

DATA SHEET

PCD3330-1

Multistandard repertory
dialler/ringer with EEPROM

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Multistandard repertory dialler/ringer with EEPROM

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1 FEATURES

1.1 Pulse/DTMF dialling

- Pulse, DTMF and 'mixed mode' dialling
- Mixed mode dialling: start with pulse dial, end with DTMF dial (e.g. for control of DTMF user equipment via a pulse network)
- Number of digits per call is infinite (FIFO register)
- Flash or register recall
- Connect a/b to earth function
- Mute functions
- Disconnect function
- Supports 16 dial key: 0 to 9 and *, #, A, B, C and D
- Supports up to 6 × 6 keyboard and various function keys including:
 - FLASH: calibrated line-break pulse
 - HOOK: toggle on-hook/off-hook or loudspeaker on/off
 - MUTE: activate/deactivate mute output
 - TONE: change to DTMF dialling (mixed mode)
 - DISconnect: return to on-hook state for calibrated time
- On-hook dialling control
- Country specifications which can be stored in EEPROM are:
 - * and # to be transmitted/not transmitted when switching over to DTMF dialling mode
 - mark-to-space ratio (3 : 2 or 2 : 1)
 - 6 tone time selections (60/90, 70/70, 80/80, 100/100, 100/140 or 140/140 ms)
 - 4 flash time selections (100, 115, 270 or 600 ms)
 - mute output type selection (M1, $\overline{M1}$, M2 or $\overline{M2}$)
 - microphone mute generated via the LSE output
 - DTMF keys or Function keys selection
- On-chip voltage reference for stabilized supply and temperature independent tone output
- On-chip filtering for low output distortion (CEPT compatible).

1.2 Number storage

- Redial by 'cursor' method (maximum 24 digits) stored in internal EEPROM
- Storage for 13 repertory dial numbers (16 digits each) or 10 repertory dial numbers (20 digits each) in internal EEPROM
- Access pause generation and termination: manually or by 'Atlanta' procedure
- Function keys for: LNR, Memory recall, Store, Access Pause and 1 key repertory
- Country specifications which can be stored in EEPROM are:
 - access pause time selection (1.5/1.0, 2.5/1.5, 3.0/3.5 or 6.0/6.0 s)
 - 10 number repertory dialler selection (1 or 2 key)
 - two repertory number programming procedures (General or Germany)
 - repertory length (16 or 20 digits)
 - generating a keytone during program actions.

1.3 Ringer

- Ringer input frequency detection
- Function key for: Program Ringer
- Three-tone ringer with 4 different ringer frequencies
- Ringer melody generation with four signal speeds and four output volume steps, keypad controlled
- Country specifications which can be stored in EEPROM are:
 - ringer input frequency detection selection
 - ringer output selection (via DTMF tone output or special ringer tone output)
 - 4 possible ringer melodies
 - 4 possible ringer repetition rates
 - 4 possible ringer volumes.

1.4 General

- On-chip oscillator uses low-cost 3.58 MHz (TV colour burst) crystal or PXE resonator
- On-chip power-on reset (typically 2.0 V)
- Supply voltage range 1.8 to 6.0 V (2.5 to 6.0 V in EEPROM erase/write and DTMF and ringer mode).

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2 GENERAL DESCRIPTION

The PCD3330-1 is a mixed-mode multistandard repertory dialler/ringer IC fabricated in a low threshold voltage CMOS technology.

The (maximum 13) repertory numbers, redial and various country specifications are stored in EEPROM so that memory retention is guaranteed for 10 years without using a battery back-up.

National telecommunications specifications can be fulfilled by changing a few bytes in EEPROM which contain the different telephone timing and dialling procedures.

The two on-chip tone generators are used for Dual Tone Multi-Frequency (DTMF) dialling, and for generating a melody during ringing, which is activated when a correct incoming ringer frequency is detected.

As an output transducer for the ringer, a loudspeaker (ringer out via tone output) or a PXE (ringer out via the special ringer output which generates square wave ringer tones with a peak-to-peak voltage of V_{DD} to V_{SS}) can be used.

The operating supply voltage is 1.8 V (2.5 V in EEPROM erase/write and DTMF and ringer mode) to 6.0 V with a low current consumption in all operating modes: standby, conversation, dialling, programming and ringer.

3 ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
PCD3330-1P	DIP28	plastic dual in-line package; 28 leads (600 mil)	SOT117-1
PCD3330-1T	SO28	plastic small outline package; 28 leads; body width 7.5 mm	SOT136-1

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4 PINNING

SYMBOL	PIN	DESCRIPTION
COL1	1	sense column keyboard input/programming EEPROM
COL2	2	sense column keyboard input/programming EEPROM
COL3	3	sense column keyboard input/programming EEPROM
COL4	4	sense column keyboard input/programming EEPROM
COL5	5	sense column keyboard input
COL6	6	sense column keyboard input
DMO	7	dial mode output
HOOK	8	cradle contact input
XTAL1	9	crystal/PXE oscillator input
XTAL2	10	crystal/PXE oscillator output
RESET	11	reset input
CE/RF	12	chip enable and zero crossing for ringer input
ROW1	13	scanning row keyboard output
ROW2	14	scanning row keyboard output
ROW3	15	scanning row keyboard output
ROW4	16	scanning row keyboard output
ROW5	17	scanning row keyboard output
ROW6	18	scanning row keyboard output
MUTE	19	mute output
RTO	20	ringer melody output
$\overline{DP/FL}$	21	dial pulse/flash inverted output
V _{SS}	22	negative supply
TONE	23	DTMF tones or ringer melody output
V _{DD}	24	positive supply
PD/DTMF	25	pulse/DTMF dial selection
RVOL1	26	ringer volume output 1
RVOL2/LSE	27	ringer volume output 2 /loudspeaker enable output
EARTH	28	earth output

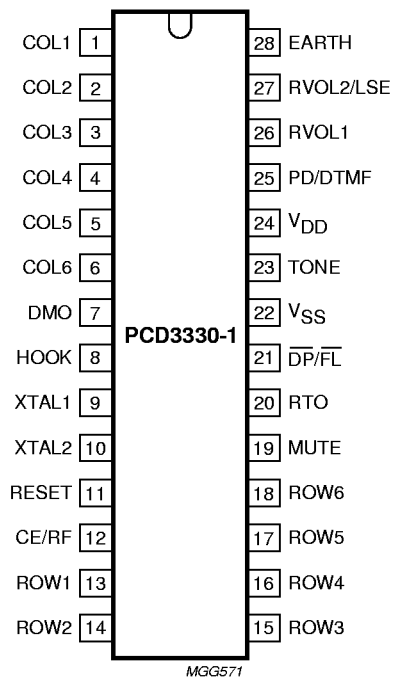


Fig.1 Pin configuration.

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5 FUNCTIONAL DESCRIPTION

5.1 Inputs/Outputs

5.1.1 COL1 TO COL6, KEYBOARD INPUTS

The sense column inputs COL1 to COL6 and the scanning row outputs ROW1 to ROW6 can be directly connected to several keyboard layouts, up to a maximum 6×6 single contact keyboard matrix.

Four of the sense columns are used to store the contents of the EEPROM in the factory (see Section 5.3).

5.1.2 DMO, DIAL MODE OUTPUT

This output is HIGH during the make and break times in pulse dial mode. Its function is to lower the DC line voltage during these pulses.

This output is LOW during DTMF dialling, during the inter-digit-pause in pulse dial mode and during conversation mode.

5.1.3 HOOK, ON/OFF HOOK DETECTION INPUT

If inputs CE and HOOK are both HIGH then the conversation, programming or dialling mode is selected. Switching the HOOK input LOW longer than the reset-delay-time results in switching to the standby mode.

If CE = HIGH and HOOK = LOW the PCD3330-1 is in the ringer mode.

5.1.4 XTAL1 AND XTAL2, OSCILLATOR INPUT/OUTPUT

Time base for the PCD3330-1 is a crystal-controlled on-chip oscillator which is completed by connecting a 3.579545 MHz crystal or ceramic resonator (PXE) between XTAL1 and XTAL2. The XTAL2 is the oscillator output and can be used as driver for another oscillator input. A low-cost quartz crystal from Philips (code number. 4322 143 04401) is available, specially for telephony applications.

The oscillator starts when V_{DD} reaches the operating voltage level and CE = HIGH.

5.1.5 RESET, RESET INPUT

When the RESET pin is connected to V_{SS} , a reset is generated by an internal power-on-reset circuit, which produces an internal reset pulse every time that the supply voltage V_{DD} crosses the power-on-reset voltage level (typ. 2.0 V).

Depending on the application it can be necessary to generate a reset via an external circuit (e.g. an external RC

network). When the RESET input becomes HIGH it initializes the IC.

The RESET-pin should not be left open (not-connected) in any circumstances.

5.1.6 CE/RF, CHIP ENABLE AND RINGER-FREQUENCY DETECT INPUT

As chip enable input (active HIGH) it is used to initialize part of the system, to switch from standby to the ringer or conversation, programming or dialling mode and to detect line breaks.

