



HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY  
COMPUTER ENGINEERING

# Microcontroller



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# CHAPTER 1

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## LED Animations

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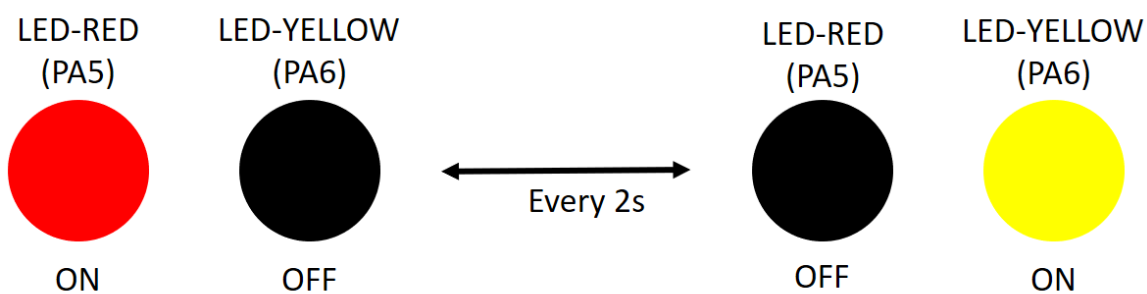


# 1 Exercise and Report

## 1.1 Exercise 1

From the simulation on Proteus, one more LED is connected to pin **PA6** of the STM32 (negative pin of the LED is connected to PA6). The component suggested in this exercise is **LED-YELLOW**, which can be found from the device list.

In this exercise, the status of two LEDs are switched every 2 seconds, as demonstrated in the figure bellow.



