PUBLIC UTILITIES COMMISSION OF SRI LANKA

Electric Vehicle Charging Stations

Technical Guidelines and Minimum Standards

7/15/2018

Background

The Government has made a decision to entrust regulation of the Electric Vehicle Charging Stations (EVCS) to the Public Utilities Commission of Sri Lanka (PUCSL. This decision allows PUCSL to involve in the following areas;

a) Establish a register of EVCS at each Distribution Licensee,

b) Issue code of practice for EVCS,

c) Determine end user tariffs,

d) Issue safety and other technical standards for EVCS and

e) Collect information on regular basis for monitoring purposes

Subsequent to this decision by the Government, PUCSL conducted a stakeholder consultation to gather the views of all the stakeholders in the industry. As part of the solution to the prevailing issues/ concerns in the EVCS industry, the PUCSL has decided to develop Technical Guidelines and Minimum Standards for the importing or manufacturing Electricity Vehicle (EV) chargers.

PUCSL contracted Technology Innovation & Engineering Consultants (TIEC) Private Limited to develop Technical Guidelines and Minimum Standards for the importing or manufacturing Electricity Vehicle (EV) chargers. From TIEC, a team lead by Dr. Lilantha Samaranayake prepared this document.

This Technical Guidelines and Minimum Standards document has been structured as follows: The first chapter is on general aspects of Electric Vehicle charging, which introduces charging modes, interface definitions, and interface types as specified in the relevant IEC standards. The chapters 2, 3, 4 and 5 have been arranged such that they give full standard information with regard to Mode 1, Mode 2, Mode 3 and Mode 4 charging respectively. Hence, if the reader is interested in Mode 3 charging for example, the reader can straight away move to chapter 3 after chapter 1. Finally the Technical Guidelines are given in Chapter 6.

Contents

Chapter 1

Electric Vehicle Charging

In an Electric Vehicle Charging Station (EVCS), the EV shall be connected to the Electric Vehicle Supply Equipment (EVSE) so that in normal conditions of use, the conductive energy transfer function operates safely.

In general, this principle is achieved by fulfilling the relevant requirements specified in IEC61851 and IEC62196 standards, and compliance is checked by carrying out all relevant tests mentioned therein.

The rated value of the ac supplied voltage for the charging equipment is up to 1000 V ac or 1500 V dc. The equipment shall operate correctly within ±6 % of the standard nominal voltage. The rated value of the frequency is 50 Hz ± 1 %.

An automotive-type vehicle for on-road use, such as passenger cars, buses, trucks, vans, electric three wheelers, electric motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, supercapacitor, fuel cell, photovoltaic array, or other source of electric current. PHEVs are also considered as electric vehicles. For the purpose of Sri Lankan standard, off-road, self-propelled electric vehicles, such as industrial trucks, hoists, lifts, golf carts, airline ground support equipment, tractors, boats, and the like, which need not be registered in the Department of Motor vehicles, Sri Lanka shall not be considered.

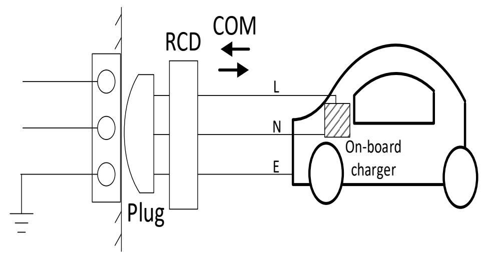
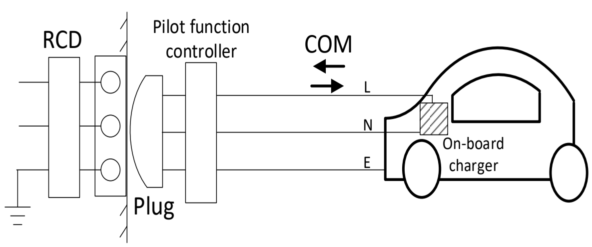
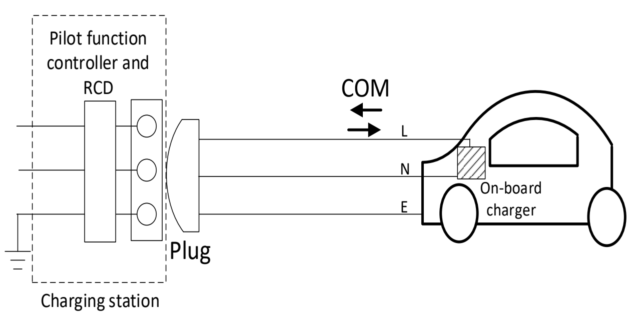
EV Charging Modes

