Simple ATM Machine

Team Members:

Alaa Ibrahim
Bassel Yasser
Sharpel Malek
Sherif Khadr

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ATM MACHINE:

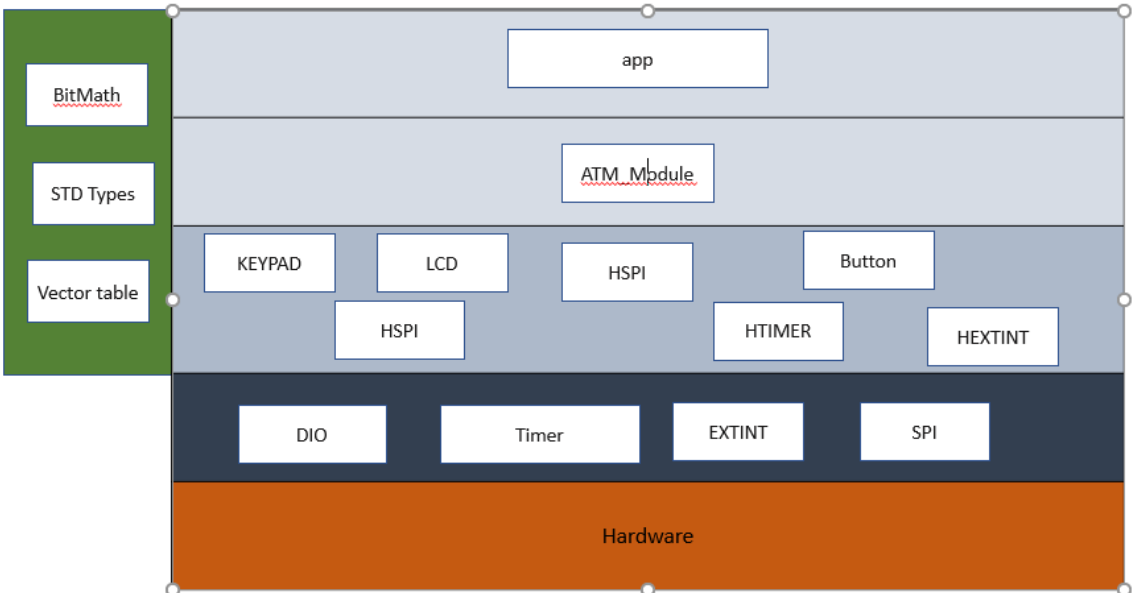


Figure 1 ATM MCU Layered Architecture

CARD MCU

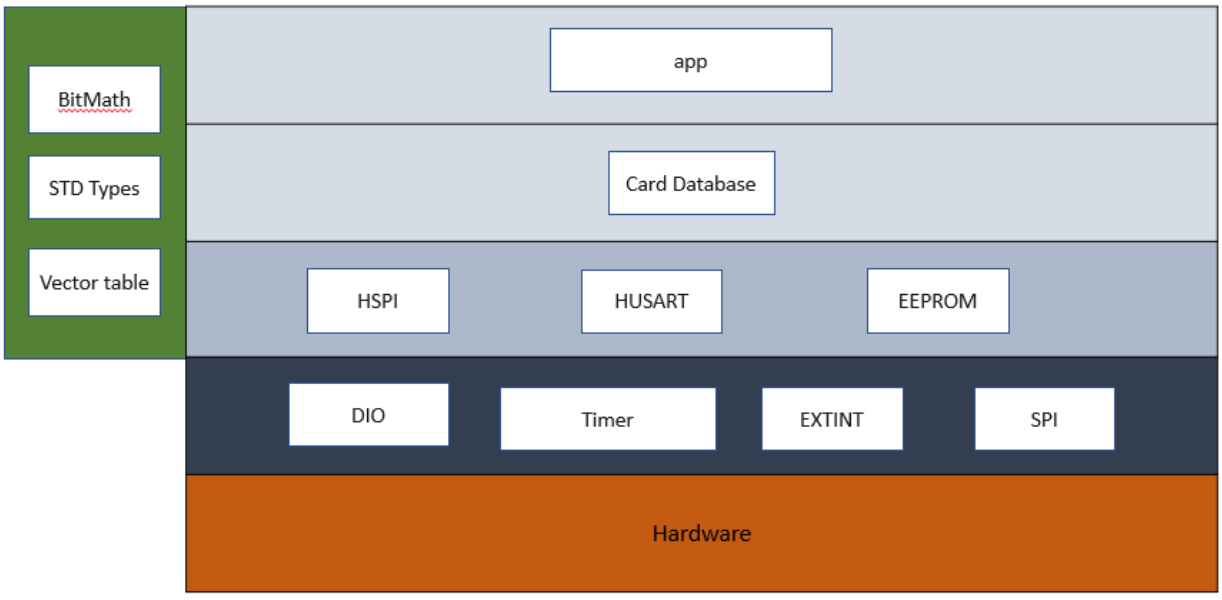


Figure 2 Card MCU Layered Architecture

02) Modules Description

MCAL Layer:

- **DIO:** For controlling GPIO pins
- **Timer:** Provides an interface with timer 0 low-level capabilities.
- **EXTINT:** it controls three external hardware interrupts on pins PD2, PD3, and PB2 which are referred to as INT0, INT1, and INT2 respectively
- **USART:** Enables MCU to communicate using serial protocols.
- **SPI:** Provides interface with SPI's low-level functionalities.
- **I2C:** Handles the i2c address oriented, multi-master, multi-slave communication.

HAL Layer:

- **Keypad:** Deal with a set of buttons arranged in a block. The 3 x 3 matrix keypad usually is used as input in a project
- **LCD:** Use for display data
- **Buzzer:** Simple module to control a buzzer.
- **HTimer:** Provides high-level functions using the lower-level timer 0 module capabilities.
- **H_EXT_INT:** Provides middle ware layer between app and external interrupt in MCAL.
- **HUSART:** Provides middle ware layer between app and UART in MCAL.
- **HSPI:** Provides high-level functionalities for using SPI communication.
- **EEPROM:** Enables MCU to interface with external EEPROM using i2c.
- **Button:** Interface with button to get its state (Enter/Zero).

Service Layer:

- **STD_Types:** Contains all the standard types used by all the layers.
- **BIT_Math:** Provides bit-wise operations.
- **Vect_table:** Contains all interrupt vectors and provides macros for dealing with general interrupt.

Application Layer:

Contains the main logic of the project.

03) Drivers' Documentation

MCAL Layer

- **DIO**

```
/*
 * AUTHOR        : Bassel Yasser
 * Function           : DIO_s8SETPinDir
 * Description   : Set Pin Direction
 * Arguments     :
 *                            - enPinCopy {DIO_PINA_0...., DIO_PIND_7}
 *                            - enPortDir {INPUT , OUTPUT}
 * Return        :   Sint8_t
 */

Sint8_t DIO_s8SETPinDir (enu_pin enPinCopy, enu_dir enPortDir)



/*
 * AUTHOR           : Bassel Yasser
 * Function         : DIO_s8SETPinVal
 * Description      : Set Pin Value
 * Arguments :
 *                            - enPinCopy {DIO_PINA_0...., DIO_PIND_7}
 *                            - enPortDir {HIGH , LOW}
 * Return           :   Sint8_t
 */
   Sint8_t DIO_s8SETPinVal (enu_pin enPinCopy, enu_val enPortVal)



/*
 * AUTHOR           : Bassel Yasser
 * Function         : DIO_s8GETPinVal
 * Description      : Set Pin Value
 * Arguments :
 *                            - enPinCopy {DIO_PINA_0...., DIO_PIND_7}
 *                            - pu8Val address of variable that u want to save value
on it
 * Return           :   Sint8_t
 */
   Sint8_t DIO_s8GETPinVal (enu_pin enPinCopy, Uint8_t* pu8Val)
```

- **Timer 0**

```
/**
 * \brief Initialize the timer with given mode
 * \param u8_a_Mode
 * \return en_TIMErrorState_t
 */
en_TIMErrorState_t TIM0_voidInit(en_TIMMode_t u8_a_Mode);

/**
 * \brief Start the timer clock after prescaling it with given value
 * \param u8_a_prescaler
 * \return en_TIMErrorState_t
 */
en_TIMErrorState_t TIM0_Start(en_TIM_CLK_SELECT_t u8_a_prescaler);

/**
 * \brief Function to stop timer 0
 * \return void
 */
void TIM0_Stop();

/**
 * \brief Set the timer to start from a certain value
 * \param u8_a_FlagValue The value to start the timer from
 * \return void
 */
void TIM0_SetValue(Uchar8_t u8_a_startValue);

/**
 * \brief Function to get the value of the overflow flag of timer 0
 * \param u8_a_FlagValue reference to a variable to store flag value *
 * \return en_TIMErrorState_t
 */
en_TIMErrorState_t TIM0_GetOVF(Uchar8_t* u8_a_FlagValue);

/**
 * \brief Function to clear timer 0 overflow flag
 * \return void
 */
void TIM0_ClearOVF(void);

/**
 * \brief Function to get the timer state (running/stopped)
 * \param u8_a_State reference to a variable to store timer state
 * \return en_TIMErrorState_t
 */
en_TIMErrorState_t TIM0_GetState(en_TIMState_t* u8_a_State);

/**
 * \brief Function to set a function to call when the timer0
 *        Overflow Interrupt is triggered
 * \param pv_a_CallbackFn reference to the function to call
 * \return en_TIMErrorState_t
 */
```

- **EXTINT:**

```
// EXT_INT TYPEDEFS
typedef enum EN_EXTINT_ERROR {
	EXTINT_OK=0,
	EXTINT_NOT_OK
}EN_EXTINT_ERROR;

typedef enum EN_Sence_Control {
	LOW_LEVEL=0,
	FALLING_EDGE,
	RISING_EDGE,
	ANY_LOGICAL_CHANGE
}EN_Sence_Control;

typedef enum EN_EXINT_NUMBER{
	EXTINT0=0,
	EXTINT1,
	EXTINT2,
}EN_EXINT_NUMBER;

typedef enum EN_GLOBAL_INT{
	DISABLE=0,
	ENABLE
}EN_GLOBAL_INT;

// EXT_INT prototypes

/*
Description : This function initializes the GLOBAL_INTERRUPT
ARGS        : takes the state ( ENABLE OR DISABLE )
return      : return EXTINT_OK if the PIN initializes correctly, EXTINT_NOT_OK otherwise
*/
EN_EXTINT_ERROR SET_GLOBAL_INTERRUPT(EN_GLOBAL_INT state);


/*
Description : This function initializes the external interrupt number and it's detecting type
ARGS        : takes the EXINT_NUMBER( INT0,INT1 OR INT2) and sense control.
return      : return EXTINT_OK if the EXINT_NUMBER initializes correctly, EXTINT_NOT_OK
otherwise
*/
EN_EXTINT_ERROR EXTINT_init(EN_EXINT_NUMBER INTx ,EN_Sence_Control INTxSense);

/*
Description : This function takes the external interrupt number and initialize call back
function.
ARGS        : takes the EXINT_NUMBER( INT0,INT1 OR INT2) and pointer to the function we want
to execute.
return      : return EXTINT_OK if the EXINT_NUMBER initializes correctly, EXTINT_NOT_OK
otherwise
*/
EN_EXTINT_ERROR EXTINT_CallBack(EN_EXINT_NUMBER INTx,void(*ptrfunc)(void));
```

- **I2C:**

```
/*****************************************************************************/
/*                  01- i2c_init_master()
            */
/* ---------------------------------------------------------------------------
 * @func   : I2C master Initialization
 * @in     : void
 * @out    : void
 *****************************************************************************/
void i2c_init_master(void);

/*****************************************************************************/
/*                  02- i2c_init_slaver()
            */
/* ---------------------------------------------------------------------------
 * @func   : I2C slave Initialization
 * @in     : void
 * @out    : void
 *****************************************************************************/
void i2c_init_slave (void);


/*****************************************************************************/
/*                  03- i2c_start()
      */
/* ---------------------------------------------------------------------------
 * @func   : Send start condition
 * @in     : void
 * @out    : void
 *****************************************************************************/
void i2c_start(void);

/*****************************************************************************/
/*                  04- i2c_repeated_start()
            */
/* ---------------------------------------------------------------------------
 * @func   : Send repeated start condition
 * @in     : void
 * @out    : void
 *****************************************************************************/
void i2c_repeated_start(void);




/*****************************************************************************/
/*                  05- i2c_send_slave_address_with_write_req()
                              */
/* ---------------------------------------------------------------------------
```

```
 * @func            : send write request from master to slave
 * @in[1]           : slave_address
 *                              - Slave address that you want to write on it
 * @out             : void
*******************************************************************************/
void i2c_send_slave_address_with_write_req(Uint8_t slave_address);

/*******************************************************************************/
/*                  06- i2c_send_slave_address_with_read_req()
                              */
/* -----------------------------------------------------------------------------
 * @func            : send read request from master to slave
 * @in[1]           : slave_address
 *                              - Slave address that you want to read from it
 * @out             : void
*******************************************************************************/
void i2c_send_slave_address_with_read_req(Uint8_t slave_address);

/*******************************************************************************/
/*                  07- i2c_write_byte()
            */
/* -----------------------------------------------------------------------------
 * @func            : Write data to slave
 * @in[1]           : byte
 *                              - write data that u need to send
 * @out             : void
*******************************************************************************/
void i2c_write_byte(Uint8_t byte);

/*******************************************************************************/
/*                  08- i2c_read_byte()
      */
/* -----------------------------------------------------------------------------
 * @func            : read data from slave
 * @in       : void
 * @out             : returned data
*******************************************************************************/
Uint8_t i2c_read_byte(void);

/*******************************************************************************/
/*                  09- i2c_stop()
      */
/* -----------------------------------------------------------------------------
 * @func            : Send Stop condition
 * @in       : void
 * @out             : void
 *******************************************************************************/
void i2c_stop(void);
```

- **UART:**

```c
typedef enum EN_USART_ERROR{
    USART_OK=0,
    USART_NOT_OK
}EN_USART_ERROR;

/*
Name    : USART_init
Description : This function initializes USART Module with selected options in USART.cfg
file.
Args    : Void (all options defined as macros).
return : Std_ReturnType (E_OK) if Module initializes Correctly, (E_NOT_OK) otherwise.
*/
EN_USART_ERROR USART_init(void);

/*
Name    : USART_sendData
Description : This function Send Data To Receiver (we can change size of data from
USART.cfg file) we select 8 bits data size.
Args    : take one argument (data to be sent) must be same size as the size we select in
Initialization function.
return : Std_ReturnType (E_OK) if module sent data Correctly, (E_NOT_OK) otherwise.
*/
EN_USART_ERROR USART_sendData(Uchar8_t data);

/*
Name    : USART_receiveData
Description : This function Receive Data from sender (we can change size of data from
USART.cfg file) we select 8 bits data size.
Args    : void
return : data received. must be same size as the size we select in Initialization
function.
*/
Uchar8_t USART_receiveData(void);

/*
Name    : USART_sendSTRING
Description : This function send array of data To Receiver. (we can change size of data
from USART.cfg file) we select 8 bits data size.
Args    : pointer to the array of data to be sent
return : void
*/
void USART_sendSTRING(Uchar8_t * str);


/*
Name    : USART_receiveSTRING
Description : This function receive data from sender and store it in array.
Args    : pointer to the array to store data received in it and size of data.
return : void
*/
void USART_receiveSTRING(Uchar8_t * str,Uchar8_t size);
```

- **SPI:**

```
/**
 * (Author: Alaa Hisham)
 * \brief Initialize the MCU as the Master
 *     in SPI communication
 * \return void
 */
void SPI_MasterInit(void);

/**
 * (Author: Alaa Hisham)
 * \brief Initialize the MCU as a slave
 *        in SPI communication
 *
 * \return void
 */
void SPI_SlaveInit(void);

/**
 * (Author: Alaa Hisham)
 * \brief Sets the value of the SPI data register
 * \param u8_a_data: Desired value
 * \return void
 */
void SPI_SetValue(Uchar8_t u8_a_data);

/**
 * (Author: Alaa Hisham)
 * \brief Exchange a letter with selected slave
 * \param u8_a_character: Character to send
 * \param pu8_a_receivedChar: Pointer to character to store received value
 * \return en_SPI_ErrorState_t
 */

en_SPI_ErrorState_t SPI_TranscieveChar(Uchar8_t u8_a_character, Uchar8_t*
pu8_a_receivedChar);

/**
 * (Author: Alaa Hisham)
 * \brief Exchange a letter with selected slave
 * \param u8_a_character: Character to send
 * \param pu8_a_receivedChar: Pointer to character to store received value
 * \return en_SPI_ErrorState_t
 */
en_SPI_ErrorState_t SPI_SlaveTranscieve(Uchar8_t u8_a_character, Uchar8_t*
pu8_a_receivedChar);

/**
 * (Author: Alaa Hisham)
 * \brief Set a notification function for the SPI Interrupt
 * \param pv_a_CallbackFn: reference to the function to callback
 *                         when the SPI Interrupt is triggered
 * \return en_SPI_ErrorState_t
 */
en_SPI_ErrorState_t SPI_SetCallback(void (*pv_a_CallbackFn)(void));
```

HAL Layer:

- **Keypad**

```
// Macros

#define R1      DIO_PINC_2
#define R2      DIO_PINC_3
#define R3      DIO_PINC_4
#define C1      DIO_PINC_5
#define C2      DIO_PINC_6
#define C3      DIO_PINC_7

// user defined datatypes

typedef enum EN_KEYPAD_BTNS
{
    KEY_1=0,
    KEY_2,
    KEY_3,
    KEY_4T,
    KEY_5,
    KEY_6,
    KEY_7,
    KEY_8,
    KEY_9,
    KEY_NOTHING

}EN_KEYPAD_BTNS;

// functions prototypes

/*****************************************************************************
 Name : KEYPAD_init()
 Description : This Function Initializes keypad pins (Rows are outputs & Columns are
inputs).
 ARGS : void
 return : void

*****************************************************************************
*****************/

void KEYPAD_init(void);

/*****************************************************************************
*******************
 *
 Name : KEYPAD_GetButton
 Description : This Function loops over other three functions (Checks (R1,R2,R3)).
 ARGS : void
 return : the pressed key or Nothing pressed

*****************************************************************************
*****************/

EN_KEYPAD_BTNS KEYPAD_GetButton(void);
/*****************************************************************************
*******************
 *
```

```
 Name : KEYPAD_checkR1 ,  KEYPAD_checkR2, KEYPAD_checkR3
 Description : functions are checking the entire row if it pressed or
not.
 ARGS : void
 return : the pressed key or Nothing pressed

*******************************************************************************
*****************/

EN_KEYPAD_BTNS KEYPAD_checkR1(void);
EN_KEYPAD_BTNS KEYPAD_checkR2(void);
EN_KEYPAD_BTNS KEYPAD_checkR3(void);
```

- **HTimer:**

```
/**
 * \brief Generate Synchronous delay (busy waiting)*
 * \param Copy_delayTime Desired delay
 * \param Copy_timeUnit Time units (Seconds, mSeconds, uSeconds)
 *
 * \return en_HTIMErrorState_t
 */
en_HTIMErrorState_t TIM0_SyncDelay(Uint32_t u32_a_delay, en_timeUnits_t u8_a_timeUnit);


/**
 * \brief Generates delay asynchronously
* \param u32_a_delay desired delay
 * \param u8_a_timeUnit delay time units
 * \param Copy_pvCallbackFn function to call when delay is complete
 *
 * \return en_TIMErrorState_t
 */
en_HTIMErrorState_t TIM0_AsyncDelay(Uint32_t u32_a_delay, en_timeUnits_t u8_a_timeUnit,
void (*Copy_pvCallbackFn)(void));

/**
 * \brief Function to end a delay asynchronously
 * To Stop Async Delay: No Restrictions
 * To Stop Sync Delay: should only be called in an ISR/Callback function
 *
 * \return void
 */
void TIM0_AsyncEndDelay();
```

- **HLCD**

```
   /*
    * function            : HLCD_vidInit
    * description   : func to set LCD initialization
    * input param   : void
    * return        : void
    * */
   void HLCD_vidInit(void)

/*
 * function         : HLCD_vidWritecmd
 * description      : func to configure some commands on lcd
 * input param      :
 *                            u8commandCopy --> take lcd cmd instructions from
instruction table
<https://components101.com/sites/default/files/component_datasheet/16x2%20LCD%20Datasheet
.pdf>
 * return           : void
 * */
   void HLCD_vidWritecmd(Uint8_t u8commandCopy)

/*
 * function         : HLCD_vidWriteChar
 * description      : func to write char on lcd
 * input param      : u8CharCopy -> take ascii code of char   or   char address on CGROM
 * return           : void
 * */
   void HLCD_vidWriteChar(Uint8_t u8CharCopy)

/*
 * function         : HLCD_ClrDisplay
 * description      : func to clear anything on lcd
 * input param      : void
 * return           : void
 * */
   void HLCD_ClrDisplay(void)

/*
 * function         : HLCD_gotoXY
 * description      : func to determine position which char print at this position on lcd
### NOTE : (2rows x 16coloms)
 * input param      :
 *                         row -> take row number 0 or 1
 *                         pos -> take colom number from 0 ~ 16
 * return           : void
 * */
   void HLCD_gotoXY(Uint8_t row, Uint8_t pos)

/*
 * function         : HLCD_WriteString
 * description      : func to write string on lcd
 * input param      : str --> which take string as argument
 * return           : void
 * */
   void HLCD_WriteString(Uint8_t* str)
/*
 * function         : HLCD_WriteInt
```

```
 * description      : func to write integer number on lcd
 * input param      : number --> which take number as argument
 * return           : void
 * */
   void HLCD_WriteInt(Uint32_t number)

/*
 * function         : HLCD_vidCreatCustomChar
 * description      : func to store new patterm on CGRAM
 * input param      :
 *                          pu8custom  -> take pointer to array which having LCD Custom
Character Generated data ### take only 8 characters
 *                          u8Location -> determine location on CGRAM [0 ~ 8]
 * return           : void
 * */
   void HLCD_vidCreatCustomChar(Uint8_t* pu8custom, Uint8_t u8Location)

/**
 * (Author: Alaa Hisham)
 * \brief Display floating point number on LCD
 *
 * \param f32_a_number: number to display
 * \return void
 */
void HLCD_DisplayFloat(float32_t f32_a_number);
```

- **Buzzer**

```
   /**
    * \brief Initialize buzzer pin as output
    * \param pst_a_buzzer reference to buzzer
    * \return void
    */
   void BUZ_Init(st_Buzzer_t* pst_a_buzzer);

   /**
    * \brief Turn the buzzer on/off
    * \param pst_a_buzzer reference to buzzer
    * \param u16_a_state BUZ_ON (or) BUZ_OFF
    * \return en_BuzzerErrorState_t
    */
   en_BuzzerErrorState_t BUZ_SetState(st_Buzzer_t* pst_a_buzzer, en_BuzzerState_t
   en_a_state);
```

- **Button**

```
   /*
   * AUTHOR               : Bassel Yasser Mahmoud
   * FUNCTION                   : HButton_Init
   * DESCRIPTION          : Initialize specified pin as input and pull up
   * RETURN               : enu_buttonError_t {BUTTON_NOK, BUTTON_OK}
   */
   enu_buttonError_t HButton_Init(enu_pin en_pinx);


/*
```

```
* AUTHOR                  : Bassel Yasser Mahmoud
* FUNCTION                : HButton_ExtIntInit
* DESCRIPTION       : Initialize specified as pull up for external interrupt
* RETURN                  : enu_buttonError_t {BUTTON_NOK, BUTTON_OK}
*/
   enu_buttonError_t HButton_ExtIntInit(enu_pin en_pinx);

/*
* AUTHOR                  : Bassel Yasser Mahmoud
* FUNCTION                : HButton_getPinVal
* DESCRIPTION       : Get pin status if it is high or low
* RETURN                  : enu_buttonError_t {BUTTON_NOK, BUTTON_OK}
*/
   enu_buttonError_t HButton_getPinVal(enu_pin en_pinx,  Uint8_t* pu8_refVal );



*
Description : This function initializes the external interrupt number and it's detecting type
and initialize call back function.
ARGS        : takes the EXINT_NUMBER( INT0,INT1 OR INT2) and sense control and and pointer to
the function we want to execute when interrupt occurs.
return      : return EXTINT_OK if the EXINT_NUMBER initializes correctly, EXTINT_NOT_OK
otherwise
*/
EN_EXTINT_ERROR H_EXTINT_create(EN_EXINT_NUMBER INTx ,EN_Sence_Control
INTxSense,void(*ptrfunc)(void));
```

- **HEXT_INT**

```
*
Description : This function initializes the external interrupt number and it's detecting
type and initialize call back function.
ARGS        : takes the EXINT_NUMBER( INT0,INT1 OR INT2) and sense control and and pointer
to the function we want to execute when interrupt occurs.
return      : return EXTINT_OK if the EXINT_NUMBER initializes correctly, EXTINT_NOT_OK
otherwise
*/
EN_EXTINT_ERROR H_EXTINT_create(EN_EXINT_NUMBER INTx ,EN_Sence_Control
INTxSense,void(*ptrfunc)(void));
```

- **HSPI**

```
/**
 * (Author: Alaa Hisham)
 * \brief Initialize the MCU as the Master in SPI communication
 * \return void
 */
void HSPI_MasterInit(void);

/**
 * (Author: Alaa Hisham)
 * \brief Initialize the MCU as a slave in SPI communication
 * \return void
 */
void HSPI_SlaveInit(void);


/**
```

```
 * (Author: Alaa Hisham)
 * \brief Function to send a single character
 * \param u8_a_character character to send
 * \return void
 */
void HSPI_SendChar(Uchar8_t u8_a_character);

/**
 * \brief Receive data in the given buffer
 *
 * \param pu8_a_data: reference to buffer to store received data
 * \param u8_a_DataSize: Size (length) of data to receive
 *
 * \return void
 */
void HSPI_ReceiveData(Uchar8_t *pu8_a_data, Uchar8_t u8_a_DataSize);


/**
 * \brief Send given data byte by byte to selected slave
 *          and receive data in exchange into given array
 * \param pu8_a_TxDataArr: Reference to array of data to be transmitted
 * \param pu8_a_RxDataArr: Reference to array to store received data
 * \param u8_a_DataLen:    Length of data to exchange (in bytes)
 *                                  (Must be less than or equal SPI_BUFFER_SIZE)
 *
 * \return en_HSPI_ErrorState_t
 */
en_HSPI_ErrorState_t HSPI_ExchangeData(Uchar8_t* pu8_a_TxDataArr, Uchar8_t*
pu8_a_RxDataArr, Uchar8_t u8_a_DataLen);


/**
 * (Author: Alaa Hisham)
 * \brief Request to send data to the master
 * \param u8_a_data: data to send
 * \return void
 */
void HSPI_SlaveRequest(Uchar8_t* pu8_a_dataPtr, Uchar8_t u8_a_DataSize);
```

