User Manual

ClairPLC

Power Line Communication Extender

for Signal Control

Version: 1.0

TraffiClair Technology Co., Ltd.

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1. Introduction

1.1 Overview

With the acceleration of urbanization, urban traffic faces increasingly significant challenges. As the number of automobiles continues to grow rapidly, many urban roads cannot meet the high traffic demands. How to enhance the precision of traffic signal control management and ensure the operational health of signal control systems has become a pressing issue for urban traffic management departments.

By integrating power IoT (Internet of Things) technology into the traffic signal control field and fully combining power line carrier technology with signal control technology, the ClairPLC equipment has emerged in this context. It addresses the problems of signal light failures caused by aging, severe damage, or irreparable cable faults within signal control systems. Additionally, it improves the accuracy of signal controllers in sensing signal light fault conditions and enhances the management precision of signal control system health. Moreover, it solves issues related to expanding the signal control systems at outdated urban intersections.

1.2 Product Composition

The ClairPLC equipment consists primarily of the **ClairPLC-Master Device** (referred to as "Master") and the **ClairPLC-Slave Device** (referred to as "Slave"), which are deployed uniformly at intersections. Each intersection requires one Master installed inside the signal cabinet, while the number of Slaves is determined by the number of signal light groups. One Slave is installed for each signal light group.

1. **ClairPLC-Master Device**: The Master collects the signal light control signals from the corresponding output terminals of the signal controller, as well as 422 signals, 485 signals, and TCP/IP protocol data. It encodes the collected signals and transmits them

to the ClairPLC-Slave Device via power lines.

2. **ClairPLC-Slave Device**: The Slave decodes the power line carrier signals sent by the Master and processes the corresponding instructions for signal light control or 422, 485, and TCP/IP protocol data required by the device.

1.3 Preparations for On-Site Installation

1.3.1. Basic Materials

1. **1m Ethernet Cable**: Used to connect the Master device to the signal controller or switch, facilitating network communication.
2. **4×1.0mm² 0.3m Jumper Cable**: Used to connect the Slave device to the terminal signal light. The number of cables required equals the number of signal light groups (0.3m per light group).
3. **3×1.0mm² 0.5m Jumper Cable**: Used to connect the Master device to the signal controller. The number of cables required equals the number of signal light groups (0.5m per light group).
4. **Plastic Zip Ties**: Used for securing Slave devices, wiring harnesses, etc.

1.3.2. Additional Items (as needed):

1. **Armored Standard Cables (National Standard)**: The length depends on local standards, the size of the intersection, and the number of signal lights. Generally, 500m is sufficient. These cables connect the signal lights to the signal controller (only two cores are needed, and a daisy-chain wiring method is recommended to save cables and pipeline space).
2. **Power Strip**: Used to expand the power connections for devices.
3. **Cable Pulling Tool**: Assists in pulling cables through pipelines.

2. Device Overview

2.1 Introduction to the ClairPLC-Master

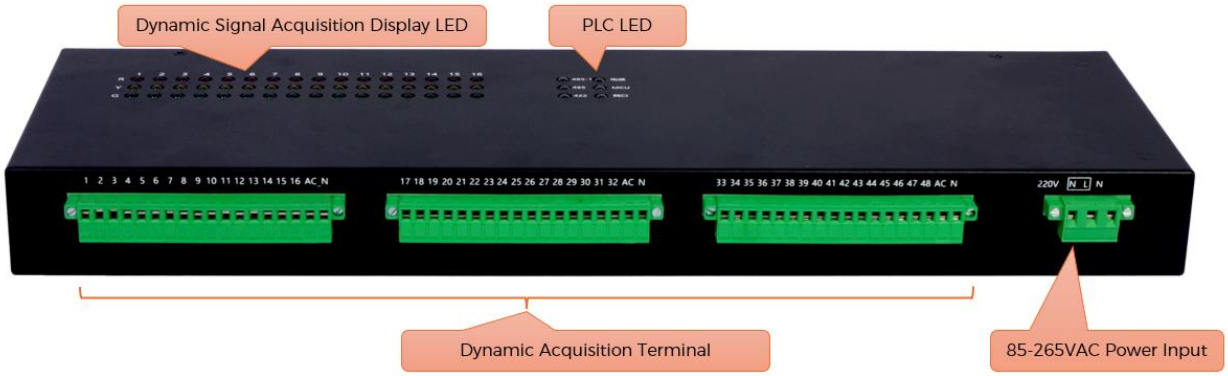


Figure 2.1.1: ClairPLC-Master, Illustration 1



Figure 2.1.2: ClairPLC-Master, Illustration 2

1. 85-265VAC Power Interface
2. Power Connection:
    - L connects to the live wire.
    - N connects to the neutral wire.
    - The ground wire is ideally connected to the casing but can be left unconnected.

3. Signal Light Status Collection Terminals:
    - Connected to the signal controller's output terminals via jumpers.
    - Follow the wiring sequence of the signal controller:
        - Channels 1-16 form one group.
        - Channels 17-32 form another group.
        - Channels 33-48 form another group.
    - Each group has a neutral line interface, which must be individually connected to the signal controller's neutral line to ensure accurate signal input.
    - Each group of three terminals corresponds to one signal light group (red, yellow, green), which are mapped to the corresponding light colors on the Master Device panel.
4. Dynamic Signal Display LED:
    - Each set of red, yellow, and green LED represents the status of one group of signal lights at the intersection.
    - A maximum of 16 red-yellow-green signal groups can be connected.
5. Status Indicator LED:
    - **Power Indicator LED**: Lights up when the switch is turned on; off indicates no power supply.
    - **MCU LED**: Blinking indicates the control unit is functioning normally; off or solid indicates a fault requiring a restart or replacement.
    - **Network Port LED**: Blinking indicates RJ45 data transmission is in progress and the connection is normal.
    - **422 LED**: Blinking indicates 422 data is being transmitted, and the connection is normal.
    - **485 LED**: Blinking indicates data is being transmitted via the 485 A and B ports, and the connection is normal.
    - **485-1 LED**: Blinking indicates data is being transmitted via the 485 A1 and B1

ports, and the connection is normal.

6. Network Port:
    - Directly connects to signal controllers, green wave display boards, radars, and other devices for network signal transmission.
7. RS485:
    - Two sets of interfaces; A and B must connect to the positive and negative ports of other 485 devices.
    - Avoid reversed wiring, which would prevent signal transmission and reception.
    - When connecting to a USB serial converter, connect pin 1 to A and pin 2 to B.
8. RS422:
    - When connecting to 422 devices, connect R+ to R+, R- to R-, T+ to T+, and T- to T-.
    - When connecting to a USB serial converter, connect pin 1 to R+, pin 2 to R-, pin 4 to T+, and pin 5 to T-.

2.2 Introduction to the Functions of the ClairPLC-Slave

The ClairPLC-Slave is available in three models, differentiated by their interfaces: RS422, RJ45, and RS485 versions. The appropriate version is selected based on the interface requirements of connected devices such as green wave display boards and radars. Signal lights can be paired with any version.

2.2.1 ClairPLC-Slave-422



Figure 2.2.1.1: ClairPLC-Slave-422



Figure 2.2.1.2: ClairPLC-Slave-422



Figure 2.2.1.3: ClairPLC-Slave-422

ClairPLC-Slave-422 Traffic Data Transmission Slave Interface Introduction:

1. 85-265VAC Power Supply:
    - The device only operates when connected to an 85-265VAC power supply. If other signal lights require power, it can be drawn from this port.
2. Status Indicator Lights:
    - **Power LED**: Lights up when powered on; off indicates no power supply.
    - **MCU LED**: Blinks to indicate normal operation of the control unit; off or solid indicates a fault that requires a restart or replacement.
    - **422 LED**: Blinks when 422 data is being transmitted, indicating a normal connection. The 422 LED remains off when only transmitting signal light status.
3. Dynamic Output Terminals:
    - Used to supply power to the four lights of the signal light. R, Y, G, and N are

connected to the red, yellow, green, and neutral terminals of the signal light, respectively.

