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Charging Infrastructure

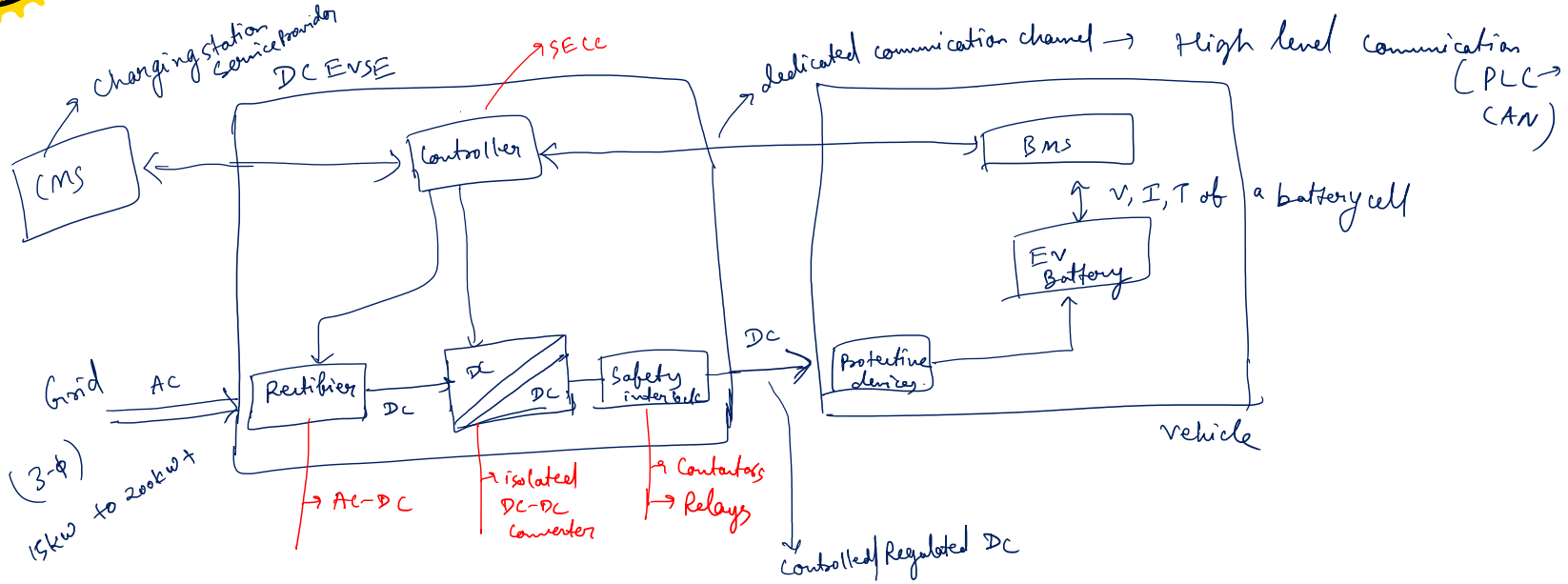
Lecture-4

Review of EV Charger Types and Nomenclatures

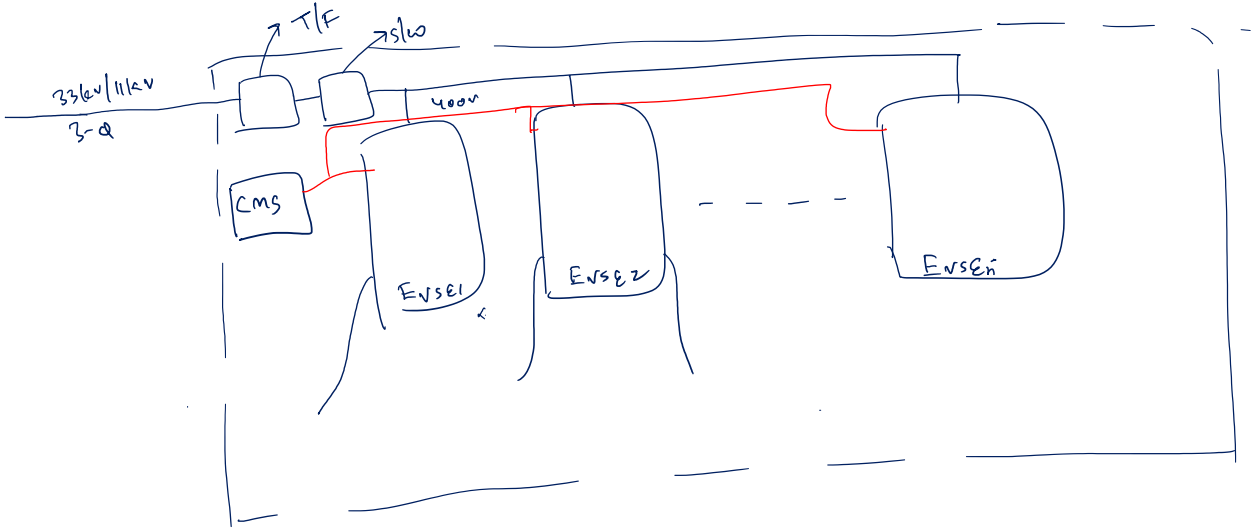
Dr. Apurv Kumar Yadav

Department of Electrical Engineering

Recap



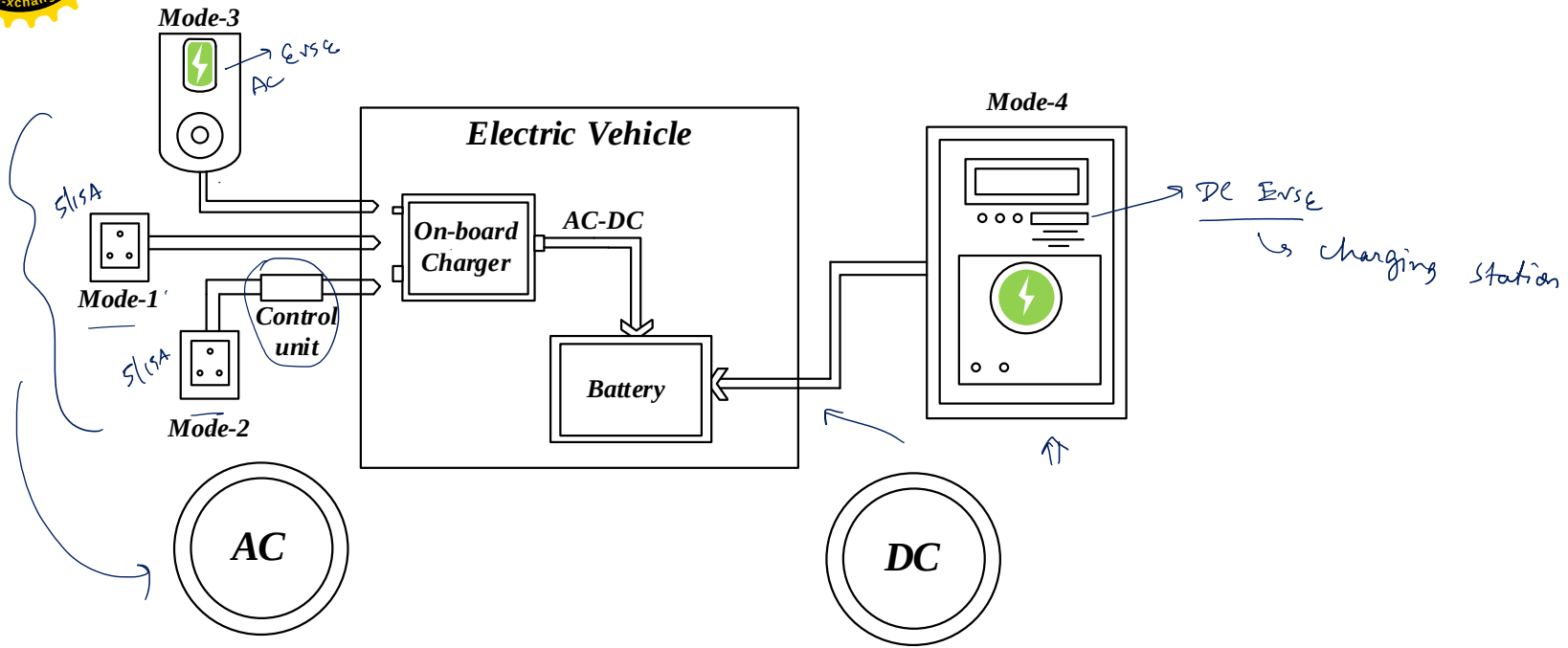
Public Charging Station



EVSE → AC
→ DC
→ 1 CG
→ 2 CG
→ 3 charging Socket

AIS-138
→ ARAI

Different Modes of an EV Charger



Source: https://www.niti.gov.in/sites/default/files/2021-08/HandbookforEVChargingInfrastructureImplementation081221.pdf

Different Modes of an EV Charger

