pLNetworks PLM150 LoRaWAN Module User Guide

Contents

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Revision History

Who	***Version***	***Date***	***Comment***
Beom Kang	1.0	05 18, 2021	Initial release

Introduction

Overview

PLNetworks PLM150 is a Sub-GHz band based wireless communication module for IoT and provides low power, long range wireless connectivity using the LoRa RF transceivers from ST. PLM150 can be interconnected with the CPU (MCU) of the host system through the UART Serial Interface and provides an optimized text command/response interface. With this interface, the host system can configure PLM150 and transmit/receive wireless data.

PLM150 implemented the LoRaWAN protocol for the wireless data transmission, enabling low power, long range two way communications.

The host can transmit commands to PLM150 for the configuration using UART interface. When PLM150 receives the commands, it applies to the configuration setting and sends the result to the host.

Features

- LoRaTM Radio Transceiver
- Ultra Low Power & High Performance Microcontroller
- 6LoWPAN, IPv6, UDP, CoAP, RPL(Cluster tree) (Scheduled)
- LoRaWAN Spec 1.0.2 Class A/C
- AES-128 encryption/decryption
- Interface: I2C, GPIO, UART, ADC
- Frequency: 902.9~927.3MHz, Data Rate: 0.3kbps~5kbps
- Range: 15km(LoRa – LOS, 10dBm, 900MHz)
- Operation Temperature: -20~60 oC

Host Interface

PLM150 connects to the Host, transmit and receive its Commands and Responses over UART using the ASCII interface. The baud rate can be changed for the Console and other external device interfaces.

[Table 1 UART Configuration]

Parameter	Value
Baudrate	115200
Data bits	8bit
Parity bits	None
Stop bits	1bit
Flow control	None

GPIO Interface

Various functions can be implemented through GPIO interface in PLM150. Currently, serial enable / disable function is implemented through GPIO 3.

[Table 2 PIN Description]

No	PIN Name	Description
1	GPIO3	Control UART1 Serial Rx Enable through GPIO 3 (HIGH : Enable, LOW : Disable) ex) When AT command is used, GPIO 3 pin is set to HIGH and GPIO3 p in is set to LOW for low power after AT command use.

Command Interface

PLM150 sends/receives Commands and Responses to the host in AT mode through UART. AT mode is to set the configuration and control the connection by issuing the standard AT commands via a serial interface. PLM150 operates in AT mode after the initial booting. Users can issue the AT commands to receive the current setting values and send the values for the configuration setting. Some of the configuration (value) changes may require to reboot the system, which can be done by issuing the “AT+RSET” command.

AT Commands

Commands Type

All of the AT command lines must start with ‘AT’ prefix and be terminated with <CR>. It supports the command syntax in Table 2. The default setting for the AT commands supports ECHO, and the user can issue “AT+ECHO=0” to stop ECHO. “AT” and <command> are case sensitive for the upper (Capital) and lower characters.

[Table 3 Command Type]

Start	Command	End
AT	<Command>	<CR>(0x0d)

The AT command supports Search and Configuration features. The Search AT commands start with “+” followed by the 4 digit string and the Configuration commands contains command values after the Search commands.

[Table 4 Search & Configuration AT Command]

Search	**Configuration**
+<command>	+<command>=<value>

The following table describes the response message format from the host when Search and Configuration AT commands are issued.

[Table 5 AT Response Type]

Start	**Response Message**	**End**
<CR><LF>(0x0d, 0x0a)	<Response Msg>	<CR><LF>(0x0d, 0x0a)

The response message informs the current configuration values and the updated values after the configuration changes by AT commands. If any fail occurs during the AT command execution, “FAIL” message will be sent as the response message.

System Command

System AT commands executes the PLM150 system configuration.

[Table 6 System Command]

Command	**Function**	**Description**
+HELP	Help	List the AT Commands that PLM150 supports.
+SHOW	Show	Return the current configuration setting values.
+RSET	PLM150 reset	Reboot PLM150. Rebooting will take 2 to 3 seconds after issuing the command.

