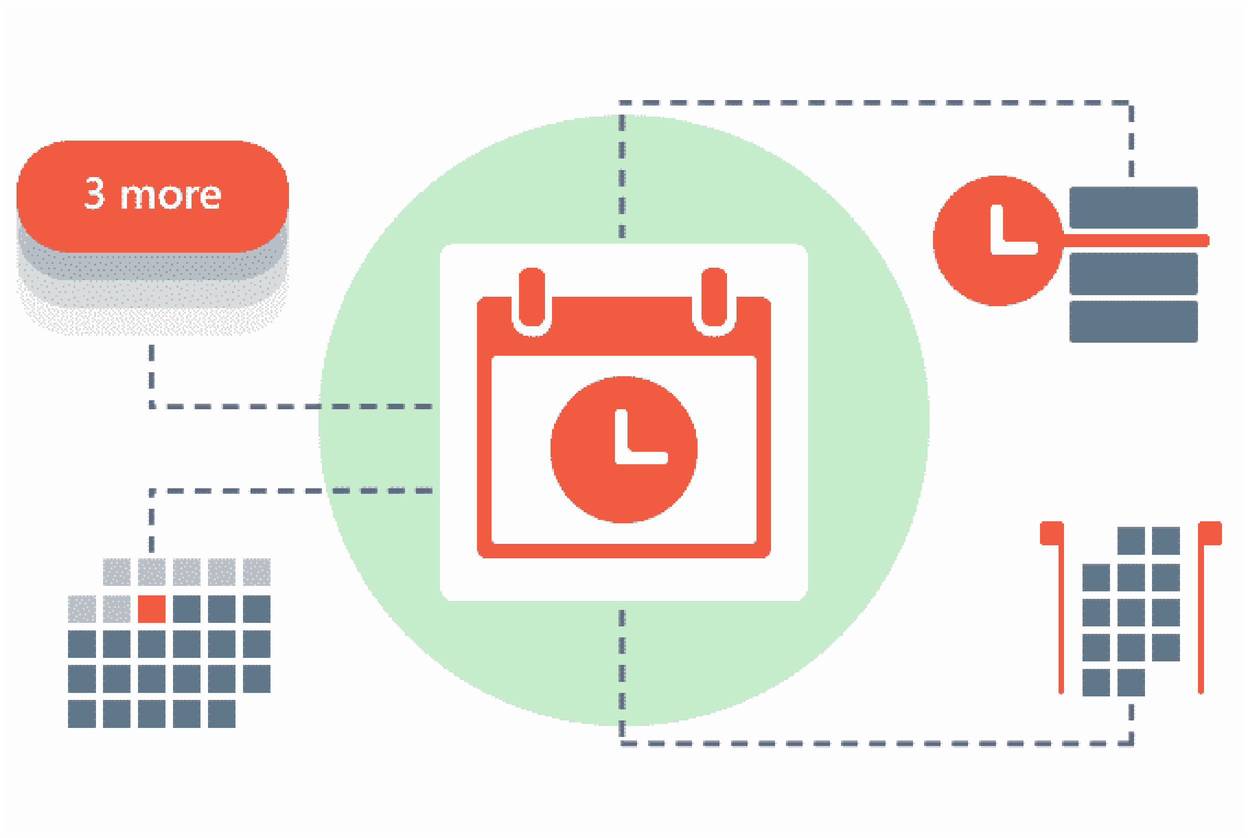


Design a Small OS

Prepared by:

Nadeen Adel

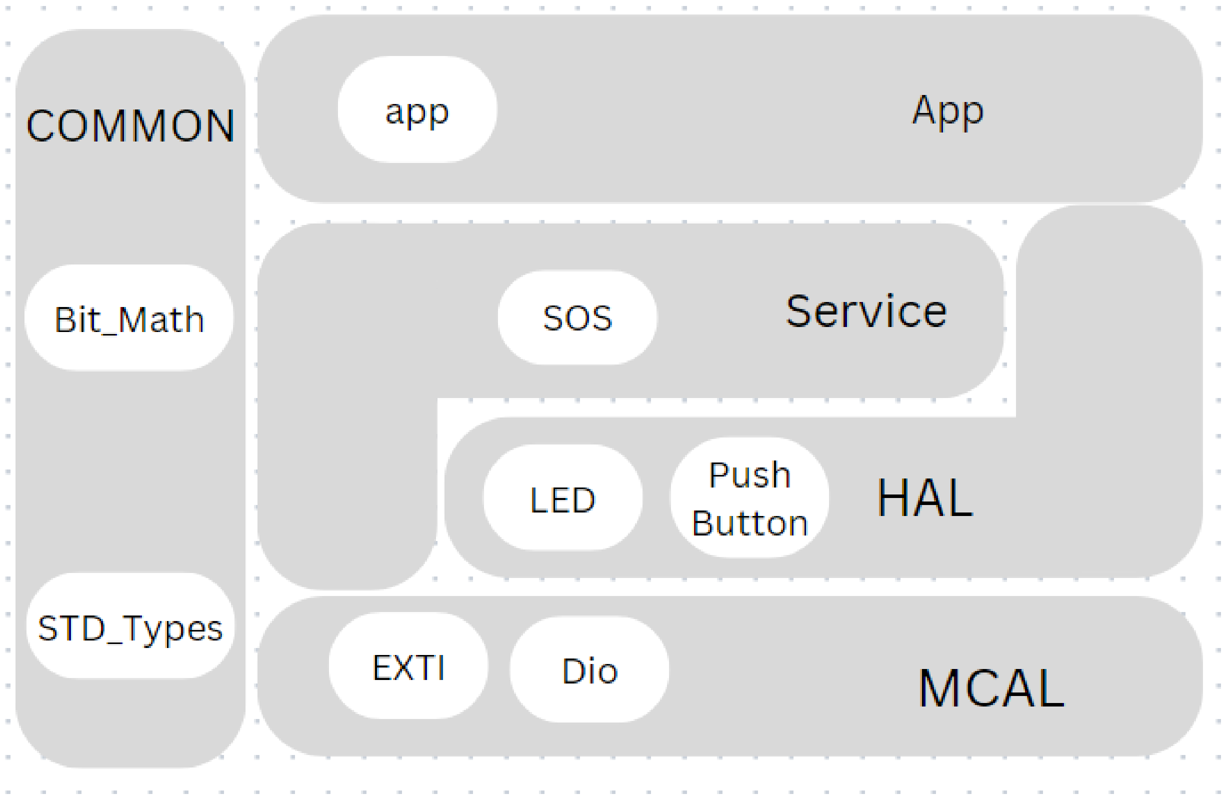
Table Of Content:

1. Introduction:

This project aims to create a small and efficient RTOS tailored for resource-constrained systems. SOS is designed to be flexible, easy to use, and well-optimized for embedded applications where real-time task management is crucial. The system employs a preemptive priority-based scheduling algorithm to ensure efficient and deterministic task execution.

2. High Level Design:

2.1 Layered Architecture:



2.2 Modules Description:

- DIO:

  controls GPIO pins.
- Timer:

  controls timing of the tasks in the program .
- EXTI:

  triggered by the push button to start or stop the scheduler.

- LED:

  controls led state in the program.
- Button:

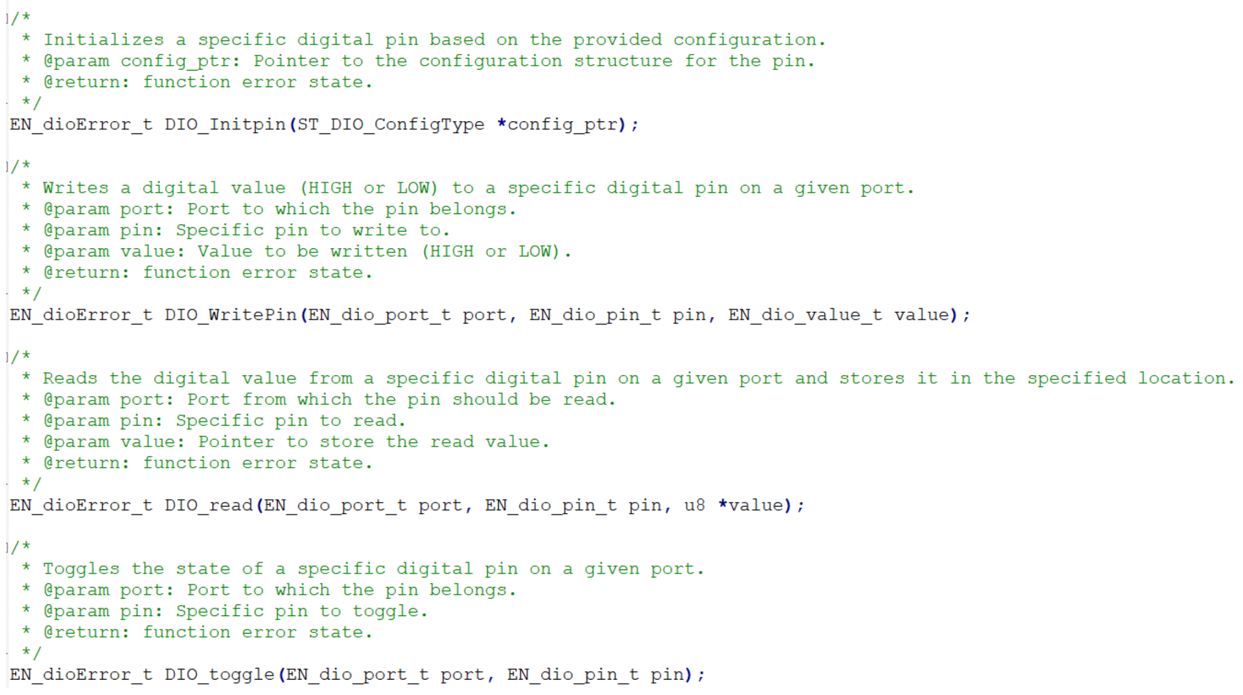
  controls start and stop of the system.
- SOS:

  operating system that manages application process.
- App:

  Contains main logic of the code.

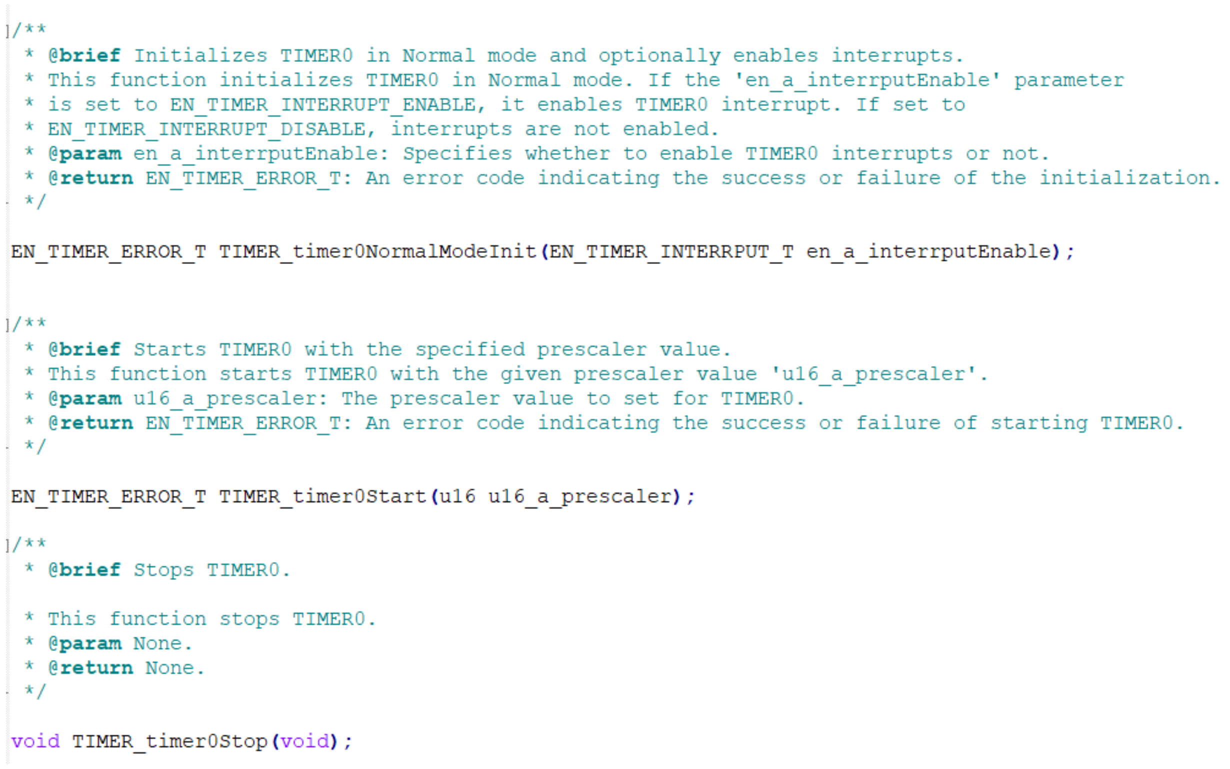
2.3 Drivers' Documentation:

2.3.1 DIO:

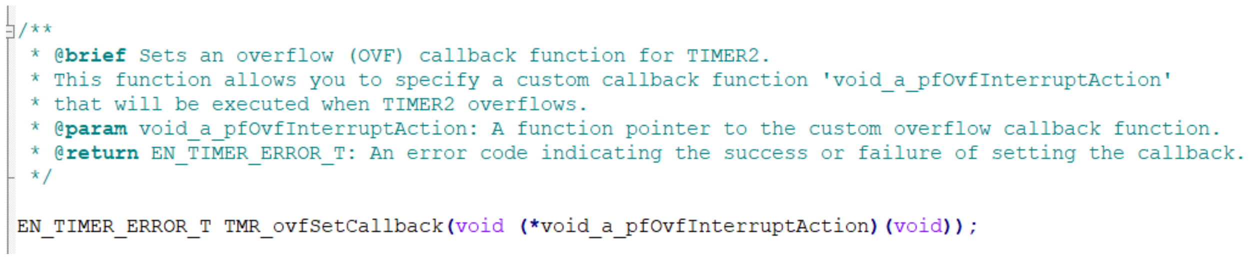


```
/*
 * Initializes a specific digital pin based on the provided configuration.
 * @param config_ptr: Pointer to the configuration structure for the pin.
 * @return: function error state.
 */
EN_dioError_t DIO_Initpin(ST_DIO_ConfigType *config_ptr);

/*
 * Writes a digital value (HIGH or LOW) to a specific digital pin on a given port.
 * @param port: Port to which the pin belongs.
 * @param pin: Specific pin to write to.
 * @param value: Value to be written (HIGH or LOW).
 * @return: function error state.
 */
EN_dioError_t DIO_WritePin(EN_dio_port_t port, EN_dio_pin_t pin, EN_dio_value_t value);

/*
 * Reads the digital value from a specific digital pin on a given port and stores it in the specified location.
 * @param port: Port from which the pin should be read.
 * @param pin: Specific pin to read.
 * @param value: Pointer to store the read value.
 * @return: function error state.
 */
EN_dioError_t DIO_read(EN_dio_port_t port, EN_dio_pin_t pin, u8 *value);

/*
 * Toggles the state of a specific digital pin on a given port.
 * @param port: Port to which the pin belongs.
 * @param pin: Specific pin to toggle.
 * @return: function error state.
 */
EN_dioError_t DIO_toggle(EN_dio_port_t port, EN_dio_pin_t pin);
```

2.3.2 Timer:

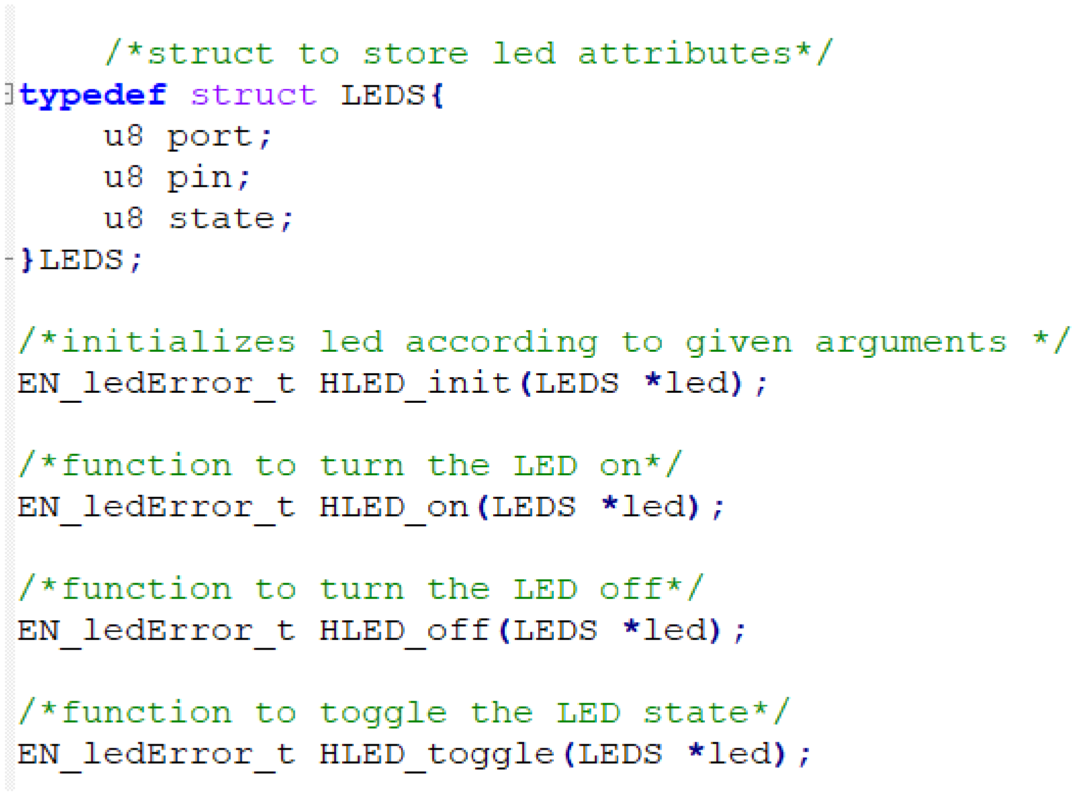


```c
/**
 * @brief Initializes TIMER0 in Normal mode and optionally enables interrupts.
 * This function initializes TIMER0 in Normal mode. If the 'en_a_interrputEnable' parameter
 * is set to EN_TIMER_INTERRUPT_ENABLE, it enables TIMER0 interrupt. If set to
 * EN_TIMER_INTERRUPT_DISABLE, interrupts are not enabled.
 * @param en_a_interrputEnable: Specifies whether to enable TIMER0 interrupts or not.
 * @return EN_TIMER_ERROR_T: An error code indicating the success or failure of the initialization.
 */

EN_TIMER_ERROR_T TIMER_timer0NormalModeInit(EN_TIMER_INTERRPUT_T en_a_interrputEnable);


/**
 * @brief Starts TIMER0 with the specified prescaler value.
 * This function starts TIMER0 with the given prescaler value 'u16_a_prescaler'.
 * @param u16_a_prescaler: The prescaler value to set for TIMER0.
 * @return EN_TIMER_ERROR_T: An error code indicating the success or failure of starting TIMER0.
 */

EN_TIMER_ERROR_T TIMER_timer0Start(u16 u16_a_prescaler);

/**
 * @brief Stops TIMER0.

 * This function stops TIMER0.
 * @param None.
 * @return None.
 */

void TIMER_timer0Stop(void);
```



