

DATA SHEET

PCF8570C

**256 × 8-bit static low-voltage RAM
with I²C-bus interface**

Preliminary specification
Supersedes data of August 1994
File under Integrated Circuits, IC12

1997 Apr 01

**256 × 8-bit static low-voltage RAM with
I²C-bus interface****PCF8570C****CONTENTS**

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1 FEATURES

- Operating supply voltage 2.5 to 6.0 V
- Low data retention voltage; minimum 1.0 V
- Low standby current; maximum 15 μ A
- Power-saving mode; typical 50 nA
- Serial input/output bus (I²C-bus)
- Address by 3 hardware address pins
- Automatic word address incrementing
- Available in DIP8 and SO8 packages.

2 APPLICATIONS

- Telephony:
 - RAM expansion for stored numbers in repertory dialling (e.g. PCD33xxA applications)
- General purpose RAM for applications requiring extremely low current and low-voltage RAM retention, such as battery or capacitor-backed.
- Radio, television and video cassette recorder:
 - channel presets
- General purpose:
 - RAM expansion for the microcontroller families PCD33xxA, PCF84CxxxA, P80CLxxx and most other microcontrollers.

3 GENERAL DESCRIPTION

The PCF8570C is a low power static CMOS RAM, organized as 256 words by 8-bits.

Addresses and data are transferred serially via a two-line bidirectional bus (I²C-bus). The built-in word address register is incremented automatically after each written or read data byte. Three address pins, A0, A1 and A2 are used to define the hardware address, allowing the use of up to 8 devices connected to the bus without additional hardware.

4 QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V _{DD}	supply voltage		2.5	6.0	
I _{DD}	supply current (standby)	f _{SCL} = 0 Hz	–	15	μ A
I _{DDR}	supply current (power-saving mode)	T _{amb} = 25 °C	–	400	nA
T _{amb}	operating ambient temperature		–40	+85	°C
T _{stg}	storage temperature		–65	+150	°C

5 ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
PCF8570CP	DIP8	plastic dual in-line package; 8 leads (300 mil)	SOT97-1
PCF8570CT	SO8	plastic small outline package; 8 leads; body width 7.5 mm	SOT176-1

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6 BLOCK DIAGRAM

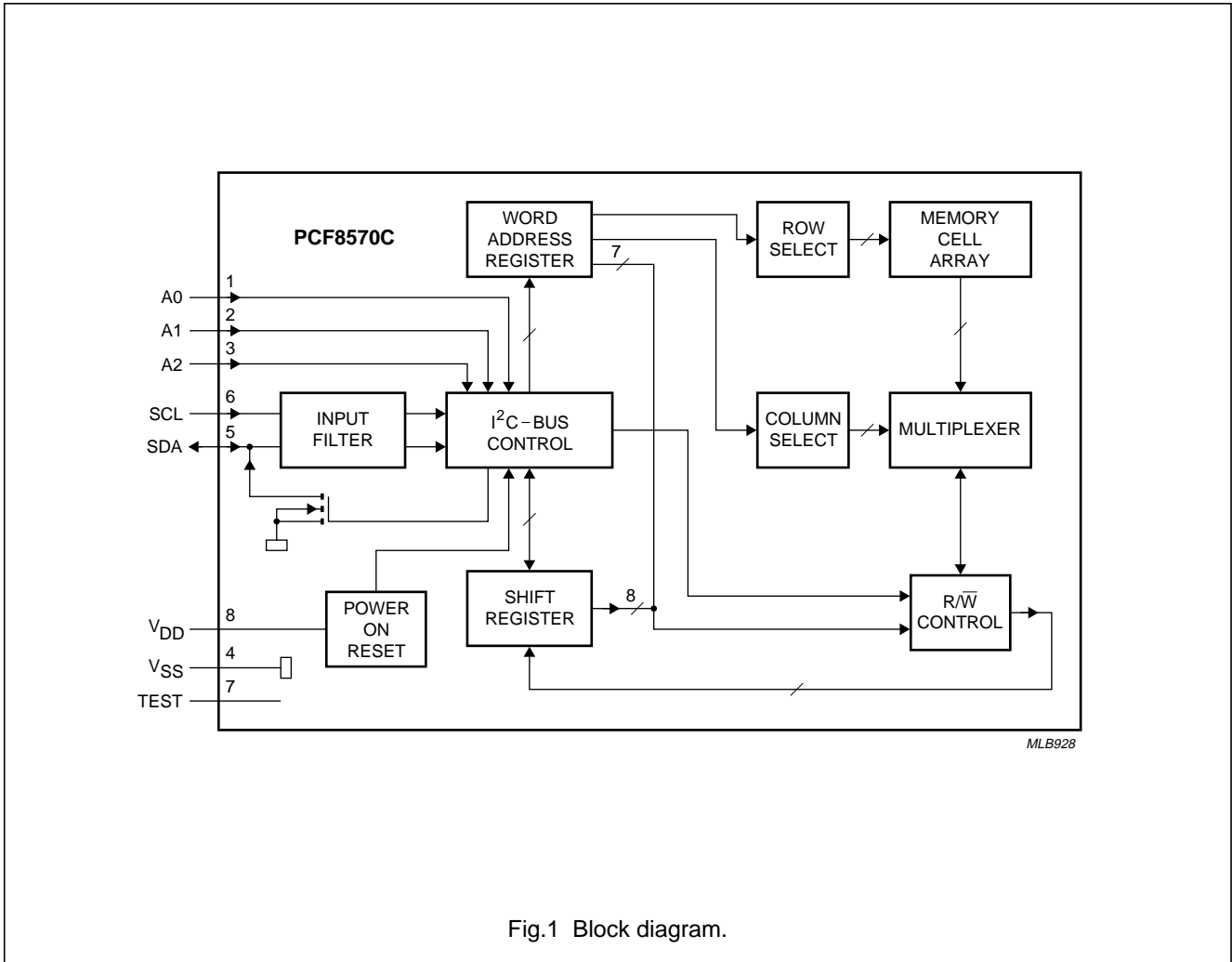


Fig.1 Block diagram.

