LP SENSOR TECHNOLOGY

LP-M03
Industrial Wireless Switch
Instruction Manual

Rev A

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1 Overview

The LP-M03 Module is an encrypted wireless "LoRa" IO module with 1 Digital input, 1 analog input and 1 DO relay output. The analog input supports voltage and current signal input. It can communicate with LP-C01 receiver for Modbus input/output. The LP-C01 wirelessly controls LP-M03 modules via Modbus TCP or Modbus RTU for any SCADA or Control System client. Each LP-C01 will support up to 128 LP-M03 Modules.

LP-M01+, LP-M02 & LP-M03 and LP-C01 with LoRa wireless technology implements secure 128-bit encryption with embedded signals that can control and monitor via the Modbus client. With a very low power consumption and a wireless communication range between an LP-C01 and an LP-M03 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 analog voltage and current inputs and digital outputs from remote devices to the Control house or central PLC location without the need for new cables, digging trenches, or adding conduit. The encrypted communications provide a secure and reliable communication.

b) Easy Integration

LP-M03 expands the availability of monitoring/control any remote I/O contact status and any analog sensor inputs via Modbus TCP/RTU in combination with the LP-C01 with any PLC / Automation Controller.

c) High Dependability

Debounce support in both software and hardware. Communications monitoring will alarm for low battery, interrupted communication, or any device malfunction.

Rugged case 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 the Modbus communication, this device can be used for virtually any application in the automation and control industry.

f) Transfer Switch System

Create a wireless version of pilot signals for any remote monitoring and control. The transfer switch system at M01+ reads an input and with the M03 module it quickly asserts the designated output to emulate, mirror, or momentary pulse. Inputs and outputs can be designated and configured via LP's configuration software.

3 Detailed Functional Description

LP-M03 LoRa the IO module collects the analog input signal from remote location and sends the signal to the gateway through encrypted LoRa signal wirelessly. It holds 1 DO relay outputs, and users can remotely control the relay on and off.

When the analog input is higher than the upper limit alarm value, lower than the lower limit alarm value or the change exceeds the threshold, the module immediately reports the current IO status to the gateway. IO status includes device status, power supply voltage, device address, device SN number, analog value, DO value, etc.

When the analog quantity returns to the normal range from exceeding the upper limit/lower limit, the IO status will be reported again. The module reports the IO status at heartbeat intervals.

The analog input channel supports 0-24 mA & 0-10 VDC input, voltage input and current input is designed to connected to different terminals for jumper mistake proof. The same input channel cannot be connected to voltage signal and current signal at the same time.
4 DOs are all relay outputs. The DO1 and DO2 are NO&NC contacts, DO3 and DO4 are NO contacts only.

Wireless data is encrypted using AES128. Users can set AES 128 KEY value.
LP-M03 reports the IO status immediately after the product is powered on, without waiting for a receiver response. This design is to proof the M03 randomly delays to reports of the first heartbeat and waits for the gateway to respond.

Users can write module DO output through gateway MODBUS. Only when writing to the corresponding DO register of the gateway, the gateway will communicate with the module through LORA, and set/reset the corresponding DO channel. Thus LP-M0x modules holds very stable connection because the connection logic consumes minimal bandwidth compared to other LoRa based wireless devices. LoRa is a low-bandwidth communication technology. In the network, each node sends as little data as possible to avoid network congestion. Each node should set a larger Heartbeat reporting time interval as much as possible if the requirements are met.

