LP SENSOR TECHNOLOGY

LP-C01
Industrial IoT Receiver
Instruction Manual

Rev B

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1 Overview

The LP-C01 Module is an encrypted wireless "LoRa" communication receiver unit that can communicate with up to 128 LP-M01/M02 remote I/O Modules. The LP-C01 converts encrypted LoRa status information from LP-M01/m02 modules to Modbus TCP or Modbus RTU via its RJ45 Ethernet and serial EIA-485 ports for any SCADA or Control System client. The LP-C01 is also capable of being used as a LoRa wireless Modbus Bridge for bypass or star connection.

LP-C01 LoRa wireless technology implements secure 128-bit encryption with embedded alarm signals that can be monitored and alarmed via its Modbus server. With a very low power consumption and a wireless communication range between an LP-C01 and an LP-M01 of up to 2 miles, it would significantly reduce material, design, and labor costs when compared to a traditional hard-wired solution.

2 Features and Benefits

a) Flexible Monitoring Application

Employ hardwired contact inputs, output controls, raw analog signals, or any custom device sensor from remote locations to the Control house or central PLC location without the need for new cables, digging trenches, or adding conduit. Encrypted communications provide secure and reliable communication.

b) Easy Integration

LP-C01 supports plug and play setup to minimize parameter settings workload compared to other wireless data concentrators. It supports Modbus TCP/RTU which is easily compatible with any PLC / Automation Controller.

c) Rugged Industrial Presentation

Rugged case design suitable for tough environments. Conformal coating on all electronic circuit boards.

d) Improved Safety & Data Transfer Reliability

Secured and encrypted wireless communications.

Replace control wiring to outside cabinets with wireless antenna, eliminating unnecessary outages or the need to go through existing paths with dangerous voltage levels.

e) Savings on Capital Cost Investments

Reduce project costs and time using wireless communication instead of traditional wired applications. No trench, conduit, or raceway requirements, less labor for design, documentation, installation, testing and maintenance. Additionally, with Modbus communication, this device can be used for virtually any application in the automation and control industry.

f) Modbus Bridge mode Extender Bypass

The LP-C01 could extend any Modbus device with encrypted LoRa wireless connections via bridge or star topology.

3 Detailed Functional Description

LP-C01 LoRa gateway receives node wireless data and converts it into bus data, which saves users from long-distance wiring. The gateway provides RJ45 and RS-485 interfaces, users can use Modbus TCP and Modbus RTU to access gateway data.

LP-C01 holds a patent pending wireless event report mechanism which saves LoRa bandwidth and also holds the fastest response speed. All M01 and M02 benefit from the mechanism which only the triggered event is actively report to C01 from M01/M02. Thus LP-C01 and LP-M0x modules hold very stable wireless connection because the reporting logic consumes minimal bandwidth compared to other brand LoRa devices are passively and continuously polling the data request from gateway.

LP-C01 has another unique wireless mechanism to avoid same frequency network signal collision. When the LP-C01 is powered on, it first sends a command to collect node data in the whole network. After receiving the command, the node powered by the power supply will report the status data with a random delay within 100ms, this will avoid too many nodes reporting to same C01 and create signal collision. The node powered by the battery may be in a dormant state for power saving. It cannot detect collect data command was received and the collect data command cannot be responded to unless there is an input status change on LP-M01 modules.

When LP-C01 works with LP-M01&M02 under same LoRa network. Each packet of data reported by the node includes the time interval for regular reporting by the node. If the reported data of the node is not received beyond the regular reporting time interval, the node I/O data will be set to an invalid state to save the bandwidth. In the network, each node sends as little data as possible to avoid network congestion. Additionally, each node should set a larger Heartbeat reporting time interval to optimize the LoRa bandwidth if allowed. Otherwise, If the amount of LoRa data in the network channel is too large, the network will generate a greater delay, and the real-time performance will be reduced.

4 Communication Architectures

4.1 Communication Schematic to connect M01+ and M02 modules.

The LP-C01 connects to LP-M01 and M02 follows the schematic below. To set up M01&M02 to connect C01 please see **Section 7.3.2.**

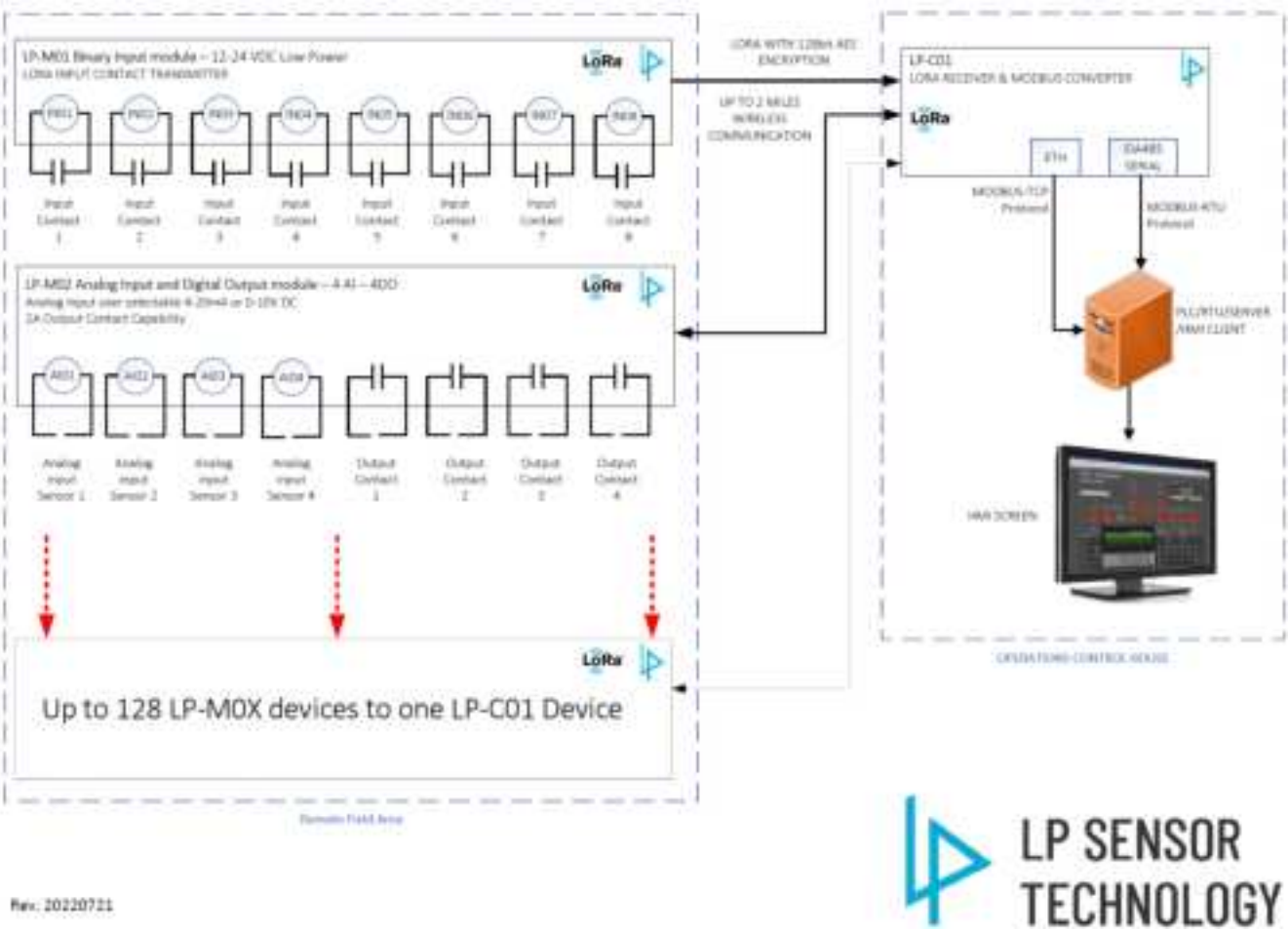


Figure 4.1 LP-C01 M01&M02 Comm Schematic

4.2 Communication Schematic for Modbus Bypass Bridge mode

Any two C01 could be setup as a bundle for Modbus bridge function. Additional pairs of bridge bundle could bypass the Modbus device to longer distance with longer latency.

