DATA SHEET

SA627

High performance low power FM IF system with high-speed RSSI

Product specification
Replaces data of November 3, 1992
RF Communications Handbook

1997 Nov 07

PHILIPS

High performance low power mixer FM IF system with high-speed RSSI

SA627

DESCRIPTION

The SA627 has faster RSSI rise and fall times. The SA627 is a high performance monolithic low-power FM IF system incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, muting, logarithmic received signal strength indicator (RSSI) with fast rise and fall time, voltage regulator and frequency check/limiter out (–). The SA627 also has an extra limiter output. This signal is buffered from the output of the limiter and provides a negative (–) limiter output. This can be used to provide a frequency check function. The SA627 is available in 20-lead SOL (surface-mounted miniature package) and 20-lead SSOP (shrink small outline package).

FEATURES

- Fast RSSI rise and fall times
- Low power consumption: 5.8mA typical at 6V
- Mixer input to >500MHz
- Mixer conversion power gain of 13dB at 45MHz
- Mixer noise figure of 4.6dB at 45MHz
- XTAL oscillator effective to 150MHz (L.C. oscillator to 1GHz local oscillator can be injected)
- 102dB 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
- Audio output - mutable
- Low external component count; suitable for crystal/ceramic/LC filters
- Excellent sensitivity: 0.22µV into 50Ω matching network for 12dB SINAD (Signal to Noise and Distortion ratio) for 1kHz tone, 8kHz deviation with RF at 45MHz and IF at 455kHz
- SA627 meets cellular radio specifications
- ESD hardened

PIN CONFIGURATION

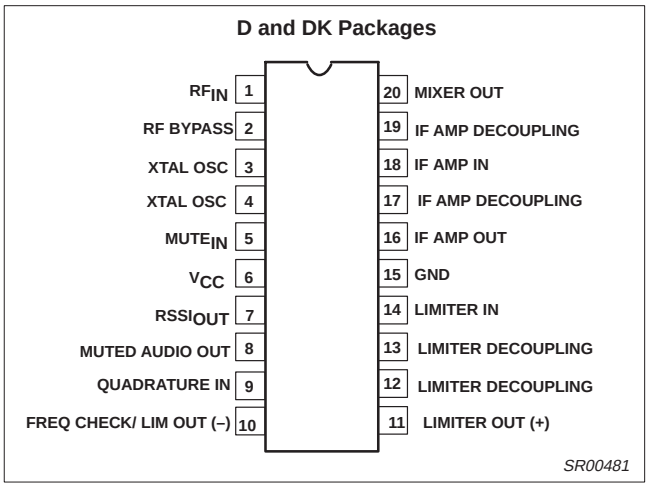


Figure 1. Pin Configuration

APPLICATIONS

- Digital cellular base stations
- 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
- Digital cordless telephones

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
20-Pin Plastic Small Outline Large (SOL) package (Surface-mount)	-40 to +85°C	SA627D	SOT163-1
20-Pin Plastic Shrink Small Outline Package (SSOP) (Surface-mount)	-40 to +85°C	SA627DK	SOT266-1

BLOCK DIAGRAM

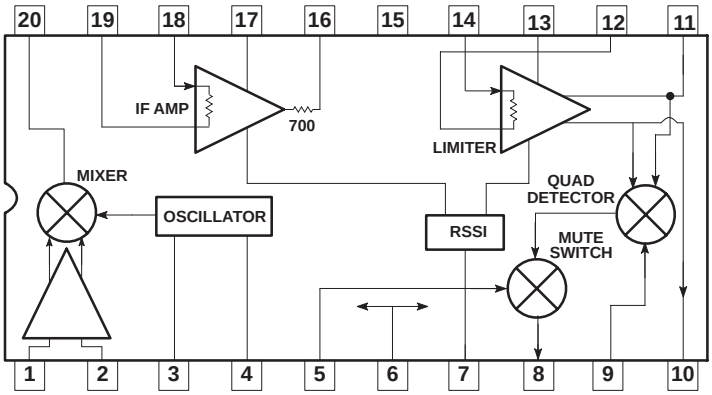


Figure 2. Block Diagram

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNITS
V_{CC}	Single supply voltage	9	V
T_{STG}	Storage temperature range	-65 to +150	°C
T_A	Operating ambient temperature range SA627	-40 to +85	°C
θ_{JA}	Thermal impedance D package	90	°C/W
	DK package	117	°C/W

DC ELECTRICAL CHARACTERISTICS

V_{CC} = +6V, T_A = 25°C; unless otherwise stated.

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			SA627			
			MIN	TYP	MAX	
V_{CC}	Power supply voltage range		4.5		8.0	V
I_{CC}	DC current drain		4.55	5.8	6.75	mA
	Mute switch input threshold (ON)		1.7			V
	(OFF)				1.0	V

