13. The timer captures the encoder data

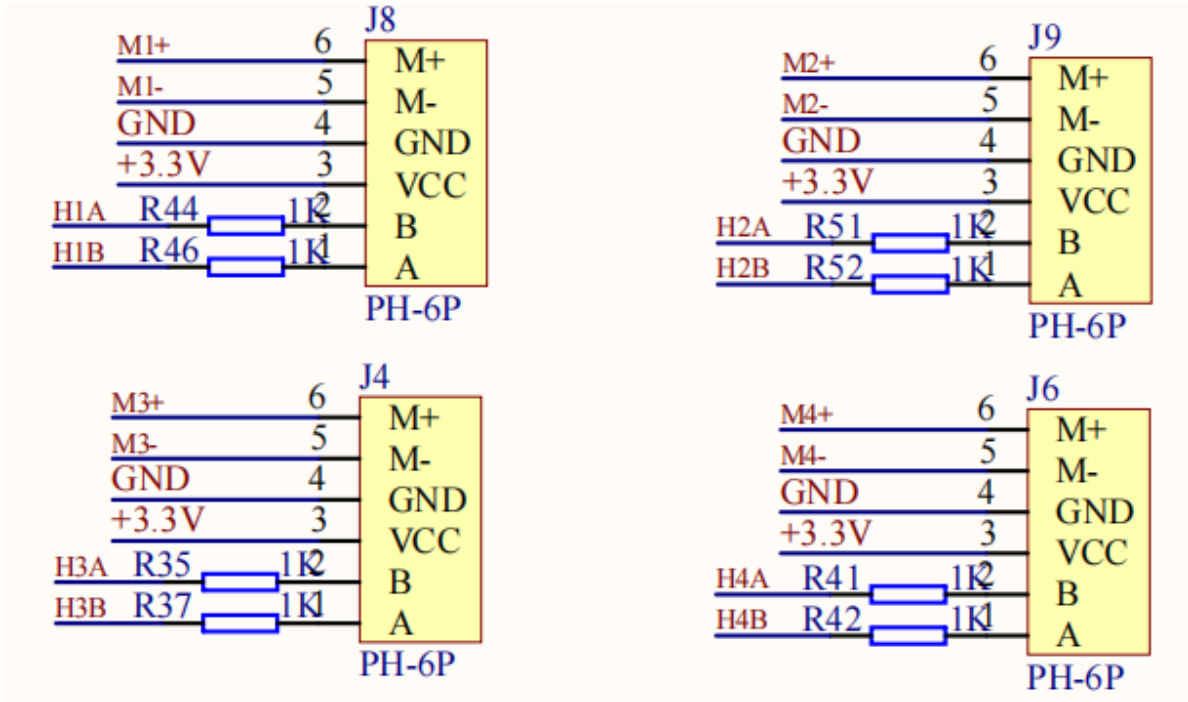
13.1. Experimental purpose

Use the timer encoder mode function of STM32 to capture the encoder data.

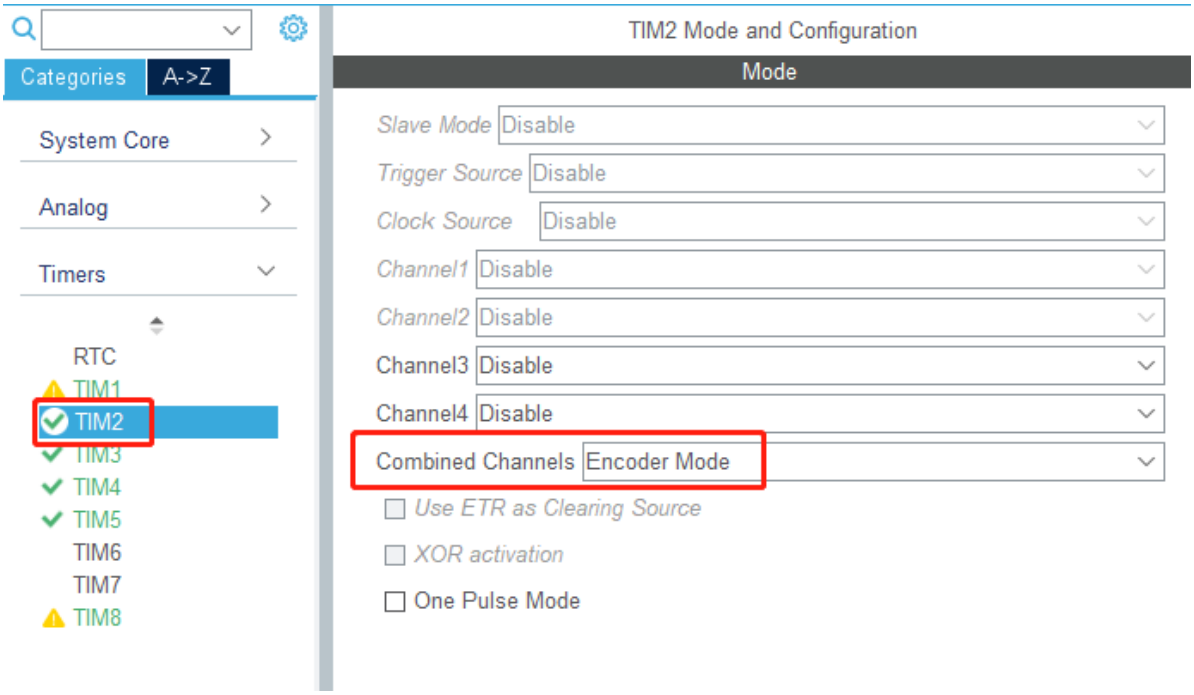
13.2. Configuration pin information

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

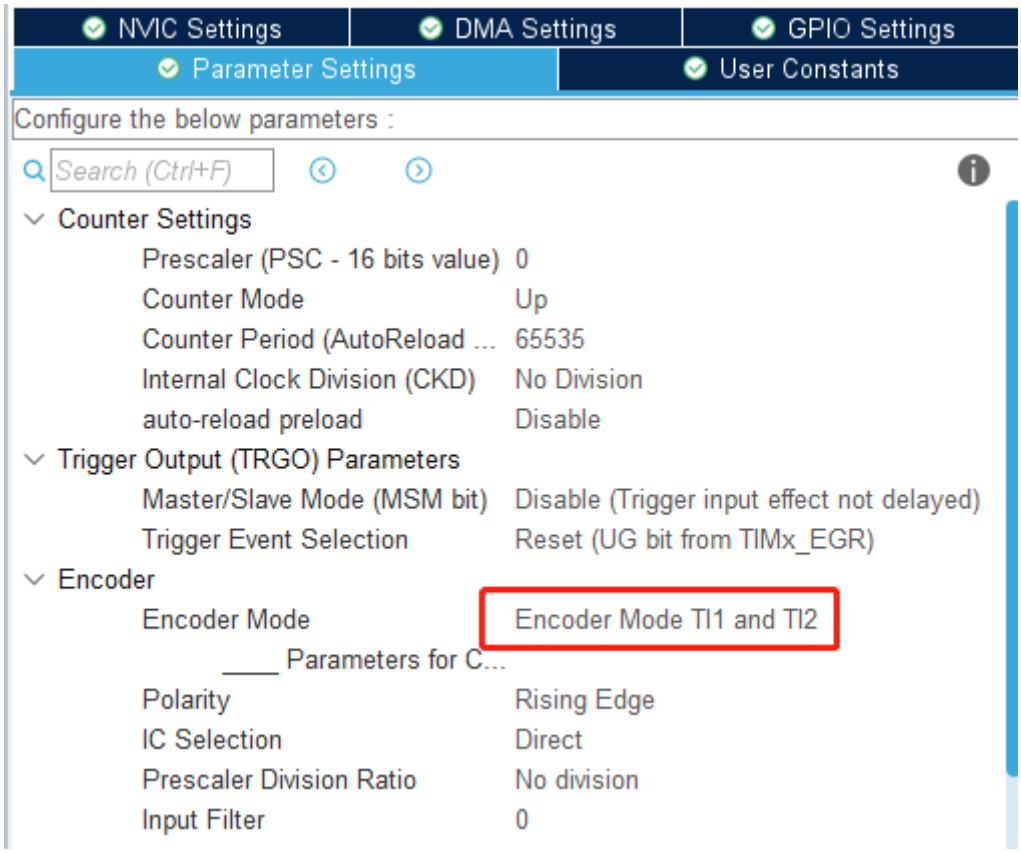
According to the schematic diagram, the two encoders of the four motors are respectively connected to channel 1 and channel 2 of timer 2 3 4 5. The motor M1 corresponds to the timer TIM2, M2 corresponds to TIM4, M3 corresponds to TIM5, and M4 corresponds to TIM3.



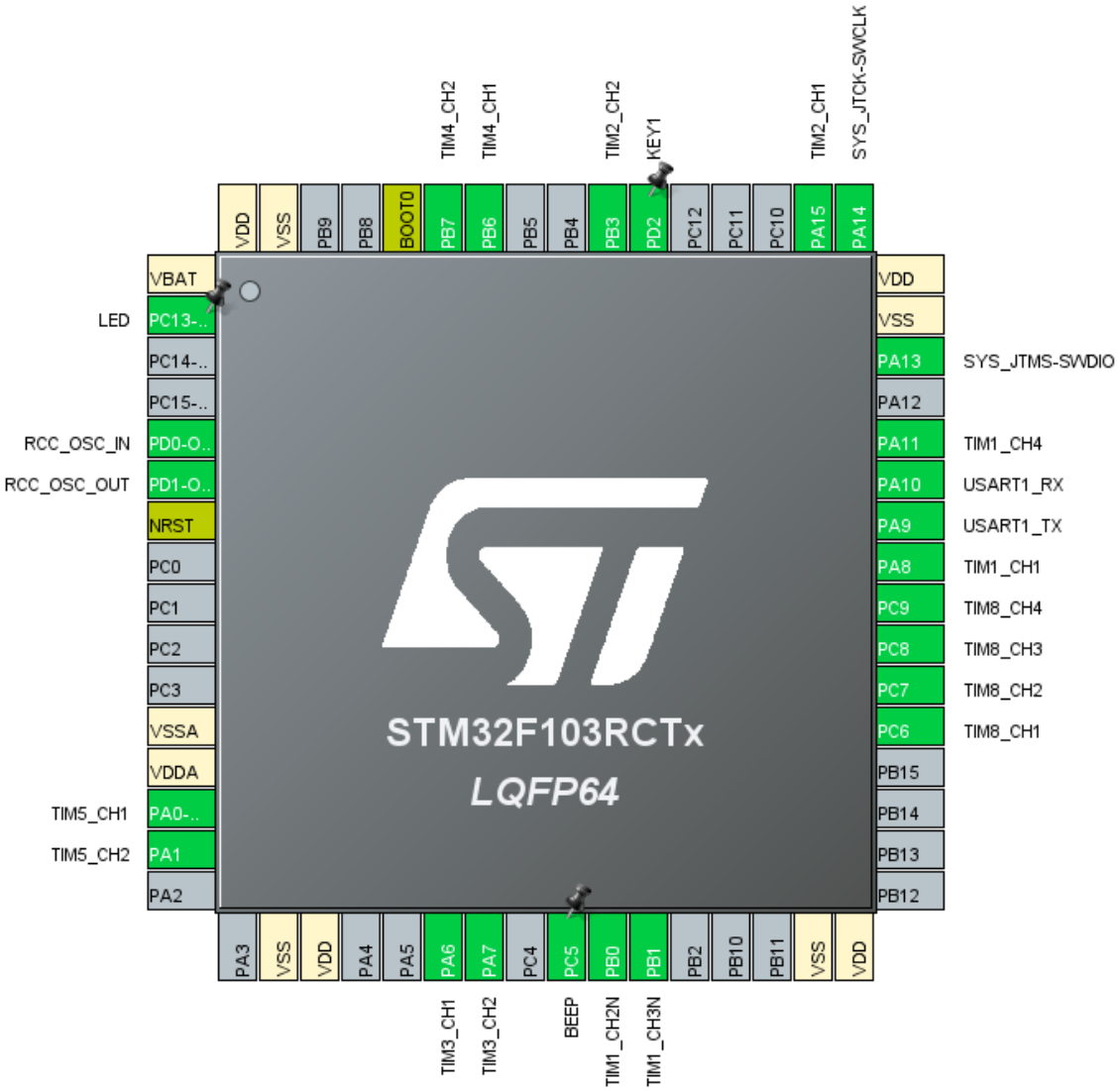
2. Taking the timer TIM2 as an example, the setting methods for TIM3, TIM4, and TIM5 are the same. Select Combined Channels mode as Encoder Mode encoder mode.



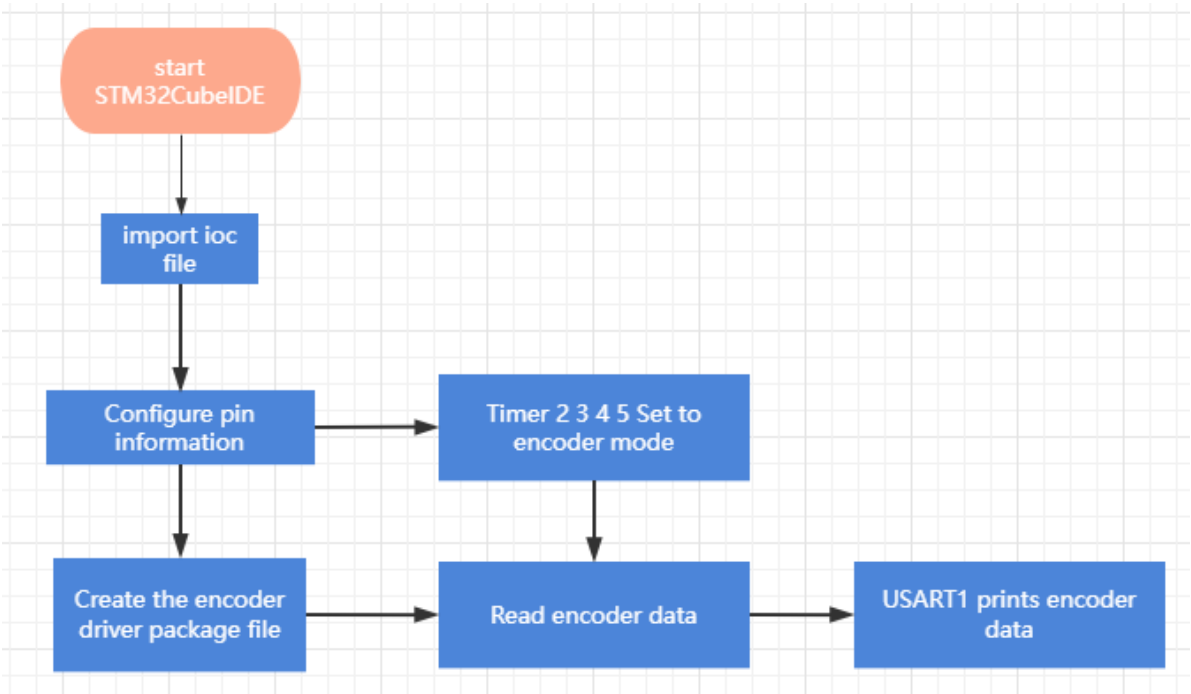
3. In the settings, change the Encoder Mode to Encoder Mode TI1 and TI2, set it to quadruple frequency, and other parameters are shown in the figure below.



The final chip configuration pins are shown in the figure below:



13.3. Analysis of the experimental flow chart



13.4. core code explanation

1. Create new bsp_encoder.h and bsp_encoder.c, and add the following content to bsp_encoder.h:

```
// 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:

Encoder timer initialization.

```
// 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 data from the encoder.

```
/**
 * @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:
 * @Parm: 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 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 count of encoders that have been counted up to now, Encoder_Get_Count_Now returns one way, and 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 content of encoder initialization in 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. The new encoder array is used to save the data of the encoder, and show_encoder is used to print the count of the encoder.

```
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.

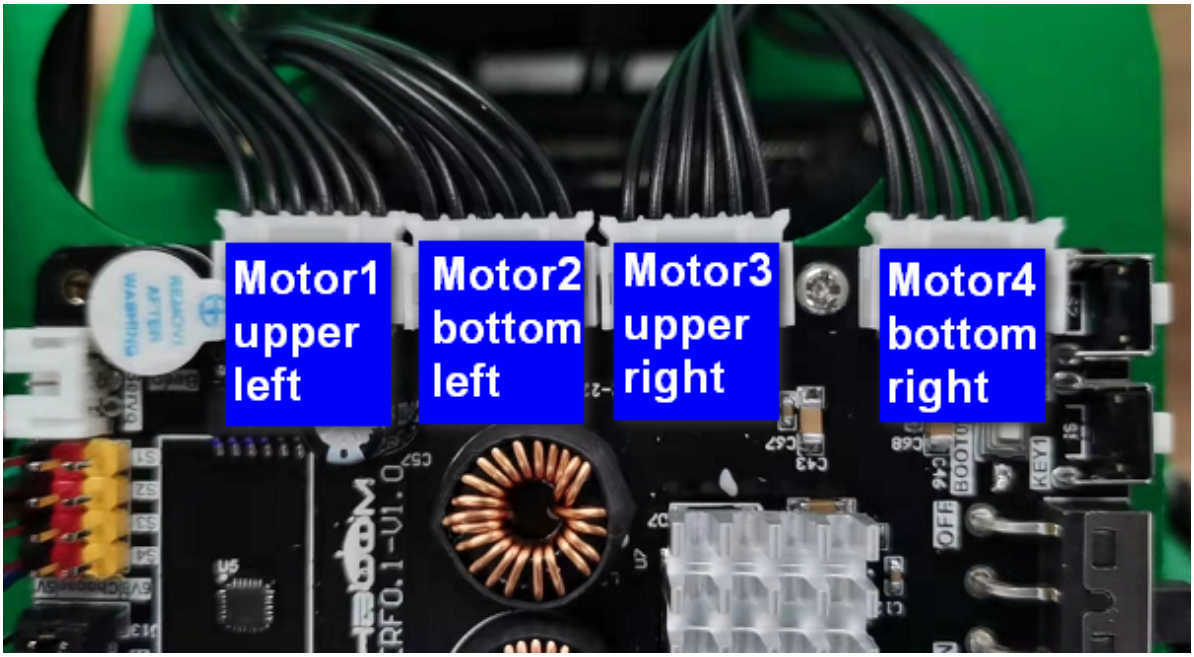
```
// main.c中循环调用此函数，避免多次修改main.c文件。
// This function is called in a loop in main.c to avoid multiple modifications to the main.c file
void Bsp_Loop(void)
{
    // Detect button down events   检测按键按下事件
    if (Key1_State(KEY_MODE_ONE_TIME))
    {
        Beep_On_Time(50);
        static int state = 0;
        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 connecting 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.



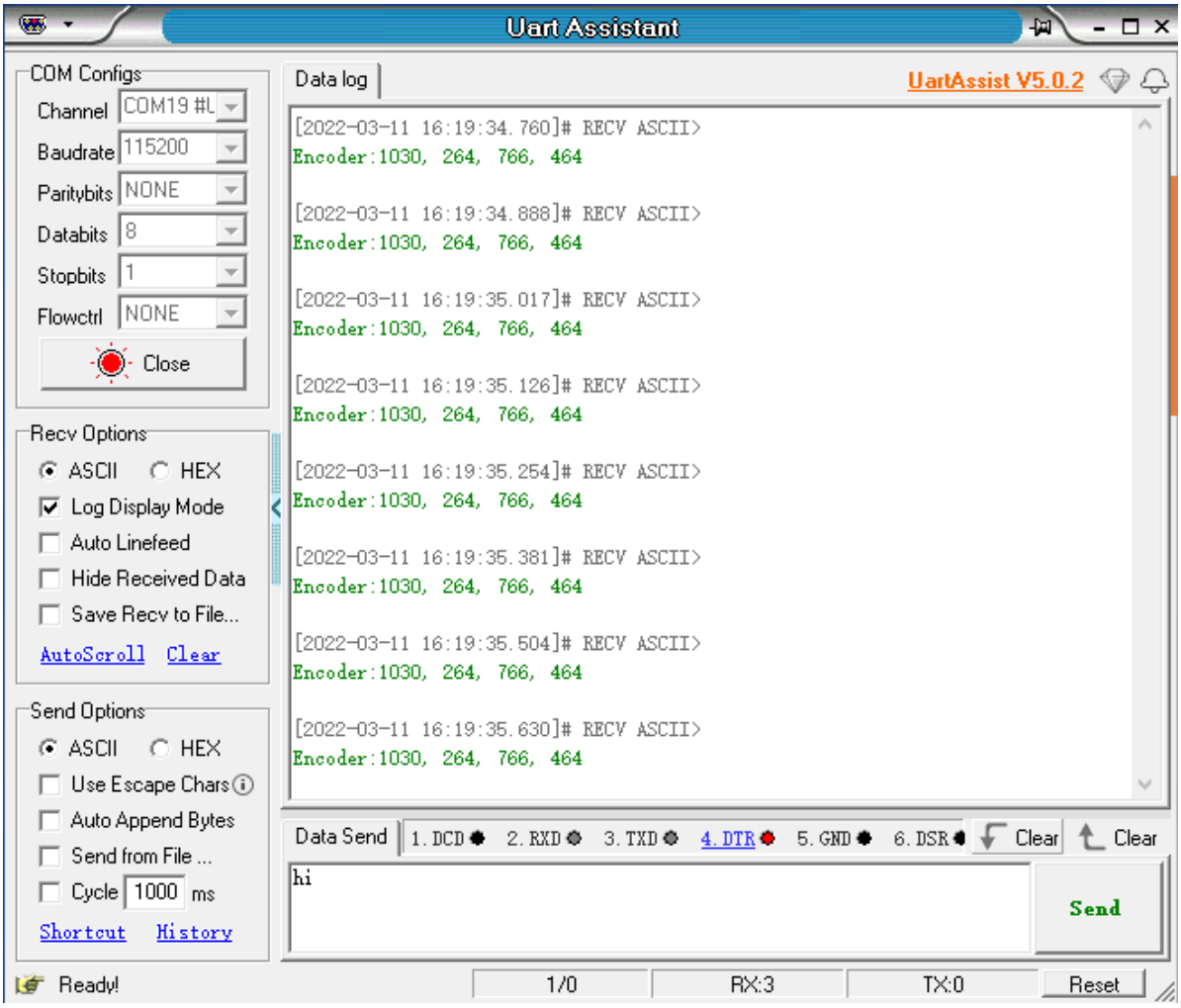
Since the power of the motor is relatively large, the expansion board should not be powered by USB 5V directly, but must be powered by DC 12V.

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

13.6. Experimental effect

Since the motor will turn when started, please stand up the trolley before the experiment, and the motor wheels are suspended in the air to avoid rampage.

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


Uart Assistant
COM Configs
Channel COM19 #L
Baudrate 115200
Paritybits NONE
Databits 8
Stopbits 1
Flowctrl NONE
Close
Recv Options
ASCII HEX
Log Display Mode
Auto Linefeed
Hide Received Data
Save Recv to File...
AutoScroll Clear
Send Options
ASCII HEX
Use Escape Chars
Auto Append Bytes
Send from File ...
Cycle 1000 ms
Shortcut History
Data log
UartAssist V5.0.2
[2022-03-11 16:19:34.760]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:34.888]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:35.017]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:35.126]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:35.254]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:35.381]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:35.504]# RECV ASCII>
Encoder:1030, 264, 766, 464
[2022-03-11 16:19:35.630]# RECV ASCII>
Encoder:1030, 264, 766, 464
Data Send
1. DCD 2. RXD 3. TXD 4. DTR 5. GND 6. DSR
Clear
Clear
hi
Send
Ready!
1/0
RX:3
TX:0
Reset