



PCF85263A

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

Rev. 5 — 1 February 2021

Product data sheet

1 General description

The PCF85263A is a CMOS ¹ Real-Time Clock (RTC) and calendar optimized for low power consumption and with automatic switching to battery on main power loss. The RTC can also be configured as a stop-watch (elapsed time counter). Three time log registers triggered from battery switch-over as well as input driven events. Featuring clock output and two independent interrupt signals, two alarms, I²C-bus interface and quartz crystal calibration.

For a selection of NXP Real-Time Clocks, see [Table 71](#)

2 Features and benefits

- UL Recognized Component (PCF85263ATL)
- Provides year, month, day, weekday, hours, minutes, seconds and 100th seconds based on a 32.768 kHz quartz crystal
- Stop-watch mode for elapsed time counting. From 100th seconds to 999 999 hours
- Two independent alarms
- Battery back-up circuit
- WatchDog timer
- Three timestamp registers
- Two independent interrupt generators plus predefined interrupts at every second, minute, or hour
- Frequency adjustment via programmable offset register
- Clock operating voltage: 0.9 V to 5.5 V
- Low current; typical 0.28 μ A at $V_{DD} = 3.0$ V and $T_{amb} = 25$ °C
- 400 kHz two-line I²C-bus interface (at $V_{DD} = 1.8$ V to 5.5 V)
- Programmable clock output for peripheral devices (32.768 kHz, 16.384 kHz, 8.192 kHz, 4.096 kHz, 2.048 kHz, 1.024 kHz, and 1 Hz)
- Configurable oscillator circuit for a wide variety of quartzes: $C_L = 6$ pF, $C_L = 7$ pF, and $C_L = 12.5$ pF
- Packages offered: S18, TSSOP8, TSSOP10, HXSON10 and WLCSP12

3 Applications

- Printers and copiers
- Electronic metering
- Digital cameras
- White goods
- Elapsed time counter

¹ The definition of the abbreviations and acronyms used in this data sheet can be found in [Section 23](#).



Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

- Network powered devices
- Battery backed up systems
- Data loggers
- Digital voice recorders
- Mobile equipment
- Accurate high duration timer

4 Ordering information

Table 1. Ordering information

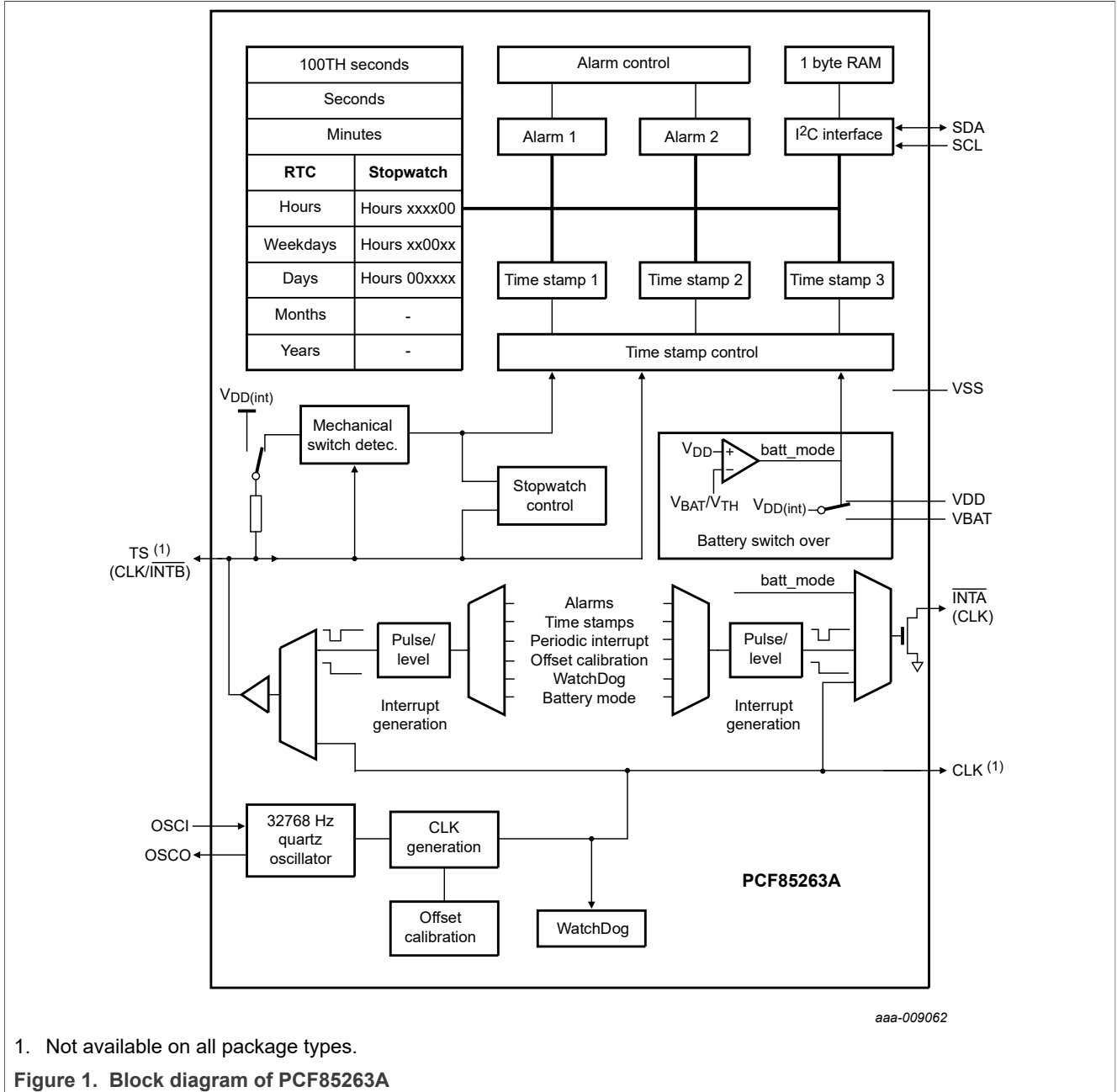
Type number	Topside marking	Package		
		Name	Description	Version
PCF85263AT/A	85263A	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
PCF85263ATL/A	263A	DFN2626-10	plastic thermal enhanced extremely thin small outline package; no leads; 10 terminals; body 2.6 × 2.6 × 0.5 mm	SOT1197-1
PCF85263ATT/A	263A	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1
PCF85263ATT1/A	263A	TSSOP10	plastic thin shrink small outline package; 10 leads; body width 3 mm	SOT552-1
PCF85263AUK	F	WLCSP12	wafer level package 12 cu pillars; body 1.19 x 0.94 x 0.22 mm with 0.25 mm pitch	SOT2035-1

4.1 Ordering options

Table 2. Ordering options

Type number	Orderable part number	Package	Packing method	Minimum order quantity	Temperature
PCF85263AT/A	PCF85263AT/AJ	SO8	reel 13" q1 ndp	2500	T _{amb} = -40 °C to +85 °C
PCF85263ATL/A	PCF85263ATL/AX	DFN2626-10	reel 7" q1 ndp	4000	T _{amb} = -40 °C to +85 °C
PCF85263ATT/A	PCF85263ATT/AJ	TSSOP8	reel 13" q1 ndp	2500	T _{amb} = -40 °C to +85 °C
PCF85263ATT1/A	PCF85263ATT1/AJ	TSSOP10	reel 13" q1 ndp	2500	T _{amb} = -40 °C to +85 °C
PCF85263AUK	PCF85263AUKZ	WLCSP12	reel 13" Q1 dry pack	20000	T _{amb} = -40 °C to +85 °C

5 Block diagram



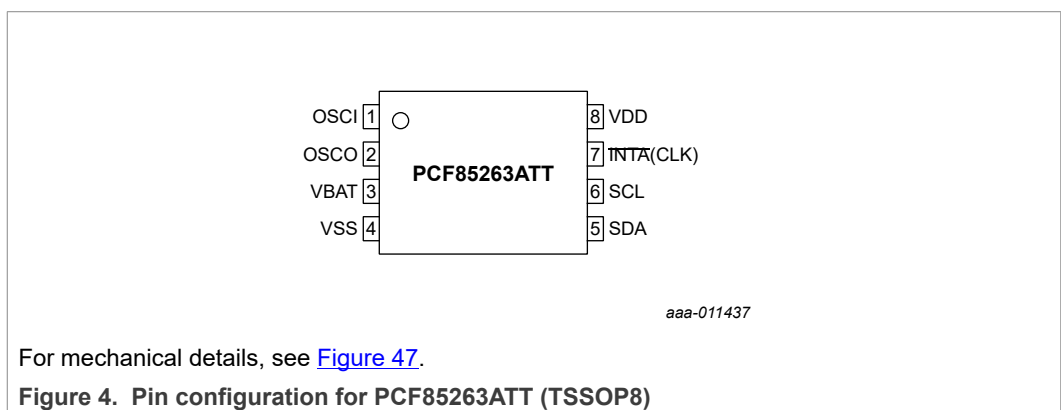
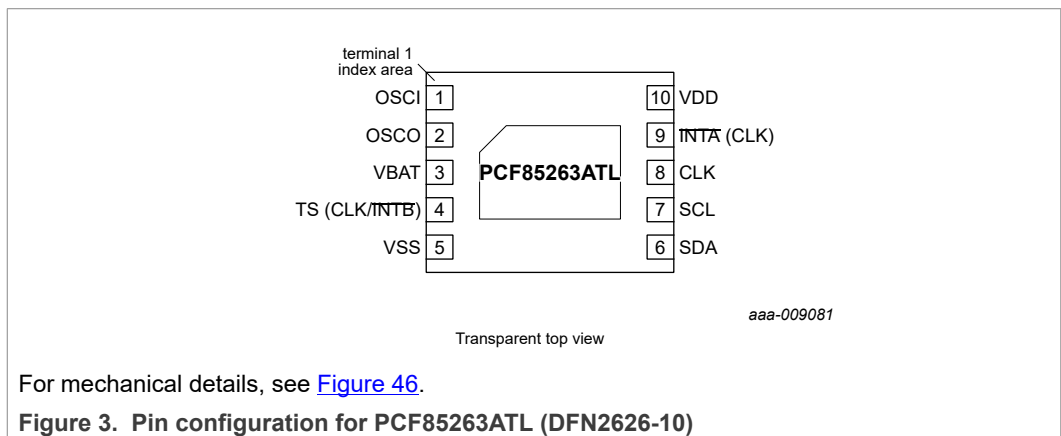
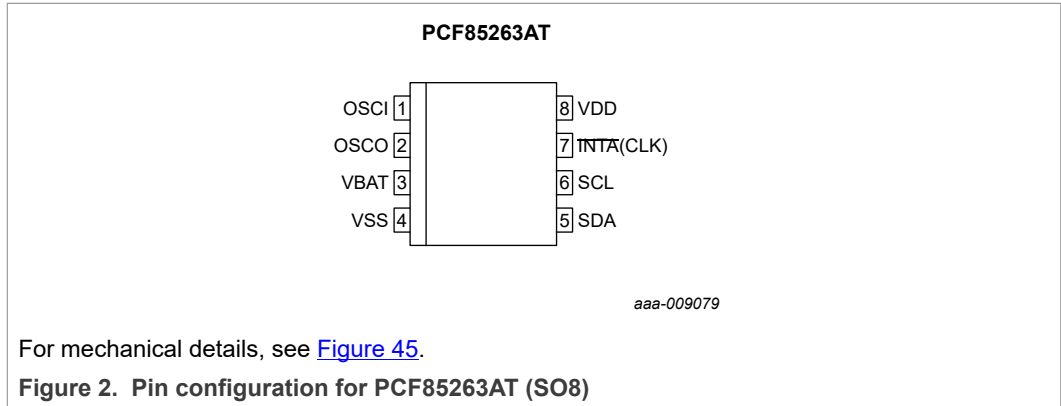
aaa-009062

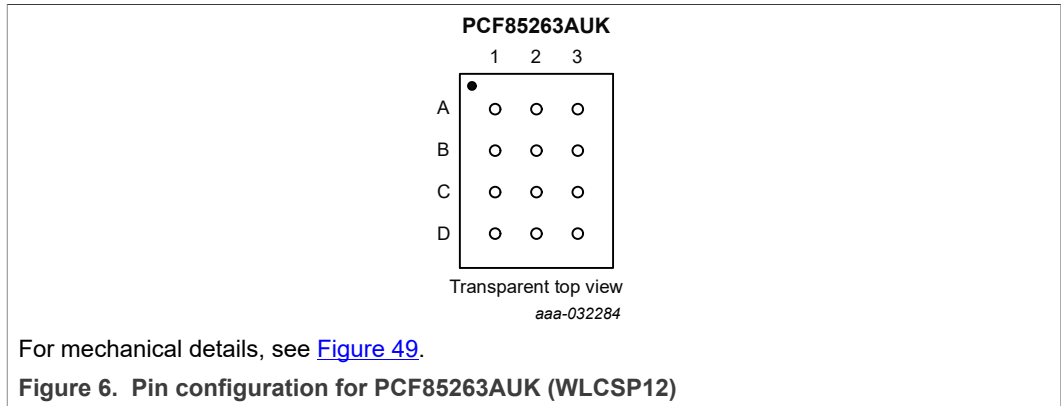
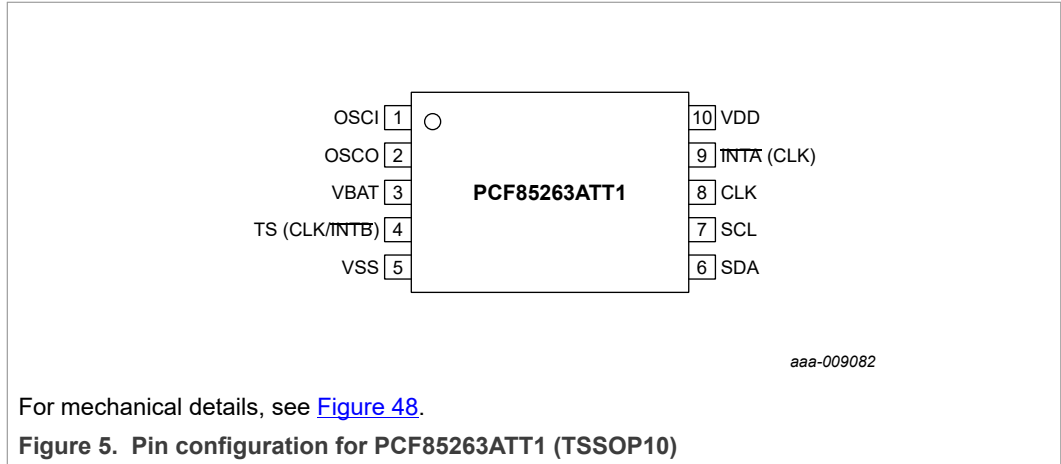
1. Not available on all package types.

Figure 1. Block diagram of PCF85263A

6 Pinning information

6.1 Pinning





6.2 Pin description

Table 3. Pin description

Input or input/output pins must always be at a defined level (V_{SS} or V_{DD}) unless otherwise specified.

Symbol	Pin					Type	Description	
	PCF85263AT (SO8)	PCF85263ATL (DFN2626-10)	PCF85263ATT (TSSOP8)	PCF85263ATT1 (TSSOP10)	PCF85263AUK (WLCSP12)		Primary use	Secondary use
OSCI	1	1	1	1	A2	input	oscillator input	-
OSCO	2	2	2	2	A3	output	oscillator output	-
VBAT	3	3	3	3	B3	supply	battery backup supply voltage ^[1]	-
TS (CLK/INTB)	-	4	-	4	C3	input/ output	can be configured with TSPM[1:0] ^[2] timestamp input	INTB and CLK output (push-pull); stop-watch control
VSS	4	5 ^[3]	4	5	D2, D3	supply	ground supply voltage	-
SDA	5	6	5	6	D1	input/ output	serial data line	-
SCL	6	7	6	7	C1	input	serial clock input	-
CLK	-	8	-	8	B2	output	CLK (push-pull)	-
INTA (CLK)	7	9	7	9	B1	output	can be configured with INTAPM[1:0] ^[4] interrupt output (open-drain)	CLK output (open-drain)
VDD	8	10	8	10	A1, C2	supply	supply voltage	-

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

- [1] Connect to VDD if not used.
- [2] See [Table 6](#) and [Table 46](#).
- [3] The die paddle (exposed pad) is connected to V_{SS} through high ohmic (non-conductive) silicon attach and should be electrically isolated. It is good engineering practice to solder the exposed pad to an electrically isolated PCB copper pad as shown in [Figure 46](#) for better heat transfer but it is not required as the RTC doesn't consume much power. In no case should traces be run under the package exposed pad.
- [4] See [Table 6](#) and [Table 48](#).

7 Functional description

The PCF85263A contains 8-bit registers for time information, for timestamp information and registers for system configuration. Included is an auto-incrementing register address, an on-chip 32.768 kHz oscillator with integrated capacitors, a frequency divider which provides the source clock for the Real-Time Clock (RTC) and calendar, and an I²C-bus interface with a maximum data rate of 400 kbit/s.

The built-in address register will increment automatically after each read or write of a data byte. After register 2Fh, the auto-incrementing will wrap around to address 00h (see [Figure 7](#)).

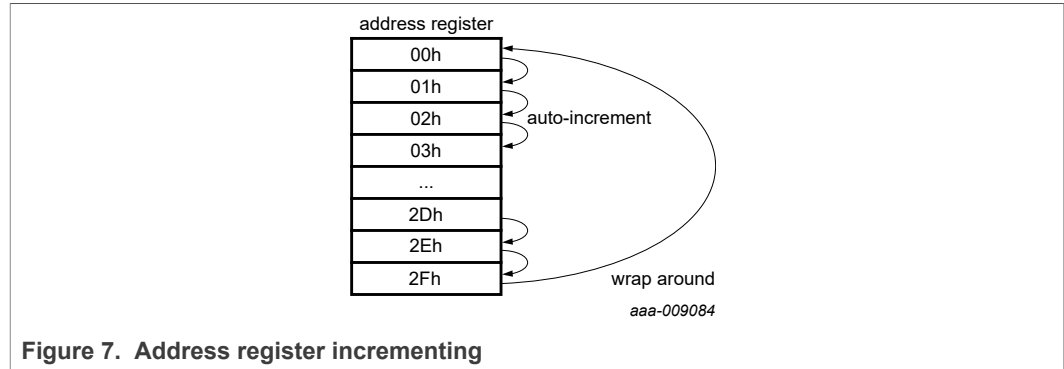


Figure 7. Address register incrementing

All registers (see [Table 4](#), [Table 5](#), and [Table 6](#)) are designed as addressable 8-bit parallel registers although not all bits are implemented. [Figure 8](#) gives an overview of the address map.

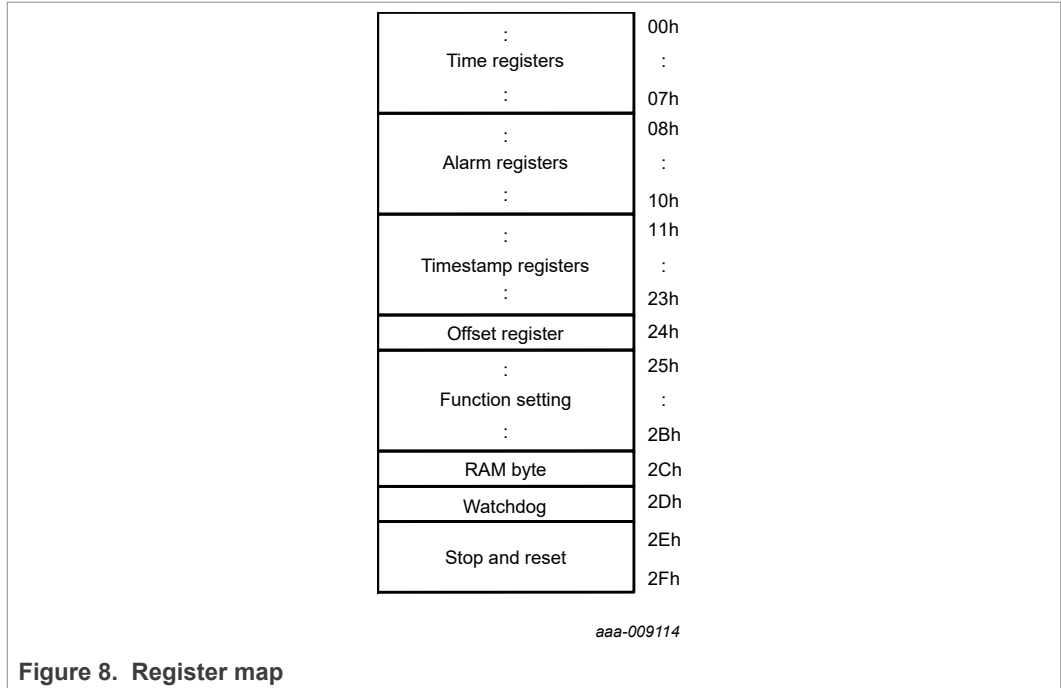


Figure 8. Register map

The 100th seconds, seconds, minutes, hours, days, months, and years as well as the corresponding alarm registers are all coded in Binary Coded Decimal (BCD) format. When one of the RTC registers is read, the contents of all time counters are frozen. Therefore, faulty reading of the clock and calendar during a carry condition is prevented.

7.1 Registers organization overview

7.1.1 Time mode registers

The PCF85263A has two time mode register sets, one for the real-time clock mode and one for the stopwatch clock mode. The access to these registers can be switched by the RTCM bit in the Function control register (28h), see [Table 6](#) and [Table 53](#).

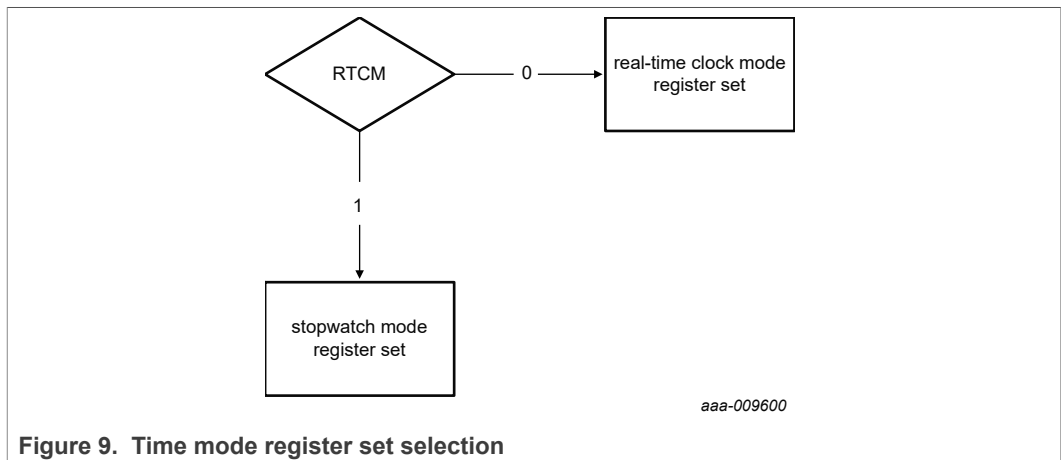


Figure 9. Time mode register set selection

7.1.1.1 RTC mode time registers overview (RTCM = 0)

Table 4. RTC mode time registers

Bit positions labeled as - are not implemented. After reset, all registers are set according to Table 61.

Address	Register name	Bit								Reference	
		7	6	5	4	3	2	1	0		
RTC time and date registers											
00h	100th_seconds	100TH_SECONDS (0 to 99)								Section 7.2	
01h	Seconds	OS	SECONDS (0 to 59)								
02h	Minutes	EMON	MINUTES (0 to 59)								
03h	Hours	-	-	AMPM	HOURS (1 to 12) in 12 hour mode						
		HOURS (0 to 23) in 24 hour mode									
04h	Days	-	-	DAYS (1 to 31)							
05h	Weekdays	-	-	-	-	-	WEEKDAYS (0 to 6)				
06h	Months	-	-	-	MONTHS (1 to 12)						
07h	Years	YEARS (0 to 99)									
RTC alarm1											
08h	Second_alarm1	-	SEC_ALARM1 (0 to 59)								Section 7.4
09h	Minute_alarm1	-	MIN_ALARM1 (0 to 59)								
0Ah	Hour_alarm1	-	-	AMPM	HR_ALARM1 (1 to 12) in 12 hour mode						
		HR_ALARM1 (0 to 23) in 24 hour mode									
0Bh	Day_alarm1	-	-	DAY_ALARM1 (1 to 31)							
0Ch	Month_alarm1	-	-	-	MON_ALARM1 (1 to 12)						
RTC alarm2											
0Dh	Minute_alarm2	-	MIN_ALARM2 (0 to 59)								Section 7.4
0Eh	Hour_alarm2	-	-	AMPM	HR_ALARM2 (1 to 12) in 12 hour mode						
0Fh	Weekday_alarm2	-	-	-	-	-	WDAY_ALARM2 (0 to 6)				
RTC alarm enables											
10h	Alarm_enables	WDAY_A2E	HR_A2E	MIN_A2E	MON_A1E	DAY_A1E	HR_A1E	MIN_A1E	SEC_A1E	Section 7.4	
RTC timestamp1 (TSR1)											
11h	TSR1_seconds	-	TSR1_SECONDS (0 to 59)								Section 7.7
12h	TSR1_minutes	-	TSR1_MINUTES (0 to 59)								
13h	TSR1_hours	-	-	AMPM	TSR1_HOURS (1 to 12) in 12 hour mode						
		TSR1_HOURS (0 to 23) in 24 hour mode									
14h	TSR1_days	-	-	TSR1_DAYS (1 to 31)							
15h	TSR1_months	-	-	-	TSR1_MONTHS (1 to 12)						
16h	TSR1_years	TSR1_YEARS (0 to 99)									
RTC timestamp2 (TSR2)											
17h	TSR2_seconds	-	TSR2_SECONDS (0 to 59)								Section 7.7
18h	TSR2_minutes	-	TSR2_MINUTES (0 to 59)								
19h	TSR2_hours	-	-	AMPM	TSR2_HOURS (1 to 12) in 12 hour mode						
		TSR2_HOURS (0 to 23) in 24 hour mode									
1Ah	TSR2_days	-	-	TSR2_DAYS (1 to 31)							
1Bh	TSR2_months	-	-	-	TSR2_MONTHS (1 to 12)						
1Ch	TSR2_years	TSR2_YEARS (0 to 99)									
RTC timestamp3 (TSR3)											
1Dh	TSR3_seconds	-	TSR3_SECONDS (0 to 59)								Section 7.7
1Eh	TSR3_minutes	-	TSR3_MINUTES (0 to 59)								
1Fh	TSR3_hours	-	-	AMPM	TSR3_HOURS (1 to 12) in 12 hour mode						
		TSR3_HOURS (0 to 23) in 24 hour mode									
20h	TSR3_days	-	-	TSR3_DAYS (1 to 31)							
21h	TSR3_months	-	-	-	TSR3_MONTHS (1 to 12)						
22h	TSR3_years	TSR3_YEARS (0 to 99)									

Table 4. RTC mode time registers...continued

Bit positions labeled as - are not implemented. After reset, all registers are set according to [Table 61](#).

Address	Register name	Bit								Reference
		7	6	5	4	3	2	1	0	
RTC timestamp mode control										
23h	TSR_mode	TSR3M[1:0]		-	TSR2M[2:0]		TSR1M[1:0]		Section 7.7	

7.1.1.2 Stop-watch mode time registers (RTCM = 1)

Table 5. Stop-watch mode time registers

Bit positions labeled as - are not implemented. After reset, all registers are set according to [Table 61](#).

Address	Register name	Bit								Reference	
		7	6	5	4	3	2	1	0		
Stop-watch time registers											
00h	100th_seconds	100TH_SECONDS (0 to 99)									Section 7.3
01h	Seconds	OS	SECONDS (0 to 59)								
02h	Minutes	EMON	MINUTES (0 to 59)								
03h	Hours_xx_xx_00	HR_XX_XX_00 (0 to 99)									
04h	Hours_xx_00_xx	HR_XX_00_XX (0 to 99)									
05h	Hours_00_xx_xx	HR_00_XX_XX (0 to 99)									
06h	not used	-	-	-	-	-	-	-	-		
07h	not used	-	-	-	-	-	-	-	-		
Stop-watch alarm1											
08h	Second_alm1	-	SEC_ALM1 (0 to 59)								Section 7.4
09h	Minute_alm1	-	MIN_ALM1 (0 to 59)								
0Ah	Hr_xx_xx_00_alm1	HR_XX_XX_00_ALM1 (0 to 99)									
0Bh	Hr_xx_00_xx_alm1	HR_XX_00_XX_ALM1 (0 to 99)									
0Ch	Hr_00_xx_xx_alm1	HR_00_XX_XX_ALM1 (0 to 99)									
Stop-watch alarm2											
0Dh	Minute_alm2	-	MIN_ALM2 (0 to 59)								Section 7.4
0Eh	Hr_xx_00_alm2	HR_XX_00_ALM2 (0 to 99)									
0Fh	Hr_00_xx_alm2	HR_00_XX_ALM2 (0 to 99)									
Stop-watch alarm enables											
10h	Alarm_enables	HR_00_XX_A2E	HR_XX_00_A2E	MIN_A2E	HR_00_XX_XX_A1E	HR_XX_00_XX_A1E	HR_XX_XX_00_A1E	MIN_A1E	SEC_A1E	Section 7.4	
Stop-watch timestamp1 (TSR1)											
11h	TSR1_seconds	-	TSR1_SECONDS (0 to 59)								Section 7.7
12h	TSR1_minutes	-	TSR1_MINUTES (0 to 59)								
13h	TSR1_hr_xx_xx_00	TSR1_HR_XX_XX_00 (0 to 99)									
14h	TSR1_hr_xx_00_xx	TSR1_HR_XX_00_XX (0 to 99)									
15h	TSR1_hr_00_xx_xx	TSR1_HR_00_XX_XX (0 to 99)									
16h	not used	-	-	-	-	-	-	-	-		
Stop-watch timestamp2 (TSR2)											
17h	TSR2_seconds	-	TSR2_SECONDS (0 to 59)								Section 7.7
18h	TSR2_minutes	-	TSR2_MINUTES (0 to 59)								
19h	TSR2_hr_xx_xx_00	TSR2_HR_XX_XX_00 (0 to 99)									
1Ah	TSR2_hr_xx_00_xx	TSR2_HR_XX_00_XX (0 to 99)									
1Bh	TSR2_hr_00_xx_xx	TSR2_HR_00_XX_XX (0 to 99)									
1Ch	not used	-	-	-	-	-	-	-	-		
Stop-watch timestamp3 (TSR3)											
1Dh	TSR3_seconds	-	TSR3_SECONDS (0 to 59)								Section 7.7
1Eh	TSR3_minutes	-	TSR3_MINUTES (0 to 59)								
1Fh	TSR3_hr_xx_xx_00	TSR3_HR_XX_XX_00 (0 to 99)									
20h	TSR3_hr_xx_00_xx	TSR3_HR_XX_00_XX (0 to 99)									

Table 5. Stop-watch mode time registers...continued

Bit positions labeled as - are not implemented. After reset, all registers are set according to Table 61.

Address	Register name	Bit								Reference
		7	6	5	4	3	2	1	0	
21h	TSR3_hr_00_xx_xx	TSR3_HR_00_XX_XX (0 to 99)								
22h	not used	-	-	-	-	-	-	-	-	
Stop-watch timestamp mode control										
23h	TSR_mode	TSR3M[1:0]		-	TSR2M[2:0]		TSR1M[1:0]			Section 7.7

7.1.2 Control registers overview

Table 6. Control and function registers overview

Bit positions labeled as - are not implemented. After reset, all registers are set according to Table 61.