- **EEPROM:**

```
/** AUTHOR  : Sherif Ashraf Khadr
* \brief : This Function Just Call To Initialize I2C as Master
*
* \param : Void
*
* \return void
*/
void eeprom_init(void)
```

```
/** AUTHOR : Sherif Ashraf Khadr
* \brief : This Function Call To Make The Sequence Of I2C Frame To Write Byte On A Device
*
* \param : Uint16_t address : This Is Device Address
*                   : Uchar8_t data : This Is Data That Will Be Write
*
* \return void
*/
void eeprom_write_byte(Uint16_t address, Uchar8_t data)


/** AUTHOR : Sherif Ashraf Khadr
* \brief : This Function Call To Make The Sequence Of I2C Frame To Read Byte On A Device
*
* \param : Uint16_t address : This Is Device Address
*
* \return Uchar8_t : Function Will Return Uchar8_t Contain The Data
*/
Uchar8_t eeprom_read_byte(Uint16_t address)



/** AUTHOR : Sherif Ashraf Khadr
* \brief : This Function Call When You Need To Write A String In The EEPROM
*
* \param : Uint16_t address : This Is Device Address
*                   : Uchar8_t *str    : This Pointer Will Store The Address Of The Array Of The Chars
* \return  Void
*/
void eeprom_write_string(Uint16_t Copy_u8Address, const Uchar8_t* str)


/** AUTHOR : Sherif Ashraf Khadr
* \brief : This Function Call When You Need To Read A String From The EEPROM
*
* \param : Uint16_t address : This Is Device Address
*                   : Uchar8_t *str    : This Pointer Will Store The Address Of The Array Of The Chars That Will Return
String In It
* \return  Void
*/
void eeprom_read_string(Uint16_t Copy_u8Address, Uchar8_t* str)
```

Card_Database Layer (CARD MCU)

```
/*
 * AUTHOR                  : Bassel Yasser Mahmoud
 * FUNCTION                : APP_terminalPinGet
 * DESCRIPTION             : Get pin from User within terminal and doing some validation
 * RETURN                  : en_terminalPinGetStatus_t {PINGET_NOK or PINGET_OK}
 */
en_terminalPinGetStatus_t APP_terminalPinGet(Uchar8_t* arr);

/*
 * AUTHOR                  : Sharpel
 * FUNCTION                : APP_terminalPanGet
 * DESCRIPTION             : Get pan from User within terminal and doing some validation
 * RETURN                  : en_terminalPanGetStatus_t {PANGET_NOK or PANGET_OK}
 */
en_terminalPanGetStatus_t APP_terminalPanGet(Uchar8_t* arr);

/*
 * FUNCTION                : SaveCardData
 * DESCRIPTION             : Saving PAN and PIN in EEPROM
 * RETURN                  : EN_TerminalDataState {DATA_SAVED, DATA_NSAVED, DATA_READ,
DATA_NREAD}
 */
EN_TerminalDataState SaveCardData(Uchar8_t *CardPan,Uchar8_t *CardPin);

/*
 * FUNCTION                : ReadCardData
 * DESCRIPTION             : Reading PAN and PIN from EEPROM
 * RETURN                  : EN_TerminalDataState {DATA_SAVED, DATA_NSAVED, DATA_READ,
DATA_NREAD}
 */
EN_TerminalDataState ReadCardData(Uchar8_t *CardPan,Uchar8_t *CardPin);

/*
 * FUNCTION                : CARD_MatchPINs
 * DESCRIPTION             : Validate if PIN no and Confirmed PIN no is Matched or not
 * RETURN                  : en_CardPinMatchError_t {PIN_Match_NOK, PIN_Match_OK}
 */
en_CardPinMatchError_t CARD_MatchPINs();
```

ATM_MODULE Layer (ATM MCU)

- **ATM:**

```
/**
 * \brief Displays welcome routine
 *
 * \return void
 */
void Welcome(void);

/**
 * (Author: Sherif Ashraf)
 * \brief Check if the pin user enters is the same as the cardholder's pin
 * \param pinFromAtm   : reference to pin entered by user
 * \param pinFromServer: reference to pin received from card
 * \return EN_PinState
 */
EN_PinState PIN_checkPinMatching(Uchar8_t *pinFromAtm,Uchar8_t *pinFromServer);

/*
* AUTHOR                : Sharpel
* FUNCTION              : Get_pin
* DESCRIPTION           : get pin from user (on the atm )
* ARGS                   : pointer to array (the size of array must be 5 or more) to store
entered pin by user
* RETURN                : PIN_OK if user enters 4 numbers , PIN_NOT_OK otherwise
*/
EN_PinState Get_pin(Uchar8_t *enteredpin);

/**
 * (Author: Sherif Ashraf)
 * \brief Locks the system and sound the buzzer
 * \param pst_a_buzzer: reference to the buzzer
 * \return en_BuzzerErrorState_t
 */
en_BuzzerErrorState_t deinitAtm(st_Buzzer_t* pst_a_buzzer);

/**
 * (Author: Alaa Hisham)
 * \brief Get the card pan and pin
 * \param pu8_a_pan: reference to buffer to receive pan from card
 * \param pu8_a_pin: reference to buffer to receive pin from card
 * \return EN_PinState
 */
EN_PinState ATM_GetCardData(Uchar8_t *pu8_a_pan, Uchar8_t *pu8_a_pin);

/*
* AUTHOR                : Sharpel
* FUNCTION              : get_amount_left
* DESCRIPTION           : get amount from user ( on the atm )
* ARGS                   : pointer to array (the size of array must be 8 or more and equal
"0000.00" initial value) to store entered pin by user
* RETURN                : void
*/
void get_amount_left (Uchar8_t * amount);
```

```
/*
* AUTHOR                : Bassel Yasser
* FUNCTION              : EXTINT_FUNC
* DESCRIPTION           : when timer 2 ISR is fire it changes the state of (Enter or Zero)
* ARGS                   : void
* RETURN                : void
*/
void EXTINT_FUNC(void);


/**
 * (Author: Alaa Hisham)
 * \brief Carries out the routine for approved card
 * \param f32_a_NewBalance: the balance to display after transaction
 * \return void
 */
void ATM_ApprovedCard(float32_t f32_a_NewBalance);
```

- **Database_check:**

```
/*
 * FUNCTION              : isValidPanAccount
 * DESCRIPTION           : Check If PAN No. Valid or not
 * RETURN                : EN_dataError_t {APPROVED
,FRAUD_CARD,CARD_STOLEN,EXCEED_MAX_DAILY_AMOUNT,INSUFFICIENT_FUND, DATA_ERROR}
 */
EN_dataError_t isValidPanAccount(Uchar8_t * pan);

/*
 * FUNCTION              : isRunningAccount
 * DESCRIPTION           : Checking if card stolen or not
 * RETURN                : EN_dataError_t {APPROVED
,FRAUD_CARD,CARD_STOLEN,EXCEED_MAX_DAILY_AMOUNT,INSUFFICIENT_FUND, DATA_ERROR}
 */
EN_dataError_t isRunningAccount(Uchar8_t * pan);

/*
 * FUNCTION              : isValidAccountAmount
 * DESCRIPTION           : Checking if there is INSUFFICIENT_FUND or not
 * RETURN                : EN_dataError_t {APPROVED
,FRAUD_CARD,CARD_STOLEN,EXCEED_MAX_DAILY_AMOUNT,INSUFFICIENT_FUND, DATA_ERROR}
 */
EN_dataError_t isValidAccountAmount(Uchar8_t * pan,Uchar8_t * amount,float32_t
*newAmount);
/*

 * FUNCTION              : isBelowMaxDailyAmount
 * DESCRIPTION           : Checking if transfered money is below limited daily amount or
not
 * RETURN                : EN_dataError_t {APPROVED
,FRAUD_CARD,CARD_STOLEN,EXCEED_MAX_DAILY_AMOUNT,INSUFFICIENT_FUND, DATA_ERROR}
 */
EN_dataError_t isBelowMaxDailyAmount(Uchar8_t * amount);

/*
```

```
 * FUNCTION               : DATABASE_checking
 * DESCRIPTION            : Card Database checking
 * RETURN                 : EN_dataError_t {APPROVED
,FRAUD_CARD,CARD_STOLEN,EXCEED_MAX_DAILY_AMOUNT,INSUFFICIENT_FUND, DATA_ERROR}
 */
EN_dataError_t DATABASE_checking (Uchar8_t * pan,Uchar8_t * amount,float32_t *newAmount);
```

Application Layer:

- **Card MCU**

```
/**
 * \brief Initializations of all used peripherals
 * \return void
 */
void APP_Init(void);

/**
 * \brief The main logic of the Card
 * \return void
 */
void APP_Start(void);
```

- **ATM MCU**

```
/**
 * \brief Initializations of all used peripherals
 * \return void
 */
void APP_Init(void);

/**
 * \brief The main logic of the ATM
 * \return void
 */
void APP_Start(void);
```

Low Level Design

MCAL Layer:

- **DIO**

```
Sint8_t DIO_s8SETPinDir (enu_pin enPinCopy, enu_dir enPortDir)
```

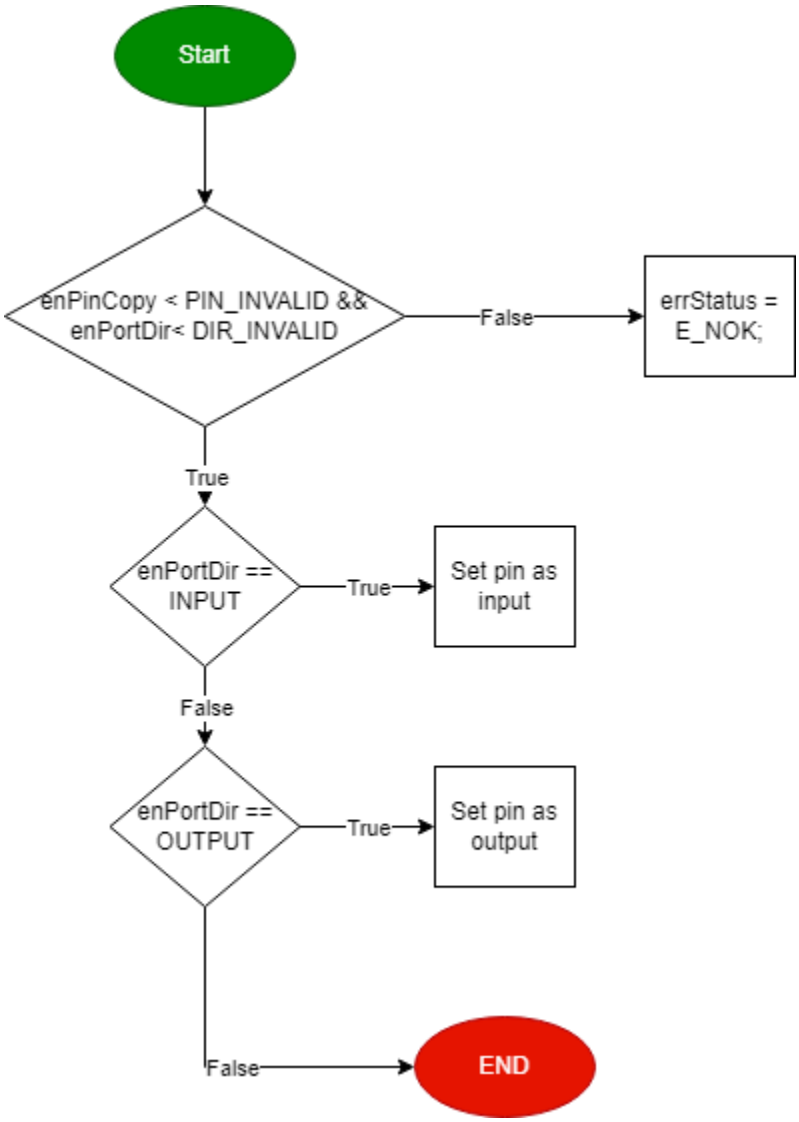


Figure 3 DIO_s8SETPinDir Flow Chart

```
Sint8_t DIO_s8SETPinVal (enu_pin enPinCopy, enu_val enPortVal)
```

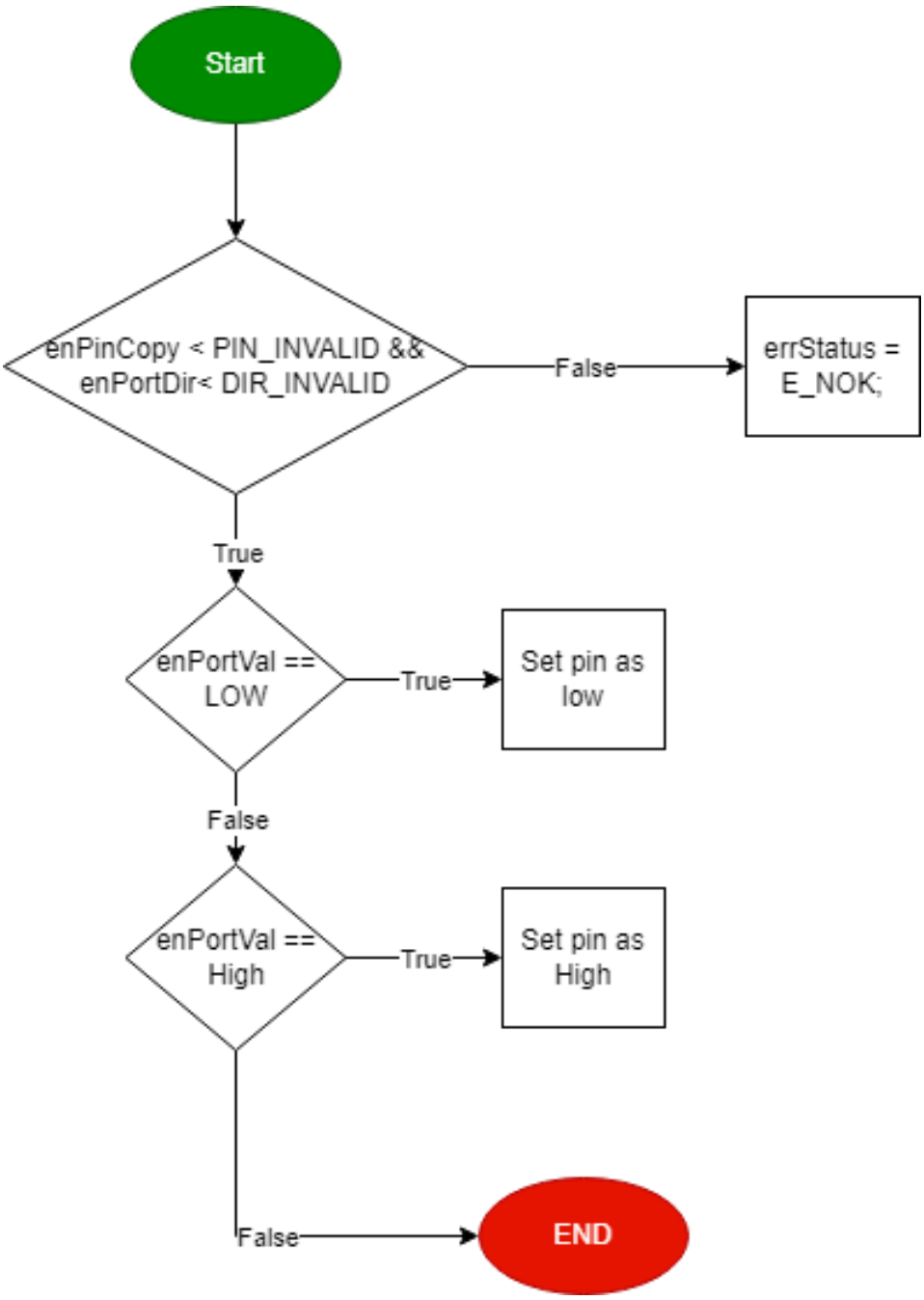


Figure 4 DIO_s8SETPinVal Flow chart

```
Sint8_t DIO_s8GETPinVal (enu_pin enPinCopy, Uint8_t* pu8Val)
```

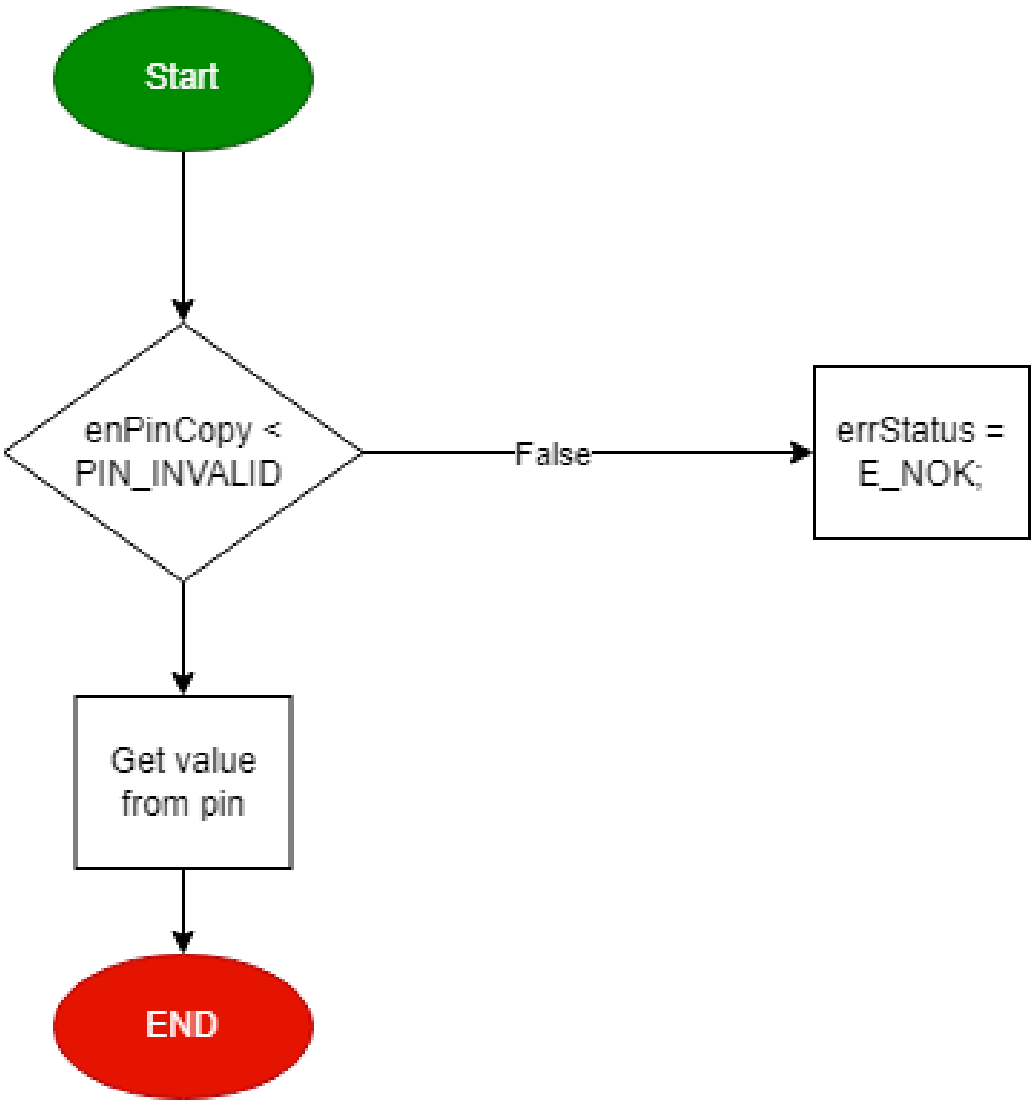


Figure 5 DIO_s8GETPinVal Flow Chart

- **Timer:**

TIM0_Init

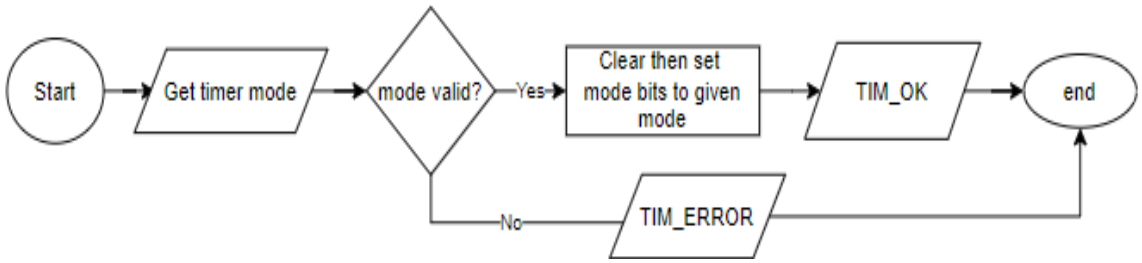


Figure 6 TIM0_Init Flow Chart

TIM0_Start

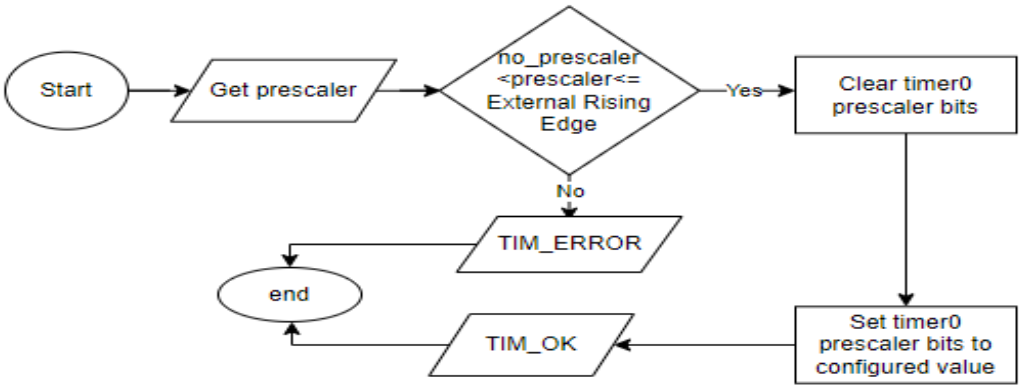


Figure 7 TIM0_Start Flow Chart

TIM0_Stop

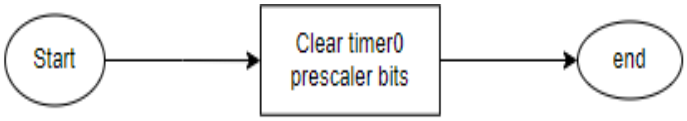
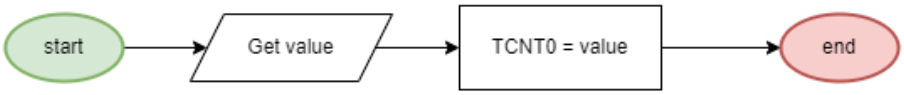
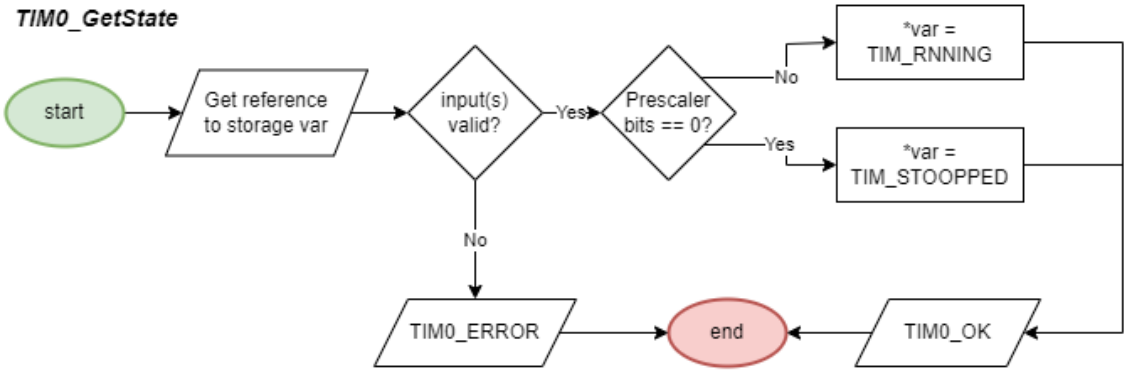


