High Precision GNSS Receiver

TN531 Series User Guide

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About This Guide

Thank you for choosing Bivocom High Precision GNSS Receiver TN531 Series.

Please thoroughly read this user guide before you configure and install the device.

This manual is compatible with below models

Model	Description
TN531-LF	4G GNSS Receiver

Summary of Changes

Date	Version	Notes	Editor
10-9-2024	V1.0	Initial new version	Caesar Chen

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1. Introduction

1.1 Overview

The Bivocom TN531 is a state-of-the-art high-accuracy positioning solution designed to meet the rigorous demands of modern applications in structural health monitoring (SHM), deformation analysis, and disaster assessment. Packed with advanced features, this innovative device combines low power consumption with easy installation, ensuring seamless integration into a wide range of environments.

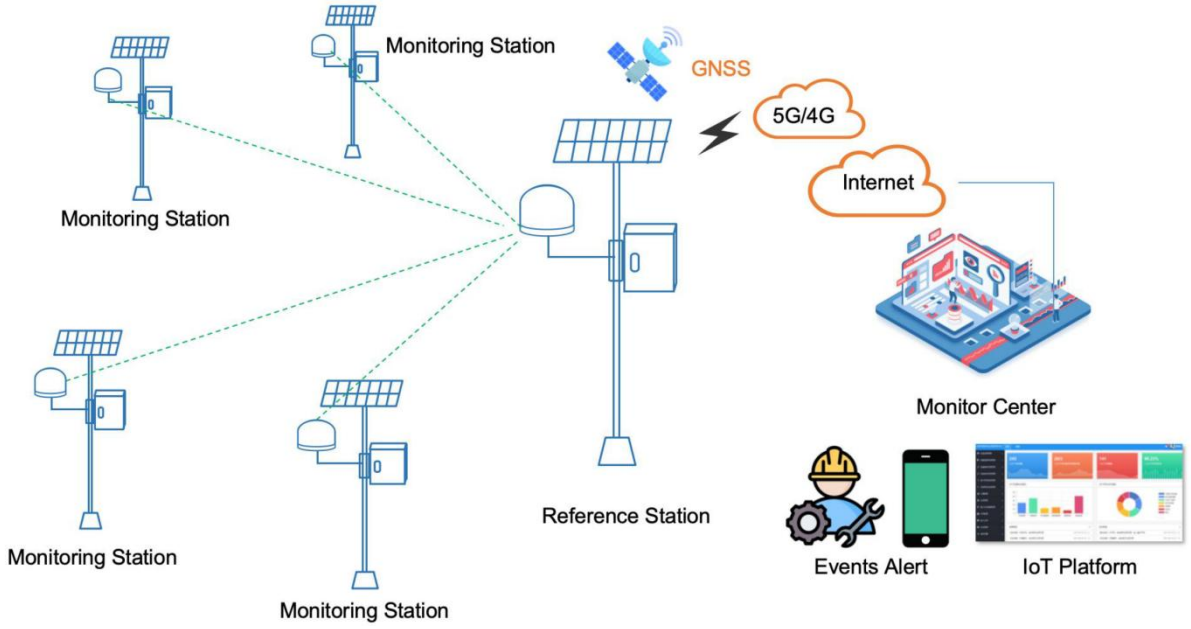
Equipped with built-in 4G connectivity and a GNSS antenna, the TN531 delivers reliable real-time data for effective monitoring. Its robust IP68 rating guarantees durability in harsh conditions, while the embedded MEMS tilt sensor and 6-axis inertial measurement unit (IMU) enhance positioning accuracy through effective compensation.

The TN531 supports real-time kinematic (RTK) positioning and adheres to industry standards such as RTCM and RINEX, making it an invaluable tool for applications in smart cities integration, geological disaster monitoring including tectonic movement detection, landslide monitoring, and volcanic activity, as well as flood monitoring. With features like 2x RS232, 1x RS485, and 1x pulse input, the TN531 offers versatile connectivity options, ensuring it meets the evolving needs of infrastructure and environmental monitoring.

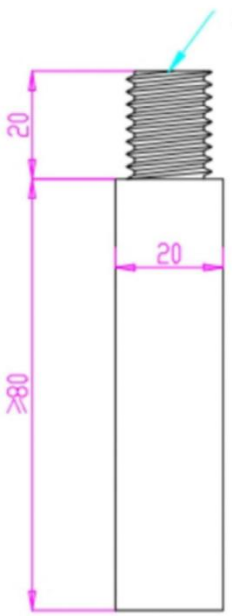
1.2 Applications

Unlock the potential of precision monitoring with the Bivocom TN531, the perfect solution for enhancing safety and efficiency in urban and natural settings.

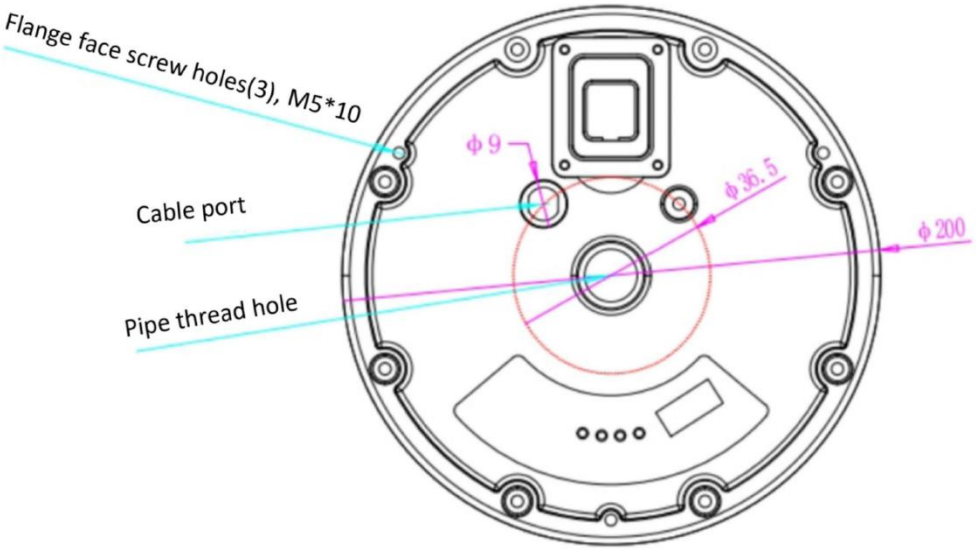
Typical application as below.



1.3 Dimensions



Pipe thread



TN531 Base

1.4 Specification

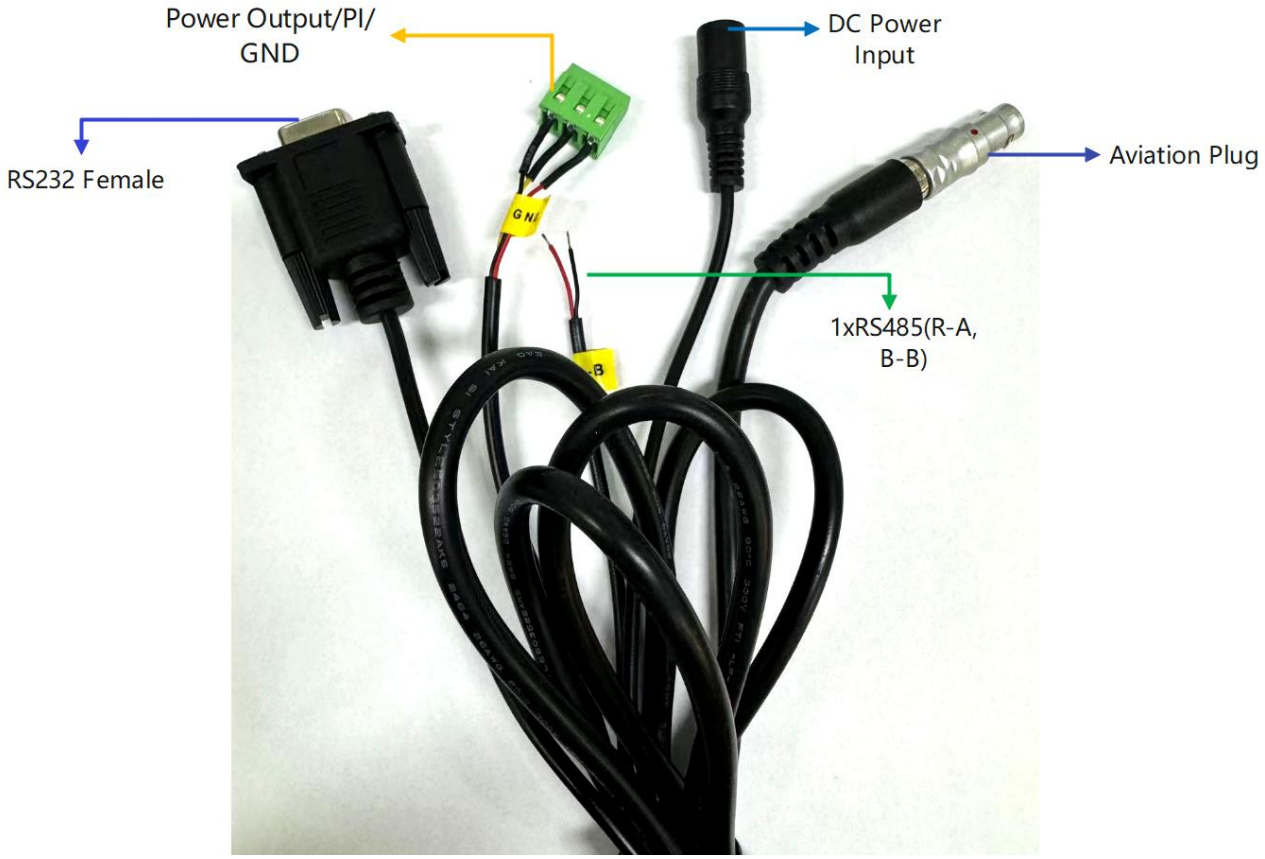
Interface	Description
System	**CPU:** Industrial 32-bit CPU **Flash:** 512KB **SRAM:** 256KB **Data Storage Flash:** 16MB
Cellular Interface	**Antenna:** Built-in **SIM Slot:** 1x Nano SIM **ESD Protection** 15KV
Serial Interface	**Connector** Terminal block, 3.5 mm female socket with lock **Ports** 1 × RS232(debug) + 1 × RS485 **Baud Rate** 300bps to 230400bps **ESD protection** 8KV for RS232, 15KV for RS485
GNSS	**Antenna:** Built-in **GPS:** GPS L1C/A /L1C/L2C/ L5 **BDS:** B1I/B2I/B1C/B2b/B2a/B3I **Galileo:** E1/E5a/ E5b

