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GB/T 20234.2 -2011

Connection set for conductive charging of electric vehicles— Part 2: AC charging coupler

电动汽车传导充电用连接装置 第 2 部分：交流充电接口

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Foreword

GB/T20234 “Connection set for conductive charging of electric vehicles” is divided into three parts:

— Part 1: General requirements;

— Part 2: AC charging coupler;

— Part 3: DC charging coupler.

This part is Part 2 of the GB/T 20234.

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

This part is under the jurisdiction of the National Standardization Technical Committee on Vehicle (SAC/TC 114).

The main organizations to draft this part are China Automotive Technology and Research Center, State Grid Corporation of China (SGCC), China National Electric Apparatus Research Institute Co., Ltd.

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GB/T 20234.2 -2011

Connection set for conductive charging of electric vehicles—

Part 2: AC charging coupler

1 Scope

This part of GB/T 20234 provides the general requirements, functional definition, types and structure, parameters and dimensions on the AC charging coupler for conductive charging of electric vehicles.
This part applies to the AC charging coupler for connection set for conductive charging of electric vehicles, its rated voltage does not exceed 440 V (AC), frequency is 50Hz, rated current does not exceed 32 A (AC).
If the power supply coupler for the AC charging coupler adopted the standardized plugs and sockets in line with the GB 2099.1, then the structure dimensions and installation dimensions provided by Appendix B and Appendix Cof this part are not applicable to these plugs and sockets.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.
GB/T 20234.1 Connection set for conductive charging of electric vehicles — Part 1: General requirements

3 Terms and definition

The terms and definitions defined in GB/T 20234.1 are applicable to this document.

4 General requirements

The technical requirements and test method for the AC charging coupler shall conform to the provisions of GB/T 20234.1.

5 The rated values of the AC charging coupler

The rated values of the AC charging coupler see table 1.

Table 1 The rated values of the AC charging coupler

Rated voltage / V	Rated current / A
250/440	16
	32

6 The functions of charging coupler

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6.1 Electrical parameter values and functions

The vehicle connector and the power supply coupler of charging mode 3 include 7 pairs of contactors respectively, their electrical parameter values and functional definitions see Table 2.

Table 2 Electrical parameter values and functional definitions of the contactors

Contactor number/ marking	Rated voltage and rated current	Functional definitions
1— (L)	250 V/440 V 16 A/32 A	AC power supply
2— (NC1)	—	Spare contactors
3— (NC2)	—	Spare contactors
4— (N)	250 V/440 V 16 A/32 A	Neutral wire
5— (⏚)	—	PE, connecting to the earth wires of the power supply unit and the vehicle body
6— (CC)	30 V 2 A	Connect confirm for charging, see Appendix A
7— (CP)	30 V 2 A	Control confirm, see Appendix A

6.2 Arrangements for the contactors

The arrangements for the contactors of the vehicle connector and the power supply coupler of charging mode 3 are shown as figure 1 and figure 2.

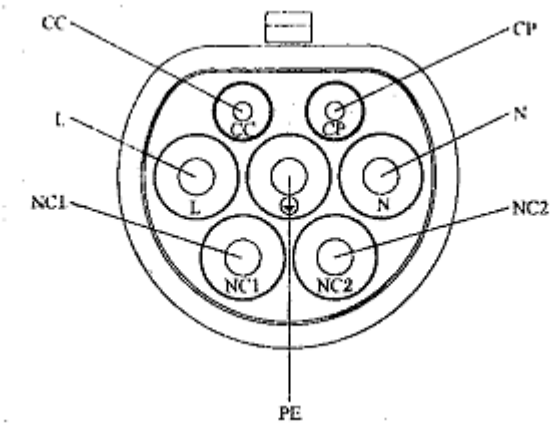

Figure 1 Arrangement for the contactors of the vehicle power supply plug

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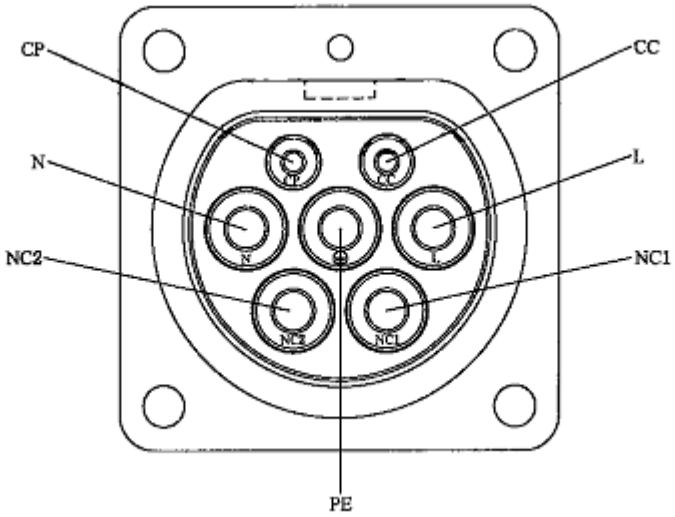

Figure 2 Arrangement for the contactors of the vehicle power supply socket

6.3 Connect interface for charging

In the process of charging connection, the contactor of protective earthing shall be closed firstly, while the contactors of the control confirm and the connect confirm for charging shall be closed lastly. In the process of disconnection, the contactors of the control confirm and the connect confirm for charging shall be disconnected firstly, while the contactor of protective earthing shall be disconnected lastly. The electrical connect interface of vehicle connector is shown as figure 3, while the electrical connect interface of power supply coupler of charging mode 3 is shown as figure 4.

Vehicle connector

Vehicle plug

1— AC power supply (L)

2— Spare 1 (NC1)

3— Spare 2 (NC2)

4— Neutral wire (N)

5 — Device earthing (⏚)

6— Connect confirm for charging (CC)

Vehicle socket

1— AC power supply (L)

2— Spare 1 (NC1)

3— Spare 2 (NC2)

4— Neutral wire (N)

5— Vehicle body earthing (⏚)

6— Connect confirm for charging (CC)

7— Control confirm (CP)

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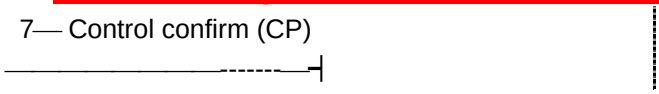