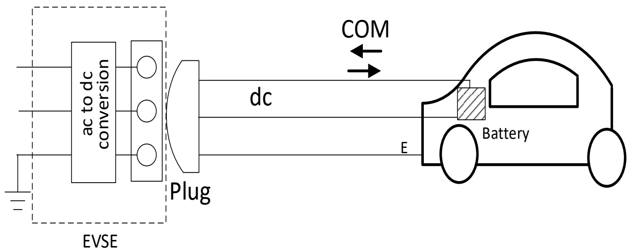
IEC 61851-1:2011 specifies 4 charging modes as

1. Mode 1 charging
2. Mode 2 charging
3. Mode 3 charging
4. Mode 4 charging

A Residual Current Device (RCD) with characteristics that are at least equivalent to Type A as defined in IEC 61008-1 or IEC 61009-1, or IEC/TR 60755 in conjunction with an over-current protection device shall be required for all modes of charging. A summary of the different charging modes and their connection requirements are given in Table 1 [11].

Table 1. Different charging modes and connection requirements

Mode	Connection arrangement			Functional requirements
	Current	**Voltage**	**Socket outlet**	
1	16 A	Single-phase: 250 V ac Three-phase: 480 V ac	Standardized socket-outlets utilizing the power and protective earth conductors.	
2	32 A		Standardized socket-outlets utilizing power and protective earth conductors together with a control pilot function and system of personnel protection against electric shock (RCD) between the EV and the plug.  	EVSE or the EVSE and vehicle system shall verify that: 1. the vehicle is properly connected to the charging infrastructure 2. continuous protective earth conductor has continuity as expected in the circuit 3. energization of the system shall not be performed until the pilot function between EVSE and EV has been established correctly.
3	Utilizing dedicated EV supply equipment (EVSE) where the control pilot function extends to control equipment in the EVSE, permanently connected to the ac supply network  With a wall mounted socket  With a charging station			

4	Utilizing an off board charger where the control pilot function extends to equipment permanently connected to the ac supply. 	In addition to the above, a serial data information exchange shall be provided for Mode 4 to allow the vehicle to control the off-board charger, except in the case of dedicated off-board chargers.

Charging Interface Definitions

The charging interface definitions as per the IEC62196 is shown in Figure 1. Accordingly, the socket-outlet is in the charging station, the plug is at the end towards the charging stations in the flexible cable between the EV and the charging station, the vehicle connector is at the EV end of the cable between the EV and the charging station and the vehicle inlet is fixed on the EV.

In Mode 2 charging, the flexible cable between the EV and the charging station is provided with in cable protective device for earth fault such as RCD.

In Mode 3 charging, there are two cable versions. The first version is removable from the wall socket and it comes with an in cable device for pilot function control. This is often referred to as CASE B in standards such as the IEC 61851. The second version is fixed at the charging station end and does not have in cable controllers. The pilot function controller is fixed inside the wall mounted charging infrastructure. This is often referred to as CASE C in standards such as the IEC 61851. The same arrangement as in the second version is used in Mode 4 dc charging.

