

# DATA SHEET

## **SA611**

1GHz low voltage LNA and mixer

Product specification  
Supersedes data of 1997 Nov 07  
IC17 Data Handbook

1999 Mar 26

# 1GHz low voltage LNA and mixer

# SA611

## DESCRIPTION

The SA611 is a combined low-noise amplifier, and mixer designed for high-performance low-power communication systems from 800-1000MHz. The low-noise preamplifier has a 1.7dB noise figure at 881MHz with 15dB gain and an IP3 intercept of -7dBm at the input. The gain is stabilized by on-chip compensation to vary less than  $\pm 0.2$ dB over -40 to +85°C temperature range. The wide-dynamic-range mixer has a 12dB noise figure and IP3 of +7.0dBm at the input at 881MHz. The nominal current drawn from a single 3V supply is 8.3mA. Additionally, the entire circuit can be powered down to further reduce the supply current to less than 20 $\mu$ A.

## FEATURES

- Low current consumption
- Outstanding gain and noise figure
- Excellent gain stability versus temperature and supply voltage
- LNA and mixer power down capability

## PIN CONFIGURATION

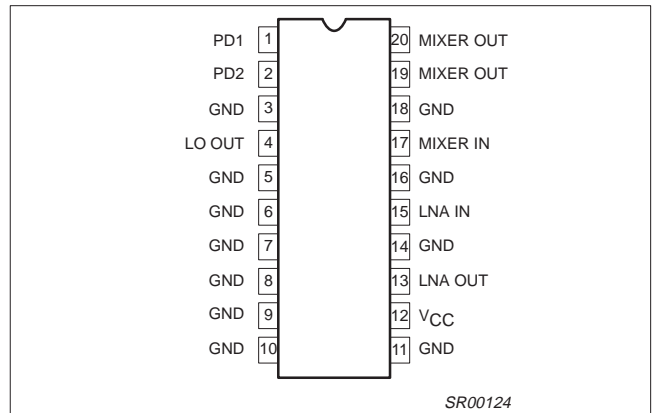


Figure 1. Pin Configuration

## APPLICATIONS

- 900MHz cellular and cordless front-end
- Spread spectrum receivers
- RF data links
- UHF frequency conversion
- Portable radio

## ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
20-Pin Shrink Small Outline Package (Surface-mount, SSOP)	-40 to +85°C	SA611DK	SOT266-1

## BLOCK DIAGRAM

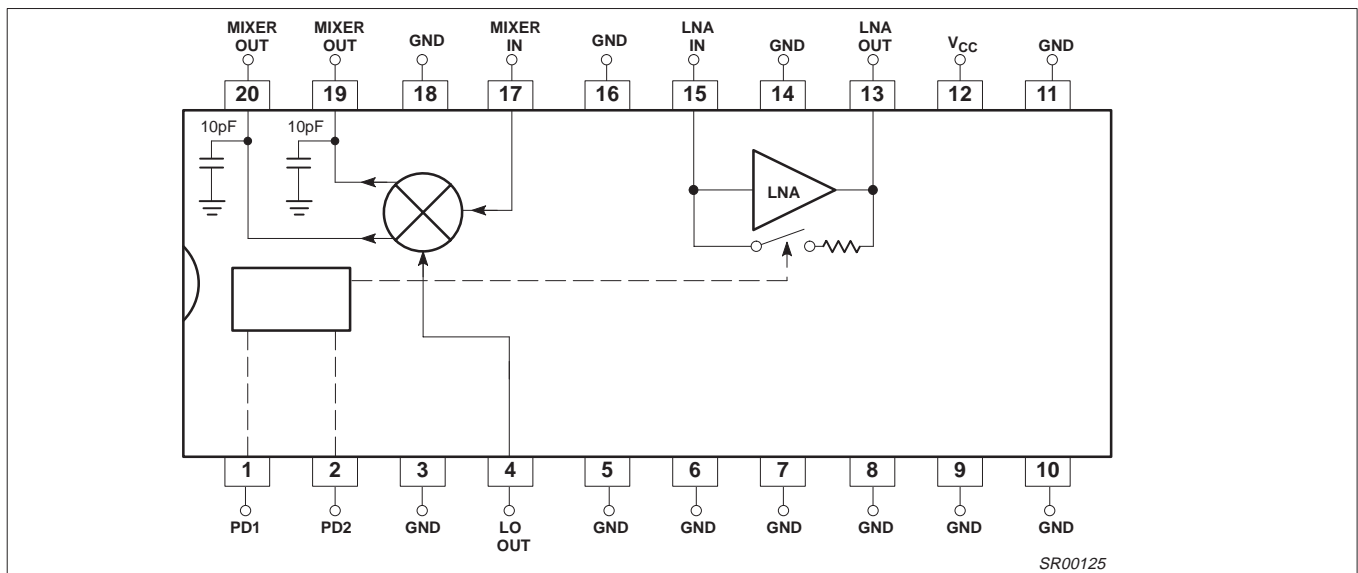


Figure 2. SA611 Block Diagram

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## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Supply voltage <sup>NO TAG</sup>	-0.3 to +6	V
$V_{IN}$	Voltage applied to any other pin	-0.3 to ( $V_{CC} + 0.3$ )	V
$P_D$	Power dissipation, $T_A = 25^\circ\text{C}$ (still air) <sup>NO TAG</sup> 20-Pin Plastic SSOP	980	mW
$T_{JMAX}$	Maximum operating junction temperature	150	$^\circ\text{C}$
$P_{MAX}$	Maximum power input/output	+20	dBm
$T_{STG}$	Storage temperature range	-65 to +150	$^\circ\text{C}$

## NOTE:

- Transients exceeding 8V on  $V_{CC}$  pin may damage product.
- Maximum dissipation is determined by the operating ambient temperature and the thermal resistance,  
 $\theta_{JA}$ : 20-Pin SSOP = 110 $^\circ\text{C}/\text{W}$
- Pins 19 and 20 are ESD sensitive (mixer outputs).

## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Supply voltage	2.7 to 5.5	V
$T_A$	Operating ambient temperature range	-40 to +85	$^\circ\text{C}$
$T_J$	Operating junction temperature	-40 to +105	$^\circ\text{C}$

## DC ELECTRICAL CHARACTERISTICS

$V_{CC} = +3.0\text{V}$ ,  $T_A = 25^\circ\text{C}$ ; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			MIN	TYP	MAX	
$I_{CC}$	Supply current	Full power-on		8.3		mA
		LNA powered-down		5.2		mA
		Full power-down		20		$\mu\text{A}$
$V_T$	PD logic threshold voltage		1.2	1.6	1.8	V
$V_{IH}$	Logic 1 level		2.0		$V_{CC}$	V
$V_{IL}$	Logic 0 level		-0.3		0.8	V
$I_{IL}$	PD1 input current	Enable = 0.4V		10		$\mu\text{A}$
$I_{IH}$	PD2 input current	Enable = 2.4V		10		$\mu\text{A}$

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**AC ELECTRICAL CHARACTERISTICS** $V_{CC} = +3.0V$ ,  $T_A = 25^{\circ}C$ ;  $RF_{IN} = 881MHz$ ,  $f_{VCO} = 964MHz$ ; unless otherwise stated.

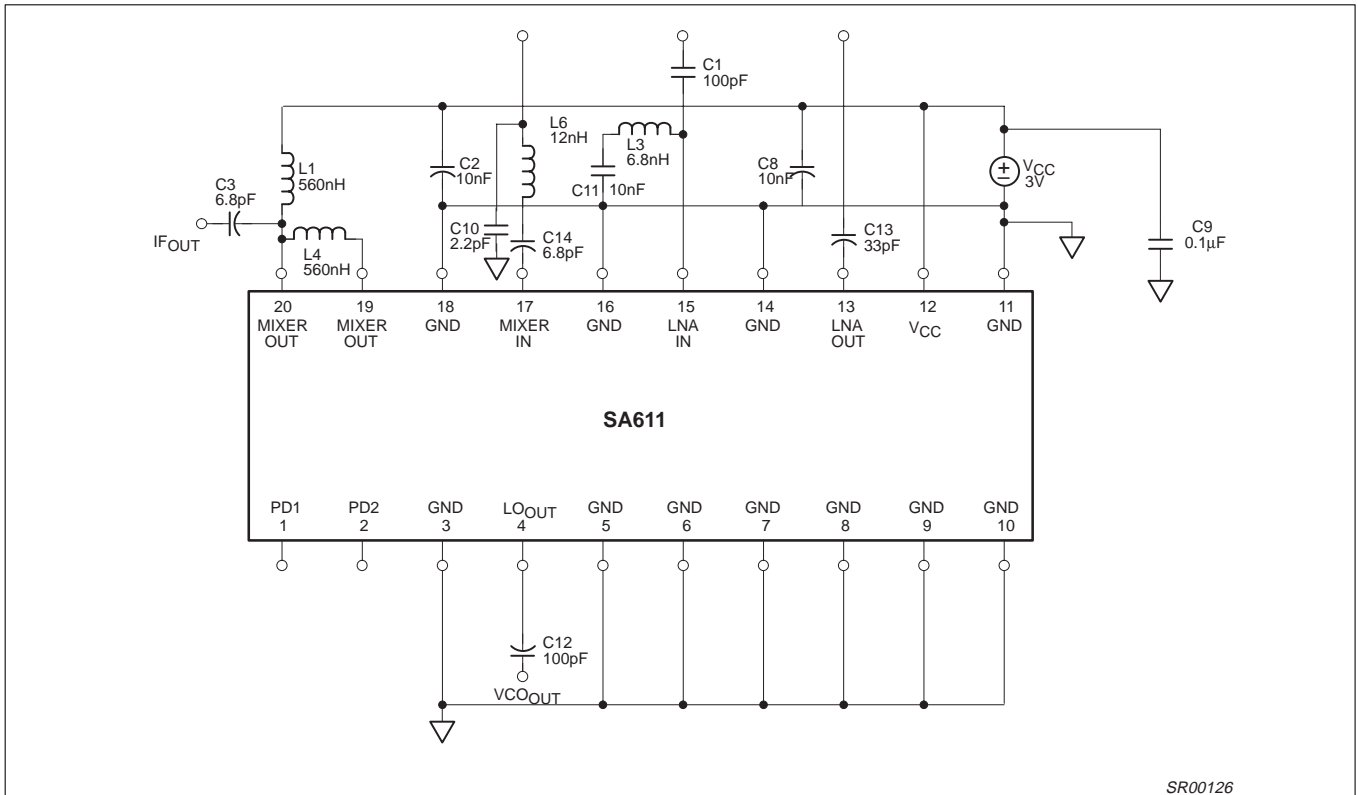
SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			-3 $\sigma$	TYP	+3 $\sigma$	
<b>Low Noise Amplifier</b>						
$f_{RF}$	RF input frequency range		800		1000	MHz
$S_{21}$	Amplifier gain			15		dB
$S_{21}$	Amplifier gain in power-down mode			-28		dB
$\Delta S_{21}/\Delta T$	Gain temperature sensitivity enabled			0.006		dB/ $^{\circ}C$
$\Delta S_{21}/\Delta f$	Gain frequency variation	800MHz - 1.0GHz		$\pm 0.013$		dB/MHz
$S_{12}$	Amplifier reverse isolation	@ 881 MHz		-28		dB
$S_{11}$	Amplifier input match	With ext. impedance matching		-10		dB
$S_{22}$	Amplifier output match			-10		dB
$P_{-1dB}$	Amplifier input 1dB gain compression			-20		dBm
IP3	Amplifier input third order intercept			-7		dBm
NF	Amplifier noise figure			1.7		dB
$t_{ON}$	Amplifier turn-on time (Enable Lo $\rightarrow$ Hi)			120		$\mu s$
$t_{OFF}$	Amplifier turn-off time (Enable Hi $\rightarrow$ Lo)			0.3		$\mu s$
<b>Mixer</b>						
$PG_C$	Mixer power conversion gain: $R_P = R_L = 1.2k\Omega$ ,	$f_{RF} = 881MHz$ , $f_{LO} = 964MHz$ , $f_{IF} = 83MHz$		8.7		dB
$S_{11M}$	Mixer input match	Ext. impedance matching req.		-10		dB
$NF_M$	Mixer SSB noise figure			12		dB
$P_{-1dB}$	Mixer input 1dB gain compression			-14.5		dBm
IP3M	Mixer input third order intercept			7.0		dBm
IP2INT	Mixer input second order intercept			15		dBm
$P_{RFM-IF}$	Mixer RF feedthrough	$RF_{IN} = -28dBm$		-45		dBm
$P_{LO-IF}$	LO feedthrough to IF	LO = -0dBm		-23		dBm
$P_{LO-RFM}$	LO to mixer input feedthrough			-36		dBm
$P_{LO-RF}$	LO to LNA input feedthrough			-38		dBm
<b>Overall System</b>						
$G_{SYS}$	System gain	LNA + Mixer	23.0	23.7	24.4	dB

