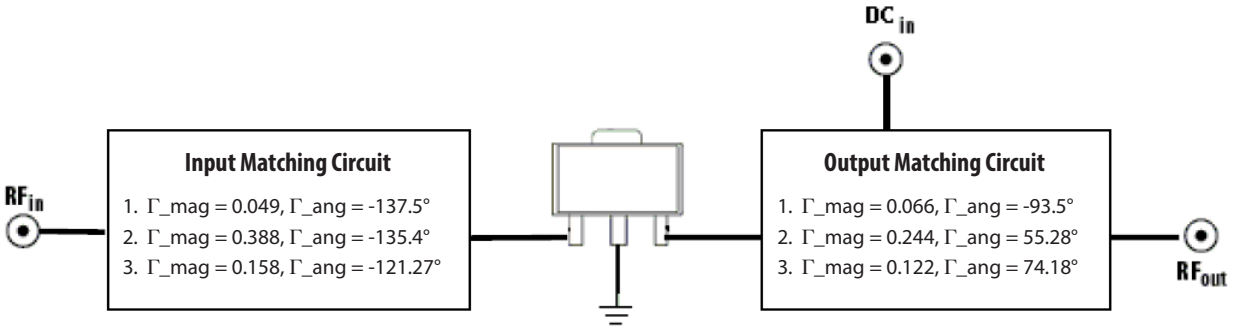
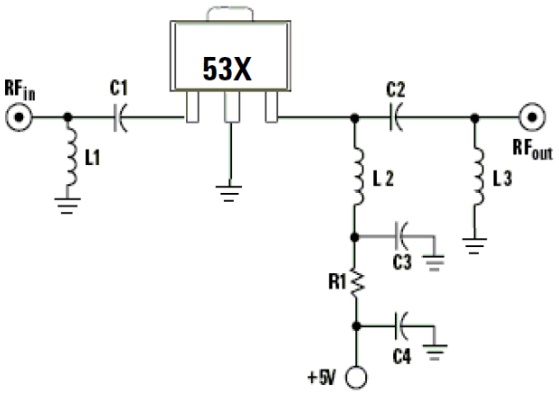
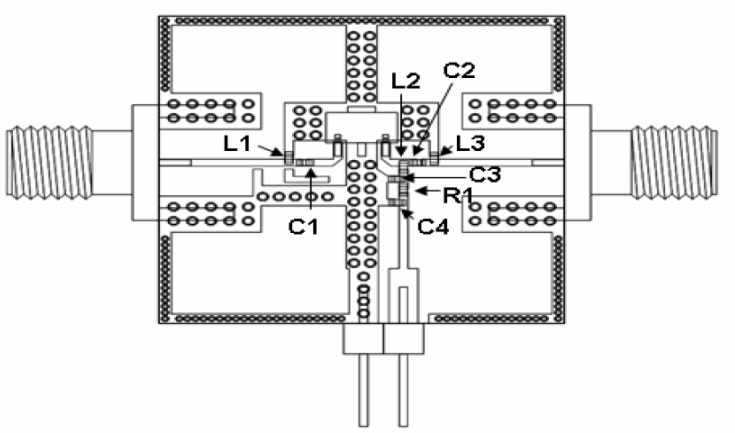


Figure 34. Demoboard and application circuit components table for Optimum OIP3

To bias the MGA-53589, a +5V supply is connected to the output pin thru an inductor labeled as L2; which isolates the in-band signal from the DC supply as shown in Figure 34. Capacitor C3 serves as an RF bypass for in-band signals while C4 helps to eliminate out the band low frequency signals. An optional R1 may be added to de-Q any resonance created between C3 and C4. Typical values range from 2.2Ω to 10Ω. A DC blocking capacitor C2, is used at the output of the MMIC to isolate the supply voltage from succeeding circuits. L3 can be added to improve the circuits ESD as well as providing a better filtering output response. On its input, the C1 acts as a DC blocking capacitor (to isolate supply voltage from previous circuits) as well as with L1, creates a filter response that remove low frequencies signals.

