

DATA SHEET

TSA6057

TSA6057T

Radio tuning PLL frequency
synthesizer

Product specification
File under Integrated Circuits, IC01

August 1988

Radio tuning PLL frequency synthesizer

TSA6057 TSA6057T

FEATURES

- On-chip AM and FM prescalers with high input sensitivity
- On-chip high performance one input (two output) tuning voltage amplifier for the AM and FM loop filters
- On-chip 2-level current amplifier (charge pump) to adjust the loop gain
- Only one reference oscillator (4 MHz) for both AM and FM
- High speed tuning due to a powerful digital memory phase detector
- 40 kHz output reference frequency for co-operation with the FM/IF system and microcomputer-based tuning interface IC (TEA6100)
- Oscillator frequency ranges of: 512 kHz to 30 MHz and 30 MHz to 150 MHz
- Three selectable reference frequencies of 1 kHz, 10 kHz or 25 kHz for both tuning ranges
- Serial 2-wire I²C-bus interface to a microcomputer and one programmable address input
- Software controlled bandswitch output.



GENERAL DESCRIPTION

The TSA6057/6057T is a bipolar single chip frequency synthesizer manufactured in SUBILO-N technology (components laterally separated by oxide). It performs all the tuning functions of a PLL radio tuning system. The IC is designed for application in all types of radio receivers.

PACKAGE OUTLINES

TSA6057: 16-lead DIL; plastic (SOT38); SOT38-1; 1996 August 07.

TSA6057T: 16-lead minipack; plastic (SO16L; SOT162A); SOT162-1; 1996 August 07.

QUICK REFERENCE DATA

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage						
pin 3		$V_{CC1} = V_{3-4}$	4.5	5.0	5.5	V
pin 16		$V_{CC2} = V_{16-4}$	V_{CC1}	8.5	12	V
Supply current	no outputs loaded					
pin 3		I_3	12	20	28	mA
pin 16		I_{16}	0.7	1.0	1.3	mA
Max. input frequency on AM _I		f_{iAM}	30	–	–	MHz
Min. input frequency on AM _I		f_{iAM}	–	–	0.512	MHz
Max. input frequency on FM _I		f_{iFM}	150	–	–	MHz
Min. input frequency on FM _I		f_{iFM}	–	–	30	MHz
Input voltage on AM _I (RMS value)	$V_{iFM} = 0$ V	$V_{iAM(rms)}$	30	–	500	mV
Input voltage on FM _I (RMS value)	$V_{iAM} = 0$ V	$V_{iFM(rms)}$	20	–	300	mV
Total power dissipation		P_{tot}	–	0.14	–	W
Operating ambient temperature range		T_{amb}	–30	–	+ 85	°C