	GLONASS: G1/G2 **QZSS:** L1C/A/L1C/L2C/ L5
Positioning Accuracy	**Static Accuracy:** H: 2.5mm + 1ppm | V: 5mm + 1ppm **RTK Accuracy:** H: 8mm + 1ppm | V: 15mm + 1ppm **Cold /Hot Start:** ⩽18s / ⩽1s **Initialization Time:** <5s **Initialization Reliability:** >99.9% **PPS Accuracy:** 20ns
Data Output	**Data Format:** NMEA 0183 V4.1, RTCM3.X **Update Rate:** Up to 20Hz
MEMS IMU Sensor	**6-Axis:** 3-axis gyroscope, 3-axis accelerometer for real-time compensated 3-axis attitude angles **Update Rate:** Up to 20Hz
Power Supply and Consumption	**Standard Power:** DC 12V/1.5A **Input Voltage:** 9-35 VDC **Communication:** 12VDC@145mA
Physical Characteristics	**Ingress Protection**：IP68 **Housing & Weight:** Aluminum alloy(base)+ABS/PC Cover, 1550g, without accessories **Dimensions:** ϕ200*150mm **Mounting:** Flange face, or pipe thread
Environmental	**Operating Temperature** -35°C to +75°C (-31℉ to +167℉) **Storage Temperature** -40°C to +80°C (-40℉ to +176℉) **Relative Humidity** 0% to 95% (non-condensing)
Software	**Network Protocols:** MQTT*, Transparent (TCP Client/Server, UDP Client/Server), Modbus Gateway (Modbus RTU to Modbus TCP), DNS, etc. **Management:** Config Tool, Cloud DMP (Device Management Platform)
Others	**LED Indicators:** System, Online, Power, Error **Built-in:** Watchdog, RTC, Timer **Approvals:** CE*, RCM*, FCC* **Warranty Period:** Standard: 12 Months Extended: 2-5 Years3
Standard Package Content	TN531 GNSS Receiver 4 IN 1 Cable(Power in/out, RS232, RS485, PI) Power cable

1.5 Definition of PIN and cables

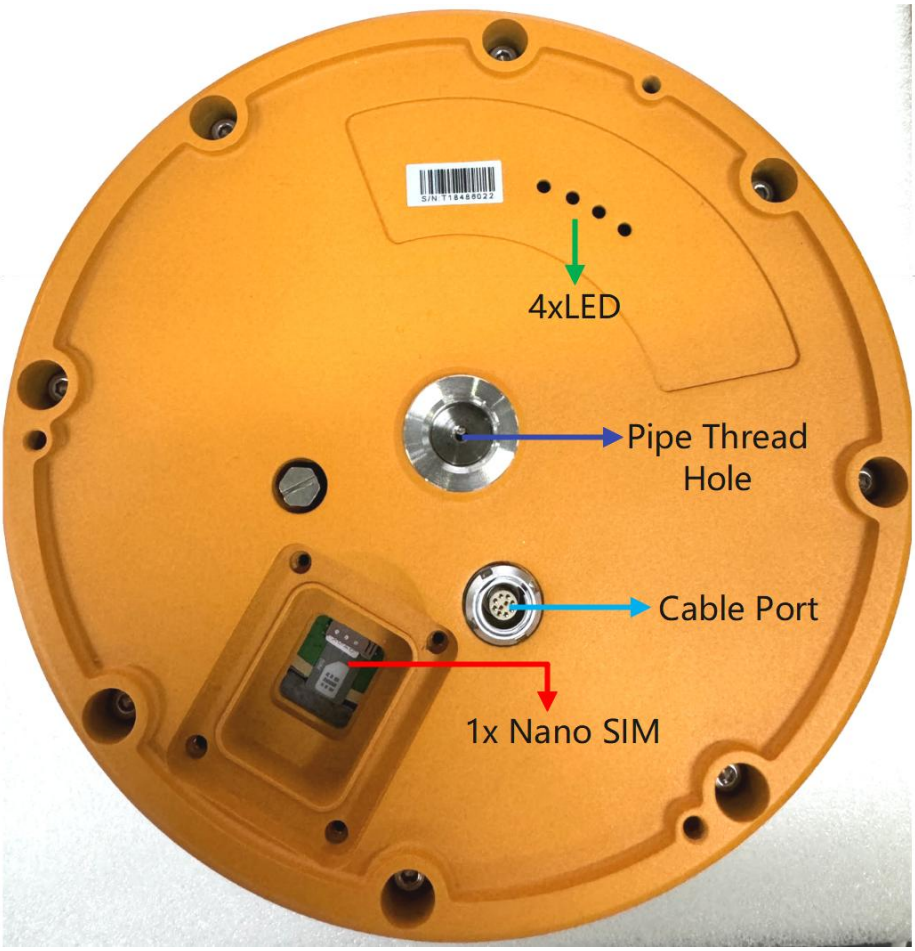
1.5.1 Definition of PIN

There is 4 IN 1 Cable(Power in/out, RS232, RS485, PI) in standard package, the definition is as below.



No.	Port Definition	Interface Type	Function Definition
1	VIN+	DC power input (Female)	Red--Positive pole
2	VIN-		Black--Negative pole
3	GND	DB9	5
4	232_RX		2
5	232_TX		3
6	VDD_OUT	3 Pin terminal	1
7	PI		2
8	GND		3
9	B	2 Pin line	Black-RS485 B
10	A		Red-RS485 A

Aviation plug should be installed at the bottom of TN531, there are 4xLEDs and a pipe thread hole. A Nano SIM is needed to connect internet, the details as as below.



1.6 Power supply requirement

Devices are often used in complex environments, in order to adapt to the complex application environment and improve the stability of the system, the equipment uses advanced power technology. Users can use BIVOCOM 12VDC/1.5A power adapter to supply power to the device, or directly supply power to the device with DC 9-35V power supply. When the user supplies power to the device with an external power supply, the stability of the power supply must be ensured (the ripple is less than 300mV, and the instantaneous voltage does not exceed 35V), and the power supply is guaranteed to be more than 4W (excluding the power consumption of the external sensor).
Using Bivocom standard 12VDC/1.5A power adapter is highly recommended.

1.7 LED Indicators

TN531 has 4 LED indicators, ‘Power’, ‘System’, ’Online’, ‘Error’, as follows.

LED Indicator	Status	Description
Power	On	Power on
System	Blink	Device is operating
Online	On	Device is online, connecting to remote server via cellular network
GNSS	On	RTCM32 data was collected

1.8 Mounting

This device supports 1*Pipe thread hole, the size of Screw thread is 5/8''-11, its robust IP68 rating guarantees durability in harsh conditions,TN531 can be installed at the top of pole body.

1.9 Lightning protection instructions

When this device is connected to outdoor sensors (rain gauge, water level gauge, etc.), we suggest you take lightning protection measures (such as installing lightning arresters, etc.) to improve the safety level of the device.

2. Getting Started

2.1 Package Checklist

The following components are included in your TN531 package.
Check the list before installation. If you find anything missing, Please feel free to contact Bivocom.

1. TN531 GNSS Receiver 1PCS
2. 4 IN 1 Cable(Power in/out, RS232,RS485, PI) 1 PCS
3. Power cable 1PCS

2.2 Installation

2.2.1 Install SIM/UIM Card

TN531 supports Nano SIM/UIM only, so if you're using a Micro SIM or Normal SIM card, you may need to replace them into Nano SIM card. There is a protecting cover covers SIM card slot, you need to use M3*12 screwdriver to unscrew 4 screws then plug or unplug SIM card.
Make sure your RTU is powered off, then put the SIM/UIM card to SIM slot with right direction, press it in and make sure it's locked and tightly matched. If you want to unplug SIM card, press SIM card edge and it will flick out.

Warning: Never install SIM/UIM card when RTU is powered on.

2.2.2 Install the 4 in 1 Cable

There is 1*4 in 1 Cable in the package(Power in/out, RS232, RS485, PI), please install the cable to the button of TN5321, sensors/PLC/microcontrollers can connect to the cable.

2.2.4 Connect cable of power adapter to TN531

The power supply of TN531 is barrel connector(4 in 1 cable), we suggest you use the power cable in the package. Bivocom's standard power supply is 1.5A/12VDC. If you have to use your own power supply, make sure the power range is 9-35VDC and it is stable enough(Ripple shall be less than 300mV, and Instantaneous voltage shall not larger than 35V), meanwhile, power shall over 4W.
Warning: Incorrect connection of the power cable may cause damage of device.

2.2.5 Connect TN531 to PC/Laptop via RS232

Use USB-RS232 adapter(DB9 interface) to connect to the RS232 female port of TN531.
For definition of RS232 serial port, please refer to item 1.5.1 respectively.

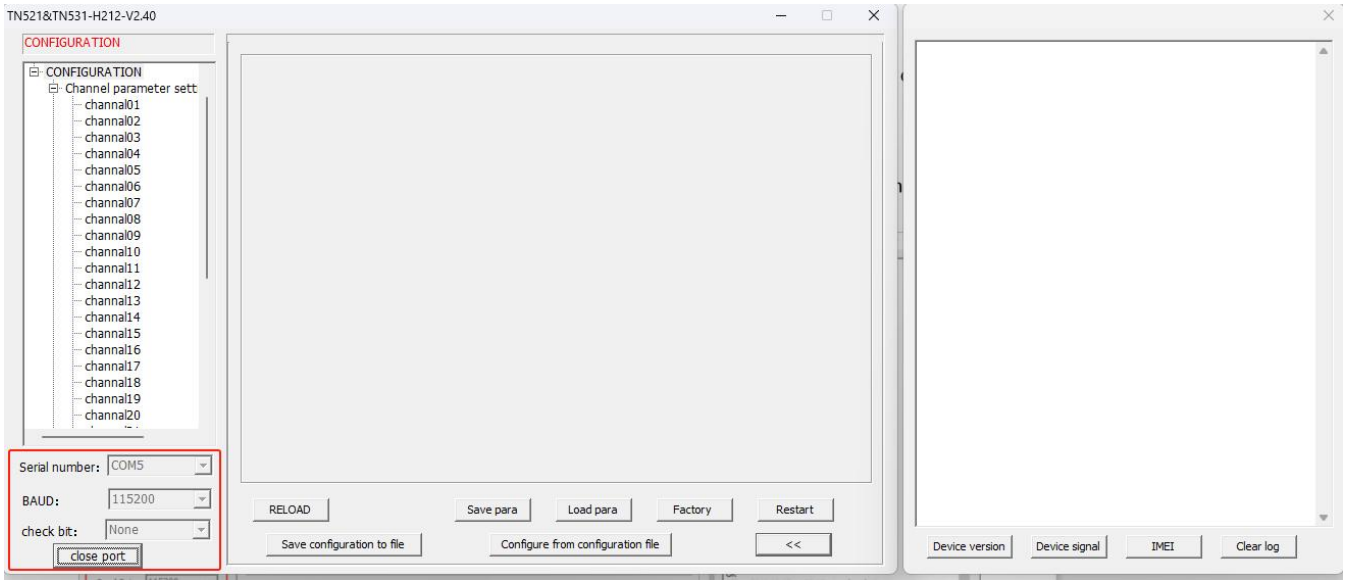
3. Configuration Tool Setting

In this chapter, you'll learn more details about how to configure the RTU via the configuration tool.

