DATA SHEET

PCD3745A
8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

Product specification

Supersedes data of 1997 Mar 04

File under Integrated Circuits, IC14

1999 Feb 02

Philips
Semiconductors

PHILIPS

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

CONTENTS

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

1 FEATURES

- 8-bit CPU, RAM and I/O
- 4.5 kbytes OTP memory; 224 bytes RAM
- 32 kHz adjustable crystal oscillator for real-time clock
- Over 100 instructions (based on MAB8048) all of 1 or 2 cycles
- 16 quasi-bidirectional I/O port lines
- 8-bit programmable Timer/event counter 1
- Two 16-bit counters with count inputs pins
- 2 single-level vectored interrupts:
  - external; peripheral Counters 1 and 2; RTC alarm
  - 8-bit programmable Timer/event counter 1
- Two test inputs, one of which also serves as the external interrupt input
- Stop and Idle modes for power saving
- Logic supply: 1.8 to 6 V
- CPU clock frequency: 1 to 16 MHz
- Operating temperature: −25 to +70 °C
- Manufactured in silicon gate CMOS process.

2 GENERAL DESCRIPTION

The PCD3745A is a microcontroller oriented towards communication and metering applications. It has 4.5 kbytes of One Time Programmable (OTP) memory, 224 bytes RAM and 16 I/O lines.
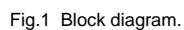
The PCD3745A also incorporates a low power Real-Time Clock (RTC) and two low power 16-bit counters. The RTC runs using a 32 kHz crystal oscillator and is register adjustable. The RTC and the counters are able to operate in all microcontroller modes. The instruction set is based on that of the MAB8048 and is software compatible with the PCD33xxA family.

This data sheet details the specific properties of the PCD3745A. The shared characteristics of the PCD33xxA family of microcontrollers are described in the *"Data Handbook IC14; Section PCD33xxA Family"*, which should be read in conjunction with this publication.

3 ORDERING INFORMATION

| TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
PCD3745AP	DIP28	plastic dual in-line package; 28 leads (600 mil)	SOT117-1
PCD3745AT	SO28	plastic small outline package; 28 leads; body width 7.5 mm	SOT136-1
PCD3745AH	LQFP32	plastic low profile quad flat package; 32 leads; body $7 \times 7 \times 1.4$ mm	SOT358-1

8-bit microcontroller with 4.5 Kbytes OTP
memory and 32 kHz real-time clock

PCD3745A

4 BLOCK DIAGRAM

1999 Feb 02

4

P1.0 to P1.6
P1.7/RCO

PORT 1
BUFFER

PORT 1
FLIP-FLOP

RTC1
RTC2

RTC

INTERNAL
CLOCK
FREQ.
÷ 30

÷ 32

T1

MEMORY
BANK
FLIP-FLOPS

TIMER/
EVENT
COUNTER

HIGHER
PROGRAM
COUNTER

LOWER
PROGRAM
COUNTER

PROGRAM
STATUS
WORD

RESIDENT
OTP-ROM
4.5 kbytes

DECODE

P0.0 to P0.7

PORT 0
BUFFER

PORT 0
FLIP-FLOP

PCD3745A

PCCR

C1LB

C1HB

C2LB

C2HB

INTERRUPT
LOGIC

ACCUMULATOR

TEMPORARY
REGISTER 2

TEMPORARY
REGISTER 1

timer interrupt

ARITHMETIC

LOGIC UNIT

INSTRUCTION
REGISTER
AND
DECODER

RAM
ADDRESS
REGISTER

MULTIPLEXER

REGISTER 0
REGISTER 1
REGISTER 2
REGISTER 3
REGISTER 4
REGISTER 5
REGISTER 6
REGISTER 7

8 LEVEL STACK
(VARIABLE LENGTH)

OPTIONAL SECOND
REGISTER BANK

DATA STORE

DECODE

CLK1

CLK2

external interrupt

DECIMAL
ADJUST

CONDITIONAL

BRANCH

LOGIC

T 1

CE/T0

TIMER
FLAG

CARRY

ACC

ACC BIT
TEST

RESIDENT RAM ARRAY
224 bytes

STOP
IDLE

CONTROL AND TIMING

CE/T0   RESET   XTAL1   XTAL2

INTERRUPT   INITIALIZE   OSCILLATOR
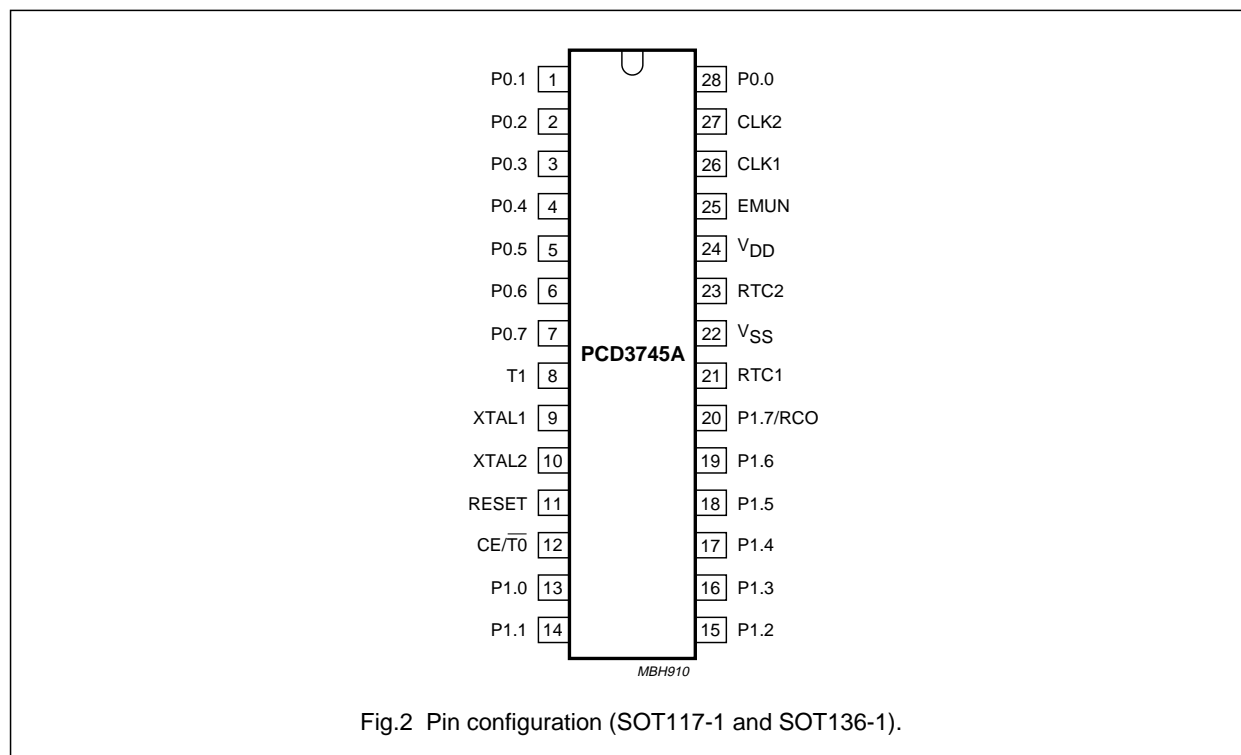
MBH909

RESIDENT RAM ARRAY

Fig.1 Block diagram.

