PHONOCUBE Lithium Battery Control System Communication Protocol

1. General Principle

The protocol defines the CAN communication (support CAN2.0) between PHONOCUBE and Lithium-ion battery management system (BMS). It mainly includes PHONOCUBE's data format to BMS and battery status data and default information from BMS up to PHONOCUBE.

2. Communication Protocol

2.1 Protocol format

CAN format: 2.0A Version, standard Frame, Baud rate 250kbit/s

2.2 Format of data from upper computer to BMS

Table 1 Format for sending orders

OUT	IN	ID	Communication Cycle	Data	
		ID= 305H	event trigger	position	Data name
				1byte	Cmd(System sending data/system shutdown order)
				2byte	control word
				3byte	ID_Of_CECU
				4byte	Upper computer heartbeat
				5byte	Reserved（to be FF）
				6byte	Reserved（to be FF）
				6byte	Reserved（to be FF）
				7byte	Reserved（to be FF）
				8byte	Reserved（to be FF）

- Byte 1/Byte 2/Byte 3/Byte 4 upper computers send data per 50ms;

- When Cmd of Byte 1=0xAA,ID_Of_CECU of Byte 3 = 0x01, ID of CECU, CECU will send the data to the upper computer and finish it within 250ms.
- Control word/upper computer heartbeat order is served to be as the condition for CECU to judge if to open the relevant charge/discharge contactor. It is defined as below:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	ChgEnable	DischgEnable

When the upper computer is active, the value of Heartbeat is accumulated from 0 to 255 while without any change when abnormal. ChgEnable (Charge contactor available sign) and DischgEnable (Discharge contactor available sign) are the start and stop orders. When the value is 0, opening relevant contactor is forbidden; when the value is 1, opening relevant contactor is allowed. Conditions of opening relevant contactor: 1. The relevant contactor is allowed to open by the upper computer; 2. The system is working normally; or the relevant contactor will be shutdown.

2.3 Battery management system status data

The system is composed of one monitor system and multiple battery management systems (BMS), which are the same except of signal group name and ID. Because of this, there will be only 1 BMS frame in chapter 2.4. All signal group name and ID of the battery management systems are listed as below:

BMS1

Group Name	ID(hex)
Data frame A uploading to the system from BMS1	316
Data frame B uploading to the system from BMS1	317
Data frame of single cell voltage 1 uploading to the system from BMS1	412
Data frame of single cell voltage 1 uploading to the system from BMS1	413
Data frame of single cell voltage 1 uploading to the system from BMS1	414

2.4 Data definition of the battery management system

Table 3 Data frame A uploading to the system from BMS

OUT	IN	ID	Communication Cycle	Data	
BM	SYS	ID=316H		Position	Data name
				1 Byte	LECU ID
				2 Byte	1st path temperature in LECU ID
				3 Byte	2nd path temperature in LECU ID
				4 Byte	AD value low byte of charge current
				5 Byte	AD value high byte of charge current
				6 Byte	AD value low byte of discharge current
				7 Byte	AD value high byte of discharge current
				8 Byte	SOC of the battery module

Calculation of temperature: Real Temperature = value of the byte- 40.

Words in red are tested by CECU.

Current calculation: Current data is AD divided by 4.096 from CECU.

SOC is the value from 1 to 100.

Table 4 Data frame B uploading to the system from BMS1

OUT	IN	ID	Communication Cycle	Data	
BM	SYS	ID=317H		Position	Data name
				1 Byte	LECU ID
				2 Byte	Voltage fault code uploaded by this LECU ID

				3 Byte	Low charge/discharge condition order in discharging
				4 Byte	Low charge/discharge condition order in charging
				5 Byte	Temperature code uploaded by this LECU ID
				6 Byte	Temperature defaulted LECU ID
				7 Byte	Current default（CECU）
				8 Byte	The system heartbeat

With the same mechanism of heartbeat with the upper computer, the data will be accumulated from 0 to 255 every time when CECU sends the system data to the upper computer. 5 same data each time; 5 anther data next time.

BYTE 3: Low discharge condition order in discharging. When SOC >20%, the value = 0; when 20%>=SOC>10%, 1; when SOC<= 10%, 2.

BYTE 4: Low charge condition order in charging. When SOC <80%, the value = 0; when SOC>=80%, 1.

Please note that the hall, current sample contractor in the protocol, is installed on CECU, so the 7th byte is the current default code uploaded from CECU, and defined as below:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Restrained	Restrained	Restrained	Restrained	A	B	C	D

C/D: Overload fault.

D=1: 60A < Load current <70A. The system will alert to the upper computer, but the discharging contactor keeps no action.

C=1: Load current > 70Ah. The system will cut down the discharging rely, and it will not be closed any more unless the system is reopen without any fault.