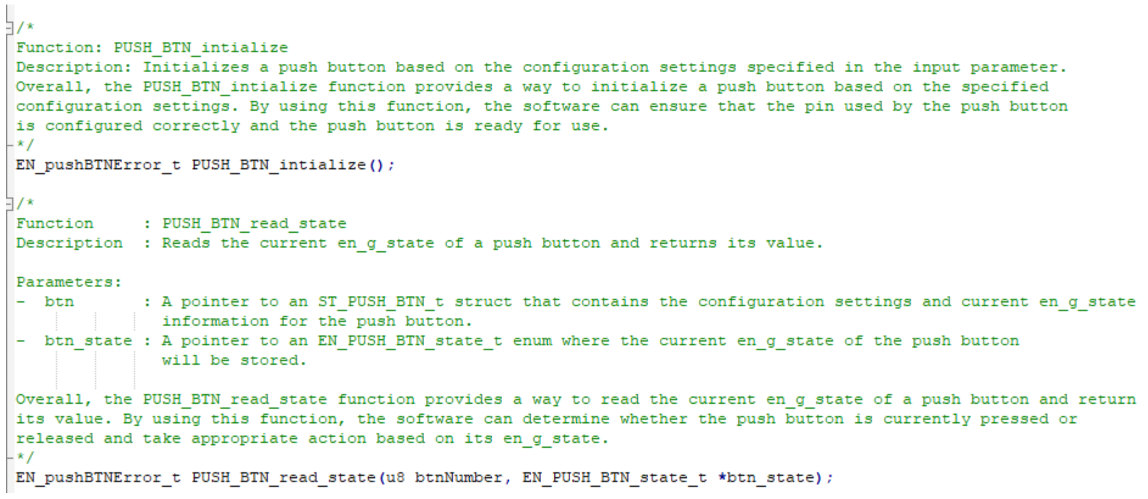
```c
/**
 * @brief Sets an overflow (OVF) callback function for TIMER2.
 * This function allows you to specify a custom callback function 'void_a_pfOvfInterruptAction'
 * that will be executed when TIMER2 overflows.
 * @param void_a_pfOvfInterruptAction: A function pointer to the custom overflow callback function.
 * @return EN_TIMER_ERROR_T: An error code indicating the success or failure of setting the callback.
 */

EN_TIMER_ERROR_T TMR_ovfSetCallback(void (*void_a_pfOvfInterruptAction)(void));
```

2.3.3 LED:



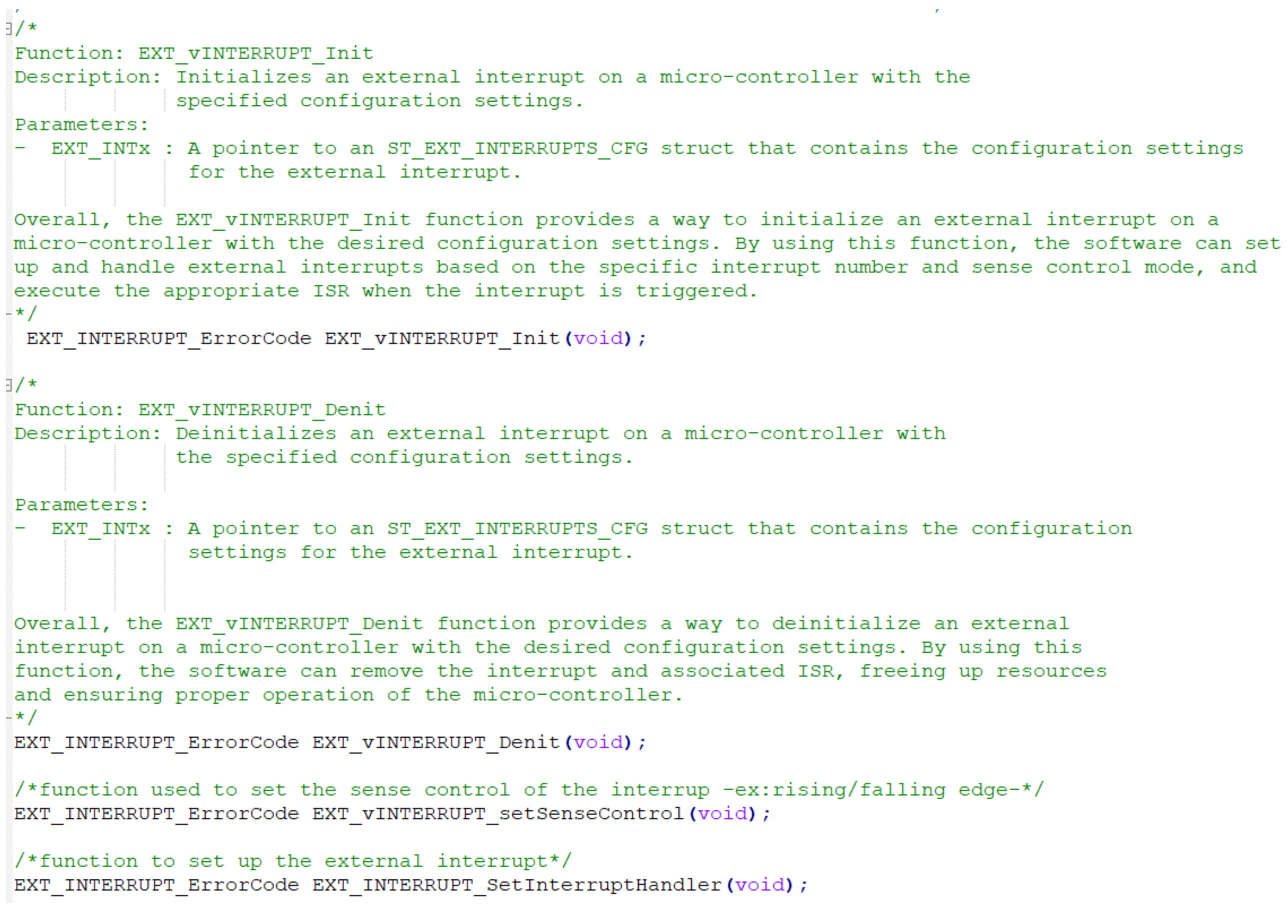
```c
    /*struct to store led attributes*/
typedef struct LEDS{
    u8 port;
    u8 pin;
    u8 state;
}LEDS;

/*initializes led according to given arguments */
EN_ledError_t HLED_init(LEDS *led);

/*function to turn the LED on*/
EN_ledError_t HLED_on(LEDS *led);

/*function to turn the LED off*/
EN_ledError_t HLED_off(LEDS *led);

/*function to toggle the LED state*/
EN_ledError_t HLED_toggle(LEDS *led);
```

2.3.4 Push Button:



```c
/*
Function: PUSH_BTN_intialize
Description: Initializes a push button based on the configuration settings specified in the input parameter.
Overall, the PUSH_BTN_intialize function provides a way to initialize a push button based on the specified
configuration settings. By using this function, the software can ensure that the pin used by the push button
is configured correctly and the push button is ready for use.
*/
EN_pushBTNError_t PUSH_BTN_intialize();

/*
Function     : PUSH_BTN_read_state
Description  : Reads the current en_g_state of a push button and returns its value.

Parameters:
-  btn       : A pointer to an ST_PUSH_BTN_t struct that contains the configuration settings and current en_g_state
               information for the push button.
-  btn_state : A pointer to an EN_PUSH_BTN_state_t enum where the current en_g_state of the push button
               will be stored.

Overall, the PUSH_BTN_read_state function provides a way to read the current en_g_state of a push button and return
its value. By using this function, the software can determine whether the push button is currently pressed or
released and take appropriate action based on its en_g_state.
*/
EN_pushBTNError_t PUSH_BTN_read_state(u8 btnNumber, EN_PUSH_BTN_state_t *btn_state);
```

2.3.5 External Interrupt:



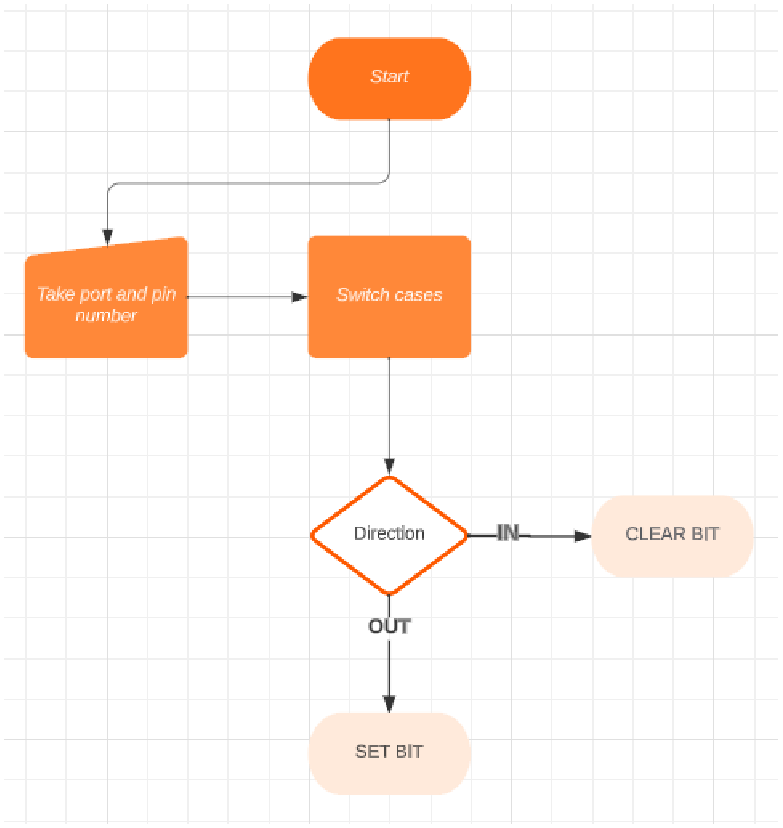
```
/*
Function: EXT_vINTERRUPT_Init
Description: Initializes an external interrupt on a micro-controller with the
             specified configuration settings.
Parameters:
-  EXT_INTx : A pointer to an ST_EXT_INTERRUPTS_CFG struct that contains the configuration settings
              for the external interrupt.

Overall, the EXT_vINTERRUPT_Init function provides a way to initialize an external interrupt on a
micro-controller with the desired configuration settings. By using this function, the software can set
up and handle external interrupts based on the specific interrupt number and sense control mode, and
execute the appropriate ISR when the interrupt is triggered.
*/
 EXT_INTERRUPT_ErrorCode EXT_vINTERRUPT_Init(void);

/*
Function: EXT_vINTERRUPT_Denit
Description: Deinitializes an external interrupt on a micro-controller with
             the specified configuration settings.

Parameters:
-  EXT_INTx : A pointer to an ST_EXT_INTERRUPTS_CFG struct that contains the configuration
              settings for the external interrupt.


Overall, the EXT_vINTERRUPT_Denit function provides a way to deinitialize an external
interrupt on a micro-controller with the desired configuration settings. By using this
function, the software can remove the interrupt and associated ISR, freeing up resources
and ensuring proper operation of the micro-controller.
*/
EXT_INTERRUPT_ErrorCode EXT_vINTERRUPT_Denit(void);

/*function used to set the sense control of the interrup -ex:rising/falling edge-*/
EXT_INTERRUPT_ErrorCode EXT_vINTERRUPT_setSenseControl(void);

/*function to set up the external interrupt*/
EXT_INTERRUPT_ErrorCode EXT_INTERRUPT_SetInterruptHandler(void);
```

3. Low Level Design:

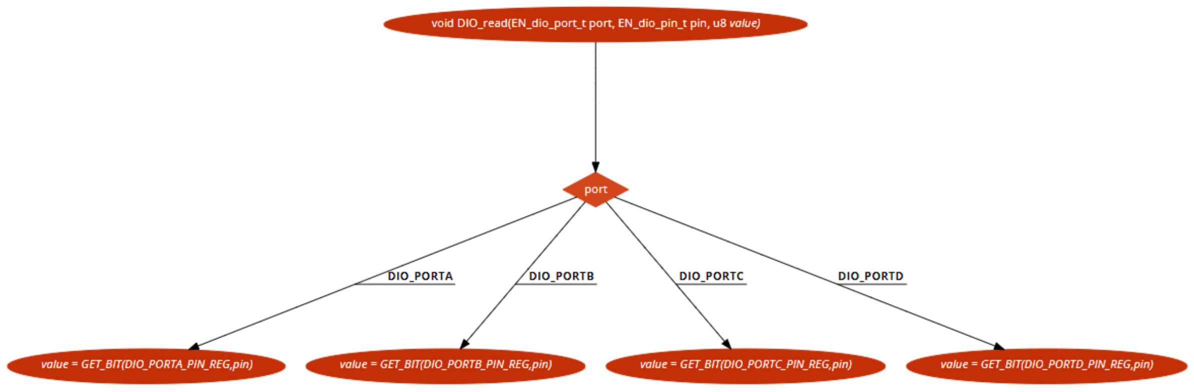
3.1 Flowcharts:

3.1.1 DIO:

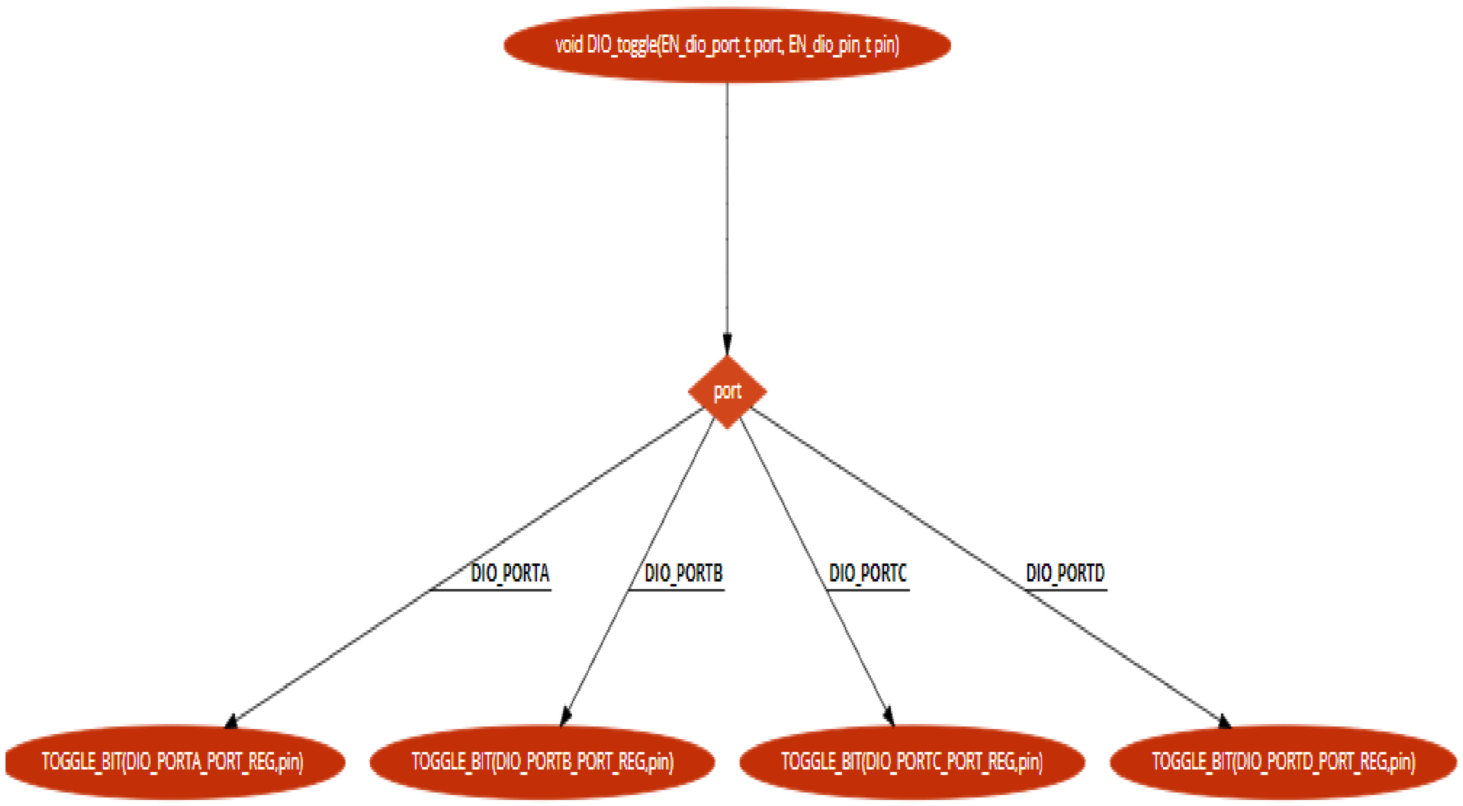
EN_dioError_t DIO_WritePin(EN_dio_port_t port, EN_dio_pin_t pin, EN_dio_value_t value)



EN_dioError_t DIO_read(EN_dio_port_t port, EN_dio_pin_t pin, u8 *value)

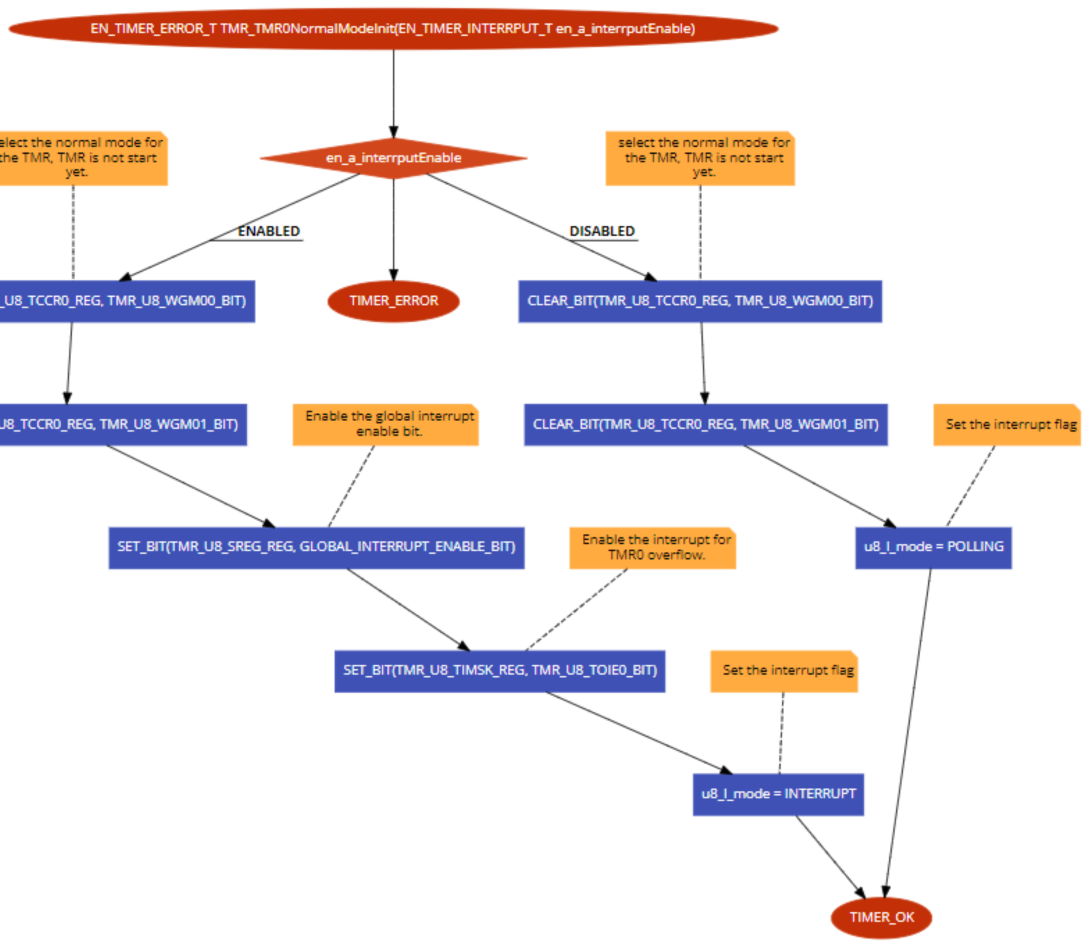

void DIO_read(EN_dio_port_t port, EN_dio_pin_t pin, u8 value)
port
DIO_PORTA
DIO_PORTB
DIO_PORTC
DIO_PORTD
value = GET_BIT(DIO_PORTA_PIN_REG,pin)
value = GET_BIT(DIO_PORTB_PIN_REG,pin)
value = GET_BIT(DIO_PORTC_PIN_REG,pin)
value = GET_BIT(DIO_PORTD_PIN_REG,pin)

EN_dioError_t DIO_toggle(EN_dio_port_t port, EN_dio_pin_t pin)