AC ELECTRICAL CHARACTERISTICS

T_A = 25°C; V_{CC} = +6V, unless otherwise stated. RF frequency = 45MHz + 14.5dBV RF input step-up; IF frequency = 455kHz; R17 = 5.1k; RF level = -45dBm; FM modulation = 1kHz with ±8kHz peak deviation. Audio output with C-message weighted filter and de-emphasis capacitor. Test circuit Figure 3. The parameters listed below are tested using automatic test equipment to assure consistent electrical characterristics. 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
			SA627			
			MIN	TYP	MAX	
Mixer/Osc section (ext LO = 300mV)						
f_{IN}	Input signal frequency			500		MHz
f_{OSC}	Crystal oscillator frequency			150		MHz
	Noise figure at 45MHz			5.0		dB
	Third-order input intercept point	f1 = 45.0; f2 = 45.06MHz		-10		dBm
	Conversion power gain	Matched 14.5dBV step-up	10	13	15	dB
		50Ω source		-1.7		dB
	RF input resistance	Single-ended input	3.0	4.7		kΩ
	RF input capacitance			3.5	4.0	pF
	Mixer output resistance	(Pin 20)	1.25	1.5		kΩ
IF section						
	IF amp gain	50Ω source		39.7		dB
	Limiter gain	50Ω source		62.5		dB
	Input limiting -3dB, R_{17} = 5.1k	Test at Pin 18		-113		dBm
	AM rejection	80% AM 1kHz	29	34	43	dB
	Audio level, R_{10} = 100k	15nF de-emphasis	80	150	260	mV_{RMS}
	SINAD sensitivity	RF level -118dB		16		dB
THD	Total harmonic distortion		-34	-42		dB
S/N	Signal-to-noise ratio	No modulation for noise		73		dB
	IF RSSI output, R_9 = 100kΩ[1]	IF level = -118dBm	0	160	650	mV
		IF level = -68dBm	1.9	2.5	3.1	V
		IF level = -18dBm	4.0	4.8	5.6	V
	IF RSSI output rise time (10kHz pulse, no 455kHz filter) (no RSSI bypass capacitor)	IF frequency = 455kHz				
		RF level = -56dBm		1.2		µs
		RF level = -28dBm		1.2		µs
		IF frequency = 10.7MHz				
		RF level = -56dBm		1.2		µs
		RF level = -28dBm		1.1		µs
	IF RSSI output fall time (10kHz pulse, no 455kHz filter) (no RSSI bypass capacitor)	IF frequency = 455kHz				
		RF level = -56dBm		2.1		µs
		RF level = -28dBm		7.6		µs
		IF frequency = 10.7MHz				
		RF level = -56dBm		2.0		µs
		RF level = -28dBm		7.3		µs
	RSSI range	R_9 = 100kΩ Pin 16		90		dB
	RSSI accuracy	R_9 = 100kΩ Pin 16		±1.5		dB
	IF input impedance		1.40	1.6		kΩ
	IF output impedance		0.85	1.0		kΩ
	Limiter input impedance		1.40	1.6		kΩ
	Limiter output impedance	Pin 10 or 11		300		Ω
	Limiter output level	Pin 10 or 11 with no load 3kΩ load (min)		280 250		mV_{RMS}

AC ELECTRICAL CHARACTERISTICS(Continued)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNITS
			SA627			
			MIN	TYP	MAX	
IF section (continued)						
	Muted audio output resistance			58		kΩ
RF/IF section (int LO)						
	System RSSI output	4.5V = V_{CC}, RF level = -27dBm		4.3		V

NOTE:
1. The generator source impedance is 50Ω, but the SA627 input impedance at Pin 18 is 1500Ω. As a result, IF level refers to the actual signal that enters the SA627 input (Pin 8) which is about 21dB less than the "available power" at the generator.

CIRCUIT DESCRIPTION

The SA627 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 39.7dB(v) of gain from a 50Ω source. The bandwidth of the limiter is about 28MHz with about 62.5dB(v) of gain from a 50Ω source. However, the gain/bandwidth distribution is optimized for 455kHz, 1.5kΩ source applications. The overall system is well-suited to battery operation as well as high performance and high quality products of all types.

The input stage is a Gilbert cell mixer with oscillator. Typical mixer characteristics include a noise figure of 5dB, conversion gain of 13dB, and input third-order intercept of -10dBm. 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 1.5kΩ resistor permitting direct connection to a 455kHz ceramic filter. The input resistance of the limiting IF amplifiers is also 1.5kΩ. With most 455kHz 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 12dB(v) insertion loss between the first and second IF stages. If the IF filter or interstage network does not cause 12dB(v) insertion loss, a fixed or variable resistor can be added between the first IF output (Pin 16) and the interstage network.

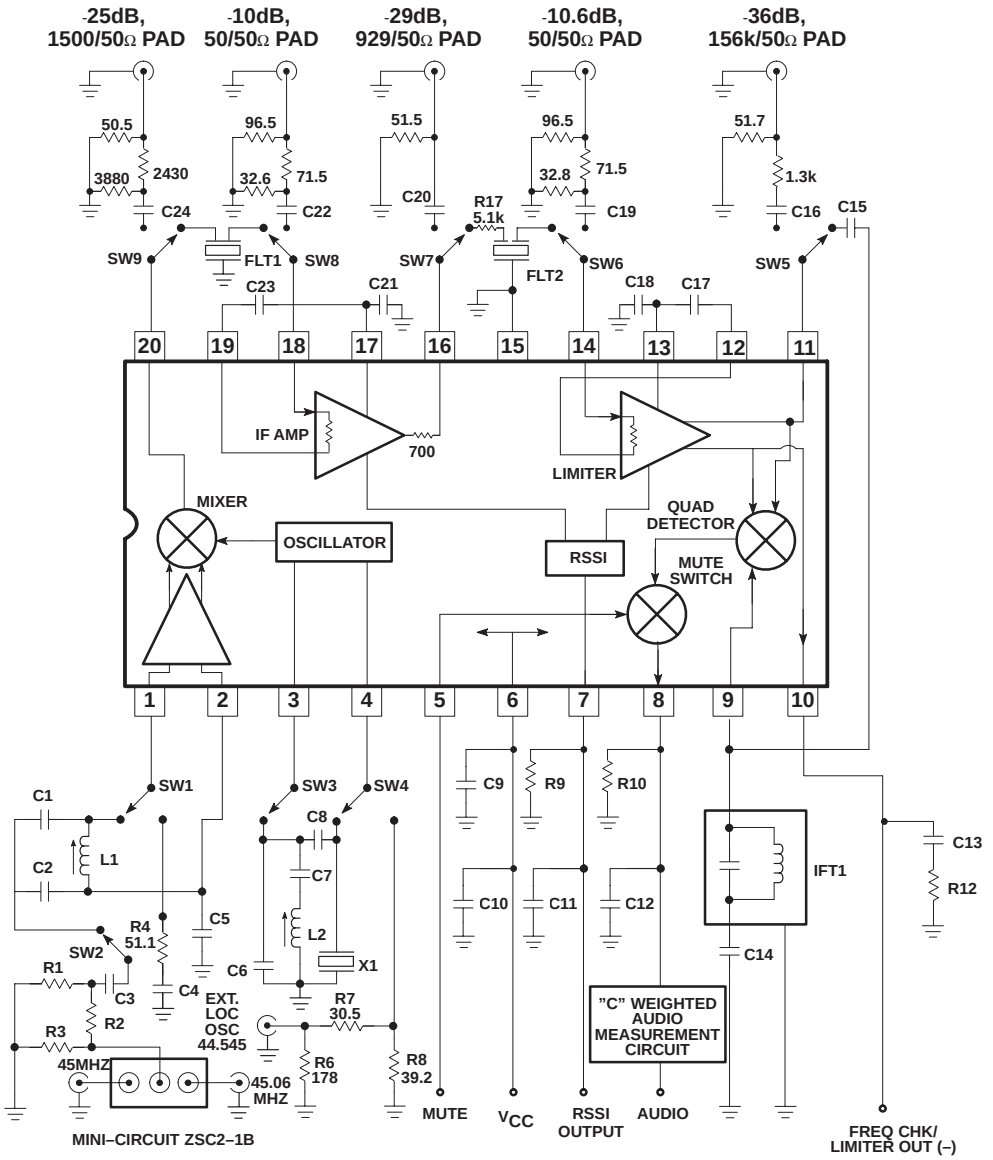
The signal from the second limiting amplifier goes to a Gilbert cell quadrature detector. One port of the Gilbert cell is internally driven by the IF. The other output of the IF is AC-coupled to a tuned quadrature network. This signal, which now has a 90° phase relationship to the internal signal, drives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

