

# DATA SHEET



## **PCF84C81A** Telecom microcontroller

Product specification  
Supersedes data of 1996 Nov 20  
File under Integrated Circuits, IC14

1998 Apr 20

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## Telecom microcontroller

## PCF84C81A

**1 FEATURES**

- Manufactured in silicon gate CMOS process
- 8-bit CPU, ROM, RAM, I/O in a 28-lead package
- 8 kbyte ROM, 256 byte RAM (PCF84C81A)
- I<sup>2</sup>C-bus interface with multi-master capability
- Over 100 instructions (based on MAB8048) all of 1 or 2 cycles
- 20 quasi-bidirectional I/O Port lines
- High sink current capability on the 8 lines of Port 1
- 8-bit programmable timer/event counter 1
- 3 single-level vectored interrupts:
  - external
  - 8-bit programmable timer/event counter 1
  - I<sup>2</sup>C-bus
- Two test inputs, one of which also serves as the external interrupt input
- Stop and Idle modes
- Supply voltage: 2.5 to 5.5 V
- Clock frequency: 1 to 16 MHz
- Operating temperature: –40 to +85 °C.

**2 GENERAL DESCRIPTION**

This data sheet details the specific properties of the PCF84C81A. 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 PCF84C81A is a general purpose CMOS microcontroller with 8 kbytes of program memory and 256 bytes of RAM. In addition to 20 I/O port lines, the microcontrollers provide an on-chip I<sup>2</sup>C-bus interface. This two-line serial bus extends the microcontroller capabilities when implemented with the powerful I<sup>2</sup>C-bus peripherals. These include LCD drivers, I/O expanders, telecom circuits, ADC and DAC converters, clock/calendar circuits, EEPROM and RAM and are listed in “Data Handbook IC12, I<sup>2</sup>C Peripherals”.

The instruction set is based on that of the MAB8048 and is a sub-set of that listed in the “PCF84CxxxA family” data sheet.

**3 ORDERING INFORMATION** (see note 1)

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
PCF84C81AP	DIP28	plastic dual in-line package; 28 leads (600 mil)	SOT117-1
PCF84C81AT	SO28	plastic small outline package; 28 leads; body width 7.5 mm	SOT136-1

**Note**

1. Please refer to the Order Entry Form (OEF) for the full type number to use when ordering. This type number will also specify the required program and the ROM mask options.

