

# DATA SHEET

## **SA626**

Low voltage high performance mixer FM  
IF system with high-speed RSSI

Product specification

1997 Sept 25

IC17 Data Handbook

# Low voltage high performance mixer FM IF system with high-speed RSSI

SA626

## DESCRIPTION

The SA626 is a low-voltage high performance monolithic FM IF system incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, high speed logarithmic received signal strength indicator (RSSI), voltage regulator and audio and fast RSSI op amps. The SA626 is available in 20-lead SOL (surface-mounted small outline large package) and 20-lead SSOP (shrink small outline package).

The SA626 was designed for high bandwidth portable communication applications and will function down to 2.7V. The RF section is similar to the famous NE605. The audio and RSSI outputs have amplifiers. The RSSI output has access to the feedback pin. This enables the designer to level adjust the outputs or add filtering.

SA626 incorporates a power down mode which powers down the device when Pin 8 is low. Power down logic levels are CMOS and TTL compatible with high input impedance.

## APPLICATIONS

- Digital cordless telephones
- Digital cellular telephones
- Digital cellular base stations
- Portable high performance communications receivers
- Single conversion VHF/UHF receivers
- SCA receivers
- RF level meter
- Spectrum analyzer
- Instrumentation
- FSK and ASK data receivers
- Log amps
- Wideband low current amplification

## FEATURES

- Fast RSSI rise and fall times
- Low power consumption: 6.5mA typ at 3V
- Power down mode ( $I_{CC} = 200\mu A$ )

## PIN CONFIGURATION

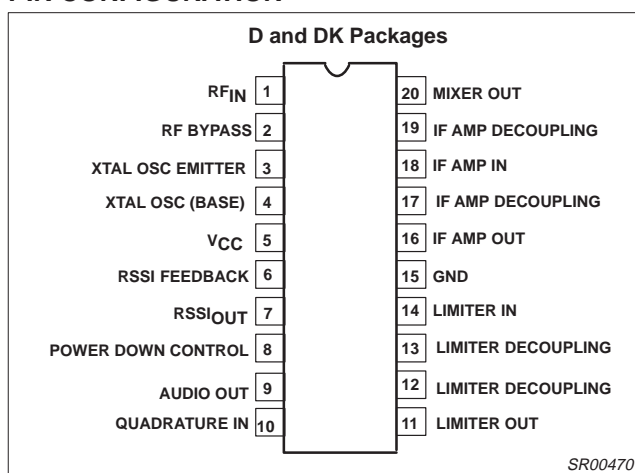


Figure 1. Pin Configuration

- Mixer input to >500MHz
- Mixer conversion power gain of 11dB at 240MHz
- Mixer noise figure of 14dB at 240MHz
- XTAL oscillator effective to 150MHz (L.C. oscillator to 1GHz, local oscillator can be injected)
- 92dB of IF Amp/Limiter power gain
- 25MHz limiter small signal bandwidth
- Temperature compensated logarithmic Received Signal Strength Indicator (RSSI) with a dynamic range in excess of 90dB
- Audio output internal buffer
- RSSI output internal buffer
- Internal op amps with rail-to-rail outputs
- 10.7MHz filter matching (330Ω) reduces external component count; suitable for crystal/ceramic/LC filters
- Excellent sensitivity: 0.54μV into 50Ω matching network for 12dB SINAD (Signal to Noise and Distortion ratio) for 1kHz tone with RF at 240MHz and IF at 10.7MHz
- SA626 meets cellular radio specifications
- ESD hardened

## ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
20-Pin Plastic Small Outline Large (SOL) package (Surface-mount)	-40 to +85°C	SA626D	SOT163-1
20-Pin Plastic Shrink Small Outline Package (Surface-mount)	-40 to +85°C	SA626DK	SOT266-1

# Low voltage high performance mixer FM IF system with high-speed RSSI

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## BLOCK DIAGRAM

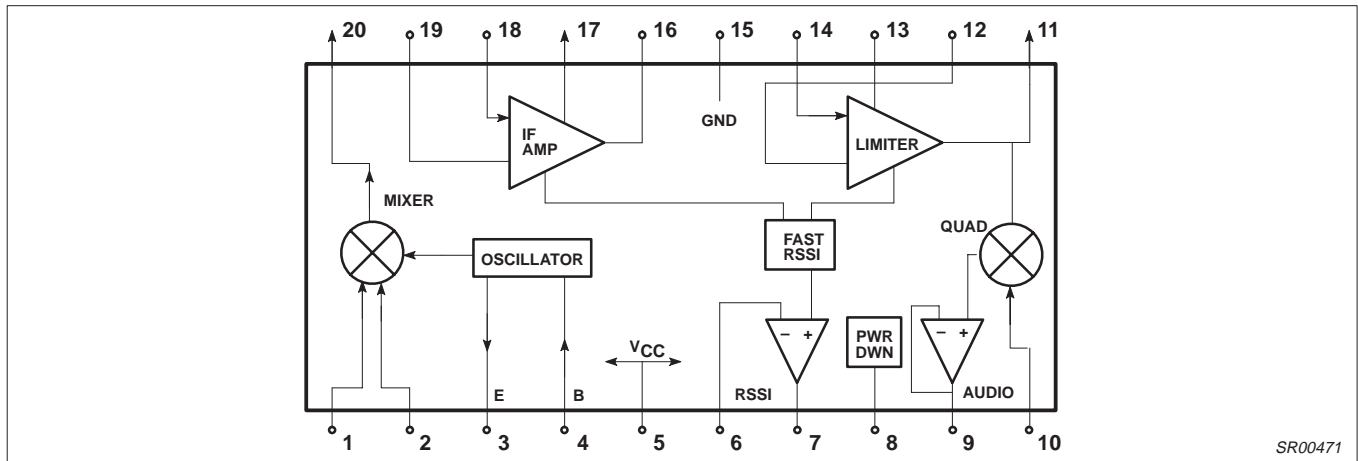


Figure 2. Block Diagram

## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Single supply voltage	0.3 to 7	V
$V_{IN}$	Voltage applied to any other pin	-0.3 to ( $V_{CC}+0.3$ )	V
$T_{STG}$	Storage temperature range	-65 to +150	°C
$T_A$	Operating ambient temperature range SA626	-40 to +85	°C
$\theta_{JA}$	Thermal impedance D package	90	°C/W
	DK package	117	°C/W