- Based on the modes of charging, the EV chargers are defined as
  - Mode-1: From a regular electrical wall socket. **For AC chargers**
  - Mode-2: From a regular electrical socket, but equipped with control box with RCD (residual current device) protection arrangement. **For AC chargers.**
  - Mode-3: Using a specific EVSE with specific connectors. **For AC chargers**.
  - Mode-4: Using a specific EVSE with specific connectors. **For DC chargers**.

Different Levels of an EV Charger

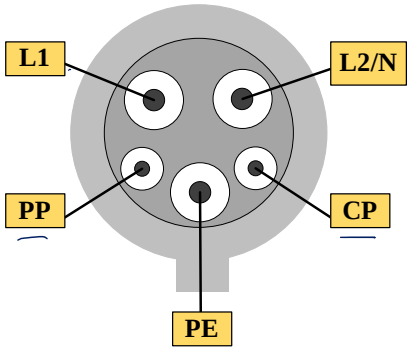
- In India, the charging levels are defined as

S. No	Charging Level	Voltage (V)	Power (kW)
1	Level 1 (AC)	230	<=3.5 kW
2	Level 1 (DC)	>=48	<=15 kW
3	Level 2 (AC)	380-400	<=22 kW
4	Level 3 (AC)	200-1000	> 22 kW
5	Level 3 (DC)	200-1000	up to 400 kW

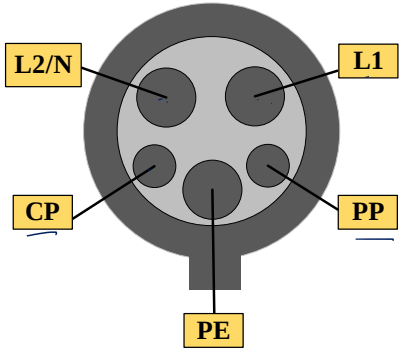
Source: https://e-amrit.niti.gov.in/standards-and-specifications

AC Type-1

- Supports single phase AC
- Two AC pins (L1, L2/N), two signals (control pilot, proximity pilot), power earthing
- Uses SAE-J1772 signaling protocol for communications (PWM based)
- Used in US and Japan
- Properly known as SAE-J1772, type-1 or Yazaki connector



Charger Plug



Vehicle Inlet Connector

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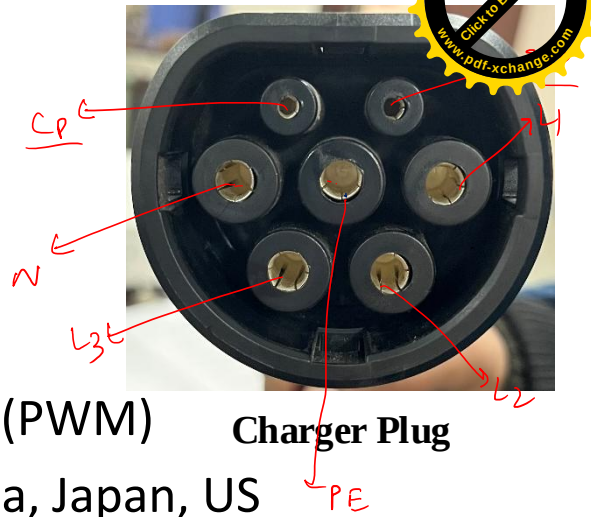
Modes
3 levels