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4 BLOCK DIAGRAM

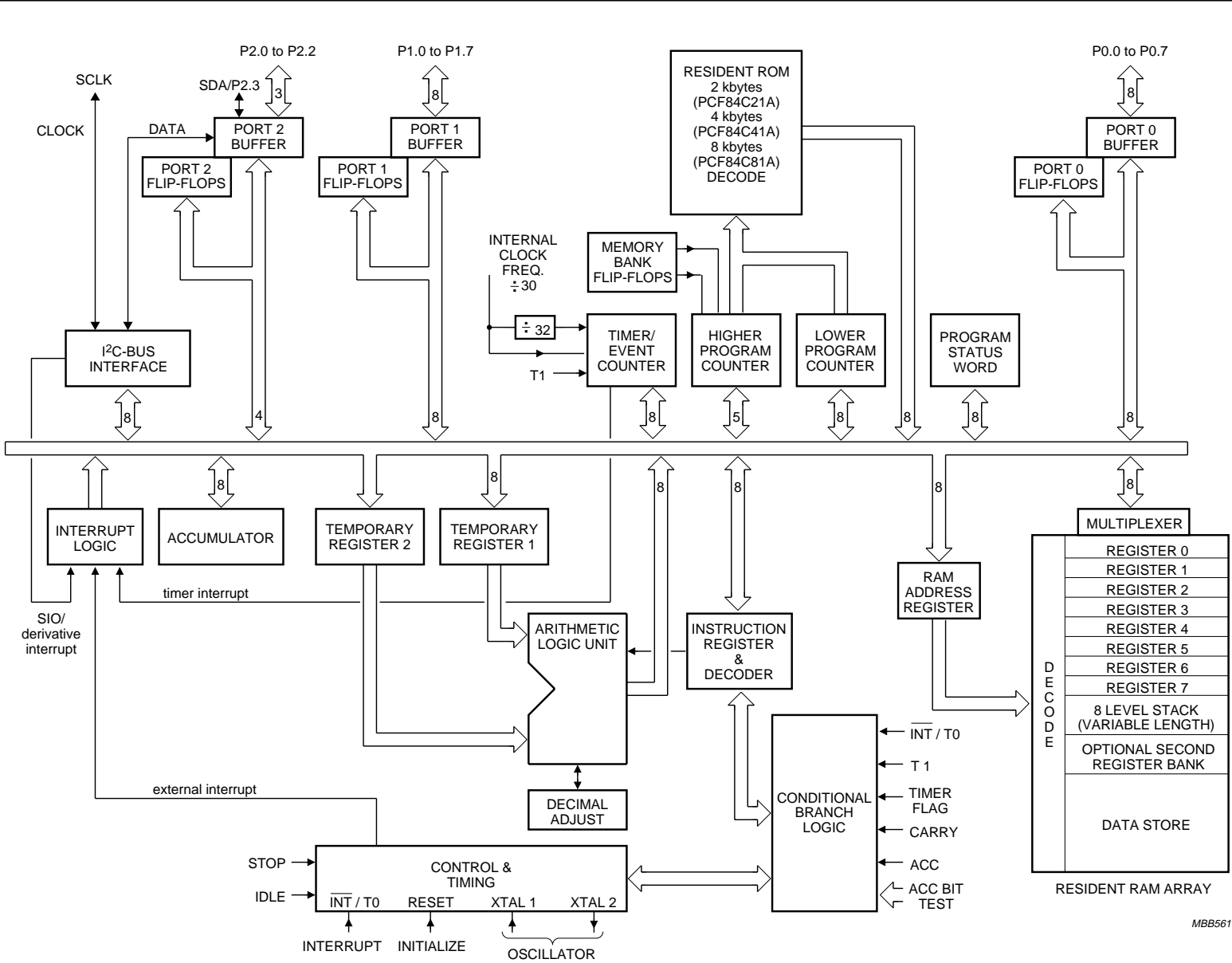


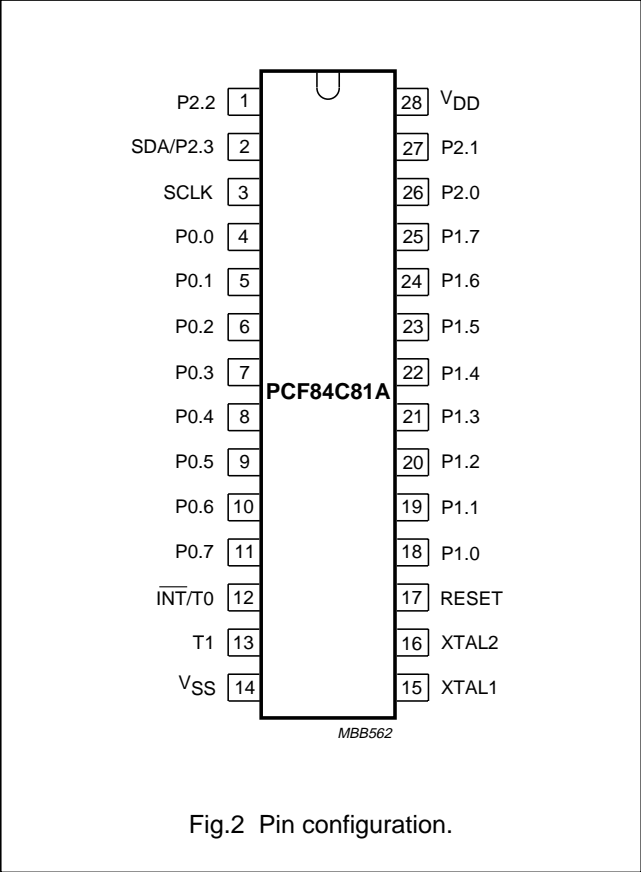
Fig.1 Block diagram.

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5 PINNING INFORMATION

5.1 Pinning



6 INSTRUCTION SET

See the “PCF84CxxxA family” data sheet for a complete description of the instruction set.

5.2 Pin description

Table 1 DIP28 and SO28 packages

SYMBOL	PIN	FUNCTION
P2.2	1	1 bit of Port 2: 4-bit quasi-bidirectional I/O port
SDA/P2.3	2	bidirectional data line of the I <sup>2</sup> C-bus interface, or 1 bit of Port 2: 4-bit quasi-bidirectional I/O port
SCLK	3	bidirectional clock line of the I <sup>2</sup> C-bus interface
P0.0 to P0.7	4 to 11	8 bits of Port 0: 8-bit quasi-bidirectional I/O port
INT/T0	12	Interrupt/Test 0
T1	13	Test 1/count input of 8-bit timer/event counter 1
V <sub>SS</sub>	14	ground
XTAL1	15	crystal oscillator input or external clock input
XTAL2	16	crystal oscillator output
RESET	17	Reset input
P1.0 to P1.7	18 to 25	8 bits of Port 1: 8-bit quasi-bidirectional I/O port
P2.0 to P2.1	26 to 27	2 bits of Port 2: 4-bit quasi-bidirectional I/O port
V <sub>DD</sub>	28	positive supply

7 HIGH SINK OUTPUT CURRENTS

The Port 1 outputs of these devices are designed for high current drive in the logic 0 state. They are capable of driving 10 mA loads and higher. Applications include drive for small relays and light-emitting diodes (LEDs).

To avoid overload, care should be taken that the total Port 1 current averages less than 80 mA, i.e. an average of 10 mA per Port 1 line. Refer to Chapter “Limiting values” which specifies an upper limit of 100 mA for I<sub>SS</sub>.

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## 8 ROM MASK OPTIONS

ROM CODE	OPTION		
Program/data	Any mix of instructions and data up to ROM size of 8 kbytes.		
Port Output			
P0.0 to P0.7	standard	open-drain	push-pull
P1.0 to P1.7	standard	open-drain	push-pull
P2.0 to P2.2	standard	open-drain	push-pull
SDA/P2.3	–	open-drain	–
Port State after reset			
P0.0 to P0.7	set	reset	–
P1.0 to P1.7	set	reset	–
P2.0 to P2.2	set	reset	–
SDA/P2.3	set	–	–
Oscillator			
Transconductance	LOW (g <sub>mL</sub> )	MEDIUM (g <sub>mM</sub> )	HIGH (g <sub>mH</sub> )

## 9 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”.

## 10 LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V <sub>DD</sub>	supply voltage	–0.5	+7	V
V <sub>I</sub>	all input voltages	–0.5	V <sub>DD</sub> + 0.5	V
I <sub>I</sub>	DC input current	–10	+10	mA
I <sub>O</sub>	DC output current except Port 1 output LOW	–10	+10	mA
I <sub>O</sub>	DC output current, Port 1 output LOW	–10	+20	mA
P <sub>tot</sub>	total power dissipation	–	125	mW
P <sub>O</sub>	power dissipation per output	–	30	mW
I <sub>DD</sub>	supply current	–50	+50	mA
I <sub>SS</sub>	ground supply current	–100	+50	mA
T <sub>stg</sub>	storage temperature range	–55	+150	°C
T <sub>j</sub>	operating junction temperature	–	90	°C

