Embedded Task

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11.04.2025

No further sensible information due to documentation in public Github repository.

Disclaimer:

The mocked hardware description was created using Github Copilot by providing the created architecture as a prompt.

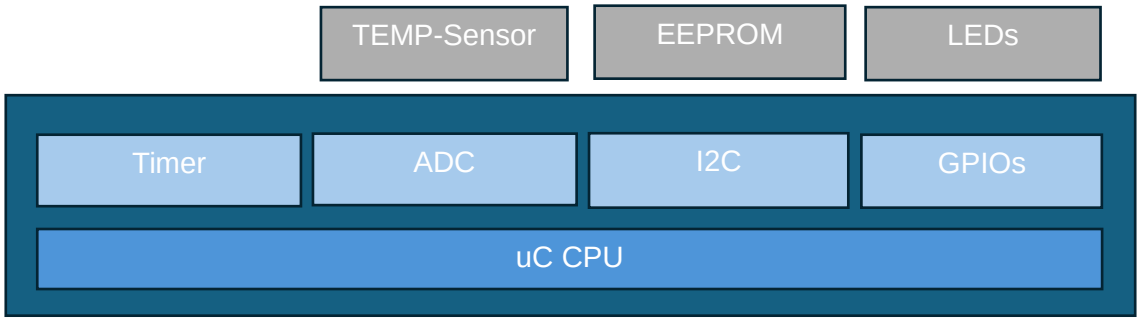
The code created for this task was commented using Github Copilot automation and statement completion.

Since the work will be done by a single person, the Github history will not follow a specific branching strategy.

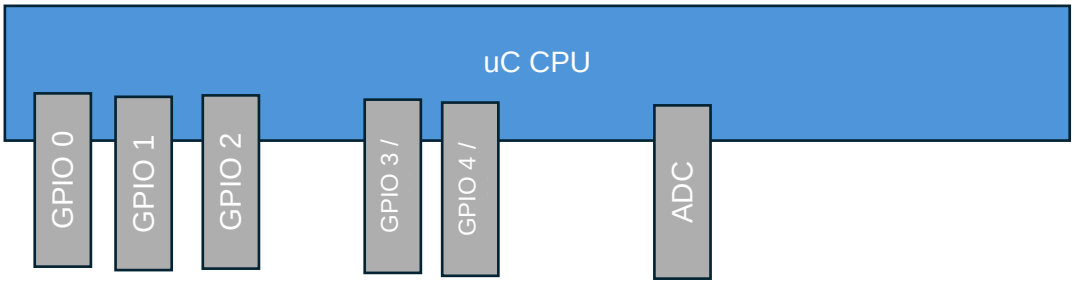
To open the diagrams plantuml installation is needed. Exports are located in the docs directory as well.

Architecture Approach:

1. Block diagram:



2. uC pinout



3. Module descriptions / Notes

TEMP (sensor):

- temp sensor provides analog signal which is translated into digital value via ADC
- output voltage of temperature sensor is matched to the accepted input voltage of the ADC (voltage devider /OP amp)

ADC:

- integrated into uC
- supports at least 10kHz sample rate (sample every 100 us)
- **clock/timer based sample frequency** to sample regularly -> to be configured (clock-based for low jitter)
- **ISR to be triggered after sampling and quantization of the temp sensor signal is done**

- sample depth / resolution:

  Temp range needed: <5°C….>105°C

  RevA - 8 bit would be sufficient to cover the temp range in 1°C steps

  RevB - 10 bit necessary to cover temp range in 0.1°C steps

  ⇨ to be configured in ADC register

  RevA - 4°C at digital value 0 (temp range 4°C…259°C / 256 steps)

RevB - 4°C at digital value 0 (temp range 4.0°C...106.3°C / 1024 steps)

- ⇨ Dimensions are chosen to fit the use case, a bigger range might be expected in reality
- ⇨ Same starting temperature to avoid additional offset to be configured