As ringer-frequency input it measures the time between two LOW-to-HIGH transitions, thus measuring the ringer frequency.

5.1.7 ROW1 TO ROW6, KEYBOARD OUTPUTS

The scanning row outputs ROW1 to ROW6 and the sense column inputs COL1 to COL6 can directly be connected to several keyboard layouts (max. a 6×6 single contact keyboard matrix).

5.1.8 MUTE, MUTE OUTPUT

The MUTE output is used during dialling. In the PCD3330-1 the MUTE output has four different selectable options:

- M1, normally LOW, but HIGH during inter-digit-pause and make/break in pulse dial mode, during tone-on and tone-off in DTMF mode, and during flash or earth
- $\overline{M1}$, the inverted signal of M1
- M2, normally LOW, HIGH during make/break in pulse dial mode, during tone-on in DTMF mode, and during flash or earth
- $\overline{M2}$, the inverted signal of M2.

Each time the M-key on the keyboard is pressed the MUTE output goes to its inverted state.

5.1.9 RTO, RINGER TONE OUTPUT

This is the special ringer output. When this output is selected the output of the internal tone generators is not connected to the TONE output but to this RTO output. The ringer output signal has a peak to peak square output voltage of $V_{DD} - V_{SS}$ (this is used with a PXE transducer).

5.1.10 $\overline{DP/FL}$, PULSE DIALLING AND REGISTER RECALL OUTPUT

The $\overline{DP/FL}$ output drives an external switching transistor in pulse dial mode.

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It pulses a calibrated FLASH or register recall pulse (if selected) when the keyboard input FLASH is pressed.

5.1.11 V_{DD} AND V_{SS}

V_{DD} and V_{SS} are the supply terminals.

5.1.12 TONE, DTMF OR RINGER TONE OUTPUT

In DTMF dialling mode the dual tones which are provided at the output TONE are filtered by an on-chip switched capacitor filter, followed by an active RC low-pass filter. Therefore, the total harmonic distortion of the DTMF tones fulfils the CEPT recommendations. An on-chip reference voltage provides output tone levels independent of supply voltages. The impedance is 100 Ω typically.

In ringer mode this TONE output can be used for generating the ringer output tones. Whether this TONE output or the special RTO (ringer tone) output is used is selected via EEPROM.

5.1.13 PD/DTMF, PULSE/TONE MODE SELECTION

To select the dialling mode, this input PD/DTMF must be connected to V_{DD} or V_{SS} .

PD/DTMF = HIGH (V_{DD}) = DTMF mode.

PD/DTMF = LOW (V_{SS}) = pulse mode.

The PCD3330-1 accept the information also during manual dialling. Switching the input to pin PD/DTMF changes the dialling mode after finishing the digit in progress.

5.1.14 RVOL1 AND RVOL2/LSE, RINGER VOLUME OUTPUTS

The RVOL1 and RVOL2 outputs can be used to control the ringer output volume in four steps. The volume can be changed via keyboard during ringing or conversation mode (off-hook). The selected output level is stored in EEPROM.

During on-hook dialling the RVOL2 output becomes the LSE output for switching the listening-in amplifier.

When the on-hook dialling option is not selected and the microphone mute option is active output LSE change to a

microphone mute which is controlled by the M-key. After off-hook this output is HIGH and will toggle by every press off the M-key.

5.1.15 EARTH, a/b LINE TO EARTH CONNECTION

The EARTH output drives an external switching transistor, which connects the a- or b-line to earth.

It pulses a calibrated EARTH pulse (if selected) when the keyboard input FLASH is pressed.

5.2 Keyboard

The PCD3330-1 is programmed to work with various keyboards which can be connected to the sense column inputs COL1 to COL6 and the scanning row outputs ROW1 to ROW6. In this specification four examples are given:

- Figure 2. The simplest keyboard. All basic functions are available but only 2-key abbreviated dialling (MEM + digit) is possible.
- Figure 3. As Fig.2 but with 3 extra 1-key abbreviated dialling keys.
- Figure 4. As Fig.2 but the 10 repertory numbers can be reached via M0 to M9 with 1-key abbreviated dialling.
- Figure 5. The most complex keyboard. A second possibility for column 4 exists. This column can be selected via EEPROM.

Keyboard entries are valid 20 ms (debounce time) after the leading edge of a keyboard entry.

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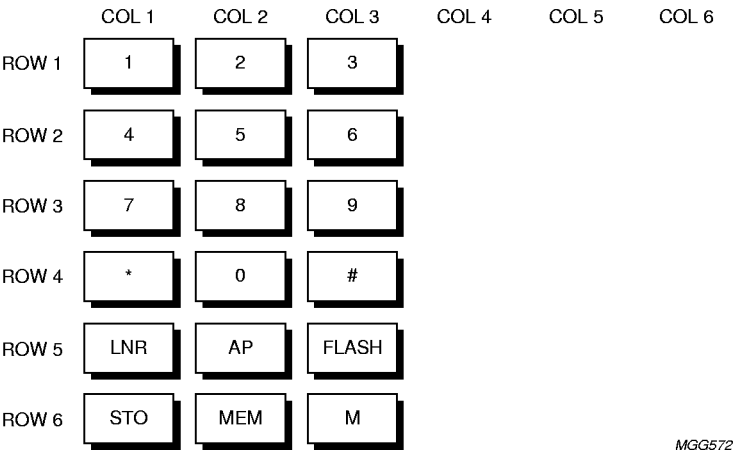


Fig.2 Basic keyboard.

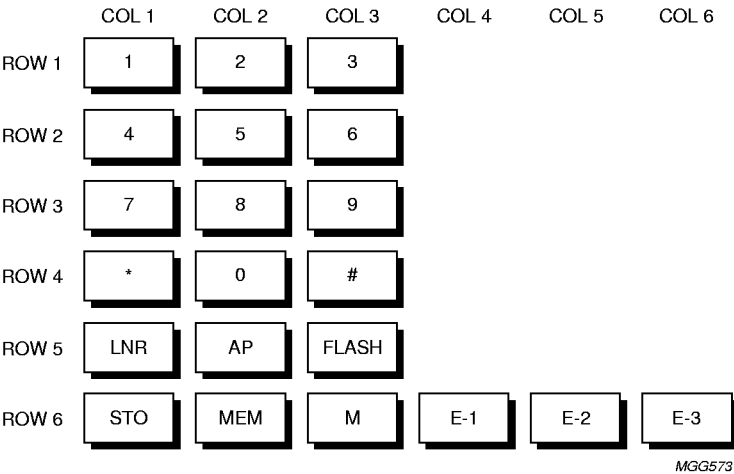


Fig.3 Basic keyboard with 3 extra 1-key abbreviated dialling keys.

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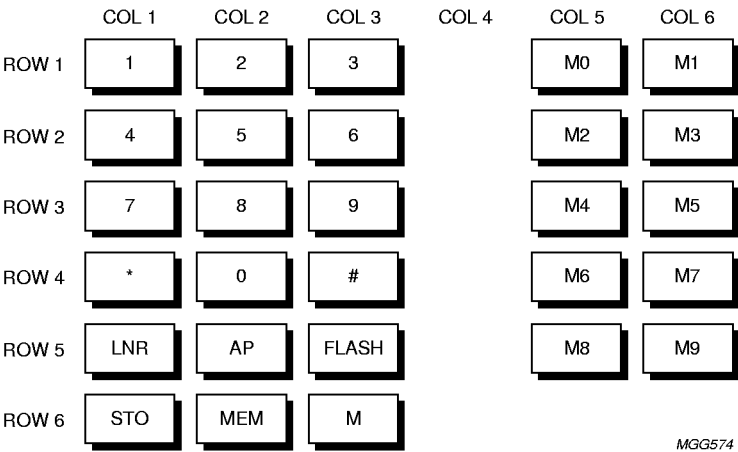


Fig.4 Basic keyboard with 10 extra 1-key abbreviated dialling keys.

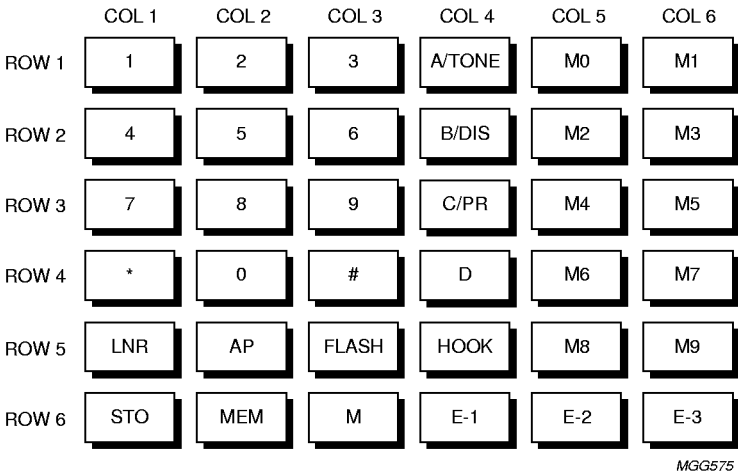


Fig.5 The most complex keyboard, option for column 4 is programmed into EEPROM.

