LoRa Module Private Protocol Version

F8L10C-02

User Manual

V1.0.0

This manual is applicable to the following products: F8L10C-02LU, F8L10C-02LN, F8L10C-02HU, F8L10C-02HN

Xiamen Four-Faith Communication Technology Co., Ltd.
https://www.fourfaith.com

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Contact Us

Address:
11th Floor, A-06 Area, No.370, Chengyi Street, Jimei District, Xiamen City, Fujian Province, China
Website:
www.fourfaith.com
Tel:
+86-592-5907276
Fax:
+86-592-5907276
Post Code:
361021
E-mail:
Sales@four-faith.com

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Chapter 1 Product Introduction

1.1 Overview

The F8L10C-02 series LoRa data transmission module is an embedded wireless data transmission module based on LoRa technology, utilizing LoRa networks to provide long-range wireless data transmission for users. The module adopts an ST ultra-low-power LoRa SoC chip, which integrates a LoRa RF transceiver and a 32-bit Arm® Cortex®-M4 CPU. Designed with an ultra-compact size and extremely low power consumption, the module supports the LoRaWAN protocol as well as Four-Faith private protocols.

Thanks to its compact design, the module can be widely applied across the IoT industry chain in M2M sectors, including smart grid, intelligent transportation, wireless metering for water, gas, and heat, wireless automated data acquisition, industrial automation, smart buildings, fire protection, public safety, environmental protection, meteorology, digital healthcare, remote sensing, military, space exploration, agriculture, forestry, water management, coal mining, and petrochemical industries.

1.2 Product Features

Industrial-grade Design

- Equipped with a high-performance industrial-grade SoC chip; supports Four-Faith private protocol and LoRaWAN 1.0.4 protocol
- The SoC supports all ISM bands from 150 MHz to 960 MHz; the module supports two frequency ranges: 410–510 MHz and 863–928 MHz
- ESD protection design compliant with national standard Level 4 requirements
- Built-in 32 MHz industrial-grade high-precision temperature-compensated crystal oscillator (TCXO)
- Low power consumption design with sleep and wake-up modes, minimum current < 2 μA
- Maximum transmit power up to 22 dBm, adjustable in multiple levels (5–22 dBm), default 20 dBm
- High receiver sensitivity up to -137 dBm @125 kHz, SF12, CR1
- Power supply input: DC 1.8–3.6 V
- Supports UART-based firmware upgrade and remote OTA
- Compact stamp-hole package with 1.27 mm pitch on four sides
- Supports multiple baud rates and RF data rates
- Supports spreading factors SF5, SF6, SF7, SF8, SF9, SF10, SF11, SF12
- In LoRa™ mode, supports data rates from 0.3 kbps to 62.5 kbps
- Supports both IPEX connector and pin header RF output options

- Supports hardware reset

1.3 Product Picture

1.4 Production Precautions

1.4.1 Moisture Sensitivity Level and Protection Requirements

Four-Faith LoRa modules are moisture-sensitive products. In humid environments, moisture absorption may cause malfunction. Therefore, all LoRa modules are shipped in vacuum packaging, with a humidity indicator card and desiccant included inside the bag to prevent moisture ingress.

Figure 1-1 Vacuum Packaging Illustration

Before use, check whether the packaging is intact. After opening the package, verify the status of the humidity indicator card inside the vacuum bag. If any of the following conditions occur, the module must be baked before use:

- Humidity indicator card: the 10% indicator turns pink and is no longer blue, as shown below.

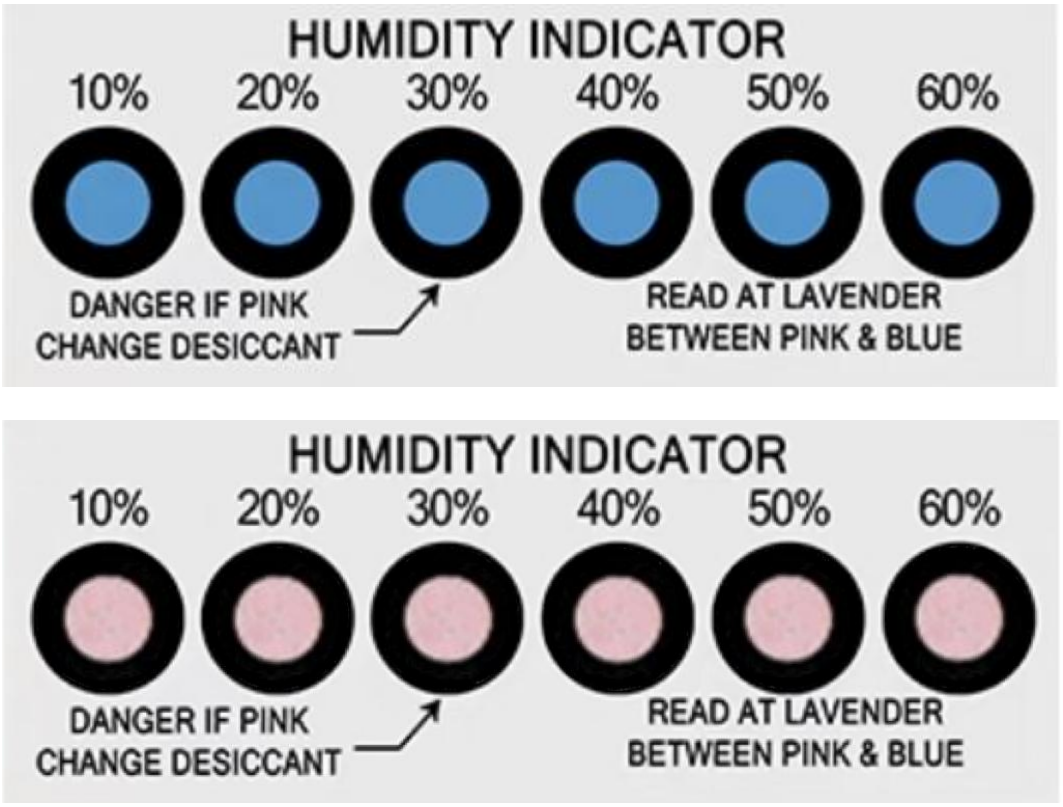


Figure 1-2 Humidity Indicator Card

1.4.2 Workshop Floor Life and Temperature & Humidity Control

The LoRa module has a Moisture Sensitivity Level (MSL) of 3, with a floor life of 168 hours.