Overall, the IF section has a gain of 90dB. For operation at intermediate frequencies greater than 455kHz, special care must be given to layout, termination, and interstage loss to avoid instability.

The demodulated output of the quadrature detector is available at two pins, one continuous and one with a mute switch. Signal attenuation with the mute activated is greater than 60dB. The mute input is very high impedance and is compatible with CMOS or TTL levels.

A log signal strength 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.

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



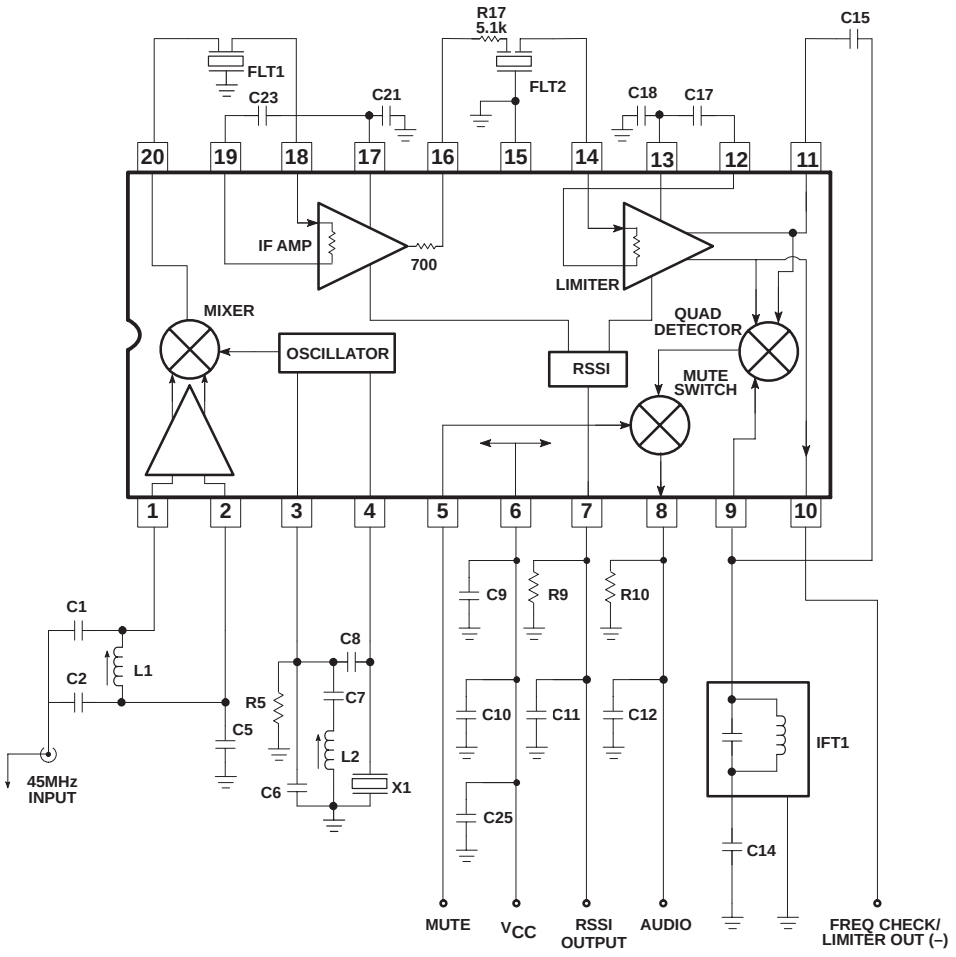
Automatic Test Circuit Component List

C1	100pF NPO Ceramic	C21	100nF ±10% Monolithic Ceramic
C2	390pF NPO Ceramic	C23	100nF ±10% Monolithic Ceramic
C5	100nF ±10% Monolithic Ceramic	C25	100nF ±10% Monolithic Ceramic
C6	22pF NPO Ceramic	Flt 1	Ceramic Filter Murata SFG455A3 or equiv
C7	1nF Ceramic	Flt 2	Ceramic Filter Murata SFG455A3 or equiv
C8	10.0pF NPO Ceramic	IFT 1	455kHz (Ce = 180pF) Toko RMC–2A6597H
C9	100nF ±10% Monolithic Ceramic	L1	147–160nH Coilcraft UNI–10/142–04J08S
C10	10μF Tantalum (minimum)	L2	0.8μH nominal Toko 292CNS–T1038Z
C11	100nF ±10% Monolithic Ceramic	X1	44.545MHz Crystal ICM4712701
C12	15nF ±10% Ceramic	R9	100k ±1% 1/4W Metal Film
C13	0.1μF ±10% Monolithic Ceramic	R17	5.1k ±5% 1/4W Carbon Composition
C14	100nF ±10% Monolithic Ceramic	R10	100k ±1% 1/4W Metal Film (optional)
C15	10pF NPO Ceramic	R11	100k ±1% 1/4W Metal Film (optional)
C17	100nF ±10% Monolithic Ceramic	R12	3kΩ ±5% 1/4W Metal Film (optional)
C18	100nF ±10% Monolithic Ceramic		

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

SR00483

Figure 3. SA627 45MHz Test Circuit (Relays as shown)



