User Manual

LoRa® Wireless Communication Module

LM-110H1

VER 1.0

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Product Description

The GlobalSat LM-110H1 is a RF module that based on LoRa® technology which provides long-range, low data rate IoT connectivity to sensors, electronic meter reading, geolocation devices, industrial monitoring and control, home and building automation, long range irrigation systems, and all kinds of IoT/ M2M equipments. It can work as the end-node devices in the LoRaWAN™ infrastructure or in GlobalSat proprietary MOST-Link mode.

Product Feature

- Built-in standard LoRaWAN™ FW and proprietary MOST-Link FW in the same module

- Default as LoRaWAN™, switch to MOST-Link by AT command

- Share same PCB/ device design for both LoRaWAN™ and private RF data communication

- For LoRaWAN™ :
  - Standard LoRaWAN™ protocol for EU868/ US915/ AS923 and profile for local settings
  - Support Class A/ Class C

- For M.O.S.T:
  - MOST-Link: use AT-command set to send data over MOST-Link protocol
  - Frequency: 860 - 928 MHz

- Multi-channel, dual data buffer (each 256 Bytes)

- LoRa®/ FSK/ GFSK/ OOK modulation, 2-way half –duplex communication, strong anti-interfere

- Easily use, auto exchange on communication & transceiver

- PIN connector for easy development and test

- Accord FCC,ETSI, Telec standard

Hardware Specifications

LoRa® Chipset	SX1276
LoRa® Module	Globalsat LoRa® module LM-130H1
Antenna	IPEX RF Connector/ RPSMA/ 50Ω
MCU	STM32 (128KB flash)
Frequency	863-870 MHz (EU) 902-928 MHz (US) 920-928 MHz (ROA)
Transmission Power	862-870 MHz (EU) @ 14 dBm 902-928 MHz (US) @ 20 dBm 920-928 MHz (ROA) @ 20 dBm
Transmission Media	UART
UART	Baud Rate : 57600 bps, Parity: 8N1
Operation Voltage	3 ~ 6 V
Current Consumption	Receiving: 21 mA Transmitting: 125 mA Sleeping: 5 uA
Transmission Distance	1KM~10KM @ 980 bps
Receiving Sensitivity	-132 dBm @ 980 bps
Operation Temperature	-40 ~ 85°C
Humidity	5 ~ 95% (Non-condensing)
Dimension	34 x 19 ± 0.1 mm (PCBA)
Connector	PIN type, pitch 2.54mm
Accessories	RPSMA Antenna (Optional) Gain: 2.95 dBi @ 902 MHz; 2.88 dBi @ 915 MHz; 2.89 dBi @ 928 MHz USB to UART Adapter Board (Optional)

Pin Definition

No	Pin	Definition	Description
1	GND	GND	Ground
2	VCC	Input	3.0 ~ 6.0 V
3	RXD	Input	UART input
4	TXD	Output	UART output
5	BZ	Output	Module's operation status
6	P2	Input	Pin2 for switching operation mode
7	P1	Input	Pin1 for switching operation mode

Product Size

UNITS
mm
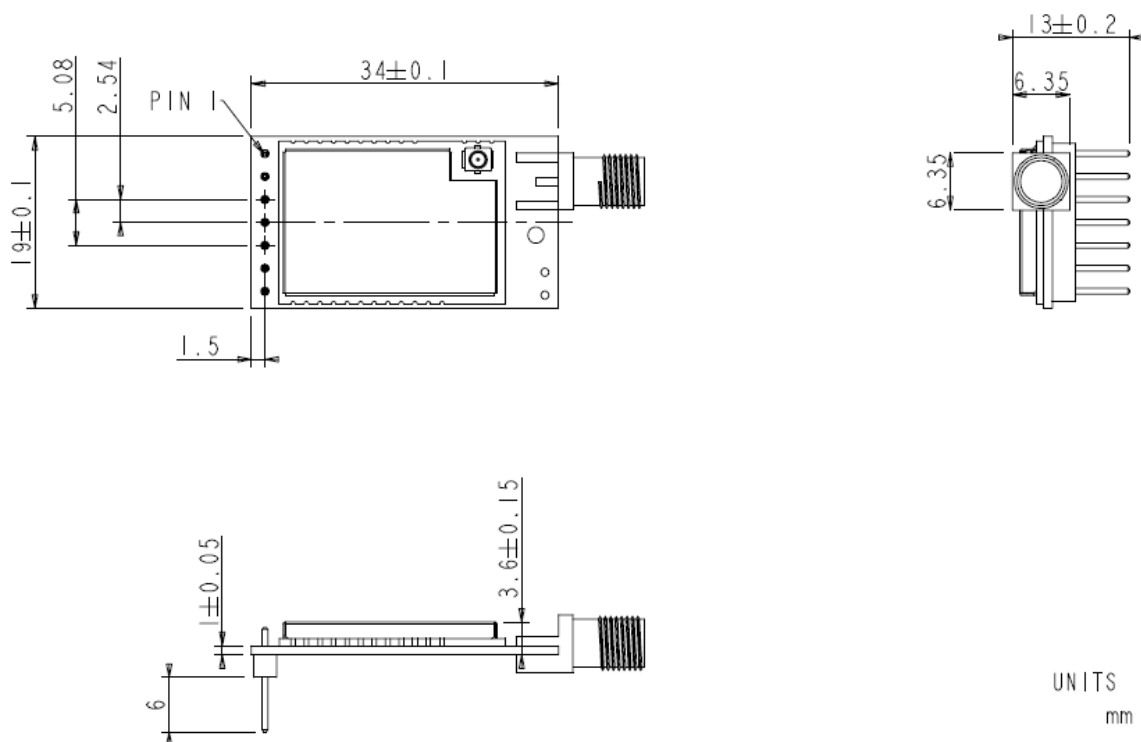
LoRaWAN™ Configuration

Activation of an end-device can be achieved in two ways, either via Over-The-Air Activation (OTAA) when an end-device is deployed or reset, or via Activation By Personalization (ABP) in which the two steps of end-device personalization and activation are done as one step.

■ Over-the-Air Activation

For over-the-air activation, end-devices must follow a join procedure prior to participating in data exchanges with the network server. An end-device has to go through a new join procedure every time it has lost the session context information. The join procedure requires the end-device to be personalized with the following information before its starts the join procedure: a globally unique end-device identifier (DevEUI), the application identifier (AppEUI), and an AES-128 key (AppKey).

■ Activation by Personalization

Under certain circumstances, end-devices can be activated by personalization. Activation by personalization directly ties an end-device to a specific network by-passing the join request join accept procedure.

Activating an end-device by personalization means that the DevAddr and the two session keys NwkSKey and AppSKey are directly stored into the end-device instead of the DevEUI, AppEUI and AppKey. The end-device is equipped with the required information for participating in a specific LoRa network when started. Each device should have a unique set of NwkSKey and AppSKey. Compromising the keys of one device shouldn't compromise the security of the communications of other devices.

Operation Mode

- Bi-directional end-devices (Class A): End-devices of Class A allow for bi-directional communications whereby each end-device's uplink transmission is followed by two short downlink receive windows. The transmission slot scheduled by the end-device is based on its own communication needs with a small variation based on a random time basis (ALOHA-type of protocol). This Class A operation is the lowest power end-device system for applications that only require downlink

communication from the server shortly after the end-device has sent an uplink transmission. Downlink communications from the server at any other time will have to wait until the next scheduled uplink.

- Bi-directional end-devices with maximal receive slots (Class C): End-devices of Class C have nearly continuously open receive windows, only closed when transmitting.

MOST-Link Configuration

Please refer to below AT Command List for the detail setting.

AAT1 － Command for parameters setting up and send /receive data.
AAT3 － Command for functions setting up under MOST-Link.

Under this protocol, the default mode is Disable (P0=0), which is the payload data transmission in transparent. It only supports command A0, A1 for AES128 encryption function.
Use AT command [AAT3 P0=1] to Enable MOST-Link mode.

Save Settings	
Command	**Description**
AAT1 Save	Respond *ok* after parameters are saved.
Reset and Reboot CPU of LM-130H1	
Command	**Description**
AAT1 Reset	Respond *ok* after entering the command.
Restore to Firmware Default Value	
Command	**Description**
AAT1 Restore	Respond *ok* after entering the command.
Enable / Disable MOST Link mode	
Command	**Description**
AAT3 P0=[parameter]	[Parameter]:1/0 **1**: enable MOST-Link **0**: disable MOST-Link Response: **ok** － parameter is valid **invalid_param** － parameter is not valid

Read MOST-Link mode status	
Command	**Description**
AAT3 P0=?	Response: **1**-MOST-Link is enabled **0**-MOST-Link is disabled
Set Operation Mode of LM-130H1	
Command	**Description**
AAT3 MD=[parameter]	[parameter]: Range: 1-3, Default=1 **1**: Mode 1, Normal mode **2**: Mode 2, Wake up mode **3**: Mode 3, Power saving mode Response: **ok** – parameter is valid **invalid_param** – parameter is not valid Note: 1. In Wake up mode, LM-130H1 stays awake and send wake up code (i.e. Normal mode plus with preamble byte) while transmitting data. 2. In Power-saving mode, LM-130H1 sleeps all the time. Send [AAT1 WK] or any command would get "ACK" as a wake up code. After getting "ACK" within 0.5 second, send [AAT3 MD=1] to change it to Normal Mode. LM-130H1 would only accept commands [AAT3 MD] and [AAT1 Save] in power-saving mode.
Read Operation Mode of LM-130H1	
Command	**Description**
AAT3 MD=?	Response: **1** – Normal mode **2** – Wake up mode **3** – Power saving mode

Read LoRa® MAC of LM-130H1	
Command	**Description**
AAT1 L0=?	Response: LoRa® MAC of LM-130H1 (16 Bytes) Example, 9B667C111B001B80

Read Model Name	
Command	**Description**
AAT1 L1=?	Response: Model name (7 Bytes) Example, LM-130H1/LM-533

Read LoRa® Firmware Version	
Command	**Description**
AAT1 L2=?	Response: Firmware version (16 Bytes) Example, F-0LR-14-1704191

Set LoRa Group ID	
Command	**Description**
AAT1 L3=[parameter]	[Parameter]: The number of LoRa® group ID. The range is 0~255. 0=disable group ID function. Default=0 Response: **ok** – parameter is valid **invalid_param** – parameter is not valid

Read LoRa® Group ID	
Command	**Description**
AAT1 L3=?	Response: The group ID (Range:0~255)

Set Rx/Tx Frequency of LoRa® Channel

Command	Description
AAT1 L4=[parameter1],[parameter2]	[Parameter1]: Rx frequency in KHz from 865000 to 928000 [Parameter2]: Tx frequency in KHz from 865000 to 928000 Response: **ok** – parameters are valid **invalid_param** – one or both parameter are not valid Example, set Rx frequency as 915MHz and Tx frequency as 915MHz The command is AAT1 L4=915000,915000

Read Rx/Tx Frequency of LoRa® Channel

Command	Description
AAT1 L4=?	Response: Rx frequency in KHz, Tx frequency in KHz

Set Data Rate of LoRa® Channel

Command	Description
AAT1 L5=[parameter]	[Parameter]: Data rate from 0 to 5 0=0.81K, 1=1.46K, 2=2.6K, 3=4.56K, 4=9.11K, 5=18.23K bps Default=3 Response: **ok** – parameter is valid **invalid_param** – parameter is not valid

Read Data Rate of LoRa® Channel

Command	Description
AAT1 L5=?	Response: Data Rate from 0 to 5

Set Wakeup Time of LoRa® Channel	
Command	**Description**
AAT1 L6=[parameter]	[Parameter]: Wakeup time from 0 to 9 0=200ms, 1=400ms, 2=600ms, 3=1s, 4=1.5s, 5=2s, 6=2.5s, 7=3s, 8=4s, 9=5s Default=3 **Response:** **ok** – parameter is valid **invalid_param** – parameter is not valid

Read Wakeup Time of LoRa® Channel	
Command	**Description**
AAT1 L6=?	Response: Wakeup time from 0 to 9

Set the index of LoRa® Channel's Tx Power	
Command	**Description**
AAT1 L7=[parameter]	[Parameter]: Index of Tx power from 0 to 7 0=5dBm, 1=7dBm, 2=9dBm, 3=11dBm, 4=13dBm, 5=15dBm, 6=17dBm, 7=20dBm Default=7 **Response:** **ok** – parameter is valid **invalid_param** – parameter is not valid

Read the index of LoRa® Channel's Tx Power	
Command	**Description**
AAT1 L7=?	Response: Index of Tx power from 0 to 7

Set LM-130H1's Role	
Command	**Description**
AAT1 MA=[parameter]	[Parameter]: 1/0 0: set LM-130H1 as Node 1: set LM-130H1 as Gateway Default=0 Response: **ok** – parameter is valid **invalid_param** – parameter is not valid

Read LM-130H1's Role Status	
Command	**Description**
AAT1 MA=?	Response: **0** – Node **1** – Gateway
Send Payload by M.O.S.T. protocol	
Command	**Description**
AAT1 T1=[parameter] * MOST-Link disable, P0=0	[Parameter]: Payload value in hexadecimal character (1-99 Bytes). **Response**: This command would get two responses. The first one responding if the command is valid or not. After the payload is sent out, it would get the second response. **1st Response:** **ok** – parameter is valid **invalid_param** – parameter is not valid **2nd Response:** **TX_OK** – payload is sent out **TX_BUSY** – payload is not sent out **Received Data from End Node AAT1 R1=RSSI,Data** ● **RSSI:** The received signal strength indicator (Range: 1~160). The bigger the value is, the stronger the signal strength is. ● **Data:** in hexadecimal character (1-99 Bytes). It is ended with <CR><LF>

Send Payload by MOST-Link protocol (LM-130H1 is gateway, MA=1)	
Command	**Description**
AAT1 T2=[parameter1],[parameter2],[para maeter3] * MOST-Link enable, P0=1	[Parameter1]:1/0 **1**: ACK enable **0**: ACK disable [Parameter2]:LoRa®_MAC The LoRa® MAC that assigned to get the payload [Parameter3]:payload Payload value in hexadecimal character (1-84 Bytes). **Response**: This command would get two responses. The first one responding if the command is valid or not. After the payload is sent out, it would get the second response. 1st Response: **ok** – parameters are valid **invalid_param** – parameter is not valid **2nd Response:** **TX_OK**– payload is sent out **TX_NO_ACK**– payload is sent out, but not get ACK **TX_BUSY**– payload is not sent out **Received Data from End Node** **AAT1 R2=RSSI,0,flag,data** ● **RSSI:** The received signal strength indicator (Range: 1~160). The bigger the value is, the stronger the signal strength is. ● **flag:** MOST-Link AT Command Flag (1 Byte in hexadecimal value) ● **Data:** in hexadecimal character (1-84 Bytes). It is ended with <CR><LF>

Send Payload by MOST-Link protocol (LM-130H1 is end node, MA=0)	
Command	**Description**
AAT1 T3=[parameter1],[parameter2] * MOST-Link enable, P0=1	[Parameter1]:1/0 **1**: ACK enable **0**: ACK disable [Parameter2]:payload Payload value in hexadecimal character (1-84 Bytes). **Response**: This command would get two responses. The first one responding if the command is valid or not. After the payload is sent out, it would get the second response. **1st Response**: **ok** － parameters are valid **invalid_param** － parameter is not valid **2nd Response:** **TX_OK**－ payload is sent out **TX_NO_ACK**－ payload is sent out, but not get ACK **TX_BUSY**－ payload is not sent out **Received Data from Gateway** **AAT1 R2=RSSI,LoRa_MAC,flag,data** ● **RSSI:** The received signal strength indicator (Range: 1~160). The bigger the value is, the stronger the signal strength is. ● **LoRa_MAC:** The LoRa® MAC of end node that sends payload to gateway (16 Bytes) ● **flag:** MOST-Link AT Command Flag (1 Byte in hexadecimal value) ● **Data:** in hexadecimal character (1-84 Bytes). It is ended with <CR><LF>

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Enable/ disable AES128 Encryption	
Command	**Description**
AAT3 A0=[parameter]	[Parameter]:1/0 **1**: Enable AES128 Encryption **0**: Disable AES128 Encryption Response: **ok** － parameter is valid **invalid_param** － parameter is not valid

Read AES128 Encryption Status	
Command	**Description**
AAT3 A0=?	Response **1**- Enable AES128 Encryption **0**- Disable AES128 Encryption

Set AES128 Encryption	
Command	**Description**
AAT3 A1=[parameter]	[Parameter]: AES128 Key in hexadecimal character(16 Bytes) Response: **ok** － parameter is valid **invalid_param** － parameter is not valid Default=**476C6F62616C53617432303136616263**

Read AES128 Encryption	
Command	**Description**
AAT3 A1=?	Response: AES128 Key in hexadecimal Character

Set Retries Number and Timeout of MOST-Link	
Command	**Description**
AAT3 P3=[parameter1],[parameter2]	[Parameter1]: Retries number of MOST-Link while not getting ACK (0~9) 0=disable, Default=0 [Parameter2]: Timeout of getting ACK (1~255 seconds) Default=3 Response: **ok** – parameter are valid **invalid_param** – one or both parameter are not valid

Read Retries Number and Timeout of MOST-Link	
Command	**Description**
AAT3 P3=?	Response: Retries number,timeout

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.   If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution:
- Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.
- This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

FOR MOBILE DEVICE USAGE (>20cm/low power)
Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This device is intended only for OEM integrators under the following conditions:

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further <u>transmitter</u> test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE: In the event that these conditions <u>can not be met</u> (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID <u>can not</u> be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID:RID-LM110H1". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.