1. Under workshop conditions of 23 °C ±5 °C and relative humidity below 60%, the module must undergo reflow soldering or other high-temperature processes within 168 hours after unpacking. Otherwise, it should be stored in an environment with relative humidity below 10% (e.g., a dry cabinet) to maintain dryness.
2. If the workshop temperature/humidity conditions are uncertain or the relative humidity exceeds 60%, complete SMT reflow within 24 hours after unpacking. Avoid opening large quantities of packages in advance.
3. To prevent soldering defects such as blistering and delamination caused by moisture absorption, strict control is required. Long exposure to air after opening vacuum packaging is not recommended.
4. If vacuum packaging is damaged, opened without following moisture control requirements, materials are stored in bulk, or the shelf life exceeds 1 year, pre-baking is required before SMT or rework. Bake at 120 °C ±5 °C for 24 hours to prevent blistering, cracking, or delamination after high-temperature soldering.
5. Before baking, remove the modules from packaging and place bare modules on high-temperature-resistant fixtures (do not bake plastic trays or reels). Modules that undergo secondary baking must be soldered within 24 hours; otherwise, store them in a dry cabinet. Ensure ESD protection during handling and wear

anti-static gloves.

6. After baking, when placing bare modules onto the SMT line, a tray must be used for the pick-and-place machine:

- Method 1: Use a dedicated tray matched to the module size.
- Method 2: If no dedicated tray is available, use the black anti-static carrier tape from the packaging. Cut multiple strips of equal length and arrange them neatly on the machine tray as a temporary fixture.

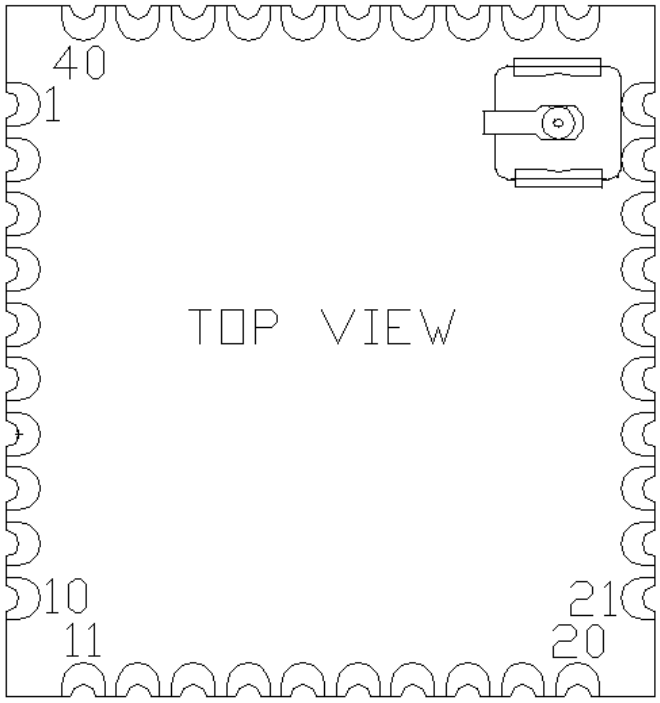
1.4.3 Storage

Recommended storage conditions: temperature 23 °C ±5 °C, relative humidity 35%–60%.

Storage period (under sealed vacuum packaging): up to 12 months under recommended conditions.

Chapter 2 Module Interface

2.1 Module Pin Definition



Module Pin Figure F8L10C-02

Module Interface Definition			
No	Definition	Input/Output	Description
1	GND	N/A	Ground
2	VCC	Input	Power Supply
3	D5	I/O	GPIO05 / ADC_IN4
4	GND	N/A	Ground
5	D2	I/O	GPIO02 / ADC_IN6
6	D10/TXDone	I/O	GPIO10 (Transmission Complete Notification) / ADC_IN7
7	RX	Input	UART Data In
8	TX	Output	UART Data Out
9	JIMS_SWDIO	Input	Debug Data
10	JTCK_SWCLK	Input	Debug Clock
11	GND	N/A	Ground
12	NC	NC	NC
13	D7	Either	NC, Reserved / Customizable
14	D8	Either	NC, Reserved / Customizable
15	NC	NC	NC
16	GND	N/A	Ground
17	D12	Either	NC, Reserved / Customizable

18	D13	Either	NC, Reserved / Customizable
19	D14	Either	NC, Reserved / Customizable
20	GND	N/A	Ground
21	GND	N/A	Ground
22	D11/RXDone	Either	GPIO11 (Reception Complete Notification)
23	STATUS	Either	Sleep Status Indicator
24	D1/SLEEP_RQ	Either	GPIO01 (Sleep Control) / ADC_IN11
25	D3	Either	GPIO03 / ADC_IN3
26	D4	Either	GPIO04 / ADC_IN8
27	GND	N/A	Ground
28	RESET	Input	External Reset Signal
29	GND	N/A	Ground
30	RF_OUT	N/A	F8L10C-02-00XN Version: RF Input/Output
31	GND	N/A	Ground
32	NC	NC	NC, Reserved
33	D15	Either	NC, Reserved / Customizable
34	GND	N/A	Ground
35	D16	Either	NC, Reserved / Customizable
36	D17	Either	NC, Reserved / Customizable
37	GND	N/A	Ground
38	D18	Either	NC, Reserved / Customizable
39	D19	Either	NC, Reserved / Customizable
40	GND	N/A	Ground

Signal input/output is defined relative to the module. In the table description, D1–D5 correspond to IO1–IO5 in the I/O application of the configuration tool. The 12-bit ADC has a reference voltage of 3.3 V, a sampling range of 0.1–3.3 V, and an accuracy of 0.01 V.

Note: Signal input/output is defined relative to the module.

Remarks:

- The sleep control pin: high level = wake-up, low level = sleep mode.
- The sleep status indicator pin: high level indicates the module is awake, low level indicates the module is in sleep mode.
- The transmission complete notification pin remains low by default and goes high for 10 ms upon completion of transmission.
- The reception complete notification pin remains low by default and goes high for 10 ms upon completion of reception (default setting, configurable via AT commands).

2.2 UART Interface

The module's Serial Communication Port 1 is a UART interface, and the pin definitions are shown in the table.

UART Pin Definition	
UART Signal	**Module Pin Number**
TX0	8
RX0	7

2.3 GPIO Specification

The F8L10C-02 module has 20 GPIO ports, with DC characteristics shown in the table.

DC Characteristics of GPIO			
Parameter	**Minimum**	**Typical**	**Maximum**
Input voltage (V) of logic 0	0		<0.3 VBAT
Input voltage (V) of logic 1	>0.7VBAT		VBAT

2.4 Maximum Rating

Maximum Rating			
Parameter	Minimum	Maximum	Unit
Input Power	-0.3	3.9	V
Pin Input Voltage	-0.3	3.9	V
Storage Temperature Range	-55	125	°C

Note: If the limit parameter is exceeded, the module may be permanently damaged.

2.5 Antenna Interfaces

The default version of the module uses a first-generation IPEX connector for the antenna interface. The F8L10C-02LN and F8L10C-02HN versions use pin 30 as the RF input/output. The module supports two types of RF interfaces: IPEX first-generation connector and 30-pin output.