7 PINNING

SYMBOL	PIN	DESCRIPTION
A0	1	hardware address input 0
A1	2	hardware address input 1
A2	3	hardware address input 2
V _{SS}	4	negative supply
SDA	5	serial data input/output
SCL	6	serial clock input
TEST	7	Input for power-saving mode (see section "Power-saving mode"). Also used as a test output during manufacture. TEST should be tied to V _{SS} during normal operation.
V _{DD}	8	positive supply

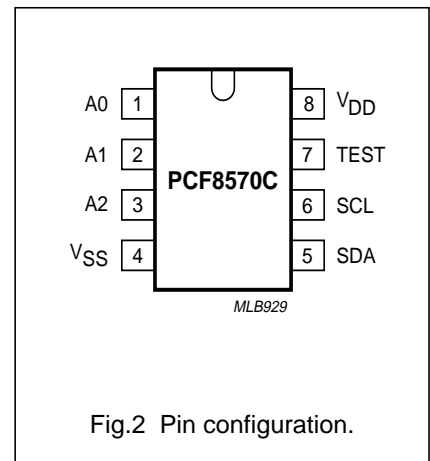


Fig.2 Pin configuration.

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8 CHARACTERISTICS OF THE I²C-BUS

The I²C-bus is for bidirectional, two-line communication between different ICs or modules. The two lines are a serial data line (SDA) and a serial clock line (SCL). Both lines must be connected to a positive supply via a pull-up resistor. Data transfer may be initiated only when the bus is not busy.

8.1 Bit transfer

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the HIGH period of the clock pulse as changes in the data line at this time will be interpreted as a control signal.

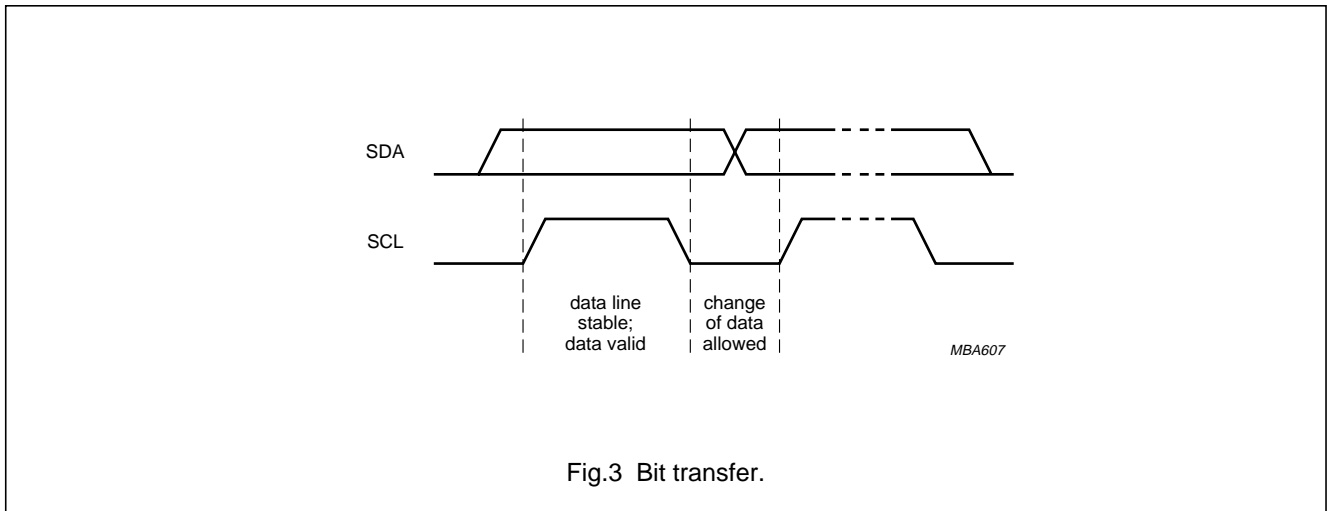


Fig.3 Bit transfer.

8.2 Start and stop conditions

Both data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line, while the clock is HIGH is defined as the start condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the stop condition (P).

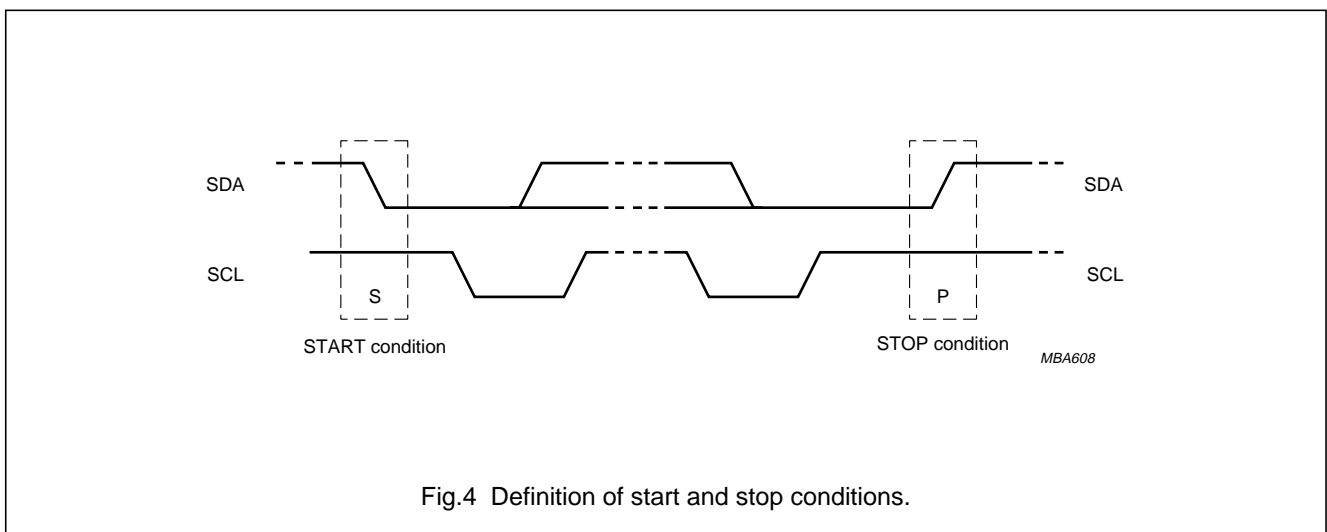


Fig.4 Definition of start and stop conditions.