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**Table 1. Power ON/OFF Control Logic**

PD1	PD2	
0	0	Full chip power-down
0	1 or open	Mixer on, LNA power-down
1 or open	0	Standby (bias on)
1 or open	1 or open	Full chip power-on (default)



**Figure 3. SA611 Applications Circuit**

SR00126

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## PERFORMANCE CHARACTERISTICS

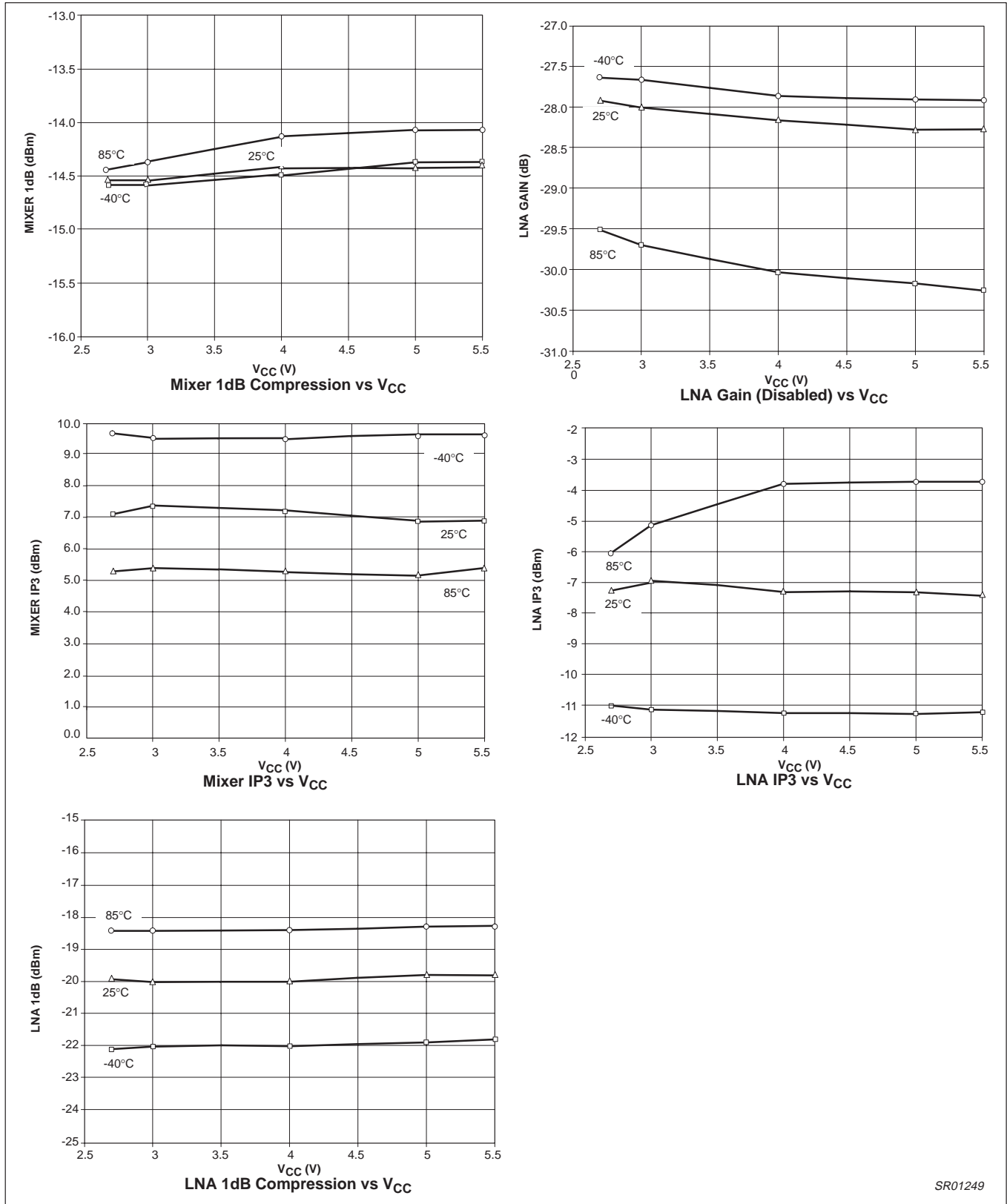


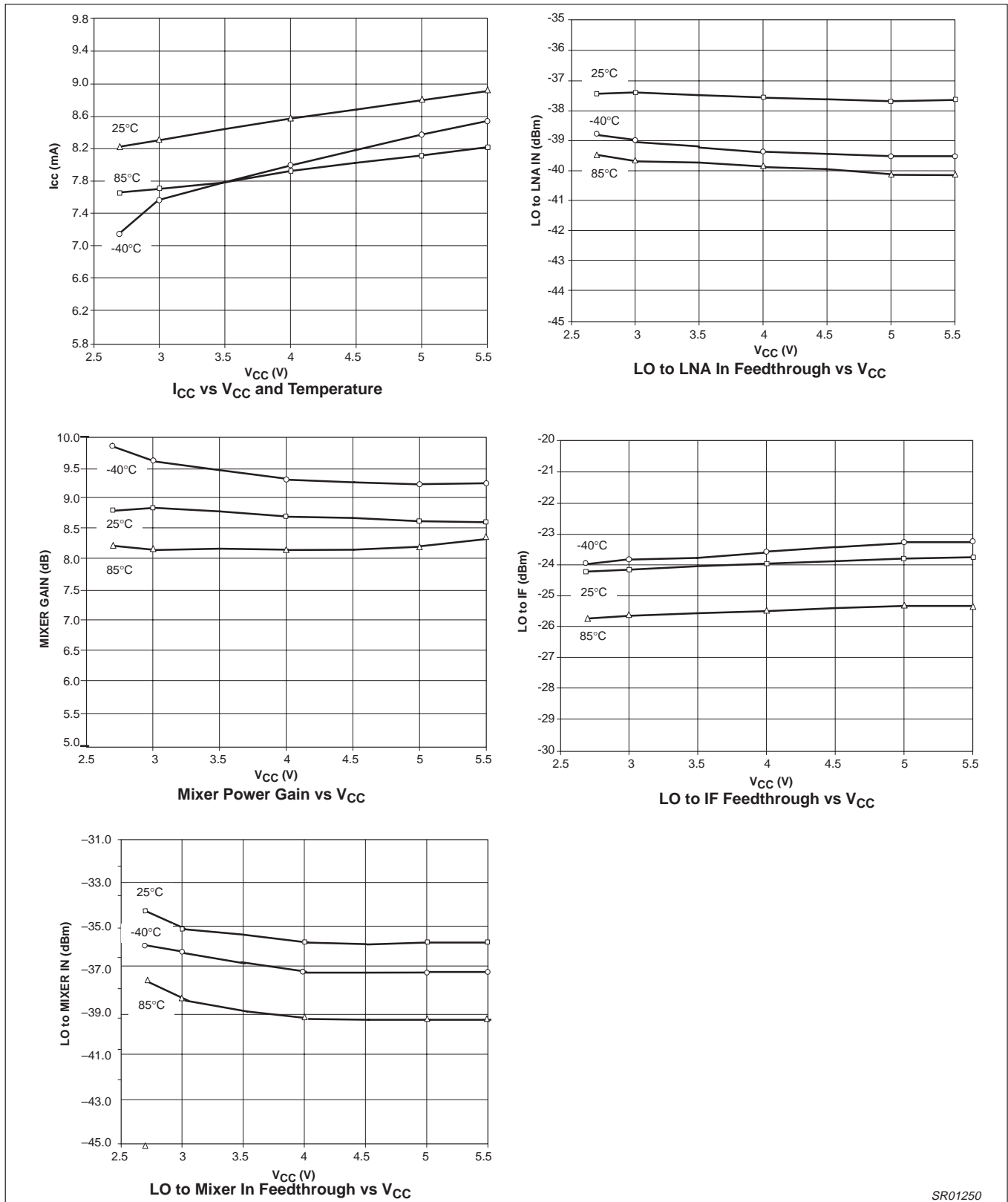
Figure 4.