Address	Register name	Bit								Reference
		7	6	5	4	3	2	1	0	
Offset register										
24h	Offset	OFFSET[7:0]								Section 7.8
Control registers										
25h	Oscillator	CLKIV	OFFM	12_24	LOWJ	OSCD[1:0]		CL[1:0]		Section 7.10
26h	Battery_switch	-	-	-	BSOFF	BSRR	BSM[1:0]		BSTH	Section 7.11
27h	Pin_IO	CLKPM	TSPULL	TSL	TSIM	TSPM[1:0]		INTAPM[1:0]		Section 7.12
28h	Function	100TH	PI[1:0]		RTCM	STOPM	COF[2:0]			Section 7.13
29h	INTA_enable	ILPA	PIEA	OIEA	A1IEA	A2IEA	TSRIEA	BSIEA	WDIEA	Section 7.9
2Ah	INTB_enable	ILPB	PIEB	OIEB	A1IEB	A2IEB	TSRIEB	BSIEB	WDIEB	Section 7.9
2Bh	Flags	PIF	A2F	A1F	WDF	BSF	TSR3F	TSR2F	TSR1F	Section 7.14
RAM byte										
2Ch	RAM_byte	B[7:0]								Section 7.6
WatchDog registers										
2Dh	WatchDog	WDM	WDR[4:0]				WDS[1:0]			Section 7.5
Stop										
2Eh	Stop_enable	-	-	-	-	-	-	-	STOP	Section 7.16
Reset										
2Fh	Resets	CPR	0	1	0	SR	1	0	CTS	Section 7.15

7.2 RTC mode time and date registers

RTC mode is enabled by setting RTCM = 0. These registers are coded in the BCD format to simplify application use.

Default state is:

Time: 00:00:00.00

Date: 2000 01 01

Weekday: Saturday

Monitor bits: OS = 1, EMON = 0

Table 7. Time and date registers in RTC mode (RTCM = 0)

Bit positions labeled as - are not implemented and return 0 when read.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00h	100th_seconds ^[1]	0 to 9				0 to 9			
01h	Seconds	OS	0 to 5			0 to 9			
02h	Minutes	EMON	0 to 5			0 to 9			
03h	Hours ^[2]	-	-	AMPM	0 to 1	0 to 9			
					0 to 2	0 to 9			
04h	Days ^[3]	-	-	0 to 3		0 to 9			
05h	Weekdays	-	-	-	-	-	0 to 6		
06h	Months	-	-	-	0 to 1	0 to 9			
07h	Years	0 to 9				0 to 9			

[1] The 100th_seconds register is only available when the 100TH mode is enabled, see [Section 7.13.1](#). When the 100TH mode is disabled, this register always returns 0.
 [2] Hour mode is set by the 12_24 bit in the Oscillator register, see [Section 7.10](#).
 [3] If the year counter contains a value, which is exactly divisible by 4, the PCF85263A compensates for leap years by adding a 29th day to February.

7.2.1 Definition of BCD

The Binary-Coded Decimal (BCD) is an encoding of numbers where each digit is represented by a separate bit field. Each bit field may only contain the values 0 to 9. In this way, decimal numbers and counting is implemented.

Example: 59 encoded as an entire number is represented by 3Bh or 11 1011. In BCD the 5 is represented as 5h or 0101 and the 9 as 9h or 1001 which combines to 59h.

Table 8. BCD coding

Value in decimal	Upper-digit (ten's place)				Digit (unit place)			
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00	0	0	0	0	0	0	0	0
01	0	0	0	1	0	0	0	1
02	0	0	1	0	0	0	1	0
:	:	:	:	:	:	:	:	:
09	1	0	0	1	1	0	0	1
10	0	0	0	0	0	0	0	0
:	:	:	:	:	:	:	:	:
98	1	0	0	1	1	0	0	0
99	1	0	0	1	1	0	0	1

7.2.2 OS: Oscillator stop

When the oscillator of the PCF85263A is stopped, the OS status bit is set. The oscillator can be stopped, for example, by connecting one of the oscillator pins OSCI or OSCO to

ground. The oscillator is considered to be stopped during the time between power-on and stable crystal resonance. This time can be in the range of 200 ms to 2 s depending on crystal type, temperature, and supply voltage.

The status bit remains set until cleared by command (see [Figure 10](#)). If the bit cannot be cleared, then the oscillator is not running. This method can be used to monitor the oscillator and to determine if the supply voltage has reduced to the point where oscillation fails.

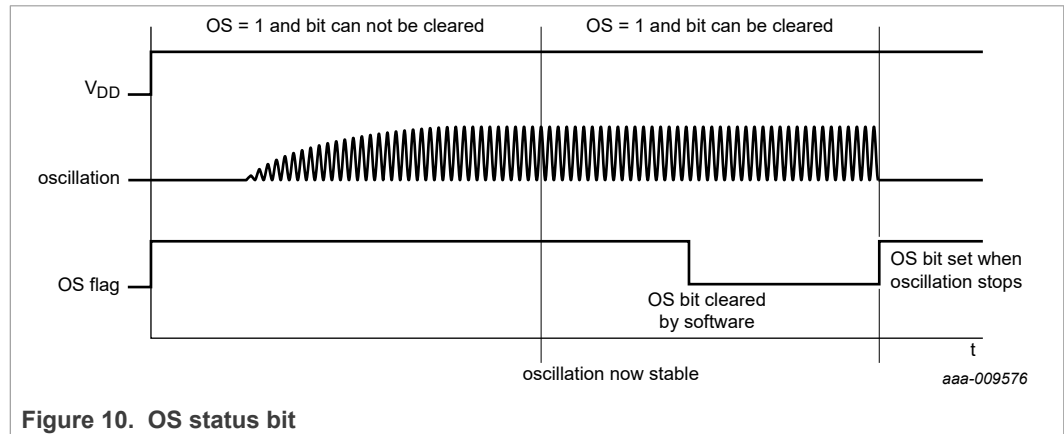


Figure 10. OS status bit

7.2.3 EMON: event monitor

The EMON can be used to monitor the status of all the flags in the Flags register, see [Section 7.14](#). When one or more of the flags is set, then the EMON bit returns a logic 1. The EMON bit cannot be cleared. EMON returns a logic 0 when all flags are cleared.

See [Figure 23](#) for a pictorial representation.

7.2.4 Definition of weekdays

Definition may be reassigned by the user.

Table 9. Weekday assignments

Day	Bit		
	2	1	0
Sunday	0	0	0
Monday	0	0	1
Tuesday	0	1	0
Wednesday	0	1	1
Thursday	1	0	0
Friday	1	0	1
Saturday	1	1	0

7.2.5 Definition of months

Table 10. Month assignments in BCD format

Month	Upper-digit (ten's place)	Digit (unit place)			
	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
January	0	0	0	0	1
February	0	0	0	1	0
March	0	0	0	1	1
April	0	0	1	0	0
May	0	0	1	0	1
June	0	0	1	1	0
July	0	0	1	1	1
August	0	1	0	0	0
September	0	1	0	0	1
October	1	0	0	0	0
November	1	0	0	0	1
December	1	0	0	1	0

7.2.6 Setting and reading the time in RTC mode

Figure 11 shows the data flow and data dependencies starting from the 100 Hz clock tick.

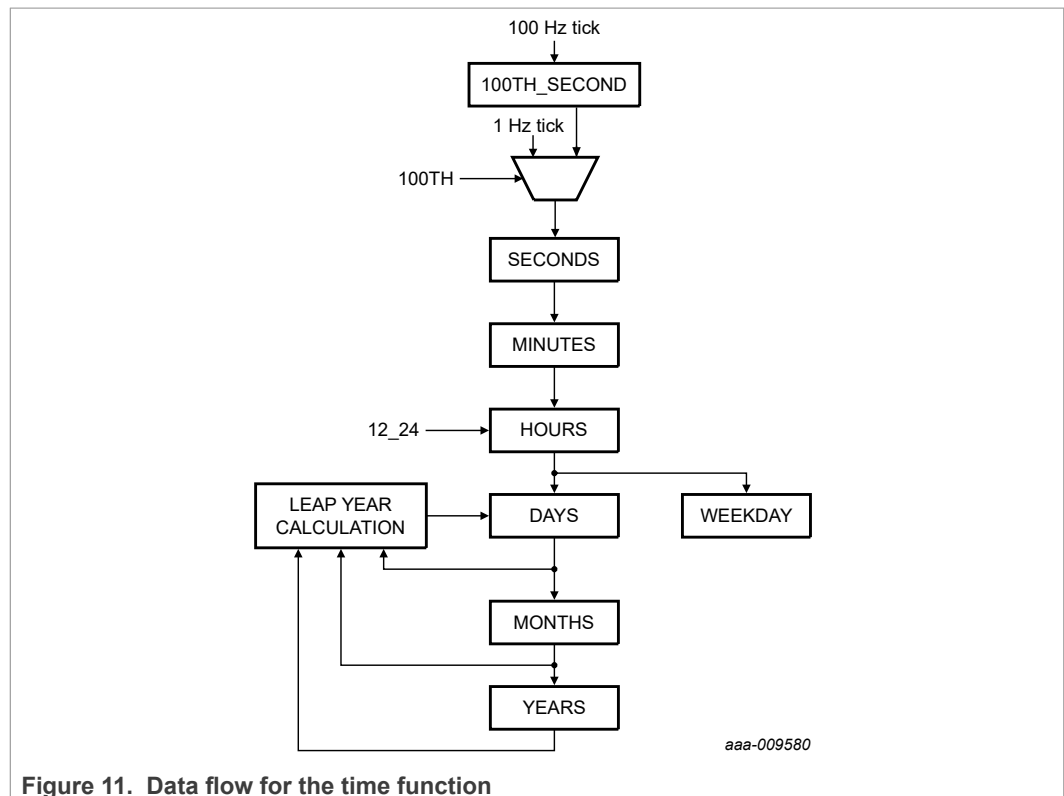


Figure 11. Data flow for the time function

During read operations, the time counting circuits (memory locations 00h through 07h) are copied into an output register. The RTC continues counting in the background.

When reading or writing the time it is very important to make a read or write access in one go, that is, setting or reading 100th seconds through to years should be made in one single access. Failing to comply with this method could result in the time becoming corrupted.

As an example, if the time (seconds through to hours) is set in one access and then in a second access the date is set, it is possible that the time increments between the two accesses. A similar problem exists when reading. A roll-over may occur between reads thus giving the minutes from one moment and the hours from the next.

Before setting the time, the STOP bit should be set and the prescalers should be cleared (see [Section 7.16](#)).

An example of setting the time: 14 hours, 23 minutes and 19 seconds.

- I²C START condition
- I²C slave address + write (A2h)
- register address (2Eh)
- write data (set STOP, 01h)
- write data (clear prescaler, A4h)
- write data (100th seconds, 00h)
- write data (Hours, 14h)
- write data (Minutes, 23h)
- write data (Seconds, 19h)
- I²C START condition
- I²C slave address + write (A2h)
- register address (2Eh)
- write data (clear STOP, 00h). Time starts counting from this point
- I²C STOP condition

7.3 Stop-watch mode time registers

These registers are coded in the BCD format to simplify application use.

Stop-watch mode is enabled by setting RTCM = 1. In stop-watch mode, the PCF85263A counts from 100th seconds to 99 9 999 hours. There are no days, weekdays, months or year registers.

Default state is:

Time

00 00 00:00:00.00

Monitor bits

OS = 1, EMON = 0 (see [Section 7.2.2](#) and [Section 7.2.3](#))

Table 11. Time registers in stop-watch mode (RTCM = 1)

Bit positions labeled as - are not implemented and return 0 when read.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00h	100th_seconds ^[1]	0 to 9				0 to 9			

Table 11. Time registers in stop-watch mode (RTCM = 1)...continued

Bit positions labeled as - are not implemented and return 0 when read.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
01h	Seconds	OS	0 to 5			0 to 9			
02h	Minutes	EMON	0 to 5			0 to 9			
03h	Hours_xx_xx_00	0 to 9			0 to 9				
04h	Hours_xx_00_xx	0 to 9			0 to 9				
05h	Hours_00_xx_xx	0 to 9			0 to 9				
06h	not used	-	-	-	-	-	-	-	-
07h	not used	-	-	-	-	-	-	-	-

[1] The 100th_seconds register is only available when the 100TH mode is enabled, see [Section 7.13.1](#). When the 100TH mode is disabled, this register always returns 0.

7.3.1 Setting and reading the time in stop-watch mode

[Figure 12](#) shows the data flow and data dependencies starting from the 100 Hz clock tick.

During read operations, the time counting circuits (memory locations 00h through 07h) are copied into an output register. The RTC continues counting in the background.

When reading or writing the time it is very important to make a read or write access in one go, that is, setting or reading 100th_seconds through to HR_00_xx_xx should be made in one single access. Failing to comply with this method could result in the time becoming corrupted.

As an example, if the seconds value is set in one access and then in a following access the minutes value is set, it is possible that the time increments between the two accesses. A similar problem exists when reading. A roll-over may occur between reads thus giving the seconds from one moment and the minutes from the next.

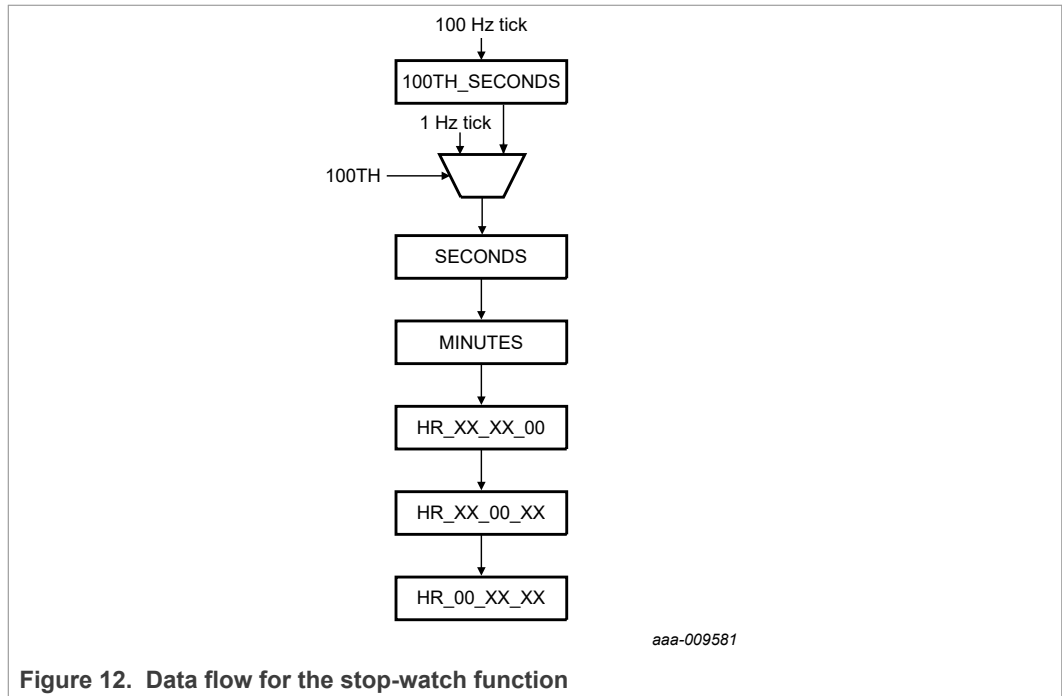


Figure 12. Data flow for the stop-watch function

7.4 Alarms

There are two independent alarms. Each is separately configured and may be used to generate an interrupt. In RTC mode, an alarm is configured for time and date. In stop-watch mode when the RTC is functioning as an elapsed time counter, an alarm is configured for time only.

7.4.1 Alarms in RTC mode

In RTC mode, Alarm 1 can be configured from seconds to months. Alarm 2 operates on minutes, hours and weekday. Each segment of the time is independently enabled. Alarms can be output on the INTA and INTB pins.

7.4.1.1 Alarm1 and alarm2 registers in RTC mode

Setting the time for alarm1: Only the information which is relevant for the alarm condition must be programmed. The unused parts are ignored.

Table 12. Alarm1 and alarm2 registers in RTC mode coded in BCD (RTCM = 0)

Bit positions labeled as - are not implemented.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RTC alarm1 registers									
08h	Second_alarm1	-	0 to 5			0 to 9			
09h	Minute_alarm1	-	0 to 5			0 to 9			
0Ah	Hour_alarm1	-	-	AMPM	0 to 1	0 to 9			
				0 to 2					

Table 12. Alarm1 and alarm2 registers in RTC mode coded in BCD (RTCM = 0)...continued
Bit positions labeled as - are not implemented.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0Bh	Day_alarm1	-	-	0 to 3		0 to 9			
0Ch	Month_alarm1	-	-	-	0 to 1	0 to 9			
RTC alarm2 registers									
0Dh	Minute_alarm2	-	0 to 5			0 to 9			
0Eh	Hour_alarm2	-	-	AMPM	0 to 1	0 to 9			
				0 to 2		0 to 9			
0Fh	Weekday_alarm2	-	-	-	-	-	0 to 6		

7.4.1.2 Alarm1 and alarm2 control in RTC mode

Table 13. Alarm_enables- alarm enable control register (address 10h) bit description

Bit	Symbol	Value	Description
RTC alarm2			
7	WDAY_A2E		weekday alarm2 enable
		0 ^[1]	disabled
		1	enabled
6	HR_A2E		hour alarm2 enable
		0 ^[1]	disabled
		1	enabled
5	MIN_A2E		minute alarm2 enable
		0 ^[1]	disabled
		1	enabled
RTC alarm1			
4	MON_A1E		month alarm1 enable
		0 ^[1]	disabled
		1	enabled
3	DAY_A1E		day alarm1 enable
		0 ^[1]	disabled
		1	enabled
2	HR_A1E		hour alarm1 enable
		0 ^[1]	disabled
		1	enabled
1	MIN_A1E		minute alarm1 enable
		0 ^[1]	disabled
		1	enabled

Table 13. Alarm_enables- alarm enable control register (address 10h) bit description...continued

Bit	Symbol	Value	Description
0	SEC_A1E		second alarm1 enable
		0 ^[1]	disabled
		1	enabled

[1] Default value.

7.4.1.3 Alarm1 and alarm2 function in RTC mode

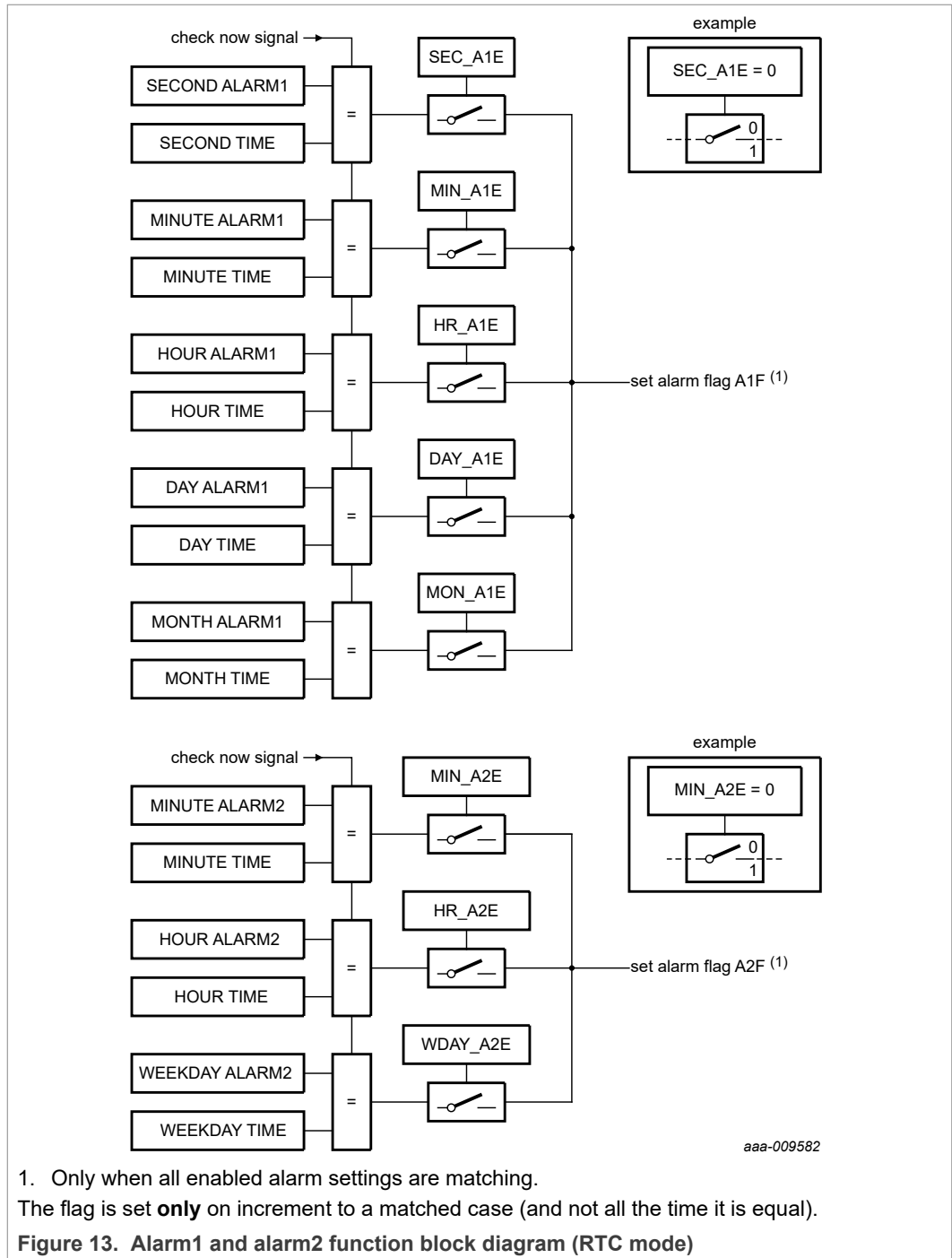
The registers at addresses 08h through 0Ch contain alarm1 information. When one or more of these registers is loaded with second, minute, hour, day, or month, and its corresponding alarm enable bit (SEC_A1E to MON_A1E) is set logic 1, then that information is compared with the current second, minute, hour, day, and month.

The registers at addresses 0Dh through 0Fh contain alarm2 information. When one or more of these registers is loaded with minute, hour or weekday, and its corresponding alarm enable bit (MIN_A2E to WDAY_A2E) is set logic 1, then that information is compared with the current minute, hour and weekday.

Alarm registers which have their alarm enable bit at logic 0 are ignored.

When the time increments to match the enabled alarms, the alarm flag in the Flags register ([Section 7.14](#)) is set. A1F for alarm1 and A2F for alarm2. The alarm flag is cleared by command.

When the time increments to match the enabled alarms, an interrupt can be generated. See [Section 7.4.3](#).



7.4.2 Alarms in stop-watch mode

In stop-watch mode, Alarm 1 can be configured from seconds to 999 999 hours. Alarm 2 operates on minutes up to 9 999 hours.

7.4.2.1 Alarm1 and alarm2 registers in stop-watch mode

Setting the time for alarm1 and alarm2: Only the information which is relevant for the alarm condition must to be programmed. The unused parts are ignored.

Table 14. Alarm1 and alarm2 registers in stop-watch mode coded in BCD (RTCM = 1)

Bit positions labeled as - are not implemented.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Stop-watch alarm1 registers									
08h	Second_alm1	-	0 to 5			0 to 9			
09h	Minute_alm1	-	0 to 5			0 to 9			
09h	Hr_xx_xx_00_alm1	0 to 9				0 to 9			
0Bh	Hr_xx_00_xx_alm1	0 to 9				0 to 9			
0Ch	Hr_00_xx_xx_alm1	0 to 9				0 to 9			
Stop-watch alarm2 registers									
0Dh	Minute_alm2	-	0 to 5			0 to 9			
0Eh	Hr_xx_00_alm2	0 to 9				0 to 9			
0Fh	Hr_00_xx_alm2	0 to 9				0 to 9			

7.4.2.2 Alarm1 and alarm2 control in stop-watch mode

Table 15. Alarm_enables- alarm enable control register (address 10h) bit description

Bit	Symbol	Value	Description
Stop-watch alarm2			
7	HR_00_XX_A2E		thousands of hours alarm2 enable
		0 ^[1]	disabled
		1	enabled
6	HR_XX_00_A2E		tens of hours alarm2 enable
		0 ^[1]	disabled
		1	enabled
5	MIN_A2E		minute alarm2 enable
		0 ^[1]	disabled
		1	enabled
Stop-watch alarm1			
4	HR_00_XX_XX_A1E		100 thousands of hours alarm1 enable
		0 ^[1]	disabled
		1	enabled
3	HR_XX_00_XX_A1E		thousands of hours alarm1 enable
		0 ^[1]	disabled
		1	enabled
2	HR_XX_XX_00_A1E		tens of hour alarm1 enable
		0 ^[1]	disabled

Table 15. Alarm_enables- alarm enable control register (address 10h) bit description...continued

Bit	Symbol	Value	Description
		1	enabled
1	MIN_A1E		minute alarm1 enable
		0 ^[1]	disabled
		1	enabled
0	SEC_A1E		second alarm1 enable
		0 ^[1]	disabled
		1	enabled

[1] Default value.

7.4.2.3 Alarm1 and alarm2 function in stop-watch mode

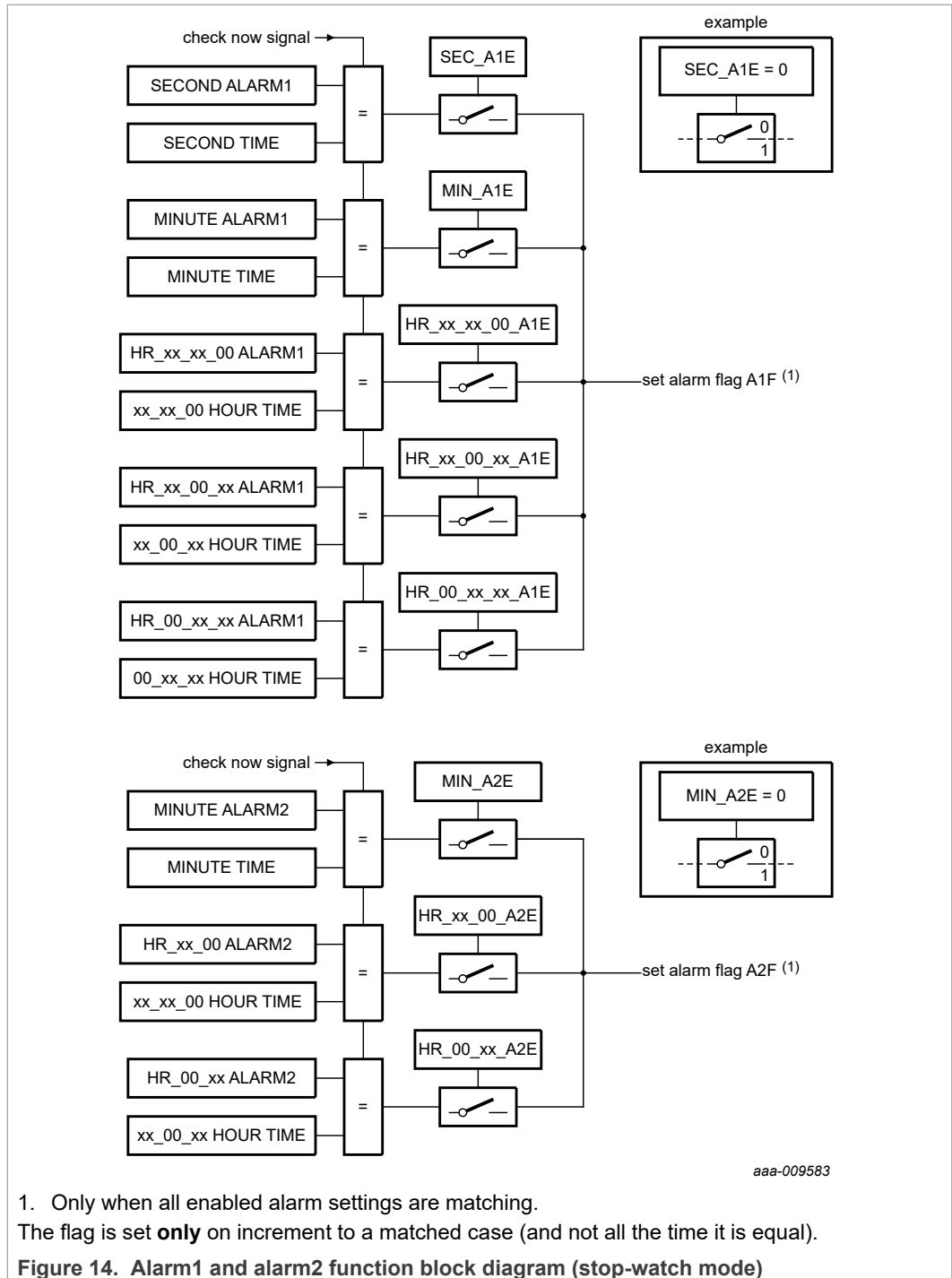
The registers at addresses 08h through 0Ch contain alarm1 information. When one or more of these registers is loaded with second, minute, and hours, and its corresponding alarm enable bit (SEC_A1E to HR_00_XX_XX_A1E) is set logic 1, then that information is compared with the current second, minute, and hours.

The registers at addresses 0Dh through 0Fh contain alarm2 information. When one or more of these registers is loaded with minute and hours, and its corresponding alarm enable bit (MIN_A2E to HR_00_XX_A2E) is set logic 1, then that information is compared with the current minute and hours.

Alarm registers which have their alarm enable bit at logic 0 are ignored.

When the time increments to match the enabled alarms, the alarm flag in the Flags register ([Section 7.14](#)) is set. A1F for alarm1 and A2F for alarm2. The alarm flag is cleared by command.

When the time increments to match the enabled alarms, an interrupt can be generated. See [Section 7.4.3](#).



7.4.3 Alarm interrupts

The generation of interrupts from the alarm functions is controlled via the alarm interrupt enable bits; A1IEA, A1IEB, A2IEA, A2IEB. These bits are in registers INTA_enable (address 29h) and INTB_enable (address 2Ah).

The assertion of flags A1F or A2F can be used to generate an interrupt at the pins INTA and INTB. The interrupt may be generated as a pulse signal every time the time

increments to match the alarm setting or as a permanently active signal which follows the condition of bit A1F and/or A2F. See [Section 7.9](#) for interrupt control.

A1F and A2F remain set until cleared by command. Once an alarm flag has been cleared, it will only be set again when the time increments to match the alarm condition once more.

When an interrupt pin is configured to pulse mode and if an alarm flag is not cleared and the time increments to match the alarm condition again, then a repeated interrupt pulse will be generated.

7.5 WatchDog

Table 16. WatchDog - WatchDog control and register (address 2Dh) bit description

Bit	Symbol	Value	Description
7	WDM		WatchDog mode
		0 ^[1]	single shot
		1	repeat mode
6 to 2	WDR[4:0]		WatchDog register bits
		0h ^[1] to 1Fh	Write: WatchDog counter load value
		0h to 1Fh	Read: current counter value
1 to 0	WDS[1:0]		WatchDog step size (source clock)
		00 ^[1]	4 seconds (0.25 Hz)
		01	1 second (1 Hz)
		10	$\frac{1}{4}$ second (4 Hz)
		11	$\frac{1}{16}$ second (16 Hz)

[1] Default value.

