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MC13850



Package Information
Plastic Package: MLPD-8
2.0 x 2.0 x 0.6 mm
Case: 2128-01

Ordering Information

Device	Device Marking	Package
MC13850EP	850	MLPD-8

MC13850

Low Noise Amplifier with Bypass Switch

1 Introduction

The MC13850 is a cost-effective, high IP3 LNA with low noise figure. This is the leadless package version of the MBC13720 device. As with the MBC13720, this device is designed for general purpose RF applications, yet has excellent high frequency gain and noise figure. An integrated bypass switch is included to preserve high input intercept performance. The input and output match are external to allow maximum design flexibility. The LNA has two selectable IP3 modes, a bypass mode and a standby mode. The MC13850 is fabricated with an advanced RF BiCMOS process using the SiGe:C module and is packaged in the MLPD-8 leadless package.

1.1 Features

- RF input frequency: 400 MHz to 2500 MHz
- Gain: 21 dB at 470 MHz, 14.5 dB at 1960 MHz and 12 dB at 2.4 GHz in high IP3 mode
- Input third order intercept point (IIP3): 10 dBm at 1960 MHz, 13 dBm at 2.4 GHz, and -2.5 dBm at 860 MHz in high IP3 mode

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This document contains information on a new product. Specifications and information herein are subject to change without notice.

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- Noise Figure (NF): 1.6 dB at 860 MHz, 1.4 dB at 1960 MHz, and 1.55 dB at 2400 MHz in low IP3 mode
- Output 1 dB compression point (P1dB): 9 dBm at 470 MHz and 11.5 dBm at 1060 MHz in high IP3 mode
- Selectable IP3 mode allows for running at the desired IP3 performance for a receiver's linearity requirements
- Bypass mode has return losses comparable to active mode, for use in systems with filters and duplexers
- Bypass mode improves dynamic range in variable signal strength environments
- Integrated logic-controlled standby mode with current drain < 1µA
- Total supply current: 5 mA at 2.7 V in low IP3 mode and 10 mA in high IP3 mode. Bypass mode <10 µA
- In a receiver system with 20% active mode and 80% bypass mode, the average current drain is 1 mA
- On-chip bias sets the bias point
- Bias stabilized for device and temperature variations
- MLPD-8 leadless package with low parasitics
- 470-860, 900, 1960, and 2400 MHz application circuit evaluation boards with characterization data are available
- Available in tape and reel packaging

Figure 1 shows a simplified block diagram of the MC13850 with the pinouts and location of the Pin 1 designator on the package.

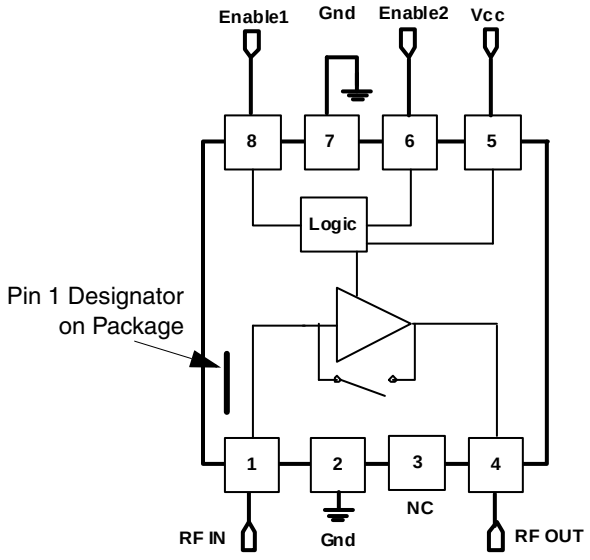


Figure 1. Simplified Block Diagram

1.2 Applications

Ideal for use in any RF product that operates between 400 MHz and 2.5 GHz, and may be applied in:

- Buffer amplifiers
- Mixers
- IF amplifiers
- Voltage controlled oscillators (VCOs)
- Use with transceivers requiring external LNAs
- ISM
- Mobile—Cellular front end LNA, GPS, two-way radios
- Consumer—WLAN, 802.11 b/g
- Auto—RKE, TPMS, GPS, active antenna, wireless security

2 Electrical Specifications

This section contains electrical characteristics of the device as well as maximum ratings and recommended operating conditions. Table 1 lists the maximum ratings for the device.

Table 1. Maximum Ratings[1] (TA=25°C, unless otherwise noted)

Ratings	Symbol	Value	Unit
Supply Voltage	V_{CC}	3.3	Vdc
Storage Temperature Range	T_{stg}	-65 to 150	°C
Operating Ambient Temperature Range	T_A	-40 to 85	°C
RF Input Power	P_{rf}	10	dBm
Power Dissipation	P_{dis}	100	mW
Thermal Resistance, Junction to Case	$R_{thetaJC}$	400	°C/W

1 Maximum Ratings are those values beyond which damage to the device may occur. Functional operation must be restricted to the limits in the Recommended Operating Conditions and Electrical Characteristics tables.

Table 2 lists the recommended operating conditions of the device.

Table 2. Recommended Operating Conditions

Characteristic	Symbol	Min	Typ	Max	Unit
RF Frequency	f_{RF}	400	—	2500	MHz
Supply Voltage	V_{CC}	2.3	—	3.0	Vdc
Logic Voltage Input High Voltage Input Low Voltage	 — V_{CC}	 1.5 0	 — —	 V_{CC} 0.95	Vdc

Table 3 lists the four modes of operation for the device that result from changing the voltage applied to the enable 1 (EN1) and enable 2 (EN2) pins.

Table 3. Truth Table

EN1	EN2	State	Current Consumption
Low	Low	Standby	< 10 μA
Low	High	Bypass	< 10 μA
High	Low	High IP3	9.9 mA
High	High	Low IP3	4.7 mA

Table 4 lists the electrical characteristics measured on evaluation boards tuned for typical application frequencies. Further details on the application circuits are shown in Section 4, "Application Information" and details on the boards are shown in Section 5, "Printed Circuit Board and Bill of Materials."

Table 4. Electrical Characteristics Measured in Frequency Specific Tuned Circuits (Vcc = 2.7V, TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
470 MHz (refer to Figure 14)					
Supply Current	Icc				
Low IP3		—	4.7	5.7	mA
High IP3		—	9.9	12.5	mA
Bypass		—	2	10	uA
RF Gain	G				dB
Low IP3		20.5	21.6	—	
High IP3		23.4	24.4	—	
Bypass		-7.4	-6.9	—	
Noise Figure	NF				dB
Low IP3		—	1.32	1.6	
High IP3		—	1.33	1.6	
Bypass		—	9.5	10	
Input IP3	IIP3				dBm
Low IP3		-12.5	-11.2	—	
High IP3		-9.2	-8	—	
Bypass		26.7	27.7	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		6	7	—	
High IP3		8.6	9.6	—	

Table 4. Electrical Characteristics Measured in Frequency Specific Tuned Circuits (continued)
(Vcc = 2.7V, TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Gain	S21				dB
Low IP3		20.5	21.5	—	
High IP3		23.1	24.1	—	
Bypass		-7.7	-6.7	—	
860 MHz (refer to Figure 14)					
RF Gain	G				dB
Low IP3		16.4	17.4	—	
High IP3		18	19	—	
Bypass		-6.7	-6.2	—	
Noise Figure	NF				dB
Low IP3		—	1.22	1.5	
High IP3		—	1.32	1.6	
Bypass		—	5.2	5.7	
Input IP3	IIP3				dBm
Low IP3		-5.3	-4	—	
High IP3		-2.3	-1.1	—	
Bypass		23.7	24.7	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		7.4	8.4	—	
High IP3		8.1	9.2	—	
Gain	S21				dB
Low IP3		17	18	—	
High IP3		18.4	19.4	—	
Bypass		-6.8	-5.8	—	
900 MHz (refer to Figure 15)					
RF Gain	G				dB
Low IP3		20	21	—	
High IP3		20.8	21.8	—	
Bypass		-4.5	-3.7	—	

Table 4. Electrical Characteristics Measured in Frequency Specific Tuned Circuits (continued)
(Vcc = 2.7V, TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Figure	NF				dB
Low IP3		—	1.38	1.6	
High IP3		—	1.53	1.75	
Bypass		—	3.85	4.6	
Input IP3	IIP3				dBm
Low IP3		-6.5	-4.1	—	
High IP3		1.75	3.5	—	
Bypass		27	27.6	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		10.9	11.9	—	
High IP3		11.1	12.1	—	
Gain	S21				dB
Low IP3		20.1	21.1	—	
High IP3		20.8	21.8	—	
Bypass		-4.5	-3.5	—	
900 MHz High IP3 (refer to Figure 16)					
RF Gain	G				dB
Low IP3		15.5	16.5	—	
High IP3		16.1	17.1	—	
Bypass		-5.2	-4.2	—	
Noise Figure	NF				dB
Low IP3		—	1.43	1.65	
High IP3		—	1.55	1.75	
Bypass		—	4.6	5.8	
Input IP3	IIP3				dBm
Low IP3		-6	-2.9	—	
High IP3		6	8	—	
Bypass		26.2	27.7	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		8	12	—	
High IP3		11.5	13.5	—	

Table 4. Electrical Characteristics Measured in Frequency Specific Tuned Circuits (continued)
(Vcc = 2.7V, TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Gain	S21				dB
Low IP3		15.7	16.7	—	
High IP3		16.2	17.2	—	
Bypass		-4.7	-3.9	—	
1960 MHz (refer to Figure 17)					
RF Gain	G				dB
Low IP3		13.8	14.8	—	
High IP3		13.9	14.9	—	
Bypass		-4.8	-3.5	—	
Noise Figure	NF				dB
Low IP3		—	1.5	1.8	
High IP3		—	1.75	2	
Bypass		—	3.2	4.4	
Input IP3	IIP3				dBm
Low IP3		3.5	6.5	—	
High IP3		8	9.6	—	
Bypass		22.6	23.6	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		1.5	3.2	—	
High IP3		2.3	4	—	
Gain	S21				dB
Low IP3		14	15	—	
High IP3		14	15	—	
Bypass		-4.8	-3.6	—	
2400 MHz (refer to Figure 18)					
RF Gain	G				dB
Low IP3		11.5	12.5	—	
High IP3		12	13	—	
Bypass		-4	-3	—	

Table 4. Electrical Characteristics Measured in Frequency Specific Tuned Circuits (continued)
(Vcc = 2.7V, TA = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Figure	NF				dB
Low IP3		—	1.6	1.95	
High IP3		—	1.85	2.2	
Bypass		—	3.2	4.3	
Input IP3	IIP3				dBm
Low IP3		7	10	—	
High IP3		11	12.5	—	
Bypass		26	27.2	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		-1	1	—	
High IP3		0	2.2	—	
Gain	S21				dB
Low IP3		11.6	12.6	—	
High IP3		12	13	—	
Bypass		-3.7	-3.2	—	

3 Scattering and Noise Parameters

Table 5 through Table 14 list the S parameters for the packaged part in a 50 Ω system for each of the four modes of operation and over temperature.

Table 5. Low IP3 Mode 25 °C Scattering Parameters
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω System)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.767	-16.4	12.078	163.6	0.02	68.8	0.854	1.1
350	0.754	-18.8	11.759	160.1	0.024	69	0.848	-2.6
400	0.742	-21.3	11.482	156.9	0.027	69.6	0.84	-5.6
450	0.727	-23.5	11.209	154.1	0.03	69.7	0.833	-8.5
500	0.693	-25.9	10.786	150.2	0.032	68.8	0.824	-8.9
550	0.675	-27.8	10.489	147.3	0.035	69.1	0.81	-11.1
600	0.664	-30.2	10.187	144.6	0.038	68.7	0.802	-13.1
650	0.647	-32.5	9.98	142.1	0.04	68.3	0.79	-15.3
700	0.628	-35	9.815	139.9	0.043	68.1	0.776	-17.2

Table 5. Low IP3 Mode 25 °C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω System)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
750	0.61	-37.2	9.608	137.5	0.045	67.9	0.761	-19.2
800	0.592	-39.5	9.262	135.4	0.048	67.5	0.748	-20.9
850	0.585	-41.6	9.045	133.3	0.051	66.3	0.736	-23
900	0.552	-43.8	8.789	131.1	0.052	66.3	0.724	-24.4
950	0.536	-46.1	8.582	129	0.054	66.1	0.707	-26
1000	0.513	-48.1	8.347	126.8	0.057	65.5	0.694	-27.8
1050	0.494	-50.1	8.137	124.9	0.058	65.2	0.682	-29.5
1100	0.474	-51.8	7.9	122.8	0.06	64.9	0.67	-31.4
1150	0.456	-53.7	7.667	121.1	0.062	64.5	0.658	-33.2
1200	0.44	-55.9	7.464	119	0.064	64.1	0.644	-34.8
1250	0.423	-57.8	7.246	117.3	0.065	63.8	0.631	-36.3
1300	0.406	-59.5	7.069	115.6	0.067	63.2	0.617	-38.6
1350	0.386	-61.6	6.866	113.8	0.068	63	0.602	-40.3
1400	0.373	-63	6.621	112.5	0.069	62.7	0.592	-41.9
1450	0.36	-64.3	6.446	111.2	0.069	63.1	0.58	-42.9
1500	0.358	-65.9	6.283	109.6	0.071	64.6	0.575	-44.2
1550	0.354	-68.8	6.185	108.9	0.074	64.7	0.575	-47.4
1600	0.347	-71.4	5.967	106.7	0.076	63.7	0.564	-49.4
1650	0.336	-74.5	5.808	105.5	0.077	63.6	0.552	-51.4
1700	0.332	-76.5	5.647	104.1	0.078	63.4	0.539	-53.1
1750	0.324	-80	5.503	102.8	0.08	63.5	0.531	-54.6
1800	0.317	-83.4	5.38	101.4	0.082	63.6	0.529	-56.3
1850	0.301	-87.4	5.234	99.9	0.085	62.7	0.528	-58.5
1900	0.291	-88.6	5.093	98.5	0.085	61.3	0.52	-60.4
1950	0.287	-90.5	4.956	97	0.085	61.1	0.518	-62.4
2000	0.284	-92.4	4.818	95.3	0.086	61.2	0.517	-64.6
2050	0.281	-94.9	4.687	93.7	0.088	61.2	0.521	-67.1
2100	0.278	-97.4	4.512	92.1	0.09	60.1	0.518	-69.7
2150	0.274	-99.4	4.366	90.3	0.091	59.8	0.513	-72.7
2200	0.272	-103.2	4.193	89.1	0.094	58.6	0.515	-76.4
2250	0.26	-106	3.958	87.3	0.096	54.7	0.501	-79.6

Table 5. Low IP3 Mode 25 °C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω System)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
2300	0.243	-106	3.781	86.9	0.091	51.6	0.472	-81.8
2350	0.235	-105.3	3.652	87.4	0.086	50.9	0.466	-82.3
2400	0.238	-101.6	3.473	86.3	0.081	51.9	0.472	-82.7
2450	0.253	-99.9	3.335	86	0.079	54.5	0.478	-86.3
2500	0.273	-101	3.158	86.8	0.077	56.8	0.455	-90.7
2550	0.294	-104.9	3.1	88.9	0.078	60	0.414	-91.5
2600	0.3	-110	3.146	89.2	0.082	61.3	0.391	-88.3

