DATA SHEET

PCF84C00
8-bit microcontroller with I²C-bus interface

Product specification
Supersedes data of May 1996
File under Integrated Circuits, IC14

1996 Nov 25

Philips
Semiconductors

PHILIPS

8-bit microcontroller with I²C-bus interface

PCF84C00

CONTENTS

1 FEATURES

- Manufactured in silicon gate CMOS process
- 8-bit CPU, RAM, I/O in a single 28-lead or 56-lead package
- 'Piggy-back' and ROM-less versions, external program memory
- 256 × 8 RAM
- 20 quasi-bidirectional I/O port lines
- Two test inputs, one of which is also the external interrupt input
- Three single-level vectored interrupts:
  - external
  - timer/event counter
  - I²C-bus
- I²C-bus interface for serial data transfer on two lines (serial I/O data via an existing port line and clock via a dedicated line)
- 8-bit programmable timer/event counter
- Clock frequency range: 100 kHz to 10 MHz
- Over 80 instructions (similar to those of the MAB8048) all of 1 or 2 cycles
- Single supply voltage (2.5 to 5.5 V)
- Stop and Idle modes
- Power-on reset circuit
- Operating temperature range: –40 to +85 °C.

2 GENERAL DESCRIPTION

This data sheet details the specific properties of the PCF84C00. The shared properties of the PCF84CxxxA family of microcontrollers are described in the *"PCF84CxxxA family"* data sheet, which should be read in conjunction with this publication.

The PCF84C00 has 20 quasi-bidirectional I/O lines, an I²C-bus serial interface, a single-level vectored interrupt structure, an 8-bit timer/event counter and on-chip clock oscillator and clock circuits.

This efficient controller also performs well as an arithmetic processor. It has facilities for both binary and BCD arithmetic plus bit-handling capabilities.

The instruction set is similar to the MAB8048 and is a sub-set of that listed in the *"PCF84CxxxA family"* data sheet.

3 ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
PCF84C00B	–	Non-standard 28-lead 'piggy-back' package with 28-pin EPROM socket on top. Bottom 'footprint' and pinning as DIP 28, version SOT117-1. The SOT117-1 information provided in Chapter "Package Outlines" is correct in these respects, but **not** for the physical size of the PCF84C00B, which is larger than the SOT117-1 package.	–
PCF84C00T	VSO56	Plastic very small outline package; 56 leads.	SOT 190-1

4 BLOCK DIAGRAM

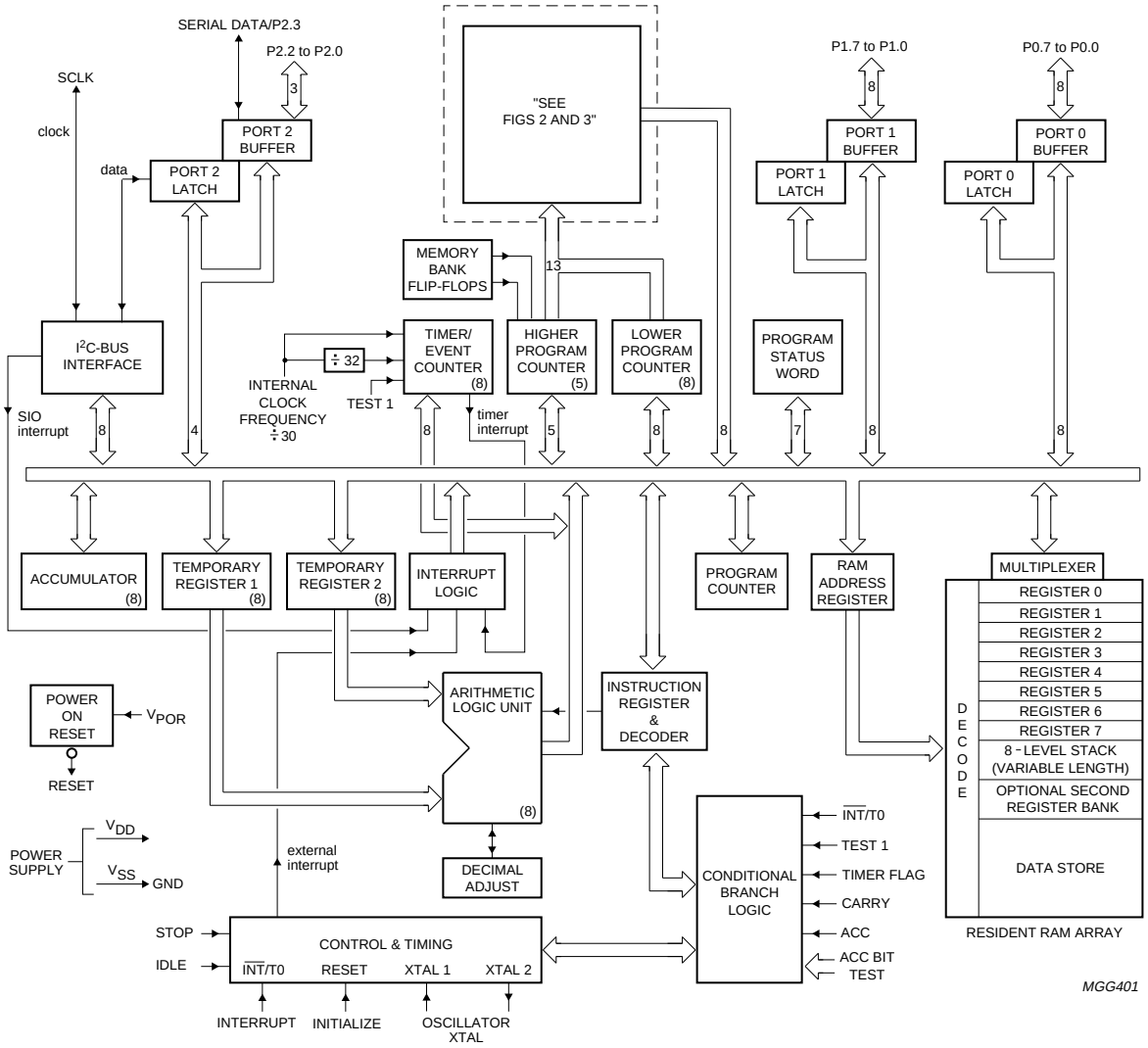


Fig.1 Block diagram.

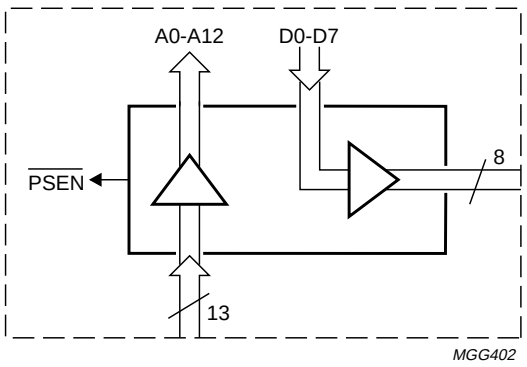


Fig.2 Replacement of dotted section in Fig.1, for the PCF84C00B ‘piggy-back’ version.

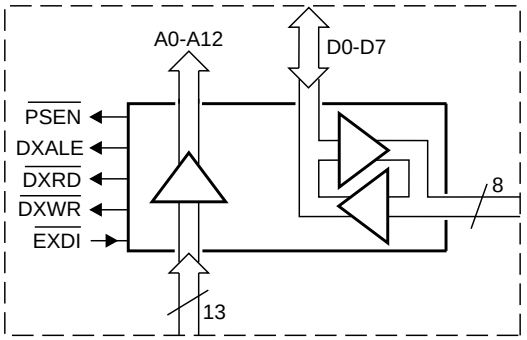


Fig.3 Replacement of dotted section in Fig.1, for the PCF84C00T ROM-less version.