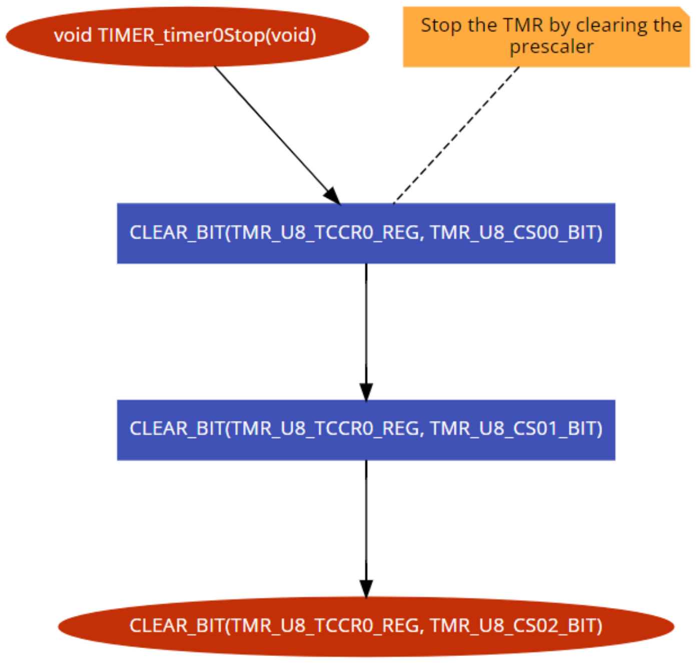

void DIO_toggle(EN_dio_port_t port, EN_dio_pin_t pin)
port
DIO_PORTA
DIO_PORTB
DIO_PORTC
DIO_PORTD
TOGGLE_BIT(DIO_PORTA_PORT_REG,pin)
TOGGLE_BIT(DIO_PORTB_PORT_REG,pin)
TOGGLE_BIT(DIO_PORTC_PORT_REG,pin)
TOGGLE_BIT(DIO_PORTD_PORT_REG,pin)

3.1.2 Timer:

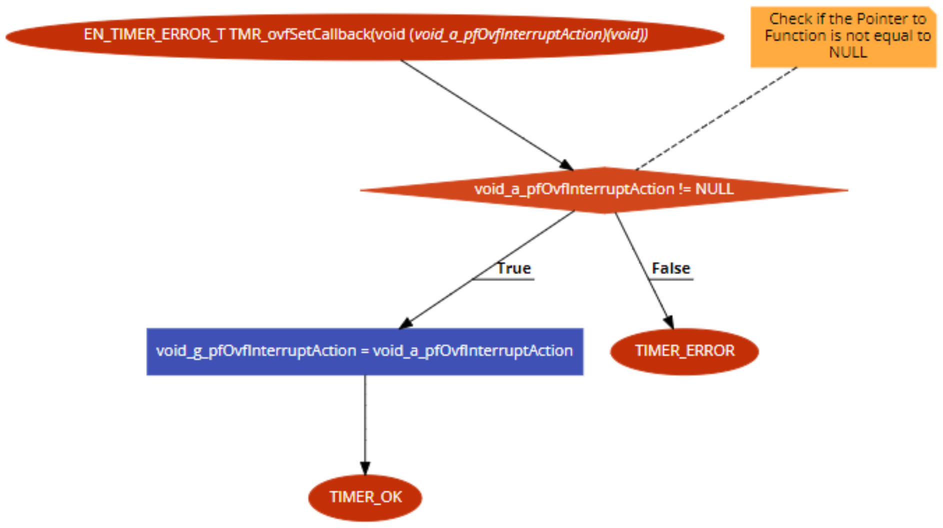
EN_TIMER_ERROR_T TMR_TMR0NormalModeInit(EN_TIMER_INTERRPUT_T en_a_interrputEnable)


EN_TIMER_ERROR_T TMR_TMR0NormalModeInit(EN_TIMER_INTERRPUT_T en_a_interrputEnable)
en_a_interrputEnable
select the normal mode for the TMR, TMR is not start yet.
select the normal mode for the TMR, TMR is not start yet.
ENABLED
DISABLED
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_WGM00_BIT)
TIMER_ERROR
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_WGM00_BIT)
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_WGM01_BIT)
Enable the global interrupt enable bit.
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_WGM01_BIT)
Set the interrupt flag
SET_BIT(TMR_U8_SREG_REG, GLOBAL_INTERRUPT_ENABLE_BIT)
Enable the interrupt for TMR0 overflow.
u8_l_mode = POLLING
SET_BIT(TMR_U8_TIMSK_REG, TMR_U8_TOIE0_BIT)
Set the interrupt flag
u8_l_mode = INTERRUPT
TIMER_OK

EN_TIMER_ERROR_T TIMER_timer0Stop(void)

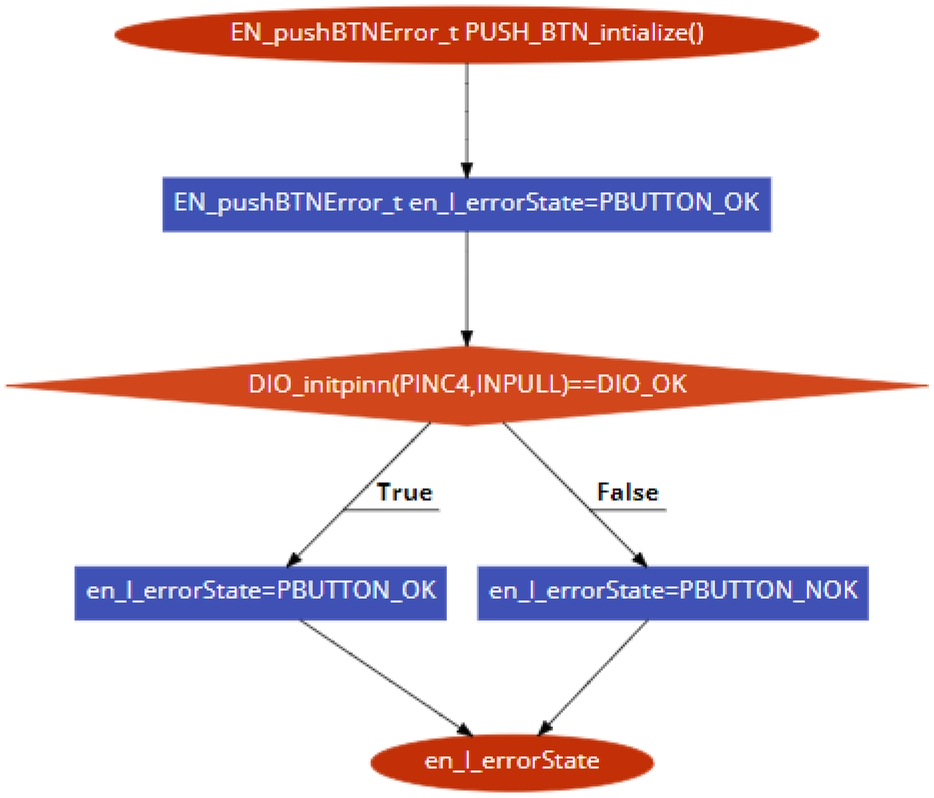

void TIMER_timer0Stop(void)
Stop the TMR by clearing the prescaler
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_CS00_BIT)
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_CS01_BIT)
CLEAR_BIT(TMR_U8_TCCR0_REG, TMR_U8_CS02_BIT)

EN_TIMER_ERROR_T TMR_ovfSetCallback(void (*void_a_pfOvfInterruptAction)(void))

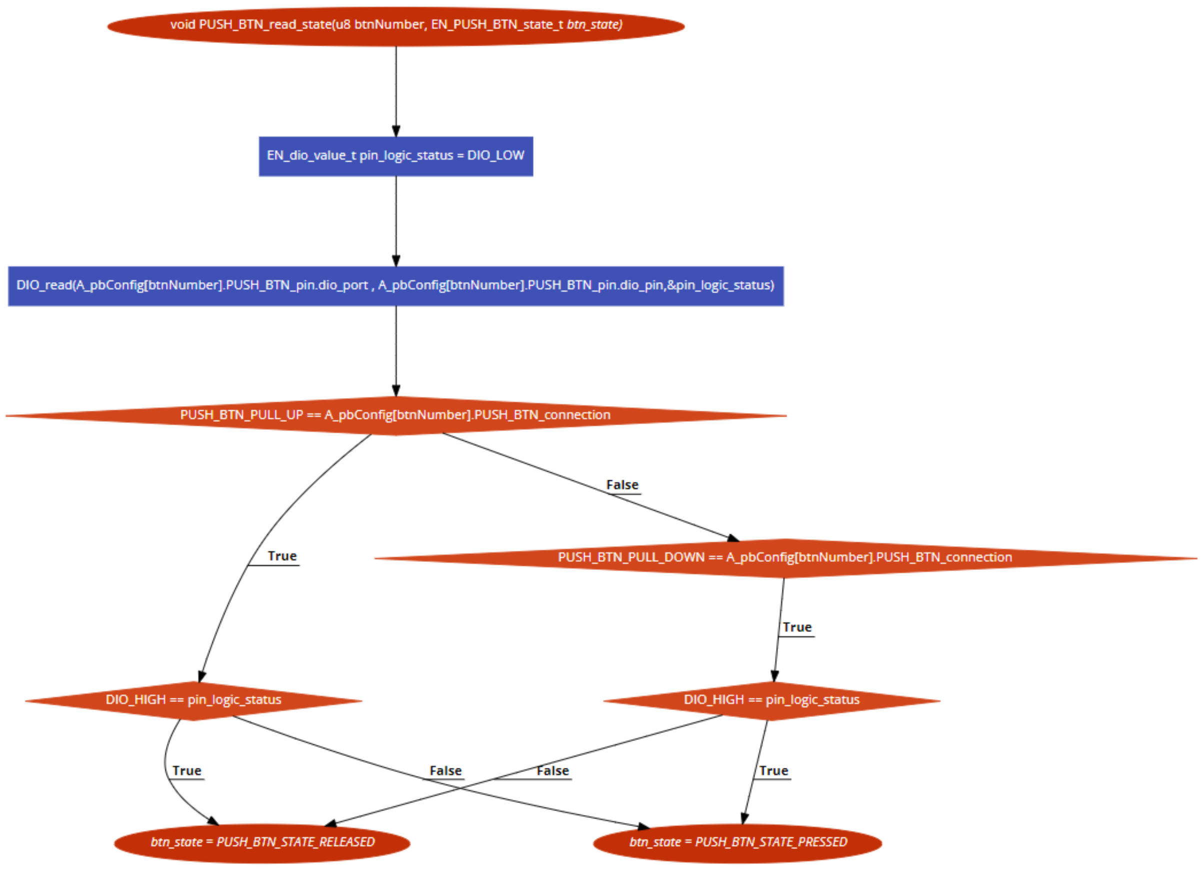

EN_TIMER_ERROR_T TMR_ovfSetCallback(void (void_a_pfOvfInterruptAction)(void))
Check if the Pointer to Function is not equal to NULL
void_a_pfOvfInterruptAction != NULL
True
False
void_g_pfOvfInterruptAction = void_a_pfOvfInterruptAction
TIMER_ERROR
TIMER_OK

3.1.3 Push Button:

EN_pushBTNError_t PUSH_BTN_intialize()

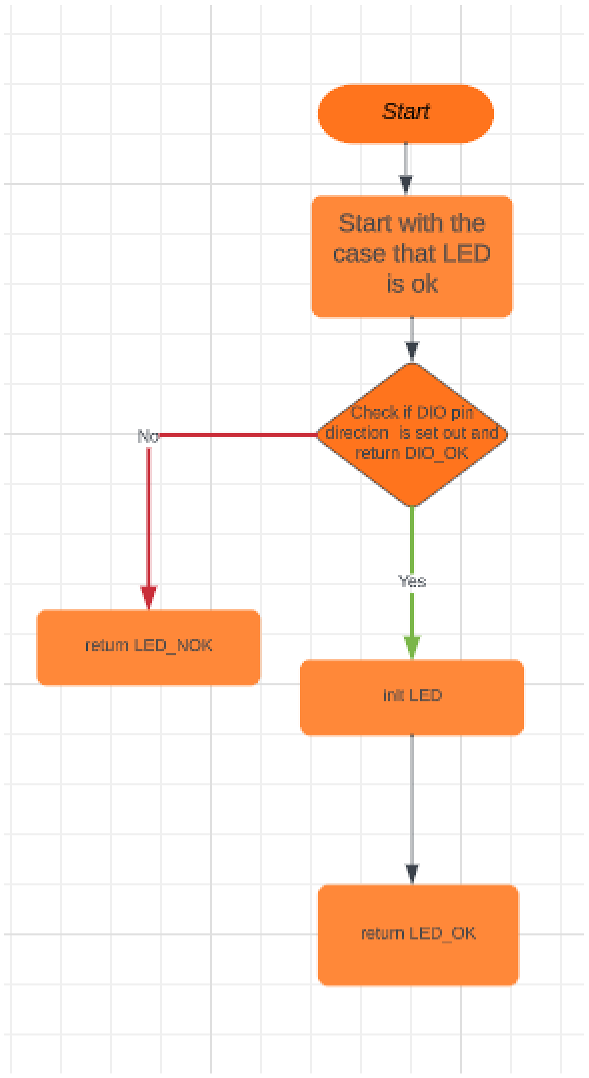

EN_pushBTNError_t PUSH_BTN_intialize()
EN_pushBTNError_t en_l_errorState=PBUTTON_OK
DIO_initpinn(PINC4,INPULL)==DIO_OK
True
False
en_l_errorState=PBUTTON_OK
en_l_errorState=PBUTTON_NOK
en_l_errorState

EN_pushBTNError_t PUSH_BTN_read_state(u8 btnNumber, EN_PUSH_BTN_state_t *btn_state)

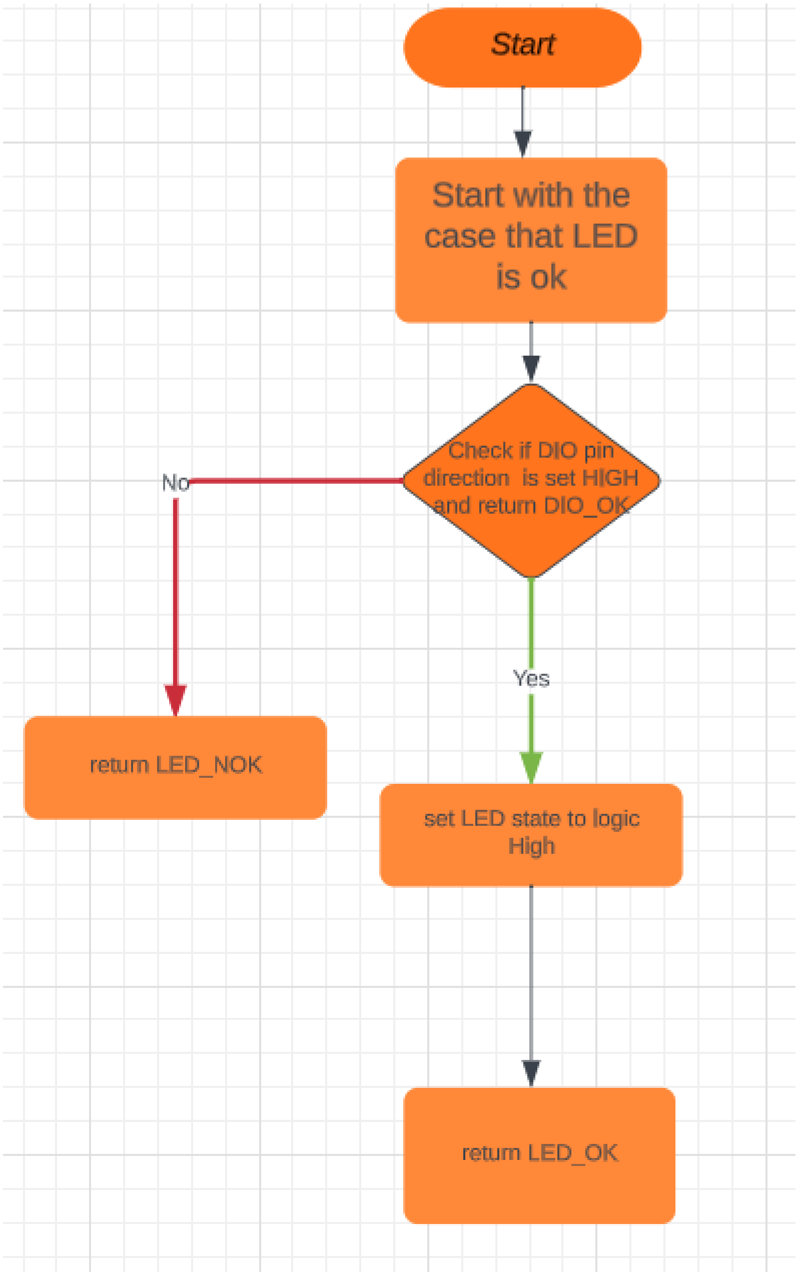

void PUSH_BTN_read_state(u8 btnNumber, EN_PUSH_BTN_state_t *btn_state)*
EN_dio_value_t pin_logic_status = DIO_LOW
DIO_read(A_pbConfig[btnNumber].PUSH_BTN_pin.dio_port , A_pbConfig[btnNumber].PUSH_BTN_pin.dio_pin,&pin_logic_status)
PUSH_BTN_PULL_UP == A_pbConfig[btnNumber].PUSH_BTN_connection
True
False
PUSH_BTN_PULL_DOWN == A_pbConfig[btnNumber].PUSH_BTN_connection
True
DIO_HIGH == pin_logic_status
DIO_HIGH == pin_logic_status
True
False
False
True
btn_state = PUSH_BTN_STATE_RELEASED
btn_state = PUSH_BTN_STATE_PRESSED

3.1.4 LED:

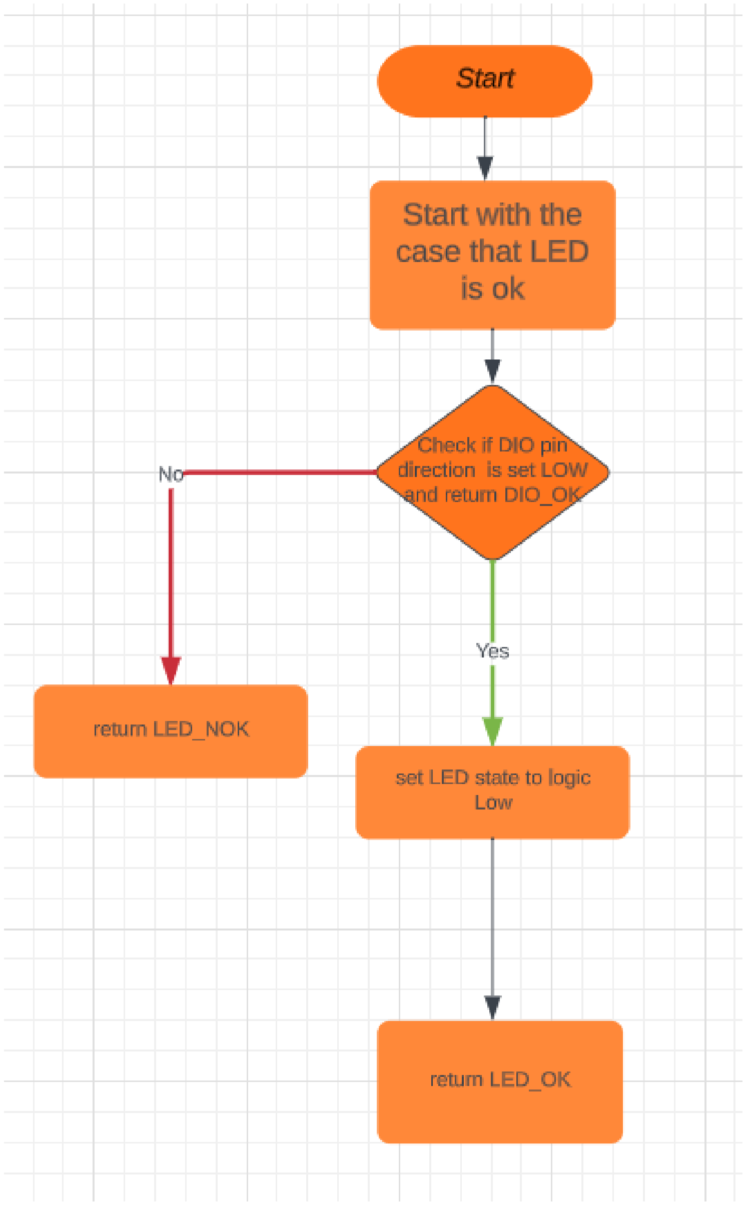
EN_ledError_t HLED_init(LEDS *led)


