DATA SHEET

TDA8735

PLL frequency synthesizer

Product specification
Supersedes data of September 1994
File under Integrated Circuits, IC01

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FEATURES

- Complete 30 MHz single-chip tuning system
- Loop amplifier included
- 2-level current amplifier (charge pump) for adjusting the loop gain
- A powerful digital memory phase detector
- Programmable reference frequencies of 1 kHz, 10 kHz or 25 kHz
- I^2C-bus interface
- Programmable address select input
- Software controlled switch output.

APPLICATIONS

- Satellite sound receiver
- Radio receiver: LW, MW and SW.

GENERAL DESCRIPTION

The TDA8735 is a single-chip PLL synthesizer designed for satellite receivers. The device can be set to two different addresses which can be used in applications where independently tuned VCOs are required.

To adapt to different frequency accuracy, 3 reference frequencies are selectable via the I^2C-bus. The charge pump current can be set to 2 values with a ratio of 1 : 100 via the I^2C-bus.

A programmable switch (open-collector) is integrated to enable mode or normal switching, or other types of application.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CC1}	supply voltage (pin 3)		4.5	5.0	5.5	V
V_{CC2}	supply voltage (pin 16)		V_{CC1}	8.5	12	V
I_{CC1}	supply current (pin 3)	outputs unloaded	12	20	28	mA
I_{CC2}	supply current (pin 16)	outputs unloaded	0.2	0.5	1	mA
$f_{i(max)}$	maximum input frequency		30	–	–	MHz
$f_{i(min)}$	minimum input frequency		–	–	512	kHz
$V_{i(rms)}$	input voltage (RMS value)		30	–	500	mV
P_{tot}	total power dissipation		–	0.14	–	W
T_{amb}	operating ambient temperature		–30	–	+85	°C

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8735	DIP16	plastic dual in-line package; 16 leads (300 mil); long body	SOT38-1
TDA8735T	SO16	plastic small outline package; 16 leads; body width 7.5 mm	SOT162-1