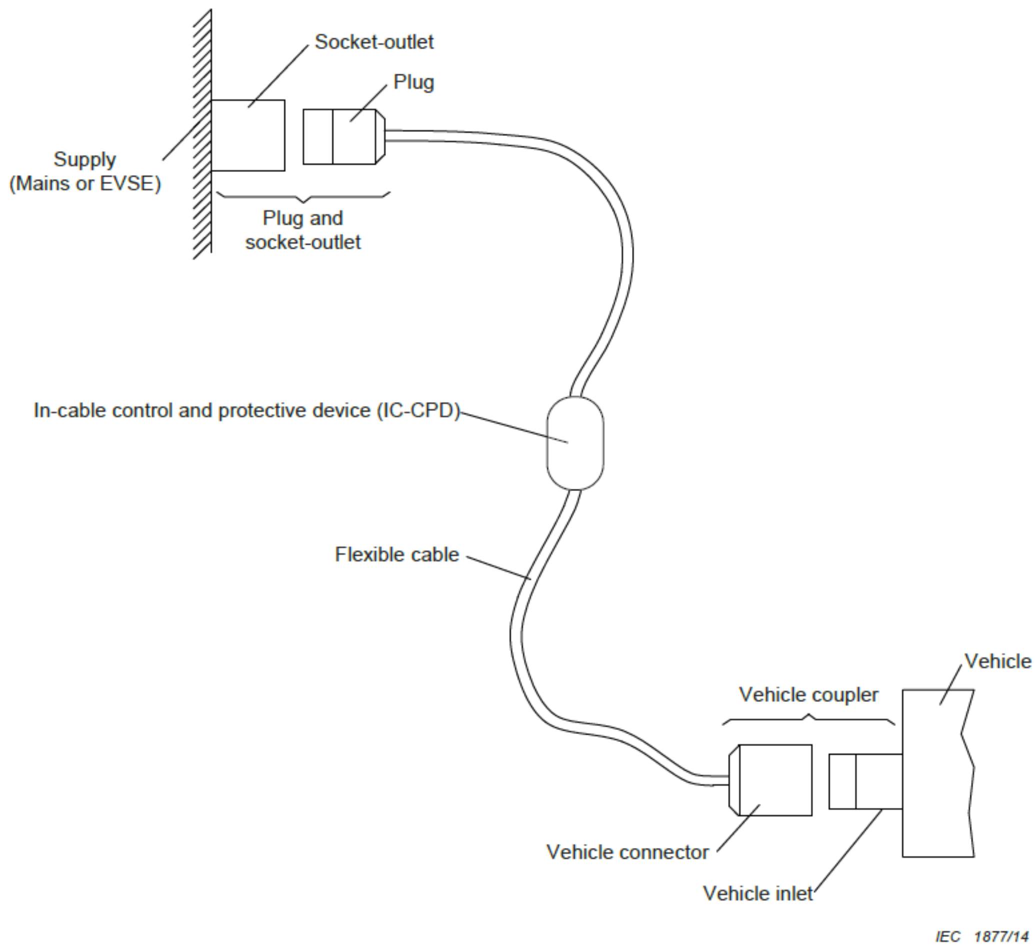


Figure 1 Interface definitions

Pilot functions

For modes 2, 3 and 4, a pilot function is mandatory. The pilot function shall be capable of performing at least the following functions;

a. Verification that the vehicle is properly connected: The EVSE shall be able to determine that the connector is properly inserted in the vehicle inlet and properly connected to the EVSE. Vehicle movement by its own propulsion system shall be impossible as long as the vehicle is physically connected to the EVSE.

b. Continuous protective earth conductor continuity checking: Equipment earth continuity between the EVSE and the vehicle shall be continuously verified. An RCD (In < 30 mA) shall be provided as a part of the EV conductive supply equipment for earthed systems. The RCD shall have a performance at least equal to Type A.

c. Energization of the system: Energization of the system shall not be performed until the pilot function between EVSE and EV has been established correctly. Energization may also be subject to other conditions being fulfilled.

d. De-energization of the system: If the pilot function is interrupted, the power supply to the cable assembly shall be interrupted but the control circuit may remain energized.

In addition, some manufacturers support the following functions

a. Selection of charging rate: A manual or automatic means shall be provided to ensure that the charging rate does not exceed the rated capacity of the ac supply network (mains), vehicle or battery capabilities.

b. Determination of ventilation requirements of the charging area: If additional ventilation is required during charging, charging shall only be allowed if such ventilation is provided.

c. Detection/adjustment of the real time available load current of the supply equipment: Means shall be provided to ensure that the charging rate shall not exceed the real time available load current of the EVSE and its power supply.

d. Retaining/releasing of the coupling: A mechanical means shall be provided to retain/release the coupler.

e. Control of bi-directional power flow to and from the vehicle.