**Report 1:** Depict the schematic from Proteus simulation in this report.

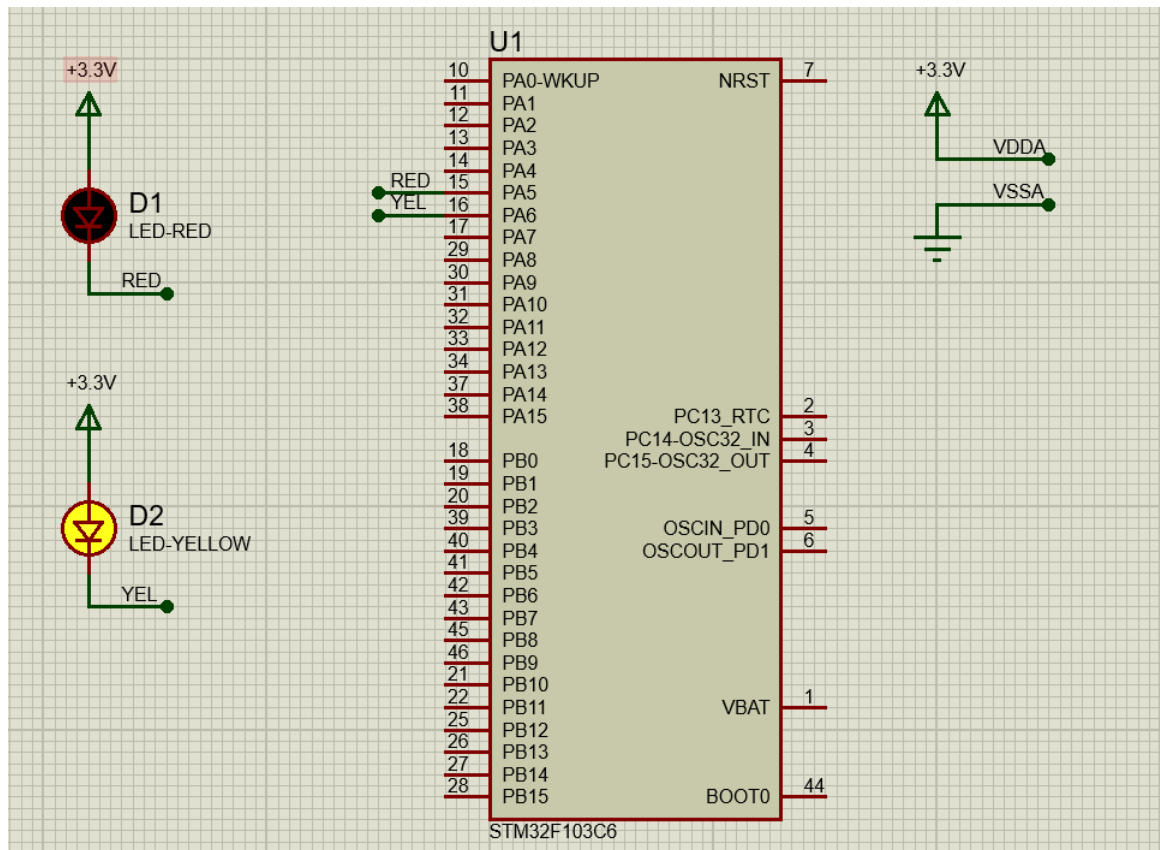


Figure 1.1: Schematic Exercise 1

**Report 2:** Present the source code in the infinite loop while.

```

1 int a=0;
2 while (1){
3     //At the first state, red led on, yellow led off.
4     if(a==0) HAL_GPIO_TogglePin(YEL_GPIO_Port, YEL_Pin);
5     //Then, each led changes their state every 2 second
6     else{
7         HAL_GPIO_TogglePin(RED_GPIO_Port, RED_Pin);
8         HAL_GPIO_TogglePin(YEL_GPIO_Port, YEL_Pin);
9     }
10    a++;
11    HAL_Delay(2000); //Set cycle time to 2 seconds
12 }

```

Program 1.1: Source code exercise 1

## 1.2 Exercise 2

Extend the first exercise to simulate the behavior of a traffic light. A third LED, named **LED-GREEN** is added to the system, which is connected to **PA7**. A cycle in this traffic light is 5 seconds for the RED, 2 seconds for the YELLOW and 3 seconds for the GREEN. The LED-GREEN is also controlled by its negative pin.

