

D9x Series LoRaWAN DTU User Manual

V3.0.1

This guide explains how to use this product. Please read this user manual carefully before using the product.

Important Information

All contents of this document are protected by law. No organization or individual may copy or distribute this document in any form without permission. We make every effort to ensure the accuracy of this document; however, unavoidable errors may still exist. We review this document regularly to keep its contents consistent with the corresponding product. Your comments and suggestions are highly appreciated.

The following instructions cover the correct use of the product and precautions intended to prevent hazards and property damage. Please read this manual carefully before using the device and strictly follow all instructions during operation.

Safety Instructions

- Do not place or install the device in direct sunlight or near heat-generating equipment.
- Do not install the device in flammable, explosive, humid, dusty, or smoky environments.
- Keep the device away from fire, strong electric fields, and strong magnetic fields; otherwise, permanent damage may occur.
- Do not install the device in locations with severe signal interference.
- Install the device as far away as possible from large metal equipment. Never install the antenna inside a metal enclosure.
- Do not install the device in high-vibration locations or on equipment subject to strong vibration.

➤ Do not drip or splash liquids onto the device. Prevent liquids from entering the enclosure.

➤ Perform all related settings in accordance with this user manual.

➤ This device uses and generates radio-frequency energy and may interfere with other radio communications. Interference cannot be guaranteed to be absent in a particular installation.

➤ To protect the product and ensure safe operation, follow this user manual. The company assumes no responsibility for damage caused by improper use or failure to follow the manual.

➤ Modification of this product is strictly prohibited.

➤ Do not install or use the product in environments that do not meet the specified operating temperature, humidity, or other environmental requirements. Keep it away from cold sources, heat sources, and open flames.

➤ Do not subject the product to external impact or vibration.

➤ When removing the enclosure, take care not to lose or damage any internal electronic components.

➤ Connect the product to other terminal devices only while the product is powered off. For outdoor use, ensure adequate waterproofing.

Product Compliance Statement

D9x complies with the essential requirements of CE and RoHS and other applicable regulations.

Document Revision History

Date	Version	Description
2024/04/22	V2.0.0	First release after a comprehensive upgrade
2025/06/22	V3.0.0	1、 Changed the ports of some data packets; 2、 When used with a ChirpStack server, server-side channel additions are supported for frequency bands other than CN470, AU915, and US915; 3、 DevNonce in the OTAA JoinRequest now increments automatically; 4、 Added persistent uplink frame-counter storage; 5、 Added Channel Activity Detection (CAD); 6、 Added terminal restart type reporting; 7、 Added serial-port firmware upgrade functionality; Updated the PC configuration software.
2026/08/17	V3.0.1	1、 Added delayed transmission after power-on with a user-configurable interval; 2、 Updated the PC software UI;

1. Product Introduction

D9x is a LoRaWAN® wireless data transmission terminal equipped with RS485 and RS232 serial interfaces. It supports bidirectional transparent transmission and Modbus master/slave modes, enabling data conversion between conventional RS485/RS232 communications and LoRaWAN® wireless communications. The device supports multiple configuration rules, including local software configuration and flexible LoRaWAN downlink configuration. D9x supports standard LoRaWAN® networking for quick connection to LoRaWAN® networks. It can work with our self-developed platform or connect to LoRaWAN platforms such as ChirpStack, making remote data acquisition and control of field devices easy. It is suitable for a wide range of indoor applications such as smart parks, smart offices, and smart classrooms.

2. User Guide

Preparation:

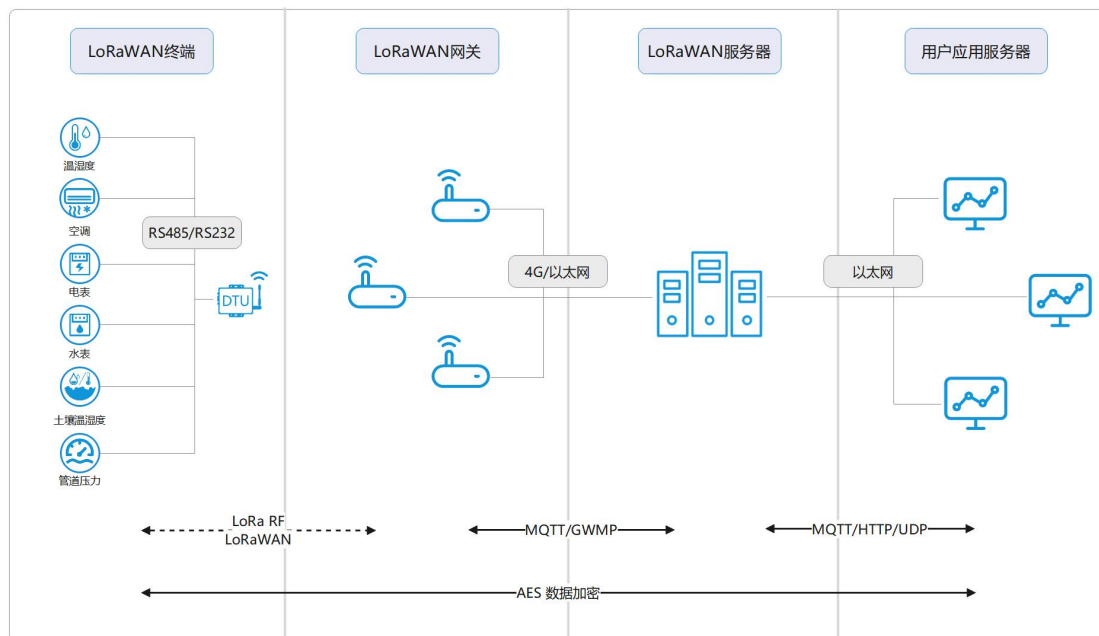
1. D9x device;
2. RS485 or RS232 device (hereinafter referred to as the application device);
3. USB-to-RS485 / USB-to-RS232 cable;
4. Computer;
5. AWTools configuration software, installer version > 26.8.14-1142.

