UM10788

User manual for I²C-bus RTC demo board OM13515

Rev. 2 — 4 August 2014 **User manual**

Document information

Info	Content
Keywords	PCF85063, OM13515, evaluation, demo board, how to get started, I^2C-bus, RTC, Real-Time Clock, tuning
Abstract	User manual for the evaluation board OM13515. It uses the low power RTC PCF85063AT with I^2C-bus interface

Revision history

Rev	Date	Description
v.2	20140804	Second revision
v.1	20140620	New user manual, first revision

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1. Introduction

The PCx85063 are a family of CMOS Real-Time Clocks (RTC) and calendar optimized for low power consumption. Different features sets are available.

The OM13515 is the ideal evaluation/demo board to use in the design phase of any project, just power and I^2C-bus must be applied.

Separate demo boards and user manuals are available for

RTC PCF85063TP/PCF85063ATL – OM11059A and UM11698

RTC with SPI-bus PCF85063BTL – OM11059 and UM10699

2. Key features

There are four RTC variants of the PCF85063x RTC with I^2C-bus:

PCF85063AT, PCF85063ATT – enhanced functionality with I^2C-bus interface

PCA85063ATT – enhanced functionality with I^2C-bus interface AEC-Q100 qualified automotive grade

PCF85063ATL – enhanced functionality with I^2C-bus interface with clock enable input

PCF85063TP – basic functionality with I^2C-bus interface

2.1 PCx85063AT, PCF85063ATT

The PCx85063A 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:
  - PCF85063AT: SO8
  - PCF85063ATT: TSSOP8
  - PCA85063ATT: TSSOP8, automotive grade, −40 °C to +105 °C
- Alarm control
- Timer
- WatchDog
- Interrupt:
  - every 30 s or 60 s
  - alarm
  - timer
  - WatchDog
- Interface: 400 kHz I^2C-bus

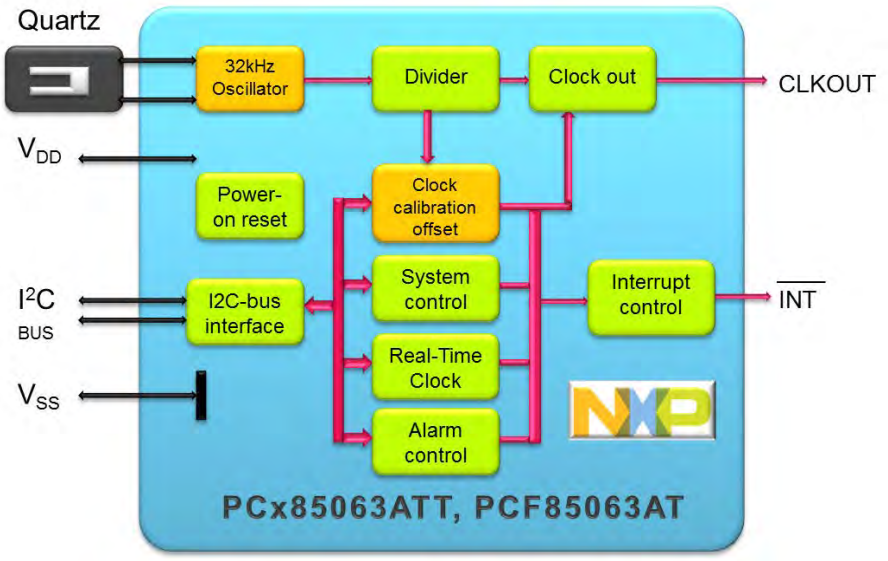


Fig 1. Block diagram of the PCx85063A

3. Hardware set-up

3.1 General requirements for the RTCs PCx85063A

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 is the standard Fast Mode I^2C-bus, operating up to 400 kHz. Adjust the values of the pull-up resistors to match the required interface speed keeping them as high impedance as possible for power savings reasons. Ensure that the specified minimum requirements of the hold times t_{LOW} and t_{HIGH} are fulfilled.

Supply voltage: The RTC is specified from 0.9 V to 5.5 V. The I^2C-bus interface is specified from 1.8 V to 5.5 V. It is recommended to have a decoupling capacitor on the V_{DD}-V_{SS} 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.