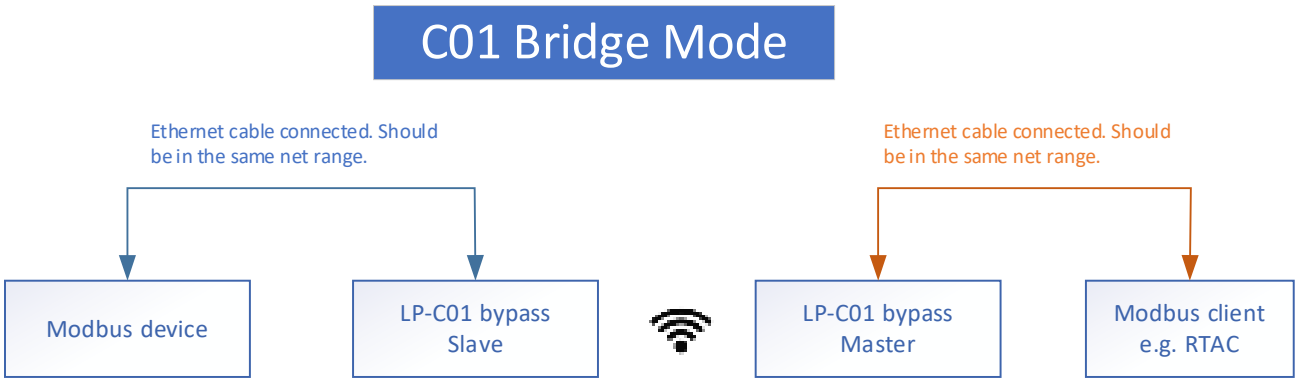


Figure 4.2 LP-C01 Bypass Bridge Mode

4.3 Communication Schematic for Modbus Star Bridge mode

LP-C01 could also be setup to establish a star topology Modbus network as shown below.

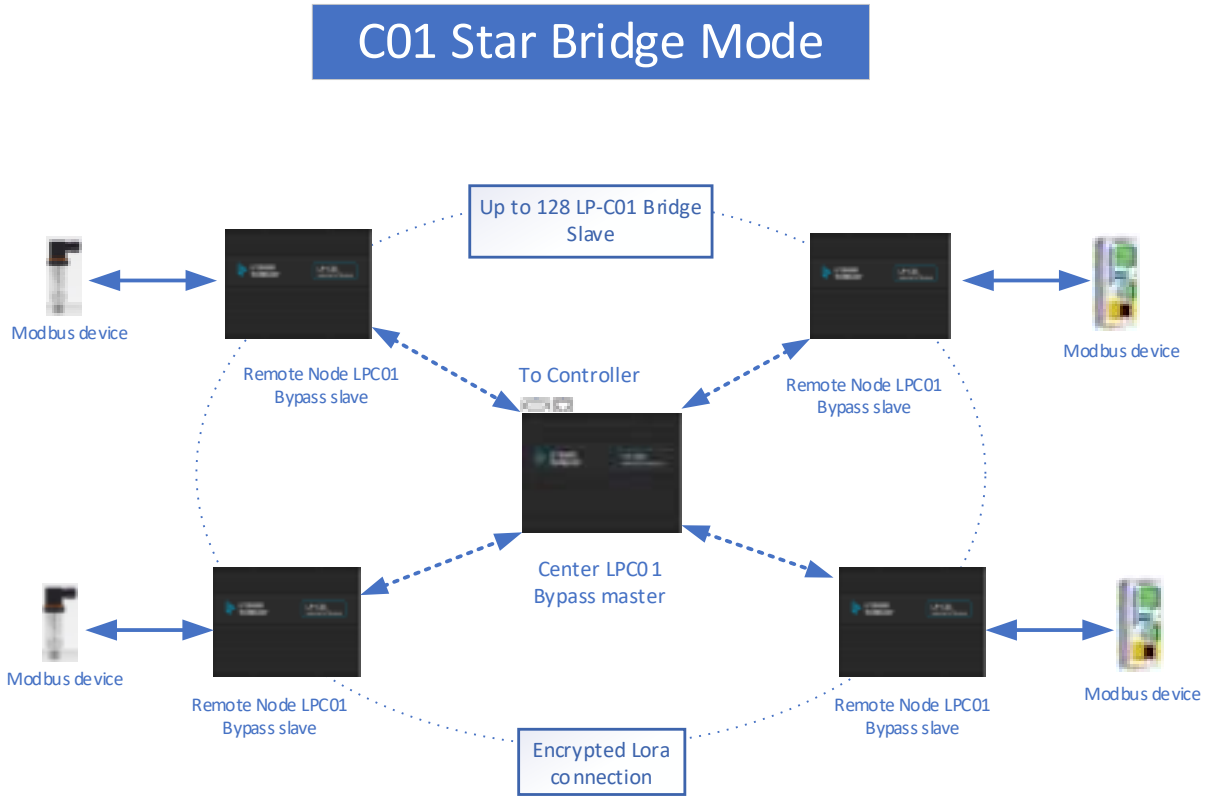


Figure 4.3 LP-C01 Star Bridge Mode

5 Protocols

5.1 Modbus TCP

Modbus TCP uses the default IP port number 502. The gateway can set a static IP address or obtain an IP address through DHCP. Users can use the PC Tool software to view the current IP address. Enter the current IP address in the web browser interface to configure network parameters. The default login username and password are both “admin”.

5.2 Modbus RTU

Modbus can be used via EIA-485 2-wire configuration. Users can set parameters such as Modbus communication address and baud rate via web interface.

5.3 Modbus MAP

Please use the Modbus Register Map to setup SCADA/PLC systems.

