PCF85063BTL

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

Rev. 0.04 — 5 April 2012 **Objective 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 0.27 μA at V_{DD} = 3.0 V and T_{amb} = 25 °C
- 3 line SPI-bus with a maximum data rate of 6.25 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 18.

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

5. Marking

Table 2. Marking codes

Type number	Marking code
PCF85063BTL	063B

6. Block diagram

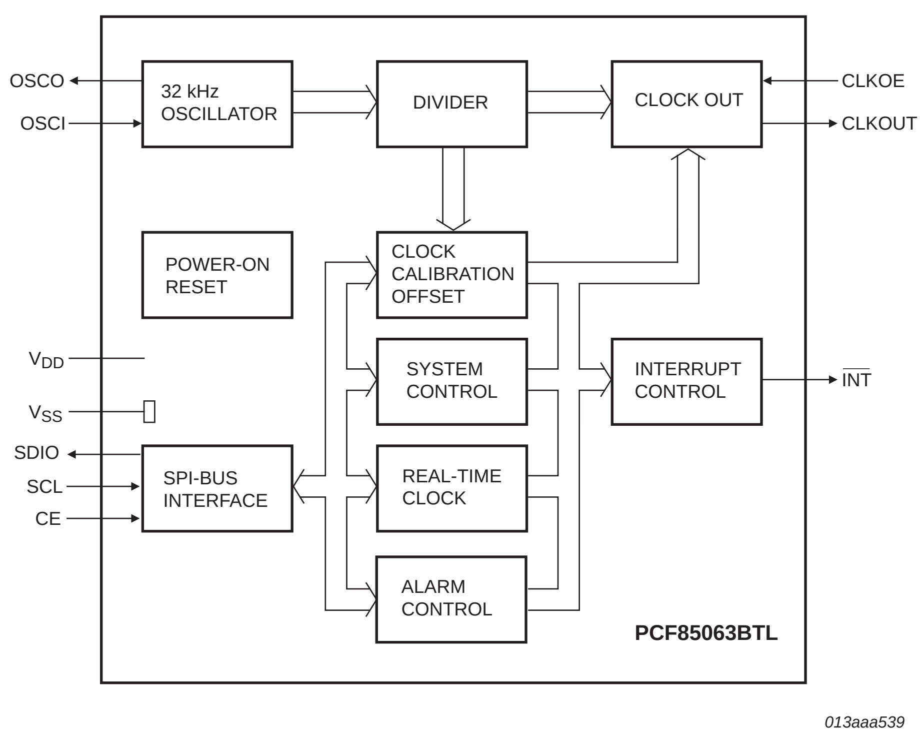
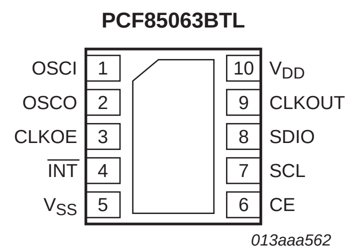


Fig 1. Block diagram of PCF85063BTL

7. Pinning information

7.1 Pinning



Transparent top view

For mechanical details, see Figure 23.

Fig 2. Pin configuration for HXSON10 (PCF85063BTL)

7.2 Pin description

Table 3. Pin description

Symbol	Pin	Type	Description
OSCI	1	input	oscillator input
OSCO	2	output	oscillator output
CLKOE	3	input	CLKOUT enable
$\overline{INT}$	4	output	interrupt output (open drain)
V_{SS}	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)
V_{DD}	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 a 400 kHz I^2C-bus interface. All registers (see Table 4) 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 Register organization

Table 4. Register overview

Bit positions labeled as - are not implemented. After reset, all register are set according to Table 7.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
Control and status registers									
00h	Control_1	EXT_TEST	-	STOP	SR	-	CIE	12_24	CAP_SEL
01h	Control_2	AIE	AF	MI	HMI	TF	COF[2:0]		
02h	Offset	MODE	OFFSET[6:0]						
03h	RAM_byte	B[7:0]							
Time and date registers									
04h	Seconds	OS	SECONDS (0 to 59)						
05h	Minutes	-	MINUTES (0 to 59)						
06h	Hours	-	-	AMPM	HOURS (1 to 12) in 12 h mode				
				HOURS (0 to 23) in 24 h mode					
07h	Days	-	-	DAYS (1 to 31)					
08h	Weekdays	-	-	-	-	-	WEEKDAYS (0 to 6)		
09h	Months	-	-	-	MONTHS (1 to 12)				
0Ah	Years	YEARS (0 to 99)							
Alarm registers									
0Bh	Second_alarm	AE_S	SECOND_ALARM (0 to 59)						
0Ch	Minute_alarm	AE_M	MINUTE_ALARM (0 to 59)						
0Dh	Hour_alarm	AE_H	-	AMPM	HOUR_ALARM (1 to 12) in 12 h mode				
				HOUR_ALARM (0 to 23) in 24 h mode					
0Eh	Day_alarm	AE_D	-	DAY_ALARM (1 to 31)					
0Fh	Weekday_alarm	AE_W	-	-	-	-	WEEKDAY_ALARM (0 to 6)		

Table 4. Register overview *...continued*

Bit positions labeled as - are not implemented. After reset, all register are set according to Table 7.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
Timer registers									
10h	Timer value	T[7:0]							
11h	Timer mode	-	-	-	TCF[1:0]		TE	TIE	TI_TP

8.2 Control registers

8.2.1 Register Control_1

Table 5. Control_1 - control and status register 1 (address 00h) bit description

Bit	Symbol	Value	Description
7	EXT_TEST	0[1]	normal mode
		1	external clock test mode
6	-	0	unused
5	STOP	0[1]	RTC clock runs
		1	RTC clock is stopped; all RTC divider chain flip-flops are asynchronously set logic 0; the RTC clock is stopped
4	SR	0[1]	no software reset
		1	initiate software reset[2]; this register will always return a 0 when read
3	-	0	unused
2	CIE	0[1]	no correction interrupt generated
		1	interrupt pulses are generated at every correction cycle
1	12_24	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 will 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 (Control_1, bit STOP = 1).
3. Clear STOP (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: RTC clock stop

The function of the STOP bit (see Figure 3) is to allow for accurate starting of the time circuits. The STOP bit function will cause the upper part of the prescaler (F_2 to F_{14}) to be held in reset and thus no 1 Hz ticks will be generated. It also stops the output of clock frequencies lower than 4 kHz on pin CLKOUT.

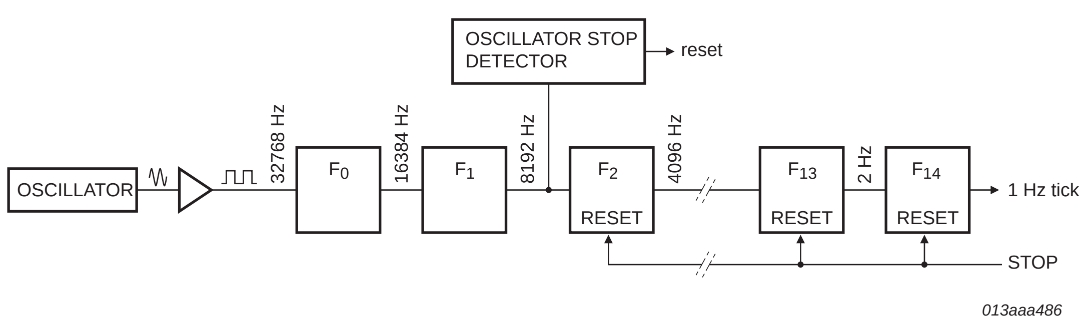
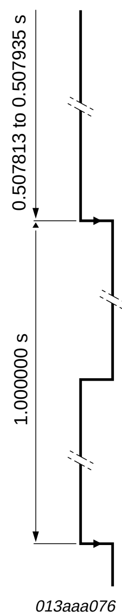


Fig 3. STOP bit functional diagram

The time circuits can then be set and do not increment until the STOP bit is released (see Figure 4 and Table 6).