Figure 8 TIM0_Stop Flow Chart

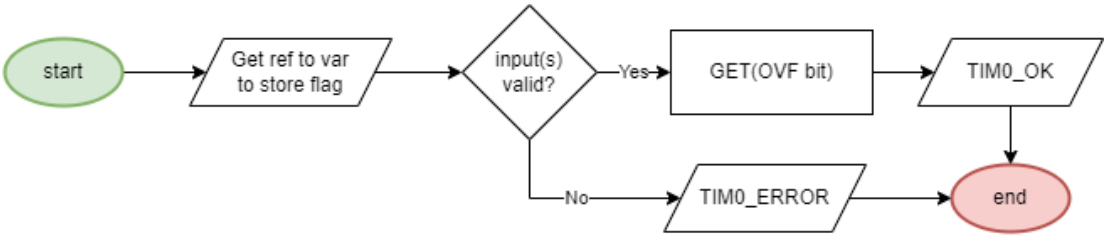
TIM0_SetValue



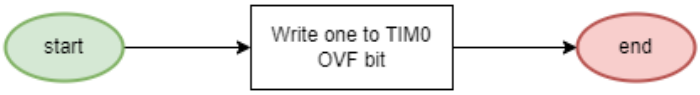
TIM0_GetState



TIM0_GetOVF



TIM0_ClearOVF



TIM0_EnableOVFInt

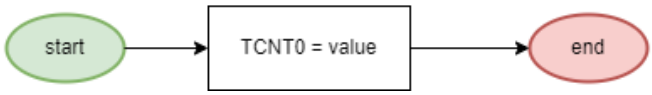


Figure 9 TIM0 remaining Flow Charts

- **EXTINT:**

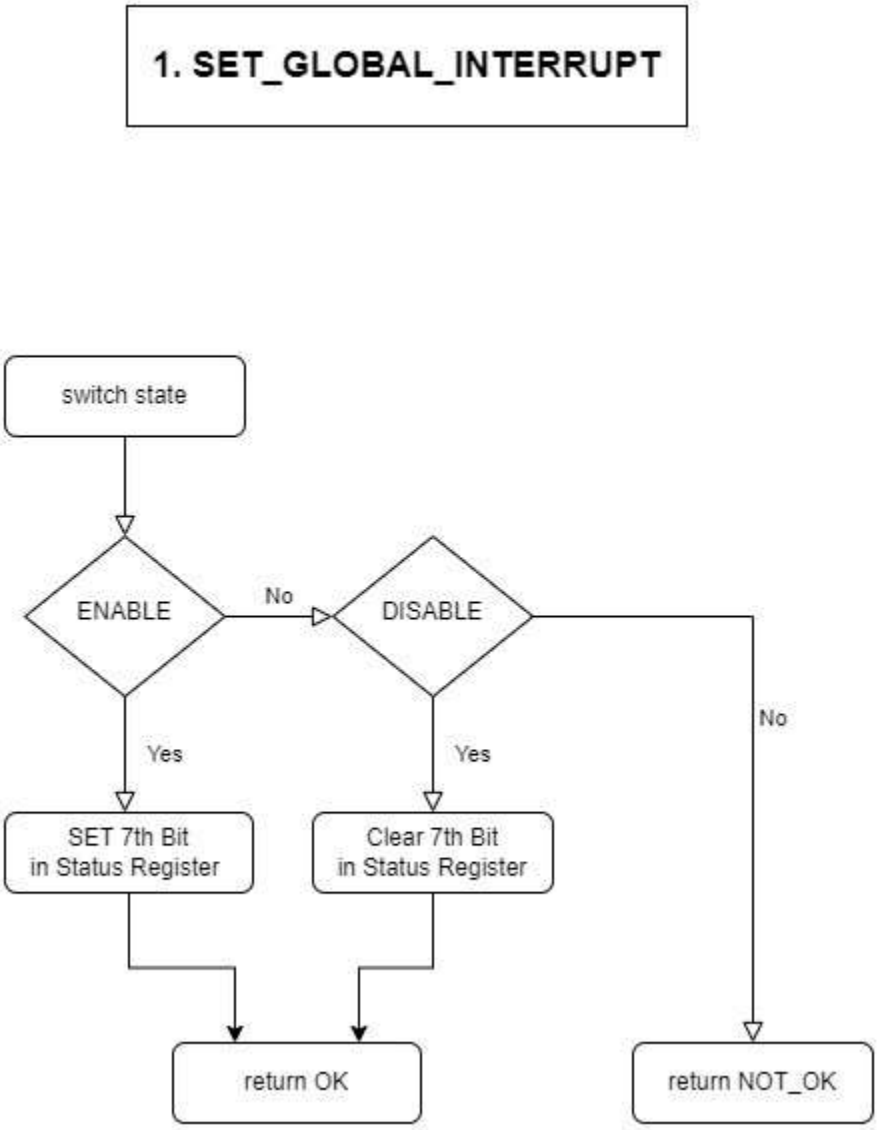


Figure 10 EXTINT: Set_Global_Interrupt

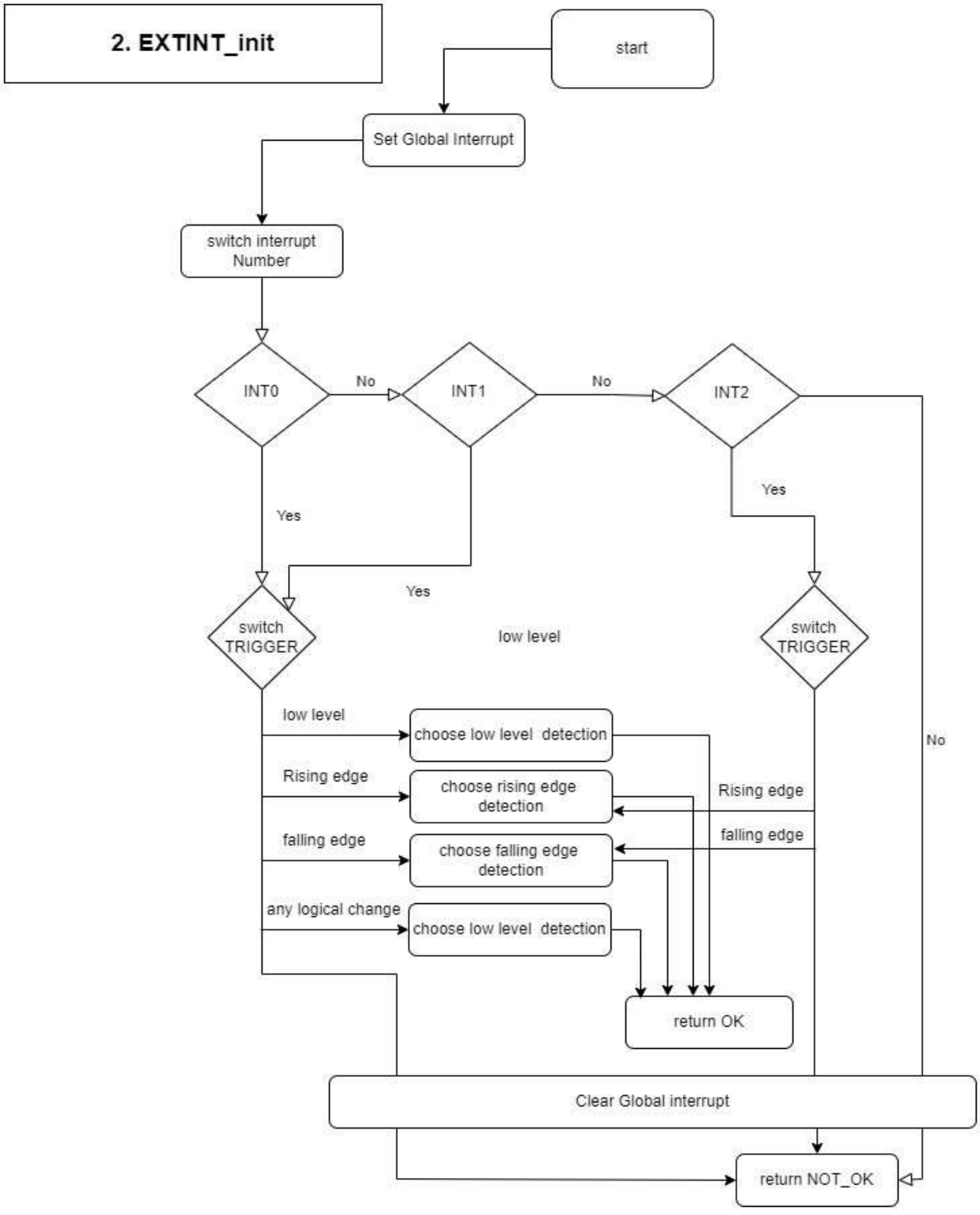


Figure 11 EXTINT_Init flow chart

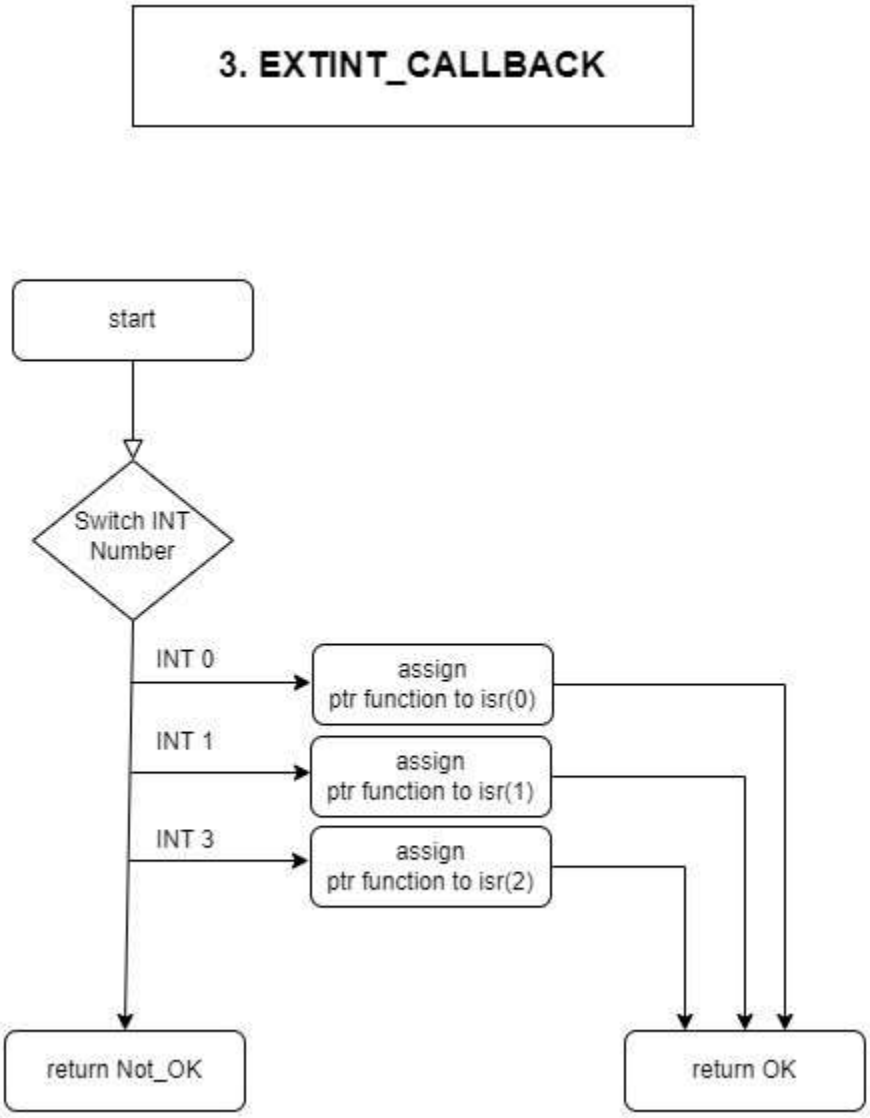


Figure 12 EXTINT_CALLBACK flow chart

- **UART:**

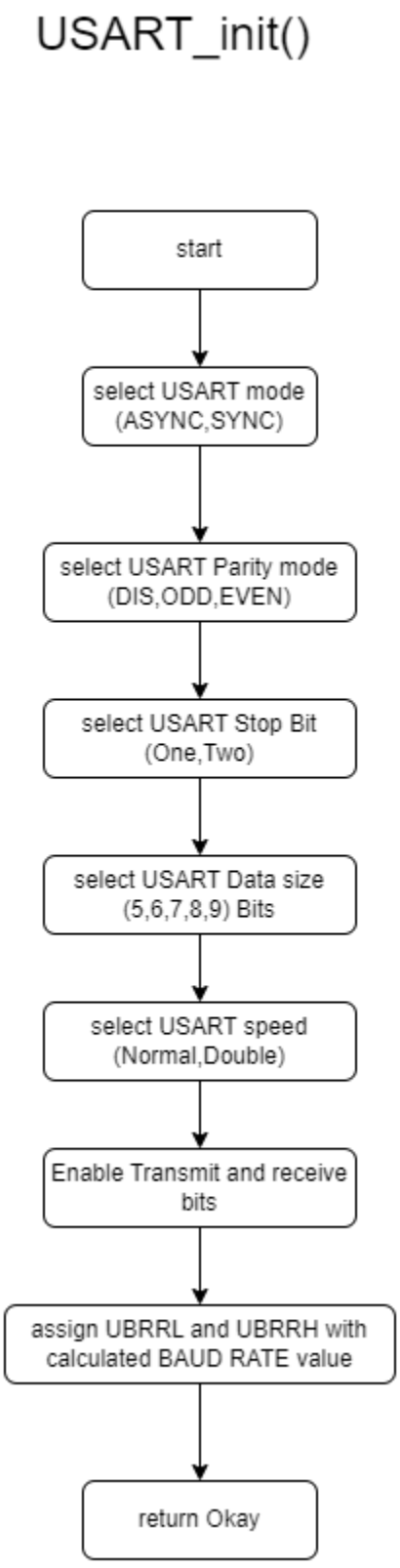


Figure 13 USART_init flow chart

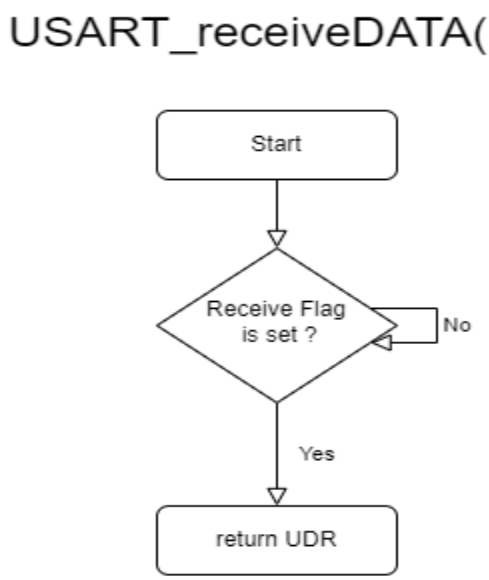


Figure 14 USART_receiveData flow chart

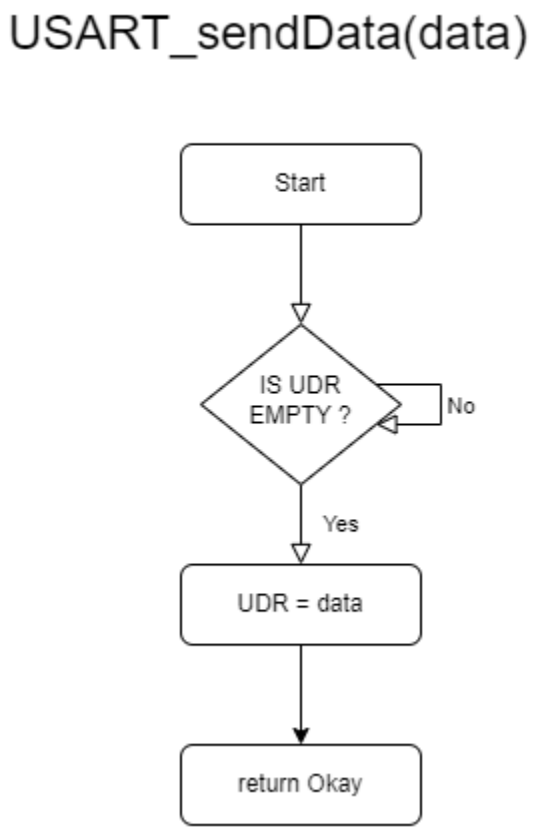


Figure 15 USART_sendData flow chart

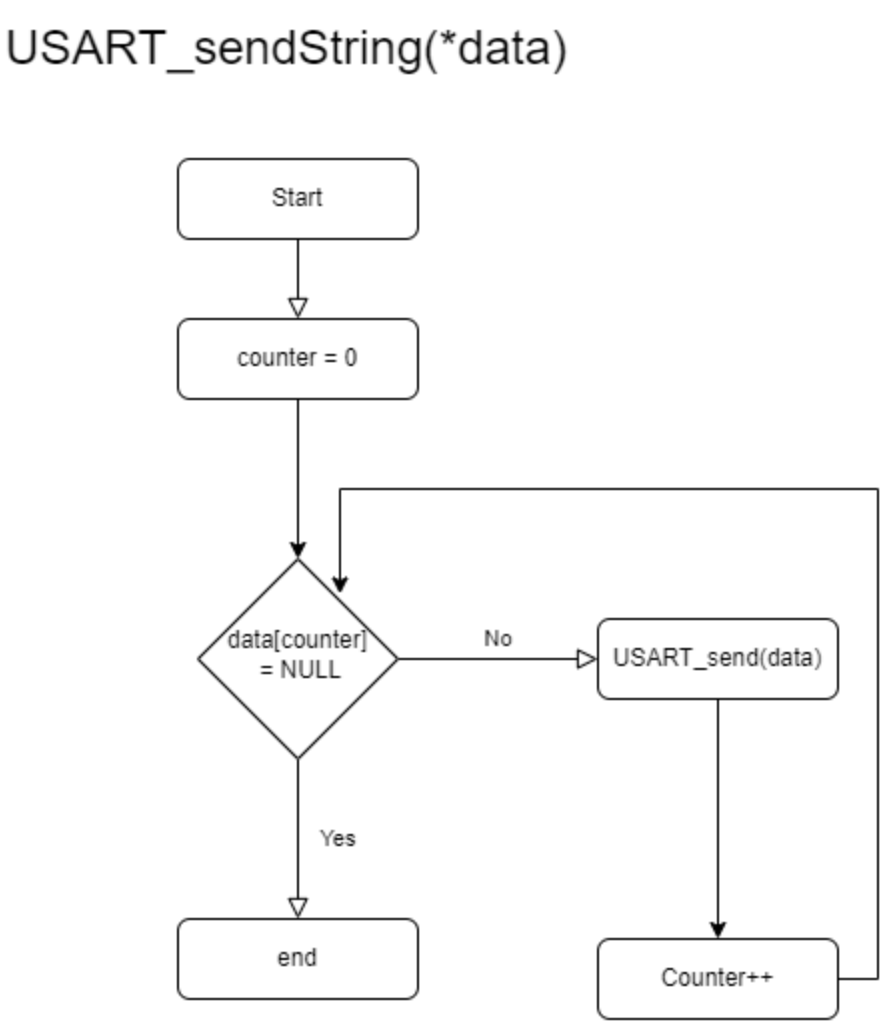


Figure 16 USART_sendString flow chart

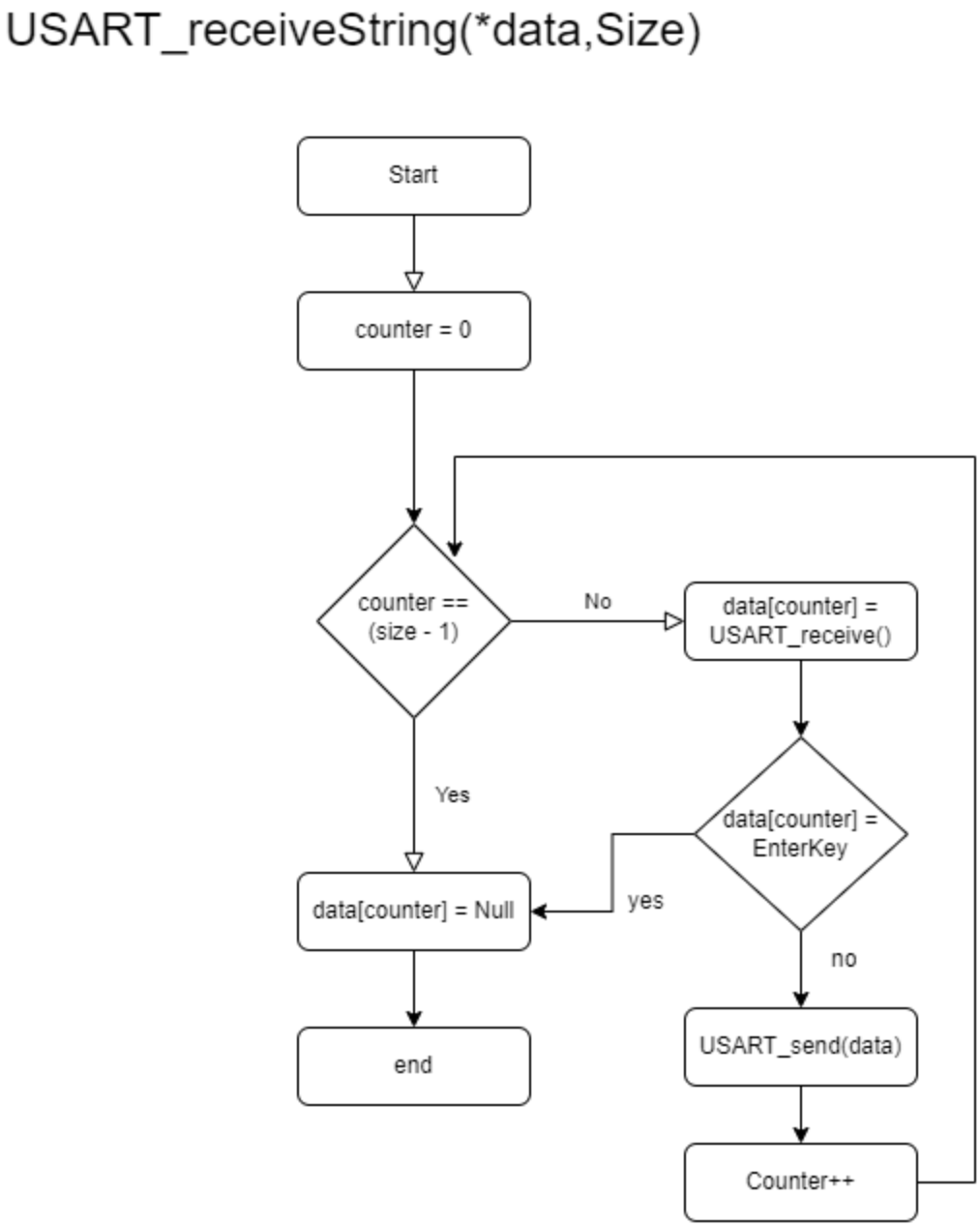


Figure 17 USART_receiveString flow chart

- **SPI:**

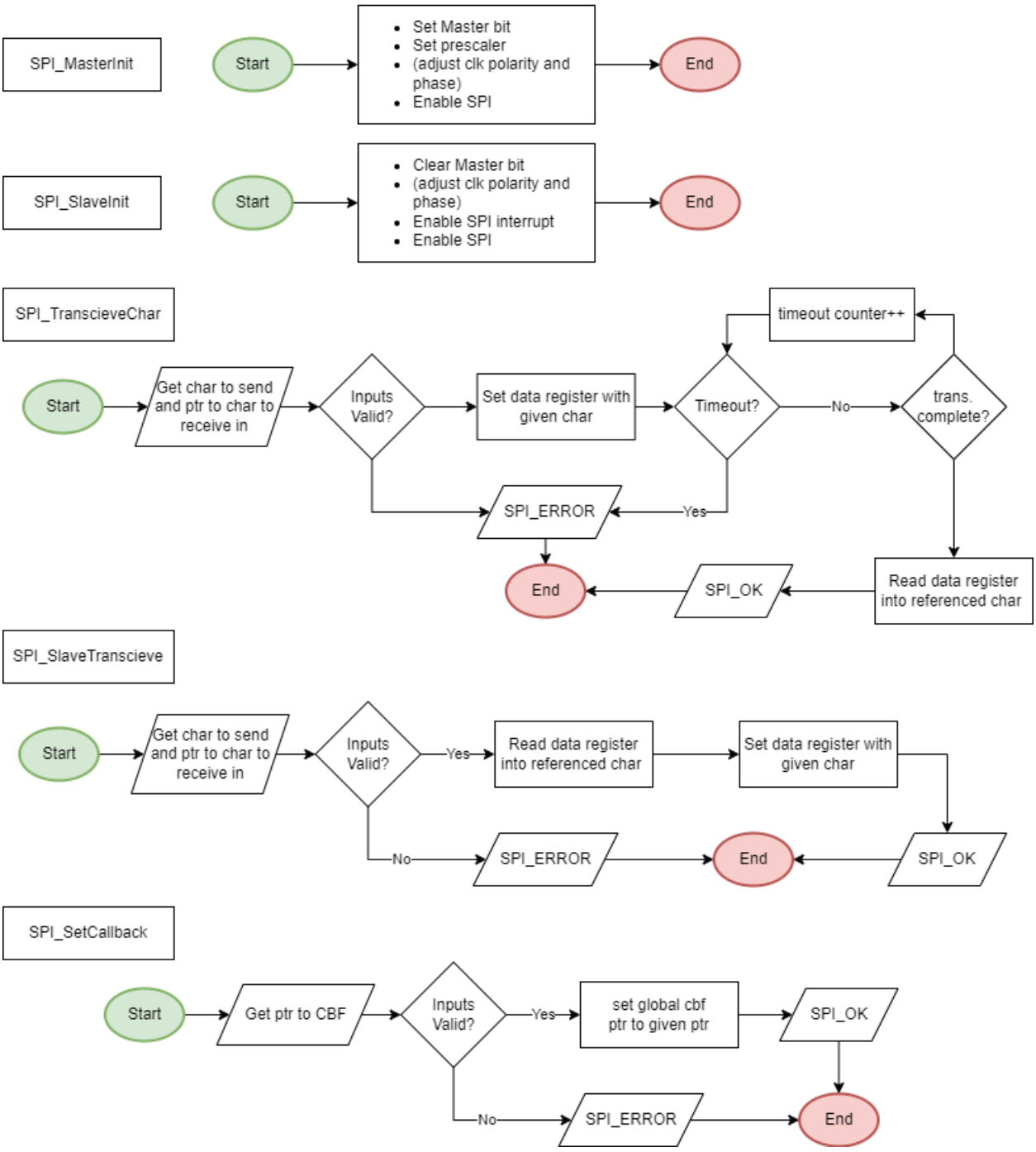


Figure 18 Flow charts of SPI APIs

- **I2C:**

```
void i2c_init_master(void);
```

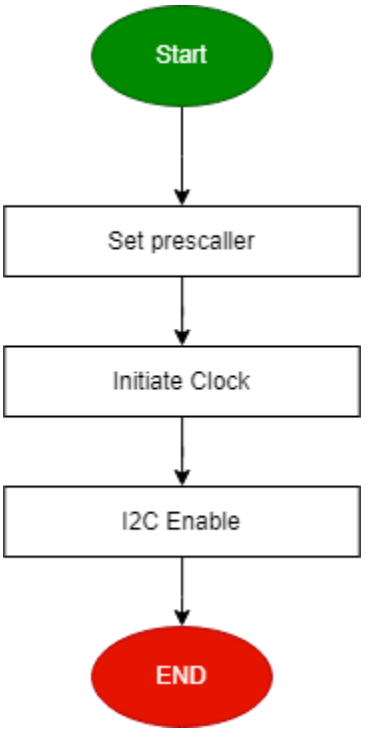


Figure 19 i2c_init_master flow chart

```
void i2c_start(void);
```

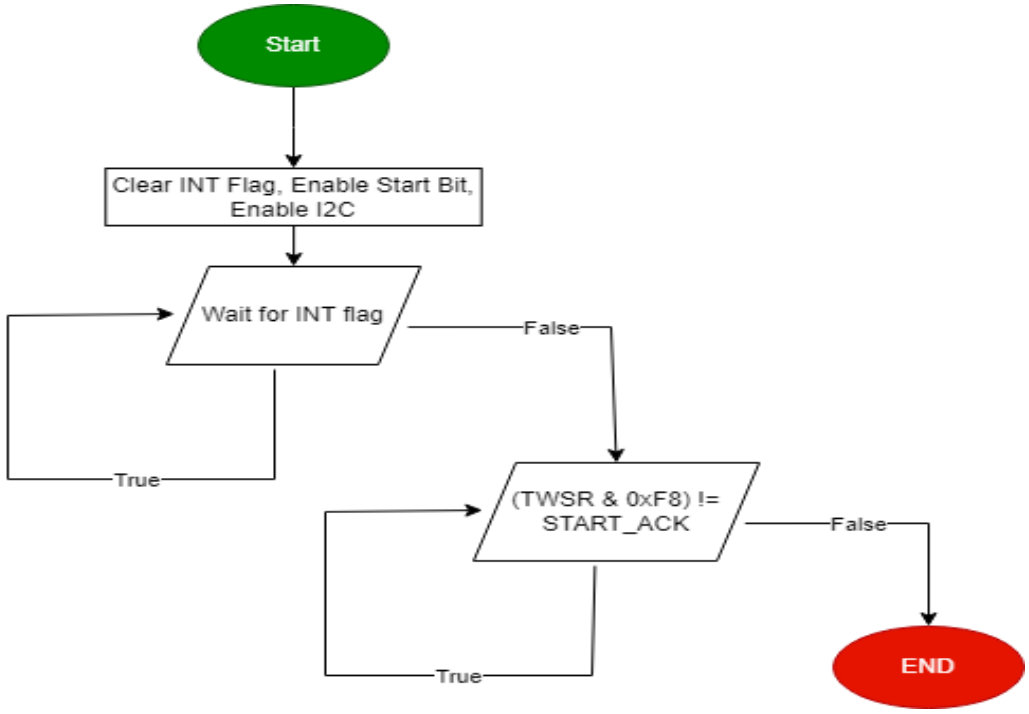


Figure 20 i2c_start flow chart

```
void i2c_repeated_start(void);
```

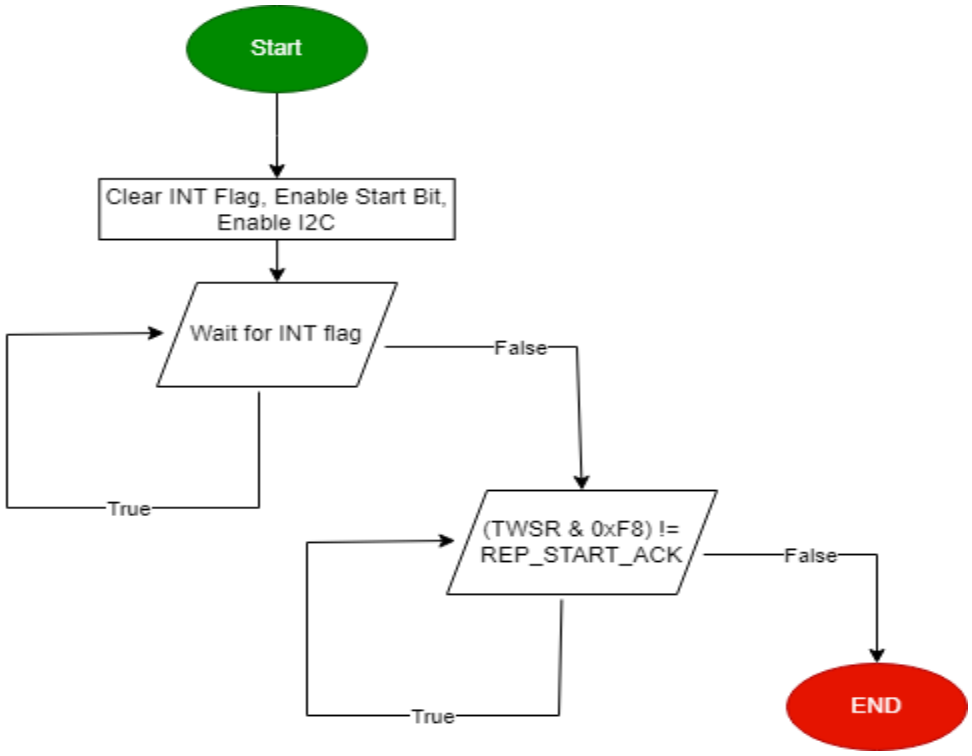


Figure 21 i2c_repeated_start flow chart

```
void i2c_send_slave_address_with_write_req(Uint8_t slave_address);
```