BLOCK DIAGRAM

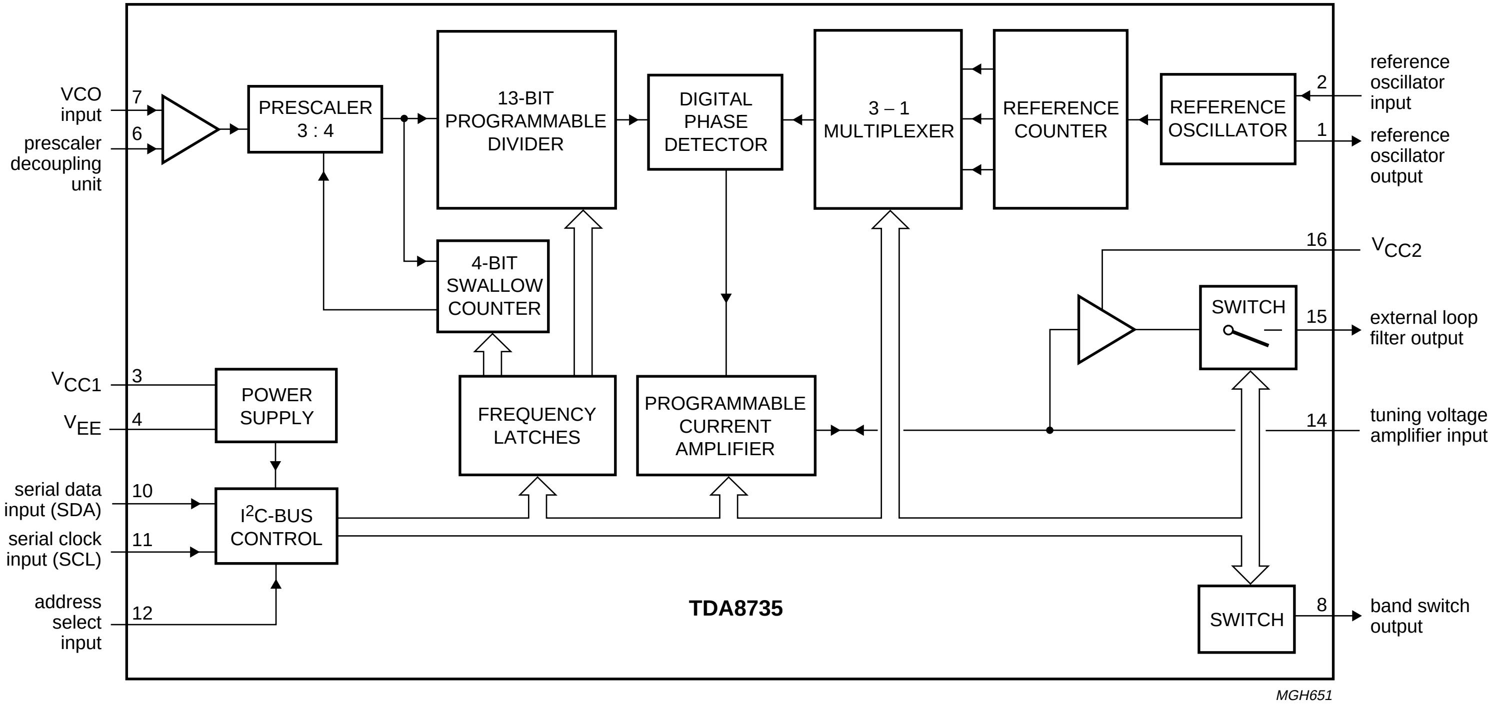


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
XTAL1	1	reference oscillator output
XTAL2	2	reference oscillator input
V_{CC1}	3	supply voltage 1
V_{EE}	4	ground
n.c.	5	not connected
DEC	6	prescaler decoupling
VCOFI	7	VCO input frequency
BS	8	band switch output
n.c.	9	not connected
SDA	10	serial data input (I^2C-bus)
SCL	11	serial clock input (I^2C-bus)
AS	12	address select input (I^2C-bus)
n.c.	13	not connected
$LOOP_I$	14	tuning voltage amplifier input
$LOOP_O$	15	external loop filter output
V_{CC2}	16	supply voltage 2

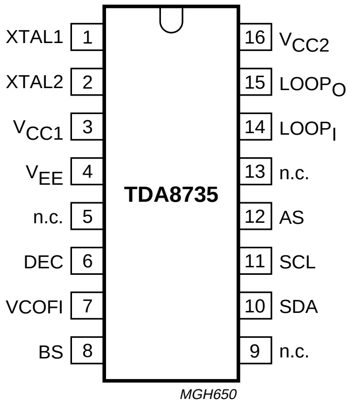


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA8735 contains the following parts and facilities:

- Input amplifier VCO signal
- A prescaler with the divisors 3 : 4 and a 2-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, 10 or 25 kHz and is applied to the digital memory phase detector
- An I^2C-bus interface with data latches and control logic; the I^2C-bus is intended for communication between microcontrollers and different ICs or modules. Detailed information on the I^2C-bus specification is available on request.
- A software-controlled switch output
- A programmable current amplifier (charge pump) which consists of a 5 and a 500 µA current source, this allows adjustment of loop gain, thus providing high-current high-speed tuning and low current-stable tuning.
  The output at the loop amplifier can deliver a tuning voltage of up to 10.5 V (V_{CC2} – 1.5 V).

Controls

The TDA8735 is controlled via the 2-wire I^2C-bus. As slave receiver for programming there is one module address, a logic 0 ($R/\overline{W}$ 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 TDA8735 in one system.

The auto increment facility of the I^2C-bus allows programming of the TDA8735 within one transmission (address + subaddress + 4 data bytes).

The TDA8735 can also be partially programmed. Transmission must then be ended by a stop condition.

The bit organization of the 4 data bytes is illustrated in Fig.3 and is described below.

The divider number is defined by 15-bit words, bits S0 to S14. To calculate the lock frequency, the divider number has to be multiplied by the selected reference frequency.