5 PINNING

Table 1 PCF84C00B (see Fig.4)

SYMBOL	PIN	TYPE	DESCRIPTION
P2.2	1	I/O	1 bit of Port 2: 4-bit quasi-bidirectional I/O port
SDA/P2.3	2	I/O	bidirectional data line of the I²C-bus interface; or 1 bit of Port 2: 4-bit quasi-bidirectional I/O line
SCLK	3	I/O	bidirectional clock line of the I²C-bus interface
P0.0 to P0.7	4 to 11	I/O	8 bits of Port 0: 8-bit quasi-bidirectional I/O port
$\overline{INT}$/T0	12	I	Interrupt/Test 0: external interrupt input (negative edge triggered)/test input pin. When used as a test input, this pin is directly tested by conditional branch instructions JT0 and JNT0.
T1	13	I	Test 1: test input pin, directly tested by conditional branch instructions JT1 and JNT1. T1 may also be selected as an input to the 8-bit timer/event counter via the STRT CNT instruction.
V_{SS}	14	P	ground: circuit earth potential
XTAL1	15	I	oscillator input: input from a crystal which determines the internal oscillator frequency or an external clock generator
XTAL2	16	I/O	oscillator output: output of the inverting amplifier
RESET	17	I/O	reset input: used to initialize the microcontroller (active HIGH); also output of power-on-reset circuit
P1.0 to P1.7	18 to 25	I/O	8 bits of Port 1: 8-bit quasi-bidirectional I/O port
P2.0 to P2.1	26, 27	I/O	2 bits of Port 2: 4-bit quasi-bidirectional I/O port
V_{DD}	28	P	power supply: 2.5 V to 5.5 V

Table 2 PCF84C00T (see Fig.5)

SYMBOL	PIN	TYPE	DESCRIPTION
P2.2	1	I/O	1 bit of Port 2: 4-bit quasi-bidirectional I/O port
SDA/P2.3	2	I/O	bidirectional data line of the I²C-bus interface; or 1 bit of Port 2: 4-bit quasi-bidirectional I/O port
SCLK	3	I/O	bidirectional clock line of the I²C-bus interface
P0.0 to P0.1	4, 5	I/O	2 bits of Port 0: 8-bit quasi-bidirectional I/O port
DXALE	6	O	Address latch enable: on the falling edge of DXALE, the Dx address can be latched in an external latch. This signal occurs only during execution of the MOV Dx, A, MOV A, Dx, ANL Dx, A and ORL Dx, A instructions, with x = 0 to 255. It is active during TS10 of cycle 1 and the first half of TS1 of cycle 2.
n.c.	7	–	not connected
P0.2 to P0.7	8 to 13	I/O	6 bits of Port 0: 8-bit quasi-bidirectional I/O port
$\overline{\text{INT}}$/T0	14	I	Interrupt/Test 0: external interrupt input (negative edge triggered)/test input pin. When used as a test input, this pin is directly tested by conditional branch instructions JT0 and JNT0; note 1.
T1	15	I	Test 1: test input pin, directly tested by conditional branch instructions JT1 and JNT1. T1 may also be selected as an input to the 8-bit timer/event counter via the STRT CNT instruction.
D0 to D2	16 to 18	I/O	3 bits of 8-bit data bus: for external memory and peripherals. The specified Stop mode supply current is valid only if external pull-ups are connected to all data lines.
A12	19	O	1 bit of 13-bit address bus: for external memory and peripherals
$\overline{\text{DXWR}}$	20	O	Write strobe (active LOW): on the rising edge, data on D0-D7 may be written to external registers. This signal occurs only during MOV Dx, A, ANL Dx, A and ORL Dx, A instructions, with x = 0 to 255. It is active during TS7 of cycle 2.
n.c.	21	–	not connected
A11 to A6	22 to 27	O	6 bits of 13-bit address bus: for external memory and peripherals
V_{SS}	28	P	ground: circuit earth potential
A5 to A0	29 to 34	O	6 bits of 13-bit address bus: for external memory and peripherals
$\overline{\text{DXRD}}$	35	O	Read strobe (active LOW): when this signal is active, external registers emulating Dx registers can be read by the data bus. This signal occurs only during execution of MOV A, Dx, ANL Dx, A and ORL Dx, A instructions, with x = 0 to 255. It is active during TS3 and TS4 of cycle 2.
D3 to D7	36 to 40	I/O	5 bits of 8-bit data bus: for external memory and peripherals. The specified Stop mode supply current is valid only if external pull-ups are connected to all data lines.
$\overline{\text{PSEN}}$	41	O	Program store enable (active LOW): $\overline{\text{PSEN}}$ is used to enable external program memory and is active during TS9 and TS10 of each machine cycle and TS1 of each following cycle. $\overline{\text{PSEN}}$ is HIGH during the Stop mode.
XTAL1	42	I	oscillator input: input from a crystal which determines the internal oscillator frequency or an external clock generator
XTAL2	43	I/O	oscillator output: output of the inverting amplifier

SYMBOL	PIN	TYPE	DESCRIPTION
RESET	44	I/O	reset input: used to initialize the microcontroller (active HIGH); also output of power-on-reset circuit
P1.0 to P1.3	45 to 48	I/O	4 bits of Port 1: 8-bit quasi-bidirectional I/O port
$\overline{EXDI}$	49	I	External derivative interrupt (active LOW): $\overline{EXDI}$ is 'OR-ed' with the internal serial interrupt and can be used to initiate an interrupt from external hardware emulating derivative functions. $\overline{EXDI}$ is pulled HIGH internally. The derivative interrupt is polled during time slot TS6 (note 1), and is only accepted if an EN SI instruction has been executed and the device is not already executing an interrupt routine. Derivative interrupts are not latched in the PCF84C00.
P1.4 to P1.7	50 to 53	I/O	4 bits of Port 1: 8-bit quasi-bidirectional I/O port
P2.0 to P2.1	54, 55	I/O	2 bits of Port 2: 4-bit quasi-bidirectional I/O port
V_{DD}	56	P	power supply: 2.5 V to 5.5 V

Note

1. The interrupt signal must remain active until the vector address (05 H) is present on the address bus.

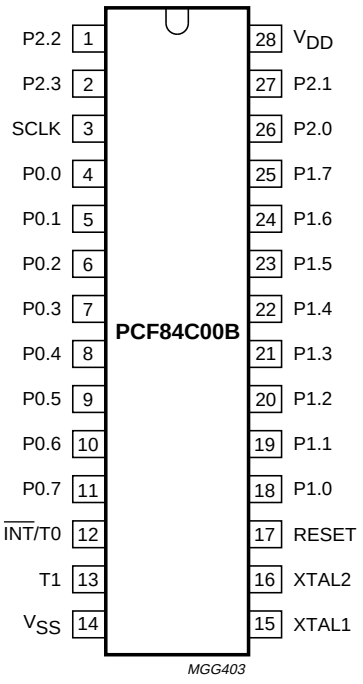


Fig.4 Bottom pinning diagram, 'piggy-back' version PCF84C00B.

