UM10699

User manual for SPI-bus RTC demoboard OM11059

Rev. 2 — 12 February 2015 **User manual**

Document information

Info	Content
Keywords	PCF85063BTL, OM11059, demoboard, how to get started, SPI-bus, RTC, Real-Time Clock, tuning
Abstract	User manual for the RTC SPI-bus demoboard OM11059 which contains PCF85063BTL

Revision history

Rev	Date	Description
v.2	20150212	revised version
v.1	20130404	new user manual, first revision

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1. Introduction

The PCF85063x are a family of CMOS Real-Time Clocks (RTC) and calendar optimized for low power consumption. Different features sets are available.

The OM11059 is the ideal evaluation/demo board to use in the design phase of any project, just power and SPI-bus must be hooked up.

A separate demoboard and a user manual are available for the I^2C-bus RTCs PCF85063AT:OM13515 and UM10788.

2. Key features

The RTC PCF85063BTL with SPI-bus is mounted together with a quartz crystal and the blocking capacitor, buffering the supply voltage.

2.1 PCF85063BTL

The RTC PCF85063BTL is a Real-Time Clock with very small form factor, counting seconds, minutes, hours, days, weekdays, months, and years.

Electronic oscillator tuning

RAM: 1 Byte

Package: HXSON10 package: 2.6 x 2.6 x 0.5 mm

Alarm control

Timer

Interrupt: every 30 s or 60 s, alarm, timer

Interface: SPI-bus, up to 8 MHz

Clock out: enabled by pin or by software

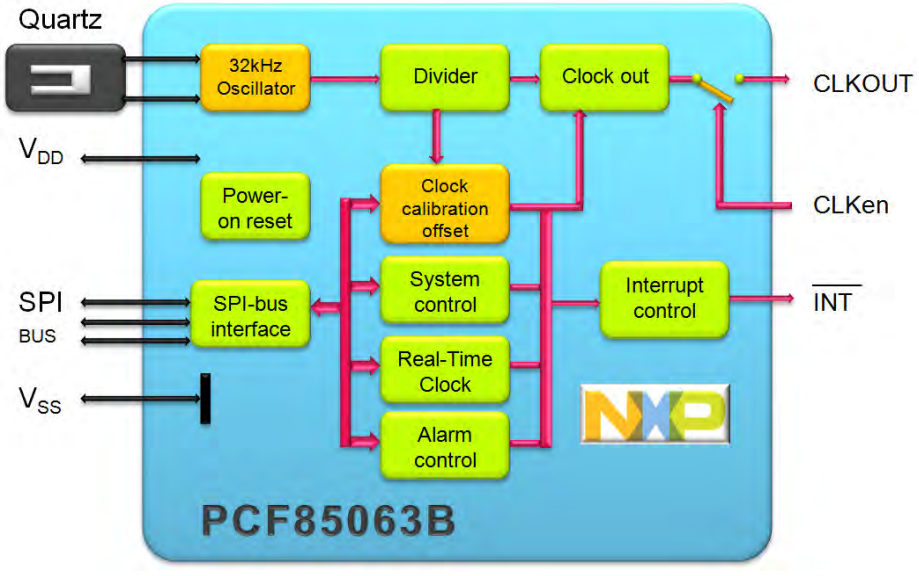


Fig 1. Block diagram of the PCF85063BTL RTC

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3. Hardware set-up

3.1 General requirements for the RTC PCF85063BTL

The RTC circuit just requires one external part: a tuning fork quartz as resonator. The oscillation capacitors are integrated and therefore there is no need for external capacitors. The quartz crystal must be placed close to the RTC circuit, avoiding long lines which may pick up noise. Avoid any tracks with high frequency signals (fast edges) close to the RTC, quartz, or quartz interconnect.

The interface uses a three-line standard SPI protocol: chip enable, serial clock, serial data I/O operating up to 8 MHz.

Supply voltage: The RTC is specified from 1.8 V to 5.5 V. The RTC, excluding the SPI-bus interface, is however operating down to a lower voltage. It is recommended to have a decoupling capacitor on the VDD-VSS rails close by.

Due to the low power consumption of below 1 µW, no precautions for heat dissipations are required.

CLKOUT can be used to measure the frequency or be used as reference for frequency generation with a PLL.

