PCF85063BTL

Tiny Real-Time Clock/calendar with alarm function and SPI-bus

Rev. 2 — 15 April 2013 **Product data sheet**

1. General description

The PCF85063BTL is a CMOS[1] Real-Time Clock (RTC) and calendar optimized for low power consumption. An offset register allows fine-tuning of the clock. All addresses and data are transferred serially via a Serial Peripheral Interface (SPI-bus) with a maximum data rate of 6.25 Mbit/s. The register address is incremented automatically after each written or read data byte.

2. Features and benefits

- Provides year, month, day, weekday, hours, minutes, and seconds based on a 32.768 kHz quartz crystal
- Clock operating voltage: 0.9 V to 5.5 V
- Low current; typical 0.22 μA at V_{DD} = 3.3 V and T_{amb} = 25 °C
- 3 line SPI-bus with a maximum data rate of 7 Mbit/s
- 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)
- Selectable integrated oscillator load capacitors for C_L = 7 pF or C_L = 12.5 pF
- Alarm function
- Countdown timer
- Minute and half minute interrupt
- Internal Power-On Reset (POR)
- Programmable offset register for frequency adjustment

3. Applications

- Digital still camera
- Digital video camera
- Printers
- Copy machines
- Mobile equipment
- Battery powered devices

1. The definition of the abbreviations and acronyms used in this data sheet can be found in Section 19.

4. Ordering information

Table 1. Ordering information

Type number	Package		
	Name	Description	Version
PCF85063BTL	HXSON10	plastic thermal enhanced extremely thin small outline package; no leads; 10 terminals; body 2.6 × 2.6 × 0.5 mm	SOT1197-1

4.1 Ordering options

Table 2. Ordering options

Product type number	IC revision	Sales item (12NC)	Delivery form
PCF85063BTL/1	1	935299022118	tape and reel, 13 inch

5. Marking

Table 3. Marking codes

Product type number	Marking code
PCF85063BTL	063B

6. Block diagram

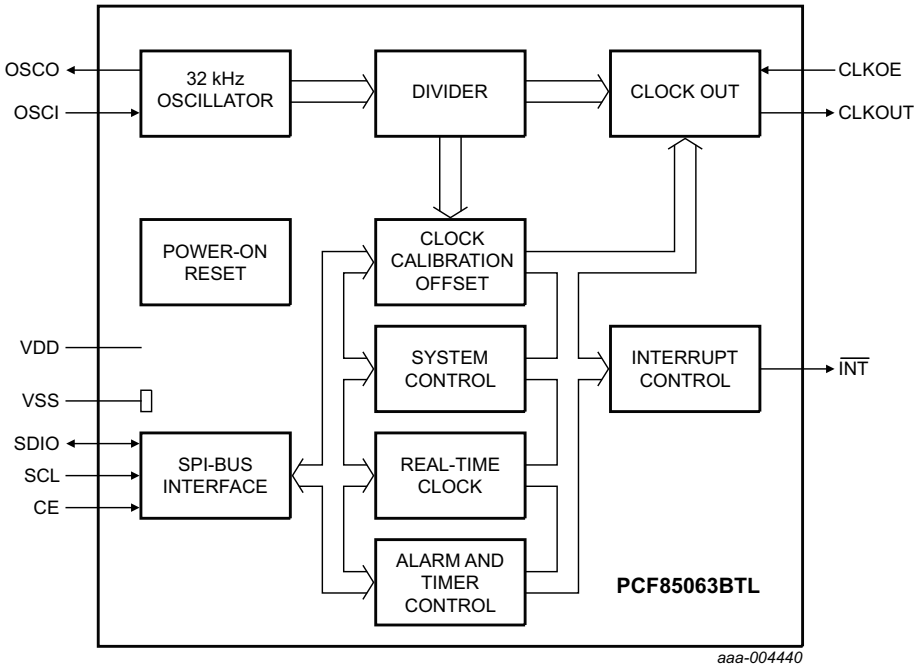
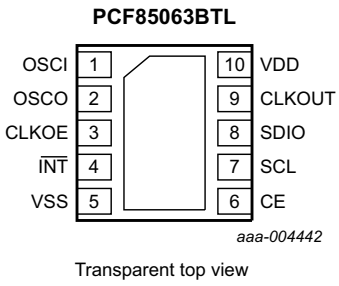


Fig 1. Block diagram of PCF85063BTL

7. Pinning information

7.1 Pinning



Transparent top view

For mechanical details, see Figure 27.

Fig 2. Pin configuration for HXSON10 (PCF85063BTL)

7.2 Pin description

Table 4. Pin description

Symbol	Pin	Type	Description
OSCI	1	input	oscillator input
OSCO	2	output	oscillator output
CLKOE	3	input	CLKOUT enable or disable pin; enable is active HIGH
$\overline{INT}$	4	output	interrupt output (open-drain)
VSS	5[1]	supply	ground supply voltage
CE	6	input	chip enable
SCL	7	input	serial clock input
SDIO	8	input/output	serial data input and output
CLKOUT	9	output	clock output (push-pull)
VDD	10	supply	supply voltage

[1] The die paddle (exposed pad) is connected to V_{SS} and should be electrically isolated.

8. Functional description

The PCF85063BTL contains 18 8-bit registers with 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 calender, and SPI-bus with a maximum data rate of 6.25 Mbit/s.

The built-in address register will increment automatically after each read or write of a data byte up to the register 11h. After register 11h, the auto-incrementing will wrap around to address 00h (see Figure 3).

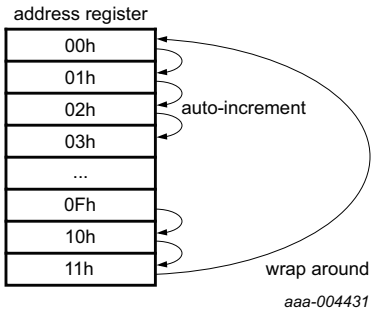


Fig 3. Handling address registers

All registers (see Table 5) are designed as addressable 8-bit parallel registers although not all bits are implemented. The first two registers (memory address 00h and 01h) are used as control and status register. The register at address 02h is an offset register allowing the fine-tuning of the clock; and at 03h is a free RAM byte. The addresses 04h through 0Ah are used as counters for the clock function (seconds up to years counters). Address locations 0Bh through 0Fh contain alarm registers which define the conditions for an alarm. The registers at 10h and 11h are for the timer function.

The 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 written or read, the contents of all time counters are frozen. Therefore, faulty writing or reading of the clock and calendar during a carry condition is prevented.

8.1 Registers organization

Table 5. Registers overview

Bit positions labeled as - are not implemented. After reset, all registers are set according to Table 8 on page 9.

Address	Register name	Bit								Reference
		7	6	5	4	3	2	1	0	
Control and status registers										
00h	Control_1	EXT_TEST	-	STOP	SR	-	CIE	12_24	CAP_SEL	Section 8.2.1
01h	Control_2	AIE	AF	MI	HMI	TF	COF[2:0]			Section 8.2.2
02h	Offset	MODE	OFFSET[6:0]							Section 8.2.3
03h	RAM_byte	B[7:0]								Section 8.2.4
Time and date registers										
04h	Seconds	OS	SECONDS (0 to 59)							Section 8.3.1
05h	Minutes	-	MINUTES (0 to 59)							Section 8.3.2
06h	Hours	-	-	AMPM	HOURS (1 to 12) in 12 hour mode					Section 8.3.3
				HOURS (0 to 23) in 24 hour mode						
07h	Days	-	-	DAYS (1 to 31)						Section 8.3.4
08h	Weekdays	-	-	-	-	-	WEEKDAYS (0 to 6)			Section 8.3.5
09h	Months	-	-	-	MONTHS (1 to 12)					Section 8.3.6
0Ah	Years	YEARS (0 to 99)								Section 8.3.7
Alarm registers										
0Bh	Second_alarm	AEN_S	SECOND_ALARM (0 to 59)							Section 8.5.1
0Ch	Minute_alarm	AEN_M	MINUTE_ALARM (0 to 59)							Section 8.5.2
0Dh	Hour_alarm	AEN_H	-	AMPM	HOUR_ALARM (1 to 12) in 12 hour mode					Section 8.5.3
				HOUR_ALARM (0 to 23) in 24 hour mode						
0Eh	Day_alarm	AEN_D	-	DAY_ALARM (1 to 31)						Section 8.5.4
0Fh	Weekday_alarm	AEN_W	-	-	-	-	WEEKDAY_ALARM (0 to 6)			Section 8.5.5
Timer registers										
10h	Timer_value	T[7:0]								Section 8.6.1
11h	Timer_mode	-	-	-	TCF[1:0]		TE	TIE	TI_TP	Section 8.6.2

8.2 Control registers

8.2.1 Register Control_1

Table 6. Control_1 - control and status register 1 (address 00h) bit description

Bit	Symbol	Value	Description	Reference
7	EXT_TEST		**external clock test mode**	Section 8.2.1.1
		0[1]	normal mode	
		1	external clock test mode	
6	-	0	unused	-
5	STOP		**STOP bit**	Section 8.2.1.2
		0[1]	RTC clock runs	
		1	RTC clock is stopped; all RTC divider chain flip-flops are asynchronously set logic 0	
4	SR		**software reset**	Section 8.2.1.3
		0[1]	no software reset	
		1	initiate software reset[2]; this bit always returns a 0 when read	
3	-	0	unused	-
2	CIE		**correction interrupt enable**	Section 8.2.3
		0[1]	no correction interrupt generated	
		1	interrupt pulses are generated at every correction cycle	
1	12_24		**12 or 24 hour mode**	Section 8.3.3 Section 8.5.3
		0[1]	24 hour mode is selected	
		1	12 hour mode is selected	
0	CAP_SEL		**internal oscillator capacitor selection** for quartz crystals with a corresponding load capacitance	-
		0[1]	7 pF	
		1	12.5 pF	

[1] Default value.

[2] For a software reset, 01011000 (58h) must be sent to register Control_1 (see Section 8.2.1.3).

8.2.1.1 EXT_TEST: external clock test mode

A test mode is available which allows for on-board testing. In this mode, it is possible to set up test conditions and control the operation of the RTC.

The test mode is entered by setting bit EXT_TEST in register Control_1. Then pin CLKOUT becomes an input. The test mode replaces the internal clock signal with the signal applied to pin CLKOUT.

The signal applied to pin CLKOUT should have a minimum pulse width of 300 ns and a maximum period of 1000 ns. The internal clock, now sourced from CLKOUT, is divided down to 1 Hz by a 2^6 divide chain called a prescaler. The prescaler can be set into a known state by using bit STOP. When bit STOP is set, the prescaler is reset to 0. (STOP must be cleared before the prescaler can operate again.)

From a stop condition, the first 1 second increment will take place after 32 positive edges on pin CLKOUT. Thereafter, every 64 positive edges cause a 1 second increment.

Remark: Entry into test mode is not synchronized to the internal 64 Hz clock. When entering the test mode, no assumption as to the state of the prescaler can be made.

Operation example:

1. Set EXT_TEST test mode (register Control_1, bit EXT_TEST = 1).
2. Set STOP (register Control_1, bit STOP = 1).
3. Clear STOP (register Control_1, bit STOP = 0).
4. Set time registers to desired value.
5. Apply 32 clock pulses to pin CLKOUT.
6. Read time registers to see the first change.
7. Apply 64 clock pulses to pin CLKOUT.
8. Read time registers to see the second change.

Repeat 7 and 8 for additional increments.

8.2.1.2 STOP: STOP bit function

The function of the STOP bit (see Figure 4) is to allow for accurate starting of the time circuits. The STOP bit function causes the upper part of the prescaler (F_2 to F_{14}) to be held in reset and thus no 1 Hz ticks are generated. It also stops the output of clock frequencies lower than 8 kHz on pin CLKOUT.