**Report 1:** Present the schematic.

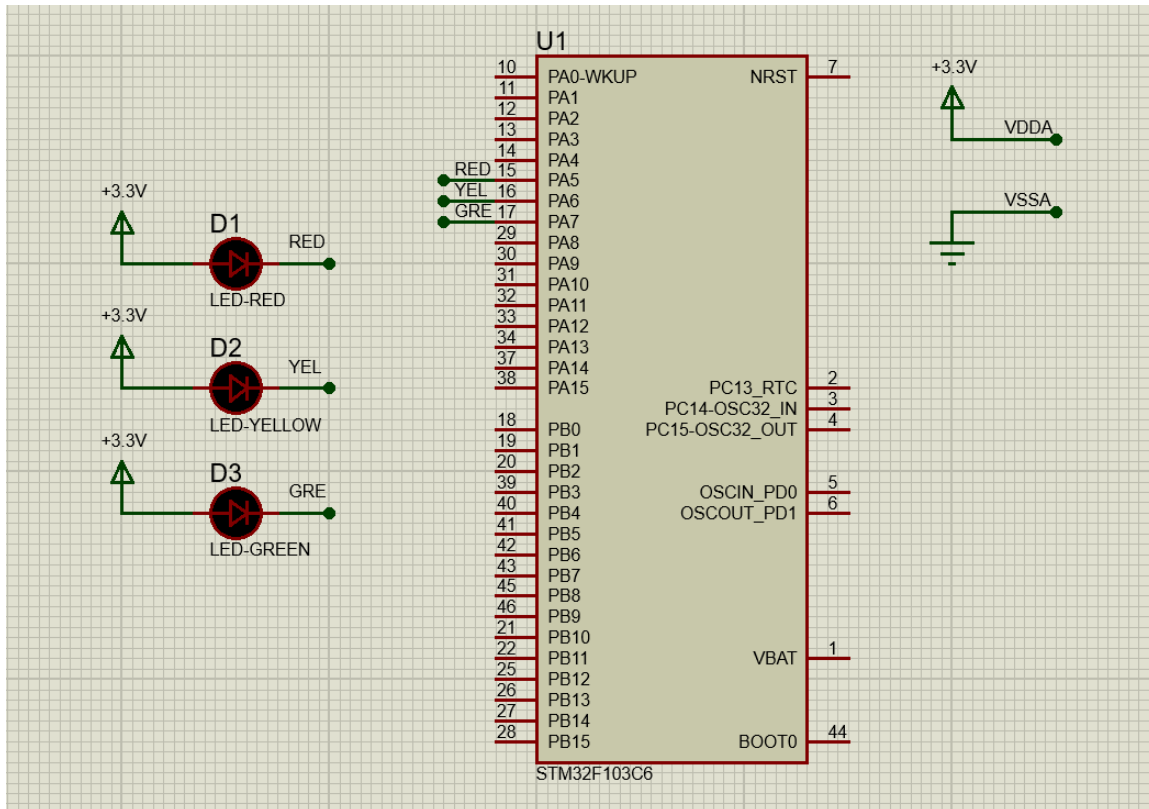


Figure 1.2: Schematic Exercise 2

**Report 2:** Present the source code in while.

```
1 int count=0;
2 while (1){
3     //The order is Red(5s) -> Green(3s) -> Yellow(2s)
4     //At first all leds are on, we need to turn off 2 leds
5     //Then the next states, we need to turn off the current
6     //led and turn on the next led.
7     //RED
8     if(count==0){
9         HAL_GPIO_TogglePin(YEL_GPIO_Port, YEL_Pin);
10        HAL_GPIO_TogglePin(GRE_GPIO_Port, GRE_Pin);
11    }
12    //YEL
13    if(count==5){
14        HAL_GPIO_TogglePin(RED_GPIO_Port, RED_Pin);
15        HAL_GPIO_TogglePin(YEL_GPIO_Port, YEL_Pin);
16    }
17    //GRE
18    if(count==8){
19        HAL_GPIO_TogglePin(YEL_GPIO_Port, YEL_Pin);
20        HAL_GPIO_TogglePin(GRE_GPIO_Port, GRE_Pin);
21    }
22    count++;
23    if(count==10){
24        count=0;
25    }
26 }
```



```

15     }
16     //GREEN
17     if(count==7){