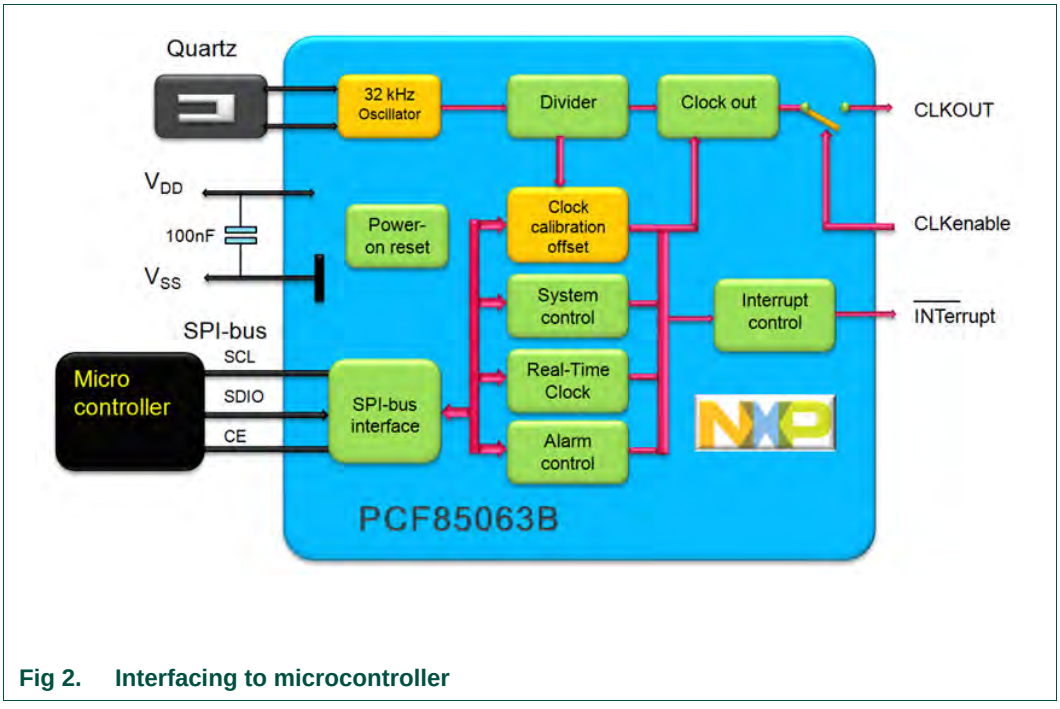


Fig 2. Interfacing to microcontroller

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3.2 Demo board OM11059

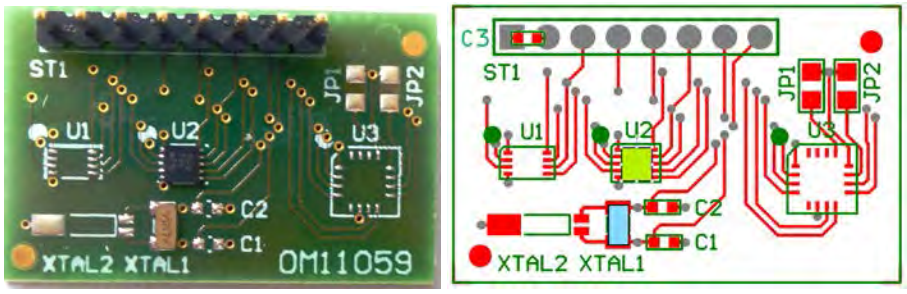


Fig 3. Picture and layout of demo bard OM11059

The OM11059 allows to easily demonstrate operation of the PCF85063BTL with SPI-bus interface. No need to solder the tiny package to a breadboard 100 mil connector for straight forward connections.

There are quartzes on the market with different load capacitance C_L. 12.5 pF is most common, 7 pF offers however lower power consumption. By default a quartz with 7 pF is mounted. Additional landing pads are available on the board to take a quartz in a tubular package.