7.5.1 WatchDog functions

The WatchDog has four selectable step sizes allowing for periods in the range from 62.5 ms to 124 seconds. For periods greater than 2 minutes, the alarm function can be used.

$$WatchDog\text{-duration} = WDR \times stepsize \tag{1}$$

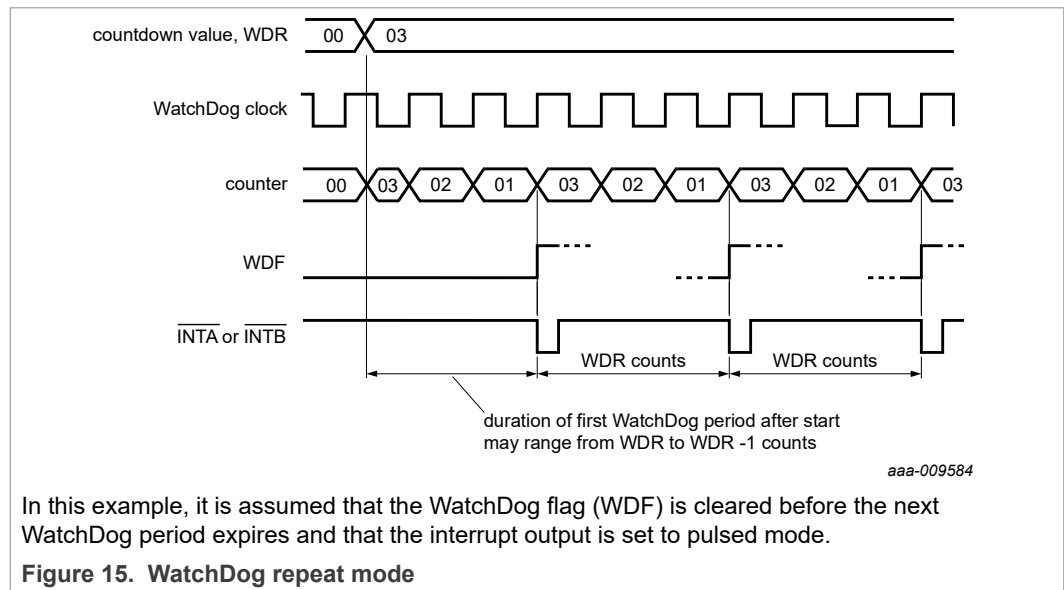
Table 17. WatchDog durations

WDS[1:0]	WatchDog step size ^[1]	Delay	
		Minimum WatchDog duration WDR = 1	Maximum WatchDog duration WDR = 31
00	4 s	4 s	124 s
01	1 s	1 s	31 s
10	$\frac{1}{4}$ s	0.25 s	7.75 s
11	$\frac{1}{16}$ s	0.0625 s	1.9375 s

[1] Time periods can be affected by correction pulses.

Remark: Note that all timings are generated from the 32.768 kHz oscillator and are based on the assumption that there is 0 ppm deviation. Deviation in oscillator frequency results in deviation in timings. This is not applicable to interface timing.

The WatchDog counts down from a software-loaded 5-bit binary value, WDR[4:0], in register WatchDog. Loading the counter with 0 stops the WatchDog. Loading the counter with a non-0 value starts the counter. Values from 1 to 31 are allowed.



If a new value of WDR[4:0] is written before the end of the current WatchDog period, then this value takes immediate effect.

When starting the timer for the first time or when reloading WDR[4:0] before the end of the current period, the first period has an uncertainty of maximum one count. The uncertainty is a result of loading the WDR[4:0] from the interface clock which is asynchronous from the WatchDog source clock. Subsequent WatchDog periods do not have such variation.

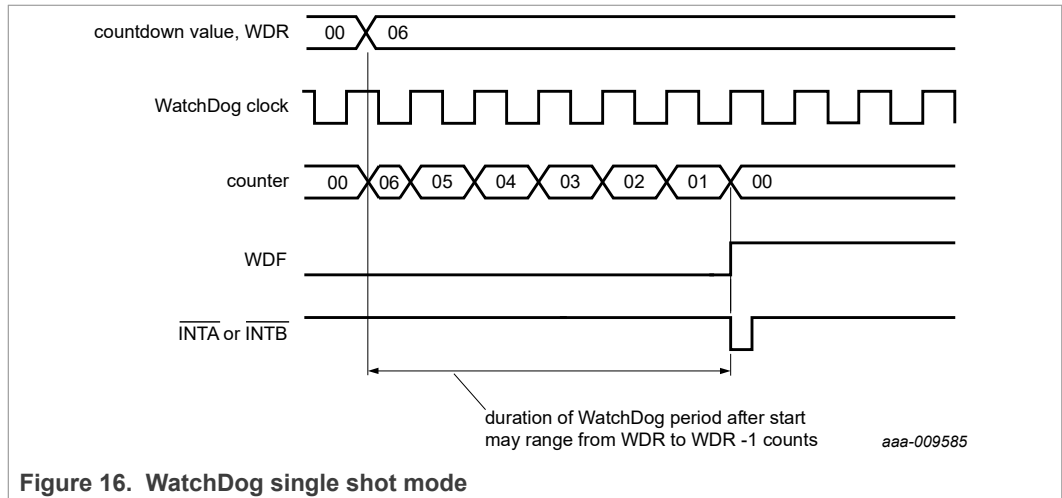
Reading the WatchDog register returns the current value of the WatchDog counter (see Figure 15) and **not** the initial value WDR[4:0]. Since it is not possible to freeze the WatchDog counter during read back, it is recommended to read the register twice and check for consistent results.

7.5.1.1 WatchDog repeat mode

In repeat mode, at the end of every WatchDog period, the WatchDog flag (bit WDF in the Flags register, Section 7.14) is set and the counter automatically reloads and starts the next WatchDog period. An example is given in Figure 15. The asserted bit WDF can be used to generate an interrupt. Bit WDF can only be cleared by command.

7.5.1.2 WatchDog single shot mode

In single shot mode, at the end of the countdown period, the WatchDog flag (bit WDF in the Flags register, Section 7.14) is set and the counter stops with the value 0. The WatchDog register must be reloaded to start another WatchDog period.



7.5.1.3 WatchDog interrupts

The generation of interrupts from the WatchDog functions is controlled via the WatchDog interrupt enable bits; WDIEA and WDIEB. These bits are in registers INTA_enable (address 29h) and INTB_enable (address 2Ah).

The assertion of the flag WDF can be used to generate an interrupt at pins $\overline{\text{INTA}}$ and $\overline{\text{INTB}}$. The interrupt may be generated as a pulsed signal every time the WatchDog counter reaches the end of the countdown period. Alternatively as a permanently active signal which follows the condition of bit WDF. WDF remains set until cleared by command.

When enabled, interrupts are triggered every time the WatchDog counter reaches the end of the countdown period and even if the WDF is not cleared, an interrupt pulse can be generated.

See [Section 7.9](#) for interrupt control.

7.6 RAM byte

Table 18. RAM_byte - 8-bit RAM register (address 2Ch) bit description

Bit	Symbol	Value	Description
7 to 0	B[7:0]	0000 0000 ^[1] to 1111 1111	RAM content

[1] Default value.

The PCF85263A provides a free RAM byte, which can be used for any purpose, for example, status bits of the system.

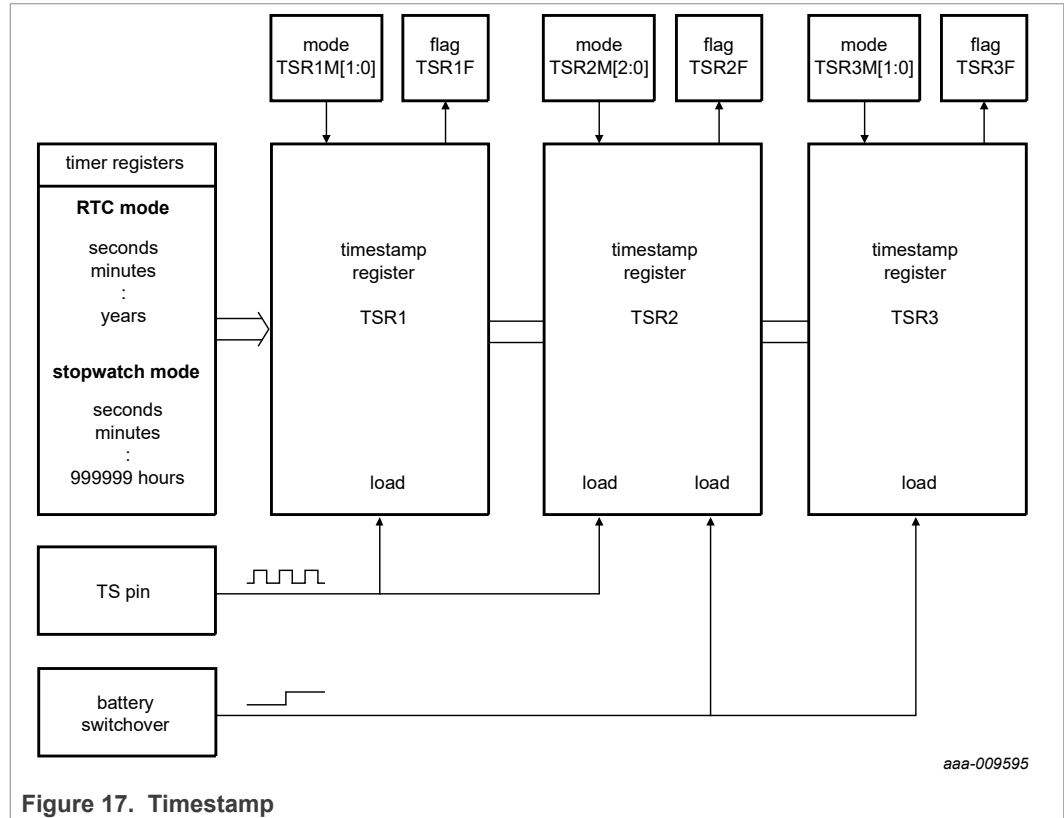
7.7 Timestamps

There are three timestamp registers which can be independently configured to record the time for battery switch-over events and/or transitions on the TS pin.

Each timestamp register has an associated flag. It is also possible to generate an interrupt signal for every timestamp register update.

Timestamps work in both RTC and stop-watch mode. During battery operation, the mechanical switch detector may also be used to trigger the timestamp.

The timestamp registers are read only and cannot be written. It is possible to set all three registers to 0 with the CTS instruction in the Resets register ([Section 7.15](#)).



The mode for each register is controlled by the TSR_mode register.

Table 19. TSR_mode - timestamp mode control register (address 23h) bit description

Bit	Symbol	Value	Description
Timestamp3 (TSR3)			
7 to 6	TSR3M[1:0]		timestamp register 3 mode
		00 ^[1]	no timestamp
		01	FB, record F irst time switch to B attery event
		10	LB, record L ast time switch to B attery event
	11	LV, record L ast time switch to V _{DD} event	
5	-	0	not used
Timestamp2 (TSR2)			
4 to 2	TSR2M[2:0]		timestamp register 2 mode
		000 ^[1]	no timestamp
		001	FB, record F irst time switch to B attery event
		010	LB, record L ast time switch to B attery event

Table 19. TSR_mode - timestamp mode control register (address 23h) bit description...continued

Bit	Symbol	Value	Description
		011	LV, record Last time switch to V _{DD} event
		100	FE, record First TS pin Event
		101	LE, record Last TS pin Event
		110 to 111	no timestamp
Timestamp1 (TSR1)			
1 to 0	TSR1M[1:0]		timestamp register 1 mode
		00 ^[1]	no timestamp
		01	FE, record First TS pin Event
		10	LE, record Last TS pin Event
		11	no timestamp

[1] Default value.

First event means that the time is only stored on the first event and not recorded for subsequent events. When the first event occurs, the associated timestamp flag is set. When the flag is cleared, then a new 'first' event is recorded. See [Figure 18](#) and [Figure 19](#).

Last event means that the time is stored on every event. When an event occurs, the associated timestamp flag is set. It is not necessary to clear the flag before a new event is recorded.

Interrupts can be generated in \overline{INTA} pin and/or \overline{INTB} pin. Interrupts are generated every time a timestamp register is updated. Interrupt generation is not conditional on the state of the timestamp flags. See [Section 7.7.1](#).

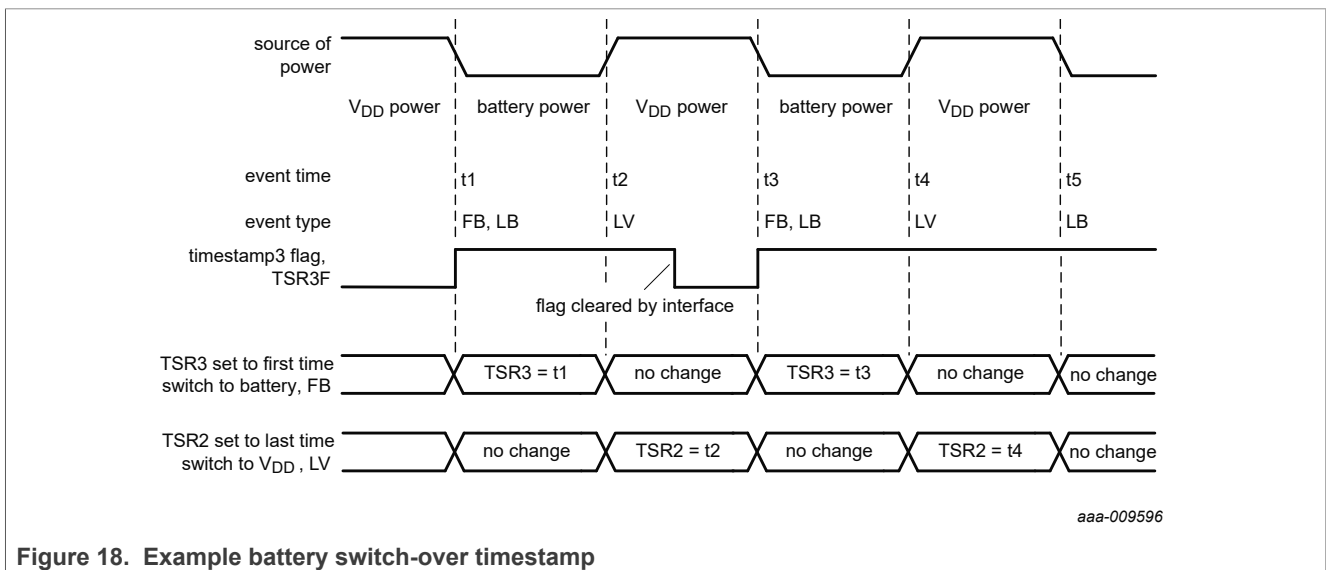
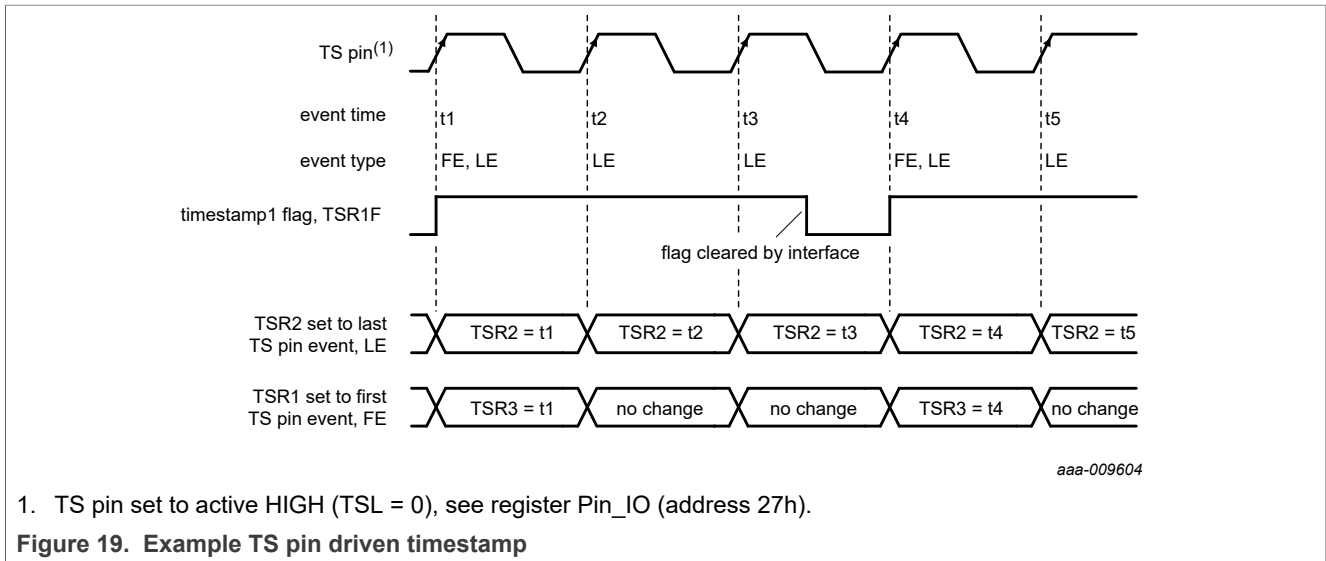


Figure 18. Example battery switch-over timestamp



The recorded time is stored in the associated timestamp register. The time format depends on the RTC mode. The timestamp registers follows the time format of the time registers.

Table 20. Timestamp registers in RTC mode (RTCM = 0)

Bit positions labeled as - are not implemented and return 0 when read.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
RTC timestamp1 (TSR1)									
11h	TSR1_seconds	-	0 to 5			0 to 9			
12h	TSR1_minutes	-	0 to 5			0 to 9			
13h	TSR1_hours	-	-	AMPM	0 to 1	0 to 9			
				0 to 2					
14h	TSR1_days	-	-	0 to 3		0 to 9			
15h	TSR1_months	-	-	-	0 to 1	0 to 9			
16h	TSR1_years	0 to 9				0 to 9			
RTC timestamp2 (TSR2)									
17h	TSR2_seconds	-	0 to 5			0 to 9			
18h	TSR2_minutes	-	0 to 5			0 to 9			
19h	TSR2_hours	-	-	AMPM	0 to 1	0 to 9			
				0 to 2					
1Ah	TSR2_days	-	-	0 to 3		0 to 9			
1Bh	TSR2_months	-	-	-	0 to 1	0 to 9			
1Ch	TSR2_years	0 to 9				0 to 9			
RTC timestamp3 (TSR3)									
1Dh	TSR3_seconds	-	0 to 5			0 to 9			

Table 20. Timestamp registers in RTC mode (RTCM = 0)...*continued*
 Bit positions labeled as - are not implemented and return 0 when read.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1Eh	TSR3_minutes	-	0 to 5			0 to 9			
1Fh	TSR3_hours	-	-	AMPM	0 to 1	0 to 9			
				0 to 2		0 to 9			
20h	TSR3_days	-	-	0 to 3		0 to 9			
21h	TSR3_months	-	-	-	0 to 1	0 to 9			
22h	TSR3_years	0 to 9				0 to 9			

Table 21. Timestamp registers in stop-watch mode (RTCM = 1)
 Bit positions labeled as - are not implemented and return 0 when read.

Address	Register name	Upper-digit (ten's place)				Digit (unit place)			
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Stop-watch timestamp1 (TSR1)									
11h	TSR1_seconds	-	0 to 5			0 to 9			
12h	TSR1_minutes	-	0 to 5			0 to 9			
13h	TSR1_hr_xx_xx_00	0 to 9				0 to 9			
14h	TSR1_hr_xx_00_xx	0 to 9				0 to 9			
15h	TSR1_hr_00_xx_xx	0 to 9				0 to 9			
16h	not used	-	-	-	-	-	-	-	-
Stop-watch timestamp2 (TSR2)									
17h	TSR2_seconds	-	0 to 5			0 to 9			
18h	TSR2_minutes	-	0 to 5			0 to 9			
19h	TSR2_hr_xx_xx_00	0 to 9				0 to 9			
1Ah	TSR2_hr_xx_00_xx	0 to 9				0 to 9			
1Bh	TSR2_hr_00_xx_xx	0 to 9				0 to 9			
1Ch	not used	-	-	-	-	-	-	-	-
Stop-watch timestamp3 (TSR3)									
1Dh	TSR3_seconds	-	0 to 5			0 to 9			
1Eh	TSR3_minutes	-	0 to 5			0 to 9			
1Fh	TSR3_hr_xx_xx_00	0 to 9				0 to 9			
20h	TSR3_hr_xx_00_xx	0 to 9				0 to 9			
21h	TSR3_hr_00_xx_xx	0 to 9				0 to 9			
22h	not used	-	-	-	-	-	-	-	-

7.7.1 Timestamps interrupts

The generation of interrupts from the timestamp functions is controlled via the timestamp interrupt enable bits; TSRIEA and TSRIEB. These bits are in registers INTA_enable (address 29h) and INTB_enable (address 2Ah).

The loading of new information into one of the timestamp registers can be used to generate an interrupt at pins $\overline{\text{INTA}}$ and $\overline{\text{INTB}}$. The interrupt may be generated as a pulsed signal every time a timestamp register updates or as a permanently active signal which follows the condition of timestamp flags, TSR1F to TSR3F. The timestamp flags remain set until cleared by command.

When enabled, interrupts are triggered every time a timestamp register updates and even if the associated flag is not cleared, an interrupt pulse can be generated.

See [Section 7.9](#) for interrupt control.

7.8 Offset register

The PCF85263A incorporates an offset register (address 24h) which can be used to implement several functions, such as:

- Accuracy tuning
- Aging adjustment
- Temperature compensation

Table 22. Offset - offset register (address 24h) bit description

Bit	Symbol	Value	Description
7 to 0	OFFSET[7:0]	see Table 24	offset value

There are two modes which define the correction period, normal mode and fast mode. The **normal mode** is suitable for offset trimming. The **fast mode** is suitable for dynamic offset correction e.g. implementing a temperature correction. The fast mode consumes more current. Offset mode is defined by bit OFFM in the Oscillator register ([Section 7.10](#)).

Table 23. OFFM bit - oscillator control register (address 25h)

See [Section 7.10](#)

Bit	Symbol	Value	Description
6	OFFM		offset mode bit
		0 ^[1]	normal mode: correction is made every 4 hours; 2.170 ppm/step
		1	fast mode: correction is made once every 8 minutes; 2.0345 ppm/step

[1] Default value.

For OFFM = 0, each LSB introduces an offset of 2.170 ppm. For OFFM = 1, each LSB introduces an offset of 2.0345 ppm. The offset value is coded in two's complement giving a range of +127 LSB to -128 LSB, see [Table 24](#).

Table 24. Offset values

OFFSET[7:0]	Offset value in decimal	Offset value in ppm	
		Normal mode OFFM = 0	Fast mode OFFM = 1
011 1 1111	+127	+275.590	+258.3815
011 1 1110	+126	+273.420	+256.3470
:	:	:	:
0000 0010	+2	+4.340	+4.0690
0000 0001	+1	+2.170	+2.0345
0000 0000 ^[1]	0	0 ^[1]	0 ^[1]
1111 1111	-1	-2.170	-2.0345
1111 1110	-2	-4.340	-4.0690
:	:	:	:
1000 0001	-127	-275.590	-258.3815
1000 0000	-128	-277.760	-260.416

[1] Default value.

The correction is made by adding or subtracting clock correction pulses, thereby changing the period of a single second but not by changing the oscillator frequency.

It is possible to monitor when correction pulses are applied. See [Section 7.8.4](#).

7.8.1 Correction when OFFM = 0

The correction is triggered once every four hours and then correction pulses are applied once per minute until the programmed correction values have been implemented.

Table 25. Correction pulses for OFFM = 0

Correction value	Every n th hour	Actual minute
+1 or -1	4	00
+2 or -2	4	00 and 01
+3 or -3	4	00, 01, and 02
:	:	:
+59 or -59	4	00 to 58
+60 or -60	4	00 to 59
+61 or -61	4	00 to 59
	4 + 1	00
+62 or -62	4	00 to 59
	4 + 1	00 and 01
:	:	:
+123 or -123	4	00 to 59
	4 + 1	00 to 59

Table 25. Correction pulses for OFFM = 0...continued

Correction value	Every n th hour	Actual minute
	4 + 2	00, 01, and 02
-128	4	00 to 59
	4 + 1	00 to 59
	4 + 2	00 to 07

7.8.2 Correction when OFFM = 1

The correction is triggered once every eight minutes and then correction pulses are applied once per second until the programmed correction values have been implemented.

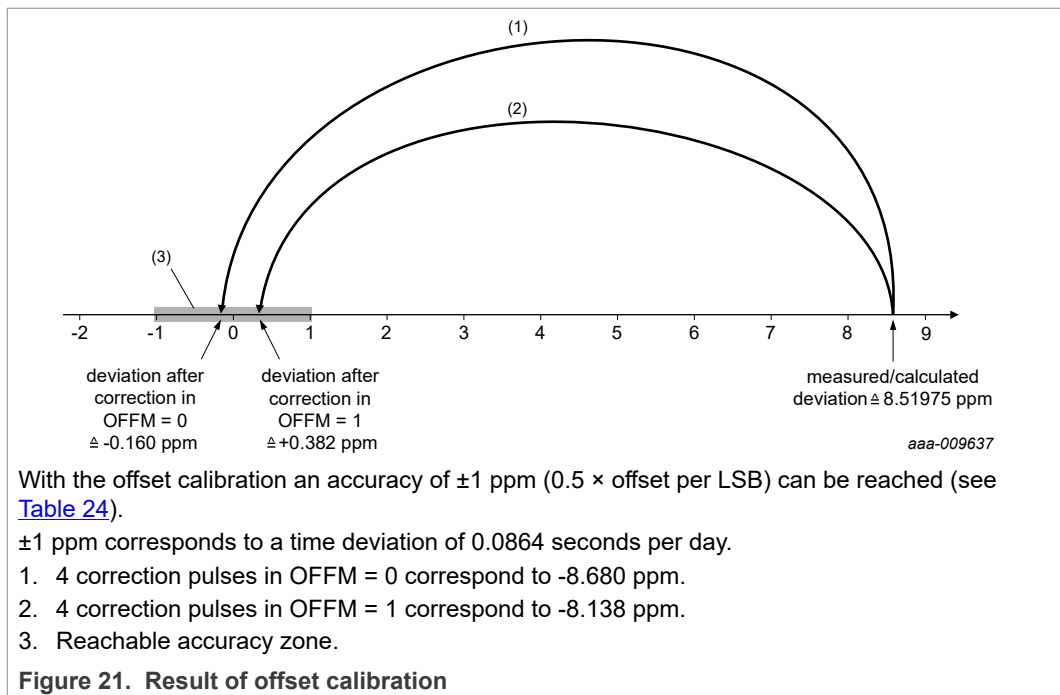
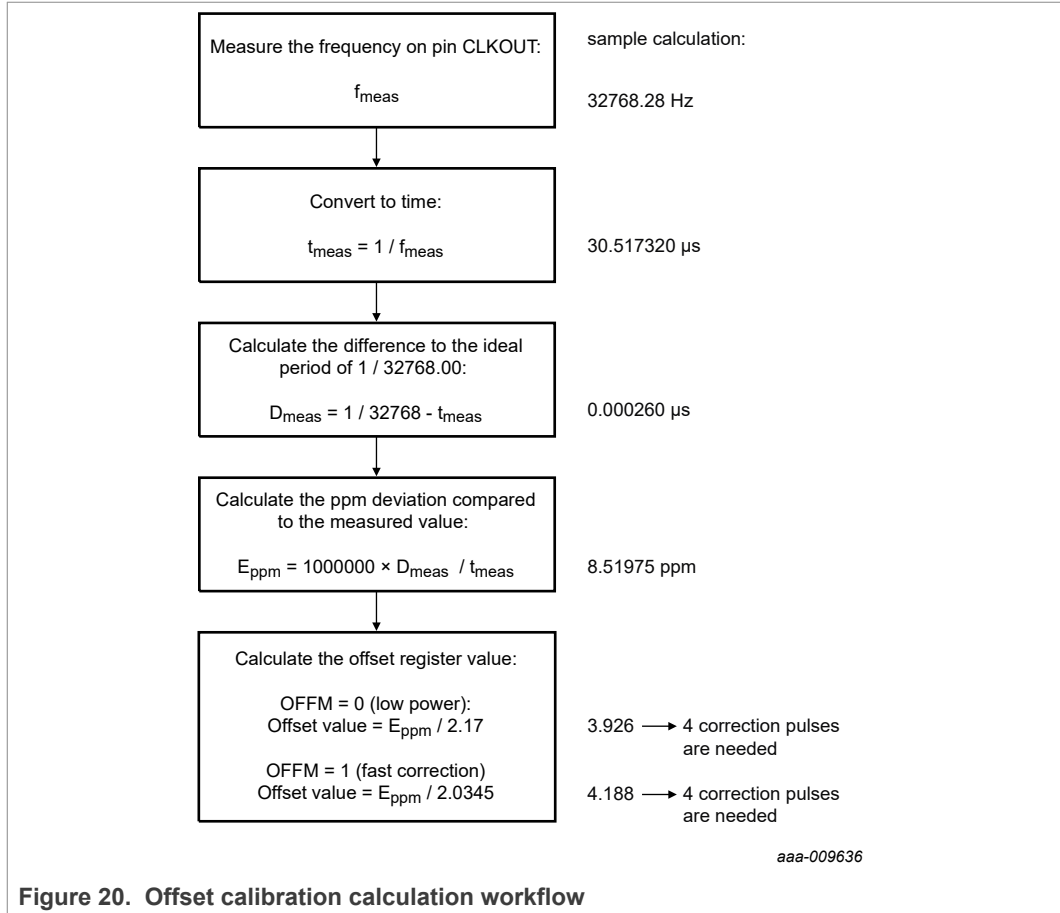
Clock correction is made more frequently in OFFM = 1; however, this can result in higher power consumption.

Table 26. Correction pulses for OFFM = 1

Correction value	Every n th minute	Actual second
+1 or -1	8	00
+2 or -2	8	00 and 01
+3 or -3	8	00, 01, and 02
:	:	:
+59 or -59	8	00 to 58
+60 or -60	8	00 to 59
+61 or -61	8	00 to 59
	8 + 1	00
+62 or -62	8	00 to 59
	8 + 1	00 and 01
:	:	:
+123 or -123	8	00 to 59
	8 + 1	00 to 59
	8 + 2	00, 01, and 02
-128	8	00 to 59
	8 + 1	00 to 59
	8 + 2	00 to 07

7.8.3 Offset calibration workflow

The calibration offset has to be calculated based on the time. [Figure 20](#) shows the workflow how the offset register values can be calculated:



7.8.4 Offset interrupts

The generation of interrupts from the offset functions is controlled via the offset interrupt enable bits; OIEA and OIEB. These bits are in registers INTA_enable (address 29h) and INTB_enable (address 2Ah).

Every time a correction pulse is made an interrupt pulse can be generated at pins $\overline{\text{INTA}}$ and $\overline{\text{INTB}}$. As there is no offset calibration flag, it is only possible to generate pulse interrupts.

See [Section 7.9](#) for interrupt control.

7.9 Interrupts

There are two interrupt output pins, $\overline{\text{INTA}}$ and $\overline{\text{INTB}}$. Both pins have the same possible sources and a dedicated register to control what is output. The pins can be used independently from each other.

$\overline{\text{INTA}}$ data is output on the $\overline{\text{INTA}}$ pin. $\overline{\text{INTA}}$ is an interrupt output pin with open-drain drive. $\overline{\text{INTA}}$ pin mode is controlled by INTAPM[1:0] bits in the Pin_IO register ([Section 7.12](#)).

$\overline{\text{INTB}}$ data is output on TS pin with push-pull drive. The TS pin must first be configured as $\overline{\text{INTB}}$ output by setting TSIO[1:0] bits in the Pin_IO register ([Section 7.12](#)).

Interrupts will only be output when the pin mode is correctly defined. Interrupts are output from the IC as active LOW signals.

The registers INTA_enable (address 29h) and INTB_enable (address 2Ah) are used to select which interrupts should be output on which pin.

