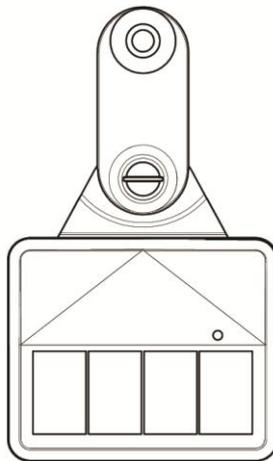


LT-10

Development Document



Version: 2.0

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1. Introduction

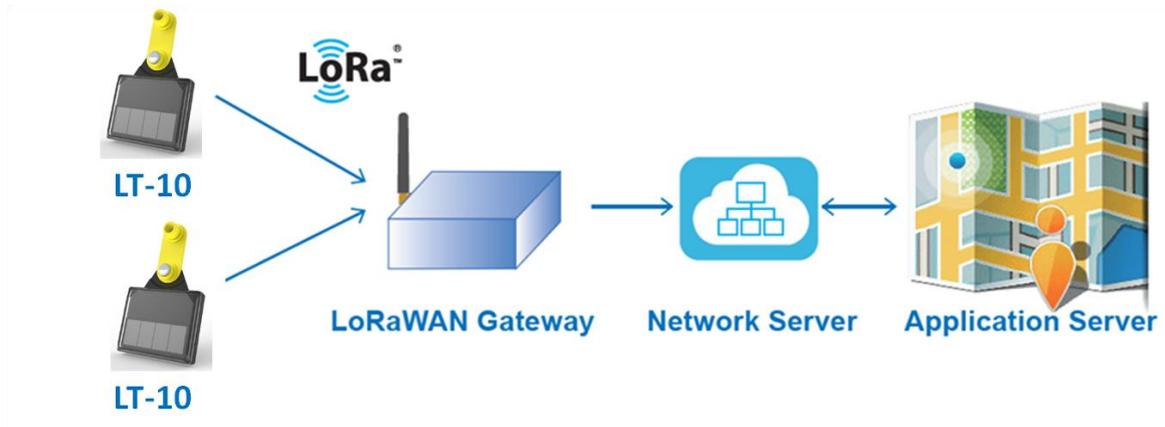
The LT-10 is a LoRaWAN compliant light solar tracker. The device has a solar panel for charging by sunlight. The high performance solar panel can provide sufficient power for continuous LoRa transmission.

Features:

- High performance solar panel to provide continuous charging for internal battery
- Provide periodic battery status messages to server
- Built-in 3 axis accelerometer for motion detector
- Configurable setting by GlobalSat configuration App via BLE
- Power Low alert
- IPX7 waterproof rating

2. Gateway Setup

LT-10 could send data via LoRa[®] technology. Please refer to the following diagram.



Before starting communication LoRaWAN[™] gateway and LT-10 LoRa[®] trackers, please refer to [LoRaWAN[™] gateway's user manual](#) to set the LoRa[®] settings by GlobalSat Configuration App.

3. Protocol Summary

3.1 Report Messages Format

3.1.1 Tracking Report Format

Tracking report format of report messages:

Protocol Version	Command ID	Longitude	Latitude	GPS Fix Status & Report Type	Battery Capacity	SPM (Smart Power Management Level)
80 1 byte	08 1 bytes	3 bytes	3 bytes	1 byte	1 byte	1 byte

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	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
Longitude	Int24 (24-bit signed integer) (Little Endian) Formula is $24\text{-bit_value} * 215 / 10^7 =$ longitude_in_decimal_degrees
Latitude	Int24 (24-bit signed integer) (Little Endian) Formula is $24\text{-bit_value} * 108 / 10^7 =$ latitude_in_decimal_degrees
Battery Capacity	8-bit unsigned integers unit: percent capacity %

SPM (Smart Power Management Level)	0= Level 0 (Report as customer's report interval P0 or R0) 1= Level 1 (Report every 2 hours) 2= Level 2 (Report every 12 hours)
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Example1: The period report is 80 08 9E 38 56 00 51 23 42 43 00.

