(3/3) Communication Protocol_NEW

Lithium-Ion Battery pack / LV, LM, LH Series

Documentation on BMU(Battery Monitoring Unit) Communication Protocol installed in Li-ion Battery Pack and Settings.

CAN / CANopen (Products manufactured since 2022.04~)
RS232 / RS422 / RS485

The new protocol, referred to as the "NEW version" is characterized by the addition of only the CANopen functionality compared to the old version. The rest remains unchanged.
CANopen will be implemented in products manufactured since April 2022, and for older versions, the feature can be enabled through firmware upgrades..

⚠ 〈Cautions〉
The specifications and user manual for this product are provided in separate documents.
Please refer to the documents below.
“(1/3) Specifications_ LV or LM Li-Ion battery”
“(2/3) User manual_ LV or LM Li-Ion battery”

BMU (Battery Monitoring Unit)

Table of contents

1. Hardware Description

1.1. Usage Guide for Remote Communication Switch Terminals

1. BMU Power Switch (Green Terminal): For products shipped until February 2020, a Locker Switch was installed. However, there was an issue of natural discharge when the switch was turned ON. To achieve more detailed control, we have changed it to a terminal contact method.

2. The line where this switch is inserted is the positive (+) line of the internal battery power.

◇ When connecting terminals 1 and 2 of the green connector, the green LED on the communication board will illuminate.

◇ Interconnect the contacts with AGV and system power.
In other words, link it with the system's (+) line switch to manage the BMU power to turn off when the system is turned off. This helps prevent battery over-discharge due to BMU standby current.

◇ Screw-on Detachable Plug, Part Number: 1777989 / PHOENIX Contact
* series : MSTB 2,5/2-STF-5,08), (2P plug, 5.08mm pitch)
* note : The mating receptacle for this connector is installed and supplied, so you don't need to prepare.

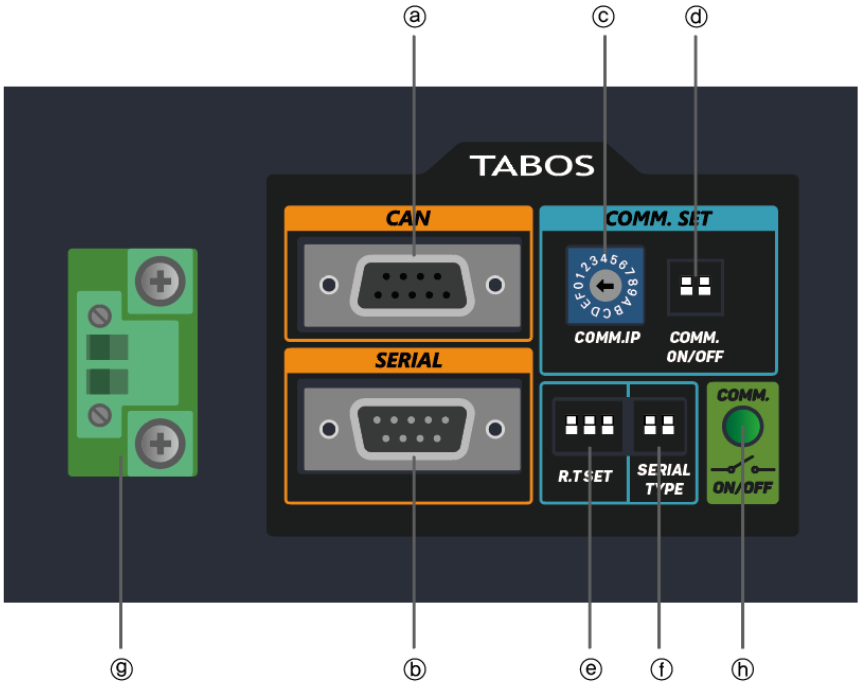
◇ Some battery packs may have a rocker switch in certain cases.

* Terminal connector models : X2COM, X3COM, X4COM,W2COM, W3COM
(Implemented starting from shipments since March 2020.
The previous version is equipped with a rocker switch.)

* Rocker switch models : CVCOM230, CHCOM230, CVCOM370, CHCOM370, CVCOM510, CHCOM510

[CAUTION]
◇ The battery provides power independently of the BMU switch
◇ Even if communication is not used, please connect this plug. It is necessary for the fan operation.
◇ During long-term storage, turn OFF this connector to prevent battery discharge.
◇ The power supply for the communication device (BMU) is derived from the internal battery. The (+) and (-) lines of the internal battery are connected to the BMU device. The terminal for this remote switch is positioned in the middle of the (+) line of the internal power supply. Therefore, if the switch terminal comes into contact with the battery output (-), a short circuit may occur. However, the battery protection circuit recognizes this as a short circuit and shuts off the entire power supply, ensuring safe usage.

1.2. Composition



ⓐ : CAN 통신 포트 (CAN port)
ⓑ : RS232 & RS485 / RS422 통신 포트
(D_sub9 Male)
ⓒ : 주소 설정 (IP SET)
ⓓ : 통신 ON/OFF (Comm. ON/OFF)
ⓔ : 종단 저항 (R.T SET)
ⓕ : 통신 선택 (Serial Type set)
ⓖ : 통신 전원 리모트 스위치 (Remote Switch)
ⓗ : 통신 전원 램프 (Comm. LED lamp)

picture 1. BMU

1.3. CAUTION to designers looking to apply this product to Autonomous Mobile Robots (AMRs) and similar applications.

CAUTION 〈1〉 : ⚠ Please refrain from using RS232C communication if possible. Even if it's used for experimental purposes in a laboratory setting, it's not advisable for industrial environments.

Reason: RS485, CAN, and similar protocols utilize higher voltage levels around 12V, whereas RS232C operates at lower voltage levels around 5V, making it more susceptible to noise interference.
In applications such as autonomous mobile robots, which often involve various motor drive devices and electrical components, noise interference is a significant concern.

Therefore, we recommend the use of communication protocols like RS485 and CAN, which offer higher noise immunity.

〈 Reference 〉 Characteristics of Supported Communication Protocols by this Battery and Recommended Approach:

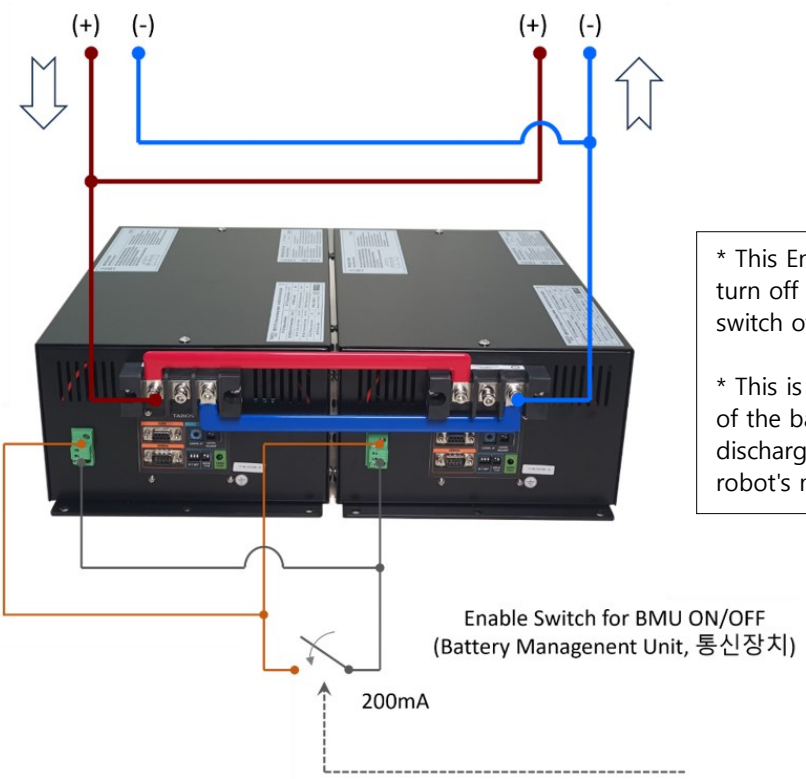
Since the data volume of communication with this battery is extremely small, the selection of communication protocol solely depends on noise immunity considerations.

Communication Standards	Noise Immunity	Signal Mode	Signal Level	Advantages	Disadvantages	Typical Applications	Recommended
RS-232C	Low	Single-ended	±5V	* Low cost design * Suitable for short distances	* Vulnerable to noise * Short cable distance	PC, printers	Not recommended
RS-422	High	Differential	+2V	* High noise immunity * Multi-drop connection possible	* More complex design than RS-232C * Uses 4 cables	Industrial automation, security systems	Usually
RS-485	Very high	2-wire differential	±12V	* Very high noise immunity * Multi-drop connection possible * Long cable distance support	* More complex design than RS-422 * High power consumption	Power systems, industrial automation	Recommended
CAN	Very high	Differential	(+)2V (logic "1"), (-)2V (logic "0")	* Very high noise immunity * Multi-drop connection possible * High speed communication * Error detection and correction function	* More complex design than RS-485 * Higher power consumption	Automotive, medical equipment	Recommended

CAUTION 〈2〉 : ⚠ Enable Switch for Battery Communication Device Power

* If the communication device remains powered on when the battery is not in use, there is a risk of battery discharge. To prevent this, the switch should be turned off when the battery is not in use.

*** When this switch is turned off, the communication device shuts down, but the main battery power remains on. The main battery power is continuously outputted, similar to an automotive lead-acid battery."**



* This Enable switch should be designed to turn off simultaneously with the main power switch of electric vehicles and robots.

* This is to prevent the communication device of the battery from remaining on and causing discharge due to residual current when the robot's movement is stopped.

CAUTION 〈3〉 : ⚠ If the Enable Switch is OFF, the battery cooling fan does not operate, leading to potential issues.

* If the cooling fan is not running, continuous charging or discharging of the battery can lead to heat generation within the battery. In such cases, if the battery cell temperature exceeds 50 degrees Celsius, the battery automatically stops charging or discharging. Once the temperature naturally cools down below a certain threshold, charging and discharging operations can resume.

CAUTION 〈4〉 : ⚠ Pinout verification is essential. (Especially USB to RS232, pin number 2 and 3 is crossed.)

*Please confirm the pinout below.

1.4. Connector Port and Select Switch Configuration Method

<table>
<tr><th></th><th>no.</th><th colspan="2">type / explanation</th><th>application</th><th>How to set / note</th></tr>
<tr><td></td><td>ⓐ</td><td colspan="2">D-SUB 9Pin(Female)
(CAN)</td><td>CAN Comm. port
(Refer to the pin mapping specifications for details)</td><td>When 'ⓐ Communication ON,' transmission and reception are enabled.
CAN communication is available without additional configuration, excluding ⓒ,ⓓ,ⓔ below.</td></tr>
<tr><td></td><td>ⓑ</td><td colspan="2">D-SUB 9 Pin (Male)
(SERIAL)</td><td>RS232 / RS485 / RS422
(Refer to the pin mapping specifications.)</td><td>When 'ⓐ Communication ON,' transmission and reception are enabled.</td></tr>
<tr><td rowspan="3">After changing the ⓒⓓⓔⓕ select switch position, it is imperative to turn the power OFF and then ON.</td><td>ⓒ</td><td>Rotary</td><td>IP set
(COMM IP)</td><td>Configurable from 0 to 15, use the indicated arrow value on the switch as the address.</td><td><u>* In hexadecimal format (0 ~ 9, A ~ F)</u>
* "You can set addresses up to a total of 16..</td></tr>
<tr><td>ⓓ</td><td>2Pin</td><td>COMM
ON/OFF</td><td>PIN1: Comm. ON/OFF
PIN2: Debug ON/OFF

〈Firm ware download mode〉
PIN1: OFF
PIN2: ON</td><td><u>* Comm. On set</u>
<table><tr><td></td><td>PIN1</td><td>PIN2</td></tr><tr><td>Comm.ON</td><td>ON</td><td>OFF</td></tr></table>ON : UP , OFF : DOWN</td></tr>
<tr><td>ⓔ</td><td>3Pin

If you use RS232C, all RT Switches have to be turned off.</td><td>Termination
Resistor
set

(RT SET)</td><td>PIN1 : for CAN
PIN2 : for RS422(RX Line)
PIN3 : for RS485 or
RS422(TX Line)
*RT = Resistor Termination
*note 1:
In the case of RS422/485, using termination resistors is not crucial, but for CAN communication, it is strongly recommended and considered essential.

*note 2 : If the user-side communication device has a termination resistor attached, the termination resistor of this device will be used. If the user-side communication device does not have a termination resistor, the termination resistor of this device will not be used either

note 3 : Refer to '1.6 Termination Resistor Usage' in this manual.</td><td> Termination Resistor Configuration
<table><tr><td></td><td>PIN1</td><td>PIN2</td><td>PIN3</td></tr><tr><td>For CAN</td><td>ON</td><td>OFF</td><td>OFF</td></tr><tr><td>For RS422</td><td>OFF</td><td>ON</td><td>ON</td></tr><tr><td>For RS485</td><td>OFF</td><td>OFF</td><td>ON</td></tr><tr><td>If you don't use termination resistor.</td><td>OFF</td><td>OFF</td><td>OFF</td></tr><tr><td>If it has termination resistor</td><td>OFF</td><td>OFF</td><td>OFF</td></tr></table>(note): ON : UP , OFF : DOWN
note : internal termination resistor = 120Ω</td></tr>
</table>

<table>
<tr>
<td></td>
<td>ⓕ</td>
<td>2Pin</td>
<td>Comm.
selection

(SERIAL
TYPE)</td>
<td>PIN1 : RS232 / RS485
PIN2 : RS485 / RS422</td>
<td>* Comm. Type settings

<table>
<tr><th></th><th>PIN1</th><th>PIN2</th></tr>
<tr><td>RS232</td><td>ON</td><td>OFF</td></tr>
<tr><td>RS422</td><td>OFF</td><td>ON</td></tr>
<tr><td>RS485</td><td>OFF</td><td>OFF</td></tr>
<tr><td>CAN</td><td colspan="2">It doesn't matter
where it is located.</td></tr>
</table>
(Note) ON : UP , OFF : DOWN
* For SERIAL communication, one of the options mentioned above should be selected.
* Simultaneous use of SERIAL and CAN is possible.</td>
</tr>
</table>

no.	type	explanation	application	How to set / note
ⓖ	2Pin	Comm. Power terminal for Remote switch	Comm. Module Power ON (Remote S/W)   (terminal SW.) (rocker SW.) * Models Terminal switch attached X2COM, X3COM, X4COM, W2COM, W3COM (Implemented starting from shipments since March 2020. The previous version is equipped with a rocker switch.) * Models Rocker Switch attached: CVCOM230, CHCOM230, CVCOM370, CHCOM370, CVCOM510, CHCOM510	*** When shorting pins 1 and 2, the power of the communication device turns on.** * When OFF, there may be some errors in BMU calculations. Using it for a certain period allows the BMU's self-learning process to eliminate errors gradually *** To reduce self-discharge, it is recommended to keep it in the OFF state during long-term storage.** * Screw-on Detachable Plug, Part Number: 1777989 / PHOENIX Contact * The mating receptacle for this connector is installed and supplied, so you don't need to prepare.
ⓗ	Signal LED	Comm. signal LED lamp (COM STATE)	4 colored LED : The LED lamp indicates charging, discharging, abnormal signals, warning signals, etc., through its color and blinking patterns (please refer to next pages.)	* If the battery is operating and the 'ⓖ Communication Power S/W' is ON, the light will come on *** The communication device will operate when the lamp is illuminated.** *** If the 'ⓖ Communication Power S/W' is ON, but the lamp does not illuminate, the battery is in a completely discharged state. Please charge the battery before use.** **(The lamp may not illuminate due to reasons such as battery short circuit or over-discharge protection. Please check accordingly.)**

** About battery error state.

category	content	description
Battery over voltage	Error	When exceeding 7S : 29.47V / 14S : 58.94V (4.21V/cell)
Battery low voltage		When falling below 7S : 21.00V / 14S : 42.00 V (3.00V/cell)
Excessive charging current		LM : more than 1.0 LH : more than1.5C
Excessive discharging current		The magnitude of excessive current varies depending on the battery AH.
High temperature		When the temperature exceeds 50 degrees Celsius.
Low temperature		When the temperature falls below 2 degrees Celsius.

*CAUTION
In case of a low-voltage state error in the battery, it is recommended to charge it immediately. The unexpected output voltage drop to 0V may occur due to the low-voltage protection circuit inside the battery.

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(Note.) Firmware distributed with fixed voltage and SOC (%) tables applied. (2020.11.10~)

To prevent SOC (%) errors occurring in various field environments, standard TABLEs have been applied.
The default shipping configuration utilizes the algorithm and calibration values of the BMU IC for calculation (rev.1.1.2).
If cumulative errors in SOC are observed during use, it is recommended to perform an update (rev.1.1.7).

After applying rev.1.1.7, there may be a rapid change in SOC (State of Charge) with voltage variations.
To address the rapid changes in SOC during charging/discharging, the following logic has been applied:
The voltage is measured continuously for 16 cycles, and the average value is compared with the TABLE before displaying. In other words, there is an interval between voltage changes and SOC changes (approximately Max. 8 seconds).

If you wish to have the latest firmware update, we will provide a separate manual and file.
Please contact us at abc@tabos.co.kr or make a request to your designated contact person.

1.5. Termination Resistor Usage Guide

◇ Reasons and Roles of Using Termination Resistor in Communication

Termination resistors are attached for two main reasons.
1) If the communication line is open at the end, a phenomenon similar to an echo occurs where the signal does not disappear but reflects back. Termination resistors prevent such reflection phenomena.
2) By allowing a constant current to circulate throughout the entire line, it is aimed at reducing stray signals and increasing resistance to noise."

◇ Usage of Termination Resistor System Based on Communication Method

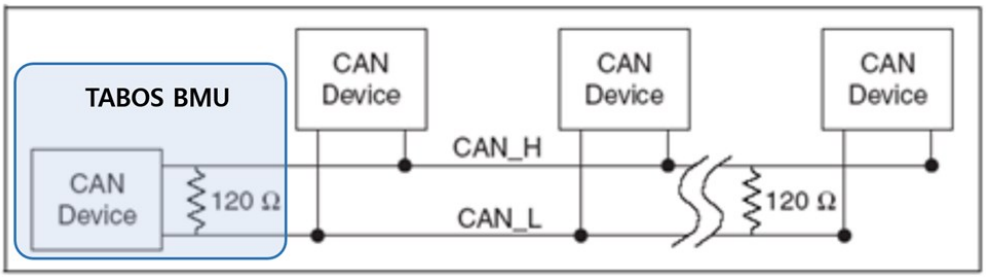
*** CAN**

- It is strongly recommended to apply the termination resistor system.
- The speed of the CAN communication section in this BMU device is 500Kbps, falling within the High-Speed CAN (40Kbps~1Mbps) category. The built-in termination resistor in this device is 120Ω..

*** RS422/485**

- It is reported that there is no significant issue even if the termination resistor system is not applied.
- It is permissible to apply the termination resistor system.
- The built-in termination resistor in this device is 120Ω.

◇ Termination Resistor System Connection Diagram



-Termination resistors should be connected at both ends of the signal line because communication on the CAN bus needs to be bidirectional.
- The termination resistor on the cable should match the impedance of the cable.
- ISO 11898 specifies an impedance of 120Ω.
- If multiple devices exist on the cable, termination resistors should be connected only to the device at the end of the cable.

◇ Battery BMU Communication Device (this device) Termination Resistor Setting

- When using the termination resistor system-
If multiple devices, including this BMU device, are connected to the communication device, only the device set as the final address (including the battery BUM) will use the termination resistor. For example, if three batteries are connected in parallel and there are no other devices connected, set the termination to 'Use' for only one battery (BMU) set as the final address, and set the rest to 'Do Not Use Termination Resistor'.

2. Communication Basic Settings and Pin Map Specifications

2.1. Communication Type

-. CAN
-. RS-232
-. RS-485
-. RS-422

2.2. Communication settings.

2.2.1. Selection of Communication Method.

- Follow the instructions in '2.2.2. CAN Communication Basic Settings' and '2.2.3. RS232 / RS422/ RS485 Communication Basic Settings' below.
- CAN communication can be used without additional configuration.
- For RS232 / RS422 / RS485 communication, refer to '1.4. Connector Port and Switch Configuration Method' for selection.
- Check the cable pin mapping (crossing TX, RX, etc.) and switch settings before use.

2.2.2. Basic Settings for CAN Communication

Format	CAN2.0A Standard
Bit rate	500 kbps (Not changeable)
DLC	8

- The recommended communication cycle is 500ms or more.

2.2.3. Basic Settings for RS232 / RS422 / RS485

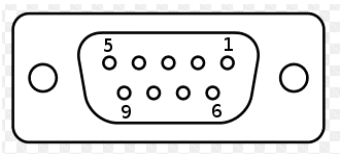
Baud rate	19200 bps
Word length	8 bit
Parity	None
Flow control	None
Stop Bit	1 bit

- The recommended communication cycle is 500ms or more.

2.3. CAN Pin Mapping

2.3.1. CAN Connertor specifications.

Name	D-sub 9Pin
Type	Female



2.3.2. CAN specification.

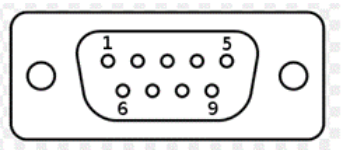
Pin number	Name	Explanation
2	CANL	CAN Low
7	CANH	CAN High

- Prohibition of connections other than the specified pin numbers (2, 7): Connection to other pins may cause malfunction.

2.4. Pin Map of RS232 / RS422 / RS485

2.4.1. RS232 / RS422 / RS485 Connector specifications

Name	D-sub 9Pin	(Prohibited connection pin) Not Connected	1 : pin for debug
Type	Male		4 : pin for debug



2.4.2. RS-232 specifications.

Pin number	Name	Explanation
2	RXD	RS-232 Input (the connection of Host's TX is required.)
3	TXD	RS-232 Output (the connection of Host's RX is required.)
5	GND	Signal Ground

2.4.3. RS-485 Specifications

Pin number	Name	Explanation
7	DATA+	RS-485 Positive Input/Output
3	DATA-	RS-485 Negative Input/Output
5	GND	Signal Ground

2.4.4. RS-422 Specifications

Pin number	Name	Explanation
7	TXD+	RS-422 Positive Output
3	TXD-	RS-422 Negative Output
2	RXD+	RS-422 Positive Input
8	RXD-	RS-422 Negative Input
5	GND	Signal Ground

3. Checkpoints for Communication Abnormalities

- The Pin Map of the BMU product may not match with cables available in the market. Please check the Pin Map carefully before use.
- If using RS-232 communication, use a dedicated 'USB to RS-232' cable.
- If using 'USB to TTL' or 'serial communication cables,' the RS-232 communication specifications may not match, causing communication issues.
- If there is suspicion about the Pin Map, try crossing TX/RX in RS-232 communication, i.e., cross-connecting pins 2 and 3.
- Please double-check the baud rate and other settings.
- If all communication settings are normal, please check if the BMU's channel rotary setting matches the channel in the command. (In the example command below, it is set to channel 0. If you are using the example command, set the BMU's channel rotary switch to "0.")

4. Configuration of CAN Communication Frame

◇ Summary :

-. CAN communication speed is set to 500Kbps, falling within the High-Speed CAN range (40Kbps~1Mbps).
- This CAN communication device is not using the CANopen protocol.
  This CAN communication device is not using the MODBUS protocol.
  It has TABOS' own proprietary communication protocol.

Caution : When the command is issued once, all CASE3 data is transmitted at once in a single transmission.

◇ Note :

-. The Pin Map of the BMU product may not match with cables available in the market. Therefore, when using this communication device, please carefully check the Pin Map and connect it for proper usage..

- Please double-check the baud rate and other settings.
- If all communication settings are normal, please check if the BMU's channel rotary setting matches the channel in the command. (In the example command below, it is set to channel 0. If you are using the example command, set the BMU's channel rotary switch to "0.")

4.1. Table of Data Frame

	ID	RTR	D1	D2	D3	D4	D5	D6	D7	D8
CASE1	ID	-	Order	-	-	-	-	-	-	-
CASE2	ID	-	Order	Auto	-	-	-	-	-	-
CASE3	ID	-	Order	Index	Data1	Data2	Data3	Data4	Data5	Data6

4.2. Description of Components

4.2.1. ID

- Address of the battery connected via CAN communication.
- Address can be set with the front rotary switch, and the address is obtained by adding 0x460 to the set value.
- Refer to '1.4. Connector Port and Switch Configuration Method' for address configuration method.

4.2.2. RTR

- Do not use.

4.2.3. Order

- Data acquisition command.
- Automatic transmission registration and cancellation command.

- Send one of the above commands.

4.2.4. Auto

- Register and start automatic transmission.
- Unregister and stop automatic transmission.
- Refer to '4.4.2 Auto Command' for details.

4.2.5. Index

- Order of data transmission.
- The data transmitted varies according to each order.
- Refer to '5.1.1 Information List for CAN Communication' for the types of data based on the order.

4.2.6. DataN

- Transmit battery information.
- Refer to '6.1.1 Information List for CAN Communication' for the types of information.

4.3. CASE1 detailed specification

4.3.1. Transmission of CASE1

① Purpose of Transmission

- To obtain information from the connected battery via CAN communication, initiated by the PC (or information requester).

② Code example.

ID	RTR	Order
0x460	-	0x60

- ID of the battery to communicate with: 0x460
- Order: Input the address of the connected battery.
- The values of ID and Order must match.
-. ex1) ID : 0x460, Order : 0x60
-. ex2) ID : 0x461, Order : 0x61

③ Details of ID

- The address of the battery connected via CAN communication with the PC (or information requester).

④ Details of RTR

-. Do not use.

⑤ Details of Order

-. Must match the requested address of the ID.
-. range : 0x60 ~ 0x6F

4.4. Details of CASE2

4.4.1. Transmission of CASE2

① Purpose of Transmission

-. Command to automatically transmit data.

-. It allows the transmission of specific battery information based on the required ID.

-. Unnecessary ID information can be deleted.

② Code example

ID		RTR	Order	Auto
0x460		-	0xAA	0xE0

③ Details of ID

-. Sends the address of the battery that will respond with the data.

④ Details of RTR

-. Do not use.

⑤ Details of Order

-. Directs the command for CASE2.

-. Instructs mode registration and deregistration with 0xAA.

⑥ Details of Auto

-. For the notation of commands related to batteries with desired IDs, automatic transmission, and transmission stop.

- please refer to '4.4.2 Auto Command'.

4.4.2. Auto 명령어

① Auto Code Table

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Range
automatic transmission start	1	1	1	x	x	x	x	x	0xE0
Transmission stop	0	1	1	x	x	x	x	x	0x60

-. x : don't care

-. n : 0 or 1

-.

② Automatic data transmission mode

- Automatically transmits data at a 100ms interval.
- Only transmits registered data.
- Initiates automatic transmission when Order is 0xAA and Auto is 0xE0.

③ Stop automatic data transmission

-. Stops transmission when Order is 0xAA and Auto is 0x60.

4.5. Details of CASE3

4.5.1. Transmission of CASE3

① The purpose of transmission:

- Responds with the data requested in the response of CASE1 or CASE2.
- The order and types of the data being responded are referenced in '6.1 Battery Information'.

② Exemple code

-.

ID	RTR	Order	Index	Data1	Data2	Data3	Data4	Data5	Data6
0x460	0	0x60	1	전압_L	전압_H	전류_L	전류_H	상태_L	상태_H

ID	RTR	Order	Index	Data1	Data2	Data3	Data4	Data5	Data6
0x460	0	0x60	2	TTF_L	TTF_H	TTE_L	TTE_H	SOC	SOH

ID	RTR	Order	Index	Data1	Data2	Data3	Data4	Data5	Data6
0x460	0	0x60	3	RC_L	RC_H	AE_L	AE_H	온도_L	온도_H

- Responds with the status to the sender.

③ ID details:

-. Sends the address of the battery responding with the data.

④ RTR details:

-. Since it doesn't request a response from the PC (or information requester), it is 0.

⑤ Order details:

-. Sends the status value of the requested battery.

⑥ Index details:

-. Specifies the sequence number of the data list.

-. Depending on the Index value, the type of data transmitted varies.

⑦ Data composition:

- Composed of 2-byte or 1-byte data combinations.
- Voltage: The actual voltage of the battery.
- Current: The current flowing through the battery (+: charging value, -: discharging value).
- Status: Bits indicating the battery's status.
- TTF (Average Time To Full): Average time to full charge.
- TTE (Average Time To Empty): Average time to complete discharge.
- SOC (State of Charge): Remaining charge percentage.
- SOH (State of Health): Battery health percentage.
- RC (Remaining Capacity): Remaining capacity in Ah.
- AE (Available Energy): Available energy in Wh.
- Temperature: Internal temperature of the battery.

4.6. Summary of CAN Command

4.6.1. Receiving Battery Data Information

*** Caution : (Transmitting all CASE3 data at once with a single command)**

External communication device CASE1 transmission Order : 0x60	→ Battery CASE3 Response Respond once

4.6.2. Start of automatic transmission mode for battery data.

External communication device CASE2 transmission Order : 0xAA, command : 0xE0	→ Battery CASE3 Response Start automatic continuous transmission every 100 milliseconds

4.6.3. End of automatic transmission mode for battery data.

External communication device CASE2 transmission Order : 0xAA, command : 0x60	→ Battery CASE3 Response Stop automatic transmission

5. Composition of RS232 / RS422 / RS485 Frame

◇ Summary :

- This CAN communication device is not using the MODBUS protocol.
- It has TABOS' own proprietary communication protocol.

◇ Caution :

- The Pin Map of the BMU product may not match with cables available in the market. Therefore, if you intend to use this communication device, please carefully check and connect the Pin Map.

- If you want to perform RS-232 communication between the battery and a device with a USB port, you can purchase a standard cable from the market. In this case, be sure to use a 'USB to RS-232' dedicated cable. 'USB to TTL' and 'USB to serial' communication cables may not match the RS-232 communication specifications of this device, leading to communication issues.

- When using RS-232 communication, connect the TX/RX of the BMU's Pin Map to the TX/RX of the cable you want to connect, making sure to cross-connect the TX/RX wires.

- Double-check the Baudrate and other settings.

- Ensure that all communication settings are correct, and confirm that the BMU's channel rotary switch and the channel in the command are set to the same value. (In the example command below, channel 0 is used as an example. If you use the example command, set the BMU's channel rotary switch to '0.')

5.1. Summary of Data Frame

Start Sentence1	+	Start Sentence2	+	Address	+	Length	+	Command	+	Order	+	Data 1
Data 2	+	...	+	Data N	+	Check sum	+	End Sentence1	+	End Sentence2		

5.2. Component Description

5.2.1. Start Sentence

-. The data begins with 0xAF + 0xFA.

5.2.2. End Sentence

-. The data ends with 0xAF + 0xA0.

5.2.3. Address

- The address of the battery to be called.
- The address can be set using the front rotary switch, and the address is obtained by adding 0x60 to the

switch setting value.
- Refer to '1.4. Connector Port and Switch Setting Method' for address setting methods.

5.2.4. Length

-. Length information of the Data Frame.

- Length = N + 3(N is the number of Data, added with Command, Order, and Checksum)

5.2.5. Command

-. Displaying the command and response of communication.

Code	송신 주체	내용
0x01	PC or information requester	State request
0x02	PC or information requester	Directive transmission
0x03	Battery	Status response
0x1F	Battery	Communication failure (data error)

5.2.6. Checksum

-. checksum = Address + Length + Command + Order + Data 1 + ... + Data N

- Checksum is 1-byte and the carry is discarded.

5.2.7. Data N

- Transmitting parameter values according to the command code
- Accepts up to a maximum of 20 values.

5.3. Details of Command

5.3.1. Command code : 0x01

Code	The sender	contents	The number of data items
0x01	PC or information requester	Request for status	2

① Exemple code

0xAF	0xFA	0x60	0x05	0x01	0x60	0x45	0x00	0x0B	0xAF	0xA0
Start Sentence		Address	Length	Command	Order	Kind 1	Kind 2	Checksum	End Sentence	

-. Request for battery status response with an address of 0x60
-. Checksum = 0x60 + 0x05 +0x01 + 0x60 + 0x45 + 0x00 = 0x0B

② Details of Address:
- The address of the battery connected to the PC (or information requester) through communication.
- Range: 0x60 ~ 0x6F

③ Details of Order:
- Must match the requested address of Address.
- Range: 0x60 ~ 0x6F
- (Relevant for 19-inch rack-mount communication)

④ Details of Kind 1:
- Basic data requested from the battery.
- Refer to the bit configuration in the table below.

Kind 1							
Upper							Lower
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit	description	Bit	description
0	Voltage	4	The time of charge completion
1	Current	5	The time of discharge completion
2	SOC	6	Temperature
3	Battery Status	7	-

⑤ Details of Kind 2

- This is the extended data requested from the battery.
- The bit configuration is referred to the table below.

Kind 2							
Upper							Lower
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit	description	Bit	description
0	SOH (State Of Health)	4	-
1	Remaining Ah	5	-
2	Remaining Energy (Wh)	6	-
3	-	7	-

5.3.2. Command code : 0x03

Code	The sender	discription	The number of data items
0x03	Battery	Status response	Up to 20

① Response Data Classification

-. Responds to data requested by the command code '0x01'
-. If Kind 1 is '0x45' and Kind 2 is '0x00', only 'Voltage', 'SOC', and 'Temperature' are responded
-. The order of the responded data follows the Data sequence below.
-. The maximum number of respondable data is 32 (Kind 1 + Kind 2, i.e., 10 types of battery information and 6 types of invalid information can be responded).
- Refer to '6.1.2 Information List for RS232, RS485, RS422' and '6.2 Battery Status Information' for details.

② Code Example

0xAF	0xFA	0x60	0x09	0x03	0x60	0x4F	0x57
Start Sentence		Address	Length	Command	Order	Data 1	Data 2

0x00	0x00	0x01	0x0F	0x81	0xAF	0xA0
Data 3	Data 4	Data 5	Data 6	Checksum	End Sentence	

-. It responds to the sender with the status.
-. Checksum = 0x60 + 0x08 + 0x03 + 0x60 + 0x4F + 0x57 + 0x00 + 0x00 + 0x01 + 0x0F = 0x81

③ Details of Address

-. It sends the address of the battery that is sending the data.

④ Details of order
- It sends the state value of the requested battery.

⑤ Composition of Data
-. Data 1 & Data 2 : It refers to the voltage according to the requested order (0x4F57 = 20311 => 203.11[V])
-. Data 3 & Data 4 : It refers to the battery status according to the requested order.
-. Data 5 & Data 6 : It refers to the temperature according to the requested order. (0x010F = 271 => 27.1[℃])

5.3.3. Command code : 0x1F

Code	The sender	Contents	The number of data
0x1F	Battery	Communication contents error	1

① Definition
-. The value of the received data does not match the defined content (3.3.1 Command code: 0x01).
-. The sender's checksum value and the checksum value calculated from the received data are different.
-. There is an error in data transmission.

② Exemple code

0xAF	0xFA	0x60	0x07	0x1F	0x03	0x11	0x10
Start Sentence		Address	Length	Command	Error	Data 1	Data 2

0x05	0x89	0x38	0xAF	0xA0
Data 3	Data 4	Checksum	End Sentence	

-. Sends a data error.
-. Checksum = 0x60 + 0x07 + 0x1F + 0x03 + 0x11 + 0x10 + 0x05 + 0x89 = 0x38
-. Data N is resent with the received code.
-. Length = N + 3 (N is the number of Data, including Command, Error, and Checksum)

③ Details of Error

Error							
Upper							Lower
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Bit	description	Bit	description
0	Length Error	4	-
1	Command Error	5	-
2	Order Error	6	-
3	Checksum Error	7	-

④ Details of Data

Data	description	Data	description
1	Length	5	-
2	Command	6	-
3	Order	7	-
4	Checksum	8	-

-. The received value is returned again.
-. Used to verify errors.

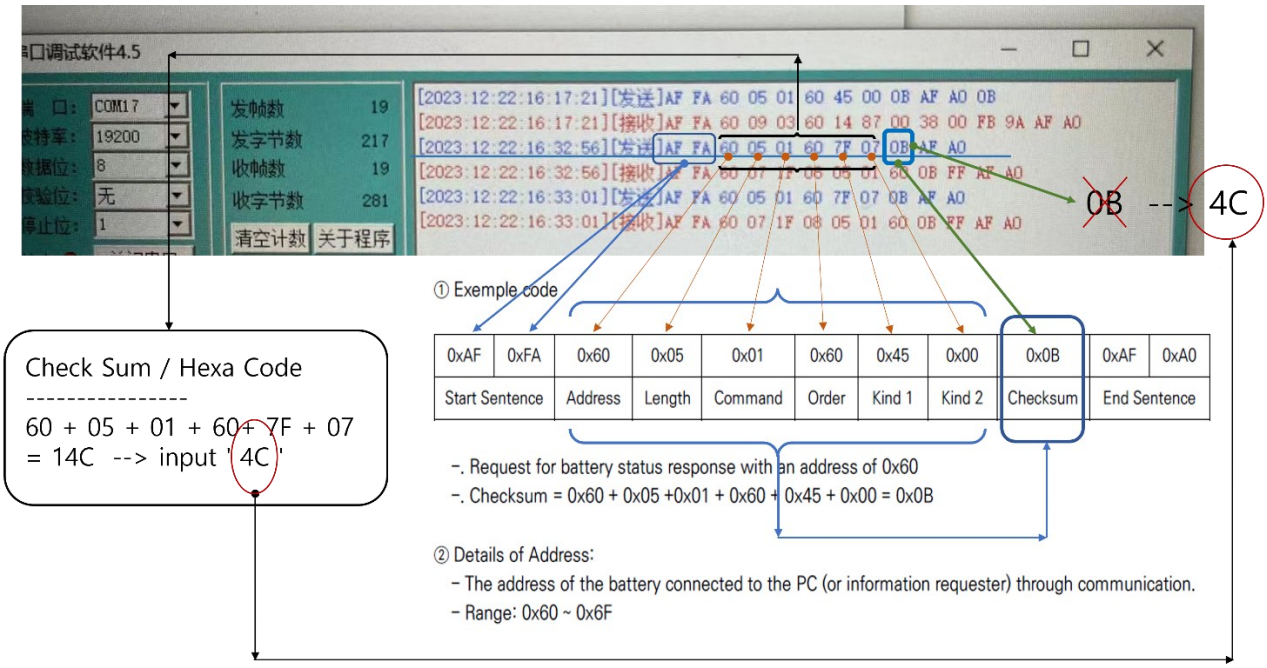
5.3.4. Wrong code example

Here is an example of a CheckSum error that occurs when writing communication code.

The CheckSum value must be calculated by the programmer as follows and entered:

Case of communication error:

In the following example, the CheckSum value should be calculated as shown below, and the resulting value '4C' should be inserted. However, an error occurred by mistakenly inputting the value '0B' as shown in this document.



6. Data information

6.1. Battery Information

6.1.1. The list of information for CAN communication

Note1: The data value (Range) must be multiplied by the Scale value before output.)
Note2: Current and temperature must be declared as signed when declaring variables.
- Signed can express the sign of a number (positive/negative), so it handles both negative and positive numbers.
- Unsigned expresses only positive numbers without a sign, and can handle larger positive values with the same bit size.

Index	Data	Type	High/Low Byte	Unit	Scale	Range
1	Data 1	Voltage	Low	V	0.01	0 ~ 655.35
	Data 2		High			
1	Data 3	Current	Low	A	0.01	(-) 327.68 ~ (+) 327.67 (-): DSCHG, (+): CHG declaring variables → signed
	Data 4		High			
1	Data 5	Battery status Information (Next chapter ☞ Details)	Low			If no data is output, the battery is in normal condition. *Abnormal state data contents: Overvoltage, low voltage, overcurrent, high temperature, low temperature, BMU communication error
	Data 6		High			
2	Data 1	Charging Completion time	Low	min	1	0 ~ 65535
	Data 2		High			
2	Data 3	Discharging Completion time	Low	min	1	0 ~ 65535
	Data 4		High			
2	Data 5	SOC	-	%	1	0 ~ 100
	Data 6	SOH				
3	Data 1	Remaining Current capacity	Low	Ah	0.01	0 ~ 655.35
	Data 2		High			
3	Data 3	Remaining Energy	Low	Wh	0.1	0 ~ 6553.5
	Data 4		High			
3	Data 5	Temperature	Low	℃	0.1	(-) 3276.8 ~ (+) 3276.7 (-): Below zero, (+): Above zero declaring variables → signed
	Data 6		High			

"S.O.C" stands for "State of Charge," indicating the current battery capacity in percentage. The calculation method for S.O.C in the product is as follows:

1. Initially, when the BMU is powered on, it calculates the remaining capacity as a percentage based on the voltage at that time.
2. Subsequently, regardless of voltage, S.O.C is calculated based on current, temperature compensation, and displayed.

If there are frequent and significant fluctuations in current, it may be challenging to read all currents in real-time. Therefore, cumulative errors in S.O.C can occur. It is recommended, especially after prolonged use or when charging is complete, to reset the BMU's power to initialize S.O.C before further use.

6.1.2. The list of information for RS232, RS485, RS422 communication

Note1: The data value (Range) must be multiplied by the Scale value before output.)
Note2: Current and temperature must be declared as signed when declaring variables.
- Signed can express the sign of a number (positive/negative), so it handles both negative and positive numbers.
- Unsigned expresses only positive numbers without a sign, and can handle larger positive values with the same bit size.

Index	Data	Type	High/Low Byte	Unit	Scale	Range
1	Data 1	Voltage	High	V	0.01	0 ~ 655.35
	Data 2		Low			
2	Data 3	Current	High	A	0.01	(-) 327.68 ~ (+) 327.67 (-): DSCHG, (+): CHG declaring variables → signed
	Data 4		Low			
3	Data 5	SOC	High	%	1	0 ~ 100
	Data 6		Low			
4	Data 7	Battery status Information (Next chapter ☞ Details)	High			If no data is output, the battery is in normal condition. *Abnormal state data contents: Overvoltage, low voltage, overcurrent, high temperature, low temperature, BMU communication error
	Data 8		Low			
5	Data 9	Charge completion time	High	min	1	0 ~ 65535
	Data 10		Low			
6	Data 11	Discharge completion time	High	min	1	0 ~ 65535
	Data 12		Low			
7	Data 13	Temperature	High	℃	0.1	(-) 3276.8 ~ (+) 3276.7 (-): Below zero, (+): Above zero declaring variables → signed
	Data 14		Low			
8	Data 15	SOH	High	%	1	0 ~ 100
	Data 16		Low			
9	Data 17	Remaining Current capacity	High	Ah	0.01	0 ~ 655.35
	Data 18		Low			
10	Data 19	Remaining Energy	High	Wh	0.1	0 ~ 6553.5
	Data 20		Low			

"S.O.C" stands for "State of Charge," indicating the current battery capacity in percentage. The calculation method for S.O.C in the product is as follows:

1. Initially, when the BMU is powered on, it calculates the remaining capacity as a percentage based on the voltage at that time.
2. Subsequently, regardless of voltage, S.O.C is calculated based on current, temperature compensation, and displayed.

If there are frequent and significant fluctuations in current, it may be challenging to read all currents in real-time. Therefore, cumulative errors in S.O.C can occur. It is recommended, especially after prolonged use or when charging is complete, to reset the BMU's power to initialize S.O.C before further use.

6.2. Battery Status Information (CAN & RS Comm. both)

6.2.1. Classification of Battery State Information

Battery status							
Upper							Lower
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8

Bit	**Caution** / contents of data	Bit	
0	Battery Over voltage	8	
1	Battery Low voltage	9	
2	Charge Over current	10	
3	Discharge over current	11	
4	High temperature	12	
5	Low temperature	13	
6	BMU error	14	
7	-	15	-

6.2.2. State Criteria

	Threshold Values		
	7S (25V)	14S (50V)	
Battery Over voltage [V]	29.47	58.94	When Exceeding the Voltage Limit
Battery Low voltage[V]	21.70	43.40	When Falling Below the Voltage Limit
Charge Over current [A]	100	70	When Exceeding the Current Limit
Discharge over current [A]	70 (Reference)	70 (Reference)	When Exceeding the Current Limit
High temperature [℃]	50	50	When Exceeding the Temperature Limit
Low temperature [℃]	2	2	When Falling Below the temperature Limit
Communication failure occurred within the BMU circuit			Supports only abnormal state warnings

Note : The settings for excessive charging current and excessive discharging current vary depending on the battery model. The above values are reference values.

6.2.3. About Alarm

-. Please check the battery status according to the state when 'FLAG BIT' occurs.