10. Control serial steering gear

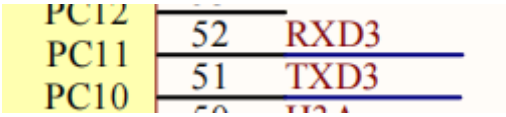
10.1. Experimental purpose

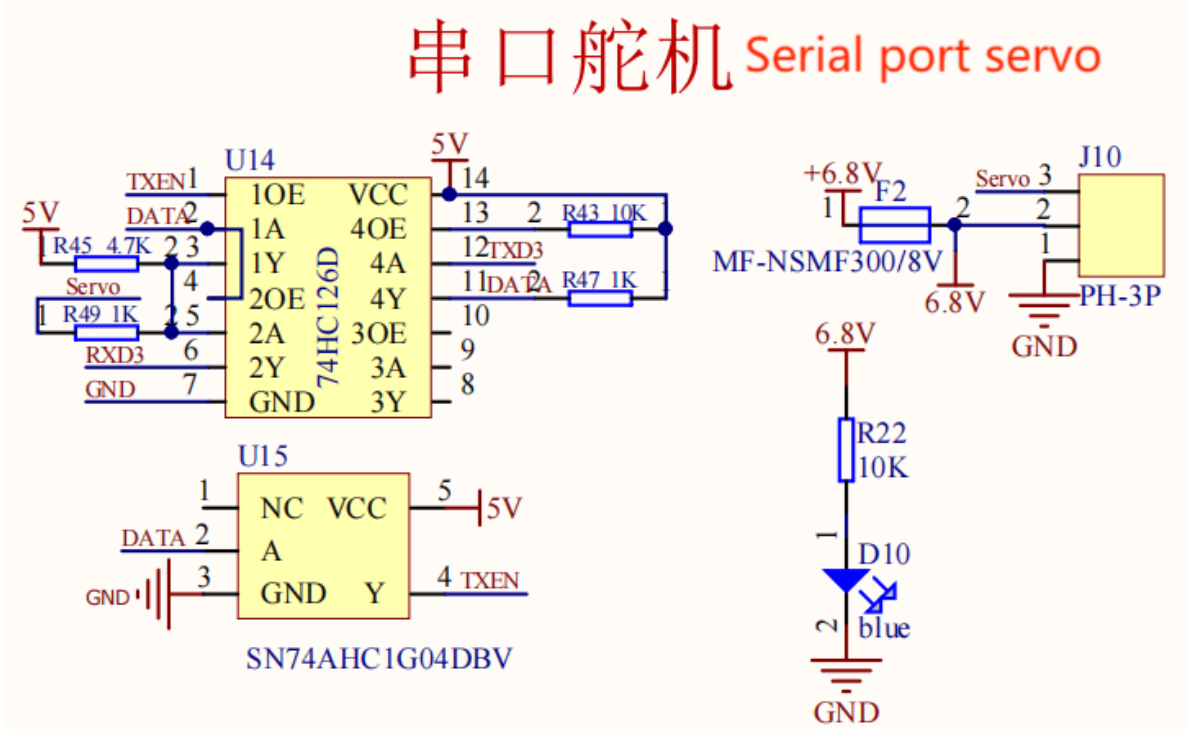
STM32 serial port function is used to control serial actuator and read the position of serial actuator.

