

# DATA SHEET

## **SA621**

1GHz - Low voltage LNA, mixer and VCO

Product specification

1997 Nov 07

IC17 Data handbook

# 1GHz low voltage LNA, mixer and VCO

# SA621

## DESCRIPTION

The SA621 is a combined low-noise amplifier, mixer and VCO 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  $\pm 0.2\text{dB}$  over -40 to +85°C temperature range. The wide-dynamic-range mixer has a 12dB noise figure and IP3 of +4.5dBm at the input at 881MHz. The integrated VCO circuit with external resonator produces a high quality LO signal that drives the mixer and is buffered to an external PLL synthesizer IC. The nominal current drawn from a single 3V supply is 13.3mA. Additionally, the entire circuit can be powered down to further reduce the supply current to less than 20 $\mu\text{A}$ .

## FEATURES

- Low current consumption
- Outstanding gain and noise figure
- Excellent gain stability versus temperature and supply voltage
- LNA, mixer and VCO power down capability
- Monotonic VCO frequency vs control voltage

## PIN CONFIGURATION

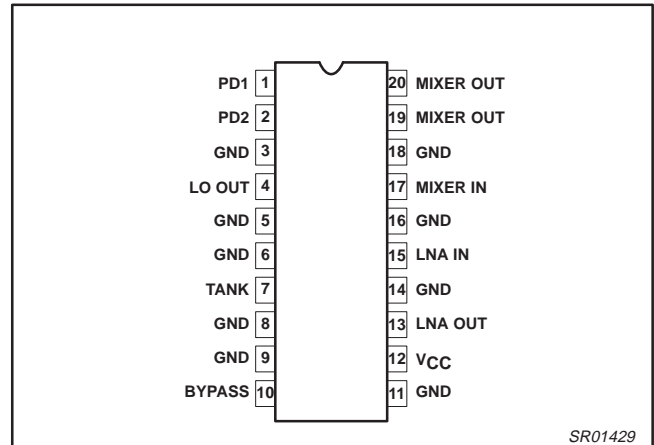


Figure 1. Pin Configuration

## 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 Thin Shrink Small Outline Package (Surface-mount, TSSOP)	-40 to +85°C	SA621DH	SOT360-1

