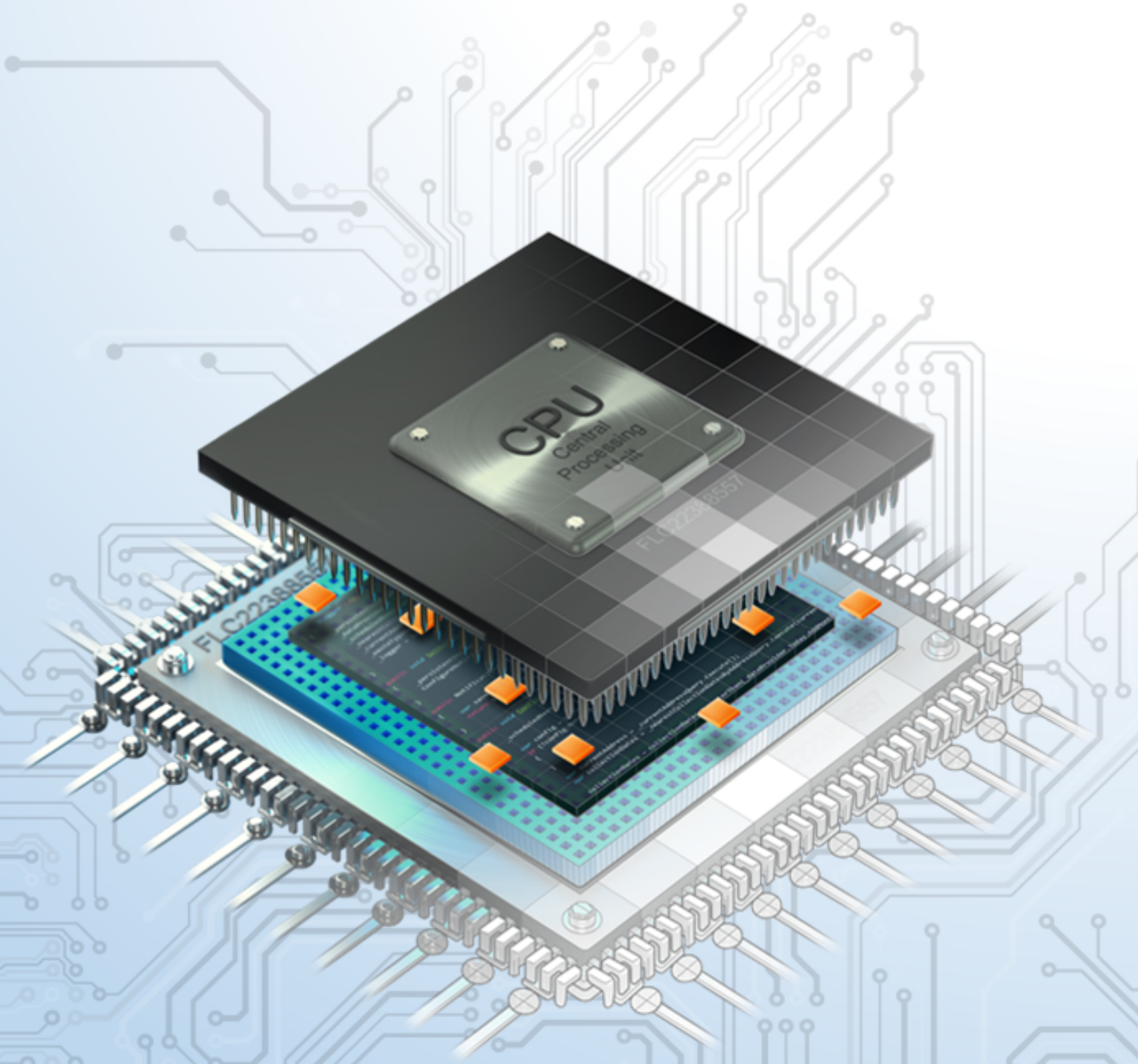
HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY
COMPUTER ENGINEERING

