Basic Communication Manager Design

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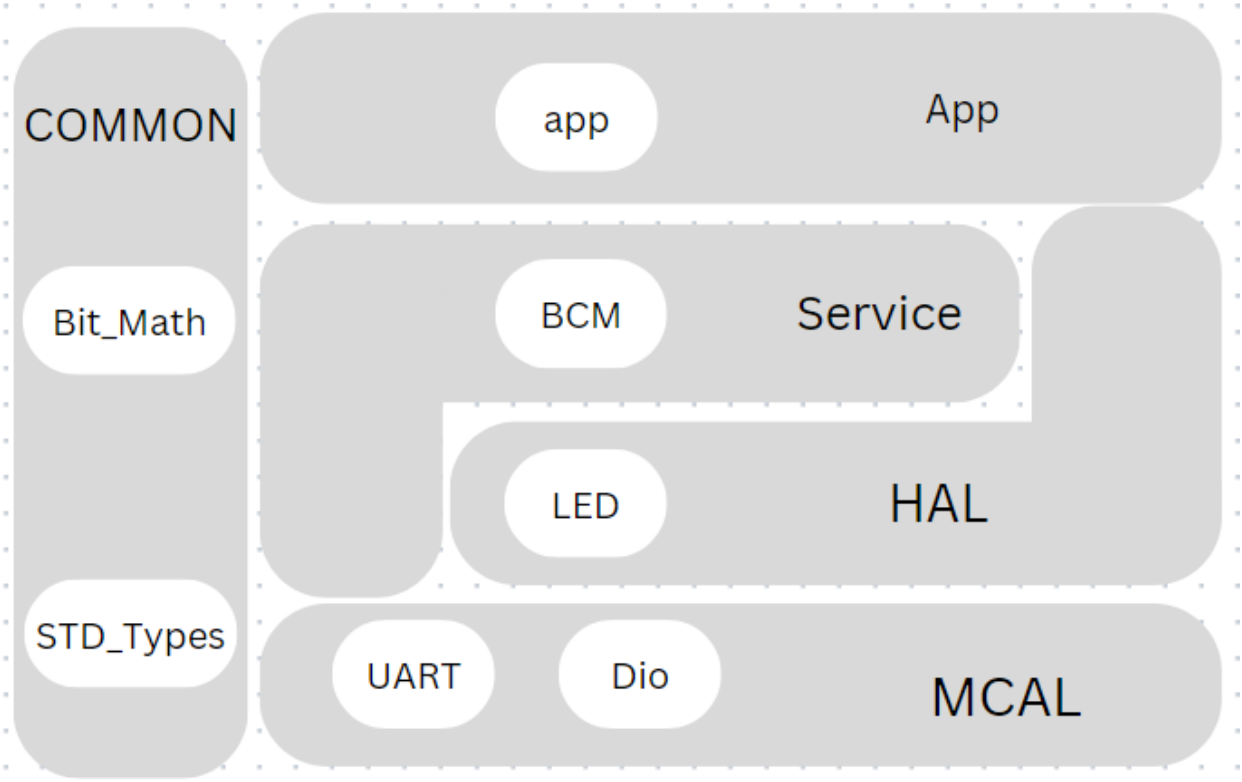
1. Introduction:

This project involves designing essential functions and APIs (Application Programming Interfaces) for the BCM, ensuring its initialization, proper termination, single-byte data transmission, and multi-byte data transfer capabilities. The BCM's functionalities will be managed through a series of well-defined functions that follow the specifications provided in the tables. These functions aim to make the BCM easy to integrate into a wide range of embedded systems, enabling developers to harness the full potential of this versatile communication module.

1. High Level Design:

2.1 Layered Architecture:



2.2 Modules Description:

- **DIO**:

  controls GPIO pins.
- **UART:**

  to send / receive (communicate) with other MCUs .

- **LED:**

  controls led state in the program.

- **BCM:**

  communication manager that manages communicating between different MCUs.

- **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 UART:

```
/*this function initailizes uart
return: error state of the UART module*/
enu_uartErrorState_t MUART_init(const ST_USART_CONFIG *config);

/*this function is used to send a byte of data via UART
return: error state of the UART module*/
enu_uartErrorState_t MUART_sendByte(u8 u8_a_data);

/*this function is used to receive a byte of data via UART
return: error state of the UART module*/
enu_uartErrorState_t MUART_receiveByte(u8* pdata);

/*this function is used to send a string of data via UART
return: error state of the UART module*/
enu_uartErrorState_t MUART_sendString(u8* pdata);
```

