Introduction to Real Time Clocks

TI Precision Labs – Microcontrollers

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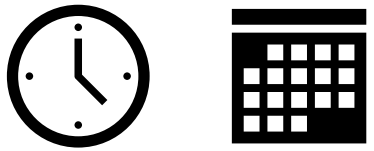
What is a real time clock?



A **real time clock** (RTC) is a highly accurate time keeping reference that enables systems to keep track of time and date in human readable formats

Scheduled Actions

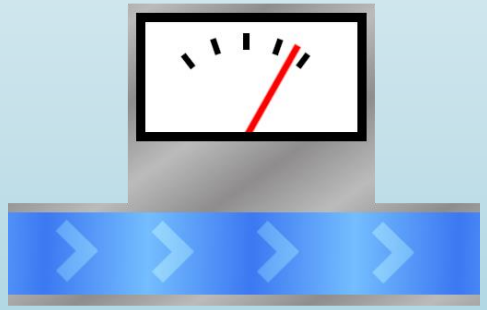
A thermostat changes the temperature setpoint on a schedule

Timestamping

Logging information may need to be saved with an accurate timestamp

Metering

A water meter must record water usage on a monthly interval



Alternatives for timekeeping

Software Delay

- ⊕ Simple
- ⊖ Low accuracy
- ⊖ CPU required

```
main()
{

  initialize_application();

  while(1)
  {
     update_application();
     delay(100000);
  }
}
```

Alternatives for timekeeping

Software Delay

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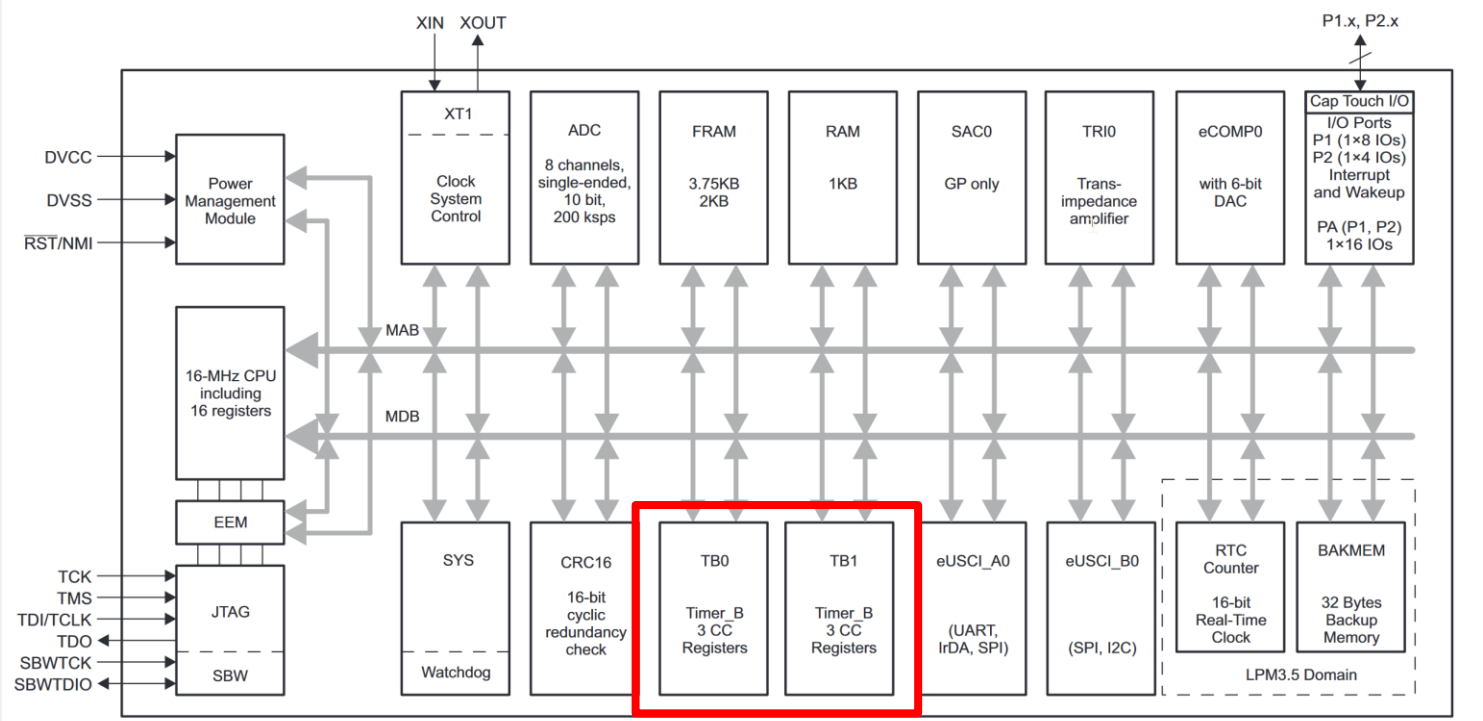
- ⊖ Low accuracy
- ⊖ CPU required