Microcontroller

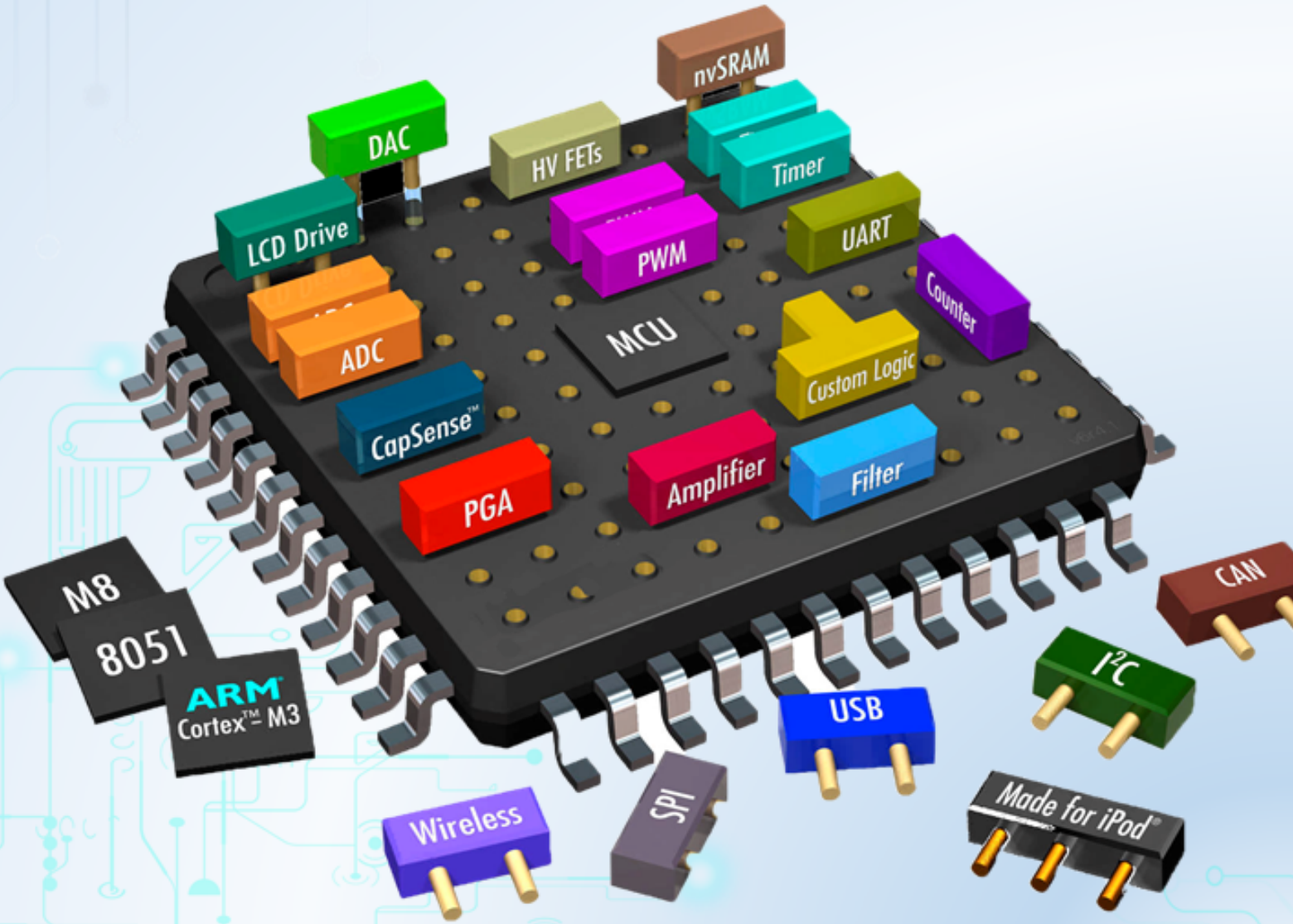


Dr. Le Trong Nhan

Mục lục

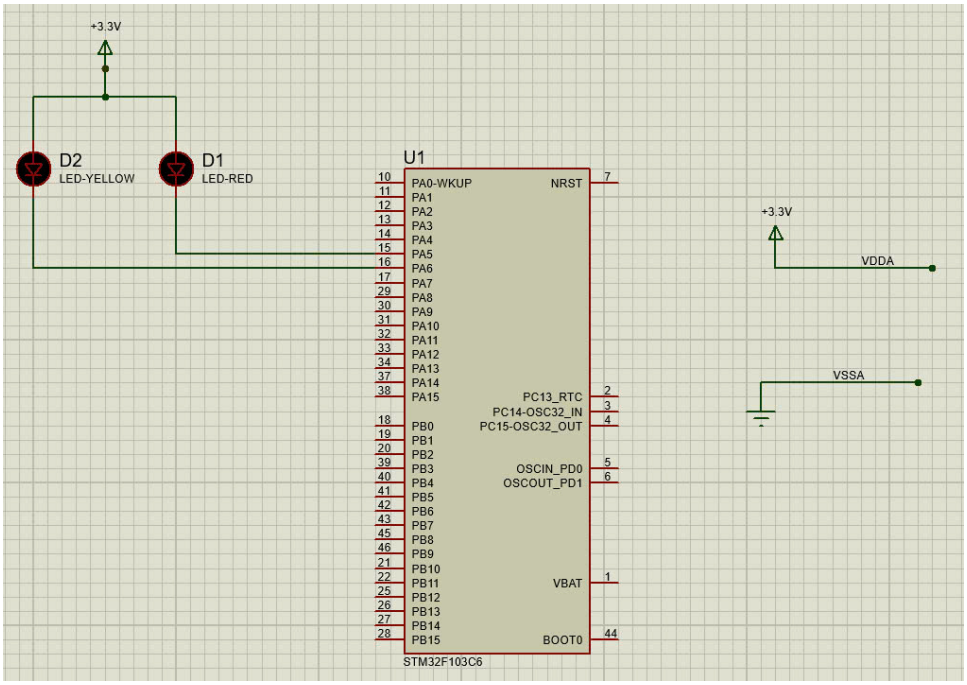
CHƯƠNG 1

LED Animations



1 Exercise and Report

1.1 Exercise 1

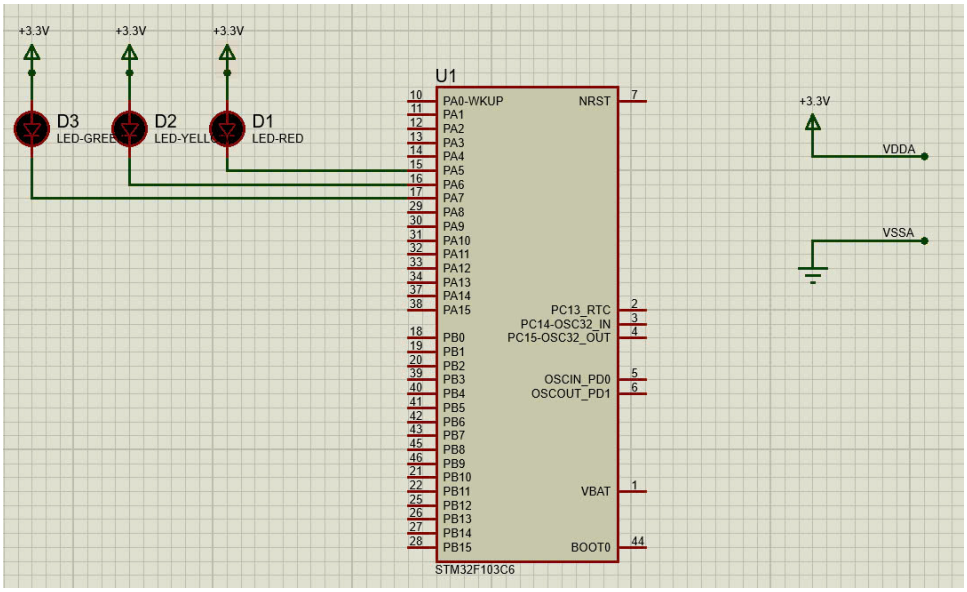


Hình 1.1: *Schematic*

```
while (1){
HAL_GPIO_WritePin(LED_RED_GPIO_Port, LED_RED_Pin, RESET);
HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port,LED_YELLOW_Pin,SET);
HAL_Delay(2000);
HAL_GPIO_WritePin(LED_RED_GPIO_Port, LED_RED_Pin, SET);
HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port,LED_YELLOW_Pin,RESET
   );
HAL_Delay(2000);
}
```