Table 6. First increment of time circuits after STOP bit release

Bit STOP	Prescaler bits[1] F_0F_1-F_2 to F_{14}	1 Hz tick	Time hh:mm:ss	Comment
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 4).

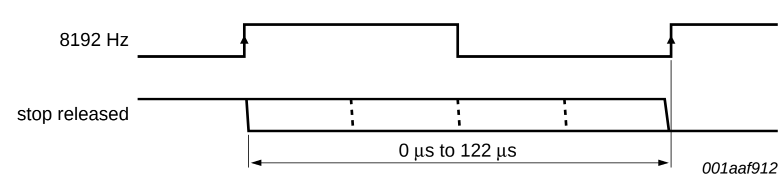
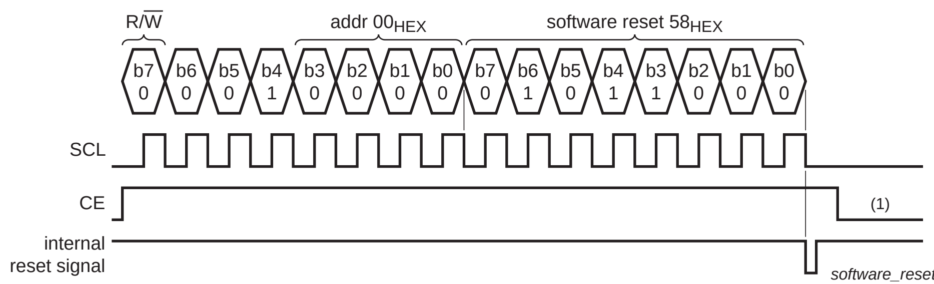


Fig 4. STOP bit release timing

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 6) and the unknown state of the 32 kHz clock.

8.2.1.3 SR: 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 5.



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

Fig 5. Software reset command

In the reset state the SPI-bus logic is initialized including the address pointer and all registers are set according to Table 7. SPI-bus communication is not possible during reset.

Table 7. Register 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

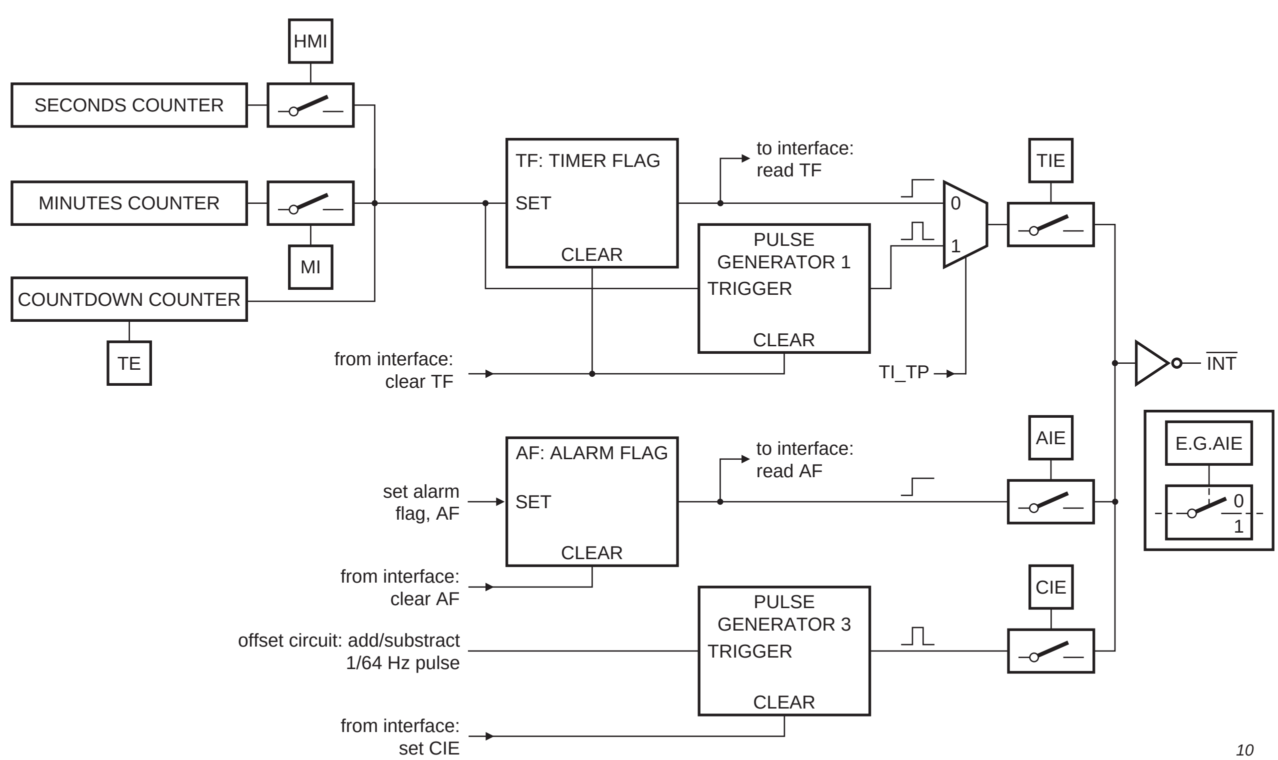
8.2.2 Register Control_2

Table 8. Control_2 - control and status register 2 (address 01h) bit description

Bit	Symbol	Value	Description
7	AIE	0[1]	alarm interrupt disabled
		1	alarm interrupt enabled
6	AF	0[1]	read: alarm flag inactive
			write: alarm flag is cleared
		1	read: alarm flag active
			write: alarm flag remains unchanged
5	MI	0[1]	minute interrupt disabled
		1	minute interrupt enabled
4	HMI	0[1]	half minute interrupt disabled
		1	half minute interrupt enabled
3	TF	0[1]	no timer interrupt generated
		1	flag set when timer interrupt generated
2 to 0	COF[2:0]	see Table 10	CLKOUT control

[1] Default value.

8.2.2.1 Alarm interrupt



When AIE bit is disabled, pin INT remains high-impedance.

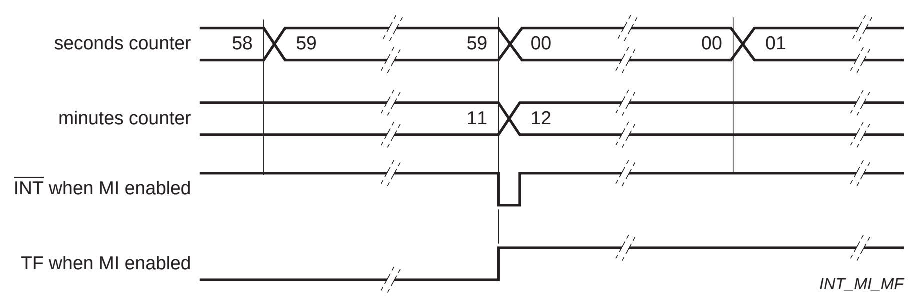
Fig 6. Interrupt scheme

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 using the interface. 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 periodic interrupts; see Figure 7. The timers are running in sync with the seconds counter (see Table 18). When starting MI, the first interrupt will be generated after 1 to 59 seconds; when starting HMI, the first interrupt will be generated after 1 to 29 seconds. Subsequent periods will 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 will not be distinguishable.