A/B: Charging fault.

B=1: 60A < charging current <70A. The system will alert to the upper computer, but the charging contactor keeps no action.

C=1: Load current > 70Ah. The system will cut down the charging rely, and it will not be closed any more unless the system is reopen without any fault.

The voltage default code is defined as below:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
A	B	C	D	E	F	G	H

A Restrained

B = 1: Over-dischargealert: 3.0V; B = 0: normal

C = 1: Over-discharge protection: 2.5V; B = 0: normal

D/E/F Restrained

G = 1: Over-charge alert: 3.5V; G = 0: normal

H = 1: Over-charge protection: 3.65V; H = 0: normal

Over-charge release voltage: 3.4V

Over-discharge release voltage: 3.05V

Temperature fault code defined as below:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
A	B	C	D	E	F	G	H

A Restrained

B = 1: Temperature difference of 2 paths over 15℃; B = 0: normal

C/D Restrained

E = 1: Low temperature alert: 0℃; G = 0: normal

F = 1: High temperature alert: >55℃<65℃; F = 0: normal

G = 1: Over temperature protection: >65℃; G = 0; normal

H = 1: Low temperature protection: -10℃; H = 0: normal

Temperature difference fault release: 10℃

High temperature fault release: 50℃

Low temperature fault release: 5℃

Table 6 Cell voltage data frame1 uploaded by BMS1

OUT	IN	ID	Communication	Data

			Cycle		
BM	SYS	ID=412H		Position	Data name
				1 Byte	Low byte of the 1st cell voltage uploaded by LECU of ID X
				2 Byte	High byte + LECU ID information of the 1st cell voltage uploaded by LECU of ID X
				3 Byte	Low byte of the 2nd cell voltage uploaded by LECU of ID X
				4 Byte	High byte + LECU ID information of the 2nd cell voltage uploaded by LECU of ID X
				5 Byte	Low byte of the 3rd cell voltage uploaded by LECU of ID X
				6 Byte	High byte + LECU ID information of the 3rd cell voltage uploaded by LECU of ID X
				7 Byte	Low byte of the 4th cell voltage uploaded by LECU of ID X
				8 Byte	High byte + LECU ID information of the 4th cell voltage uploaded by LECU of ID X

E.g. If the frame of ID 412H is as below in turn,

1st byte	2nd byte	3rd byte	4th byte	5th byte	6th byte	7th byte	8th byte

0x8C	0xXA	0x8C	0xYA	0x8C	0xXA	0x8C	0xYA

then the frame means that the hexadecimal value of the 1st cell voltage is 0x0A8C uploaded by the LECU with its ID (X*16+Y) and 2700 in decimal system, and then the real value of the cell voltage is 2700*1.5=4050mV. It is the same way for the 2nd ~4th cell. Blow is ID(413/414 with the same calculation method)

Table 7 Cell voltage data frame1 uploaded by BMS2

OUT	IN	ID	Communication Cycle	Data	
BM	SYS	ID=4 13H		Position	Data name
				1 Byte	Low byte of the 5th cell voltage uploaded by LECU of ID X
				2 Byte	High byte + LECU ID information of the 5th cell voltage uploaded by LECU of ID X
				3 Byte	Low byte of the 6th cell voltage uploaded by LECU of ID X
				4 Byte	High byte + LECU ID information of the 6th cell voltage uploaded by LECU of ID X
				5 Byte	Low byte of the 7th cell voltage uploaded by LECU of ID X
				6 Byte	High byte + LECU ID information of the 7th cell voltage uploaded by LECU of ID X
				7 Byte	Low byte of the 8th cell voltage uploaded by LECU of ID X
				8 Byte	High byte + LECU ID information of the 8th cell voltage uploaded by LECU of ID X

Table 8 Cell voltage data frame1 uploaded by BMS3

OUT	IN	ID	Communication Cycle	Data	
BM	SYS	ID=414H		Position	Data name
				1 Byte	Low byte of the 9th cell voltage uploaded by LECU of ID X
				2 Byte	High byte + LECU ID information of the 9th cell voltage uploaded by LECU of ID X
				3 Byte	Low byte of the 10th cell voltage uploaded by LECU of ID X
				4 Byte	High byte + LECU ID information of the 10th cell voltage uploaded by LECU of ID X
				5 Byte	Low byte of the 11th cell voltage uploaded by LECU of ID X
				6 Byte	High byte + LECU ID information of the 11th cell voltage uploaded by LECU of ID X
				7 Byte	Low byte of the 12th cell voltage uploaded by LECU of ID X

				8 Byte	High byte + LECU ID information of the 12th cell voltage uploaded by LECU of ID X