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**11 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.3	2.5	–	5.5	V
$I_{DD}$	operating supply current	note 1; see Figs 4 and 5 $V_{DD} = 3$ V; $f_{xtal} = 3.58$ MHz ( $g_{mL}$ ) $V_{DD} = 5$ V; $f_{xtal} = 10$ MHz ( $g_{mL}$ ) $V_{DD} = 5$ V; $f_{xtal} = 16$ MHz ( $g_{mM}$ ) $V_{DD} = 5$ V; $f_{xtal} = 16$ MHz ( $g_{mH}$ )	– – – –	0.3 1.1 1.7 2.5	0.6 3.0 5.0 6.0	mA mA mA mA
$I_{DD(idle)}$	supply current (Idle mode)	note 1; see Figs 6 and 7 $V_{DD} = 3$ V; $f_{xtal} = 3.58$ MHz ( $g_{mL}$ ) $V_{DD} = 5$ V; $f_{xtal} = 10$ MHz ( $g_{mL}$ ) $V_{DD} = 5$ V; $f_{xtal} = 16$ MHz ( $g_{mM}$ ) $V_{DD} = 5$ V; $f_{xtal} = 16$ MHz ( $g_{mH}$ )	– – – –	0.2 0.8 1.2 1.7	0.4 1.6 4.0 5.0	mA mA mA mA
$I_{DD(stp)}$	supply current (Stop mode)	$V_{DD} = 2.5$ V; notes 1 and 2; see Fig.8	–	1.2	10	µA
<b>Inputs</b>						
$V_{IL}$	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	$V_{SS} \leq V_I \leq V_{DD}$	–1	–	+1	µA
<b>Outputs</b>						
$I_{OL}$	LOW level output sink current [except Port 1; SDA/P2.3 and SCLK]	$V_{DD} = 5$ V; $V_O = 0.4$ V; see Fig.9	1.6	5	–	mA
$I_{OL1}$	LOW level output sink current; Port 1	$V_{DD} = 5$ V; $V_O = 1.2$ V; see Fig.10	10	19	–	mA
$I_{OL2}$	LOW level output sink current; SDA/P2.3 and SCLK	$V_{DD} = 5$ V; $V_O = 0.4$ V; see Fig.11	3	6.5	–	mA
$I_{OH}$	HIGH level pull-up output source current	$V_{DD} = 5$ V; $V_O = 3.5$ V; see Fig.12	40	100	–	µA
		$V_{DD} = 5$ V; $V_O = 0$ V; see Fig.12	–	–140	–400	µA
$I_{OH1}$	HIGH level push-pull output source current	$V_{DD} = 5$ V; $V_O = 4.6$ V; see Fig.13	–1.6	–7	–	mA
<b>Oscillator (see Fig.14)</b>						
$g_{mL}$	LOW transconductance	$V_{DD} = 5$ V	0.2	0.4	1.0	mS
$g_{mM}$	MEDIUM transconductance	$V_{DD} = 5$ V	0.9	1.6	3.2	mS
$g_{mH}$	HIGH transconductance	$V_{DD} = 5$ V	3.0	4.5	9.0	mS
$R_F$	feedback resistor		0.3	1.0	3.0	MΩ

**Notes**

- $V_{IL} = V_{SS}$ ;  $V_{IH} = V_{DD}$ ; 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).
- $V_{IL} = V_{SS}$ ;  $V_{IH} = V_{DD}$ ; 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.

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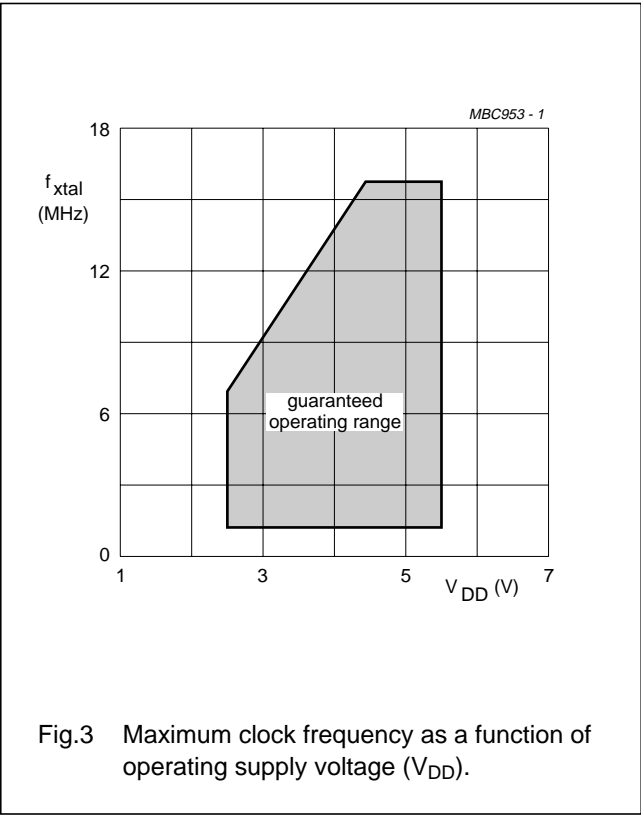
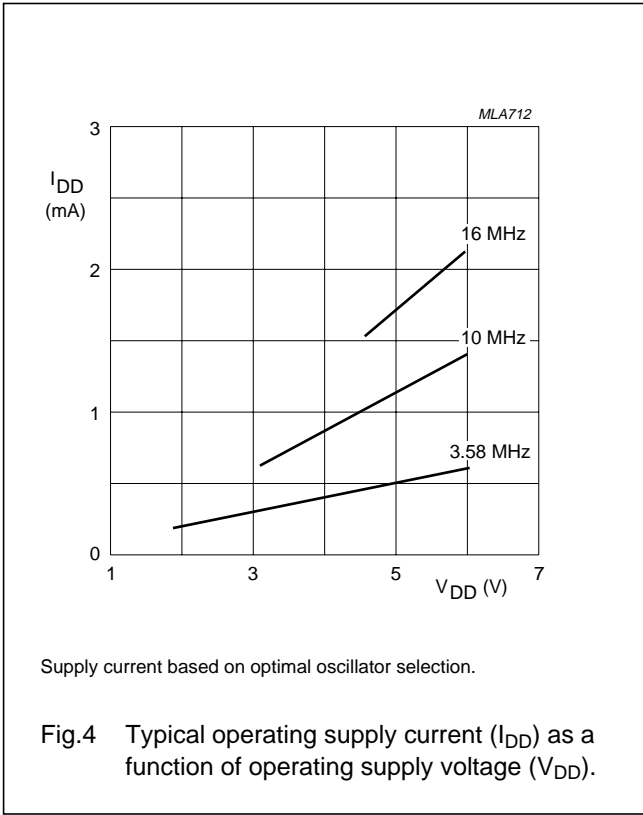
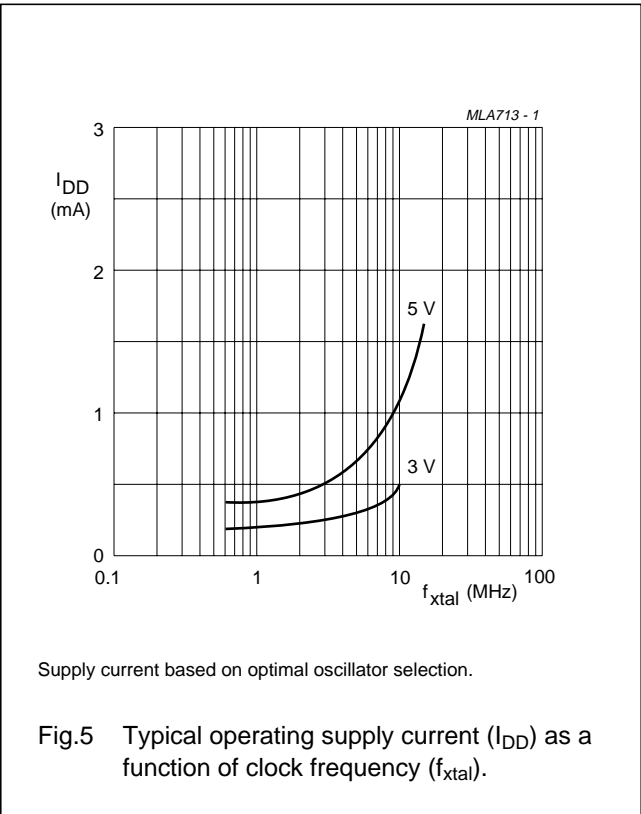