2.3.3 LED:

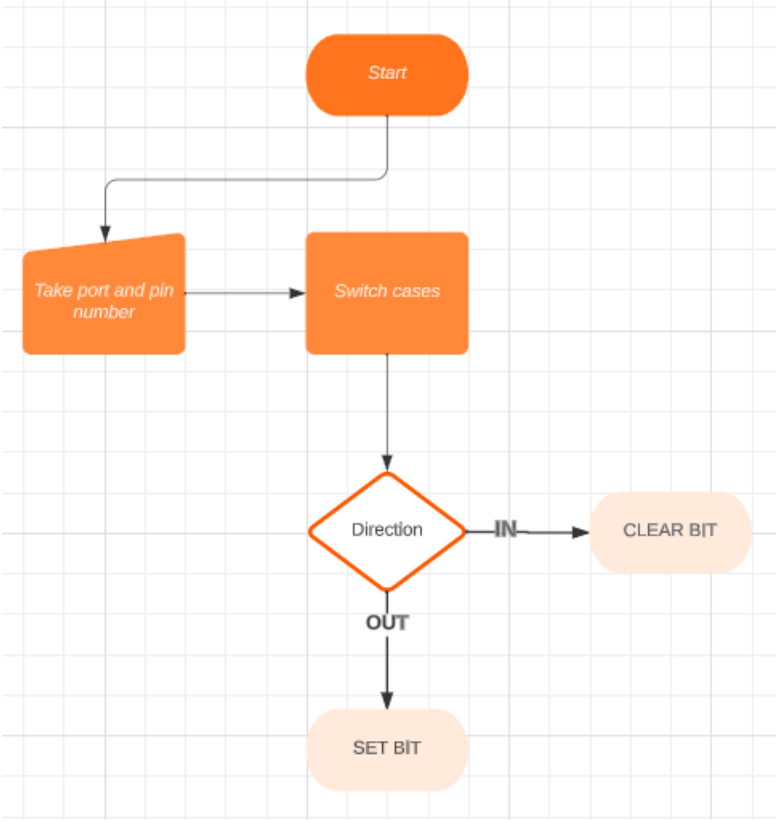
```
/*Enum for error state*/
typedef enum
{
    LED_OK,
    LED_NOK
    }EN_ledError_t;

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

/*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);
```

3. Low Level Design:

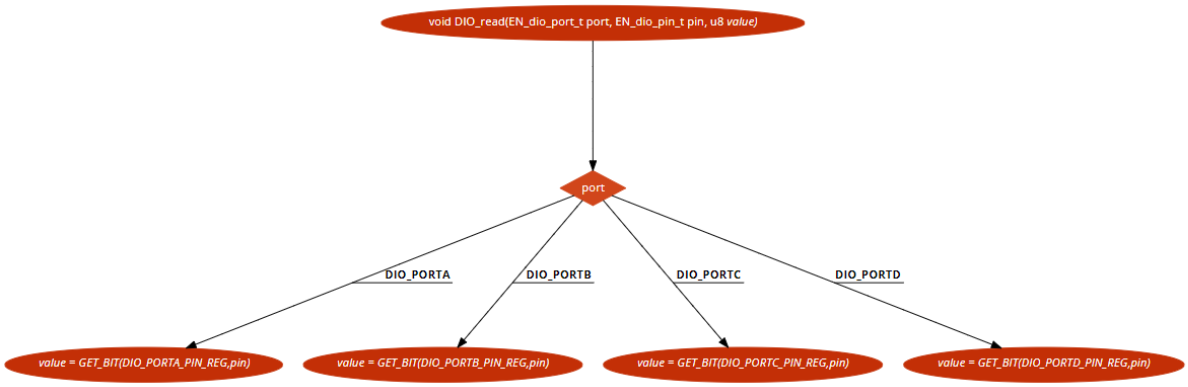
3.1Flowcharts:

3.1.1 DIO:

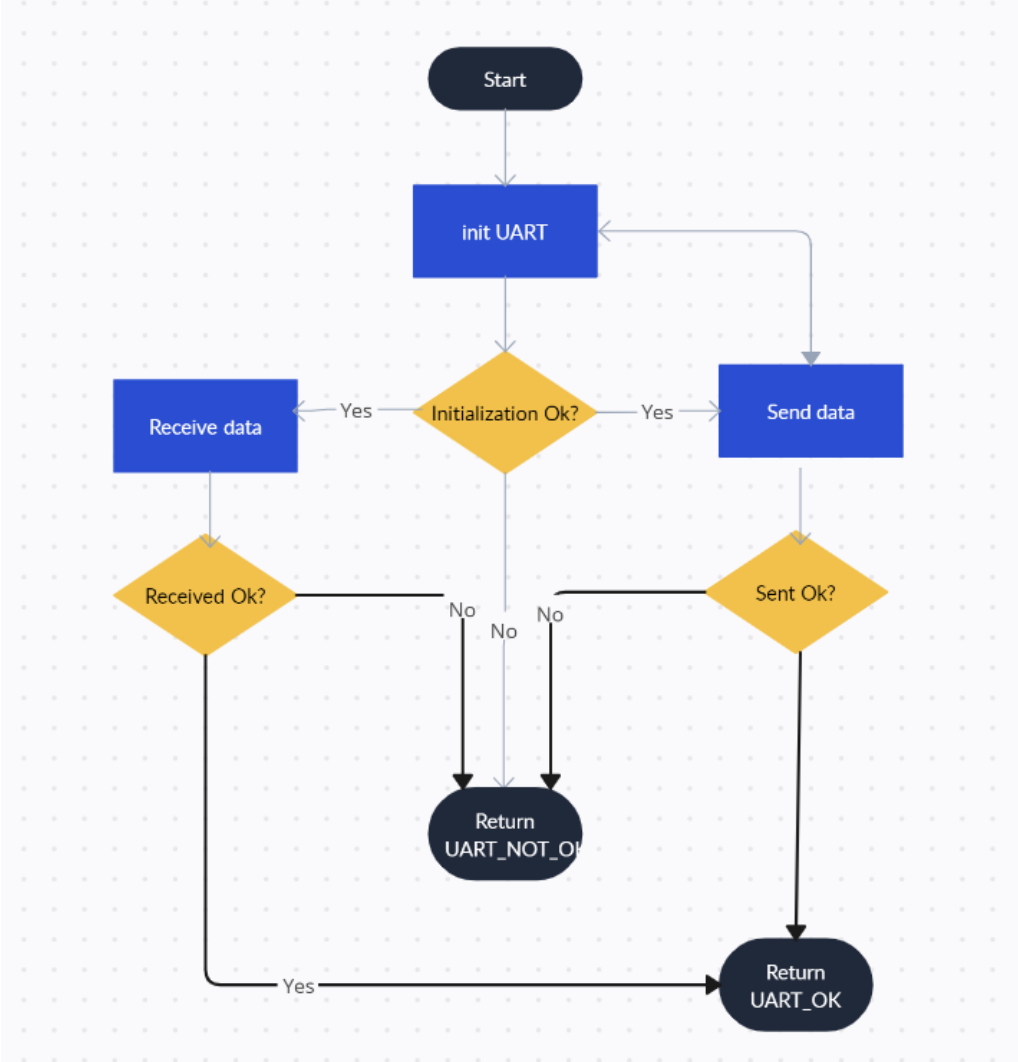
EN_dioError_t DIO_WritePin(EN_dio_port_t port, EN_dio_pin_t pin, EN_dio_value_t value)