4 Communications Architectures

4.1 Communication Schematic to connect M01+ and M03 modules

For Setup the LP-C01, M01,M02&M03 LoRa network. Please see Section 7.2.2

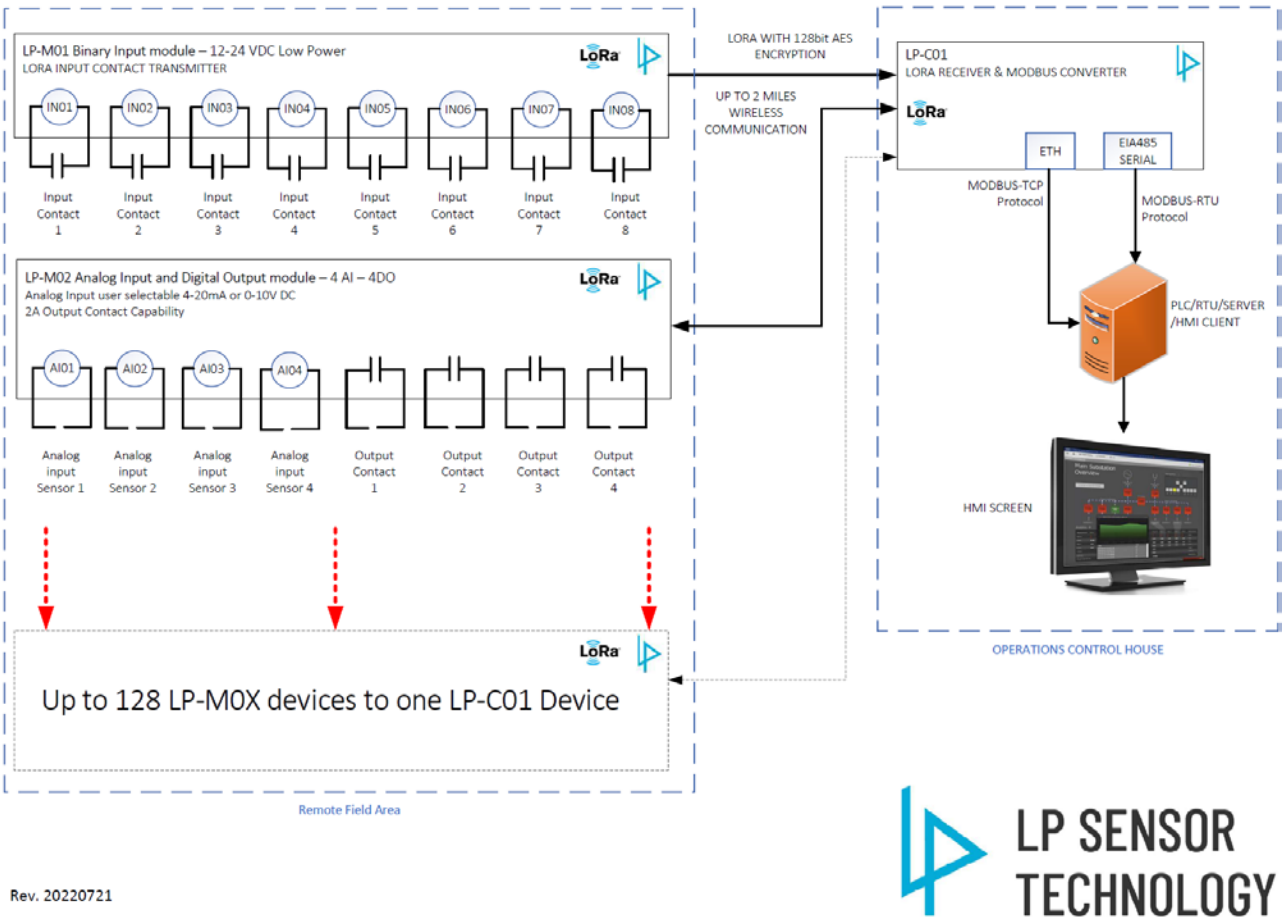


Figure 4.1 LP-C01 M01&M03 Comm Schematic

4.2 M01+ and M03 Transfer Switch Schematic

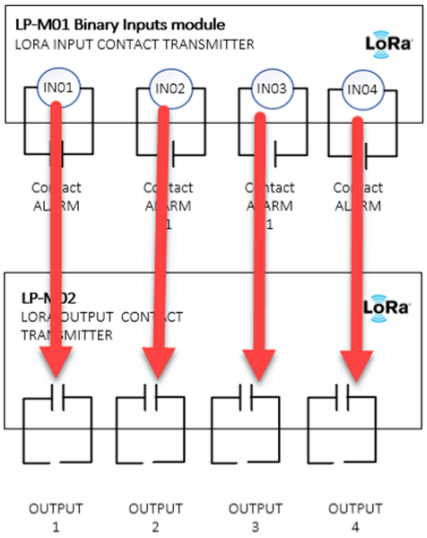


Figure 4.2 LP- M01&M03 Transfer Switch point to point status follow/pulse

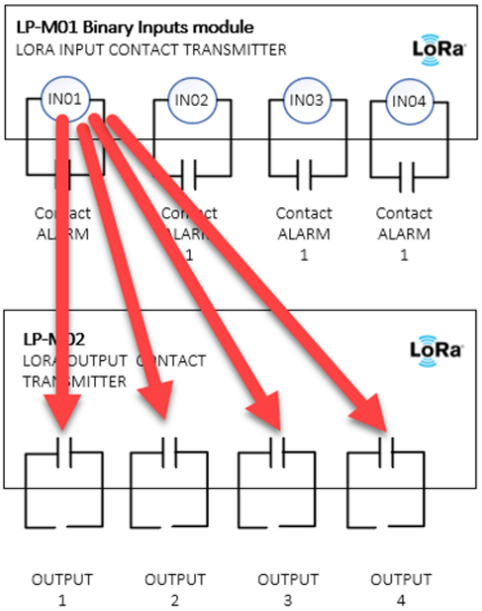


Figure 4.3 LP- M01input to multiple M03 output

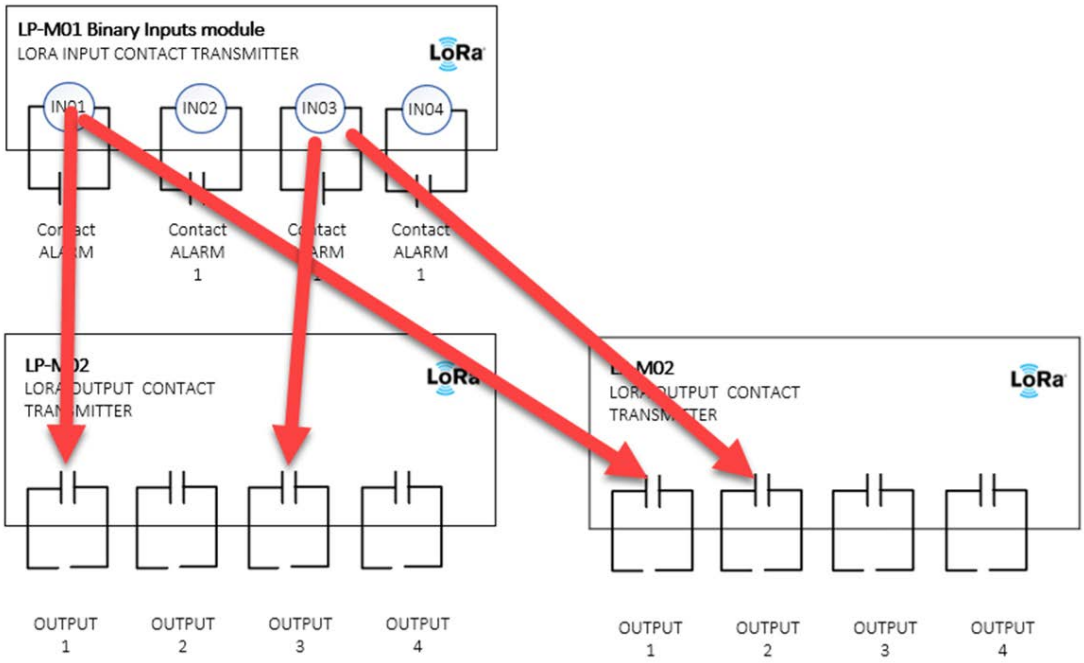


Figure 4.4 LP- M01input bundled to multiple M03

5 Protocol support (Via LP-C01)

5.1 Modbus TCP

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

5.2 Modbus RTU

Modbus can also be used via RS485. Users can set parameters such as Modbus communication address and baud rate via web interface.

5.3 Modbus MAP

Table 5-1 LP-M03 Input Register Modbus Map (Analog Input)

Main Input registers for LPM03		
Offset	Register name	Description
0	AI1	65535-Not available; other value is for current/voltage uint: uA/mV
1	unused	unused
2	unused	unused
3	unused	unused
4	unused	unused
5	unused	unused
6	unused	unused
7	unused	unused

Table 5-2 LP-M03 Holding Register Modbus Map (Controls)

Main Holding registers for LPM03		
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	unused	unused
2	unused	unused
3	unused	unused
4	unused	unused
5	unused	unused
6	unused	unused
7	unused	unused

6 Hardware

6.1 LP-M03 Front view

Figure 6.1 LP-M03 Front view

1) **Power Supply Terminals**
   PWR+ & PWR-: Supports 100-480VAC power inputs.
   GND: Power Ground.

