WoMaster

LoRa I/O Device User Manual

LoRa Master Controller
LM100/LM200
LoRa End Node Device
LC100/LR100 Series

User Manual: v1.0.4
LM100 FW: v1.3.x
LM200 FW: V1.0
LC144 FW: v1.3.x
LR 100 FW: v1.0.x
LoRa Utility: v1.3.x

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Disclaimer

WoMaster reserves the right to make changes to this user manual or to the product hardware at any time without notice. It is the user’ s responsibility to determine whether there have been any such updates or amendments herein. Defects, malfunctions, or failures of the warranted Product(s) caused by damage resulting from unforeseeable incidents (such as lightings, floods, fire, etc.), environmental and atmospheric disturbances, other external forces such as power line disturbances and surge, host computer malfunction and virus, incorrect power input, or incorrect cabling, incorrect grounding and damages caused by misuse, abuse and unauthorized alteration or repair are not warranted.

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Content

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1 Overview

The LM LoRa Master Controller and LC LoRa End-Node series utilizes the latest Low Power Wide Area (LPWA) technology to build Modbus/RTU communication for long-distance, wide-coverage, and low power consumption wireless IoT applications.

Multiple analog inputs and outputs are supported in LC100 series, such as voltage inputs and outputs, current inputs and outputs, PWM output and one RS-485 port for Modbus RTU slave. One LM100 RS485 Modbus RTU can connect up to 250pcs LC100 LoRa end nodes for two-way communications where field site analog signals are sent from LC100 and controlled by LM100. The LC100 supports up to20 Modbus slave devices.

The LR100 series support modbus function code 03,04 and LoRaWAN protocol, and also utilizes LPWA technology to build one-way, long-distance communication coverage with LoRa WAN Cloud Gateway for filed RS-485 RTU slave device connect with IoT Cloud Service.

Although the radio transmission technology is same, the LM100, LM200 and LC100 are utilized proprietary protocol based on LoRa MAC and different with LR100 standard LoRa WAN protocol.

The LC100 and LR100 support up to 20 Modbus slave devices. The LoRa wireless distance can reach up to 3-6KM distance depending on the environment.

The LM100/LC100 series offers great flexibility in wireless IoT applications, such as LED light control, environment sensors and meters reading for Smart City Applications such as Lighting, Smart Farming, Smart Environment Monitor, etc.

2 Product Specification

Model and features listed in the table below:

Feature \ Model	LM100	LM200	LC144	LR140
LoRa MAC Transparent	Yes	Yes	Yes	No
LoRa WAN Technology	No	No	No	Yes
RS 485, 2-Wire	Yes	No	Yes	Yes
LoRa RTU 485 /Slave	Yes, x1	No	No	No
LoRa RTU 485 /Host	No	No	Yes , x1	Yes, x1
Analog Input	No	No	Yes	Yes
Analog Output	No	No	Yes	No
PWM Output	No	No	Yes	No

2.1 Specification - LM100 /LM200/ LC144 Series

Wireless Specification	
Frequency	Supports 2 Models- 900Mhz, 400Mhz for different region. (the available frequency may limited by different country's law)
Wireless Technology	Low Power Wide Area – LoRa MAC Technology
Radio TX Power	22dBm (Maximum). The launch power may be limited by country's law.
Radio RX Sensitivity	- 148dBm, SF=12 @ 250bps
Spreading Factor	SF5/SF6/SF7/SF8/SF9/SF10/SF12, Default SF7 Remote Configurable by ModBus RTU / Register writing command or configured through USB interface by LoRa Utility (Contact your sales for Utility tool)
Demodulator SNR	LoRa Demodulator Signal to Noise Ratio: -2.5dB ~ -20dB
Operating Mode	Modbus protocol over the Air (LoRa MAC Transparent Transmission) with configurable Echo time and retransmission technology
Forwarding Data Buffer	256Bytes FIFO Data Buffer for LoRa signal transmission
Data Encryption	128bits AES with configurable key
Management	

System Management	1 x Micro USB 2.0 port for system configuration
Software Utility	Windows© Based Utility
Remote Management	Remote Configure by Modbus RTU/ Read/Write Command
I/O Interface	
Antenna Connector	1x 50 ohm, Female SMA
Serial Interface	2-wires RS-485 Terminal Connector with 1kv isolation Connector Type: Removable Terminal Connector Supported Model: LM-100 (Slave), LC-100(Host)
Serial Parameters	Baud Rate: 1200bps,2400bps, 4800bps, 9600bps Data Bits: 8 Parity Check: None, Even, Odd Stop Bit: 1,2
Current Input	2 Channels Detection Range: 4-20mA Accuracy Level: 0.3%
Voltage Input	2 Channels Detection Range: 0~10 V Accuracy Level: 0.2%
Current Output	1 Channel Output Range: 4-20mA @ Typical 24V Power Input Accuracy Level: 0.3%
Voltage Output	1 Channel Output Range: 0.03~10V Output Type: Open Collect (O.C.) / Push-Pull (Internal Jumper setting) - Accuracy Level: 0.2%, Full Scale (F.S.)
PWM Output	Frequency: 100Hz~1KHz with 0.2% Duty-Cycle Accuracy Output Type-1: 5V, 200mA (Max) Output Type-2: Open Collect (O.C.), 10V /200mA (Max)
System Indication	
LED	Power (On): System Power applied LoRa (Blinking): LoRa RF Signal on Communication
Power Requirement	
Input Rating	Typical DC 24V, Rating: 10~30V 3-Pins Removable Terminal Connector for V+ ,Com and Earth Ground
Reverse Protection	Yes
Power	LM100/LM200: 1 Watt @ DC 24V power input

Consumption	LC144: 3 Watts (Max) @ DC 24V power input
Mechanical	
Installation	DIN Rail Mount
Enclosure Material	UL94v0, ABS , Anti- U/V
Ingress Protection	IP 40
Dimension	26(D) x 102.5 (H) x 72 mm (W) / with wall mounting clip
Weight	115g
Environmental	
Operating Temperature	-40°C~75°C, 0% ~ 90%, Non-Condensing
Storage Temperature	-40°C~80°C, 0% ~ 90%, Non-Condensing
Reliability & Warranty	
MTBF	>20000 Hours
Warranty	3 Years
Standards	
EMC	Compliance with IEC / EN61000-6-2, IEC/ EN61000-6-4 (**Note-1**)
EMI	Electromagnetic Immunity: CISPR 22, FCC part 15B Class A (**Note-1**)
EMS	Electromagnetic Suspension: IEC 61000-4-2 ESD IEC 61000-4-3 RS IEC 61000-4-4 EFT IEC 61000-4-5 Surge IEC 61000-4-6 CS IEC 61000-4-8 Pulse Magnetic Field

Note: 1. Compliance standards.

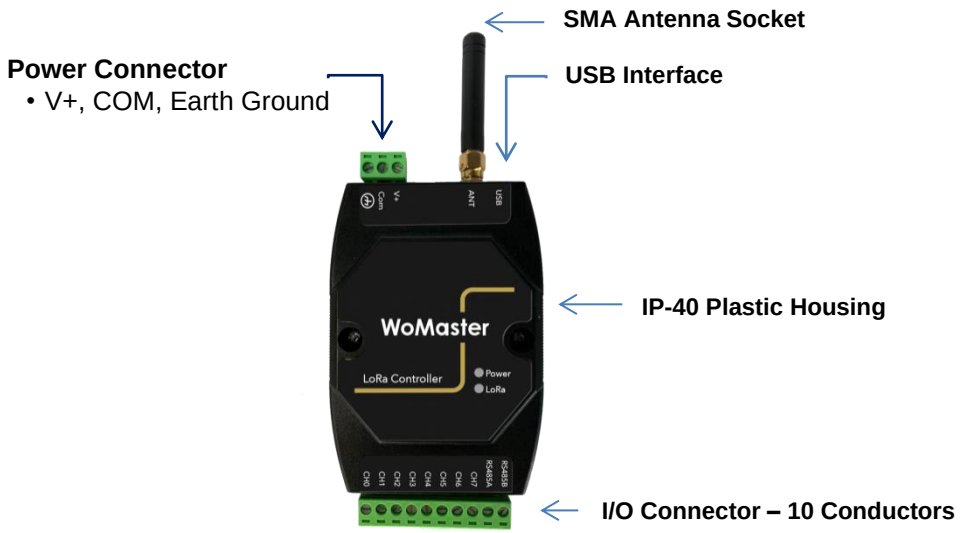
2.2 Specification - LR140

Wireless Specification	
Frequency	-900 model : Frequency Support EU 868Mhz, US915Mhz, AS 923Mhz, KR 920Mhz -400 model : Frequency Support EU 433Mhz Frequency adjust by Utility
Wireless Technology	Low Power Wide Area – LoRa MAC Technology
Radio TX Power	17dBm (50mW) (Maximum)
Radio RX Sensitivity	- 148dBm, SF=12 @ 250bps
Spreading Factor	SF5/SF6/SF7/SF8/SF9/SF10/SF12, Default SF7 Remote Configurable by ModBus RTU / Register writing command
Demodulator SNR	LoRa Demodulator Signal to Noise Ratio: -2.5dB ~ -20dB
Operating Mode	Modbus protocol over the Air (LoRa MAC Transparent Transmission) with configurable Echo time and retransmission technology
Forwarding Data Buffer	256Bytes FIFO Data Buffer for LoRa signal transmission
Data Encryption	128bits AES with configurable key
Management	
System Management	1 x Micro USB 2.0 port for system configuration
Software Utility	Windows© Based LoRa Utility
I/O Interface	
Antenna Connector	1x 50 ohm, Female SMA
Serial Interface	2-wires RS-485 Terminal Connector with 1kv isolation Connector Type: Removable Terminal Connector Supported Model: LM-100 (Slave), LC-100(Host) Modbus Function Code: #1,#2,#3,#4,5,#6,#15,#16 DMA function: Available on LC144 for Modbus Read Function Code
Serial Parameters	Baud Rate: 1200bps,2400bps, 4800bps, 9600bps Data Bits: 8 Parity Check: None, Even, Odd Stop Bit: 1,2

Current Input	2 Channels Detection Range: 4-20mA Accuracy Level: 0.3%
Voltage Input	2 Channels Detection Range: 0~10 V Accuracy Level: 0.2%
System Indication	
LED	Power (On): System Power applied LoRa (Blinking): LoRa RF Signal on Communication
Power Requirement	
Input Rating	Typical DC 24V, Rating: 10~30V 3-Pins Removable Terminal Connector for V+ ,Com and Chassis Earth Ground
Reverse Protection	Yes
Power Consumption	LR-140: 3 Watts @ DC 24V power input

3 System Appearance & Connector description

The LM, LC and LR series utilize same enclosure with one 3-pin terminal connector for system power and earth grounding. The other 10-pin connector is I/O access. The detail assignment will show in the following table.



I/O Channel #	LM100/LM200	LC144	LR140
0	Not Available	V-in: 0~10V, Positive	V-in: 0~10V, Positive
1	Not Available	I-in: 4~20mA, Positive	I-in: 4~20mA, Positive
2	Not Available	V-in: 0~10V, Positive	V-in: 0~10V, Positive
3	Not Available	I-in: 4~20mA,Positive	I-in: 4~20mA,Positive
4	Not Available	I-out:4~20mA, Positive	Not Available
5	Not Available	V-out:0~10V, Positive	Not Available
6	Not Available	PWM-out: 5V,Positive	Not Available
7	Not Available	PWM-out: 10V Positive	Not Available
RS-485A	RTU Slave mode (LM100) Not Available (LM200)	RTU Host mode	RTU Host mode
RS-485B	RTU Slave mode (LM100) Not Available (LM200)	RTU Host mode	RTU Host mode

Table 3-1

Note: The analog input/ output Com (negative) is share with Power Input “Com”.

4 Hardware Installation

4.1 DIN Rail Installation

The LM100/LM200, LC100 and LR100 series supports DIN Rail installation, insert the upper end of the DIN-Rail clip into the back of the DIN-Rail track from its upper side and lightly push the bottom of the DIN-Rail clip into the track. The DIN Rail should comply with DIN EN50022 standard. Using wrong DIN rail may cause unsafe installation.

4.2 Power Wiring

The system power input range supports DC 10~30V. It is recommended apply AC/DC Switching type power supply with DC 24V/1.5A output for the main power source. The Following diagram shows how to wiring the power system from AC/DC Switching Power Supply

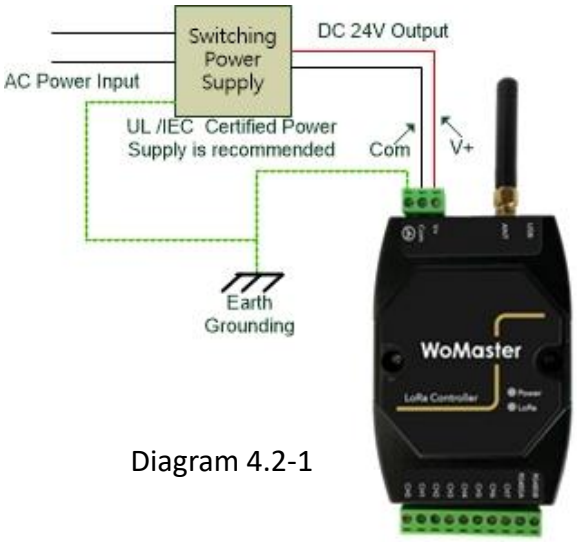


Diagram 4.2-1

During the power wiring, please turn-off the AC power input, and make sure the Earth Ground is well connected with Switching Power Supply module, LoRa Device and Earth Grounding System for noise immunity.

4.3 Analog Input Wiring

The LC144 and LR140 support 2 Types of Analog Input, 4~20mA and 0~10V with 3‰ accuracy.
The Analog Input function is available for LC100 and LR100 series. About the definition of channel type, please refer to Table 3-1, Chapter-3.
Both of LC144 and LR140 adopted 12bits A/D converter with 3‰ accuracy for the industrial IoT filed site application.