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

Fig 7. $\overline{\text{INT}}$ example for MI

Table 9. Effect of bits MI and HMI on $\overline{\text{INT}}$ 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 the Offset has the value 00h the periods will be 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 the interface.

The status of the timer flag TF can affect the $\overline{\text{INT}}$ pulse generation depending on the setting of TI_TP (see Section 8.6.2):

- When TI_TP is set logic 1
  - an $\overline{\text{INT}}$ pulse is generated independent of the status of the timer flag TF
  - TF stays set until it is cleared

  - TF does not affect $\overline{\text{INT}}$
  - the countdown timer runs in a repetitive loop and keeps generating timed periods.
- When TI_TP is set logic 0
  - the $\overline{\text{INT}}$ generation follows the TF flag
  - TF stays set until it is cleared
  - If TF is not cleared before the next coming interrupt no $\overline{\text{INT}}$ 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 an open-drain output and enabled at power-on. When disabled the output is high-impedance.

The duty cycle of the selected clock is not controlled. However, due to the nature of the clock generation, all will be 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 will generate 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 10. CLKOUT frequency selection

Bits 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 will be 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
- Ageing adjustment
- Temperature compensation

Table 11. Offset - offset register (address 02h) bit description

Bit	Symbol	Value	Description
7	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 12	offset value

[1] Default value.

Each LSB will introduce an offset of 4.34 ppm for MODE = 0 and 4.069 ppm for MODE = 1. 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 12. 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 $^1/_{1024}$ s pulse will be generated on pin $\overline{INT}$. In the case that multiple correction pulses are applied, a $^1/_{1024}$ s interrupt pulse will be 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 13. Correction pulses for MODE = 0

Correction value	Hour	Minute	Correction pulses on INT1 per minute[1]
+1 or –1	02	00	1
+2 or –2	02	00 and 01	1
+3 or –3	02	00, 01, and 02	1
:	:	:	:
+59 or –59	02	00 to 58	1
+60 or –60	02	00 to 59	1
+61 or –61	02	00 to 59	1
	03	00	1
+62 or –62	02	00 to 59	1
	03	00 and 01	1
+63 or –63	02	00 to 59	1
	03	00, 01, and 02	1
–64	02	00 to 59	1
	03	00, 01, 02, and 03	1

[1] The correction pulses on pin $\overline{\text{INT1}}$ are $\frac{1}{64}$ s wide.

In MODE = 0, any timer or clock output using a frequency below 64 Hz will be affected by the clock correction (see Table 14).

Table 14. Effect of correction pulses 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
$\frac{1}{60}$	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 15. Correction pulses for MODE = 1

Correction value	Minute	Second	Correction pulses on $\overline{\text{INT1}}$ per second[1]
+1 or –1	02	00	1
+2 or –2	02	00 and 01	1
+3 or –3	02	00, 01, and 02	1
:	:	:	:
+59 or –59	02	00 to 58	1
+60 or –60	02	00 to 59	1
+61 or –61	02	00 to 58	1
	02	59	2
+62 or –62	02	00 to 58	1
	02	59	2
+63 or –63	02	00 to 58	1
	02	59	4
–64	02	00 to 58	1
	02	59	5

[1] The correction pulses on pin $\overline{\text{INT1}}$ 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 4.096 kHz will be also affected by the clock correction (see Table 16).

Table 16. Effect of correction pulses 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 8 shows the worklow how the offset register values can be calculated:

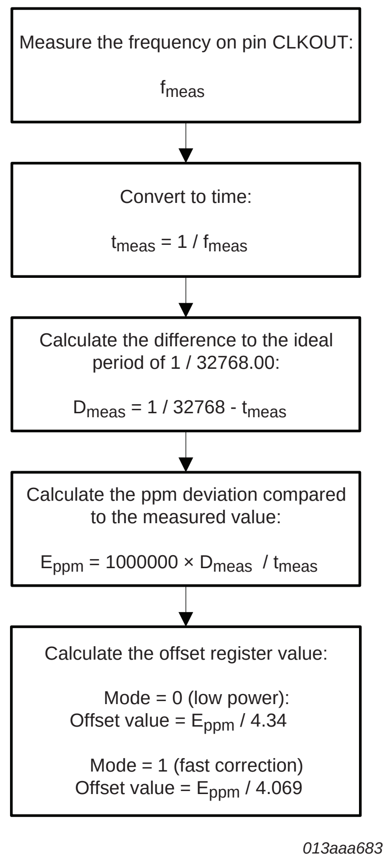


Fig 8. Offset calibration calculation workflow

8.2.4 Register: RAM_byte

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

Table 17. 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

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

8.3.1 Register Seconds

Table 18. Seconds - seconds register (address 04h) bit description

Bit	Symbol	Value	Place value	Description
7	OS	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 19
3 to 0		0[1] to 9	unit place	

[1] Default value.

Table 19. 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: 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 will remain set until cleared by software (see Figure 9). 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.

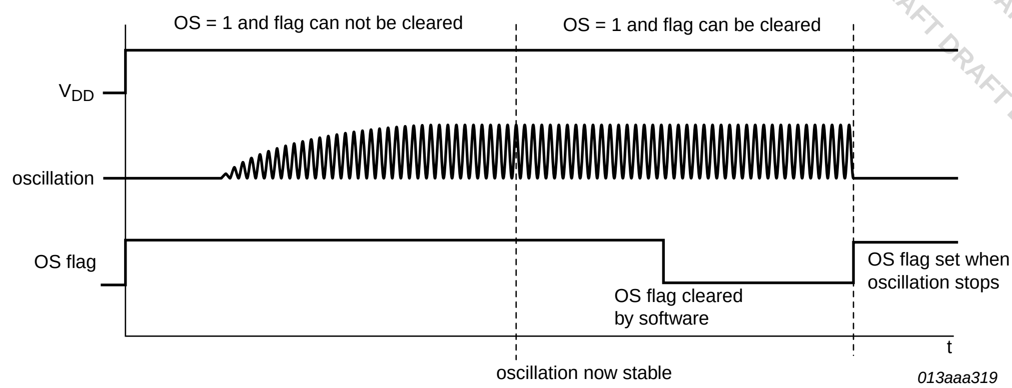


Fig 9. OS flag

8.3.2 Register Minutes

Table 20. Minutes - minutes register (address 05h) bit description

Bit	Symbol	Value	Place value	Description
7	-	-	-	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 21. Hours - hours register (address 06h) bit description

Bit	Symbol	Value	Place value	Description
7 to 6	-	-	-	unused
12 hour mode[1]				
5	AMPM	0[2]	-	indicates AM
		1	-	indicates 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 22. Days - days register (address 07h) bit description

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

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

[2] Default value.

8.3.5 Register Weekdays

Table 23. Weekdays - weekdays register (address 08h) bit description

Bit	Symbol	Value	Description
7 to 3	-	-	unused
2 to 0	WEEKDAYS	0 to 6	actual weekday values, see Table 24

Table 24. 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 re-assigned by the user.

[2] Default value.

8.3.6 Register Months

Table 25. Months - months register (address 09h) bit description

Bit	Symbol	Value	Place value	Description
7 to 5	-	-	-	unused
4	MONTHS	0 to 1	ten's place	actual month coded in BCD format, see Table 26
3 to 0		0 to 9	unit place	

Table 26. 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 27. 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 10 shows the data flow and data dependencies starting from the 1 Hz clock tick.