Different AC

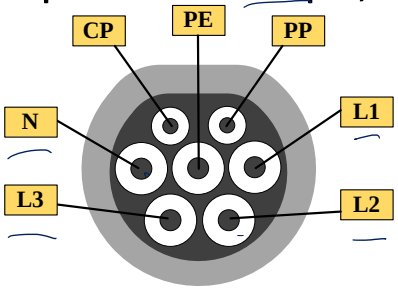
Charger plugs and Vehicle inlet connectors

AC Type-2

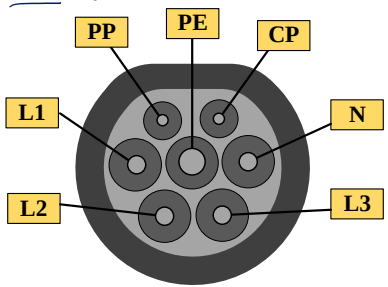
- Both single and three phase AC charging
- Two signal pins, five power pins
- Also called as Mennekes connector
- Connector specifications are given in IEC 62196
- Uses SAE-J1772 signaling protocol for communications (PWM)
- Adopted in Europe, UK, India, rest of world except China, Japan, US



Charger Plug



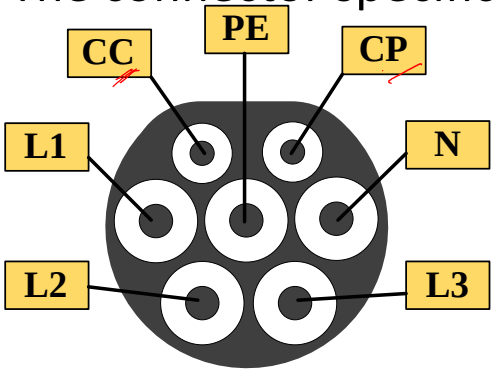
Charger Plug



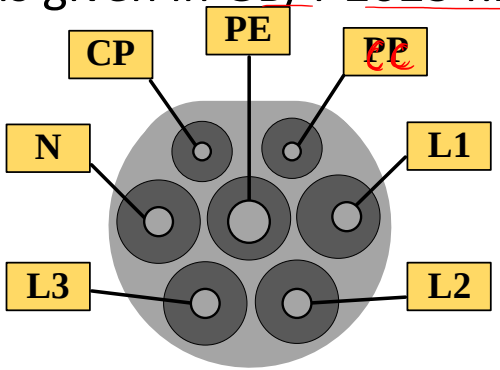
Vehicle Inlet Connector

GB/T AC

- Originated from China
- Formulated by Guobiao Standardization Commission, China
- Two signal pins, five power pins.
- Supports both 1-phase and 3-phase AC.
- The connector specifications is given in GB/T 20234.2 standard.

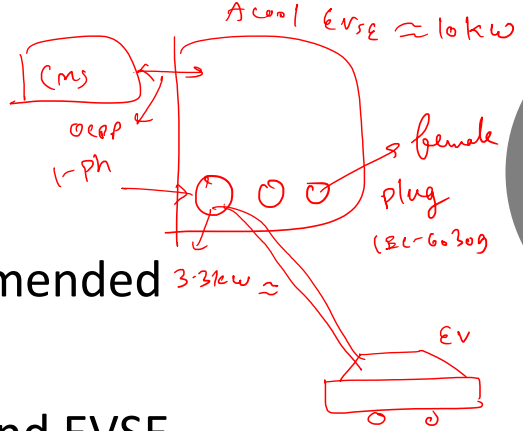


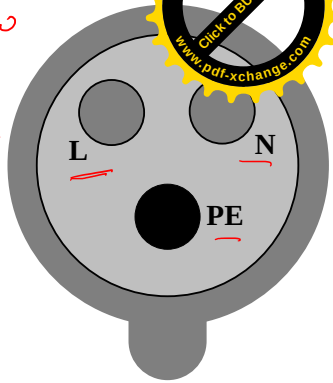
Charger Plug



Vehicle Inlet Connector

AC001





Charger Plug

- IEC 60309 industrial plug and connector
- Support single-phase supply
- EVSE with 3 independent output are recommended
- Used for 3-Ws or early models of cars
- No dedicated communication between EV and EVSE
- OCPP for communication between EVSE and central management system (CMS)