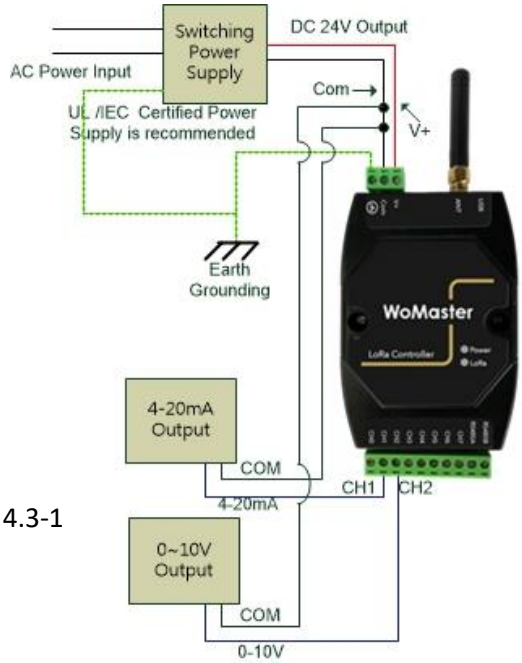


Diagram 4.3-1

4.4 Analog Voltage Output Wiring

The Analog output provides 0~10V voltage output open collect (O.C.) driven mode, and 4~20mA current output.

The analog voltage output supports output range from zero to 10 volts with push-pull or external O.C. mode for Far-End device internal pull-high application.

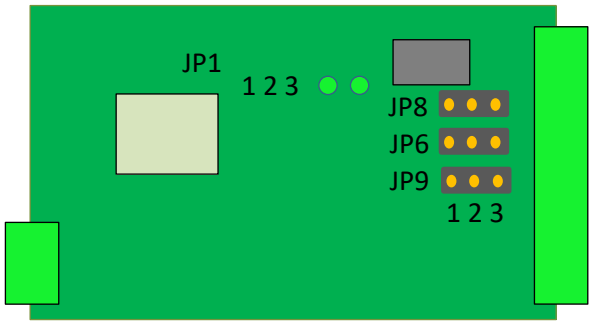
Push-Pull mode: Internal pull high resistor and connected to Power Input V+, and output current up to 200mA.

O.C. mode: External pull high by far-end connected device where the control input circuit adopted resistor and connected to internal power.

Jumper	Channel #	Location	O.C. – Ext. Pull-High	Push-Pull. Internal Pull-High (No Ext. R)
JP8	CH-7 (PWM 10V)	Nearby CH-7	1-2 Short (Default)	2-3 Short
JP6	CH-6 (PWM 5V)	Nearby CH-6	1-2 Short	2-3 Short (Default)
JP9	CH-5 (Vout)	Nearby CH-5	1-2 Short (Default)	2-3 Short

There are 4 jumpers located at PCBA top side as following drawing.

Change the JP8, JP6 and JP9 for output mode change, and the JP1 is for firmware upgrade.



CH-5 Voltage Output (0~10V) – JP9

The Push-pull output current up to 200mA, and the O.C. mode depends on the connected device internal pull-high resistance. Change the position of JP9 for mode changes. In push-pull mode, the output voltage should lower than Power input voltage. Since, the internal circuit is connected with system power.

4~20mA Current Output: the current output control is commonly used at linear control system, like as electrical valve control applied for oil/liquid control system.
The I-out (CH4) wiring refers to Diagram 4.4-2.

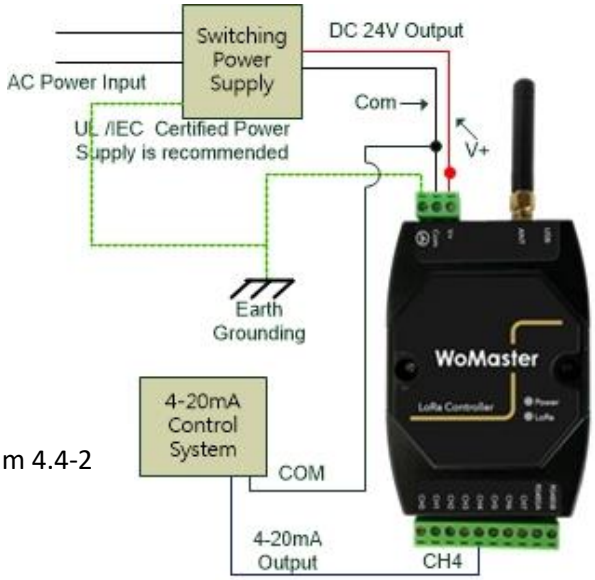


Diagram 4.4-2

4.5 PWM (Pulse Width Modulation) Output

CH-6 PWM 5V Output – JP6

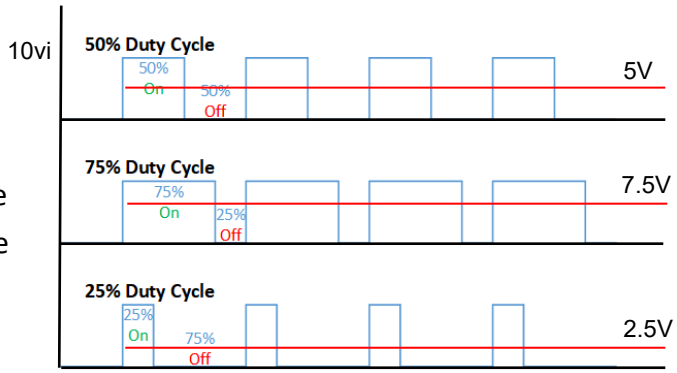
The CH-6 default is PWM 5V output with certain duty-cycle and operating in push-pull mode. Once, the jumper change to O.C. mode the output voltage will refer to the connected device internal voltage, the limited voltage is 30V.

CH-7 PWM 10V Output – JP8

The CH-7 default is PWM 10V output with certain duty-cycle and operating in push-pull mode. Once, the jumper change to O.C. mode the output voltage will refer to the connected device internal voltage, the limited voltage is 30V.

Theory of PWM Duty-Cycle Control

The PWM control uses constant voltage as output, and adjusts the duty cycle to control the PWM dimmer output.
In the diagram 4.5-1, the output voltage is 10V, modulate the On/Off duty cycle, and the end control device internal get voltage will be "Full-Volt x Duty Cycle %".
Example: Full _Output = 10V
50% Duty Cycle, the End Control Device measured 5V, 75% get 7.5V and so on.



4.6 RS-485 Wiring

The LM, LC and LR series have equipped one isolated 2-wire RS-485 serial interface for long distance communication. The baud-rate support 1200bps, 2400bps, 4800bps and 9600bps, it is configured by LoRa Node Utility that download from WoMaster support Web site. The RS-485 HOST mode is supported in LC and LR model, and SLAVE mode only for LM100.

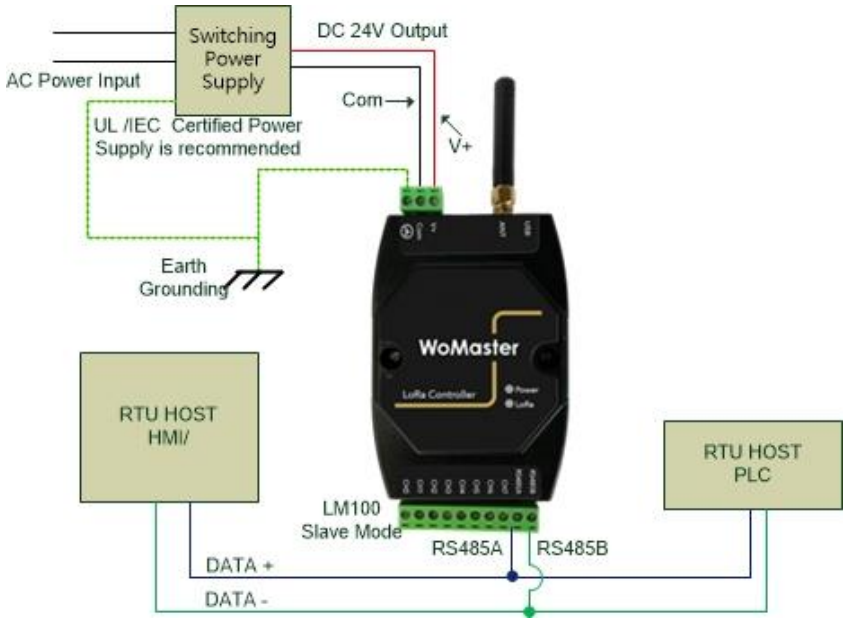


Diagram 4.6-1

The diagram 4.6-1 show the LM100 connects with Host Device, such as HMI, PLC system, and the diagram 4.6-2 show the LC100, LR140 connect with RTU Sensors.

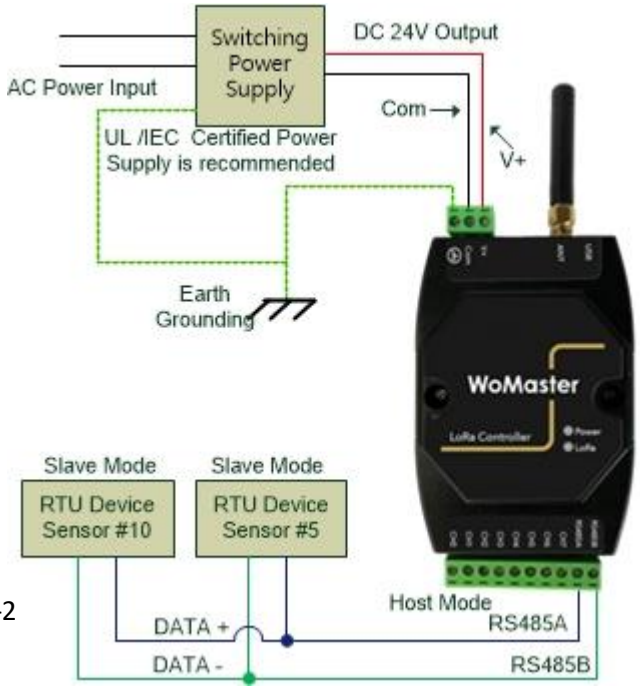


Diagram 4.6-2

5 LoRa Utility Configuration

The LoRa Node device must configure before installed on the filed-site, the LoRa Utility could be down-load from the website: www.womaster.eu.
Connects the LoRa device with computer and power reset the LoRa device, then the LoRa device will into configure mode when detected the USB mode change. During the configuration mode, all of new system settings will not effective until next power reset.

5.1 Connects LoRa device with LoRaUtility

The LoRa Utility is un-installed, ensure the LoRa node device have powering on, connecting with PC via USB cable before execute the Utility – " LoRaUtility.exe".

The Utility main screw show as below diagram " 5.1-1 Full Function TAB"

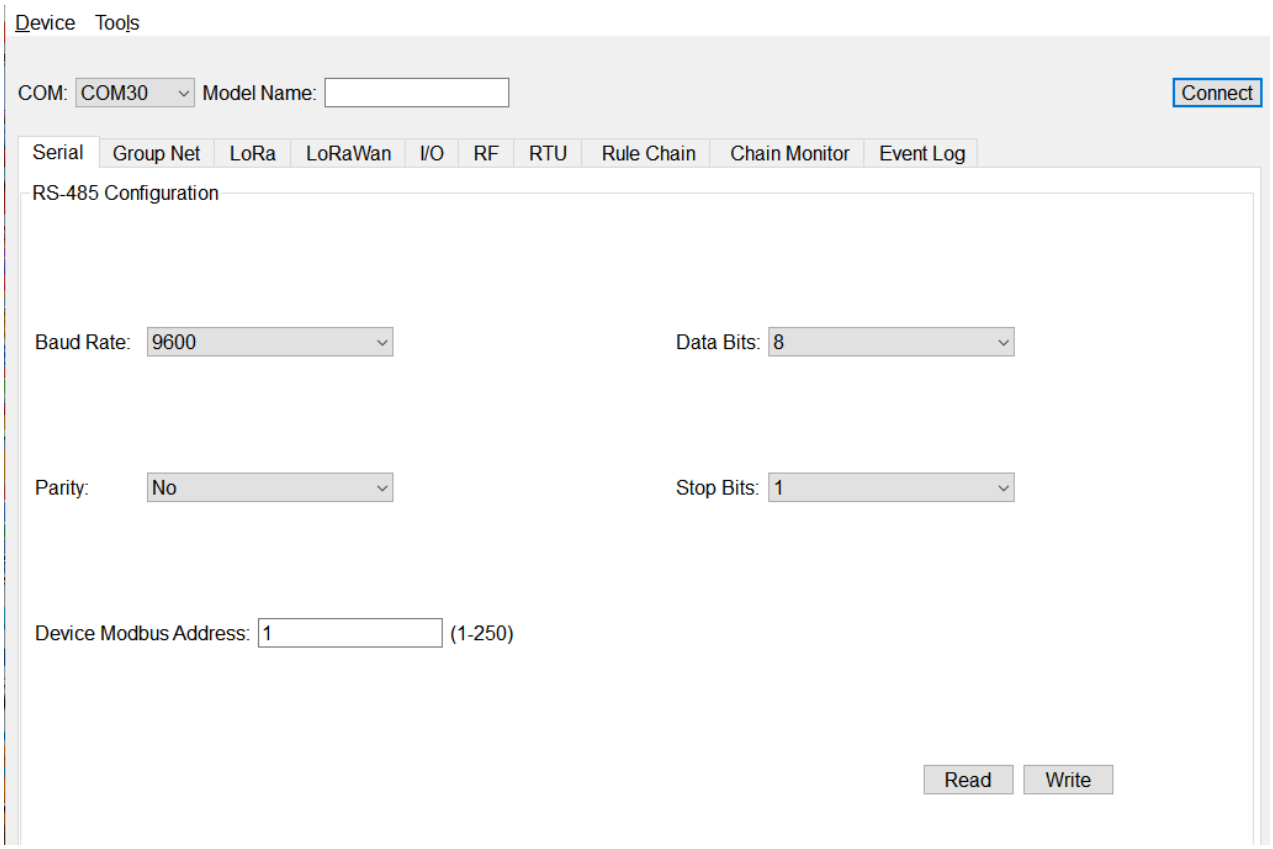


Diagram 5.1-1 Full Function TAB

Click “COM” and select the USB mapping com port number. Diagram 5.1-2

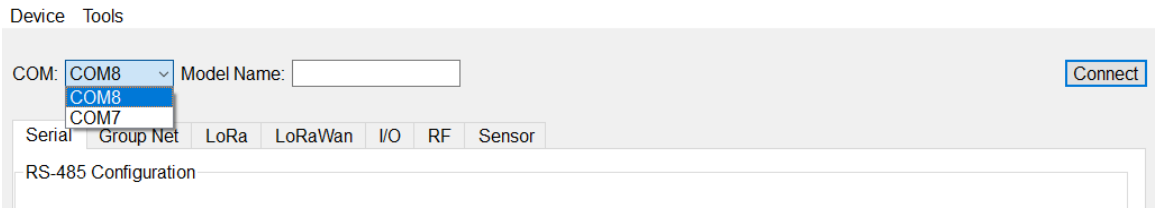


Diagram 5.1-2

Clicks the “Tools”, selects the “Options” for PC USB/Serial setting. The default parameter is Non parity check, 115200bps, 8 Data bits, 1 Stop bit (115200, N, 8, 1), the response time out is 1000ms, and retry number is 1. After new parameters setting, click “Apply” to apply the setting. It is recommend does not modify these parameters. The LM100/LM200/LC100/LR100 supports USB COM port baud rate auto sensing. Diagram 5.1-3, 5.1-4

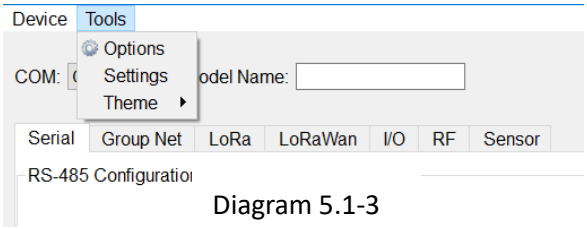


Diagram 5.1-3

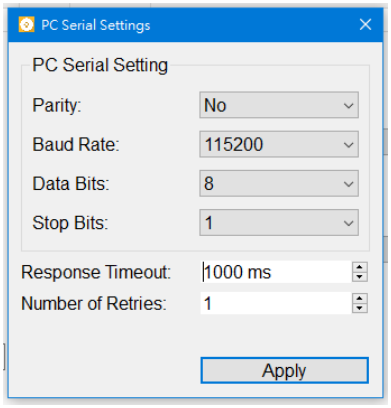


Diagram 5.1-4

Click the “Connect” icon, the login dialog will pop up for user name and password input. Diagram 5.1-5

LR140 LC144 communication mode just only select USB. LM communication mode can select USB and 485.