## DC ELECTRICAL CHARACTERISTICS

$V_{CC} = +3V$ ,  $T_A = 25^\circ C$ ; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			SA626			
			MIN	TYP	MAX	
$V_{CC}$	Power supply voltage range		2.7	3.0	5.5	V
$I_{CC}$	DC current drain	Pin 8 = HIGH	5.5	6.5	7.5	mA
$I_{CC}$	Standby	Pin 8 = LOW		0.2	0.5	mA
	Input current	Pin 8 LOW	-10		10	$\mu A$
		Pin 8 HIGH	-10		10	$\mu A$
	Input level	Pin 8 LOW	0		$0.3V_{CC}$	V
		Pin 8 HIGH	$0.7V_{CC}$		$V_{CC}$	V
$t_{ON}$	Power up time	RSSI valid (10% to 90%)		10		$\mu s$
$t_{OFF}$	Power down time	RSSI invalid (90% to 10%)		5		$\mu s$

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## AC ELECTRICAL CHARACTERISTICS

$T_A = 25^\circ\text{C}$ ;  $V_{CC} = +3\text{V}$ , unless otherwise stated. RF frequency = 240.05MHz + 14.5dBV RF input step-up; IF frequency = 10.7MHz; RF level = -68dBm; FM modulation = 1kHz with  $\pm 125\text{kHz}$  peak deviation. Audio output with C-message weighted filter and de-emphasis filter. Test circuit Figure 1. The parameters listed below are tested using automatic test equipment to assure consistent electrical characteristics. The limits do not represent the ultimate performance limits of the device. Use of an optimized RF layout will improve many of the listed parameters.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			SA626			
			MIN	TYP	MAX	
<b>Mixer/Osc section (ext LO = 160mV<sub>RMS</sub>)</b>						
$f_{IN}$	Input signal frequency			500		MHz
$f_{OSC}$	External oscillator (buffer)			500		MHz
	Noise figure at 240MHz			14		dB
	Third-order input intercept point	Matched $f_1=240.05$ ; $f_2=240.35\text{MHz}$		-16		dBm
	Conversion power gain	Matched 14.5dBV step-up	8	11	14	dB
	RF input resistance	Single-ended input		700		$\Omega$
	RF input capacitance			3.5		pF
	Mixer output resistance	(Pin 20)		330		$\Omega$
<b>IF section</b>						
	IF amp power gain			38		dB
	Limiter amp power gain			54		dB
	Input limiting -3dB	Test at Pin 18		-105		dBm
	AM rejection	80% AM 1kHz		50		dB
	Audio level	Unity gain	120	160	200	mV <sub>RMS</sub>
	Audio DC level	Pin 9, no signal		1.0		V
	SINAD sensitivity	IF level = -111dBm		16		dB
THD	Total harmonic distortion			-43	-38	dB
S/N	Signal-to-noise ratio	No modulation for noise		60		dB
	IF RSSI output with buffer	IF level = -118dBm		0.2	0.5	V
		IF level = -68dBm	0.3	0.6	1.0	V
		IF level = -10dBm	0.9	1.3	1.8	V
	IF RSSI output rise time (10kHz pulse, no 10.7MHz filter) (no RSSI bypass capacitor)	IF frequency = 10.7MHz RF level = -56dBm RF level = -28dBm		1.2		$\mu\text{s}$
				1.1		$\mu\text{s}$
	IF RSSI output fall time (10kHz pulse, no 10.7MHz filter) (no RSSI bypass capacitor)	IF frequency = 10.7MHz RF level = -56dBm RF level = -28dBm		2.0		$\mu\text{s}$
				7.3		$\mu\text{s}$
	RSSI range			90		dB
	RSSI accuracy			$\pm 1.5$		dB
	IF input impedance			330		$\Omega$
	IF output impedance			330		$\Omega$
	Limiter input impedance			330		$\Omega$
	Limiter output impedance			300		$\Omega$
	Limiter output level with no load			130		mV <sub>RMS</sub>
<b>RF/IF section (int LO)</b>						
	Audio level	RF level = -10dBm		160		mV <sub>RMS</sub>
	System RSSI output	RF level = -10dBm		1.4		V
	System SINAD	RF level = -106dBm		12		dB