Table 5-1 LP-C01 Modbus Register Map

LP-C01 Modbus register map				
Address	***Name***	***Supported function code***	***R/W***	***Description***
Coil **Max 128 nodes**				
00001	Node 0 enable	1;5;15	RW	0-node enable 1-node disable
00001 + n	Node n enable	1;5;15	RW	0-node enable 1-node disable
Input registers **Max 128 nodes**	**LP-M0X (Max 128 Nodes)**			
30001…30008	Main input registers for Node 0	04	R	See Main input registers for each detailed LP-M01+ and LP-M02 modules
30009…30016	Main input registers for Node 1	04	R	See Main input registers for each detailed LP-M01+ and LP-M02 modules
(30001+8*n) … (30008+8*n)	Main input registers for Node n(Range 0…127)	04	R	See Main input registers for each detailed LP-M01+ and LP-M02 modules
31025	Special input register1 for Node 0	04	R	Node 0 Card type LPM01 (0x01) LPM02 (0x02)

31026	Special input register2 for Node 0	04	R	Node 0 Serial number
31027	Special input register3 for Node 0	04	R	Node 0 Power supply voltage in mv
31028	Special input register4 for Node 0	04	R	Node 0 status bit0: Communication error bit1: Power error bit2: IO error bit3: Internal error
31029…31032	Special input register for Node 1	04	R	
(31025+4*n) … (31028+4*n)	Special input register for Node n (Range 0…127)	04	R	
31537	Gateway status	04	R	Gateway status bit0: Communication error bit1: Power error bit2: IO error bit3: Internal error
Holding registers				
40001…40008	Main holding registers for Node 0	03;06	RW	65535: Error For DO channel, when writing nonzero value means logic 1, relay switch on; when writing 0 means logic 0, relay switch off. After writing, current value will be written in this register: 0-switch off, 1-switch on, 65535-invalid
40009…40016	Main holding registers for Node 1	03;06	RW	
(40001+8*n)...(40008+8*n)	Main holding registers for Node n	03;06	RW	

Table 5-2 LP-M01+ Input Register Modbus Map (Binary/Counter Input)

Main Input registers for LP-M01+			
Offset	Register name	Description	
0	DI1	0-Contact off 1-Contact on 65535-Invalid	
1	DI2	0-Contact off 1-Contact on 65535-Invalid	
2	DI3	0-Contact off 1-Contact on 65535-Invalid	
3	DI4	0-Contact off 1-Contact on 65535-Invalid	
4	DI5/CNT1	0-Contact off 1-Contact on 65535-Invalid	CNT: Any other value 65535 is Invalid (To Clear register to 0, Write 1 to same address in Holding register “400xx")
5	DI6/CNT2	0-Contact off 1-Contact on 65535-Invalid	CNT: Any other value 65535 is Invalid (To Clear register to 0, Write 1 to same address in Holding register “400xx")
6	DI7/CNT3	0-Contact off 1-Contact on 65535-Invalid	CNT: Any other value 65535 is Invalid (To Clear register to 0, Write 1 to same address in Holding register “400xx")
7	DI8	0-Contact off 1-Contact on 65535-Invalid	

Table 5-3 LP-M02 Input Register Modbus Map (Analog Input)

Main Input registers for LPM02		
Offset	Register name	Description
0	AI1	65535-Not available; other value is for current/voltage uint: uA/mV
1	AI2	65535-Not available; other value is for current/voltage uint: uA/mV
2	AI3	65535-Not available; other value is for current/voltage uint: uA/mV
3	AI4	65535-Not available; other value is for current/voltage uint: uA/mV
4	unused	unused
5	unused	unused
6	unused	unused
7	unused	unused

Table 5-4 LP-M02 Holding Register Modbus Map (Controls)

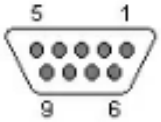
Main Holding registers for LPM02		
Offset	Register name	Description
0	DO1	65535: Error For DO channel, when writing nonzero value means logic 1, relay switch on; when writing 0 means logic 0, relay switch off. After writing, current value will be written in this register: 0-switch off, 1-switch on, 65535-invalid
1	DO2	65535: Error For DO channel, when writing nonzero value means logic 1, relay switch on; when writing 0 means logic 0, relay switch off. After writing, current value will be written in this register: 0-switch off, 1-switch on, 65535-invalid
2	DO3	65535: Error For DO channel, when writing nonzero value means logic 1, relay switch on; when writing 0 means logic 0, relay switch off. After writing, current value will be written in this register: 0-switch off, 1-switch on, 65535-invalid
3	DO4	65535: Error For DO channel, when writing nonzero value means logic 1, relay switch on; when writing 0 means logic 0, relay switch off. After writing, current value will be written in this register: 0-switch off, 1-switch on, 65535-invalid
4	unused	unused
5	unused	unused
6	unused	unused
7	unused	unused

6 Hardware

6.1 LP-C01 Front view

Figure 6.1 LP-C01 Front view

1) **USB-C setting port**
   USB-C port is for PC setting only. See section 7.3 for detailed setting guideline.
2) **EIA-485 Port (9pin) Modbus RTU**
   DB9 Female port provide the EIA-485 MODBUS RTU connection (half duplex).
   Port parameter could be setup through USB-C or Web interface (ETH port)
   Pin definition:



DB9	Designation
1	TxD/RxD+
2	TxD/RxD-
3	
4	
5	GND
6	
7	
8	
9	

3) **Ethernet Port (10/100Mbps RJ45)**

Support Modbus TCP output.
Default IP: 192.168.0.7
Username: admin
Password: admin
See 7.4 for Web interface setup.

4) **Status & Power LED**
Status LED will be on red when Internal input register 31537 holds a value other than 0.

6.2 LP-C01 Rear view

Figure 6.2 LP-C01 Rear view

5) **Antenna Port**
RG174 Coax SMA Female Antenna port. Requires SMA Male cable/Antenna.
6) **Alarm Contact**
The hardwired alarm contact is for monitoring system alarms. (Synced with internal Modbus register 31537)
7) **Power port**
Support 9-30VDC wide range input.

6.3 Antenna Installation

Install the antenna or coax cable onto the SMA threaded interface. Antenna installation is crucial for signal transmission. The antenna needs to be placed at an elevated position without any block.

7 Product operation

7.1 LED indicator

Table 8-1 LP-C01 LED Specs

POWER (green)	Steady on; flashing when wireless sending/receiving
	2HZ flashing in Bootloader mode (For firmware update)
STATUS (red)	Lights up when there is an error state (MODBUS Register 31537)

7.2 Configure the product via USB.

Users can connect Type C USB cable to configure the product, read logs, perform device upgrades, etc.
Using the PC tool, you can configure the product timing reporting time interval, alarm reporting time interval, sampling time interval, positioning time interval, upper and lower limit alarm values, display units, network access parameters, etc.

7.3 Configuration Software

7.3.1 USB port driver installation. (Supports Windows7, 10, & Windows 11)

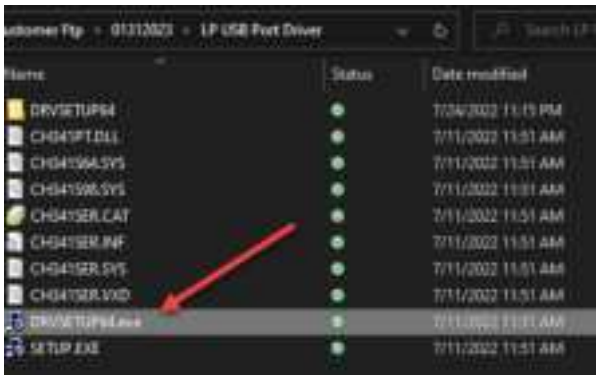


Figure 7.1 LP-C01 USB Driver

Click “INSTALL”

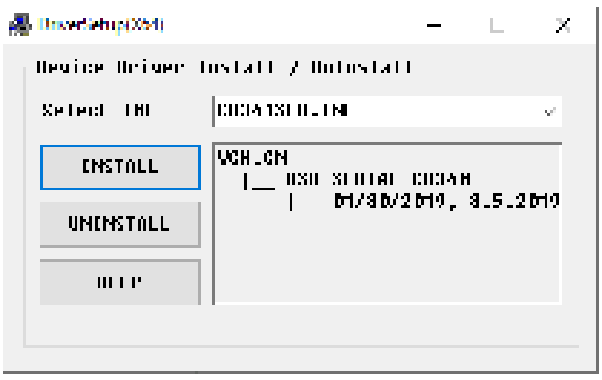


Figure 7.2 LP-C01 USB Driver Installation

7.3.2 Interface layout and connect C01 to M01&M02

Open the LP-C01 setting tools.