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

5 PINNING INFORMATION

5.1 Pinning
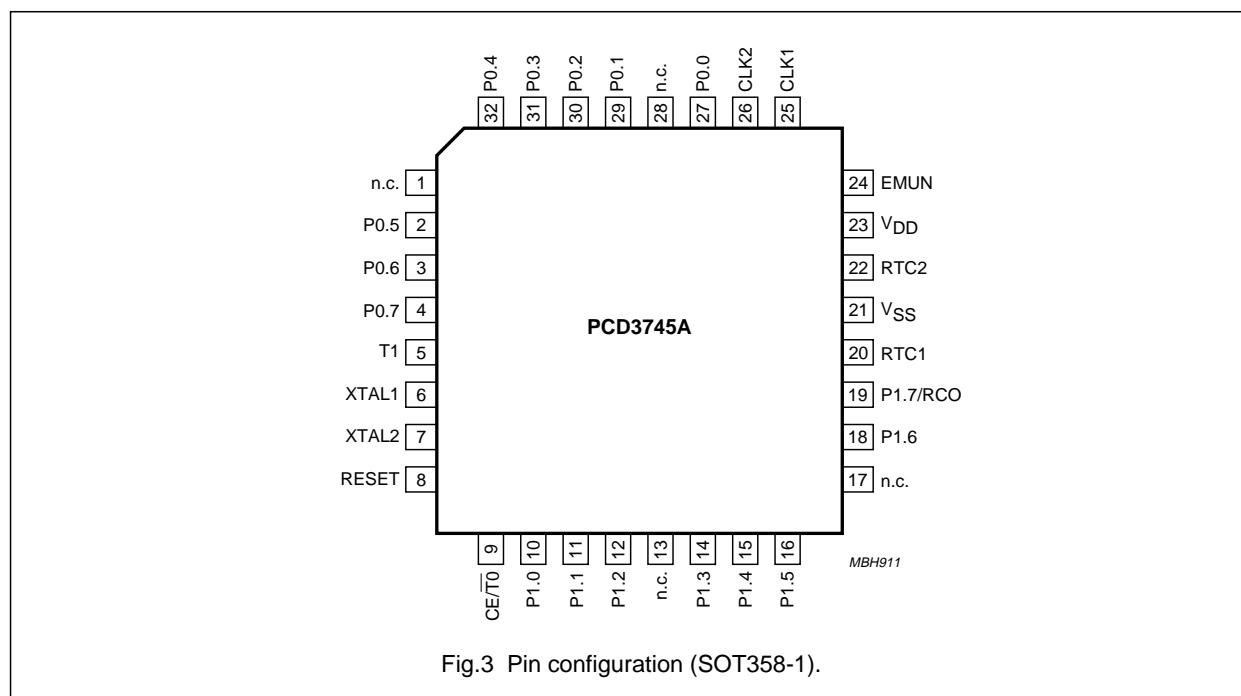
Fig.2 Pin configuration (SOT117-1 and SOT136-1).

Fig.3 Pin configuration (SOT358-1).

5.2   Pin description

Table 1   SOT117-1 and SOT136-1 packages

SYMBOL	PIN	DESCRIPTION
P0.0 to P0.7	28, 1 to 7	Port 0: 8 quasi-bidirectional I/O lines
T1	8	Test 1 or count input of 8-bit Timer/event counter 1
XTAL1	9	crystal oscillator or external clock input
XTAL2	10	crystal oscillator output
RESET	11	reset input
CE/$\overline{T0}$	12	chip enable or Test 0
P1.0 to P1.6	13 to 19	Port 1: 7 quasi-bidirectional I/O lines
P1.7/RCO	20	Port 1: 1 quasi-bidirectional I/O line/Real Clock Output 16 kHz
RTC1	21	RTC 32 kHz oscillator input
V_{SS}	22	ground
RTC2	23	RTC 32 kHz oscillator output
V_{DD}	24	positive supply voltage
EMUN	25	emulation pin, must be connected to V_{DD} for normal mode operation.
CLK1	26	count input of 16-bit peripheral Counter 1
CLK2	27	count input of 16-bit peripheral Counter 2

Table 2   SOT358-1 package

SYMBOL	PIN	DESCRIPTION
n.c.	1, 13, 17, 28	not connected
T1	5	Test 1 or count input of 8-bit Timer/event counter 1
XTAL1	6	crystal oscillator or external clock input
XTAL2	7	crystal oscillator output
RESET	8	reset input
CE/$\overline{\overline{T0}}$	9	chip enable or Test 0
P1.0 to P1.6	10 to 12, 14 to 16, 18	Port 1: 7 quasi-bidirectional I/O lines
P1.7/RCO	19	Port 1: 1 quasi-bidirectional I/O line/Real Clock Output 16 kHz
RTC1	20	RTC 32 kHz oscillator input
V_{SS}	21	ground
RTC2	22	RTC 32 kHz oscillator output
V_{DD}	23	positive supply voltage
EMUN	24	emulation pin, must be connected to V_{DD} for normal mode operation.
CLK1	25	count input of 16-bit peripheral Counter 1
CLK2	26	count input of 16-bit peripheral Counter 2
P0.0 to P0.7	27, 29 to 32, 2 to 4	Port 0: 8 quasi-bidirectional I/O lines

6 REAL-TIME CLOCK (RTC)

The RTC consists of a 32 kHz crystal oscillator, a 32 kHz to 1 second, 1.5 second and 1 minute divider chain, an 8-bit Frequency Adjustment Register (FAR) and the Clock Control Register (CLCR). The complete real-time clock section is independent of the microcontroller status, even in Idle or Stop mode.

6.1 Oscillator

The internal 32 kHz oscillator requires an external 32.768 kHz quartz crystal (a positive deviation up to +259 ppm is allowed by using frequency adjustment) and an external feedback resistor (4.7 MΩ) connected between the RTC1 and RTC2 pins. The oscillator is controlled by the RUN bit in the Clock Control Register.

6.2 Divider chain

The divider chain operates with the 32 kHz oscillator output and divides this signal down to produce three different clocks with periods of 1 second, 1.5 second and 1 minute. Depending on the state of the ITS and SITS bits in the Clock Control Register, the falling edge of the 1 second, 1.5 second or 1 minute clock is used to set the Clock Interrupt Flag (CIF) in the Clock Control Register. Since the clock interrupt is used to let the microcontroller leave the Stop mode, it is wire ORed with the external interrupt (CE/$\overline{T0}$) and has the same functionality, e.g. it must be enabled in the Clock Control Register (ECI = 1) and by execution of EN I. The clock interrupt will then be treated as an external interrupt

Additionally, the divider chain generates a 16 kHz clock (RCO) that can be routed through port line P1.7/RCO, controlled by the ERCO bit in the Clock Control Register.

6.3 Frequency adjustment

Frequency adjustment is used to extend the interrupt time by defining the number of 16 kHz clocks in the Frequency Adjustment Register that will be counted twice within the first 1 second or 1.5 second period after a minute interrupt. The DIV512 is reset if its contents is equal to FAR, this will extend the time of the next interrupt. This is done within the first 1 second or 1.5 seconds of every minute. If the second interrupt is used (ITS = 1 and SITS = 0), every 60th interval may be up to 15.3 ms longer than the others as a result of the frequency adjustment. If the 1.5 second interrupt is used (ITS = 1 and SITS = 1), the prolongation will affect every 40th interval. The adjusted Minute Interrupt Time (MIT) shows now a maximum deviation of 0.5 ppm.

The frequency adjustment value of the real-time clock section is defined by the decimal value of the contents of the 8-bit Frequency Adjustment Register. It can be read or written. The significance of the individual bits is illustrated by the following equation:

$$\text{Minute Interrupt Time (MIT)} = 60 \times 2^{\frac{14}{\overline{FRCO}}} + \frac{FAR}{2^{14}}$$

Table 7 shows the recommended correction factor FAR for all allowed real-time clock frequencies (FRCO).

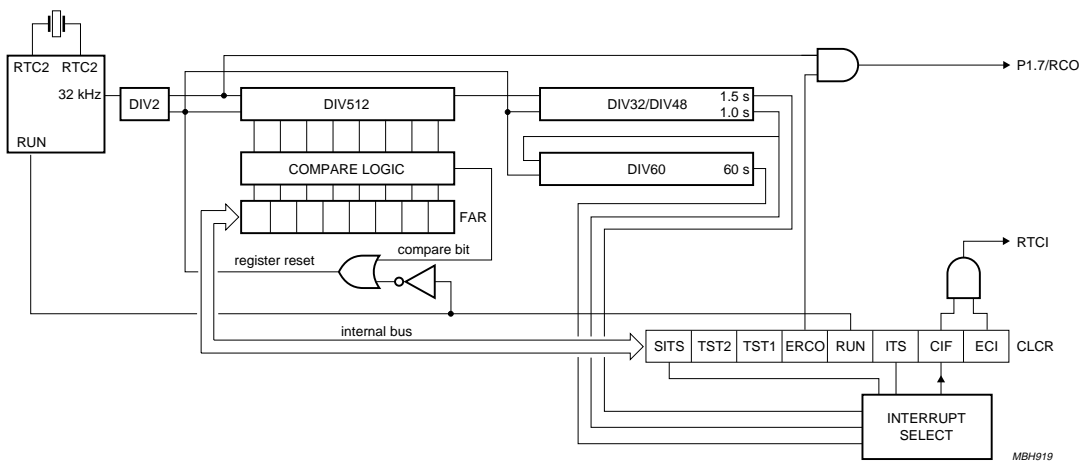The value of CLCR and FAR at reset is 00H.

Fig.4 RTC block diagram.