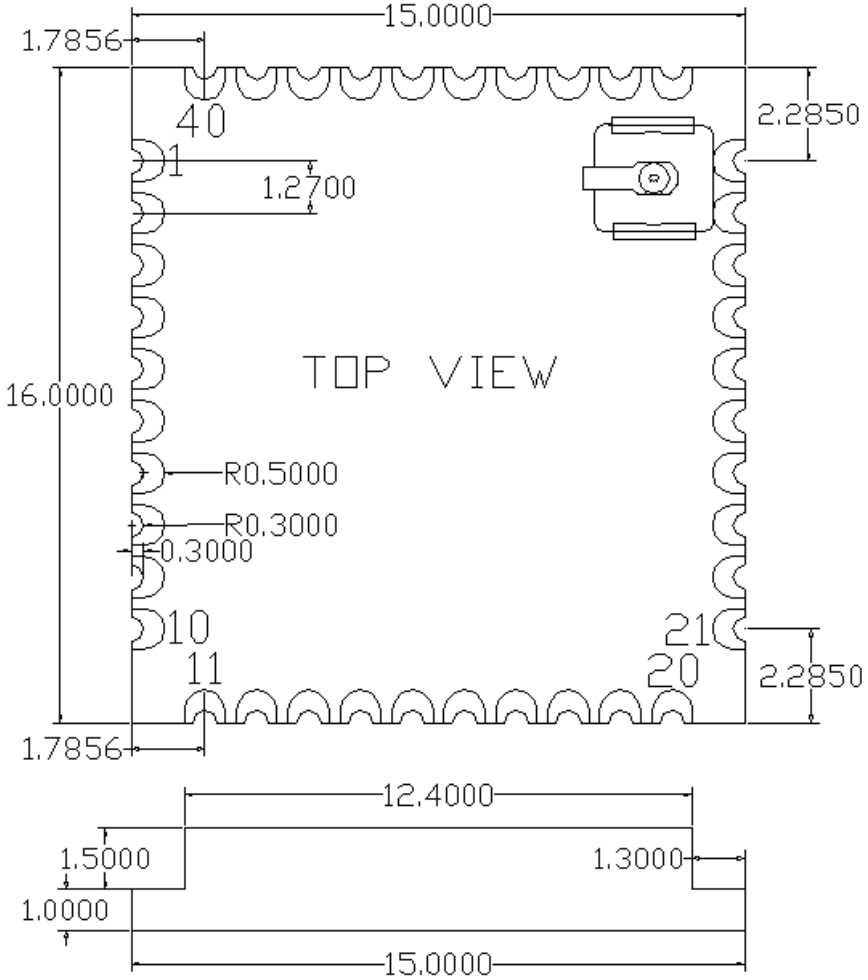
For external antennas, the Voltage Standing Wave Ratio (VSWR) should not exceed 2. Use the shortest possible RF coaxial cable to minimize insertion loss. Antenna placement should avoid large metal surfaces to prevent degradation of radiation performance. When using an internal antenna, the PCB design must reserve sufficient clearance. Antenna design should be carried out by a professional antenna engineer to achieve

optimal radiation performance. Internal antennas must be designed considering the terminal's PCB, enclosure, and installation environment. Different terminals require separately designed antennas and cannot be interchanged.

Peripheral RF circuits and antenna designs must follow 50-ohm system impedance matching guidelines or consult our technical support team for guidance.

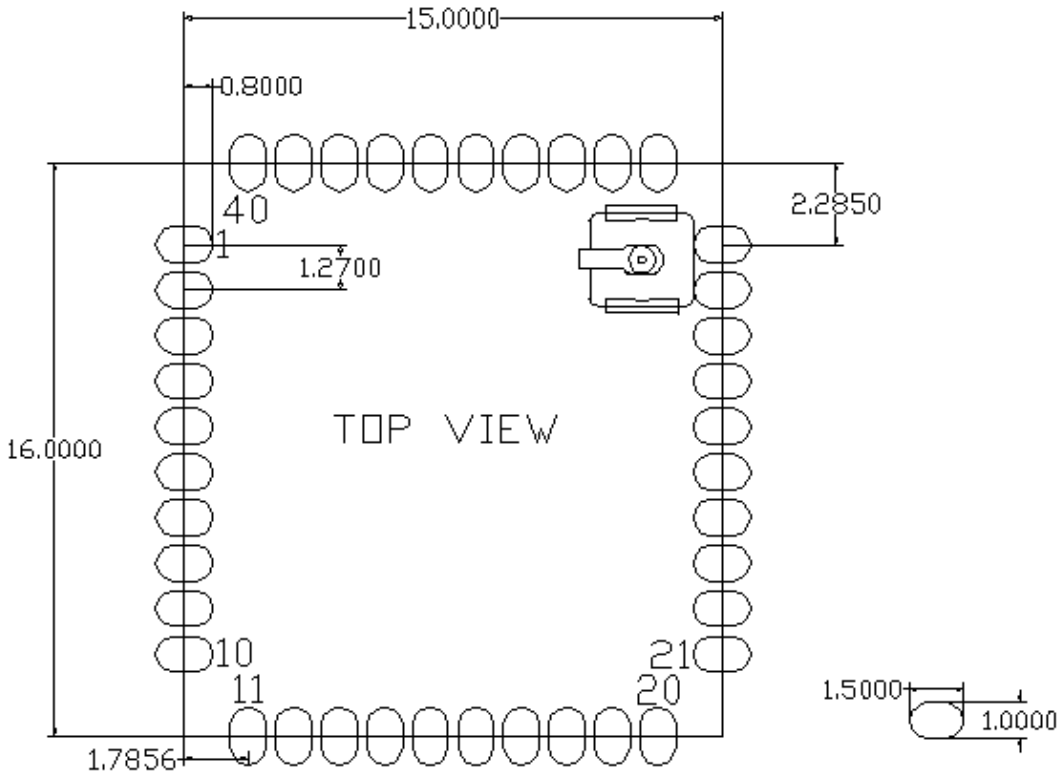
Chapter 3 Module Packaging

3.1 Module Package View



Note: All marked dimensions are in millimeters (mm).

3.2 Recommended Package Design Dimensions



Note: All marked dimensions are in millimeters (mm).