Example pilot function controller sample circuits have been provided in IEC61851 Appendix A, B and C.

Interface Types

Type I

Type 1 is the Vehicle Connector / Vehicle Inlet pair used in the USA and Japan following the SAE1772 USA standard. This standard is limited to single phase and typically lower power output than Type II. The Type I cable is permanently fixed to the EV charging station.

Type II

The Vehicle Connector / Vehicle Inlet and Plug and Socket-Outlet pairs used in the Europe belongs to Type II. It supports both single phase and three phase charging at a higher power than Type I. For Type II, the charging cable is detachable at the EV charging station end, so that Type II station can charge both Type I and Type II EVs.

Combined Charging System

The Combined Charging System (CCS) is a standard-compliant charging system for electric vehicles, which supports both conventional ac charging and fast dc charging. Both ac and dc vehicle connectors fit into the CCS vehicle inlet.

CHAdeMO

The Japanese CHAdeMO consortium developed a standard that specifies the vehicle connector and vehicle inlet design, communication protocol and dc fast-charge station capacities. CHAdeMO dc fast charging uses a charger built into the charging station to deliver dc power directly to the vehicle battery, and adjusts the charging voltage and current to the EV.

Tesla

The charging system of Tesla is unique in the respect that it uses the same two power pins for both single phase ac and dc and two communication pins. The Tesla coupler and interface are designed in such a way that the EV can be charged using a Tesla charger (either ac or dc) or using an adapter from a Type 1 SAE J1772 charger or a CHAdeMO charger.

Chapter 2

Minimum Standards for Home Charging

Mode 1

Power interfaces

If the EV charging station has a power supply cord with a plug complying with BS 1363, a compatible outlet must be installed. The Type I socket-outlet for EV charging facility used in Sri Lanka shall be a square pin, 13 A, 230 V socket-outlet complying with BS 1363 and it should be protected for over current and earth fault at the supply using suitable protective devices such as miniature circuit breakers and residual current detectors respectively.

The Type II socket-outlet for EV charging facility used in Sri Lanka shall be a round five pin industrial socket (L1, L2, L3, N and PE), 16 A, 400 V socket-outlet complying with IEC60309 and it should be protected for over current and earth fault at the supply using suitable protective devices such as miniature circuit breakers and residual current detectors respectively.

The charging cable consisting of in-cable control supporting the mandatory pilot functions will be provided by the EV manufacturer.

Installation standards

The choice of circuit components should match the ratings of the EV charging station as given in IEC61851, i.e. 16A, 250 V for single phase or 16 A, 480 V three phase. The station must be supplied from a separate branch circuit; this may require adding a circuit breaker to the distribution panel. Since this type of apparatus is considered a continuous load, the existing service line must be able to support the additional load.

Otherwise, it may be necessary to change the panel and the service line. However, the station may be connected to an existing branch circuit of appropriate rating (e.g., the 20 A circuit supplying a kitchen range), if a locking mechanism is installed to prevent both loads from being supplied simultaneously.

Conductor gauge must be selected so as to limit voltage drops in compliance with IET Wiring Regulations 18th Edition (BS7671).

Energy metering

Three general approaches have been identified that can be used for metering EV load in Mode 1; single metering, submetering, and separate metering. All metering equipment provided to measure the use of electricity shall comply with IEC 62052.

Single Metering

The EV load is counted as part of the total **house** load, and is not separately measured. This approach as shown in Figure 2 is used for virtually any other new appliance purchased by a **household** and is sometimes referred to as ‘whole house’ metering.

