```c
/* USER CODE BEGIN Header */
/**

*****************************************************************************
*
  * @file           : main.c
  * @brief          : Main program body

*****************************************************************************
*
  * @attention
  *
  * Copyright (c) 2023 STMicroelectronics.
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  *
  * This software is licensed under terms that can be found in the LICENSE
file
  * in the root directory of this software component.
  * If no LICENSE file comes with this software, it is provided AS-IS.
  *

*****************************************************************************
*
  */
/* USER CODE END Header */
/* Includes -----------------------------------------------------------------
-*/
#include "main.h"

/* Private includes ---------------------------------------------------------
-*/
/* USER CODE BEGIN Includes */
#include <stdint.h>
#include "stm32f0xx.h"
/* USER CODE END Includes */

/* Private typedef ----------------------------------------------------------
-*/
/* USER CODE BEGIN PTD */

/* USER CODE END PTD */

/* Private define -----------------------------------------------------------
-*/
/* USER CODE BEGIN PD */

// Definitions for SPI usage
#define MEM_SIZE 8192 // bytes
#define WREN 0b00000110 // enable writing
#define WRDI 0b00000100 // disable writing
#define RDSR 0b00000101 // read status register
#define WRSR 0b00000001 // write status register
#define READ 0b00000011
#define WRITE 0b00000010
/* USER CODE END PD */
/* Private macro ------------------------------------------------------------
-*/
/* USER CODE BEGIN PM */

/* USER CODE END PM */

/* Private variables --------------------------------------------------------
-*/
TIM_HandleTypeDef htim16;

/* USER CODE BEGIN PV */
// TODO: Define any input variables

//LED patterns to display
static uint8_t patterns[] = {0b10101010, 0b01010101, 0b11001100, 0b00110011,
0b11110000, 0b00001111};

//EEPROM memory addresses for storing the patterns
static uint16_t EEPROM_ADR[] = {0x0, 0x1, 0x2, 0x3, 0x4, 0x5};

//data variable to read from EEPROM
static uint8_t data;

//counter for read_from_address function
uint16_t current_ADR = 0;

//toggle between interrupts
uint8_t toggle =0;

//debounce protection
uint8_t buttonState;


/* USER CODE END PV */

/* Private function prototypes ----------------------------------------------
-*/
void SystemClock_Config(void);
static void MX_GPIO_Init(void);
static void MX_TIM16_Init(void);
/* USER CODE BEGIN PFP */
void EXTI0_1_IRQHandler(void);
void TIM16_IRQHandler(void);
static void init_spi(void);
static void write_to_address(uint16_t address, uint8_t data);
static uint8_t read_from_address(uint16_t address);
static void delay(uint32_t delay_in_us);
/* USER CODE END PFP */

/* Private user code --------------------------------------------------------
-*/
/* USER CODE BEGIN 0 */

/* USER CODE END 0 */

/**
  * @brief  The application entry point.
  * @retval int
  */
int main(void)
{
  /* USER CODE BEGIN 1 */
  /* USER CODE END 1 */

  /* MCU Configuration-------------------------------------------------------
-*/

  /* Reset of all peripherals, Initializes the Flash interface and the
Systick. */
  HAL_Init();

  /* USER CODE BEGIN Init */
  /* USER CODE END Init */

  /* Configure the system clock */
  SystemClock_Config();

  /* USER CODE BEGIN SysInit */
  init_spi();
  /* USER CODE END SysInit */

  /* Initialize all configured peripherals */
  MX_GPIO_Init();
  MX_TIM16_Init();
