



LoRa AT+Command Manual

Powered by MS500

FEATURES

- Powered by MS500, the eWBM's Ultra-Low Power Advanced Security MCU
 - ◇ Cortex M0
 - ◇ Hardware Security system.
- SEMTECH SX1276 radio transceiver supporting LoRa.
 - ◇ Receiver Sensitivity up to -136 dBm
 - ◇ Frequency Range: 920 – 923 MHz (Korea), 923 (Japan/Asia), 863 – 870 MHz (EU), 902 – 928 MHz (North America), 865 – 867 MHz (India)
 - ◇ Up to 14 dBm Output Power
 - ◇ LoRa Alliance Certified
- UART Communication Interface
 - ◇ AT+Command set support for LoRaWAN
- LoRaWAN Certified
 - ◇ KR920-923 (Korea), AS923 (Japan/Asia), EU863-870 (Europe)

CONTENTS

- Features 2
- Contents..... 3
- 1. Features..... 6
- 2. Application Model 7
- 3. Serial Port Setup 7
- 4. Command Format..... 7
- 5. AT+Command usage Scenario 8
 - 5.1. Initial Join request to Network Server Over the air activation (OTAA) 8
 - 5.2. Data transfer during server connection (Upload, download)..... 10
 - 5.3. Entering Sleep Mode and Waking up from Sleep Mode 11
- 6. Activation Command 12
 - 6.1. Command Table 12
 - 6.2. Command Details..... 12
 - 6.2.1. AT+DEVEUI 12
 - 6.2.2. AT+APPEUI 13
 - 6.2.3. AT+APPKEY 13
 - 6.2.4. AT+PNM 14
 - 6.2.5. AT+NJM 14
 - 6.2.6. AT+CLASS..... 15
 - 6.2.7. AT+JOIN 15
 - 6.2.8. AT+NJS..... 16
 - 6.2.9. AT+AJOIN..... 16
 - 6.2.10. AT+NWKSKEY 17
 - 6.2.11. AT+APPSKEY 17
 - 6.2.12. AT+DADDR 18
 - 6.2.13. AT+NWKID..... 18
 - 6.2.14. AT+AINF..... 19
- 7. UP/Down Link Command 20
 - 7.1. Command Table 20
 - 7.2. Command Details..... 20


- 7.2.1. AT+SEND..... 20
- 7.2.2. AT+SENDB 21
- 7.2.3. AT+RECV 21
- 7.2.4. AT+RECVB..... 22
- 7.2.5. AT+RSSI 23
- 7.2.6. AT+SNR..... 23
- 8. LoRaMAC Configure Command 24
 - 8.1. Command Table 24
 - 8.2. Command Details..... 24
 - 8.2.1. AT+REGION 24
 - 8.2.2. AT+ADR 25
 - 8.2.3. AT+DR..... 26
 - 8.2.4. AT+RX2FQ..... 27
 - 8.2.5. AT+RX2DR 27
 - 8.2.6. AT+RX1DL 28
 - 8.2.7. AT+RX2DL 28
 - 8.2.8. AT+JN1DL 29
 - 8.2.9. AT+JN2DL 29
 - 8.2.10. AT+MUFR 30
 - 8.2.11. AT+MCFR..... 30
 - 8.2.12. AT+TXP 31
 - 8.2.13. AT+FCU 32
 - 8.2.14. AT+FCD 32
 - 8.2.15. AT+BAT 33
 - 8.2.16. AT+LCHK 33
 - 8.2.17. AT+CRYPTO 34
- 9. System Command..... 35
 - 9.1. Command Table 35
 - 9.2. Command Detail 35
 - 9.2.1. AT+RESET 35
 - 9.2.2. AT+SINF 36
 - 9.2.3. AT+VER 36
 - 9.2.4. AT+SAG..... 37

- 9.2.5. AT+CFM 37
- 9.2.6. AT+SLEEP 38
- 9.2.7. AT+ALARM 38
- 9.2.8. AT+TIME 39
- 9.2.9. AT+DATE 40
- 9.2.10. AT+ECHO 40
- 10. Debug Command 41
 - 10.1. Command Table 41
 - 10.2. Command Detail 41
 - 10.2.1. AT+DBG 41
 - 10.2.2. AT+TXCW 42
 - 10.2.3. AT+RXTT 42
 - 10.2.4. AT+TXTT 43
 - 10.2.5. AT+TSTP 43
 - 10.2.6. AT+GPIO 44
- Document Revision and Reference 45

1. FEATURES

- Powered by MS500, the eWBM's Ultra-Low Power Advanced Security MCU
 - ◇ Cortex M0
 - ◇ Hardware Security system.
- SEMTECH SX1276 radio transceiver supporting LoRa.
 - ◇ Receiver Sensitivity up to -136 dBm
 - ◇ Frequency Range: 920 – 923 MHz (Korea), 923 (Japan/Asia), 863 – 870 MHz (EU), 902 – 928 MHz (North America), 865 – 867 MHz (India)
 - ◇ Up to 14 dBm Output Power
 - ◇ LoRa Alliance Certified
- UART Communication Interface
 - ◇ AT+Command set support for LoRaWAN
- LoRaWAN Certified
 - ◇ KR920-923 (Korea), AS923 (Japan/Asia), EU863-870 (Europe)

2. APPLICATION MODEL

 DLS76_01K41

 eLR100-US, eLR100-UL

3. SERIAL PORT SETUP

- Baud rate : 115200
- Data : 8 bit
- Parity : None
- Stop : 1 bit
- Flow control : none

4. COMMAND FORMAT

A. FORMATTING RULES FOR CHARACTER STRING COMMAND

- i. Command Line terminates either in <CR> or <LF>.
- ii. Command Parameter is defined by a Blank Character.
- iii. Command Parameter is separated by the symbol <, > as described below.
 - ➔ CR + LR + '<' + "OK or an error string" + '>' + CR + LR

B. Status Strings following command execution

- I. All commands return with one of the following four status strings after execution as shown below.
 - <OK>: Command executed successfully
 - <Failed>: Command failed to execute
 - <Failed: "Error Character String">
 - <Command Not Found>: Command is Not Found.