Radio tuning PLL frequency synthesizer

TSA6057 TSA6057T

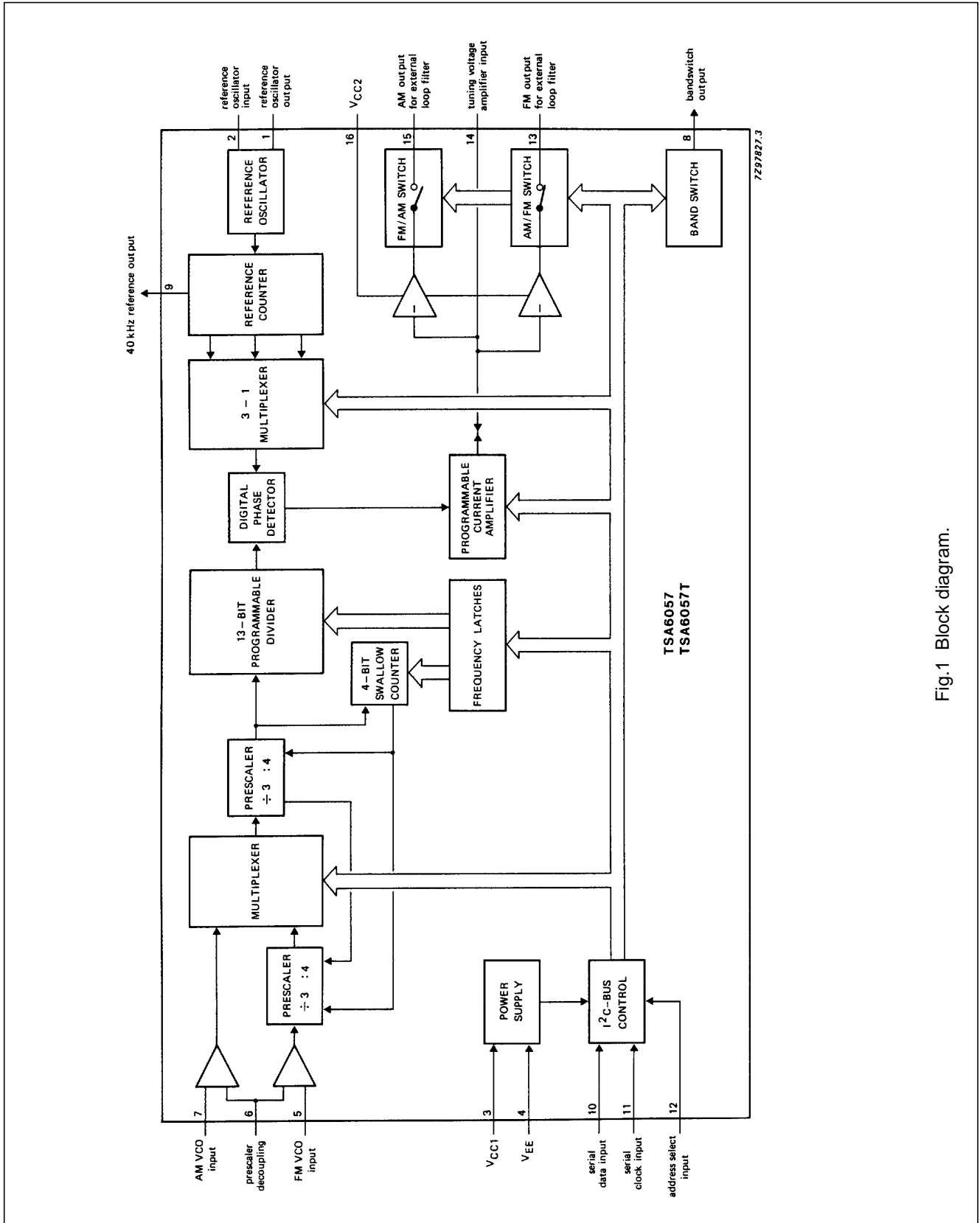


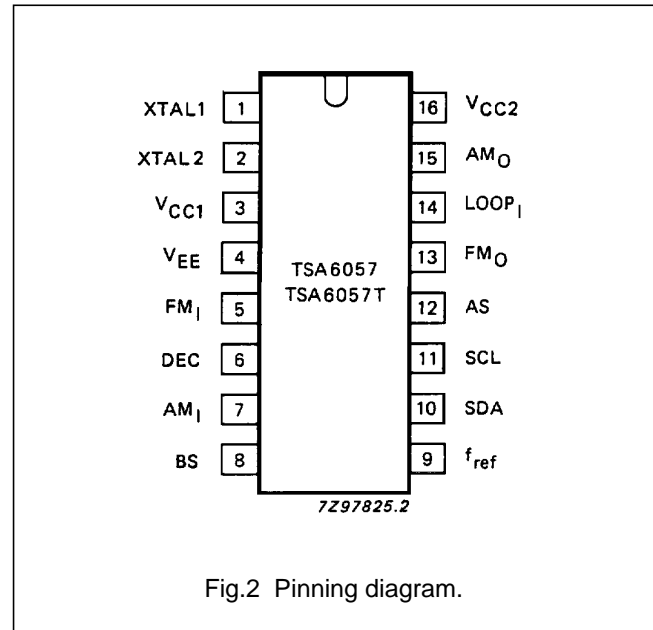
Fig.1 Block diagram.

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

PINNING

1	XTAL1	reference oscillator output
2	XTAL2	reference oscillator input
3	V _{CC1}	positive supply voltage
4	V _{EE}	ground
5	FM _I	FM VCO input
6	DEC	prescaler decoupling
7	AM _I	AM VCO input
8	BS	bandswitch output
9	f _{ref}	40 kHz reference output
10	SDA	serial data input; I ² C-bus
11	SCL	serial clock input; I ² C-bus
12	AS	address select input; I ² C-bus
13	FM _O	FM output for external loop filter
14	LOOP _I	tuning voltage amplifier input
15	AM _O	AM output for external loop filter
16	V _{CC2}	positive supply voltage



FUNCTIONAL DESCRIPTION

The TSA6057/6057T contains the following parts and facilities:

- Separate input amplifiers for the AM and FM VCO-signals.
- A prescaler with the divisors 3:4 on AM and 15:16 on FM, a multiplexer to select AM or FM and a 4-bit programmable swallow counter.
- A 13-bit programmable counter.
- A digital memory phase detector.
- A reference frequency channel comprised of a 4 MHz crystal oscillator followed by a reference counter. The reference frequency can be 1 kHz, 10 kHz or 25 kHz and is applied to the digital memory phase detector. The reference counter also outputs a 40 kHz reference frequency to pin 9 for co-operation with the FM/IF system and microcomputer-based tuning interface IC (TEA6100).
- A programmable current amplifier (charge pump) which consists of a 5 μ A and a 450 μ A current source. This allows adjustment of loop gain, thus providing high current-high speed tuning and low current-stable tuning.
- A one input – two output tuning voltage amplifier. One output is connected to the external AM loop filter and the other output to the external FM loop filter. Under software control, the AM output is switched to a high impedance state by the FM/AM switch in the FM position and the FM output is switched to a high impedance state by the AM/FM switch in the AM position. The outputs can deliver a tuning voltage of up to 10.5 V.
- An I²C-bus interface with data latches and control logic. The I²C-bus is intended for communication between microcontrollers and different ICs or modules. Detailed information on the I²C-bus specification is available on request.
- A software-controlled bandswitch output.

