

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

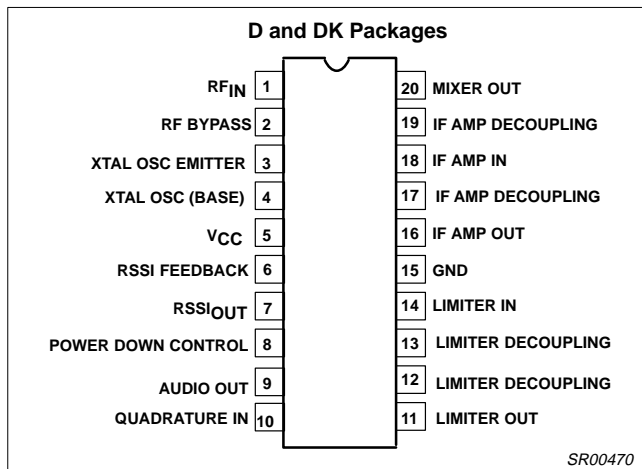


Figure 1. Pin Configuration

- 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

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BLOCK DIAGRAM

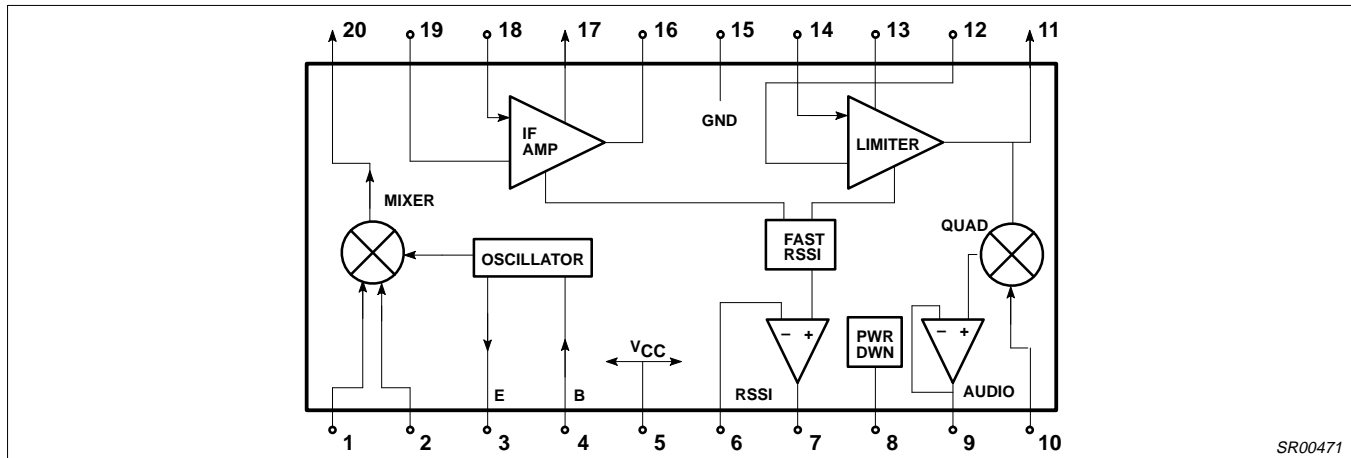


Figure 2. Block Diagram

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	
θ_{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	μA
		Pin 8 HIGH	-10		10	μA
	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		μs
t_{OFF}	Power down time	RSSI invalid (90% to 10%)		5		μs

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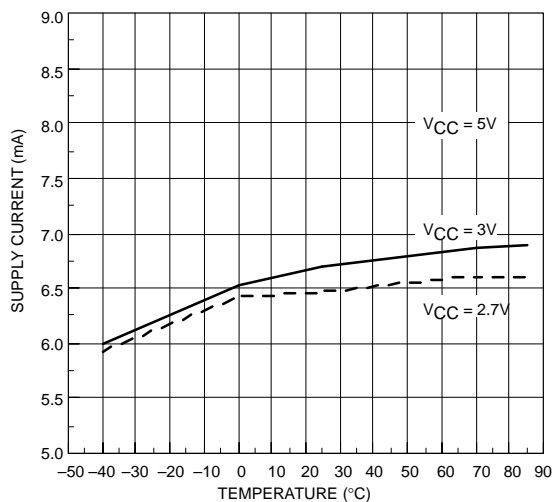
AC ELECTRICAL CHARACTERISTICS

