DATA SHEET

SA636

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

Product specification
Replaces data of 1994 Jun 16
IC17 Data Handbook

1997 Nov 07

PHILIPS

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

SA636

DESCRIPTION

The SA636 is a low-voltage high performance monolithic FM IF system with high-speed RSSI incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, logarithmic received signal strength indicator (RSSI), voltage regulator, wideband data output and fast RSSI op amps. The SA636 is available in 20-lead SSOP (shrink small outline package).

The SA636 was designed for high bandwidth portable communication applications and will function down to 2.7V. The RF section is similar to the famous SA605. The data output has a minimum bandwidth of 600kHz. This is designed to demodulate wideband data. The RSSI output is amplified. The RSSI output has access to the feedback pin. This enables the designer to adjust the level of the outputs or add filtering.

SA636 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

- DECT (Digital European Cordless Telephone)
- Digital cordless telephones
- Digital cellular telephones
- Portable high performance communications receivers
- Single conversion VHF/UHF receivers
- FSK and ASK data receivers
- Wireless LANs

FEATURES

- Wideband data output (600kHz min.)
- Fast RSSI rise and fall times
- Low power consumption: 6.5mA typ at 3V
- Mixer input to >500MHz
- Mixer conversion power gain of 11dB at 240MHz
- Mixer noise figure of 12dB at 240MHz

PIN CONFIGURATION

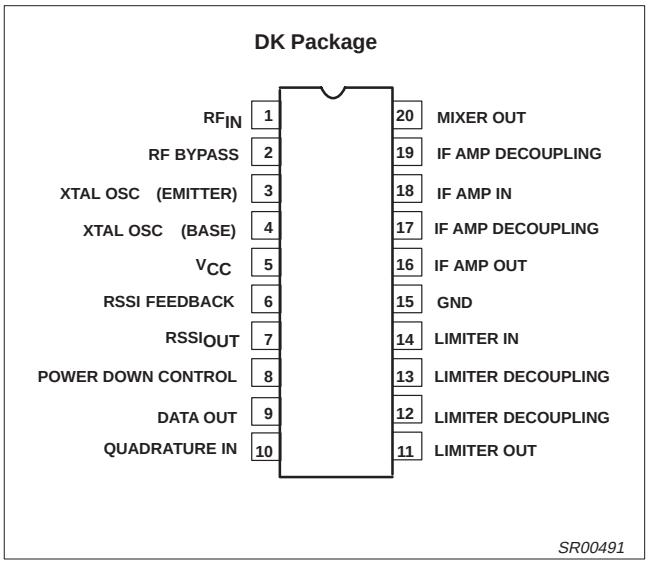


Figure 1. Pin Configuration

- XTAL oscillator effective to 150MHz (L.C. oscillator to 1GHz local oscillator can be injected)
- 92dB of IF Amp/Limiter gain
- 25MHz limiter small signal bandwidth
- Temperature compensated logarithmic Received Signal Strength Indicator (RSSI) with a dynamic range in excess of 90dB
- RSSI output internal op amp
- Internal op amps with rail-to-rail outputs
- Low 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
- ESD hardened
- 10.7MHz filter matching (330Ω)
- Power down mode (I_{CC} = 200µA)

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
20-Pin Plastic Shrink Small Outline Package (Surface-mount)	-40 to +85°C	SA636DK	SOT266-1

BLOCK DIAGRAM

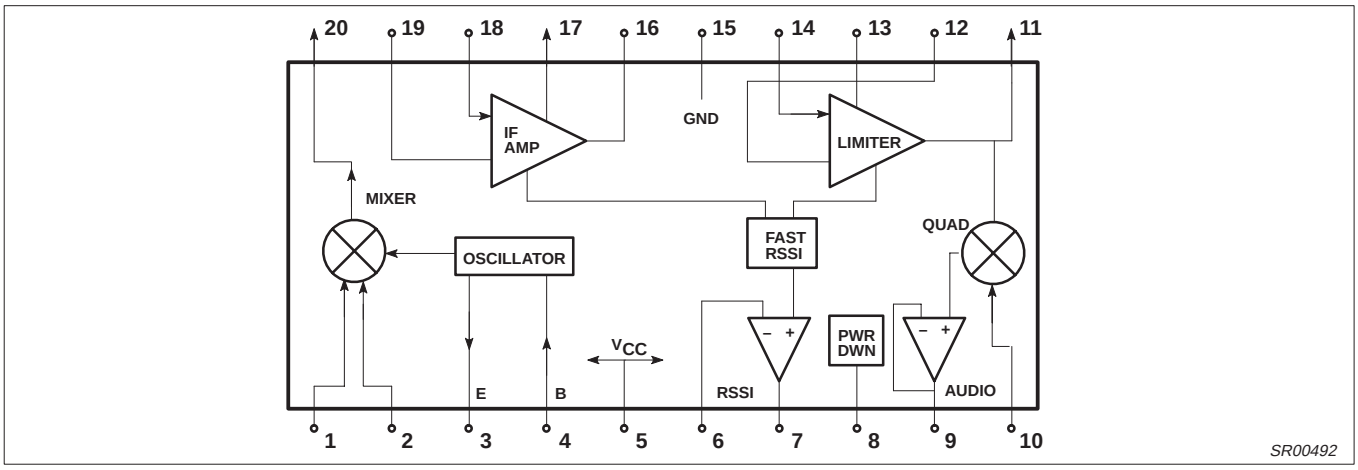


Figure 2. Block Diagram

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 SA636	–40 to +85	°C

NOTE: θ_{JA}, Thermal impedance DK package 117°C/W

DC ELECTRICAL CHARACTERISTICS

V_{CC} = +3V, T_A = 25°C; unless otherwise stated.