Configuration Steps:

1. Set the D9x serial parameters to match those of the application device;
2. Configure D9x for transparent transmission or scheduled data

acquisition and reporting;

3. Set the D9x communication frequencies so they match those of the LoRaWAN gateway;
4. Enter the network activation parameters on the LoRaWAN server / LoRaWAN edge gateway (a gateway with an integrated LoRaWAN server) to activate the D9x device on the network.



2.1. Configure D9x

2.1.1. Connect to D9x to Obtain Device Information

D9x can be configured through RS232 or RS485.

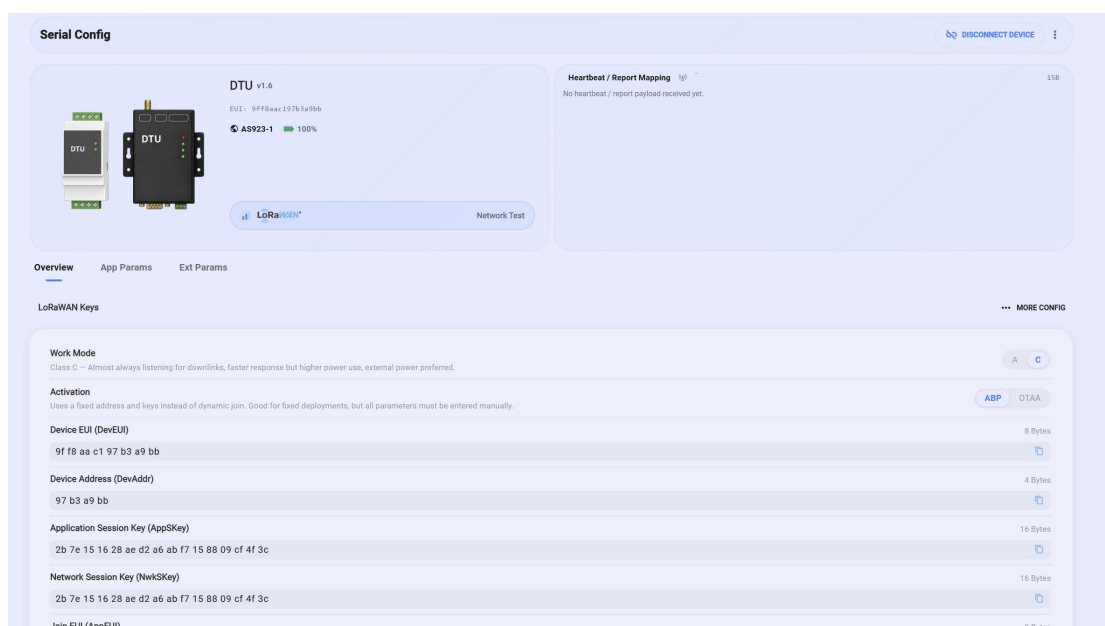
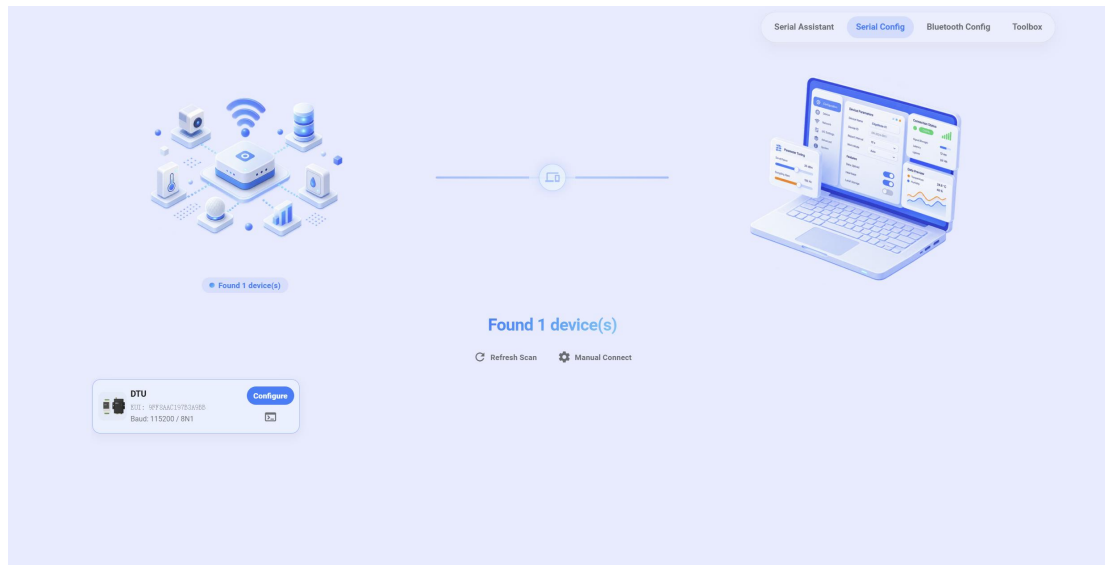
Preparation:

- USB-to-RS485 / USB-to-RS232 cable
- Computer
- AWTools configuration tool

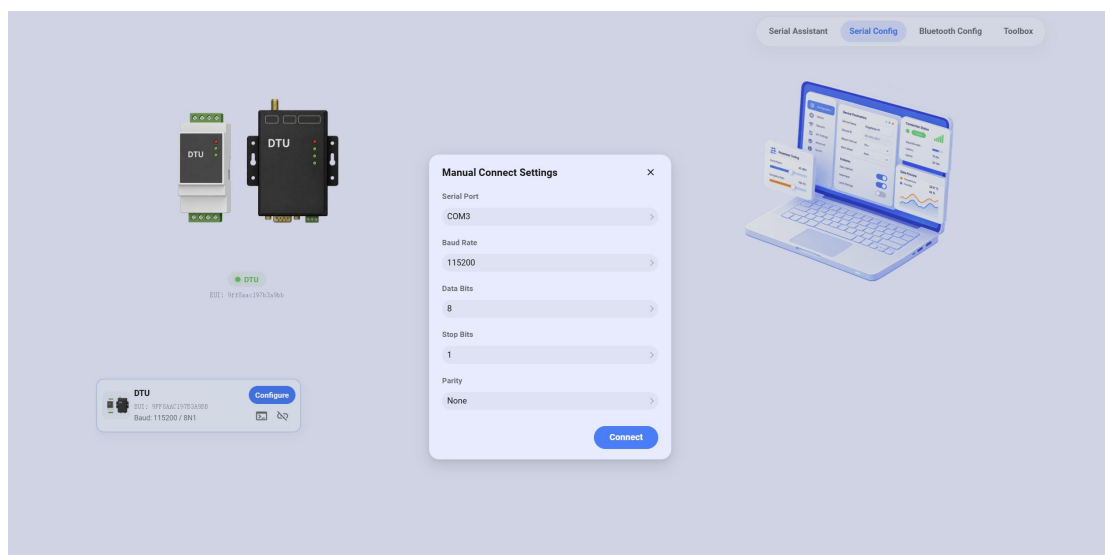
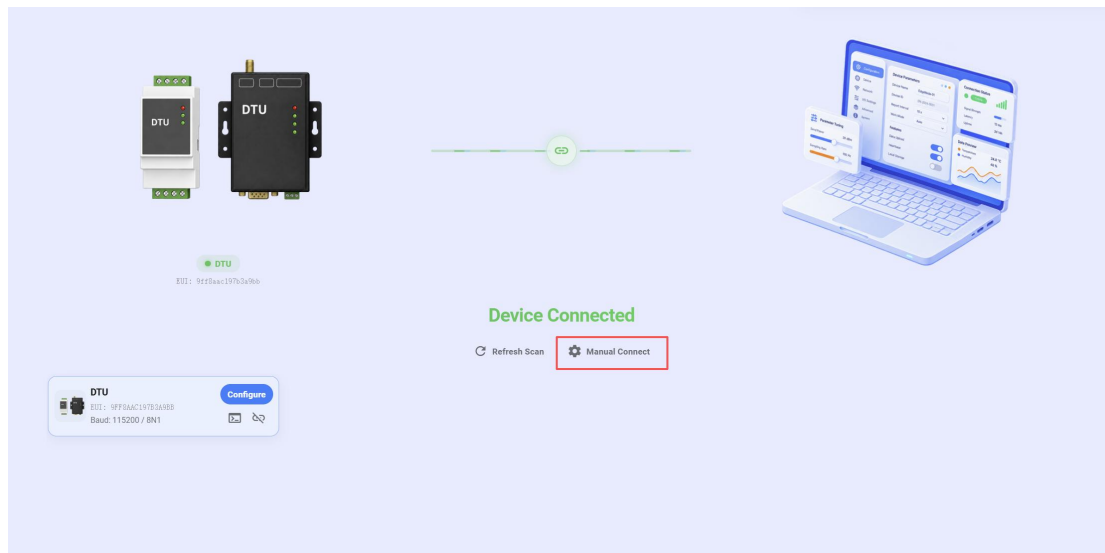
Connect the Device to the Computer:

1. Connect the D9x to the computer using a USB-to-RS485 or USB-to-RS232 adapter, then open AWTools;

2. After opening the software, if the RS485/RS232 connection is correct, wait for the serial ports to be scanned, then click “Configure”;



3、 Alternatively, click “Manual Connect”, set the serial-port parameters, and then click “Start Connection”;



Default DTU Serial Parameters

Serial Parameter	RS485	RS232
Baud Rate	9600	115200
Data Bits	8	8
Stop Bits	1	1
Parity	None	None

2.1.2. Serial Port Parameter Settings

In this step, configure the D9x serial-port parameters to match those of the application device so that serial communication can be established between them.