4. RS422 Interface:
    - Can be connected to devices such as signal lights, green wave display boards, and radars.

2.2.2 ClairPLC-Slave-485



Figure 2.2.1.1: ClairPLC-Slave-485



Figure 2.2.1.2: ClairPLC-Slave-485



Figure 2.2.1.3: ClairPLC-Slave-485

ClairPLC-Slave-485 Traffic Data Transmission Slave Interface Introduction:

1. 85-265VAC Power Supply:
    - The device only operates when connected to an 85-265VAC power supply. If other signal lights require power, it can be drawn from this port.
2. Status Indicator Lights:
    - **Power LED**: Lights up when powered on; off indicates no power supply.
    - **MCU LED**: Blinks to indicate normal operation of the control unit; off or solid indicates a fault that requires a restart or replacement.
    - **485 LED**: Blinks when 485 data is being transmitted, indicating a normal connection. The 485 LED remains off when only transmitting signal light status.
3. Dynamic Output Terminals:
    - Used to supply power to the four lights of the signal light. R, Y, G, and N are connected to the red, yellow, green, and neutral terminals of the signal light, respectively.
4. RS485 Interface:
    - Can be connected to devices such as signal lights, green wave display boards, and radars.

2.2.3 ClairPLC-Slave-Eth



Figure 2.2.3.1: ClairPLC-Slave-Eth



Figure 2.2.3.2: ClairPLC-Slave-Eth



Figure 2.2.3.3: ClairPLC-Slave-Eth

ClairPLC-Slave-Eth Traffic Data Transmission Slave Interface Introduction:

1. 85-265VAC Power Supply:
    - The device only operates when connected to an 85-265VAC power supply. If other signal lights require power, it can be drawn from this port.
2. Status Indicator LED:
    - **Power LED**: Lights up when powered on; off indicates no power supply.
    - **MCU LED**: Blinks to indicate normal operation of the control unit; off or solid indicates a fault that requires a restart or replacement.
    - **RJ-45 LED**: Blinks when network data is being transmitted, indicating a normal connection. The RJ-45 light remains off when only transmitting signal light status.
3. Dynamic Output Terminals:
    - Used to supply power to the four lights of the signal light. R, Y, G, and N are

connected to the red, yellow, green, and neutral terminals of the signal light, respectively.

4. Network Port:
    - Can be connected to devices such as signal lights, green wave display boards, and radars.

2.3 Filter Introduction



Figure 2.3.1: Filter

On the **LINE side**, connect the power supply wire, and on the **LOAD side**, connect the load wire. Connect **L** to the live wire, **G** to the ground wire, and **N** to the neutral wire.
Follow the instructions for proper wiring and use cable ties to secure the filter inside the signal cabinet. Avoid letting the filter's wires bear direct stress, as this can prevent issues such as interference with the main device's frequency band and signal light failure.

Filters are only needed at intersections without isolated power supplies. And the filter is not included as a standard accessory in the delivery package.