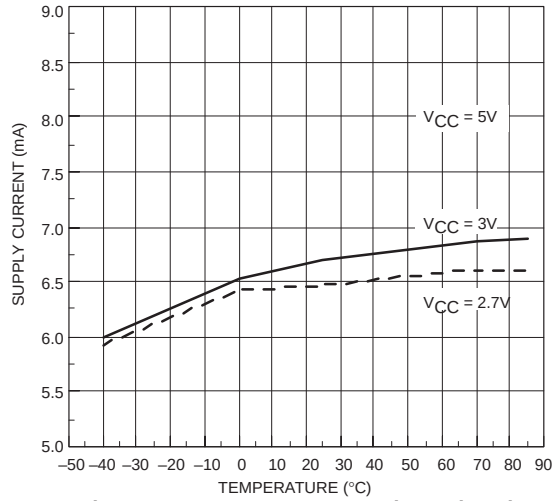
SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			SA636			
			MIN	TYP	MAX	
V_{CC}	Power supply voltage range		2.7	3.0	5.5	V
I_{CC}	DC current drain	Pin 8 = HIGH	5.5	6.5	7.5	mA
	Input current	Pin 8 LOW	–10		10	µA
		Pin 8 HIGH	–10		10	
	Input level	Pin 8 LOW	0		$0.3V_{CC}$	V
		Pin 8 HIGH	$0.7V_{CC}$		V_{CC}	
I_{CC}	Standby	Pin 8 = LOW		0.2	0.5	mA
t_{ON}	Power up time	RSSI valid (10% to 90%)		10		µs
t_{OFF}	Power down time	RSSI invalid (90% to 10%)		5		µs

AC ELECTRICAL CHARACTERISTICS

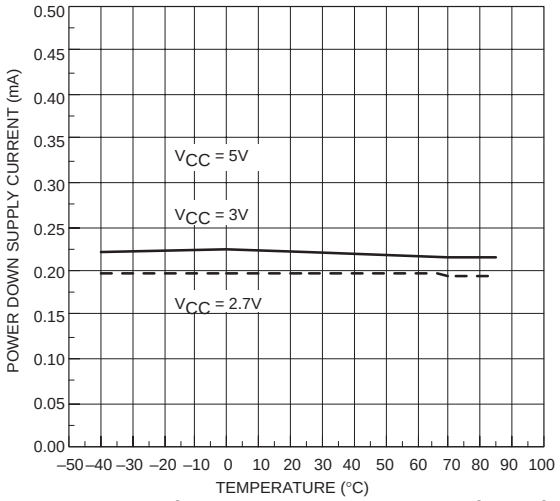
T_A = 25°C; V_{CC} = +3V, unless otherwise stated. RF frequency = 240.05MHz + 14.5dBV RF input step-up; IF frequency = 10.7MHz; RF level = -45dBm; FM modulation = 1kHz with ±125kHz peak deviation. Audio output with C-message weighted filter and de-emphasis capacitor. Test circuit Figure 1. The parameters 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
			SA636			
			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			12		dB
	Third-order input intercept point	Matched f1=240.05; f2=240.35MHz		-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 gain	330Ω load		38		dB
	Limiter gain	330Ω load		54		dB
	Input limiting -3dB	Test at Pin 18		–105		dBm
	AM rejection	80% AM 1kHz		50		dB
	Data level	R_{LOAD} = 100kΩ	120	130		mV$_{RMS}$
	3dB data bandwidth		600	700		kHz
	SINAD sensitivity	RF 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	IF frequency = 10.7MHz				
	(10kHz pulse, no 10.7MHz filter)	RF level = -56dBm		1.2		µs
	(no RSSI bypass capacitor)	RF level = -28dBm		1.1		µs
	IF RSSI output fall time	IF frequency = 10.7MHz				
	(10kHz pulse, no 10.7MHz filter)	RF level = -56dBm		2.0		µs
	(no RSSI bypass capacitor)	RF level = -28dBm		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)						
	System RSSI output	RF level = -10dBm		1.4		V
	System SINAD	RF level = -106dBm		12		dB

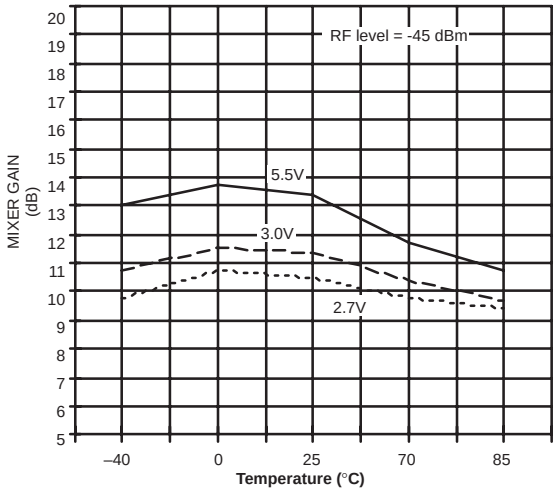
PERFORMANCE CHARACTERISTICS



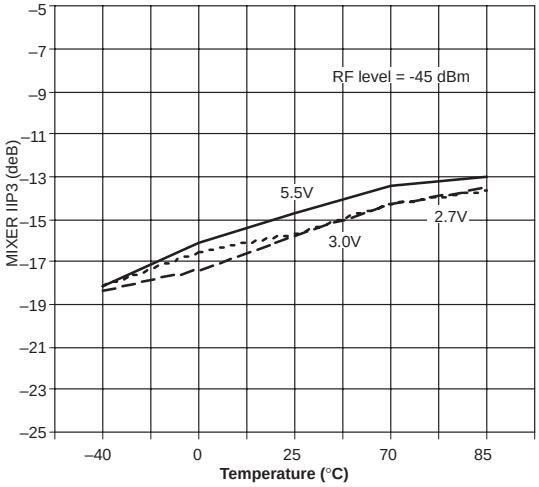
Supply Current vs Temperature and Supply Voltage



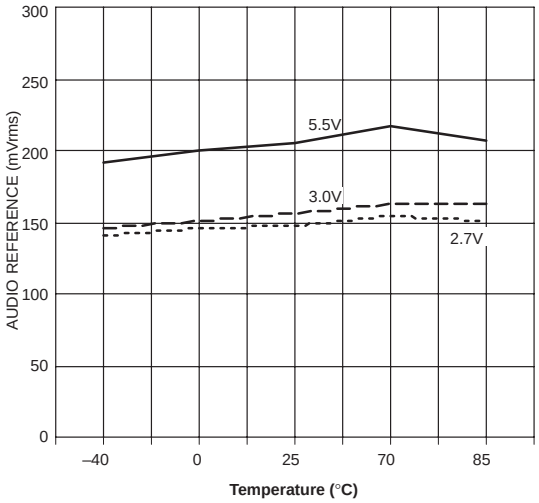
Power Down Supply Current vs Temperature and Supply Voltage