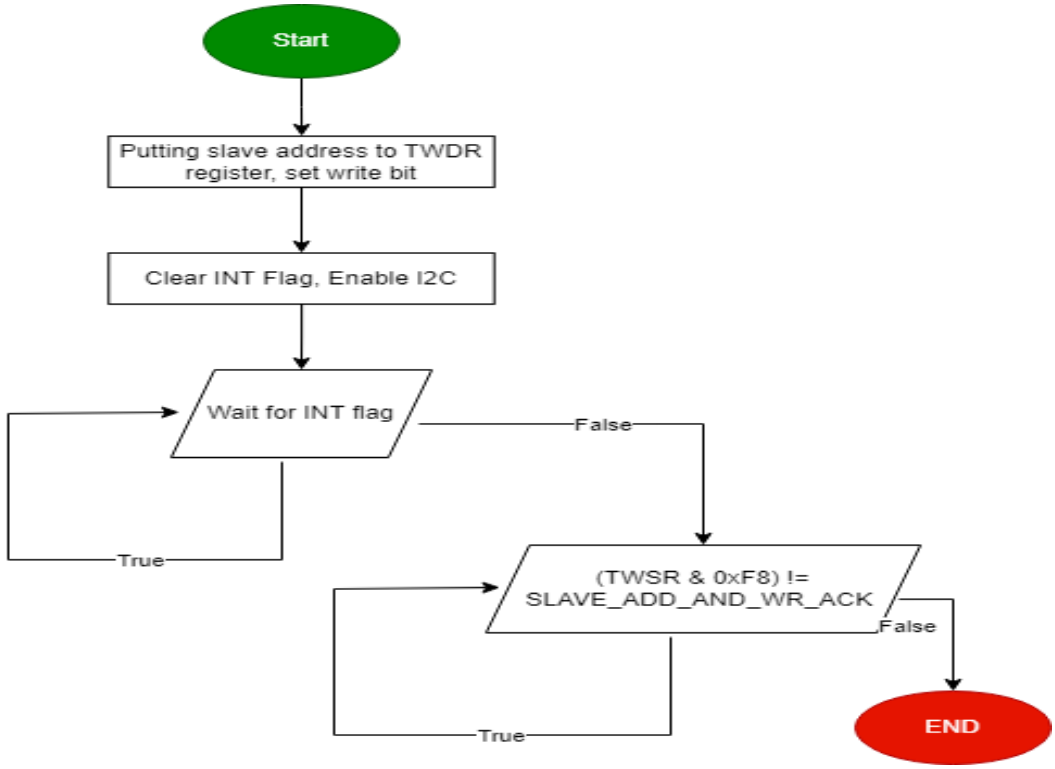


Figure 22 i2c_send_slave_address_with_write_req flow chart

```
void i2c_send_slave_address_with_read_req(Uint8_t slave_address);
```

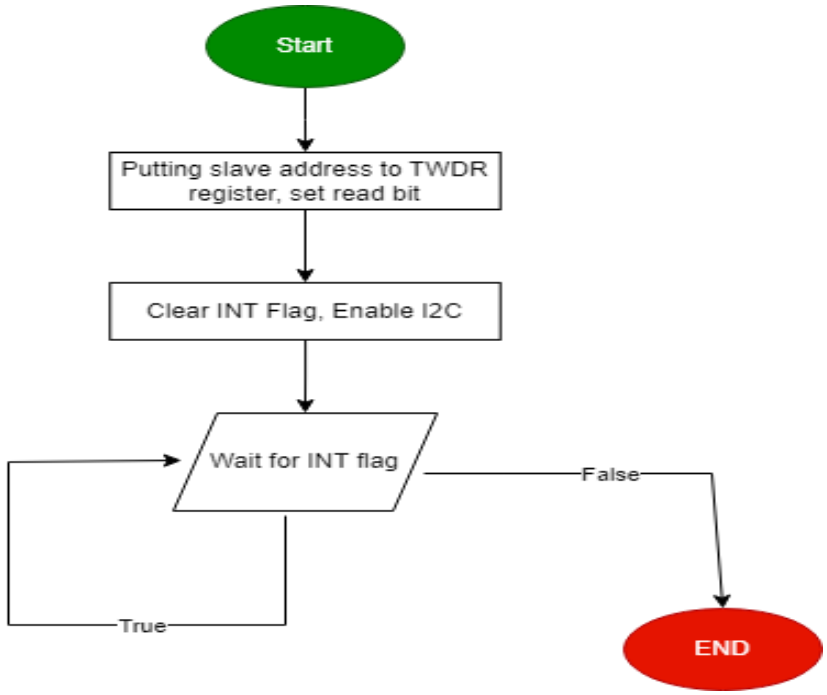


Figure 23 i2c_send_slave_address_with_read_req flow chart

```
void i2c_write_byte(Uint8_t byte);
```

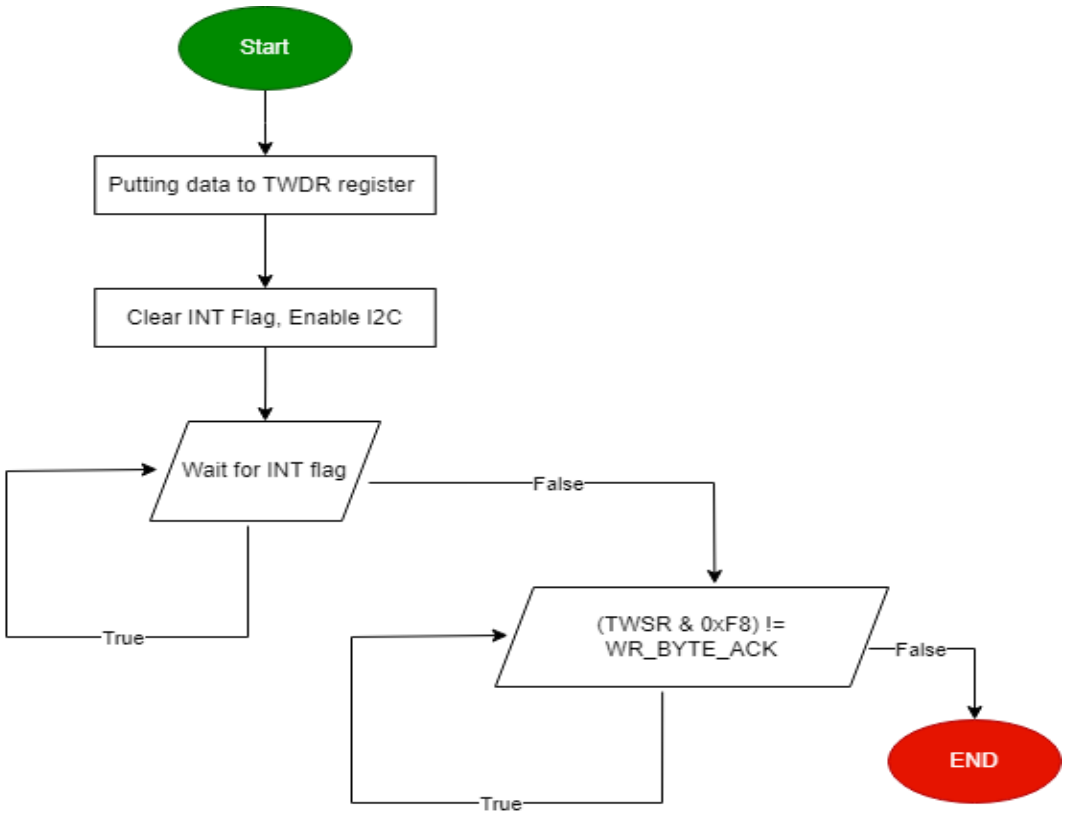


Figure 24 i2c_write_byte flow chart

```
Uint8_t i2c_read_byte(void);
```

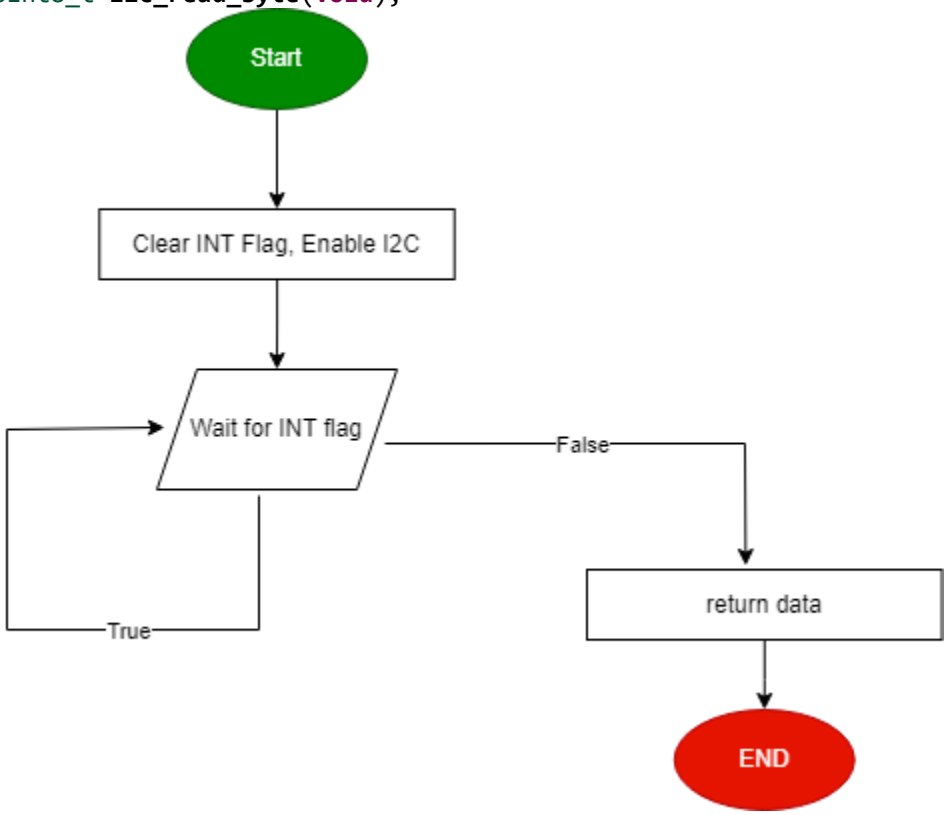


Figure 25 i2c_read_byte flow chart

```
void i2c_stop(void);
```

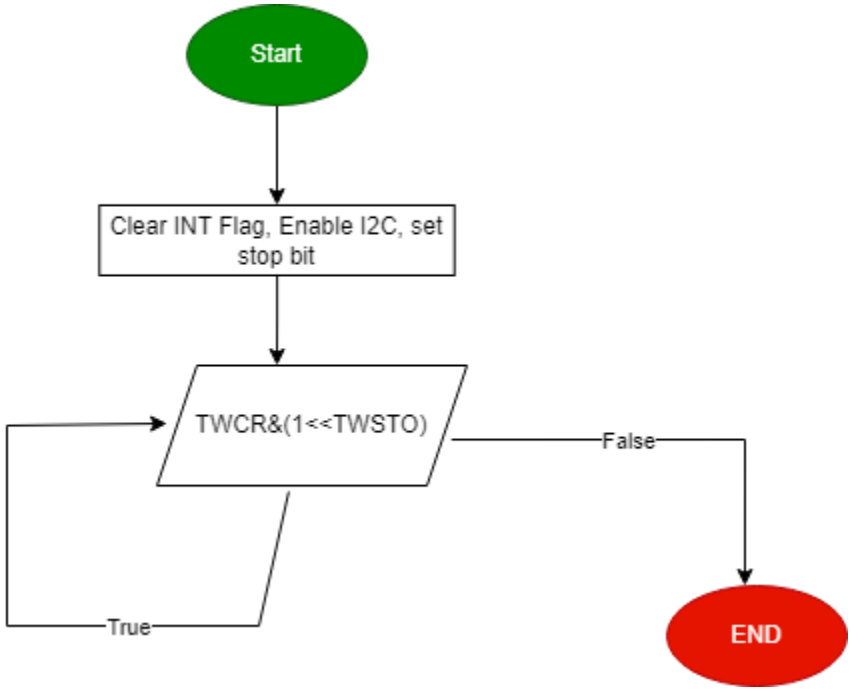


Figure 26 i2c_stop flow chart

HAL Layer

- **HTimer0**

HTIM0_SyncDelay

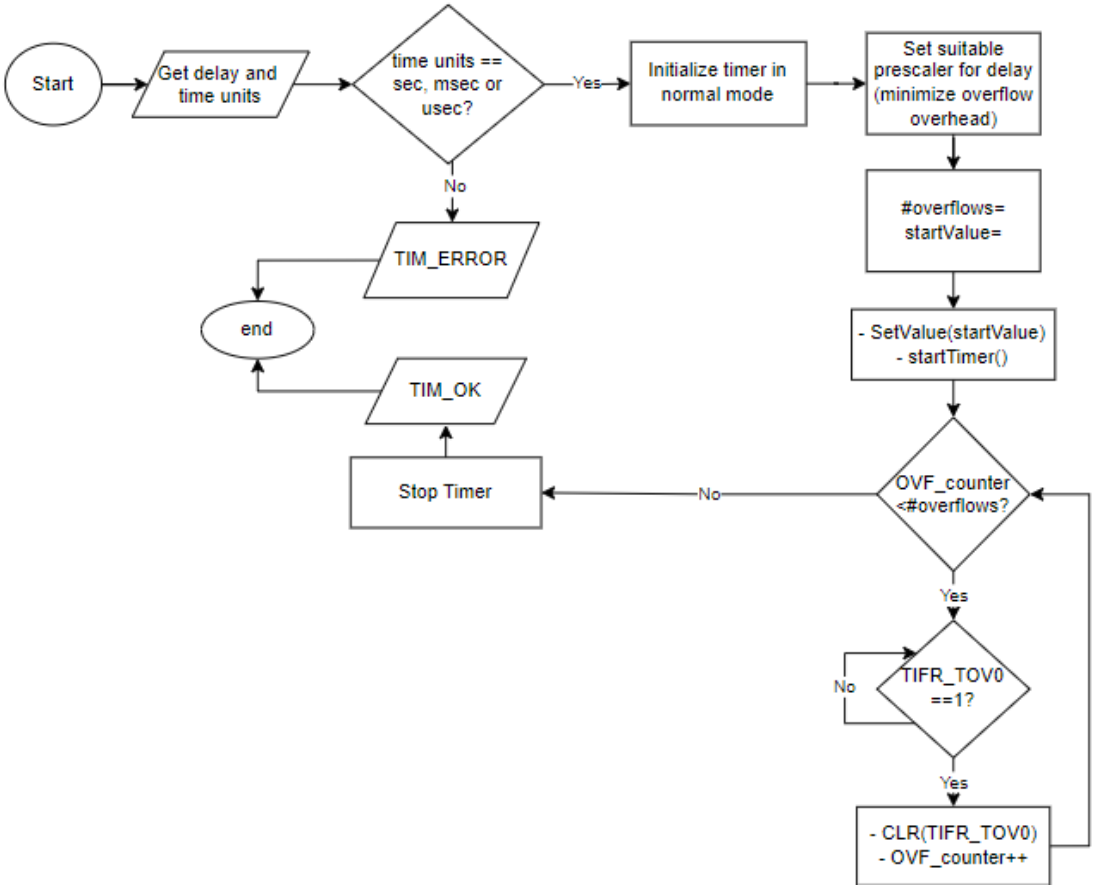


Figure 27 HTIM0_SyncDelay Flow Chart

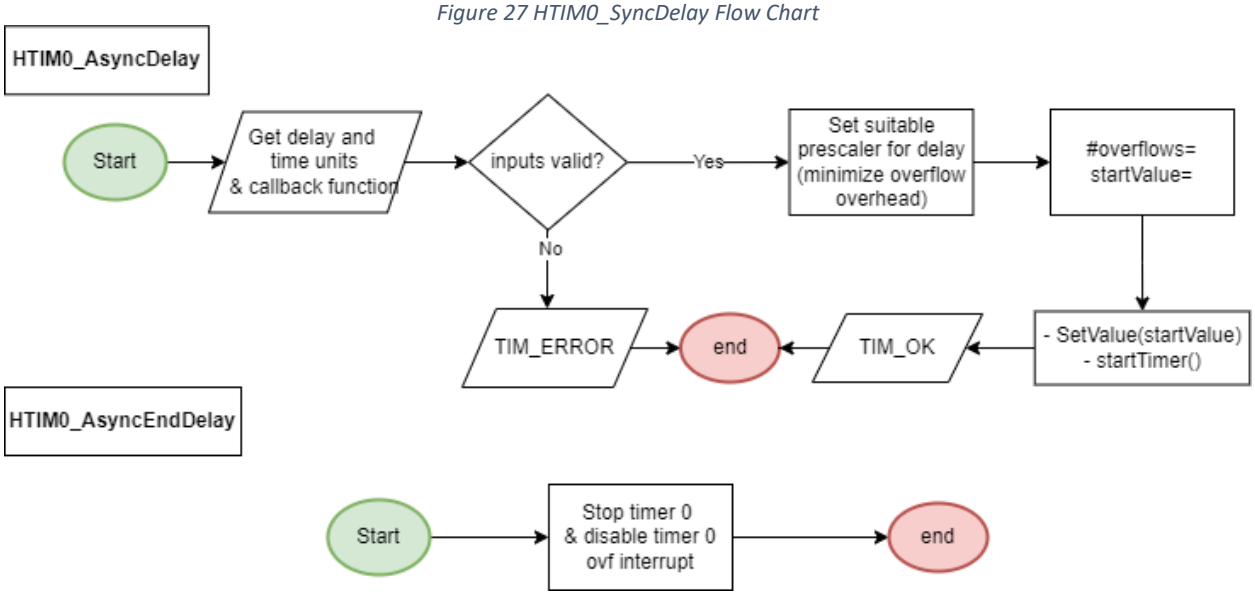


Figure 28 HTIM0_AsyncDelay and EndDelay

- **HSPI**

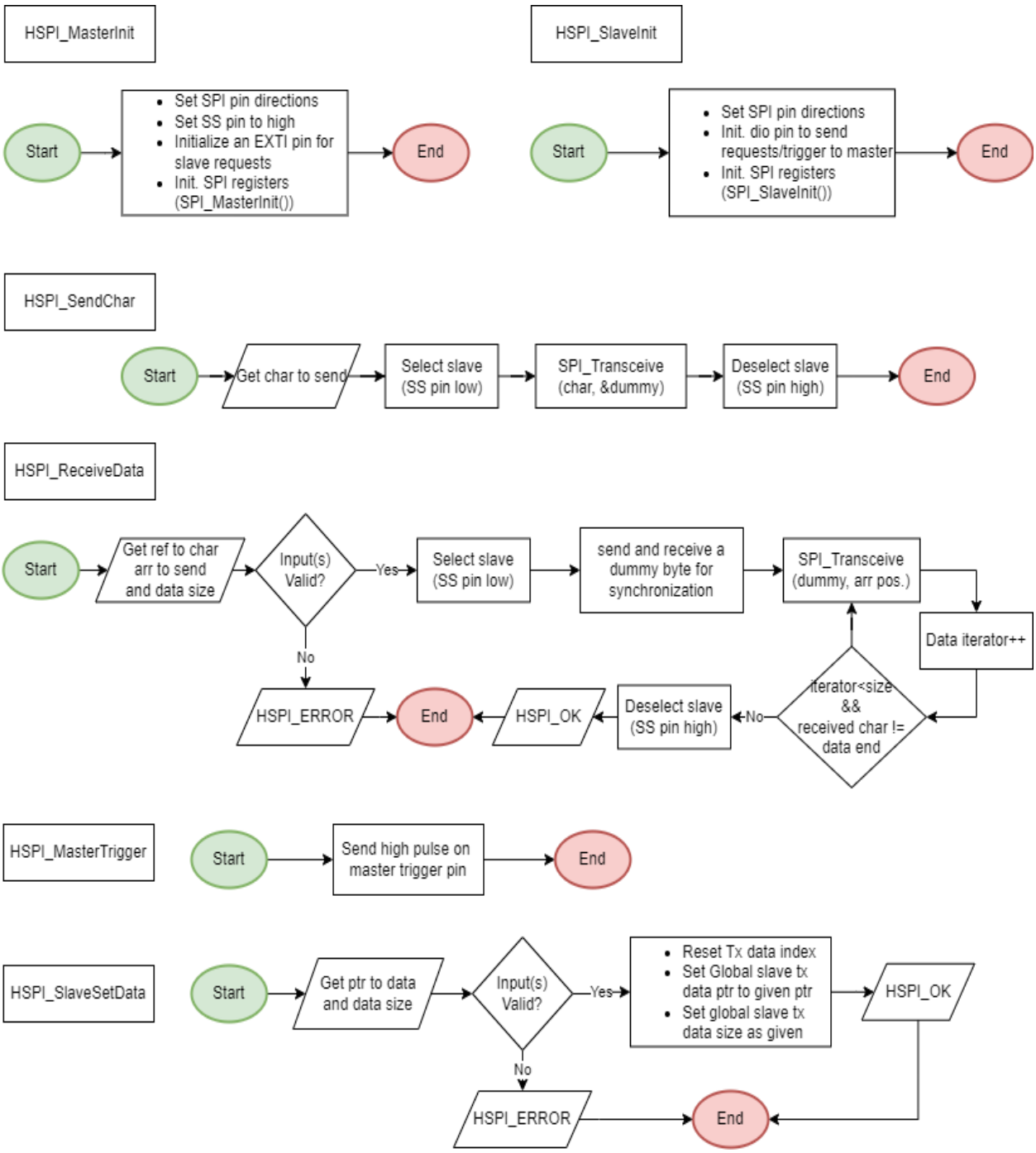


Figure 29 Flow charts of HSPI APIs

- **LCD**

```
void HLCD_vidInit(void)
```

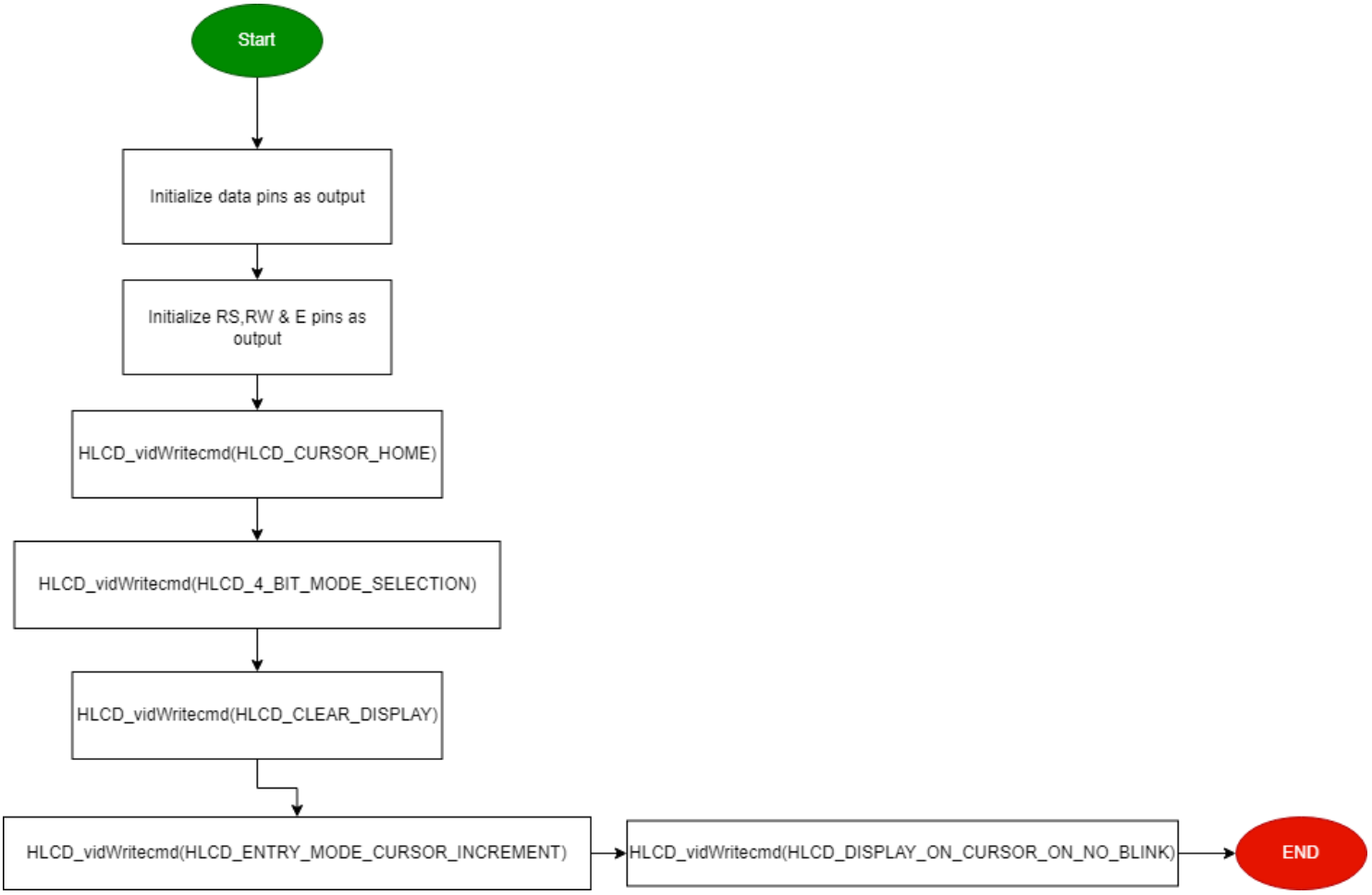


Figure 30 HLCD_vidInit Flow Chart

```
void HLCD_vidWritecmd(Uint8_t u8commandCopy)
```

