Electric Vehicle Charging System and Communication Protocol Standard Interpretation

China Electricity Council
Nari Group Corporation

SESEC translation For Reference Only

Jan 11, 2016
1. Introduction to Preparation Process
2. Interpretation of Standard Provisions
3. Recommendations for Transformation and Upgrade
The development of new energy vehicles is the surest path to auto power.

Electric vehicle is a strategic emerging industry in China and plays an important role in increasing the energy security, tackling climate change, and improving environmental protection. For the past few years, the CPC Central Committee and the State Council have continues to increase the policy support to electric vehicles and charging infrastructures and made planning and deployment in terms of top design and policy supports. The electric vehicle and charging infrastructure is ushering in a period of rapid development.
1. Introduction to Preparation Process

Standard is a support technology to promote the scale development of electric vehicles and standardize the construction of charging infrastructures.

Charging coupler standard is the basis of electric vehicles and charging infrastructures.

Charging coupler standard is the basis for the interconnection of electric vehicles and charging infrastructures.

Charging coupler standard is the basis to guarantee safe and reliable charging of electric vehicles.

Charging coupler standard is the basis of implementing national policies.
1. Introduction to Preparation Process

Five criteria are released as follows:

- **Electric vehicle conductive charging system - Part 1: General requirements (GB/T 18487.1-2015)**
  - It provides the requirements of foundation, versatility, and security for electric vehicle charging system

- **Connection set for conductive charging of electric vehicles - General requirements (GB/T 20234.1-2015)**

- **Connection set for conductive charging of electric vehicles - AC charging coupler (GB/T 20234.2-2015)**

- **Connection set for conductive charging of electric vehicles - DC charging coupler (GB/T 20234.3-2015)**
  - It provides the definition, requirements, test methods, and inspection rules of connection set and makes an explicit statements on the physical sizes and electrical performance of AC and DC charging couplers.

- **Communication protocols between off-board conductive charger and battery management system for electric vehicle (GB/T 27930-2015)**
  - It provides communication protocols for charging control of AC charger and electric vehicle.
GB/T 20234.2
AC charging coupler

GB/T 20234.1
General requirements of charging connection set

GB/T 18487.1
General requirements for charging System

GB/T 20234.3
DC charging coupler

GB/T 27930
Communication protocol

Connection style
Control pilot
System requirements
Connection requirements
Connection requirements
Connection style
Control pilot
Protocol
Protocol
Connection requirements

1. Introduction to Preparation Process

Standardization Administration of the People's Republic of China
National Energy Administration
Ministry of Industry and Information of the People's Republic of China
Ministry of Science and Technology of the People's Republic of China

China Electricity Council
China Automotive Technology & Research Center

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1. Introduction to Preparation Background

Working characteristics I:

Jointly drafted by

Operators

Facility manufacturers

Car manufacturers

Connector manufacturers

Scientific research unit

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1. Introduction to Preparation Background

Working characteristics II:

Soliciting comments from all sides

A total of nearly 1,000 feedbacks is collected through formal soliciting comments from the public twice and covers all areas, such as domestic and foreign auto enterprises, charging infrastructure companies, charging infrastructure operators, and electric vehicle demonstration cities.

On Nov 20, 2014, the China Electricity Council organized a Symposium on Feedbacks from Chinese and Foreign Enterprises Concerning GB/T18487.1. Car manufacturers from Germany, the United States, Japan, and China were invited to have a face-to-face discussion with the drafting group.
1. Introduction to Preparation Background

Working characteristics III:

Careful handling of major technical problems

- With regard to the patent problems in which the temperature monitoring of charging coupler may be involved, the China Electricity Council seeks views of the State Intellectual Property Office and makes careful analysis on the original patents claims to explore solutions of intellectual property rights.
- As for the subject of installing electronic lock to DC charger mechanical lock, the drafting group has held several meetings to discuss issues like where to put the electronic lock, how to put, and how to realize the technical scheme. It is finalized after several revisions and discussions.
1. Introduction to Preparation Background

Working characteristics IV:

Verification standard for carrying out open test of charging interoperability

Owing to the complexity of charging compatibility, to further improve the charging coupler and communication protocol standards, in combination with the standards of the Interoperability Test Specification of Electric Vehicle Conductive Charging and the Communication Protocols Conformance between Off-board Conductive Charger and Battery Management System for Electric Vehicle which are still being formulated, the China Electricity Council has initiated an open testing for charging interoperability of electric vehicle. 8 testing agencies were organized to conduct charging compatibility test for over 50 products from 42 enterprises. Any problems exposed shall be further solved.
各有关单位：

根据中电联《关于开展电动汽车传导充电互操作性测试活动的通知》（标准函[2015]270号）要求和企业自愿报名、按要求提交并审核的情况，确定参加此次电动汽车传导充电互操作性试行单位有：