## BLOCK DIAGRAM

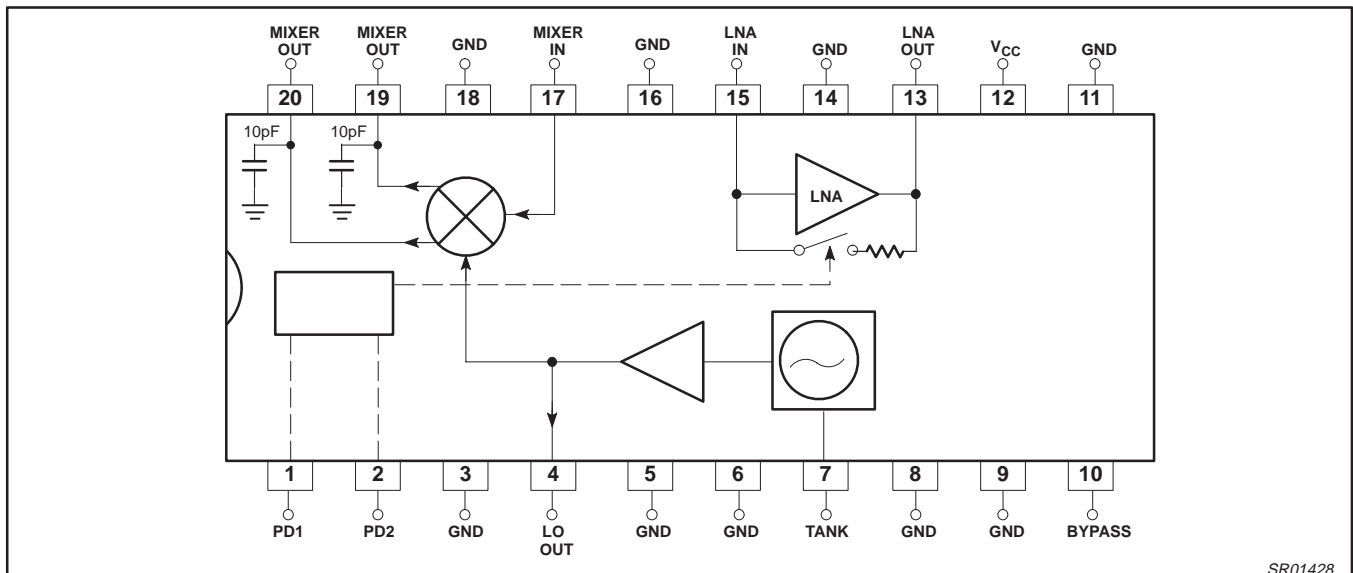


Figure 2. SA621 Block Diagram

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## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Supply voltage <sup>1</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>2</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		13.3		mA
		LNA powered-down		10		mA
		Standby (VCO + bias)		5.7		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<sub>CC</sub> = +3.0V, T<sub>A</sub> = 25°C; R<sub>F IN</sub> = 881MHz, f<sub>VCO</sub> = 964MHz; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			-3σ	TYP	+3σ	
<b>Low Noise Amplifier</b>						
f <sub>RF</sub>	RF input frequency range		800		1000	MHz
S <sub>21</sub>	Amplifier gain			15		dB
S <sub>21</sub>	Amplifier gain in power-down mode			-28		dB
ΔS <sub>21</sub> /ΔT	Gain temperature sensitivity enabled			0.006		dB/°C
ΔS <sub>21</sub> /Δf	Gain frequency variation	800MHz - 1.0GHz		±0.013		dB/MHz
S <sub>12</sub>	Amplifier reverse isolation	@ 881 MHz		-28		dB
S <sub>11</sub>	Amplifier input match	With ext. impedance matching		-10		dB
S <sub>22</sub>	Amplifier output match			-10		dB
P <sub>-1dB</sub>	Amplifier input 1dB gain compression			-20		dBm
IP3	Amplifier input third order intercept			-7		dBm
NF	Amplifier noise figure			1.7		dB
t <sub>ON</sub>	Amplifier turn-on time (Enable Lo → Hi)			120		μs
t <sub>OFF</sub>	Amplifier turn-off time (Enable Hi → Lo)			0.3		μs
<b>Mixer</b>						
P <sub>GC</sub>	Mixer power conversion gain: R <sub>P</sub> = R <sub>L</sub> = 1.2kΩ,	f <sub>RF</sub> = 881MHz, f <sub>LO</sub> = 964MHz, f <sub>IF</sub> = 83MHz		8.7		dB
S <sub>11M</sub>	Mixer input match	Ext. impedance matching req.		-10		dB
NF <sub>M</sub>	Mixer SSB noise figure			12		dB
P <sub>-1dB</sub>	Mixer input 1dB gain compression			-10		dBm
IP3 <sub>M</sub>	Mixer input third order intercept			4.5		dBm
IP2 <sub>INT</sub>	Mixer input second order intercept			15		dBm
P <sub>RFM-IF</sub>	Mixer RF feedthrough	R <sub>F IN</sub> = -25dBm		-41		dBm
P <sub>LO-IF</sub>	LO feedthrough to IF	LO = -10dBm		-23		dBm
P <sub>LO-RFM</sub>	LO to mixer input feedthrough			-52		dBm
P <sub>LO-RF</sub>	LO to LNA input feedthrough			-38		dBm
<b>Voltage Controlled Oscillator (VCO)<sup>1</sup></b>						
f <sub>VCO</sub>	VCO frequency range		883		1083	MHz
P <sub>VCO</sub>	VCO power out	See Figure 3	-10	-8		dBm
	VCO phase noise <sup>2</sup>	Offset = 30kHz		-109		dBc/Hz
		Offset = 60kHz		-115		
	Harmonic content			-22		dBc
	Residual modulation				45	dB
	Pulling figure	VSWR=2:1, all phases		±500		kHz
	Pushing figure			±100		kHz/V
<b>Overall System</b>						
G <sub>SYS</sub>	System gain	LNA + Mixer	23.0	23.7	24.4	dB

**NOTES:**

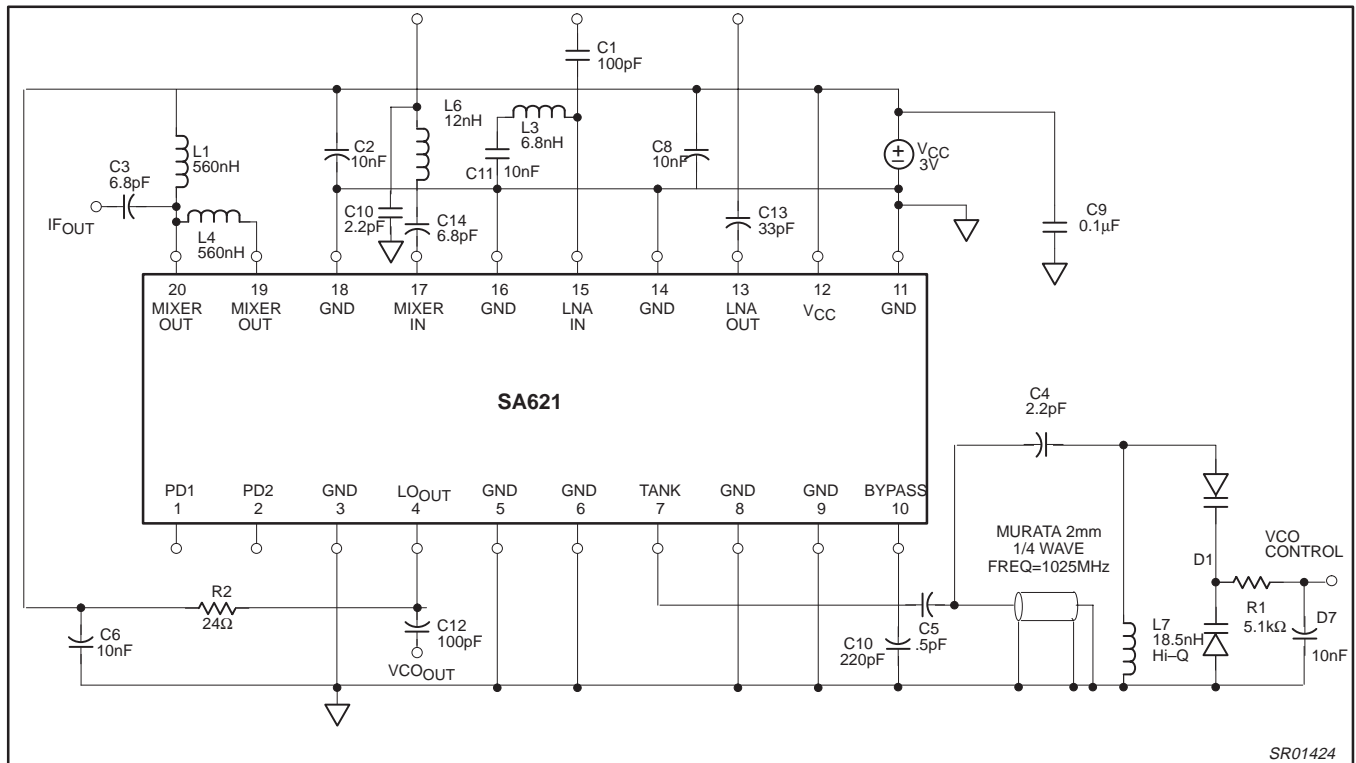
- VCO performance dependent on external components.
- Based on copper-plated 2mm ceramic resonator (1/4 wave), f = 1025MHz, and can be improved by silver-plated or larger resonators.