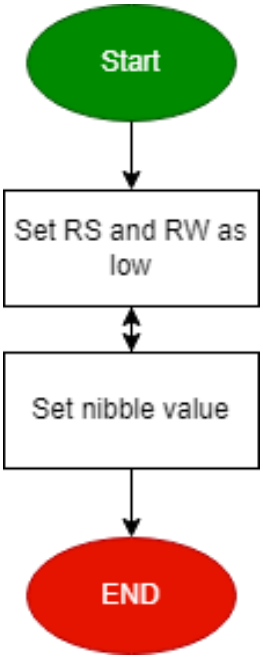


Figure 31 HLCD_vidWritecmd Flow Chart

```
void HLCD_vidWriteChar(Uint8_t u8CharCopy)
```

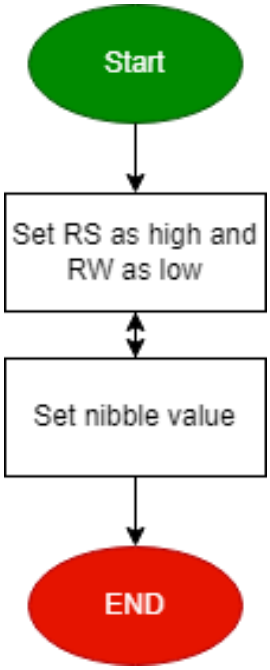


Figure 32 HLCD_vidWriteChar Flow Chart

```
void HLCD_ClrDisplay(void)
```

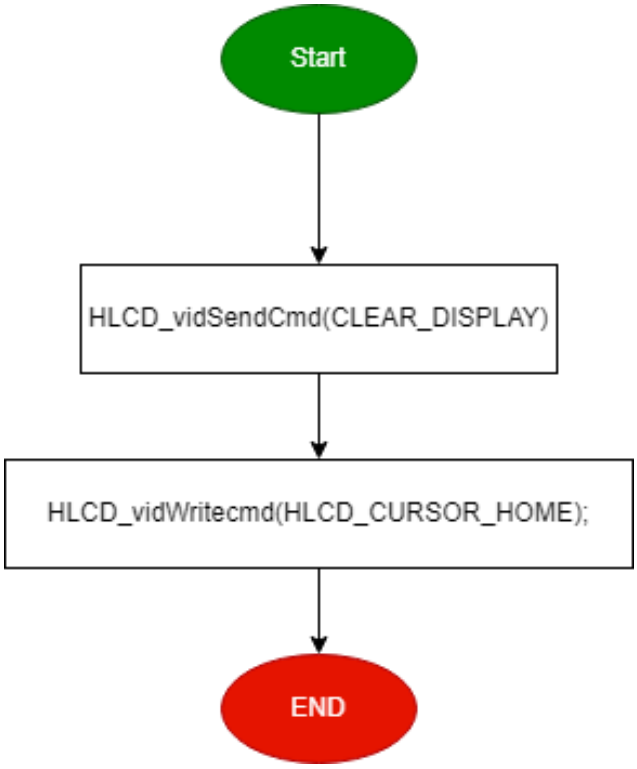


Figure 33 HLCD_ClrDisplay Flow Chart

```
void HLCD_gotoXY(Uint8_t row, Uint8_t pos)
```

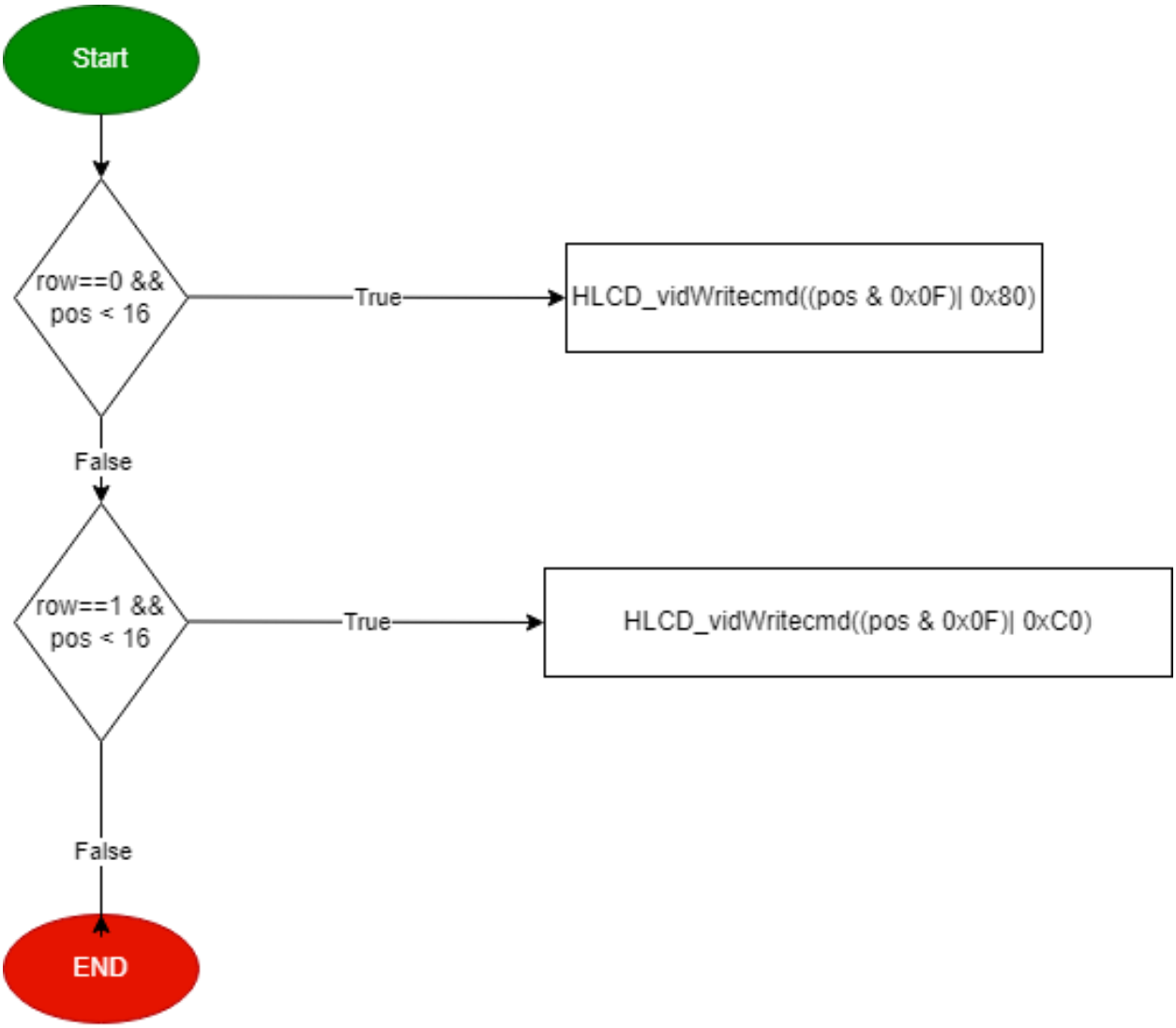


Figure 34 HLCD_gotoXY Flow Chart

```
void HLCD_WriteString(Uint8_t* str)
```

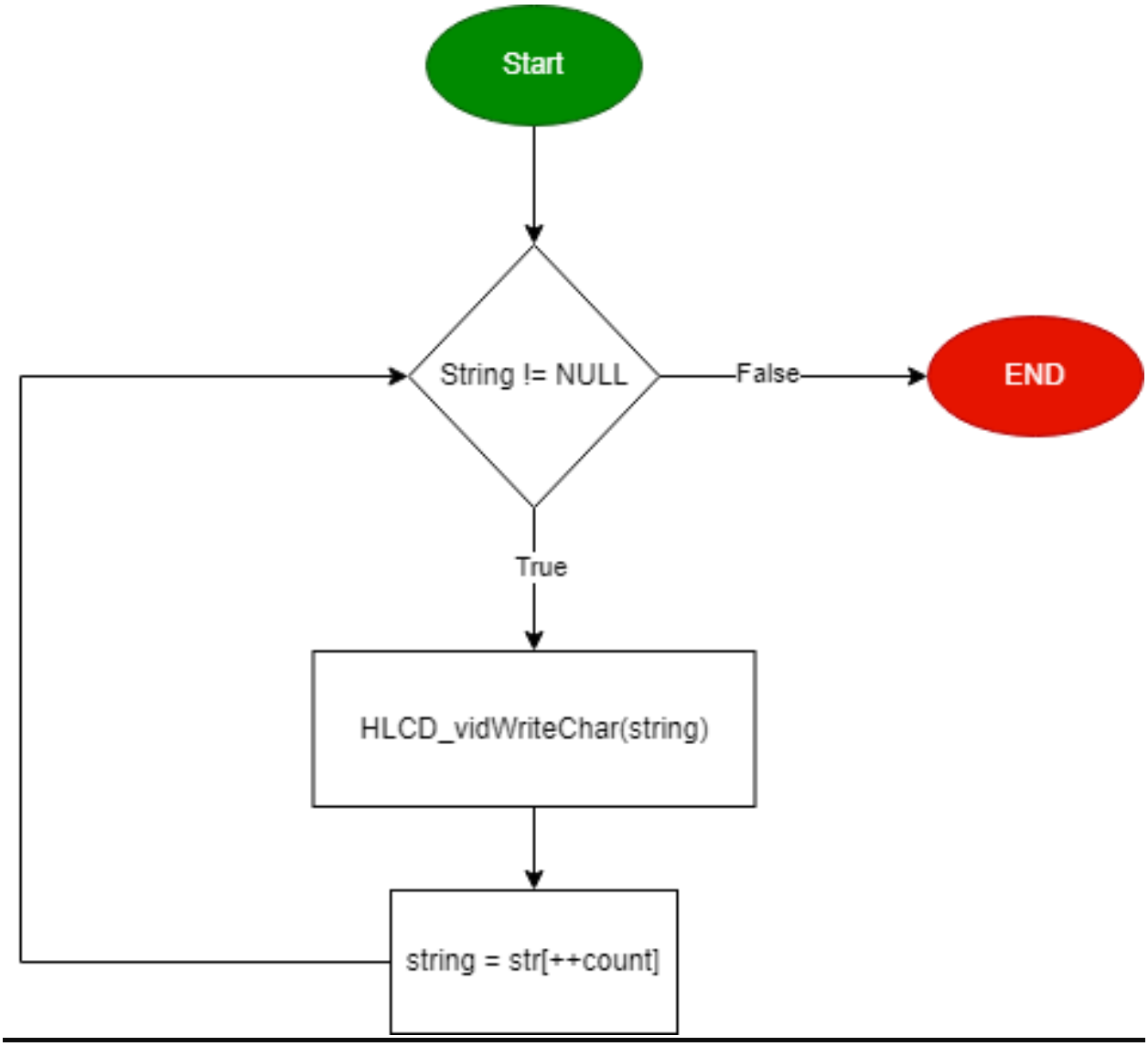


Figure 35 HLCD_WriteString Flow Chart

```
void HLCD_WriteInt(Uint32_t number)
```

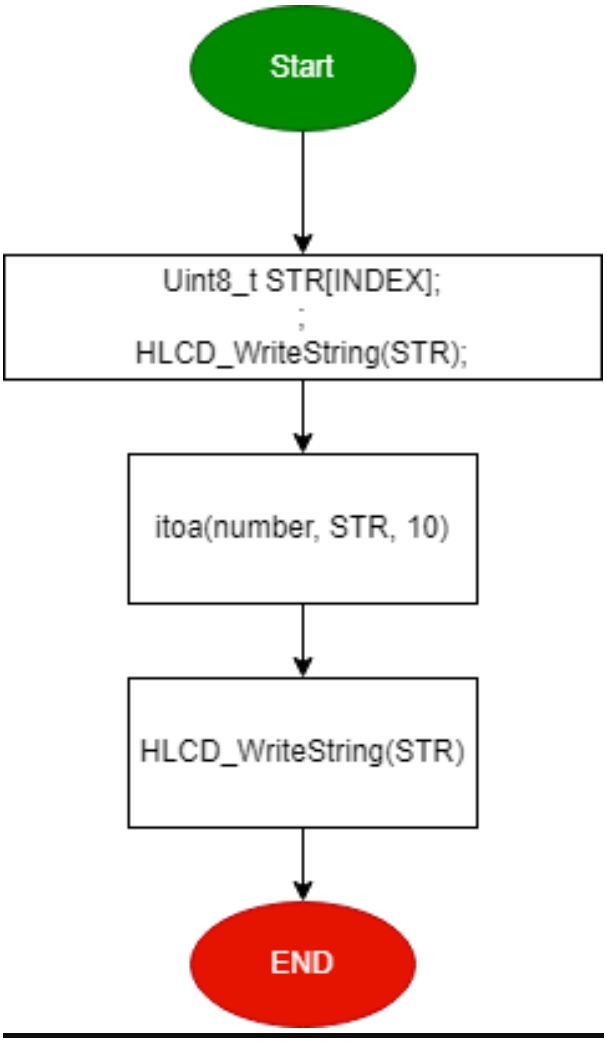


Figure 36 HLCD_WriteInt Flow Chart

```
void HLCD_vidCreatCustomChar(Uint8_t* pu8custom, Uint8_t u8Location)
```

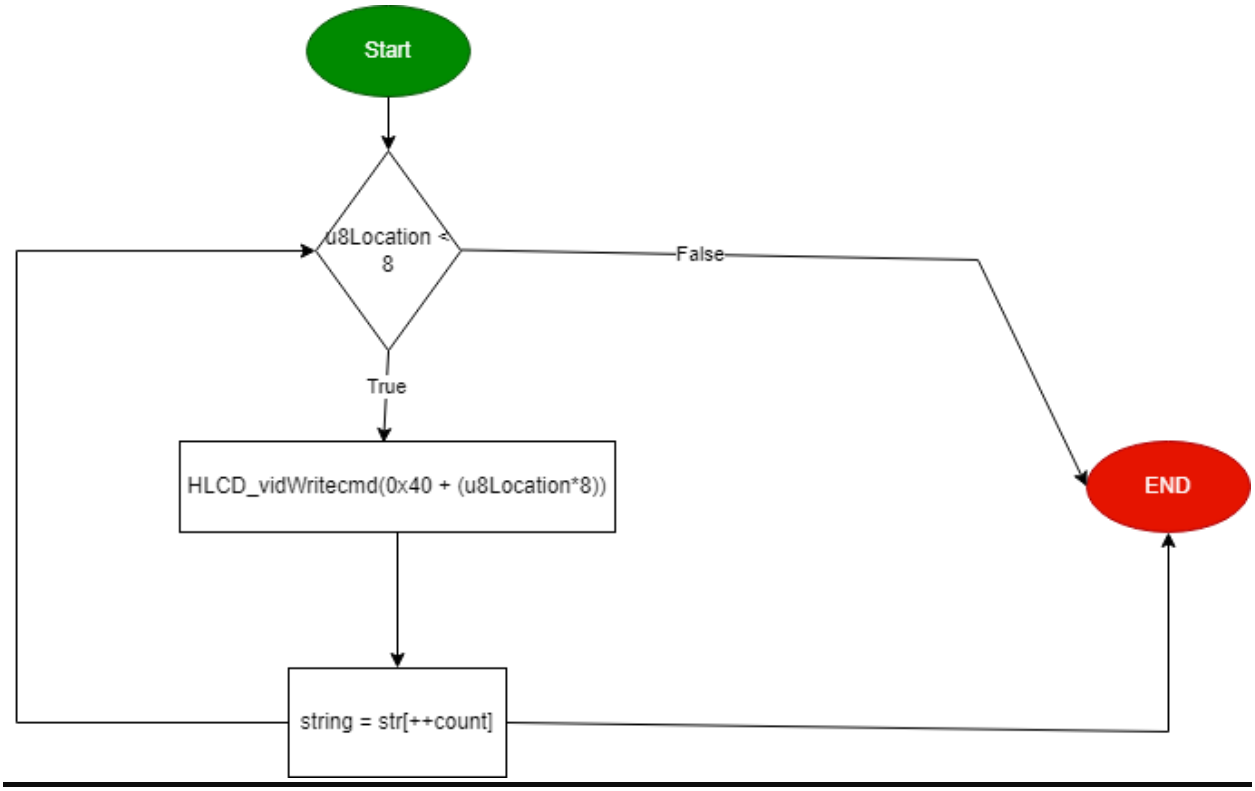


Figure 37 HLCD_vidCreatCustomChar Flow Chart

```
void HLCD_DisplayFloat(float32_t f32_a_number);
```

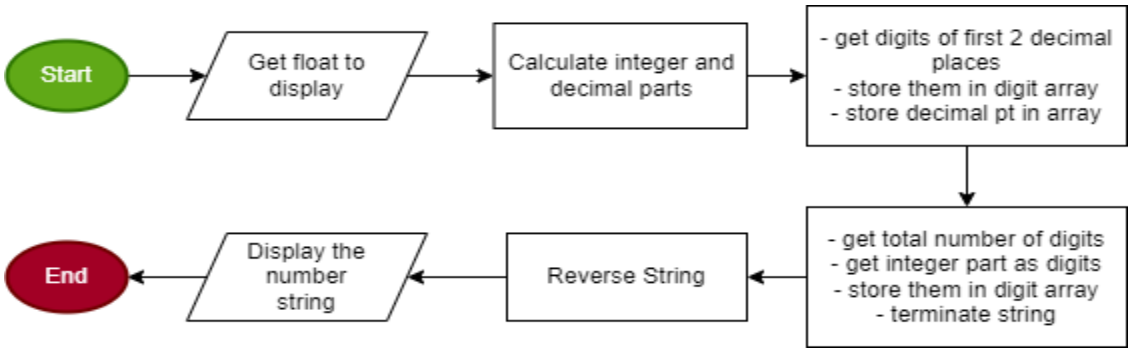


Figure 38 HLCD_DisplayFloat flow chart

- **Keypad**

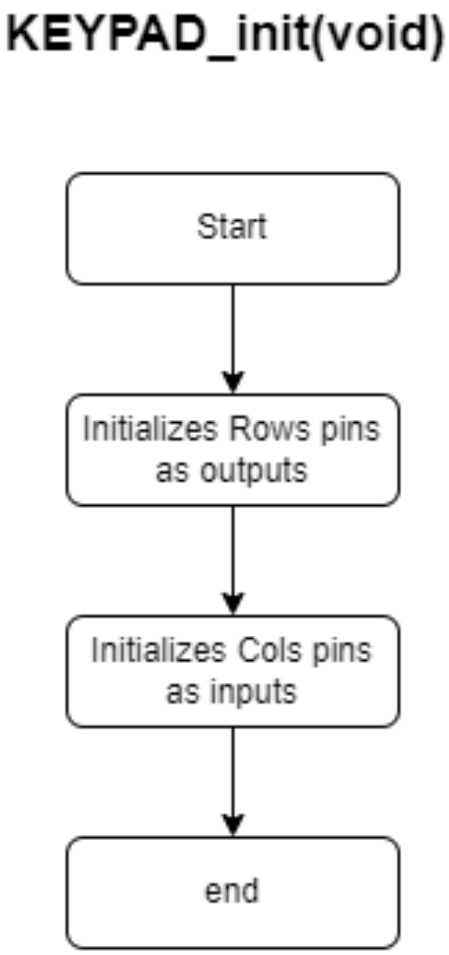


Figure 39 KEYPAD_Init Flow Chart

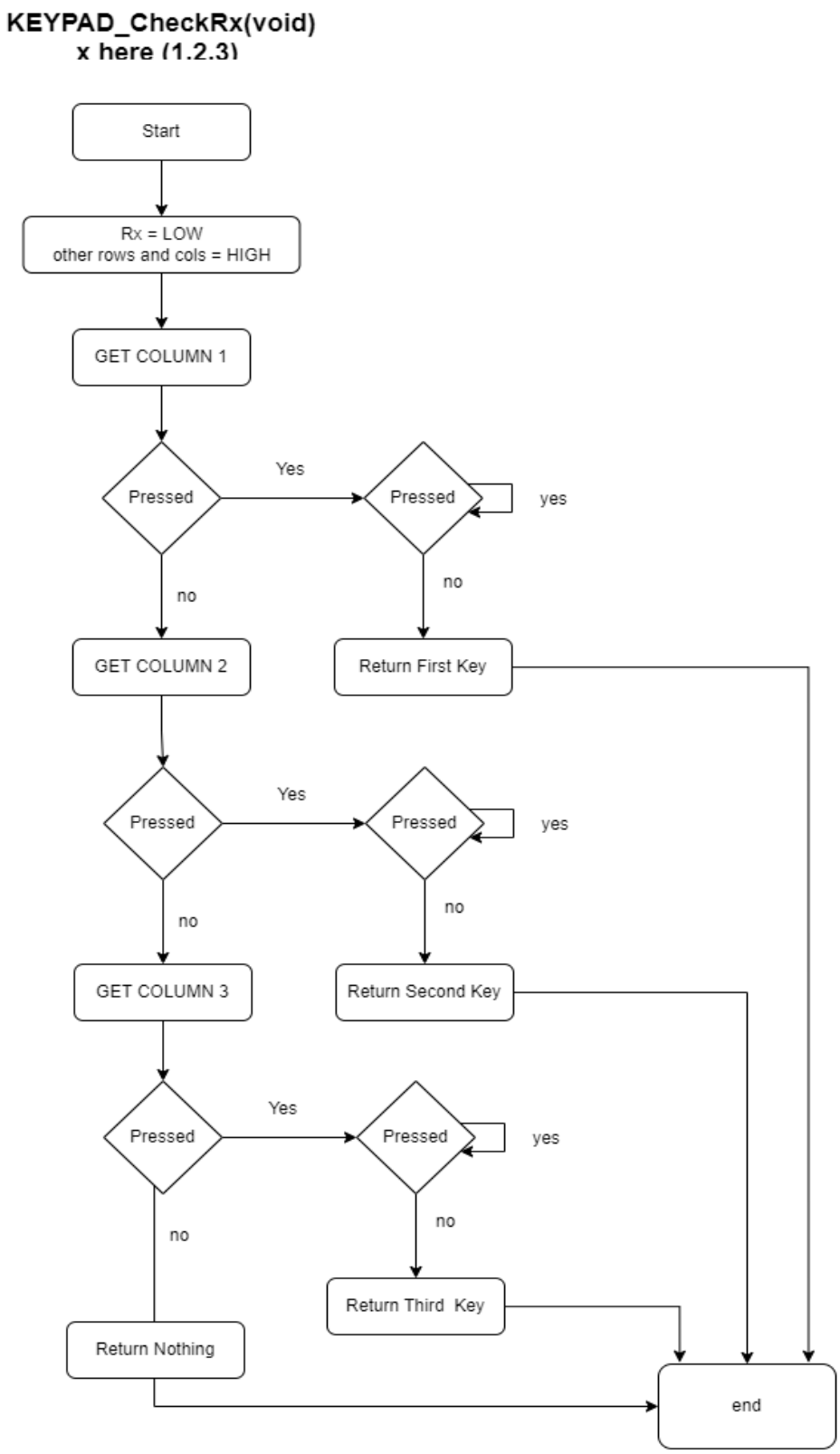


Figure 40 KEYPAD_CheckRx Flow Chart

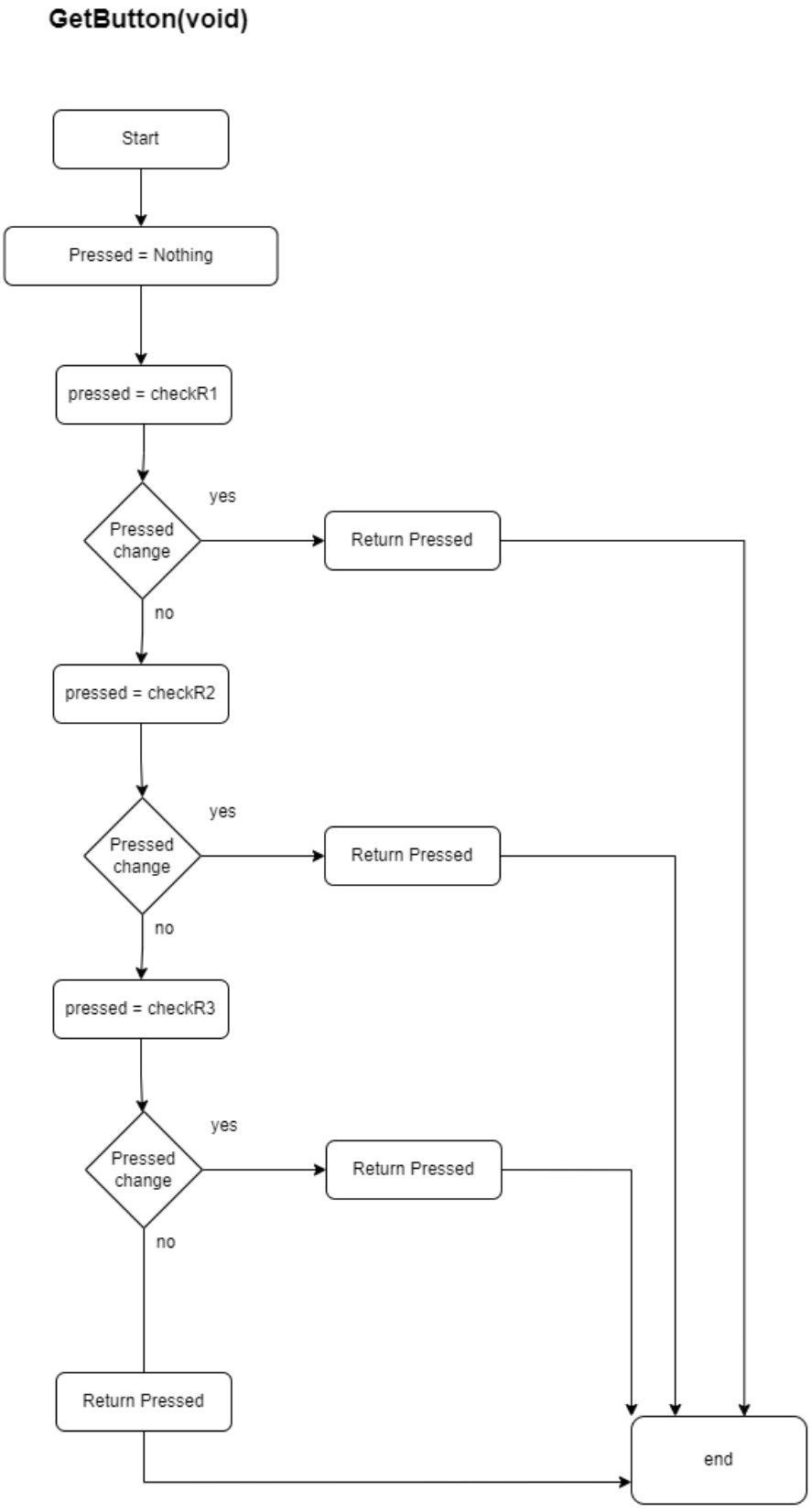
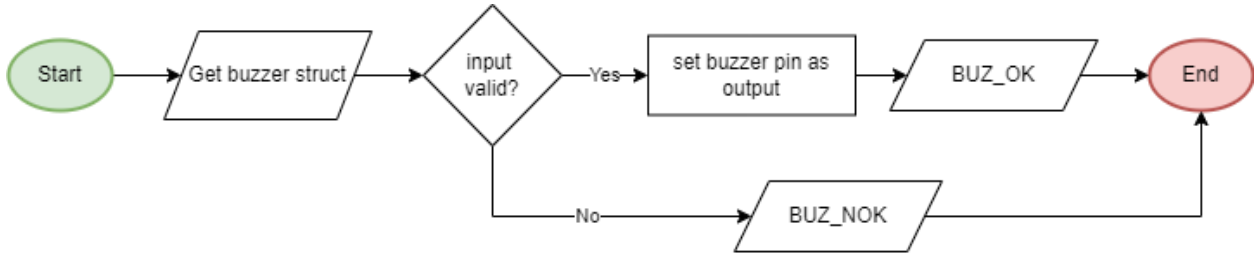