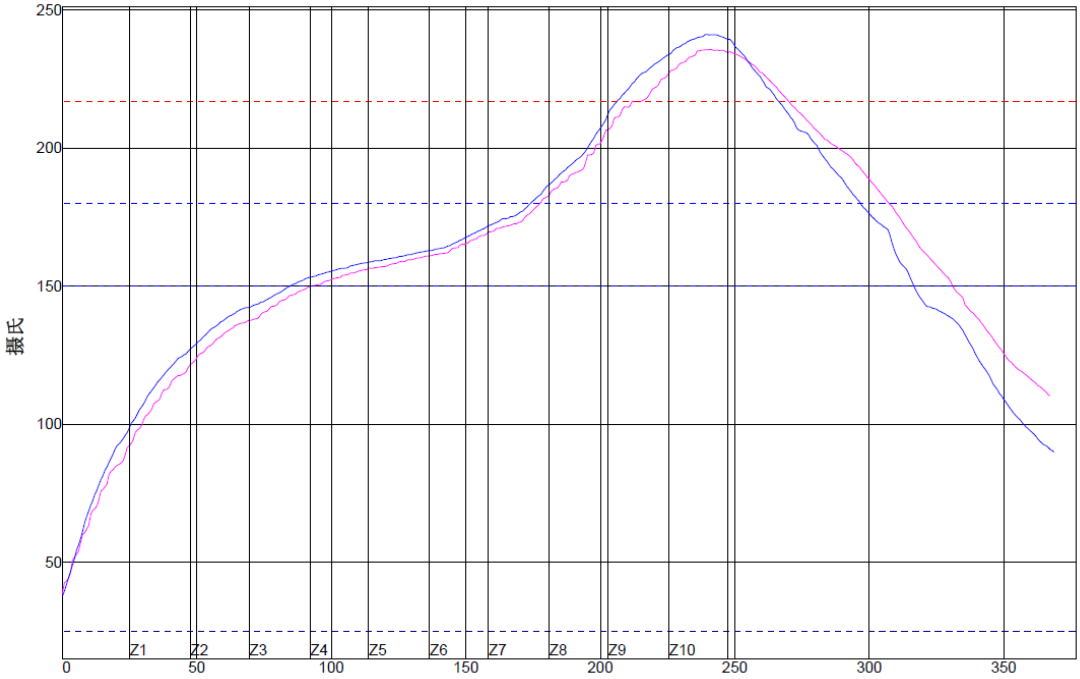
3.3 Reflow Soldering Temperature Profile Range

Recommended to perform soldering in accordance with the IPC/JEDEC J-STD-020B standard.

Soldering Temperature:
When using a temperature-controlled soldering iron, the temperature should not exceed 340°C, and the soldering time for each pin should not exceed 2 seconds.

SMT Temperature Profile:

For SMT reflow soldering, it is recommended to use the following temperature profile:



PWI=94%		Max Ramp-Up Rate		Max Ramp-Down Rate		Preheat (25–150°C)	
Line Color	2	1.96	-4%	-1.28	72%	93.1	23%
Line Color	3	2.05	5%	-1.43	57%	84.4	2%
Difference		0.09		0.15		8.70	

PWI=94%		Soak Time (150–180°C)		Time Above 217°C (Reflow Time)		Peak Temperature		Ramp Rate: 3°C/s (250–200°C)	
Line Color	2	85.4	-15%	55.5	-27%	235.8	-54%	-1.15	94%
Line Color	3	89.4	-2%	60.5	-14%	241.3	-10%	-1.48	81%
Difference		4		4.5		5.5		0.33	

Chapter 4 Module Interfaces Configuration

4.1 UART Communication Mode

4.1.1 Signal Description

The following standard UART signals are used:

- **TX**: Transmit data
- **RX**: Receive data

4.1.2 Hardware Connection

The UART hardware connection is shown in Figure 4-1

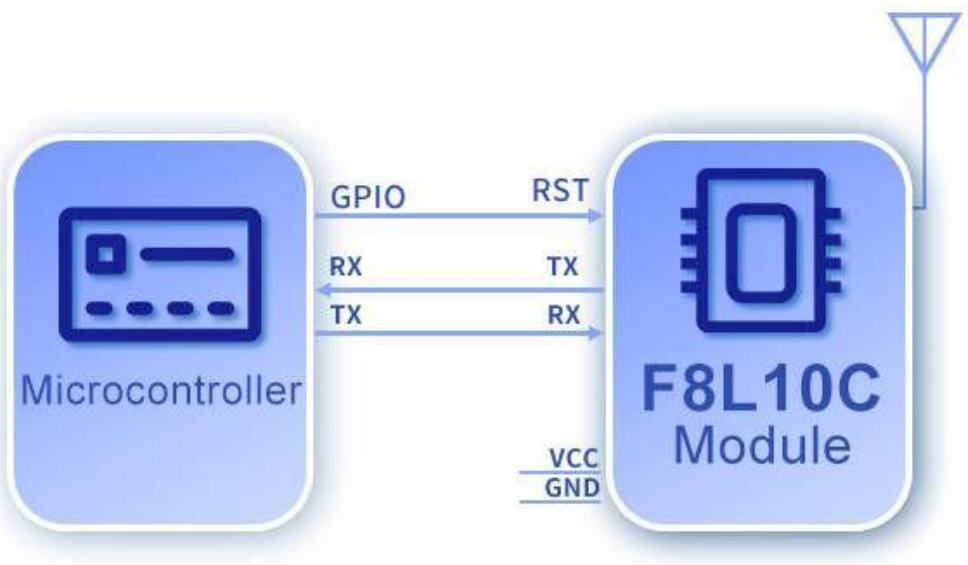


Figure 4-1 UART Interface Connection

Example: As shown in Figure 4-2, a device with a UART interface can be directly connected to the pins of the F8L10C-02 module to form a UART-to-RF communication system.

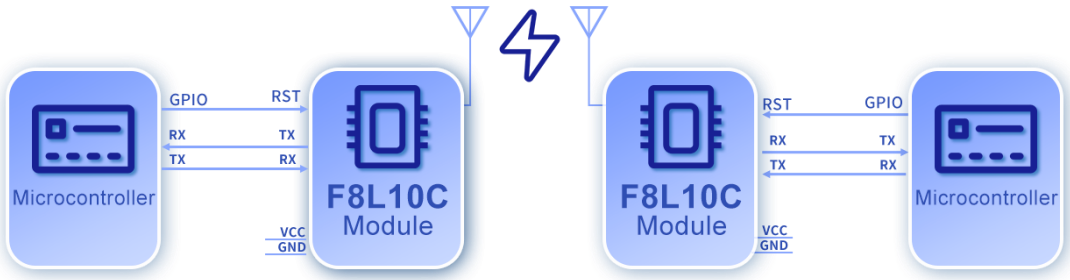


Figure 4-2 Diagram of Communication Between Two Modules

4.1.3 Communication Byte Format

The UART interface communication byte format is shown in Figure 4-3.

