UM10698

User manual for I2C-bus RTC demo board OM11059A

Rev. 4 — 2 November 2015 User manual

Document information

Info	Content
Keywords	PCF85063TP, PCF86063ATL, OM11059A, demoboard, how to get started, I²C-bus, RTC, Real-Time Clock, tuning
Abstract	User manual for the RTC I²C-bus demoboard OM11059A which contains PCF85063TP and PCF85063ATL

Revision history

Rev	Date	Description
v.4	20151102	Revised user manual
v.3	20140227	Revised user manual
v.2	20130404	Revised user manual
v.1	20130320	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 two version of OM11059A are the ideal evaluation/demo boards to use in the design phase of any project, just power and I²C-bus must be hooked up.

A separate demoboard and a user manual are available for the SPI-bus RTC PCF85063BTL: OM11059 and UM10699.

2. Key features

There are two RTC variants of the PCF85063x RTC with I²C-bus:

PCF85063TP basic functionality with I²C-bus interface

PCF85063ATL enhanced functionality with I²C-bus interface

2.1 PCF85063TP

The PCF85063TP 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: HWSON8 package: 2 x 3 x 0.5 mm

Interrupt: every 30 s or 60 s (e.g. for waking up the microcontroller)

Interface: 400 kHz I²C-bus

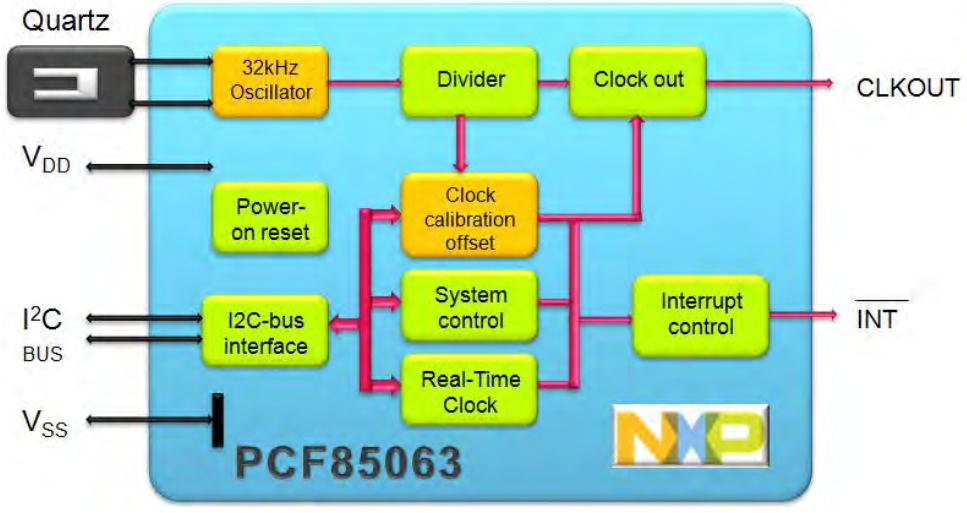


Fig 1. Block diagram of the PCF85063TP RTC

2.2 PCF85063ATL

The PCF85063ATL 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: 400 kHz I^2C-bus