Figure 41 GetButton Flow Chart

- **Buzzer**

BUZ_Init



BUZ_SetState

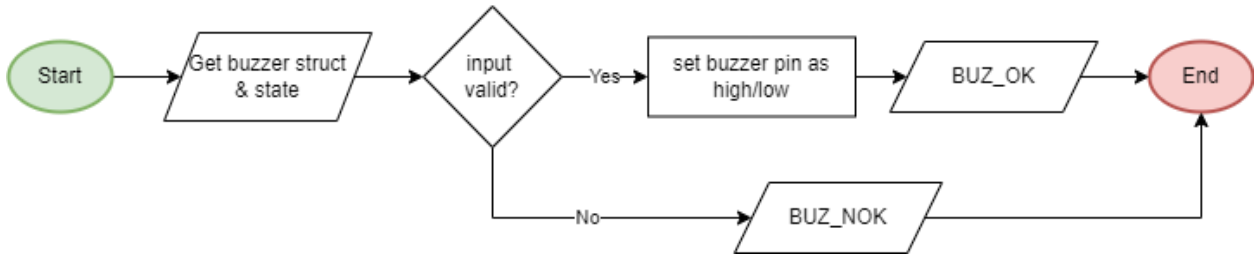


Figure 42 Buzzer Init & SetState Flow Charts

- **HEXTINT:**

H_EXTINT_create(INTx ,INTxSense,*ptrfunc)

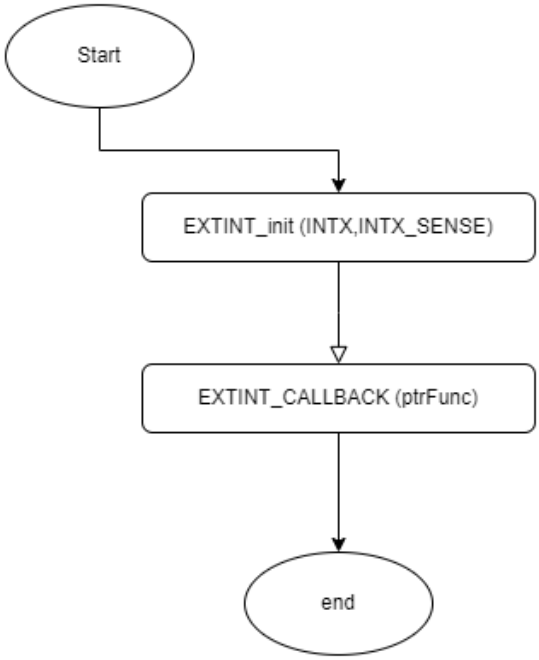


Figure 43 H_EXTINT_create flow chart

- **Button:**

```
enu_buttonError_t HButton_Init(enu_pin);
```

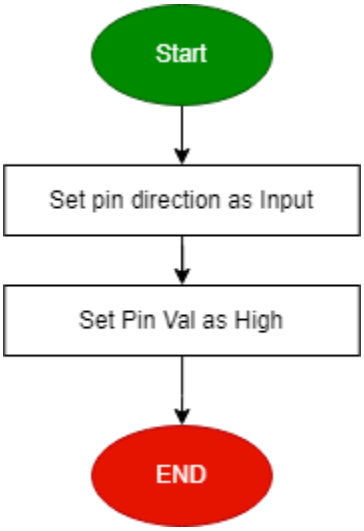


Figure 454 HButton_Init flow chart

```
enu_buttonError_t HButton_ExtIntInit(enu_pin);
```

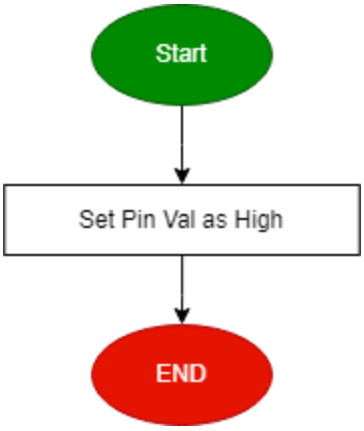


Figure 445 HButton_ExtIntInit flow chart

```
enu_buttonError_t HButton_getPinVal(enu_pin en_pinx,  Uint8_t* pu8_refVal );
```

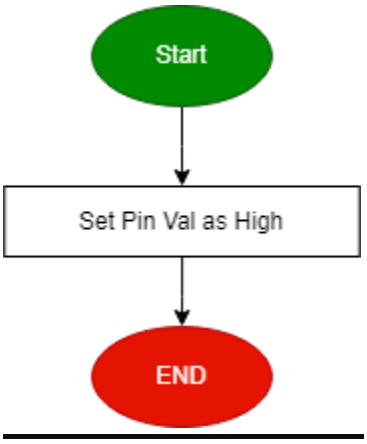


Figure 46 HButton_getPinVal flow chart

- **EEPROM**

```
void eeprom_init(void)
```

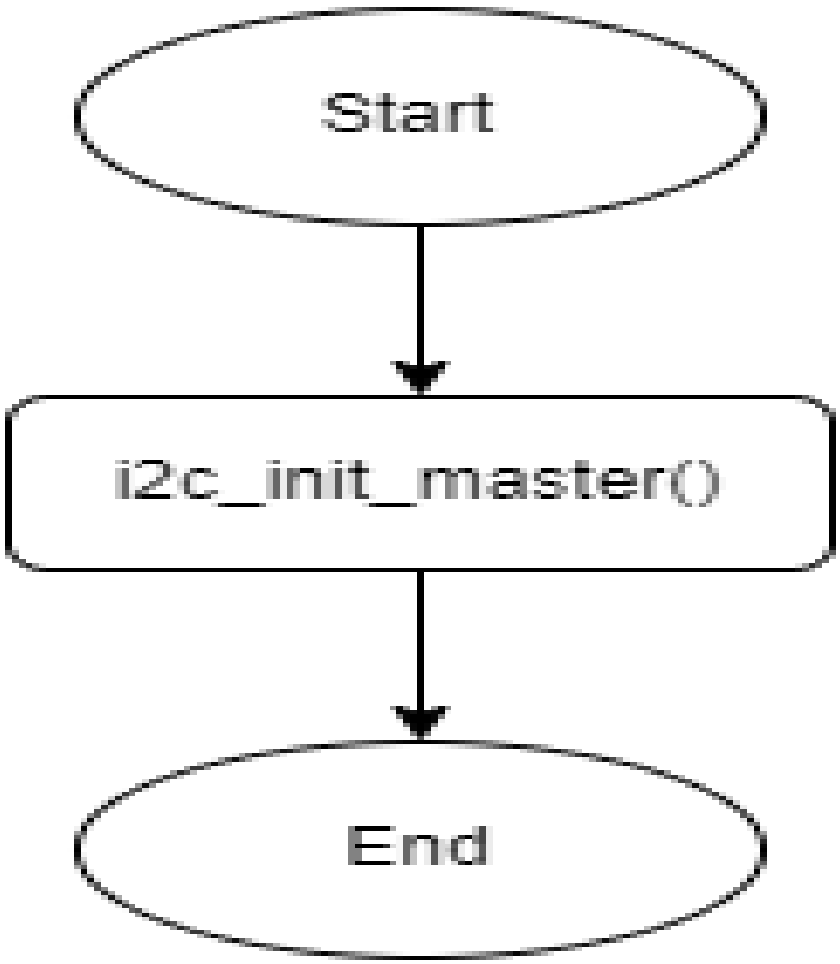


Figure 47 eeprom_init flow chart

void eeprom_write_byte(Uint16_t address, Uchar8_t data)

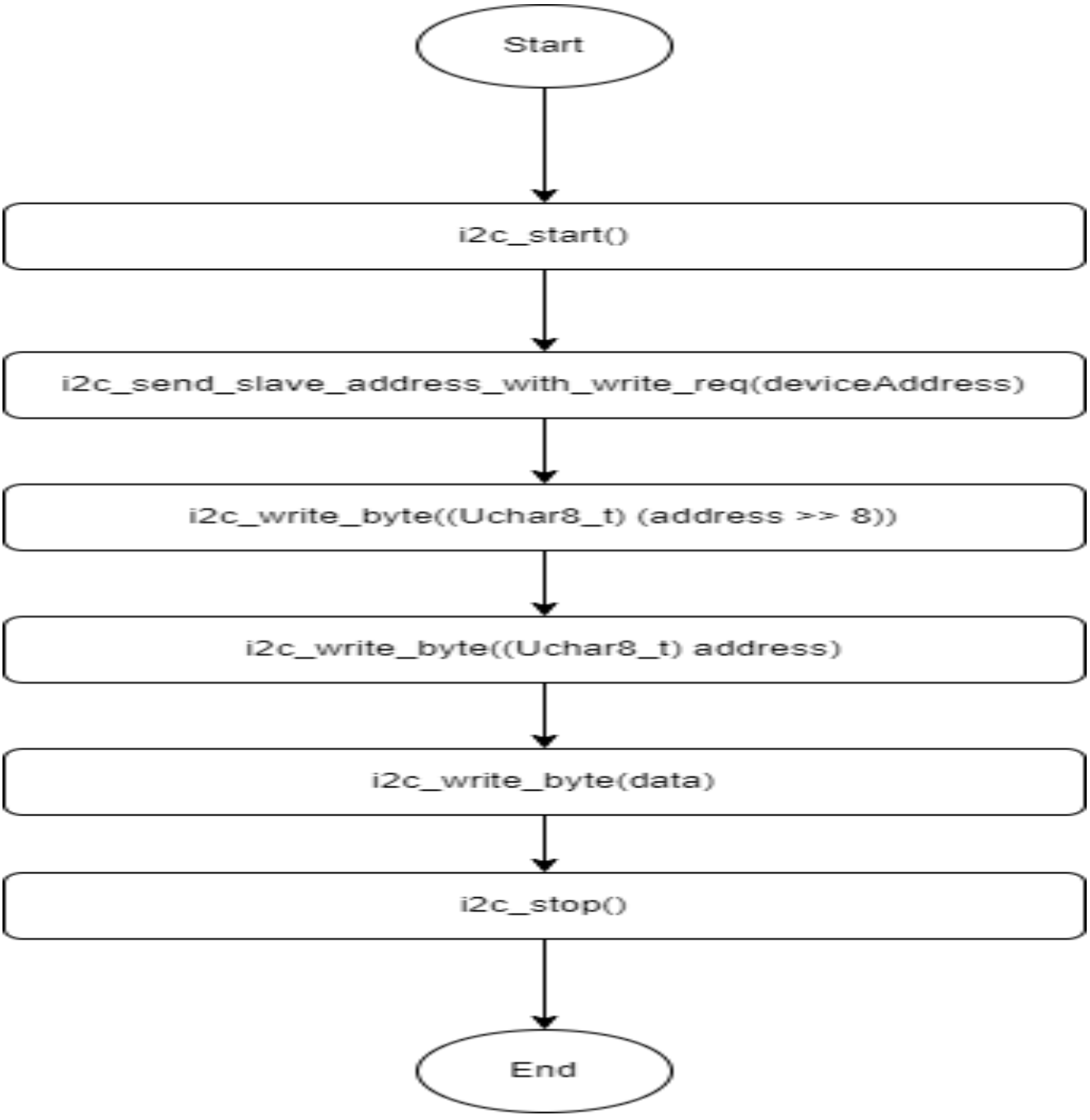


Figure 48 eeprom_write_byte flow chart

```
Uchar8_t eeprom_read_byte(Uint16_t address)
```

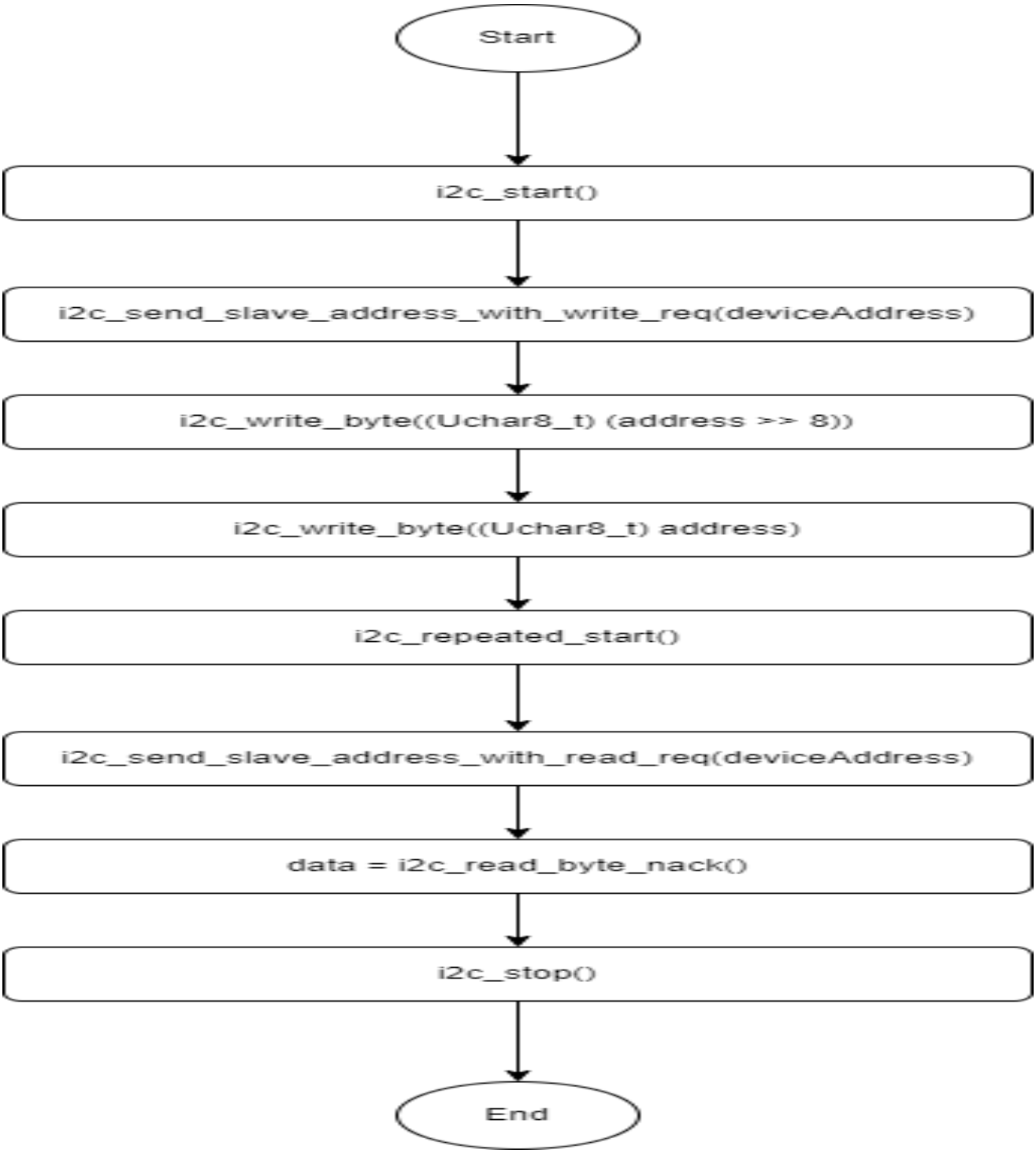


Figure 49 eeprom_read_byte flow chart

void eeprom_write_string(Uint16_t Copy_u8Address, const Uchar8_t* str)

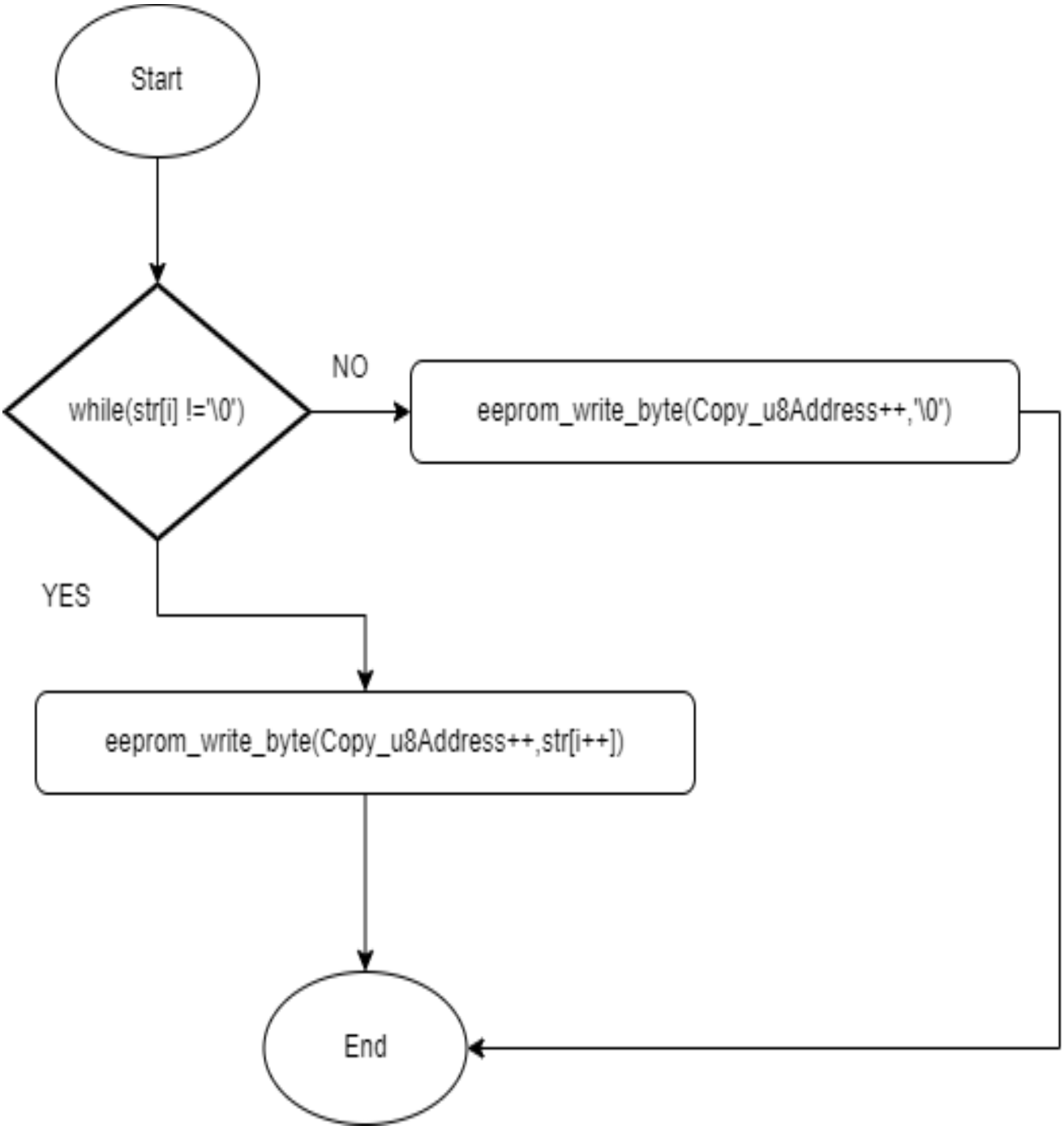


Figure 50 eeprom_write_string flow chart

```
void eeprom_read_string(Uint16_t Copy_u8Address, Uchar8_t* str)
```

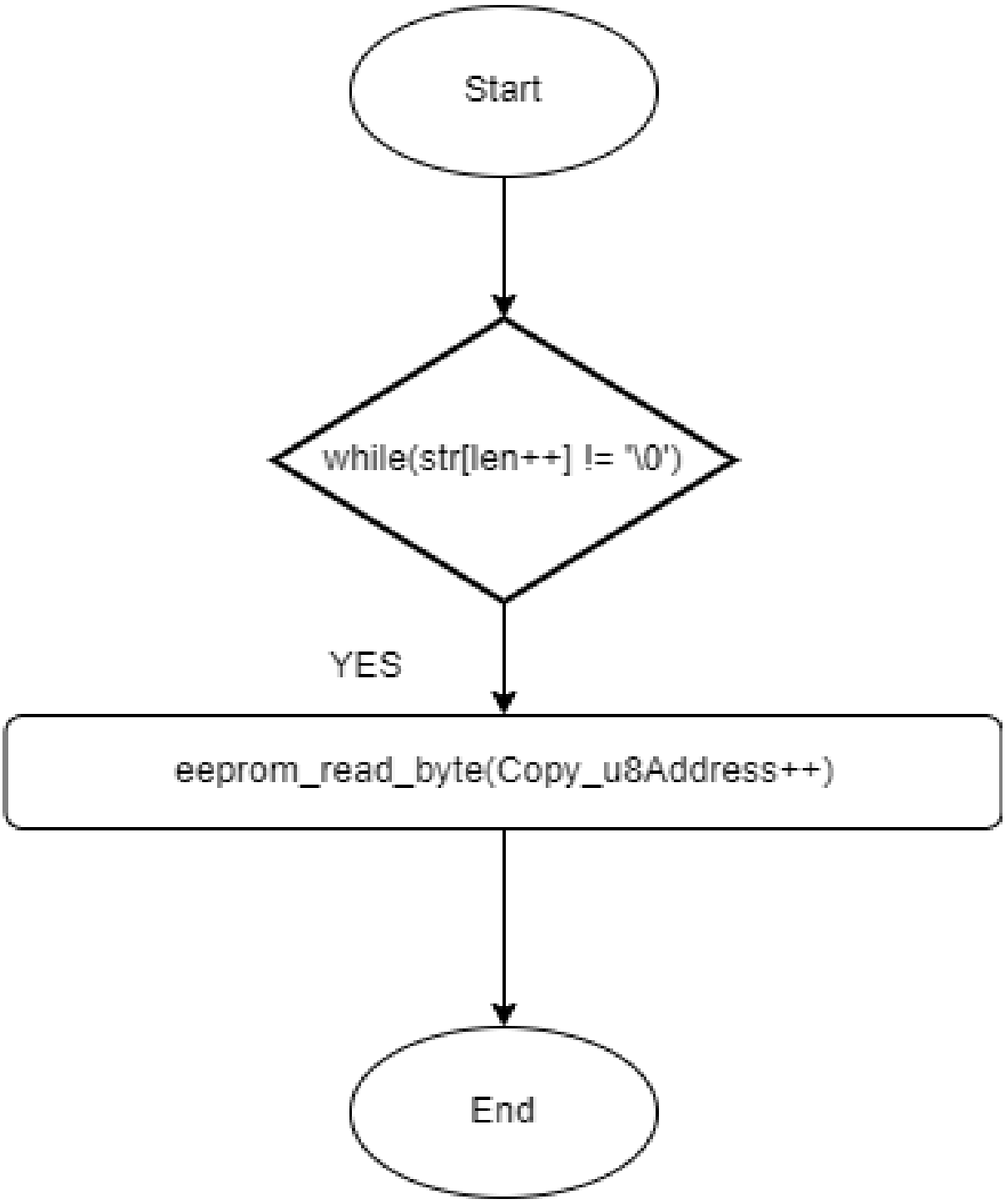


Figure 51 eeprom_read_string flow chart

Card_Database Layer (CARD MCU)

```
en_terminalPinGetStatus_t APP_terminalPinGet(Uchar8_t* arr);
```

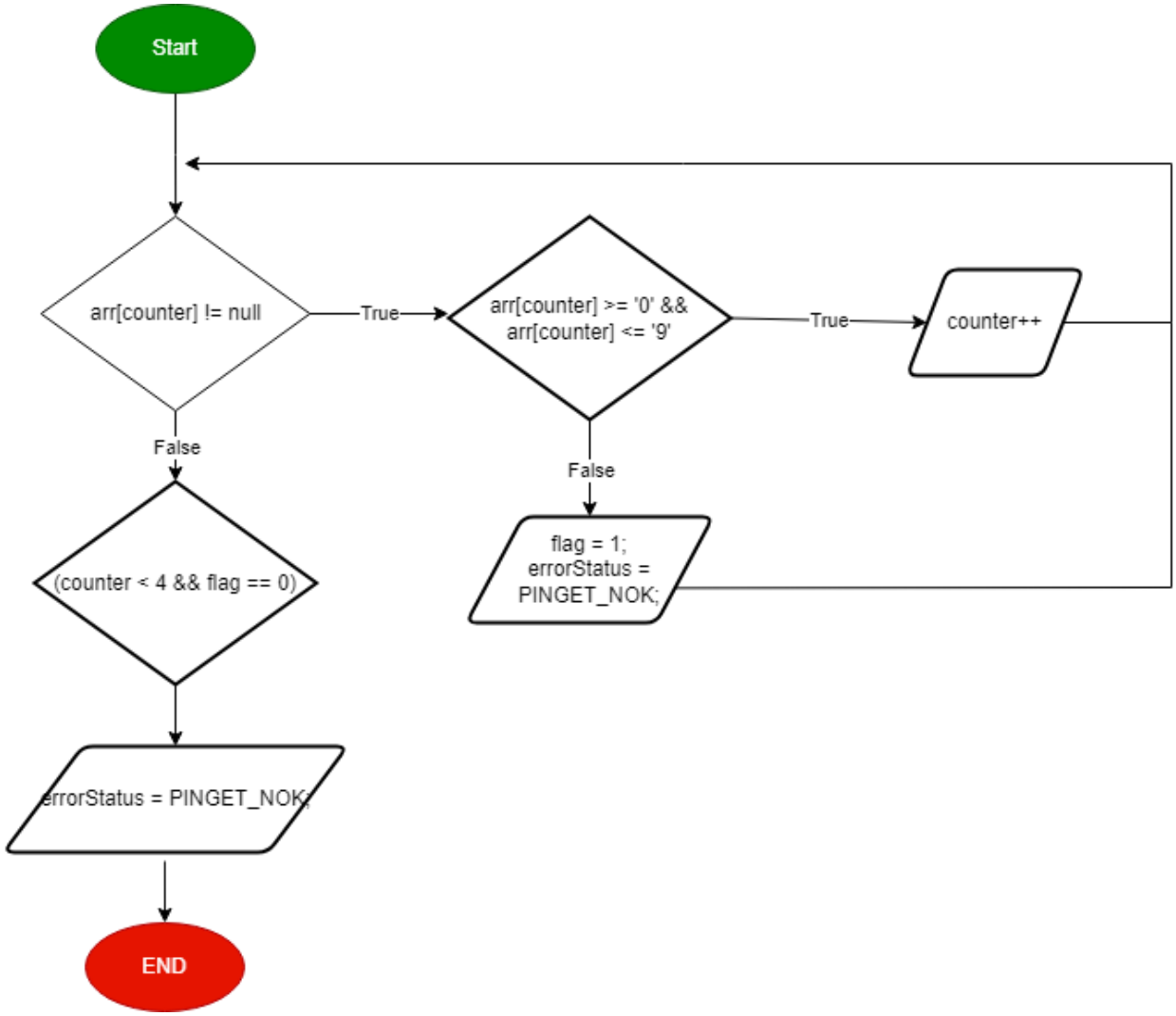


Figure 52 APP_terminalPinGet flow chart

```
en_terminalPanGetStatus_t APP_terminalPanGet(Uchar8_t* arr);
```