	Start	D0	D1	D2	D3	D4	D5	D6	D7	Stop

Figure 4-3 UART Interface Communication Byte Format

1. **Communication Interface:** UART
2. **Baud Rate:** 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
3. **Start Bit:** 1 bit
4. **Data Bits:** 8 bits
5. **Stop Bits:** 1 or 2 bits
6. **Parity:** None / Odd / Even

UART uses asynchronous transmission and reception, allowing simultaneous sending and receiving, enabling full-duplex communication. Data transmission can be initiated either by an external device or by the module itself.

As shown in Figure 4-3, each data byte consists of one start bit (low level), 8 data bits, and one stop bit (high level).

Example: As shown in Figure 4-4, the diagram illustrates UART transmitting the byte 0x1F (decimal 31) in 8-N-1 mode (8 data bits, no parity, 1 stop bit).

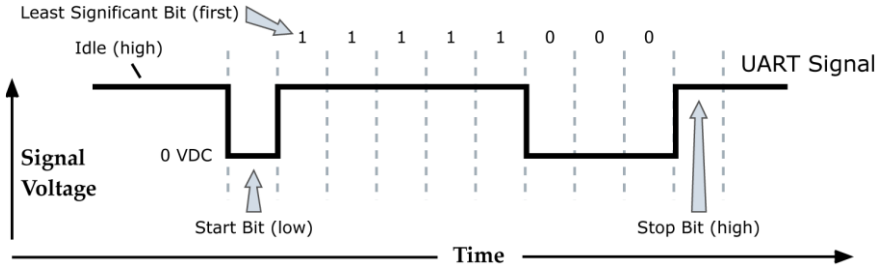


Figure 4-4 Data Transmission Diagram for 0x1F

Chapter 5 Parameters Configuration

5.1 Configuration Connection

Before configuring the F8L10C-02 series module, it is necessary to connect the module to a host device. The host can be a PC or other devices with a UART interface, as shown in Figure 4-1. For connection to a PC, a dedicated development board for the LoRa module provided by our company can be used (the F8L10C-02 needs to be mounted on an adapter board). The connection diagram is shown in Figure 5-1:

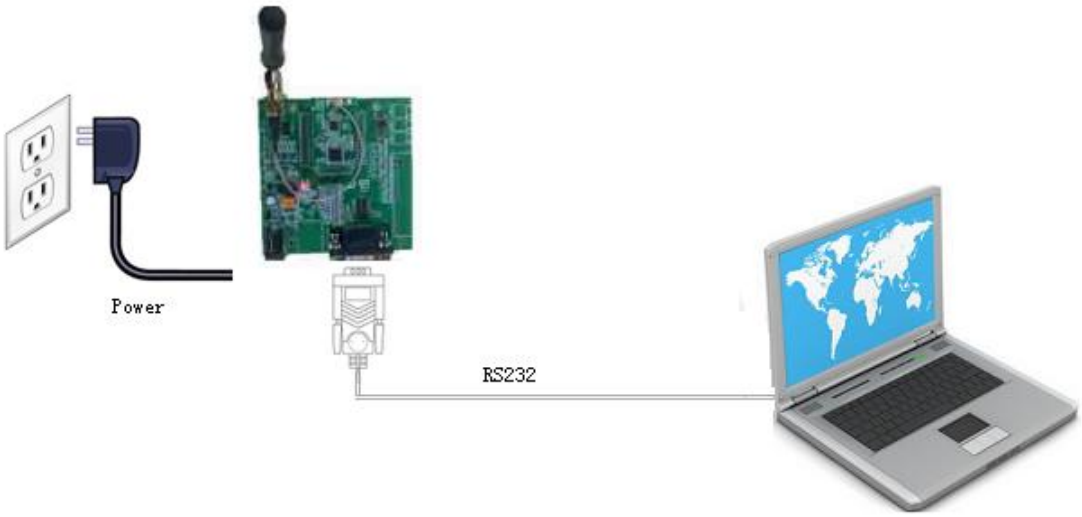


Figure 5-1 Configuration Connection between F8L10C-02 and PC

5.2 Parameter Configuration Method Introduction

The F8L10C-02 series modules support two configuration methods:

1. **Configuration via the latest Four-Faith LoRa configuration software (LoRaConfig):**
   All parameters can be configured through the corresponding options in the software interface. This method is suitable when users can conveniently use a PC for configuration.
2. **Configuration via extended AT commands (hereinafter referred to as AT commands):**
   With this method, users only need a serial communication program to configure all parameters of the F8L10C-02 module, such as HyperTerminal on Windows, or minicom and PuTTY on Linux. Alternatively, users can directly configure the module via their own MCU system. Before using extended AT commands, the module must be set to configuration mode.

For AT command configuration, please refer to the AT Command Manual.
Configuration via the software is shown in Figure 5-2.

Figure 5-2 Configuration Interface

In the toolbar, select **"Options"** and then the submenu **"Serial Port Settings"** to display the parameters of the currently opened serial port. Please select the correct settings in this section and open the serial port. If the button on the right side of the serial port settings shows **"Close Port"**, it indicates that the port is already open; otherwise, please open the port.

After powering on the device, click **"Load Parameters"** in the configuration software. The module will automatically load the current configuration parameters from the device according to the software version and display them in the parameter area. You can then begin configuring all parameters of the F8L10C-02, as shown in Figure 5-2.

5.3 Parameter Description

The following sections mainly describe the configuration items of the F8L10C-02 module using the AT command configuration method.

5.3.1 LoRa Network Parameter

5.3.1.1 Network ID

The Network ID is used to distinguish different LoRa networks. Only devices operating on the same channel and using the same Network ID can communicate with each other.

5.3.1.2 Device Type

A node with Device Type 1 (repeater) has relay functionality and requires continuous power supply.

A node with Device Type 2 (terminal) has no relay function and can enter sleep mode.

5.3.1.3 Device ID

Sets the module ID, with a configurable range of 0–65527.

5.3.1.4 Relay Address (Unused)

Note: The F8L10C-02 supports the MESH protocol, and this parameter is not used. To enable relay functionality, simply configure the device type of the relay node as a repeater.

5.3.1.5 Transparent Transmission Address

In transparent transmission mode, serial data can be directly sent to the device with this address. Configurable range: 0–65535.

5.3.1.6 Carrier Frequency

This is the operating frequency for data transmission. Different hardware modules support different frequency bands, generally divided into low-frequency bands (below 525 MHz) and high-frequency bands (above 525 MHz).

Typical frequency ranges include 410–510 MHz and 863–928 MHz, with 1000 kHz per channel. Different regions have different frequency regulations and interference levels, which may affect the bit error rate. Therefore, this value should be adjusted based on actual conditions.

The default value is 433 MHz for low-frequency modules and 868 MHz for high-frequency modules.

5.3.1.7 Transmit Power

The maximum transmit power is 22 dBm. The factory default setting is 20 dBm.

5.3.1.8 Air Data Rate

This defines the data rate over the air, with 8 selectable levels (SF5–SF12). Higher levels correspond to higher data rates, but shorter transmission distances under the same conditions. Therefore, this parameter should be adjusted according to the application environment.