3.1 Config Tool

In the previous section, after finish the TN531 installation and connect it with your laptop via RS232 female port, you may need an RS232 to USB adaptor if your laptop doesn't support DB9 interface.

Open the RTU config tool, there are serial port settings of your laptop, select the right COM port, and Baud Rate (the default is 115200). Normally it will automatically detect the right port and has linked the connection by default. If not, please change it accordingly.



Click 'Reload' button Reload to reload the initial settings from the device, then you are allowed to configure all settings on the tool. Click 'Save' Save when settings changed. 'Restart' Restart it to quit the configuration mode and go into work mode(communication mode).

Note: You have to 'Reload' it before change any settings when in work mode.

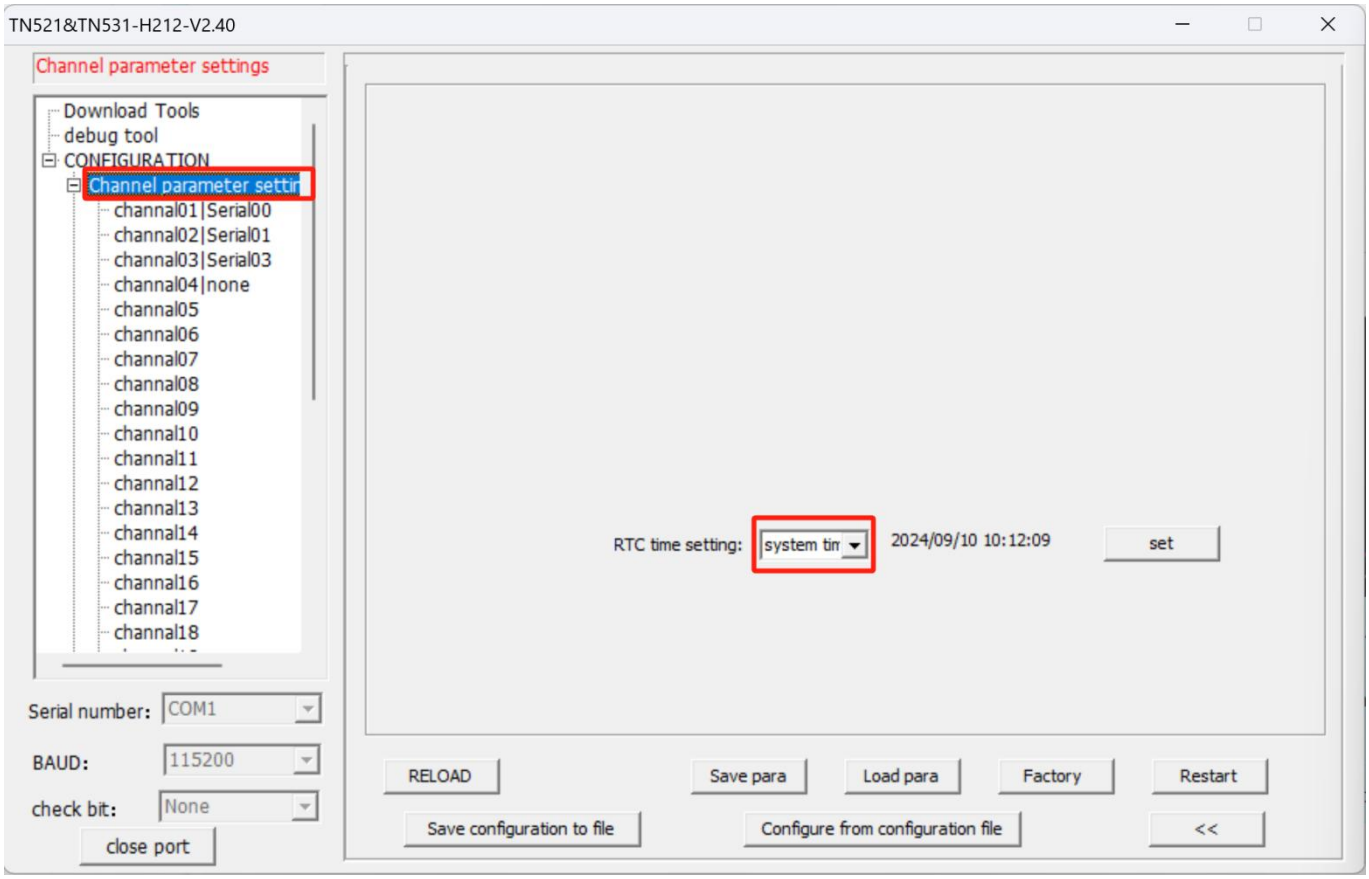
On the configuration tool board, you are also allowed to perform 'Factory', 'Save para' and 'Load para', Check

'Device version', 'Device signal' and 'Clear' the syslog.

After entering into configuration mode, you are able to change all the settings on tool panel, as below detailed explanations.

3.1.1 RTC Setting

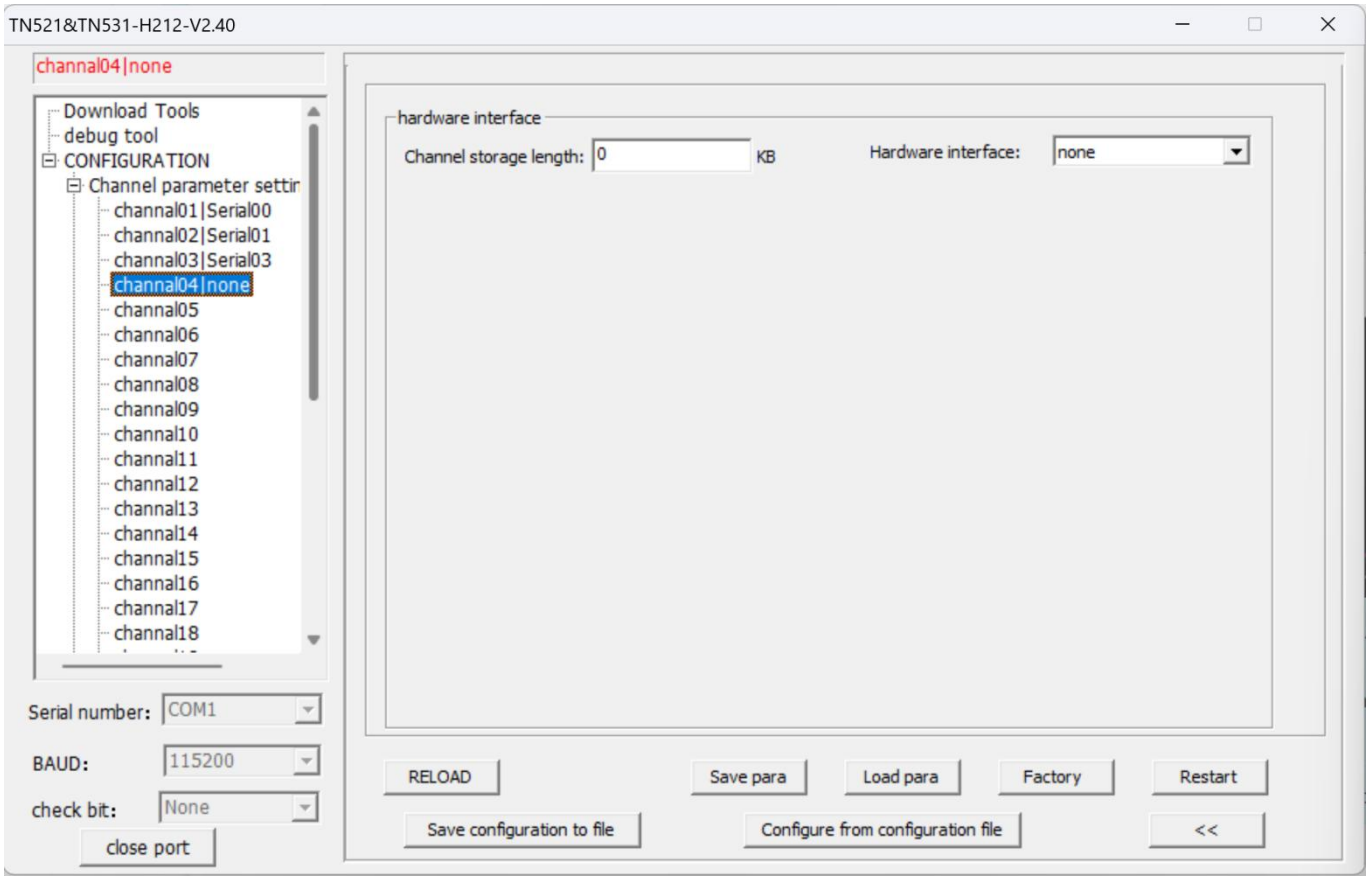
You can set the RTC time according to the current system time, or you can enter the time manually.



3.1.2 Channel Setting

You can configure the channel storage length and hardware interface when you configure the channels.

Note: channel01~03 are set for built-in 6-Xis MEMS sensor by default, please start configure from channel04.



