

LT-501 Series Development Document



Version: 1.4

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1. Introduction

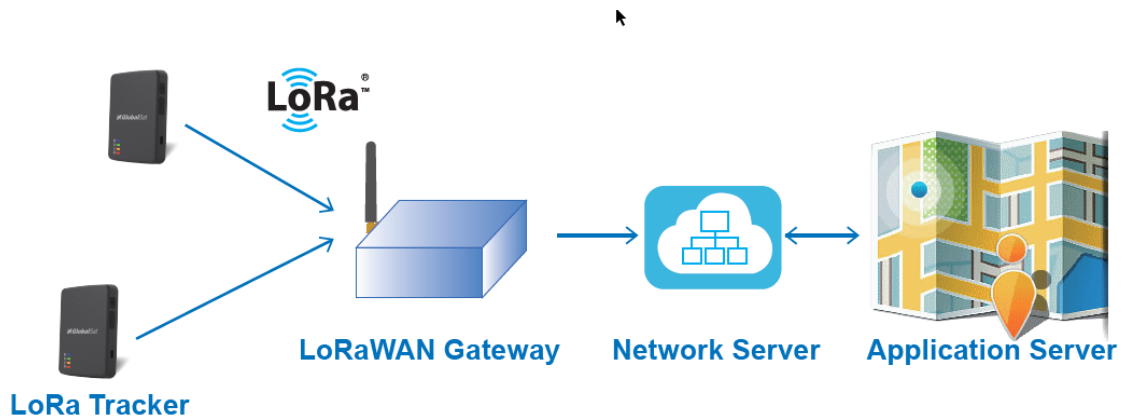
LT-501 is a RF Network tracker specifically designed for both indoor and outdoor monitoring on objects. It is compact, light, and easy to use. The device allows monitoring center to remotely configure and track the device immediately or periodically by sending RF commands to the device.

Features:

- Configurable period report and motion report
- Power Low/Off alert (buzzer)
- Support both OTAA and ABP mode
- Help reports

2. Gateway Setup

LT-501 could send data via LoRa[®] technology. Please refer to the following diagram.



Before starting communication LoRaWAN[™] gateway and LT-501 LoRa[®] trackers, please refer to [LoRaWAN[™] gateway's user manual](#) to set the LoRa[®] settings by GlobalSat LT-501 Config Tool.

3. Protocol Summary

3.1 Report Messages Format

3.1.1 Tracking Report Format

Report format of report messages:

Protocol Version	Command ID	Longitude	Latitude	GPS Fix Status & Report Type	Battery Capacity	Date & Time
0C 1 byte	1002 2 bytes	4 bytes	4 bytes	1 byte	1 byte	4 bytes

GPS Fix Status & Report Type:

GPS Fix Status	Report Type
Bit5~Bit7	Bit0~Bit4

Parameters of Report Message

Parameters	Description
GPS-fix Status	00=not fix, 01=2D fix, 10=3D fix
Report Type	1=Ping report 2=Periodic mode report 4=Motion mode static report 5=Motion mode moving report 6=Motion mode static to moving report 7=Motion mode moving to static report 15=Low battery alarm report 17=Power on (temperature) 19=Power off (low battery) 20=Power off (temperature) 25=External GPS antenna fail report 26= Schedule report
Battery Capacity	xxx

	unit: percent capacity
Longitude	xxx.xxxxxx unit: degree
Latitude	xx.xxxxxx unit: degree
Date & Time	Epoch time from 1970/01/01 Refer to https://en.wikipedia.org/wiki/Unix_time

For example, the period report is 0c1002dbc43d07**63737d01****2264** A4989659

Protocol version: 0C

Command ID: 1002 => Tracking report

Longitude: dbc43d07 => 0x073dc4db => 121,488,603 x 0.000001 = 121.488603°

Latitude: **63737d01** => 0x017d7363 => 24,998,755 x 0.000001 = 24.998755°

GPS-fix Status: **0x22** => 34 / 32 = 1 => 2D Fix

Report Type: **0x22** => 34% 32= 2 => Periodic mode report

Battery Capacity: **0x64** => 100 %

Time: A4989659 => 0x599698A4 => 1,503,041,700
=> 8/18/2017 7:35:00 AM

When data rate is DR0, LT-501 would send shortened report format as following

Protocol Version	Command ID	Longitude	Latitude	GPS Fix Status & Report Type
80 1 byte	83 1byte	4 bytes	4 bytes	1 byte (Bit 5~bit7)

GPS Fix Status & Report Type:

GPS Fix Status	Report Type
Bit5~Bit7	Bit0~Bit4

For example, the received short motion static report is 80838dc13d07016a7d0144

3.1.2 Help Report Format

Report format of report messages:

Protocol Version	Command ID	Longitude	Latitude	GPS Fix Status & Alarm Type	Battery Capacity	Date & Time
0C 1 byte	0B00 2 bytes	4 bytes	4 bytes	1 byte	1 byte	4 bytes

GPS Fix Status & Alarm Type:

GPS Fix Status	Alarm Type
Bit5~Bit7	Bit0~Bit4 01=Help Report

For example, the received help report is 0C 0B 00 58 C2 3D 07 A5 6A 7D 01 01 64 64 9A 96 59

When data rate is DR0, LT-501 would send shortened report format as following

Protocol Version	Command ID	Longitude	Latitude	GPS Fix Status & Alarm Type
80 1 byte	01 1 byte	4 bytes	4 bytes	1 byte

GPS Fix Status & Alarm Type:

GPS Fix Status	Alarm Type
Bit5~Bit7	Bit0~Bit4 01=Help Report

For example, the received short help report is 80 01 85 C0 3D 07 8D 6A 7D 01 01

3.1.3 Beacon Report Format

Tracking Report format of report messages:

Protocol Version	Command ID	Beacon ID	Report Type & Beacon Type	RSSI	Tx Power	Battery Capacity
0C 1 byte	1302 2 bytes	iBeacon: UUID + Major ID + Minor ID (20Bytes) Eddystone: Eddystone-UID (Namespace ID + Instance ID) 17~20byte left with zero ALTBeacon : Beacon ID (20Bytes) 20 bytes	1 byte	1 byte	1 byte	1 byte

Report Type & Beacon Type:

Beacon Type	Report Type
Bit5~Bit7 0: Beacon not available 1: iBeacon 2: Eddystone Beacon 3: ALT Beacon	Bit0~Bit4

For example, the received iBeacon's period report is 0C 13 02 74 27 8B DA B6 44 45 20 8F 0C 72 0E AF 05 99 35 00 00 00 00 22 00 C5 64

Help Report format of report messages:

Protocol Version	Command ID	Beacon ID	Report Type & Beacon Type	RSSI	Tx Power	Battery Capacity
0C 1 byte	0700 2 bytes	iBeacon : UUID + Major ID + Minor ID (20Bytes) Eddystone : Eddystone-UID (Namespace ID + Instance ID)	1 byte	1 byte	1 byte	1 byte

		17~20byte left with zero ALTBeacon: Beacon ID (20Bytes) 20 bytes				
--	--	--	--	--	--	--

Alarm Type & Beacon Type:

Beacon Type	Alarm Type
Bit5~Bit7 0: Beacon not available 1: iBeacon 2: Eddystone Beacon 3: ALTBeacon	Bit0~Bit4 01=Help Report

For example, the received iBeacon's help report is 0C 07 00 74 27 8B DA B6 44 45 20 8F 0C 72 0E AF 05 99 35 00 00 00 00 21 BC C5 64

Note:

1. When BLE(beacon) is enabled, our device would receive beacon signal for 5 seconds before sending report. The broadcast report interval of beacon transmitter is recommended as 0.1 sec or less.
2. When the device receives several beacon signals, the beacon ID with the strongest signal would be transmitted with its information as the report.
3. When the device receives beacon signal and GPS fix at the same time, it would transmit beacon report only.

3.2 Command Format

Ping:

Protocol Version	Command ID	Command Type (Ping)	Reserved	Reserved	GPS on Interval
0C (1 Bytes)	0600 (2 Bytes)	Bit0=1 Bit1=0 Bit5:GPS ON/OFF, 0=GPS OFF, respond location immediately 1=Turn GPS on (1 Byte)	00 (1 Byte)	0000 (2 Bytes)	Bit0~Bit13: GPS interval Bit14=0 Bit15=0 (2 Bytes) The command type's bit5=1
Example: Ping device and turn on GPS for 10 seconds					
0C	0600	21	00	0000	0A00

Period Mode:

Protocol Version	Command ID	Command Type (Period Mode)	Reserved	Report Interval	Reserved
0C (1 Bytes)	0600 (2 Bytes)	Bit0=0 Bit1=1 (1 Byte)	00 (1 Byte)	Bit0~Bit13: report interval in seconds Bit14=0 Bit15=0 (2 Bytes)	0000 (2 Bytes)
Example: Set device to be period mode with report interval of 30 seconds					
0C	0600	02	00	1E00	0000

Motion Mode

Protocol Version	Command ID	Command Type (Period Mode)	Reserved	Moving Interval	Static Interval
0C (1 Bytes)	0600 (2 Bytes)	Bit0=1 Bit1=1 Bit3 - bit4: G-sensor sensitivity	00 (1 Byte)	Bit0~Bit13: report interval in seconds Bit14=0	Bit0~Bit13: report interval in seconds Bit14=0

		(Low: 0x01, Medium: 0x02 : High: 0x03) (1 Byte)		Bit15=0 (2 Bytes)	Bit15=0 (2 Bytes)
Example: Set device to be motion mode with moving report interval of 30 seconds, and static report 3600 seconds and G-sensor sensitivity as medium					
0C	0600	13	00	1E00	100E

Dismiss Help Report

Protocol Version	Command ID	Reserved	Stop Help Report
0C (1 Bytes)	1102 (2 Bytes)	(8 Bytes)	01 (1 Byte)
Example: Stop help report			
0C	1102	0000000000000000	01

Set Device

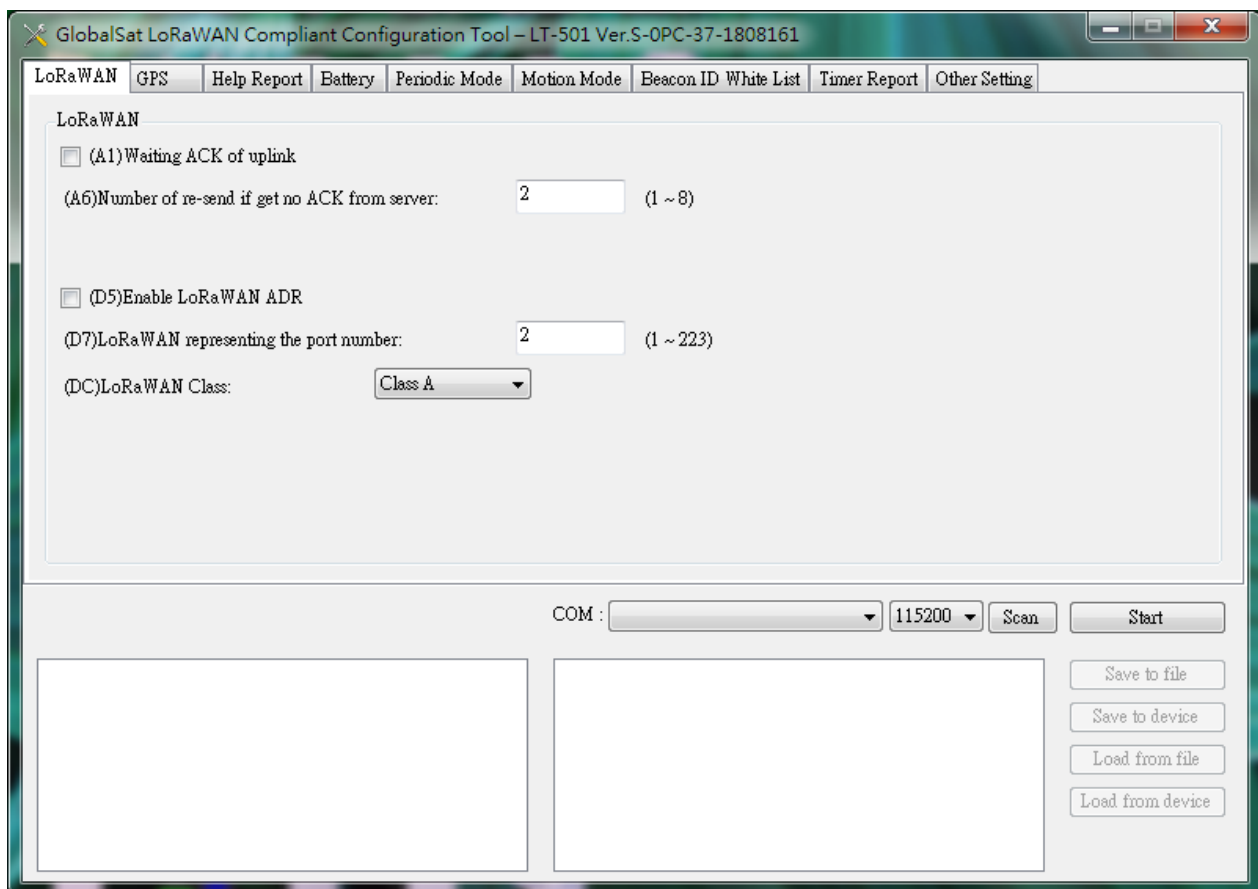
Protocol Version	Command ID	Data Length	Parameters	Carriage Return and Line Feed (CR and LF)
0C (1 Byte)	0800 (2 Bytes)	Include the length of command code word (parameter) and CR+LF (1 Byte)	L2(parameters) Refer to 3.3 Configuration Parameters	0D0A (2 Bytes)
Example: Set device to disable GPS[L2(CD=1)				
0C	0800	0A	4c322843443d3129	0D0A