Clock out: enabled by pin or by software

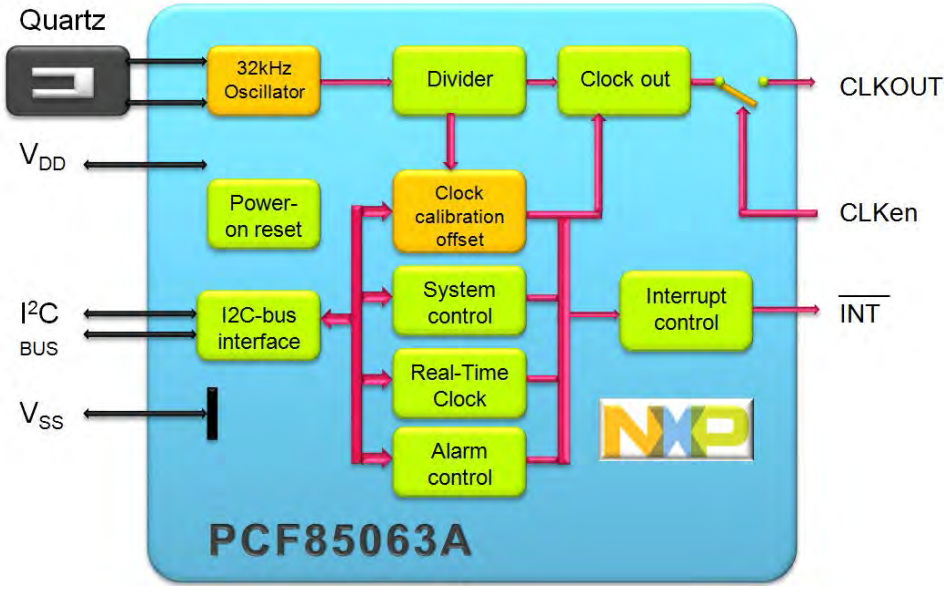


Fig 2. Block diagram of the PCF85063ATL RTC

3. Hardware set-up

3.1 General requirements for the RTCs PCF85063TP and PCF85063ATL

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 pull-up values to match the required interface speed keeping them as high impedance as possible for power system saving. 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 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.

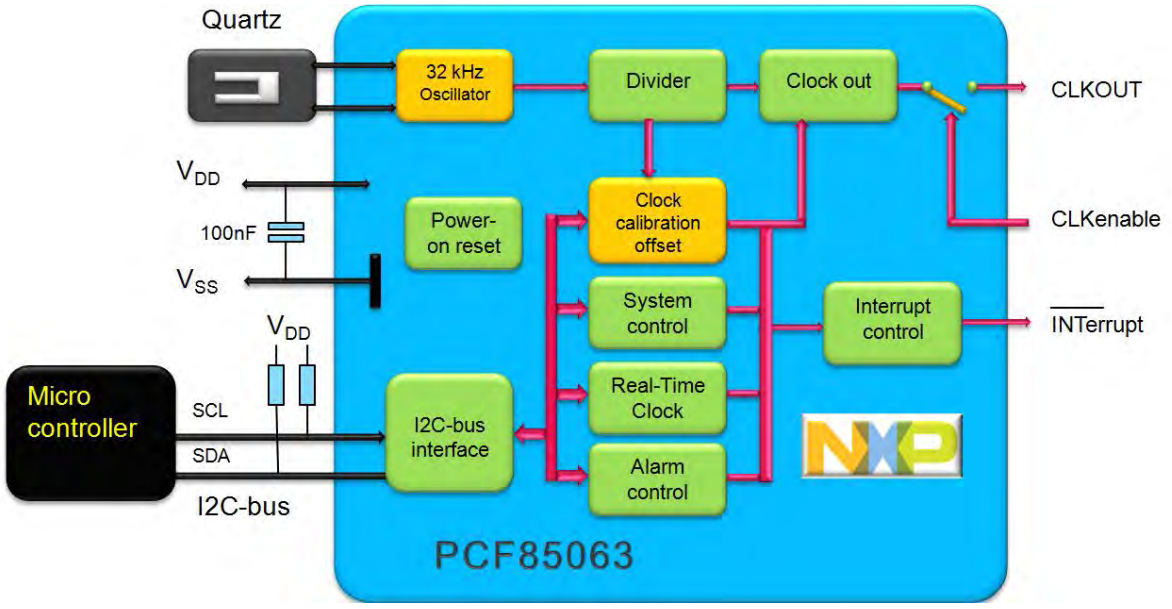


Fig 3. Interfacing to microcontroller

3.2 Demo board OM11059A (original version)

U1 = PCF85063TP, U2 = PCF85063ATL.

Fig 4. Picture of demo board OM11059A

The original version of OM11059A allows to easily demonstrate the operation of the PCF85063x with I²C-bus interface. No need to solder the tiny package to a breadboard 100 mil connector for straight forward connections.

Both RTCs are on board and can be selected by setting the jumpers J1 and J2 (see Fig 5).