2) **Digital Outputs (See Section 8 for specs)**
   LOAD1: NO

3) **Analog Inputs (See Section 8 for specs)**
   Channel 1support 4-20mA and 0-10V inputs. The dead band, measuring range, RAW data or Engineer units output is configurable via Setting tools.

4) **Antenna Port**
   RG174 Coax SMA Female Antenna port. Requires SMA Male cable/Antenna.

6.2 Install Antenna

Install the antenna or coax cable onto the SMA threaded interface. Antenna installation is crucial for signal transmission. Setup up antenna at a high position when needed.

7 Product operation

7.1 Configure the product via UART pin.

Users can connect UART USB adapter 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.

7.2 Configuration Software

7.2.1 USB port Drivers installation

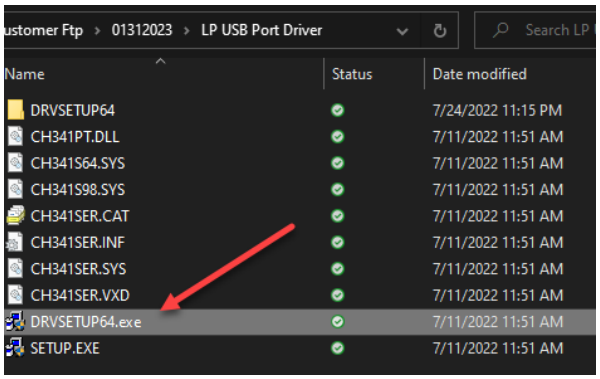


Figure 7.1 LP-M01 USB Driver

Click “INSTALL”

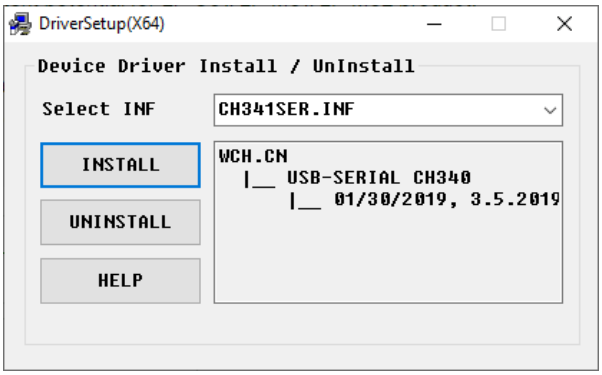


Figure 7.2 LP-M03 USB Driver Installation

7.2.2 Interface layout

Open the LP-M03 setting tools.

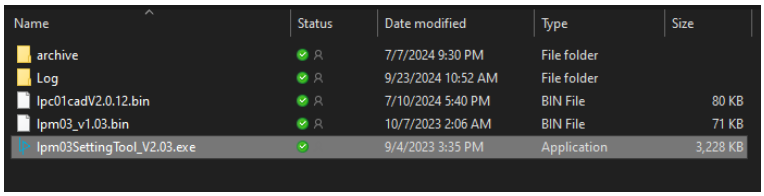


Figure 7.3 LP-M03 Setting Tool

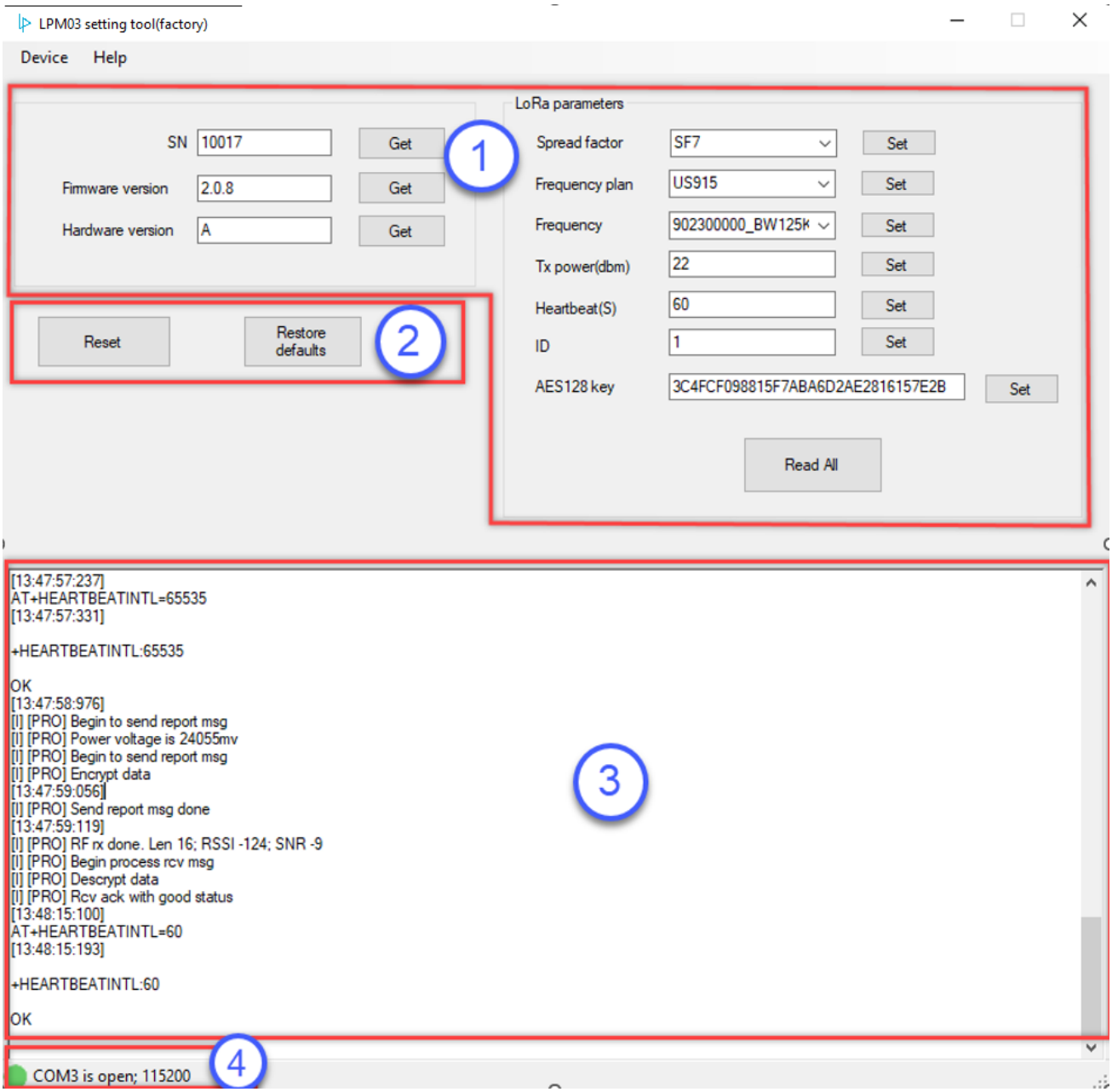


Figure 7.4 LP-M03 Setting Tool Interface

1) **Device Parameter setting zone. (Setup M01&M03 to C01 LoRa network.)**
   To connect M01/M03 to C01. Use this area to setup the parameters of the device. The M01and M03 should be share same **Spread Factor, Frequency Plan, Frequency, AES128 KEY** to establish the connect. A hardware reset (click the Reset button in Zone 2) is recommended after each setting changes.

