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**Communication Protocols between Battery
Management System and Off-board Charger for
Electric Vehicles**

电动汽车电池管理系统与非车载充电机之间的通信协议

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Foreword

The data frame format of this Standard is specified in CAN Bus Technical Specifications 2.0 issued in September, 1991.

Annex A of this Standard is normative; Annex B is informative.

This Standard was proposed by and shall be under the jurisdiction of the National Technical Committee of Auto Standardization.

The drafting organizations of this Standard: Tianjin Qingyuan Electric Vehicle Co., Ltd., China Automotive Technology & Research Center, Shenzhen BYD Co., Ltd., Chery Automobile Co., Ltd., Beijing Institute of Technology, Beijing Jiaotong University, Institute of Electrical Engineering Chinese Academy of Science and China Electronics Technology Group Corporation No. 10 Research Institute.

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Communication Protocols between Battery Management System and off-board Charger for Electric Vehicles

1 Scope

This Standard specifies communication protocols between battery management system (hereinafter referred to as BMS) and off-board charger (hereinafter referred to as charger) for electric vehicles.

This Standard applies to off-board charging for electric vehicles.

CAN identifier of this Standard is 29 bits, and communication baud rate is 250 kbps, but this Standard is not limited to 29-bit identifier and 250 kbps communication baud rate. If other formats are used, their CAN identifier shall be made by reference to this Standard.

Data transmission of this Standard is by the format of low bits transmitted first.

Negative current value represents charging; positive current value represents discharging.

2 Normative References

The provisions in the following documents become part of this Part through reference in this Standard. For dated documents, the subsequent amendments (excluding corrigenda) or revisions do not apply to this Standard. However, all parties who enter into agreement based on this Standard are encouraged to study whether the latest versions of these documents are applicable. For undated documents, the latest versions apply to this Standard.

ISO 11898-1:2006, Road Vehicles – Controller Area Network (CAN) – Part 1: Data Link Layer and Physical Signalling

SAE J1939-11:2006, Recommended Practice for a Serial Control and Communications Vehicle Network – Part 11: Physical Layer, 250K bits/s, Twisted Shielded Pair

message

One or more CAN data frames with the same parameter group number

4 Physical Layer Interface

4.1 The Physical layer realizes the electric connection in the network between BMS and charger

4.2 A CAN interface independent to the power assembly control system is preferred for the communications between BMS and charger.

4.3 The Physical layer adopting this Standard shall meet the specifications of the international standards ISO 11898-1 and SAE J1939-11.

5 Data Link Layer

5.1 General

Data link layer provides reliable data transmission between physical connections.

5.2 Frame format

As shown in Figure 1, the CAN extended data frame is divided into different bit fields, where the arbitration field which has a 29-bit identifier, including an 11-bit basic identifier and an 18-bit identifier extension. The CAN data frame format of this Standard is referred to SAE J1939-21; and the 29-bit identifier of the arbitration field is further defined.

5.3 Protocol data unit

The CAN data frame includes a single protocol data unit (PDU), as shown in Figure 2. The protocol data unit consists of seven parts, namely priority (P), reserved bits (R), data page (DP), PDU format (PF), PDU specific (PS), source address (SA) and data field.

The description of all parts in the protocol data unit is as follows:

5.3.1 Priority (P)

or charger fails to receive each other's message within the specified period of time, it is determined that it is a time-out, and the time-out time is always 5s, unless otherwise specified; and in the event of a time-out, the BMS or charger sends the error message and enters the error handling state. See Annex A for the formats and contents of messages; and see Annex B for the overview flow charts and flow charts of all phases of the charging process.

6.2 Handshake phase

After the physical connection between BMS and charger is completed and electrified, and that the manual setting of CAN identifier format and communication baud rate is completed, the BMS and charger enter the handshake phase. During the handshake phase, the BMS first test whether the low-voltage auxiliary power supply is normal; if it is not normal, the BMS sends error message to the charger, and the charge should turn off the output of low-voltage power supply; if the low-voltage power supply is normal, both sides shall do handshake during the phase, and determine the battery information (e.g. battery type and manufacturing date of battery pack) and the relevant information of the charger (e.g. charger number and charging plug number).

6.3 Configuration phase

After the handshake phase, the BMS and charger enter the configuration phase. During the phase, the charger sends the message of its maximum output capacity to the BMS; then the BMS judges whether charging can be done in accordance with the maximum output capacity of the charger.