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Table 1 Function of the keys

SYMBOL	DESCRIPTION
0 to 9, * and #	Standard keyboard. In pulse dialling mode the valid keys are the 10 numeric keys (0 to 9) – the 2 non-numeric dial keys (* and #) have no effect on the dialling. In DTMF dialling mode the 10 numeric keys and the 2 non-numeric dial keys are valid.
A to D	If selected (EEPROM bit), these keys are only valid in DTMF dialling mode.
TONE	If selected, pulse to DTMF switching key (mixed mode dialling).
DIS	If selected (EEPROM bit), disconnect key will activate output $\overline{DP/FL}$ for 800 ms. In this case the telephone set turns to the ON-HOOK state for this calibrated time.
PR	If selected (EEPROM bit), program ringer key. With this key the ringer output volume and ringer repetition rate can be changed.
M0 to M9	One key abbreviated dialling, the 10 repertory numbers are directly accessible via keys M0 to M9.
LNR	Last number redial.
AP	Access pause key, results in inserting an access pause in the telephone number.
FLASH	FLASH/EARTH key, depending on the status programmed this key starts a FLASH or an EARTH procedure.
HOOK	Hook key (for on-hook dialling/loudspeaker on/off); as long as the handset stays on the cradle activation of this key switches the set off-hook/on-hook. When the handset is not on the cradle activation of this key switches the loudspeaker on/off (listening-in feature).
STO	STORE key.
MEM	Two-key abbreviated dialling (MEM + digit), the repertory numbers M0 to M9 are also accessible via this two-key dialling procedure.
M	Mute key, each time this key is pressed and dialling is not active, the mute output goes to HIGH or LOW depending on the previous state.
E-1 to E-3	One key abbreviated dialling, three extra repertory numbers which are only directly accessible by keys E-1 to E-3; these numbers can only be used when the repertory length is 16 digits (programmable in EEPROM).

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5.3 EEPROM organization and programming procedures

5.3.1 EEPROM ORGANIZATION

The dialling, memory, and ringer options and the telephone numbers are all stored in EEPROM. By using EEPROM no special backup requirement are necessary such as battery, current from the line, or very big capacitors.

Table 2 describes the meaning of each EEPROM byte at a repertory length of 16 and 20 digits.

Table 3 describes the meaning of each bit of all the bytes that do not contain telephone numbers.

Table 2 EEPROM organization

FUNCTION	REPERTORY LENGTH IS 16 DIGITS		REPERTORY LENGTH IS 20 DIGITS	
	LENGTH	BYTE PLACES	LENGTH	BYTE PLACES
Redial	13 bytes	0 to 12	13 bytes	0 to 12
M0 or MEM + 0	8 bytes	16 to 23	10 bytes	16 to 25
M1 or MEM + 1	8 bytes	24 to 31	10 bytes	26 to 35
M2 or MEM + 2	8 bytes	32 to 39	10 bytes	36 to 45
M3 or MEM + 3	8 bytes	40 to 47	10 bytes	46 to 55
M4 or MEM + 4	8 bytes	48 to 55	10 bytes	56 to 65
M5 or MEM + 5	8 bytes	56 to 63	10 bytes	66 to 75
M6 or MEM + 6	8 bytes	64 to 71	10 bytes	76 to 85
M7 or MEM + 7	8 bytes	72 to 79	10 bytes	86 to 95
M8 or MEM + 8	8 bytes	80 to 87	10 bytes	96 to 105
M9 or MEM + 9	8 bytes	88 to 95	10 bytes	106 to 115
E-1	8 bytes	96 to 103	not available	–
E-2	8 bytes	104 to 111	not available	–
E-3	8 bytes	112 to 119	not available	–
Options	4 bytes	120 to 123	4 bytes	120 to 123
Program Blocking	1 byte	127	1 byte	127

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Table 3 Option bit status and location

FUNCTION	EEPROM BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Not sending *	120	X	X	X	X	X	X	X	0
Sending *	120	X	X	X	X	X	X	X	1
Not sending #	120	X	X	X	X	X	X	0	X
Sending #	120	X	X	X	X	X	X	1	X
Mark to space ratio 3 : 2	120	X	X	X	X	X	0	X	X
Mark to space ratio 2 : 1	120	X	X	X	X	X	1	X	X
Tone/pause 60/90 ms	120	X	X	0	0	0	X	X	X
Tone/pause 70/70 ms	120	X	X	0	0	1	X	X	X
Tone/pause 80/80 ms	120	X	X	0	1	0	X	X	X
Tone/pause 100/100 ms	120	X	X	0	1	1	X	X	X
Tone/pause 100/140 ms	120	X	X	1	0	0	X	X	X
Tone/pause 140/140 ms	120	X	X	1	0	1	X	X	X
Flash duration 100 ms	120	0	0	X	X	X	X	X	X
Flash duration 115 ms	120	0	1	X	X	X	X	X	X
Flash duration 270 ms	120	1	0	X	X	X	X	X	X
Flash duration 600 ms	120	1	1	X	X	X	X	X	X
Mute is M1	121	X	X	X	X	X	X	0	0
Mute is $\overline{M1}$	121	X	X	X	X	X	X	0	1
Mute is M2	121	X	X	X	X	X	X	1	0
Mute is $\overline{M2}$	121	X	X	X	X	X	X	1	1
General program proc.	121	X	X	0	X	X	X	X	X
General program proc.	121	X	X	1	X	X	X	X	X
Repertory 16 digits	121	X	0	X	X	X	X	X	X
Repertory 20 digits	121	X	1	X	X	X	X	X	X
M1/M2 mute	121	0	X	X	X	X	X	X	X
Microphone mute	121	1	X	X	X	X	X	X	X
Access Pause time for pulse dialling (Inter-digit pause not included)									
A.P. time 1.5 s	121	X	X	X	0	0	X	X	X
A.P. time 2.5 s	121	X	X	X	0	1	X	X	X
A.P. time 3.0 s	121	X	X	X	1	0	X	X	X
A.P. time 6.0 s	121	X	X	X	1	1	X	X	X
Access Pause time for DTMF dialling (Tone-off time not included)									
A.P. time 1.0 s	121	X	X	X	0	0	X	X	X
A.P. time 1.5 s	121	X	X	X	0	1	X	X	X
A.P. time 3.5 s	121	X	X	X	1	0	X	X	X
A.P. time 6.0 s	121	X	X	X	1	1	X	X	X

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FUNCTION	EEPROM BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Ringer via pin RTO	122	X	X	X	X	X	X	X	0
Ringer via pin TONE	122	X	X	X	X	X	X	X	1
Ringer melody A	122	X	X	X	X	0	0	X	X
Ringer melody B	122	X	X	X	X	0	1	X	X
Ringer melody C	122	X	X	X	X	1	0	X	X
Ringer melody D	122	X	X	X	X	1	1	X	X
Ringer volume 1	122	X	X	0	0	X	X	X	X
Ringer volume 2	122	X	X	0	1	X	X	X	X
Ringer volume 3	122	X	X	1	0	X	X	X	X
Ringer volume 4	122	X	X	1	1	X	X	X	X
Ringer repetition 1	122	0	0	X	X	X	X	X	X
Ringer repetition 2	122	0	1	X	X	X	X	X	X
Ringer repetition 3	122	1	0	X	X	X	X	X	X
Ringer repetition 4	122	1	1	X	X	X	X	X	X
Ringer detection LOW 1	123	X	X	X	X	X	X	0	0
Ringer detection LOW 2	123	X	X	X	X	X	X	0	1
Ringer detection LOW 3	123	X	X	X	X	X	X	1	0
Ringer detection LOW 4	123	X	X	X	X	X	X	1	1
Ringer detection HIGH 1	123	X	X	X	X	0	0	X	X
Ringer detection HIGH 2	123	X	X	X	X	0	1	X	X
Ringer detection HIGH 3	123	X	X	X	X	1	0	X	X
Ringer detection HIGH 4	123	X	X	X	X	1	1	X	X
A to D keys	123	X	X	X	0	X	X	X	X
Function keys	123	X	X	X	1	X	X	X	X
Flash keytone	123	X	X	0	X	X	X	X	X
EARTH function	123	X	X	1	X	X	X	X	X
No keytone	123	X	0	X	X	X	X	X	X
Keytone active	123	X	1	X	X	X	X	X	X
No on-hook dialling	123	0	X	X	X	X	X	X	X
On-hook dialling control	123	1	X	X	X	X	X	X	X

5.3.2 EEPROM PROGRAMMING PROCEDURES

The PCD3330-1 supports four EEPROM programming procedures:

1. LNR is described in Section 5.6.2
2. Repertory numbers is described in Section 5.6.9
3. Via pins 1 to 4 (COL1 to COL4)
4. Via keyboard (can be locked with the **Program Blocking** byte).

Method 3 is normally used by the setmaker before the set leaves his factory.