Table 7-1 LP-M01 parameter settings

parameter	Definition	Scope	Defaults
Spread factor	LoRa spreading factor	SF7-SF12	SF7
Frequency Plan	US915/EU868		
Frequency	Communication Frequency	902.3 MHZ -914.2 MHZ	902.3 MHZ
Tx power	Antenna Transmit power	- 3 ~ 22dbm	22dbm
Heartbeat(S)	Regular polling rate cycle	1-65535	60
ID: Node number (Only for LP-M modules)	Module communication address	0 ~ 127	1
AES128 key	AES128 key	128bit encryption key	

2) **Function buttons for device**
   a) Restore Defaults: Restore all parameters back to factory default setting. (Only use for trouble shooting.)
   b) Reset: reset the hardware. (Required after key parameter change or firmware update.)
3) **Data log window**
   Show Realtime info of LP-M03 comm status.
4) **USB-C port comm status**

7.2.3 Dropdown manual layout

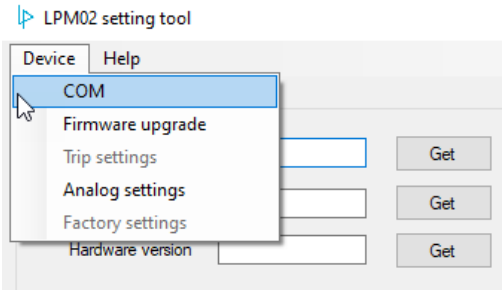


Figure 7.5 LP-M03 Setting Tool Dropdown manual

a) **COM:**
Setup connection from PC to LP-M03, See section 7.2.4

b) **Firmware Upgrade:**
Firmware Upgrade function. See section 7.2.5

c) **Trip Settings:**
Transfer Switch settings See Section 7.2.6

d) **Analog Settings:**
Analog Input Settings See Section 7.2.7

e) **Factory Settings:**
For manufacturer use only.

7.2.4 Connect the Uart pin port from Computer to LP-M03 via USB adapter.

1) Similar to LP-M01, Click “COM”

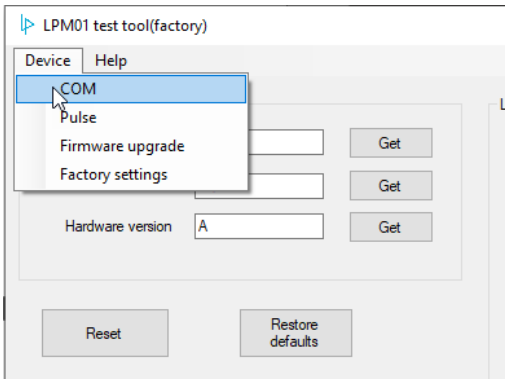


Figure 7.6 LP-M01 Setting Tool COM Interface

2) Select “COM# - USB - SERIAL CH340” Then click connect. (Setting tools can only be connected to specific device. E.g., M01 tools can only connect to LP-M01. Force option is only used for trouble shooting.)

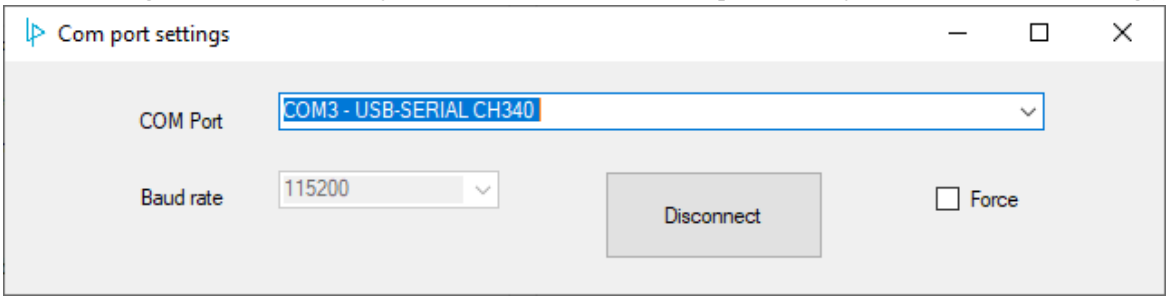


Figure 7.7 LP-M01 Setting Tool COM port setting

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

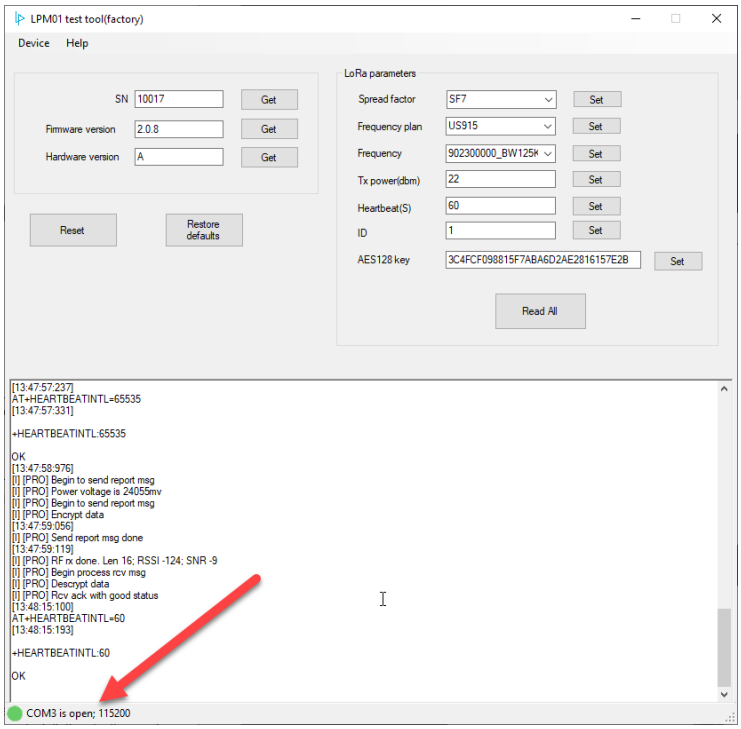


Figure 7.8 LP-M03 Setting Tool COM port status

7.2.5 Firmware Upgrade

1) The firmware update procedure is identical to LP-M01. Please select Firmware upgrade in Device dropdown manual.