Note: Once the data rate is set, all devices must use the same rate; otherwise, communication will not be possible.
Default value: Level 3. Coding rate: CR 4/5.

Rate Level	Air Data Rate (kbps)	Spreading Factor (SF)	Bandwidth (kHz)
1	0.3	SF12	125
	0.6	SF12	250
	1.2	SF12	500
2	0.6	SF11	125
	1.1	SF11	250
	2.1	SF11	500
3	1.0	SF10	125
	2.0	SF10	250
	3.9	SF10	500
4	1.8	SF9	125
	3.5	SF9	250
	7.0	SF9	500
5	3.1	SF8	125
	6.3	SF8	250
	12.5	SF8	500
6	5.5	SF7	125
	10.9	SF7	250
	21.9	SF7	500
7	9.4	SF6	125
	18.8	SF6	250
	37.5	SF6	500
8	15.6	SF5	125
	31.3	SF5	250
	62.5	SF5	500

5.3.2 System Parameter

5.3.2.1 Serial Port Operating Mode

The module's serial port operating modes include "TRNS", "AT", "API", and "MODBUS". Where:

"TRNS": Transparent transmission mode. In this mode, a transparent destination address must be configured.

"AT": AT command mode. Refer to the AT Command Manual for operation. Typically used for parameter configuration and manual testing.

"API": API operation mode. Refer to the API Command Manual for command formats. The maximum API payload length is 75 bytes.

"MODBUS": MODBUS operation mode. Refer to the MODBUS Command Manual for command formats.

Default value: TRNS

5.3.2.2 Debug Level

The debug level controls the module's log output and includes three levels:

0: No log output

1: Outputs key log information

2: Outputs detailed log information

Default value: 1

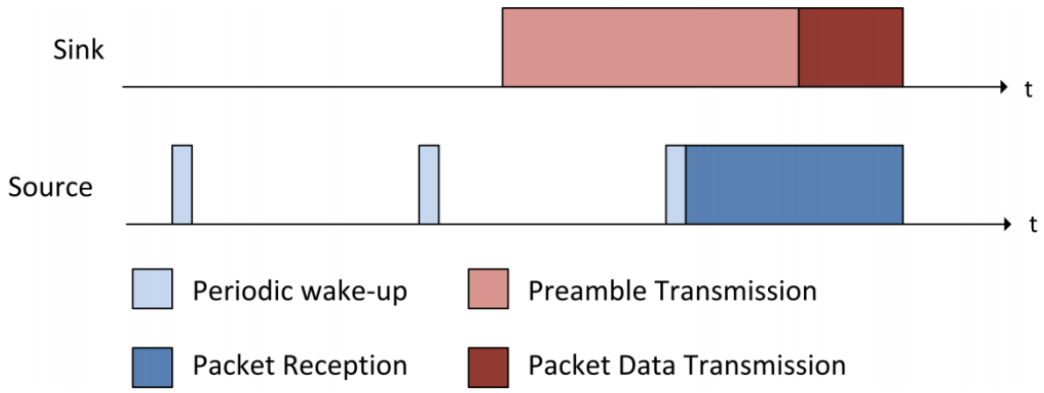
5.3.2.3 Sleep Mode

When the device operates in low-power mode, it can be set to NONE (no sleep), TIME

(timed sleep), or DEEP (deep sleep).
In deep sleep mode, the module can only be awakened by resetting via the RST pin or by setting the sleep control pin to a high level.
Default value: NONE

5.3.2.4 Wake-up over the Air

In wireless network applications, there is a low-power operating mode known as wake-up over the air. Even when a node is in sleep mode, it can be remotely awakened via wireless signals to receive data.
The basic principle is that the initiating device adds a long preamble before the valid data. The receiving node periodically wakes up to listen to the network. Once the preamble is detected, it enters the normal receiving process; otherwise, it immediately returns to sleep and waits for the next wake-up cycle.



If wake-up over the air needs to be enabled, configuration should be performed separately for the **wake-up transmitter** and the **sleeping receiver**.

For the **sleeping receiver** in wake-up over the air mode, the following parameters need to be configured:

- **Wake-up Time**: The duration (in ms) that the device remains awake after receiving wireless data. After receiving over-the-air data and completing serial data transmission, the device stays awake for this period before entering sleep mode.
- **Sleep Time**: The sleep cycle duration (in seconds). When the sleep period expires, the device wakes up to listen for the preamble.

For the **wake-up transmitter**, the **preamble time** must be configured. This value must match the sleep time of the receiver; otherwise, communication may fail.

5.3.3 Serial Port Parameter

The serial communication parameters can be configured, including baud rate, data bits, parity, and stop bits.

Default values: Baud rate 115200, format 8N1.

Chapter 6 Reference Circuits

The F8L10C-02 series modules are SMT-compatible RF modules. When designing the circuit board, the module should be treated as a single component unit. Therefore, the following considerations should be taken into account for PCB layout and routing:

PCB Layout
During PCB layout, under the premise of meeting mechanical structure requirements, the wireless module should be placed away from components that may generate electromagnetic interference or heat, such as speakers, buzzers, switching power supplies, and inductors. In the module placement area, place as many fast-response capacitors as possible near the power interface to prevent instantaneous power surges from damaging the module.

PCB Routing
Data lines should preferably run in parallel on the same layer and be kept as equal in length as possible. Routing should be avoided within the module area, and the integrity of the ground copper plane should be maintained as much as possible.

6.1 Power Supply Reference Circuit

Power supply design is critical for the module. The F8L10C-02 can be powered by an LDO with low quiescent current and an output current capability greater than 0.5A. During data transmission, the power supply must remain within the normal operating range; otherwise, abnormal operation or even permanent damage to the module may occur. Ensure that the power supply is stable and that the voltage does not fluctuate significantly.

To prevent excessive voltage drop on VBAT, it is recommended to place a low-ESR (ESR = 0.7Ω) capacitor of at least 100 μF in parallel near the VBAT input pin of the module, along with filtering capacitors of 100 nF, 33 pF (0603 package), and 10 pF (0603 package). The reference circuit for the VBAT input is shown in the figure below.

Additionally, the PCB trace for VBAT should be as short and wide as possible to reduce equivalent impedance, ensuring that no significant voltage drop occurs under high current at maximum transmit power. It is recommended that the VBAT trace width be no less than 2 mm, and the longer the trace, the wider it should be.