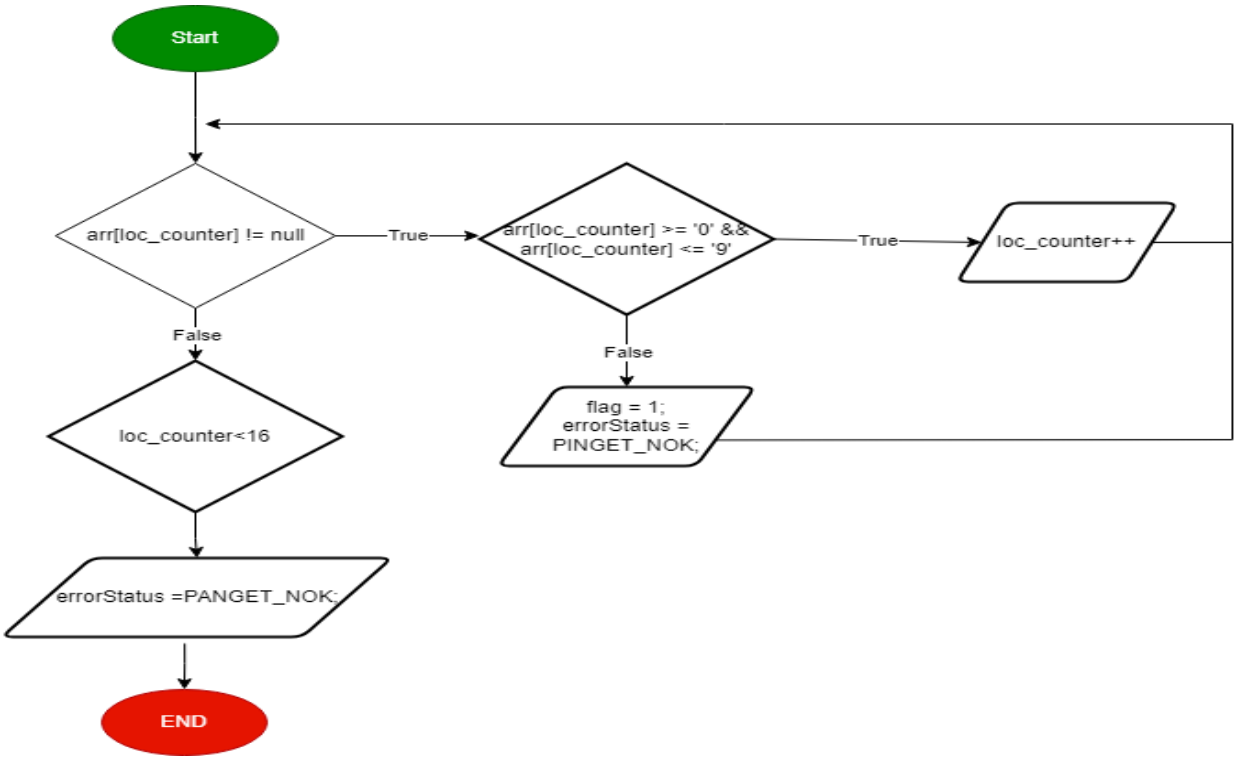


Figure 53 APP_terminalPanGet flow chart

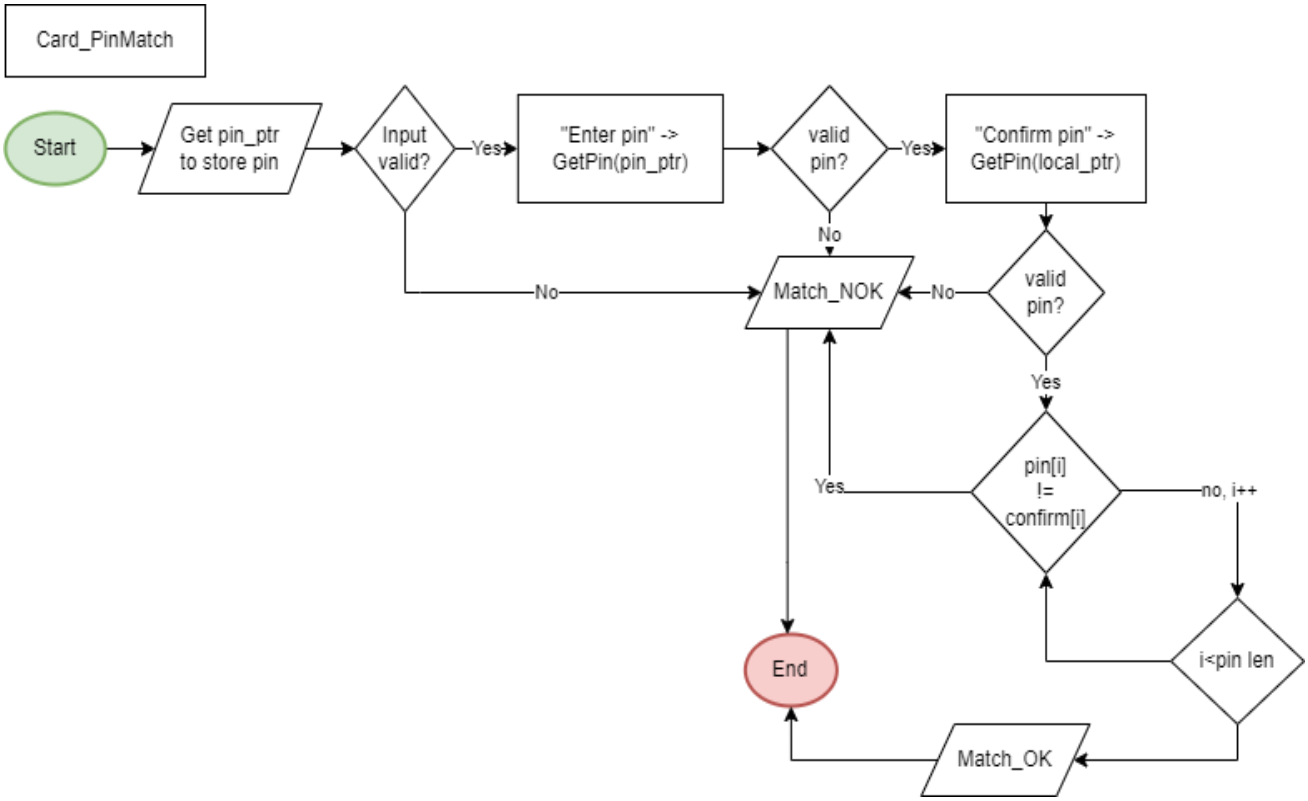


Figure 54 CARD_PinMatch flow chart

SaveCardData

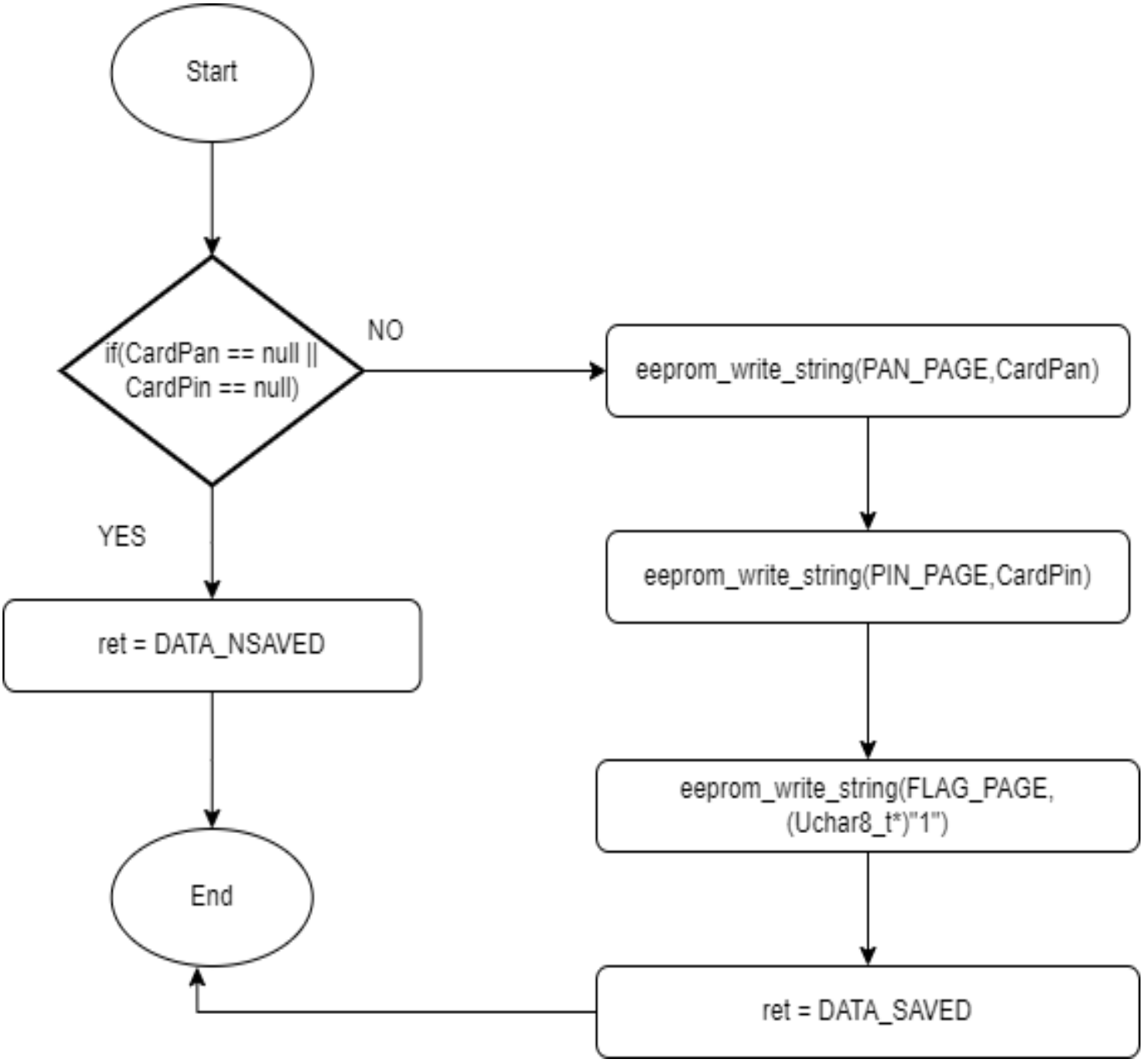


Figure 55 SaveCardData flow chart

ReadCardData

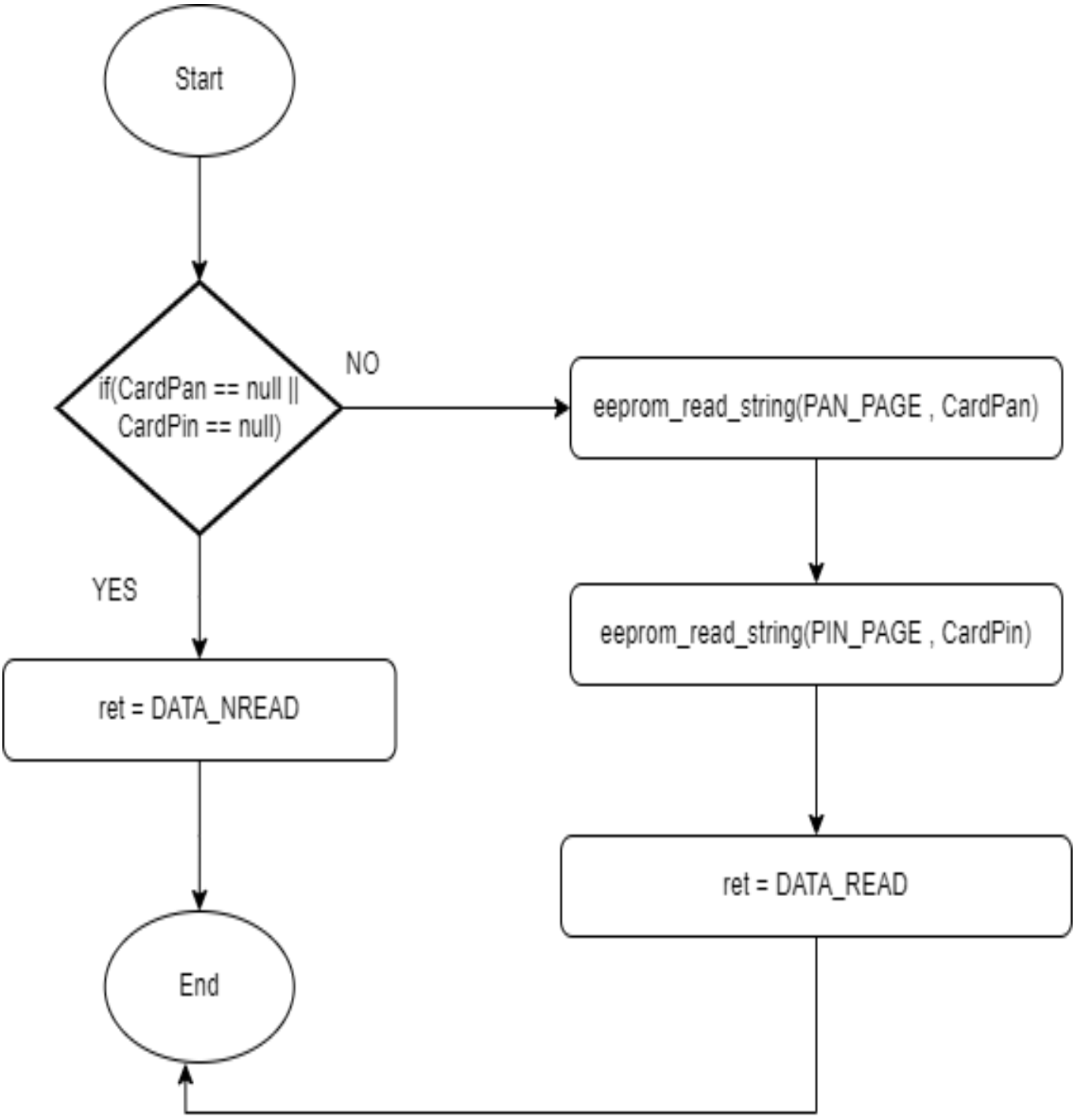


Figure 56 ReadCardData flow chart

- **Database_check:**

```
EN_dataError_t isValidPanAccount(Uchar8_t * pan);
```

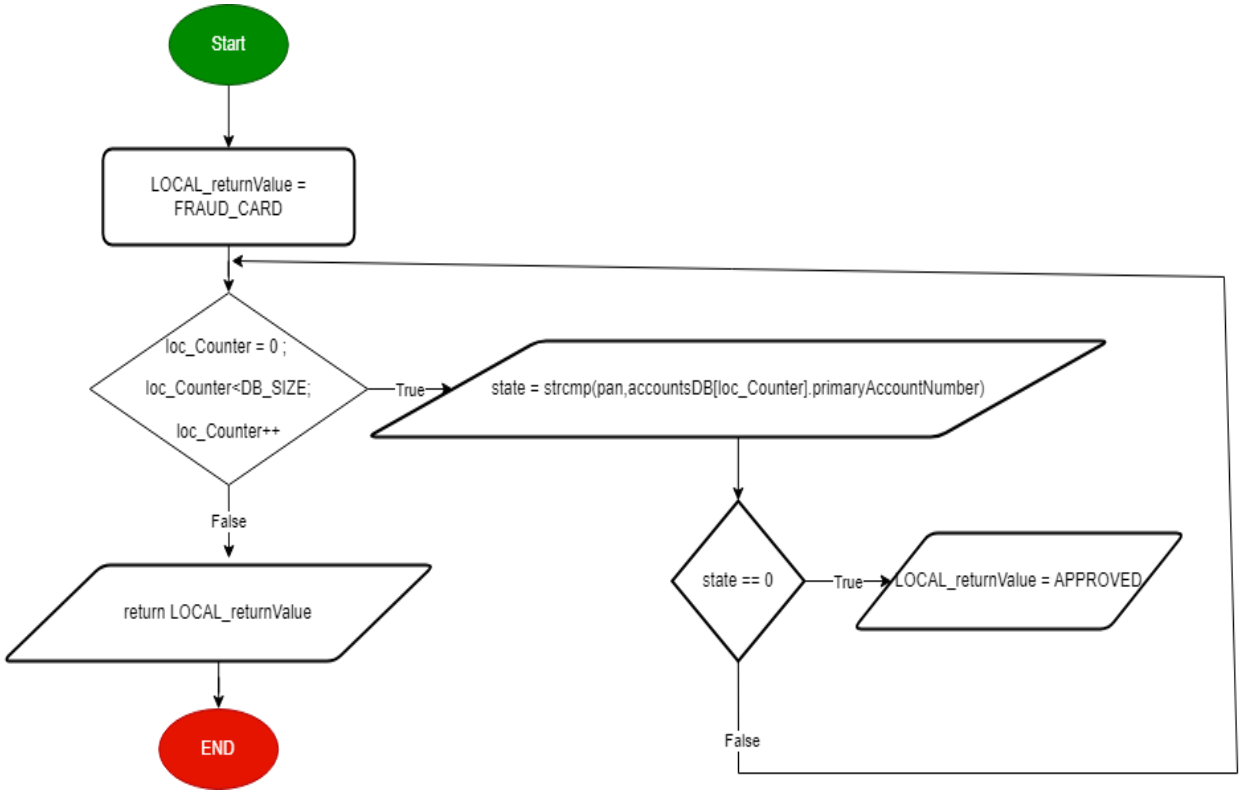


Figure 57 isValidPanAccount flow chart

```
EN_dataError_t isRunningAccount(Uchar8_t * pan);
```

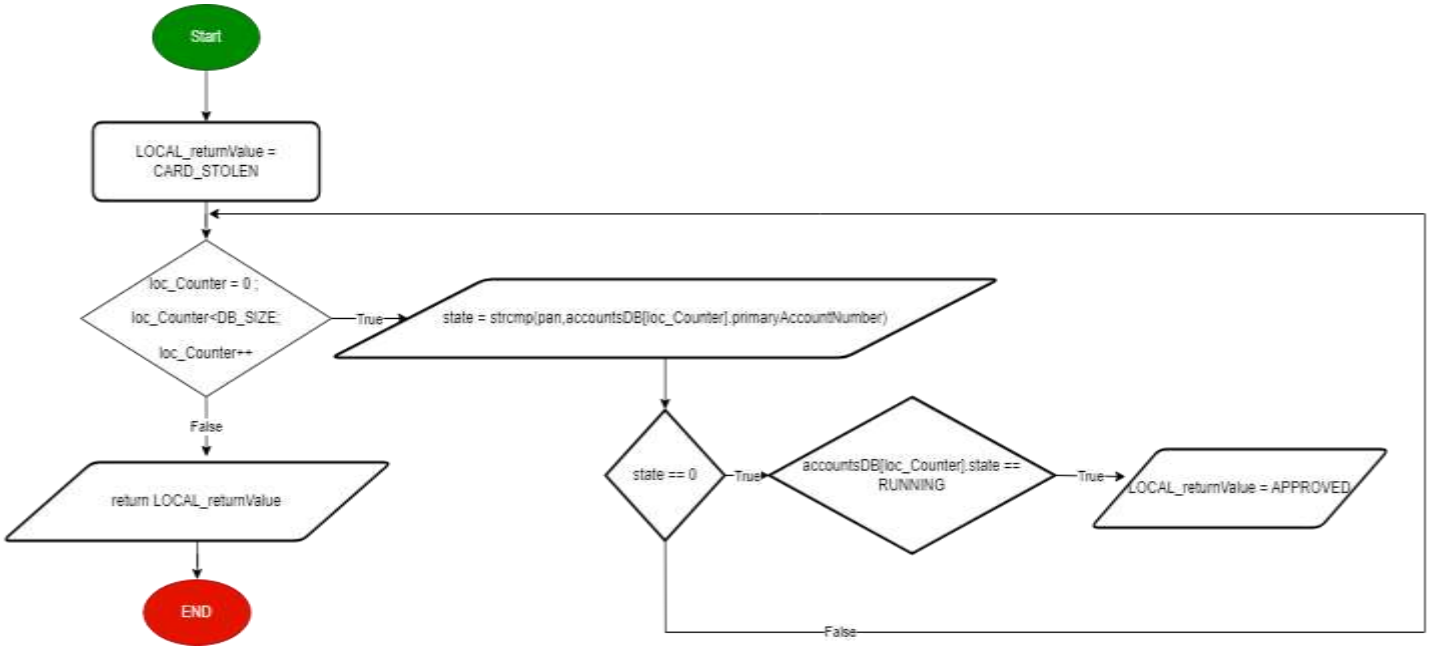


Figure 58 isRunningAccount flow chart

```
EN_dataError_t isValidAccountAmount(Uchar8_t *pan,Uchar8_t *amount,float32_t *newAmount);
```

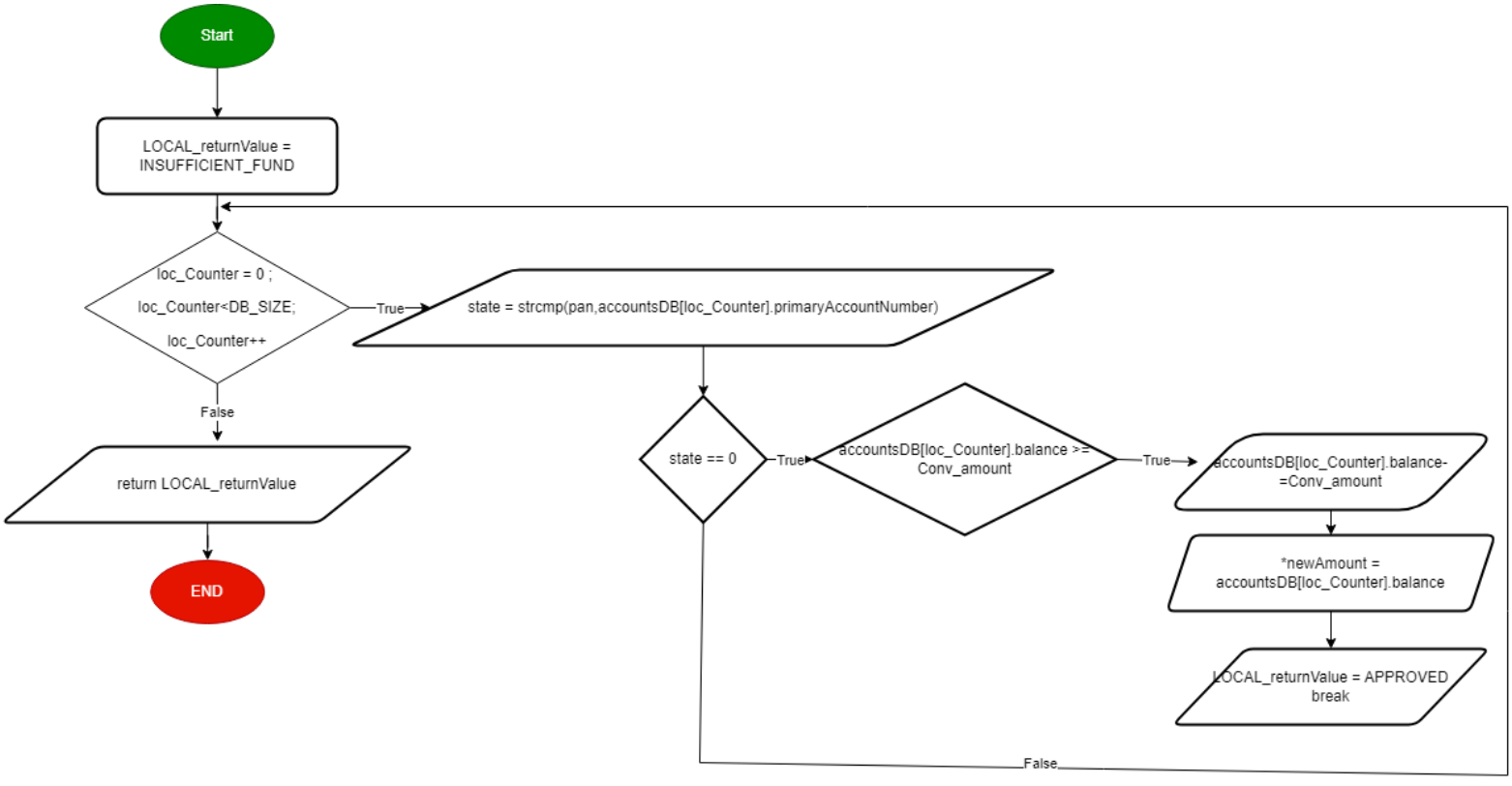


Figure 59 isValidAccountAmount flow chart

```
EN_dataError_t isBelowMaxDailyAmount(Uchar8_t * amount);
```

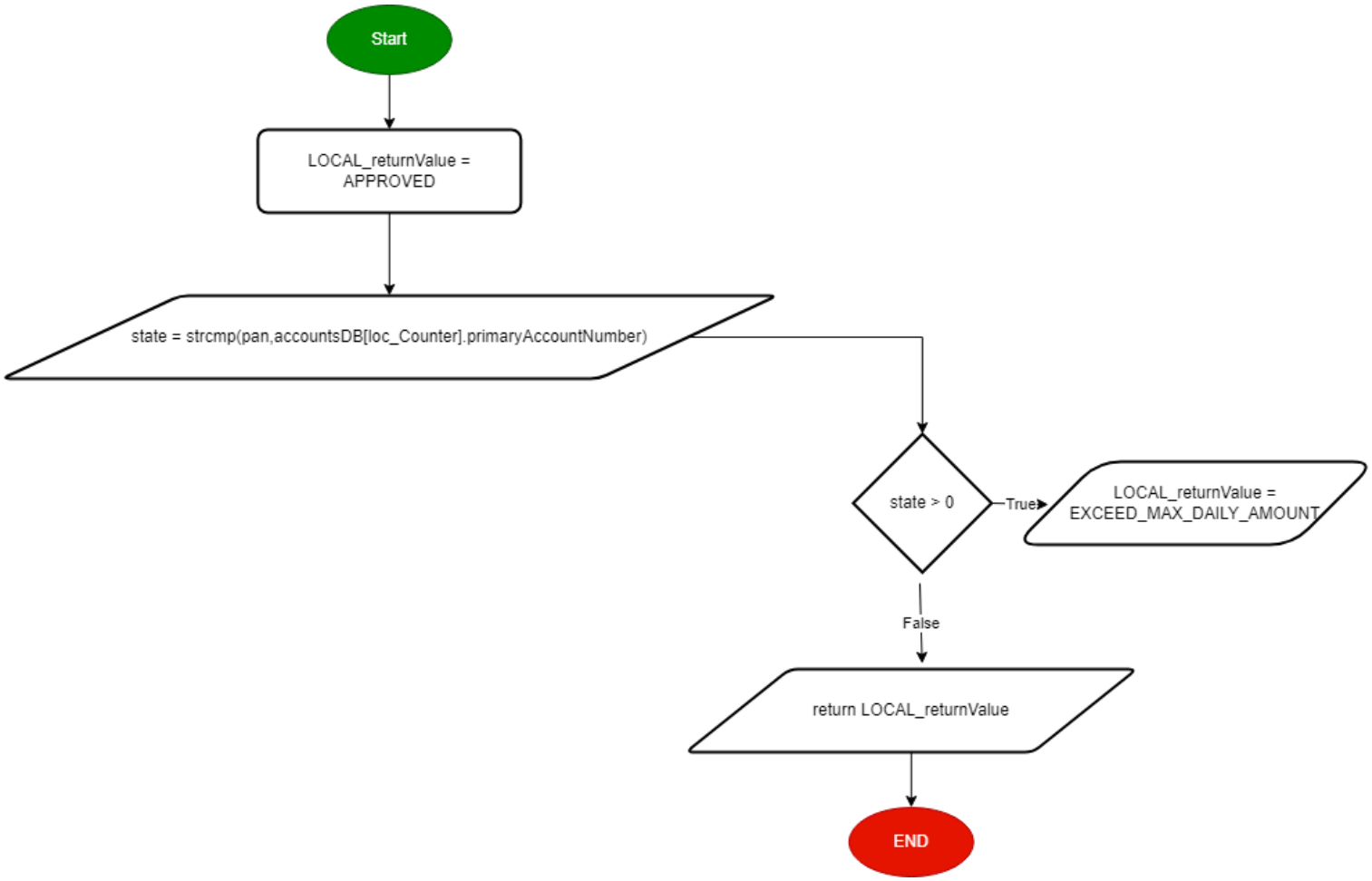


Figure 60 isBelowMaxDailyAmount flow chart

```
EN_dataError_t DATABASE_checking (Uchar8_t * pan,Uchar8_t *
amount,float32_t *newAmount);
```