  /* USER CODE BEGIN 2 */

  // TODO: Start timer TIM16
  HAL_TIM_Base_Start_IT(&htim16);


  // TODO: Write all "patterns" to EEPROM using SPI
  for (i = 0; i < sizeof(patterns); i++) {
    write_to_address(EEPROM_ADR[i], patterns[i]);
  }

  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */

      // TODO: Check button PA0; if pressed, change timer delay
      buttonState = HAL_GPIO_ReadPin(Button0_GPIO_Port, Button0_Pin);
      if ((HAL_GPIO_ReadPin(Button0_GPIO_Port, Button0_Pin))!=buttonState)
      {
            toggle = !toggle;
            if(toggle)
            {
                  TIM16->ARR = 499;
            }
            else
            {
                  TIM16->ARR = 999;
            }
      }
  }
  /* USER CODE END 3 */
}

/**
  * @brief System Clock Configuration
  * @retval None
  */
void SystemClock_Config(void)
{
  LL_FLASH_SetLatency(LL_FLASH_LATENCY_0);
  while(LL_FLASH_GetLatency() != LL_FLASH_LATENCY_0)
  {
  }
  LL_RCC_HSI_Enable();

   /* Wait till HSI is ready */
  while(LL_RCC_HSI_IsReady() != 1)
  {

  }
  LL_RCC_HSI_SetCalibTrimming(16);
  LL_RCC_SetAHBPrescaler(LL_RCC_SYSCLK_DIV_1);
  LL_RCC_SetAPB1Prescaler(LL_RCC_APB1_DIV_1);
  LL_RCC_SetSysClkSource(LL_RCC_SYS_CLKSOURCE_HSI);

   /* Wait till System clock is ready */
  while(LL_RCC_GetSysClkSource() != LL_RCC_SYS_CLKSOURCE_STATUS_HSI)
  {

  }
  LL_SetSystemCoreClock(8000000);

   /* Update the time base */
  if (HAL_InitTick (TICK_INT_PRIORITY) != HAL_OK)
  {
    Error_Handler();
  }
}

/**
  * @brief TIM16 Initialization Function
  * @param None
  * @retval None
  */
static void MX_TIM16_Init(void)
{

  /* USER CODE BEGIN TIM16_Init 0 */

  /* USER CODE END TIM16_Init 0 */
  /* USER CODE BEGIN TIM16_Init 1 */

  /* USER CODE END TIM16_Init 1 */
  htim16.Instance = TIM16;
  htim16.Init.Prescaler = 8000-1;
  htim16.Init.CounterMode = TIM_COUNTERMODE_UP;
  htim16.Init.Period = 1000-1;
  htim16.Init.ClockDivision = TIM_CLOCKDIVISION_DIV1;
  htim16.Init.RepetitionCounter = 0;
  htim16.Init.AutoReloadPreload = TIM_AUTORELOAD_PRELOAD_ENABLE;
  if (HAL_TIM_Base_Init(&htim16) != HAL_OK)
  {
    Error_Handler();
  }
  /* USER CODE BEGIN TIM16_Init 2 */
  NVIC_EnableIRQ(TIM16_IRQn);
  /* USER CODE END TIM16_Init 2 */

}

/**
  * @brief GPIO Initialization Function
  * @param None
  * @retval None
  */
static void MX_GPIO_Init(void)
{
  LL_EXTI_InitTypeDef EXTI_InitStruct = {0};
  LL_GPIO_InitTypeDef GPIO_InitStruct = {0};
/* USER CODE BEGIN MX_GPIO_Init_1 */
/* USER CODE END MX_GPIO_Init_1 */

  /* GPIO Ports Clock Enable */
  LL_AHB1_GRP1_EnableClock(LL_AHB1_GRP1_PERIPH_GPIOF);
  LL_AHB1_GRP1_EnableClock(LL_AHB1_GRP1_PERIPH_GPIOA);
  LL_AHB1_GRP1_EnableClock(LL_AHB1_GRP1_PERIPH_GPIOB);

  /**/
  LL_GPIO_ResetOutputPin(LED0_GPIO_Port, LED0_Pin);

  /**/
  LL_GPIO_ResetOutputPin(LED1_GPIO_Port, LED1_Pin);

  /**/
  LL_GPIO_ResetOutputPin(LED2_GPIO_Port, LED2_Pin);

  /**/
  LL_GPIO_ResetOutputPin(LED3_GPIO_Port, LED3_Pin);

  /**/
  LL_GPIO_ResetOutputPin(LED4_GPIO_Port, LED4_Pin);

  /**/
  LL_GPIO_ResetOutputPin(LED5_GPIO_Port, LED5_Pin);

  /**/
  LL_GPIO_ResetOutputPin(LED6_GPIO_Port, LED6_Pin);
```

```
/**/
LL_GPIO_ResetOutputPin(LED7_GPIO_Port, LED7_Pin);

/**/
LL_SYSCFG_SetEXTISource(LL_SYSCFG_EXTI_PORTA, LL_SYSCFG_EXTI_LINE0);

/**/
LL_GPIO_SetPinPull(Button0_GPIO_Port, Button0_Pin, LL_GPIO_PULL_UP);

/**/
LL_GPIO_SetPinMode(Button0_GPIO_Port, Button0_Pin, LL_GPIO_MODE_INPUT);

/**/
EXTI_InitStruct.Line_0_31 = LL_EXTI_LINE_0;
EXTI_InitStruct.LineCommand = ENABLE;