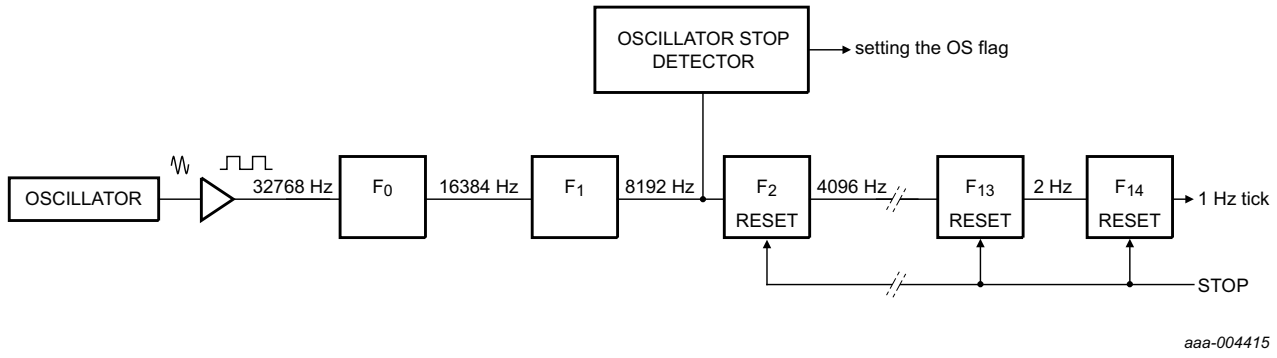
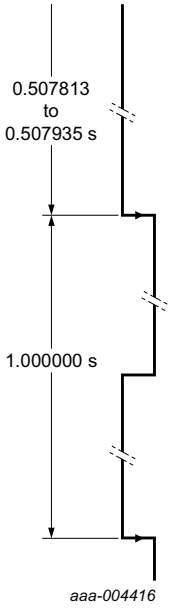


Fig 4. STOP bit functional diagram

The time circuits can then be set and do not increment until the STOP bit is released (see Figure 5 and Table 7).

Table 7. First increment of time circuits after STOP bit release

Bit	Prescaler bits[1]	1 Hz tick	Time	Comment
STOP	F_0F_1-F_2 to F_{14}		hh:mm:ss	
Clock is running normally				
0	01-0 0001 1101 0100		12:45:12	prescaler counting normally
STOP bit is activated by user. F_0F_1 are not reset and values cannot be predicted externally				
1	XX-0 0000 0000 0000		12:45:12	prescaler is reset; time circuits are frozen
New time is set by user				
1	XX-0 0000 0000 0000		08:00:00	prescaler is reset; time circuits are frozen
STOP bit is released by user				
0	XX-0 0000 0000 0000		08:00:00	prescaler is now running
	XX-1 0000 0000 0000		08:00:00	-
	XX-0 1000 0000 0000		08:00:00	-
	XX-1 1000 0000 0000		08:00:00	-
	:		:	:
	11-1 1111 1111 1110		08:00:00	-
	00-0 0000 0000 0001		08:00:01	0 to 1 transition of F_{14} increments the time circuits
	10-0 0000 0000 0001		08:00:01	-
	:		:	:
	11-1 1111 1111 1111		08:00:01	-
	00-0 0000 0000 0000		08:00:01	-
	10-0 0000 0000 0000		08:00:01	-
	:		:	:
	11-1 1111 1111 1110		08:00:01	-
	00-0 0000 0000 0001		08:00:02	0 to 1 transition of F_{14} increments the time circuits

[1] F_0 is clocked at 32.768 kHz.

The lower two stages of the prescaler (F_0 and F_1) are not reset. And because the SPI-bus is asynchronous to the crystal oscillator, the accuracy of restarting the time circuits is between zero and one 8.192 kHz cycle (see Figure 5).

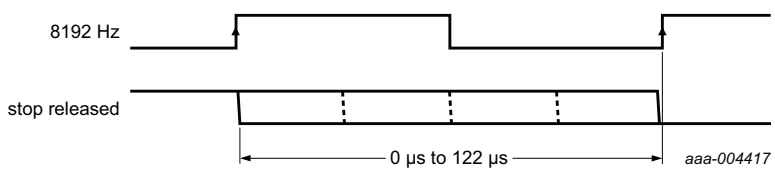
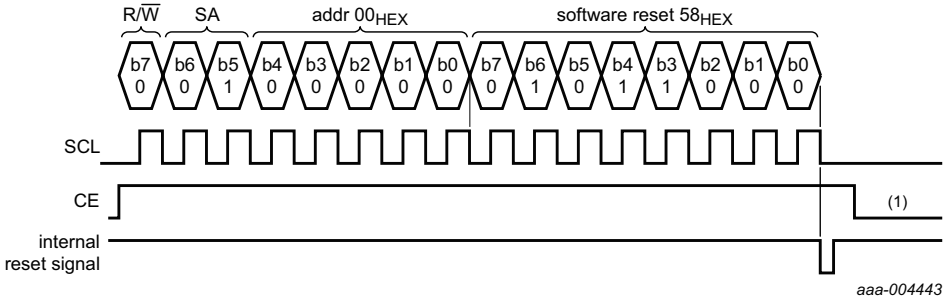


Fig 5. STOP bit release timing

The first increment of the time circuits is between 0.507813 s and 0.507935 s after STOP bit is released. The uncertainty is caused by the prescaler bits F_0 and F_1 not being reset (see Table 7) and the unknown state of the 32 kHz clock.

8.2.1.3 Software reset

A reset is automatically generated at power-on. A reset can also be initiated with the software reset command. Software reset command means setting bits 6, 4, and 3 in register Control_1 (00h) logic 1 and all other bits logic 0 by sending the bit sequence 01011000 (58h), see Figure 6.



(1) When CE is inactive, the interface is reset.

Fig 6. Software reset command

In reset state all registers are set according to Table 8 and the address pointer returns to address 00h.

Table 8. Registers reset values

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
00h	Control_1	0	0	0	0	0	0	0	0
01h	Control_2	0	0	0	0	0	0	0	0
02h	Offset	0	0	0	0	0	0	0	0
03h	RAM_byte	0	0	0	0	0	0	0	0
04h	Seconds	1	0	0	0	0	0	0	0
05h	Minutes	0	0	0	0	0	0	0	0
06h	Hours	0	0	0	0	0	0	0	0
07h	Days	0	0	0	0	0	0	0	1
08h	Weekdays	0	0	0	0	0	1	1	0
09h	Months	0	0	0	0	0	0	0	1
0Ah	Years	0	0	0	0	0	0	0	0
0Bh	Second_alarm	1	0	0	0	0	0	0	0
0Ch	Minute_alarm	1	0	0	0	0	0	0	0
0Dh	Hour_alarm	1	0	0	0	0	0	0	0
0Eh	Day_alarm	1	0	0	0	0	0	0	0
0Fh	Weekday_alarm	1	0	0	0	0	0	0	0
10h	Timer_value	0	0	0	0	0	0	0	0
11h	Timer_mode	0	0	0	1	1	0	0	0

The PCF85063BTL resets to:

Time — 00:00:00

Date — 20000101

Weekday — Saturday

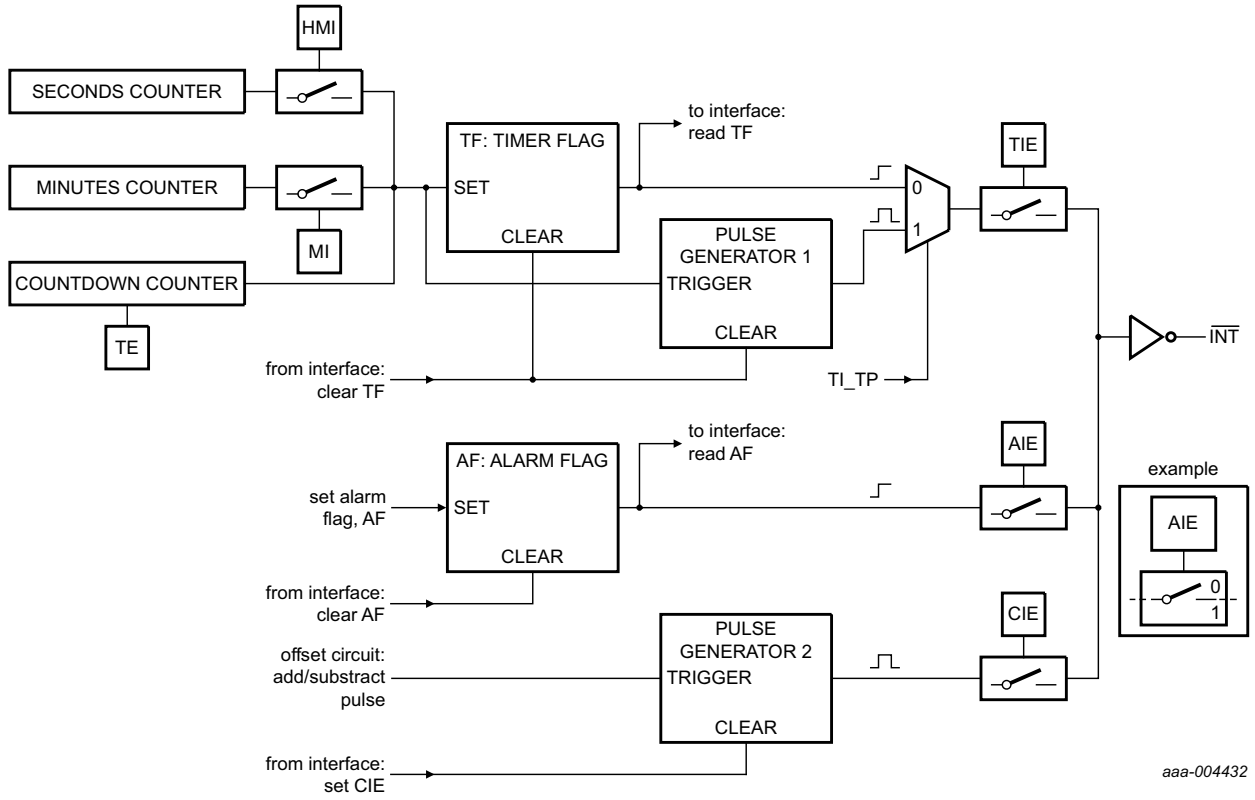
8.2.2 Register Control_2

Table 9. Control_2 - control and status register 2 (address 01h) bit description

Bit	Symbol	Value	Description	Reference
7	AIE		**alarm interrupt**	Section 8.2.2.1 Section 8.5.6
		0[1]	disabled	
		1	enabled	
6	AF		**alarm flag**	Section 8.2.2.1 Section 8.5.6
		0[1]	read: alarm flag inactive	
			write: alarm flag is cleared	
		1	read: alarm flag active	
			write: alarm flag remains unchanged	
5	MI		**minute interrupt**	Section 8.2.2.2 Section 8.2.2.3
		0[1]	disabled	
		1	enabled	
4	HMI		**half minute interrupt**	Section 8.2.2.2 Section 8.2.2.3
		0[1]	disabled	
		1	enabled	
3	TF		**timer flag**	Section 8.2.2.1 Section 8.2.2.3 Section 8.6.3
		0[1]	no timer interrupt generated	
		1	flag set when timer interrupt generated	
2 to 0	COF[2:0]	see Table 11	**CLKOUT control**	Section 8.2.2.4

[1] Default value.

8.2.2.1 Alarm interrupt



When AIE bit is disabled, pin $\overline{INT}$ remains high-impedance.

Fig 7. Interrupt scheme

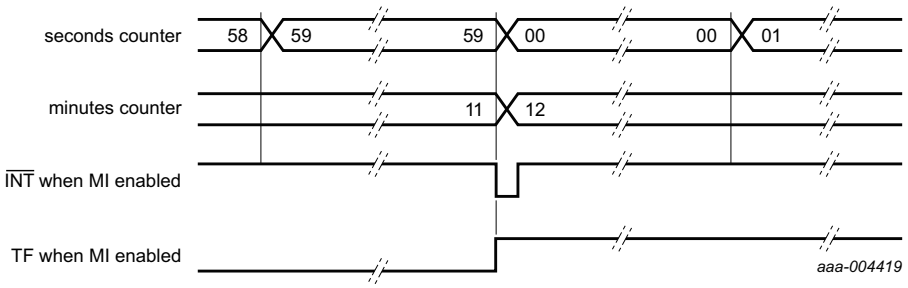
AIE: This bit activates or deactivates the generation of an interrupt when AF is asserted, respectively.