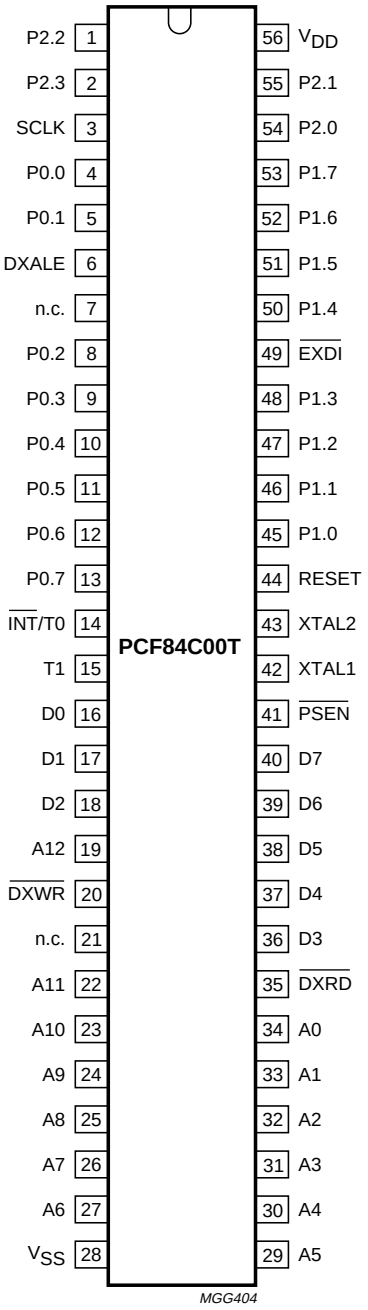


Fig.5 Pinning diagram; ROM-less version PCF84C00T.

6 FUNCTIONAL DESCRIPTION

6.1 'Piggy-back' version PCF84C00B

The PCF84C00B package has standard pinning on the bottom to facilitate insertion as a mask-programmed device. An EPROM can be mounted on top in an additional socket. The total package height is greater than the height of a standard DIP package. The PCF84C00B can address up to 8 kbytes of external ROM/RAM, and has 256 bytes of internal data RAM.

6.2 ROM-less version PCF84C00T

The PCF84C00T microcontroller contains no on-chip ROM, but has all address and data lines brought out to access an external ROM or EPROM. Consequently, this version has more pins (see Fig.5) than the devices in the PCF84CxxxA family with on-chip or 'piggy-back' ROM. The PCF84C00T can address up to 8 kbytes of external program memory, and has 256 bytes of internal data RAM.

6.3 Data memory

Data memory consists of 256 bytes of Random-Access Memory (RAM). All locations are indirectly addressable using RAM pointer registers; up to 16 designated locations are directly addressable. Memory also includes an 8-level program counter stack addressed by a 3-bit stack pointer.

6.4 I/O facilities

Each device has 23 I/O lines arranged as follows:

- Port 0; 8-bit parallel port (P0.0-P0.7)
- Port1; 8-bit parallel port (P1.0-P1.7)
- Port 2; 4-bit parallel port (P2.0-P2.3)
- SCLK ; I²C-bus (serial I/O) clock line
- $\overline{\text{INT}}$/T0; External interrupt and test input. When used as a test input, it can be directly tested by conditional branch instructions JT0 and JNT0.
- T1; Test input which can alter program sequences when tested by conditional jump instructions JT1 and JNT1. T1 also functions as an input to the 8-bit timer/event counter.

6.5 Reset

A positive-going signal on the RESET input/output:

- Sets the program counter to zero
- Selects location 0 of memory bank 0 and register bank 0
- Sets the stack pointer to zero (000); pointing to RAM address 8
- Disables the interrupts (external, timer and I²C-bus)
- Stops the timer/event counter, then sets it to zero
- Sets the timer prescaler to divide by 32
- Resets the timer flag
- Sets all ports except P2.3 to input mode
- Sets the I²C-bus interface to slave receiver mode and disables the I²C-bus interface
- Cancels Idle and Stop mode.

A negative-going signal on the RESET input/output:

- Sets P2.3/SDA and SCLK to HIGH after a maximum of 30 clock pulses
- Sets the I²C-bus interface to slave receiver mode and disables the I²C-bus interface after a maximum of 30 clock pulses
- Starts program execution after 1866 clock pulses.

7 LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DD}	supply voltage		–0.8	+8	V
V_I	all input voltages		–0.5	V_{DD}+0.5	V
I_I	DC input current		–10	+10	mA
I_O	DC output current		–10	+10	mA
P_{tot}	total power dissipation		–	125	mW
T_{stg}	storage temperature		–65	+150	°C

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
T_{amb}	operating ambient temperature range	$P_{tot(max)}$ = 100 mW	–40	+70	°C
		$P_{tot(max)}$ = 30 mW	–40	+85	°C
T_j	operating junction temperature		–	90	°C

8 HANDLING

Inputs and outputs are protected against electrostatic discharge in normal handling. However, it is good practice to take normal precautions appropriate to handling MOS devices. See *"Data Handbook IC14 Section: Handling MOS devices"*.

9 DC CHARACTERISTICS

V_{DD} = 2.5 to 5.5 V; V_{SS} = 0 V; T_{amb} = –40 to +85 °C; all voltages with respect to V_{SS}; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{DD}	operating supply voltage	see Fig.6	2.5	–	5.5	V
I_{DD}	operating supply current	note 1; see Fig.7				
		V_{DD} = 5 V; f_{xtal} = 10 MHz	–	1.6	3.2	mA
		V_{DD} = 5 V; f_{xtal} = 6 MHz	–	1	2	mA
		V_{DD} = 3 V; f_{xtal} = 3.58 MHz	–	0.3	0.6	mA
$I_{DD(idle)}$	supply current (Idle mode)	note 1; see Fig.8				
		V_{DD} = 5 V; f_{xtal} = 10 MHz	–	0.8	1.6	mA
		V_{DD} = 5 V; f_{xtal} = 6 MHz	–	0.5	1	mA
		V_{DD} = 3 V; f_{xtal} = 3.58 MHz	–	0.15	0.4	mA
$I_{DD(stp)}$	supply current (Stop mode)	notes 1 and 2; see Fig.9				
		V_{DD} = 2.5 V; T_{amb} = 25 °C	–	1.2	2.5	µA
		V_{DD} = 2.5 V; T_{amb} = 85 °C	–	–	10	µA
Inputs						
V_{IL}	LOW level input voltage		0	–	$0.3V_{DD}$	V
V_{IH}	HIGH level input voltage		$0.7V_{DD}$	–	V_{DD}	V
I_{LI}	input leakage current	$V_{SS} < V_I < V_{DD}$	–1	–	+1	µA
Outputs						
I_{OL}	LOW level output sink current	V_{DD} = 5 V ±10%; V_O = 0.4 V (except P2.3/SDA, SCLK and Port 1); see Fig.10	1.6	3	–	mA
		P2.3/SDA, SCLK; see Figs 11 and 12	3	–	–	mA
I_{OH}	HIGH level pull-up output source current	V_{DD} = 5 V ±10%; V_O = $0.7V_{DD}$	–40	–	–	µA
		V_{DD} = 5 V ±10%; V_O = V_{ss}	–	–	–400	µA
I_{OH}	HIGH level push-pull output source current	V_{DD} = 5 V ±10%; V_O = V_{DD} – 0.4 V; see Fig.13	–1.6	–3	–	mA

Notes

1. V_{IL} = V_{SS}; V_{IH} = V_{DD}; open drain outputs connected to V_{SS}; all other outputs, including XTAL2, open (typical values at 25 °C with crystal connected between XTAL1 and XTAL2).
2. V_{IL} = V_{SS}; V_{IH} = V_{DD}; RESET and T1 at V_{SS}; $\overline{INT}$/T0 at V_{DD}; crystal connected between XTAL1 and XTAL2; open drain outputs connected to V_{SS}; all other outputs open.