18         HAL_GPIO_TogglePin(YEL_GPIO_Port , YEL_Pin);
19         HAL_GPIO_TogglePin(GRE_GPIO_Port , GRE_Pin);
20     }
21     //RED
22     if(count==10){
23         HAL_GPIO_TogglePin(GRE_GPIO_Port , GRE_Pin);
24         HAL_GPIO_TogglePin(RED_GPIO_Port , RED_Pin);
25     }
26     count++;
27     if(count==15) count=5;
28     HAL_Delay(1000); //Set cycle time to 1 second
29 }
30 }

```

Program 1.2: Source code exercise 2

### 1.3 Exercise 3

Extend to the 4-way traffic light. Arrange 12 LEDs in a nice shape to simulate the behaviors of a traffic light.

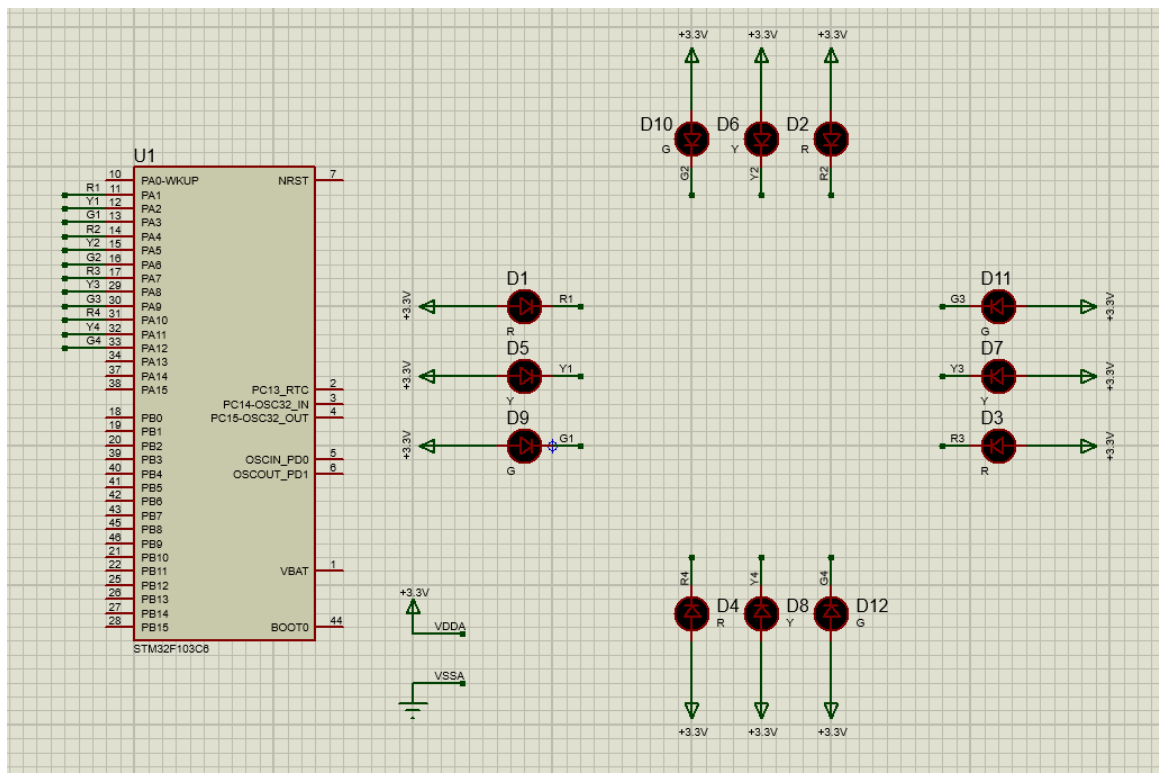


Figure 1.3: Reference design for a 4 way traffic light

## 1.4 Exercise 4

Add **only one 7 led segment** to the schematic in Exercise 3. This component can be found in Proteus by the keyword **7SEG-COM-ANODE**. For this device, the common pin should be connected to the power supply and other pins are supposed to be connected to PB0 to PB6. Therefore, to turn-on a segment in this 7SEG, the STM32 pin should be in logic 0 (0V).