Table 27. $\overline{\text{INTA}}$ and $\overline{\text{INTB}}$ interrupt control bits

Bit	7	6	5	4	3	2	1	0
INTA_enable - $\overline{\text{INTA}}$ pin enable control (address 29h)								
Symbol	ILPA	PIEA	OIEA	A1IEA	A2IEA	TSRIEA	BSIEA	WDIEA
INTB_enable - $\overline{\text{INTB}}$ pin enable control (address 2Ah)								
Symbol	ILPB	PIEB	OIEB	A1IEB	A2IEB	TSRIEB	BSIEB	WDIEB

Table 28. Definition of interrupt control bits

Bit	Symbol		Value	Description
	$\overline{\text{INTA}}$	$\overline{\text{INTB}}$		
7	ILPA	ILPB		level or pulse mode
			0 ^[1]	interrupt generates a pulse
			1	interrupt follows flags (permanent signal)
6	PIEA	PIEB		periodic interrupt enable
			0 ^[1]	no periodic interrupt generated
			1	periodic interrupt generated
5	OIEA	OIEB		offset correction interrupt enable
			0 ^[1]	no correction interrupt generated
			1	interrupt generated from correction

Table 28. Definition of interrupt control bits...continued

Bit	Symbol		Value	Description
	INTA	INTB		
4	A1IEA	A1IEB		alarm1 interrupt enable
			0 ^[1]	no alarm interrupt generated
			1	alarm interrupt generated
3	A2IEA	A2IEB		alarm2 interrupt enable
			0 ^[1]	no alarm interrupt generated
			1	alarm interrupt generated
2	TSRIEA	TSRIEB		timestamp register interrupt enable
			0 ^[1]	no timestamp register interrupt generated
			1	timestamp register interrupt generated
1	BSIEA	BSIEB		battery switch interrupt enable
			0 ^[1]	no battery switch interrupt generated
			1	battery switch interrupt generated
0	WDIEA	WDIEB		WatchDog interrupt enable
			0 ^[1]	no WatchDog interrupt generated
			1	WatchDog interrupt generated

[1] Default value.

7.9.1 ILPA/ILPB: interrupt level or pulse mode

Interrupts can be configured to generate a pulse or to send a continuous level (permanent signal) which follows the state of the flag.

In pulse mode, an interrupt pulse is generated every time that the selected source triggers.

Triggered means

- for periodic interrupts, every time a period has elapsed
- for offset correction, every time a correction pulse is initiated
- for alarms, every time the time increments to match the alarm time
- for timestamps, every time a register updates
- for battery switch, every time the IC switches to or from battery
- for WatchDog, every time the counter reaches the end of its count

The interrupt signal goes active coincident with the triggering event. The signal is cleared by an internal 128 Hz clock. The internal clock is asynchronous to the triggering event and so the pulse duration has a minimum period of one 128 Hz cycle and a maximum of two 128 Hz cycles. Interrupt pulses may be shortened by clearing the flag before the end of the pulse period.

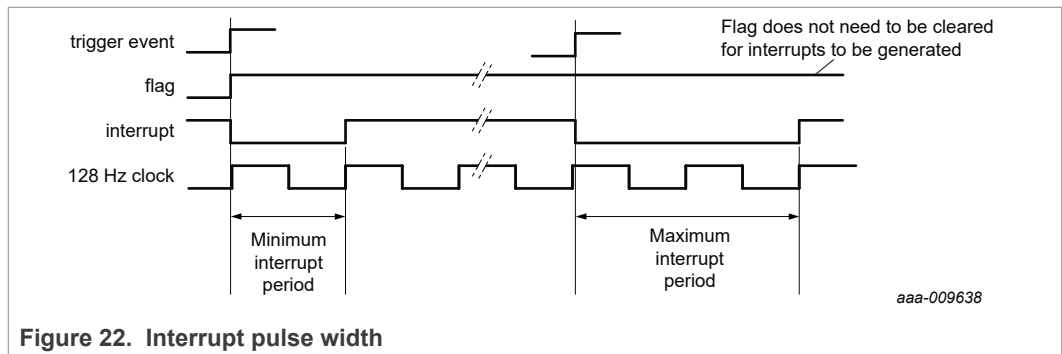


Figure 22. Interrupt pulse width

In level mode, the interrupt signal follows the state of the flag. Only interrupts which are enabled will affect the pin state. All enabled flags must be cleared for the interrupt signal to be cleared.

The EMON is used only for monitoring **all** flags and can be read back in the minutes register. See [Section 7.2.3](#).

7.9.2 Interrupt enable bits

The remainder of the bits in register INTA_enable (address 29h) and register INTB_enable (address 2Ah) are used to select which interrupt data goes where. See [Figure 23](#)

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

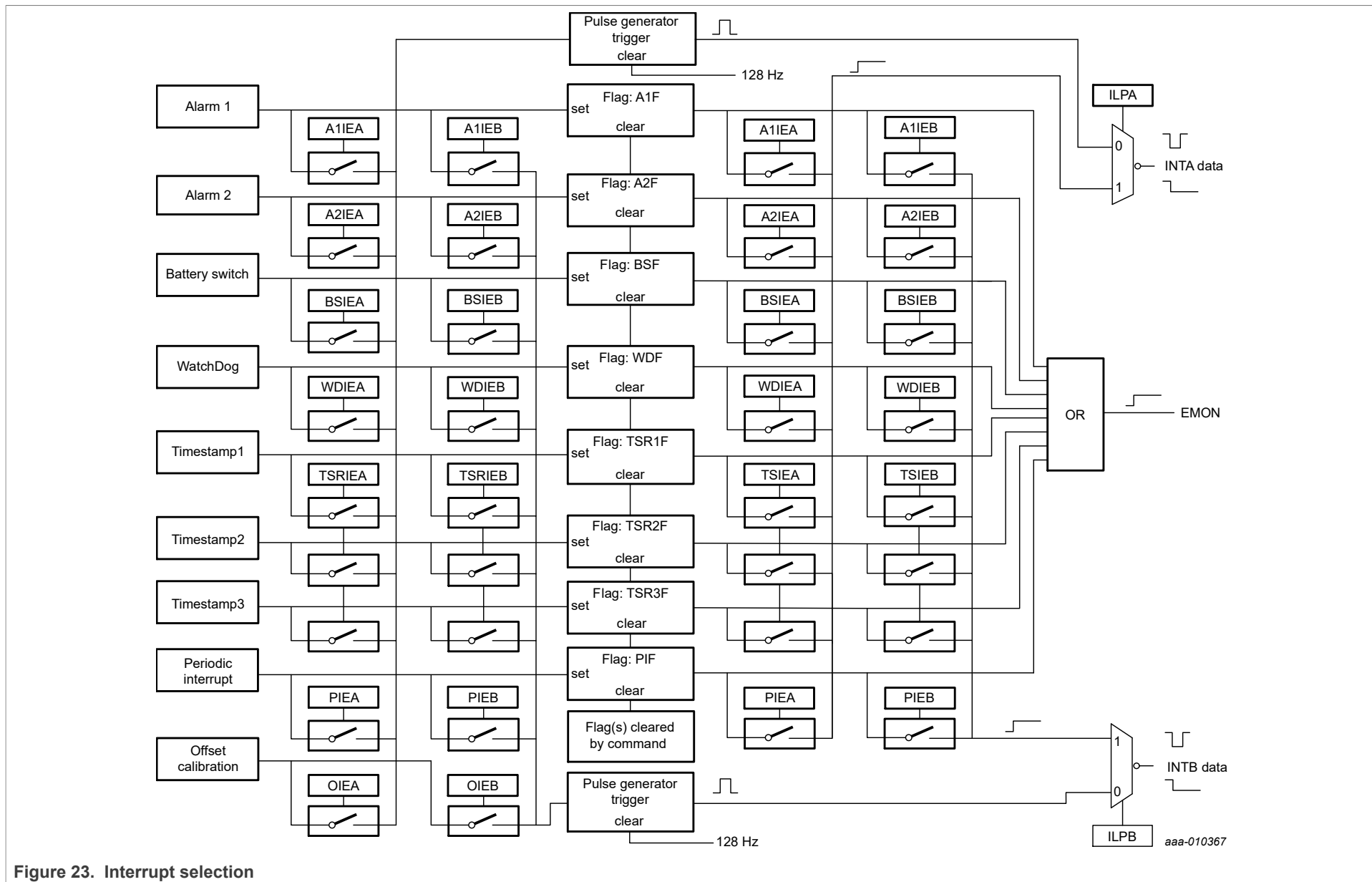


Figure 23. Interrupt selection

7.10 Oscillator register

Table 29. Oscillator - oscillator control register (address 25h) bit description

Bit	7	6	5	4	3	2	1	0
Symbol	CLKIV	OFFM	12_24	LOWJ	OSCD[1:0]		CL[1:0]	
Section	Section 7.16	Section 7.8	Section 7.10.3	Section 7.10.4	Section 7.10.5		Section 7.10.6	

7.10.1 CLKIV: invert the clock output

Table 30. CLKIV bit - oscillator control register (address 25h)

Bit	Symbol	Value	Description
7	CLKIV		output clock inversion
		0 ^[1]	non-inverting; LOWJ mode will affect rising edge
		1	inverted; LOWJ mode will affect falling edge

[1] Default value.

The clock selected with the COF[2:0] bits (register Function, address 28h) can be inverted. This is intended for use in conjunction with the low jitter mode, LOWJ. The low jitter mode reduces the jitter for the rising edge of the output clock. If the reduced jitter needs to be on the falling edge, for example when using an open-drain clock output, then the CLKIV bit can be used to implement this.

7.10.2 OFFM: offset calibration mode

See [Section 7.8](#) for a full description of offset calibration.

7.10.3 12_24: 12 hour or 24 hour clock

Table 31. 12_24 bit - oscillator control register (address 25h)

Bit	Symbol	Value	Description
5	12_24		12 hour or 24 hour mode
		0 ^[1]	24 hour mode is selected
		1	12 hour mode is selected

[1] Default value.

In RTC mode, time counting can be configured for 24 hour clock or 12 hour clock with the AMPM flag.

This bit is ignored in stop-watch mode.

7.10.4 LOWJ: low jitter mode

Table 32. LOWJ bit - oscillator control register (address 25h)

Bit	Symbol	Value	Description
4	LOWJ		low jitter CLK output bit

Table 32. LOWJ bit - oscillator control register (address 25h)...continued

Bit	Symbol	Value	Description
		0 ^[1]	normal
		1	reduced CLK output jitter; increase I _{DD}

[1] Default value.

Oscillator circuits suffer from jitter. In particular, ultra low-power oscillators like the one used in the PCF85263A are optimized for power and not jitter. By setting the LOWJ bit, the jitter performance can be improved at the cost of power consumption.

7.10.5 OSCD[1:0]: quartz oscillator drive control

Table 33. OSCD[1:0] bits - oscillator control register (address 25h)

Bit	Symbol	Value	Description
3 to 2	OSCD[1:0]		oscillator drive bits
		00 ^[1]	normal drive; R _{S(max)} : 100 kΩ
		01	low drive; R _{S(max)} : 60 kΩ; reduced I _{DD}
		10, 11	high drive; R _{S(max)} : 500 kΩ; increased I _{DD}

[1] Default value.

The oscillator is designed to be used with quartz with a series resistance up to 100 kΩ. This covers the typical range of 32.768 kHz quartz crystals. Series resistance is also referred to as: ESR, motional resistance, or R_S.

A low drive mode is available for low series resistance quartz. This reduces the current consumption.

For very high series resistance quartz, there is a high drive mode. Current consumption increases substantially in this mode.

7.10.6 CL[1:0]: quartz oscillator load capacitance

Table 34. CL[1:0] bits - oscillator control register (address 25h)

Bit	Symbol	Value	Description
1 to 0	CL[1:0]		internal oscillator capacitor selection for quartz crystals with the corresponding load capacitance of C _L :
		00 ^[1]	7.0 pF
		01	6.0 pF
		10	12.5 pF
		11	12.5 pF

[1] Default value.

C_L refers to the load capacitance of the oscillator circuit and allows for a certain amount of package and PCB parasitic capacitance. When the oscillator circuit matches the C_L parameter of the quartz, then the frequency offset is zero.

The PCF85263A is designed to operate with quartz with C_L values of 6.0 pF, 7.0 pF and 12.5 pF.

12.5 pF are generally the cheapest and most widely available, but also require the most power to drive. The circuit also operates with 9.0 pF quartz, however the offset calibration would be needed to compensate. If a 9.0 pF quartz is used, then it is recommended to set C_L to 7.0 pF.

7.11 Battery switch register

This register configures the battery switch-over mode.

Associated with the battery switch-over is the battery switch flag (BSF) in the Flags register (Section 7.14). Whenever the IC switches to battery operation, the flag is set. The flag can only be read when operating from V_{DD} power, however an interrupt pulse or static LOW signal can be generated whenever switching to battery. An interrupt pulse can also be generated when switching back to V_{DD} power. Examples are given in Figure 25 and Figure 26.

When switched to battery, the V_{DD} power domain is disabled. This means that I²C pins are ignored, CLK output is disabled and Hi-Z, TS pin output mode is disabled and Hi-Z, TS digital input is ignored and may be left floating. TS pin mechanical switch detector is active. INTA output is still active for interrupt output and battery switch indication, but disabled for clock output.

Table 35. IO pin behavior in battery mode

IO pin (mode)	V _{DD} operation	V _{BAT} operation
SCL	active input	disabled; may be left floating
SDA	active input/output	disabled; may be left floating
CLK	active output	disabled; Hi-Z
TS (output mode)	active output	disabled; Hi-Z
TS (digital input)	active input	disabled; may be left floating
TS (mechanical switch input)	active input	active input
INTA	active output	active interrupt output

Table 36. Battery_switch - battery switch control (address 26h) bit description

Bit	7	6	5	4	3	2	1	0
Symbol	-	-	-	BSOFF	BSRR	BSM[1:0]		BSTH
Section	-	-	-	Section 7.11.1	Section 7.11.2	Section 7.11.3	Section 7.11.4	

7.11.1 BSOFF: battery switch on/off control

Table 37. BSOFF bit - battery switch control (address 26h) bit description

Bit	Symbol	Value	Description
4	BSOFF		battery switch on/off
		0 ^[1]	enable battery switch feature
		1	disable battery switch feature

[1] Default value.

The battery switch circuit may be disabled when not used. This disables all the circuit and save power consumption. When disabled connect V_{BAT} and V_{DD} together.

7.11.2 BSRR: battery switch internal refresh rate

Table 38. BSRR bit - battery switch control (address 26h) bit description

Bit	Symbol	Value	Description
3	BSRR		battery switch refresh rate
		0 [1]	low
		1	high

[1] Default value.

Non-user bit. Recommended to leave set at default.

7.11.3 BSM[1:0]: battery switch mode

Table 39. BSM[1:0] bits - battery switch control (address 26h) bit description

Bit	Symbol	Value	Description
2 to 1	BSM[1:0]		battery switch mode bits
		00 [1]	switching at the V _{th} level
		01	switching at the V _{BAT} level
		10	switching at the higher level of V _{th} or V _{BAT}
		11	switching at the lower level of V _{th} or V _{BAT}

[1] Default value.

Switching is automatic and controlled by the voltages on the VBAT and VDD pins. There are three modes:

- Compare V_{DD} with an internal reference (V_{th})
- Compare V_{DD} with V_{BAT}
- Compare V_{DD} with an internal reference (V_{th}) and V_{BAT}

The last mode is useful when a rechargeable battery is employed.

Table 40. Battery switch-over modes

BSM[1:0]	Condition	Internal power
00	V _{DD} > V _{th}	V _{DD}
	V _{DD} < V _{th}	V _{BAT}
01	V _{DD} > V _{BAT}	V _{DD}
	V _{DD} < V _{BAT}	V _{BAT}
10	V _{DD} > the higher of V _{th} or V _{BAT}	V _{DD}
	V _{DD} < the higher of V _{th} or V _{BAT}	V _{BAT}
11	V _{DD} > the lower of V _{th} or V _{BAT}	V _{DD}
	V _{DD} < the lower of V _{th} or V _{BAT}	V _{BAT}

Due to the nature of the power switch circuit there is a switching hysteresis (see [Figure 24](#) and [Table 67](#)).

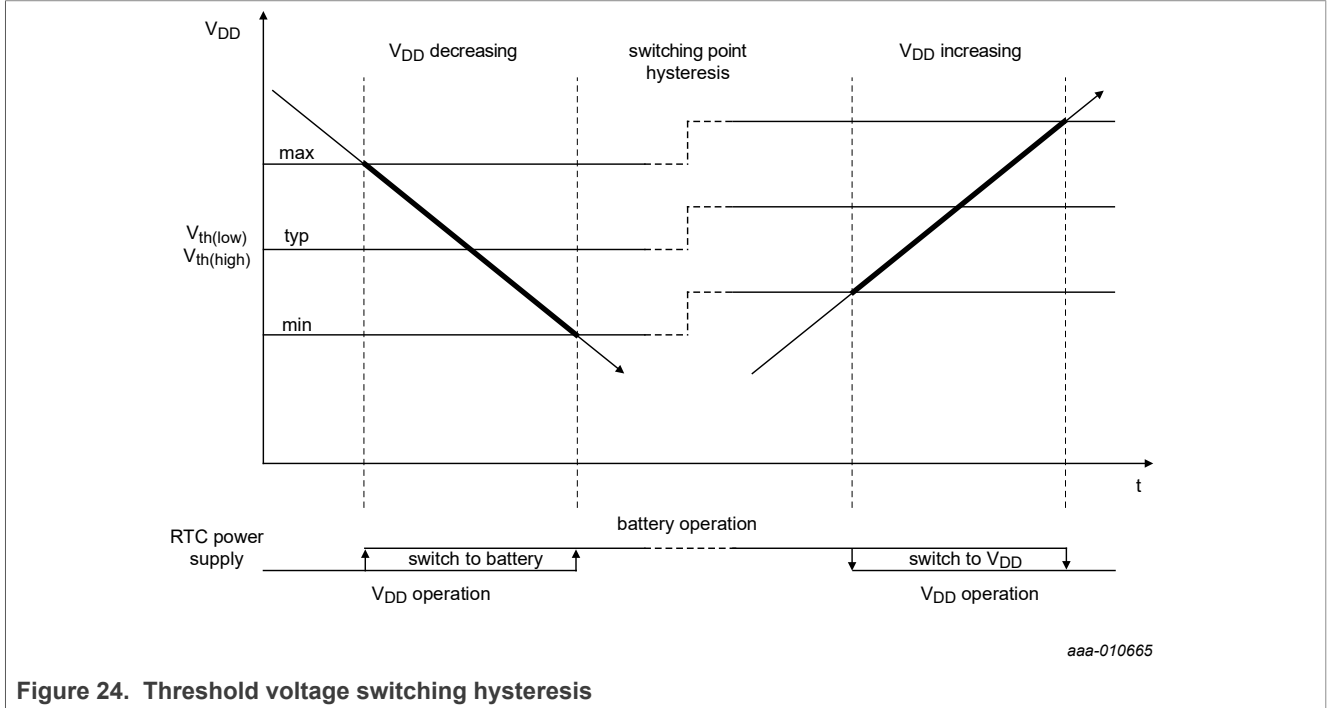


Figure 24. Threshold voltage switching hysteresis

7.11.3.1 Switching at the V_{th} level, $BSM[1:0] = 00$

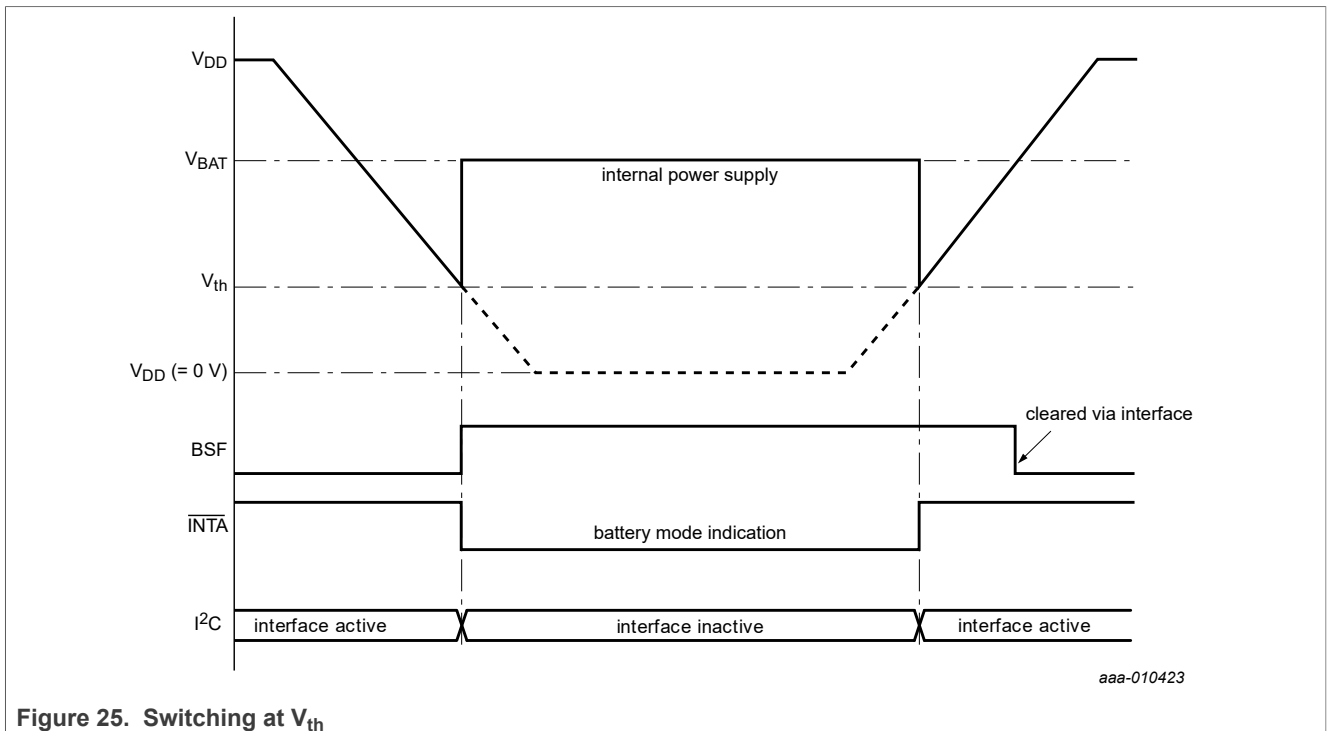


Figure 25. Switching at V_{th}

7.11.3.2 Switching at the V_{BAT} level, BSM[1:0] = 01

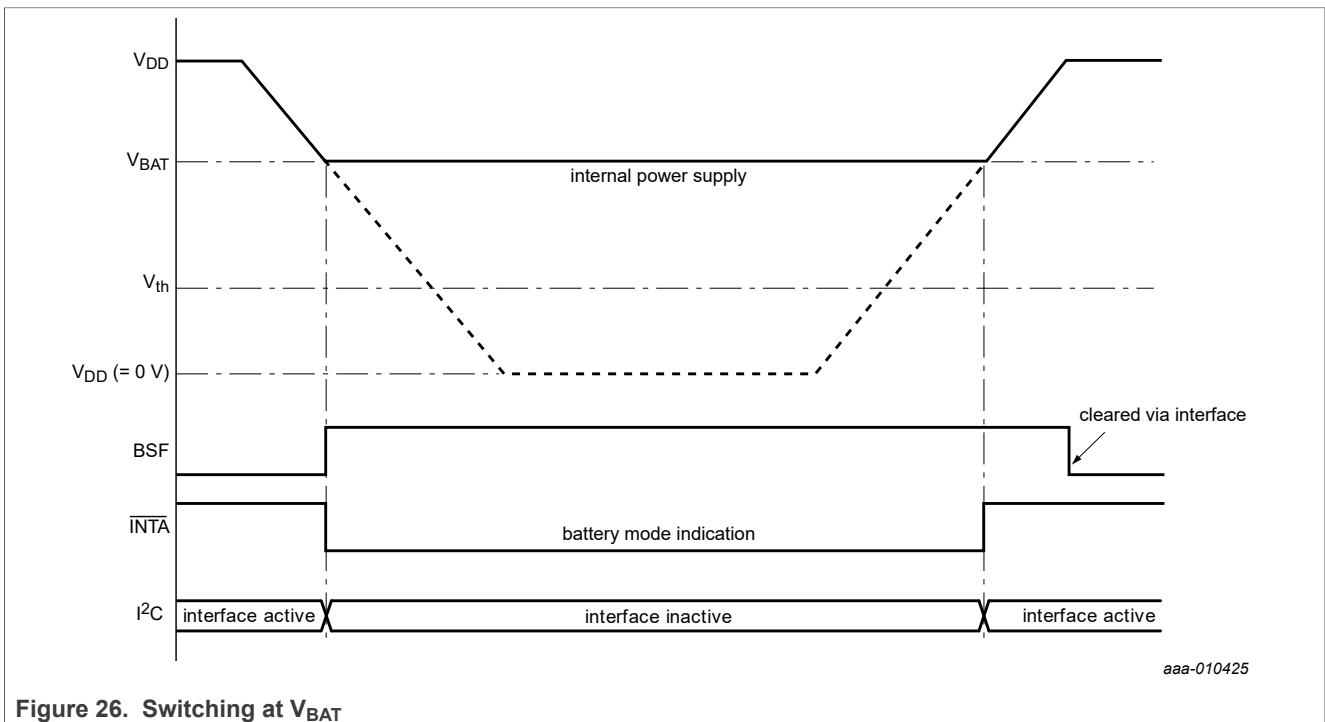


Figure 26. Switching at V_{BAT}

7.11.3.3 Switching at the higher of V_{BAT} or V_{th} level, BSM[1:0] = 10

With this mode switching takes place when V_{DD} falls below the higher of V_{th} or V_{BAT}. In [Figure 27](#), an example is given where the threshold is set to 1.5 V and a single cell battery is connected to V_{BAT}. In this example, switching to the battery voltage takes place when V_{DD} falls below V_{th}.

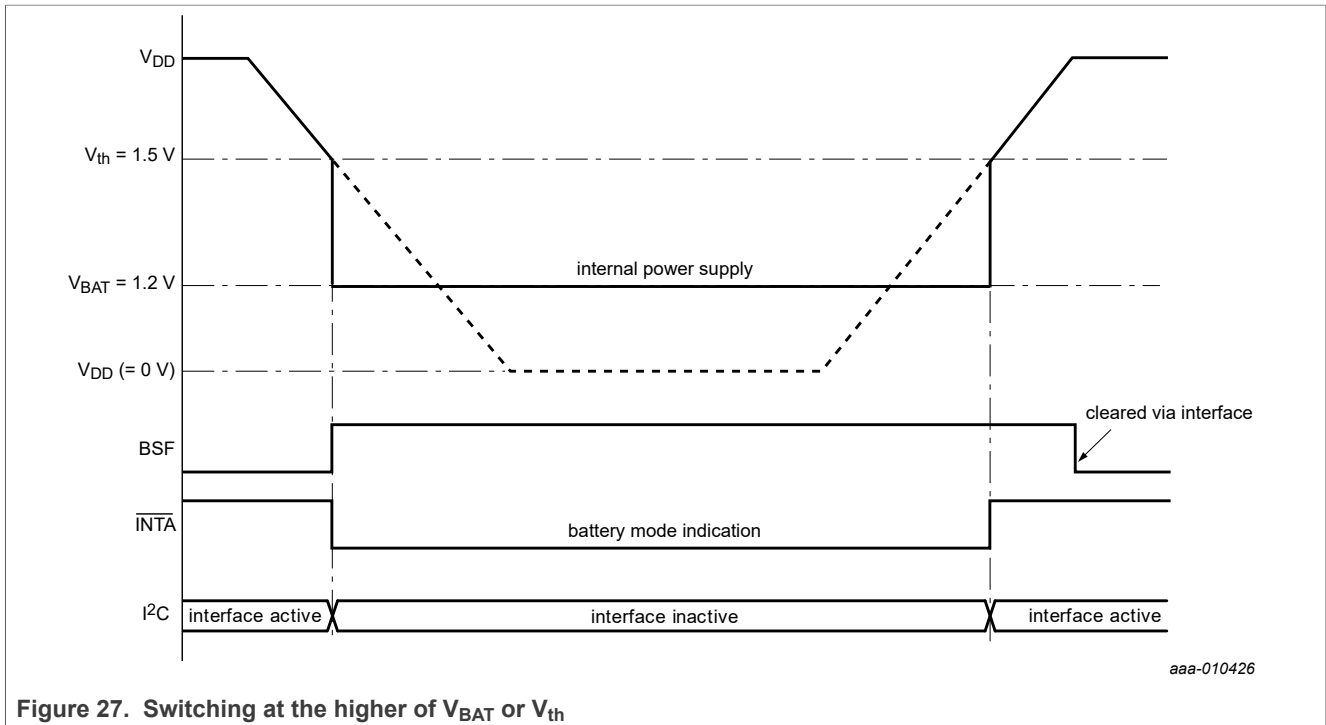


Figure 27. Switching at the higher of V_{BAT} or V_{th}

7.11.3.4 Switching at the lower of V_{BAT} and V_{th} level, $BSM[1:0] = 11$

With this mode switching takes place when V_{DD} falls below the lower of V_{th} or V_{BAT} . In Figure 28, an example is given where the threshold is set to 1.5 V and a single cell battery is connected to V_{BAT} . In this example, switching to the battery voltage takes place when V_{DD} falls below V_{BAT} .

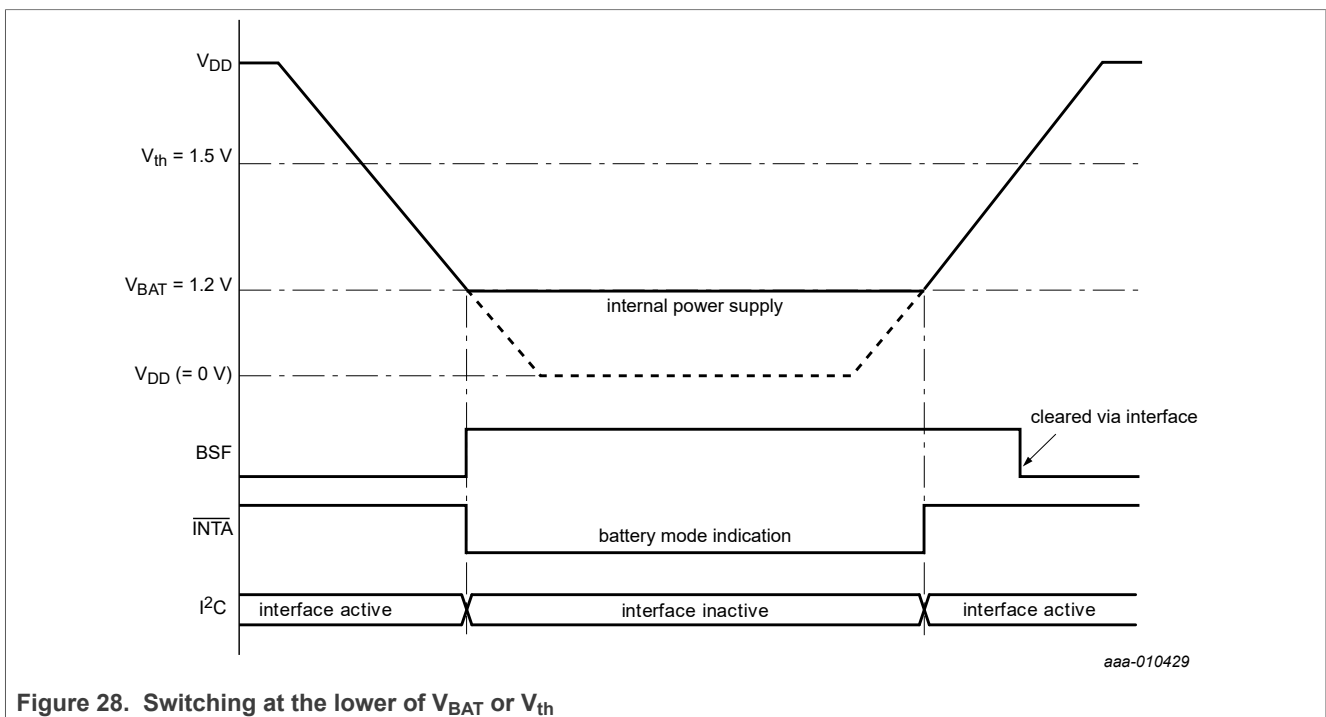


Figure 28. Switching at the lower of V_{BAT} or V_{th}

7.11.4 BSTH: threshold voltage control

Table 41. BSTH - battery switch control (address 26h) bit description

Bit	Symbol	Value	Description
0	BSTH		battery switch threshold voltage, V_{th}
		0 ^[1]	V _{th} = 1.5 V
		1	V _{th} = 2.8 V

[1] Default value.