10.2. Configure pin information

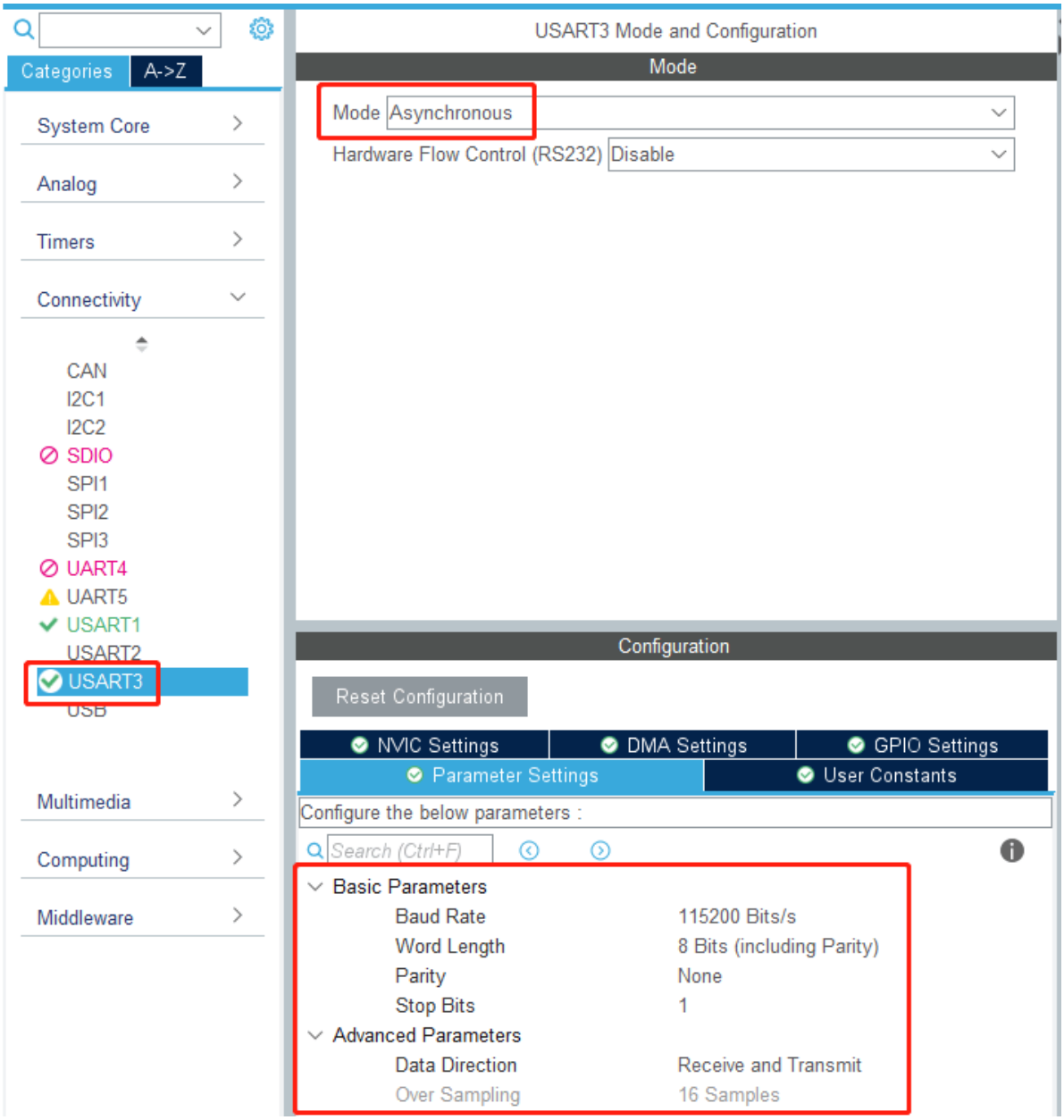
1. Import the ioc file from the Serial project and name it Serial_Servo.

According to the schematic diagram, the serial actuator is connected to the pins of serial ports 3, PC10 and PC11.



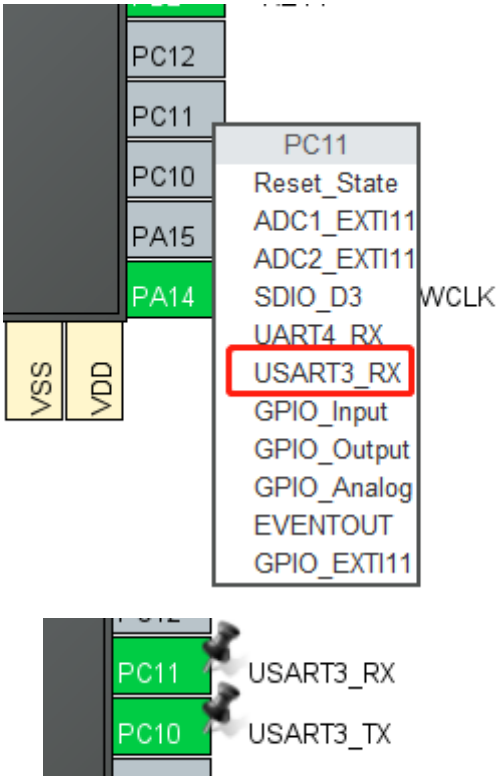


2. Set serial port 3 to Asynchronous mode, other parameters as shown below.

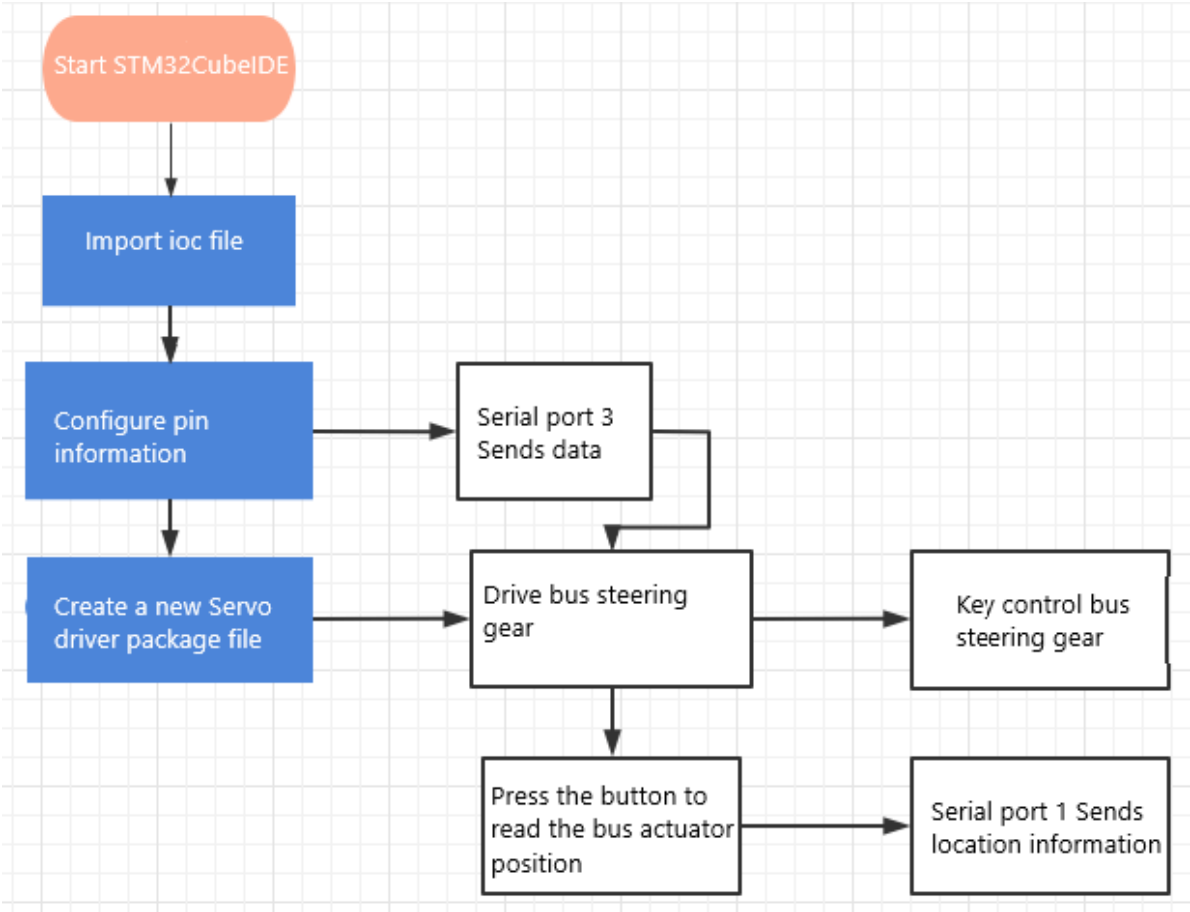


3. Because the default pins of serial port 3 are PB10 and PB11, and serial port 3 in the expansion module schematic is connected to PC10 and PC11, the serial port remapping function is required.

First click on pin PC11 and select USART3_RX. After this operation, the pins of serial port 3 will be remapped to PC10 and PC11.



10.3. Analysis of experimental flow chart



10.4. Core code interpretation

1. Create bsp_uart_servo.h and bsp_uart_servo.c, and add the following information to bsp_uart_servo.

```
#define MEDIAN_VALUE          2000
#define MID_VAL_ID6           3100

#define MID_ID5_MAX           3700
#define MID_ID5_MIN           380
// (uint16_t)((MID_ID5_MAX-MID_ID5_MIN)/3+MID_ID5_MIN)
#define MID_VAL_ID5           1486


#define RX_MAX_BUF            8
#define MAX_SERVO_NUM         6

// 限制串口舵机最大和最小脉冲输入值
// Limits the maximum and minimum pulse input values of the serial servo
#define MAX_PULSE             4000
#define MIN_PULSE             96


void UartServo_Ctrl(uint8_t id, uint16_t value, uint16_t time);
void UartServo_Set_Snyc_Buffer(uint16_t s1, uint16_t s2, uint16_t s3, uint16_t s4, uint16_t s5, uint16_t s6);
void UartServo_Sync_Write(uint16_t sync_time);
void UartServo_Set_Torque(uint8_t enable);
void UartServo_Set_ID(uint8_t id);


void UartServo_Get_Angle(uint8_t id);
void UartServo_Revice(uint8_t Rx_Temp);
uint8_t UartServo_Rx_Parse(void);
```

2. Create the following content in the bsp_uart_servo.c file:

According to the communication protocol of serial actuator, create UartServo_Ctrl(id, value, time) to control the actuator. id corresponds to the ID of the steering gear to be controlled. If id=0xFE(254), all steering gear is controlled. value indicates the position to which the steering gear is controlled, and time indicates the running time. Before reaching the maximum speed, the shorter the time, the faster the running.

```
// Control Servo 控制舵机, id=[1-254], value=[MIN_PULSE, MAX_PULSE], time=[0, 2000]
void UartServo_Ctrl(uint8_t id, uint16_t value, uint16_t time)
{
    uint8_t head1 = 0xff;
    uint8_t head2 = 0xff;
    uint8_t s_id = id & 0xff;
    uint8_t len = 0x07;
    uint8_t cmd = 0x03;
    uint8_t addr = 0x2a;

    if (value > MAX_PULSE)
        value = MEDIAN_VALUE;
    else if (value < MIN_PULSE)
        value = MEDIAN_VALUE;

    uint8_t pos_H = (value >> 8) & 0xff;
    uint8_t pos_L = value & 0xff;

    uint8_t time_H = (time >> 8) & 0xff;
    uint8_t time_L = time & 0xff;

    uint8_t checknum = (~(s_id + len + cmd + addr +
                          pos_H + pos_L + time_H + time_L)) & 0xff;
    uint8_t data[] = {head1, head2, s_id, len, cmd, addr,
                      pos_H, pos_L, time_H, time_L, checknum};

    USART3_Send_ArrayU8(data, sizeof(data));
}
```

2. Create the following content in the bsp_uart_servo.c file:
3. The UartServo_Get_Angle() function requests the current position of the steering gear.

```
// Request current position of servo  请求舵机当前位置
void UartServo_Get_Angle(uint8_t id)
{
    uint8_t head1 = 0xff;
    uint8_t head2 = 0xff;
    uint8_t s_id = id & 0xff;
    uint8_t len = 0x04;
    uint8_t cmd = 0x02;
    uint8_t param_H = 0x38;
    uint8_t param_L = 0x02;

    uint8_t checknum = (~(s_id + len + cmd + param_H + param_L)) & 0xff;
    uint8_t data[] = {head1, head2, s_id, len, cmd, param_H, param_L, checknum};
    USART3_Send_ArrayU8(data, sizeof(data));
}
```

4. The UartServo_Revice(Rx_Temp) function receives data from serial port 3, determines whether it conforms to the serial port steering gear communication protocol, and updates the Rx_Data array and sets New_Frame to 1 if it conforms to a frame of data.

```
// Receiving serial port data  接收串口数据
void UartServo_Revice(uint8_t Rx_Temp)
{
    switch (Rx_Flag)
    {
    case 0:
        if (Rx_Temp == 0xff)
        {
            Rx_Data[0] = 0xff;
            Rx_Flag = 1;
        }
        break;

    case 1:
        if (Rx_Temp == 0xf5)
        {
            Rx_Data[1] = 0xf5;
            Rx_Flag = 2;
            Rx_index = 2;
        }
        else
        {
            Rx_Flag = 0;
            Rx_Data[0] = 0x0;
        }
        break;

    case 2:
        Rx_Data[Rx_index] = Rx_Temp;
        Rx_index++;
        if (Rx_index >= RX_MAX_BUF)
        {
            Rx_Flag = 0;
            New_Frame = 1;
        }
        break;
    default:
        break;
    }
}
```

5. Analyze the data returned by the serial actuator, return 1 after reading successfully, and print the data, otherwise return 0.

```
// 解析串口数据，读取成功返回1， 否则返回0
// Parses serial port data, returns 1 on success, 0 otherwise
uint8_t UartServo_Rx_Parse(void)
{
    uint8_t result = 0;
    if (New_Frame)
    {
        result = 1;
        New_Frame = 0;
        uint8_t checknum = (~(Rx_Data[2] + Rx_Data[3] + Rx_Data[4] + Rx_Data[5] + Rx_Data[6])) & 0xff;
        if (checknum == Rx_Data[7])
        {
            uint8_t s_id = Rx_Data[2];
            uint16_t read_value = Rx_Data[5] << 8 | Rx_Data[6];

            // Print the servo position data  打印读取到舵机位置数据
            printf("read arm value:%d, %d\n", s_id, read_value);
        }
    }
    return result;
}
```

6. Add the following write and read functions for serial port 3 in bsp_uart.c.

```
// Initialize USART3  初始化串口3
void USART3_Init(void)
{
    HAL_UART_Receive_IT(&huart3, (uint8_t *)&RxTemp, 1);
}

// The serial port sends one byte  串口发送一个字节
void USART3_Send_U8(uint8_t ch)
{
    HAL_UART_Transmit(&huart3, (uint8_t *)&ch, 1, 0xFFFF);
}

// The serial port sends a string of data  串口发送一串数据
void USART3_Send_ArrayU8(uint8_t *BufferPtr, uint16_t Length)
{
    while (Length--)
    {
        USART3_Send_U8(*BufferPtr);
        BufferPtr++;
    }
}
```

```
// The serial port receiving is interrupted. Procedure  串口接收完成中断
void HAL_UART_RxCpltCallback(UART_HandleTypeDef *huart)
{
    if (huart==&huart1)
    {
        // 测试发送数据，实际应用中不应该在中断中发送数据
        // Test sending data. In practice, data should not be sent during interrupts
        USART1_Send_U8(RxTemp);

        // Continue receiving data  继续接收数据
        HAL_UART_Receive_IT(&huart1, (uint8_t *)&RxTemp, 1);
    }
    if (huart==&huart3)
    {
        UartServo_Revice(RxTemp_3);
        // Continue receiving data  继续接收数据
        HAL_UART_Receive_IT(&huart3, (uint8_t *)&RxTemp_3, 1);
    }
}
```

7. Add the content initialized by serial port 3 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);
    USART1_Init();
    USART3_Init();
}
```

8. Add the function of key reading and control serial actuator in Bsp_Loop() function.

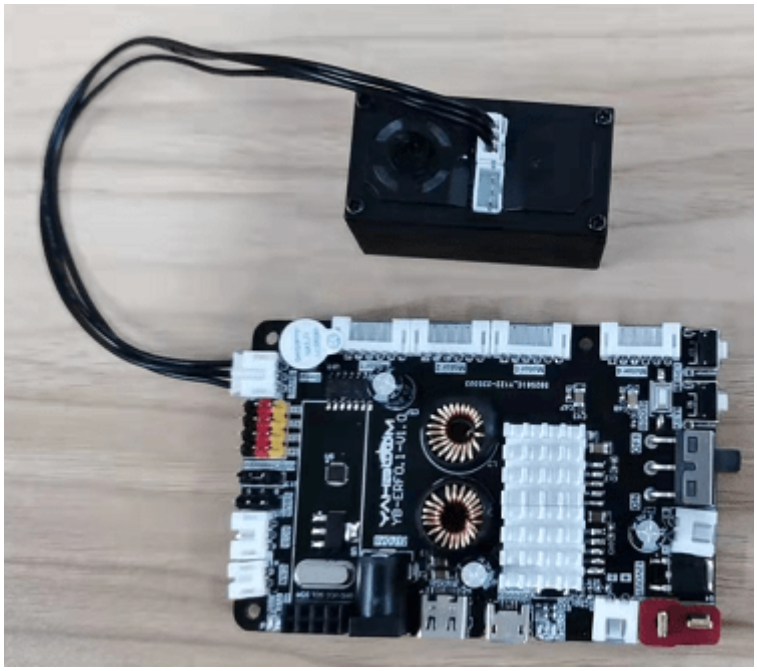
```
// main.c中循环调用此函数，避免多次修改main.c文件。
// This function is called in a loop in main.c to avoid
void Bsp_Loop(void)
{
    // Detect button down events    检测按键按下事件
    if (Key1_State(KEY_MODE_ONE_TIME))
    {
        Beep_On_Time(50);
        static int press = 0;
        press++;
        printf("press:%d\n", press);

        UartServo_Get_Angle(servo_id);
        HAL_Delay(12);
        if (press%2)
        {
            UartServo_Ctrl(servo_id, 1000, 500);
        }
        else
        {
            UartServo_Ctrl(servo_id, 3000, 500);
        }
    }

    UartServo_Rx_Parse();
    Bsp_Led_Show_State_Handle();
    Beep_Timeout_Close_Handle();
    HAL_Delay(10);
}
```

10.5. Hardware connection

The serial serial steering gear must be connected to the serial serial steering gear port on the expansion board. The serial serial steering gear port has the anti-reverse connection function. Serial actuator can be cascaded multiple, because the expansion board power supply current is limited, so do not connect too many steering gear, the current test six steering gear can be used normally.



Because the power of the serial port actuator is relatively large, do not directly use the USB 5V power supply for the expansion board. Instead, use the battery power supply.

10.6. Experimental effect

After burning the program, the LED light flashes every 200 milliseconds. By pressing the button several times, the serial actuator will return between 1000 position and 3000 position, and return the position data before the movement.