EXTI_InitStruct.Mode = LL_EXTI_MODE_IT;
EXTI_InitStruct.Trigger = LL_EXTI_TRIGGER_RISING;
LL_EXTI_Init(&EXTI_InitStruct);

/**/
GPIO_InitStruct.Pin = LED0_Pin;
GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
LL_GPIO_Init(LED0_GPIO_Port, &GPIO_InitStruct);

/**/
GPIO_InitStruct.Pin = LED1_Pin;
GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
LL_GPIO_Init(LED1_GPIO_Port, &GPIO_InitStruct);

/**/
GPIO_InitStruct.Pin = LED2_Pin;
GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
LL_GPIO_Init(LED2_GPIO_Port, &GPIO_InitStruct);

/**/
GPIO_InitStruct.Pin = LED3_Pin;
GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
LL_GPIO_Init(LED3_GPIO_Port, &GPIO_InitStruct);

/**/
GPIO_InitStruct.Pin = LED4_Pin;
GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
```

```
  GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
  LL_GPIO_Init(LED4_GPIO_Port, &GPIO_InitStruct);

  /**/
  GPIO_InitStruct.Pin = LED5_Pin;
  GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
  GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
  GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
  GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
  LL_GPIO_Init(LED5_GPIO_Port, &GPIO_InitStruct);

  /**/
  GPIO_InitStruct.Pin = LED6_Pin;
  GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
  GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
  GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
  GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
  LL_GPIO_Init(LED6_GPIO_Port, &GPIO_InitStruct);

  /**/
  GPIO_InitStruct.Pin = LED7_Pin;
  GPIO_InitStruct.Mode = LL_GPIO_MODE_OUTPUT;
  GPIO_InitStruct.Speed = LL_GPIO_SPEED_FREQ_LOW;
  GPIO_InitStruct.OutputType = LL_GPIO_OUTPUT_PUSHPULL;
  GPIO_InitStruct.Pull = LL_GPIO_PULL_NO;
  LL_GPIO_Init(LED7_GPIO_Port, &GPIO_InitStruct);

/* USER CODE BEGIN MX_GPIO_Init_2 */
/* USER CODE END MX_GPIO_Init_2 */
}

/* USER CODE BEGIN 4 */

// Initialise SPI
static void init_spi(void) {

  // Clock to PB
  RCC->AHBENR |= RCC_AHBENR_GPIOBEN;      // Enable clock for SPI port

  // Set pin modes
  GPIOB->MODER |= GPIO_MODER_MODER13_1; // Set pin SCK (PB13) to Alternate
Function
  GPIOB->MODER |= GPIO_MODER_MODER14_1; // Set pin MISO (PB14) to Alternate
Function
  GPIOB->MODER |= GPIO_MODER_MODER15_1; // Set pin MOSI (PB15) to Alternate
Function
  GPIOB->MODER |= GPIO_MODER_MODER12_0; // Set pin CS (PB12) to output push-
pull
  GPIOB->BSRR |= GPIO_BSRR_BS_12;         // Pull CS high

  // Clock enable to SPI
  RCC->APB1ENR |= RCC_APB1ENR_SPI2EN;
  SPI2->CR1 |= SPI_CR1_BIDIOE;
      // Enable output
  SPI2->CR1 |= (SPI_CR1_BR_0 |  SPI_CR1_BR_1);                           //
Set Baud to fpclk / 16
```

```
  SPI2->CR1 |= SPI_CR1_MSTR;
      // Set to master mode
  SPI2->CR2 |= SPI_CR2_FRXTH;
      // Set RX threshold to be 8 bits
  SPI2->CR2 |= SPI_CR2_SSOE;
      // Enable slave output to work in master mode
  SPI2->CR2 |= (SPI_CR2_DS_0 | SPI_CR2_DS_1 | SPI_CR2_DS_2);      // Set to
8-bit mode
  SPI2->CR1 |= SPI_CR1_SPE;
      // Enable the SPI peripheral
}

// Implements a delay in microseconds
static void delay(uint32_t delay_in_us) {
  volatile uint32_t counter = 0;
  delay_in_us *= 3;
  for(; counter < delay_in_us; counter++) {
    __asm("nop");
    __asm("nop");
  }
}

// Write to EEPROM address using SPI
static void write_to_address(uint16_t address, uint8_t data) {

      uint8_t dummy; // Junk from the DR

      // Set the Write Enable latch
      GPIOB->BSRR |= GPIO_BSRR_BR_12; // Pull CS low
      delay(1);
      *((uint8_t*)(&SPI2->DR)) = WREN;