SR01249

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## PERFORMANCE CHARACTERISTICS



SR01250

Figure 5.

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## PERFORMANCE CHARACTERISTICS

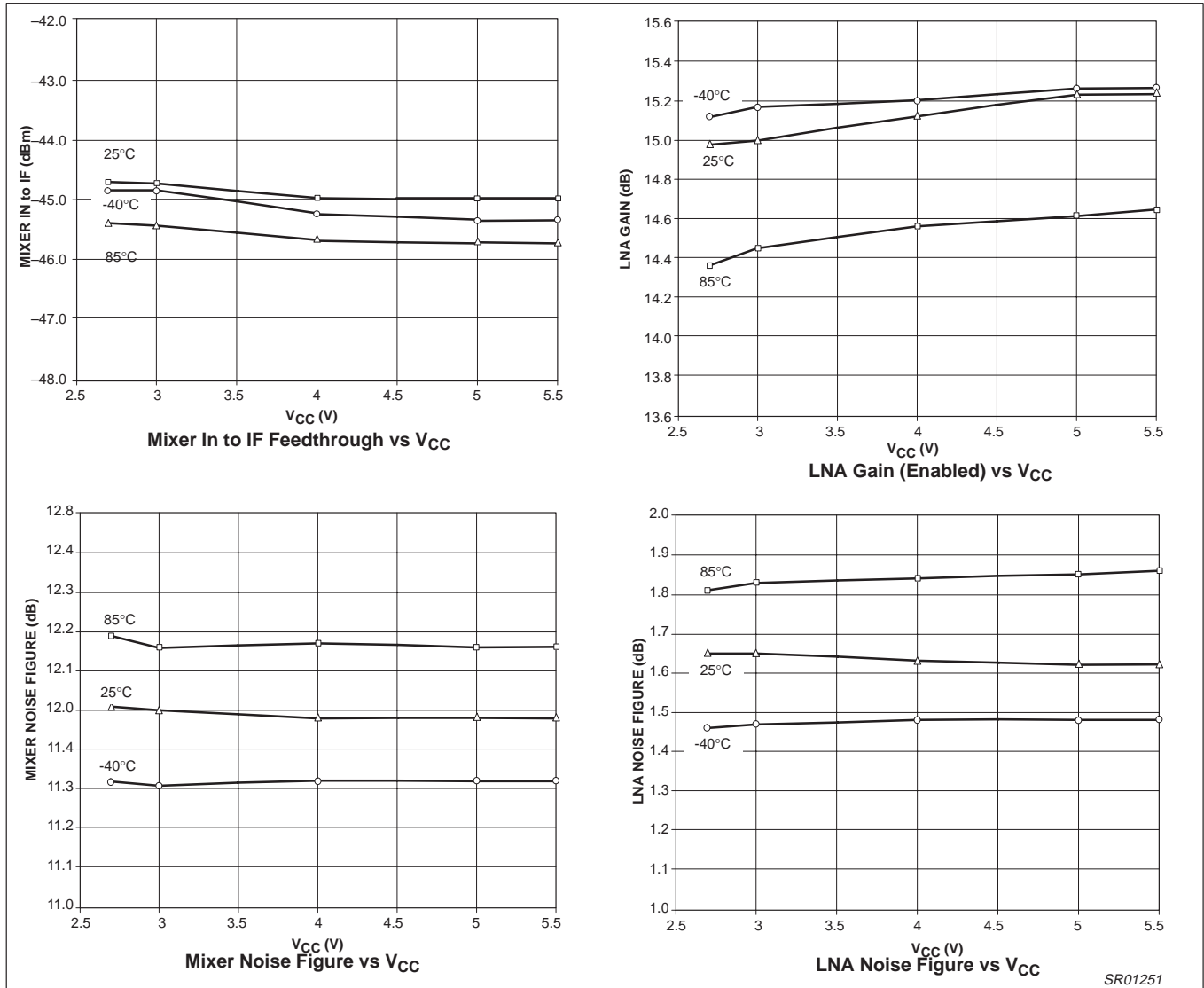


Figure 6.