- ADC register addresses (assumption): 0x30

ADC Config Register								
0x30	N/A (Bit7)	N/A	N/A	Resolution	Trigger source	ISR flag clear	ISR enable	Enable/Disable (Bit0)

- Resolution: 1 – 10 bit, 0 – 8 bit
- Trigger source: 0 – Timer Clk0 (internal) , 1 – external Timer
- No focus on conversion mode, clock scaling and other potential ADC parameters

ADC Value Register High								
0x31	(Bit7)							(Bit0)

ADC Value Register Low								
0x32	(Bit7)							(Bit0)

Clk0:

Clk0 Config Register								
0x40	N/A (Bit7)	N/A	N/A	N/A	N/A	Clock Frequency	Clock Frequency	Enable/Disable (Bit0)

- Clock frequency: 0b00 – 10 kHz , 0b01 – 20kHz, …
  - ⇨ No clock divider considered to keep it simple

GPIOs (for LEDs):

- LED turned on when GPIO high

GPIO Register								
0x50	N/A (Bit7)	N/A	FUNC SELECT	Read (High/Low)	RESET	SET	Input/Output	Enable/Disable GPIO (Bit0)

Assumptions:

- 1 bit for FUNCTION select (1 - I2C, 0-GPIO)

- GPIO_0 register-> Red (Address: 0x50)
- GPIO_1 register -> Yellow (Address: 0x51)
- GPIO_2 register -> Green (Address: 0x52)

EEPROM:

- hardware abstraction for i2c interface
- storage addressing: 1 Byte
- storage size: 256 Byte (0x00...0xFF)

- external via I2C
- chosen I2C address: 0x80 + Write(0) / Read(1)
- I2C buffer size: 1 Byte
- HW serial read through iteration (no sequential read implemented)

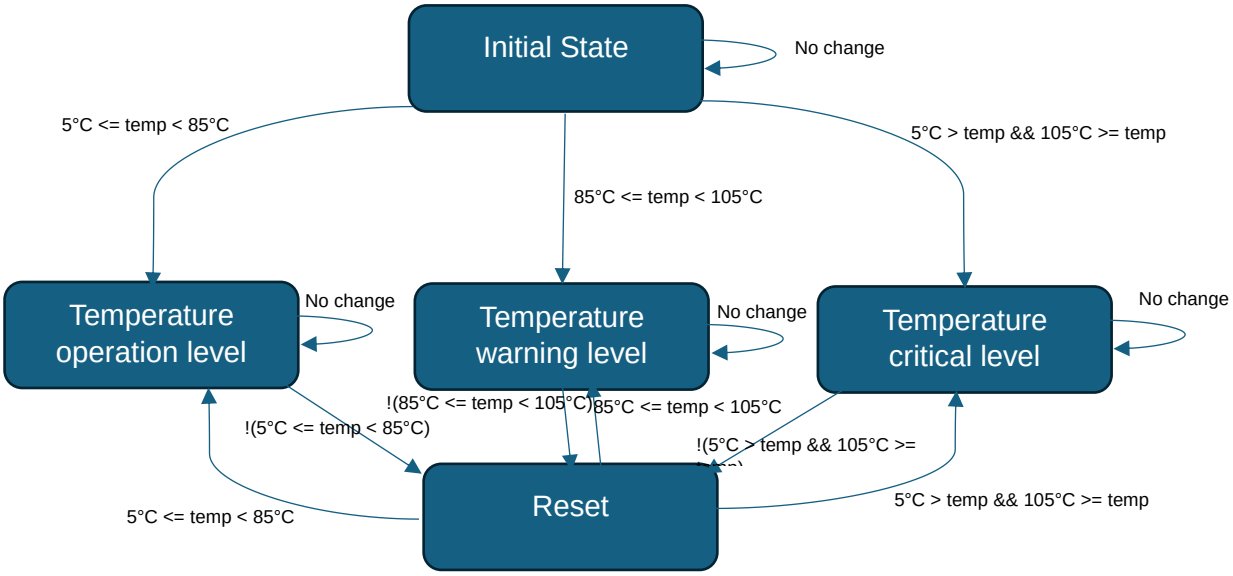
I2C Config Register								
0x61	(Bit7)	Address	Address	Address	Address	Address	Address	Read/Write GPIO (Bit0)