Default User Name and Password is “admin”

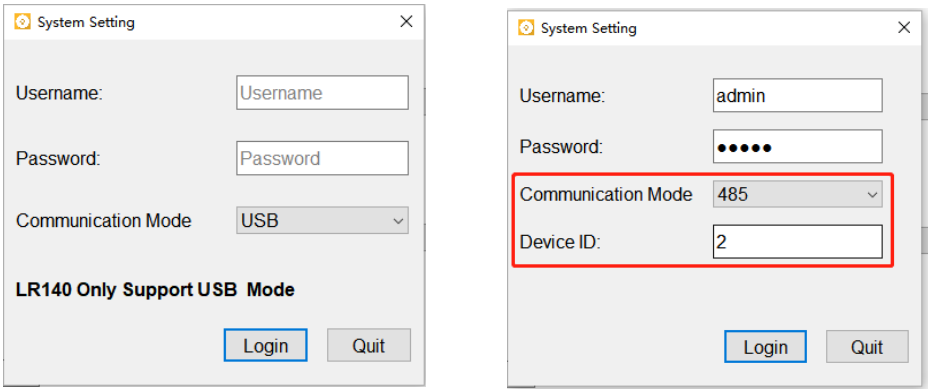


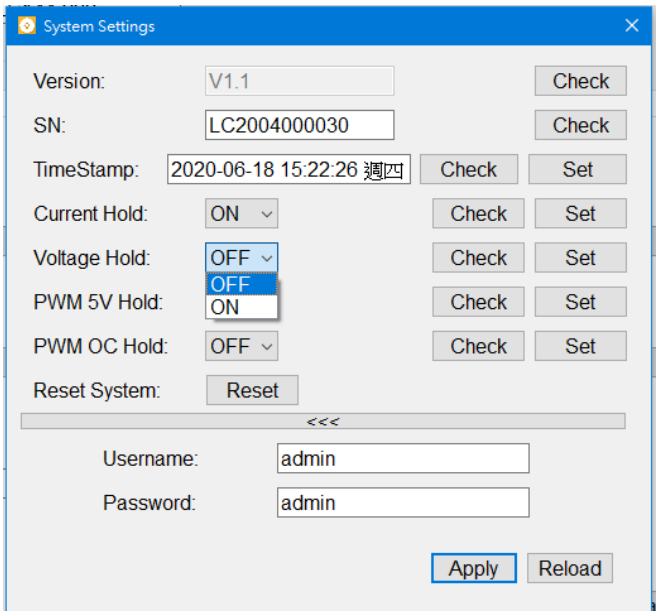
Diagram 5.1-5

System Settings for version, S/N, TimeStamp, Output value Hold configure and Username, Password modification.

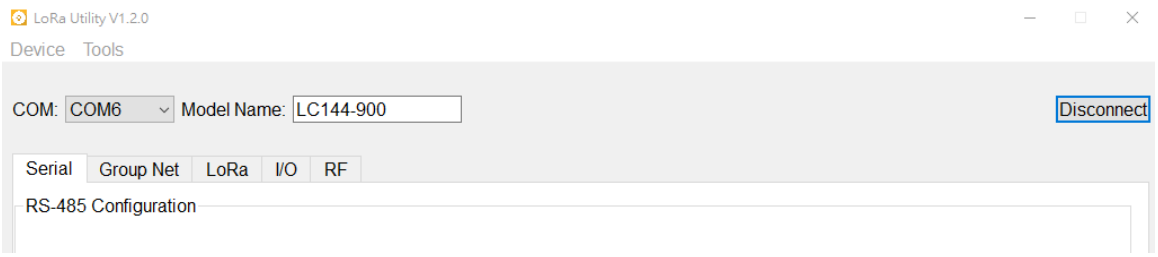
Clicks the “Tools” and select the “Setting” for those parameters setting.

Click “Apply” icon to apply the new setting, then warning dialog will pop up to make sure perform new setting. Click “Yes” to apply it. Diagram 5.1-5

Character Length is 16Bytes for username and password.



Once login the LoRa Node system, the utility will show the connective device model and the COM port information. Meanwhile, it will present available function TAB for different model. For the easy understanding, the function TAB listed in table as following Table 5.1-1 for fdifferent product series.



Function TAB	LM100	LM200	LC100	LR100	Note
Serial	Modbus Slave	N/A	Modbus Host	Modbus Host	
Group Net	Yes	Yes	Yes	N/A	
LoRa	Yes	Yes	Yes	N/A	
LoRaWan	N/A	N/A	Not Available	Yes	
I/O	N/A	N/A	Yes	Analog Input	
RF	Yes	Yes	Yes	Yes	
RTU	N/A	N/A	Yes	Yes	
Rule Chain	N/A	N/A	N/A	N/A	IO Mapping
Chain Monitor	N/A	Yes	N/A	N/A	
Event Log	N/A	Yes	N/A	N/A	

Table 5.1-1

5.2 Serial Port Configuration – LM100, LC100, LR100

The LM100/ LC100/ LR100 support one RS-485 serial interface with different Modbus mode. Following table shows the Modbus mode information for each model.

Channel #	LM100	LC144	LR140
RS-485A	RTU Slave mode	RTU Host mode	RTU Host mode
RS-485B	RTU Slave mode	RTU Host mode	RTU Host mode

Table 5.2-1

The Serial RS485 Configuration Page is for Serial communication parameter setting. Click “Read “to download device’s internal setting, and “Write” to set new parameters into device. The LM/LC should give independent Device Modbus Address. The LM’s Modbus address also is the Group ID for LM/LC LoRa MAC Net Grouping.

Baud Rate: 1200, 2400, 4800, 9600 bps
Data bit: 8 bit
Parity Check: No, Even, Odd
Stop bit: 1, 2bit
Device Modbus Address: the Modbus address ID range supports from 1 to 250. The Modbus Address should not same as other device which belong same LoRa MAC communication group, it includes HMI, PLC on RS485 main communication bus, and other RTU devices connected under LC100.

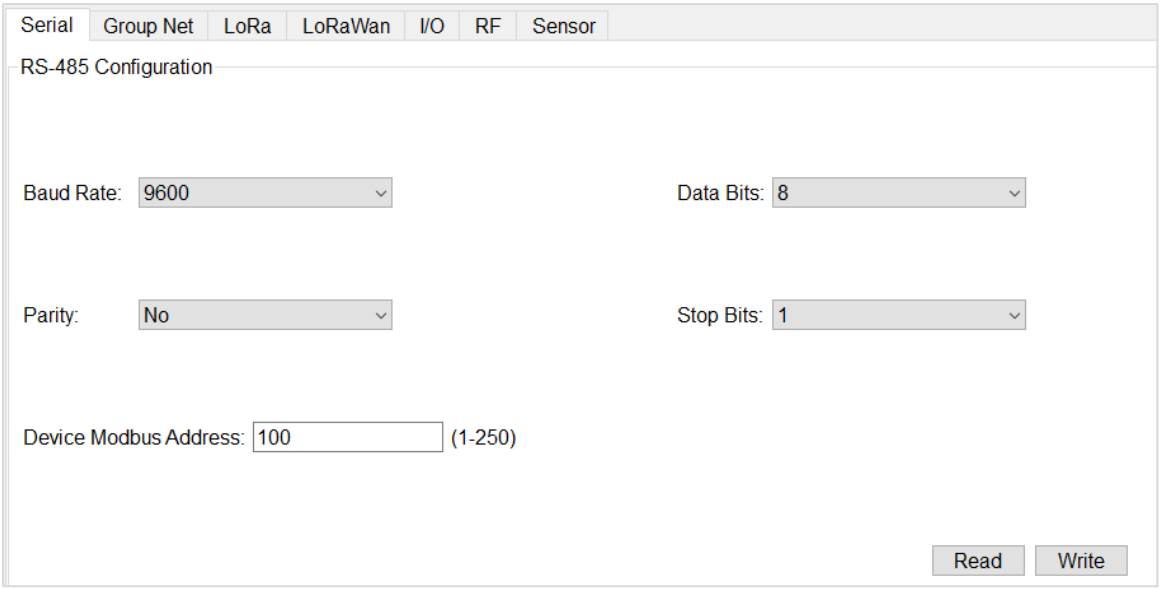


Diagram 5.2-1

5.3 Group Net – LM100, LM200 and LC100

Group Net Parameters – establish a wireless communication group that deploys LoRa MAC technology. Click “Read” to read current parameter, and click” Write” to write new parameters into system.

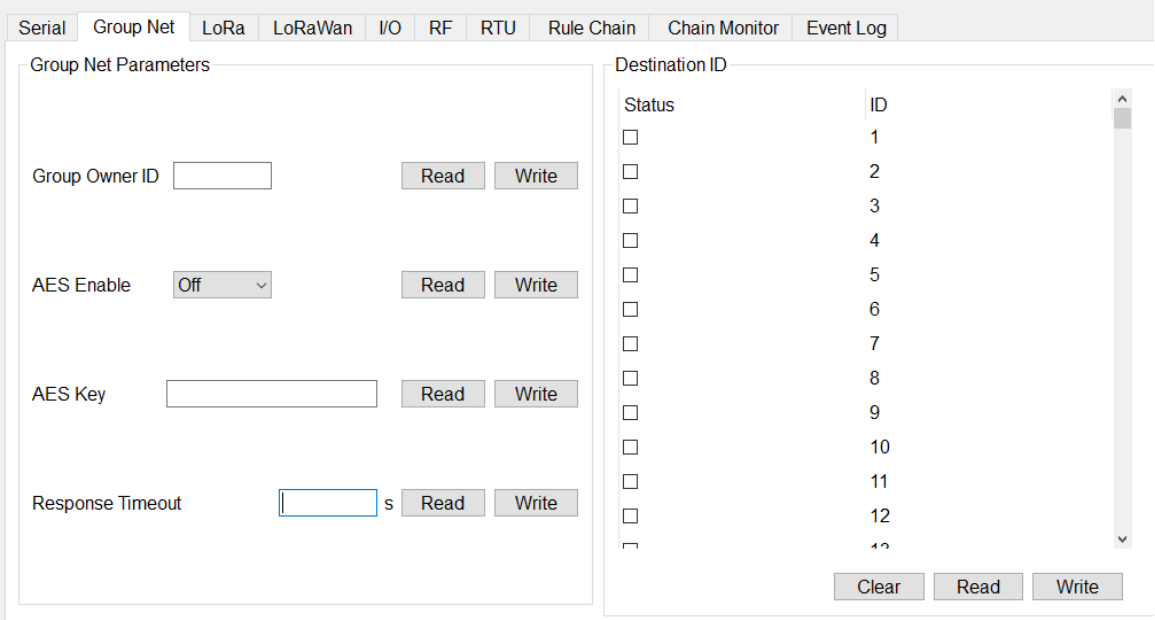


Diagram 5.3-1

GroupOwner ID: It is only for LoRa Controller -LC series, and LM is not allows perform read and write. The Group Owner ID is the Modbus ID address of LM100 or LM200. The LoRa Controller –LC series recognize LoRa packet received and send to Group Net owner (LM) will utilize this Group Owner ID (LM’s Modbus ID). With wrong Group Owner ID setting will cause communication malfunction. As the net grouping theory, the LC devices with same Modbus ID address will not communicate with wrong LM. Since, each LC has its own Group Net Owner.

AES On/Off: Enable, Disable the encryption of Lora transmission. The encryption key of LM and LC should be same.

AES Key: the encryption key for LM and LC series. Key length supports 16bytes.
The LM and LC which are in same LoRa MAC transmission group should be applied with same AES Key for Data encryption.

Response Time Out: Set the timeout time for each communication between LM and LC. As the LPWAN LoRa wireless technology, it does not guaranty the reliability of LoRa Communication. As this resulting, the LM and LC deployed ECHO mechanism to make sure the successful of communication. During the time-out period, LM will re-transmit

until out of time. If the Upper layer Modbus RTU Host (HMI, PLC controller) request busy and the LM100 can't establish communication with LC, then the Modbus Data may be dropped. However, the Modbus protocol also specifies the re-polling and waiting timer mechanism for the real filed-site application if far-end Modbus slave in busy.

Destination ID: This setting is only for LC that has connected to Modbus RTU slave device. Those Modbus RTU slave devices have independent Modbus Device Address. Click and Select the Address for Modbus RTU slave Devices which are installed with LC or LR.
Click "Read" to download the RTU Modbus slave device's ID that storage in the LC or LR, and "Write" to write new RTU slave device's ID into LC.