Figure 3 Schematic diagram for electrical connect interface of vehicle

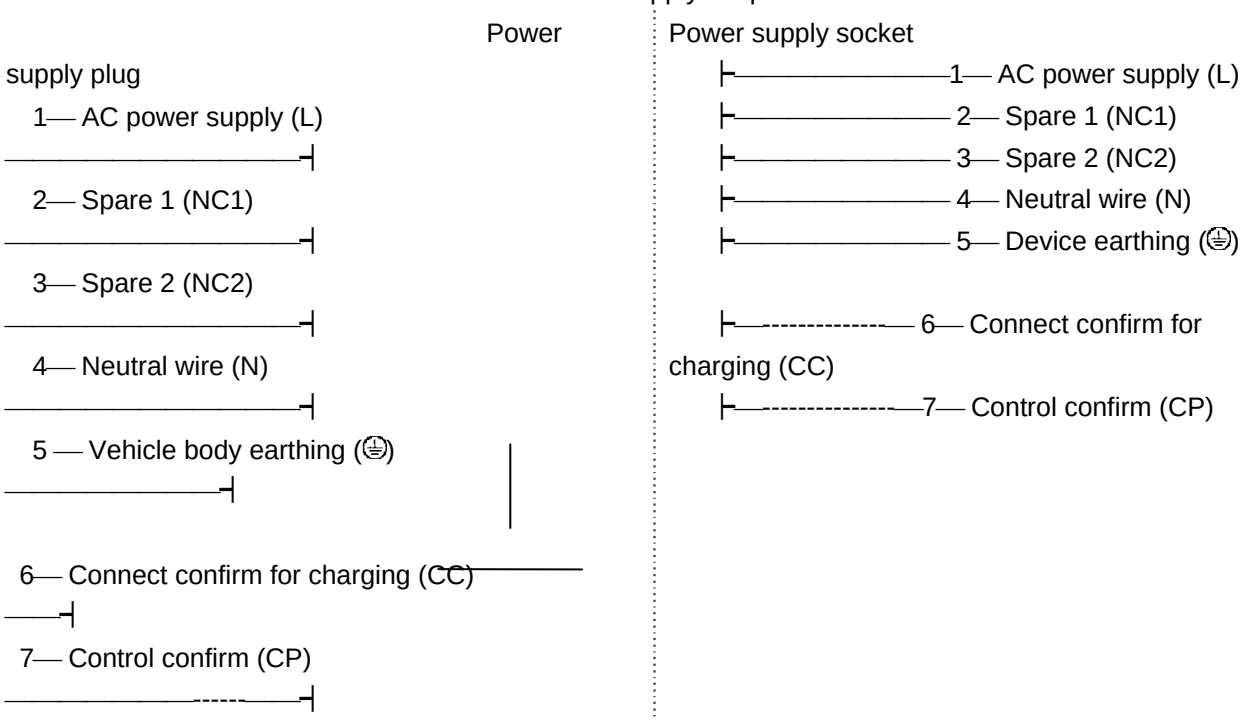

Figure 4 Schematic diagram for electrical connect interface of power supply coupler of charging mode 3

7 Structure dimensions and installation dimensions

The structure dimensions of AC charging coupler shall conform to the provisions of Appendix B, the installation dimensions refer to Appendix C and Appendix D.

Appendix A
(Informative)
Control-steering circuit and control principle

A.1 Control-steering circuit

A.1.1 Charging mode 3

When the charging mode 3 is adopted to charge for the electric vehicle, it is recommended to use the typical control-steering circuits shown as figure A.1 (connection mode A), figure A.2 (connection mode B) and figure A.3 (connection mode C) to perform the connect confirm for charging connection set and the judgment for the

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parameter of rated current. This circuit is composed of the control device for power supply, the contactors K1 and K2 (may be set with one only), the resistances R1, R2, R3 and RC, the diode D1, the switches S1, S2 and S3, the vehicle-bone charger and the vehicle control device, among which, the vehicle control device may be Integrated in the vehicle-bone charger or other vehicle-bone control units. The recommended parameters for the control-steering circuit refer to table A.3. The resistance RC is fixed on the plug of vehicle. The switch S1 is an internal switch of the power unit. The switch S2 is an internal switch of the vehicle, after the vehicle connector is fully connected with the power supply coupler, if the vehicle-bone charger there is faulf-free after fulfilling self testing, and the battery is at a chargeable state, S2 is closed up (if the vehicle is set with the function of “charging request” or “charging control”, it shall meet that the vehicle is at the “charging request” or “chargeable” state simultaneously). The switch S3 is an internal normally closed switch of the plug of vehicle, and it is coupled with the pressed button on the plug (for triggering the mechanical locking device), when pressing the button to relieve the mechanical locking function, S3 is at a cut-off state simultaneously. For the vehicle with a charging current no more than 16 A (depending on the input power of the vehicle-bone charger configured), the switch S2 may also be not configured in the control-steering circuit. The functions and control logic analysis in this appendix are based on the control-steering circuit configured with switch S2, for the control-steering circuit to be not configured with switch S2, it will be same as that the switch S2 is at a normally closed state.

A.1.2 Charging mode 2

When the connection mode B of charging mode 2 is adopted to charge for the electric vehicle, it is recommended to use the control-steering circuit shown as figure A.4 to perform the connect confirm for charging connection set and the judgment for the parameter of rated current.

A.1.3 Charging mode 1

When the connection mode B of charging mode 1 is adopted to charge for the electric vehicle, it is recommended to use the circuit shown as figure A.5 to perform the charge.

Note: when the switch S3 is switched at different states, the power supply unit and the vehicle-bone charger may do response action. Following response actions corresponding to the switch S3 could be used as a reference, concrete response actions shall be depended on the control strategy set by power supply unit manufacturer and vehicle manufacturer.

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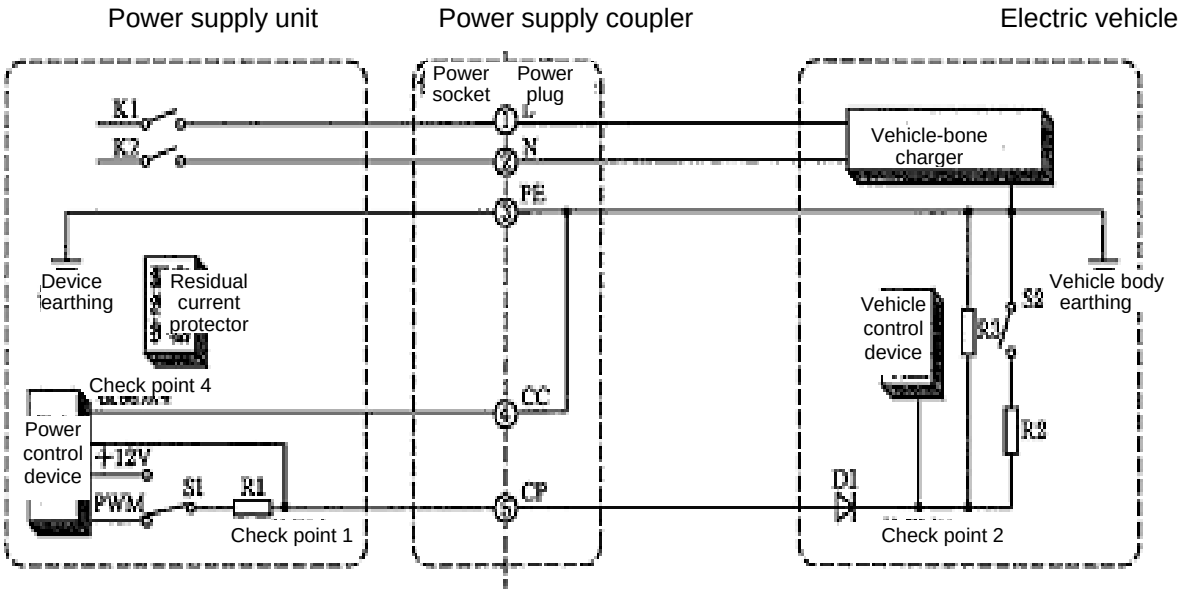

Figure A.1 Schematic diagram for typical control-steering circuit with connection mode A of charging mode 3

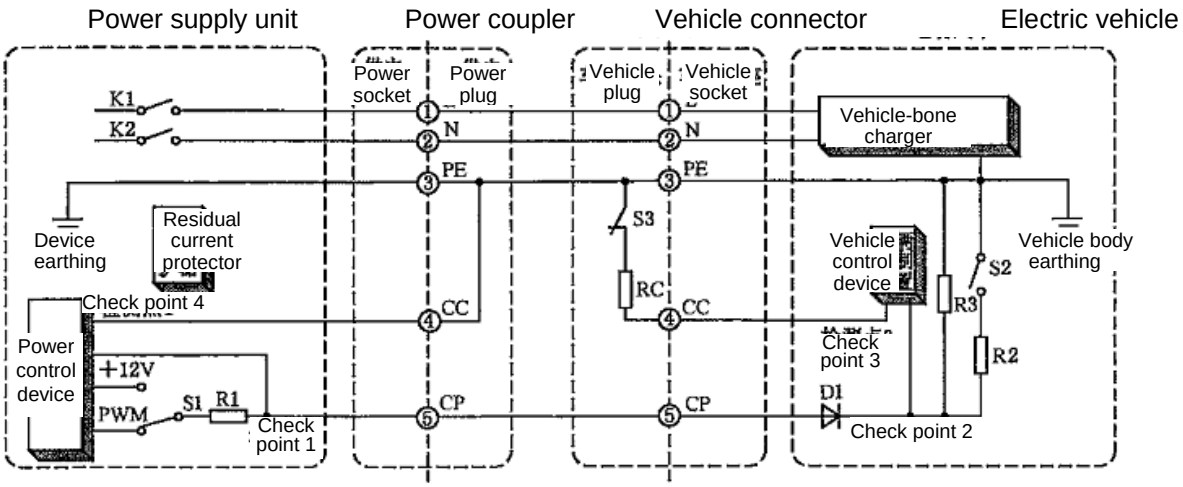

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Figure A.2 Schematic diagram for typical control-steering circuit with connection mode B of charging mode 3