Application Component List

C1	100pF NPO Ceramic
C2	390pF NPO Ceramic
C5	100nF ±10% Monolithic Ceramic
C6	22pF NPO Ceramic
C7	1nF Ceramic
C8	10.0pF NPO Ceramic
C9	100nF ±10% Monolithic Ceramic
C10	10μF Tantalum (minimum) *
C11	100nF ±10% Monolithic Ceramic
C12	15nF ±10% Ceramic
C13	150pF ±2% N1500 Ceramic
C14	100nF ±10% Monolithic Ceramic
C15	10pF NPO Ceramic
C17	100nF ±10% Monolithic Ceramic
C18	100nF ±10% Monolithic Ceramic
C21	100nF ±10% Monolithic Ceramic
C23	100nF ±10% Monolithic Ceramic
C25	100nF ±10% Monolithic Ceramic
Flt 1	Ceramic Filter Murata SFG455A3 or equiv
Flt 2	Ceramic Filter Murata SFG455A3 or equiv
IFT 1	455kHz (Ce = 180pF) Toko RMC–2A6597H
L1	147–160nH Coilcraft UNI–10/142–04J08S
L2	0.8μH nominal Toko 292CNS–T1038Z
X1	44.545MHz Crystal ICM4712701
R9	100k ±1% 1/4W Metal Film
R17	5.1k ±5% 1/4W Carbon Composition
R5	Not Used in Application Board (see Note 8)
R10	100k ±1% 1/4W Metal Film (optional)
R11	100k ±1% 1/4W Metal Film (optional)

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

SR00484

Figure 4. SA627 45MHz Application Circuit

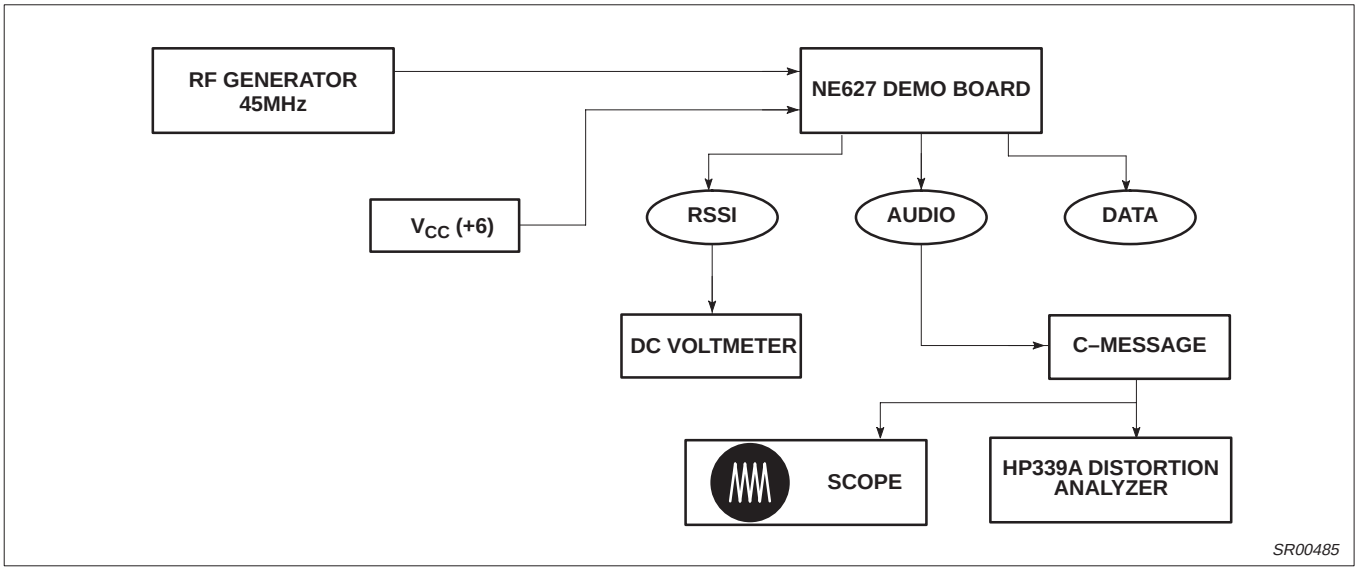


Figure 5. SA627 Application Circuit Test Set Up

NOTES:
1. C-message: The C-message filter has a peak gain of 100 for accurate measurements. Without the gain, the measurements may be affected by the noise of the scope and HP339 analyzer.
2. Ceramic filters: The ceramic filters can be 30kHz SFG455A3s made by Murata which have 30kHz IF bandwidth (they come in blue), or 16kHz CFU455Ds, also made by Murata (they come in black). All of our specifications and testing are done with the more wideband filter.
3. RF generator: Set your RF generator at 45.000MHz, use a 1kHz modulation frequency and a 6kHz deviation if you use 16kHz filters, or 8kHz if you use 30kHz filters.
4. Sensitivity: The measured typical sensitivity for 12dB SINAD should be 0.22µV or -120dBm 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 250mV 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 10-15µF or higher value tantalum capacitor on the supply line is essential. A low frequency ESR screening test on this capacitor will ensure consistent good sensitivity in production. A 0.1µF bypass capacitor on the supply pin, and grounded near the 44.545MHz oscillator improves sensitivity by 2-3dB.
8. R5 can be used to bias the oscillator transistor at a higher current for operation above 45MHz. Recommended value is 22kΩ, but should not be below 10kΩ.