Table 1 Divider number setting; note 1

$\overline{\text{ON}}$	DIVIDER NUMBER SETTING	INPUT
0	$(S0 + S1) \times 2^1$ to $+ S13 \times 2^{13} + S14 \times 2^{14}$	ON

Note

1. Where the minimum divider ratio is: $2^6 = 64$ to $2^{15} - 1 = 32761$.

Table 2 Bit CP (used to control the charge pump; DB0 : D0)

CP	CURRENT
0	LOW
1	HIGH

Table 3 Bits REF1 and REF2 (used to set the reference frequency applied to the phase detector; DB2 : D7 and D6)

REF1	REF2	FREQUENCY (kHz)
0	0	1
0	1	10
1	0	25
1	1	0

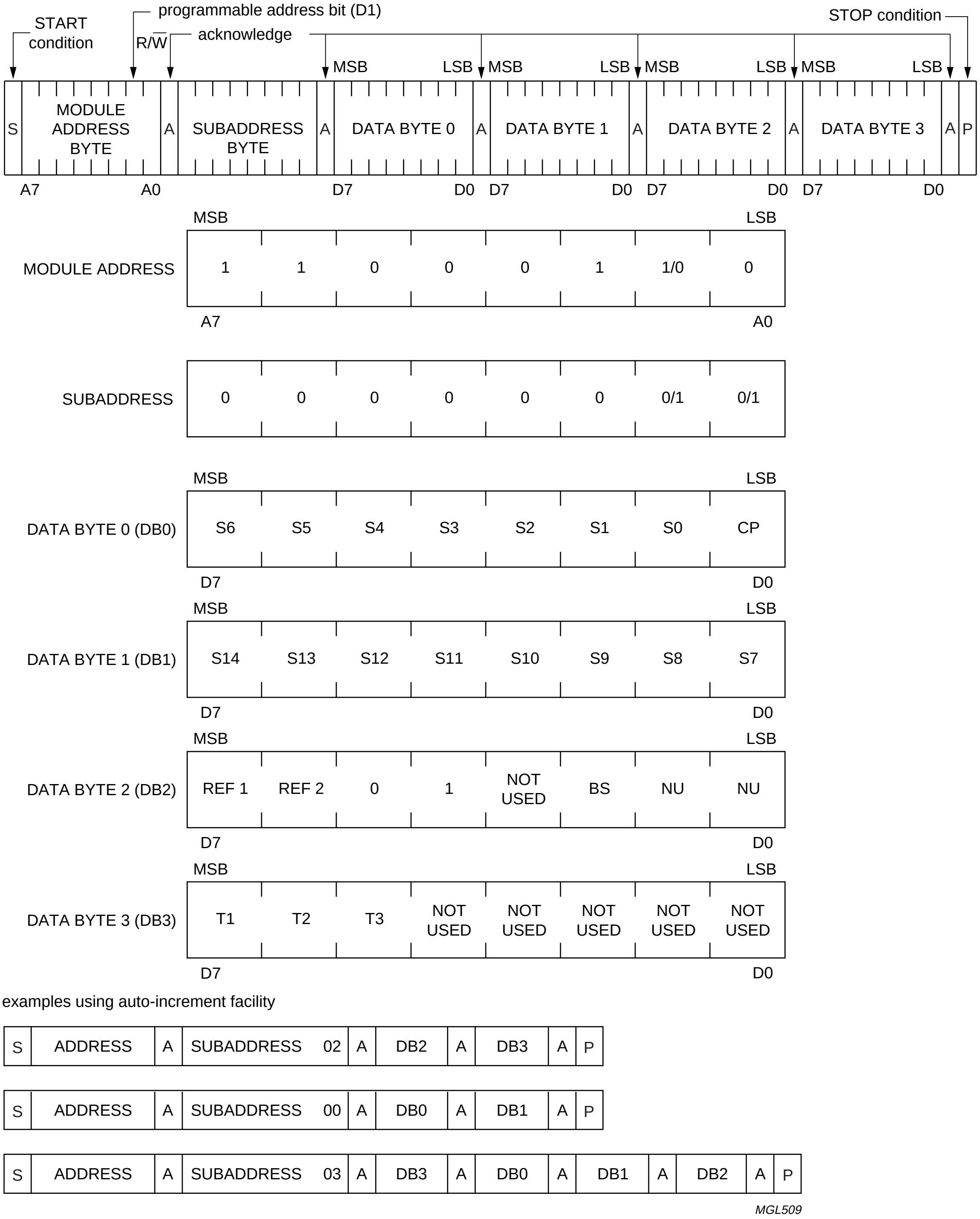
Table 4 Bit OPAMP (used to control the switch in the tuning voltage amplifier output circuitry; DB2 : D4)

OPAMP	SWITCH
1	on
0	off

Table 5 Bit BS (used to control the open-collector switch output; DB2 : D2)

BS	SWITCH OUTPUT
1	sink current
0	floating

The data byte DB3 must be set to 0 to 0. It is also used for test purposes (see Fig.3).