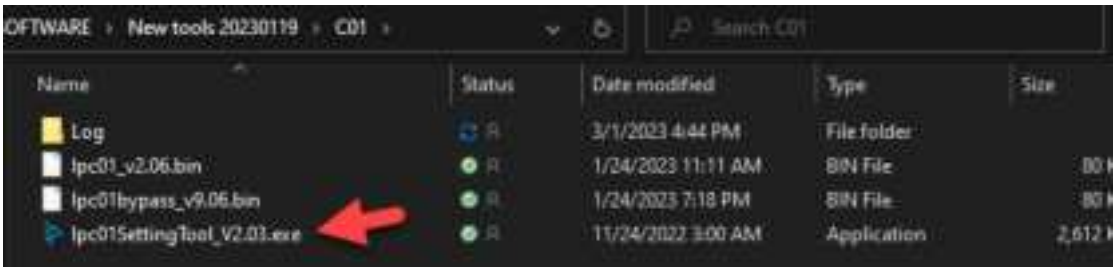


Figure 7.3 LP-C01 Setting Tool

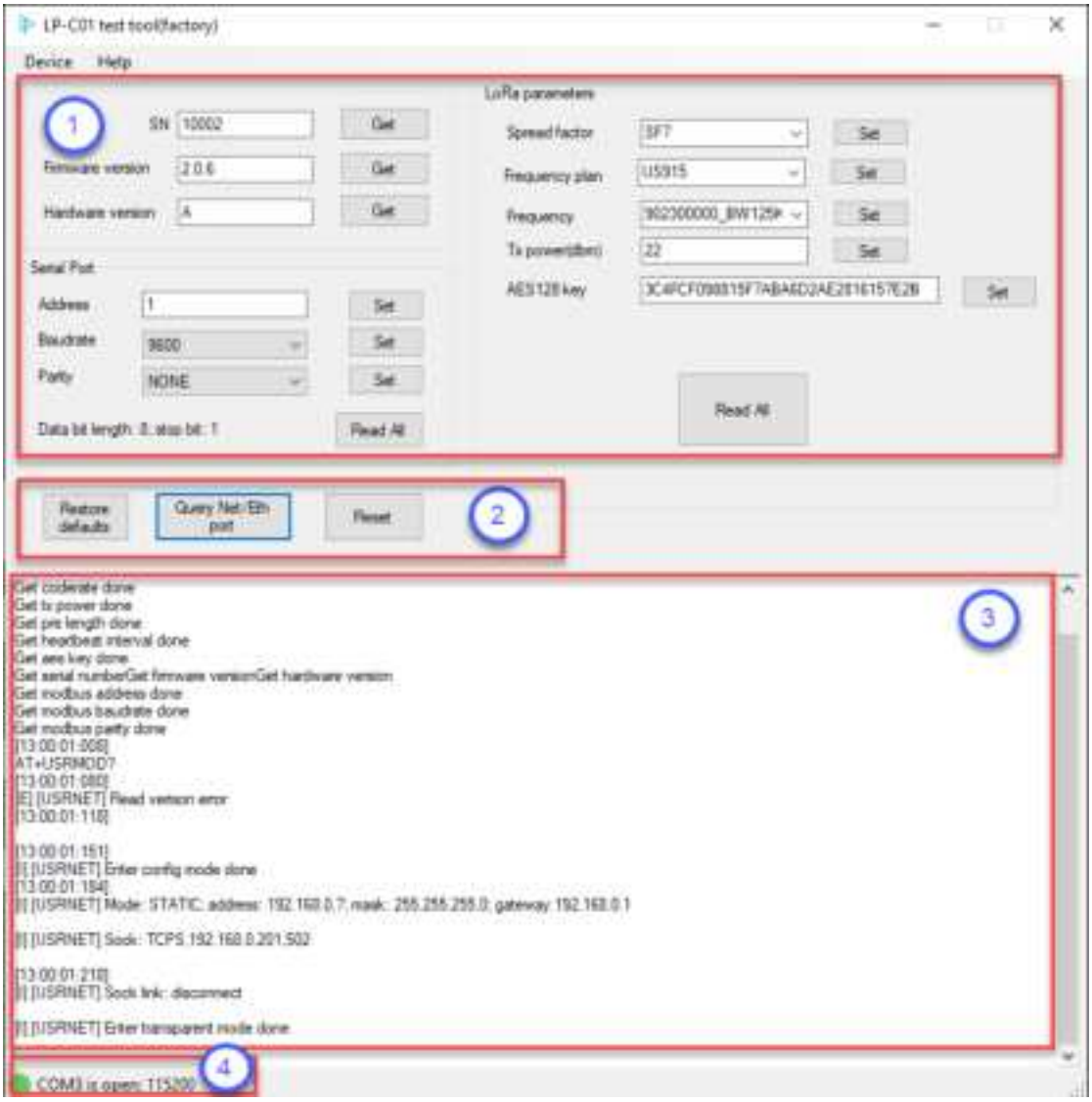


Figure 7.4 LP-C01 Setting Tool Interface

1) **Device Parameter setting zone.**

Use this area to setup the parameters of the device. A hardware reset (click the Reset button in Zone 2) is recommended after each setting changes.

Table 8-2 LP-C01 parameter settings

Parameter	Definition	Scope	Defaults
Spread factor	LoRa spreading factor	SF7-SF12	SF7
Frequency	Communication Frequency	903 MHZ -928 MHZ	903 MHZ
Tx power	Antenna Transmit power	- 3 ~ 22dbm	22dbm
Node number (Only for LP-M modules)	Module communication address	0 ~ 127	1
AES128 key	AES128 key	128bit encryption key	
RS485 ID	RS485 address	0-254	1
RS485 Baud rate	RS485 baud rate	9600/19200/38400/57600/115200	9600
RS485 parity	RS485 parity check	NONE / ODD / EVEN	NONE
Modbus TCP	Default IP		192.168.0.7
Modbus RTU port	Default Port		502

Note: IP address information could be read via NET/ETH Port button.

To setup a LoRa network connect C01 with M01&M02 modules, simply setup C01 and M01/M2 under same:

- **Spread Factor**
- **Frequency Plan and Frequency**
- **AES 128bit Key**

The M01&M02 should be setup with unique node ID# to address on C01 Modbus Registers.

2) Function buttons for device

a) Restore Defaults: Restore all parameters back to factory default setting. (Only use for trouble shooting.)

b) Query Net/Eth port: Click to show Ethernet port parameters. Use this button find IP to Web setup interface.

c) Reset: reset the hardware. (Required after key parameter change or firmware update.)

3) Data log window

Show Realtime info of LP-C01 comm status.

4) USB-C ports comm status

7.3.3 Dropdown manual layout

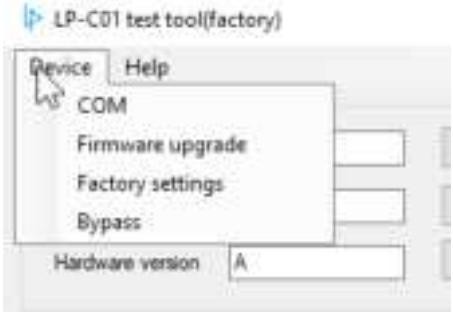


Figure 7.5 LP-C01 Setting Tool Dropdown manual

a) **COM:**
   Setup connection from PC to LP-C01, See section 7.3.4
b) **Firmware Upgrade:**
   Firmware Upgrade function. See section 7.3.5
c) **Factory Settings:**
   For manufacturer use only.
d) **Bypass:**
   Wireless Bridge Function Settings See Section 7.3.6

7.3.4Connect the USB-C cable from Computer to LP-C01 USB-C port.