Fig.3 Maximum clock frequency as a function of operating supply voltage ( $V_{DD}$ ).



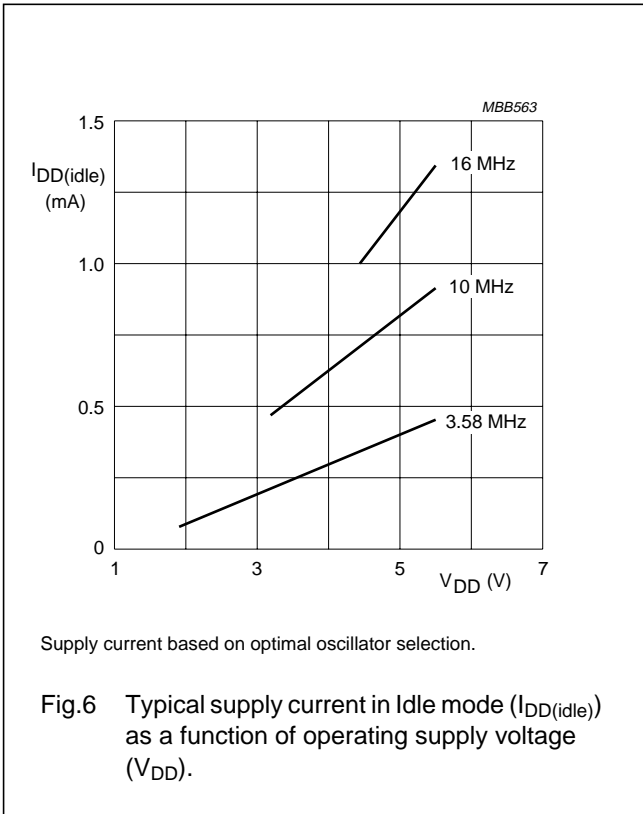
Supply current based on optimal oscillator selection.

Fig.4 Typical operating supply current ( $I_{DD}$ ) as a function of operating supply voltage ( $V_{DD}$ ).



Supply current based on optimal oscillator selection.

Fig.5 Typical operating supply current ( $I_{DD}$ ) as a function of clock frequency ( $f_{xtal}$ ).