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

Controls

The TSA6057/6057T is controlled via the 2-wire I²C-bus. For programming there is one module address, a logic 0 R/W bit, a subaddress byte and four data bytes. The subaddress determines which one of the four data bytes is transmitted first. The module address contains a programmable address bit (D1) which with address select input AS (pin 12) makes it possible to operate two TSA6057s in one system.

The auto increment facility of the I²C-bus allows programming of the TSA6057/6057T within one transmission (address + subaddress + 4 data bytes).

- The TSA6057/6057T can also be partially programmed. Transmission must then be ended by a stop condition.

The bit organization of the 4 data bytes is shown in Fig.3 and are described in sections (a) to (f).

(a) The bits S0 to S16 (DB0: D7-D1; DB1: D7-D0; DB2: D1-D0) together with bit FM/AM (DB2: D5) are used to set the divisor of the input frequency at inputs AM_I (pin 7) or FM_I (pin 5). If the system is in lock the following is valid:

FM/AM	INPUT FREQUENCY (F _I)	INPUT
0	$(S0 \times 2^0 + S1 \times 2^1 \dots + S13 \times 2^{13} + S14 \times 2^{14}) \times f_{ref}$	AM _I
1	$(S0 \times 2^0 + S1 \times 2^1 \dots + S15 \times 2^{15} + S16 \times 2^{16}) \times f_{ref}$	FM _I

Where

The minimum dividing ratio for AM mode is $2^6 = 64$

The minimum dividing ratio for FM mode is $2^8 = 256$

(b) The bit CP is used to control the charge pump current (DB0: D0).

CP	CURRENT
0	low
1	high

(c) The bits REF1 and REF2 are used to set the reference frequency applied to the phase detector (DB2: D7-D6).

REF1	REF2	FREQUENCY (KHZ)
0	0	1
0	1	10
1	0	25
1	1	none

(d) The bit FM/AM OPAMP controls the switch AM/FM; FM/AM in the tuning voltage amplifier output circuitry (DB2: D4).

FM/AM OPAMP	SWITCH FM/AM	SWITCH AM/FM
1	closed	open
0	open	closed

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

(e) The bit BS controls the open collector bandswitch output (DB2: D2).

BS	BANDSWITCH OUTPUT
1	sink current
0	floating

(f) The data byte DB3 must be set to 0 0. It is also used for test purposes.