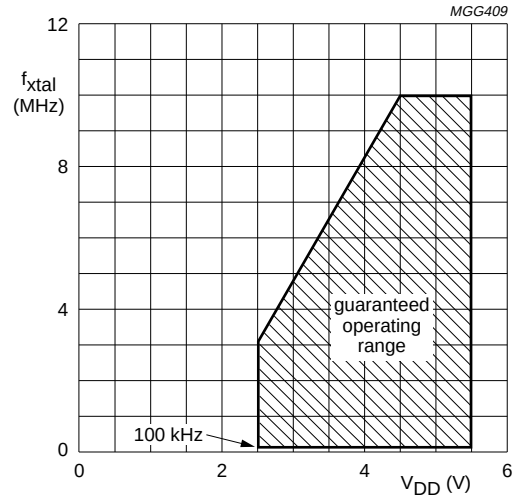
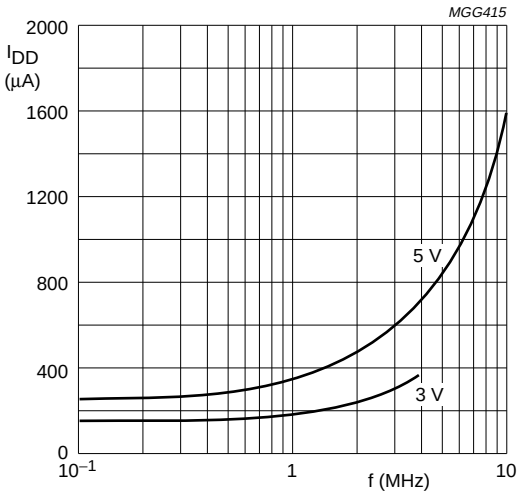
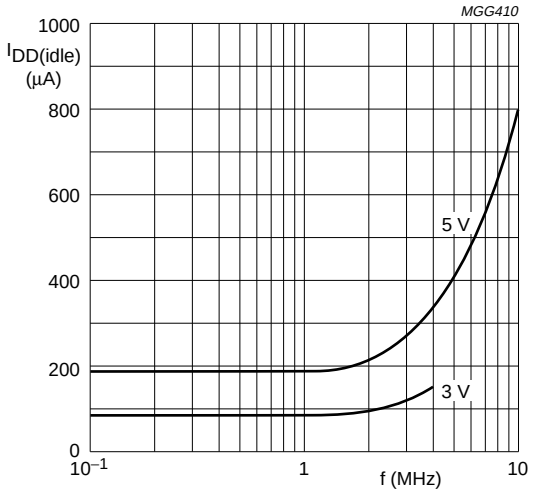


Fig.6 Maximum clock frequency (f_{xtal}) as a function of the supply voltage.



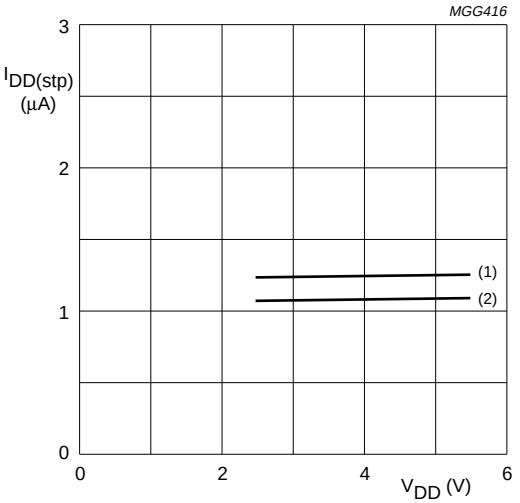
V_{DD} = 5 V.
V_{DD} = 3 V.

Fig.7 Typical operating supply current (I_{DD}) as a function of clock frequency (f_{xtal}).



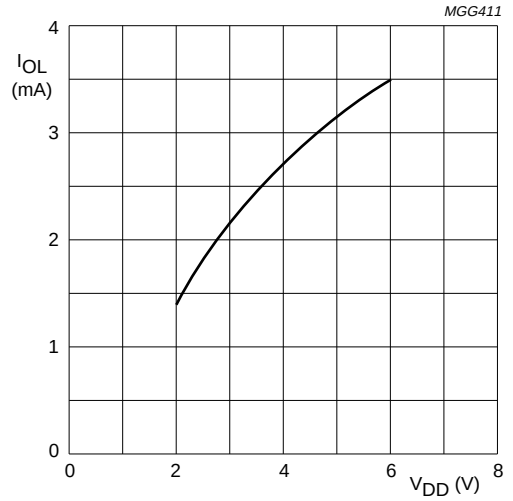
V_{DD} = 5 V.
V_{DD} = 3 V.

Fig.8 Typical supply current in Idle mode ($I_{DD(idle)}$) as a function of clock frequency (f_{xtal}).



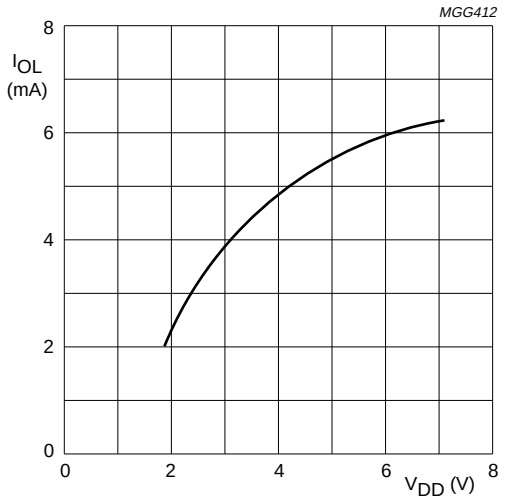
(1) T_{amb} = 85 °C.
(2) T_{amb} = 25 °C.

Fig.9 Typical supply current in Stop mode ($I_{DD(stp)}$) as a function of the supply voltage (V_{DD}).



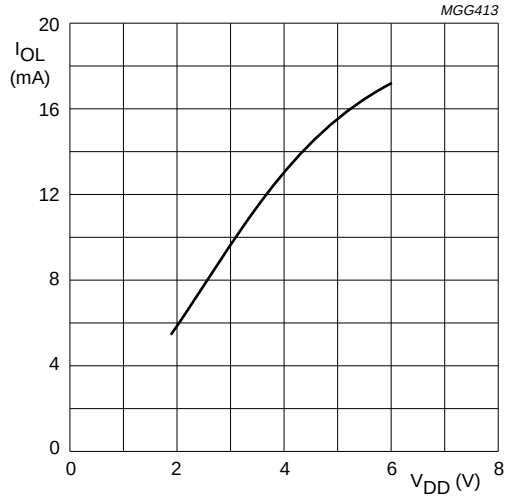
V_O = 0.4 V.

Fig.10 Typical output sink current (I_{OL}), outputs P0.0 to P0.7 and P2.0 to P2.2, as a function of the supply voltage (V_{DD}).