SR01251



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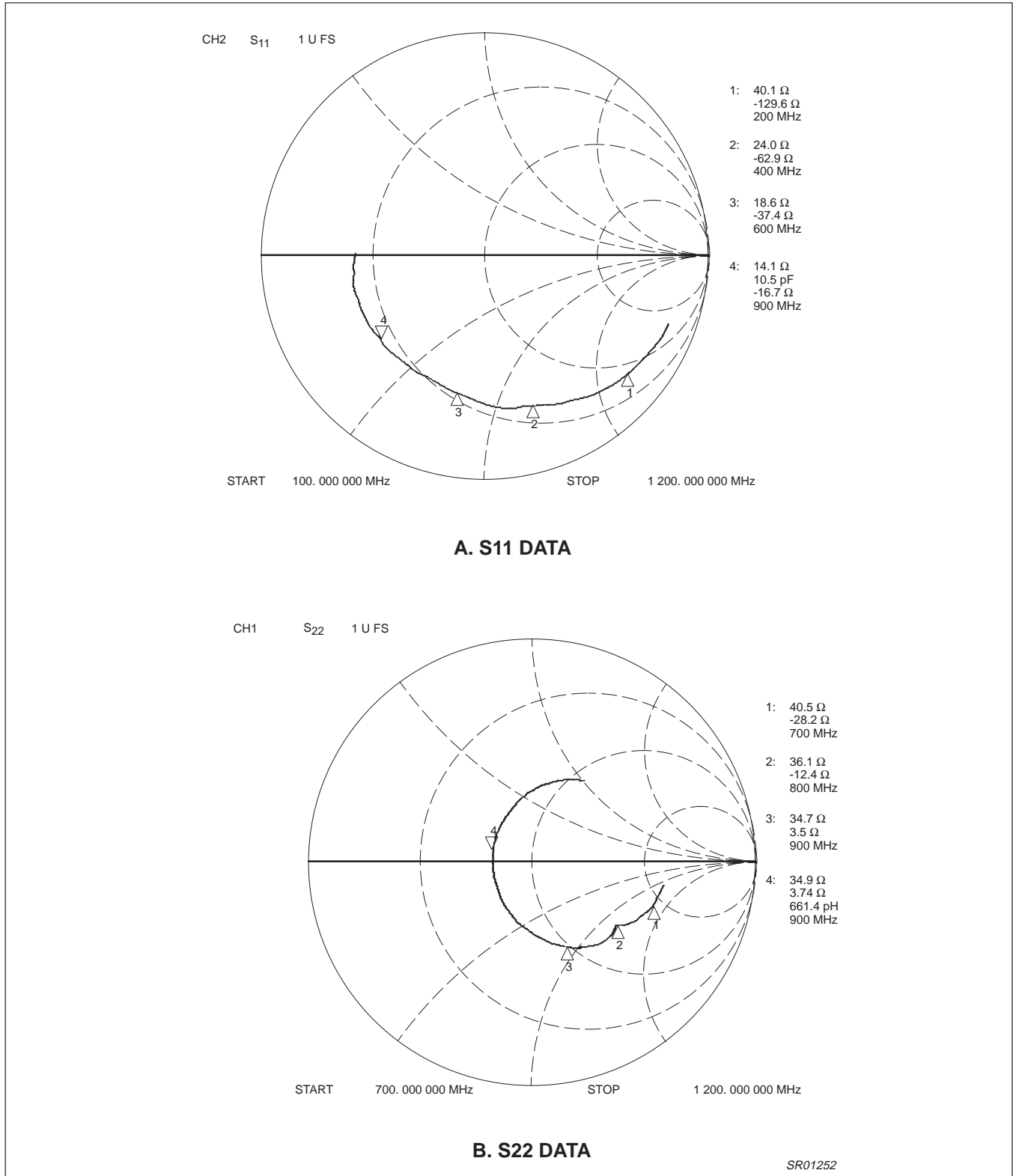


Figure 7. Typical S<sub>11</sub> of LNA at 3V

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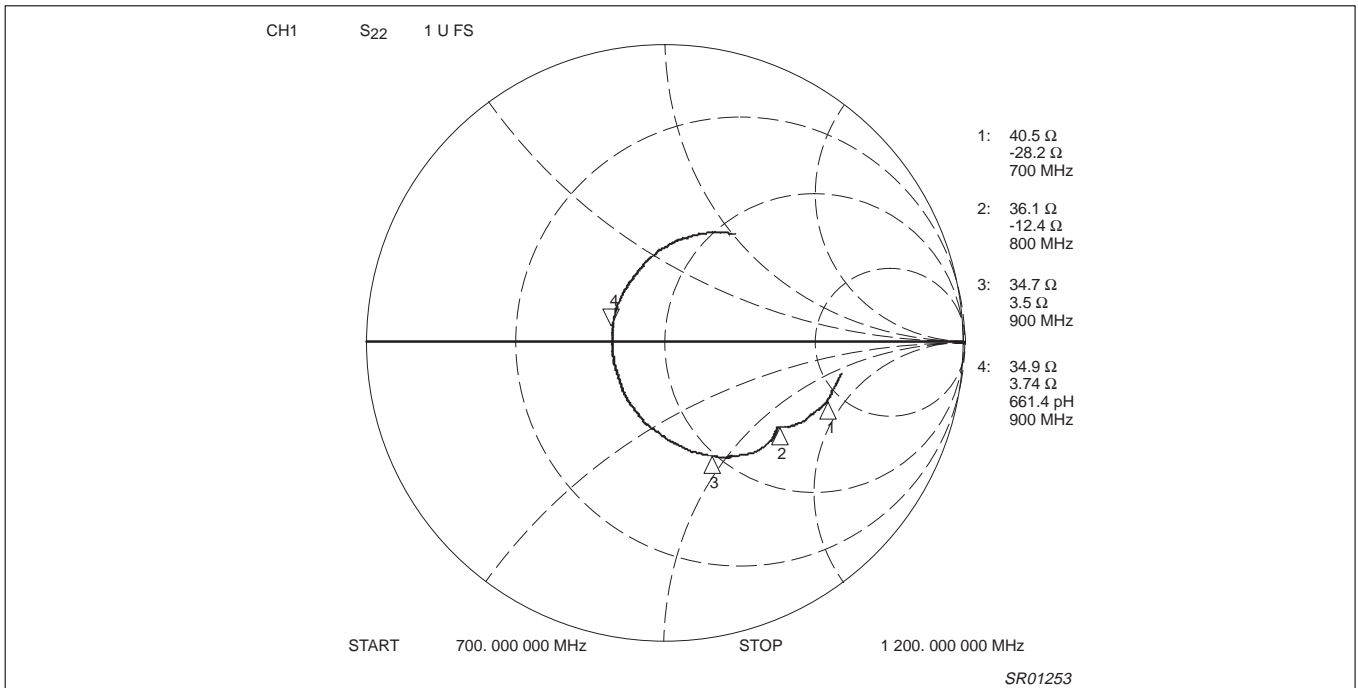


