INTEGRATED CIRCUITS

DATA SHEET

PCA167x series

32 kHz watch circuits using a silver-oxide or a 3 V lithium battery

Product specification
Supersedes data of 1997 Apr 22
File under Integrated Circuits, IC16

1998 Apr 03

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FEATURES

- 32 kHz oscillator, amplitude regulated with excellent frequency stability
- High immunity of the oscillator to leakage currents
- Very low current consumption; typically 150 nA
- Stop function for accurate timing
- Chopped motor pulses available
- Power-on reset for fast testing
- Various test modes for testing the mechanical parts of the watch and the IC.

GENERAL DESCRIPTION

The PCA167x series devices are CMOS integrated circuits specially suited for battery-operated, quartz-crystal-controlled wrist-watches, with a bipolar stepping motor.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE(1)		
	NAME	DESCRIPTION	VERSION
PCA1672U	–	chip in tray	–
PCA1673U	–	chip in tray	–
PCA1675U	–	chip in tray	–
PCA1676U/10	–	chip on foil	–
PCA1677U	–	chip in tray	–

Note

1. Figure 1 and Chapter “Package outline” show details of standard package, available for large orders only. Chapter “Chip dimensions and bonding pad locations” shows exact pad locations for other delivery formats.

PINNING

SYMBOL	PIN	DESCRIPTION
V_{SS}	1	ground (0 V)
TEST	2	test output
OSC IN	3	oscillator input
OSC OUT	4	oscillator output
V_{DD}	5	positive supply voltage
M1	6	motor 1 output
M2	7	motor 2 output
RESET	8	reset input

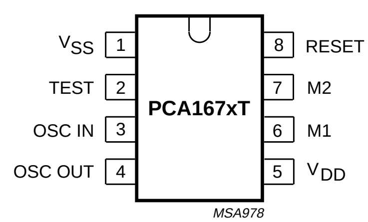


Fig.1 Pin configuration, PCA167xT, (PMFP8).

FUNCTIONAL DESCRIPTION AND TESTING

Motor pulse

The motor output pulse widths (t_P) and the cycle times (t_T) are given in Chapter "Available types".

Power-on reset

For correct operation of the Power-on reset the rise time of V_{DD} from 0 V to 1.55 V should be less than 0.1 ms.
All resettable flip-flops are reset. Additionally the polarity of the first motor pulse is positive: $V_{M1} - V_{M2} \geq 0$ V.

Customer testing and stop mode

An output frequency of 32 Hz is provided at RESET (pin 8) to be used for exact frequency measurement.

Connecting the RESET to V_{DD} stops the motor pulses leaving them in a HIGH impedance 3-state condition and a 32 Hz signal is produced at the TEST pin. A debounce circuit protects against accidental stoppages due to mechanical shock to the watch (t_{DEB} = 14.7 to 123.2 ms).

Connecting RESET to V_{SS} activates the test mode.
The motor pulse period is 31.25 ms instead of t_T. Test and stop mode are disabled by disconnecting RESET (open-circuit).

AVAILABLE TYPES

Refer to Fig.2 and to Chapters "Ordering information" and "Functional description and testing".

SHORT TYPE NUMBER	DELIVERY FORMAT(1)	PERIOD t_T (s)	SPECIFICATIONS				
			PULSE WIDTH t_P (ms)	DRIVE (%)	EEPROM	BATTERY EOL DETECTION	REMARKS
1672	U	1	7.8	56	no	no	3 V Lithium
1673	U	1	5.8	56	no	no	3 V Lithium
1675	U	1/16	5.8	100	no	no	no oscillator
1676	U/10	10	5.8	56	no	no	3 V Lithium
1677	U	10	7.8	100	no	no	1.5 V

Note

1. U = Chip in trays; U/10 = chip on foil.

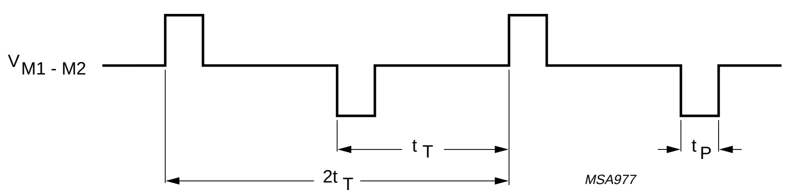


Fig.2 Motor output waveform (normal operation).