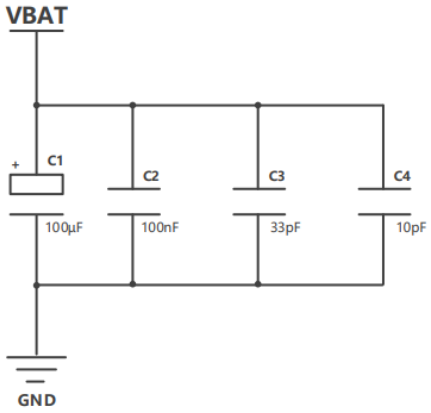


Figure 6-1 VBAT Input Reference Circuit of F8L10C-02

6.2 Serial Communication Reference Circuit

The following describes two types of host systems:

1. **PC as Host:**
   The F8L10C-02 connects to a PC via an RS232 serial port, requiring an RS232 transceiver (e.g., SP3243), as shown in Figure 6-2.

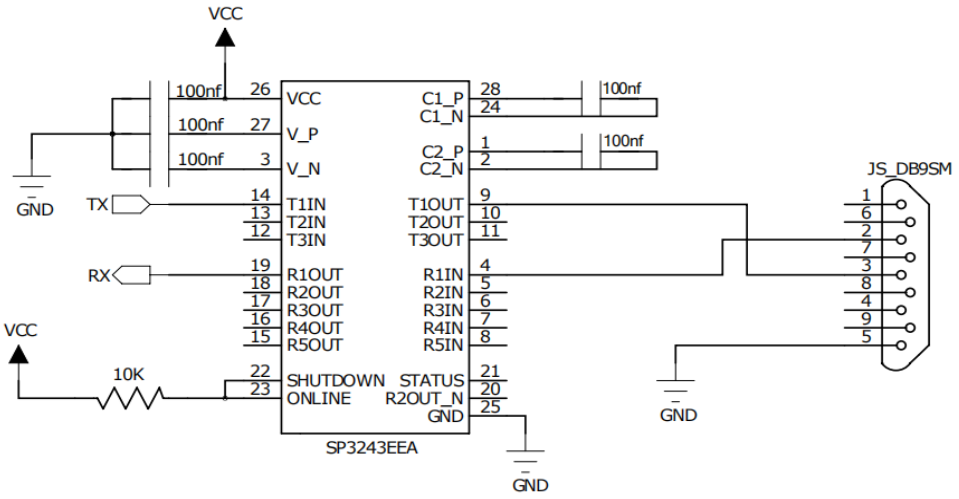


Figure 6-2 Reference Circuit for F8L10C-02 to PC RS232 Connection

2. **Industrial PC as Host:**
   The F8L10C-02 connects to an industrial PC via an RS485 bus, requiring an RS485 transceiver (e.g., SP3485), as shown in Figure 6-3.

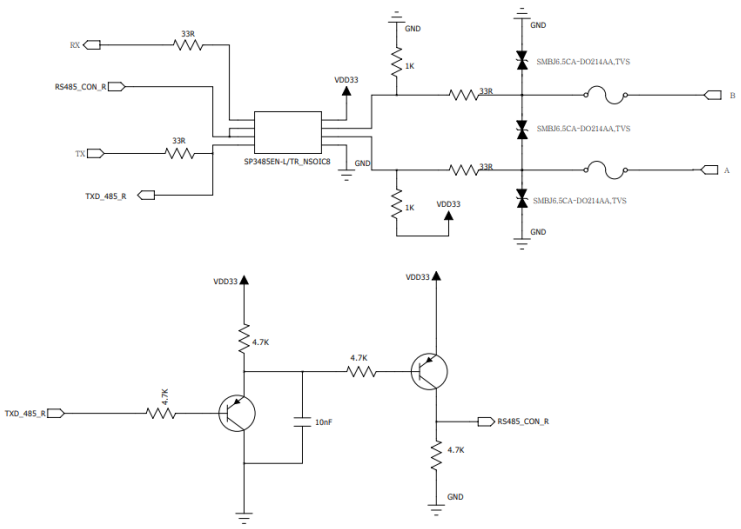


Figure 6-3 Reference Circuit for F8L10C-02 to Industrial PC RS485 Connection

3. **MCU as Host:**
   If the MCU power supply differs from that of the module, a level-shifting circuit is required. As shown in Figures 6-4 and 6-5, a transistor can be used for level conversion. The resistors shown are for reference only and should be recalculated during design. The diode in the diagram is a Schottky diode (forward voltage drop of 0.3V). If another diode is used, select one with a low forward voltage drop to ensure that the RXD_module input remains below the low-level threshold when receiving a low signal.

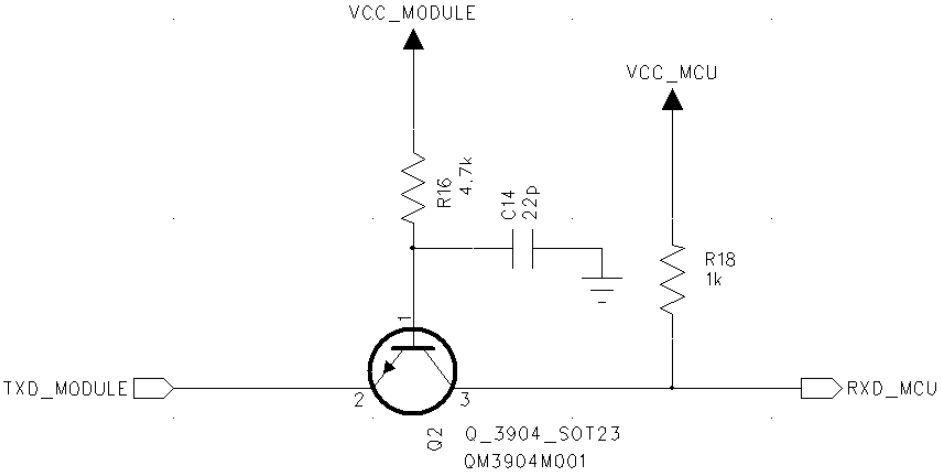


Figure 6-4 UART Interface RX Level-Shifting Reference Design

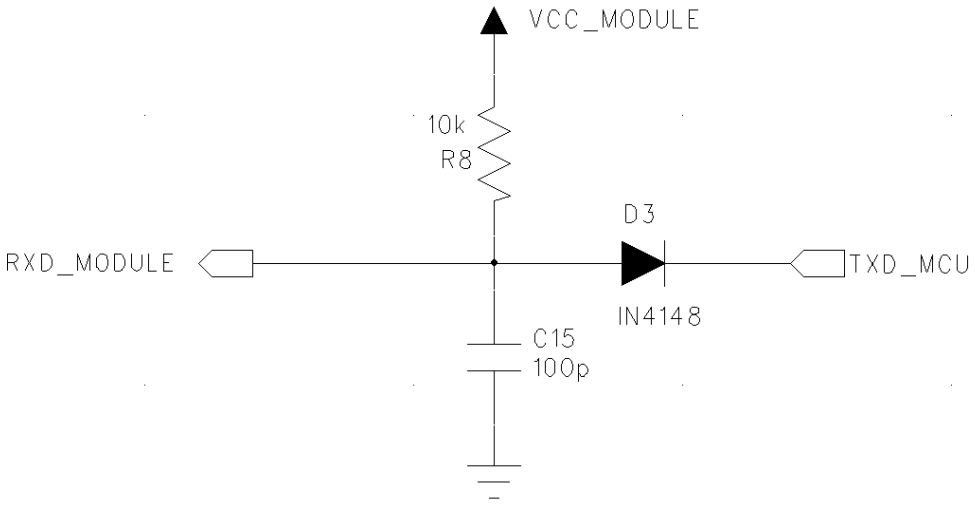


Figure 6-5 UART Interface RX Level-Shifting Reference Design

As shown in Figure 6-6, a dedicated level-shifting IC can also be used for voltage conversion. Various options are available, and users can select according to their needs.