Table 6. Low IP3 Mode 85°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.763	-17	12.148	163.4	0.02	67.8	0.851	0.9
350	0.75	-19.3	11.83	159.9	0.024	68.5	0.847	-2.9
400	0.737	-21.8	11.54	156.6	0.026	69.1	0.837	-5.9
450	0.723	-24.1	11.255	153.8	0.029	69.4	0.831	-8.8
500	0.691	-26.5	10.828	149.9	0.032	68.4	0.823	-9.1
550	0.674	-28.6	10.552	147.1	0.035	68.6	0.81	-11.5
600	0.662	-31.1	10.271	144.3	0.038	68	0.801	-13.5
650	0.643	-33.6	10.062	141.7	0.04	67.4	0.788	-15.8
700	0.625	-36	9.866	139.6	0.043	67.6	0.775	-17.5
750	0.604	-38.8	9.712	136.9	0.046	66.5	0.76	-20
800	0.581	-41.1	9.347	134.5	0.048	65.7	0.743	-21.8
850	0.569	-43.1	9.113	132.4	0.05	65	0.727	-23.7
900	0.535	-45.2	8.821	130.2	0.051	64.9	0.714	-24.9
950	0.519	-47.2	8.576	128.2	0.053	64.7	0.697	-26.4
1000	0.497	-48.9	8.33	126.1	0.055	64.5	0.683	-27.9
1050	0.48	-50.7	8.108	124.3	0.057	64.2	0.673	-29.7
1100	0.464	-52	7.873	122.4	0.058	64	0.66	-31.4
1150	0.449	-53.8	7.655	120.9	0.06	64.1	0.648	-32.9

Table 6. Low IP3 Mode 85°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1200	0.436	-56.2	7.47	118.8	0.062	64.2	0.637	-34.3
1250	0.421	-58.3	7.268	117.1	0.064	63.9	0.627	-36
1300	0.404	-60	7.085	115.3	0.065	63.7	0.613	-38.2
1350	0.387	-62.5	6.899	113.5	0.067	63.7	0.601	-40.2
1400	0.376	-64.4	6.674	112.2	0.068	63.4	0.594	-41.8
1450	0.363	-67	6.507	110.6	0.069	63.6	0.583	-43.6
1500	0.354	-69.3	6.324	108.7	0.071	63.5	0.569	-45.4
1550	0.344	-71.8	6.18	107.9	0.073	63.5	0.563	-48.2
1600	0.335	-73.6	5.948	106	0.074	63.3	0.553	-49.6
1650	0.325	-76.5	5.79	104.8	0.076	62.8	0.542	-51.6
1700	0.322	-78.2	5.62	103.5	0.076	62.2	0.53	-53
1750	0.313	-81.3	5.477	102.4	0.077	62.7	0.522	-54.5
1800	0.304	-84.3	5.349	101.1	0.079	63.1	0.52	-56.2
1850	0.295	-87.2	5.22	99.7	0.08	63	0.521	-57.6
1900	0.286	-89.3	5.09	98.2	0.082	62.6	0.521	-59.6
1950	0.283	-91.5	4.956	96.8	0.083	62.3	0.521	-61.6
2000	0.281	-93.6	4.819	94.9	0.084	61.9	0.52	-64.4
2050	0.275	-95.7	4.674	93.4	0.085	61.9	0.525	-67
2100	0.276	-97.8	4.502	91.8	0.087	61.9	0.525	-69.5
2150	0.275	-99.8	4.357	90.1	0.089	61.9	0.521	-72.6
2200	0.271	-103.5	4.183	89	0.093	59.9	0.519	-76.7
2250	0.262	-104.8	3.972	87.5	0.093	56.3	0.504	-79
2300	0.252	-104.7	3.826	86.8	0.089	54.6	0.489	-80.9
2350	0.248	-105.4	3.686	86.8	0.087	54.2	0.487	-82.9
2400	0.248	-104.3	3.482	85.3	0.084	53.6	0.485	-84.8
2450	0.254	-102.5	3.322	85.4	0.08	54.5	0.482	-88.1
2500	0.272	-102.8	3.152	86.7	0.077	57.3	0.456	-92
2550	0.289	-106.1	3.111	88.9	0.078	60.8	0.414	-91.9
2600	0.295	-110.5	3.163	89	0.082	62.3	0.398	-88.5

Table 7. Low IP3 Mode -40°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω System)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.77	-15.7	11.982	163.5	0.02	69.3	0.858	1.4
350	0.759	-17.9	11.655	160.3	0.024	69.8	0.855	-2.3
400	0.747	-20.2	11.369	157.2	0.027	70.6	0.849	-5.2
450	0.733	-22.4	11.081	154.5	0.03	70.4	0.841	-8
500	0.701	-24.5	10.651	150.7	0.032	69.5	0.83	-8.4
550	0.684	-26.4	10.36	147.9	0.035	69.7	0.818	-10.7
600	0.674	-28.7	10.084	145.3	0.038	69.1	0.814	-12.6
650	0.658	-31	9.895	142.9	0.041	68.5	0.802	-14.9
700	0.64	-33.4	9.744	140.8	0.043	68.3	0.785	-16.9
750	0.621	-35.7	9.57	138.4	0.046	67.6	0.77	-19.3
800	0.602	-38	9.225	136.3	0.049	67.1	0.761	-21
850	0.596	-40	9.013	134.2	0.051	65.9	0.747	-23
900	0.56	-42.2	8.75	132	0.053	65.8	0.732	-24.5
950	0.543	-44.2	8.538	130	0.055	65.3	0.715	-26.3
1000	0.52	-46.1	8.314	127.8	0.057	64.8	0.703	-28
1050	0.5	-47.8	8.1	125.9	0.059	64.3	0.692	-29.7
1100	0.48	-48.9	7.838	123.9	0.06	63.7	0.673	-31.4
1150	0.466	-50.5	7.621	122.5	0.062	63.5	0.662	-33.2
1200	0.455	-52.5	7.445	120.6	0.064	63.8	0.654	-34.2
1250	0.439	-54.7	7.27	118.9	0.066	63.3	0.647	-36.1
1300	0.423	-56.2	7.108	117	0.068	63.1	0.632	-38.5
1350	0.403	-58.7	6.922	115.2	0.069	62.5	0.616	-40.7
1400	0.392	-60.4	6.693	113.8	0.07	62.2	0.611	-42.5
1450	0.374	-62.5	6.523	112.2	0.071	62	0.598	-43.9
1500	0.367	-63.9	6.335	110.4	0.072	62.4	0.582	-45.2
1550	0.36	-66.3	6.227	109.8	0.074	62.7	0.579	-48.4
1600	0.352	-68.3	5.993	107.7	0.076	62	0.569	-50
1650	0.338	-71.2	5.841	106.5	0.077	61.7	0.558	-51.7
1700	0.336	-72.4	5.674	105.2	0.078	61.1	0.543	-53.1
1750	0.329	-75.7	5.539	104	0.079	61.3	0.531	-54.6
1800	0.319	-79.2	5.42	102.5	0.08	61.8	0.53	-56.1

Table 7. Low IP3 Mode -40°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = High, 50 Ω System)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1850	0.302	-82.5	5.272	101.2	0.082	62	0.536	-57.5
1900	0.293	-82.9	5.152	99.8	0.084	60.9	0.532	-59.6
1950	0.292	-85.2	5.028	98.3	0.085	60.5	0.529	-61.8
2000	0.288	-87.6	4.899	96.4	0.086	60.2	0.53	-64.6
2050	0.282	-90.1	4.763	94.7	0.087	59.7	0.534	-67.2
2100	0.278	-92.5	4.576	93	0.089	58.7	0.529	-69.7
2150	0.274	-93.5	4.434	91.3	0.089	58.7	0.519	-72.5
2200	0.275	-96.7	4.273	90.2	0.092	59	0.526	-76.1
2250	0.27	-101	4.047	88	0.097	56	0.517	-79.4
2300	0.242	-102.3	3.853	87.4	0.093	50.6	0.485	-82.2
2350	0.229	-100.3	3.704	88.5	0.086	49.1	0.47	-82.9
2400	0.235	-95.7	3.55	87.2	0.081	51	0.482	-82.4
2450	0.252	-94.7	3.43	86.4	0.079	53	0.499	-86.2
2500	0.271	-95.5	3.224	86.7	0.077	54.7	0.479	-91.1
2550	0.293	-99.2	3.108	89.1	0.077	57.8	0.43	-93.9
2600	0.302	-104.8	3.16	90.3	0.081	60.6	0.397	-91.4

Table 8. High IP3 Mode 25°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.637	-22.9	18.316	155.3	0.018	65.4	0.771	-3
350	0.61	-26.1	17.76	150.7	0.021	66.1	0.755	-7.1
400	0.584	-29.4	17.271	146.2	0.024	66.5	0.739	-10.3
450	0.554	-32.3	16.716	142.3	0.026	66.9	0.724	-13.4
500	0.511	-34.4	15.873	137.9	0.028	67	0.707	-13.1
550	0.491	-36.7	15.221	134.7	0.03	67.1	0.688	-15.4
600	0.469	-39.2	14.597	131.8	0.032	67.4	0.674	-17.3
650	0.445	-41.6	14.055	128.9	0.034	67.7	0.657	-19.2
700	0.423	-44.1	13.507	126.4	0.036	68	0.64	-20.7

Table 8. High IP3 Mode 25°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
750	0.401	-46.2	13.005	124	0.038	68.6	0.624	-22.5
800	0.379	-48.6	12.435	121.7	0.04	68.3	0.611	-24.1
850	0.364	-50.7	11.975	119.5	0.042	67.9	0.596	-25.8
900	0.337	-52.5	11.48	117.4	0.044	68.2	0.583	-27
950	0.322	-54.6	11.051	115.5	0.046	68.5	0.569	-28.4
1000	0.3	-56.2	10.614	113.5	0.048	68.3	0.556	-30
1050	0.284	-58.4	10.23	111.8	0.049	68.7	0.545	-31.3
1100	0.267	-59.5	9.823	110	0.051	68.4	0.533	-33.2
1150	0.252	-61.1	9.444	108.6	0.053	68.8	0.522	-34.8
1200	0.241	-63.3	9.116	107	0.054	68.9	0.511	-36.1
1250	0.228	-65.1	8.779	105.5	0.056	69	0.5	-37.2
1300	0.214	-66.5	8.481	104.1	0.057	69.1	0.487	-39.4
1350	0.201	-68.7	8.182	102.8	0.058	69.3	0.476	-41.1
1400	0.193	-70.5	7.877	101.7	0.06	69.7	0.469	-42.5
1450	0.187	-72.5	7.629	100.7	0.061	70.3	0.461	-43.2
1500	0.185	-75.2	7.399	99.5	0.063	71.5	0.457	-44.5
1550	0.185	-78.8	7.215	98.8	0.066	71.5	0.454	-47.6
1600	0.181	-82.9	7.001	97.4	0.068	71.1	0.447	-49.1
1650	0.177	-87.8	6.828	96.3	0.069	71.5	0.444	-50.5
1700	0.172	-91.9	6.647	94.7	0.072	71	0.442	-52
1750	0.163	-97.1	6.451	93.3	0.073	70.7	0.441	-54.5
1800	0.158	-101.5	6.253	91.8	0.075	70.4	0.444	-57.2
1850	0.149	-107.3	6.026	90.2	0.078	69.6	0.444	-60
1900	0.14	-108.1	5.81	89.2	0.078	68.5	0.436	-62.5
1950	0.14	-108.5	5.618	88.1	0.078	68.4	0.431	-64.9
2000	0.143	-109.4	5.437	86.9	0.079	68.5	0.431	-67.4
2050	0.146	-112.9	5.269	85.6	0.082	68.6	0.437	-69.8
2100	0.146	-115.7	5.068	84.2	0.083	67.6	0.435	-72.6
2150	0.146	-117.1	4.877	82.8	0.084	67.6	0.433	-75.8
2200	0.151	-121.7	4.675	81.5	0.088	66.5	0.438	-79.8
2250	0.145	-126.8	4.415	80.1	0.089	62.7	0.429	-83.7

Table 8. High IP3 Mode 25°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
2300	0.125	-126.1	4.168	79.9	0.085	59.2	0.405	-86.1
2350	0.118	-119.8	3.98	80.5	0.079	59.5	0.396	-87
2400	0.127	-109.2	3.789	80.7	0.074	61.6	0.399	-88.2
2450	0.153	-105.6	3.647	81.3	0.074	65.1	0.405	-91.5
2500	0.179	-108.8	3.501	82.8	0.075	68	0.381	-95.7
2550	0.201	-114.7	3.465	84.6	0.077	70.4	0.348	-96.5
2600	0.21	-121.6	3.517	85	0.082	71	0.326	-93.7

Table 9. High IP3 Mode 85°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.596	-25.6	19.666	153.2	0.018	64.2	0.759	-3.2
350	0.571	-28.7	18.791	148.5	0.021	65.3	0.746	-7.5
400	0.547	-32.1	17.972	144.2	0.023	66.1	0.728	-10.6
450	0.525	-34.9	17.164	140.5	0.025	66.6	0.713	-13.6
500	0.487	-37.1	16.152	136.5	0.027	66.4	0.699	-13.3
550	0.468	-39.9	15.476	133.3	0.029	66.8	0.68	-15.7
600	0.447	-42.5	14.804	130.4	0.031	67	0.665	-17.6
650	0.422	-45.2	14.209	127.4	0.033	67.3	0.648	-19.5
700	0.401	-47.9	13.626	124.9	0.035	67.7	0.631	-21
750	0.376	-50.4	13.093	122.3	0.037	67.9	0.615	-22.8
800	0.353	-52.7	12.499	119.9	0.039	68.1	0.6	-24.4
850	0.336	-55.3	12.05	117.7	0.041	68	0.586	-26
900	0.309	-57.6	11.518	115.5	0.043	67.8	0.574	-27.1
950	0.294	-59.6	11.037	113.6	0.044	67.8	0.556	-28.7
1000	0.274	-61.5	10.581	111.7	0.046	68	0.542	-30
1050	0.259	-64	10.173	110	0.047	68.1	0.531	-31.6
1100	0.242	-64.9	9.747	108.3	0.049	68.4	0.518	-33
1150	0.227	-66.4	9.357	107	0.05	69.1	0.506	-34.4