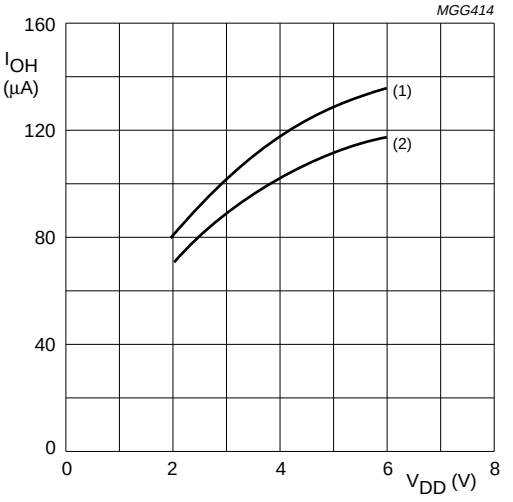
V_O = 0.4 V.

Fig.11 Typical output sink current (I_{OL}), outputs P2.3/SDA and SCLK, as a function of the supply voltage (V_{DD}).



V_O = 1.2 V.

Fig.12 Typical output sink current (I_{OL}), outputs P1.0 to P1.7, as a function of the supply voltage (V_{DD}).



(1) $V_O = V_{SS}$.
(2) $V_O = 0.7V_{DD}$.

Fig.13 Typical push-pull output source current (I_{OH}) as a function of the supply voltage (V_{DD}).

10 AC CHARACTERISTICS

V_{DD} = 2.5 to 5.5 V; V_{SS} = 0 V; T_{amb} = –40 to +85 °C; all voltages with respect to V_{SS}; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.(2)	MAX.	UNIT
t_r	rise time all outputs	note 1	–	30	–	ns
t_f	fall time all outputs	note 1	–	30	–	ns
T_{cy}	cycle time	30CP; note 2	3	–	30	µs
PCF84C00/non-standard pins:						
t_{CC}	control pulse width	Fig.16	–	9CP	–	µs
t_{AS}	address to $\overline{\text{PSEN}}$ set-up	Fig.16	–	1.5CP	–	µs
t_{DS}	data to $\overline{\text{PSEN}}$ set-up	Fig.16	–	2CP	–	µs
t_{DR}	data hold time	Fig.16	0	–	–	ns
t_{SDO}	data out to $\overline{\text{DWXR}}$ set-up	Fig.17	–	2CP	–	µs
t_{HDO}	data out to $\overline{\text{DXWR}}$ hold	Fig.17	–	1CP	–	µs
t_{SLPH}	time from DXALE to $\overline{\text{PSEN}}$	Figs 14, 15 and 17	–	1.5CP	–	µs
t_{DS1}	data-in to $\overline{\text{DXRD}}$ set-up	Figs 14, 15 and 17	–	2.5CP	–	µs
t_{DR1}	data-in to $\overline{\text{DXRD}}$ hold	Figs 14 and 17	0	–	–	ns
t_{DXALE}	HIGH time of DXALE	Figs 14, 15 and 17	–	4.5CP	–	µs
t_{DXRD}	LOW time of $\overline{\text{DXRD}}$	Figs 14 and 17	–	6CP	–	µs
t_{DXWR}	LOW time of $\overline{\text{DXWR}}$	Figs 15 and 17	–	3CP	–	µs

Notes

1. At V_{DD} = 5 V; T_{amb} = 25 °C; C_L = 50 pF.
2. 1 time slot (TS) = 3CP, 1 clock pulse (CP) = $1/f_{xtal}$.

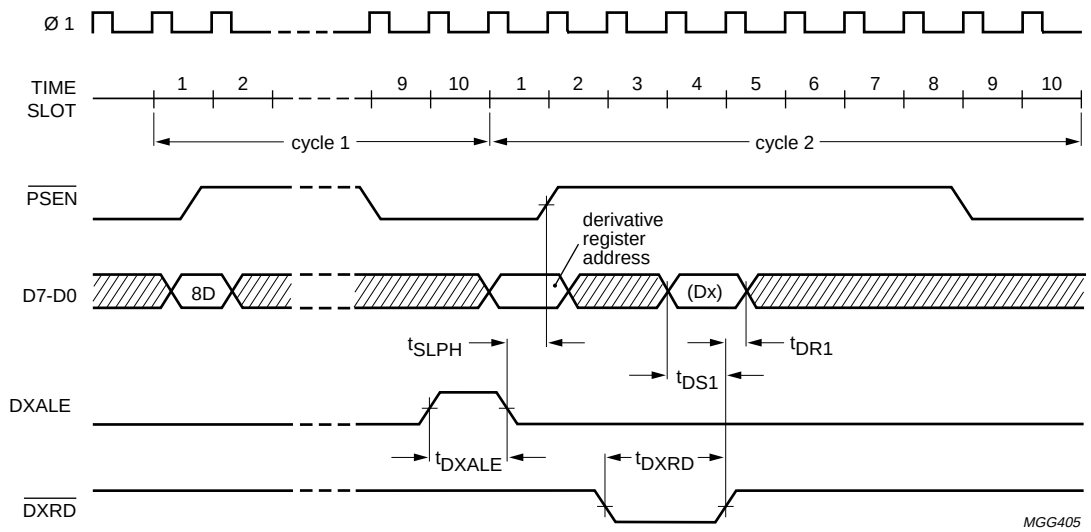


Fig.14 MOV A, Dx timing (PCF84C00T only).

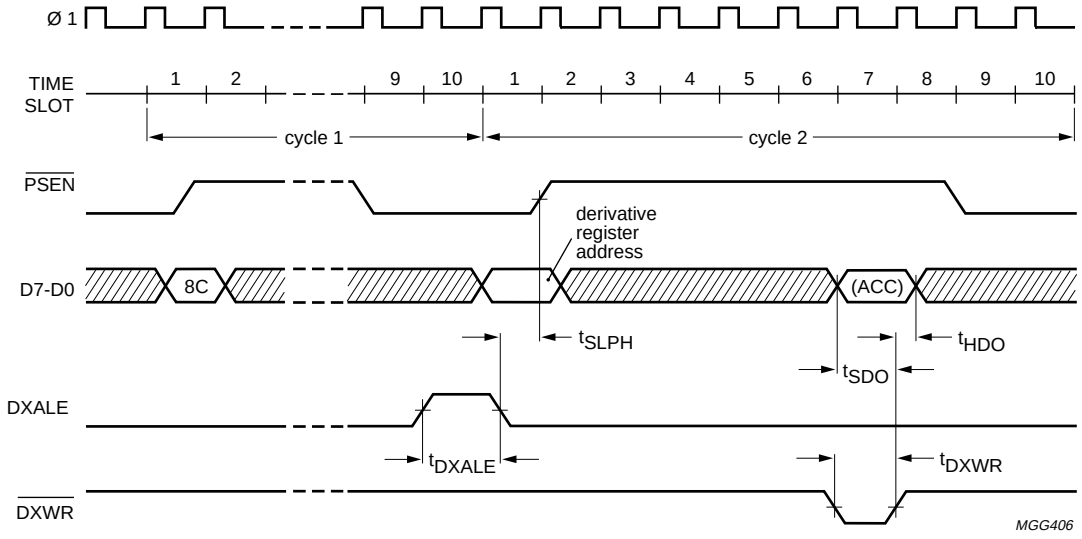


Fig.15 MOV Dx, A timing (PCF84C00T only).