Start
Start with the case that LED is ok
Check if DIO pin direction is set out and return DIO_OK
No
Yes
return LED_NOK
init LED
return LED_OK

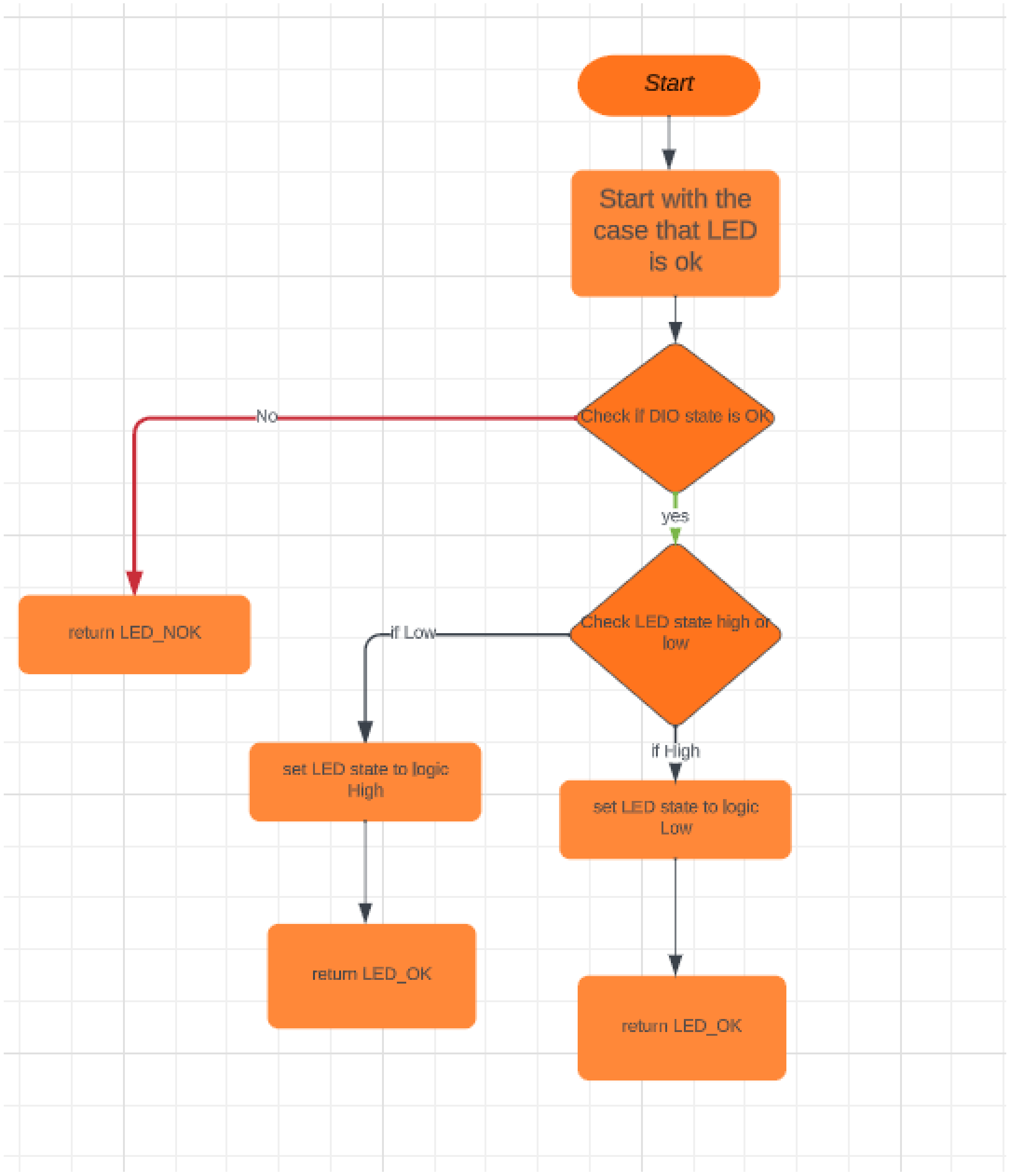
EN_ledError_t HLED_on(LEDS *led)


Start
Start with the case that LED is ok
Check if DIO pin direction is set HIGH and return DIO_OK
No
Yes
return LED_NOK
set LED state to logic High
return LED_OK

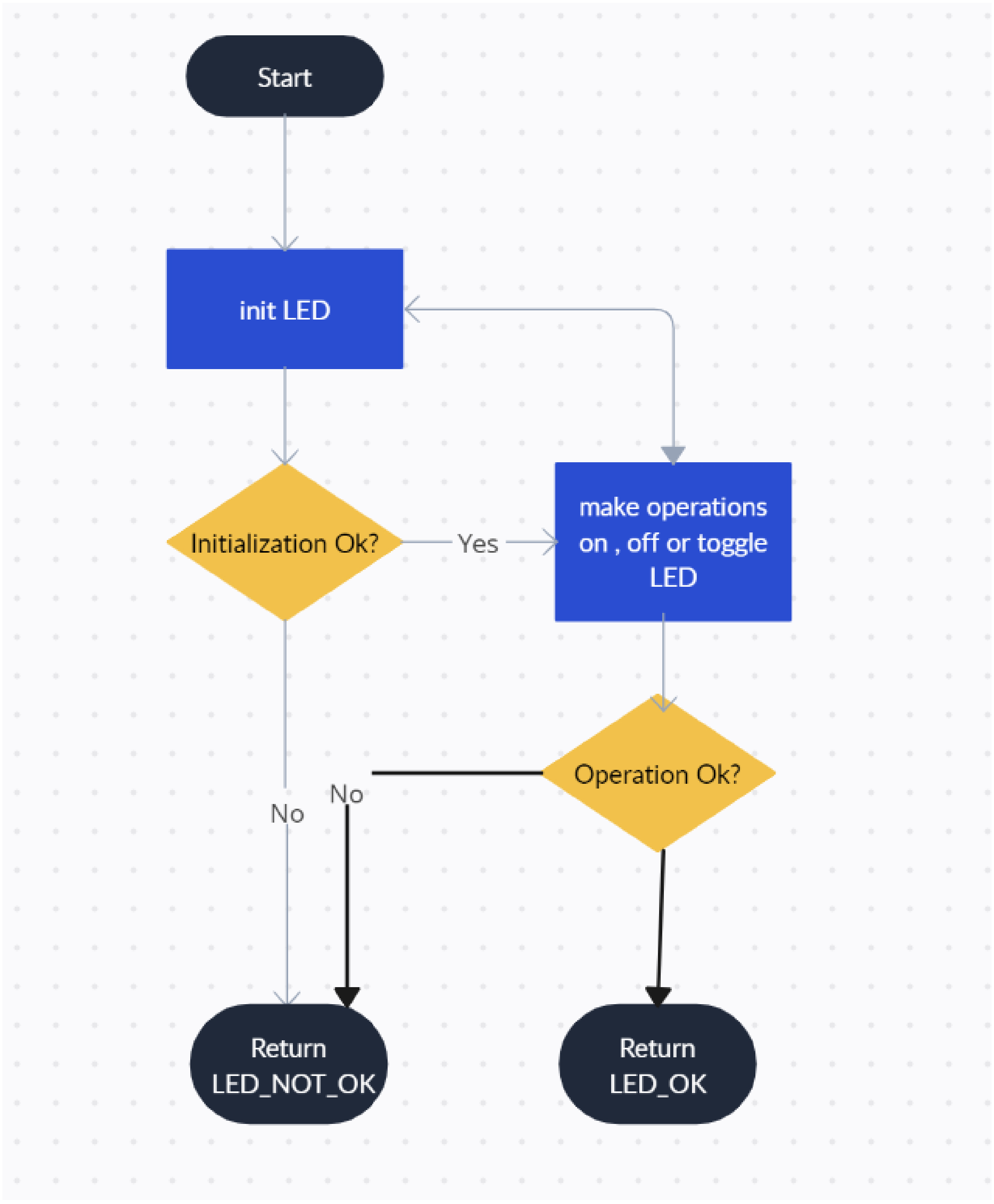
EN_ledError_t HLED_off(LEDS *led)


Start
Start with the case that LED is ok
Check if DIO pin direction is set LOW and return DIO_OK
No
Yes
return LED_NOK
set LED state to logic Low
return LED_OK

EN_ledError_t HLED_toggle(LEDS *led)

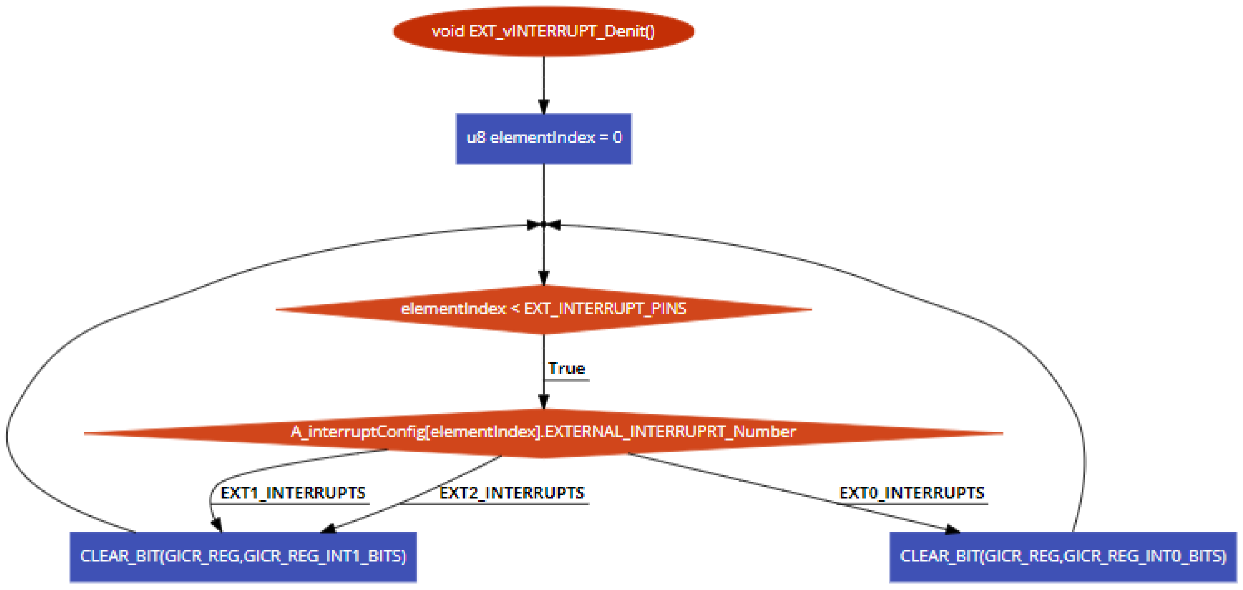

Start
Start with the case that LED is ok
Check if DIO state is OK
No
return LED_NOK
yes
Check LED state high or low
if Low
set LED state to logic High
return LED_OK
if High
set LED state to logic Low
return LED_OK

Flowchart for the whole driver:

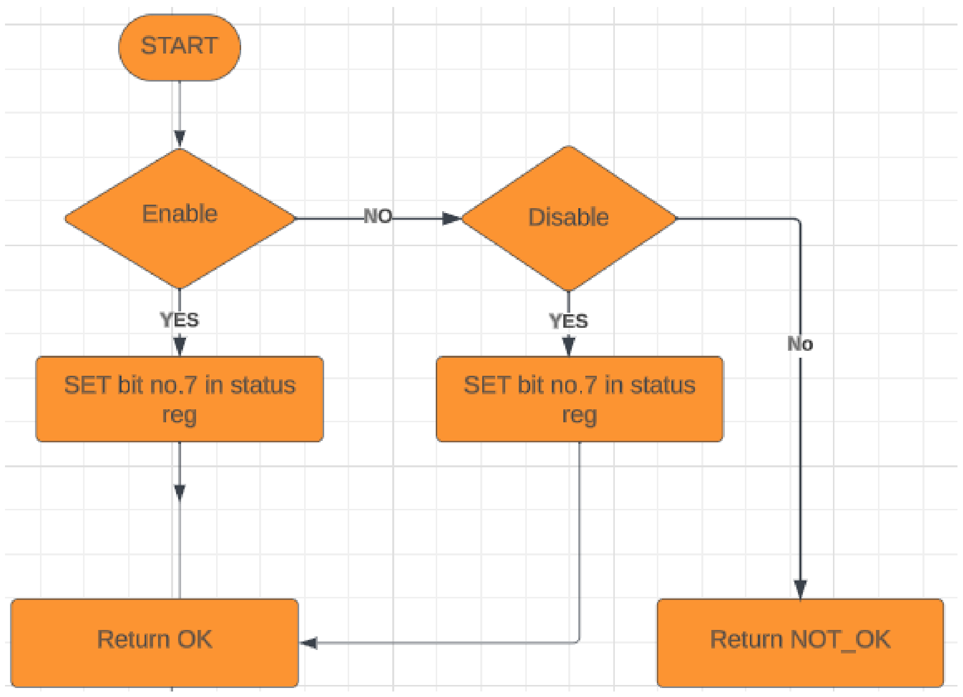


3.1.5 External Interrupt:

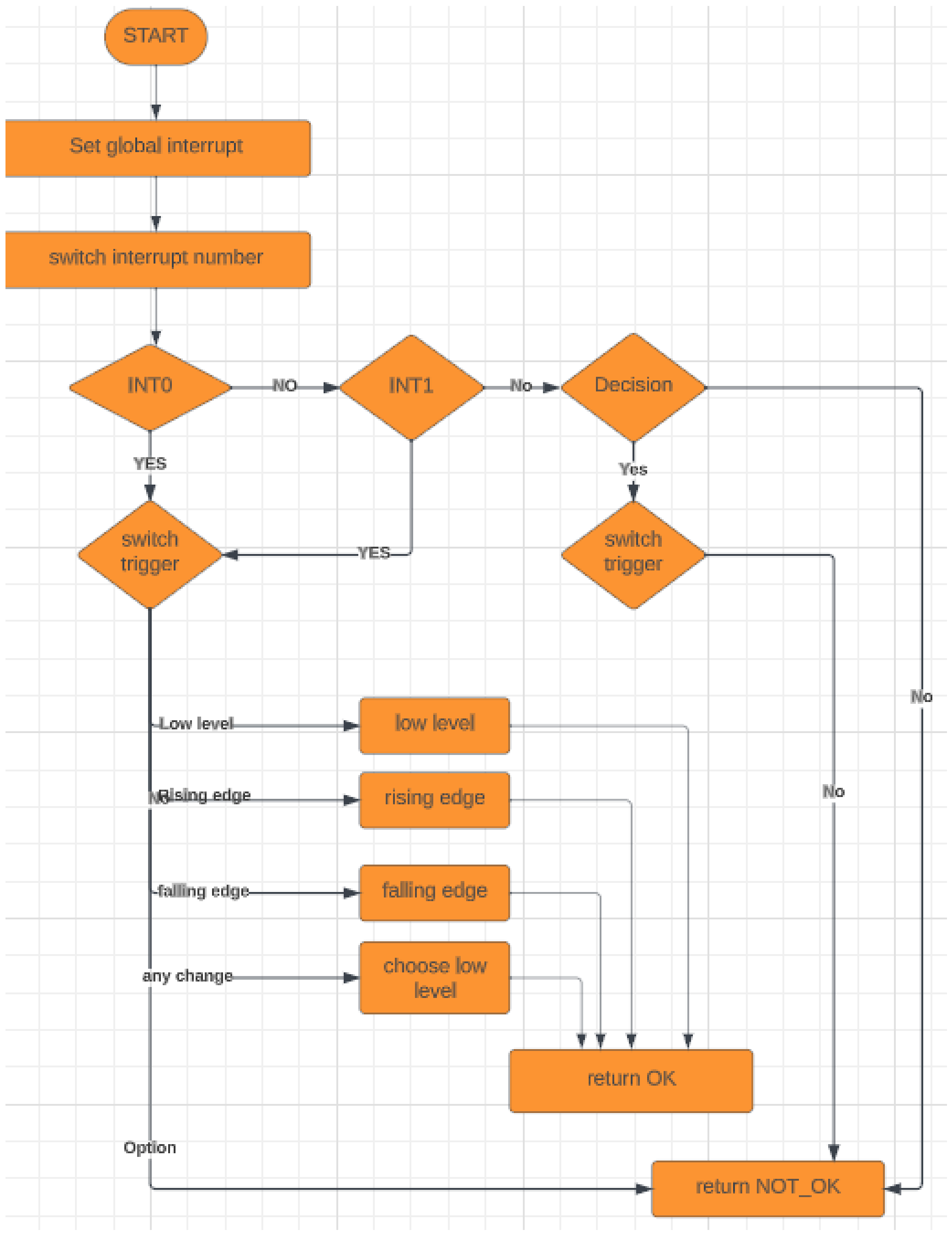
EN_EXTINT_ERROR EXT_vINTERRUPT_Denit()


void EXT_vINTERRUPT_Denit()
u8 elementIndex = 0
elementIndex < EXT_INTERRUPT_PINS
True
A_interruptConfig[elementIndex].EXTERNAL_INTERRUPRT_Number
EXT1_INTERRUPTS
EXT2_INTERRUPTS
EXT0_INTERRUPTS
CLEAR_BIT(GICR_REG,GICR_REG_INT1_BITS)
CLEAR_BIT(GICR_REG,GICR_REG_INT0_BITS)

EN_EXTINT_ERROR EXT_vINTERRUPT_Init()

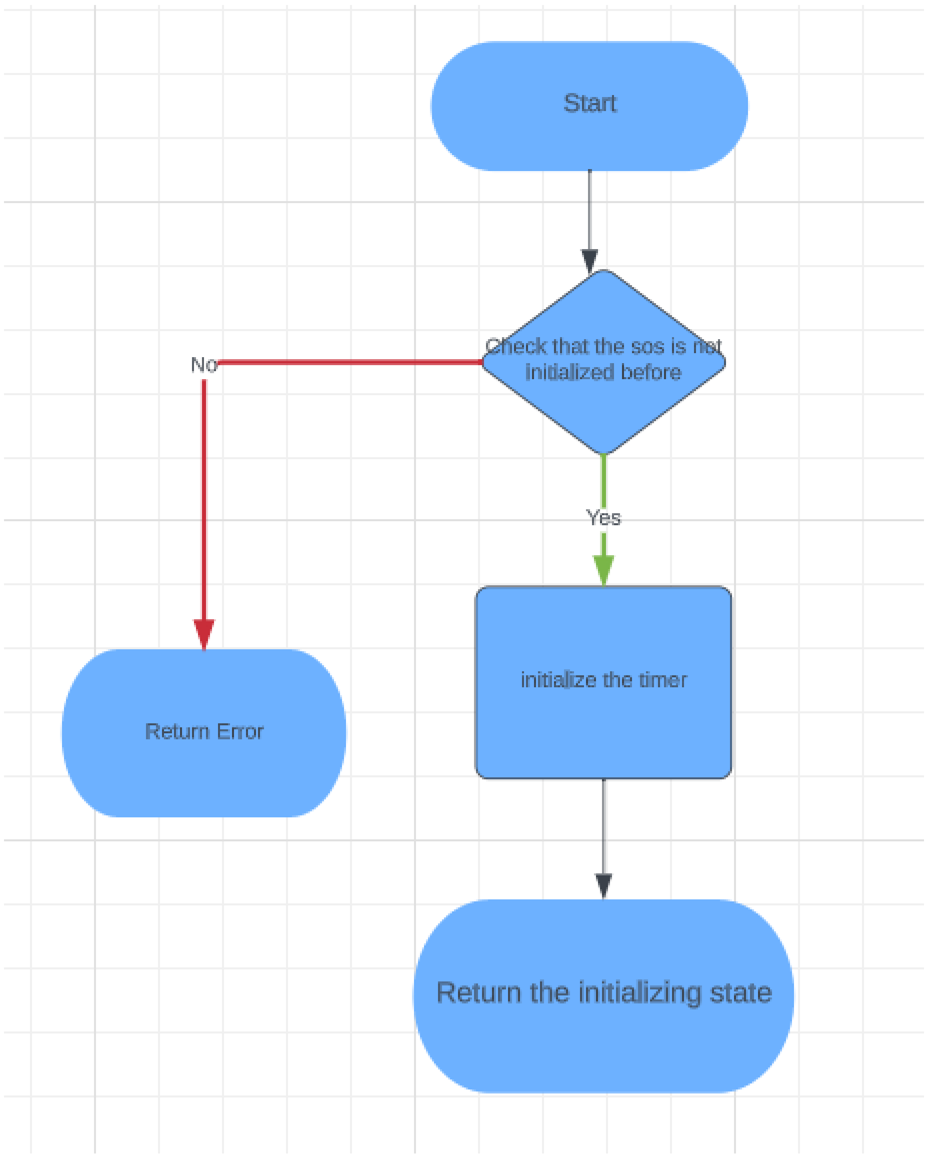


EN_EXTINT_ERROR EXTINT_init(EN_EXINT_NUMBER INTx ,EN_Sense_Control INTxSense)