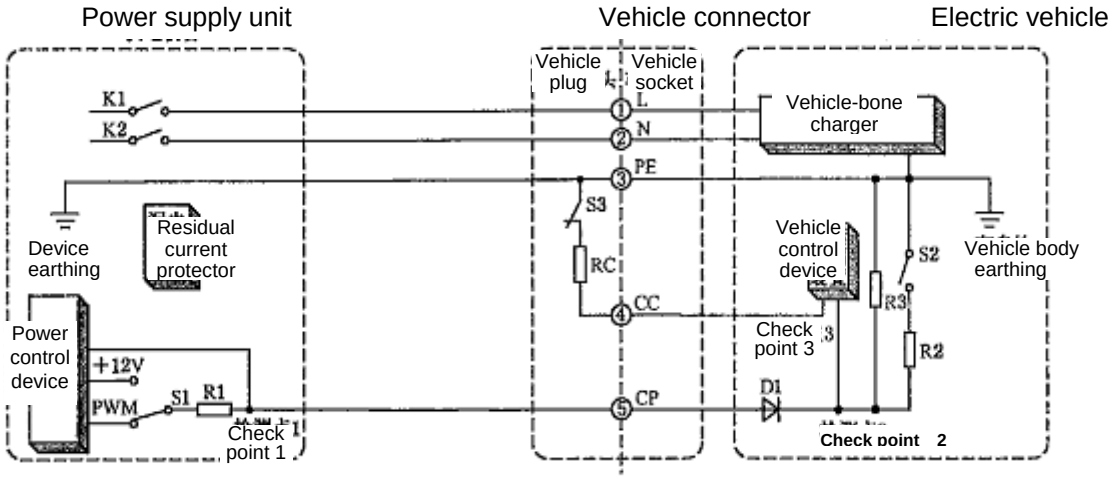

Figure A.3 Schematic diagram for typical control-steering circuit with connection mode C of charging mode 3

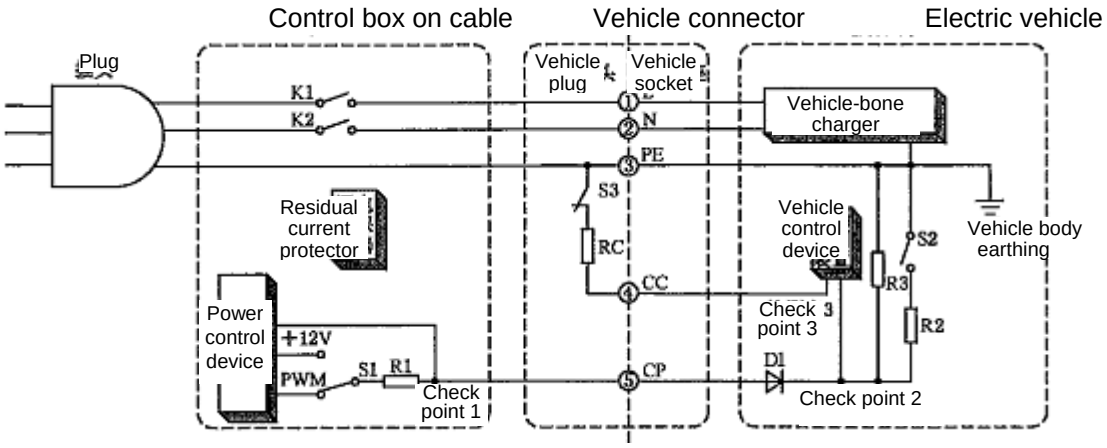

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Figure A.4 Schematic diagram for control-steering circuit with connection mode B of charging mode 2

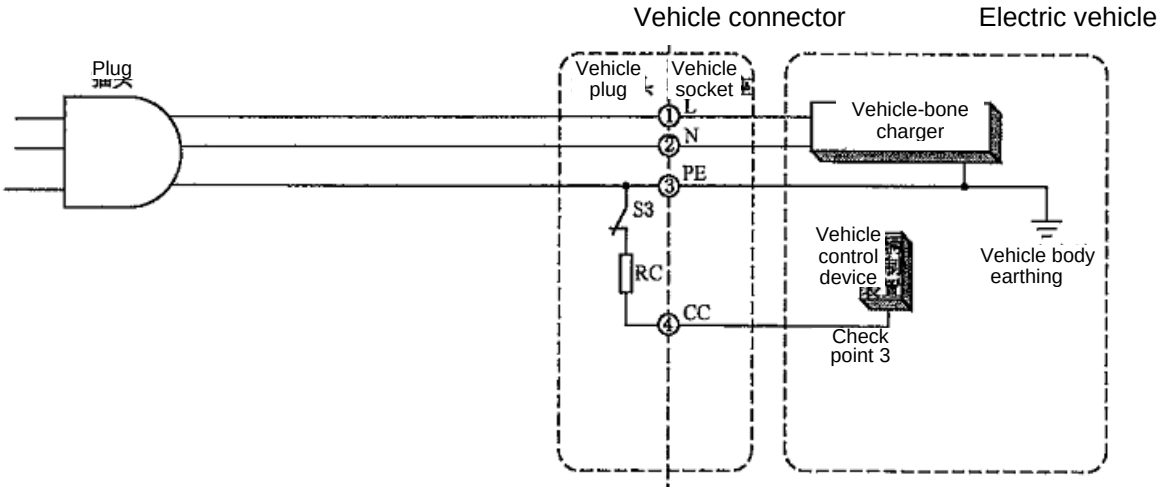

Figure A.5 Schematic diagram for the circuit with connection mode B of charging mode 1

A.2 Fundamental function of control-steering circuit

A.2.1 Connect confirm

The vehicle control device judges that, via the resistance value between check point 3 and PE, whether the vehicle plug is connected fully with the vehicle socket (for the connection mode B and C). The power supply control device judges that, via the voltage value at check point 1 or check point 4, whether the power supply plug is connected fully with the power supply socket (for the connection mode A and B).

A.2.2 Identification for the current carrying capacity of charging connection set and the power of power supply unit

The vehicle control device confirms the rated capacity of the present charging connection set (cable) via the resistance value between check point 3 and PE; the maximum current supplied presently by the power supply unit is confirmed via the duty ratio of the PWM signal measured from the check point 2. The voltage of oscillator is shown as Figure A.6.

