TLM Series LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler with 2 x 10/100Base-T(x) Ports, 1 x RS232 and 1 x RS485 Serial Ports and/or BPL (Broadband Power Line Link) User Manual

1. About TLM Series LoRaWAN EndNode Modems with Modbus TCP/RTU Scheduler

TLM Series LoRaWAN EndNode Modems are designed for industrial-grade Radio Frequency (RF) communication and particularly for facilities of rugged industry and infrastructure. TLM Series LoRaWAN EndNode Modems are tailored to perform various features such as wide temperature range, wide power input range and several connectivity ports. Thus, TLM Series LoRaWAN EndNode Modems are the best choice for facility management, sewage treatment, power utility, telecommunication, transportation and all other applications that require LoRaWAN connectivity.

REDZ Broadband Power Line (BPL) link allows device to communicate with full transparent TCP/IP standard over Low Voltage power lines and allows easy connection between TCP/IP based terminals without use of extra cables.

TLM Series LoRaWAN EndNode Modems can create a link between field devices and LoRaWAN server. Field devices with TCP/IP connectivity can be read via Modbus TCP protocol and data can be sent to LoRaWAN Server. Also field devices with RS232/RS485 Serial interface can be read in Modbus RTU protocol and data can be sent to LoRaWAN Server. Transparent connection between field devices and applications and LoRaWAN server is also available. Typical applications: Automated Meter reading, Wireless networks, Home – Building – Industrial Automation, Remote Control, Wireless Sensors, Telemetry, Wireless Alarm and Security Systems...

2. Hardware Features

TLM Series LoRaWAN EndNode Modems have the versions with and without BPL (Broadband Power Line) Link.

2.1 Features

- Radio Band Options:

  865MHZ

  IN 865 MHz – India, LoRaWAN RF Communication

  868MHZ

  EU 868 MHz – Europe, LoRaWAN RF Communication

  915MHz

  US 915 MHz – Covers US 902-928MHz ISM Band, LoRaWAN RF Communication

  923MHz

  AS 923 MHz – BN 923 MHz – Brunei, LoRaWAN RF Communication

  AS 923 MHz – KH 923 MHz – Cambodia, LoRaWAN RF Communication

AS 923 MHz – ID 923 MHz – Indonesia, LoRaWAN RF Communication

AS 923 MHz – JP 920 MHz – Japan, LoRaWAN RF Communication

AS 923 MHz – LA 923 MHz – Laos, LoRaWAN RF Communication

AS 923 MHz – NZ 915 MHz – New Zealand, LoRaWAN RF Communication

AS 923 MHz – SG 920 MHz – Singapore, LoRaWAN RF Communication

AS 923 MHz – TW 922 MHz – Taiwan, LoRaWAN RF Communication

AS 923 MHz – TH 920 MHz – Thailand, LoRaWAN RF Communication

AS 923 MHz – VN 920 MHz – Vietnam, LoRaWAN RF Communication

- Supports 2 x 10/100Base-T(X) ports
- Supports Full/Half-Duplex, auto MDI/MDI-X on each port
- DHCP Server Capability
- Supports 1 x RS232 and 1 x RS485 Serial Connection up to 921600 Baud
- Embedded web interface for ease of use
- Instant switch between Server-Client Operating Modes with buttons
- 3 Main Device Functions:

  LoRaWAN Modbus TCP Scheduler

  LoRaWAN Modbus RTU Scheduler

  LoRaWAN Transparent Mode (Transparent bridge between LoRaWAN and TCP/IP or Serial Side)
- Up to 10 device connection in Modbus TCP or RTU Scheduler or Transparent TCP/IP modes
- Definable Modbus Serial Interface for Modbus RTU (RS232 or RS485 usage in same device)
- Selectable Modbus Function Code, Definable Register Address, Total Register Number, Query Interval and Time Out durations.
- Built in LoRaWAN Duty Cycle Check for EU868 and AS923 Models
- Built in LoRaWAN payload size check and. User can read any data in any interval TLM will automatically split based on Maximum Payload Size allowed and Duty Cycle Block Times
- Sub-Band Mask Configurable for US915 Model
- Easy monitor of transmitted data on web interface
- Easy to follow Device Status on web interface

- Activation Over Air (OTAA) or Activation by Personalization (ABP) Selectable
- User defined LoRAWAN Port
- Adaptive Data Rate functionality
- Selectable Uplink Data Rate
- Selectable Power Level
- LoRaWAN Class C and Class A support
- Easy to follow LoRaWAN packages on web interface
- Black List and White List based TCP/IP connection filter in transparent mode
- Firmware Upgrade over Web
- 2 firmware storage capability on same device (1 active only)
- AC or DC wide range power options
- Wide operating temperature range from -25 to 70 °C AC and -40 to 85 °C DC power input versions
- Rugged Metal IP-40 housing design
- DIN-Rail mounting

2.2 Extra Features for Models with BPL

- Supports 2 x 10/100Base-T(X) ports + 1 x BPL link
- Wide range 3 phase AC input
- Supports up to 30Mbps PHY rate on BPL with Up to 10 hops and 1000 nodes
- Up to 432 sub-carriers from 2 to 28MHz analog bandwidth
- Support LDPC-C FEC with 128-bit AES core
- Plug and play with Master/Slave selection via web interface

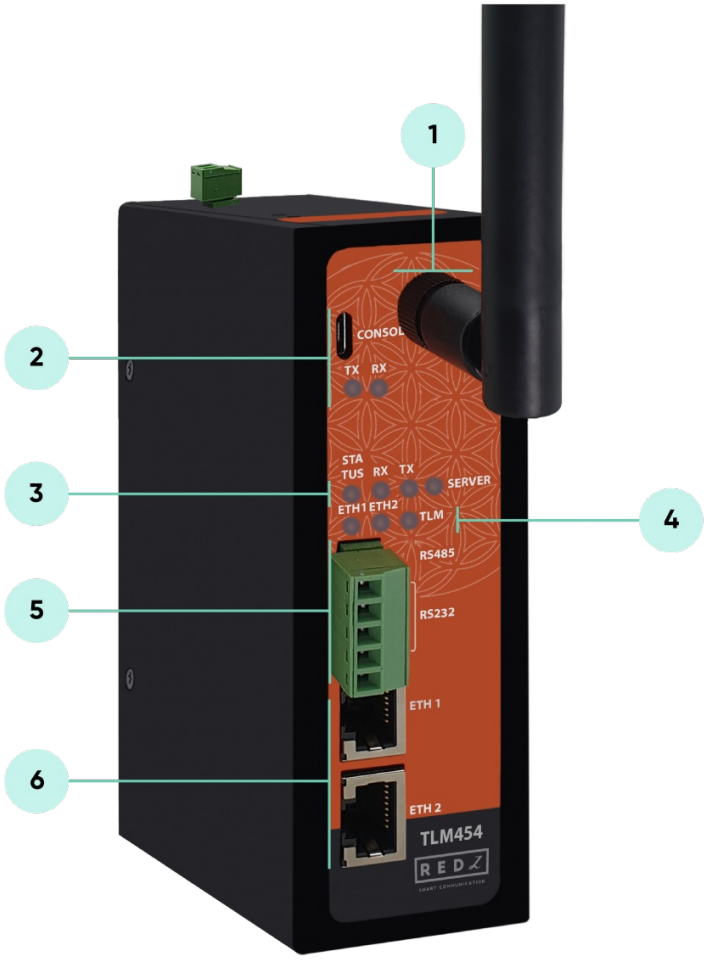
3. Installation

Each device has a Din-Rail kit on rear panel. The Din-Rail kit helps device to fix on the Din-Rail. Slant the switch and mount the metal spring to Din-Rail.

Then Push the switch toward the Din-Rail until you heard a “click” sound.

4. Front Panel Description

4.1 TLM344 & TLM444 & TLM354 & TLM454 & TLM364 & TLM464 & TLM374 & TLM474



1. Standard SMA female Antenna interface, 50 ohm
2. Micro USB Console port for LOG in 115200 baud

   Console Tx and Rx Blinks when data transmission occurs
3. Device Status LEDs

   STATUS: Blinks based on device operation

   - When TCP line used blinks during no connection and keeps ON after TCP connection

   - When Serial line used keeps ON

   Device Tx and Rx Blinks when data transmission occurs

   SERVER: Keeps ON after selecting Server from Server-Client Operating Modes. Keeps OFF if Client operating Mode selected
4. ETHERNET Activity LEDs for port 1, 2 and TLM device itself. Blinks during ethernet activity
5. 5 pin Terminal Block

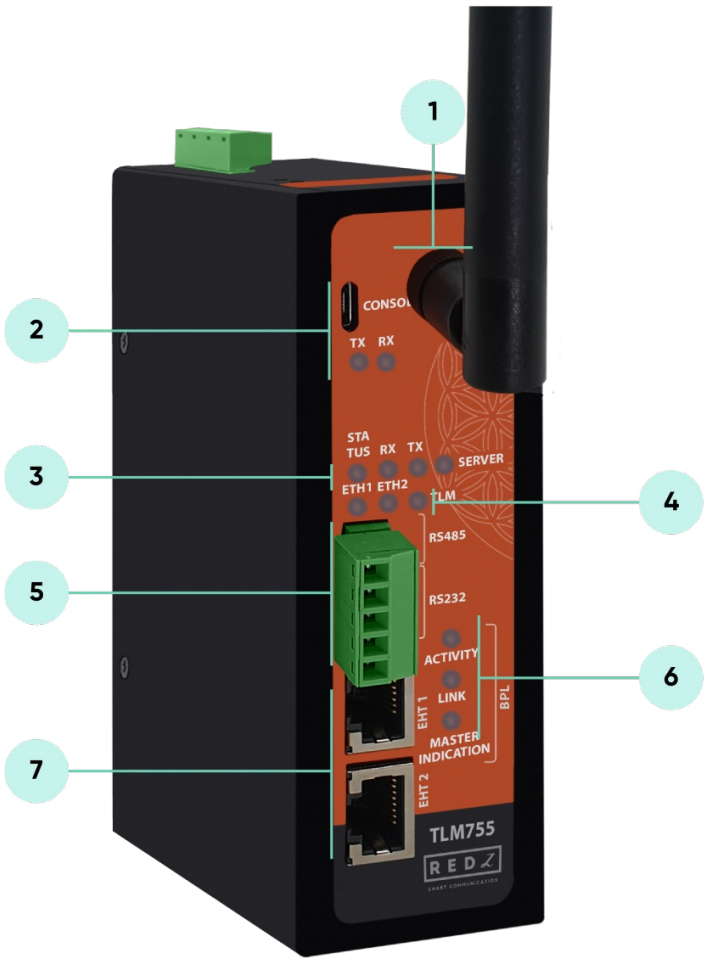
   RS232: Tx, Rx and GND pins

RS485: A, B and GND pins

Can be activated over web interface and baud rate/data type configurable

6. 10/100Base-T(X) Ethernet ports

4.2 TLM745 & TLM755 & TLM765 & TLM775



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   STATUS: Blinks based on device operation

   -When TCP line used blinks during no connection and keeps ON after TCP connection

   -When Serial line used keeps ON

   Device Tx and Rx Blinks when data transmission occurs

   SERVER: Keeps ON after selecting Server from Server-Client Operating Modes. Keeps OFF if Client operating Mode selected
4. ETHERNET Activity LEDs for port 1, 2 and TLM device itself. Blinks during ethernet

activity

5. 5 pin Terminal Block for Serial Line

   RS232: Tx, Rx and GND pins

   RS485: A, B and GND pins

   Can be activated over web interface and baud rate/data type configurable

6. BPL Status LED

   ACTIVITY: Blinks during BPL Ethernet activity

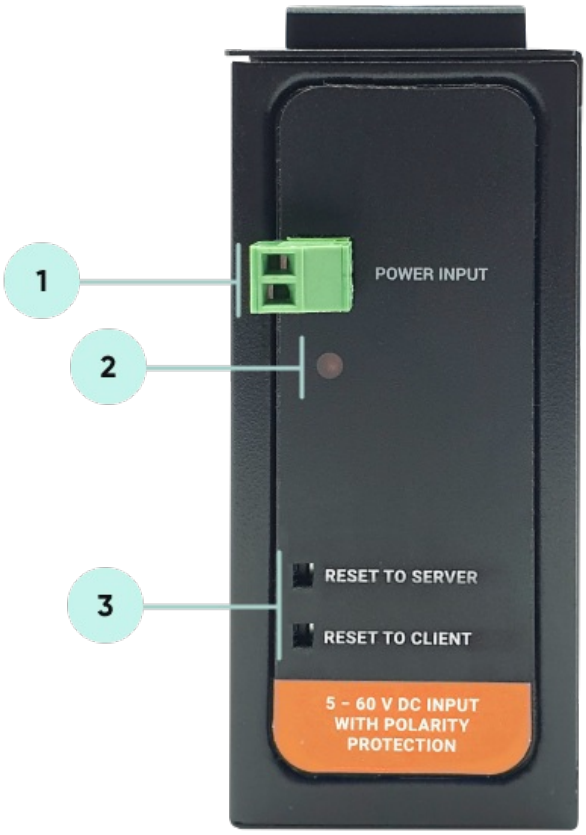
   LINK: LED Turns ON if the link can be established over BPL

   MASTER INDICATION: LED Turns ON if the device is configured and powered as “BPL Master” device

7. 10/100Base-T(X) Ethernet ports

5. Top Panel Description

5.1 TLM344 & TLM354 & TLM364 & TLM374



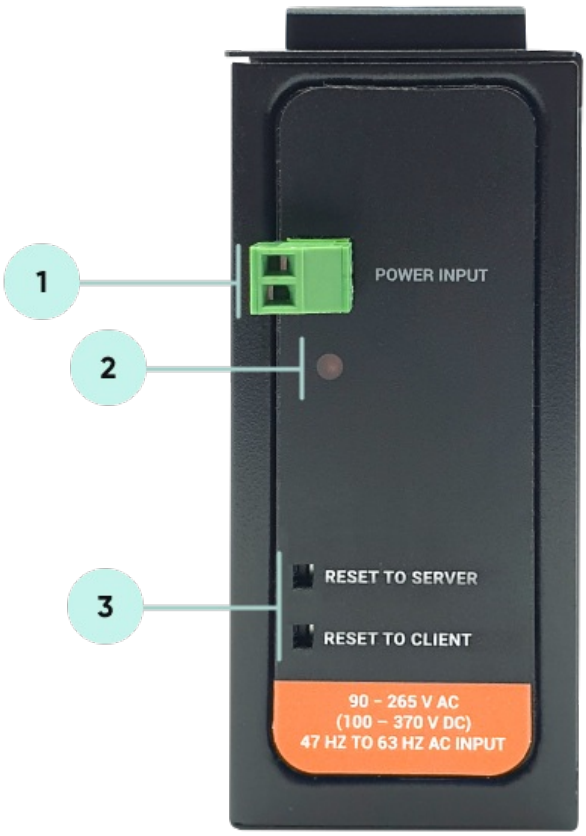
1. Power Input DC: 5-48V DC (max. 60V). Polarity protected so that the power input can be connected in any direction
2. Power LED: Turns ON when there is power in device
3. Reset Buttons

   RESET TO SERVER: Resets the device to factory setting as Server from Server-Client Operating Modes

   RESET TO CLIENT: Resets the device to factory setting as Client from Server-Client Operating Modes

   Reset can be done at any time by pushing any of the buttons for more than 5 seconds.

5.2 TLM444 & TLM454 & TLM464 & TLM474



1. Power Input AC: 90 - 265V AC (100 – 370V DC), 47Hz to 63Hz AC input
2. Power LED: Turns ON when there is power in device
3. Reset Buttons

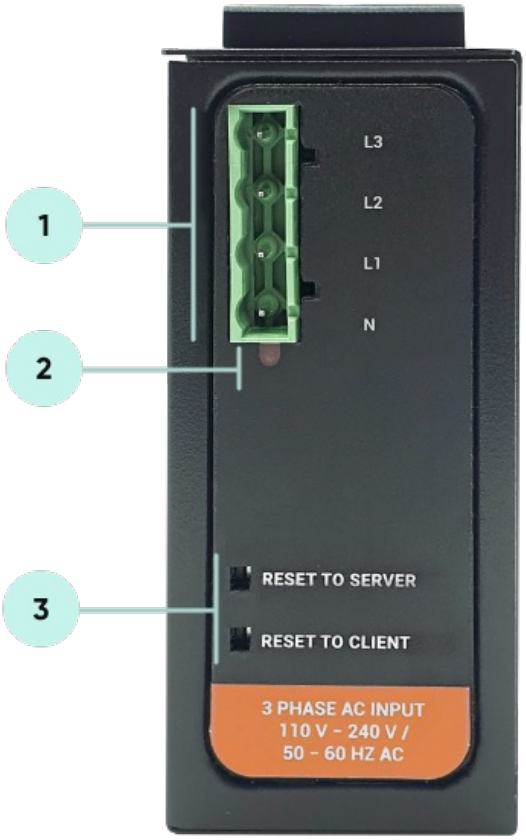
   RESET TO SERVER: Resets the device to factory setting as Server from Server-Client

Operating Modes

RESET TO CLIENT: Resets the device to factory setting as Client from Server-Client Operating Modes

Reset can be done at any time by pushing any of the buttons for more than 5 seconds.

5.3 TLM745 & TLM755 & TLM765 & TLM775



1. Power Input AC: 3 phase input, 110V–240V/50-60Hz. It is also ok to connect only single phase to the device such as L1-N connection only.

   AC Power supply use L1-N only. Phase 2-3 connections are used to BPL signal transmission.
2. Power LED: Turns ON when there is power in device
3. Reset Buttons

   RESET TO SERVER: Resets the device to factory setting as Server from Server-Client Operating Modes

> RESET TO CLIENT: Resets the device to factory setting as Client from Server-Client Operating Modes
>
> Reset can be done at any time by pushing any of the buttons for more than 5 seconds.

6. Ethernet Cables

TLM Series LoRaWAN EndNode Modems have standard Ethernet ports. According to the link type, the switches use CAT 3, 4, 5, 5e UTP cables to connect to any other network device (PCs, servers, switches, routers, or hubs).

6.1 Cable Type and Specifications

Cable	Type	Max. Length	Connector
10BASE-T	Cat. 3, 4, 5 100-ohm	UTP 100 m (328 ft)	RJ-45
100BASE-TX	Cat. 5 100-ohm UTP	UTP 100 m (328 ft)	RJ-45

6.2 ETH Cable Pin Assignments

With 100BASE-TX/10BASE-T cable, pins 1 - 2 are used for transmitting data and pins 3 - 6 are used for receiving data.

Pin Number	Description
1	TD+
2	TD-
3	RD+
4	Not Used
5	Not Used
6	RD-
7	Not Used
8	Not Used

7. System Comparison Between CAT5 and BPL Links

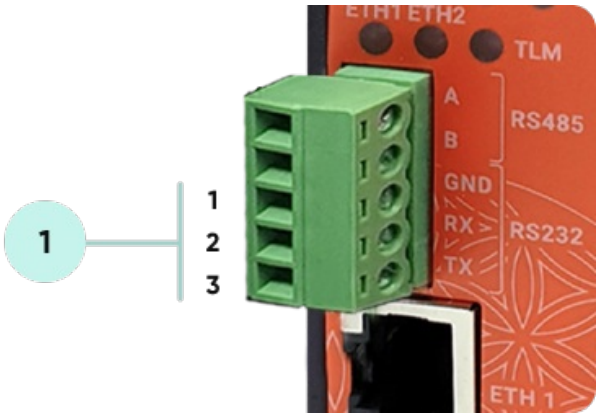
	CAT5 Based System	BPL Link Based System
Media	CAT5	Power Line
Bandwidth	100Mbps	Up to 30Mbps
Re-Wire	Yes	No, Using existing Power Line
Span	<100m	<600m

Multiple Nodes	N/A	Up to 10 hops/1000 nodes
Encryption	Yes, but difficult to configure	Yes, Plug & Play
Installment	Difficult	Easy, simply user power line
Installment Cost	High	Low
Total Cost	High	Low

8. Serial Cables

TLM Series LoRaWAN EndNode Modems have 1 x RS232 and 1 xRS485 port. Serial line can be connected other serial devices such as RTUs, PLCs, energy meters or any other field device.