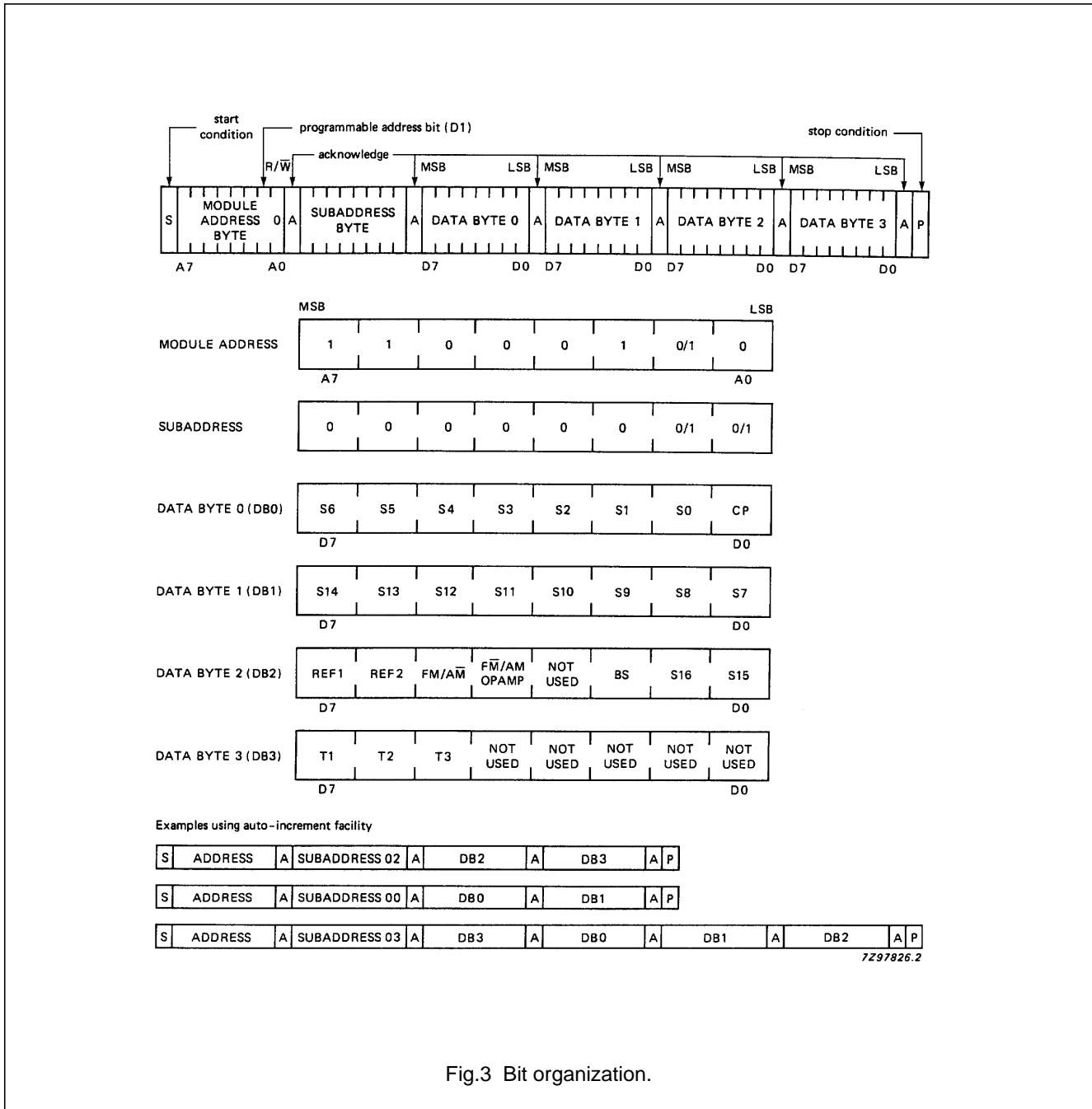


Fig.3 Bit organization.

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T**RATINGS**

Limiting values in accordance with the Absolute Maximum System (IEC 134)

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
Supply voltage (pin 3)	$V_{CC1} = V_{3-4}$	-0.3	5.5	V
Supply voltage (pin 16)	$V_{CC2} = V_{16-4}$	V_{CC1}	12.5	V
Total power dissipation	P_{tot}	–	0.85	W
Operating ambient temperature	T_{amb}	-30	+85	°C
Storage temperature range	T_{stg}	-65	+150	°C

CHARACTERISTICS $V_{CC1} = 5\text{ V}$; $V_{CC2} = 8.5\text{ V}$; $T_{amb} = 25\text{ °C}$; unless otherwise specified

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (pin 3)		V_{CC1}	4.5	5.0	5.5	V
Supply voltage (pin 16)		V_{CC2}	V_{CC1}	8.5	12	V
Supply current	no outputs loaded					
pin 3		I_{CC1}	12	20	28	mA
pin 16		I_{CC2}	0.7	1.0	1.3	mA
I²C-bus inputs (SDA; SCL)						
Input voltage HIGH		V_{IH}	3.0	–	5.0	V
Input voltage LOW		V_{IL}	-0.3	–	1.5	V
Input current HIGH		I_{IH}	–	–	10	μA
Input current LOW		I_{IL}	–	–	10	μA
SDA output	open collector					
Output voltage LOW	$I_{OL} = 3.0\text{ mA}$	V_{OL}	–	–	0.4	V
AS input						
Input voltage HIGH		V_{IH}	3.0	–	5.0	V
Input voltage LOW		V_{IL}	-0.3	–	1.0	V
Input current HIGH		I_{IH}	–	–	10	μA
Input current LOW		I_{IL}	–	–	10	μA
RF input (AM; FM)						
Max. input frequency on AM_I		f_{iAM}	30	–	–	MHz
Min. input frequency on AM_I		f_{iAM}	–	–	0.512	MHz
Max. input frequency on FM_I		f_{iFM}	150	–	–	MHz
Min. input frequency on FM_I		f_{iFM}	–	–	30	MHz
Input voltage on AM_I (RMS value)	$V_{iFM} = 0\text{ V}$ measured in Fig.4	$V_{iAM(rms)}$	30	–	500	mV
Input impedance AM_I resistance		R_{AM}	–	5.9	–	kΩ
capacitance		C_{AM}	–	2	–	pF

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
RF input (AM; FM); continued						
Input voltage on FM _I (RMS value)	V _{iAM} = 0 V measured in Fig.4	V _{iFM(rms)}	20	–	300	mV
Input impedance FM _I resistance		R _{FM}	–	3.6	–	kΩ
capacitance		C _{FM}	–	2	–	pF
Oscillator (XTAL1; XTAL2)						
Crystal resonance resistance (4 MHz)	see Fig.5	R _{XTAL}	–	–	150	Ω
Programmable charge pump						
Output current to loop filter bit CP = logic 0		I _{chp}	3	5	7	μA
bit CP = logic 1		I _{chp}	400	500	600	μA
Ripple rejection						
20 log ΔV _{CC1} /ΔV _O	f _{ripple} = 100 Hz	RR	40	50	–	dB
20 log ΔV _{CC2} /ΔV _O		RR	40	50	–	dB
Bandswitch output (pin 8)						
Output voltage HIGH		V _{OH}	–	–	12	V
Output voltage LOW	I _{OL} = 3 mA	V _{OL}	–	–	0.8	V
Output leakage current	V _{OH} = 12 V	I _{LO}	–	–	10	μA
Reference frequency output (pin 9)						
Output frequency	4 MHz crystal	f _{ref}	–	40	–	kHz
Output voltage HIGH	I _{source} = 5 μA	V _{OH}	1.2	1.4	1.7	V
Output voltage LOW		V _{OL}	–	0.1	0.2	V
Tuning voltage amplifier outputs						
AM output (pin 15) max. output voltage	I _{source} = 0.5 mA	V _{O(max)}	V _{CC2} –1.5	–	–	V
min. output voltage	I _{sink} = 1 mA	V _{O(min)}	–	–	0.8	V
max. output source current		I _{source}	0.5	–	–	mA
max. output sink current		I _{sink}	1.0	–	–	mA