Program 1.1: main.c

1.2 Exercise 2

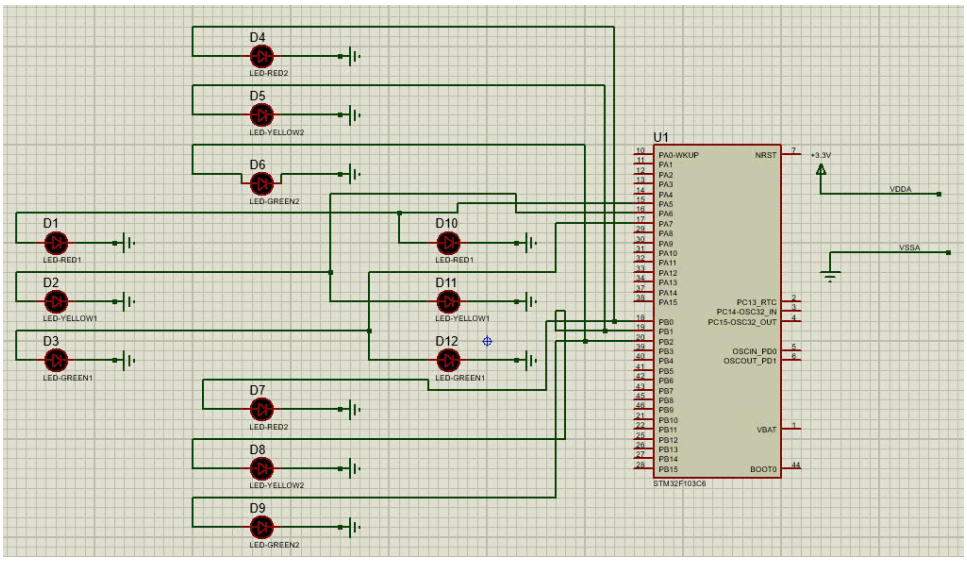


Hình 1.2: Schematic

```
while (1){
        HAL_GPIO_WritePin(LED_RED_GPIO_Port, LED_RED_Pin,
   RESET);
        HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port,
   LED_YELLOW_Pin, SET);
        HAL_GPIO_WritePin(LED_GREEN_GPIO_Port,
   LED_GREEN_Pin, SET);
        HAL_Delay(5000);
        HAL_GPIO_WritePin(LED_GREEN_GPIO_Port,
   LED_GREEN_Pin, RESET);
        HAL_GPIO_WritePin(LED_RED_GPIO_Port, LED_RED_Pin,
   SET);
        HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port,
   LED_YELLOW_Pin, SET);
        HAL_Delay(3000);
        HAL_GPIO_WritePin(LED_YELLOW_GPIO_Port,
   LED_YELLOW_Pin, RESET);
        HAL_GPIO_WritePin(LED_GREEN_GPIO_Port,
   LED_GREEN_Pin, SET);
        HAL_GPIO_WritePin(LED_RED_GPIO_Port, LED_RED_Pin,
   SET);
        HAL_Delay(2000);
}
```

Program 1.2: main.c

1.3 Exercise 3



Hình 1.3: Schematic

```
void settrafficlight1(GPIO_TypeDef* LED_GIPO_Port, uint16_t
    LED_Pin,GPIO_TypeDef* LED_1GIPO_Port, uint16_t LED_1Pin
   ,GPIO_TypeDef* LED_2GIPO_Port, uint16_t LED_2Pin)
  {
     HAL_GPIO_WritePin(LED_GIPO_Port, LED_Pin, SET);
     HAL_GPIO_WritePin(LED_1GIPO_Port, LED_1Pin, RESET);
     HAL_GPIO_WritePin(LED_2GIPO_Port, LED_2Pin, RESET);
  }
```

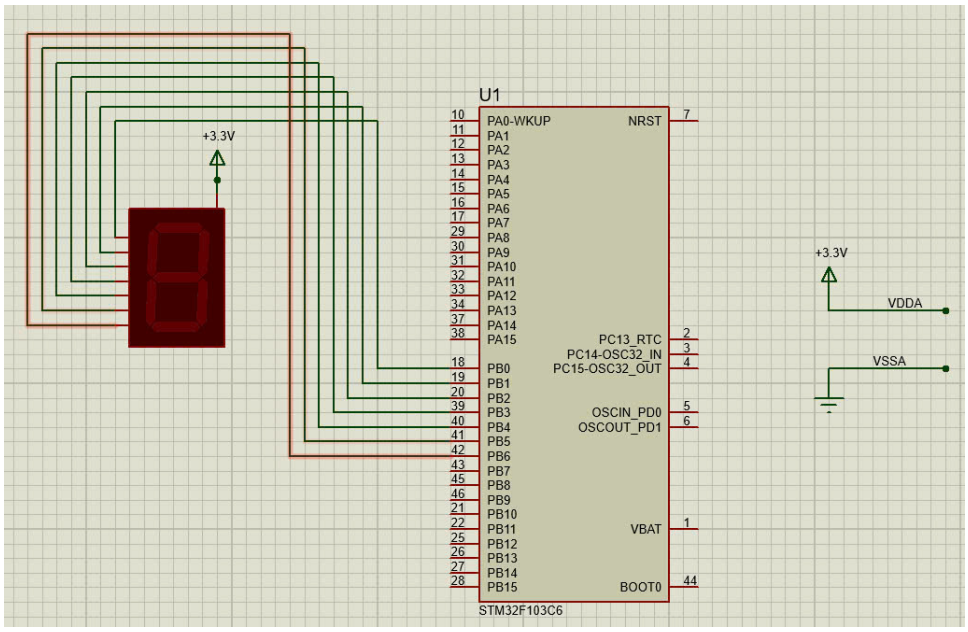
Program 1.3: Ex3.c

```
while (1){
settrafficlight1(LED_RED1_GPIO_Port,LED_RED1_Pin,
   LED_YELLOW1_GPIO_Port, LED_YELLOW1_Pin,
   LED_GREEN1_GPIO_Port, LED_GREEN1_Pin);
settrafficlight1(LED_GREEN2_GPIO_Port, LED_GREEN2_Pin,
   LED_RED2_GPIO_Port, LED_RED2_Pin, LED_YELLOW2_GPIO_Port,
    LED_YELLOW2_Pin) ;
HAL_Delay(3000);
settrafficlight1(LED_YELLOW2_GPIO_Port, LED_YELLOW2_Pin,
   LED_GREEN2_GPIO_Port, LED_GREEN2_Pin, LED_RED2_GPIO_Port
   , LED_RED2_Pin);
HAL_Delay(2000);
settrafficlight1(LED_RED2_GPIO_Port, LED_RED2_Pin,
   LED_YELLOW2_GPIO_Port, LED_YELLOW2_Pin,
   LED_GREEN2_GPIO_Port, LED_GREEN2_Pin);
settrafficlight1(LED_GREEN1_GPIO_Port, LED_GREEN1_Pin,
   LED_RED1_GPIO_Port, LED_RED1_Pin, LED_YELLOW1_GPIO_Port,
    LED_YELLOW1_Pin);
HAL_Delay(3000);
```

```
10 settrafficlight1(LED_YELLOW1_GPIO_Port, LED_YELLOW1_Pin,
      LED_GREEN1_GPIO_Port, LED_GREEN1_Pin, LED_RED1_GPIO_Port
      , LED_RED1_Pin);
11 HAL_Delay(2000);
12 }
```