5.4 LoRa (LoRa MAC Transmission Technology) – LM100/LM200/LC100

The LoRa setting page is the configure page for LoRa transmission parameters about Radio frequency, Bandwidth, Spreading Factor, Code Rate and the Transmit power. Click "Read" to down load previous setting, and "Writing" to keep new settings into LM100 and LC100.
This setting page is not available for LR140. Since, LR140 follows LoRaWAN standard protocol, LR140 will auto search and negotiate with LoRaWAN Gateway.
The LoRa Transmission parameters of LM100 and LC100 should be same for the successful LoRa communication.

After all of setting is done, Click "Write" to apply new parameters into device, and "Read' for current setting inspect.

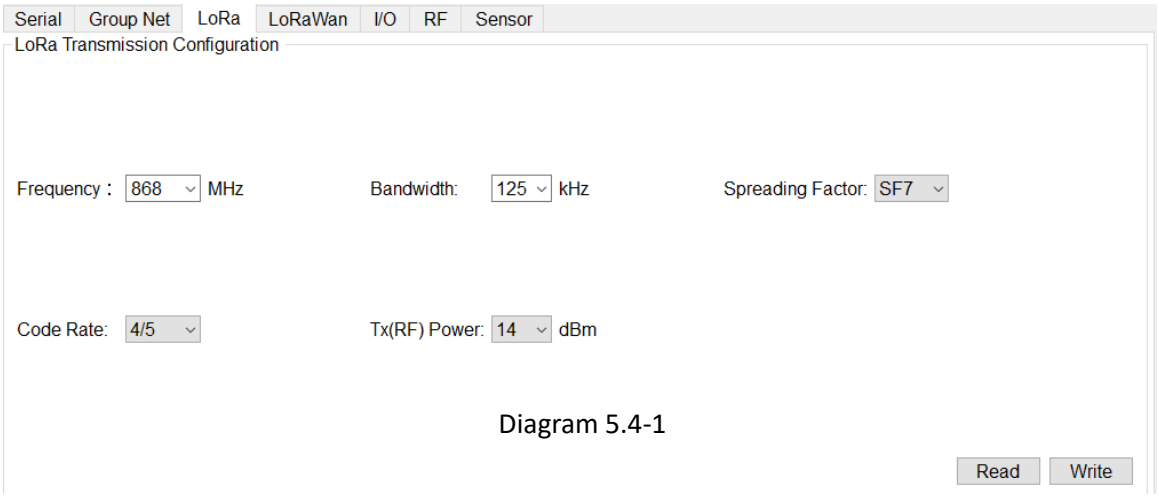


Diagram 5.4-1

Frequency: Main Frequency Setting of LoRa Radio Frequency. The LM100 and LC100 provide 2 types of major central frequency for different region, 400Mhz and 900Mhz. Check your device model and select suitable frequency that match your device's operating frequency.
For example, LC144-900 supports 850~930 MHz, which is specified in the range of 900 MHz Radio Model. With wrong frequency setting may cause system malfunction.

In some models for certain region or country, the frequency and TX power is specified. The utility can't modify the frequency and TX power, then it will poll-up error dialog to remind error setting.

Region Model	Operating Frequency	Radio Model
EU433	433Mhz	400Mhz
EU868	868Mhz	900Mhz
AS923	923Mhz	900Mhz
KR920	920Mhz	900Mhz
US915	915Mhz	900Mhz

Table 5.4-1

Bandwidth: there are 3 options for bandwidth setting- 125 Khz, 250 Khz, 500 Khz.

Spreading Factor: there are 8 options for Spreading Factor setting – SF5, SF6, SF7, SF8, SF9, SF10, SF11, SF12.

The effective amount of LoRa transmission data is related to the spreading factor and bandwidth. In the following reference table 5.4-2, it shows the amount of bitrate is decrease with Spreading Factor based on 125 khz bandwidth. It is trade off with Spreading Factor and bandwidth. With the higher Spreading Factor, the transmission will get better Signal Noise Ratio to ensure the transmission quality, but got lower bitrate, higher distance and slower transmit time.
Here is the trade-off concept of LoRa:
Lower the Spreading Factor -> Higher the Data Rate.-> Less Range
Higher the Spreading Factor -> Less the Data Rate –>Higher the over-the-air time.-> More range

Spreading Factor	Chips/Symbol	SNR Limit	Time-on-air (10Bytes Packet)	Bitrate
7	128	-7.5	56ms	5469 bps
8	256	-10	103ms	3125 bps

9	512	-12.5	205ms	1758 bps
10	1024	-15	371ms	977 bps
11	2048	-17.5	741ms	537 bps
12	4096	-20	1483ms	293 bps

Table 5.4-2 Based on 125 Khz Bandwidth

Code Rate: supports 4 options 4/5, 4/6, 4/7, 4/8.

Tx(RF) Power: Transmit power setting. The maximum transmit power up to 22dBm.

5.5 LoRaWan-LR100 only

The LoRaWan Setting page I sonly for Device which is supports LoRaWAN protocol-LR100 series. It is not available for LM100 and LC100 series.

The LR100 series support 2 communication mode with LoRaWAN Gateway – ABP and OTAA modes. The LR100 series only supports 1 communication mode, either ABP or OTAA. The communication mode should be same as the LoRaWAN Gateway.

Before setting those parameters, you have to prepare LoRaWan gateway that LR100 is going to connected.

For example, the diagram 5.5-2 and diagram 5.2-3 show the LoRaWan Server configure WEB UI of WR322-EC-LoRaWAN in ABP mode and OTAA mode.

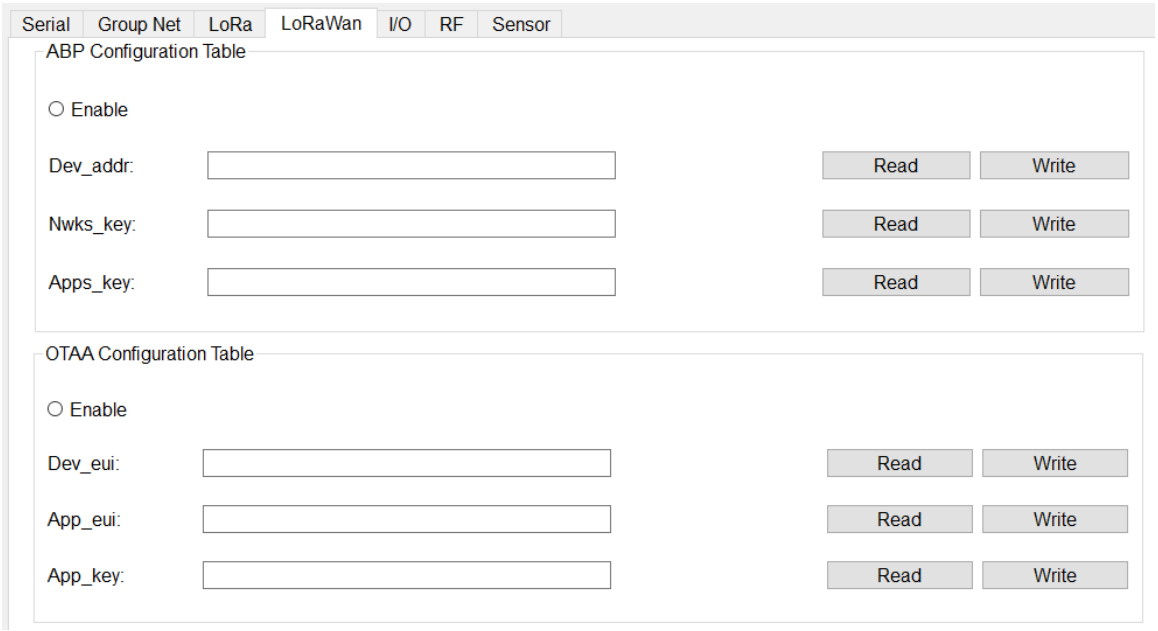


Diagram 5.5-1

Select ABP or OTAA mode, and Click “Enable”, fill-in the parameters that gets from LoRaWAN Gateway and Click “Write” to write new setting to LR100, “Read” to get

current setting.

The LR100 communication with WR322-EC-LoRaWAN in OTAA mode, the App_eui is not necessary. But, for the other brand of LoRaWan Gateway, it may need fill-in App_eui information.

The parameters of ABP and OTAA should be generates by LoRaWan Gateway, refers the diagram 5.5-2, 5.5-3. By click the “Generation” to generate that information.

ABP Configuration Table

Enable: Click and Select LR100 operating in ABP mode with LoRaWan Gateway

Dev_addr (Device Address): Device Address of LoRaWan Gateway

Nwks_key (Network Session Key): communication session key between LoRaWAN Gateway and LR100.

Apps_Key (Applications Key): the key of Application

OTAA Configuration Table

Device_eui: Extended Unique Identifier of Network Device

App_eui: Extended Unique Identifier of Network Device

App_Key (Application Key): the key of Application

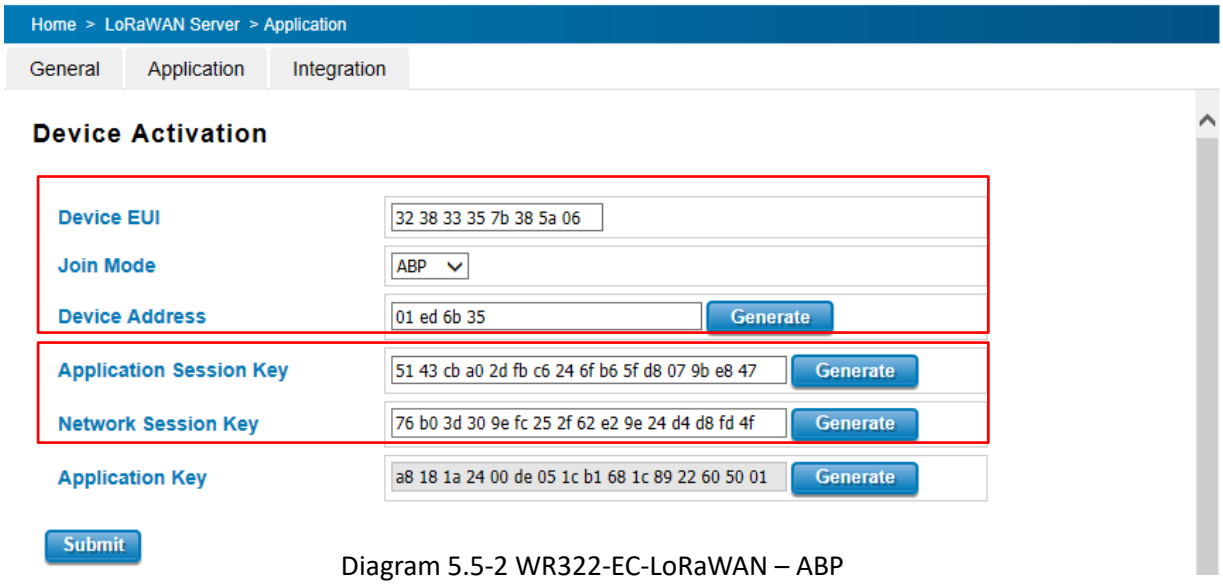


Diagram 5.5-2 WR322-EC-LoRaWAN – ABP

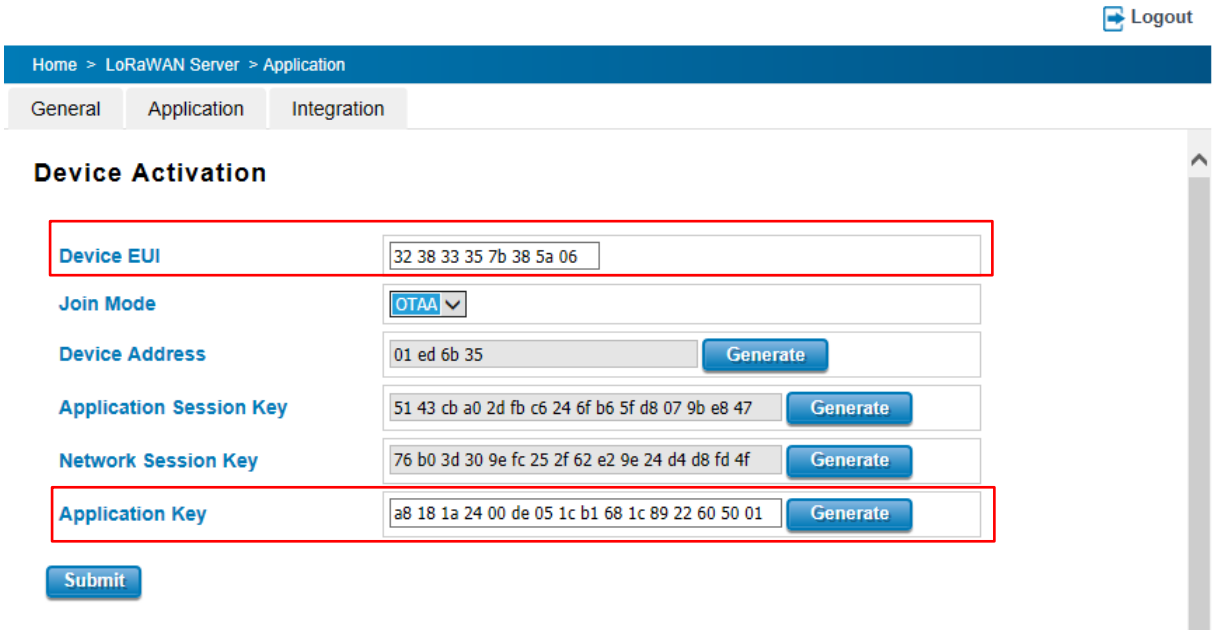


Diagram 5.5-3 WR322-EC-LoRaWAN – OTAA

5.6 I/O – LM100/LC100/LR100

The I/O Page is only for the testing, diagnostic the status of analog I/O. All of parameters will not keep in the device internally once USB connection removed. Diagram 5.6-1 shows the I/O setting page for LC. About the available Analog I/O , you can refer the table 3.1