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

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

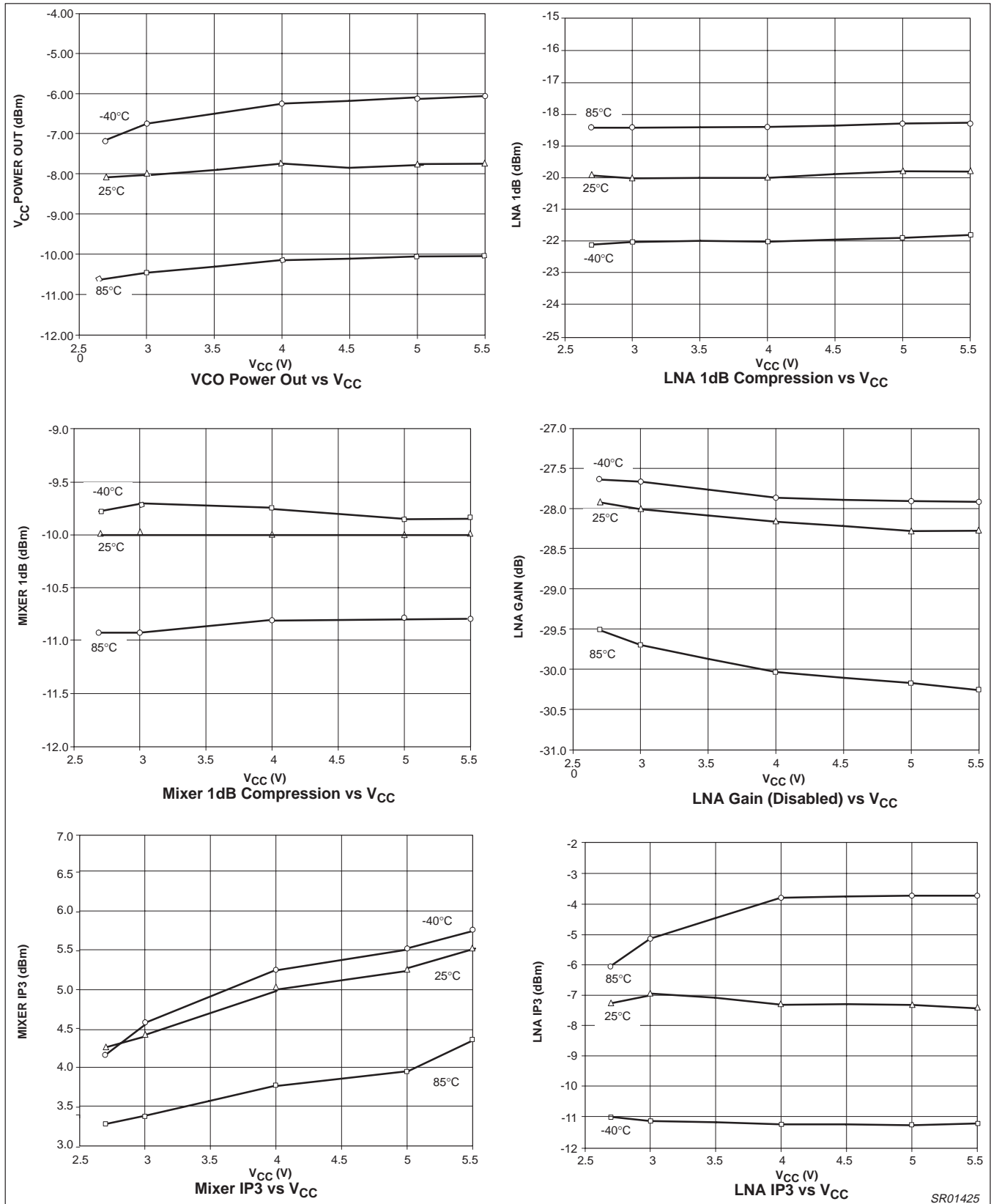


**Figure 3. SA621 Applications Circuit**

# 1GHz low voltage LNA, mixer and VCO

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## PERFORMANCE CHARACTERISTICS



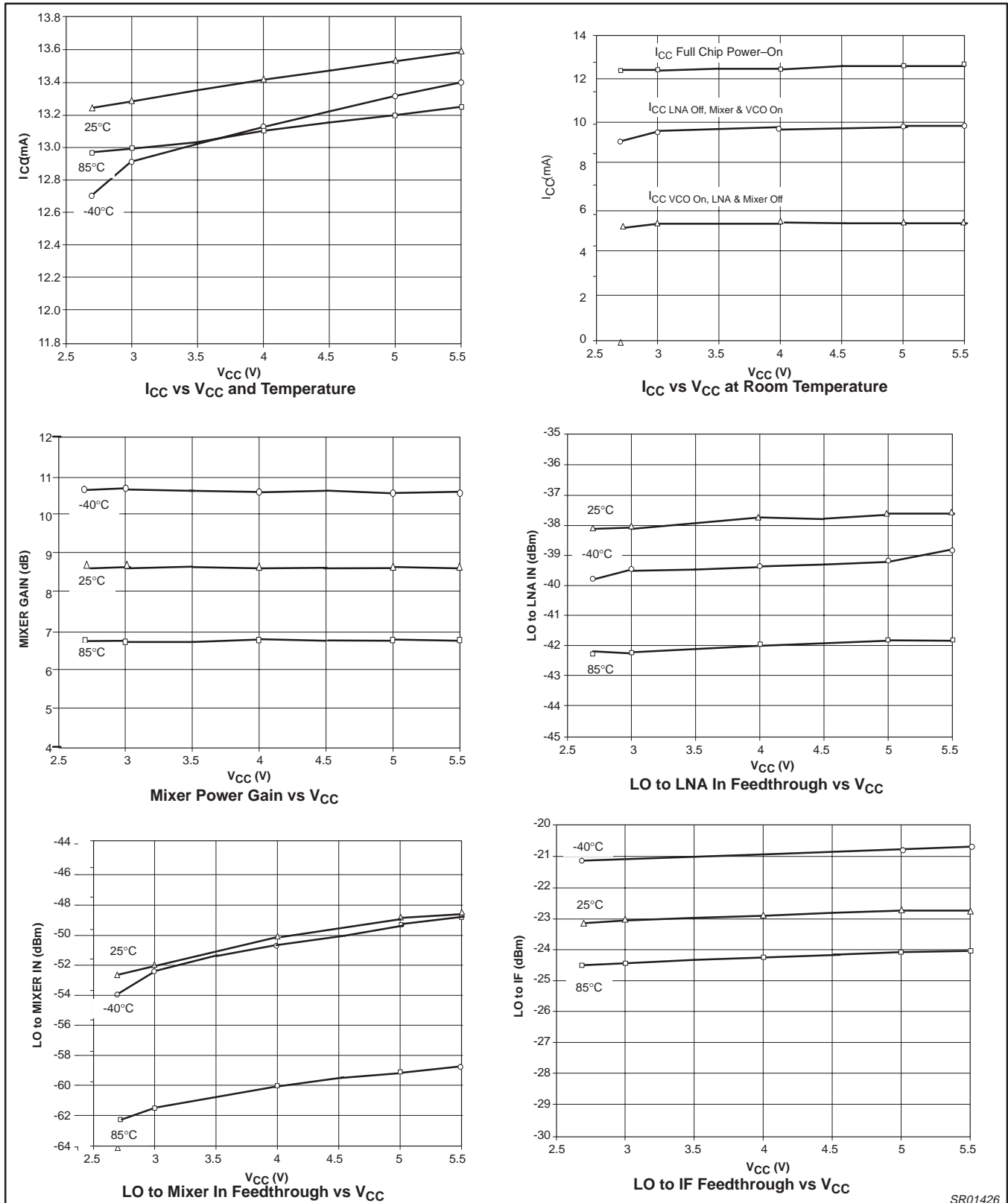
SR01425

Figure 4.