Radio tuning PLL frequency synthesizer

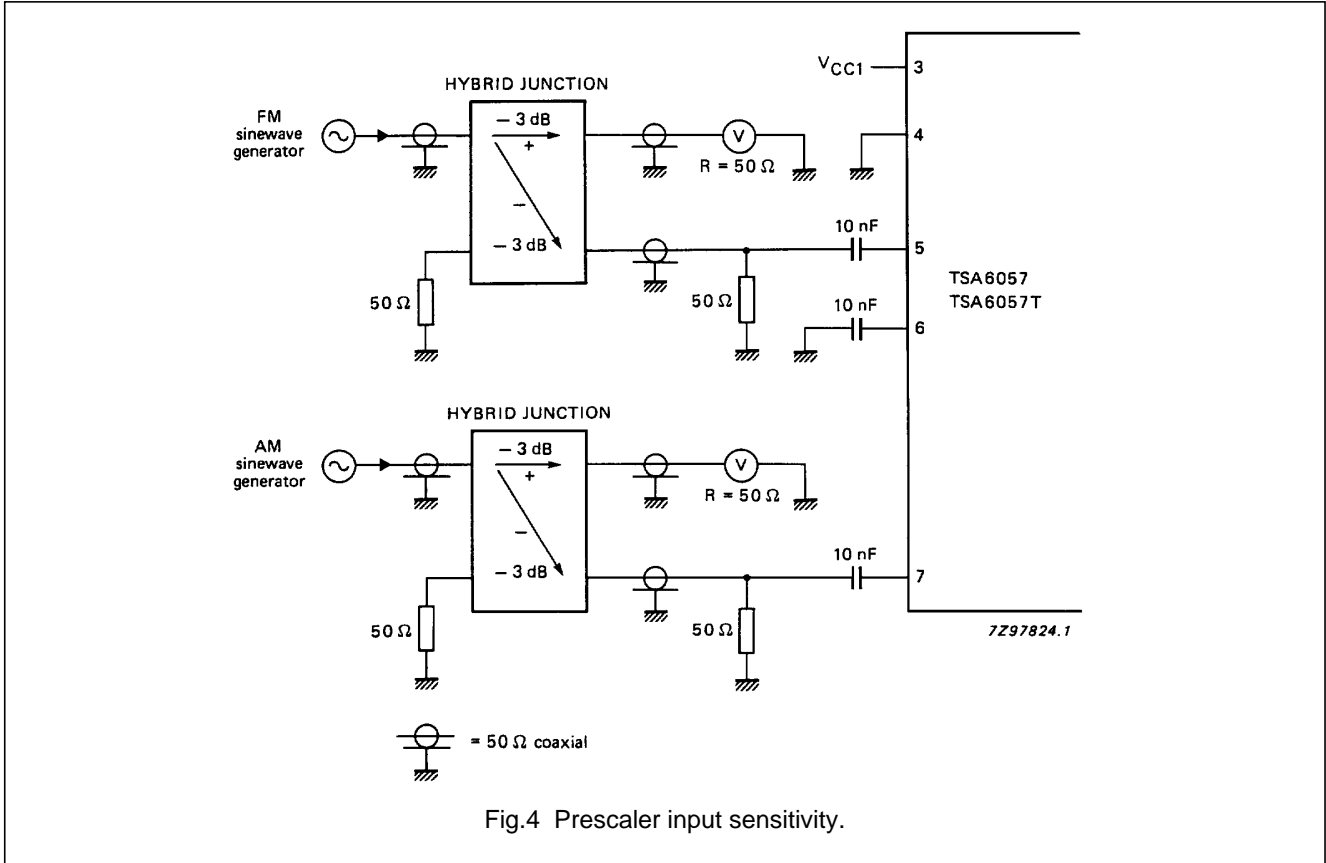
TSA6057
TSA6057T

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Tuning voltage amplifier outputs; continued						
FM output (pin 13)						
max. output voltage	$I_{\text{source}} = 0.5 \text{ mA}$	$V_{O(\text{max})}$	$V_{\text{CC2}} - 1.5$	–	–	V
min. output voltage	$I_{\text{sink}} = 1 \text{ mA}$	$V_{O(\text{min})}$	–	–	0.8	V
max. output source current		I_{source}	0.5	–	–	mA
max. output sink current		I_{sink}	1.0	–	–	mA
Impedance of switched off output		$Z_{O(\text{off})}$	5	–	–	M Ω
Input bias current (absolute value)		I_{bias}	–	1	5	nA