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

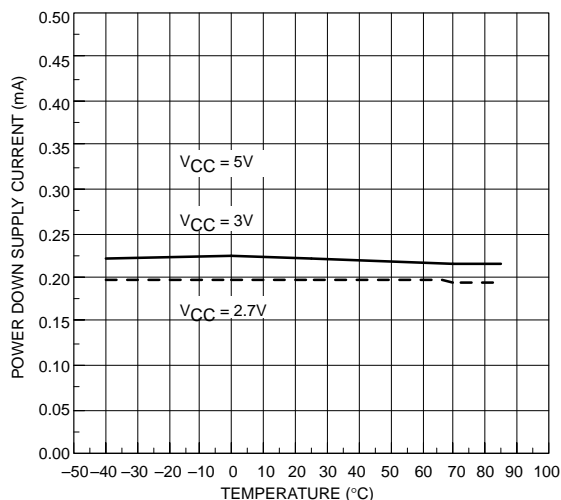
SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			SA626			
			MIN	TYP	MAX	
Mixer/Osc section (ext LO = 160mV_{RMS})						
f_{IN}	Input signal frequency			500		MHz
f_{OSC}	External oscillator (buffer)			500		MHz
	Noise figure at 240MHz			14		dB
	Third-order input intercept point	Matched $f_1=240.05$; $f_2=240.35\text{MHz}$		-16		dBm
	Conversion power gain	Matched 14.5dBV step-up	8	11	14	dB
	RF input resistance	Single-ended input		700		Ω
	RF input capacitance			3.5		pF
	Mixer output resistance	(Pin 20)		330		Ω
IF section						
	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 _{RMS}
	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		μs
				1.1		μs
	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		μs
				7.3		μs
	RSSI range			90		dB
	RSSI accuracy			± 1.5		dB
	IF input impedance			330		Ω
	IF output impedance			330		Ω
	Limiter input impedance			330		Ω
	Limiter output impedance			300		Ω
	Limiter output level with no load			130		mV _{RMS}
RF/IF section (int LO)						
	Audio level	RF level = -10dBm		160		mV _{RMS}
	System RSSI output	RF level = -10dBm		1.4		V
	System SINAD	RF level = -106dBm		12		dB

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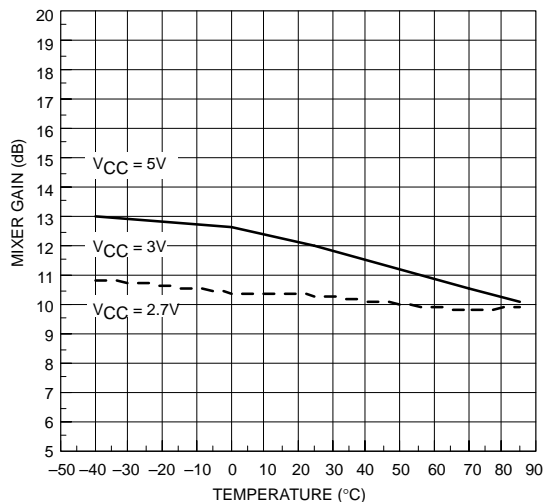
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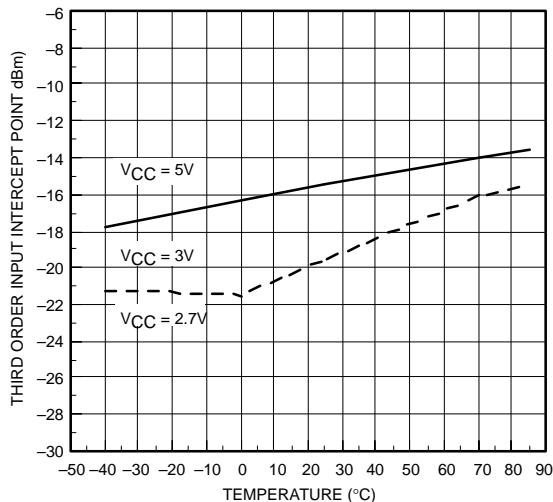
Supply Current vs Temp and Supply Voltage