Circuit description (for Max OIP3)





Bill of Materials

		Description			
Circuit Symbol	**Size**	**For 0.9GHz [4]**		**For 1.9GHz [5]**	
L1	0402	27nH	Toko	12nH	Toko
C1	0402	10pF	Kyocera	3.3pF	Murata
L2	0402	33nH	Toko	4.7nH	Toko
C2	0402	5.1pF	Murata	1.8pF	Kyocera
L3	0402	NA	Not in use	12nH	Toko
C3	0402	150pF	Murata	150pF	Murata
C4	0402	0.1uF	Murata	0.1uF	Murata
R1	0402	0ohm	Koa	0ohm	Koa

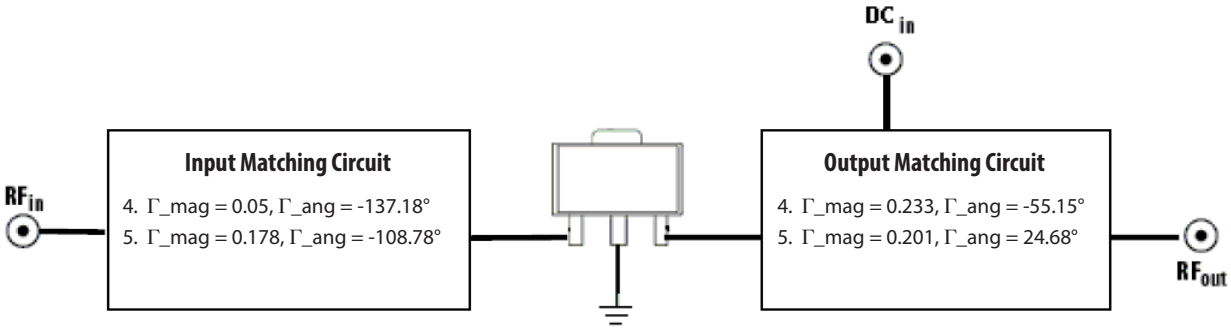


Figure 35. Demoboard and application circuit components table for max OIP3

	Tested at 25°C on Max OIP3 tuned Demoboard		
Parameters	**900MHz [4]**	**1900MHz [5]**	**Unit of measurement**
OIP3	40.9	39.6	dBm
NF	1.26	1.47	dB
Gain	17.5	15.9	dB
P1dB	18.6	18.4	dBm
PAE	25.0	27.0	%
Rlin	-15.3	-13.3	dB
Rlout	-12.1	-17.1	dB
Isolation	-22.2	-22.2	dB