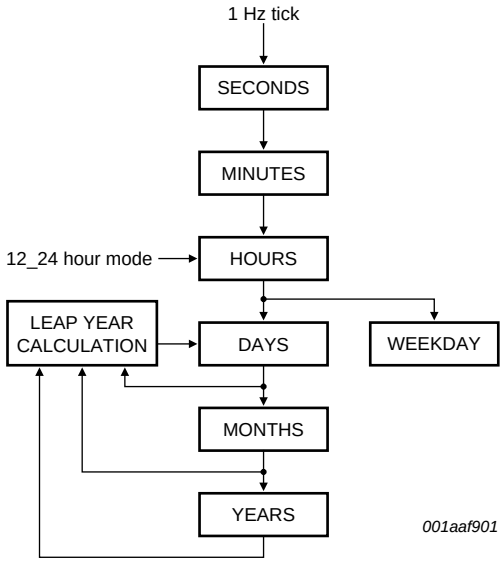


Fig 10. Data flow for the time function

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

This 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 11).

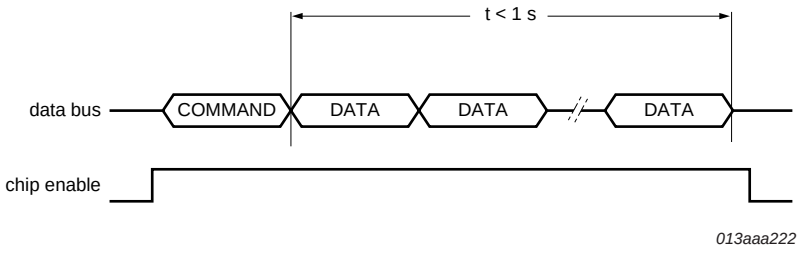


Fig 11. Access time for read/write operations

As a consequence 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 may 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.

8.5 Alarm registers

8.5.1 Register Second_alarm

Table 28. Second_alarm - second alarm register (address 0Bh) bit description

Bit	Symbol	Value	Place value	Description
7	AE_S	0	-	second alarm is enabled
		1[1]	-	second alarm is 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 29. Minute_alarm - minute alarm register (address 0Ch) bit description

Bit	Symbol	Value	Place value	Description
7	AE_M	0	-	minute alarm is enabled
		1[1]	-	minute alarm is 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 30. Hour_alarm - hour alarm register (address 0Dh) bit description

Bit	Symbol	Value	Place value	Description
7	AE_H	0	-	hour alarm is enabled
		1[1]	-	hour alarm is disabled
6	-	-	-	unused
12 hour mode[2]				
5	AMPM	0[1]	-	indicates AM
		1	-	indicates PM
4	HOUR_ALARM	0[1] to 1	ten's place	hour alarm information coded in BCD format when in 12 hour mode
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 coded in BCD format when in 24 hour mode
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 31. Day_alarm - day alarm register (address 0Eh) bit description

Bit	Symbol	Value	Place value	Description
7	AE_D	0	-	day alarm is enabled
		1[1]	-	day alarm is disabled
6	-	-	-	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 32. Weekday_alarm - weekday alarm register (address 0Fh) bit description

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

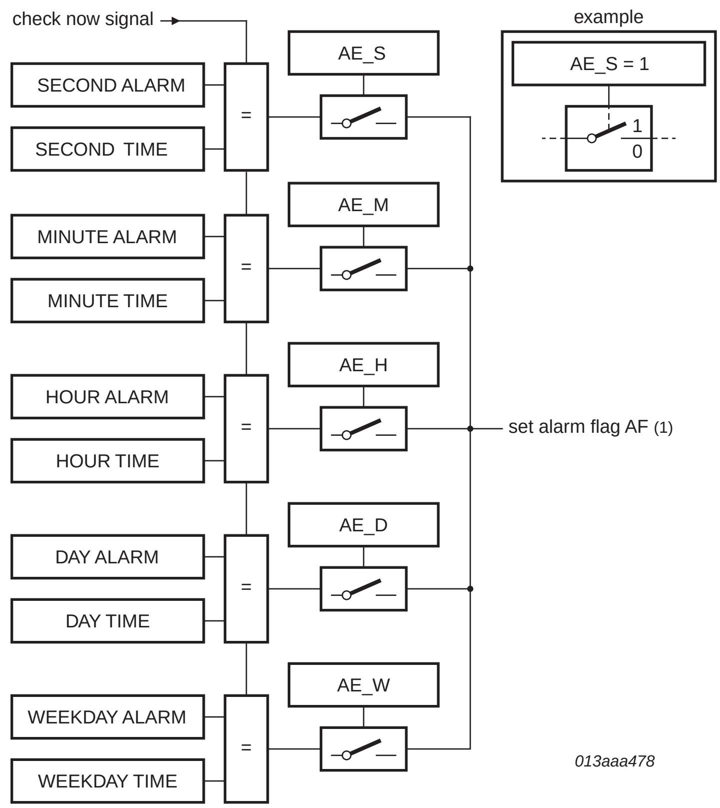
[1] Default value.

8.5.6 Alarm function

By clearing the alarm enable bit (AE_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 ($\overline{\text{INT}}$). The AF is cleared using the interface.

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 AE_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 $\overline{\text{INT}}$ pin follows the condition of bit AF. AF will remain set until cleared by the interface. 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 AE_x bit at logic 1 are ignored.



(1) Only when all enabled alarm settings are matching.
It's only on increment to a matched case that the alarm flag is set, see Section 8.5.6.

Fig 12. 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 33. Timer_value - timer value register (address 10h) bit description

Bit	Symbol	Value	Description
7 to 0	T[7:0]	0h[1] to FFh	countdown period in seconds: $CountdownPeriod = \frac{n}{SourceClockFrequency}$ where n is the countdown value

[1] Default value.

8.6.2 Register Timer_mode

Table 34. Timer_mode - timer control register (address 11h) bit description

Bit	Symbol	Value	Description
7 to 5	-	-	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]	$\frac{1}{60}$ 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 10.

8.6.3 Timer functions

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

Table 35. Timer clock frequency and timer durations

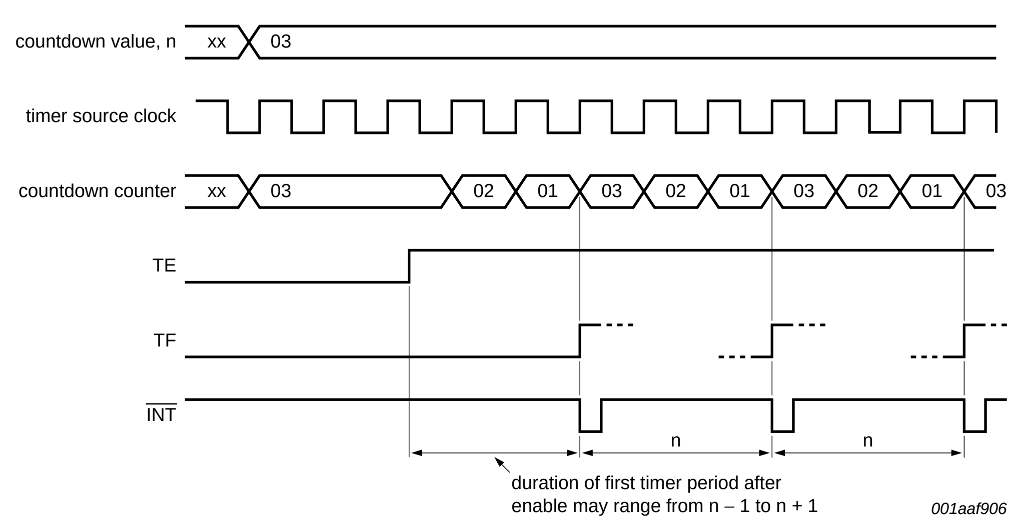
TCF[1:0]	Timer source clock frequency[1]	Delay	
		Minimum timer duration n = 1	Maximum timer duration n = 255
00	4.096 kHz	244 µs	62.256 ms
01	64 Hz	15.625 ms	3.984 s
10	1 Hz[2]	1 s	255 s
11	$^{1}/_{60}$ Hz[2]	60 s	4 h 15 min

[1] When not in use, TCF 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 will result in deviation in timings. This is not applicable to interface timing.