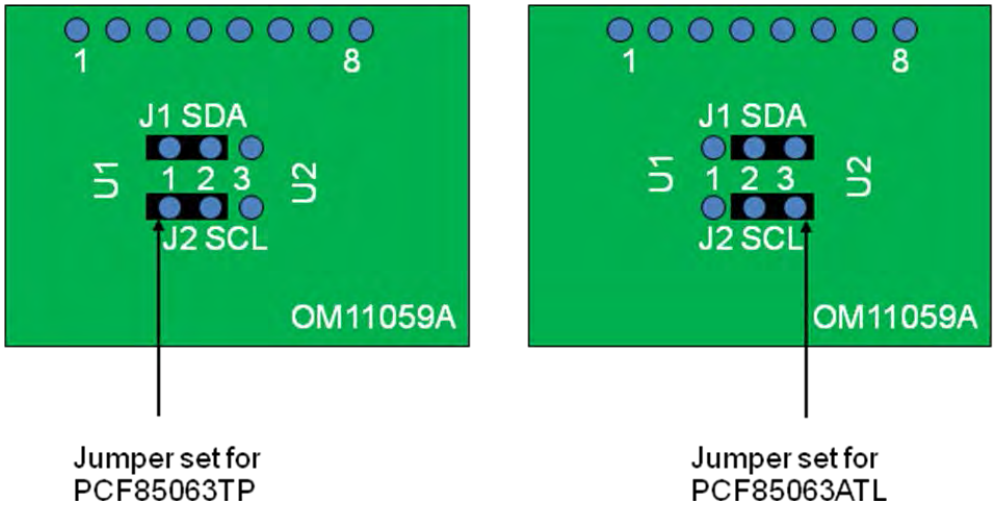


Fig 5. Jumper settings

On the market, there are quartzes with different load capacitance C_L. 12.5 pF is most common, 7 pF offers however lower power consumption. To evaluate the difference, the PCF85063TP is connected to a quartz with C_L=7 pF and the PCF85063ATL is connected to a quartz with 12.5 pF. Also the V_{DD} blocking capacitors are mounted (C1, C2).

Straight forward interfacing:

- Set jumper to either PCF85063TP or PCF85063ATL
- Connect supply voltage (e.g. 3.3 V): VSS to pin 1, VDD to pin 2
- Connect I^2C-bus (pull-up resistor needed): SCL to pin 3, SDA to pin 4
- Communicate to the RTC

