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IEEE Standard for Technical Specifications of a DC Quick and Bidirectional Charger for Use with Electric Vehicles

IEEE Vehicular Technology Society

Developed by the
Intelligent Transportation Systems

IEEE Std 2030.1.1™-2021
(Revision of IEEE Std 2030.1.1-2015)

IEEE

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Approved 9 November 2021

IEEE SA Standards Board

Abstract: Direct-current (dc) charging is a method of charging that facilitates rapid energy transfer from the electric grid to plug-in vehicles. This method of charging allows significantly more current to be drawn by the vehicle versus lower rated alternating-current (ac) systems. A combination of vehicles that can accept high-current dc charge and the dc supply equipment that provides it has led to the use of terminology such as “fast charging,” “fast charger,” “dc charger,” “quick charger,” etc.

DC charging and ac charging vary by the location at which ac current is converted to dc current. For typical dc charging, the current is converted at the off-board charger, which is separate from the vehicle. For ac charging, the current is converted inside the vehicle, by means of an on-board charger.

The location of the ac to dc conversion equipment, or converter, shapes the complexity of the equipment design. Regarding ac charging, as previously mentioned, the conversion is on board the vehicle. This allows the original equipment maker (OEM) designed systems to control the charging operation in its entirety. The on-board charger (converter) and battery controller solution is under direct control of the vehicle manufacturer.

For dc charging, an entirely new challenge exists for OEMs. The dc charger is now external to the vehicle and requires the vehicle engineers to control an external power device. For the reason of necessary interoperability, standards such as IEEE Std 2030.1.1 are provided to assist developers.

Keywords: automotive, CHAdeMO, dc charger, dc charging, electric vehicle, fast charger, fast charging, IEC 61851-23, IEEE 2030.1.1™, rapid charging, SAE, SAE J1772, SAE J2836/2

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Introduction

This introduction is not part of IEEE Std 2030.1.1-2022, IEEE Standard for Technical Specifications of a DC Quick and Bidirectional Charger for Use with Electric Vehicles.

This standard defines requirements for the designs of electric vehicles and dc quick chargers that promote efficient and rapid charging between electric vehicles and dc quick chargers. This document specifies the collaborative actions between electric vehicles and quick chargers referencing relevant international specifications.

Acknowledgment

Grateful acknowledgment is made to the CHAdeMO Association for permission to use the following source material in Annex A: CHAdeMO 1.0.1 (21 May 2013), Technical Specifications of Quick Charger for the Electric Vehicle.

Contents

IEEE Standard for Technical Specifications of a DC Quick and Bidirectional Charger for Use with Electric Vehicles

1. Overview

1.1 Scope

This standard specifies the design interface of electric vehicles and direct current (dc) bidirectional chargers that utilize battery electric vehicles as power storage devices.

1.2 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals is *required to*).[1,2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.
[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEC 62196-3, Plugs, socket-outlets, vehicle connectors and vehicle inlets—Conductive charging of electric vehicles—Part 3: Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and contact-tube vehicle couplers.[3]

ISO 11898-1, Road vehicles—Controller area network (CAN)—Part 1: Data link layer and physical signalling.[4]

ISO 11898-2, Road vehicles—Controller area network (CAN)—Part 2: High-speed medium access unit.

SAE J1772, Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler.[5]

SAE J2836/2, Use Cases for Communications between Plug-in Vehicles and Off-Board DC Charger.

SAE J2847/2, Communication Between Plug-In Vehicles and Off-Board DC Chargers.

SAE J2931/1, Digital Communications for Plug-in Electric Vehicles.

SAE J2931/4, Broadband PLC Communication for Plug-in Electric Vehicles.

UL 2202, Electric Vehicle (EV) Charging System Equipment (AC to DC).[6]

UL 2251 Plugs, Receptacle, Couplers for Electric Vehicles.

UL 2231-1 Personnel Protection Systems for Electric Vehicle Supply Circuits: General Requirements.

UL 2231-2 Personnel Protection Systems for Electric Vehicle Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems.

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[7]

ac input power blackout: Voltage fall of ac input power supply below the specified voltage range.

bus off: A state in which participation in the communications on the shared transmission line for exchange of electronic signals is prohibited.

[3] IEC publications are available from the International Electrotechnical Commission (https://www.iec.ch) and the American National Standards Institute (https://www.ansi.org/).
[4] ISO publications are available from the International Organization for Standardization (https://www.iso.org/) and the American National Standards Institute (https://www.ansi.org/).
[5] SAE publications are available from the Society of Automotive Engineers (https://www.sae.org/).
[6] UL publications are available from Underwriters Laboratories (https://www.ul.com/).
[7] *IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

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CAN communication: Communication that is one of the types of vehicle-mounted network protocol and is used between charger and vehicle. A communication method used for transmitting control signals between an electric vehicle and a quick charger in the CHAdeMO system. (ISO 11898-2[8])

charging: Supplying direct current to a battery from an external power source, producing a chemical reaction of the active substances and storing electrical energy in the battery as chemical energy.

charging cable: A cable that is connected to the electric vehicle for charging purposes.

charging connector: A connecting apparatus equipped with the charger in order to charge electric vehicles.

control power supply: Power supply to supply dc power to communication control circuit in the charger, vehicle, and other accessories.

converter: A device to convert ac power to dc power.

earth leakage circuit breaker (ELCB): A device to detect errors and to break the circuit in case of the following errors:

a) Earth leakage current from the power line

b) Overcurrent on the power line

earthing: To electrically connect the enclosure and metallic pipes, etc., to the earth with electric wires.

electric vehicle (EV): A vehicle using an electric motor as a powertrain.

electric vehicle (EV) contactor: A switching device on dc charging circuit to on-board battery.

electric vehicle supply equipment (EVSE)): The equipment that controls charging and discharging current to and from a vehicle. It comprises an indicator, charge/discharge cable assemblies, and so on.

enclosure: Exterior of the charger, including the knob, handle, grip, and so on.

error frame: A data frame that is transmitted when a bus error is detected.

ground fault (s**ometimes described as earth fault):** Electrically energized condition where the insulation state between main circuit and ground, including insulation deterioration between dc power circuit and charger enclosure or vehicle chassis.

ground fault detection: To detect ground fault.

ID: A name that is given to classify data information and transmission node.

inverter: A device to convert dc power to ac power.

main circuit: An electric circuit to supply dc charging current to on-board battery, which consists of power receiving part from input ac power, converting circuit from ac current to dc charging current and charging current output circuit.

main power supply: Power supply to supply dc power to on-board battery.

on-board battery: A battery for propulsion mounted on an electric vehicle.

[8] Information on references can be found in Clause 2.

on-board dc 12 V power supply: An auxiliary electric vehicle battery used for communication and charging control.

vehicle relay: The switch that controls the electric vehicle contactor.

4. Conventions

4.1 General

This standard uses binary and hexadecimal notation of fields in text and tables. The interpretation of the bit and nibble ordering in these fields adheres to the rules described in 4.2 through 4.7, unless specifically defined otherwise within Annex A or Annex B.

4.2 Binary representation

Binary fields are used with a prefix of "0b" to indicate the binary (or base-2) nature of the data. The field starts with the most significant bit (MSB).

A general binary representation of a field has the following format:

0bB*n*…B1B0

with bit "B*n*" representing the MSB and bit "B0" representing the least significant bit (LSB).

Examples:

a) 0b001
In this example, "1" is the LSB. The value of this field is equivalent to the value of 1 in decimal notation.

b) 0b10000
In this example, "1" is the MSB. The value of this field is equivalent to the value of 16 in decimal notation.

4.3 Hexadecimal representation

Hexadecimal (Hex) fields are used with a prefix of "0x" to indicate the hexadecimal (or base-16) nature of the data. The field starts with the most significant nibble of the fields. Hex digits A, B, C, D, E, and F are capitalized.

A general hexadecimal representation of a field has the following format:

0xHn…H1H0

with nibble "Hn" representing the most significant nibble and nibble "H0" representing the least significant nibble.

Examples:

a) 0x00E
In this example, “E” is the least significant nibble.

b) 0xE00
In this example, “E” is the most significant nibble.

A hexadecimal field can be converted into a binary field by replacing each nibble with the corresponding binary value (following the representation of binary fields).

In this standard, the term “octet” is used to identify two consecutive nibbles of data (i.e., a bit string of length 8). The term “byte” is synonymous with the preferred term, “octet.” The use of the term “byte” has been preserved in normatively referenced material.

Hexadecimal numbers can also be represented in the following form:

H’n,….1,0

4.4 Decimal representation

Values specified in decimal are coded in natural binary unless otherwise stated.

The use of the decimal point in base-10 decimal numbers indicates the separation between units on the left and tenths of units on the right. This standard does not use a comma for the same purpose. Commas are used to separate units of one thousand and one hundred, one million and one-hundred thousand, and so on.

4.5 Transmission sequence

See Annex A, Annex B, and Annex C for their specific transmission sequence.

4.6 Equations

Multiplication is represented as an “×” rather than as an “x” to avoid confusion with hexadecimal numbers and variables.

4.7 Units of measure

Metric units are used.

Interpretations of common units of measure are as follows:

— k (analog) = 1000
— K (digital) (e.g., kilobits) = 1024 (2^{10})
— M (analog) = 1 000 000

— M (digital) = 1 048 576 (2^{20})

— n (analog) = 10^{-9}

— Ω = Ohm

5. Common requirements

5.1 Background

In electric vehicles, the charger may be located internally or externally to the vehicle. When the charger is internal to the vehicle, it is developed for the specific type and size of the battery used in the vehicle. Simple ac voltage may be connected to the on-board charger's power inlet. However, it may be difficult to charge large batteries quickly using common residential ac voltage and current. If the charger is external to the vehicle, it requires communication with the battery control system. This communication protocol may be different by vehicle model, so external chargers can be designed to accommodate multiple technologies. The benefit is that dc chargers can provide more charging energy to the vehicle, which can reduce charge time ("quick charging").

Clause 5 describes the common requirements pertaining to collaborative actions between electric vehicles and quick chargers.

Annex A and/or Annex B shall be used to implement these charging systems.

5.2 Requirements

These requirements are "common" requirements for the specifications in Annex A and Annex B.

a) General:

1) Device shall be able to indicate to the user the status of the charging process and take corrective actions if required.

2) Both the charger and the vehicle shall be equipped with a means to confirm they stay physically and/or electrically connected with each other during charging.

3) The charger shall be equipped with a means to stop charging in the case that communication between the vehicle and the charger (via the communications interface) is interrupted.

4) When the protective conductor between the charger and the vehicle is disconnected**,** the charger shall stop charging within 10 s.

5) The charger shall be able to detect loss of isolation, short circuit, and ground faults.

6) The charger shall be equipped with an overvoltage protection function.

7) The system shall be designed so that a level of voltage that is dangerous to the human body shall not be applied on the charging connector when the connector is not connected to the vehicle.

8) The system shall be designed to prevent users from touching electrically energized parts on the vehicle and the charger.

9) The charger shall be equipped with a means of earth leakage current detection and automatic disconnection to help prevent electric shock.

10) The charger or charging connector shall be equipped with measures (e.g., plastic cap on connector power terminals) to reduce the risk of contact with exposed live parts as a measure against remaining electric charge on the charging connector.

11) The charger shall be equipped with a means of protection against overload and short circuit in the ac main circuit or internal circuit of the charger.

12) The charging system shall be designed so that the voltage level between any accessible conductive parts, including charging cable and charging connector, and any grounding parts decreases to less than 60 V within 1 s or less, after connector removal from station or vehicle.

b) Communications:

A data communications interface shall be used to transmit parameters required for charging control. The charger and vehicle shall exchange the parameters through the interface.

c) Outdoor/indoor conductive charging:

The charger shall be designed to endure the following environmental conditions:

1) IP degree (outdoor): more than or equal to IP44.

2) IP degree (indoor): more than or equal to IP41:

In the following country, the Rain Test in UL 2202 is applicable: U.S.

3) Ambient temperature: −10 °C to 40 °C:

In the following country, the test at –35 °C may be required in UL 2231-1: U.S.

4) Ambient humidity: 5% to 95%.

5) Altitude: Charger shall work at 1000 m or lower.

Annex A

(normative)

CHAdeMO specifications

A.1 Scope of application

This annex describes specifications that shall be incorporated into the designs of electric vehicles and quick chargers in order to enable efficient and rapid charging between electric vehicles and quick chargers.

This annex describes specifications pertaining to collaborative actions between electric vehicles and quick chargers. Design firms and manufacturers shall also reference relevant international specifications, listed in Clause 2, and domestic laws/regulations on electrical equipment.

IEC 61851-23:2014 [B40] and IEC 61851-24:2014 [B41] have specified general requirements on dc EV charging station.[9] System A in Annex AA of IEC 61851-23:2014 and System A in Annex A of IEC 61851-24:2014 have given specific requirements for dc EV charging station, which use the same interface and digital communication method given in this annex. This annex gives detailed specification for charging station and vehicle manufacturers, which conform to Annex AA of IEC 61851-23:2014 and Annex A of IEC 61851-24:2014.

In the following country, UL 2202 is applicable as a safety standard: U.S.

A.1.1 Protocol number and changing protocol in case of the different versions

Any revisions to specification documents shall be recorded in the revision history, along with the description of the changes or additions made. The CHAdeMO protocol number is assigned to manage software compatibility between charger and vehicle developed under different specification versions.

A.2 Vehicle coupler

Vehicle coupler shall conform to IEC 62196-3 Standard sheets for configuration “AA.”

In the following country, UL 2251 is applicable as a safety standard: U.S.

A.2.1 Vehicle inlet

Vehicle inlet shall comply with IEC 62196-3 standard sheets for configuration AA as a connected object of the vehicle coupler that is part of the charging cable assembly, and its soundness shall be confirmed.

In the following country, UL 2251 is applicable as a safety standard: U.S.

[9] The numbers in brackets correspond to those of the bibliography in Annex C.

A.2.2 Charging cable

The charging cable should consist of power wires and signal wires, and it shall comply with international standards such as IEC or the requirements in national standards of each country. The power wires and signal wires shall have conductor size and electric wire coating material that is appropriately designed for the charging current. In addition, the signal wires that are applicable to CAN communication shall be twisted pair wires in order to reduce conductive noise of differential mode signals.

In the following country, UL 62 is applicable as a safety standard: U.S.

A.3 Installation conditions and main specifications

The manufacturer shall manufacture the charger with a design that conforms to the following:

a) Standard usage conditions as shown in Table A.1

b) Panel-related specifications as shown in Table A.2 and Table A.3

c) Device specifications as shown in Table A.4

d) Design specifications as shown in Table A.5

Table A.1—Standard usage conditions

Installation location	Outside
Altitude	1000 m or lower
Ambient temperature	−10 °C to 40 °C
Ambient humidity	30% to 90%, no dew condensation

In Table A.1, a test at –35 °C may be required in UL 2231-1 in the following country: U.S.

Table A.2—Panel-related specifications

<table>
<tr><td>Panel performance[ab]</td><td colspan="2">Indoor use: more than or equal to IP41
Outdoor use: more than or equal to IP44</td></tr>
<tr><td>Panel color</td><td colspan="2">In compliance with local ordinances for markings and visibility</td></tr>
<tr><td rowspan="7">Insulation performance</td><td>Item</td><td>Insulation performance</td></tr>
<tr><td>Input circuit—Output circuit</td><td>Double insulation or Reinforced insulation</td></tr>
<tr><td>Input circuit—SELV[bc]</td><td>Double insulation or Reinforced insulation</td></tr>
<tr><td>Output circuit—SELV[bc]</td><td>Less than 500 V: Basic insulation
More than 500 V and up to 1000 V: Double insulation or Reinforced insulation</td></tr>
<tr><td>Input circuit—Protective conductor</td><td>Basic insulation</td></tr>
<tr><td>Output circuit—Protective earthing conductor</td><td>Less than 500 V:
Basic insulation
More than 500 V and up to 1000 V:
Double insulation or Reinforced insulation</td></tr>
<tr><td colspan="2">Test voltage
a) Withstand ac voltage test (1 min, 50 Hz/60 Hz)
1) Primary side on main circuit (- GND): Un + 1200 Vrms
2) Secondary side on main circuit (- GND):
— 500 V or below:
Un + 1200 Vrms
— More than 500 V and below 1000 V:
$2\times(\mathrm{Un} + 1200)$ Vrms
3) Between primary side and secondary side of isolation transformer:[c]
$2\times(\mathrm{Un} + 1200)$ Vrms
Un: Nominal voltage between neutral and line or phase and earth
If dc voltage is used on this test instead of ac, the applied dc voltage shall be equal to the peak value of regulated ac test voltage.
b) Impulse withstand voltage test
1) Perform the impulse withstand voltage test as defined in IEC 60664-1. The test voltage of the impulse withstand voltage test shall be defined in Table A.3. Overvoltage category III shall be applied in the charger. If the charger manufacturer shall apply the overvoltage category corresponding to its installation environment, the manufacturer shall separately discuss that agreed upon between the charger manufacturer and a certifying body. One step higher voltage than the test voltage defined in Table A.3 shall be applied in case the insulation level between input circuit and output circuit is either Double insulation or Reinforced insulation.
2) The charger shall reduce the output impulse voltage that may be applied to a vehicle to less than or equal to 2500 V. Perform the impulse withstand voltage test as defined in IEC 60664-1. In addition, measure the voltage between P and N of the output circuit in charger while applying the test voltage defined by IEC 60664-1. Applied points shall meet the following requirements:
— Each phase voltage to protective earthing conductor (perform the test at all combinations of each phase including a neutral line)
— Line voltage performs the test at all combinations of line voltage</td></tr>
</table>

[a] Basic or Reinforced insulation shall be implemented on the secondary side of the isolation transformer against the primary one. In the following country, the potential shall be 1000 V plus twice the maximum rated voltage: U.S.

[b] In the following country, the Rain Test in UL 2202 is applicable: U.S.

Table A.3—Test voltage of the impulse withstand voltage test

Nominal voltage of the supply system		Voltage line to neutral derived from nominal voltages up to and including [V]	Test voltage			
			Overvoltage category [V]			
Three phase [V]	Single phase [V]		I	II	III	IV
		50	330	500	800	1500
		100	500	800	1500	2500
	120–240	150	800	1500	2500	4000
230/400, 277/480		300	1500	2500	4000	6000
400/690		600	2500	4000	6000	8000
1000		1000	4000	6000	8000	12 000

Table A.4—Device specifications

Control method	Constant current control based on the current command from the vehicle
Input power supply	Nominal voltage in each country: AC (±15%), 50 Hz or 60 Hz (±5%). Total power factor: 0.95 or more (on the condition with maximum rated output power and current of the charger). Input power supply can be defined by each manufacturer, but its specification shall comply with standard or regulation of each country. If ac input voltage to earth exceeds 300 V, in case of 6 kV transient voltage application test on main circuit, transient voltage to earth on secondary circuit shall be depressed below 2.5 kV by using arrestor, etc. If an arrestor is used to mitigate transient voltage, the arrestor may be omitted on this test.
Output range	Output voltage range: 150 V up to 500 V (Mandatory) 50 V up to 500 V (Recommended) 150 V up to 1000 V (optional)[b] Output current range: 0 up to 125 A (standard operating condition) 0 up to 200 A (standard operating condition/specific operating condition)[c] 0 up to 400 A (standard operating condition/specific operating condition)[c]
Current ripple	Up to 10 Hz: 1.5 Ap-p or less Up to 5 kHz: 3.0 Ap-p or less Up to 150 kHz: 9.0 Ap-p or less
AC/DC conversion efficiency	90% [a] or higher (including auxiliary loss, on the condition with maximum rated output power and current of the charger)
Acoustic noise	65 dB or less (1 m far from each side surface; 1 m high from the floor surface) (on the condition with maximum rated output power and current of the charger)
Communication system	Communication protocol: CAN2.0B Active, [ISO11898-2], Standard format
	Transmission rate: 500 kbps
	Transmission cycle: 100 ms ± 10%
Protection system	Main circuit: Interrupt power supply on occurrence of ground fault and short circuits
	Control circuit: Interrupt power supply on occurrence of ground faults and short circuits

[a] Minimum conversion efficiency recommended by CHAdeMO.

[b] Refer to A.11.5.3.3.

[c] Refer to A.5.5 and A.11.5.3.2.

Table A.5—Design specifications

Operating panel	Charge start button: Blue (recommendation). Charge stop button: Green (recommendation).
	Each button or lamp is lighting during standby and blinking during operation (recommendation).
Emergency stop	Emergency stop button: Red.
	Emergency stop button shall retain its pushed condition until reset operation. Emergency stop button shall be reset only by manual operation. Clear panel window to prevent wrong operation (recommendation). Emergency stop button is only required if specified by applicable legislation where charger is installed.

A.4 Requirements for basic design of the charger and the vehicle

A.4.1 Charging method

The current control method shall be adopted for charging. The vehicle shall send a charging current request to the charger at a constant time interval. The charger shall output dc current for charging corresponding to the request value. The charger shall regulate the output current in response to the change in the request value from the vehicle.

A.4.2 Control signal line

Dedicated control signal lines shall be used to transmit signals concerning the start and termination of charging.

A.4.3 Data communications

A data circuit shall be used to transmit parameters required for charging control. The charger and vehicle shall exchange the parameters through the circuit.

A.4.4 Essential functions

The essential functions are as follows:

a) Connection confirmation (Proximity detection): Both the charger and the vehicle shall be equipped with a means to confirm that they stay connected with each other. The vehicle that applied to “Plug and Charge” (see NOTE) shall supply the “connector proximity detection” line with a 12 V signal. The charger shall detect the status of connector mating and use it as a trigger to start charging. However, the vehicles before version 1.2 that do not supply the “connector proximity detection” line with a 12 V signal is not applicable.

   NOTE—Instantly starting charge at the same time that connect mating is confirmed.[10]

b) Power supply shutdown upon communications disruption:

   1) The charger shall be equipped with a means to stop charging immediately in the case that communication between the vehicle and the charger (via the control signal lines or data communication lines) is interrupted.

[10] Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

2) In addition to data communication, there shall be a means that the vehicle instructs the charger to stop charging. When the vehicle detects disruption of data communication, the charger shall be notified to stop charging by the means.

c) Prevention of false-drive (requirement for the vehicle):

1) The vehicle shall monitor the status of the connection between the vehicle and the charger and shall have a means to prevent drive while the charging connector is connected with the vehicle inlet (including before and after charging).

2) The vehicle shall use a "connector proximity detection" circuit for the confirmation of a connection excluding the period from the point at which the "vehicle charge permission" circuit is turned on to the point at which the EV contactor is opened.

d) Detection of protective conductor disconnection between charger and vehicle: When the protective conductor between the charger and the vehicle is disconnected, the charger shall stop charging immediately.

e) Detection of ground fault on the dc power circuit: During charging, the charger shall detect any ground fault on the dc power circuit. In the event that ground fault is detected in the dc power circuit, the charger shall stop applying dc voltage or supplying dc current to the charging cable immediately. If equipped, the on-board fault detection of the vehicle shall not interfere with the ground fault detection capability of the dc charger.

f) Protection against short circuit in the dc power circuit: The charger shall have means to protect itself and vehicle and prevent problems in the power supply such as the ac mains from short circuit. In addition, the dc power circuit and exposed live parts of a charger shall be properly designed to prevent a short circuit that may be caused by water leakage and ingress of foreign materials.

g) Prevention of overvoltage in vehicle system: The charger shall have means to limit overvoltage in vehicle systems.

h) Charge current interruption function: The vehicle shall have contactors with sufficient capacity to break charge current.

i) Protection of EV contactor: The charger shall continue to provide dc 12 V to the EV contactor, keeping both switch (d1) and switch (d2) turned on, until the output charging current has become less than or equal to 5 A. This requirement shall also be applied to the event of an abnormality including power failure, load fluctuation, pressing of the emergency stop button, and so on.

j) Safety design for receiving stop signals: The charger shall stop charging when it receives a stop instruction by either "control signal" or "CAN communication."

k) Voltage and current measurement: The charger shall have the means to measure voltage and current in the output circuit.

l) Error logging function: The charger shall have a means to store and display error information for users and maintenance personnel.

m) Charging cable assembly: The charger shall be equipped with the charging cable assembly in compliance with the requirements defined in A.2.2, A.4.7, A.5.4, and A.13 and the maximum output voltage and current of the charger.

A.4.5 Protection against electric shock

The live parts of the charger and the vehicle shall be designed to prevent users from approaching.

The voltage or electric charge of a level harmful to the human body shall not be applied to the vehicle inlet and the charging connector during the normal insertion or release of the charging connector, as well as when the charging connector has been disconnected by accident.

In case the accessible live parts on the charger or the charging cable assembly have been exposed, the voltage between the exposed conductive parts and the protective earthing conductor shall be less than 60 V within 1 s after the exposure.

The charger shall have earth leakage detection and automatic disconnection functions to prevent electric shock.

The vehicle shall have the function (e.g., redundant EV contactors) to avoid high voltage being applied to the vehicle inlet even when the welding of EV contactors occurred. Alternatively, the vehicle shall have the function or structure (e.g., protection cover for the vehicle inlet) to prevent users from touching live parts of the vehicle inlet in such a case.

The charging connector shall not be released when energized.

The charger shall reduce the charging current to less than or equal to 5 A within 30 ms after the control signals are interrupted during energization. The control signals for detecting the interruption can be selected by charger manufacturers.

The charger shall have a circuit breaker for protection against short-circuit/overload current and ground fault/earth leakage at the receiving point of electricity. To satisfy the requirements for function maintenance of the control circuit, it is recommended the charger shall have a circuit breaker (AC-ELCB1 and AC-ELCB2 drawn in Figure A.1) on each of the branched circuits just after the branch of the main circuit and the control circuit. Although the circuit breakers may be installed in the upstream of the charger, it is necessary to instruct installers to install the circuit breakers equipped with adequate performance.

NOTE—AC-ELCB (Earth Leakage Circuit Breaker) can be replaced with an alternative equivalent equipment.

The charging cable assembly shall have sufficient strength and preventive measures against mechanical stresses under normal use. The connector holder of the charger shall be located at a height ranging between 0.5 m to 1.5 m above ground.

A.4.6 Overload current protection

The charger shall have a function against overload and short-circuit current to prevent hazards in the power supply. The charger and the vehicle shall have a function against overload and short circuit in each circuit in order to protect each other and shall have a protective coordination to protect the charging cable and accompanying circuit from short circuit and overload current.

A.4.7 Fire or heat hazard protection

The cross-sectional size of the conductor of power wires in a charging cable shall be greater than or equal to the “reference cable size” defined in Table A.6 (see NOTE in table). Also, the requirements for a charging cable having a cross-sectional size less than the reference cable size are defined in A.5.4.3.

The cable size of the protective conductor shall be 0.75 mm^2 or more.

Table A.6—Cross section of conductor for power wires of charging cable

Standard	Reference cable size
IEC standard (in compliance with IEC 60228)	25 mm^2
UL standard (in compliance with UL 62)	4 AWG (21.2 mm^2)
NOTE—Even when the cross-sectional size of the conductor of power wires in a charging cable greater than or equal to the "reference cable size," the requirements of A.5.4.3.1 and A.5.4.3.2 can be applied in order to prevent the welding of the EV contactor in case of a short circuit. In the following country, wire size shall comply with UL 2251: U.S.	

A.4.8 CPU monitoring

The charger and vehicle shall each monitor its own CPU status. Any malfunction or failure affecting charge control capability shall result in a termination to the charge operation, initiated by the vehicle or dc charger.

A.5 Circuit requirements

A.5.1 Main circuit

Basic configuration of main circuit is shown in Figure A.1.

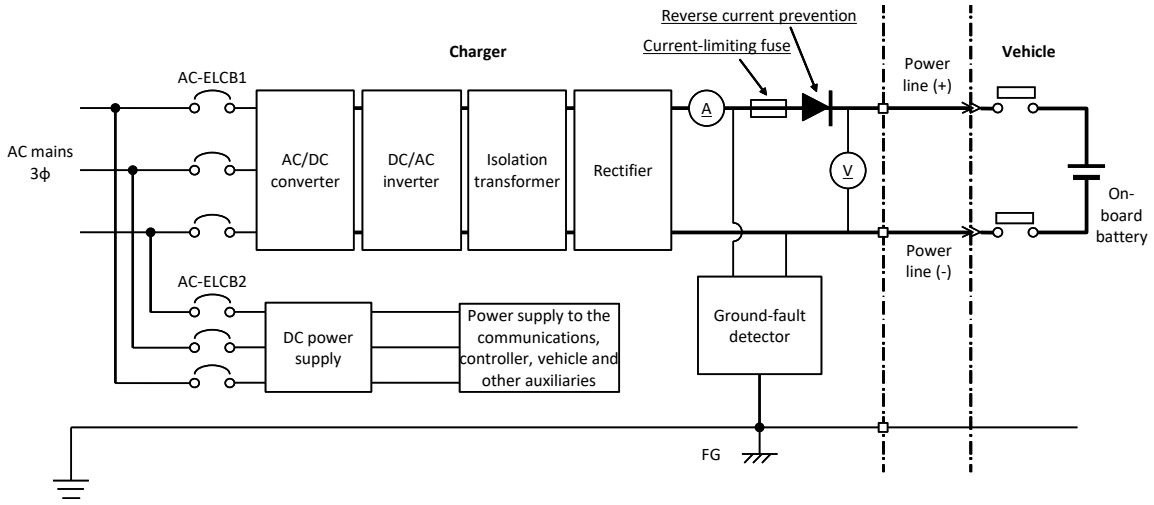


Figure A.1—Typical circuit configuration

A.5.1.1 Isolation of input and output circuits

Input ac circuit and output dc circuit shall be separated by reinforced insulation or double insulation.

In the following country, insulation shall comply with UL 2202: U.S.

A.5.1.2 Function maintenance of the control circuit

Even in the case when an abnormality occurs in the main circuit, the control functions, such as controlling and communicating with the vehicle and protecting and monitoring itself, by the control circuit shall not be terminated.

A.5.1.3 Reverse current prevention diode

The charger shall have a reverse current prevention diode in the output circuit in order to prevent reverse current flowing from the traction battery to the charger, including inrush current.

A.5.1.4 Current-limiting fuse

A.5.1.4.1 Requirements for charger

The charger shall have a current-limiting fuse (passive device) in the output circuit in order to protect itself and the output circuit between a vehicle inlet and a vehicle fuse from the short circuit of P and N of the output circuit. The requirements of the current-limiting fuse of the charger are shown in Table A.7.

Table A.7—Specification of the current-limiting fuse

Item	Requirement
Electrical characteristic	Fast-acting
Ampere rating	More than the maximum current of the charger
Operating joule-integral I^2t	Less than or equal to 0.4 MA^2s

A.5.1.4.2 Requirements for vehicle

The vehicle shall have the means to protect the vehicle circuit in accordance with the requirements of ISO 17409. The operating joule-integral of the fuse on the vehicle side shall be less than or equal to 2.5 MA^2s.

A.5.1.5 Coordination of short-circuit current protection and overload current protection

A.5.1.5.1 Requirements for charger

The charger shall comply with the following requirements. In addition, if a charging cable with the cable size of the power lines being less than the reference cable is installed, the charger shall not only comply with the requirements of A.5.1.5 but also protect the charging cable by the current-limiting fuse inside the charging connector as defined in A.5.4.3.1.

A.5.1.5.1.1 Short-circuit current protection

The charger shall be equipped with a short-circuit protection function. The charger shall interrupt the short-circuit current immediately by using an inverter gate block of the charger as soon as the short circuit between P and N of the output circuit is detected. However, the overload current shall be interrupted by the gate block earlier than the specification of the short-circuit current protection specified by each charger manufacturer, which is defined in A.5.1.5.1.2.

If a charging cable with the cable size of the power lines more than or equal to the reference cable size is installed, the short-circuit withstand rating (operating joule-integral I^2t) of the wiring including the charging cable in the output circuit of the charger shall be more than or equal to 6.4 MA^2s.

If a charger equipped with the current limiting fuse in the connector is installed, the charging connector latch shall not be released when the current limiting fuse is blown.

A.5.1.5.1.2 Overload current protection

There are cases where the wiring including the charging cable in the output circuit of the charger and the cable of the vehicle side cannot be protected by the current limiting fuse of the charger. Therefore, the charger shall shift to an error stop within 5 s after the output current is larger than the error judgment value defined in Table A.8 is detected.

Table A.8—Overload current protection

Charging current request (H'102.3) (see NOTE)	Error judgment value
0 A–50 A	Charging current request (H'102.3) + 10 A
50 A–400 A	Charging current request (H'102.3) × 120%
NOTE—"Charging current request (extended) (H'110.1, H'110.2)" should be used instead of "Charging current request (H'102.3)" in case "High current control" as defined in A.11.5.3.2 is applied.	

A.5.1.5.2 Requirements for vehicle

The vehicle shall interrupt the short-circuit current and the overload current by using protective means such as the fuse on the vehicle side in case the cable of the vehicle side cannot be protected by the short-circuit protection and the overload current protection.