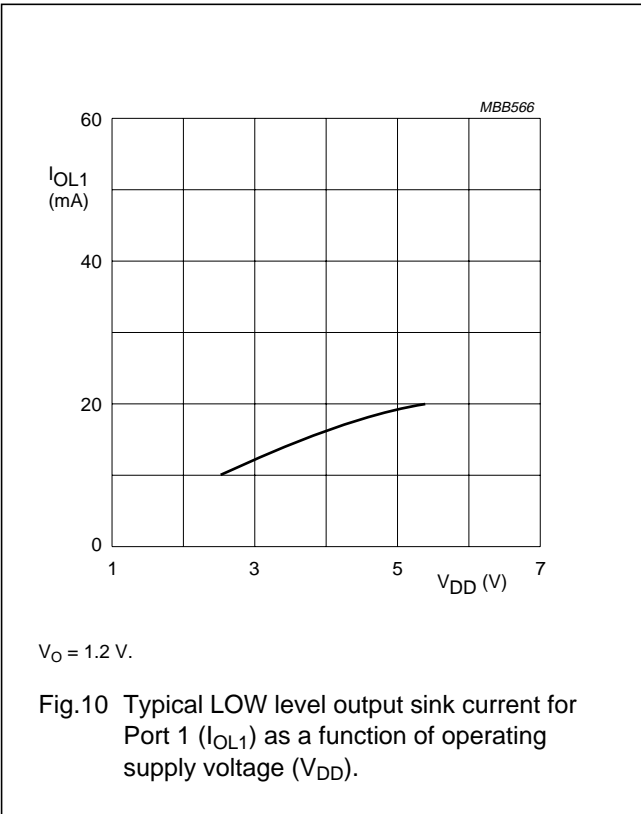
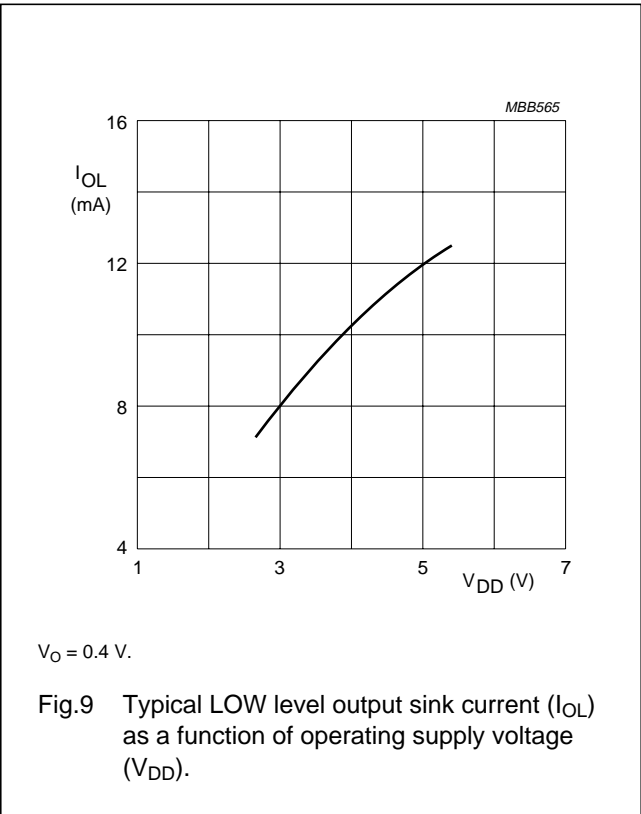
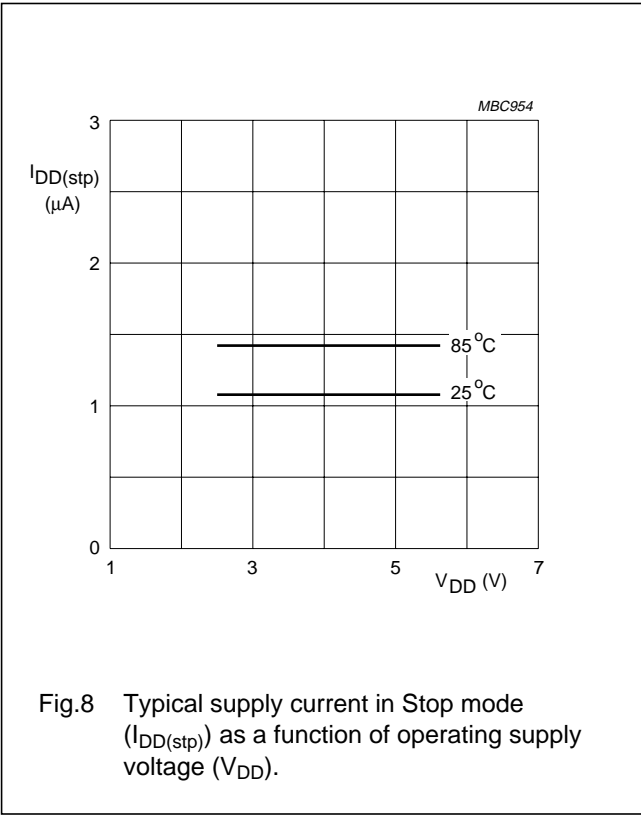
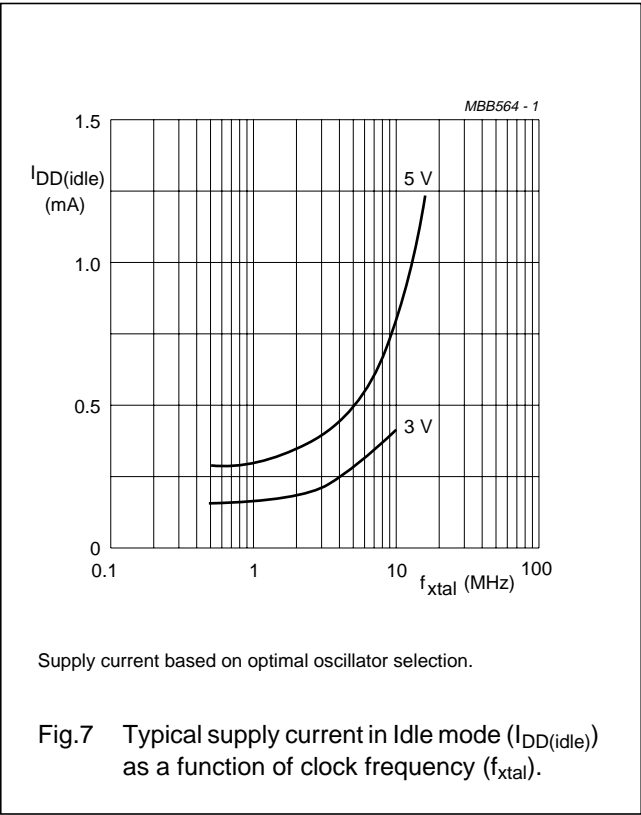
Supply current based on optimal oscillator selection.

Fig.6 Typical supply current in Idle mode ( $I_{DD(idle)}$ ) as a function of operating supply voltage ( $V_{DD}$ ).