	MSB							LSB
MODULE ADDRESS	1	1	0	0	0	1	1/0	0
	A7							A0

SUBADDRESS	0	0	0	0	0	0	0/1	0/1

	MSB							LSB
DATA BYTE 0 (DB0)	S6	S5	S4	S3	S2	S1	S0	CP
	D7							D0

	MSB							LSB
DATA BYTE 1 (DB1)	S14	S13	S12	S11	S10	S9	S8	S7
	D7							D0

	MSB							LSB
DATA BYTE 2 (DB2)	REF 1	REF 2	0	1	NOT USED	BS	NU	NU
	D7							D0

	MSB							LSB
DATA BYTE 3 (DB3)	T1	T2	T3	NOT USED	NOT USED	NOT USED	NOT USED	NOT USED
	D7							D0

examples using auto-increment facility

S	ADDRESS	A	SUBADDRESS 02	A	DB2	A	DB3	A	P

S	ADDRESS	A	SUBADDRESS 00	A	DB0	A	DB1	A	P

S	ADDRESS	A	SUBADDRESS 03	A	DB3	A	DB0	A	DB1	A	DB2	A	P

Fig.3 Bit organization.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC1}	supply voltage (pin 3)	–0.3	+5.5	V
V_{CC2}	supply voltage (pin 16)	V_{CC1}	12.5	V
P_{tot}	total power dissipation	–	0.85	W
T_{amb}	operating ambient temperature	–30	+85	°C
T_{stg}	storage temperature	–65	+150	°C

HANDLING

Every pin withstands the ESD test in accordance with *“MIL-STD-883C category B”* (2000 V).

CHARACTERISTICS

V_{CC1} = 5 V; V_{CC2} = 8.5 V; T_{amb} = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
V_{CC1}	supply voltage (pin 3)		4.5	5.0	5.5	V
V_{CC2}	supply voltage (pin 16)		V_{CC1}	8.5	12	V
I_{CC1}	supply current (pin 3)	no outputs loaded	12	20	28	mA
I_{CC2}	supply current (pin 16)	no outputs loaded	0.2	0.5	1	mA
		TDA8735T only	0.7	1	1.5	mA
I²C-bus inputs (SDA and SCL)						
V_{IH}	HIGH-level input voltage		3.0	–	5.0	V
V_{IL}	LOW-level input voltage		–0.3	–	+1.5	V
I_{IH}	HIGH-level input current		–	–	10	µA
I_{IL}	LOW-level input current		–	–	10	µA
SDA output						
V_{OL}	LOW-level output voltage	open-collector; I_{OL} = 3.0 mA	–	–	0.4	V
AS input						
V_{IH}	HIGH-level input voltage	AS = C6	3.0	–	5.0	V
V_{IL}	LOW-level input voltage	AS = C4	–0.3	–	+1.0	V
I_{IH}	HIGH-level input current		–	–	10	µA
I_{IL}	LOW-level input current		–	–	10	µA
RF input						
$f_{i(max)}$	maximum input frequency		30	–	–	MHz
$f_{i(min)}$	minimum input frequency		–	–	512	kHz
$V_{i(rms)}$	input voltage (RMS value)	measured in Fig.4	30	–	500	mV
R_i	input resistance		–	5.9	–	kΩ
C_i	input capacitance		–	2	–	pF