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

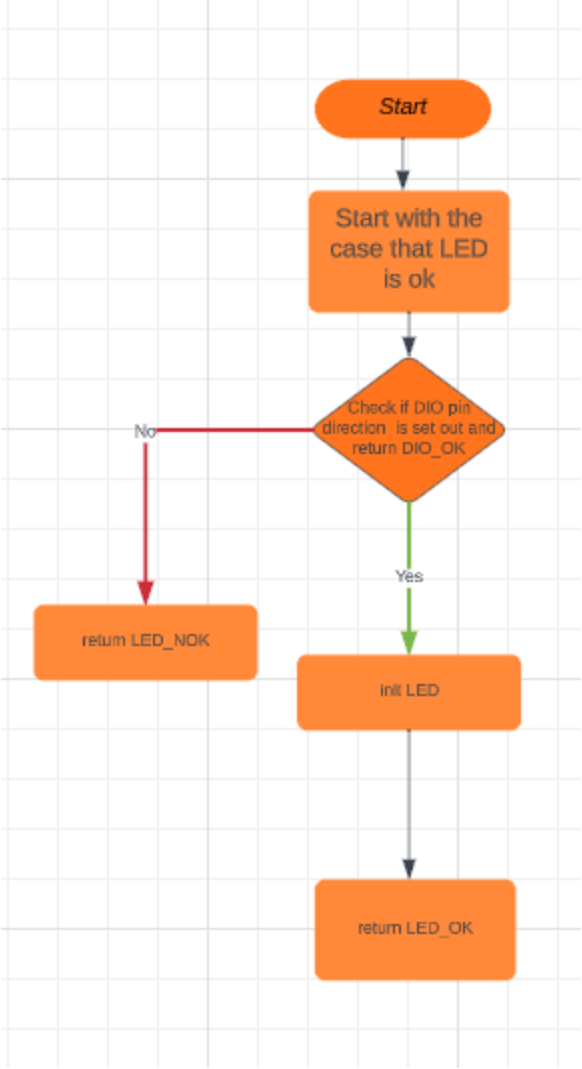


3.1.2 UART:

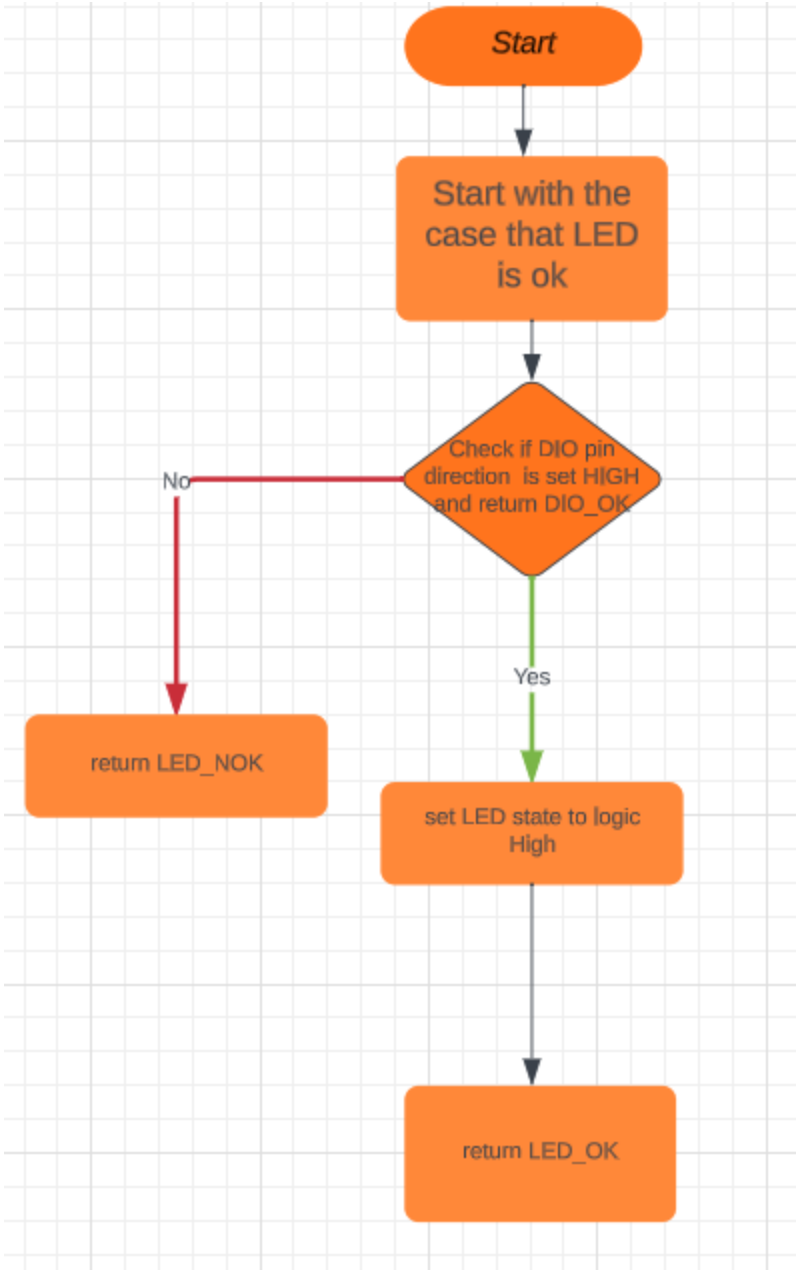


3.1.3 LED:

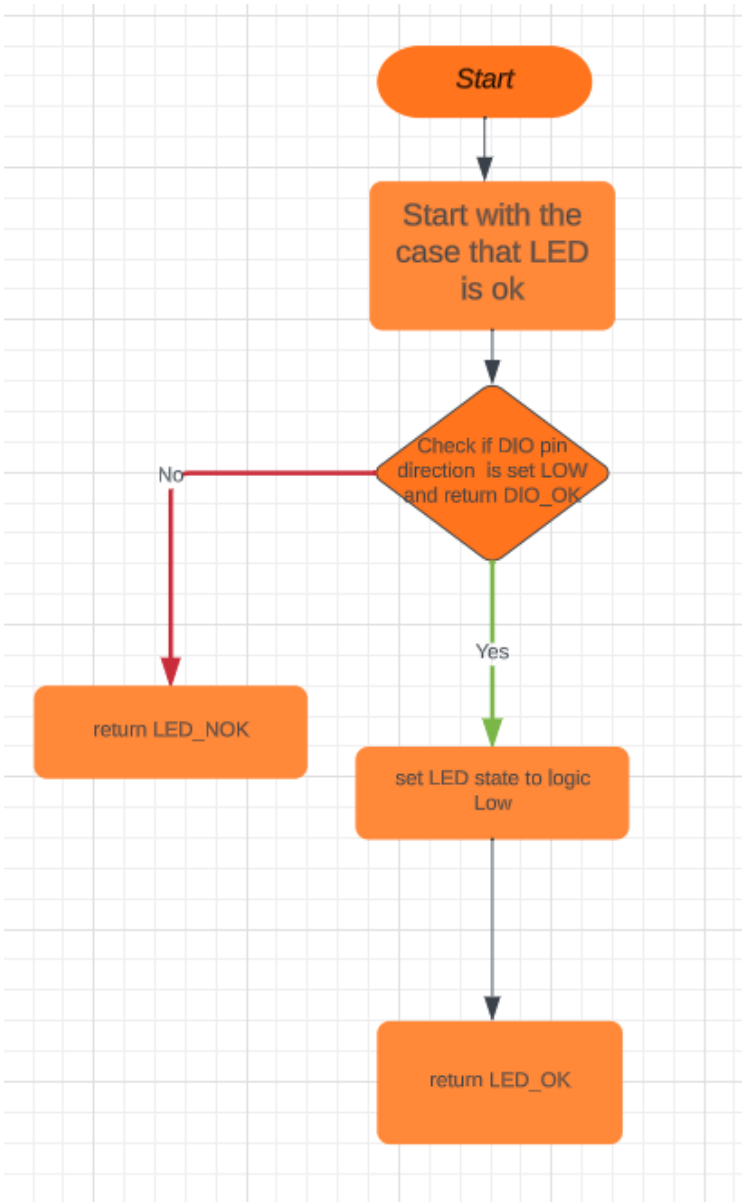
EN_ledError_t HLED_init(LEDS *led)