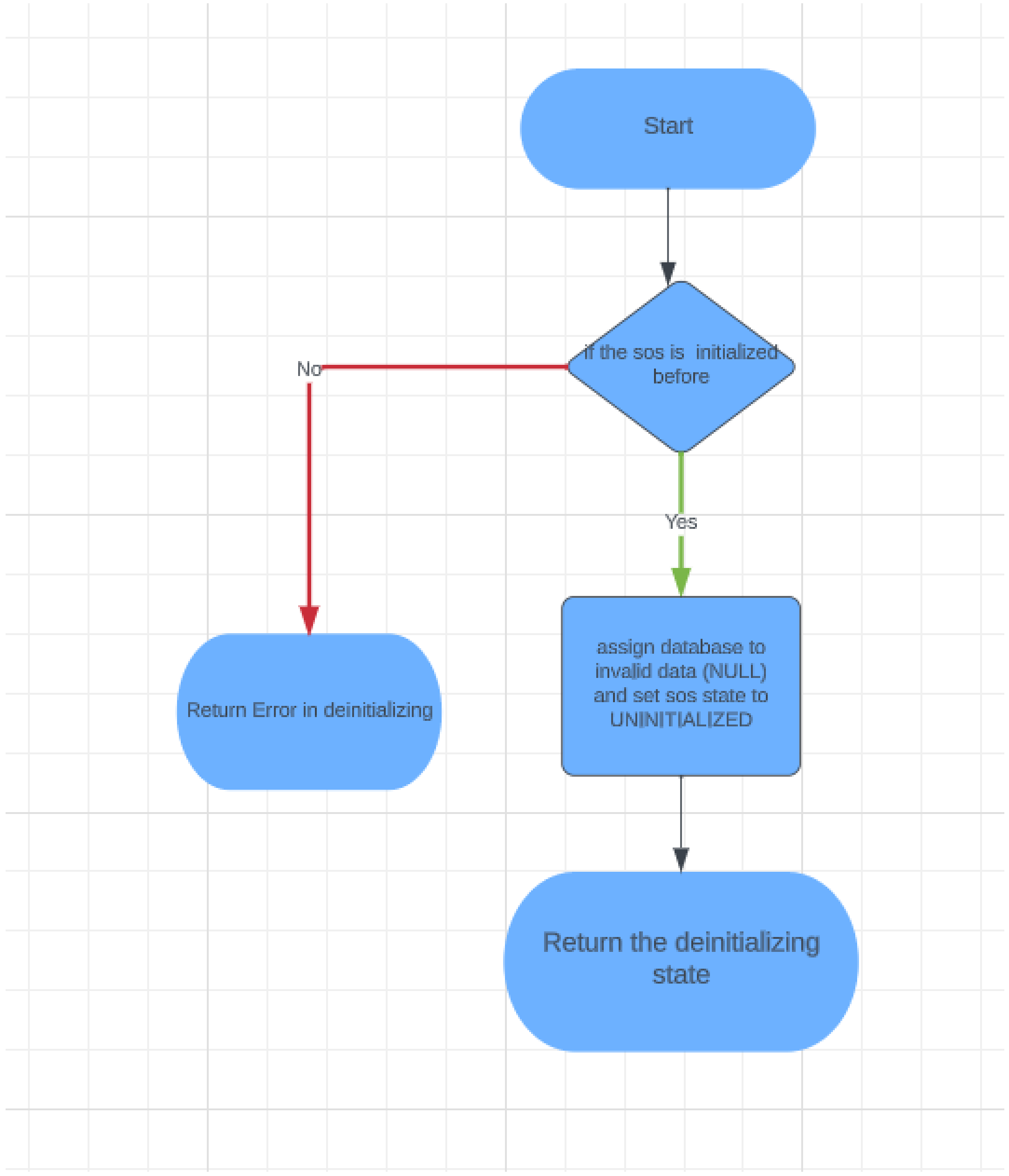


3.1.6 SOS:

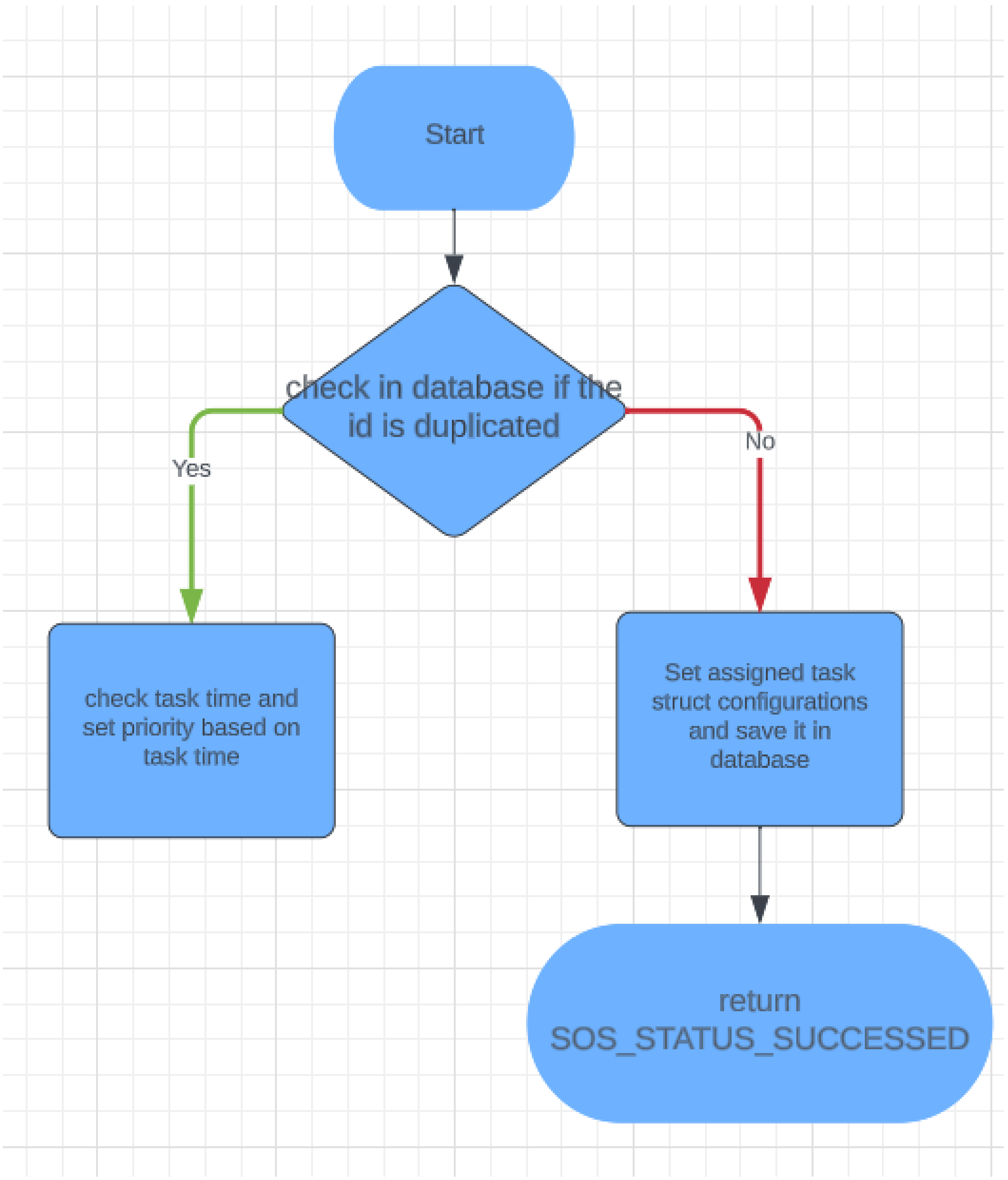
enu_sosErrorState_t sos_init (void);


Start
Check that the sos is not initialized before
No
Yes
Return Error
initialize the timer
Return the initializing state

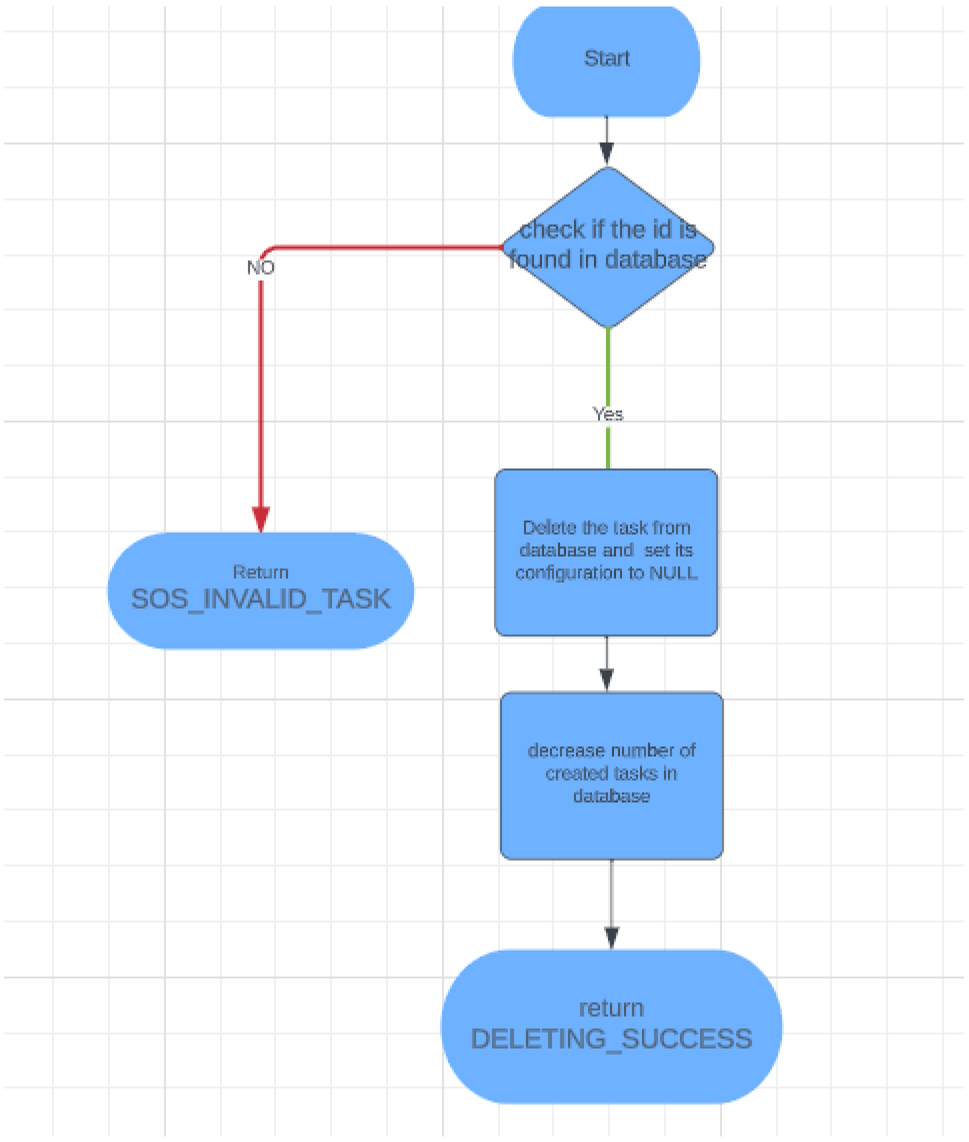
enu_sosErrorState_t sos_deinit (void);


Start
if the sos is initialized before
No
Yes
Return Error in deinitializing
assign database to invalid data (NULL) and set sos state to UNINITIALIZED
Return the deinitializing state

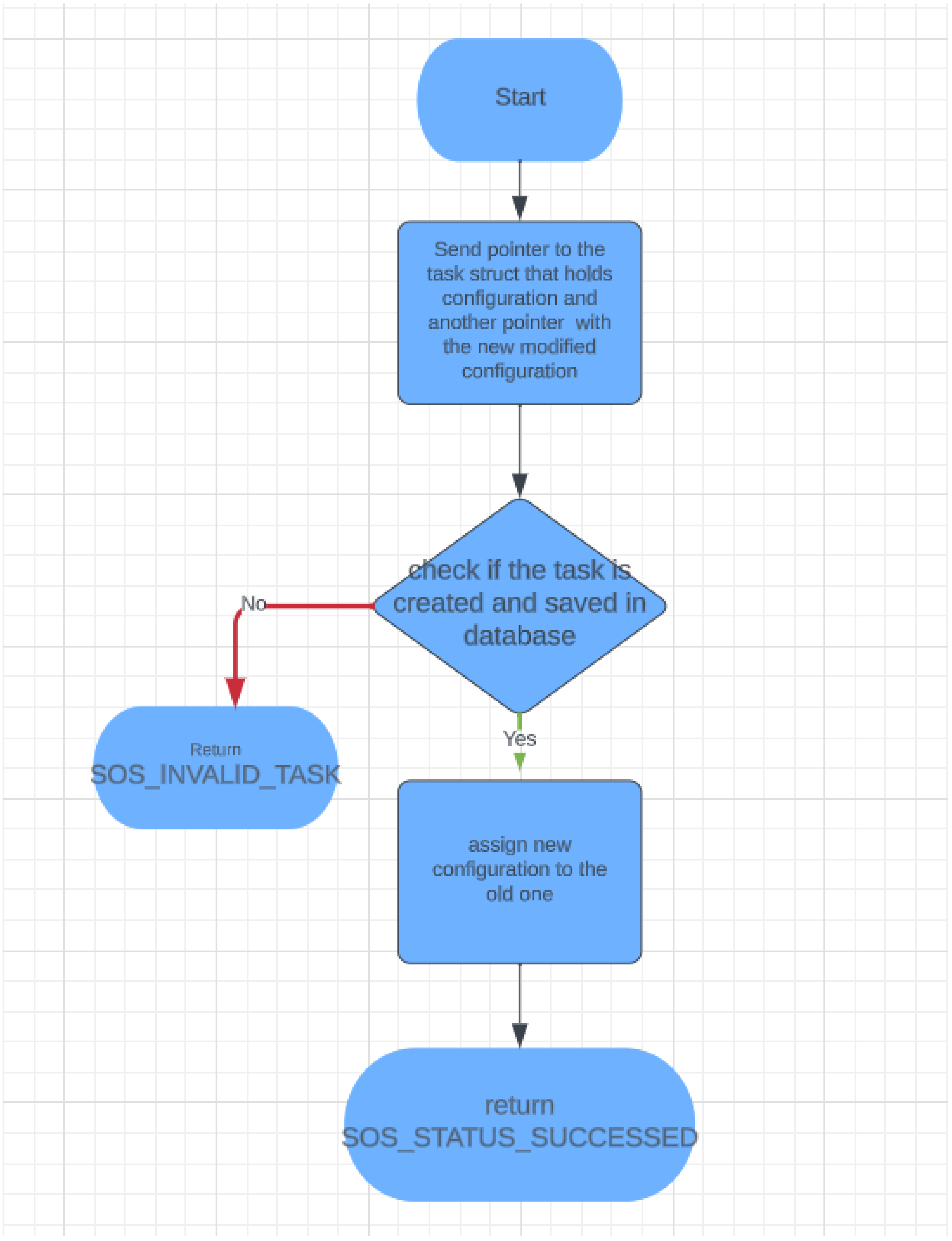
enu_sosErrorState_t sos_create_task(str_sosTask_t *ptr_str_sosTask);


Start
check in database if the id is duplicated
Yes
No
check task time and set priority based on task time
Set assigned task struct configurations and save it in database
return SOS_STATUS_SUCCESSED

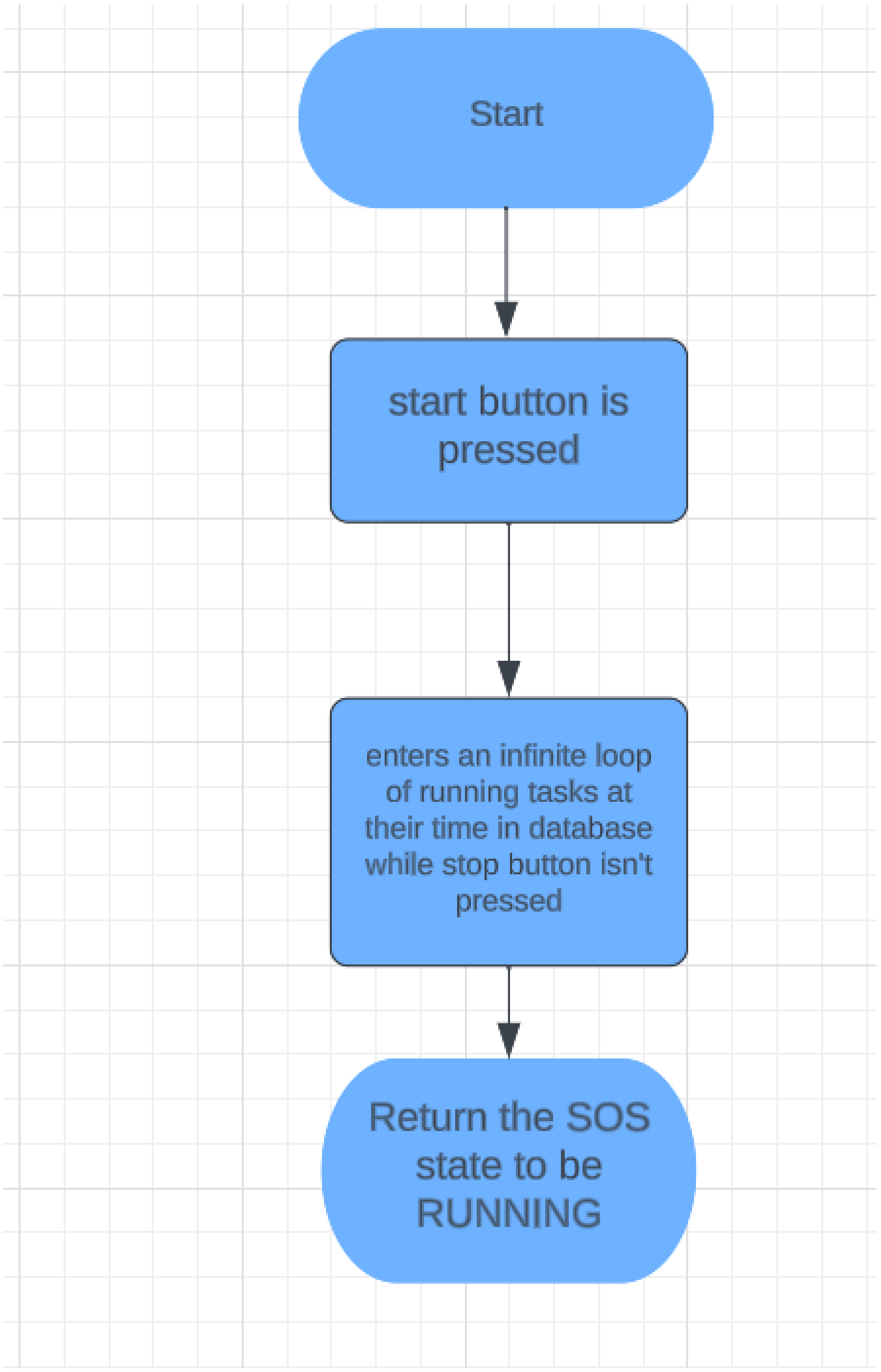
enu_sosErrorState_t sos_delete_task (uint8_t u8_a_task_id);