一、明确职责要求

各方应按照《电动汽车传导充电互操作性测试活动实施方案》的要求进行产品测试。

（一）参加厂家按计划的时间和要求，将试生产产品送至检测机构指定地点，现场检测机构按检测机构指定地点，现场检测机构按要求进行产品测试。

（二）检测机构严格按检测标准进行取样，做好记录。

（三）检测机构按检测标准要求进行检测，完成检测报告。

（四）检测机构按检测标准要求进行检测，完成检测报告。

二、参加单位名称

（一）参加厂家按计划的时间和要求，将试生产产品送至检测机构指定地点，现场检测机构按要求进行产品测试。

（二）检测机构严格按检测标准进行取样，做好记录。

（三）检测机构按检测标准要求进行检测，完成检测报告。

（四）检测机构按检测标准要求进行检测，完成检测报告。
<p>| | |</p>
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<td>3</td>
<td><strong>Recommendations for Transformation and Upgrade</strong></td>
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</table>
2. Interpretation of Standard Provisions

This section of **GB/T 18487** specifies the electric vehicle conductive charging system classification, general requirements, communication, electric shock protection, connection between electric vehicle and power supply unit, special requirements of vehicle coupler and power supply coupler, structural requirements of power supply unit, performance requirements, overload protection and short circuit protection, emergency stop, using conditions, maintenance and identification and description. [Scope of GB/T 18487.1]

**Provisions Interpretation**

- On the basis of GB/T 18487.1-2001 and with main reference of IEC61851.1 ED3.0 CDV, GB/T 18487.1-2015 is modified and improved in accordance with the actual situations of existing domestic vehicles, facilities, and power grids. It covers the following contents: classification, electric shock protection, connection between vehicles and facilities, structural requirements of power supply unit, performance requirements, and using conditions.

- Relevant standards closely associated with this standard are as follows: GB/T 20234-2015 series standards, GB/T 27930-2015, GB/T cables of electric vehicle conductive charging system, and NB/T Electric Vehicle Mode 2 Charging Cable Control and Protection Device.
2. Interpretation of Standard Provisions

Original Text

This section applies to the electric vehicle power supply unit for charging the off-board conductive charger of electric vehicle and includes AC charging spot, off-board charger, and connection set of conductive charging of electric vehicle. The maximum nominal voltage of power supply is 1000V AC or 1500V DC. The maximum for rated output voltage is 1000V AC or 1500V DC.

[Scope of GB/T 18487.1]

Provisions Interpretation

- Suitable for off-board and conductive power supply unit, but different from on-board and wireless charging;
- Suitable for AC charging spot, off-board charger (AC), and connection set;
- Nominal voltage of power supply and rated output voltage are the same as IEC.
2. Interpretation of Standard Provisions

Mode 1
When the electric vehicle is connected to the AC mains (power supply), the power supply side is provided with plugs and sockets in consistent with the requirements of GB 2099.1 and GB 1002, as well as phase lines, neutral lines, and conductor with ground protection. [3.1.2.1 of GB/T 18487.1]
Single-phase AC power supply shall be used and shall not exceed 8A and 250V. Mode 1 is not allowed to charge the electric vehicle. [5.1.1 of GB/T 18487.1]

Provisions Interpretation

- Plugs and sockets as per GB 2099.1 and GB 1002 are adopted for charging;
- Single-phase AC power supply shall not exceed 8A;
- Mode 1 is prohibited to charge electric vehicle.
2. Interpretation of Standard Provisions

Mode 2
The power supply side is provided with plugs and sockets in consistent with the requirements of GB 2099.1 and GB 1002, as well as phase lines, neutral lines, and conductor with ground protection. Besides, cable control and protection device (IC-CPD) is also adopted as charging connection. [3.1.2.2 of GB/T 18487.1] Single-phase AC power supply shall be used. If the power supply side is provided with 16A plugs and sockets in consistent with the requirements of GB2099.1 and GB1002, the output current shall not exceed 13A. However, if the power supply side is provided with 10A plugs and sockets in consistent with the requirements of GB2099.1 and GB1002, the output current shall not exceed 8A. It shall have functions of residual current protection and over current protection. [5.1.2 of GB/T 18487.1]

Provisions Interpretation

- To ensure the safety of Mode 2, only single-phase power supply and plugs and sockets in consistent with the requirements of GB2099.1 and GB1002 are taken into account;
- The margin between output current and rated value of standard plugs and sockets shall be 20%;
- Mode 2 shall have function of residual current protection.
2. Interpretation of Standard Provisions

Mode 3
When the electric vehicle is connected to AC mains (power supply), a special power supply unit is used for direct connection between the electric vehicle and AC mains. Moreover, the special power supply unit is equipped with a control pilot device. [3.1.2.3 of GB/T 18487.1] Mode 3 shall have function of residual current protection. Case A, B, and C connection are applicable to Mode 3. Single-phase AC power supply shall not exceed 32A. In case three-phase power supply is greater than 32A, case C connection shall be adopted. [5.1.3 of GB/T 18487.1]

Provisions Interpretation

- When the electric vehicle is connected to AC mains through a special power supply unit, case A or B or C shall be used;
- Mode 3 shall have function of residual current protection, see 10.3;
- Single-phase power supply shall not exceed 32A;
- Three-phase power supply shall not exceed 63A, see Table A.1 and A.2;
- In case three-phase power supply is greater than 32A, case C connection shall be adopted.
2. Interpretation of Standard Provisions

**Mode 4**
When the electric vehicle is connected to AC mains or DC mains, the DC power supply unit with control pilot functions is used. [3.1.2.4 of GB/T 18487.1]

Mode 4 is able to be directly connected with AC mains or DC mains. Only case C connection applies to Mode 4. [5.1.4 of GB/T 18487.1]

**Provisions Interpretation**

- The electric vehicle is connected to AC or DC mains through DC power supply unit;
- Mode 4 can only take case C connection;
- Control pilot function is shown in Appendix B.
2. Interpretation of Standard Provisions

**Original Text**

Electric vehicle charging equipment [4.4 of GB/T 18487.1]
Electric vehicle charging equipment is classified by output voltages:
- **AC**: Single-phase 220V, three-phase 380V;
- **DC**: 200V-500V, 350V-700V, 500V-950V.
Preferred values of DC charging current: 80A, 100A, 125A, 160A, 200A, 250A.

Note: Power supply unit higher than 950V shall be determined by car manufacturers and power supply unit manufacturers by consultation.

**Provisions Interpretation**

- DC voltage levels shall take into account the low cost, wide range, and high efficiency, and refers to IEC classification. The demands of passenger cars and commercial vehicles are basically met.
- DC current levels shall take into account the cross-sectional area and carrying capacity of charging cable, such as 80A for 16m³, 100A for 25m³, 125A for 35m³, 160A for 50m³, 200A for 70m³, and 250A for 95m³.
- High-voltage DC charging (>950V) may be determined by car manufacturers and equipment manufacturers through consultation.

Table D.2 – Typical voltage ranges for isolated d.c. EV charging stations

<table>
<thead>
<tr>
<th>Voltage range</th>
<th>Example of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 18 V to 60 V</td>
<td>Electric scooters</td>
</tr>
<tr>
<td>2 50 V to 500 V</td>
<td>Electric passenger vehicles</td>
</tr>
<tr>
<td>3 200 V to 500 V</td>
<td>Electric passenger vehicles</td>
</tr>
<tr>
<td>4 400 V to 800 V</td>
<td>Electric buses</td>
</tr>
</tbody>
</table>

NOTE: Full current control would be maintained between these above defined voltage ranges. Specific current supply conditions may exist below these voltage ranges.
2. Interpretation of Standard Provisions

**Protection level** for touching dangerous parts

- For all charging modes and connection type, the protection level of shall be at least: **IPXXC**;
- For all charging modes and case B or C connection, as vehicle plugs and vehicle sockets are coupled, the vehicle plugs and sockets shall be: **IPXXD**;
- For charging mode 3 and case A or B connection, as vehicle plugs and vehicle sockets are coupled, the vehicle plugs and sockets shall be: **IPXXD**;
- For charging mode 1, 2, and 3 and case B or C connection, as vehicle plugs and vehicle sockets are uncoupled, the vehicle plugs and sockets shall be: **IPXXB**;
- For charging mode 3 and case A or B connection, as vehicle plugs and vehicle sockets are uncoupled, the vehicle plugs and sockets shall be: **IPXXB**;
- For charging mode 4 and case C connection, as vehicle plugs and vehicle sockets are uncoupled, effective measures shall be taken to prevent human body from touching DC charging pins and conductor part of casing. [7.2.1 of GB/T 18487.1]

### Provisions Interpretation

- **IPXXA**: the back of hands, **IPXXB**: fingers, **IPXXC**: Tools, **IPXXD**: metal wire;
- When coupled: IPXXD, when uncoupled: IPXXB
- Since the existing physical size of DC charging connection set fails to meet IPXXB when uncoupled, effective measures shall be taken to prevent human body from touching conductor parts of plugs and sockets.
2. Interpretation of Standard Provisions

Original Text

Under the circumstances that the rated charging current is greater than 16A, the power supply socket and vehicle socket should be provided with temperature monitoring device, while the power supply unit and the electric vehicle should have functions of temperature monitoring and over temperature protection. [9.1 of GB/T 18487.1]

Note: To install the temperature monitoring device on the standard plug end in Mode 2 may involve patent issues.

Provisions Interpretation

- In consideration of (1) the matching problem between sockets and plugs of different brands, and (2) the increase in the resistance caused by dust deposits of sockets and plugs, the coupler over temperature due to high current charging for a long time should lead to security risk. It stipulates that when the current is greater than 16A, the plug end should be provided with temperature monitoring device, while the power supply unit and the vehicle should have functions of temperature monitoring and over temperature protection.

- By retrieving the temperature monitoring patents of charging coupler at home and abroad, it found the installation of temperature monitoring device on the standard plug in Mode 2, if required, may lead to patent issues. Panasonic and GE has applied for related patents in China.
2. Interpretation of Standard Provisions

Original Text

In addition to cable assembly, it is not allowed to use extended cable assembly for the connection of the electric vehicle and the power supply unit of electric vehicle. [9.2 of GB/T 18487.1]

Extended Cable Assembly

It is a cable assembly, including a flexible cable or wire, and equipped with a non-rewirable plug and a matching non-rewirable portable socket. [3.4.2 of GB/T 18487.1]

Note 1: When the plug and the socket do not match, the cable is called as "adapter cable".

Note 2: The wire sets in Mode 1, 2, and 3 are not extended cable assembly.

Provisions Interpretation

- The connection of electric vehicle and power supply unit depends on cable assembly (see 3.4.1), rather than extended cable assembly, as shown below:

Extended Cable Assembly (adapter cable)
2. Interpretation of Standard Provisions

Original Text

When AC charging current is greater than 16A, the couplers of power supply and vehicle should be locked in accordance with relevant requirements of GB/T20234.1. The sockets of power supply and vehicle should be equipped with electronic locking device to avoid accidental disconnection in the process of charging. In case the electronic lock fails to operate reliably, the charging of the power supply unit or the electric vehicle should be suspended or not enabled. [9.6 of GB/T 18487.1]

Provisions Interpretation

- Condition to install locking device during AC charging: charging current is greater than 16A;
- The electronic locking device should be mounted on the socket ends of the power supply and vehicle to avoid unexpected disconnection;
- In case the electronic lock fails to operate reliably (at this point, the power supply unit or electric vehicle shall be able to detect the locking status, for example, the electronic lock shall give feedback through locking signals.), the charging of the power supply unit or the electric vehicle should be suspended or not enabled in the preparation.

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2. Interpretation of Standard Provisions

Original Text

During DC charging, the vehicle couplers should be locked in accordance with relevant requirements of GB/T20234.1. The plug end of vehicle should be provided with mechanical locking device, while the power supply unit shall be able to check whether the mechanical lock is reliably locked. The vehicle plug should be provided with electronic locking device. When the electronic lock is in the locking position, it is unable to operate the mechanical lock and the power supply unit shall check whether the electronic lock is reliably locked. In case the mechanical lock or electronic lock fails to operate reliably, the charging of the power supply unit or the electric vehicle should be suspended or not enabled. [9.6 of GB/T 18487.1]

Provisions Interpretation

- During DC charging, the vehicle plug should be provided with mechanical lock and the power supply unit should be able to check whether the mechanical lock is locked reliably (mechanical lock gives feedback through locking signals – switch S);
- The vehicle plug should be provided with electronic lock. When the electronic lock is in the locking position, it is unable to operate the mechanical lock and the two types of locks are interlocked. The power supply unit shall check whether the electronic lock is reliably locked (for example, the electronic lock gives feedback through locking signals, see C.1)
2. Interpretation of Standard Provisions

Original Text

The AC power supply unit should be equipped with either type A or B of residual current protector in accordance with the relevant requirements of GB14048.2-2008, GB 16916.1-2014 and GB 22794-2008. Protective measures should be taken against fault current:
- Type B of residual current protector, or
- Type A of residual current protector, or
- Relevant devices functioned as type A of residual current protector. [9.6 of GB/T 18487.1]

Provisions Interpretation

- Since DC component generated by AC charging will affect the quality of power grid, the residual current protector should be installed on the AC power supply unit for offering protection.
- Residual current protector:
  - Type AC: residual sinusoidal alternating current
  - Type A: residual sinusoidal alternating current + residual pulsating direct current
  - Type B: residuals DC residual current or 10 mA smooth DC residual current with a superposition of 0.4 time rated residual operating current \( I_{\Delta n} \) on AC residual current ( whichever is greater) ( see 8.1.2)
  - Smooth DC residual current or 10 mA smooth DC residual current with a superposition of 0.4 time rated residual operating current \( I_{\Delta n} \) on pulsating DC residual current ( whichever is greater) ( see 8.1.3)
  - Pulsating DC residual current generated by two-phase or polyphase rectifier circuit ( see 8.1.4 and 8.1.5)
  - Smooth DC residual current generated by multi-phase circuit ( see 8.1.6)
2. Interpretation of Standard Provisions

Control pilot circuit can be normally operated without installing switch S2. The vehicle without switch S2 should be charged through single phase, with maximum charging current not more than 8A. [A.1.1 of GB/T 18487.1]

Provisions Interpretation

- If the vehicle has no switch S2, the power supply unit is unable to interact with the vehicle (in case of S2 closed, the power supply unit is informed to start charging; in case of S2 disconnected, the power supply unit is informed to stop charging). To ensure the security of charging, it stipulates that only single-phase charging shall be adopted and shall not exceed 8A.

Note: For 2011 version, in the absence of S2, the charging current shall be equal to or less than 16A.

Figure A.7 AC Charging Connection Control Sequence Diagram without S2
2. Interpretation of Standard Provisions

The vehicle control device is to confirm the rated capacity of present charging connection device (cable) via detection of the resistance value between testing point 3 and PE. The maximum supply current of current power supply unit is determined through measuring the duty ratio of PWM signal in testing point 2. [A.2.2 of GB/T 18487.1]

Provisions Interpretation

- See status C, D, E, and F in the Table A.3 for the rated capacity of cable; see Mapping Table A.1 and A.2 for duty ratio.

Curve should be consistent with the IEC. The new GB stipulates: the maximum charging current is 63A

<table>
<thead>
<tr>
<th>RC</th>
<th>Cable Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5KΩ/0.5W</td>
<td>10A (13A in IEC)</td>
</tr>
<tr>
<td>680Ω/0.5W</td>
<td>16A (20A in IEC)</td>
</tr>
<tr>
<td>220Ω/0.5W</td>
<td>32A</td>
</tr>
<tr>
<td>100Ω/0.5W</td>
<td>63A</td>
</tr>
</tbody>
</table>

\[ I_{\text{max}} = (D \times 100 - 64) \times 2.5 \]

\[ I_{\text{max}} = D \times 100 \times 0.6 \]
2. Interpretation of Standard Provisions

The vehicle control device is to check whether the vehicle plug and the vehicle socket are fully connected via measuring the resistance value between testing point 3 and PE.

If unconnected, S3 is closed; CC is unconnected; and the resistance value between testing point 3 and PE is infinite. If half connected, S3 is disconnected; CC is connected; and the resistance value between testing point 3 and PE is Rc+R4. If fully connected, S3 is closed; CC is connected; and the resistance value between testing point 3 and PE is Rc.

[A.3.3 of GB/T 18487.1]

Provisions Interpretation

- The shunt resistor R4 of S3 is introduced into the vehicle plug to judge whether the vehicle coupler is half connected. The value of R4 is shown in Table A.3.

<table>
<thead>
<tr>
<th>State</th>
<th>R4</th>
</tr>
</thead>
<tbody>
<tr>
<td>State C’</td>
<td>1.8KΩ/0.5W</td>
</tr>
<tr>
<td>State D’</td>
<td>2.7KΩ/0.5W</td>
</tr>
<tr>
<td>State E’</td>
<td>3.3KΩ/0.5W</td>
</tr>
<tr>
<td>State F’</td>
<td>3.3KΩ/0.5W</td>
</tr>
</tbody>
</table>
2. Interpretation of Standard Provisions

The ends of charger and vehicle are provided with IMD electric circuit. The charger is responsible for insulation inspection of the inside of charger (including charging cables) after the connection of power supply coupler, but before K5 and K6 are closed to charge. During the charging after IMD return circuit of charger end is disconnected from AC charging return circuit via switch, and K5 and K6 are closed, the electric vehicle is responsible for insulation inspection of the entire system. [B.4.1 of GB/T 18487.1]

### Provisions Interpretation

- **Responsibility of insulation inspection**
  - Before charging (before K5 and K6 are closed), off-board charger is in charge of insulation monitoring of charger and cable.
  - During charging (after K5 and K6 are closed), the electric vehicle is in charge of insulation monitoring of the entire system.

- **Judge the insulation detection,**
  - \( R = \min(R_{DC+,PE}, R_{DC-,PE}) \)
  - \( R > 500 \, \Omega/V \), safe;
  - \( 100 \, \Omega/V < R \leq 500 \, \Omega/V \), alarm, continue to charge;
  - \( R \leq 100 \, \Omega/V \), fault, stop charging.
2. Interpretation of Standard Provisions

On the completion of IMD detection of charger, the charging output voltage should be timely discharged to avoid voltage surge generated on the battery load in the process of charging. On the completion of charging, the charging output voltage of charger should be timely discharged to prevent operators from shock damages. The selected parameters of discharge circuit should guarantee that the voltage of power supply coupler falls below 60V DC within 1s after the charging connector is off. [B.4.2 of GB/T 18487.1]

- Voltage discharge after the insulation detection of charger is completed - protect the security of battery
  K1 and K2 are closed to conduct insulation detection. The output voltage should be the lower value of either the total maximum permissible charging voltage or the rated voltage of power supply unit, as shown in B.3.3
- Voltage discharge on the completion of charging - protect personal safety
- Discharge circuit parameter requirements
  The voltage falls below 60V DC within 1s after the vehicle coupler is off.
2. Interpretation of Standard Provisions

The vehicle end should be able to detect PE fault in the charging process. [B.3.5 of GB/T 18487.1]

Provisions Interpretation

- Outcome of PE fault:
  1. failure of insulation detection on pile end;
  2. floating vehicle as a result of the damaged ground wire may produce disturbance to communication.

- Diagrams:
  - Normal PE
  - Pile end of PE fault
  - Vehicle end of PE fault
2. Interpretation of Standard Provisions

See Figure B.2 for DC charging connection process and control sequence. See Table B.3 for description of DC charging connection control sequence. [B.5 of GB/T 18487.1]

<table>
<thead>
<tr>
<th>Provisions Interpretation</th>
<th>Signal system / information conditions</th>
<th>EV charger</th>
<th>Charger</th>
<th>Unconnected</th>
<th>Initialization and data interaction stage</th>
<th>Energy transmission phase</th>
<th>Off stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Closed mechanical lock</td>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td>70</td>
<td>71</td>
<td>72</td>
</tr>
<tr>
<td>2 Closed electronic lock (S')</td>
<td>Charger</td>
<td>Close</td>
<td>Open</td>
<td>Close</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Closed auxiliary power K3 and K4</td>
<td>Feedback signal S' of electronic lock</td>
<td>Charger</td>
<td>Open</td>
<td>Close</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Communication handshake, version interaction</td>
<td>Data exchange</td>
<td>Charger</td>
<td>Open</td>
<td>Close</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Insulation detection of charger</td>
<td>Contactor K3 and K4</td>
<td>Charger</td>
<td>open</td>
<td>Close</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Discharge circuit inserted into the charger</td>
<td>Insulation monitoring of circuit switch</td>
<td>Charger</td>
<td>Open</td>
<td>Close</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Switching switch of discharge circuit</td>
<td>Charger</td>
<td>Open</td>
<td>Close</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure B.2 DC Charging Connection Control Sequence
2. Interpretation of Standard Provisions

Original Text

Communication rate between charger and BMS is 250kbit/s. [5 of GB/T 27930]
Note: In special occasions with harsh communication environment (e.g., commercial vehicle charging stations with long communication distance), 50kbit/s of communication rate is exploited after negotiation among manufacturers of power supply unit and electric vehicle.

Provisions Interpretation

- The communication rate between off-board charger and BMS defaults to 250 kbit/s.
- By taking into account the application situations, such as commercial vehicle charging stations with long communication distance, over length cable may have an effect on the reliability of communication. Manufactures of power supply unit and electric vehicle, having had friendly discussion, agree to adopt 50kbit/s of communication rate to increase the compatibility of communication protocol.

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2. Interpretation of Standard Provisions

As newly added messages for product compatibility, CHM and BHM are taken as standard versions to judge whether charger and BMS are correctly used in the startup phase of handshake. [6.5 of GB/T 27930]

Charger handshake message (CHM) [10.1.1 of GB/T 27930]

BMS handshake message (BHM) [10.1.2 of GB/T 27930]

Table 3 Message Classification in Charging Handshake Stage

<table>
<thead>
<tr>
<th>Message code</th>
<th>Message description</th>
<th>PGN (Dec)</th>
<th>PGN (Hex)</th>
<th>Priority</th>
<th>Data length byte</th>
<th>Message cycle ms</th>
<th>Source address - destination address</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM</td>
<td>Charger handshake</td>
<td>9,728</td>
<td>002600H</td>
<td>6</td>
<td>3</td>
<td>250</td>
<td>Charger - BMS</td>
</tr>
<tr>
<td>BHM</td>
<td>Vehicle handshake</td>
<td>9,984</td>
<td>002700H</td>
<td>6</td>
<td>2</td>
<td>250</td>
<td>BMS - charger</td>
</tr>
</tbody>
</table>

Table 8 PGN9728 Message Format

<table>
<thead>
<tr>
<th>Starting byte or bit</th>
<th>Length</th>
<th>SPN</th>
<th>SPN definition</th>
<th>Send options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3 bytes</td>
<td>2,600</td>
<td>Communication protocol version number of charger: the standard states that the current version is V1.1, representing as byte3, byte2—0001H; byte1—01H</td>
<td>Required</td>
</tr>
</tbody>
</table>

Table 9 PGN9984 Message Format

<table>
<thead>
<tr>
<th>Starting byte or bit</th>
<th>Length</th>
<th>SPN</th>
<th>SPN definition</th>
<th>Send options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 bytes</td>
<td>2,601</td>
<td>Maximum permissible charging voltage</td>
<td>Required</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>Introduction to Preparation Background</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Interpretation of Standard Provisions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Recommendations for Transformation and Upgrade</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*SESEC translation For Reference Only*
3. Recommendations for Transformation and Upgrade

Step up publicity and enforcement efforts of standards

The implementation of 2011 Standard has revealed the problem of charging compatibility owing to different understandings from different manufacturers. To put the charging coupler standard into effect, it is recommended to organize experts to propagate and interpret the standard, in favor of accurate understanding and grasping the standards by various manufacturers.
(1) In Appendix A of **GBT27930**, the position of "Yes" and "No" in Figure A.9 swap. Reason: An error in printing.
(2) In 9.2 of GBT 18487.1, for "the extended cable assembly or secondary cable assembly shall not be capitalized for the connection of electric vehicle and the power supply unit of electric vehicle", "or second cable assembly" is deleted.

Reason: There is no definition of secondary cable assembly in the standard. It referred to IEC61851.1 ED3.0 CD3. However, in the original text of the latest IEC61851.1 ED3.0 CDV, the secondary cable assembly has already deleted. Hence, the deletion of secondary cable assembly in the GBT18487.1-2015 is considered as well.
(3) In 10.1.2 of GBT27930, for "Message function: after BMS received PGN9984 charger handshake message", "9984" is changed into "9728".
Reason: An error in edition. PGN in charger handshake message shall be 9728.

(4) In 10.1.3 of GBT27930, for "after the on-board charger identification message is received, the confirmation code equals to 0xAA.", "on-board charger" is changed into "BMS".

(5) In Appendix B of GBT27930, "8906" in the Table B.2 is changed into "8960".
Reason: An error in edition. Decimal 8960 corresponds to hexadecimal 2300H.
(6) In 10.1.3 of GBT27930, "the use of 250kbit/s of communication rate" is deleted. 
   Reason: It is unnecessary to highlight 250kbit/s. 50kbit/s can be used in special occasions, as shown in Chapter 5.

(7) In 10.1.4 of GBT27930, "10ms of sending interval" is changed into "the sending interval among frames is 10ms". 
   Reason: The addition of "among frames" makes description much more accurate.

(8) In 7) of 10.2.1 of GBT27930, "total power battery voltage of the entire vehicle" is changed into "current power battery voltage of entire vehicle". 
   Reason: An error in edition. It ensures the description in Table 12 accords with following description.

(9) In Figure A.10 of GBT27930, "disconnect vehicle relay" and "enter system hibernation" in the low right corner swap. 
   Reason: In practice, the disconnection of vehicle relay (K5 and K6) is occurred prior to the enter of system hibernation, which is also shown in other cases. So, the adjustment is made.
3. Recommendations for Transformation and Upgrade

Carry out electromagnetic compatibility test

To provide evidence whether it is in line with the standards of charging coupler and communication protocol, it is recommended to carry out the certification of charging coupler compatibility and employ qualified testing institutes to conduct the compatibility test in accordance with national standard of interoperability test. Meanwhile, the security of charging infrastructure and the formulation of electromagnetic compatibility test standards shall be strengthened. The security and electromagnetic compatibility test shall be carried out. The charging infrastructure should be safe, reliable, and interconnected.
Transform, upgrade, and fulfill new standard

New coupler and communication protocol standard have comprehensively improved the charging security and compatibility. To better solve the problem of charging interconnection, the existing charging infrastructure and electric vehicle should be upgraded to facilitate the users, avoiding huge waste of social resources owing to incompatibility of charging infrastructure and electric vehicle. The auto enterprises and the charging infrastructure operators are encouraged to carry out necessary transformation and upgrade of charging system.
3. Recommendations for Transformation and Upgrade

Transformation of charging infrastructure

I. Addition of electronic lock and temperature monitoring functions
   - Replace charging cables (including electronic lock and temperature monitoring)
   - Replace control module and wire contribution (addition of the control of electronic lock, position collection, and temperature collection)
   - Modify software and add functions of electronic lock and temperature monitoring

II. Software upgrade as per new standards
   - Change the communication protocol with BMS
   - Alter the charging control procedures, including: auxiliary power sequence, adhesion test, battery voltage detection, and precharge etc.
### 3. Recommendations for Transformation and Upgrade

#### 1 - DC Charging Communication Protocol and Process Compatibility Analysis

<table>
<thead>
<tr>
<th>BMS as per old standard</th>
<th>Charger as per old standard</th>
<th>Charger as per new standard</th>
</tr>
</thead>
</table>
| **①** The length of messaging message is defined not in strict accordance with the standard.  
**Solution:** The sender sends message in strict accordance with the standard, while the receiver never judges its length.  
**②** Priority error  
**Solution:** The sender defines the message in strict accordance with the standard, while the receiver never judges its priority.  
**③** Lack of 1 in the undefined position  
**Solution:** The sender defines the message in strict accordance with the standard, while the receiver makes no judgment.  
**④** The starting and ending times of some messages are inconsistency.  
**Solution:** The receiver never judges messages undesired.  
For some car enterprises, K5 and K6 are closed upon the reception of CRO-0xAA.  
**Solution:** K1 and K2 are closed only when the battery voltage is correct after CRO-0xAA is sent.  
The electric vehicle with normally closed K5 and K6 does not match with the charging infrastructure with adhesion test. | • In the present of phenomenon of ①②③④.  
**Solution:** The same as ①②③④  
• For some car enterprises, K5 and K6 are closed upon the reception of CRO-0xAA.  
**Solution:** It requires to upgrade vehicle procedures.  
• The time to wait for identification message after the auxiliary power is detected by car enterprises is shorter than the insulation inspection of charging infrastructure. It stops due to timeout.  
**Solution:** It requires to upgrade vehicle procedures.  
• Charging infrastructure fails to receive BHM message.  
**Solution:** It requires to communicate with BMS as per old standard.  
• K5 and K6 of electric vehicle are normally closed. The charging infrastructure is unable to charge.  
**Solution:** It requires to upgrade vehicle procedures.  
• The closure of K5 and K6 of electric vehicle is delayed after system start. The charging infrastructure hasn't begun to detect the battery voltage. Charging is impossible due to the failure of insulation inspection of charging infrastructure, or the equipment is burned as a result of reverse connection of battery voltage.  
**Solution:** It requires to upgrade vehicle procedures. | • In the present of phenomenon of ①②③④.  
**Solution:** The same as ①②③④  
• Vehicle fails to receive CHM message.  
**Solution:** It requires to communicate with charging infrastructure as per old standard.  
• It lacks the ability to carry out insulation inspection and the charging infrastructure of discharge circuit has potential safety hazards.  
**Solution:** It requires to upgrade procedures of charging infrastructure. |

| BMS as per new standard | **None** |

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*SESEC translation For Reference Only*
3. Recommendations for Transformation and Upgrade

1 - DC Charging Communication Protocol and Process Compatibility Analysis

**GBT18487.1-2001** gives no definition to DC charging. Please see Draft for Comment discussed in **2014** for part of car enterprises and charging infrastructure manufacturers. **GBT27930-2011 (V1.0)** gives no definition to charging procedures and sequences, but only defines communication protocol. There exist certain problems in the interconnection of new and old standards because the charging infrastructure manufacturers or car enterprises are not in accordance with the standard for the implementation or have different understandings for the standard.

**Conclusion**

- K5 and K6 fail to be closed by the electric vehicle in the stage of parameter configuration, but are closed or delayed in closing in the presence of auxiliary power. There are serious hidden dangers in the charging process of charging infrastructure, which may burn down the electric vehicle or some of the electrical parts of the electric vehicle, even endanger personal safety.
- The electric vehicle and the charging infrastructure, with no reference of the Draft for Comment after the discussion of GBT18487 on March 2014, are unable to be compatible with the new standard. It requires to upgrade the procedures.
## 3. Recommendations for Transformation and Upgrade

### 2 - AC Charging Compatibility Analysis

<table>
<thead>
<tr>
<th>Electric vehicle as per old standard</th>
<th>Charging pile as per old standard</th>
<th>Charging pile as per new standard</th>
</tr>
</thead>
</table>
| *Since the charging infrastructure has no pilot circuit in consistent with the standard, it is unable to match with the charging.*  
**Solution:** It is upgraded to the pilot circuit as defined in the standard.  
• Inconsistent definition of PWM duty cycle, or no PWM  
**Solution:** It is upgraded to PWM as defined in the new standard. |
| Electric vehicle as per new standard | *Since the electric vehicle has no pilot circuit in consistent with the standard, it is unable to match with the charging.*  
**Solution:** It is upgraded to the pilot circuit as defined in the standard.  
• Inconsistent definition of PWM duty cycle, or no response to PWM  
**Solution:** It is upgraded to PWM as defined in the new standard. |
| None | None | None |
3. Recommendations for Transformation and Upgrade

3 - AC Charging Compatibility Analysis

Conclusion

- The charging pile and electric vehicle, with no reference of 2011 Standard, shall be upgraded to the pilot circuit as defined in the new standard;

- It requires to upgrade procedures because PWM duty cycle is not defined in line with the new standard.
3. Recommendations for Transformation and Upgrade

Software upgrade as per new standards

- Change the communication protocol with charger
- Alter the charging control procedures, including: waiting delays of system startup, and sequence for K5 and K6 closure
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