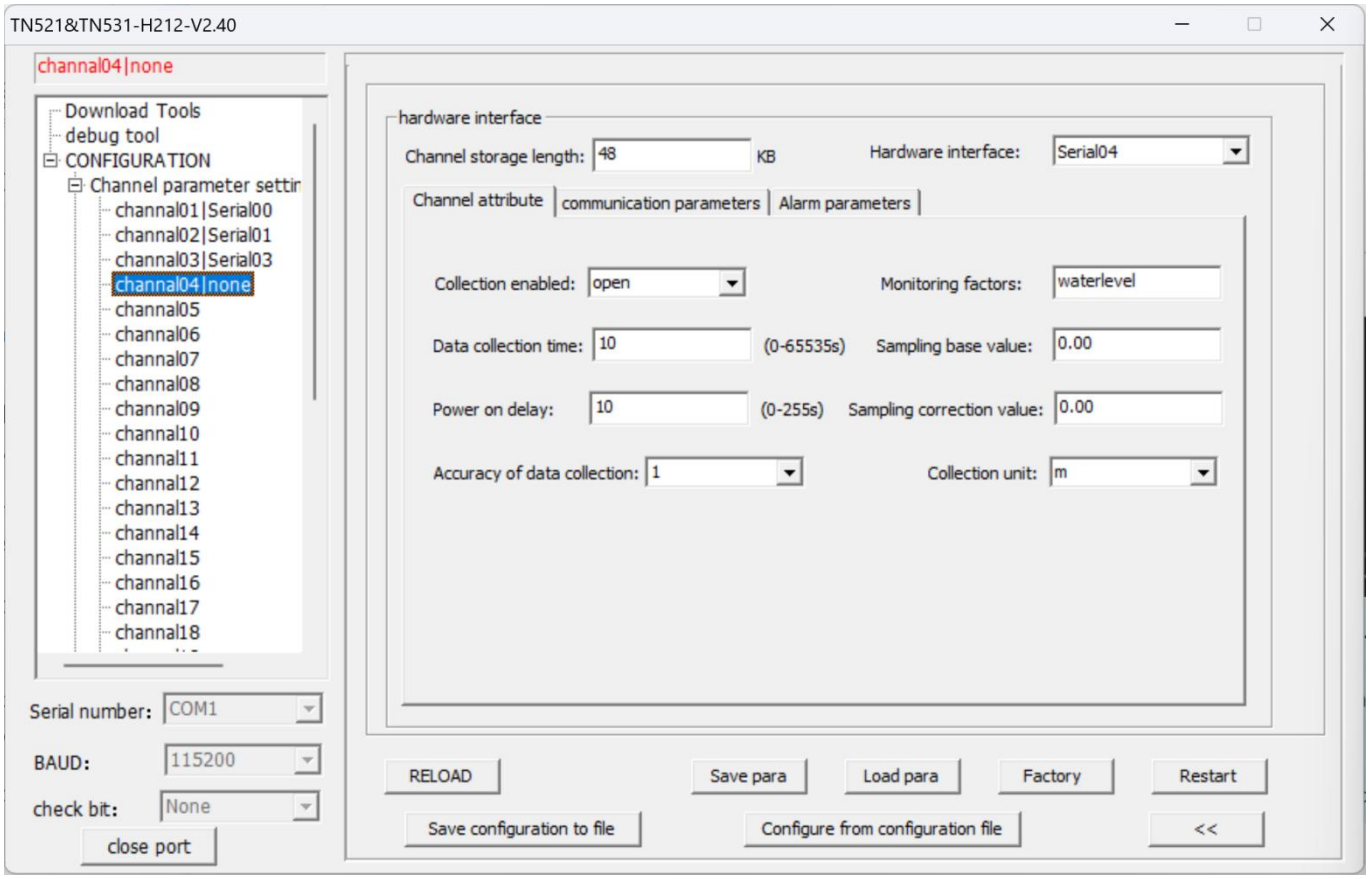
Parameter Name	Description
CH storage length	The size of the stored data, Unit: KB
Hardware Interface	Serial port(COM0-COM2, 2 ports in total)
	Pulse input(PI0, 1 ports in total)

3.1.3 Hardware Interface

1) Serial Port

For serial port setting, there are 3 main partners to configure, ‘Channel attribute’, ‘Communication parameters’ and ‘Alarm parameters’.

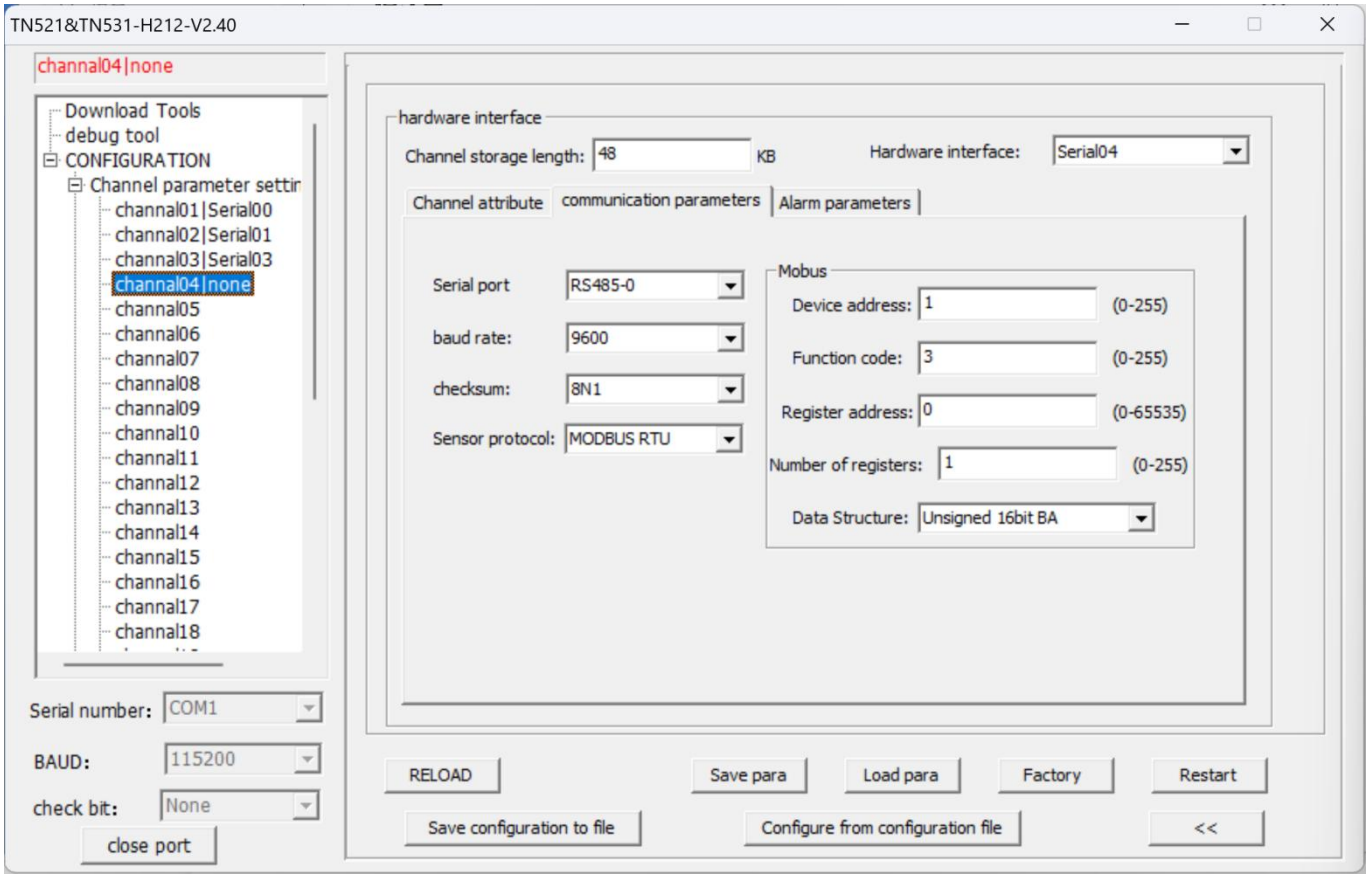
a) Channel attribute



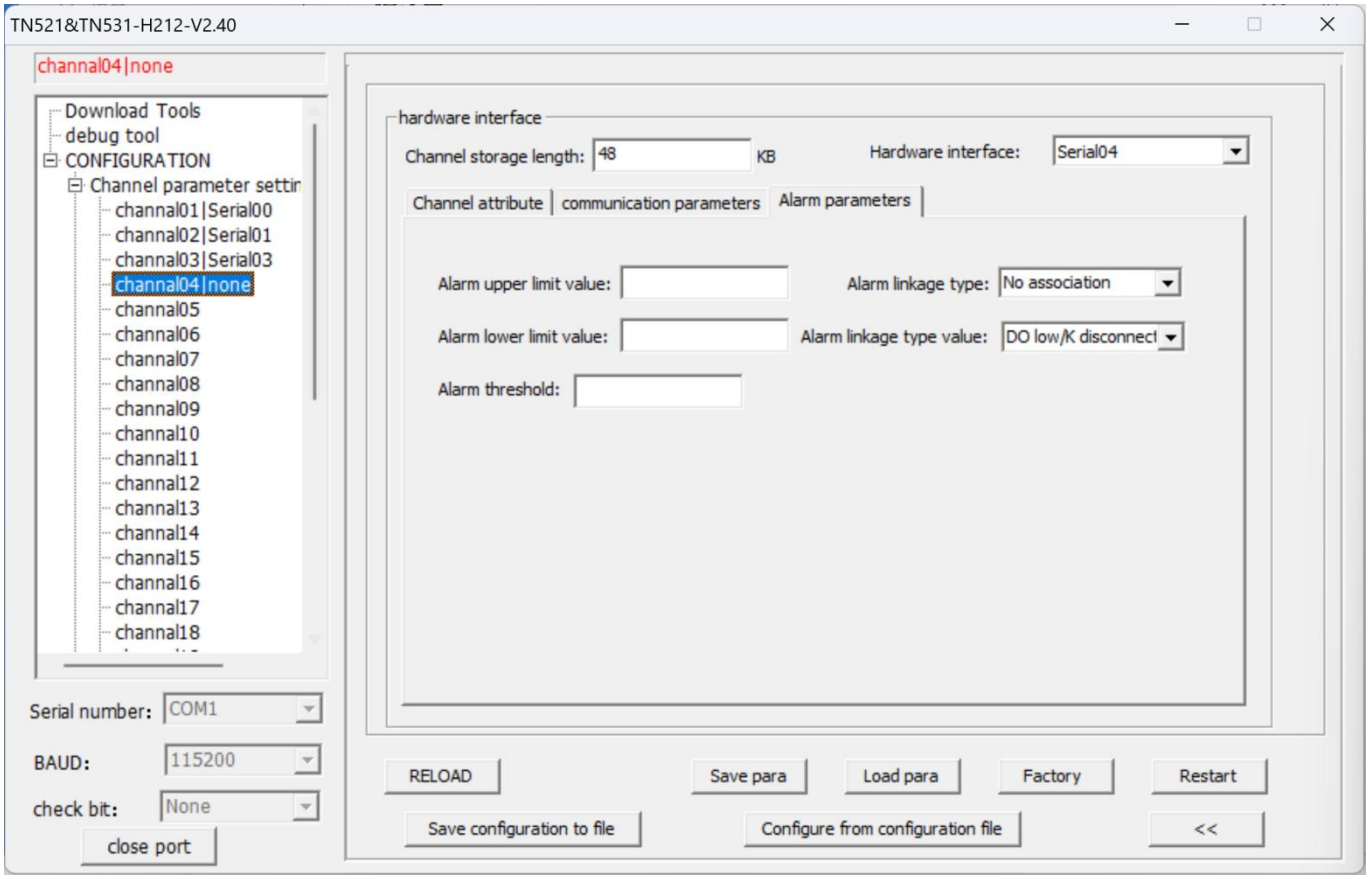
Parameter Name	Description
Collection enabled	Enable or disable data acquisition
Data collect time	Setting acquisition time interval, from 0-65535s
Power on delay	You can configure a time that TN531 will wait for the time you've set before it sends data acquisition request to your field sensor.
Accuracy of data collection	The accuracy of data, 0.01, 0.1, 1, 1000 to choose, and you can also set up the number you want. For example, you're collecting data at 0.001m, and you want to store the data in mm format, choosing 1000, that means your server will receive data at 1mm format.
Monitoring factors	Setting the factor to report to server.
Sampling Base Value	Assumed base value of sampling. By configuring this value, the data received at server is an accurate data. For example, the base value of water level gauge is 10m, and final water level is 20m, that means the data change is 10m.
Sampling Corrected Value	Correct the sampling value. If the data has fixed error, you can set a corrected value to correct it.
Collection Unit	Choose the unit for the type of data.(cm, m, m3/s)