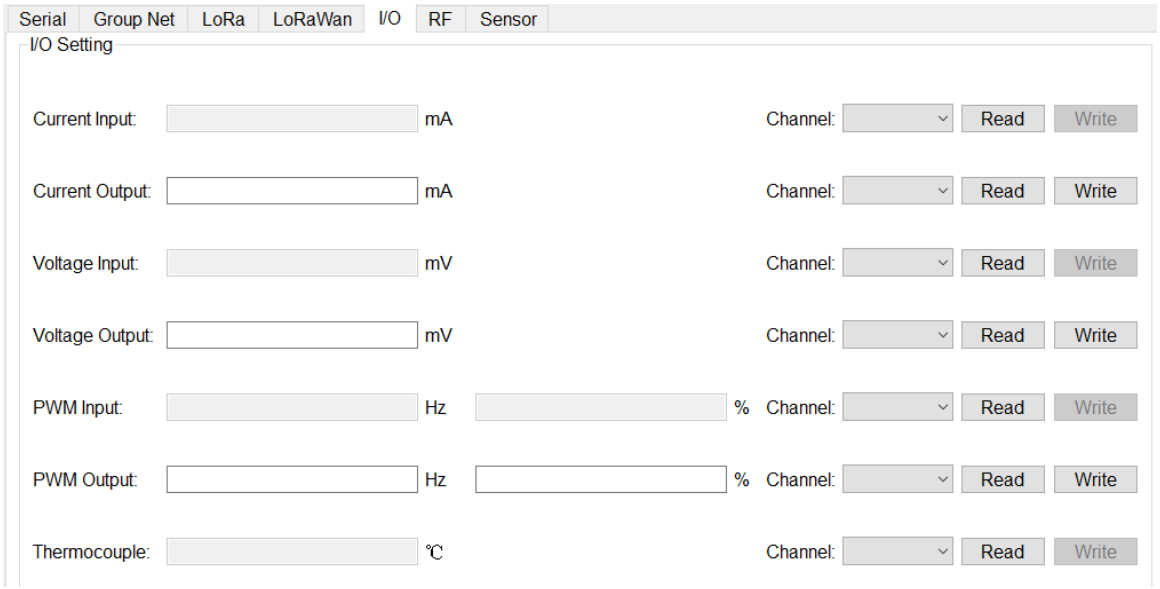


Diagram 5.6-1 I/O Configure Page

The I/O setting page includes Current Input/ Output, Voltage Input/Output, PWM Input/ Output information.

Select “Channel” and Click” Read” to import the parameter that read from the channel selected.

Each type of analog field will show with different color, white color is allowed to perform “Read” and “Write”, gray color is only for read function.

Some of model provides multiple channels in same type, and then select the target channel number that you want to monitor or testing.

5.7 RF

The RF page is for radio signal quality monitoring. The RSSI is Radio Signal Strength Indication, SNR is Signal Noise Ratio. If the RSSI is good, but the SNR is low, the transmission quality will not good. Therefore, you can adjust the frequency to avoid the interference of noise. The Diagram5.7-1 shows the RSSI, SNR page.

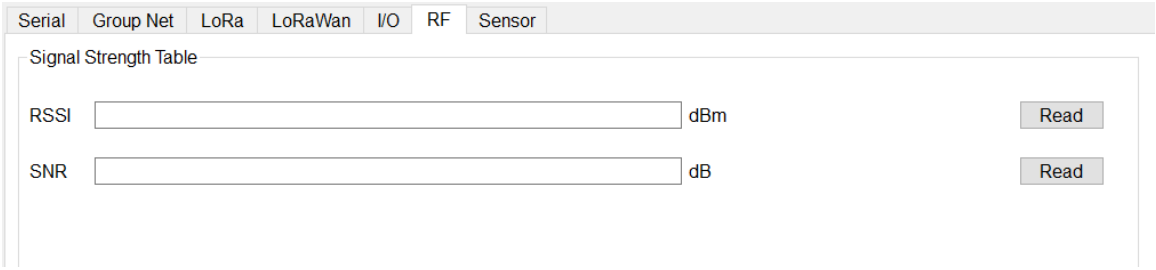


Diagram 5.7-1 RF- Radio Signal Strength Table

5.8 RTU

The RTU page is only for LR100 series. Since, the LR100 supports standard LoRaWan architecture and provides RS-485 interface for Modbus RTU slave device connection. Therefore, the LR100 provides RTU setting page for RTU Device parameter setting.

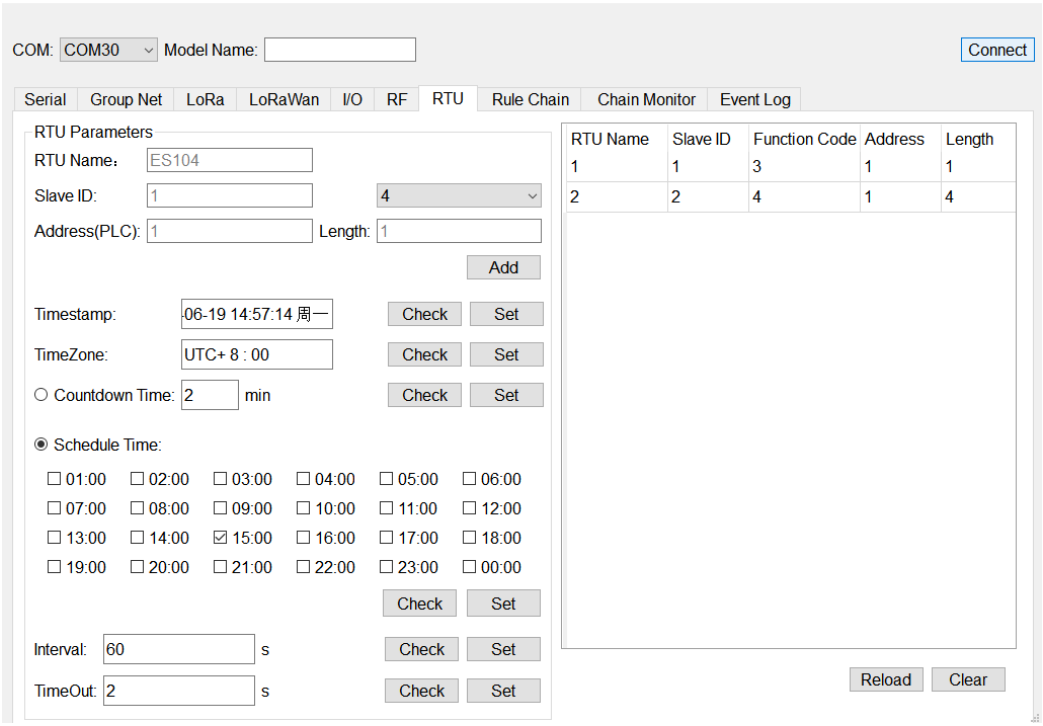


Diagram 5.8-1 RTU Configure Page

RTU Name: Give a Name for the RTU device. The Name will forward to Gateway as a Tag Name for recognize.

Local Analog Input for Voltage and Current: LR140 supports 2 Channels Voltage measuring and 2 Channels Current measuring functions. The internal RTU information shows as below table:

RTU Name	Modbus Slave ID	Start Address (PLC)	Length
VIN0	10	1017	1
AIN1	10	1002	1
VIN2	10	1019	1
AIN1	10	1004	1

Table 5.8-1 LR140 Internal Analog Input register address Table & RTU Name

The RTU Name is unchangeable, Modbus Slave ID assign any number between 1-250 , and the start address (PLC) is fixed for different type of analog input.

Channel 0- Voltage Input: RTU Name Set “VIN0

Channel 1 - Current Input: RTU Name Set “AIN1”

Channel 2- Voltage Input: RTU Name Set “VIN2”

Channel 3-Current Input: RTU Name Set “AIN3”
Slave ID: any available ID**.**
Start Address: register address, refers the table 5.8-1 above**.**

Slave ID: Modbus ID of RTU Device. Modbus function code suport 03 and 04.
Address: the register address that existed in RTU device which is going to read and forward to Gateway.
Length: the depth of reading register. Maximum length is ten.

Click “Add” to add new RTU entry, “Reload” to import current RTU device information existed in LR100.

TimeStamp: Provides Time Synchronize function with Utility. Once disconnect USB cable, the RTC internal timer will keep it until power reset. The LR100 also perform Time Synchronize with Gateway if Gateway supports. Click “Check” to read the time from windows system, and “Set” write time to LR100.

CountDown Time: count down timer for next LoRaWAN data forwarding**.** Once the time decreases to zero, the LR100 will start pulling and forwarding the register’s data to Gateway one by one.

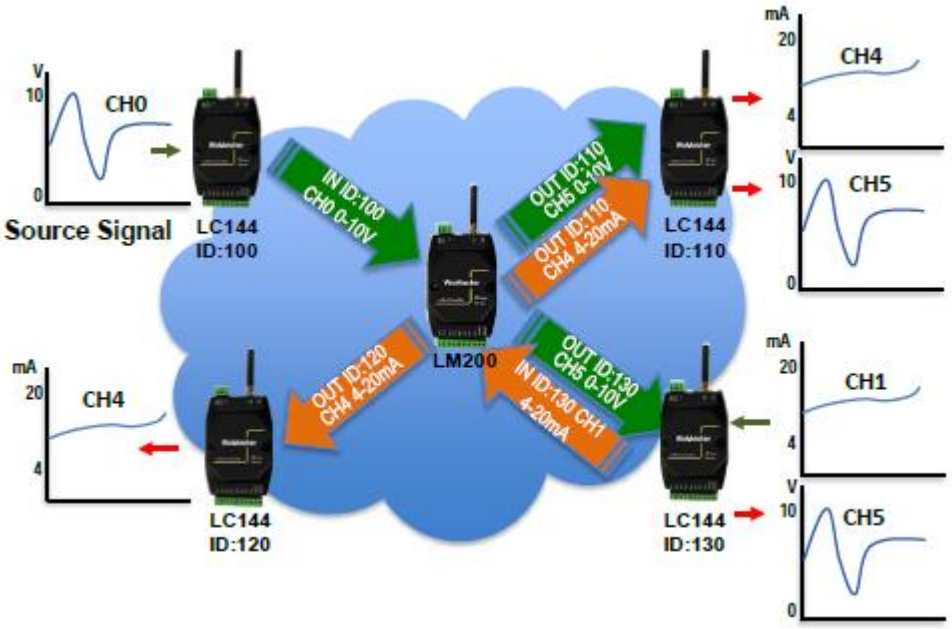
Schedule Time: provides Hourly LoRaWAN data forwarding**.** Select the time, and Click “Set” to write the Time table to LR100 for hourly forwarding.
The CountDown-Time and Schedule-Time are either one function.

Interval: the forwarding interval time of each LoRaWan packet.
Click “Check” to import current setting, and “Set” write new value into system.

5.9 Rule Chain – LM200 IO mapping with LC

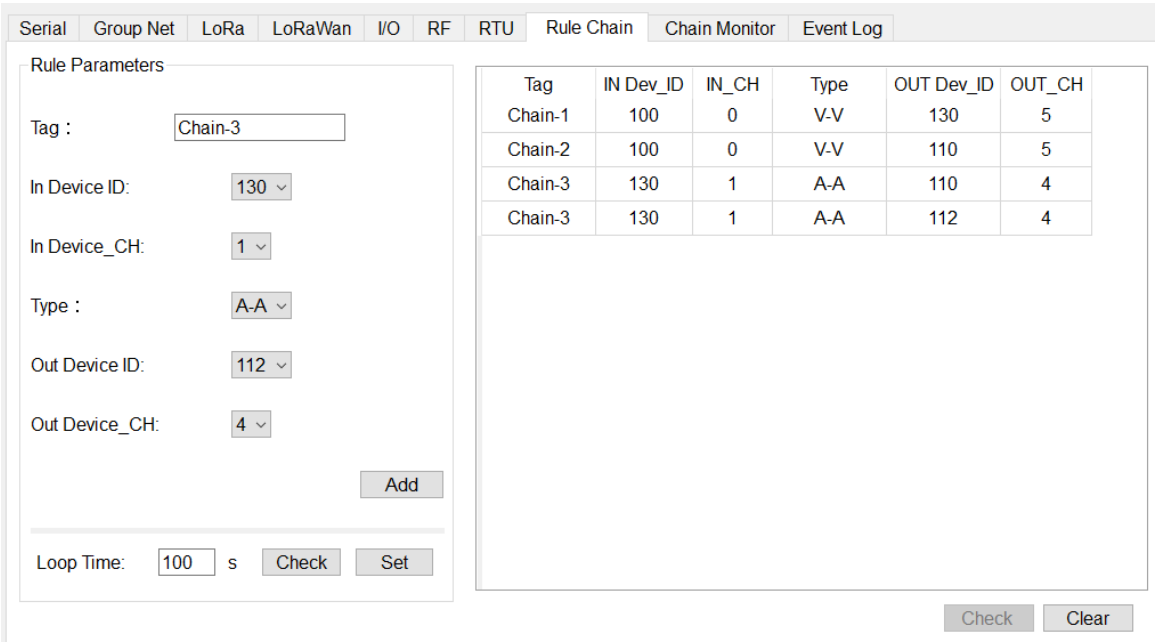
The Rule Chain function is for LM200 IO Mapping group application. The LM200 links 2 LC end node controller, and polling one-side input value and mapping to another side LC controller for remote signal control.

In the following diagram, LM200 actives as mapping controller, polling source signal and output to target device's certain channel.



Tag Name (Rule Name)	Tracking Rule - Input	Tracking Rule -Output
Chain-1	ID:100-CH0	ID:130-CH5
Chain-2	ID:100-CH0	ID:110-CH5
Chain-3	ID:130-CH1	ID:110-CH4
Chain-4	ID:130-CH1	ID:120-CH4

In the IO Mapping mode, the LC device should be grouping with LM200, all of the rules should be created via the utility and save to LM200. Once, the LC device grouping with LM200, then it won't communicate with LM100.



Rule Parameters

Tag: name of rule name for easy understanding

In Device ID: the device ID of Source Signal

In Device CH: the Channel of Source Signal

Type: IO Mapping & Tracking type. It could be Voltage (In) mapping to Voltage (Out), Voltage (In) mapping to Current (Out), or Current (In) mapping to Voltage (Out). However, different signal will mapping and ratio output in different type signal.

