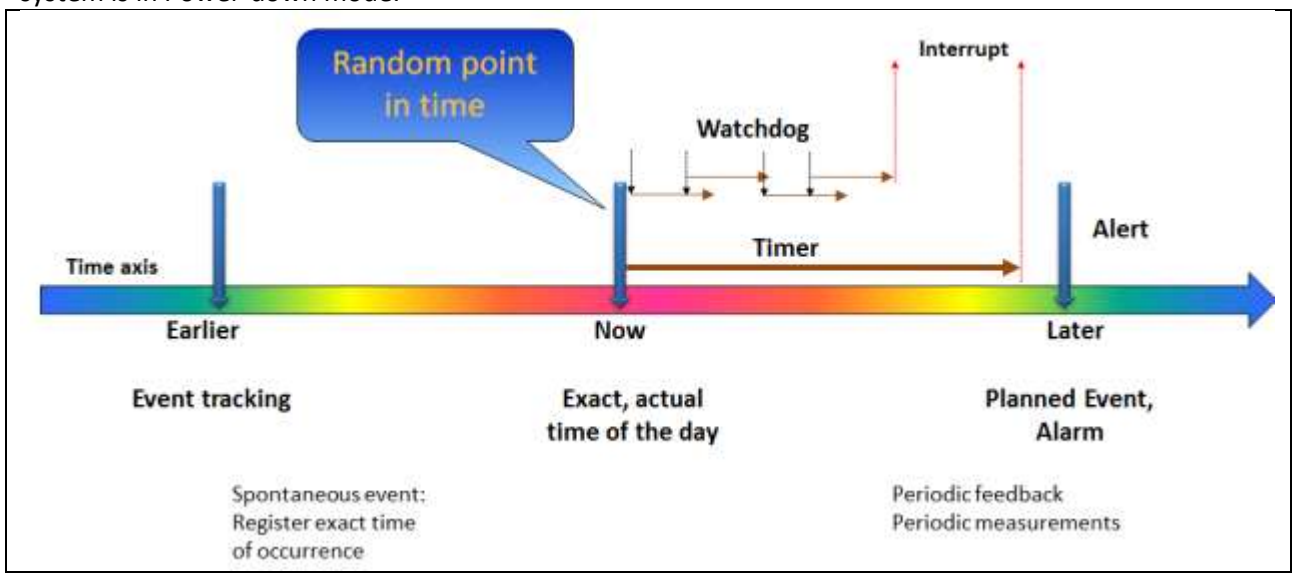
Exact timing, with smallest footprint consuming hardly any power

(Markus Hintermann, Micro Crystal AG)

Tracking the actual time of a spontaneously occurring events or triggering an action of a given length at a certain point in time are best managed by a Micro Crystals RTC-Modules, no matter if the rest of the system is in Power-down mode.



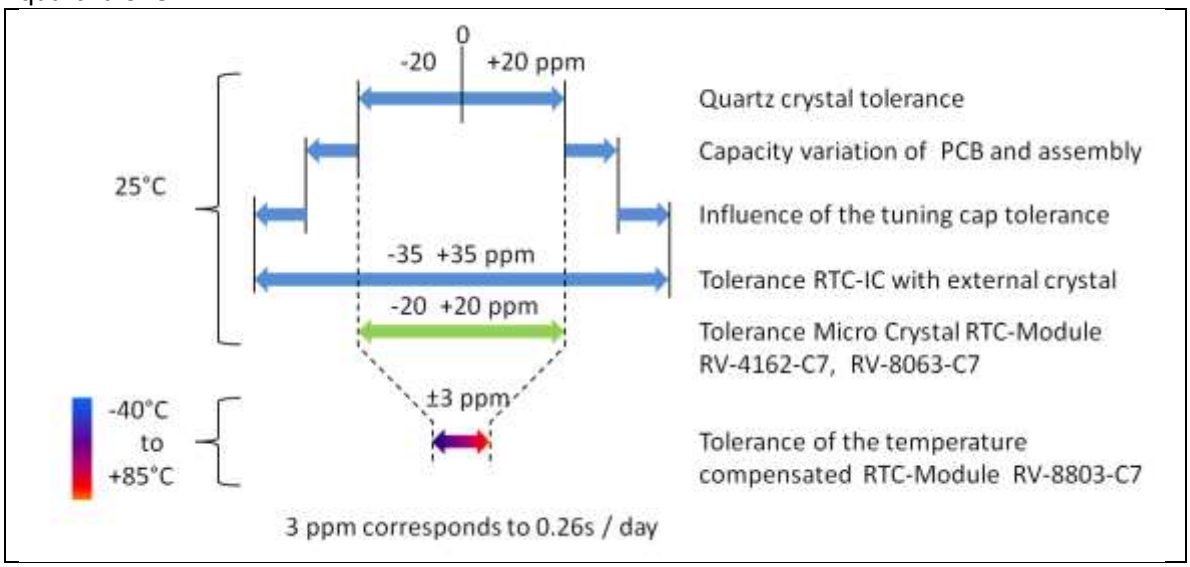
Micro Crystal, a division of the Swatch Group, is well known for its miniature Quartz crystals applicable for a large variety of applications: Consumer, Industrial, Automotive and Medical. The Real-Time Clock Modules from Micro Crystal are the logical evolution from ultra-low power circuit technology in combination with state of the art Crystals and package technology. All components combined in a small package save PC-board real-estate and shorten time to market.