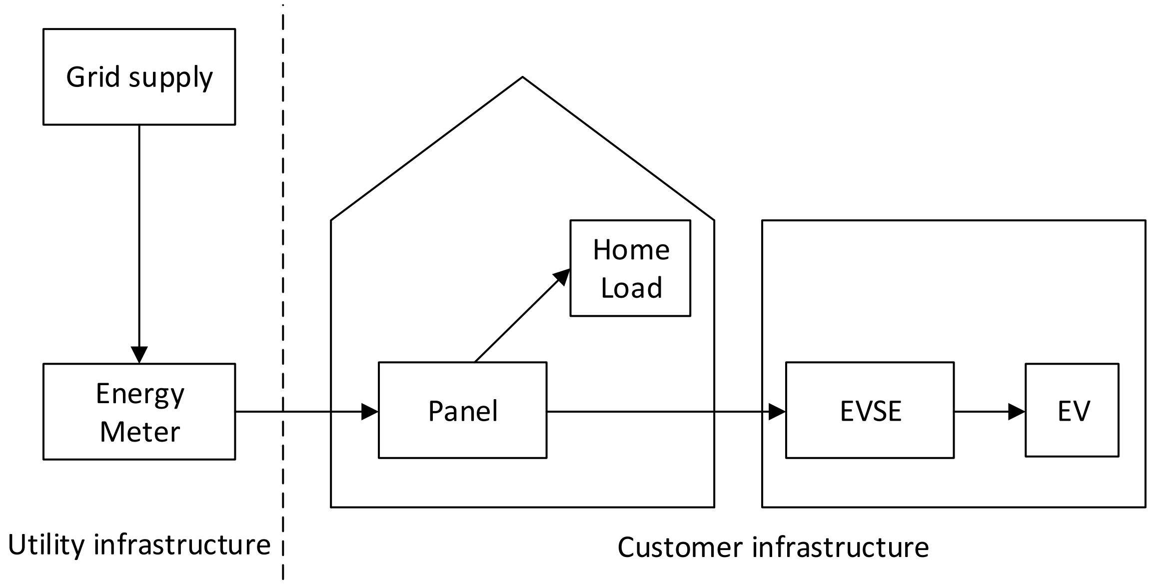


Figure 2 Single metering

Separate Metering

The EV load is measured and billed separately from the rest of the customer load, using a dedicated revenue grade meter. The EV load is essentially charged to a separate account from the rest of the customer's load, though the accounts can be aggregated into one bill. Separate metering is sometimes referred to as 'parallel metering' and is shown in Figure 3.

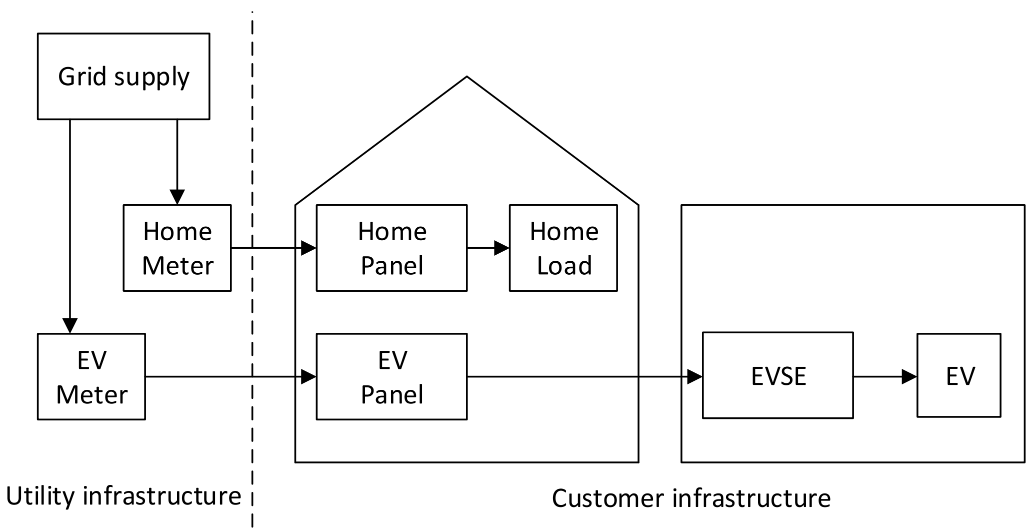


Figure 3 Separate Metering

Submetering

The EV load is measured by a meter installed between the main meter and the EVSE that acts as a submeter for the EV load. This meter measures EV load as a subset of the entire load, while the original customer meter measures the entire customer load as shown in Figure 4. For billing purposes, the EV meter load needs to be subtracted from the main meter load to avoid double-counting the EV consumption. Submetering is sometimes referred to as 'subtractive metering' or 'series metering.