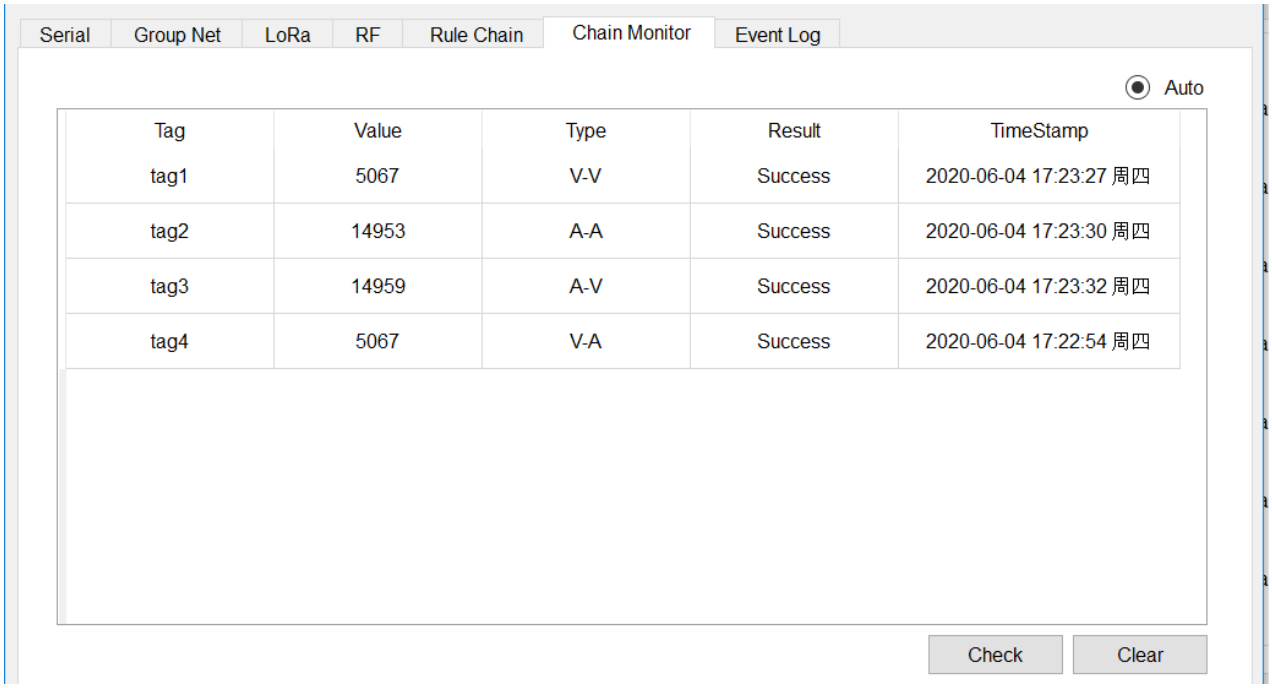
Out Device ID: the device ID of Output Target device

Out Device CH: the Channel of Target Device Channel

Loop Time: the waiting time of next time to start process all rules. Each rule will take 3~5 seconds process if there is not any re-transmits.

5.10 Chain Monitor – LM200

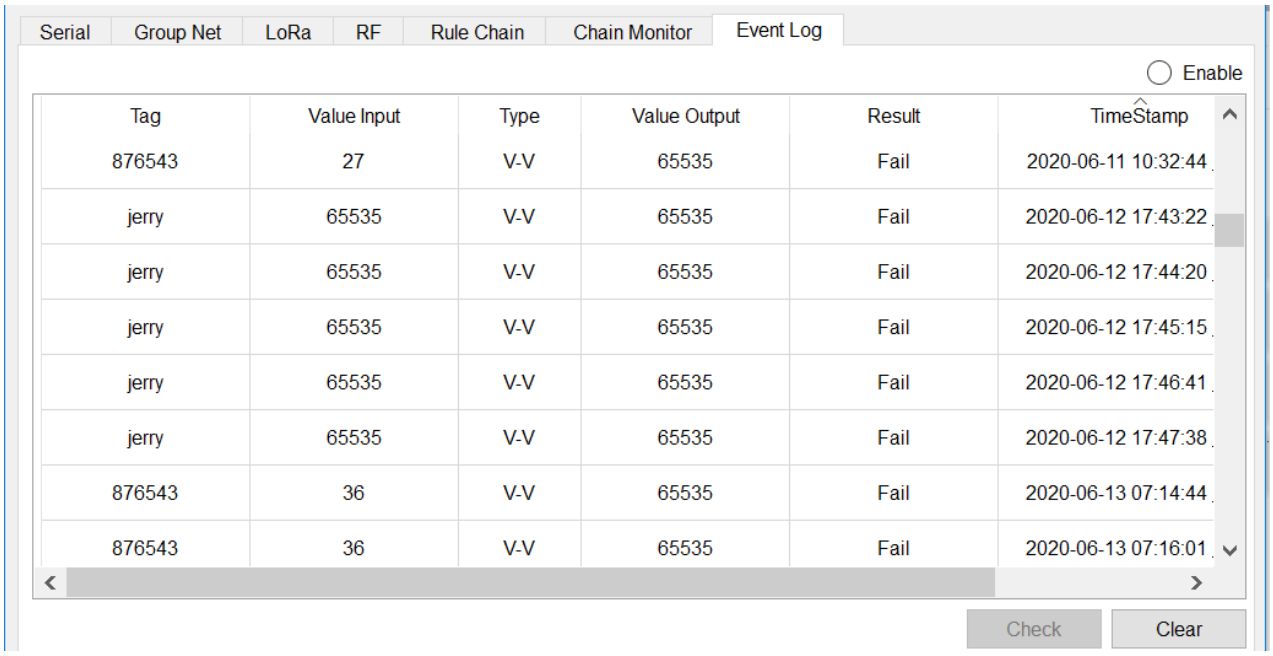
The Chain Monitor provides on-line review the IO mapping result. Once the LM200 & LC configured, user can click this TAB for the real time monitoring the transmission result.



In the Tag1, the read Value is 5067 with mV unit, the real value is 5.067V. Tag2 is 14953 in unit uA, and the real value is 14.953mA.

5.11 Event Log – LM200

The event Log shows the fault transmissions.



5.12 DMA – LC144

LC144 has the function of optional timing polling RTU devices.It supports max 20 registers. LC144 maps the value of the RTU polled to the register inside the device.When LM100 polls the RTU, LC will directly send the latest value stored in LC144. We call it “DMA(Direct

Memory Access)".So,it will reduce the response time of RTU and increase the number of retransmissions between LM and LC.

The latest firmware v1.3.2 for LM100 and v1.3.4 for LC144 and LoraUtility support DMA. They also support 01,02,03,04 function code.

1. DMA Setting on LC144 with LoraUtility

Right click in the "Destination ID"area of the following page.

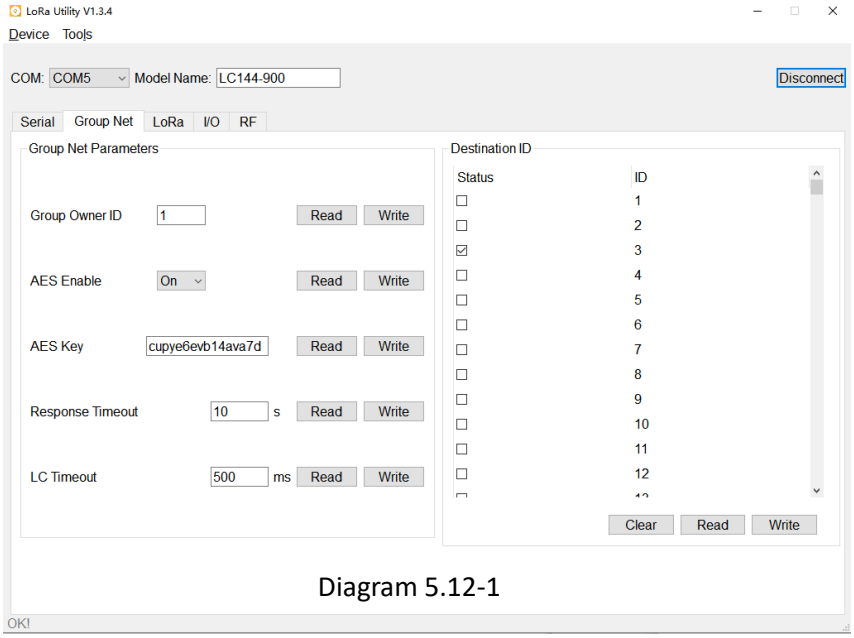


Diagram 5.12-1

The following page will appear.

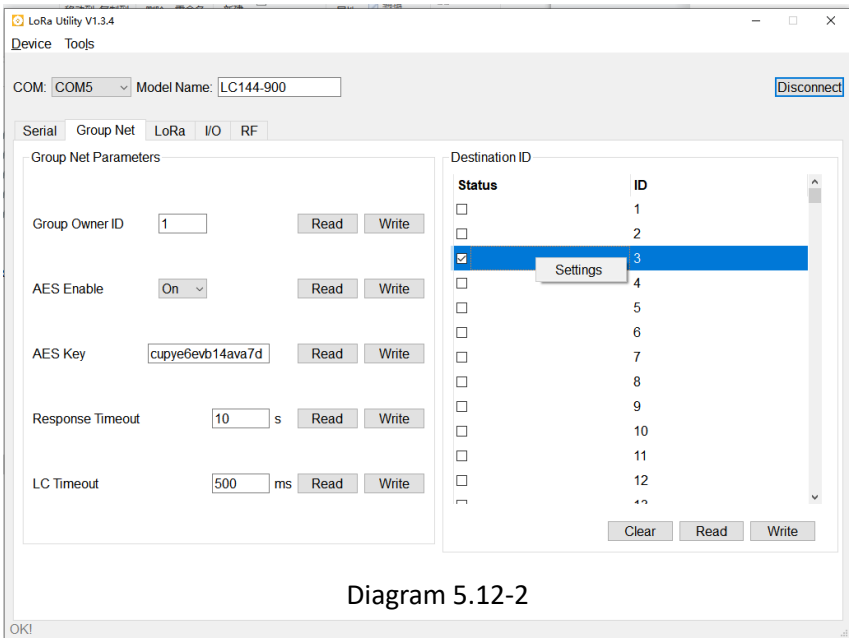


Diagram 5.12-2

Click on "Settings",then the following page will appear.

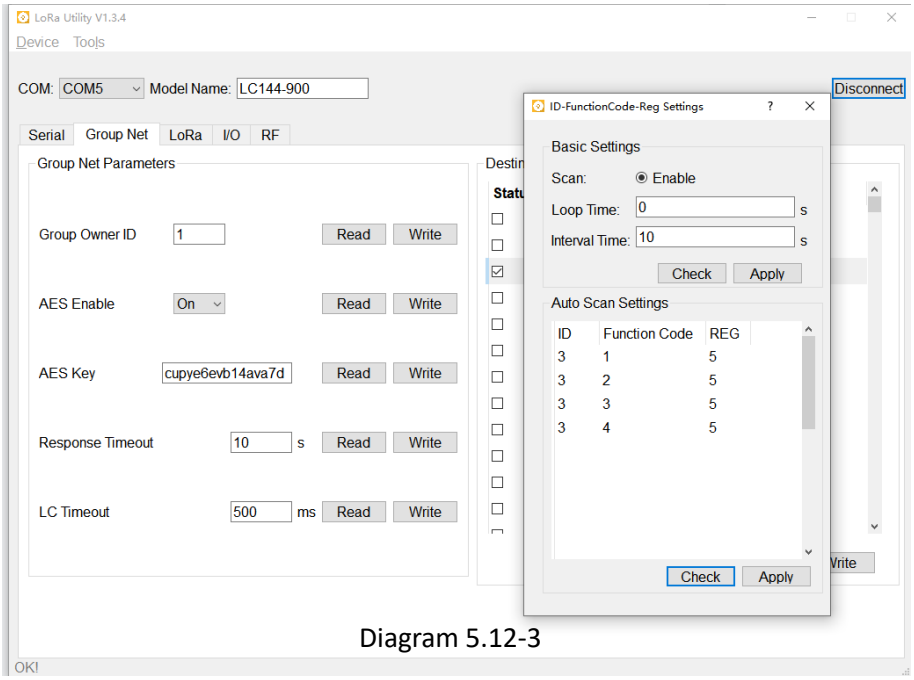


Diagram 5.12-3

Scan: if you select “Enable”, it will enable DMA.

Loop Time: The interval between the next polling after LC has polled all registers.

Interval Time: The interval of LC polling every register.

Auto Scan Settings: Add or delete the ID,Function code and register of RTU.

Check: Click on “Check”, LoraUtility will read the configuration from LC.

Apply: Click on “Apply”,make the settings take effect.

“LC Timeout“ on LC144: the response timeout of RTU When LC polls RTU.

“LC Timeout” on LM100: If you want to get the value of RTU connected to LC144 in time.

6 LC/LM - ModBus RTU Protocol (Register Control Table)

The WoMaster LoRa Node device is developed base on Modbus RTU protocol. Most of control and communication parameters can be read or write by Modbus RTU protocol through the RS485 interface. In the LoRa MAC Transparent architecture, the Modbus RTU Host can easily attached the remote, far-end Modbus RTU slave devices through the LM100 and LC100 series. Besides, the analog information of LC100 also can be polling by traditional Modbus RTU protocol. The following table shows the Modbus Register information.