Female plug (EVSE)

Male plug (from EV with cable)

Introduced by Department of Heavy Industries, Government of India

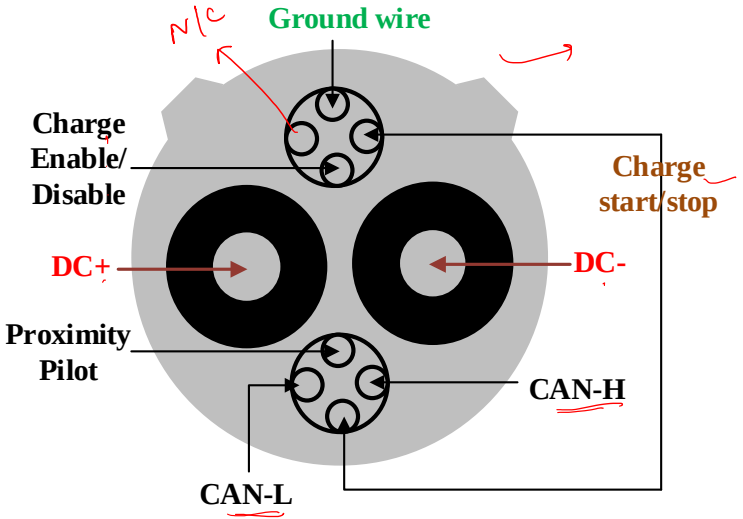
https://heavyindustries.gov.in/sites/default/files/2023-09/Standardization%20of%20protocol.pdf

Different DC

Charger plugs and Vehicle inlet connectors

DC CHAdeMO

- Adopted in Japan, initiative by Japanese manufacturers: Fuji heavy industries ltd, Toyota, Nissan, Tokyo electric power company, Mitsubishi
- Uses CAN communication
- Used for DC Charging