MGA-53589 Typical Scatter Parameters

T_c=25°C, V_d=5.0V, I_d=52mA, Z_o=50Ω

Freq	S11	S11	S11	S21	S21	S21	S12	S12	S12	S22	S22	S22	
GHz	Mag.	Ang.	dB	Mag.	Ang.	dB	Mag.	Ang.	dB	Mag.	Ang.	dB	K
0.10	0.628	-70.2	-4.0	16.865	147.5	24.5	0.062	39.1	-24.1	0.539	-65.1	-5.4	0.462
0.20	0.420	-104.1	-7.5	12.092	141.2	21.6	0.075	21.4	-22.5	0.327	-101.4	-9.7	0.723
0.30	0.337	-124.2	-9.5	10.255	139.8	20.2	0.079	13.4	-22.1	0.233	-127.0	-12.6	0.867
0.40	0.297	-138.0	-10.5	9.388	138.1	19.5	0.080	8.8	-21.9	0.186	-149.4	-14.6	0.946
0.50	0.276	-148.4	-11.2	8.879	135.5	19.0	0.081	5.4	-21.8	0.162	-170.0	-15.8	0.992
0.60	0.238	-165.2	-12.5	8.530	132.4	18.6	0.082	3.0	-21.8	0.167	177.2	-15.5	1.029
0.70	0.231	-172.4	-12.7	8.279	128.8	18.4	0.082	0.8	-21.7	0.156	163.1	-16.1	1.047
0.80	0.227	-178.7	-12.9	8.063	124.8	18.1	0.082	-1.1	-21.7	0.149	150.1	-16.6	1.060
0.90	0.223	176.3	-13.0	7.871	120.6	17.9	0.083	-2.9	-21.7	0.143	136.5	-16.9	1.071
1.00	0.223	171.8	-13.0	7.690	116.3	17.7	0.083	-4.6	-21.6	0.140	124.3	-17.1	1.081
1.10	0.224	168.0	-13.0	7.513	111.9	17.5	0.083	-6.2	-21.6	0.139	111.9	-17.1	1.089
1.20	0.225	164.9	-13.0	7.338	107.4	17.3	0.083	-7.8	-21.6	0.142	100.5	-16.9	1.098
1.30	0.228	161.9	-12.8	7.165	102.9	17.1	0.083	-9.3	-21.6	0.147	89.5	-16.6	1.108
1.40	0.231	159.6	-12.7	6.989	98.4	16.9	0.083	-10.8	-21.6	0.155	79.8	-16.2	1.118
1.50	0.234	157.2	-12.6	6.816	94.0	16.7	0.083	-12.2	-21.6	0.161	70.4	-15.8	1.130
1.60	0.241	155.4	-12.3	6.654	89.4	16.5	0.083	-13.5	-21.7	0.171	62.7	-15.4	1.139
1.70	0.248	153.5	-12.1	6.484	84.9	16.2	0.082	-14.8	-21.7	0.180	55.3	-14.9	1.151
1.80	0.256	151.4	-11.8	6.311	80.5	16.0	0.082	-16.1	-21.7	0.191	49.2	-14.4	1.164
1.90	0.265	149.2	-11.5	6.140	76.1	15.8	0.082	-17.5	-21.8	0.202	43.4	-13.9	1.177
2.00	0.273	147.0	-11.3	5.969	71.7	15.5	0.081	-18.6	-21.8	0.213	38.0	-13.4	1.192
2.10	0.281	144.8	-11.0	5.795	67.4	15.3	0.081	-19.7	-21.9	0.222	33.1	-13.1	1.210
2.20	0.287	143.0	-10.9	5.619	63.3	15.0	0.080	-20.6	-21.9	0.228	28.8	-12.9	1.233
2.30	0.298	142.1	-10.5	5.481	59.4	14.8	0.080	-21.4	-21.9	0.235	26.7	-12.6	1.243
2.40	0.315	139.7	-10.0	5.353	55.3	14.6	0.080	-22.7	-22.0	0.248	24.0	-12.1	1.256
2.50	0.323	136.8	-9.8	5.206	51.1	14.3	0.080	-23.7	-22.0	0.258	20.0	-11.8	1.268
3.00	0.357	124.2	-9.0	4.511	30.9	13.1	0.078	-28.4	-22.1	0.278	5.5	-11.1	1.376
3.50	0.368	116.6	-8.7	3.794	11.3	11.6	0.076	-32.7	-22.4	0.268	-0.5	-11.4	1.614
4.00	0.530	103.8	-5.5	3.236	-5.1	10.2	0.076	-34.9	-22.4	0.209	-10.6	-13.6	1.595
5.00	0.571	63.1	-4.9	2.286	-40.0	7.2	0.077	-45.9	-22.3	0.175	24.2	-15.2	2.041
6.00	0.678	46.8	-3.4	1.558	-65.1	3.9	0.080	-55.1	-21.9	0.272	38.6	-11.3	2.236
7.00	0.756	37.5	-2.4	1.227	-84.5	1.8	0.084	-64.4	-21.5	0.289	38.6	-10.8	2.115
8.00	0.799	20.7	-2.0	0.915	-109.0	-0.8	0.084	-82.2	-21.5	0.394	30.6	-8.1	2.180
9.00	0.756	2.9	-2.4	0.663	-129.8	-3.6	0.075	-101.9	-22.4	0.498	20.5	-6.0	3.337
10.00	0.736	-11.4	-2.7	0.495	-145.2	-6.1	0.072	-115.8	-22.9	0.585	10.4	-4.7	4.346
11.00	0.664	-22.0	-3.6	0.360	-158.7	-8.9	0.044	-138.6	-27.1	0.664	3.5	-3.6	9.838
12.00	0.793	-28.2	-2.0	0.327	-172.5	-9.7	0.052	-160.3	-25.8	0.708	-1.6	-3.0	5.181
13.00	0.788	-29.9	-2.1	0.324	174.5	-9.8	0.053	-176.8	-25.5	0.717	-8.5	-2.9	4.923
14.00	0.736	-38.9	-2.7	0.280	159.5	-11.0	0.050	175.5	-26.0	0.703	-17.4	-3.1	7.852
15.00	0.662	-52.4	-3.6	0.278	146.5	-11.1	0.071	165.3	-22.9	0.713	-24.6	-2.9	6.562
16.00	0.602	-81.7	-4.4	0.280	125.1	-11.0	0.091	139.7	-20.8	0.731	-31.5	-2.7	5.383
17.00	0.500	-54.4	-6.0	0.322	125.1	-9.8	0.125	139.5	-18.0	0.771	-34.0	-2.3	3.401
18.00	0.501	-78.9	-6.0	0.383	100.4	-8.3	0.176	116.0	-15.1	0.732	-37.1	-2.7	2.290
19.00	0.307	-96.0	-10.3	0.409	77.7	-7.8	0.207	93.1	-13.7	0.659	-45.3	-3.6	2.925
20.00	0.073	-47.1	-22.7	0.389	54.2	-8.2	0.225	71.5	-12.9	0.499	-55.0	-6.0	4.325