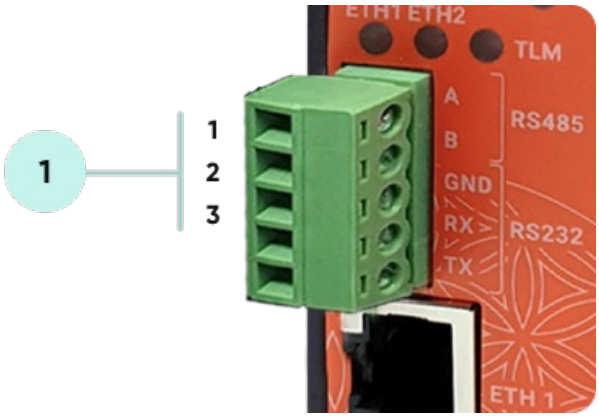
8.1 RS232 Cable Pin Assignments



1. Terminal connector for 3 wire Tx-Rx-GND RS232 data transmission

Pin Number	Description
1	GND
2	Rx
3	Tx

8.2 RS485 Cable Pin Assignments



1. Terminal Connector for 2 wire RS485 connection and GND (if needed)

Pin Number	Description
1	A
2	B

3	GND (Suggested to use)

9. Usage Scenarios and Connection Diagrams

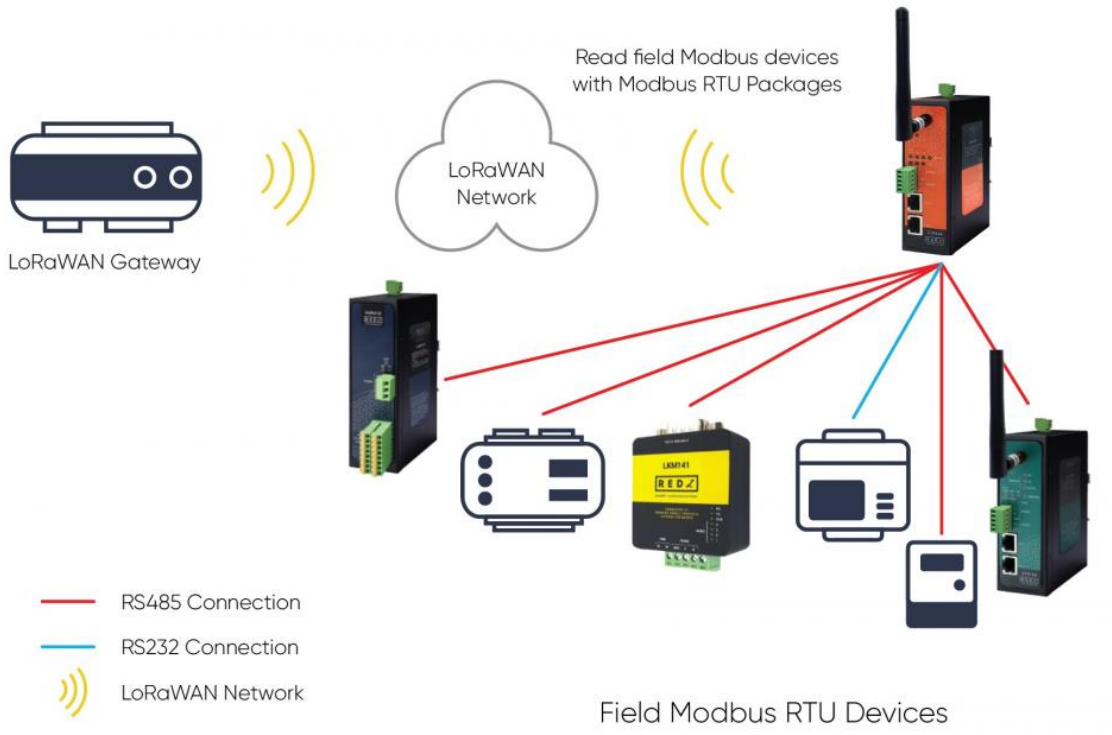
Some of the usage scenarios of TLM Series LoRaWAN EndNode Modems are described below. Usages are not limited to that examples and user may create their own usage scenario.

9.1 Send Field Modbus RTU Device Data to LoraWAN Server

TLM Series LoRaWAN EndNode Modems can read field Modbus RTU devices based on its Modbus RTU Scheduler and can send data to LoRaWAN server. TLM can automatically arrange data send interval and package size based on LoRaWAN regulations, user do not need to make calculations to fit to duty cycle, TLM can do it automatically for AS923 and EU868 Models. If package size is more than available payload size or if there are many packages in the queue, TLM can split/store in its memory until next available interval.

TLM LoRaWAN Configuration

- Server Mode
- Device Function: Modbus RTU Scheduler



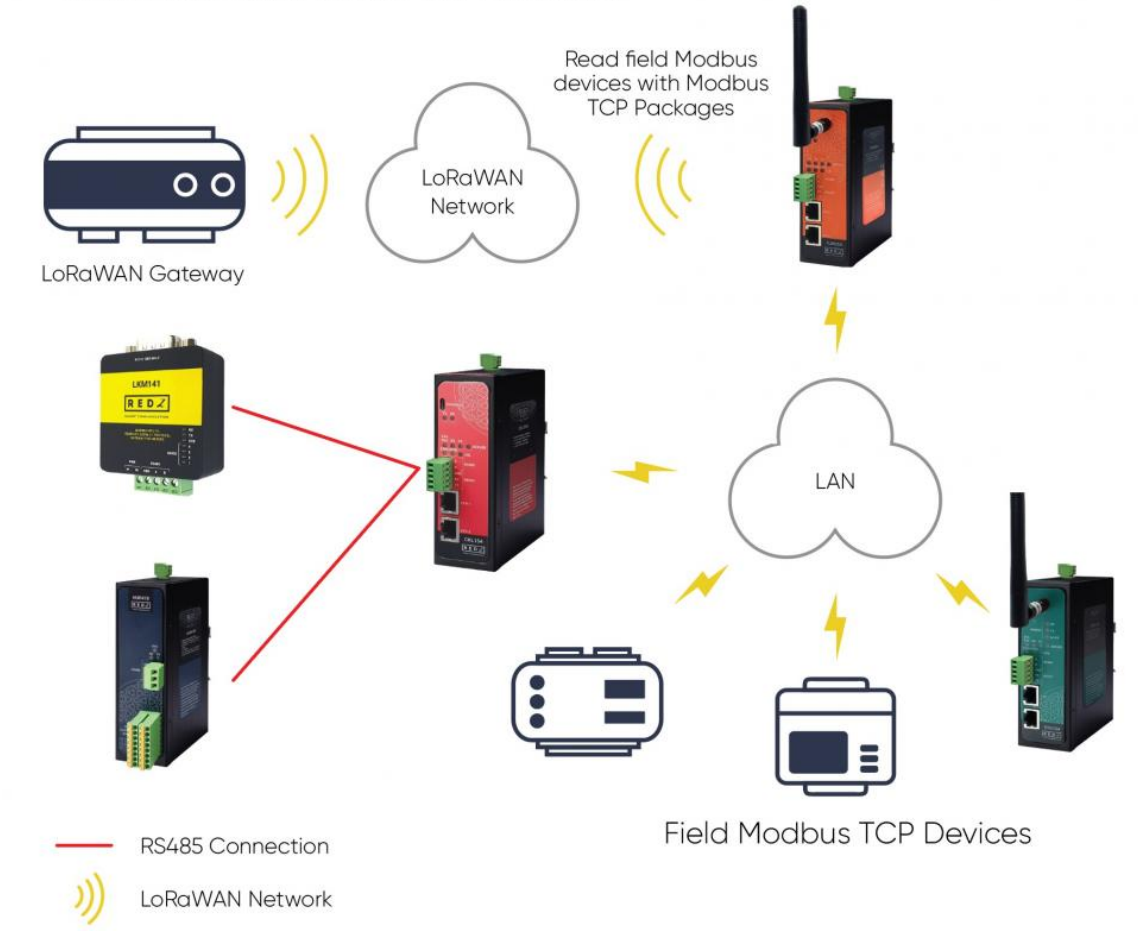
TLM Series LoRaWAN EndNode Modem set to Server Mode and device function set to Modbus RTU Scheduler. TLM can be individually connected to RS232 device and RS485 device, both serial interface can be active at same time. Field Modbus RTU devices such as protocol converters, energy analyzers, PLCs and remote IO devices can be read by TLM Series LoRaWAN EndNode Modem and their data can be send to LoRaWAN Server automatically.

9.2 Send Field Modbus TCP Device Data to LoraWAN Server

TLM Series LoRaWAN EndNode Modems can read field Modbus TCP devices based on its Modbus TCP Scheduler and can send data to LoRaWAN server. TLM can automatically arrange data send interval and package size based on LoRaWAN regulations, user do not need to make calculations to fit to duty cycle, TLM can do it automatically for AS923 and EU868 Models. If package size is more than available payload size or if there are many packages in the queue, TLM can split/store in its memory until next available interval.

TLM LoRaWAN Configuration

- Client Mode
- Device Function: Modbus TCP Scheduler



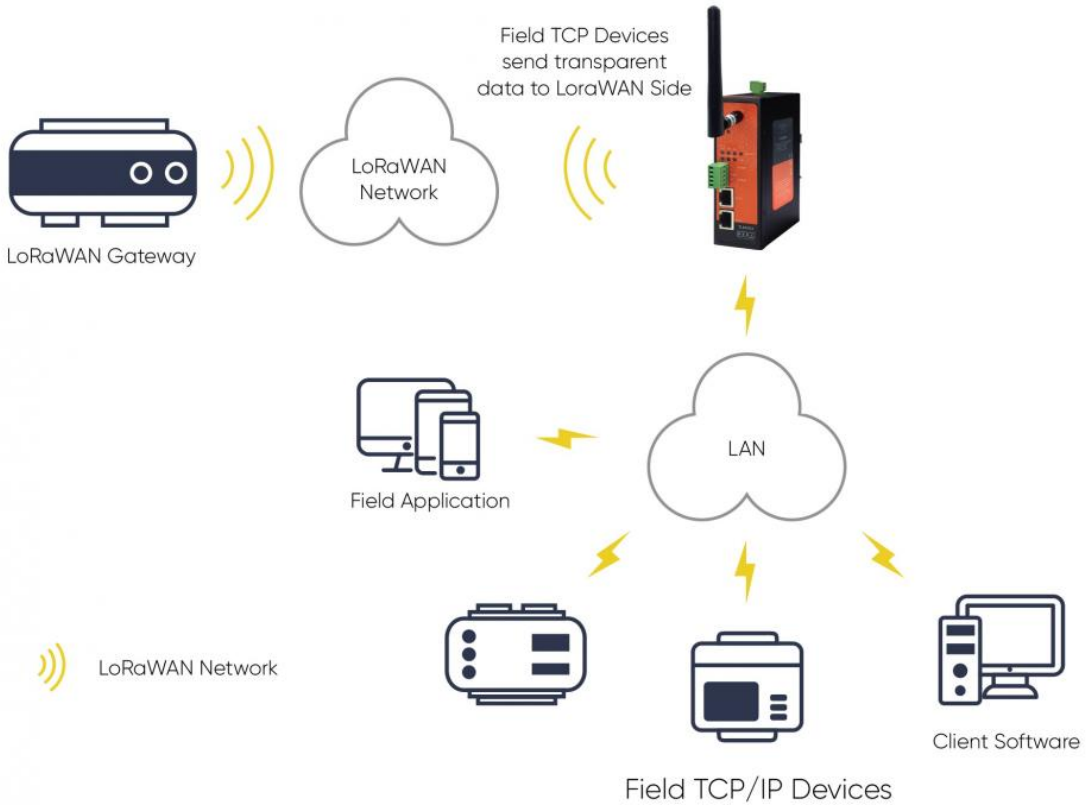
TLM Series LoRaWAN EndNode Modem set to Client Mode and device function set to Modbus TCP Scheduler. TLM can be connected to field Modbus TCP devices and it has built in mechanism to keep connection alive. Field Modbus TCP devices such as protocol converters, energy analyzers, PLCs and remote IO devices can be read by TLM Series LoRaWAN EndNode Modem and their data can be send to LoRaWAN Server automatically.

9.3 Send Field TCP/IP Devices Data to LoraWAN Server Transparently

TLM Series LoRaWAN EndNode Modems can also act as transparent gateway between field TCP/IP devices and LoRaWAN server. TLM can listen data from field TCP/IP devices and can send received data to LoRaWAN server. TLM can automatically arrange data send interval and package size based on LoRaWAN regulations, user do not need to make calculations to fit to duty cycle, TLM can do it automatically for AS923 and EU868 Models. If package size is more than available payload size or if there are many packages in the queue, TLM can split/store in its memory until next available interval.

TLM LoRaWAN Configuration

- Server Mode
- Device Function: Transparent



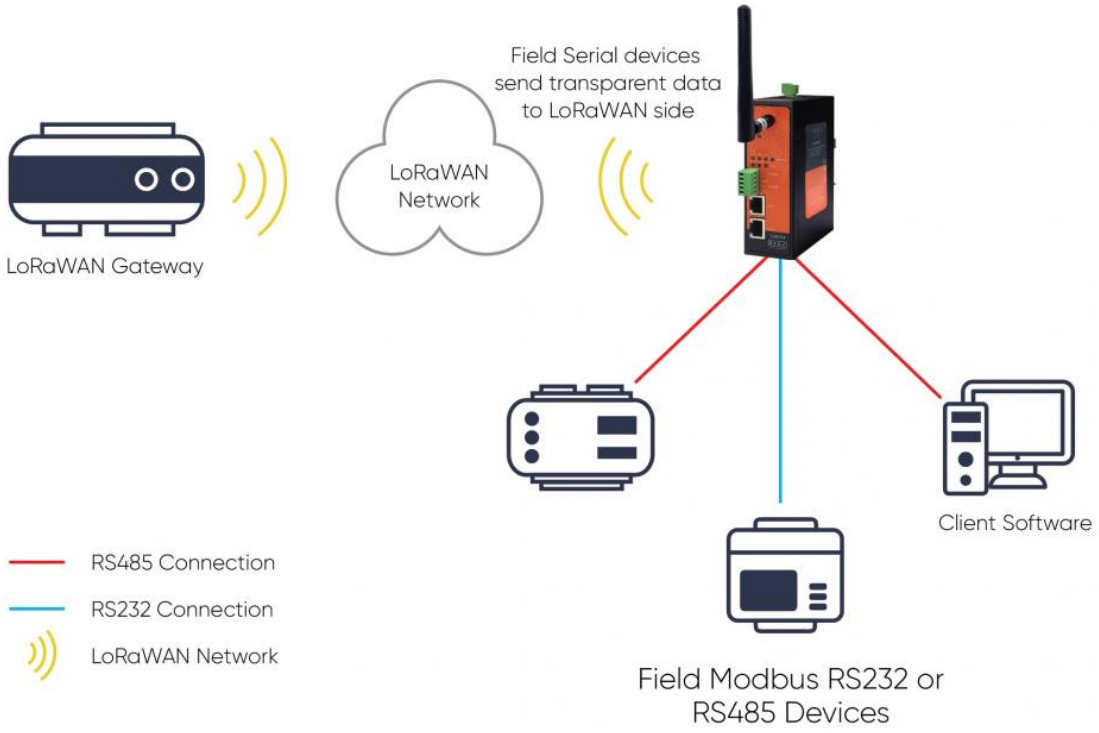
TLM Series LoRaWAN EndNode Modem set to Server Mode and device function set to Transparent. Field TCP/IP devices such as PLCs and local or remote software systems can connect to TLM listening port and can send data to LoRaWAN Server automatically.

9.4 Send Field Serial Devices Data to LoraWAN Server Transparently

TLM Series LoRaWAN EndNode Modems can also act as transparent gateway between field RS232 or RS485 Serial devices and LoRaWAN server. TLM can get data from field serial devices and can send received data to LoRaWAN server. TLM can automatically arrange data send interval and package size based on LoRaWAN regulations, user do not need to make calculations to fit to duty cycle, TLM can do it automatically for AS923 and EU868 Models. If package size is more than available payload size or if there are many packages in the queue, TLM can split/store in its memory until next available interval.

TLM LoRaWAN Configuration

- Client Mode
- Device Function: Transparent



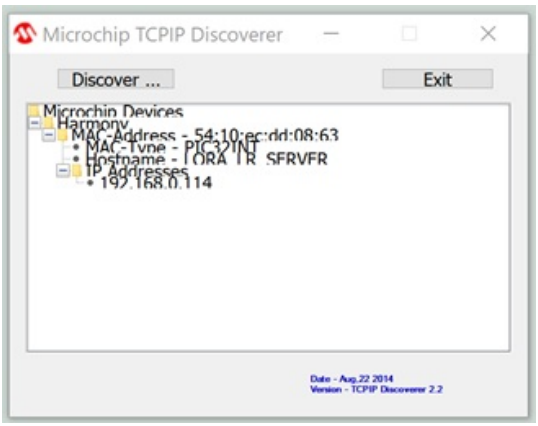
TLM Series LoRaWAN EndNode Modem set to Client Mode and device function set to Transparent. Field RS232 or RS485 devices such as PLCs and local software systems can make link with TLM over serial interface and can send data to LoRaWAN Server automatically.

10. Configuration via WEB Interface

TLM Series LoRaWAN EndNode Modems can be configured over web interface.

Device will get IP from DHCP client when connected to a network. User can use discovery tool to see IP of the device.

Once the IP of the device is get, user may login the device by simply typing the Ip address of device.



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NOTE: TLM default firmware runs with DHCP off and expects an IP lease. If user need static IP or prefers DHCP on during start up, additional firmware is available.

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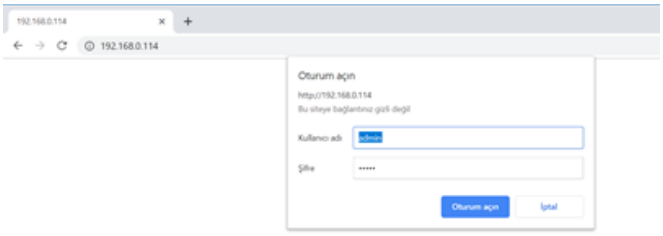
NOTE: If there is no DHCP server in LAN, REDZ device will get default 192.168.1.1 IP if it is set as Server Mode. It will get default 192.168.1.100 IP if it is set as Client mode.

10.1 Connecting Web Interface

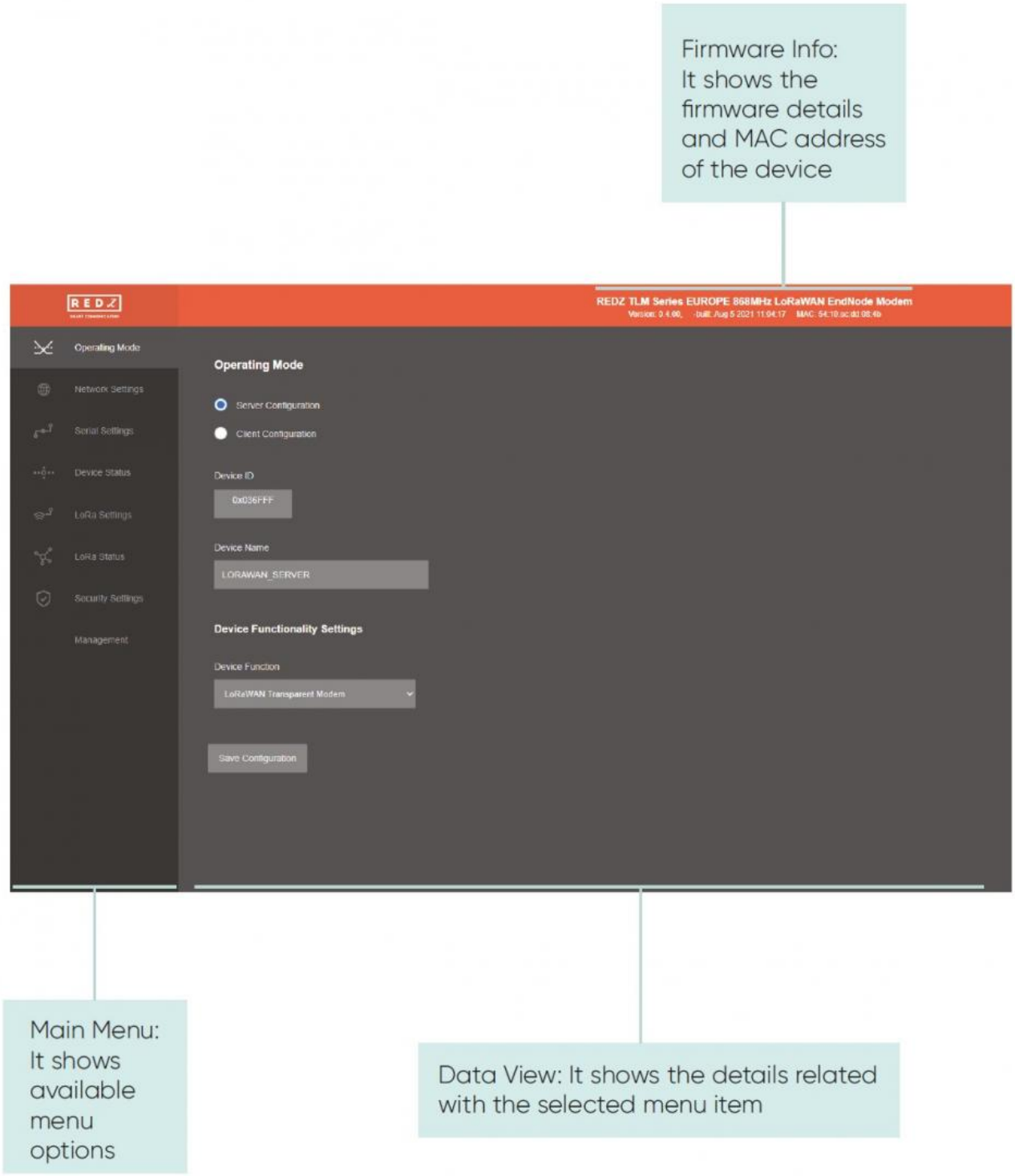
Simply write IP of the device to the http client. Google Chrome is suggested to use. Login screen will pop up.