The threshold for battery switch-over is selectable between two voltages, 1.5 V and 2.8 V.

7.11.5 Battery switch interrupts

The generation of interrupts from the battery switch function is controlled via the battery switch interrupt enable bits; BSIEA and BSIEB. These bits are in registers INTA_enable (address 29h) and INTB_enable (address 2Ah).

The assertion of the flag BSF (register Flags, address 2Bh) can be used to generate an interrupt at pins $\overline{\text{INTA}}$ and $\overline{\text{INTB}}$. The interrupt may be generated as a pulsed signal or alternatively as a permanently active signal which follows the condition of bit BSF. BSF remains set until cleared by command.

When enabled, interrupts are triggered every time the battery switch circuit switches to either battery or to V_{DD} and even if the BSF is not cleared, an interrupt pulse can be generated.

In addition, the $\overline{\text{INTA}}$ pin can be configured as a battery mode indicator (INTAPM[1:0] = 00). See [Section 7.12.6](#). This mode differs from a general interrupt signal in that it is only controlled by the current battery switch status.

See [Section 7.9](#) for interrupt control.

Remark: $\overline{\text{INTB}}$ pin is only active when the IC is operating from V_{DD}.

7.12 Pin_IO register

Table 42. Pin_IO- pin input output control register (address 27h) bit description

Bit	7	6	5	4	3	2	1	0
Symbol	CLKPM	TSPULL	TSL	TSIM	TSPM[1:0]		INTAPM[1:0]	
Section	Section 7.12.1	Section 7.12.2	Section 7.12.3	Section 7.12.5	Section 7.12.4		Section 7.12.6	

This register is used to define the input and output modes of the IC.

7.12.1 CLKPM: CLK pin mode control

Table 43. CLKPM bit - Pin_IO control register (address 27h)

Bit	Symbol	Value	Description
7	CLKPM ^[1]		CLK pin mode
		0 ^[2]	enable CLK pin
		1	disable CLK pin

[1] CLK pin is not available on all package types.

[2] Default value.

Setting the CLKPM bit disables the CLK output and force the pin to drive out a logic 0. Clearing this bit enables the pad to output the selected clock frequency (see bits COF[2:0] in the Function register, see [Table 50](#)).

7.12.2 TSPULL: TS pin pull-up resistor value

Table 44. TSPULL bit - Pin_IO control register (address 27h)

Bit	Symbol	Value	Description
6	TSPULL		TS pin pull-up resistor value
		0 ^[1]	80 kΩ
		1	40 kΩ

[1] Default value.

Controls the pull-up resistor value used in the mechanical switch detector. For applications where there is a large capacitance on the TS pin e.g. from a long connecting cable to the mechanical switch, the pull-up resistor value can be halved to improve switch detection.

Using the low-resistance value increases current consumption when the switch is closed i.e. shorting to V_{SS}.

7.12.3 TSL: TS pin level sense

Table 45. TSL bit - Pin_IO control register (address 27h)

Bit	Symbol	Value	Description
5	TSL		TS pin input sense
		0 ^[1]	active HIGH
		1	active LOW

[1] Default value.

The active state of the TS pin can be defined for use as a timestamp trigger and/or as stop control for the time counting. Active HIGH implies a transition from logic 0 to logic 1 is active. Active LOW implies a transition from logic 1 to logic 0 is active.

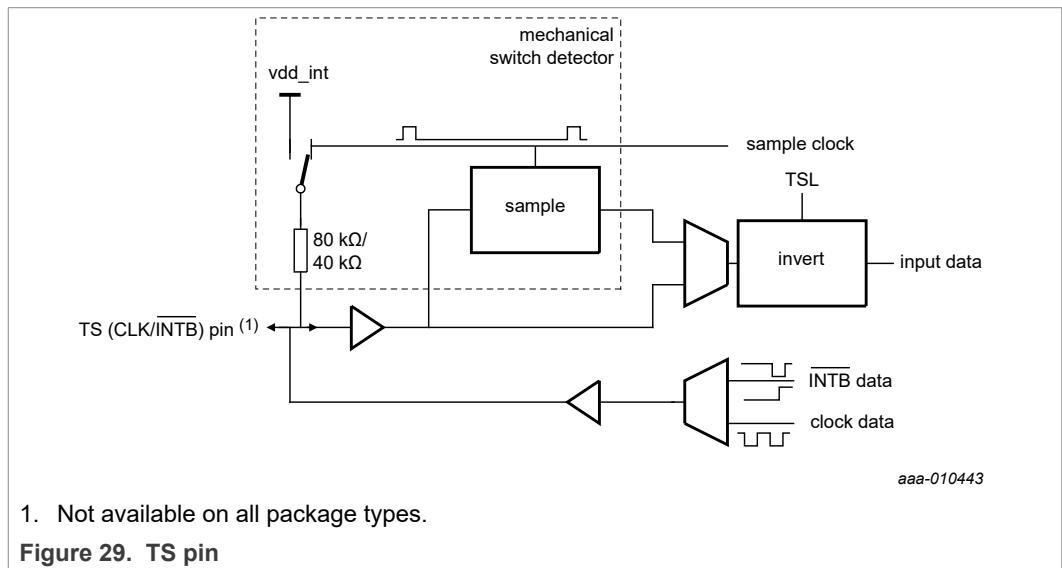
7.12.4 TSPM[1:0]: TS pin I/O control

Table 46. TSPM[1:0] bits - Pin_IO control register (address 27h)

Bit	Symbol	Value	Description
3 to 2	TSPM[1:0]		TS pin IO mode
		00 ^[1]	disabled; input can be left floating
		01	$\overline{\text{INTB}}$ output; push-pull
		10	CLK output; push-pull
		11	input mode

[1] Default value.

These bits control the operation of the TS pin.



TSIM is only considered when the TS pin is in input mode.

7.12.4.1 TS pin output mode; $\overline{\text{INTB}}$

It is possible to output $\overline{\text{INTB}}$ data on the TS pin. The output is push-pull. No output is available when on V_{BAT} . When on V_{BAT} the output is Hi-Z.

7.12.4.2 TS pin output mode; CLK

It is possible to output a clock frequency on the TS pin. Clock frequency is selected with the COF[2:0] bits in the Function register (Section 7.13). The output is push-pull. No output is available when on V_{BAT} . When on V_{BAT} the output is Hi-Z.

7.12.4.3 TS pin disabled

When disabled the pin is Hi-Z and can be left floating.

7.12.5 TSIM: TS pin input type control

Table 47. TSIM bit - Pin_IO control register (address 27h)

Bit	Symbol	Value	Description
4	TSIM		TS pin input mode
		0 ^[1]	CMOS input; reference to V_{DD} ; disabled when on V_{BAT}
		1	mechanical switch mode; active pull-up sampled at 16 Hz; operates on V_{DD} and V_{BAT}

[1] Default value.

In CMOS input mode (TSIM = 0), input is taken directly from the TS pin. The input is conditioned by the setting of TSL. When operating on the battery voltage (V_{BAT}), the input is disabled and is allowed to float.

In mechanical switch detector mode (TSIM = 1), the TS pin is sampled at a rate of 16 Hz for a period of 30.5 μs. At the same time as the sample a pull-up resistor is activated to detect an open pin or a pin shorted to V_{SS}. The input is referenced to the internal power supply. This mode operates when on V_{DD} or V_{BAT}. The pull-up resistor value can be controlled by TSPULL bit in the Pin_IO register (see [Section 7.12](#)).

7.12.5.1 TS pin input mode

There are two input types which are controlled by the TSIM bit. The TS input can be used to generate a timestamp event by configuring the timestamp mode bits; TSR2M[2:0] and TSR1M[1:0] bits in TSR_mode register (see [Table 19](#)).

Also it is possible to use the TS pin to control counting of time. This is typically for use with the stop-watch mode where an elapsed time counter function can be implemented. Using the STOPM bit in the Function register (see [Table 50](#)) it is possible to control the STOP bit by the TS pin.

7.12.6 INTAPM[1:0]: INTA pin mode control

Table 48. INTAPM[1:0] bits - Pin_IO control register (address 27h)

Bit	Symbol	Value	Description
1 to 0	INTAPM[1:0]		INTA pin mode
		00 ^[1]	CLK output mode
		01	battery mode indication
		10	INTA output
		11	Hi-Z

[1] Default value.

The INTA pin can be used to output three different signals.

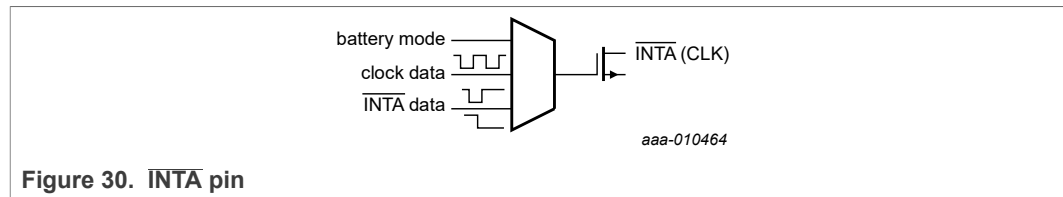


Figure 30. INTA pin

7.12.6.1 INTAPM[1:0]: INTA

The primary function of the INTA pin is to output INTA data. INTA data is controlled by the bits of the INTA_enable register (see [Table 28](#)).

The output is active LOW with an open-drain output. The output is available during V_{DD} and V_{BAT} operation.

7.12.6.2 INTAPM[1:0]: clock data

It is possible to output a clock frequency on the INTA pin. Clock frequency is selected with the COF[2:0] bits in the Function register ([Section 7.13](#)). The output is active LOW with an open-drain output. The output is available only during V_{DD} operation. The output is Hi-Z when operating from V_{BAT}.

Remark: Clock output is the default state. To save power, it is recommended to disable the clock when not being used. If no clock is required, then set COF[2:0] in the Function register (Section 7.13) to CLK disabled. If clock output is only required on the CLK pin, then set the INTA pin to either INTA data or battery mode.

7.12.6.3 INTAPM[1:0]: battery mode indication

It is possible to output the state of the power switch on the INTA pin. The output has an open-drain output. The output is available during V_{DD} and V_{BAT} operation.

Table 49. INTA battery mode

Power supply	INTA pin state
V _{DD}	INTA = Hi-Z
V _{BAT}	INTA = logic 0

7.13 Function register

Table 50. Function - chip function control register (address 28h) bit description

Bit	7	6	5	4	3	2	1	0
Symbol	100TH	PI[1:0]		RTCM	STOPM	COF[2:0]		
Section	Section 7.13.1	Section 7.13.2		Section 7.13.3	Section 7.13.4	Section 7.13.5		

7.13.1 100TH: 100th seconds mode

Table 51. 100TH bit - Function control register (address 28h)

Bit	Symbol	Value	Description
7	100TH		100th second mode
		0 ^[1]	100th second disabled
		1	100th second enabled

[1] Default value.

The PCF85263A can be configured to count at a resolution of 1 second or 0.01 seconds. In 100th mode, the 100th_seconds register becomes available and the RTC counts at a resolution of 0.01 seconds.

The 256 Hz clock signal is divided by 3 for fourteen 100 Hz periods and then by 2 for eleven 100 Hz periods. This produces an effective division ratio of 2.56 with a maximum jitter of 3.91 ms. Over twenty-five 100 Hz cycles the jitter is 0 ns.

7.13.2 PI[1:0]: Periodic interrupt

Table 52. PI[1:0] bits - Function control register (address 28h)

Bit	Symbol	Value	Description
6 to 5	PI[1:0]		periodic interrupt
		00 ^[1]	no periodic interrupt
		01	once per second
		10	once per minute

Table 52. PI[1:0] bits - Function control register (address 28h)...continued

Bit	Symbol	Value	Description
		11	once per hour

[1] Default value.

The periodic interrupt mode can be used to enable pre-defined timers for generating pulses on the interrupt pin. Interrupts once per second, once per minute or once per hour can be generated.

When disabled, the timers are reset. When enabled, the time to the first pulse is between the chosen period and the chosen period minus 1 seconds.

The timers are not affected by STOP.

When the periodic interrupt triggers, the PIF (PI flag) in the Flags register ([Section 7.14](#)) is set.

The flag does not have to be cleared to allow another $\overline{\text{INTA}}$ or $\overline{\text{INTB}}$ pulse.

The duration of the periodic interrupt is unaffected by offset calibration.

See [Section 7.9](#) for a description of interrupt pulse control and output pins.

7.13.3 RTCM: RTC mode

Table 53. RTCM bit - Function control register (address 28h)

Bit	Symbol	Value	Description
4	RTCM		RTC mode
		0 ^[1]	real-time clock mode
		1	stop-watch mode

[1] Default value.

The RTC mode is used to control how the time is counted. When configured as a classic RTC, then time is counted from 100th seconds to years. In stop-watch mode, time is counted from 100th seconds to 999 999 hours.

Table 54. RTC time counting modes

RTCM	Mode	Time counting
0	RTC	100th seconds ^[1] , seconds, minutes, hours, days, weekdays, months, years
1	stop-watch	100th seconds ^[1] , seconds, minutes, hours (0 hours to 999 999 hours)

[1] Enabled with 100TH bit in the Function register ([Section 7.13](#)).

7.13.4 STOPM: STOP mode control

Table 55. STOPM bit - Function control register (address 28h)

Bit	Symbol	Value	Description
3	STOPM		STOP mode
		0 ^[1]	RTC stop is controlled by STOP bit only
		1	RTC stop is controlled by STOP bit or TS pin

[1] Default value.

The STOP register bit in the Oscillator register ([Section 7.10](#)) is used to stop the counting of time in both RTC mode and stop-watch mode. Stopping of the oscillator can also be controlled from the TS pin. The TS pin must first be configured as an input by the TSPM[1:0] bits, then selected for active HIGH or active LOW by the TSL bits.

Table 56. Oscillator stop control when STOPM = 1

STOP bit ^[1]	TSL	TS pin ^[2]	Oscillator state	Description
0	0	0	running	TS pin active HIGH
		1	stopped	
	1	0	stopped	TS pin active LOW
		1	running	
1	-	-	stopped	TS pin ignored

[1] In the Oscillator register ([Section 7.10](#)).

[2] TSPM[1:0] = 11.

7.13.5 COF[2:0]: Clock output frequency

Table 57. COF[2:0] bits - Function control register (address 28h)

Bit	Symbol	Value	Frequency selection (Hz)		
			CLK pin	TS pin	INTA pin
2 to 0	COF[2:0]	000 ^[1]	32 768	32 768	32 768
		001	16 384	16 384	16 384
		010	8 192	8 192	8 192
		011	4 096	4 096	4 096
		100	2 048	2 048	2 048
		101	1 024	1 024	1 024
		110	1	1	1
		111	static LOW	static LOW	Hi-Z

[1] Default value.

A programmable square wave is available at pin CLK. Operation is controlled by the COF[2:0] bits. Frequencies of 32.768 kHz (default) down to 1 Hz can be generated for use as a system clock, microcontroller clock, input to a charge pump, or for calibration of the oscillator.

Pin CLK is a push-pull output and enabled at power-on. Pin CLK can be disabled by setting CLKPM = 1 in the Pin_IO register ([Section 7.12](#)). When disabled, the CLK pin is LOW.

The selected clock frequency may also be output on the TS pin and the $\overline{\text{INTA}}$ pin. The CLKIV bit may be used to invert the clock output. CLKIV does not invert for the setting COF[2:0] = 111.

The duty cycle of the selected clock is not controlled. However, due to the nature of the clock generation, all clock frequencies except 32.768 kHz have a duty cycle of 50:50.

Table 58. Clock duty cycles

COF[2:0]	Frequency (Hz)	Typical duty cycle ^[1]
000 ^[2]	32 768	60 : 40 to 40 : 60
001	16 384	50 : 50
010	8 192	50 : 50
011	4 096	50 : 50
100	2 048	50 : 50
101	1 024	50 : 50
110	1 ^[3]	50 : 50
111	static	-

[1] Duty cycle definition: % HIGH-level time : % LOW-level time.

[2] Default values. The duty cycle of the CLKOUT when outputting 32,768 Hz could change from 60:40 to 40:60 depending on the detector since the 32,768 Hz is derived from the oscillator output which is not perfect. It could change from device to device and it depends on the silicon diffusion. There is nothing that can be done from outside the chip to influence the duty cycle.

[3] 1 Hz clock pulses are not affected by offset correction pulses.

7.14 Flags register

Table 59. Flags - Flag status register (address 2Bh) bit description

Bit	Symbol	Flag name	Value	Description
7	PIF	Periodic Interrupt Flag Section 7.13.2	0 ^[1]	read: periodic interrupt flag inactive write: periodic interrupt flag is cleared
			1	read: periodic interrupt flag active write: periodic interrupt flag remains unchanged
6	A2F	Alarm2 Flag Section 7.4	0 ^[1]	read: alarm2 flag inactive write: alarm2 flag is cleared
			1	read: alarm2 flag active write: alarm2 flag remains unchanged
5	A1F	Alarm1 Flag Section 7.4	0 ^[1]	read: alarm1 flag inactive write: alarm1 flag is cleared
			1	read: alarm1 flag active write: alarm1 flag remains unchanged
4	WDF	WatchDog Flag Section 7.5	0 ^[1]	read: WatchDog flag inactive write: WatchDog flag is cleared
			1	read: WatchDog flag active write: WatchDog flag remains unchanged
3	BSF	Battery Switch Flag Section 7.11	0 ^[1]	read: battery switch flag inactive write: battery switch flag is cleared
			1	read: battery switch flag active write: battery switch flag remains unchanged

Table 59. Flags - Flag status register (address 2Bh) bit description...continued

Bit	Symbol	Flag name	Value	Description
2	TSR3F	Timestamp Register 3 event Flag Section 7.7	0 ^[1]	read: timestamp register 3 flag inactive write: timestamp register 3 flag is cleared
			1	read: timestamp register 3 flag active write: timestamp register 3 flag remains unchanged
1	TSR2F	Timestamp Register 2 event Flag Section 7.7	0 ^[1]	read: timestamp register 2 flag inactive write: timestamp register 2 flag is cleared
			1	read: timestamp register 2 flag active write: timestamp register 2 flag remains unchanged
0	TSR1F	Timestamp Register 1 event Flag Section 7.7	0 ^[1]	read: timestamp register 1 flag inactive write: timestamp register 1 flag is cleared
			1	read: timestamp register 1 flag active write: timestamp register 1 flag remains unchanged

[1] Default value.

The flags are set by their respective function. A full description can be found there. All flags behave the same way. They are set by some function of the IC and remain set until overwritten by command. It is possible to clear flags individually. To prevent one flag being overwritten while clearing another, a logic AND is performed during a write access. All flags are combined to generate an event monitoring signal called EMON. EMON is described in [Section 7.2.3](#) and can be read as the MSB of minutes register.

7.15 Reset register

Table 60. Reset - software reset control (address 2Fh) bit description

Bit	7	6	5	4	3	2	1	0
Symbol	CPR	0	1	0	SR	1	0	CTS
Section	Section 7.15.2				Section 7.15.1			Section 7.15.3

For a

- software reset (SR), 0010 1100 (2Ch) must be sent to register Reset (address 2Fh). A software reset also triggers CPR and CTS
- clear prescaler (CPR), 1010 0100 (A4h) must be sent to register Reset (address 2Fh)
- clear timestamp (CTS), 0010 0101 (25h) must be sent to register Reset (address 2Fh)

It is possible to combine CPR and CTS by sending 1010 0101 (A5h).

Remark: Any other value sent to this register is ignored.

7.15.1 SR - Software reset

A reset is automatically generated at power-on. A reset can also be initiated with the software reset command.

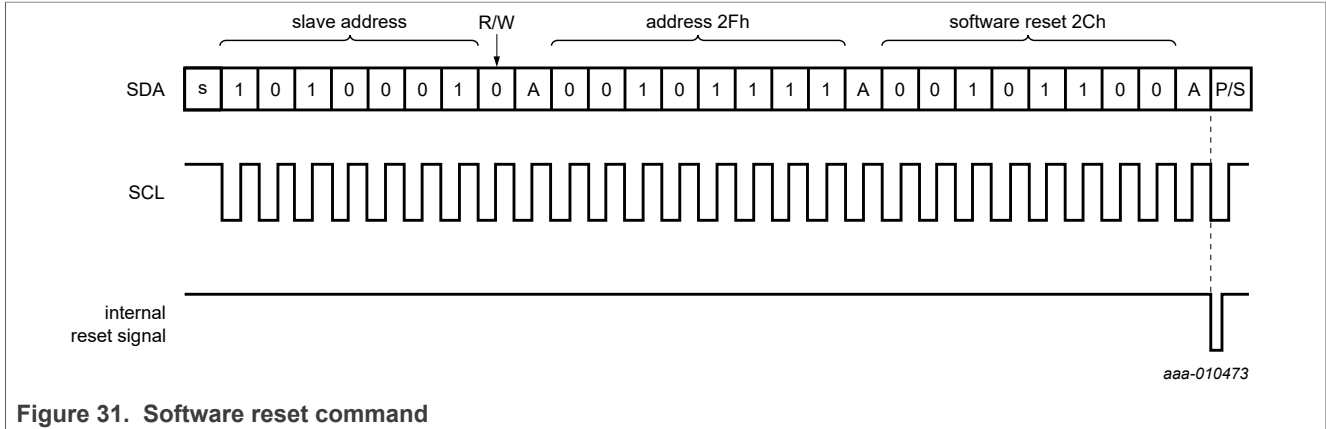


Figure 31. Software reset command

The PCF85263A resets to:

Mode: real-time clock, 100th second off

Time: 00:00:00.00

Date: 2000.01.01

Weekday: Saturday

Battery switch: on, switching on the lower threshold voltage

Oscillator: C_L = 7 pF

Pins: INTA = 32 kHz output, CLK = 32 kHz output, TS = disabled

In the reset state, all registers are set according to [Table 61](#).

Table 61. Registers reset values

Registers labeled as - remain unchanged.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
00h	100TH_seconds	0	0	0	0	0	0	0	0
01h	Seconds	1	0	0	0	0	0	0	0
02h	Minutes	0	0	0	0	0	0	0	0
03h	Hours	0	0	0	0	0	0	0	0
04h	Days	0	0	0	0	0	0	0	1
05h	Weekdays	0	0	0	0	0	1	1	0
06h	Months	0	0	0	0	0	0	0	1
07h	Years	0	0	0	0	0	0	0	0
08h	Second_alarm1	-	-	-	-	-	-	-	-
	Second_alm1	-	-	-	-	-	-	-	-
09h	Minute_alarm1	-	-	-	-	-	-	-	-
	Minute_alm1	-	-	-	-	-	-	-	-
0Ah	Hour_alarm1	-	-	-	-	-	-	-	-
	Hr_xx_xx_00_alm1	-	-	-	-	-	-	-	-

Table 61. Registers reset values...continued
 Registers labeled as - remain unchanged.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
0Bh	Day_alarm1	-	-	-	-	-	-	-	-
	Hr_xx_00_xx_alm1								
0Ch	Month_alarm1	-	-	-	-	-	-	-	-
	Hr_00_xx_xx_alm1								
0Dh	Minute_alarm2	-	-	-	-	-	-	-	-
	Minute_alm2								
0Eh	Hour_alarm2	-	-	-	-	-	-	-	-
	Hr_xx_00_alm2								
0Fh	Weekday_alarm2	-	-	-	-	-	-	-	-
	Hr_00_xx_alm2								
10h	Alarm enables	0	0	0	0	0	0	0	0
11h to 16h	Timestamp 1	0	0	0	0	0	0	0	0
17h to 1Ch	Timestamp 2	0	0	0	0	0	0	0	0
1Dh to 22h	Timestamp 3	0	0	0	0	0	0	0	0
23h	Timestamp_mode	0	0	0	0	0	0	0	0
24h	Offset	0	0	0	0	0	0	0	0
25h	Oscillator	0	0	0	0	0	0	0	0
26h	Battery_switch	0	0	0	0	0	0	0	0
27h	Pin_IO	0	0	0	0	0	0	0	0
28h	Function	0	0	0	0	0	0	0	0
29h	INTA_enable	0	0	0	0	0	0	0	0
2Ah	INTB_enable	0	0	0	0	0	0	0	0
2Bh	Flags	0	0	0	0	0	0	0	0
2Ch	RAM_byte	0	0	0	0	0	0	0	0
2Dh	WatchDog	0	0	0	0	0	0	0	0
2Fh	Reset	0	0	0	0	0	0	0	0

7.15.2 CPR: clear prescaler

To set the time for RTC mode accurately or to clear the time in stop-watch mode, the clear prescaler instruction is needed.

Before sending this instruction, it is recommended to first set *stop* either by the STOP bit or by the TS pin (see STOPM bit).

See STOP definition for an explanation on using this instruction.

7.15.3 CTS: clear timestamp

The timestamp registers (address 11h to 22h) can be set to all 0 with this instruction.

7.16 Stop_enable register

Table 62. Stop_enable - control of STOP bit (address 2Eh)

Bit	Symbol	Value	Description
7 to 1	-	0000 000	not used
0	STOP		STOP bit
		0 ^[1]	RTC clock runs
		1	RTC clock is stopped

[1] Default value.

The STOP bit stops the time from counting in both RTC mode and stop-watch mode. For RTC mode STOP is useful to set the time accurately. For stop-watch mode it is the start/stop control for the watch.

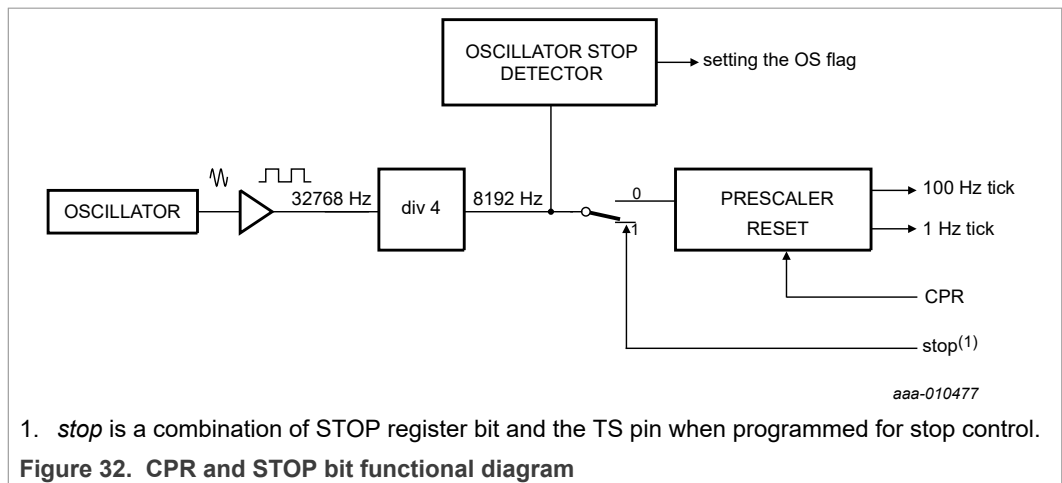
The counter can also be controlled from the TS pin by configuring STOPM in the Function register (Section 7.13). The internal stop signal is a combination of STOP and the TS pin state.

Table 63. Counter stop signal

STOP bit	TS pin ^[1] ^[2]	stop signal	Counter
1	-	1	stopped
-	1	1	stopped
0	0	0	running

[1] Requires STOPM and TSPM[1:0] to be configured.

[2] TSL = 0 (active HIGH) (Pin_IO register, address 27h).



The *stop* signal blocks the 8.192 kHz clock from generating system clocks and freezes the time. In this state, the prescaler can be cleared with the CPR command in the Resets register (Section 7.15).

Remark: The output of clock frequencies is not affected.

The time circuits can then be set and do not increment until the STOP bit is released.

The *stop* acts on the 8.192 kHz signal. And because the I²C-bus or TS pin input is asynchronous to the crystal oscillator, the accuracy of restarting the time circuits is between zero and one 8.192 kHz cycle (see Figure 33).

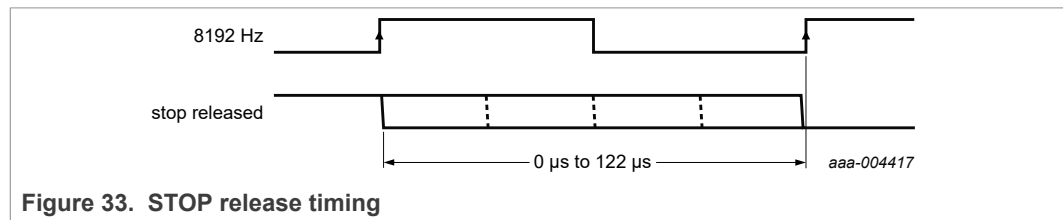


Figure 33. STOP release timing

The first increment of the time circuits is between 0 s and 122 μs after STOP is released.

The flow for accurately setting the time in RTC mode is:

- start an I²C access at register 2Eh
- set STOP bit
- send CPR instruction
- address counter rolls over to address 00h
- set time (100th seconds, seconds to years)
- end I²C access
- wait for external time reference to indicate that time counting should start
- start an I²C access at register 2Eh
- clear STOP bit (time starts counting from now)
- end I²C access

The flow for resetting time in stop-watch mode is:

- start an I²C access at register 2Eh
- set STOP bit
- send CPR instruction
- address counter will roll over to address 00h
- set time to 000000:00:00.00
- end I²C access

8 I²C-bus interface

The I²C-bus is for bidirectional, two-line communication between different ICs. The two lines are a Serial DATA line (SDA) and a Serial CLOCK line (SCL). Both lines must be connected to a positive supply via a pull-up resistor. Data transfer may be initiated only when the bus is not busy. Both data and clock lines remain HIGH when the bus is not busy. The PCF85263A acts as a slave receiver when being written to and as a slave transmitter when being read from.

Remark: When on V_{BAT} power, the interface is not accessible.