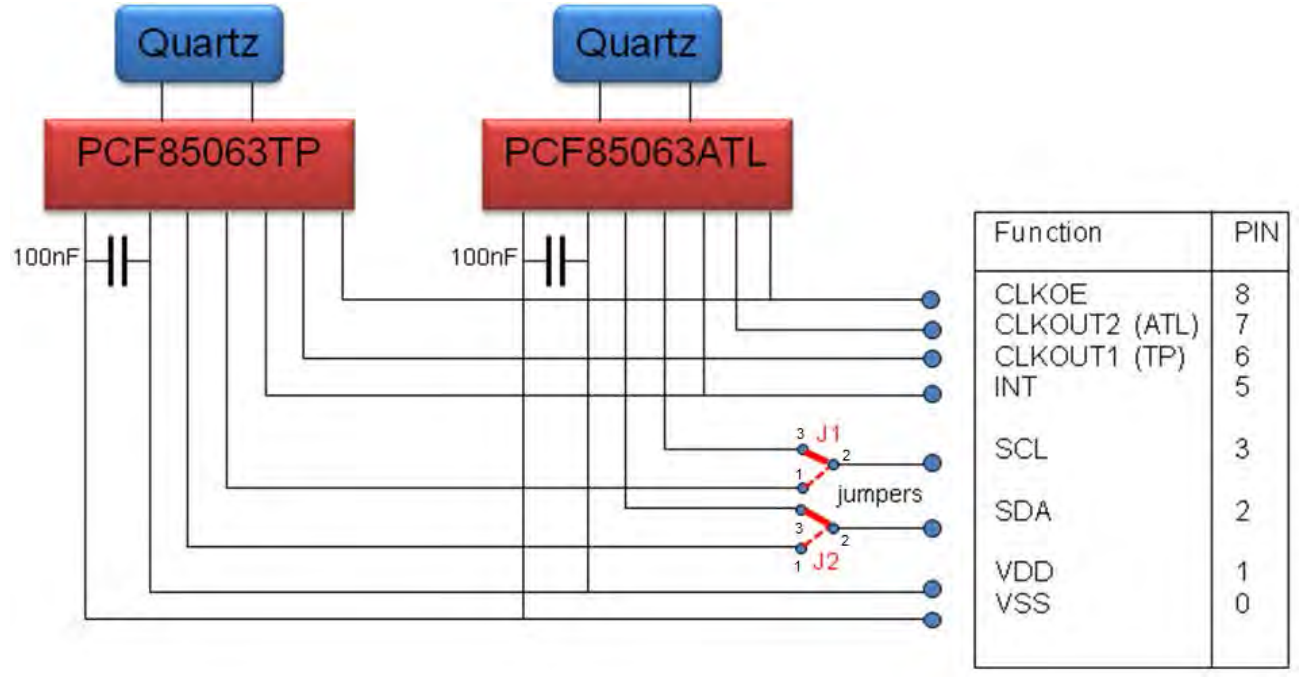


Fig 6. OM11059A block diagram

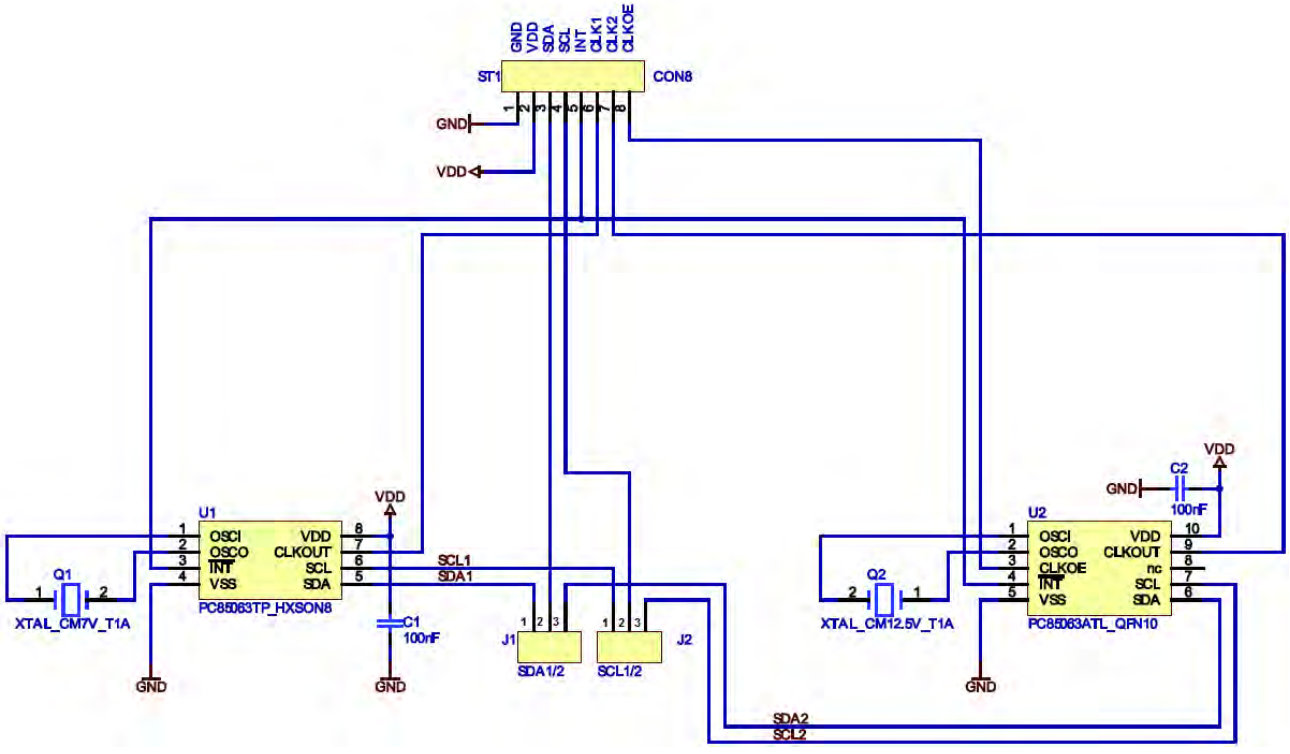


Fig 7. OM11059A schematic for PCF85063TP and PCF85063ATL

3.3 Demo board OM11059A (newer version)

U1 = PCF85063ATL.