8-bit microcontroller with 4.5 kbytes OTP
memory and 32 kHz real-time clock

PCD3745A

6.4 Clock Control Register (CLCR)

Table 3 Clock Control Register (address 20H)

7	6	5	4	3	2	1	0
SITS	TST2	TST1	ERCO	RUN	ITS	CIF	ECI

Table 4 Description of CLCR bits

BIT	SYMBOL	DESCRIPTION
7	SITS	**Second Interrupt Time Select.** If SITS = 1 and ITS = 1, then the interrupt time is 1.5 seconds.
6	TST2	**Test 2 input.** This is a test bit and must be fixed at zero by user software.
5	TST1	**Test 1 input.** This is a test bit and must be fixed at zero by user software.
4	ERCO	**Enable 16 kHz Clock Output.** If ERCO = 0, then P1.7/RCO is a port line. If ERCO = 1, then P1.7/RCO is a 16 kHz clock output. The port instructions for P1.7/RCO are not inhibited and therefore the state of both the port line and flip-flop may be read in and the port flip-flop may be written to by port instructions.
3	RUN	**Clock Run/Stop.** If RUN = 0, then the 32 kHz oscillator is stopped and the divider chain is reset. If RUN = 1, then the 32 kHz oscillator and the divider chain are running.
2	ITS	**Interrupt Time Select.** If ITS = 1 and SITS = 0, then the interrupt time is one second. If ITS = 0 and SITS = X, then the interrupt time is one minute.
1	CIF	**Clock Interrupt Flag.** Set by hardware, if RTC divider chain overflows (every second, 1.5 second or minute depending on ITS) or by software. Reset: by software.
0	ECI	**Enable Clock Interrupt.** If ECI = 0, the RTC interrupt is disabled. If ECI = 1, the RTC interrupt is enabled.

6.5 Frequency Adjustment Register (FAR)

Table 5 Frequency Adjustment Register (address 21H)

7	6	5	4	3	2	1	0
FAR7	FAR6	FAR5	FAR4	FAR3	FAR2	FAR1	FAR0

Table 6 Description of FAR bits

BIT	SYMBOL	DESCRIPTION
7	FAR7	The state of these 8-bits determine the frequency adjustment value for the real-time clock section; see Table 7.
6	FAR6	
5	FAR5	
4	FAR4	
3	FAR3	
2	FAR2	
1	FAR1	
0	FAR0	

Table 7 Selection of FRCO

FAR (HEX)	FRCO	FAR (HEX)	FRCO
00	16384.000	22	16384.566
01	16384.018	23	16384.584
02	16384.033	24	16384.600
03	16384.051	25	16384.617
04	16384.066	26	16384.635
05	16384.084	27	16384.650
06	16384.100	28	16384.668
07	16384.117	29	16384.684
08	16384.135	2A	16384.701
09	16384.150	2B	16384.717
0A	16384.168	2C	16384.734
0B	16384.184	2D	16384.750
0C	16384.201	2E	16384.768
0D	16384.217	2F	16384.783
0E	16384.234	30	16384.801
0F	16384.250	31	16384.816
10	16384.268	32	16384.834
11	16384.283	33	16384.850
12	16384.301	34	16384.867
13	16384.316	35	16384.885
14	16384.334	36	16384.900
15	16384.350	37	16384.918
16	16384.367	38	16384.934
17	16384.385	39	16384.951
18	16384.400	3A	16384.967
19	16384.418	3B	16384.984
1A	16384.434	3C	16385.000
1B	16384.451	3D	16385.018
1C	16384.467	3E	16385.033
1D	16384.484	3F	16385.051
1E	16384.500	40	16385.066
1F	16384.518	41	16385.084
20	16384.533	42	16385.100
21	16384.551	43	16385.117

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

FAR (HEX)	FRCO	FAR (HEX)	FRCO
44	16385.135	66	16385.701
45	16385.150	67	16385.717
46	16385.168	68	16385.734
47	16385.184	69	16385.750
48	16385.201	6A	16385.768
49	16385.217	6B	16385.783
4A	16385.234	6C	16385.801
4B	16385.250	6D	16385.816
4C	16385.268	6E	16385.834
4D	16385.283	6F	16385.850
4E	16385.301	70	16385.867
4F	16385.316	71	16385.885
50	16385.334	72	16385.900
51	16385.350	73	16385.918
52	16385.367	74	16385.934
53	16385.385	75	16385.951
54	16385.400	76	16385.967
55	16385.418	77	16385.984
56	16385.434	78	16386.000
57	16385.451	79	16386.018
58	16385.467	7A	16386.033
59	16385.484	7B	16386.051
5A	16385.500	7C	16386.066
5B	16385.518	7D	16386.084
5C	16385.533	7E	16386.100
5D	16385.551	7F	16386.117
5E	16385.566	80	16386.135
5F	16385.584	81	16386.150
60	16385.600	82	16386.168
61	16385.617	83	16386.184
62	16385.635	84	16386.201
63	16385.650	85	16386.217
64	16385.668	86	16386.234
65	16385.684	87	16386.250

FAR (HEX)	FRCO	FAR (HEX)	FRCO
88	16386.268	A6	16386.768
89	16386.283	A7	16386.783
8A	16386.301	A8	16386.801
8B	16386.316	A9	16386.816
8C	16386.334	AA	16386.834
8D	16386.350	AB	16386.850
8E	16386.367	AC	16386.867
8F	16386.385	AD	16386.885
90	16386.400	AE	16386.900
91	16386.418	AF	16386.918
92	16386.434	B0	16386.934
93	16386.451	B1	16386.951
94	16386.467	B2	16386.967
95	16386.484	B3	16386.984
96	16386.500	B4	16387.000
97	16386.518	B5	16387.018
98	16386.533	B6	16387.033
99	16386.551	B7	16387.051
9A	16386.566	B8	16387.066
9B	16386.584	B9	16387.084
9C	16386.600	BA	16387.100
9D	16386.617	BB	16387.117
9E	16386.635	BC	16387.135
9F	16386.650	BD	16387.150
A0	16386.668	BE	16387.168
A1	16386.684	BF	16387.184
A2	16386.701	C0	16387.201
A3	16386.717	C1	16387.217
A4	16386.734	C2	16387.234
A5	16386.750	C3	16387.250

FAR (HEX)	FRCO	FAR (HEX)	FRCO
C4	16387.268	E2	16387.768
C5	16387.283	E3	16387.783
C6	16387.301	E4	16387.801
C7	16387.316	E5	16387.816
C8	16387.334	E6	16387.834
C9	16387.350	E7	16387.850
CA	16387.367	E8	16387.867
CB	16387.385	E9	16387.885
CC	16387.400	EA	16387.900
CD	16387.418	EB	16387.918
CE	16387.434	EC	16387.934
CF	16387.451	ED	16387.951
D0	16387.467	EE	16387.967
D1	16387.484	EF	16387.984
D2	16387.500	F0	16388.002
D3	16387.518	F1	16388.018
D4	16387.533	F2	16388.035
D5	16387.551	F3	16388.051
D6	16387.566	F4	16388.068
D7	16387.584	F5	16388.084
D8	16387.600	F6	16388.102
D9	16387.617	F7	16388.117
DA	16387.635	F8	16388.135
DB	16387.650	F9	16388.152
DC	16387.668	FA	16388.168
DD	16387.684	FB	16388.186
DE	16387.701	FC	16388.201
DF	16387.717	FD	16388.219
E0	16387.734	FE	16388.234
E1	16387.750	FF	16384.000

7   PERIPHERAL COUNTER 1 AND COUNTER 2

The PCD3745A has two on-chip 16-bit peripheral counters: Counter 1 and Counter 2. Both counters can count pulses in the frequency range of 0 to 1 MHz and both will operate in all modes of the microcontroller (Idle, Stop and Operating modes).

The count process and the interrupt on overflow function for each counter is enabled/disabled by setting the appropriate ECx and ECxI bits in the Peripheral Counter Control Register (PCCR). The count process starts with setting the ECx bit to a logic 1 and can be stopped in every state by resetting the ECx bit to a logic 0. The counter inputs are CLK1 for Counter 1 and CLK2 for Counter 2. Each counter input is connected to a Schmitt trigger in order to reduce noise susceptibility. A falling edge of the pulses on these inputs will increment the enabled counters by one. The 16-bit counters are also byte-wise read and writeable, e.g. they can be set to a specific value, for example to count less than 2^{16} events (refer to Table 13 for register addresses).

The 16-bit counters and the PCCR (see Table 8) are set to 0000H and 00H respectively, after reset.

Counting events during a write access may be lost. During a read access they are considered when the length of the count pulse is greater than $2/f_{xtal}$ + 500 ns. To ensure correct operation it is recommended to disable the count process during a read or write operation to the counter registers.

In the count mode, if the ECxI bit is set, an overflow (count transition from FFFFH to 0000H) of the counter will set the CxF bit, which starts the interrupt sequence. CxF is wired ORed with CE/$\overline{T0}$ and consequently the effect is the same as an external interrupt. Within this interrupt sequence the interrupt source must be searched and CxF should be reset to enable the microcontroller to service future interrupts. CxF is set by hardware or software but can be reset by software.

The operation of the 16-bit counters when used in a metering application is shown in Fig.5.

Note: If the counter value is set from 0000H to FFFFH by software and the status 0000H was reached either by clocking (overflow) or by hardware reset the subsequent clock pulse (CLKx) will NOT set the interrupt flag (C1F or C2F) in the PCCR register!

