Electric Water Heater Project documentation

SWIFT ACT
YOU DREAM, WE ACT
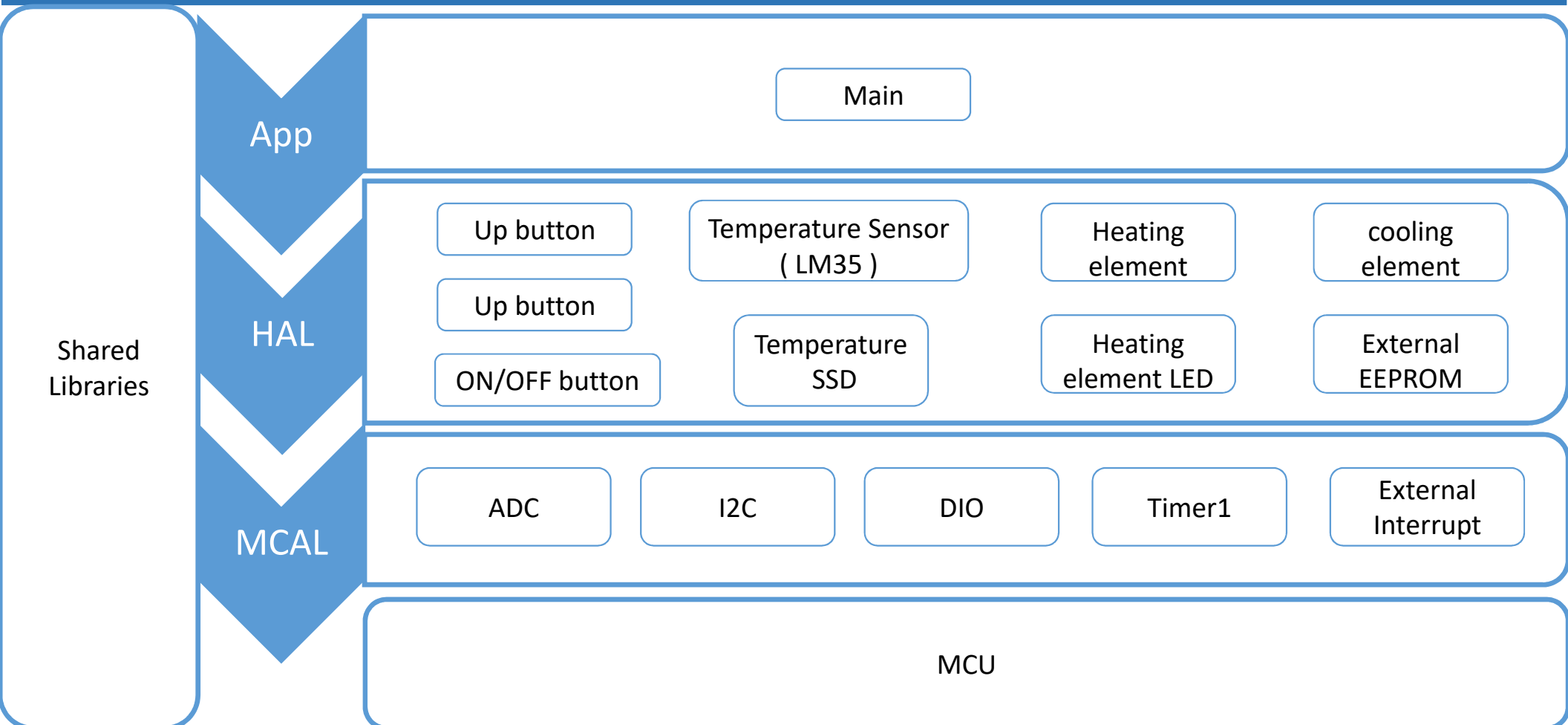
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Layered Architecture

Shared Libraries	

App

Main

HAL

Up button

Up button

ON/OFF button

Temperature Sensor (LM35)