b) Communication parameters

This is to configure the communication parameter of this channel on TN531, as well as Modbus parameter.



c) Alarm

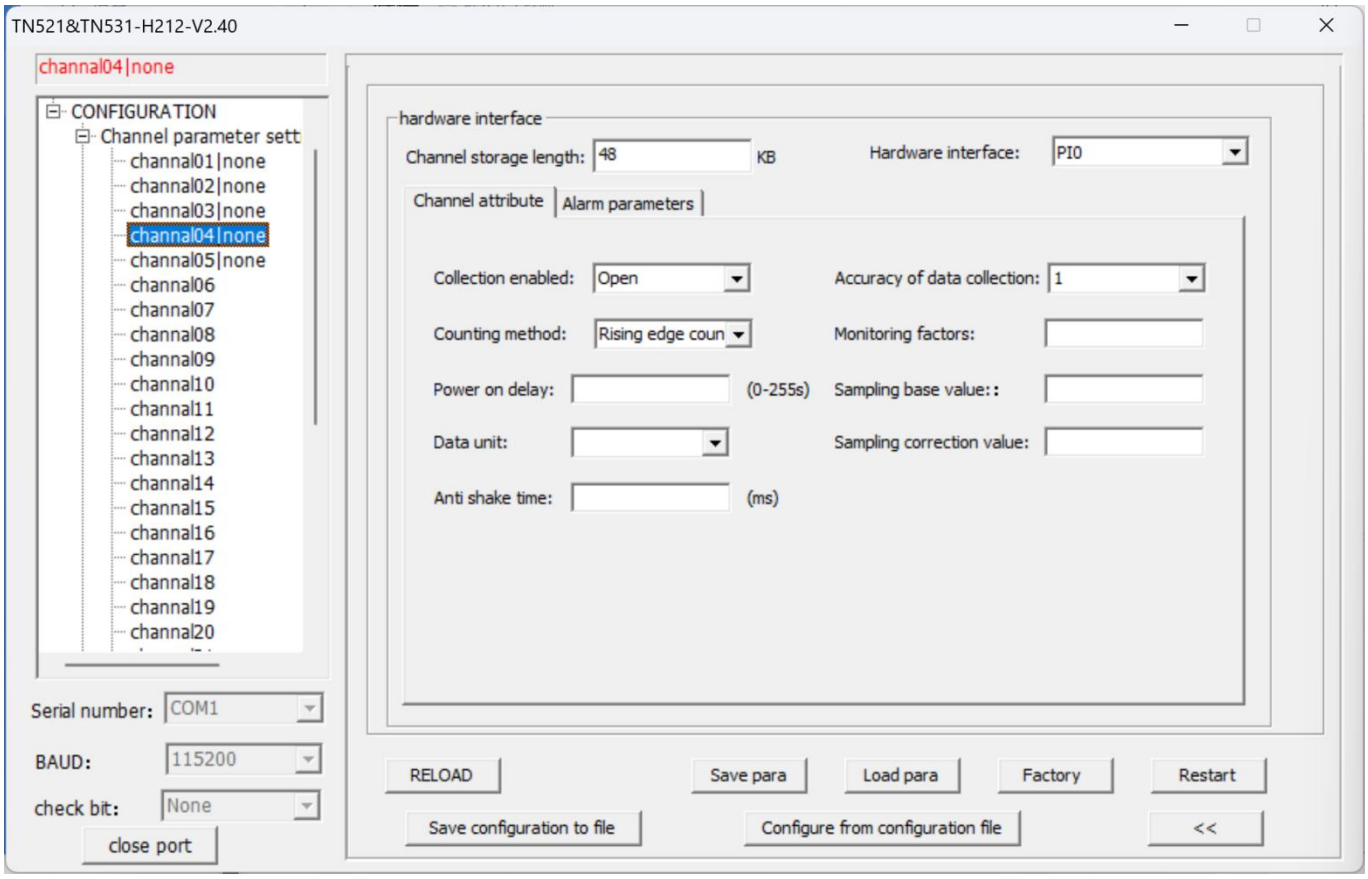


Parameters	Description
Alarm upper limit value	You can set a maximum value for alarm, once it exceeds this value, RTU will send alarm message
Alarm lower limit value	You can set a minimum value for alarm, once it exceeds this value, RTU will send alarm message
Alarm threshold	You can set a value that if the data surpass this value RTU will sent alarm message

2) Pulse Input

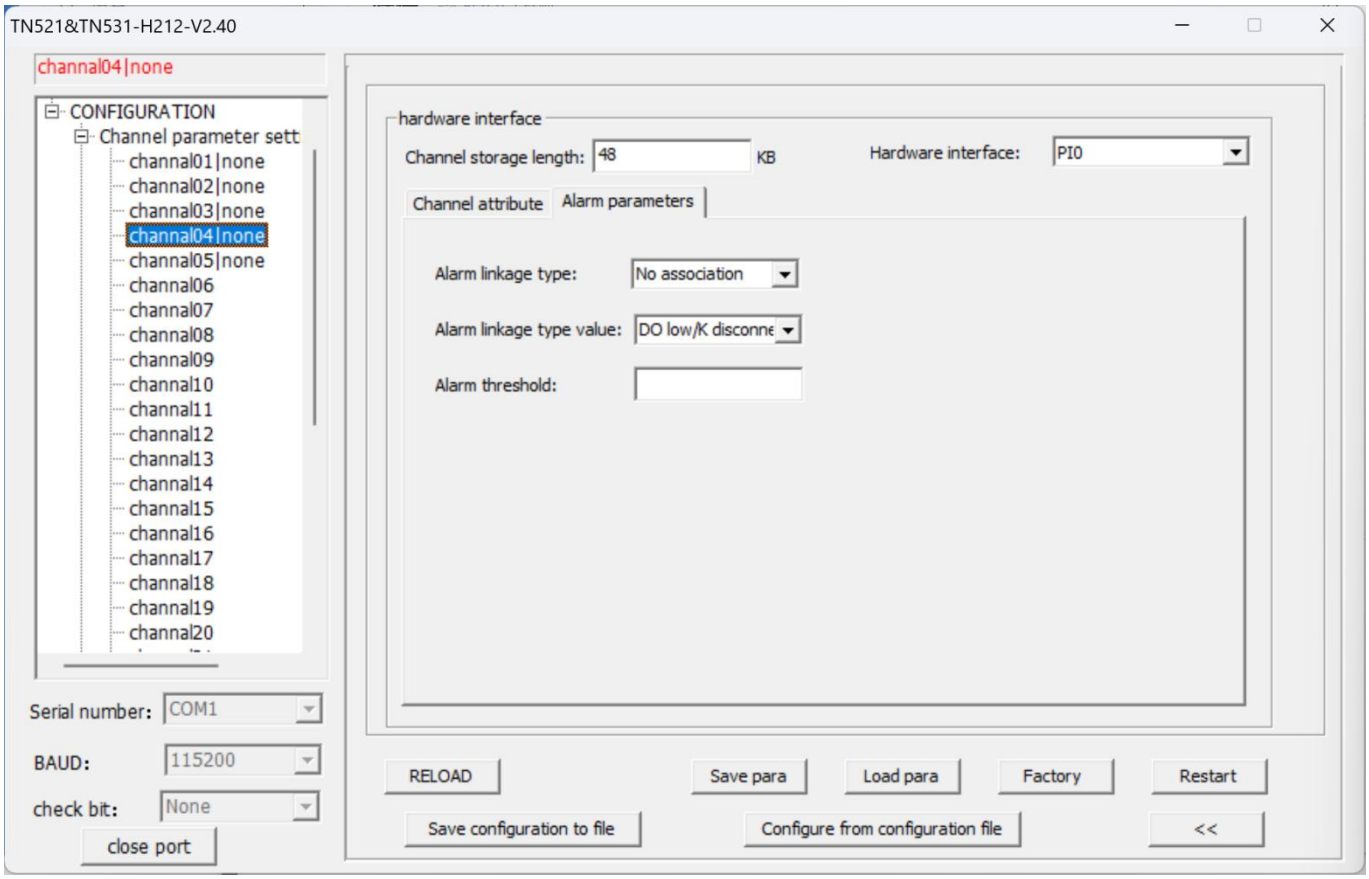
For Pulse Input, there are 2 main parameters to configure, Basic and Alarm.

a) Basic



Parameter Name	Description
Collection enabled	Enable or disable data acquisition
Counting Method	No, rising edge, falling edge, double edge
Power on delay	You can configure a time that TN531 will wait for the time you've set before it sends data acquisition request to your field sensor.
Data Unit	mm, cm, m, m3/s
Accuracy of data collection	The accuracy of data, 0.01, 0.1, 1, 1000 to choose, and you can also set up the number you want. For example, you're collecting data at 0.001m, and you want to store the data in mm format, choosing 1000, that means your server will receive data at 1mm format.
Monitoring factors	Setting the factor to report to server.
Sampling Base Value	Assumed base value of sampling. By configuring this value, the data received at server is an accurate data. For example, the base value of water level gauge is 10m, and final water level is 20m, that means the data change is 10m.
Sampling Corrected Value	Correct the sampling value. If the data has fixed error, you can set a corrected value to correct it.