7.1   Peripheral Counter Control Register (PCCR)

**Table 8**   Peripheral Counter Control Register (address 40H)

7	6	5	4	3	2	1	0
EC1	EC1I	0	C1F	EC2	EC2I	0	C2F

Table 9   Description of PCCR bits

BIT	SYMBOL	DESCRIPTION
7	EC1	**Enable Counter 1.** If EC1 = 1, the counter is enabled and increments upwards every HIGH-to-LOW transition on pin CLK1. If EC1 = 0, the incrementing stops and the counter keeps the accumulated value. This bit is set/reset by software.
6	EC1I	**Enable Counter 1 Interrupt Flag.** When EC1I is set to a logic 1, the C1F event requests an interrupt. This bit is set/reset by software.
5	0	not used
4	C1F	**Counter 1 Interrupt Flag.** If C1F = 1, then a counter overflow has occurred in Counter 1. Set by hardware and software; reset by software.
3	EC2	**Enable Counter 2.** If EC2 = 1, the counter is enabled and increments upwards every HIGH-to-LOW transition on pin CLK2. If EC2 = 0, the incrementing stops and the counter keeps the accumulated value. This bit is set/reset by software.
2	EC2I	**Enable Counter 2 Interrupt Flag.** When EC2I is set to a logic 1, the C2F event requests an interrupt. This bit is set/reset by software.
1	0	not used
0	C2F	**Counter 2 Interrupt Flag.** If C2F = 1, then a counter overflow has occurred in Counter 2. Set by hardware and software; reset by software.

Fig.5 Operation of the 16-bit counters used in metering applications.
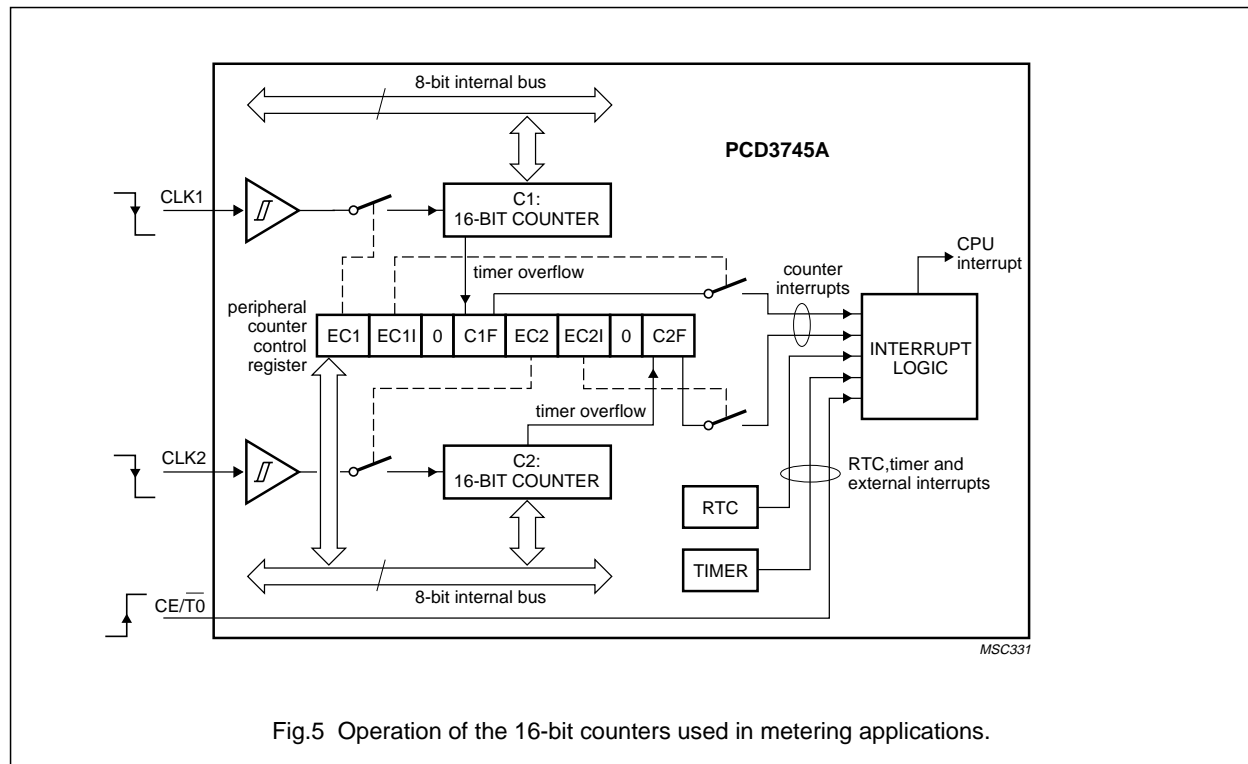
8   THE RTC, COUNTER 1 AND COUNTER 2 INTERRUPTS

As well as the CE/$\overline{T0}$ interrupt three additional interrupt events are defined which have the same effect as an external interrupt (see *"PCD33xxA family data sheet"*).

- **Real Time Clock.** This interrupt is controlled by the Clock Interrupt Flag (CIF) and the Enable Clock Interrupt (ECI) bit both of which reside in the Clock Control Register (see Tables 3 and 4)

- **Counter 1.** This interrupt is controlled by the Counter 1 Interrupt Flag (C1F) and the Enable Counter 1 Interrupt Flag (EC1I) both of which are located in the Peripheral Counter Control Register (see Tables 8 and 9)

- **Counter 2.** This interrupt is controlled by the Counter 2 Interrupt Flag (C2F) and the Enable Counter 2 Interrupt Flag (EC2I) both of which are located in the Peripheral Counter Control Register (see Tables 8 and 9).

To use these interrupt sources the external interrupt must be enabled (EN I). Interrupt servicing is exactly the same as for an external interrupt. The interrupt routine must include instructions that will determine the interrupt source and remove the cause of the derivative interrupt by explicitly clearing CIF, C1F or C2F.

By not clearing these flags the microcontroller is unable to detect interrupts of the same type. In the interrupt routine the CE/$\overline{T0}$ interrupt has to be deduced from the fact that neither CIF or C1F or C2F is set. If the specific interrupt is not used, CIF, C1F or C2F may be directly tested by the program. Obviously, CIF, C1F or C2F can also be asserted under program control, e.g. to generate a software interrupt.

Although the clock interrupt and Counter 1 and Counter 2 are part of a derivative function they are linked to the external interrupt (see Fig.6).

A clock, Counter 1 or Counter 2 interrupt request is serviced under the following circumstances:

- No interrupt routine is being processed

- No external interrupt request is pending

- The enable clock interrupt and enable Counter 1 and Counter 2 interrupt bit in the derivative Clock Control Register and Peripheral Counter Control Register respectively is set.
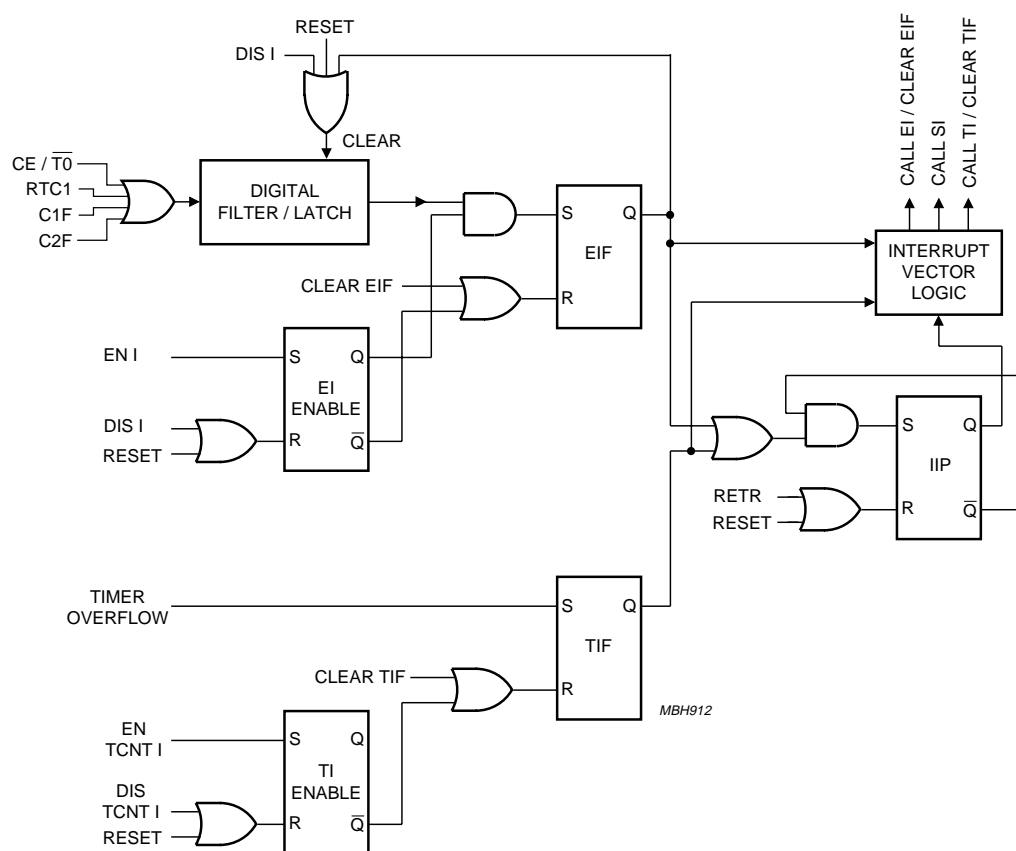
Fig.6 Simplified interrupt logic schematic (the R input overrules the S input for all flags).