Program 1.4: main.c

1.4 Exercise 4



Hình 1.4: Schematic

```
1  void display7SEG(int num) {
2        const uint8_t segmentMap[10] = {
3            0b11111100,
4            0b01100000,
5            0b11011010,
6            0b11110010,
7            0b01100110,
8            0b10110110,
9            0b10111110,
10           0b11100000,
11           0b11111110,
12           0b11110110
13       };
14   HAL_GPIO_WritePin(a_GPIO_Port, a_Pin, (segmentMap[num] &
      0b10000000) ? GPIO_PIN_RESET : GPIO_PIN_SET);
15   HAL_GPIO_WritePin(b_GPIO_Port, b_Pin, (segmentMap[num] &
      0b01000000) ? GPIO_PIN_RESET : GPIO_PIN_SET);
16   HAL_GPIO_WritePin(c_GPIO_Port, c_Pin, (segmentMap[num] &
      0b00100000) ? GPIO_PIN_RESET : GPIO_PIN_SET);
```

```
  HAL_GPIO_WritePin(d_GPIO_Port, d_Pin, (segmentMap[num] &
   0b00010000) ? GPIO_PIN_RESET : GPIO_PIN_SET);
  HAL_GPIO_WritePin(e_GPIO_Port, e_Pin, (segmentMap[num] &
   0b00001000) ? GPIO_PIN_RESET : GPIO_PIN_SET);
  HAL_GPIO_WritePin(f_GPIO_Port, f_Pin, (segmentMap[num] &
   0b00000100) ? GPIO_PIN_RESET : GPIO_PIN_SET);
  HAL_GPIO_WritePin(g_GPIO_Port, g_Pin, (segmentMap[num] &
   0b00000010) ? GPIO_PIN_RESET : GPIO_PIN_SET);
  }
```