# Low voltage high performance mixer FM IF system with high-speed RSSI

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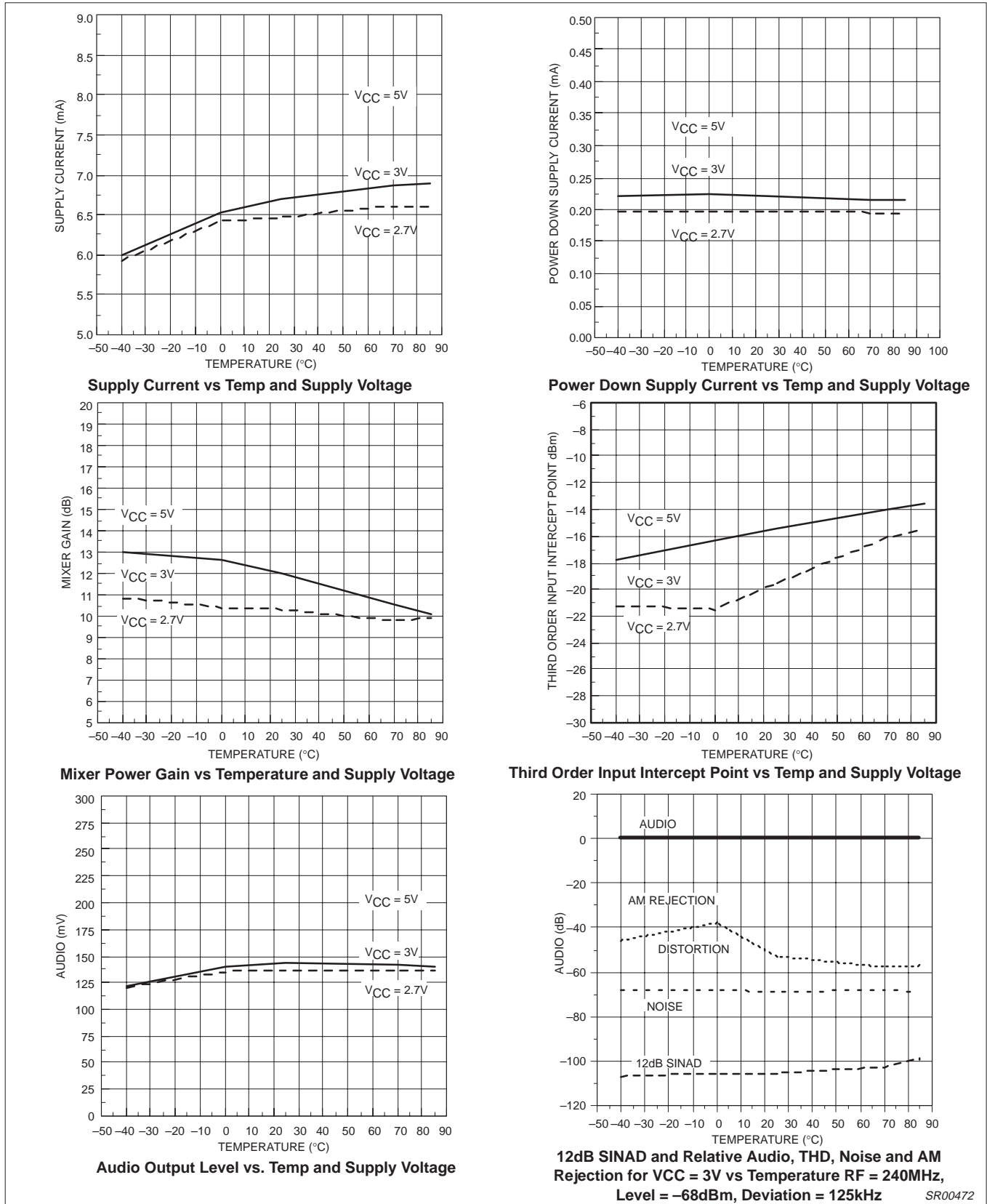


Figure 3. Performance Characteristics

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# Low voltage high performance mixer FM IF system with high-speed RSSI

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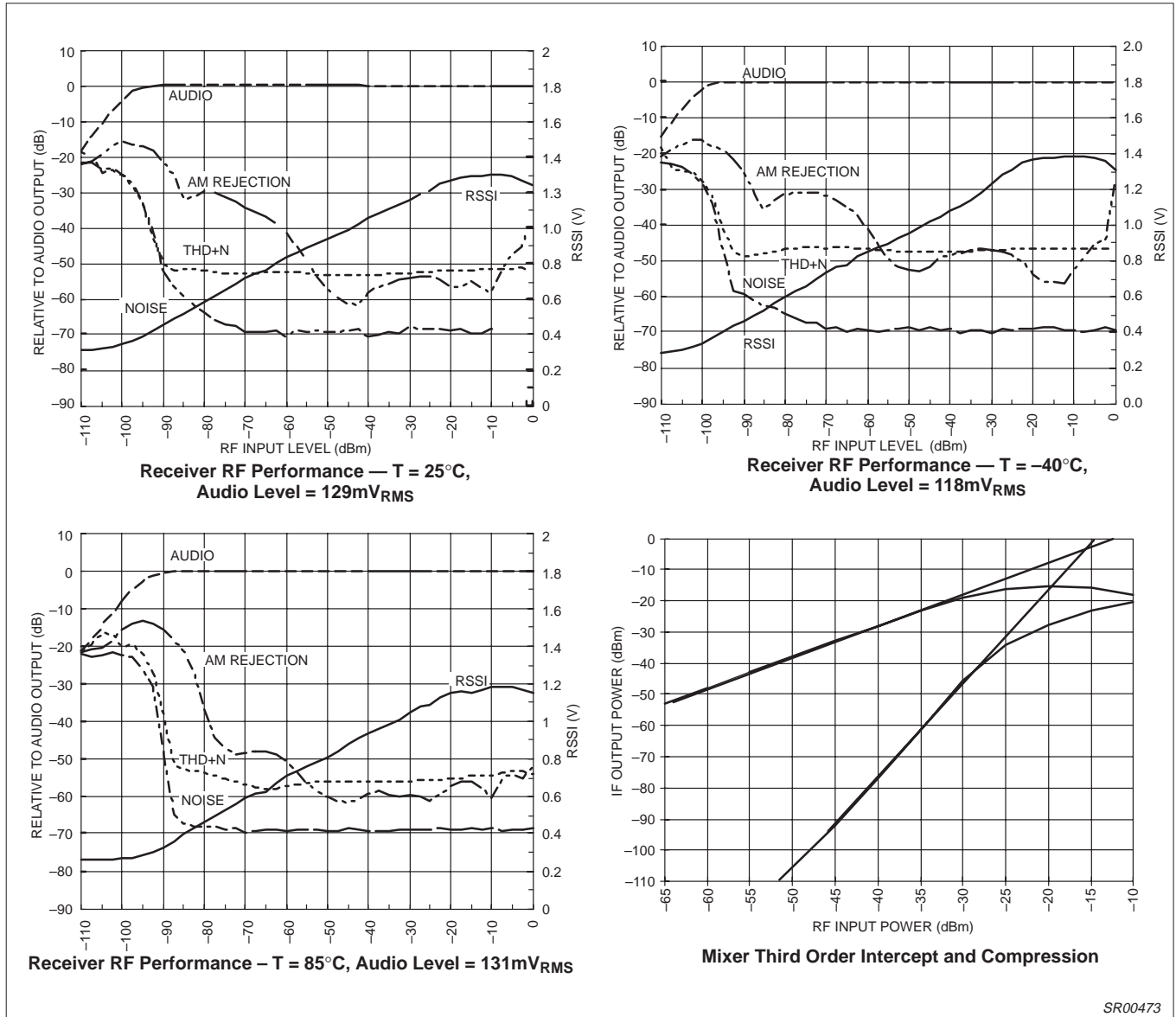