C. Command Attributes

- I. All Commands have one or more of the following attributes.
 - R: Command to read out data and/or to monitor system status
 - W: Command to Write and/or to control system status
 - F: Command to store configuration in Flash memory
 - +: Reset the module after system control command is executed
 - E: Asynchronous Event (for example when data is received)

5. AT+COMMAND USAGE SCENARIO

5.1. INITIAL JOIN REQUEST TO NETWORK SERVER OVER THE AIR ACTIVATION (OTAA)

1. To connect to LoRa network server, the device EUI information of the node device (module) must be sent to the server company, and in return the server company must provide Application EUI (AppEUI) and Application KEY (AppKEY) to each node.

A) Device EUI of the Node can be obtained by using AT+Command (see below), or from module label

```
AT+DEVEUI
0000000000000001
<OK>
```

2. The received AppEUI and AppKey are stored in the Node device (Module) by using the following AT+Command.

```
AT+APPEUI 70b3d57ed0010e4f
<OK>
AT+APPKEY de52ddd16146079649c89a0c1bd9eae5
<OK>
```


3. Execute AT+JOIN command to join the server. The connection status can be checked in the resulting Log file. It can also be confirmed by running AT+NJS command.

```

AT+JOIN
Send JOIN_REQ Port 0 Size 0 Adr 1 AdrAckReq 0 Ack 0 Cnt 0
00:00:19.925 TxConfig ch 922500000 pwr 14 bw 0 sf7

<OK>
00:00:20.001 TxDone
00:00:24.974 RxConfig ch 922500000 bw 0 sf7
00:00:26.037 RxConfig ch 921900000 bw 0 sf12
00:00:27.072 TxConfig ch 922100000 pwr 14 bw 0 sf7
00:00:27.148 TxDone
00:04:42.642 RxConfig ch 922100000 bw 0 sf7
Rx1 JOIN_ACCEPT size 33 rssi -88 snr 24 Rx1DrOffset 0 RxDelay1 1000 Rx2Dr 0

[EVENT] JOINED ← A Event Message is generated when the server connection is completed.
AT+NJS ← To monitor the Join status to the server
1 ← (0: not connected, 1: connected)
<OK>

```

4. AT+COMMAND as shown below is used to setup mode automatically during the boot mode of the module.

```

AT+AJOIN 1 <- set "1"

<OK>
AT+RESET <- Reset (Reboot) the Module
*
Boot by CPU
OTAA
KR920
Boot completed <- Message indicating the Booting is completed

* an Attempt to auto Join as shown below.

Send JOIN_REQ Port 0 Size 0 Adr 1 AdrAckReq 0 Ack 0 Cnt 0
00:07:34.585 TxConfig ch 922500000 pwr 14 bw 0 sf7
00:07:34.660 TxDone
AT+A00:07:39.644 RxConfig ch 922500000 bw 0 sf7
Rx1 JOIN_ACCEPT size 33 rssi -88 snr 26 Rx1DrOffset 0 RxDelay1 1000 Rx2Dr 0
[EVENT] JOINED <- Join is completed

```

5.2. DATA TRANSFER DURING SERVER CONNECTION (UPLOAD, DOWNLOAD)

1. Uplink: Send Data from the Node to Network server

```

AT+SENDB 2:1100ff -> Send the 3 Byte Hexadecimal [ 11, 00, ff ] data to Port #2
Send UNCONFIRMED_UP Port 2 Size 3 Adr 1 AdrAckReq 0 Ack 0 Cnt 0
00:16:37.677 TxConfig ch 922100000 pwr 14 bw 0 sf12

<OK>
00:16:39.009 TxDone
00:16:40.035 RxConfig ch 922100000 bw 0 sf12
00:16:41.046 RxConfig ch 921900000 bw 0 sf12

```

2. Downlink: Identifying data sent from a network server to a Node

This is under the default Class A. In order to receive data at a Node, Uplink data must be sent to Server.

```

AT+SEND 2:hello -> Send Text Data "hello" to Port #2
Send UNCONFIRMED_UP Port 2 Size 5 Adr 1 AdrAckReq 0 Ack 0 Cnt 1
00:18:36.373 TxConfig ch 923100000 pwr 14 bw 0 sf12

<OK>
00:18:37.705 TxDone
00:18:38.720 RxConfig ch 923100000 bw 0 sf12
00:18:39.732 RxConfig ch 921900000 bw 0 sf12

Rx2 UNCONFIRMED_DOWN size 16 rssi -91 snr 29 Adr 0 AdrAckReq 0 Ack 0 Cnt 0

[EVENT] RECVB 1:aabbff -> Received the 3 Byte Hexadecimal data [ aa,bb,ff] from server to Port #1

AT+RECVB <- To confirm the received downlink data
1:aabbff

<OK>
AT+RECVB <- Once confirmed, the received data is removed. Thus, no output.
1:

<OK>

```

5.3. ENTERING SLEEP MODE AND WAKING UP FROM SLEEP MODE

: When there is no activity after connecting to the network server, set the device in Sleep mode to save battery power

1. Wake up the module by RESET signal after entering sleep mode

```
AT+SLEEP <- Command to Enter Sleep Mode
[EVENT] SLEEP <- Message indicating Entering Sleep Mode is completed

*
Wakeup by RESETN <- Message indicating the Wake up by RESET
OTAA
KR920
Wakeup completed <- Message indicating Wake up is completed
```

2. Wake up by setting the RTC Alarm

```
AT+ALARM 5 <- Set to Wake up, 5 second after entering Sleep Mode

<OK>

AT+SLEEP <- Command to Enter Sleep Mode
[EVENT] SLEEP <- Entering Sleep Mode is completed

*
Wakeup by RTC <- Message indicating Wake up by RTC
OTAA
KR920
Wakeup completed <- Message indicating Wake Up is completed
```

6. ACTIVATION COMMAND

6.1. COMMAND TABLE

Table 1 Activation Command Table

AT Command	Description	Reference
AT+DEVEUI	Unique End-device identifier	6.2.1
AT+APPEUI	Unique ID of the Application Server	6.2.2
AT+APPKEY	Encryption Key Between the Msg (Source and the destination)	6.2.3
AT+PNM	Public Network Mode Status	6.2.4
AT+NJM	Network Join Mode	6.2.5
AT+CLASS	LoRa Mac Class	6.2.6
AT+JOIN	Execute JOIN request for LoRa Network Server	6.2.7
AT+NJS	Join (Network Server Connection) Status	6.2.8
AT+AJOIN	Execute auto JOIN after the booting	6.2.9
AT+NWKSKY	Network Session Key	6.2.10
AT+APPSKEY	Application Session Key	6.2.11
AT+DADDR	Device Address (4 Byte)	6.2.12
AT+NWKID	Returns Network ID (4 Byte)	6.2.13
AT+AINF	Returns Activation setting value	6.2.14

6.2. COMMAND DETAILS

6.2.1. AT+DEVEUI

- End-device identifier in IEEE EUI64 address space (Provided by the Module Manufacturer)
- 16 Hex Digit (8 Byte)

Table 2 AT+DEVEUI

Syntax	Operation	Remark
	R	Readout the current value of DevEUI [Example] AT+DEVEUI 0000000000000001 <OK>
AT+DEVEUI	WF	Update DevEUI with specified value and store it in secure storage (in Flash memory) [Format] : AT+DEVEUI <devEUI> <ENTER> [Example] AT+ DEVEUI 0000000000000001 <OK>

6.2.2. AT+APPEUI

- The AppEUI is a global application ID in IEEE EUI64 address space (Provided by the Lora Network Supplier)
- 16 Hex digit (8 Byte) input and output.

Table 3 AT+APPEUI

Syntax	Operation	Remark
AT+APPEUI	R	Readout the current value of AppEUI [Example] AT+APPEUI 70b3d57ed0010e4f <OK>
	WF	Update AppEUI with specified value and store it in secure storage (in Flash memory) [Format] : AT+APPEUI <AppEUI> <ENTER> [Example] AT+ APPEUI 70b3d57ed0010e4f <OK>

6.2.3. AT+APPKEY

- To read out the Application key (AppKey). The AppKey is an AES-128 root key specific to the end-device (Provided by the Lora Network Supplier).
- 32 hex digit (16 Byte) input and output.

Table 4 AT+APPKEY

Syntax	Operation	Remark
AT+APPKEY	R	Readout the current value of Application Key [Example] AT+APPKEY de52ddd16146079649c89a0c1bd9eae5 <OK>
	WF	Update Application Key (16 Byte) with specified value (ABP only) and store it in secure storage (in Flash memory). [Format] : AT+APPKEY <AppKey> <ENTER> [Example] AT+APPKEY de52ddd16146079649c89a0c1bd9eae5 <OK>

- **Note)** AppKey: 32 hex digit (16 Byte)

6.2.4. AT+PNM

- Public Network Mode Status
% (Under the Lora Network (Server) Policy).

Table 5 AT+PNM

Syntax	Operation	Remark
AT+PNM	R	Readout the current setting value of Public Network Mode [Example] AT+PNM 1 <OK>
	WF	Update the setting value of Public Network Mode with specified value [Format] : <u>AT+PNM <0 1> <ENTER></u> [Example] AT+PNM 0 <OK>

- **Note)** 0 : Public Network OFF
1 : Public Network ON (Default)

6.2.5. AT+NJM

- Command for Network Join Mode Setting

Table 6 AT+NJM

Syntax	Operation	Remark
AT+NJM	R	Return with current setting value of Network Join Mode [Example] AT+NJM 1 <OK>
	WF	Update Network Join Mode Setting with specified value [Format] : <u>AT+NJM <0 1> <ENTER></u> [Example] AT+NJM 1 <OK>

- **Note)** 0: ABP
1: OTAA (Default)

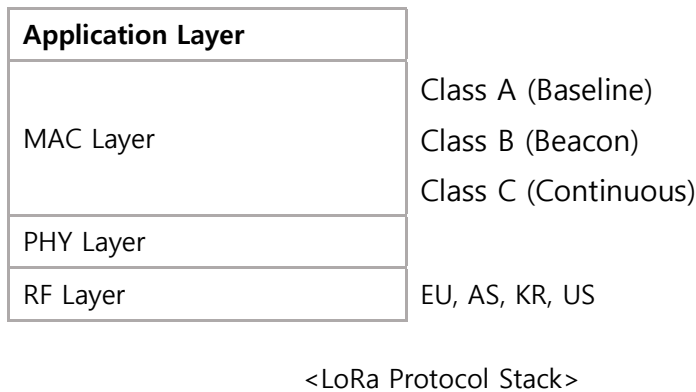
6.2.6. AT+CLASS

- Command for setting the LoRa MAC Class

Table 7 AT+CLASS

Syntax	Operation	Remark
AT+CLASS	R	Return with current setting value of LoRa MAC Class [Example] AT+CLASS A <OK>
	WF	Update the LoRa MAC CLASS with specified value [Format] : <u>AT+CLASS <LoRa MAC Class> <ENTER></u> [Example] AT+CLASS C <OK>

- **Note)** LoRa MAC Class : A(Default), B, or C



6.2.7. AT+JOIN

- Command to Join LoRa Network Server

Table 8 AT+JOIN

Syntax	Operation	Remark
AT+JOIN	W	Join Request command to LoRa Network Server [Format] : <u>AT+JOIN <ENTER></u> [Example] AT+JOIN <OK>
	E	When JOIN Request is successful, the EVENT Message returns [Example] <timestamp><space>"[EVENT]"<space>"JOINED"<CR><LF> 03:00:02.556 [EVENT] JOINED

6.2.8. AT+NJS

- Command to check Join Status

Table 9 AT+NJS

Syntax	Operation	Remark
		[Format] : <u>AT+NJS <ENTER></u>
AT+NJS	R	[Example] AT+NJS 1 <OK>

- **Note)** 0 : Network not joined
1 : Network joined

6.2.9. AT+AJOIN

- Command to set Automatic Join Request when device is booted.

Table 10 AT+AJOIN

Syntax	Operation	Remark
		Return with current setting value of Automatic Join Request when device is booted.
	R	[Example] AT+AJOIN 0 <OK>
AT+AJOIN		Update the setting value of Automatic Join Request when device is booted with specified value
	WF	[Format] : <u>AT+AJOIN <0 1> <ENTER></u> [Example] AT+AJOIN 1 <OK>

- **Note)** 0 : OFF (Automatic Join Request is off)
1 : ON (Automatic Join Request is set)

6.2.10. AT+NWKSKEY

- Network Session Key (16 Byte)
% Automatic from OTAA Join Mode
- 32 hex digit (16 Byte) input and output.

Table 11 AT+NWKSKEY

Syntax	Operation	Remark
AT+NWKSKEY	R	Readout the current setting value of Network Session Key [Example] AT+NWKSKEY 74b3ee804428aaca16f319ab5d615f0b <OK>
	WF	Update Network Session Key (16 Byte) with specified value (ABP only) [Format] : AT+NWKSKEY <Network Session Key> <ENTER> [Example] AT+NWKSKEY 74b3ee804428aaca16f319ab5d615f0b <OK>

6.2.11. AT+APPSKEY

- Application Session Key (16 Byte)
- 32 hex digit (16 Byte) input and output.

Table 12 AT+APPSKEY

Syntax	Operation	Remark
AT+APPSKEY	R	Readout the current setting value of Application Session Key [Example] AT+APPSKEY 5e337a1a75a4f87911cb718631a162ff <OK>
	WF	Update Application Session Key (16byte) with specified value (ABP only) [Format] : AT+NWKSKEY <APPSKEY> <ENTER> [Example] AT+APPSKEY 5e337a1a75a4f87911cb718631a162ff <OK>

6.2.12. AT+DADDR

- Device Address (4 Byte)
- -> 8 hex digit (4 Byte) input and output. (e.g.) MSB 0x26, 0x05, 0x21, 0xe9

Table 13 AT+DADDR

Syntax	Operation	Remark
AT+DADDR	R	Readout current value of device address (4 Byte) [Example] AT+DADDR 260521e9 <OK>
	WF	Update Device Address with specified value (ABP only) [Format] : <u>AT+DADDR <Device Address> <ENTER></u> [Example] AT+DADDR 260521e9 <OK>

6.2.13. AT+NWKID

- Network ID (4 Byte)
-> Returns with 8 hex digits (4 Byte) (e.g. MSB 0x00, 0x12, 0x34, 0x56)
- Update Network ID with specified value (3 Byte) (e.g. MSB 0x12, 0x34, 0x56)

Table 14 AT+DADDR

Syntax	Operation	Remark
AT+NWKID	R	Readout current value of Network ID (4 Byte) [Example] AT+NWKID 00123456 <OK>
	WF	Update Network ID with specified value (3 Byte) (ABP Only) [Format] : <u>AT+DADDR <Device Address> <ENTER></u> [Example] AT+DADDR 123456 <OK>

6.2.14. AT+AINF

- Returns Related to Activation Setting Configuration
- Return Format: “AT Command Name” + “.” + setting value

Table 15 AT+AINF

Syntax	Operation	Remark
		[Format] : AT+AINF <ENTER>
		[Example]
		AT+AINF
		DEVEUI:0000000000000002
		APPEUI:70b3d57ed0010e4f
		APPKEY:de52ddd16146079649c89a0c1bd9eae5
		PNM:Public
		NJM:OTAA
		CLASS:A
		NJS:Joined0
		NetID:00123456
		DADDR:260521e9
		NWKSKEY:74b3ee804428aaca16f319ab5d615f0b
		APPSKEY:5e337a1a75a4f87911cb718631a162ff
		AJOIN:Auto
		<OK>
AT+AINF	R	

7. UP/DOWN LINK COMMAND

7.1. COMMAND TABLE

Table 16 UP/Down Link Command Table

AT Command	Description	Reference
AT+SEND	LoRa Data Uplink (data type in text)	7.2.1
AT+SENDB	LoRa Data Uplink (data type in hexadecimal)	7.2.2
AT+RECV	Confirm Received Downlink Data (data type in text)	7.2.3
AT+RECVB	Confirm Received Downlink Data (data type in hexadecimal)	7.2.4
AT+RSSI	Returns RSSI value of the last received data	7.2.5
AT+SNR	Returns SNR value from the last received data	7.2.6

7.2. COMMAND DETAILS

7.2.1. AT+SEND

- LoRa Data Uplink Command
- Send Data Type : text data

Table 17 AT+SEND

Syntax	Operation	Remark
AT+SEND	W	Uplink command of LoRa Data Data transfer type: text <hr/> [Format] : <code>AT+SEND <application port>:<data> <ENTER></code> [Example] Send text data string "12345" (5 Byte) to port #2 <code>AT+SEND 2:12345</code> <code><OK></code>

- **Note)** When the data is sent successfully, `<OK>` message returns
 If Failed to send, `<AT_ERROR>` message returns

7.2.2. AT+SENDB

- LoRa Data Uplink Command
- Send Data type : hexadecimal data

Table 18 AT+SENDB

Syntax	Operation	Remark
AT+SENDB	W	Uplink command of LoRa Data Data transfer type: hexadecimal <hr/> [Format] : <u>AT+SENDB <application port>:<data> <ENTER></u> <hr/> [Example] Send 5 Byte hexadecimal 0x0a 0x0b 0x0c 0x0d 0x0e to Port #2 AT+SENDB 2:0a0b0c0d0e <OK>

- **Note)** When the data is sent successfully, <OK> message returns.
If failed, <AT_ERROR> message returns.

7.2.3. AT+RECV

- Readout Received Downlink Data
- Received Data Type : text data

Table 19 AT+RECV

Syntax	Operation	Remark
AT+RECV	R	Readout received downlink data Data type: text <hr/> [Format] : <u>AT+RECV <application port>:<data> <ENTER></u> <hr/> [Example 1] No Data Received AT+RECV 0: <OK> [Example 2] Received Data is 12345 through port #2 AT+RECV 2:12345 <OK>

7.2.4. AT+RECVB

- Readout Received Downlink Data
- Received Data Type: hexadecimal data

Table 20 AT+RECVB

Syntax	Operation	Remark
		Readout received downlink data Data type: hexadecimal
		[Format] : <u>AT+RECVB=<application port>:<data> <ENTER></u>
		[Example] Received Data is 0x0a 0x0b 0x0c 0x0d 0x0e through port #2
	R	AT+RECVB 2:0a0b0c0d0e <OK>
AT+RECVB		* Once received data is read out, the data is removed. Thus, the following subsequent readout command returns no data as shown below. AT+RECVB 2: <OK>
	E	An EVENT Message is printed out when Payload data is received [Example] "[EVENT]"<space>"RECVB"<space><port number><colon> "Hex data"<CR><LF> [EVENT] RECVB 99:000102030405060708090a0b0c0d0e0f

7.2.5. AT+RSSI

- Readout RSSI value of the last received data

Table 21 AT+RSSI

Syntax	Operation	Remark
		Readout RSSI value of the last received data
		[Format] : <u>AT+RSSI <ENTER></u>
AT+RSSI	R	[Example] AT+RSSI -10 <OK>

7.2.6. AT+SNR

- Readout SNR (signal noise ratio) value of the last received data

Table 22 AT+SNR

Syntax	Operation	Remark
		Readout SNR value of the last received data
		[Format] : <u>AT+SNR <ENTER></u>
AT+SNR	R	[Example] AT+SNR 26 <OK>

8. LORAMAC CONFIGURE COMMAND

8.1. COMMAND TABLE

Table 23 LoRaMAC Configure Command

AT Command	Description	Reference
AT+REGION	LoRaMAC Region Configuration	8.2.1
AT+ADR	ADR Command	8.2.2
AT+DR	Data Rate Command	8.2.3
AT+RX2FQ	RX Window 2 frequency Command	8.2.4
AT+RX2DR	RX Window 2 data rate (0-7 corresponding to DR_X)	8.2.5
AT+RX1DL	The TX and the RX Window 1 Delay	8.2.6
AT+RX2DL	The TX and the RX Window 2 Delay	8.2.7
AT+JN1DL	The TX and the RX Window 1 Join Accept Delay	8.2.8
AT+JN2DL	The TX and the RX Window 2 Join Accept Delay	8.2.9
AT+MUFR	Unconfirmed uplink resend	8.2.10
AT+MCFR	Confirmed uplink resend	8.2.11
AT+TXP	TX Power index	8.2.12
AT+FCU	Uplink Counter	8.2.13
AT+FCD	Downlink Counter	8.2.14
AT+BAT	Battery Level	8.2.15
AT+LCHK	MAC Command <i>LinkCheckReq</i>	8.2.16
AT+CRYPTO	Encryption Configuration (Standard)	8.2.17

8.2. COMMAND DETAILS

8.2.1. AT+REGION

- Returns LoRaMAC Region Configuration

Table 24 AT+REGION

Syntax	Operation	Remark
		Readout current set value of LoRaMAC Region Configuration
AT+REGION	R	LORAMAC_REGION_AS923 = 0, LORAMAC_REGION_AU915 = 1, LORAMAC_REGION_CN470 = 2, LORAMAC_REGION_CN779 = 3, LORAMAC_REGION_EU433 = 4, LORAMAC_REGION_EU868 = 5, LORAMAC_REGION_KR920 = 6, (default) LORAMAC_REGION_IN865 = 7, LORAMAC_REGION_US915 = 8, LORAMAC_REGION_US915_HYBRID = 9

[Example]
 - Show status set to KR920 region

AT+REGION
 6

<OK>

Update the REGION set with specified value

[Format] : AT+REGION <0 - 9> <ENTER>

Warning) Once the parameter is set for Region, it becomes effective only after device reset.

WF

[Example] Update the Region set to KR920

AT+REGION 6
 <OK>

8.2.2. AT+ADR

- Auto Data Rate (ADR) Configuration

Table 25 AT+ADR

Syntax	Operation	Remark
AT+ADR	R	Readout current set value of ADR Configuration [Example] AT+ADR 1 <OK>
	WF	Set ADR Configuration [Format] : <u>AT+ADR <0 1> <ENTER></u> [Example] set ADR configuration to 0 AT+ADR 0 <OK>

- **Note)** 0 : ADR off, 1 : ADR on

8.2.3. AT+DR

- Current Data Rate Configuration Status. The spreading factor (SF) may vary by region.

Table 26 AT+DR

Syntax	Operation	Remark
AT+DR	R	Returns with current data rate [Example] AT+DR 0 <OK>
	WF	Update data rate with specified number [Format] : <u>AT+DR <data rate> <ENTER></u> [Example] AT+DR 5 5 <OK>

- **Note)** Data Rate Configuration

0: SF12 BW125 (KR920, AS923, EU868)

1: SF11 BW125 (KR920, AS923, EU868)

2: SF10 BW125 (KR920, AS923, EU868)

3: SF9 BW125 (KR920, AS923, EU868)

4: SF8 BW125 (KR920, AS923, EU868)

5: SF7 BW125 (KR920, AS923, EU868)

6: SF7 BW250 (AS923, EU868)

7: FSK (AS923, EU868)

8.2.4. AT+RX2FQ

- RX Window 2 Frequency Command

Table 27 AT+RX2FQ

Syntax	Operation	Remark
AT+RX2FQ	R	Readout the current frequency of RX Window 2 [Example] AT+RX2FQ 921900000 <OK>
	W	Update the frequency of RX Window 2 with specified number [Format] : AT+RX2FQ <Rx Window 2> <ENTER> [Example] AT+RX2FQ 921900000 <OK>

8.2.5. AT+RX2DR

- RX Window 2 data rate (0-7 corresponding to DR_X) Command

Table 28 AT+RX2DR

Syntax	Operation	Remark
AT+RX2DR	R	Readout current value of Rx Window 2 data rate [Example] AT+RX2DR 0 <OK>
	W	Update Rx Window 2 data rate with specified number [Format] : AT+RX2FQ <0-7 corresponding to DR_X> <ENTER> [Example] AT+RX2DR 0 <OK>

8.2.6. AT+RX1DL

- Set the delay between the end of the TX and the begin of RX Window 1 in ms.

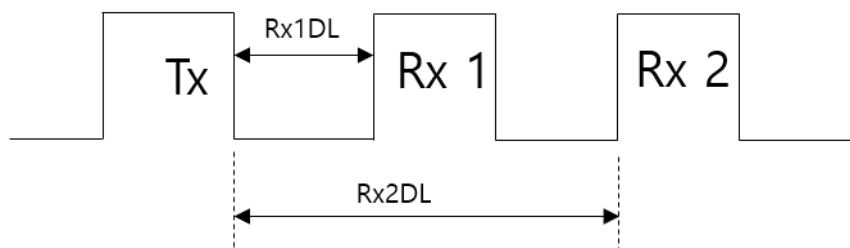


Table 29 AT+RX1DL

Syntax	Operation	Remark
AT+RX1DL	R	Readout the delay between the end of the TX and the RX Window 1 in ms [Example] AT+RX1DL 1000 <OK>
	W	Set the delay between the end of the TX and the RX Window 1 in ms [Format] : AT+RX1DL <delay> <ENTER> [Example] AT+RX1DL 1000 <OK>

8.2.7. AT+RX2DL

- Set the delay between the end of the TX and the begin of RX Window 2 in ms

Table 30 AT+RX2DL

Syntax	Operation	Remark
AT+RX2DL	R	Readout the delay between the end of the TX and the RX Window2 in ms [Example] AT+RX2DL 2000 <OK>
	W	Set the delay between the end of the Tx and the begin of Rx Window 2 in ms [Format] : AT+RX2DL <delay> <ENTER> [Example] AT+RX2DL 2000 <OK>

8.2.8. AT+JN1DL

- This command allows the user to access the join delay on RX window 1 in ms.

Table 31 AT+JN1DL

Syntax	Operation	Remark
AT+JN1DL	R	Readout the Join Accept Delay between the end of the Tx and the Join Rx Window 1 in ms [Example] AT+JN1DL 5000 <OK>
	W	Set the Join Accept Delay between the end of the Tx and the Join Rx Window 1 in ms [Format] : AT+JN1DL <delay> <ENTER> [Example] AT+JN1DL 5000 <OK>

8.2.9. AT+JN2DL

- Set the Join Accept delay between the end of the Tx and the Join Rx Window 2 in ms

Table 32 AT+JN2DL

Syntax	Operation	Remark
AT+JN2DL	R	Readout the Join Accept Delay between the end of the Tx and the Join Rx Window 2 in ms [Example] AT+JN2DL 6000 <OK>
	W	Set the Join Accept Delay between the end of the Tx and the Join Rx Window 2 in ms [Format] : AT+JN2DL <delay> <ENTER> [Example] AT+JN2DL 6000 <OK>

8.2.10. AT+MUFR

- Command to repeat the unconfirmed uplink without waiting for acknowledgement from the server. The default value is set to 1. The maximum number of repetitions is set to 15.

Table 33 AT+MUFR

Syntax	Operation	Remark
AT+MUFR	R	Readout the set value of repetition for unconfirmed uplink [Example] AT+MUFR 15 <OK>
	W	Set the value of repetition for unconfirmed uplink with specified value [Format] : AT+MUFR <number> <ENTER> [Example] AT+MUFR 15 <OK>

- **Note)** number: number of repetition (1-15), default=1, max = 15

8.2.11. AT+MCFR

- Resend command for confirmed uplink. The send command is repeated until acknowledgement from server is arrived. The default number of repetitions is set to 8.

Table 34 AT+MCFR

Syntax	Operation	Remark
AT+MCFR	R	Readout the current setting value of resend for confirmed uplink [Example] AT+MCFR 8 <OK>
	W	Set the number of resend for confirmed uplink [Format] : AT+MCFR <number> <ENTER> [Example] AT+MCFR 8 <OK>

- **Note)** number: number of resend (1-8), default=8

8.2.12. AT+TXP

➤ Tx Power Index Command

Table 35 AT+TXP

Syntax	Operation	Remark
AT+TXP	R	Readout the current setting of Transmit Power Index Value [Example] AT+TXP 0 <OK>
	W	Update the Tx power index value with specified value [Format] : AT+TXP <index(0 ~ 7 in KR920)> <ENTER> [Example] AT+TXP 0 <OK>

➤ **Note)** Tx Power Index Value

➤ Tx Power Index Value Table

TxPower(dBM)	0	1	2	3	4	5	6	7	8	9	10
Region											
AS923	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	Max EIRP -12	Max EIRP -14	-	-	-
AU915	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	Max EIRP -14	Max EIRP -14	Max EIRP -16	Max EIRP -18	Max EIRP -20
CN470	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	Max EIRP -14	Max EIRP -14	-	-	-
CN779	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	-	-	-	-	-
EU433	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	-	-	-	-	-
EU868	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	Max EIRP -14	Max EIRP -14	-	-	-
IN865	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	Max EIRP -14	Max EIRP -14	Max EIRP -16	Max EIRP -18	Max EIRP -20
KR920	Max EIRP	Max EIRP -2	Max EIRP -4	Max EIRP -6	Max EIRP -8	Max EIRP -10	Max EIRP -14	Max EIRP -14	-	-	-
US915	Max ERP	Max ERP -2	Max ERP -4	Max ERP -6	Max ERP -8	Max ERP -10	Max ERP -16	Max ERP -16	Max ERP -16	Max ERP -16	Max ERP -10
US915_HYBRID	Max ERP	Max ERP -2	Max ERP -4	Max ERP -6	Max ERP -8	Max ERP -10	Max ERP -16	Max ERP -16	Max ERP -16	Max ERP -16	Max ERP -10

8.2.13. AT+FCU

- Uplink Counter Command

Table 36 AT+FCU

Syntax	Operation	Remark
AT+FCU	R	Readout current value of the uplink counter [Example] AT+FCU 65535 <OK>
	W	Set the Uplink Counter (For Testing Purpose) [Format] : <u>AT+FCU <number> <ENTER></u> [Example] AT+FCU 65535 <OK>

- **Note)** number: uplink counter (0-65535)

8.2.14. AT+FCD

- Downlink Counter Command

Table 37 AT+FCD

Syntax	Operation	Remark
AT+FCD	R	Readout the current value of downlink counter [Example] AT+FCD 65535 <OK>
	W	Set Downlink Counter with specified value (For Testing Purpose) [Format] : <u>AT+FCD <number> <ENTER></u> [Example] AT+FCD 65535 <OK>

- **Note)** number: downlink counter (0-65535)

8.2.15. AT+BAT

- This command allows user to access the battery level of the end-device

Table 38 AT+BAT

Syntax	Operation	Remark
AT+BAT	R	Readout the current value of battery level [Example] AT+BAT 0 <OK>
	W	Update the battery level with specified value [Format] : <u>AT+BAT <Battery level> <ENTER></u> [Example] AT+BAT 254 <OK> - Updated battery level value is sent to server as part of <i>DevStatusAns</i>

- **Note)** Battery level
0: USB / 1: Min level ~ / 254: Fully charged / 255: Error

8.2.16. AT+LCHK

- Line Check Command. The command is used to check that the link is working properly.

Table 39 AT+LCHK

Syntax	Operation	Remark
AT+LCHK	W	The Mac command <i>LinkCheckReq</i> is sent to server [Format] : <u>AT+LCHK <ENTER></u> [Example] AT+LCHK <OK>
	E	Response from server with EVENT message LinkCheckAns [Example] <timestamp><space>"[EVENT]"<space>"LinkCheckAns"<CR><LF> [EVENT] LinkCheckAns

8.2.17. AT+CRYPTO

- Update Encryption Configuration (Standard)
 - > ** LoRaWAN uses the AES as encryption method

Table 40 AT+CRYPTO

Syntax	Operation	Remark
AT+CRYPTO	R	Readout the current setting value of encryption method [Example] AT+CRYPTO 0 <OK>
	WF	Set the encryption method to 1 (i.e. ARIA) [Format] : AT+CRYPTO <number> <ENTER> [Example] AT+CRYPTO 1 <OK>

- Note) [1] number : Encryption methods
0 : AES (*Default) / 1 : ARIA

[2] ARIA is a block cipher which is selected as a standard cryptographic technique in Korea.

[3] Exception: ARIA is incompatible with LoRaWAN standard. When JOIN is requested in OTAA mode, the AES is used instead of ARIA. The ARIA is used in Uplink/Downlink data encryption.

9. SYSTEM COMMAND

9.1. COMMAND TABLE

Table 41 SYSTEM Command

AT Command	Description	Reference
AT+RESET	System Reset	9.2.1
AT+SINF	System Information	9.2.2
AT+VER	Firmware Version	9.2.3
AT+SAG	Antenna Gain	9.2.4
AT+CFM	Uplink Packet Type	9.2.5
AT+SLEEP	Enters Low Power Mode	9.2.6
AT+ALARM	RTC Wakeup time	9.2.7
AT+TIME	RTC time	9.2.8
AT+DATE	RTC Date	9.2.9
AT+ECHO	AT Command Responding Message ECHO	9.2.10

9.2. COMMAND DETAIL

9.2.1. AT+RESET

- System reset command

Table 42 AT+RESET

Syntax	Operation	Remark
		System reset command
		After the Reset execute, the boot message is output
		[Example]
AT+RESET	W+	AT+RESET
		*
		Boot by CPU
		OTAA
		KR920
		Boot completed

9.2.2. AT+SINF

- Command to readout system information
- Output format: “AT Command Name” + “:” + configured value

Table 43 AT+SINF

Syntax	Operation	Remark
		[Example] AT+SINF
AT+SINF	R	VER:0.01 REGION:KR920 DATE:2000:01:01 TIME:05:49:54.275 ECHO:On SAG:0.000000 dBi ADR:Enabled DR:0-SF12-BW125 MCFR:8 (Confirmed Uplink retry count) MUFR:1 (Unconfirmed Uplink retry count) CFM:Unconfirmed(Uplink Message Type) ALARM:0 seconds <OK>

9.2.3. AT+VER

- Firmware Version Information

Table 44 AT+SAG

Syntax	Operation	Remark
		Readout firmware version
AT+VER	R	[Example] AT+VER 0.01 <OK>

9.2.4. AT+SAG

- Command to readout Antenna Gain

Table 45 AT+SAG

Syntax	Operation	Remark
AT+SAG	R	Readout Antenna Gain Configuration [Example] AT+SAG 0.000000 <OK>
	WF	Update the antenna gain. [Format] <u>AT+SAG <gain> <ENTER></u> [Example] AT+SAG -1 -1.000000 <OK>

- **Note)** default Value : 0 dBm
[gain] : Integer Input Value between -4 and 6 (dBm) is allowed

9.2.5. AT+CFM

- Readout and set command for Uplink Packet Type

Table 46 AT+CFM

Syntax	Operation	Remark
AT+CFM	R	Readout uplink packet type [Example] AT+CFM 1 <OK>
	WF	Update the Uplink Packet Type [Format] <u>AT+CFM <type> <ENTER></u> [Example] AT+CFM 0 <OK>

- Note) Type
1 : Confirmed Packet
0 : Unconfirmed Packet

9.2.6. AT+SLEEP

- Enter to Sleep Mode

Table 47 AT+SLEEP

Syntax	Operation	Remark
		[Format] <u>AT+SLEEP <ENTER></u>
		[Example] AT+SLEEP
		*
	W	Wakeup by RESETN
AT+SLEEP		OTAA KR920 Wakeup completed
		Enter Sleep Mode
	E	[Example] <timestamp><space>"[EVENT]"<space>"SLEEP"<CR><LF> [EVENT] SLEEP

- Note) * Wakeup through ALARM (RTC Timer) or RESETN events

9.2.7. AT+ALARM

- RTC Wakeup time

Table 48 AT+ALARM

Syntax	Operation	Remark
		Readout the current set value of RTC wakeup time
		[Example] AT+ALARM
	R	5 <OK>
		Update the RTC wakeup time with specified number
		[Format] AT+ALARM <ver> <ENTER>
AT+ALARM		[Example 1] AT+ALARM 5 <OK>
	W	[Example 2] Wake up by alarm after entering the Sleep Mode AT+SLEEP [EVENT] SLEEP
		*

Wakeup by RTC
 OTAA
 KR920
 Wakeup completed

- **Note)** [1] Default is 0 sec
 [2] Return value is a positive number in seconds

9.2.8. AT+TIME

- RTC Time Command

Table 49 AT+TIME

Syntax	Operation	Remark
	R	Displays the RTC time [Example] AT+TIME 15:43:09.630 <OK>
AT+TIME	W	Update the RTC time [Format] Hour(2 digit):Min(2 digit):Sec(2 digit):ms(3 digit) [Example] AT+TIME 15:42:30 <OK>

Note) Use the same input format as shown in the displayed output time.

9.2.9. AT+DATE

- RTC Date Command

Table 50 AT+DATE

Syntax	Operation	Remark
AT+DATE	R	Displays the RTC date [Example] AT+DATE 2018:03:15 <OK>
	W	Update the RTC date <u>year(4 digit):month(2 digit):date(2 digit)</u> [Example] AT+DATE 2018:3:15 <OK>

- **Note)** Use the same input format as shown in the displayed output date.

9.2.10. AT+ECHO

- Echo command

Table 51 AT+ECHO

Syntax	Operation	Remark
AT+ECHO	R	Readout the setting value of the Echo Command. The default is 0 (i.e. OFF) [Example] AT+ECHO 0 <OK>
	WF	- Set the Echo command with specified value [Format] <u>AT+ECHO < 0 1 > <ENTER></u> [Example] AT+ECHO 1 <OK>

- **Note)** 1 : ON
0 : OFF (Default)

10. DEBUG COMMAND

10.1. COMMAND TABLE

Table 52 Debug Command

AT Command	Description	Reference
AT+DBG	Event and Debug Message Configuration	10.2.1
AT+TXCW	FSK Tx Continuous Wave mode (Tx Signal Strength Test))	10.2.2
AT+RXTT	LoRa Rx Signal Strength Test	10.2.3
AT+TXTT	LoRa Tx Signal Strength Test	10.2.4
AT+TSTP	Stop RF Test	10.2.5
AT+GPIO	MS500 GPIO Pin Information	10.2.6

10.2. COMMAND DETAIL

10.2.1. AT+DBG

- Readout the Debug Message Type

Table 53 AT+DBG

Syntax	Operation	Remark
		Readout the current setting value of Debug Message.
	R	AT+DBG 0
AT+DBG		<OK>
		Update the Debug Message with specified value.
	W	AT+DBG 1
		<OK>

- **Note)** 0 : Debug message Off / 1 : Debug message On

10.2.2. AT+TXCW

- FSK Tx Continuous Wave Mode (Tx Strength Test)

Table 54 AT+TXCW

Syntax	Operation	Remark
AT+TXCW	W	[Format] <u>AT+TXCW <frequency> <Power in dBm> <Timeout (Sec)></u> <u><ENTER></u> [Example] AT+TXCW 920000000 14 100000 <OK>
	E	Tx Timeout (Tx End) <timestamp><space>"[EVENT]"<space>"TXCW TIMEOUT"<CR><LF> 03:00:02.556 [EVENT] TXCW timeout

10.2.3. AT+RXTT

- LoRa Rx (RF Strength Test)

Table 55 AT+RXTT

Syntax	Operation	Remark
AT+RXTT	W	[Format] <u>AT+RXST <Spreading Factor (Data rate)> Bandwidth(0,1,2)</u> <u><ENTER></u> [Example] Frequency = 922500000, SF=7, 125kHz for Rx mode until the data is received. AT+RXTT 922500000 7 0 <OK>
	E	1. Rx Receive Data Print format: <timestamp><space>"[EVENT]"<space>"RXST"<space>"Data Size"<space>"RSSI value"<space>"SNR value"<CR><LF> [EVENT] RxDone size 23 rssi -6 snr 26 2. Rx Error <timestamp><space>"[EVENT]"<space>"RXST error"<CR><LF> [EVENT] RXerror

- Note) * Bandwidth 0 : 125 kHz
 1 : 250 kHz
 2 : 500 kHz

10.2.4. AT+TXTT

- LoRa Tx RF Test
 - % LoRaMac can be used after the device reboot.

Table 56 AT+TXTT

Syntax	Operation	Remark
AT+TXTT	W	[Format] <u>AT+TXST <Power(dBm)> <Spreading Factor(Data rate)> BW<0,1,2> (Data Size)<transmission frequency (sec)> <ENTER></u> [Example] Frequency (922500000), 14dBm, SF7, Bandwidth 125kHz, 100Byte Data is transmitted in 5 sec period.
	E	AT+TXTT 922500000 14 7 0 100 5 <OK> 1. Tx transmission is successful Print format: <timestamp><space>"[EVENT]"<space>" TXST transmitted" <CR><LF> [EVENT] TxDone 2. Tx Transmission Timeout (Transmission failure) Print format: <timestamp><space>"[EVENT]"<space>" TXST timeout" <CR><LF> [EVENT] TxTimeout

10.2.5. AT+TSTP

- RF Test Stop

Table 57 AT+TSTP

Syntax	Operation	Remark
AT+TSTP	W	[Format] <u>AT+TXST</u> <OK>

10.2.6. AT+GPIO

- Returns with the MS500 GPIO Pin Configuration

Table 58 AT+GPIO

Syntax	Operation	Remark
	R	<p>[Example]</p> <p>Returns with information on PC6 Pin Configuration (* Pin Name is case-insensitive)</p> <p>AT+GPIO PC6 Pull-Down GPIO(Out) 1 <OK></p>
		<p>Update the MS500 GPIO Pin Execute</p> <p>[Format] AT+GPIO < Pin > <Input/Output> <ENTER></p>
		<p>[Example 1]</p> <p>- PC6 Pin Input Configuration (Use either 'I' or 'i')</p> <p>AT+GPIO PC6 i <OK></p>
AT+GPIO	W	<p>[Example 2]</p> <p>- Confirm the configuration value of PC6 pin</p> <p>AT+GPIO PC6 Pull-Down GPIO(In) 0 <OK></p> <p>[Example 3]</p> <p>- Set the PC6 Pin Output Configuration (Use either 'O' or 'o')</p> <p>AT+GPIO PC6 o 1 <OK></p> <p>[Example 4]</p> <p>- Confirm the configuration value of PC6 pin</p> <p>AT+GPIO PC6 Pull-Down GPIO(Out) 1 <OK></p>

DOCUMENT REVISION AND REFERENCE

Revision History

Revision	Date	Author	Description
0.01	2018/12/21	ewbm	First Draft
0.02	2019/01/10	ewbm	Add AT+Command Scenarios
0.1	2019/02/28	ewbm	Enhanced tables and added figures

Copyright Notice

Copyright © 2019 eWBM Co., Ltd. All rights reserved.

This document is the copyrighted work of eWBM Co., Ltd. and is owned by eWBM Co., Ltd. It is provided as a reference for the sole purpose of MS500 microcontroller based system design.

No part of the software and documentation may be reproduced, transmitted, or translated, in any form or by any means, electronic, mechanical, manual, optical, or otherwise, without prior written permission of eWBM Co., Ltd.

No Warranty Notice

eWBM Co., Ltd. makes no warranty of any kind in regard to this material which is delivered to you as is, including, but not limited to, the implied warranties as to its accuracy or fitness for a specific purpose. Any use of this technical documentation or the information contained therein is at the risk of the user. eWBM Co., Ltd. shall not be liable for errors contained therein or for incidental consequential damages in connection with the furnishing, performance or use of the material.