3. Wiring Operation Instructions

3.1 Wiring Diagram

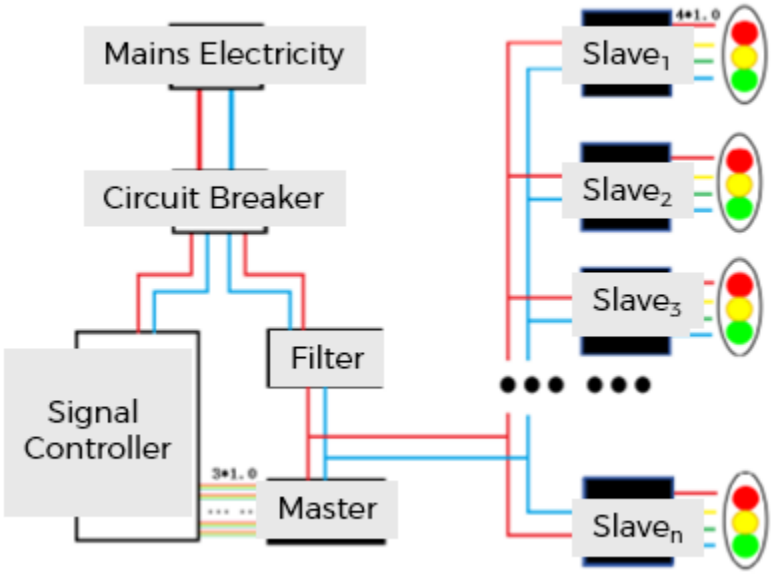


Figure 3.1.1 Wiring Diagram

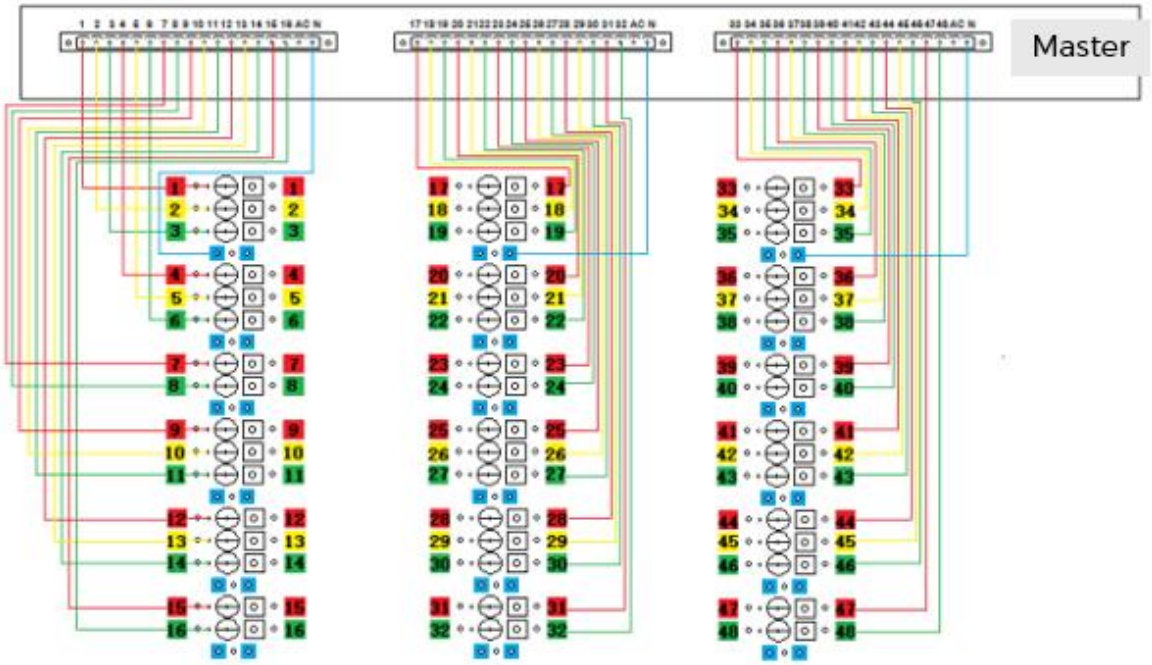


Figure 3.1.2 Phase Plate Host Wiring Diagram 1

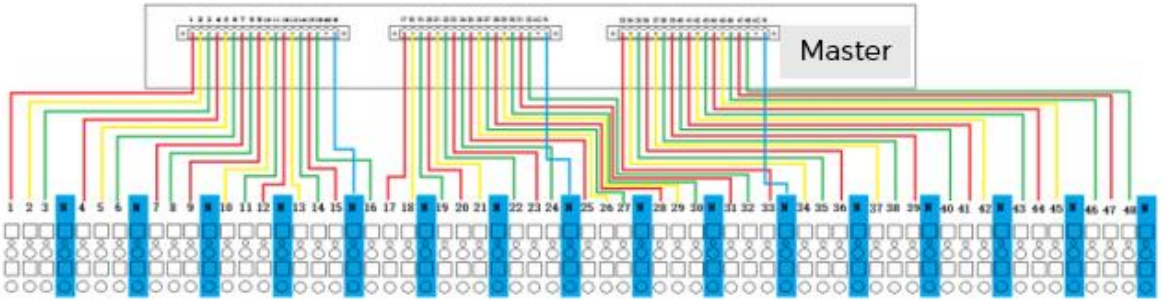


Figure 3.1.3 Phase Plate Host Wiring Diagram 2

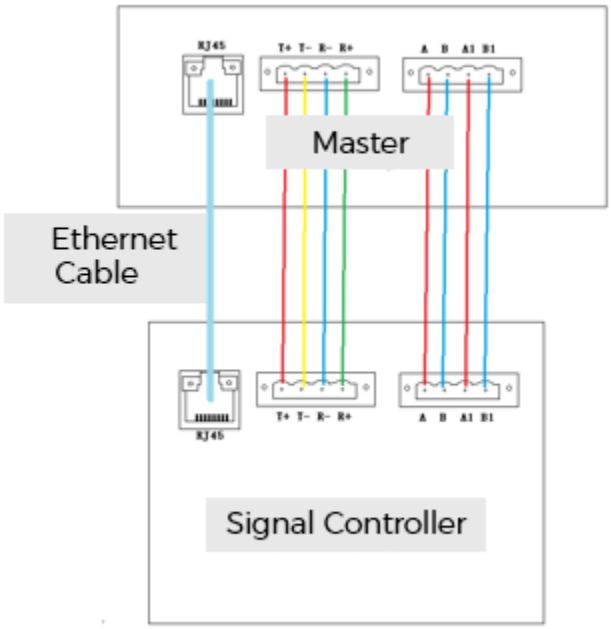


Figure 3.1.4 Master Network Diagram

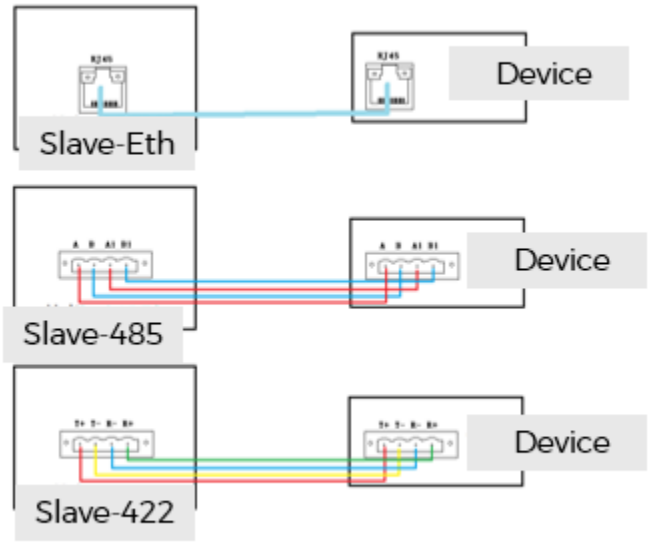


Figure 3.1.5 Slave Network Diagram

3.2 Wiring Instructions

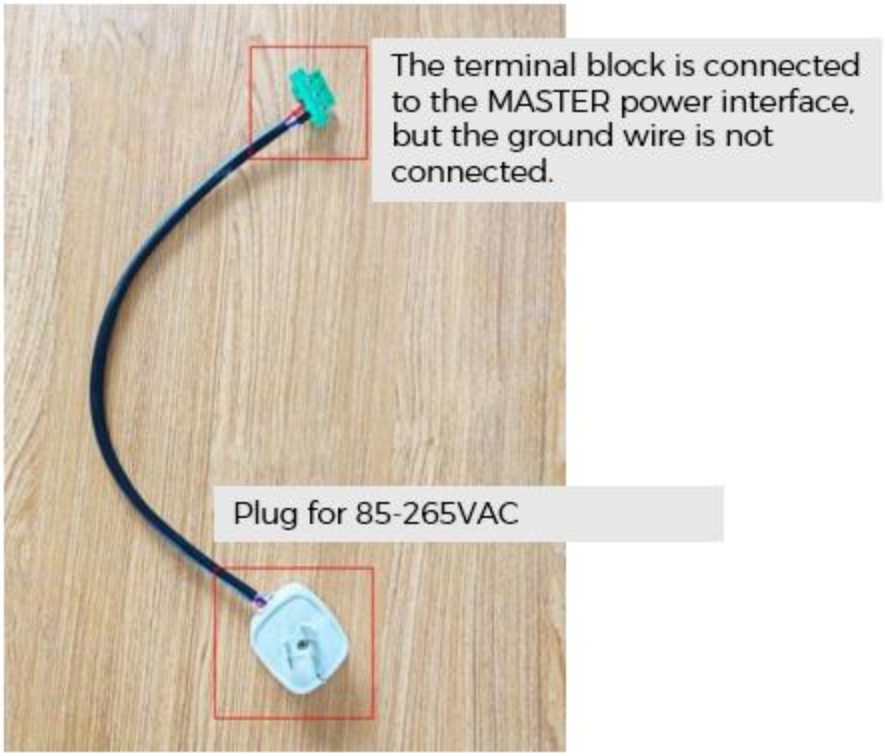


Figure 3.2.1: Master Power Supply Line

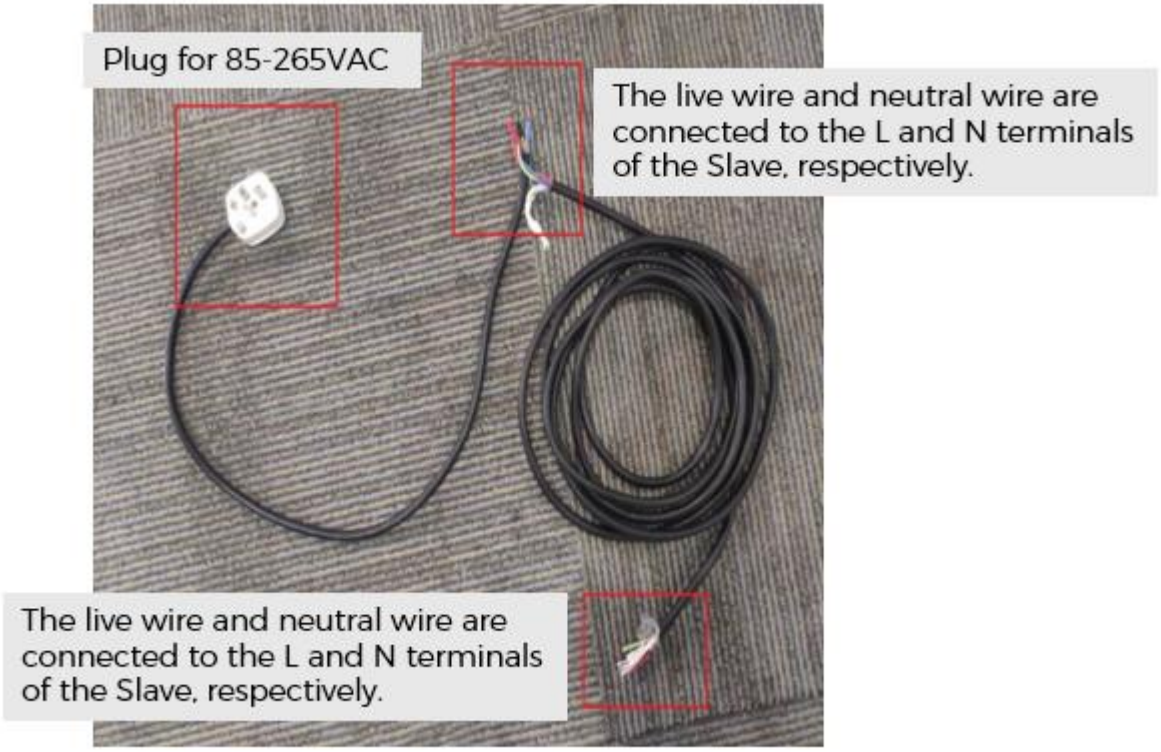


Figure 3.2.2: Slave Power Supply Line

1). Insert the 85-265VAC plug directly into the power outlet.