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## PERFORMANCE CHARACTERISTICS



SR01426

Figure 5.

# 1GHz low voltage LNA, mixer and VCO

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## PERFORMANCE CHARACTERISTICS

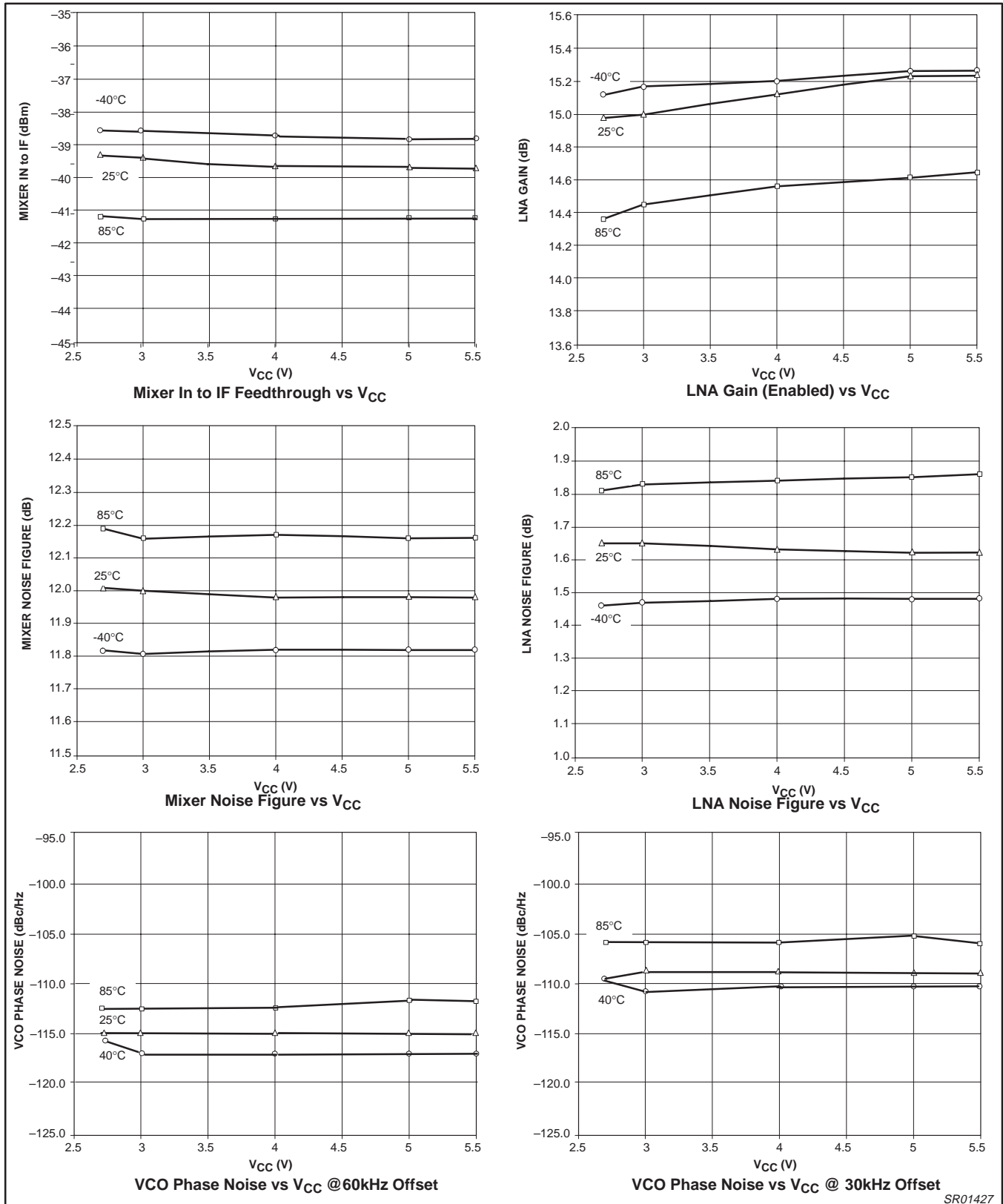


Figure 6.

SR01427



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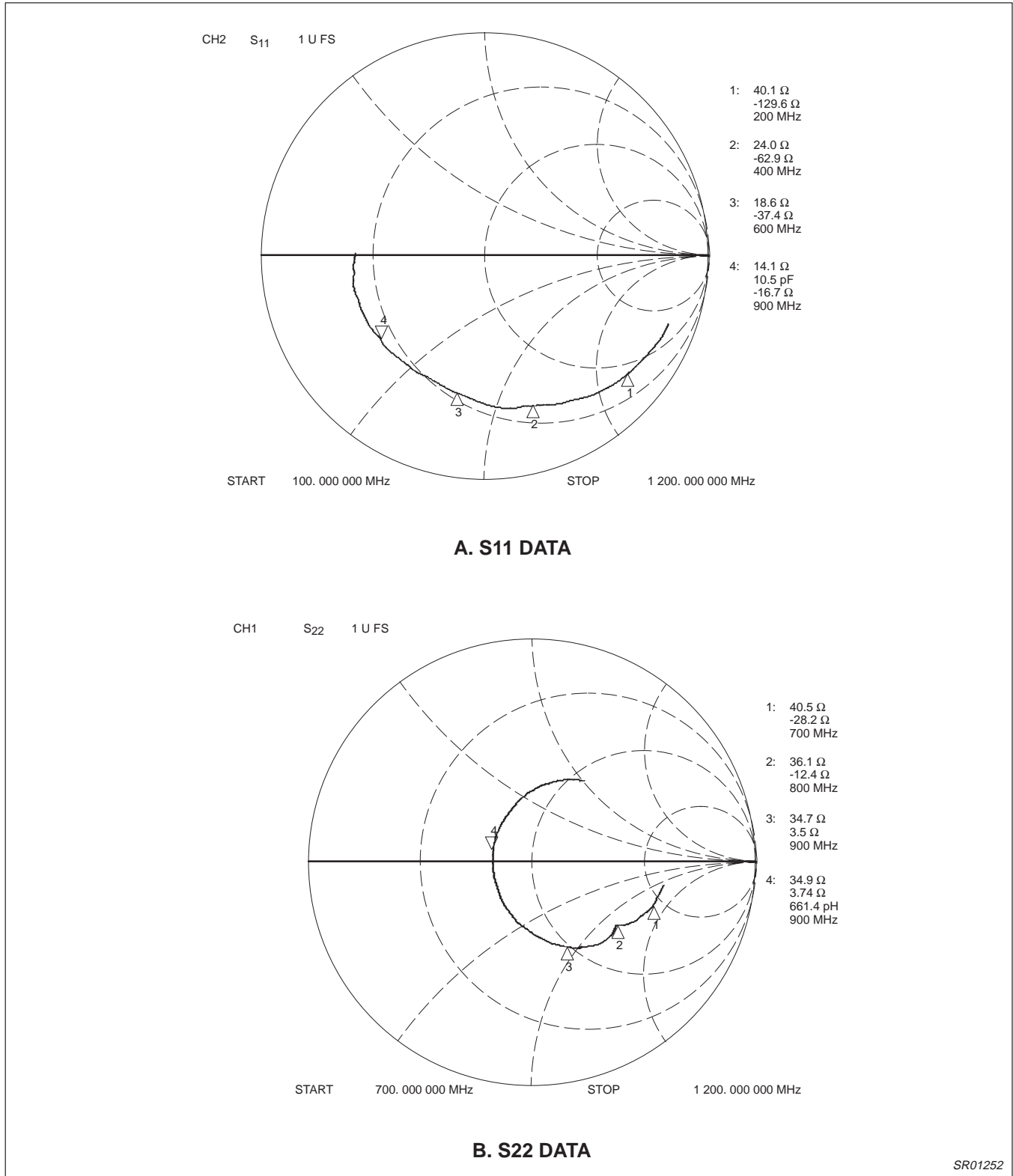