The timer counts down from a software-loaded 8-bit binary value, n, in register Timer_value. Loading the counter with 0 stops the timer. Values from 1 to 255 are valid. When the counter reaches 1, the timer flag (bit TF in register Control_2) will be set and the counter automatically re-loads and starts the next timer period. Reading the timer will return the current value of the countdown counter (see Figure 13).



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 13. General countdown timer behavior

If a new value of n is written before the end of the current timer period, then this value will take immediate effect. NXP does not recommend changing n without first disabling the counter by setting bit TE logic 0. The update of n 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 which results in an undetermined countdown period for the first period. The countdown value n will, however, be correctly stored and correctly loaded on subsequent timer periods.

When the TIE flag is set, an interrupt signal on $\overline{\text{INT}}$ will be generated provided that 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 will have an uncertainty which is a result of the enable instruction being generated from the interface clock which is asynchronous from the timer source clock. Subsequent timer periods will have no such delay. The amount of delay for the first timer period will depend on the chosen source clock, see Table 36.

Table 36. First period delay for timer counter value n

Timer source clock	Minimum timer period	Maximum timer period
4.096 kHz	n	n + 1
64 Hz	n	n + 1
1 Hz	(n – 1) + $^{1}/_{64}$ Hz	n + $^{1}/_{64}$ Hz
$^{1}/_{60}$ Hz	(n – 1) + $^{1}/_{64}$ Hz	n + $^{1}/_{64}$ 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 software. The asserted bit TF can be used to generate an interrupt at pin $\overline{\text{INT}}$. 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 34.

When reading the timer, the current countdown value is returned and **not** the initial value n. 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 will be affected by the Offset_register. The duration of a program period will vary 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 therefor 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 n. As a consequence, the width of the interrupt pulse varies (see Table 37).

Table 37. $\overline{\text{INT}}$ operation[1]

Source clock (Hz)	$\overline{\text{INT}}$ period (s)	
	n = 1[2]	n > 1[2]
4096	$^{1}/_{8192}$	$^{1}/_{4096}$
64	$^{1}/_{128}$	$^{1}/_{64}$
1	$^{1}/_{64}$	$^{1}/_{64}$
$^{1}/_{60}$	$^{1}/_{64}$	$^{1}/_{64}$

[1] TF and $\overline{\text{INT}}$ become active simultaneously.

[2] n = loaded countdown value. Timer stops when n = 0.

9. SPI-bus interface

Data transfer to and from the device is made via a 3-wire SPI-bus (see Table 38). 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 14).

Table 38. 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; will be high-Z 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 will be 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.

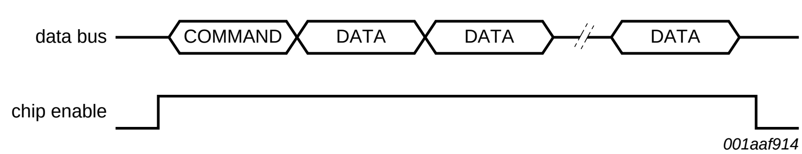


Fig 14. Data transfer overview

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 rollover to zero after the last register is accessed. The read/write bit ($R/\overline{W}$) defines if the following bytes will be read or write information.

Table 39. 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 4	SA	001	subaddress; other codes will cause the device to ignore data transfer
3 to 0	RA	0h to Fh	register address range

In Figure 15, the register Seconds is set to 45 seconds and the register Minutes is set to 10 minutes. In Figure 16, the Months and Years registers are read.

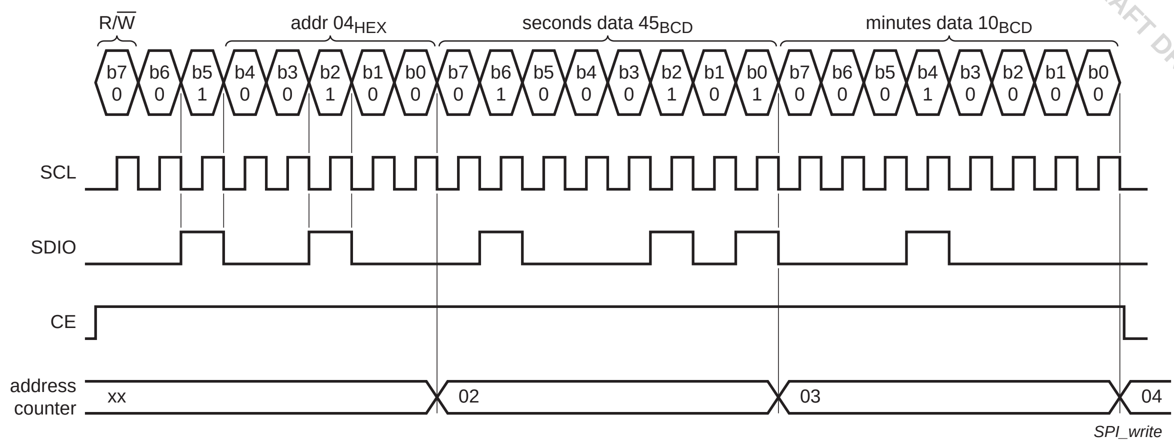


Fig 15. Serial bus write example

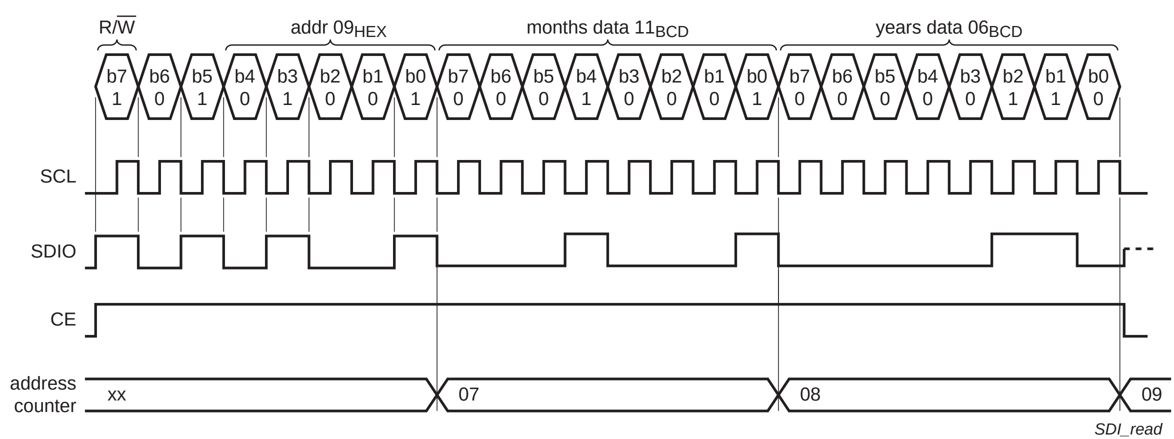


Fig 16. Serial bus read example

10. Internal circuitry

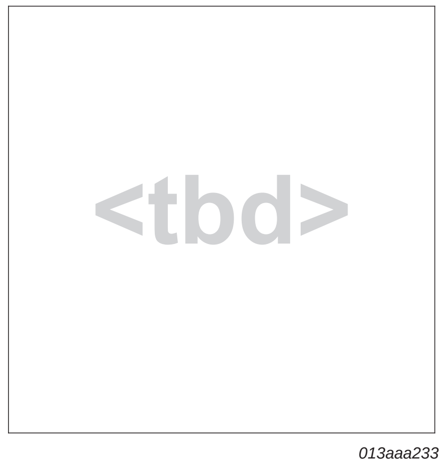


Fig 17. Device diode protection diagram

11. Limiting values

Table 40. 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, SDA, and 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]	-	±1750	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. 6 “JESD22-A114”.