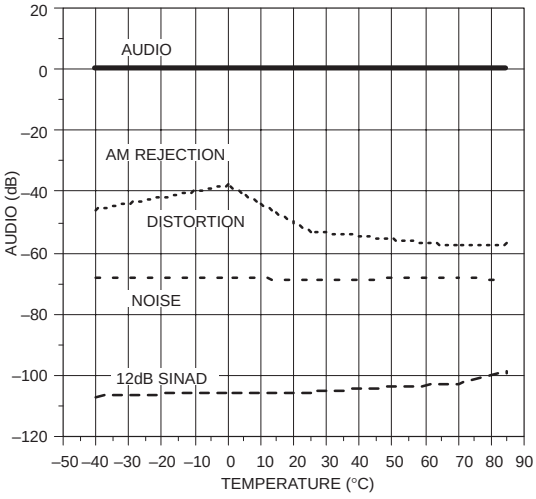
Mixer Power Gain vs Temperature and Supply Voltage



Mixer IIP3 at 240MHz vs Temperature and Supply Voltage



Audio Reference Level vs Temperature and Supply Voltage

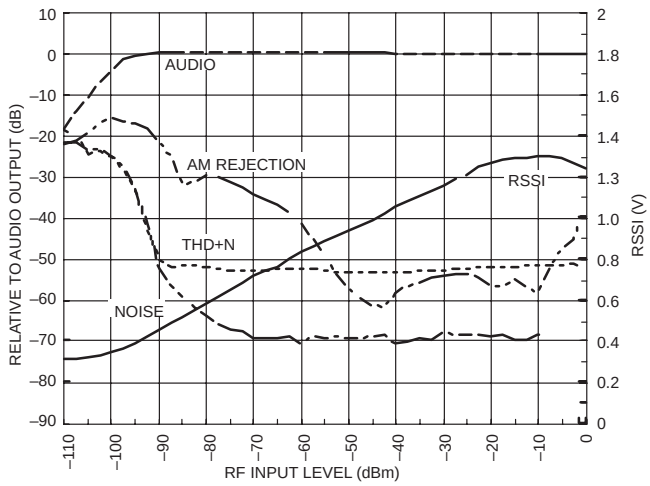


12dB SINAD and Relative Audio, THD, Noise and AM Rejection for VCC = 3V vs Temperature RF = 240MHz, Level = –68dBm, Deviation = 125kHz

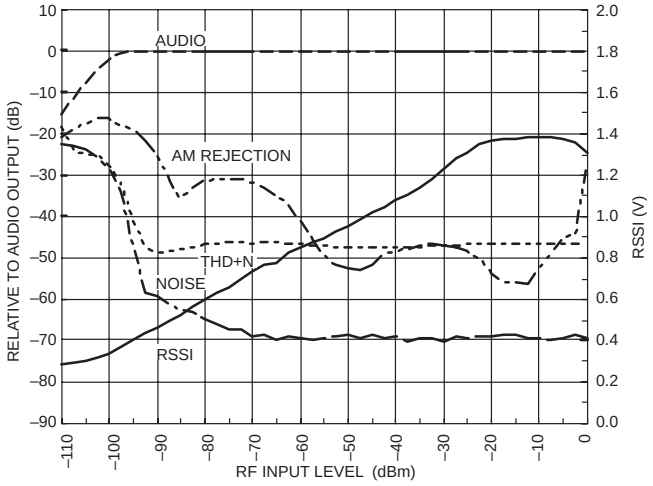
SR00493

Figure 3. Performance Characteristics

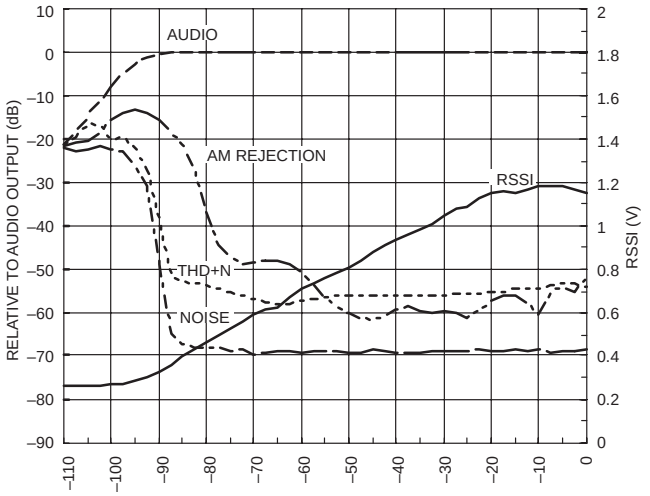
PERFORMANCE CHARACTERISTICS (continued)



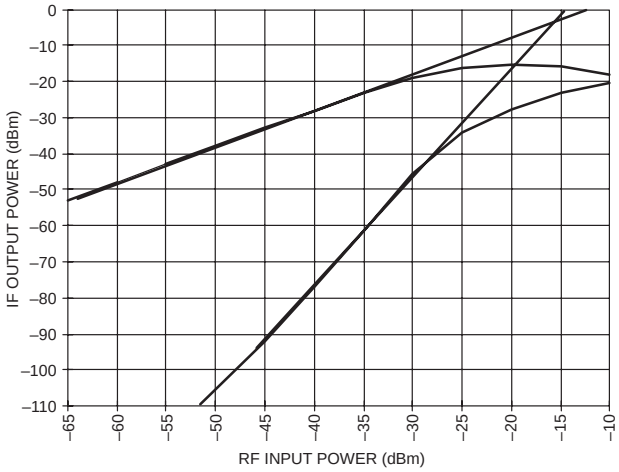
Receiver RF Performance — T = 25°C, Audio Level = 129mV$_{RMS}$