Figure 8. Typical S<sub>22</sub> of LNA at 3V

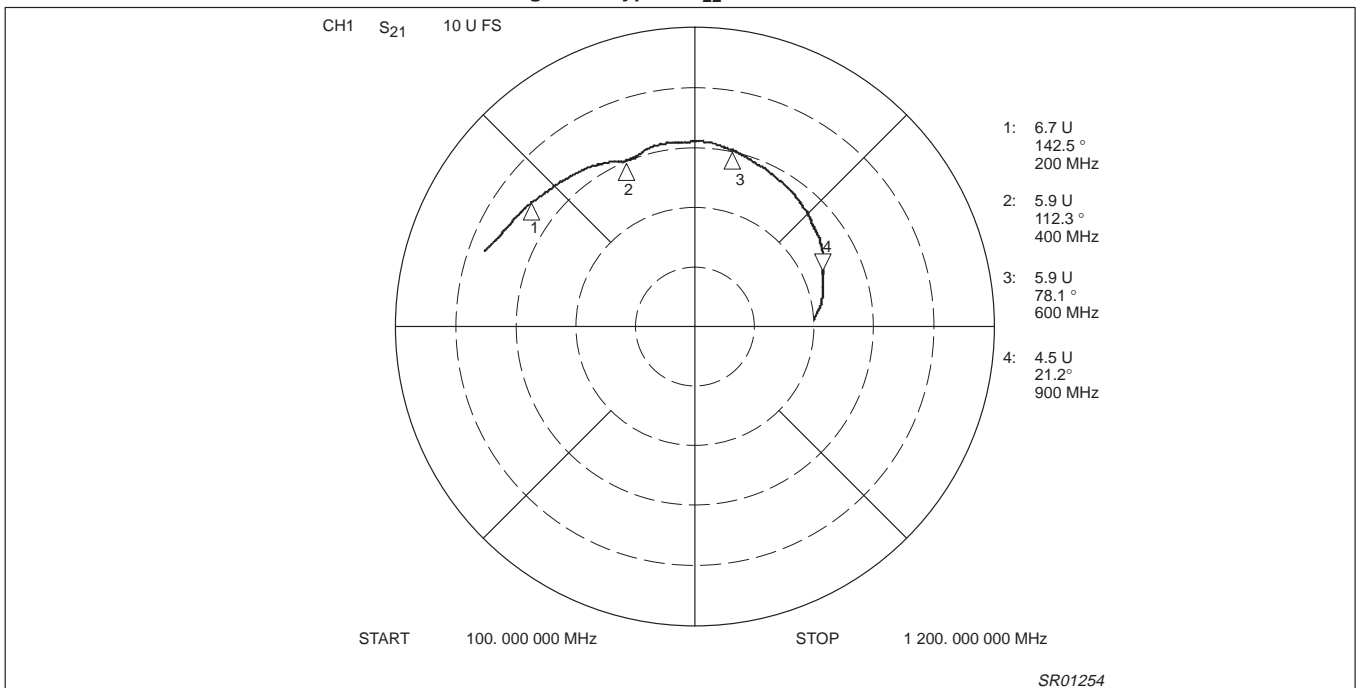


Figure 9. Typical S<sub>21</sub> of LNA at 3V

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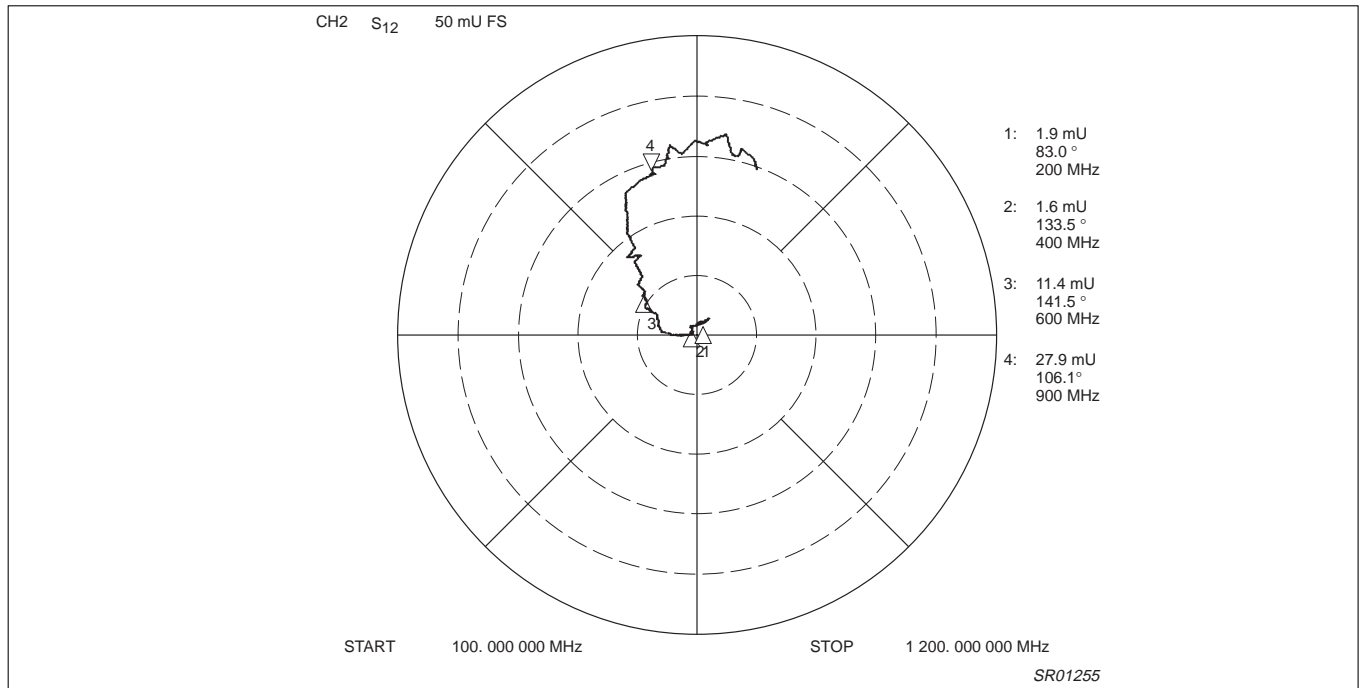


