Electric Water Heater

Swift Act Challenge

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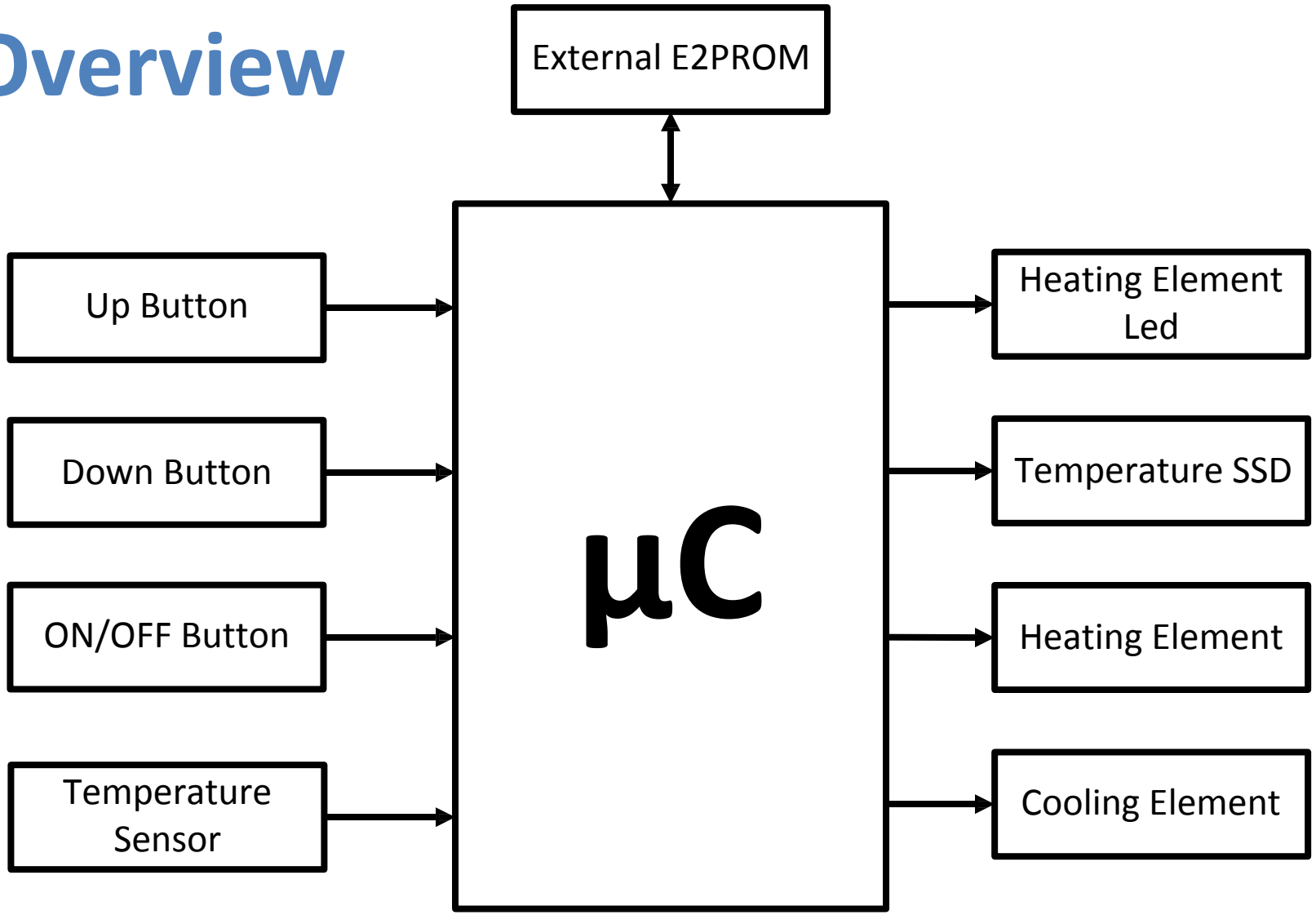
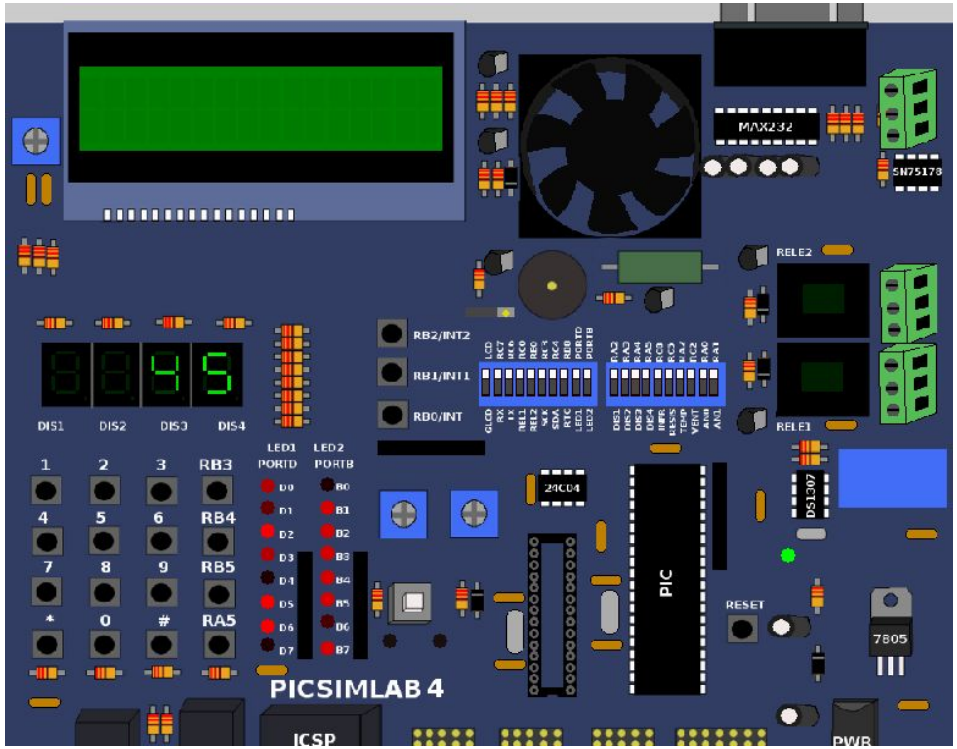
Overview