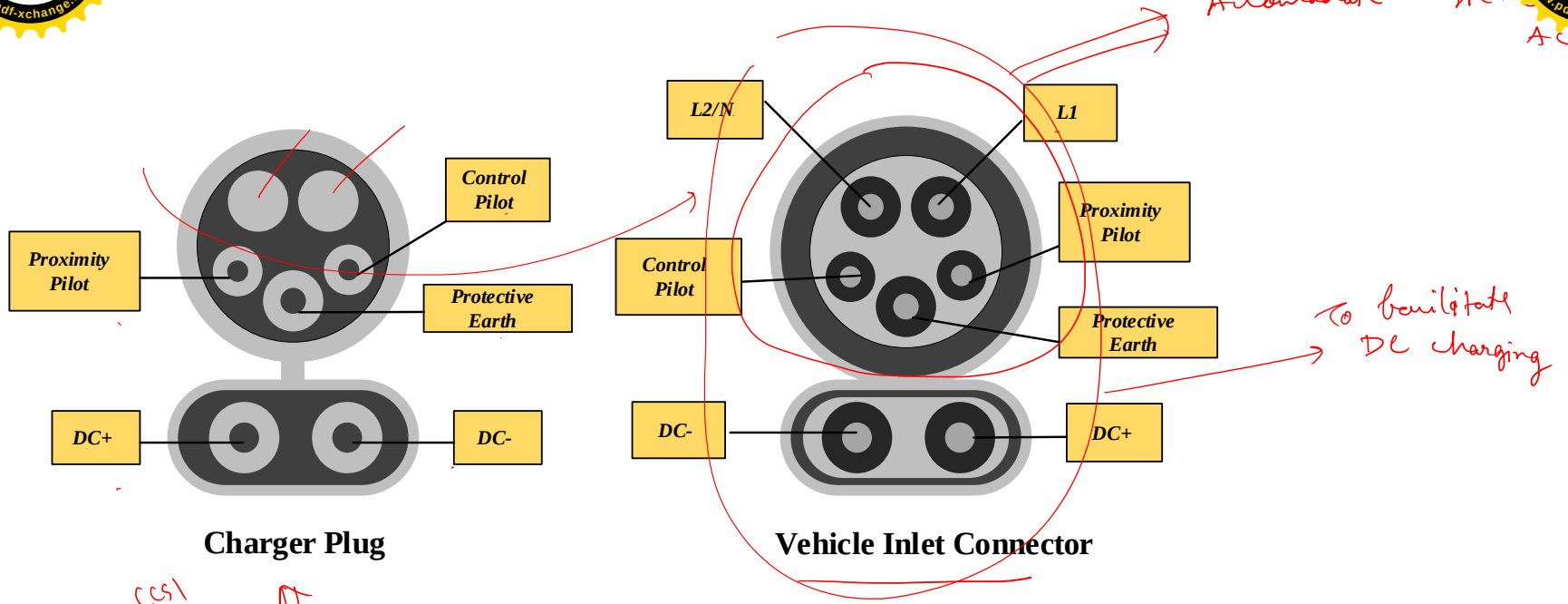


DC CCS1

- Combined both AC Type-1 and DC charging
- The Combo AC and DC charging connector comply with the IEC 62196
- PLC communication for DC charging and PWM signaling for AC charging
- Using one vehicle inlet socket, both AC and DC charging can be done
- CCS1 is used in US

US
JAPAN.
SAE J1772
Power line communication
ISO 15118 | DIN SPEC 70121 | IEC 61851
PLC

DC CCS1



Charger Plug

Vehicle Inlet Connector

DC CCS2

- Combined both AC Type-2 and DC charging
- The combo AC and DC charging connector comply with the IEC 62196
- PLC communication for DC charging and PWM signaling for AC charging
- Using one vehicle inlet socket, both AC and DC charging can be done.
- CCS2 is accepted in Europe, India and UK → for high propulsion system
- The communication is compliant with IEC 61851, ISO 15118, DIN SPEC 70121. → Germany