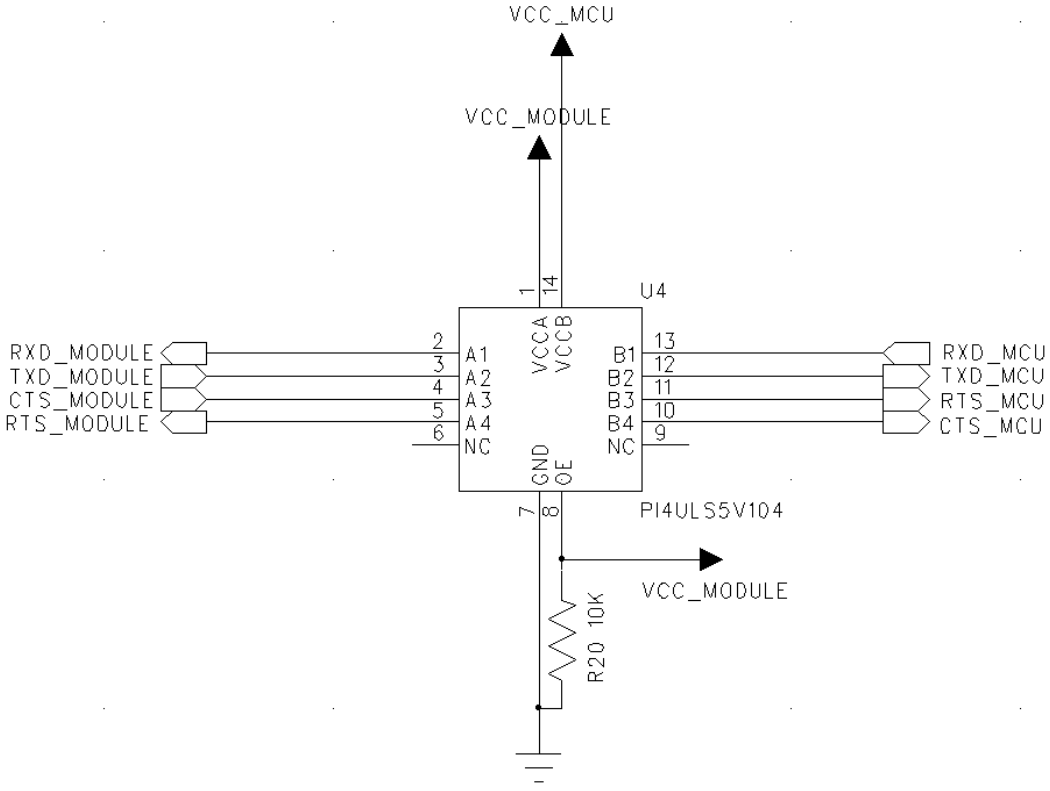


Figure 6-6 UART Interface Level-Shifting IC Reference Design

6.3 I/O Input and Output Control Design

The module's I/O pins can be used to control LED indicators. Since the output current of standard I/O pins is relatively low, it is recommended to use a transistor for control, as shown below:

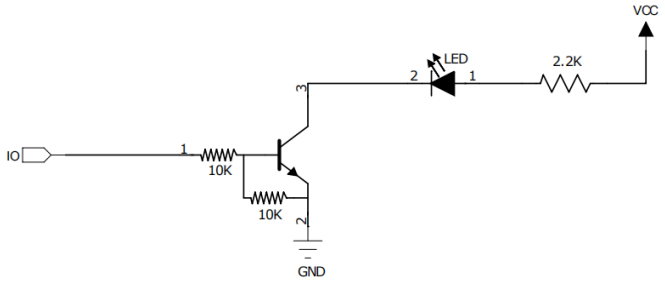


Figure 6-7 LED Control Circuit

6.4 I/O Port Protection Circuit

The module's I/O pins have default ESD protection levels of HBM ±2000V and CDM ±800V. If higher ESD protection is required, users can add external protection circuits to improve immunity, as shown below:

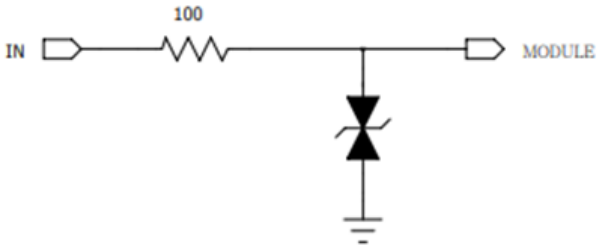


Figure 6-10 I/O Port Protection Circuit

6.5 Reset Circuit

The F8L10C-02 starts automatically upon power-up and does not have dedicated power-on or power-off pins. However, it provides a hardware reset pin (digital input, active low). The reset pulse width must be greater than 200 ms, and the valid low-level voltage must not exceed 0.4V.

Due to complex operating environments and long working durations, issues such as system hangs or false connections may occur. Proper recovery mechanisms should be considered in the application design:

1. **Manual Reset:**
   Use a push button to pull the reset pin to ground when pressed and disconnect it when released.
2. **MCU-Controlled Reset:**
   Use an MCU to control a transistor to pull the RESET pin low for hardware reset, as shown below:

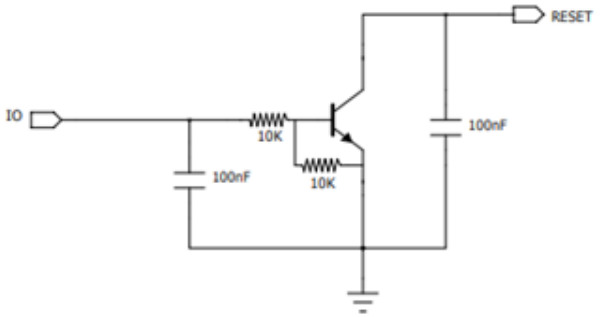


Figure 6-11 MCU-Controlled Transistor Reset Reference Circuit