Temperature SSD

Heating element

Heating element LED

cooling element

External EEPROM

MCAL

ADC

I2C

DIO

Timer1

External Interrupt

MCU

State Machine Tabular Representation

Current State	Event	Action	Next State
Sleep Mode	ON/OFF button is Pushed	• 7-segments display the current water temp. • The timer Interrupt is enabled to read the temperature every 1 ms . • The average of Temp. sensor last 10 readings control the cooling and the heating elements and the heating element LED based on the temp set in the EEPROM (Initially = 60) . • Up/Down buttons interrupt is enabled for temperature setting .	Operating Mode
Operating Mode	ON/OFF button is Pushed	• 7-segments are turned off • The cooling and heating elements and the heating element led are turned off . • The timer Interrupt is disabled • Up/Down buttons interrupt is disabled for temperature setting .	Sleep Mode
Operating Mode	Up or Down button is Pushed	• 7-segments blink with the last temp. set in EEPROM	Set Temp. Mode
Set Temp. Mode	Up button is Pushed	• Temp. set is increased by 5 and displayed on 7-segments	Set Temp. Mode
Set Temp. Mode	Up button is Pushed	• Temp. set is decreased by 5 and displayed on 7-segments	Set Temp. Mode
Set Temp. Mode	5 seconds are elapsed without pushing Up or Down buttons	• Last Temp. set is saved in EEPROM	Operating Mode
Set Temp. Mode	ON/OFF button is Pushed	• Wait for the remaining time of the 5 seconds setting is elapsed , then turn off all actuators and displays and disable timer interrupt and Up/Down buttons interrupts .	Sleep Mode

State Machine Graphical Representation
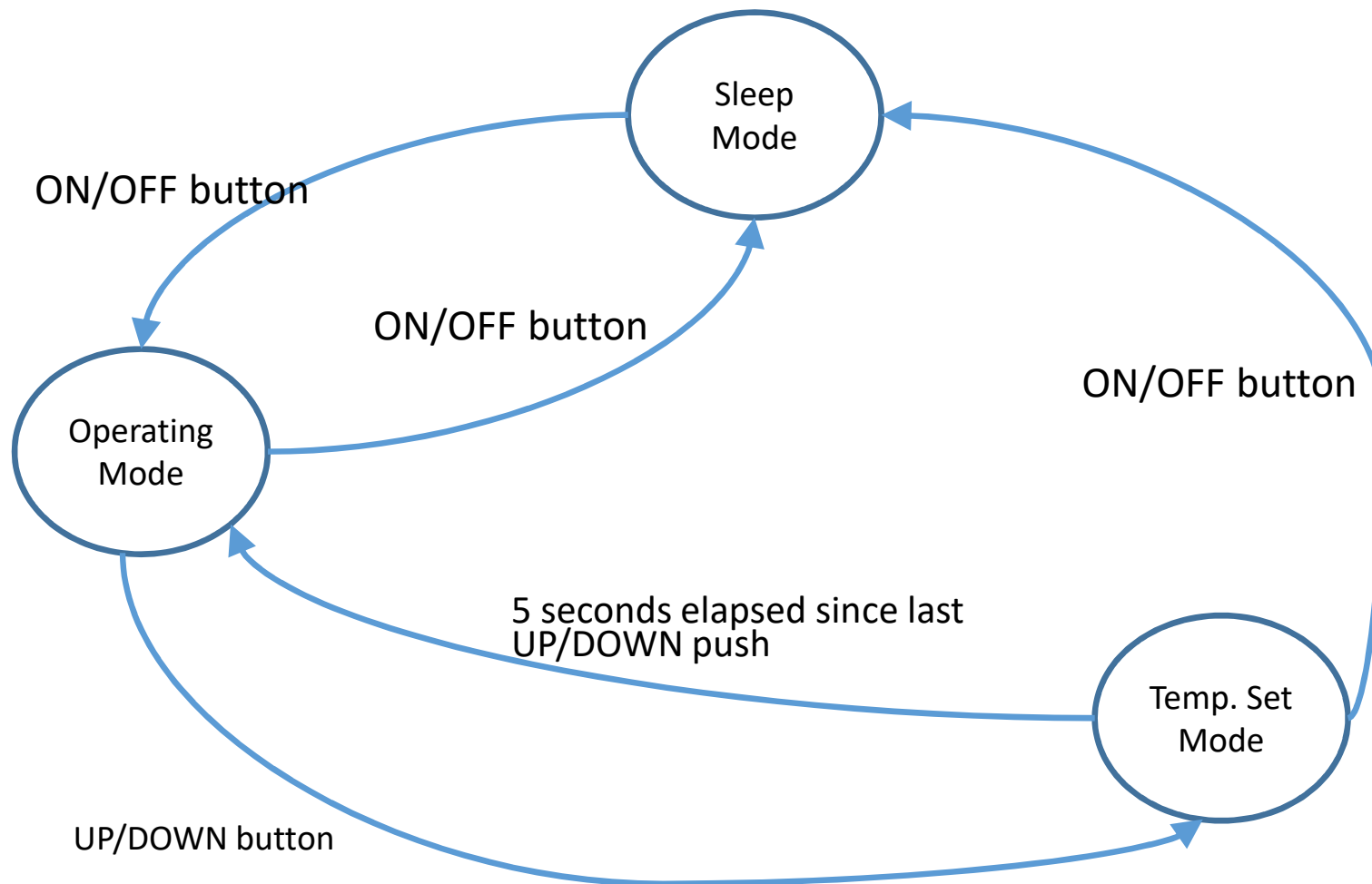
Sleep Mode State