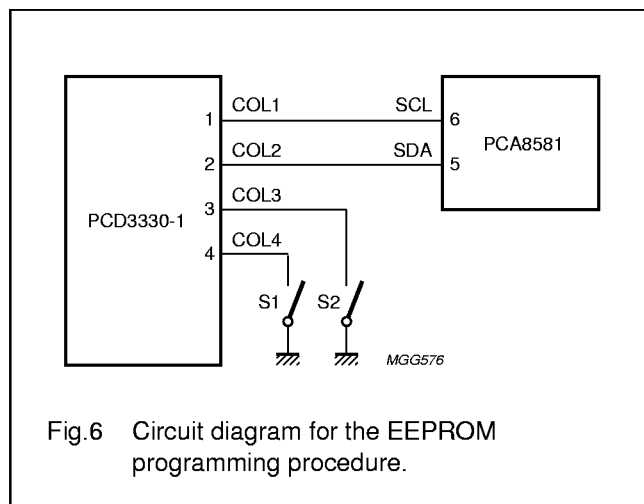
Method 4 is most suited for usage in the field (e.g. the shop where the set is purchased).

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5.3.2.1 Factory EEPROM programming procedure

The COL1 to COL4 of the PCD3330-1 can be used in the factory to read or write the contents of the internal EEPROM. COL1 (pin 1) is the SCL and COL2 (pin 2) is the SDA of the I²C-bus interface, while COL3 (pin 3) and COL4 (pin 4) determine the mode selected. In Fig.6 the principle for this programming procedure is given.



The status of pins COL3 and COL4 is read directly after a power-on-reset and the status can be changed with switches S1 and S2 (open: pin is HIGH; closed: pin is LOW).

Table 4 Function of switches S1 and S2

S1	S2	MODE
open	open	normal mode
closed	open	test mode: PCD3330-1 EEPROM write
closed	closed	test mode: PCD3330-1 EEPROM read

If during the programming mode S1 is opened the programming stops and the PCD3330-1 goes to the telephone mode. If now S1 is closed again the set stays in telephone mode.

In the write mode the PCD3330-1 is able to read the contents of an external RAM (128 bytes) or the PCF8581 (EEPROM) via COL1 and COL2.

In the read mode the PCD3330-1 sends the contents of its internal EEPROM via COL1 and COL2 to the external device.

All 128 bytes of EEPROM are read or written in each read or write operation.

5.3.2.2 EEPROM programming procedures via keyboard

This procedure is only active if EEPROM **Program Blocking** byte (number 127 of the internal EEPROM) is set to 'FF' hex. If this byte is '00' hex it is not possible to do the program procedures described in this chapter. Byte 127 of the EEPROM can only be set by the factory EEPROM programming procedure.

In the field all telephone options can be changed easily by a special program procedure:

- Depress the STO-key (this selects the program mode)
- Depress the LNR-key (switches the program module to storing EEPROM options)
- Depress the first key of a three digit access code (the 1)
- Depress the second key of a three digit access code (the 6)
- Depress the third key of a three digit access code (the 0)
- Depress the LNR-key again (end the access code)
- Press the byte number (last digit of the EEPROM byte number given in Table 2)
- Press the number of the bit to change (see Table 2)
- Press 0 or 1 (this changes the EEPROM bit contents)
- Depress the LNR-key, which stores the correction into EEPROM, now select a new byte or go to end
- End the routine by pressing the STO-key again.

If during this procedure a mistake is made correction is possible after proper access code by pressing the LNR-key and during access code only by STO-key. In all cases the routine can be ended by pressing the STO-key.

Example:

Change the mark-to-space ratio from 3 : 2 to 2 : 1. Then bit 2 of EEPROM byte-120 has to be changed from 0 to 1. The necessary action is as follows:

- Depress the STO-key
- Depress the LNR-key
- Depress the 1-key (first digit access code)
- Depress the 6-key (second digit access code)
- Depress the 0-key (third digit access code)
- Depress the LNR-key again (end the access code)
- Press the 0-key (last digit of EEPROM byte-120 is the 0)
- Press the 2-key (bit 2 has to be changed)
- Press the 1 (changes the mark-to-space ratio to 2 : 1)
- Press the LNR or STO-key.

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The STO-key will end the programming procedure, whereas after the LNR-key a new byte can be selected to have the required bit changed.

5.4 Operation mode overview

The PCD3330-1 has in total five operation modes: standby, conversation, ringer, dialling and programming. The state diagram is given in Fig.7.

When both CE/RF and the HOOK input are LOW the PCD3330-1 goes to the standby mode, in which the contents of the redial register is refreshed, the oscillator switched off and the device enters the low current state.

A HIGH state on the CE/RF and/or the HOOK input will cause a complete initialization of the PCD3330-1 which means setting of the I/O pins, clearing of the RAM and reloading the EEPROM contents into it.

5.5 Pulse/DTMF dialling function

5.5.1 PULSE/DTMF MODE SELECTION BY PIN

The PCD3330-1 has two dialling modes, pulse dialling and Dual Tone Multi Frequency (DTMF). These can be selected via the PD/DTMF input in the following way:

PD/DTMF = HIGH (V_{DD}) = DTMF mode.

PD/DTMF = LOW (V_{SS}) = pulse mode.

The controller accepts the information also during manual dialling. Switching the input to the pin PD/DTMF changes the dialling mode after transmitting the digit in progress.

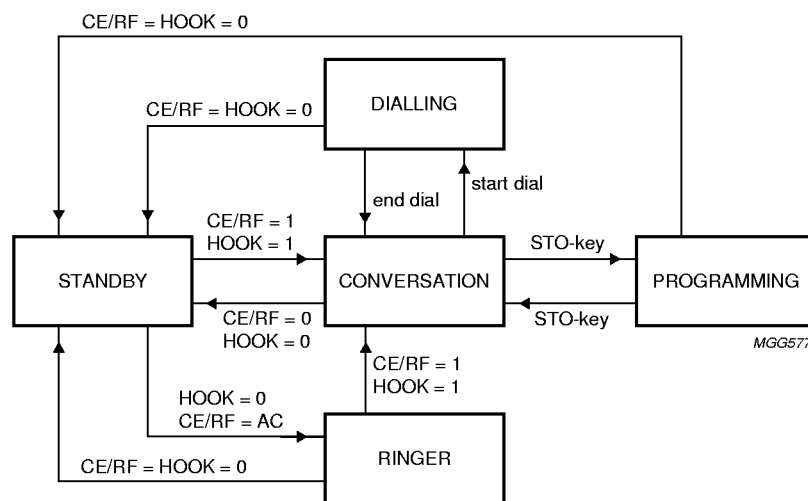


Fig.7 State diagram of the PCD3330-1 dialler/ringer.

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5.5.2 PULSE DIALLING (PD/DTMF = LOW)

The keyboard entry initiates a recall of a previously stored number or is a simultaneous keying-in and pulsing-out activity, with storing for possible later recall. If in the recalled number or at keying-in the keys A,B,C or D (options A to D keys selected) are used these digits are not transmitted.

If at keying-in the keys * or # are used this results in a switch over to DTMF dialling. Normally, keying in is faster than pulsing-out (fed from the redial register). Pulse sequences start with an inter-digit pause of 840 ms duration, followed by a sequence of pulses corresponding to the present digit in store. Each pulse starts with a mark (line break) followed by space (line make).

The pulse period is 100 ms with a mark-to-space ratio of 3 : 2 or 2 : 1 (mark-to-space ratio selection). After transmission of a digit, the next digit is processed, again starting with an inter-digit pause. The pulses are available at the DP/FL output and can be used to drive an external switching transistor in pulse dialling mode.

The transmission IC is put in the dialling mode by means of output MUTE.

Output MUTE has several programmable options, MUTE can be configured as M1, $\overline{\text{M1}}$, M2 and $\overline{\text{M2}}$. In Fig.8 the timing diagram of these output possibilities is given.

After completion of the number string the circuit changes from dialling mode to conversation mode.

5.5.3 DUAL TONE MULTI FREQUENCY (DTMF) DIALLING (PD/DTMF = HIGH)

The PCD3330-1 converts keyboard inputs into data for the on-chip DTMF generator. Tones are transmitted via output TONE with six programmable minimum tone burst/pause durations of 60/90, 70/70, 80/80, 100/100, 100/140 or 140/140 ms. The maximum tone burst duration is equal to the key depression time. With redial and repertory dialling tones are automatically fed at the programmed rate. Again the MUTE output has several programmable options namely, M1, $\overline{\text{M1}}$, M2 and $\overline{\text{M2}}$. In Fig.9 the timing diagram of these output possibilities is given.