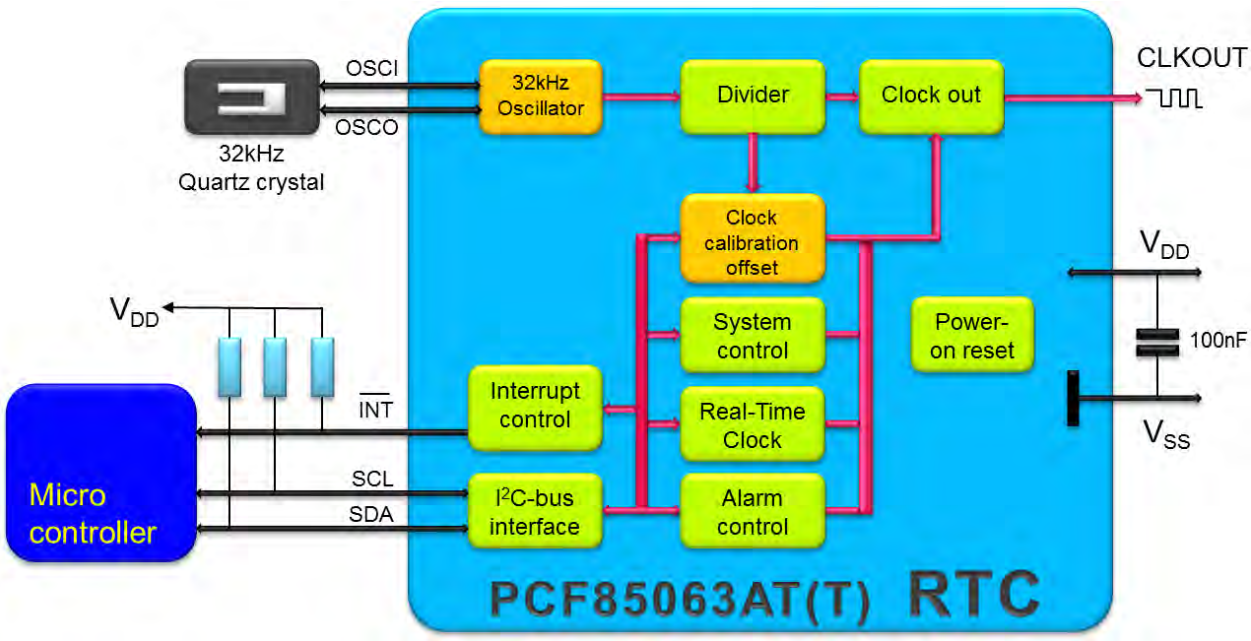


Fig 2. Interfacing to the microcontroller

3.2 Demo board OM13515

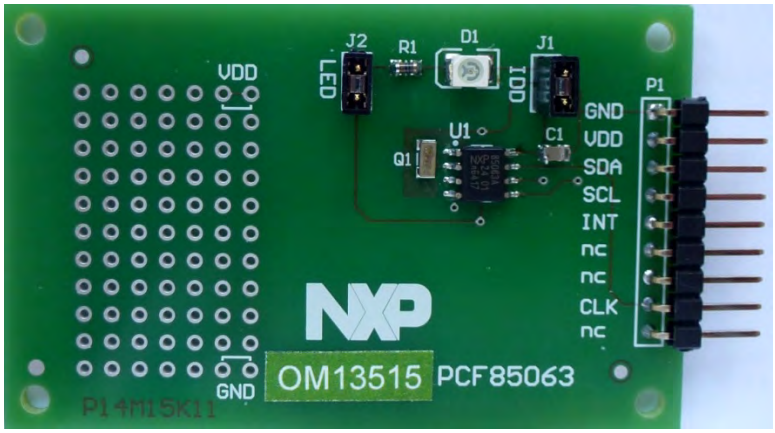


Fig 3. Picture of demo board OM13515

The OM13515 allows easily demonstrating the operation of the PCx85063A with I²C-bus interface. No need to solder the tiny package to a breadboard 100 mil connector for straight forward connections.