AF: When an alarm occurs, AF is set logic 1. This bit maintains its value until overwritten by command. To prevent one flag being overwritten while clearing another, a logic AND is performed during a write access.

8.2.2.2 MI and HMI: minute and half minute interrupt

The minute interrupt (bit MI) and half minute interrupt (bit HMI) are pre-defined timers for generating interrupt pulses on pin $\overline{INT}$; see Figure 8. The timers are running in sync with the seconds counter (see Table 19 on page 18).

When starting MI, the first interrupt will be generated after 1 second to 59 seconds. When starting HMI, the first interrupt will be generated after 1 second to 29 seconds. Subsequent periods do not have such a delay. The timers can be enabled independently from one another. However, a minute interrupt enabled on top of a half minute interrupt is not distinguishable.



In this example, the TF flag is not cleared after an interrupt.

Fig 8. INT example for MI

Table 10. Effect of bits MI and HMI on INT generation

Minute interrupt (bit MI)	Half minute interrupt (bit HMI)	Result
0	0	no interrupt generated
1	0	an interrupt every minute
0	1	an interrupt every 30 s
1	1	an interrupt every 30 s

The duration of the timer is affected by the register Offset (see Section 8.2.3). Only when OFFSET[6:0] has the value 00h the periods are consistent.

8.2.2.3 TF: timer flag

The timer flag (bit TF) is set logic 1 on the first trigger of MI, HMI, or the countdown timer. The purpose of the flag is to allow the controlling system to interrogate what caused the interrupt: timer or alarm. The flag can be read and cleared by command.

The status of the timer flag TF can affect the INT pulse generation depending on the setting of TI_TP (see Section 8.6.2 “Register Timer_mode” on page 27):

- When TI_TP is set logic 1
  - an INT pulse is generated independent of the status of the timer flag TF
  - TF stays set until it is cleared
  - TF does not affect INT
  - the countdown timer runs in a repetitive loop and keeps generating timed periods
- When TI_TP is set logic 0
  - the INT generation follows the TF flag
  - TF stays set until it is cleared
  - If TF is not cleared before the next coming interrupt, no INT is generated
  - the countdown timer stops after the first countdown

8.2.2.4 COF[2:0]: Clock output frequency

A programmable square wave is available at pin CLKOUT. Operation is controlled by the COF[2:0] bits in the register Control_2. 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 CLKOUT is a push-pull output and enabled at power-on. CLKOUT can be disabled by setting COF[2:0] to 111 or by setting CLKOE LOW. When disabled, the CLKOUT is LOW.

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

The STOP bit function can also affect the CLKOUT signal, depending on the selected frequency. When the STOP bit is set logic 1, the CLKOUT pin generates a continuous LOW for those frequencies that can be stopped. For more details of the STOP bit function, see Section 8.2.1.2.

Table 11. CLKOUT frequency selection

COF[2:0]	CLKOUT frequency (Hz)	Typical duty cycle[1]	Effect of STOP bit
000[2]	32768	60 : 40 to 40 : 60	no effect
001	16384	50 : 50	no effect
010	8192	50 : 50	no effect
011	4096	50 : 50	CLKOUT = LOW
100	2048	50 : 50	CLKOUT = LOW
101	1024	50 : 50	CLKOUT = LOW
110	1[3]	50 : 50	CLKOUT = LOW
111	CLKOUT = LOW	-	-

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

[2] Default value.

[3] 1 Hz clock pulses are affected by offset correction pulses.

8.2.3 Register Offset

The PCF85063BTL incorporates an offset register (address 02h) which can be used to implement several functions, such as:

- Accuracy tuning
- Aging adjustment
- Temperature compensation

Table 12. Offset - offset register (address 02h) bit description

Bit	Symbol	Value	Description
7	MODE		**offset mode**
		0[1]	normal mode: offset is made once every two hours
		1	course mode: offset is made every 4 minutes
6 to 0	OFFSET[6:0]	see Table 13	**offset value**

[1] Default value.

For MODE = 0, each LSB introduces an offset of 4.34 ppm. For MODE = 1, each LSB introduces an offset of 4.069 ppm. The values of 4.34 ppm and 4.069 ppm are based on a nominal 32.768 kHz clock. The offset value is coded in two's complement giving a range of +63 LSB to −64 LSB.

Table 13. Offset values

OFFSET[6:0]	Offset value in decimal	Offset value in ppm	
		Normal mode MODE = 0	Fast mode MODE = 1
0111111	+63	+273.420	+256.347
0111110	+62	+269.080	+252.278
:	:	:	:
0000010	+2	+8.680	+8.138
0000001	+1	+4.340	+4.069
0000000[1]	0	0[1]	0[1]
1111111	−1	−4.340	−4.069
1111110	−2	−8.680	−8.138
:	:	:	:
1000001	−63	−273.420	−256.347
1000000	−64	−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. To enable correction interrupt generation, bit CIE (register Control_1) has to be set logic 1. At every correction cycle a pulse is generated on pin $\overline{\text{INT}}$. The pulse width depends on the correction mode. If multiple correction pulses are applied, an interrupt pulse is generated for each correction pulse applied.

8.2.3.1 Correction when MODE = 0

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

Table 14. Correction pulses for MODE = 0

Correction value	Update every n^{th} hour	Minute	Correction pulses on INT per minute[1]
+1 or −1	2	00	1
+2 or −2	2	00 and 01	1
+3 or −3	2	00, 01, and 02	1
:	:	:	:
+59 or −59	2	00 to 58	1
+60 or −60	2	00 to 59	1
+61 or −61	2	00 to 59	1
	2nd and next hour	00	1
+62 or −62	2	00 to 59	1
	2nd and next hour	00 and 01	1
+63 or −63	02	00 to 59	1
	2nd and next hour	00, 01, and 02	1
−64	02	00 to 59	1
	2nd and next hour	00, 01, 02, and 03	1

[1] The correction pulses on pin $\overline{INT}$ are $1/64$ s wide.

In MODE = 0, any timer or clock output using a frequency below 64 Hz is affected by the clock correction (see Table 15).

Table 15. Effect of correction pulses on frequencies for MODE = 0

Frequency (Hz)	Effect of correction
CLKOUT	
32768	no effect
16384	no effect
8192	no effect
4096	no effect
2048	no effect
1024	no effect
1	affected
Timer source clock	
4096	no effect
64	no effect
1	affected
$1/60$	affected

8.2.3.2 Correction when MODE = 1

The correction is triggered once every four minutes and then correction pulses are applied once per second up to a maximum of 60 pulses. When correction values greater than 60 pulses are used, additional correction pulses are made in the 59th second.

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

Table 16. Correction pulses for MODE = 1

Correction value	Update every nth minute	Second	Correction pulses on INT per second[1]
+1 or −1	2	00	1
+2 or −2	2	00 and 01	1
+3 or −3	2	00, 01, and 02	1
:	:	:	:
+59 or −59	2	00 to 58	1
+60 or −60	2	00 to 59	1
+61 or −61	2	00 to 58	1
	2	59	2
+62 or −62	2	00 to 58	1
	2	59	3
+63 or −63	2	00 to 58	1
	2	59	4
−64	2	00 to 58	1
	2	59	5

[1] The correction pulses on pin $\overline{INT}$ are $^1/_{1024}$ s wide. For multiple pulses, they are repeated at an interval of $^1/_{512}$ s.

In MODE = 1, any timer source clock using a frequency below 1.024 kHz is also affected by the clock correction (see Table 17).

Table 17. Effect of correction pulses on frequencies for MODE = 1

Frequency (Hz)	Effect of correction
CLKOUT	
32768	no effect
16384	no effect
8192	no effect
4096	no effect
2048	no effect
1024	no effect
1	affected
Timer source clock	
4096	no effect
64	affected
1	affected
$^1/_{60}$	affected

8.2.3.3 Offset calibration workflow

The calibration offset has to be calculated based on the time. Figure 9 shows the workflow how the offset register values can be calculated:

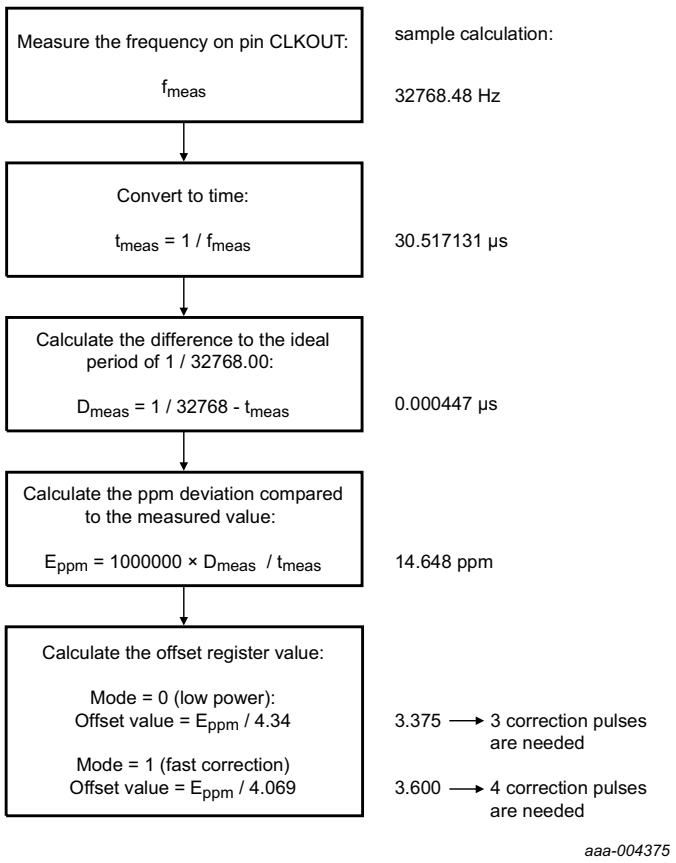
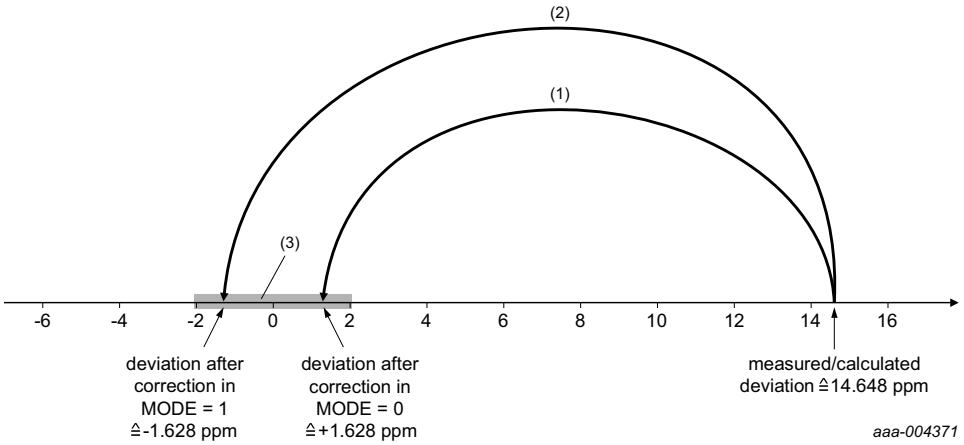


Fig 9. Offset calibration calculation workflow



With the offset calibration an accuracy of ±2 ppm (0.5 × offset per LSB) can be reached (see Table 13).

±1 ppm corresponds to a time deviation of 0.0864 seconds per day.

(1) 3 correction pulses in MODE = 0 correspond to −13.02 ppm.

(2) 4 correction pulses in MODE = 1 correspond to −16.276 ppm.

(3) Reachable accuracy zone.

Fig 10. Result of offset calibration

8.2.4 Register RAM_byte

The PCF85063BTL provides a free RAM byte, which can be used for any purpose, for example, status byte of the system.

Table 18. RAM_byte - 8-bit RAM register (address 03h) bit description

Bit	Symbol	Value	Description
7 to 0	B[7:0]	00000000[1] to 11111111	**RAM content**

[1] Default value.