1) Click “COM”

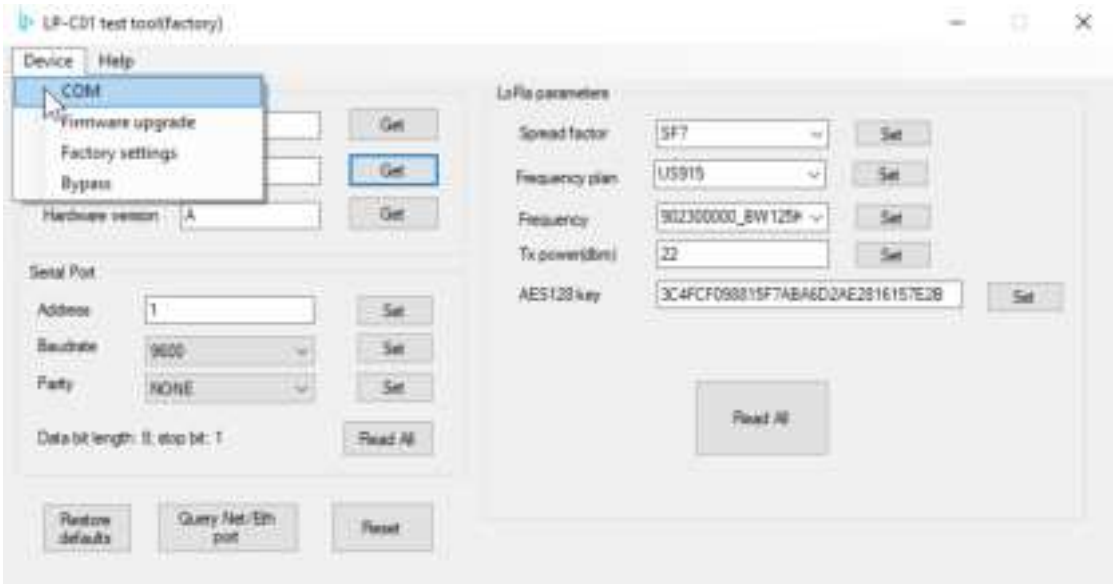


Figure 7.6 LP-C01 Setting Tool COM Interface

2) Select “COM# - USB - SERIAL CH340” Then click connect. (Setting tools can only be connected to specific device. E.g., C01 tools can only connect to LP-C01. Force option is only used for trouble shooting.)

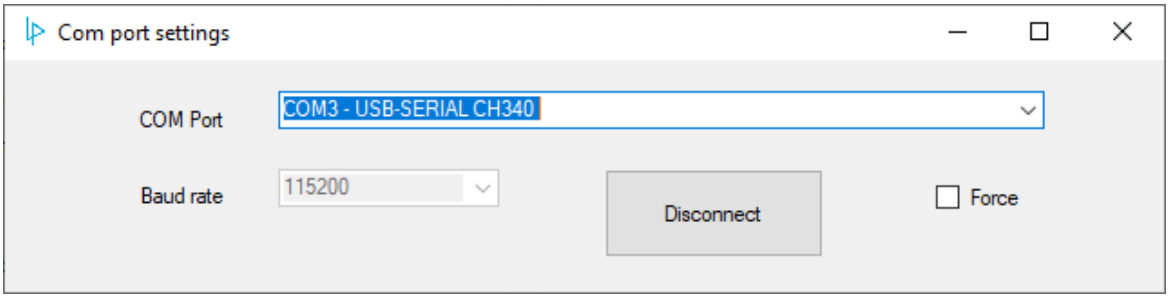


Figure 7.7 LP-C01 Setting Tool COM port setting

3) Check Port connection status at left bottom of main setting window.

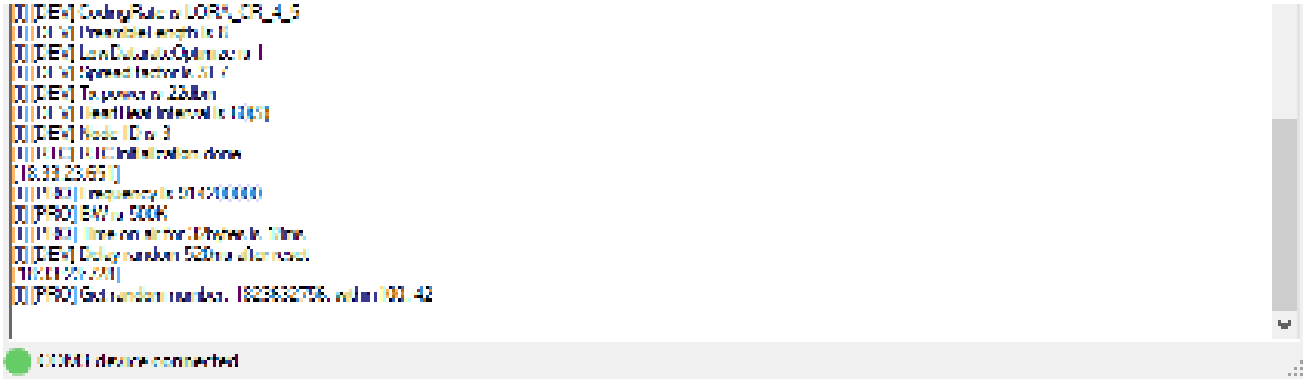


Figure 7.8 LP-C01 Setting Tool COM port status

7.3.5 Firmware Upgrade

1) Select Firmware upgrade in Device dropdown manual

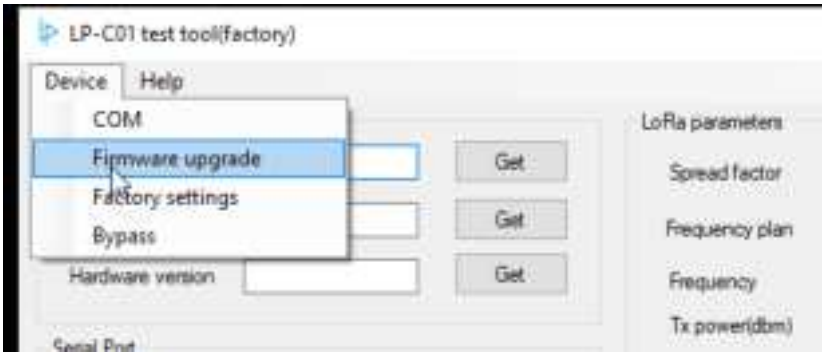


Figure 7.9 LP-C01 Setting Tool Firmware upgrade select

2) confirm the Firmware Revision before upgrading.