Table 9. High IP3 Mode 85°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1200	0.219	-68.9	9.032	105.5	0.052	69.3	0.496	-35.6
1250	0.211	-70.4	8.689	104.1	0.053	69.9	0.487	-36.7
1300	0.197	-72.7	8.384	102.7	0.055	70.1	0.475	-38.9
1350	0.186	-75	8.074	101.4	0.056	70.8	0.466	-40.3
1400	0.18	-77.9	7.786	100.3	0.058	71	0.46	-42.1
1450	0.175	-80.5	7.533	99.4	0.059	71.9	0.454	-43.1
1500	0.174	-84.7	7.301	98	0.062	72.2	0.444	-45
1550	0.17	-88.3	7.09	97.2	0.064	72.2	0.441	-47.6
1600	0.168	-91.3	6.865	96	0.066	72.3	0.439	-48.8
1650	0.171	-96.4	6.701	95	0.068	72	0.435	-50.8
1700	0.169	-100.8	6.514	93.5	0.07	71.6	0.433	-52.2
1750	0.16	-106.4	6.317	92	0.071	71.4	0.432	-54.8
1800	0.153	-111	6.098	90.6	0.073	71.3	0.433	-57.3
1850	0.149	-114.1	5.889	89.4	0.074	71	0.435	-59.6
1900	0.146	-116	5.698	88.2	0.076	70.5	0.436	-62.3
1950	0.147	-118.1	5.514	87	0.077	70.4	0.435	-64.9
2000	0.149	-120.3	5.318	85.5	0.078	70	0.436	-68.4
2050	0.148	-122.6	5.11	84.3	0.08	69.4	0.438	-71.4
2100	0.152	-123.2	4.904	83.3	0.08	69	0.431	-74
2150	0.157	-123.4	4.719	82.2	0.082	69.7	0.431	-76.9
2200	0.164	-128.7	4.526	81	0.087	68.6	0.436	-80.8
2250	0.154	-132.2	4.263	80	0.087	63.8	0.424	-85
2300	0.142	-128.4	4.036	80	0.082	61.8	0.406	-87.2
2350	0.144	-123.4	3.834	81.2	0.077	62.5	0.389	-90.3
2400	0.159	-120.9	3.742	82.7	0.074	66.1	0.369	-89.7
2450	0.17	-121.8	3.725	82.3	0.076	68.5	0.379	-89.5
2500	0.183	-122	3.582	82.3	0.077	69.4	0.372	-92.9
2550	0.199	-124.9	3.518	83.5	0.078	71.3	0.344	-93.5
2600	0.209	-129.3	3.543	83.4	0.082	72.4	0.333	-90.5

Table 10. High IP3 Mode -40°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.779	-15.2	11.546	164.4	0.02	68.6	0.839	0.3
350	0.766	-17.4	11.388	160.9	0.023	69.2	0.832	-3.7
400	0.749	-20	11.312	157.6	0.026	69.4	0.821	-6.7
450	0.73	-22.4	11.235	154.6	0.029	69.3	0.811	-9.8
500	0.691	-24.9	11.006	150.3	0.031	68.2	0.801	-10.2
550	0.675	-26.7	10.656	147.5	0.034	68.2	0.787	-12.8
600	0.667	-28.9	10.312	144.9	0.036	67.5	0.771	-15.2
650	0.647	-31.2	10.177	142.3	0.038	67.5	0.753	-17.3
700	0.624	-34	10.129	139.8	0.04	67.6	0.735	-19
750	0.599	-36.5	10.049	137.1	0.043	67.4	0.719	-20.8
800	0.574	-39.2	9.79	134.6	0.045	67.2	0.707	-22.4
850	0.56	-41.6	9.656	132.2	0.048	66.3	0.695	-24.3
900	0.518	-44	9.455	129.7	0.05	66	0.685	-25.7
950	0.5	-46.3	9.227	127.5	0.052	65.4	0.668	-27.4
1000	0.474	-48.3	9.01	125.1	0.053	65.2	0.653	-29.1
1050	0.455	-50.4	8.778	123.1	0.055	64.7	0.643	-31.1
1100	0.437	-51.8	8.5	121.3	0.057	64.5	0.63	-33
1150	0.416	-53.8	8.276	119.6	0.058	64.2	0.618	-34.8
1200	0.397	-56.1	8.092	117.2	0.06	63.6	0.6	-36.4
1250	0.38	-57.5	7.845	115.4	0.061	64	0.586	-37.6
1300	0.361	-59.1	7.65	113.6	0.062	64	0.572	-39.7
1350	0.339	-60.9	7.422	111.9	0.063	64.5	0.561	-40.9
1400	0.325	-62.6	7.182	110.4	0.064	64.3	0.553	-42.5
1450	0.312	-63.6	7.001	109.3	0.065	65.7	0.548	-43.4
1500	0.309	-66.2	6.852	107.5	0.068	65.8	0.541	-45.4
1550	0.3	-69.3	6.724	106.7	0.071	65.2	0.534	-48.6
1600	0.294	-71.5	6.485	105	0.072	64.9	0.523	-49.5
1650	0.284	-75.1	6.35	103.7	0.074	64.8	0.516	-51.2
1700	0.279	-77.6	6.203	102.1	0.075	64.3	0.512	-52.3
1750	0.265	-81.4	6.046	100.4	0.076	64	0.509	-54.5
1800	0.251	-84.3	5.863	98.8	0.077	63.9	0.508	-56.4

Table 10. High IP3 Mode -40°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = High, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1850	0.237	-86.9	5.676	97.3	0.079	63.9	0.509	-58.6
1900	0.228	-87.6	5.521	96	0.08	63.4	0.508	-60.9
1950	0.226	-89.9	5.371	94.6	0.081	63.3	0.508	-63.1
2000	0.223	-92.2	5.206	92.8	0.083	62.9	0.507	-66.2
2050	0.218	-94.5	5.028	91.4	0.085	62.4	0.509	-69.4
2100	0.215	-96.4	4.845	90	0.085	61	0.504	-71.7
2150	0.214	-97	4.69	88.3	0.085	61.1	0.503	-74.8
2200	0.216	-100.2	4.493	87.1	0.088	61.8	0.509	-79.1
2250	0.209	-103.1	4.224	85.7	0.091	58.2	0.486	-83.4
2300	0.199	-101.1	4.051	85.4	0.087	55.5	0.462	-85.4
2350	0.204	-100.3	3.875	86	0.083	55.2	0.455	-88.1
2400	0.213	-100.8	3.678	86.2	0.081	55.3	0.432	-89.6
2450	0.223	-101.6	3.658	86.9	0.078	57.9	0.424	-88.8
2500	0.23	-103.6	3.531	86	0.078	58.6	0.426	-91.3
2550	0.245	-105.9	3.388	87.2	0.077	60.8	0.398	-94
2600	0.259	-111.7	3.414	88.2	0.08	63.2	0.367	-91.8

Table 11. Bypass Mode 25°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = High, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.881	-22.3	0.315	73.1	0.312	72.8	0.868	-8
350	0.858	-25.4	0.361	68.7	0.357	68.4	0.852	-13.1
400	0.833	-28.5	0.403	64.7	0.399	64.4	0.83	-17.3
450	0.808	-31.2	0.442	61.1	0.438	60.8	0.809	-21.3
500	0.766	-34.4	0.467	56.7	0.463	56.5	0.787	-22.7
550	0.742	-37.1	0.499	53.6	0.495	53.3	0.76	-25.9
600	0.715	-39.5	0.527	50.6	0.523	50.4	0.736	-28.6
650	0.689	-41.9	0.553	47.8	0.549	47.6	0.712	-31.3
700	0.662	-44.4	0.576	45	0.571	44.9	0.687	-33.6

Table 11. Bypass Mode 25°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = High, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
750	0.637	-46.6	0.596	42.5	0.592	42.4	0.663	-36
800	0.613	-48.7	0.614	40.1	0.61	40	0.637	-38.1
850	0.588	-51	0.632	37.9	0.625	37.4	0.615	-40.2
900	0.565	-53	0.645	35.6	0.638	35.3	0.595	-42
950	0.546	-55.2	0.657	33.6	0.649	33.3	0.572	-43.5
1000	0.523	-56.9	0.665	31.5	0.658	31.2	0.551	-44.8
1050	0.505	-58.9	0.672	29.7	0.665	29.4	0.535	-45.9
1100	0.488	-60.7	0.677	28.1	0.67	27.9	0.524	-47.2
1150	0.467	-63.1	0.684	26.5	0.677	26.3	0.515	-48.7
1200	0.442	-65.6	0.687	24.8	0.68	24.5	0.507	-50.1
1250	0.406	-67.3	0.681	23.1	0.674	22.8	0.502	-51.5
1300	0.373	-62.5	0.669	23.2	0.662	23	0.498	-54.6
1350	0.407	-60.6	0.69	23.6	0.684	23.3	0.479	-57.6
1400	0.418	-64.3	0.707	21.9	0.701	21.7	0.462	-59
1450	0.415	-67.6	0.714	20.2	0.707	20	0.452	-59.8
1500	0.41	-70.3	0.718	18.7	0.711	18.5	0.442	-61.2
1550	0.405	-72.7	0.719	17.2	0.713	17	0.437	-62.7
1600	0.4	-74.9	0.719	15.8	0.713	15.6	0.434	-63.9
1650	0.396	-77.3	0.718	14.6	0.712	14.3	0.432	-65.2
1700	0.394	-79.4	0.716	13.2	0.71	13	0.43	-66.7
1750	0.391	-81.9	0.713	11.9	0.707	11.7	0.43	-68.6
1800	0.388	-84.7	0.708	10.6	0.702	10.4	0.433	-70.2
1850	0.383	-87.9	0.7	9.3	0.694	9.1	0.434	-71.8
1900	0.368	-91.6	0.685	8.2	0.68	8	0.439	-73.9
1950	0.332	-93	0.665	8.4	0.66	8.1	0.442	-77.2
2000	0.336	-85.8	0.676	9.2	0.67	9	0.432	-79.7
2050	0.369	-87.1	0.683	7.8	0.678	7.5	0.43	-80.4
2100	0.386	-91	0.679	6.1	0.673	6	0.433	-81.2
2150	0.389	-95.1	0.665	4.8	0.66	4.7	0.44	-83.2
2200	0.356	-98.5	0.645	5	0.64	4.9	0.444	-86.2
2250	0.365	-91.1	0.661	5.2	0.656	5.1	0.441	-86.8

Table 11. Bypass Mode 25°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = High, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
2300	0.401	-93.1	0.659	3.3	0.653	3.1	0.448	-87.9
2350	0.417	-96.9	0.646	1.8	0.641	1.7	0.453	-90
2400	0.427	-100.5	0.63	0.8	0.625	0.6	0.46	-92.2
2450	0.43	-104.2	0.613	0.2	0.606	-0.1	0.462	-94.1
2500	0.426	-108.3	0.593	0.1	0.586	-0.3	0.456	-96.5
2550	0.406	-112.5	0.579	0.9	0.573	0.6	0.437	-96.9
2600	0.369	-114.9	0.571	0.9	0.565	0.6	0.438	-94.4

Table 12. Bypass Mode 85°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = high, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.877	-22.8	0.318	72.9	0.308	72.3	0.867	-8.2
350	0.852	-25.7	0.364	68.5	0.353	68	0.852	-13.3
400	0.826	-28.9	0.406	64.4	0.395	63.9	0.83	-17.5
450	0.803	-31.6	0.444	60.8	0.433	60.3	0.808	-21.5
500	0.76	-34.7	0.469	56.5	0.458	56.1	0.787	-22.9
550	0.737	-37.3	0.5	53.4	0.489	53	0.759	-26.1
600	0.71	-39.6	0.529	50.4	0.517	50	0.735	-28.8
650	0.683	-42	0.554	47.6	0.542	47.2	0.711	-31.5
700	0.657	-44.4	0.576	45	0.564	44.6	0.687	-33.6
750	0.631	-46.4	0.596	42.4	0.584	42.1	0.662	-35.9
800	0.607	-48.4	0.613	40.1	0.602	39.8	0.638	-38
850	0.581	-50.8	0.633	38	0.613	37.2	0.619	-40
900	0.556	-52.9	0.645	35.9	0.626	35.2	0.601	-41.6
950	0.537	-54.9	0.657	33.9	0.638	33.3	0.58	-43.3
1000	0.513	-56.3	0.666	32	0.647	31.4	0.563	-44.9
1050	0.494	-57.5	0.674	30.4	0.655	29.7	0.55	-46.8
1100	0.481	-58.1	0.68	28.9	0.661	28.3	0.535	-48.5
1150	0.469	-59.4	0.687	27.6	0.668	27	0.521	-50.4

Table 12. Bypass Mode 85°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = high, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1200	0.46	-61	0.696	26.3	0.677	25.7	0.509	-52.3
1250	0.451	-62.5	0.703	24.8	0.684	24.2	0.495	-53.7
1300	0.436	-64.1	0.707	23.3	0.689	22.8	0.483	-55.5
1350	0.426	-65.9	0.711	22	0.694	21.4	0.47	-57
1400	0.416	-67.7	0.715	20.7	0.697	20.1	0.463	-58.7
1450	0.408	-69.5	0.716	19.4	0.699	18.9	0.456	-59.8
1500	0.402	-71.3	0.719	18.2	0.702	17.7	0.446	-61.6
1550	0.398	-73	0.72	16.9	0.703	16.4	0.444	-63.4
1600	0.393	-74.5	0.72	15.8	0.703	15.3	0.442	-64.8
1650	0.391	-76.3	0.72	14.6	0.703	14.1	0.438	-66.5
1700	0.388	-77.5	0.718	13.4	0.701	12.9	0.436	-68.1
1750	0.383	-78.9	0.716	12.3	0.699	11.8	0.433	-70.2
1800	0.382	-80.8	0.712	11.1	0.696	10.6	0.436	-72.1
1850	0.383	-82.6	0.708	10.1	0.692	9.6	0.437	-73.6
1900	0.381	-84.3	0.702	9.1	0.687	8.6	0.439	-75.4
1950	0.382	-86.2	0.696	8.2	0.681	7.7	0.438	-77.4
2000	0.383	-87.7	0.689	7.3	0.674	6.8	0.441	-80.1
2050	0.383	-89.5	0.68	6.6	0.666	6.1	0.446	-81.8
2100	0.387	-91.3	0.674	6.1	0.659	5.6	0.444	-83.3
2150	0.385	-92.5	0.667	5.7	0.654	5.2	0.444	-85.3
2200	0.378	-92.8	0.664	5.3	0.65	4.8	0.445	-87.1
2250	0.392	-91.9	0.665	4.4	0.651	3.9	0.452	-88.3
2300	0.409	-92.6	0.658	3	0.645	2.6	0.46	-89.7
2350	0.42	-94.7	0.646	1.9	0.633	1.5	0.465	-91.7
2400	0.428	-97.2	0.63	1.2	0.617	0.7	0.471	-94.1
2450	0.428	-99.9	0.613	1.2	0.594	0.3	0.474	-97
2500	0.424	-101.9	0.599	2.3	0.581	1.4	0.461	-99.8
2550	0.416	-102.6	0.601	3.6	0.583	2.7	0.439	-99.8
2600	0.416	-101.7	0.615	3.6	0.596	2.7	0.431	-98.1