Figure 10. Typical S<sub>12</sub> of LNA at 3V

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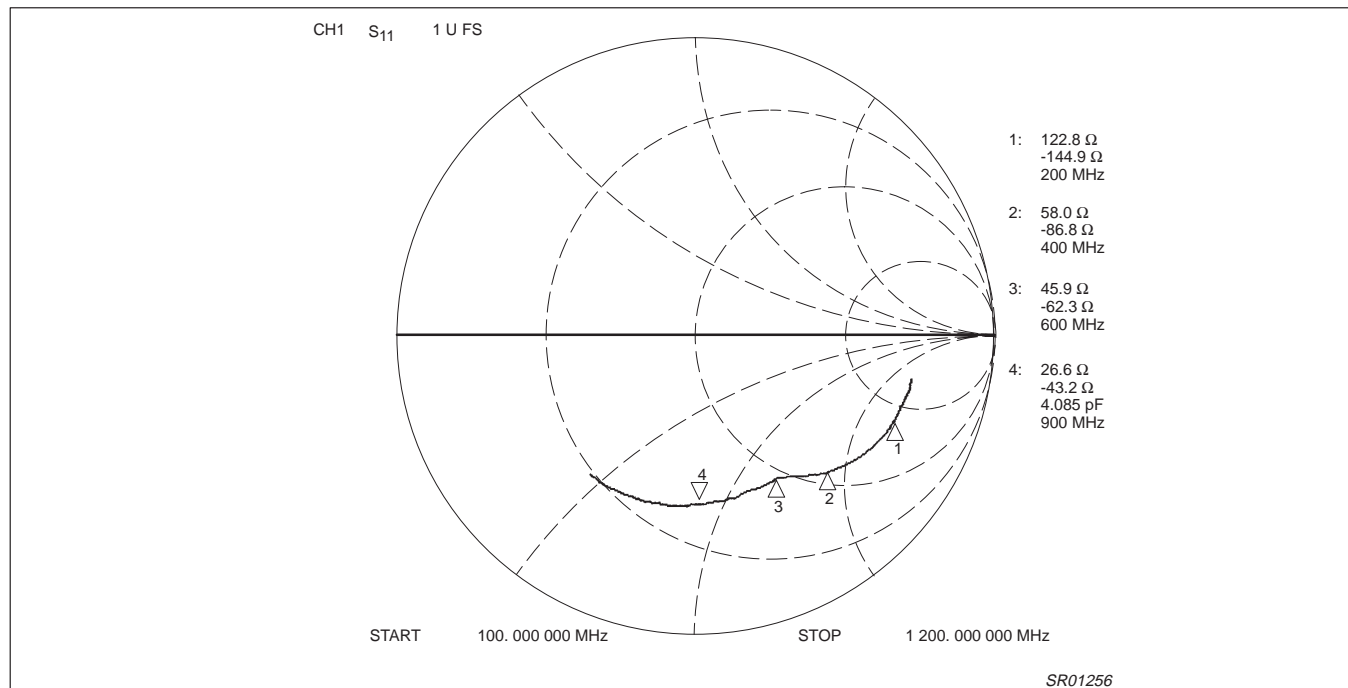


Figure 11. Typical S<sub>11</sub> of Mixer at 3V

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Table 2. Typical S-Parameters of LNA at 3V

LNA								
Freq (MHz)	$ S_{11} $ (U)	$\angle S_{11}$ (deg)	$ S_{21} $ (U)	$\angle S_{21}$ (deg)	$ S_{12} $ (U)	$\angle S_{12}$ (deg)	$ S_{22} $ (U)	$\angle S_{22}$ (deg)
100	0.86	-20	7.4	160	0.001	91.91	0.59	-9.62
122	0.86	-24	7.1	156	0.001	62	0.58	-11.71
144	0.85	-28	7.0	151	0.001	105.42	0.58	-13.86
166	0.83	-32	6.9	148	0.000	91.65	0.57	-15.89
188	0.82	-36	6.8	144	0.002	100.23	0.57	-17.80
210	0.81	-41	6.7	140	0.002	73.57	0.56	-20.05
232	0.80	-45	6.6	136	0.002	99.70	0.55	-22.37
254	0.79	-48	6.5	133	0.001	84.00	0.54	-24.60
276	0.78	-52	6.4	130	0.001	103.18	0.53	-26.89
298	0.76	-56	6.3	126	0.002	94.33	0.52	-28.72
320	0.75	-59	6.3	123	0.002	66.98	0.51	-30.98
342	0.73	-63	6.2	119	0.002	108.53	0.50	-32.79
364	0.71	-66	6.1	116	0.002	118.13	0.48	-34.68
386	0.70	-69	6.0	113	0.001	103.4	0.47	-36.06
408	0.69	-72	5.9	111	0.001	175.94	0.46	-36.64
430	0.68	-76	5.9	109	0.004	174.1	0.45	-37.21
452	0.69	-78	6.0	106	0.006	162.02	0.46	-38.41
474	0.68	-82	6.1	102	0.007	160.07	0.47	-41.54
496	0.67	-85	6.1	97	0.008	153.6	0.47	-45.75
518	0.66	-89	6.1	93	0.010	146.17	0.46	-50.35
540	0.65	-92	6.1	89	0.009	142.13	0.45	-54.73
562	0.63	-96	6.1	85	0.010	138.49	0.43	-59.16
584	0.62	-99	6.0	81	0.011	146.17	0.42	-63.93
606	0.62	-102	5.9	77	0.011	140.55	0.40	-68.56
628	0.61	-104	5.8	72	0.013	137.2	0.38	-73.48
650	0.61	-107	5.7	69	0.013	130.62	0.36	-78.19
672	0.60	-109	5.7	65	0.016	129.77	0.34	-83.75
694	0.60	-112	5.6	61	0.016	131.94	0.31	-89.81
716	0.59	-115	5.5	57	0.017	128.67	0.29	-96.92
738	0.59	-118	5.5	53	0.019	127.53	0.27	-104.48
760	0.59	-121	5.3	48	0.021	123.42	0.24	-112.81
782	0.59	-124	5.3	44	0.021	122.31	0.22	-122.41
804	0.59	-126	5.1	40	0.022	119.52	0.21	-132.81
826	0.59	-129	5.0	36	0.024	118.29	0.19	-145.39
848	0.59	-132	4.9	31	0.026	115.98	0.18	-159.13
870	0.59	-135	4.8	26	0.027	111.9	0.17	-175.11
892	0.59	-138	4.6	22	0.028	108.11	0.18	169.02
914	0.59	-142	4.5	18	0.028	105.92	0.19	154.96
936	0.59	-144	4.3	14	0.028	106.13	0.20	141.94
958	0.59	-148	4.2	9	0.030	99.79	0.22	130.27
980	0.59	-151	4.0	4	0.031	99.30	0.24	119.5
1002	0.59	-153	3.8	0	0.031	94.81	0.26	110.61
1024	0.59	-157	3.6	-2	0.032	90.91	0.28	102.16
1046	0.59	-160	3.5	-6	0.032	85.65	0.30	94.98
1068	0.59	-164	3.3	-10	0.033	86.10	0.33	88.45
1090	0.59	-167	3.2	-14	0.033	80.59	0.35	82.47
1112	0.59	-170	3.0	-18	0.031	79.18	0.36	77.17
1134	0.58	-172	2.8	-22	0.030	46.32	0.38	71.98
1156	0.58	-175	2.7	-25	0.031	78.57	0.39	67.45
1178	0.57	-178	2.5	-28	0.031	73.66	0.41	62.73
1200	0.57	178	2.4	-31	0.029	71.78	0.42	58.87