2). Connect the wiring terminals shown in **Figure 3.2.1** to the corresponding connection ports in **Figure 2.1.1**.

3). Connect the live (L) and neutral (N) wires from **Figure 3.2.2** to the terminal blocks in **Figure 2.2.1.2 / 2.2.2.2 / 2.2.3.2**.

4. Debugging Instructions

4.1 Preparation

4.1.1 Tools:

- **Cross screwdriver**: For tightening or loosening screws.
- **Flathead screwdriver**: For additional adjustments or fine-tuning.
- **Wire stripper**: To remove the insulation from wires.
- **Multimeter**: For checking voltage, current, and continuity.
- **Insulation tape**: For ensuring safe and secure connections.
- **Network cable**: For data transmission between devices.
- **Network cable tester**: To ensure the network cables are functioning properly.
- **Computer**: For configuring and monitoring the system.
- **RS422 Serial Adapter**: As shown in the diagram, for connecting RS422 communication ports.



Figure 4.1.1: Debugging Tools

This USB to RS422 Serial Adapter (debugging tool) is not a standard accessory included in the delivery package.

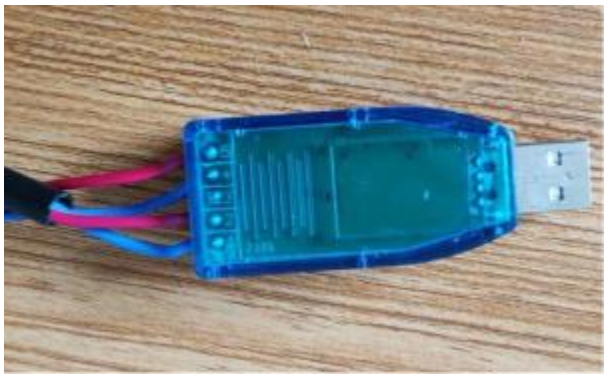


Figure 4.1.2: Debugging Tools Wiring

4.1.2 Software: ClairPLC Maintenance Tool – PowerInside.exe

PowerInside.exe

4.2 Master Configuration

Insert the pluggable terminal block of the RS422 serial adapter into the main control board as follows:

1: Connect to R+

2: Connect to R-

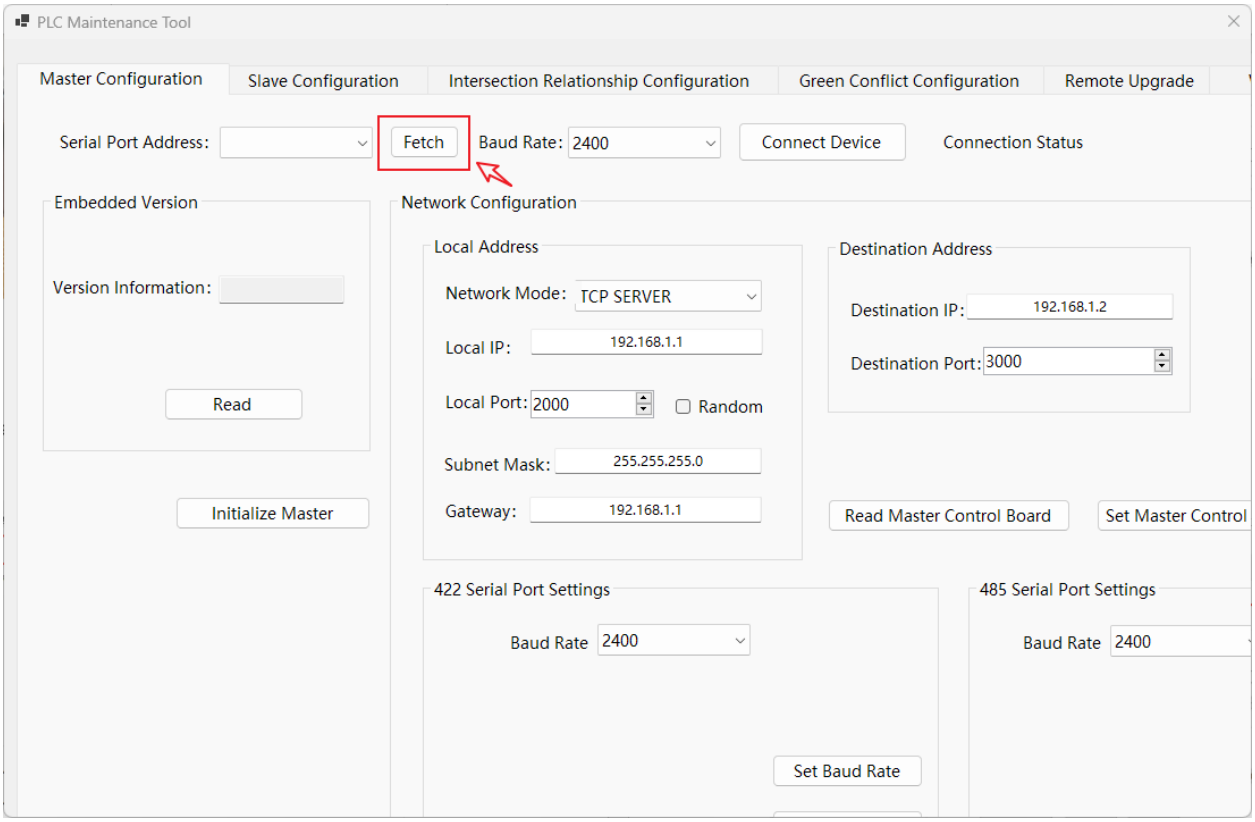
4: Connect to T+

5: Connect to T-

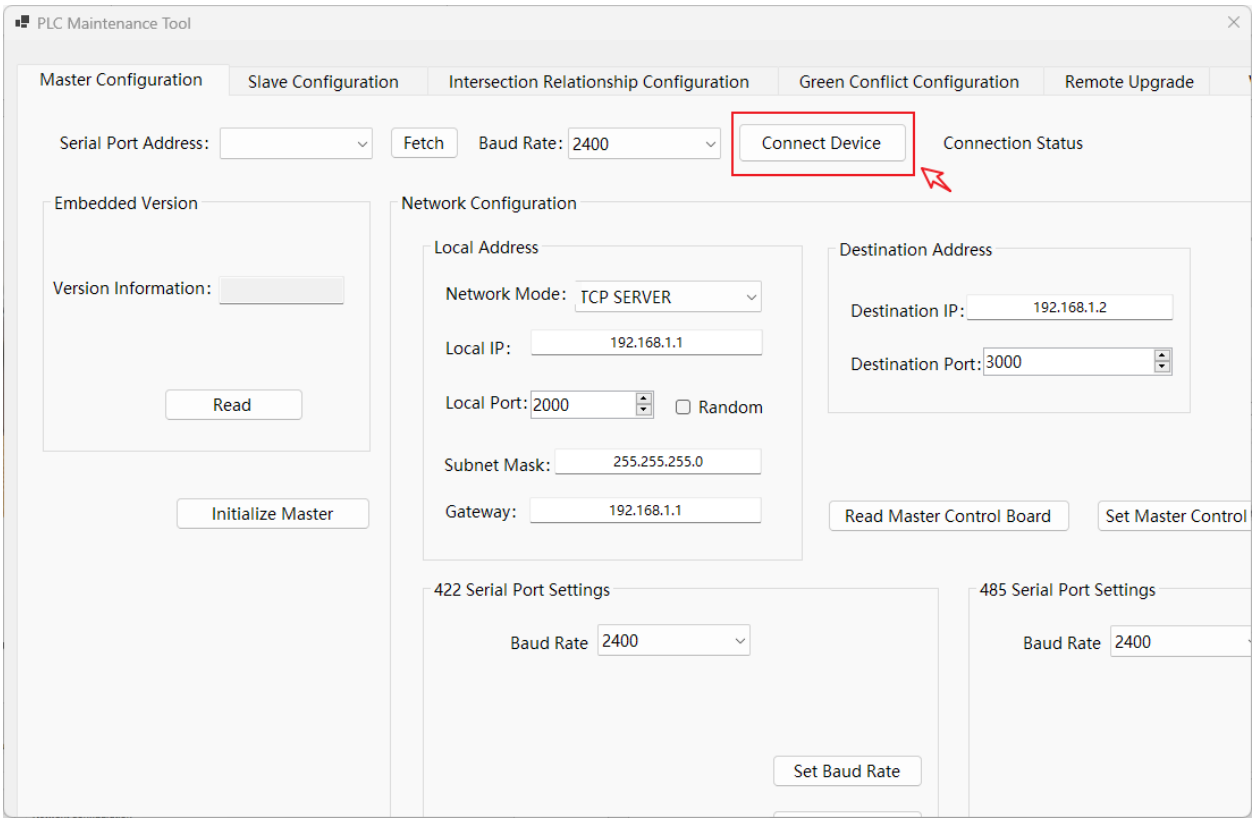


Figure 4.2.1: Master Wiring Ports

(1) Open the ClairPLC maintenance tool PowerInside and click **"Fetch Serial Port Address"**.

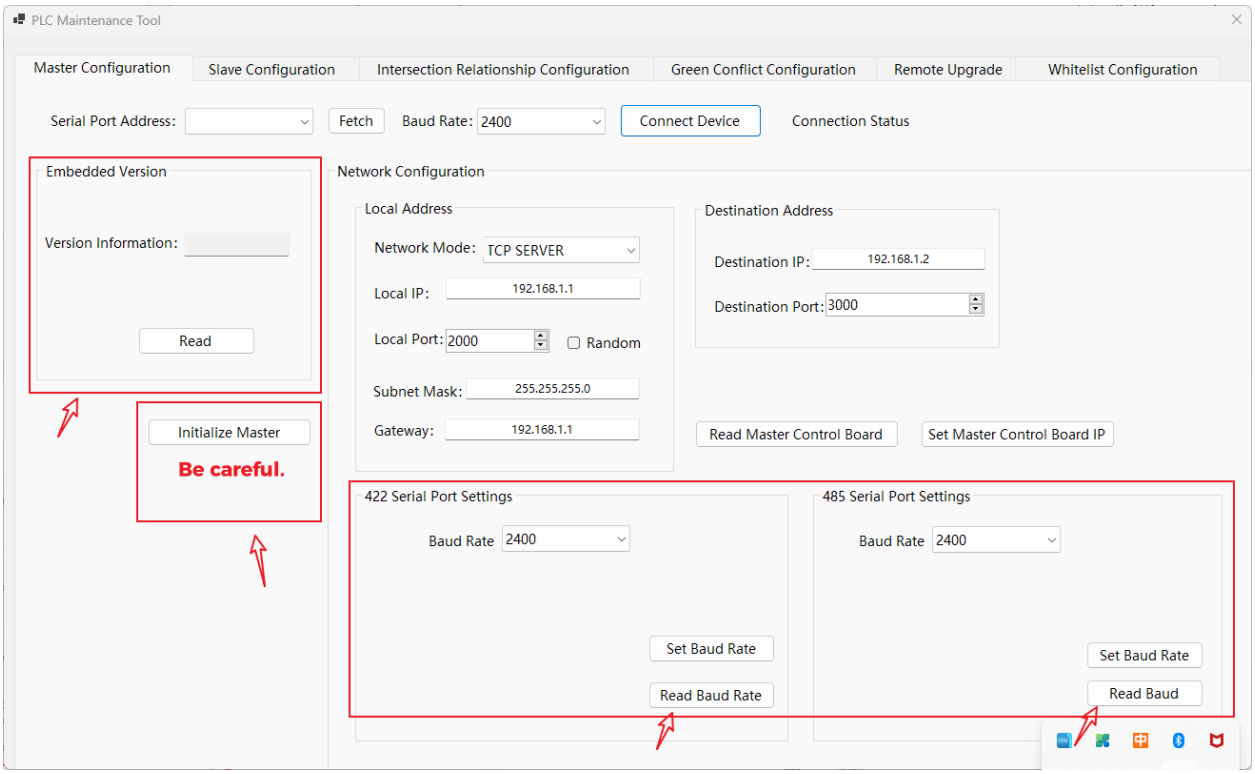


(2) After obtaining the serial port address, click **"Connect Device"**.

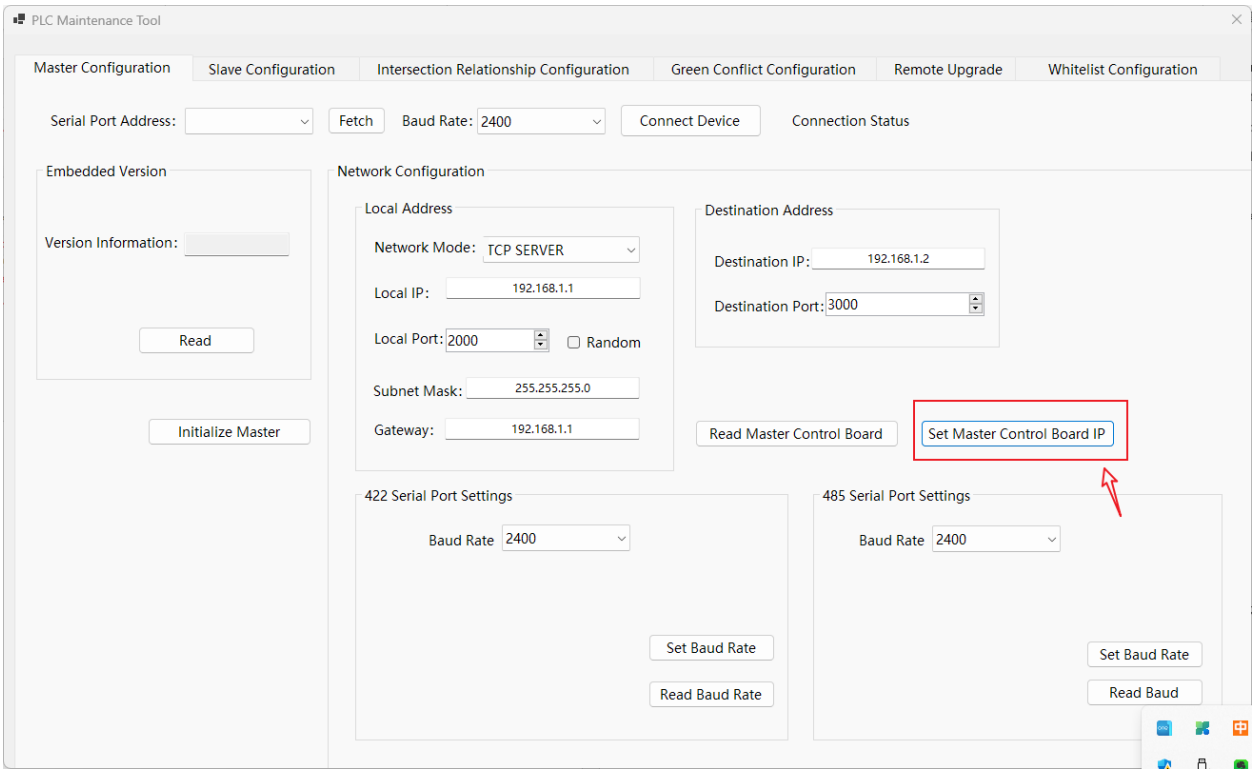


(3) Once connected, it will display "Device Connected Successfully!". If this message does not appear, click **"Disconnect"**, wait for about 5 seconds, and then click **"Connect"** again.