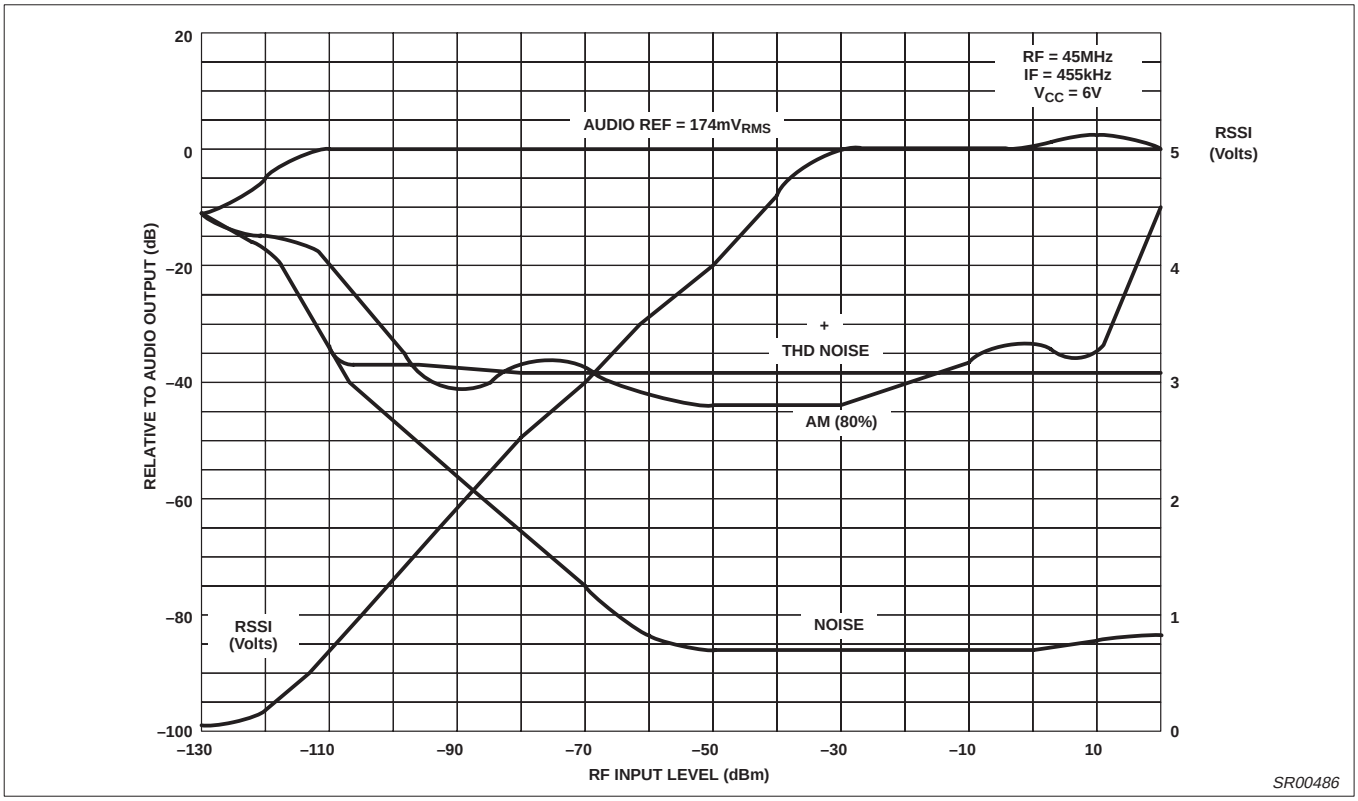


Figure 6. SA627 Application Board at 25°C

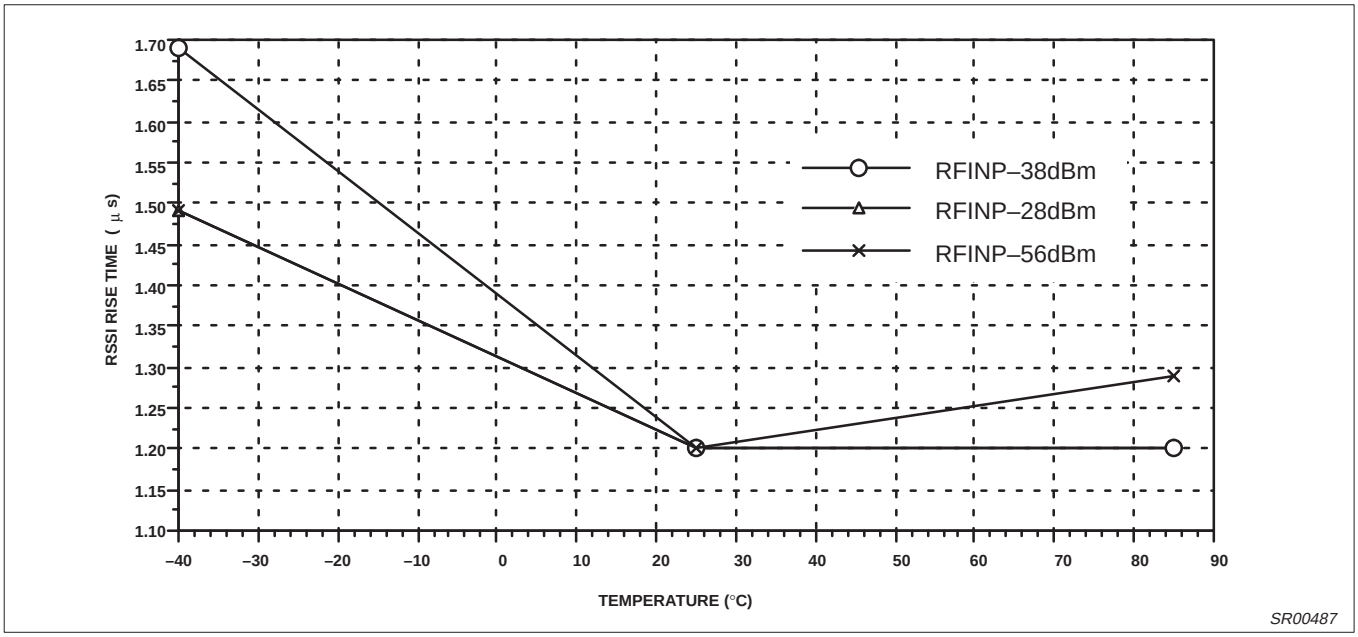


Figure 7. SA627 Rise Time 455kHz IF Frequency

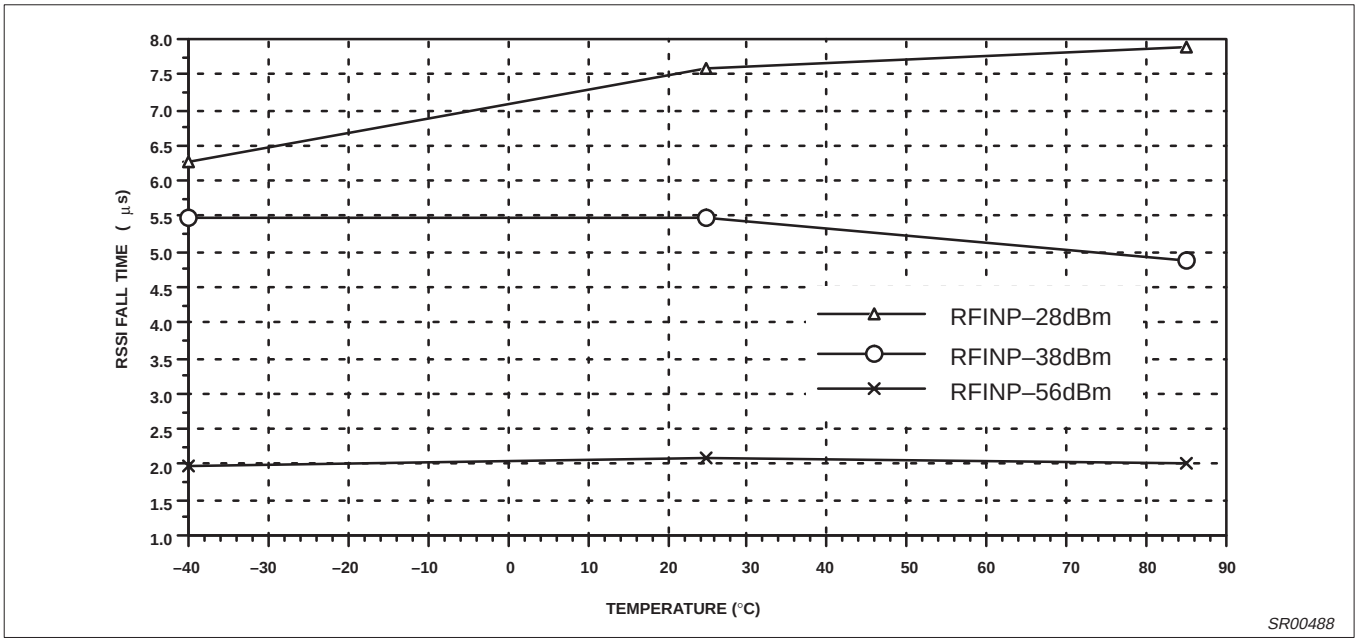


Figure 8. SA627 Fall Time 455kHz IF Frequency

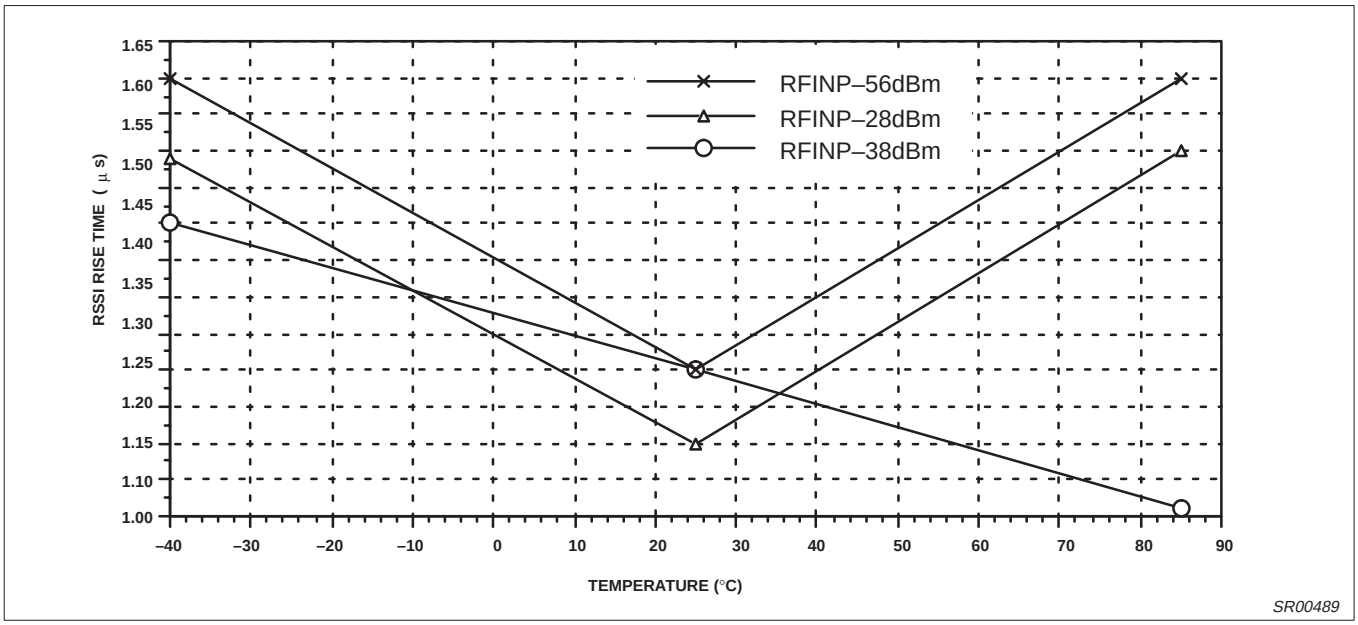


Figure 9. SA627 Rise Time 10.7MHz IF Frequency