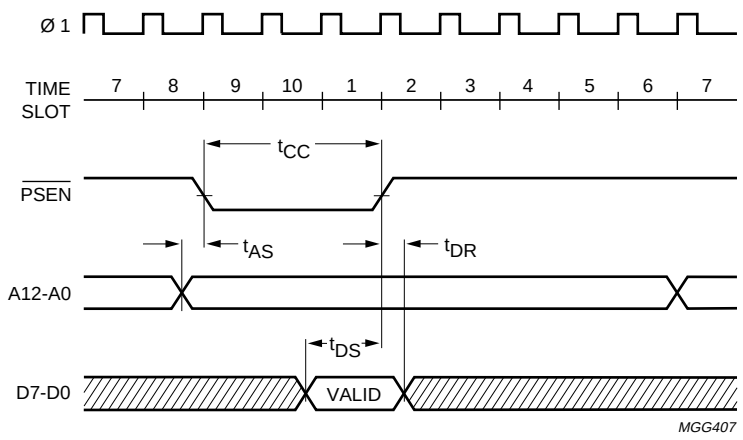


Fig.16 External memory access timing (PCF84C00T and PCF84C00B).

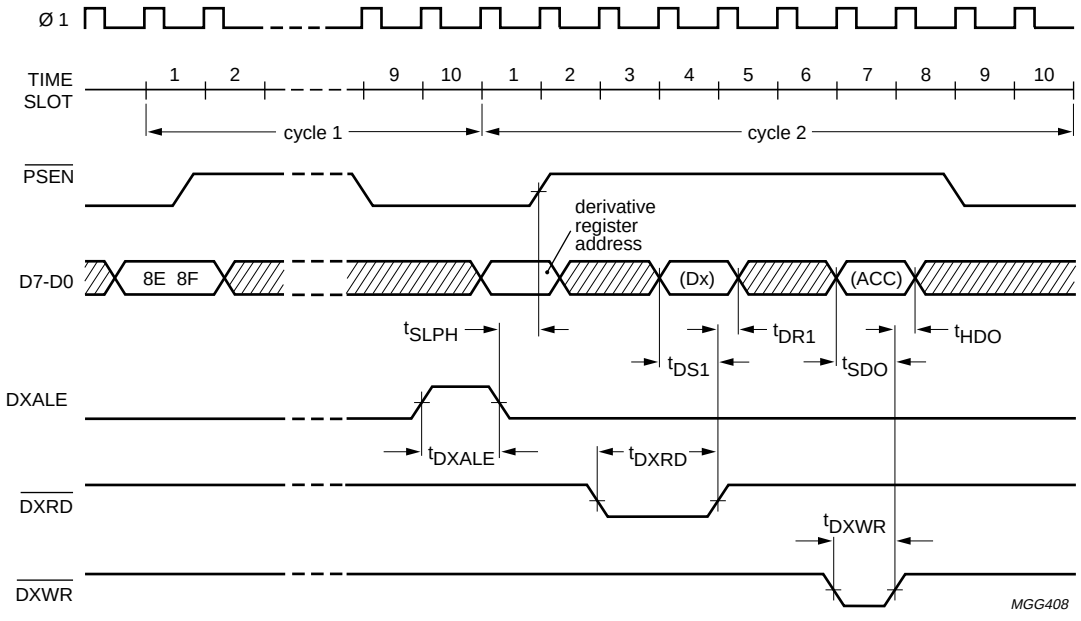


Fig.17 ANL/ORL derivative interface timing (PCF84C00T only).

Table 3 I²C-bus timing

SYMBOL	PARAMETER	INPUT (see Fig.18)	OUTPUT (see Fig.19; note 1)
SCLK			
$t_{HD;STA}$	START condition hold time	$\geq \frac{14}{f_{xtal}}$	$\frac{DF+9}{2 \times f_{xtal}}$
t_{LOW}	SCLK LOW time	$\geq \frac{17}{f_{xtal}}$	$\frac{DF-3}{2 \times f_{xtal}}$; note 2
t_{HIGH}	SCLK HIGH time	$\geq \frac{17}{f_{xtal}}$	$\frac{DF+3}{2 \times f_{xtal}}$; note 2
t_{RC}	SCLK rise time	≤1 µs	≤1 µs; note 3
t_{FC}	SCLK fall time	≤0.3 µs	≤0.1 µs; note 4
SDA			
t_{BUF}	bus free time	$\geq \frac{14}{f_{xtal}}$	≥ 4.7 µs; note 5
$t_{SU;DAT}$	data set-up time	≥250 ns	$\geq \frac{15}{f_{xtal}}$; note 6
$t_{HD;DAT}$	data hold time	≥ 0	$\geq \frac{9}{f_{xtal}}$
t_{RD}	SDA/P2.3 rise time	≤1 µs	≤1 µs; note 3
t_{FD}	SDA/P2.3 fall time	≤0.3 µs	≤0.1 µs; note 4
$t_{SU;STO}$	STOP condition set-up time	$\geq \frac{14}{f_{xtal}}$	$\frac{DF-3}{2 \times f_{xtal}}$

Notes

1. DF stands for Division Factor: the divisor of f_{xtal} (see the *"PCF84CxxxA family"* data sheet).
2. Values given for ASC = 0; for ASC =1: $t_{HIGH} = \frac{3\,(DF+1)}{4 \times f_{xtal}}$; $t_{LOW} = \frac{DF-3}{4 \times f_{xtal}}$
3. Determined by I²C-bus capacitance (C_b) and external pull-up resistor.
4. At maximum allowed I²C-bus capacitance C_b = 400 pF.
5. Determined by program.
6. If $t_{LOW} < \frac{24}{f_{xtal}}$, $t_{SU:DAT} \geq \frac{t_{LOW}-9}{f_{xtal}}$, independent of ASC.

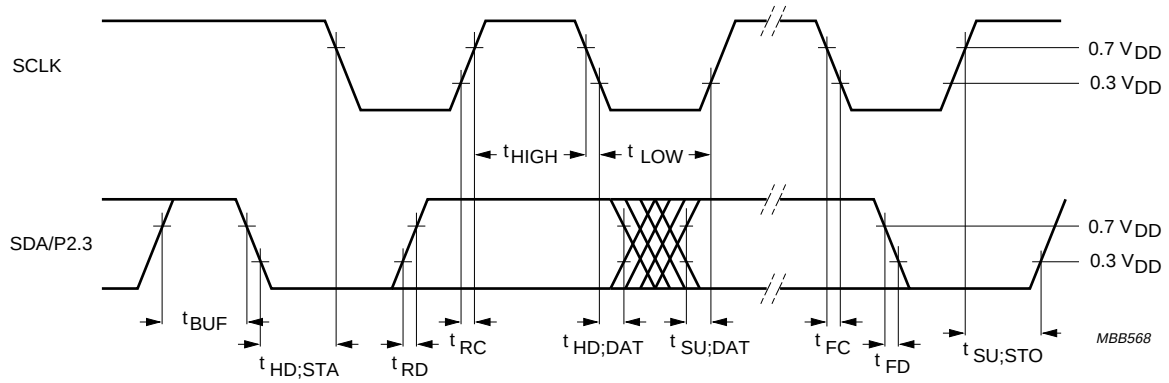


Fig.18 Slave SCLK receiver SDA/P2.3 timing (SCLK and SDA/P2.3 are inputs).