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DD}	supply voltage	V_{SS} = 0 V; note 1	–1.8	+6	V
V_I	all input voltages		V_{SS}	V_{DD}	V
	output short-circuit duration		indefinite		
T_{amb}	operating ambient temperature		–10	+60	°C
T_{stg}	storage temperature		–30	+100	°C

Note

1. Connecting the battery with reversed polarity does not destroy the circuit, but in this condition a large current flows, which will rapidly discharge the battery.

HANDLING

Inputs and outputs are protected against electrostatic discharges in normal handling. However, to be totally safe, it is advisable to take handling precautions appropriate to handling MOS devices. Advice can be found in *"Data Handbook IC16, General, Handling MOS Devices"*.

CHARACTERISTICS

V_{DD} = 1.55 V; V_{SS} = 0 V; f_{osc} = 32.768 kHz; T_{amb} = 25 °C; crystal: R_S = 20 kΩ; C_1 = 2 to 3 fF; C_L = 8 to 10 pF; C_0 = 1 to 3 pF; unless otherwise specified.

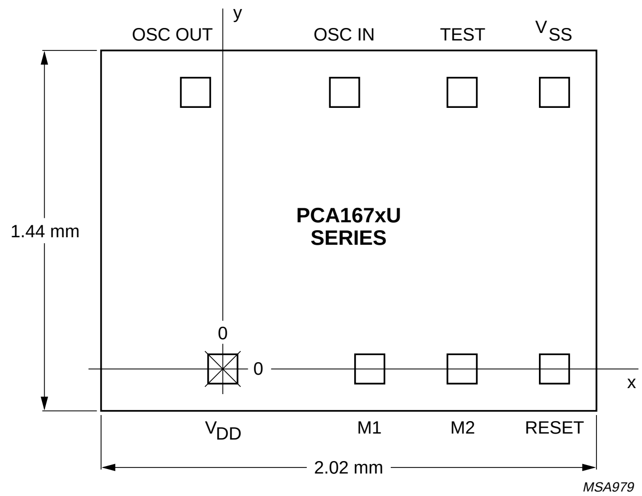
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{DD}	supply voltage	T_{amb} = –10 to +60 °C	1.2	1.5	3.5	V
ΔV_{DD}	supply voltage variation	transient; V_{DD} = 1.2 to 3.5 V	–	–	0.25	V
I_{DD1}	supply current	between motor pulses	–	150	250	nA
I_{DD2}	supply current	between motor pulses; V_{DD} = 3.5 V	–	200	350	nA
I_{DD3}	supply current	stop mode; pin 8 connected to V_{DD}	–	180	300	nA
I_{DD4}	supply current	stop mode; pin 8 connected to V_{DD}; V_{DD} = 3.5 V	–	300	480	nA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Motor output						
V_{sat}	saturation voltage Σ (P + N)	R_L = 2 kΩ; T_{amb} = −10 to +60 °C	–	150	200	mV
R_{sc}	short-circuit resistance Σ (P + N)	$I_{transistor}$ < 1 mA	–	200	300	Ω
t_T	cycle time		note 1			
t_P	pulse width		note 2			
Oscillator						
$V_{OSC\ ST}$	starting voltage		1.2	–	–	V
g_m	transconductance	$V_{i(p-p)}$ = 50 mV	6	15	–	µS
t_{osc}	start-up time		–	1	–	s
Δf/f	frequency stability	ΔV_{DD} = 100 mV	–	0.05×10^{-6}	0.3×10^{-6}	
C_i	input capacitance		–	3	–	pF
C_o	output capacitance		19	24	29	pF
Reset input						
f_o	output frequency		–	32	–	Hz
ΔV_o	output voltage swing	R = 1 MΩ; C = 10 pF	1.4	–	–	V
t_{edge}	edge time	R = 1 MΩ; C = 10 pF	–	1	–	µs
I_{im}	peak input current	note 3	–	320	–	nA
$I_{i(av)}$	average input current		–	10	–	nA
Test mode						
t_{T1}	cycle time		–	31.25	–	ms
t_{DEB}	debounce time	RESET = V_{DD}	14.7	–	123.2	ms

Notes

1. Cycle time can be changed to one of the following values: 1, 5, 10, 12 or 20 s (see Chapter “Available types”).
2. Pulse width can be varied from 2 ms to 15.7 ms in steps of 1 ms (see Chapter “Available types”).
3. Duty factor is 1 : 32 and RESET = V_{DD} or V_{SS}.

CHIP DIMENSIONS AND BONDING PAD LOCATIONS



Chip area: 2.91 mm^2.

Bonding pad dimensions: 110 µm × 110 µm.

Chip thickness: 200 ±25 µm, with bumps: 270 ±25 µm.