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Oscillator (XTAL1 and XTAL2)						
R_{xtal}	crystal resonance resistance (4 MHz)	see Fig.5	–	–	150	Ω
Programmable charge pump						
I_{CHP}	output current to loop filter	bit CP				
		logic 0	3	5	7	μA
		logic 1	400	500	600	μA
		logic 0; TDA8735T only	3	5	9	μA
Ripple rejection						
RR	$20\log\frac{\Delta V_{CC1}}{\Delta V_O}$	f_{ripple} = 100 Hz	40	50	–	dB
	$20\log\frac{\Delta V_{CC2}}{\Delta V_O}$	f_{ripple} = 100 Hz	40	50	–	dB
Band switch output (pin 8)						
V_{OH}	HIGH-level output voltage		–	–	12	V
V_{OL}	LOW-level output voltage	I_{OL} = 3 mA	–	–	0.8	V
$\lvert I_{LO} \rvert$	output leakage current	V_{OH} = 12 V	–	–	10	μA
Tuning voltage amplifier output (pin 15)						
$V_{o(max)}$	maximum output voltage	I_{source} = 0.5 mA	V_{CC2} – 1.5	–	–	V
$V_{o(min)}$	minimum output voltage	I_{sink} = 1 mA	–	–	0.8	V
I_{source}	maximum output source current		0.5	–	–	mA
I_{sink}	maximum output sink current		1.0	–	–	mA
$Z_{o(off)}$	impedance of switched off output		5	–	–	MΩ
$\lvert I_{bias} \rvert$	input bias current (absolute value)		–	1	5	nA

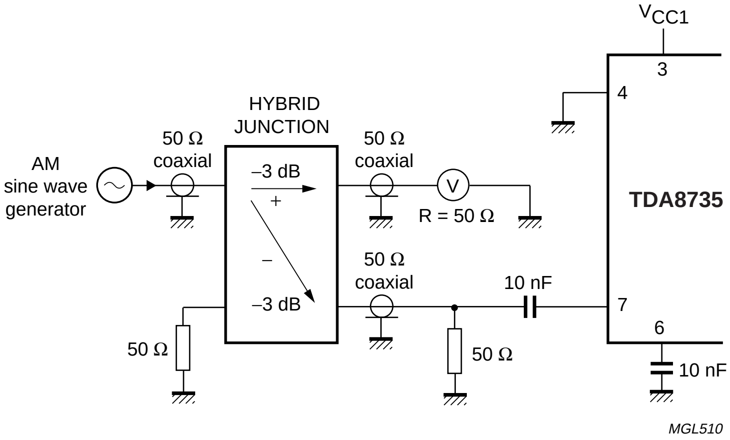


Fig.4 Prescaler input sensitivity (set-up measurement).

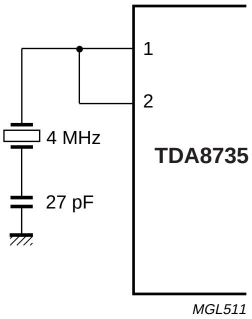
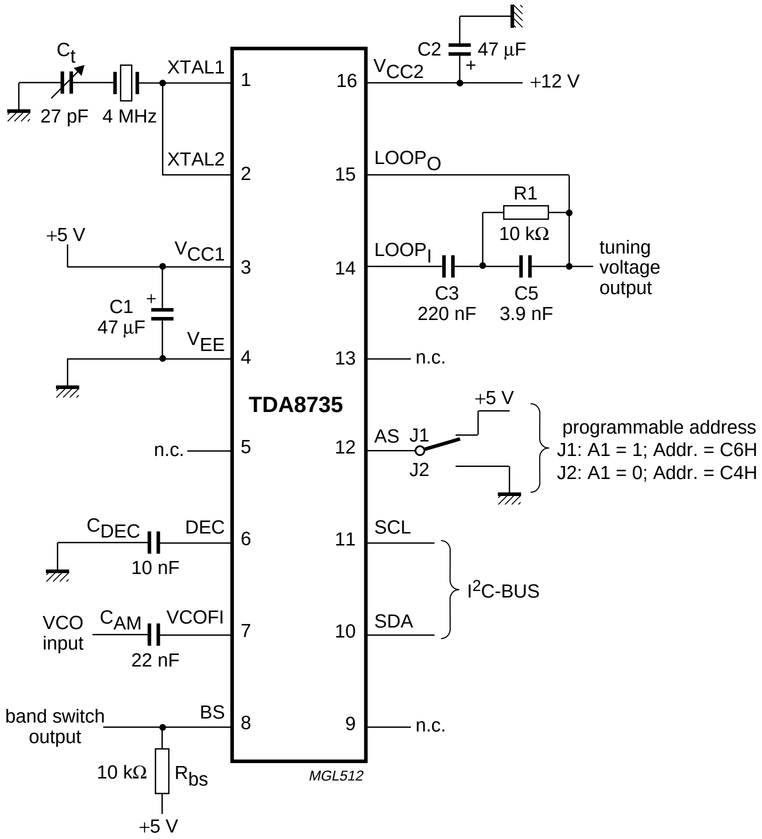