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8.3 System configuration

A device generating a message is a 'transmitter', a device receiving a message is the 'receiver'. The device that controls the message is the 'master' and the devices which are controlled by the master are the 'slaves'.

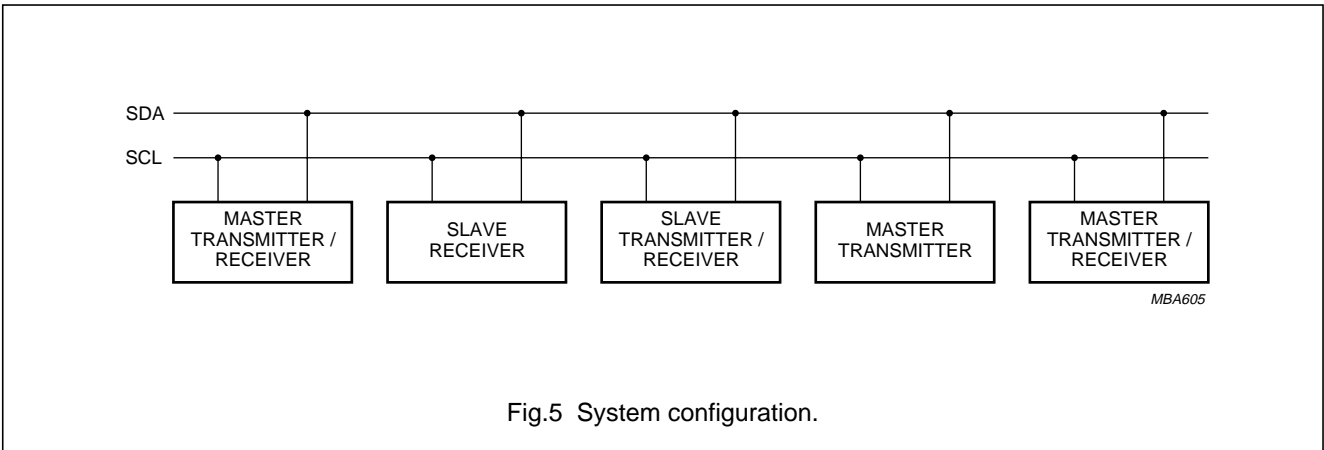


Fig.5 System configuration.

8.4 Acknowledge

The number of data bytes transferred between the start and stop conditions from transmitter to receiver is unlimited. Each byte of eight bits is followed by an acknowledge bit. The acknowledge bit is a HIGH level signal put on the bus by the transmitter during which time the master generates an extra acknowledge related clock pulse. A slave receiver which is addressed must generate an acknowledge after the reception of each byte. Also a master receiver must generate an acknowledge after the reception of each byte that has been clocked out of the slave transmitter.

The device that acknowledges must pull down the SDA line during the acknowledge clock pulse, so that the SDA line is stable LOW during the HIGH period of the acknowledge related clock pulse (set-up and hold times must be taken into consideration). A master receiver must signal an end of data to the transmitter by not generating an acknowledge on the last byte that has been clocked out of the slave. In this event the transmitter must leave the data line HIGH to enable the master to generate a stop condition.

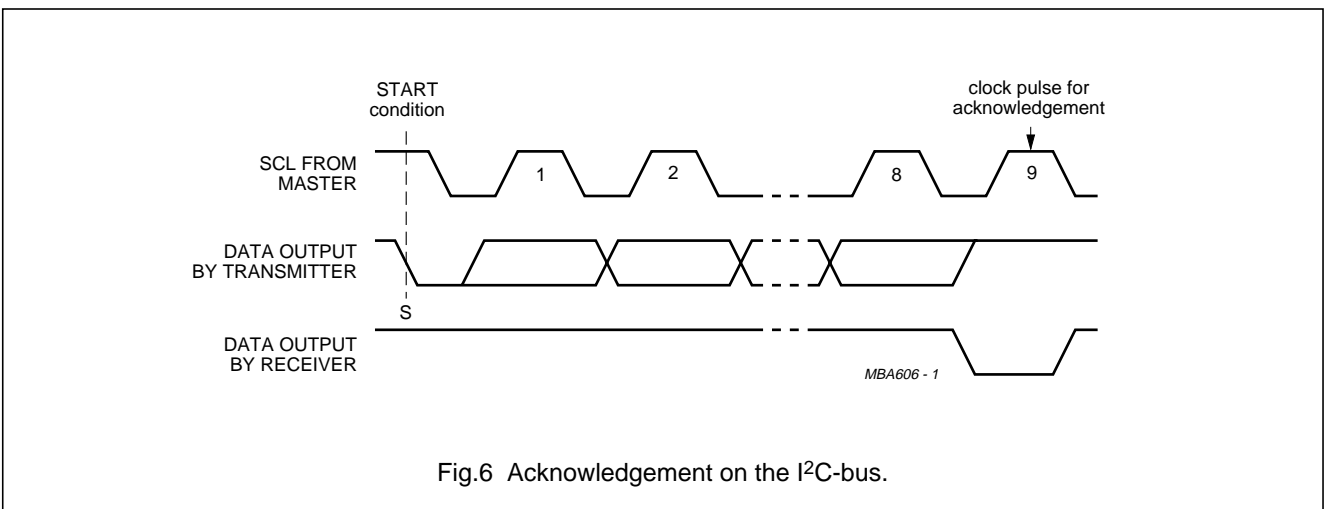


Fig.6 Acknowledgement on the I²C-bus.