8.3 Time and date registers

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

8.3.1 Register Seconds

Table 19. Seconds - seconds register (address 04h) bit description

Bit	Symbol	Value	Place value	Description
7	OS			**oscillator stop**
		0	-	clock integrity is guaranteed
		1[1]	-	clock integrity is not guaranteed; oscillator has stopped or has been interrupted
6 to 4	SECONDS	0[1] to 5	ten's place	**actual seconds** coded in BCD format, see Table 20
3 to 0		0[1] to 9	unit place	

[1] Default value.

Table 20. Seconds coded in BCD format

Seconds value in decimal	Upper-digit (ten's place)			Digit (unit place)			
	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
00[1]	0	0	0	0	0	0	0
01	0	0	0	0	0	0	1
02	0	0	0	0	0	1	0
:	:	:	:	:	:	:	:
09	0	0	0	1	0	0	1
10	0	0	1	0	0	0	0
:	:	:	:	:	:	:	:
58	1	0	1	1	0	0	0
59	1	0	1	1	0	0	1

[1] Default value.

8.3.1.1 OS flag: Oscillator stop

When the oscillator of the PCF85063BTL is stopped, the OS flag 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 flag remains set until cleared by command (see Figure 11). If the flag 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.

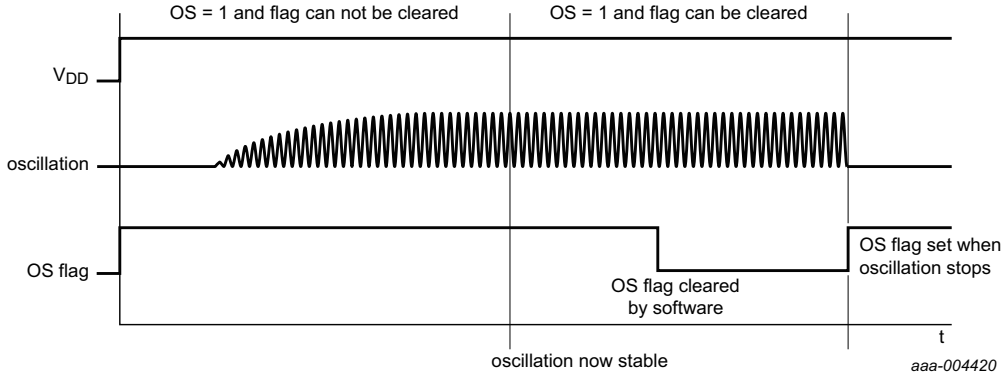


Fig 11. OS flag

8.3.2 Register Minutes

Table 21. Minutes - minutes register (address 05h) bit description

Bit	Symbol	Value	Place value	Description
7	-	0	-	unused
6 to 4	MINUTES	0[1] to 5	ten's place	**actual minutes** coded in BCD format
3 to 0		0[1] to 9	unit place	

[1] Default value.

8.3.3 Register Hours

Table 22. Hours - hours register (address 06h) bit description

Bit	Symbol	Value	Place value	Description
7 to 6	-	00	-	unused
12 hour mode[1]				
5	AMPM			**AM/PM indicator**
		0[2]	-	AM
		1	-	PM
4	HOURS	0[2] to 1	ten's place	**actual hours in 12 hour mode** coded in BCD format
3 to 0		0[2] to 9	unit place	
24 hour mode[1]				
5 to 4	HOURS	0[2] to 2	ten's place	**actual hours in 24 hour mode** coded in BCD format
3 to 0		0[2] to 9	unit place	

[1] Hour mode is set by the 12_24 bit in register Control_1.

[2] Default value.

8.3.4 Register Days

Table 23. Days - days register (address 07h) bit description

Bit	Symbol	Value	Place value	Description
7 to 6	-	00	-	unused
5 to 4	DAYS[1]	0[2] to 3	ten's place	**actual day** coded in BCD format
3 to 0		0[3] to 9	unit place	

[1] If the year counter contains a value, which is exactly divisible by 4 (including the year 00), the PCF85063BTL compensates for leap years by adding a 29th day to February.

[2] Default value.

[3] Default value is 1.

8.3.5 Register Weekdays

Table 24. Weekdays - weekdays register (address 08h) bit description

Bit	Symbol	Value	Description
7 to 3	-	00000	unused
2 to 0	WEEKDAYS	0 to 6	**actual weekday** values, see Table 25

Table 25. Weekday assignments

Day[1]	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[2]	1	1	0

[1] Definition may be reassigned by the user.

[2] Default value.

8.3.6 Register Months

Table 26. Months - months register (address 09h) bit description

Bit	Symbol	Value	Place value	Description
7 to 5	-	000	-	unused
4	MONTHS	0 to 1	ten's place	**actual month** coded in BCD format, see Table 27
3 to 0		0 to 9	unit place	

Table 27. 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[1]	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

[1] Default value.

8.3.7 Register Years

Table 28. Years - years register (0Ah) bit description

Bit	Symbol	Value	Place value	Description
7 to 4	YEARS	0[1] to 9	ten's place	**actual year** coded in BCD format
3 to 0		0[1] to 9	unit place	

[1] Default value.

8.4 Setting and reading the time

Figure 12 shows the data flow and data dependencies starting from the 1 Hz clock tick.

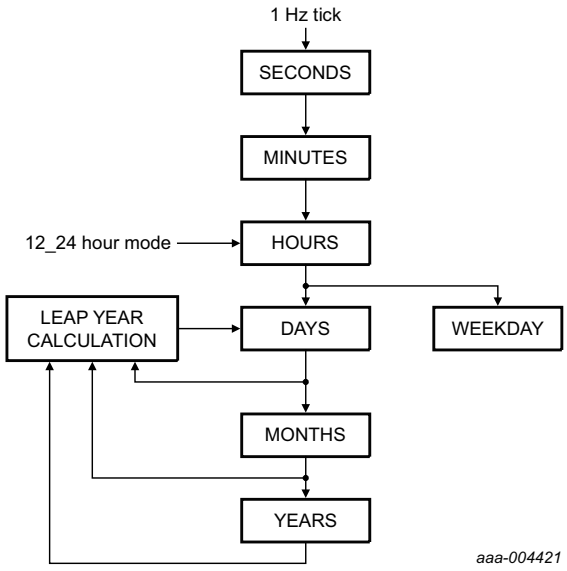


Fig 12. Data flow for the time function

During read/write operations, the time counting circuits (memory locations 04h through 0Ah) are blocked.

The blocking prevents

- Faulty reading of the clock and calendar during a carry condition
- Incrementing the time registers during the read cycle

After this read/write access is completed, the time circuit is released again and any pending request to increment the time counters that occurred during the read/write access is serviced. A maximum of 1 request can be stored; therefore, all accesses must be completed within 1 second (see Figure 13).

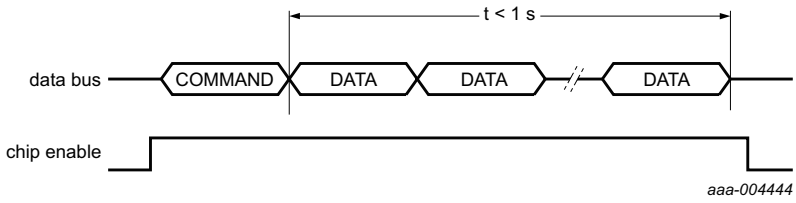


Fig 13. Access time for read/write operations

Because of this method, it is very important to make a read or write access in one go, that is, setting or reading 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 will increment 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.

Recommended method for reading the time:

1. Send read command with register address pointing to 4 (Seconds) by sending 04h
2. Read Seconds
3. Read Minutes
4. Read Hours
5. Read Days
6. Read Weekdays
7. Read Months
8. Read Years

8.5 Alarm registers

8.5.1 Register Second_alarm

Table 29. Second_alarm - second alarm register (address 0Bh) bit description

Bit	Symbol	Value	Place value	Description
7	AEN_S			**second alarm**
		0	-	enabled
		1[1]	-	disabled
6 to 4	SECOND_ALARM	0[1] to 5	ten's place	**second alarm information** coded in BCD format
3 to 0		0[1] to 9	unit place	

[1] Default value.

8.5.2 Register Minute_alarm

Table 30. Minute_alarm - minute alarm register (address 0Ch) bit description

Bit	Symbol	Value	Place value	Description
7	AEN_M			**minute alarm**
		0	-	enabled
		1[1]	-	disabled
6 to 4	MINUTE_ALARM	0[1] to 5	ten's place	**minute alarm information** coded in BCD format
3 to 0		0[1] to 9	unit place	

[1] Default value.

8.5.3 Register Hour_alarm

Table 31. Hour_alarm - hour alarm register (address 0Dh) bit description

Bit	Symbol	Value	Place value	Description
7	AEN_H			**hour alarm**
		0	-	enabled
		1[1]	-	disabled
6	-	0	-	unused
12 hour mode[2]				
5	AMPM			**AM/PM indicator**
		0[1]	-	AM
		1	-	PM
4	HOUR_ALARM	0[1] to 1	ten's place	**hour alarm information in 12 hour mode** coded in BCD format
3 to 0		0[1] to 9	unit place	
24 hour mode[2]				
5 to 4	HOUR_ALARM	0[1] to 2	ten's place	**hour alarm information in 24 hour mode** coded in BCD format
3 to 0		0[1] to 9	unit place	

[1] Default value.

[2] Hour mode is set by the 12_24 bit in register Control_1.

8.5.4 Register Day_alarm

Table 32. Day_alarm - day alarm register (address 0Eh) bit description

Bit	Symbol	Value	Place value	Description
7	AEN_D			**day alarm**
		0	-	enabled
		1[1]	-	disabled
6	-	0	-	unused
5 to 4	DAY_ALARM	0[1] to 3	ten's place	**day alarm information** coded in BCD format
3 to 0		0[1] to 9	unit place	

[1] Default value.

8.5.5 Register Weekday_alarm

Table 33. Weekday_alarm - weekday alarm register (address 0Fh) bit description

Bit	Symbol	Value	Description
7	AEN_W		**weekday alarm**
		0	enabled
		1[1]	disabled
6 to 3	-	0	unused
2 to 0	WEEKDAY_ALARM	0[1] to 6	**weekday alarm information** coded in BCD format

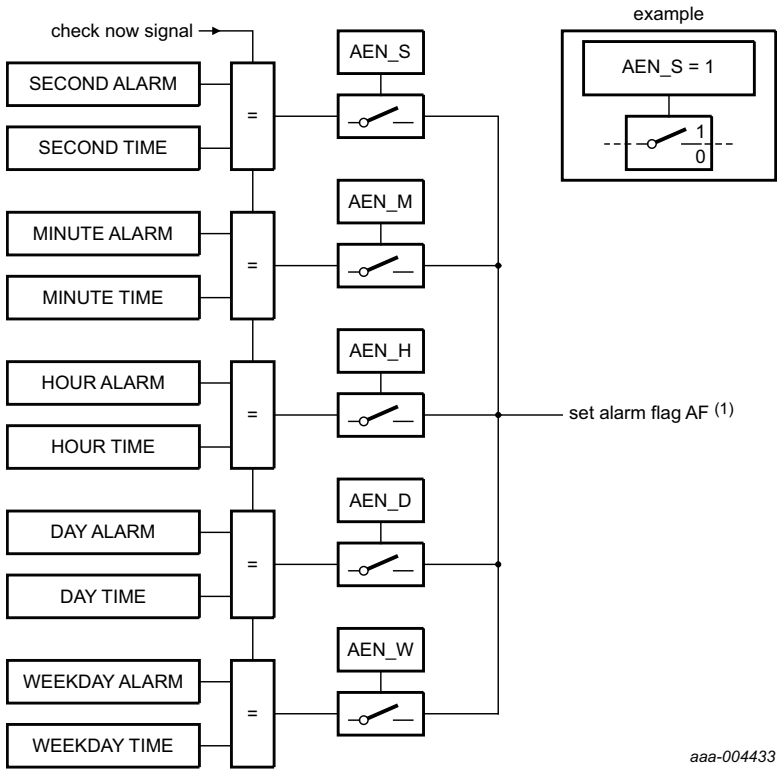
[1] Default value.