Figure 7. Typical S<sub>11</sub> of LNA at 3V

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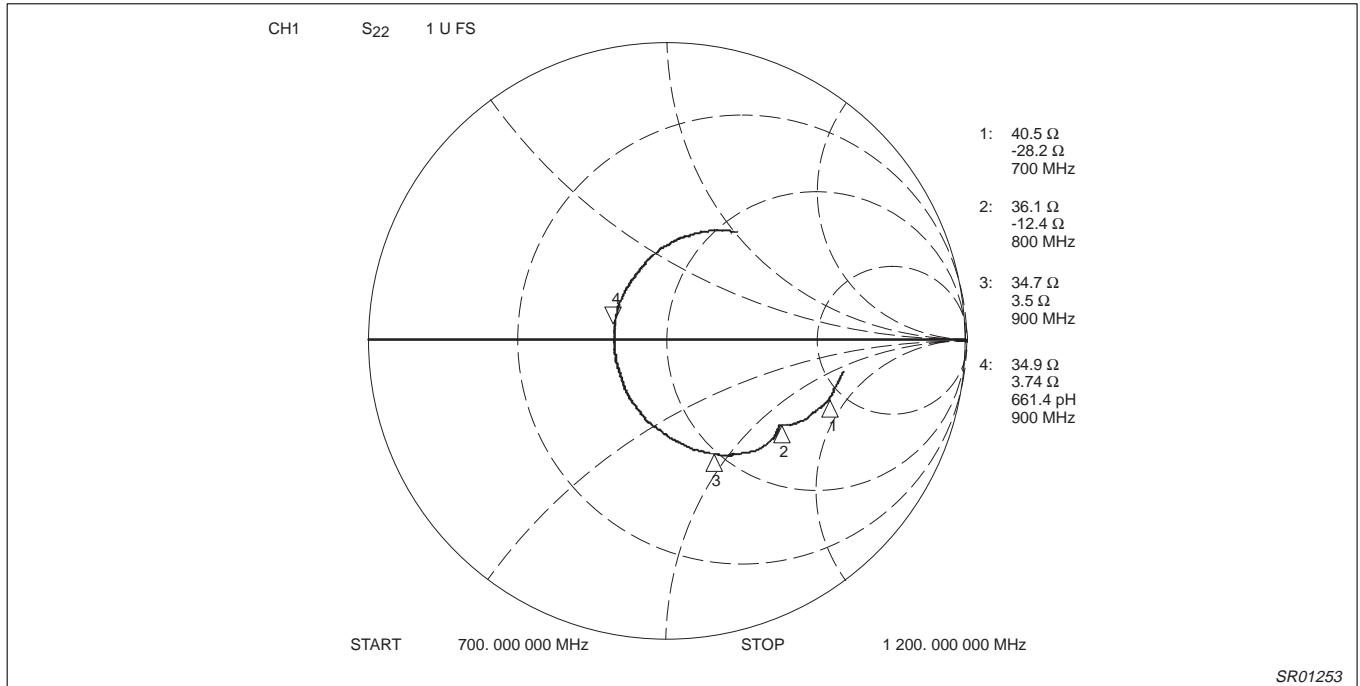