3.3 Configuration Parameters

Most behaviors of LT-501 could be changed by Configuration Parameters. You could change the setting of configuration parameters by the following method. Connect LT-501 to personal computer via charging clip and USB cable and then set the configuration parameters by “GlobalSat LoRaWAN Compliant Configuration Tool-LT-501”.

Please connect LT-501 to PC by the USB cable.

Please switch LT-501 to USB mode by short press on the function button.



1. Please select the COM port at the field of COM.
2. Please select the baud rate as “115200”.
3. Then please click “Start” button. The “Load from device” button would be enabled.
4. Please click “Load from device” button. (You would see message displayed on the field below the COM port field.) You would read the configuration parameters of LT-501.
 - Save device setting: After setting the configuration parameters, you have to

click “Save to device” button to save the setting in the LT-501 which connected to PC presently. You could also save the device setting as a file with the format of pro. The method is to click “Save to file” button after completing the setting. Then you have to direct to the path for saving that file and name that file.

- **Make same configuration parameters for several devices:** After setting the configuration parameters for one device, you could click “Save to file” button to save that setting as a file. Then you could connect the other device to PC, select the COM port, click “Load from file” button. Then please click “Save to device” button.

Configuration Parameters

		Code word	Parameters	Type	Description
Main	Device	O0	Enable/Disable Power Off button	1/0	0=disable 1=enable Default=1
		O3	Enable/Disable Function button	1/0	0=disable 1=enable Default=1
		O4	Power on operating mode	u8	2=Periodic 4=Motion 7=Standby Default=2 Note: After setting O4 as the different mode via configuration tool, please reset the device for running the new setting.
		O7	Firmware version	char(28)	Read only
		OU	BLE firmware version	char(28)	Read only
		OV	BLE boot loader version	char(28)	Read only
		Other	Gt	G-sensor sensitivity	u8

		O1	Interval for triggering motion sensor	u16, in seconds	1 ~ 100 Default=5
		OD	Interval of beep	u16, in seconds	0~60,000, 0=disable Default=60,000, continuously beep
		O2	Enable/disable BLE(Beacon)	1/0	0= enable 1= disable Default=0
		OS	Max GPS fixed time for ping	u16, in seconds	5 ~ 3600 Default=120
GPS	GPS	C0	GPS always on	1/0	0=disable 1=enable Default=0
		C1	The time to get GPS-fix if LT-501 got GPS-fix over 1 hour ago	u16, in seconds	60 ~ 600 Default=120
		C2	The time to get GPS-fix if LT-501 got GPS-fix within 1 hour	u16, in seconds	10 ~ 120 Default=40
		C3	First report time (static to motion)	u16, in seconds	0 ~ 600 If "C3"=0, the device will send static to motion report according to R1. Default=5
		C8	Maximum GPS off time	u16, in seconds	0 ~ 65535 Default=0
		CD	Enable/ disable GPS	1/0	0=enable 1=disable Default=0
		T4	Enable/ disable GPS when the beacon signal is detected	1/0	0=enable 1=disable Default=0

Communication	Acknowledgement	A1	Wait confirmation from gateway after sending message to gateway	1/0	0=disable 1=enable Default=1
		A6	Number of re-sending reports without getting ACK from gateway	u8	1~8 Default=2
Tracking	Period	P0	Report interval of period report	u32, in seconds	>=10 Default=60
	Motion	R0	Report interval in static state	u32, in seconds	>=10 Default=3,600
		R1	Report interval in moving state	u32, in seconds	>=10 Default=30
		RH	GPS always on in moving state	1/0	0=disable 1=enable Default=1
	Standby	T0	Number of schedule report	u8	0~12 0=disable
		T1	Schedule report settings	char	<= 48 chars UTC Time 24 hour Note: Each set needs to have 4 chars and the scheduled time needs to be put from small to large. Ex. 0000090012301800 means to report at 00:00/09:00/12:30/18:00 4 sets of scheduled report. T0 has to set as 4.

Addition	Beacon ID White List	B0	White list Beacon ID 1	char(42), Max	Hex string Null=disable Default=NULL Byte 0: beacon type. 02 -> iBeacon 03 -> EddyStone_UID, 07-> AltBeacon Byte 1 - 20 : Beacon ID For the details, please refer to Ch4.3.
		B1	White list Beacon ID 2	char(42), Max	
		B2	White list Beacon ID 3	char(42), Max	
		B3	White list Beacon ID 4	char(42), Max	

4. Communication

4.1 LoRaWAN™ Parameter Setting

In order to activate the communication between gateway and device, it is necessary to set LoRaWAN™ parameter at the beginning. Please make sure the LoRaWAN™ settings (such as NwkSKey, AppSkKey, AppEui, AppKey) in LT-501 matched with the settings in network server. Please set the LoRaWAN™ settings by the Globalsat TR-203 Log Tool.