Protocol version: 80

Command ID: 08 => Tracking report

Longitude: 9E3856 => (to Big Endian) 0x56389E => (Int24 to Decimal) 5,650,590
 $(5,650,590 * 215) / 10^7 = 121,487,685 * 0.000001 = 121.487685^\circ$

Latitude: 005123 => (to Big Endian) 0x235100 => 2,314,496
 $(2,314,496 * 108) / 10^7 = 24,996,556 * 0.000001 = 24.996556^\circ$

GPS-fix Status: 0x42 => 66 / 32 = (get bit5~bit7) 2 => 3D Fix

Report Type: 0x42 => 66% 32= 2 => (get bit0~bit4) Periodic mode report

Battery Capacity: 0x43 => 67 %

SPM: 00 => Level 0

Example2: The period report is 80 08 1F 53 FB 00 51 23 45 62 02.

Protocol version: 80

Command ID: 08 => Tracking report

Longitude: 1F53FB => 0xFB531F which is larger than 0x800000
 So $0xFB531F - 0x1000000 = 0xFFFFB531F => -306,401$
 $(-306,401 * 215) / 10^7 = -6,587,621.5 * 0.000001 = -6.5876215^\circ$

Latitude: 005123 => 0x235100 => 2,314,496
 $(2,314,496 * 108) / 10^7 = 24,996,556 * 0.000001 = 24.996556^\circ$

GPS-fix Status: 0x45 => 69 / 32 = (get bit5~bit7) 2 => 3D Fix

Report Type: 0x45 => 69% 32= (get bit0~bit4) 5 => Motion mode moving report

Battery Capacity: 0x62 => 98 %

SPM: 02 => Level 2

3.2 Command Format

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)
<p>Example: Set C1=60 L2(C1=60) Please transfer this command by ASCII to Hex format as following.</p> <p>L » 4C 2 » 32 (» 28 C » 43 1 » 31 = » 3D 6 » 36 0 » 30) » 29</p>				
0C	0800	0B	4C322843313D363029	0D0A

Send downlink command '0C08000B4c322843313d3630290D0A' to device for setting C1=60.

3.3 Configuration Parameters

Most behaviors of LT-10 could be changed by Configuration Parameters. You could change the setting of configuration parameters by GlobalSat Configuration App or by sending downlink command.

Configuration Parameters					
		Code word	Parameters	Type	Description
	Device	O4	Power on operating mode	u8	2=Periodic 4=Motion Default=2
		O7	Firmware version	char(28)	Read only
	Other setting	Gt	G-sensor sensitivity for motion detection	u8	5=high, 10=medium, 25=low Default=10
		O1	Interval for triggering motion sensor	u16, in seconds	1 ~ 100 Default=5
Z5		Device Security Key for App	char(8)	Default=00000000	
Z6		SPM (Smart Power Management Level)	1/0	0=disable 1=enable Default=1 For its details, please check chapter 6.	
GPS	GPS	CD	enable/disable GPS	1/0	0=disable 1=enable Default=1
		C1	The time to get GPS-fix if LT-10 got GPS-fix over 1 hour ago	u16, in seconds	30 ~ 600 Default=120
		C2	The time to get GPS-fix if	u16, in	10 ~ 120

			LT-10 got GPS-fix within 1 hour	seconds	Default=40
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Communication	Acknowledgement	A1	Wait confirmation from gateway after sending message to gateway	1/0	0=disable 1=enable Default=0
		A6	Number of re-sending reports without getting ACK from gateway	u8	1~8 Default=1
Tracking	Period	P0	Report interval of period report	u32, in seconds	>=600 Default=3600
	Motion	R0	Report interval in static state	u32, in seconds	>=600 Default=3600
		R1	Report interval in moving state	u32, in seconds	>=600 Default=3600