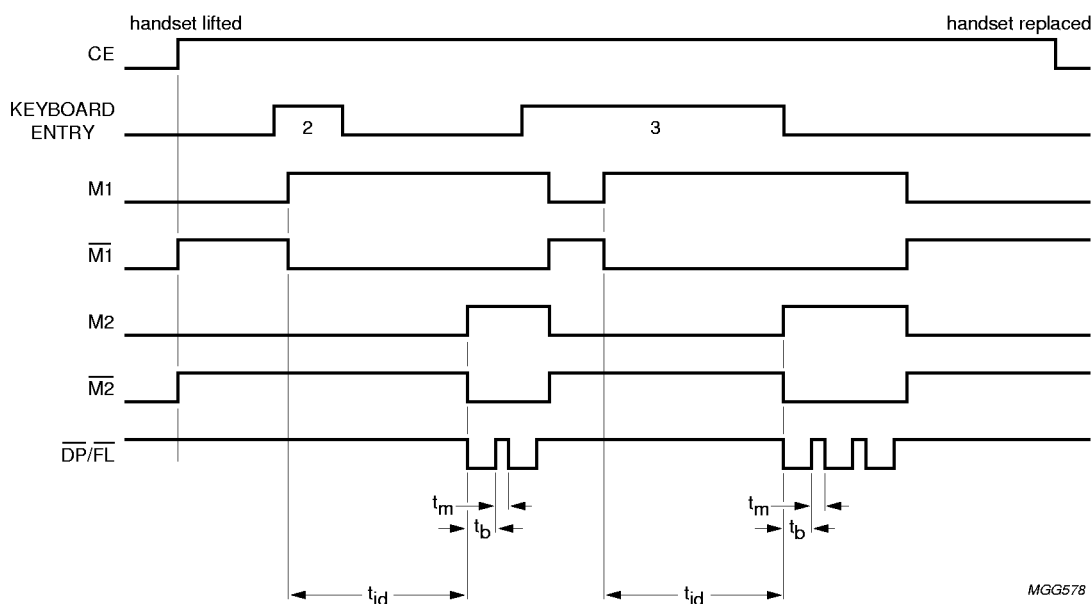


Fig.8 Timing diagram in pulse mode, showing $\overline{\text{DP/FL}}$ and MUTE outputs.

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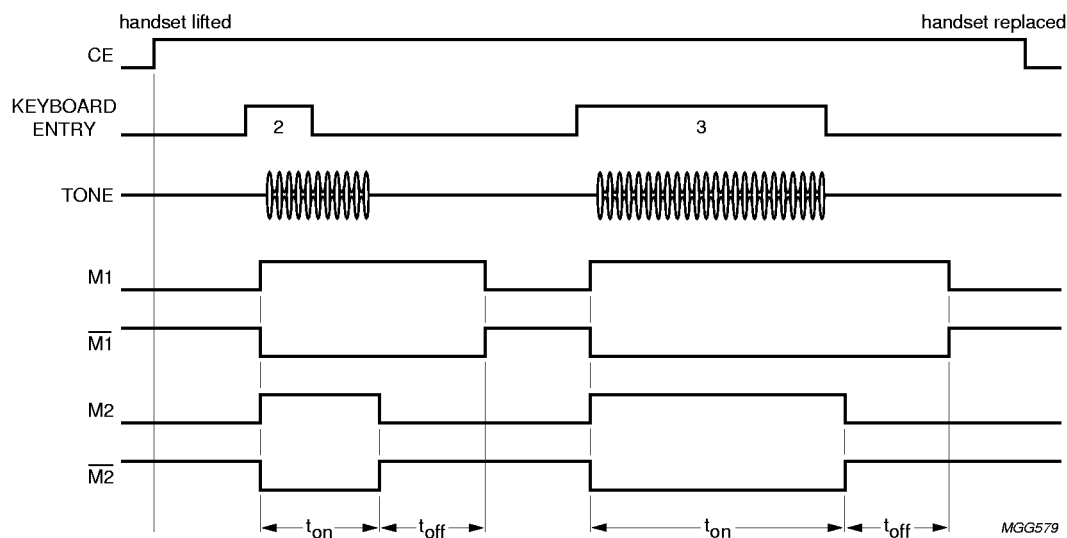


Fig.9 Timing diagram in DTMF mode, showing MUTE outputs.

5.5.4 DTMF DIALLING IN PULSE DIALLING MODE (MIXED MODE DIALLING)

If the controller is set to the pulse dial mode (pin PD/DTMF is LOW), activation of keys TONE, * or # changes the dialling mode to DTMF.

Its entry is stored in the redial register and it generates automatically an access pause, after which the following digits are transmitted in the DTMF mode.

The digits entered after keys TONE, * or # are not transmitted in the redial mode. The TONE key is never transmitted in the redial mode.

The TONE key is never transmitted, whether * or # are transmitted depends on the selected option.

A second touch of the TONE key is ignored. The * or # keys pressed after a switch over to DTMF dialling are all transmitted.

If the controller is initially set to the DTMF mode (pin PD/DTMF is HIGH), activation of TONE is ignored and the * or # are stored in the redial register and transmitted in DTMF mode.

5.5.5 FLASH OR EARTH FUNCTION

Whether the Flash or Earth function is activated by the FLASH key is programmed in the EEPROM.

If the FLASH function is selected a calibrated FLASH pulse (recall register) is generated on the $\overline{DP/FL}$ output and the MUTE output is active.

The calibrated FLASH time is programmed for 100, 115, 270 or 600 ms in EEPROM.

If the EARTH ('Connect a/b to earth') function is selected, the EARTH output becomes HIGH and the MUTE output is active. The time of earth connection is 400 ms.

When the FLASH key is pressed the telephone number entered before the FLASH key is stored in the redial register (EEPROM).

- After dialling 1 - 2 - 3 - 'FLASH' - on-hook Redial is 1 - 2 - 3
- After dialling 1 - 2 - 3 - 'FLASH' - 4 - 5 - 6 - on-hook Redial is 4 - 5 - 6.

5.5.6 DISCONNECT FUNCTION

This DIS (disconnect) key is only available if the function key option is programmed. Touching the DIS key activates output $\overline{DP/FL}$ for 800 ms. In this case the telephone set turns to the ON-HOOK state for this calibrated time, after which it comes back to the OFF-HOOK mode.

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5.5.7 MUTE FUNCTION (M-KEY)

When no dialling or programming is active, every time this M-key is pressed the MUTE output goes to the active or inactive state depending on its previous status.

When the MUTE output is in the active state and another key is pressed then the MUTE output is switched back to the inactive state.

When there is the on-hook dialling is not selected and the Microphone mute flag in EEPROM is HIGH, every press off the M-key will result in the inverted value of the RVOL2/LSE output. At off-hook the status of this output is HIGH.

5.5.8 ON-HOOK DIALLING CONTROL

If required, the on-hook dialling control feature can be selected by programming the corresponding bit in EEPROM.

When this on-hook dialling feature is selected, the power supply to the PCD3330-1 must be maintained during on-hook.

In telephone sets developed for on-hook dialling (an electronic hook-switch must be present) activation of the HOOK-key during on-hook results in an off-hook via the $\overline{DP/FL}$ output, and the LSE output becomes HIGH. As long as the handset stays on the cradle a new activation of the HOOK-key results in an on-hook, and the LSE output becomes LOW.

When during on-hook dialling the handset is lifted from the cradle the on-hook dialling mode is switched off and the LSE output is set to the active (LOW) state.

When the handset is off-hook (not on the cradle) activation of this HOOK-key switches the loudspeaker on (LSE = HIGH) or off (LSE = LOW) (listening-in feature).

5.6 Number storage, transmission and redial

5.6.1 NUMBER STORAGE AND TRANSMISSION

If the first key pressed at off-hook is 0 to 9 in pulse dialling or 0 to 9, * and # in DTMF dialling mode, digits are entered into the work register and compared with the previous entries stored in the redial register. As long as the newly dialled digits are equal to those stored, the contents of the redial register are unaffected.

When the newly pressed digit is different from the one stored in the redial register the contents of the work register are copied to the redial register when going on-hook (or every other action equal to on-hook).

Up to 24 digits can be stored in the redial register. After the work register overflows, a 10 digits First-In-First-Out register (FIFO) takes over as buffer and the contents of the work register is now copied to the redial register.

After transmitting the first digit of the FIFO register this position is automatically cleared to provide space for the storage of new data. In this way, the total number that can be transmitted is unlimited, provided the key-in rate is not excessive. However, if the FIFO register overflows (more than 10 digits in store) further input is ignored.

Input digits are transmitted immediately with minimum transmission time. Transmission continues for as long as digits are input.

5.6.2 LAST NUMBER REDIAL (1 TO 24 DIGITS)

If the first key pressed and released is LNR, the stored number in the redial register is recalled and transmitted immediately.

The LNR key can be used in two other ways, known as the 'cursor' method and the 'Atlanta' procedure, to allow external numbers to be redialled from a PABX with an appropriate access pause.

5.6.3 ACCESS PAUSE BY CURSOR METHOD

If the first key entered is not LNR but numerical digits, these digits are compared to those held in store. As long as the digits entered equal those stored, the redial register is not cleared and dialling can be continued by pressing the redial key. The already dialled part is not redialled. Redial is inhibited as soon an entry is unequal to the digit at the same position held in store.