A.5.1.6 Power supply to the vehicle

The charger shall have a dc power supply to provide power for the EV contactor, and so on. The dc power supply shall be provided by the control circuit and shall not be influenced by abnormality in the main circuit (e.g., earth leakage and overload current) as described in A.5.1.2 and item i) in A.4.4.

The requirements of the power supply to vehicle shall be defined in Table A.9.

Table A.9—Requirements of power supply to the vehicle

Supply voltage	12 V (dc) Voltage fluctuation tolerance: ±10% of supply voltage
Continuous rating	2 A, 24 W
Circuit Protection	Short-circuit current to the vehicle shall decrease less than 6 A within 1 s after the short circuit occurs. The wiring of the signal wires shall tolerate the short-circuit current in consideration of the applicable wire size.

A.5.1.7 Current and voltage measurement

The charger shall measure output voltage and current in the output circuit. The output voltage shall be measured at a point between the reverse current prevention diode and the charging connector.

When placing the current-limiting fuse on the vehicle side of the reverse current prevention diode, the output voltage shall be measured at a point between the current-limiting fuse and the charging connector.

A.5.1.8 Earthing, grounding, and protective conductor

A.5.1.8.1 General requirements

Protective earthing conductors of the input circuit shall be connected to the protective conductor of the output circuit without any resistance.

A.5.1.8.2 AC input circuit

a) Conductive parts such as enclosures shall be earthed with protective conductors.

b) Standards regarding earthed conductors shall comply with technical specifications in each country.

c) Design and install the earthed and protective contactors with consideration of electrical noise reduction and electrical shock protection best practices.

A.5.1.8.3 DC output circuit

a) Earth terminals in the charger shall be connected to ones in the vehicle by protective conductor in the charging cable.

b) Protective conductor described in A.5.2 shall be directly connected to earth terminals of the charger rather than via the enclosure of the charger.

c) Chassis ground terminal in the vehicle shall connect to the vehicle chassis.

A.5.1.9 Internal protection

The charger shall have a mechanism for monitoring ground fault, short-circuit, overcurrent, and temperature rise inside the charger, as well as for immediately disconnecting main circuit from external power grid upon detection of any fault.

A.5.1.10 Ground fault detection on the dc output circuit

A.5.1.10.1 Basic requirements

A leakage current monitoring device for detecting ground fault on dc power circuits (secondary circuit of the charger and vehicle-side circuit) shall be installed in the charger. Figure A.2 and Table A.10 specify a detection circuit and detection sensitivity for dc leakage current monitoring. Requirements for the monitoring device are given in item e) of A.7.2.8.2. The insulation monitoring device on the vehicle shall be disabled while the EV contactors are closed, and it shall not affect the operation of the leakage current monitoring in the charger while the vehicle is connected with the charging connector.

The charger shall stop in the event of leakage detection and shall not be operable until the expected operating conditions are satisfied.

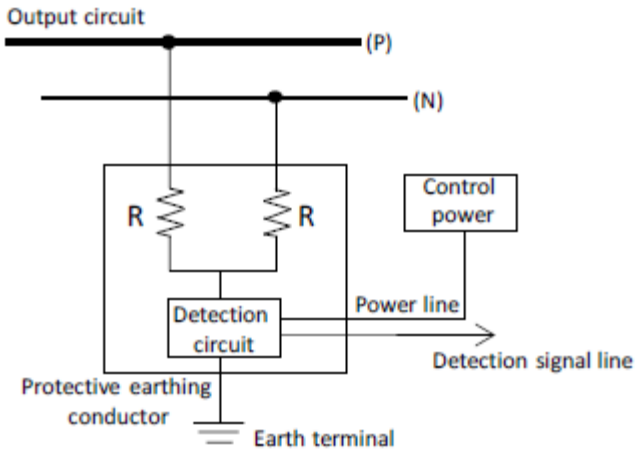


Figure A.2—DC leakage current monitoring circuit

Table A.10—Specification of dc leakage current monitoring

	Item	Specification
1	Detection voltage range	Comply with the output range of charger.
2	Detection method	DC leakage current detection through neutral grounding
3	Sensing performance	The monitoring device shall output the trip signal when the insulation resistance ratio between the main circuit and charger enclosure (including vehicle chassis) gets lower than 100 Ω/V. [V: output voltage][a]
4	Operating time	1.0 s or less
5	False operation prevention time	0.2 s or more (see NOTE)
6	Resistance R	The resistance shall be installed to limit the maximum ground fault current to 12.5 mA. For example, in the case of a charger with dc 150 V to dc 1000 V, the resistance value is 80 kΩ or more. In the following country, the measuring output current shall be 5 mA: U.S.
NOTE—To prevent accidental activation due to short-term noise current.		

[a]In the operation voltage less than 60 V, the criteria of 100 Ω/V may be not applicable. [In some countries, 100 Ω/V criterion is required from operation voltage of 50 V (UL-standard)]. However, the charger shall be able to detect 0 Ω fault at less than 60 V operation voltage.

A.5.1.10.2 Failure detection of ground fault detection circuit (Self-diagnostic function)

The charger shall check the integrity of its ground fault detection circuit in the period from when switch (d1) is turned on to when switch (d2) is turned on. The charger shall shift to an error stop process in case a failure in the ground fault detection circuit is detected. The charger shall at least diagnose the following defined items:

a) Open failure and short-circuit failure of resistance R

b) Open failure of ground fault detection circuit (e.g., open detecting resister of ground fault current)

c) Open failure of power lines

d) Open failure of protective earthing conductor

e) Voltage abnormality of control power (including short circuit of power lines)

A.5.1.11 Overvoltage protection in the event of EV contactor interruption

The charger shall control the output voltage to not exceed the maximum value shown in Table A.11 to protect a vehicle system in case EV contactors are opened during charging.

Table A.11—Requirements of the overvoltage protection

Target battery voltage (H'102.1, H'102.2)	Maximum value of overvoltage
500 V or less	600 V
750 V or less	900 V
1000 V or less	1200 V

A.5.1.12 Support for EV contactor welding detection

The charger shall have the following output circuit characteristics to support the EV contactor welding detection (see A.10 for details):

a) Within 1 s after the vehicle opens the EV contactor, the voltage in the output circuit of the charger shall be reduced to less than or equal to 25% of the voltage before opening the EV contactor.

b) Within 2 s after the vehicle opens the EV contactor, the voltage in the output circuit of the charger shall be reduced to less than or equal to 10 V.

A.5.1.13 Charger protection against overvoltage including voltage surge

The charger and the vehicle shall satisfy the following requirements in order to prevent the disconnection of the protective conductor due to the ground fault in the output circuit of charger:

a) The surge protective device (SPD) shall not be installed at the vehicle between P and GND or N and GND.

b) When the surge protective device (SPD) is installed at the charger between P and GND or N and GND, the SPD shall not cause a short circuit with the single fault between P and GND or N and GND.

c) Y capacitors or any other device shall not cause a short circuit with the single fault between P and GND or N and GND (see NOTE 1).

However, chargers and vehicles should install the SPD such as a bidirectional Zener diode (see NOTE 2) on the CAN communication circuit. Installation of the SPD on other sequence circuits is recommended.

NOTE 1—Y capacitors designed as fail open type can be placed between P and GND or N and GND.

NOTE 2—See IEC 61643-12.

A.5.1.14 Output circuit requirements

A.5.1.14.1 Inrush current

Inrush current through the power lines of the charging connector when the EV contactor is closed shall be less than or equal to 20 A.

A.5.1.14.2 Impedance requirements for charger

The impedance between P and N of the output circuit of the charger from the reverse current prevention diode to the tip of the charging connector shall meet the requirements that follow during the time period from (d2) ON to charging current request (H'102.3) that becomes more than or equal to 1 A:

— Capacitance: Less than or equal to 1 μF

— Resistance: More than or equal to 40 kΩ

In addition, the charger shall comply with the requirements defined in Table A.12 to prevent electric shock from touching the live parts.

Table A.12—Requirements for preventing electric shock

Target battery voltage	Requirement
500 V or less	The Y capacitance of the charger output circuit shall be 0.5 μF or less per rail.
More than 500 V up to 1000 V	The charger shall have double or reinforced insulation between P and N, P and GND, and N and GND of the output circuit.

A.5.1.14.3 Circuit requirements

The output circuit of the charger shall meet either of the following requirements a) or b). In addition, either the requirement c) or d) shall be satisfied if an element connecting P and N exists:

a) No fuse shall exist in series with the output circuit from the reverse current prevention diode to the tip of the charging connector. However, the following cases are excluded:

   1) When the current-limiting fuse is placed to the vehicle side of the reverse current prevention diode, double insulation or reinforced insulation shall be implemented in the output circuit from the reverse current prevention diode to the current-limiting fuse between P and N.

   2) A fuse inside the charging connector can be excluded when a charging cable with the cable size of the power lines less than the reference cable defined in A.5.4.3.1 is installed.

b) Double insulation or reinforced insulation shall be implemented in the output circuit from the reverse current prevention diode to the tip of the charging connector.

c) Fast-acting fuse with an ampere rating of less than or equal to 2 A shall be installed in the element connecting P and N.

d) The element shall have a means to prevent a short circuit caused by a single failure (see NOTE).

NOTE—A failure caused by a single event (e.g., a failure of a discrete device), including the consequential failures resulting from this failure.

A.5.1.15 Impedance requirements for vehicle

The discharge (bleed-off) characteristic of the residual voltage (electric charge) between P and N, P and GND, and N and GND shall comply with the requirements of ISO 17409. In addition, the capacitance between P and N from the vehicle inlet to the EV contactor as seen by the charger shall be less than or equal to 1 μF.

In addition, the vehicle shall comply with the requirements defined in Table A.13 to prevent electric shock from touching live parts.

Table A.13—Requirements for preventing electric shock

Target battery voltage	Requirement
500 V or less	The total Y capacitance between P and GND and N and GND of the vehicle, including the stray capacitance of the traction battery, shall be 1.1 μF or less per rail.
More than 500 V up to 1000 V	The vehicle shall have double or reinforced insulation between P and N, P and GND, and N and GND of the dc charging circuit.

A.5.1.16 Control of latch holding circuit

A.5.1.16.1 Basic requirements

The charger shall control the latch holding circuit. The charger shall hold the latch of the charging connector to prevent the detachment of the charging connector from a vehicle inlet during the energization state.

The latch shall be able to be released when the charger is not in the energization state. The latch can optionally be held at any time when the charger is not in the energization state.

A.5.1.16.2 Error detection of latch holding circuit

The charger shall monitor the condition of the latch holding circuit, and charging shall not be started or shall be stopped if an abnormality (e.g., discontinuity) is detected. This condition monitoring shall always be performed.

When power wires with a cross-sectional size less than the reference cable size are installed, the charging connector shall adopt a self-holding type electrical lock mechanism (see NOTE). In this case, the error detection of the latch holding circuit during charging shall not be required continuously.

NOTE—In the case of a self-holding electrical lock mechanism using a permanent magnet, the continuity of the inside circuit (e.g., drive circuit and return circuit) in the latch holding circuit should be monitored before holding the latch. Also, when confirming that the latch is released properly from the holding state, the permanent magnet should not react to the flowing current when the continuity is confirmed.

A.5.2 Sequence circuit

The interface with the vehicle shall have a sequence circuit as shown in Figure A.3. Circuit constants of this sequence circuit shall be in accordance with Table A.14 (charger side) and Table A.15 (vehicle side). For the opto-couplers f, g, j, and k shown in Figure A.3, alternative devices such as relays and transistors may be used.

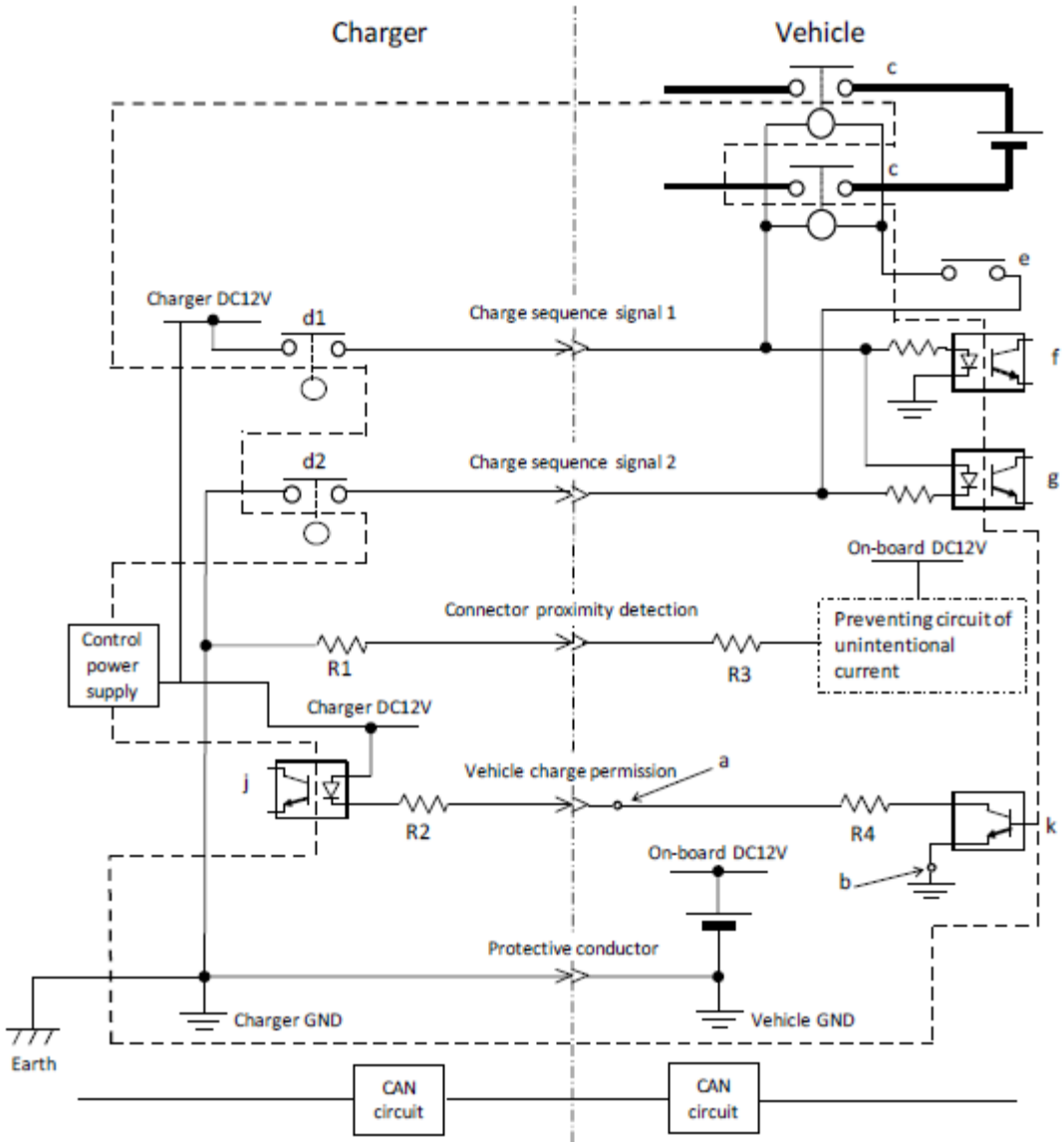


Figure A.3—Sequence circuit

Table A.14—Specification for sequence circuit (charger side)

Terminal	Item	Minimum value	Typical value	Maximum value	Unit
Charge sequence signal 1	Charger dc 12 V	10.8	12.0	13.2	V
Connector proximity detection	Resistor R1	190	200	210	Ω
Vehicle charge permission	Resistor R2	950	1000	1050	Ω
Charge sequence signal 1	Relay d1 load current	2	—	2000	mA
Charge sequence signal 2	Relay d2 load current	2	—	2000	mA

Table A.15—Specifications for sequence circuit (vehicle side)

Terminal	Item	Minimum value	Typical value	Maximum value	Unit
Charge sequence signal 1	Load current (when d1 ON)	10	—	2000	mA
Charge sequence signal 2	Load current (when d1 and d2 ON)	10	—	2000	mA
Connector proximity detection	Resistor R3	950	1000	1050	Ω
	On-board dc 12 V	8	12	16	V
Vehicle charge permission	Resistor R4	190	200	210	Ω
Vehicle charge permission	Load current (leakage current) between a-b when switch k OFF	—	—	2	mA
	Vce (collector-emitter voltage of transistor “k”) at collector current = 10 mA	—	—	0.5	V

A.5.2.1 Circuit voltage

The charger and the vehicle shall supply dc 12 V to the other side.

A.5.2.2 Signal line

The signal wire size of the charging cable shall be selected to not interfere with the operation of a device such as the opto-coupler of both charger and vehicle, or discontinuity (e.g., disconnection) of the signal wires shall not occur. Also, the wire size shall be selected to not interfere with equipotential earthing.

A.5.2.3 Prevention of noise and unintended current flow

Both the charger and vehicle shall prevent noise and unintentional current in the control signal circuit (within the limits of a dotted line in Figure A.3) by using components such as an opto-coupler. In addition, the vehicle shall meet the following requirements:

a) Prevent the unintentional current flow to the charger by using a method such as not connecting the vehicle side circuit to the connector proximity detection line under the time period from turning on switch (k) to opening the EV contactor. An example of “preventing the circuit of unintentional current” is shown in Figure A.4.

b) Do not use the connector proximity detection line as a pseudo-protective conductor.

c) Do not cause the unintentional current flow via vehicle relay (e) or any other vehicle side circuit.

d) Switch (k) of the vehicle shall be turned off compulsorily when the continuity of the protective conductor (e.g., disconnection) is lost. The vehicle contactor shall be opened within 1 s after the protective conductor disconnection by the automatic shutdown function of the sequence circuit shown in Figure A.3.

e) Do not use unidirectional SPD on any control signal circuits or CAN communication circuit.

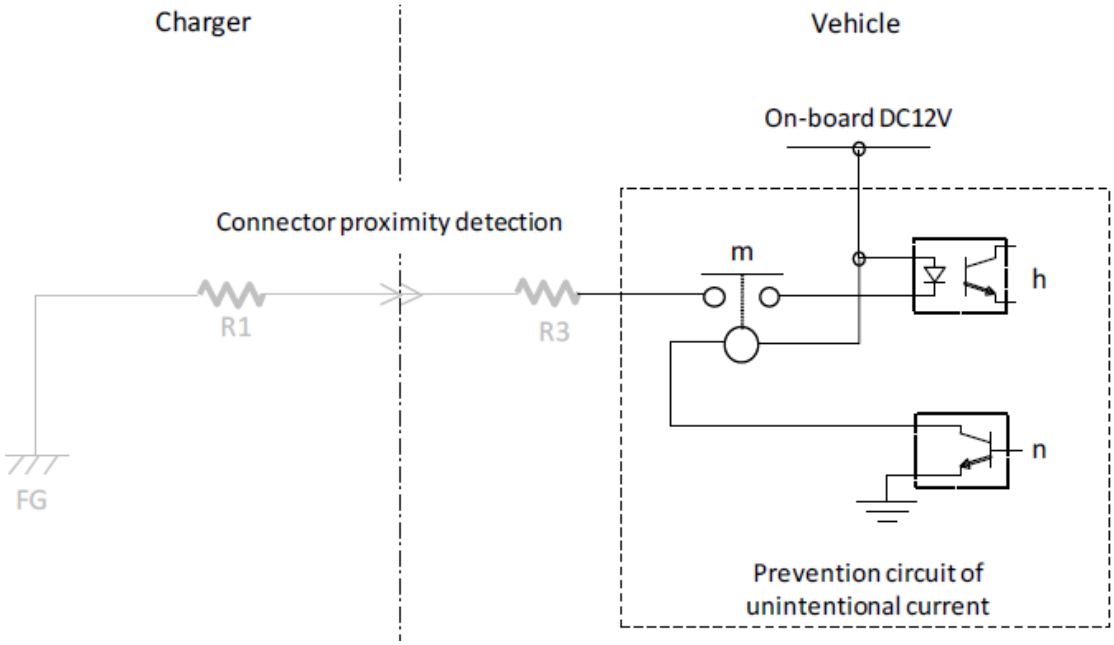


Figure A.4—Example of preventing the circuit of unintentional current

Table A.16—Explanation of figure symbols

Symbol	Explanation
On-board dc 12 V	DC power for control of vehicle.
h	Signal element indicating the state of the charging connector mating (e.g., opto-coupler).
n	Vehicle switch interlocked with the behavior of power switch of vehicle such as ignition.
m	Vehicle switch interlocked with Switch “n”. Control circuit of vehicle can be connected to “connector proximity detection” line by turning on switch “n”.

A.5.2.4 Power supply to the EV contactor

The vehicle can use dc 12 V power supply from the charger to operate the EV contactor. If the EV contactor is operated by the power supply from the vehicle, the vehicle relay (e) shall be opened immediately after the dc 12 V power supply from the charger is lost in order to secure a safety level equivalent to the condition in which the EV contactor is operated by the power supplied from the charger.

A.5.2.5 Grounding wire

The negative terminal of control power such as on-board dc 12 V of the vehicle shall be connected to the vehicle chassis. The negative terminal of dc 12 V of the charger shall be connected to the earthing terminal of the charger or the protective earthing conductor.

A.5.2.6 Signal line protection

Both the charger and vehicle shall have a resistor defined in Table A.14 and Table A.15 in the control signal circuit in order to protect the “connector proximity detection” line and “vehicle charge permission” line from short circuit and ground fault.

The vehicle shall have a current-limiting fuse in signal wires of which short circuit to “charge sequence signal 1” or “charge sequence signal 2” of the control signal circuit may occur. The current limiting fuse shall be interrupted within 5 s when the short-circuit current is more than or equal to 15 A.

A.5.2.7 Redundancy of charging control about start and stop signal

The charger and the vehicle shall use both the vehicle charge permission line of the control signal circuit and CAN communication in order to improve the reliability of the start and stop request of the charge when the start or stop is implemented. An example of system configuration about redundancy of charging control is shown in Figure A.5.

The charger shall determine that the vehicle has given the permission to charge only when both the control signal and CAN communication indicate the charging permission. The charger shall stop charging when it receives a stop instruction by either the control signal or CAN communication. To process the stop instruction without fail, the vehicle charge permission line of the control signal circuit shall directly be connected to the inverter circuit of the charger, and charging shall be securely stopped by terminating the inverter circuit compulsorily without interposing the process of any circuit medium such as CPU if the vehicle charge permission line is changed to OFF.

In addition, the error detection signal of the latch holding circuit (see Figure A.8) shall be directly connected to the inverter circuit of the charger, and charging shall be securely stopped by terminating the inverter circuit compulsorily without interposing the process of any circuit medium such as CPU if the error detection signal is received.

A control circuit directly connected to the inverter circuit may be substituted by using a CPU different from the inverter control CPU to detect the change of “vehicle charge permission” line from ON to OFF and to detect the “error detection signal of latch holding circuit.”

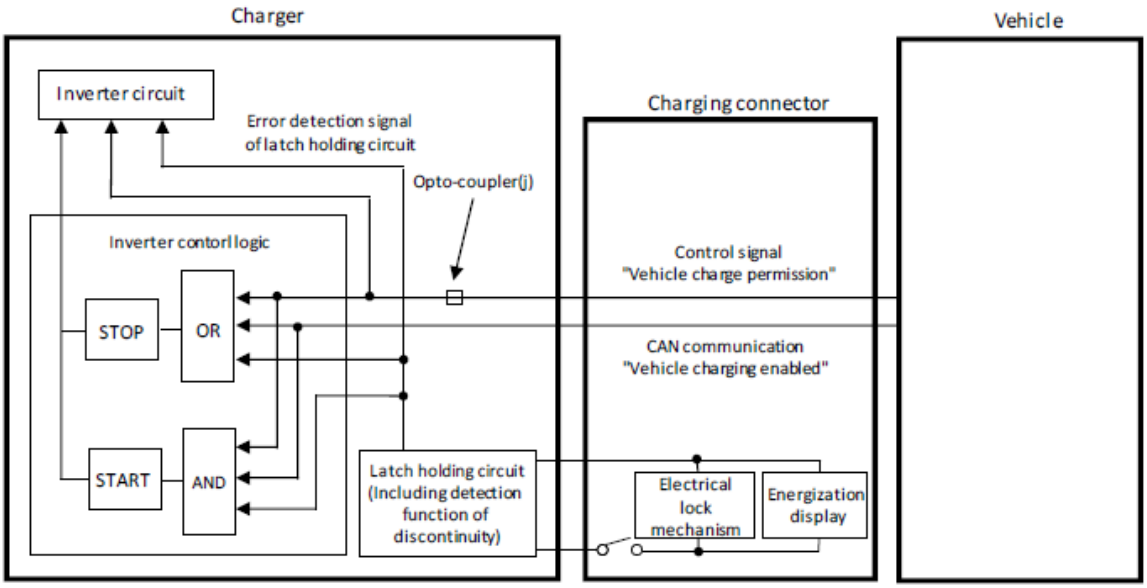


Figure A.5—Example of system configuration about redundancy of charging control for start and stop signal

A.5.2.7.1 Logical discrepancy judgment of the stop signal

The charger shall detect the following logical discrepancy between the “vehicle charge permission” line of the control signal and “vehicle charging enabled” (H’102.5.0) of the CAN communication. Charger shall stop the charge after notifying the vehicle of the error in case the following logical discrepancy is detected:

a) When the control signal “vehicle charge permission” circuit from the vehicle is in the ON state before transmitting the first CAN communication data from the charger, the charger shall regard it as logical inconsistency (indicated as “1” in Figure A.6).

b) When the “vehicle charging enabled” (H’102.5.0) is ON before the control signal “vehicle charge permission” circuit is turned ON, the charger shall regard it as a logical discrepancy (indicated as “2” in Figure A.6).

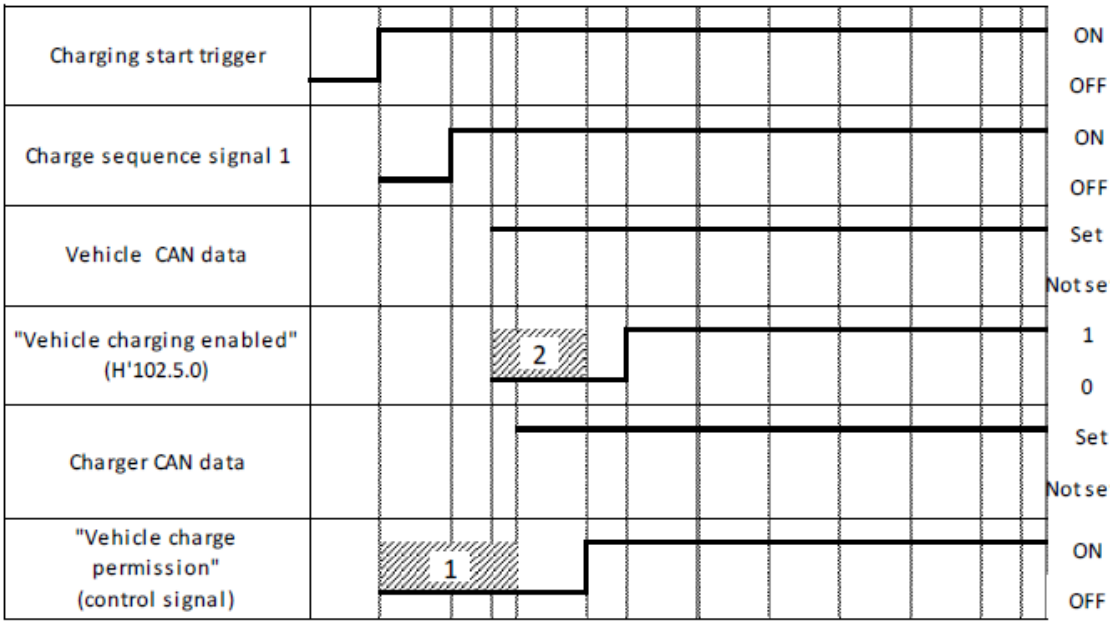


Figure A.6—Timing of logical discrepancy detection

A.5.3 Communications circuit

There shall be a data circuit for CAN communication (see ISO 11898-1 and ISO 11898-2), which facilitates one-on-one communication between the vehicle and the charger. Parameters for charge control (current order value, voltage/current measurement results, flags indicating charging/vehicle conditions, etc.) shall be exchanged via this communication circuit.

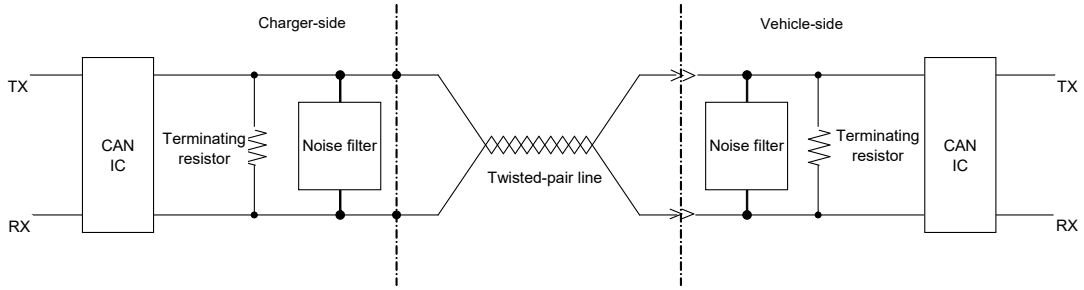


Figure A.7—CAN communication circuit

A.5.3.1 Terminating resistor

Both the charger and the vehicle shall be equipped with a terminating resistor (nominal resistance: 120 Ω, its tolerance in compliance with ISO 11898-2).

A.5.3.2 Noise filter

Both the charger and the vehicle shall be equipped with separate noise filters to reduce conducted noise in common mode and differential mode.

A.5.3.3 Twisted-pair line

A twisted pair line shall be used as the communication line that links the charger with the vehicle so as to reduce differential mode noise.

A.5.3.4 CAN transceiver

The CAN communication circuit shall have a CAN transceiver that is in compliance with ISO 11898.

A.5.4 Charging cable assembly

A.5.4.1 Immobilization of charging connector

The charging connector shall be mechanically mated with a vehicle inlet with the use of a latch having sufficient mechanical strength. In addition, it shall be possible to lock and release the charging connector latch via the charger's control.

A.5.4.1.1 Display function of latch holding

The charging connector shall have a means to indicate the status of the latch holding state by a lamp, and so on, for notifying users.

A.5.4.1.2 Detection of latch state

The charging connector shall have a function to detect the latch state such as a switch that can be interlocked with the operation of the latch. The charging connector shall constantly monitor the continuity of the latch holding circuit and shall have a function to notify the charger electrically of the failure if any abnormality occurs. An example of latch holding circuit is shown in Figure A.8.

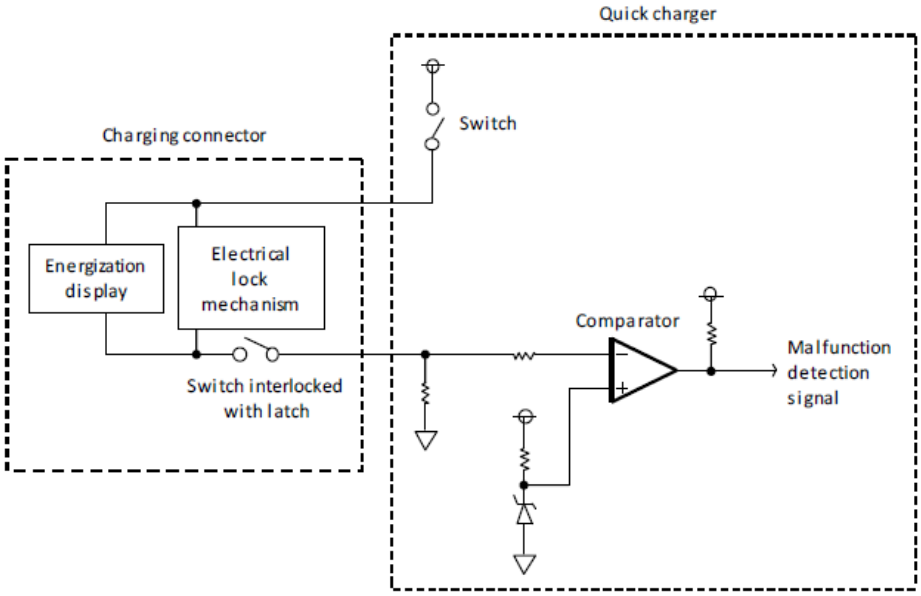


Figure A.8—Example of charging connector lock circuit

A.5.4.2 Emergency release

The charging connector shall be able to be released by emergency operation (see NOTE) using an exclusive tool handled by maintenance personnel when the charging connector cannot be released because of an abnormality.

The emergency release equipment must use the exclusive tools. It cannot be release d by familiar tools such as in-vehicle tools (screwdriver, etc.)

NOTE—The charging connector that has been released by emergency operation should not be used continuously after the failure because of safety concerns.

A.5.4.3 Application of a charging cable with cross-sectional size less than the reference cable size

Power wires of the charging cable with a cross-sectional size less than the reference cable size corresponding to the maximum output power of a charger can be applied. In this case, the charging connector shall also comply with the following requirements.