Fig 8. Picture of PCF85063ATL demo board OM11059A

The 2nd version of OM11059A allows to easily demonstrate the operation of only the popular PCF85063ATL with I²C-bus interface. No need to solder the tiny package to a breadboard 100 mil connector for straight forward connections.

Straight forward interfacing:

- Set jumper J1 for operation without current meter; jumper J2 & J3 used to invoke INT and CLKOE
- Connect supply voltage (e.g. 3.3 V): VSS (GND) to pin 1, VDD to pin 2
- Connect I²C-bus (pull-up resistor needed): SCA to pin 3, SDL to pin 4
- Communicate to the RTC

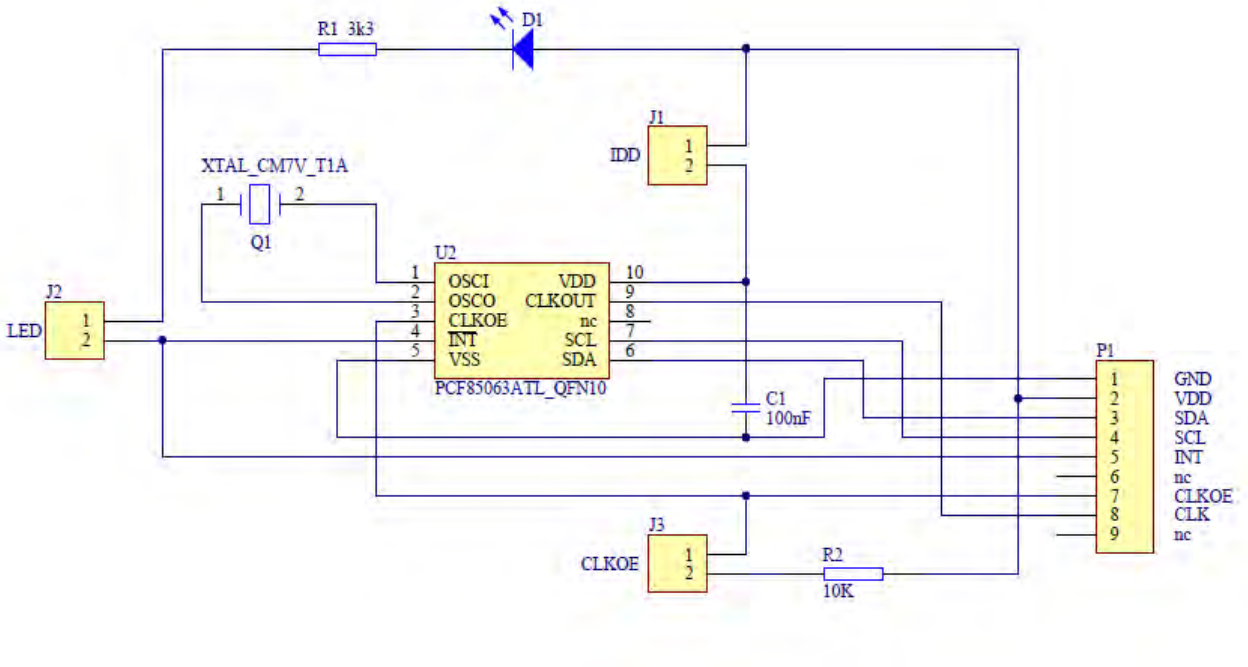


Fig 9. OM11059A schematic for PCF85063ATL

4. Software set-up

4.1 Functionality

The RTC PCF85063TP and PCF85063ATL are controlled via standard I²C-bus interface. Common I²C protocol applies. The interface is the standard Fast Mode I²C-bus, 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 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.

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.