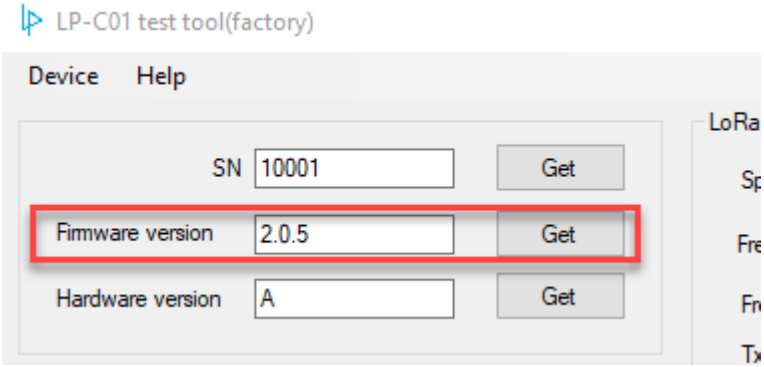


Figure 7.10 LP-C01 Firmware version check

3) Follow the step to finish Firmware upgrade

Figure 7.11 LP-C01 Firmware Upgrade window

4) Select the firmware file to upgrade.

Figure 7.12 LP-C01 Firmware bin file select

5) Confirm the firmware file revision before update.

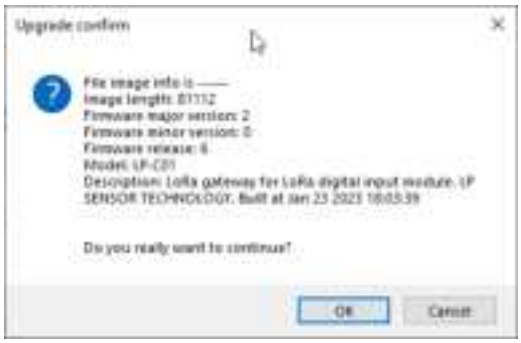


Figure 7.13 LP-C01 Firmware upgrade confirm window

6) Wait until update process finished. (Do NOT disconnect usb cable or power supply during firmware update.)

Figure 7.14 LP-C01 Firmware upgrade process

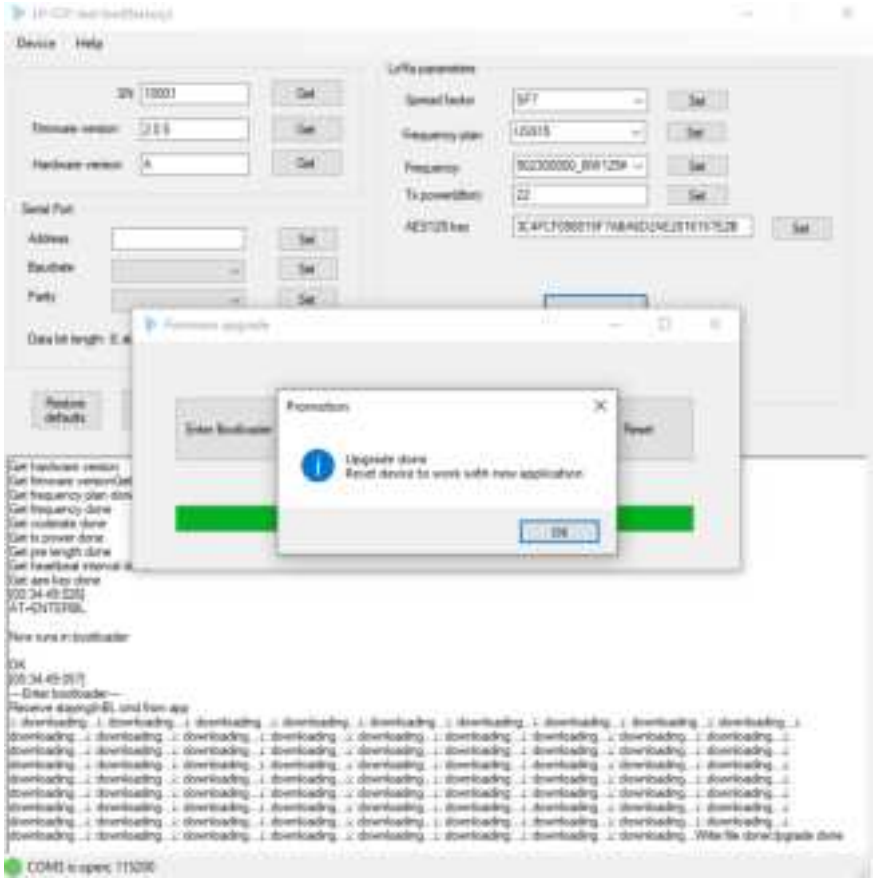


Figure 7.15 LP-C01 Firmware upgrade process finished

7) Click “Reset” after upgrade done.

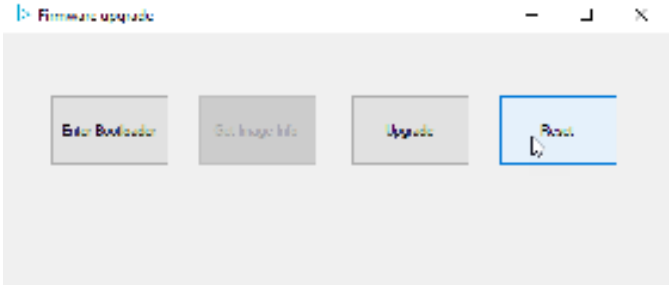


Figure 7.16 LP-C01 Reset after firmware upgrade finished

8) Click Get for new firmware version check.

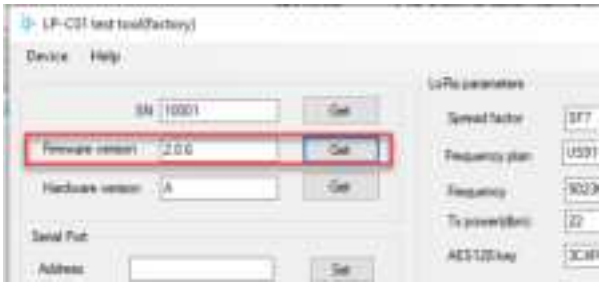


Figure 7.17 LP-C01 firmware version check

7.3.6 Modbus bypass (Bridge) mode setting

a) Upgrade both Master and slave LP-C01 to **9.0X Firmware first (important).**

b) Select Bypass.