Hardware Timer

- ⊕ Accurate
- ⊕ No CPU required
- ⊖ Missing calendar features



Alternatives for timekeeping

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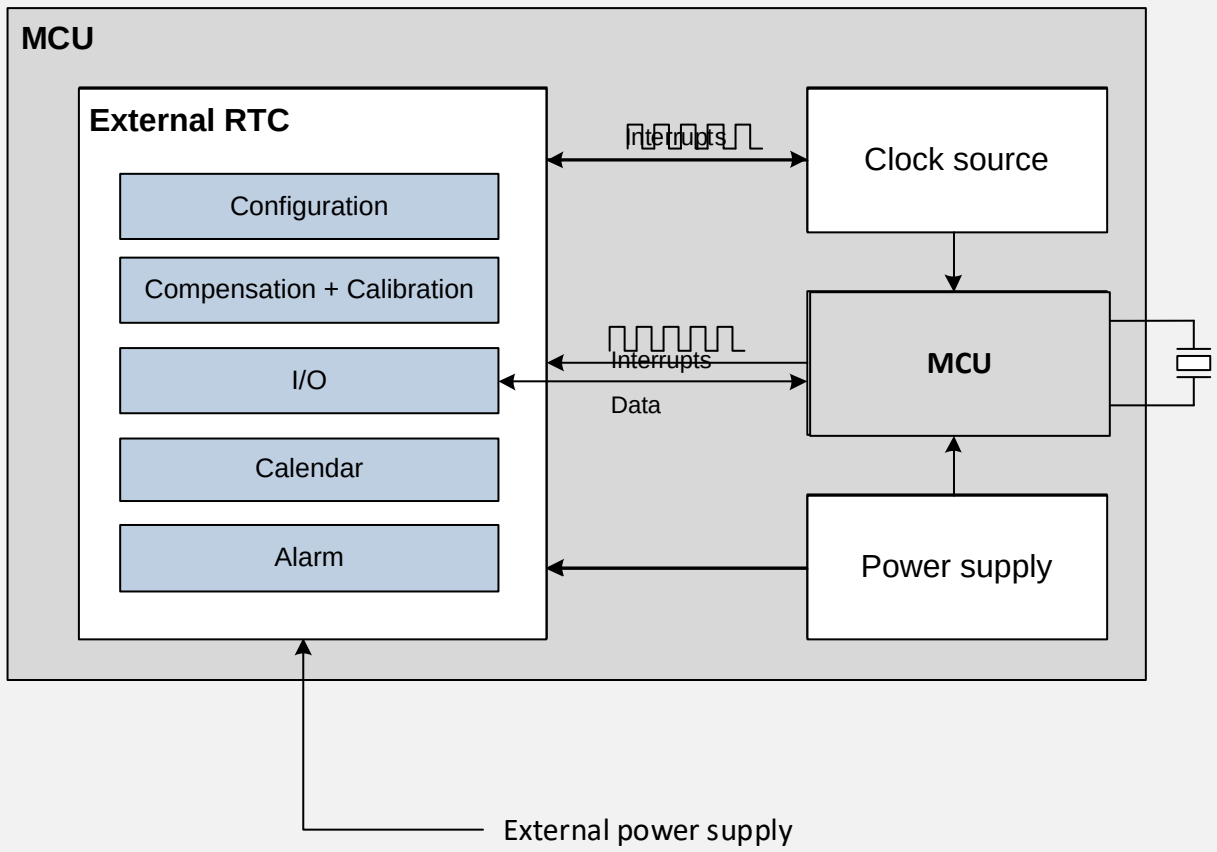
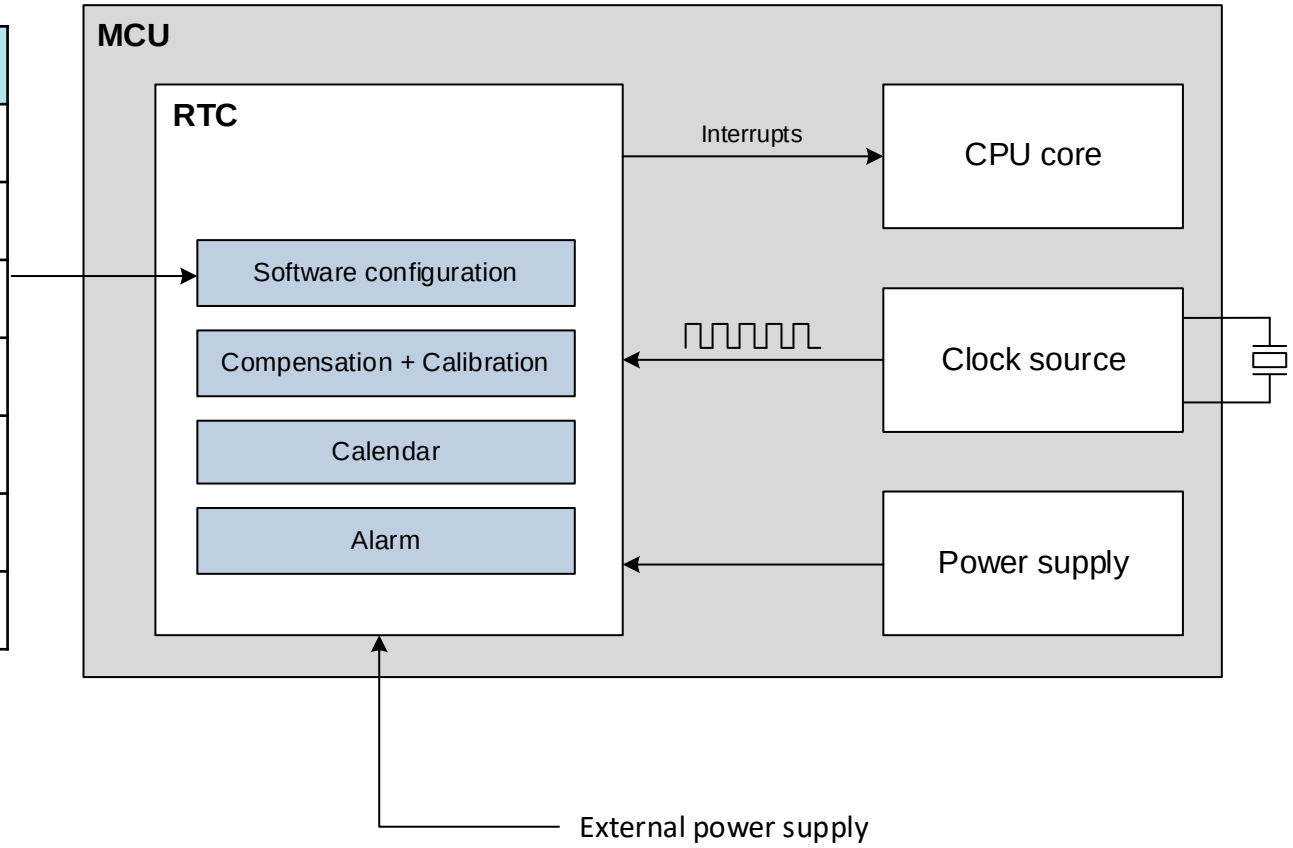
RTC