A.5.4.3.1 Overload current protection and coordination

The charger shall have a means to protect the charging cable against overload current and short-circuit current by using a device such as current-limiting fuse in the charging connector. The protective means shall protect the charging cable from short-circuit currents up to 10 kA (see NOTE) at the vehicle inlet of the charging connector. It is recommended that the overload current protection device be fast acting to help avoid EV contactor welding because of the short-circuit current.

NOTE—A means to identify the vehicle in which the short-circuit current may exceed 10 kA at a vehicle inlet is under consideration.

A.5.4.3.2 Latch holding

The latch shall be held even in the case of failure such as discontinuity in the latch holding circuit during energization. The electrical mechanism of the latch holding circuit shall be a self-holding type (see NOTE 1).

The latch holding circuit shall not be limited to Figure A.8 and shall comply with the applicable electrical lock mechanism.

NOTE 1—Self-holding type refers to an electrical lock mechanism that does not require a power supply to retain latch hold by using a magnetic latching solenoid with a permanent magnet, and so on.

NOTE 2—After being checked by maintenance personnel, the charging connector that underwent emergency release may be restored to the normal condition. However, it is not permitted to use the charging connector continuously without any confirmation.

A.5.5 Protection against overtemperature of the charging cable assembly

If the charger is compatible with the high current control of the extended specifications in A.11.5.3.2, at least one “Case” from B1 to D2 in Table A.17 shall be applied to the charging cable assembly. If the charger is not compatible with the high current control, “Case A” in Table A.17 shall be applied to the charging cable assembly.

The charger shall not apply the high current control without matching the requirements (specific combination of items defined in A.5.5.1.1 and A.5.5.1.2) for the applied "Case" in Table A.17.

A.5.5.1 Classification of the specification

To help ensure the protection against overtemperature of the charging cable assembly, a combination of requirements to be applied, according to the specification of the charger, are defined in Table A.17.

Table A.17—Combination table of the requirements for the protection against overtemperature of the charging cable assembly

Case	Output current range	Item a	Item b	Item c	Item d
A	0–200 A	Compliant	—	Compliant	—
B1	0–200 A	Noncompliant	Compliant	Compliant	—
B2		Noncompliant	Compliant[a]	Noncompliant	Compliant
C1	0–400 A	Compliant	—	Noncompliant	Compliant
D1	0–400 A	Noncompliant	Compliant	Compliant	—
D2		Noncompliant	Compliant[a]	Noncompliant	Compliant

[a]Item b may be omitted if a charge cable is also able to be protected concurrently by the protective means of the charging connector (item d).

A.5.5.1.1 Requirements of standard operating condition

Case A of Table A.17 is defined as the standard operating condition. The charger shall meet the requirements of both item a and item c of Table A.18.

A.5.5.1.2 Requirements of specific operating condition

Each "Case" from B1 to D2 in Table A.17 is defined as a specific operating condition. The charger shall apply the high current control of the extended specification in A.11.5.3.2 and shall satisfy each item in Table A.18 that is required by the selected "Case" in Table A.17. Also, in the case of a specific operating condition, the output current exceeding the rated current of the charging cable assembly can be dynamically charged by the charger.

The conditions required in each output current range are provided as follows:

a) For output current range: 0 A to 200 A:

   1) If item a is noncompliant:

      The charger shall meet the requirements of both item b and item c (this corresponds to Case B1 of Table A.17).

   2) If both item a and item c are noncompliant:

      The charger shall meet the requirements of both item b and item d. However, item b may be omitted if a charging cable is also able to be protected concurrently by the protective means of the charging connector (item d) (this corresponds to Case B2 of Table A.17).

b) For output current range: 0 A to 400 A:

1) If item a is compliant:

The charger shall meet the requirements of item d (this corresponds to Case C1 of Table A.17)

2) If item a is noncompliant:

The charger shall meet the requirements of both item b and item c (this corresponds to Case D1 of Table A.17).

3) If both item a and item c are noncompliant:

The charger shall meet the requirements of both item b and item d. However, Item b may be omitted if a charge cable is also able to be protected concurrently by the protective means of the charging connector (item d) (this corresponds to Case D2 of Table A.17).

Each requirement that the charging cable and charging connector shall meet is defined in Table A.18.

Table A.18—Requirements for the charging cable and the charging connector (rated current, protection against overtemperature)

Item	Requirements
a	A charging cable having a rated current more than or equal to the maximum current of the charger shall be used.
b	By using either monitoring or estimating the surface temperature of the charging cable, the output current shall be limited or stopped to prevent an overtemperature. For the limitation of the output current, the dynamic control function defined in A.11.5.3.1 shall be applied.
c	A charging connector having a rated current (specified by each connector manufacturer) more than or equal to the maximum current of the charger shall be used.
d	By monitoring the temperature of both the P and N terminals of the charging connector, with a temperature sensor or an equivalent means,[a] the output current shall be reduced or stopped to prevent an overtemperature. For the limitation of the output current, the dynamic control function defined in A.11.5.3.1 shall be applied.

[a]Example of an equivalent means: a charging connector with a function to open the latch lock circuit (e.g., temperature fuse and relay) when the terminal temperature exceeds the design limit value.

A.5.5.2 Charging cable

The surface temperature of the charging cable shall comply with all requirements defined in Table A.19 while operating under the ambient temperature of 40 °C. The requirements for the rated current and protection against overtemperature of the power lines of the charging cable are defined in item a and item b of Table A.18. The charger shall apply the se to the charging cable assembly based on Table A.17.

Table A.19—Temperature requirement of charging cable

Applicable area	Requirement
Graspable part	It shall not exceed 60 °C
Touchable part	It shall not exceed 85 °C

A.5.5.3 Charging connector

The terminal temperature of the charging connector shall comply with all requirements defined in Table A.20 while operating under the ambient temperature of 40 °C.

The requirements for the rated current and protection against overtemperature of the charging connector are defined in item c and item d of Table A.18. The charger shall apply these requirements to the charging cable assembly based on Table A.17.

Table A.20—Temperature requirement of charging connector

Applicable area	Requirement
Increase value ΔT of terminal temperature	It shall remain less than or equal to 50 K
Terminal temperature	It shall not exceed 90 °C

A.5.5.4 Diagnostic check of temperature monitoring function

The charger shall check the integrity of the temperature monitoring function (e.g., a temperature sensor) of the charging cable assembly when equipped with such a function. The integrity check of the temperature monitoring function shall be performed at the time when the charging connector is not mated with a vehicle or before charging (from d1 ON to before EV contactor ON).

The diagnostic check for the temperature monitoring function shall judge a failure when the measured difference between the monitored terminals (P and N) of the charging connector in the output circuit exceeds a specified value. This specified value shall be determined and agreed to by both the charger and the charging connector manufacturer.

When an abnormality of the temperature monitoring function is detected before charging, either the "available output current (extended)" shall be set to less than or equal to the "continuous rated current 1" or the charger shall shift to error stop. Therefore, when the abnormality is detected, the charger shall not operate under the "continuous rated current 2" or the "short time rated current."

The charger shall apply one or a combination of the following three means when the protection against overtemperature of the charging cable assembly depends only on the temperature monitoring functions using a temperature sensor and an abnormality of the monitoring function cannot be detected. To apply the protective means, failure mode and effect analysis shall be performed, and hereby a fail-safe against all the extracted malfunction and failure modes shall be implemented:

a) Application of functional safety (in compliance with IEC 61508):

   Low-frequency activation demand mode: SIL4

b) Redundancy design:

   Redundancy design of hardware without interposing CPUs (see Figure A.9)

   Or

   Redundancy design with two CPUs

c) Means specified by each charger manufacturer:

   In the following country, UL 1998 and UL 991, UL 61730-1, IEC 61508-1, and all parts, ISO13849-1 and ISO 13849-2 and all parts, or ISO 26262 is accepted: U.S.

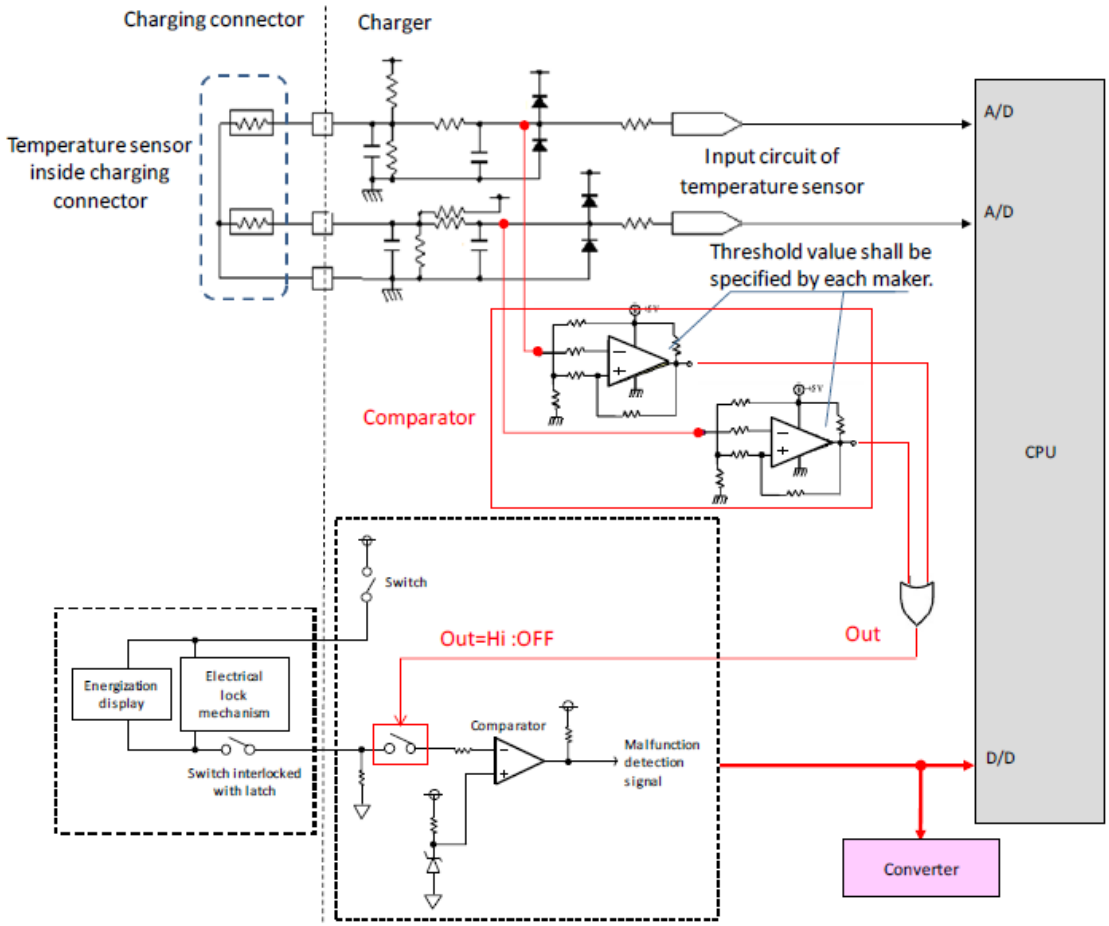


Figure A.9—Redundancy design of hardware without interposing CPU (example)

A.5.5.5 Diagnostic check of cooling function

The charger may control the temperature of the active cooling charging cable assembly with a function to limit the temperature rise of the charging cable as well as the terminal in the charging connector (e.g., air-cooled, liquid cooled, and peltier device).

The charger shall diagnose the abnormality of the cooling function in case the charging cable assembly is equipped with the cooling function. When the charger detects the abnormality of the cooling function, either the “available output current (extended)” shall be decreased to less than or equal to the continuous rated current 1 within 10 s or the charger shall shift to error stop within 10 s. Therefore, when the abnormality is detected, the charger shall not operate under the “continuous rated current 2” or the “short time rated current”.

A.5.5.6 Measures for overtemperature at the terminal of the charging connector

A charger operating in the specific operating condition shall shift to error stop within 10 s after the temperature of the terminal in a charging connector exceeds 90 °C is detected. Also, the charging operation shall not be resumed unless inspection and repair are performed by maintenance personnel if this error occurs three times in a row when the high-current control is applied.

A.5.5.7 Countermeasures for overtemperature of the charging cable

The charger shall comply with the following requirements when the surface temperature of the charging cable exceeds 60 °C. If there are any additional regulations that need to be satisfied around the installation of the warning label, the grip, or the handle for each country, they will also have to be met.

An example for installation of the warning label and the grip is shown in Figure A.10, as follows:

a) A grip and handle shall be attached on a graspable part.

b) A warning label shall be displayed on a touchable part. (e.g., ISO 7010 (A1: W017 [Hot surface] or Ed1:W001 [General warning])).

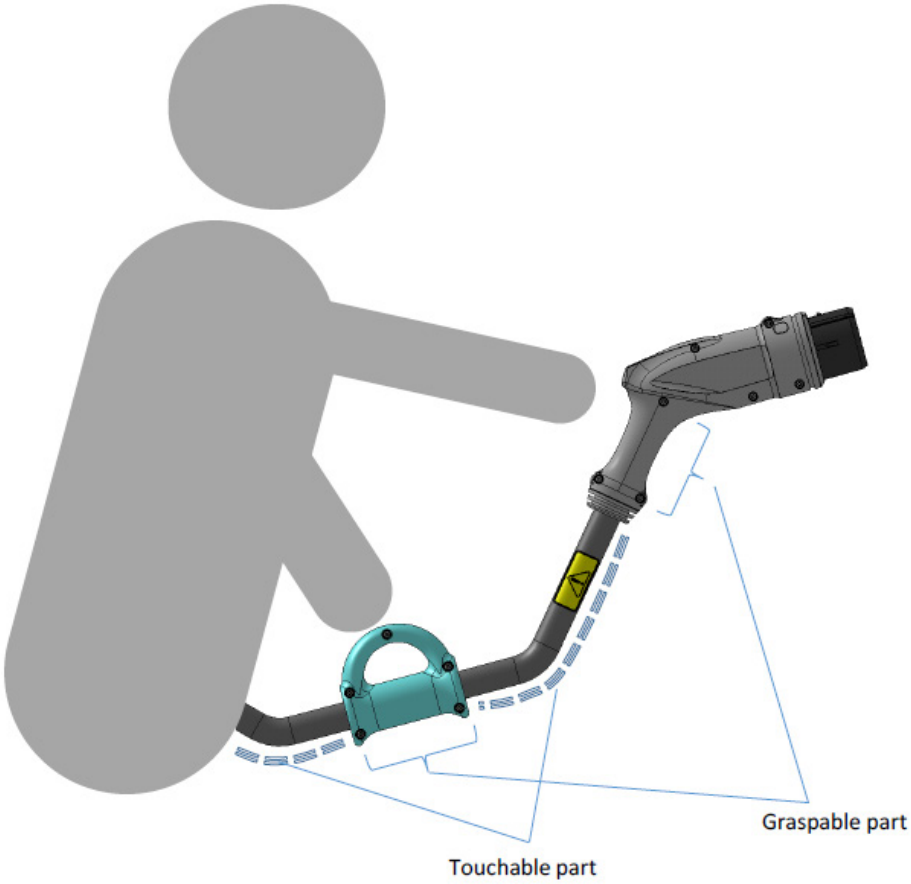


Figure A.10—Example of installation of warning label and grip /handle

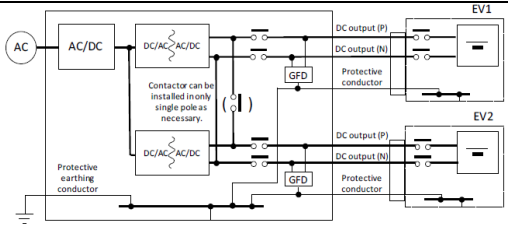
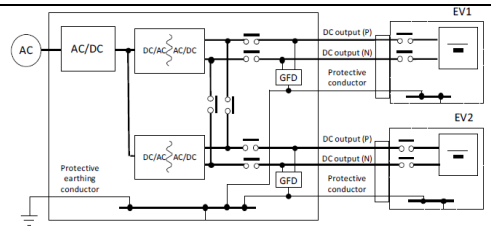
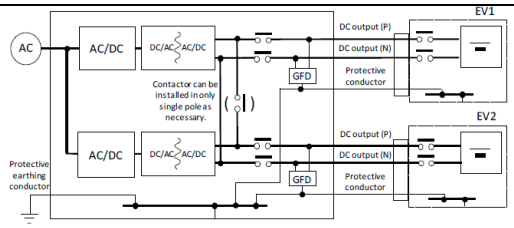
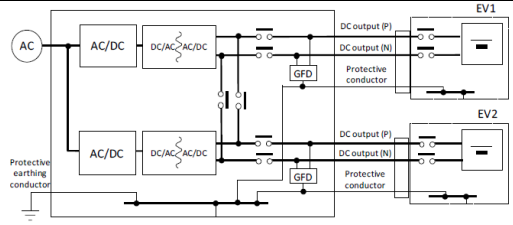
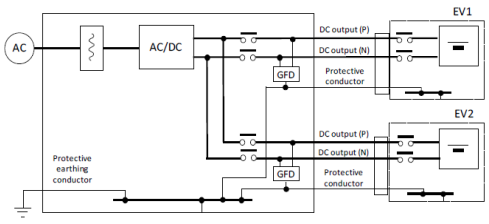
A.5.6 Requirements for multioutlet charger

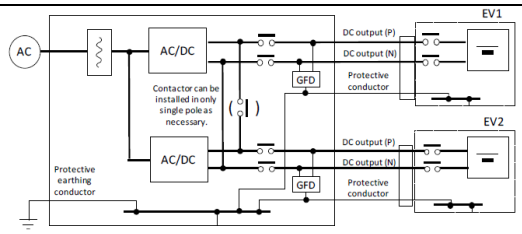
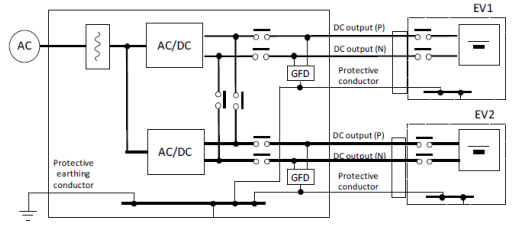
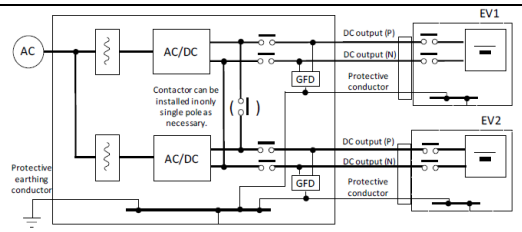
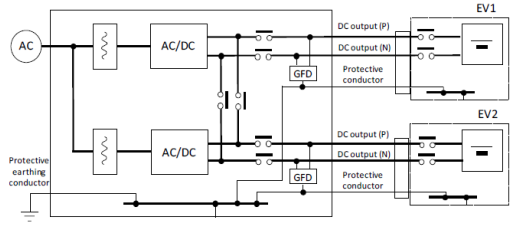
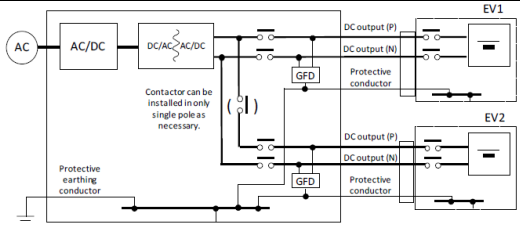
The requirements for a multioutlet charger are defined in this subclause. A multioutlet charger has two or more charging cable assemblies (dc or ac), and it is capable of charging a single vehicle alone or multiple vehicles simultaneously. This subclause applies to a charging system in which at least one of the two or more outlets is a charging connector based on Annex A specifications.

Representative system configurations are shown are shown in Table A.21. The possibility of simultaneous charging of multiple vehicles shall be determined based on examples in Table A.21.

A charger having multiple independent charging circuits cased in one enclosure is out of the scope for the multioutlet chargers as defined in this subclause. Unless otherwise specified, all requirements defined in Annex A shall be applied to any charger having a charging cable assembly based on Annex A specifications.

Table A.21—Examples of multioutlet charger system configuration

No	System configuration	Power unit		Connection line between output circuits	Simultaneous charging
		AC/DC	DC/DC		
1		Single	Multiple	Shared	Impossible
2		Single	Multiple	Not shared	Possible
3		Multiple	Multiple	Not shared	Impossible
4		Multiple	Multiple	Not shared	Possible
5		Single	None	Shared	Impossible

No	System configuration	Power unit		Connection line between output circuits	Simultaneous charging
		AC/DC	DC/DC		
6		Multiple	None	Shared	Impossible
7		Multiple	None	Not shared	Impossible
8		Multiple	None	Shared	Impossible
9		Multiple	None	Not shared	Possible
10		Single	Single	Shared	Impossible

A.5.6.1 Classification of multioutlet chargers

Typical use case and classification of multioutlet charger s as defined in this subclause shall be defined by the following:

a) Classification by cable assembly:

1) A charger having only a multiple charging cable assembly all based on the Annex A specifications.

2) A charger having at least one charging cable assembly based on the Annex A specifications and one or more charging cable assembly/assemblies based on other charging method(s).

b) Classification by circuit configuration:

1) A charger capable of simultaneous charging (see NOTE 1)

2) A charger incapable of simultaneous charging (see NOTE 2)

NOTE 1—System configuration s of No. 2, No. 4, and No. 9 defined in Table A.21 are capable of simultaneous charging. Simultaneous charging means that output circuits including the charging cable assemblies are connected and charging to multiple vehicles at the same time.

NOTE 2—System configuration s of No. 1, No. 3, No. 5, No .8, and No. 10 defined in Table A.21 are incapable of simultaneous charging. Even if simultaneous charging is impossible, multiple charging connectors can be mated with multiple vehicles at the same time, as long as the connectors of noncharging circuits are not electrically connected to a vehicle.

c) Classification by power unit of charger:

1) A charger having a single power unit

2) A charger having multiple power units

A.5.6.2 General requirements

A multioutlet charger shall meet the following requirements:

a) Prevention of electric shock at the unmated charging connector s when charging:

Hazardous voltages shall not appear at the terminal of the unmated charging connector when the terminal is accessible during any charging mode.

b) Prevention of the unintended electric connection of different vehicle side circuits:

Different vehicle side circuits shall not be electrically connected to each other during simultaneous connection or simultaneous charging via the output circuit of the charger.

c) Disconnecting device in output circuit:

A disconnection device shall be installed in the power lines of each output circuit and the circuits between output circuits. The disconnecting device shall be controlled so that the charger will comply with the requirements of item a) and item b). Even if a single failure such as a welding of the disconnecting device occurs, the charger shall comply with the requirements of item a) and item b).

Also, clearance and creepage distance when the disconnecting device is opened shall comply with at least basic insulation.

d) Prevention of unintentional voltage:

The protective earthing conductor of each output circuit shall be directly connected to the earthing terminal inside the charger in order to suppress the potential difference between vehicle chassis as well as between vehicle chassis and the enclosure of the charger when multiple vehicles are being connected to the charger.

e) Ground fault detection in the output circuit:

The ground fault detection circuit defined in A.5.1.10 shall be installed in each output circuit, and the charger shall detect a ground fault in each output circuit. Each ground fault detection circuit shall not interfere with each other and shall not cause a malfunction or a false detection.

f) Rating:

The rating of each output circuit, circuit connecting output circuits, and electrical components such as disconnecting devices installed in the output circuits shall be set in the consideration of operation at the maximum output voltage (including the tolerances of the output circuit) of the connected output circuit.

A.5.6.3 Circuit requirements

A.5.6.3.1 Electrical isolation of output circuit

a) A charger with simultaneous charging is possible:

Each output circuit shall be electrically isolated with other output circuits, and the output circuits shall not be connected to each other because of a single failure. The charger shall meet the following requirements:

1) Multiple output circuits, excluding the power lines connecting each output circuit, shall be isolated with each other by basic insulation, reinforced insulation, or double insulation. If basic insulation is applied between output circuits, the insulation condition between the output circuits between P and P of the different output circuits, between N and N of the different output circuits, and between P and N of the different output circuits shall be monitored and charging shall be stopped in case of a failure.

2) A disconnecting device on both P and N in the power lines connecting each output circuit shall be installed, and each output circuit shall be isolated.

3) Each output circuit between P and chassis, N and chassis shall be isolated by basic insulation, reinforced insulation, or double insulation.

b) A charger with simultaneous charging is impossible:

Output circuit of noncharging side shall be electrically isolated from the other output circuits by using at least disconnecting devices defined in item c) in A.5.6.2.

c) Power lines connecting between output circuits:

The power lines connecting between output circuits shall be connected to the charger side (upstream) from the disconnecting device in each output circuit required in item a) in A.5.6.3.2. The power lines connecting between output circuits shall meet the requirements in item b) in A.5.6.3.2.

A.5.6.3.2 Disconnecting device in output circuit

a) Disconnecting device in output circuit:

A disconnecting device (C1 and C2 described in Figure A.11) that can isolate electrically the output power of the charger and the tip of the output circuit shall be installed in each output circuit. The disconnecting device shall comply with all the following:

1) The disconnecting device shall always be open when the charging connector is not mated with a vehicle inlet.

2) The disconnecting device shall be open before the charging sequence starts when the charging connector is mated with a vehicle inlet.

3) Welding detection shall be performed before charging (the period between the start of the charging sequence and output of charging current). If any abnormality is detected during the welding detection, charging of all the output circuits shall be terminated. Thereafter any operation of the charger shall be suspended until the abnormality of the disconnecting device is removed.

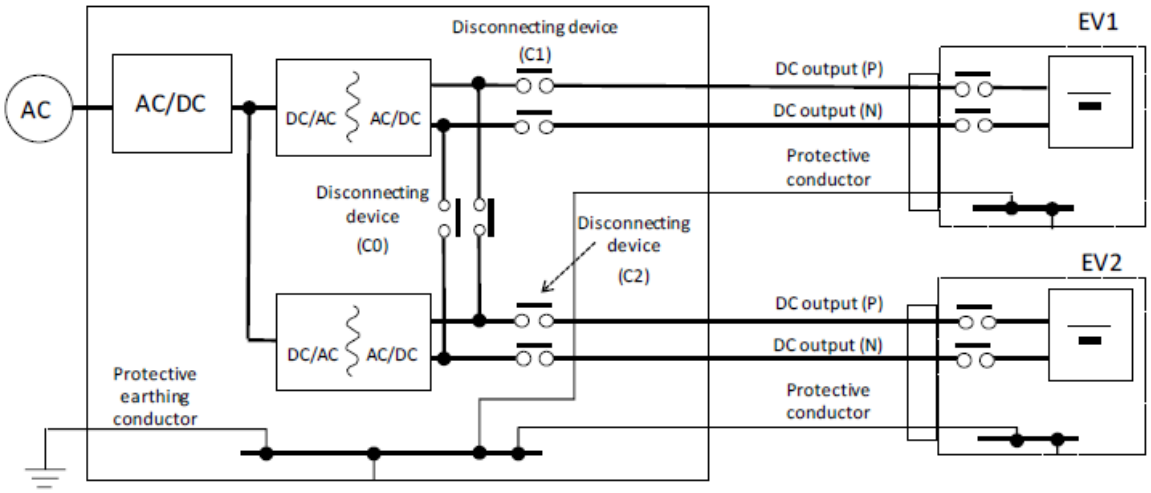
b) Disconnecting device(s) in between output circuits:

The disconnecting device (C0 described in Figure A.11) installed in the power lines connecting output circuits shall comply with all the following requirements:

1) Welding detection (see NOTE) of the disconnecting device shall be performed before the disconnecting device in each output circuit [defined in item a) in A.5.6.3.2] is closed and after the disconnecting device [item b) in A.5.6.3.2] is opened. If any abnormality is detected during welding detection, the charging of all the output circuits shall be terminated. Thereafter an operation of the charger shall be suspended until the abnormality of the disconnecting device is removed.

2) Different output circuits of the vehicle side shall not be electrically connected by closing both the disconnecting device defined in item a) in A.5.6.3.2 in each output circuit and the disconnecting device [defined in item b) in A.5.6.3.2].

NOTE—A diagnostic check should be performed to check whether both disconnecting devices are welded simultaneously when the disconnecting devices are installed in both the P and N power lines between output circuits.



NOTE—The other components are not described in this figure because the purpose of this figure is to explain the installation position of only the disconnecting devices.

Figure A.11—Example of disconnecting device

A.5.6.4 Prevention of inrush current during additional charging (power sharing)

When adding power (power sharing) from another power unit(s) of the charger, the disconnecting devices installed in the power lines connecting output circuits shall be closed after the output voltage (including any voltage such as residual electric charge) of the newly outputting side is dropped to less than or equal to the output voltage of the output circuit to which the power is added, in order to prevent inrush current.

A.5.6.5 Stop condition when abnormality occurs

When an abnormality is detected, the charging of all the output circuits shall be terminated. However, only relevant output circuits in which the abnormality occurs on may be terminated with the following abnormalities:

a) A failure of the control signal

b) An abnormality on the vehicle side (e.g., timeout or error flag of CAN communication)

c) Interruption of CAN communication

d) An abnormality of the output circuit in case each output circuit is isolated electrically from each other and the disconnecting devices between output circuits [defined in item b) in A.5.6.3.2] are open

A.5.6.6 Additional requirements to avoid an unintended electrical connection between vehicles or reduce the hazard

Requirements to avoid an unintended electrical connection between the vehicles to be connected simultaneously to a charger or to reduce a hazard caused by an abnormality of disconnecting devices between the output circuits defined in item b) in A.5.6.3.2 shall be defined as follows. The charger shall have at least one measure as defined in the following:

a) Reverse current prevention diodes shall be installed on the vehicle side (downstream) of the disconnecting device defined in item a) in A.5.6.3.2 of all output circuits.

b) To protect from a short circuit between output circuits, a current-limiting fuse shall be installed in the output circuit of the short-circuit current. The current-limiting fuse shall meet the requirements of operating joule-integral I^2t (less than or equal to 0.4 MA^2s), defined in Table A.7 (see NOTE).

c) An interlock function for preventing closure of the disconnecting devices [defined in item b) in A.5.6.3.2] shall be installed in a state for both P and N of the disconnecting devices in each output circuit defined in item a) in A.5.6.3.2 are closed. Specifically, either one of the following or a combined means shall be implemented:

   1) Application of functional safety for operation of the disconnecting device (in compliance with IEC 61508):

      Low-frequency activation demand mode: SIL4.

   2) Safety mechanism:

      Prevention of unintentional operation of the disconnecting device without interposing CPU.

   3) Means specified by each charger manufacturer:

      Example: Monitoring function and fail-safe of disconnecting device (the functions that detect a single pole of a disconnecting device has been welded and disable the charging before both pole s of a disconnecting device are welded).

NOTE—The current-limiting fuse defined in A.5.1.4 can substitute this. However, the current limiting fuse should not be installed on the vehicle side of the reverse current prevention diode.

In the following country, UL 1998 and UL 991, UL 61730-1, IEC 61508-1 and all parts, ISO 13849-1 and ISO 13849-2 and all parts, or ISO 26262 is accepted: U.S.

A.6 Communication control

A.6.1 Communication protocol

The requirements for the communication protocol are in Table A.22.

Table A.22—Communication protocol

Item	Specifications
Communication standard	ISO11898-1, ISO11898-2
Protocol	CAN 2.0B Active
Format	Standard format (ID length: 11 bits) Extended format shall not be used.
Communication speed	500 kbps
Bit sample point	72.5% to 87.5%

A.6.2 CAN bus

The charger and the vehicle shall have a dedicated CAN communication circuit (shown in Figure A.12) and shall perform the charging control defined in this specification.

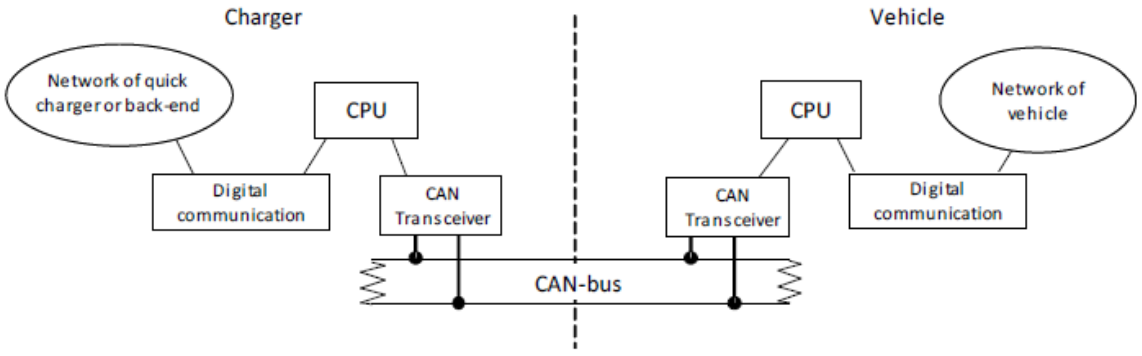


Figure A.12—CAN bus

A.6.3 Transmission method

The charger and the vehicle shall meet the following requirements in Table A.23.