9 REDUCED POWER MODES

9.1 Idle mode

In Idle mode, the Real-time clock, Counter 1 and
Counter 2 sections remain operative. In addition to the
description given in the *"PCD33xxA family data sheet"*,
Idle mode may be left by a clock or a counter interrupt
event (see Section 8).

9.2 Stop mode

In Stop mode the Real-Time Clock, Counter 1, Counter 2
and the 32 kHz crystal oscillator sections remain operative
(depending on the state of the RUN and ECx bits in CLCR
and PCCR). In addition to the description given in the
"PCD33xxA family data sheet", Stop mode may be left by
a clock or a counter interrupt event (see Section 8).

10 INSTRUCTION SET RESTRICTIONS

RAM space is restricted to 224 bytes; care should be taken
to avoid accesses to non-existing RAM locations.

11 TIMING

The PCD3745A operates over a clock frequency range of
1 to 16 MHz.

12 RESET

In addition to the conditions given in the *"PCD33xxA family
data sheet"*, all derivative registers are cleared in the reset
state.

13 SUMMARY OF CONFIGURATIONS

Table 10 Port configuration (see notes 1 and 2)

TYPE	PORT 0								PORT 1							
	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
PCD3745A	3R	3R	3S	3S	3R	3R	3R	3R	1S	1S	1S	1S	1R	1R	1R	1S

Notes

1. 1 = standard I/O; 3 = push-pull Output.

2. Port state after reset: S = Set (HIGH) and R = Reset (LOW).

Table 11 Product configurations

FEATURE	DESCRIPTION
Program/data code	any mix of instructions and data up to OTP memory size of 4.5 kbytes
Oscillator transconductance	fixed at LOW transconductance (g_{mL}); the maximum crystal clock frequency is 6 MHz

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

14 OTP PROGRAMMING

The programming of the PCD3745A OTP is based on the OM4260 programmer (Ceibo MP-51) which is available from Philips. The OM4260 works in conjunction with various adapters and supports the package types listed in Table 12.

The low voltage OTP program memory used is of Anti-Fuse-PROM type and cannot be erased after programming. Thus, the complete OTP memory cannot be tested by the factory, but only partially via a special test array. The average expected yield is 97%.

Detailed information on the OTP programming is available in the *"PCD3755x Application Note"*, available from Philips Sales offices.

Table 12 OTP programming overview

DEVICE	PHILIPS TYPE NUMBER	CEIBO TYPE NUMBER	SUPPORTED PACKAGE
Ceibo MP-51	OM4260	MP-51 programmer base	–
PCD3745A	OM5007	adapter DIP	DIP28
	OM5030	adapter SO	SO28
	OM5037; note 1	socket converter LQFP32	LQFP32

Note

1. As the OM5037 is only a socket converter, the OM5007 is also needed to program the PCD3745A in the LQFP32 package.

15 SUMMARY OF DERIVATIVE REGISTERS

Table 13 Register map

ADDRESS (HEX)	REGISTER	7	6	5	4	3	2	1	0
00 to 1F	not used	–	–	–	–	–	–	–	–
20	Clock Control Register (CLCR)	SITS	TST2	TST1	ERCO	RUN	ITS	CIF	ECI
21	Frequency Adjustment Register (FAR)	FAR7	FAR6	FAR5	FAR4	FAR3	FAR2	FAR1	FAR0
22 to 3F	not used	–	–	–	–	–	–	–	–
40	Peripheral Counter Control Register (PCCR)	EC1	EC1I	0	C1F	EC2	EC2I	0	C2F
41	Counter 1 Low Byte (C1LB)	C1LB7	C1LB6	C1LB5	C1LB4	C1LB3	C1LB2	C1LB1	C1LB0
42	Counter 1 High Byte (C1HB)	C1HB7	C1HB6	C1HB5	C1HB4	C1HB3	C1HB2	C1HB1	C1HB0
43	Counter 2 Low Byte (C2LB)	C2LB7	C2LB6	C2LB5	C2LB4	C2LB3	C2LB2	C2LB1	C2LB0
44	Counter 2 High Byte (C2HB)	C2HB	C2HB	C2HB	C2HB	C2HB	C2HB	C2HB	C2HB
45 to FF	not used	–	–	–	–	–	–	–	–

16 LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134); see notes 1 and 2.

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{DD}	supply voltage	−0.8	+7.0	V
V_I	all input voltages	−0.5	V_{DD} + 0.5	V
I_I, I_O	DC input or output current	−10	+10	mA
P_{tot}	total power dissipation	–	125	mW
P_O	power dissipation per output	–	30	mW
I_{SS}	ground supply current	−50	+50	mA
T_{stg}	storage temperature	−65	+150	°C
T_j	operating junction temperature	–	90	°C

Notes

1. Stresses above those listed under Limiting Values may cause permanent damage to the device.

2. Parameters are valid over the operating temperature range unless otherwise specified. All voltages are with respect to V_{SS} unless otherwise stated.

17 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 *"Handling MOS devices"*).

18 DC CHARACTERISTICS

V_{DD} = 1.8 to 6 V; V_{SS} = 0 V; T_{amb} = −25 to +70 °C; f_{xtal} = 3.58 MHz; f_{RTC} = 32768 Hz; all voltages with respect to V_{SS} unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (see Figs 8, 9, 10, 11, 12 and 13)						
V_{DD}	supply voltage					
	operating		1.8	–	6	V
	RAM data retention in Stop mode		1.0	–	6	V
I_{DD}	operating supply current	V_{DD} = 3 V; note 1	–	0.35	0.7	mA
$I_{DD(ID)}$	supply current Idle mode	V_{DD} = 3 V; note 1	–	0.25	0.5	mA
$I_{DD(stp)}$	supply current Stop mode	T_{amb} = 25 °C; counters and RTC not running; notes 1 and 2	–	1.0	5.0	µA
		T_{amb} = −25 to +70 °C; counters and RTC not running; notes 1 and 2	–	–	10	µA
		T_{amb} = 25 °C; counters and RTC running at 33 kHz; notes 1 and 2	–	3.0	6.0	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	$V_{SS} \leq V_I \leq V_{DD}$	−1	–	+1	µA

| SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Port outputs (see Figs 14, 15 and 16)						
I_{OL}	LOW-level port sink current	$V_{DD} = 3$ V; $V_O = 0.4$ V	0.7	3.5	–	mA
I_{OH}	HIGH-level port pull-up source current	$V_{DD} = 3$ V; $V_O = 2.7$ V	−10	−30	–	μA
		$V_{DD} = 3$ V; $V_O = 0$ V	–	−140	−300	μA
I_{OH}	HIGH-level port push-pull source current	$V_{DD} = 3$ V; $V_O = 2.6$ V	−0.7	−3.5	–	mA
Real-time clock 32 kHz oscillator						
g_m	transconductance	$V_{i(p-p)} < 50$ mV	2	10	50	μS
δf/f	frequency adjustment		−0.6	–	+0.6	ppm
$C_{I(RTC1)}$	RTC1 pin input capacitance		–	10	–	pF
$C_{O(RTC2)}$	RTC2 pin output capacitance		–	10	–	pF
Clock inputs of peripheral counters (CLK1 and CLK2)						
$V_{th(LH)}$	positive-going threshold voltage	$V_{DD} = 5$ V; $T_{amb} = +25$ °C; see Fig.7	–	$0.6V_{DD}$	–	V
$V_{th(HL)}$	negative-going threshold voltage	$V_{DD} = 5$ V; $T_{amb} = +25$ °C; see Fig.7	–	$0.4V_{DD}$	–	V
t_W	pulse width	notes 3 and 4; see Fig.7	500	–	–	ns
f_c	count frequency	note 4	0	–	1	MHz
XTAL oscillator						
g_{mL}	LOW transconductance	$V_{DD} = 5$ V; see Fig.18	0.2	0.4	1.0	mA/V
R_f	feedback resistor		0.3	1.0	3.0	MΩ

Notes

1. $V_{IL} = V_{SS}$; $V_{IH} = V_{DD}$; outputs open:

    a) Maximum values: external clock at XTAL1 and XTAL2 open-circuit.

    b) Typical values: at 25 °C; crystal connected between XTAL1 and XTAL2.