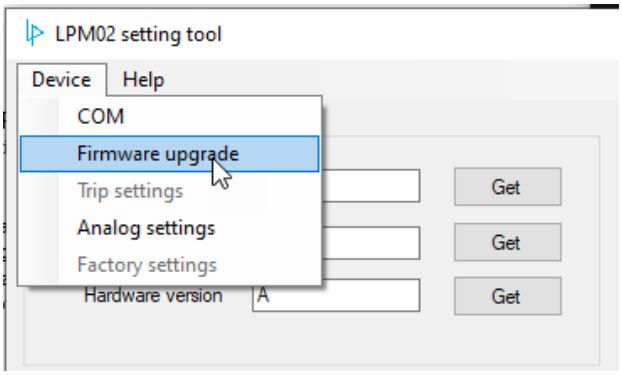


Figure 7.9 LP-M03 Setting Tool Firmware upgrade Select

2) confirm the Firmware Revision before upgrading.

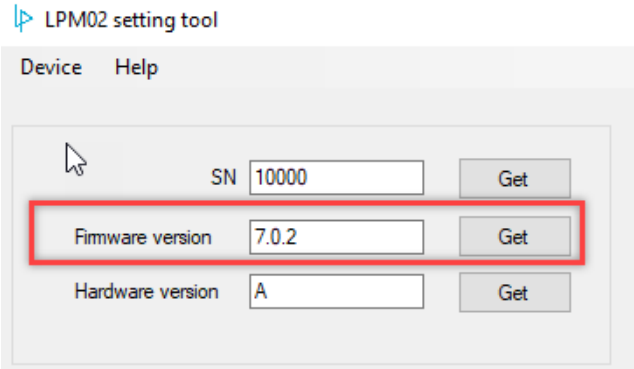


Figure 7.10 LP-M03 Firmware version check

3) Follow the step to finish Firmware upgrade. Click on Enter Bootloader

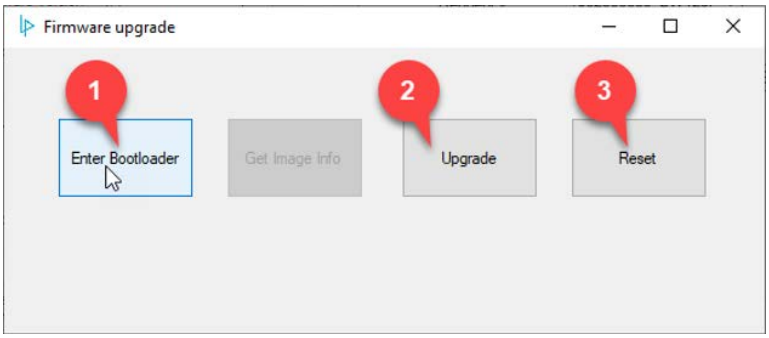


Figure 7.11 LP-M03 Firmware Upgrade window

4) Next, select the firmware file to upgrade.

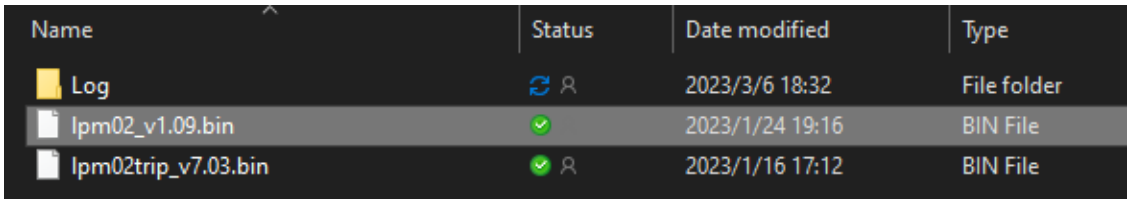


Figure 7.12 LP-M03 Firmware bin file pickup

5) Confirm the firmware file revision before update.