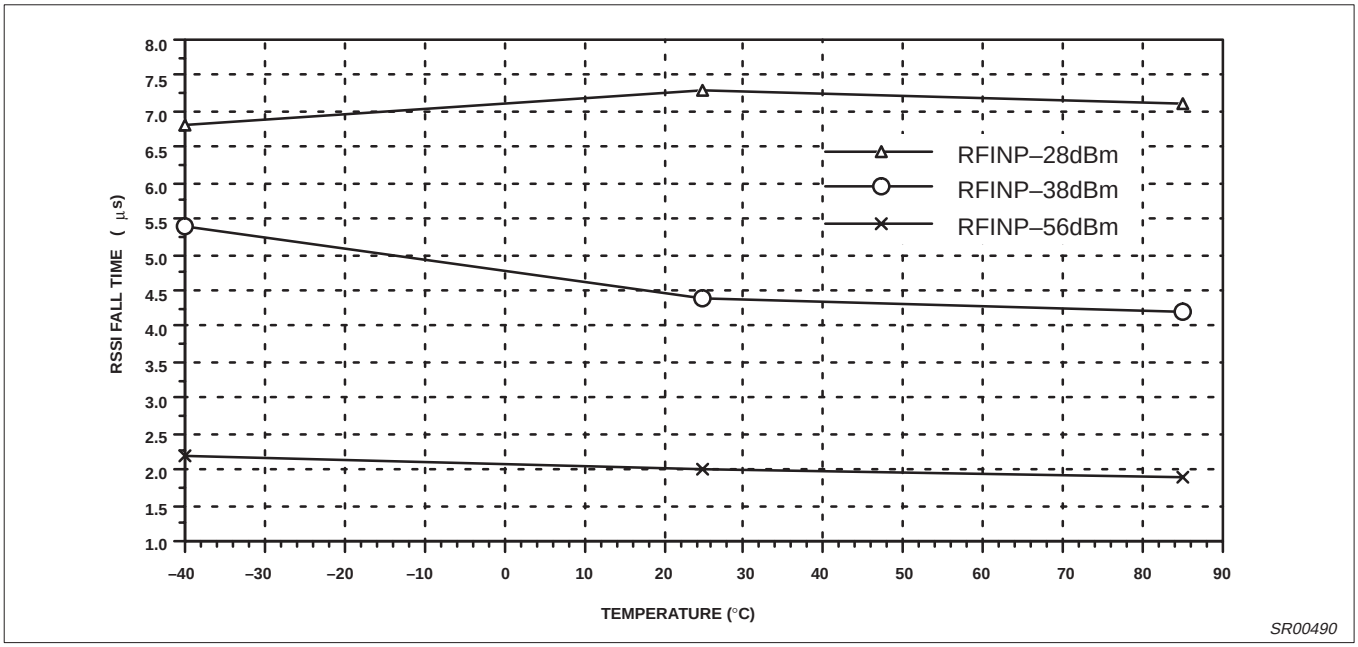
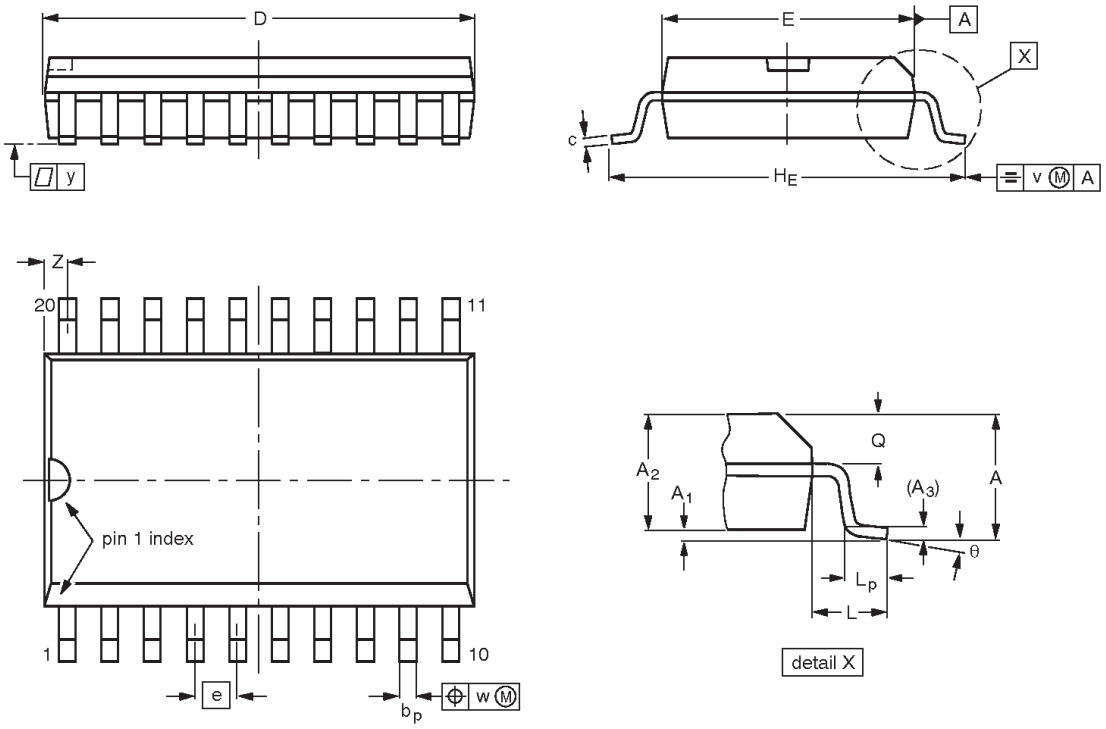
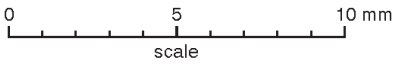


Figure 10. SA627 Fall Time 10.7MHz IF Frequency

SO20: plastic small outline package; 20 leads; body width 7.5 mm **SOT163-1**





DIMENSIONS (inch dimensions are derived from the original mm dimensions)

