

PLM100

(Part No : M100PW, M100CW)

User's Guide

(LoRaWAN)

Revision History

<i>Who</i>	<i>Version</i>	<i>Date</i>	<i>Comment</i>
Beom Kang	1.0	Mar 09, 2018	Initial release
MY Heo	1.1	Jul 13, 2018	Remove explanation PLS100 and add PLM100
Beom Kang	1.2	Dec 13, 2019	Adjust Tx Power Table

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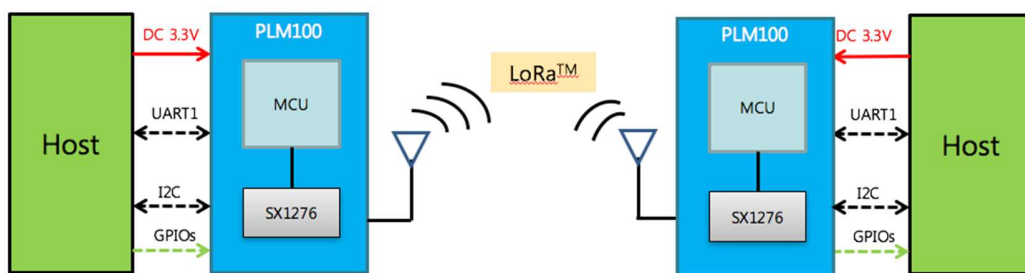
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1 Introduction

1.1 Overview

PLNetworks PLM100 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 Semtech. PLM100 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 PLM100 and transmit/receive wireless data.

PLM100 (Part No : M100PW, M100CW) implemented the LoRaWAN protocol for the wireless data transmission, enabling low power, long range two way communications.



[Figure 1. PLM100 Network Diagram]

Note: this document is intended to describe an implementation of the LoRa wireless communication module using RF transceivers from Semtech, which information and specifications can be found in more detail from the website (<http://www.semtech.com/>).

PLM100 can transmit sensor data to the host using PLNetworks' evaluation board, PL-EVK1. PL-EVK1 supports UART interface and allows to attach MEMS based sensors (temperature, humidity, pressure, illumination, proximity/movement, gyroscope, etc.).

The host can transmit commands to PLM100 for the configuration using UART interface. When PLM100 receives the commands, it applies to the configuration setting and sends the result to the host.

1.2 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/B/C
- AES-128 encryption/decryption
- Interface: I2C, GPIO, UART, ADC
- Frequency: 920.6~928MHz, Data Rate: 0.3kbps~5kbps
- Range: 15km(LoRa – LOS, 10dBm, 900MHz)
- Operation Temperature: -20~60 °C
- Max Current: 30~40mA(TX), 10mA(Listen), 11uA(Sleep)

1.3 Host Interface

PLM100 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

1.4 GPIO Interface

Various functions can be implemented through GPIO interface in PLM100. 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 pin is set to LOW for low power after AT command use.

2 Command Interface

PLM100 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. PLM100 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.

2.1 AT Commands

2.1.1 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.

2.1.2 System Command

System AT commands executes the PLS100 system configuration.

[Table 6 System Command]

Command	Function	Description
+HELP	Help	List the AT Commands that PLS100 supports.
+SHOW	Show	Return the current configuration setting values.
+RSET	PLS100 reset	Reboot PLS100. 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 number of seconds. Note: AT commands via Console, data sending and receiving will not be executed during the specified sleep time.
+GEUI	Serial number	Return PLS100 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 Baudrate	Configure UART baud rate for a sensor interface (in the event 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

2.1.3 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 <table><tr><th>SF</th><th>Data Rate</th><th>Rx sensitivity</th></tr><tr><td>7</td><td>5.4kbps</td><td>-125</td></tr><tr><td>8</td><td>3.1kbps</td><td>-128</td></tr><tr><td>9</td><td>1.7kbps</td><td>-131</td></tr><tr><td>10</td><td>0.9kbps</td><td>-134</td></tr><tr><td>11</td><td>0.5kbps</td><td>-136</td></tr><tr><td>12</td><td>0.3kbps</td><td>-137</td></tr></table>	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	12	0.3kbps	-137
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																					
12	0.3kbps	-137																					
+CORA +CORA= <value>	Coding Rate	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																					
+BWTH +BWTH= <value>	Channel Bandwidth	Set the Channel bandwidth (0~2) 1: 125kHz, 2: 250kHz, 3:500kHz <Default Value> : 125KHz																					
+OPWR +OPWR= <Channel>,<power>	Output Power	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>	Tx Power	Configuration (EIRP)	0	MaxEIRP	1	MaxEIRP – 2dBm	2	MaxEIRP – 4dBm	3	MaxEIRP – 6dBm	4	MaxEIRP – 8dBm	5	MaxEIRP – 10dBm							
Tx Power	Configuration (EIRP)																						
0	MaxEIRP																						
1	MaxEIRP – 2dBm																						
2	MaxEIRP – 4dBm																						
3	MaxEIRP – 6dBm																						
4	MaxEIRP – 8dBm																						
5	MaxEIRP – 10dBm																						

		6	MaxEIRP – 12dBm	
		7	MaxEIRP – 14dBm	
+FFRE +FFRE=1 or 0	Frequency Force	Whether or not to use default Frequency (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		

2.1.4 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 Appkey	Set the LoRaWAN Real Appkey (1: enable, 0: disable) <Default Value> : Enable
+DPRD +DPRD= <value>	LoRaWAN Data Tx Period	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

2.1.5 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!