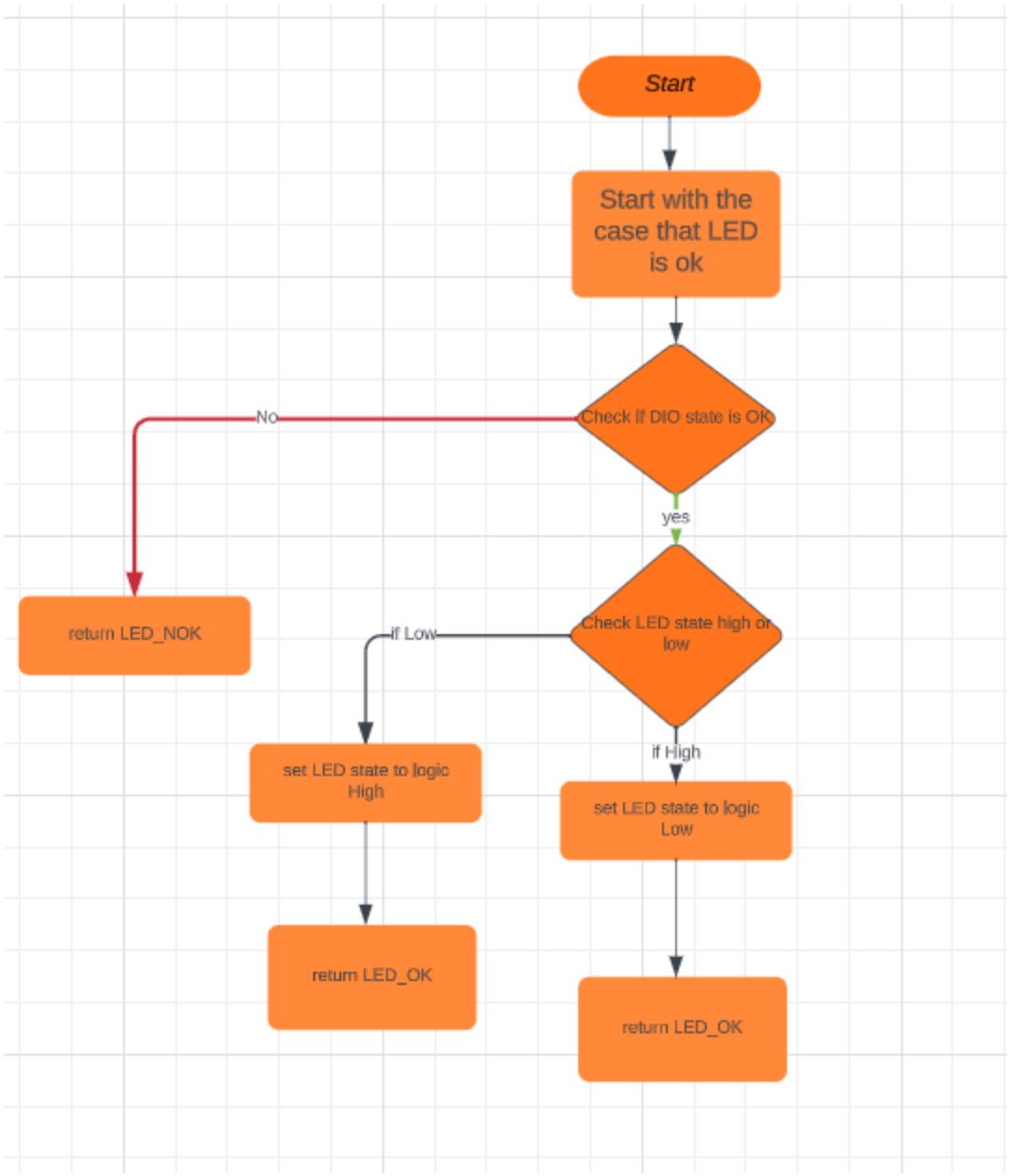
EN_ledError_t HLED_on(LEDS *led)