- ON/OFF Status = OFF_STATE .
- Turn off SSD.
- Turn off the heating Element and its LED .
- Turn off the Cooling Element.
- Disable UP and DOWN buttons interrupt (RB PORT change interrupt) .
- Disable Timer 1 Interrupt (Temp Sensor triggering) .

Operating Mode State

- ON/OFF Status = ON_STATE .

- Turn ON SSD and display the current water temperature .

- Enable UP and DOWN buttons interrupt (RB PORT change interrupt) .

- Enable Timer 1 Interrupt (Temp Sensor triggering) .

- Timer interrupt triggers the Temperature sensor to read the current water temperature every 100 ms , take the average of the last 10 readings , and then control the actuators based on this average value :

  ➢ If this average value is less than the set temperature by 5 degrees ,
     then The Heating Element should be turned ON , otherwise it should be turned off .
  ➢ If this average value is grater than the set temperature by 5 degrees ,
     then The Cooling Element should be turned ON , otherwise it should be turned off .

Set Temperature Mode State

- This mode is active once First Up/Down push while operating mode is active ,
  and the first push does not affect the temp set .

- It lasts for 5 seconds since last Up/Down push .

- SSD should display the last temp set blinking .

- Each Up push increases the temp set by 5 degrees .

- Each Down push decreases the temp set by 5 degrees .

- Before exiting this state , save the last temp set to the EEPROM .

Detailed Design

- **Temperature Sensor**
  - ➤ TempSensor_Init
  - ➤ Temp_ControlWaterTemp

- **Push Buttons**
  - ➤ Push_Buttons_Init
  - ➤ PushButtons_SetCallBacks

- **Actuators**
  - ➤ Cooler_Init
  - ➤ Cooler_TurnOn
  - ➤ Cooler_TurnOff
  - ➤ Heater_Init
  - ➤ Heater_TurnOn
  - ➤ Heater_TurnOff

- **Seven Segment Display**
  - ➤ Seven_Segments_Init
  - ➤ Seven_Segments_DeInit
  - ➤ Left_7_Segment_DisplayDigit
  - ➤ Right_7_Segment_DisplayDigit
  - ➤ Seven_Segments_Display_2Digits

- **EEPROM**
  - ➤ EEPROM_Init
  - ➤ EEPROM_WriteToEEPROM
  - ➤ EEPROM_ReadFromEEPROM