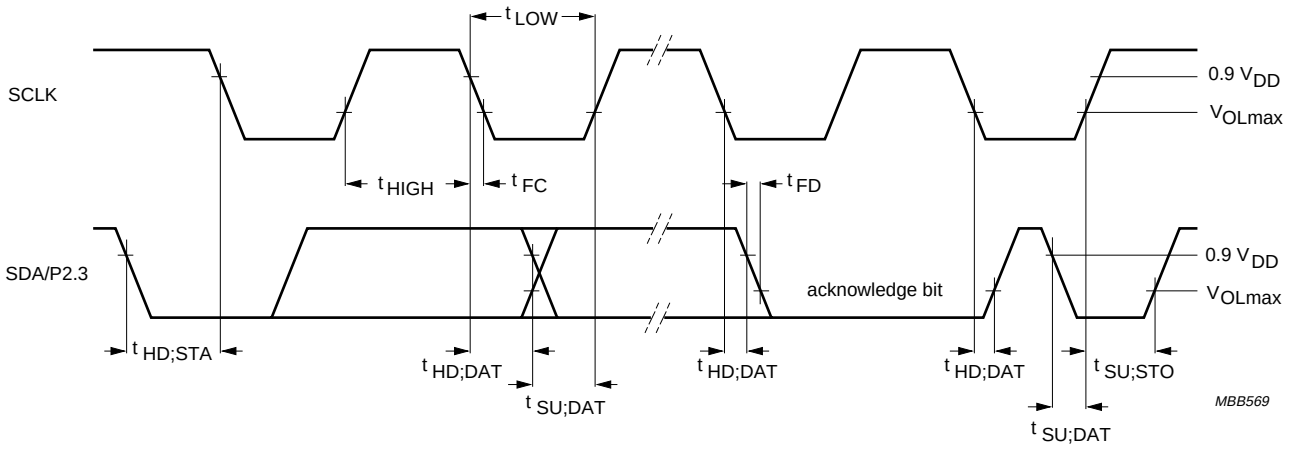


Fig.19 Master SCLK and transmitter SDA/P2,3 timing (SCLK and SDA/P2.3 are outputs).

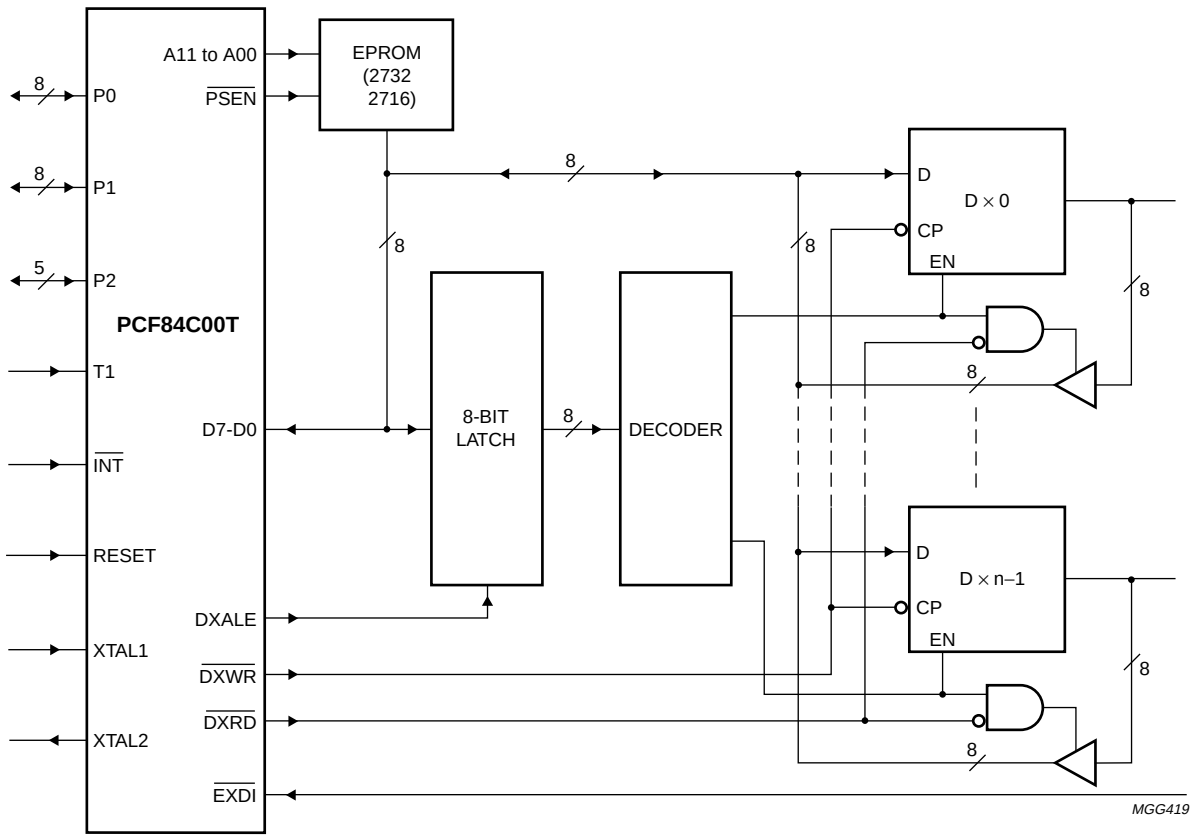
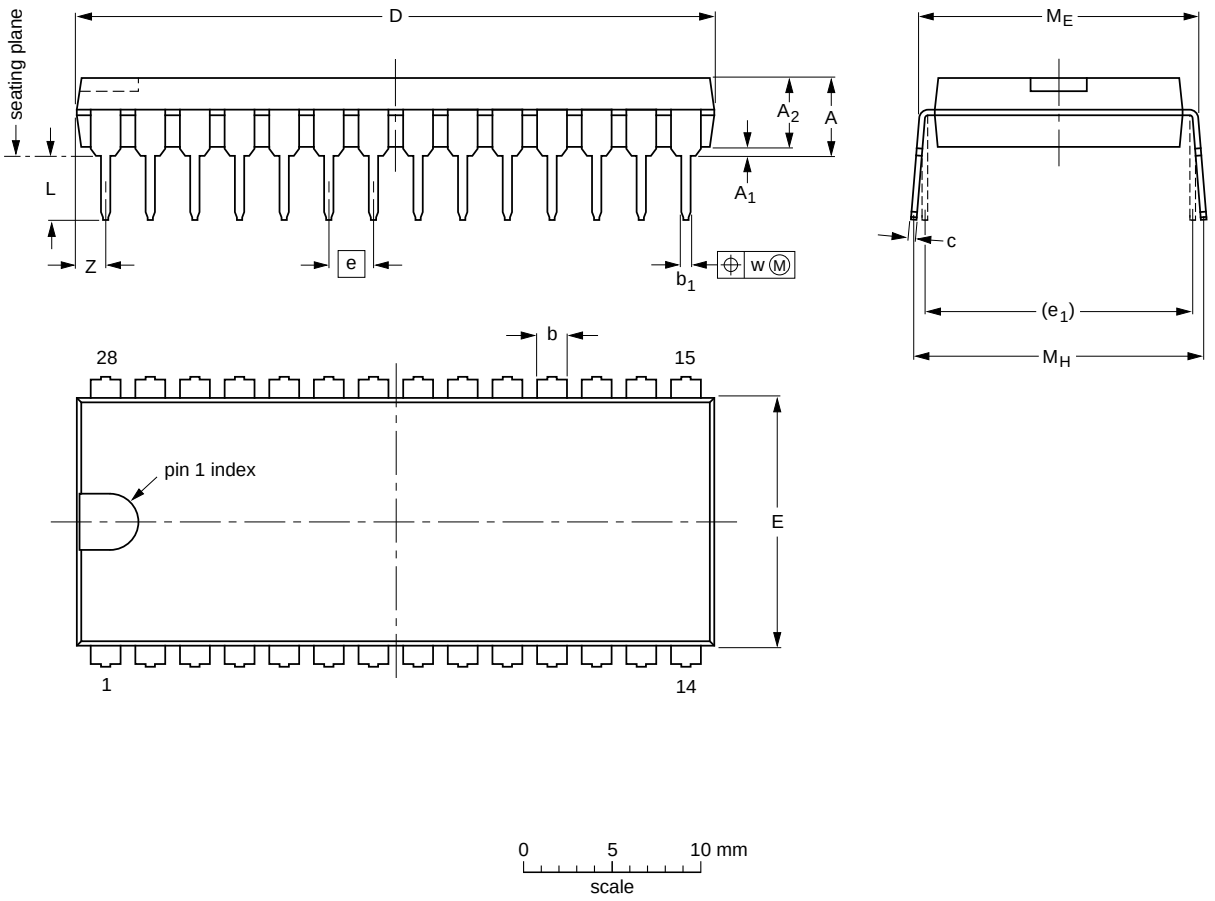