(4) On the left side, you can read the embedded version of the mainboard. Please note that the **"Initialize Master"** option below is for maintenance use only and should not be clicked. The middle and right sides display the main unit network configuration module. Be sure to read the mainboard IP before configuring the IP address. The **422** and **485** settings should be configured according to the baud rate of the traffic signal or other connected devices.

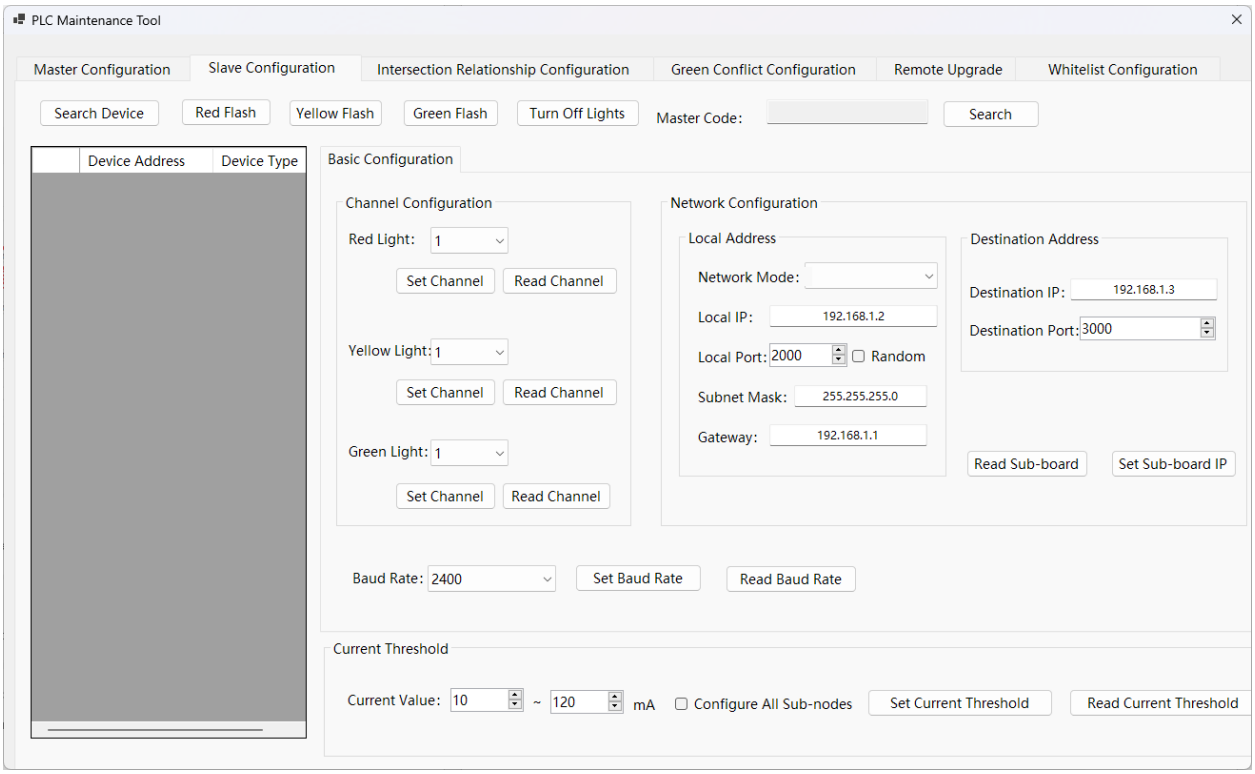

PLC Maintenance Tool
Master Configuration
Slave Configuration
Intersection Relationship Configuration
Green Conflict Configuration
Remote Upgrade
Whitelist Configuration
Serial Port Address:
Fetch
Baud Rate: 2400
Connect Device
Connection Status
Embedded Version
Version Information:
Read
Initialize Master
Be careful.
Network Configuration
Local Address
Network Mode: TCP SERVER
Local IP: 192.168.1.1
Local Port: 2000
Random
Subnet Mask: 255.255.255.0
Gateway: 192.168.1.1
Destination Address
Destination IP: 192.168.1.2
Destination Port: 3000
Read Master Control Board
Set Master Control Board IP
422 Serial Port Settings
Baud Rate 2400
Set Baud Rate
Read Baud Rate
485 Serial Port Settings
Baud Rate 2400
Set Baud Rate
Read Baud

(5) After successfully reading, a success message will pop up, showing the current IP settings and port configurations of the main unit. Change the IP to be in the same IP segment as the traffic signal, set the network mode to **TCP CLIENT**, select **Random Port** for the local port, set the **Destination IP** to the traffic signal's IP, and set the **Destination Port Number** to the traffic signal's port number. After making these changes, click the **"Set Master Control Board IP"** option at the bottom right. After about 2-5 seconds, a **"Set Successfully"** popup will appear.