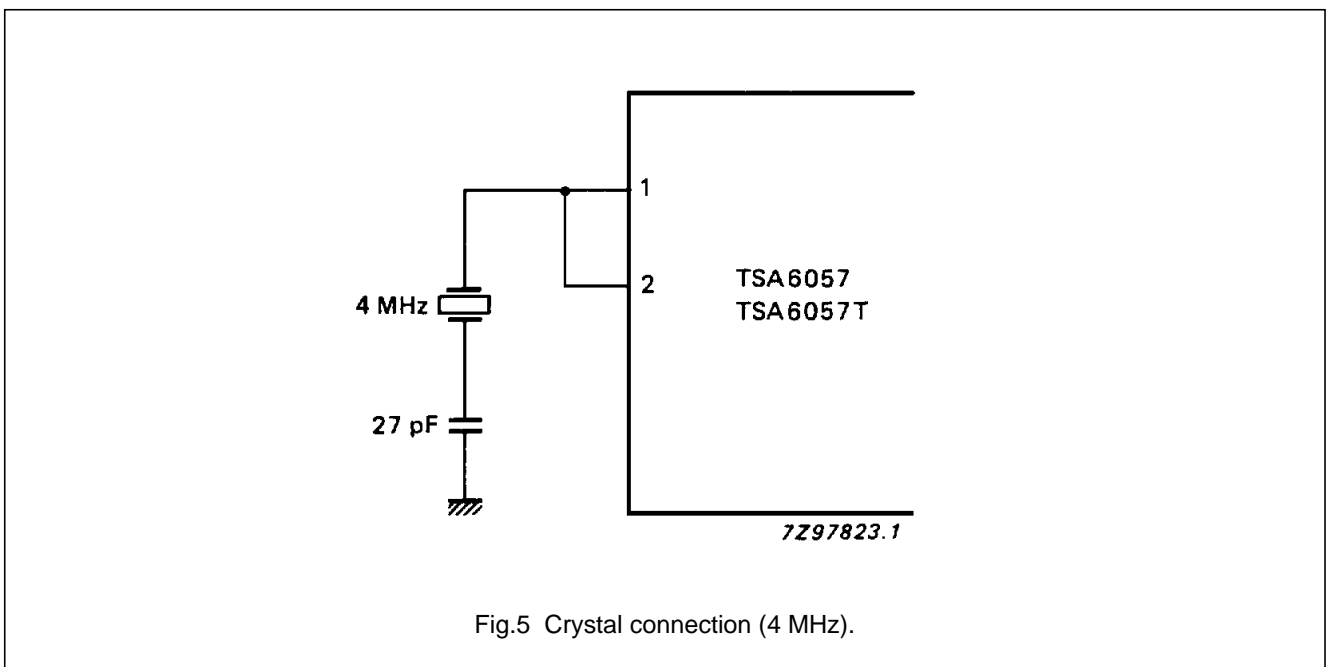
Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