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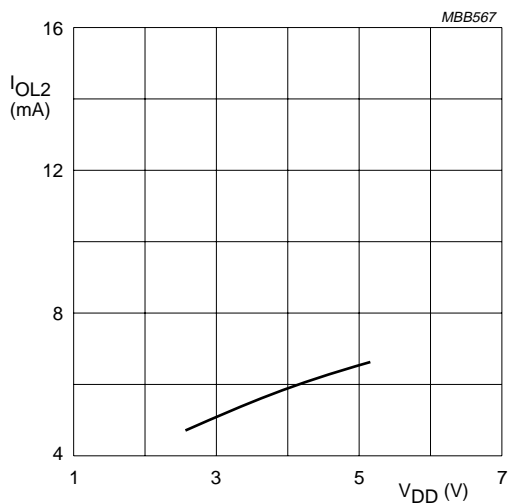


Fig.11 Typical LOW level output sink current for SDA/P2.3 or SCLK ( $I_{OL2}$ ) as a function of operating supply voltage ( $V_{DD}$ ).

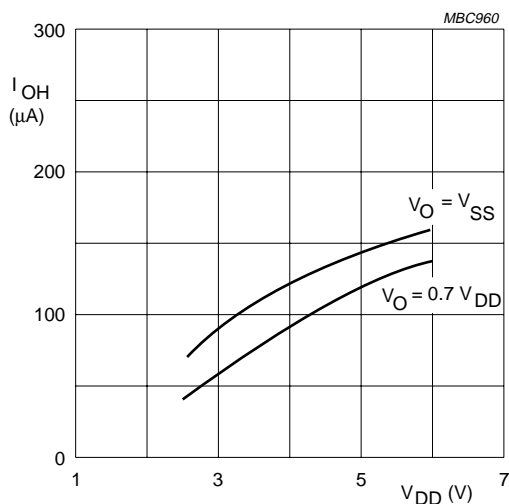
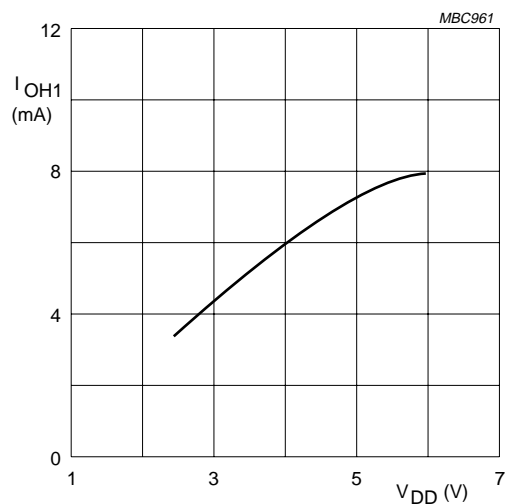


Fig.12 Typical HIGH level pull-up output source current ( $I_{OH}$ ) as a function of operating supply voltage ( $V_{DD}$ ).



$V_{OL} = V_{DD} - 0.4 \text{ V.}$

Fig.13 Typical HIGH level push-pull output source current ( $I_{OH1}$ ) as a function of operating supply voltage ( $V_{DD}$ ).

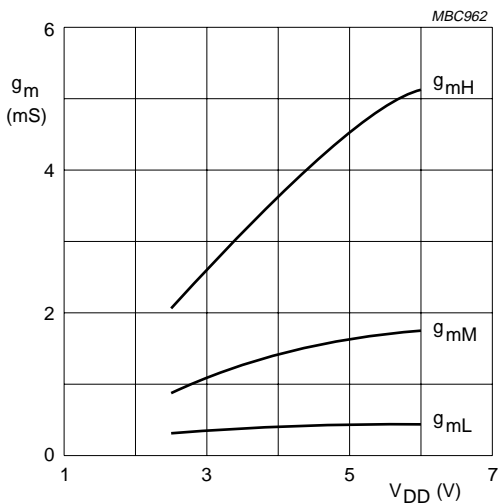


Fig.14 Typical transconductance values ( $g_m$ ) as a function of operating supply voltage ( $V_{DD}$ ) for the options  $g_{mL}$ ,  $g_{mM}$  and  $g_{mH}$ .

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**12 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.	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	$V_{DD} = 5$ V; $T_{amb} = 25$ °C; $C_L = 50$ pF	–	30	–	ns
$f_{xtal}$	clock frequency	see Fig.3	1	–	16	MHz

**Table 2** I<sup>2</sup>C-bus timing (see Figs 15 and 16)

SYMBOL	PARAMETER	INPUT (see Fig.14)	OUTPUT (see Fig.15; note 1)
<b>SCLK</b>			
$t_{HD;STA}$	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	$\leq 1$ µs	$\leq 1$ µs; note 3
$t_{FC}$	SCLK fall time	$\leq 0.3$ µs	$\leq 0.1$ µs; note 4
<b>SDA</b>			
$t_{BUF}$	bus free time	$\geq \frac{14}{f_{xtal}}$	$\geq 4.7$ µs; note 5
$t_{SU;DAT}$	data set-up time	$\geq 250$ ns	$\geq \frac{15}{f_{xtal}}$ ; note 6
$t_{HD;DAT}$	data hold time	$\geq 0$	$\geq \frac{9}{f_{xtal}}$
$t_{RD}$	SDA/P2.3 rise time	$\leq 1$ µs	$\leq 1$ µs; note 3
$t_{FD}$	SDA/P2.3 fall time	$\leq 0.3$ µs	$\leq 0.1$ 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 I<sup>2</sup>C-bus capacitance ( $C_b$ ) and external pull-up resistor.