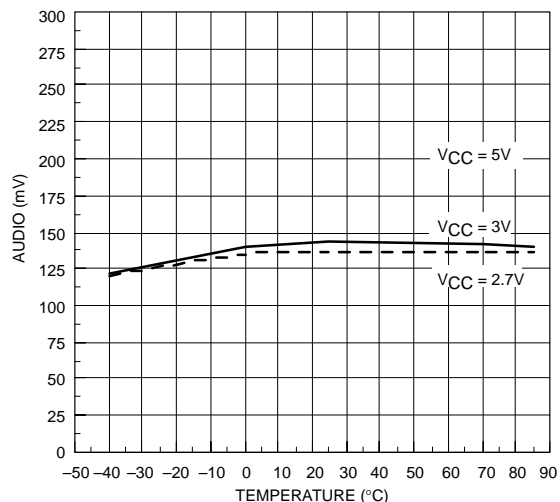
Power Down Supply Current vs Temp and Supply Voltage



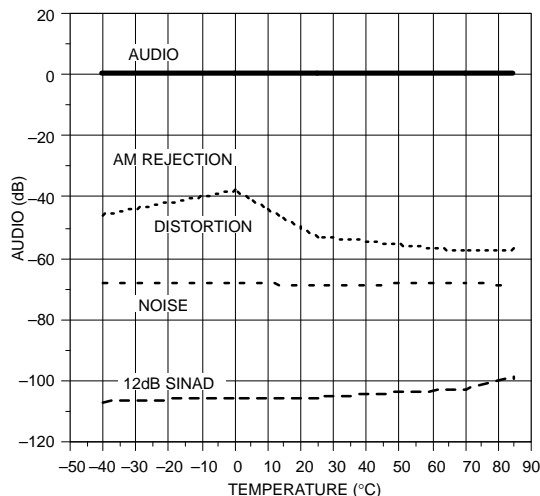
Mixer Power Gain vs Temperature and Supply Voltage



Third Order Input Intercept Point vs Temp and Supply Voltage



Audio Output Level vs. Temp and Supply Voltage



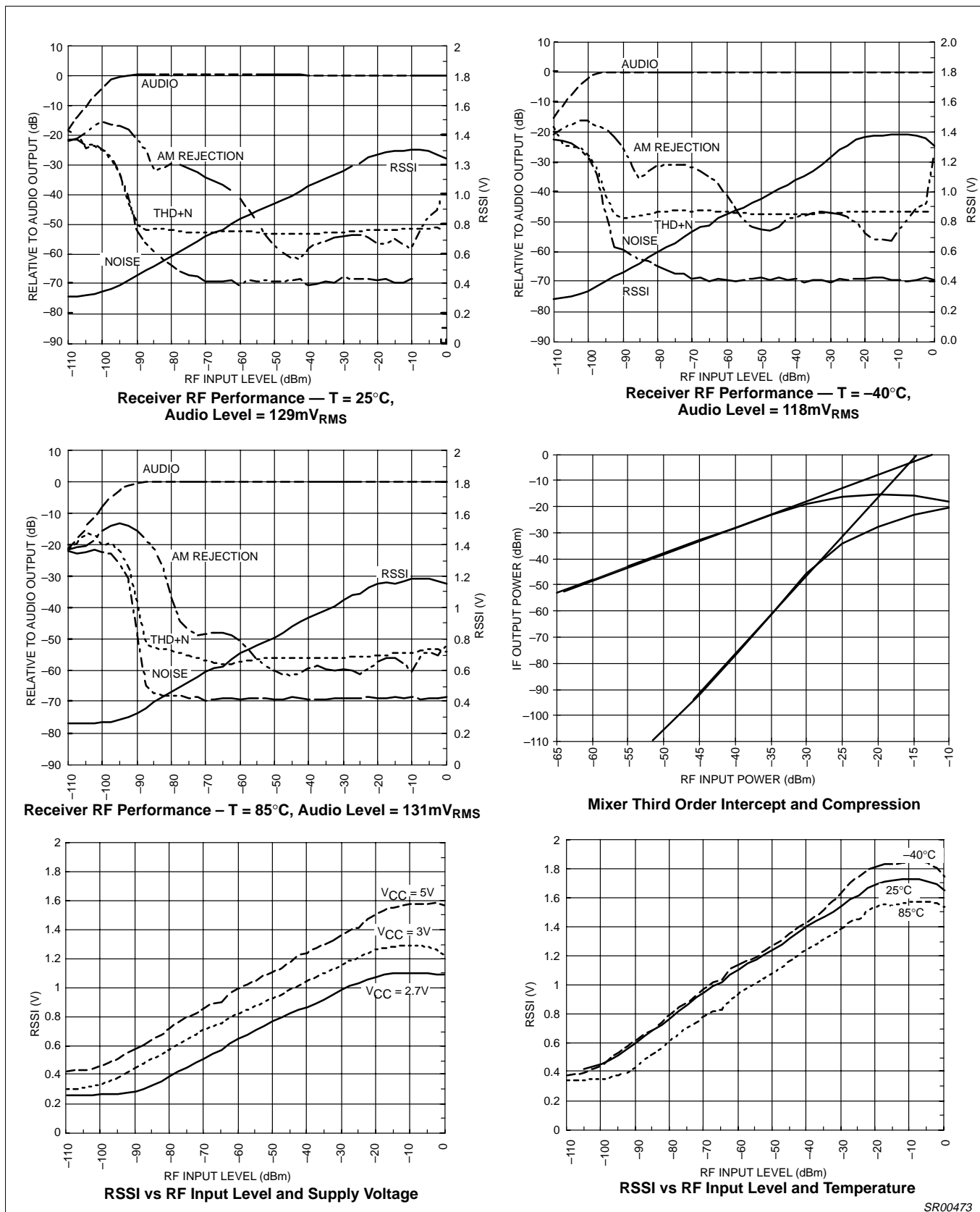
12dB SINAD and Relative Audio, THD, Noise and AM Rejection for V_{CC} = 3V vs Temperature RF = 240MHz, Level = -68dBm, Deviation = 125kHz