SENSITIVITY MEASUREMENT



APPLICATION INFORMATION



Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

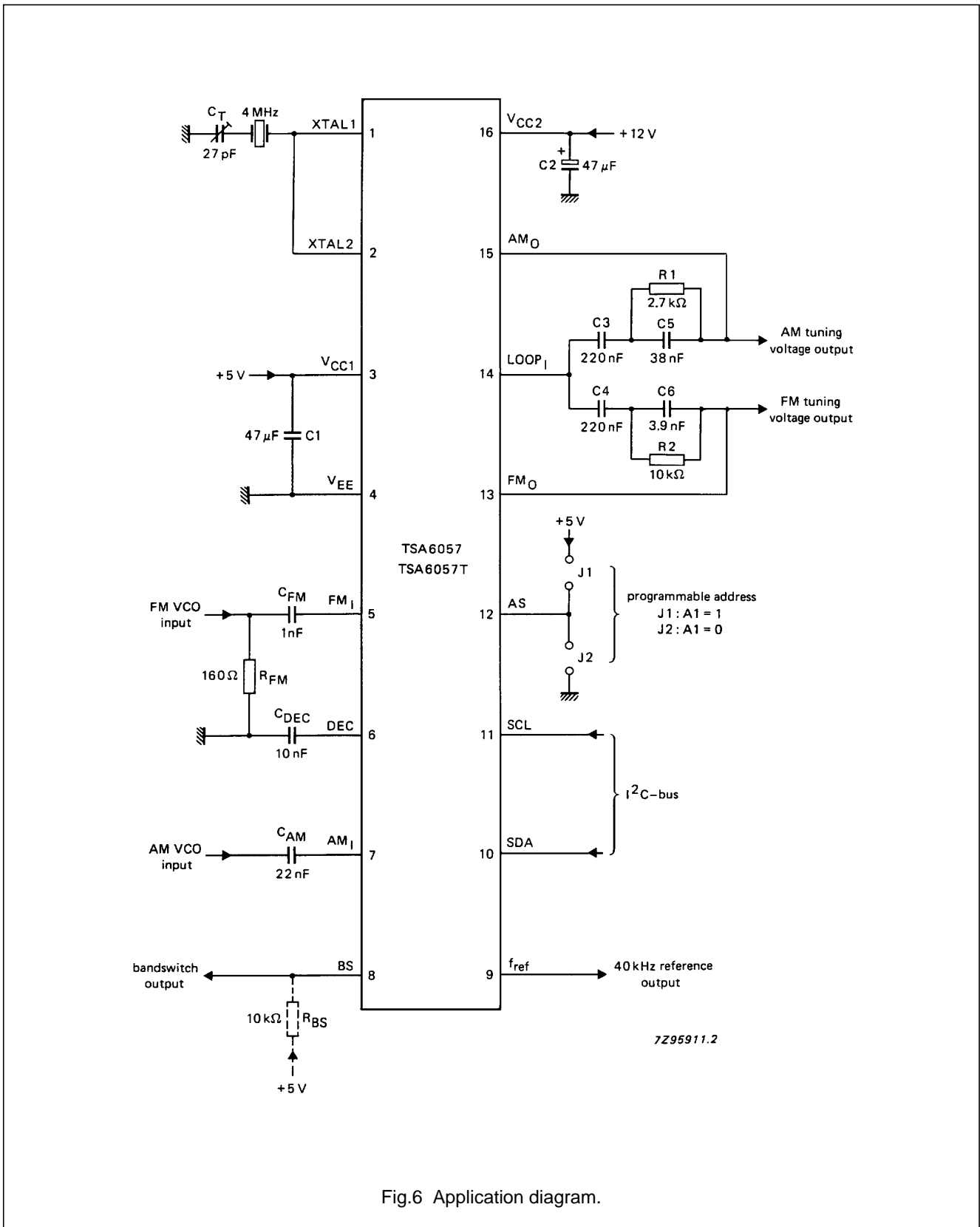


Fig.6 Application diagram.

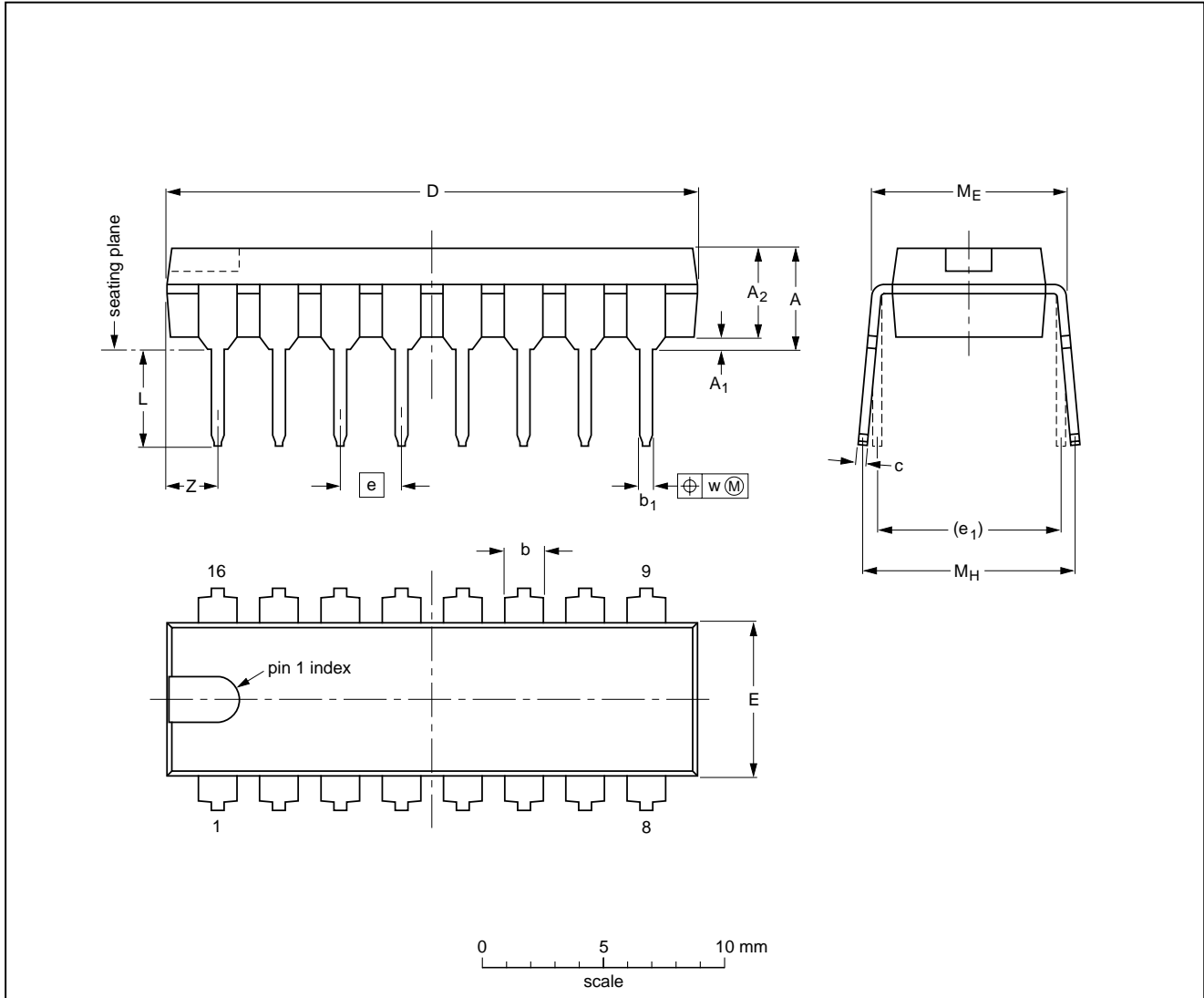
Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