Implement a function named **display7SEG(int num)**. This function is invoked in the while loop for testing as following:

```
1 int counter = 0;
2 while (1){
3     if(counter >= 10) counter = 0;
4     display7SEG(counter++);
5     HAL_Delay(1000);
6 }
```

Program 1.3: An example for your source code

**Report 1:** Present the schematic.

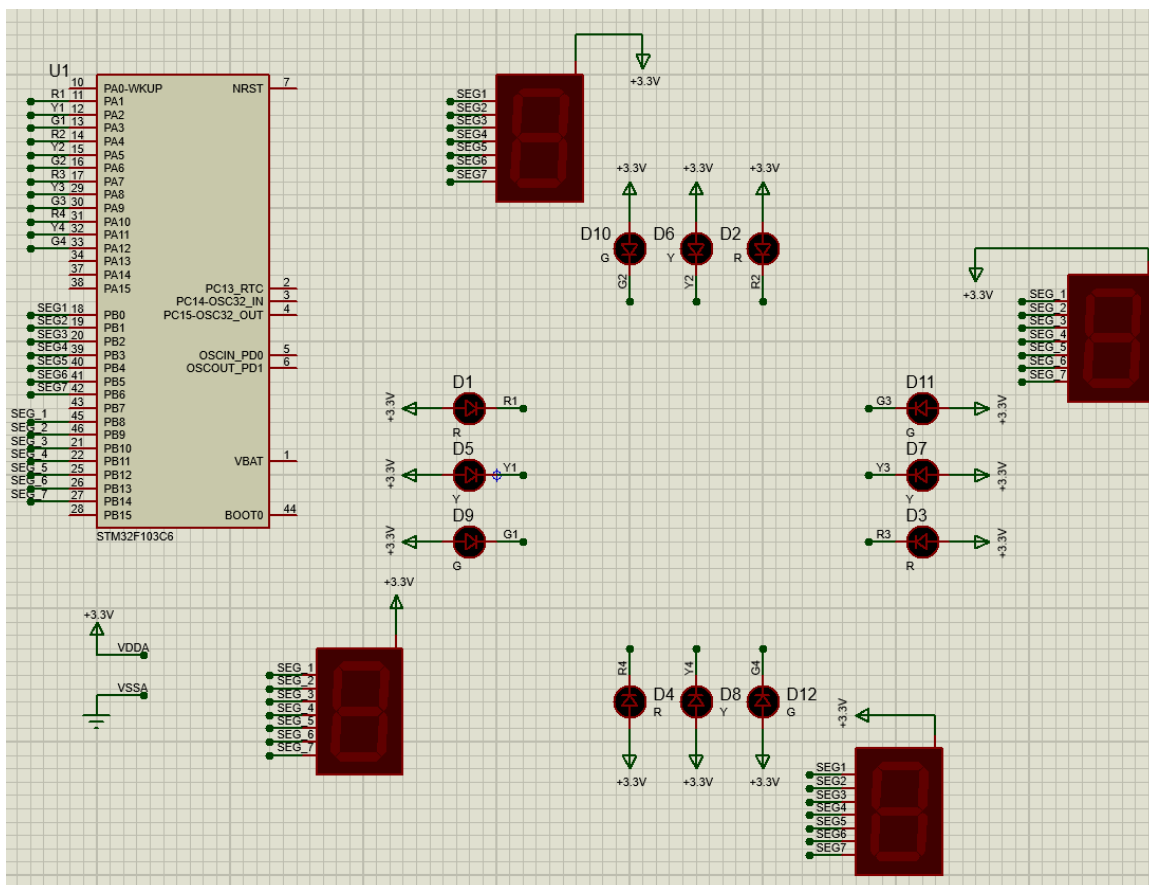


Figure 1.4: Display a number on 7 segment LED

**Report 2:** Present the source code for display7SEG function.

```
1 void display7SEG(int num){
2 //Make 10 case for 7SEG led to display from 0 to 9
3     switch(num){
4         case 0:
5             HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
6             HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
7             HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
8             HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
9             HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, RESET);
10            HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, RESET);
11            HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, SET);
12            break;
13        case 1:
14            HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, SET);
15            HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
16            HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
17            HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, SET);
18            HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, SET);
19            HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, SET);
20            HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, SET);
21            break;
22        case 2:
23            HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
24            HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
25            HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, SET);
26            HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
27            HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, RESET);
28            HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, SET);
29            HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
30            break;
31        case 3:
32            HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
33            HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
34            HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
35            HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
36            HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, SET);
37            HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, SET);
38            HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
39            break;
40        case 4:
41            HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, SET);
42            HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
43            HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
44            HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, SET);
45            HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, SET);
46            HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, RESET);
47            HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
48            break;
```

```

49  case 5:
50      HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
51      HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, SET);
52      HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
53      HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
54      HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, SET);
55      HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, RESET);
56      HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
57      break;
58  case 6:
59      HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
60      HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, SET);
61      HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
62      HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
63      HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, RESET);
64      HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, RESET);
65      HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
66      break;
67  case 7:
68      HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
69      HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