2. $V_{DD} = 1.8$ V; RESET, T1 and CE/$\overline{T0}$ at V_{SS}.

3. For proper operation of the counters the count pulse width (t_W), negative and positive, should be 500 ns. If the intention is to access the counters in read mode during counting, the count pulse width should be at least $2/f_{xtal}$ + 500 ns.

4. Verified on sample bases. Not tested during production.
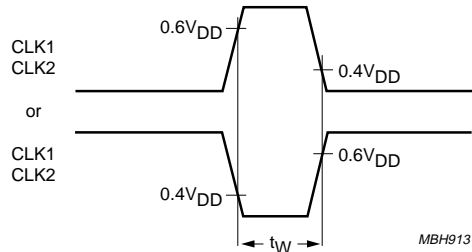
Fig.7 Definition of count pulse width (t_W).
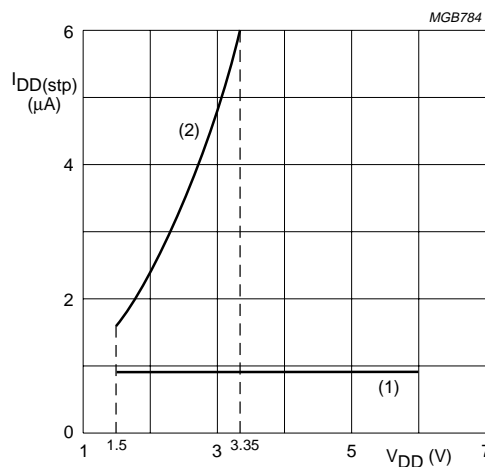
(1) RTC stopped; −25 to 70 °C.
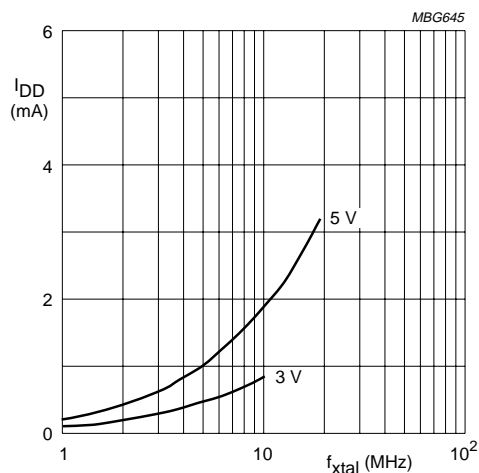(2) RTC running; −25 to 70 °C.

Fig.8 Typical supply current (I_{DD}) in Stop mode as
a function of supply voltage (V_{DD}).
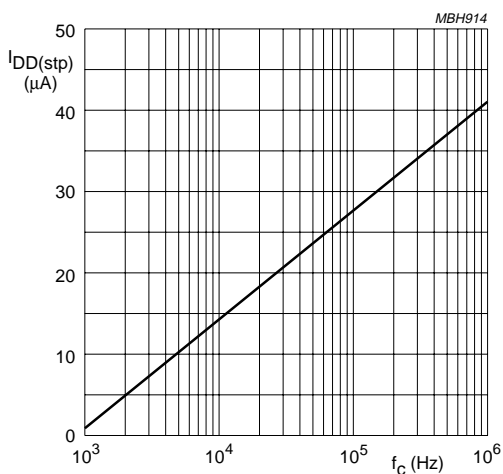
Fig.9 Typical supply current ($I_{DD(stp)}$) in Stop
mode as a function of counter frequency,
both counters running in parallel.
(V_{DD} = 3 V; T_{amb} = +25 °C),
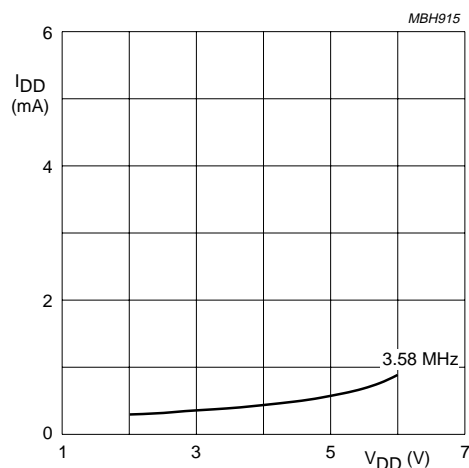
Measured with crystal between XTAL1 and XTAL2.

Fig.10 Typical operating supply current (I_{DD}) as a
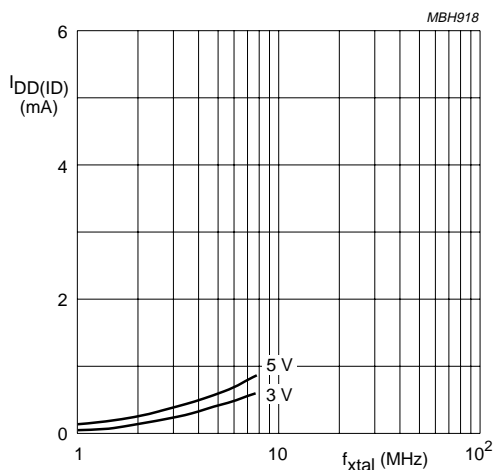function of supply voltage (V_{DD}).

MBG645

Measured with function generator on XTAL1.

Fig.11 Typical operating supply current (I_{DD}) as a
function of clock frequency (f_{xtal}).

MBH916
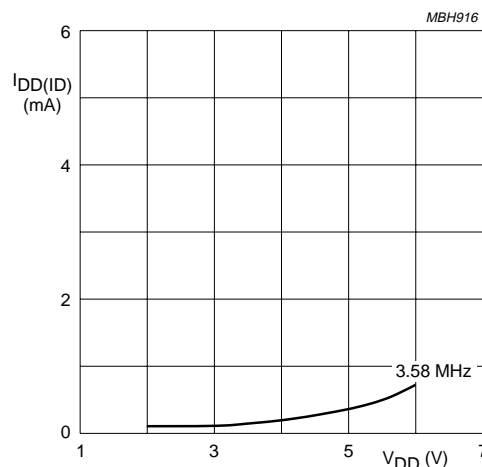
Measured with crystal between XTAL1 and XTAL2.

Fig.12 Typical supply current ($I_{DD(ID)}$) in Idle mode
as a function of supply voltage (V_{DD}).

MBH918

Measured with function generator on XTAL1.

Fig.13 Typical supply current ($I_{DD(ID)}$) in Idle mode
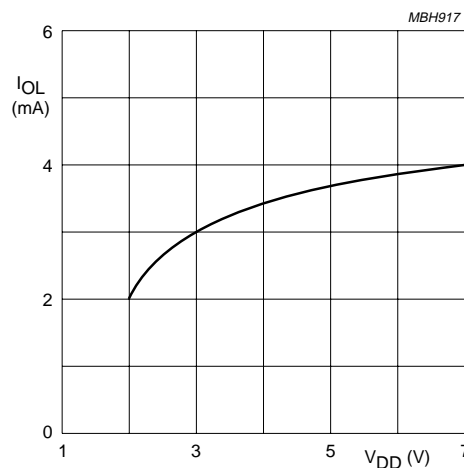as a function of clock frequency (f_{xtal}).

MBH917

V_O = 0.4 V.

Fig.14 Typical LOW level port output sink current
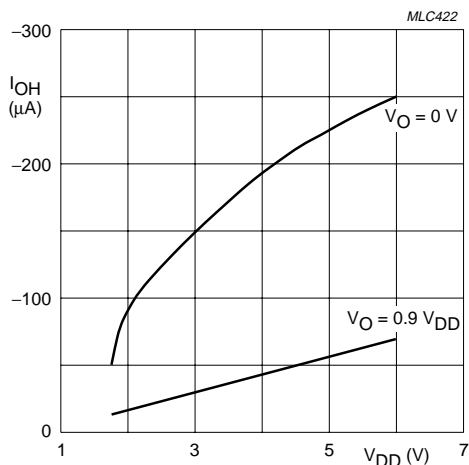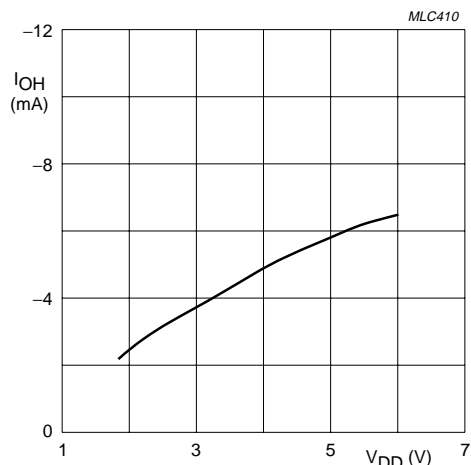(I_{OL}) as a function of supply voltage (V_{DD}).