This 'cursor' method allows an access code to be entered and access confirmation tone to be received before an external number is redialled.

5.6.4 ACCESS PAUSE BY ATLANTA PROCEDURE

If the first key entered is the redial key, but this key is kept down, then only the first digit held in the redial register is transmitted. After releasing the redial key the remaining digits held in the redial register are dialled.

The 'Atlanta' procedure allows a single stored access digit to be transmitted, but redial of the external number to be delayed until access has been confirmed.

5.6.5 10-NUMBER REPERTORY DIALLING

The PCD3330-1 includes a 10-number repertory dialler, 16 or 20 digits each, which is accessible with a one or two-key procedure.

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The 10 repertory numbers can be recalled with the M0 to M9 keys or by pressing the MEM key followed by a numeric digit from 0 to 9.

If the keyboard matrix contains the keys M0 to M9, each of the 10 repertory numbers can be recalled using the corresponding single key.

If the keyboard matrix contains the MEM key each of the 10 repertory numbers can be recalled by depressing MEM followed by the numeric digit 0 to 9.

The maximum length of these repertory numbers is 16 or 20 digits (depending on the programmed repertory number length) including the manually stored access pauses.

5.6.5.1 Chain dialling

Repertory numbers can be dialled-out after or before entering manual dialling or last number redial and by entering the memory locations in successive order ('chain dialling').

During transmission of a number recalled from the memory location, the controller does not accept keyboard entries. Dialling can be continued as soon as the number under transmission is completed.

Note that the last memory location which is transmitted is stored in the redial register.

5.6.6 3-NUMBER REPERTORY DIALLING

When the repertory length programmed in EEPROM is set to 16 digits, the PCD3330-1 includes also an additional 3-number repertory dialler.

These repertory numbers are only accessible with the one-key procedure.

These 3 repertory numbers can only be recalled with the E-1 to E-3 keys.

The maximum length of these repertory numbers is 16 digits including the manually stored access pauses. The chain dialling procedure is equal to that explained in 10-number repertory dialling.

5.6.7 ACCESS PAUSE STORAGE

If during entering a telephone number via keyboard for normal dialling or during repertory number programming the AP-key (access pause key) is pressed, then an access pause is stored in the redial or repertory dial register.

5.6.8 MANUAL ACCESS PAUSES

The AP-key is used to insert an access pause during manual dialling. It is possible to select between four possible access pause times for each dialling mode:

For pulse dialling 1.5, 2.5, 3.0 or 6.0 s (inter-digit pause not included).

For DTMF dialling 1.0, 1.5, 3.5 or 6.0 s (inter-digit pause not included).

5.6.9 STORING REPERTORY NUMBERS

When the Keytone active bit in EEPROM is HIGH, every key activation in programming mode will result in a keytone of 1046 Hz lasting 200 ms.

The store mode starts after going off-hook and depressing the STO-key. With the PCD3330-1 a selection can be made between two store modes, the 'General' and the 'German'.

Repertory numbers can be stored into EEPROM via the one-key access or the two-key access method and following the German or General storing procedures. This is detailed in Tables 5 and 6.

Table 5 One-key access repertory number mode (M0 to M9 and E-1 to E-3)

GENERAL PROCEDURE	GERMAN PROCEDURE
Set in operation mode	set in operation mode
Depress STO (store key)	depress STO (store key)
Telephone number	location (M0 to M9/E-1 to E-3)
Depress STO (store key)	telephone number
Location (M0 to M9/E-1 to E-3)	STO (store key)

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Table 6 Two-key access repertory number mode (MEM + 0 to 9)

GENERAL PROCEDURE	GERMAN PROCEDURE
Set in operation mode	set in operation mode
Depress STO (store key)	depress STO (store key)
Telephone number	depress MEM (location key)
Depress STO (store key)	depress 0 to 9 (real location)
Depress MEM (location key)	telephone number
Depress 0 to 9 (real location)	depress STO (store key)

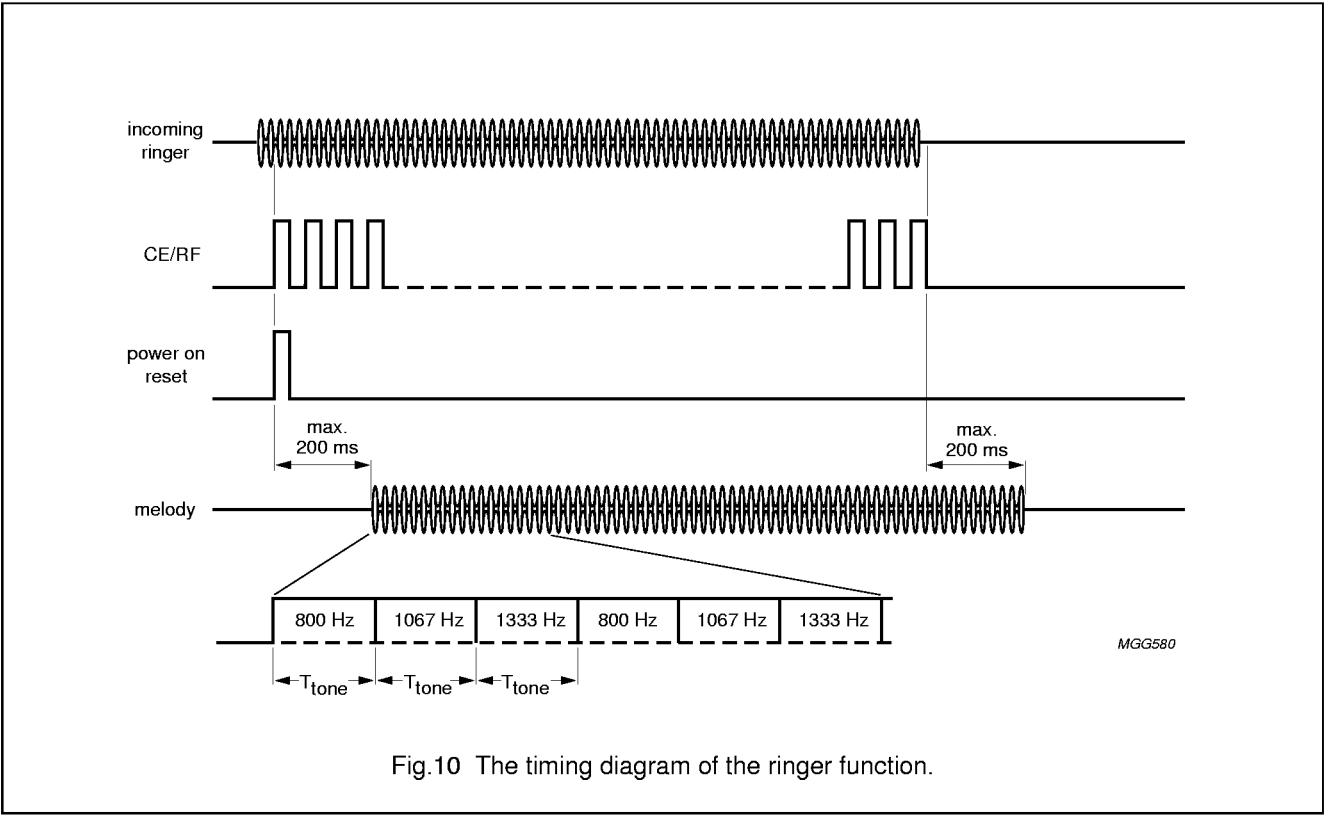
Memory locations can be cleared by following the same procedure as for storing a number, without actually entering a number.

5.7 Ringer function

The PCD3330-1 has a three-tone melody ringer with the following characteristics:

- Ringer output pin selection
- Ringer input frequency measurement
- Ringer melodies selection
- Ringer volume change during conversation and ringer mode
- Ringer repetition rate change during conversation and ringer mode.

In Fig.10 the timing diagram of the ringer function is given.



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5.7.1 RINGER OUTPUT PIN SELECTION

The ringer signal is sent via the special Ringer Tone Output (RTO) or via the TONE output depending on the option selected.

When a loudspeaker is used as a transducer, it is better to use the TONE output. One of the internal tone generators directly supplies this output with $V_{RMS} = 181 \text{ mV}$.

The RTO output signal, used for PXE transducers, is a block with a peak-to-peak output voltage of $V_{DD} - V_{SS}$.

5.7.2 RINGER INPUT FREQUENCY MEASUREMENT

The melody ringer becomes active for all incoming ringer frequencies higher than the ringer detection LOW frequency and lower than the ringer detection HIGH frequency supplied to the CE/RT input of the PCD3330-1. The ringer detection LOW and ringer detection HIGH frequencies are selected such that it is possible to use this PCD3330-1 for both single and double phase rectifier applications. It is possible to select one out of four ringer detection LOW and four ringer detection HIGH frequencies options which are given below:

- Ringer detection LOW 1: 16 Hz
- Ringer detection LOW 2: 20 Hz
- Ringer detection LOW 3: 32 Hz
- Ringer detection LOW 4: 40 Hz
- Ringer detection HIGH 1: 35 Hz
- Ringer detection HIGH 2: 60 Hz
- Ringer detection HIGH 3: 70 Hz
- Ringer detection HIGH 4: 120 Hz.