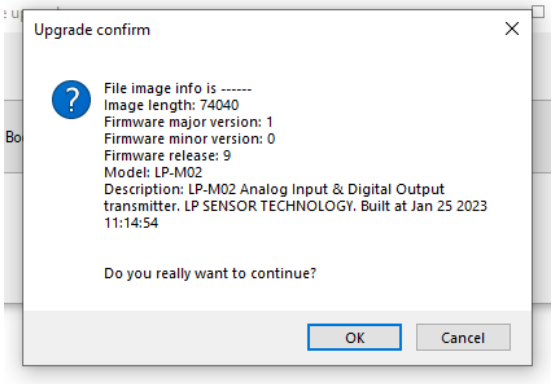


Figure 7.13 LP-M03 Firmware upgrade confirmation

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

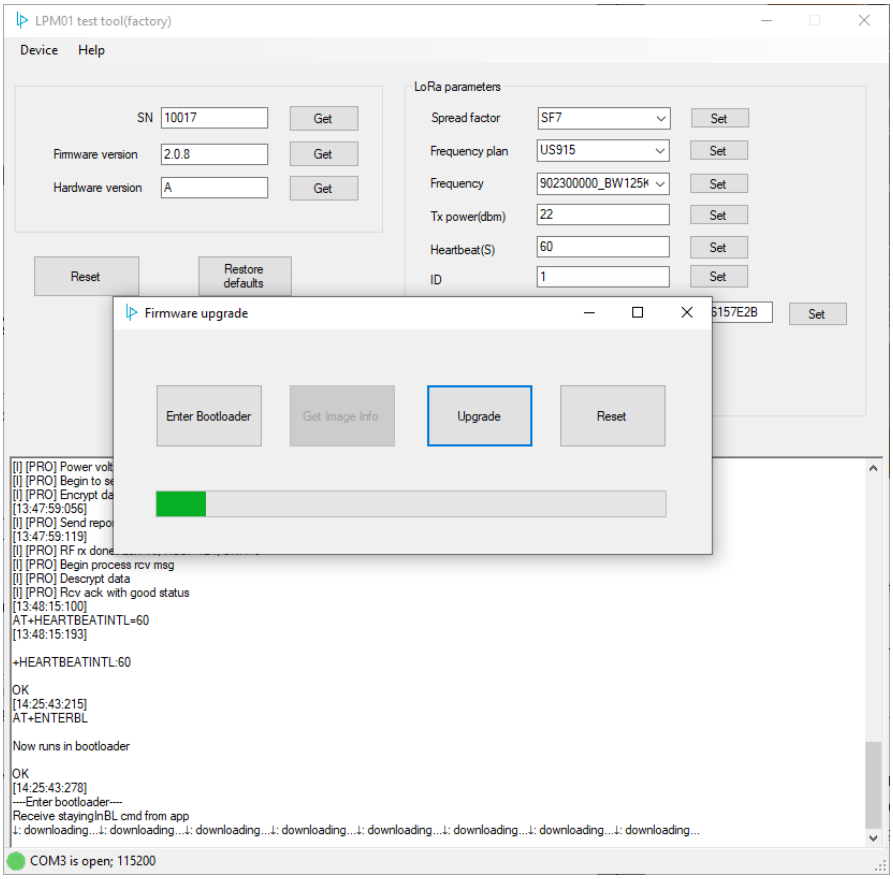


Figure 7.14 LP-M03 Firmware upgrade process

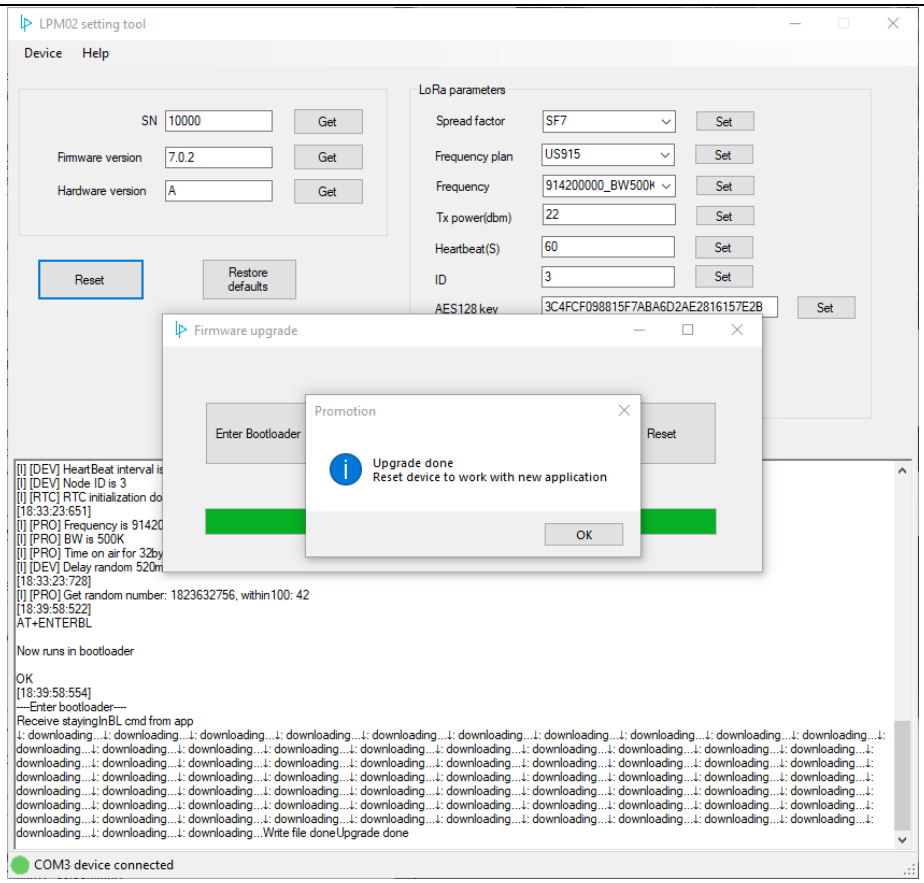


Figure 7.15 LP-M03 Firmware upgrade process finished

7) Click “Reset” after upgrade done.

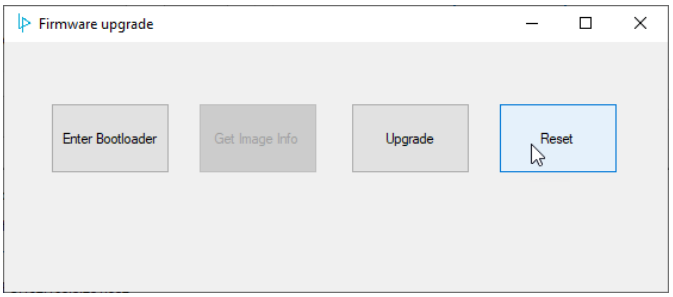


Figure 7.16 LP-M03 Reset after firmware upgrade finished

8) Click Get for new firmware version check.

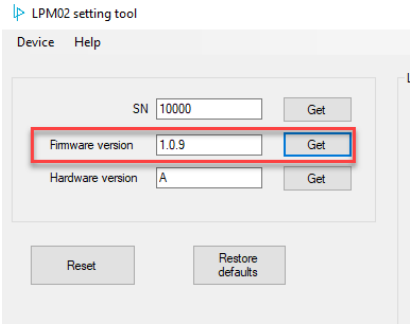


Figure 7.17 LP-M03 firmware version check

7.2.6 Analog Input setting

1) Select Pulse in Device dropdown manual

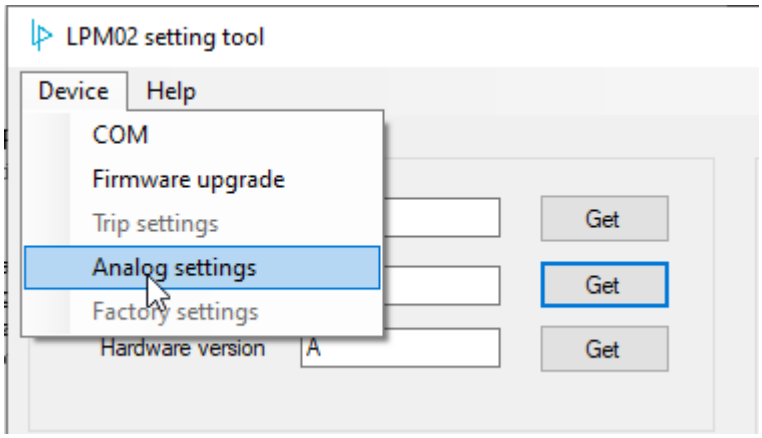


Figure 7.18 LP-M03 Setting Tool Analog Input setup select

2) Select AI01 – AI04 through drop down manual to setup Analog input channel parameters.