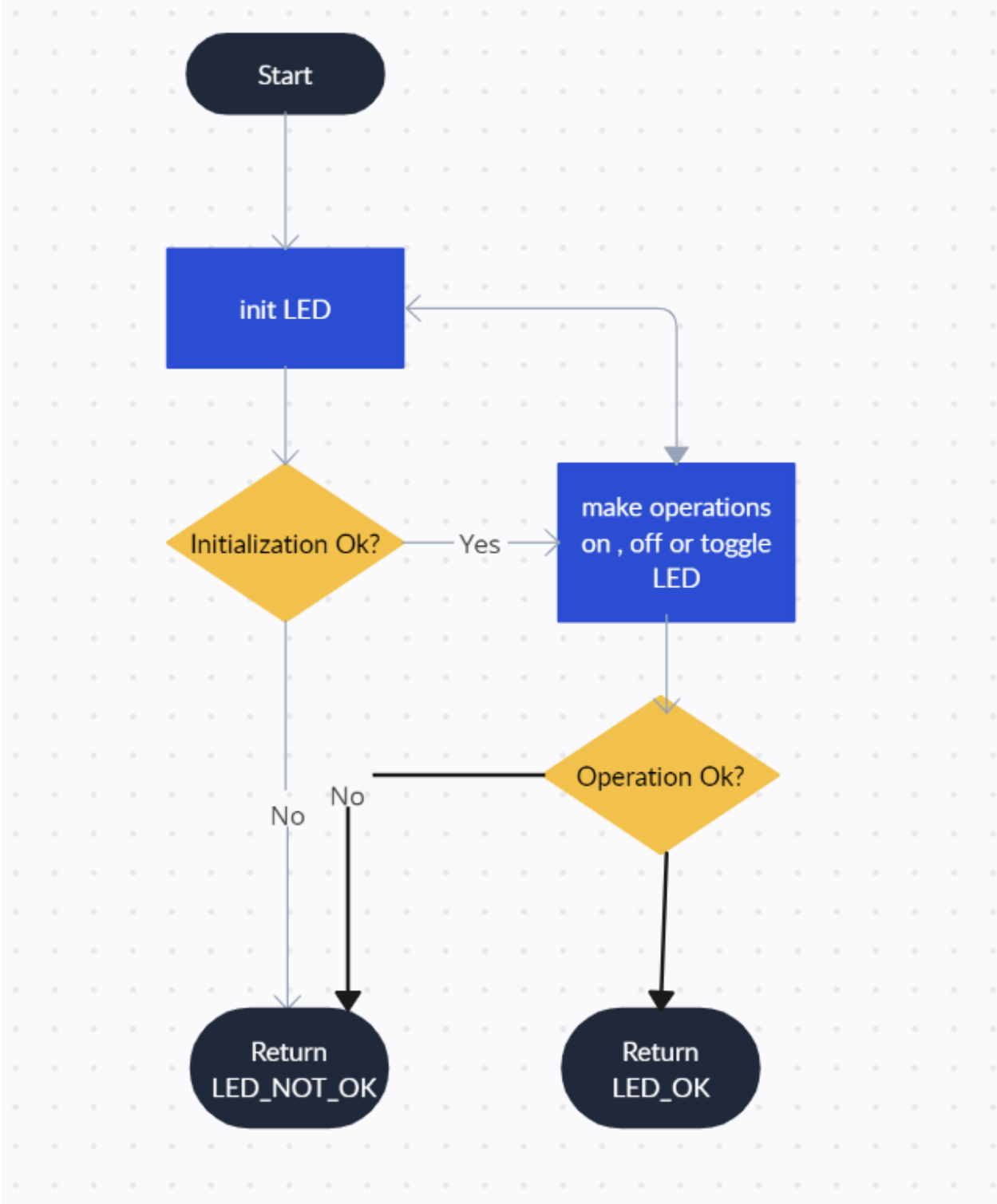
EN_ledError_t HLED_off(LEDS *led)



EN_ledError_t HLED_toggle(LEDS *led)



Flowchart for the whole driver:



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;
```

3.2.3 UART:

```
/*USART SYNCHRONIZATION MODE OPTIONS:
 USART_ASYNC_MODE
  USART_SYNC_MODE
*/
 #define  USART_SET_SYNCH_MODE    USART_SYNC_MODE


/*USART SPEED MODE OPTIONS:
  USART_NORMAL_SPEED
  USART_DOUBLE_SPEED
*/
 #define  USART_SET_SPEED    USART_NORMAL_SPEED


/*USART PARITY OPTIONS :
 USART_NO_PARITY
 USART_ODD_PARITY
 USART_EVEN_PARITY
*/
 #define USART_SET_PARITY_MODE       USART_EVEN_PARITY

/*USART DATA SIZE OPTIONS :
  USART_DATA_SIZE_5
  USART_DATA_SIZE_6
  USART_DATA_SIZE_7
  USART_DATA_SIZE_8
  USART_DATA_SIZE_9
*/
 #define USART_SET_DATA_SIZE         USART_DATA_SIZE_8