5.7.3 RINGER MELODIES SELECTION

The ringer melody generator can select out of four different ringer melody options (stored in EEPROM), given in Table 7.

Table 7 Ringer melody options

RINGER MELODY	FREQ. 1 (Hz)	FREQ. 2 (Hz)	FREQ. 3 (Hz)
Ringer melody A	738	826	925
Ringer melody B	800	1067	1333
Ringer melody C	1455	1621	1810
Ringer melody D	1995	2223	2510

5.7.4 RINGER VOLUME CHANGE DURING CONVERSATION AND RINGER MODE

The ringer volume can be controlled by the port pins RVOL1 and RVOL2 and its value is stored in EEPROM.

The output volume can be changed:

- Via the EEPROM programming procedure (see Section 5.3.2)
- During conversation mode, when the function keys option is chosen, with a special key sequence
- During active ringer by a simple key press.

In Conversation mode the procedure is as follows:

- Put the set in conversation mode (supply necessary)
- Depress PR (ringer program key)
- Press one of the four acceptable volume keys (1 to 4); see Table 8.

Table 8 Ringer volume control, conversation mode

KEY	RVOL1	RVOL2
1	0	0 (minimum output power)
2	1	0
3	0	1
4	1	1 (maximum output power)

The newly selected value is directly stored into EEPROM.

During active ringing the PR key is not used, the procedure is as follows:

- Activate the ringer (only then this volume correction is possible)
- Press one of the four acceptable volume keys (1 to 4); see Table 9.

Table 9 Ringer volume control, active ringer mode

KEY	RVOL1	RVOL2
1	0	0 (minimum output power)
2	1	0
3	0	1
4	1	1 (maximum output power)

The newly selected value is directly stored into EEPROM.

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5.7.5 RINGER REPETITION RATE CHANGE DURING CONVERSATION AND RINGER MODE

The generated melody is built up out of three frequencies. These frequencies are generated successively in a selected repeat frequency.

There are four steps and they can be changed:

- Via the EEPROM programming procedure (See Section 5.3.2)
- During conversation mode, when the function keys option is chosen, with a special key sequence
- During active ringer by a simple key press.

In conversation mode the procedure is as follows:

- Put the set in conversation (supply necessary)
- Depress PR (ringer program key)
- Press one of the four acceptable repeat frequency keys (9, *, 0 or #) see Table 10.

Table 10 Ringer repetition rate selection, conversation mode

KEY	FREQUENCY (Hz)	TONE TIME (ms)
9	7	47.6
*	11	30.3
0	15	22.2
#	20	16.6

The newly selected value is directly stored into EEPROM.

During active ringing the PR key is not used, the procedure is as follows:

- Active the ringer (only then this repetition rate correction is possible)
- Press one of the four acceptable repeat frequency keys (9, *, 0 or #) see Table 11.

Table 11 Ringer repetition rate selection, active ringer mode

KEY	FREQUENCY (Hz)	TONE TIME (ms)
9	7	47.6
*	11	30.3
0	15	22.2
#	20	16.6

The newly selected value is directly stored into EEPROM.

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6 LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{DD}	supply voltage	-0.8	+7	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
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

7 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 IC03, Section: General, Handling MOS devices*).

8 DC CHARACTERISTICS

$V_{DD} = 1.8$ to 6 V (note 1); $V_{SS} = 0$ V; $T_{amb} = -25$ to $+70$ °C; all voltages with respect to V_{SS} ; $f_{osc} = 3.579545$ MHz; $R_X \leq 100$ Ω ; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply voltage						
V _{DD}	supply voltage	operating; note 1	1.8	–	6	V
		RAM data retention in Standby mode	1.0	–	6	V
Supply current						
I _{DD}	supply current	Dialling/Ringer mode; V _{DD} = 3 V; note 2	–	0.8	1.6	mA
		Conversation/Programming mode; V _{DD} = 3 V; note 2	–	0.35	0.7	mA
		Standby mode (notes 2 and 3); at V _{DD} = 1.8 V; T _{amb} = 25 °C	–	1.0	5.5	µA
		Standby mode (notes 2 and 3); at V _{DD} = 1.8 V; T _{amb} = 70 °C	–	–	10	µA

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
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
Port outputs						
I_{OL}	LOW level output sink current	at $V_{DD} = 3\text{ V}$; $V_O = 0.4\text{ V}$	0.7	3.5	–	mA
I_{OH}	HIGH level output pull-up source current	at $V_{DD} = 3\text{ V}$; $V_O = 2.7\text{ V}$	10	30	–	μA
		at $V_{DD} = 3\text{ V}$; $V_O = 0\text{ V}$	–	140	300	μA
I_{OH1}	HIGH level output push-pull source current	at $V_{DD} = 3\text{ V}$; $V_O = 2.6\text{ V}$	0.7	3.5	–	mA
Tone output (notes 1 and 4)						
$V_{HG(RMS)}$	output RMS voltage	HIGH group	158	181	205	mV
$V_{LG(RMS)}$		LOW group	125	142	160	mV
Δf	frequency deviation		–0.6	–	+0.6	%
V_{DC}	DC voltage level		–	$\frac{1}{2}V_{DD}$	–	V
$ Z_O $	output impedance		–	100	500	Ω
G_v	voltage gain (pre-emphasis) of group		1.5	2.0	2.5	dB
THD	total harmonic distortion	at $T_{amb} = 25\text{ }^\circ\text{C}$; note 5	–	–25	–	dB
EEPROM (notes 1, 6 and 7)						
N_{cyc}	endurance (erase/write cycles)		100000	–	–	cycles
t_{ret}	data retention		10	–	–	years

Notes to characteristics

1. Tone output, EEPROM erase and EEPROM write require $V_{DD} \geq 2.5\text{ V}$.
2. $V_{IL} = V_{SS}$, $V_{IH} = V_{DD}$; open drain outputs connected to V_{SS} ; all other outputs open; maximum values: external clock at XTAL1; XTAL2 open; typical values at $T_{amb} = 25\text{ }^\circ\text{C}$; crystal connected between XTAL1 and XTAL2.
3. $V_{IL} = V_{SS}$, $V_{IH} = V_{DD}$; RESET, HOOK and CE/RT at V_{SS} ; crystal connected between XTAL1 and XTAL2; open-drain outputs connected to V_{SS} ; all other outputs open.
4. Values are specified for DTMF frequencies only (CEPT compatible).
5. Related to the low group frequency component (CEPT compatible).
6. Verified on sampling basis.
7. After final testing the value of each EEPROM bit is typically HIGH, but this state cannot be guaranteed.

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9 APPLICATION INFORMATION

A block diagram of an electronic feature phone built around the PCD3330-1 is shown in Fig. 11. It comprises the following dedicated telecom ICs:

- TEA1067 speech/transmission IC
- TEA1083A call progress monitor IC
- PCD3330-1 dialler/ringer IC.

