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Conformance test for communication protocols between off-board conductive charger and battery management system for electric vehicle

电动汽车非车载传导式充电机与

电池管理系统之间的通信协议一致性测试

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Table of Contents

Foreword....3

Introduction....4

1 Scope....5

2 Normative references....5

3 Terms and definitions....5

4 Abbreviations....8

5 Conformance testing requirements....9

6 Conformance testing system....11

7 Conformance testing content....12

Annex A (normative) Static documents of protocol conformance testing....49

Foreword

This Standard is drafted in accordance with the rules given in GB/T 1.1-2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The issuing organizations of this document shall not be held responsible for identifying any or all such patent rights.

This Standard is proposed by and shall be under the jurisdiction of China Electricity Council.

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Introduction

Protocol conformance testing is a kind of functional testing, which is to test the protocol implementation under test in a certain network environment by using a series of test sequences. By comparing the similarities and differences between actual output and expected output, to determine the extent to which the implementation under test is consistent with the description standard. By protocol conformance testing, it will reduce the risk of errors when the product is running in the field.

In the realization process of the protocol, due to 1) the ambiguity of the protocol standard description and the ambiguity of understanding, 2) the programming mode and implementation method of the protocol are different, and 3) the protocol implementation has different device selection and configuration and other reasons, there are some differences between different protocol implementations, therefore, it is necessary to carry out protocol conformance testing.

Protocol conformance testing is to detect the existence of errors rather than verify that it is error-free. Relying solely on conformance testing cannot absolutely guarantee the interoperability of the application, so it shall carry out the interoperability testing on the basis of conformance testing.

Protocol conformance testing is the basis for interoperability testing. Only for products that pass the protocol conformance testing indicating that they meet the requirements of the relevant protocol standards, carrying out interoperability testing is meaningful.

Protocol conformance testing does not include evaluation of the design of the protocol standard itself, nor the performance, redundancy, robustness and reliability assessment of the particular protocol implementation body.

Conformance test for communication protocols between off-board conductive charger and battery management system for electric vehicle

1 Scope

This Standard specifies the conformance testing requirements, conformance testing system and conformance testing content for communication protocols between off-board conductive charger (hereinafter referred to as charger) and battery management system (hereinafter referred to as BMS) for electric vehicle.

This Standard applies to the conformance testing carried out for products that are stated to comply with GB/T 27930-2015.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the dated edition cited applies. For undated references, the latest edition of the referenced document (including all amendments) applies.

GB/T 17178.1-1997 Information technology - Open systems interconnection - Conformance testing methodology and framework - Part 1: General concepts

GB/T 27930-2015 Communication protocols between off-board conductive charger and battery management system for electric vehicle

3 Terms and definitions

For the purpose of this document, the following terms and definitions and those defined in GB/T 17178.1-1997 apply.

3.1

abstract test case

A complete and independent specification of the actions required to achieve a specific teat purpose defined at the level of abstraction of a particular abstract test method. It starts and ends in a stable testing state.

[GB/T 17178.1-1997, definition 3.3.39]

3.8

implementation conformance statement [ICS] proforma

A document, in the form of a questionnaire, which becomes an ICS when completed for an implementation or system.

[GB/T 17178.1-1997, definition 3.3.40]

3.9

implementation extra information for testing; IXIT

A statement made by a supplier or implementer of an IUT which contains or references all of the information (in addition to information given in the ICS) related to the IUT and its testing environment, which will enable the test laboratory to run an appropriate test suite against the IUT.

[GB/T 17178.1-1997, Definition 3.3.41]

3.10

implementation extra information for testing [IXIT] proforma

A document, in the form of a questionnaire, which becomes an IXIT when completed for an IUT.

[GB/T 17178.1-1997, definition 3.3.42]

3.11

protocol implementation conformance statement; PICS

An ICS for an implementation or system claimed to conform to a given protocol specification.

[GB/T 17178.1-1997, definition 3.3.80]

3.12

protocol implementation extra information for testing; PIXIT

An IXIT related to testing for conformance to a given protocol specification.

[GB/T 17178.1-1997, definition 3.3.81]

CCS: charger charging status message

CEM: charger error message

CHM: charger handshake message

CML: charger maximum/minimum output parameter message

CRM: charger recognition message

CRO: charger readiness status message

CSD: charger statistical data message

CST: charger stopping charging message

CTS: charger time synchronization message

ETS: executable test suite

ICS: implementation conformance statement

IUT: implementation under test

IXIT: implementation extra information for testing

PICS: protocol implementation conformance statement

PIXIT: protocol implementation extra information for testing

5 Conformance testing requirements

5.1 General

This Standard is to verify whether IUT meets the requirements of GB/T 27930-2015, that is to verify the conformance between IUT and the standard in terms of protocol implementation.