To visualize the interrupt an LED (D1) is mounted. To minimize the power consumption it can be switched off by removing the jumper J2.

To measure the current consumption just replace jumper J1 by a µA-meter.

The market offers quartzes with different load capacitances: C_L= 12.5 pF is most common, C_L= 7 pF as used on the board, offers however lower power consumption.

Straight forward interfacing:

- Connect supply voltage (e.g. 3.3 V): V_{SS} to pin 1, V_{DD} to pin 2
- Connect I²C-bus (pull-up resistor needed): SCL to pin 4, SDA to pin 3
- Connect interrupt and or CLKOUT if required
- Communicate with the RTC

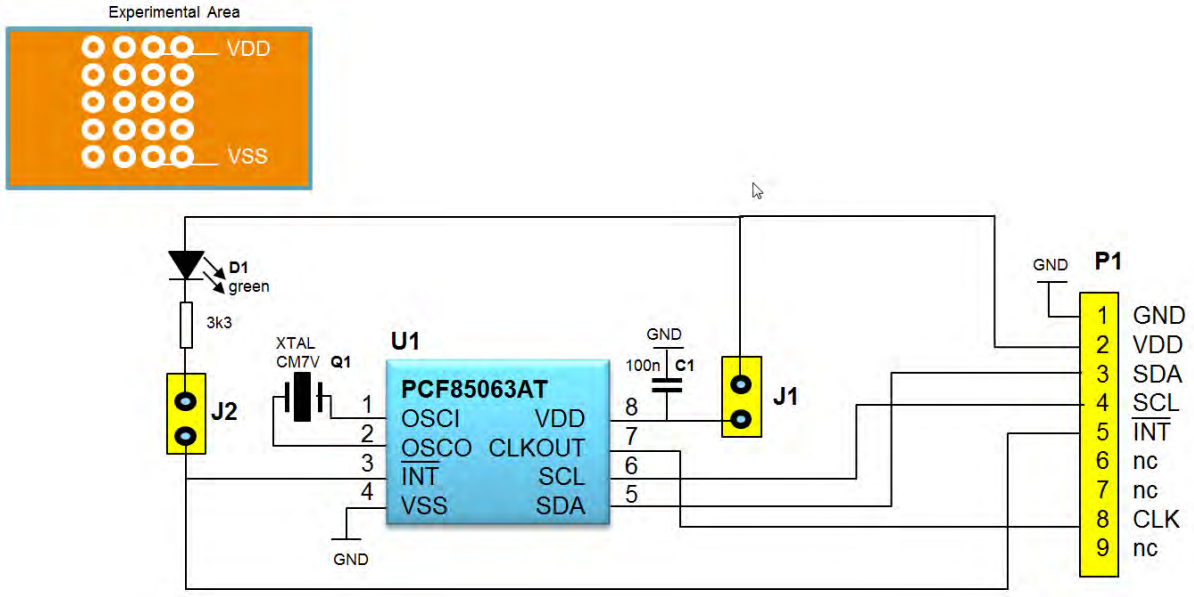


Fig 4. OM13515 circuit diagram

4. Graphical User Interface with OM13518 USB-I²C-bus dongle

4.1 USB-I²C dongle

Details are described in the user manual UM10789.

The OM13518 dongle is a ready to run module. It creates a virtual COM-port via an USB connection. It provides three I²C-bus connections with 5 V option to power the application (max 450 mA).

Power consumption: module/total: <50 mA/max 500 mA

I²C-bus clock frequency: 245 Hz – 400 kHz

USB driver for Windows: Windows XP, Windows 7, Windows 8

Size: 50 mm × 40 mm × 15 mm

Fig 5. A) Dongle OM13518, B) connected to an evaluation board

4.2 Software GUI

The software control via a GUI allows a fast start to communicate to the different circuits.

Aside from the detailed GUI pages for the Real-Time Clocks, a UNIVERSAL INTERFACE allows to communicate with any I²C-bus device by entering directly the hex codes. Example: s A2 28 p

Where s stands for the I²C START and p for the I²C STOP condition.