b) Alarm

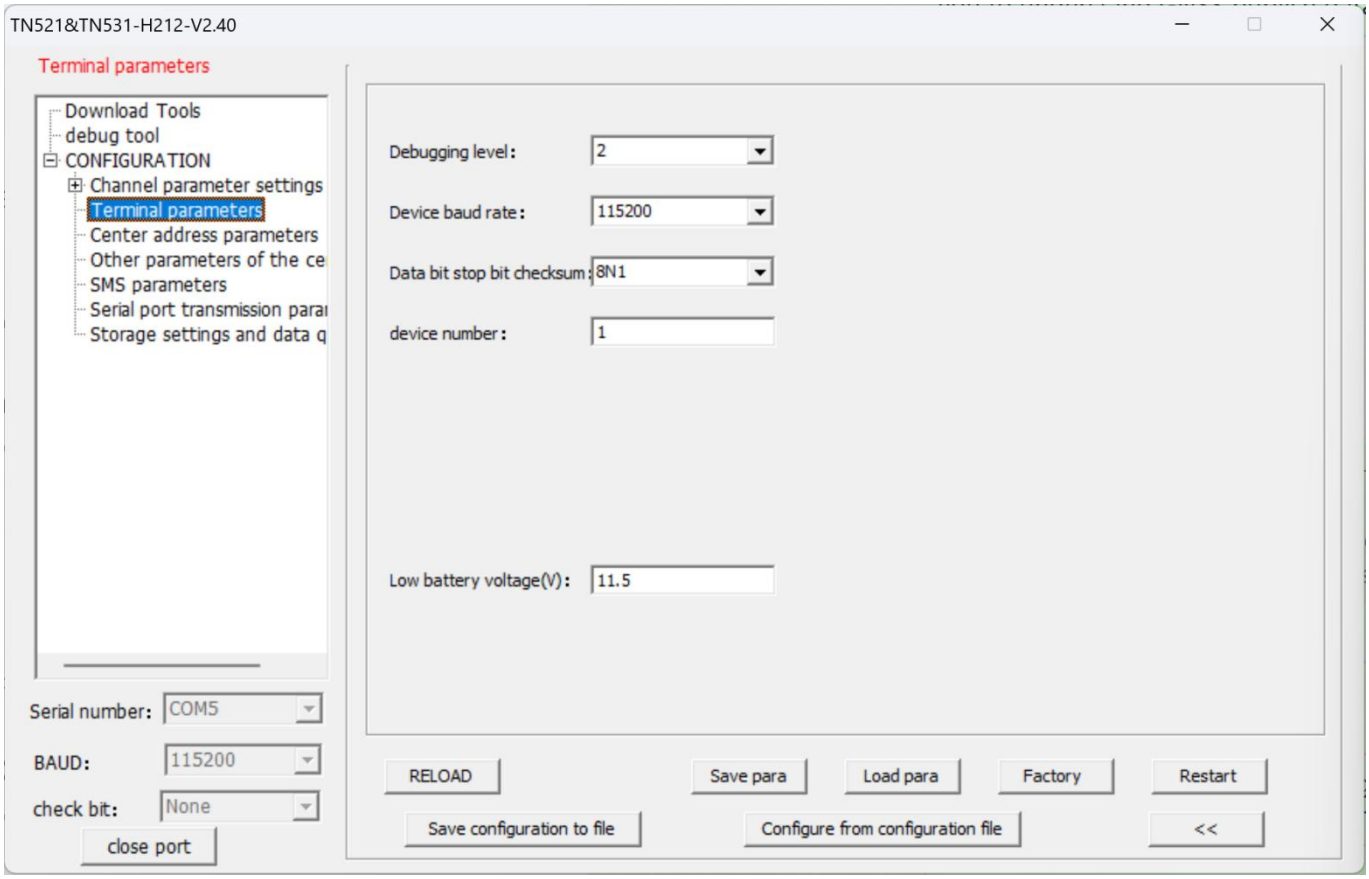


Parameters	Description
Alarm threshold	You can set a value that if the data surpass this value RTU will sent alarm message

3.1.4 Terminal Parameters

Configure the com ports settings at “Com Setting” page, only the RS232-1 and RS485-0 be supported on standard TN531.

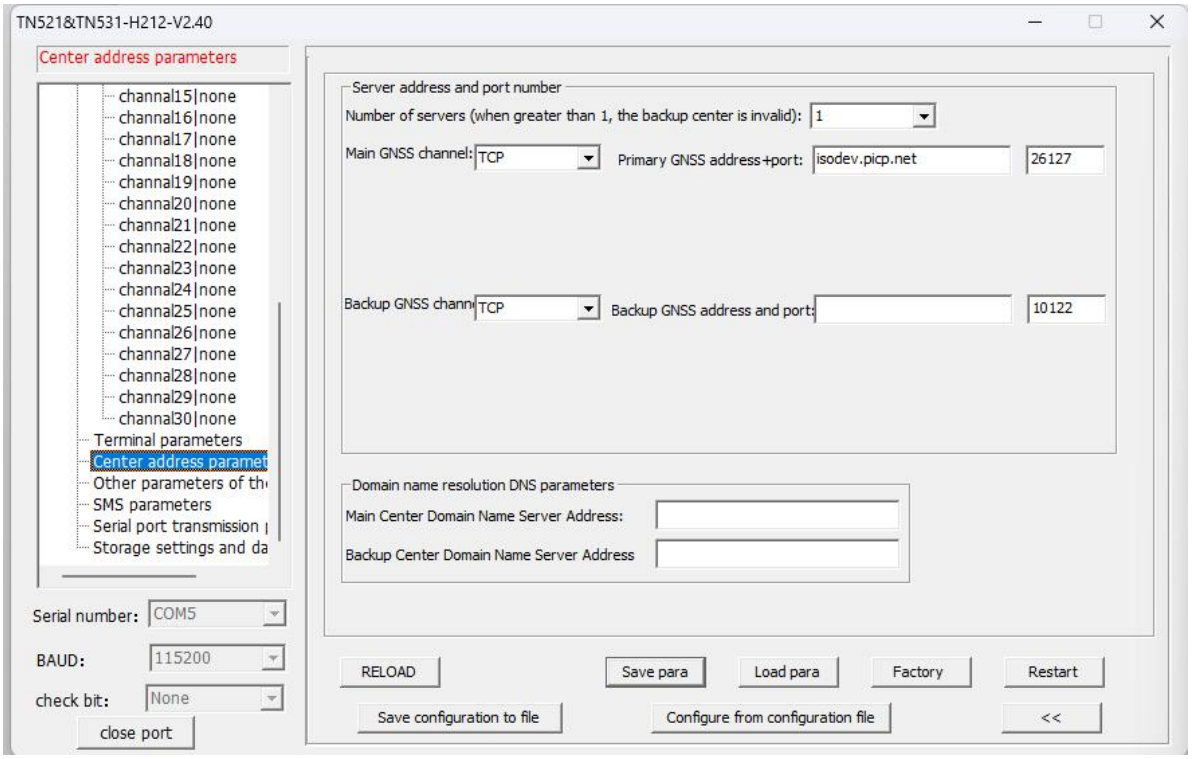
Note: RS485-1 setting only available if your TN531 is customized support up to 2-RS485 ports.



Parameters	Description
Debug Level	0(no log)
	1(Part of important logs export from RS232/RS485)
	2(Part of important logs export from RS232/RS485)
Baud Rate	300bps~115200bps
Data, Stop and Parity Bit	8N1, 8O1, 8E1
Device Number	The number of RTU
Battery Current	Unit: V

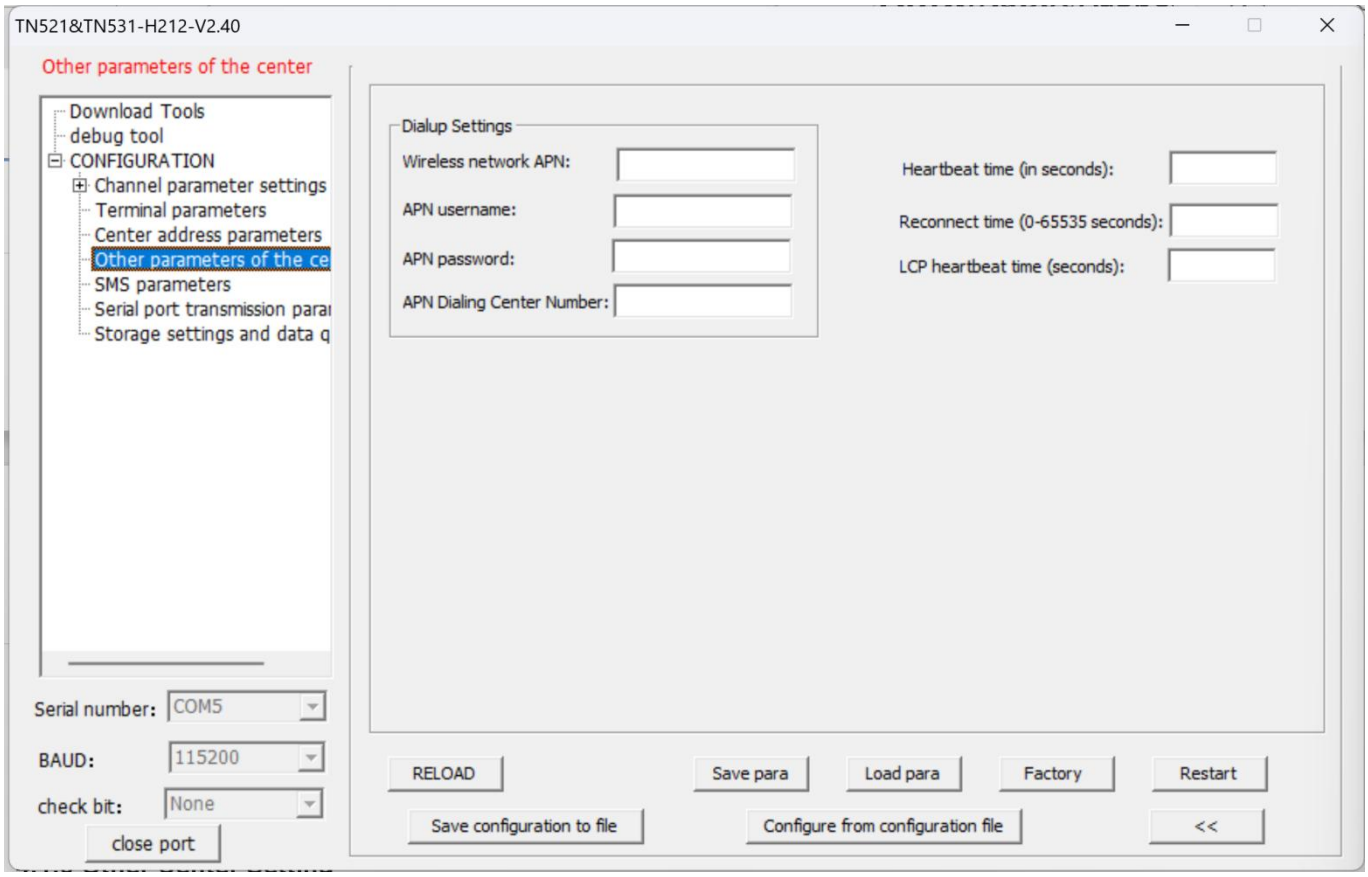
3.1.5 Center Address

You can configure the data center for GNSS and other sensors' data, there are up to 2 data center can be configured.