4.3 Software instructions for setting the clock

4.3.1 Setting the time

Setting the clock to 3.45 pm December 15, 2011:

• I^2C-bus	S	Start condition
• Slave address	1010 0010	write bit set
• 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 (for the PCF85063ATL)
	0000 0010	set 12 hour mode and select option for 7 pF quartz (for the PCF85063TP)
• I^2C-bus	Repeated start condition	
• Slave address	1010 0010	write bit set
• 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 0101	15th
• Weekdays	0000 0100	Thursday (4th day of the week)
• Month	0001 0010	December
• Year	0001 0001	(20)11
• I^2C-bus	P	Stop condition

4.3.2 Reading the clock

• Reading the clock	(2 minutes after writing)	
• I^2C-bus	S	Start condition
• Slave address	1010 0010	write bit set
• Register address	0000 0100	address pointer to seconds byte (4)
• I^2C-bus	Sr	repeated start condition
• Slave address	1010 0011	read mode
• Read register 4, seconds	. . . . .	e.g. 56 Seconds, (clock integrity ok → OS = 0)

- Minutes . . . . . e.g. 45 (Minutes)
- Hours . . . . . e.g. 03 (PM 03h)
- Days . . . . . e.g. 15 (15th)
- Weekdays . . . . . e.g. 04 (Thursday)
- Month . . . . . e.g. 12 (December)
- Year . . . . . e.g. 11 (20)11
- I2C-bus P Stop condition

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.

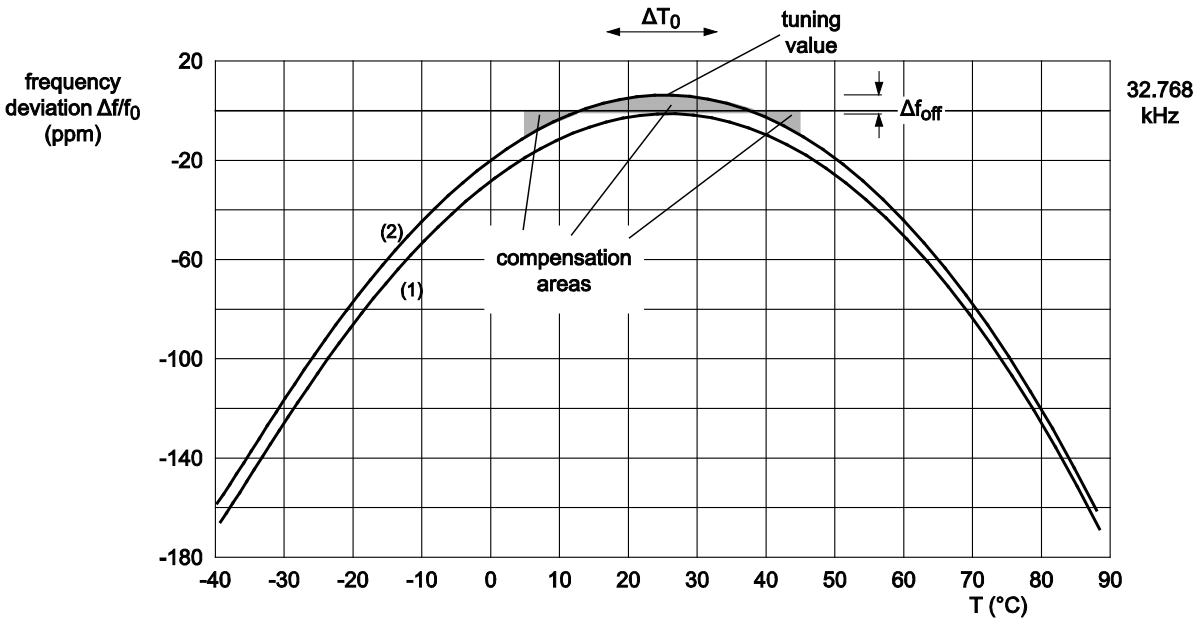
The quartzes require a characteristic load capacity of either 7 pF or 12.5 pF. Oscillators utilizing 7 pF quartzes feature slightly lower power consumption, where the quartzes of 12.5 pF have largest production quantities. The tracks between quartz and RTC represent also some parasitic capacitances and 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. (See Fig 5.)



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

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

Fig 10. Temperature averaged over application range 5 °C to 45 °C

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7. List of figures

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