[2] Pass level; Charged-Device Model (CDM), according to Ref. 7 “JESD22-C101”.

[3] Pass level; latch-up testing, according to Ref. 8 “JESD78” at maximum ambient temperature ($T_{amb(max)}$).

[4] According to the NXP store and transport requirements (see Ref. 10 “NX3-00092”) the devices have to be stored at a temperature of +8 °C to +45 °C and a humidity of 25 % to 75 %. For long term storage products deviant conditions are described in that document.

12. Static characteristics

Table 41. Static characteristics

V_{DD} = 1.1 V to 5.5 V; V_{SS} = 0 V; T_{amb} = −40 °C to +85 °C; f_{osc} = 32.768 kHz; quartz R_s = 15 kΩ; C_L = 7 pF; unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Supplies							
V_{DD}	supply voltage	for clock data integrity; interface inactive	[1]	0.9	-	5.5	V
		interface active		1.6	-	5.5	V
I_{DD}	supply current	interface inactive; CLKOUT disabled;	[2]				
		T_{amb} = 25 °C					
		V_{DD} = 5.0 V		-	120	-	nA
		V_{DD} = 3.0 V		-	110	-	nA
		V_{DD} = 2.0 V		-	100	-	nA
		T_{amb} = −40 °C to +85 °C	[2]				
		V_{DD} = 2.0 V		-	-	330	nA
		V_{DD} = 3.0 V		-	-	350	nA
		V_{DD} = 5.0 V		-	-	380	nA
		interface active					
		f_{SCL} = 4.5 MHz; V_{DD} = 5 V		-	250	400	µA
		f_{SCL} = 1.0 MHz; V_{DD} = 3 V		-	30	80	µA
Inputs							
V_{IL}	LOW-level input voltage			-	-	0.3V_{DD}	V
V_{IH}	HIGH-level input voltage			0.7V_{DD}	-	-	V
V_I	input voltage	on pins CE, SDI, SCL, OSCI, CLKOE, CLKOUT		−0.5	-	+5.5	V
I_{LI}	input leakage current						
		V_I = V_{DD} or V_{SS} on pins SDI, SCL, OSCI, CLKOE, CLKOUT		-	0	-	µA
		V_I = V_{SS} on pin CE		−1	0	-	µA
		post ESD event		−1	-	+1	µA
R_{pd}	pull-down resistance	on pin CE		-	240	550	kΩ
C_i	input capacitance	on pins SDI, SCL, CLKOE and CE	[3]	-	-	7	pF
Outputs							
V_O	output voltage	on pins CLKOUT and $\overline{INT}$	[4]	−0.5	-	+5.5	V
		on pin OSCO		−0.5	-	+5.5	V
		on pin SDO		−0.5	-	V_{DD} + 0.5	V
V_{OH}	HIGH-level output voltage	on pin SDO		0.8V_{DD}	-	V_{DD}	V

Table 41. Static characteristics *...continued*

V_{DD} = 1.1 V to 5.5 V; V_{SS} = 0 V; T_{amb} = −40 °C to +85 °C; f_{osc} = 32.768 kHz; quartz R_s = 15 kΩ; C_L = 7 pF; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OL}	LOW-level output voltage	on pin SDO	V_{SS}	-	$0.2V_{DD}$	V
		on pins CLKOUT and $\overline{INT}$; V_{DD} = 5 V; I_{OL} = 1.5 mA	V_{SS}	-	0.4	V
I_{OH}	HIGH-level output current	output source current; V_{OH} = 4.6 V; V_{DD} = 5 V on pin SDO	1.5	-	-	mA
I_{OL}	LOW-level output current	output sink current; V_{OL} = 0.4 V; V_{DD} = 5 V on pins $\overline{INT}$, SDO and CLKOUT	1.5	-	-	mA
I_{LO}	output leakage current	$V_O = V_{DD}$ or V_{SS}	-	0	-	µA
		post ESD event	−1	-	+1	µA
$C_{L(itg)}$	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

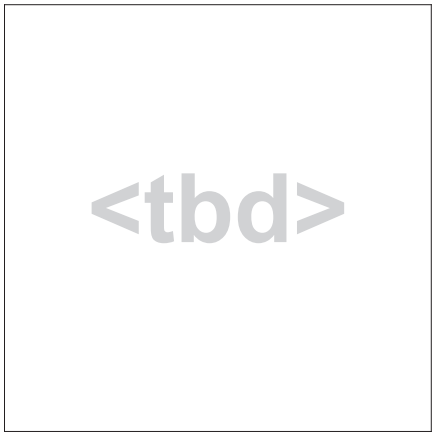
[1] For reliable oscillator start at power-on: $V_{DD} = V_{DD(min)} + 0.3$ V.

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

[3] Implicit by design.

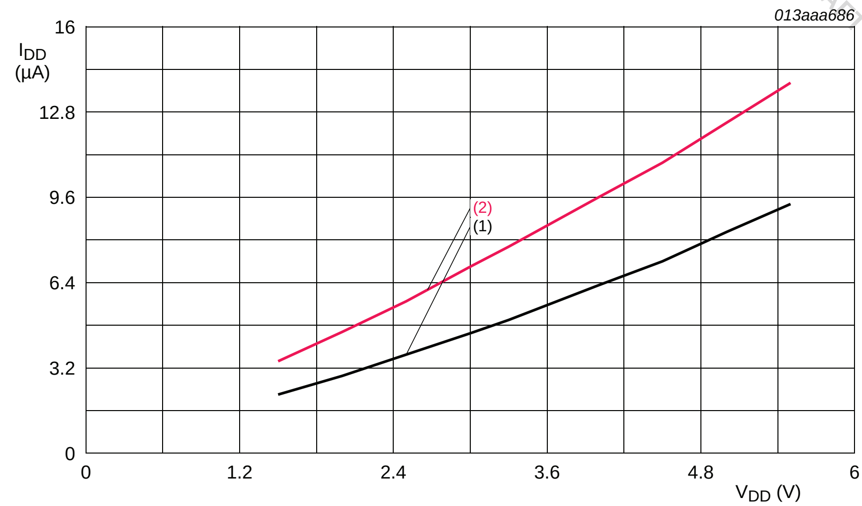
[4] Refers to external pull-up voltage.

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



V_{DD} = 3 V.