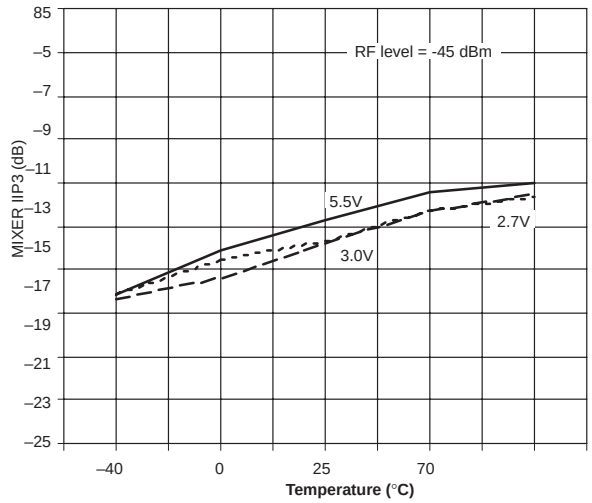
Receiver RF Performance — T = –40°C, Audio Level = 118mV$_{RMS}$



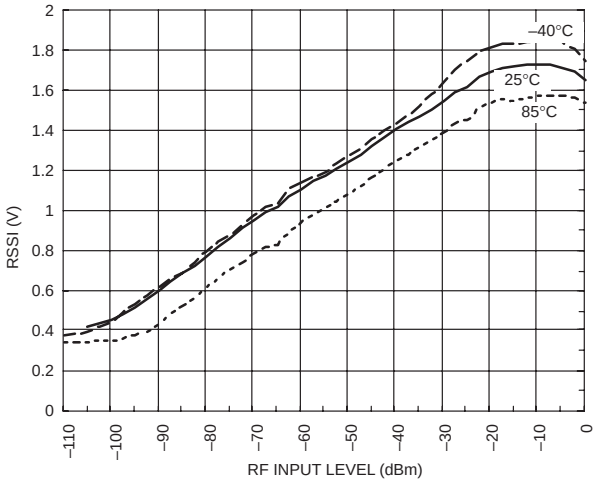
Receiver RF Performance – T = 85°C, Audio Level = 131mV$_{RMS}$



Mixer Third Order Intercept and Compression



Mixer IIP3 at 240MHz vs Temperature and Supply Voltage



RSSI vs RF Input Level and Temperature

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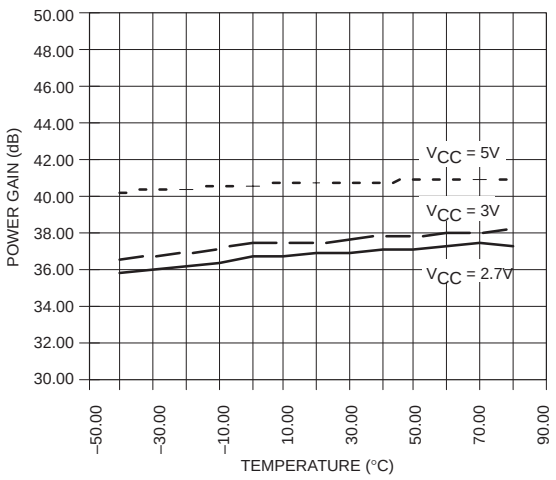
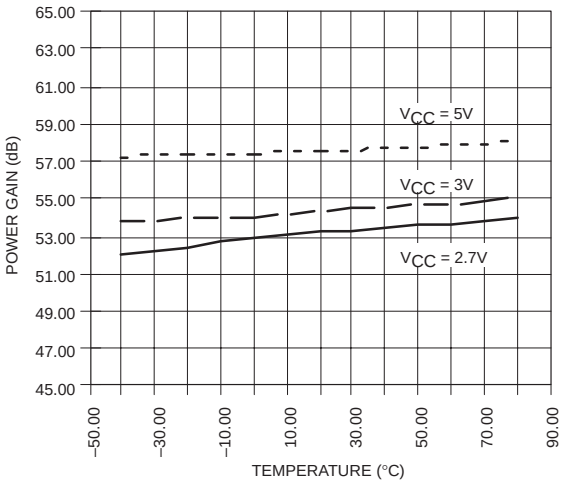
Figure 4. Performance Characteristics

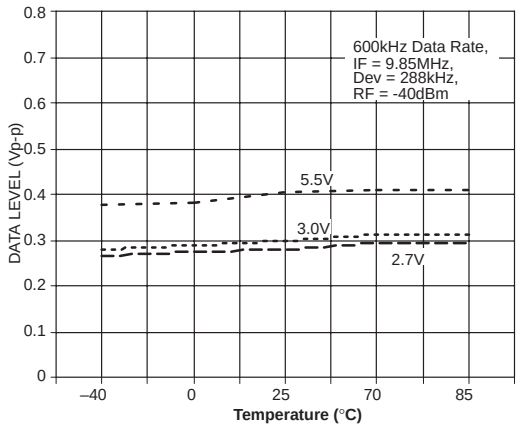
PERFORMANCE CHARACTERISTICS (continued)



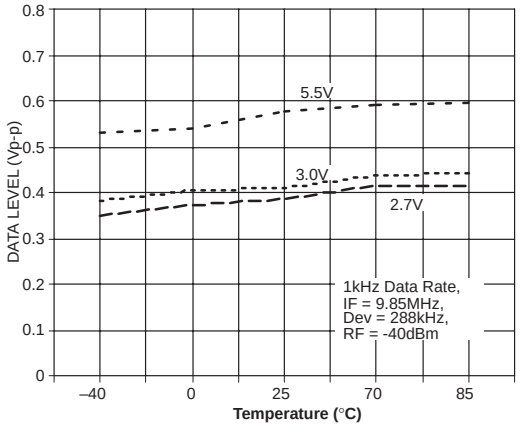
SA626 IF Amplifier Gain vs Temperature vs Supply Voltage