The universal properties of the Micro Crystal RTC-Modules are the ideal engine for solving accurate timing tasks independently applicable in all market segments: Portable, Wearable, IoT, Test and Measurement, Automotive or Medical applications.
The integration of the RTC-Circuit together with the Xtal to build a RTC-Module gives for the customer 5 major advantages:

1. Oscillator working at the optimal operating point
2. Enhanced precision → improved timing accuracy
3. Smaller space requirements
4. Insensitive to environmental conditions, like humidity, EMC, spikes, …
5. Basis for optimal temperature compensation

1. **Oscillator working at optimal operating point**
    a. The accuracy of the RTC is influenced by the components of the oscillator, not only the tolerances of the Xtal but also the parasitics of the PC-board are part of the equation.
    b. Through integration Micro Crystal is able to minimize and compensate the spread of the components to outperform the accuracy of discrete solutions. (RTC chip with external Xtal)

2. **Enhanced Precision**
   For accurate time keeping the oscillator is calibrated at 25°C. During the modules electrical final test the precision is verified again. The tolerance of the whole circuits is now as low as of the quartz alone.



3. **Reduced size**
   Continuously increased integration density of the semiconductor processes shrunk the RTC block size to << 1mm^2, compared with the size of the bond pads and suitable SMD package the interconnect overhead is considerable. In parallel also the manufacturing technologies for the 32 kHz tuning fork crystals progressed. Since 32 kHz crystals show best performance under vacuum, Micro Crystal has now developed a miniature package hosting together the quartz and the semiconductor circuit in the same cavity. Due to internally connecting the Xtal with the Integrated Circuit 2 external pads could be omitted. The complete RTC-Module compares in size to a 1206 chip-cap (3.2 x 1.5mm).

4. **Robustness in respect to environmental conditions**
   The ceramic package is hermetically sealed and protects from external environmental changes. High humidity or contamination by dust, have no influence to the oscillator performance. Tight connections between Xtal and chip inside the module enhance the robustness, filtering unwanted interference signals.

5. **Optimal Temperature compensation**
   Piggybacking the Xtal and Integrated Circuit in one small package is the optimal pre-requirement for accurate temperature compensation. Both components are tracking the same temperature; therefore optimal frequency compensation over a large temperature range is achieved. (-40°C to +85°C.

Advanced applications with Real-Time Clock Modules

Aside the obvious tasks tracking time and date a number of microcontroller functions are moved to the RTC with the objective: reduction of power consumption during power down mode.

a) Time stamp:
   Special events trigger an internal interrupt to latch the actual time. This function has no impact to the power consumption. Different functions may trigger a time stamp: Changed signals at the event input or the time of switch over to battery back-up mode.

b) Timing short or long periods accurately:
A desired period can be precisely controlled. For short periods in the range of milliseconds to several minutes the internal timer is the best choice. Longer periods are well achieved with the alarm facility. Applications like controlling the measuring intervals, (length and pause) or also switch off delays can be programmed easily without involvement of the microcontroller for execution. This has also no impact on the current consumption. The microcontroller will be woken up only at the end for executing the needed action to follow.

c) Monitoring the microcontroller by a watchdog:
More often blue books for new applications require an autonomous watchdog for monitoring the software. For example is the microcontroller waiting for an external signal which will inadvertently no more occur, the watchdog will interrupted the controller after a given time to take resetting action accordingly avoiding the program staying in an endless loop.

Internet of Things: IoT

The desire to link all components at home and in the industry makes also no halt for physically small units. Especially we find tight conditions with wireless sensors, data logger and actuators. Micro Crystals Modules offer full RTC functions in the size of a 1206 SMD component. The interfaces I^2C and SPI allow placing them anywhere on the board.

Micro Crystal offers 3 RTC Modules in the miniature package C7

RV-4162-C7: the standard I^2C-Bus bus RTC with 1/100s resolution. Aside the watchdog function and a frequency generator it also continuously monitors the oscillator performance.

RV-8803-C7: the industries best RTC featuring highest accuracy with lowest power consumption in smallest package.

RV-8063-C7: standard RTC with SPI interface similar to the RV-4162-C7.

	RV-4162-C7 Standard RTC	RV-8803-C7 Temperature compensated RTC	RV-8063-C7 Standard RTC
Interface	I^2C-Bus, 400 kHz	I^2C-Bus, 400 kHz	SPI-Bus 7 MHz
			
Current consumption	350nA , VDD = 3.0V	240nA, VDD = 3.0V	190nA , VDD = 3.0V
Supply voltage range	1.0 - 4.4 V	1.5 - 5.5 V	0.9 – 5.5 V
Accuracy	± 20 ppm @ 25°C	± 1.5 ppm @ 0-50°C (0.13 s/Tag) ± 3.0 ppm @ -40 - +85°C (0.26 s /Tag)	±20 ppm @ 25°C

About the author:

Markus Hintermann,
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