Figure 4. Performance Characteristics

SR00473

# Low voltage high performance mixer FM IF system with high-speed RSSI

SA626

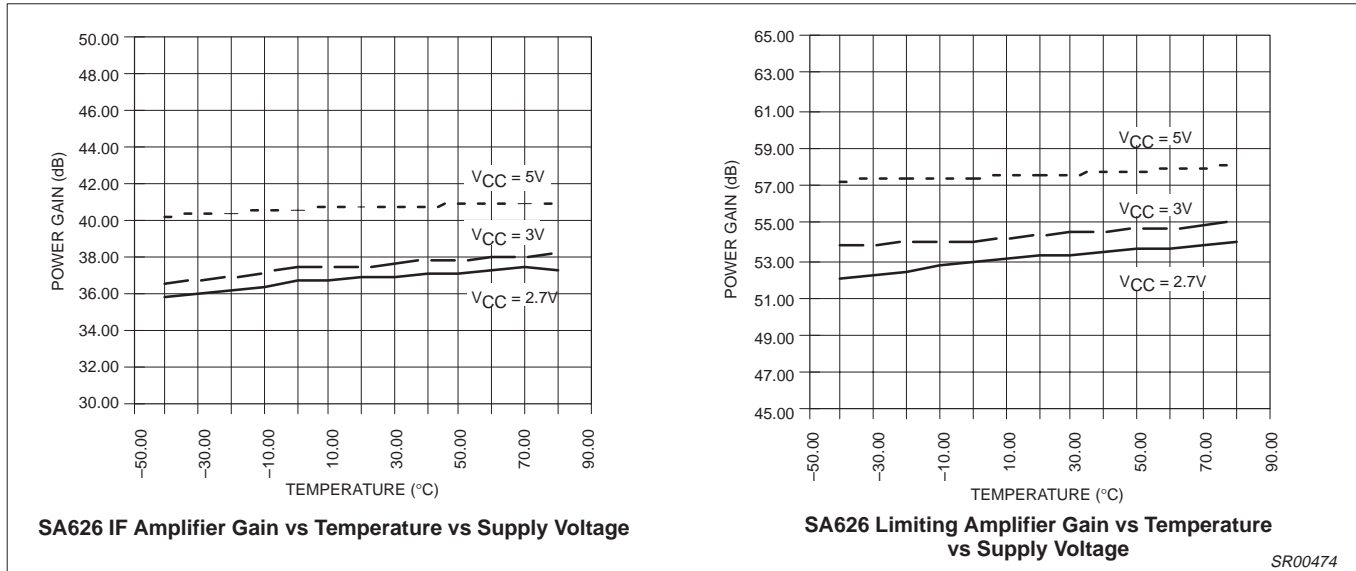


Figure 5. Performance Characteristics

## CIRCUIT DESCRIPTION

The SA626 is an IF signal processing system suitable for second IF or single conversion systems with input frequency as high as 1GHz. The bandwidth of the IF amplifier is about 40MHz, with 38dB of power gain from a 50Ω source. The bandwidth of the limiter is about 28MHz with about 54dB of power gain from a 50Ω source. However, the gain/bandwidth distribution is optimized for 10.7MHz, 330Ω source applications. The overall system is well-suited to battery operation as well as high performance and high quality products of all types, such as cordless and cellular hand-held phones.

The input stage is a Gilbert cell mixer with oscillator. Typical mixer characteristics include a noise figure of 14dB, conversion power gain of 11dB, and input third-order intercept of -16dBm. The oscillator will operate in excess of 1GHz in L/C tank configurations. Hartley or Colpitts circuits can be used up to 100MHz for xtal configurations. Butler oscillators are recommended for xtal configurations up to 150MHz.

The output of the mixer is internally loaded with a 330Ω resistor permitting direct connection to a 10.7MHz ceramic filter. The input resistance of the limiting IF amplifiers is also 330Ω. With most 10.7MHz ceramic filters and many crystal filters, no impedance matching network is necessary. To achieve optimum linearity of the log signal strength indicator, there must be a 3dB insertion loss

between the first and second IF stages. If the IF filter or interstage network does not cause 3dB insertion loss, a fixed or variable resistor can be added between the first IF output (Pin 16) and the interstage network.

The signal from the second limiting amplifier goes to a Gilbert cell quadrature detector. One port of the Gilbert cell is internally driven by the IF. The other output of the IF is AC-coupled to a tuned quadrature network. This signal, which now has a 90° phase relationship to the internal signal, drives the other port of the multiplier cell.

Overall, the IF section has a power gain of 92dB. For operation at intermediate frequency at 10.7MHz. Special care must be given to layout, termination, and interstage loss to avoid instability.

The demodulated output of the quadrature drives an internal op amp. This op amp is configured as a unity gain buffer. It can drive an AC load as low as 5kΩ with a rail-to-rail output.

A log signal strength indicator completes the circuitry. The output range is greater than 90dB and is temperature compensated. This log signal strength indicator exceeds the criteria for AMPs or TACs cellular telephone, and RCR-28 cordless telephone. This signal drives an internal op amp. The op amp is capable of rail-to-rail output. It can be used for gain, filtering, or 2nd-order temperature compensation of the RSSI, if needed.