Default user name: **admin**

Default password: **admin**



Main screen of device will appear with following information



10.2 MENU: Operating Mode

From this menu user may select the operating mode of the device. TLM has 3 Main Device Function:

1. Modbus TCP Scheduler: TLM reads field Modbus TCP devices and send data to LoRaWAN Server.
2. Modbus RTU Scheduler: TLM reads field Modbus RTU devices and send data to LoRaWAN Server.
3. Transparent Mode: TLM sends any Package from TCP/IP or Serial Side to LoRaWAN Server.

Data is bidirectional in each device function, means LoRaWAN can also send data to field devices based on LoRaWAN class A or C.

- TLM can act as Modbus TCP Scheduler and send Modbus TCP data to LoRaWAN Server. TLM is set to Client Mode and Device Function is Modbus TCP Scheduler.

- TLM can act as Modbus RTU Scheduler and send Modbus RTU data to LoRaWAN Server. TLM is set to Server Mode and Device Function is Modbus RTU Scheduler.

- TLM can act as transparent gateway between field TCP/IP devices and LoRaWAN Server. TLM is set to Server Mode and Device Function is LoRaWAN Transparent Modem. Field TCP/IP devices can connect listening port of TLM and can send data to LoRaWAN Server.

- TLM can act as transparent gateway between field RS232 or RS485 serial devices and LoRaWAN Server. TLM is set to Client Mode and Device Function is LoRaWAN Transparent Modem. Field serial devices can be connected to TLM and can send data to LoRaWAN Server.

“Device ID” field is used to identify device with unique ID number which is also matched with LoRA module of the device.

“Device Name” field is used to identify device and also used during REDZ special design, plug and play Server-Client Operating Modes.

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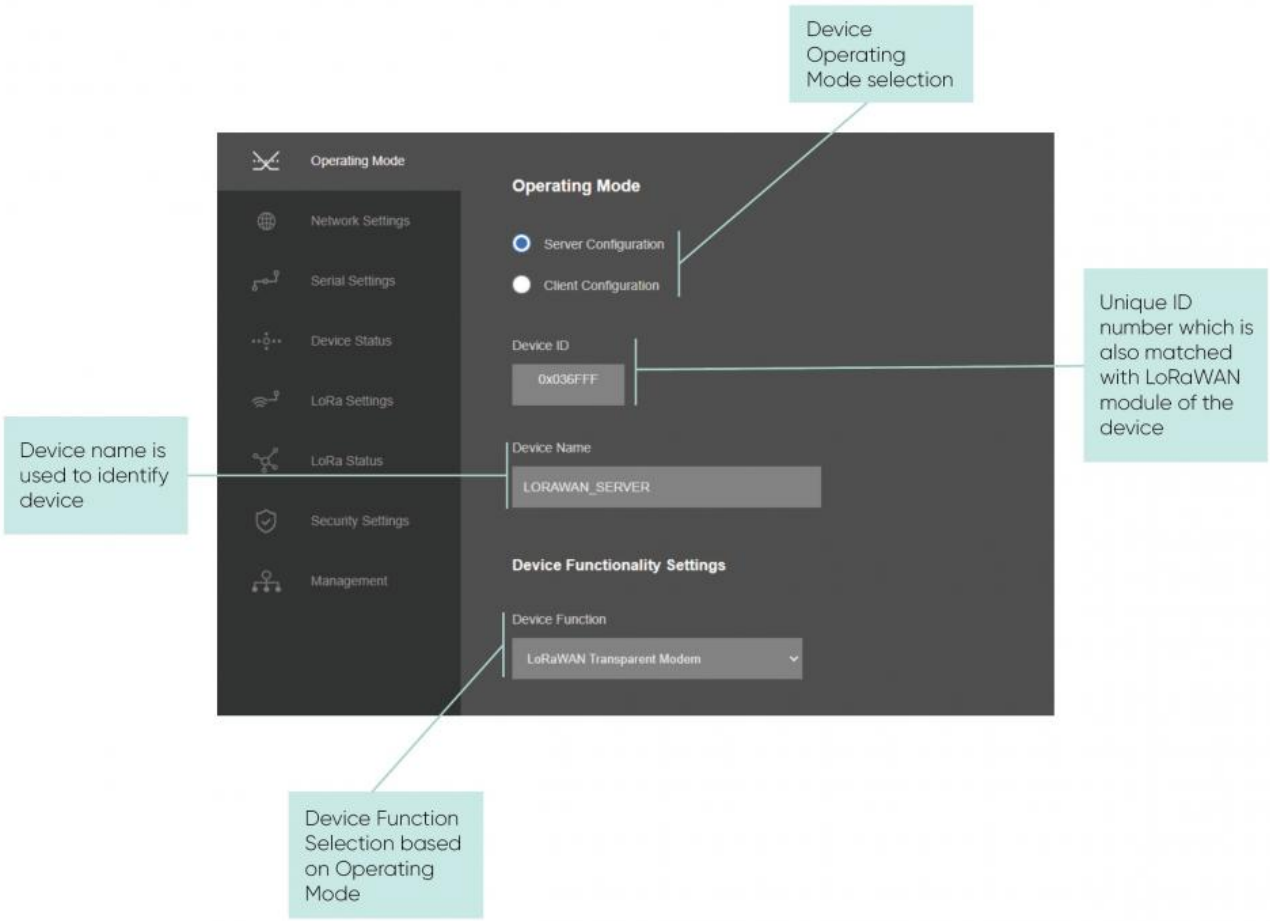
NOTE: TLM Series LoRaWAN EndNode Modems have built in mechanism to check maximum allowed payload size. If package received (transparent package, Modbus TCP package or Modbus RTU package) exceeds maximum allowed payload size, then TLM automatically splits package and send split messages to LoRaWAN Server 1 by one by storing split message in memory.

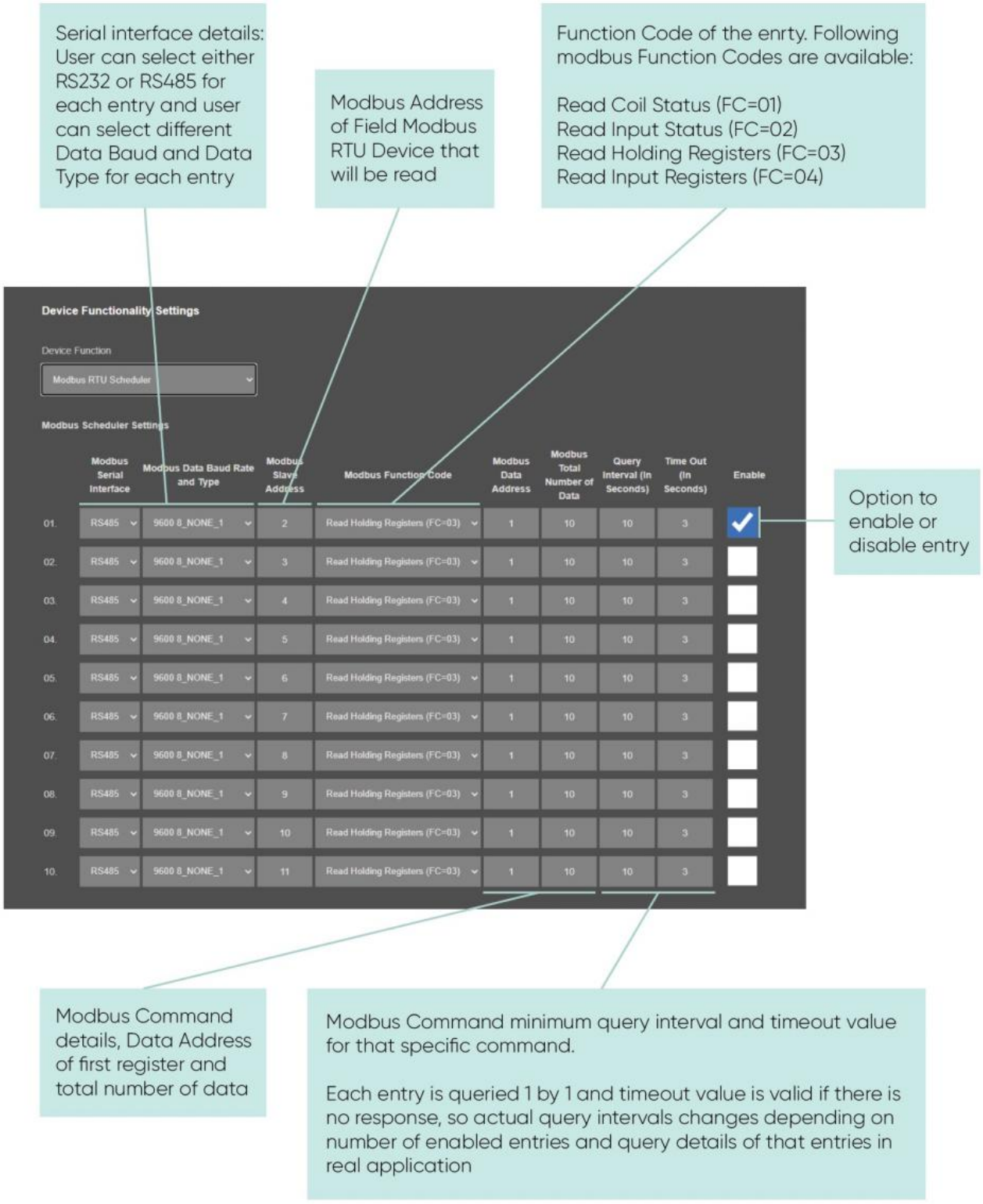
TLM can store up to 100 last messages in its memory queue.

TLM can also automatically blocks data sending based on duty cycle and continues to send back again when duty cycle block time is over. First in messages in queue is send first (FIFO).



If Device Operating Mode is Server and Device Function is set as Modbus RTU Scheduler, following settings will be shown.

Users may enter Modbus RTU Scheduler details including Serial interface settings and Modbus RTU command settings and query intervals.



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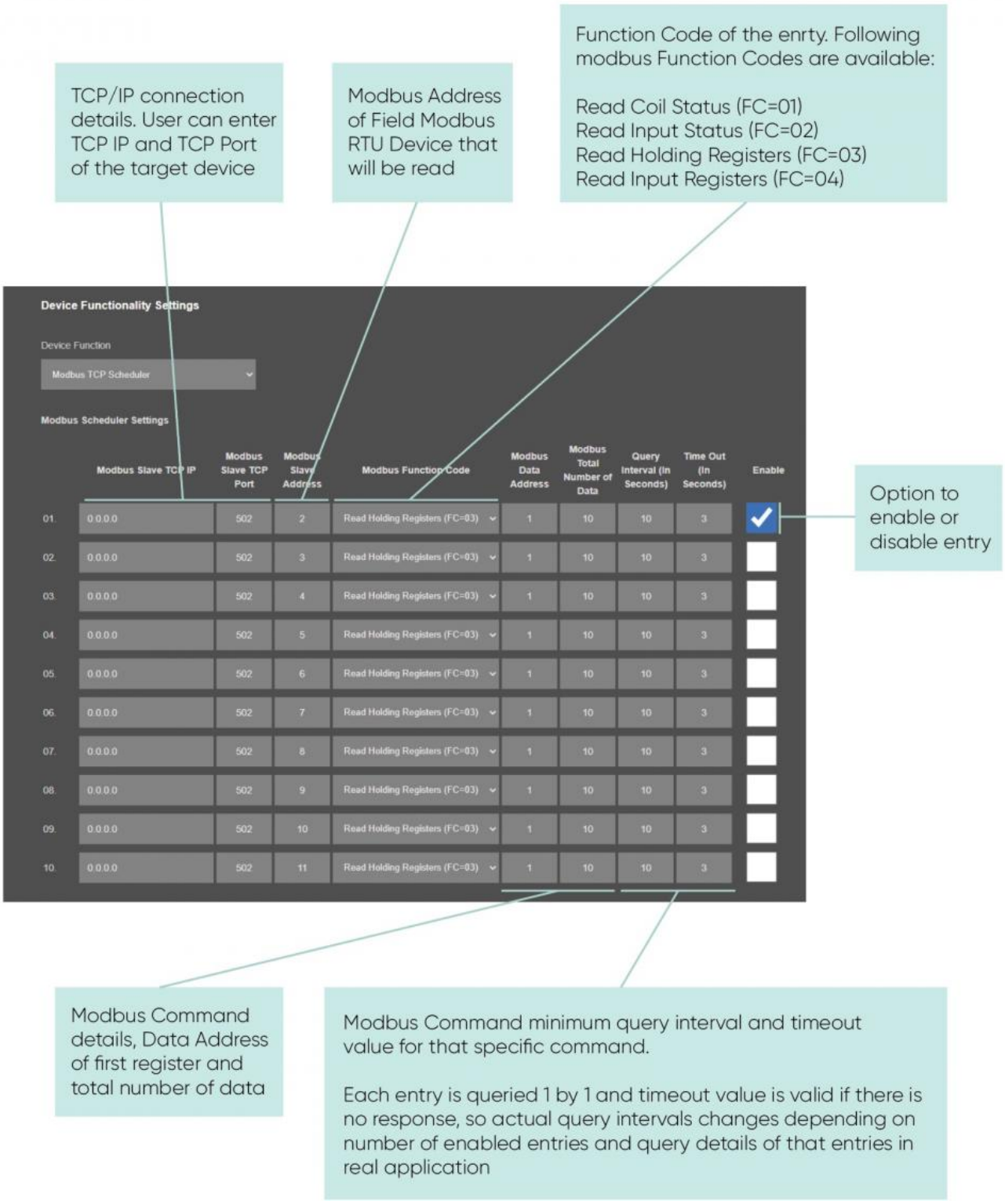
NOTE: Up to 10 commands can be activated in TLM Series LoRaWAN EndNode Modems. User can read many registers with 1 command. If the command response length exceeds maximum allowed payload then TLM splits the Modbus package, store it and send split packages 1 by 1 according to duty cycle limitations.

If Device Operating Mode is Client and Device Function is set as Modbus TCP Scheduler, following settings will be shown.

Users may enter Modbus TCP Scheduler details including TCP/IP parameters and Modbus TCP command settings and query intervals.



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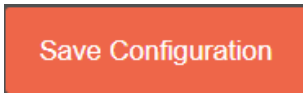
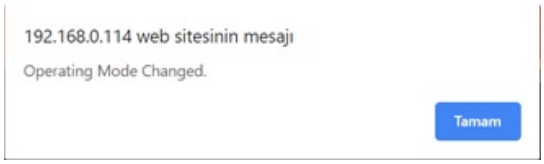
NOTE: Up to 10 commands can be activated in TLM Series LoRaWAN EndNode Modems. User can read many registers with 1 command. If the

command response length exceeds maximum allowed payload then TLM splits the Modbus package, store it and send split packages 1 by 1 according to duty cycle limitations.

Once the setting has been changed, “Save Configuration” button will be enabled.



After clicking button system will tell if the settings applied successfully or not.



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NOTE 1: TLM Series LoRaWAN EndNode Modems can keep configuration of 2 different modes in its memory and once the configuration enabled, its already saved settings will be applied. Device can act as Server or Client at a time.

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NOTE 2: Settings will be applied once the device is rebooted from web interface or repowered manually.

10.3 MENU: Network Settings - Server

From this menu user may change the network settings of the device.

If Modbus RTU Device Function is selected:

- User can activate DHCP server.

- User can force device to a static IP.

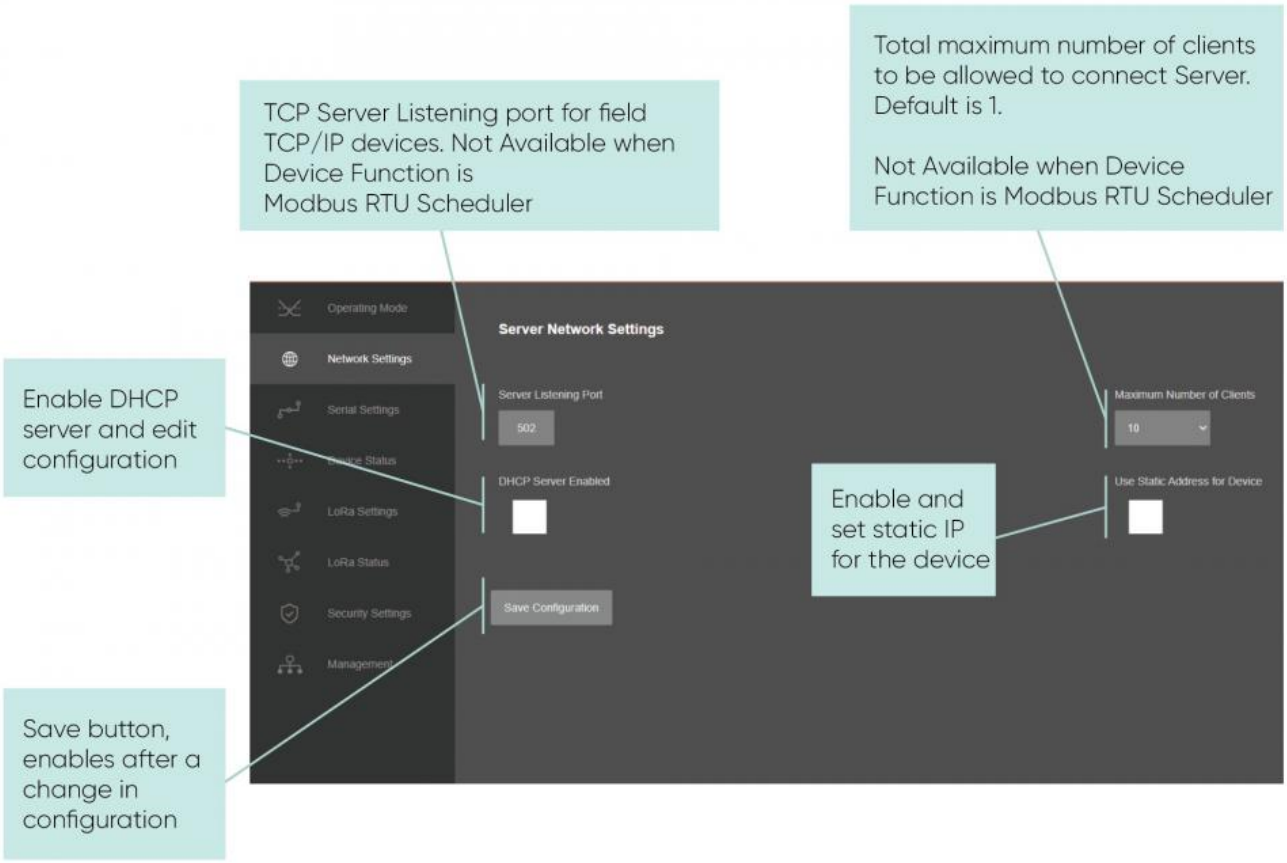
If Transparent Device Function is selected:

- User can change TCP Listening port for field devices

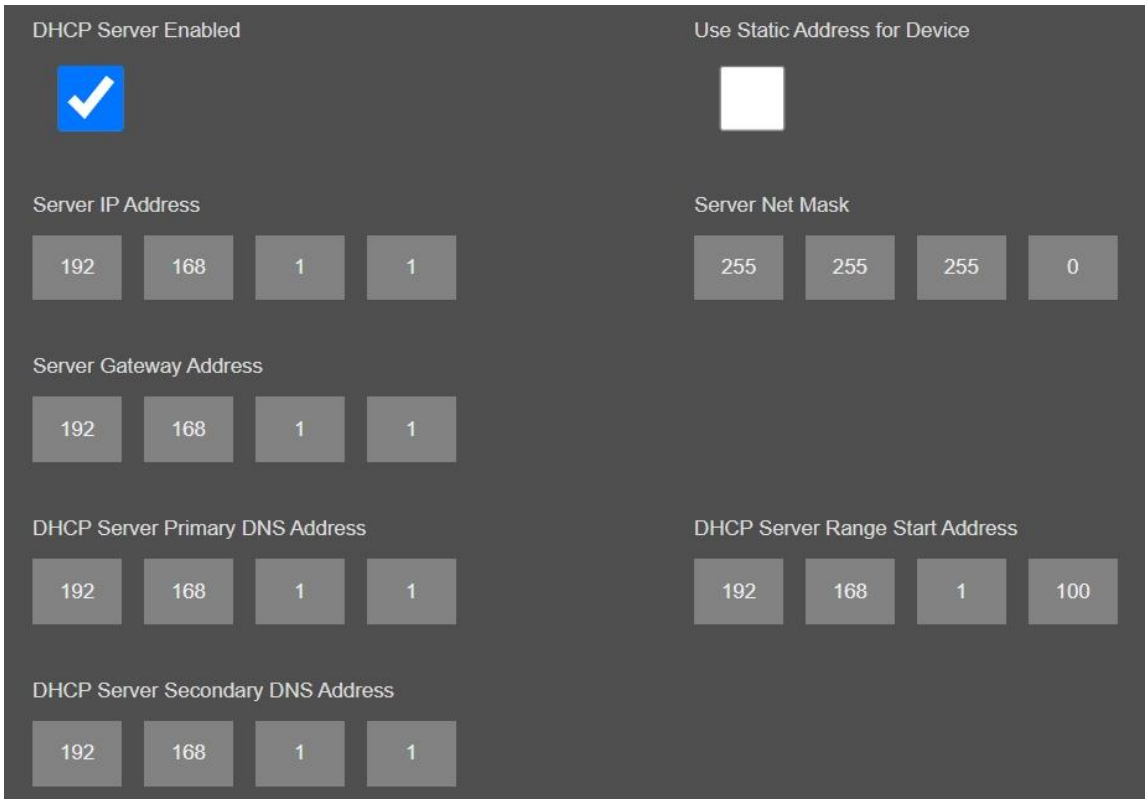
- User can select maximum number of clients allowed to connect device.

- User can activate DHCP server.

- User can force device to a static IP.



Following parameters and static IP settings available for “DHCP Server” setting.



Also if the device has Broadband Power Line (BPL) option

- User can select operating mode of BPL either MASTER or NODE.

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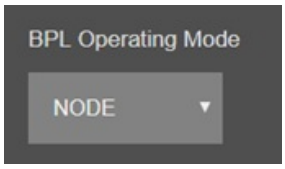
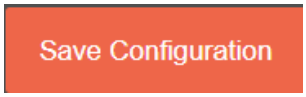
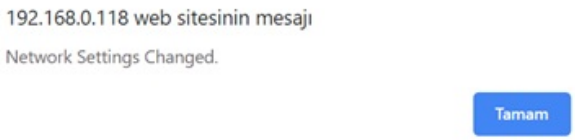
NOTE: Standard firmware of REDZ BPL supports up to 10 hops and 1000 nodes. Only 1 device can be MASTER in same network.



Once the setting has been changed, “Save Configuration” button will be enabled.



After clicking button system will tell if the settings applied successfully or not.



☝

NOTE 1: TLM Series LoRaWAN EndNode Modems can keep configuration of 2 different modes in its memory and once the configuration enabled, its already saved settings will be applied. Device can act as Server or Client at a time.

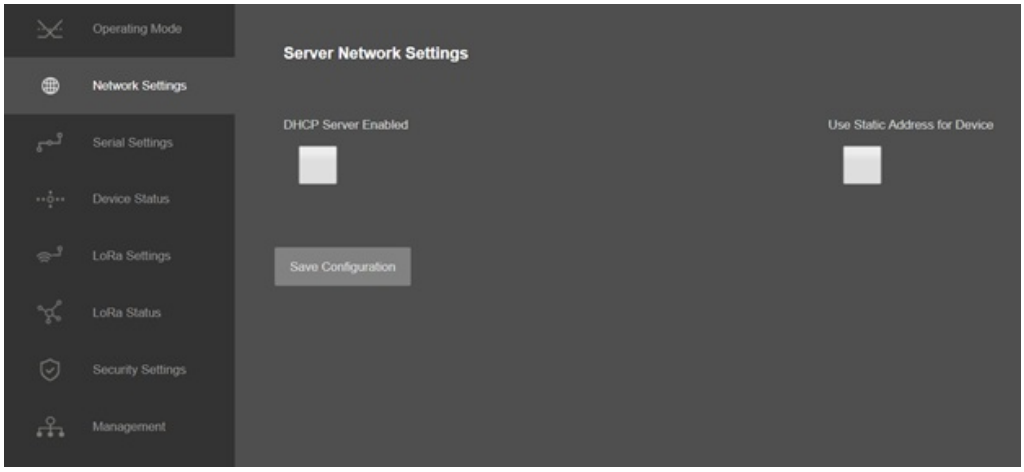
☝

NOTE 2: Settings will be applied once the device is rebooted from web interface or repowered manually.

☝

NOTE 3: If one of the Serial connections is enabled when the Device Function is Transparent, the device will act as Serial to LoRaWAN Transparent Gateway and only following menu items will be available.

Same options are available when Device Function is set to Modbus RTU Scheduler as well.



10.4 MENU: Network Settings - Client

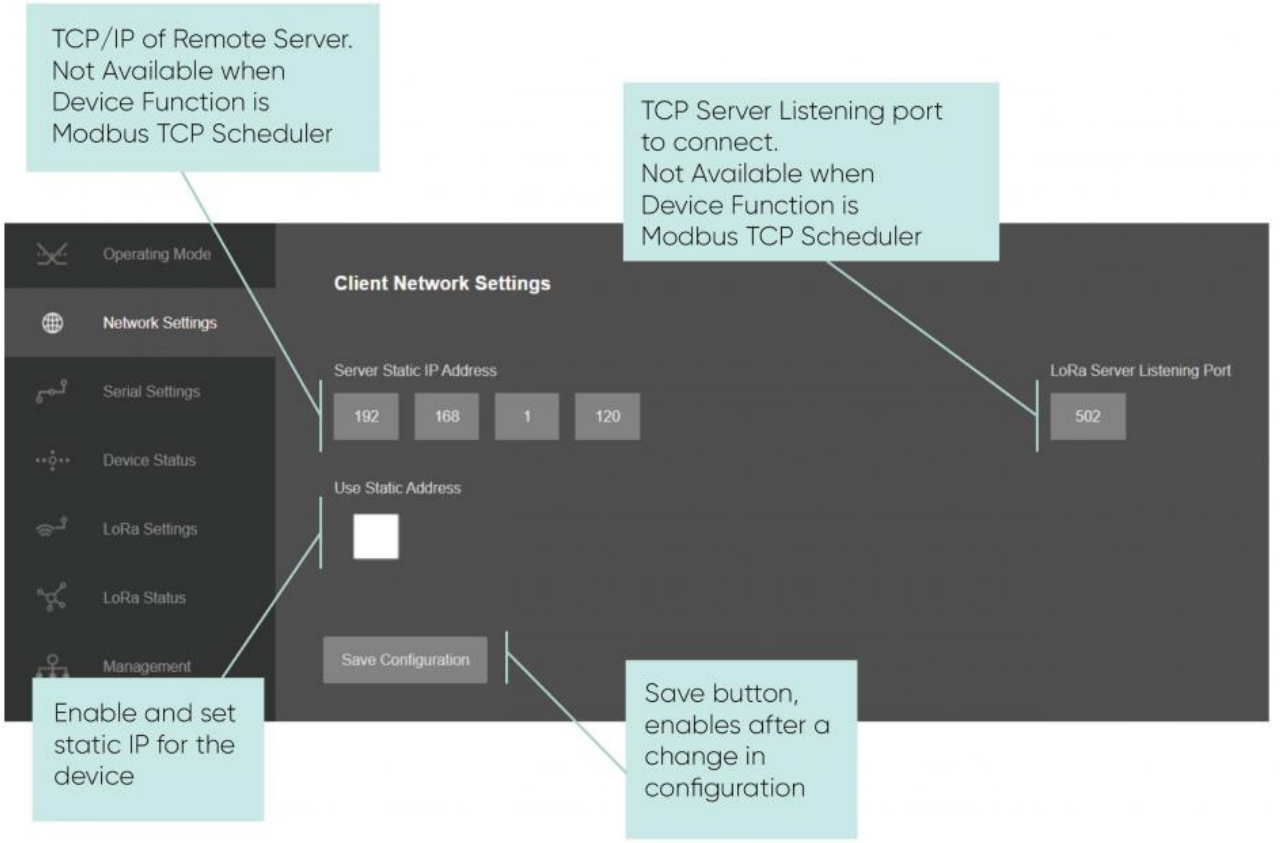
From this menu user may change the network settings of the device.

- User can force device to a static IP.

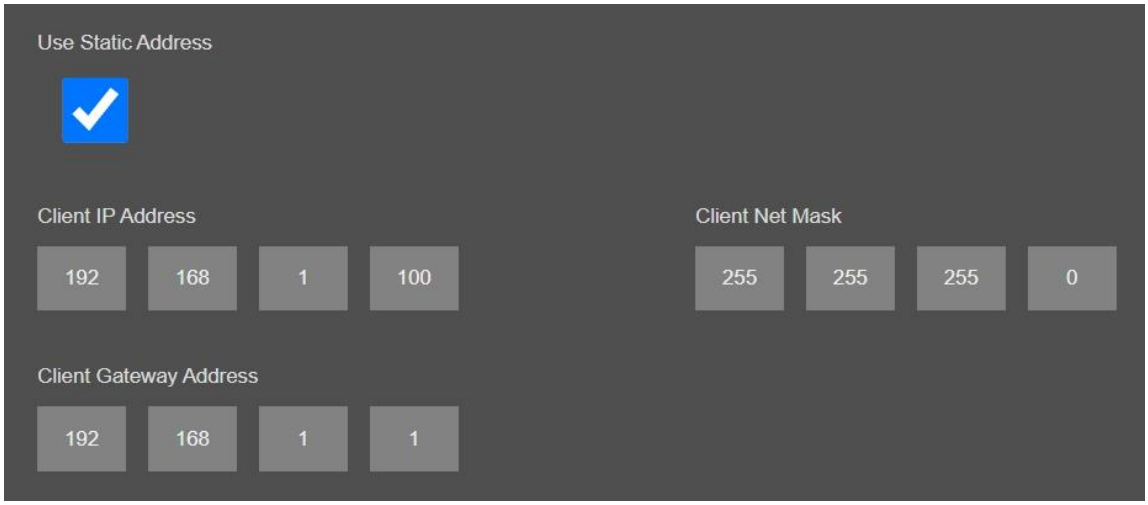
If Transparent Device Function is selected:

- User can enter IP of the Target Server.

- User can change target TCP Server Listening port.



Following parameters and static IP settings available for “Use Static IP Address” setting

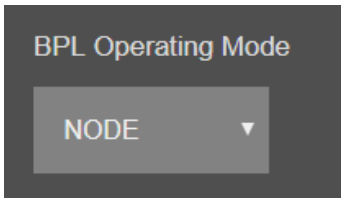


Also if the device has Broadband Power Line (BPL) option

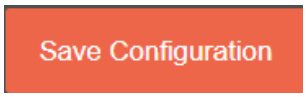
- User can select operating mode of BPL either MASTER or NODE

☝

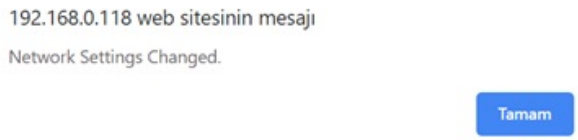
NOTE: Standard firmware of REDZ BPL supports up to 10 hops and 1000 nodes. Only 1 device can be MASTER in same network. If the device is in client mode, it is suggested to use “NODE” as setting.



Once the setting has been changed, “Save Configuration” button will be enabled.



After clicking button system will tell if the settings applied successfully or not.



☝

NOTE 1: TLM Series LoRaWAN EndNode Modems can keep configuration of 2 different modes in its memory and once the configuration enabled, its already saved settings will be applied. Device can act as Server or Client at a time

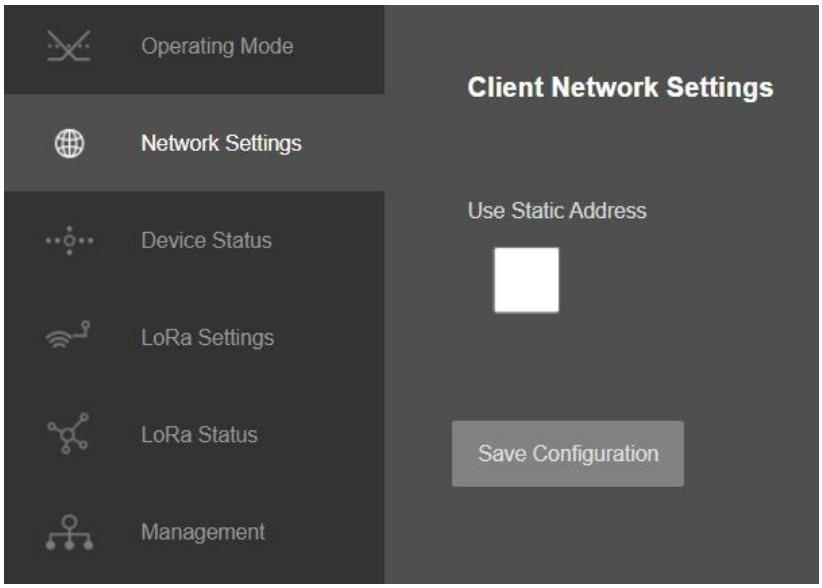
☝

NOTE 2: Settings will be applied once the device is rebooted from web interface or repowered manually.

☝

NOTE 3: If one of the Serial connections is enabled when the Device Function is Transparent, the device will act as Serial to LoRaWAN Transparent Gateway and only following menu items will be available.

Same options are available when Device Function is set to Modbus TCP Scheduler as well.



10.5 MENU: Serial Settings

This menu is available when

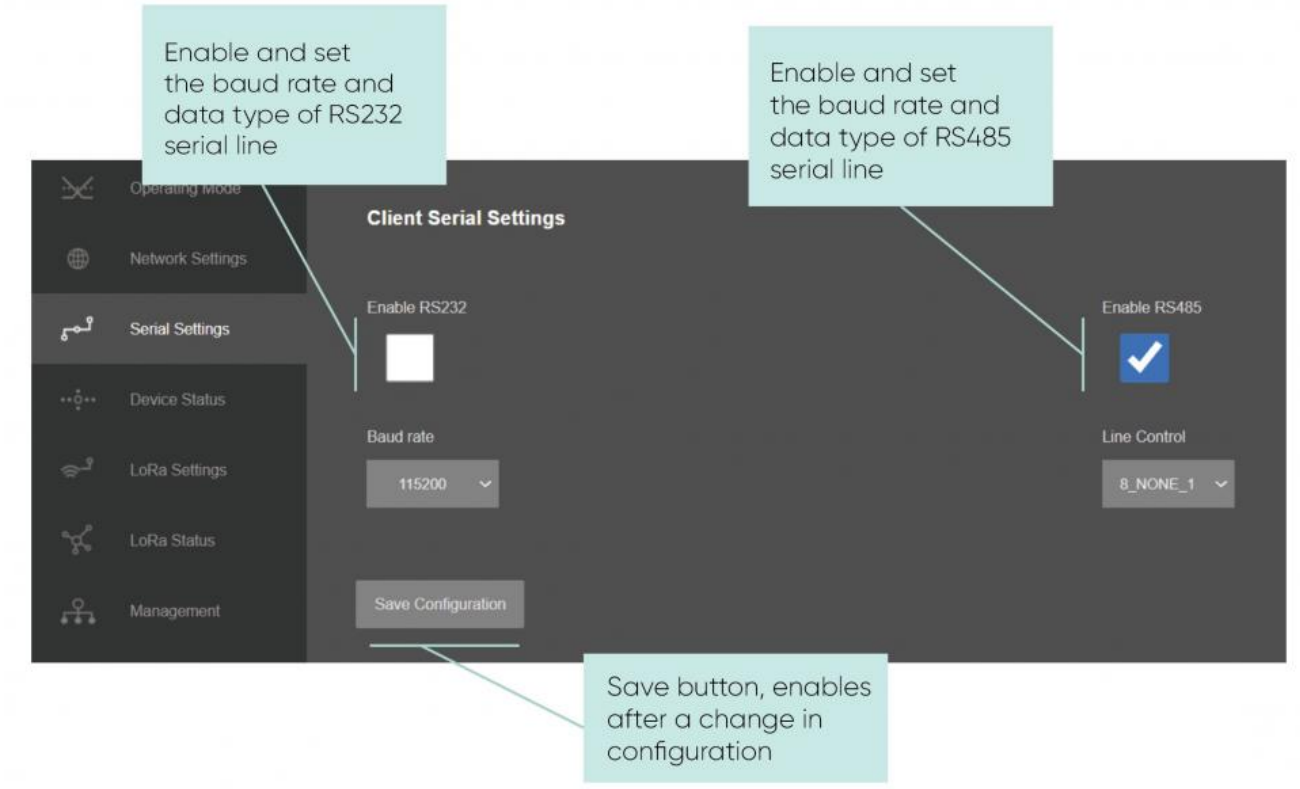
- Device Function is set to LoRaWAN Transparent Modem.

Otherwise, menu item will not be available for Modbus RTU Scheduler or Modbus TCP Scheduler Device functions.

From this menu user may activate RS232 or RS485 connection. Once serial connection enabled, the device will act as Serial to LoRaWAN Transparent Gateway and some Network options will be disabled. Yet again web interface with basic network settings will be accessible.

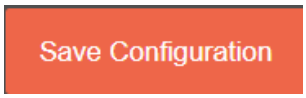
- User can select to activate RS232 line and can set baud rate and data type for serial line.

- User can select to activate RS485line and can set baud rate and data type for serial line.

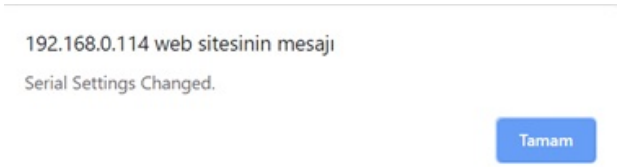


Following settings are available for serial line.

Once the setting has been changed, “Save Configuration” button will be enabled.



After clicking button system will tell if the settings applied successfully or not.



☝

NOTE: TLM Series LoRaWAN EndNode Modems can keep configuration of 2 different modes in its memory and once the configuration enabled, its already saved settings will be applied. Device can act as Server or Client at a time. Let’s say TCP Server enabled in Server operating mode and RS232 serial line enabled in Client operating mode on same device, the device can switch between to settings simply by changing the mode.

☝

NOTE: Settings will be applied once the device is rebooted from web interface or repowered manually.