Fig.15 Typical HIGH level output pull-up source current (I_{OH}) as a function of supply voltage (V_{DD}).

$V_O = V_{DD} - 0.4$ V.

Fig.16 Typical HIGH level push-pull output source current (I_{OH}) as a function of supply voltage (V_{DD}).

19 AC CHARACTERISTICS

V_{DD} = 1.8 to 6 V; V_{SS} = 0 V; T_{amb} = −25 to +70 °C; all voltages with respect to V_{SS} unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
t_r	rise time all outputs	V_{DD} = 5 V; T_{amb} = 25 °C; C_L = 50 pF	–	30	–	ns
t_f	fall time all outputs		–	30	–	ns
f_{xtal}	clock frequency	see Fig.17	1	–	16	MHz
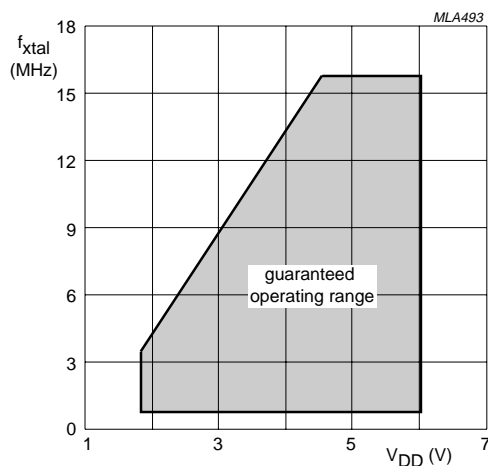
Fig.17 Maximum clock frequency (f_{xtal}) as a function of supply voltage (V_{DD}).

Fig.18 Typical transconductance of XTAL oscillator
as a function of supply voltage (V_{DD}).

Fig.19 Typical RTC oscillator transconductance as
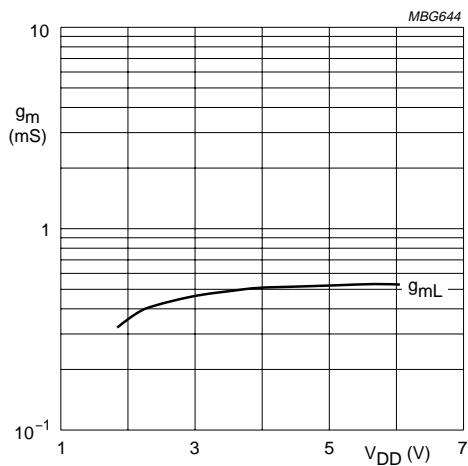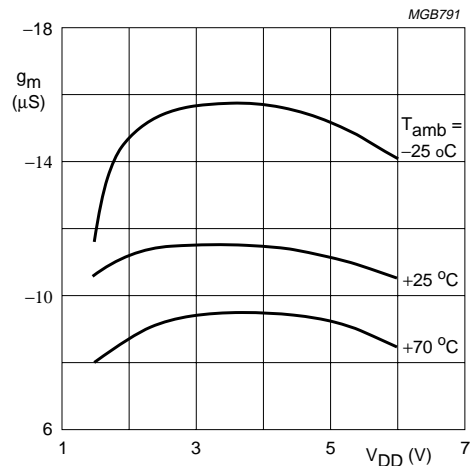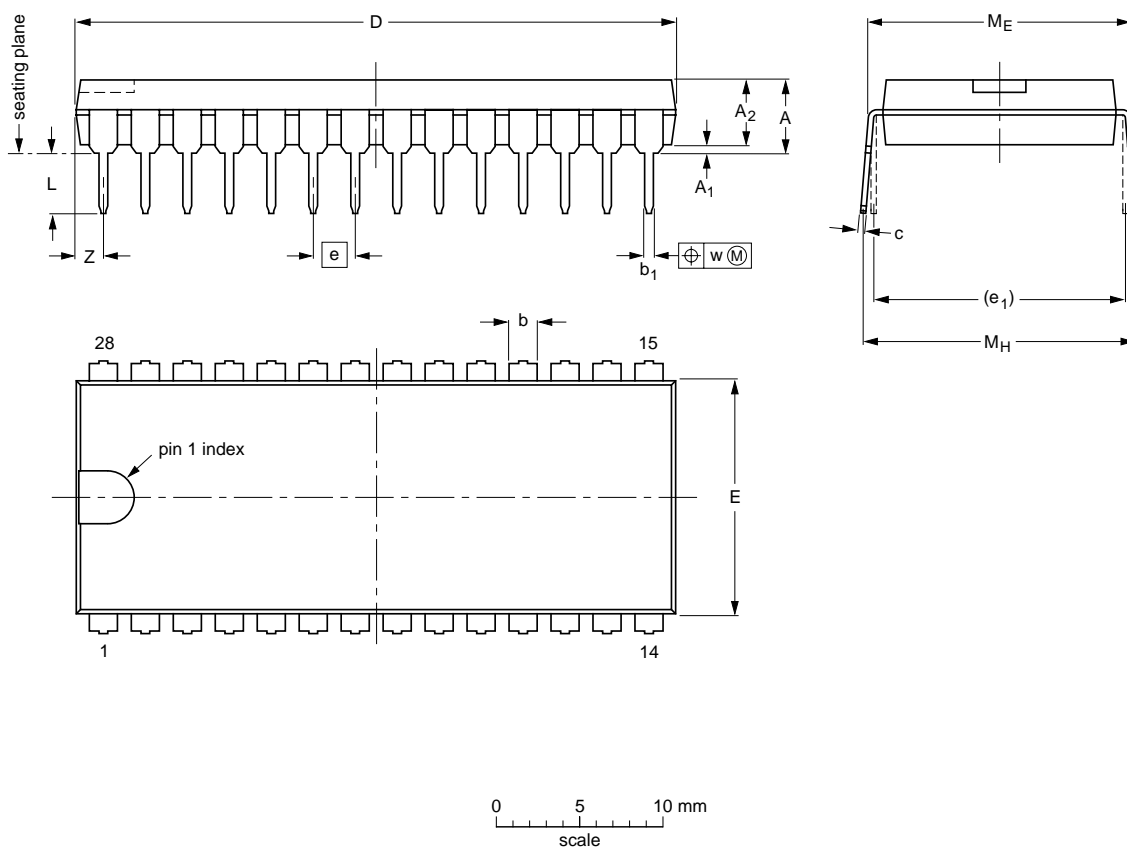a function of supply voltage (V_{DD}).