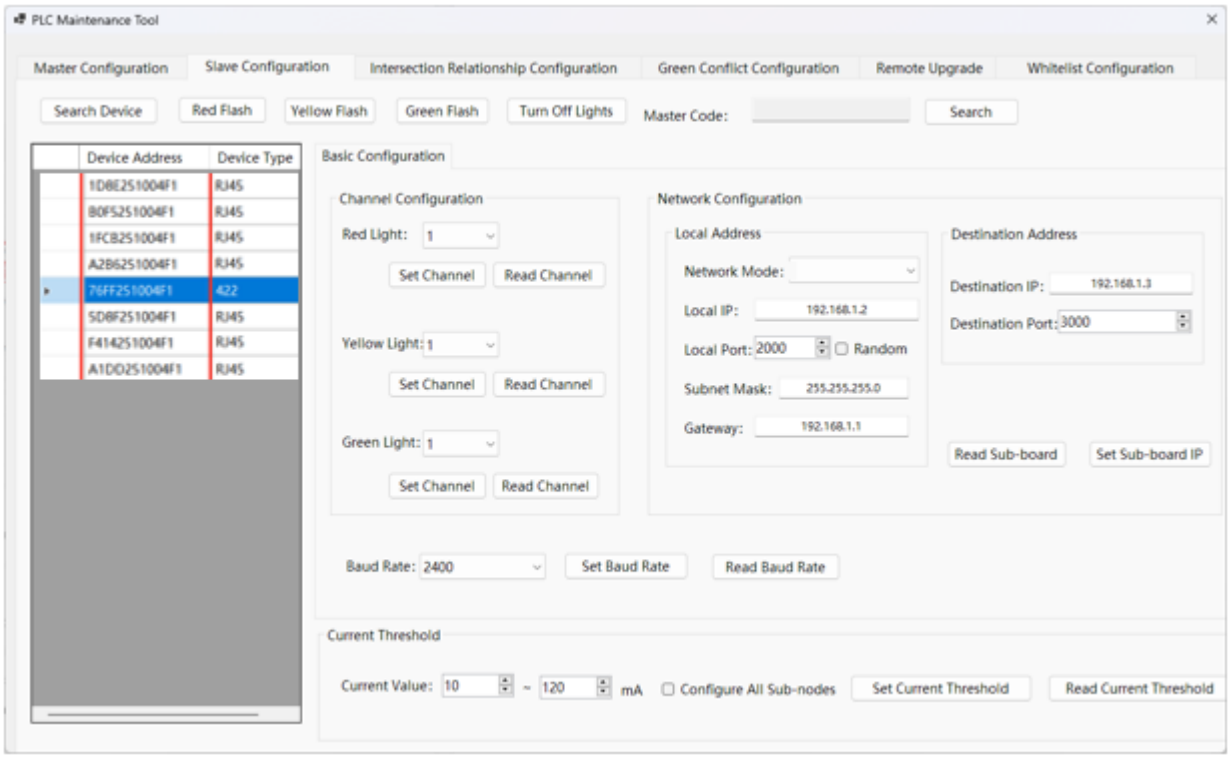


4.3 Slave Device Configuration

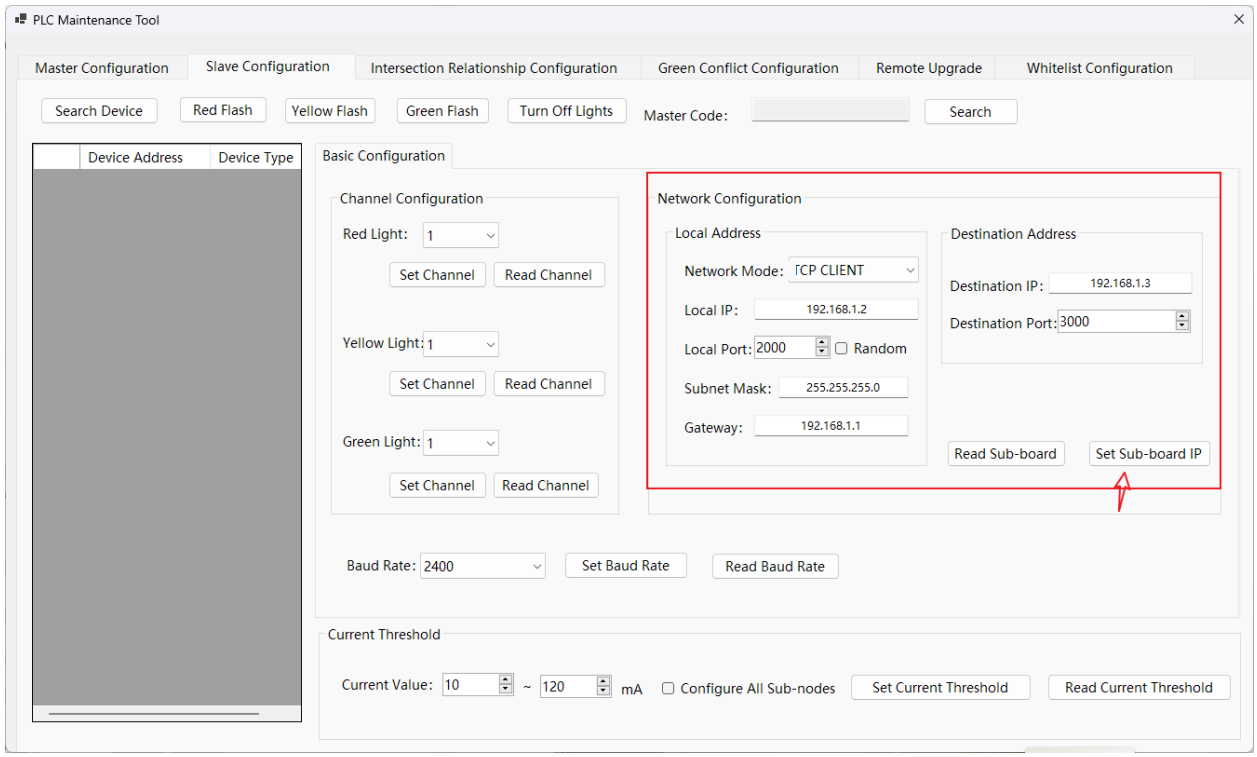
(1) First, click **"Search Device"**, select the slave device model, and then click the **[Red Flash]** function to make the device's lights flash. This will help identify the channel number of the slave device.



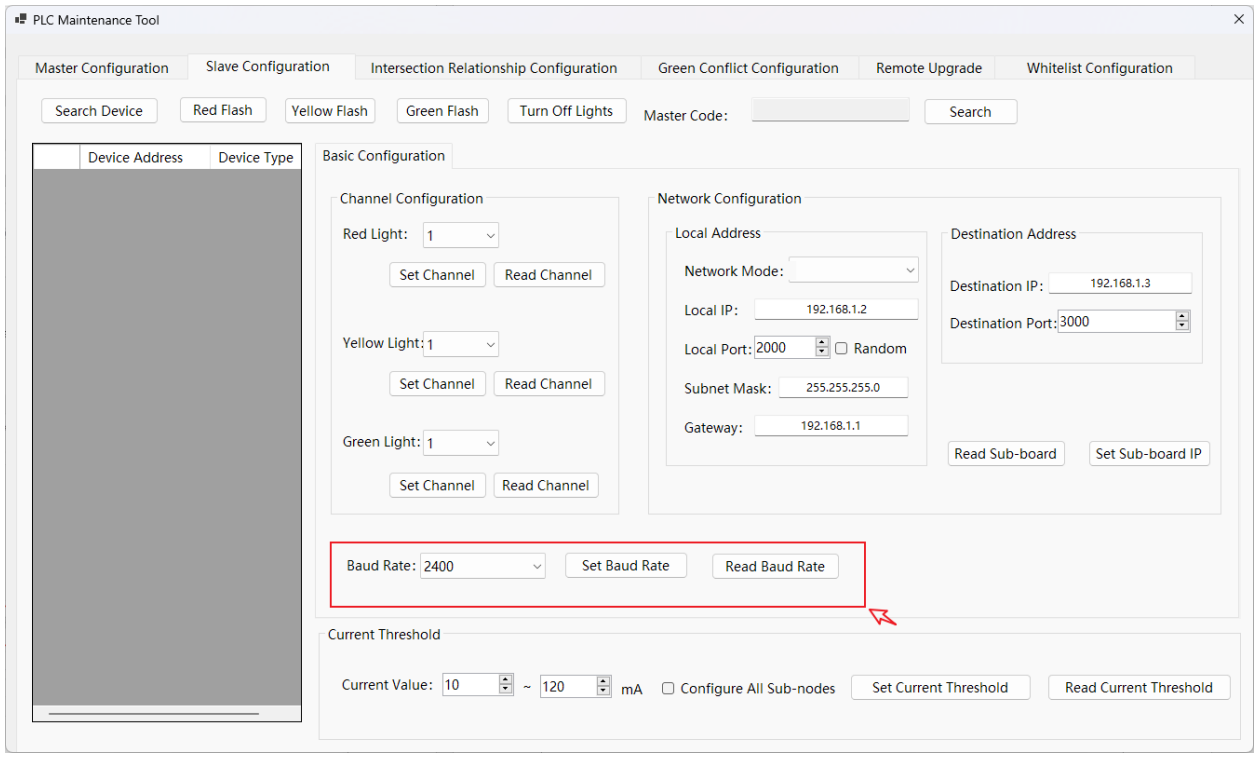
(2) Click on **"Slave Configuration"**, then click **"Search Devices"** (all devices will be displayed within 2 minutes, and if there are many devices, they should all appear within that time). Use the **[Red Flash]**, **[Yellow Flash]**, and **[Green Flash]** functions to help determine if the device light states are stable and to locate the slave device. After identifying the correct red, yellow, and green light channels, click **[Set Channels]**. Wait for 3-5 seconds until a **"Set Successful"** popup appears. Then click **[Read Channels]** to verify if the channels have been configured correctly. (The maximum number of slave devices that can be searched is 16.)



(4) First, click **RJ-45** to read the Slave IP. Within 5 seconds, the current Slave IP will be displayed. Change the IP to the same IP segment as the endpoint device, set the network mode to **TCP CLIENT**, select a **random local port**, set the **destination IP** to the endpoint device IP, and the **destination port number** to the signal machine's port number. After making the changes, click on the **Set Sub-board IP** option in the bottom right corner. After 2-5 seconds, a **"Set Successful"** popup will appear.