SR00472

Figure 3. Performance Characteristics

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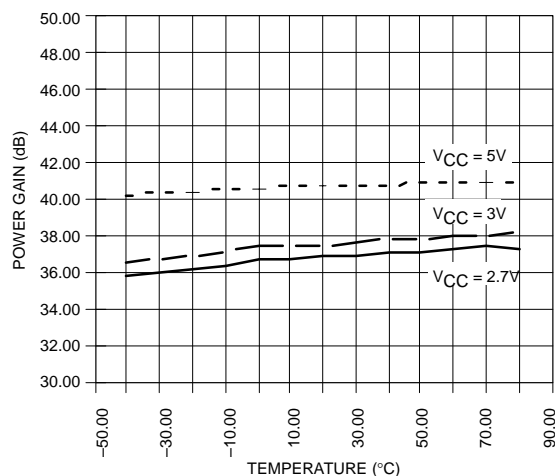


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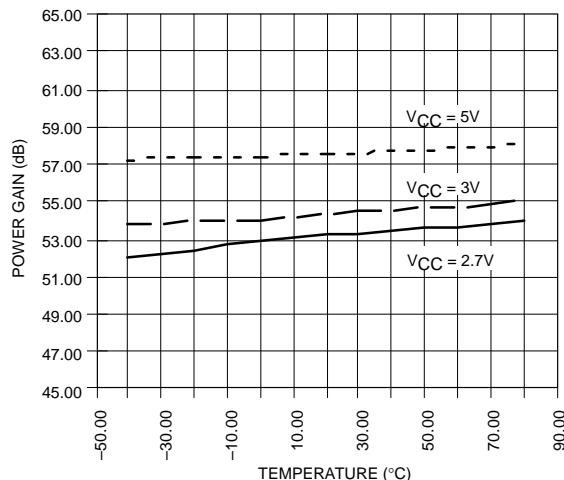
Figure 4. Performance Characteristics

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

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SA626 IF Amplifier Gain vs Temperature vs Supply Voltage



SA626 Limiting Amplifier Gain vs Temperature vs Supply Voltage

SR00474

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.

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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 _{CC}	+3.00		10	QUAD. IN	+3.00	

Figure 6. Pin Functions

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SA626

PIN FUNCTIONS (continued)