- ⊕ Convenient date formats
- ⊕ Calendar and alarm features
- ⊕ Calibration and temperature compensation



RTC block diagram

RTC Configuration	Value
Year	0x2022
Month	0x07
Day	0x19
Day of the week	0x02
Hour	0x11
Minute	0x59
Second	0x30



RTC calendar

- RTC calendar functionality allows an application to track the date and time in a human readable format
- Date and time can be stored in convenient formats for processing such as binary coded decimal (BCD).
- Logging example:
  1. Application detects logable event
  2. Read date and time from RTC
  3. Write data and timestamp to nonvolatile memory
  4. Application goes back to sleep

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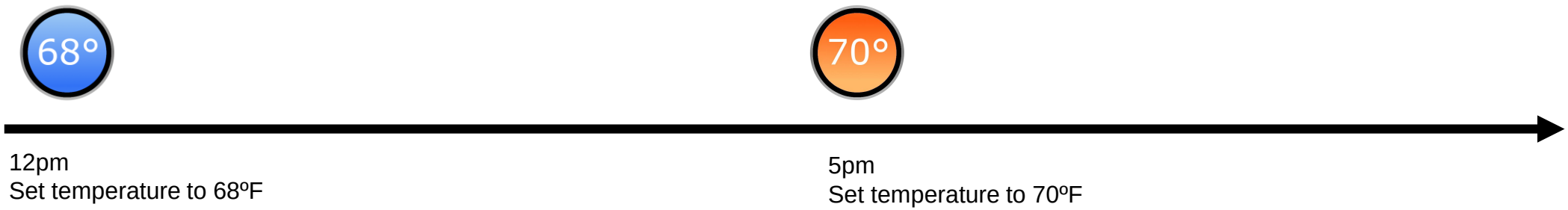
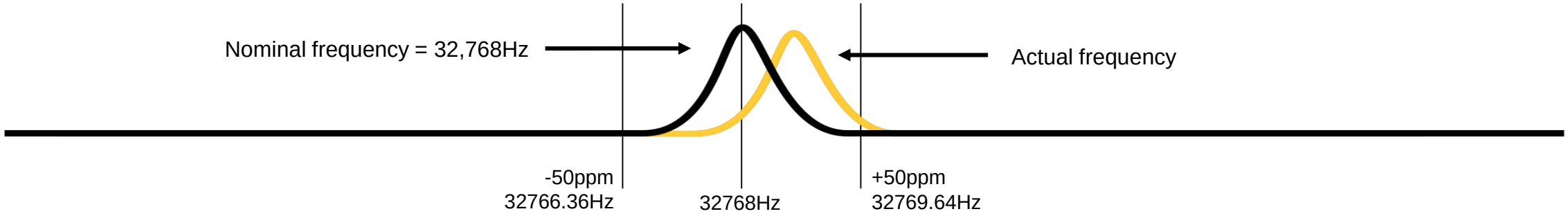
RTC alarm

- RTC alarm functionality allows an application to perform an action at a specific date and time
- RTC can fire an interrupt to wake the MCU from sleep mode
- Thermostat example:
  1. Application is in sleep mode
  2. RTC fires an interrupt at a predefined date and time
  3. Application performs task (*change the set temperature)*
  4. Application goes back to sleep



RTC clock source considerations

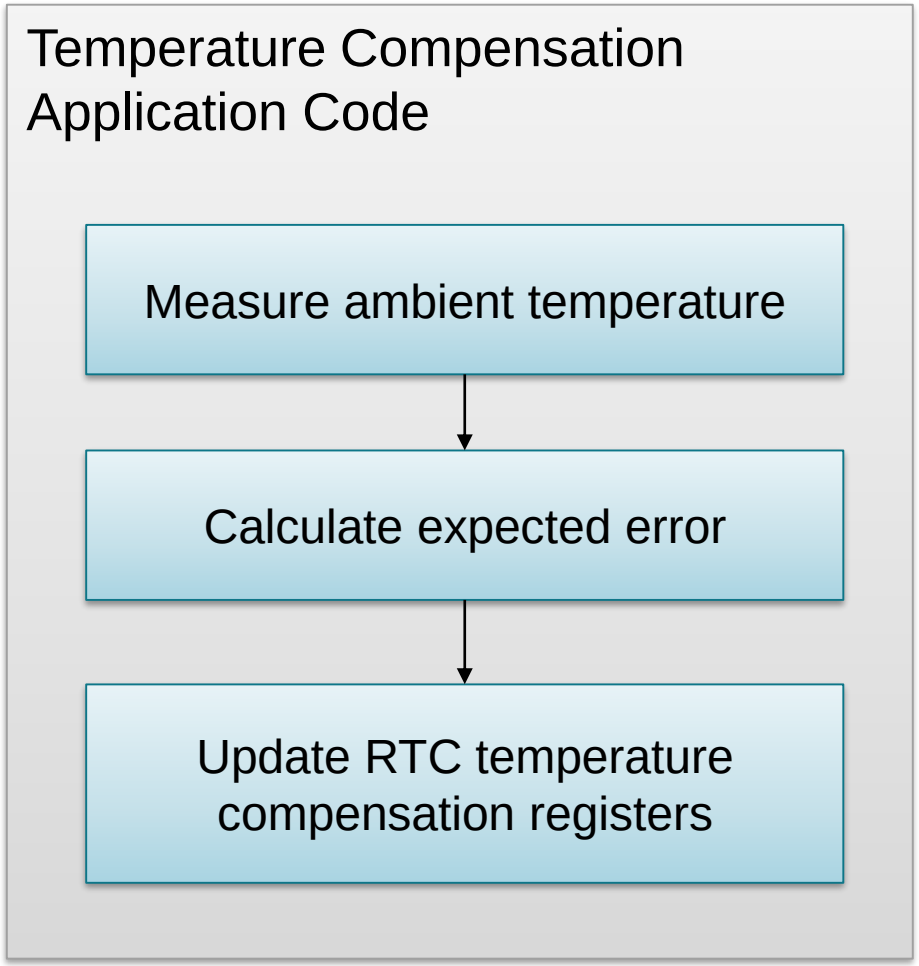
- RTC accuracy is determined directly by the accuracy of it's clock source.
- Crystal oscillators have offset error. Example: ±50ppm 32,768Hz crystal.
  - Worse case error over one day: $(seconds\ in\ a\ day) \times \frac{50ppm}{10^6} \approx 4.3\frac{seconds}{day}$