Straight forward interfacing:

- Connect supply voltage (e.g. 3.3 V): VSS to pin 1, VDD to pin 2
- Connect SPI-bus: CE to pin 4, SCL to pin 3, SDI/O to pin 7
- Communicate to the RTC

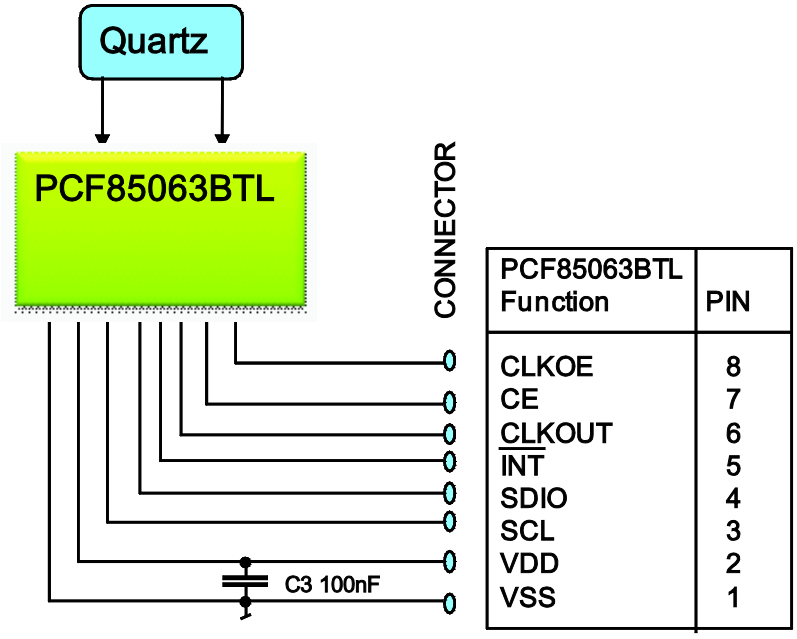


Fig 4. OM11059 block diagram

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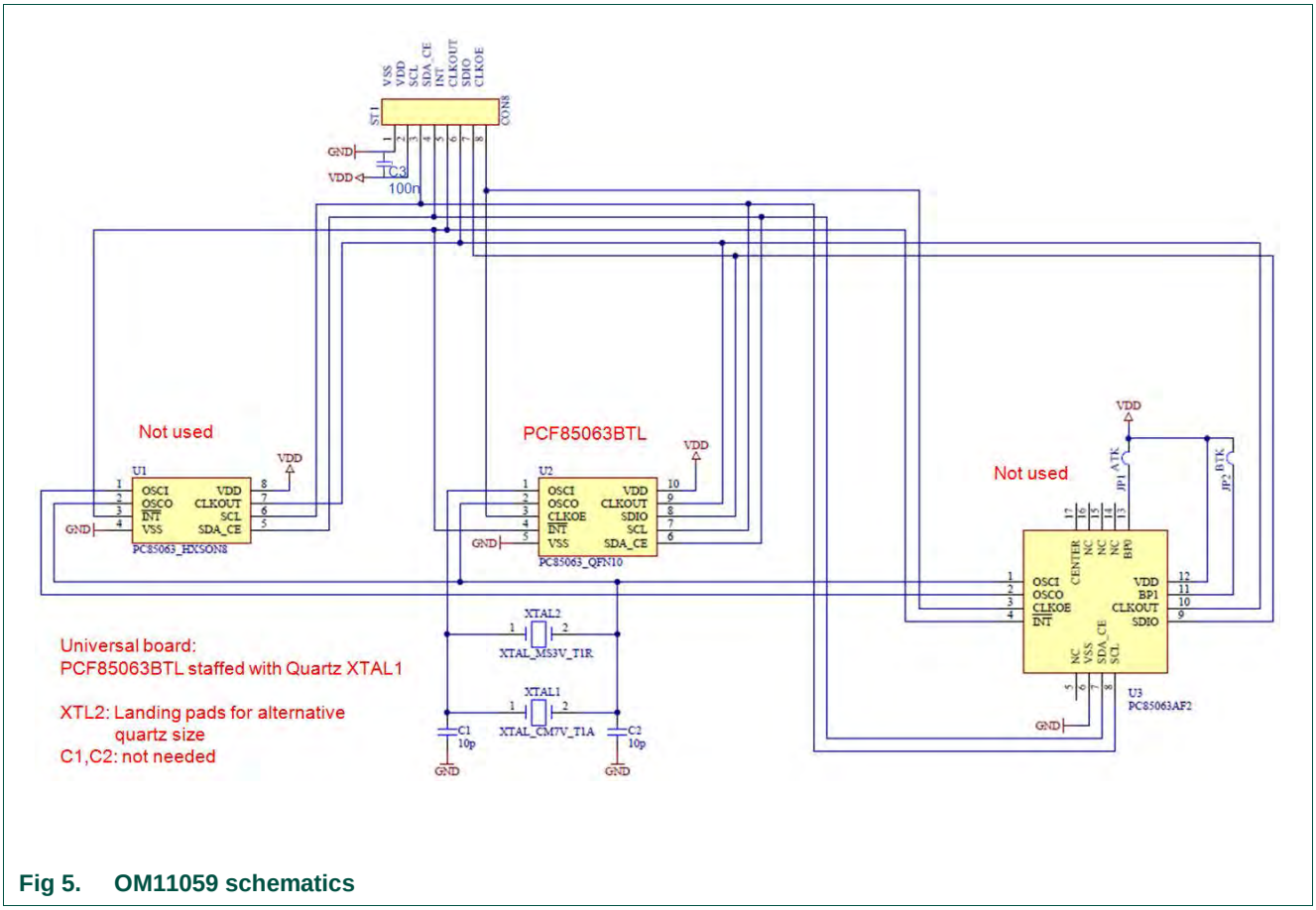