PLC

IS - 17017 - 2 - 3 → CCCS2 & chademo

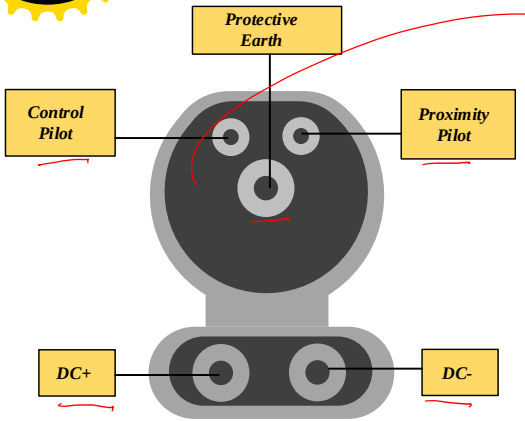
1000V, 500A

AIS - 138 - Part - 2

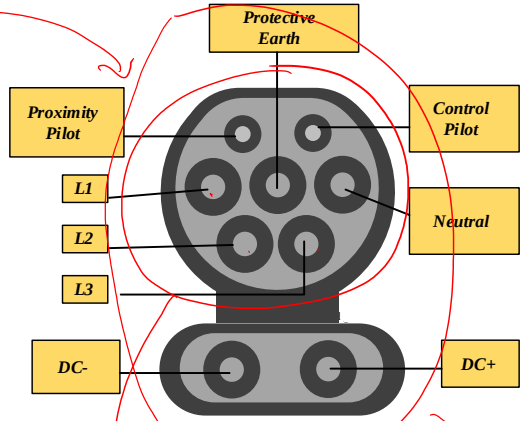
400kw

50kw / 60kw

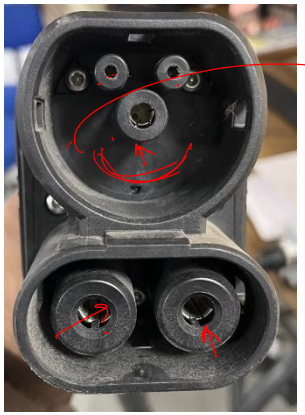
DC CCS2



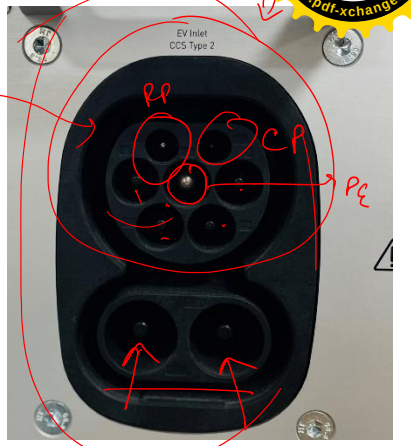
Charger Plug



Vehicle Inlet Connector



Charger Plug



Vehicle Inlet Connector

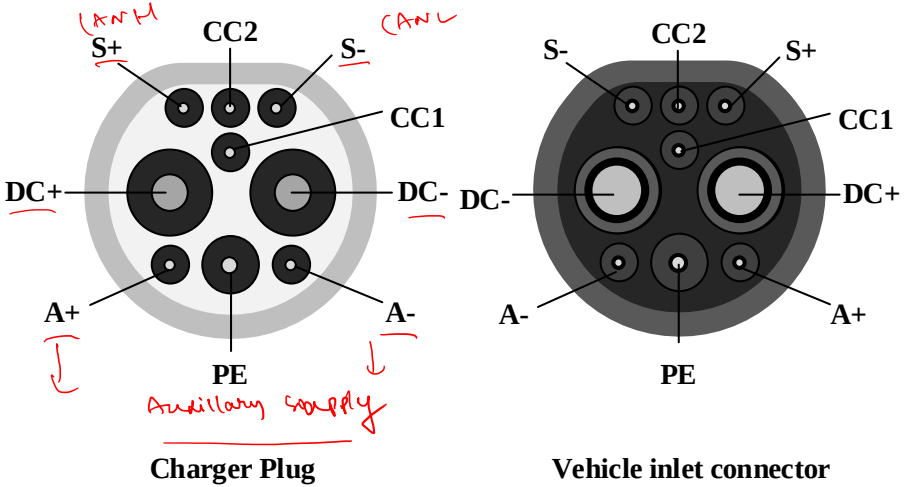
DC CCS2

accomodate AC Type 2 connector

facilate DC charging

DC GB/T

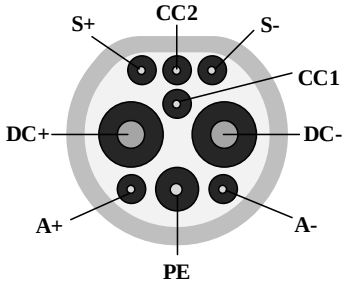
- Originated from China
- Uses CAN communication
- Voltage: 1500V and Current: 800A
- Uses GB/T 20234.3 connector



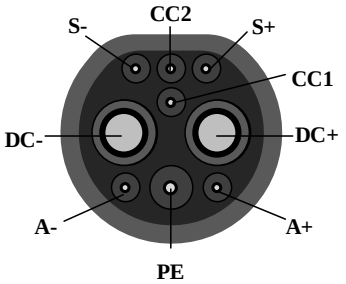
Charger Plug Vehicle inlet connector

BEVC-DC001

- Input: 3-phase AC
- Output: Supports up to a maximum of 10kW for 48V system and 15 kW for 72V systems
- Communication is derived from IEC 61851-24 and GB/T 27930 (application layer)
- Uses CAN communication
- GB/T 20234.3 Connector with 5 m Cable



Charger Plug



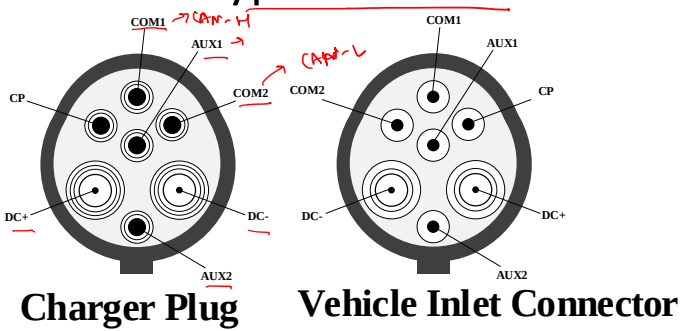
Vehicle inlet connector

Introduced by Department of Heavy Industries, Government of India

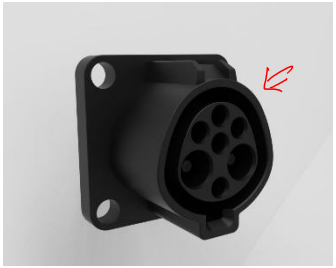
https://heavyindustries.gov.in/sites/default/files/2023-09/Standardization%20of%20protocol.pdf