Fig.20 Block diagram of the external Dx register interface. The Dx interface can only be used with PCF84C00T.

11 PACKAGE OUTLINES

DIP28: plastic dual in-line package; 28 leads (600 mil) **SOT117-1**



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

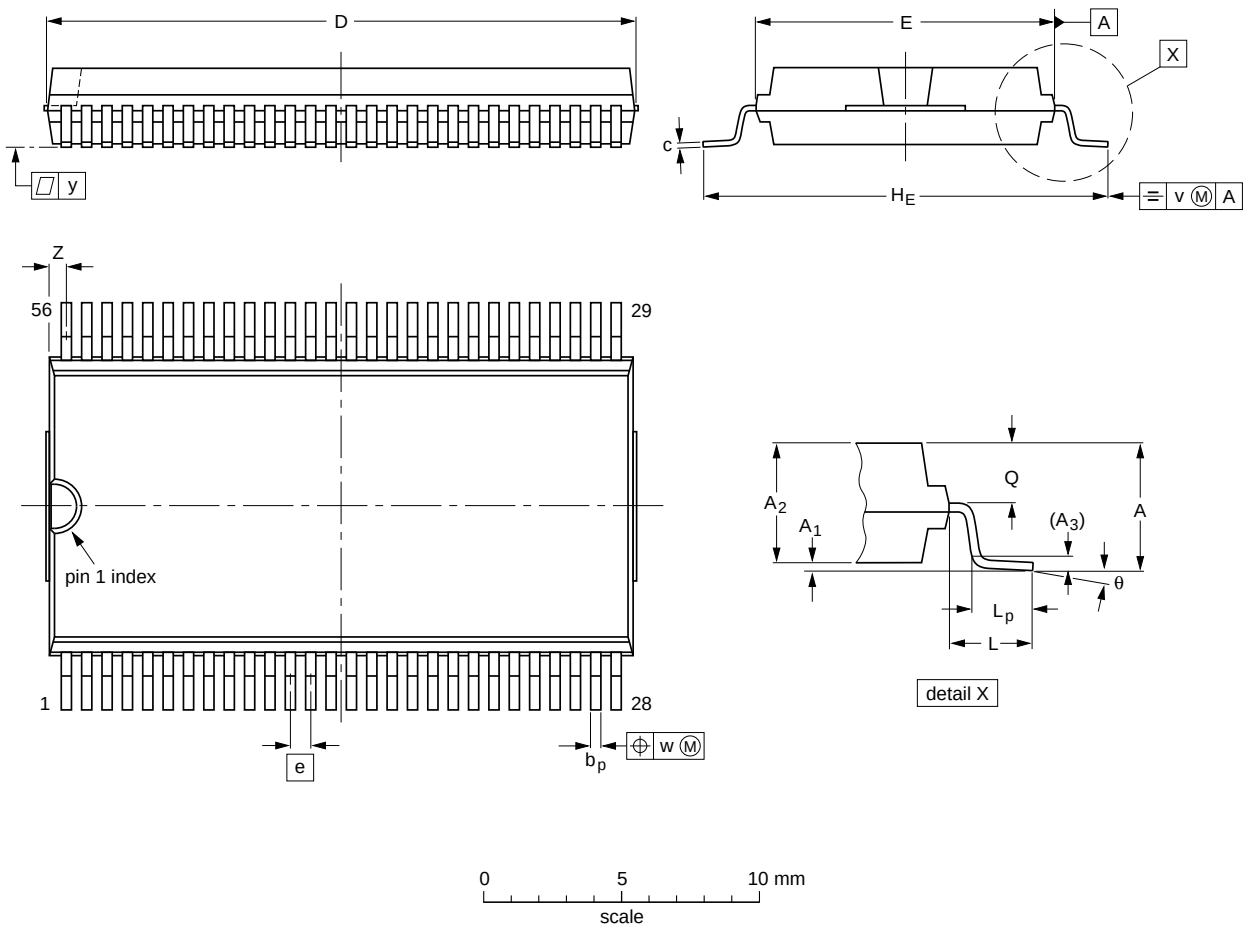
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	5.1	0.51	4.0	1.7 1.3	0.53 0.38	0.32 0.23	36.0 35.0	14.1 13.7	2.54	15.24	3.9 3.4	15.80 15.24	17.15 15.90	0.25	1.7
inches	0.20	0.020	0.16	0.066 0.051	0.020 0.014	0.013 0.009	1.41 1.34	0.56 0.54	0.10	0.60	0.15 0.13	0.62 0.60	0.68 0.63	0.01	0.067

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			
SOT117-1	051G05	MO-015AH				~~92-11-17~~ 95-01-14

VSO56: plastic very small outline package; 56 leads **SOT190-1**



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

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	3.3	0.3 0.1	3.0 2.8	0.25	0.42 0.30	0.22 0.14	21.65 21.35	11.1 11.0	0.75	15.8 15.2	2.25	1.6 1.4	1.45 1.30	0.2	0.1	0.1	0.90 0.55	7^o 0^o
inches	0.13	0.012 0.004	0.12 0.11	0.01	0.017 0.012	0.0087 0.0055	0.85 0.84	0.44 0.43	0.03	0.62 0.60	0.089	0.063 0.055	0.057 0.051	0.008	0.004	0.004	0.035 0.022	

Note

1. Plastic or metal protrusions of 0.3 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT190-1						~~92-11-17~~ 96-04-02

12 SOLDERING

12.1 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).

12.2 DIP

12.2.1 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.

12.2.2 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.

12.3 SO and VSO

12.3.1 REFLOW SOLDERING

Reflow soldering techniques are suitable for all SO and VSO 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.

12.3.2 WAVE SOLDERING

Wave soldering techniques can be used for all SO and VSO 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.

12.3.3 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.

13 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.	

14 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.

15 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.

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. +7 095 247 9145, Fax. +7 095 247 9144

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 TAIWAN Ltd., 23-30F, 66,
Chung Hsiao West Road, Sec. 1, P.O. Box 22978,
TAIPEI 100, Tel. +886 2 382 4443, Fax. +886 2 382 4444

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

Printed in The Netherlands 457021/1200/02/pp24 Date of release: 1996 Nov 25 Document order number: 9397 750 01025

Let's make things better.

Philips Semiconductors

PHILIPS