External E2PROM
Up Button
Down Button
ON/OFF Button
Temperature Sensor
µC
Heating Element Led
Temperature SSD
Heating Element
Cooling Element

Hardware

- Using PICSimLab v0.8.0
- Board: PICGenios, PIC16F877A
- peripherals from the board:
  - Fan as cooling element
  - Heater as heating element
  - LM35 Heating Sensor
  - 7 Seg-Dsiplay
  - External EEPROM -> i2c
  - Heating LED [RB6]
  - Push buttons:
    - Power [RB3]
    - Up [RB4]
    - Down [RB5]
- Using MPLAB IDE



Specifications – ON/OFF Behavior

1. If power is connected to the heater, the electric water heater is in OFF state
2. If the “ON/OFF” button is released and the electric water heater is in OFF state, the electric water heater goes to ON state
3. If the “ON/OFF” button is released and the electric water heater is in ON state, the electric water heater goes to OFF state
4. In the OFF state, all display should be turned OFF

Specifications – Temperature Setting

1. The “Up” or “Down” buttons are used to change the required water temperature (set temperature)
2. The first “Up” or “Down” button press, enters the temperature setting mode
3. After entering temperature setting mode, a single “Up” button press increase the set temperature by 5 degrees
4. After entering temperature setting mode, a single “Down” button press decrease the set temperature by 5 degrees
5. The minimum possible set temperature is 35 degrees
6. The maximum possible set temperature is 75 degrees
7. The “External E2PROM” should save the set temperature once set
8. If the electric water heater is turned OFF then ON, the stored set temperature should be retrieved from the “External E2PROM”
9. The initial set temperature is 60 degrees