MGA-53589 Typical Noise Parameters

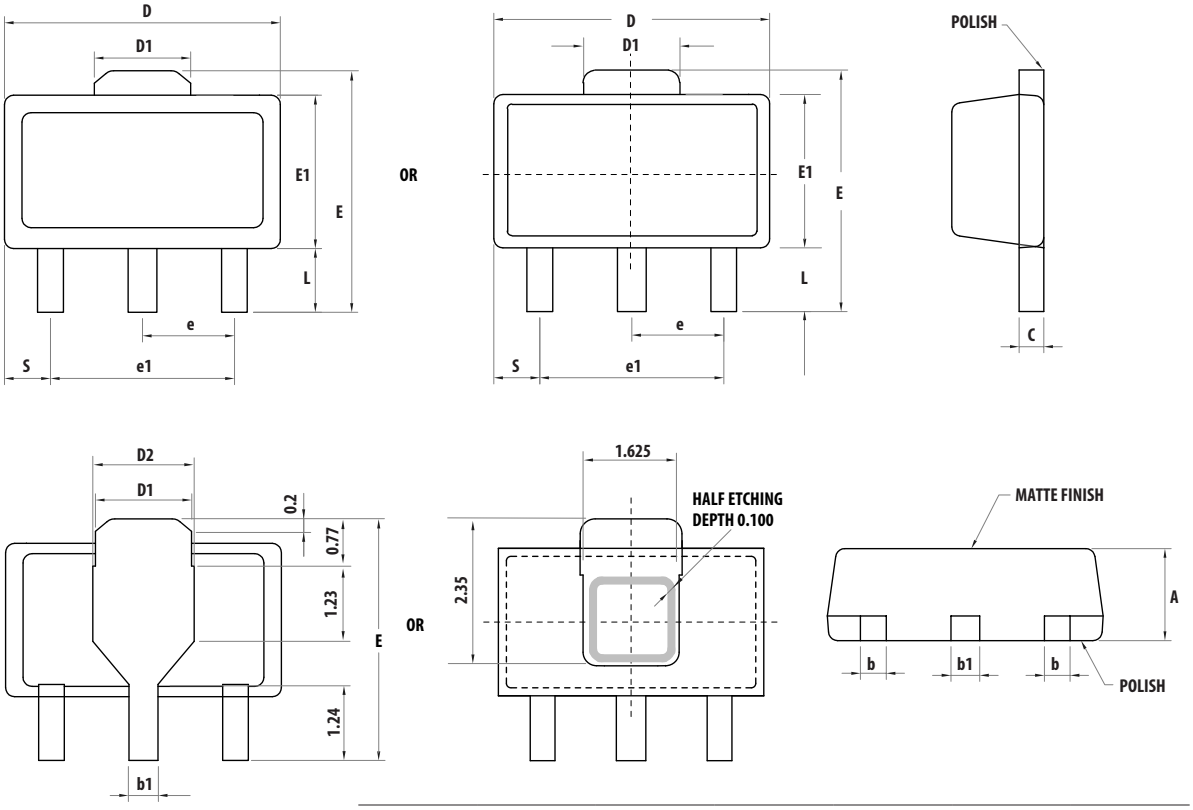
T_c=25°C, V_d=5.0V, I_d=52mA, Z_o=50Ω

Freq (GHz)	F_{min} (dB)	Γ_{opt} Mag	Γ_{opt} Ang	R_n/Z_0	Ga (dB)
0.5	1.121	0.137	-159.6	0.092	19.26
0.8	1.049	0.185	-157.2	0.076	18.6
0.9	1.07	0.207	-160.5	0.082	18.48
1	1.092	0.207	-154.4	0.082	18.36
1.5	1.152	0.238	-150.3	0.09	17.66
2	1.338	0.283	-143.4	0.094	16.87
2.5	1.521	0.332	-138.1	0.13	15.99
3	1.649	0.359	-120.4	0.142	14.98
3.5	1.675	0.4	-108.3	0.186	13.94
4	1.91	0.443	-94.7	0.284	12.86
4.5	1.935	0.488	-77.3	0.4	11.75
5	2.28	0.532	-70.6	0.54	10.65
5.5	2.496	0.597	-55.7	0.792	9.65
6	2.638	0.617	-42.7	1.098	8.57