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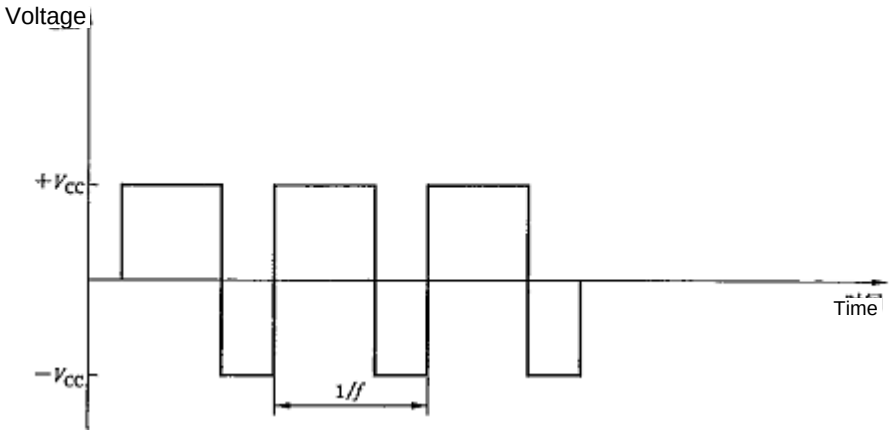

Figure A.6 Voltage of the oscillator

A.2.3 Monitor in charging process

In charging process, the vehicle control device can perform the monitoring for the resistance value between check point 3 and PE (for the connection modes B and C), as well as the duty ratio of the PWM signal measured from the check point 2, the control device for power supply can perform the monitoring for the voltage value at check point 4 and check point 1 (for the connection modes A and B of charging mode 3).

A.2.4 Stop of charging system

In charging process, when charging is finished or the condition to charge unceasingly can not be met for other reasons, the vehicle control device and the control device for power supply stop respectively the control functions related to the charging.

A.3 Procedure of operation and control in charging process

A.3.1 Mating the vehicle plug with vehicle socket, making the vehicle to be at an state unable to drive

After mating the vehicle plug with the vehicle socket, the scheme for the overall design of the vehicle may automatically start certain trigger condition (such as turning on the switch of charging, connecting the vehicle plug with the vehicle socket or performing the settings of function triggering for the charging button, switch etc.) to make the vehicle to be at an state unable to drive via interlock or other control measures.

A.3.2 Confirm the power supply coupler to be fully connected already (for the connection modes A and B of charging mode 3)

The power supply control device judges that, via the voltage value at check point 1 or check point 4, whether the power supply plug is connected fully with the power supply socket.

A.3.3 Confirm the vehicle connector to be fully connected already (for the connection mode B and C)

The vehicle control device judges that, via the resistance value between check point 3 and PE, whether the vehicle plug is connected fully with the vehicle socket.

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A.3.4 Confirm the charging connection set to be fully connected already

After the operator fulfills the settings for startup of charging for the power supply unit, if it is faulf-free, and the power supply coupler has benn fully connected (for the connection modes A and B of charging mode 3), then the switch S1 is switched to the PWM connection state from the state connected to 12 V＋, and the control device for power supply sends out the PWM signals. The power supply control device judges that, via the voltage value at check point 1 or check point 4, whether the charging connection set is connected fully. The vehicle control device judges that, via the PWM signal measured from the check point 2, whether the charging connection set is connected fully.

A.3.5 The vehicle in train

Under the condition of that a self-check for the vehicle-bone charger is finished, and the battery is at the chargeable state, the vehicle control device closes the switch S2 (if the vehicle is set with the function of “charging request” or “charging control”, it shall meet that the vehicle is at the “charging request” or “chargeable” state simultaneously).

A.3.6 The power supply control device in train

The power supply control device judges that, via the voltage value measured at check point 1, whether the vehicle is in train. When the peak voltage at check point 1 is the corresponding voltage value of mode 3 in table A.2, then the power supply control device makes the power supply circuit to be turned on via closing the contactors K1 and K2.

A.3.7 Starting of the charging system

A.3.7.1 After the electrical connection for electric vehicle and power supply unit is established, The vehicle control device confirms the maximum power supply capacity of the power supply unit via judging the duty ratio of the PWM signal measured from the check point 2, and the rated capacity of the cable is confirmed via the resistance value measured between check point 3 and PE. The connection state of the vehicle connector as well as the resistance value see table A.1. The vehicle control device performs the comparison for the maximum current value supplied presently by the power supply unit, the rated input current value of the vehicle-bone charger as well as the rated capacity of the cable, and set their minimum value to be as the allowable maximum input current at present for the vehicle-bone charger. When the vehicle control device judges that the charging connection set has been fully connected, and after the setting for the allowable maximum input current for the vehicle-bone charger has been fulfilled, the vehicle-bone charger starts to perform the charging for the electric vehicle.

A.3.7.2 When the vehicle connector is at the state of full connection, and the vehicle control device does not receive the PWM signals from the check point 2, if the vehicle control device receives the signal from the driver to request for forced charge (require to set the manual triggering device on the vehicle for the request of charging), the power setting for the vehicle-bone charger shall be based on the mode with an input current no more than 13 A to perform the charging for electric vehicle. In charging process, if the PWM signals from the

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check point 2 are received, then the setting for the allowable maximum input current of the vehicle-bone charger depends on the maximum power supply capacity of power supply unit and the minimum rated current of vehicle-bone charger.

A.3.8 Check the change of the connection state of charging coupler and the power supply capacity of power supply unit

A.3.8.1 In charging process, the connection state of vehicle connector and power supply couple is confirmed by the vehicle control device via periodic monitoring check point 2 and check point 3, and by the control device for power supply via periodic monitoring check point 1 and check point 4, the monitoring cycle is no more than 50 ms.

A.3.8.2 The vehicle control device performs uninterrupted detection for the PWM signals from the check point 2, when theduty ratio is changed, the vehicle control device will instantaneously adjust the output power of vehicle-bone charger, the detection cycle is no more than 5 s.

A.3.9 Charge ending or stopping under normal condition

A.3.9.1 In charging process, when the charge reaches the ending condition set in the vehicle, or the driver implements a command of charge stopping for the vehicle, the vehicle control device cuts off the switch S2, and makes the vehicle-bone charger to be at the charge stopping state.

A.3.9.2 In charging process, when the charge reaches the ending condition set by the operator, or the operator implemented a command of charge stopping for the control device for power supply or detected the switch S2 has been cut off, then the control device for power supply switches the switch S1 to ＋12 V connection state, and cuts off the AC power supply circuit via cutting off the contactors K1 and K2.

A.3.10 Charge ending or stopping under abnormal condition

A.3.10.1 In charging process, the vehicle control device judges the connection state of the vehicle plug and the vehicle socket via the resistance value measured between check point 3 and PE (for the connection mode B and C), if it is judged that the switch S3 is changed into cut-off (state B) from close, and lasted for a certain time (such as 300 ms), then the vehicle control device controls the vehicle-bone charger to stop charge and cuts off S2.

A.3.10.2 In charging process, the vehicle control device judges the connection state of the vehicle plug and the vehicle socket via the resistance value measured between check point 3 and PE (for the connection mode B and C), if it is judged that the vehicle connector is changed into cut-off (state A) from full connection, then the vehicle control device controls the vehicle-bone charger to stop charge and cuts off S2.

A.3.10.3 In charging process, the vehicle control device carries out the test through detecting the PWM signals from the check point 2, when the signals interrupt, the vehicle control device controls the vehicle-bone charger to stop charge.

A.3.10.4 In charging process, if the voltage values at check point 1 are 12 V (state 1), 9 V (state 2) or other states to be not 6 V (state 3), then the control device for power supply cuts off the AC power supply circuit.

A.3.10.5 In charging process, the control device for power supply carries out the test through detecting the check point 4 (for the connection modes A and B of charging mode 3), the control device for power supply switches the switch S1 to ＋12 V connection state, and cuts off the AC power supply circuit.

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A.3.10.6 In charging process, if the residual current protector (residual current circuit breaker) acts, then the vehicle-bone charger is at an over low voltage state, the vehicle control device cuts off the switch S2.

Note: If the control device for power supply cuts off the power supply circuit and ends the charge for the reason that the charging connection set is changed into cut-off (state A and state 1) from full connection, then the operator shall check and recover the connection, and the charge will be able to proceed only when the charging setting is restarted.