Address	Name	Type	Description
40001	Baud Rate	R/W	0：9600 1：4800 2：2400 3：1200 Hex Code, 1 Byte
40002	Data Length	R/W	8：8 Data Bits HEX Code, 1Byte
40003	Stop Bit	R/W	1：1 Stop bit 2：2 Stop bit HEX Code, 1 Byte
40004	Parity Check	R/W	0：None Parity Check 1：Even 2：Odd Hex Code, 1 Byte
40005	MODBUS Device ID	R/W	1~250, 1 Byte HEX Code
40022	Lora_freq_band	R/W	Unit：0.1MHz
40023	Lora_TX Power	R/W	2byte 14~22 Unit：dBm HEX Code, Big Endian
40024	Lora_Spreading Factor	R/W	0:SF5 1:SF6 2:SF7 3:SF8 4:SF9 5:SF10 6:SF11 7:SF12 HEX Code
40025	Lora_Bandwidth	R/W	0:125Khz 1:250Khz 2:500Khz

			HEX Code
40026	Lora_Code Rate	R/W	1:4/5 2:4/6 3:4/7 4:4/8 HEX Code
40101	Source ID (Group Net Owner – LM100)	R/W	Range：1~250 HEX code
40102	Bitmap	R/W	1.RTU device connected with LC device 2.Group member of Each Group Net (for LM100) Each bit present Modbus ID number HEX, Big Endian
40118	AES Enable	R/W	1:Enable, 0：Disable
40119	AES Key	R/W	16 bytes , HEX, Big Endian
40134	Model Name	R/O	16 bytes , HEX, ASCII Code
40142	SN	R/O	16 bytes, HEX, Big Endian
40150	Timeout response time	R/W	2 bytes, Unit:Second LM only, HEX, Big Endian
40161	RSSI	R/O	2byte, HEX, Big Endian
40162	SNR	R/O	2byte, HEX, Big Endian
40171	Firmware version	R/O	16byte , HEX, Big Endian
40179	Reset	W/O	2byte , HEX, Big Endian
LC144 A/O Log Register (Latest setting for output channel register)			
40301	Log: Voltage Output Value	R/O	2 bytes, Unit：0.001V HEX, Big Endian
40302	Log: Current Output Value	R/O	2 bytes, Unit：0.001mA HEX, Big Endian
40303	Log: PWM 5V Output Frequency	R/O	2 bytes, HEX, Big Endian
40304	Log: PWM 5V Output Duty Cycle	R/O	2 bytes, HEX, Big Endian

40305	Log: PWM OC Output Frequency	R/O	2 bytes, HEX, Big Endian
40306	Log: PWM OC Output Duty Cycle	R/O	2 bytes, HEX, Big Endian
LC144 A/IO Register			
41017	CH0 Voltage Input	R/O	2 byte, Unit：0.001V HEX, Big Endian
41002	CH1 Current Input	R/O	2 byte, Unit：0.001mA HEX, Big Endian
41019	CH2 Voltage Input	R/O	2 byte, Unit：0.001V HEX, Big Endian
41004	CH3 Current Input	R/O	2 byte, Unit：0.001mA HEX, Big Endian
41069	CH4 Current Output	R/W	2 byte, Unit：0.001mA HEX, Big Endian
41086	CH5 Voltage Output	R/W	2byte, Unit：0.001V HEX, Big Endian
41109	CH6 PWM 5V, Frequency	W/O	2 Bytes, Frequency HEX, Big Endian
41110	CH6 PWM 5V, Duty Cycle	W/O	2 Bytes, Duty Cycle HEX, Big Endian
41111	CH7 PWM 10V, Frequency	W/O	2 Bytes, Frequency HEX, Big Endian
41112	CH7 PWM 10V, Duty Cycle	W/O	2 Bytes, Duty Cycle HEX, Big Endian
LR140 A/I Register (Unreadable for Modbus protocol or LoRa GW)			
41017	CH0 Voltage Input	R/O	2 byte, Unit：0.001V Hex Code, Little Endian
41002	CH1 Current Input	R/O	2 byte, Unit：0.001mA Hex Code, Little Endian
41019	CH2 Voltage Input	R/O	2 byte, Unit：0.001V Hex Code, Little Endian
41004	CH3 Current Input	R/O	2 byte, Unit：0.001mA Hex Code, Little Endian

R/O: Read Only, W/O: Write Only, R/W: support Read and Write function

WoMaster

7 LR100 series - Data Parsing

The LR100 forwarding data in scheduling, and those Lora packet is defined as following.

2x2 Bytes	7 Bytes	8 Bytes	1 Byte	2 Bytes	1 Byte	2 Bytes x Count of Reg.	1 Byte
2xPreambles	Time	Sensor Name	ModBus ID	Reg. Addr.	Count of Reg.	Data Payload	End Symbol

- **Preamble:** 2 Bytes per preamble, and send 2 Preambles with 0x0485
- **Time (7 Bytes)** : unsigned integer, HEX, Ex：0x14 0x02 0x14 0x04 0x0f 0x3B 0x01 = DEC 20,02,20,04,15,59,01 year-month-day-weekday-hour-minute-second
  Year 2020, Feb, 20, Thursday, 15:59:01
- **Sensor (8Bytes):** type string, ASC II Code, pattern “test” = 0x74 0x65 0x73 0x74 0x0 0x0 0x0 0x0
- **Modbus ID (1Byte)**: unsigned integer, HEX Format. Ex. ID 250 =->0xFA, ID 188 => 0xBC
- Reg. Address (2 Bytes): type: unsigned integer, Little endian, DEC Format. Ex. Reg. Addr. 510 -> Hex 0xf5,0x01
- **Count of Register (1Byte)**: unsigned integer, HEX, Ex: 10, Data width is 2Byte/Per Register plus 10 = 20Bytes
- **Data Payload** : format defined by Modbus RTU Slave device, and data forward in HEX code, Little Endian mode
- **0xaa** = End Symbol

The LR100 also send Heart-Beat to Gateway. The Heart-Beat Format as following.

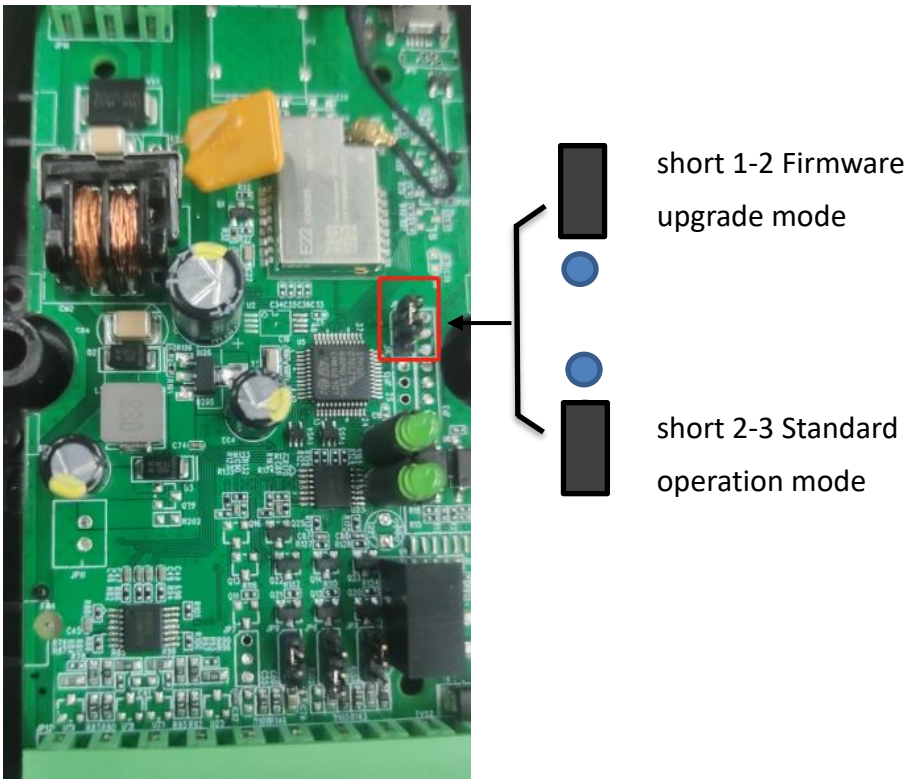
2x2 Bytes	7 Bytes	6 Bytes
2xPreambles	Time	“online”

1. **Preamble:** 2 Bytes per preamble, and send 2 Preambles with 0x0485
2. **Time (7 Bytes) :** unsigned integer, HEX code. Ex：0x14 0x02 0x14 0x04 0x0f 0x3B 0x01 = DEC 20,02,20,04,15,59,01 year-month-day-weekday-hour-minute-second =>Year 2020, Feb, 20, Thursday, 15:59:01

8 System Firmware Upgrade

The device supports the firmware upgrade function. The default setting is 2-3 short for normal operation, and short 1-2 pin will get into firmware upgrade mode. Programming new firmware via the USB and STM32 software tool which performs by Windows.

When the device operates in different modes, the jumper cap position is set as shown in the figure below.



Pin numbers of row pins are shown in the figure below:

Pin Header

Jumper cap

The firmware programming tool is downloaded from the hyperlink - https://www.st.com/en/development-tools/stm32cubeprog.html

All of the copyrights belong to ST Semiconductor. It needs to perform online registration.

Select the software version which depends on your programming platform.

The following procedure based on Windows 64 bits O.S.

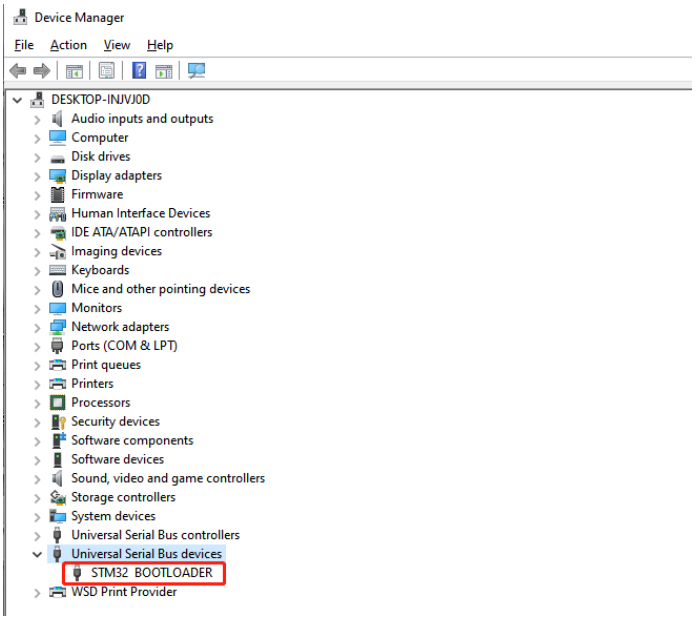
Get Software

	Part Number	Download	Previous versions
+	STM32CubePrg-Lin	Get Software	Select version
+	STM32CubePrg-Mac	Get Software	Select version
+	STM32CubePrg-W32	Get Software	Select version
+	STM32CubePrg-W64	Get Software	Select version

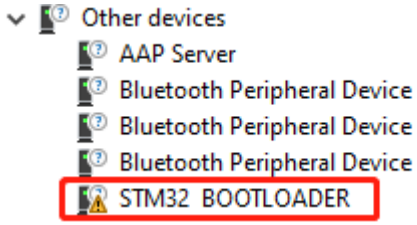
8.1 Update STM32

After the software installation is completed, it is necessary to confirm whether the STM32 driver is available before upgrading.

Disconnect the power supply of device and change the position of the jumper cap to upgrade mode. Connect your device to your PC using USB. Open the PC Device Manager and "STM32 BOOTLOADER" will be displayed in the Universal Serial Bus devices subdirectory. The installation success status is shown in the following figure.



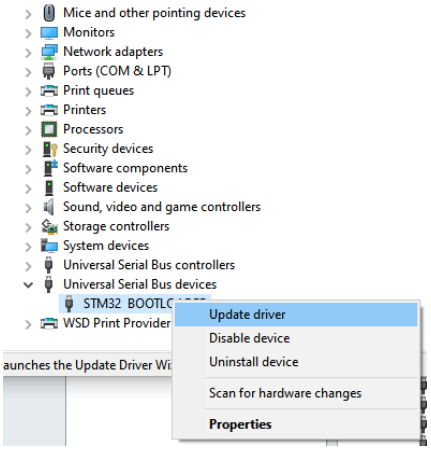
If the drive is shown as follows: A yellow exclamation mark appears, the drive is not installed properly. You need to reinstall the driver at this time.

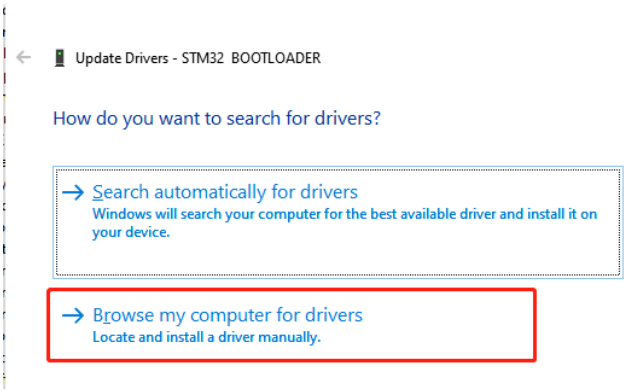


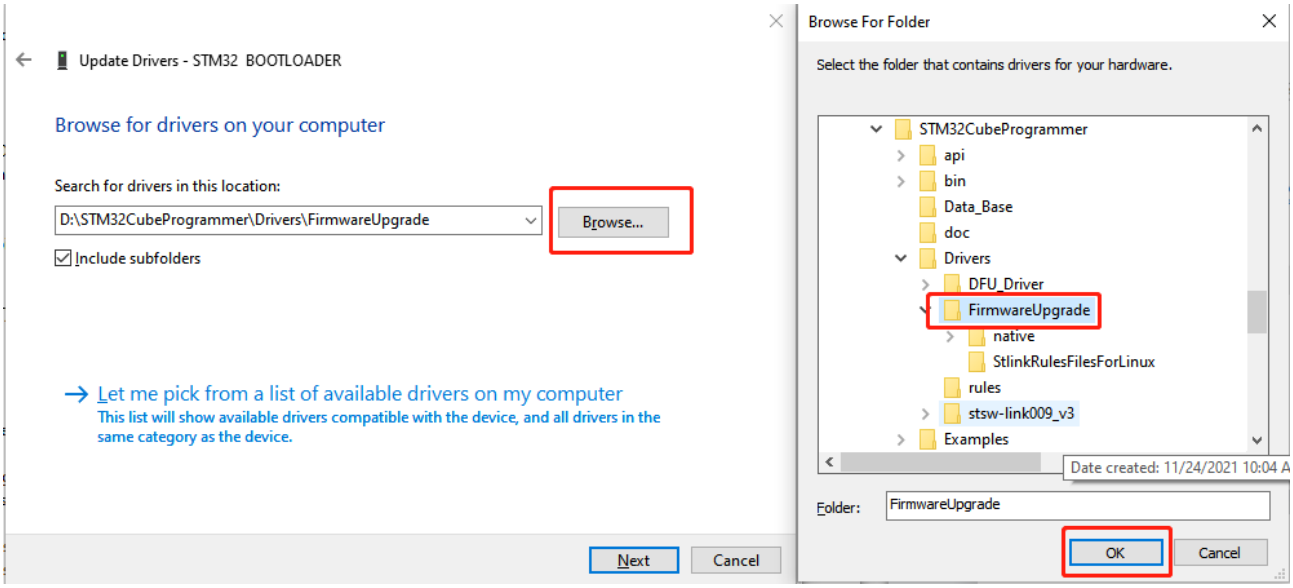
Update driver steps:

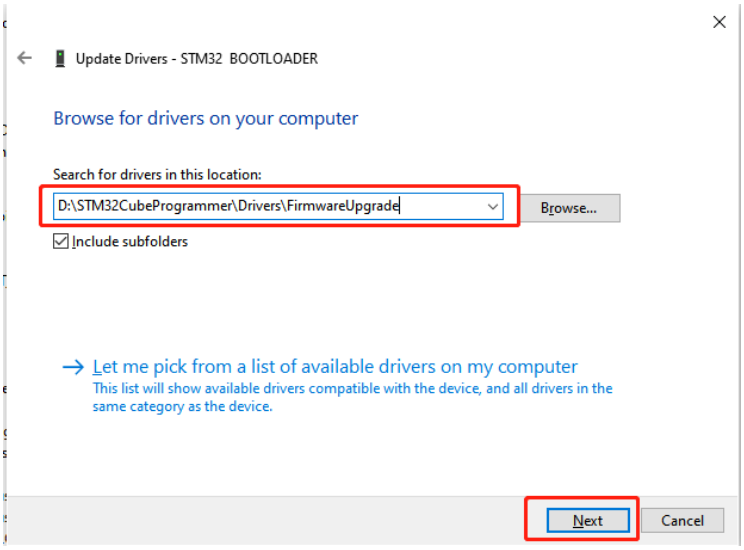
Right-click ”STM BOOTLOADER”=>Update driver=>Browse my computer for drivers=> Browse=> STM32CubeProgrammer\ Drivers\ FirmwareUpgrade=> OK=> Next

After completing the above steps, the yellow exclamation mark on the drive disappears, indicating that the drive has been successfully installed.