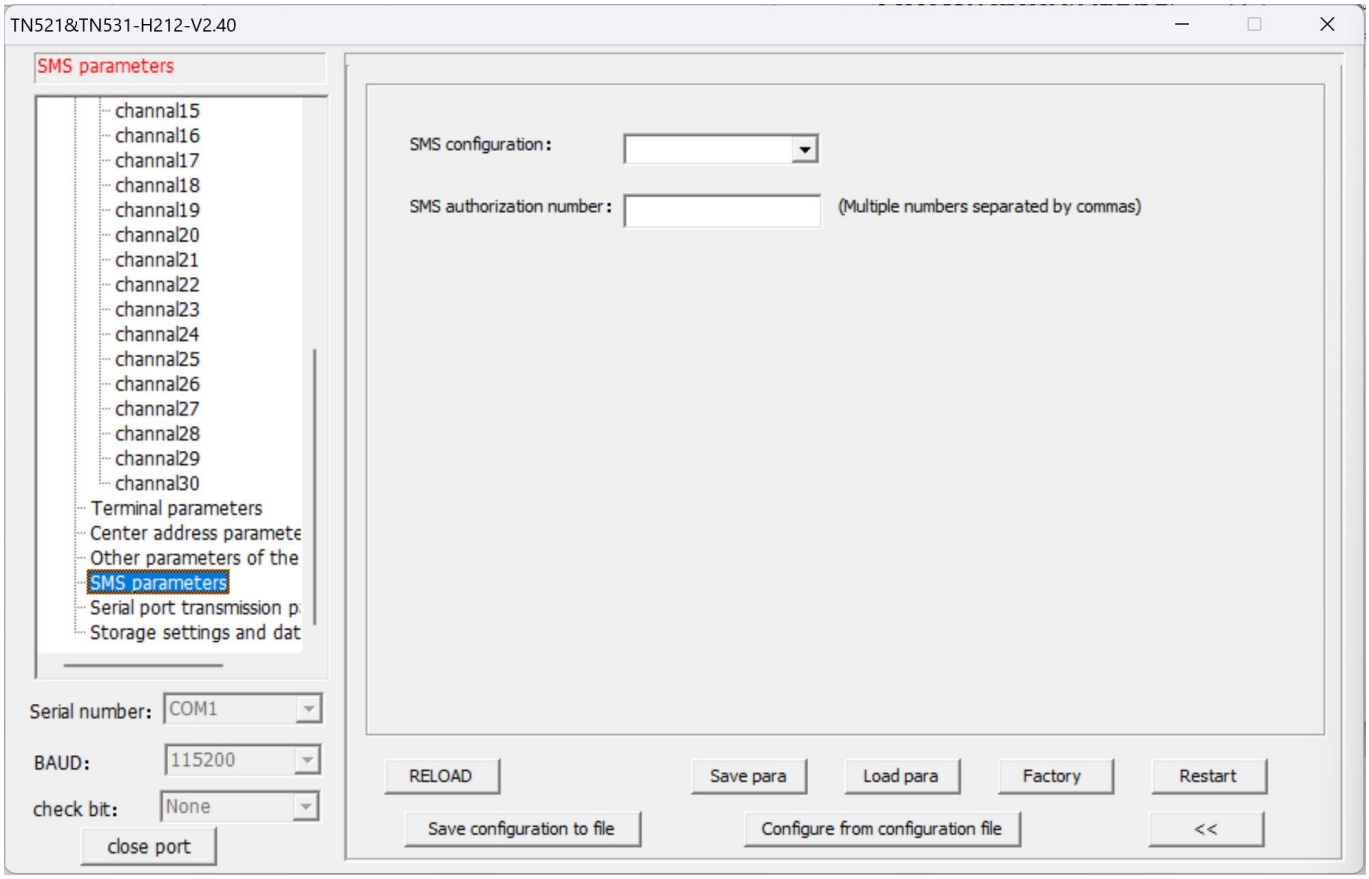
Parameter	Description
Data Center Number	Supports up to 5 data center, when choose number over 1, backup is invalid
Main GNSS channel	The protocol to report GNSS data, support TCP, SMS, Beidou Satellite, maritime satellite, PSTN, Shortwave, serial port and UDP
Center Addr+Port	Domain name or IP address supported

3.1.6 Other Center Setting



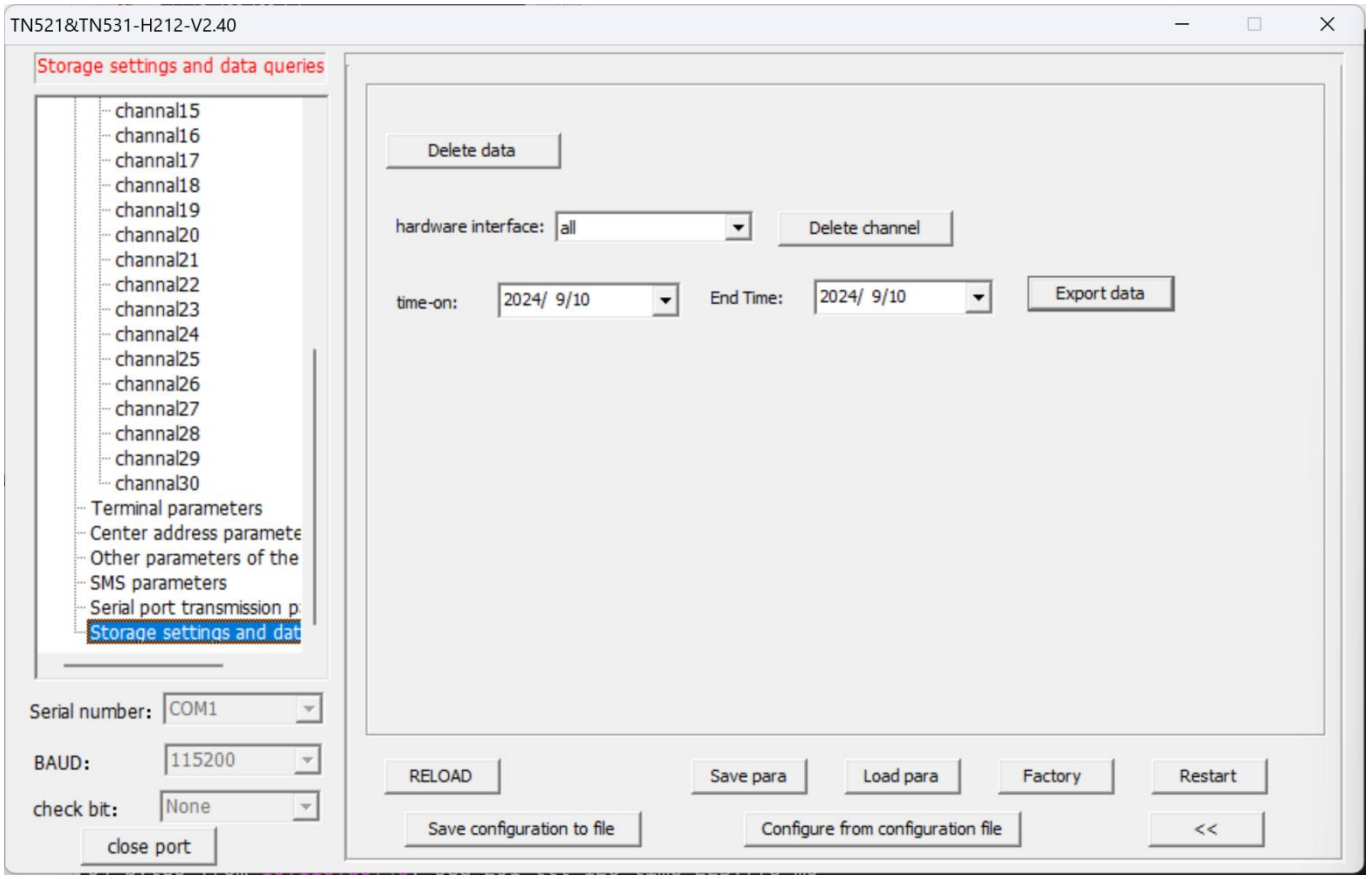
Parameter	Description
APN	APN of SIM card from your local carriers
Username	Username of APN
Password	Password of APN
APN Dialing Center	Call center number of APN
Heartbeat Time	Heartbeat time, 60 seconds is suggested for TCP mode, and 31 seconds for UDP
Reconnect Time Interval	Waiting time for disconnection reconnection
LCP Heartbeat Interval	LCP level detection, keep it as default

3.1.7 SMS Setting



Parameter	Description
SMS Setting	Open, Close
SMS Setting Authorized Number	Authorized phone number to receive SMS, multi number will be separated by comma

3.1.8 Data Storage Setting



Parameter	Description
Delete channel	Delete the storage record
Expert data	Export the data record