Table A.1 The connection state of vehicle connector and the resistance value of RC

States	RC	S3	The connection state of vehicle connector and the rated current
A	—	—	Vehicle connector is not connected fully
B	—	Cut off	Mechanical locking device is at an unlock state
C	680 Ω/0.5 W[a]	close	Vehicle connector has been connected fully, rated capacity of charging cable is 16 A
D	220 Ω/0.5 W[a]	close	Vehicle connector has been connected fully, rated capacity of charging cable is 32 A
[a] The precision of resistance RC is ± 3%.			

Table A.2 The voltage state at check point 1

State of charging process	Is the charging connection set connected	S2	If vehicle can be cgarged	Peak voltage at check point 1 (measures after stabilizing)/ V	Notes
State 1	No	Cut off	No	12	S1 is switched to the state connected with PWM, vehicle connector is not connected fully, voltage at check point 2 is 0
State 2	Yes	Cut off	No	9	R3 has been detected
State 3	Yes	close	Yes	6	Vehicle-bone charger and power unit are under normal working condition

Table A.3 Recommended parameters for the control-steering circuit

Object	Parameters[a]	Symbol	Unit	Nominal value	Max. value	Min. value
Power supply unit	Output high voltage	$+V_{cc}$	V	12.00	12.60	11.40
	Output low voltage	$-V_{cc}$	V	−12.00	−12.60	−11.40
	Output frequency	f	Hz	1000.00	1030.00	970.00
	Output duty ratio	Dc_o	—	—	+1%	−1%
	Time set for signal[b]	T_s	μs	n.a.	3	n.a.
	Signal up-response time	T_r	μs	n.a.	2	n.a.
	Signal down-response time	T_f	μs	n.a.	2	n.a.

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	R1 equivalent resistance	*R*1	Ω	1 000	1 030	970
	State 1 (voltage at check point 1)	*U*1a	V	12	12.8	11.2
	State 2 (voltage at check point 1)	*U*1b	V	9	9.8	8.2
	State 3 (voltage at check point 1)	*U*1c	V	6	6.8	5.2
Electric vehicle	R2 equivalent resistance	*R*2	Ω	1 300	1 339	1 261
	R3 equivalent resistance	*R*3	Ω	2 740	2 822	2 658
	Voltage drop of equivalent diode	*V*d1	V	0.70	0.85	0.55
	Input duty ratio	Dc_i	—	—	+1%	–1%
[a] Their precisions shall reach the requirement under the environmental conditions and within the available service life. [b] The time consumed from beginning of the conversion to reaching the steady value.						

Appendix B
(Normative)
Structure dimensions of the charging coupler

B.1 Structure dimensions of the vehicle connector

Structure dimensions of the vehicle plugs see figure B.1.

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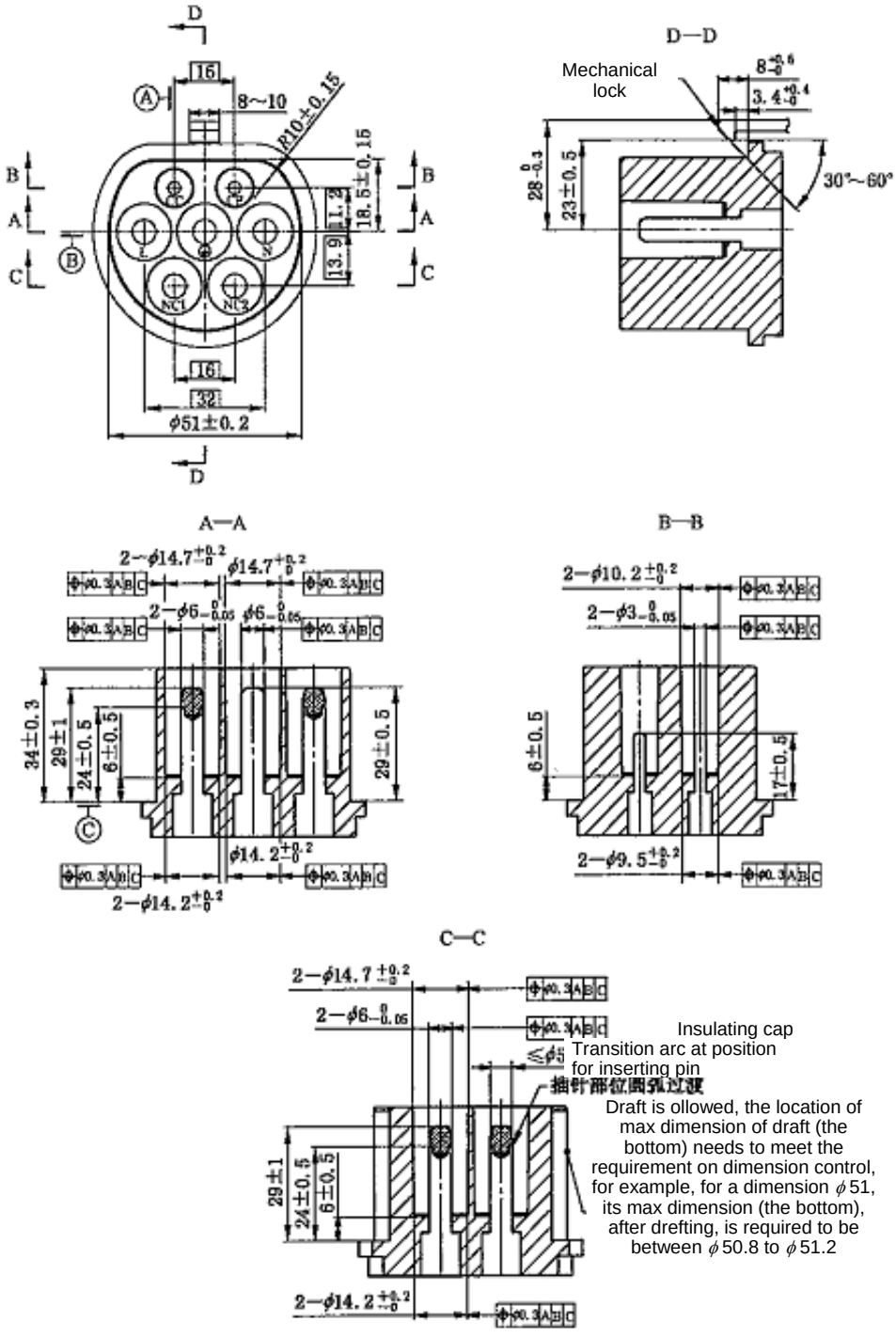

Figure B.1 Structure dimensions of the vehicle plugs

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Structure dimensions of the vehicle sockets see figure B.2.

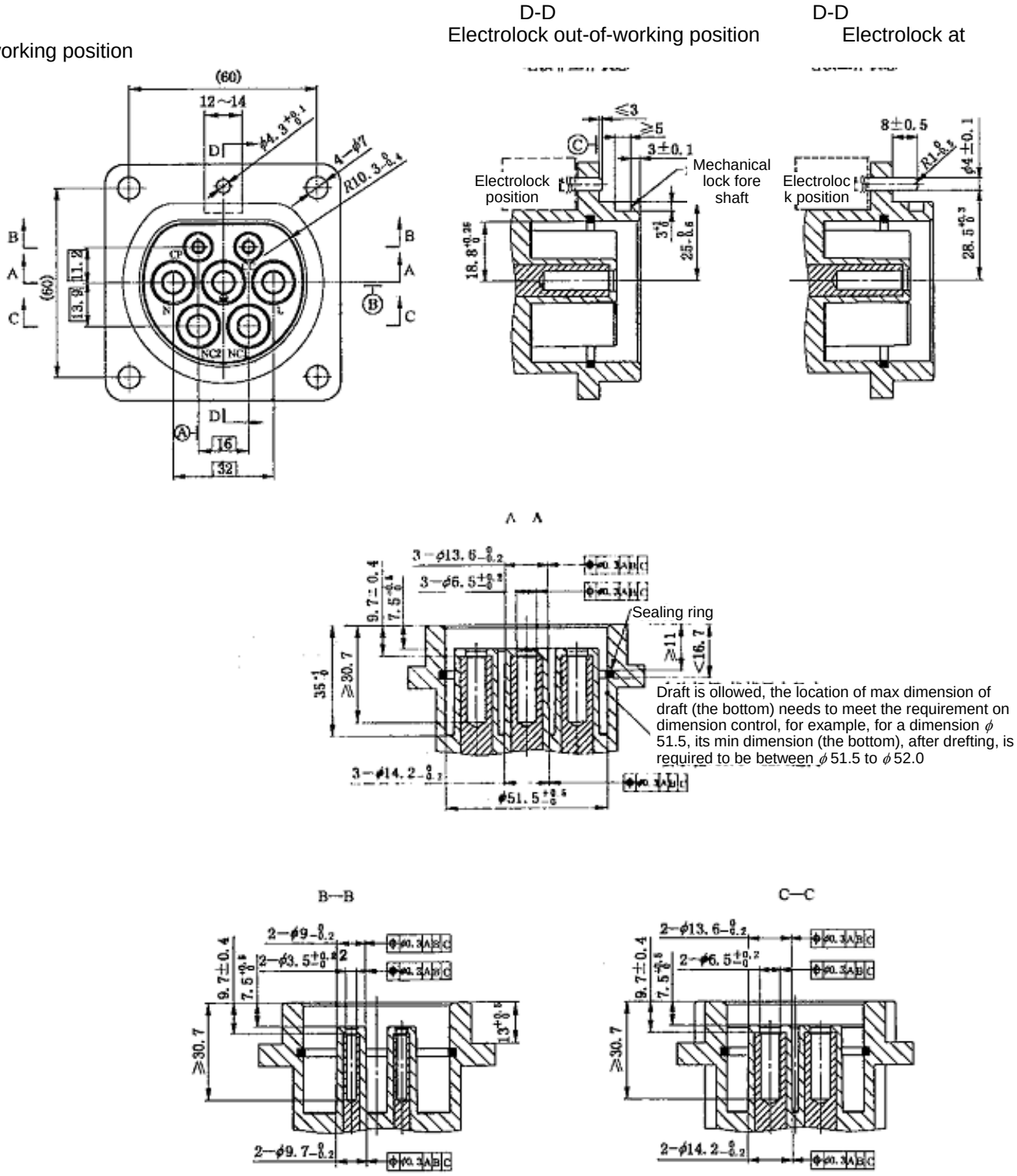

Figure B.2 Structure dimensions of the vehicle sockets

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B.2 Structure dimensions of the power supply coupler of charging mode 3

Structure dimensions of the power supply plugs of charging mode 3 see figure B.3.

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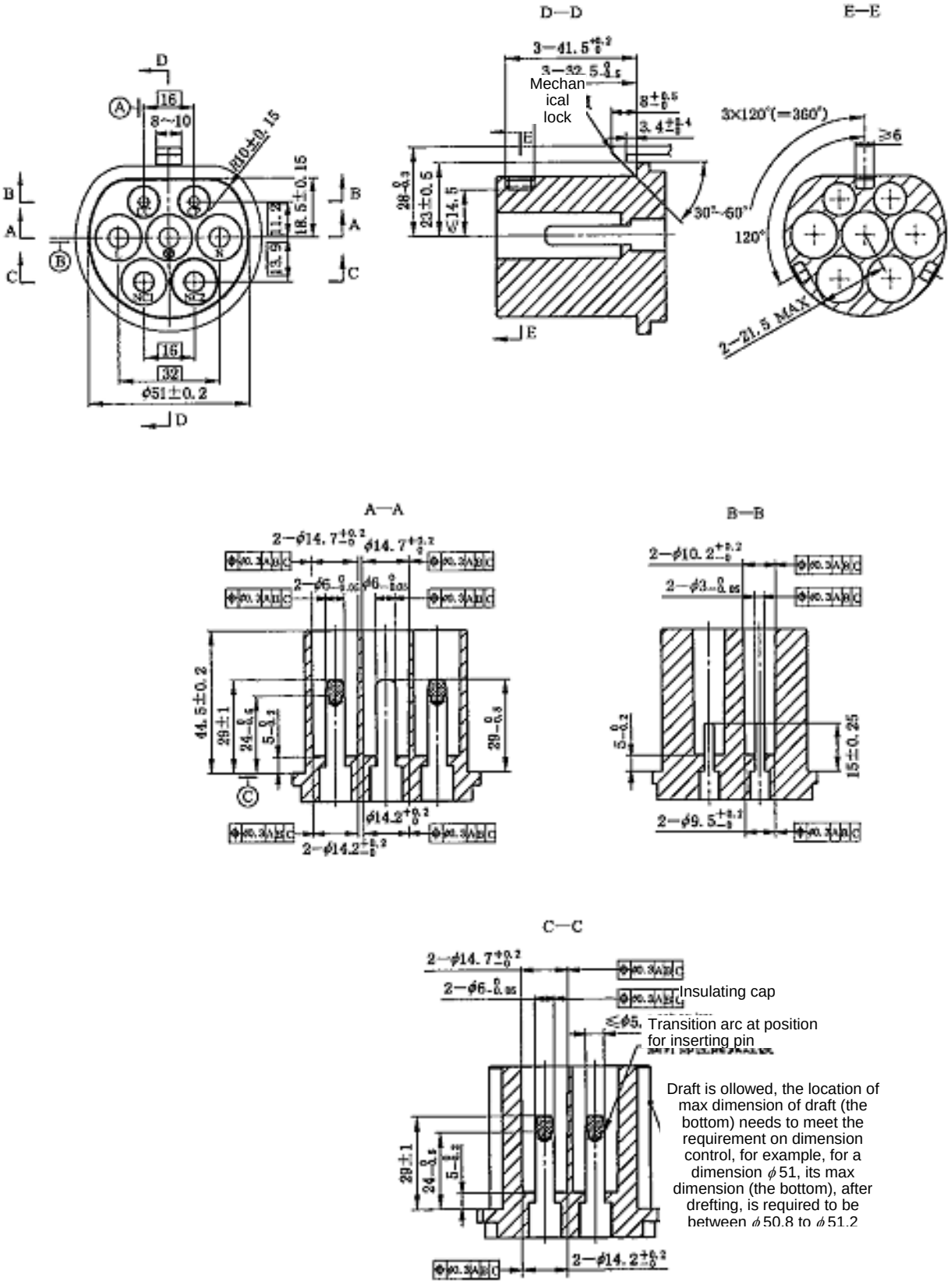

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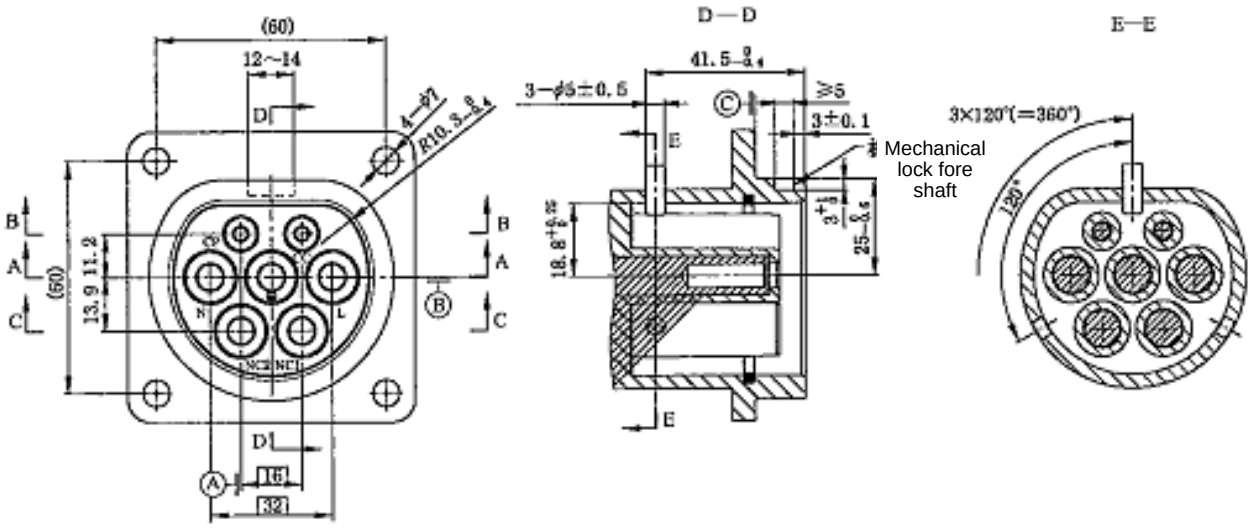
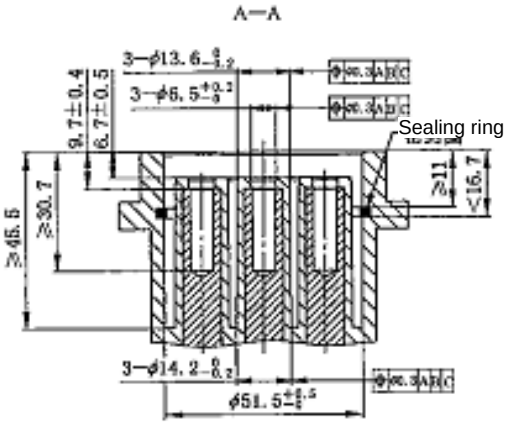
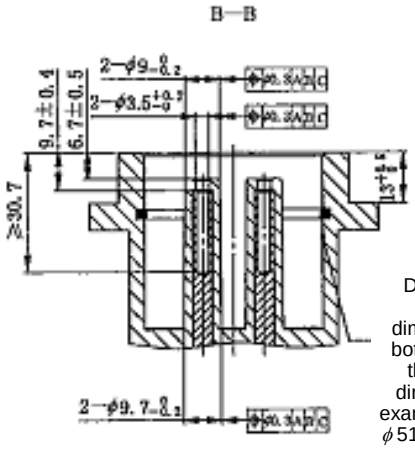
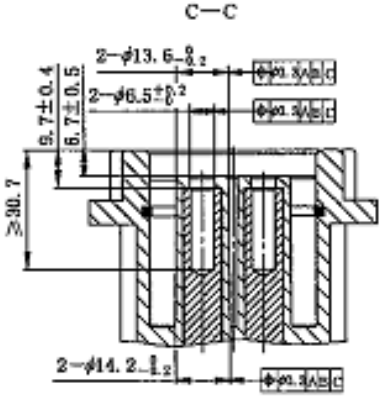
Structure dimensions of the power supply sockets of charging mode 3 see figure B.4.









Draft is ollowed, the location of max dimension of draft (the bottom) needs to meet the requirement on dimension control, for example, for a dimension φ51.5, its min dimension (the bottom), after drefting, is required to be between φ51.5 to φ52.0

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Figure B.4 Structure dimensions of the power supply sockets of charging mode 3

Appendix C
(Informative)
Examples for installation dimensions of the vehicle socket and the power supply sockets of charging mode 3

C.1 Installation requirements for the vehicle socket

C.1.1 Mode of front installation

Installation example for the mode of front installation of the vehicle socket is shown as figure C.1.

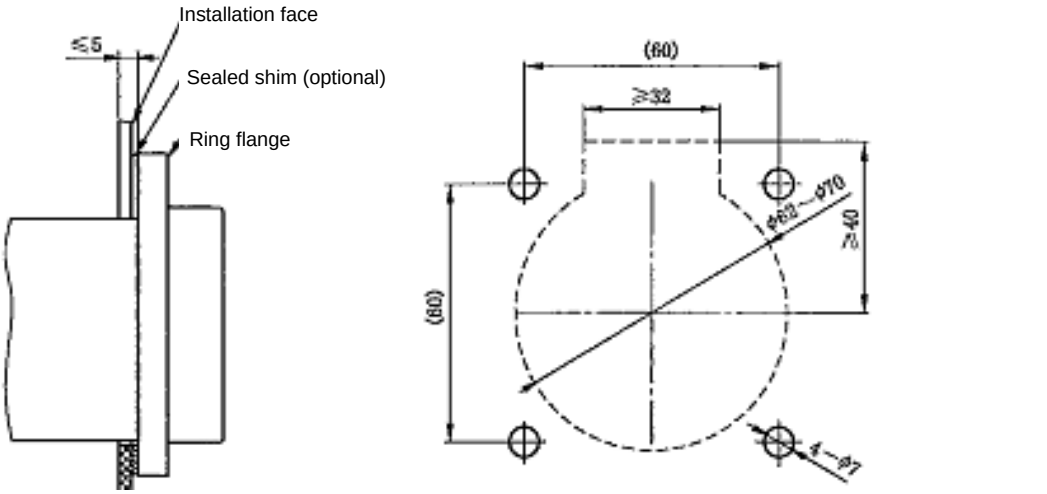

Figure C.1 Installation example for the mode of front installation of vehicle socket

C.1.2 Mode of rear installation

Installation example for the mode of rear installation of vehicle socket is shown as figure C.2.

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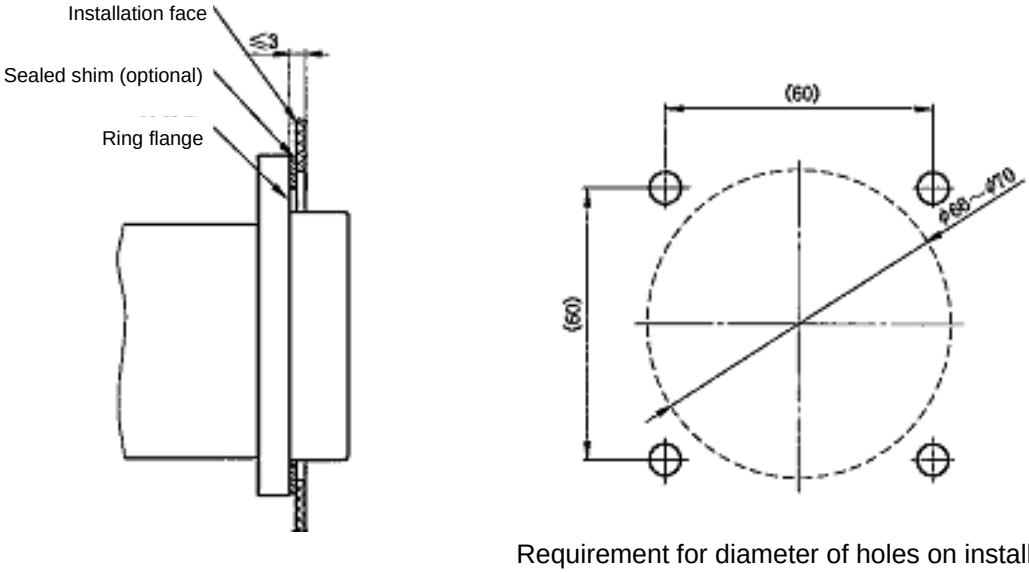

Figure C.2 Installation example for the mode of rear installation of vehicle socket

C.2 Installation example for the power supply socket of charging mode 3

C.2.1 Mode of front installation

Installation example for the mode of front installation of the power supply socket of charging mode 3 is shown as figure C.3.

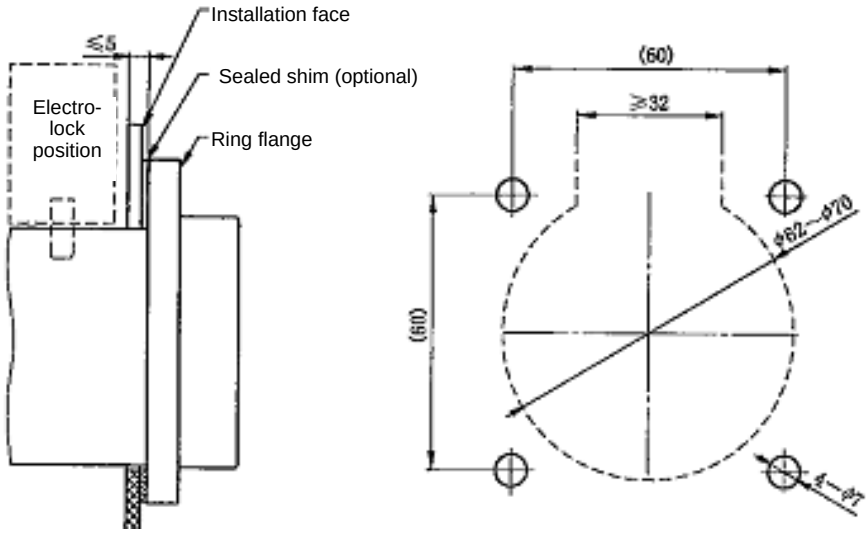

Figure C.3 Installation example for the mode of front installation of the power supply socket of charging mode 3

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C.2.2 Mode of rear installation

Installation example for the mode of rear installation of the power supply socket of charging mode 3 is shown as figure C.4.

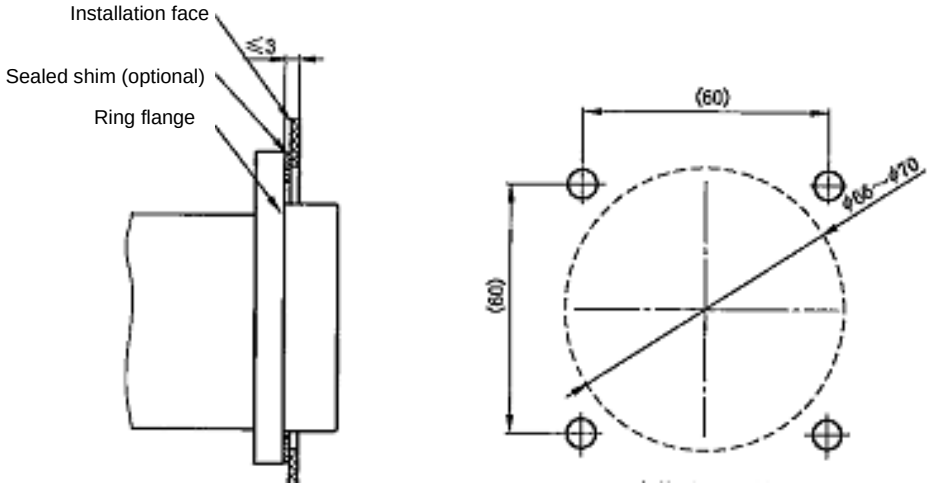

Figure C.4 Installation example for the mode of rear installation of the power supply socket of charging mode 3

Appendix D
(Informative)
Example for space dimensions of the vehicle plug and the power supply plug for charging mode 3

Example for space dimensions of vehicle plug and power supply plug for charging mode 3 is shown as figure D.1.

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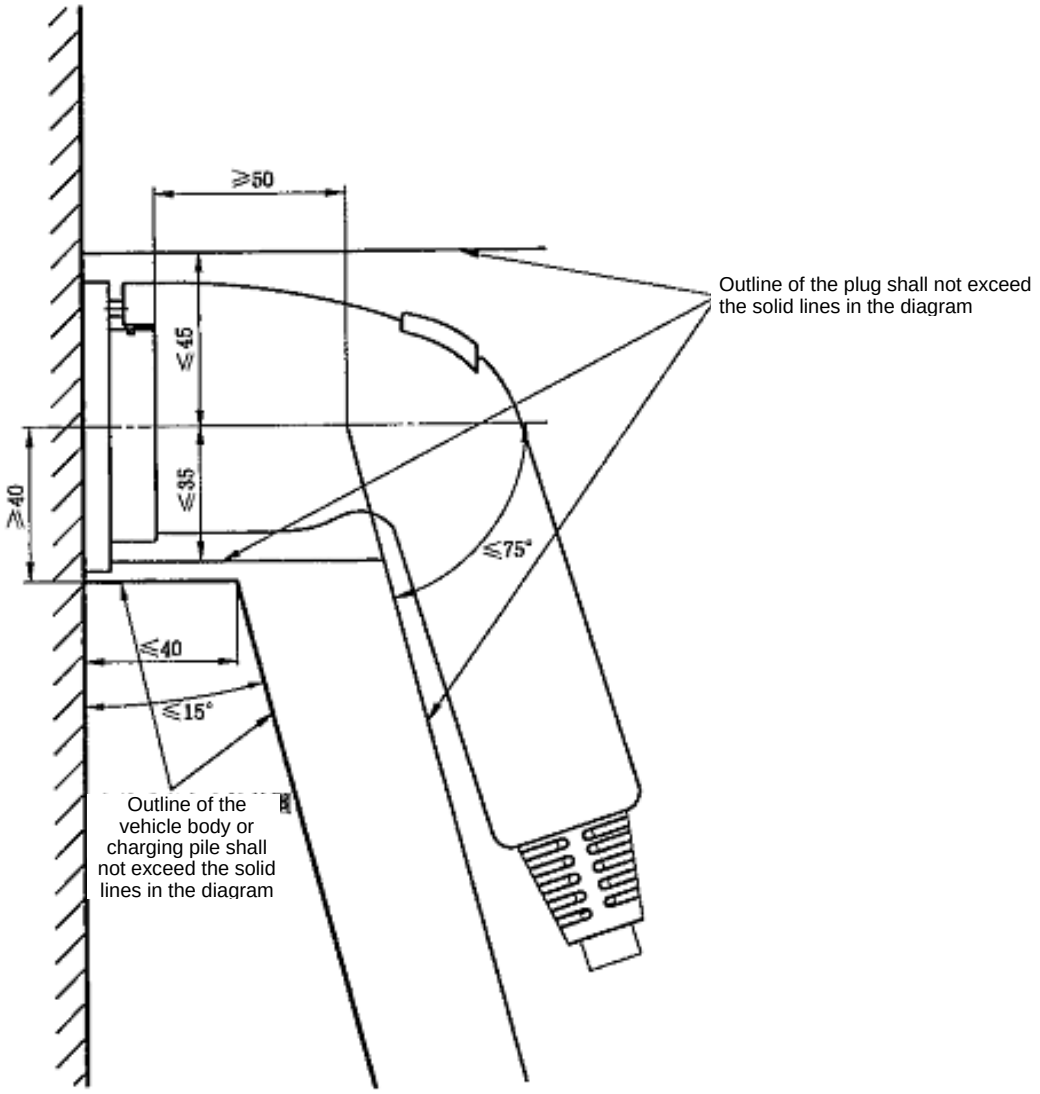

Note: this figure only indicates the correlation of the dimensions between the vehicle plugs and the vehicle, or between the power supply plugs for charging mode 3 and the power supply unit, and does not indicate the configuration of a specific product.

Figure D.1 Example for space dimensions of the vehicle plug and the power supply plug for charging mode 3

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