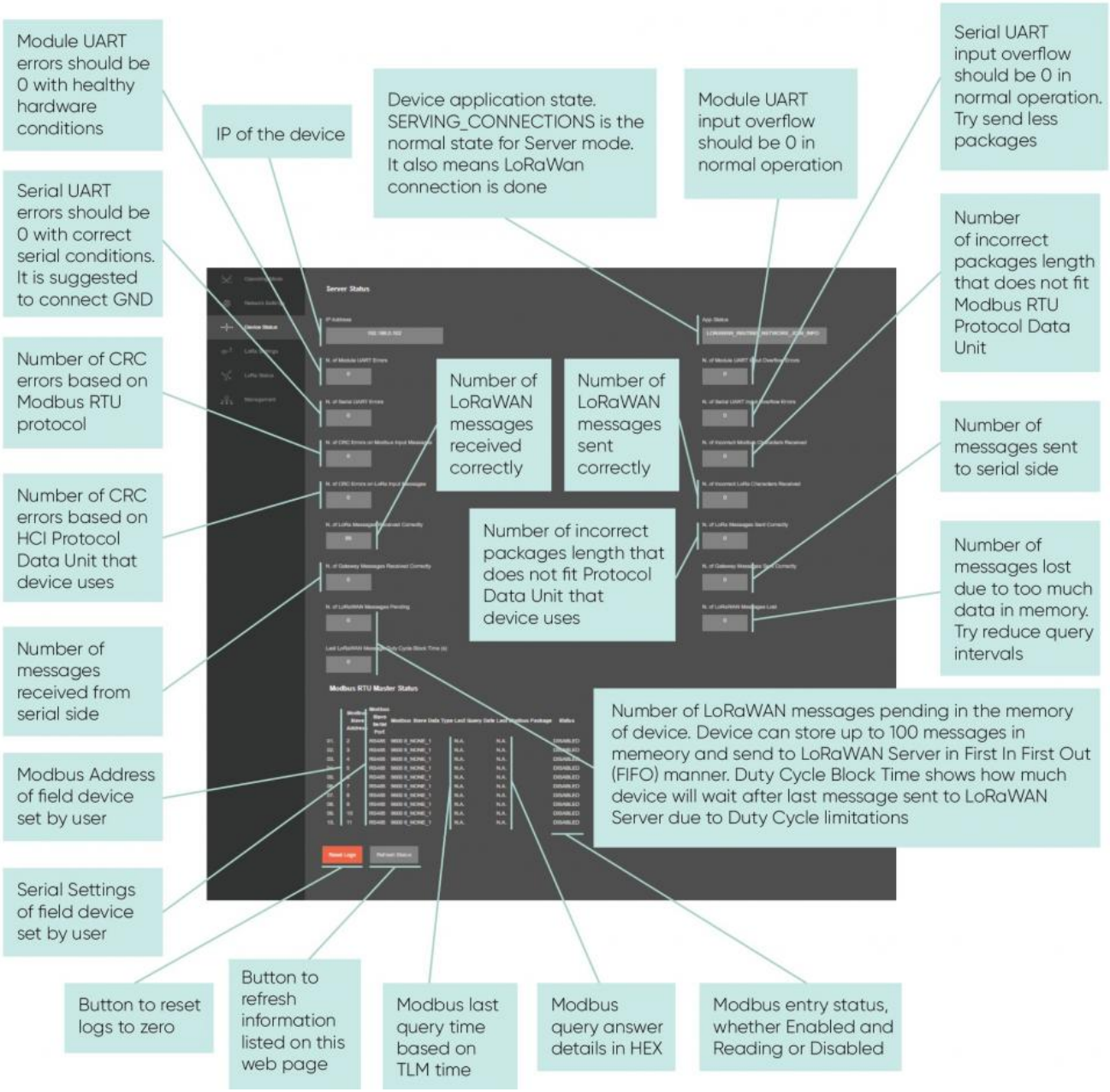
☝

NOTE: This page has same settings both for Server and Client operating modes. The Menu is available when Device Function is set to LoRaWAN Transparent Modem.

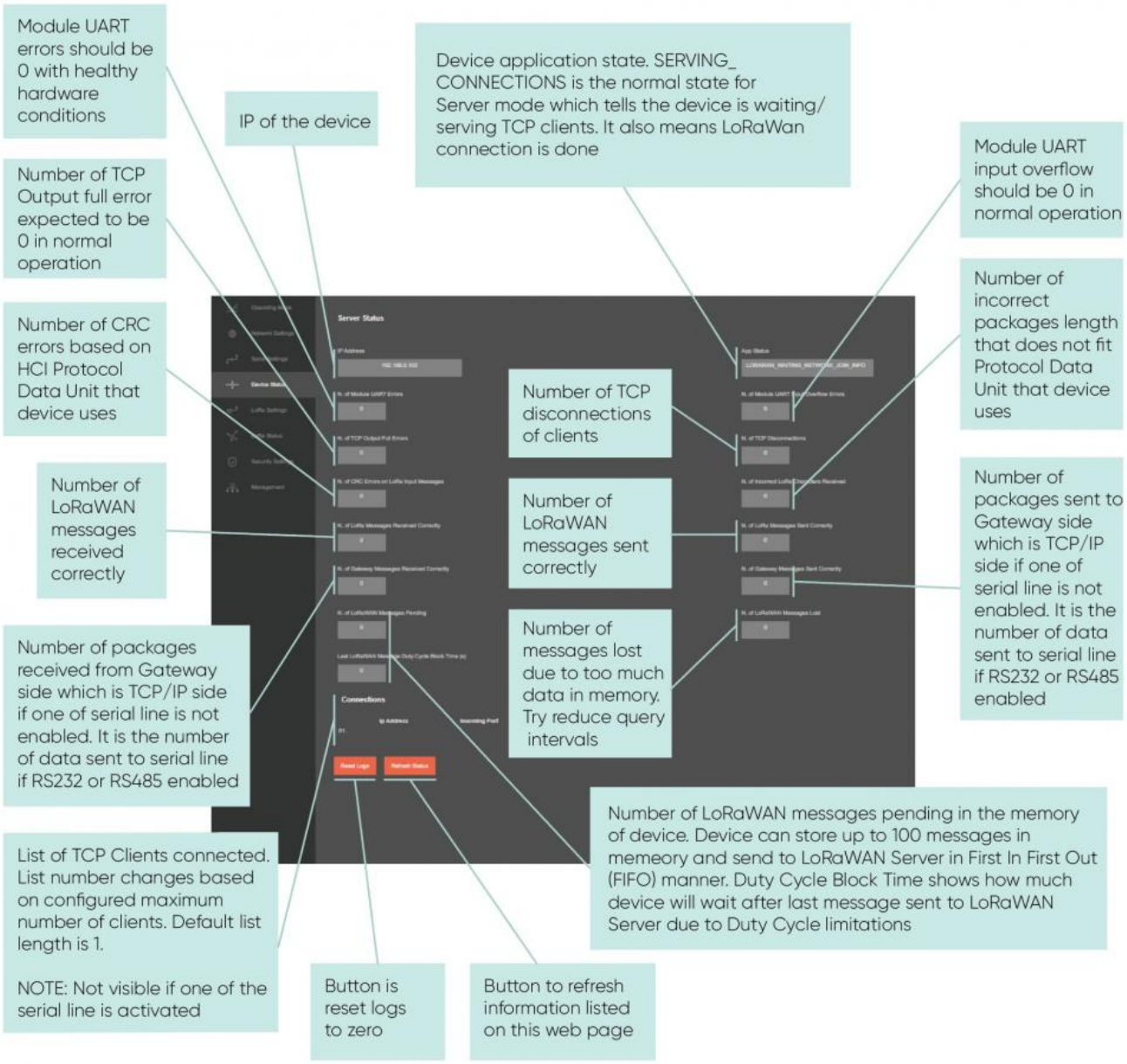
10.6 MENU: Device Status - Server

From this menu user may monitor device status and statistics based on operating mode of device. The page also helps users to check device health.

When device Function is set to Modbus RTU Scheduler, following page will be available:



When device Function is set to LoRaWAN Transparent Modem, following page will be available:



After clicking “Refresh Status” button, system will reload data only and will not reload page. Button will be disabled during reload for an instance. If timeout occurs during the reload, the button will be enabled again with warning of timeout. In normal operation reload of status data will be done immediately.

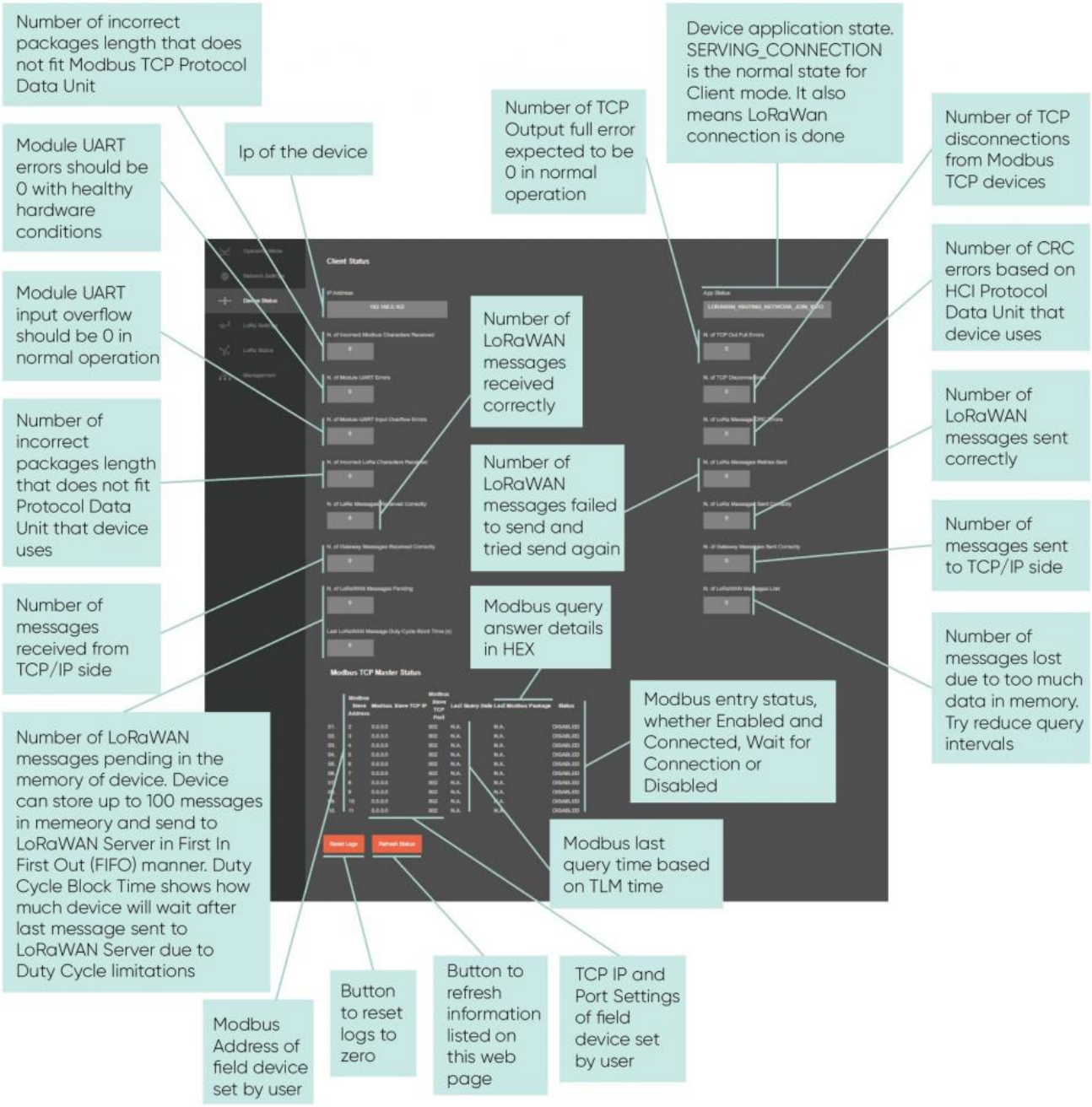
☝

NOTE: Connected client list will not be visible if one of the serial lines is activated and device will act as Serial to LoRaWAN Server Transparent Modem. Device Status page will also be slightly different.

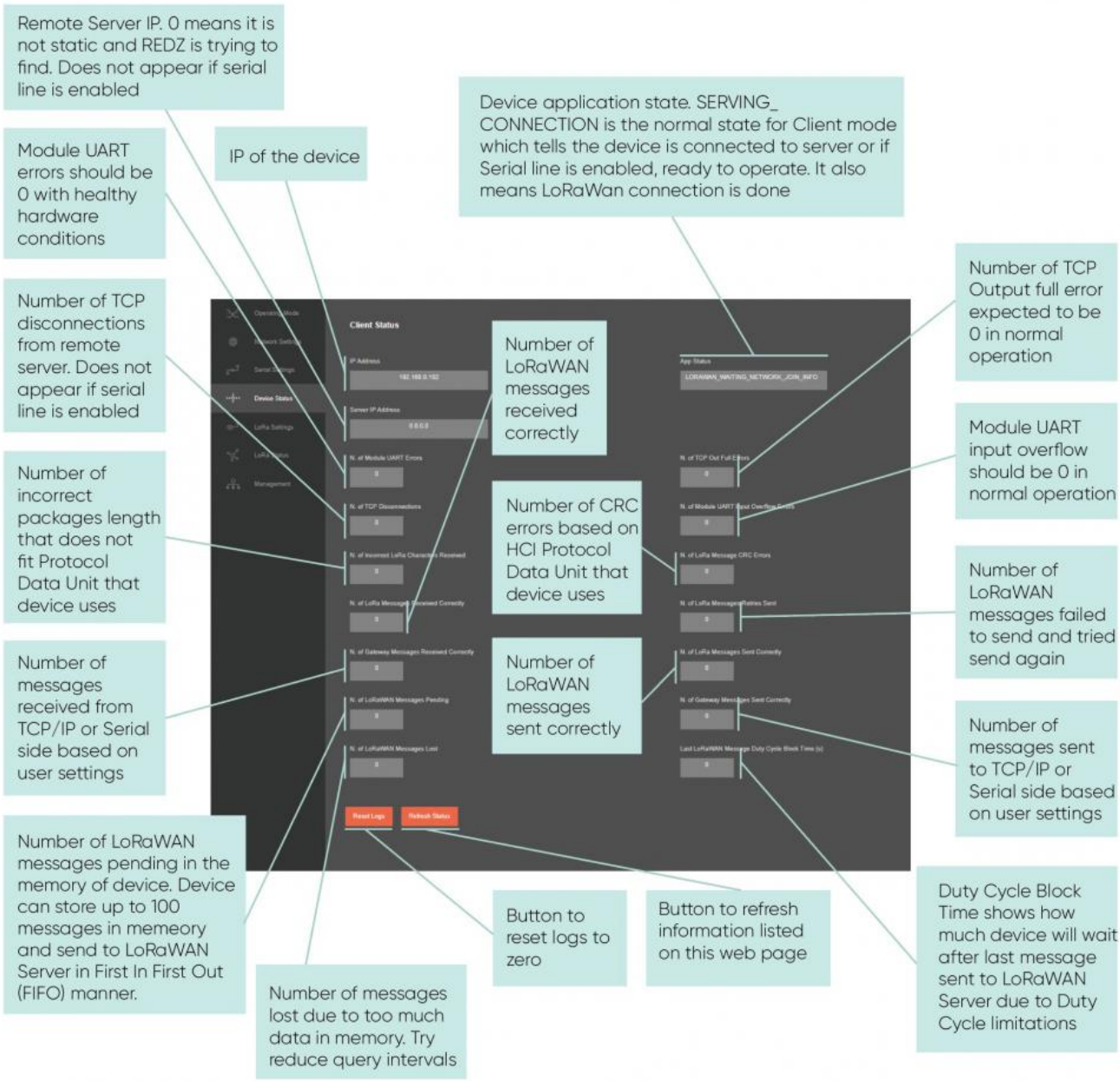
10.7 MENU: Device Status - Client

From this menu user may monitor device status and statistics based on operating mode of device. The page also helps users to check device health.

When device Function is set to Modbus TCP Scheduler, following page will be available:



When device Function is set to LoRaWAN Transparent Modem, following page will be available:



After clicking “Refresh Status” button, system will reload data only and will not reload page. Button will be disabled during reload for an instance. If timeout occurs during the reload, the button will be enabled again with warning of timeout. In normal operation reload of status data will be done immediately

☝

NOTE: If one of the serial lines is activated and device will act as Serial to LoRaWAN Server Transparent Modem. Device Status page will also be slightly different.

10.8 MENU: LoRa Settings

From this menu user may change LoRaWAN parameters.

- Select Activation method

End-Device Activation Over the Air (OTAA)

End-Device Activation by Personalization (ABP)

- Enter Device Address, Network Session Key and Application Session Key if ABP selected

- Enter Application EUI and Application Key if OTAA selected (device already have unique Device EUI)

- Change LoRaWAN port

- Activate or Deactivate Adaptive Data Rate

- Select Uplink Data Rate

- Select Tx Power Level (EIRP)

- Select LoRaWAN Class A or Class C (only unicast messages supported)

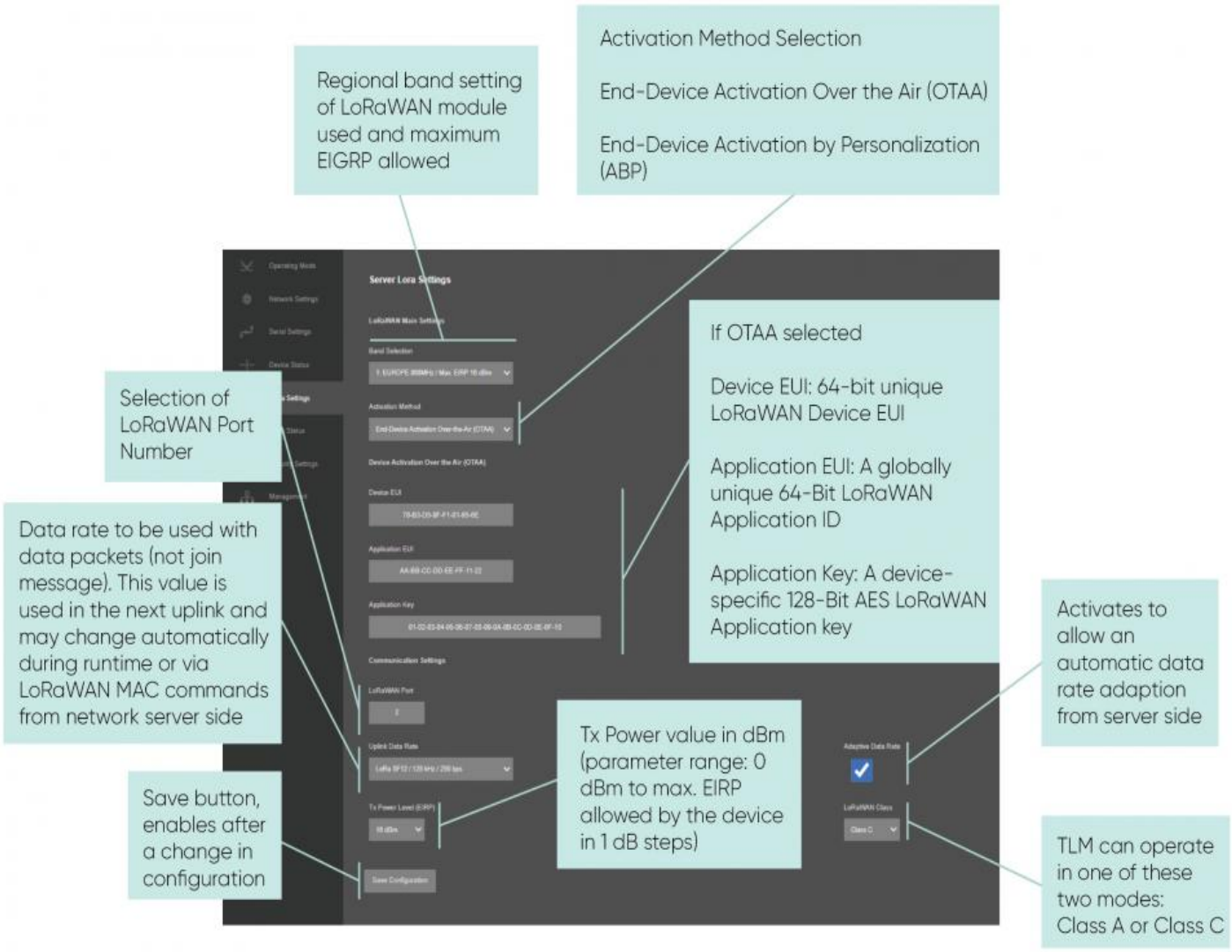
- Enter Sub-Band Mask 1 and Sub-Band Mask 2 values for US915 models

TLM uses Semtech's LoRa proprietary spread spectrum modulation technique. This modulation, in contrast to conventional modulation techniques, permits an increase in link budget and increased immunity to in-band interference. It achieves sensitivities 8 dB better than FSK modulation.