Figure 8. Typical S<sub>22</sub> of LNA at 3V

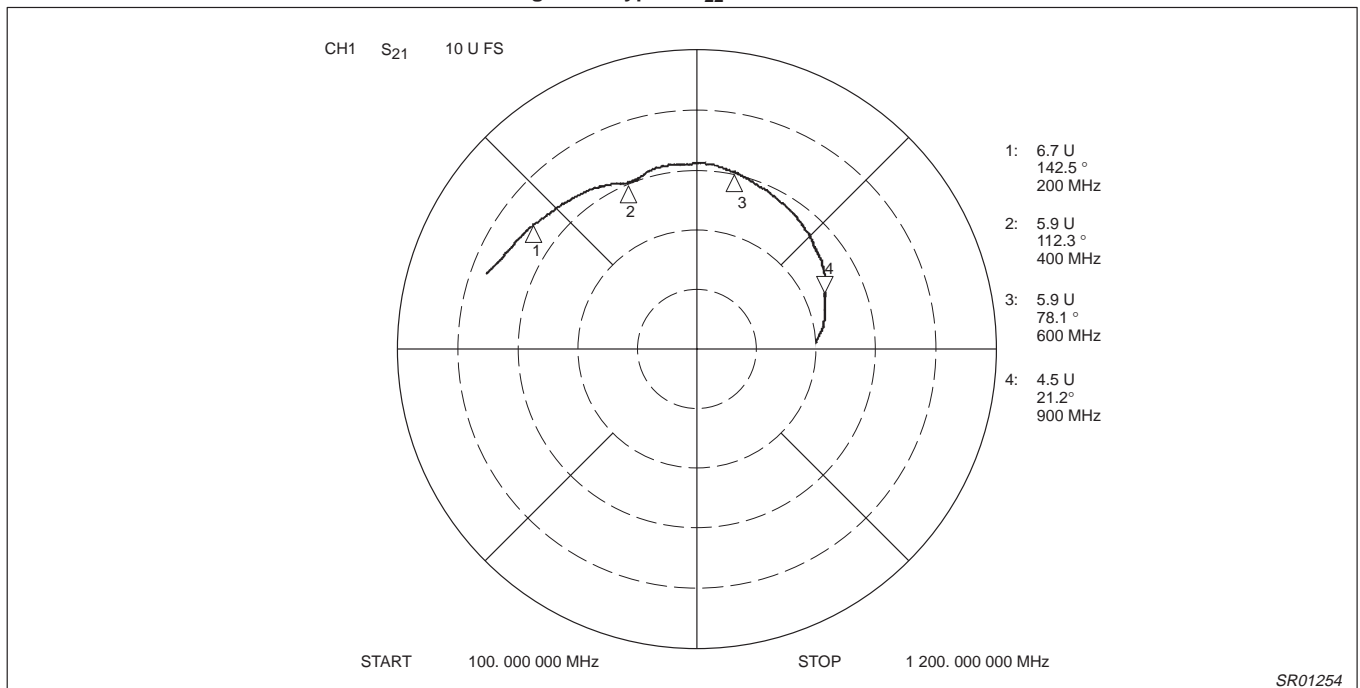


Figure 9. Typical S<sub>21</sub> of LNA at 3V

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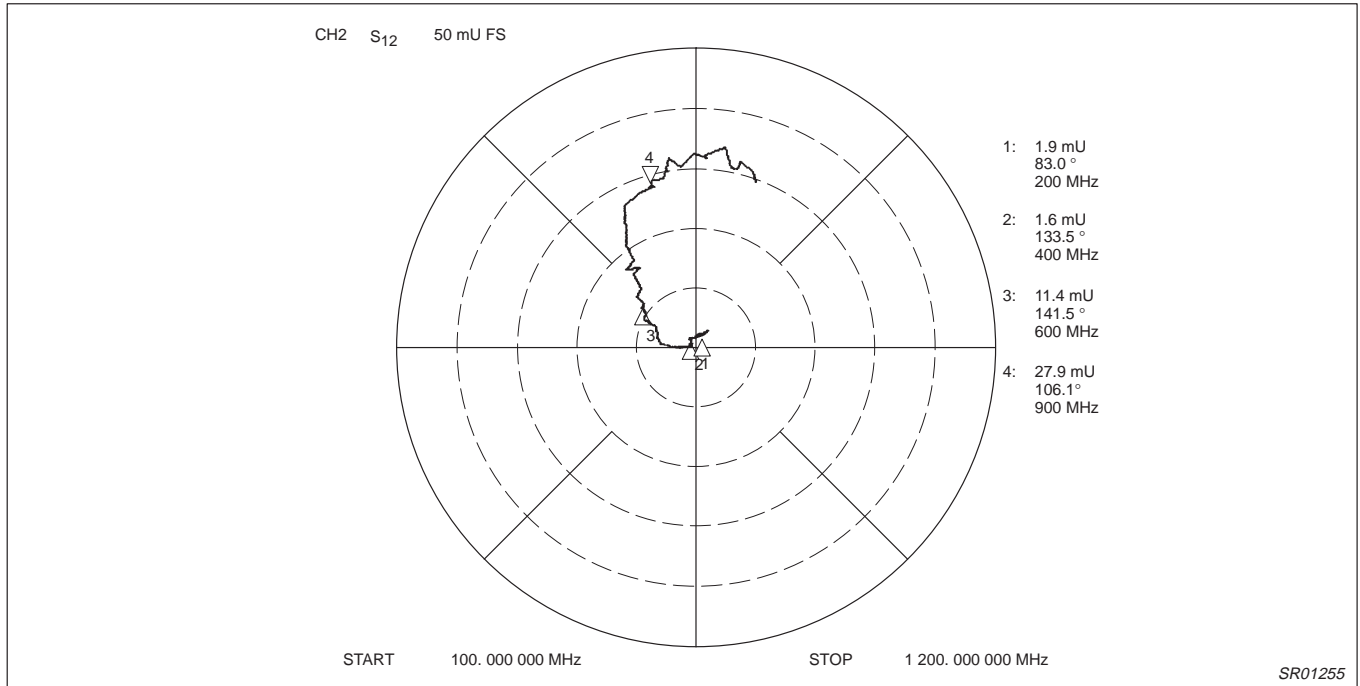