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8.5 I²C-bus protocol

Before any data is transmitted on the I²C-bus, the device which should respond is addressed first. The addressing is always carried out with the first byte transmitted after the start procedure. The I²C-bus configuration for the different PCF8570CC WRITE and READ cycles is shown in Figs 7, 8 and 9.

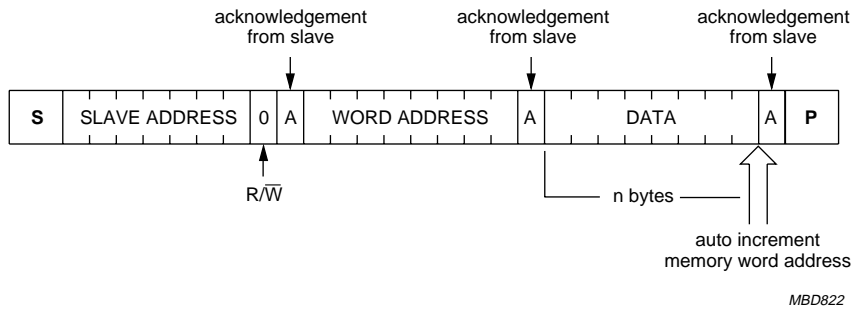


Fig.7 Master transmits to slave receiver (WRITE) mode.

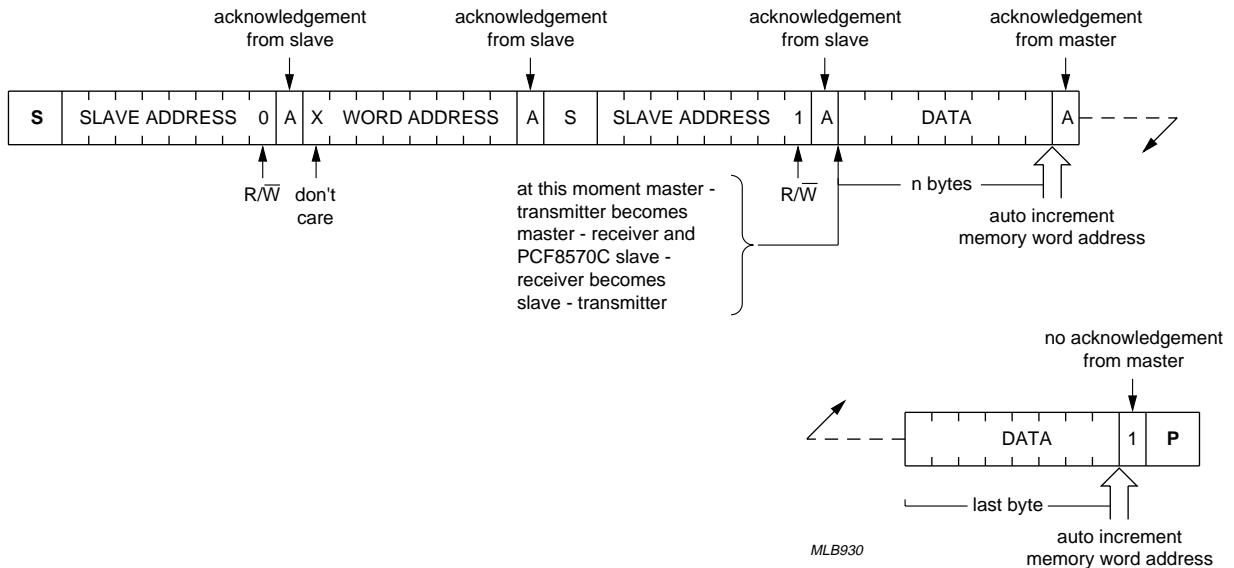


Fig.8 Master reads after setting word address (WRITE word address; READ data).

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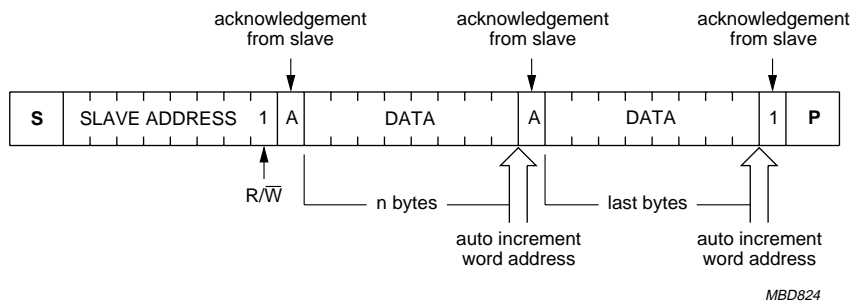


Fig.9 Master reads slave immediately after first byte (READ mode).

9 LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V _{DD}	supply voltage (pin 8)	-0.8	+8.0	V
V _I	input voltage (any input)	-0.8	V _{DD} + 0.8	V
I _I	DC input current	-	±10	mA
I _O	DC output current	-	±10	mA
I _{DD}	positive supply current	-	±50	mA
I _{SS}	negative supply current	-	±50	mA
P _{tot}	total power dissipation per package	-	300	mW
P _O	power dissipation per output	-	50	mW
T _{amb}	operating ambient temperature	-40	+85	°C
T _{stg}	storage temperature	-65	+150	°C

10 HANDLING

Inputs and outputs are protected against electrostatic discharge in normal handling. However, to be totally safe, it is desirable to take precautions appropriate to handling MOS devices. Advice can be found in Data Handbook IC12 under "Handling MOS Devices".