PACKAGE OUTLINES

DIP16: plastic dual in-line package; 16 leads (300 mil); long body

SOT38-1



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

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.7	0.51	3.7	1.40 1.14	0.53 0.38	0.32 0.23	21.8 21.4	6.48 6.20	2.54	7.62	3.9 3.4	8.25 7.80	9.5 8.3	0.254	2.2
inches	0.19	0.020	0.15	0.055 0.045	0.021 0.015	0.013 0.009	0.86 0.84	0.26 0.24	0.10	0.30	0.15 0.13	0.32 0.31	0.37 0.33	0.01	0.087

Note

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

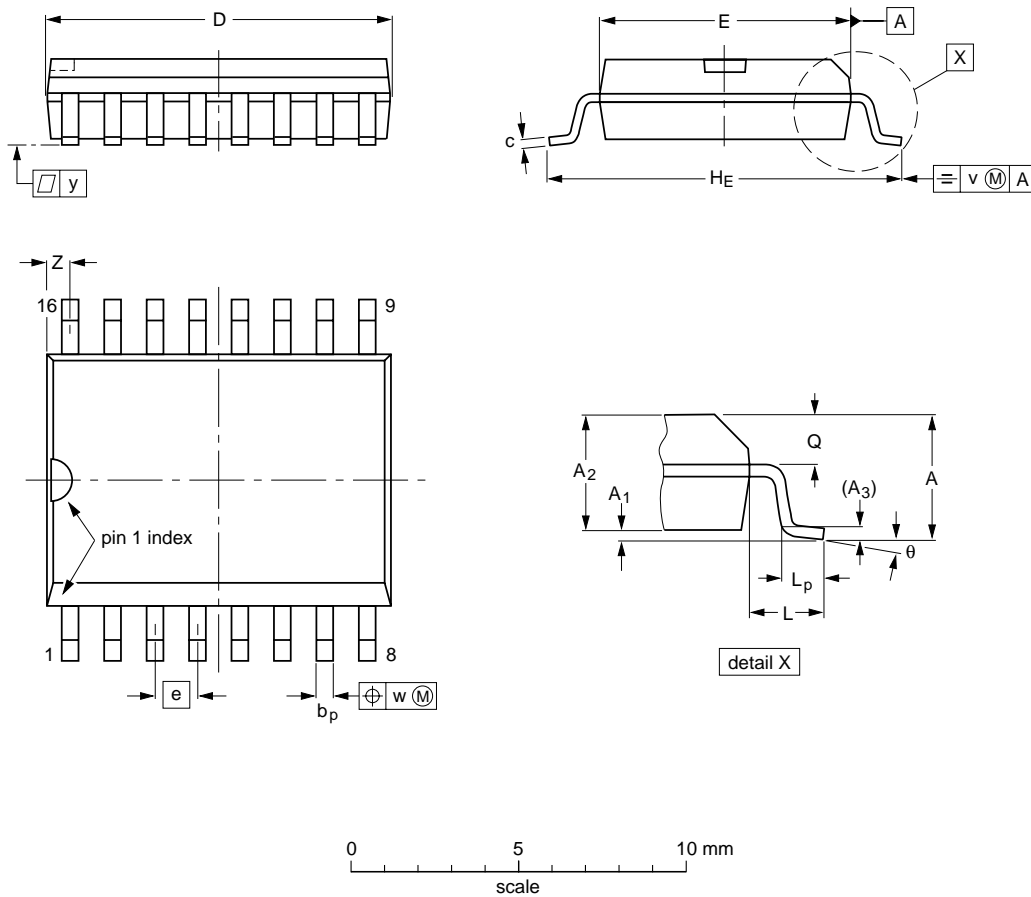
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT38-1	050G09	MO-001AE				92-10-02 95-01-19

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

SO16: plastic small outline package; 16 leads; body width 7.5 mm

SOT162-1



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	10.5 10.1	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	0.41 0.40	0.30 0.29	0.050	0.419 0.394	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		
SOT162-1	075E03	MS-013AA			95-01-24 97-05-22

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "IC Package Databook" (order code 9398 652 90011).

DIP

SOLDERING BY DIPPING OR BY WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

SO

REFLOW SOLDERING

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

WAVE SOLDERING

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

REPAIRING SOLDERED JOINTS

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Radio tuning PLL frequency synthesizer

TSA6057
TSA6057T**DEFINITIONS**

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

PURCHASE OF PHILIPS I²C COMPONENTS

Purchase of Philips I²C components conveys a license under the Philips' I²C patent to use the components in the I²C system provided the system conforms to the I²C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.