Figure 10. Typical S<sub>12</sub> of LNA at 3V

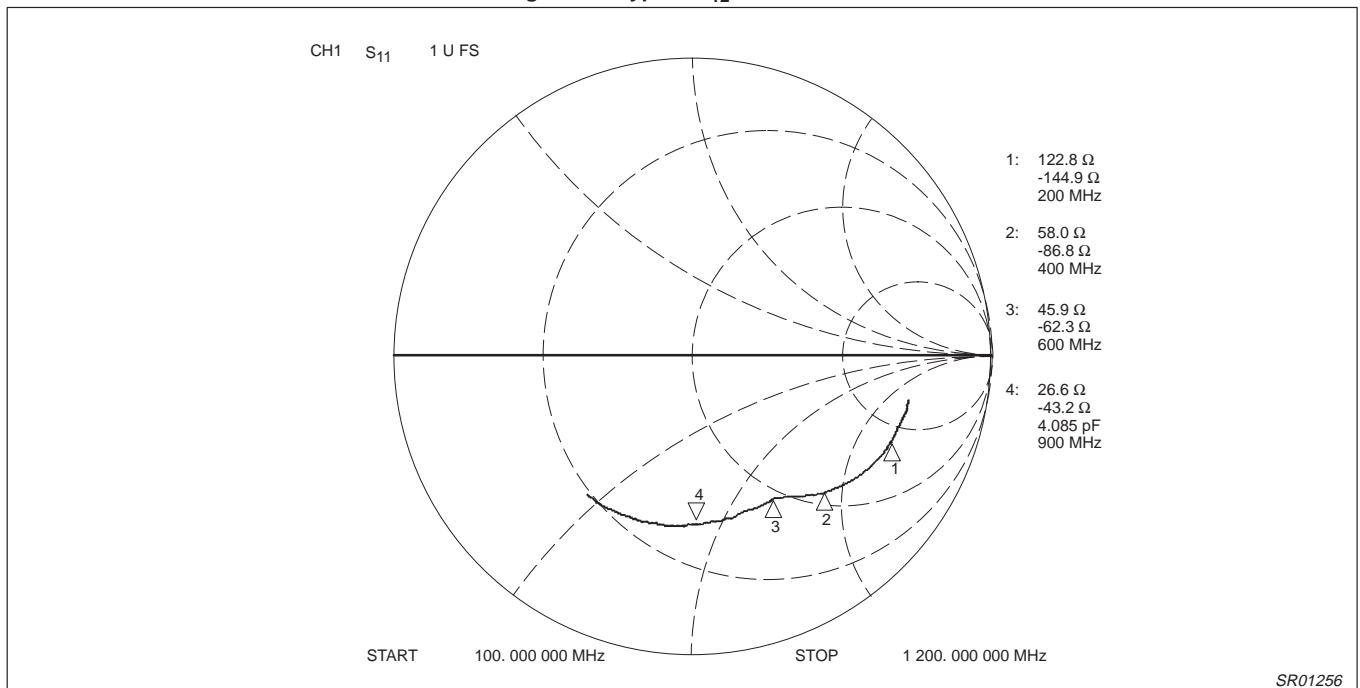


Figure 11. Typical S<sub>11</sub> of Mixer at 3V

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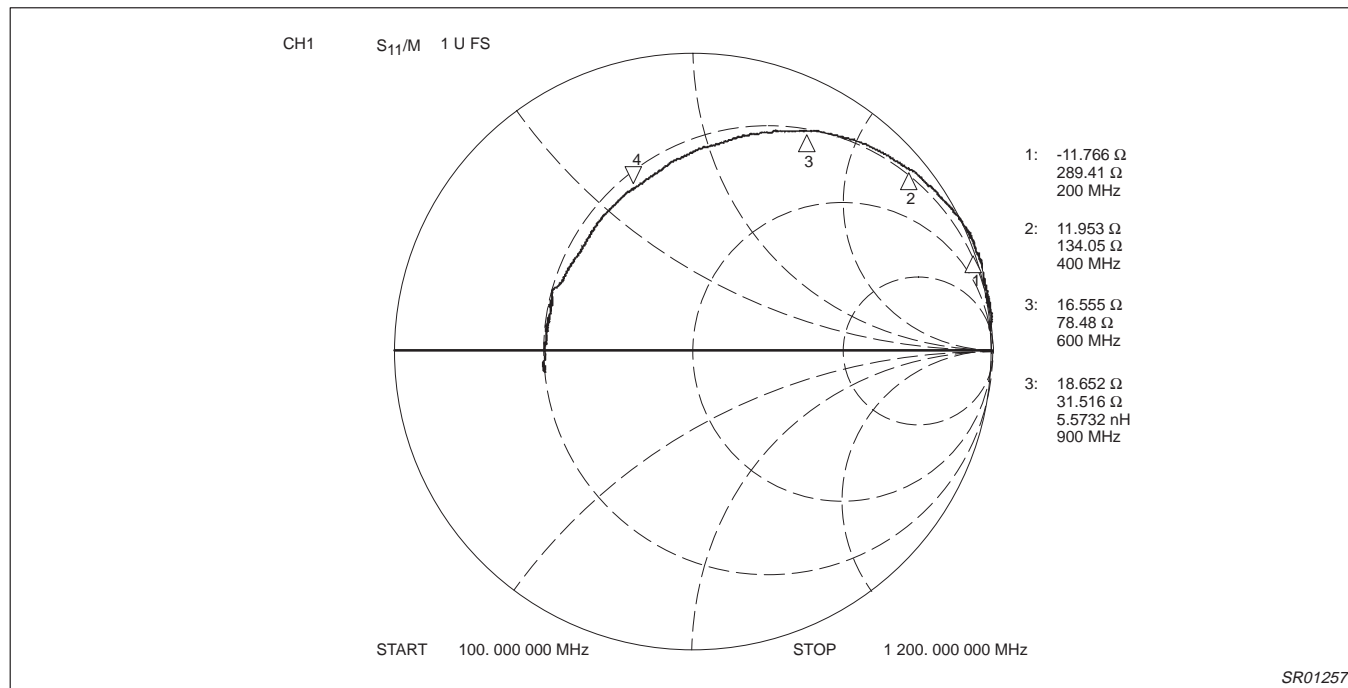