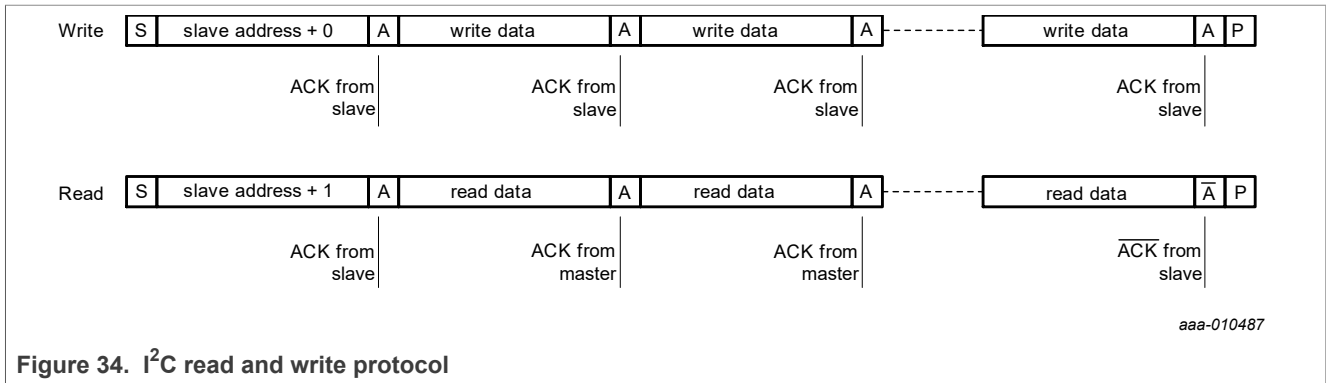


Figure 34. I²C read and write protocol

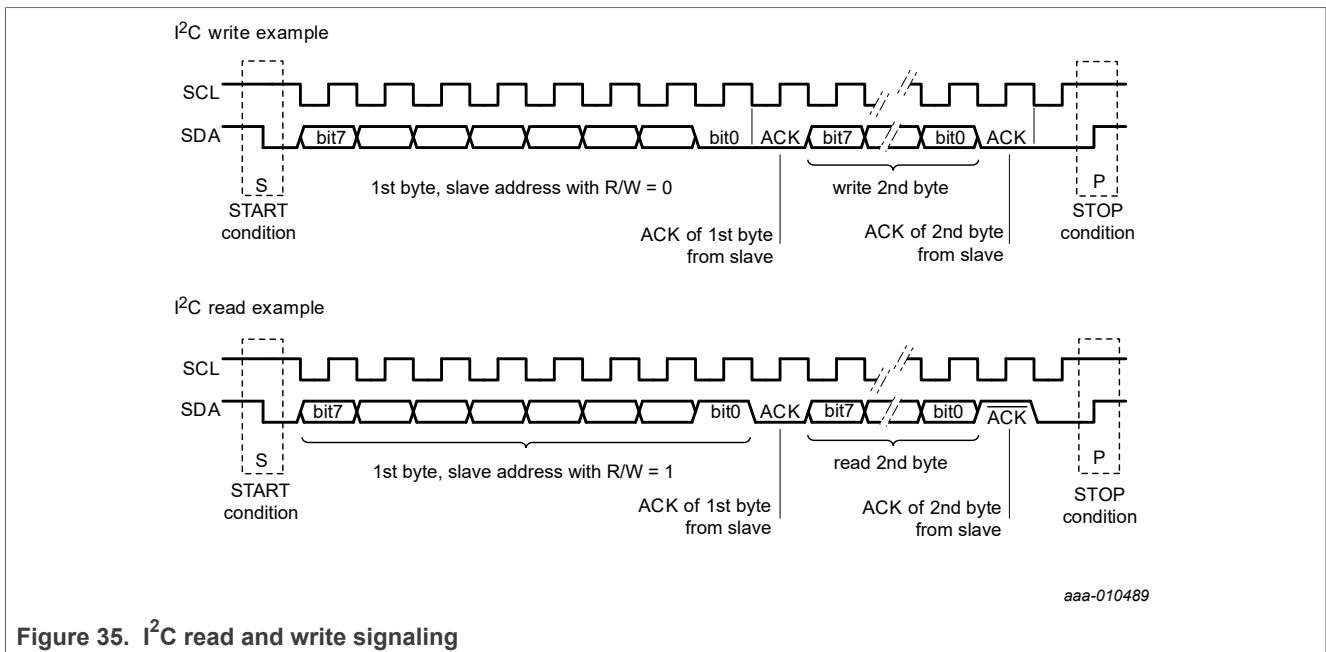


Figure 35. I²C read and write signaling

8.1 Bit transfer

One data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the HIGH period of the clock pulse, as changes in the data line at this time are interpreted as STOP or START conditions.

8.2 START and STOP conditions

A HIGH-to-LOW transition of the data line while the clock is HIGH is defined as the START condition - S.

A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the STOP condition - P (see [Figure 35](#)).

8.3 Acknowledge

Each byte of 8 bits is followed by an acknowledge cycle. An acknowledge is defined as logic 0. A not-acknowledge is defined as logic 1.

When written to, the slave will generate an acknowledge after the reception of each byte. After the acknowledge, another byte may be transmitted. It is also possible to send a STOP or START condition.

When read from, the master receiver must generate an acknowledge after the reception of each byte. When the master receiver no longer requires bytes to be transmitter, it must generate a not-acknowledge. After the not-acknowledge, either a STOP or START condition must be sent.

A detailed description of the I²C-bus specification is given in [8].

9 Interface protocol

The PCF85263A uses the I²C interface for data transfer. Interpretation of the data is determined by the interface protocol.

9.1 Write protocol

After the I²C slave address is transmitted, the PCF85263A requires that the register address pointer is defined. It can take the value 00h to 2Fh. Values outside of that range will result in the transfer being ignored, however the slave will still respond with acknowledge pulses.

After the register address is transmitted, write data is transmitted. The minimum number of data write bytes is 0 and the maximum number is unlimited. After each write, the address pointer increments by one. After address 2Fh, the address pointer will roll over to 00h.

- I²C START condition
- I²C slave address + write
- register address
- write data
- write data
- :
- write data
- I²C STOP condition; an I²C RE-START condition is also possible.

9.2 Read protocol

When reading the PCF85263A, reading starts at the current position of the address pointer. The address pointer for read data should first be defined by a write sequence.

- I²C START condition
- I²C slave address + write
- register address
- I²C STOP condition; an I²C RE-START condition is also possible.

After setting the address pointer, a read can be executed. After the I²C slave address is transmitted, the PCF85263A will immediately output read data. After each read, the address pointer increments by one. After address 2Fh, the address pointer will roll over to 00h.

- I²C START condition
- I²C slave address + read

- read data (master sends acknowledge bit)
- read data (master sends acknowledge bit)
- :
- read data (master sends **not**-acknowledge bit)
- I²C STOP condition. An I²C RE-START condition is also possible.

The master must indicate that the last byte has been read by generating a not-acknowledge after the last read byte.

9.3 Slave addressing

9.3.1 Slave address

One I²C-bus slave address (1010 001) is reserved for the PCF85263A. The entire I²C-bus slave address byte is shown in [Table 64](#).

Table 64. I²C slave address byte

	Slave address							
Bit	7	6	5	4	3	2	1	0
	MSB							LSB
	1	0	1	0	0	0	1	R/W

After a START condition, the I²C slave address has to be sent to the PCF85263A device.

Slave address can also be written in a hexadecimal format:

- A2h - Write slave address
- A3h - Read slave address

10 Application design-in information

In this application, stop-watch mode is used to implement an elapsed time counter. The TS pin is used with a mechanical switch to start and stop the time. Each time the time is stopped, timestamp2 is loaded with the current time and an interrupt is generated on the INTA pin.

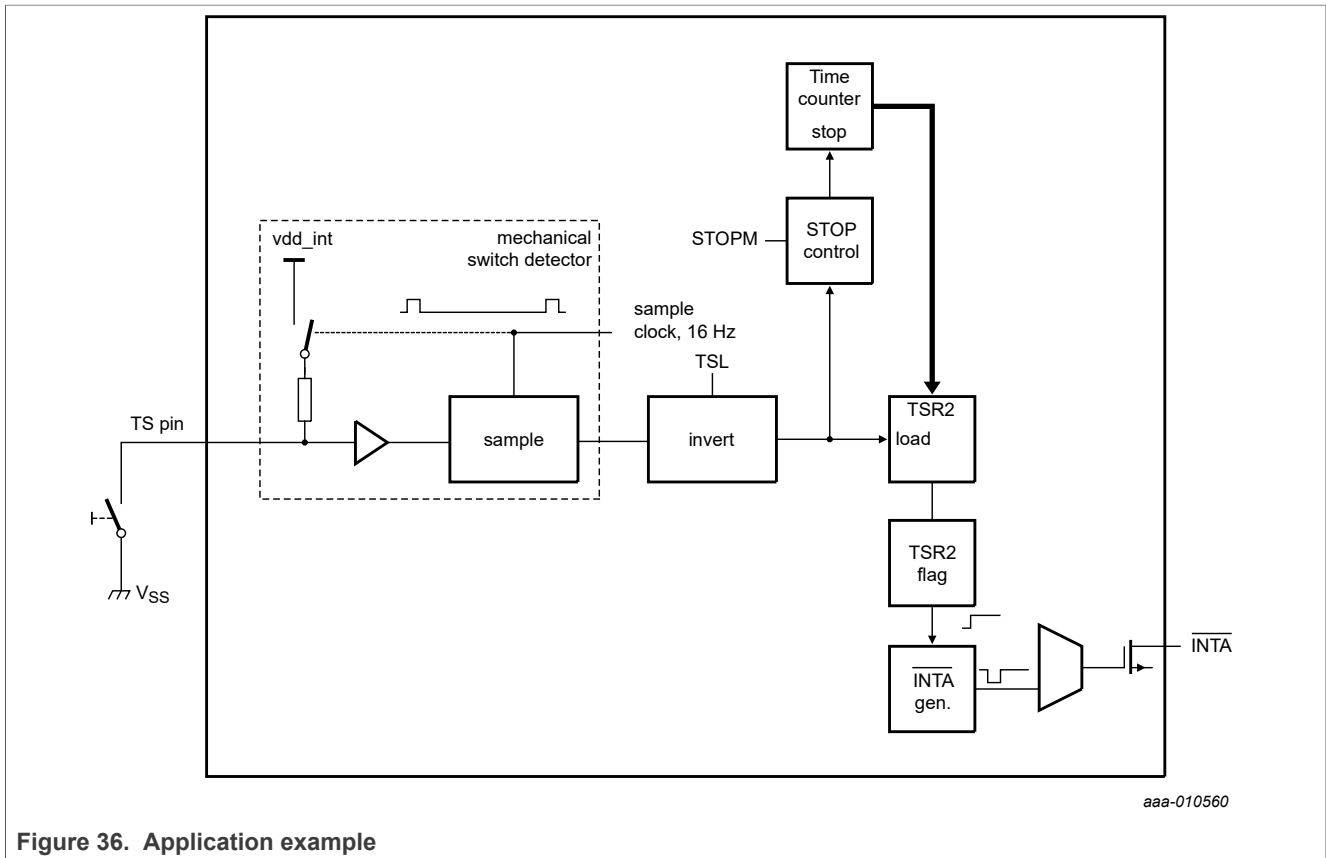


Figure 36. Application example

The RTC must be configured correctly for this mode of operation. Outlined in [Table 65](#) are the settings needed for this mode.

In addition, the time must be set and any other configurations like battery switch-over, quartz oscillator driving mode, etc., which are dependent on the application.

The sampler circuit shown in [Figure 36](#) will hold invalid data until the mechanical switch detector mode is enabled. It then requires a minimum of one sample period to initialize to the current TS pin level. It is recommended to enable the mechanical detector mode on the TS pin at least 62.5 ms before enabling the TS event mode. Failure to do so can result in a false first event.

Table 65. Application configuration

Register	Section	Bit(s)	State	Comment
Pin_IO	Section 7.12	TSPM[1:0]	11	TS pin in input mode
Pin_IO	Section 7.12	TSIM	1	select mechanical switch mode
Pin_IO	Section 7.12	TSL	1	TS pin input is active LOW
Function	Section 7.13	STOPM	1	allow TS pin to control STOP
		TSRIEA	1	allow timestamps to create interrupts
		ILPA	0	generate interrupt pulses
TSR_mode	Section 7.12	TSR2M[2:0]	101	last event mode for timestamp2
Pin_IO	Section 7.12	INTAPM[1:0]	10	output interrupt on $\overline{\text{INTA}}$

Figure 37 shows the waveforms that can be expected. *sample clock*, *vdd_int* and *stop* are internal nodes. *vdd_int* is the supply which operates the IC and will be either V_{DD} or V_{BAT}, depending on the state of the battery switch-over.

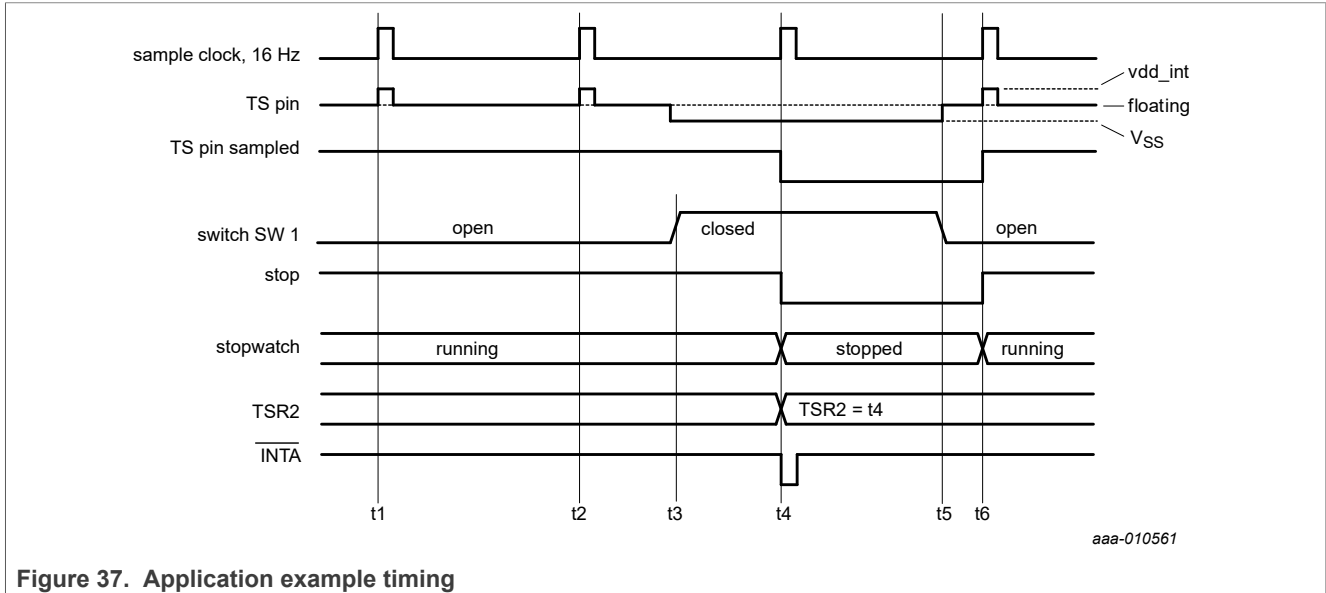


Figure 37. Application example timing

- At and before t1, SW1 is open (TS pin floating). The TS pin is sampled and the internal pull-up resistor will pull the pin HIGH to *vdd_int*. No actions are taken by the IC.
- At t2, SW1 is still open. No action is taken by the IC.
- At t3, SW1 closes. The TS pin is now shorted to V_{SS}. The TS pin has not been sampled yet, so no action is taken by the IC.
- At t4, SW1 is closed. The internal pull-up resistor is enabled, but TS pin remains LOW. The pin is then sampled and the LOW level detected. As the TSL bit was set for active LOW detection, the HIGH-LOW transition of TS pin sampled triggers an event. STOPM mode was configured to allow the TS pin to stop the time counting. As the TSL bit was set for active LOW, time counting stops when the TS pin is LOW. Timestamp register 2 was configured to take a copy of the time on an event of the TS pin, hence TSR2 loads the time t4. TSR2F is also set. $\overline{\text{INTA}}$ was configured to generate an interrupt when TSR2 loads a new time, hence an interrupt pulse is seen on $\overline{\text{INTA}}$.
- At t5, SW1 is opened. No action is taken by the IC.
- At t6, SW1 is open. The internal pull-up is active and the TS pin raises to *vdd_int* level. The HIGH level is sampled and causes the *stop* signal to be released and time starts counting again.

11 Internal circuitry

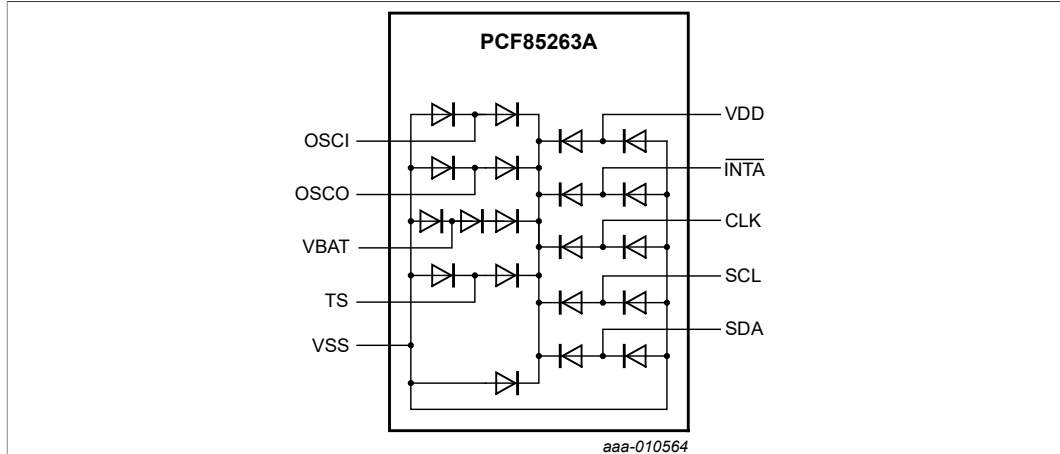



Figure 38. Device diode protection diagram of PCF85263A

12 Safety notes

CAUTION



This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices. Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

13 Limiting values

Table 66. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit	
V _{DD}	supply voltage		-0.5	+6.5	V	
I _{DD}	supply current		-50	+50	mA	
V _{BAT}	battery supply voltage		-0.5	+6.5	V	
I _{BAT}	battery supply current		-50	+50	mA	
V _I	input voltage	on pins SCL, SDA, OSCI, TS	-0.5	+6.5	V	
V _O	output voltage		-0.5	+6.5	V	
I _I	input current	at any input	-10	+10	mA	
I _O	output current	at any output	-10	+10	mA	
P _{tot}	total power dissipation		-	300	mW	
V _{ESD}	electrostatic discharge voltage	HBM	[1]	-	±3500	V
		CDM	[2]			
		PCF85263AT		-	±1500	V
		PCF85263ATL		-	±1750	V
		PCF85263ATT		-	±1000	V
		PCF85263ATT1		-	±2000	V
PCF85263AUK		-	±1000	V		
I _{lu}	latch-up current		[3]	-	200	mA
T _{stg}	storage temperature		[4]	-65	+150	°C
T _{amb}	ambient temperature	operating device		-40	+85	°C

[1] Pass level; Human Body Model (HBM) according to [1].

[2] Pass level; Charged-Device Model (CDM), according to [2].

[3] Pass level; latch-up testing, according to [3] at maximum ambient temperature (T_{amb(max)}).

[4] According to the store and transport requirements (see [9]) the devices have to be stored at a temperature of +8 °C to +45 °C and a humidity of 25 % to 75 %.

14 Characteristics

Table 67. Characteristics

V_{DD} = 0.9 V to 5.5 V; V_{SS} = 0 V; T_{amb} = -40 °C to +85 °C; f_{osc} = 32.768 kHz; quartz R_s = 60 kΩ; C_L = 7 pF; all registers in reset state; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
Supplies							
V _{DD}	supply voltage	interface inactive; f _{SCL} = 0 Hz	[1]	0.9	-	5.5	V
		interface active; f _{SCL} = 400 kHz	[2]	1.8	-	5.5	V
V _{BAT}	battery supply voltage		[1]	0.9	-	5.5	V
I _{DD}	supply current	CLKOUT disabled; V _{DD} = 3.3 V; interface inactive; f _{SCL} = 0 Hz	[3]				

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

Table 67. Characteristics...continued

$V_{DD} = 0.9\text{ V to }5.5\text{ V}$; $V_{SS} = 0\text{ V}$; $T_{amb} = -40\text{ °C to }+85\text{ °C}$; $f_{osc} = 32.768\text{ kHz}$; quartz $R_s = 60\text{ k}\Omega$; $C_L = 7\text{ pF}$; all registers in reset state; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
		battery switch enabled					
		$T_{amb} = 25\text{ °C}$	-	320	480	nA	
		$T_{amb} = 50\text{ °C}$	-	370	550	nA	
		$T_{amb} = 85\text{ °C}$	-	590	885	nA	
		battery switch disabled	[4]				
		$T_{amb} = 25\text{ °C}$	-	280	420	nA	
		$T_{amb} = 50\text{ °C}$	-	330	500	nA	
		$T_{amb} = 85\text{ °C}$	-	550	825	nA	
		CLKOUT disabled; $V_{DD} = 3.3\text{ V}$; interface active; $f_{SCL} = 400\text{ kHz}$	-	10	-	μA	
Reference voltage							
V_{th}	threshold voltage	HIGH falling V_{DD}	2.4	2.6	2.8	V	
		HIGH rising V_{DD}	2.5	2.7	2.95	V	
		LOW falling V_{DD}	1.3	1.4	1.5	V	
		LOW rising V_{DD}	1.37	1.47	1.6	V	
		reference voltage hysteresis	-	± 50	-	mV	
Inputs [5]							
V_I	input voltage		-0.5	-	+5.5	V	
V_{IL}	LOW-level input voltage		-0.5	-	+0.3 V_{DD}	V	
V_{IH}	HIGH-level input voltage		0.7 V_{DD}	-	5.5	V	
I_{LI}	input leakage current	$V_I = V_{SS}$ or V_{DD}	-	0	-	μA	
		post ESD event	-0.5	-	+0.5	μA	
C_i	input capacitance		[6]	-	7	pF	
$R_{PU(TS)}$	pull-up resistance on pin TS	80 k Ω mode	[7]	68	80	92	k Ω
		40 k Ω mode	[7]	36	40	64	k Ω
Outputs							
V_{OH}	HIGH-level output voltage	on pin CLK, TS	0.8 V_{DD}	-	V_{DD}	V	
V_{OL}	LOW-level output voltage	on pins SDA, $\overline{\text{INTA}}$, CLK, TS	V_{SS}	-	0.2 V_{DD}	V	
I_{OH}	HIGH-level output current	output source current; $V_{OH} = 2.9\text{ V}$; $V_{DD} = 3.3\text{ V}$; on pin CLK, TS	1	3	-	mA	

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

Table 67. Characteristics...continued

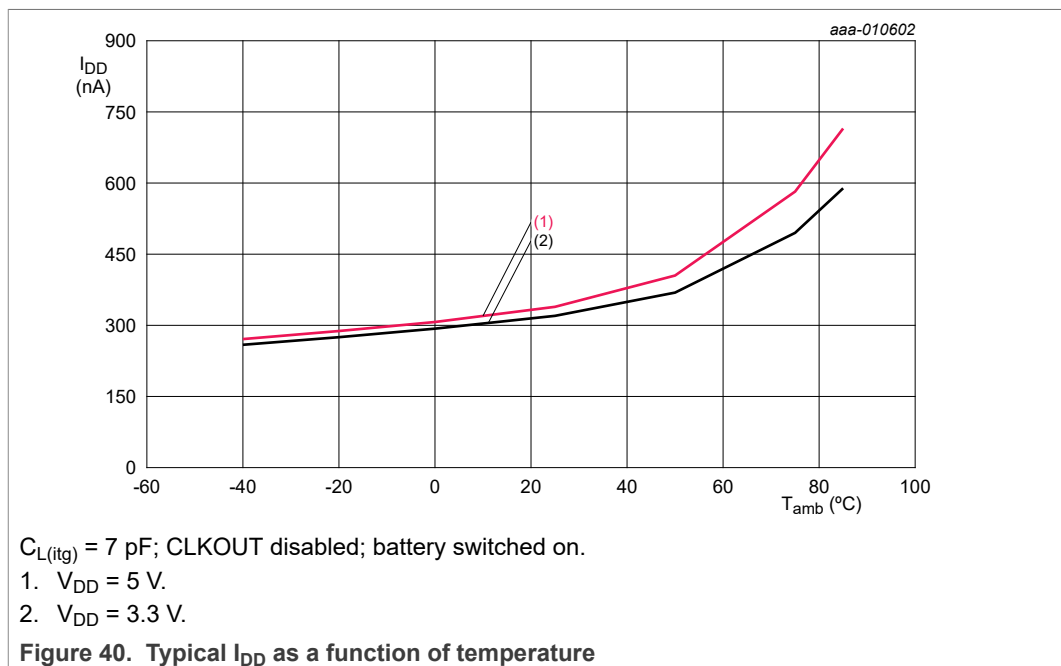
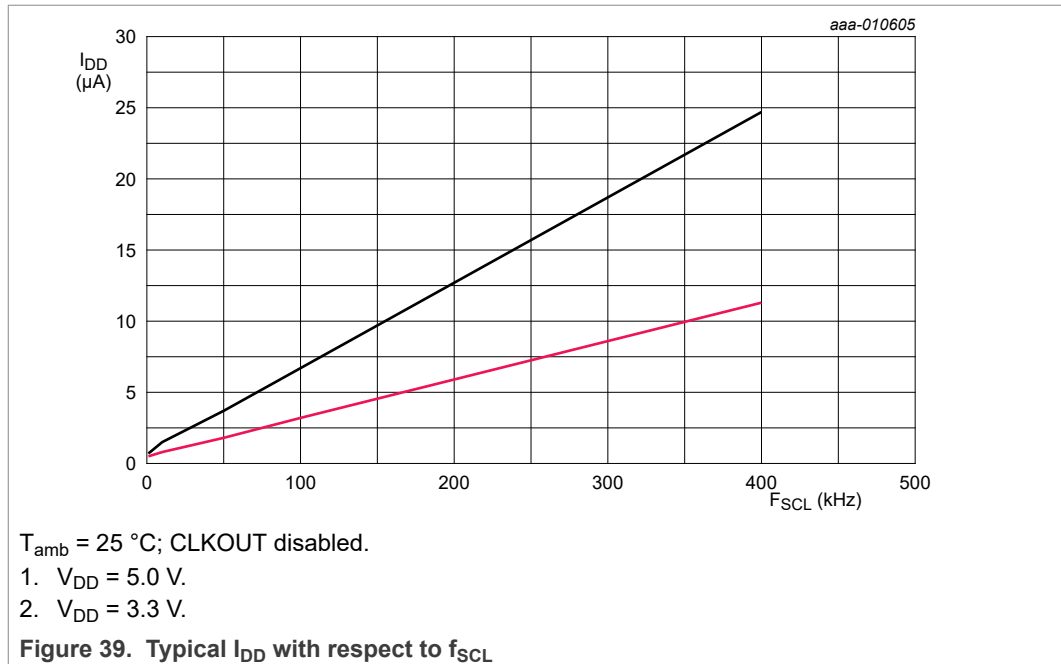
V_{DD} = 0.9 V to 5.5 V; V_{SS} = 0 V; T_{amb} = -40 °C to +85 °C; f_{osc} = 32.768 kHz; quartz R_s = 60 kΩ; C_L = 7 pF; all registers in reset state; unless otherwise specified.

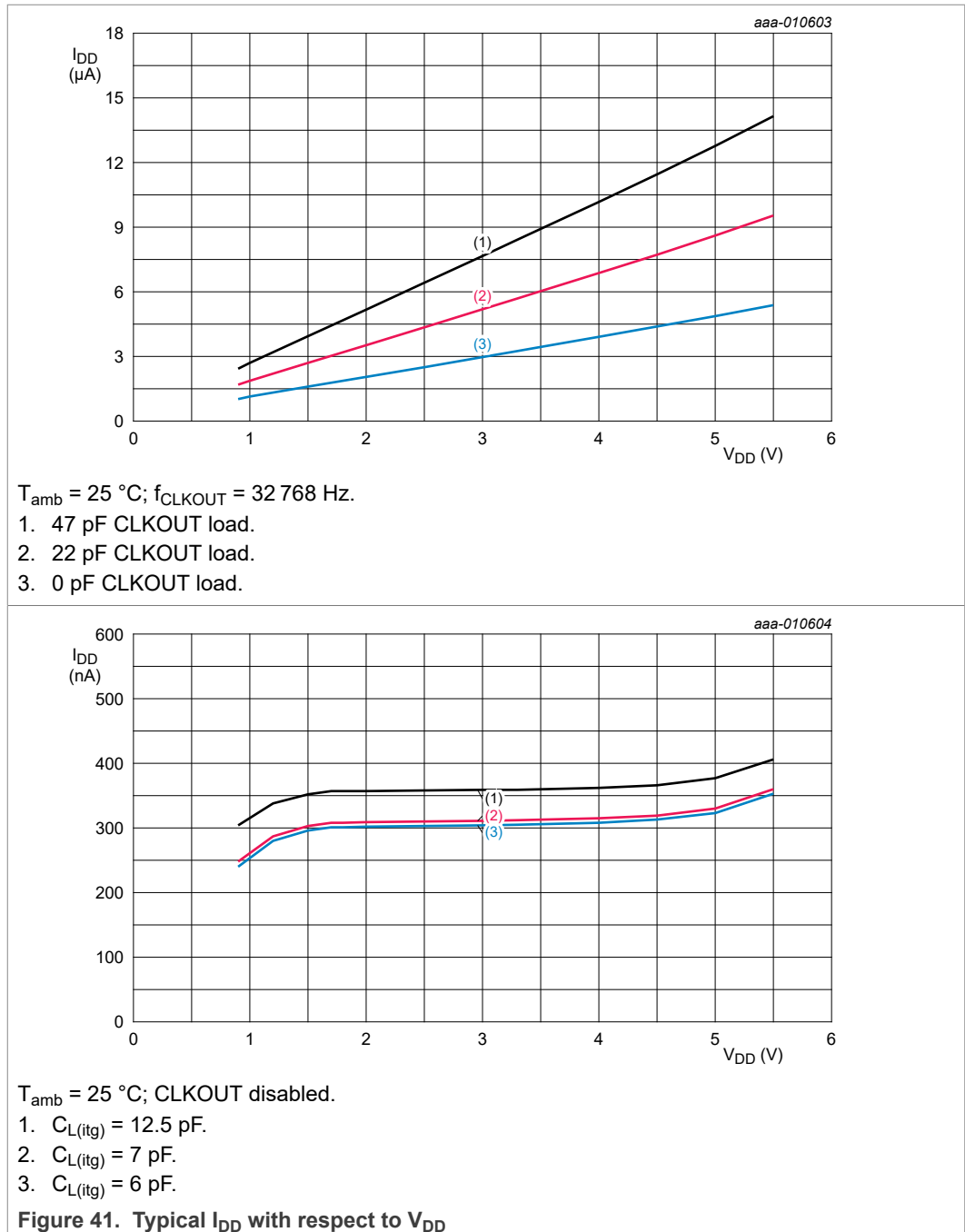
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
I _{OL}	LOW-level output current	output sink current; V _{OL} = 0.4 V; V _{DD} = 3.3 V					
		on pin SDA	3	8.5	-	mA	
		on pin INTA	2	6	-	mA	
		on pin CLK	1	3	-	mA	
		on pin TS	1	3	-	mA	
Oscillator							
Δf _{osc} /f _{osc}	relative oscillator frequency variation	ΔV _{DD} = 200 mV; T _{amb} = 25 °C	-	0.075	-	ppm	
t _{jit}	jitter time	LOWJ = 0	[8]	-	50	-	ns
		LOWJ = 1		-	25	-	ns
C _{L(itg)}	integrated load capacitance	on pins OSC0, OSC1; V _{DD} = 3.3 V	[9]				
		C _L = 6 pF		4.8	6	7.2	pF
		C _L = 7 pF		5.6	7	8.4	pF
		C _L = 12.5 pF		10	12.5	15	pF
R _s	series resistance	of the quartz; normal drive	[10]	-	60	100	kΩ

- [1] For reliable oscillator start-up at power-on use V_{DD} greater than 1.2 V. If powered up at 0.9 V the oscillator will start but it might be a bit slow, especially if at high temperature. Normally the power supply is not 0.9 V at start-up and only comes at the end of battery discharge. V_{DD} min of 0.9 V is specified so that the customer can calculate how large a battery or capacitor they need for their application. V_{DD} min of 1.2 V or greater is needed to ensure speedy oscillator start-up time.
- [2] 400 kHz I2C operation is production tested at 1.8 V. Design methodology allows I2C operation at 1.8 V - 5 % (1.71 V) which has been verified during product characterization on a limited number of devices.
- [3] Measured after reset and CLK disabled, level of inputs is V_{DD} or V_{SS}.
- [4] Measured after reset, CLK disabled, battery switch disabled and level of inputs is V_{DD} or V_{SS}.
- [5] The I²C-bus interface of PCF85263A is 5 V tolerant.
- [6] Implicit by design.
- [7] See [Table 44](#).
- [8] See [Table 32](#).
- [9] Integrated load capacitance, C_{L(itg)}, is a calculation of C_{OSC1} and C_{OSC0} in series.

$$C_{L(itg)} = \frac{C_{osc1}C_{osc0}}{C_{osc1}+C_{osc0}}$$

[10] See [Table 33](#).