Table 13. Bypass Mode -40°C Scattering Parameters (Vcc = 2.7V, Enable 1 = Low, Enable 2 = high, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.878	-22.7	0.318	73.1	0.309	72.5	0.868	-8.1
350	0.854	-25.7	0.363	68.7	0.354	68.2	0.853	-13.2
400	0.828	-28.9	0.406	64.7	0.396	64.2	0.832	-17.4
450	0.805	-31.5	0.445	61.1	0.434	60.6	0.81	-21.4
500	0.762	-34.7	0.469	56.8	0.459	56.4	0.79	-22.8
550	0.739	-37.3	0.501	53.7	0.491	53.3	0.762	-26
600	0.714	-39.7	0.53	50.7	0.519	50.3	0.738	-28.8
650	0.686	-42.1	0.556	47.9	0.545	47.6	0.715	-31.5
700	0.661	-44.5	0.579	45.3	0.568	45	0.691	-33.8
750	0.635	-46.5	0.599	42.7	0.588	42.4	0.666	-36.1
800	0.612	-48.5	0.617	40.4	0.606	40.1	0.642	-38.3
850	0.586	-50.9	0.637	38.3	0.618	37.5	0.622	-40.4
900	0.563	-52.9	0.65	36.2	0.632	35.5	0.602	-42.1
950	0.545	-55	0.663	34.2	0.644	33.6	0.58	-43.9
1000	0.524	-56.6	0.673	32.3	0.654	31.7	0.561	-45.5
1050	0.507	-58.3	0.682	30.5	0.663	29.9	0.545	-47.3
1100	0.493	-59.7	0.689	29	0.67	28.4	0.529	-48.6
1150	0.475	-61.6	0.697	27.5	0.679	26.9	0.517	-50.1
1200	0.46	-63.4	0.705	25.9	0.687	25.3	0.508	-52
1250	0.447	-64.8	0.71	24.2	0.692	23.7	0.495	-53.5
1300	0.431	-66.5	0.713	22.7	0.696	22.2	0.483	-55.3
1350	0.416	-68.2	0.714	21.2	0.697	20.7	0.472	-56.7
1400	0.398	-69.8	0.713	19.8	0.697	19.2	0.466	-58.3
1450	0.381	-69.6	0.705	18.9	0.69	18.4	0.466	-59.7
1500	0.39	-69.3	0.713	18.7	0.697	18.2	0.454	-62.5
1550	0.397	-71.6	0.721	17.4	0.705	16.9	0.446	-64.4
1600	0.395	-73.9	0.723	16	0.707	15.5	0.441	-65.5
1650	0.393	-76.2	0.724	14.7	0.708	14.2	0.438	-67
1700	0.392	-77.8	0.721	13.4	0.706	12.8	0.436	-68.5
1750	0.386	-79.8	0.719	12.1	0.704	11.6	0.433	-70.5
1800	0.381	-82.2	0.713	10.9	0.698	10.4	0.437	-72.3

Table 13. Bypass Mode -40°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = high, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
1850	0.372	-83.3	0.705	10.1	0.69	9.6	0.439	-74.1
1900	0.376	-83.8	0.703	9.3	0.688	8.9	0.438	-76
1950	0.381	-86.2	0.697	8.3	0.683	7.8	0.437	-78
2000	0.382	-88	0.691	7.4	0.677	7	0.439	-80.6
2050	0.38	-89.3	0.684	6.9	0.67	6.4	0.442	-82.2
2100	0.391	-90.5	0.681	6	0.667	5.6	0.441	-83.4
2150	0.396	-92.5	0.672	5.2	0.659	4.7	0.443	-85.4
2200	0.387	-94.9	0.662	4.8	0.65	4.4	0.444	-87.5
2250	0.384	-93.3	0.665	4.5	0.653	4	0.448	-88.6
2300	0.404	-92.7	0.661	2.9	0.648	2.4	0.456	-89.8
2350	0.419	-94.5	0.646	1.6	0.634	1.1	0.461	-91.7
2400	0.431	-97	0.629	1	0.617	0.5	0.468	-93.8
2450	0.433	-100	0.616	1.2	0.598	0.3	0.471	-96.4
2500	0.431	-102.4	0.602	1.9	0.584	1	0.462	-99.1
2550	0.423	-103.8	0.599	3.1	0.582	2.2	0.441	-99.7
2600	0.42	-103.4	0.612	3.3	0.595	2.4	0.431	-98

Table 14. Standby Mode 25°C Scattering Parameters
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
300	0.947	-2.1	0.021	77.2	0.021	77	0.923	8.9
350	0.945	-2.3	0.025	78.8	0.025	78.7	0.927	6.2
400	0.944	-2.6	0.028	80	0.028	80	0.927	4.3
450	0.943	-2.6	0.032	81.4	0.032	81.1	0.928	2.5
500	0.932	-4	0.035	80.5	0.035	80.4	0.939	2.4
550	0.933	-4.3	0.039	81.2	0.039	80.9	0.934	1
600	0.931	-4.8	0.043	81.6	0.042	81.4	0.933	-0.1
650	0.928	-5.1	0.046	82	0.046	81.8	0.933	-1.3
700	0.924	-5.7	0.05	82.3	0.05	82.2	0.932	-2.2

Table 14. Standby Mode 25°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
750	0.923	-6	0.054	82.3	0.054	82.1	0.929	-3.4
800	0.923	-6.4	0.058	82.4	0.058	82.3	0.924	-4.4
850	0.918	-7.1	0.062	82.6	0.061	82.3	0.922	-5.6
900	0.914	-7.5	0.066	82.5	0.066	82.1	0.923	-6.6
950	0.913	-8.2	0.07	82.3	0.07	82.1	0.918	-7.5
1000	0.908	-8.6	0.074	81.8	0.074	81.7	0.916	-8.6
1050	0.902	-9.1	0.078	81.9	0.078	81.6	0.914	-9.8
1100	0.9	-9.5	0.082	81.5	0.082	81.4	0.91	-11.1
1150	0.896	-10.1	0.086	81.1	0.086	80.9	0.907	-12.4
1200	0.891	-10.8	0.091	80.7	0.09	80.3	0.904	-13.5
1250	0.888	-11.6	0.095	80.2	0.094	80	0.901	-14.6
1300	0.885	-12.1	0.099	79.7	0.098	79.5	0.897	-16.1
1350	0.881	-12.7	0.103	79.1	0.103	78.9	0.893	-17.6
1400	0.875	-13.5	0.107	78.4	0.106	78.3	0.89	-19.1
1450	0.87	-14.2	0.11	77.8	0.109	77.6	0.887	-20.5
1500	0.868	-14.8	0.114	77.8	0.113	77.6	0.883	-22.1
1550	0.872	-15.7	0.118	77.6	0.118	77.4	0.879	-23.9
1600	0.869	-16.9	0.123	77	0.123	76.7	0.874	-25.6
1650	0.864	-18.2	0.128	76.2	0.127	75.9	0.867	-27.3
1700	0.859	-19.5	0.132	75.3	0.131	75.1	0.862	-29.1
1750	0.85	-20.8	0.136	74.2	0.136	74	0.856	-30.9
1800	0.84	-22.1	0.14	73.5	0.14	73.4	0.85	-32.9
1850	0.819	-22.8	0.146	72.3	0.145	72.1	0.843	-34.8
1900	0.826	-22.9	0.149	70.6	0.148	70.4	0.836	-36.9
1950	0.83	-24.4	0.151	69.5	0.15	69.3	0.826	-39
2000	0.827	-25.9	0.153	68.9	0.152	68.7	0.818	-40.9
2050	0.82	-27.4	0.157	68.6	0.156	68.5	0.812	-42.8
2100	0.817	-28.8	0.162	67.5	0.161	67.4	0.803	-45
2150	0.812	-30.4	0.165	66.6	0.164	66.5	0.792	-47.3
2200	0.799	-32.1	0.172	65.5	0.172	65.5	0.784	-49.4
2250	0.786	-32.9	0.18	62.3	0.179	62.2	0.779	-51.7

Table 14. Standby Mode 25°C Scattering Parameters (continued)
(Vcc = 2.7V, Enable 1 = Low, Enable 2 = Low, 50 Ω system)

f (MHz)	S11		S21		S12		S22	
	Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
2300	0.79	-33.5	0.179	57.4	0.178	57.3	0.765	-54.5
2350	0.794	-35	0.17	54.6	0.17	54.5	0.744	-57.2
2400	0.797	-36.7	0.16	54.2	0.159	54.1	0.72	-59.8
2450	0.799	-38.6	0.157	56.5	0.155	56.2	0.686	-62.1
2500	0.797	-40.8	0.157	58.3	0.156	58.2	0.628	-63
2550	0.792	-43.1	0.162	60.1	0.161	59.8	0.588	-59.5
2600	0.784	-45.4	0.173	59.7	0.172	59.5	0.603	-55

Table 15 and Table 16 list the Noise parameters for the packaged part as measured in a 50 Ω system for low and high IP3 modes of operation and at several bias levels.

Table 15. Low IP3 Mode Noise Parameters
(50 Ω system)

Freq (MHz)	Fmin (dB)	Gamma Opt		Rn	Ga (dB)
		Mag	Angle		
Vcc = 2.7 V, Icc = 4.7 mA					
300	0.94	0.188	30	6.22	28.45
500	0.92	0.184	13.3	7.14	25.83
700	0.91	0.17	4.2	7.49	23.66
800	0.9	0.161	2.2	7.55	22.71
900	0.9	0.15	1.7	7.59	21.85
1000	0.91	0.139	2.7	7.65	21.07
1200	0.91	0.116	8.6	7.82	19.68
1500	0.96	0.087	25.8	7.8	17.9
1700	1	0.077	41.6	7.22	16.82
1900	1.05	0.078	59.9	6.59	15.72
2000	1.1	0.083	69.7	6.84	15.14
2100	1.12	0.093	79.8	7.9	14.53
2400	1.26	0.151	110.9	7.83	12.4
2500	1.31	0.181	121.2	6.02	11.57
2600	1.37	0.218	131.3	10.25	10.65

Table 15. Low IP3 Mode Noise Parameters (continued)
(50 Ω system)

Freq (MHz)	Fmin (dB)	Gamma Opt		Rn	Ga (dB)
		Mag	Angle		
Vcc = 3.0 V, Icc = 4.7 mA					
300	0.91	0.161	30.8	6.45	28.26
500	0.87	0.168	13.3	7.05	25.74
700	0.82	0.161	3.9	7.35	23.64
800	0.8	0.154	2	7.43	22.73
900	0.86	0.145	1.8	7.49	21.89
1000	0.92	0.135	3.1	7.52	21.12
1200	1.02	0.112	9.8	7.55	19.76
1500	1.15	0.083	28.3	7.53	18
1700	1.21	0.071	44.7	7.55	16.92
1900	1.26	0.072	63.4	7.61	15.82
2000	1.27	0.078	73.2	7.63	15.24
2100	1.28	0.088	83.1	7.63	14.63
2400	1.29	0.151	112.7	7.14	12.52
2500	1.28	0.185	122	6.73	11.69
2600	1.27	0.226	130.9	6.19	10.79
Vcc = 3.3 V, Icc = 4.7 mA					
300	0.93	0.151	39.2	6.41	28.06
500	0.89	0.159	21.9	7.1	25.57
700	0.84	0.152	5.8	7.52	23.5
800	0.82	0.145	-0.6	7.62	22.61
900	0.89	0.136	-5.3	7.68	21.79
1000	0.96	0.125	-7.8	7.72	21.03
1200	1.07	0.103	-4.4	7.77	19.7
1500	1.21	0.073	28.8	7.75	17.95
1700	1.27	0.062	75.3	7.38	16.86
1900	1.32	0.064	145.6	6.67	15.72
2000	1.34	0.071	-169.1	6.56	15.12
2100	1.35	0.083	-116.4	7.21	14.47
2400	1.35	0.152	90.6	8.34	12.21

Table 15. Low IP3 Mode Noise Parameters (continued)
(50 Ω system)

Freq (MHz)	Fmin (dB)	Gamma Opt		Rn	Ga (dB)
		Mag	Angle		
2500	1.34	0.188	177.5	5.5	11.31
2600	1.33	0.231	-85.9	9.22	10.33

Table 16. High IP3 Mode Noise Parameters
(50 Ω system)

Freq (MHz)	Fmin (dB)	Gamma Opt		Rn	Ga (dB)
		Mag	Angle		
Vcc = 2.7 V, Icc = 9.9 mA					
300	1.15	0.087	24.3	5.89	29.63
500	1.12	0.049	16.9	6.03	26.99
700	1.1	0.026	88.7	6.29	24.78
800	1.1	0.02	148.4	5.96	23.8
900	1.1	0.017	-139.1	5.88	22.9
1000	1.1	0.017	-56.1	6.1	22.08
1200	1.11	0.025	131.8	6.99	20.59
1500	1.16	0.053	74	7.17	18.65
1700	1.21	0.079	-98.3	6.17	17.45
1900	1.26	0.109	56.7	6.79	16.24
2000	1.3	0.125	116.1	8.44	15.61
2100	1.34	0.14	160.3	10.38	14.95
2400	1.47	0.185	178.7	6.23	12.7
2500	1.52	0.199	139	6.51	11.84
2600	1.57	0.211	72.4	12	10.9
Vcc = 3.0 V, Icc = 9 mA					
300	0.94	0.04	141.2	5.37	29.7
500	0.98	0.022	-101.1	5.81	27.04
700	1.03	0.014	45.5	6.14	24.81
800	1.05	0.014	127.8	6	23.84
900	1.07	0.016	-145	6.04	22.94
1000	1.1	0.02	-53.6	6.45	22.11

Table 16. High IP3 Mode Noise Parameters (continued)
(50 Ω system)

Freq (MHz)	Fmin (dB)	Gamma Opt		Rn	Ga (dB)
		Mag	Angle		
1200	1.14	0.033	138.7	6.21	20.63
1500	1.2	0.063	79.3	7.09	18.7
1700	1.24	0.089	-81.1	7.43	17.49
1900	1.28	0.117	110.7	6.97	16.26
2000	1.3	0.132	-158.3	5.91	15.62
2100	1.32	0.147	-71.5	8.72	14.94
2400	1.38	0.192	155.6	5.75	12.62
2500	1.4	0.206	-142.3	6.12	11.72
2600	1.41	0.22	-88.3	9.29	10.74
Vcc = 3.3 V, Icc = 9 mA					
300	0.92	0.035	161.1	5.54	29.42
500	0.98	0.023	93.7	6.06	26.9
700	1.04	0.02	84.5	6.27	24.77
800	1.07	0.021	99.4	6.3	23.83
900	1.1	0.024	125.8	6.27	22.97
1000	1.12	0.028	162.9	6.2	22.16
1200	1.18	0.042	-95.2	6.73	20.7
1500	1.24	0.072	112.6	6.79	18.77
1700	1.29	0.097	-83.9	7.66	17.54
1900	1.33	0.124	90.3	7.84	16.28
2000	1.34	0.138	178.9	5.86	15.62
2100	1.36	0.153	-92.7	8.13	14.92
2400	1.35	0.146	-136.8	6.45	15.27
2500	1.41	0.197	160.5	5.73	12.52
2600	1.44	0.225	-50.3	11.99	10.58

Figure 2 through Figure 9 are constant noise figure and gain circles with input and output stability regions shown on Smith charts. Gamma opt, noise resistance and stability at the frequency are shown for both low and high IP3 modes of operation.