Fig.5 Crystal connection (4 MHz).

APPLICATION INFORMATION

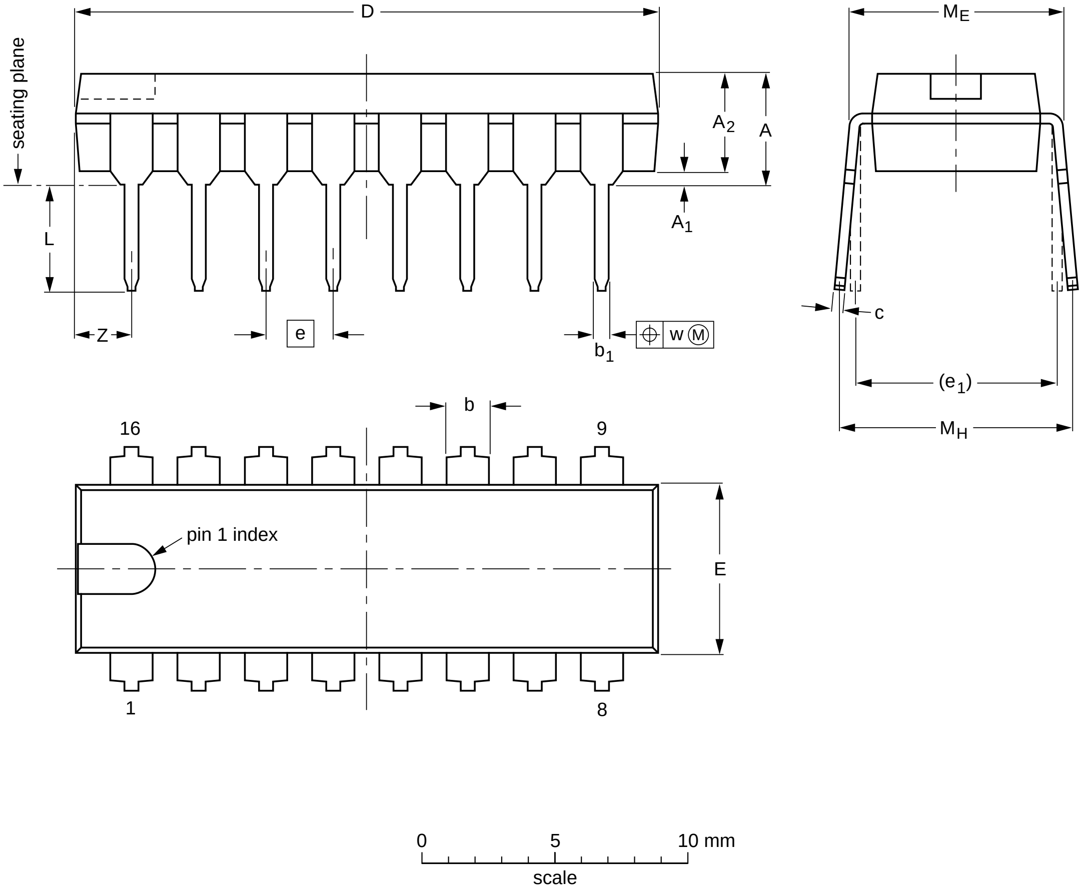


Loop filter depends on VCO parameters.

Fig.6 Application example.