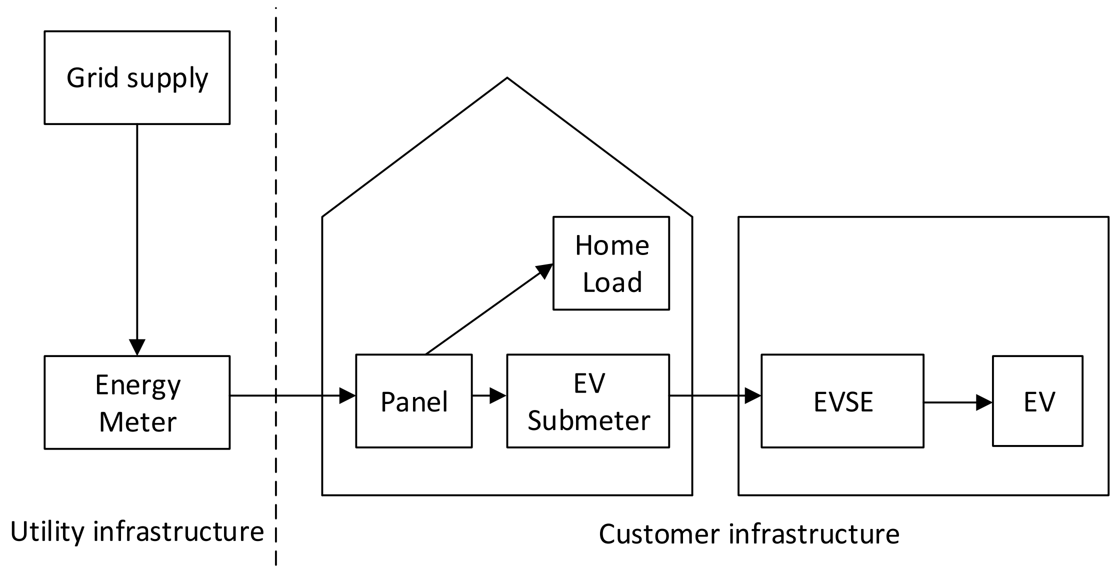


Figure 4 Submetering

Minimum meter functionalities

Minimum meter functionalities for each metering arrangement for home charging are listed in Table 2.

Table 2 Minimum meter functionalities

	Single Metering	Submetering	Separate Metering
EV Metering Accuracy and Functionality	NA	Greater accuracy of the submeter is achieved at a higher cost to customers.	Require the same accuracy requirements as Advanced Metering Infrastructure (AMI) meters. Require AMI Compatibility.
Minimum load data granularity	NA	Multiple time intervals consistent with the number of intervals in the utility EV tariff structure	Multiple time intervals consistent with the number of intervals in the utility EV tariff structure
Minimum Communication Functionality for the meter	NA	Daily reporting will be necessary to enable consumers to track online billing information.	Same as AMI meter

Minimum Meter Data Storage Functionality	NA	Time of use data storage	Same as AMI meter
Boundary Definition	EVSE should be owned by customers	EV meter and EVSE should be owned by customer	EV meter should be owned by utility, EVSE should be owned by the customer
Who owns for the meter?	Utility owns primary meter used to measure all usage	Customer	Utility

Safety codes and standards for chargers

Both onboard and off-board chargers need to comply with various specifications mandated by the government and the utility depending on the country. In general the following are the key safety and operation requirements for onboard chargers in Mode 1:

- Electromagnetic compatibility (EMC) emission and immunity (European standard (EN): EN 55011, EN 55022 and IEC 61000-4.
- Efficiency more than or equal to 96%.
- Harmonics current total harmonic distortion (iTHD) <7% as specified in Institute of Electrical and Electronics Engineers (IEEE) 519 requirements.
- Minimum enclosure protection IP54.
- Safety in terms of breaking capacities, cables and connectors, phase fault and earth fault conditions in compliance with IEC 62196, IEC 61851 and Conformité Européene (CE) marking.