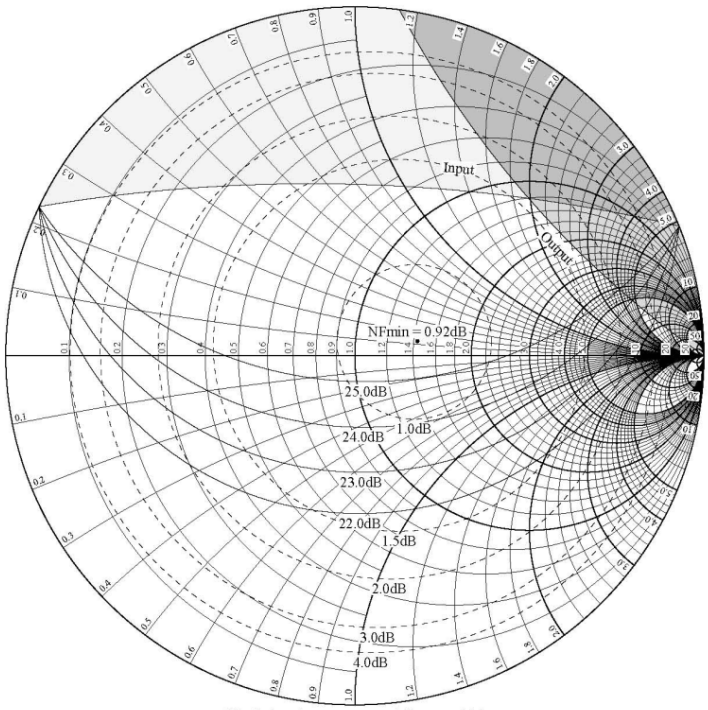


Figure 2. Constant Noise Figure and Gain Circles, 500 MHz, Low IP3 Mode, 25 °C

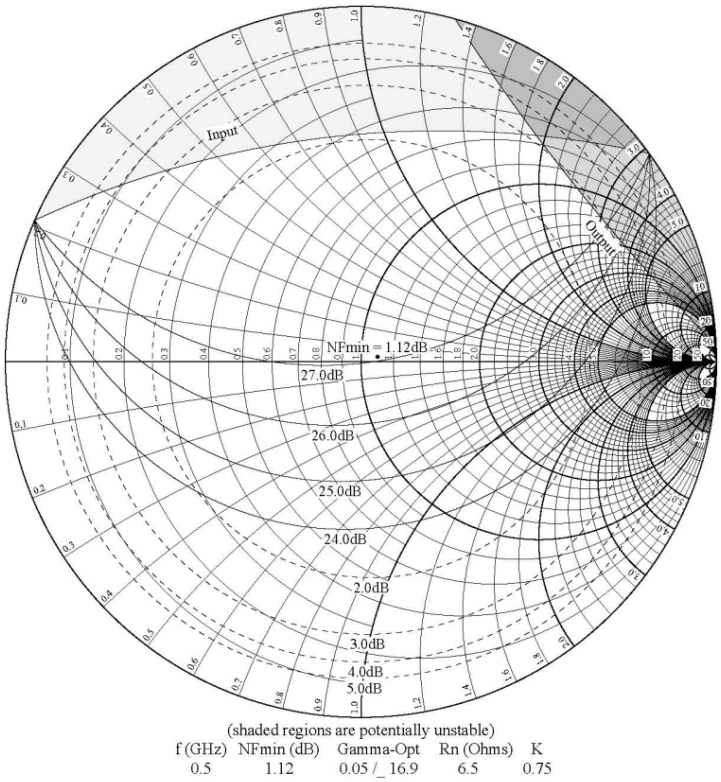
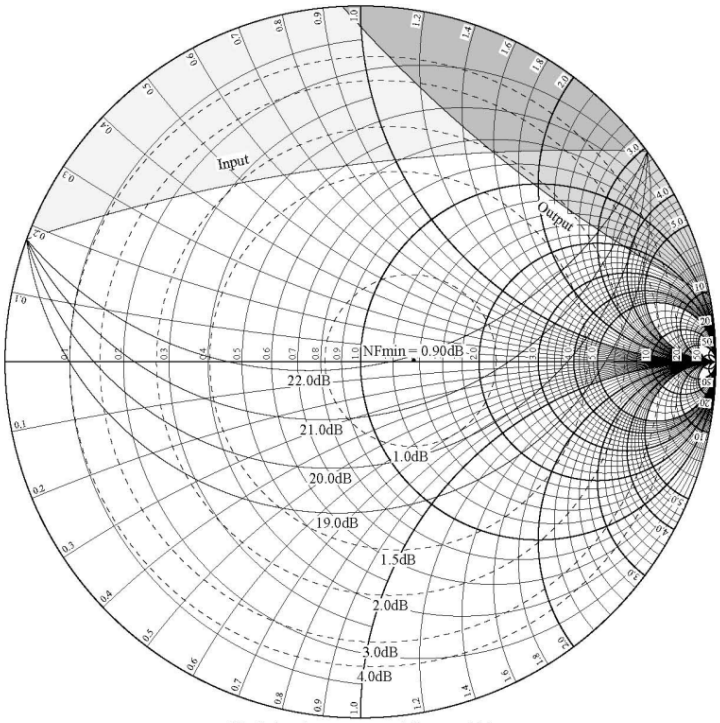


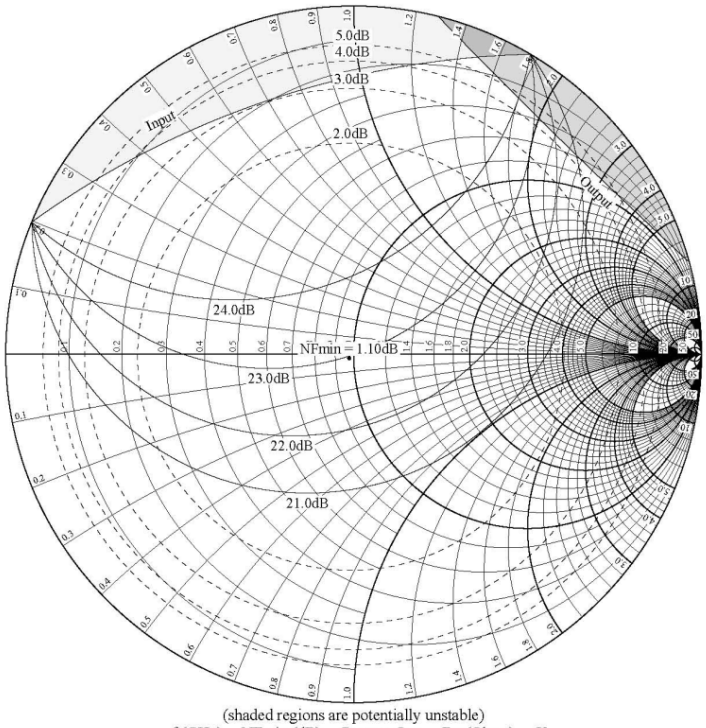
Figure 3. Constant Noise Figure and Gain Circles, 500 MHz, High IP3 Mode, 25 °C



(shaded regions are potentially unstable)

f (GHz)	NFmin (dB)	Gamma-Opt	Rn (Ohms)	K
0.9	0.90	0.15 /_ 1.7	7.5	0.62

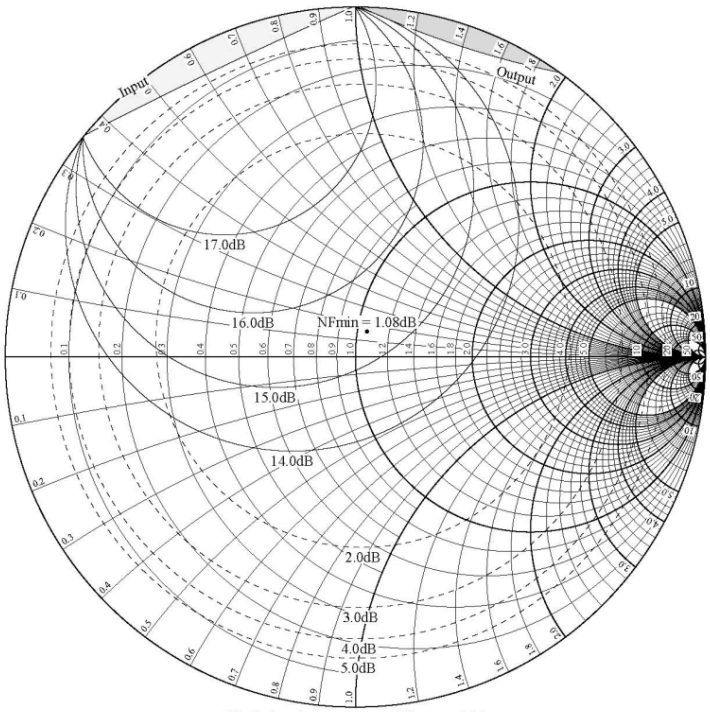
Figure 4. Constant Noise Figure and Gain Circles, 900 MHz, Low IP3 Mode, 25 °C



(shaded regions are potentially unstable)

f (GHz)	NFmin (dB)	Gamma-Opt	Rn (Ohms)	K
0.9	1.10	0.02 /_ -139.1	6.0	0.85

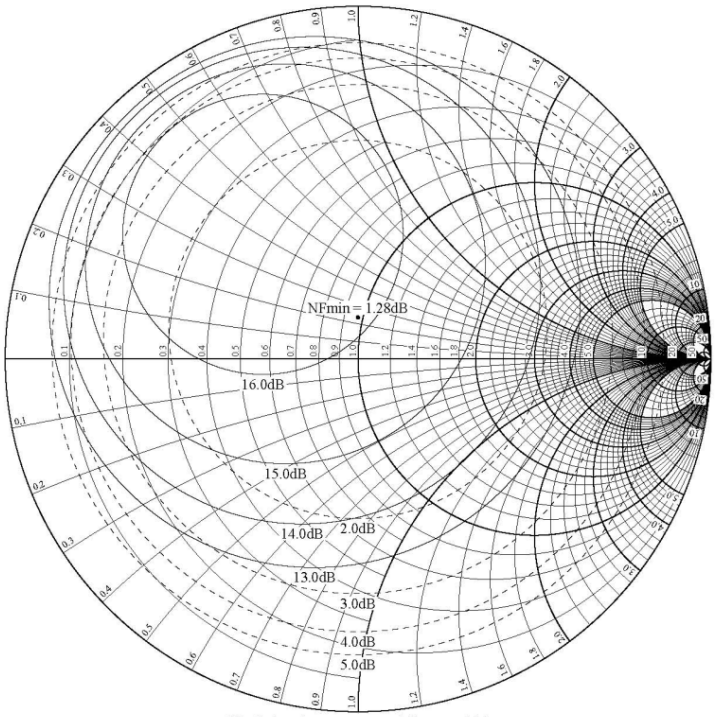
Figure 5. Constant Noise Figure and Gain Circles, 900 MHz, High IP3 Mode, 25 °C



(shaded regions are potentially unstable)

f (GHz)	NFmin (dB)	Gamma-Opt	Rn (Ohms)	K
1.96	1.08	0.08 / _ 65.7	7.5	0.92

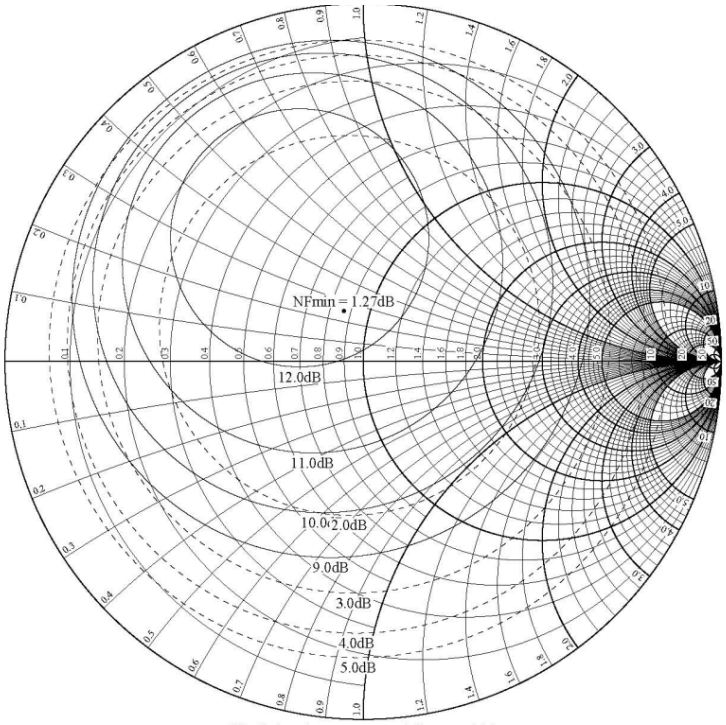
Figure 6. Constant Noise Figure and Gain Circles, 1960 MHz, Low IP3 Mode, 25 °C



(shaded regions are potentially unstable)

f (GHz)	NFmin (dB)	Gamma-Opt	Rn (Ohms)	K
1.96	1.28	0.12 / _ 90.1	7.5	1.08

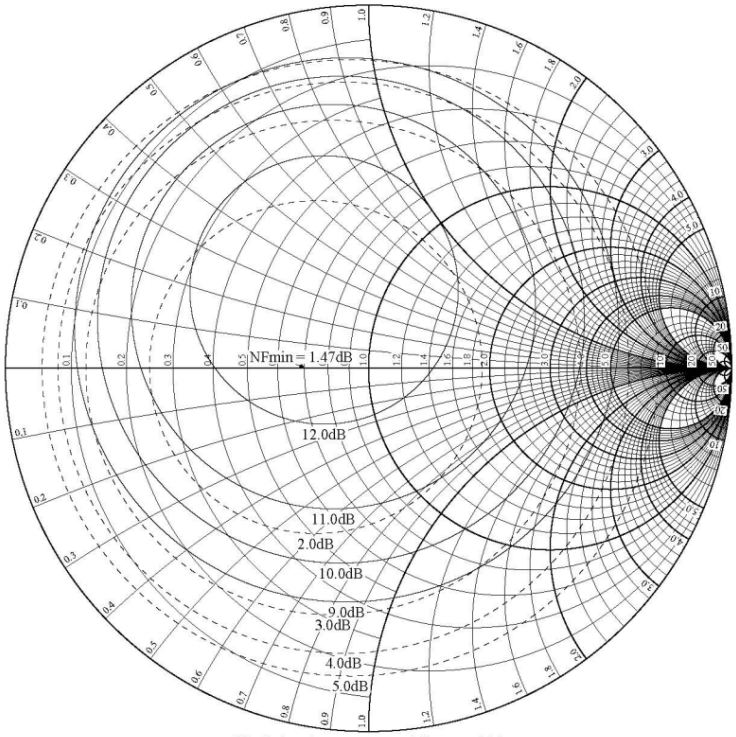
Figure 7. Constant Noise Figure and Gain Circles, 1960 MHz, High IP3 Mode, 25 °C



(shaded regions are potentially unstable)

f (GHz)	NFmin (dB)	Gamma-Opt	Rn (Ohms)	K
2.4	1.27	0.15 /_ 110.9	7.0	1.35

Figure 8. Constant Noise Figure and Gain Circles, 2400 MHz, Low IP3 Mode, 25 °C



(shaded regions are potentially unstable)

f (GHz)	NFmin (dB)	Gamma-Opt	Rn (Ohms)	K
2.4	1.47	0.185 /_ 178.7	5.5	1.57

Figure 9. Constant Noise Figure and Gain Circles, 2400 MHz, High IP3 Mode, 25 °C

Figure 10 and Figure 11 show minimum noise figure and associated gain swept over frequency for packaged parts in a 50 Ω system.