8.5.6 Alarm function

By clearing the alarm enable bit (AEN_x) of one or more of the alarm registers, the corresponding alarm condition(s) are active. When an alarm occurs, AF is set logic 1. The asserted AF can be used to generate an interrupt ($\overline{INT}$). The AF is cleared by command.

The registers at addresses 0Bh through 0Fh contain alarm information. When one or more of these registers is loaded with second, minute, hour, day or weekday, and its corresponding AEN_x is logic 0, then that information is compared with the current second, minute, hour, day, and weekday. When all enabled comparisons first match, the alarm flag (AF in register Control_2) is set logic 1.

The generation of interrupts from the alarm function is controlled via bit AIE. If bit AIE is enabled, the $\overline{INT}$ pin follows the condition of bit AF. AF remains set until cleared by command. Once AF has been cleared, it will only be set again when the time increments to match the alarm condition once more. Alarm registers which have their AEN_x bit at logic 1 are ignored.



(1) Only when all enabled alarm settings are matching.
It is only on increment to a matched case that the alarm flag is set.

Fig 14. Alarm function block diagram

8.6 Timer registers

The 8-bit countdown timer at address 10h is controlled by the register Timer_mode at address 11h.

8.6.1 Register Timer_value

Table 34. Timer_value - timer value register (address 10h) bit description

Bit	Symbol	Value	Description
7 to 0	T[7:0]	0h[1] to FFh	**countdown timer value**[2]

[1] Default value.

[2] Countdown period in seconds: $CountdownPeriod = \frac{T}{SourceClockFrequency}$ where T is the countdown value.

8.6.2 Register Timer_mode

Table 35. Timer_mode - timer control register (address 11h) bit description

Bit	Symbol	Value	Description
7 to 5	-	000	unused
4 to 3	TCF[1:0]		**timer clock frequency**
		00	4.096 kHz timer source clock
		01	64 Hz timer source clock
		10	1 Hz timer source clock
		11[1]	$1/60$ Hz timer source clock
2	TE		**timer enable**
		0[1]	timer is disabled
		1	timer is enabled
1	TIE		**timer interrupt enable**
		0[1]	no interrupt generated from timer
		1	interrupt generated from timer
0	TI_TP[2]		**timer interrupt mode**
		0[1]	interrupt follows timer flag
		1	interrupt generates a pulse

[1] Default value.

[2] How the setting of TI_TP and the timer flag TF can affect the $\overline{INT}$ pulse generation is explained in Section 8.2.2.3 on page 12.

8.6.3 Timer functions

The timer has four selectable source clocks allowing for countdown periods in the range from 244 μs to 4 hours 15 min. For periods longer than 4 hours, the alarm function can be used.

Table 36. Timer clock frequency and timer durations

TCF[1:0]	Timer source clock frequency[1]	Delay	
		Minimum timer duration T = 1	Maximum timer duration T = 255
00	4.096 kHz	244 μs	62.256 ms
01	64 Hz	15.625 ms	3.984 s
10	1 Hz[2]	1 s	255 s
11	$1/60$ Hz[2]	60 s	4 hours 15 min

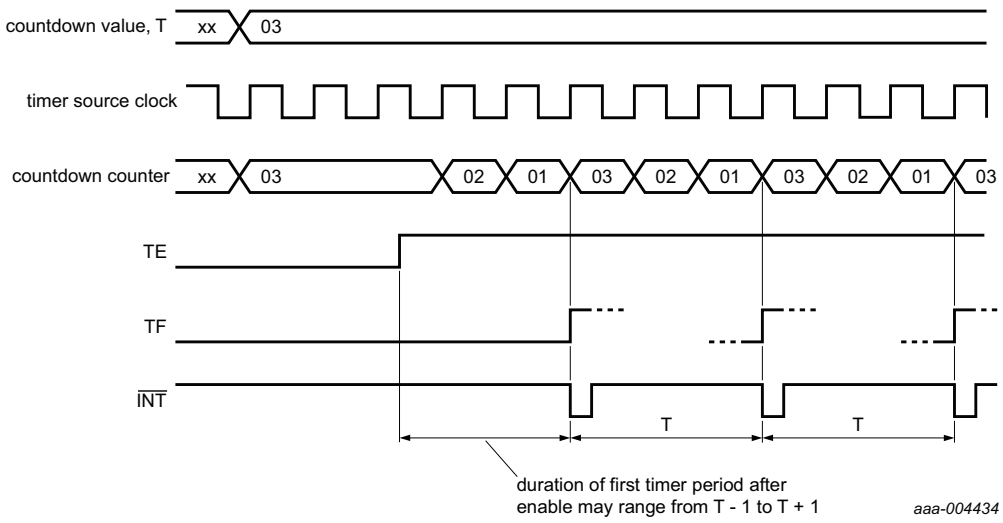
[1] When not in use, TCF[1:0] must be set to $1/60$ Hz for power saving.

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

Remark: Note that all timings which are generated from the 32.768 kHz oscillator 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 timer counts down from a software-loaded 8-bit binary value, T[7:0], in register Timer_value. Loading the counter with 0 stops the timer. Values from 1 to 255 are valid.

When the counter decrements from 1, the timer flag (bit TF in register Control_2) is set and the counter automatically re-loads and starts the next timer period.



In this example, it is assumed that the timer flag is cleared before the next countdown period expires and that the pin $\overline{INT}$ is set to pulsed mode.

Fig 15. General countdown timer behavior

If a new value of T is written before the end of the current timer period, then this value takes immediate effect. NXP does not recommend changing T without first disabling the counter by setting bit TE logic 0. The update of T is asynchronous to the timer clock. Therefore changing it without setting bit TE logic 0 may result in a corrupted value loaded into the countdown counter. This results in an undetermined countdown period for the first period. The countdown value T will, however, be correctly stored and correctly loaded on subsequent timer periods.

When the TIE flag is set, an interrupt signal on $\overline{INT}$ is generated if this mode is enabled. See Section 8.2.2 for details on how the interrupt can be controlled.

When starting the timer for the first time, the first period has an uncertainty. The uncertainty is a result of the enable instruction being generated from the interface clock which is asynchronous from the timer source clock. Subsequent timer periods do not have such delay. The amount of delay for the first timer period depends on the chosen source clock, see Table 37.

Table 37. First period delay for timer counter value T

Timer source clock	Minimum timer period	Maximum timer period
4.096 kHz	T	T + 1
64 Hz	T	T + 1
1 Hz	$(T-1)+\frac{1}{64\ Hz}$	$T+\frac{1}{64\ Hz}$
$1/60$ Hz	$(T-1)+\frac{1}{64\ Hz}$	$T+\frac{1}{64\ Hz}$

At the end of every countdown, the timer sets the countdown timer flag (bit TF in register Control_2). Bit TF can only be cleared by command. The asserted bit TF can be used to generate an interrupt at pin $\overline{INT}$. The interrupt may be generated as a pulsed signal every countdown period or as a permanently active signal which follows the condition of bit TF. Bit TI_TP is used to control this mode selection and the interrupt output may be disabled with bit TIE, see Table 35 and Figure 15.

When reading the timer, the current countdown value is returned and **not** the initial value T. Since it is not possible to freeze the countdown timer counter during read back, it is recommended to read the register twice and check for consistent results.

Timer source clock frequency selection of 1 Hz and $1/60$ Hz is affected by the Offset register. The duration of a program period varies according to when the offset is initiated. For example, if a 100 s timer is set using the 1 Hz clock as source, then some 100 s periods will contain correction pulses and therefore be longer or shorter depending on the setting of the Offset register. See Section 8.2.3 to understand the operation of the Offset register.

8.6.3.1 Countdown timer interrupts

The pulse generator for the countdown timer interrupt uses an internal clock and is dependent on the selected source clock for the countdown timer and on the countdown value T. As a consequence, the width of the interrupt pulse varies (see Table 38).

Table 38. $\overline{INT}$ operation

TF and $\overline{INT}$ become active simultaneously.

Source clock (Hz)	$\overline{INT}$ period (s)	
	T = 1[1]	T > 1[1]
4096	$1/8192$	$1/4096$
64	$1/128$	$1/64$
1	$1/64$	$1/64$
$1/60$	$1/64$	$1/64$

[1] T = loaded countdown value. Timer stops when T = 0.

9. Characteristics of the SPI-bus interface

Data transfer to and from the device is made via a 3-wire SPI-bus (see Table 39). The chip enable signal is used to identify the transmitted data. Each data transfer is a byte, with the Most Significant Bit (MSB) sent first (see Figure 16).

Table 39. Serial interface

Symbol	Function	Description
CE	chip enable input	when LOW, the interface is reset; pull-down resistor included; active input may be higher than V_{DD}, but may not be wired permanently HIGH
SCL	serial clock input	when CE is LOW, this input may float; input may be higher than V_{DD}
SDIO	serial data input and output	
	input	when CE is LOW, input may float; input may be higher than V_{DD}; input data is sampled on the rising edge of SCL
	output	push-pull output; drives from V_{SS} to V_{DD}; output data is changed on the falling edge of SCL; is high-impedance when not driving

The transmission is controlled by the active HIGH chip enable signal CE. The first byte transmitted is the command byte. Subsequent bytes are either data to be written or data to be read. Data is sampled on the rising edge of the clock and transferred internally on the falling edge.

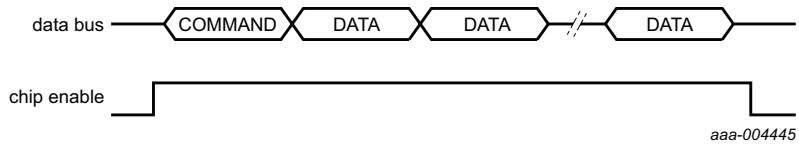


Fig 16. Data transfer overview

The command byte defines the address of the first register to be accessed and the read/write mode. The address counter will auto increment after every access and will roll over to zero after the last register is accessed (see Figure 3). The (R/$\overline{W}$) bit defines whether the following bytes are read or write information.

Table 40. Command byte definition

Bit	Symbol	Value	Description
7	R/$\overline{W}$		**data read or data write selection**
		0	write data
		1	read data
6 to 5	SA	01	**subaddress**; other codes will cause the device to ignore data transfer
4 to 0	RA	0h to 11h	**register address range**; other addresses will be ignored

In Figure 17, the register Seconds is set to 45 seconds and the register Minutes is set to 10 minutes. In Figure 18, the Months and Years registers are read.