Specifications – Temperature Sensing

1. The temperature sensor measures the water temperature
2. The water temperature should increase, if the “Heating Element” is ON
3. The water temperature should decrease, if the “Cooling Element” is ON
4. Temperature should be sensed once every 100 ms
5. The decision to turn ON or OFF either the “Heating Element” or the “Cooling Element” based on the average of the last 10 temperature readings

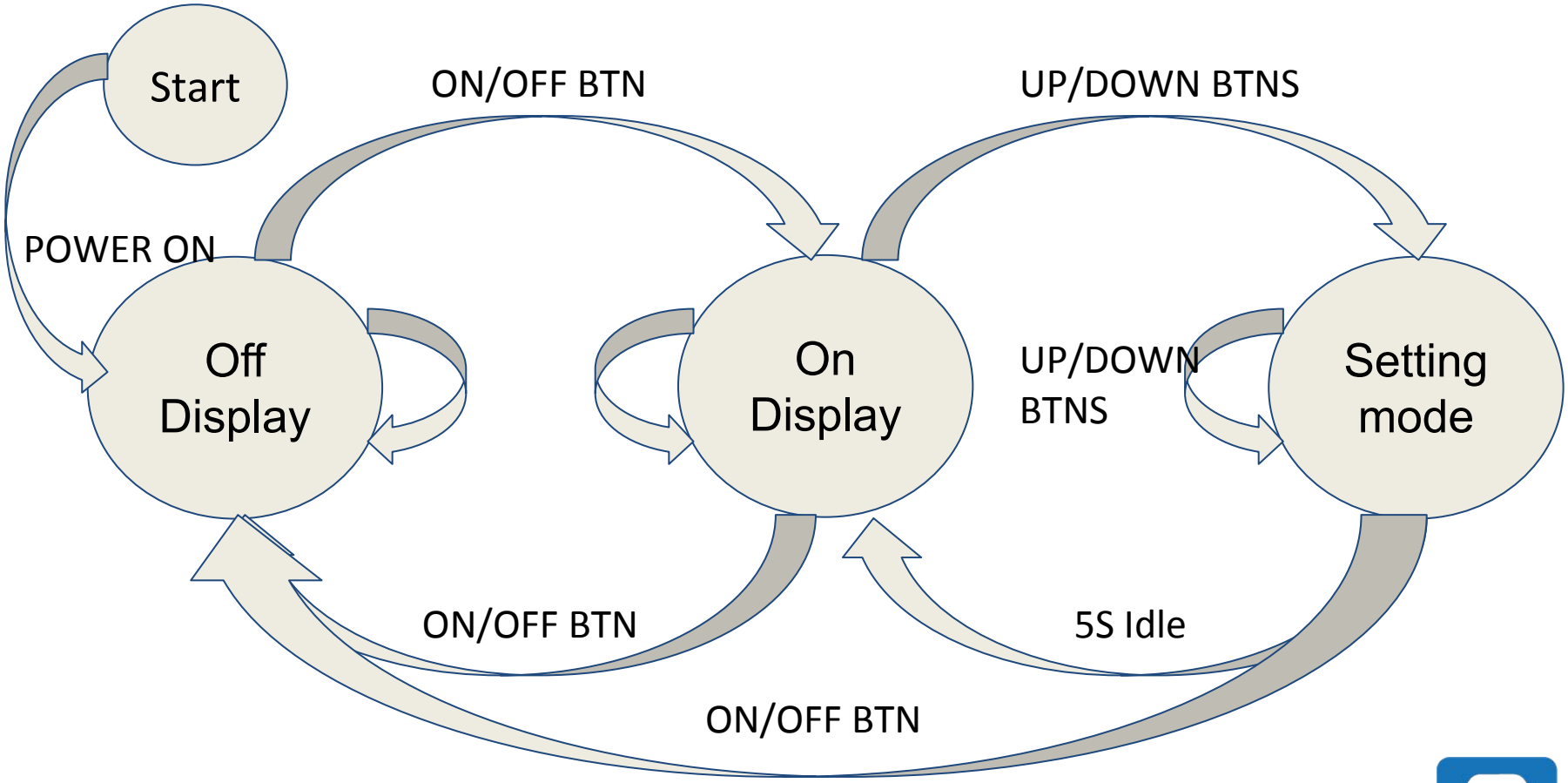
Specifications – Heating/Cooling Elements