LoRaWAN	LoRaWAN Parameters	D5	LoRaWAN ADR	1/0	0=disable 1=enable Default=0
			Enable Duty Cycle	1/0	0=disable 1=enable US Default=0 EU & AS923 Default=1
			Join Mode	1/0	0=ABP 1=OTAA Default=0
			DevEui	8 bytes Hex	It is the same as LoRa MAC sticker on device.
			AppKey	16 bytes Hex	[For OTAA mode] Default= 0123456789ABCDEFEFCDAB8967452301
			AppEui	8 bytes Hex	[For OTAA mode] Default= 000DB5AA00000010
			NwkSKey	16 bytes Hex	[For ABP mode] Default= 28AED22B7E1516A609CFABF715884F3C
			AppSKey	16 bytes Hex	[For ABP mode] Default= 1628AE2B7E15D2A6ABF7CF4F3C158809
			DevAddr	4 bytes Hex	[For ABP mode] It's the last 4 bytes of LoRa MAC sticker on device.
			RxDelay1	int, in μ s	800000~1200000
			Rx1_OpenTime	Int, in ms	US, AU915 & AS923: 150 ~ 800 EU: 250~800 Default=250
			Rx2_OpenTime	Int, in ms	US, AU915 & AS923: 150 ~ 800 EU: 250~800 Default=250

4. Communication

4.1 Acknowledgement

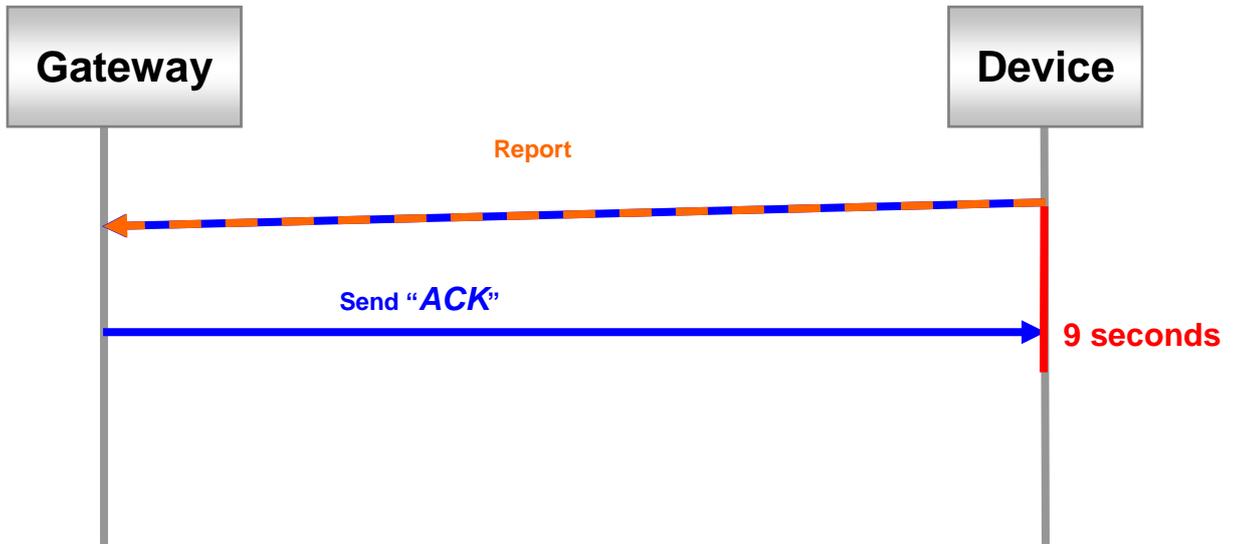
Acknowledgement is the acknowledge receipt used to confirm if gateway receive the report from device.

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

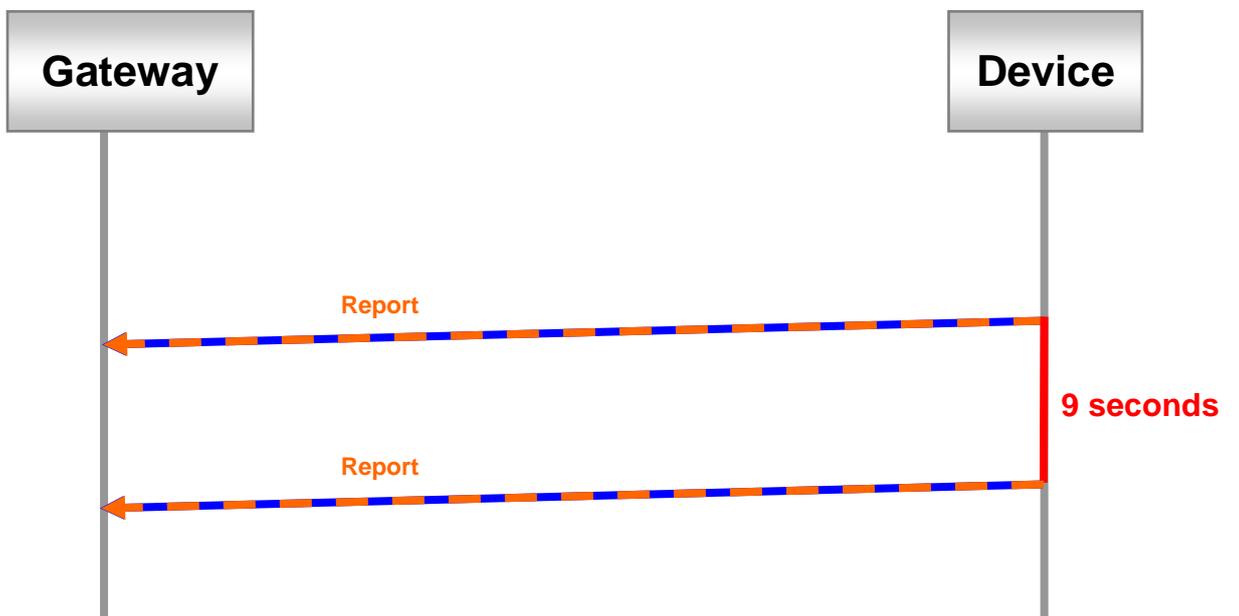
Code word	Parameters	Value	Description
A1	Wait confirmation from gateway after sending message to gateway	1/0	0=disable 1=enable Default=0
A6	Number of re-sending reports without getting ACK from gateway	u8	1~8 Default=1

4.1.1 Receive Acknowledgement from Gateway

Receive ACK from gateway within 9 seconds:



Not receive ACK from gateway within 9 seconds:



5. Tracking

5.1 Periodic Mode

Periodic mode is for setting an interval for LT-10 to regularly report its location according to the interval. You could set it to be periodic mode by setting parameter O4=2 via configuration App. When it reaches the report time, it 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	>= 600 Default=3600

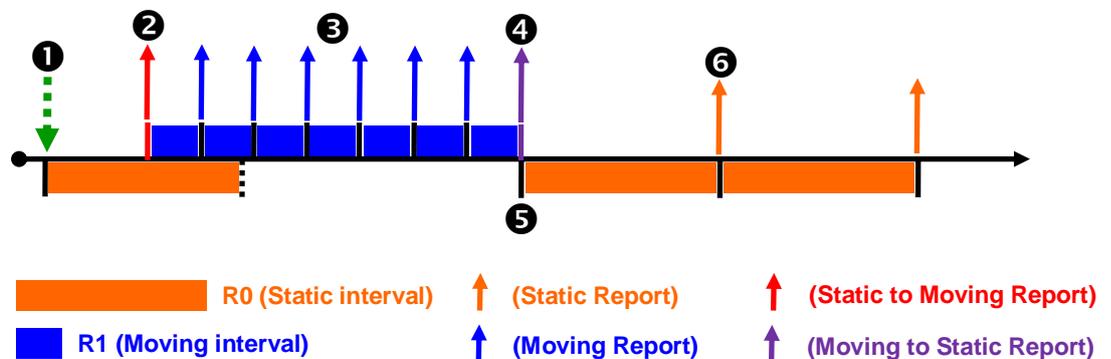
Example:

The periodic report is 800800000000000025901.

5.2 Motion Mode

Motion mode is an economic report mode. Under motion mode, LT-10 will report its location with high frequency when it detects motion (moving state). When it 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 it 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 it detects motion, and the other is when it is static. The behavior is as following:



①	Receive command and then enter motion static mode.
②	When LT-10 detects motion, it will enter motion moving mode and send “static to moving” report.
③	Motion Moving Report.
④	When LT-10 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-10 to be motion mode by setting parameter O4=4 via GlobalSat configuration App.

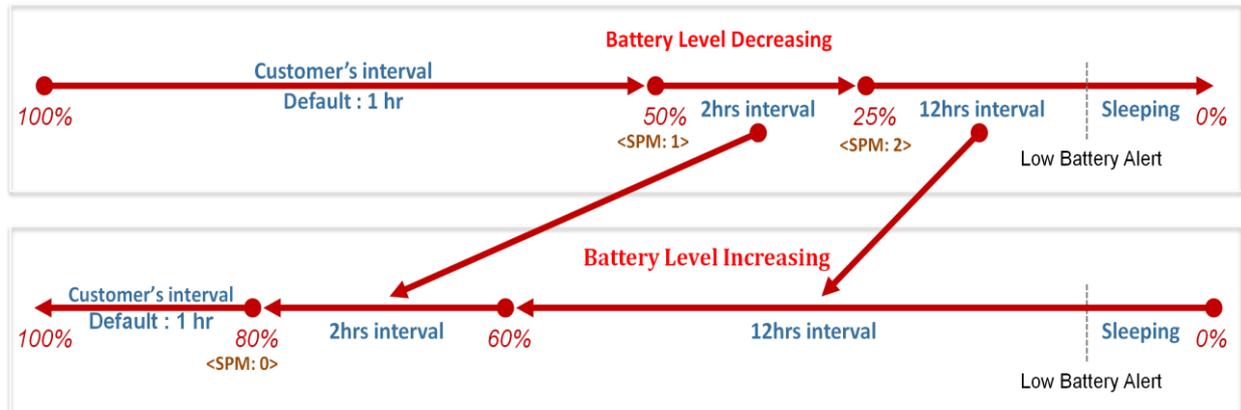
The parameters of motion mode:

Code word	Parameters	Value	Description
R0	Report interval in static state	u32, in seconds	>= 600 Default=3600
R1	Report interval in moving state	u32, in seconds	>= 600 Default=3600

Example:

The static report is 800800000000000045c00.

6. SPM (Smart Power Management)



SPM is a power management mechanism according to real battery level in order for LT-10 to be survived as long as possible. SPM is executed as defaults. For first time to apply our device, we suggest to place it under sufficient sunshine till battery level reaches 80% above. Then it will report according to periodic report interval once per hour according to defaults. When battery level is lower than 50%, it would go to stage1 of SPM with two hours report interval in order to save power. If the battery level continually decreases to 25% below, it would go to stage2 of SPM with twelve hours report interval due to the critical weather condition. In case if device sends low battery alert, it would go to sleeping mode soon and then would not send any report.

When battery level increases gradually, it will report with twelve hours interval between 5% and 60%. When it reaches 60% above, it will report with two hours report interval. Eventually, when it is higher than 80%, it will report according to customer's report interval. If you would like device always send with your report interval, SPM could be disabled by App setting. **However, the device may go to sleeping mode easily when sunshine condition is worse.**