SA626 Limiting Amplifier Gain vs Temperature vs Supply Voltage



Data Level vs Temperature and Supply Voltage

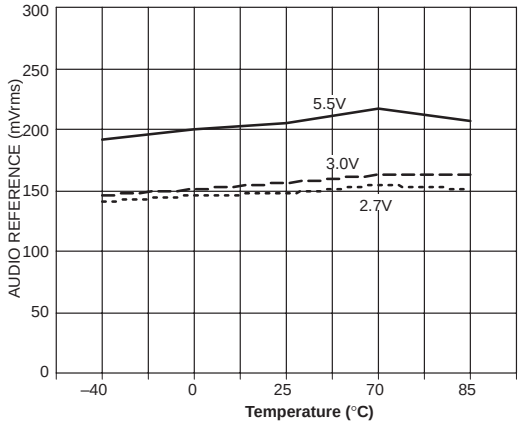


Data Level vs Temperature and Supply Voltage

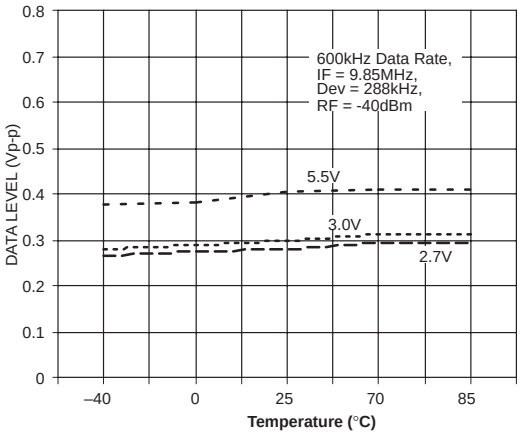
SR00495

Figure 5. Performance Characteristics

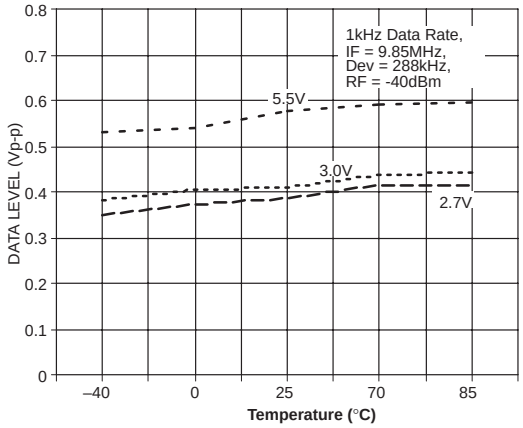
PERFORMANCE CHARACTERISTICS (continued)



Audio Reference Level vs Temperature and Supply Voltage



Data Level vs Temperature and Supply Voltage

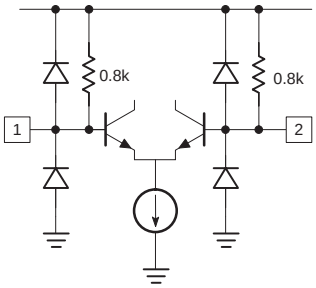
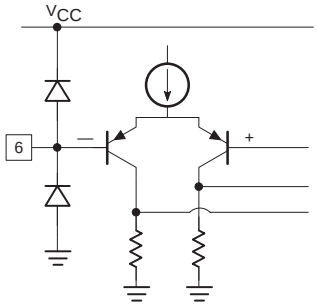
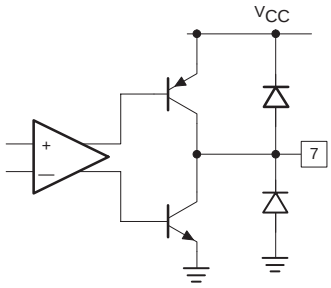
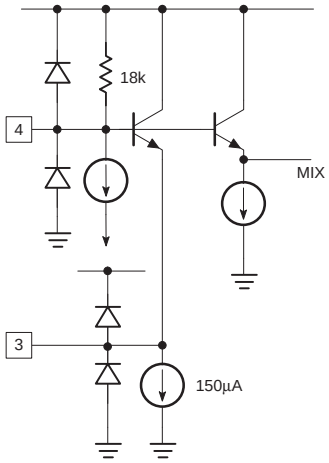
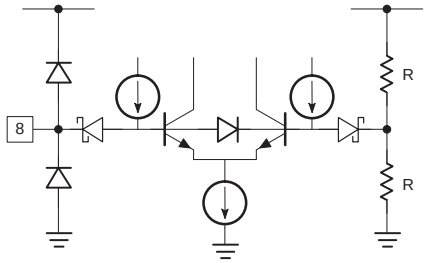
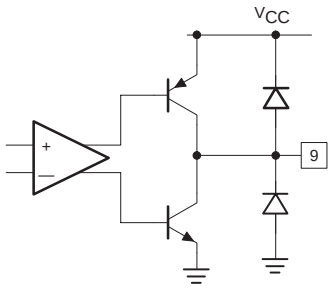
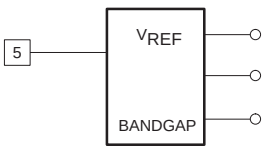
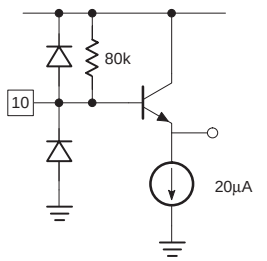


Data Level vs Temperature and Supply Voltage

SR00496

Figure 6. Performance Characteristics

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	DATA OUT	+1.09	
5	V_{CC}	+3.00		10	QUAD. IN	+3.00	

SR00497

Figure 7. Pin Functions

PIN FUNCTIONS (continued)