DC Connector for LEVs

- Input: 3-phase AC
- Output: Supports up to maximum of 12 kW upto 120V DC
- The plug gets accepted by Bharat charging alliance (BCA) and incorporated in IS-17017-2-6 standard
- Communication using CAN communication as per IS-17017-25
- Also called as Type-6 connector



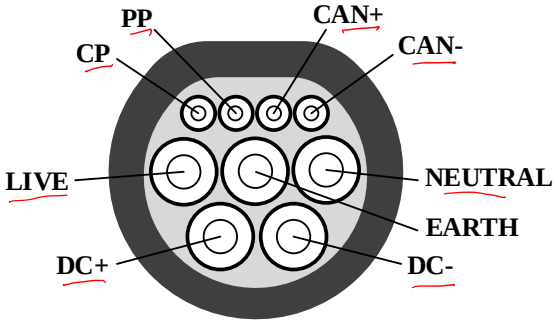
Charger Plug Vehicle Inlet Connector



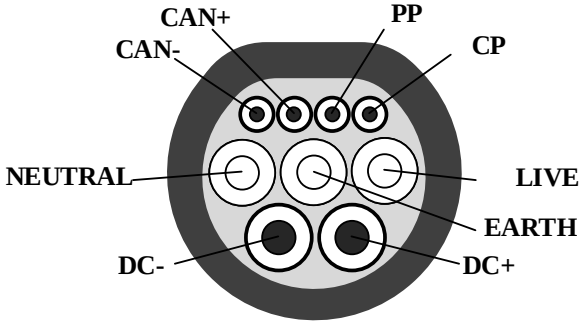
https://evstory.in/bharat-charge-alliance-promoted-lev-dc-charging-standard-gains-stronghold/

Combined AC and DC connector for LEVs

- Input: 3-phase AC
- Output: Supports up to maximum of 12 kW up to 120V DC; 7 kW up to 240V AC
- Incorporated in IS-17017-2-7, supports both AC and DC charging systems for LEVs
- Communication using CAN communication as per IS-17017-31
- Also called as Type-7 connector

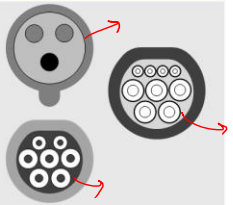
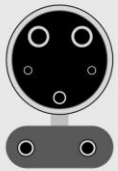
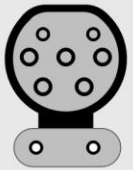
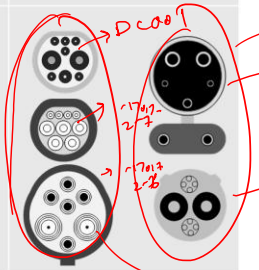


Charger Plug



Vehicle Inlet Connector

Region-wise Chargers Used

Type of Charging	North America	Japan	EU & rest of the market	China	India
AC					
Plug Name	Type 1	Type 1	Type 2	GB/T	1EC-60309, Type 2 Type-7
DC					
Plug Name	CCS1	CHAdeMO	CCS2	GB/T	GB/T, CCS2, CHAdeMO, Type-6, Type-7

Summary of the Chargers

Sl. No.	Particulars	CCS	CHAdeMO	GB/T	BHARAT
1.	Region	Originated in USA but adopted Worldwide	Originated in Japan, adopted worldwide	China	India
2.	Charging connector	SAE J1772/ IEC 62196-2	CHAdeMO	GB/T-20234	GB/T-20234, IEC-60309, IS17017-2
3.	Communication	PLC	CAN	CAN	CAN, PLC
4.	Type of Charging	AC and DC	DC	AC and DC	AC and DC

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