+SLEP +SLEP=<sec>	Sleep Mode	Put the system to low-power (Sleep) mode for the specified n umber of seconds. Note: AT commands via Console, data sending and receiving will not be executed during the specified sleep time.
+GEUI	Serial number	Return PLM150 Serial Number(EUI). Read-only
+BATT	Power Voltage	Returns the Voltage value of input power. If a battery is used, the battery power level value will be returned .
+CBAR +CBAR=<baudrate>	Console Baudrate	Configure UART baud rate to the host. Supporting baud rate : 9600, 19200, 38400, 57600, 115200 <Default Value> : 115200
+UBAR +UBAR=<baudrate>	User UART Baudrat e	Configure UART baud rate for a sensor interface (in the even t of connecting any sensors). Supporting baud rate: 9600, 19200, 38400, 57600, 115200 <Default Value> : 9600
+ECHO +ECHO=1 or 0	Console Echo mode	Console UART Echo mode (1: enable, 0:disable)

		<Default Value> : Enable
+DEFL	Default Configuration	Reset the system to the factory setting (applied after rebooting the system).
+UREL +UREL=1 or 0	UART Relay	Return the data inputted to UART0 to the console (UART1) (1: enable, 0: disable) <Default Value> : Disable
+RXDP +RXDP=1 or 0	RX Display	Set the received data format (1: HEX, 0: ASCII) <Default Value> : ASCII

LoRa RF Command

In the case of LoRaWAN, using the ADR function networks server changes the frequency and LoRa setting value according to the channel environment. However, in order to fix the RF setting directly without using the ADR function, set it through the following command.

[Table 7 LoRa RF Command]

Command	Function	Description
+FREQ +FREQ=<channel>	RF Frequency	Configure RF channel (0~7). As the channel number increases, Starting 923.2MHz, the center frequency increases by 0.2 MHz. <Default Value> : 923.2MHz
+SPFA +SPFA=<value>	Spreading Factor	Set the value of LoRa Spreading Factor (7~12) Higher value will result lower data rate but Long distance <Default Value> : SF10

ex) Channel bandwidth 125kHz case

SF	Data Rate	Rx sensitivity
7	5.4kbps	-125
8	3.1kbps	-128
9	1.7kbps	-131
10	0.9kbps	-134
11	0.5kbps	-136

<table>
<tr><td></td><td></td><td><table>
<tr><td>12</td><td>0.3kbps</td><td>-137</td></tr>
</table></td></tr>
<tr><td>+CORA
+CORA=<value></td><td>Coding Rate</td><td>Set the Coding Rate used for the data sending (1~4)
1: 4/5, 2:4/6, 3:4/7, 4:4/8
<Default Value> : 4/5</td></tr>
<tr><td>+BWTH
+BWTH=<value></td><td>Channel Bandwidth</td><td>Set the Channel bandwidth (0~2) 1: 125kHz, 2: 250kHz, 3:500kHz
<Default Value> : 125KHz</td></tr>
<tr><td>+OPWR
+OPWR=<Channel>,<power></td><td>Output Power</td><td>Set the Tx Power
– Channel : Total 8 Channels (0~7)
– MaxEIRP : 10 dBm ex) AT+OPWR=0,0<CR>
<Default Value> : 0(MaxEIRP)<table>
<tr><th>Tx Power</th><th>Configuration
(EIRP)</th></tr>
<tr><td>0</td><td>MaxEIRP</td></tr>
<tr><td>1</td><td>MaxEIRP – 2dBm</td></tr>
<tr><td>2</td><td>MaxEIRP – 4dBm</td></tr>
<tr><td>3</td><td>MaxEIRP – 6dBm</td></tr>
<tr><td>4</td><td>MaxEIRP – 8dBm</td></tr>
<tr><td>5</td><td>MaxEIRP – 10dBm</td></tr>
</table></td></tr>
</table>

		6	MaxEIRP – 12dBm	
		7	MaxEIRP – 14dBm	
+FFRE +FFRE=1 or 0	Frequency Force	Whether or not to use default Frequecy (1: enable, 0: disable) <Default Value> : Disable		
+FSPF +FSPF=1 or 0	SF Force	Whether or not to use default LoRa setting (Spreading Factor, Bandwidth ,Coding Rate) (1: enable, 0: disable) <Default Value> : Disable		
+FOPW +FOPW=1 or 0	Pa Force	Whether or not to use default Power setting (1: enable, 0: disable) <Default Value> : Disable		
+FDRT +FDRT=1 or 0	Retry Force	Whether or not to use default Retry setting (1: enable, 0: disable) <Default Value> : Disable		

LoRaWAN Command

[Table 8 LoRaWAN Command]

Command	Function	Description
+AEUI +AEUI=<string>	Application EUI	Set the application EUI (8byte hexa)
+APKE +APKE=<string>	Application Key	Set the application Key (16byte hexa)
+NSKE +NSKE=<string>	Network session Key	Set the network session Key (16byte hexa)

+ASKE +ASKE=<string>	Application session Key	Set application session Key (16byte hexa)
+DADR +DADR=<string>	Device address	Set device address (4byte hexa)
+LTYP +LTYP=1 or 0	LoRa packet type	Set the LoRa packet type (0: Unconfirmed, 1: Confirmed) <Default Value> : Confirmed
+LPRT +LPRT=<FPort>	LoRaWAN FPort	Set the LoRaWAN FPort (0 ~ 255) <Default Value> : 172
+CLAS +CLAS=<Class>	LoRaWAN Class	Set the LoRaWAN Class (0: A, 1: B, 2: C) *Class B is not prepared <Default Value> : Class A
+ADRE +ADRE=1 or 0	LoRaWAN ADR	Set the LoRaWAN ADR funciont on/off (1: enable, 0: disable) <Default Value> : Enable
+PUBL +PUBL=1 or 0	LoRaWAN Public	Set the LoRaWAN Public or not (1: enable, 0: disable) <Default Value> : Enable
+RAKE +RAKE=1 or 0	LoRaWAN Real Appk ey	Set the LoRaWAN Real Appkey (1: enable, 0: disable) <Default Value> : Enable
+DPRD +DPRD=<value>	LoRaWAN Data Tx P eriod	Set the LoRaWAN Data Tx Period (0 ~ 2592000) <Default Value> : 30
+DRTY	LoRaWAN Data	Set the LoRaWAN Data Tx Retry number of times

+DRTY=<value>	Tx Retry	(0 ~ 8) <Default Value> : 1
+LCHK	LinkCheckReq Command	Transfer LinkCheckReq Mac Command to Server

Data Transfer Command

[Table 9 Data Transfer Command]

Command	**Function**	**Description**
+DATA=<string>	Transfer Data	Transfer input data(string) to Server ex) AT+DATA=<application string><CR>

When data is received, the sender's Fport and RF signal strength (RSSI) value are transmitted to the host through the console UART together with the received data as follows.

[Table 10 Receive Data Format]

Data Recv Format	**Example**
RECV:<Fport>:<RSSI>:<Data>	RECV:172:-110:hello world!

FCC Compliance 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.

FCC Interference Statement

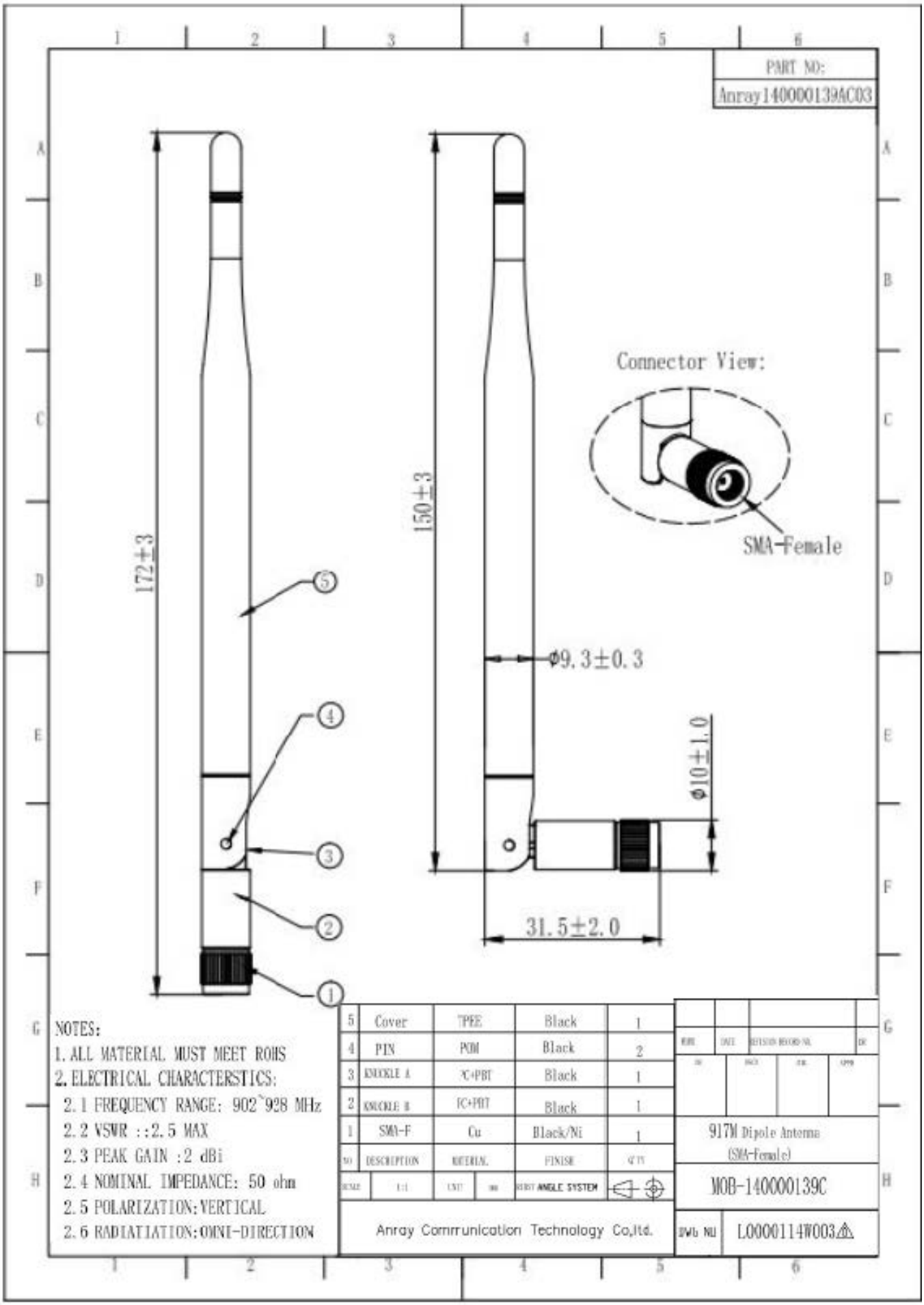
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate 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 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 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.
FCC 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 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Antenna designs



Information on test modes and additional testing requirements

a) The modular transmitter has been fully tested by the module grantee on the required number of channels,modulation types and modes, it should not be necessary for the host installer to re-test all the available

transmitter modes or settings.It is recommended that the host product manufacturer installing the modular transmitter,perform some investigative measurements to confirm that the resulting composite system does not exceed the spurious emissions limits or band edge limits(e.g.,where a different antenna may be causing additional emissions).
b) The testing should check for emissions that may occur due to the intermixing of emissions with the other transmitter, digital circuitry,or due to physical properties of the host product(enclosure). This investigation is especially important when integrating
multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration. It is important to note that host product manufactures should not assume that because the modular transmitter is certified that they do not have any responsibility for final product compliance.

Additional testing, Part 15 subpart B disclaimer

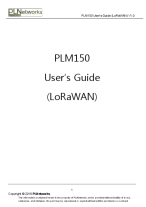
The final host/module combination need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
The host integrator installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation and should refer to guidance in KDB 996369.
This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter.

- OEM integrators must ensure that its product is electrically identical to the device, FCC ID: 2AUV6-PLM150 reference designs. Any modifications to module reference designs may invalidate regulatory approvals in relation to the product, or may necessitate notifications to the relevant regulatory authorities.
- OEM integrators are responsible for regression testing to accommodate changes to designs, new antennas, and host and submit for C2PC filings.
- Colocation with other transmitter modules will be addressed through filings for those co-located transmitters when necessary or that colocation of other transmitters will be according to applicable KDB guidelines including those for RF exposure
- Appropriate labels must be affixed to the product that complies with applicable regulations in all respects. The regulatory label on the final system must include the statement: “Contains FCC ID: 2AUV6-PLM150”.
    1. The module is limited to OEM installation ONLY.
    2. OEM integrators are responsible for ensuring that the end-user has no manual instructions to remove or install module.
    3. The module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
    4. Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations.

End Product Labeling

The module is labeled with its own FCC ID. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following: “Contains FCC ID: 2AUV6-PLM150”

Documents / Resources

	**pLNetworks PLM150 LoRaWAN Module** [pdf] User Guide PLM150, 2AUV6-PLM150, 2AUV6PLM150, PLM150, LoRaWAN Module