1. The “Heating Element” should be turned ON, if the current water temperature is less than the set temperature by 5 degrees
2. The “Cooling Element” should be turned OFF, if the current water temperature is less than the set temperature by 5 degrees
3. The “Heating Element” should be turned OFF, if the current water temperature is greater than the set temperature by 5 degrees
4. The “Cooling Element” should be turned ON, if the current water temperature is greater than the set temperature by 5 degrees
5. If the “Heating Element” is ON, the “Heating Element Led” should blink every 1 second
6. If the “Cooling Element” is ON, the “Heating Element Led” should be ON

Specifications – Seven Segments

1. 2 seven segment by default show the current water temperature or the set temperature
2. If the electric water heater is in the temperature setting mode, the 2 seven segment displays should blink every 1 second and show the set temperature
3. In the temperature setting mode, every change in the set temperature should be reflected on the 2 seven segment displays
4. The 2 seven segment display should exit the temperature setting mode, if the “UP” and “Down” buttons are not pressed for 5 seconds

Finite State Machine



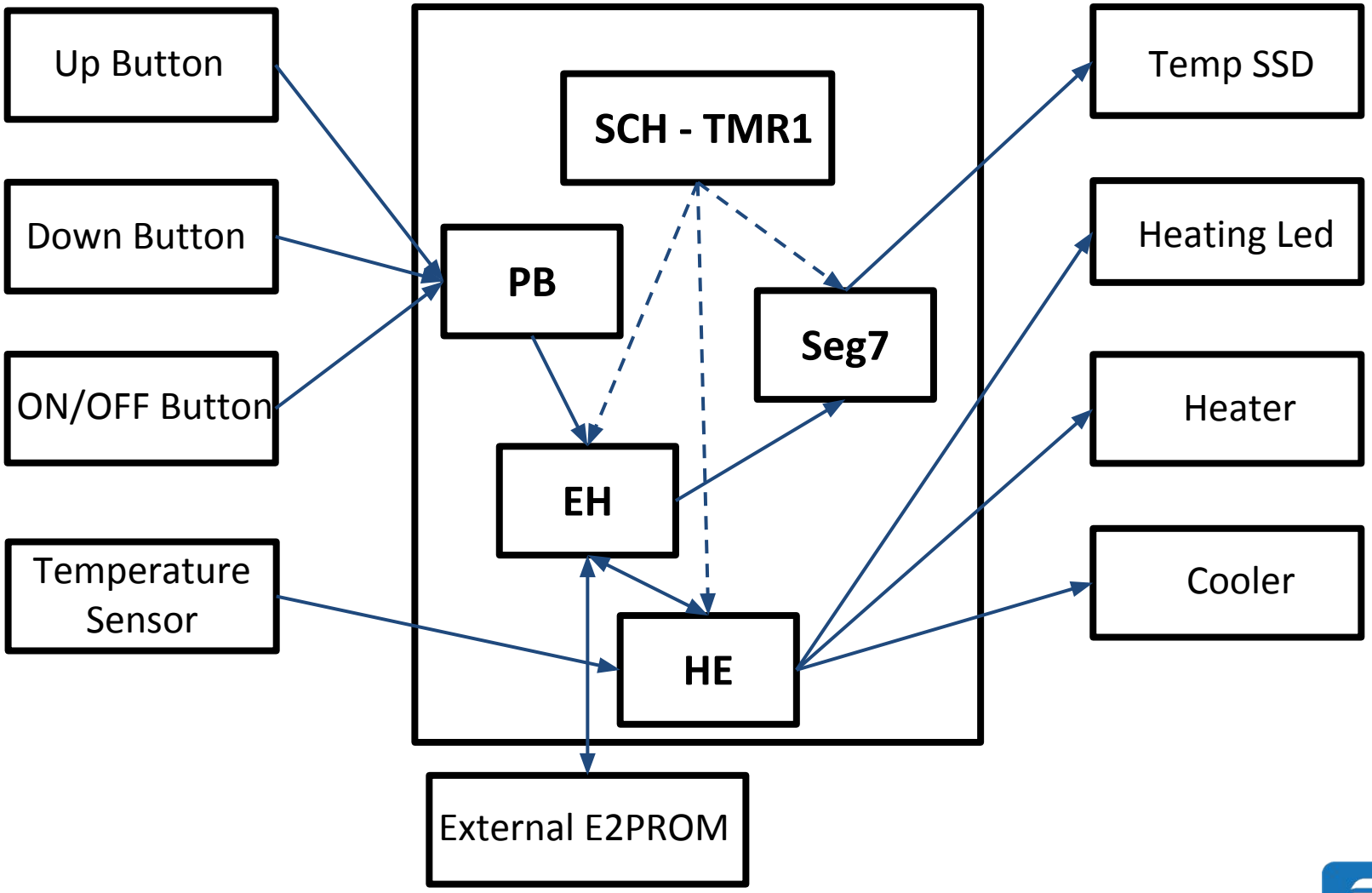