3.2 Modbus RTU Protocol

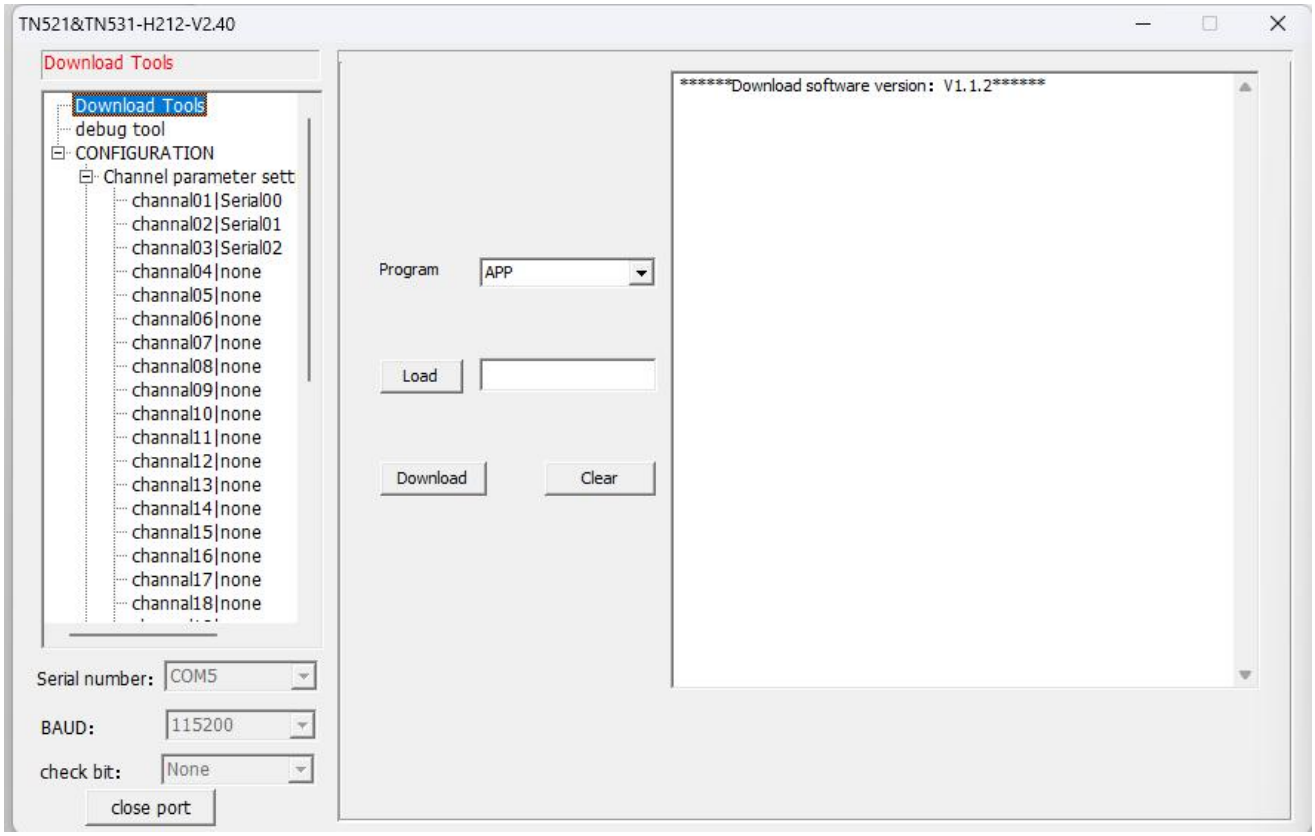
Please refer to Bivocom Modbus RTU protocol instruction for more details.

4. Firmware Upgrade

4.1 Local Upgrade

Make sure the RTU TN531 is connected to your PC via RS232 cable, you can keep the device power off at this moment.

1) Click download



2) Click “Load”, and find the firmware you want to upgrade, then click download.

3) Power on the RTU, start to upgrade.

4) When it shows “download success ok”, that means firmware upgrade completed and successfully.

Appendix I AT Commands

1. Basic Setting

Configuration Item	AT Command	Description
Device ID	AT+IDNT=x	X: device ID Example：AT+IDNT=12345678
Modbus work mode	AT+MBCHNNL=x	Set Modbus work mode X: 0 disable MODBUS 1 Network RTU Example：AT+MBCHNNL=1
Device SIM Number	AT+SIMNO=xx	Set SIM Card No. Xx: the max length is 19 Example：AT+SIMNO=13812345678
Modbus Device Address (1-255)	AT+MBADDR=xx	Set the Modbus Device Address Xx: device address Example：AT+MBADDR=2
Work Mode	AT+PROTTXT=xx	Set Work Mode Xx: 0 DTU 1 MODEM Example: AT+PROTTXT=0
Modbus Update Interval	AT+MBUPSEC=xx	Xx: Second value Example: AT+MBUPSEC=10
RTC Setting	AT+EXCCLK=XX	Example: AT+EXCCLK=2019/04/19,16:51:00,5

2. Com Setting

Configuration Item	AT Command	Description
Function switch	AT+COMIFENyy=xx	yy: 1=RS232-1 2=RS485-0 xx: 0=disable 1=enable Example: AT+COMIFEN01=0
		yy:

Baud rate	AT+COMSPEEDyy=xx	1=RS232-1 2=RS485-0 xx: Baud rate Example: AT+TRANCOMSPEED01=115200
Frame Interval	AT+COMFRMINTRyy=xx	yy: 1=RS232-1 2=RS485-0 xx: frame interval value Example: AT+COMFRMINTR01=30
Databit, Parity, Stopbit	AT+COMPARITYyy=xx	yy: 1=RS232-1 2=RS485-0 x: 8N1,8E1,8O1 Example: AT+COMPARITY01=8E1
Command Content	AT+DETAILCONTyy=x	yy : 1-10 X:command content Example: AT+DETAILCONT03=01 03 00 00 00 22 C5 D3
hex	AT+DETAILCODEyy=x	yy : 1-10 X: 0=string 1=HEX Example: AT+DETAILCODE03=1
Interval Time	AT+DETAILTIMEyy=x	yy : 1-10 X: second Example: AT+DETAILTIME03=10
COM Choose	AT+DETAILCOMyy=x	yy : 1-10 X: 0 1 RS232-1 2 RS485-0 Example: AT+DETAILCOM03=2

3. Network Address

Configuration Item	AT Command	Description
Data Center	AT+SERNUM=x	Set the number of datacenter x：0-5，0=disable this feature Example: AT+SERNUM=1
Protocol	AT+TRANMODEyy=xx	Set the channel communication protocol yy：01-05=center No. x：0 ftcp 1 CTCP 2 HTCP 3 NUDP 4 CUDP 5 HUDP Example: AT+TRANMODE01=1
Cache	AT+SERSVLENyy=xx	yy：01-05=center No. x：Cache size Example: AT+SERSVLEN01=10
Main Addr	AT+MULTISERyy=xx	yy：01-05=main server，06-10=backup server xx：address Example: AT+MULTISER01=isodev.picp.net
Port	AT+MULTIPORTyy=xx	yy: 01-05=main server port accordingly, 06-10=backup server port x: 0-65535 Example: AT+MULTIPORT01=10121
Com Select	AT+SERCOMTYPEyy=xx	yy: 01-05 center No. xx: 0 Rs232-1 1 Rs485-0 Example: AT+SERCOMTYPE01=1
Offline Data Storage	AT+SERSVOFFyy=xx	yy: 01-05=center No. xx: 0 disable 1 enable Example: AT+SERSVOFF01=0
Main DNS Server	AT+MULTIDNS01=xx	xx：DNS address Example: AT+MULTIDNS01=8.8.8.8
Backup DNS Server	AT+MULTIDNS02=xx	xx：Backup DNS server Example: AT+MULTIDNS02=8.8.8.8

4. Other Settings

Configuration Item	AT Command	Description
APN	AT+APN=xx	xx：APN value Example: AT+APN=nbiot
APN Username	AT+USERNAME=xx	xx：APN username value Example: AT+USERNAME=test1
APN Password	AT+USERPASSWORD=xx	xx：APN password value Example: AT+USERPASSWORD=testpwd
Call center	AT+CALLNO=xx	Set the APN call center xx：call center value Example: AT+CALLNO=
Heartbeat Interval	AT+HRTSEC=x	x：0-65535 second, 0=disable heartbeat Example: AT+HRTSEC=40
Reconnect Time	AT+RECONSEC=x	x：0-65535 second Example: AT+RECONSEC=10
TCP Keepalive	AT+KPLVMIN=x	x：keepalive interval Example: AT+KPLVMIN=12
Network Selection	AT+NETMODE=x	X: 0 auto 1:GSM only 2:TD-SCDMA only 3:WCDMA only 4. CDMA only 5. HDR only 6. LTE only Example: AT+NETMODE=0
FTCP Transfer Meaning	AT+CONVERT=x	x : 0=No, 1=Yes, Example: AT+CONVERT=0
Custom Login Data	AT+SELFLGN=x	X: register data Example: AT+SELFLGN=hello
Custom heartbeat Data	AT+SELFHRT=x	Set the heartbeat data X: heartbeat data value Example: AT+SELFHRT=hello
Custom Login data type	AT+SELFLGNHEX=x	Set the custom register data type x : 0=string,1=hex Example: AT+SELFLGNHEX=0
Custom heartbeat data	AT+SELFHRTHEX=x	Set the custom heartbeat data type

Type		x : 0=string,1=HEX Example: AT+SELFLGNHEX=0

Appendix II Data Structure

No	Parameter	Description	Example
0	Unsigned 16bit AB	unsigned 16bit integer (2 byte), low byte first	Example: 01 03 02 11 22 0D 34 Note: HEX 2211 DEC 8721
1	Unsigned 16bit BA	unsigned 16bit integer (2 byte), high byte first	Example: 01 03 02 11 22 0D 34 Note: HEX 1122 DEC 4386
2	Signed 16bit AB	Signed 16bit integer (2 byte), low byte first	Example: 01 03 02 11 22 0D 34 Note: HEX 2211 DEC 8721
3	Signed 16bit BA	Signed 16bit integer (2 byte), high byte first	Example: 01 03 02 11 22 0D 34 Note: HEX 1122 DEC 4386
4	Unsigned 32bit ABCD	Unsigned 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 44332211 DEC 1144201745
5	Unsigned 32bit BADC	Unsigned 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 33441122 DEC 860098850
6	Unsigned 32bit CDAB	Unsigned 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 22114433 DEC 571556915
7	Unsigned 32bit DCBA	Unsigned 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 11223344 DEC 287454020
8	Signed 32bit ABCD	Unsigned 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 44332211 DEC 1144201745
9	Signed 32bit BADC	Signed 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 33441122 DEC 860098850
10	Signed 32bit CDAB	Signed 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 22114433 DEC 571556915
11	Signed 32bit DCBA	Signed 32bit integer (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 11223344

			DEC 287454020
12	Float ABCD	Signed 32bit float (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX 44332211 Float 716.532288
13	Float BADC	Signed 32bit Float (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX33441122 Float 0.000000
14	Float CDAB	Signed 32bit Float (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX22114433 Float 0.000000
15	Float DCBA	Signed 32bit Float (4 byte)	Example: 01 03 02 11 22 33 44 C6 C3 Note: HEX11223344 Float 0.000000