There are 2 GUI versions:

USB_I2C_GUI_85063TP for the PCF85063TP RTC with basic features, no alarm facility

USB_I2C_GUI_85063A for the full featured PCx85063A RTC

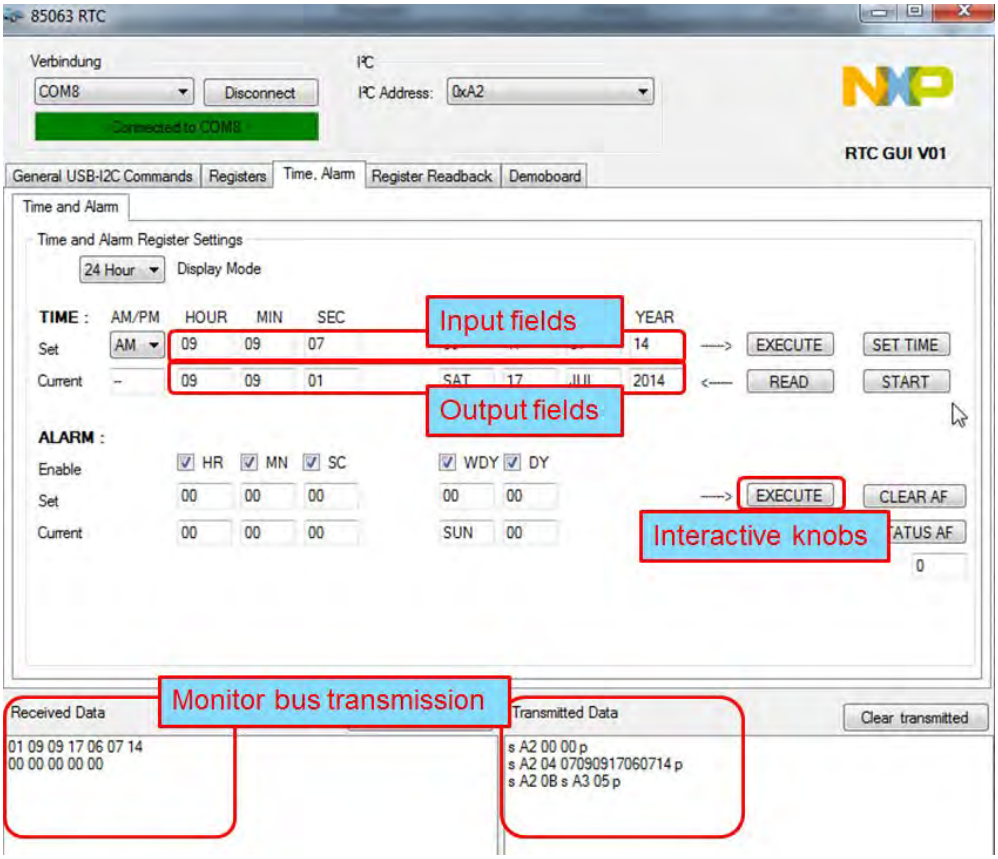


Fig 6. GUI-page example: *Time Alarm settings*

5. Software set-up

5.1 Functionality

The RTC PCx85063A is controlled via a standard Fast Mode I²C-bus interface, operating up to 400 kHz.

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 number of 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. Interrupts can also be generated by the alarm facility, the timer and the WatchDog.

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

5.2 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.

The RTC PCF85063x has a frequency tuning facility; its operation is explained in section RTC tuning. The RTC can stay switched on all the time. There is no need to restart or reset the clock.

5.3 Software instructions for setting the clock

5.3.1 Setting the time

Setting the clock to 3.45 pm December 15, 2014:

I^2C-bus	S	START condition
Slave address	1010 0010	address pointer to status word 0
Register address	0000 0000	address pointer to status word 0
Status word 0	0000 0010	set 12 hour mode and select option for 7 pF quartz
I^2C-bus	Sr	Repeated START condition
Slave address	1010 0010	R/$\overline{W}$ = 0, write mode
Register address	0000 0100	address pointer to Seconds register, address 4h
Seconds	0000 0000	0 seconds (clock integrity ok → MSB OS = 0)
Minutes	0100 0101	45 min
Hours	0010 0011	PM, 3
Days	0001 0101	15^{th}
Weekdays	0000 0001	Monday (1^{st} day of the week)
Month	0001 0010	December (12^{th} month)
Year	0001 0100	(20)14
I^2C-bus	P	STOP condition