Fig 18. I_{DD} as a function of temperature

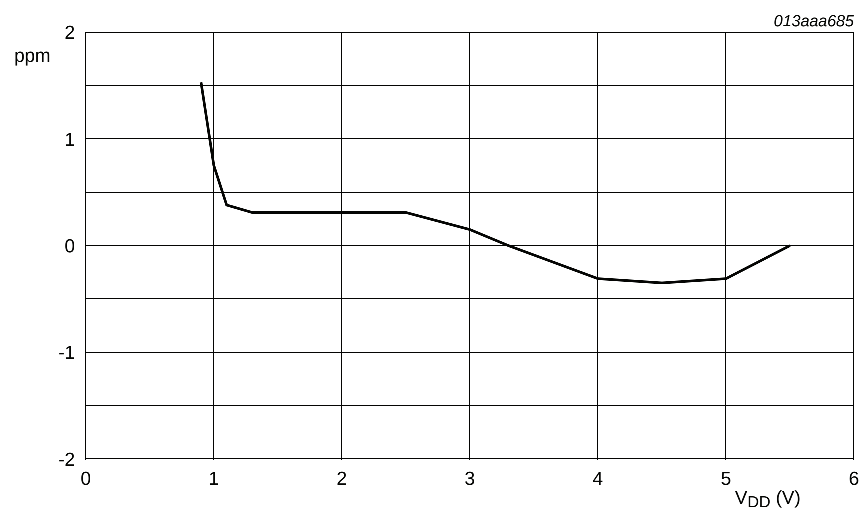


T_{amb} = 25 °C; f_{CLKOUT} = 32768 Hz.

(1) 22 pF.

(2) 47 pF.

Fig 19. I_{DD} with respect to V_{DD} when CLKOUT active



T_{amb} = 25 °C; C_L = 7 pF

Fig 20. Oscillator frequency variation with respect to V_{DD}

13. Dynamic characteristics

Table 42. SPI-bus characteristics

V_{SS} = 0 V; T_{amb} = −40 °C to +85 °C. 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} = 1.6 V		V_{DD} = 2.4 V		V_{DD} = 3.3 V		V_{DD} = 5.0 V		Unit
			Min	Max	Min	Max	Min	Max	Min	Max	
Timing characteristics (see Figure 21)											
$f_{clk(SCL)}$	SCL clock frequency		-	2.9	-	4.54	-	5.71	-	8.0	MHz
t_{SCL}	SCL time		345	-	220	-	175	-	125	-	ns
$t_{clk(H)}$	clock HIGH time		90	-	50	-	45	-	40	-	ns
$t_{clk(L)}$	clock LOW time		200	-	120	-	95	-	70	-	ns
t_r	rise time	for SCL signal	-	100	-	100	-	50	-	50	ns
t_f	fall time	for SCL signal	-	100	-	100	-	50	-	50	ns
$t_{su(CE)}$	CE set-up time		40	-	35	-	30	-	25	-	ns
$t_{h(CE)}$	CE hold time		40	-	30	-	25	-	15	-	ns
$t_{rec(CE)}$	CE recovery time		30	-	25	-	20	-	15	-	ns
$t_{w(CE)}$	CE pulse width	measured after valid subaddress is received	-	0.99	-	0.99	-	0.99	-	0.99	s
t_{su}	set-up time	set-up time for SDI data	10	-	5	-	3	-	2	-	ns
t_h	hold time	hold time for SDI data	40	-	15	-	10	-	5	-	ns
$t_{d(R)SDO}$	SDO read delay time	bus load = 50 pF	-	190	-	108	-	85	-	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	-	70	-	45	-	40	-	27	ns
$t_{t(SDI-SDO)}$	transition time from SDI to SDO	to avoid bus conflict	0	-	0	-	0	-	0	-	ns

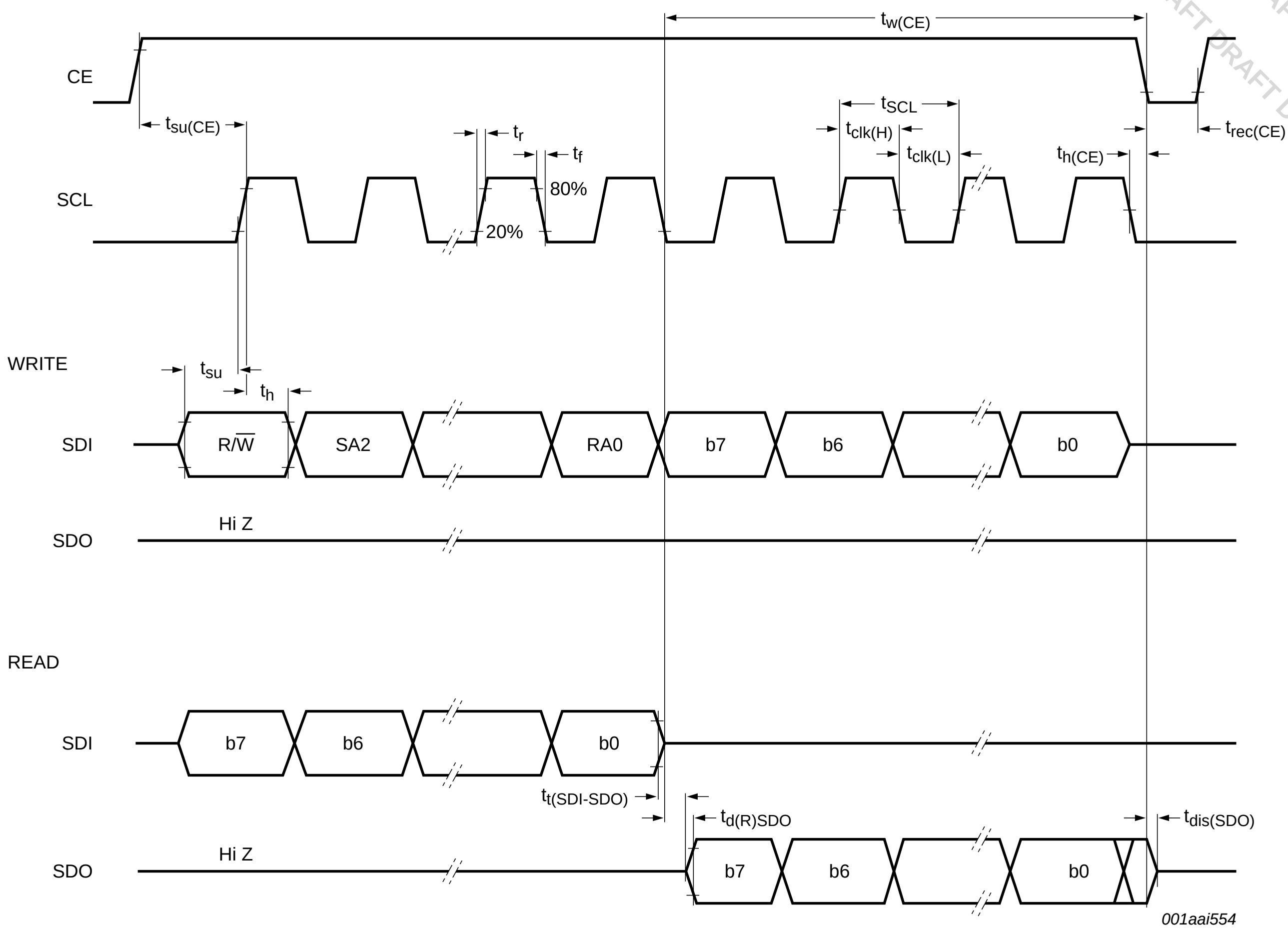


Fig 21. SPI-bus timing

14. Application information

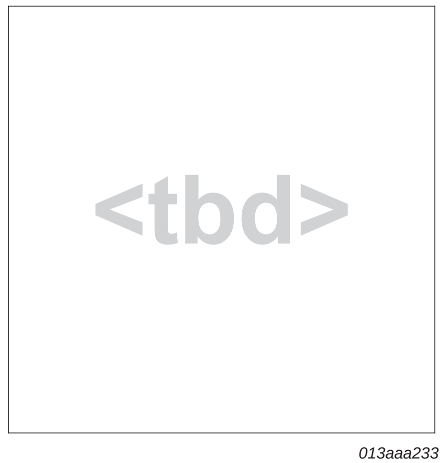


Fig 22. Application diagram

14.1 Quartz frequency adjustment

14.1.1 Method 1: fixed OSCI capacitor

By evaluating the average capacitance necessary for the application layout, a fixed capacitor can be used. The frequency is best measured via the 32.768 kHz signal available after power-on at pin CLKOUT. The frequency tolerance depends on the quartz crystal tolerance, the capacitor tolerance, and the device-to-device tolerance. Average deviations of less than ±5 minutes per year can easily be achieved.