Start
check if the id is found in database
NO
Yes
Return SOS_INVALID_TASK
Delete the task from database and set its configuration to NULL
decrease number of created tasks in database
return DELETING_SUCCESS

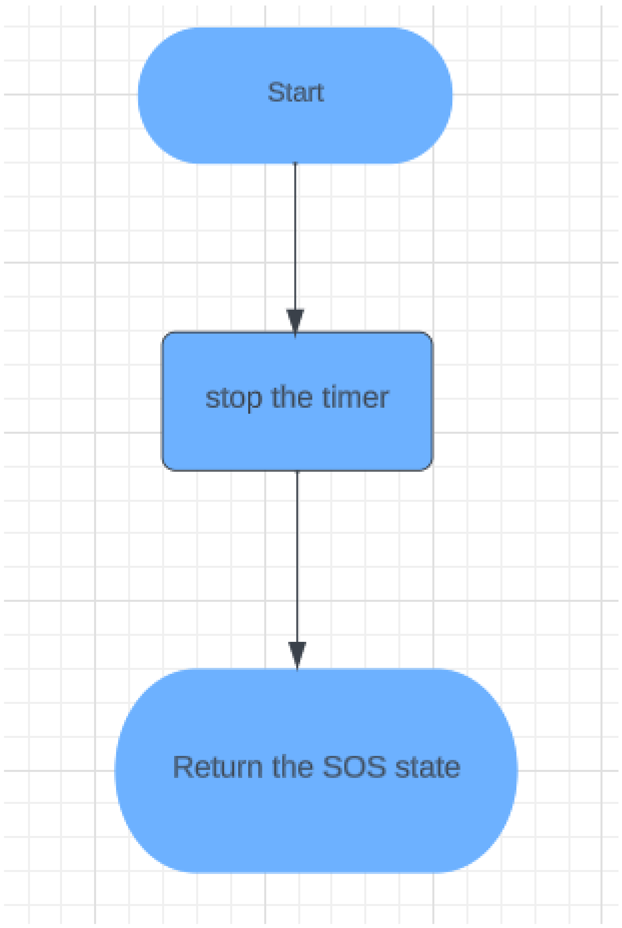
enu_sosErrorState_t sos_modify_task (str_sosTask_t *ptr_str_sosTask,str_sosTask_t *ptr_str_sosModTask);


Start
Send pointer to the task struct that holds configuration and another pointer with the new modified configuration
check if the task is created and saved in database
No
Return SOS_INVALID_TASK
Yes
assign new configuration to the old one
return SOS_STATUS_SUCCESSED

enu_sosErrorState_t sos_run(void);

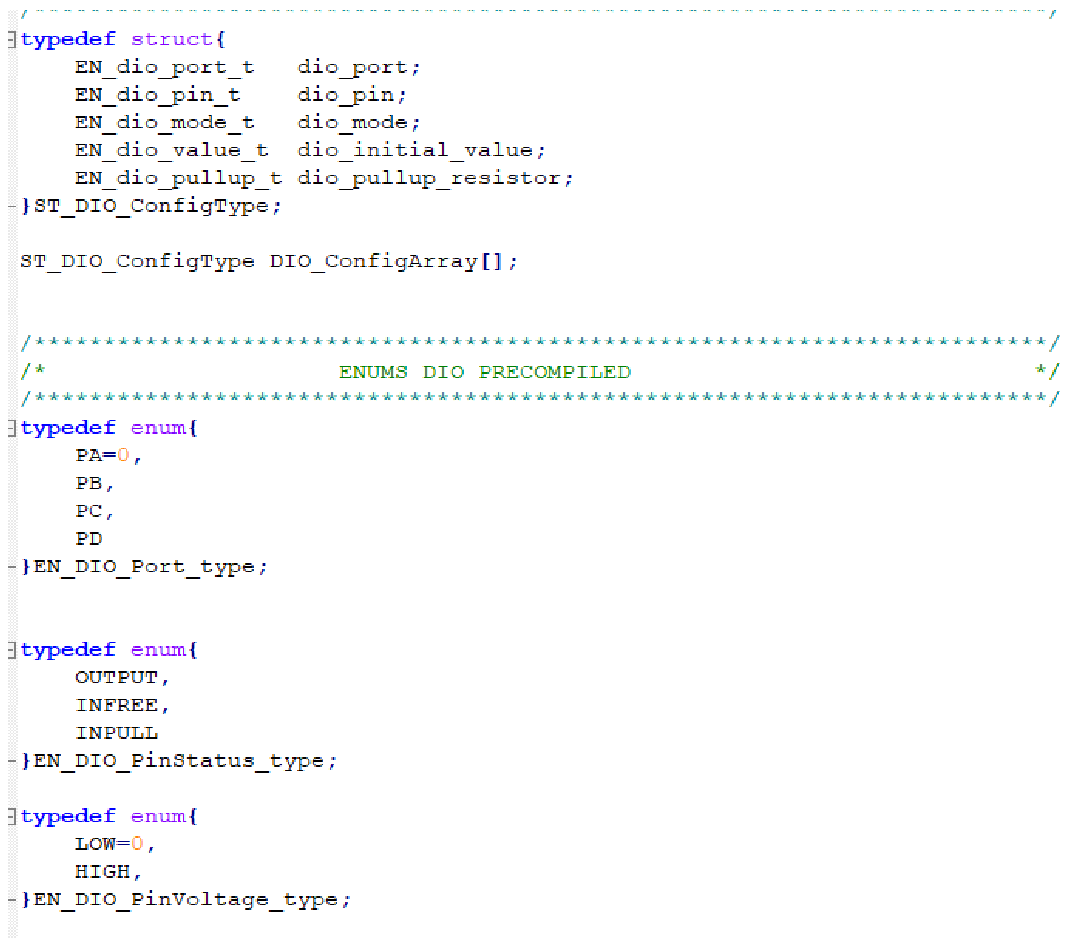

Start
start button is pressed
enters an infinite loop of running tasks at their time in database while stop button isn't pressed
Return the SOS state to be RUNNING

enu_sosErrorState_t sos_disable(void);

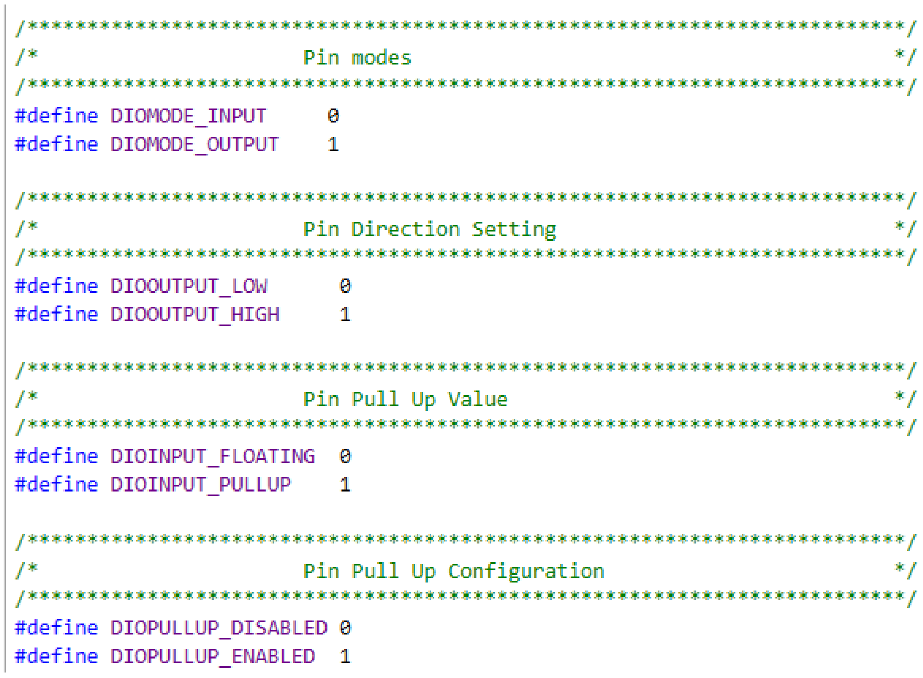


3.2 Configurations:

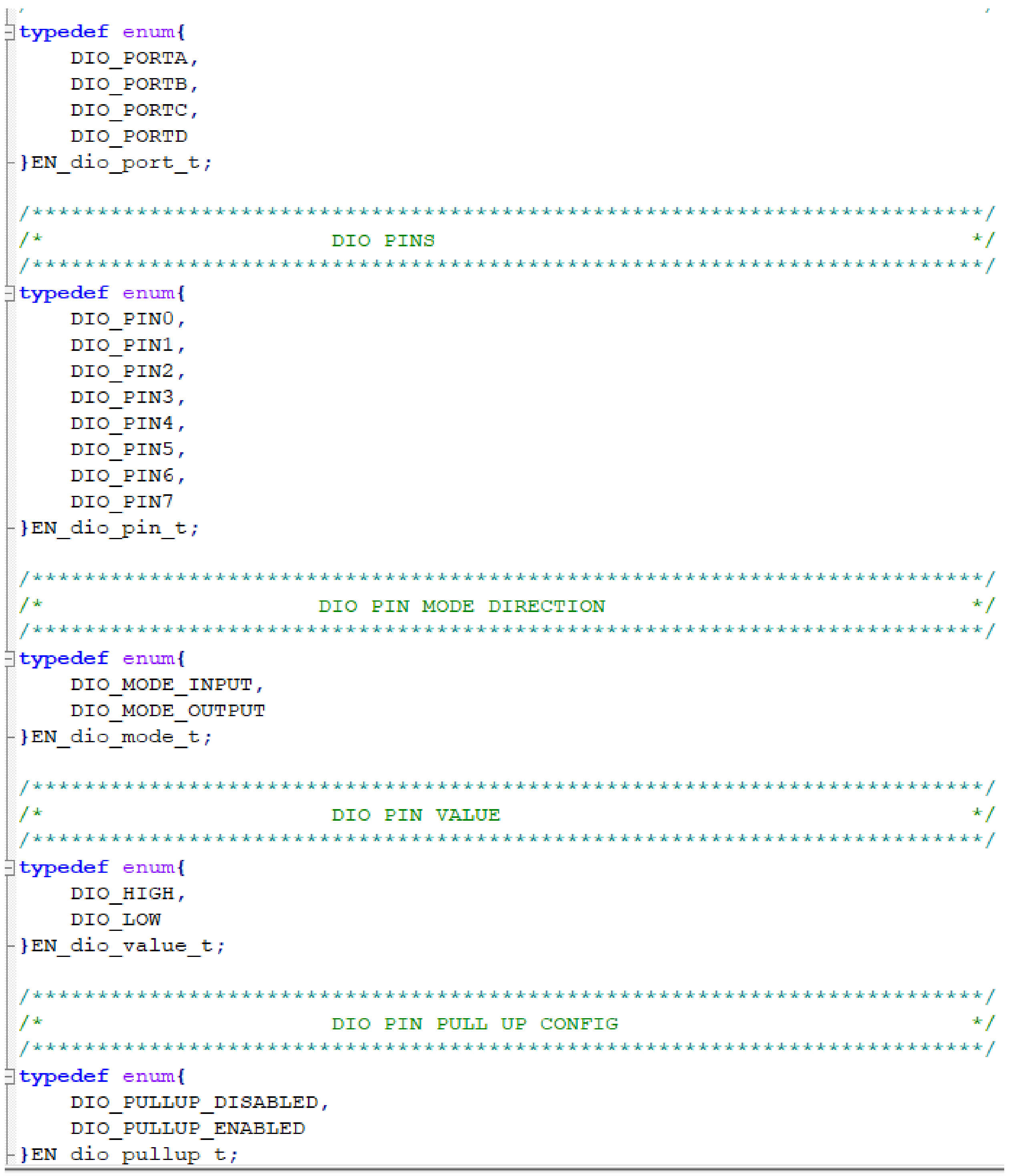
3.2.1 DIO:



```
/*************************************************************************/
typedef struct{
    EN_dio_port_t   dio_port;
    EN_dio_pin_t    dio_pin;
    EN_dio_mode_t   dio_mode;
    EN_dio_value_t  dio_initial_value;
    EN_dio_pullup_t dio_pullup_resistor;
}ST_DIO_ConfigType;

ST_DIO_ConfigType DIO_ConfigArray[];


/*************************************************************************/
/*                      ENUMS DIO PRECOMPILED                            */
/*************************************************************************/
typedef enum{
    PA=0,
    PB,
    PC,
    PD
}EN_DIO_Port_type;


typedef enum{
    OUTPUT,
    INFREE,
    INPULL
}EN_DIO_PinStatus_type;

typedef enum{
    LOW=0,
    HIGH,
}EN_DIO_PinVoltage_type;
```

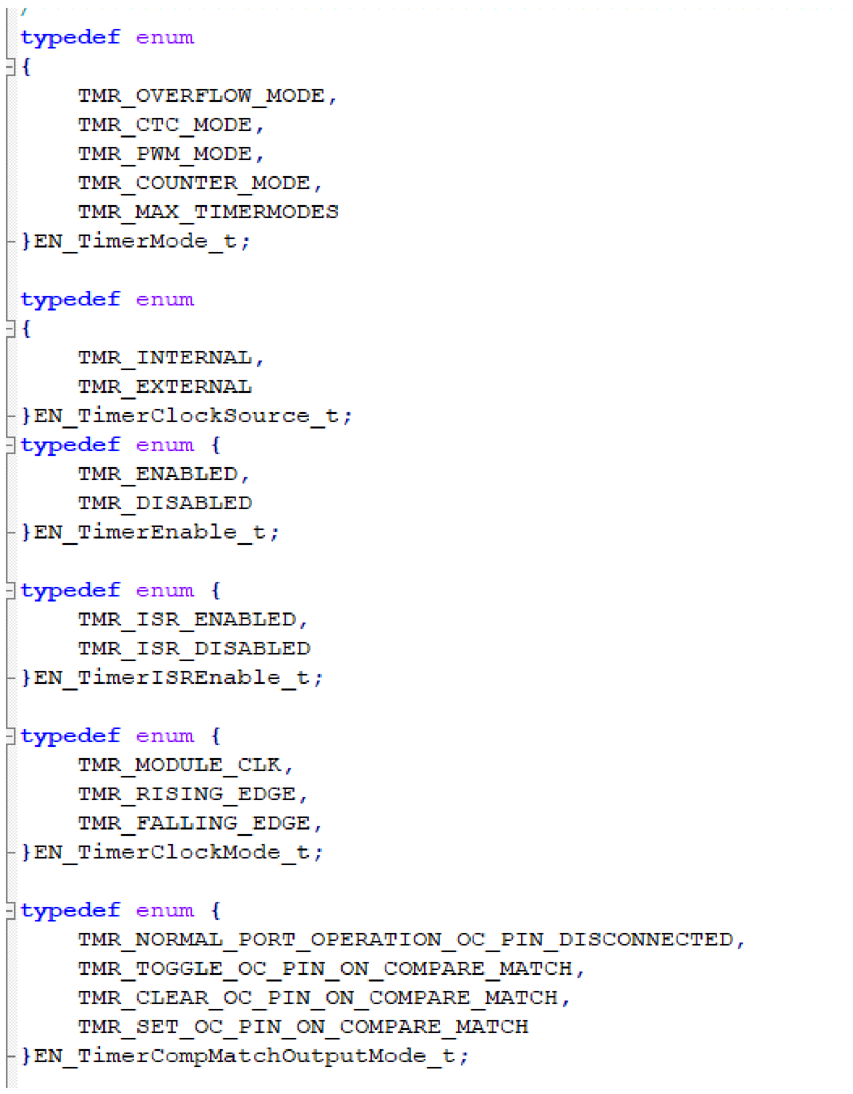


```
/*************************************************************************/
/*                      Pin modes                                        */
/*************************************************************************/
#define DIOMODE_INPUT     0
#define DIOMODE_OUTPUT    1

/*************************************************************************/
/*                      Pin Direction Setting                            */
/*************************************************************************/
#define DIOOUTPUT_LOW      0
#define DIOOUTPUT_HIGH     1

/*************************************************************************/
/*                      Pin Pull Up Value                                */
/*************************************************************************/
#define DIOINPUT_FLOATING  0
#define DIOINPUT_PULLUP    1

/*************************************************************************/
/*                      Pin Pull Up Configuration                        */
/*************************************************************************/
#define DIOPULLUP_DISABLED 0
#define DIOPULLUP_ENABLED  1
```



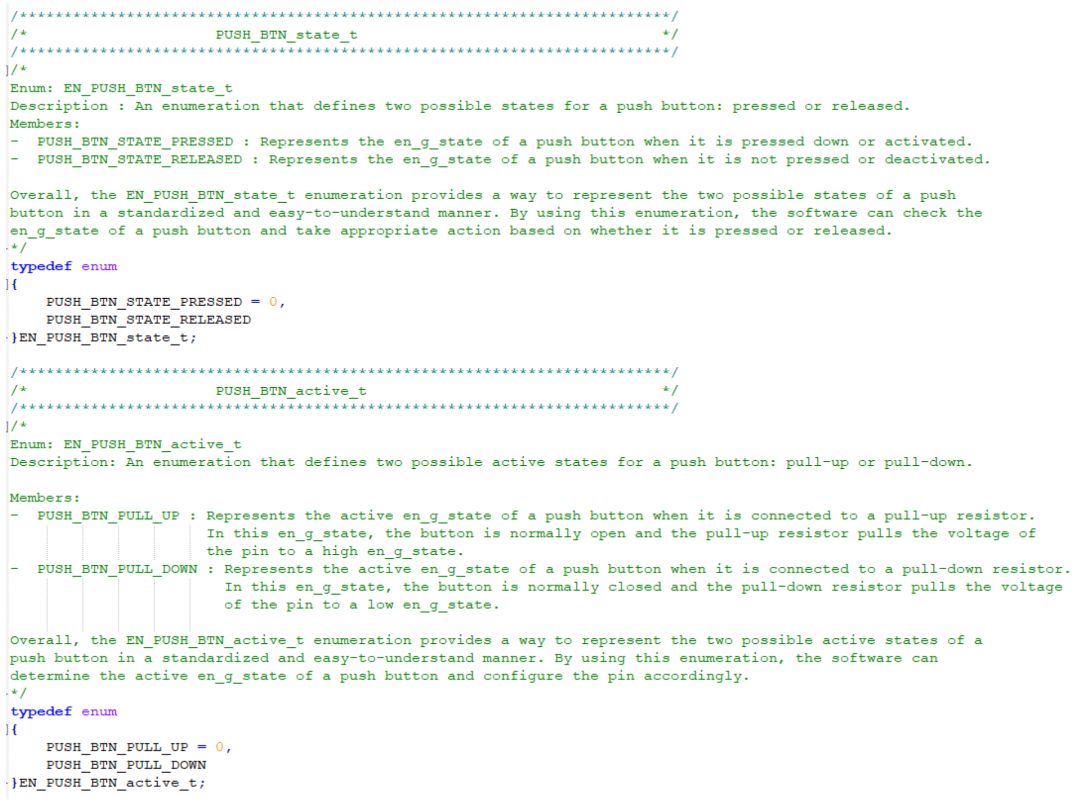
```c
typedef enum{
    DIO_PORTA,
    DIO_PORTB,
    DIO_PORTC,
    DIO_PORTD
}EN_dio_port_t;

/************************************************************************/
/*                       DIO PINS                                       */
/************************************************************************/
typedef enum{
    DIO_PIN0,
    DIO_PIN1,
    DIO_PIN2,
    DIO_PIN3,
    DIO_PIN4,
    DIO_PIN5,
    DIO_PIN6,
    DIO_PIN7
}EN_dio_pin_t;

/************************************************************************/
/*                      DIO PIN MODE DIRECTION                          */
/************************************************************************/
typedef enum{
    DIO_MODE_INPUT,
    DIO_MODE_OUTPUT
}EN_dio_mode_t;

/************************************************************************/
/*                       DIO PIN VALUE                                  */
/************************************************************************/
typedef enum{
    DIO_HIGH,
    DIO_LOW
}EN_dio_value_t;

/************************************************************************/
/*                       DIO PIN PULL UP CONFIG                         */
/************************************************************************/
typedef enum{
    DIO_PULLUP_DISABLED,
    DIO_PULLUP_ENABLED
}EN_dio_pullup_t;
```