Overview **App Params** Ext Params

UART Info (RS232)

Baud Rate
UART communication speed. It must match the external device or communication will fail or look garbled. 115200 >

Data Bits
Number of data bits in each UART frame. The default is usually correct. 8 >

Stop Bits
Number of stop bits at the end of each UART frame. It must match the external device. 1 >

Parity
UART parity mode used for error checking. It must match the external device. None >

UART Info (RS485)

Baud Rate
UART communication speed. It must match the external device or communication will fail or look garbled. 4800 >

Data Bits
Number of data bits in each UART frame. The default is usually correct. 8 >

Stop Bits
Number of stop bits at the end of each UART frame. It must match the external device. 1 >

Parity
UART parity mode used for error checking. It must match the external device. None >

➤ **Serial Acquisition Delay:**

At low baud rates, especially when acquiring data with multiple scripts, the serial acquisition delay should be increased appropriately. Otherwise, data acquisition may fail. This setting is applicable when the baud rate is below 1200 bps.

➤ **Supported Baud Rates:**

110/300/600/1200/2400/4800/9600/14400/19200/38400/43000/57600/76800/115200

2.1.3. Operating Mode Settings

Transparent Transmission Mode:

Transparent transmission mode is enabled by default at the factory. In this mode, D9x can obtain data from the application device in two ways:

- 1、The application device actively reports data, and D9x forwards

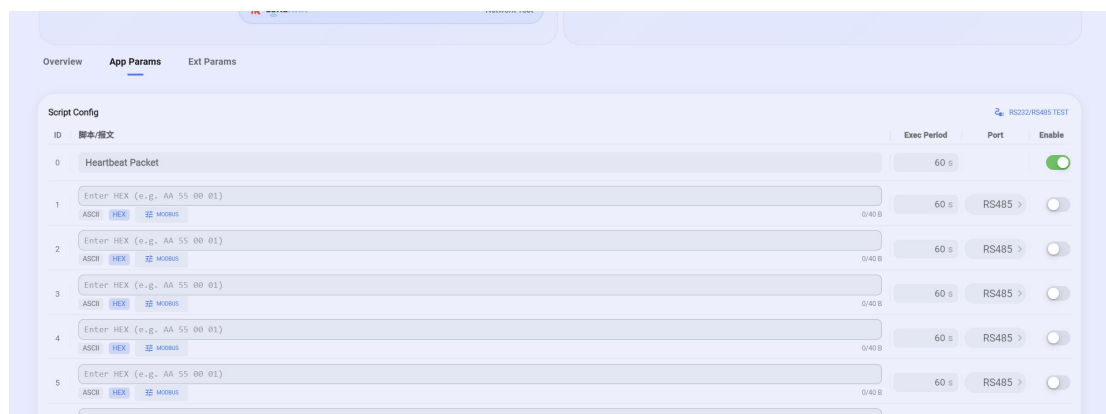
the received data to the gateway immediately;

2、 The gateway sends a command to D9x, which then obtains data from the application device.

Active Acquisition Mode:

Because most LoRaWAN gateways have limited downlink capacity, D9x provides a script-based acquisition function. D9x periodically sends configured commands to obtain data from the application device, thereby reducing downlink load on the gateway.

✧ **Important: A script contains commands sent to the application device to read data. Scripts must be created according to the communication protocol of the application device.**



1、 Script 0 is the heartbeat packet. It periodically reports device information so that the online status of the device can be determined. The reporting interval can be configured. (For detailed parsing, refer to Section 3.1 of the communication protocol.) (The content of this heartbeat packet cannot be modified.)