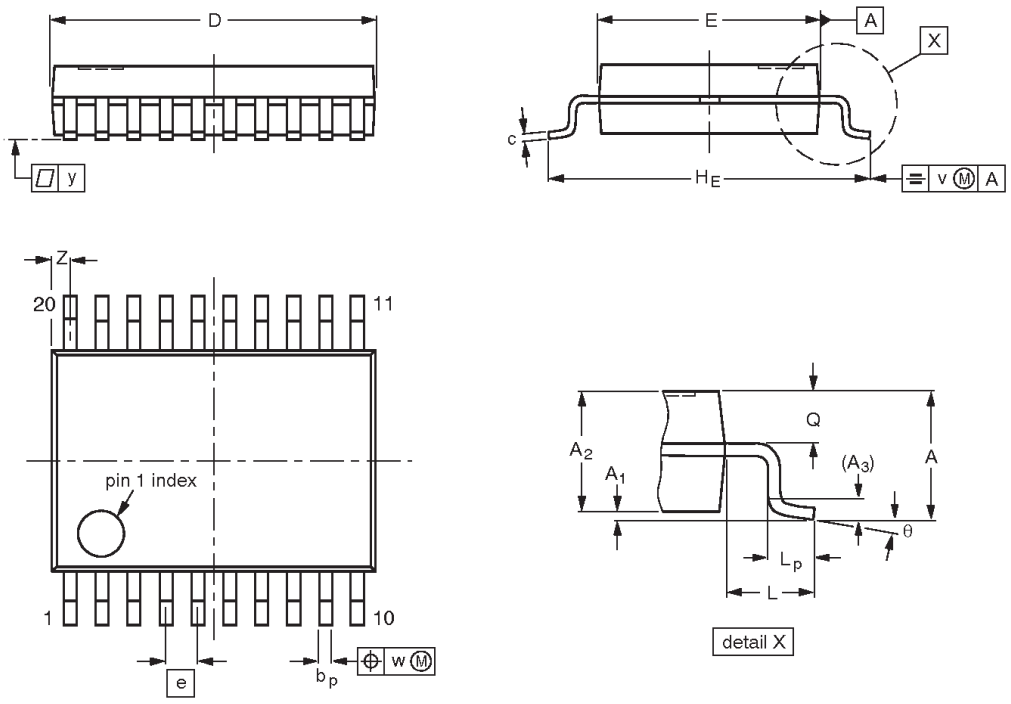
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mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	13.0 12.6	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8^o 0^o
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.51 0.49	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