Part Number Ordering Information

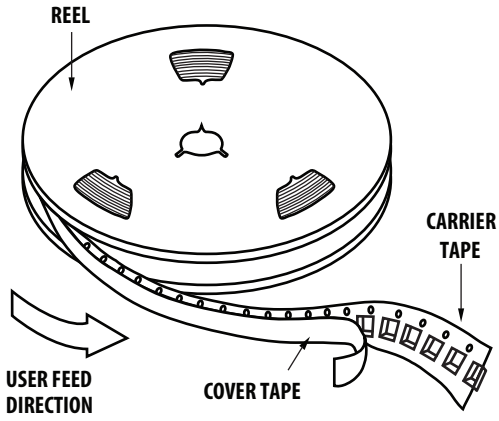
Part Number	No of devices	Container
MGA-53589-BLKG	100	7″ Tape/Reel
MGA-53589-TR1G	3000	13″ Tape/Reel

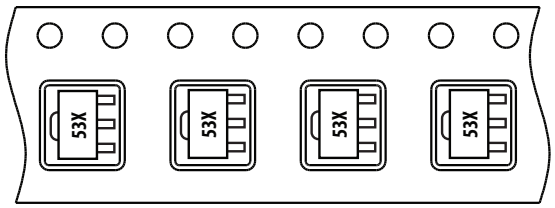
SOT89 Package Dimensions



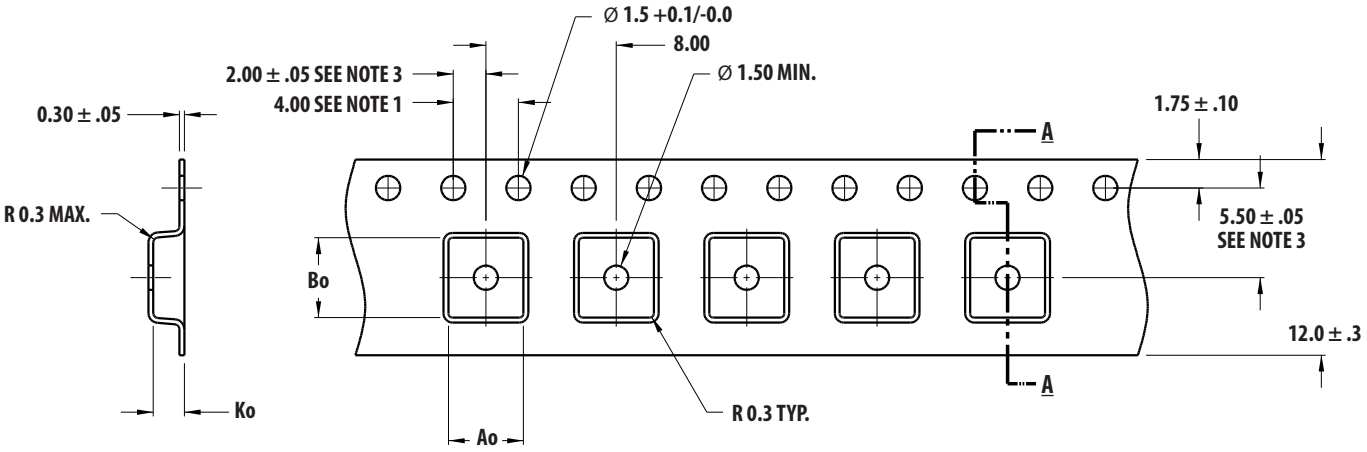
	Dimensions in mm			Dimensions in inches		
Symbols	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	1.40	1.50	1.60	0.055	0.059	0.063
L	0.89	1.04	1.20	0.0350	0.041	0.047
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.030
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
D2	1.45	1.65	1.80	0.055	0.062	0.069
E	3.94	-	4.25	0.155	-	0.167
E1	2.40	2.50	2.60	0.094	0.098	0.102
e1	2.90	3.00	3.10	0.114	0.118	0.122
S	0.65	0.75	0.85	0.026	0.030	0.034
e	1.40	1.50	1.60	0.054	0.059	0.063