      while ((SPI2->SR & SPI_SR_RXNE) == 0); // Hang while RX is empty
      dummy = SPI2->DR;
      GPIOB->BSRR |= GPIO_BSRR_BS_12; // Pull CS high
      delay(5000);

      // Send write instruction
      GPIOB->BSRR |= GPIO_BSRR_BR_12;                    // Pull CS low
      delay(1);
      *((uint8_t*)(&SPI2->DR)) = WRITE;
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;

      // Send 16-bit address
      *((uint8_t*)(&SPI2->DR)) = (address >> 8);      // Address MSB
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;
      *((uint8_t*)(&SPI2->DR)) = (address);           // Address LSB
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;

      // Send the data
      *((uint8_t*)(&SPI2->DR)) = data;
      while ((SPI2->SR & SPI_SR_RXNE) == 0); // Hang while RX is empty
      dummy = SPI2->DR;
      GPIOB->BSRR |= GPIO_BSRR_BS_12; // Pull CS high
      delay(5000);
}

// Read from EEPROM address using SPI
static uint8_t read_from_address(uint16_t address) {

      uint8_t dummy; // Junk from the DR

      // Send the read instruction
      GPIOB->BSRR |= GPIO_BSRR_BR_12;                 // Pull CS low
      delay(1);
      *((uint8_t*)(&SPI2->DR)) = READ;
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;

      // Send 16-bit address
      *((uint8_t*)(&SPI2->DR)) = (address >> 8);      // Address MSB
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;
      *((uint8_t*)(&SPI2->DR)) = (address);           // Address LSB
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;

      // Clock in the data
      *((uint8_t*)(&SPI2->DR)) = 0x42;                    // Clock out some
junk data
      while ((SPI2->SR & SPI_SR_RXNE) == 0);          // Hang while RX is
empty
      dummy = SPI2->DR;
      GPIOB->BSRR |= GPIO_BSRR_BS_12;                     // Pull CS high
      delay(5000);

      return dummy;
// Return read data
}

// Timer rolled over
void TIM16_IRQHandler(void)
{
      // Acknowledge interrupt
      HAL_TIM_IRQHandler(&htim16);

      // TODO: Change to next LED pattern; output 0x01 if the read SPI data
is incorrect
      data = read_from_address(EEPROM_ADR[current_ADR]);

      //Task 5: Failsafe - change data to error code in case incorrect
information is read from EEPROM
      if (data != patterns[current_ADR]){
            data = 0b00000001;
      }
      //Write to LEDs
      GPIOB -> data;

      //Task 4: keep track of address value to read from EEPROM
      if (current_ADR == sizeof(patterns)){
            current_ADR = 0;
      }
      else{
            current_ADR = current_ADR + 1;
      }

}

/* USER CODE END 4 */

/**
  * @brief  This function is executed in case of error occurrence.
  * @retval None
  */
void Error_Handler(void)
{
  /* USER CODE BEGIN Error_Handler_Debug */
  /* User can add his own implementation to report the HAL error return state
*/
  __disable_irq();
  while (1)
  {
  }
  /* USER CODE END Error_Handler_Debug */
}

#ifdef  USE_FULL_ASSERT
/**
  * @brief  Reports the name of the source file and the source line number
  *         where the assert_param error has occurred.
  * @param  file: pointer to the source file name
  * @param  line: assert_param error line source number
  * @retval None
  */
void assert_failed(uint8_t *file, uint32_t line)
{
  /* USER CODE BEGIN 6 */
  /* User can add his own implementation to report the file name and line
number,
     ex: printf("Wrong parameters value: file %s on line %d\r\n", file, line)
*/
  /* USER CODE END 6 */
}
#endif /* USE_FULL_ASSERT */
```