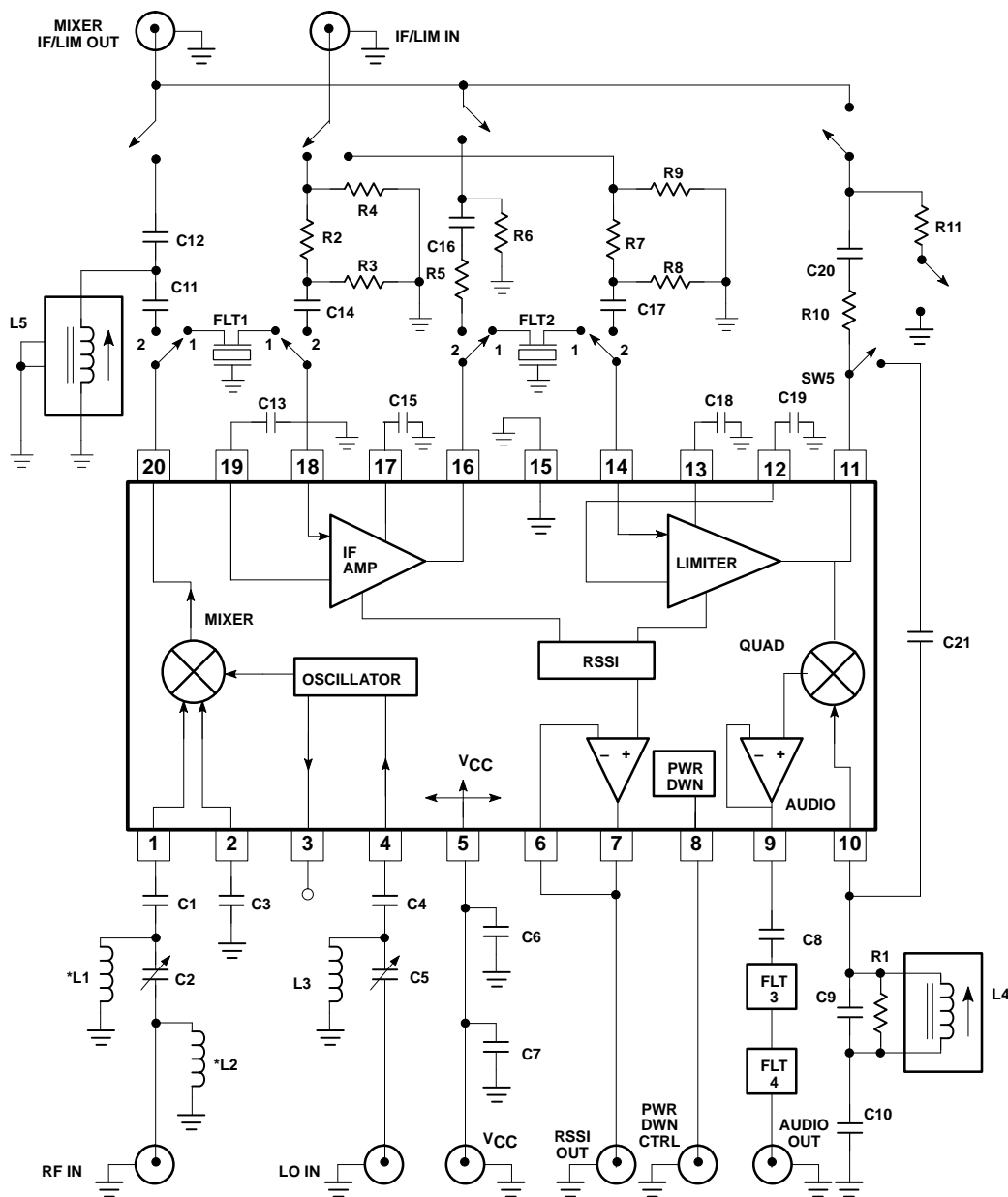
PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT	PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT
11	LIMITER OUT	+1.35		16	IF AMP OUT	+1.22	
12	LIMITER DECOUP	+1.23		17	IF AMP DECOUP	+1.22	
13	LIMITER COUPLING	+1.23		18	IF AMP IN	+1.22	
14	LIMITER IN	+1.23		19	IF AMP DECOUP	+1.22	
15	GND	0		20	MIXER OUT	+1.03	

SR00476

Figure 7. Pin Functions (cont.)

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Automatic Test Circuit Component List