3.2.2 Timer:

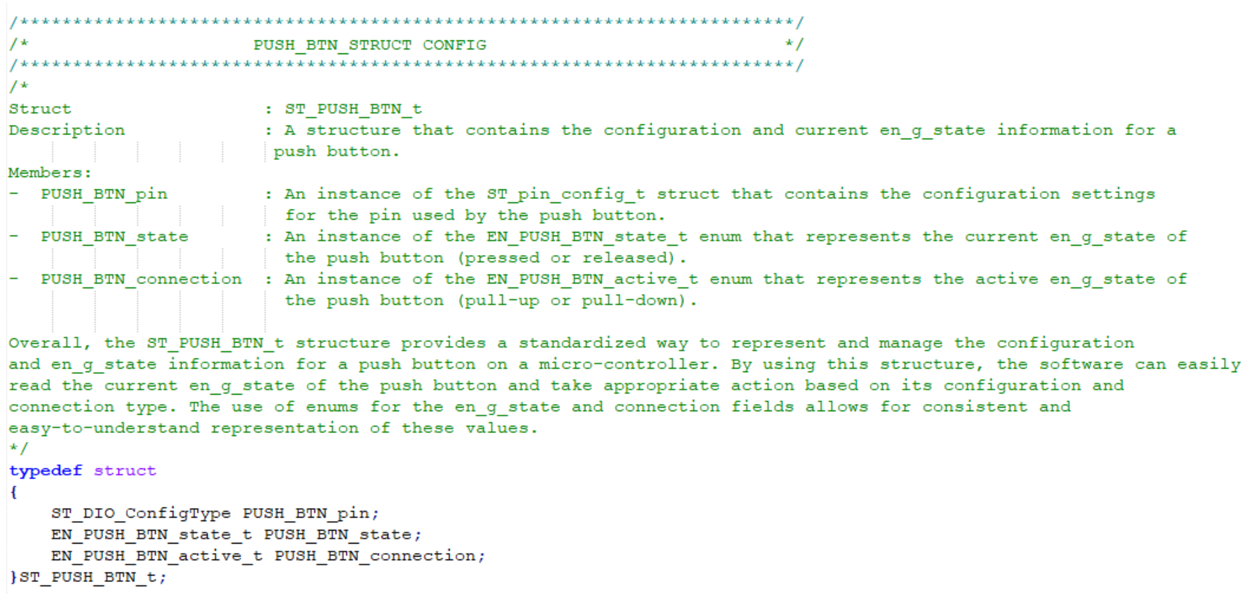


```c
typedef enum
{
    TMR_OVERFLOW_MODE,
    TMR_CTC_MODE,
    TMR_PWM_MODE,
    TMR_COUNTER_MODE,
    TMR_MAX_TIMERMODES
}EN_TimerMode_t;

typedef enum
{
    TMR_INTERNAL,
    TMR_EXTERNAL
}EN_TimerClockSource_t;
typedef enum {
    TMR_ENABLED,
    TMR_DISABLED
}EN_TimerEnable_t;

typedef enum {
    TMR_ISR_ENABLED,
    TMR_ISR_DISABLED
}EN_TimerISREnable_t;

typedef enum {
    TMR_MODULE_CLK,
    TMR_RISING_EDGE,
    TMR_FALLING_EDGE,
}EN_TimerClockMode_t;

typedef enum {
    TMR_NORMAL_PORT_OPERATION_OC_PIN_DISCONNECTED,
    TMR_TOGGLE_OC_PIN_ON_COMPARE_MATCH,
    TMR_CLEAR_OC_PIN_ON_COMPARE_MATCH,
    TMR_SET_OC_PIN_ON_COMPARE_MATCH
}EN_TimerCompMatchOutputMode_t;
```

3.2.3 Push Button:

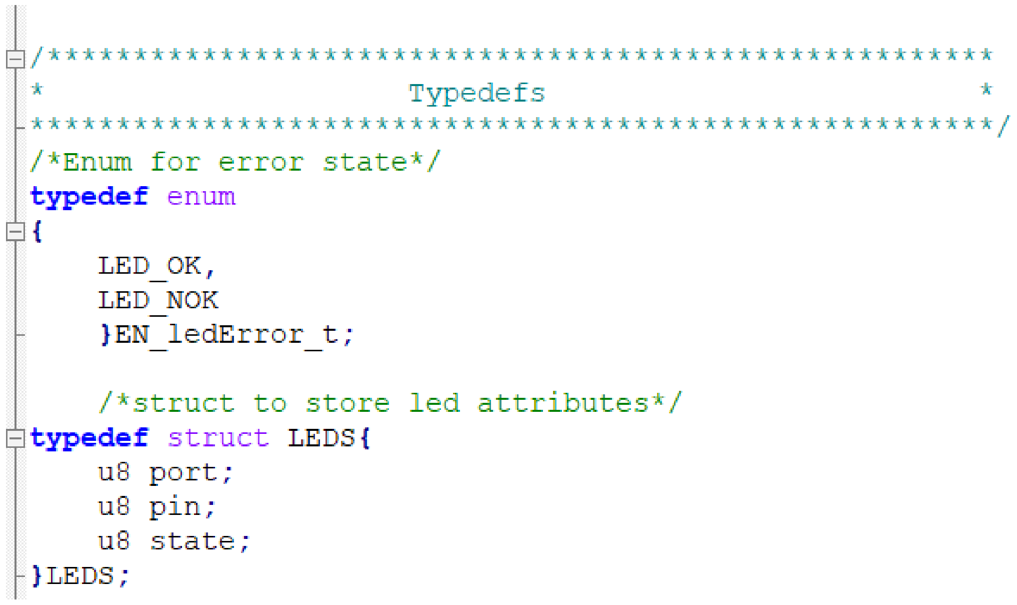


```
/*************************************************************************/
/*                      PUSH_BTN_state_t                                 */
/*************************************************************************/
/*
Enum: EN_PUSH_BTN_state_t
Description : An enumeration that defines two possible states for a push button: pressed or released.
Members:
-  PUSH_BTN_STATE_PRESSED : Represents the en_g_state of a push button when it is pressed down or activated.
-  PUSH_BTN_STATE_RELEASED : Represents the en_g_state of a push button when it is not pressed or deactivated.

Overall, the EN_PUSH_BTN_state_t enumeration provides a way to represent the two possible states of a push
button in a standardized and easy-to-understand manner. By using this enumeration, the software can check the
en_g_state of a push button and take appropriate action based on whether it is pressed or released.
*/
typedef enum
{
    PUSH_BTN_STATE_PRESSED = 0,
    PUSH_BTN_STATE_RELEASED
}EN_PUSH_BTN_state_t;

/*************************************************************************/
/*                      PUSH_BTN_active_t                                */
/*************************************************************************/
/*
Enum: EN_PUSH_BTN_active_t
Description: An enumeration that defines two possible active states for a push button: pull-up or pull-down.

Members:
-  PUSH_BTN_PULL_UP : Represents the active en_g_state of a push button when it is connected to a pull-up resistor.
                      In this en_g_state, the button is normally open and the pull-up resistor pulls the voltage of
                      the pin to a high en_g_state.
-  PUSH_BTN_PULL_DOWN : Represents the active en_g_state of a push button when it is connected to a pull-down resistor.
                        In this en_g_state, the button is normally closed and the pull-down resistor pulls the voltage
                        of the pin to a low en_g_state.

Overall, the EN_PUSH_BTN_active_t enumeration provides a way to represent the two possible active states of a
push button in a standardized and easy-to-understand manner. By using this enumeration, the software can
determine the active en_g_state of a push button and configure the pin accordingly.
*/
typedef enum
{
    PUSH_BTN_PULL_UP = 0,
    PUSH_BTN_PULL_DOWN
}EN_PUSH_BTN_active_t;
```



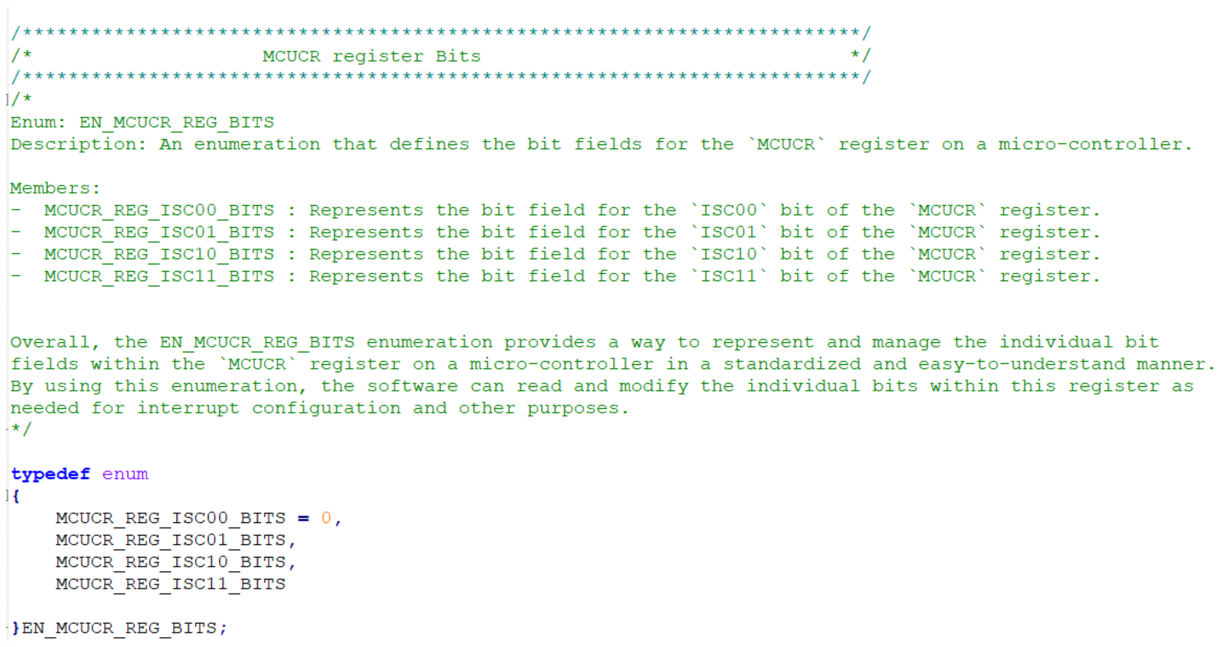
```
/*************************************************************************/
/*                      PUSH_BTN_STRUCT CONFIG                           */
/*************************************************************************/
/*
Struct                   : ST_PUSH_BTN_t
Description              : A structure that contains the configuration and current en_g_state information for a
                          push button.
Members:
-  PUSH_BTN_pin          : An instance of the ST_pin_config_t struct that contains the configuration settings
                           for the pin used by the push button.
-  PUSH_BTN_state        : An instance of the EN_PUSH_BTN_state_t enum that represents the current en_g_state of
                           the push button (pressed or released).
-  PUSH_BTN_connection   : An instance of the EN_PUSH_BTN_active_t enum that represents the active en_g_state of
                           the push button (pull-up or pull-down).

Overall, the ST_PUSH_BTN_t structure provides a standardized way to represent and manage the configuration
and en_g_state information for a push button on a micro-controller. By using this structure, the software can easily
read the current en_g_state of the push button and take appropriate action based on its configuration and
connection type. The use of enums for the en_g_state and connection fields allows for consistent and
easy-to-understand representation of these values.
*/
typedef struct
{
    ST_DIO_ConfigType PUSH_BTN_pin;
    EN_PUSH_BTN_state_t PUSH_BTN_state;
    EN_PUSH_BTN_active_t PUSH_BTN_connection;
}ST_PUSH_BTN_t;
```

3.2.4 LED:

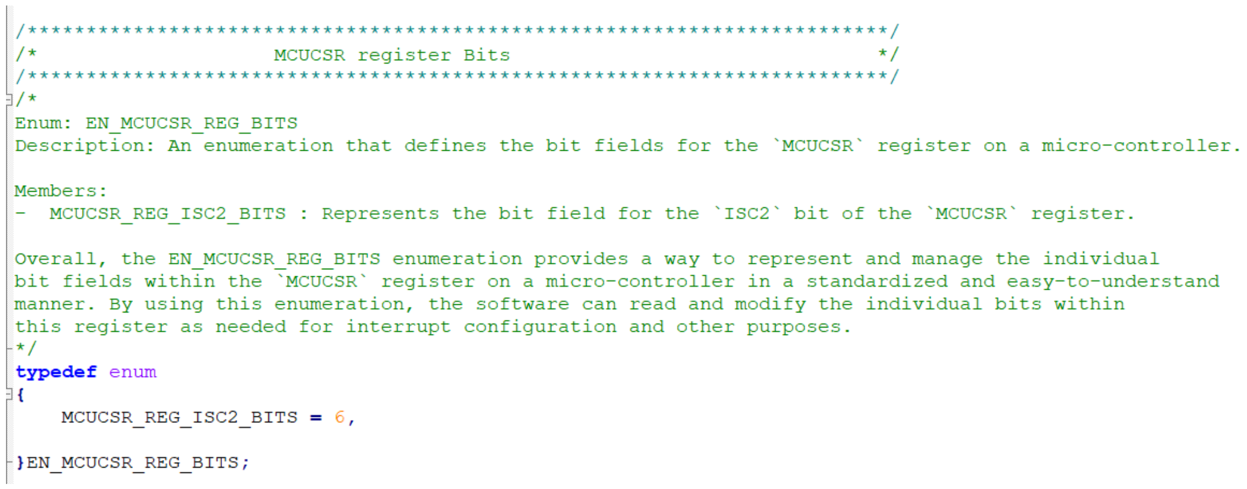


```
/*********************************************************
*                       Typedefs                          *
*********************************************************/
/*Enum for error state*/
typedef enum
{
    LED_OK,
    LED_NOK
    }EN_ledError_t;

    /*struct to store led attributes*/
typedef struct LEDS{
    u8 port;
    u8 pin;
    u8 state;
}LEDS;
```

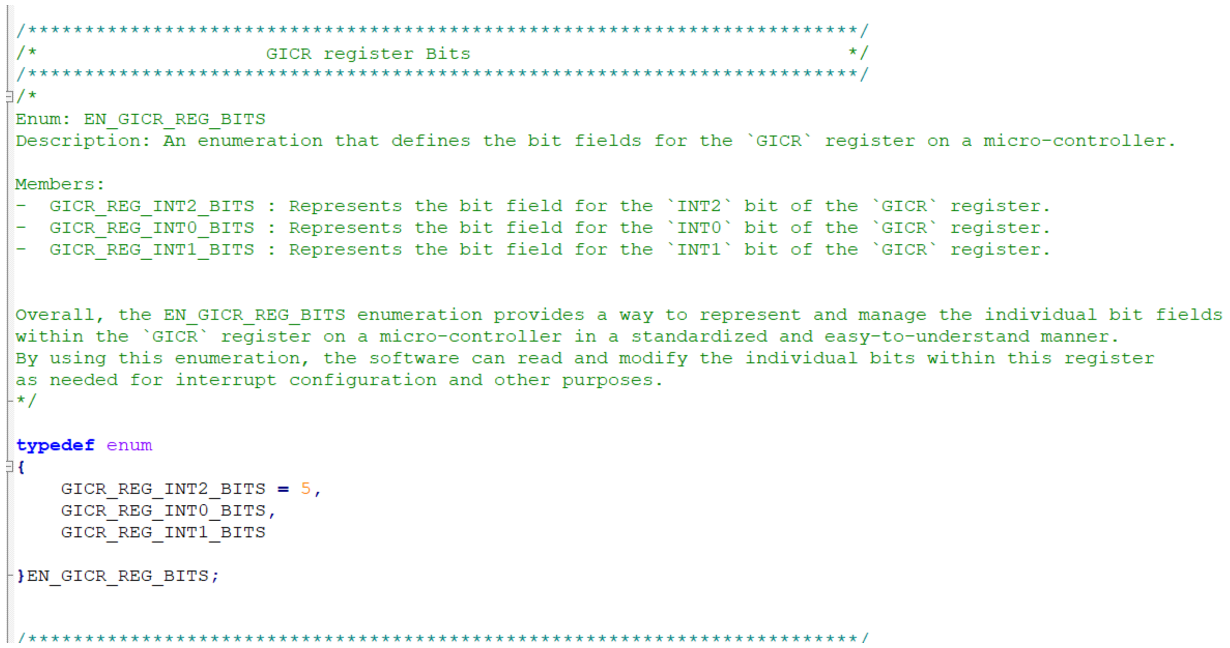
3.2.5 External Interrupt:



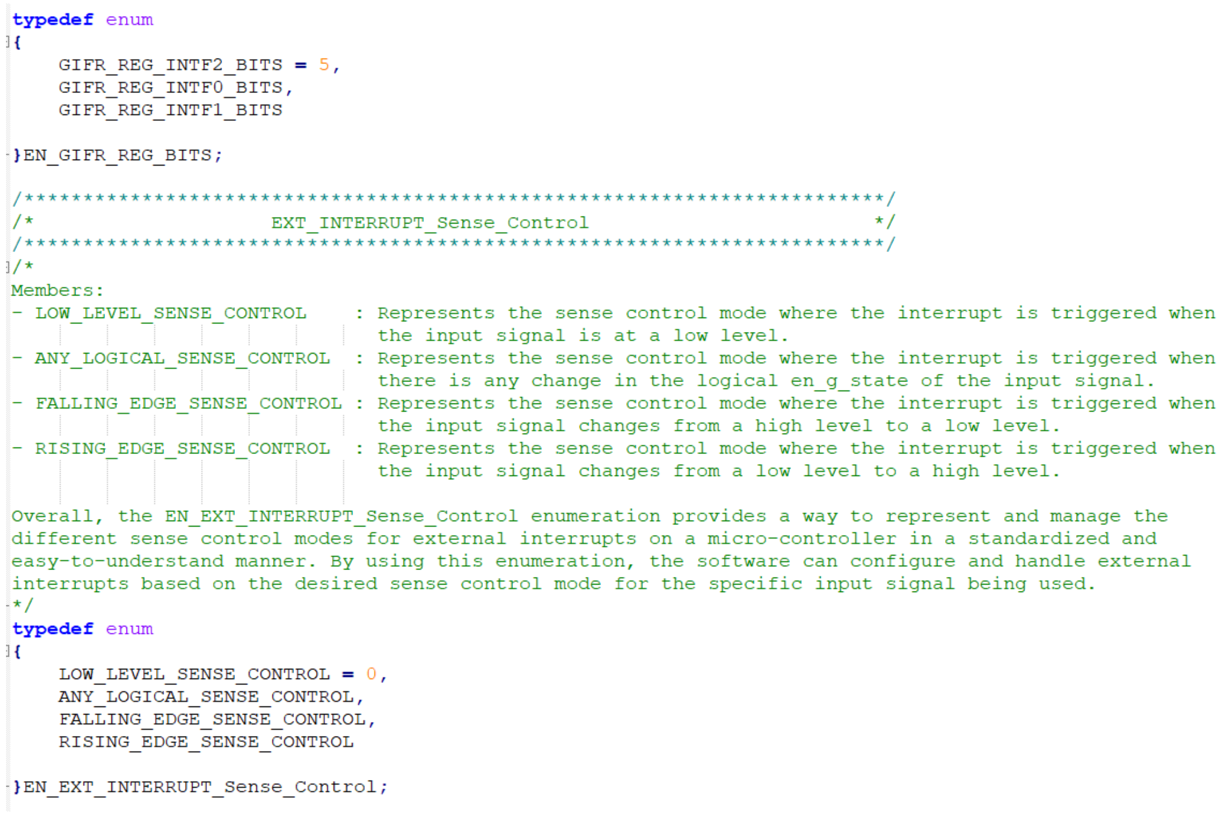
```
/****************************************************************************/
/*                    MCUCR register Bits                                   */
/****************************************************************************/
/*
Enum: EN_MCUCR_REG_BITS
Description: An enumeration that defines the bit fields for the `MCUCR` register on a micro-controller.

Members:
-  MCUCR_REG_ISC00_BITS : Represents the bit field for the `ISC00` bit of the `MCUCR` register.
-  MCUCR_REG_ISC01_BITS : Represents the bit field for the `ISC01` bit of the `MCUCR` register.
-  MCUCR_REG_ISC10_BITS : Represents the bit field for the `ISC10` bit of the `MCUCR` register.
-  MCUCR_REG_ISC11_BITS : Represents the bit field for the `ISC11` bit of the `MCUCR` register.


Overall, the EN_MCUCR_REG_BITS enumeration provides a way to represent and manage the individual bit
fields within the `MCUCR` register on a micro-controller in a standardized and easy-to-understand manner.
By using this enumeration, the software can read and modify the individual bits within this register as
needed for interrupt configuration and other purposes.
*/

typedef enum
{
    MCUCR_REG_ISC00_BITS = 0,
    MCUCR_REG_ISC01_BITS,
    MCUCR_REG_ISC10_BITS,
    MCUCR_REG_ISC11_BITS

}EN_MCUCR_REG_BITS;
```