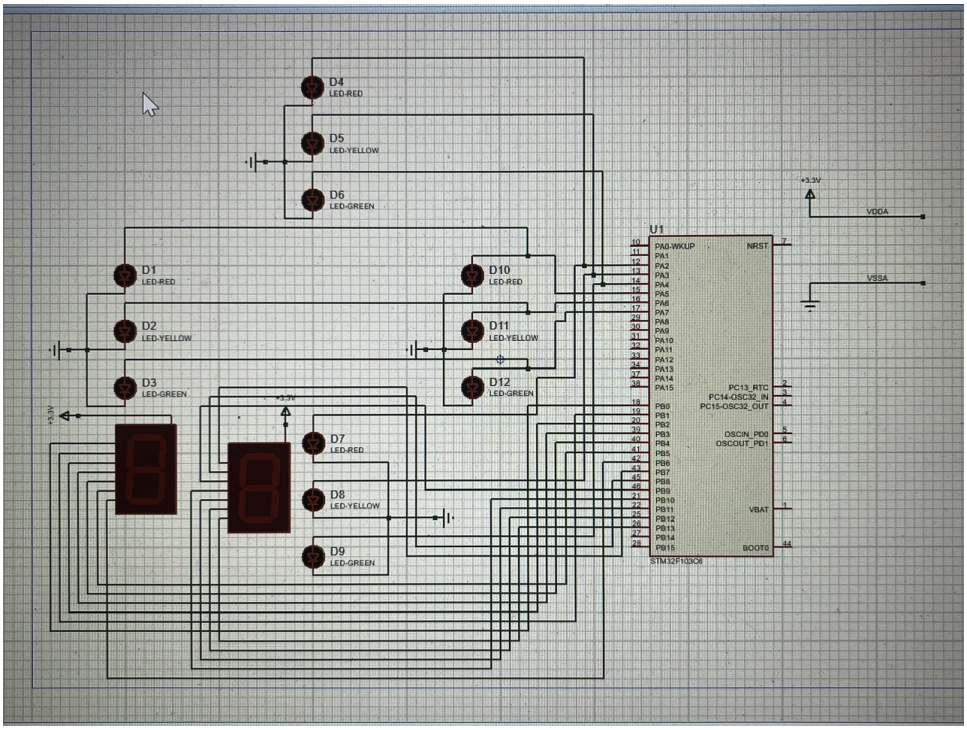
Program 1.5: Ex4.c

```
int counter = 0;
while (1){
    if(counter >= 10) counter = 0;
    display7SEG(counter++);
    HAL_Delay(1000);

}
```

Program 1.6: main.c

1.5 Exercise 5



Hình 1.5: Schematic

```
int counterred=6;
  int counteryellow=2;
  int countergreen=3;
```

```
GPIO_TypeDef* segmentPorts[2][NUM_SEGMENTS] = {
      {a1_GPIO_Port, b1_GPIO_Port, c1_GPIO_Port, d1_GPIO_Port, e1_GPIO_Port, f1_GPIO_Port, g1_GPIO_Port},
      {a2_GPIO_Port, b2_GPIO_Port, c2_GPIO_Port, d2_GPIO_Port, e2_GPIO_Port, f2_GPIO_Port, g2_GPIO_Port}
  };
  uint16_t segmentPins[2][NUM_SEGMENTS] = {
      {a1_Pin, b1_Pin, c1_Pin, d1_Pin, e1_Pin, f1_Pin, g1_Pin},
      {a2_Pin, b2_Pin, c2_Pin, d2_Pin, e2_Pin, f2_Pin, g2_Pin}
  };
  const uint8_t segmentMap[10] = {
        0b11111100,
        0b01100000,
        0b11011010,
        0b11110010,
        0b01100110,
        0b10110110,
        0b10111110,
        0b11100000,
        0b11111110,
        0b11110110
    };
  void settrafficlight1(GPIO_TypeDef* LED_GIPO_Port, uint16_t LED_Pin,GPIO_TypeDef* LED_1GIPO_Port, uint16_t LED_1Pin,GPIO_TypeDef* LED_2GIPO_Port, uint16_t LED_2Pin){
        HAL_GPIO_WritePin(LED_GIPO_Port, LED_Pin, SET);
        HAL_GPIO_WritePin(LED_1GIPO_Port, LED_1Pin, RESET);
        HAL_GPIO_WritePin(LED_2GIPO_Port, LED_2Pin, RESET);
      }
  void display7SEG(int ledNum, int num) {
        for (int i = 0; i < NUM_SEGMENTS; i++) {
            HAL_GPIO_WritePin(segmentPorts[ledNum][i], segmentPins[ledNum][i],
                              (segmentMap[num] & (0b10000000 >> i)) ? RESET : SET);
        }
    }
  void process(){
      settrafficlight1(LED_RED1_GPIO_Port, LED_RED1_Pin, LED_YELLOW1_GPIO_Port, LED_YELLOW1_Pin, LED_GREEN1_GPIO_Port, LED_GREEN1_Pin);
      settrafficlight1(LED_GREEN2_GPIO_Port, LED_GREEN2_Pin, LED_RED2_GPIO_Port, LED_RED2_Pin, LED_YELLOW2_GPIO_Port, LED_YELLOW2_Pin) ;
        for(int i=5;i>=2;i--){
          display7SEG(0, counterred--);
```