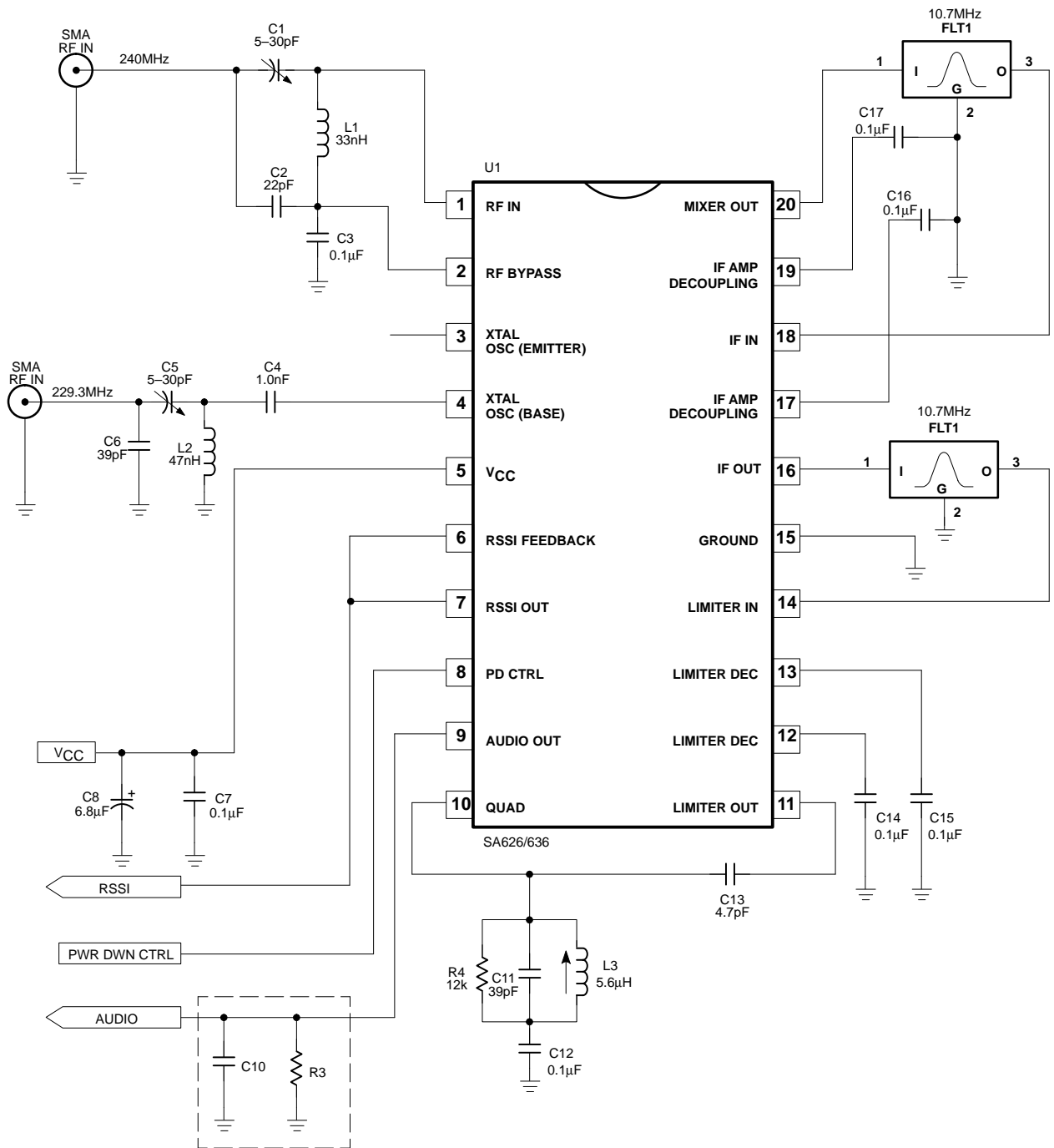
R1 8.2kΩ select	C1 0.1μF	C12 160pF select	L1 150nH select for input match
R2 6.42kΩ	C2 1–5pF select for input match	C13 1000pF	L2 22nH select for input match
R3 347.8Ω	C3 0.1μF	C14 0.1μF	L3 47nH select for input match
R4 49.9Ω	C4 0.1μF	C15 1000pF	L4 5.6μH select for input match
R5 1kΩ	C5 1–5pF select for input match	C16 0.1μF	L5 1.27–2.25μH select for mixer output match
R6 49.9Ω	C6 100pF	C17 0.1μF	
R7 6.42kΩ	*C7 6.8μF 10V	C18 1000pF	
R8 347.8Ω	C8 1μF	C19 1000pF	FLT1 10.7MHz (Murata SFE10.7MA5-A)
R9 49.9Ω	C9 39pF select	C20 0.1μF	FLT2 10.7MHz (Murata SFE10.7MA5-A)
R10 1kΩ	C10 0.1μF	C21 1pF	FLT3 "C" message weighted
R11 49.9Ω	C11 0.1μF		FLT4 Active de-emphasis

*NOTE: This value can be reduced when a battery is the power source.