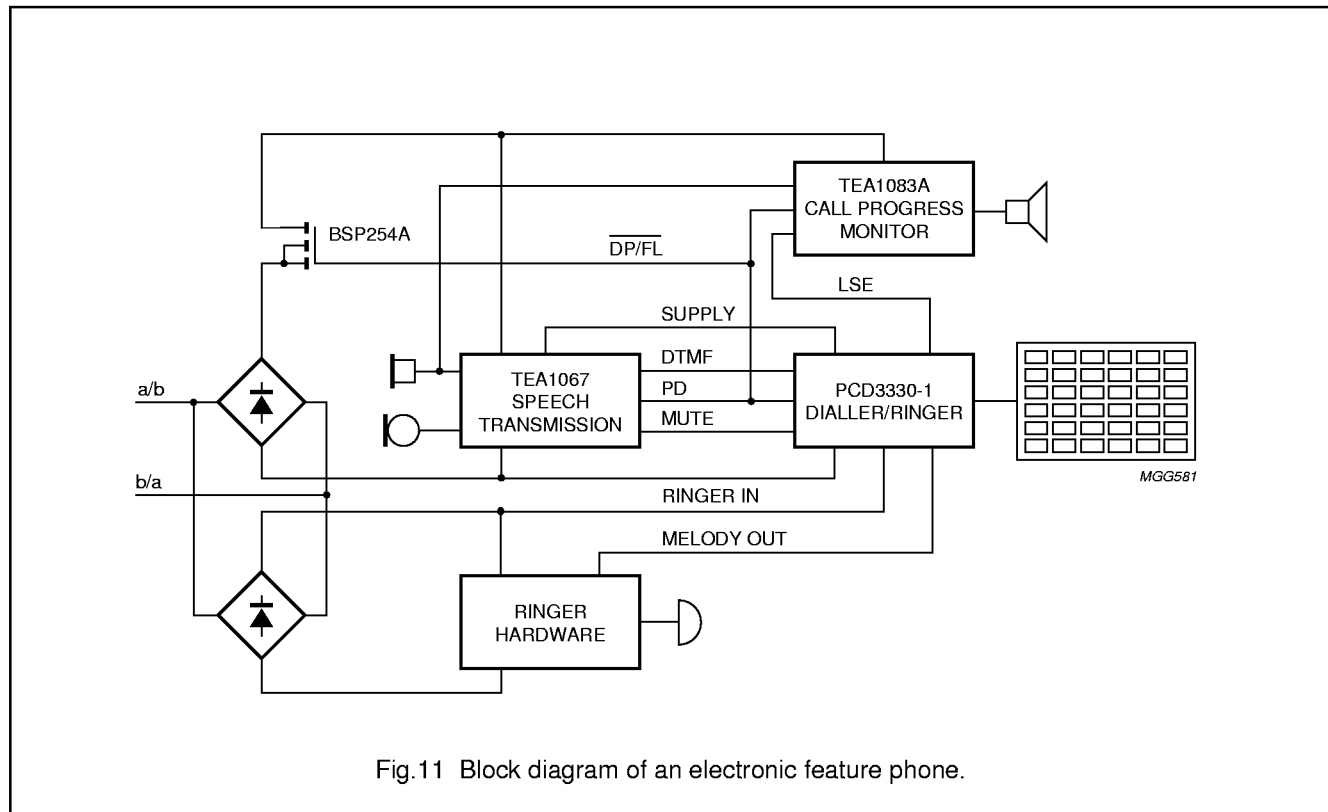


Fig.11 Block diagram of an electronic feature phone.

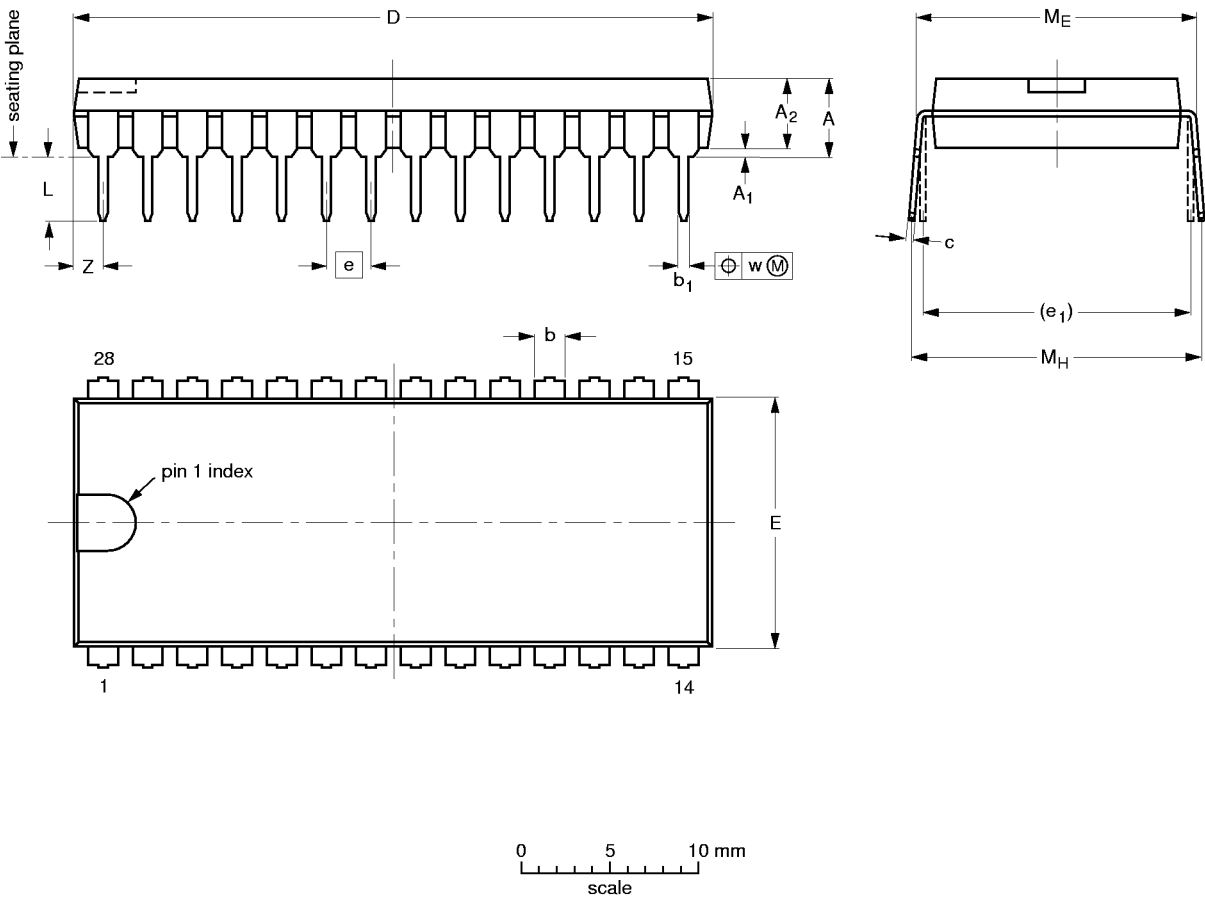
Multistandard repertory dialler/ringer with
EEPROM

PCD3330-1

10 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.

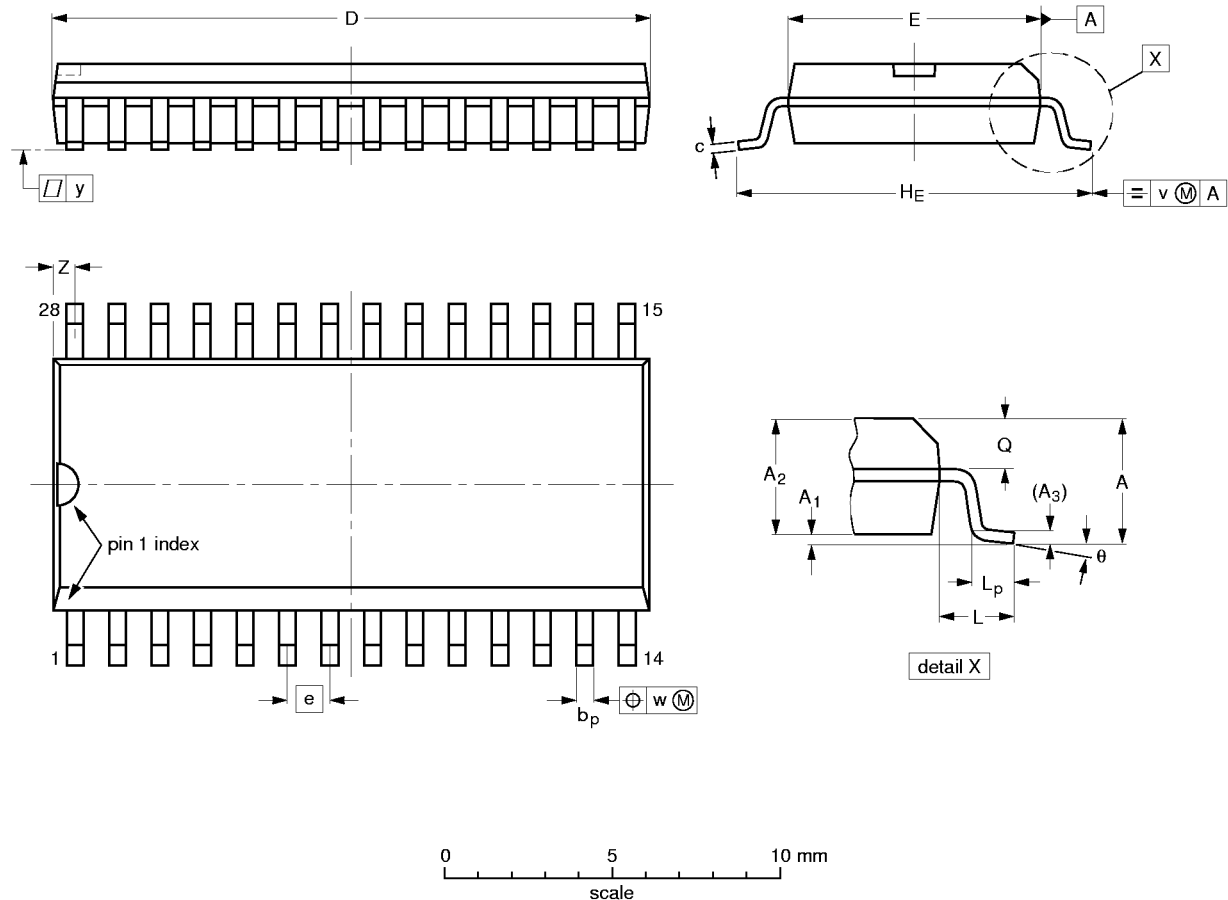
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT117-1	051G05	MO-015AH				92-11-17 95-01-14

Multistandard repertory dialler/ringer with
EEPROM

PCD3330-1

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.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	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	0.42 0.39	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				91-08-13 95-01-24