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11 DC CHARACTERISTICS

$V_{DD} = 2.5$ to 6.0 V; $V_{SS} = 0$ V; $T_{amb} = -40$ to $+85$ °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{DD}	supply voltage		2.5	–	6.0	V
I_{DD}	supply current standby mode	$V_I = V_{DD}$ or V_{SS} ; $f_{SCL} = 0$ Hz; $T_{amb} = -25$ to $+70$ °C	–	–	5	μA
	operating mode	$V_I = V_{DD}$ or V_{SS} ; $f_{SCL} = 100$ Hz	–	–	200	μA
V_{POR}	Power-on reset voltage	note 1	1.5	1.9	2.3	V
Inputs, input/output SDA						
V_{IL}	LOW level input voltage	note 2	–0.8	–	$0.3V_{DD}$	V
V_{IH}	HIGH level input voltage	note 2	$0.7V_{DD}$	–	$V_{DD} + 0.8$	V
I_{OL}	LOW level output current	$V_{OL} = 0.4$ V	3	–	–	mA
I_{LI}	input leakage current	$V_I = V_{DD}$ or V_{SS}	–1	–	+1	μA
Inputs A0, A1, A2 and TEST						
I_{LI}	input leakage current	$V_I = V_{DD}$ or V_{SS}	–250	–	+250	nA
Inputs SCL and SDA						
C_i	input capacitance	$V_I = V_{SS}$	–	–	7	pF
Low V_{DD} data retention						
V_{DDR}	supply voltage for data retention		1	–	6	V
I_{DDR}	supply current	$V_{DDR} = 1$ V	–	–	5	μA
		$V_{DDR} = 1$ V; $T_{amb} = -25$ to $+70$ °C	–	–	2	μA
Power-saving mode (see Figs 13 and 14)						
I_{DDR}	supply current	TEST = V_{DD} ; $T_{amb} = 25$ °C	–	50	400	nA
t_{HD2}	recovery time		–	50	–	μs

Notes

- The Power-on reset circuit resets the I²C-bus logic when $V_{DD} < V_{POR}$. The status of the device after a Power-on reset condition can be tested by sending the slave address and testing the acknowledge bit.
- If the input voltages are a diode voltage above or below the supply voltage V_{DD} or V_{SS} an input current will flow; this current must not exceed ± 0.5 mA.

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12 AC CHARACTERISTICS

All timing values are valid within the operating supply voltage and ambient temperature range and reference to V_{IL} and V_{IH} with an input voltage swing of V_{SS} to V_{DD}.

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
I²C-bus timing (see Fig.10; note 1)					
f _{SCL}	SCL clock frequency	–	–	100	kHz
t _{SP}	tolerable spike width on bus	–	–	100	ns
t _{BUF}	bus free time	4.7	–	–	μs
t _{SU;STA}	START condition set-up time	4.7	–	–	μs
t _{HD;STA}	START condition hold time	4.0	–	–	μs
t _{LOW}	SCL LOW time	4.7	–	–	μs
t _{HIGH}	SCL HIGH time	4.0	–	–	μs
t _r	SCL and SDA rise time	–	–	1.0	μs
t _f	SCL and SDA fall time	–	–	0.3	μs
t _{SU;DAT}	data set-up time	250	–	–	ns
t _{HD;DAT}	data hold time	0	–	–	ns
t _{VD;DAT}	SCL LOW-to-data out valid	–	–	3.4	μs
t _{SU;STO}	STOP condition set-up time	4.0	–	–	μs

Note

1. A detailed description of the I²C-bus specification, with applications, is given in brochure "The I²C-bus and how to use it". This brochure may be ordered using the code 9398 393 40011.