4. At maximum allowed I<sup>2</sup>C-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.

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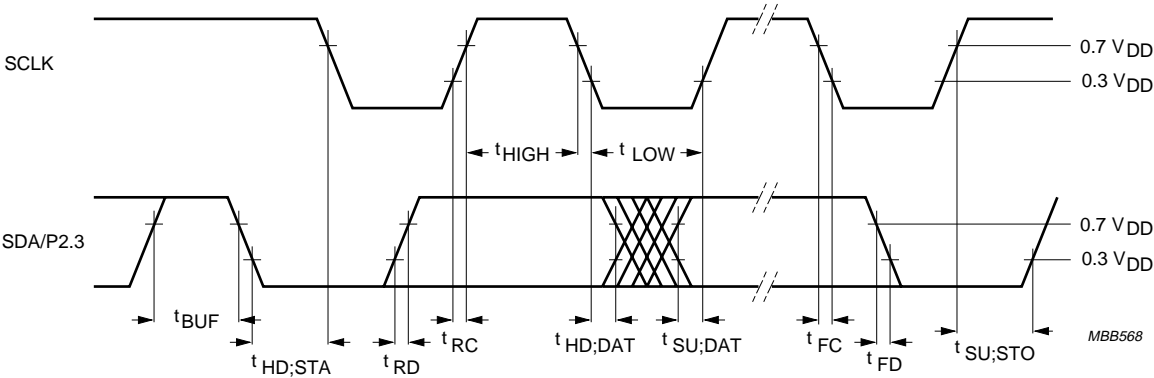


Fig.15 Slave SCLK receiver SDA/P2.3 timing (SCLK and SDA/P2.3 are inputs).

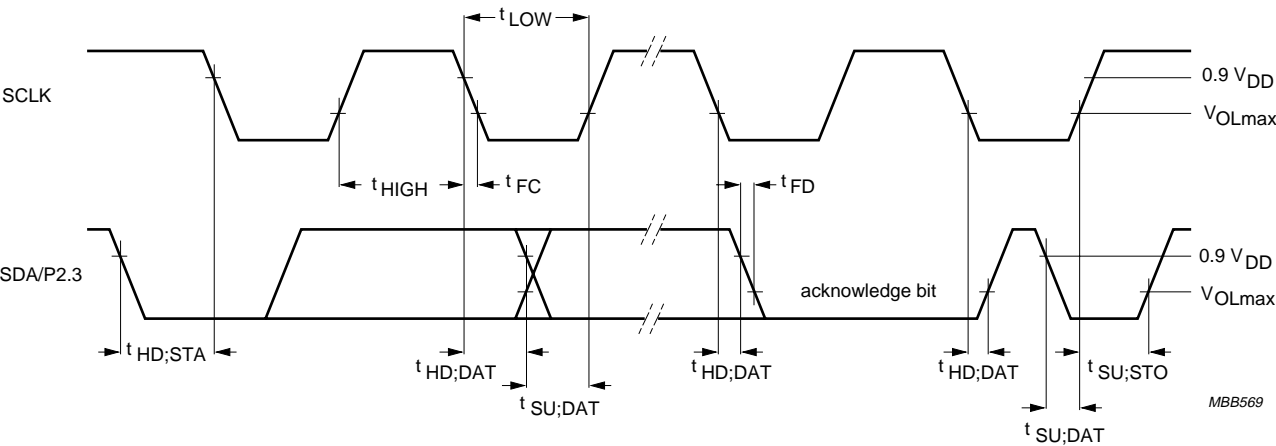


Fig.16 Master SCLK and transmitter SDA/P2,3 timing (SCLK and SDA/P2.3 are outputs).

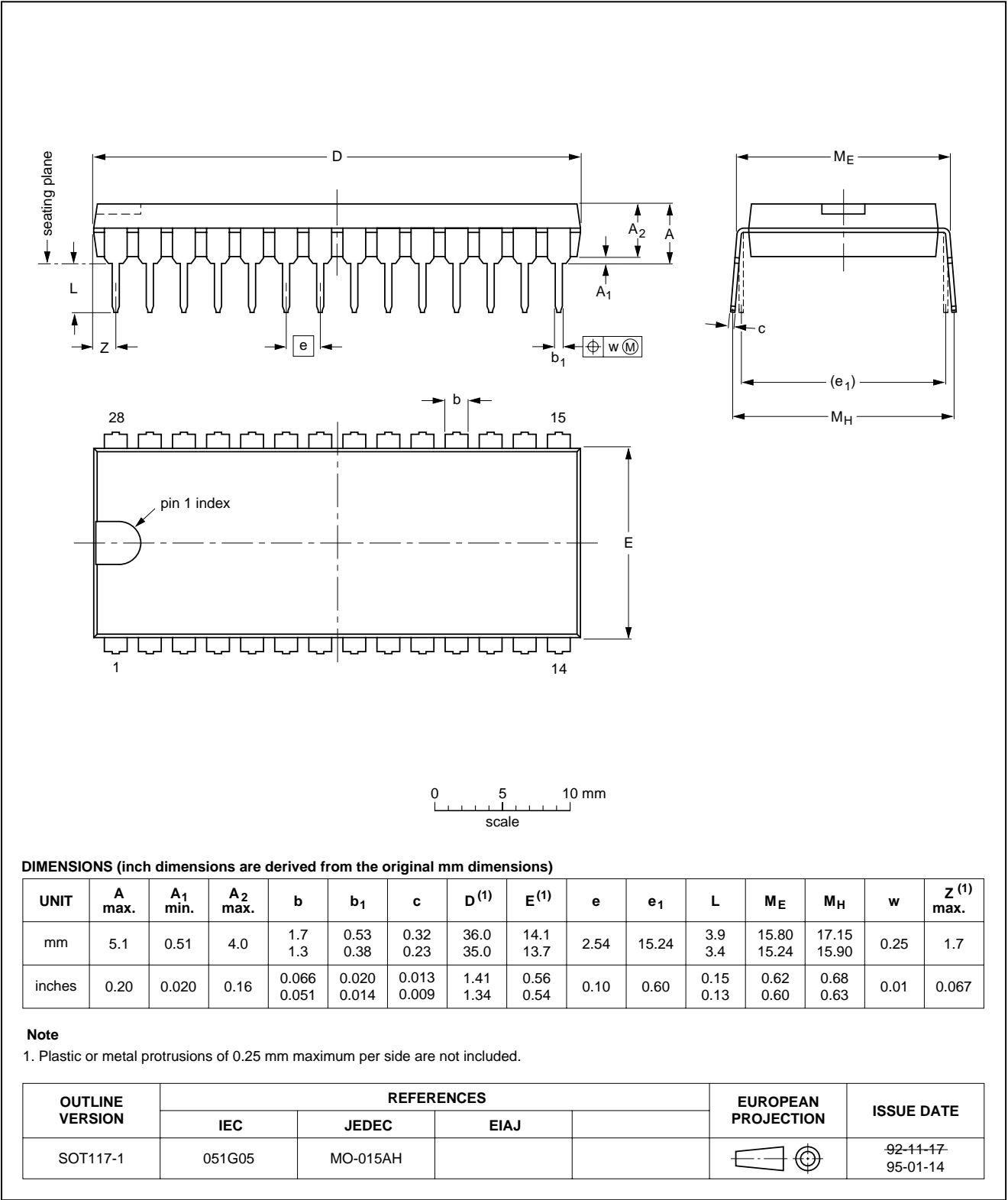
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13 PACKAGE OUTLINES