Fig 5. OM11059 schematics

4. Software set-up

4.1 Functionality

The RTC PCF85063BTL is controlled via standard SPI-bus interface. Common SPI protocol applies.

Theoretically there is no lower speed limit, however a read or write access to the RTC must be finalized within one second after initiating it, otherwise time counter increments could be lost. During access, the time registers of the RTC are frozen and after the read or write sequence is completed, a seconds increment is executed if required.

The clock tracks the actual time from seconds to year. It must be initially set to the correct time of the actual time zone. The days per month and leap year are corrected automatically. Leap years are assumed whenever the year is dividable by 4.

The RTC can be programmed to generate an interrupt every 30 seconds or every 60 seconds.

At address byte 03h is a general purpose RAM byte to store temporary information.

4.2 System testing

There is a fast mode facility to test the functionality of the RTC; it can be activated by setting the EXT_TEST bit in the Control_1 word.

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The RTC PCF85063BTL has a frequency tuning facility; its operation is explained in section 5.

The RTC can stay switched on all the time. There is no need to restart or reset the clock.

4.3 Software instructions for setting the clock

4.3.1 Setting the time

Setting the clock to 3.45 pm February 14, 2015,

• CE		chip enable
• Register address	0000 0000	address pointer to status word 0
• Status word 0	0000 0011	set 12 hour mode and select option for 12.5 pF quartz
	0000 0010	set 12 hour mode and select option for 7 pF quartz
• CE		chip disable
• CE		chip enable
• Register address	0000 0100	address pointer to seconds register
• Seconds	0000 0000	0 Seconds (clock integrity ok → MSB OS = 0)
• Minutes	0100 0101	45 min
• Hours	0010 0011	PM, 3 (clock integrity ok → OS = 0)
• Days	0001 0100	14th day of month
• Weekdays	0000 0110	Saturday (6th day of the week)
• Month	0000 0010	February
• Year	0001 0101	(20)15
• CE		chip disable

4.3.2 Reading the clock

• Reading the clock	(2 minutes after writing)	
• CE		chip enable
• Register address	0000 0100	address pointer to seconds (R/$\overline{W}$ bit = 1)
• Read register 4, seconds	. . . . .	e.g. 56 Seconds, (clock integrity ok → OS = 0)
• Minutes	. . . . .	e.g. 46 (Minutes)
• Hours	. . . . .	e.g. 03 (PM 03h)
• Days	. . . . .	e.g. 14 (14th)
• Weekdays	. . . . .	e.g. 06 (Saturday)
• Month	. . . . .	e.g. 02 (February)
• Year	. . . . .	e.g. 15 (20)15
• CE		chip disable

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5. RTC tuning

5.1 Frequency tuning

The 32 kHz quartzes are typically sold with a tolerance at room temperature of either ±10 ppm or ±20 ppm. 11.5 ppm corresponds to 1 s/day.