5.2 Testing process

The entire testing process is shown in Figure 1. Preparation for testing includes filling in static documents, building test system, etc. PICS document and PIXIT document are done by IUT provider and test laboratory. After confirming that all devices are normally started, it may turn on PC test software and conduct subsequent test operations. After the test is completed, a test report is generated to draw the test conclusion.

No. of test case	**BN.1001**	
Preconditions	1) The CAN communication speed of the test system and the BMS is set to 250 kbit/s; 2) The physical connection between the test system and the BMS is completed and to ensure lock; 3) The low-voltage auxiliary power circuit contactor K3K4 of the test system is closed	
	Test procedure	Expected result
	The test system does not send messages, and does not start the insulation monitoring	1) The BMS does not send any message within 60 s from the BMS startup; 2) After 60 s, the BMS sends the BEM message with SPN3901 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.1002**	
Preconditions	1) The CAN communication speed of the test system and the BMS is set to 250 kbit/s; 2) The physical connection of the test system and the BMS is completed and to ensure lock; 3) The low-voltage auxiliary power circuit contactor K3K4 of the test system is closed	
	Test procedure	Expected result
	The test system sends a message that does not match the definition of CHM message type and does not start the insulation monitoring	1) The BMS does not send any message within 60 s from the BMS startup; 2) After 60 s, the BMS sends a BEM message with SPN3901 = 01, and the message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.1003**	
Preconditions	1) The test system and the BMS complete handshake confirmation; 2) The test system completes insulation monitoring	
	Test procedure	Expected result
	The test system stops sending messages	1) Within 30 s since the CHM message was first sent, the BMS sends a BRM message in a period of 250 ms; 2) After 30 s, the BMS sends a

		01, and the message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.1007**	
Preconditions	The test system's reception of BRM message is completed	
	Test procedure	Expected result
	The test system stops sending messages	1) Within 5 s since the BRM message was first sent, the BMS sends a BRM message in a period of 250 ms; 2) After 5 s, the BMS sends a BEM message with SPN3901 = 01, and the message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.1008**	
Preconditions	The test system's reception of BRM message is completed	
	Test procedure	Expected result
	The test system sends a message that does not match the definition of CRM message type in a period of 250 ms	1) Within 5 s since the BRM message was first sent, the BMS sends a BRM message in a period of 250 ms; 2) After 5 s, the BMS sends a BEM message with SPN3901 = 01, and the message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.1009**	
Preconditions	The test system's reception of BRM message is completed	
	Test procedure	Expected result
	The test system sends a CRM message with SPN2560 ≠ 0xAA and SPN2560 ≠ 0x00 in a period of 250 ms	1) Within 5 s since the BRM message was first sent, the BMS sends a BRM message in a period of 250 ms; 2) After 5 s, the BMS sends a BEM message with SPN3901 = 01, and the message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015

		2) After 5 s, the BMS sends the BEM message with SPN3904 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.2006**	
Preconditions	The test system receives the BRO message with SPN2829 = 0xAA	
Test procedure		Expected result
	The test system sends the CRO message with SPN2830 ≠ 0xAA in a period of 250 ms	1) Within 60 s since the BRO message with SPN2829 = 0xAA is first sent, the BMS sends the message in a period of 250 ms. The message format, content and period meet the requirements of 9.2 and 10.2.4 in GB/T 27930-2015; 2) After 60 s, the BMS sends the BEM message with SPN3904 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.2007**	
Preconditions	The test system receives the BRO message with SPN2829 = 0xAA	
Test procedure		Expected result
	The test system continues to send the CML message in a period of 250 ms and sends the CTS message (optional) in a period of 500 ms. The message format, content and period meet the requirements of 9.2, 10.2.2 and 10.2.3 in GB/T 27930-2015	1) Within 5 s since the BRO message with SPN2829 = 0xAA is first sent, the BMS sends the message in a period of 250 ms. The message format, content and period meet the requirements of 9.2 and 10.2.4 in GB/T 27930-2015; 2) After 5 s, the BMS sends the BEM message with SPN3904 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015