14.1.2 Method 2: OSCI trimmer

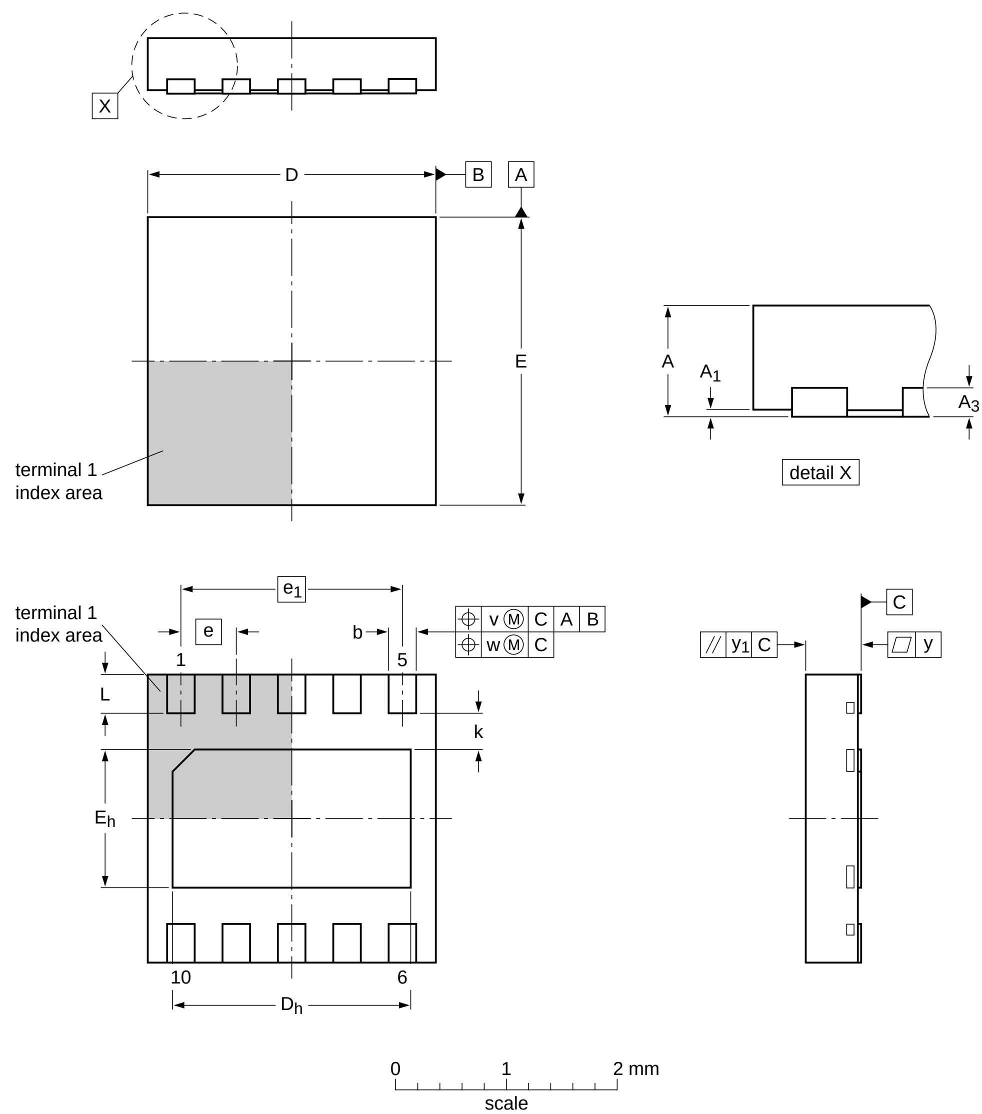
Using the 32.768 kHz signal available after power-on at pin CLKOUT, fast setting of a trimmer is possible.

14.1.3 Method 3: OSCO output

Direct measurement of OSCO out (accounting for test probe capacitance).

15. Package outline

HXSON10: 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
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~~ 11-01-20

Fig 23. Package outline SOT1197-1 (HXSON10) of PCF85063BTL

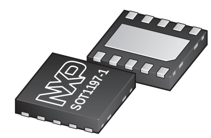


Fig 24. Three dimensional package drawing of PCF85063BTL (HXSON10)

16. 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.

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 25) 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 43 and 44

Table 43. SnPb eutectic process (from J-STD-020C)

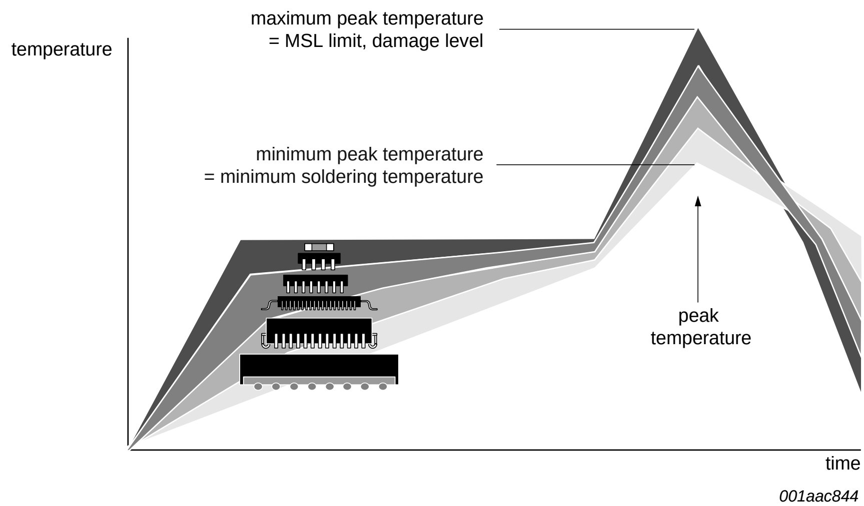
Package thickness (mm)	Package reflow temperature (°C)	
	Volume (mm^3)	
	< 350	≥ 350
< 2.5	235	220
≥ 2.5	220	220

Table 44. Lead-free process (from J-STD-020C)

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 25.



MSL: Moisture Sensitivity Level

Fig 25. Temperature profiles for large and small components

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

18. Abbreviations

Table 45. Abbreviations

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

19. References

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

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

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

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

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

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

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

[8] **JESD78 —** IC Latch-Up Test

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

[10] **NX3-00092 —** NXP store and transport requirements

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

20. Revision history

Table 46. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
PCF85063BTL_0.04	20120404	Objective data sheet	-	PCF85063BTL_0.03
PCF85063BTL_0.03	20111110	Objective data sheet	-	PCF85063BTK_0.02
PCF85063BTK_0.02	20110513	Objective data sheet	-	PCF85063BTK_0.01
PCF85063BTK_0.01	20110420	Objective data sheet	-	-

21. Legal information

21.1 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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23. Tables

24. Figures

25. Contents

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