PACKAGE OUTLINES

DIP16: plastic dual in-line package; 16 leads (300 mil); long body SOT38-1

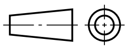


DIMENSIONS (inch dimensions are derived from the original mm dimensions)

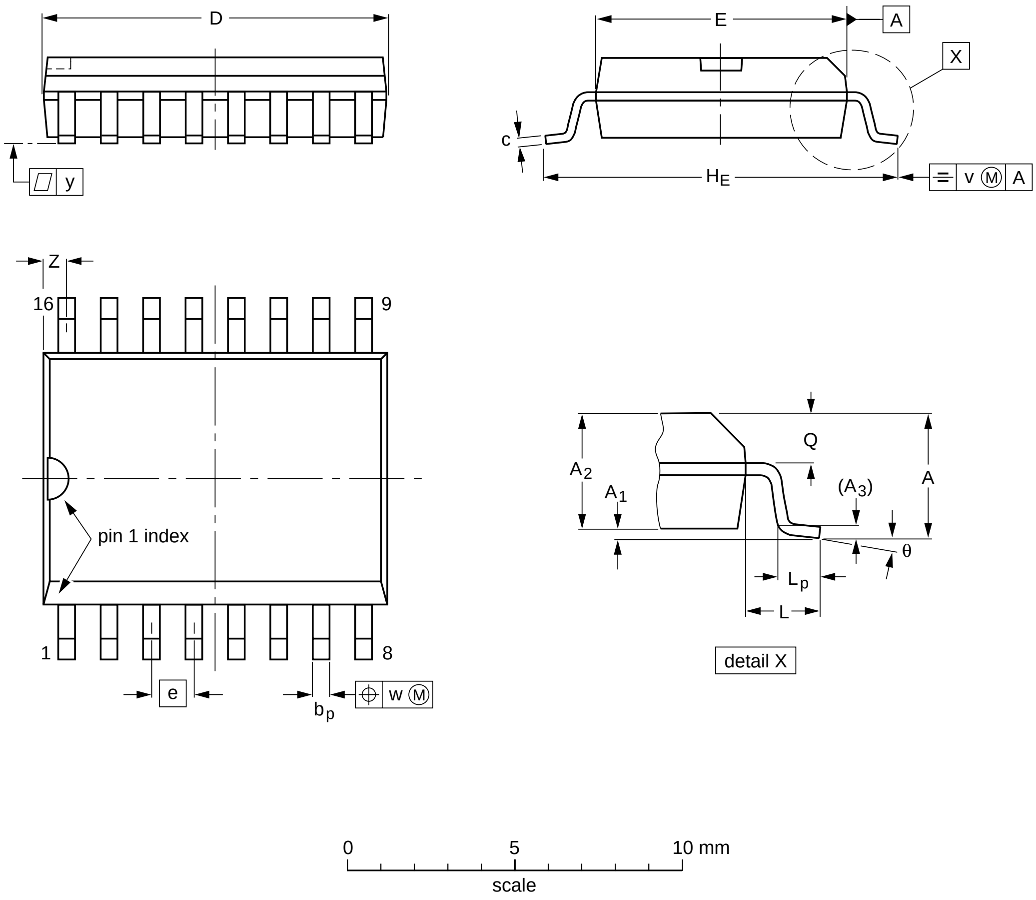
UNIT	A max.	A1 min.	A2 max.	b	b1	c	D (1)	E (1)	e	e1	L	ME	MH	w	Z (1) max.
mm	4.7	0.51	3.7	1.40 1.14	0.53 0.38	0.32 0.23	21.8 21.4	6.48 6.20	2.54	7.62	3.9 3.4	8.25 7.80	9.5 8.3	0.254	2.2
inches	0.19	0.020	0.15	0.055 0.045	0.021 0.015	0.013 0.009	0.86 0.84	0.26 0.24	0.10	0.30	0.15 0.13	0.32 0.31	0.37 0.33	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

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

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 *“Data Handbook IC26; Integrated Circuit Packages”* (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.

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 I^{2}C COMPONENTS

Purchase of Philips I^{2}C components conveys a license under the Philips' I^{2}C patent to use the components in the I^{2}C system provided the system conforms to the I^{2}C specification defined by Philips. This specification can be ordered using the code 9398 393 40011.

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