LoRa also provides significant advantages in both blocking and selectivity, solving the traditional design compromise between range, interference immunity and energy consumption.

Tx Power Level EIGRP is calculated as following:

Max. EIRP = MIN (Max. allowed EIRP, Max. RF Power + RF Gain + 2.15dB)

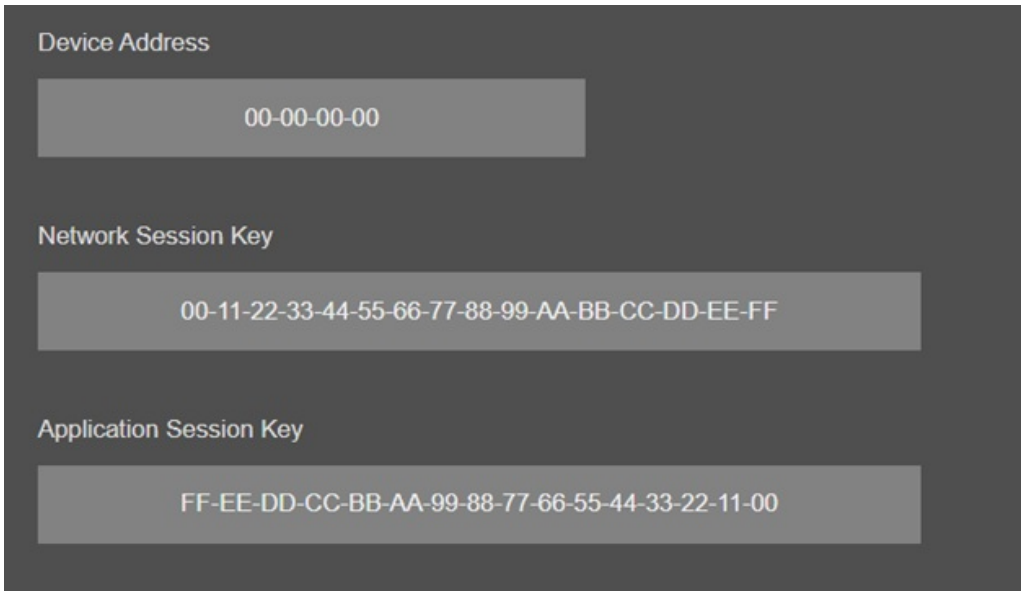


If ABP is selected, following settings will be available:

Device Address: A unique 32-Bit device-address, used for radio communication within a LoRaWAN network.

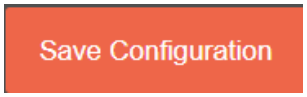
Network Session Key: A device-specific 128-Bit network session key used for MIC calculation and verification.

Application Session Key: A device-specific 128-Bit application session key used to encrypt and decrypt the payload field of application specific messages.

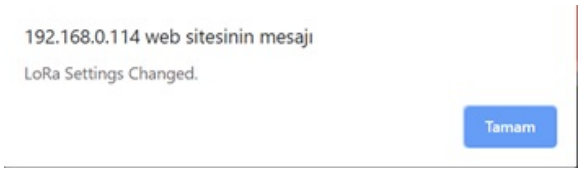


Sub-Band Mask 1 and Sub-Band Mask 2 values also available in this creen for US915 models

Once the setting has been changed, “Save Configuration” button will be enabled.



After clicking button system will tell if the settings applied successfully or not.



☝

NOTE 1: TLM Series LoRaWAN EndNode Modems can keep configuration of 2 different modes in its memory and once the configuration enabled, its already saved settings will be applied. Device can act as Server or Client at a time. This way different LoRa settings can be stored in 2 different operating modes.

☝

NOTE 2: Settings will be applied once the device is rebooted from web interface or repowered manually.

☝

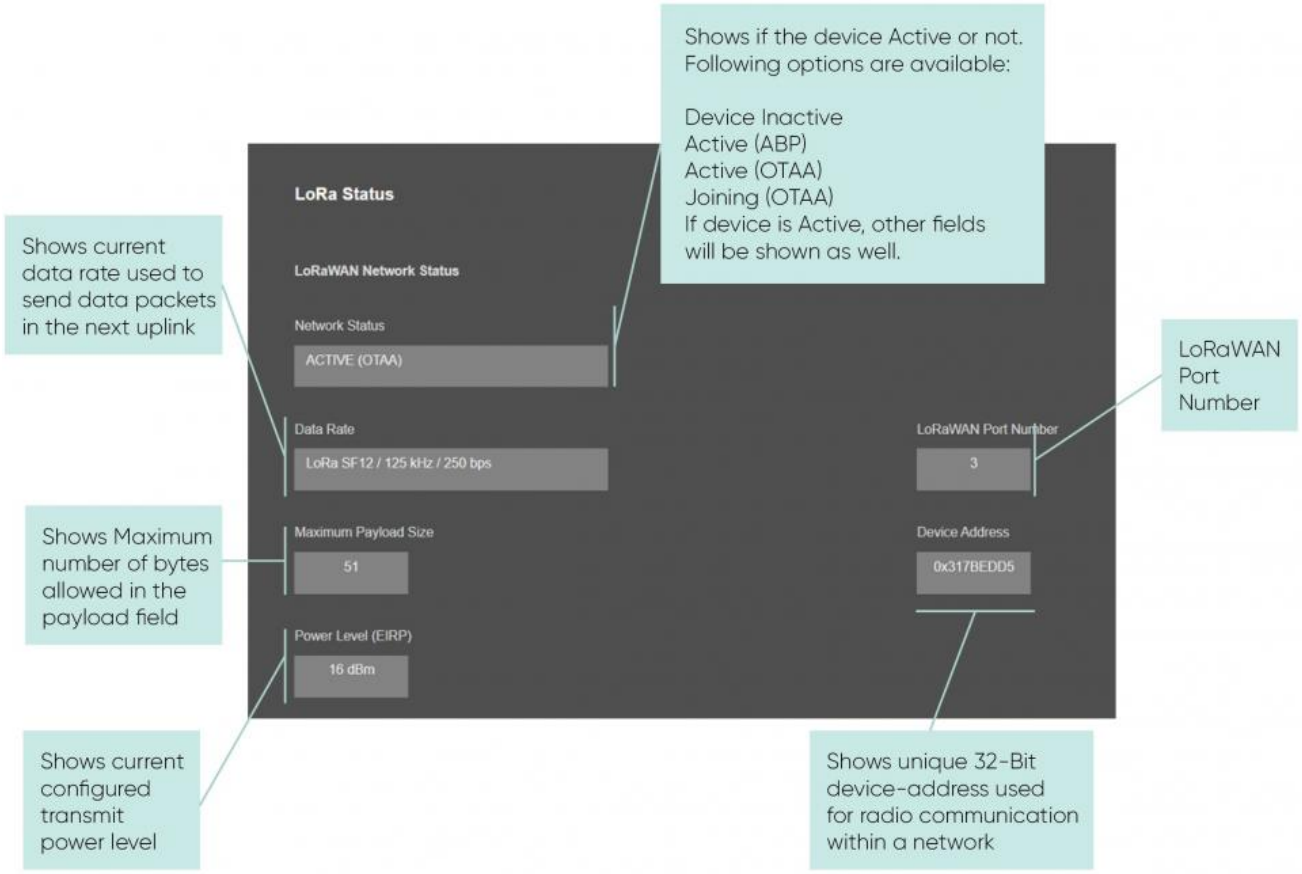
NOTE 3: This page has same settings both for Server and Client operating modes.

10.9 MENU: LoRa Status

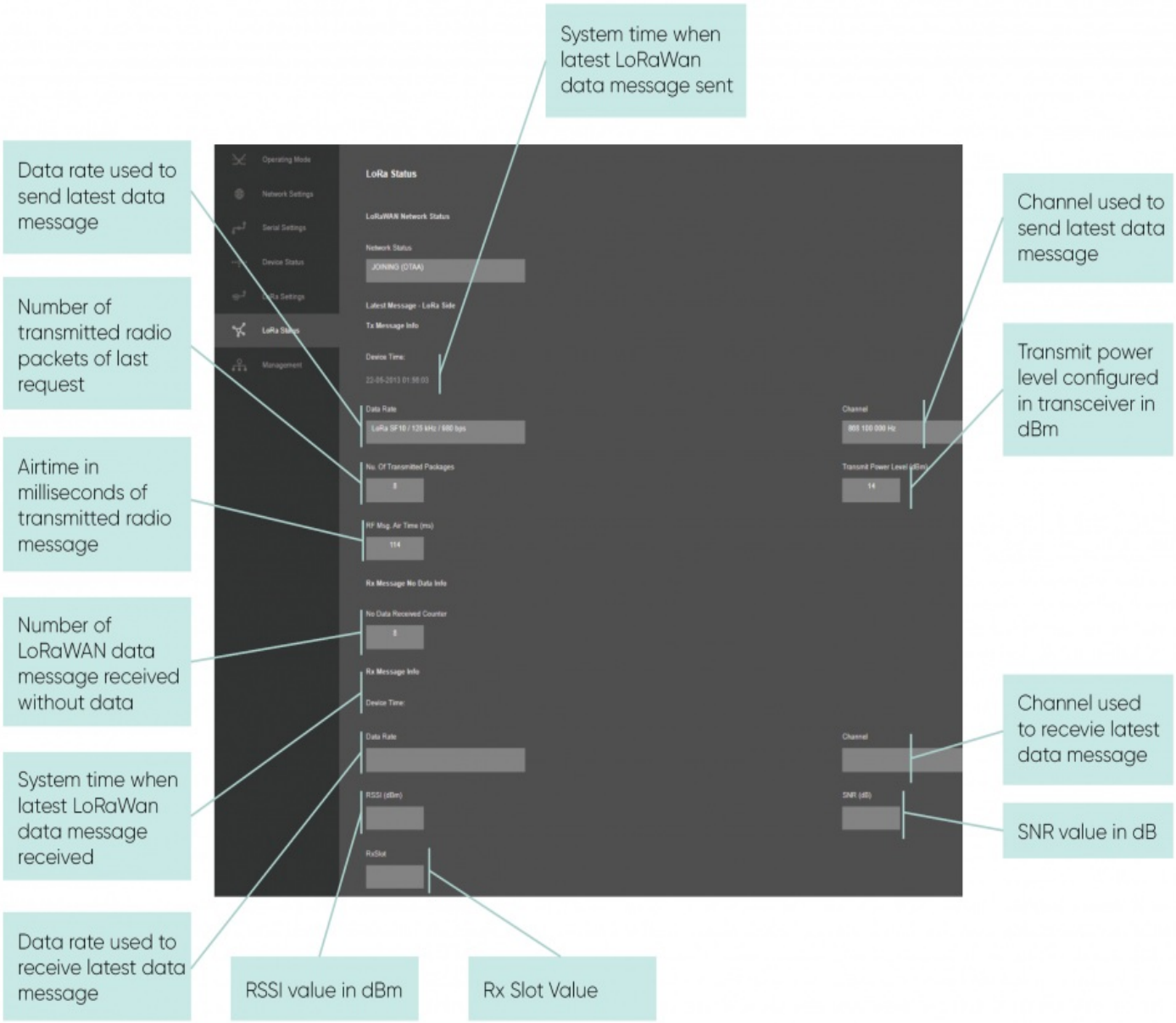
From this menu user may monitor LoRa status and package details. Package from gateway side comes from either TCP/IP or RS232/RS485 serial line based on operating mode of device. The page also helps users to diagnose LoRaWAN connection status.

The page has several parts.

Network/activation Status:

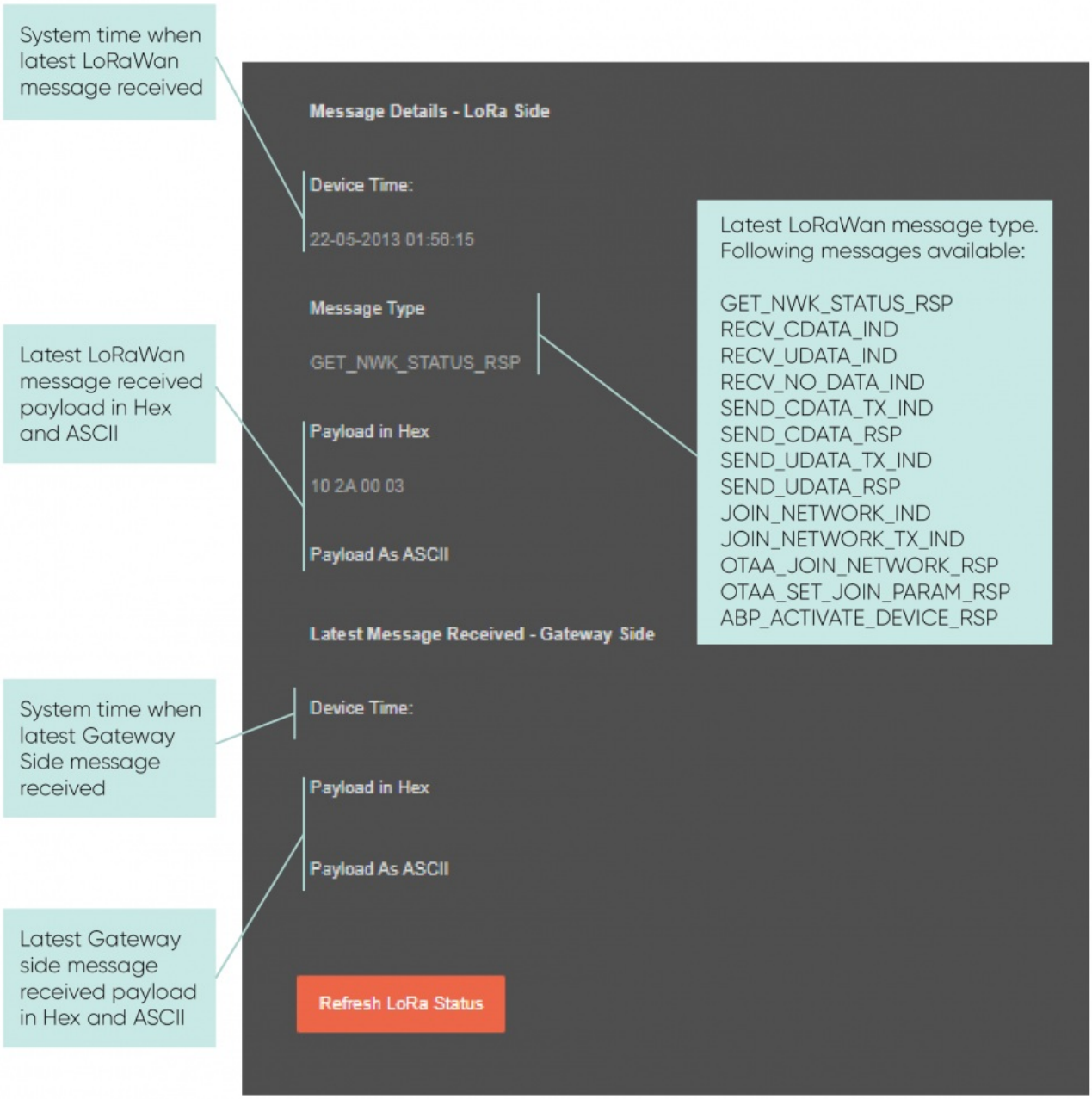


Latest Sent and Received LoRaWan Data Message Details:



Latest LoRaWan and Gateway Side Message Details:

Gateway side is TCP/IP or Serial side based on user settings.



☝

NOTE: This page has same options both for Server and Client operating modes.

10.10 MENU: Security Settings - Server

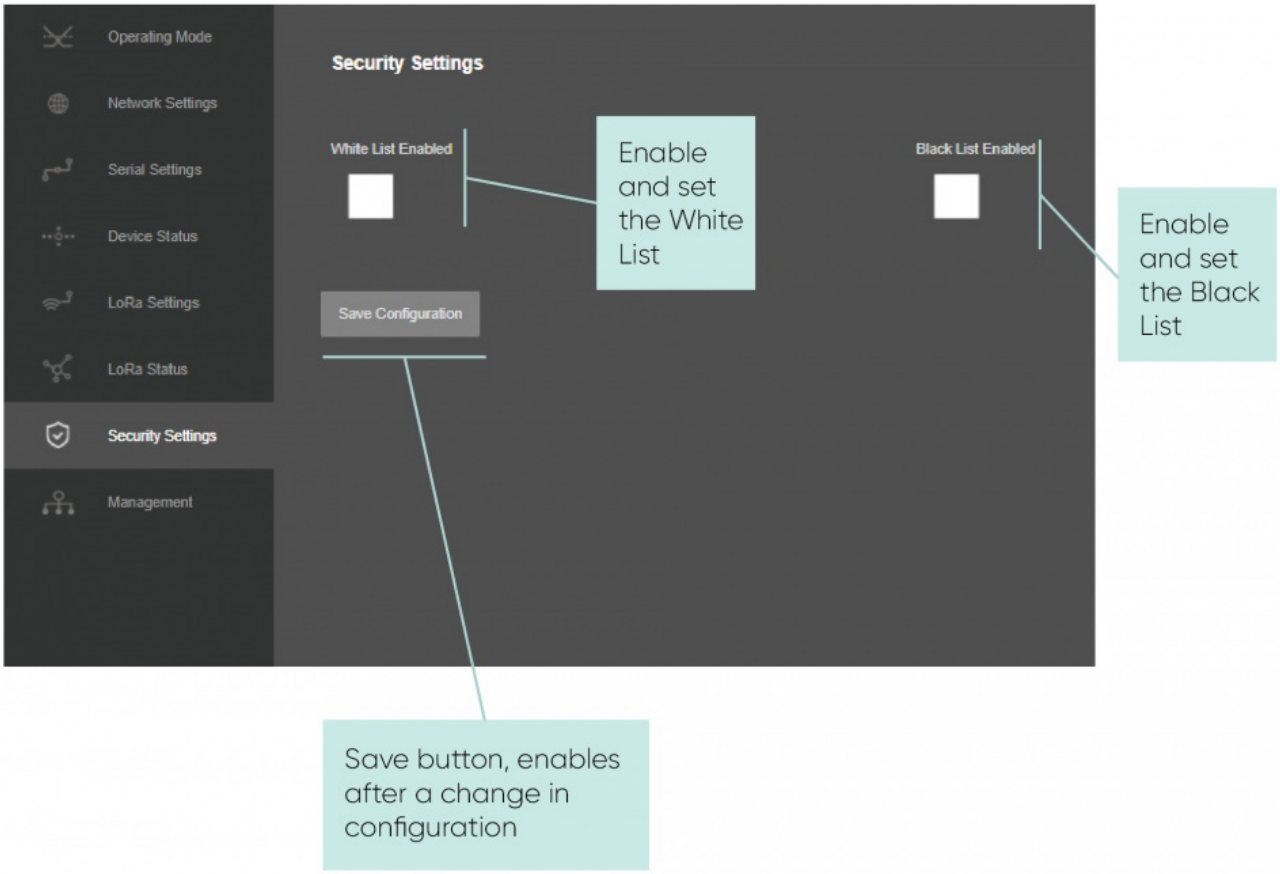
☝

NOTE: This menu is available only in Server Operating mode and when Device Function is set to LoRaWAN Transparent Modem since it filters TCP/IP connections based on IP of the devices.

From this menu user may activate TCP IP filter based on White list (accepted packages from IP Address) or Black list (rejected packages from IP Address).

- User can select to activate White List and REDZ device will accept data packages only from the devices with addresses stated in the list.