# Low voltage high performance mixer FM IF system with high-speed RSSI

SA626

## PIN FUNCTIONS

PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT	PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT
1	RF IN	+1.07		6	RSSI FEEDBACK	+0.20	
2	RF BYPASS	+1.07		7	RSSI OUT	+0.20	
3	XTAL OSC	+1.57		8	POWER DOWN	+2.75	
4	XTAL OSC	+2.32		9	AUDIO OUT	+1.09	
5	V <sub>CC</sub>	+3.00		10	QUAD. IN	+3.00	

SR00475

Figure 6. Pin Functions



# Low voltage high performance mixer FM IF system with high-speed RSSI

## SA626

### PIN FUNCTIONS (continued)

PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT	PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT
11	LIMITER OUT	+1.35		16	IF AMP OUT	+1.22	
12	LIMITER DECOUP	+1.23		17	IF AMP DECOUP	+1.22	
13	LIMITER COUPLING	+1.23		18	IF AMP IN	+1.22	
14	LIMITER IN	+1.23	19	IF AMP DECOUP	+1.22		
15	GND	0		20	MIXER OUT	+1.03	

SR00476

Figure 7. Pin Functions (cont.)

# Low voltage high performance mixer FM IF system with high-speed RSSI

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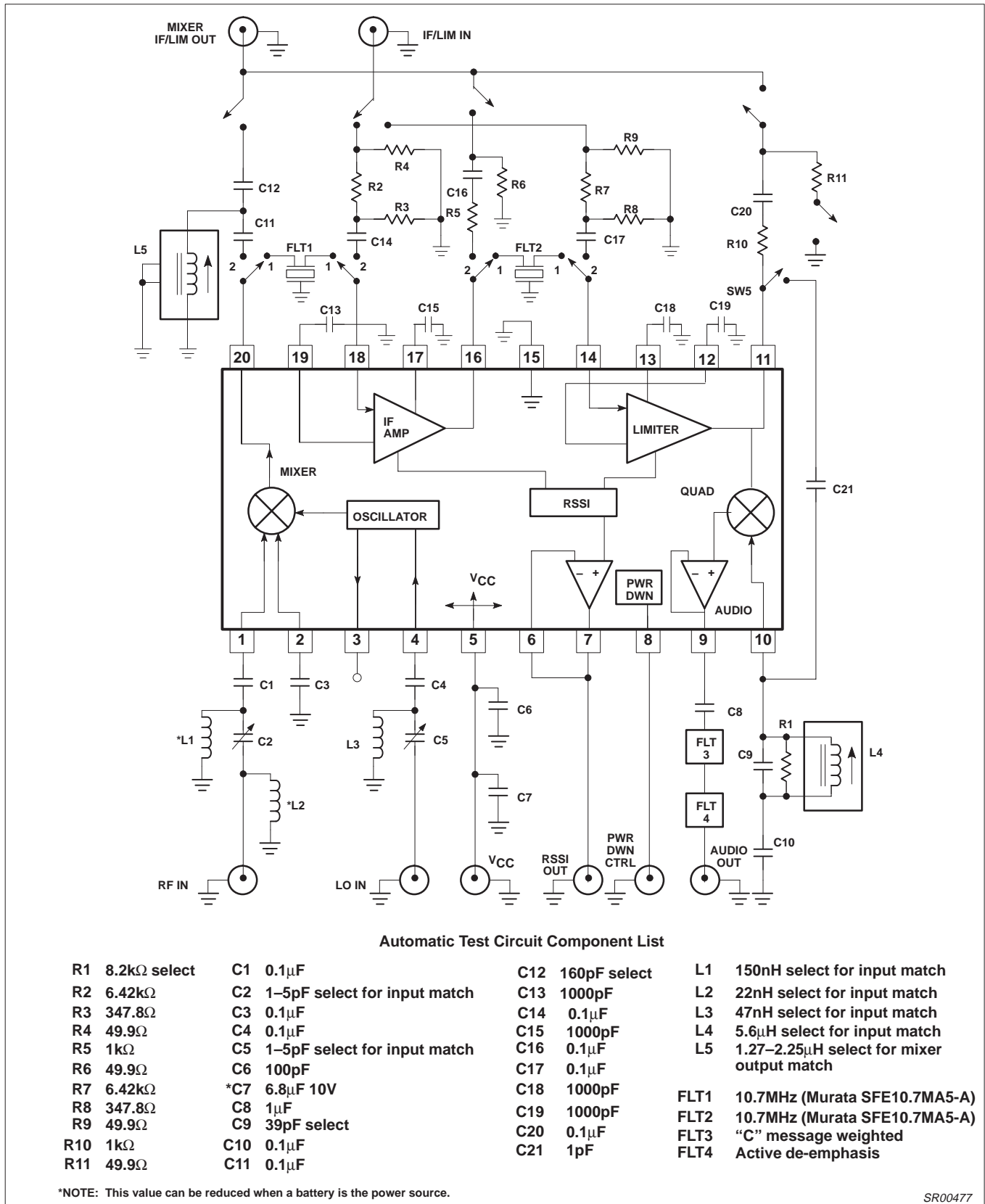