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

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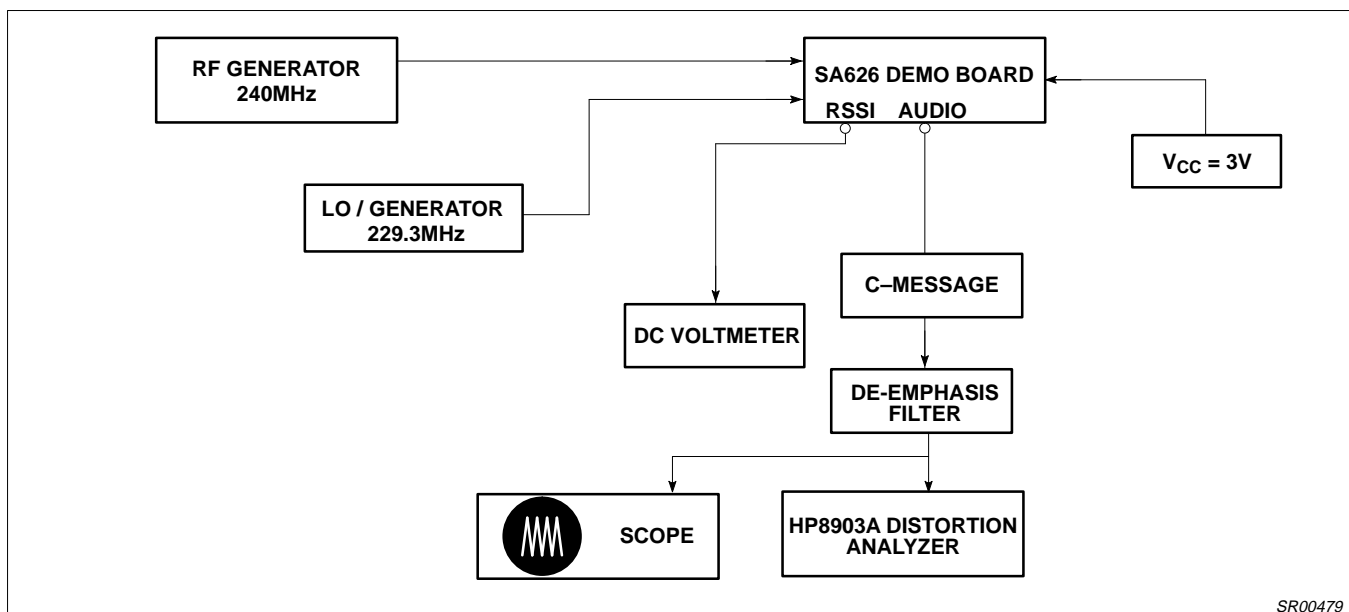
NOTE: For SA626 C10 and R3 are not required.

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

SR00478

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

SA626



SR00479

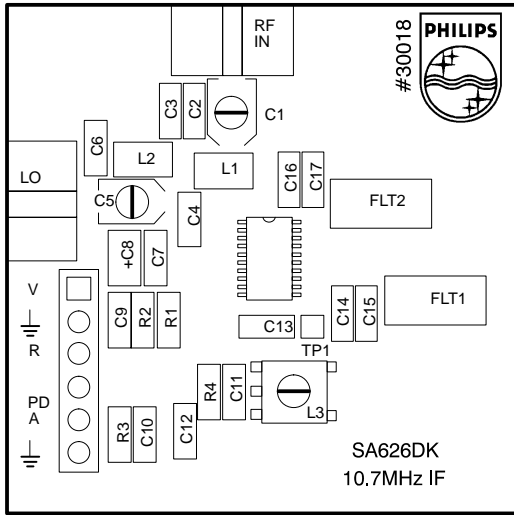
Figure 10. SA626 Application Circuit Test Set Up

NOTES:

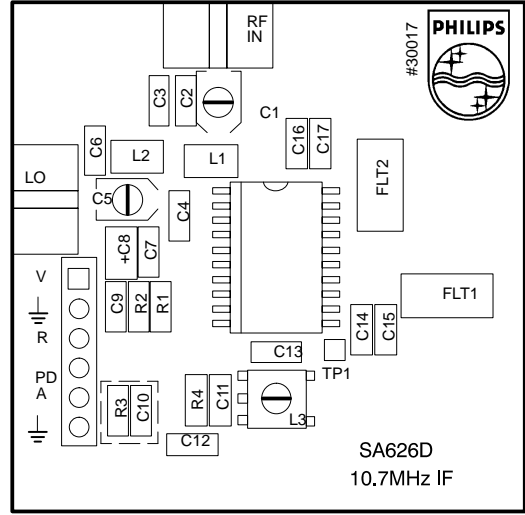
1. C-message: The C-message and de-emphasis filter combination has a peak gain of 10 for accurate measurements. Without the gain, the measurements may be affected by the noise of the scope and HP8903A analyzer. The de-emphasis filter has a fixed -6dB/Octave slope between 300Hz and 3kHz.
2. Ceramic filters: 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 μ V or -112dBm 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 μ F bypass capacitor on the supply pin improves sensitivity.