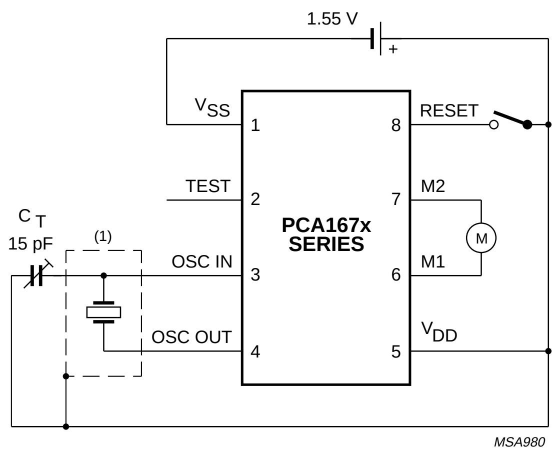
Fig.3 Bonding pad locations, PCA167xU series; 8 terminals.

Table 1 Bonding pad locations (dimensions in µm)

All x/y coordinates are referenced to the centre of pad (V_{DD}), see Fig.3.

PAD	x	y
V_{SS}	1290	1100
TEST	940	1100
OSC IN	481	1100
OSC OUT	–102	1100
V_{DD}	0	0
M1	578	0
M2	930	0
RESET	1290	0
chip corner (max. value)	–497.5	–170

APPLICATION INFORMATION

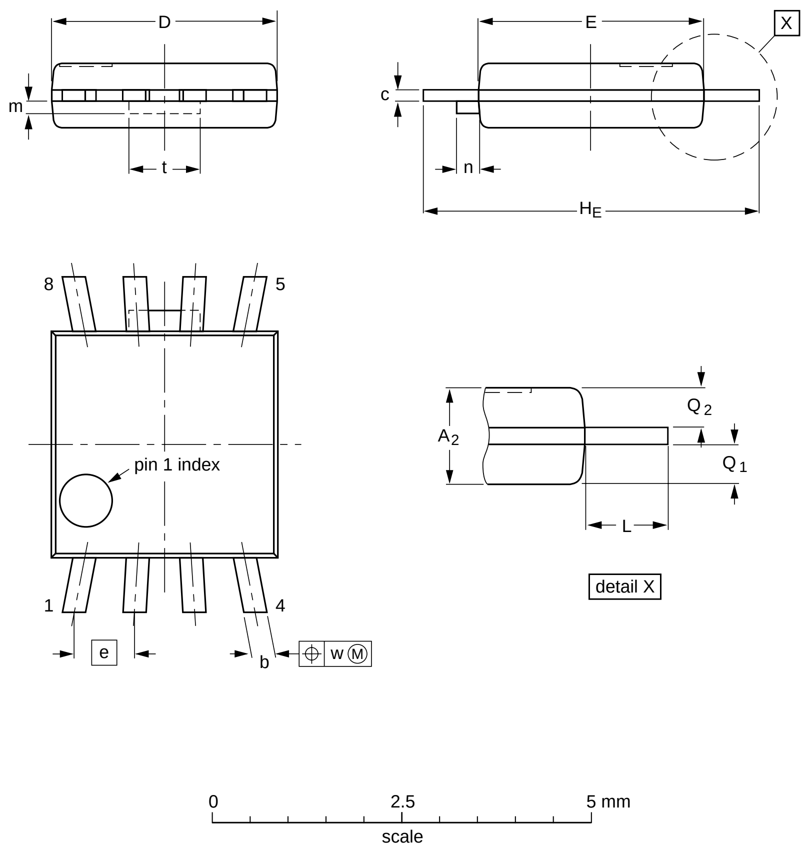


(1) Quartz crystal case should be connected to V_{DD}. Stray capacitance and leakage resistance from RESET, M1 or M2 to OSC IN should be less than 0.5 pF or larger than 20 MΩ.

Fig.4 Typical application circuit diagram.

PACKAGE OUTLINE

PMFP8: plastic micro flat package; 8 leads (straight) **SOT144-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A_2	b	c	D (1)	E (1)	e	H_E	L	m max.	n max.	Q_1	Q_2	t	w
mm	0.90 0.70	0.40 0.25	0.19 0.12	3.1 2.9	3.1 2.9	0.80	4.6 4.4	0.75	0.26	0.3	0.40 0.30	0.40 0.30	0.95	0.1

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			
SOT144-1						~~94-01-25~~ 95-01-24

SOLDERING

Introduction

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

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

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.

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.

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.

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.	

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