70      HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
71      HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, SET);
72      HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, SET);
73      HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, SET);
74      HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, SET);
75      break;
76  case 8:
77      HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
78      HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
79      HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
80      HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
81      HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, RESET);
82      HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, RESET);
83      HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
84      break;
85  case 9:
86      HAL_GPIO_WritePin(SEG1_GPIO_Port, SEG1_Pin, RESET);
87      HAL_GPIO_WritePin(SEG2_GPIO_Port, SEG2_Pin, RESET);
88      HAL_GPIO_WritePin(SEG3_GPIO_Port, SEG3_Pin, RESET);
89      HAL_GPIO_WritePin(SEG4_GPIO_Port, SEG4_Pin, RESET);
90      HAL_GPIO_WritePin(SEG5_GPIO_Port, SEG5_Pin, SET);
91      HAL_GPIO_WritePin(SEG6_GPIO_Port, SEG6_Pin, RESET);
92      HAL_GPIO_WritePin(SEG7_GPIO_Port, SEG7_Pin, RESET);
93      break;
94  }
95  }

```

Program 1.4: Source code exercise 4

## 1.5 Exercise 5

Integrate the 7SEG-LED to the 4 way traffic light. In this case, the 7SEG-LED is used to display countdown value.

```
1 //In crossroads, there 2 couple of traffic light
2 int count1=0; //Count for Led 1,3
3 int count2=0; //Count for Led 2,4
4 int count1_1=0; //Count for 7-SEG 1,3
5 int count2_1=0; //Count for 7-SEG 2,4
6 while (1){
7 //TRAFFIC LIGHT
8 //State 0 (TL1-3: Green, TL2-4:Red)
9     if(count1==0){
10         //GRE
11         HAL_GPIO_TogglePin(Y1_GPIO_Port, Y1_Pin);
12         HAL_GPIO_TogglePin(R1_GPIO_Port, R1_Pin);
13         HAL_GPIO_TogglePin(Y3_GPIO_Port, Y3_Pin);
14         HAL_GPIO_TogglePin(R3_GPIO_Port, R3_Pin);
15         count1_1=3;
16     }
17     if(count2==0){
18         //RED
19         HAL_GPIO_TogglePin(Y2_GPIO_Port, Y2_Pin);
20         HAL_GPIO_TogglePin(G2_GPIO_Port, G2_Pin);
21         HAL_GPIO_TogglePin(Y4_GPIO_Port, Y4_Pin);
22         HAL_GPIO_TogglePin(G4_GPIO_Port, G4_Pin);
23         count2_1=5;
24     }
25 //State 1 (TL1-3:Yellow, TL2-4:Green)
26     if(count1==3){
27         //YEL
28         HAL_GPIO_TogglePin(G1_GPIO_Port, G1_Pin);
29         HAL_GPIO_TogglePin(Y1_GPIO_Port, Y1_Pin);
30         HAL_GPIO_TogglePin(G3_GPIO_Port, G3_Pin);
31         HAL_GPIO_TogglePin(Y3_GPIO_Port, Y3_Pin);
32         count1_1=2;
33     }
34     if(count2==5){
35         //GRE
36         HAL_GPIO_TogglePin(R2_GPIO_Port, R2_Pin);
37         HAL_GPIO_TogglePin(G2_GPIO_Port, G2_Pin);
38         HAL_GPIO_TogglePin(R4_GPIO_Port, R4_Pin);
39         HAL_GPIO_TogglePin(G4_GPIO_Port, G4_Pin);
40         count2_1=3;
41     }
42
43
44
```

```

45 //State 2 (TL1-3:Red, TL2-4:Yellow)
46     if(count1==5){
47         //RED
48         HAL_GPIO_TogglePin(Y1_GPIO_Port, Y1_Pin);
49         HAL_GPIO_TogglePin(R1_GPIO_Port, R1_Pin);
50         HAL_GPIO_TogglePin(Y3_GPIO_Port, Y3_Pin);
51         HAL_GPIO_TogglePin(R3_GPIO_Port, R3_Pin);
52         count1_1=5;
53     }
54     if(count2==8){
55         //YEL
56         HAL_GPIO_TogglePin(Y2_GPIO_Port, Y2_Pin);
57         HAL_GPIO_TogglePin(G2_GPIO_Port, G2_Pin);
58         HAL_GPIO_TogglePin(Y4_GPIO_Port, Y4_Pin);
59         HAL_GPIO_TogglePin(G4_GPIO_Port, G4_Pin);
60         count2_1=2;
61     }
62 //State 3 (TL1-3:Green, TL2-4:Red)
63     if(count1==10){
64         //GRE
65         HAL_GPIO_TogglePin(G1_GPIO_Port, G1_Pin);
66         HAL_GPIO_TogglePin(R1_GPIO_Port, R1_Pin);
67         HAL_GPIO_TogglePin(G3_GPIO_Port, G3_Pin);
68         HAL_GPIO_TogglePin(R3_GPIO_Port, R3_Pin);
69         count1_1=3;
70     }
71     if(count2==10){
72         //RED
73         HAL_GPIO_TogglePin(Y2_GPIO_Port, Y2_Pin);
74         HAL_GPIO_TogglePin(R2_GPIO_Port, R2_Pin);
75         HAL_GPIO_TogglePin(Y4_GPIO_Port, Y4_Pin);
76         HAL_GPIO_TogglePin(R4_GPIO_Port, R4_Pin);
77         count2_1=5;
78     }
79     display7_SEG(count1_1);
80     display7SEG(count2_1);
81 //Setting counter variable
82 //Count up "traffic light" led
83     count1++;
84     count2++;
85     if(count1>=13) count1=3;
86     if(count2>=15) count2=5;
87 //Count down "7SEG" led
88     count1_1--;
89     count2_1--;
90     HAL_Delay(1000); //Set cycle time to 1 second for real-
91     time display
92 }