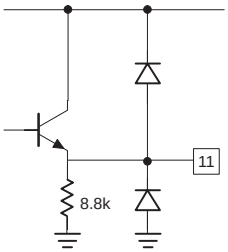
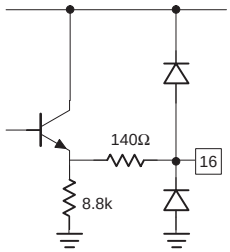
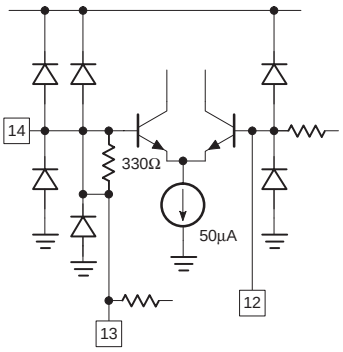
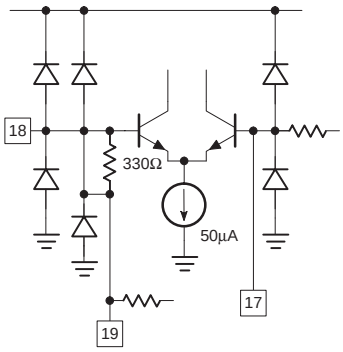
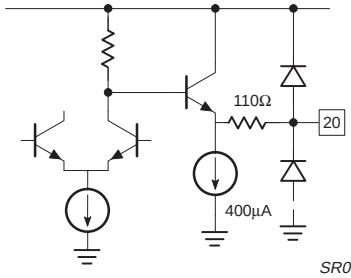
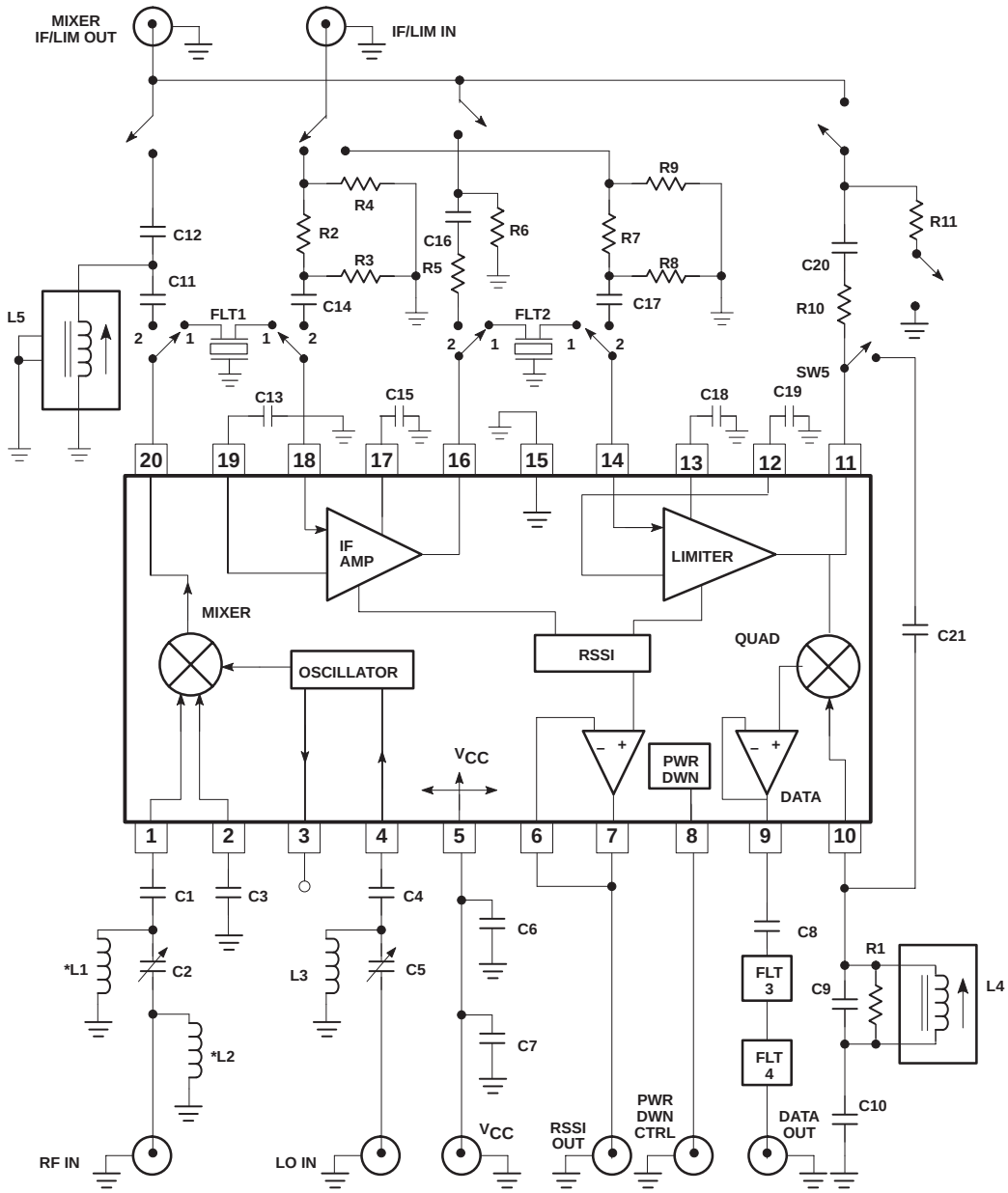
PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT	PIN No.	PIN MNEMONIC	DC V	EQUIVALENT CIRCUIT
11	LIMITER OUT	+1.35		16	IF AMP OUT	+1.22	
12	LIMITER DECOUP	+1.23		17	IF AMP DECOUP	+1.22	
13	LIMITER COUPLING	+1.23		18	IF AMP IN	+1.22	
14	LIMITER IN	+1.23		19	IF AMP DECOUP	+1.22	
15	GND	0		20	MIXER OUT	+1.03	

Figure 8. Pin Functions (cont.)



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	FLT1	10.7MHz (Murata SFE10.7MA5-A)
R8	347.8Ω	C8	1μF	C19	1000pF	FLT2	10.7MHz (Murata SFE10.7MA5-A)
R9	49.9Ω	C9	39pF select	C20	0.1μF	FLT3	"C" message weighted
R10	1kΩ	C10	0.1μF	C21	1pF	FLT4	Active de-emphasis
R11	49.9Ω	C11	0.1μF				

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

SR00501

Figure 9. SA636 240.05MHz (RF) / 10.7MHz (IF) Test Circuit

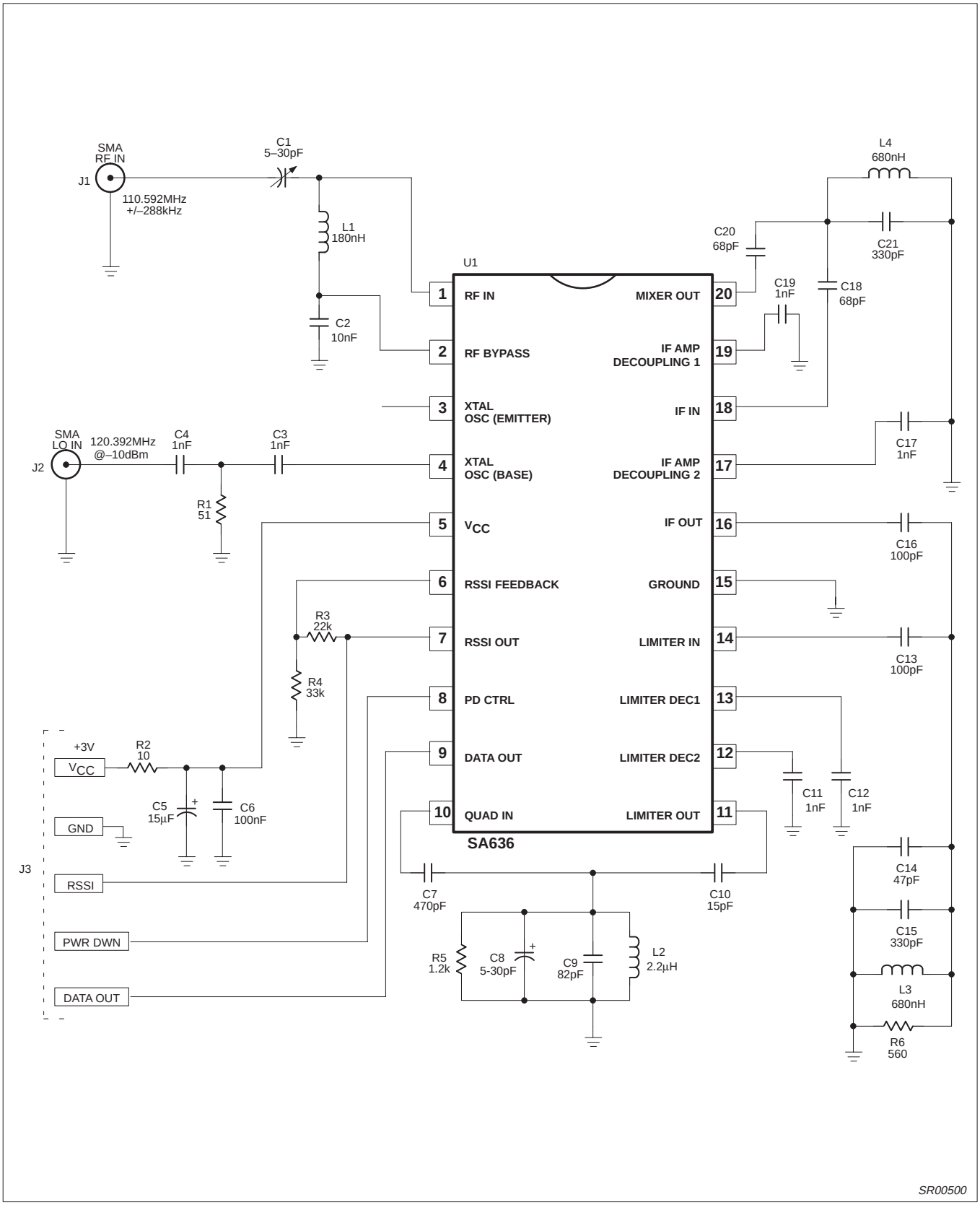


Figure 10. SA636 110.592MHz (RF) / 9.8MHz (IF) DECT Application Circuit

Table 1. DECT Application Circuit Electrical Characteristics

RF frequency = 110.592MHz; IF frequency = 9.8MHz; RF level = -45dBm; FM modulation = 100kHz with ±288kHz peak deviation.

SYMBOL	PARAMETER	TEST CONDITIONS	TYPICAL	UNITS
Mixer/Osc section (ext LO = 160mV$_{RMS}$)				
PG	Conversion power gain		13	dB
NF	Noise Figure at 110MHz		12	dB
IIP3	Third order input intercept	Matched f1 = 110.592; f2 = 110.892MHz	-15	dBm
R_{IN}	RF input resistance		690	Ω
C_{IN}	RF input capacitance		3.6	pF
IF section				
	IF amp gain	330Ω load	38	dB
	Limiter amp gain	330Ω load	54	dB
	Data level	R_{LOAD} = 3kΩ	130	mV$_{RMS}$
	3dB data bandwidth		700	kHz
RF/IF section (internal LO)				
	System RSSI output	RF level = -10dBm	1.4	V
	System S/N[1]	RF level = -83dBm	10	dB

NOTE:
1. 10dB S/N corresponds to BER = 10^{-3}.

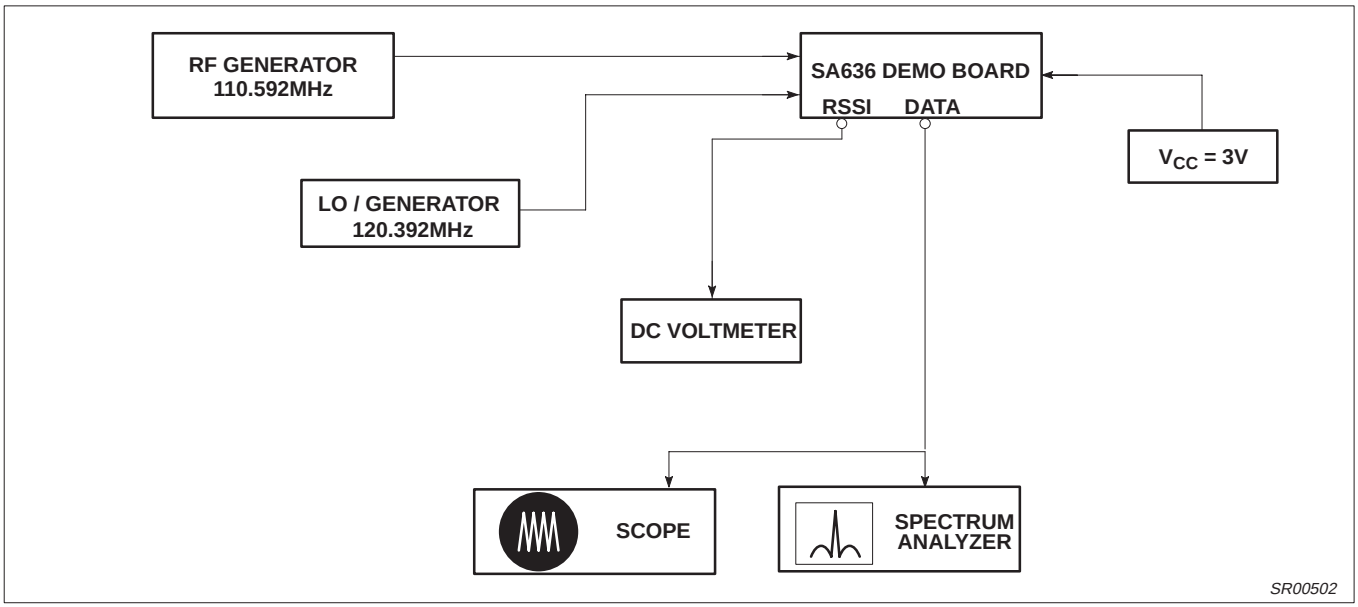
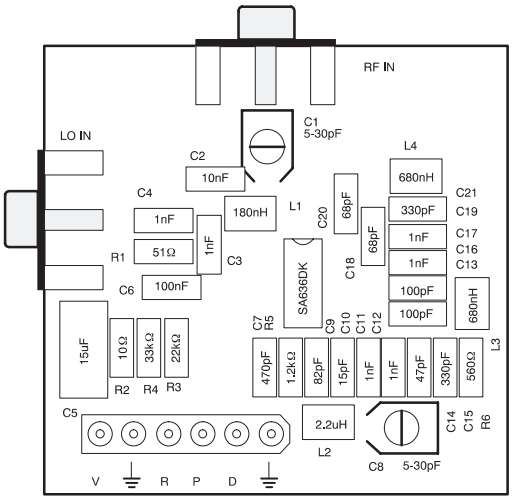
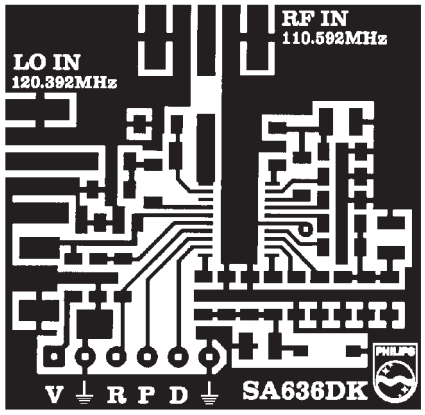