Figure 12. Typical 1/S<sub>11</sub> of VCO (Pin 7) at 3V

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

LNA								
Freq (MHz)	S <sub>11</sub>   (U)	<S <sub>11</sub> (deg)	S <sub>21</sub>   (U)	<S <sub>21</sub> (deg)	S <sub>12</sub>   (U)	<S <sub>12</sub> (deg)	S <sub>22</sub>   (U)	<S <sub>22</sub> (deg)
100	0.86	-20	7.4	160	0.001	92	0.59	-10
122	0.86	-24	7.1	156	0.001	62	0.58	-12
144	0.85	-28	7.0	151	0.001	105	0.58	-14
166	0.83	-32	6.9	148	0.000	92	0.57	-16
188	0.82	-36	6.8	144	0.002	100	0.57	-18
210	0.81	-41	6.7	140	0.002	74	0.56	-20
232	0.80	-45	6.6	136	0.002	100	0.55	-22
254	0.79	-48	6.5	133	0.001	84	0.54	-25
276	0.78	-52	6.4	130	0.001	103	0.53	-27
298	0.76	-56	6.3	126	0.002	94	0.52	-29
320	0.75	-59	6.3	123	0.002	67	0.51	-31
342	0.73	-63	6.2	119	0.002	108	0.50	-33
364	0.71	-66	6.1	116	0.002	118	0.48	-35
386	0.70	-69	6.0	113	0.001	103	0.47	-36
408	0.69	-72	5.9	111	0.001	176	0.46	-37
430	0.68	-76	5.9	109	0.004	174	0.45	-37
452	0.69	-78	6.0	106	0.006	162	0.46	-38
474	0.68	-82	6.1	102	0.007	160	0.47	-42
496	0.67	-85	6.1	97	0.008	153	0.47	-46
518	0.66	-89	6.1	93	0.010	146	0.46	-50
540	0.65	-92	6.1	89	0.009	142	0.45	-55
562	0.63	-96	6.1	85	0.010	138	0.43	-59
584	0.62	-99	6.0	81	0.011	146	0.42	-64
606	0.62	-102	5.9	77	0.011	141	0.40	-69
628	0.61	-104	5.8	72	0.013	137	0.38	-73
650	0.61	-107	5.7	69	0.013	131	0.36	-78
672	0.60	-109	5.7	65	0.016	130	0.34	-84
694	0.60	-112	5.6	61	0.016	132	0.31	-90
716	0.59	-115	5.5	57	0.017	129	0.29	-97
738	0.59	-118	5.5	53	0.019	128	0.27	-104
760	0.59	-121	5.3	48	0.021	123	0.24	-113
782	0.59	-124	5.3	44	0.021	122	0.22	-122
804	0.59	-126	5.1	40	0.022	120	0.21	-133
826	0.59	-129	5.0	36	0.024	118	0.19	-145
848	0.59	-132	4.9	31	0.026	116	0.18	-159
870	0.59	-135	4.8	26	0.027	112	0.17	-175
892	0.59	-138	4.6	22	0.028	108	0.18	169
914	0.59	-142	4.5	18	0.028	106	0.19	155
936	0.59	-144	4.3	14	0.028	106	0.20	142
958	0.59	-148	4.2	9	0.030	100	0.22	130
980	0.59	-151	4.0	4	0.031	99	0.24	120
1002	0.59	-153	3.8	0	0.031	95	0.26	111
1024	0.59	-157	3.6	-2	0.032	91	0.28	102
1046	0.59	-160	3.5	-6	0.032	86	0.30	95
1068	0.59	-164	3.3	-10	0.033	86	0.33	88
1090	0.59	-167	3.2	-14	0.033	81	0.35	82
1112	0.59	-170	3.0	-18	0.031	79	0.36	77
1134	0.58	-172	2.8	-22	0.030	46	0.38	72
1156	0.58	-175	2.7	-25	0.031	79	0.39	67
1178	0.57	-178	2.5	-28	0.031	74	0.41	63
1200	0.57	178	2.4	-31	0.029	72	0.42	59

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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

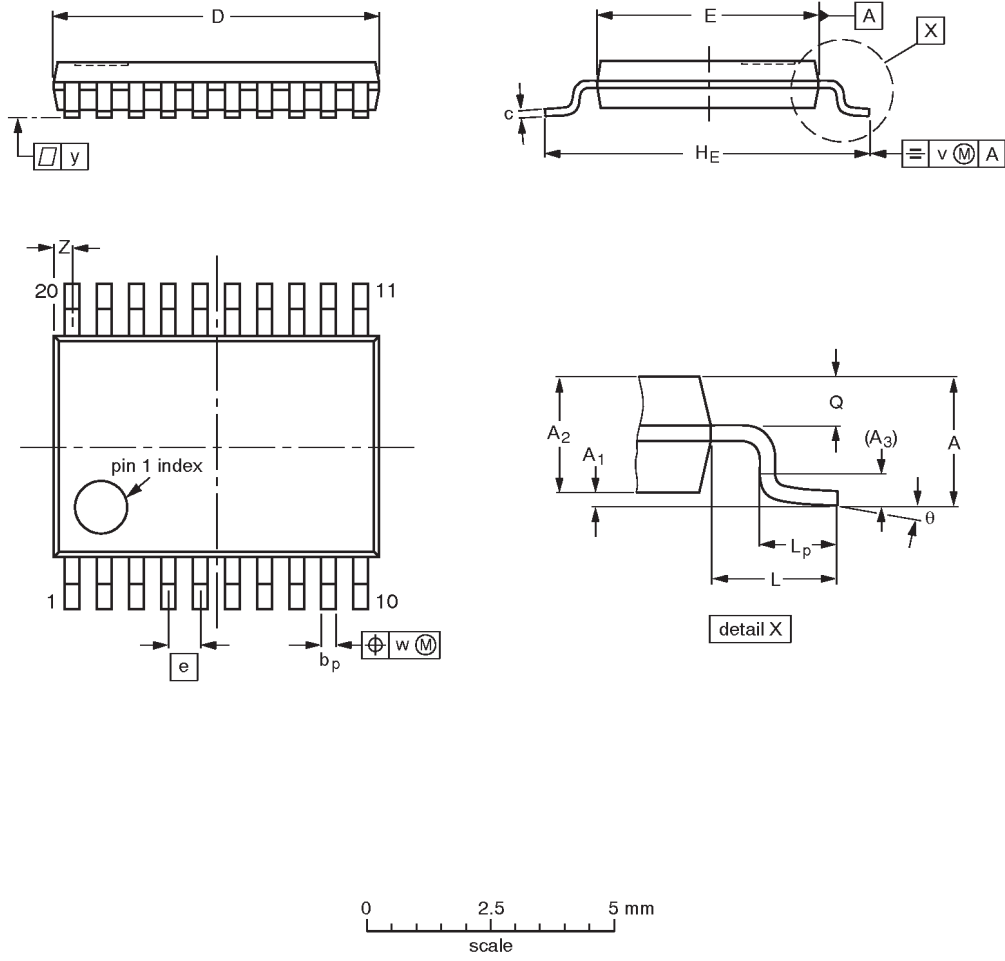
Mixer		
Freq (MHz)	S <sub>11</sub>   (U)	<S <sub>11</sub> (deg)
672	0.54	-65
694	0.54	-67
716	0.54	-69
738	0.54	-71
760	0.54	-73
782	0.55	-76
804	0.55	-78
826	0.55	-80
848	0.55	-82
870	0.55	-85
892	0.56	-87
914	0.55	-90
936	0.56	-93
958	0.56	-96
980	0.56	-98
1002	0.56	-101
1024	0.57	-104
1046	0.57	-106
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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**TSSOP20: plastic thin shrink small outline package; 20 leads; body width 4.4 mm**

**SOT360-1**



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	$\theta$
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	6.6 6.4	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.5 0.2	8° 0°

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT360-1		MO-153AC				-93-06-16- 95-02-04

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## DEFINITIONS

Data Sheet Identification	Product Status	Definition
<i>Objective Specification</i>	<b>Formative or in Design</b>	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
<i>Preliminary Specification</i>	<b>Preproduction Product</b>	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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