```

Program 1.5: Source code exercise 5

## 1.6 Exercise 6

In this exercise, a new Proteus schematic is designed to simulate an analog clock, with 12 different number. The connections for 12 LEDs are supposed from PA4 to PA15 of the STM32.

**Report 1:** Present the schematic.

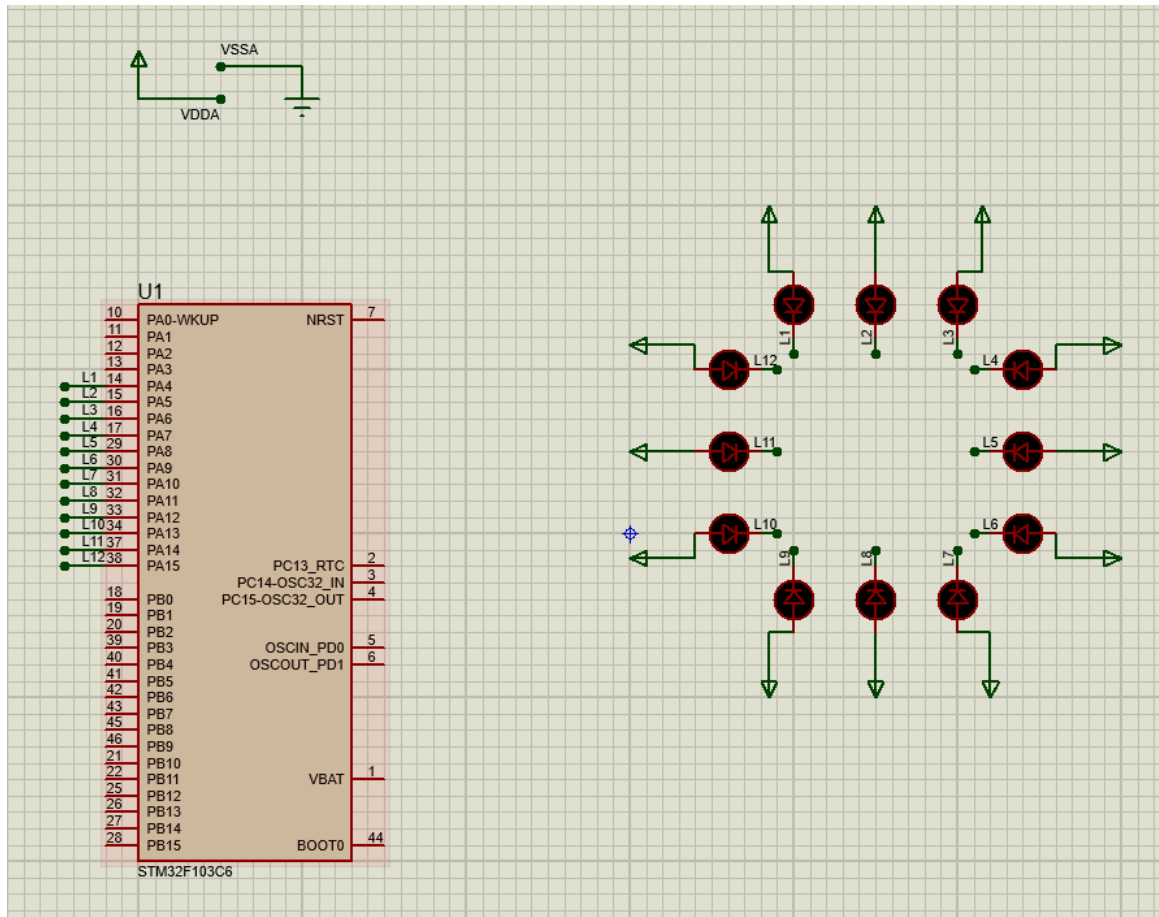


Figure 1.5: Schematic exercise 6

**Report 2:** Implement a simple program to test the connection of every single LED. This testing program should turn every LED in a sequence.

```
1 //Implement "Blink" function to make 12 blink continuously
2 void Blink1(int count){
3     if(count==1){HAL_GPIO_TogglePin(L1_GPIO_Port, L1_Pin);}
4     if(count==2){HAL_GPIO_TogglePin(L2_GPIO_Port, L2_Pin);}
5     if(count==3){HAL_GPIO_TogglePin(L3_GPIO_Port, L3_Pin);}
6     if(count==4){HAL_GPIO_TogglePin(L4_GPIO_Port, L4_Pin);}
7     if(count==5){HAL_GPIO_TogglePin(L5_GPIO_Port, L5_Pin);}
8     if(count==6){HAL_GPIO_TogglePin(L6_GPIO_Port, L6_Pin);}
9     if(count==7){HAL_GPIO_TogglePin(L7_GPIO_Port, L7_Pin);}
10    if(count==8){HAL_GPIO_TogglePin(L8_GPIO_Port, L8_Pin);}
11    if(count==9){HAL_GPIO_TogglePin(L9_GPIO_Port, L9_Pin);}
12    if(count==10){HAL_GPIO_TogglePin(L10_GPIO_Port, L10_Pin)}
    ;}
```

```

13  if(count==11){HAL_GPIO_TogglePin(L11_GPIO_Port , L11_Pin)
    ;}
14  if(count==12){HAL_GPIO_TogglePin(L12_GPIO_Port , L12_Pin)
    ;}
15  }
16  //Infinite loop while
17  int a=0;
18  while (1){
19      Blink1(a++);
20      if(a>12) a=0;
21      HAL_Delay(50);
22  }

```

Program 1.6: Source code exercise 6

## 1.7 Exercise 7

Implement a function named **clearAllClock()** to turn off all 12 LEDs. Present the source code of this function.

```

1  //Set all pin at level 0
2  void clearAllClock() {
3      HAL_GPIO_WritePin(L1_GPIO_Port , L1_Pin , SET);
4      HAL_GPIO_WritePin(L2_GPIO_Port , L2_Pin , SET);
5      HAL_GPIO_WritePin(L3_GPIO_Port , L3_Pin , SET);
6      HAL_GPIO_WritePin(L4_GPIO_Port , L4_Pin , SET);
7      HAL_GPIO_WritePin(L5_GPIO_Port , L5_Pin , SET);
8      HAL_GPIO_WritePin(L6_GPIO_Port , L6_Pin , SET);
9      HAL_GPIO_WritePin(L7_GPIO_Port , L7_Pin , SET);
10     HAL_GPIO_WritePin(L8_GPIO_Port , L8_Pin , SET);
11     HAL_GPIO_WritePin(L9_GPIO_Port , L9_Pin , SET);
12     HAL_GPIO_WritePin(L10_GPIO_Port , L10_Pin , SET);
13     HAL_GPIO_WritePin(L11_GPIO_Port , L11_Pin , SET);
14     HAL_GPIO_WritePin(L12_GPIO_Port , L12_Pin , SET);
15 }