I2C Address Register								
0x61	(Bit7)	Address	Address	Address	Address	Address	Address	Read/Write GPIO (Bit0)

Fragmentation:

- Byte 0: Hardware revision
- Byte 1-8: Hardware serial number

Statemachine:



Initial State:

- Read revision from EEPROM
- apply revision specific configuration for GPIOs, Serial and ADC
- wait for first feedback/interrupt from ADC

Temperature operation level:

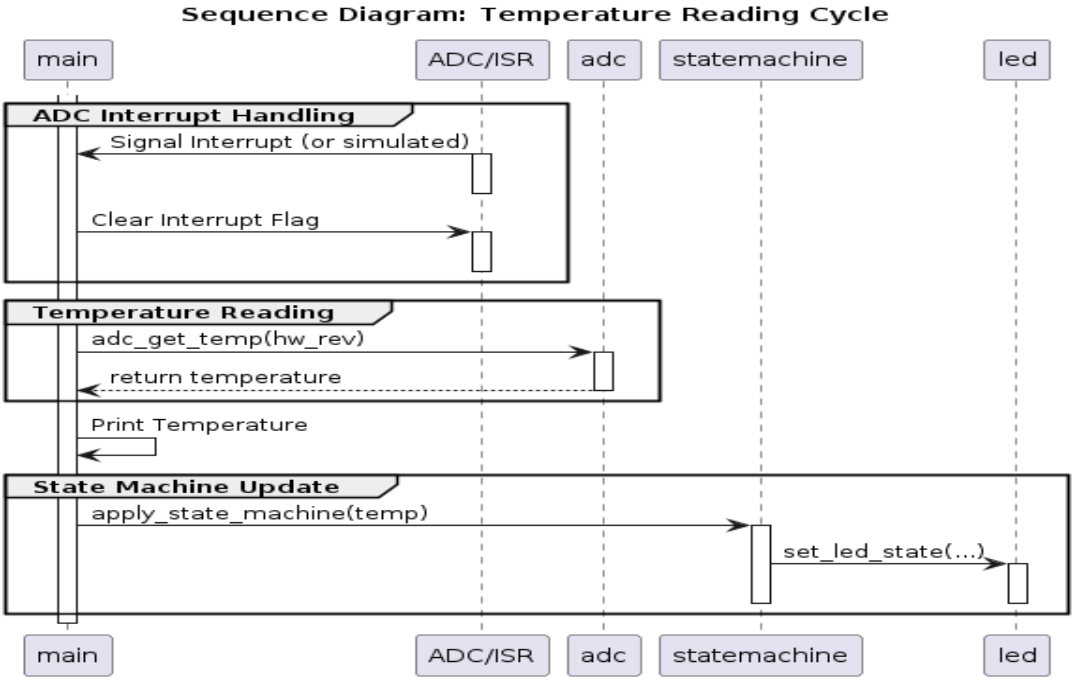
- set GPIO2/LED2 to High
- wait for transition