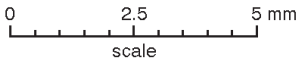
Note

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

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_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	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^o 0^o

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

High performance low power mixer FM IF system with high-speed RSSI

SA627

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.
Product Specification	Full Production	This data sheet contains Final Specifications. 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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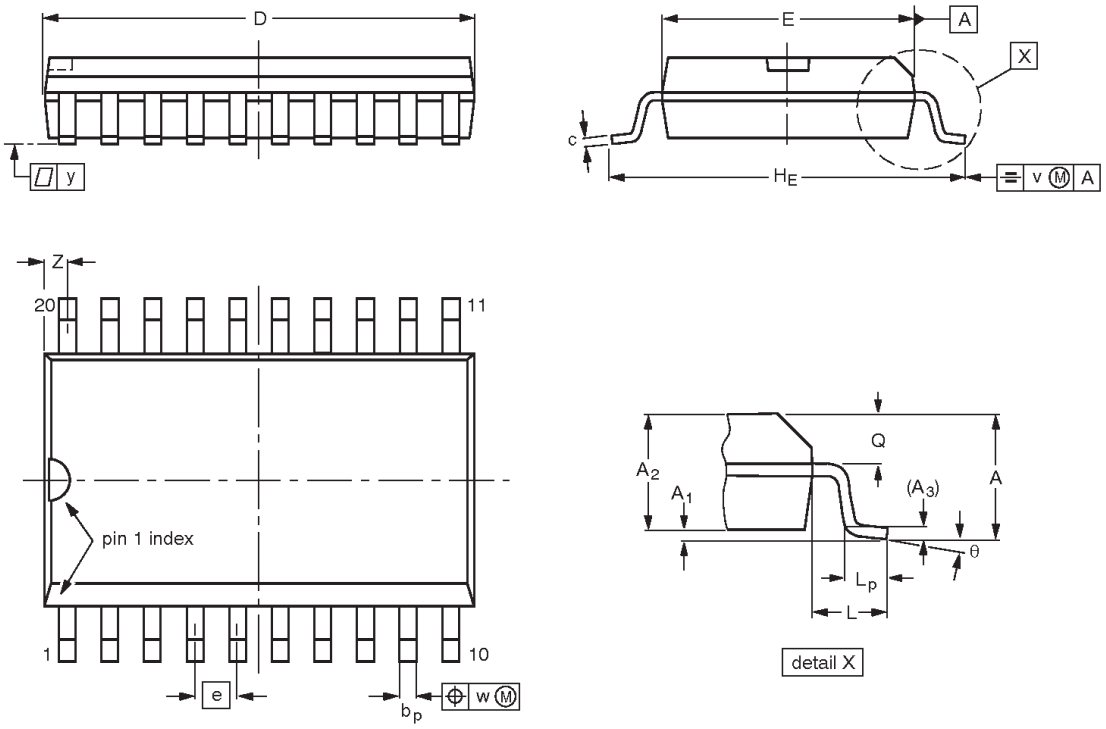
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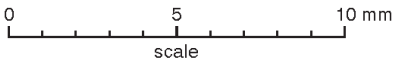
Let's make things better.

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SO20: plastic small outline package; 20 leads; body width 7.5 mm **SOT163-1**





DIMENSIONS (inch dimensions are derived from the original mm dimensions)

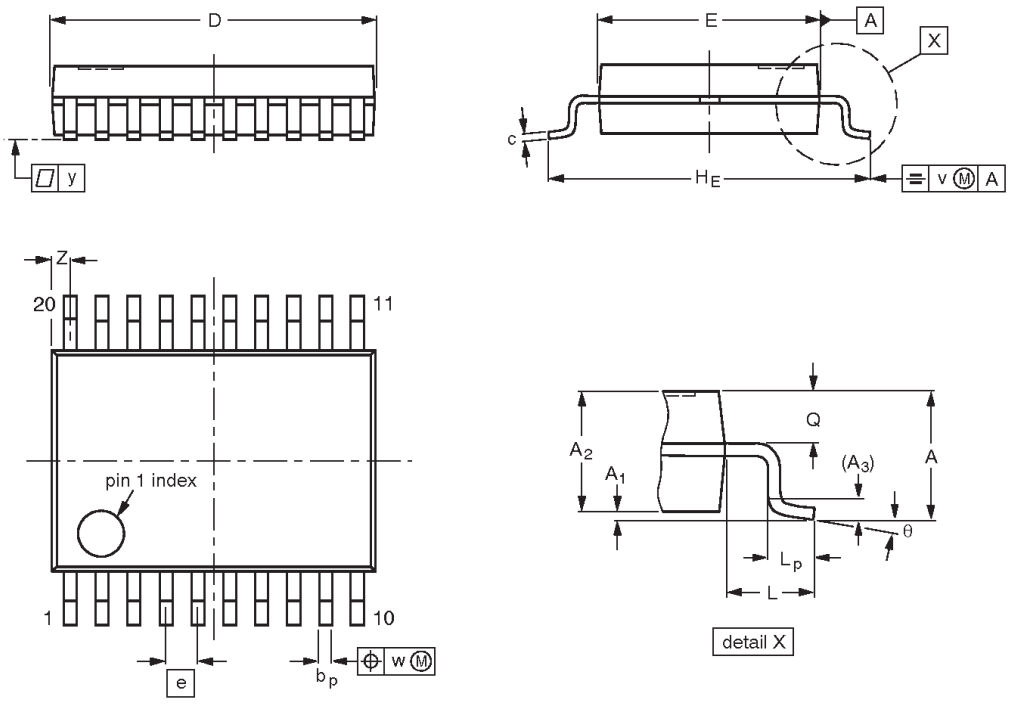
UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	13.0 12.6	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8^o 0^o
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.51 0.49	0.30 0.29	0.050	0.42 0.39	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

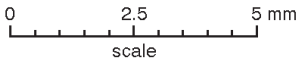
Note

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

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_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	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^o 0^o

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