- Offset calibration helps reduce error
  1. Measure units RTC clock error against a high precision source
  2. Update RTC registers with measured offset

RTC temperature compensation

- Crystals drift with changes in temperatures
- Temperature compensation can help reduce error

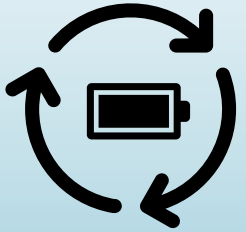


RTC power sources

RTC always needs power

Option 1 – System provides constant power to RTC

- \+ Can be sufficiently low-power
- − Fails if system looses power



Option 2 – RTC can switch to backup power supply

- \+ Preserves time in unstable power environments
- − Requires additional circuitry

RTC review

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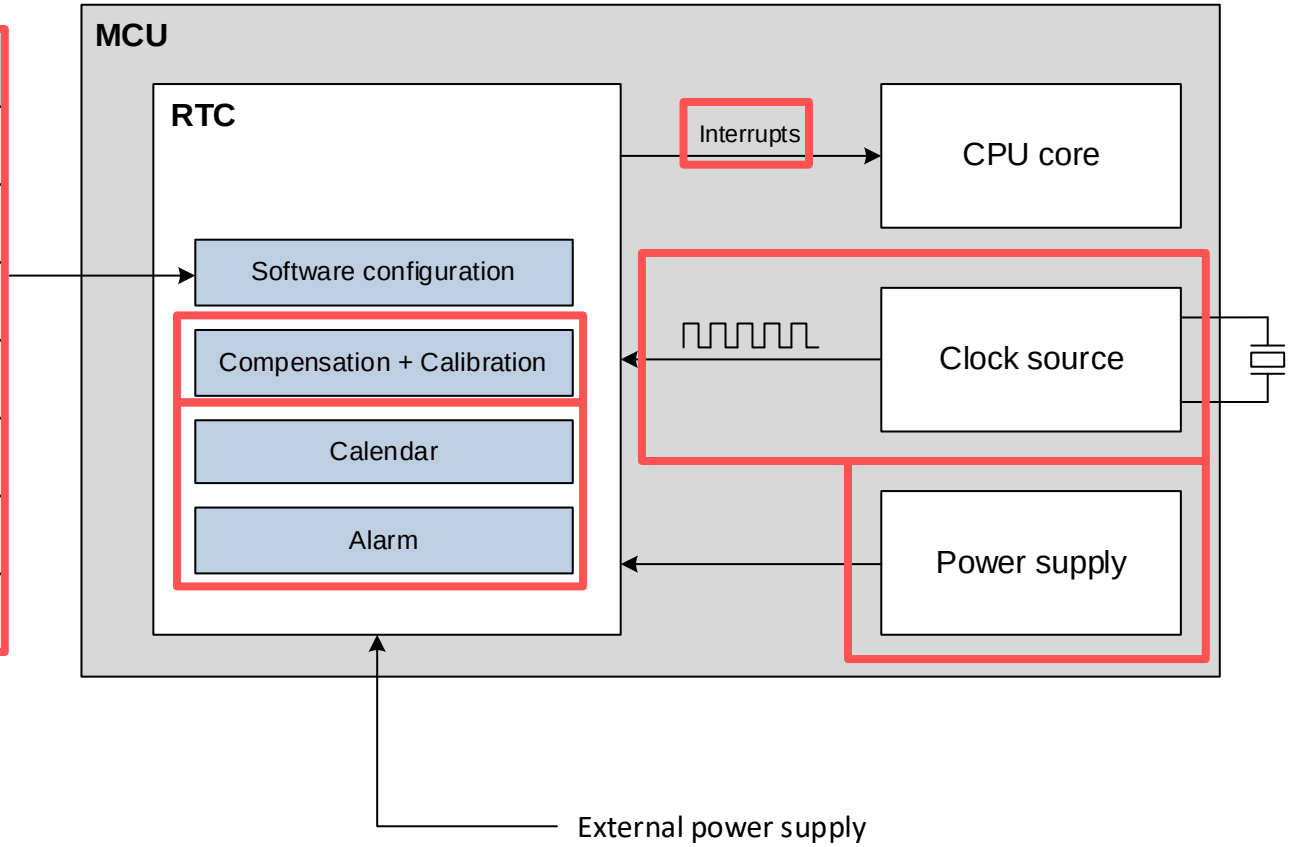

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