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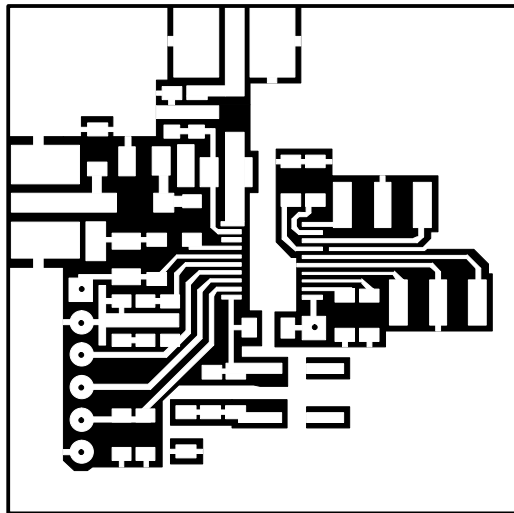
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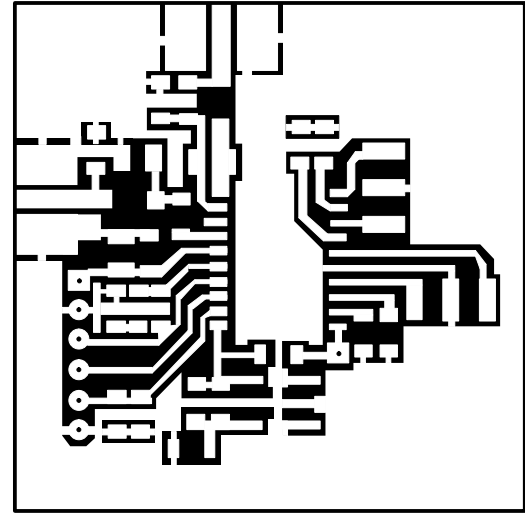
TOP SILK SCREEN (SSOP)



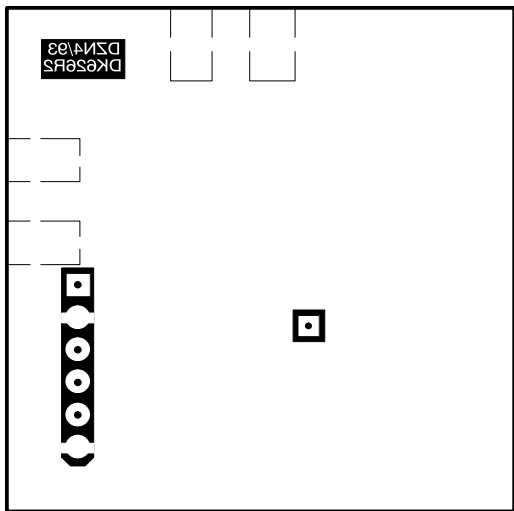
TOP SILK SCREEN (SOL)



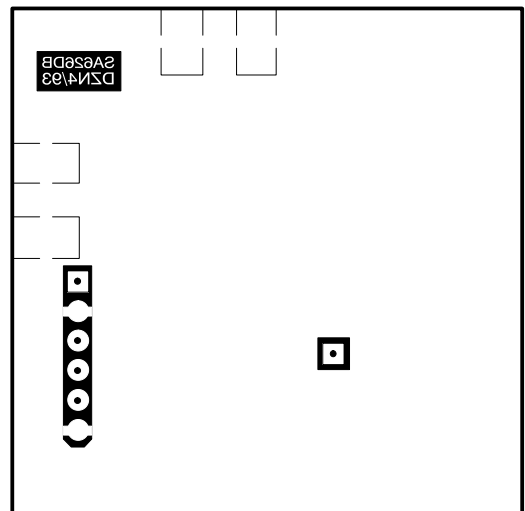
TOP VIEW (SSOP)



TOP VIEW (SOL)



BOTTOM VIEW (SSOP)



BOTTOM VIEW (SOL)

Figure 11. SA626 Demoboard Layout (Not Actual Size)

SR00480