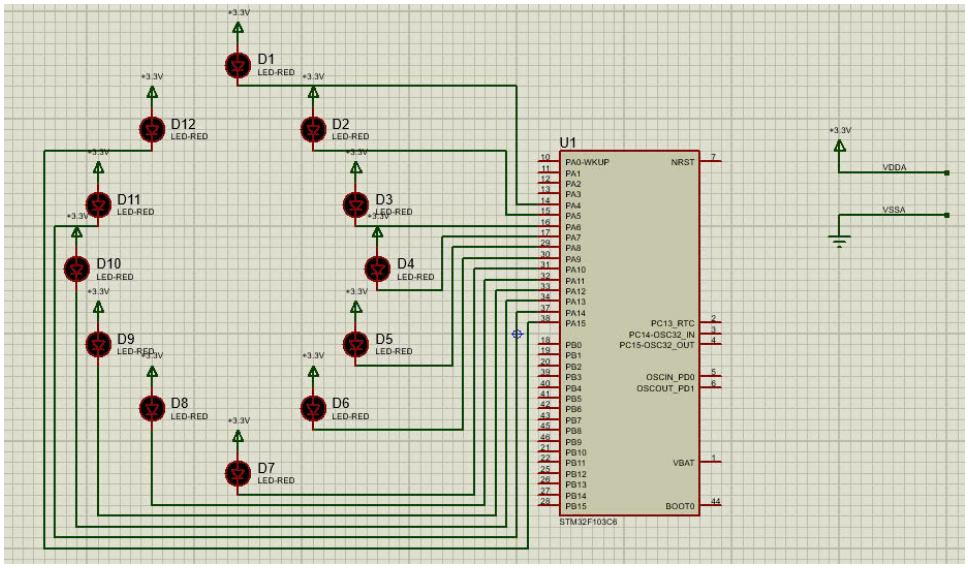
```
          display7SEG(1, countergreen--);
          HAL_Delay(1000);
        }
        settrafficlight1(LED_YELLOW2_GPIO_Port,
    LED_YELLOW2_Pin, LED_GREEN2_GPIO_Port, LED_GREEN2_Pin,
    LED_RED2_GPIO_Port, LED_RED2_Pin);
      for(int i=2;i>=0;i--){
        display7SEG(0, counterred--);
        display7SEG(1, counteryellow--);
        HAL_Delay(1000);
        if(i<=0){
          counterred=6;
          counteryellow=2;
          countergreen=3;
        }
      }
      settrafficlight1(LED_RED2_GPIO_Port, LED_RED2_Pin,
    LED_YELLOW2_GPIO_Port, LED_YELLOW2_Pin,
    LED_GREEN2_GPIO_Port, LED_GREEN2_Pin);
      settrafficlight1(LED_GREEN1_GPIO_Port, LED_GREEN1_Pin
    , LED_RED1_GPIO_Port, LED_RED1_Pin,
    LED_YELLOW1_GPIO_Port, LED_YELLOW1_Pin);
      for(int i=5;i>=2;i--){
              display7SEG(1, counterred--);
              display7SEG(0, countergreen--);
            HAL_Delay(1000);
      }
      settrafficlight1(LED_YELLOW1_GPIO_Port,
    LED_YELLOW1_Pin, LED_GREEN1_GPIO_Port, LED_GREEN1_Pin,
    LED_RED1_GPIO_Port, LED_RED1_Pin);
      for(int i=2;i>=0;i--){
            display7SEG(1, counterred--);
            display7SEG(0, counteryellow--);
          HAL_Delay(1000);
          if(i<=0){
            counterred=6;
            counteryellow=2;
            countergreen=3;
          }
      }
    }
```

Program 1.7: Ex5.c

```
while (1){
      process();
}
```

Program 1.8: main.c

1.6 Exercise 6



Hình 1.6: Schematic

```
int counter=0;
GPIO_TypeDef* segmentPorts[12] = {
      LED0_GPIO_Port, LED1_GPIO_Port,LED2_GPIO_Port,
   LED3_GPIO_Port,LED4_GPIO_Port,LED5_GPIO_Port,
    LED6_GPIO_Port,LED7_GPIO_Port,LED8_GPIO_Port,
   LED9_GPIO_Port,LED10_GPIO_Port,LED11_GPIO_Port};
uint16_t segmentPins[12]={
      LED0_Pin,LED1_Pin,LED2_Pin,LED3_Pin,LED4_Pin,LED5_Pin
   ,LED6_Pin,LED7_Pin
                              ,LED8_Pin,LED9_Pin,
   LED10_Pin,LED11_Pin};
void TurnOnEveryClock(int num) {
          for (int i = 0; i < 12; i++) {
            if(i==num)HAL_GPIO_WritePin(segmentPorts[num],
   segmentPins[num], RESET);
            else HAL_GPIO_WritePin(segmentPorts[i],
   segmentPins[i], SET);
          }
      }
```

Program 1.9: Ex6.c

```
while (1){
    if(counter>=12) counter=0;
    TurnOnEveryClock(counter++);
    HAL_Delay(1000);
   }
```