```

Program 1.7: Source code exercise 7



## 1.8 Exercise 8

Implement a function named **setNumberOnClock(int num)**. The input for this function is from **0 to 11** and an appropriate LED is turn on. Present the source code of this function.

```
1 void setNumberOnClock(int num){
2     switch(num){
3         case 0:
4             HAL_GPIO_WritePin(L2_GPIO_Port, L2_Pin, RESET); break;
5         case 1:
6             HAL_GPIO_WritePin(L3_GPIO_Port, L3_Pin, RESET); break;
7         case 2:
8             HAL_GPIO_WritePin(L4_GPIO_Port, L4_Pin, RESET); break;
9         case 3:
10            HAL_GPIO_WritePin(L5_GPIO_Port, L5_Pin, RESET); break;
11        case 4:
12            HAL_GPIO_WritePin(L6_GPIO_Port, L6_Pin, RESET); break;
13        case 5:
14            HAL_GPIO_WritePin(L7_GPIO_Port, L7_Pin, RESET); break;
15        case 6:
16            HAL_GPIO_WritePin(L8_GPIO_Port, L8_Pin, RESET); break;
17        case 7:
18            HAL_GPIO_WritePin(L9_GPIO_Port, L9_Pin, RESET); break;
19        case 8:
20            HAL_GPIO_WritePin(L10_GPIO_Port, L10_Pin, RESET); break
21            ;
22        case 9:
23            HAL_GPIO_WritePin(L11_GPIO_Port, L11_Pin, RESET); break
24            ;
25        case 10:
26            HAL_GPIO_WritePin(L12_GPIO_Port, L12_Pin, RESET); break
27            ;
28        case 11:
29            HAL_GPIO_WritePin(L1_GPIO_Port, L1_Pin, RESET); break;
30    }
31 }
```

Program 1.8: Source code exercise 8

## 1.9 Exercise 9

Implement a function named **clearNumberOnClock(int num)**. The input for this function is from **0 to 11** and an appropriate LED is turn off.

```
1 void clearNumberOnClock(int num){
2     switch(num){
3     case 0:
4         HAL_GPIO_WritePin(L2_GPIO_Port, L2_Pin, SET); break;
5     case 1:
6         HAL_GPIO_WritePin(L3_GPIO_Port, L3_Pin, SET); break;
7     case 2:
8         HAL_GPIO_WritePin(L4_GPIO_Port, L4_Pin, SET); break;
9     case 3:
10        HAL_GPIO_WritePin(L5_GPIO_Port, L5_Pin, SET); break;
11    case 4:
12        HAL_GPIO_WritePin(L6_GPIO_Port, L6_Pin, SET); break;
13    case 5:
14        HAL_GPIO_WritePin(L7_GPIO_Port, L7_Pin, SET); break;
15    case 6:
16        HAL_GPIO_WritePin(L8_GPIO_Port, L8_Pin, SET); break;
17    case 7:
18        HAL_GPIO_WritePin(L9_GPIO_Port, L9_Pin, SET); break;
19    case 8:
20        HAL_GPIO_WritePin(L10_GPIO_Port, L10_Pin, SET); break;
21    case 9:
22        HAL_GPIO_WritePin(L11_GPIO_Port, L11_Pin, SET); break;
23    case 10:
24        HAL_GPIO_WritePin(L12_GPIO_Port, L12_Pin, SET); break;
25    case 11:
26        HAL_GPIO_WritePin(L1_GPIO_Port, L1_Pin, SET); break;
27    }
28 }
```

Program 1.9: Source code exercise 9

## 1.10 Exercise 10

Integrate the whole system and use 12 LEDs to display a clock. At a given time, there are only 3 LEDs are turn on for hour, minute and second information.

```
1 // Clock start at 00:00:00
2 int h=0;
3 int m=0;
4 int s=0;
5 while (1){
6 //1 led represents for 5 second/ 5 minute so i display the
   integer part of s:5 and m:5
7 //The second hand need to run 5 cycles to count up the
   minute hand by 1
8     setNumberOnClock(h);
9     setNumberOnClock(m/5);
10    setNumberOnClock(s/5);
11    s++;
12    HAL_Delay(1000); //Set cycle time to 1 second for real-
time display
13    clearNumberOnClock((s-1)/5); //Clear the last state of
"seconds"
14
15    if(s>59){
16        s=0;
17        clearNumberOnClock(m/5);
18        m++;
19        setNumberOnClock(m/5);
20    }
21    if(m>59){
22        m=0;
23        clearNumberOnClock(h);
24        h++;
25        setNumberOnClock(h);
26    }
27    if(h>11){
28        clearNumberOnClock(h);
29        h=0;
30        setNumberOnClock(h);
31    }
```

Program 1.10: Source code exercise 10

link github lab 1: [https://github.com/LongSmallHand/VXL\\_Lab1.git](https://github.com/LongSmallHand/VXL_Lab1.git)

**END**