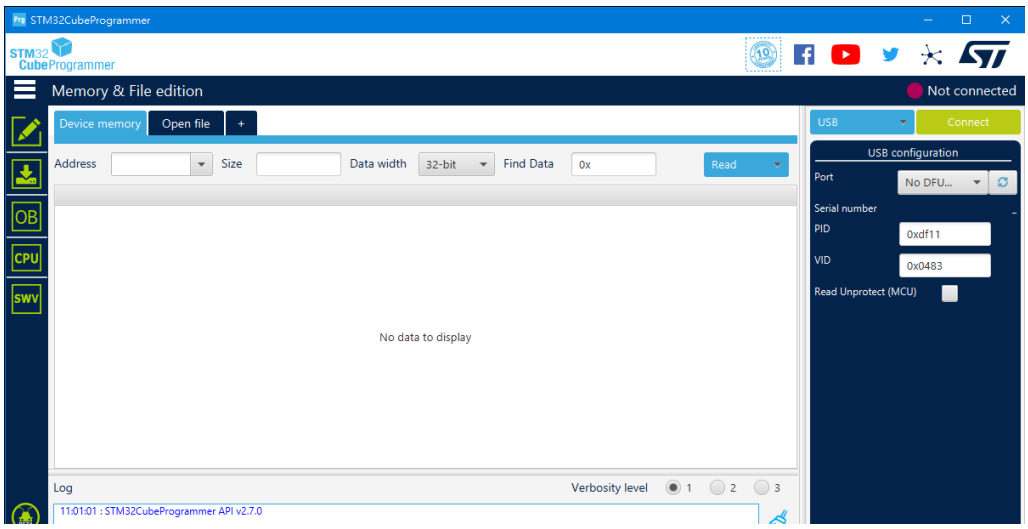




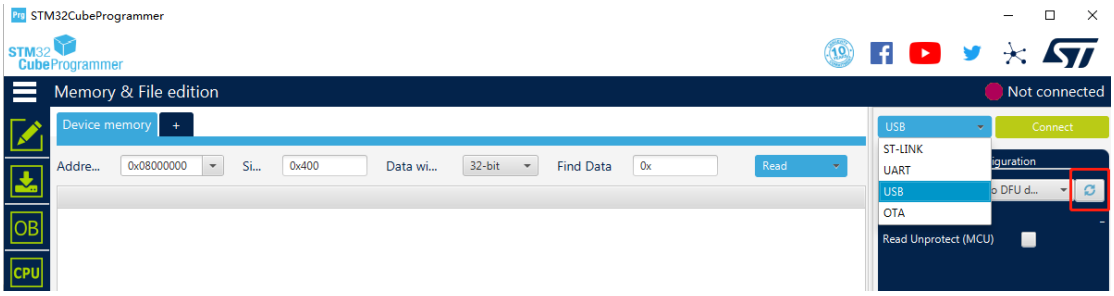


8.2 Start STM32 Cube Programmer

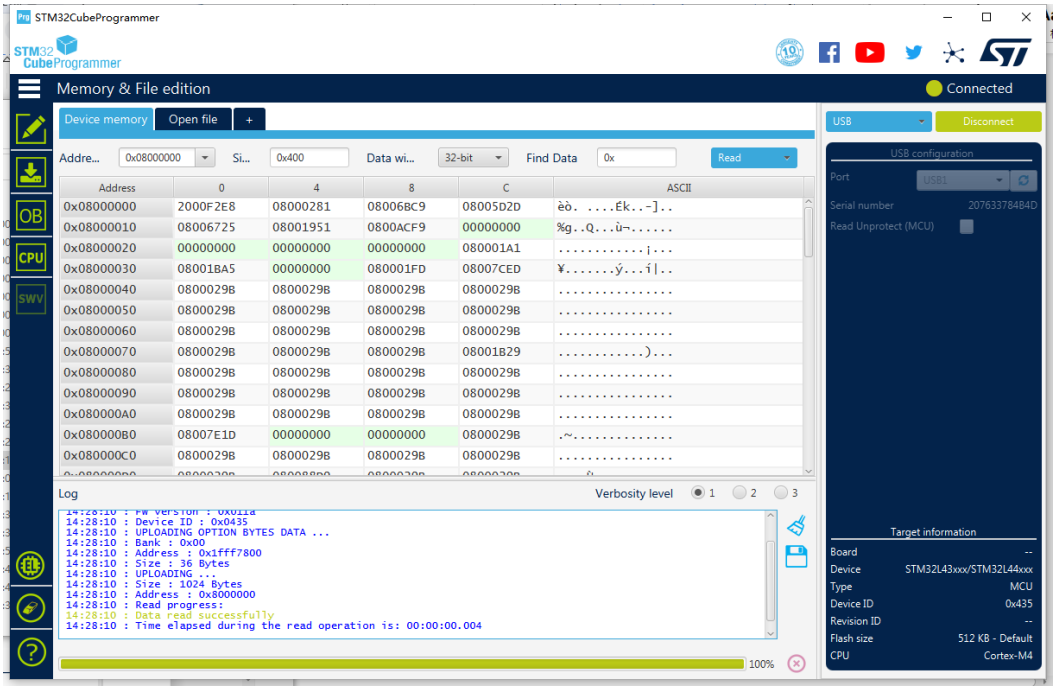
Step-1. Run the software “STM32 Cube Programmer”, the User Interface is like as below:



Step-2. Select the Interface –USB, and refresh the Port located at USB Configuration, then it will show the “USB X(Port)”.

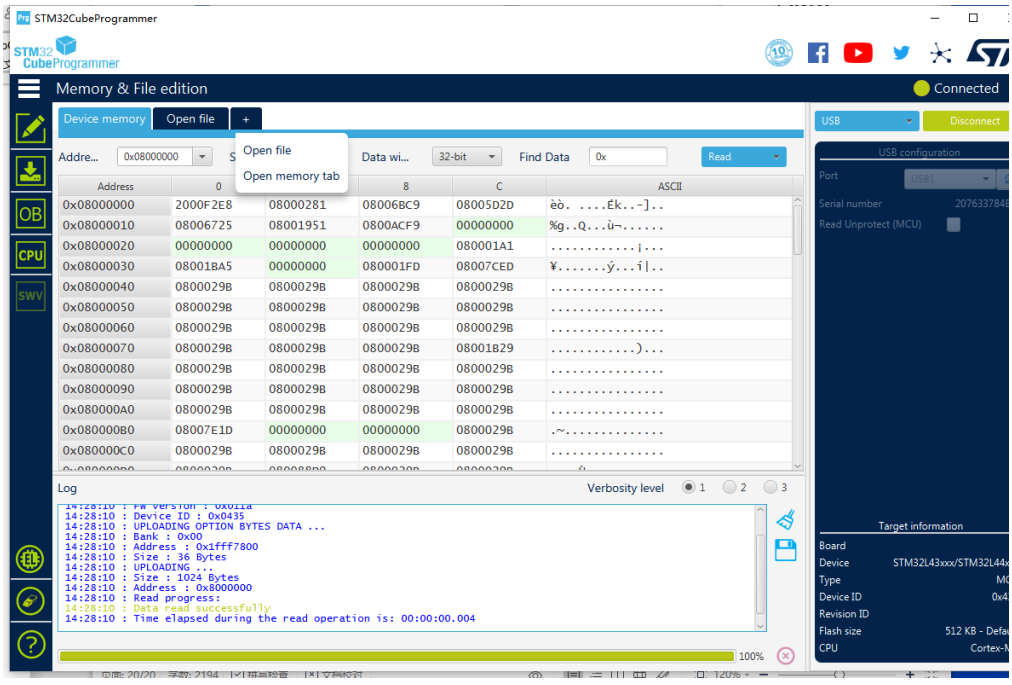


Click the “Connect”, then the tool will download the current HEX from the system. The UI will like as below:

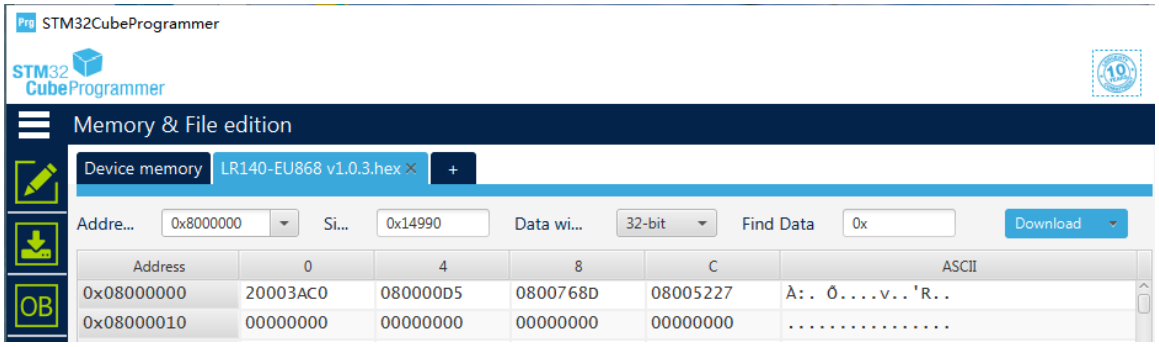


Now, the programming tool is successfully connected to the system.

Step-3: Download new firmware for the programmer. Click “Open file” and select target firmware – LR/LC/LM xxx. hex.

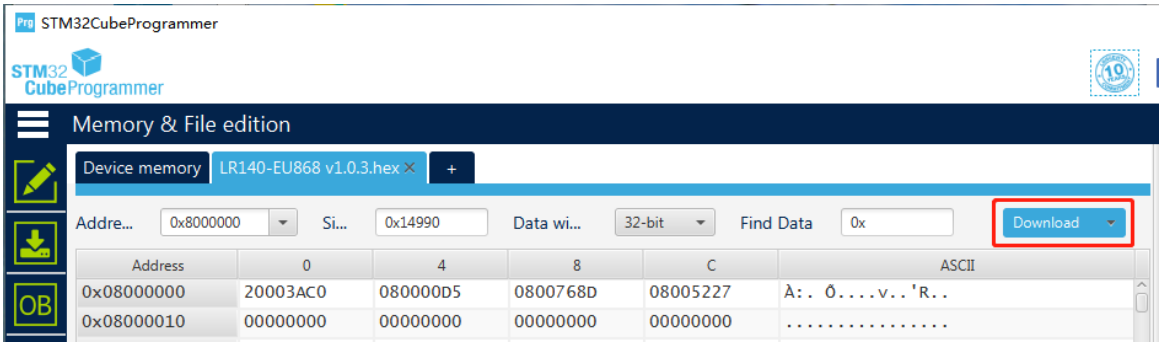


Once select target new firmware, the programmer will read and create a new TAB “LR140-EU868 xxx. hex”.



Step-4: Start Programming into the system

Click the “Download” icon to start programming into the system. After completed programming, it will pop up dialogue to remind process done.



Step-5 Finish Firmware Upgrade process

Disconnect the power supply, close the programming tool, and change the jumper to 2-3 short. Then power on the system and use the "LoRa Utility" to check the firmware version.

Click the Tools –Setting, and perform a version Check.

It shows the version you upgraded. Congratulations, the firmware upgrade was successful. Don’t forget to check the Setting again, ensure the setting is not changed due to the firmware upgrade.

WoMaster

Release Note

Release Note - LM100 / LC100/ LR100 User's Manual			
Version	Description	By	Date
0.00	New Edition for: LM 100, LC 100, LR 100 Firmware version LR100: v0.3 LC100:v1.01 LM100:v1.01 LoRa Utility V0.5.10	RF	03/20/2020
V1.0	1. Utility version V1.21 for LM200 new features 2. LC144 supports internal resister for Push-Pull directly Voltage output and O.C. mode for External Pull-high resistor. (jumper setting information) 3. Add LM200 configuration for Utility. TAB- Rule Chain, TAB-Chain Monitoring, TAB-Event Log.	RF	06/19/2020
V1.0.1	1. Utility version V1.2.3 for LC144 new features 2. LC144 supports DMA	Jerry.L	08/20/2020
V1.0.2	1. Utility version V1.3.4 for LC144 new features 2. LC144 supports 01,02,03,04 function code when use DMA	Ann	11/30/2021
V1.0.3	1.Utility version V1.3.4.1 for LM100 new features 2.LM100 support RS485 read / write parameters	Ann	06/10/2022
V1.04	1.Update device Specification 2.Add LC100 and LR100 support 20 modbus slave devices 3.Add LR140-EU868 modbus function code 04 and System Firmware Upgrade	Ann	06/19/2023