DLS11 Geteway User Manual
（LTE-LoRA）

（Document version V1.0.1）

- UART←→UART/LoRA/LTE
- LoRA←→LoRA/UART/LTE
- LTE←→UART/LoRA
- Repeater, Gateway
- Data Recorder
- Wireless Sensor

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OVERVIEW

The DLS11 is a low-power data gateway with built-in batteries and LoRA and LTE (4G) wireless. The "real-time online" LoRA transceiver is used to collect and store the data sent by other LoRA devices, and the stored data is periodically repackaged into standard data packets and sent to the remote server through LTE network. The data sending methods include SMS, TCP, email, FTP, etc. Using a SINGLE SIM card can realize the remote data transmission function of multiple devices.

Note: This manual applies to DLS11_xxxx (see "Product Selection" for details).

APPLICATION

- Automatic measurement and control LoRA-4G workstation
- LoRA repeater and frequency changer
- Wireless data recorder
- Serial interface device to wireless
- Match different LoRAs
- LoRA - 4G gateway

PRODUCT SELECTION

Model: DLS-AB_xUXX

- DLS: Product type identifier, fixed as DLS (Double L System), L is LoRA and LTE.
- A: The number of built-in LoRA, can be 0, 1, or 2.
- B: The number of built-in LTE, can be 0, 1, or 2.
- xUXX: UART port definition code. Example: 2UT2 indicates two UART interfaces, TTL and RS232.
  - xU: The number of UART interfaces, can be 1 or 2.
  - XX: UART port type. 2 - RS232, 4 - RS485, and T - TTL.

Recommended model

Model	Number of digital interface			Sensor interface				Built-in Battery
	UART	LoRA	LTE					
DLS10_1U2	1	1	0					2400mAH*3
DLS10_2UT2	2	1	0					2400mAH*3
DLS11_1U2	1	1	1					2400mAH*3
DLS11V_1U2	1	1	1	4				850mAH*3
DLS21T_1U2	1	2	1				4	850mAH*3
DLS21VI_1U2	1	2	1	2		2		850mAH*3

This table does not list all models

Internal battery refers to the maximum capacity of the internal battery that can be installed. A built-in battery is not a standard option.

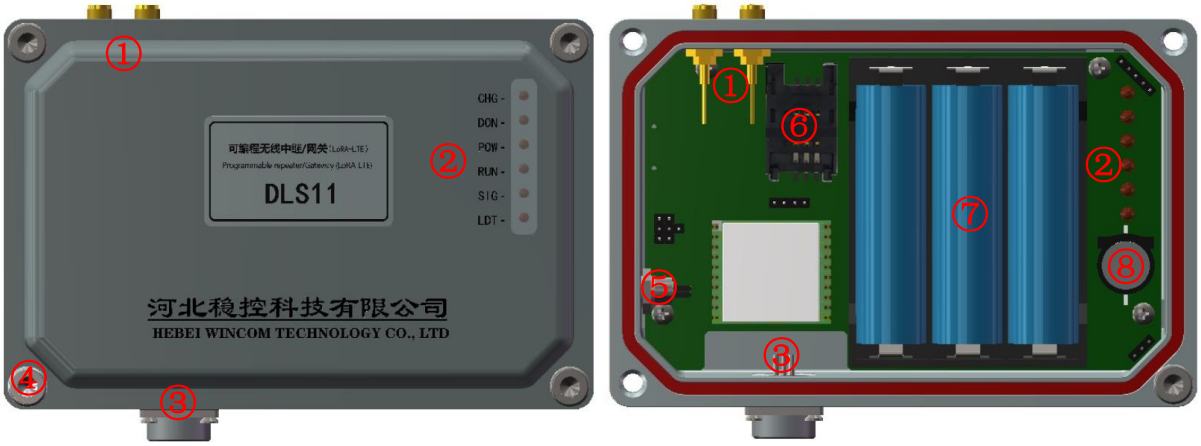
PARAMETERS/SPECIFICATIONS

Test conditions and environment: Unless otherwise specified, the following indicators are measured at room temperature of 25℃.

Object	Conditions	Value			Unit
		MIN	STD	MAX	
Size	148x98x43 (BxCxD)				mm^3
IP Grade	IP65				
Power	1~3 18650 lithium + external charging interface				
Battery capacity	3*2500mAH				
ExPower		5.5	12	24	V
Power consumption (Battery powered)	Sleep State		10		uA
	Working		150	250	mA
	Transient peak		2.0		A
Battery life①	Built-in battery (3) sent every hour		4		Months
Temperature	Operating temperature	-20		80	℃
	Storage temperature	-60		120	
Flash		4			MByte
LoRA	433MHz	420		450	MHz
	868MHz	854		884	MHz
	915MHz	901		931	MHz
	number of channels		15		
	Air rate	300	2604	37500	bps
LTE	LTE-TDD B38/B39/B40/B41 LTE-FDDB1/B3/B8 TD-SCDMA B34/B39 UMTS/HSDPA/HSPA+ B1/B8 CDMA 1X/EVDO BC0 GSM/GPRS/EDGE900/1800 MHz				
UART Baud rate		1200	115200	460800	bps
Note ① : Power loss caused by battery self-discharge and frequent wake up in complex networks is not considered.					

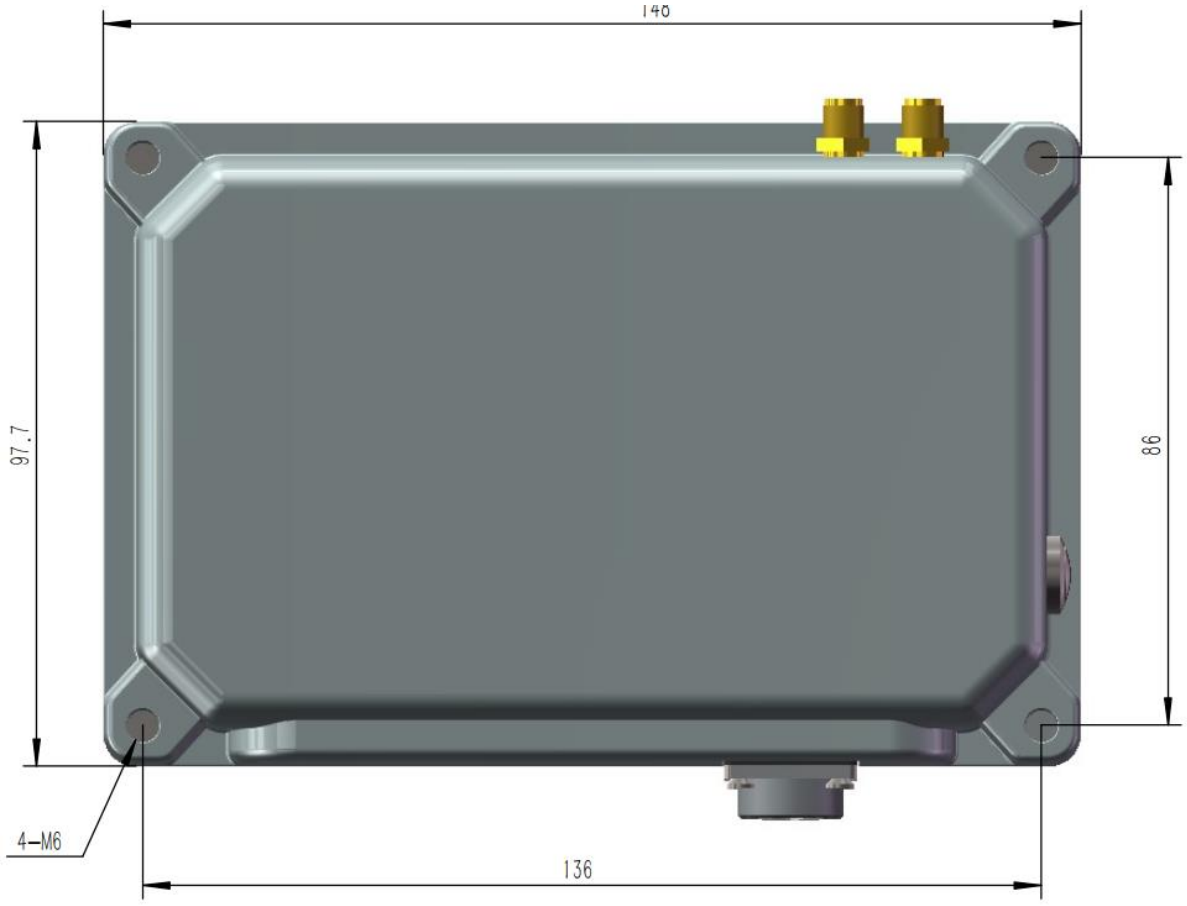
STRUCTURE/MOUNTING DIMENSIONS

Structure



① antenna ②Indicator leds ③ Power&Communication ④Fixing screw
⑤ Test key ⑥SIM Socked ⑦ Compartment ⑧Button battery

Mounting Dimensions



Mounting Dimensions（Bottom）

INDICATOR LEDs

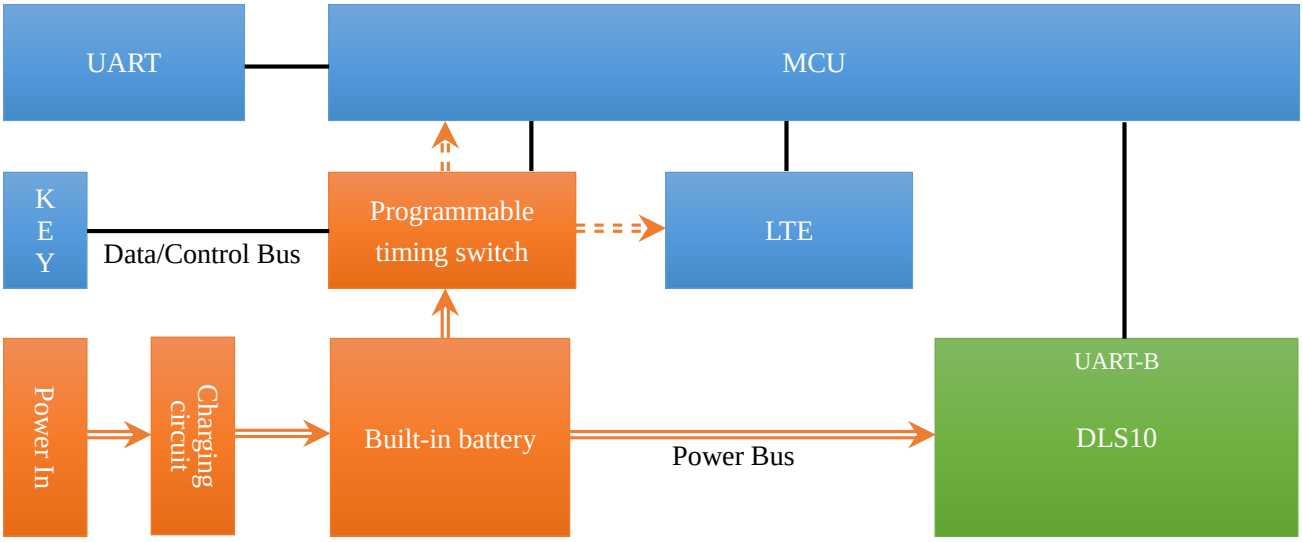
Indicator Function

Symbol	Name	Status	Description	Node
CHG	Charging	ON	Be Charging…	
DON	Charging done	ON	Charging completed	
POW	Power	ON	Be Working…	
		OFF	Has Sleep	
RUN	Running state	1Hz	Be Working…	
		OFF	Has Sleep	
SIG	LTE signal	ON	Searching the network	
		0.6Hz	Registered network	
		2.5Hz	The data link is established	
		OFF	LTE not working	
LDT	LoRA datas	1Hz	Not sleep	
		Flash	Receiving data	
		Short	Detecting wake-up signal	

INTERFACE DEFINITION

Pin	Symbol	Name	Descr
1	VIN	External power input +	DC5.5V~24V
2	GND	Power input -	
3	GND		
4	TXD/A	RS232 Send Pin /RS485(D+)	
5	RXD/B	RS232 Receiv pin /RS485(D-)	

Functional Block Diagram



DLS11 Function block diagram

1. START To USE

As shown in the functional block diagram, DLS11 is built-in with DLS10 (LoRA real-time online relay and transceifer), which is responsible for receiving and storing data packets from LoRA. Under the control of program-controlled timing switch, DLS11 automatically starts at a predetermined time interval, reads the data stored by DLS10 and sends it to the remote data server through LTE.

For a detailed description of DLS10, see "DLSx0 Data Repeater User Manual.pdf".

1.1 Install Batteries/Connect External Power

The DLS11 operates using a built-in battery and/or an external power supply.When connected to an external power supply, the DLSxx is powered entirely by the external power supply, which also charges the built-in battery.

The methods and steps for installing the built-in battery are as follows: Open the cover of the DLSxx device, install the battery in the battery holder, and pay attention to the positive and negative of the battery.

1.2 Digital Interface

The DLS11 connects to the upper computer (usually a computer) through a UART digital interface (RS232, RS485, and TTL) to complete data and parameter communication.

Note that the communication is possible only when the interface parameters are the same.UART interface parameters include Baud Rate, Data bit, Parity bit, and Stop bit.

DLS communication interface default parameters

Interface	Parameter Name	Default	Unit
UART	Baud Rate	115200	bps
	Parity bit	N	
	Data bit	8	bits
	Stop bit	1	bits

1.3 Device Information

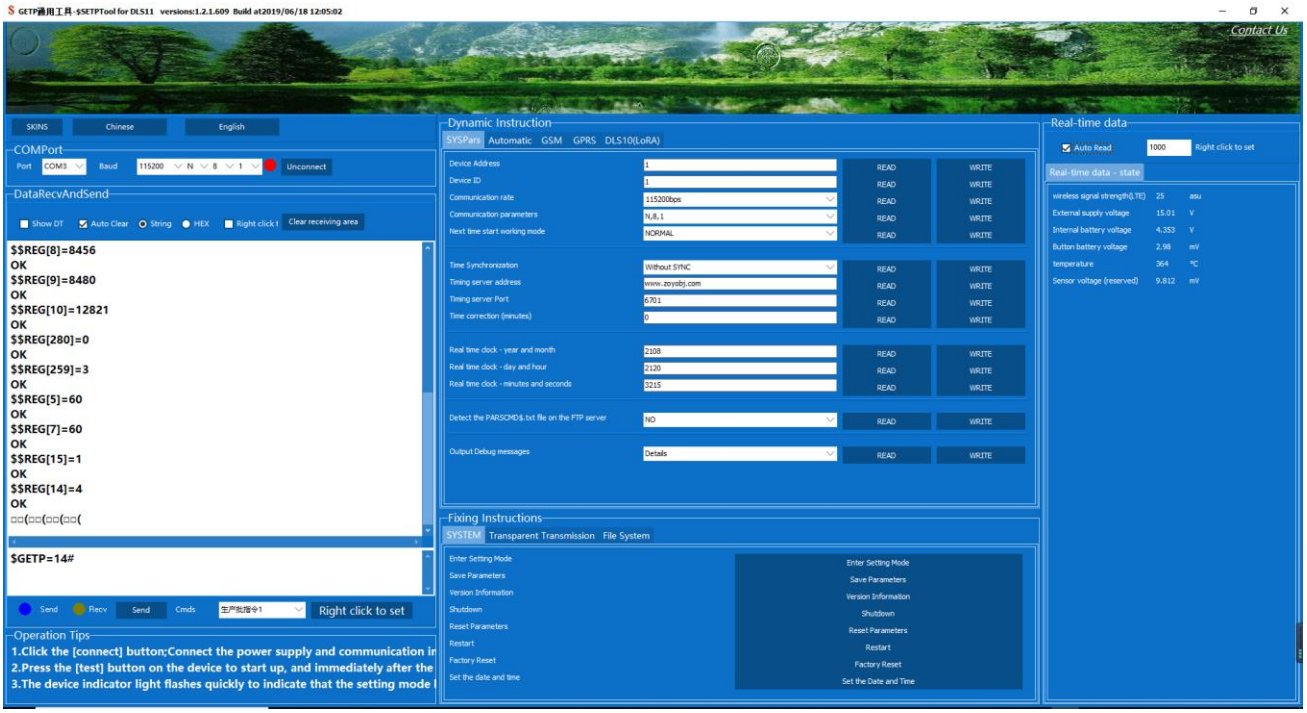
When the device is powered on and started, DLS11 automatically outputs the basic device information through UART. When the device is running, Used “$INFO” to get the device information. The basic information is as follows:

```
type:       DLS11_1U2            Device Model
hwVer:      1.00                 Hardware version
sfVer:      1.00                 Firmware version
UDID=3A0858812345600             Device serial number (UNIQUE IDENTIFIER)
```

1.4 Use $SETPTool read and write parameters

$SETPTool is a general equipment testing, parameter reading and writing tools, suitable for most of our company's equipment.If you want to write your own test tool, refer to the section "2. Communication Protocols".

The home screen of “$SETPTool for DLS11” is as shown in the following figure.



Parameters can be read and modified as prompted in the lower left corner of the main interface, and real-time data of the device can be read automatically.For more detailed instructions on how to use $SETPTool, see the "General parameter configuration Tool SETPTool Instructions.pdf" file.

1.5 DLSx0 Work Mode

1.5.1 Work Mode

DLSx0 has two working modes: Timeout sending and parameter setting. By default, the device works in the timeout sending mode. To enter the parameter setting mode, send @setm to the device.

- **Timeout Sending Mode:** Default working mode of the device.In this mode, the device is in a low-power timing state, and LoRA receives and stores data packets from other devices.When it starts automatically after a predetermined time interval, DLS11 checks the stored data and sends it to the server through LTE after startup, and enters the low-power state again after the work is completed.User buttons can also start the device immediately.
- **Parameter Setting Mode:** When the device starts and receives the "@setm" command, the parameter setting mode is entered.In this mode, the device never shuts down, waiting for the user's command.This mode is generally used for parameter access.

1.5.2 Working mechanism of timeout sending mode

DLS11 starts periodically under the control of the two time parameters.

Time SCAN interval INTE SCAN: The device checks the time every INTE SCAN minutes. If the preset sending interval is reached (INTE SEND), the device is started and data is sent. If not, the device continues to wait.

Data sending interval INTE SEND: This parameter determines how many minutes to send data at intervals.

1.5.3 Working mode related register (parameter)

Working mode related register (parameter) WKMOD: A value of 0 indicates that the register is working in timeout send mode and a value of 1 indicates that the register is working in parameter setting mode. WKMOD is automatically 0 at each power-on.

Next startup mode NEXT_SET: Sets the working mode that the device automatically enters during the next startup.0: normal. 1: Data is forcibly sent once, and then the parameter automatically reset to 0. 2: Parameter setting mode is entered.3: Always send data.4: Always enter parameter setting mode.

2. COMMUNICATION PROTOCOL

2.1 Registers (parameters) summary

2.1.1 Registers (read/write)

Register summary Table (read/write)

Reg Addr	Symbol	Name	Value Range	Default	Unit	Descr
0	DEV_ADDR	Device Address	1~255	0x01		
1	DEV_ID	Device identification	1~255	0x01		
2	BAUDRATE	UART Baud rate	12~4608	1152	100bps	
281	UART_PARS	UART parameters①				
3	RTC_SYNC	Sync RTC	0: Never 1:From the LTE service provider 2:From the NTP service 3:From the TCP server	0		
262	NTP_SEV	NTPserver addr		www.zoyobj.com		
278	NTP_PORT	NTPPort Num	0~65535	6701		
13	WKMOD	Work mode	0: Timeout 1: Setting	0		
4	NEXT_SET	State of the next startup	0:Normal 1:Send once 2: Configuration Mode(once) 3: Send 4:Configuration	0		
5	INTE_SCAN	scan interval	1~65535	2	minutes	
7	INTE_SEND	Send interval	0:Never 1~65535	8	minutes	
8	RTC_YM	RTC, BCD Code format				

9	RTC_DH					
10	RTC_MS					
11	TIM_RNET	Register for network timeout values	0:Smart 1~65535	0	Seconds	
14	SEND_WAY	data sending methods	0: UART 1: SMS 2: TCP 3: Email 4: FTP 5: RF (LoRA)	2		
15	DAT_PRO	Send Protocol	0: HEX 1: STR1.0 2: STR2.0	1		
259	DEBUG_MSG	Debug messages ②		1		
SMS (Short Message Service) parameters						
38	RDC_PH1	Data center number	cell phone number			
44	RDC_PH2	Data center number	cell phone number			
50	SMSC	SMS Centre Number				
51	USR_SMSC	SMS Centre Number source	0:Read from SIM card 1:User Settings	0		
LTE APN (Access Point Name) parameters						
60	APN	Access Point Name		CMNET		
TCP server parameters						
72	TCP_SEV	TCP Servdr addr		www.zoyobj.com		
88	TCP_PORT	TCP Port	1~65535	8000		
89	TCP_ONLINE	online time	1~65535	0	seconds	
Email parameters(sender)						
95	SMTP_SEV	SMTP Server		smtp.126.com		
111	SMTP_PORT	SMTP Port		25		
112	POP3_SEV	POP3 Server		pop.126.com		
128	POP3_PORT	POP3 Port		110		
129	MAIL_USER	SMTP User				
137	MAIL_PASS	SMTP Pass				
149	MAIL_SOUC	Email addr				
165	SUBJECT	Subject Title		VS4XXDatas		
FTP server parameters						
179	MAIL_TGET	Email addr				
FTP 服务器参数						
195	FTP_SEV	FTP Server addr		www.zoyobj.com		
211	FTP_PORT	FTP Port		8021		
212	FTP_USER	FTP User		VS4XX		
228	FTP_PASS	FTP Pass		VS4XX000		

236	FTP_PATH	Relative path		/		
244	FTP_FNAME	File Name		VS4XXDATA		
280	FTP_PFILE	Check the FTP parameters file		0		
Lora parameters						
283	RF_SF	Spreading Factor ③	6~12	8		
284	RF_CR	Encoding Rate ③	1~4	2		
285	RF_BW	Bandwidth ③	0~9	7		
286	RF_CH	ChNum ③	0~15	7		
287	RF_POW	Sending Power ③	0~15	10		

（1）UART Communication parameter register

bits	Name	Value	Unit
bit5:4	Stop bit	00B/11B：1	bits
		01B：1.5	
		10B：2.0	
bit3:2	Parity bit	00B/11B：None	
		01B：Odd	
		10B：Even	
bit1:0	Data bit	00B：8	bits
		01B/10B/11B：9	

（2）Debug Message register

Whether to output the running and debugging information of the device.

bits	Name	Value	Unit
bit1	Details Tips		
bit0	Basic Process Tips		

（3）射频(LoRA)参数

射频参数包括 LoRA 扩频因子、编码率、信道带宽、频道号、发射功率。

当 LoRA 设备之间通讯时，通讯双方的扩频因子、编码率、信道带宽、频道号必须完全一致。

DLS11 会将上述 5 个参数同步设置到内嵌的 DLS10，关于 DLS10 的使用说明以及更多参数说明，请参阅“DLSx0 数传中继器用户手册.pdf”。

Rf parameters include LoRA Spreading Factor, coding rate, bandwidth, channel number, and transmission power.

When LoRA devices communicate with each other, the Spreading Factor, coding rate, channel bandwidth, and channel number must be identical.

DLS11 synchronizes the preceding five parameters to the embedded DLS10. For details about how to use DLS10 and more parameters, see “DLSx0 Digital Repeater User Manual.pdf”.

2.1.2 Registers (only read)

Register Summary Table (read only)

Reg addr	Symbol	Name	Value Range	Unit
355	SINGAL	LTE signal strength	<15: Poor >=15 >25: Very good >31: Abnormal	
357	VOL_EX	External supply voltage		mV
358	VOL_VCC	Work Supply voltage①		mV
359	VOL_BBAT	Button battery voltage ②		mV
360	TMP_CORE	MCU temperature		0.1℃
363	VOL_SEN	Sensor voltage (reserved)		mV

(1) Working voltage: When there is no external power supply, the working voltage refers to the voltage of the built-in battery; when there is an external power supply, the working voltage refers to the voltage generated by the external power supply (constant about 4.3V).
(2) Clock battery voltage: built-in button battery voltage, when lower than 2.0V should be replaced with a new button battery.

2.2 Parameter read and write protocol

DLSx0 supports device address-based MODBUS, custom AABB, and string instruction set protocols.

2.2.1 MODBUS Protocols

DLSxx supports MODBUS 03, 04, and 06 instruction codes.
(1) 03 (0x03) /04 (0x04) instruction code: read multiple consecutive registers. The instruction format is as follows
Instruction data frame structure

Dev Addr	Function Code 0x03	Start Addr	Regs Count	CRC
1 Bytes	1 Bytes	2 Bytes	2 Bytes	2 Bytes

The returned data frame structure

Dev Addr	Function Code 0x03	Datas Lenth	Datas	CRC
1 Bytes	1 Bytes	2 Bytes	n Bytes	2 Bytes

Example: read the register whose device address is 1, register start address is 0, and read 10 registers continuously
Host sending instruction (HEX): 01 03 00 00 00 0A C5 CD
DLSxx return: 01 03 14 00 01 00 01 04 80 00 00 00 00 00 3C 00 00 00 3C 21 08 21 21 4F 1A
When reading multiple registers, do not read more than 32 registers at a time. Do not attempt to read a register that does not exist.
(2) 06 (0x06) instruction code: modify the value of a single register, the instruction format is as follows
Instruction data frame structure

Dev Addr	Function Code 0x06	Reg Address	Reg Value	CRC

1 Bytes	1 Bytes	2 Bytes	2 Bytes	2 Bytes

The returned data frame structure

Dev Addr	Function Code 0x06	Reg Address	Reg Value	CRC
1 Bytes	1 Bytes	2 Bytes	2 Bytes	2 Bytes

Example: Example: change the value of register 2 in device address 1 to 1152

Host sending instruction (HEX): 01 06 00 02 04 80 2B 6A

DLSxx return: 01 06 00 02 04 80 2B 6A

(3) Check code calculation

CRC16 - MODBUS algorithm:

```
unsigned int crc16(unsigned char *dat, unsigned int len)
{
unsigned int crc=0xffff;
unsigned char i;
while(len!=0)
{
crc^=*dat;
for(i=0;i<8;i++)
{
if((crc&0x0001)==0)
crc=crc>>1;
else
{
crc=crc>>1;
crc^=0xa001;
}
}
len-=1;
dat++;
}
return crc;
}
```

2.2.2 AABB Protocols

Read register

	Frame head	Dev Addr	Reg Address	Checksum
HEX	AA BB	1 Bytes	1 Bytes	1 Bytes

Return

	Frame head	Dev Addr	Reg Address	Reg value	checksum
HEX	AA BB	1 Bytes	1 Bytes	2 Bytes	1 Bytes

For example, read the value of register 7 on the DLS device whose address is 1.

Send (HEX): AA BB 01 07 6D

Device returns (HEX): AA BB 01 07 00 3C A9, 0x003C is 60 in decimal.

Modify register

	Frame head	Dev Addr	Reg Address	Reg Value	checksum
HEX	AA BB	1 Bytes	1 Bytes |0x80	2 Bytes	1 Bytes

Return

	Frame head	Dev Addr	Reg Address	Reg Value	checksum
HEX	AA BB	1 Bytes	1 Bytes	2 Bytes	1 Bytes

For example, change the value of register 2 of the DLS device with address 1 to 1152 (0x0480).

Send (HEX): AA BB 01 82 04 80 6C

Device returns: AA BB 01 02 04 80 EC

Note: The AABB protocol can only access registers with addresses 0 to 127.

Note: in AABB protocol, 0xFF is a universal address.

2.2.3 Device address-based string protocol

(1) Read register

Instruction	Reg Address	End
$GETP=	xxx	\r\n

Instruction: fixed as "$GETP= ".

Reg Address: The register address represented by a numeric characters.

For example, read the value of register 2 in DLS11 whose device address is 1

Send to DLS: $GETP=2

DLS return: $REG[2]=01152

(2) Modify register

Instruction	Reg Address	Reg Values	End
$SETP=	xxx	,xxx	\r\n

Instruction: fixed as "$SETP= ".

Reg Address: The register address represented by a numeric characters.

Reg Values: The register value represented by numeric characters.

For example, change the value of register 2 in DLS11 of device address 1 to 1152.

Send to DLS: $SETP=10,1152

DLS return: OK

2.2.4 Other Instruction

Instruction	Functional Description
@SETM	Enter the parameter setting mode
@STTN=x	Transparently transmits data to a submodule in the device
$SAVE	Save parameters
$INFO	Read basic device information
$REST	Restart
$STDN	Shutdown
$RSTP	Restore factory parameters
$STFC	Writes the current parameters to the factory area

$STDF	Restore the default parameters
$STDT=xxxx	Set the date and time.Example: $STDT=2015/12/21 18:37:05

2.3 Data sending and packet protocol

2.3.1 DLS11 Data sending

DLS11 is a LORa-LTE gateway device dedicated to receiving data packets from other LoRA devices, storing them and sending them centrally to the server after a predetermined time interval (currently only the LoRA data packet format for VSxxx devices is supported).The sending mode can be UART, SMS, TCP, EMAIL, FTP, and RF. (Set the value of register SEND_WAY to select).

When sending data, you can also change the register DAT_PRO to select the format of the data packet. If the sending mode is UART, TCP, or RF, HEX or STR1.0 format is recommended. If the sending mode is EMAIL or FTP, only STR2.0 format can be used.

When data is sent through TCP, EMAIL, or FTP, the UDID is used to identify different devices.A UDID is a string of 15 characters. Each device has a unique UDID.The last two characters of the UDID of DLS11 are always 00.

DLS11 sends packets from several VSxxx devices. In order to distinguish different VSxxx devices, DLS dynamically generates a unique UDID (UDID) based on the device ID (IDn) of the sender (a VSxxx) in the received packets. The UDID code is generated as follows: Replace the last two characters of the DLS11 UDID with the hexadecimal character string of the IDn.

Example: The UDID of The DLS11 is "123456789012300". When it reads a received data packet, it will parse out "Sender device address IDn". If IDn is 0x01, it will dynamically generate UDID "123456789012301" for this data.Send to the server using this UDID.

2.3.2 Packet structure

(1) HEX format

Hexadecimal data, data frame length 91 bytes.

Data Address	Data length	Remarks
0	1	Fixed 0x02
1~2	2	Device ID
3~6	4	Data record number
7~12	6	The time stamp BCD code year month day hour minute second
13	1	Reserved,
14	1	The signal strength of mobile network is 0~31
15~16	2	Temperature (unit: 0.1℃)
17~18	2	Work Supply voltage, unit: mV
19~20	2	External supply voltage, unit: mV
21~24	4	Reserved,
25~88	2*32=64	Monitoring data for 32 channels
89~90	2	CRC16 check code

(2) STR format 1.0

A hexadecimal string.The data length is 156 bytes.Every 2 characters are converted to 1 byte of data. For example, the string "1A" means 0x1A (or 26 in decimal).

Data Address	Data length	Remarks
0~1	2 characters	Device ID
2~5	4 characters	Data record number
6~7	2 characters	Reserved,
8~9	2 characters	The signal strength of mobile network is 0~31
10~11	2 characters	Temperature (unit:℃)
12~15	4 characters	Reserved,
16~19	4 characters	Work Supply voltage, unit: mV
20~23	4 characters	External supply voltage, unit: mV
24~151	128 characters	Monitoring data for 32 channels
152~155	4 characters	CRC16 check code

(3) STR format 2.0

A data set represented by a data name and a decimal string (easier to read).

Data string	Remarks
VOL1=nnnnn	Working voltage (or internal battery voltage), in mV nnnnn is a fixed number of five characters.
VOL2=nnnnn	External supply voltage, unit: mV
DVID=nnnnn	Device ID
TEMP=nnnnn	Temperature (unit: 0.1℃)
CHxx=nnnnn	Monitoring data for 32 channels
CH……	

2.3.3 UART/ RF LoRA data send

The above data frames are directly sent through the device's RS232, RS485, LoRA physical interfaces without any other additional content.

When the data output protocol is selected as "STR2.0", the data items are separated by \r\n.

2.3.4 LTE (4G)-SMS

Send the above data frame directly to the target phone number.

When the data output protocol is selected as "STR2.0", the data items are separated by \r\n.

Tip: When sending and receiving data using SMS, use the sender's mobile phone number and device ID to identify different devices.

2.3.5 LTE (4G)-TCP

DLS11 connects to the TCP server as a TCP client and sends the following data frames after the connection is successful:

UDID of the device + ">" + above data frame.

Example: 15B87911B123401>datas

2.3.6 LTE (4G)-EMail

Using LTE (4G) network, send the data to the mailbox, the email content is as follows:

Device ID 15B87911B123456

BATV CHGV SIGV TEMP

10282 00000 00016 00031

GMT	CH01	CH02	CH03	CH04	CH05	CH06	CH07	CH08	CH09	CH10…
2016-04-30	15:08:01	00000	00000	00000	00000	00000	00000	00000	00000	00000…
2016-04-30	16:08:01	00000	00000	00000	00000	00000	00000	00000	00000	00000…
……										
2016-04-30	20:08:01	00000	00000	00000	00000	00000	00000	00000	00000	00000…

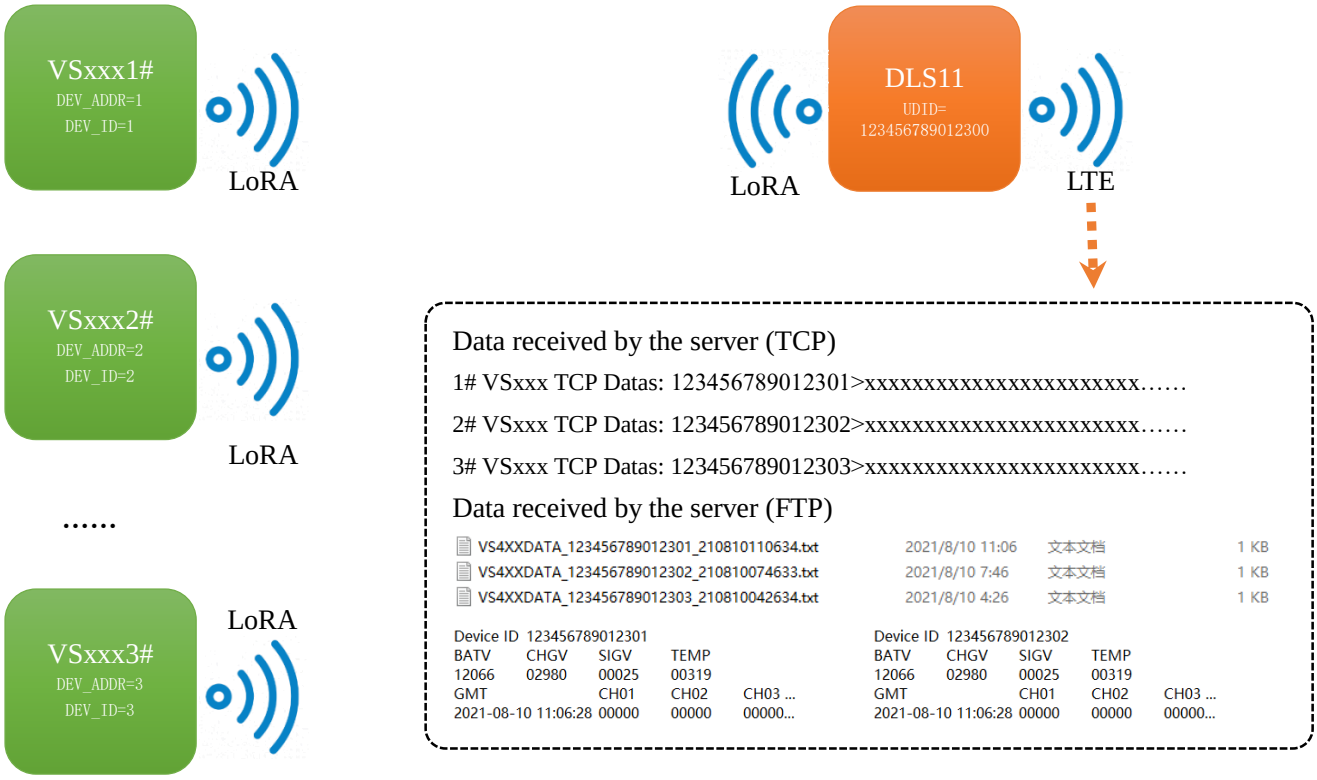
2.3.7 LTE (4G)-FTP

Using LTE (4G) network, send the data file to the FTP server, the contents of the file are the same as the above email.

3. DLS APPLICATION EXAMPLE

The following Application Example (AN) are based on the DLS default parameters.

3.1 Use DLS11 to send multiple VSxxx monitoring data



3.2 Use DLS11 to receive data from LoRA repeater