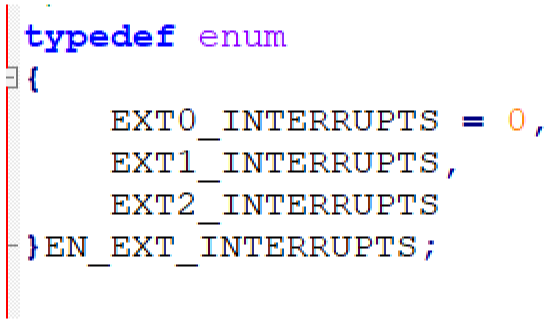
```c
/****************************************************************************/
/*                      MCUCSR register Bits                                */
/****************************************************************************/
/*
Enum: EN_MCUCSR_REG_BITS
Description: An enumeration that defines the bit fields for the `MCUCSR` register on a micro-controller.

Members:
-  MCUCSR_REG_ISC2_BITS : Represents the bit field for the `ISC2` bit of the `MCUCSR` register.

Overall, the EN_MCUCSR_REG_BITS enumeration provides a way to represent and manage the individual
bit fields within the `MCUCSR` register on a micro-controller in a standardized and easy-to-understand
manner. By using this enumeration, the software can read and modify the individual bits within
this register as needed for interrupt configuration and other purposes.
*/
typedef enum
{
    MCUCSR_REG_ISC2_BITS = 6,

}EN_MCUCSR_REG_BITS;
```



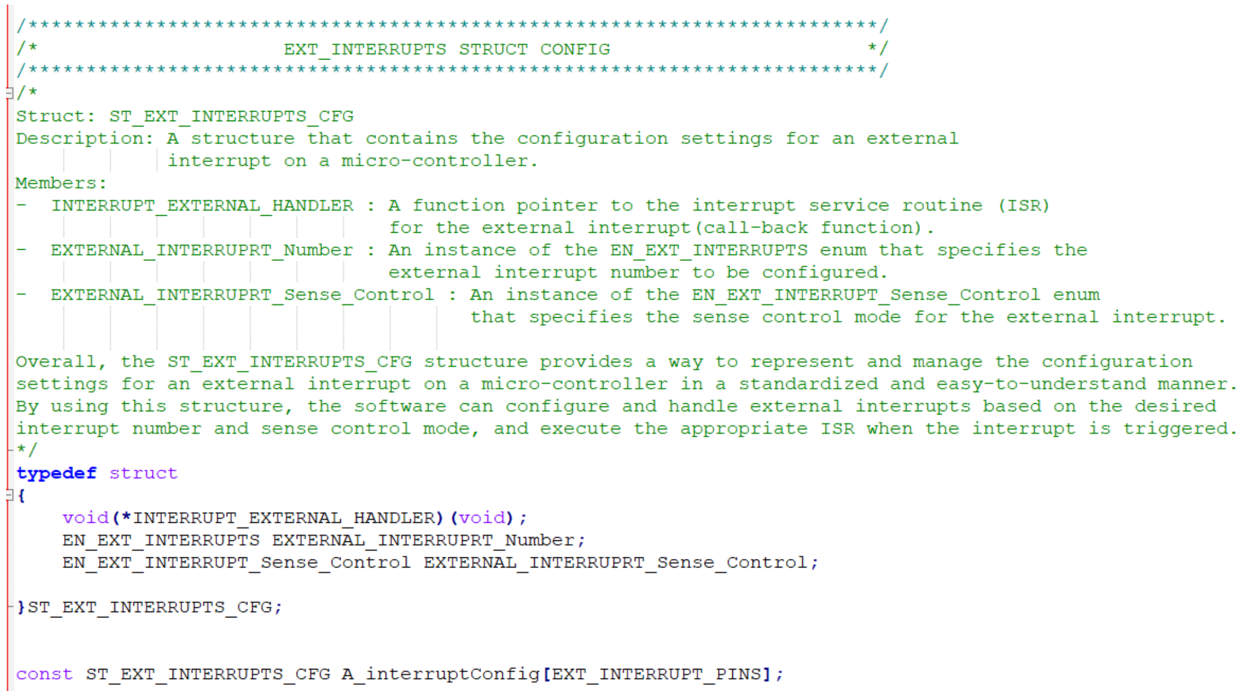
```c
/****************************************************************************/
/*                      GICR register Bits                                  */
/****************************************************************************/
/*
Enum: EN_GICR_REG_BITS
Description: An enumeration that defines the bit fields for the `GICR` register on a micro-controller.

Members:
-  GICR_REG_INT2_BITS : Represents the bit field for the `INT2` bit of the `GICR` register.
-  GICR_REG_INT0_BITS : Represents the bit field for the `INT0` bit of the `GICR` register.
-  GICR_REG_INT1_BITS : Represents the bit field for the `INT1` bit of the `GICR` register.


Overall, the EN_GICR_REG_BITS enumeration provides a way to represent and manage the individual bit fields
within the `GICR` register on a micro-controller in a standardized and easy-to-understand manner.
By using this enumeration, the software can read and modify the individual bits within this register
as needed for interrupt configuration and other purposes.
*/

typedef enum
{
    GICR_REG_INT2_BITS = 5,
    GICR_REG_INT0_BITS,
    GICR_REG_INT1_BITS

}EN_GICR_REG_BITS;


/****************************************************************************/
```



```c
typedef enum
{
    GIFR_REG_INTF2_BITS = 5,
    GIFR_REG_INTF0_BITS,
    GIFR_REG_INTF1_BITS

}EN_GIFR_REG_BITS;

/****************************************************************************/
/*                      EXT_INTERRUPT_Sense_Control                         */
/****************************************************************************/
/*
Members:
- LOW_LEVEL_SENSE_CONTROL    : Represents the sense control mode where the interrupt is triggered when
                               the input signal is at a low level.
- ANY_LOGICAL_SENSE_CONTROL  : Represents the sense control mode where the interrupt is triggered when
                               there is any change in the logical en_g_state of the input signal.
- FALLING_EDGE_SENSE_CONTROL : Represents the sense control mode where the interrupt is triggered when
                               the input signal changes from a high level to a low level.
- RISING_EDGE_SENSE_CONTROL  : Represents the sense control mode where the interrupt is triggered when
                               the input signal changes from a low level to a high level.

Overall, the EN_EXT_INTERRUPT_Sense_Control enumeration provides a way to represent and manage the
different sense control modes for external interrupts on a micro-controller in a standardized and
easy-to-understand manner. By using this enumeration, the software can configure and handle external
interrupts based on the desired sense control mode for the specific input signal being used.
*/
typedef enum
{
    LOW_LEVEL_SENSE_CONTROL = 0,
    ANY_LOGICAL_SENSE_CONTROL,
    FALLING_EDGE_SENSE_CONTROL,
    RISING_EDGE_SENSE_CONTROL

}EN_EXT_INTERRUPT_Sense_Control;
```



```c
typedef enum
{
    EXT0_INTERRUPTS = 0,
    EXT1_INTERRUPTS,
    EXT2_INTERRUPTS
}EN_EXT_INTERRUPTS;
```



```c
/*************************************************************************/
/*                     EXT_INTERRUPTS STRUCT CONFIG                      */
/*************************************************************************/
/*
Struct: ST_EXT_INTERRUPTS_CFG
Description: A structure that contains the configuration settings for an external
             interrupt on a micro-controller.
Members:
-  INTERRUPT_EXTERNAL_HANDLER : A function pointer to the interrupt service routine (ISR)
                                for the external interrupt(call-back function).
-  EXTERNAL_INTERRUPRT_Number : An instance of the EN_EXT_INTERRUPTS enum that specifies the
                                external interrupt number to be configured.
-  EXTERNAL_INTERRUPRT_Sense_Control : An instance of the EN_EXT_INTERRUPRT_Sense_Control enum
                                       that specifies the sense control mode for the external interrupt.

Overall, the ST_EXT_INTERRUPTS_CFG structure provides a way to represent and manage the configuration
settings for an external interrupt on a micro-controller in a standardized and easy-to-understand manner.
By using this structure, the software can configure and handle external interrupts based on the desired
interrupt number and sense control mode, and execute the appropriate ISR when the interrupt is triggered.
*/
typedef struct
{
    void(*INTERRUPT_EXTERNAL_HANDLER)(void);
    EN_EXT_INTERRUPTS EXTERNAL_INTERRUPRT_Number;
    EN_EXT_INTERRUPT_Sense_Control EXTERNAL_INTERRUPRT_Sense_Control;

}ST_EXT_INTERRUPTS_CFG;


const ST_EXT_INTERRUPTS_CFG A_interruptConfig[EXT_INTERRUPT_PINS];
```

SOS APIs:

sos_init()

Function Name	sos_init
Syntax	enu_system_status_t sos_init (void);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	None
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_STATUS_INVALID_STATE: In case The SOS is already initialized

sos_deinit()

Function Name	sos_deinit
Syntax	enu_system_status_t sos_deinit (void);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	None
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_STATUS_INVALID_STATE: In case The SOS is not initialized

sos_create_task()

Function Name	sos_create_task
Syntax	enu_system_status_t sos_create_task (str_sosTask_t *ptr_str_sosTask);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	*ptr_str_sosTask:holds task's configuration
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_NULL_PTR: In case of NULL pointer
	SOS_INVALID_ARG:In case of wrong arguments

sos_modify_task()

Function Name	sos_modify_task
Syntax	enu_system_status_t sos_modify_task (str_sosTask_t *ptr_str_sosTask,str_sosTask_t *ptr_str_sosModTask);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	*ptr_str_sosTask:holds task's configuration *ptr_str_sosModTask:holds task's modification configuration
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_NULL_PTR: In case of NULL pointer
	SOS_INVALID_TASK:In case of wrong task not found

sos_delete_task()

Function Name	sos_delete_task
Syntax	enu_system_status_t sos_delete_task (uint8_t task_id);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	task_id:the id of the task to be deleted
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_INVALID_TASK:In case of wrong task not found

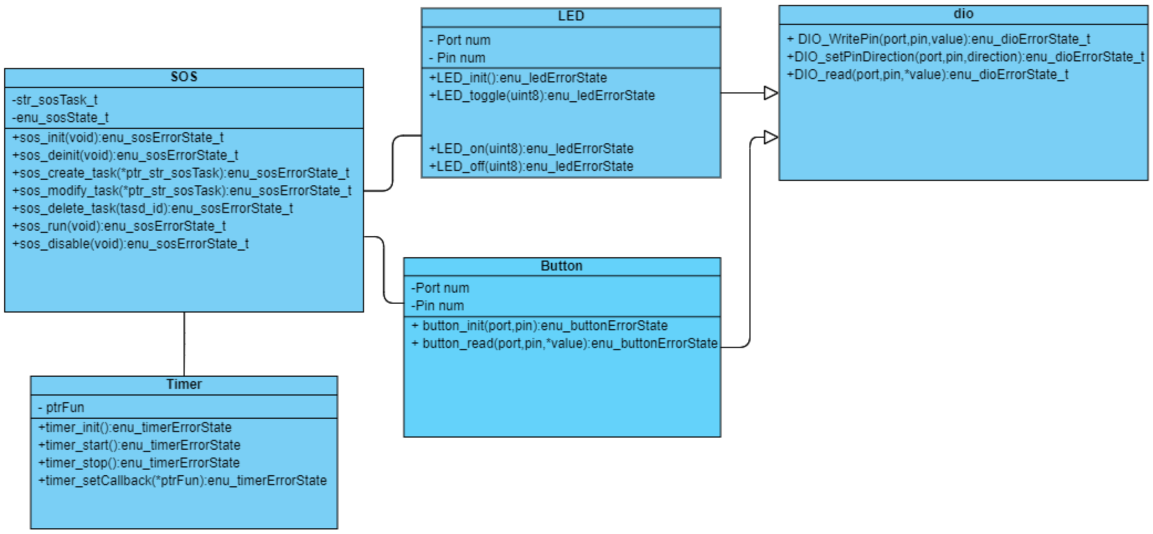
sos_run()

Function Name	sos_run
Syntax	enu_system_status_t sos_run (void);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	None
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_STATUS_FAILED: In case of the SOS is already running

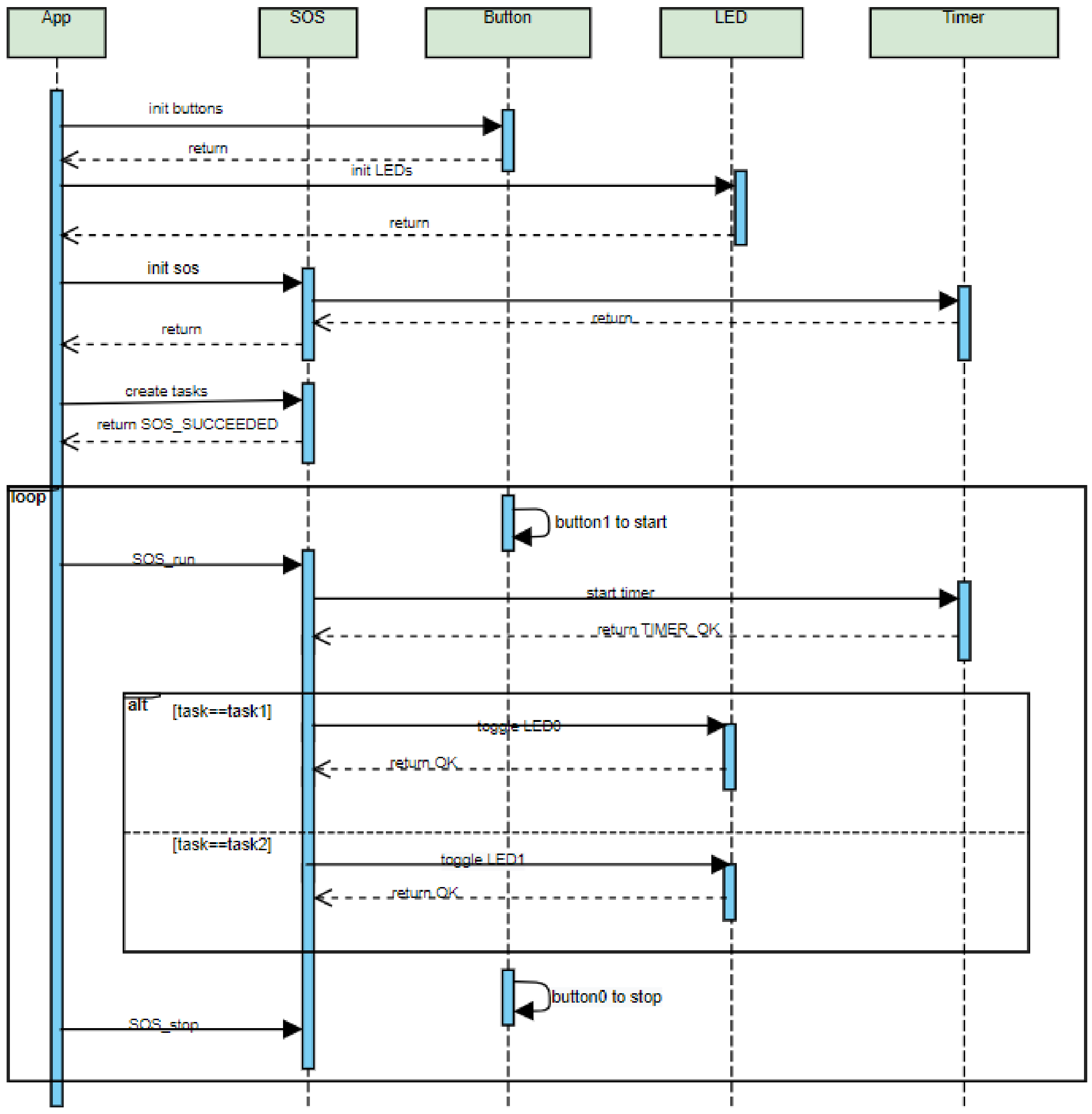
sos_disable()

Function Name	sos_disable
Syntax	enu_system_status_t sos_disable (void);
Synch/Asynch	Synchronous
Reentrancy	Non-Reentrant
Parameters(in):	None
Parameters(out):	None
Parameters(in,out):	None
Return:	SOS_STATUS_SUCCESS: In case of Successful Operation
	SOS_STATUS_FAILED: In case of the SOS is already stopped

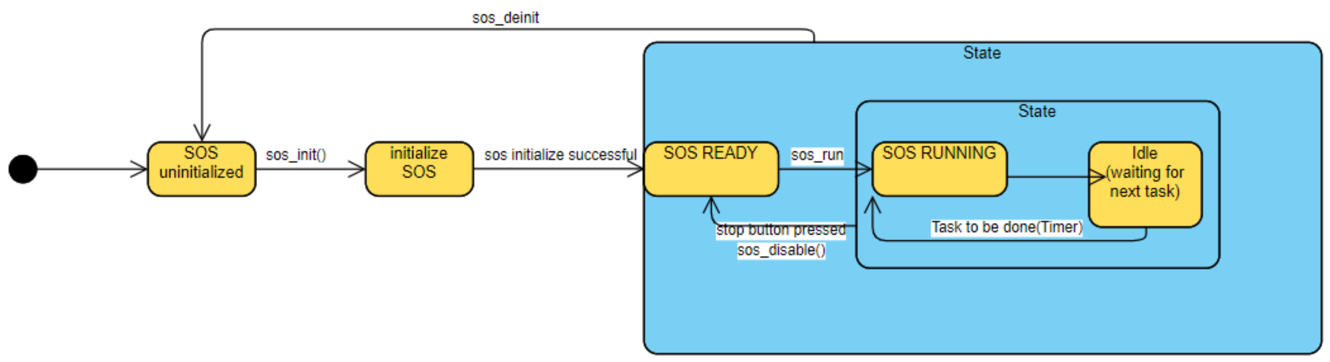
SOS Class Diagram :


LED
- Port num
- Pin num
+LED_init():enu_ledErrorState
+LED_toggle(uint8):enu_ledErrorState
+LED_on(uint8):enu_ledErrorState
+LED_off(uint8):enu_ledErrorState
dio
+ DIO_WritePin(port,pin,value):enu_dioErrorState_t
+DIO_setPinDirection(port,pin,direction):enu_dioErrorState_t
+DIO_read(port,pin,*value):enu_dioErrorState_t
SOS
-str_sosTask_t
-enu_sosState_t
+sos_init(void):enu_sosErrorState_t
+sos_deinit(void):enu_sosErrorState_t
+sos_create_task(*ptr_str_sosTask):enu_sosErrorState_t
+sos_modify_task(*ptr_str_sosTask):enu_sosErrorState_t
+sos_delete_task(tasd_id):enu_sosErrorState_t
+sos_run(void):enu_sosErrorState_t
+sos_disable(void):enu_sosErrorState_t
Button
-Port num
-Pin num
+ button_init(port,pin):enu_buttonErrorState
+ button_read(port,pin,*value):enu_buttonErrorState
Timer
- ptrFun
+timer_init():enu_timerErrorState
+timer_start():enu_timerErrorState
+timer_stop():enu_timerErrorState
+timer_setCallback(*ptrFun):enu_timerErrorState

System Sequence Diagram:



SOS State Machine:


sos_deinit
State
State
SOS uninitialized
sos_init()
initialize SOS
sos initialize successful
SOS READY
sos_run
SOS RUNNING
Idle (waiting for next task)
stop button pressed
sos_disable()
Task to be done(Timer)