- User can select to activate Black List and REDZ device will accept all data packages except from the devices with addresses stated in the list.

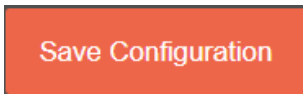


Following settings are available for any of the list.

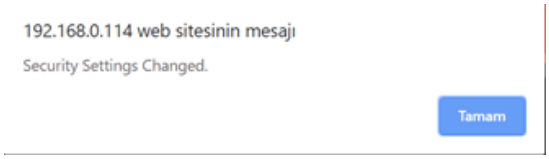
☝

NOTE: In this page user can enter 0.0.0.0 or the exact IP value of the device. The options with 0.0.0.0 will be discarded (not filtered).

Once the setting has been changed, “Save Configuration” button will be enabled.



After clicking button system will tell if the settings applied successfully or not.



☝

NOTE: Settings will be applied once the device is rebooted from web interface or repowered manually.

10.11 MENU: Management

From this menu user may change parameters or send command to device

- User can change system time. There is no battery inside the device so clock will be lost after a power down and will set to default.

☝

NOTE: The device restarts itself every 86400 seconds (which means every 24 hours). There are also timeout restart routines in Server mode during listening clients and in Client Mode trying to connect to the server (both preset to 10 minutes which means device will restart system if fails to connect a server in Client mode or a client do not connect in preset time in Server mode)

- User can change firmware of device. TLM Series LoRaWAN EndNode Modems has easy to use firmware capability and system can store 2 firmware at memory. After a firmware change, user can restore back old firmware anytime needed.

☝

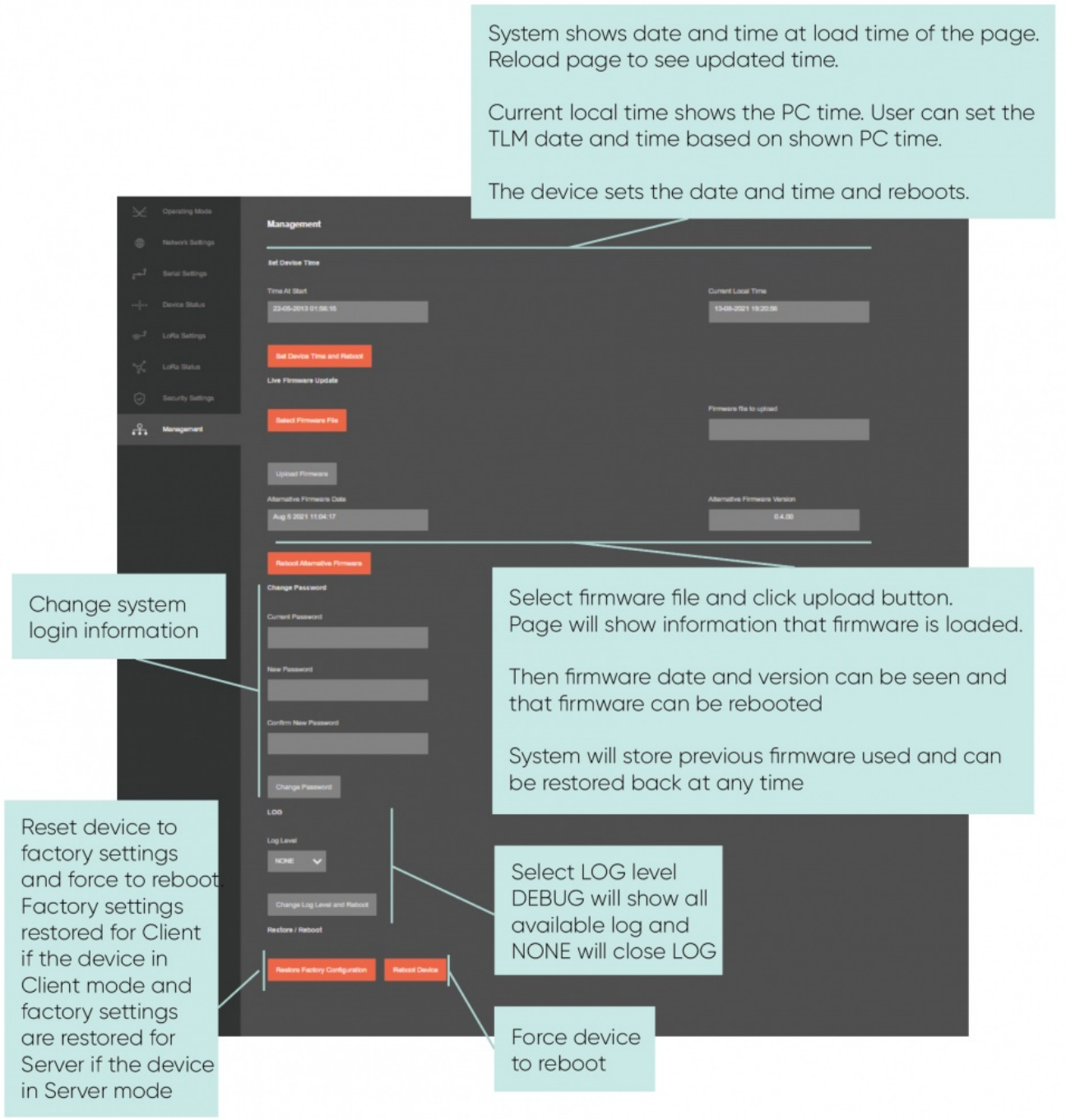
NOTE: After a firmware change old configuration will be used for minor changes. If a major change occurs system will restore to factory default configuration.

- User can change the login information

- User can change the debug level of the device. REDZ TLM Series LoRaWAN EndNode Modems series has micro-USB and gives log in 115200 - 8N1 format.

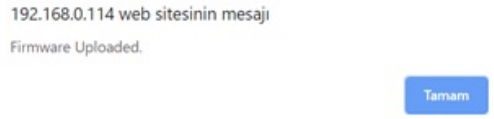
Any terminal program can be used to listen the LOG over micro-USB port of the device which is recognized as Virtual COM port in PC.

- User can restore to factory settings and force device to reboot. Factory settings restored for Client if the device in Client mode and factory settings are restored for Server if the device in Server mode.



Firmware upgrade is possible only with files that REDZ supplied. Once the file selected, TLM shows selected file:

Then “Upload Firmware” button must be clicked. Then user must wait until page shows the result.

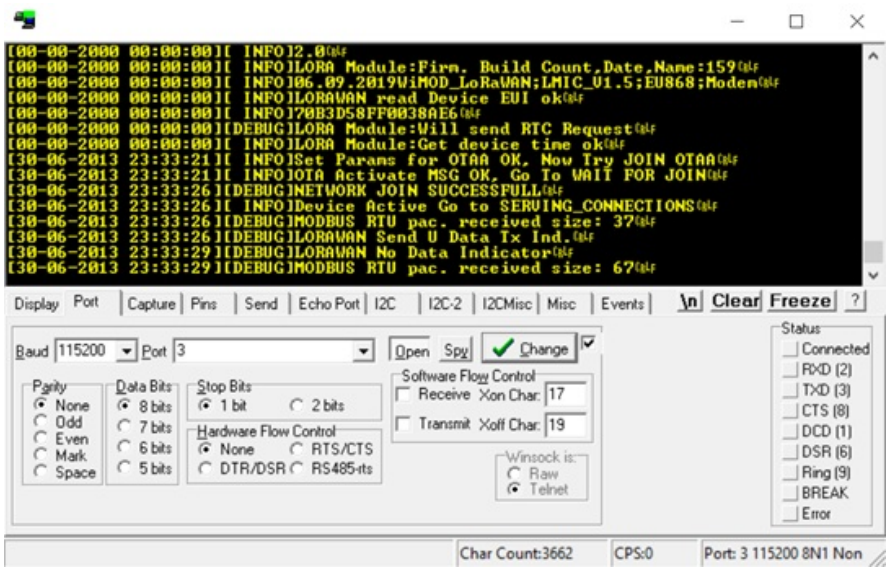


☝

NOTE: This make take few seconds only. Please wait.

Then system will show the firmware date and version and user can reboot that firmware.

Typical log for the system is shown below:



☝

NOTE: This page has same settings both for Server and Client operating modes.

11. Read Modbus Data and send to LoRaWAN server

This section gives example how TLM Series LoRaWAN EndNode Modems can be used to read field Modbus RTU device and send data to LoRaWAN server.

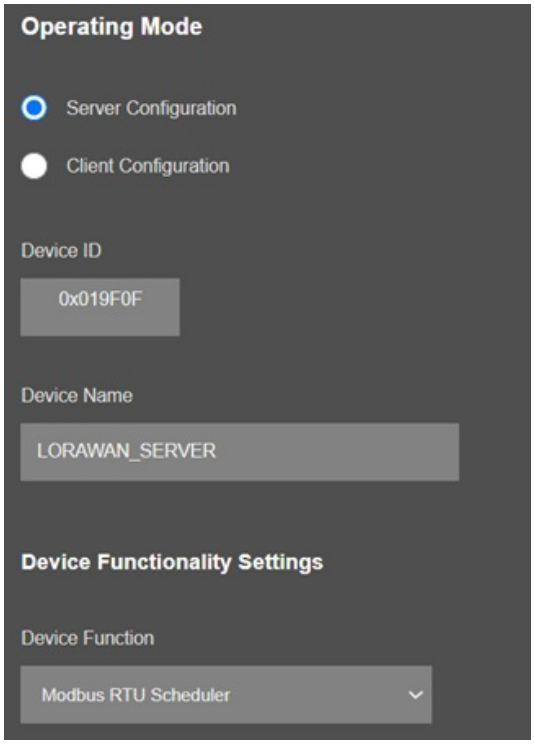
Used devices:

1. TLM Series LoRaWAN EndNode Modem
2. STG Series Wireless MBus – Modbus RTU/TCP Converter as Field Modbus RTU device
3. LoRaWAN Gateway device and Loriot server as LoRaWAN server

11.1 Selecting Modbus TCP or Modbus RTU

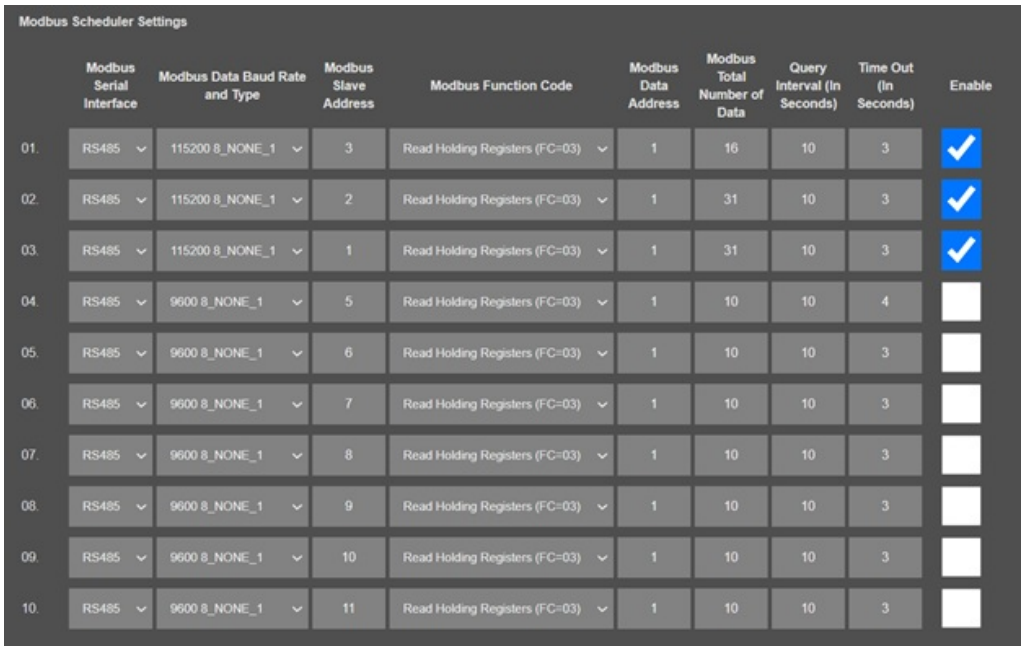
As a first step user should select under Operating Mode page device Configuration and Device Function. For this example we set Server Operating Mode and Device Function as Modbus RTU Scheduler.

If field device is Modbus TCP, user should select Client Operating Mode and Device Function as Modbus TCP Scheduler.



11.2 Selecting Modbus TCP or Modbus RTU

Once the device function is set, a list with maximum 10 entries will be shown on Operating Mode page.



Modbus Scheduler Settings

	Modbus Serial Interface	Modbus Data Baud Rate and Type	Modbus Slave Address	Modbus Function Code	Modbus Data Address	Modbus Total Number of Data	Query Interval (In Seconds)	Time Out (In Seconds)	Enable
01.	RS485	115200 8_NONE_1	3	Read Holding Registers (FC=03)	1	16	10	3	☑
02.	RS485	115200 8_NONE_1	2	Read Holding Registers (FC=03)	1	31	10	3	☑
03.	RS485	115200 8_NONE_1	1	Read Holding Registers (FC=03)	1	31	10	3	☑
04.	RS485	9600 8_NONE_1	5	Read Holding Registers (FC=03)	1	10	10	4	☐
05.	RS485	9600 8_NONE_1	6	Read Holding Registers (FC=03)	1	10	10	3	☐
06.	RS485	9600 8_NONE_1	7	Read Holding Registers (FC=03)	1	10	10	3	☐
07.	RS485	9600 8_NONE_1	8	Read Holding Registers (FC=03)	1	10	10	3	☐
08.	RS485	9600 8_NONE_1	9	Read Holding Registers (FC=03)	1	10	10	3	☐
09.	RS485	9600 8_NONE_1	10	Read Holding Registers (FC=03)	1	10	10	3	☐
10.	RS485	9600 8_NONE_1	11	Read Holding Registers (FC=03)	1	10	10	3	☐

In our example TLM connected to field device and field device (STG Series Wireless MBus – Modbus RTU Converter) supports 3 different clients.

Modbus Serial Interface: Field device is connected to RS485 serial port. GND connection should be done.

Data Baud Rate and Type: Must be configured based on field Modbus device serial settings.

Modbus Slave Address: For each query, user should enter unique Modbus Slave address. TLM will query those slaves.

Function Code: Function Code of the entry should be configured based on field Modbus device. Following Modbus Function Codes are available:

Read Coil Status (FC=01)

Read Input Status (FC=02)

Read Holding Registers (FC=03)

Read Input Registers (FC=04)

Data Address and Total Number of Data: Modbus Command details should be configured based on field Modbus device. Data Address of first register and total number of data.

Query Interval and Timeout Value: Modbus Command minimum query interval and timeout value for that specific command.

Each entry is queried 1 by 1 and timeout value is valid if there is no response, so actual query intervals changes depending on number of enabled entries and query details of that entries in real application.

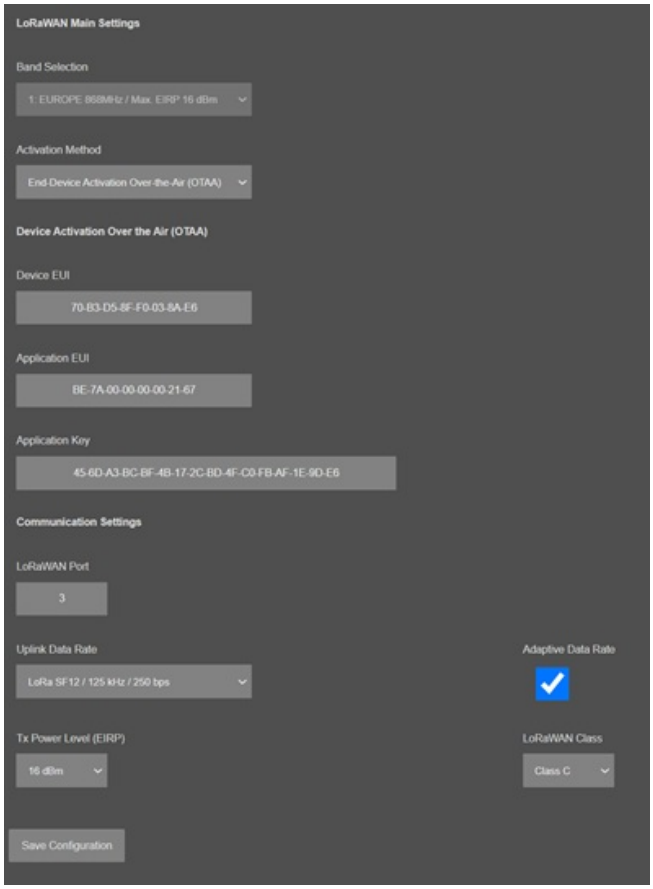
Usually, it is good idea to enter longer query intervals to save data usage.

Enable Query: Option to enable or disable entry. We need to query 3 slaves so that we enabled 3 entries only.

Click Save Configuration when all settings are done.

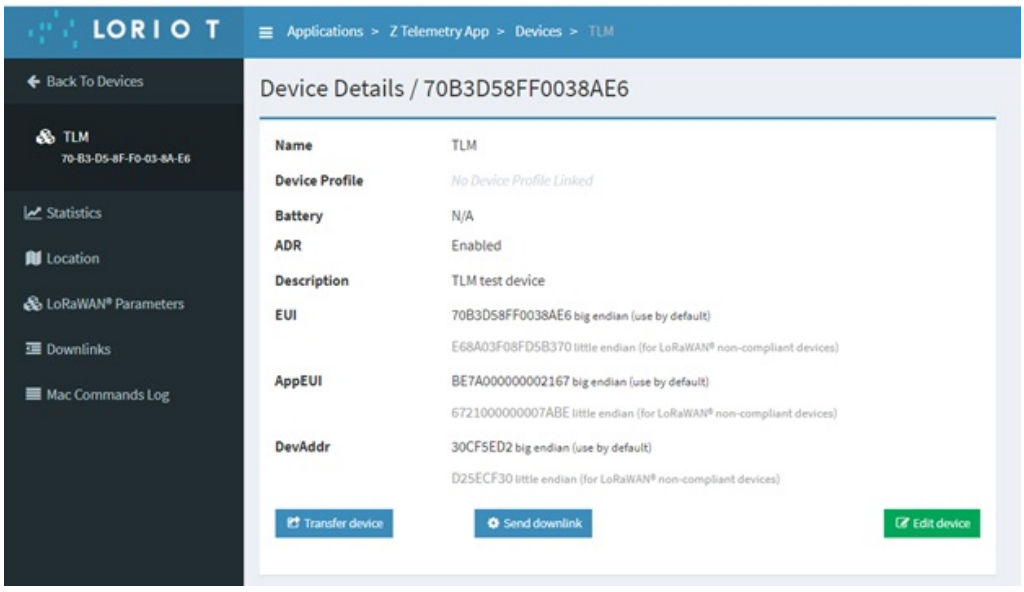
11.3 Entering LoRaWAN Settings

Next step will be making the settings for LoRaWAN server.

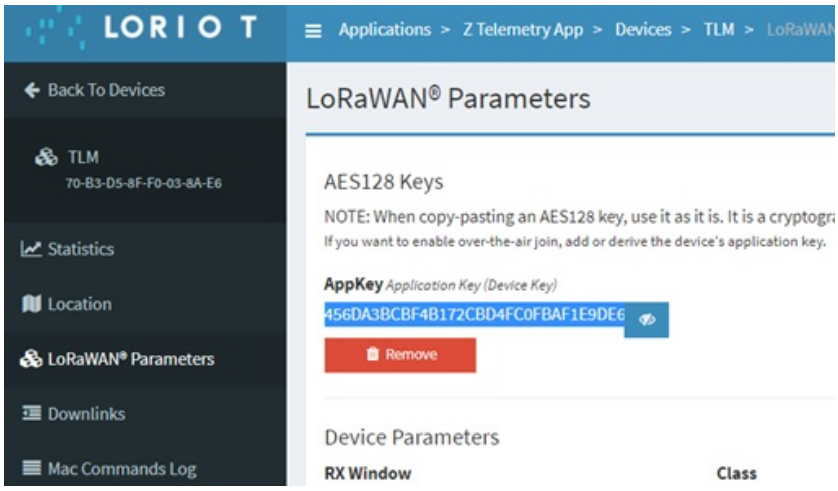


Activation Method: We selected End-Device Activation Over-the-Air (OTAA) method for this example. Activation by Personalization (ABP) can also be selected if needed.