Table A.23—Transmission method

Item		Specifications
Transmission order	Data frame	ID shall be sent in ascending order.
	Data byte	Byte shall be sent in ascending order from byte 0 (Little-endian/Intel type).
	Data bit	Bit shall be sent in the descending order from MSB.
Synchronization		Synchronization during the transmission cycle is unnecessary.
Transmission cycle		100 ms ± 10[%] (see Figure A.13).

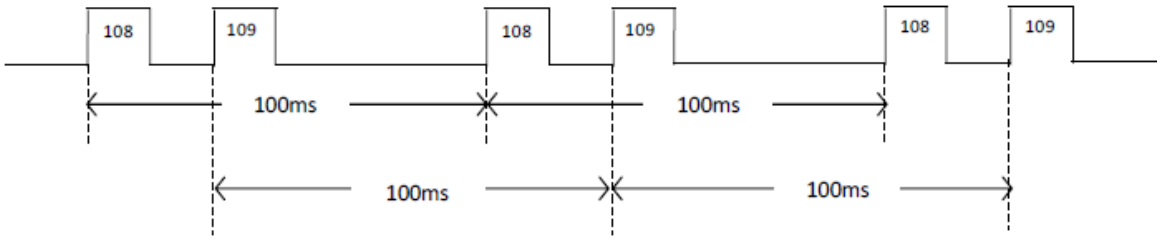


Figure A.13—Transmission cycle (example of transmission from the charger)

A.6.4 Reception method

The charger and the vehicle shall receive the CAN communication data in the data area defined in A.6.6.

A.6.5 CAN reception error

The charger shall stop charging if the charger and the vehicle cannot receive data frames for more than 1.0 s. Errors detection starts after the reception of the first CAN data.

Condition:

a) Any IDs may be used for detecting nonarrival of data frames.

b) The value of the most recently received normal data shall be used while the state of frame nonarrival continues.

The following conditions are not interpreted as reception errors:

c) Incorrect ID order (when data frames are not received in the ascending order).

d) Out of the transmission cycle (when the transmission cycle deviates beyond the margin of 10% from 100 ms).

e) Reception of other than data area.

A.6.6 Data format

a) ID:
ID allocation is shown in Table A.24.

Table A.24—ID allocation

	ID number
Charger	H'108, H'109
Vehicle	H'100, H'101, H'102

b) Data length: Fixed at 8 bytes.

c) Data area: Data area is summarized in Table A.25 and each parameter is further described in A.6.6.1 and A.6.6.2.

Table A.25—Data table

Source	Destination	ID	Byte	Content	Remarks
Vehicle	Charger	H'100	0	Minimum charge current	
			1		Not used
			2, 3	Minimum battery voltage	
			4, 5	Maximum battery voltage	
			6	Charged rate constant value	
			7		Not used
		H'101	0		Not used
			1	Maximum charging time (by 10 s)	
			2	Maximum charging time (by 1 min)	
			3	Estimated charging time (by 1 min)	
			4		Not used
			5, 6	Total capacity of battery	
			7		Not used
		H'102	0	CHAdeMO protocol number	
			1, 2	Target battery voltage	
			3	Charging current request	
			4	Fault flag	
			5	Status flag	
			6	State of charge	
			7		Not used
Charger	Vehicle	H'108	0	Identifier of support for EV contactor welding detection	
			1, 2	Available output voltage	
			3	Available output current	
			4, 5	Threshold voltage	
			6		Not used
			7		Not used
		H'109	0	CHAdeMO protocol number	
			1, 2	Present voltage	
			3	Present charging current	
			4		Not used
			5	Status / faults flag	
			6	Remaining charging time (by 10 s)	
			7	Remaining charging time (by 1 min)	

A.6.6.1 Data format of the vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
100	100	8	0	7-0	Minimum charge current	A		0	200	
			1	7-0	—	—	—	—	—	Not used
			2	7-0	Minimum battery voltage	V	—	0	600	H'100.2: Low byte
			3	7-0						H'100.3: High byte
			4	7-0	Maximum battery voltage	V	—	0	600	H'100.4: Low byte
			5	7-0						H'100.5: High byte
			6	7-0	Charged rete reference constant	%	—	0	100	Fixed at 0x64 (100 %)
			7	7-0	—	—	—	—	—	Not used
101	100	8	0	7-0	—	—	—	—	—	Not used
			1	7-0	Maximum charging time (10 s unit)	10 s	—	0	2540	Set 0xFF to this value in case the byte 2 (unit: 1 min) is used
			2	7-0	Maximum charging time (1 min unit)	min	—	0	255	
			3	7-0	Estimated charging time	min	—	0	254	
			4	7-0	—	—	—	—	—	Not used
			5	7-0	Total capacity of battery	0.1 kWh	—	0.1	6553.5	H'101.5: Low byte
			6	7-0						H'101.6: High byte
			7	7-0	—	—	—	—	—	Not used
102	100	8	0	7-0	CHAdeMO protocol number	—	3	0	255	0x03: CHAdeMO specification ver.2.0
			1	7-0	Target battery voltage	V	—	0	600	H'102.1: Low byte
			2	7-0						H'102.2: High byte
			3	7-0	Charging current request	A	0	0	200	
			4	7-5	—	—	—	—	—	Not used
				4	Battery voltage deviation error	—	0	0	1	0: normal, 1: error
				3	High battery temperature	—	0	0	1	0: normal, 1: error
				2	Battery current deviation error	—	0	0	1	0: normal, 1: error
				1	Battery undervoltage	—	0	0	1	0: normal, 1: error
				0	Battery overvoltage	—	0	0	1	0: normal, 1: error
			5	7-5	—	—	—	—	—	Not used
				4	Normal stop request before charging	—	0	0	1	0: No request, 1: Stop request
				3	Vehicle status	—	1	0	1	0: EV contactor close or during welding detection, 1: EV contactor open or termination of welding detection
				2	Charging system error	—	0	0	1	0: normal, 1: error
				1	Vehicle shift position	—	0	0	1	0: "Parking" position, 1: other position
				0	Vehicle charging enabled	—	0	0	1	0: disabled, 1: enabled
			6	7-0	State of charge	%		0	100	
			7	7-0	—	—	—	—	—	Not used

A.6.6.2 Data format of the charger

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
108	100	8	0	7-1	—	—	—	—	—	Not used
				0	Welding detection	—	1	0	1	1: compatible with EV contactor welding detection
			1	7-0	Available output voltage	V	—	0	600	H'108.1: Low byte H'108.2: High byte
			2	7-0						
			3	7-0	Available output current	A	—	0	200	—
			4	7-0	Threshold voltage	V	—	0	600	H'108.4: Low byte H'108.5: High byte
			5	7-0						
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used
109	100	8	0	7-0	CHAdeMO protocol number	—	3	0	255	0x03: CHAdeMO specification ver.2.0
			1	7-0	Present output voltage	V	—	0	600	H'109.1: Low byte H'109.2: High byte
			2	7-0						
			3	7-0	Present charging current	A	—	0	255	—
			4	7-0	—	—	—	—	—	Not used
			5	7-6	—	—	—	—	—	Not used
				5	Charging stop control	—	1	0	1	0: operating, 1: during stop control or stop condition
				4	Charging system error	—	0	0	1	0: normal, 1: error
				3	Battery incompatibility	—	0	0	1	0: compatible, 1: incompatible
				2	Energizing state	—	0	0	1	0: disable, 1: enable
				1	Charger error	—	0	0	1	0: normal, 1: error
				0	Charger status	—	0	0	1	0: standby, 1: charging
			6	7-0	Remaining charging time (in the unit of 10 s)	10 s	0	0	2540	Set 0xFF to this value in case H'109.7 (unit: 1 min) is used.
			7	7-0	Remaining charging time (in the unit of 1 min)	min	0	0	255	—

A.7 Charging control

A.7.1 Overview

The charger charges the on-board battery using the “constant current charging method” with the vehicle as master and the charger as slave. The charger outputs charging current according to charging current request, transmitted by the vehicle to the charger. The order value from the vehicle is notified to the charger in CAN communication with the cycle of 100 ms. When the vehicle changes its order value, the charger shall change output current to correspond to the change (see Figure A.14 and Figure A.15).

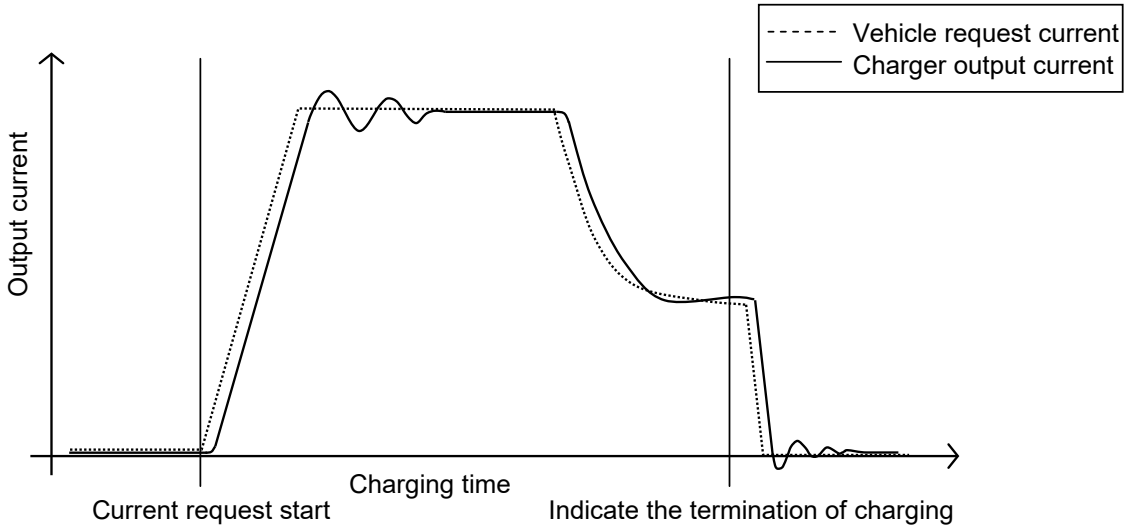
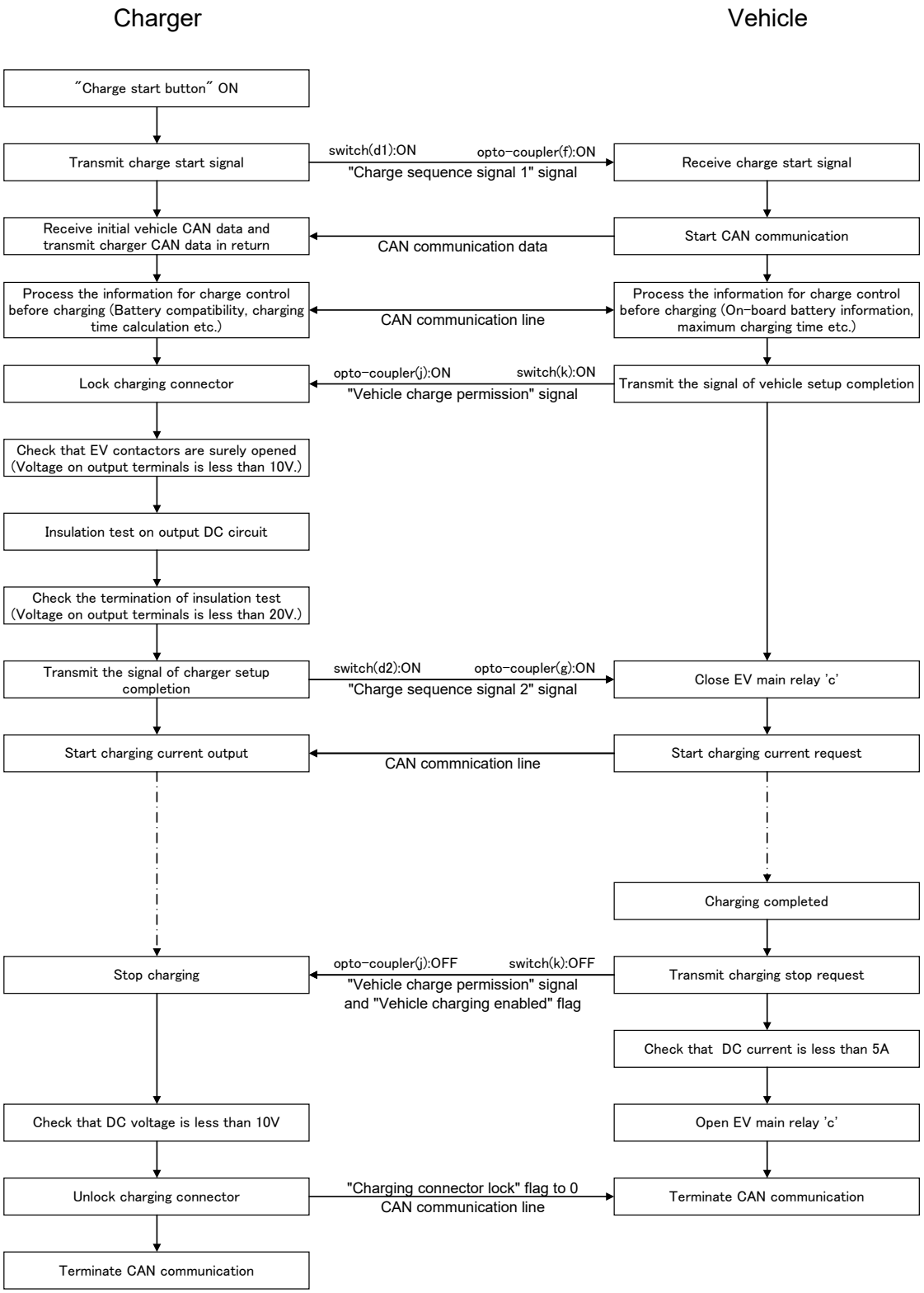


Figure A.14—Relationship between vehicle order and charger output



NOTE—For proximity detection between the connector and the inlet, see item c) in A.4.4, and control and communication timing are specified in A.11. Reference Figure A.3 for the sequence circuit.

Figure A.15—Charging control flow

A.7.2 Basic requirements

A.7.2.1 Start

The charging control process shall be started by the request from charger.

A.7.2.2 Permission

a) The charger shall not apply voltage/current on charging circuit of the vehicle until it receives the "charging permission" signal from the vehicle.

b) The "Charging permission" signal from the vehicle to the charger shall be transmitted via both the "control signal line" and "CAN communication signal line."

c) The charger shall determine that the vehicle has given it charging permission only when signals from both the "control signal line" and "CAN communication signal line" convey "permission" information.

d) The vehicle indicates charging permission with the following signals:

   1) "Charge permission signal line": When on-board switch (k) is ON.

   2) "Vehicle CAN data": When #102.5.0 ("Vehicle charging enabled" flag) is "1".

A.7.2.3 Termination

a) Both the charger and the vehicle shall be able to indicate the termination of charging control to each other.

b) Both the charger and the vehicle shall support "Charge control termination command patterns" described in Table A.26.

c) If even one of the "Notice to the other party" items described in each command pattern in Table A.26 is performed, the receiver side shall determine that the sender has instructed charge control termination, and immediately shift to the charge termination process.

Table A.26—Charge control termination command patterns

Command pattern	Source	Reason	Notice to the other party		Destination
			Noticing way	Signal status	
1	Vehicle	Charged rate of on-board battery has reached a specified level.	— #102.5.0 (Vehicle charging enabled) — Switch (k) [a]	0 OFF	Charger
2	Charger	"Charge stop button has been pushed." Or "Charging time has reached a specified value."	— #109.5.5 (Charger Stop control)	1	Vehicle
3	Vehicle	Vehicle malfunction detected. Charger malfunction detected.	— Switch (k) — #102.5.0 (Vehicle charging enabled) — Fault-related flags in #102	OFF 0 1	Charger
4	Charger	Charger malfunction detected. Vehicle malfunction detected.	— Fault-related flags in #109.5 — #109.5.5 (Charger Stop control)	1 1	Vehicle
NOTE—#XXX.Y.Z stands for CAN data defined in A.6.6. #XXX: CAN data ID, Y: byte position and Z: bit position.					

[a] Turned off in a specified period of time after #102.5.0 becomes 0.

A.7.2.4 Method

Both the charger and the vehicle shall control charging together with a predetermined sequence as defined in A.11.

A.7.2.5 Control timing

A.7.2.5.1 Observing time constraints

Both the charger and the vehicle shall have two time constraints, compliance time and time-out time, defined for each charging control process to manage the time required in the processes. The time constraints are defined as A.7.2.5.1.1 and A.7.2.5.1.2.

A.7.2.5.1.1 Compliance time

The compliance time is the processing time with which both the charger and the vehicle shall comply. It shall be defined in the following two approaches:

a) Maximum time: Within XX.X seconds

b) Specified time: Between YY.Y seconds and ZZ.Z seconds

A.7.2.5.1.2 Time-out time

The time-out time is the time to monitor any delay in control processes of the other party, the vehicle, or the charger, and to force the charging control to shift to the termination process in the event of excessive delay. It shall be specified as follows:

Time-out: UU.U seconds:

When the control process of the other party, the vehicle, or the charger does not end after UU.U seconds have elapsed, the system shall determine that there is an error, and shift to the termination process within 2 s. In this case, for the time-out process by the vehicle, change #102.5.2 (charging system fault) to a 1 in the CAN message data and transmit to the charger.

For the time-out process by the charger, change #109.5.4 (Charger system malfunction) to a 1 in the CAN message data and transmit to the vehicle.

A.7.2.6 Parameter exchange

Both the charger and the vehicle shall control charging with exchanging CAN charging parameters specified in A.11.

A.7.2.7 Measurement

A.7.2.7.1 Circuit current and voltage

The charger shall measure output current and voltage and send these values to the vehicle via CAN network continuously through all charging control processes from charging start (CAN communication start) to charging termination (unlock charging connector and CAN communication termination).

With regard to circuit voltage, the vehicle and the charger shall measure and estimate voltage value at the point described in Table A.27. If it is difficult to measure voltage at specified points directly, monitored value shall be compensated to adopt as measured value.

Table A.27—Voltage estimating point

Measurer	Measurement point
Charger	Output terminals in the charger[a, b]
Vehicle	Terminals at the vehicle inlet

[a] Monitored value should be corrected as the one measured at the charging connector terminals and the charger shall use it for charging control and sending voltage data to the vehicle.

[b] Resistance value of the charging cable, required for the voltage compensation should be measured by Figure A.16.

A.7.2.7.2 Resistance measure with a voltage drop method

a) Short the charging cable on the charger side.

b) Apply current from external power supply equipment equivalent to the charger maximum output current, measure the voltage, and calculate the resistance of charging cable.

c) See Equation (A.1) to calculate the resistance of the charging cable (R).

$$R = Vcbl/I \quad (A.1)$$

where

R is the resistance of the charging cable
Vcbl is the voltage of the charging cable at the charging connector
I is the current through the shunt resistance

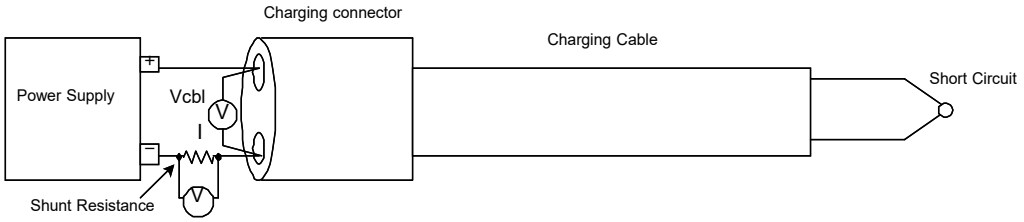


Figure A.16—Resistance measurement with voltage drop method

A.7.2.7.3 Measuring system evaluation

a) The vehicle shall compare the voltage value measured by itself with the value by the charger.

b) As a result of the comparison mentioned in item a), if the deviation more than previously specified value is detected, the vehicle shall judge that charging fault has occurred and notify the charger of charging termination. The judging method is described in A.8.

A.7.2.8 Monitoring and protection

A.7.2.8.1 Continuous monitoring

The vehicle and the charger shall constantly monitor the items listed in A.7.2.8.1.1 and A.7.2.8.1.2, respectively.

The manufacturer shall prescribe the specific implementation methods.

A.7.2.8.1.1 Vehicle

a) Problems on the charging circuit of the vehicle

b) Control timing and process time for the charger and the vehicle

c) Output response of the charger to the charging current request

d) Difference between measured voltage value the vehicle and the one of the charger

e) Connection with the charger

f) Immobility of the vehicle (check the position of shift lever, etc.)

g) Problem with CAN communication reception

h) Problem with vehicle CPU (monitoring by a watch-dog timer, etc.)

i) Status of EV contactor including welding

A.7.2.8.1.2 Charger

a) Ground fault on dc power circuit

b) Circuit problem (main charging circuit, control/communication circuits)

c) Power supply problem (charging inverter, power supply for control/EV contactor)

d) Control timing and processing time for the charger and the vehicle

e) Immobility of the vehicle (check “Vehicle shift position,” etc.)

f) Locking status of charging connector

g) Status of the “Charge start button,” “Charge stop button,” and “Emergency stop button”

h) Problem with CAN communication reception

i) Problem with CPU (monitoring by a watch-dog timer, etc.)

A.7.2.8.2 Requirements for the charger

The charger shall have the following diagnosis and monitoring functions in addition to continuous monitoring:

a) Compatibility check of on-board battery:

Before the start of charging, the charger shall receive the following information related to on-board battery from the vehicle through CAN communication:

— Maximum battery voltage: #.100.4, #.100.5

— Target battery voltage: #.102.1, #.102.2

The charger shall compare the voltage setting value of the vehicle and its maximum output voltage.

If the vehicle requires charging voltage beyond maximum output voltage of the charger, the charger shall set “Battery incompatibility” flag #109.5.3 to 1 and notify that it is incapable of charging.

The voltage information exchanged between the vehicle and the charger via CAN communication shall be corrected value of the measuring parts stipulated in Table A.27.

b) Insulation test for output dc circuit:

— The charger shall apply insulation test voltage to the output circuit (from the charger to the vehicle inlet) before charging in order to check ground fault and short circuit. The charger shall comply with the following requirements defined in Table A.28.

Table A.28—Requirements for the insulation test for output DC circuit

Item	Specification
Detection method	Use short-circuit and ground fault detection functions. Ground fault detection shall be carried out throughout the charging period including not only during the insulation test but also from the start to the end of charging.
Check timing	The insulation test shall be conducted each time before the charging starts.
Test voltage	The lower of the Target battery voltage (H'102.1, H'102.2) and the Available output voltage (H'108.1, H'108.2) shall beset as the insulation test voltage. When the voltage is less than 500 V, the test voltage shall be 500 V. The accuracy is within ±5%.
Period of test voltage application	Longer than "false operation prevention time." (This is not the period of insulation test but the time to maintain the test voltage after the applied voltage reached the test voltage.)
Process	Close switch (d2) after confirming that the output circuit is operating normally. If abnormal events have occurred during this test, the charger shall immediately stop applying the test voltage in the output circuit. The charger shall check that the EV contactor is open before applying the test voltage in the output circuit.
Error judgment (insulation test and short circuit diagnosis)	Judging criterion shall be less than 20 kΩ when the charger performs insulation test and short circuit diagnosis between (P) and (N) of the output circuit, which is short of EV contactor. The charger manufacturer can define the criterion to be less than 20 kΩ. The charger shall shift to error stop in case the resistance is less than the criteria defined by each charger manufacturer.
Interruption period of ground fault detection function	In order to avoid false detection caused by the influence of stray capacity of vehicle, the ground fault detection function shall be temporarily interrupted during the following time periods: — After switch (d2) is turned on, for the duration of 0.5 s from [voltage in the output circuit ≥50 V and H'102.5.3 (vehicle status) = 1]. — After charging is completed, from [output current in the output circuit ≤5 A and charger status (H'109.5.0) = 0] and thereafter.

c) On-board battery protection:

— If the circuit voltage exceeds "maximum battery voltage" described in item a) of A.7.2.8.2, during charging, the charger shall detect the error within 2s and then stop charging within 2.5 s.

— The charger shall monitor the charging time, and stop charging when charging time exceeds the specified time "maximum charging time" received from the vehicle.

d) Voltage check:

The charger shall check the circuit voltage at the following stages and compare it with the stipulated value given in Table A.29. In the event that the voltage does not meet the stipulated value, the charger shall make the shift to termination process.

e) Self-diagnostic features of the dc leakage current monitoring device:

— The charger shall confirm the dc leakage current monitoring device is operating normally before the start of charging (during the insulation test).

— The charger shall not start the charging operation if a malfunction or abnormality in the dc leakage current monitoring device is detected.

Table A.29—Charging stage and check item

Charging stage	Check item	Criteria
Before insulation test	Open status of the EV contactor.	Less than or equal to 10 V
After insulation test	No voltage in the output circuit after the completion of the insulation test. (Do not apply voltage in the output circuit at the time in which the EV contactor is about to be closed to prevent EV contactors from being damaged by inrush current.)	Less than or equal to 20 V
Before current output	Closed status of the EV contactor.	More than or equal to 50 V
Before releasing latch holding	No voltage in the output circuit after the completion of charging.	Less than or equal to 10 V

A.7.2.9 Protection of EV contactor

- (d1) and (d2) switches of the sequence circuit in the charger shall not be opened until charge current to the vehicle falls to the specified value.
- The specified value is 5 A.
- The vehicle shall operate EV contactor unless in emergency such as in "emergency stop."
- Even at "emergency stop," the switches (d1) and (d2) of the charger shall not open until the current output is halted.
- Even if ac input power blackout or load fluctuations are lowering the power supply voltage, the dc 12 V power supply voltage to the vehicle shall be maintained until the charge current to the vehicle reaches a specified level (5 A) or below. Also make sure to keep the (d1) and (d2) switches ON (closed state). See Requirement i) of A.4.4.

A.7.2.10 Termination process in emergency stop

The following means shall be taken to immediately stop supplying power to main charge circuit and the charger to bring the charger to an emergency stop when the "Emergency stop button" is pushed or when a significant fault or problem occurs on the charger:

a) Turn off inverter gate of the charger.

b) Immediately open the main circuit breaker AC-ELCB1 (see A.5.1).

Even in this case, do not immediately interrupt power supply of the control circuit in conjunction with the occurrences of malfunction and abnormality, and observe the provisions described in Requirement i) of A.4.4 and A.7.2.9.

A.7.2.11 Recovery from charging suspension

If charging is suspended due to a problem or power outage, the charging operation shall not be recovered automatically. The charger shall be equipped with a means permitting the charging station user or the maintenance personnel to reset to operational mode.

A.7.3 Charging current order from the vehicle and response performance of the charger

Charging current order from the vehicle and output current response of the charger shall meet the characteristics shown in Table A.30.

Table A.30—Requirement for charging current request of the vehicle (#102.3)

Item	Symbol	Condition	Specification			
			Min	Typ	Max	Unit
Charging current request range	Ireq	—	0	—	(#108.3) Available output current	A
Changing speed of order value during charging	ΔIreq1	—	−20	—	20	A/s

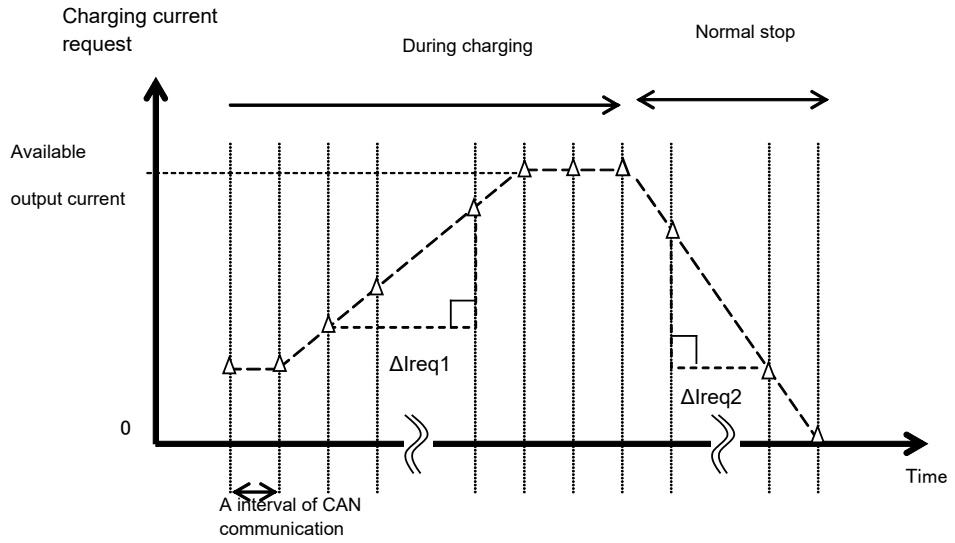


Figure A.17—Regulation for the charging request

Table A.31—Requirements for the charger's output response performance

Item	Symbol	Condition	Specification			
			Min	Typ	Max	Unit
Output accuracy	Idev	Charging current request: 0 A to 50 A	Typ − 2.5 A	Charging current request	Typ + 2.5 A	A
		Charging current request: 50 A to 125 A	Typ × 95%		Typ × 105%	
		Charging current request: 200 A up to 400 A	Typ × 95%		Typ × 105%	
Control delay to vehicle request	Td		—	—	1.0	s
Output response speed	ΔIout1	At charging (for both rise and fall)	20	—	—	A/s
Output current descending speed	ΔIout2	At a normal stop	100	—	200	
		At an emergency stop	200	—	—	
		At an emergency stop [e.g., switch (k) OFF)]	The output current shall drop to 5 A within 30 ms			

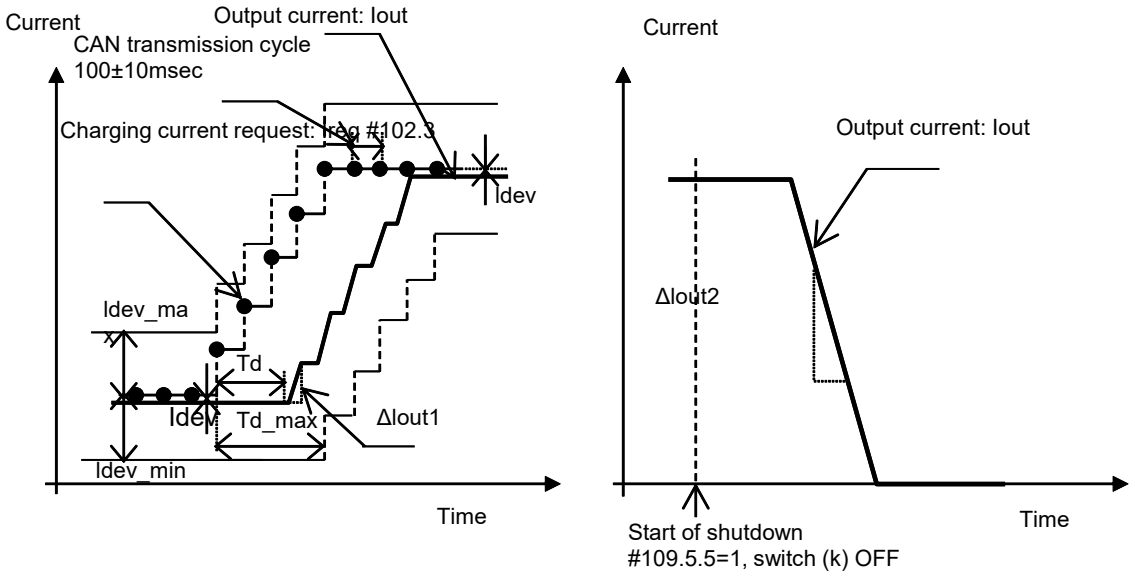


Figure A.18—Output response performance of charger without CAN communication error left side: during charging, right side: at the time of stop

A.7.4 Current/voltage measurement accuracy and its reflection to CAN information

Voltage/current measurement accuracy of the charger and permissible delay in transmitting CAN data to vehicles are specified in Table A.32.

Table A.32—Voltage and current measurement accuracy

Item	Accuracy	
Current (instrumental precision)	Within ± (1.5 % of actual value + 1.0 A)	
Voltage (instrumental precision)	500 V or less	Within ± 5 V
	More than 500 V	Within ± 10 V
CAN data update delay	Transmit current/voltage data within 0.5 s including measurement delay and CAN communication transmission delay.	

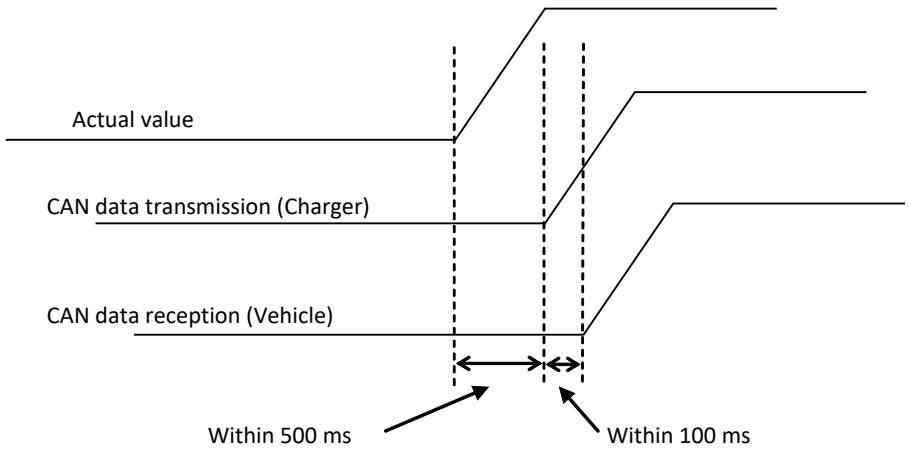


Figure A.19—Definition of measurement delay and data transmission delay

A.7.5 CHAdeMO control protocol number

The charger and the vehicle shall, respectively, set #.109.0 and #.102.0 to the protocol number values specified in Table A.33 from first CAN communication data, and they shall not be changed until the end of the sequence.

Table A.33—CHAdeMO control protocol number settings

CHAdeMO version of standard specifications	CHAdeMO control protocol number
Before 0.9	0
0.9, 0.9.1	1
1.0.0, 1.0.1, 1.2, 1.3	2
2.0.0, 2.0.1	3

A.7.6 Display

A.7.6.1 Information to charger users

The following information relating to charging control shall be displayed (display by lamp, letters, sound, images, labels, and the combination of these):

a) Charger status:
   1) Standby stage
   2) Preparation stage
   3) Charging stage
   4) Charging termination stage
   5) Emergency stop stage

b) Removal of the charging connector. When the charging process stops abnormally, displayed information may prohibit usage of the charging connector. (Display may show a message indicating a risk of electric shock.)

c) Display in the case of CAN communication failure. If CAN data is not sent from the vehicle after the start of charging, the charging connector may not be properly inserted in the vehicle inlet. If this event occurs, it is preferable to display the message “Please check charging connector for proper insertion.”

A.7.6.2 Guidance related to users

Warnings that are necessary for users shall be displayed as appropriate, regardless of output charging current.

A.8 Error definition

A.8.1 Error list

The following requirements shall be met:

a) The charger shall monitor its operational status as well as the vehicle status, and the vehicle shall do the same.

b) The requirements detailed in Table A.34 and Table A.35 (types of trouble, judging criteria, notice to the other device via CAN communication) shall be met.

c) The charger and vehicles shall be designed with thorough considerations on error display and recording functions, so that when error conditions are detected, the charger's users or maintenance personnel can take corrective action efficiently.

d) If the charger or the vehicle receives a flag indicating trouble or fault (see A.6.6), acknowledgment shall not be required (e.g., when the vehicle notifies the charger, via CAN, of trouble, the charger shall not send a CAN message to acknowledge the vehicle trouble). This is so as to help identify on which side the trouble has occurred.

Table A.34—Error information list (detected by the vehicle)

Error detector	Location of error	Reason for error judgment	Judging criteria	CAN message			
				Item name	ID	Byte	bit
Vehicle	Vehicle	On-board battery voltage has reached the upper limit during charging.	On-board battery voltage > Vehicle CAN “maximum battery voltage.”	Battery over-voltage	H’102	4	0
Vehicle	Vehicle	On-board battery voltage has reached the lower limit during charging.	On-board battery voltage is lower than the lower limit of voltage specified by the vehicle (due to over-discharge, etc.).	Battery under-voltage	H’102	4	1
Vehicle	Charger or vehicle	Output current of the charger does not follow the charging current request sent from the vehicle (current deviation).	Vehicle shall evaluate the current deviation error by comparing “Present output current,” “Charging current request,” measured current by vehicle and etc. Judging example: In the case of charger’s CHAdeMO control protocol number is 0x00. The vehicle shall judge that an error has occurred if the circuit current exceeds at least 12 A above the “maximum value of Charging current request in the last 1 s.” In the case of charger’s CHAdeMO control protocol number is 0x01 or higher. The vehicle shall judge that an error has occurred if present circuit current is either at least 12 A above the “maximum value of Charging current request in the last one second” or at least 12 A below the “minimum value of Charging current request in the last 1 s,” when the charger is in the charging mode (#.109.5.5 Charging stop control) is 0.	Battery current deviation error	H’102	4	2
Vehicle	Vehicle	On-board battery temperature has reached the upper limit during charging.	On-board battery temperature exceeds the upper limit.	High battery temperature	H’102	4	3
Vehicle	Charger or vehicle	Voltage figure sent from the charger (Present output voltage) is different from the on-board battery voltage.	Vehicle shall evaluate the battery voltage differential error by comparing “Present output voltage,” measured voltage by vehicle, and etc. Judging example: The vehicle shall judge that an error has occurred if measured voltage in the charger cannot be contained within ± 10 V of measured on in the vehicle for consecutive 5 s.	Battery voltage differentia error	H’102	4	4
Vehicle	Charger or vehicle	Various procedures in the charger exceed the time-out value specified in the specification document.	Time-out value is exceeded.	Charging system fault	H’102	5	2
Vehicle	Charger or vehicle	CAN data from the charger cannot be received during charging.	CAN reception error defined in A.6.5 continues for 1 s or longer.	Charging system fault	H’102	5	2
Vehicle	Charger or vehicle	Any other faults.	Of errors detected by the vehicle, those that are caused by the charger. Based on manufacturers’ own criteria.	Charging system fault	H’102	5	2
Vehicle	Vehicle	The vehicle becomes movable state during charging.	Position of the shift lever, etc.	Vehicle shift position	H’102	5	1

Table A.35—Error information list (detected by the charger)

Error detector	Location of error	Reason for error judgment	Judging criteria	CAN message			
				Item name	ID	Byte	bit
Charger	Charger	An error has occurred in the charger.	— Fault detection and tripping operation by AC-ELCB1. — Based on manufacturers' criteria (e.g., short circuit, ground fault and/or etc on the primary side of the isolated transformer)	Charger malfunction	H'109	5	1
Charger	Charger	Charging connector lock error.	Malfunction of charging connector lock circuit.	Charger malfunction	H'109	5	1
Charger	Vehicle or Charger	Main circuit error.	DC short circuit, dc ground fault.	Charging system malfunction	H'109	5	4
Charger	Charger	Emergency stop button is pushed.	Emergency stop button is ON.	Charger malfunction	H'109	5	1
Charger	Vehicle or charger	The voltage required by the vehicle is higher than charger "available output voltage."	Vehicle "target battery voltage" > Charger "available output voltage.""	Battery incompatibility	H'109	5	3
Charger	Vehicle or charger	Various procedures of the vehicle exceed the time-out value specified in the specification document.	Time-out value is exceeded.	Charging system malfunction	H'109	5	4
Charger	Vehicle or charger	CAN data from the vehicle cannot be received during charging.	CAN reception error specified in A.6.5 continues for 1 s or longer.	Charging system malfunction	H'109	5	4
Charger	Vehicle or charger	On-board battery voltage is not applied to the main circuit before the start of charging.	Measured voltage is less than 50 V after d2 is ON.	Charging system malfunction	H'109	5	4
Charger	Vehicle or charger	The voltage required by the vehicle is higher than charger "available output voltage."	Vehicle "Charging current request" > Charger "available output current."	Charging system malfunction	H'109	5	4
Charger	Vehicle or charger	On-board battery continues to apply voltage to the main circuit after the termination of charging.	Voltage measured by the charger > 10 V.	Charging system malfunction	H'109	5	4
Charger	Vehicle or charger	When "DC Voltage" exceeds "Threshold Voltage."	"Vdc" > Vehicle CAN "LIMIT_VOLT" = False.	Charging system malfunction	H'109	5	4
Charger	Vehicle	Any other faults.	Of errors that the charger detects, those that are caused by the vehicle. Based on manufacturers' own criteria.	Charging system malfunction	H'109	5	4
Charger	Vehicle or charger	A discrepancy between CAN parameter and sequence signal.	Cases specified in A.5.2.7.1.	Charging system malfunction	H'109	5	4

A.9 EMC performance (emission)

This subclause defines test method and limit value of EMC performance (Emission). Charger shall comply with the following requirements.

In the following country, the Resistance to Environmental Noise test in accordance with UL 2231-2 is required for a personnel protection system: U.S.

A.9.1 Usage environment and category

Usage environment and category of charger shall be defined in Table A.36 and Table A.37. The charger shall comply with the limit value in each test corresponding to the environment and category specified in A.9.2.

a) Usage environment:

Usage environment shall be defined in Table A.36.

Table A.36—Usage environment

Usage environment	Definition
Class A	The environment in which the charge is used in all locations other than residential and directly connected to a low voltage power supply network. For Class A off-board electric vehicle charging systems, the instructions for use accompanying the product shall contain the following warning: **CAUTION—**This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.
Class B	The environment which the charger is used in residential location. For Class B off-board electric vehicle charging systems, the instructions for use accompanying the product shall contain the following warning: **WARNING—**Even if meeting the requirements for residential environments, on-board radio reception can be disturbed by noise generated by the off-board electric vehicle charging systems.

b) Category:

Environment category shall be defined in Table A.37.

Charger manufacturers shall take appropriate measures if electromagnetic disturbance is caused in the field, cooperating with charger operators or installation personnel if necessary.

Table A.37—Category

Category	Definition
C1	The charger that is used with rated power up to 25 kVA.
C2	The charger that is used with rated power over 25 kVA, and up to 75 kVA.
C3	The charger that is used with rated power over 75 kVA.

A.9.2 EMC test

A.9.2.1 Harmonic current

The charger shall comply with the limit value of IEC 61000-3-12.

A.9.2.2 AC conducted emission

The charger shall comply with the limit value of Table A.38.

Table A.38—Limit value of ac conducted emission

Frequency (MHz)	Class A dB (μV)						Class B dB (μV)	
	C1		C2		C3		C1, C2, C3	
	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average	Quasi-peak	Average
0.15 to 0.5	79	66	100	90	130	120	66 Decreasing linearly with logarithm of frequency to 56	56 46
0.5 to 5.0	73	60	86	76	125	115	56	46
5.0 to 30.0	73	60	90 Decreasing linearly with logarithm of frequency to 73	80 60	115	105	60	50
NOTE—The charger should comply with the limit value underfollowing condition. 20% of maximum rated power ±10% and 80% of maximum rated power ±10%.								

A.9.2.3 DC conducted emission

The charger shall comply with the limit value of Table A.39.

Table A.39—Limit value of DC conducted emission

Frequency (MHz)	Class A, B dB (μV)			
	C1, C2		C3	
	Quasi-peak	Average	Quasi-peak	Average
0.15 to 0.5	79	66	100	90
0.5 to 5.0	73	60	86	76
5.0 to 30.0	73	60	90 Decreasing linearly with logarithm of frequency to 73	80 60
NOTE—The charger should be in compliance with the limit value under following condition. 20% of maximum rated power ±10% and 80% of maximum rated power ±10%.				

A.9.2.4 Radiated emission

The charger shall comply with the limit value of Table A.40.

Table A.40—Limit value of radiation emission

Frequency (MHz)	Class A dB (μV/m)				Class B dB (μV/m)			
	10 m	Detector/ bandwidth	3 m	Detector/ bandwidth	10 m	Detector/ bandwidth	3 m	Detector/ bandwidth
30 to 230	40	Quasi-peak 120 kHz	50	Quasi-peak 120kHz	30	Quasi-peak 120 kHz	40	Quasi-peak 120 kHz
230 to 1000	47		57		37		47	
1000 to 3000	46	Average 1 MHz	56	Average 1MHz	40	Average 1 MHz	50	Average 1 MHz
3000 to 6000	50		60		44		54	
1000 to 3000	66	Peak 1 MHz	76	Peak 1MHz	60	Peak 1 MHz	70	Peak 1 MHz
3000 to 6000	70		80		64		74	
NOTE—The limit values should be applied corresponding to the measurement facility (3 m or 10 m).								

A.9.2.5 Voltage surge (spike noise)

The charger shall comply with the limit value of Table A.41.

Table A.41—Measuring points and limit value of voltage surge

Item	Measuring point	Limit value (V)
Power line	Between P and N	±50
	Between P and GND	±50
	Between N and GND	±50
Signal line	Between Charge sequence signal 1 and GND Between Charge sequence signal 2 and GND Between Connector proximity detection and GND Between Vehicle charge permission and GND	±25 (Duty cycle: 5% or less) ±15 (Duty cycle: 5% to 20% or less) ±10 (Duty cycle: 20% to 50% or less)
	Between CAN H and GND	±25
	Between CAN L and GND	±25
	Between CAN H and L	±0.5 (Under recessive condition)

A.9.2.6 Current ripple

The charger shall comply with the limit value of Table A.42.

Table A.42—Limit value of current ripple

Frequency[a]	Limit value (Ap-p)
10 Hz or less	1.5
5 kHz or less	3.0
150 kHz or less	9.0

[a]Setting value of cut-off frequency of filter.

A.9.2.7 Smart key influence

The charger shall comply with the limit value of Table A.43.

Table A.43—Limit value of smart key influence

Frequency (kHz)	Limit value/peak value dB (μA/m)
2 to 10	62 to 60
10 to 30	60
30 to 75	60 to 95
75 to 120	95 to 55
120 to 140	55
140 to 185	55 to 95

A.9.2.8 Noise limit on the protective conductor between charger and vehicle

The charger shall comply with the limit value of Table A.44.

Table A.44—Limit value of noise of protective conductor

Item	Criteria (A)
10 s measurement	±1.0
Arbitrary time span	±1.0

A.10 Welding detection procedure by the vehicle

This clause describes an EV contactor welding detection method, which detects welded EV contactors by measuring voltage dropping transition of the charger. The charger shall have circuit characteristics specified in this clause as a requirement.

A.10.1 Requirement for the charger

If capacitance on the vehicle circuit is 1 μF or less, the charger shall have the circuit characteristics shown in Figure A.20.

If the error that the charger cannot satisfy is the voltage drop characteristic in Figure A.20, the charger shall set the Welding Detection Identifier (H'108.0.0) to 0, notify Charger error (H'109.5.1) = 1 or Charging system error (H'109.5.4) = 1 to vehicle, and shift to the error stop process.

If the error that the charger can satisfy is the voltage drop characteristic in Figure A.20, the charger shall keep the Welding Detection Identifier (H'108.0.0) = 1, notify Charger error (H'109.5.1) = 1 to vehicle, and shift to the error stop process.

A.10.2 Precautions for the vehicle

a) If the vehicle receives a Welding Detection Identifier (H'108.0.0) = 0, the vehicle shall not perform the welding detection of EV contactors. Else the vehicle shall perform the welding detection of EV contactors after the output current from the charger is stopped.

b) The vehicle shall carry out the welding detection within 4 s from the charging output stop (output current falls below 5 A and “Charger status” flag = 0) to open of switch (d1) and (d2).

c) Capacitance of on-board circuit between the vehicle inlet and contactors shall be 1 μF or less.

d) If the vehicle uses voltage value (“Present output voltage”) that is measured by the charger and sent to the vehicle via CAN communication to check vehicle inlet voltage, diagnostic logic shall be designed in consideration of “CAN data update delay” stipulated in Table A.32.

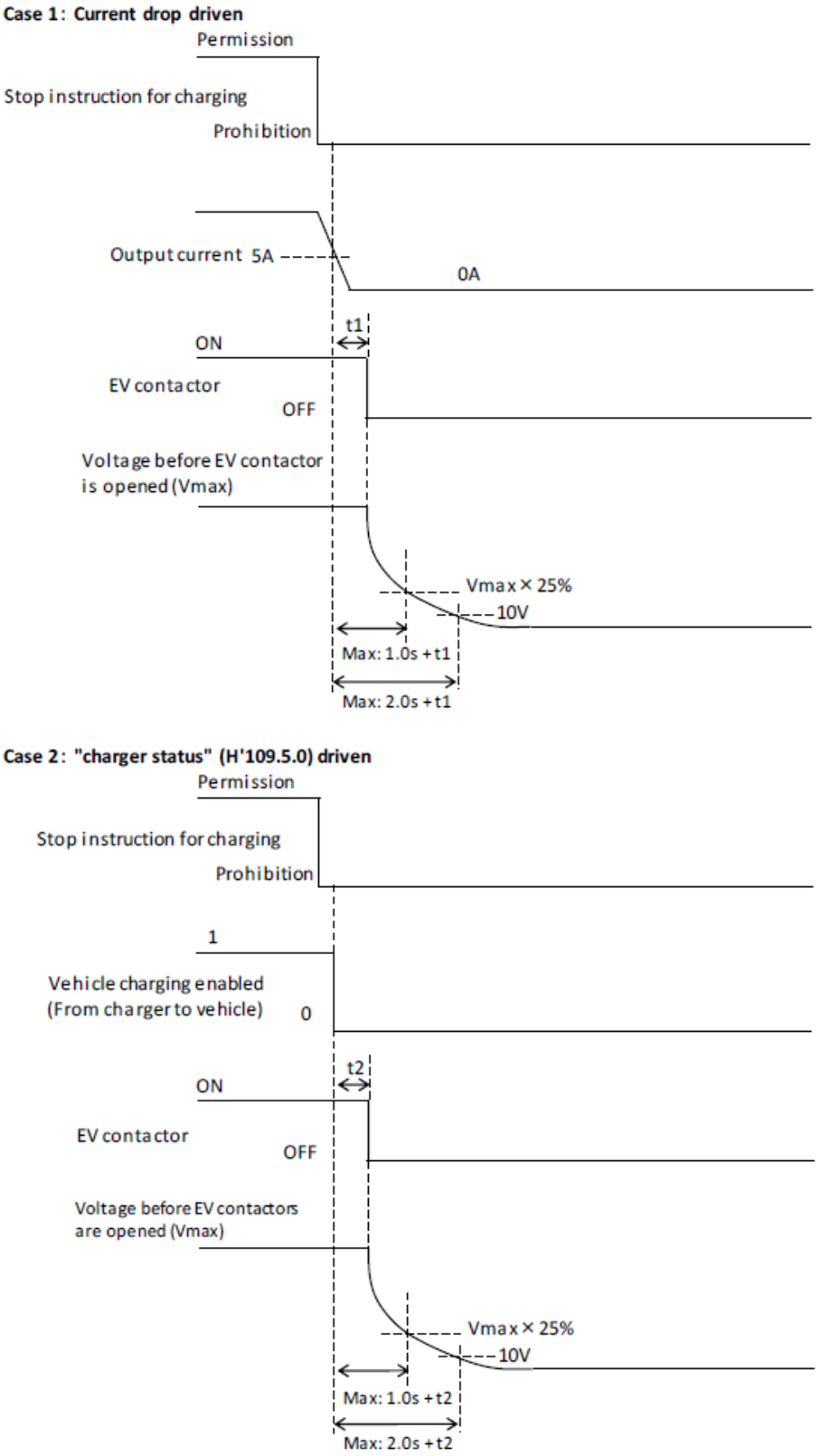


Figure A.20—Requirement for output circuit characteristic on welding detection

In Figure A.20, t1 and t2 should be within 0.5 s (vehicle shall perform the process as soon as possible. Condition for voltage drop is state of opening of EV contactor (Impedance is infinite)

A.10.2.1 Example of welding detection logic on the vehicle

a) Check less than 5 A of charging current, “charger status” flag #.109.5.0 = 0 and “Welding detection Identifier” flag #.108.0.0 = 1.

b) Open the EV contactor on power line (+).

c) Check the voltage at vehicle inlet terminals. If the voltage exceeds the specified value, it is determined that the EV contactor is welded.

d) Close the EV contactor on power line (+).

e) Check the voltage at vehicle inlet terminals.

f) Open the EV contactor on power line (−).

g) Check the voltage at vehicle inlet terminals. If the voltage exceeds the specified value, it is determined that the EV contactor is welded.

h) Close the EV contactor on power line (−).

i) Check the voltage at vehicle inlet terminals.

j) Open the EV contactors on power (+) and power line (−).

k) Terminate welding detection logic sequence.

A.11 Charging sequence

A.11.1 CHAdeMO charging system: CAN communication vehicle message specifications

CAN communication messages sent from the vehicle to the charger shall be in accordance with Table A.45.

A.11.2 CHAdeMO charging system: CAN communication charger message specifications

CAN communication data sent from the charger to the vehicle shall be in accordance with Table A.46.

Table A.45—VEHICLE_MESSAGES

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
H'100	0	Minimum charge current	Minimum current required for charging.	Set the value to prevent discharge of the traction battery calculated from power consumption such auxiliary power of vehicle. (Offset 1) (Example of setting) 0x00: request for current equivalent to 1.5 kW 0x01: no request 0x02: request of 1 A	Set to a value from the start of CAN communication timing and shall be updated continuously.	Shift to normal stop when the condition that Available output current (H'108.3) is less than Minimum charge current (H'100.0) continues for 5 s. Do not output current which is less than this value. Regard current equivalent to 1.5 kW as minimum charge current in case 0x00 is received.
H'100	2,3	Minimum battery voltage	The minimum voltage of the vehicle traction battery (voltage at the vehicle).	Set the voltage defined by vehicle manufacturers.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to judge "Battery incompatibility (H'109.5.3)."
H'100	4,5	Maximum battery voltage	Voltage that charger shall stop charging to protect the traction battery (voltage at the vehicle inlet).	Vehicle shall send a stop signal before the voltage of traction battery exceeds this value because the stop by the charger is backup means in case the voltage of traction battery exceeds this value. The vehicle shall set this value in consideration of the detecting accuracy of charger and voltage drop between the vehicle inlet and the traction battery.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to calculate "Threshold voltage (H'108.4, H'108.5)."

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
H'100	6	Charged rate reference constant	Fixed value to display charged rate.	Set fixed value 100% (0x064).	Set to a value from the start of CAN communication timing and shall not be updated.	Use this value only to display the charged rate. "Charged rate (for display)" = "Charged rate (H'102.6)" / "Charged rate reference constant" (H'100.6) × 100.
H'101	1	Maximum charging time (10 s unit)	Maximum charging time that vehicle permits charger.	Set charging time to this value in case vehicle would like to set in 10 s. This value is set based on "available output voltage (H'108.1, H'108.2)" and "available output current (H'108.3)" of charger.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to set timer for stop. "H'109.6 (10s units)" shall be counted down in case "maximum charging time (H'101.1)" is not 0xFF.
H'101	2	Maximum charging time (1 min unit)	Maximum charging time that vehicle permits charger.	Set charging time to this value in case vehicle would like to set in 1 minute. This value is set based on "available output voltage (H'108.1, H'108.2)" and "available output current (H'108.3)" of charger.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to set timer for stop. "H'109.7 (1min units)" shall be counted down in case "maximum charging time (H'101.1)" is 0xFF.
H'101	3	Estimated charging time	Estimated charging time until the finishing time of charging calculated by vehicle.	Set estimated charging time to this value for charger as reference information (Offset 1). (Example of setting) 0x00: Do not display any value on the charger	A vehicle using this effective value shall send the effective value (other than 0x00) by the time when the switch (k) is turned on. 0x00 shall not be set again after this value is changed from 0x00 to the effective value.	Indicate this value on a display of the charger, which this value is the estimated charging time until completion of the charging. Use this value for display only, and this value shall not be indicated in case 0x00 is received. This value shall be

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
				0x01: Display 0 min on the charger 0x1F: Display 30 min on the charger	Update interval shall be decided by vehicle.	displayed in case other than 0x01 set to this value is received. It is prohibited to use this value for charging control to stop. Do not display this value in case the charging shifts to stop process.
H'101	5, 6	Total capacity of traction battery	Total battery capacity used for traction mounted on an vehicle.	Set 0x0000 in case this value is not used.	A vehicle using this effective value shall send the effective value (other than 0x00) by the time when the switch (k) is turned on. 0x00 shall not be set again after this value is changed from 0x00 to the effective value. Update interval shall be decided by vehicle.	Use this value for display etc. This value may differ from the actual one. This value shall not be used in case this value is 0x0000.
H'102	0	CHAdeMO protocol number	Charging control version that vehicle corresponds with.	Set the version of charging control defined by the specification that vehicle corresponds with to this value. Setting values including the lower versions of the specification are as follows. 0x00: CHAdeMO specification 0.9 and earlier 0x01: CHAdeMO specification 0.9 and 0.9.1 0x02: CHAdeMO specification 1.0.0, 1.0.1, 1.1 and 1.2	Set to a value from the start of CAN communication timing and shall not be updated.	Confirm the version of charging control.

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
				0x03: CHAdeMO specification 2 .0 This value shall not be changed in case a charger having a setting value of the lower version is connected.		
H'102	1,2	Target battery voltage	Target value of charging voltage (Voltage value at a vehicle inlet).	Set the voltage defined by vehicle manufacturers to this value.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to calculate “compatibility check of traction battery” and “available output current (H’108.3).”
H'102	3	Charging current request	Current value that vehicle requests charger during charging.	Request range: less than and equal to “available output current (H’108.3)” Changing rate: –20A/s up to +20A/s	Set 0x00 before charging. This value shall be updated continuously during charging. Set 0x00 at the stop of charging.	Output current responding to this value.
H'102	4(0)	Battery overvoltage	Error flag indicating a voltage of traction battery which exceeded a unique management value defined by vehicle.	Set 1 to this flag when the voltage of traction battery exceeds “maximum battery voltage (H’100.4, H’100.5).” Vehicle shall shift to error stop process in case the vehicle detects any error, and this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
H'102	4(1)	Battery undervoltage	Error flag indicating a voltage of traction battery that is less than a unique management value defined by vehicle.	Set 1 to this flag when the voltage of traction battery is less than a lower limit voltage managed by vehicle (e.g., over discharge). Vehicle shall shift to error stop process in case the vehicle detects any error, and this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.
H'102	4(2)	Battery current deviation error	Error flag indicating a difference between "charging current request (H'102.3)" and the output current of charger. Vehicle recommends to decide the error judgment under the following conditions: —The output current exceeds the "charging current request (H'102.3)" by more than or equal to 10% or 20 A and	Set 1 to this flag when a difference between "charging current request (H'102.3)" and output current measured by vehicle deviates a unique management value of vehicle. Vehicle shall shift to error stop process in case the vehicle detects any error, and this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
			—The duration of the deviation is 1 s or more			
H'102	4(3)	High battery temperature	Error flag indicating temperature of traction battery that exceeded a unique management value defined by vehicle.	Set 1 to this flag when a temperature of traction battery exceeds an upper limit temperature managed by vehicle. Vehicle shall shift to error stop process in case the vehicle detects any error, and this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.
H'102	4(4)	Battery voltage deviation error	Error flag indicating a difference between a voltage of traction battery measured by vehicle and “present output voltage (H’109.1, H’109.2)” which deviates a unique management value defined by vehicle.	Set 1 to this flag when a difference between a voltage of traction battery measured by vehicle and “present output voltage (H’109.1, H’109.2)” deviates a unique management value of vehicle. Vehicle shall shift to error stop process in case the vehicle detects any error, and this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
H'102	5(0)	Vehicle charging enabled	Flag indicating charge permission status of the vehicle.	Set 1 to this flag in case vehicle permits charging. Set 0 to this flag in case vehicle prohibits charging. Vehicle shall shift to a stop process in case this flag is changed to 0 from 1.	See a control timing chart about setting of charge permission and charge prohibition.	Shift to stop process in case this flag is changed to 0 from 1 after charging started.
H'102	5(1)	Vehicle shift position	Status flag indicating position of a shift lever of vehicle	Set 0 to this flag when position of a shift lever is in “parking.” Set 1 to this flag when position of a shift lever is other than in “parking.” Vehicle shall shift to stop process in case this flag is set to 1. “Parking” means a state that a vehicle cannot move easily.	Set to a value from the start of CAN communication timing and shall be updated continuously. This flag shall be interlocked with the position of a shift lever.	Shift to stop process in case this flag that is set to 1 is received.
H'102	5(2)	Charging system error	Error flag indicating a vehicle error or a charger error detected by vehicle	Vehicle shall shift to error stop process in case the vehicle detects any error, and this flag is set to 1. Set 1 to this flag in case of the following conditions. —Excess of time out. —CAN communication error continues for 1.0s (e.g., un-reception of CAN communication). —Vehicle error or charger error detected by vehicle.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.

ID	Byte (bit)	Data name	Content	Vehicle processing		Charger processing
				Processing related to main content	Set timing	
H'102	5(3)	Vehicle status	Status flag indicating closing / opening of EV contactor and a termination of welding detection	Set 1 to this flag from CAN communication is started. Set 0 from 1 to this flag when EV contactor is closed. Set 1 from 0 to this flag at the end of the welding detection or when EV contactor is opened.	Set to a value from the start of CAN communication timing and shall be updated continuously. This flag shall be interlocked with the progress of charging control.	Process a time-out in case this flag is still 0 after shifting to a stop process.
H'102	5(4)	Normal stop request before charging	Flag indicating a stop request of charging control from vehicle before charging	Set 0 to this flag when vehicle do not require to stop. Set 1 to this flag when vehicle require to stop.	This flag can be updated until “charging current request (H’ 102.3)” is set to 1 A or more. Update this flag continuously. Maintain 1 in case of stop request.	Shift to stop process in case this flag that is set to 1 is received. Do not use this flag as a stop judgment of charging control after “charging request current (H’102.3)” which is 1 A or more is received.
H'102	6	State of charge	Charged rate of traction battery calculated by vehicle that is only used for display on charger	State of charge (SOC) of traction battery shall be set in % unit.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Use this value only to display the charged rate. “Charged rate (for display)” = “Charged rate (H’102.6)” / “Charged rate reference constant” (H’100.6) × 100.

Table A.46—CHARGER_MESSAGES

ID	Byte (bit)	Data name	Content	Charger processing		Vehicle processing
				Processing related to main content	Set timing	
H'108	0	Welding detection Identifier	Identifier indicating characteristic of output circuit of charger which corresponds to welding detection of EV contactor.	Charger shall have circuit characteristic defined in A.10 and shall set this value to "1".	Set to a value from the start of CAN communication timing and update the value.	Confirm whether charger has the circuit characteristic which corresponds to welding detection of EV contactor and the conditions under which the welding detection can be performed are satisfied.
H'108	1,2	Available output voltage	Maximum output voltage value of charger. (Voltage at the tip of charging connector)	Charger shall shift to stop process when the "target battery voltage (H'102.1, H'102.2)" exceeds this value.	Set to a value from the start of CAN communication timing and shall not be updated.	Confirm the specification of charger.
H'108	3	Available output current	The maximum value that a charger can output.	Charger shall shift to error stop process when the "charging current request (H'102.3)" exceeds this value.	Set to a value from the start of CAN communication timing. This value shall be updated until when the "charging current request (H'102.3)" that is more than or equal to 1 A is received.	Use this value for upper limit of "charging current request H'102.3)." Use this value to calculate "maximum charge time (H'101.1, H'101.2)."
H'108	4,5	Threshold voltage	Voltage to judge changing stop which shall be used for the protection of traction battery.	Charger shall compare the "maximum battery voltage (H'100.4, H'100.5)" with the "available output voltage (H'108.1, H'108.2)," and set the lower value. Charger shall shift to error stop process when output voltage value reaches this value exceeds this value.	Set to a value from the start of CAN communication timing. This value shall be updated until when the "charging current request (H'102.3)" that is more than or equal to 1 A is received.	Receive the value as information from charger.

ID	Byte (bit)	Data name	Content	Charger processing		Vehicle processing
				Processing related to main content	Set timing	
H'109	0	CHAdeMO protocol number	Charging control version that charger corresponds with.	Set the version of charging control defined by the specification that vehicle corresponds with to this value. Setting values including the lower versions of the specification are as follows: 0x00: CHAdeMO specification 0.9 and earlier 0x01: CHAdeMO specification 0.9 and 0.9.1 0x02: CHAdeMO specification 1.0.0, 1.0.1, 1.1, and 1. 2 0x03: CHAdeMO specification 2.0 This value shall not be changed in case a vehicle having a setting value of the lower version is connected.	Set to a value from the start of CAN communication timing and shall not be updated.	Confirm the version of charging control.
H'109	1,2	Present output voltage	Voltage in output circuit measured by charger.	Voltage in output circuit measured by charger shall be converted into CAN value, and it shall be sent to vehicle.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Use this value to judge “Battery voltage deviation error (H’102.4.4).”
H'109	3	Present charge current	Measured current value of the output circuit in the charger.	Current in output circuit measured by charger shall be converted into CAN value, and it shall be sent to vehicle.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.
H'109	5(0)	Charger status	Status flag indicating charging.	Set 0 to this flag before charging (e.g., initial value, during insulation test) and at the end of the charging (shifting to stop process and charging current decreases less than or equal to 5 A).	Set to a value from the start of CAN communication timing and shall be updated continuously.	Confirm the state of charger.

ID	Byte (bit)	Data name	Content	Charger processing		Vehicle processing
				Processing related to main content	Set timing	
				Set 1 to this flag during charging.	This flag shall be interlocked with the progress of charging control.	
H'109	5(1)	Charger error	Error flag indicating charger's error detected by charger.	Charger shall detect error and shall shift to error stop process in case this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.
H'109	5(2)	Energizing state	Status flag indicating a state in which voltage can be applied from charger or a state in which output charging is permitted.	See the control timing chart to set this flag. Set 1 to this flag when vehicle permits charger to charge and/or voltage in output circuit exceeds 10 V. Set 0 to this flag when vehicle prohibits charger to charge and/or voltage in output circuit is less than or equal to 10 V. The latch shall be held and shall not be mated with a vehicle inlet while this flag is set to 1.	Set to a value from the start of CAN communication timing and shall be updated continuously. This flag shall be interlocked with the progress of charging control.	EV contactor must not be turned on in case this flag is set to 0 because the charging connector may not be mated with a vehicle inlet.
H'109	5(3)	Battery incompatibility	Error flag indicating "available output voltage" of charger which is not suitable for charging to traction battery.	Set 1 to this flag in case "target battery voltage (H'102.1, H'102.2)" of vehicle exceeds "available output voltage (H'108.1, H'108.2)" or "Minimum battery voltage (H'100.2, H' 100.3)" of vehicle is below "output voltage lower limit." Charger shall detect error and shall shift to error stop process in case this flag is set to 1.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.
H'109	5(4)	Charging system error	Error flag indicating vehicle error or charger error	Charger shall detect error and shall shift to error stop process in case this flag is set to 1.	Update this flag continuously. Maintain 1 after	Shift to stop process in case this flag that is set to 1 is received.

ID	Byte (bit)	Data name	Content	Charger processing		Vehicle processing
				Processing related to main content	Set timing	
			detected by charger.	Set 1 to this flag in case of the following conditions: —Vehicle error or charger error detected by charger. —Short circuit, ground fault or electric al leakage in output circuit. —Excess of time-out. —CAN communication error continues for 1.0 s (e.g., un-reception of CAN communication). —In case “charging current request (H’102.3)” of vehicle exceeds “available output current (H’108.3)” of charger. —When charger shift s to stop process, output voltage does not reach less than or equal to 10 V even when 4 s has passed after output current becomes less than or equal to 5 A and both switch (d1) and switch (d2) are turned off (This flag shall be sent within 2 s). —In case voltage measured by charger in output circuit is more than or equal to “threshold voltage (H’108.4, H’108.5)” of charger. —Logical discrepancy is detected defined in A.5.2.7.1 —In case “target battery voltage (H’102.1, H’102.2)” of vehicle exceeds “maximum battery voltage (H’100.4, H’100.5).”	confirming an error.	

ID	Byte (bit)	Data name	Content	Charger processing		Vehicle processing
				Processing related to main content	Set timing	
				—In case overload current protection is operated, which is defined in A.5.1.5.1.2. —In case opto couplers j become OFF during charging.		
H'109	5(5)	Charging stop control	Status flag indicating a state in which charging control of charger shift to stop process.	Set this flag to 1 before charging (e.g., initial value and during insulation test). Change this flag to 0 from 1 after shifting to the start of charging control. Also, both the timing that the "charging stop control (H'109.5.5)" is changed to 0 from 1 and the timing that the "charger status (H'109.5.0)" is changed to 1 from 0 shall be in an exclusive relation. Set 1 from 0 to this flag in case the charging sequence shifts to stop process (including a state of stop process).	Set to a value from the start of CAN communication timing and shall be updated continuously. This flag shall be interlocked with the progress of charging control.	Confirm the state of charger.
H'109	6	Remaining charging time (10 s unit)	Remaining charging time managed by charger.	Set the value using the "maximum charging time (H'101.1, H'101.2)" sent by vehicle and management value of its charger to this value. This value shall count down, and charger shall shift to stop process in case this value becomes 0 s. The remaining charging time shall not be displayed on charger in case the "estimated charging time (H'101.3)" which is other than 0x00 is received. This value shall count down in case the "maximum charging time (10 s unit).	Set this value after the "maximum charging time (H'101.1, H'101.2)" of vehicle are received. This value shall be updated (count down) continuously in case the charging is started. Set this value to 0 after becoming output current is less than or equal to 5 A in case charger shifts to stop process.	Receive the value as information from charger.

ID	Byte (bit)	Data name	Content	Charger processing		Vehicle processing
				Processing related to main content	Set timing	
				(H'101.1)" which is other than 0xFF is received.		
H'109	7	Remaining charging time (1min unit)	Remaining charging time managed by charger	Set the value using the "maximum charging time (H'101.1, H'101.2)" sent by vehicle and management value of its charger to the value. This value shall be counted down, and charger shall shift to stop process in case this value becomes 0 min. The "remaining charging time" shall not be displayed on charger in case the "estimated charging time (H'101.3)" which is other than 0x00 is received. This value shall count down in case the "maximum charging time (10 s unit) (H'101.1)" which is 0xFF is received.	Set this value after the "maximum charging time (H'101.1, H'101.2)" of vehicle are received. This value shall be updated (count down) continuously in case the charging is started. Set this value to 0 after becoming output current is less than or equal to 5 A in case charger shifts to stop process.	Receive the value as information from charger.

A.11.3 CAN communication message transmission default value set

The vehicle shall send the initial value of CAN data to the charger with the values of Table A.47.

Table A.47—CAN communication message transmission default value set of vehicle

ID	Byte, bit	Item	Content
100	0	Minimum current	Set “minimum current” defined by vehicle
	1	Not used	Set 0x00
	2	Minimum battery voltage (Low byte)	Lower limit voltage for backup to stop by a charger (Low byte)
	3	Minimum battery voltage (High byte)	Lower limit voltage for backup to stop by a charger (High byte)
	4	Maximum battery voltage (Low byte)	Upper limit voltage for backup to stop by a charger (Low byte)
	5	Maximum battery voltage (High byte)	Upper limit voltage for backup to stop by a charger (High byte)
	6	Charged rate constant value	Set fixed value (0x64: 100 %) related to charged rate
	7	Not used	Set 0x00
101	0	Not used	Set 0x00
	1	Maximum charging time (unit: 10 s)	Set 0x00 (Maximum charging time that vehicle permits charger)
	2	Maximum charging time (unit: 1 min)	Set 0x00 (Maximum charging time that vehicle permits charger)
	3	Estimated charging time (unit: 1 min)	Estimated time until stop of charging (Set “0x00” if vehicle does not require this parameter to be displayed on charger)
	4	Not used	Set 0x00
	5	Total capacity of battery (Low byte)	Set total capacity of battery (Low byte)
	6	Total capacity of battery (High byte)	Set total capacity of battery (High byte)
	7	Not used	Set 0x00
102	0	CHAdeMO protocol number	Set 0x03
	1	Target battery voltage (Low byte)	Target value of charging voltage (Low byte)
	2	Target battery voltage (High byte)	Target value of charging voltage (High byte)
	3	Charging current request	Set 0x00
	4	Fault flag	Set present vehicle state and result of abnormality detection
	5	Status flag	Set a flag such as position of vehicle shift lever, present vehicle state, and charge enabled state
	6	State of charge	Set state of charge of battery (unit: %)
	7	Not used	Set 0x00
NOTE 1—Set “maximum charging time” by the time switch (k) turns on. NOTE 2—Set “maximum battery voltage” by the time switch (k) turns on. NOTE 3—Set “target battery voltage” after receiving “available output voltage” of a charger.			

The charger shall calculate the following parameters using the internal parameter of the vehicle’s CAN data and the charger’s CAN data (see Table A.48). The calculation results shall be set in the charger’s CAN data and sent to the vehicle:

a) Available output current

b) Threshold voltage

Table A.48—CAN communication message transmission default value set of charger

ID	Byte, bit	Item	Content
108	0, 0	Welding detection	Set “1”
	1	Available output voltage (Low byte)	Set low byte of “available output voltage” of charger
	2	Available output voltage (High byte)	Set high byte of “available output voltage” of charger
	3	Available output current	Set “available output current” of charger
	4	Threshold voltage (Low byte)	Set low byte of “threshold voltage” of charger
	5	Threshold voltage (High byte)	Set high byte of “threshold voltage” of charger
	6	Not used	Set 0x00
	7	Not used	Set 0x00
109	0	CHAdeMO protocol number	Set 0x03
	1	Present voltage (Low byte)	Set output voltage measured by charger (Low byte)
	2	Present voltage (High byte)	Set output voltage measured by charger (High byte)
	3	Present charging current	Set output current measured by charger
	4	Not used	Set 0x00
	5	Status/fault flag	Set a state of a charger and a results of fault status
	6	Remaining charging time (Unit: 10 s)	Setting value of charger (initial value)
	7	Remaining charging time (Unit: 1 min)	Setting value of charger (initial value)

In Table A.48, in case “target battery voltage” becomes 0x00 during the calculation of “available output current,” the charger shall avoid divide by zero.

A.11.4 Explanatory diagram for status flags of the charger and the vehicle

Charger and vehicle status flag are shown in Figure A.21.

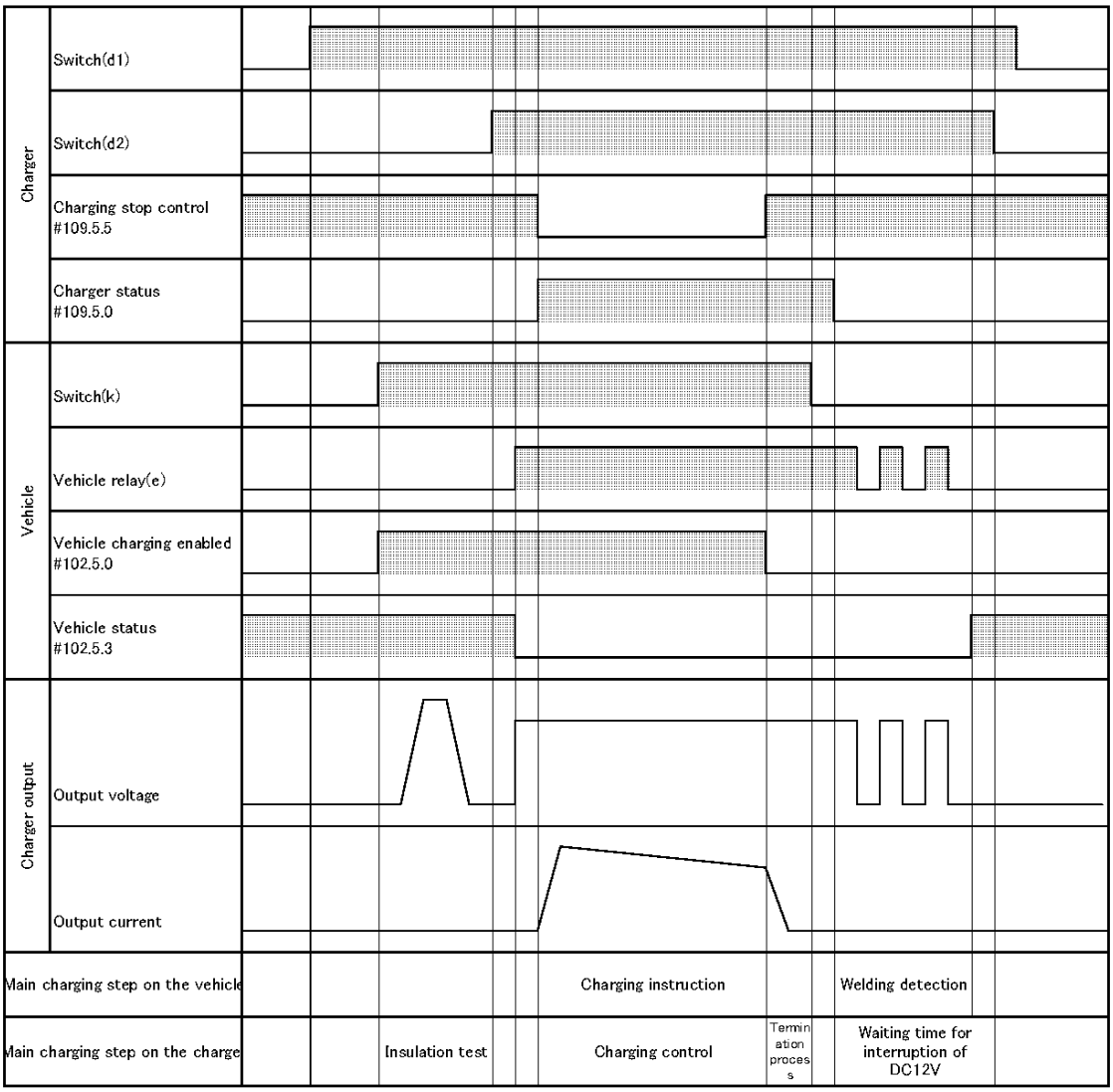


Figure A.21—CHARGER_STATUS

A.11.5 Extended specifications

A.11.5.1 General rules

This subclause describes the extended functions to be added. The extended functions can be implemented by the charger or vehicle manufacturer optionally. The extended functions can be used when the charger and the vehicle notify each other of the availability of the extended functionality by the dedicated CAN data frames and the extended specification implemented by both the charger and the vehicle match each other.

A.11.5.2 Communication protocol

Communication protocol of the extended function shall comply with the following specifications.

A.11.5.2.1 Transmission method

CAN transmission of the extended specification shall comply with the transmission method of A.6.3, and the data shall be sent with the format defined in this specification.

A.11.5.2.2 Reception method

CAN reception of the extended specification shall comply with the reception process of A.6.4, and the data shall be sent with the format defined in this specification.

A.11.5.2.3 Data format for extended function

Charger and vehicle shall add the following data format to implement the extended function:

a) ID:

ID allocation is shown in Table A.49.

Table A.49—ID allocation

	ID
Vehicle	H’110
Charger	H’118

b) Data length:

Fixed at 8 bytes.

c) Data area:

Data area is shown in Table A.50, Table A.51, and Table A.52.

A value shall be set in data area (it is prohibited to set a value not in a data area).

Table A.50—Data area

From	To	ID	Byte	Data name	Remarks
Vehicle	Charger	H’110	0	Extended function 1	
			1–7		Reserve
Charger	Vehicle	H’118	0	Extended function 1	
			1–7		Reserve

Table A.51—Data area of vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
110	100	8	0	7-4	—	—	—	—	—	Not used
				3	Reserved	—	—	—	—	Reserved
				2	High voltage control	—	—	0	1	0: Incompatible 1: Compatible
				1	High current control	—	—	0	1	0: Incompatible 1: Compatible
				0	Dynamic control	—	—	0	1	0: Incompatible 1: Compatible
			1	7-0	—	—	—	—	—	Not used
			2	7-0	—	—	—	—	—	Not used
			3	7-0	—	—	—	—	—	Not used
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used

Table A.52—Date area of charger

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
118	100	8	0	7-4	—	—	—	—	—	Not used
				3	Reserved	—	—	—	—	Reserved
				2	High voltage control	—	—	0	1	0: Incompatible 1: Compatible
				1	High current control	—	—	0	1	0: Incompatible 1: Compatible
				0	Dynamic control	—	—	0	1	0: Incompatible 1: Compatible
			1	7-0	—	—	—	—	—	Not used
			2	7-0	—	—	—	—	—	Not used
			3	7-0	—	—	—	—	—	Not used
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used

A.11.5.3 Extended function

The extended functions defined in this extended specification is shown in Table A.53. The charger and vehicle shall keep sending an ID defined in the extended specification and a flag corresponding to the extended function as well as other IDs during charging control regardless of “CHAdeMO protocol number” of the connection destination and the implementation of the extended function or not.

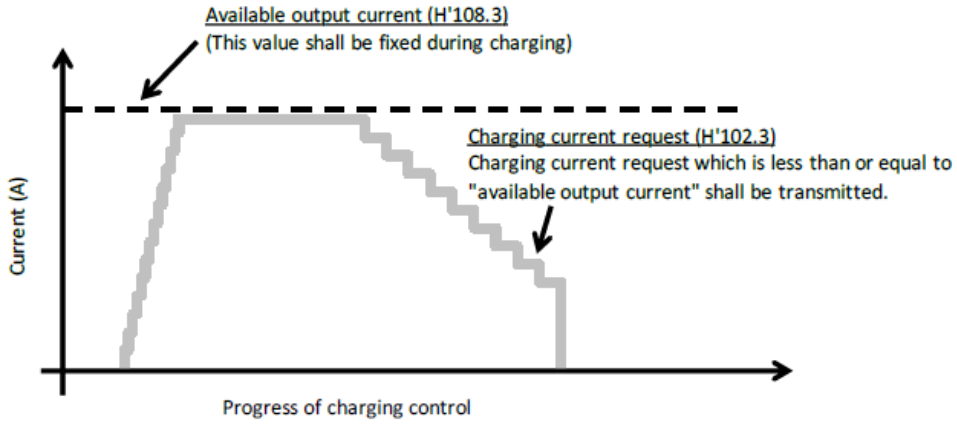
Table A.53—Data allocation of the extended function

Name	Vehicle flag	Charger flag
Dynamic control	H’110.0.0	H’118.0.0
High current control	H’110.0.1	H’118.0.1
High voltage control	H’110.0.2	H’118.0.2

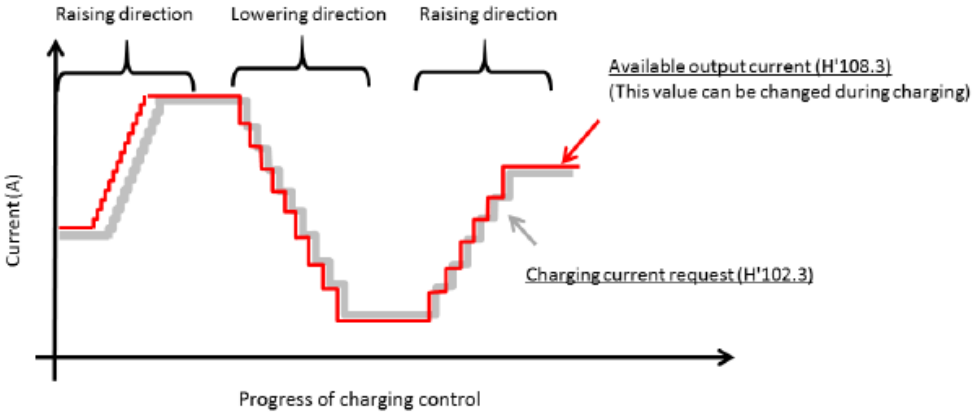
A.11.5.3.1 Dynamic control

Dynamic control is a function in which the charger can increase or decrease its “available output current” during charging.

When the charger dynamically changes the “available output current” to a new target value during charging, the vehicle shall transmit the “charging current request” value less than or equal to the “available output current” in response. The process of the dynamic control is shown in Figure A.22.



(a) Charging system incompatible with dynamic control (standard charging control)



(b) Charging system which is compatible with dynamic control

Figure A.22—Mechanism of dynamic control (example)

A.11.5.3.1.1 Scope of application

This extended function shall be applied to the combination of the charger and the vehicle, both of which implement the dynamic control. The timing chart corresponding to this function is shown in Figure A.23.

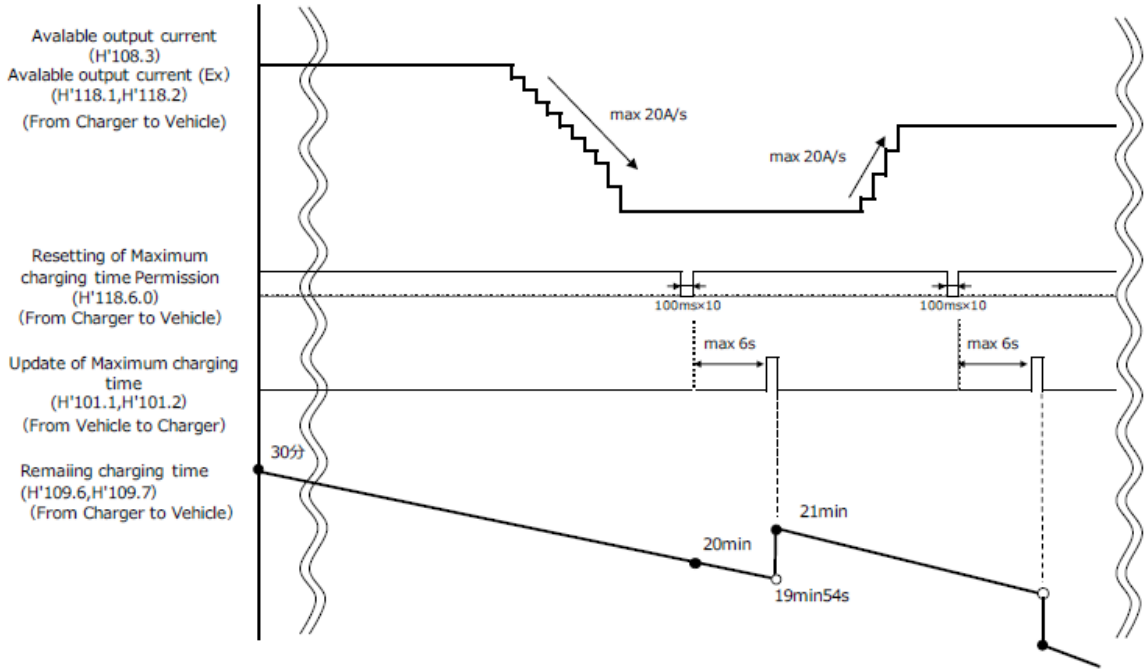


Figure A.23—Timing chart

A.11.5.3.1.2 Available output current (H’108.3) and available output current (extended) (H’118.1, H’118.2)

A charger compatible with dynamic control shall satisfy the following requirements to change the available output current during charging.

In case the high current control is applied, the available output current (extended) (H’118.1, H’118.2) is used. The detail of high current control is defined in A.11.5.3.2:

a) The charger shall calculate the latest “available output current” using the battery voltage and the maximum output power of the charger.

b) After changing “available output current” when “available output current” is stable or the definite period of time is passed, the charger shall send enable resetting the maximum charging time (H'118.6 .0).

c) The changing rate of the “available output current” is from –20 A/s to 20 A/s.

A.11.5.3.1.3 Remaining charging time (H'109.6, H'109.7)

A charger compatible with the dynamic control shall satisfy the following requirements to change the "remaining charging time" during charging:

a) The charger shall calculate the "remaining charging time (H'109.6, H'109.7)."

b) After changing the "permission to reset the maximum charging time (H'118.6.0 118.6.0)" from disable to enable, the charger shall update the "maximum charging time" value within 6 s if the value is different from the previous value.

c) The charger shall notify the recalculated "remaining charging time" to the vehicle at exactly 10 s after changing the "permission to reset the maximum charging time (H'118.6.0 118.6.0)" from disable to enable.

d) The charger shall restart the countdown or continue with the previous countdown process of the "remaining charging time" and shift to the charge stop process if the "remaining charging time" reaches 0.

A.11.5.3.1.4 Charging current request (H'102.3)

The vehicle shall satisfy the following requirements when changing the "charging current request" during charging in order to perform dynamic control:

a) The vehicle shall calculate the charging current request.

b) The vehicle shall continuously monitor the "available output current," and if the value has been changed, the vehicle shall change the "charging current request" so that the "charging current request" will become lower than the "available output current."

c) In case the "charging current request" exceeds the "available output current" the vehicle shall immediately change the "charging current request" to less than or equal to the "available output current." In addition, the output current descending speed shall comply with the specification defined in item c) in A.11.5.3.1.2.

A.11.5.3.1.5 Maximum charging time (H'101.1, H'101.2)

The vehicle shall satisfy the following requirements when changing the "maximum charging time" during charging in order to perform dynamic control:

a) The vehicle shall calculate the "maximum charging time."

b) The vehicle shall change the "maximum charging time" within 6 s after the "permission to reset the maximum charging time (H'118.6.0)" has been changed from disable to enable. However, it is possible that the maximum charging time remains the same even after the available output current has been changed.

A.11.5.3.1.6 Exception of error judgment

When the charger applies the dynamic control, the charger shall set an adequate error judgment time or error invalid time depending on the diagnosis when the "available output current" is compared with the "charging current request," due to a CAN communication lag between the charger and the vehicle.

A.11.5.3.1.7 Data area

The data area of the vehicle and of the charger are provided in Table A.54 and Table A.55, respectively.

Table A.54—Data area of vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
110	100	8	0	7-0	Extended function 1	—	—	—	—	
			1	7-0	—	—	—	—	—	Not used
			2	7-0	—	—	—	—	—	Not used
			3	7-0	—	—	—	—	—	Not used
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used

Table A.55—Data area of charger

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
118	100	8	0	7-0	Extended function 1	—	—	—	—	
			1	7-0	—	—	—	—	—	Not used
			2	7-0	—	—	—	—	—	Not used
			3	7-0	—	—	—	—	—	Not used
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-1	—	—	—	—	—	Not used
				0	Permission to reset the maximum charging time					0: enable 1: disable
			7	7-0	—	—	—	—	—	Not used

A.11.5.3.1.8 Requirements for CAN communication message

The requirements for the CAN communication message are provided in Table A.56 and Table A.57.

Table A.56—Communication data sent from vehicle to charger

Data name ID, Byte, Bit	Content	Process of vehicle		Process of charger
		Main process	Set timing	
Maximum charging time (10 s unit) H'101.1	Maximum charging time that vehicle permits charger.	Set this value in case vehicle would like to set in 10 s. Set this value based on “available output voltage (H’108.1, H’108.2)” and, either “available output current (H’108.3)” or “available output current (extended) (H’118.1, H’118.2)” of charger. This value shall be recalculated in case “permission to reset the maximum charging time (H’118.6.0)” is changed from disable to enable during charging.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on]. This value shall be changed within 6s after “permission to reset the maximum charging time (H’118.6.0)” is changed from disable to enable during charging. This value is allowed to remain the same.	Use this value to set timer for stop. “H’109.6 (10 s units)” shall be counted down in case “maximum charging time (H’101.1)” is not 0xFF.
Maximum charging time (1 min unit) H'101.2	Maximum charging time that vehicle permits charger.	Set this value in case vehicle would like to set in 1 minute interval. Set this value based on “available output voltage (H’108.1, H’108.2)” and, either “available output current (H’108.3)” or “available output current (extended) (H’118.1, H’118.2)” of charger. This value shall be recalculated in case the “permission to reset the maximum charging time (H’118.6.0)” is changed from disable to enable during charging.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on]. This value shall be changed within 6 s after “permission to reset the maximum charging time (H’118.6.0)” is changed from disable to enable during charging. This value is allowed to remain the same.	Use this value to set timer for stop. “H’109.7 (1 min units)” shall be counted down in case “maximum charging time (H’101.1)” is 0xFF.
Charging current request H’102.3	Current value that vehicle requests charger during charging	Request range: less than or equal to “available output current (H’108.3)” Changing rate: –20 A/s up to + 20 A/s	Set 0x00 before charging. This value shall be updated continuously during charging. Set 0x00 at the stop of charging.	Output current responding to this value.
Dynamic control H'110.0.0	Flag indicating vehicle that is compatible with dynamic control.	Set this flag to 1 in case the vehicle applies dynamic control of extended function. Set this flag to 0 in case the vehicle does not apply dynamic control of extended function.	Set to a value from the start of CAN communication timing and shall not be updated.	Use this flag for confirmation process of extended function.

Table A.57—Communication data sent from charger to vehicle

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
Available output current H'108.3	Maximum value that a charger can output	Charger shall shift to error stop process when the "request charging current (H'102.3)" or "request charging current (extended) (H'110.1, H'110.2)" exceeds this value. In case the value change by dynamic control, changing rate is from –20 A/s to 20 A/s.	Set to a value from the start of CAN communication timing. This value can be updated until when the "charging current request (H'102.3)" that is more than or equal to 1 A is received. This value can be updated while the dynamic control is applied during charging.	Use this value for upper limit of "charging current request" (H'102.3). Use this value to calculate "maximum charge time (H'101.1, H'101.2)."
Remaining charging time (10 s unit) H'109.6	Remaining charging time managed by charger	Set this value by using the "maximum charging time (H'101.1, H'101.2)" sent by vehicle and management value of its charger. This value shall count down, and charger shall shift to stop process in case this value becomes 0 s. The remaining charging time shall not be displayed on charger in case the "estimated charging time (H'101.3)" which is other than 0x00 is received. This value shall count down in case the "maximum charging time (10 s unit) (H'101.1)" which is other than 0xFF is received. Calculate this value by using "maximum charging time (H'101.1, H'101.2)" of vehicle which is changed within 6 s after the "permission to reset the maximum charging time (H'118.6.0)" is changed from disable to enable during charging.	Set this value after the "maximum charging time (H'101.1, H'101.2)" of vehicle are received. This value shall be updated (count down) continuously in case the charging is started. Set this value to 0 after becoming output current is less than or equal to 5 A in case charger shifts to stop process. The recalculated value shall be transmitted to the vehicle within 10 s after the "permission to reset the maximum charging time (H'118.6.0)" is changed from disable to enable during charging.	Confirm the state of charger.
Remaining charging time (1 min unit) H'109.7	Remaining charging time managed by charger	Set this value by using the "maximum charging time (H'101.1, H'101.2)" sent by vehicle and management value of its charger. This value shall be counted down, and charger shall shift to stop process in case this value becomes 0 min. The "remaining charging time" shall not be displayed on charger in case the "estimated charging time (H'101.3)" which is other than 0x00 is received.	Set this value after the "maximum charging time (H'101.1, H'101.2)" of vehicle are received. This value shall be updated (count down) continuously in case the charging is started. Set this value to 0 after becoming output current is less than or equal to 5 A in case charger shifts to stop process. The recalculated value shall be transmitted to the vehicle within 10 s after the "permission to reset	Confirm the state of charger.

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
		This value shall count down in case the “maximum charging time (10 s unit) (H’101.1)” which is 0xFF is received. Calculate this value by using “maximum charging time (H’101.1, H’101.2)” of vehicle which is changed within 6 s after the “permission to reset the maximum charging time (H’118.6.0)” is changed from disable to enable during charging.	the maximum charging time (H’118.6.0)” is changed from disable to enable during charging.	
Dynamic control H'118.0.0	Flag indicating charger that is compatible with dynamic control.	Set this flag to 1 in case the vehicle applies dynamic control of extended function. Set this flag to 0 in case the vehicle does not apply dynamic control of extended function.	Set to a value from the start of CAN communication timing and shall not be updated.	Use this flag for confirmation process of extended function.
Permission to reset the maximum charging time H’118.6.0	Flag indicating to reset timing of maximum charging time. (0: enable, 1: disable)	When “available output current” is stable or the definite period of time is passed while dynamic control is effective, set to 0.	Set to 1 from the start of CAN communication timing, and then update in accordance with dynamic control.	This is utilized to calculate “maximum charging time (H’101.1, H’101.2)” when value changed from 1 to 0.

A.11.5.3.2 High current control

High current control is an extended function that allows the charger to charge under the specific operating condition. This extended function shall not be applied when a charger cannot output charging current under the specific operating condition. In addition, a vehicle that applies this extended function shall be designed so that the temperature of the terminal at the P and N cannot exceed 90 °C. Also, the charger and vehicle that apply this extended function shall also apply dynamic control.

A.11.5.3.2.1 Scope of application

This extended function shall be applied to the combination of the charger and the vehicle, both of which implement the high current control.

A.11.5.3.2.2 Subroutine

The extended function “dynamic control” defined in A.11.5.3.1 shall be applied when the high current control is implemented.

A.11.5.3.2.3 Data area

The data area of the vehicle and of the charger are provided in Table A.58 and Table A.59, respectively.

Table A.58—Data area of vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
110	100	8	0	7-0	Extended function 1	—	—	—	—	
			1	7-0	Charging current request (extended)	A	—	0	1023	H'110.1: Low byte H'110.2: High byte
			2	7-0						
			3	7-0	—	—	—	—	—	Not used
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used

Table A.59—Data area of charger

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
118	100	8	0	7-0	Extended function 1	—	—	—	—	
			1	7-0	Available output current (extended)	A	—	0	1023	H'118.1: Low byte H'118.2: High byte
			2	7-0						
			3	7-0	Present charging current (extended)	A	—	0	1023	H'118.3: Low byte H'118.4: High byte
			4	7-0						
			5	7	—	—	—	—	—	Not used
				6	Reliability design (temperature monitoring function)	—		0	1	0: Not applied 1: Applied
				5	Overtemperature protection (for charging connector)	—		0	1	0: Not installed 1: Installed
				4	Current limiting function (for charging connector)	—		0	1	0: Not installed 1: Installed
				3	Cooling function (for charging connector)	—		0	1	0: Not operated 1: Operating
				2	Current limiting function (for charging cable)	—		0	1	0: Not installed 1: Installed
				1	Cooling function (for charging cable)	—		0	1	0: Not operated 1: Operating
				0	Operating condition	—		0	1	0: Standard 1: Specific
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used

A.11.5.3.2.4 Requirements for CAN communication message

The requirements for the CAN communication message are provided in Table A.60 and Table A.61.

Table A.60—CAN communication data to be sent from vehicle to charger

Data name ID, Byte, Bit	Content	Process of vehicle		Process of charger
		Main process	Set timing	
Request charging current H'102.3	—	Vehicle shall not use this value in case the high current control is applied.	Set this value to 0x00 before charging. Set this value to 0xFF when more than or equal to 1 A is set in "request charging current (for extended) (H'110.1, H'110.2)," and hereafter it shall not be updated.	This value is invalid in case the high current control is applied.
High current control H'110.0.1	A flag indicating a vehicle is compatible with high current control	Set this flag to 0 in case the high current control is not applied. Set this flag to 1 in case the high current control is applied.	Set to a value from the start of CAN communication timing and shall not be updated.	Use this value for "Confirmation process of extended function."
Request charging current (extended) H'110.1, H'110.2	Current value that vehicle requests charger during charging	Request range: less than or equal to "available output current (for extended) (H'118.1, H'118.2)." Changing rate: –20 A/s up to +20 A/s.	Set 0x00 before charging. This value shall be updated continuously during charging. Set 0x00 at the stop of charging.	Output current responding to this value.

Table A.61—CAN communication data to be sent from charger to vehicle

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
Available output current H'108.3	—	Charger shall not use this value in case the high current control is applied.	Set to a value from the start of CAN communication timing and shall be updated. Set this value to 0xFF and it shall not be updated when the process shifts to the charging control (the timing that "Charger status (H'109.5.0)" is changed from 0 to 1).	This value is invalid in case the high current control is applied.
Present charging current H'109.3	—	Charger shall not use this value in case the high current control is applied.	Set to a value from the start of CAN communication timing and shall be updated. Set this value to 0xFF and it shall not be updated when the process shifts to the charging control (the timing that "Charger status (H'109.5.0)" is changed from 0 to 1).	This value is invalid in case the high current control is applied.
Charger error H'109.5.1	Error flag indicating charger's error detected by charger	Charger shall detect error and shall shift to error stop process in case this flag is set to 1. Set 1 to this flag in case of the following conditions: — Abnormality of surface temperature of charging cable (see A.5.5.4; only in case the charger shifts to stop process) — Abnormality of temperature monitoring function (see A.5.5.4; only in case the charger shifts to stop process) — Abnormality of the cooling function (see A.5.5.5) — Abnormality of overtemperature at the terminal in the charging connector (see A.5.5.6)	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.
Charging system error H'109.5.4	Error flag indicating vehicle error or charger error detected by charger	Charger shall detect error and shall shift to error stop process in case this flag is set to 1. Set 1 to this flag within 10s after the following error occurs: — Terminal temperature at a charging connector that exceeds 90 °C is detected.	Update this flag continuously. Maintain 1 after confirming an error.	Shift to stop process in case this flag that is set to 1 is received.
High current control H'118.0.1	A flag indicating a charger is compatible with high current control	Set this flag to 0 in case the high current control is not applied. Set this flag to 1 in case the high current control is applied.	Set to a value from the start of CAN communication timing and shall not be updated.	Use this value for "Confirmation process of extended

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
				function."
Available output current (extended) H'118.1, H'118.2	Maximum output current value of the charger	Charger shall shift to error stop process when the "charging current request (for extended) (H'110.1, H'110.2)" exceeds this value. In case the value change by dynamic control, changing rate is from –20 A/s to 20 A/s.	Set to a value from the start of CAN communication timing. This value can be updated by "Request charging current (extended) (H'110.1, H'110.2)" which is more than or equal to 1 A from a vehicle is received.	Use this value for upper limit of "Charging current request (for extended) (H'110.1, H'110.2)." Use this value to calculate "maximum charge time (H'101.1, H'101.2)."
Present charging current (extended) H'118.3, H'118.4	Measured current value of the output circuit in the charger	Current in output circuit measured by charger shall be converted into CAN value, and it shall be sent to vehicle.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.
Operating condition H'118.5.0	A flag indicating operating condition of a charger.	Set this value to 0 in case "Present charging current (for extended) (H'118.3, H'118.4)" is less than or equal to rated current of a charging cable. Set this value to 1 in case "Present charging current (for extended) (H'118.3, H'118.4)" exceeds rated current of a charging cable.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.
Cooling function (for charging cable) H'118.5.1	A flag indicating the charging cable is compatible with a function that retains the temperature rise of the charging cable (This flag corresponds to item b defined in A.5.5.5).	Set this value to 0 in case the charging cable has the function that retains temperature rise but non-operation or it does not have the function. Set this value to 1 in case the charging cable has the function that retains temperature rise and during operation.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.
Current limiting function (for charging cable) H'118.5.2	A flag indicating the charging cable is compatible with a function that retains the charging current	Set this value to 0 in case the charging cable has the function that retains charging current but nonoperation to prevent surface temperature rise of the charging cable or it does not have the function.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
	based on measured result of surface temperature of the charging cable [This flag corresponds to item c defined in Table A.17(c)].	Set this value to 1 in case the charging cable has the function that retains charging current and during operation to prevent surface temperature rise of the charging cable or it does not have the function.		
Cooling function (for charging connector) H'118.5.3	A flag indicating the charging connector is compatible with the function which retains temperature rise of the charging connector (This flag corresponds to item d defined in A.5.5.5).	Set this value to 0 in case the charging connector has the function that retains terminal temperature rise of the charging connector but non-operation or it does not have the function. Set this value to 1 in case the charging connector has the function that retains terminal temperature rise of the charging connector and during operation.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.
Current limiting function (for charging connector) H'118.5.4	A flag indicating the charging connector is compatible with the function that retains charging current based on measured result of terminal temperature of the charging connector [This flag corresponds to the example of an equivalent means defined in Table A.17(c)].	Set this value to 0 in case the charging connector has the function that retains charging current but non-operation to prevent terminal temperature rise of the charging connector or it does not have the function. Set this value to 1 in case the charging connector has the function that retains charging current and during operation to prevent terminal temperature rise of the charging connector.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.
Overtemperature protection (for charging connector) H'118.5.5	A flag indicating the charging connector is compatible with the function of overtemperature protection of the charging connector	Set this flag to 0 in case the function to open the latch lock circuit is not implemented when terminal temperature exceeding specified value. Set this flag to 1 in case the function to open the latch lock circuit is implemented when terminal temperature exceeding specified value.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
	[This flag corresponds to item f defined in Table A.17(c)].			
Reliability design (Temperature monitoring function) H'118.5.6	A flag indicating the charging current shall be decreased less than or equal to the continuous rated current 1 or the charger shall shift to error stop in case a malfunction of the charging cable and the charging connector is detected [This flag corresponds to Table A.17(c) and Table A.18(c)].	Set this flag to 0 in case the charger cannot decrease the charging current less than or equal to the continuous rated current 1 and it does not shift to error stop when a malfunction of the charging cable and the charging connector is detected. Set this flag to 1 in case the charger can decrease the charging current less than or equal to the continuous rated current 1 and it shifts to error stop when a malfunction of the charging cable and the charging connector is detected.	Set to a value from the start of CAN communication timing and shall be updated continuously.	Receive the value as information from charger.

A.11.5.3.3 High voltage control

High voltage control is an extended function that enables charging up to 1000 V. This extended function shall not be implemented into chargers that do not fulfill safety and control requirements for output voltage exceeding 500 V.

A.11.5.3.3.1 Scope of application

This extended function shall be applied to the combination of the charger and the vehicle, both of which implement the high voltage control.

A.11.5.3.3.2 Data area

The data area of the vehicle and of the charger are provided in Table A.62 and Table A.63, respectively.

Table A.62—Data area of vehicle

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
100	100	8	2	7-0	Minimum battery voltage	V	—	0	1200	H'100.2: Low byte H'100.3: High byte
			3	7-0						
100	100	8	4	7-0	Maximum battery voltage	V	—	0	1200	H'100.4: Low byte H'100.5: High byte
			5	7-0						
102	100	8	1	7-0	Target battery voltage	V	—	0	1200	H'102.1: Low byte H'102.2: High byte
			2	7-0						

Table A.63—Data area of charger

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
108	100	8	1	7-0	Available output voltage	V	—	0	1200	H'108.1: Low byte H'108.2: High byte
			2	7-0						
			4	7-0	Threshold voltage	V	—	0	1200	H'108.4: Low byte H'108.5: High byte
			5	7-0						
109	100	8	1	7-0	Present output voltage	V	—	0	1200	H'109.1: Low byte H'109.2: High byte
			2	7-0						

A.11.5.3.3.3 Requirements for CAN communication message

The requirements for the CAN communication message are provided in Table A.64 and Table A.65.

Table A.64—Communication data sent from vehicle to charger

Data name ID, Byte, Bit	Content	Process of vehicle		Process of charger
		Main process	Set timing	
Minimum battery voltage H'100.2, H'100.3	The minimum voltage of the vehicle traction battery (voltage at the vehicle inlet).	Set the voltage defined by vehicle manufacturers.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to judge "Battery incompatibility (H'109.5.3)."
Target battery voltage H'102.1, H'102.2	Target value of charging voltage (Voltage value at a vehicle inlet).	Set the voltage defined by vehicle manufacturers to this value.	Update this value before or at the timing when switch (k) is turned on [Do not update this value after the switch (k) is turned on].	Use this value to calculate "compatibility check of traction battery" and "available output current (H'108.3)." And use this value for protection of vehicle system from overvoltage (A.5.1.11) and for setting of insulation test voltage for output dc circuit [item b) in A.7.2.8.2].

Table A.65—Communication data to be sent from charger to vehicle

Data name ID, Byte, Bit	Content	Process of charger		Process of vehicle
		Main process	Set timing	
Available output voltage H'108.1, H'108.2	Maximum output voltage value of charger. (voltage at the tip of charging connector)	Charger shall shift to stop process when the "target battery voltage (H'102.1, H'102.2)" exceeds this value.	Set to a value from the start of CAN communication timing and shall not be updated.	Confirm the specification of charger.

A.11.5.3.3.4 Protection of charger system from overvoltage

When connected to a charger system incompatible with high voltage control, the vehicle compatible with high voltage control shall not use the high voltage control function or shall prohibit charging so that voltage exceeding 500 V will not be applied to the charger.

A.12 Introduction of unintended current flow and countermeasures to prevent it

If the protective conductor (grounding wire) continuity is lost, the charger and vehicle control signal circuits may form a pseudo-ground circuit. A pseudo-ground circuit will inhibit protective conductor fault detection by not turning off the opto-coupler (f) and the opto-coupler (j). The requirements to prevent the formation of such circuits are in A.5.2.3.

The two most common unintended circuits that are formed when the protective conductor continuity is lost are described in this subclause and shown in Figure A.24.

A.12.1 Unintended circuit #1

When the “connector proximity detection” line is connected to the on-board control power supply, a closed circuit is formed between this line and the “vehicle charge permission” line. In this case, the “connector proximity detection” line forms a pseudo-ground circuit.

A.12.2 Unintended circuit #2

When a surge protection device (SPD) such as a unidirectional Zener diode is installed on the vehicle “charge sequence signal 2” line, a pseudo-ground circuit is formed when the charger closes relay (d2).

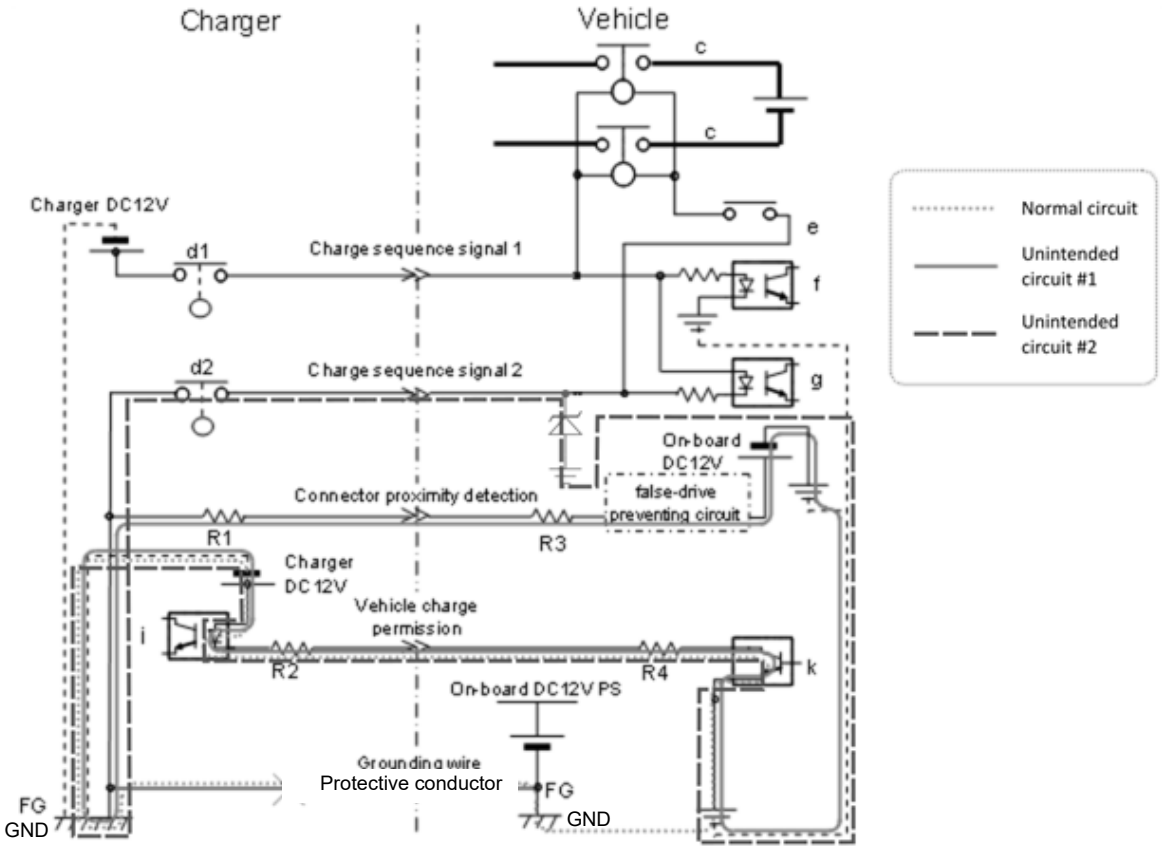


Figure A.24—Example of unintended current flow

A.13 Pin assignment of charging connector

This clause describes the pin assignment of a charging connector. The interface circuit (between the charger and the vehicle) is shown in Figure A.25. The pin assignment of the charging connector is shown in Figure A.26.

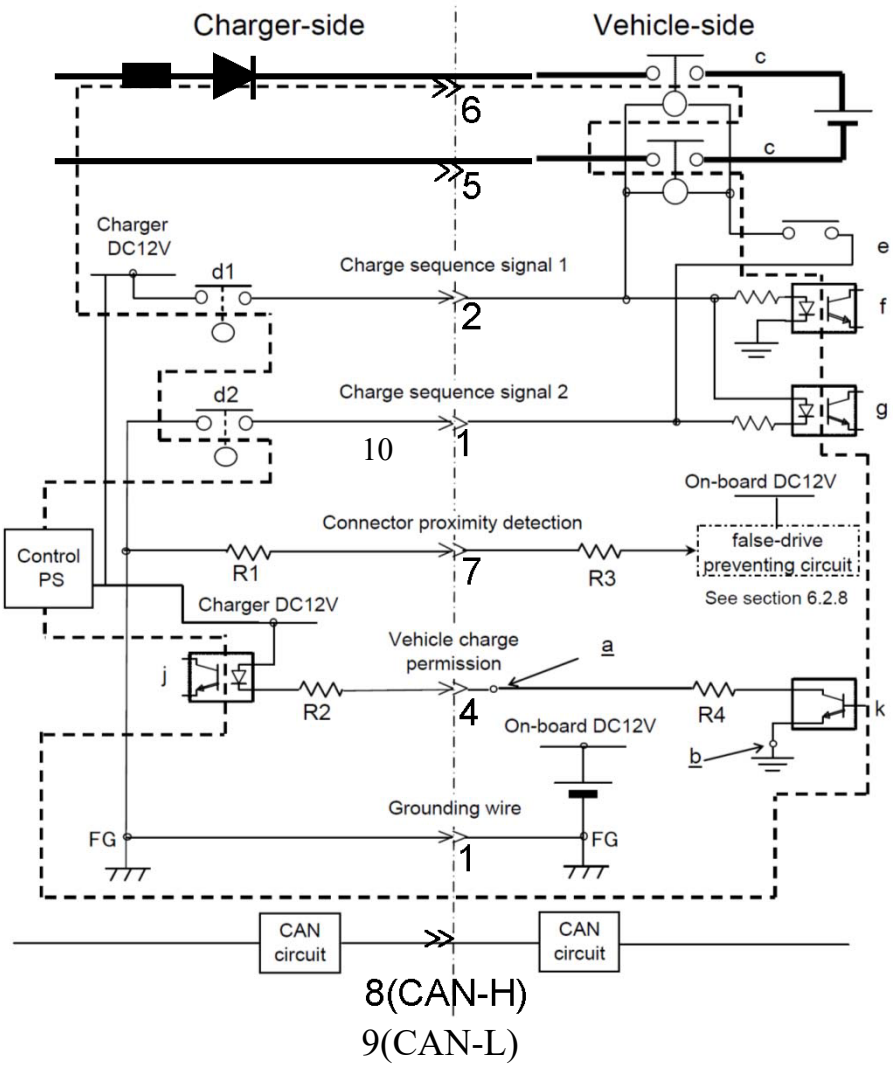


Figure A.25—Interface circuit (between the charger and the vehicle)

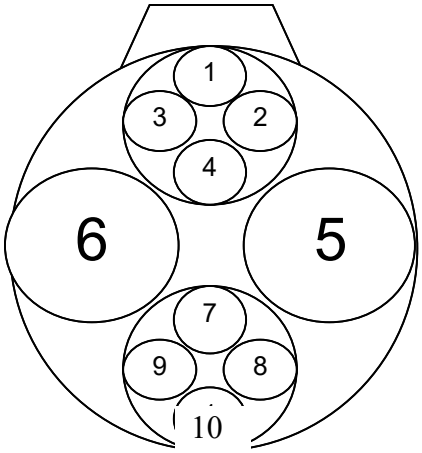


Figure A.26—Pin assignment of the charger connector

A.14 Bidirectional power transfer

A.14.1 General

This clause provides specifications on the functional requirements for a bidirectional power transfer system between the EVSE and the EV. All requirements in A.1 to A.13 are valid, except as follows.

A.14.2 Charge/discharge mode

a) In a charge/discharge mode, the EVSE shall control charge/discharge current within the range of maximum charge current (in charge mode using, charge current command value) and maximum discharge current. The accuracy of current control shall be determined by system requirements, and so on. In addition, the charge/discharge mode may be used only for either charging or discharging by setting the maximum charge current or maximum discharge current to 0.

b) Provided that the stopping conditions of the EVSE are met in charge/discharge mode, such as when it is determined that the EVSE has reached the minimum discharge voltage, the minimum remaining battery capacity for discharging/the minimum charging rate for discharging, and the maximum charge voltage or the maximum remaining capacity for charging/maximum charging rate for charging, the EVSE shall proceed to stop-sequence. If it is determined that the stopping conditions of a vehicle are met, the vehicle may proceed stop-sequence. (See Figure A.27.)

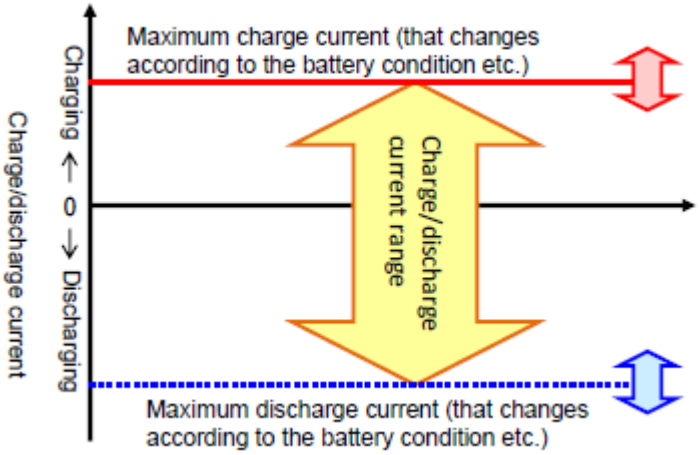


Figure A.27—Schematic view of current control in charge/discharge mode

A.14.3 Compatibility check

When an EVSE is connected to a dischargeable vehicle, the “charge/discharge mode” shall be realized according to the sequence correspondence table shown in Table A.66. It is desirable that when the EVSE is connected to a nondischargeable vehicle (see A.14.4), the EVSE shall be able to charge the vehicle.

A.14.3.1 Charge/discharge sequence control number and the sequence change

The “charge/discharge sequence control numbers” shall be set in order to control the charge/discharge sequence.

When the EVSE is connected to a vehicle with a different "charge/discharge sequence control number," the charge/discharge control sequence shall be operated with the control sequence corresponding to the lower sequence control number.

Table A.66—Charge/discharge sequence control number

V2H guideline version	Charge/discharge sequence control number
Ver.1.0 and earlier	0x00
Ver.2.0 (Appendix A)	0x01
Ver.2.0 (Appendix B)	0x02

A.14.3.2 Correspondence to CHAdeMO charge sequence control number

The correspondence between the CHAdeMO charge sequence control numbers and charge/discharge sequence control numbers are specified in Table A.67.

Table A.67—Sequence correspondence table

		Charge/discharge sequence control number	
		0x01	0x02
CHAdeMO charge sequence control number	0x01	Applicable	Not applicable
	0x02	Not applicable	Applicable

NOTE 1—Vehicles and EVSE using the "not applicable" combinations of sequences should not be manufactured.

NOTE 2—When charge/discharge sequence control number (ID201/209) is not received, the vehicle or the EVSE should determine that the other is the EVSE or the vehicle of the model before the V2H guideline 1.1.

A.14.4 Connection to a nondischargeable vehicle

It is desirable that a nondischargeable vehicle that is connected to an EVSE shall be charged according to the EVSE's charging capability using the charging protocol to which the vehicle is applicable. The EVSE that does not have the function shall clearly display that fact.

A.14.5 Circuit requirements

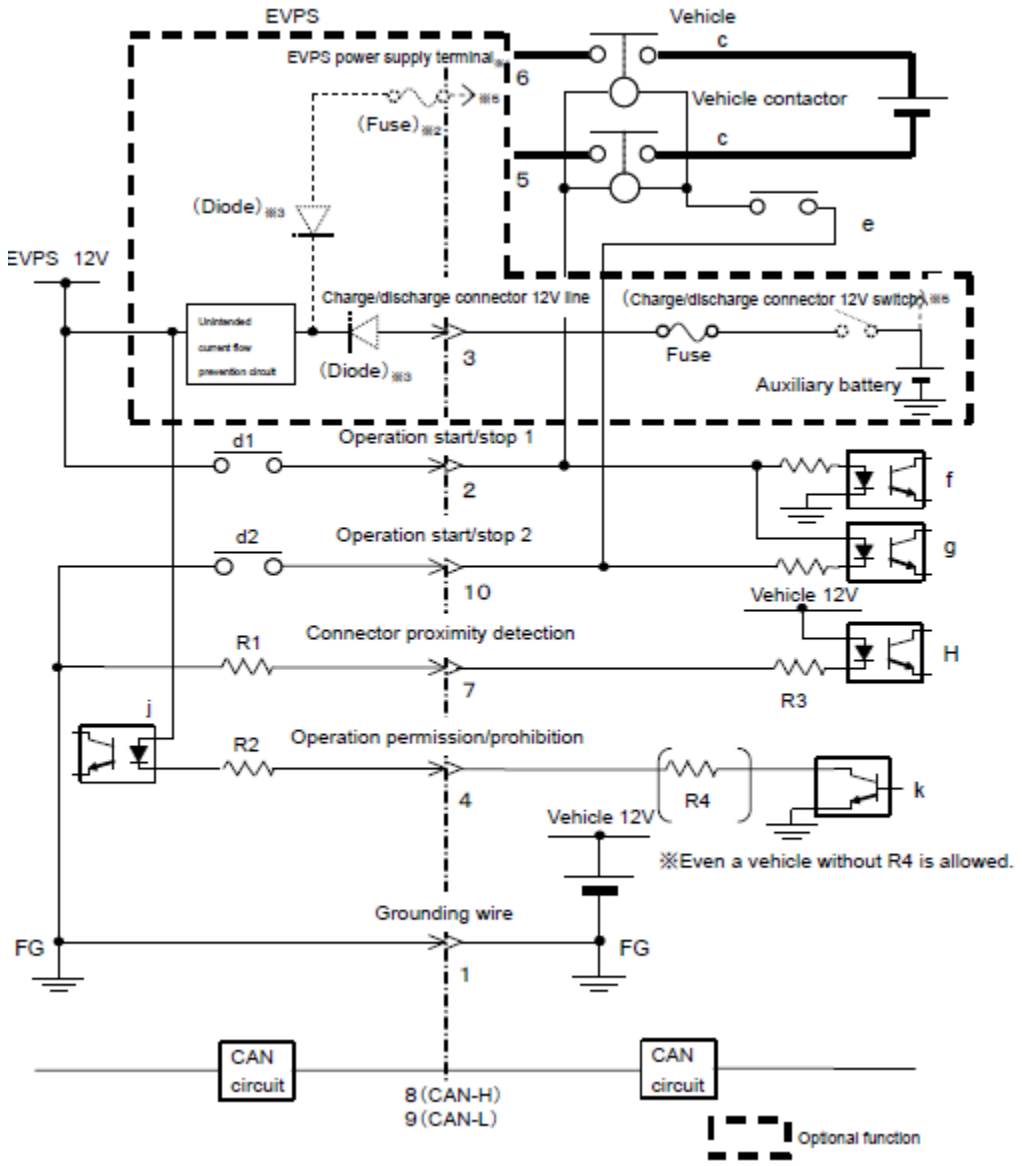
The basic configuration of the main circuit is the same as in Figure A.1, but the reverse current prevention diode should be replaced with a precharge circuit.

A.14.6 Precharge circuit

The reverse current prevention diode in A.5.1.3 should be replaced with a precharge circuit.

A.14.7 Sequence circuit

The figures and tables in A.5.2 should be replaced with Figure A.28 and Table A.68 and Table A.69.



1—Power supply terminal for EVSE to which the power is supplied from cigarette socket.

2—“Fuse” is a reference example. (A fuse in a cigarette socket, etc. are assumed.)

3—“Diode” is a reference example. It shall prevent adverse current to the auxiliary battery.

4—For the background and purpose of the unintended current flow prevention circuit, see A.5.2.3 and A.12.

5—Auxiliary battery power line.

Figure A.28—Sequence circuit

Table A.68—Specification for sequence circuit (charger side)

Terminal	Item	Minimum value	Typical value	Maximum value	Unit
Operation start/stopl 1	EVSE dc 12 V	10.8	12.0	13.2	V
Connector proximity detection	Resistor R1	190	200	210	Ω
Operation permission/prohibition	Resistor R2	950	1000	1050	Ω
Operation start/stop 1	Relay d1 load current	2		2000	mA
Operation start/stop 2	Relay d2 load current	2		2000	mA
The 3rd pin (Charge/discharge connector 12 V line) at the time of the optional function shown by the dotted line in Figure A.28 Sequence circuit, diameter and length of grounding wire		The resistance shall be less than the line resistance equivalent to the one on the conditions of conductor temperature 80 °C, 1.25 mm^2 and 7.5 m (15 m for round-trip).			

Table A.69—Specifications for sequence circuit (vehicle side)

Terminal	Item	Minimum value	Typical value	Maximum value	Unit
Operation start/stop 1	Load current (when d1 ON)	10		2000	mA
Operation start/stop 2	Load current (when d1 and d2 ON)	10		2000	mA
Connector proximity detection	Resistor R3	950	1000	1050	Ω
	On-board dc 12 V	8	12	16	V
Operation permission/prohibition	Resistor R4	190	200	210	Ω
Operation permission/prohibition	Load current (leakage current) between a-b when switch k OFF			2	mA
	Vce (collector-emitter voltage of transistor “k”) at collector current = 10 mA			0.5	V
Charge/discharge connector 12V line (Note 1)	Voltage (Note 2)	—	12	16	V
	Rated fuse	—	—	10	A
NOTE 1—For the current, refer to Table A.68. NOTE 2—Voltage of charge/discharge connector 12 V line is different from the one of EVSE 12 V.					

A.14.8 Data format

Table A.24 and Table A.25 should be replaced with Table A.70 and Table A.71, respectively.

Table A.70—ID allocation

	ID number
EVSE	H'108, H'109, H’208, H’209, H’708
Vehicle	H'100, H'101, H'102, H’200, H’201, H’700

Table A.71—Data table

Source	Destination	ID	Byte	Content	Remarks
Vehicle	EVSE	H'100	0	Minimum charge current	
			1		Not used
			2		Not used
			3		Not used
			4, 5	Maximum battery voltage	
			6	Charged rate constant value	
			7		Not used
		H'101	0		Not used
			1	Maximum charging time (by 10 s)	
			2	Maximum charging time (by 1 min)	
			3	Estimated charging time (by 1 min)	
			4		Not used
			5, 6	Total capacity of battery	
			7		Not used
		H'102	0	CHAdeMO protocol number	
			1, 2	Maximum charge voltage	
			3	Maximum charge current	
			4	Fault flag	
			5	Status flag	
			6	State of charge	
			7		Not used
		H’200	0	Maximum discharge current	
			1		Not used
			2		Not used
			3		Not used
			4, 5	Minimum discharge voltage	
			6	Minimum remaining battery capacity for discharging	
			7	Maximum remaining battery capacity for charging (optional)	
		H’201	0	Charge/discharge sequence number	
			1, 2	Approximate discharge completion time (optional)	
			3, 4	Available vehicle energy (optional)	
			5		Not used
			6		Not used
			7		Not used
		H’700	0	Automaker code	
			1-7	Conform to each automaker’s optional specification	
EVSE	Vehicle	H'108	0	Identifier of support for EV contactor welding detection	
			1, 2	Available output voltage	
			3	Available output current	
			4, 5	Threshold voltage	
			6		Not used
			7		Not used
		H'109	0	CHAdeMO protocol number	
			1, 2	Present voltage	
			3	Present charging current	
			4	Discharge compatibility	

Source	Destination	ID	Byte	Content	Remarks
			5	Status/faults flag	
			6	Remaining charging time (by 10 s)	
			7	Remaining charging time (by 1 min)	
		H’208	0	Present discharge current	
			1, 2	Available input voltage	
			3	Available input current	
			4		Not used
			5		Not used
			6, 7	Lower threshold voltage	
		H’209	0	Charge/discharge sequence control number	
			1, 2	Remaining discharging time (optional)	
			3		Not used
			4		Not used
			5		Not used
			6		Not used
			7		Not used
		H’708	0	Compatible maker code	
			1–7	Conform to each manufacturer’s optional specification	

A.14.8.1 Data format of the vehicle

The table in A.6.6.1 should be replaced with the following information:

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
100	100	8	0	7-0	Minimum charge current	A		0	200	
			1	7-0	—	—	—	—	—	Not used
			2	7-0	—	—	—	—	—	Not used
			3	7-0	—	—	—	—	—	Not used
			4	7-0	Maximum battery voltage	V	—	0	600	H'100.4: Low byte H'100.5: High byte
			5	7-0						
			6	7-0	Charged rate constant value	%	—	0	100	Fixed at 0x64 (100 %)
			7	7-0	—	—	—	—	—	Not used
101	100	8	0	7-0	—	—	—	—	—	Not used
			1	7-0	Maximum charging time (10 s unit)	10 s	—	0	2540	Set 0xFF to this value in case the byte 2 (unit: 1 min) is used
			2	7-0	Maximum charging time (1 min unit)	min	—	0	255	
			3	7-0	Estimated charging time	min	—	0	254	
			4	7-0	—	—	—	—	—	Not used
			5	7-0	Total capacity of battery	0.1 kWh	—	0.1	6553.5	H'101.5: Low byte H'101.6: High byte
			6	7-0						
			7	7-0	—	—	—	—	—	Not used
102	100	8	0	7-0	CHAdeMO protocol number	—	3	0	255	0x03: CHAdeMO specification ver.2.0
			1	7-0	Miximum battery voltage	V	—	0	600	H'102.1: Low byte H'102.2: High byte
			2	7-0						
			3	7-0	Maximum current request	A	0	0	200	
			4	7-5	—	—	—	—	—	Not used
				4	Battery voltage deviation error	—	0	0	1	0: normal, 1: error
				3	High battery temperature	—	0	0	1	0: normal, 1: error
				2	Battery current deviation error	—	0	0	1	0: normal, 1: error
				1	Battery undervoltage	—	0	0	1	0: normal, 1: error
				0	Battery overvoltage	—	0	0	1	0: normal, 1: error
			5	7-5	—	—	—	—	—	Not used
				4	Normal stop request before charging	—	0	0	1	0: No request, 1: Stop request
				3	Vehicle status	—	1	0	1	0: EV contactor close or during welding detection, 1: EV contactor open or termination of welding detection
				2	Charging/discharging system error	—	0	0	1	0: normal, 1: error
				1	Vehicle shift position	—	0	0	1	0: "Parking" position, 1: other position
				0	Vehicle charging/discharging enabled	—	0	0	1	0: disabled, 1: enabled
			6	7-0	State of charge	%		0	100	
			7	7-0	—	—	—	—	—	Not used

200	100	8	0	7-0	Maximum discharge current	A	0	-255	0	00 h means -255 A, and FFh means 0 A.
			1	7-0	—	—	—	—	—	Not used
			2	7-0	—	—	—	—	—	Not used
			3	7-0	—	—	—	—	—	Not used
			4	7-0	Minimum discharge voltage	V	0	0	600	H'200.4: Low byte H'200.5: High byte
			5	7-0						
			6	7-0	Minimum charging rate for discharging	%		0	100	
			7	7-0	Minimum discharging rate for charging (optional)	%		0	100	If these values are not used, the setting is 0.
201	100	8	0	7-0	Charge/discharge sequence control number			0	255	
			1	7-0	Approximate discharge completion time (optional)	Min		0	65534	H'201.1: Low byte, H'201.2: High byte If these values are not used, the setting is 0.
			2	7-0						
			3	7-0	Available vehicle energy (optional)	0.1 kWh		0.0	6553.4	H'201.3: Low byte, H'201.4: High byte If these values are not used, the setting shall be 0.
			4	7-0						
			5	7-0	—	—	—	—	—	Not used
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used
700	100	8	0	7-0	Automaker code			0	255	0: incompatible 1 to 255: The value assigned to each automaker shall be set.
			1	7-0						
			2	7-0						
			3	7-0						
			4	7-0						
			5	7-0						
			6	7-0						
			7	7-0						

A.14.8.2 Data format of the EVSE

The table in A.6.6.2 should be replaced with the following information:

ID (H')	Period (ms)	DLC	Byte	Bit	Name	Unit	Initial	Min	Max	Specification
108	100	8	0	7-1	—	—	—	—	—	Not used
				0	Welding detection	—	1	0	1	1: compatible with EV contactor welding detection
			1	7-0	Available output voltage	V	—	0	600	H'108.1: Low byte H'108.2: High byte
			2	7-0						
			3	7-0	Available output current	A	—	0	200	—
			4	7-0	Threshold voltage	V	—	0	600	H'108.4: Low byte H'108.5: High byte
			5	7-0						
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used

109	100	8	0	7-0	CHAdeMO protocol number	—	3	0	255	0x03: CHAdeMO specification ver.2.0
			1	7-0	Present output voltage	V	—	0	600	H'109.1: Low byte H'109.2: High byte
			2	7-0						
			3	7-0	Present charging current	A	—	0	255	
			4	7-6	—	—	—	—	—	Not used
				0	Discharge compatibility			0	1	0: incompatible, 1: compatible
			5	7-6	—	—	—	—	—	Not used
				5	Charge/discharge stop control	—	1	0	1	0: operating, 1: during stop control or stop condition
				4	Charge/discharge system error	—	0	0	1	0: normal, 1: error
				3	Battery incompatibility	—	0	0	1	0: compatible, 1: incompatible
				2	Connector lock	—	0	0	1	0: disable, 1: enable
				1	EVSE error	—	0	0	1	0: normal, 1: error
				0	EVSE status	—	0	0	1	0: standby, 1: charging
			6	7-0	Remaining charging time (in the unit of 10 s)	10 s	0	0	2540	Set 0xFF to this value in case H'109.7 (unit: 1 min) is used.
			7	7-0	Remaining charging time (in the unit of 1 min)	min	0	0	255	
208	100	8	0	7-0	Present discharge current	A	0	−255	0	00h means −255 A, and FFh means 0 A.
			1	7-0	Available input voltage	V	0	0	600	H'208.0: Low byte H'208.1: High byte
			2	7-0						
			3	7-0	Available input current	A	0	−255	0	00h means −255 A, and FFh means 0 A.
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-0	Lower threshold voltage	V		0	600	H'208.6: Low byte H'208.7: High byte
			7	7-0						
209	100	8	0	7-0	Charge/discharge sequence control number			0	255	
			1	7-0	Remaining discharging time (optional)	Min		0	65534	If these values are not used, the setting shall be 0.
			2	7-0						
			3	7-0	—	—	—	—	—	Not used
			4	7-0	—	—	—	—	—	Not used
			5	7-0	—	—	—	—	—	Not used
			6	7-0	—	—	—	—	—	Not used
			7	7-0	—	—	—	—	—	Not used
708	100	8	0	7-0	Compatible maker code			0	255	0: incompatible 1 to 255: If a compatible automaker code is received, the same value shall be set.
			1	7-0						
			2	7-0						
			3	7-0						
			4	7-0						
			5	7-0						
			6	7-0						
			7	7-0						

A.14.9 Bidirectional power transfer system: CAN communication message specifications

Table A.45 and Table A.46 should be replaced by Table A.72 and Table A.73, respectively.

Table A.72—VEHICLE_MESSAGES

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'100	0	Minimum charge current	Minimum current required for charging	Set the value to prevent discharge of the traction battery calculated from power consumption such auxiliary power of vehicle. (Offset 1) (Example of setting) 0x00: request for current equivalent to 1.5 kW 0x01: no request 0x02: request of 1 A	Set to a value from the start of CAN communication timing and shall be updated continuously.	Shift to normal stop when the condition that Available output current (H'108.3) is less than Minimum charge current (H'100.0) continues for 5 s. Do not output current that is less than this value. Regard current equivalent to 1.5 kW as minimum charge current in case 0x00 is received.
H'100	2,3	Minimum battery voltage	The minimum voltage of the vehicle traction battery (voltage at the vehicle	Set the voltage defined by vehicle manufacturers.	Update this value before or at the timing when switch (k) is turned on (Do not update this value after the switch (k) is turned on).	Use this value to judge 'Battery incompatibility (H'109.5.3)'.
H'100	4,5	Maximum battery voltage	Voltage value[a] to decide that the EVSE stops charging in order to protect on-board battery.	There is a backup protection from the EVSE, but the vehicle shall stop charging before charging voltage exceeds this value. — This value shall be set in consideration of voltage measuring accuracy (stipulated in A.7.4 of the EVSE and the vehicle or voltage drop between vehicle inlet and on-board battery.	This value shall be updated until switch (k) is turned on. Do not update this value after final value is set.	— Use this value to calculate "Threshold voltage."

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'100	6	Charged rate reference constant	Maximum charged rate of on-board battery.	Note that the unit of this parameter is changed from kWh to %. 100%（fixed）	This value shall be updated until switch (K) is turned on. Do not update this value after final value is set.	— Use this value only to display charged rate on the charger. — Charged rate (for display) = Charged rate (#102.6)/Charged rate reference constant (#100.6) × 100
H'101	1	Maximum charging time (by 10 seconds)	Maximum charging time permitted to the charger by the vehicle.	— Use this value when the vehicle sets charging time by 10 seconds. — Calculate and set this value based on charger CAN “Available output current” and “Available output current.”	This value shall be updated until switch(K) is turned on. Do not update this value after final value is set.	— Use this value to terminate charging by timer.
H'101	2	Maximum charging time (by minute)	Same as above.	— Use this value when the vehicle sets charging time by minute.	This value shall be updated until switch(K) is turned on. Do not update this value after final value is set.	— Use this value to terminate charging by timer. — If H’101.1 is 0xFF, use this value in “Maximum charging time calculation” process.
H’101	3	Estimated charging time (by minute)	Estimated time of charging termination calculated by the vehicle.	Send to the EVSE as reference information. Set this value to 0x00 if this value is not notified to the charger.	The vehicle shall decide update frequency.	— Use only for display. — Use for charging control (stop condition etc.) is prohibited. — Show users the notice to take this time for reference. — Do not display if this value is 0. — Do not use this time for display during terminating procedure. In this period, the EVSE shall display remaining charging time as 0 min or not display it.
H’101	5, 6	Total capacity of battery (Declared value)	Total capacity of traction battery	Input the battery capacity declared in product catalogs. Note that this parameter is optional. Set 0x0000, if not used.	This parameter shall be updated until Switch (k) is turned on.	Use this parameter when is necessary for display on the charger, etc. This declared value may differ from the actual one. When the charger recognizes 0x0000, it shall not use this parameter for any information.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'102	0	CHAdeMO control protocol number	Charge specification version that the vehicle corresponds.	Set the number stipulated in this specification.	Set the number from initial CAN data transmission and do not update it.	Use this value to switch version of charge control sequences.
H'102	1,2	Target battery voltage	Target charging voltage value.[a]	Set this value as voltage value at vehicle inlet terminals.	This value shall be updated until switch (K) is turned on. Do not update this value after final value is set.	— Use to check “Battery incompatibility” and calculate “Available output current.”
H'102	3	Maximum charge current	Maximum charge current that the vehicle permits to the EVSE.	The value shall be set in consideration of the following conditions. — Rate of change: Between –20 A/sec and +20 A/sec	— The initial value shall be set at 0 and the value shall be updated as needed	— At the time of charge/discharge mode, current shall be output using this value as the upper limit. — If EVSE has a bigger this value than Available output current, it doesn't use stopping judgment.
H'102	4(0)	Battery over-voltage	Status flag indicating the voltage status of on-board battery.	— Set this flag to 1 when an error stipulated in Table A. 34 has occurred. — At the same time, turn the switch (k) off.	Update as needed, and hold “1” after the malfunction is determined.	— Regardless of opto-coupler (j) status, the EVSE shall regard this flag as charging termination order from the vehicle if it is equal to 1, and stop charging.
H'102	4(1)	Battery under-voltage	Status flag indicating the voltage status of on-board battery.	— Set this flag to 1 when an error stipulated in Table A. 34 has occurred. — At the same time, turn the switch (k) off.	Update as needed, and hold “1” after the malfunction is determined.	Same as battery overvoltage.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'102	4(2)	Battery current deviation error	The flag indicating that the EVSE's input or output exceeds vehicle's maximum charge current or maximum discharge current.	— If the EVSE's output exceeds the maximum charge current continually, the flag shall be changed to 1. The overcurrent threshold shall be set at 10 A (absolute value) or more, and the time threshold shall be set at 5sec or more. — If the EVSE's input exceeds the range of the maximum discharge current continually, the flag shall be changed to 1. The overcurrent threshold shall be set at 10 A (absolute value) or more and the time threshold shall be set at 5sec or more. — The vehicle charge/discharge enabled and switch (k) shall be turned off at the same time.	— The value shall be constantly updated, and after the fault is detected, it shall be kept at 1.	— Regardless of the condition of the opto-coupler (j), if this flag is 1, it shall be considered as the vehicle's request to stop charging/discharging, and the EVSE shall move to the stop control.
H'102	4(3)	High battery temp-erature	Status flag that indicates temperature conditions of on-board battery.	— Set this flag to 1 when an error stipulated in Table A. 34 has occurred. — At the same time, turn the switch (k) off.	Update as needed, and hold "1" after the malfunction is determined.	Same as battery current deviation error.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'102	4(4)	Battery voltage deviation error	Flag indicating the result of judgment regarding the difference between measured voltage of on-board battery and "Present output voltage" measured by the charger.	— Set this flag to 1 when an error stipulated in Table A. 34 has occurred. — At the same time, turn the switch (k) off.	Update as needed, and hold "1" after the malfunction is determined.	Same as high battery temperature.
H'102	5(0)	Vehicle charging/ discharging enabled	Flag indicating charging/discharging permission status of the vehicle.	Charging/discharging enabled: 1, charging/discharging disabled: 0	— After CAN communication starts and the vehicle sends the EVSE data required for prior to a start of charging/discharging, change the flag 0 to 1. — Change this flag 1 to 0 when the vehicle sends the "charging/discharging stop" notification to the EVSE.	— Regardless of the condition of the opto-coupler (j), if this flag is 0, it shall be considered as the vehicle's request to stop charging/discharging, and the EVSE shall move to the stop control. — When this flag is 0, the insulation test shall not be conducted.
H'102	5(1)	Vehicle shift position	Status flag indicating the shift lever position	— Set this flag to 0 when the shift lever is in "parking" position. Set to 1 when it is in other position. — Turn the switch (k) OFF if the shift position is changed except "parking" during charging.[b]	Set a value from initial CAN data transmission and coordinate with the shift position.	Regardless of the status of opto-coupler (j), if this flag is 1, the EVSE shall regard this flag as charging stop order from the vehicle and terminate charging process.[c]

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'102	5(2)	Charging/ discharging system fault	Flag indicating the presence of the malfunction originated in the vehicle among the malfunctions detected by the vehicle.	When an error stipulated in Table A.34 has occurred, the flag is changed to 1. At the same time, turn switch (k) OFF.	Update as needed, and hold "1" after the malfunction is determined.	— Regardless of the condition of the opto-coupler (j), if this flag is 0, it shall be considered as the vehicle's request to stop charging/discharging, and the EVSE shall move to the stop control.
H'102	5(3)	Vehicle status	Flag indicating the OPEN/CLOSE status of EV contactors and the result of vehicle contactor welding detection.	Set the flag to 0 when the vehicle relay is closed, and set as 1 after the termination of welding detection.	Set the flag to 0 when the vehicle relay is closed, and set as 1 after the termination of welding detection.	If this flag is 0 even after charger termination process has started, stop the charger by time-out processing.
H'102	5(4)	Normal stop request before charging	Flag used by the vehicle to instruct the EVSE to stop charging control.	Set the flag to 1 when the vehicle instructs charging termination, and set to 0 in reverse case.	This value shall be updated until initial value of "Charging current request" is set. Do not update this value after initial value transmission.	— If this flag is 1, start normal termination process before charging. — This flag cannot be used as judging condition for charge control termination after reception of initial value of "Charging current request." — The EVSE shall not regard this flag "1" as vehicle malfunction.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'102	5(7)	Vehicle discharge compatibility flag	The flag indicating the vehicle is compatible with discharging	The value shall be set according to the vehicle specification.	— The value shall be set from the first time of the CAN communication, and it shall not be updated. However, if it is inevitable to reset the value, e.g. for battery protection, the value is updated from 1 to 0 and only discharging shall be prohibited. — The value indicates the compatibility with the V2H charge/discharge mode (compatible: 1, incompatible: 0)	— Only when both this flag and the "EVSE discharge compatibility flag" are 1, the control in charge/discharge mode shall be implemented. — Charge/discharge mode determination shall not be implemented for 0.5 sec from the first communication. If this flag becomes 0 after the charge/discharge mode determination, discharge control shall not be implemented.
H'102	6	Charged rate	Present charged rate of the on-board battery.	(Note) Unit of this parameter for EV on-board battery is changed from kWh to %.	Set the number from initial CAN data transmission and update as needed.	Use this value only to display charged rate on the charger. Charged rate (for display) = Charged rate (#102.6) / Charged rate reference constant (#100.6) × 100
H'200	0	Maximum discharge Current	Maximum discharge current that the vehicle permits to the EVSE.	This value shall be set according to the vehicle's battery condition in consideration of the following conditions. Rate of change: –20 A/sec to +20 A/sec.	The initial value shall be set at 0 (0xFF) and the value shall be constantly updated (only when it is inevitable, e.g., for battery protection).	— At the time of the Charge/discharge mode, discharging shall be implemented with this value as the upper limit. — There are vehicles of the models before the V2H guideline 1.1 whose initial value is not set at 0. The control error shall be avoided by masking the initial value etc. — If EVSE has a bigger this value than Available input current, it does not use stopping judgment.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'200	4, 5	Minimum discharge voltage	Minimum voltage that the vehicle can discharge.	The minimum voltage for discharging permitted by the vehicle shall be set.	— This value can be updated until the switch (k) is turned off. — Once this value is set, it shall not be updated.	This shall be used to calculate the lower threshold voltage.
H'200	6	Minimum remaining battery capacity for discharging	Minimum battery capacity with which the vehicle permits discharging.	— This value shall be set as the minimum discharge voltage of the vehicle battery. — If this value is not used, 0x00 shall be set.	— This value shall be set from the initial CAN communication, and it shall be constantly updated.	— When the EVSE reaches this value, the EVSE prohibits only discharge. (But the EVSE can continue charge.) However, in case of the vehicles before the V2H guideline 1.0, the unit of this value is kWh. Using the next expression, the EVSE converts a unit into %. Minimum discharging rate for charging [%] = Minimum remaining battery capacity for charging [kWh] ÷ Total battery capacity [kWh]×100 [%] In addition, the EVSE cuts off a decimal and applies a unit conversion result. — The EVSE shall not be used until the switch (k) is turned on.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'200	7	Maximum remaining battery capacity for charging (optional)	Maximum battery capacity with which the vehicle permits charging.	— This value shall be set as the maximum charging capacity of the vehicle battery. — If this value is not used, 0x00 shall be set.	— This value shall be set from the initial CAN communication, and it shall be constantly updated.	— When the EVSE reaches this value, the EVSE prohibits only charge. (But the EVSE can continue discharge.) However, in case of the vehicles before the V2H guideline 1.0, the unit of this value is kWh. Using the next expression, the EVSE converts a unit into %. Maximum charging rate for charging [%] = Maximum remaining battery capacity for charging [kWh] ÷ Total battery capacity [kWh] × 100 [%] In addition, the EVSE cuts off a decimal and applies a unit conversion result. — When the EVSE receives 0, it shall not be used with the assumption that the value is not set. — The EVSE shall not be used until the switch (k) is turned on.
H'201	0	Charge/ discharge sequence control number	The number showing the charge/discharge sequence with which the vehicle is compatible.	The number specified in the V2H guideline shall be set.	— This value shall be set from the initial CAN communication, and it shall not be updated.	This number shall be used to switch the charge/discharge sequence.

ID	Byte (bit)	Data name	Content	Vehicle processing		EVSE processing
				Processing related to main content	Set timing	
H'201	1, 2	Approx-imate discharge completion time (optional)	Approximate time to complete discharging that the vehicle calculates (to be displayed)	— The duration of discharging with the present load or the given load (under the conditions of the automaker) shall be set. — If this value is not used, 0x0000 shall be set.	— This value shall be set from the initial CAN communication, and it shall be constantly updated.	— This shall be used only for displaying. — Using this for charge control (as a stopping condition etc.) is prohibited. — This shall be displayed in a way that the user can understand that this is an approximate value. — When the value is 0, this shall not be displayed.
H'201	3, 4	Available vehicle energy (optional)	The energy that the vehicle can supply (to be displayed)	— The amount of power stored in the onboard accumulator or fuel battery, or the power generated by gasoline, which the vehicle can supply shall be set. — If this value is not used, 0x0000 shall be set.	— This value shall be set from the start of the CAN communication, and it shall be constantly updated.	— This shall be used only for displaying. — Using this for charge control (as a stopping condition etc.) is prohibited. — This shall be displayed in a way that the user can understand that this is an approximate value. — When the value is 0, this shall not be displayed.
H'700	0	Automaker code	The number showing the automaker	The number assigned to each automaker shall be set. 0x00 shall be set for a vehicle incompatible to the option.	— The value shall be set from the first time of the CAN communication, and it shall not be updated.	— If the EVSE is compatible with the optional specification, this same value as this value shall be set in the "compatible maker code." — If the EVSE is incompatible with the optional specification, the "compatible maker code" shall be set at 0.
H'700	1–7	Conform to each manu-facturer's optional speci-fication				

[a] Voltage value at vehicle inlet terminals.
[b] Parking: It is a state that the vehicle cannot easily move.
[c] The EVSE shall not regard this flag "1" as vehicle malfunction.

Table A.73—EVSE MESSAGES

ID	Byte (bit)	Data name	Content	EVSE processing		Vehicle processing
				Processing related to main content	Set timing	
H'108	0	Welding detection Identifier	Identifier indicating characteristic of output circuit of EVSE which corresponds to welding detection of EV contactor.	— EVSE shall have circuit characteristic defined in A.10 and shall set this value to "1".	Set to a value from the start of CAN communication timing and update the value.	Confirm whether EVSE has the circuit characteristic that corresponds to welding detection of EV contactor and the conditions under which the welding detection can be performed are satisfied.
H'108	1,2	Available output voltage	Maximum output voltage value of the EVSE.[a]	— If the EVSE receives "target battery voltage" exceeding this value from the vehicle, regard this situation as "Battery incompatible" and shift to charge termination process.	Set the number from initial CAN data transmission and do not update it.	Use to set "target battery voltage," etc.
H'108	3	Available output current	Current that the EVSE can output at present.	— The smaller value between this value and the "maximum charge current" shall be set as the target charge current.	This value shall be set from the initial CAN communication. The initial value shall be the maximum current that can be output by the EVSE, and during the charging/discharging, the value shall be updated from time to time as the current which can be output by the EVSE.	— This value is used to calculate the "maximum charging time."
H'108	4,5	Threshold voltage	Judgmental voltage value to stop charging process for on-board battery protection.	— The EVSE shall compare vehicle CAN "maximum battery voltage" with charger CAN "available output voltage," set the lower value to this value. — When circuit voltage reaches to this value, the EVSE stops charging output.	This flag may be updated until the initial value of charging current request is sent from the vehicle.	The vehicle receives this value as a EVSE's information.
H'109	0	CHAdeMO control protocol number	Number indicating software version of charging sequences with which the EVSE deals.	Set the number stipulated in the specifications.	Set the number from initial CAN data transmission and do not update it.	Use to switch charging sequence version.

ID	Byte (bit)	Data name	Content	EVSE processing		Vehicle processing
				Processing related to main content	Set timing	
H'109	1,2	Present output voltage	Measured voltage value of output circuit in the EVSE.	— See A.5.1.7. — See A.7.4.	Set the number from initial CAN data transmission and update it as needed.	Use to judge “Battery voltage deviation error.”
H'109	3	Present charge current	Measured current value of the output circuit in the EVSE.	— See A.5.1.7. — See A.7.4.	Set the number from initial CAN data transmission and update it as needed.	The vehicle receives this value as a EVSE’s information.
H’109	4(0)	EVSE discharge compatibility flag	The flag indicating the EVSE is compatible with discharging.	The value shall be set according to the EVSE’s specification.	— The value shall be set from the initial CAN communication, and shall not be updated. — This flag shows the compatibility with the charge/discharge mode (Compatible:1, incompatible: 0)	Only when this flag and the “vehicle discharge compatibility flag” are 1, the vehicle shall move to the charge/discharge mode.
H'109	5(0)	EVSE status	The flag indicating the EVSE is inputting/outputting charge/discharge current.	— The initial value shall be set at 0. — The value is 0 during the insulation diagnosis. — The value shall be set at 1 when the EVSE starts input/output of the charge/discharge current. — The value shall be changed to 0 after the inverter is gated off and the EVSE stops input/output (charge/discharge current is 5 A or less).	The value shall be set at 1 when the input/output of the charge/discharge current from the EVSE starts, and the input/output of the charge/discharge current stops, the value shall be updated to be 0.	This shall be used to determine the EVSE’s controlling status.
H'109	5(1)	EVSE error	The flag indicating the presence/absence the fault detected by the EVSE which is determined to be caused by the EVSE.	In the following cases, this flag shall be set at 1. When a fault is detected, the EVSE shall quickly start stop processing: — The fault detected by the EVSE determined to be caused by the EVSE (based on the manufacturer's own standard). — The connector lock circuit disconnection and the fault in the locking circuit fault.	The value shall be constantly updated, and after the fault is detected, it shall be kept at 1.	When this flag is set at 1, the switch (k) shall be turned off.

ID	Byte (bit)	Data name	Content	EVSE processing		Vehicle processing
				Processing related to main content	Set timing	
H'109	5(2)	Connector lock	The flag showing the electromagnetic locking condition of the charge/discharge connector.	The value shall be set according to the electromagnetic locking condition. Locked:1, unlocked: 0	The value shall be set from the initial CAN communication, and when the connector is locked, the value shall be set at 1. When the connector is unlocked, the value shall be set at 0. However, this value may be set at 0 as needed while locking condition is kept.	The vehicle relay shall be operated after the locked condition is verified.
H'109	5(3)	Battery incompatibility	Flag used if maximum output voltage of the EVSE is not suitable for on-board battery charging.	— Set this flag to 1 if an error stipulated in Table A.35 has occurred.	Update as needed, and hold “1” after the malfunction is determined.	Turn switch (k) off when this flag is set to 1.
H'109	5(4)	Charge/ discharge system fault	The flag indicating that a fault is detected when the combination between the EVSE and the vehicle as well as the vehicle’s condition are verified.	If the following errors are occurred, this flag shall be changed to 1. When a fault is detected, the EVSE shall quickly start stop processing: — An error stipulated in Table A.35 has occurred. — The timeout period is passed. — The fault in the CAN receiving continues for 1 second or more. — After the d2 switch is turned on, the voltage measurement is less than 50 V.	The value shall be constantly updated, and after the fault is detected, it shall be kept at 1.	When this flag is set at 1, the switch (k) shall be turned off.

ID	Byte (bit)	Data name	Content	EVSE processing		Vehicle processing
				Processing related to main content	Set timing	
H'109	5(5)	Charge/discharge stop control	The flag indicating that the EVSE's charge/discharge control has entered into the stop mode.	1: EVSE is preparing for the charging/discharging or implementing stop control (including stopping condition). 0: EVSE is operating in the charge/discharge mode. The following are the conditions of changing this flag from 0 to 1 during EVSE's charging/discharging: 1) The opt-coupler(j) is off 2) The stop button is pressed. 3) A fault is detected	When the EVSE enters into the mode to lower the charge current and discharge current in order to control stopping, the value shall be set at 1.	This shall be received as the information of EVSE.
H'109	6	Remaining charge time (by 10 s)	Remaining charge time retained by the charger.	— Set based on the "maximum charge time" sent from the vehicle. — The EVSE shall shift to charge termination process if this value becomes 0.	Set after obtaining the "maximum charge time" of the vehicle. Update as needed after the charging output has started. After charging termination process starts, set this value to 0 when the current becomes 5 A or less.	The vehicle receives this value as a EVSE's information.
H'109	7	Remaining charge time (by minute)	Same as above.	— Use this value if the vehicle set "maximum charging time (by minute)." — If the charger set remaining charging time to this value, count down on charging time until the end of charging.	Set after obtaining the "maximum charge time" of the vehicle. Update as needed after the charge output has started. After charging termination process starts, set this value to 0 when the current becomes 5 A or less.	Same as above.

ID	Byte (bit)	Data name	Content	EVSE processing		Vehicle processing
				Processing related to main content	Set timing	
H'208	0	Present discharge Current	The measurement value of the discharge current between the EVSE the vehicle.	The circuit current measured by the EVSE.	This value shall be set from the initial CAN communication, and it shall be constantly updated.	This can be monitored by being compared with the vehicle's circuit current measurement and used to determine stopping conditions, etc. If both the present charge current and this value continue to be 0 for a long period of time, this value can be used to determine the stopping timing, etc.
H'208	1, 2	Available input voltage	The EVSE's minimum input voltage	The minimum voltage with which the EVSE can operate.	This value shall be set from the initial CAN communication, and it shall not be updated.	This shall be received as the information of EVSE.
H'208	3	Available input current	The EVSE's maximum current that can be input from the vehicle.	The current with which the EVSE stops discharging in order to protect the circuit.	This value shall be set from the initial CAN communication, and it shall not be updated.	This shall be received as the information of EVSE.
H'208	6, 7	Lower threshold voltage	The voltage with which the EVSE shall stop when the vehicle cannot stop at the minimum discharge voltage of the vehicle system due to a fault.	During charging, the higher value between the available input voltage and the minimum discharge voltage shall be set. When the voltage of the EVSE circuit falls under this value, discharging shall be stopped. The stop processing with this value shall not be implemented.	This value shall be set from the initial CAN communication, and it shall not be updated.	This shall be received as the EVSE's information, and it is used as the determined voltage to prohibit only discharging (the charge can continue) in order for the EVSE to protect the vehicle battery.
H'209	0	Charge/discharge sequence control number	The number showing the charge/discharge sequence with which the EVSE is compatible.	The number specified in the V2H guideline shall be set.	This value shall be set from the start of the CAN communication, and it shall not be updated.	This number shall be used to switch the charge/discharge sequence.
H'209	1, 2	Remaining discharging time (optional)	The remaining discharging time of the EVSE.	If this value is not used, 0x0000 shall be set.	After the start of the discharge control, this value shall be constantly updated.	This shall be received as the information of EVSE.

ID	Byte (bit)	Data name	Content	EVSE processing		Vehicle processing
				Processing related to main content	Set timing	
H'708	0	Compatible maker code	The value showing if the EVSE is compatible with the automaker's optional specification	If the EVSE is compatible with the optional specification, the same value of the "automaker code" shall be set. If the EVSE is not compatible with the option, the code shall be set at 0x00.	After receiving the "automaker code," if the EVSE is compatible with the automaker's optional specification, the same value as the "automaker code" shall be set, and if the EVSE is incompatible with it, 0 shall be set. Once the value is set, it shall not be updated.	This shall be received as the information of whether the EVSE is compatible with the optional specification.
H'708	1–7	Conform to each manufacturer's optional specifi-cation				

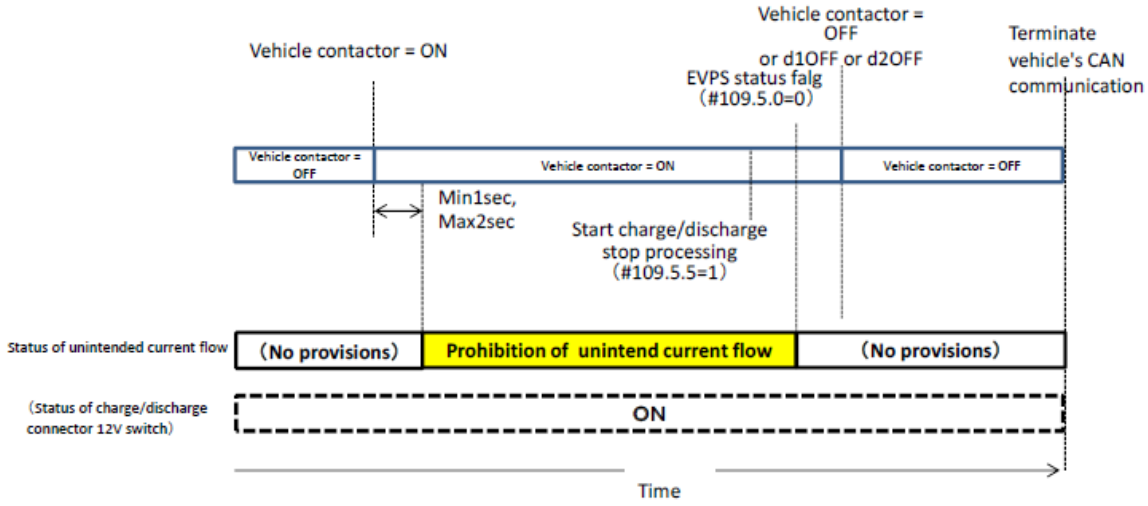
[a] Voltage value on the charger circuit (at charging connector terminals).

A.14.10 Power supply through onboard 12 V (optional function)

Only at the time of the independent operation for an emergency, such as a blackout, the charge/discharge control may be started (and operated) through the power terminal for EVSE or the charge/discharge 12 V line shown by the dotted line in Figure A.28.

The requirements for actuating the unintended current flow prevention circuit are shown in Figure A.29.

The EVSE shall monitor the operation of the unintended current flow prevention circuit, and if the requirements are not satisfied, the EVSE shall proceed with a power supply stop sequence.



NOTE—When the CHAdeMO sequence control number is 0x01, the vehicle contactor = ON should be triggered when the dc main circuit voltage is 50 V or more since no CAN communication can detect the vehicle contactor.

Figure A.29—Use of onboard 12 V power supply

Since the EVSE and the vehicle may use the charge/discharge connector 12 V line of the third pin as a power source, the EVSE shall not use it for other purposes.

A.15 Optional specification of each manufacturer

If CAN IDs are set and controlled for each manufacturer and for each control sequence according to the data allocations, the problem of two or more manufacturers using the same CAN ID can be avoided, and each manufacturer can implement its own control.

Even if the optional specifications are used, the usages of existing IDs (100, 101, 102, 108, 109, 200, 201, 208, and 209) and the control sequence shall not be changed.

The request for any unspecified ID use in a manufacturer’s optional specification shall be made to CHAdeMO association.

Annex B

(normative)

Technical specifications for combination ac/dc systems for use with electric vehicles

B.1 Overview

This annex describes the specifications normative to the implementation of the (ac and dc) combined charging system (commonly referred to as “combo” chargers). The combo charging systems use a single multipurpose vehicle inlet connection for both ac and dc charging.

Comprehensive usage measures, electromagnetic compatibility issues, and other topics to cover all charging scenarios are cited in B.2.

B.2 Applicable normative references

The applicable normative references to implement a complete ac/dc charging system for use with electric vehicles for combo charging are cited in this subclause.

The SAE and ISO/IEC have harmonized the material content of the following standards and recommended practices, even if the document numbering structure differs. The bibliography includes equivalent DIN and ISO/IEC documents required to build a combo charging system:

- SAE J1772
- SAE J2836/2
- SAE J2847/2
- SAE J2931/1
- SAE J2931/4

Annex C

(informative)

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