Device Orientation





Tape Dimensions



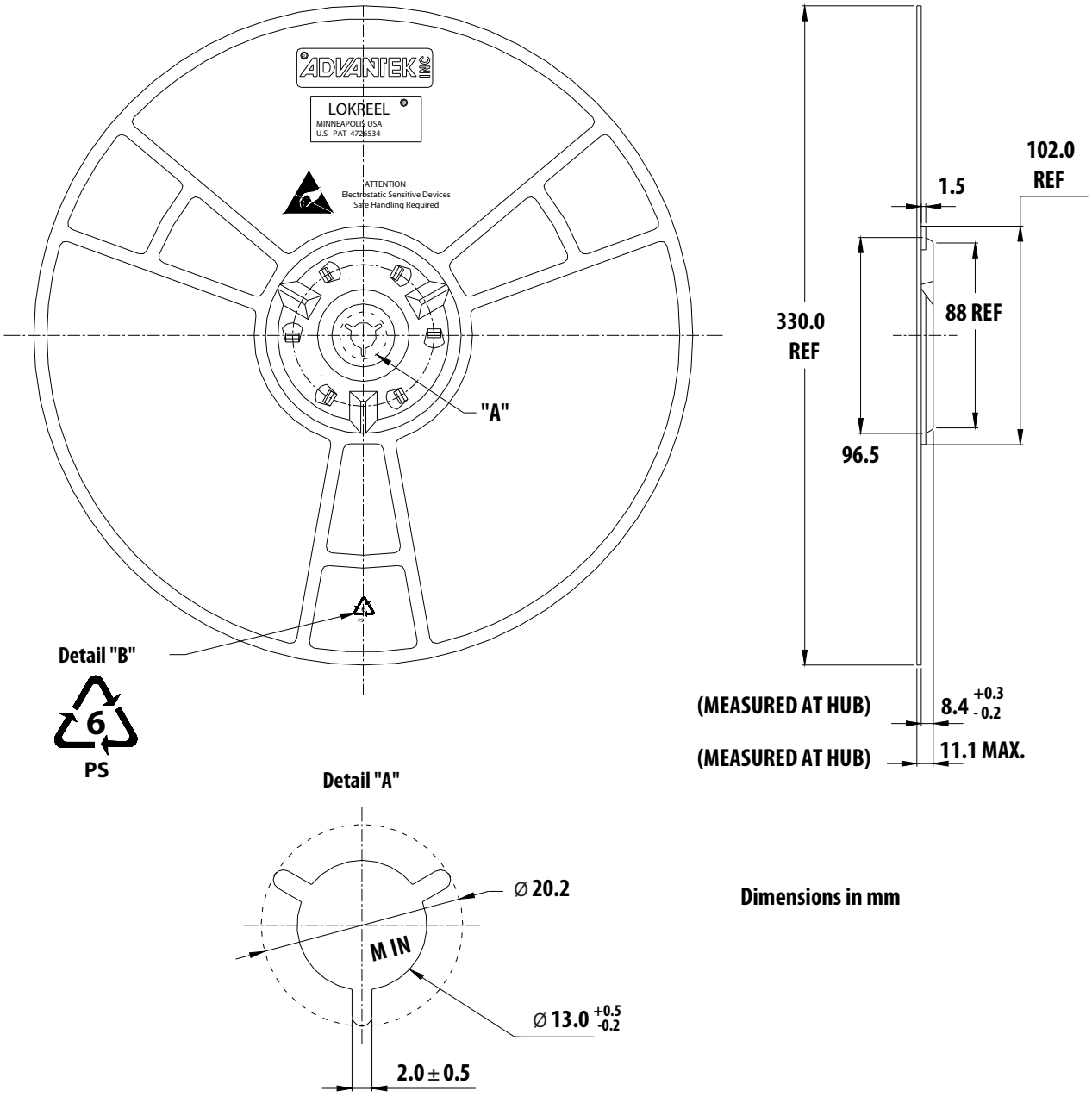
SECTION A - A

Ao = 4.60
Bo = 4.90
Ko = 1.90

DIMENSIONS IN MM

NOTES:
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2. CAMBER IN COMPLIANCE WITH EIA 481
3. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE

Reel Dimensions – 13″ Reel



Dimensions in mm

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

AV02-1706EN - November 11, 2013

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