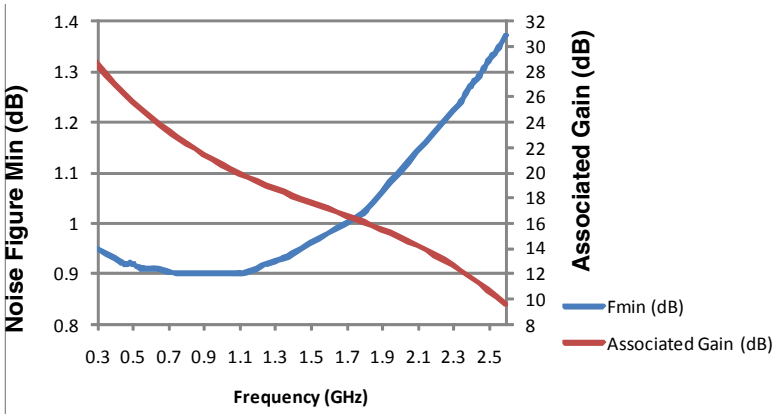


Figure 10. Minimum Noise Figure and Associated Gain vs. Frequency (Low IP3 Mode)

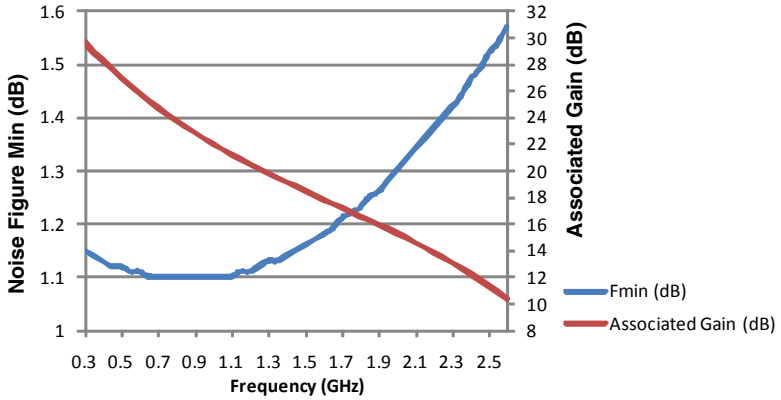


Figure 11. Minimum Noise Figure and Associated Gain vs. Frequency (High IP3 Mode)

Figure 12 and Figure 13 show maximum stable/available gain and forward insertion gain swept over frequency for packaged parts in a 50 Ω system.

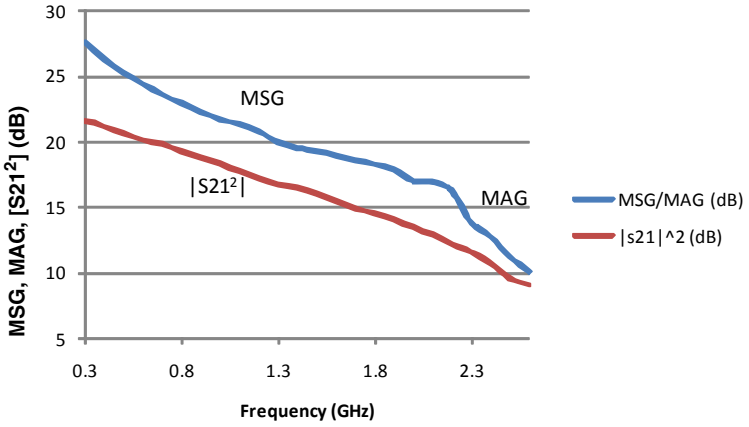


Figure 12. Maximum Stable/Available Gain and Forward Insertion Gain vs. Frequency (Low IP3 Mode)

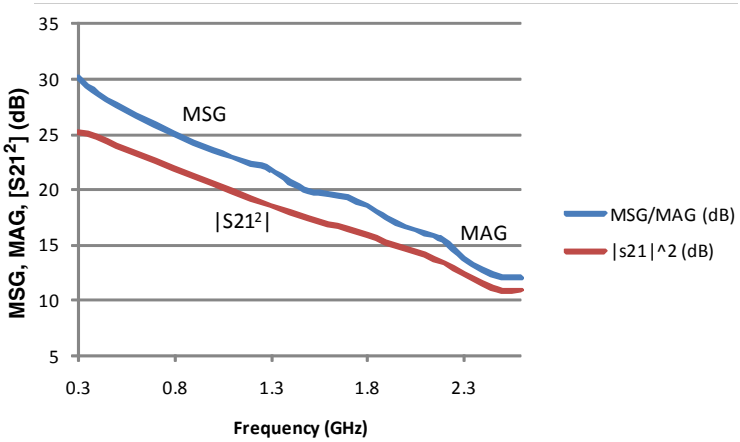


Figure 13. Maximum Stable/Available Gain and Forward Insertion Gain vs. Frequency (High IP3 Mode)

4 Application Information

The MC13850 LNA is designed for applications in the 400 MHz to 2.5 GHz range. It has four different modes: Low IP3, High IP3, bypass and standby. The LNA is programmable through the Enable 1 and Enable 2 pins. In Low IP3 mode, current consumption is optimized. Current consumption is higher in High IP3 mode to boost the intercept point performance. The gain difference between Low IP3 and High IP3 modes is typically 1.0 dB, and typically the Low and High IP3 modes have similar noise figures. The internal bypass switch is designed for broadband applications. One of the advantages of the MC13850 is the simplification of the matching network in both bypass and amplifier modes. The bypass switch is designed so that changes of input and output return losses between bypass mode and active mode are minimized. As a result, the mismatch of the LNA input and output is minimized and the matching network design is simplified.

In the design of the external matching network, conjugate matching does not necessarily provide the best noise figure and gain performance. Designing for a balance between noise figure, gain, return losses and intercept point provides circuits that demonstrate overall performance. For a particular application or specification requirement, the matching can be changed to achieve enhanced performance of one parameter. Typical circuits are provided for 470 MHz–860 MHz, 900 MHz, 1.96 GHz and 2.4 GHz applications.

Figure 14 shows the typical application circuit for 470 MHz–860 MHz. The noise figure, input intercept point, gain and return losses are optimized. L1 and C2 act as a low frequency trap to improve the input intercept point.

In Figure 15, the typical application circuit for 900 MHz is shown. The input low frequency trap again is used to maximize the input intercept point. It has moderate IP3 performance for high gain. Figure 16 shows the 900 MHz application circuit with feedback network for higher IP3. Capacitive feedback is used to increase the third order input intercept point while decreasing gain and provides unconditional stability. The corresponding printed circuit boards are shown in Figure 19 through Figure 23. Table 22 lists the bill of materials for the application circuit evaluation boards.

4.1 470 MHz–860 MHz Application

This application was designed to provide NF < 1.4 dB, S21 gain > 21 dB, OIP3 of 10 dBm with return losses better than -10 dB at 470 MHz and NF < 1.3 dB, S21 gain > 17 dB, OIP3 of 13 dBm at 860 MHz. This is a broadband application with application to UHF. The performance can be further optimized for narrowband applications such as RKE at the lower frequency, or wireless security at the higher frequency. Typical performance that can be expected from this circuit at 2.7V is listed in Table 17.

Figure 14 shows the 470 MHz–860 MHz schematic with package pinouts and circuit components.

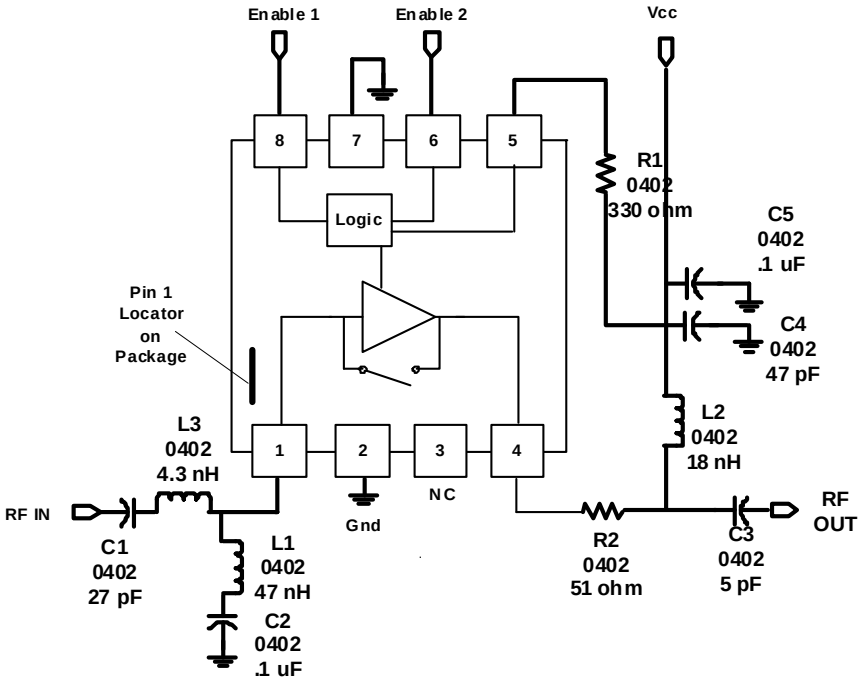


Figure 14. 470 MHz–860 MHz Application Schematic

Table 17. Typical 470 MHz–860 MHz Evaluation Board Performance (Vcc = 2.7V, T_{A} = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
470 MHz (refer to Figure 14)					
Supply Current	Icc				
Low IP3		—	4.7	5.7	mA
High IP3		—	9.9	12.5	mA
Bypass		—	2	10	uA
RF Gain	G				dB
Low IP3		20.5	21.6	—	
High IP3		23.4	24.4	—	
Bypass		-7.4	-6.9	—	

Table 17. Typical 470 MHz–860 MHz Evaluation Board Performance (continued)
(Vcc = 2.7V, $T_{A=}$ 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Figure	NF				dB
Low IP3		—	1.32	1.6	
High IP3		—	1.33	1.6	
Bypass		—	9.5	10	
Input IP3	IIP3				dBm
Low IP3		-12.5	-11.2	—	
High IP3		-9.2	-8	—	
Bypass		26.7	27.7	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		6	7	—	
High IP3		8.6	9.6	—	
Input Return Loss	S11				dB
Low IP3		—	-5.2	-4.1	
High IP3		—	-10.6	-8.5	
Bypass		—	-4.2	-3.2	
Gain	S21				dB
Low IP3		20.5	21.5	—	
High IP3		23.1	24.1	—	
Bypass		-7.7	-6.7	—	
Reverse Isolation	S12				dB
Low IP3		—	-27.3	-20	
High IP3		—	-30.6	-25	
Bypass		—	-6.7	-6.2	
Output Return Loss	S22				dB
Low IP3		—	-6.6	-5.6	
High IP3		—	-10.2	-9.2	
Bypass		—	-11.7	-10.7	

Table 17. Typical 470 MHz–860 MHz Evaluation Board Performance (continued)
(Vcc = 2.7V, $T_{A=}$ 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
860 MHz (refer to Figure 14)					
RF Gain	G				dB
Low IP3		16.4	17.4	—	
High IP3		18	19	—	
Bypass		-6.7	-6.2	—	
Noise Figure	NF				dB
Low IP3		—	1.22	1.5	
High IP3		—	1.32	1.6	
Bypass		—	5.2	5.7	
Input IP3	IIP3				dBm
Low IP3		-5.3	-4	—	
High IP3		-2.3	-1.1	—	
Bypass		23.7	24.7	—	
Power Output at 1.0 dB Gain Compression	P1dB				dBm
Low IP3		7.4	8.4	—	
High IP3		8.1	9.2	—	
Input Return Loss	S11				dB
Low IP3		—	-13.7	-11	
High IP3		—	-21.3	-17	
Bypass		—	-6	-5	
Gain	S21				dB
Low IP3		17	18	—	
High IP3		18.4	19.4	—	
Bypass		-6.8	-5.8	—	
Reverse Isolation	S12				dB
Low IP3		—	-26.9	-25	
High IP3		—	-29.2	-28.2	
Bypass		—	-5.7	-5	

Table 17. Typical 470 MHz–860 MHz Evaluation Board Performance (continued)
(Vcc = 2.7V, T_{A} = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Output Return Loss	S22				dB
Low IP3		—	-5.3	-4.3	
High IP3		—	-7.2	-6.2	
Bypass		—	-8.2	-7.2	

4.2 900 MHz Application

This application was designed to provide NF < 1.4 dB, S21 gain > 21 dB, OIP3 of 17 dBm with return losses better than -10 dB at 900 MHz. Typical performance that can be expected from this circuit at 2.7V is listed in Table 18.

Figure 15 shows the 900 MHz schematic with package pinouts and circuit components.

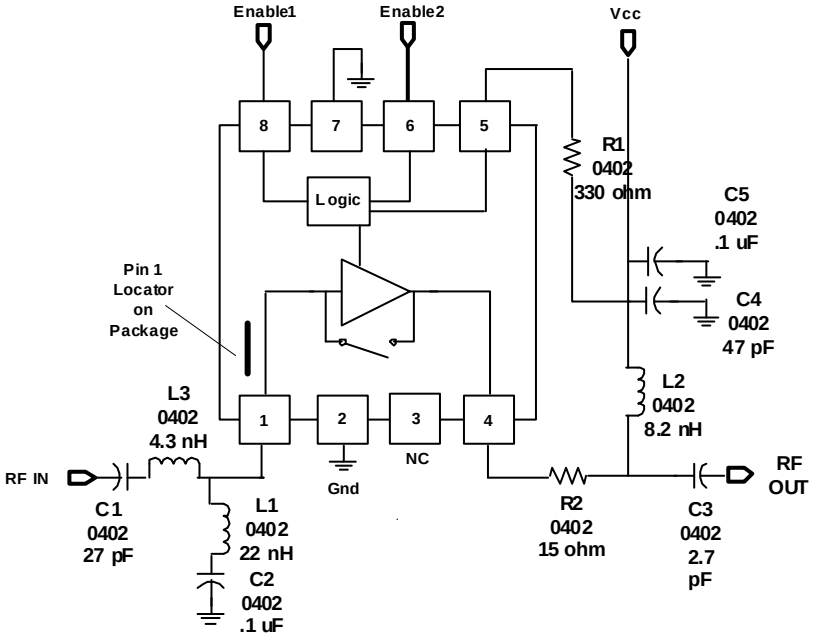


Figure 15. 900 MHz Application Schematic

Table 18. Typical 900 MHz Evaluation Board Performance
(Vcc = 2.7V, Ta = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
900 MHz (refer to Figure 15)					
Supply Current	Icc				
Low IP3		—	4.7	5.7	mA
High IP3		—	9.9	12.5	mA

Table 18. Typical 900 MHz Evaluation Board Performance (continued)
(Vcc = 2.7V, Ta = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Bypass		—	2	10	uA
RF Gain	G				dB
Low IP3		20	21	—	
High IP3		20.8	21.8	—	
Bypass		-4.5	-3.7	—	
Noise Figure	NF				dB
Low IP3		—	1.38	1.6	
High IP3		—	1.53	1.75	
Bypass		—	3.85	4.6	
Input IP3	IIP3				dBm
Low IP3		-6.5	-4.1	—	
High IP3		1.75	3.5	—	
Bypass		27	27.6	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		10.9	11.9	—	
High IP3		11.1	12.1	—	
Input Return Loss	S11				dB
Low IP3		—	-10.7	-7	
High IP3		—	-15.3	-12	
Bypass		—	-9.5	-8	
Gain	S21				dB
Low IP3		20.1	21.1	—	
High IP3		20.8	21.8	—	
Bypass		-4.5	-3.5	—	
Reverse Isolation	S12				dB
Low IP3		—	-23.9	-22.8	
High IP3		—	-26.8	-25.7	
Bypass		—	-3.5	-2.5	
Output Return Loss	S22				dB
Low IP3		—	-10.7	-9.6	
High IP3		—	-18.4	-15	
Bypass		—	-18	-12.6	

4.3 900 MHz High IP3 Application

This application was designed to demonstrate performance at 900 MHz using capacitive feedback from the output to input to raise IP3. Typical performance that can be expected from this circuit at 2.75V is listed in Table 19.