7.4.3 Charging stage

Test cases of the charging stage are shown in Table 4. The test is mainly for

		length is 9 bytes; 3) The BMS sends the BSM message in a period of 250 ms. The message format, content and period meet the requirements of 9.3 and 10.3.4 in GB/T 27930-2015. The message length is 7 bytes; 4) The BMS sends the BMV message, the BMT message, the BSP message in a period of 10 s. The message format, content and period meet the requirements of 9.3 and 10.3.5, 10.3.6 and 10.3.7 in GB/T 27930-2015 (optional)
No. of test case	**BP.3003**	
Preconditions	The test system voluntarily suspends charging	
	Test procedure	Expected result
	The test system sends the CST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015. The reason for the suspension may be: a) Reach the condition set by the charger. b) Manual suspension. c) Failure suspension: charger over-temperature failure; charge connector failure; charger internal over-temperature failure; required power cannot be transmitted; charger emergency stop failure; mismatch current; abnormal voltage; other failures NOTE: The “manual suspension” includes suspension by swiping the card, pressing the stop button, etc.	1) MS stops sending BCL, BCS, BSM, BMV (optional), BMT (optional) and BSP (optional) messages; 2) The BMS send the BST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.8 in GB/T 27930-2015. The message length is 4 bytes; 3) It enters into the charge completion communication process
No. of test case	**BP.3004**	
Preconditions	The BMS voluntarily suspends charging	
	Test procedure	Expected result

		and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.3007**	
Preconditions	The BMS voluntarily suspends charging and sends the BST message in a period of 10 ms	
Test procedure		Expected result
	The test system sends the message that does not match the CST message type definition in a period of 10 ms	1) Within 5 s since the BST message is first sent, the BMS sends the BST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.8 in GB/T 27930-2015; 2) After 5 s, the BMS sends the BEM message with SPN3906 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.3008**	
Preconditions	The BMS voluntarily suspends charging and sends the BST message in a period of 10 ms	
Test procedure		Expected result
	The test system continues to send the CCS message in a period of 50 ms. The message format, content and period meet the requirements of 9.3 and 10.3.3 in GB/T 27930-2015	1) Within 5 s since the BST message is first sent, the BMS sends the BST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.8 in GB/T 27930-2015; 2) After 5 s, the BMS sends the BEM message with SPN3906 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015

7.4.4 End of charging stage

Test cases of the end of charging stage are shown in Table 5. The test is mainly for communication logic and BSD messages in this stage.

	2) The test system disconnects K1K2, K3K4	
No. of test case	**BN.4001**	
Preconditions	The test system first receives the BSD message	
Test procedure		Expected result
	The test system stops sending messages	1) Within 10 s since the BST message is first sent, the BMS sends the BSD message in a period of 250 ms. The message format, content and period meet the requirements of 9.4 and 10.4.1 in GB/T 27930-2015. 2) After 10 s, the BMS sends the BEM message with SPN3907 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.4002**	
Preconditions	The test system first receives the BSD message	
Test procedure		Expected result
	The test system sends the message that does not match the CSD message type definition in a period of 250 ms	1) Within 10 s since the BST message is first sent, the BMS sends the BSD message in a period of 250 ms. The message format, content and period meet the requirements of 9.4 and 10.4.1 in GB/T 27930-2015. 2) After 10 s, the BMS sends the BEM message with SPN3907 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.1 in GB/T 27930-2015
No. of test case	**BN.4003**	
Preconditions	The test system receives the BSD message	
Test procedure		Expected result
	The test system continues to send the CST message in a period of 10 ms. The message format, contents and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015	1) Within 10 s since the BST message is first sent, the BMS sends the BSD message in a period of 250 ms. The message format, content and period meet the requirements of 9.4 and 10.4.1

Preconditions	1) The charger and the test system enter the handshake identification stage; 2) The test system receives the CRM message with SPN2560 = 0x00	
	Test procedure	Expected result
	The test system continues to use the transmission protocol function to send the BRM message in a period of 250 ms. The message format, contents and period meet the requirements of 9.1 and 10.1.4 in GB/T 27930-2015	1) Within 5 s since the CRM message with SPN2560 = 0xAA message is sent, the charger uses the transmission protocol function to receive the BRM message and sends the CRM message with SPN2560 = 0xAA in a period of 250 ms. The message format, content and period meet the requirements of 9.1 and 10.1.3 in GB/T 27930-2015; 2) After 5 s, the charger sends the CEM message with SPN3922 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.2 in GB/T 27930-2015

7.5.2 Charging parameters configuration stage

Test cases of the charging parameters configuration stage are shown in Table 7. The test is mainly for communication logic, CTS messages, CML messages and CRO messages in this stage.

Table 7 -- Charger test cases - Charging parameters configuration stage

No. of test case	**DP.2001**	
Preconditions	The charger and the test system enter the charging parameter configuration stage	
	Test procedure	Expected result
	The test system uses the transmission protocol function to send the BCP message in a period of 500 ms. The message format, content and period meet the requirements of 9.2 and 10.2.1 in GB/T 27930-2015	1) The charger uses the transmission protocol function to receive the BCP message; 2) The charger stops sending the CRM message with SPN2560 = 0xAA; 3) The charger sends the CML message in a period of 250 ms; and sends the CTS message in a period of 500 ms (optional). The message format, content and

		byte
No. of test case	**DN.2001**	
Preconditions	The charger and the test system enter the charging parameter configuration stage	
	Test procedure	Expected result
	The test system stops sending messages	1) Within 5 s since the CRM message with SPN2560 = 0xAA is first sent, the charger sends the CRM message with SPN2560 = 0xAA in a period of 250 ms; 2) After 5 s, the charger sends the CEM message with SPN3922 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.2 in GB/T 27930-2015
No. of test case	**DN.2002**	
Preconditions	The charger and the test system enter the charging parameter configuration stage	
	Test procedure	Expected result
	The test system does not use transmission protocol function to send the BCP message	1) Within 5 s since the CRM message with SPN2560 = 0xAA is first sent, the charger sends the CRM message with SPN2560 = 0xAA in a period of 250 ms; 2) After 5 s, the charger sends the CEM message with SPN3922 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.2 in GB/T 27930-2015
No. of test case	**DN.2003**	
Preconditions	The test system receives the CML message and the CTS message (optional)	
	Test procedure	Expected result
	The test system stops sending messages	1) Within 5 s since the CRM message and the CTS message (optional) are first sent, the charger sends the CML message in a period of 250 ms and sends the CTS message in a period of 500 ms (optional); 2) After 5 s, the charger sends the

Table 8 -- Charger test cases - Charging stage

No. of test case	**DP.3001**	
Preconditions	The test system receives the CRO message with SPN2830 = 0xAA	
	Test procedure	Expected result
	The test system uses the transmission protocol function to send the BCS message in a period of 250 ms and the BCL message in a period of 50 ms. The message format, content and period meet the requirements of 9.3 and 10.3.1 and 10.3.2 in GB/T 27930-2015	1) The charger uses the transmission protocol function to receive the BCS message; 2) The charger stops sending the CRO message with SPN2830 = 0xAA; 3) The charger sends the CCS message in a period of 50 ms. The message format, content and period meet the requirements of 9.3 and 10.3.3 in GB/T 27930-2015. The message length is 7 bytes
No. of test case	**DP.3002**	
Preconditions	1) The charger and the test system are at the charging stage; 2) The charger and the test system are normally charged	
	Test procedure	Expected result
	The test system sends the BMV message, the BMT message, the BSP message in a period of 10 s. The message format, content and period meet the requirements of 9.3 and 10.3.5, 10.3.6 and 10.3.7 in GB/T 27930-2015	The charger uses the transmission protocol function to receive the BMV message, the BMT message, the BSP message or to drop the connection
No. of test case	**DP.3003**	
Preconditions	1) The charger and the test system are at the charging stage; 2) The test system appears anomaly when simulating the traction battery and sends the corresponding message	
	Test procedure	Expected result
	The test system sends the BSM message according to the reason of the anomaly. The message format, content and period meet the requirements of 9.3 and 10.3.4 in GB/T 27930-2015. The possible conditions and message definitions include: a) Cell voltage anomaly: SPN3090 = 01 or SPN3090 = 10;	The charger stops sending the CCS message and stops the power output at the same time; and sends the CST messages in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015. The message length is 4 bytes

	content and period meet the requirements of 9.3 and 10.3.4 in GB/T 27930-2015. SPN3090 ~ SPN3095 are all set to 00 (normal battery state) and SPN3096 is set to 00 (charging is forbidden)	and charger communicate normally according to the charging process; 2) Within 10-min waiting time, if SPN3090 ~ SPN3095 of the messages received by the test system are all 00 (normal battery state) and SPN3096 is 01 (charging is allowed), the charger will resume charging and the surge current shall meet the requirements of 9.7 in GB/T 18487.1 -2015; 3) When the waiting time exceeds 10 min, the charger stops charging and sends the CST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015. The message length is 4 bytes. At the same time stop the power output
No. of test case	**DP.3006**	
Preconditions	1) The charger and the test system are at the charging stage; 2) The test system voluntarily suspends charging	
	Test procedure	Expected result
	The test system suspends charging and sends the BST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.8 in GB/T 27930-2015. The reason for the suspension may be as follows: a) Reach the desired SOC target value; reach the total voltage set value; reach the cell voltage set value; b) Failure suspension: insulation failure; output connector over-temperature failure; BMS component output connector over-temperature failure; charging	The charger receives the BST message, stops sending the CCS message, and sends the CST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015. The message length is 4 bytes. At the same time stops the power output

Preconditions	The charger and the test system are at the normal charging state	
	Test procedure	Expected result
	The test system sends the BCL message in a period of 50 ms. The message format, content and period meet the requirements of 9.3 and 10.3.1 in GB/T 27930-2015. And send the BCS message without using the transmission protocol function	1) Within 5 s since the last reception of the BCS message, the charger sends the CCS message. The message format, content and period meet the requirements of 9.3 and 10.3.3 in GB/T 27930-2015; 2) After 5 s, the charger sends the CEM message with SPN3924 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.2 in GB/T 27930-2015
No. of test case	**DN.3008**	
Preconditions	The charger and the test system are at the normal charging state	
	Test procedure	Expected result
	The test system uses the transmission protocol function to send the BCS message in a period of 250 ms. The message format, content and period meet the requirements of 9.3 and 10.3.2 in GB/T 27930-2015. Sent the message that does not match the BCL message type definition	1) The charger uses the transmission protocol function to receive the BCS message; 2) Within 1 s since the last reception of the BCL message, the charger sends the CCS message. The message format, content and period meet the requirements of 9.3 and 10.3.3 in GB/T 27930-2015; 3) After 1 s, the charger sends the CEM message with SPN3924 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.2 in GB/T 27930-2015
No. of test case	**DN.3009**	
Preconditions	The charging voluntarily suspends charging, and sends the CST message in a period of 10 ms	
	Test procedure	Expected result
	The test system stops sending messages	1) Within 5 s since the CST message is first sent, the charger sends the CST message in a period of 10 ms. The message format, content and period meet

		CSD message. Turn off the auxiliary power, and the charging ends
No. of test case	**DP.4002**	
Preconditions	The charger suspends charging due to failure (failure type with treatment method b, c), and the current charging process has ended	
Test procedure		Expected result
	Restart charging using cards, App, etc.	1) The charger fails to respond to the charging, and it needs to re-plug the charging connection device to continue charging
No. of test case	**DN.4001**	
Preconditions	The test system voluntarily suspends charging, and sends the BST message and receives the CST message	
Test procedure		Expected result
	The test system stops sending messages	1) Within 10 s since the CST message is first sent, the charger sends the CST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015. 2) After 10s, the charger sends the CEM message with SPN3927 = 01. The message format, content and period meet the requirements of 9.5 and 10.5.2 in GB/T 27930-2015
No. of test case	**DN.4002**	
Preconditions	The test system voluntarily suspends charging, and sends the BST message and receives the CST message	
Test procedure		Expected result
	The test system sends the message that do not match the BSD message type definition in a period of 250 ms	1) Within 5 s since the CST message is first sent, the charger sends the CST message in a period of 10 ms. The message format, content and period meet the requirements of 9.3 and 10.3.9 in GB/T 27930-2015. 2) After 10s, the charger sends the CEM message with SPN3927 = 01. The message format, content and period meet the requirements

Annex A

(normative)
Static documents of protocol conformance testing

A.1 General

Static documents of conformance testing for communication protocols between charger and BMS are provided, in the form of a template, to the IUT provider, whom fill in the blank fields of the template according to the specific conditions of the IUT and then submit to the test laboratory.

Static documents include PICS and PIXIT.

A.2 Protocol implementation conformance statements PICS

Protocol implementation conformance statements PICS document is shown in Table A.1.

Table A.1 -- PICS template document

Protocol implementation conformance statements PICS			
Manufacturer's name			
Manufacturer's address			
Product name		Specifications model	
Software version number		Software check code	
Applicable technical standard	GB/T 27930-2015 Communication protocols between off-board conductive charger and battery management system for electric vehicle		
Specifically meet the following requirements in the standard			
Mandatory & Optional			
Message name	SPN	Description	Support or not
CHM	2600	Charger communication protocol version number	□ Support □ Not support
BHM	2601	Maximum allowable charging total voltage	□ Support □ Not support
CRM	2560	Identification result	□ Support □ Not support
	2561	Charger number	□ Support □ Not support
	2562*	Code of region where charger/charging station is	□ Support □ Not support
BRM	2565	BMS communication protocol version number	□ Support □ Not support

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