Program 1.10: main.c

1.7 Exercise 7

```
void clearAllClock(){
    HAL_GPIO_WritePin(GPIOA, LED_PINS, SET);
}
```

Program 1.11: main.c

1.8 Exercise 8

```
GPIO_TypeDef* segmentPorts[12] = {LED0_GPIO_Port,
   LED1_GPIO_Port,LED2_GPIO_Port,LED3_GPIO_Port,
   LED4_GPIO_Port,
LED5_GPIO_Port,LED6_GPIO_Port,LED7_GPIO_Port,LED8_GPIO_Port
   ,LED9_GPIO_Port,LED10_GPIO_Port,LED11_GPIO_Port};
uint16_t segmentPins[12]={LED0_Pin,LED1_Pin,LED2_Pin,
   LED3_Pin,LED4_Pin,LED5_Pin,LED6_Pin,LED7_Pin
            ,LED8_Pin,LED9_Pin,LED10_Pin,LED11_Pin};
void clearNumberOnClock(int num) {
   HAL_GPIO_WritePin(segmentPorts[num], segmentPins[num],
   RESET);
 }
```

Program 1.12: Ex8.c

1.9 Exercise 9

```
GPIO_TypeDef* segmentPorts[12] = {LED0_GPIO_Port,
   LED1_GPIO_Port,LED2_GPIO_Port,LED3_GPIO_Port,
   LED4_GPIO_Port,
LED5_GPIO_Port,LED6_GPIO_Port,LED7_GPIO_Port,LED8_GPIO_Port
   ,LED9_GPIO_Port,LED10_GPIO_Port,LED11_GPIO_Port};
uint16_t segmentPins[12]={LED0_Pin,LED1_Pin,LED2_Pin,
   LED3_Pin,LED4_Pin,LED5_Pin,LED6_Pin,LED7_Pin
            ,LED8_Pin,LED9_Pin,LED10_Pin,LED11_Pin};
void clearNumberOnClock(int num) {
   HAL_GPIO_WritePin(segmentPorts[num], segmentPins[num],
   SET);
 }
```

Program 1.13: Ex9.c

1.10 Exercise 10

```
int second=0;
int minute=0;
```

```
int hour=0;
GPIO_TypeDef* segmentPorts[12] = {LED0_GPIO_Port,
   LED1_GPIO_Port,LED2_GPIO_Port,LED3_GPIO_Port,
   LED4_GPIO_Port,
LED5_GPIO_Port,LED6_GPIO_Port,LED7_GPIO_Port,LED8_GPIO_Port
   ,LED9_GPIO_Port,LED10_GPIO_Port,LED11_GPIO_Port};  //
   LED 1
uint16_t segmentPins[12]={LED0_Pin,LED1_Pin,LED2_Pin,
   LED3_Pin
  ,LED4_Pin,LED5_Pin,LED6_Pin,LED7_Pin,LED8_Pin,LED9_Pin,
   LED10_Pin,LED11_Pin};
void setClock(int num){
          HAL_GPIO_WritePin(segmentPorts[num], segmentPins[
   num], RESET);
        }
void clearClock(int num){
          HAL_GPIO_WritePin(segmentPorts[num], segmentPins[
   num], SET);
        }
void setClockBegin(int hour,int minute,int second){
          HAL_GPIO_WritePin(segmentPorts[hour], segmentPins
   [hour], RESET);
        if(minute%5==0) HAL_GPIO_WritePin(segmentPorts[
   minute/5], segmentPins[minute/5], RESET);
        if(second%5==0) HAL_GPIO_WritePin(segmentPorts[
   second/5], segmentPins[second/5], RESET);
        HAL_Delay(2000);
        }
```

Program 1.14: Ex10.c

```
setClockBegin(hour,minute,second);
  while (1)
  {
    second++;
            if (second >= 60) {
                second = 0;
                minute++;
                setClock((minute / 5+12)%12);
        if(((minute / 5+11)%12)!=hour) clearClock(((minute
   / 5+11)%12));
                if (minute >= 60) {
                    minute = 0;
                    hour++;
                    setClock((hour+12)%12);
                    if((hour+11)%12!=0) clearClock((hour
   +11)%12);
                    if (hour >= 12) {
                        hour = 0;
                    }
```

```
18                  }
19              }
20              setClock((second / 5+12)%12);
21    if(((second / 5+11)%12)!=hour&&((second / 5+11)%12)!=(
    minute/5+12)%12) clearClock(((second / 5+11)%12));
22              HAL_Delay(100);
23          }
```

Program 1.15: main.c