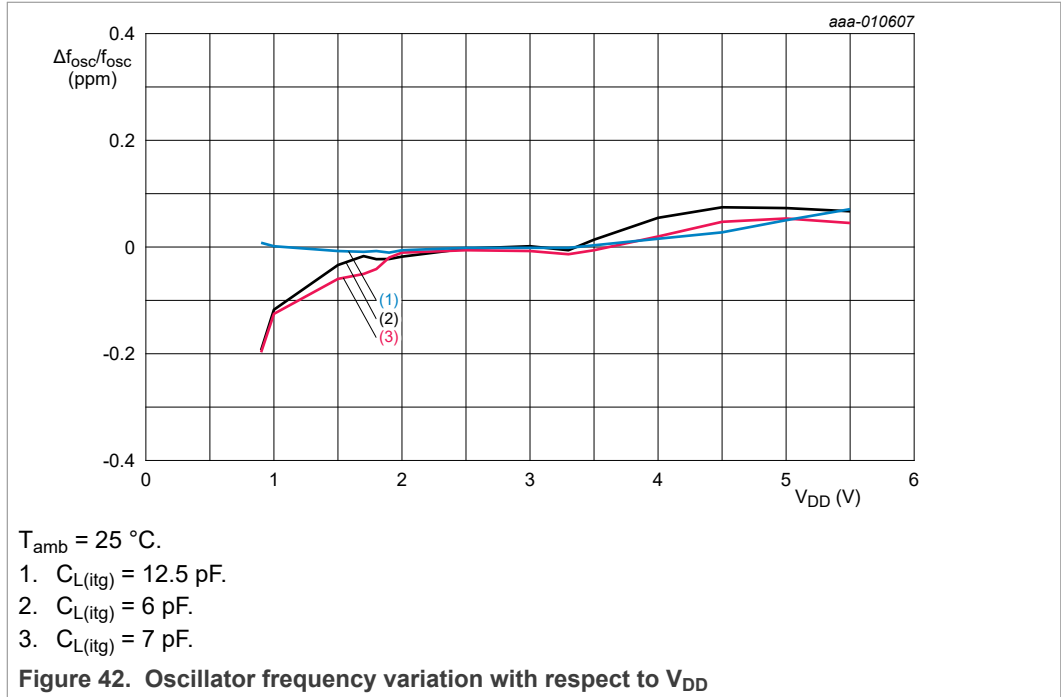


Table 68. I²C-bus characteristics

$V_{DD} = 1.8\text{ V to }5.5\text{ V}; V_{SS} = 0\text{ V}; T_{amb} = -40\text{ }^{\circ}\text{C to }+85\text{ }^{\circ}\text{C}; f_{osc} = 32.768\text{ kHz}; \text{quartz } R_s = 60\text{ k}\Omega; C_L = 7\text{ pF};$ unless otherwise specified. All timing values are valid within the operating supply voltage and temperature range and referenced to V_{IL} and V_{IH} with an input voltage swing of V_{SS} to V_{DD} [1].

Symbol	Parameter	Conditions	Min	Max	Unit
C_b	capacitive load for each bus line		-	400	pF
f_{SCL}	SCL clock frequency		[2] 0	400	kHz
$t_{HD;STA}$	hold time (repeated) START condition		0.6	-	μs
$t_{SU;STA}$	set-up time for a repeated START condition		0.6	-	μs
t_{LOW}	LOW period of the SCL clock		1.3	-	μs
t_{HIGH}	HIGH period of the SCL clock		0.6	-	μs
t_r	rise time of both SDA and SCL signals		20	300	ns
t_f	fall time of both SDA and SCL signals		[3] [4] $20 \times (V_{DD} / 5.5\text{ V})$	300	ns
t_{BUF}	bus free time between a STOP and START condition		1.3	-	μs
$t_{SU;DAT}$	data set-up time		100	-	ns

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

Table 68. I²C-bus characteristics...continued

$V_{DD} = 1.8\text{ V to }5.5\text{ V}$; $V_{SS} = 0\text{ V}$; $T_{amb} = -40\text{ }^{\circ}\text{C to }+85\text{ }^{\circ}\text{C}$; $f_{osc} = 32.768\text{ kHz}$; quartz $R_s = 60\text{ k}\Omega$; $C_L = 7\text{ pF}$; unless otherwise specified. All timing values are valid within the operating supply voltage and temperature range and referenced to V_{IL} and V_{IH} with an input voltage swing of V_{SS} to V_{DD} [1].

Symbol	Parameter	Conditions	Min	Max	Unit
$t_{HD;DAT}$	data hold time		0	-	ns
$t_{SU;STO}$	set-up time for STOP condition		0.6	-	μs
$t_{VD;DAT}$	data valid time		0	0.9	μs
$t_{VD;ACK}$	data valid acknowledge time		0	0.9	μs
t_{SP}	pulse width of spikes that must be suppressed by the input filter		0	50	ns

- [1] A detailed description of the I²C-bus specification is given in [8].
- [2] I²C-bus access time between two STARTs or between a START and a STOP condition to this device must be less than one second.
- [3] A device must internally provide a hold time of at least 300 ns for the SDA signal (with respect to the $V_{IH(min)}$ of the SCL signal) to bridge the undefined region of the falling edge of SCL.
- [4] The maximum t_f for the SDA and SCL bus lines is specified at 300 ns. The maximum fall time for the SDA output stage t_f is specified at 250 ns. This allows series protection resistors to be connected in between the SDA and the SCL pins and the SDA/SCL bus lines without exceeding the maximum specified t_f .

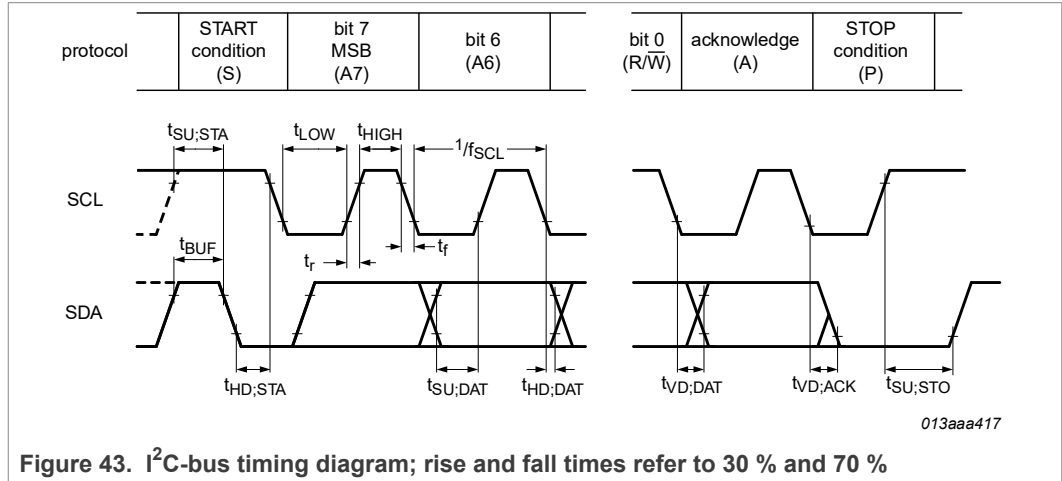


Figure 43. I²C-bus timing diagram; rise and fall times refer to 30 % and 70 %

15 Application information

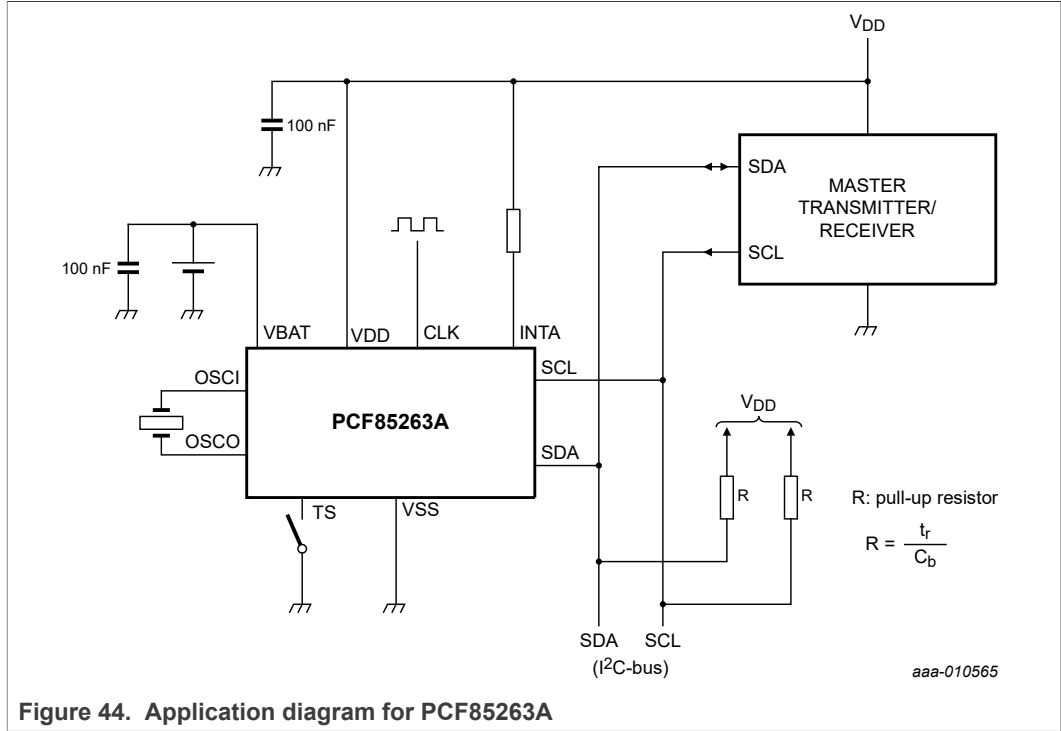



Figure 44. Application diagram for PCF85263A

The data sheet values were obtained using a crystal with an ESR of 60 kΩ. If a crystal with an ESR of 70 kΩ is used then the power consumption would increase by a few nA and the start-up time will increase slightly.

16 Test information

16.1 Quality information

UL Component Recognition

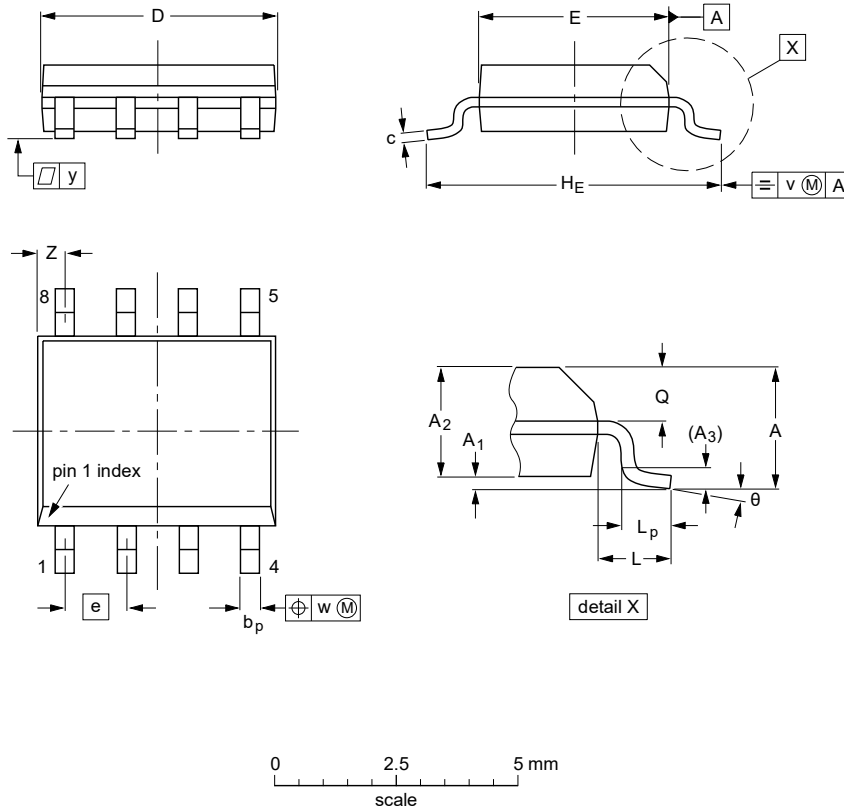


This (component or material) is Recognized by UL. Representative samples of this component have been evaluated by UL and meet applicable UL requirements.

17 Package outline

SO8: plastic small outline package; 8 leads; body width 3.9 mm

SOT96-1



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

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

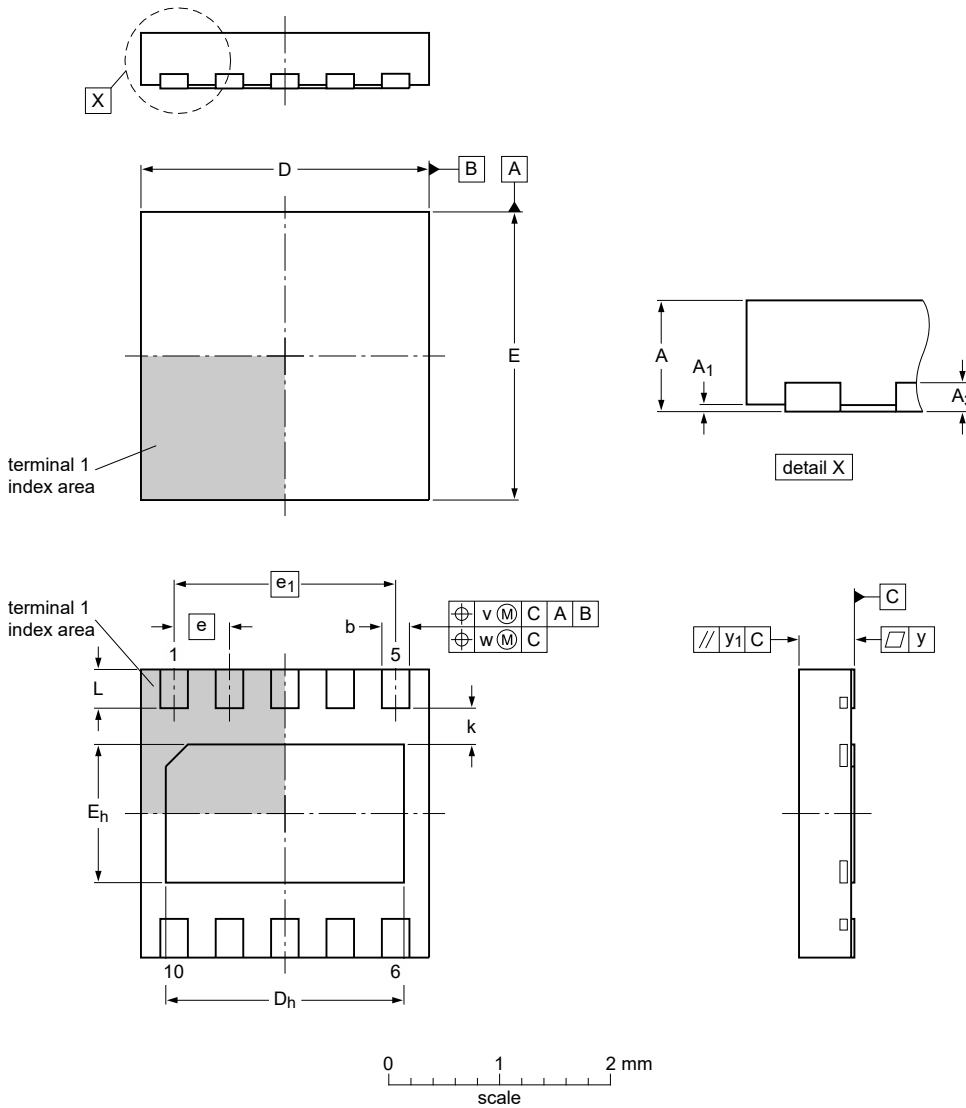
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA		
SOT96-1	076E03	MS-012			99-12-27 03-02-18

Figure 45. Package outline SOT96-1 (SO8), PCF85263AT

DFN2626-10: plastic thermal enhanced extremely thin small outline package; no leads;
10 terminals; body 2.6 x 2.6 x 0.5 mm

SOT1197-1



Dimensions

Unit ⁽¹⁾	A	A ₁	A ₃	b	D	D _h	E	E _h	e	e ₁	k	L	v	w	y	y ₁
max	0.5	0.05		0.30	2.7	2.20	2.7	1.30				0.40				
mm nom			0.127	0.25	2.6	2.15	2.6	1.25	0.5	2		0.35	0.1	0.05	0.05	0.05
min		0.00		0.20	2.5	2.10	2.5	1.20			0.2	0.30				

Note

1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

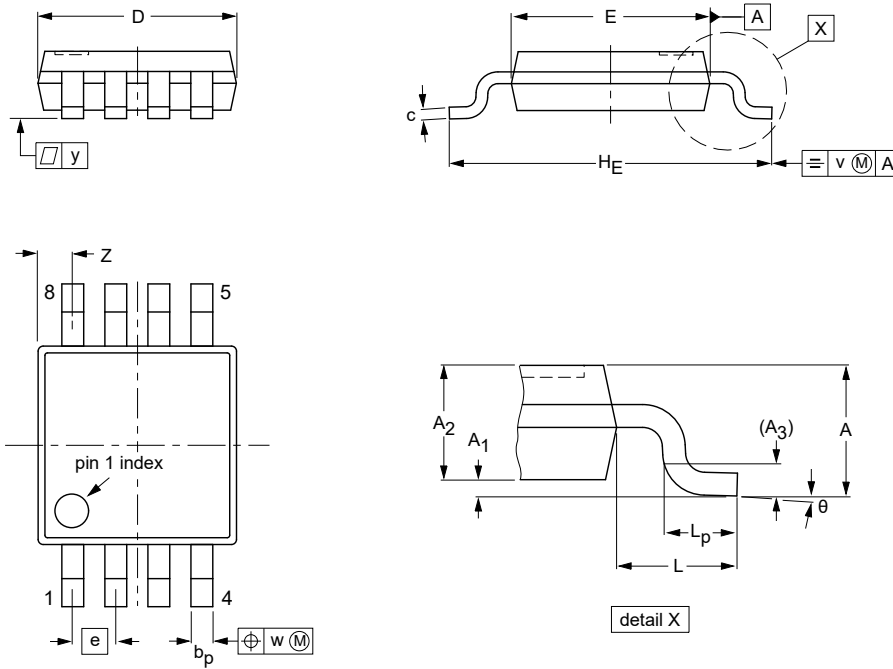
sot1197-1_po

Outline version	References			European projection	Issue date
	IEC	JEDEC	JEITA		
SOT1197-1	---	---	---		11-01-20 12-09-16

Figure 46. Package outline SOT1197-1 (DFN2626-10), PCF85263ATL

TSSOP8: plastic thin shrink small outline package; 8 leads; body width 3 mm

SOT505-1



DIMENSIONS (mm are the original dimensions)

UNIT	A _{max.}	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	v	w	y	Z ⁽¹⁾	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.45 0.25	0.28 0.15	3.1 2.9	3.1 2.9	0.65	5.1 4.7	0.94	0.7 0.4	0.1	0.1	0.1	0.70 0.35	6° 0°

Notes

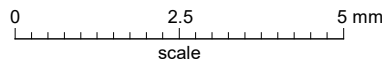
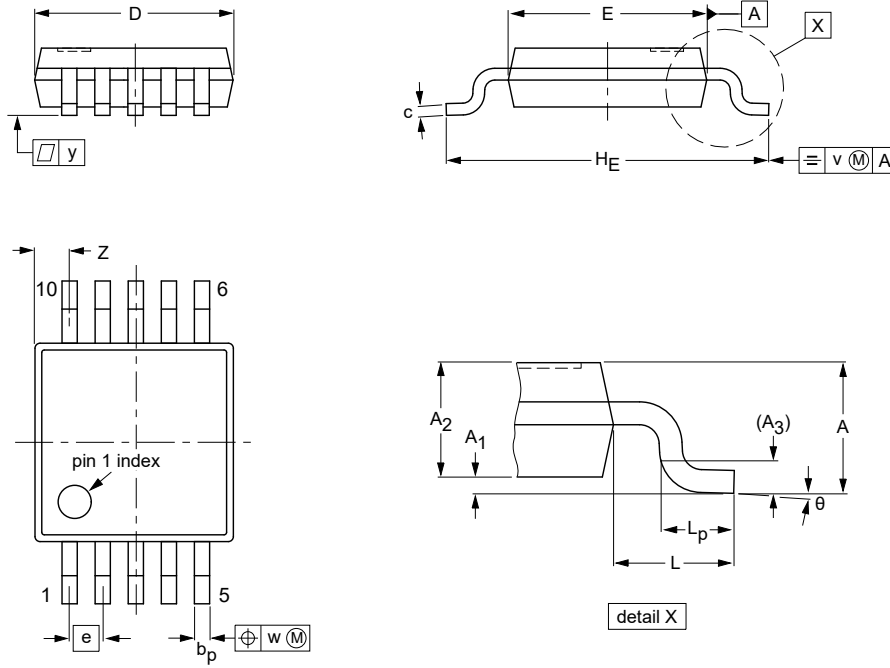
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT505-1						99-04-09 03-02-18

Figure 47. Package outline SOT505-1 (TSSOP8), PCF85263ATT

TSSOP10: plastic thin shrink small outline package; 10 leads; body width 3 mm

SOT552-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	v	w	y	Z ⁽¹⁾	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.15	0.23 0.15	3.1 2.9	3.1 2.9	0.5	5.0 4.8	0.95	0.7 0.4	0.1	0.1	0.1	0.67 0.34	6° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT552-1						-99-07-29- 03-02-18

Figure 48. Package outline SOT552-1 (TSSOP10), PCF85263ATT1

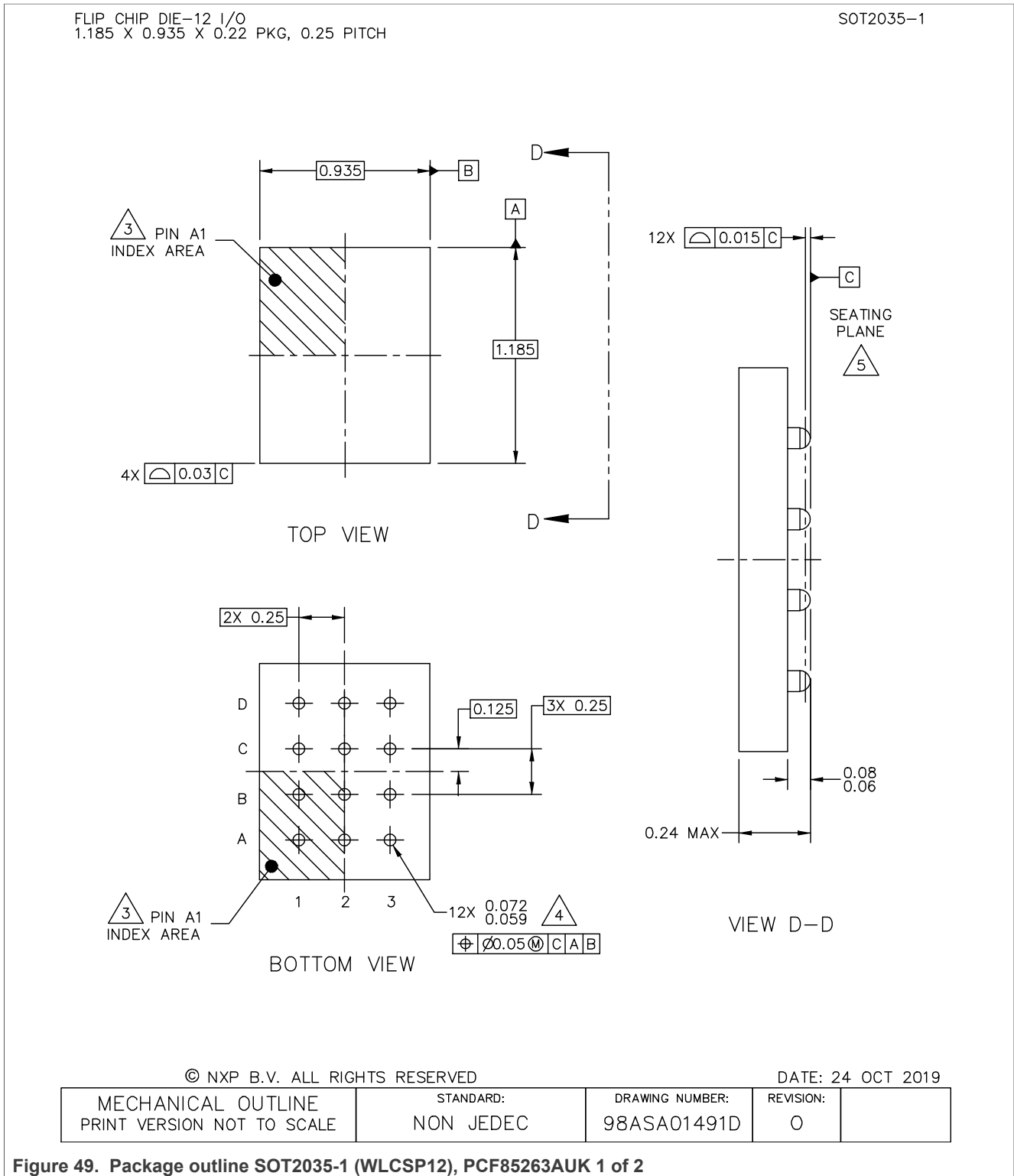


Figure 49. Package outline SOT2035-1 (WLCSP12), PCF85263AUK 1 of 2

Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

FLIP CHIP DIE—12 I/O
1.185 X 0.935 X 0.22 PKG, 0.25 PITCH

SOT2035-1

NOTES:

1. ALL DIMENSIONS IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PIN A1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. MAXIMUM SOLDER BALL DIAMETER MEASURED PARALLEL TO DATUM C.
5. DATUM C, THE SEATING PLANE, IS DETERMINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.

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DATE: 24 OCT 2019

MECHANICAL OUTLINE PRINT VERSION NOT TO SCALE	STANDARD: NON JEDEC	DRAWING NUMBER: 98ASA01491D	REVISION: 0	
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Figure 50. Package outline SOT2035-1 (WLCSP12), PCF85263AUK 2 of 2

18 Handling information

All input and output pins are protected against ElectroStatic Discharge (ESD) under normal handling. When handling Metal-Oxide Semiconductor (MOS) devices ensure that all normal precautions are taken as described in *JESD625-A*, *IEC 61340-5* or equivalent standards.

19 Packing information

For tape and reel packing information, please see [4], [5], [6], and [7] in [Section 24](#).

20 Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

20.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

20.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

20.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

20.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 51](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 69](#) and [Table 70](#)

Table 69. SnPb eutectic process (from J-STD-020D)

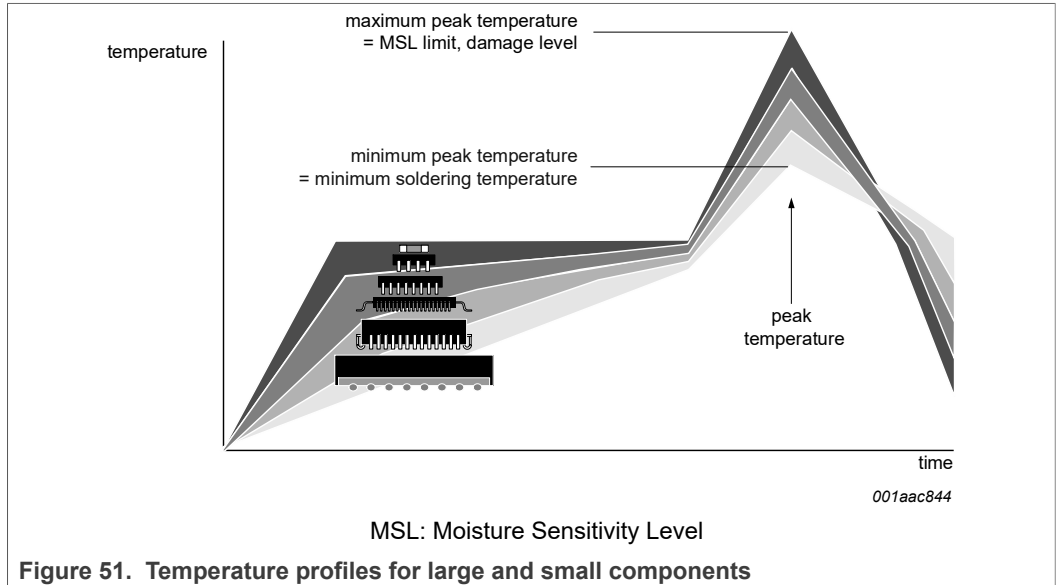
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm ³)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

Table 70. Lead-free process (from J-STD-020D)

Package thickness (mm)	Package reflow temperature (°C)		
	Volume (mm ³)		
	< 350	350 to 2000	> 2000
< 1.6	260	260	260
1.6 to 2.5	260	250	245
> 2.5	250	245	245

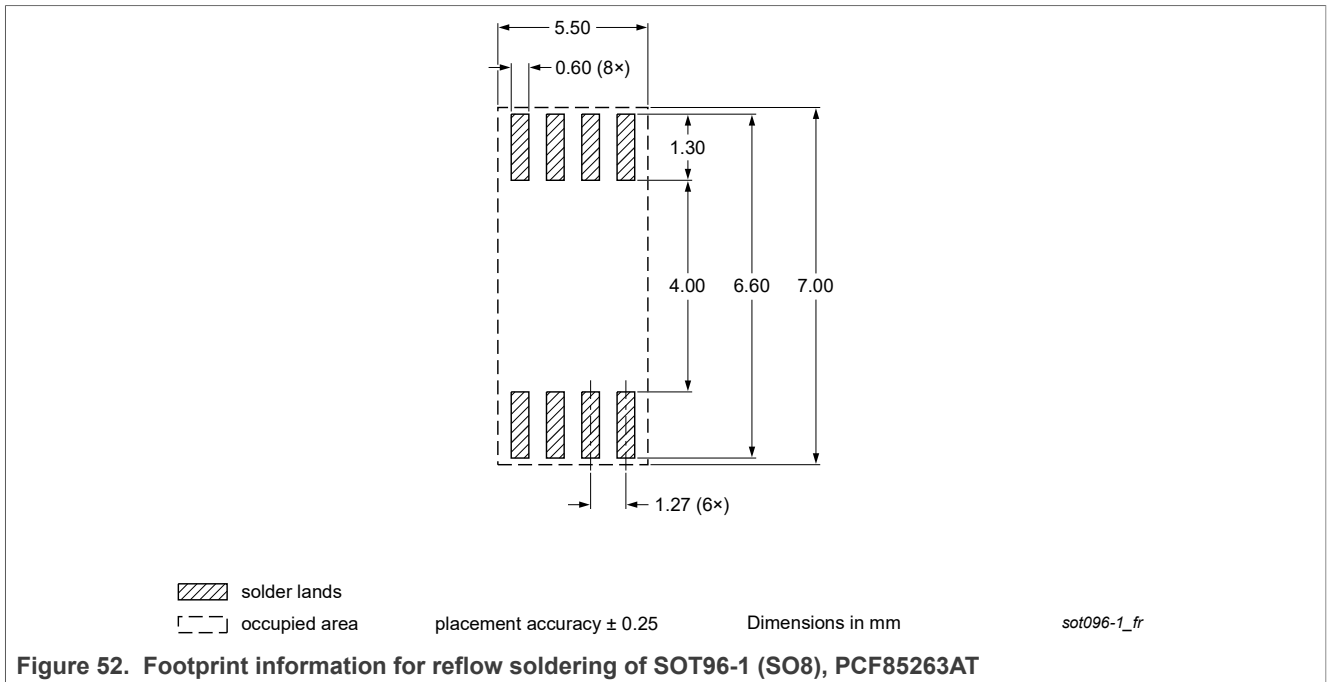
Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 51](#).