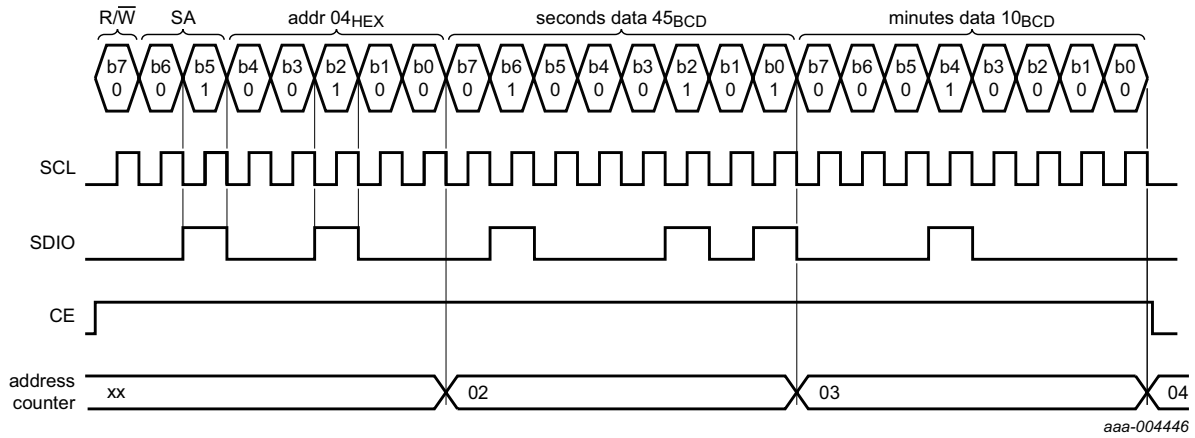


Fig 17. SPI-bus write example

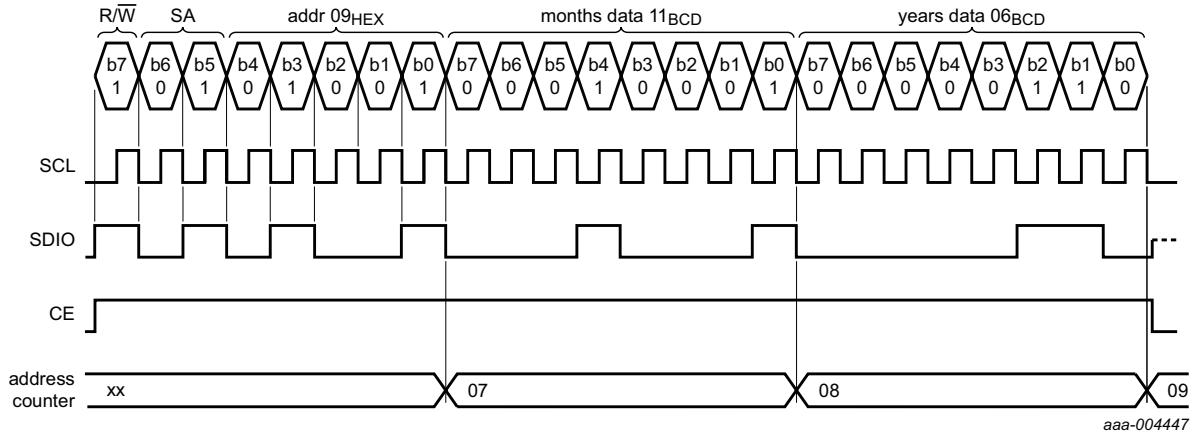


Fig 18. SPI-bus read example

10. Internal circuitry

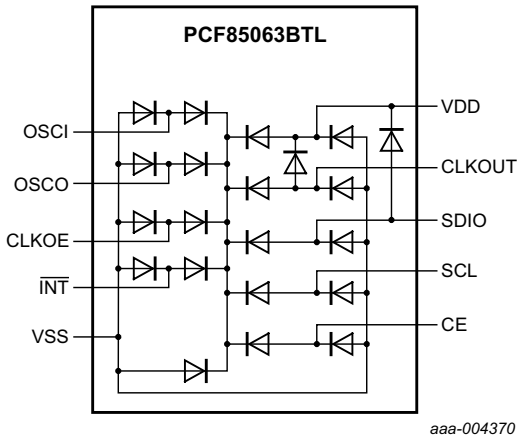


Fig 19. Device diode protection diagram of PCF85063BTL

11. Limiting values

Table 41. 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_I	input voltage	on pins SCL, SDIO, OSCI		–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]	-	±5000	V
		CDM	[2]	-	±2000	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 Ref. 7 “JESD22-A114”.

[2] Pass level; Charged-Device Model (CDM), according to Ref. 8 “JESD22-C101”.

[3] Pass level; latch-up testing, according to Ref. 9 “JESD78” at maximum ambient temperature ($T_{amb(max)}$).

[4] According to the store and transport requirements (see Ref. 12 “UM10569”) the devices have to be stored at a temperature of +8 °C to +45 °C and a humidity of 25 % to 75 %.

12. Characteristics

Table 42. Static 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; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Supplies							
V_{DD}	supply voltage	interface inactive; f_{SCL} = 0 MHz	[1]	0.9	-	5.5	V
		interface active; f_{SCL} = 1 MHz	[1]	1.8	-	5.5	V
I_{DD}	supply current	CLKOUT disabled; V_{DD} = 3.3 V	[2]				
		interface inactive; f_{SCL} = 0 Hz					
		T_{amb} = 25 °C		-	220	450	nA
		T_{amb} = 50 °C	[3]	-	250	500	nA
		T_{amb} = 85 °C		-	470	600	nA
		interface active; f_{SCL} = 1 MHz		-	45	200	µA
Inputs							
V_I	input voltage			V_{SS}	-	5.5	V
V_{IL}	LOW-level input voltage			V_{SS}	-	$0.3V_{DD}$	V
V_{IH}	HIGH-level input voltage			$0.7V_{DD}$	-	V_{DD}	V
I_{LI}	input leakage current	V_I = V_{SS} or V_{DD}		-	0	-	µA
		post ESD event		−0.15	-	+0.15	µA
C_i	input capacitance	on pins SDIO, SCL, CE, CLKOE	[4]	-	-	7	pF
Outputs							
V_{OH}	HIGH-level output voltage	on pins SDIO, CLKOUT		$0.8V_{DD}$	-	V_{DD}	V
V_{OL}	LOW-level output voltage	on pins SDIO, $\overline{INT}$, CLKOUT		V_{SS}	-	$0.2V_{DD}$	V
I_{OH}	HIGH-level output current	output source current; V_{OH} = 2.9 V; V_{DD} = 3.3 V					
		on pin SDIO		2	5	-	mA
		on pin CLKOUT		1	3	-	mA
I_{OL}	LOW-level output current	output sink current; V_{OL} = 0.4 V; V_{DD} = 3.3 V					
		on pins SDIO, $\overline{INT}$		2	6	-	mA
		on pin CLKOUT		1	3	-	mA

Table 42. Static 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; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Oscillator							
$\Delta f_{osc}/f_{osc}$	relative oscillator frequency variation	ΔV_{DD} = 200 mV; T_{amb} = 25 °C		-	0.075	-	ppm
$C_{L(itg)}$	integrated load capacitance	on pins OSCO, OSCI	[5]				
		C_L = 7 pF		4.2	7	9.8	pF
		C_L = 12.5 pF		7.5	12.5	17.5	pF
R_S	series resistance			-	-	100	kΩ

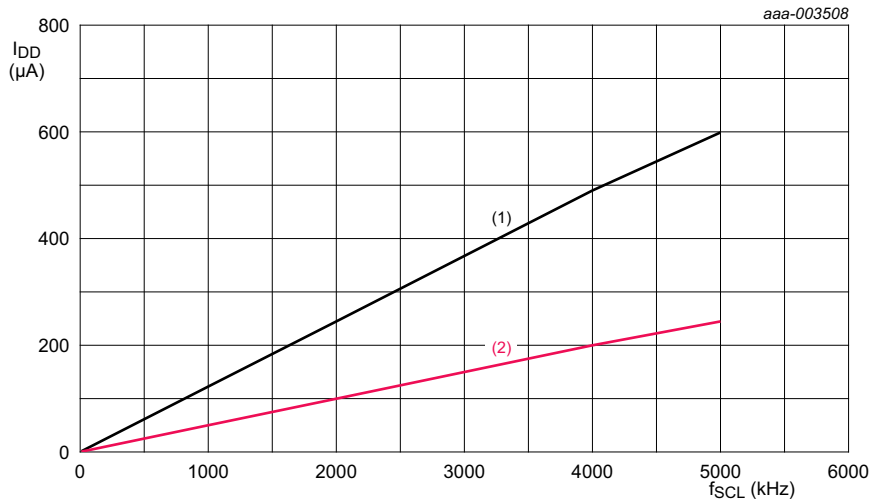
[1] For reliable oscillator start at power-on: $V_{DD} = V_{DD(po)sit}$ min + 0.3 V.

[2] Timer source clock = $1/60$ Hz, level of pins CE, SDIO, and SCL is V_{DD} or V_{SS}.

[3] Tested on sample basis.

[4] Implicit by design.

[5] Integrated load capacitance, $C_{L(itg)}$, is a calculation of C_{OSCI} and C_{OSCO} in series: $C_{L(itg)} = \frac{(C_{OSCI} \cdot C_{OSCO})}{(C_{OSCI} + C_{OSCO})}$.

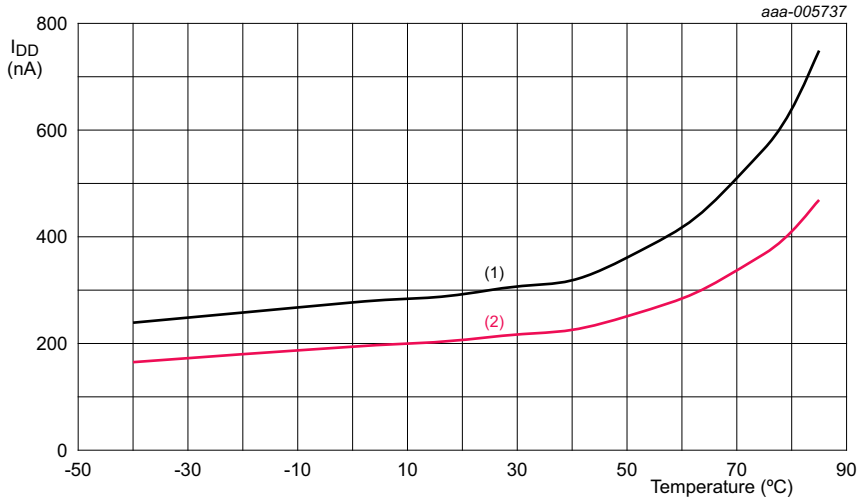


T_{amb} = 25 °C; CLKOUT disabled.

(1) V_{DD} = 5.0 V.

(2) V_{DD} = 3.3 V.

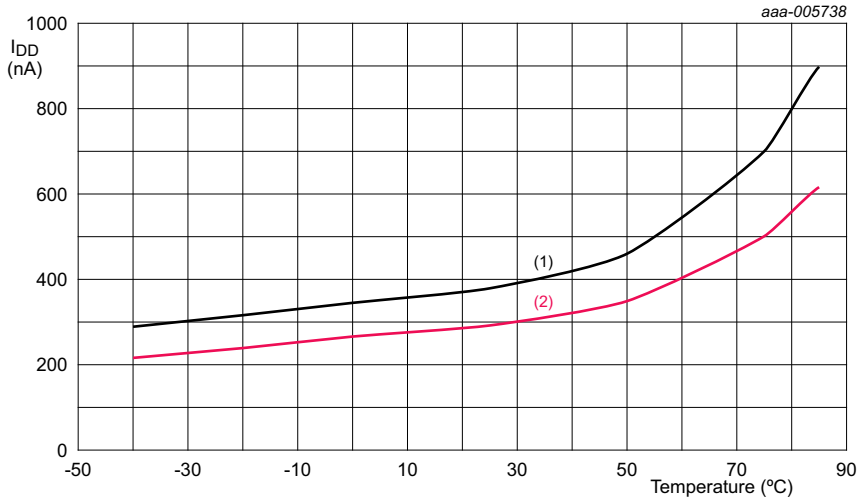
Fig 20. Typical I_{DD} with respect to f_{SCL}



$C_{L(itg)}$ = 7 pF; CLKOUT disabled.

(1) V_{DD} = 5.5 V.

(2) V_{DD} = 3.3 V.

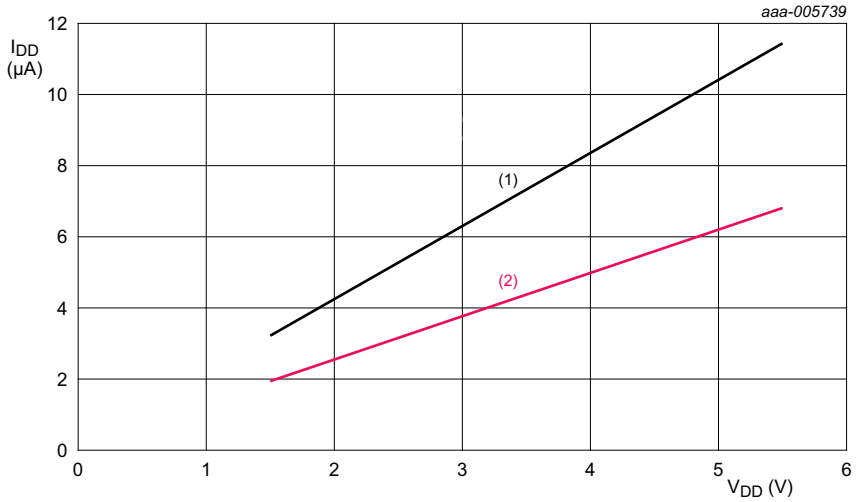


$C_{L(itg)}$ = 12.5 pF; CLKOUT disabled.