The quartzes require a characteristic load capacity of either 7 pF or 12.5 pF. Oscillators utilizing 7 pF quartzes feature slightly lower power consumption, where the quartzes of 12.5 pF have largest production quantities. The tracks between quartz and RTC represent also some parasitic capacitances and must be kept short.

The PCF85063 has a tuning facility where above tolerances can be compensated. Tuning procedure:

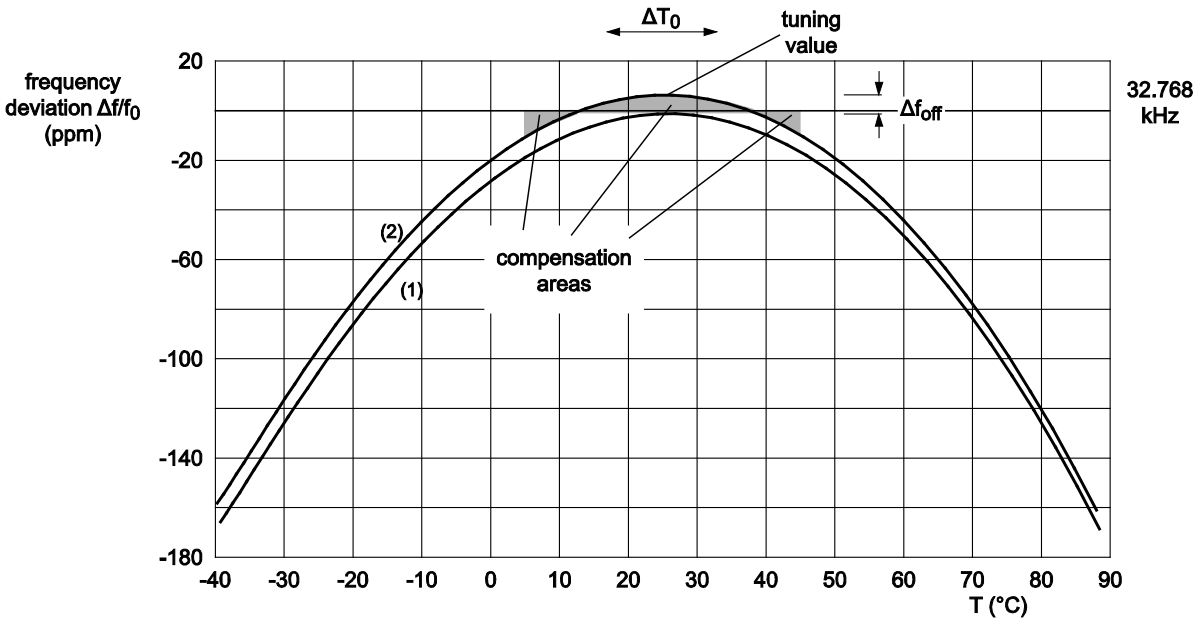
- Measure the 32xxx Hz (f) signal at the CLKOUT pin.
- The offset is calculated in ppm as

  $\Delta f_{[ppm]} = 10^6 \times (f - 32768) / 32768$
- Consult the offset table in the data sheet. Take the correction value and write it into the register 02h.
- The correction is done by means of inhibition or addition: the oscillator runs at constant speed, then every 2 hours (mode 0) 1 second is corrected to by making it shorter or longer. This is not easily visible at the CLKOUT.
- Corrections can also be applied every 4 minutes by using mode 1. This mode will consume slightly more power.

The 32 kHz quartzes are of the type tuning fork and feature a parabolic frequency response over temperature. When the application is dominantly used over a limited temperature range, it is often helpful to tune the frequency to be slightly higher at the turn-over point. The error around 25 °C (clock goes too fast) is then compensated during the time when temperature is lower or higher. For example, for operation between 5 °C and 45 °C, tune the clock 8 ppm faster than the value for 25 °C would be. (Fig 6.)

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(1) Characteristic if tuned to 32.768 kHz at 25 ºC.

(2) Characteristic if tuned with the positive offset Δf_{off}.

Fig 6. Temperature averaged over application range 5 °C to 45 °C

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Date of release: 12 February 2015
Document identifier: UM10699