/*USART STOP BITS OPTIONS :
  USART_ONE_STOP_BIT
  USART_TWO_STOP_BITS
*/
 #define USART_SET_STOP_BITS        USART_TWO_STOP_BITS


/*USART BAUD RATE OPTIONS
  BAUD_2400
  BAUD_4800
  BAUD_9600
  BAUD_14400
  BAUD_19200
  BAUD_28800
  BAUD_38400
*/
 #define USART_SET_BAUD_RATE        BAUD_9600
```

```c
/*USART SYNCHRONIZATION MODE OPTIONS:
USART_ASYNC_MODE
 USART_SYNC_MODE
*/
typedef enum EN_USART_SET_MODE{
    USART_ASYNC_MODE=0,
    USART_SYNC_MODE
    }EN_USART_SET_MODE;


/*USART SPEED MODE OPTIONS:
 USART_NORMAL_SPEED
 USART_DOUBLE_SPEED
*/
typedef enum EN_USART_SET_SPEED{
 USART_NORMAL_SPEED=0,
 USART_DOUBLE_SPEED
}EN_USART_SET_SPEED;


/*USART PARITY OPTIONS :
USART_NO_PARITY
USART_ODD_PARITY
USART_EVEN_PARITY
*/
typedef enum EN_USART_SET_PARITY{
 USART_NO_PARITY=0,
 USART_ODD_PARITY,
 USART_EVEN_PARITY
}EN_USART_SET_PARITY;


/*USART DATA SIZE OPTIONS :
 USART_DATA_SIZE_5
 USART_DATA_SIZE_6
 USART_DATA_SIZE_7
 USART_DATA_SIZE_8
 USART_DATA_SIZE_9
*/
typedef enum EN_USART_SET_DATA_SIZE{
     USART_DATA_SIZE_5=0,
     USART_DATA_SIZE_6,
     USART_DATA_SIZE_7,
     USART_DATA_SIZE_8,
     USART_DATA_SIZE_9
    }EN_USART_SET_DATA_SIZE;
```

```
typedef enum EN_USART_SET_STOP_BITS{
    USART_ONE_STOP_BIT=0,
    USART_TWO_STOP_BITS
    }EN_USART_SET_STOP_BITS;


/*USART BAUD RATE OPTIONS
 BAUD_2400
 BAUD_4800
 BAUD_9600
 BAUD_14400
 BAUD_19200
*/
typedef enum EN_USART_SET_BAUD_RATE{
     BAUD_2400=2400,
     BAUD_4800=4800,
     BAUD_9600=9600,
     BAUD_14400=14400,
     BAUD_19200=19200
}EN_USART_SET_BAUD_RATE;



/*CPU FREQUENCY OPTIONS
 FCPU_4MHZ
 FCPU_8MHZ
 FCPU_16MHZ
*/
typedef enum EN_USART_SET_FCPU{
    FCPU_4MHZ=4000000,
    FCPU_8MHZ=8000000,
    FCPU_16MHZ=16000000
    }EN_USART_SET_FCPU;

typedef struct ST_USART_CONFIG{

        EN_USART_SET_MODE  SYNC_MODE;
        EN_USART_SET_FCPU FCPU;
        EN_USART_SET_BAUD_RATE BAUD_RATE;
        EN_USART_SET_SPEED SPEED_MODE;
        EN_USART_SET_PARITY PARITY_MODE;
        EN_USART_SET_STOP_BITS STOP_BIT;
        EN_USART_SET_DATA_SIZE DATA_SIZE;

    }ST_USART_CONFIG;
```

```
const ST_USART_CONFIG st_g_USARTconf = {
    .SYNC_MODE = USART_SYNC_MODE,
    .FCPU = FCPU_8MHZ,
    .BAUD_RATE = BAUD_9600,
    .SPEED_MODE = USART_NORMAL_SPEED,
    .PARITY_MODE = USART_EVEN_PARITY,
    .STOP_BIT = USART_TWO_STOP_BITS,
    .DATA_SIZE = USART_DATA_SIZE_8,
};
```

3.2.3 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;
```

BCM APIs:

BCM_init()

Function Name	bcm_init
Syntax	enu_system_status_t bcm_init (str_bcm_instance_t* ptr_str_bcm_instance);
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in):	ptr_str_bcm_instance: Address of the BCM Instance
Parameters (out):	None
Parameters (in, out):	None
Return:	BCM_STATUS_SUCCESS: In case of Successful Operation BCM_STATUS_INVALID_STATE: In case of Failed Operation

BCM_deinit()

Function Name	bcm_deinit
Syntax	enu_system_status_t bcm_init (str_bcm_instance_t* ptr_str_bcm_instance);
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in):	ptr_str_bcm_instance: Address of the BCM Instance
Parameters (out):	None
Parameters (in, out):	None
Return:	BCM_STATUS_SUCCESS: In case of Successful Operation BCM_STATUS_INVALID_STATE: In case of Failed Operation