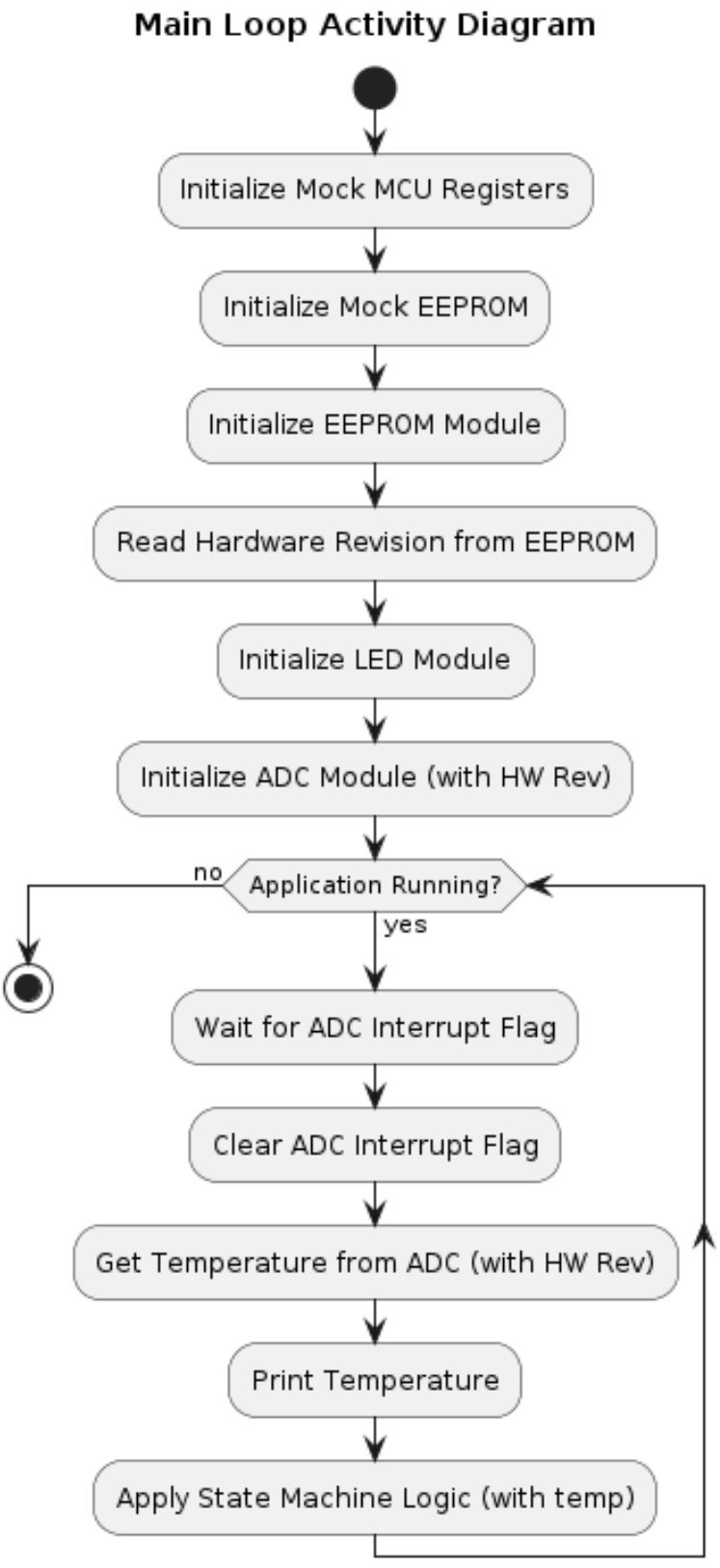
Temperature warning level:

- set GPIO1/LED1 to High
- wait for transition

Temperature critical level:

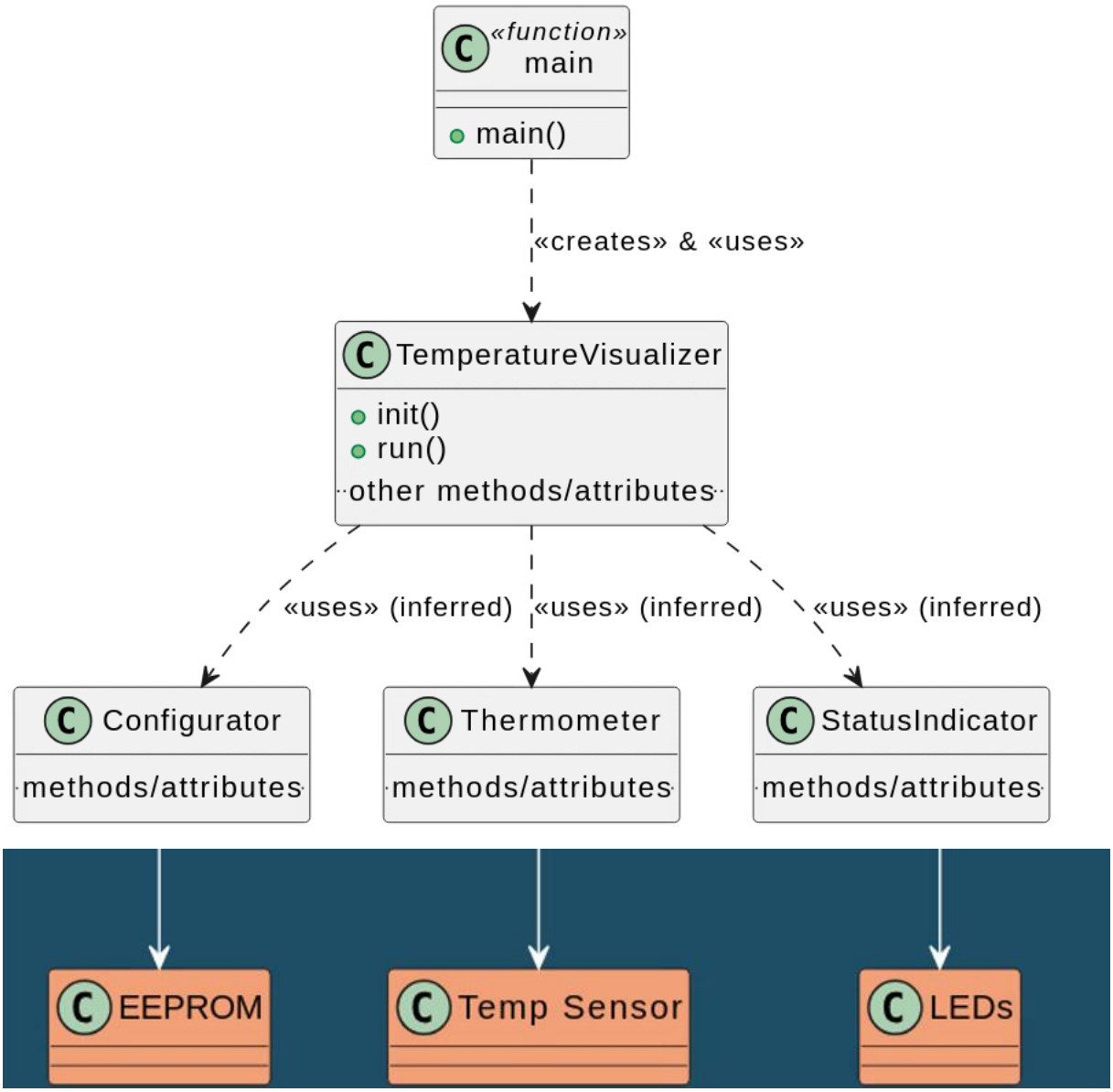
- set GPIO0/LED0 to High
- wait for transition




Main Loop Activity Diagram
Initialize Mock MCU Registers
Initialize Mock EEPROM
Initialize EEPROM Module
Read Hardware Revision from EEPROM
Initialize LED Module
Initialize ADC Module (with HW Rev)
Application Running?
no
yes
Wait for ADC Interrupt Flag
Clear ADC Interrupt Flag
Get Temperature from ADC (with HW Rev)
Print Temperature
Apply State Machine Logic (with temp)

Using C++ and OOP (differences):

Modelling the system parts in SW.



- Abstracting the low-level interfaces / hardware and encapsulate them including necessary memory
- To keep things clear the C++ solution implements the higher abstraction layer and communication mechanisms included in there
- use smart instantiation mechanisms (smart pointers) will not be considered

C++ Sequence Diagram: