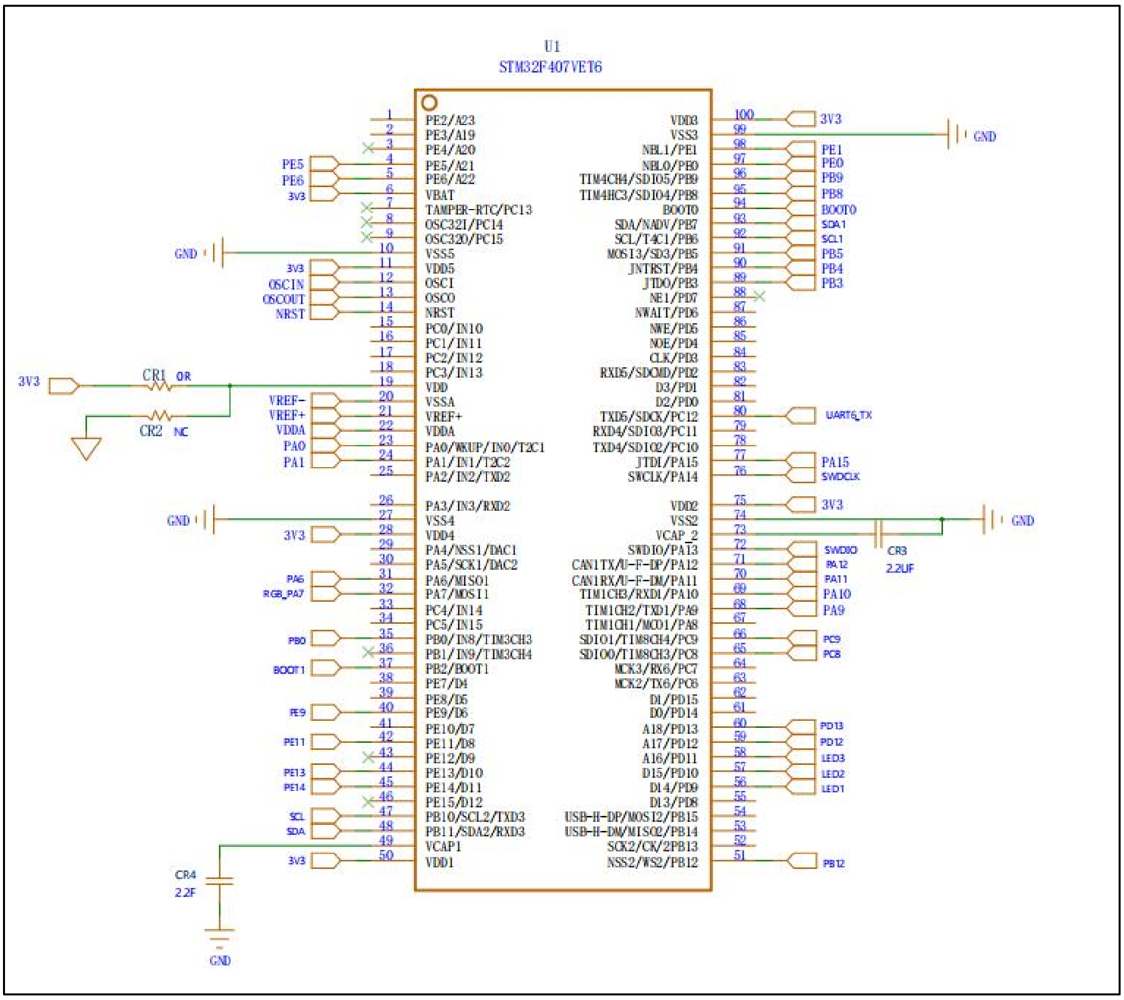
RRCLite Schematic Explanation

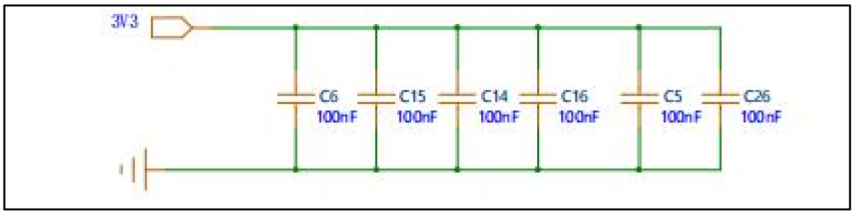
1. Main Chip Description

Main chip: STM32F407VET6



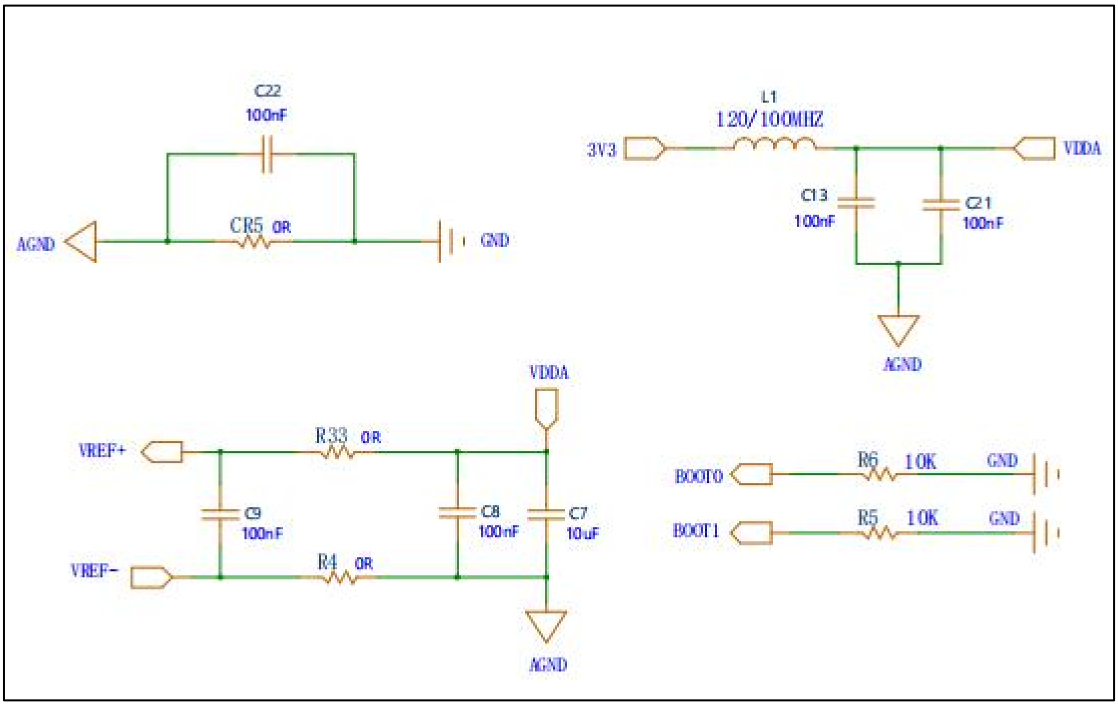
This STM32F407VET6 has 100 pins. As you can see, many of these pins are already in use, while others are left available for customers to use in their own development. Below, we will detail which pins are in use, their functions, and which pins are available.

2. Shut Capacity



These 100nf capacitors are connected to the 3.3V supply on the STM32F407VET6. The functions of these bypass capacitors are voltage stabilization and filtering.

3. Peripheral Circuit of VET6



The connections between AGND (analog ground) and GND (digital ground), as well as between 3V3 and VDDA, play an important role in the peripheral circuit of the device.

Analog and digital signals often need to coexist on the same circuit board. However, the switching processes of digital circuits can introduce noise which can negatively impact the performance of analog circuits. To mitigate this issue, two separate systems are typically used: one for the analog circuit (AGND) and another for the digital circuit (GND). This approach ensures that the ground currents of the analog and digital parts do not interfere with each other as much as possible, while keeping the entire system at the same potential to minimize the impact of noise.

3V3 is the power supply voltage, and VDDA is the analog power supply voltage. The circuit may be a power decoupling design.

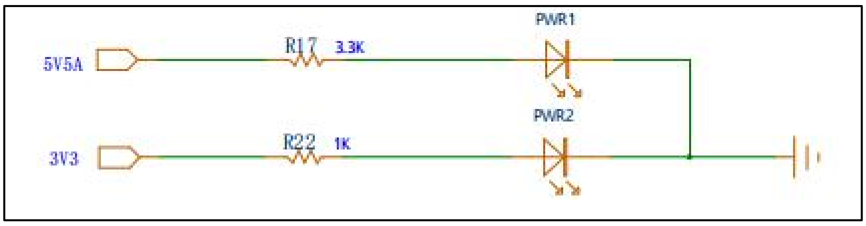
An LC filter consists of an inductor L of 120/100HZ and two capacitors C of 100nF in parallel. It is used to reduce the high-frequency noise of the power supply voltage, thereby providing a more stable analog power supply voltage VDDA. This is the power decoupling design used for the peripheral circuit.

VREF+ and VREF- are each connected in parallel with two 100nF capacitors, which are called decoupling capacitors. Decoupling capacitors are used to reduce high-frequency noise on the power lines, smooth the power supply voltage, and provide a more stable voltage.

In addition, a 10uF capacitor is connected to AGND through two 0-ohm resistors. This is a power filtering method. The 10uF capacitor can provide low-frequency decoupling, while the 0-ohm resistor can provide a low-impedance path between the power and ground lines. This helps to reduce the influence of power supply noise on voltage, improving the accuracy and performance of ADC and DAC circuits.

4. Power Indicator

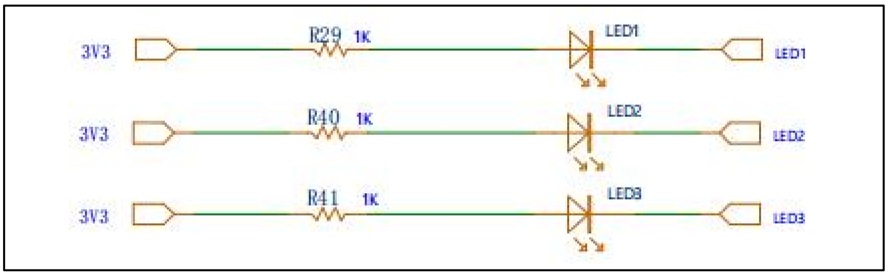
The three circuits of the power indicator light utilize resistors to regulate the current flowing through the LED, thus preventing overheating and damage to the LED.



In the first circuit, a 5V power supply is used with a 3.3k resistor and the LED is connected to the ground. The current can be calculated using Ohm's law: I = V/R. Therefore, the current I = 5V / 3.3kΩ = 1.52mA. This is a safe current value, as the maximum continuous operating current for most LEDs is approximately 20mA.

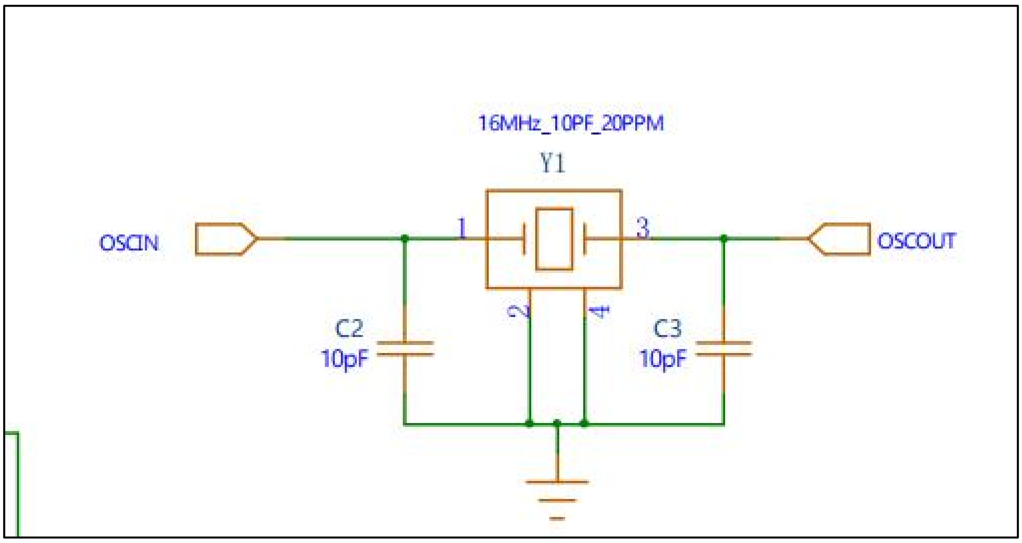
In the second circuit, a 3.3V power supply is used with a 1k resistor and the

LED is connected to the ground. Similarly, the current can be calculated as I = 3.3V / 1kΩ = 3.3mA. This current value is also safe.

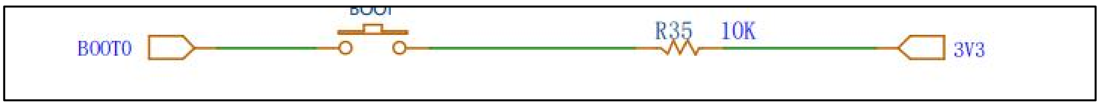


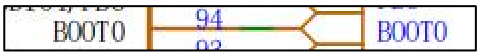
In the third circuit, this type of connection is typically used to indicate the status of the main chip. When the PD9/PD10/PD11 pins are configured as low-level outputs, the current flows through the LED and resistor to the ground (GND), illuminating the LED connected to the corresponding pin. When the PD9/PD10/PD11 pins are configured as high-level (3.3V) outputs, the voltage difference across the LED is 0, and the current stops flowing. This causes the LED connected to the corresponding pin to turn off.

5. Crystal Oscillator Circuit



A 16MHz crystal oscillator is connected in parallel to the OSCIN and OSCOUT pins, which are connected together. Each pin of the STM32F407VET6 chip's crystal oscillator is then connected to ground through a 10pF capacitor (oscillation capacitor). These capacitors provide a loop that allows the crystal to start oscillating, thereby generating a stable clock signal.



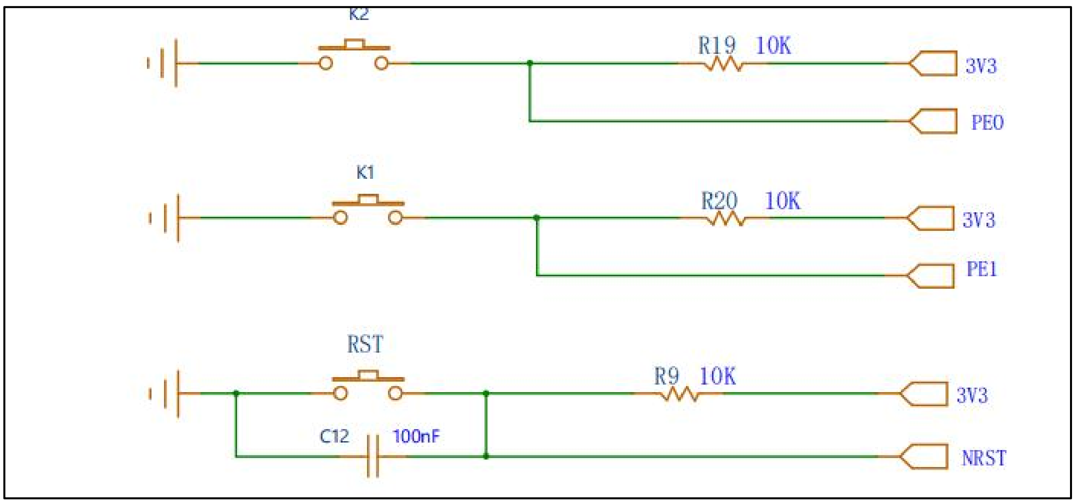


BOOT and BOOT1: BOOT0 and BOOT1 are digital input pins that read the state of the voltage (high or low) at power-up or reset, and select different boot sources based on these states. For more details, please refer to the STM32F407VET6_Datasheet.

For example, booting from built-in flash memory, system memory, or a connected external memory device. The BOOT0 and BOOT1 pins are each connected to ground through a 10KΩ resistor. This means that these pins will be pulled low at power-up or reset. This is to set the default boot mode.

In addition, to accommodate possible special requirements, the BOOT0 pin supports connecting to a high voltage by pressing the BOOT button at power-up, booting from system memory.

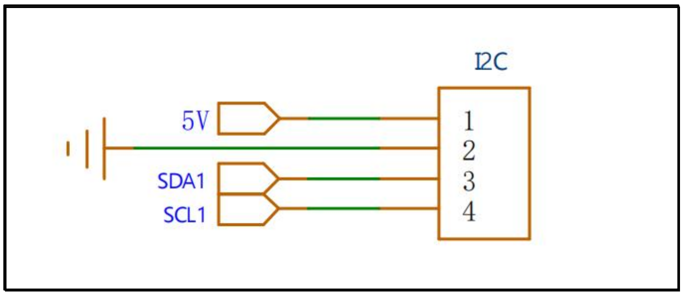
6. Button Circuit

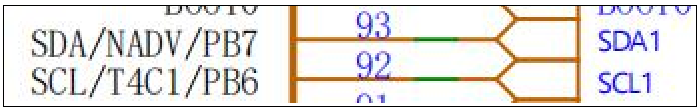


These three circuits are button circuits with pull-down resistors. When the button is not pressed, the PE0 pin is connected to the 3.3V power supply through a 10kΩ resistor. Therefore, the PE0 pin reads a high level voltage. When the button is pressed, the PE0 pin is directly connected to ground. Then, the PE0 pin reads a low level voltage.

The NRST reset button and PE1 circuit are the same.

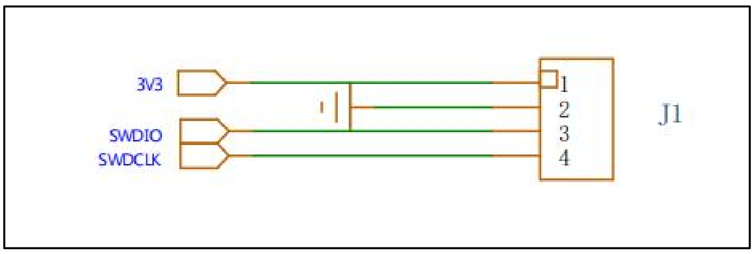
7. I2C Reserved Interface





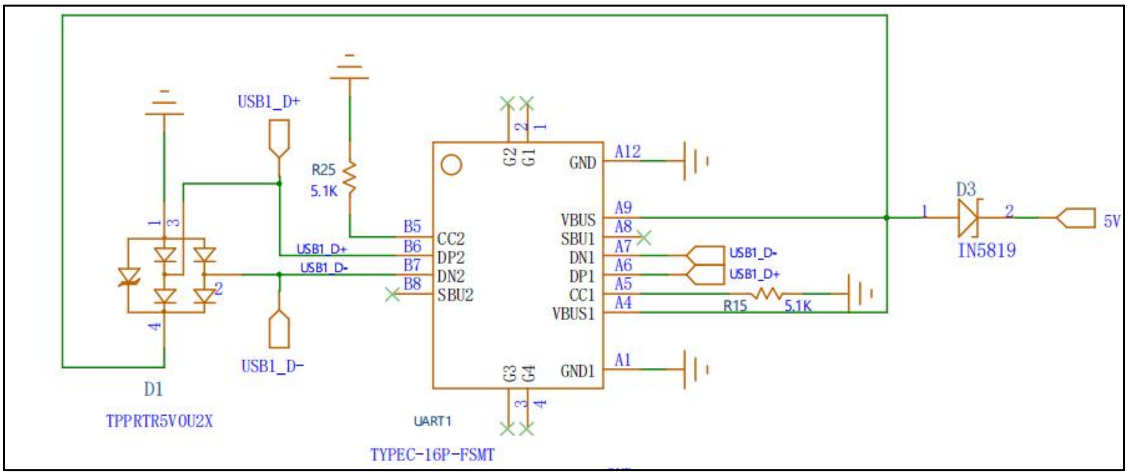
The reserved I2C interface can be used to connect external I2C devices, such as language devices and OLED screens. Here, the I2C2 pin of the STM32 is connected.

8. SWD Download



The two pins are usually used as a debugging port (SWD interface) in the STM32F407VET6 chip. PA13 is SWDIO (data line) and PA14 is SWCLK (clock line).

9. TYPEC Port



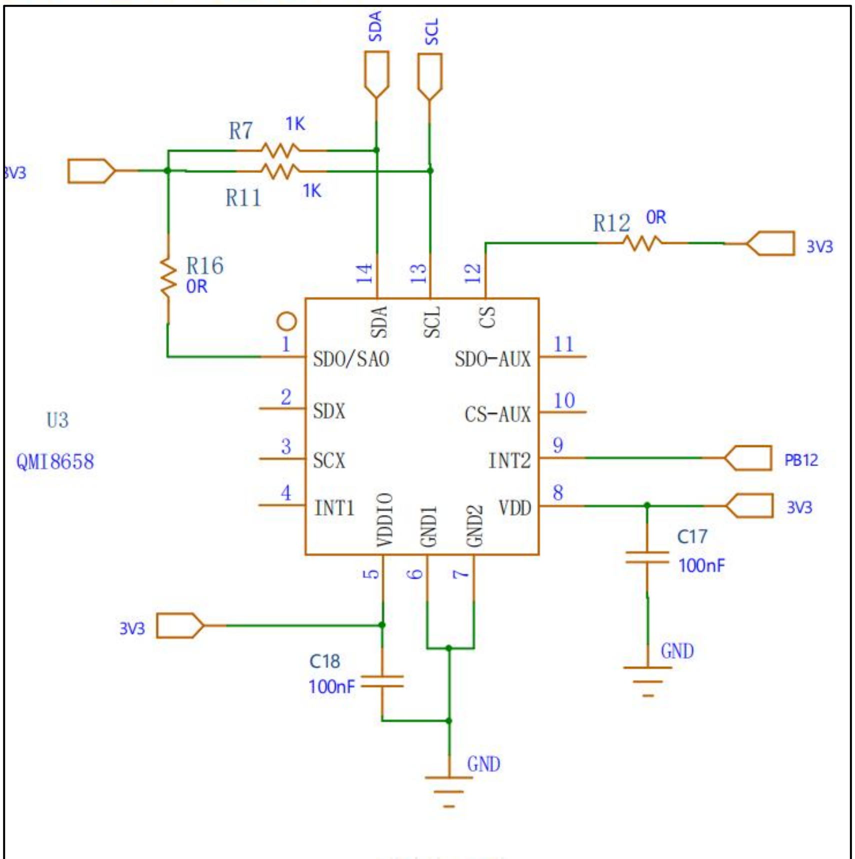
A diode is connected to the VBUS pin to prevent reverse current on the VBUS line.

The cathode of the diode is connected to the VBUS pin, and the anode is connected to the power circuit.

This allows the power circuit to receive power from the VBUS pin, but prevents reverse power supply to the VBUS line.

DP2 and DN2 are differential data lines of the USB Type-C connector used for transmitting USB data. Connecting an ESD protection device can prevent these lines from being damaged by electrostatic discharge (ESD) or other over-voltage events.

10. QMI8658



IMU Circuit

A 1k resistor is connected to the SCL and SDA pins of the QMI8658 as pull-up resistors. This means that the device can pull the line down to a low level voltage, but cannot actively pull it up to a high level voltage.

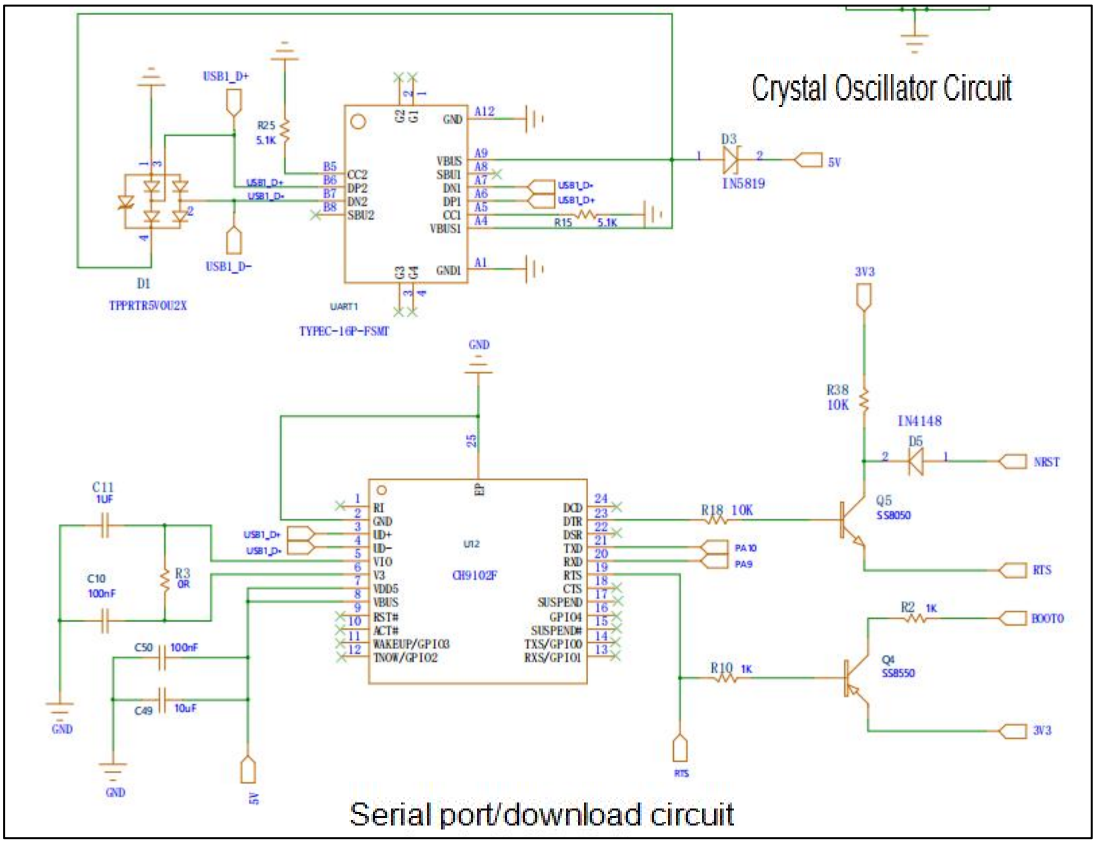
Power connection: The VCC pin of the MPU-6050 needs to be connected to a 3.3V power supply, and the GND pin should be connected to ground.

I2C signal line connection: SDA and SCL are the two important lines for I2C communication, which are the data line and the clock line, respectively. The corresponding pins for I2C function should be connected to the SDA and SCL pins of the MPU-6050. For example, on the STM32F407VET6, PB11 can be selected as SDA and PB10 as SCL.

Interrupt pin: The INT2 pin is the interrupt output. When the QMI8658 has new data to be read or other events occur, an interrupt signal can be sent to the STM32F407VET6 chip through this pin.

Capacitor mounted on it: When the QMI8658 starts to work and draws current from the power line, the capacitor can quickly provide the required current to avoid a momentary drop in the power supply voltage. The capacitor can simultaneously absorb high-frequency noise on the power line to prevent noise from entering the QMI8658 and affecting its performance.

11. CH9102F Serial Port 1 Circuit



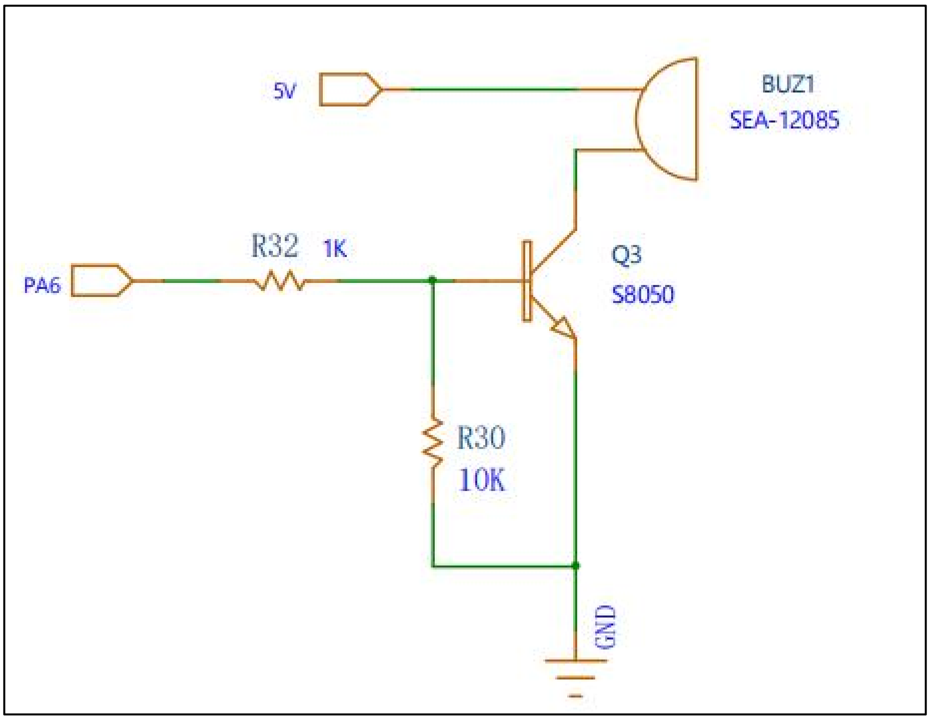
The USB_D+ and USB_D- pins of the TYEC interface are respectively connected to the USB_D+ and USB_D- pins of the CH9102F for USB communication.

VIO and V3 are the power pins of the CH9102F, connected to the VCC power supply through 0Ω resistors. Decoupling capacitors (1uF and 100nF) connected in parallel between these pins and ground are used to stabilize the power supply voltage and filter noise.

The TXD (transmit) and RXD (receive) pins of the CH9102F are respectively connected to the PA9 and PA10 pins on the microcontroller for UART communication. This is used for serial port 1 of the main chip.

In addition, this serial port features a serial programming function. For more details, please refer to the CH9102F_Datasheet.

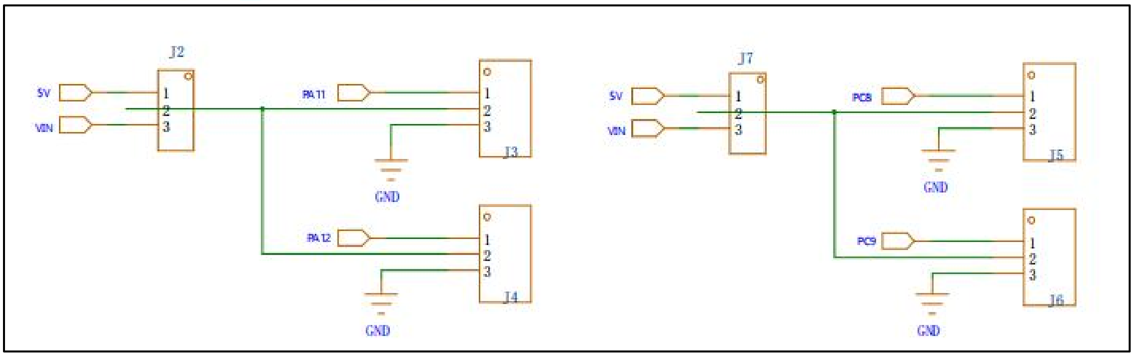
12. Buzzer



One end of the buzzer is connected to a 5V power supply, and the other end of the buzzer is connected to the base of an S8050 transistor. The base is grounded through a 10kΩ resistor, and connected to the PA6 pin on the microcontroller through a 1kΩ resistor.

If you want the buzzer to sound, make the PA6 pin of the main chip output high level voltage. This will turn on the transistor, allowing current to flow through the buzzer and causing it to sound. If you want to stop the buzzer from sounding, make the PA6 pin output a low level voltage. This will turn off the transistor, preventing current from flowing through the buzzer and causing it to stop. This buzzer is a peripheral device used for emitting sound prompts or alarms by controlling the pin level.

13. 4-Ch Servo Interface

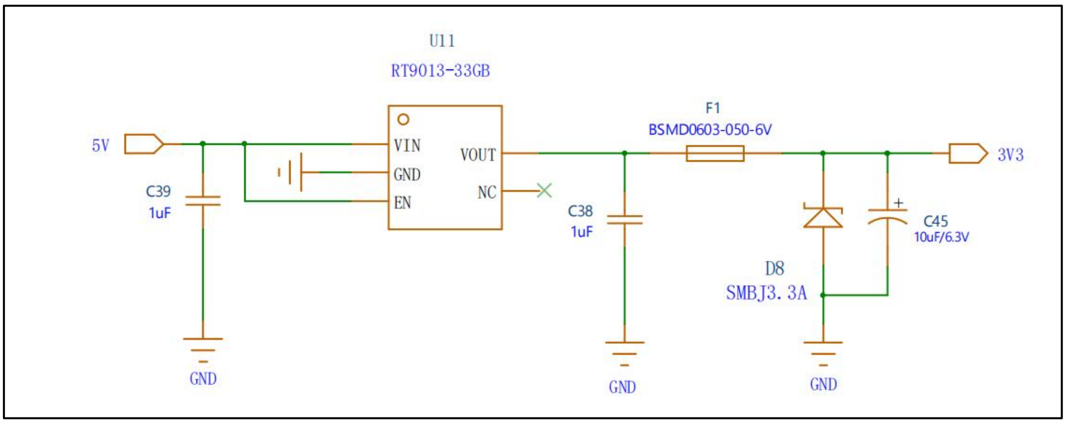


These four interfaces can be connected to the servos to control them.

The servo interfaces are paired in load voltage distribution, and specific selections can be made by shorting the jumper caps.

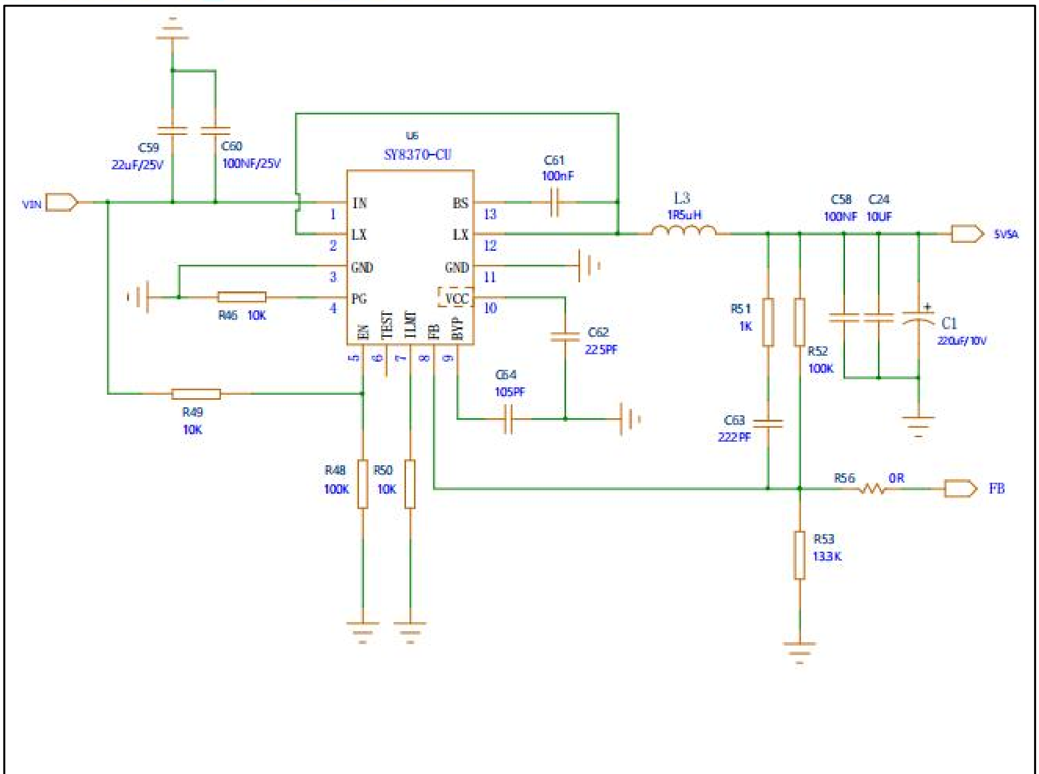
The 5V pin is used for low voltage servos, while the VIN pin is used for high voltage servos connected to a high voltage power supply.

14. 5V to 3.3V Circuit



BSMD0603-050-6V is a fuse that is connected to the output of the RT9013-33GB. It is designed to protect against damage from excessive current. When the current exceeds the rated value of the fuse, it will break, cutting off the current.

15. Raspberry Pi 5V Power Supply Circuit & Onboard 5V Power Circuit

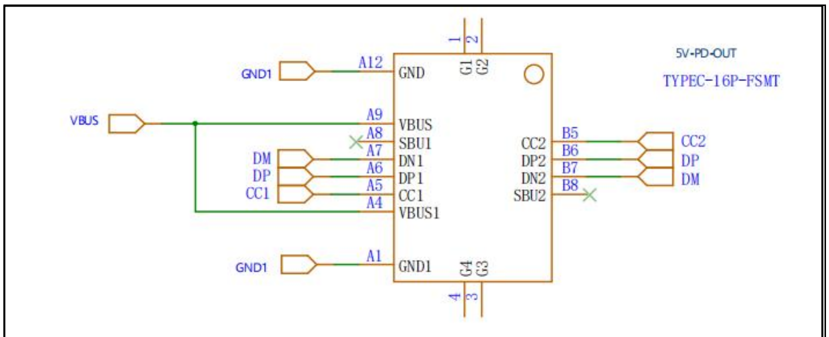


5V5A power supply output circuit

As the name implies, this circuit supplies power to our Raspberry Pi using an RT8389GSP power chip. The output, 5V5A, can be adjusted via R24 and R25 according to the formula: V_OUT = V_FB * (1 + R1/R2).

V_OUT is the output voltage of the regulator.

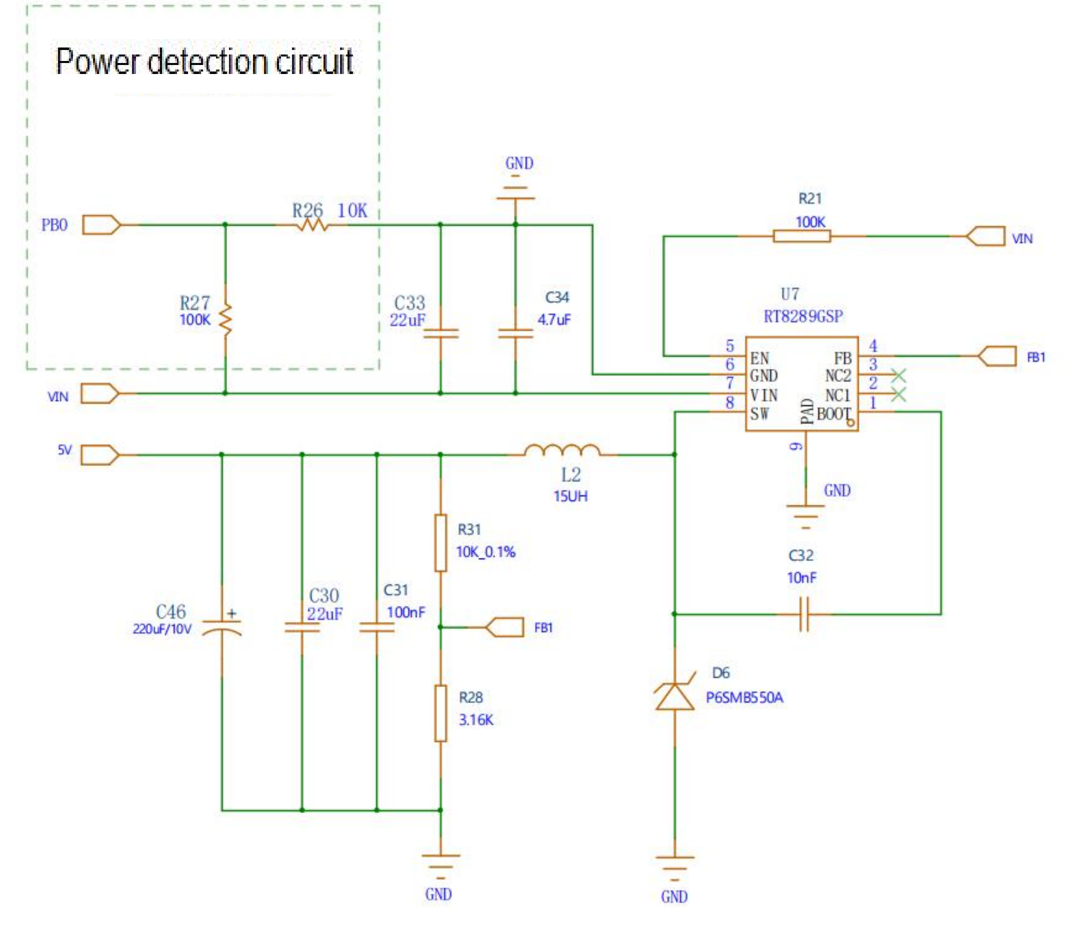
V_FB is the feedback reference voltage, which is a fixed value set internally in the regulator. In this case, the value is typically 1.222V. For more information, you can access RT8289GSP_ datasheet.



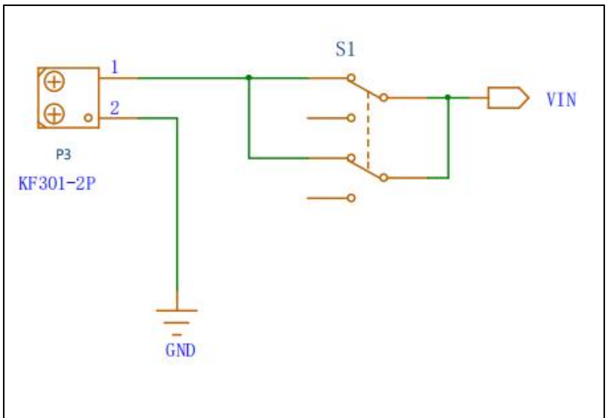
5V external (PD protocol) output circuit

The Raspberry Pi power supply circuit also includes a type-C interface for providing 5V5A power output.

Furthermore, there is an onboard 5V power supply circuit on the Raspberry Pi that is also adjustable.



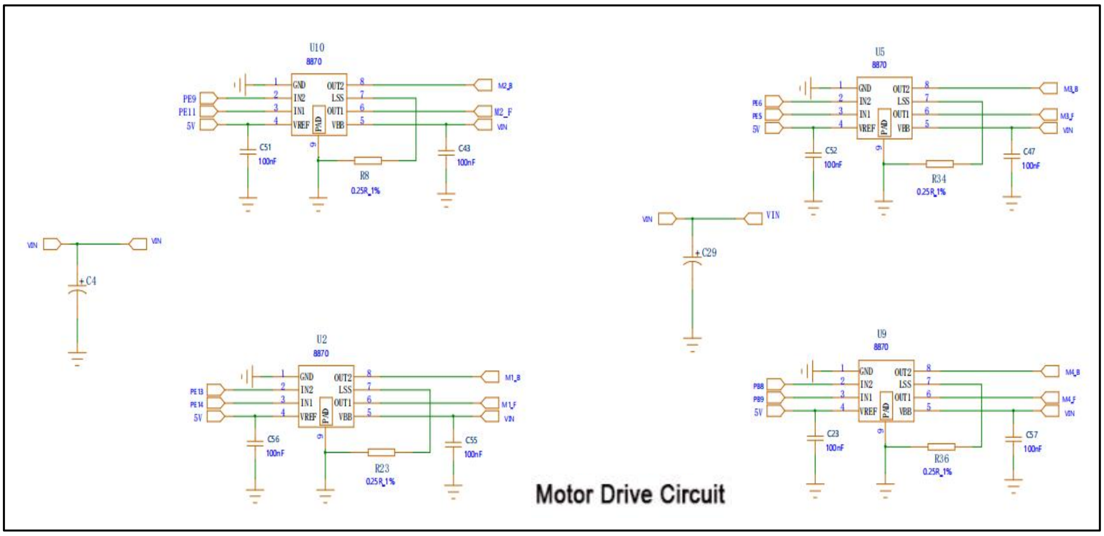
On-board 5V Power Circuit



Power interface control circuit

S1 is the switch for controlling the power supply.

16. Motor Drive Circuit



Motor Drive Circuit

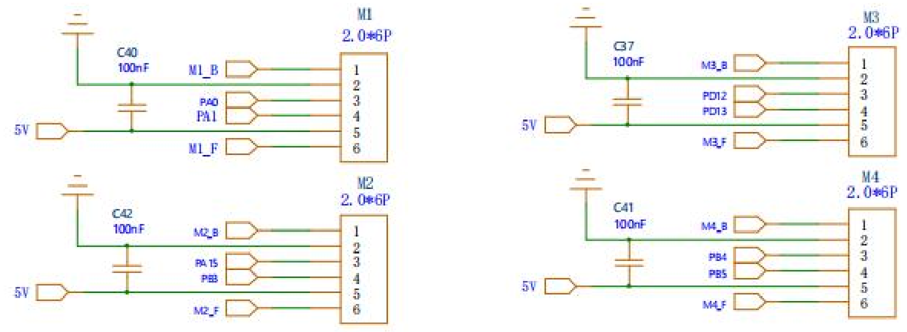
The motor drive circuit uses the YX-4055AM motor driver chip to control four motors. The chip is connected to the main chip's PA9, PA11, PE5, PE6, PE13, PE14, PB8, and PB9 pins to control the motor's rotation speed and direction.

In addition, the C4, C36, C29, and C48 capacitors are used for filtering and denoising. These capacitors can function as a filter to help remove noise from the power line. The 220uF capacitor can effectively remove low-frequency noise, while the 100nF capacitor is better at removing high-frequency noise.

The capacitors also help stabilize the power supply voltage. When the load current changes, the power supply voltage may fluctuate. In this case, the capacitors can provide the necessary current to the circuit to help stabilize the power supply voltage and prevent voltage transients.

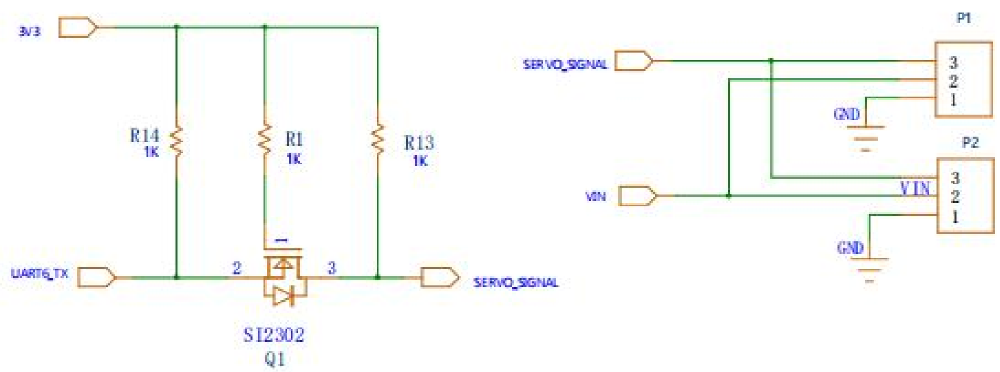
Furthermore, the capacitors can prevent excessive peak current from flowing to the power supply when the circuit suddenly requires a large current.

The following are the interfaces for the encoded motors, which are connected to the output pins of the motor driver chip and filtered by a 100nF capacitor.



Motor encoder circuit

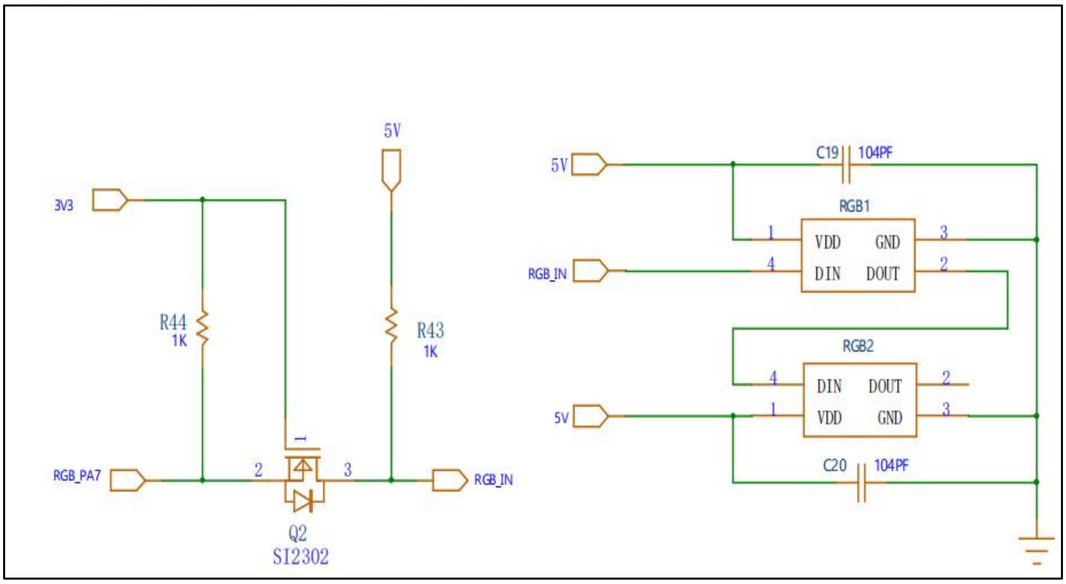
17. Bus Servo Interface



Bus servo interface circuit

This is the circuit and interface for the bus servos, which are connected in series with PC12 on the main chip.

18. The RGB-LED (Red-Green-Blue Light Emitting Diode) Circuit



The RGB LEDs used in this circuit is based on the WS2812B series, which uses a single data line to control the color of the LEDs. This allows for serial control, and the STM32F407VET6 uses the SPI protocol to control the LEDs. The color information for several RGB LEDs is output on the signal line at once, and the connected RGB LEDs will read the color information in sequence according to their connection order, allowing them to change colors simultaneously.