Figure 16 shows the *High IP3 900 MHz* schematic with package pinouts and circuit components. This 900 MHz application differs from the 900 MHz application in Section 4.2, "900 MHz Application in that it uses output to input feedback capacitance to raise the IP3 performance.

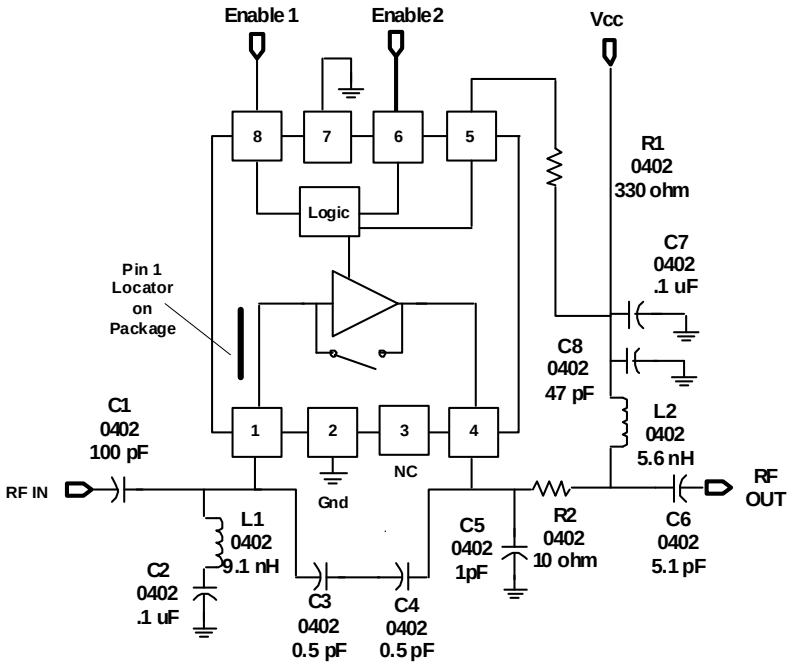


Figure 16. 900 MHz High IP3 Application Schematic

Table 19. Typical 900 MHz High IP3 Evaluation Board Performance (Vcc - 2.75V, TA = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
900 MHz (refer to Figure 16)					
Supply Current	Icc				
Low IP3		—	4.7	5.7	mA
High IP3		—	9.9	12.5	mA
Bypass		—	2	10	uA
RF Gain	G				dB
Low IP3		15.5	16.5	—	
High IP3		16.1	17.1	—	
Bypass		-5.2	-4.2	—	

Table 19. Typical 900 MHz High IP3 Evaluation Board Performance (continued)
(Vcc - 2.75V, TA = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Figure	NF				dB
Low IP3		—	1.43	1.65	
High IP3		—	1.55	1.75	
Bypass		—	4.6	5.8	
Input IP3	IIP3				dBm
Low IP3		-6	-2.9	—	
High IP3		6	8	—	
Bypass		26.2	27.7	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		8	12	—	
High IP3		11.5	13.5	—	
Input Return Loss	S11				dB
Low IP3		—	-12	-8	
High IP3		—	-10	-8	
Bypass		—	-9	-7	
Gain	S21				dB
Low IP3		15.7	16.7	—	
High IP3		16.2	17.2	—	
Bypass		-4.7	-3.9	—	
Reverse Isolation	S12				dB
Low IP3		—	-19.3	-17.5	
High IP3		—	-22.4	-21	
Bypass		—	-3.9	-3.2	
Output Return Loss	S22				dB
Low IP3		—	-11	-8.5	
High IP3		—	-12.8	-10	
Bypass		—	-31	-24	

4.4 1960 MHz Application

This application was designed to provide NF = 1.5 dB, S21 gain > 15 dB, OIP3 of 20 dBm with return losses better than -10 dB at 1960 MHz. Typical performance that can be expected from this circuit at 2.7V is listed in Table 20.

Figure 17 shows the 1960 MHz schematic with package pinouts and circuit components.

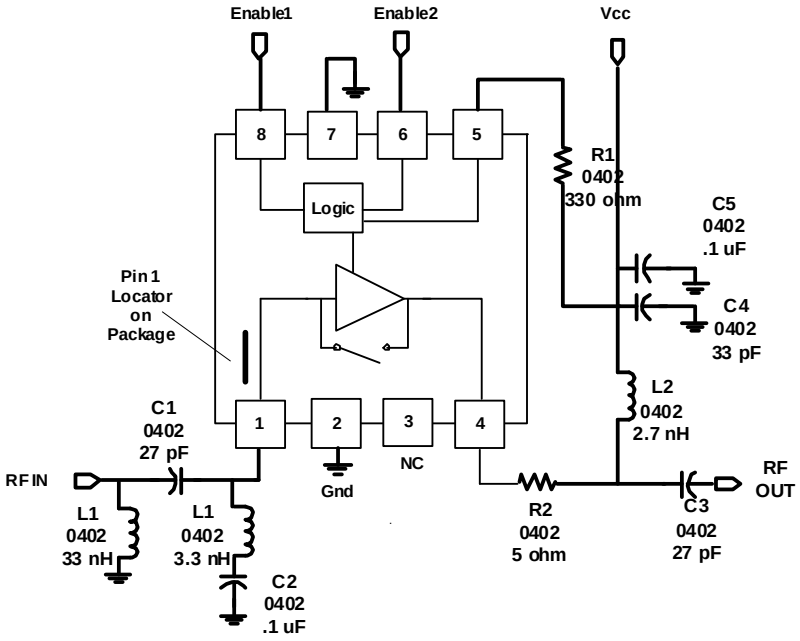


Figure 17. 1960 MHz Application Schematic

Table 20. Typical 1900 MHz Evaluation Board Performance (Vcc = 2.7V, Ta = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
1960 MHz (refer to Figure 17)					
Supply Current	Icc				
Low IP3		—	4.7	5.7	mA
High IP3		—	9.9	12.5	mA
Bypass		—	2	10	uA
RF Gain	G				dB
Low IP3		13.8	14.8	—	
High IP3		13.9	14.9	—	
Bypass		-4.8	-3.5	—	

Table 20. Typical 1900 MHz Evaluation Board Performance (continued)
(Vcc = 2.7V, Ta = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Figure	NF				dB
Low IP3		—	1.5	1.8	
High IP3		—	1.75	2	
Bypass		—	3.2	4.4	
Input IP3	IIP3				dBm
Low IP3		3.5	6.5	—	
High IP3		8	9.6	—	
Bypass		22.6	23.6	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		1.5	3.2	—	
High IP3		2.3	4	—	
Input Return Loss	S11				dB
Low IP3		—	-12	-9.5	
High IP3		—	-12.5	-10	
Bypass		—	-11	-8	
Gain	S21				dB
Low IP3		14	15	—	
High IP3		14	15	—	
Bypass		-4.8	-3.6	—	
Reverse Isolation	S12				dB
Low IP3		—	-21	-20	
High IP3		—	-22.5	-21.5	
Bypass		—	-3.7	-2.5	
Output Return Loss	S22				dB
Low IP3		—	-13	-9	
High IP3		—	-15	-11	
Bypass		—	-8	-6	

4.5 2400 MHz Application

This application was designed to provide NF = 1.6 dB, S21 gain = 12 dB, OIP3 of 23 dBm at 2400 MHz. Typical performance that can be expected from this circuit at 2.7V is listed in Table 21.

Figure 18 shows the 2400 MHz schematic with package pinouts and circuit components.

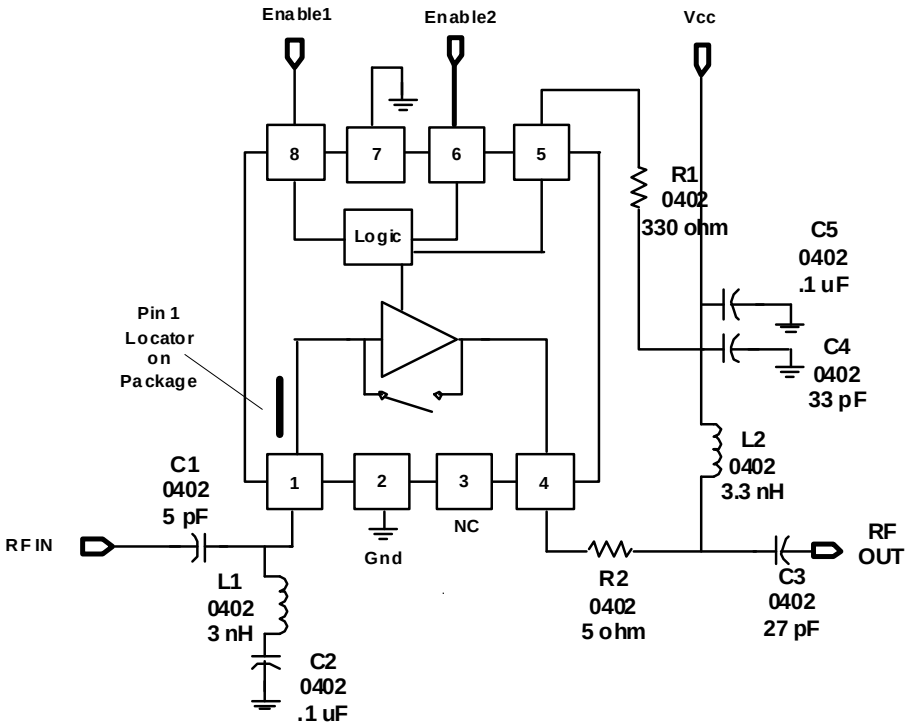


Figure 18. 2400 MHz Application Schematic

Table 21. Typical 2400 MHz Evaluation Board Performance (Vcc = 2.7V, Ta = 25°C)

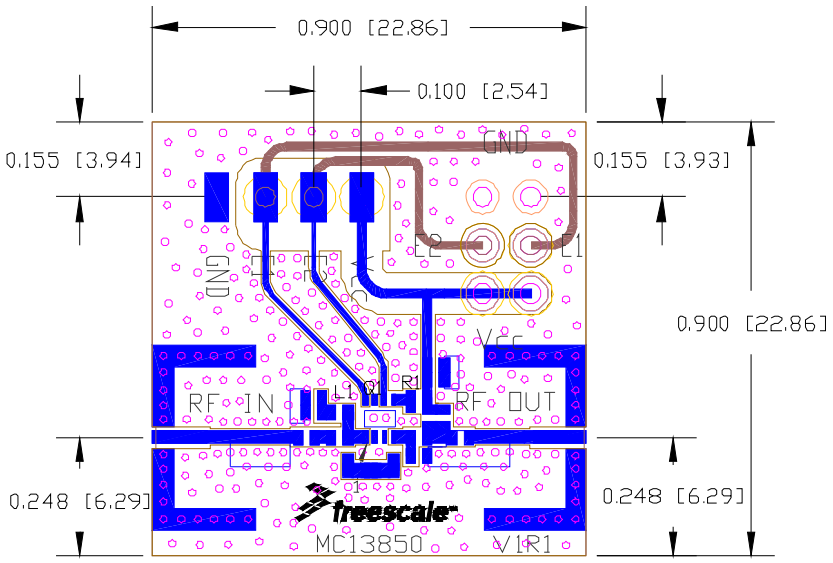
Characteristic	Symbol	Min	Typ	Max	Unit
2400 MHz (refer to Figure 18)					
Supply Current	Icc				
Low IP3		—	4.7	5.7	mA
High IP3		—	9.9	12.5	mA
Bypass		—	2	10	uA
RF Gain	G				dB
Low IP3		11.5	12.5	—	
High IP3		12	13	—	
Bypass		-4	-3	—	

Table 21. Typical 2400 MHz Evaluation Board Performance (continued)
(Vcc = 2.7V, Ta = 25°C)

Characteristic	Symbol	Min	Typ	Max	Unit
Noise Figure	NF				dB
Low IP3		—	1.6	1.95	
High IP3		—	1.85	2.2	
Bypass		—	3.2	4.3	
Input IP3	IIP3				dBm
Low IP3		7	10	—	
High IP3		11	12.5	—	
Bypass		26	27.2	—	
Power Output at 1.0 dB Gain Compression	P1dBoutput				dBm
Low IP3		-1	1	—	
High IP3		0	2.2	—	
Input Return Loss	S11				dB
Low IP3		—	-9	-7.5	
High IP3		—	-9.5	-8	
Bypass		—	-19.5	-12	
Gain	S21				dB
Low IP3		11.6	12.6	—	
High IP3		12	13	—	
Bypass		-3.7	-3.2	—	
Reverse Isolation	S12				dB
Low IP3		—	-20	-19	
High IP3		—	-20.6	-20	
Bypass		—	-2.9	-2.4	
Output Return Loss	S22				dB
Low IP3		—	-25	-15	
High IP3		—	-27	-15	
Bypass		—	-16	-10	

5 Printed Circuit Board and Bill of Materials

Figure 19 is a drawing of the printed circuit board. Figure 21 through Figure 25 are drawings of the evaluation boards used for each of the application frequency designs described in Section 4. These drawings show the boards with the circuit matching components placed and identified.



Note: Dimensions are in inches and [mm].

