EMBEDDED SYSTEMS

PROJECT

TRAFFIC LIGHTS SIMULATOR using TIVA C

GROUP - 16

CED17I004
CED17I023
CED17I031
CED17I034
CED17I035

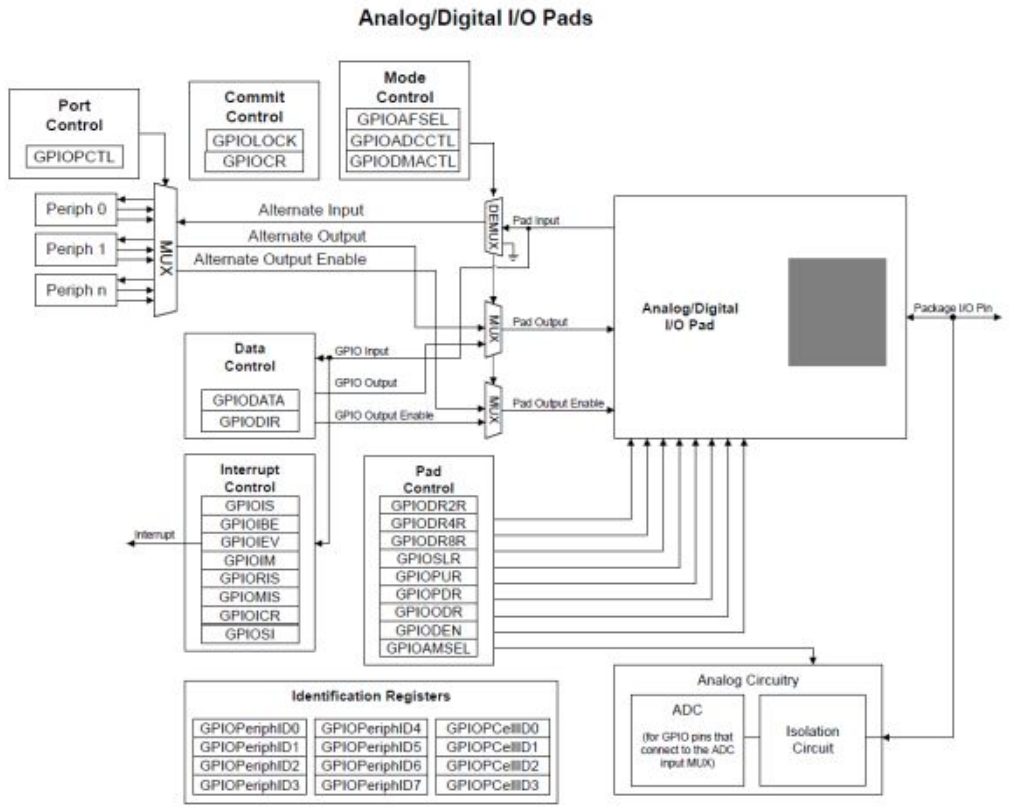
TIVA C GPIOS:

GPIOs are the basic interfaces of any microcontroller. Without GPIOs we won't have any other way to use a micro and it will be nothing more different than a chunk of well-fabricated silicon. Through them we can interface both transducers or sensors and actuators. We can also connect other devices like a display, external devices and so on.

Tiva C micros are low power ARM Cortex M4 MCUS and run typically at 3.3V and so you can guess the logic levels of GPIO pins. However, except a few GPIOs (PB0, PB1, PD4 and PD5) all GPIO pins are 5V tolerant. This 5V tolerant feature is a smart addition and most people will simply overlook it or won't fully realize its potential use.

Basic Architecture

In the block diagram shown below we can see the internal architecture of a Tiva C GPIO pin. The first thing that will strike our mind is the number of registers attached to a pin and thereby the several options a GPIO pin possesses.



MikroC GPIO library functions used in the code are:

- GPIO_Clk_Enable – enables a GPIO port's clock.
- GPIO_Clk_Disable – disables a GPIO port's clock.
- GPIO_Unlock – unlocks GPIO pins.
- GPIO_Lock – locks GPIO pins
- GPIO_Config – sets up GPIO pin functionalities, direction and properties.
- GPIO_Alternate_Function_Enable – specifies alternate function pins and enables them.

- Firstly, we need to enable the clock for the GPIO that we are wanting to use.
- Library function GPIO_Clk_Enable() does that. This is followed by actual GPIO setup.
- If We need PF1, PF2 and PF3 to be outputs. This is done by GPIO_Config() library function.
- This function has several argument parameters that define GPIO properties.
- The first argument states which GPIO port we are concerned with.
- The second masks the required pins.
- The third selects GPIO direction.
- Finally, the last parameters further select what features we want from these pins.

```
void setup_GPIOs()
{
    delay_ms(2000);
    GPIO_Clk_Enable(&GPIO_PORTA);
    GPIO_Config(&GPIO_PORTA, (_GPIO_PINMASK_2 | _GPIO_PINMASK_3), _GPIO_DIR_OUTPUT, (_GPIO_CFG_DIGITAL_ENABLE | _GPIO_CFG_DRIVE_8mA), _GPIO_PINCODE_NONE);

    GPIO_Clk_Enable(&GPIO_PORTB);
    GPIO_Config(&GPIO_PORTA, (_GPIO_PINMASK_0 | _GPIO_PINMASK_1 | _GPIO_PINMASK_2 | _GPIO_PINMASK_3 | _GPIO_PINMASK_4 | _GPIO_PINMASK_5 | _GPIO_PINMASK_6
    | _GPIO_PINMASK_7 ), _GPIO_DIR_OUTPUT, (_GPIO_CFG_DIGITAL_ENABLE | _GPIO_CFG_DRIVE_8mA), _GPIO_PINCODE_NONE);


    GPIO_Clk_Enable(&GPIO_PORTC);
    GPIO_Config(&GPIO_PORTA, (_GPIO_PINMASK_4 | _GPIO_PINMASK_5 | _GPIO_PINMASK_6 | _GPIO_PINMASK_7 ), _GPIO_DIR_OUTPUT, (_GPIO_CFG_DIGITAL_ENABLE
    | _GPIO_CFG_DRIVE_8mA), _GPIO_PINCODE_NONE);


    GPIO_Clk_Enable(&GPIO_PORTE);
    GPIO_Config(&GPIO_PORTA, (_GPIO_PINMASK_0 | _GPIO_PINMASK_1 | _GPIO_PINMASK_2 | _GPIO_PINMASK_3 | _GPIO_PINMASK_4 | _GPIO_PINMASK_5),
    _GPIO_DIR_OUTPUT, (_GPIO_CFG_DIGITAL_ENABLE | _GPIO_CFG_DRIVE_8mA), _GPIO_PINCODE_NONE);
}
```

- Here, we have set up all of the ports required for our circuit as outputs.

- The ports used are :
    - PA2, PA3
    - PB0, PB1, PB2, PB3, PB4, PB5, PB6, PB7
    - PC4, PC5, PC6, PC7
    - PE0, PE1, PE2, PE3, PE4, PE5

```
void setup_GPIOs()

void main()
{
    int count = 1;
    int mode = 0;

    setup_GPIOs();

    while(1)
    {
        if(mode == 0)
        {
            if(count == 1)
            {
                GPIO_PORTB_DATA3_bit = 1;
                GPIO_PORTA_DATA2_bit = 1;
                GPIO_PORTE_DATA1_bit = 1;
                GPIO_PORTC_DATA6_bit = 1;

                delay_ms(3000);
                count++
            }
```

<u>METHOD - A, CASE - A:</u>

- Signals at road 1, 2, 3, 4 are all red.

- After a delay of 3 seconds, Yellow at road 1 is blinked to indicate that it is going to change signal next.
- Count is incremented, so that it can move to the next case.

```
else if(count == 2)
{
    GPIO_PORTE_DATA1_bit = 0;
    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTE_DATA3_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;

    delay_ms(3000);

    GPIO_PORTE_DATA3_bit = 0;

    delay_ms(1000);

    GPIO_PORTE_DATA2_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;

    count++;
}
```

METHOD - A, CASE - B:

- Red signal of road 1 is turned off, and the green signal is turned on.
- After a delay of 3 seconds, Yellow signals at road 1 and 2 are blinked to indicate that they are going to change signal next.
- Count is incremented, so that it can move to the next case.

```
else if(count == 3)
{
    GPIO_PORTC_DATA6_bit = 0;
    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA4_bit = 1;

    delay_ms(3000);

    GPIO_PORTC_DATA4_bit = 0;

    delay_ms(1000);

    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTC_DATA5_bit = 0;

    count++;
}
```

METHOD - A, CASE - C:

- Red signal of road 2 is turned off, and the green signal is turned on.
- Green signal of road 1 is turned off, and the red signal is turned on.
- After a delay of 3 seconds, Yellow signals at road 2 and 3 are blinked to indicate that they are going to change signal next.
- Count is incremented, so that it can move to the next case.

```
else if(count == 4)
{
    GPIO_PORTB_DATA5_bit = 1;
    GPIO_PORTB_DATA3_bit = 0;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;

    delay_ms(3000);

    GPIO_PORTB_DATA5_bit = 0;

    delay_ms(1000);

    GPIO_PORTB_DATA4_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;

    count++;
}
```

METHOD - A, CASE - D:

- Red signal of road 3 is turned off, and the green signal is turned on.
- Green signal of road 2 is turned off, and the red signal is turned on.
- After a delay of 3 seconds, Yellow signals at road 3 and 4 are blinked to indicate that they are going to change signal next.
- Count is incremented, so that it can move to the next case.

```
else if(count == 5)
{
    GPIO_PORTB_DATA0_bit = 1;
    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTA_DATA2_bit = 0;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;

    delay_ms(3000);

    GPIO_PORTB_DATA0_bit = 0;

    delay_ms(1000);

    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTA_DATA3_bit = 0;

    mode++;
}
```

METHOD - A, CASE - E:

- Red signal of road 4 is turned off, and the green signal is turned on.
- Green signal of road 3 is turned off, and the red signal is turned on.
- After a delay of 3 seconds, Yellow signal at road 4 is blinked to indicate that it is going to change signal next.
- Mode is incremented, so that it can move to the next Method.

```
else
{
    if(count == 1)
    {

        GPIO_PORTB_DATA3_bit = 1;
        GPIO_PORTA_DATA2_bit = 1;
        GPIO_PORTE_DATA1_bit = 1;
        GPIO_PORTC_DATA6_bit = 1;
        GPIO_PORTE_DATA0_bit = 1;
        GPIO_PORTE_DATA5_bit = 1;
        GPIO_PORTB_DATA7_bit = 1;
        GPIO_PORTB_DATA2_bit = 1;

        delay_ms(3000);

        GPIO_PORTE_DATA0_bit = 1;
        GPIO_PORTE_DATA5_bit = 1;
        GPIO_PORTB_DATA7_bit = 1;
        GPIO_PORTB_DATA2_bit = 1;
        delay_ms(300);
        GPIO_PORTE_DATA0_bit = 0;
        GPIO_PORTE_DATA5_bit = 0;
        GPIO_PORTB_DATA7_bit = 0;
        GPIO_PORTB_DATA2_bit = 0;
        delay_ms(300);
        GPIO_PORTE_DATA0_bit = 1;
        GPIO_PORTE_DATA5_bit = 1;
        GPIO_PORTB_DATA7_bit = 1;
        GPIO_PORTB_DATA2_bit = 1;
        delay_ms(300);
        GPIO_PORTE_DATA0_bit = 0;
        GPIO_PORTE_DATA5_bit = 0;
        GPIO_PORTB_DATA7_bit = 0;
        GPIO_PORTB_DATA2_bit = 0;
        delay_ms(300);
        GPIO_PORTE_DATA0_bit = 1;
        GPIO_PORTE_DATA5_bit = 1;
        GPIO_PORTB_DATA7_bit = 1;
        GPIO_PORTB_DATA2_bit = 1;
        delay_ms(300);
        GPIO_PORTE_DATA0_bit = 0;
        GPIO_PORTE_DATA5_bit = 0;
        GPIO_PORTB_DATA7_bit = 0;
        GPIO_PORTB_DATA2_bit = 0;
        delay_ms(300);
        count++;
```

METHOD - B, CASE - A:

- Signals at road 1, 2, 3, 4 are all red and all pedestrian signals are green.
- Red signals at all roads are blinked to indicate they are going to change next.
- Count is incremented, so that it can move to the next case.
- Blue LEDs are used to indicate that they must not go straight ahead or turn left. They may turn right.
- Green LEDs are used to indicate that they must not turn right or turn left. They may go straight ahead.
- Count is incremented, so that it can move to the next case.

```
else if(count == 2)
{

    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;
    GPIO_PORTE_DATA0_bit = 1;
    GPIO_PORTE_DATA3_bit = 1;
    GPIO_PORTB_DATA1_bit = 1;

    delay_ms(3000);


    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);


    GPIO_PORTE_DATA1_bit = 0;
    GPIO_PORTB_DATA1_bit = 0;
    GPIO_PORTE_DATA4_bit = 1;

    delay_ms(3000);
```

```
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);

    GPIO_PORTE_DATA0_bit = 0;

    count++;
}
```

METHOD - B, CASE - B:

- Green and Blue signals at road 1 and 4 respectively are turned on.
- After a delay of 3 seconds, Yellow signals at road 1 and 4 are blinked to indicate that they are going to change signal next.
- Green and Blue signals at road 1 are turned on, Blue signal at road 4 is turned off.
- After a delay of 3 seconds, Yellow signals at road 1 and 4 are blinked to indicate that they are going to change signal next.
- Count is incremented, so that it can move to the next case.

```
else if(count == 3)
{

    GPIO_PORTB_DATA7_bit = 1;
    GPIO_PORTE_DATA3_bit = 0;
    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA4_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;

    delay_ms(3000);


    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTE_DATA2_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);


    GPIO_PORTE_DATA4_bit = 0;
    GPIO_PORTC_DATA6_bit = 0;
    GPIO_PORTC_DATA7_bit = 1;

    delay_ms(3000);
```

```
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);

    GPIO_PORTB_DATA7_bit = 0;

    count++;
}
```

METHOD - B, CASE - C:

- Green and Blue signals at road 2 and 1 respectively are turned on.
- After a delay of 3 seconds, Yellow signals at road 1 and 2 are blinked to indicate that they are going to change signal next.
- Green and Blue signals at road 2 are turned on, Blue signal at road 1 is turned off.
- After a delay of 3 seconds, Yellow signals at road 2 and 3 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
else if(count == 4)
{

    GPIO_PORTB_DATA2_bit = 1;
    GPIO_PORTC_DATA4_bit = 0;
    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTB_DATA5_bit = 1;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;

    delay_ms(3000);


    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTC_DATA5_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTC_DATA5_bit = 0;
    delay_ms(300);

    GPIO_PORTC_DATA7_bit = 0;
    GPIO_PORTB_DATA3_bit = 0;
    GPIO_PORTB_DATA6_bit = 1;

    delay_ms(3000);
```

```
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);

    GPIO_PORTB_DATA2_bit = 0;

    count++;
}
```

METHOD - B, CASE - D:

- Green and Blue signals at road 3 and 2 respectively are turned on.
- After a delay of 3 seconds, Yellow signals at road 3 and 2 are blinked to indicate that they are going to change signal next.
- Green and Blue signals at road 3 are turned on, Blue signal at road 2 is turned off.
- After a delay of 3 seconds, Yellow signals at road 3 and 4 are blinked to indicate that they are going to change signal next.

- Count is incremented, so that it can move to the next case.

```
else if(count == 5)
{

    GPIO_PORTE_DATA5_bit = 1;
    GPIO_PORTB_DATA5_bit = 0;
    GPIO_PORTA_DATA2_bit = 1;
    GPIO_PORTB_DATA3_bit = 1;
    GPIO_PORTB_DATA0_bit = 1;
    GPIO_PORTE_DATA1_bit = 1;
    GPIO_PORTC_DATA6_bit = 1;

    delay_ms(3000);

    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 1;
    GPIO_PORTA_DATA3_bit = 1;
    delay_ms(300);
    GPIO_PORTB_DATA4_bit = 0;
    GPIO_PORTA_DATA3_bit = 0;
    delay_ms(300);


    GPIO_PORTB_DATA6_bit = 0;
    GPIO_PORTA_DATA2_bit = 0;
    GPIO_PORTB_DATA1_bit = 1;

    delay_ms(3000);
```

```
                GPIO_PORTE_DATA2_bit = 1;
                GPIO_PORTA_DATA3_bit = 1;
                delay_ms(300);
                GPIO_PORTE_DATA2_bit = 0;
                GPIO_PORTA_DATA3_bit = 0;
                delay_ms(300);
                GPIO_PORTE_DATA2_bit = 1;
                GPIO_PORTA_DATA3_bit = 1;
                delay_ms(300);
                GPIO_PORTE_DATA2_bit = 0;
                GPIO_PORTA_DATA3_bit = 0;
                delay_ms(300);
                GPIO_PORTE_DATA2_bit = 1;
                GPIO_PORTA_DATA3_bit = 1;
                delay_ms(300);
                GPIO_PORTE_DATA2_bit = 0;
                GPIO_PORTA_DATA3_bit = 0;
                delay_ms(300);

                GPIO_PORTB_DATA0_bit = 0;
                GPIO_PORTE_DATA5_bit = 0;
                count = 1 ;
            }



            }
        }



    }
}
```

METHOD - B, CASE - E:

- Green and Blue signals at road 4 and 3 respectively are turned on.

- After a delay of 3 seconds, Yellow signals at road 4 and 3 are blinked to indicate that they are going to change signal next.

- Green and Blue signals at road 4 are turned on, Blue signal at road 3 is turned off.
- After a delay of 3 seconds, Yellow signals at road 4 and 1 are blinked to indicate that they are going to change signal next.
- Count is set to 1.