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

SOT117-1

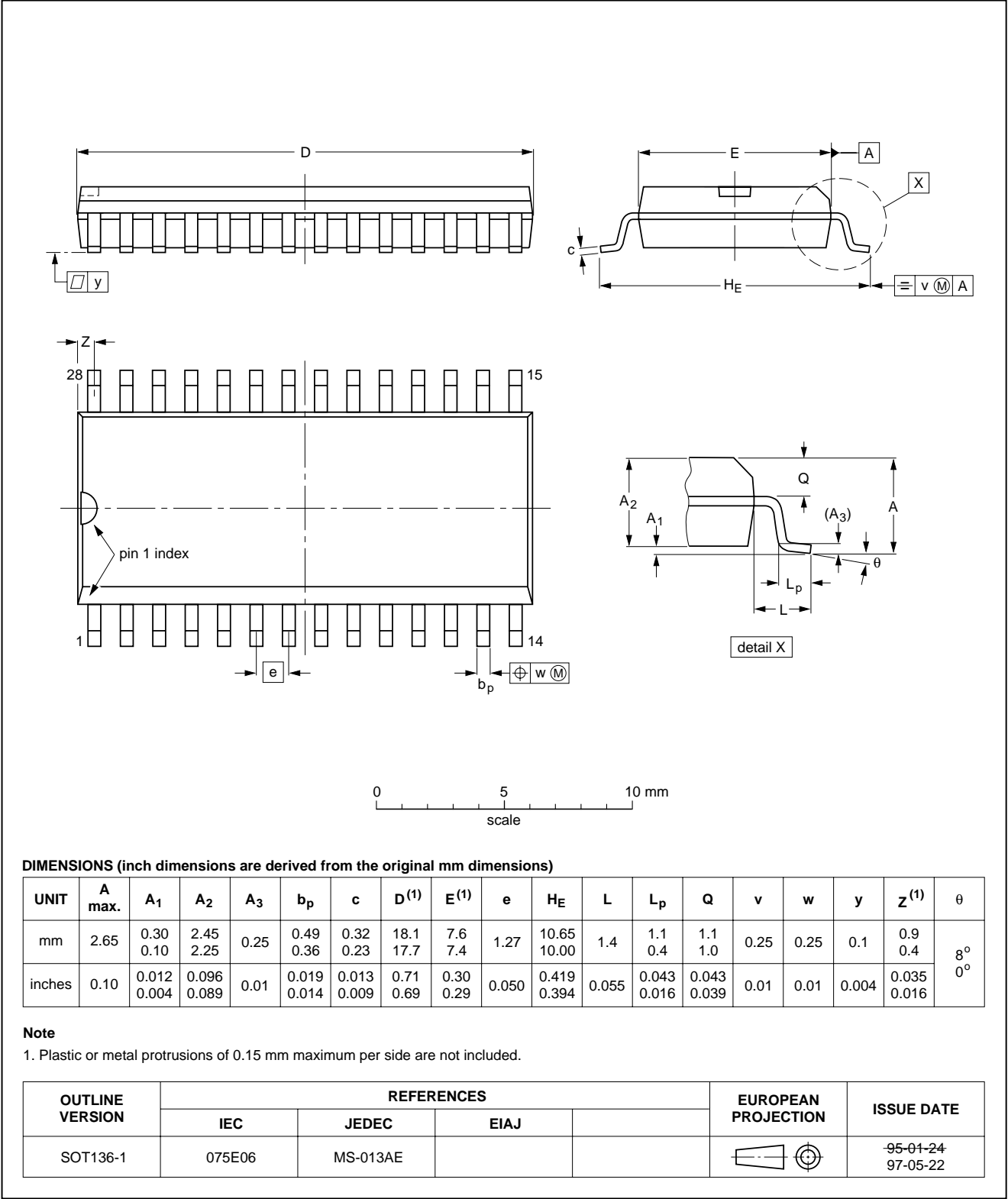


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SO28: plastic small outline package; 28 leads; body width 7.5 mm

SOT136-1



## Telecom microcontroller

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**14 SOLDERING****14.1 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 *"Data Handbook IC26; Integrated Circuit Packages"* (order code 9398 652 90011).

**14.2 DIP****14.2.1 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.

**14.2.2 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.

**14.3 SO****14.3.1 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.

**14.3.2 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.

**14.3.3 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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**15 DEFINITIONS**

<b>Data sheet status</b>	
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.
<b>Limiting values</b>	
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.	
<b>Application information</b>	
Where application information is given, it is advisory and does not form part of the specification.	

**16 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.

**17 PURCHASE OF PHILIPS I<sup>2</sup>C COMPONENTS**

Purchase of Philips I<sup>2</sup>C components conveys a license under the Philips' I<sup>2</sup>C patent to use the components in the I<sup>2</sup>C system provided the system conforms to the I<sup>2</sup>C 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**

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