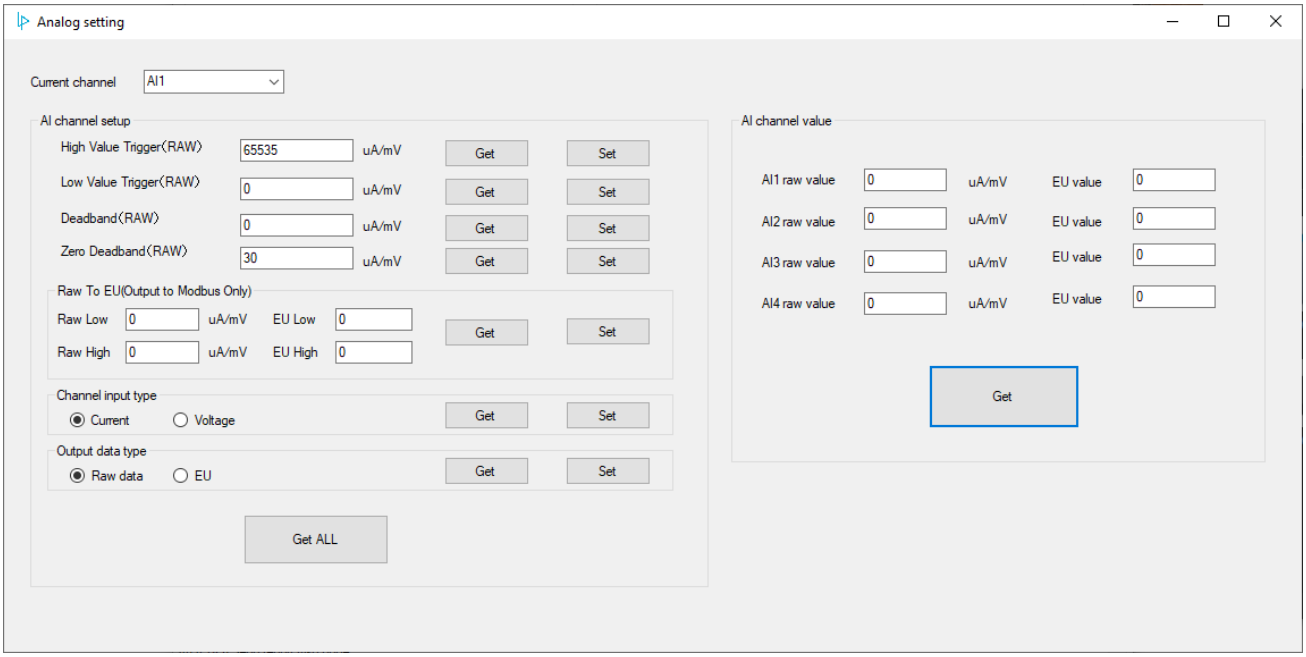


Figure 7.19 LP-M03 Analog Input Setting Window

a) **Current Channel:** Select Analog channel to setup.

b) AI Channel setup

i. **High Value Trigger (RAW):** This is the high reading level threshold to trigger M03 to send analog readings to C01 register. (M03 will report to C01 by heartbeat cycle normally if no trigger happened. If not needed, leave the value at 65535)

ii. **Low Value Trigger (RAW):** This is the low reading level threshold to trigger M03 to send analog readings to C01 register. (M03 will report to C01 by heartbeat cycle normally if no trigger happened. If not needed, leave the value at 0)

iii. **Deadband (RAW):** Setup deadband here. Only analog input value change is higher than the deadband will report to C01.

iv. **Raw to EU (Output to Modbus Only):**

Use this window to setup RAW to EU conversion.

E.g., 4-20mA RAW current analog input for a 0-100 EU output should setup as below:

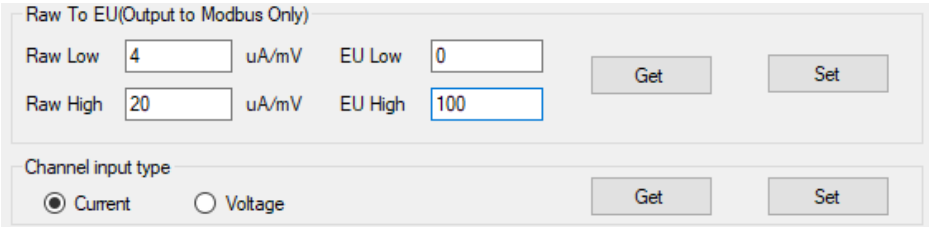


Figure 7.20 LP-M03 RAW to EU setting example

v. **Channel Input Type:** Config current or voltage input for the AI channel. **(Critical)**

vi. **Output data type**: Config M03 is sending RAW or EU data to C01 register.

vii. **AI Channel Value**: Realtime AI value readings in M03

7.2.7 Transfer Switch mode setting

1) Upgrade both Paired M01 & M03 to **7.0X Firmware** first (important).
2) The LoRa parameters of M01 & M03 bundle need to be the same. (except ID#)

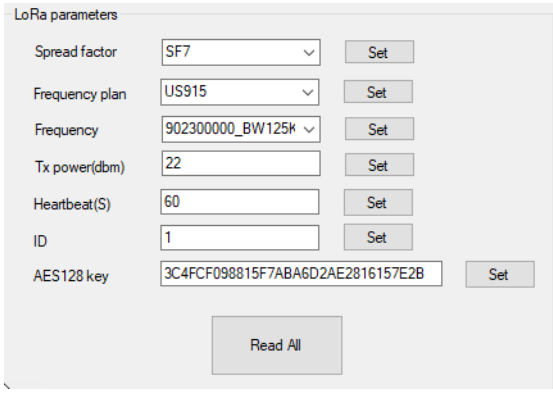
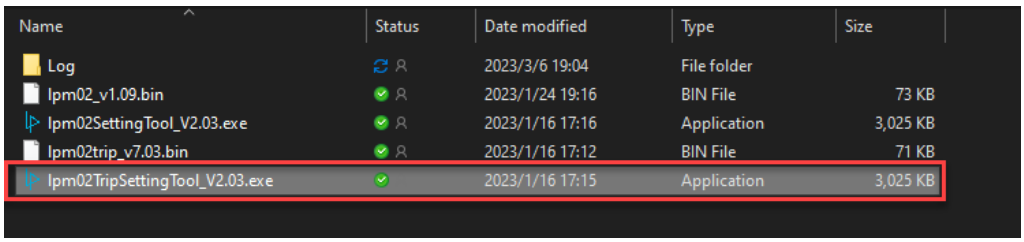