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Table 3. Typical S-Parameters of Mixer at 3V

Mixer		
Freq (MHz)	S <sub>11</sub>   (U)	<S <sub>11</sub> (deg)
100	0.73	-11
122	0.73	-147
144	0.72	-16
166	0.72	-19
188	0.72	-21
210	0.71	-24
232	0.70	-27
254	0.70	-29
276	0.69	-32
298	0.68	-34
320	0.67	-37
342	0.66	-39
364	0.64	-42
386	0.63	-44
408	0.62	-46
430	0.61	-48
452	0.59	-50
474	0.58	-52
496	0.57	-53
518	0.56	-54
540	0.55	-56
562	0.55	-57
584	0.54	-59
606	0.54	-61
628	0.54	-62
650	0.54	-64

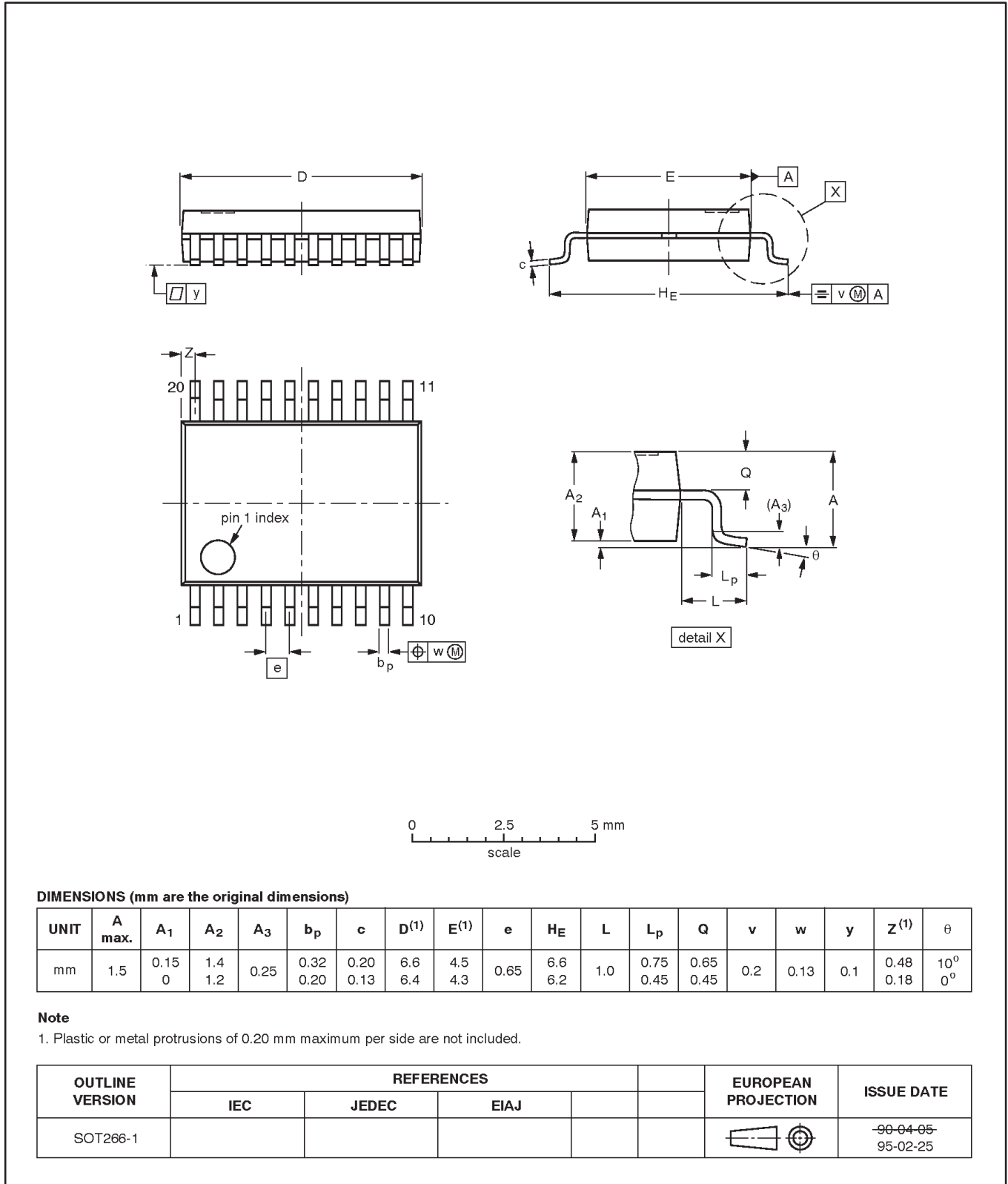
Mixer		
Freq (MHz)	S <sub>11</sub>   (U)	<S <sub>11</sub> (deg)
672	0.54	-65
694	0.54	-67
716	0.54	-69
738	0.54	-71
760	0.54	-73
782	0.55	-76
804	0.55	-78
826	0.55	-80
848	0.55	-82
870	0.55	-85
892	0.56	-87
914	0.55	-90
936	0.56	-93
958	0.56	-96
980	0.56	-98
1002	0.56	-101
1024	0.57	-104
1046	0.57	-106
1068	0.57	-110
1090	0.57	-112
1112	0.57	-115
1134	0.57	-118
1156	0.57	-121
1178	0.57	-124
1200	0.57	-127

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**SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm**

**SOT266-1**



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**Data sheet status**

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
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[1] Please consult the most recently issued datasheet before initiating or completing a design.

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