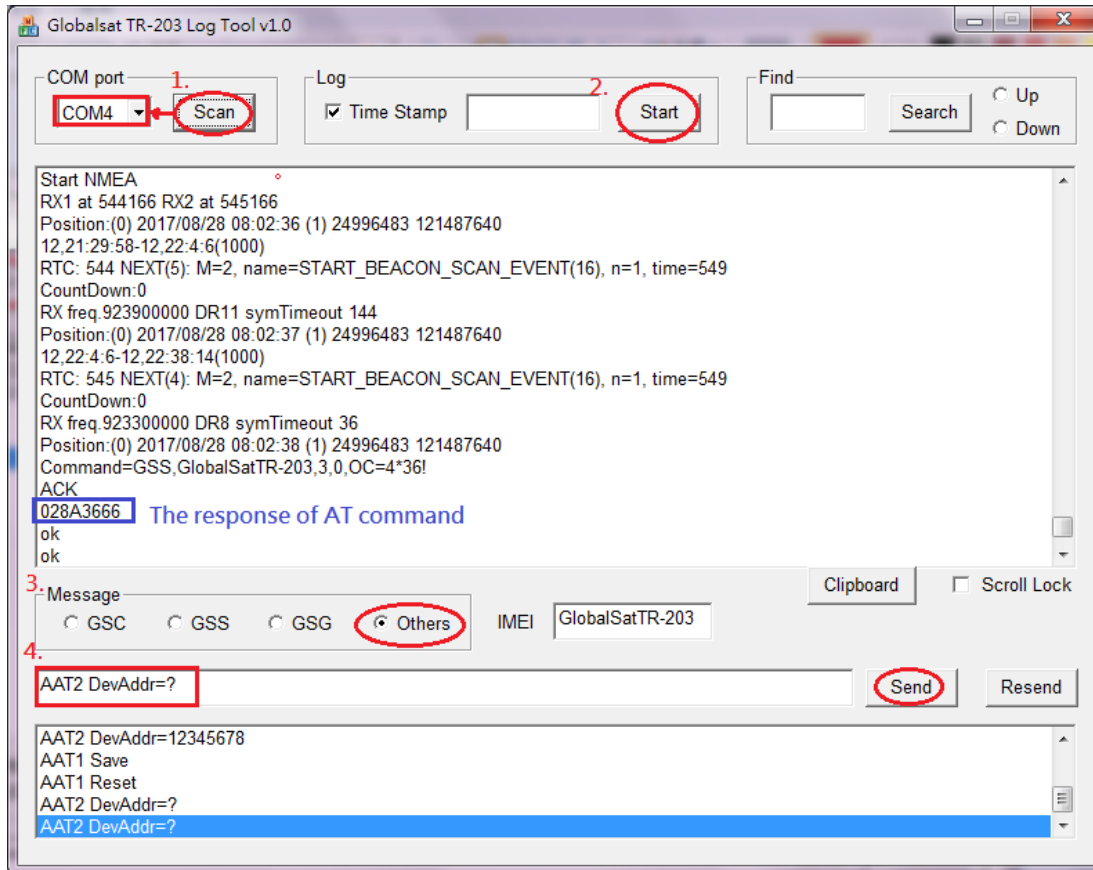
Please download the tool at the following link.

https://drive.google.com/open?id=13Cti6zn6yd5-rb0pAi63shhRVw_9u3YT

Please decompress the file and open it.

Please connect LT-501 to PC by the USB cable.

Please switch LT-501 to USB mode by short pressing the function button



- 1) Please click on “Scan” button. The COM port would be displayed.
- 2) Please click on “Start” button. (The warning message could be ignored.)
- 3) Select Message "GSS" and enter “3,0,OC=4”. Then click "Send" button. The display message would be stopped for checking AT command easily.
- 4) Select message to “Others”. Enter the AT command at the field at left side of “Send” button.

Ex. "AAT2 DevAddr=?" -> respond "028A3666"

Ex. "AAT2 AppSKey=?" -> respond "1628AE2B7E15D2A6ABF7CF4F3C158809"

Note:

- a. For OTAA, set the AppEui & AppKey per your NS settings. Make sure to set the JoinMode=1.
- b. For ABP, set the AppSKey & NwkSKey & JoinMode=0.

Remember to do save and reset after you finish AT command settings. For AT command details, please refer to chapter “7 AT Commands”.

- 5) Select Message "GSS" and enter “3,0,OC=1” via TR-203 log tool. Then click "Send" button. The display message will be back to complete log message.

Few LoRaWAN™ parameters are included as the table below.

Code word	Parameters	Value	Description
D5	LoRaWAN ADR	1/0	0=disable 1=enable Default=1
D7	LoRaWAN port number	u8	1~233 Default=2
DC	LoRaWAN class	u8	0,2 0=Class A 2=Class C

4.2 Acknowledgement

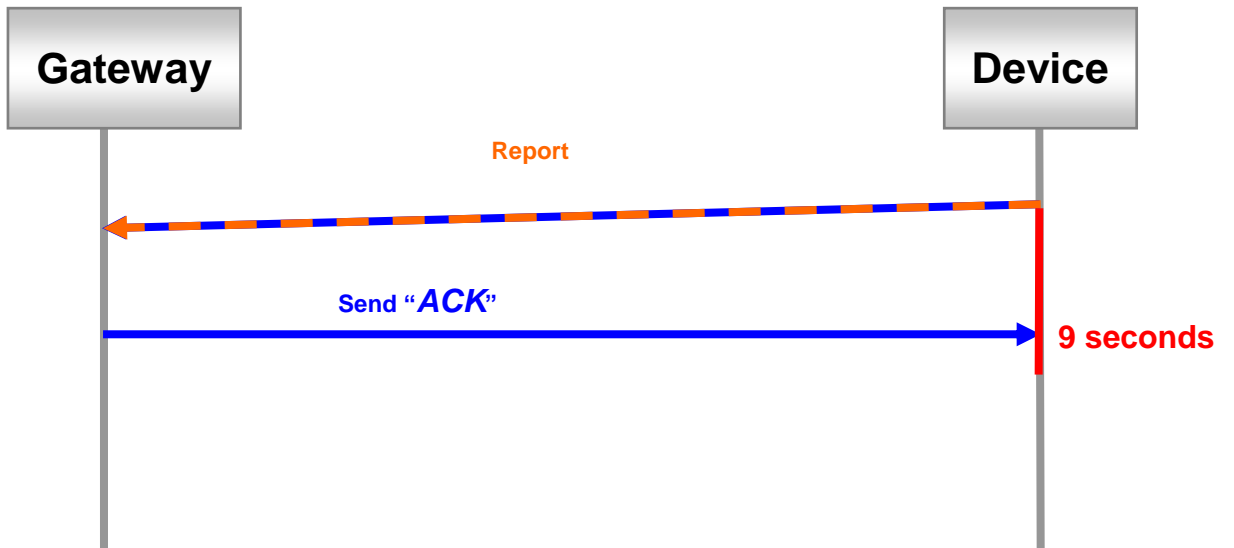
Acknowledgement is the acknowledge receipt used to confirm if gateway receive the report from device.

The following parameters must be set to enable/disable acknowledgement.

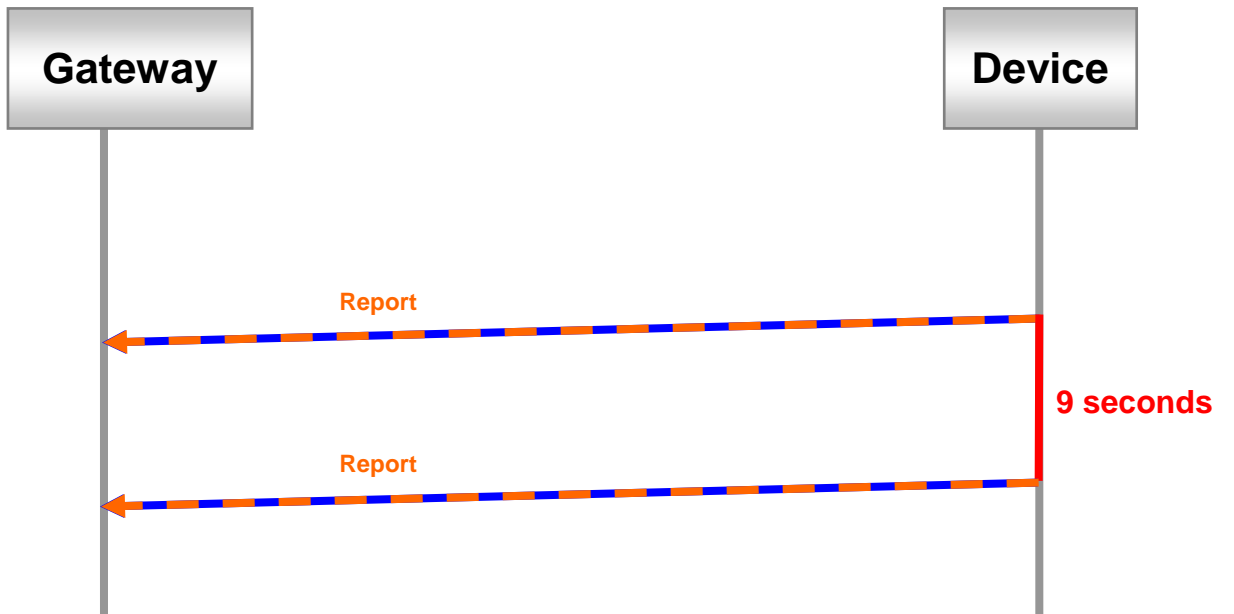
Code word	Parameters	Value	Description
A1	Wait confirmation from gateway after sending message to gateway	1/0	Default=1
A6	Number of re-sending reports without getting ACK from gateway	u8	1~8 Default=2

4.2.1 Receive Acknowledgement from Gateway

Receive ACK from gateway within 9 seconds:



Not receive ACK from gateway within 9 seconds:



4.3 Beacon ID White List

White list Beacon ID could be used as mask. It is a filter for BLE beacons (white list) to be able to filter out unwanted BLE beacons.

For example, the user uses iBeacon and Beacon ID white list is “02aabbccdd”. When the device receives any iBeacon signal (02 means iBeacon) which first 4 bytes of UUID are “aabbccdd”, the device will accept this data and send beacon report with this Beacon ID. If the Beacon type is unmatched or the first 4 bytes of UUID are not matched with Beacon ID white list, the data will be dropped by the device.

Note:

1. For white list setting, it needs to be set accordingly (B0->B1->B2->B3). Only when B0 is set, you could use B1.
2. Letter sensitivity only can be supported for lowercase. Letter needs to be 0~9, A~F.
3. The shortest white list is 2 bytes which include beacon type and 1st byte of white list beacon ID. The longest white list is 17 bytes which include beacon type and 16 bytes complete white list beacon ID for iBeacon and EddyStone_UID. The longest white list is 21 bytes which include beacon type and 20 bytes complete white list beacon ID for AltBeacon.

Beacon Type \ Length	Shortest White List	Longest White List
iBeacon	2	17
EddyStone_UID	2	17
AltBeacon	2	21

Code word	Parameters	Value	Description
B0	White list Beacon ID 1	char(42), Max	Hex string Null=disable Default=NULL Byte 0: beacon type. 02 -> iBeacon 03 -> EddyStone_UID, 07-> AltBeacon Byte 1 - 20 : Beacon ID
B1	White list Beacon ID 2	char(42), Max	
B2	White list Beacon ID 3	char(42), Max	
B3	White list Beacon ID 4	char(42), Max	

5. Tracking

5.1 Ping

Ping is for getting the present location of LT-501 immediately. LT-501 will report its present location and concerning information when getting the ping command.

Example:

The ping report is 0c1002dbc43d0763737d010164 A4989659

Note: When the device receives ping command from application server, it would receive beacon signal for 5 seconds. Once the device confirms the beacon signal is valid, it would transmit the beacon report immediately. Or it would continue to receive GPS signal till GPS fix. The maximum GPS open time is according to the parameter OS.

5.2 Periodic Mode

Periodic mode is for setting an interval for LT-501 to regularly report its location according to the interval. You could set LT-501 to be periodic mode by setting parameter O4=2 via configuration tool. When it reaches the report time, LT-501 will turn on GPS and report the location and concerning information to LoRaWAN™ gateway.

The parameter of periodic mode:

Code word	Parameter	Value	Description
P0	Report interval	u32, in seconds	>= 10 Default=60

Example:

The periodic report 0c1002dbc43d0763737d012264 a135ad20

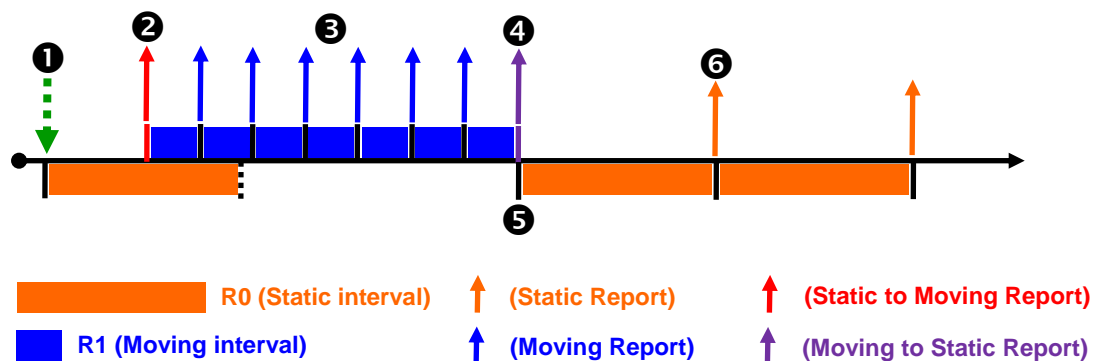
Note:

If P0 is less than 30 seconds, please enable C0 to make sure LT-501 could get GPS fix.

5.3 Motion Mode

Motion mode is an economic report mode. Under motion mode, LT-501 will report its location with high frequency when LT-501 detects motion (moving state). When LT-501 is static, it will report its location with low frequency (static state). It can save the report-transmission fee. Between the moving state and static state, there is a validation state for LT-501 not to jump to static state as soon as it does not detect motion.

There are 2 report frequency of motion mode, one is when LT-501 detects motion, and the other is when LT-501 is static. The behavior is as following:



①	Receive command and then enter motion static mode.
②	When LT-501 detects motion, it will enter motion moving mode and send “static to moving” report.
③	Motion Moving Report.
④	When LT-501 is static, it will send “moving to static” report and then return to the motion static mode.
⑤	Re-start timer for motion static interval.
⑥	Motion Static Report.

You could define the content of report and the report interval of motion mode. You could set LT-501 to be motion mode by setting parameter O4=4 via configuration tool.

The parameters of motion mode:

Code word	Parameters	Value	Description
R0	Report interval in static state	u32, in seconds	>= 10 Default=3600
R1	Report interval in moving	u32, in	>= 10

	state	seconds	Default=30
RH	GPS always on in moving state	1/0	1=enable 0=disable Default=1

Example:

The static report 0c1002dbc43d0763737d014464 a135ad20

6. Help Report

When Help button is long pressed, LT-501 would immediately send one help report to LoRaWAN™ gateway. And LT-501 would try to get GPS fix and send help reports to LoRaWAN™ gateway according to the interval set by G0 parameter till LT-501 gets GPS fix and gets server acknowledgement. Application server could also send dismiss help report command to stop LT-501 sending help reports.

Code word	Parameters	Value	Description
G0	Interval of sending help report	u16, in seconds	>=1 Default=30

Example:

The help report is 0C 0B 00 58 C2 3D 07 A5 6A 7D 01 01 64 64 9A 96 59

7. AT Commands

Save Settings	
Command	Description
AAT1 Save	Respond ok after parameters are saved.
Reset and Reboot	
Command	Description
AAT1 Reset	Respond ok after entering the command.
Restore to Default Value	
Command	Description
AAT1 Restore	Respond ok after entering the command.
Set Device Address	
Command	Description
AAT2 DevAddr=[parameter1]	<p>[parameter1]: device address in 4-byte hexadecimal characters, from 00000001 – FFFFFFFF.</p> <p>Respond: ok if address is valid invalid_param if device address is not valid</p> <p>Device address must be unique in the current network. This must be directly set solely for activation by personalization devices (ABP mode).</p>
Read Device Address	
Command	Description
AAT2 DevAddr=?	Respond: device address in 4-byte hexadecimal characters from 00000001 ~ FFFFFFFF.
Set Device EUI	
Command	Description

AAT2 DevEui=[parameter]	<p>[parameter]: Device EUI in 8-byte hexadecimal character.</p> <p>Respond:</p> <p>ok if device EUI is valid</p> <p>invalid_param if device EUI is not valid</p> <p>This command sets the globally unique device identifier for the module.</p>
Read Device EUI	
Command	Description
AAT2 DevEui=?	Response: Device EUI in 8-byte hexadecimal character.
Set Application EUI	
Command	Description
AAT2 AppEui=[parameter]	<p>[parameter]: the application EUI in 8-byte hexadecimal character.</p> <p>Response:</p> <p>ok if application EUI is valid</p> <p>invalid_param if application EUI is not valid</p> <p>Default AppEUI: 0000000000010203</p> <p>.</p>
Read Application EUI	
Command	Description
AAT2 AppEui=?	Response: the application EUI in 8-byte hexadecimal character. To perform a hard reset, press and hold the power button for 8 to 10 seconds.
Set Network Session Key	
Command	Description
AAT2 NwkSKey=[parameter]	<p>[parameter]: the network session key in 16-byte hexadecimal character</p> <p>Response:</p> <p>ok if network session key is valid</p>

	<p><i>invalid_param</i> if network session key is not valid</p> <p>Default network session key: 28AED22B7E1516A609CFABF715884F3C</p>
Read Network Session Key	
Command	Description
AAT2 NwkSKey=?	Response: the network session key in 16-byte hexadecimal character
Set Application Session Key	
Command	Description
AAT2 AppSKey=[parameter]	<p>[parameter]: the application session key in 16-byte hexadecimal character</p> <p>Response:</p> <p>ok if application session key is valid</p> <p><i>invalid_param</i> if application session key is not valid</p> <p>Default network session key: 1628AE2B7E15D2A6ABF7CF4F3C15880 9</p>
Read Application Session Key	
Command	Description
AAT2 AppSKey=?	Response: the application session key in 16-byte hexadecimal character
Set Application Key	
Command	Description
AAT2 AppKey=[parameter]	<p>[parameter]: application key in 16-byte hexadecimal character.</p> <p>Response:</p> <p>ok if application key is valid</p> <p><i>invalid_param</i> if application key is not valid</p> <p>Default application key: 0123456789ABCDEFEFCDAB896745230 1</p>
Read Application Key	

Command	Description
AAT2 AppKey=?	Response: application key in 16-byte hexadecimal character.
Set Activation Type	
Command	Description
AAT2 JoinMode=[parameter]	[parameter]: 0: ABP mode 1: OTAA mode Response: ok if parameter1 is 0 or 1 invalid_param if parameter1 is not 0 or 1
Read Activation Type	
Command	Description
AAT2 JoinMode=?	Response: 0- ABP mode 1- OTAA mode
Set Delay Time	
Command	Description
AAT2 RxDelay1=[parameter]	[parameter]: delay between the transmission window and the first reception window in microseconds from 100000 to 10000000. Response: ok if parameter1 is from 100000 to 10000000 invalid_param if parameter1 is not from 100000 to 10000000.
Read Delay Time	
Command	Description
AAT2 RxDelay1=?	Response: delay between the transmission and the first reception window in microseconds from 100000 to 10000000.

Enable/ disable Duty Cycle	
Command	Description
AAT2 DutyCycle=[parameter]	<p>[parameter]: 0- disable Duty Cycle 1- enable Duty Cycle</p> <p>Response: ok if parameter1 is 0 or 1 invalid_param if parameter1 is not 0 or 1</p>
Read the state of Duty Cycle	
Command	Description
AAT2 DutyCycle=?	<p>Response: 0-Duty Cycle is disabled. 1-Duty Cycle is enabled.</p>
Enable/disable to check Payload size	
Command	Description
AAT2 PLCheck=[parameter]	<p>[parameter]: 0: disable to check payload size 1: enable to check payload size</p> <p>Response: ok if parameter 1 is 0 or 1 invalid_param if parameter1 is not 0 or 1</p>
Read if module would check Payload size	
Command	Description
AAT2 PLCheck=?	<p>Response: 0-firmware would not check payload size 1-firmware would check payload size</p>
Set Rx2 Frequency and data rate	
Command	Description
AAT2 Rx2_Freq_DR=[parameter1],[parameter2]	<p>[parameter1]: Rx2 frequency in decimal number from 000000001 to 999999999 in Hz. [parameter2]: Rx2 Data Rate from 0 to</p>

	<p>15.</p> <p>Response:</p> <p>ok if Rx2 frequency and data rate are valid</p> <p>invalid_param if Rx2 frequency or data rate is not valid</p> <p>Example, Set Rx2 frequency and data rate to be 866.5MHz and DR3.</p> <p>The command is AAT2 Rx2_Freq_DR=866500000,3.</p>
Read Rx2 Frequency and data rate	
Command	Description
AAT2 Rx2_Freq_DR=?	<p>Response: the frequency and Data Rate of RX2.</p> <p>Example, When RX2 frequency is 915MHz and Data Rate is 3, the response message is "Freq.915000000, DR3".</p>
Set Offset of Rx1 Data Rate	
Command	Description
AAT2 Rx1DrOffset=[parameter]	<p>[parameter1]: the offset of Rx1's data rate</p> <p>The Rx1DrOffset sets the offset between the uplink data rate and the downlink data rate used to communicate with the end-device on the first reception slot (Rx1). As a default this offset is 0. The offset is used to take into account maximum power density constraints for base stations in some regions and to balance the uplink and downlink radio link margins.</p>
Read Offset of Rx1 Data Rate	
Command	Description

AAT2 Rx1DrOffset=?	Response: the offset between the uplink data rate and the downlink data rate.
Set Tx Channel (the frequency, Data Rate, status and the number of band grouping)	
Command	Description
<p>AAT2 Tx_Channel=[parameter1],[parameter2][parameter3],[parameter4] [parameter5]</p>	<p>[parameter1]: the channel number. The range for US is from 0 to 71. The range for EU is from 0 to 15.</p> <p>[parameter2]: the frequency of Tx channel from 000000001 to 999999999 in Hz.</p> <p>[parameter3]: the operating range of Data Rate. (The left one is DR's Max, the right one is DR's Min.) The range of DR is from 0 to 15.</p> <p>Note: According to LoRaWAN_Regional_Parameter.pdf, Data Rate in some regions will be limited in a particular range. For example, upstream 64 channels numbered 0 to 63 utilizing LoRa[®] 125 kHz BW varying from DR0 to DR3 for US.</p> <p>[parameter4]: 0/1 representing the channel is close/open.</p> <p>[parameter5]: the number of band grouping. The range for US is 0. The range for EU is from 0 to 3.</p> <p>Please refer to AAT2 Tx_Band=[parameter1],[parameter2],[parameter3] for further understanding.</p> <p>Response: ok if parameters are valid</p>

	<p><i>invalid_param</i> if one of parameters is not valid.</p> <p>For example: Set to open Channel 3 to use frequency of 977.3MHz with maximum data rate DR4, and minimum data rate DR0 and use band grouping 0's Tx power and duty cycle. The command is as following. AAT2 Tx_Channel=3,973300000,40,1,0</p>
Read specific Tx Channel	
Command	Description
AAT2 Tx_Channelx=?	<p>Fill the channel number at the variable x field</p> <p>Response: the specific Tx channel's information.</p> <p>For example: Read the Channel 15's Tx information AAT2 Tx_Channel15=? Response: channel_15,Freq.905300000,DrRange.0-3,Status0, Band0</p>
Set the duty cycle and Tx power index for Tx band	
Command	Description
AAT2 Tx_Band= [parameter1], [parameter2], [parameter3]	<p>[parameter1]: the number of band grouping. The number of US is 0. The range of EU is from 0 to 3.</p> <p>[parameter2]: the value of duty cycle, from 1 to 9999. The real duty cycle could be calculated as (100% / duty cycle value).</p> <p>[parameter3]: the index of Tx power, from 0 to 15.</p> <p>Response: ok if all parameters are valid</p>

	<p><i>invalid_param</i> if one of parameters is not valid.</p> <p>For example: Set band grouping 0 to use duty cycle as 2% and Tx power index 5 AAT2 Tx_Band=0,50,5 (for US) Note : The value of duty cycle 2% in command= 100% / 2%=50</p>
Read all Tx band's duty cycle and Tx power index	
Command	Description
AAT2 Tx_Band=?	Response: the list of all Tx bands' duty cycle and Tx power index.
Read specific Tx band's duty cycle and Tx power index	
Command	Description
AAT2 Tx_Bandx=?	<p>Fill the band grouping at the variable x field</p> <p>Response: the specific band grouping number's duty cycle and Tx power index. For example, read band 0's duty cycle and Tx power index: AAT2 Tx_Band0=? Response: Band_0, DutyCycle.1, TxPower.5</p>
Read the number of uplink frame counter	
Command	Description
AAT2 Uplink_Count=?	Response: the number of uplink frame counter.
Read the number of downlink frame counter	
Command	Description
AAT2 Downlink_Count=?	Response: the number of downlink frame counter.
Set the Tx power index table	
Command	Description

<p>AAT2 Tx_Power= [parameter1],[parameter2]</p>	<p>[parameter1]: the index of Tx power from 0 to 15.</p> <p>[parameter2]: the corresponding Tx Power. The range for US is 0 dBm to 30 dBm. The range for EU is from 0 dBm to 20 dBm.</p> <p>Response: ok if the parameters are valid invalid_param if one of parameters is not valid</p>
<p>Read the Tx power index and corresponding power</p>	
<p>Command</p>	<p>Description</p>
<p>AAT2 Tx_Power=?</p>	<p>Response: the entire Tx power index and the corresponding power.</p>
<p>Read the specific Tx index's corresponding Tx power</p>	
<p>Command</p>	<p>Description</p>
<p>AAT2 Tx_Powerx=?</p>	<p>Fill the specific Tx index in the variable x field</p> <p>Response: The specific Tx power index's corresponding power.</p> <p>For example, read the Tx power index 2's corresponding Tx power The command is AAT2 Tx_Power2=? Response: TxPower_2, 26 dBm.</p>
<p>Set the maximum payload size (without repeater) of different Data Rate</p>	
<p>Command</p>	<p>Description</p>
<p>AAT2 PI_Max_Length= [parameter1],[parameter2]</p>	<p>[parameter1]: Data Rate from 0 to 15.</p> <p>[parameter2]: maximum payload size (N) from 0 to 255.</p> <p>Response: ok if parameters are valid invalid_param if one of parameters is not valid</p>

Read the maximum payload size (without repeater) of all Data Rates	
Command	Description
AAT2 PI_Max_Length=?	Response: maximum payload size of all Data Rate
Read the maximum payload size (without repeater) of specific Data Rate	
Command	Description
AAT2 PI_Max_Lengthx=?	<p>Fill the specific level of Data Rate in the variable x field</p> <p>Response: the maximum length of the specific Data Rate's payload.</p> <p>Example, read the maximum payload size of Data Rate 3</p> <p>The command is AAT2 PI_Max_Length3=?</p> <p>Response: DR_3, MaxLength.242</p>
Set the maximum payload size (with repeater) of different Data Rate	
Command	Description
AAT2 Plre_Max_Length=[parameter1],[parameter2]	<p>[parameter1]: Data Rate from 0 to 15.</p> <p>[parameter2]: maximum payload size (N) from 0 to 255.</p> <p>Response:</p> <p>ok if parameters are valid</p> <p>invalid_param if one of parameters is not valid</p>
Read the maximum payload size (with repeater) of all Data Rates	
Command	Description
AAT2 Plre_Max_Length=?	Response: the maximum payload size of all Data Rate.
Read the maximum payload size (with repeater) of specific Data Rate	
Command	Description
AAT2 Plre_Max_Lengthx=?	Fill the specific level of Data Rate in the variable x field

	Response: the maximum payload size of specific Data Rate.
Set the channel number that Network Server cannot send command to change	
Command	Description
AAT2 DefChannelLimit=[parameter]	[parameter]: US range:1-71, default=71 EU range:1-15, default=3 Response: ok if parameter is valid invalid_param parameter is not valid
Read the channel number that Network Server cannot send command to change	
Command	Description
AAT2 DefChannelLimit=?	Response: the channel number that Network Server cannot send command to change it.
Set the LBT function	
Command	Description
AAT2 LBTMode=[parameter]	[parameter]: 1/0 1: enable LBT function 0: disable LBT function LBT is the acronym of Listen Before Talk. Before sending the uplink, LT-501 would "listen" if the noise reaches to the threshold, LT-501 would not send the uplink. Response: ok if parameter is valid invalid_param parameter is not valid
Read the LBT function status	
Command	Description
AAT2 LBTMode=?	Response: 1-LBT function is enabled.

	0-LBT function is disabled.
Set the RSSI limit for LBT function	
Command	Description
AAT2 LBTRssiLimit=[parameter]	[parameter]: the threshold of noise that LT-501 would not send uplink to prevent from failure of uplink. Range:-1dBm~-150dBm, default=-80dBm Response: ok if parameter is valid invalid_param parameter is not valid
Read the RSSI limit for LBT function	
Command	Description
AAT2 LBTRssiLimit=?	Response: the threshold of noise that LT-501 would not send uplink

The following AT commands would only be available on EU standard firmware.

Read the ISM Band to EU standard or AS923 Specs.	
Command	Description
AAT2 ISM_Band=?	Response: 1-AS923 Specs. 0-EU standard
Set the ISM Band to EU standard or AS923 Specs.	
Command	Description
AAT2 ISM_Band=[parameter]	[parameter]: 0/1 1: AS923 Spec. 0: EU standard Response: <i>ok</i> if parameter is valid <i>invalid_param</i> parameter is not valid
Read the AS923 downlink dwell time	
Command	Description
AAT2 Down_Dwelltime=?	Response: 1-Transmission time must be within 400ms. 0-No limit to transmission time
Set the AS923 downlink dwell time	
Command	Description
AAT2 Down_Dwelltime=[parameter]	[parameter]: 1: Transmission time must be within 400ms. 0: No limit to transmission time Response: <i>ok</i> if parameter is valid <i>invalid_param</i> parameter is not valid
Read the AS923 uplink dwell time	
Command	Description
AAT2 Up_Dwelltime=?	Response: 1-Transmission time must be within 400ms. 0-No limit to transmission time

Set the AS923 uplink dwell time	
Command	Description
AAT2 Up_Dwelltime=[parameter]	<p>[parameter]:</p> <p>1: Transmission time must be within 400ms.</p> <p>0: No limit to transmission time</p> <p>Response:</p> <p>ok if parameter is valid</p> <p>invalid_param parameter is not valid.</p>
Set the maximum payload size (without repeater) of different Data Rate when AS923 uplink/downlink dwell time=1	
Command	Description
AAT2 PIMax_DT_Length=[parameter1],[parameter2]	<p>[parameter1]: Data Rate from 0 to 15.</p> <p>[parameter2]: maximum payload size (N) from 0 to 255.</p> <p>Response:</p> <p>ok if parameters are valid</p> <p>invalid_param if one of parameters is not valid</p> <p>Note:</p> <p>When AS923 uplink/downlink dwell time=0, the command for setting maximum payload size is AAT2 PIMax_Length=[parameter1],[parameter2]</p>
Read the maximum payload size (without repeater) of all Data Rates when AS923 uplink/downlink dwell time=1	
Command	Description
AAT2 PIMax_DT_Length=?	Response: maximum payload size of all Data Rate
Read the maximum payload size (without repeater) of specific Data Rate when AS923 uplink/downlink dwell time=1	
Command	Description
AAT2 PIMax_DT_Lengthx=?	<p>Fill the specific level of Data Rate in the variable x field</p> <p>Response: the maximum length of the specific</p>

	Data Rate's payload. Example, read the maximum length of Data Rate 3's payload The command is AAT2 PI_Max_Length3=? Response: DR_3, MaxLength.242
Set the maximum payload size (with repeater) of different Data Rate when AS923 uplink/downlink dwell time=1	
Command	Description
AAT2 Plre_Max_DT_Length=[parameter1],[parameter2]	[parameter1]: Data Rate from 0 to 15. [parameter2]: maximum payload size (N) from 0 to 255. Response: ok if parameters are valid invalid_param if one of parameters is not valid
Read the maximum length (with repeater) of all Data Rates when AS923 uplink/downlink dwell time=1	
Command	Description
AAT2 Plre_Max_DT_Length=?	Response: the maximum payload size of all Data Rate.
Read the maximum payload size (with repeater) of specific Data Rate	
Command	Description
AAT2 Plre_Max_DT_Lengthx=?	Fill the specific level of Data Rate in the variable x field Response: the maximum payload size of specific Data Rate.
Read the Rx1 frequency for specific Tx channel	
Command	Description
AAT2 Rx1_Freqx=?	Fill the specific Tx channel in the variable x field Response: the Rx1 frequency for specific Tx channel.