BCM_send()

Function Name	BCM_send
Syntax	enu_system_status_t bcm_init (str_bcm_instance_t* ptr_str_bcm_instance,u8* ptr_u8_a_byte);
Sync/Async	Asynchronous
Reentrancy	Reentrant
Parameters (in):	ptr_str_bcm_instance: Address of the BCM Instance ptr_u8_a_byte : Address of the sending byte
Parameters (out):	None
Parameters (in, out):	None
Return:	BCM_STATUS_SUCCESS: In case of Successful Operation BCM_STATUS_INVALID_STATE: In case of Failed Operation

BCM_send_n()

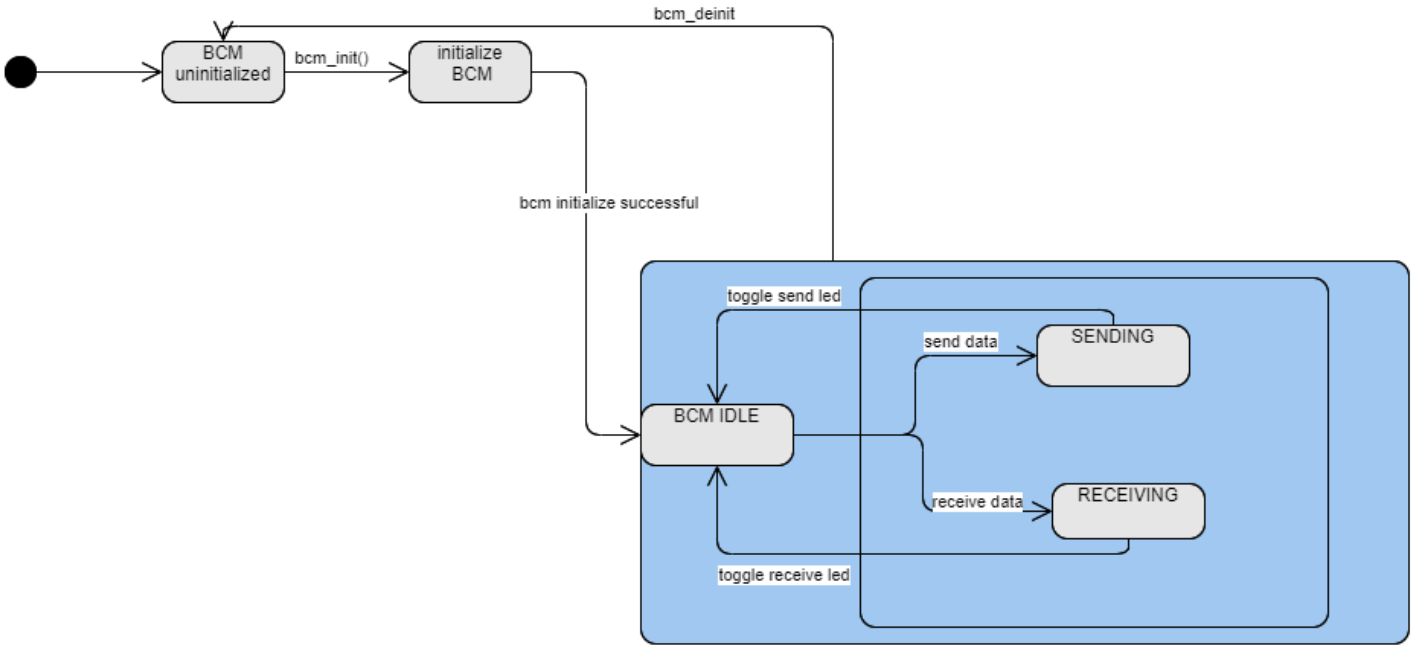
Function Name	BCM_send_n
Syntax	enu_system_status_t bcm_init (str_bcm_instance_t* ptr_str_bcm_instance,u8* ptr_u8_a_byte);
Sync/Async	Asynchronous
Reentrancy	Reentrant
Parameters (in):	ptr_str_bcm_instance: Address of the BCM Instance ptr_u8_a_byte : Address of the sending bytes uint16_size: Variable contains data size
Parameters (out):	None
Parameters (in, out):	None
Return:	BCM_STATUS_SUCCESS: In case of Successful Operation BCM_STATUS_INVALID_STATE: In case of Failed Operation

bcm_dispatcher ()

Function Name	BCM_dispatcher
Syntax	enu_system_status_t BCM_dispatcher(str_bcm_instance_t* ptr_str_bcm_instance)
Sync/Async	Synchronous
Reentrancy	Non Reentrant
Parameters (in):	ptr_str_bcm_instance: Address of the BCM Instance
Parameters (out):	None
Parameters (in, out):	None
Return:	BCM_STATUS_SUCCESS: In case of Successful Operation BCM_STATUS_INVALID_STATE: In case of Failed Operation

UML:

BCM State Machine:



BCM Class Diagram:

BCM Sequence Diagram: