

## 13. Timer captures encoder data

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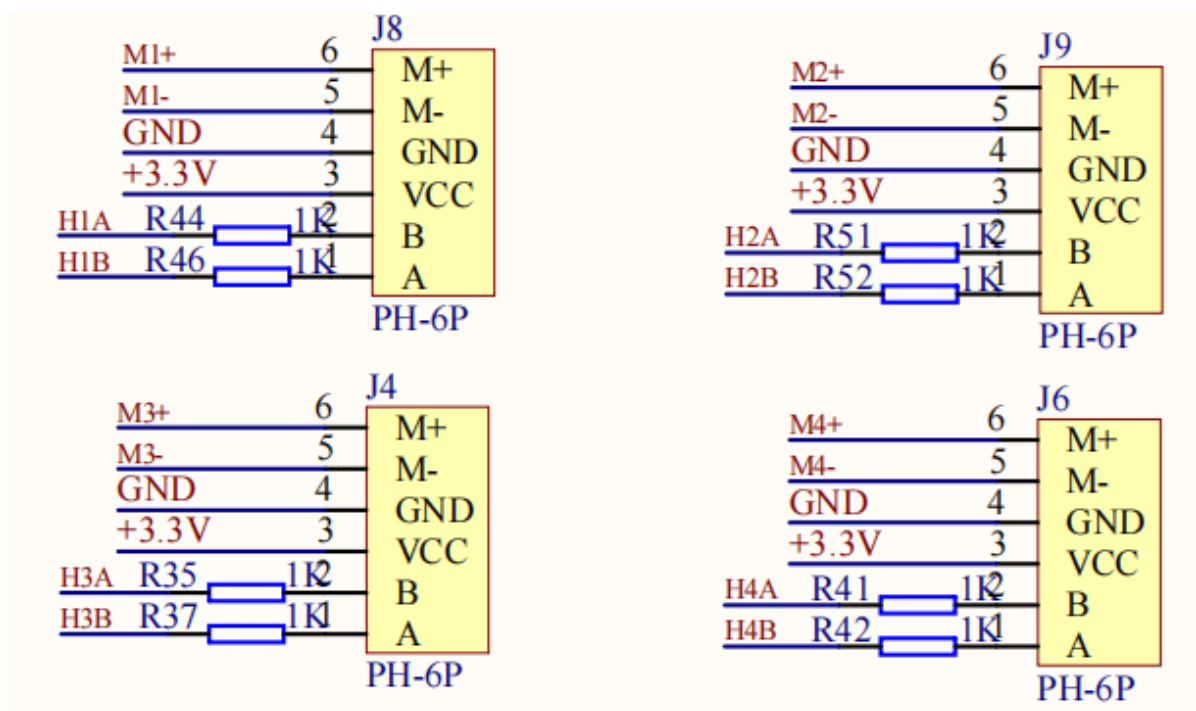
### 13.1. Experimental purpose

Capture encoder data using STM32's timer encoder mode function.

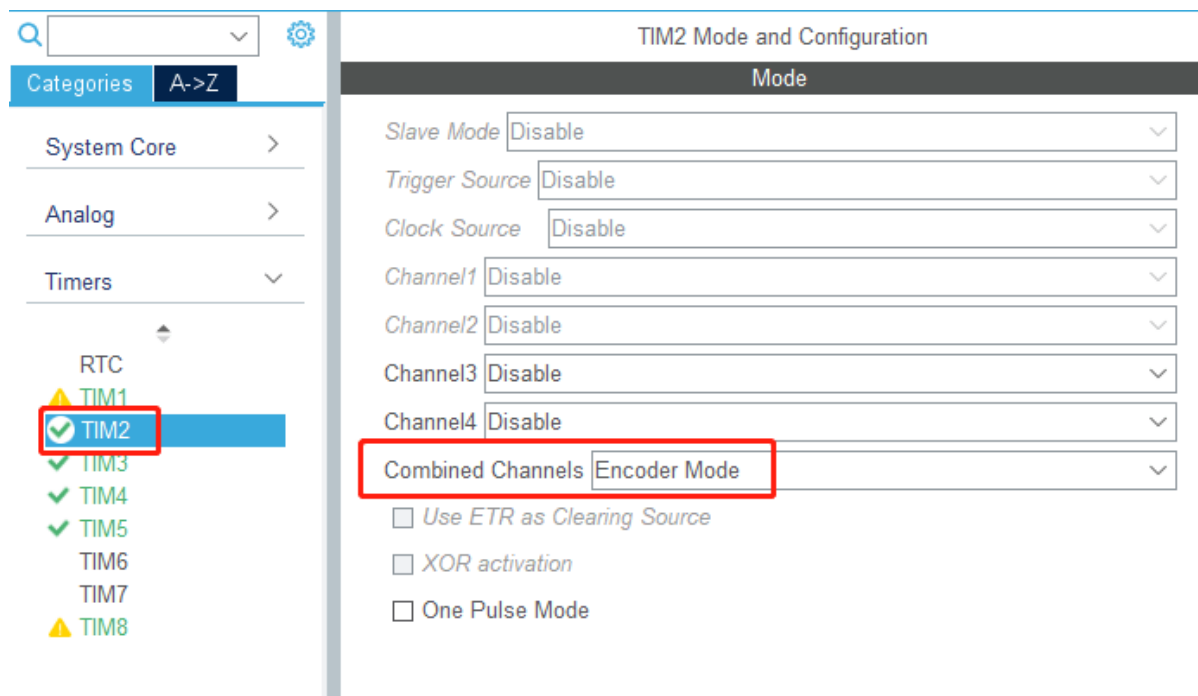
### 13.2. Configure pin information

1. Import ioc file from Motor project, name it Encoder, and then related driver of serial port 1.

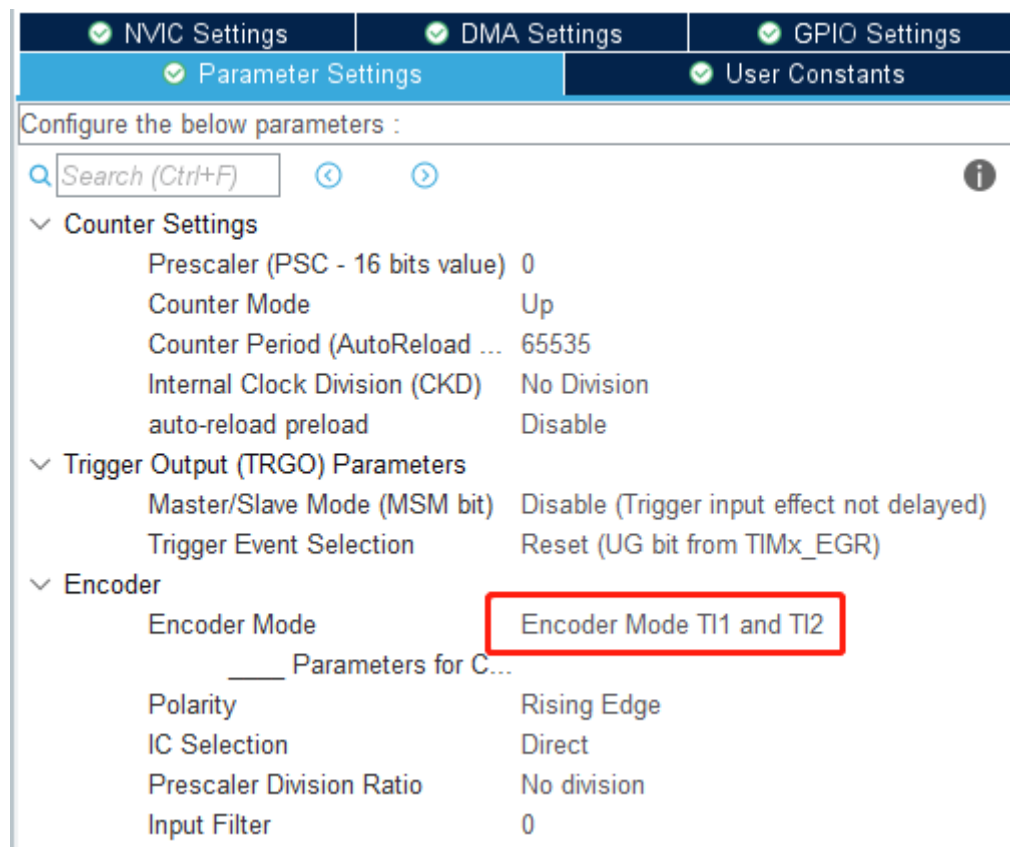
According to the schematic diagram, the two encoders of the four motors are respectively connected to channel 1 and channel 2 of the timers 2 3 4 5. The motor M1 corresponds to the timer TIM2, M2 corresponds to TIM4, M3 corresponds to TIM5, and M4 corresponds to TIM3



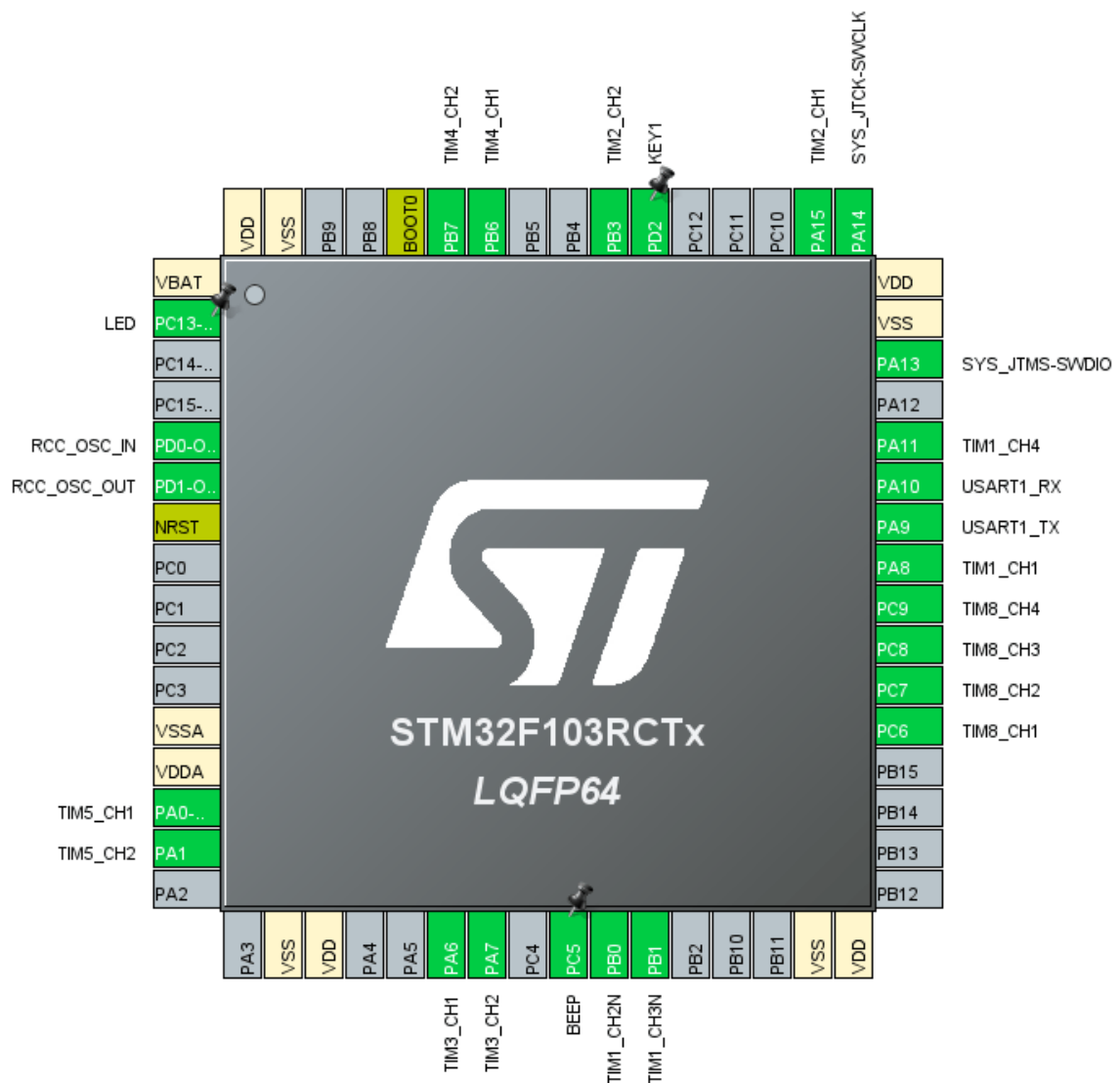
2. Take timer TIM2 as an example. The setting mode of timer TIM3, TIM4, and TIM5 is the same. Select Combined Channels Mode as Encoder Mode.



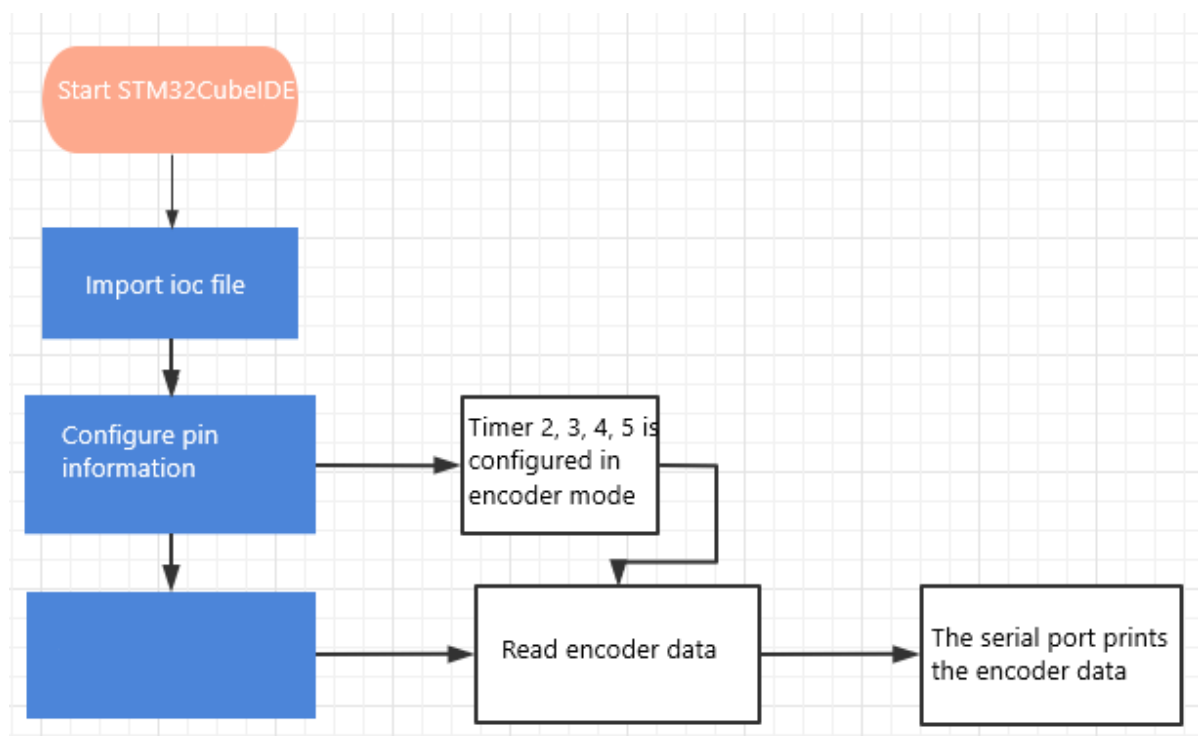
3. Change Encoder Mode to Encoder Mode TI1 and TI2, and set the encoder mode to quadruple frequency. Other parameters are shown in the following figure.



The final chip configuration pin is shown in the figure below:



### 13.3. Analysis of experimental flow chart



## 13.4. Core code interpretation

1. Create bsp\_encoder.h and bsp\_encoder.c, and add the following information to bsp\_encoder.

```
// 轮子转一整圈，编码器获得的脉冲数:30*11*2*2
// One full turn of the wheel, the number of pulses
#define ENCODER_CIRCLE          (1320)

void Encoder_Init(void);
void Encoder_Update_Count(void);
int Encoder_Get_Count_Now(uint8_t Motor_id);
void Encoder_Get_ALL(int* Encoder_all);
```

2. Create the following content in the bsp\_encoder.c file:

The encoder timer is initialized.

```
// Initializing timer  初始化定时器
void Encoder_Init(void)
{
    HAL_TIM_Encoder_Start(&htim2, TIM_CHANNEL_1 | TIM_CHANNEL_2);
    HAL_TIM_Encoder_Start(&htim3, TIM_CHANNEL_1 | TIM_CHANNEL_2);
    HAL_TIM_Encoder_Start(&htim4, TIM_CHANNEL_1 | TIM_CHANNEL_2);
    HAL_TIM_Encoder_Start(&htim5, TIM_CHANNEL_1 | TIM_CHANNEL_2);
}
```

3. Read the encoder data.

```
/**
 * @Brief: To read the encoder count, call every 10 milliseconds  读取编码器计数，需每10毫秒调用一次
 * @Note:
 * @Param: Motor_id: 电机的ID号:MOTOR_ID_M1, MOTOR_ID_M2, MOTOR_ID_M3, MOTOR_ID_M4
 * @Retval: Returns encoder count data  返回编码器计数数据
 */
static int16_t Encoder_Read_CNT(uint8_t Motor_id)
{
    int16_t Encoder_TIM = 0;
    switch(Motor_id)
    {
        case MOTOR_ID_M1: Encoder_TIM = (short)TIM2 -> CNT; TIM2 -> CNT = 0; break;
        case MOTOR_ID_M2: Encoder_TIM = (short)TIM4 -> CNT; TIM4 -> CNT = 0; break;
        case MOTOR_ID_M3: Encoder_TIM = (short)TIM5 -> CNT; TIM5 -> CNT = 0; break;
        case MOTOR_ID_M4: Encoder_TIM = (short)TIM3 -> CNT; TIM3 -> CNT = 0; break;
        default: break;
    }
    return Encoder_TIM;
}
```

4. Update the total count value of the encoder. It needs to be called every 10 milliseconds.

```

// 更新编码器的计数总值。需每10毫秒调用一次
// Update the count value of the encoder. call every 10 milliseconds
void Encoder_Update_Count(void)
{
    // g_Encoder_M1_Now += Encoder_Read_CNT(MOTOR_ID_M1);
    g_Encoder_M1_Now -= Encoder_Read_CNT(MOTOR_ID_M1);

    g_Encoder_M2_Now += Encoder_Read_CNT(MOTOR_ID_M2);
    // g_Encoder_M2_Now -= Encoder_Read_CNT(MOTOR_ID_M2);

    g_Encoder_M3_Now += Encoder_Read_CNT(MOTOR_ID_M3);
    // g_Encoder_M3_Now -= Encoder_Read_CNT(MOTOR_ID_M3);

    // g_Encoder_M4_Now += Encoder_Read_CNT(MOTOR_ID_M4);
    g_Encoder_M4_Now -= Encoder_Read_CNT(MOTOR_ID_M4);
}

```

5. Return the total number of encoders counted from the start to the present, Encoder\_Get\_Count\_Now returns one way, Encoder\_Get\_ALL returns four ways.

```

// 返回开机到现在总共统计的编码器的计数（单路）。
// Returns the total count of encoders from boot up to now (single channel)
int Encoder_Get_Count_Now(uint8_t Motor_id)
{
    if (Motor_id == MOTOR_ID_M1) return g_Encoder_M1_Now;
    if (Motor_id == MOTOR_ID_M2) return g_Encoder_M2_Now;
    if (Motor_id == MOTOR_ID_M3) return g_Encoder_M3_Now;
    if (Motor_id == MOTOR_ID_M4) return g_Encoder_M4_Now;
    return 0;
}

// 获取开机到现在总共的四路编码器计数。
// Get the total four - way encoder count up to now
void Encoder_Get_ALL(int* Encoder_all)
{
    Encoder_all[0] = g_Encoder_M1_Now;
    Encoder_all[1] = g_Encoder_M2_Now;
    Encoder_all[2] = g_Encoder_M3_Now;
    Encoder_all[3] = g_Encoder_M4_Now;
}

```

6. Add the encoder initialization to the Bsp\_Init() function.

```

// The peripheral device is initialized  外设设备初始化
void Bsp_Init(void)
{
    Beep_On_Time(50);
    Motor_Init();
    Encoder_Init();
}

```

7. Create encoder array to store encoder data. show\_encoder is used to print encoder count.

```

int encoder[4] = {0};
int show_encoder = 0;

```

8. On the basis of the original control motor, the function of printing encoder data every 100 milliseconds is added.

```

// main.c中循环调用此函数，避免多次修改main.c文件。
// This function is called in a loop in main.c to avoid multiple modifications to the main.c file
void Bsp_Loop(void)
{
    // Detect button down events    检测按键按下事件
    if (Key1_State(KEY_MODE_ONE_TIME))
    {
        Beep_On_Time(50);
        static int state = 0;
        state++;
        int speed = 0;
        if (state == 1)
        {
            speed = 2000;
            Motor_Set_Pwm(MOTOR_ID_M1, speed);
            Motor_Set_Pwm(MOTOR_ID_M2, speed);
            Motor_Set_Pwm(MOTOR_ID_M3, speed);
            Motor_Set_Pwm(MOTOR_ID_M4, speed);
        }
        if (state == 2)
        {
            Motor_Stop(0);
        }
        if (state == 3)
        {
            speed = -2000;
            Motor_Set_Pwm(MOTOR_ID_M1, speed);
            Motor_Set_Pwm(MOTOR_ID_M2, speed);
            Motor_Set_Pwm(MOTOR_ID_M3, speed);
            Motor_Set_Pwm(MOTOR_ID_M4, speed);
        }
        if (state == 4)
        {
            state = 0;
            Motor_Stop(1);
        }
    }

    show_encoder++;
    if (show_encoder > 10)
    {
        show_encoder = 0;
        Encoder_Get_ALL(encoder);
        printf("Encoder:%d, %d, %d, %d\n", encoder[0], encoder[1], encoder[2], encoder[3]);
    }

    Encoder_Update_Count();
    Bsp_Led_Show_State_Handle();
    Beep_Timeout_Close_Handle();
    HAL_Delay(10);
}

```

## 13.5. Hardware connection

The motor connection line needs to be connected to the corresponding motor as shown in the figure below, otherwise it may cause the problem that the program does not match the phenomenon. Motor 1 corresponds to the Motor in the upper left corner of the body, Motor 2 corresponds to the Motor in the lower left corner, motor 3 corresponds to the motor in the upper right corner, and Motor 4 corresponds to the motor in the lower right corner.



Because the power of the motor is relatively large, do not directly use USB 5V power supply for the expansion board, and must use battery power supply.

Then connect the micro-USB cable to the expansion board and computer.

## 13.6. Experimental effect

Since the motor will turn when started, please set up the car before the experiment, and the motor wheels are suspended to avoid rampaging.

After burning the program, the LED light flashes every 200 milliseconds. Open the serial assistant, you can see the encoder data. Press the first forward, the second free stop, the third backward, the fourth brake stop.