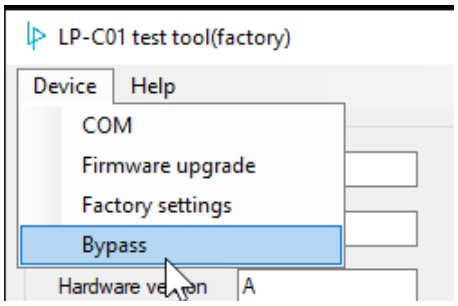


Figure 7.18 LP-C01 Modbus Bridge (bypass) Mode

c) Follow the Schematic to setup the Master and Slave C01

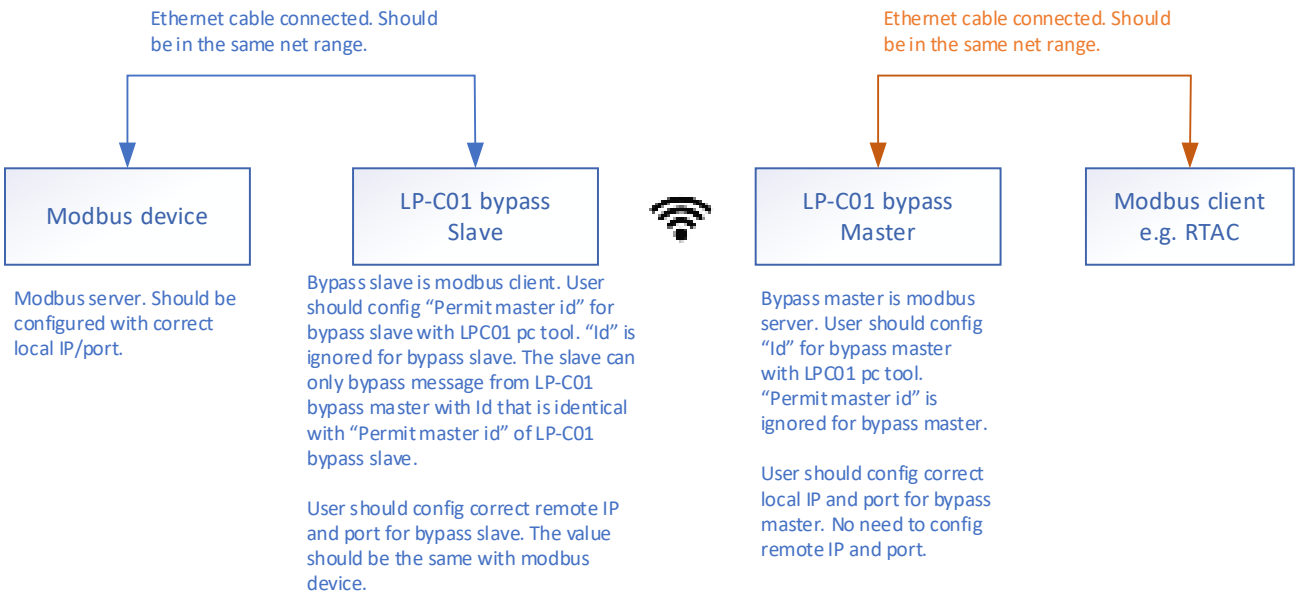


Figure 7.19 LP-C01 Modbus Bridge (bypass) Setting logic

d) A setting example between Master & Slave C01.

Figure 7.20 LP-C01 Modbus Bridge (bypass) Setting window

7.4 Web Interface port parameter setup

Both Serial and Ethernet port parameters could be setup here. (For SCADA Server connection or Bridge mode setup)

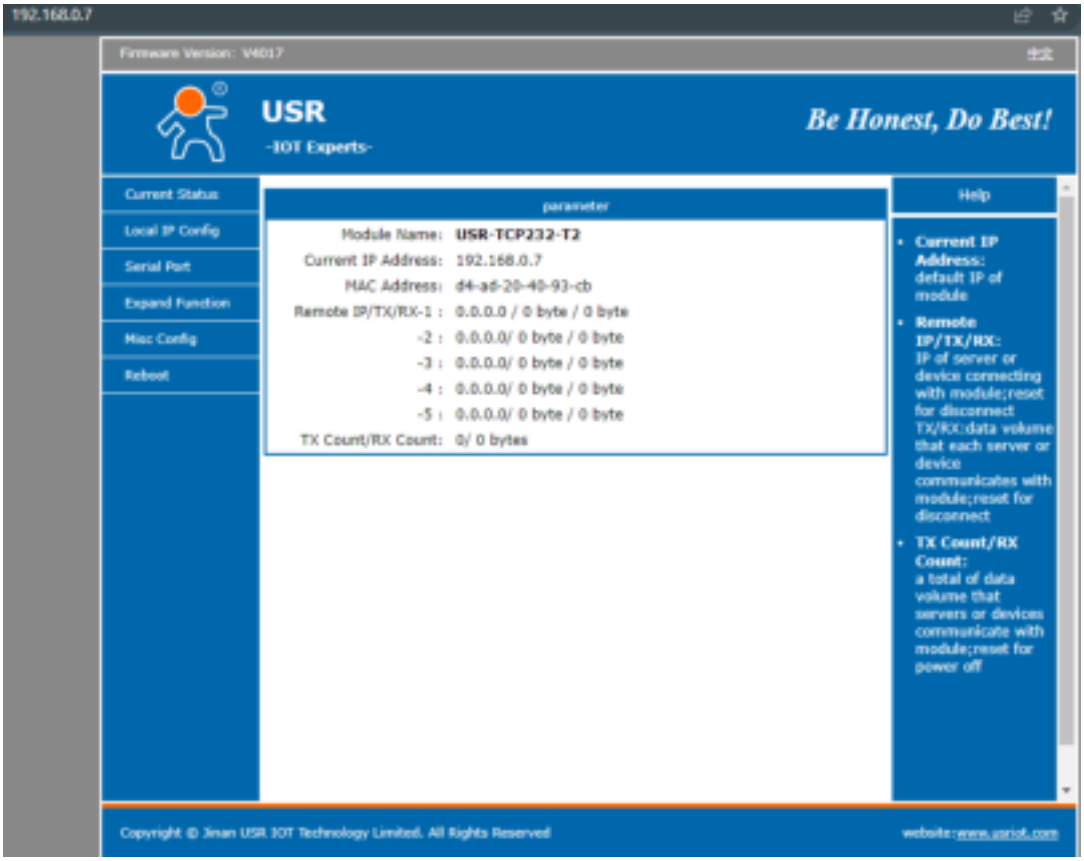


Figure 7.21 LP-C01 web interface Setting window

Ethernet Port parameter settings:

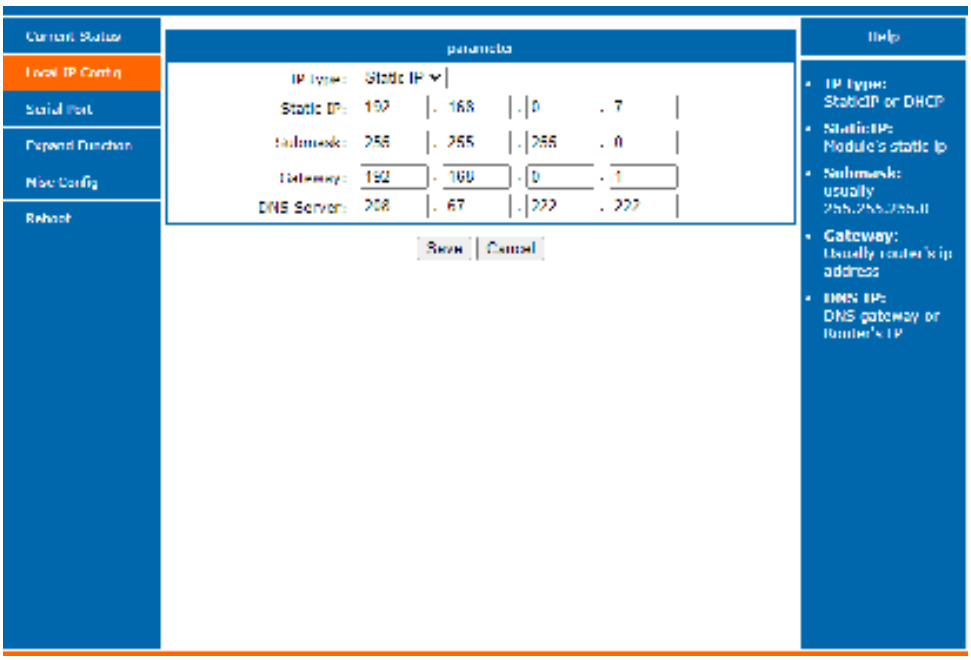


Figure 7.22 LP-C01 web interface ETH PORT Setting window

Serial Port Parameter settings:

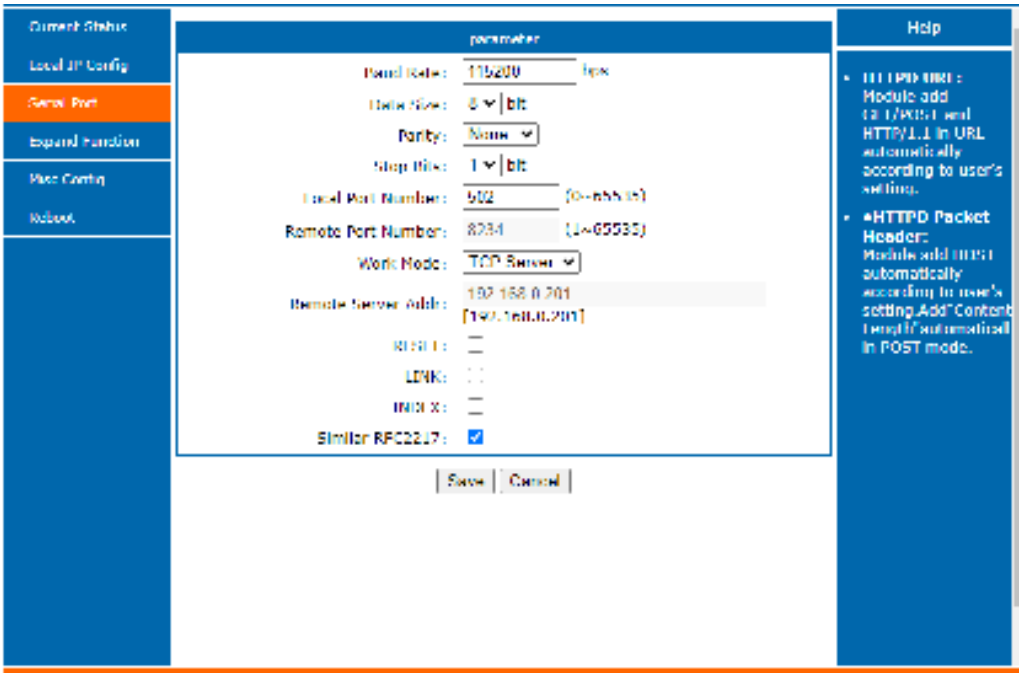


Figure 7.23 LP-C01 web interface SERIAL PORT Setting window

8 Specifications

8.1 Product Specification

Power Supply:

10-30VDC, 3 W maximum

Communications:

Wireless communication encryption：

AES 128-bit LoRa

Supported LoRa Wireless Frequencies：

915MHz (US), 868 MHz (EU)

Wireless Channel:

Single (72 Different Frequency Channels selectable for US915)

Antenna：External

128 maximum nodes supported at each channel.

Latency between node switching: <10ms

Spread Factor: SF7- SF12

Maximum wireless communication range:

2.5 mile (with 4db Antenna installed)

Output Protocols:

- Modbus TCP
- Modbus RTU

Ports:

Ethernet RJ45 10/100 Mbps

RS485 Serial Port: 9600 bps - 115200 bps

USB-C: Settings port

Dimensions:

153mm(L)*143mm(W)*41.2(H)

6.02"(L)*5.62mm(W)*1.62(H)

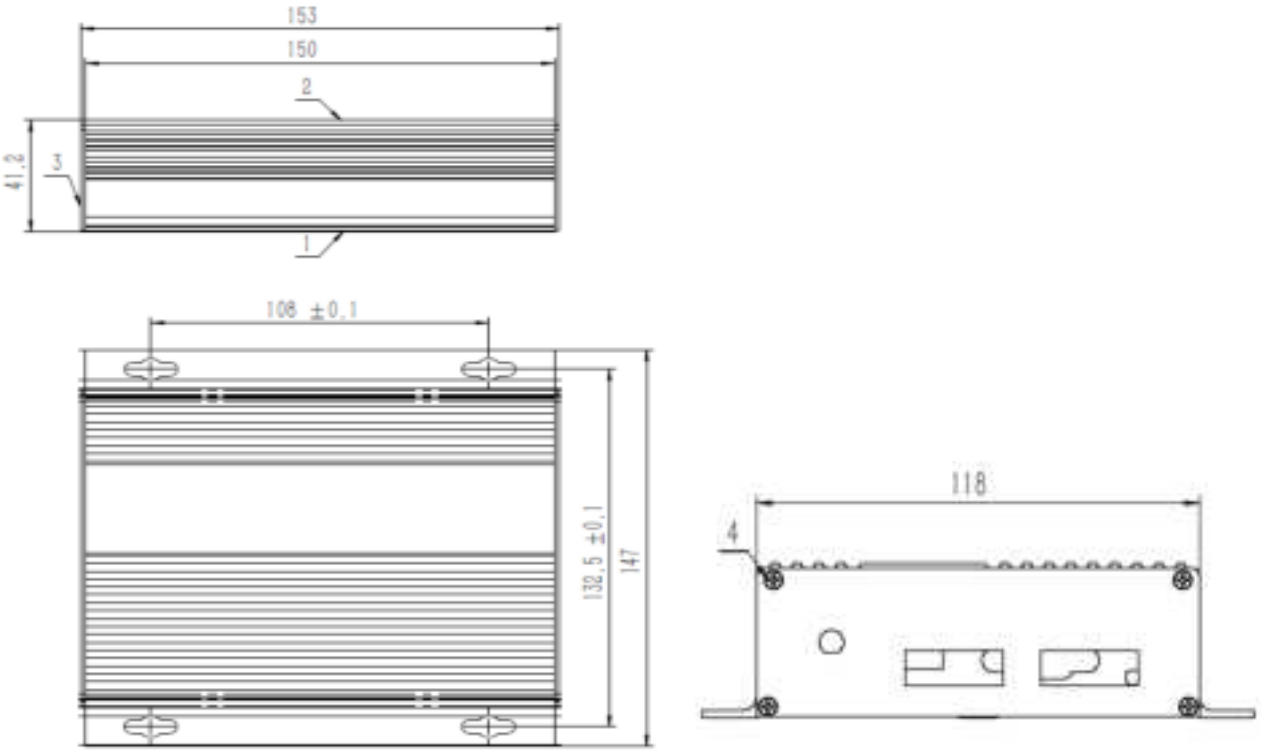


Figure 8.1 LP-C01 Dimensions

Operating Temperature:

–40°C to +85°C (–40°F to +185°F)

Weight:

452g

Case Material:

Aluminum alloy

IP ratings:

IP65

Compliance

Designed and manufactured under an ISO 9001 certified quality management system.

Notes:

This equipment has been evaluated and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio

communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The device generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the RF sources radiating struc ture(s) and the body of the user or nearby persons.

SIMPLIFIED EU DECLARATION OF CONFORMITY The simplified EU declaration of conformity referred to in Article 10(9) shall be provided as follows: Hereby, LP Sensor Technology declares that the radio equipment type LP-C01 Series Industrial IoT Receiver in compliance with Directive 2014/53/EU.

Frequency Band：

Uplink: 868.1 MHz, 868.3MHz, 902MHz, 928MHz

Downlink: 868.1 MHz, 868.3MHz, 902MHz, 928MHz

CE

9 Revision History

Table 9-1 Document Revision History

date	Version	Revise
2022/4/12	Rev 1a	initial version
2022/5/5	Rev 2a	Updated per testing updates
2022/5/11	Rev A	Customer release
2022/8/5	Rev 1b	Added M02 Modbus map
2022/11/20	Rev 2b	Added Modbus Bypass mode
2023/1/17	Rev 3b	Update Comm schematics
2023/3/7	Rev B	update all figures and Tables Customer release