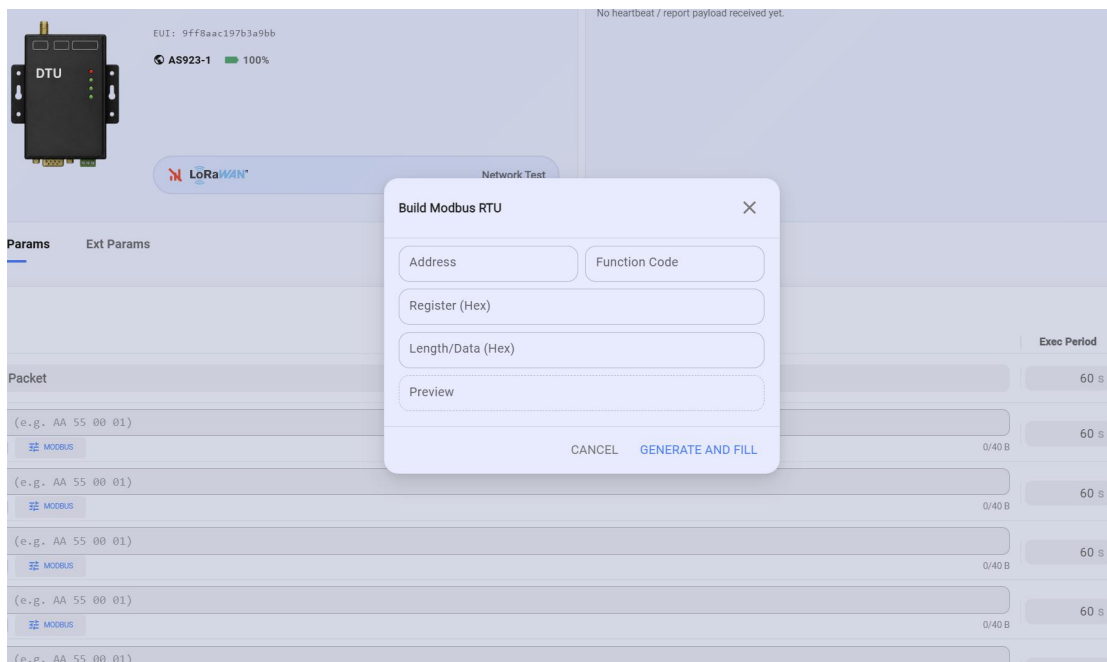


2、 Scripts support both HEX and ASCII formats, with a maximum length of 40 bytes.



3、Up to 16 acquisition scripts are supported. When using multiple scripts, assign acquisition intervals appropriately.

4、The script editor supports Modbus command generation. Enter the device address, function code, starting register address, and number of registers to read; the CRC is calculated automatically and the resulting command is inserted into the script.



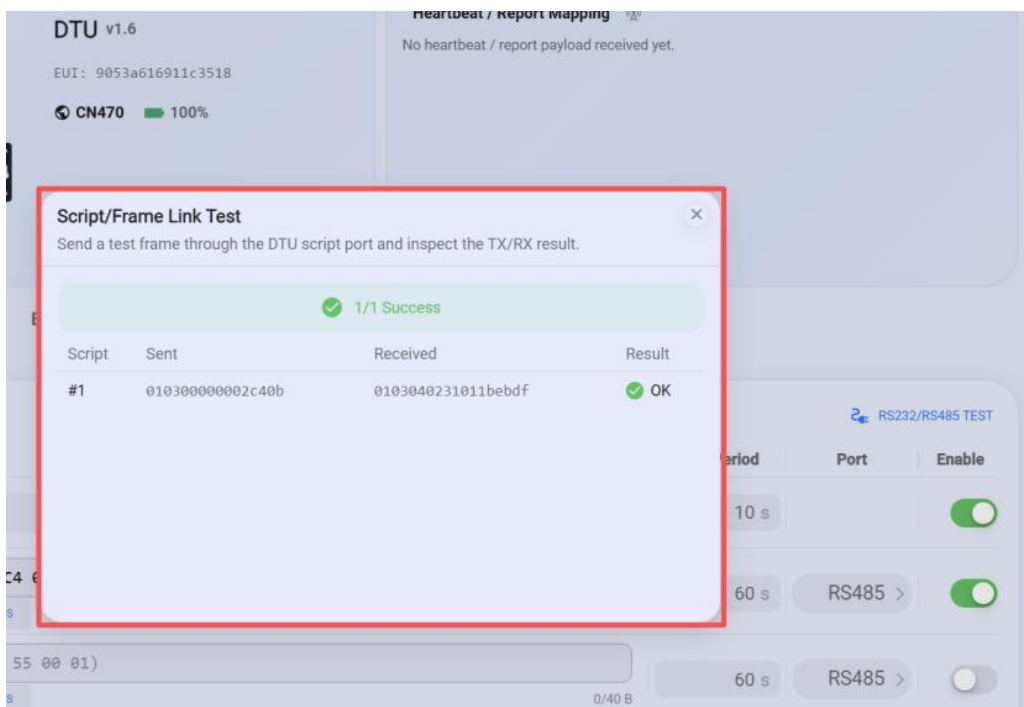
5、The minimum script acquisition interval is 10 s, and the maximum is 86,400 s.

✧ **Important: Set the minimum script acquisition interval according to**

the operating status of the connected sensor. Setting the interval too short may cause acquisition failures.

6、 After configuring a script, you can verify it. Enter the script, enable it, and click “Script Test”.

❖ **Important: To test a script, the corresponding sensor must be connected to the appropriate serial port. Also check that the wiring is correct.**



The steps above complete the communication configuration between D9x and the application device. Next, configure communication between D9x and the LoRaWAN network.

2.1.4. Basic LoRaWAN Configuration

Before connecting the device to a LoRaWAN network, the relevant network communication parameters must be configured. Complete the LoRaWAN network configuration as described below.

If you are unfamiliar with common LoRaWAN parameters, refer to the table below for their meanings:

Parameter	Description
Operating Mode (CLASS A)	Device Class A: Uses the standard ALOHA communication mode, including uplink communication, downlink communication, and fixed receive windows. Suitable for most low-power sensors and application scenarios.
Operating Mode (CLASS C)	Device Class C: Keeps Receive Window 2 continuously open so that downlink messages can be received at any time. Suitable for applications requiring low latency and frequent downlinks.
Activation Mode (ABP)	Activation by Personalization: A LoRaWAN activation method in which the network session key, application session key, and device short address are preconfigured at the factory, allowing immediate communication. Suitable for applications where keys do not need to be changed frequently.
Activation Mode (OTAA)	Over-the-Air Activation: A LoRaWAN activation method that activates the device through dynamic key negotiation and over-the-air communication, providing greater security and flexibility. Suitable for mobile and cross-network applications.
Device EUI (DevEUI)	Unique device identifier used for OTAA activation. It can be found on the product label.
Device Address (DevAddr)	Device short address used for ABP activation. It can be found on the product label.
Join EUI (AppEUI)	Application identifier: a 64-bit globally unique identifier used to identify and manage a specific application in a LoRaWAN network. Default: 0000000000000001

Application Session Key (AppSKey)	Application session key used in ABP mode to encrypt and decrypt data transmitted between the device and the application server. Default key: 2b7e151628aed2a6abf7158809cf4f3c
Network Session Key (NwkSKey)	Network session key used in ABP mode to encrypt and decrypt data transmitted between the device and the network server and for device authentication. Default key: 2b7e151628aed2a6abf7158809cf4f3c
Application Key (AppKey)	Application key used in OTAA mode for key protection during communication between the device and the application server and for device authentication. Default key: 2b7e151628aed2a6abf7158809cf4f3c
ADR	Adaptive Data Rate: When enabled, the network server can adjust the terminal data rate and transmit power. Recommended when the device is stationary.
ACK	Acknowledgment: A message confirming successful packet reception to improve transmission reliability. Suitable for applications requiring high reliability.
Start Channel	The first frequency channel used when the device joins the LoRaWAN network or communicates for the first time.
End Channel	The last frequency channel used within the configured frequency range, ensuring communication remains within the specified spectrum.
Spreading Factor	Spreading Factor: When ADR is disabled, the device transmits data using the configured SF. A lower SF provides a higher data rate and is better suited to short-range communication, and vice versa. Setting range: 7-12
Transmit Power	Device transmit power: PA version default: 27 dBm; standard version default: 22 dBm.
Confirmed Uplink	When enabled, every uplink requires an acknowledgment from the platform. This improves reliability but increases power consumption and downlink usage.

✧ **Important: After configuring the above parameters as required by the LoRaWAN server, the D9x device can be activated on the LoRaWAN server. Refer to the LoRaWAN Server User Manual / Edge Gateway User Manual for the procedure for connecting terminal products to our LoRaWAN server / LoRaWAN edge gateway. D9x can also be used with LoRaWAN gateways and servers from other**

manufacturers; refer to the corresponding manufacturer documentation for specific procedures.

2.2. Multicast Configuration

Multicast Settings

Enable Multicast

Allows the device to receive multicast messages sent to a group of devices.

Multicast ID

Group ID used to identify which multicast group this device belongs to.

255

Multicast Addr

4 Bytes

ff ff ff ff

Multicast AppKey

16 Bytes

2b 7e 15 16 28 ae d2 a6 ab f7 15 88 09 cf 4f 3c

Multicast NwsKey

16 Bytes

2b 7e 15 16 28 ae d2 a6 ab f7 15 88 09 cf 4f 3c

Multicast Channel

Channel or frequency index used for multicast downlinks.

25 (505.3) >

Multicast SF

Spreading factor used for multicast downlinks.

SF12(DR0) >

Multicast Uplink Delay

Delay before subsequent application uplinks after a valid multicast downlink, from 0 to 60000 ms; 0 starts the reply flow immediately.

0 ms

Enable Multicast	When enabled, DTUs can be configured in batches.
Multicast ID	Multicast group number used to identify which multicast group the device belongs to.
Multicast Address	Default: ffffffff, multicast short address
Multicast Application Key (AppSKey)	Multicast application session key Default: 2b7e151628aed2a6abf7158809cf4f3c
Multicast Network Key (NwsKey)	Multicast network session key Default: 2b7e151628aed2a6abf7158809cf4f3c
Multicast Channel	Default: Channel 25 (505.3 MHz), downlink frequency for Receive Window 2.
Multicast Spreading Factor	Default: SF12 (DR0), downlink spreading factor for Receive Window 2.
Multicast Uplink Delay	After receiving a valid multicast downlink, delays the subsequent application uplink. Range: 0-60,000 ms; 0 means enter the reply

	process immediately.
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2.3. More Settings

Overview

App Params

Ext Params

LoRaWAN Keys

...

MORE CONFIG

Work Mode

Class C – Almost always listening for downlinks, faster response but higher power use, external power preferred.

A

C

Activation

Uses a fixed address and keys instead of dynamic join. Good for fixed deployments, but all parameters must be entered manually.

ABP

OTAA

Device EUI (DevEUI)

8 Bytes

90 53 a6 16 91 1c 35 18

Device Address (DevAddr)

4 Bytes

91 1c 35 18

Application Session Key (AppSKey)

16 Bytes

2b 7e 15 16 28 ae d2 a6 ab f7 15 88 09 cf 4f 3c

Network Session Key (NwkSKey)

16 Bytes

LoRaWAN Advanced



Communication

Max Join Count

How many times the device will try to join the network again after a join failure.

3 >

Max Send Count

Maximum send attempts for one confirmed uplink, including the first send. For example, 3 means 1 initial send and up to 2 retries if no ACK is received.

3 >

ADR

When enabled, the network automatically adjusts rate and power. Recommended when the signal environment is stable.



RX2 Config

RX2 Channel

Channel or frequency index used by the second receive window. It must match the platform settings.

25 (505.3) >

RX2 SF

Spreading factor used by the second receive window. A mismatch may cause missed downlinks.

SF12(DR0) >

Window Config

RX1 Delay

How long the device waits after an uplink before opening the first receive window.

1000 ms

RX1 Wait

How long the first receive window stays open.

3000 ms

RX2 Delay

How long the device waits after RX1 before opening the second receive window.

2000 ms

RX2 Wait

How long the second receive window stays open.

3000 ms

Extended Info

Fast Send Mode

Sends queued data as quickly as possible and usually skips waiting for receive windows. Best for uplink-only scenarios.



Hot Load

In OTAA mode, tries to reuse the previous join information after reboot so communication can resume faster.



Simple FCnt

Uses a simpler frame-counter handling mode for compatibility with some platforms. Leave default if unsure.



Rx Continuous

Keeps the device receiving continuously so downlinks can arrive quickly, but power use increases a lot.



CAD

Checks whether the channel is busy before sending. This can reduce collisions but may add delay.



FCntUp Hold

Tries to keep the uplink frame counter continuous so the platform does not reject data after a reboot.



Function	Description
Max Join Attempts	Maximum number of additional join attempts after a join failure.
Max Send Attempts	Maximum number of transmissions for one confirmed uplink, including the initial transmission. For example, 3 means one initial transmission plus up to two retransmissions if no ACK is received.
ADR	When enabled, the network automatically adjusts the data rate and transmit power. Recommended when the radio environment is stable.
RX2 Channel	Channel or frequency index used by the second receive window. It must match the platform configuration. Default: Channel 25, 505.3 MHz
RX2 SF	Spreading factor used by the second receive window. If the settings do not match, downlinks may not be received. Default: SF12, DR0
RX1 Delay	Time to wait after an uplink transmission before opening the first receive window. Default: 1000 ms
RX1 Window Duration	How long the first receive window remains open. Default: 3000 ms
RX2 Delay	Time to wait after the first receive window closes before opening the second receive window. Default: 2000 ms
RX2 Window Duration	How long the second receive window remains open. Default: 3000 ms
Fast Send Mode	Prioritizes the fastest possible acquisition and uplink at the expense of downlink reception performance. Under special conditions, transparent mode can send up to one packet per second. Note: Downlink data may not be received in Fast Send Mode.
Hot Load	In OTAA mode, after a restart the device attempts to reuse the previous join information and continue communication, reducing rejoin time.
Simple FCnt	The uplink frame counter cycles within 0-65535. Disabled by default. Note: If this function is used, it is recommended that the LoRaWAN server be configured to skip frame-counter validation.
Continuous	The device remains continuously in receive mode for prompt

Receive	downlink reception, but power consumption increases significantly.
Channel Activity Detection	Quickly checks whether LoRa traffic is present on the current channel. If the channel is idle, data is sent immediately; if the channel is busy, the device waits and retries. Note: After three detections, the device will transmit forcibly, so collisions cannot be completely avoided.
FCntUp Retention	The terminal uplink frame counter is retained after power loss. A factory reset clears the counter.
Window 2 SF	Spreading factor for Receive Window 2. Default: SF12; configurable from SF7 to SF12. After changing this value on the DTU, the server RX2 spreading factor must be changed accordingly. Intended for frequent downlinks to multiple Class C devices. Note: Changes require corresponding LoRaWAN server configuration.
Window 2 Downlink Channel	Default: Channel 25 (505.3 MHz). Used for frequent downlinks to multiple Class C devices. Note: Changes require corresponding LoRaWAN server configuration.
Multicast Switch	When enabled, DTUs can be configured in batches.
Multicast Channel	Default: Channel 25 (505.3 MHz), downlink frequency for Receive Window 2.
Multicast Window 2 SF	Default: SF12 (DR0), downlink spreading factor for Receive Window 2.
Multicast Address	Default: ffffffff, multicast short address
Multicast AppSKey	Multicast application session key Default: 2b7e151628aed2a6abf7158809cf4f3c
Multicast NwkSKey	Multicast network session key: Default: 2b7e151628aed2a6abf7158809cf4f3c

3. Communication Protocol

Device uplink and downlink data are both based on hexadecimal format.

3.1. Restart Packet

Restart packet port: 214

HEX data: 01 indicates a hardware restart

03 indicates a software restart

04 indicates a hardware watchdog restart

05 indicates a software watchdog restart

3.2. Uplink Packets

Heartbeat Packet Parsing

Heartbeat packet port: 40

Heartbeat

packet:

cede3400000a0c0a04c10000000300000002fced

cede	Packet Header
34	Packet type; 34 indicates a heartbeat packet
00000a	Heartbeat interval, unit: s; decimal value: 10 s
0a0c	Module temperature, unit: °C; decimal value / 100: 25.72 °C
04c1	Input voltage, unit: V; decimal value / 100: 12.17 V
00000003	Scripts 1 and 2 enabled 4 bytes / 32 bits; each bit represents one script switch. 0 = disabled, 1 = enabled.
00000002	Number of scripts successfully acquired in the current cycle Example: if two configured scripts are both acquired successfully, the value is 00000002.
fc	XOR Checksum
eced	Packet Tail

Power-On Packet Parsing

Power-on packet port: 215

Power-on packet: 100601060000000304

10	10: Standard DTU 11: High-power DTU
06	Communication protocol: 04
0106	Software version: 1.6

00000003	Indicates Scripts 1 and 2 are enabled 4 bytes / 32 bits; each bit represents one script switch. 0 = disabled, 1 = enabled.
04	Device battery level 04: Full

Packet Port Description

Port	Description
214	Restart Packet
215	DTU Power-On Packet
40	Heartbeat Packet
42	Command Response Packet
43	Downlink Configuration Response Packet
51	RS232 Transparent Uplink Packet
52	RS485 Transparent Uplink Packet
1	Script 1 Packet
2	Script 2 Packet
3	Script 3 Packet
...	...
15	Script 15 Packet
16	Script 16 Packet

3.3. Remote Parameter Configuration

D9x supports modifying certain parameters and configurations through downlink HEX packets. Make changes carefully to avoid communication failure after modification.

Perform configuration only when uplink and downlink communication are functioning normally. Configuration packets can be

sent directly using a port number in the range $0 < \text{port} < 255$. After a successful modification, D9x returns the corresponding response packet on port 43. One minute after configuration is completed, D9x automatically restarts for the changes to take effect.

LoRa Channel Modification

Channel	Downlink Packet (HEX)	Response Packet (HEX)
0-7	cede1b00071ceced	cede1b00071ceced
8-15	cede1b080f1ceced	cede1b080f1ceced
16-23	cede1b10171ceced	cede1b10171ceced
24-31	cede1b181f1ceced	cede1b181f1ceced
32-39	cede1b20271ceced	cede1b20271ceced
40-47	cede1b282f1ceced	cede1b282f1ceced
48-55	cede1b30371ceced	cede1b30371ceced
56-63	cede1b383f1ceced	cede1b383f1ceced
64-71	cede1b40471ceced	cede1b40471ceced
72-79	cede1b484f1ceced	cede1b484f1ceced
80-87	cede1b50571ceced	cede1b50571ceced
88-95	cede1b585f1ceced	cede1b585f1ceced

LoRa SF Modification

SF	Downlink Packet (HEX)	Response Packet (HEX)
7	cede1c071beced	cede1c071beced
8	cede1c0814eced	cede1c0814eced
9	cede1c0915eced	cede1c0915eced
10	cede1c0a16eced	cede1c0a16eced

11	cede1c0b17eced	cede1c0b17eced
12	cede1c0c10eced	cede1c0c10eced

Enable/Disable Script

Packet Header	Command	Script No.	Enable/Disable	XOR Checksum	Packet Tail
cede	31	XX	00 Disable 01 Enable	XX	eced

Example: cede31000031eced disables Script 0.

cede31010131eced enables Script 1.

Online XOR checksum tool: [BCC Checksum Online Calculator ip33.com](http://BCCChecksumOnlineCalculator.ip33.com)

For XOR checksum calculation, exclude the packet header and packet tail.

Modify Script Acquisition Interval

Packet Header	Command	Script No.	Interval	XOR Checksum	Packet Tail
cede	32	XX	XXXXXX	XX	eced

Example: cede32000000784aeced sets the interval of Script 0 to 120 s.

cede32010000784beced sets the interval of Script 1 to 120 s.

Note: The maximum script interval is 86,400 s.

Receive Window 2 Frequency & Spreading Factor

Packet Header	Command	SF	Channel	XOR Checksum	Packet Tail
cede	21	XX	XX	XX	eced

Example: cede211a0833eced sets SF8 and Channel 26 (505.5 MHz).

cede21190c34eced sets SF12 and Channel 25 (505.3 MHz).

Multicast Switch

Packet	Command	Enable/Disable	XOR	Packet Tail
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Header			Checksum	
cede	60	01: Enable 00: Disable	XX	eced

Example: cede600161eced enables multicast.

cede600060eced disables multicast.

Multicast Address Parameter Settings

Packet Header	cede
Command	61
Window 2 SF	XX
Window 2 Channel	XX
Multicast ID	FF
Multicast Address (4 bytes)	FFFFFFFF (default short address)
APPSKEY (16 bytes)	2b7e151628aed2a6abf7158809cf4f3c (default key)
NWKSKEY (16 bytes)	2b7e151628aed2a6abf7158809cf4f3c (default key)
XOR Checksum	XX
Packet Tail	eced

Example:

cede61190cffabcde1242b7e151628aed2a6abf7158809cf4f552b7e151628aed2a6abf7158809cf4f3c41eced

Channel: 25 (505.3 MHz), SF: 12, Multicast ID: ff (fixed and not configurable), Multicast Address: adcd124, AppSKey:

2b7e151628aed2a6abf7158809cf4f55, NwkSKey:

2b7e151628aed2a6abf7158809cf4f3c, XOR checksum: 41