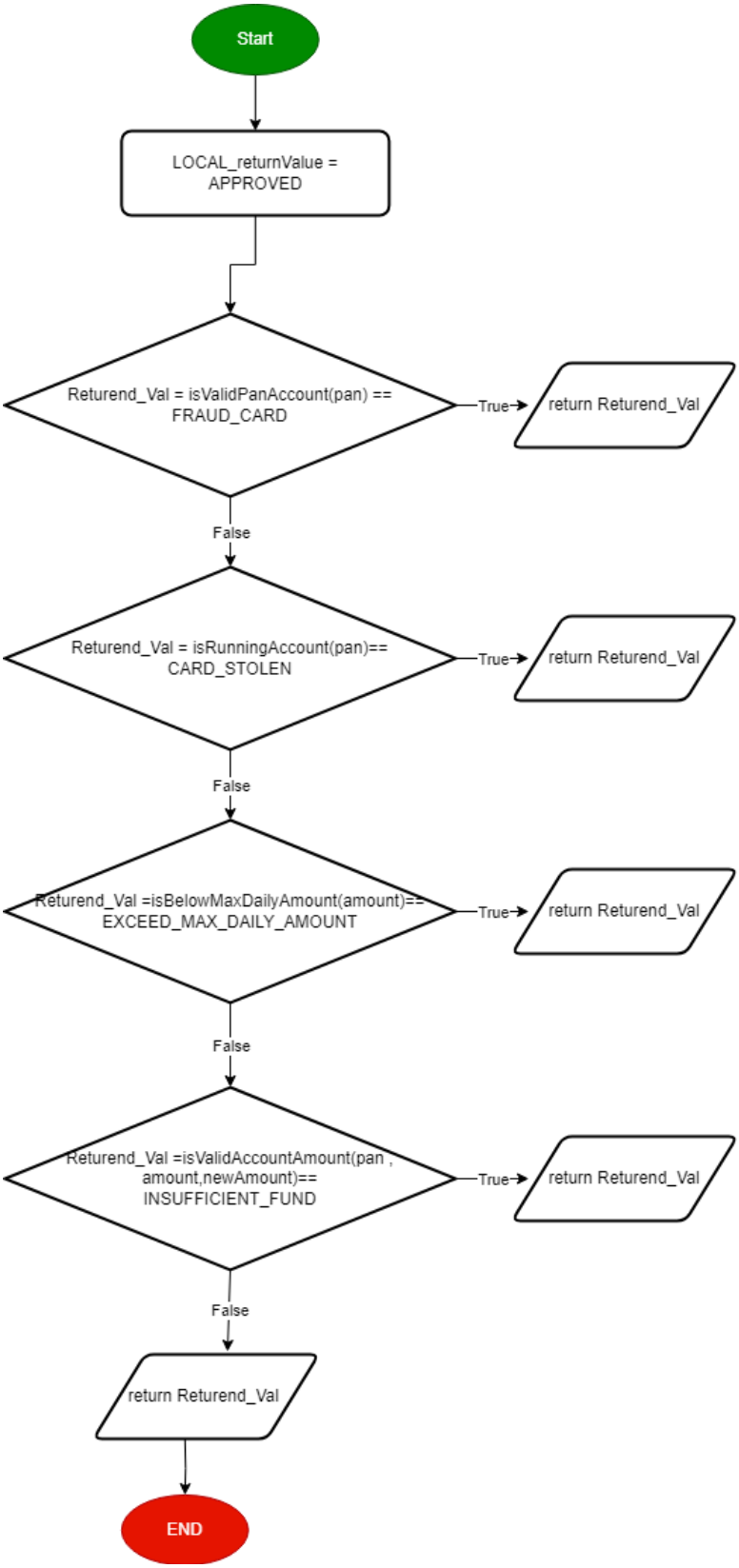


Figure 61 DATABASE_checking flow chart

- **ATM Module**

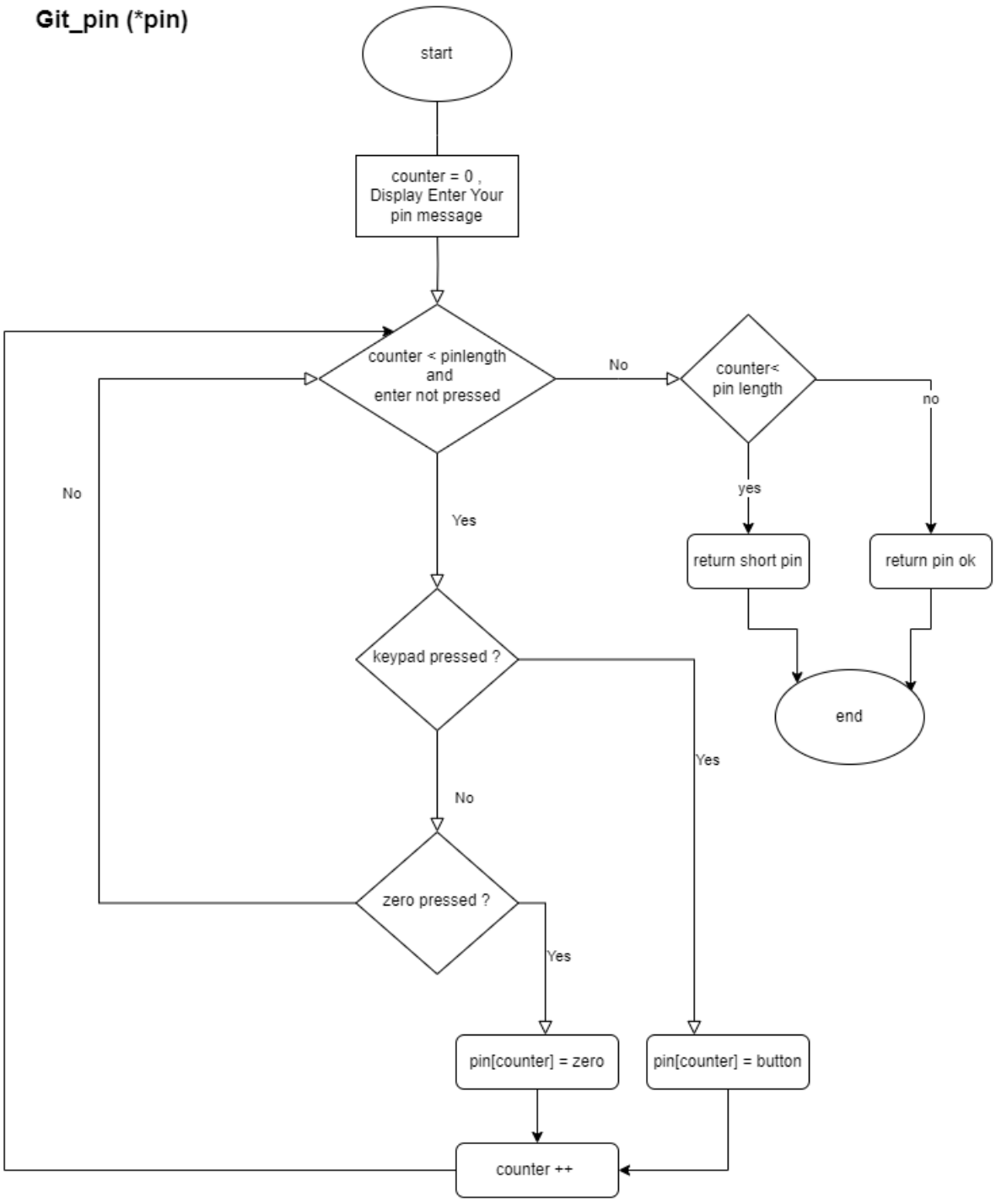


Figure 62 Get_pin flow chart

Git_amount_left (*amount)

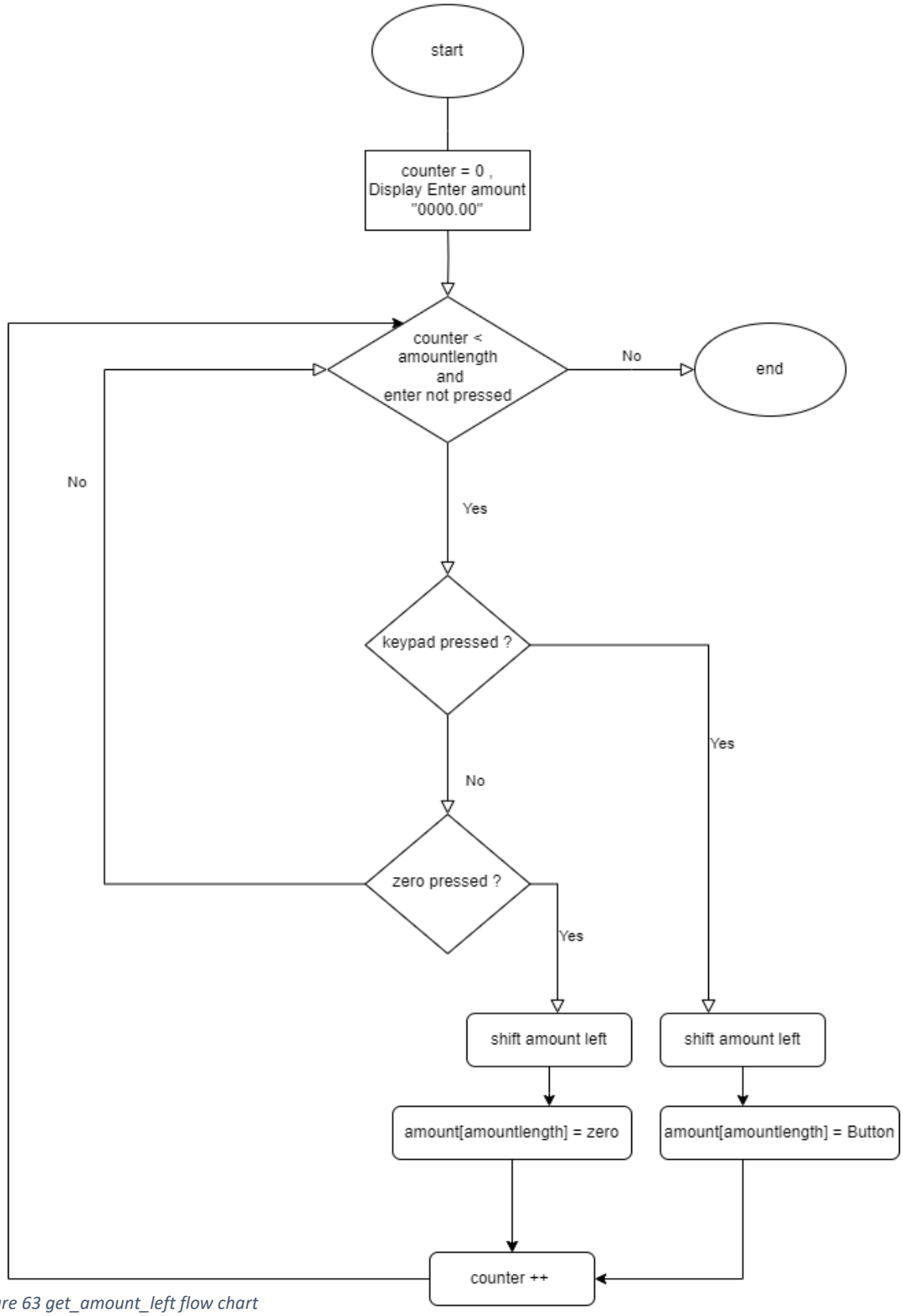


Figure 63 get_amount_left flow chart

PIN_checkPinMatching

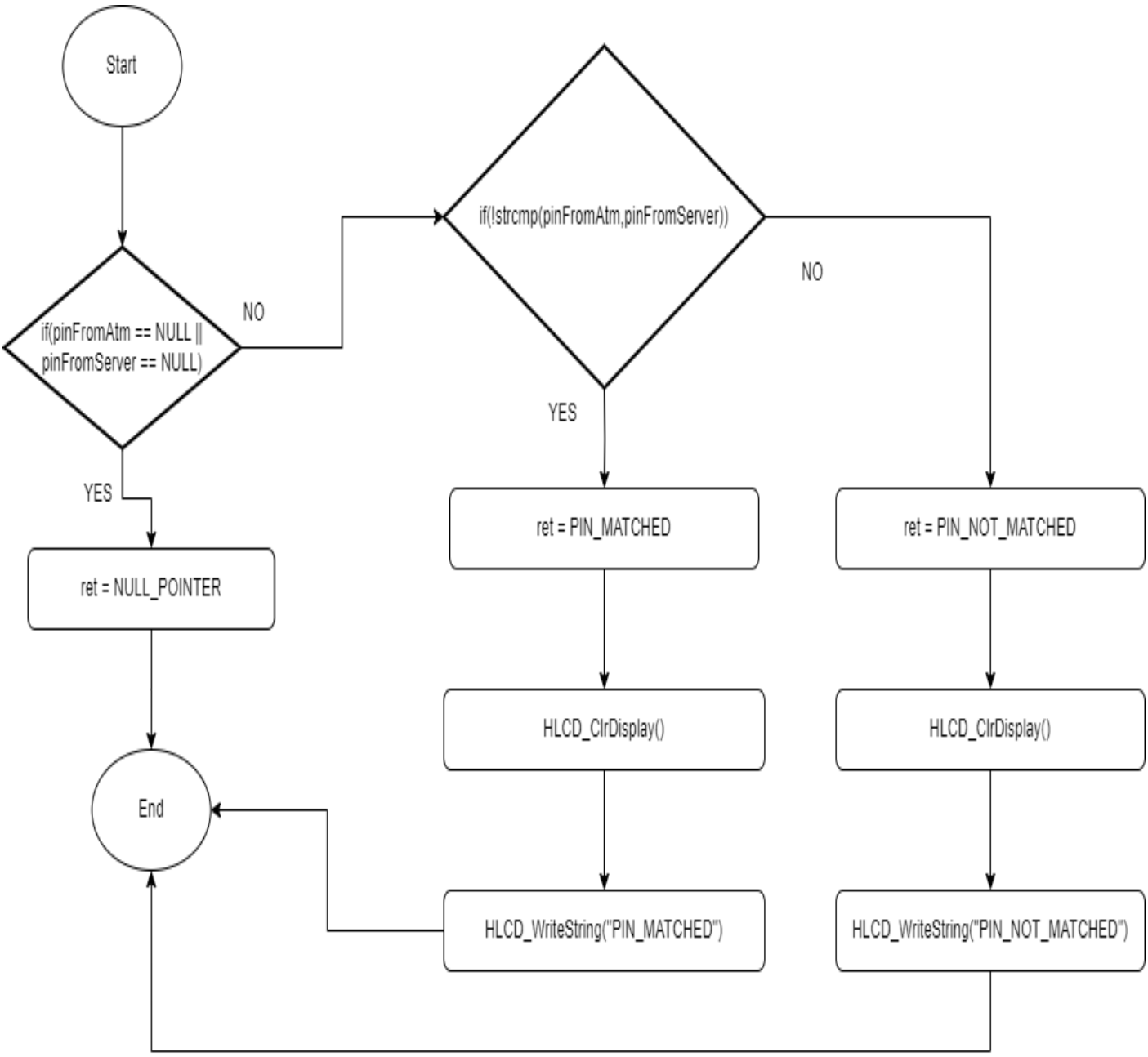


Figure 64 PIN_checkPinMatching flow chart

deinitAtm

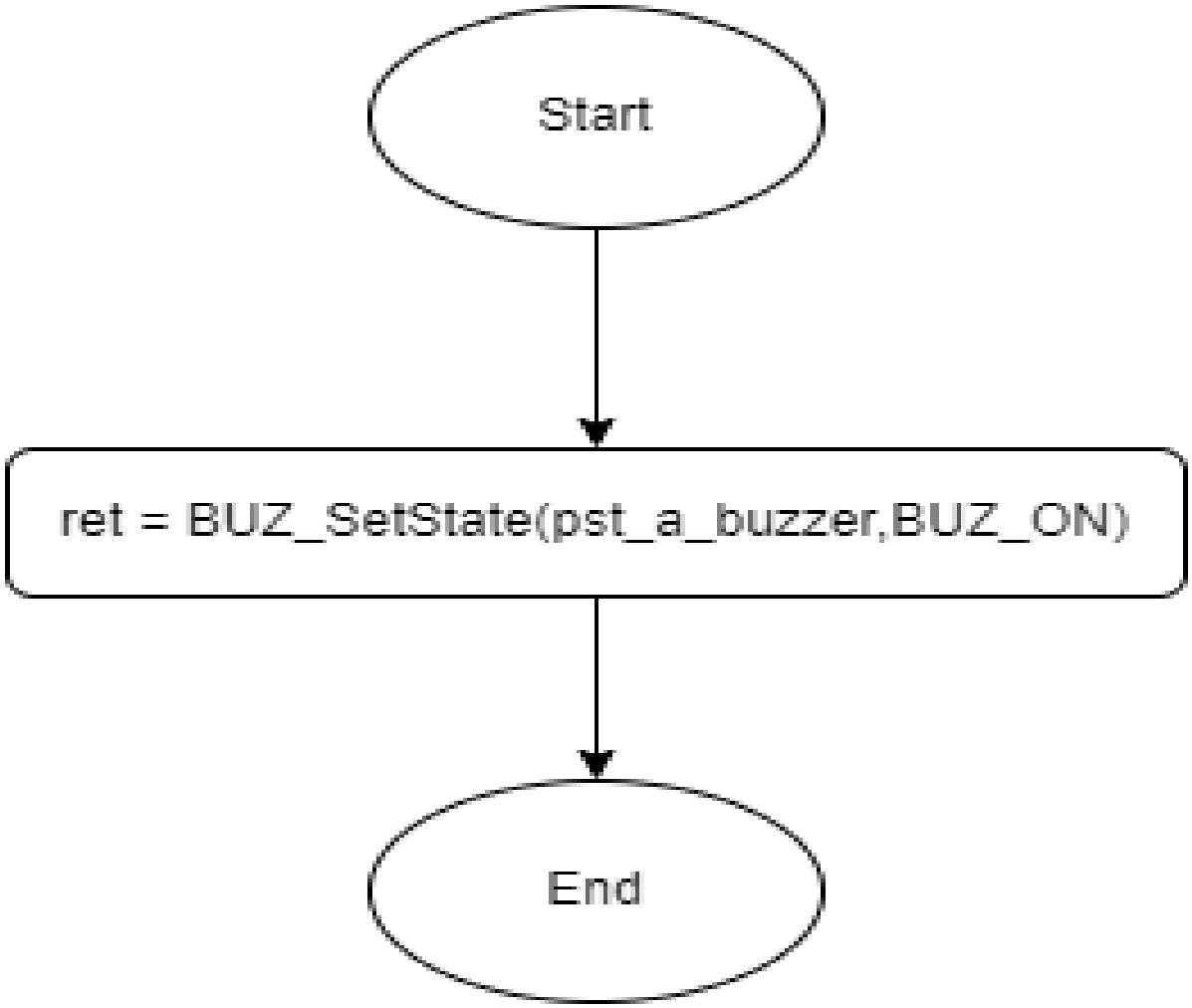


Figure 65 deinitAtm flow chart

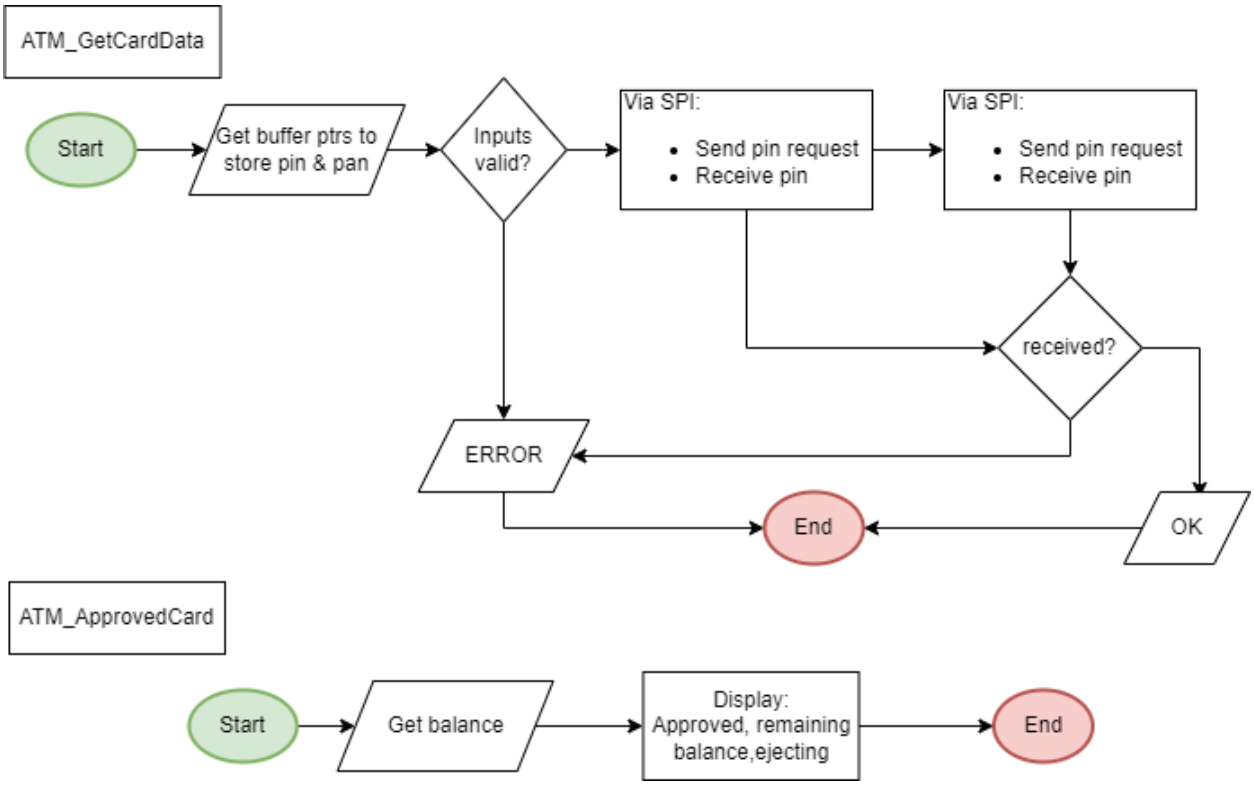


Figure 66 ATM_GetCardData & ATM_ApprovedCard flow charts

Application Layer:

- **Card App**

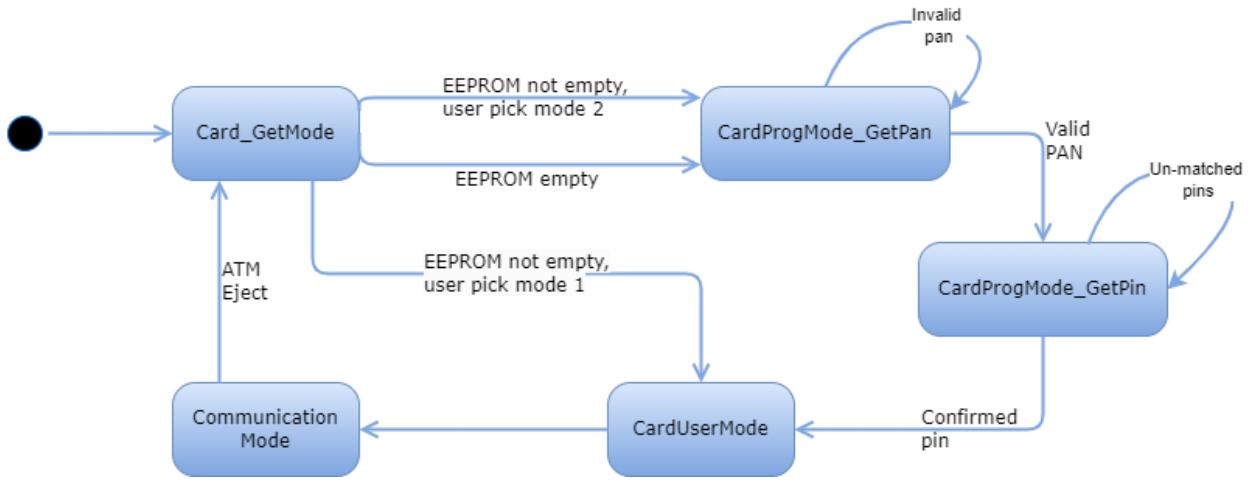


Figure 67 Card App state machine

- **ATM App**

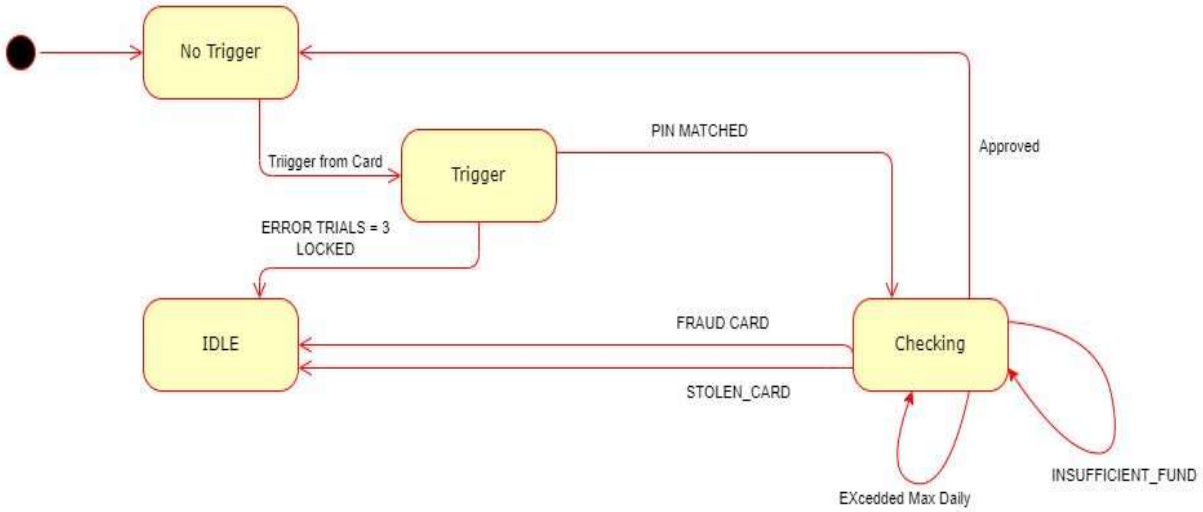


Figure 68 ATM App state machine