(1) V_{DD} = 5.5 V.

(2) V_{DD} = 3.3 V.

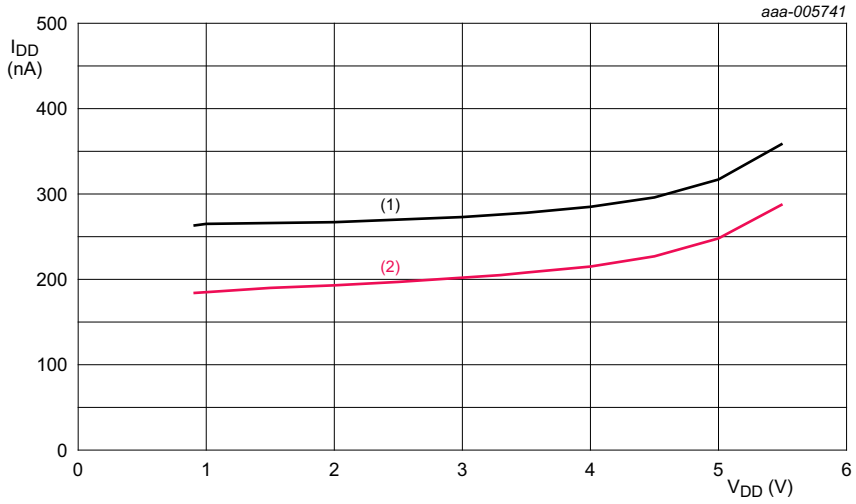
Fig 21. Typical I_{DD} as a function of temperature



T_{amb} = 25 °C; f_{CLKOUT} = 32768 Hz.

(1) 47 pF CLKOUT load.

(2) 22 pF CLKOUT load.

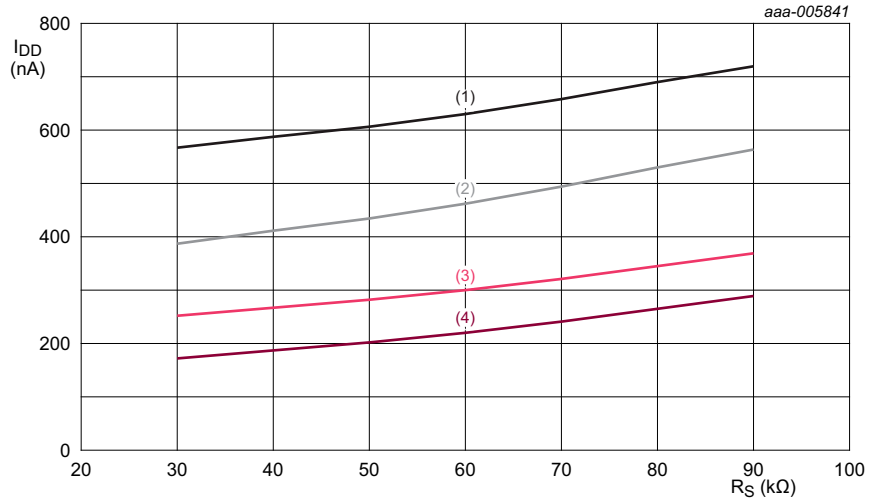


T_{amb} = 25 °C; CLKOUT disabled.

(1) $C_{L(itg)}$ = 12.5 pF.

(2) $C_{L(itg)}$ = 7 pF.

Fig 22. Typical I_{DD} with respect to V_{DD}



V_{DD} = 3.3 V; CLKOUT disabled.

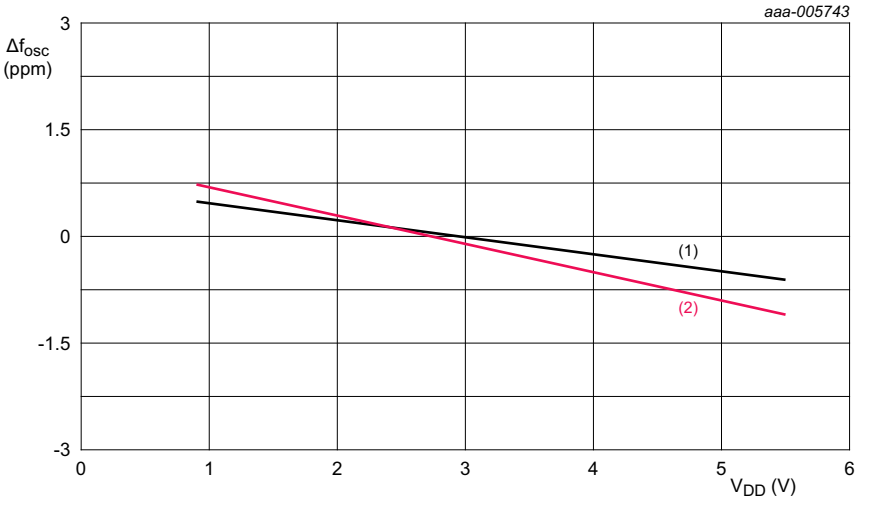
(1) $C_{L(itg)}$ = 12.5 pF; 50 °C; maximum value.

(2) $C_{L(itg)}$ = 7 pF; 50 °C; maximum value.

(3) $C_{L(itg)}$ = 12.5 pF; 25 °C; typical value.

(4) $C_{L(itg)}$ = 7 pF; 25 °C; typical value.

Fig 23. I_{DD} with respect to quartz R_S



T_{amb} = 25 °C.

(1) $C_{L(itg)}$ = 7 pF.

(2) $C_{L(itg)}$ = 12.5 pF.

Fig 24. Oscillator frequency variation with respect to V_{DD}

Table 43. SPI-bus characteristics

V_{DD} = 1.8 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; 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}.

Symbol	Parameter	Conditions	V_{DD} = 1.8 V to 3.3 V		V_{DD} > 3.3 V to 5.5 V		Unit
			Min	Max	Min	Max	
f_{SCL}	SCL clock frequency		-	5	-	7	MHz
t_{SCL}	SCL time		140	-	140	-	ns
$t_{clk(H)}$	clock HIGH time		80	-	80	-	ns
$t_{clk(L)}$	clock LOW time		110	-	60	-	ns
t_r	rise time	for SCL signal	-	100	-	50	ns
t_f	fall time	for SCL signal	-	100	-	50	ns
$t_{su(CE)}$	CE set-up time		15	-	15	-	ns
$t_{h(CE)}$	CE hold time		10	-	10	-	ns
$t_{rec(CE)}$	CE recovery time		50	-	50	-	ns
$t_{w(CE)}$	CE pulse width	measured after valid subaddress is received	-	0.99	-	0.99	s
t_{su}	set-up time	set-up time for SDIO data	5	-	5	-	ns
t_h	hold time	hold time for SDIO data	50	-	20	-	ns
$t_{d(R)SDO}$	SDO read delay time	bus load = 50 pF	-	110	-	60	ns
$t_{dis(SDO)}$	SDO disable time	no load value; bus will be held up by bus capacitance; use RC time constant with application values	-	50	-	50	ns
$t_{t(SDI-SDO)}$	transition time from SDI to SDO	to avoid bus conflict; on pin SDIO	0	-	0	-	ns

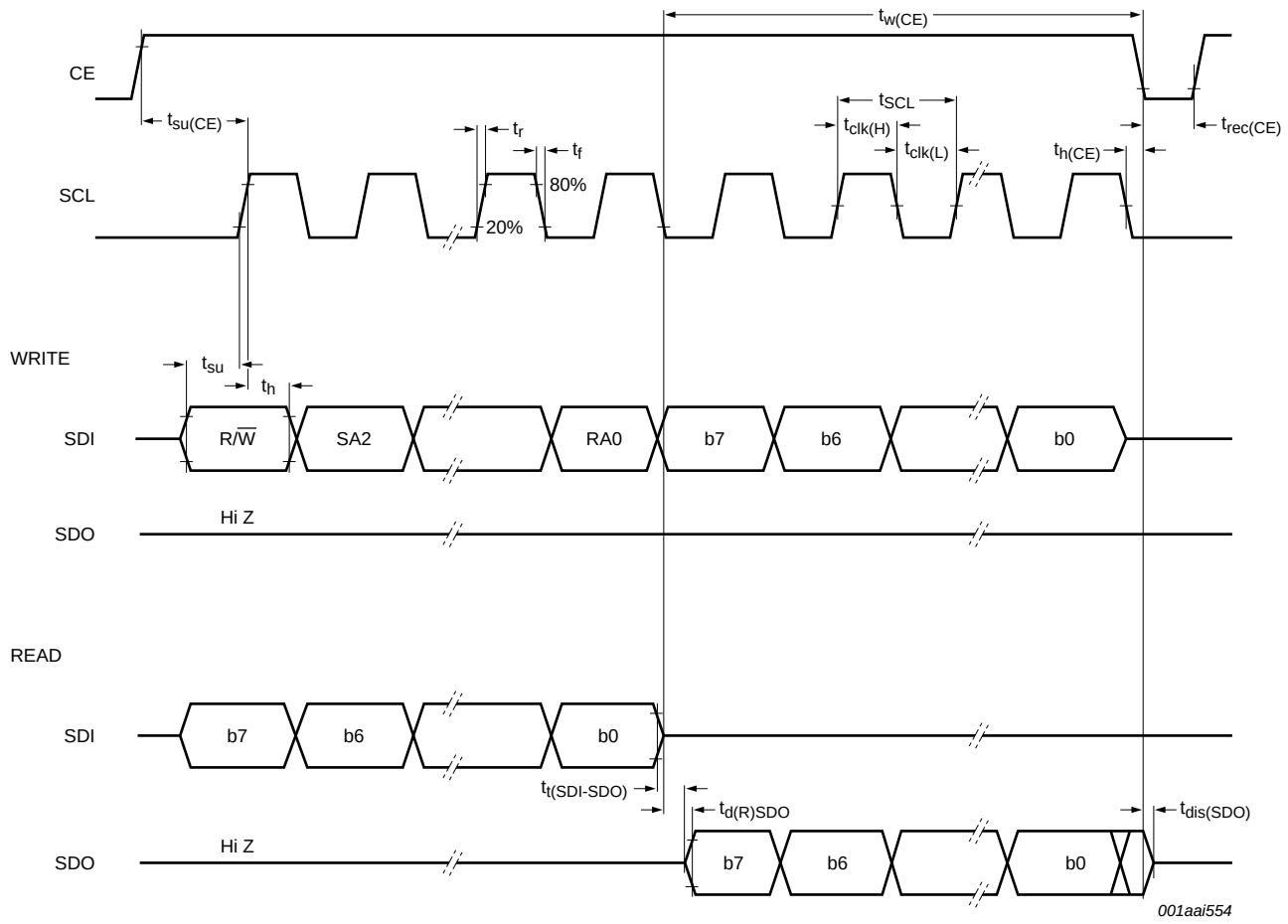
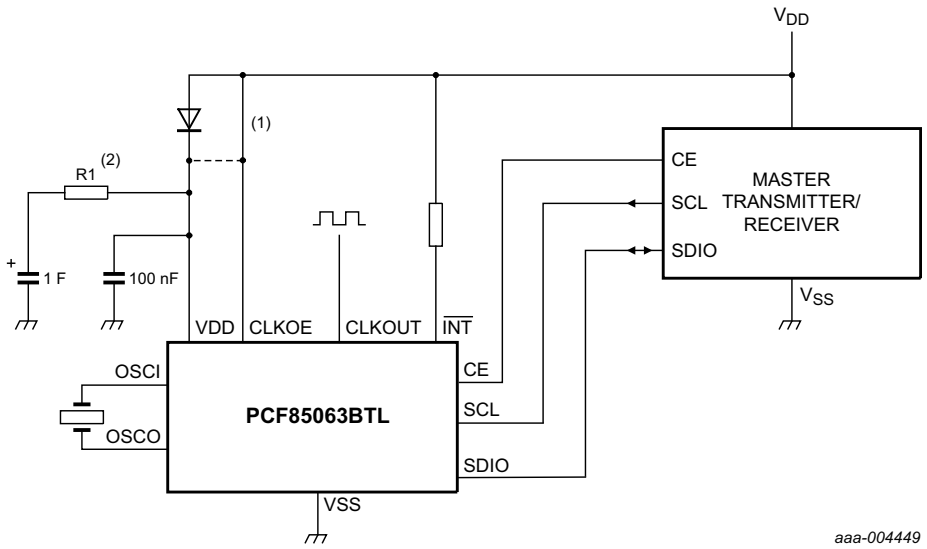


Fig 25. SPI-bus timing

13. Application information



A 1 farad super capacitor combined with a low V_F diode can be used as a standby or back-up supply. With the RTC in its minimum power configuration that is, timer off and CLKOUT off, the RTC may operate for weeks.

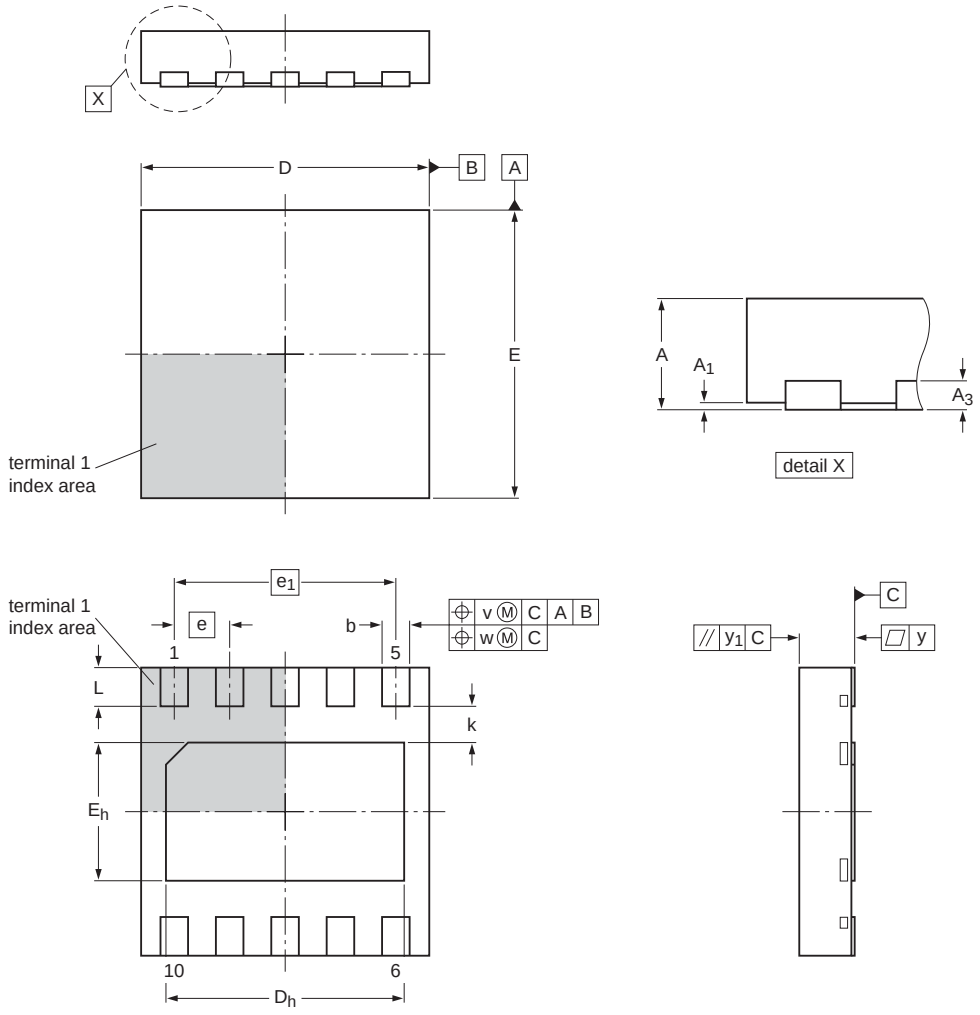
(1) If the clock signal (pin CLKOUT) is required in power-down mode, pin CLKOE has to be connected to the cathode side of the diode.

(2) R1 limits the inrush current to the super capacitor at power-on.

Fig 26. Application diagram for PCF85063BTL

14. Package outline

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	A1	A3	b	D	Dh	E	Eh	e	e1	k	L	v	w	y	y1
mm	max	0.5	0.05		0.30	2.7	2.20	2.7	1.30				0.40				
	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

Fig 27. Package outline SOT1197-1 (HXSON10) of PCF85063BTL

15. 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.

16. Packing information

16.1 Tape and reel information

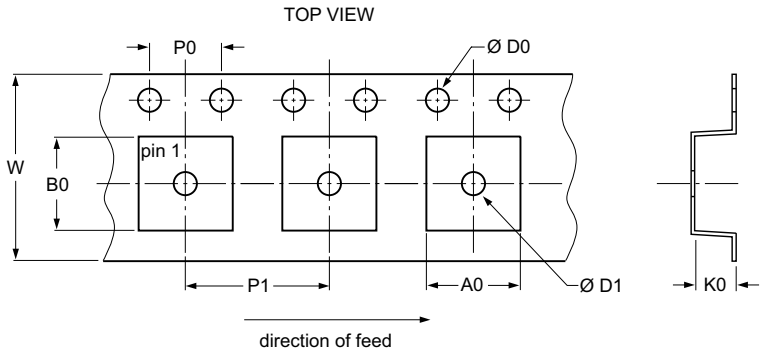


Fig 28. Tape and reel details for PCF85063BTL

Table 44. Carrier tape dimensions of PCF85063BTL

Symbol	Description	Value	Unit
Compartments			
A0	pocket width in x direction	2.9	mm
B0	pocket width in y direction	2.9	mm
K0	pocket depth	0.8	mm
P1	pocket hole pitch	4	mm
D1	pocket hole diameter	1	mm
Overall dimensions			
W	tape width	8	mm
D0	sprocket hole diameter	1.5	mm
P0	sprocket hole pitch	4	mm

17. 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"*.

17.1 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.

17.2 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

17.3 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

17.4 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 29) 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 45 and 46

Table 45. SnPb eutectic process (from J-STD-020D)

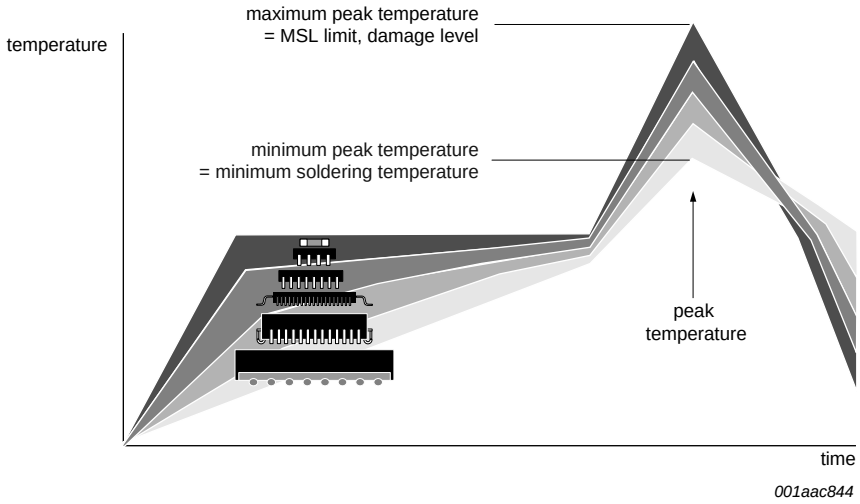
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm^3)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

Table 46. 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 29.



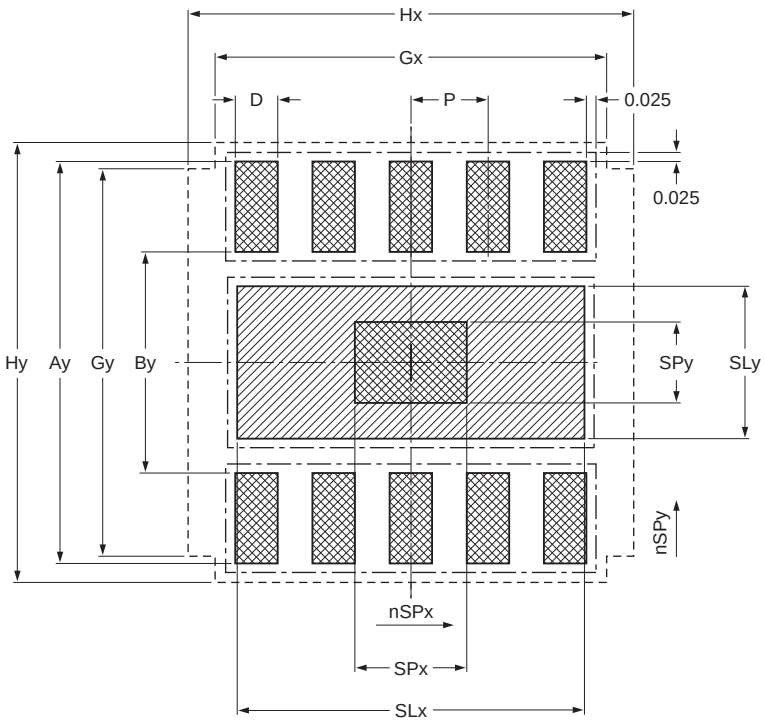
MSL: Moisture Sensitivity Level

Fig 29. Temperature profiles for large and small components

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

18. Footprint information

Footprint information for reflow soldering of DFN2626-10 package **SOT1197-1**



Generic footprint pattern
Refer to the package outline drawing for actual layout

solder land

solder paste deposit

solder land plus solder paste

occupied area

solder resist

DIMENSIONS in mm

P	Ay	By	D	SLx	SLy	SPx	SPy	Gx	Gy	Hx	Hy
0.5	3.05	1.9	0.25	2.2	1.3	0.8	0.4	2.5	2.85	2.85	3.3

Issue date ~~11-07-27~~ 12-09-16

sot1197-1_fr

Fig 30. Footprint information for reflow soldering of SOT1197-1 (HXSON10) of PCF85063BTL

19. Abbreviations

Table 47. Abbreviations

Acronym	Description
AM	Ante Meridiem
BCD	Binary Coded Decimal
CDM	Charged-Device Model
CMOS	Complementary Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
IC	Integrated Circuit
LSB	Least Significant Bit
MSB	Most Significant Bit
MSL	Moisture Sensitivity Level
PCB	Printed-Circuit Board
PM	Post Meridiem
POR	Power-On Reset
RAM	Random Access Memory
RTC	Real-Time Clock
SMD	Surface Mount Device
SPI	Serial Peripheral Interface

20. References

[1] **AN10365 —** Surface mount reflow soldering description

[2] **AN10366 —** HVQFN application information

[3] **AN11247 —** Improved timekeeping accuracy with PCF85063, PCF8523 and PCF2123 using an external temperature sensor

[4] **IEC 60134 —** Rating systems for electronic tubes and valves and analogous semiconductor devices

[5] **IEC 61340-5 —** Protection of electronic devices from electrostatic phenomena

[6] **IPC/JEDEC J-STD-020 —** Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

[7] **JESD22-A114 —** Electrostatic Discharge (ESD) Sensitivity Testing Human Body Model (HBM)

[8] **JESD22-C101 —** Field-Induced Charged-Device Model Test Method for Electrostatic-Discharge-Withstand Thresholds of Microelectronic Components

[9] **JESD78 —** IC Latch-Up Test

[10] **JESD625-A —** Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices

[11] **SNV-FA-01-02 —** Marking Formats Integrated Circuits

[12] **UM10569 —** Store and transport requirements

21. Revision history

Table 48. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCF85063BTL v.2	20130415	Product data sheet	-	PCF85063BTL v.1
Modifications:	• Adjusted block diagram (Figure 1) • Improved description of correction pulses (Table 14 and Table 16) • Adjusted Table 34 and Section 8.6.3 • Enhanced application information (Figure 26) • Adjusted I_{DD} and I_{LI} values (Table 42) • Adjusted SPI-bus timing values (Table 43)			
PCF85063BTL v.1	20130123	Objective data sheet	-	-

22. Legal information

22.1 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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24. Tables

25. Figures

26. Contents

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