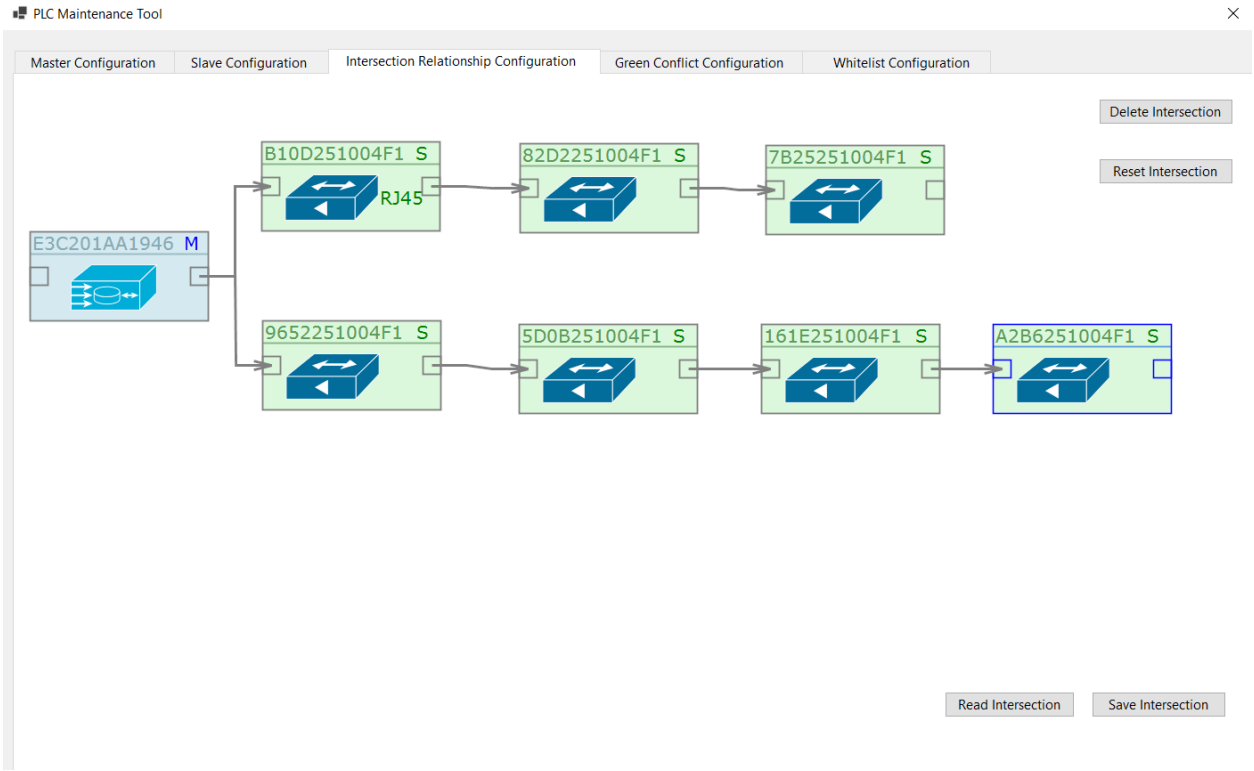
(5) This step is for setting the baud rate of the endpoint devices communicating via 422 or 485.



4.4 Intersection Relationship Configuration

Follow the steps in the diagram in the given order:

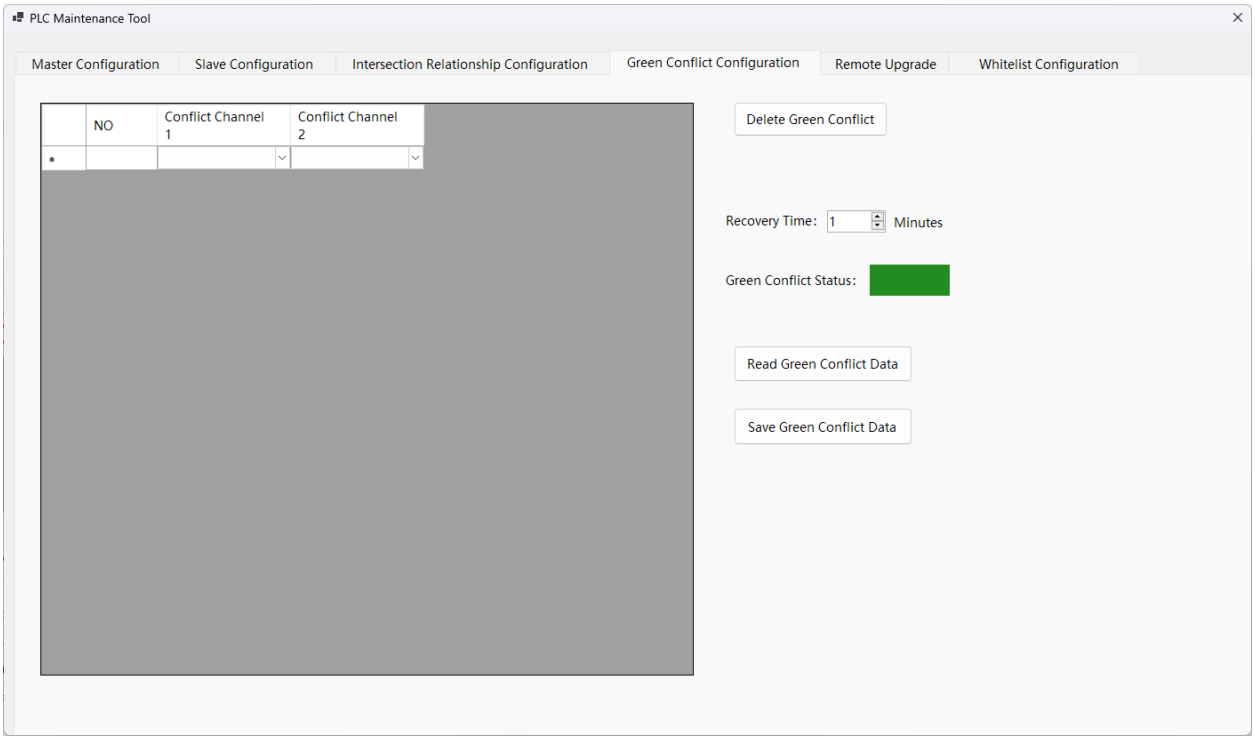
1. First, reset the intersection relationship.
2. Then, use the master and slave devices to draw the link according to the actual wiring sequence.
3. After completing the drawing, save the intersection relationship.
4. Finally, read the intersection relationship to ensure that it has been saved correctly.



Delete the connection between devices:

First, accurately click on the segment of the connection, then click on **[Delete Intersection Link]**.

4.5 Green Conflict Configuration



(1) First, identify the two conflicting channels to test (primarily the green light channels) [For example, set North Direct 3 and East Direct 27].

(2) In the power line carrier maintenance tool, find [Configure Conflict Channels], and select the configured Conflict Channel 1 and Conflict Channel 2.

(3) After completing the configuration, click [Save Red-Green Conflict Data].

Effect: All light statuses will change to yellow flashing, indicating the successful red-green conflict test.

4.6 Precautions

1. Electrical:

(1) The master and slave devices must be on the same power grid environment.

(2) The power grid should be after isolation and voltage regulation.

(3) Ensure that the two-core cable providing power to the slave device is in good condition

and free from grounding issues.

2. Equipment:

(1) The device has an MCU indicator light. Except for custom versions (where the MCU light is off), the MCU should blink for other versions. If the indicator light remains on or off, restart the device, and it should begin blinking normally within about 1 minute. If the blinking still does not appear after multiple attempts, contact pre-sales technical support for assistance.

(2) During the configuration process, promptly label the equipment with tags for easier construction and installation.