Figure 7.21 LP-M01&M03 LoRa Parameter setup

3) Select Transfer Switch Setting Tools:



Name	Status	Date modified	Type	Size
Log		2023/3/6 19:04	File folder	
lpm02_v1.09.bin		2023/1/24 19:16	BIN File	73 KB
lpm02SettingTool_V2.03.exe		2023/1/16 17:16	Application	3,025 KB
lpm02trip_v7.03.bin		2023/1/16 17:12	BIN File	71 KB
lpm02TripSettingTool_V2.03.exe		2023/1/16 17:15	Application	3,025 KB

Figure 7.22 LP-M03 Transfer Switch setting tool

4) Have the device COM connected and select Transfer Trip in device drop manual:

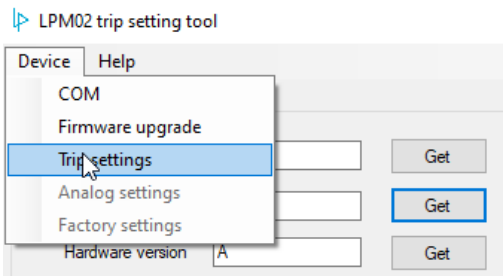


Figure 7.23 LP-M03 Transfer Switch setting tool select

5) Select Output channel on M03 in dropdown manual to setup:

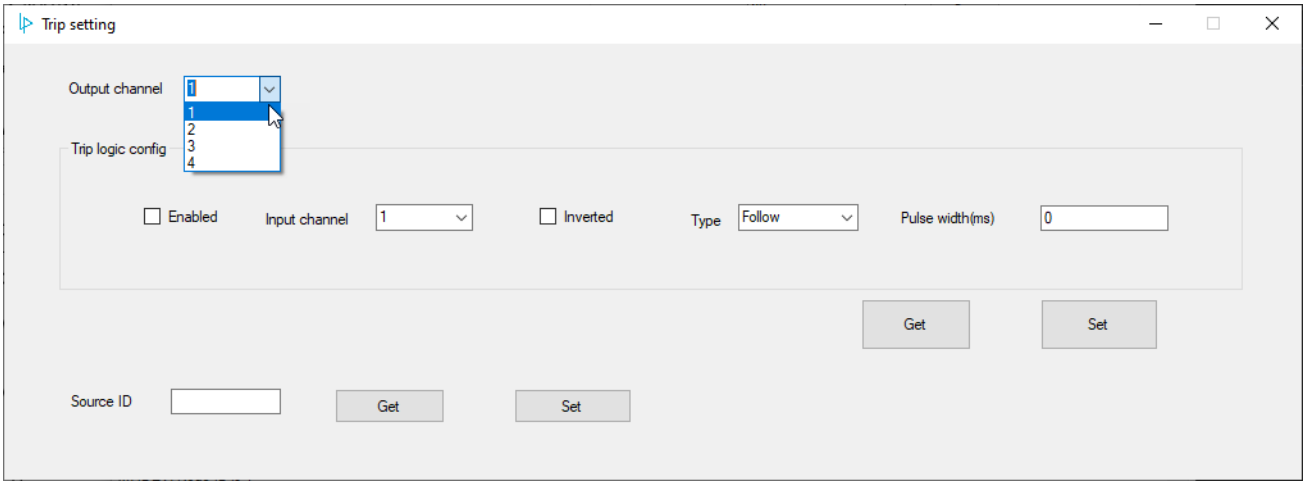


Figure 7.24 LP-M03 Transfer Switch setting window

a) **Output Channel:** Select the output DO channel to setup bundle with M01 DI input.

b) **Trip Logic Config:**

   i. **Enabled:** Select to enable bundle with LP-M01 DI input.

   ii. **Input channel:** This is the source Binary Input channel on M01 which bundled with M03.

   iii. **Inverted:** Select the Output Binary value to be inverted as input value.

   iv. **Type:** There are two types to select as options:

   - **Follow:** M03 output will send exactly same output as M01 input
   - **Pulse:** M03 output will send a user defined pulse when M01 input value send.

   v. **Source ID:** Select the M01 module ID to read the input. **(Critical)**

8 Specifications

8.1 Product Specification

Power Supply:

100-480VAC, 3 Watts maximum

Digital Output Ratings:

Contact configuration:

1 NO contacts

Rated current:

3 A @ 480VAC

Rated voltage / Max switching voltage AC:

240/480 VAC

Maximum breaking capacity AC:

1250 VA

Mechanical endurance:

15x106 cycles

Rated frequency of operation with/without load:

6/1200 min

Analog Input Ratings:

Current: 4-20mA (Range: 0-27mA)

Voltage: 0-10V (Range: 0-12.8V)

Accuracy: 0.25%

Communications:

Input latency： <100ms

Output latency: <200ms when under normal wireless environment

Wireless communication encryption：

AES-128bit custom authorization key support.

Output Protocol:

- LoRa Based encrypted wireless communication
- MODBUS TCP & MODBUS RTU (via LP-C01)

Supported LoRa Wireless Frequencies：

915MHz (US), 868 MHz (EU)

Antenna：

External

Channel：

Single

Maximum wireless communication range:

2.5 mile (with 4db Antenna installed)

UART Port：

3pin Uart wire part (For settings & firmware update only)

Operating Temperature：

–40°C to +85°C (–40°F to +185°F)

Weight

572g

Dimensions：

8.2"L*2.2"W*1.7"H

206(mm)L*54(mm)W* 34(mm)H

Compliance

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

Notes:

It is a Class A product, and it may cause interference if used in residential areas. Such use should be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

This equipment has been tested 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 source's radiating structure(s) and the body of the user or nearby persons.

SIMPLIFIED EU DECLARATION OF CONFORMITY: Hereby, LP Sensor Technology declares that the radio equipment type LP-M0 Series Industrial IoT module LP-M03 is in compliance with Directive 2014/53/EU.

Frequency Band：

Uplink: 868.1 MHz-868.3MHz for EU, 902.5 MHz-914.9 MHz for US

Downlink: 868.1 MHz-868.3MHz for EU, 903 MHz-914.2 MHz for US

9 Revision History

Table 9-1 Document Revision History

Date	Version	Revise
2024/9/5	Rev A	initial version