6.4 Charging phase

After the configuration phase, the BMS and charger enter the charging phase. During the whole charging phase, the BMS controls the whole charging process by sending in real time the battery charging level requirements to the charger. The charger regulates the charging voltage and charging current to ensure the charging process is normal based on the battery charging level requirements; in addition, the BMS and charger also send each other their own charging states, and when the BMS sends a message for the first time during the charging phase, it gives priority to the message of the battery charging state.

The BMS judges whether to terminate charging, in accordance with whether the charging process is normal or not, whether the battery state meets the charging termination conditions set by the BMS or not and whether the BMS receives the charging termination message from the charger; and the charger judges whether to terminate charging, in accordance with whether the charging process is normal or not, whether the charging parameters set by human are met or not and whether the charging termination message from the BMS is received or not.

6.5 Charging termination phase

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
CRM	Charger identification message	Reserved					D20 to D21 – identification result (00-BMS, non-identifiable; 01-BMS, identifiable)	Charging plug number	Charger number

Message purpose: to provide the charger identification information to the BMS.

Sending section: the handshake phase. After the physical connection between BMS and charger is completed and electrified, and that the manual setting of CAN identifier format and communication baud rate is completed, the charger sends messages to the BMS once every other 250 ms.

Sender: the charger.

Description:

a) Charger number:

data length: 1 byte; format: 1/ bit, 0 offset; data scope: 0 to 255;

b) Charging plug number:

data length: 1 byte; format: 1/bit, 0 offset; data scope: 0 to 255.

A.1.3 Battery information messages

Message code	Message description	Priority	Data byte	Refresh rate	29-bit identifier
BIM	Battery identification message	6	8	250 ms	0x18E5E5F4

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
BIM	Battery information message	Battery pack ID number				Battery type	Day	Month	Year

Message purpose: to confirm the battery information.

Sending section: the handshake phase. the BMS sends messages to the charger once every other 250 ms until it receives the message of the maximum output capacity of the charger.

Sender: the BMS.

Description:

a) Year:

data length: 2 bytes; format: 0.1 V/bit, 0V offset; data scope: 0 to 800 V;

b) Maximum charging voltage:

the maximum charging voltage refers to the maximum voltage that the charger can control and output;

data length: 2 bytes; format: 0.1 V/bit, 0 V offset; data scope: 0 to 800 V;

c) Charging current:

the charging current refers to the maximum current that the charger can control and output;

data length: 2 bytes; format: 0.1 A/bit, -800 A offset; data scope: -800 to 0 A;

d) Pulse discharging current:

the pulse discharging current refers to the discharging current that the charger allows, and the charger should be set to 0 if it has no discharging function;

data length: 1 byte; format: 2 A/bit, 0 A offset; data scope: 0 to 500 A;

e) Duration of pulse discharging:

the charger should be set to 0 if it has no discharging function;

data length: 1 byte; format: 1 s/bit, 0 s offset; data scope: 0 to 255 s.

A.2.2 BMS charging preparation messages

Message code	Message description	Priority	Data byte	Refresh rate	29-bit identifier
BCRM	BMS charging preparation message	6	1	250 ms	0x18E7E5F4

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
BCRM	BMS charging preparation message								D00 to D03 –charging preparation state (0000 – BMS is unable to charge; 0011 – BMS fails to complete charging preparation; 1111 – BMS completes charging preparation)

			010 – constant-current charging)		
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Message purpose: to let the charger regulates the charging voltage and charging current to ensure the normal process of charging based on the battery charging level requirements. If the charger fails to receive the message within 100 ms, it is a time-out, and then the charger should immediately terminate charging.

Sending section: the charging phase.

Sender: the BMS.

Description:

a) Charging mode:

In the constant-voltage charging mode, the charger is capable of giving a stable output voltage within the tolerances of the set values, and the output current cannot exceed the current requirement value; in the constant-current charging mode, the charger should be capable of giving a stable output current within the tolerances of the set values, and the output voltage cannot exceed the voltage requirement value;

b) Voltage requirement:

data length: 2 bytes; format: 0.1 V/bit, 0 V offset; data scope: 0 to 800 V;

c) Current requirement:

data length: 2 bytes; format: 0.1 A/bit, -800 A offset; data scope: -800 to 500 A.

A.3.2 Battery charging state messages

Message code	Message description	Priority	Data byte	Refresh rate	29-bit identifier
BCSM	Battery charging state message	6	8	250 ms	0x183DE5F4

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
BCSM	Battery charging state message	Estimated fully charging time/min	Current SOC/%	Battery pack maximum temperature/°C	Battery pack minimum temperature	Charging current measured value/A	Charging voltage measured value/V		

Message purpose: the BMS sends the charger the battery pack charging voltage, charging current, battery pack maximum temperature and battery pack minimum temperature measured, then the charger monitors the charging process based on the

Message purpose: to let the BMS monitor whether the charging current and voltage controlled by the charger at present are consistent with battery charging level requirement, in order to ensure the whole charging process.