Soldering Note: The center flag under the part needs to be soldered down to ground on the bo

Figure 19. Printed Circuit Board

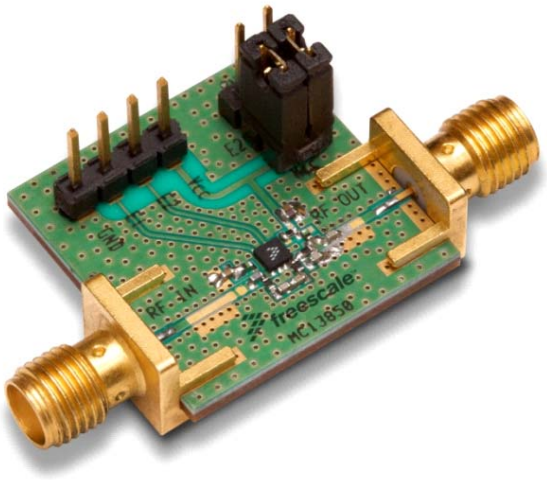


Figure 20. Typical Assembled Evaluation Board with SMA Connectors

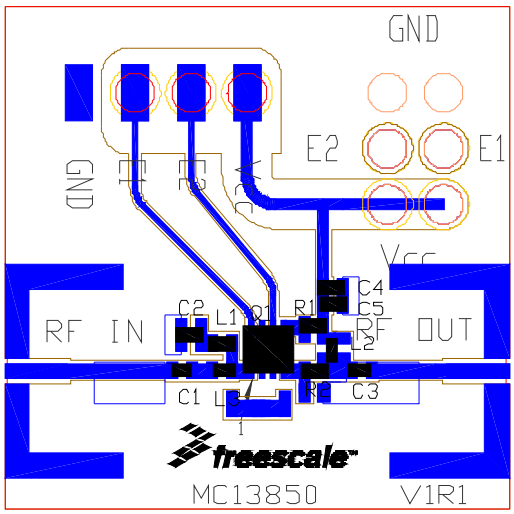


Figure 21. 470–860 MHz Application Board

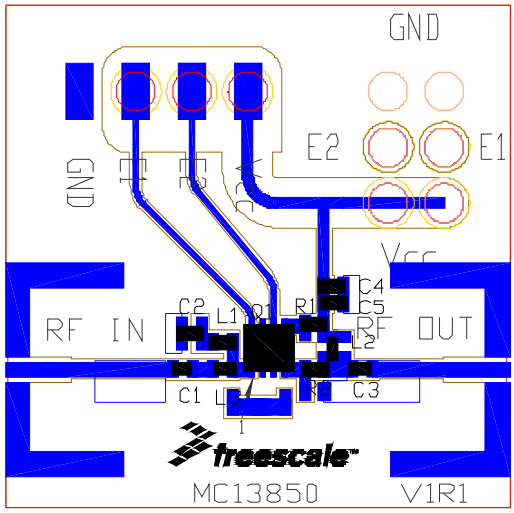


Figure 22. 900 MHz Application Board

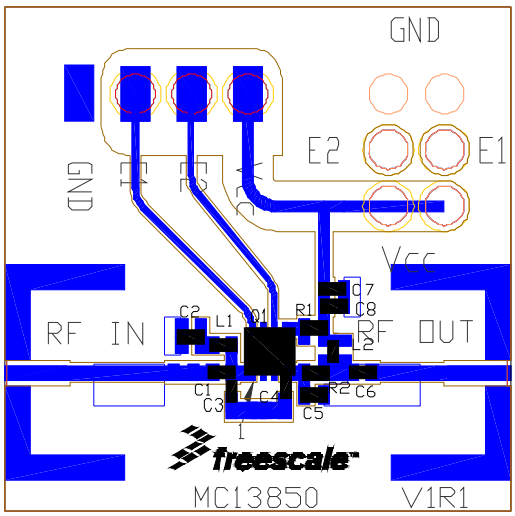


Figure 23. 900 MHz High IP3 Application Board

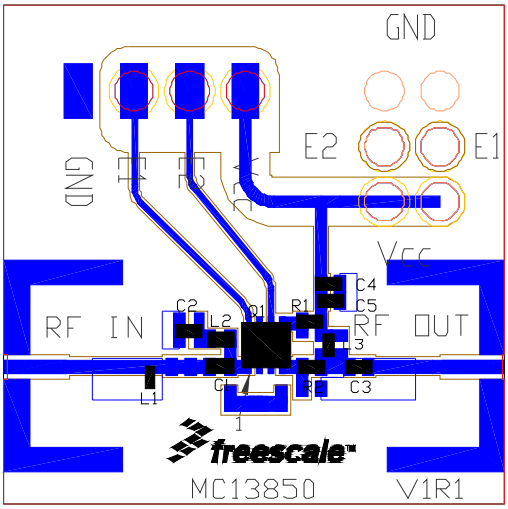


Figure 24. 1960 MHz Application Board

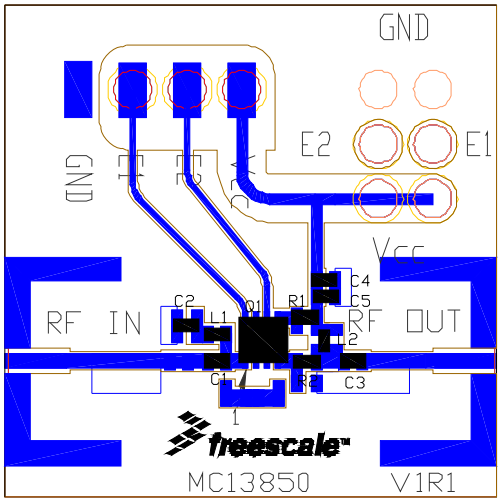


Figure 25. 2400 MHz Application Board

The Bill of Materials for each of the application frequency circuit boards is listed in Table 22. The value, case size, manufacturer and circuit function of each component are provided.

Table 22. Bill of Materials for the Application Circuit Boards

Component	Value	Case	Manufacturer	Comments
470–860 MHz (refer to Figure 21)				
C1	27 pF	402	Murata	DC block, input match
C2	0.1 uF	402	Murata	Low freq. bypass
C3	5 pF	402	Murata	DC block, output match
C4	47 pF	402	Murata	860 MHz short
C5	0.1 uF	402	Murata	Low freq. bypass
L1	47 nH	402	Murata	Input match
L2	18 nH	402	Murata	Output match, bias decouple
L3	4.3 nH	402	Murata	Input match
R1	330 Ω	402	KOA	Logic circuit bias
R2	51 Ω	402	KOA	Lower gain, improve return losses
900 MHz (refer to Figure 22)				
C1	27 pF	402	Murata	DC block, input match
C2	0.1 uF	402	Murata	DC block, input match
C3	2.7 pF	402	Murata	DC block, output match
C4	47 pF	402	Murata	900 MHz short
C5	0.1 uF	402	Murata	Low freq. bypass
L1	22 nH	402	Murata	Input match

Table 22. Bill of Materials for the Application Circuit Boards (continued)

Component	Value	Case	Manufacturer	Comments
L2	8.2 nH	402	Murata	Output match, bias decouple
L3	4.3 nH	402	Murata	Input match
R1	330 Ω	402	KOA	Logic circuit bias
R2	15 Ω	402	KOA	Lower gain, improve return losses
900 MHz High IP3 (refer to Figure 23)				
C1	100 pF	402	Murata	DC block, input match
C2	0.1 uF	402	Murata	DC block, input match
C3	0.5 pF	402	Murata	IP3 improvement
C4	0.5 pF	402	Murata	IP3 improvement
C5	1.0 pF	402	Murata	Output match
C6	5.1 pF	402	Murata	Output match
C7	0.1 uF	402	Murata	Bypass
C8	47 pF	402	Murata	900 MHz short
L1	9.1 nH	402	Murata	Input match
L2	5.6 nH	402	Murata	Output match
R1	330 Ω	402	KOA	Logic circuit bias
R2	10 Ω	402	KOA	Lower gain, increase stability
1960 MHz (refer to Figure 24)				
C1	27 pF	402	Murata	DC block, input match
C2	0.1 uF	402	Murata	DC block
C3	27 pF	402	Murata	DC block, output match
C4	33 pF	402	Murata	1960 MHz short
C5	0.1 uF	402	Murata	Low freq. bypass
L1	33 nH	402	Murata	Input match
L2	3.3 nH	402	Murata	Input match
L3	2.7 nH	402	Murata	Output match, bias decouple
R1	330 Ω	402	KOA	Logic circuit bias
R2	5 Ω	402	KOA	Lower gain, increase stability
2400 MHz (refer to Figure 25)				
C1	5 pF	402	Murata	DC block, input match
C2	0.1 uF	402	Murata	DC block
C3	27 pF	402	Murata	DC block, output match

Table 22. Bill of Materials for the Application Circuit Boards (continued)

Component	Value	Case	Manufacturer	Comments
C4	33 pF	402	Murata	1960 MHz short
C5	0.1 uF	402	Murata	Low freq. bypass
L1	3 nH	402	Murata	Input match
L2	3.3 nH	402	Murata	Input match
R1	330 Ω	402	KOA	Logic circuit bias
R2	5 Ω	402	KOA	Lower gain, increase stability

6 Packaging

Figure 26 and Figure 27 are the package drawings with dimensions for the MLPD-8, 2 × 2 × 0.6 mm, package.

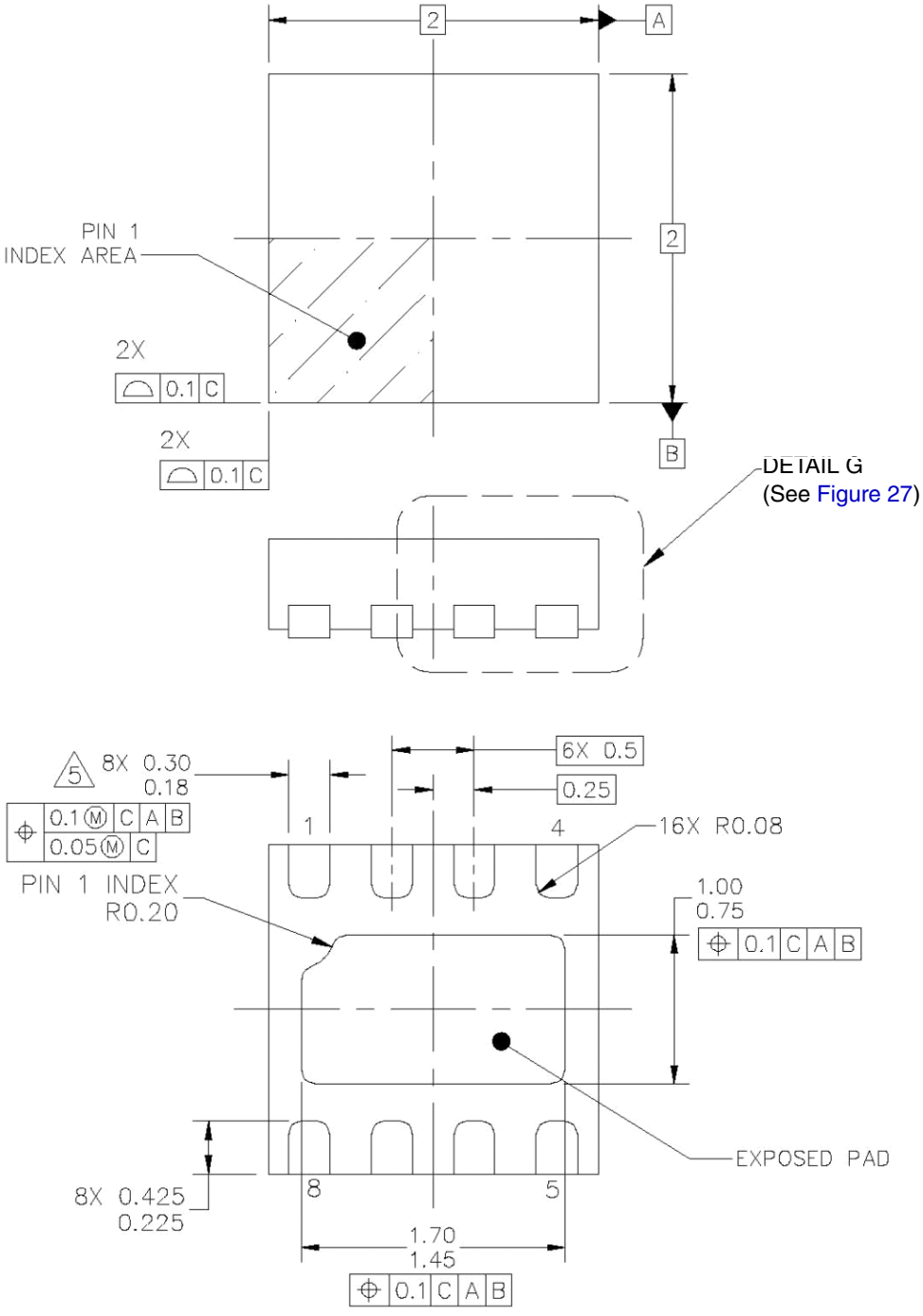


Figure 26. Outline Dimensions for MLPD-8

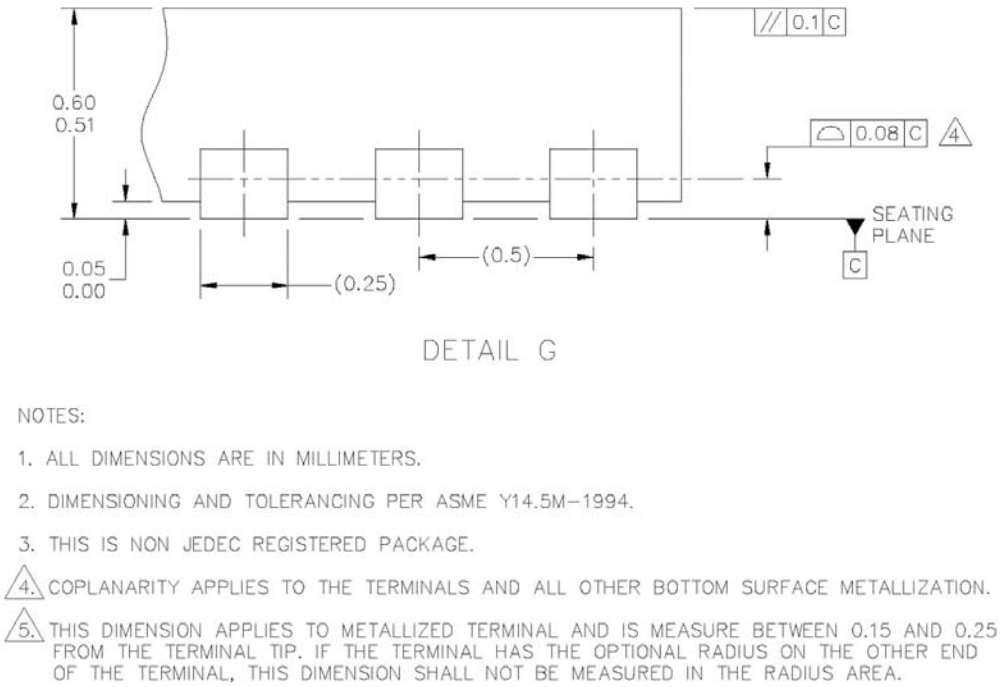


Figure 27. Packaging Details

7 Product Documentation

This data sheet is labeled as a particular type: Product Preview, Advance Information, or Technical Data. Definitions of these types are available at: http://www.freescale.com.

8 Revision History

Table 23 summarizes the revisions to this document since Rev. 0.

Table 23. Revision History

Revision	Description of Change
0	Initial Release
1	Technical Content Changes include: • In Table 4, min and max values added. • Added Table 5–Table 16, S parameters. • Added Figure 2–Figure 9, constant gain and noise figure circles. • Added Figure 10,Figure 11, minimum NF and associated gain. • Added Figure 12, Figure 13, maximum stable gain and forward insertion gain. • Section 4 application circuit performance parameters extensively revised. • Section 5 printed circuit board and application board drawings added. • Table 22 bill of materials for application revised. • Section 6 package drawing changed to MLPD-8 package.

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