For further information on temperature profiles, refer to Application Note AN10365 “Surface mount reflow soldering description”.

21 Footprint information



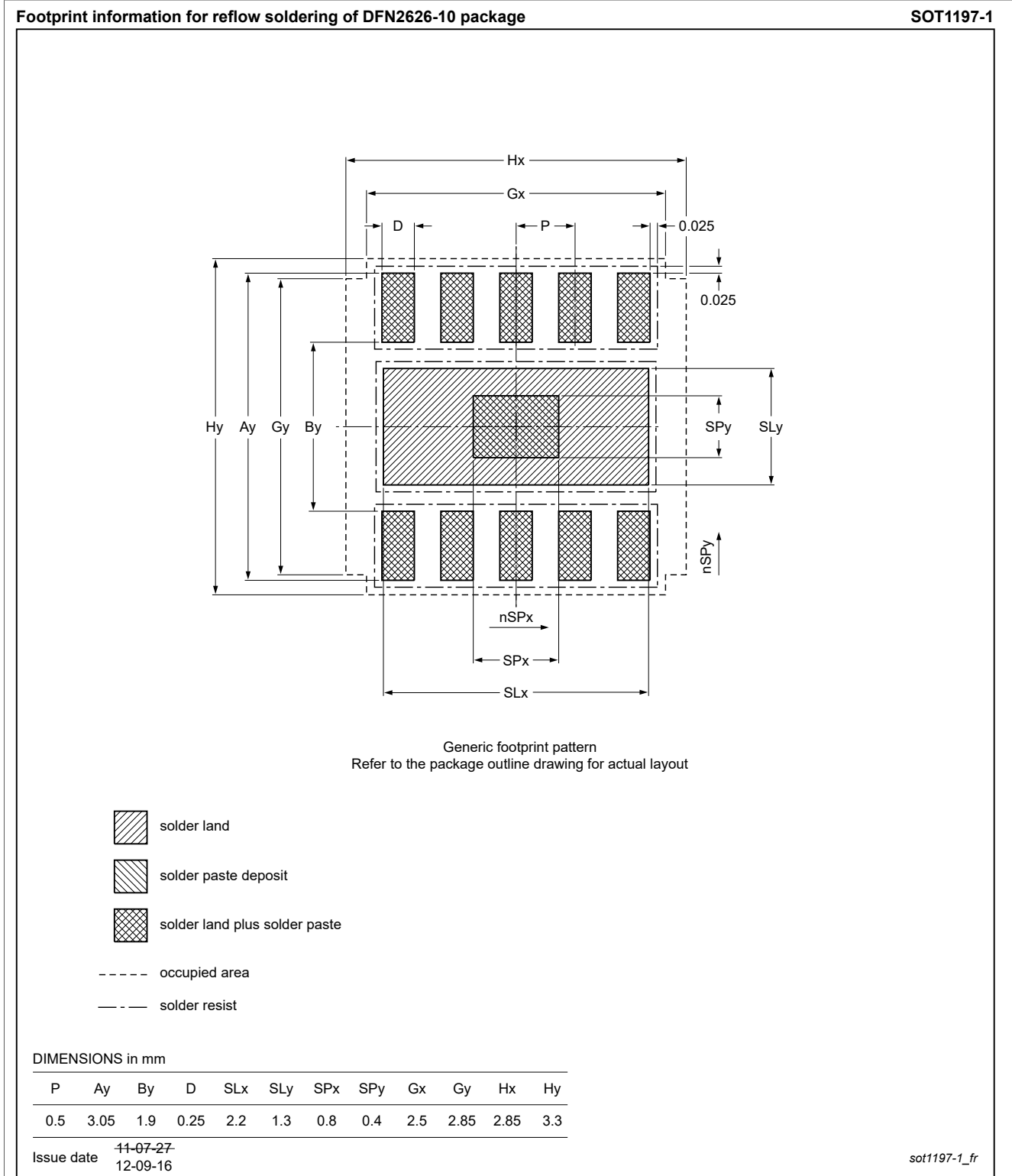
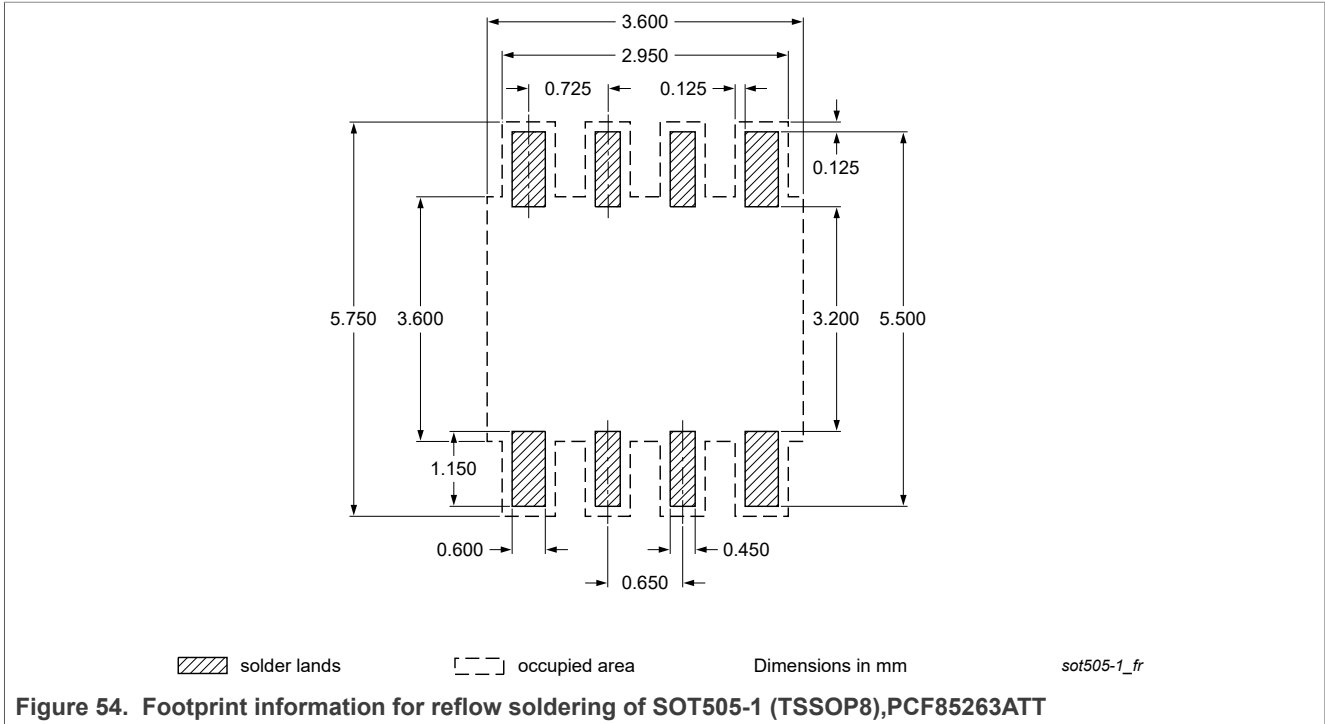


Figure 53. Footprint information for reflow soldering of SOT1197-1 (DFN2626-10),PCF85263ATL



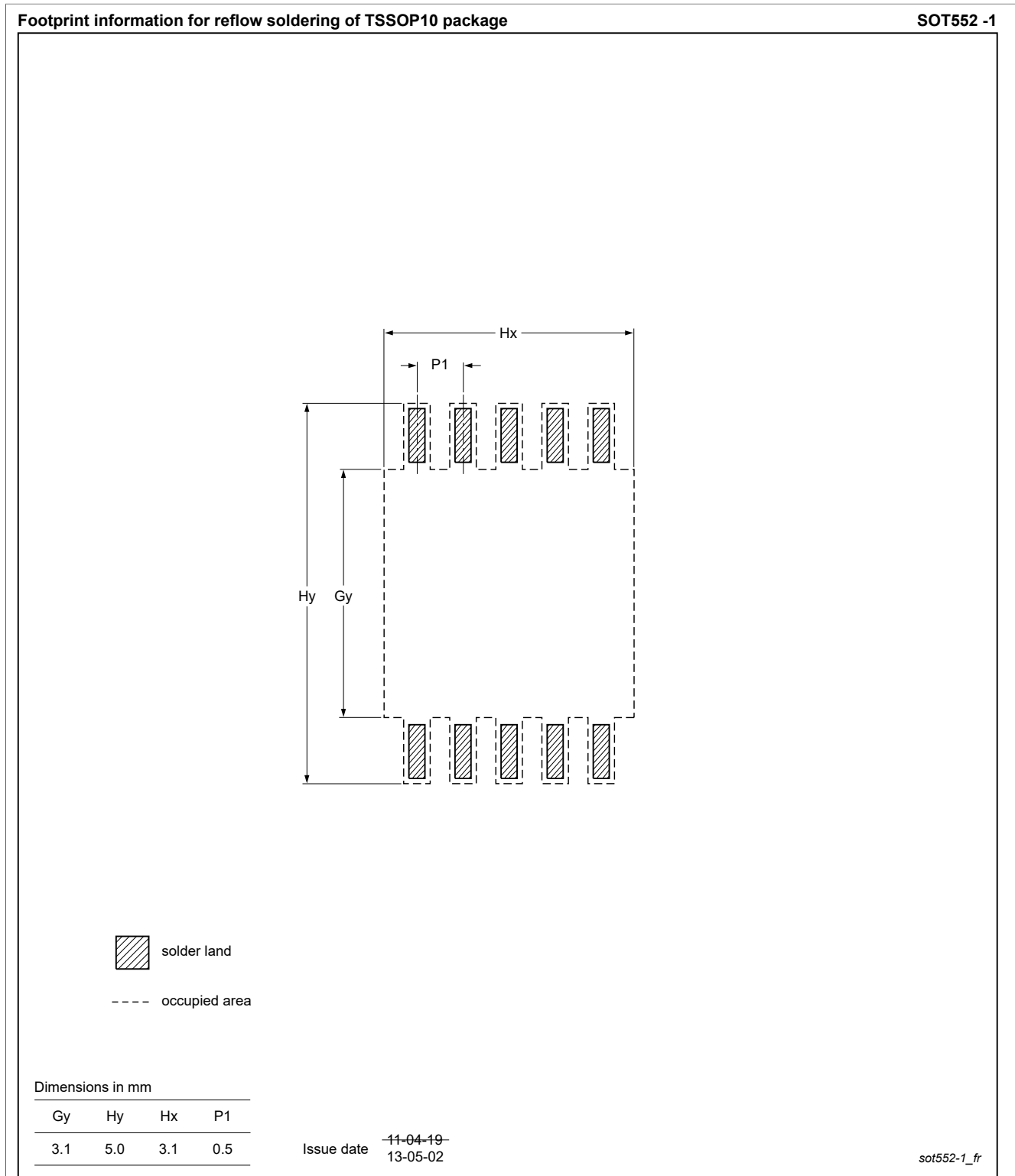


Figure 55. Footprint information for reflow soldering of SOT552-1 (TSSOP10), PCF85263ATT1

22 Appendix

22.1 Real-Time Clock selection

Table 71. Selection of Real-Time Clocks

Type name	Alarm, Timer, Watchdog	Interrupt output	Interface	I _{DD} , typical (nA)	Battery backup	Timestamp, tamper input	AEC-Q100 compliant	Special features	Packages
PCF8563	X	1	I ² C	250	-	-	-	-	SO8, TSSOP8, HVSON10
PCF8564A	X	1	I ² C	250	-	-	-	integrated oscillator caps	WLCSP
PCA8565	X	1	I ² C	600	-	-	grade 1	high robustness, T _{amb} = -40 °C to 125 °C	TSSOP8, HVSON10
PCA8565A	X	1	I ² C	600	-	-	-	integrated oscillator caps, T _{amb} = -40 °C to 125 °C	WLCSP
PCF85063	-	1	I ² C	220	-	-	-	basic functions only, no alarm	HXSON8
PCF85063A	X	1	I ² C	220	-	-	-	tiny package	SO8, DFN2626-10
PCF85063B	X	1	SPI	220	-	-	-	tiny package	DFN2626-10
PCF85263A	X	2	I ² C	230	X	X	-	time stamp, battery backup, stopwatch 1/100 s	SO8, TSSOP10, TSSOP8, DFN2626-10
PCF85263B	X	2	SPI	230	X	X	-	time stamp, battery backup, stopwatch 1/100s	TSSOP10, DFN2626-10
PCF85363A	X	2	I ² C	230	X	X	-	time stamp, battery backup, stopwatch 1/100s, 64 Byte RAM	TSSOP10, DFN2626-10
PCF85363B	X	2	SPI	230	X	X	-	time stamp, battery backup, stopwatch 1/100s, 64 Byte RAM	TSSOP10, DFN2626-10
PCF8523	X	2	I ² C	150	X	-	-	lowest power 150 nA in operation, FM+ 1 MHz	SO8, HVSON8, TSSOP14, WLCSP
PCF2123	X	1	SPI	100	-	-	-	lowest power 100 nA in operation	TSSOP14, HVQFN16
PCF2127	X	1	I ² C and SPI	500	X	X	-	temperature compensated, quartz built in, calibrated, 512 Byte RAM	SO16
PCF2127A	X	1	I ² C and SPI	500	X	X	-	temperature compensated, quartz built in, calibrated, 512 Byte RAM	SO20
PCF2129	X	1	I ² C and SPI	500	X	X	-	temperature compensated, quartz built in, calibrated	SO16
PCF2129A	X	1	I ² C and SPI	500	X	X	-	temperature compensated, quartz built in, calibrated	SO20
PCA2129	X	1	I ² C and SPI	500	X	X	grade 3	temperature compensated, quartz built in, calibrated	SO16
PCA21125	X	1	SPI	820	-	-	grade 1	high robustness, T _{amb} = -40 °C to 125 °C	TSSOP14

23 Abbreviations

Table 72. Abbreviations

Acronym	Description
BCD	Binary Coded Decimal
CMOS	Complementary Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
I ² C	Inter-Integrated Circuit
IC	Integrated Circuit
LSB	Least Significant Bit

Table 72. Abbreviations...continued

Acronym	Description
MSB	Most Significant Bit
MSL	Moisture Sensitivity Level
PCB	Printed-Circuit Board
POR	Power-On Reset
RTC	Real-Time Clock
SCL	Serial CLock line
SDA	Serial DATa line
SMD	Surface Mount Device

24 References

- [1] JESD22-A114 Electrostatic Discharge (ESD) Sensitivity Testing Human Body Model (HBM)
- [2] JESD22-C101 Field-Induced Charged-Device Model Test Method for Electrostatic-Discharge-Withstand Thresholds of Microelectronic Components
- [3] JESD78 IC Latch-Up Test
- [4] SOT96-1_118 SO8; Reel pack; SMD, 13", packing information
- [5] SOT505-1_118 TSSOP8; Reel pack; SMD, 13", packing information
- [6] SOT552-1_118 TSSOP10; Reel pack; SMD, 13", packing information
- [7] SOT1197-1_115 DFN2626-10; Reel pack; SMD, 7", packing information
- [8] UM10204 I²C-bus specification and user manual
- [9] UM10569 Store and transport requirements

25 Revision history

Table 73. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCF85263A v.5	20210201	Product data sheet	-	PCF85263A v.4.1
Modification:	<ul style="list-style-type: none"> • Added product type number PCF85263AUK • Updated Section 4 			
PCF85263A v.4.1	20151127	Product data sheet	-	PCF85263A v.4
Modification:	<ul style="list-style-type: none"> • Correction of typo release date. 			
PCF85263A v.4	20151118	Product data sheet	-	PCF85263A v.3
Modifications:	<ul style="list-style-type: none"> • Updated Table 3 ^[1] • Updated Table 58 ^[2] • Table 67: <ul style="list-style-type: none"> – Corrected V_I min from V_{SS} to -0.5 V – Corrected V_{IL} min from V_{SS} to -0.5 V – Corrected V_{IH} max from V_{DD} to 5.5 V – Corrected ^[3] – Added ^[4] • Added text to Section 15 			

Table 73. Revision history...continued

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCF85263A v.3	20150116	Product data sheet	-	PCF85263A v.2
Modifications:	<ul style="list-style-type: none"> • Corrected Figure 36, Section 2 • Corrected V_{th} values in Table 67 • Added ESD values of PCF85263AT in Table 66 			
PCF85263A v.2	20140710	Product data sheet	-	PCF85263A v.1
PCF85263A v.1	20140418	Product data sheet	-	-

- [1] The die paddle (exposed pad) is connected to V_{SS} through high ohmic (non-conductive) silicon attach and should be electrically isolated. It is good engineering practice to solder the exposed pad to an electrically isolated PCB copper pad as shown in [Figure 46](#) for better heat transfer but it is not required as the RTC doesn't consume much power. In no case should traces be run under the package exposed pad.
- [2] Default values. The duty cycle of the CLKOUT when outputting 32,768 Hz could change from 60:40 to 40:60 depending on the detector since the 32,768 Hz is derived from the oscillator output which is not perfect. It could change from device to device and it depends on the silicon diffusion. There is nothing that can be done from outside the chip to influence the duty cycle.
- [3] For reliable oscillator start-up at power-on use V_{DD} greater than 1.2 V. If powered up at 0.9 V the oscillator will start but it might be a bit slow, especially if at high temperature. Normally the power supply is not 0.9 V at start-up and only comes at the end of battery discharge. V_{DD} min of 0.9 V is specified so that the customer can calculate how large a battery or capacitor they need for their application. V_{DD} min of 1.2 V or greater is needed to ensure speedy oscillator start-up time.
- [4] 400 kHz I2C operation is production tested at 1.8 V. Design methodology allows I2C operation at 1.8 V - 5 % (1.71 V) which has been verified during product characterization on a limited number of devices.

26 Legal information

26.1 Data sheet status

Document status ^{[1][2]}	Product status ^[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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Tiny Real-Time Clock/calendar with alarm function, battery switch-over, time stamp input, and I²C-bus

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Tables

Tab. 1.	Ordering information	2	Tab. 37.	BSOFF bit - battery switch control (address 26h) bit description	40
Tab. 2.	Ordering options	2	Tab. 38.	BSRR bit - battery switch control (address 26h) bit description	41
Tab. 3.	Pin description	5	Tab. 39.	BSM[1:0] bits - battery switch control (address 26h) bit description	41
Tab. 4.	RTC mode time registers	8	Tab. 40.	Battery switch-over modes	41
Tab. 5.	Stop-watch mode time registers	9	Tab. 41.	BSTH - battery switch control (address 26h) bit description	45
Tab. 6.	Control and function registers overview	10	Tab. 42.	Pin_IO- pin input output control register (address 27h) bit description	45
Tab. 7.	Time and date registers in RTC mode (RTCM = 0)	11	Tab. 43.	CLKPM bit - Pin_IO control register (address 27h)	45
Tab. 8.	BCD coding	11	Tab. 44.	TSPULL bit - Pin_IO control register (address 27h)	46
Tab. 9.	Weekday assignments	12	Tab. 45.	TSL bit - Pin_IO control register (address 27h)	46
Tab. 10.	Month assignments in BCD format	13	Tab. 46.	TSPM[1:0] bits - Pin_IO control register (address 27h)	46
Tab. 11.	Time registers in stop-watch mode (RTCM = 1)	14	Tab. 47.	TSIM bit - Pin_IO control register (address 27h)	47
Tab. 12.	Alarm1 and alarm2 registers in RTC mode coded in BCD (RTCM = 0)	16	Tab. 48.	INTAPM[1:0] bits - Pin_IO control register (address 27h)	48
Tab. 13.	Alarm_enables- alarm enable control register (address 10h) bit description	17	Tab. 49.	INTA battery mode	49
Tab. 14.	Alarm1 and alarm2 registers in stop-watch mode coded in BCD (RTCM = 1)	20	Tab. 50.	Function - chip function control register (address 28h) bit description	49
Tab. 15.	Alarm_enables- alarm enable control register (address 10h) bit description	20	Tab. 51.	100TH bit - Function control register (address 28h)	49
Tab. 16.	WatchDog - WatchDog control and register (address 2Dh) bit description	23	Tab. 52.	PI[1:0] bits - Function control register (address 28h)	49
Tab. 17.	WatchDog durations	23	Tab. 53.	RTCM bit - Function control register (address 28h)	50
Tab. 18.	RAM_byte - 8-bit RAM register (address 2Ch) bit description	25	Tab. 54.	RTC time counting modes	50
Tab. 19.	TSR_mode - timestamp mode control register (address 23h) bit description	26	Tab. 55.	STOPM bit - Function control register (address 28h)	50
Tab. 20.	Timestamp registers in RTC mode (RTCM = 0)	28	Tab. 56.	Oscillator stop control when STOPM = 1	51
Tab. 21.	Timestamp registers in stop-watch mode (RTCM = 1)	29	Tab. 57.	COF[2:0] bits - Function control register (address 28h)	51
Tab. 22.	Offset - offset register (address 24h) bit description	30	Tab. 58.	Clock duty cycles	52
Tab. 23.	OFFM bit - oscillator control register (address 25h)	30	Tab. 59.	Flags - Flag status register (address 2Bh) bit description	52
Tab. 24.	Offset values	31	Tab. 60.	Reset - software reset control (address 2Fh) bit description	53
Tab. 25.	Correction pulses for OFFM = 0	31	Tab. 61.	Registers reset values	54
Tab. 26.	Correction pulses for OFFM = 1	32	Tab. 62.	Stop_enable - control of STOP bit (address 2Eh)	56
Tab. 27.	INTA and INTB interrupt control bits	34	Tab. 63.	Counter stop signal	56
Tab. 28.	Definition of interrupt control bits	34	Tab. 64.	I2C slave address byte	60
Tab. 29.	Oscillator - oscillator control register (address 25h) bit description	38	Tab. 65.	Application configuration	61
Tab. 30.	CLKIV bit - oscillator control register (address 25h)	38	Tab. 66.	Limiting values	64
Tab. 31.	12_24 bit - oscillator control register (address 25h)	38	Tab. 67.	Characteristics	64
Tab. 32.	LOWJ bit - oscillator control register (address 25h)	38	Tab. 68.	I2C-bus characteristics	69
Tab. 33.	OSCD[1:0] bits - oscillator control register (address 25h)	39	Tab. 69.	SnPb eutectic process (from J-STD-020D)	79
Tab. 34.	CL[1:0] bits - oscillator control register (address 25h)	39	Tab. 70.	Lead-free process (from J-STD-020D)	79
Tab. 35.	IO pin behavior in battery mode	40	Tab. 71.	Selection of Real-Time Clocks	84
Tab. 36.	Battery_switch - battery switch control (address 26h) bit description	40	Tab. 72.	Abbreviations	84

Tab. 73. Revision history	85
---------------------------------	----

Figures

Fig. 1. Block diagram of PCF85263A	3	Fig. 33. STOP release timing	57
Fig. 2. Pin configuration for PCF85263AT (SO8)	4	Fig. 34. I2C read and write protocol	58
Fig. 3. Pin configuration for PCF85263ATL (DFN2626-10)	4	Fig. 35. I2C read and write signaling	58
Fig. 4. Pin configuration for PCF85263ATT (TSSOP8)	4	Fig. 36. Application example	61
Fig. 5. Pin configuration for PCF85263ATT1 (TSSOP10)	5	Fig. 37. Application example timing	62
Fig. 6. Pin configuration for PCF85263AUK (WLCSP12)	5	Fig. 38. Device diode protection diagram of PCF85263A	63
Fig. 7. Address register incrementing	6	Fig. 39. Typical IDD with respect to fSCL	67
Fig. 8. Register map	7	Fig. 40. Typical IDD as a function of temperature	67
Fig. 9. Time mode register set selection	7	Fig. 41. Typical IDD with respect to VDD	68
Fig. 10. OS status bit	12	Fig. 42. Oscillator frequency variation with respect to VDD	69
Fig. 11. Data flow for the time function	13	Fig. 43. I2C-bus timing diagram; rise and fall times refer to 30 % and 70 %	70
Fig. 12. Data flow for the stop-watch function	16	Fig. 44. Application diagram for PCF85263A	71
Fig. 13. Alarm1 and alarm2 function block diagram (RTC mode)	19	Fig. 45. Package outline SOT96-1 (SO8), PCF85263AT	72
Fig. 14. Alarm1 and alarm2 function block diagram (stop-watch mode)	22	Fig. 46. Package outline SOT1197-1 (DFN2626-10), PCF85263ATL	73
Fig. 15. WatchDog repeat mode	24	Fig. 47. Package outline SOT505-1 (TSSOP8), PCF85263ATT	74
Fig. 16. WatchDog single shot mode	25	Fig. 48. Package outline SOT552-1 (TSSOP10), PCF85263ATT1	75
Fig. 17. Timestamp	26	Fig. 49. Package outline SOT2035-1 (WLCSP12), PCF85263AUK 1 of 2	76
Fig. 18. Example battery switch-over timestamp	27	Fig. 50. Package outline SOT2035-1 (WLCSP12), PCF85263AUK 2 of 2	77
Fig. 19. Example TS pin driven timestamp	28	Fig. 51. Temperature profiles for large and small components	80
Fig. 20. Offset calibration calculation workflow	33	Fig. 52. Footprint information for reflow soldering of SOT96-1 (SO8), PCF85263AT	80
Fig. 21. Result of offset calibration	33	Fig. 53. Footprint information for reflow soldering of SOT1197-1 (DFN2626-10), PCF85263ATL	81
Fig. 22. Interrupt pulse width	36	Fig. 54. Footprint information for reflow soldering of SOT505-1 (TSSOP8), PCF85263ATT	82
Fig. 23. Interrupt selection	37	Fig. 55. Footprint information for reflow soldering of SOT552-1 (TSSOP10), PCF85263ATT1	83
Fig. 24. Threshold voltage switching hysteresis	42		
Fig. 25. Switching at V _{th}	42		
Fig. 26. Switching at V _{BAT}	43		
Fig. 27. Switching at the higher of V _{BAT} or V _{th}	44		
Fig. 28. Switching at the lower of V _{BAT} or V _{th}	44		
Fig. 29. TS pin	47		
Fig. 30. INTA pin	48		
Fig. 31. Software reset command	54		
Fig. 32. CPR and STOP bit functional diagram	56		

Contents

1	General description	1	7.10	Oscillator register	38
2	Features and benefits	1	7.10.1	CLKIV: invert the clock output	38
3	Applications	1	7.10.2	OFFM: offset calibration mode	38
4	Ordering information	2	7.10.3	12_24: 12 hour or 24 hour clock	38
4.1	Ordering options	2	7.10.4	LOWJ: low jitter mode	38
5	Block diagram	3	7.10.5	OSCD[1:0]: quartz oscillator drive control	39
6	Pinning information	4	7.10.6	CL[1:0]: quartz oscillator load capacitance	39
6.1	Pinning	4	7.11	Battery switch register	40
6.2	Pin description	5	7.11.1	BSOFF: battery switch on/off control	40
7	Functional description	6	7.11.2	BSRR: battery switch internal refresh rate	41
7.1	Registers organization overview	7	7.11.3	BSM[1:0]: battery switch mode	41
7.1.1	Time mode registers	7	7.11.3.1	Switching at the V _{th} level, BSM[1:0] = 00	42
7.1.1.1	RTC mode time registers overview (RTCM = 0)	8	7.11.3.2	Switching at the VBAT level, BSM[1:0] = 01	43
7.1.1.2	Stop-watch mode time registers (RTCM = 1)	9	7.11.3.3	Switching at the higher of VBAT or V _{th} level, BSM[1:0] = 10	43
7.1.2	Control registers overview	10	7.11.3.4	Switching at the lower of VBAT and V _{th} level, BSM[1:0] = 11	44
7.2	RTC mode time and date registers	10	7.11.4	BSTH: threshold voltage control	45
7.2.1	Definition of BCD	11	7.11.5	Battery switch interrupts	45
7.2.2	OS: Oscillator stop	11	7.12	Pin_IO register	45
7.2.3	EMON: event monitor	12	7.12.1	CLKPM: CLK pin mode control	45
7.2.4	Definition of weekdays	12	7.12.2	TSPULL: TS pin pull-up resistor value	46
7.2.5	Definition of months	13	7.12.3	TSL: TS pin level sense	46
7.2.6	Setting and reading the time in RTC mode	13	7.12.4	TSPM[1:0]: TS pin I/O control	46
7.3	Stop-watch mode time registers	14	7.12.4.1	TS pin output mode; INTB	47
7.3.1	Setting and reading the time in stop-watch mode	15	7.12.4.2	TS pin output mode; CLK	47
7.4	Alarms	16	7.12.4.3	TS pin disabled	47
7.4.1	Alarms in RTC mode	16	7.12.5	TSIM: TS pin input type control	47
7.4.1.1	Alarm1 and alarm2 registers in RTC mode	16	7.12.5.1	TS pin input mode	48
7.4.1.2	Alarm1 and alarm2 control in RTC mode	17	7.12.6	INTAPM[1:0]: INTA pin mode control	48
7.4.1.3	Alarm1 and alarm2 function in RTC mode	18	7.12.6.1	INTAPM[1:0]: INTA	48
7.4.2	Alarms in stop-watch mode	19	7.12.6.2	INTAPM[1:0]: clock data	48
7.4.2.1	Alarm1 and alarm2 registers in stop-watch mode	19	7.12.6.3	INTAPM[1:0]: battery mode indication	49
7.4.2.2	Alarm1 and alarm2 control in stop-watch mode	20	7.13	Function register	49
7.4.2.3	Alarm1 and alarm2 function in stop-watch mode	21	7.13.1	100TH: 100th seconds mode	49
7.4.3	Alarm interrupts	22	7.13.2	PI[1:0]: Periodic interrupt	49
7.5	WatchDog	23	7.13.3	RTCM: RTC mode	50
7.5.1	WatchDog functions	23	7.13.4	STOPM: STOP mode control	50
7.5.1.1	WatchDog repeat mode	24	7.13.5	COF[2:0]: Clock output frequency	51
7.5.1.2	WatchDog single shot mode	24	7.14	Flags register	52
7.5.1.3	WatchDog interrupts	25	7.15	Reset register	53
7.6	RAM byte	25	7.15.1	SR - Software reset	53
7.7	Timestamps	25	7.15.2	CPR: clear prescaler	55
7.7.1	Timestamps interrupts	30	7.15.3	CTS: clear timestamp	56
7.8	Offset register	30	7.16	Stop_enable register	56
7.8.1	Correction when OFFM = 0	31	8	I²C-bus interface	57
7.8.2	Correction when OFFM = 1	32	8.1	Bit transfer	58
7.8.3	Offset calibration workflow	32	8.2	START and STOP conditions	58
7.8.4	Offset interrupts	34	8.3	Acknowledge	58
7.9	Interrupts	34	9	Interface protocol	59
7.9.1	ILPA/ILPB: interrupt level or pulse mode	35	9.1	Write protocol	59
7.9.2	Interrupt enable bits	36	9.2	Read protocol	59
			9.3	Slave addressing	60
			9.3.1	Slave address	60
			10	Application design-in information	60
			11	Internal circuitry	63

12	Safety notes	63
13	Limiting values	64
14	Characteristics	64
15	Application information	71
16	Test information	71
16.1	Quality information	71
17	Package outline	72
18	Handling information	78
19	Packing information	78
20	Soldering of SMD packages	78
20.1	Introduction to soldering	
20.2	Wave and reflow soldering	
20.3	Wave soldering	
20.4	Reflow soldering	
21	Footprint information	80
22	Appendix	84
22.1	Real-Time Clock selection	84
23	Abbreviations	84
24	References	85
25	Revision history	85
26	Legal information	87

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