Figure 11. SA636 Application Circuit Test Set Up

NOTES:
1. RF generator: Set your RF generator at 110.592MHz, use a 100kHz modulation frequency and a ±288kHz deviation.
2. Layout: The layout is very critical in the performance of the receiver. We highly recommend our demo board layout.
3. 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.
4. Supply bypass and shielding: All of the inductors, the quad tank, and their shield must be grounded. A 0.1µF bypass capacitor on the supply pin improves sensitivity.



TOP SILK SCREEN (SSOP)



TOP VIEW (SSOP)

BOTTOM VIEW (SSOP)

SR00503

Figure 12. SA636 Demoboard Layout (Not Actual Size)

CIRCUIT DESCRIPTION

The SA636 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 gain from a 50Ω source. The bandwidth of the limiter is about 28MHz with about 54dB of 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 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 for narrowband applications. 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. For applications requiring wideband IF filtering, such as DECT, external LC filters are used (see Figure 10). To achieve optimum linearity of the log signal strength indicator, there must be a 6dB(v) insertion loss between the first and second IF stages. If the IF filter or interstage network does not cause 6dB(v) 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^{o} phase relationship to the internal signal, drives the other port of the multiplier cell.

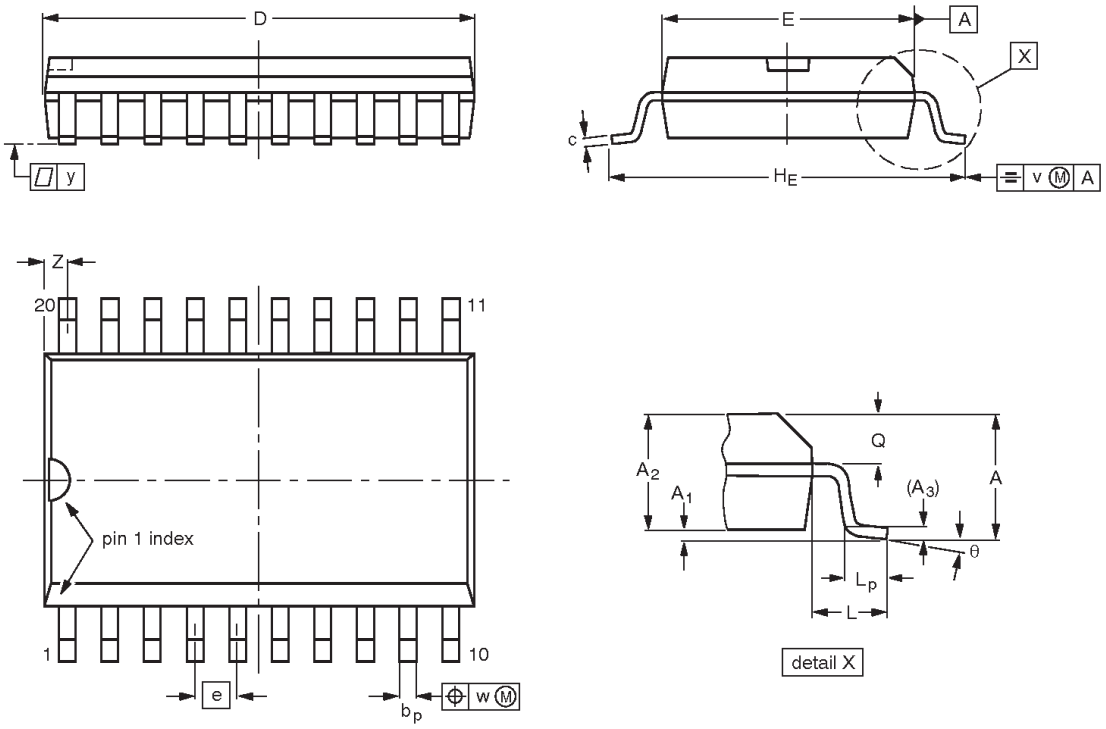
Overall, the IF section has a gain of 90dB. For operation at intermediate frequency at 10.7MHz. Special care must be given to layout, termination, and interstage loss to avoid instability.

The demodulated output (DATA) of the quadrature is a voltage output. This output is designed to handle a minimum bandwidth of 600kHz. This is designed to demodulate wideband data, such as in DECT applications.

A Receive Signal Strength Indicator (RSSI) 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, DECT 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.

NOTE: $dB(v) = 20\log V_{OUT}/V_{IN}$

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_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
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^o 0^o
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

DEFINITIONS

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