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

20 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

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

SO28: plastic small outline package; 28 leads; body width 7.5 mm

SOT136-1
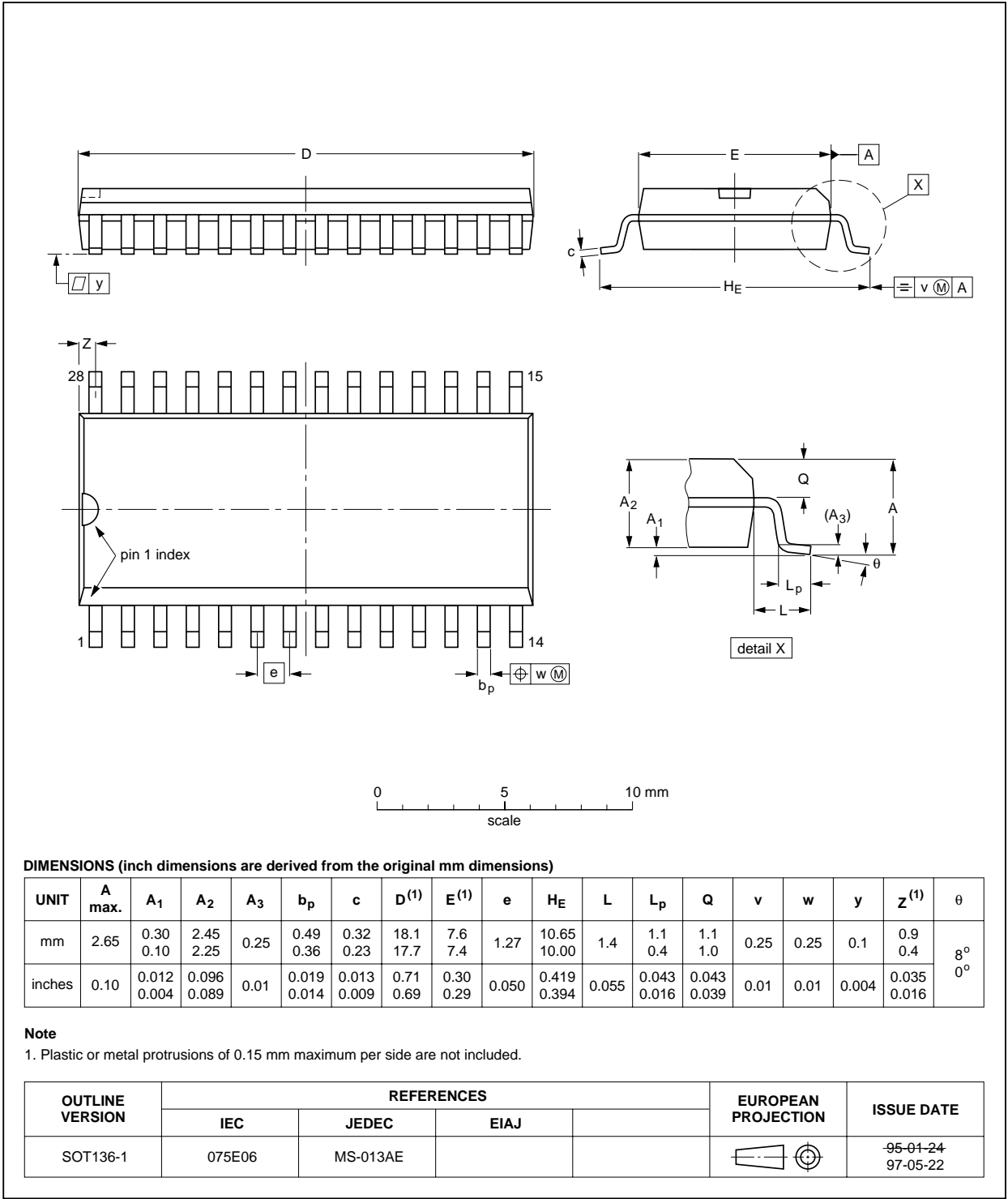

DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A₁	A₂	A₃	bₚ	c	D(1)	E(1)	e	Hₑ	L	Lₚ	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	18.1 17.7	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	0.71 0.69	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.

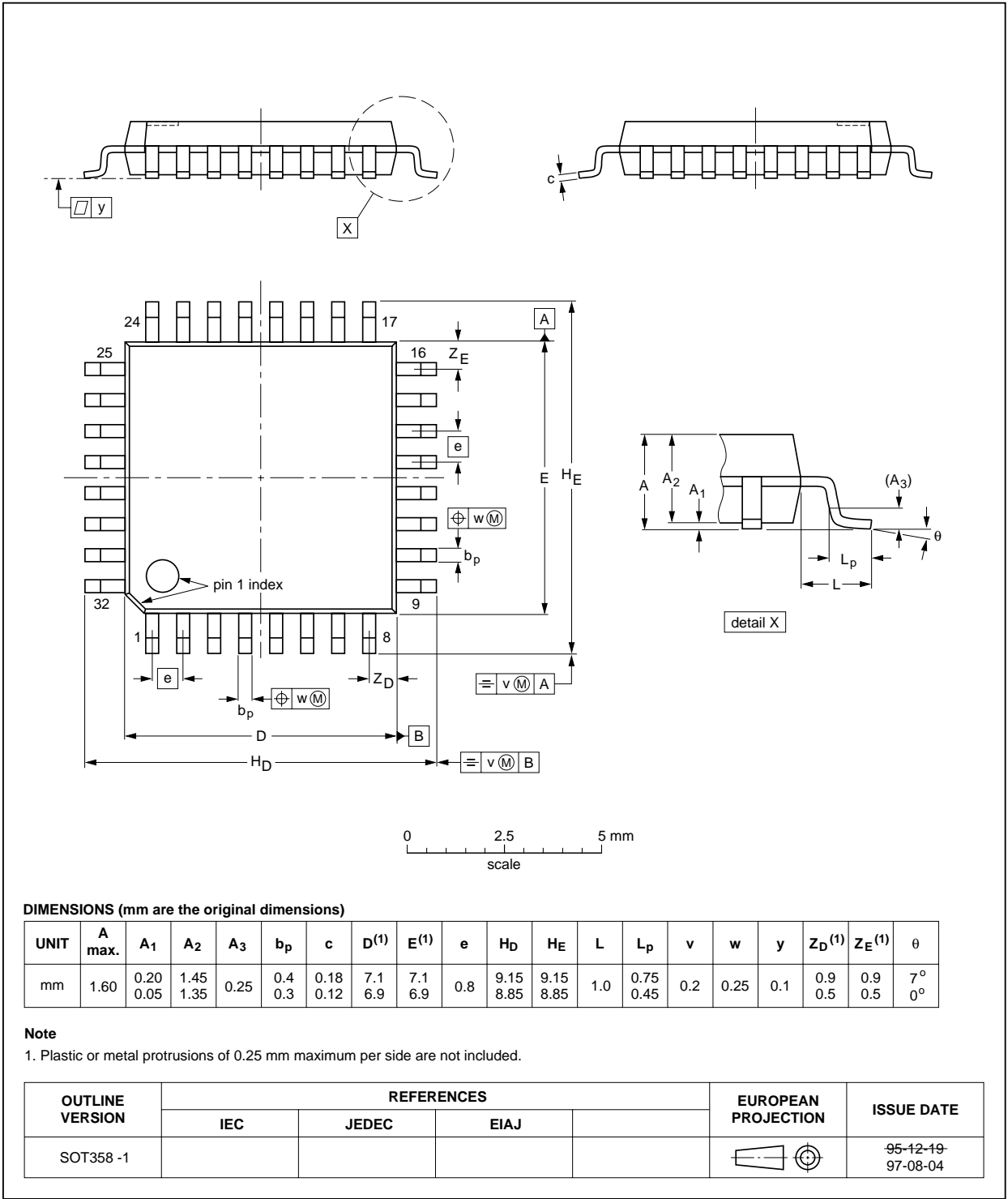| OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT136-1	075E06	MS-013AE				~~95-01-24~~ 97-05-22

8-bit microcontroller with 4.5 kbytes OTP memory and 32 kHz real-time clock

PCD3745A

LQFP32: plastic low profile quad flat package; 32 leads; body 7 x 7 x 1.4 mm

SOT358-1

DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A₁	A₂	A₃	bₚ	c	D(1)	E(1)	e	H_D	H_E	L	Lₚ	v	w	y	Z_D(1)	Z_E(1)	θ
mm	1.60	0.20 / 0.05	1.45 / 1.35	0.25	0.4 / 0.3	0.18 / 0.12	7.1 / 6.9	7.1 / 6.9	0.8	9.15 / 8.85	9.15 / 8.85	1.0	0.75 / 0.45	0.2	0.25	0.1	0.9 / 0.5	0.9 / 0.5	7° / 0°

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			
SOT358 -1						95-12-19 97-08-04

21 SOLDERING

21.1 Introduction

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"* (document order number 9398 652 90011).

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

21.2 Through-hole mount packages

21.2.1 Soldering by dipping or by solder wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joints 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.

21.2.2 Manual soldering

Apply the soldering iron (24 V or less) to the lead(s) of the package, either 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.

21.3 Surface mount packages

21.3.1 Reflow soldering

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferable be kept below 230 °C.

21.3.2 Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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.

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.

21.3.3 Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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.

21.4   Suitability of IC packages for wave, reflow and dipping soldering methods

MOUNTING	PACKAGE	SOLDERING METHOD		
		WAVE	**REFLOW**[1]	**DIPPING**
Through-hole mount	DBS, DIP, HDIP, SDIP, SIL	suitable[2]	–	suitable
Surface mount	BGA, SQFP	not suitable	suitable	–
	HLQFP, HSQFP, HSOP, HTSSOP, SMS	not suitable[3]	suitable	–
	PLCC[4], SO, SOJ	suitable	suitable	–
	LQFP, QFP, TQFP	not recommended[4][5]	suitable	–
	SSOP, TSSOP, VSO	not recommended[6]	suitable	–

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.

2. For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.

3. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).

4. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.

5. Wave soldering is only suitable for LQFP, QFP and TQFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.

6. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

22   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.	

23   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.

8-bit microcontroller with 4.5 kbytes OTP
memory and 32 kHz real-time clock

PCD3745A

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 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

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: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +30 1 489 4339/4239, Fax. +30 1 481 4240

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

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

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
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 108-8507, 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, Fax +9-5 800 943 0087

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

Pakistan: see Singapore

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 319762,
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: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, 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, Fax. +1 800 943 0087

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 62 5344, Fax.+381 11 63 5777

For all other countries apply to: Philips Semiconductors,
International 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   275002/00/02/pp32   Date of release: 1999 Feb 02   Document order number: 9397 750 05153

Let's make things better.

Philips
Semiconductors

PHILIPS