Also, device is defined in Loriot LoRaWAN Server.with this specific Device EUI 70-B3-D5-8F-F0-03-8A-E6



Application Key and Apllication EUI: Values entered based on values in Loriot LoRaWAN Server.



LoRaWAN Port: Port is selected for this Application. Port 1 is used by TLM Status info, so any number between 2 and 255 can be entered here based on Application needs.

Data Rate and Other Settings: We selected Adaptive data rate so that TLM can arrange automatically the Uplink Data Rate based on LoRaWAN server side. Other settings are available based on Application needs. In this example LoRaWAN Class C is used.

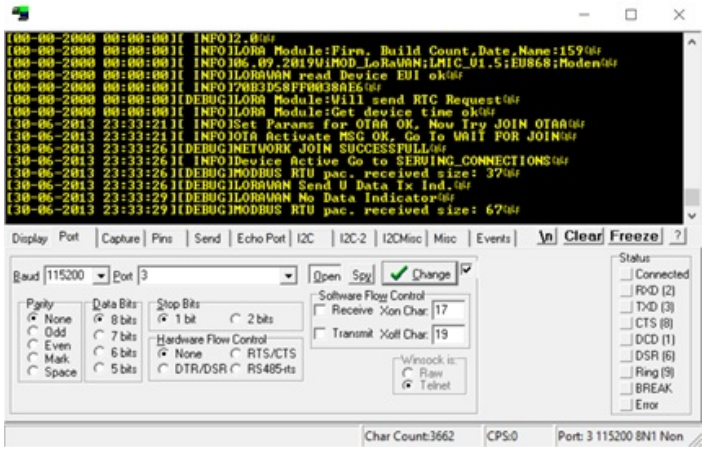
Click Save Configuration when all settings are done and Restart device with command under Management menu.

11.4 Check Status of LoRaWAN Activation

LoRaWAN device activation can be monitored from TLM LoRa Status page.

Once the device is Active, it will start reading field Modbus devices.

If Activation takes longer then expected, user can also activate device LOG and try check details.



11.5 Monitor Read Modbus Data

Reading of Modbus devices can be monitored from Device Status page.

Modbus RTU Master Status

	Modbus Slave Address	Modbus Slave Serial Port	Modbus Slave Data Type	Last Query Date	Last Modbus Package	Status
01.	3	RS485	115200 8_NONE_1	30-06-2013 23:33:09	03 03 20 19 14 21 90 09 B4 00 13 00 07 00 02 00 00 00 01 00 03 44 9A 3F FF 00 00 00 01 00 2D 1E 2AAD 21 8B DC	READING
02.	2	RS485	115200 8_NONE_1	30-06-2013 23:33:12	02 03 3E 71 28 48 80 2C 2D 00 34 00 04 00 0C 00 00 00 01 00 02 00 00 00 00 00 00 00 01 00 03 00 00 00 00 00 00 00 01 00 07 00 00 00 00 00 00 00 01 00 08 41 A5 D7 0A 00 00 00 01 00 0C 41 A5 AE 14 71 2F	READING
03.	1	RS485	115200 8_NONE_1	30-06-2013 23:33:04	01 03 3E 19 01 22 04 26 97 00 33 00 07 00 06 00 00 00 01 00 2D 07 02 0AAD 00 00 00 01 00 03 45 5F BF FF 00 00 00 01 00 03 00 00 00 00 00 00 00 01 00 07 00 00 00 00 00 00 01 00 01 00 03 45 5F BF FF 72 E1	READING
04.	5	RS485	9600 8_NONE_1			DISABLED
05.	6	RS485	9600 8_NONE_1			DISABLED
06.	7	RS485	9600 8_NONE_1			DISABLED
07.	8	RS485	9600 8_NONE_1			DISABLED
08.	9	RS485	9600 8_NONE_1			DISABLED
09.	10	RS485	9600 8_NONE_1			DISABLED
10.	11	RS485	9600 8_NONE_1			DISABLED

In this example all 3 queries are ok and we can see last messages from field device under Last Modbus Package column.

11.6 How Data Are Sent to LoRaWAN Server

When the device is Active, it will send status information to the server. Status information is always sent to LoRaWAN Port 1.

Status Frame has n bytes of data (max 28 bytes)

- Frame Type: 1 Byte

- Device ID: 4 Bytes

- Target Port: 1 Byte

- Device Date Time: 4 Bytes

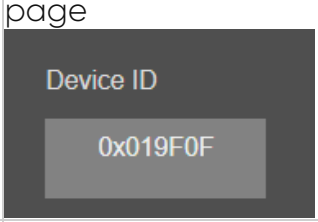
- Firmware Version: 3 Bytes

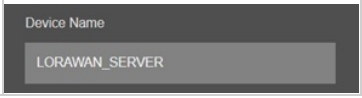
- Device Name: (n Bytes, max 15)

Here is example message and its structure:

Last data (10 latest records)

FCntUp	Time	Port	Data
1	a few seconds ago	1	10 00 01 9f 0f 03 34 21 7d a7 00 02 0f 4c 4f 52 41 57 41 4e 5f 53 45 52 56 45 52

Number	Byte Count	Data	Explanation	Example (Hex)
1	1 Byte	Frame Type	Gives detail of frame and used protocol 0x10: status frame and Modbus RTU target protocol 0x11: status frame and Modbus TCP target protocol 0x12: status frame and transparent protocol	10
2	4 Bytes	Device ID	Unique ID of the device that is shown on Operating Mode page 	00 01 9F 0F
3	1 Byte	Target Port	LoraWan Port that will be used to send data	03
4	4 Bytes	Device Date Time	Here are sample codes to get Date Time Details #define RTC_GET_SECONDS(t) ((t) & 0x3F) #define RTC_GET_MINUTES(t) (((t) >> 6) & 0x3F) #define RTC_GET_MONTHS(t) (((t) >> 12) & 0x0F) #define RTC_GET_HOURS(t) (((t) >> 16) & 0x1F) #define RTC_GET_DAYS(t) (((t) >> 21) & 0x1F) #define	34 21 7D A7

			RTC_GET_YEARS(t) ((((t) >> 26) & 0x3F) + 2000)	
5	3 Bytes	Firmware Version	Firmware version of TLM used	00 02 0F
6	Remaining Bytes (max 15)	Device Name	TLM Device Name that is shown on Operating Mode page 	4c 4f 52 41 57 41 4e 5f 53 45 52 56 45 52

After status frame, TLM Series LoRaWAN EndNode Modem will send read modbus data in special frame. Frame changes based on Modbus TCP or Modbus RTU reading.

Last data (10 latest records)

FCntUp	Time	Port	Data
1	a few seconds ago	1	10 00 01 9f 0f 03 34 21 7d a7 00 02 0f 4c 4f 52 41 57 41 4e 5f 53 45 52 56 45 52

Remaining Bytes Device Name of TLM: Device Name that is shown on Operating Mode page.

MODBUS RTU Frame:

Modbus RTU Data Frame has n bytes of data (Allowed by Maximum Payload Size which is also shown in LoRa Status Page)

- Frame Type: 1 Byte

- Slave ID: 1 Byte

- Modbus Function Code: 1 Byte

- Modbus Start Register Value: 2 Bytes

- Total Registers Queried: 2 Bytes

- Total Numbers of Data Bytes: 1 Bytes

- Data Bytes: N bytes (Total Frame length will be less than or equal to Maximum Payload Size allowed)

Here is example data read by TLM and shown in Device Status page:

Modbus Slave Address	Modbus Slave Serial Port	Modbus Slave Data Type	Last Query Date	Last Modbus Package	Status
3	RS485	115200 8_NONE_1	01-07-2013 02:23:59	03 03 20 19 14 21 90 09 B4 00 13 00 07 00 02 00 00 00 01 00 03 44 9A 3F FF 00 00 00 01 00 2D 15 2D AD 21 38 39	READING

Here is how it is shown in Loriot LoRaWAN server:

FCntUp	Time	Port	Data
14	3 minutes ago	3	00 03 03 00 00 00 10 20 19 14 21 90 09 b4 00 13 00 07 00 02 00 00 00 01 00 03 44 9a 3f ff 00 00 00 01 00 2d 0e 2d ad 21

Number	Byte Count	Data	Explanation	Example (Hex)
1	1 Byte	Frame Type	Gives detail of frame and used protocol 0x00: data frame and Modbus RTU target protocol 0x01: data frame and Modbus TCP target protocol 0x02: data frame and transparent protocol	00
2	1 Byte	Slave ID	Field Modbus Device Slave ID	03
3	1 Byte	Modbus Function Code	Modbus Function Code used to read that Field Modbus Device	03
4	2 Bytes	Modbus Start Register Value	Modbus Start Register value that query is done	00 00
5	2 Bytes	Total Registers Queried	Modbus Command Total Register Value queried	00 10
6	1 Byte	Total Numbers of Data Bytes	Shows how many data bytes will follow after this byte	20
7	N Bytes	Data	Data itself. Total Frame length will be less than or equal to Maximum Payload Size allowed User should parse data based on their own application	19 14 21 90 09 b4 00 13 00 07 00 02 00 00 00 01 00 03 44 9a 3f ff 00 00 00 01 00 2d 36 2c ad 21

MODBUS TCP Frame:

Modbus TCP Data Frame has n bytes of data (Allowed by Maximum Payload Size which is also shown in LoRa Status Page)

- Frame Type: 1 Byte

- Field Device TCP IP: 4 Bytes

- Field Device TCP Port:2 Bytes

- Slave ID: 1 Byte

- Modbus Function Code: 1 Byte

- Modbus Start Register Value: 2 Bytes

- Total Registers Queried: 2 Bytes

- Total Numbers of Data Bytes: 1 Bytes

- Data Bytes: N bytes (Total Frame length will be less than or equal to Maximum Payload Size allowed)

Here is example data read by TLM and shown in Device Status page:

Modbus Slave Address	Modbus Slave TCP IP	Modbus Slave TCP Port	Last Query Date	Last Modbus Package	Status
15	192.168.0.119	502	01-07-2013 02:42:46	00 03 00 00 00 04 0F 01 01 00	CONNECTED / READING

Here is how it is shown in Loriot LoRaWAN server:

FCntUp	Time	Port	Data
2	a few seconds ago	2	01 c0 a8 00 77 01 f6 0f 01 00 01 00 08 01 00

Number	Byte Count	Data	Explanation	Example (Hex)
1	1 Byte	Frame Type	Gives detail of frame and used protocol 0x00: data frame and Modbus RTU target protocol 0x01: data frame and Modbus TCP target protocol 0x02: data frame and transparent protocol	01
2	4 Bytes	Field Device TCP IP	TCP IP Value of field Modbus Device 192.168.0.119 in this example	C0 A8 00 77

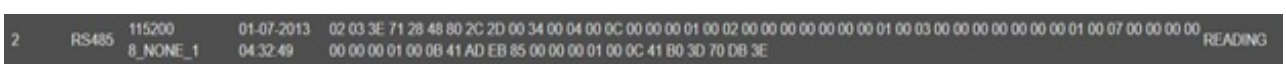
3	2 Bytes	Field Device TCP Port	TCP Port Value of field Modbus Device 502 in this example	01 F6
4	1 Byte	Slave ID	Field Modbus Device Slave ID	0F
5	1 Byte	Modbus Function Code	Modbus Function Code used to read that Field Modbus Device	01
6	2 Bytes	Modbus Start Register Value	Modbus Start Register value that query is done	00 01
7	2 Bytes	Total Registers Queried	Modbus Command Total Register Value queried	00 08
8	1 Byte	Total Numbers of Data Bytes	Shows how many data bytes will follow after this byte	01
9	N Bytes	Data	Data itself. Total Frame length will be less than or equal to Maximum Payload Size allowed User should parse data based on their own application	00

11.7 How Data Are Sent to LoRaWAN Server When Package Size is more than Maximum Payload Size

TLM Series LoRaWAN EndNode Modems has unique feature to resize frames for LoRaWAN and also unique feature to calculate duty cycles based on LoRaWAN duty cycle limitations. Users do not need to worry on query interval or response size, TLM Series LoRaWAN EndNode Modems automatically splits and send read data.

Here is example reading command from TLM Modbus RTU Scheduler settings:

Here is example reading status from TLM Modbus RTU Scheduler settings:



Example Modbus response is 67 bytes, and based on Modbus RTU frame, Data is 62 bytes (

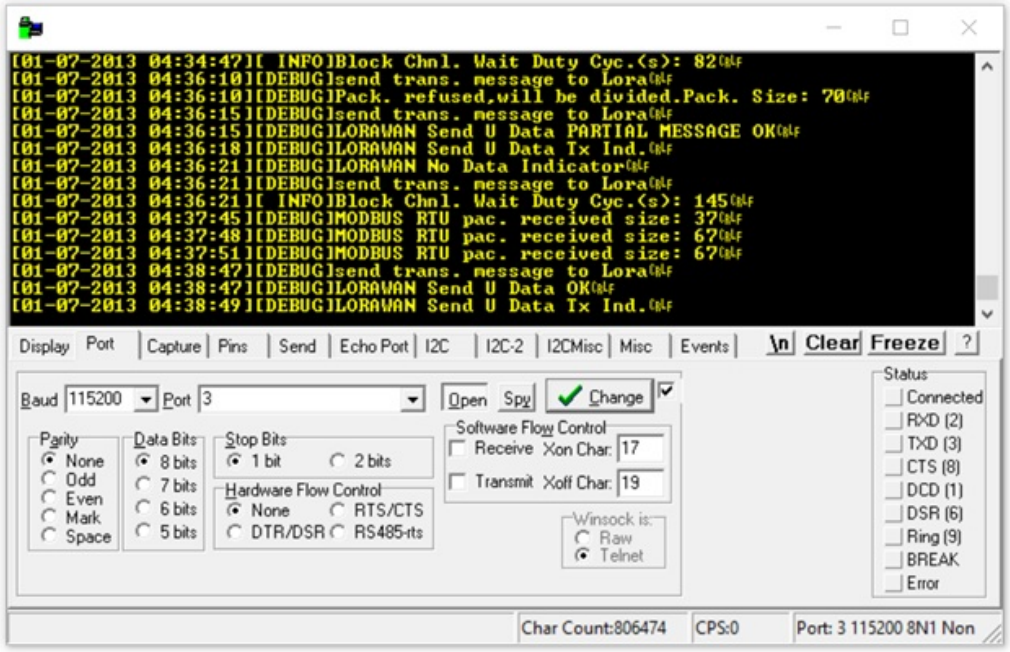
31 registers):

02 03 3E 71 28 48 80 2C 2D 00 34 00 04 00 0C 00 00 00 01 00 02 00 00 00 00 00 00 00 01 00 03 00 00 00 00 00 00 00 01 00 07 00 00 00 00 00 00 00 01 00 0B 41 AD EB 85 00 00 00 01 00 0C 41 B0 3D 70 DB 3E

Maximum Payload size can be seen in LoRa Status page which is 51 bytes in this example:

TLM automatically divides data and send to LoRaWAN Server split messages and wait to send next part until duty cycle is available.

Here is device LOG for the long Modbus frame and information regarding package split and duty cycle wait.



Here is how data is shown in Loriot LoRaWAN Server:

FCntUp	Time	Port	Data
4	a few seconds ago	3	00 02 03 00 15 00 0a 14 00 00 00 01 00 0b 41 ad eb 85 00 00 00 01 00 0c 41 b0 3d 70
3	3 minutes ago	3	00 02 03 00 00 00 15 2a 71 28 48 80 2c 2d 00 34 00 04 00 0c 00 00 00 01 00 02 00 00 00 00 00 00 00 00 01 00 03 00 00 00 00 00 00 00 01 00 07 00 00 00 00

First Message

Number	Byte Count	Data	Explanation	Example Value (Hex)
1	1 Byte	Frame Type	0x00: data frame and Modbus RTU target protocol	00
2	1 Byte	Slave ID	Field Modbus	02

3	1 Byte	Modbus Function Code	Modbus Function Code used to read that Field Modbus Device	03
4	2 Bytes	Modbus Start Register Value	Modbus Start Register value that query is done	00 00
5	2 Bytes	Total Registers Queried	Modbus Command Total Register Value queried TLM automatically divides based on available Payload size	00 15
6	1 Byte	Total Numbers of Data Bytes	Shows how many data bytes will follow after this byte 42 bytes + 8 bytes header information Total 50 bytes, byte still available in allowed payload size however t is not enough to show a register in 1 byte	2A
7	42 Bytes	Data	Split Data	71 28 48 80 2c 2d 00 34 00 04 00 0c 00 00 00 01 00 02 00 00 00 00 00 00 00 01 00 03 00 00 00 00 00 00 00 01 00 07 00 00 00 00

LOG shows that TLM waited 145 seconds after first message, then sent next part of split message

Second Message

Number	Byte Count	Data	Explanation	Example Value (Hex)

1	1 Byte	Frame Type	0x00: data frame and Modbus RTU target protocol	00
2	1 Byte	Slave ID	Field Modbus Device Slave ID	02
3	1 Byte	Modbus Function Code	Modbus Function Code used to read that Field Modbus Device	03
4	2 Bytes	Modbus Start Register Value	Modbus Start Register value that query is done is now start from Register 31 since first 30 of them queried and result shared in first message	00 15
5	2 Bytes	Total Registers Queried	Modbus Command Total Register Value queried Total 31 (0x1F) registers, 0x15 already shared now remaining 0x0A (10 registers) will be shared	00 0A
6	1 Byte	Total Numbers of Data Bytes	Shows how many data bytes will follow after this byte 0x14 equals to 20 bytes for remaining 10 registers	14
7	20 Bytes	Data	Split Data	00 00 00 01 00 0b 41 ad eb 85 00 00 00 01 00 0c 41 b0 3d 70

12. Ordering Information

TLM344: 865MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 5-48V (max. 60V) DC Power Input

TLM444: 865MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 90 - 265V AC (100 – 370V DC), 47Hz to 63Hz AC Power Input

TLM745: 865MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports + 1 x BPL (Broadband Power Line) Link, 1 x RS232 & 1 x RS485, 3 Phase AC Power Input, 110V–240V/50-60Hz

TLM354: 868MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 5-48V (max. 60V) DC Power Input

TLM454: 868MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 90 - 265V AC (100 – 370V DC), 47Hz to 63Hz AC Power Input

TLM755: 868MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports + 1 x BPL (Broadband Power Line) Link, 1 x RS232 & 1 x RS485, 3 Phase AC Power Input, 110V–240V/50-60Hz

TLM364: 915MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 5-48V (max. 60V) DC Power Input

TLM464: 915MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 90 - 265V AC (100 – 370V DC), 47Hz to 63Hz AC Power Input

TLM765: 915MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports + 1 x BPL (Broadband Power Line) Link, 1 x RS232 & 1 x RS485, 3 Phase AC Power Input, 110V–240V/50-60Hz

TLM374: 923MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 5-48V (max. 60V) DC Power Input

TLM474: 923MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports, 1 x RS232 & 1 x RS485, 90 - 265V AC (100 – 370V DC), 47Hz to 63Hz AC Power Input

TLM775: 923MHz LoRaWAN EndNode Modem with Modbus TCP/RTU Scheduler, 2x 10/100 T(x) ETH ports + 1 x BPL (Broadband Power Line) Link, 1 x RS232 & 1 x RS485, 3 Phase AC Power Input, 110V–240V/50-60Hz

13. Product Selection

Model	Operating Frequency	5-48V (max.60V) DC Power Input	90 - 265V AC (100 – 370V DC), 47Hz to 63Hz AC Power Input	3 Phase AC Power input, 110V–240V/50-60Hz AC Power Input	2 x 10/100 T(x) ETH Ports	1 x RS232 and 1 x RS485 Serial Ports	BPL (Broadband Power Line) Link
TLM344	865MHz	X			X	X	
TLM444	865MHz		X		X	X	

TLM745	865MHz			X	X	X	X
TLM354	868MHz	X			X	X	
TLM454	868MHz		X		X	X	
TLM755	868MHz			X	X	X	X
TLM364	915MHz	X			X	X	
TLM464	915MHz		X		X	X	
TLM764	915MHz			X	X	X	X
TLM374	923MHz	X			X	X	
TLM474	923MHz		X		X	X	
TLM775	923MHz			X	X	X	X