Figure 8. SA626 240.5MHz (RF) / 10.7MHz (IF) Test Circuit

# Low voltage high performance mixer FM IF system with high-speed RSSI

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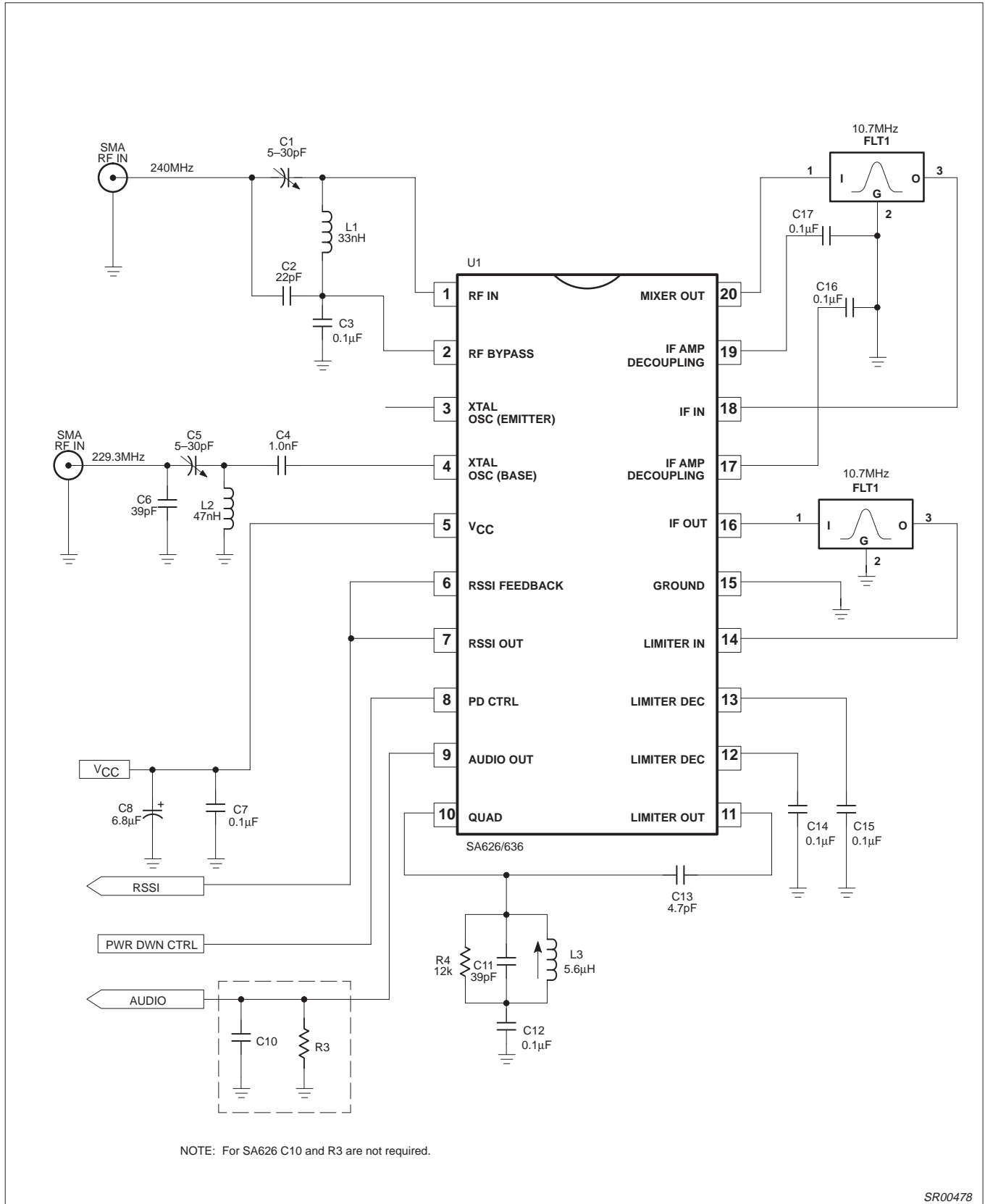


Figure 9. SA626 240MHz (RF) / 10.7MHz (IF) Application Circuit

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# Low voltage high performance mixer FM IF system with high-speed RSSI

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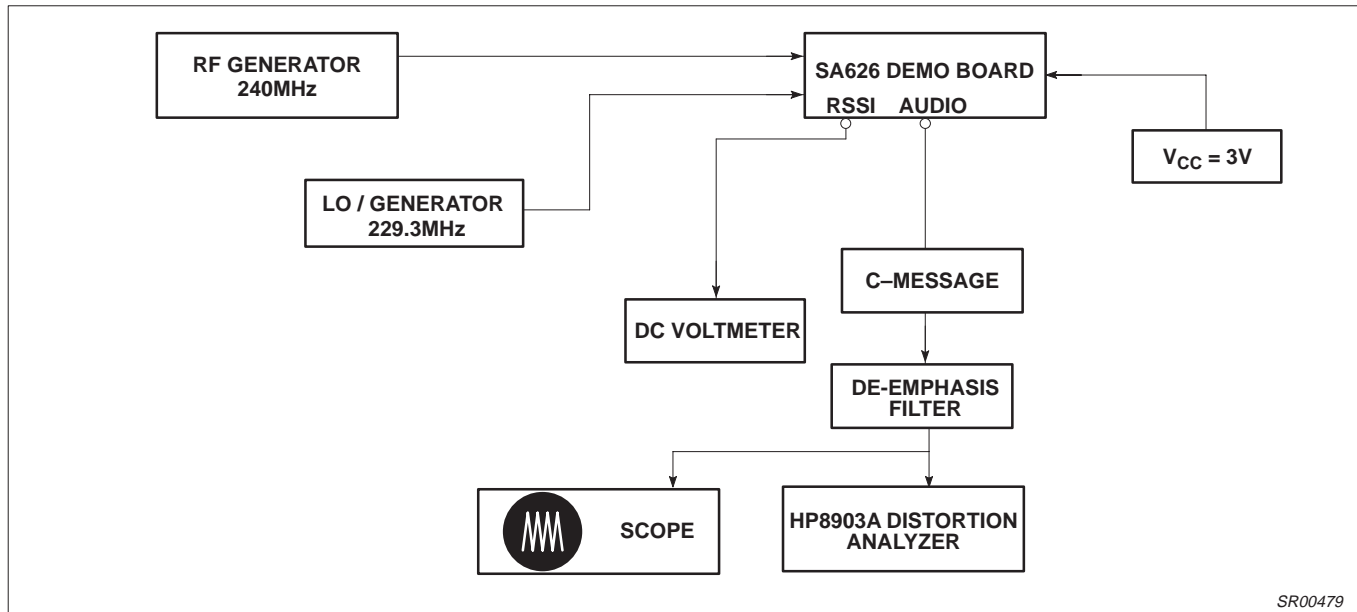