Detailed Design

- Electrical_Heater
  - EH_Init
  - EH_Update
  - Get_Setting_Temp
- SCH
  - SCH_Init
  - SCH_Start
  - SCH_Add_Task
  - SCH_Dispatch_Tasks
- Heating_Element
  - Heating_Elements_init
  - eating_Element_Update
  - Get_avg_Temp
- PB
  - PB_Init
  - PB_Update
  - PB_GetState
- Seg7
  - Seg7_Init
  - Seg7_Update
  - Set_Seg7
- EXT_E2PROM
  - EXT_E2PROM_Init
  - EXT_E2PROM_Read
  - EXT_E2PROM_Write

Detailed Design

- ADC
  - ADC_Init
  - ADC_Read
- I2C
  - I2C_Init
  - I2C_Start
  - I2C_Re_Start
  - I2C_Stop
  - I2C_Rd
  - I2C_Write
  - I2C_Busy
- GPIO
  - GPIO_InitPort
  - GPIO_InitPortPin
  - GPIO_SetPortState
  - GPIO_SetPortPinState
  - GPIO_GetPortPinState

Context-Diagram



Timing Analysis

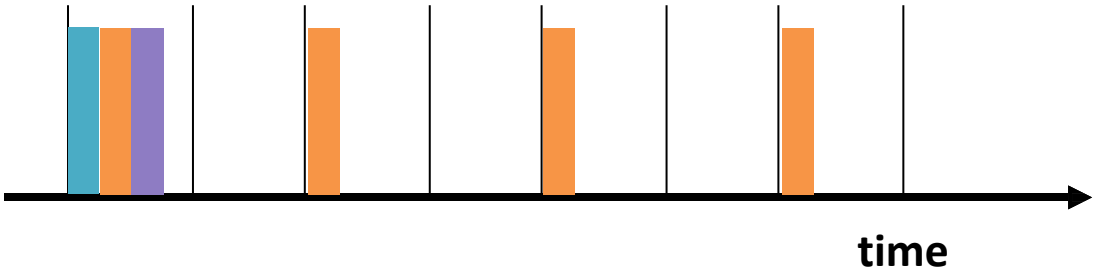
Task	Actions	BCET (ms)	WCET(ms)	Period of Action (ms)	Period of task (ms)
EH	Update state Update PB Update 7Seg numbers	~0 ~0 ~0	~0 ~0 ~0	20 20 1000	20
SSD	Update SSD	~0	~0	2	2
HE	Read Temp Update Heater/cooler	~0 ~0	~0 ~0	100 100	100
				Tick (ms)	1
				Major Cycle (ms)	20

Schedulability Check

SSD Task @ 2 ms

HE Task @ 100 ms

EH Task @ 20 ms




thank you
danke
謝謝
ngiyabonga
teşekkür ederim
gracias
merci
obrigado
dziękuję
bedankt
спасибо
Баярлалаа
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