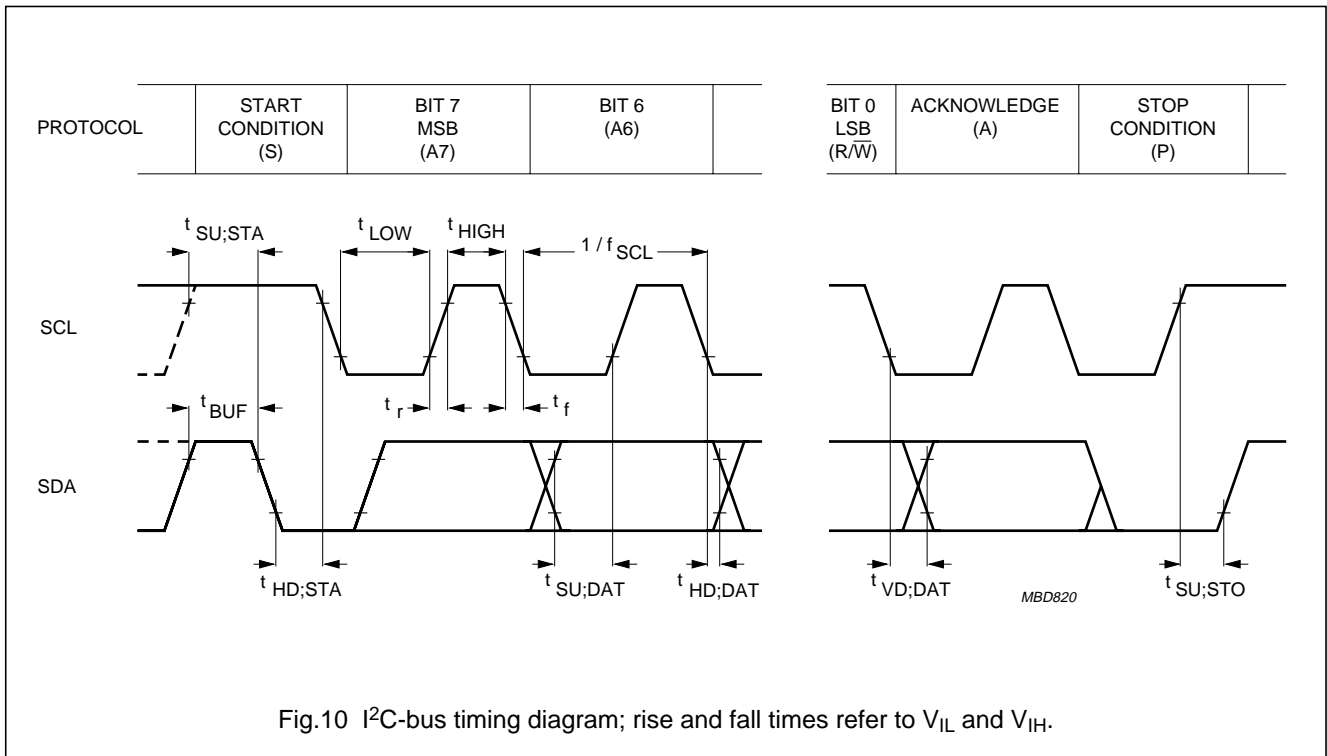


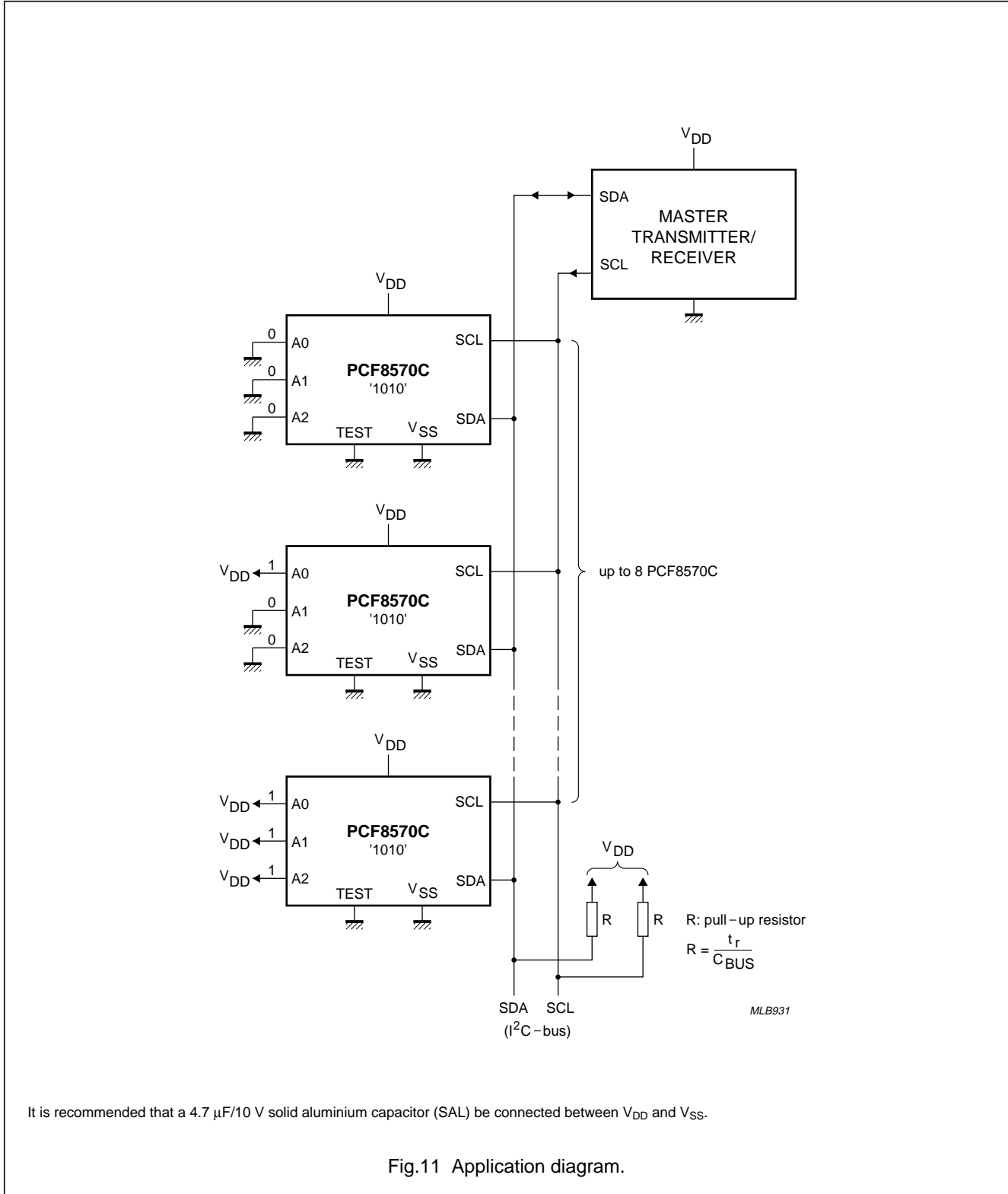
Fig.10 I²C-bus timing diagram; rise and fall times refer to V_{IL} and V_{IH}.

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13 APPLICATION INFORMATION

13.1 Application example



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13.2 Slave address

The PCF8570C has a fixed combination 1 0 1 0 as group 1, while group 2 is fully programmable (see Fig.12).

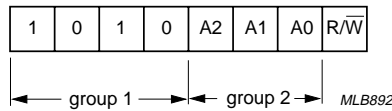
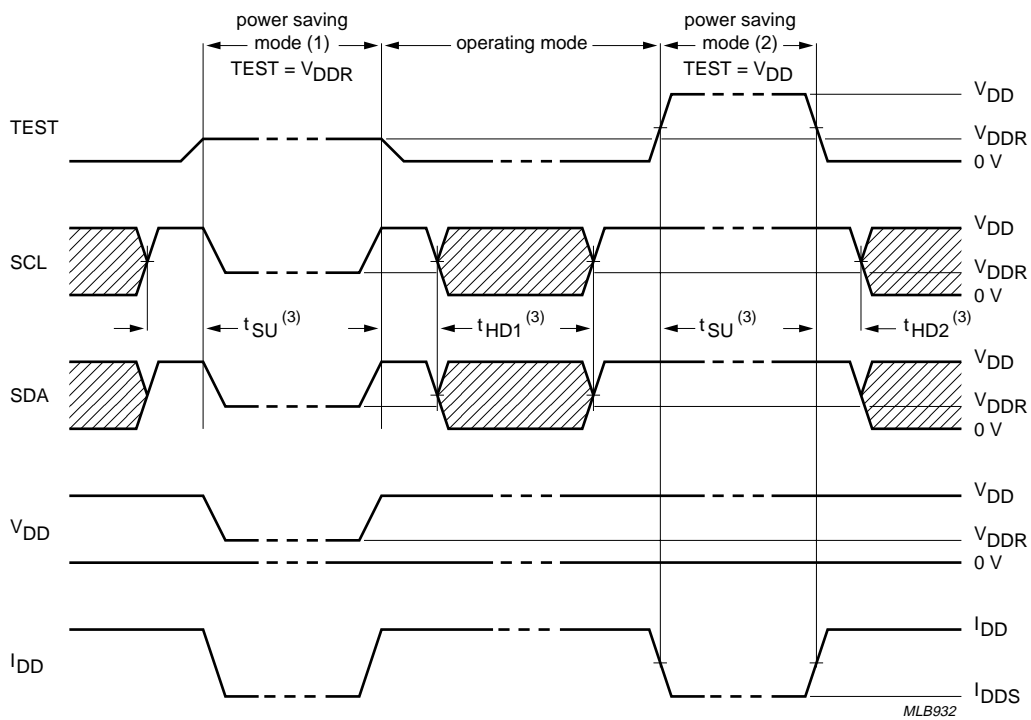


Fig.12 Slave address.

13.3 Power-saving mode

With the condition TEST = V_{DD} or V_{DDR} the PCF8570C goes into the power-saving mode and I²C-bus logic is reset.



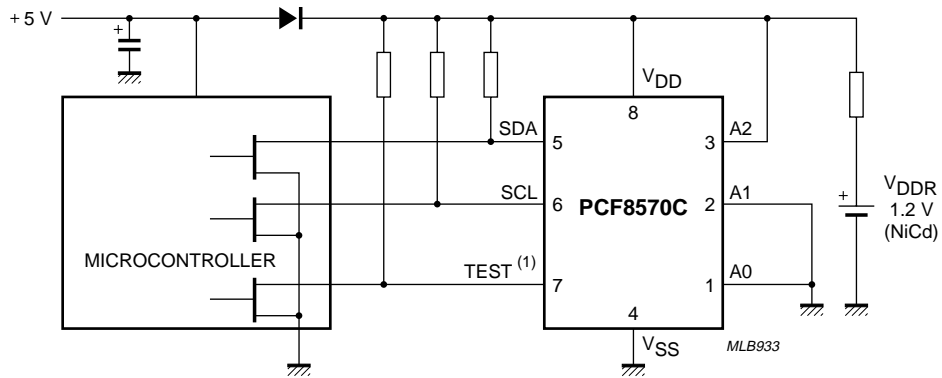
MLB932

- (1) Power-saving mode without 5 V supply voltage.
- (2) Power-saving mode with 5 V supply voltage.
- (3) t_{SU} and t_{HD1} ≥ 4 μs and t_{HD2} ≥ 50 μs.

Fig.13 Timing for power-saving mode.

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It is recommended that a 4.7 μF/10 V solid aluminium capacitor (SAL) be connected between V_{DD} and V_{SS}.

(1) In the operating mode TEST = 0 V; in the power-saving mode TEST = V_{DDR}.

Fig.14 Application example for power-saving mode.

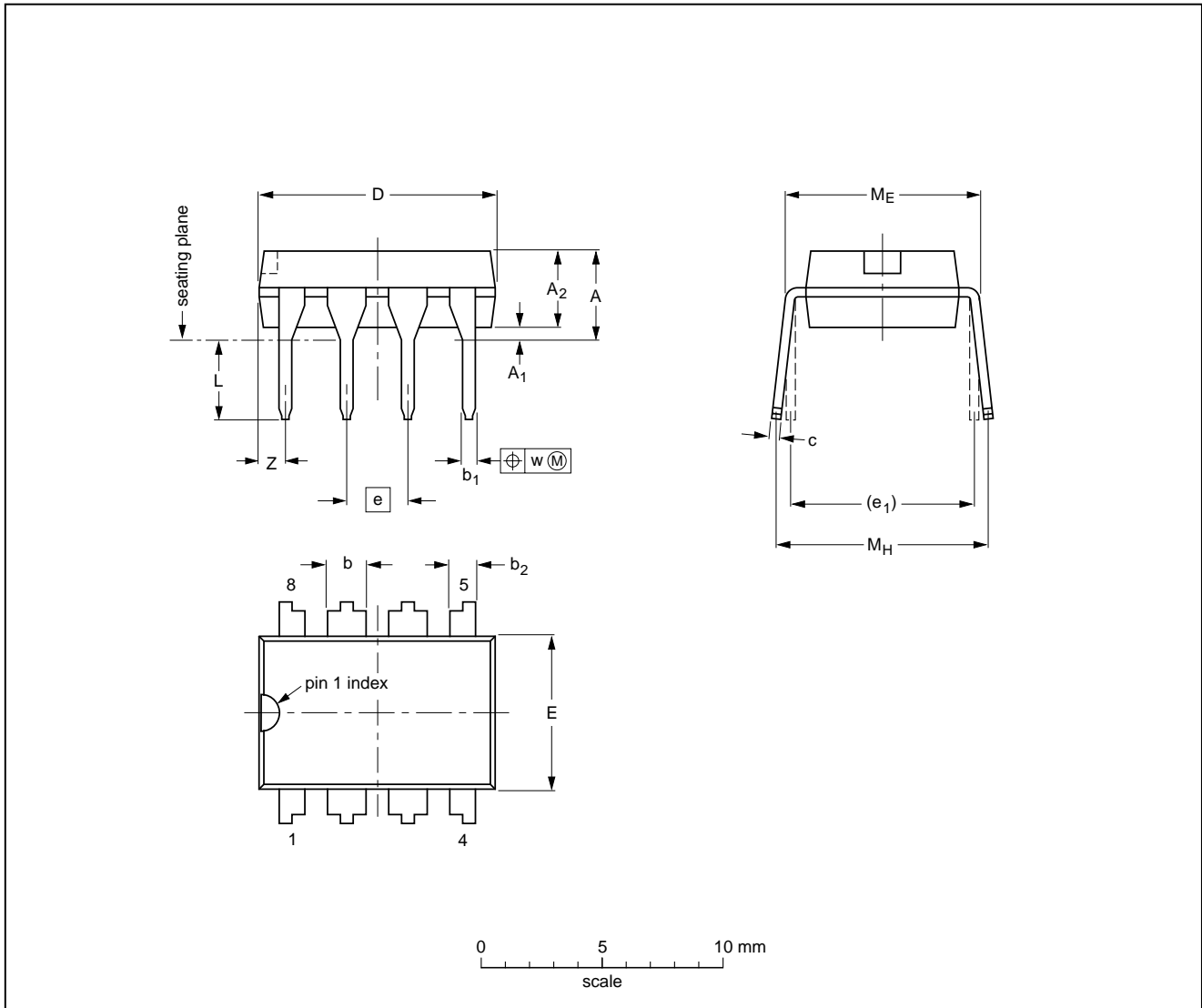
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14 PACKAGE OUTLINES

DIP8: plastic dual in-line package; 8 leads (300 mil)

SOT97-1



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

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	b ₂	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.020	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.045

Note

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

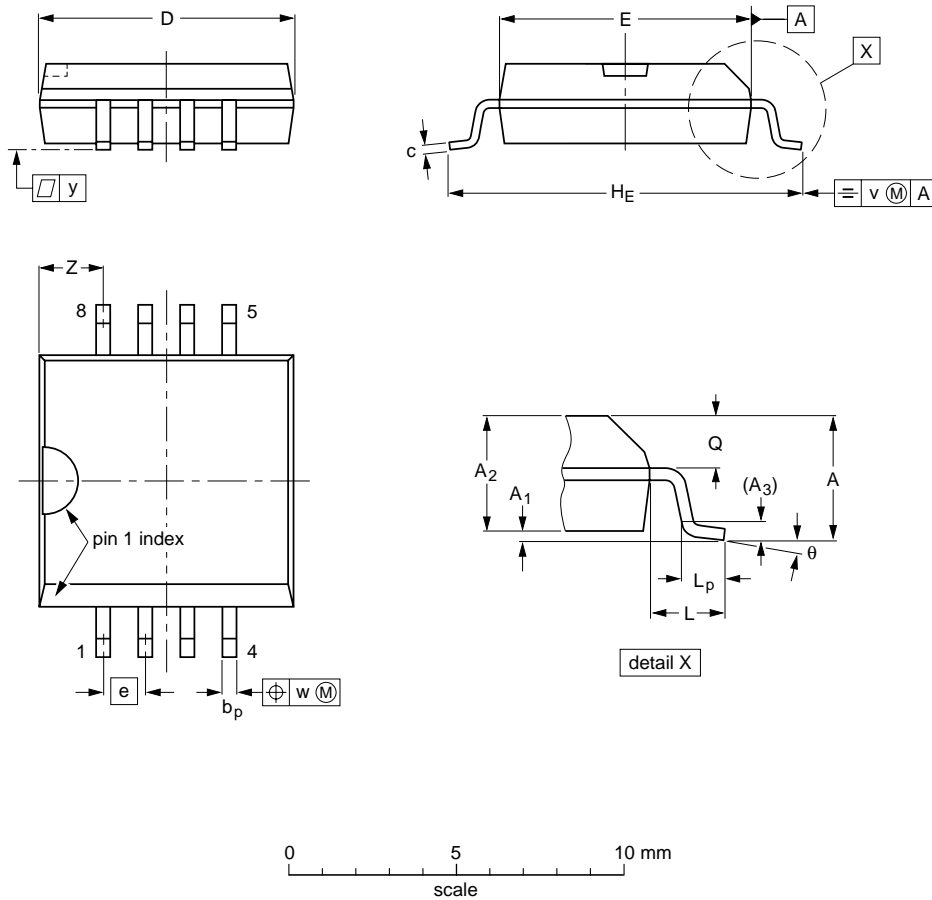
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT97-1	050G01	MO-001AN				92-11-17 95-02-04

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SO8: plastic small outline package; 8 leads; body width 7.5 mm

SOT176-1



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	0.3 0.1	2.45 2.25	0.25	0.49 0.36	0.32 0.23	7.65 7.45	7.6 7.4	1.27	10.65 10.00	1.45	1.1 0.45	1.1 1.0	0.25	0.25	0.1	2.0 1.8	8° 0°
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.30 0.29	0.30 0.29	0.050	0.419 0.394	0.057	0.043 0.018	0.043 0.039	0.01	0.01	0.004	0.079 0.071	

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		
SOT176-1					95-02-25 97-05-22

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15 SOLDERING

15.1 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).

15.2 DIP

15.2.1 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.

15.2.2 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.

15.3 SO

15.3.1 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.

15.3.2 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.

15.3.3 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.

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16 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.	

17 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.

18 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.

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NOTES

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NOTES

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTH RYDE, NSW 2113,
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 689 211, Fax. +359 2 689 102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +45 32 88 2636, Fax. +45 31 57 1949

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615800, Fax. +358 9 61580/xxx

France: 4 Rue du Port-aux-Vins, BP317, 92156 SURESNES Cedex,
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 4894 339/239, Fax. +30 1 4814 240

Hungary: see Austria

India: Philips INDIA Ltd, Shivsagar Estate, A Block, Dr. Annie Besant Rd.
Worli, MUMBAI 400 018, Tel. +91 22 4938 541, Fax. +91 22 4938 722

Indonesia: see Singapore

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, TEL AVIV 61180,
Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZAWA,
Tel. +48 22 612 2831, Fax. +48 22 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 1231,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,
Tel. +27 11 470 5911, Fax. +27 11 470 5494

South America: Rua do Rocio 220, 5th floor, Suite 51,
04552-903 São Paulo, SÃO PAULO - SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 829 1849

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 3 301 6312, Fax. +34 3 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 632 2000, Fax. +46 8 632 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2686, Fax. +41 1 481 7730

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2870, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90 212 279 2770, Fax. +90 212 282 6707

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 625 344, Fax. +381 11 635 777

For all other countries apply to: Philips Semiconductors, Marketing & Sales Communications,
Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: <http://www.semiconductors.philips.com>

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