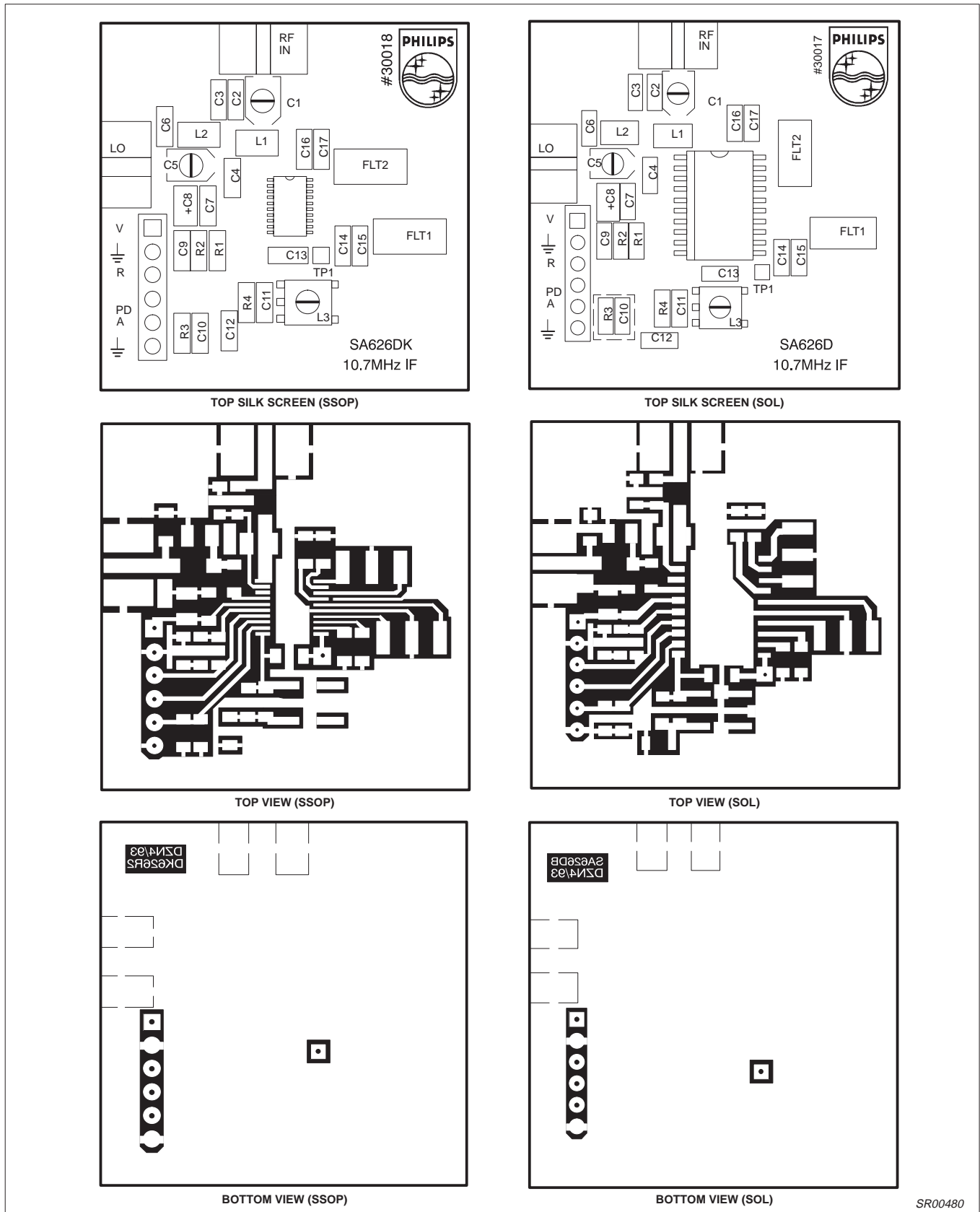
Figure 10. SA626 Application Circuit Test Set Up

## NOTES:

1. C-message: The C-message and de-emphasis filter combination has a peak gain of 10 for accurate measurements. Without the gain, the measurements may be affected by the noise of the scope and HP8903A analyzer. The de-emphasis filter has a fixed -6dB/Octave slope between 300Hz and 3kHz.
2. Ceramic filters: The ceramic filter can be SFE10.7MA5-A made by Murata which has 280kHz IF bandwidth.
3. RF generator: Set your RF generator at 240.000MHz, use a 1kHz modulation frequency and a 125kHz deviation.
4. Sensitivity: The measured typical sensitivity for 12dB SINAD should be  $0.54\mu\text{V}$  or  $-112\text{dBm}$  at the RF input.
5. Layout: The layout is very critical in the performance of the receiver. We highly recommend our demo board layout.
6. RSSI: The smallest RSSI voltage (i.e., when no RF input is present and the input is terminated) is a measure of the quality of the layout and design. If the lowest RSSI voltage is 500mV or higher, it means the receiver is in regenerative mode. In that case, the receiver sensitivity will be worse than expected.
7. Supply bypass and shielding: All of the inductors, the quad tank, and their shield must be grounded. A  $0.1\mu\text{F}$  bypass capacitor on the supply pin improves sensitivity.

# Low voltage high performance mixer FM IF system with high-speed RSSI

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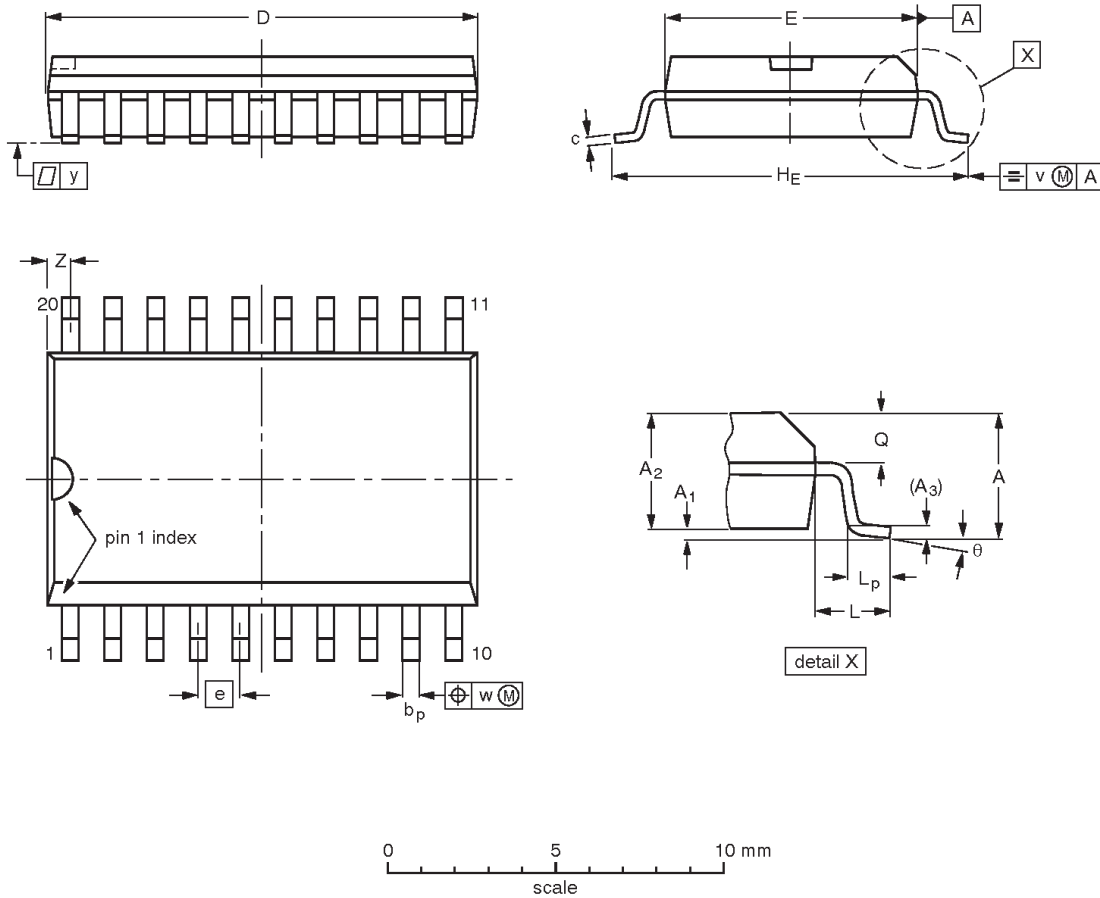
Figure 11. SA626 Demoboard Layout (Not Actual Size)

# Low voltage high performance mixer FM IF system with high-speed RSSI

SA626

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1



**DIMENSIONS (inch dimensions are derived from the original mm 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>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	$\theta$
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	13.0 12.6	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.51 0.49	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

**Note**

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

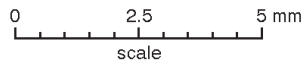
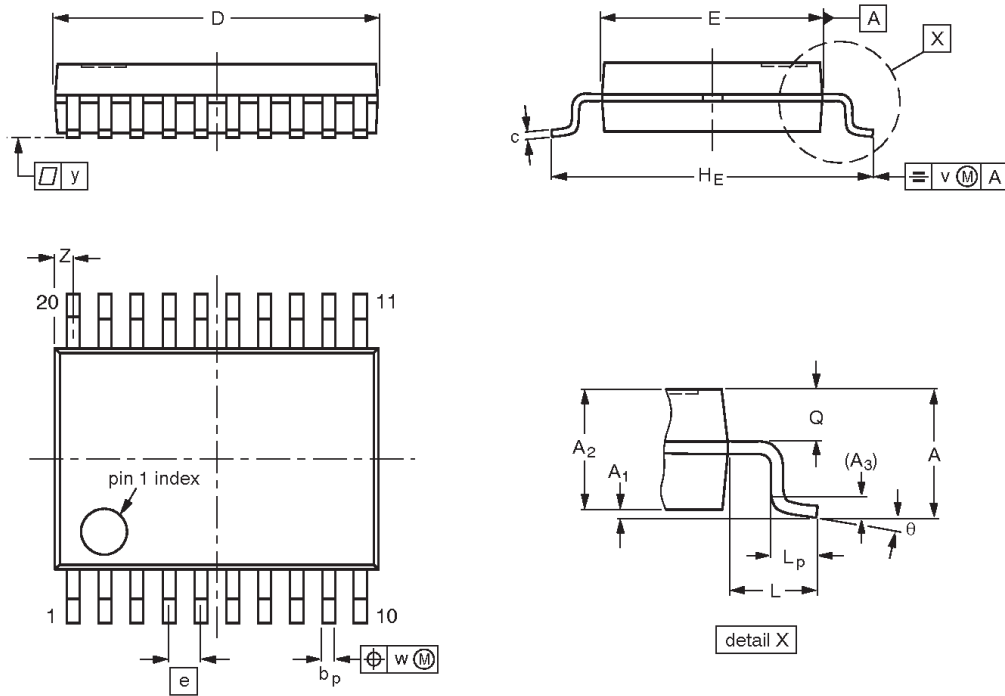
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT163-1	075E04	MS-013AC				92-11-17 95-01-24

# Low voltage high performance mixer FM IF system with high-speed RSSI

SA626

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

SOT266-1



**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>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.5	0.15 0	1.4 1.2	0.25	0.32 0.20	0.20 0.13	6.6 6.4	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.45	0.65 0.45	0.2	0.13	0.1	0.48 0.18	10° 0°

**Note**

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT266-1						90-04-05 95-02-25

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**SA626**

**DEFINITIONS**

<b>Data Sheet Identification</b>	<b>Product Status</b>	<b>Definition</b>
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