5.3.2 Reading the clock

Reading the clock (2 minutes after writing)

I^2C-bus	S	START condition
Slave address	1010 0010	R/$\overline{W}$ = 1, read mode
Register address	0000 0100	address pointer to Seconds register
I^2C-bus	Sr	repeated start condition
Slave address	1010 0011	read mode
Read register 4		e.g. 56 seconds, (clock integrity ok → OS = 0)
Minutes		e.g. 47 (Minutes)
Hours		e.g. 23 (PM, 03h)
Days		e.g. 15 (15^{th})
Weekdays		e.g. 01 (Monday)
Month		e.g. 12 (December)
Year		e.g. 14 (20)14
I^2C-bus	P	STOP condition

6. RTC tuning

6.1 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. Program the CAP_SEL bit in register Control_1 accordingly. 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.

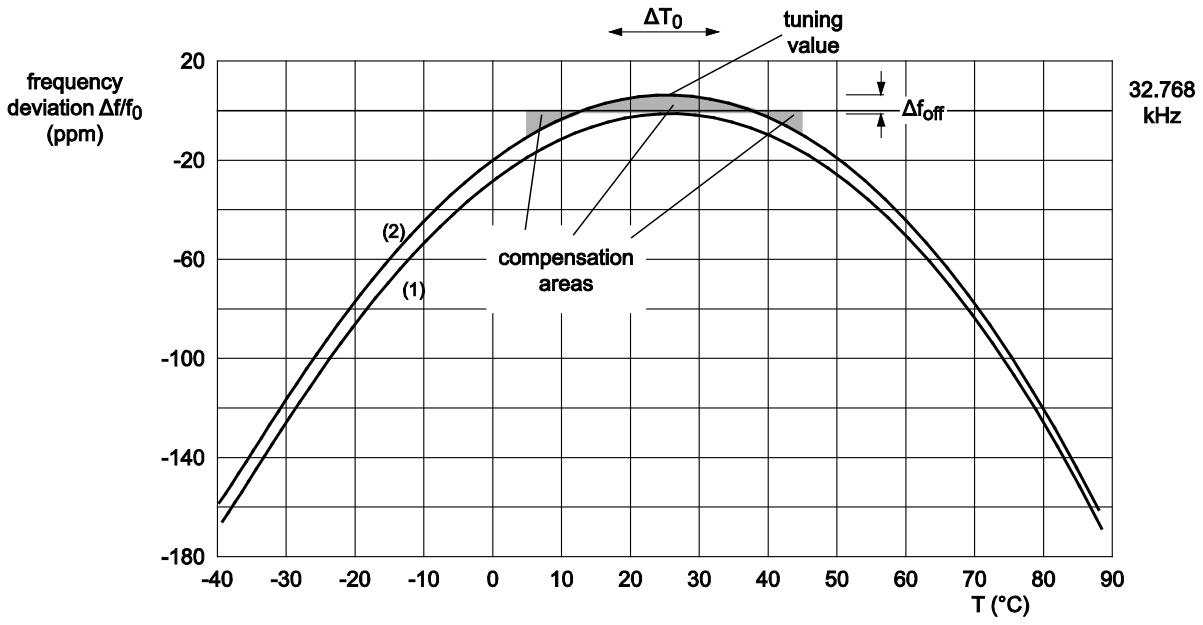
Tuning procedure:

- 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 7)



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

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

Fig 7. Temperature averaged over application range 5 °C to 45 °C

7. References

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

[2] **UM10301** - User Manual for NXP Real Time Clocks PCF85x3, PCA8565 and PCF2123, PCA2125

[3] **UM10789** - USB-I²C-bus interface OM13518 with a GUI for the RTCs

[4] **PCF85063A** - Tiny Real-Time Clock/calendar with alarm function and I²C-bus, data sheet

[5] **PCF85063TP** - Tiny Real-Time Clock/calendar and I²C-bus, data sheet

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9. List of figures

10. Contents

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