Sending section: the charging phase.

Sender: the charger.

Description:

a) Voltage output value:

data length: 2 bytes; format: 0.1 V/bit, 0 V offset; data scope: 0 to 800 V;

b) Current output value:

data length: 2bytes; format: 0.1 A/bit, -800 A offset; data scope: -800 to 500 A;

c) Accumulated charging time:

data length: 2 bytes; format: 1 min/bit, 0 min offset; data scope: 0 to 6 000 min.

A.3.4 BMS charging termination messages

Message code	Message description	Priority	Data byte	Refresh rate	29-bit identifier
BACM	BMS charging termination message	5	4	20 ms	0x14E8E5F4

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
BACM	BMS charging termination message					D30 to D31 – charging termination is normal or not (00 – abnormal charging termination; 11 – normal charging termination); D32 to D33 – judgment basis for charging termination	D20 – current matches or not (0 – match; 1 – not match); D21 – voltage matches or not (0 – match; 1 – not match)	D10 – over-temperature failure of battery and electronic components (0 – there is no failure; 1 – there is failure); D11 – failure of BMS hardware (0 – there is no failure; 1 –	D00 – set value of total voltage is reached or not (0 – not reached; 1 – reached); D01 – set value of cell (module) voltage is reached

	termination message					normal (00 – abnormal charging termination; 11 – normal charging termination); D32 to D33 – judgment basis for charging termination (00 – charger terminates charging first; 11 – BMS terminates charging first)	or not (0 – match; 1 – not match); D21 – voltage matches or not (0 – match; 1 – not match)	charger (0 – there is no failure; 1 – there is failure); D 11 – failure of charger hardware (0 – there is no failure; 1 – there is failure); D12 – failure of transmission of electricity required (0 – there is no failure; 1 – there is failure); D13 – over- temperature failure of connector (0 – there is no failure; 1 – there is failure); D14 – failure of weak high-voltage insulation (0 – there is no failure; 1 – there is failure); D15 – other failure (0 – there is no failure; 1 –	charger total voltage is reached or not (0 – not reached; 1 - reached); D01 – set electricity value of charger is reached or not (0 – not reached; 1 - reached); D02 – set value of charging time is reached or not (0 – not reached; 1 – reached)
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data length: 2 bytes; format: 0.001 V/bit, 0 V offset; data scope: 0 to 18 V.

A.4.2 Charger charging statistics messages

Message code	Message description	Priority	Data byte	Refresh rate	29-bit identifier
CCSM	Charger charging statistics message	6	8	250 ms	0x18FF04E5

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
CCSM	Charger charging statistics message	Reserved	Charger number	Energy output/ kWh		Accumulated charging time/ min		Electricity output/ Ah	

Message purpose: to let the charging monitoring system confirm the charging statistics data of the charger for the charging process.

Sending section: the charging termination phase.

Sender: the charger.

Description:

a) Electricity output:

data length: 2 bytes; format: 0.1 Ah/bit, 0 Ah offset; data scope: 0 to 600 Ah;

b) Accumulated charging time:

data length: 2 bytes; format: 1 min/bit, 0 min offset; data scope: 0 to 6 000 min;

c) Energy output:

data length: 2 bytes; format: 0.1 kWh, 0 kWh offset; data scope: 0 to 500 kWh;

d) Charger number:

data length: 1 byte; format: 1/bit, 0 offset; data scope: 0 to 255.

A.5 Error messages

A.5.1 BMS error messages

Message code	Message description	Priority	Data byte	Refresh rate	29-bit identifier
BEM	BMS error message	4	4	20 ms	0x10FF05F4

Message code	Message description	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
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- D BMS tests whether low-voltage auxiliary power supply is normal
- E yes
- F BMS sends charger BMS identification message after receiving charger identification message, D20 to D21 = 00
- G time out
- H charger receives BMS identification message or not
- I no
- J yes
- K charger sends BMS charger identification message, D20 to D21 = 01
- L BMS receives charger identification message, D20 to D21 = 01
- M time out
- N no
- O yes
- P BMS sends charger battery information message
- Q time out
- R no
- S charger receives battery information message or not
- T error
- U yes
- V configuration phase

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