Standards for interfaces and cables

IEC 62893-1:2017(E) specifies construction, dimensions and test requirements for cables with extruded insulation and sheath having a voltage rating of up to and including 1000V ac for flexible applications under harsh conditions for the power supply between the electricity supply point of the EVCS and the EV.

Ordinary duty cables with rated voltage 300/500 V are only permitted for Mode 1 charging. Maximum conductor temperature for the cables in this part of IEC 62893 is 90 ºC.

Chapter 3

Minimum Standards for

EV Charging Station

Mode 2

Power interfaces

If the EV charging station has a power supply cord with a plug complying with BS 1363, a compatible outlet must be installed. Type I does not support Mode 2 in Sri Lanka and hence it must be Type II.

The Type II socket-outlet for EV charging facility used in Sri Lanka shall be a round five pin industrial socket (L1, L2, L3, N and PE), 32 A socket-outlet complying with IEC60309. The RCD is incorporated in the in-cable control and protective device provided by the EV manufacturer, which will also cover the mandatory pilot functions in addition to the over current detection, over temperature detection and the protective earth (PE) detection from the socket-outlet. A typical socket-outlet, plug, vehicle connector and vehicle inlet with their pin connections are shown in Figures 5, 6, 7 and 8 respectively.

Figure 5 Type II Socket-outlet (IEC60309) in Mode 2;

Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Figure 6 Type II Plug (IEC60309) in Mode 2;

Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Figure 7 Type II Vehicle connector in Mode 2;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Figure 8 Vehicle inlet supporting Mode 2;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Installation standards

The choice of circuit components should match the ratings of the EV charging station as given in IEC61851, i.e. 32 A, 400 V three phase. The station must be supplied from a separate branch circuit; this may require adding a circuit breaker and a Type A RCD with appropriate rating to the distribution panel. Since this type of apparatus is considered a continuous load, the existing service line must be able to support the additional load. Otherwise, it may be necessary to change the panel and the service line. Conductor gauges must be selected so as to limit voltage drops in compliance with IET Wiring Regulations 18^{th} Edition (BS7671).

The installation shall be carried out under the supervision of a chartered engineer by an electrician who has qualifications and experience at the level of Sri Lanka Qualifications Framework Level 4.

The electrician may follow the guidelines given below:

- Read the manufacturer’s installation instructions.
- Consult the nameplate in order to make sure the apparatus is approved with the recognized certification marking and determine the ratings, e.g., 400 V, 32 A.
- Ensure that the distribution panel is capable of supplying the additional load, according to the prescriptions of IET Wiring Regulations 18th Edition (BS7671) as each station in the case of multiple dwelling units (MDU) is considered as a separate continuous load.
- Install the wiring between the panel and the EVSC using the appropriate method as specified in BS7671.
- Install a circuit breaker with the appropriate rating in the distribution panel (40 A in this example).
- Anchor the socket-outlet solidly to the wall.
- Make the connections and energize the EVSC.
- Check whether the station operates correctly.

Energy metering

Metering equipment provided to measure the use of electricity shall comply with IEC 62052.

Three general approaches have been identified that can be used for metering EV load in Mode 2 as well; single metering, submetering, and separate metering. Unlike in Mode 1, Mode 2 charging may be adopted in industrial and commercial EV charging stations. In such industrial and commercial applications, it is natural to use MDUs, where separate branch circuits will be required to each dwelling unit. Hence, the most sensible metering approach will be either separate metering or submetering, where the meter readings will be used to charge the customers who use the facility. The two cases have been shown in Figures 9 and 10 respectively. Depending on the capacity of the grid supply, and the demand of the EVSC, the utility will have to decide on the need of a separate transformer.

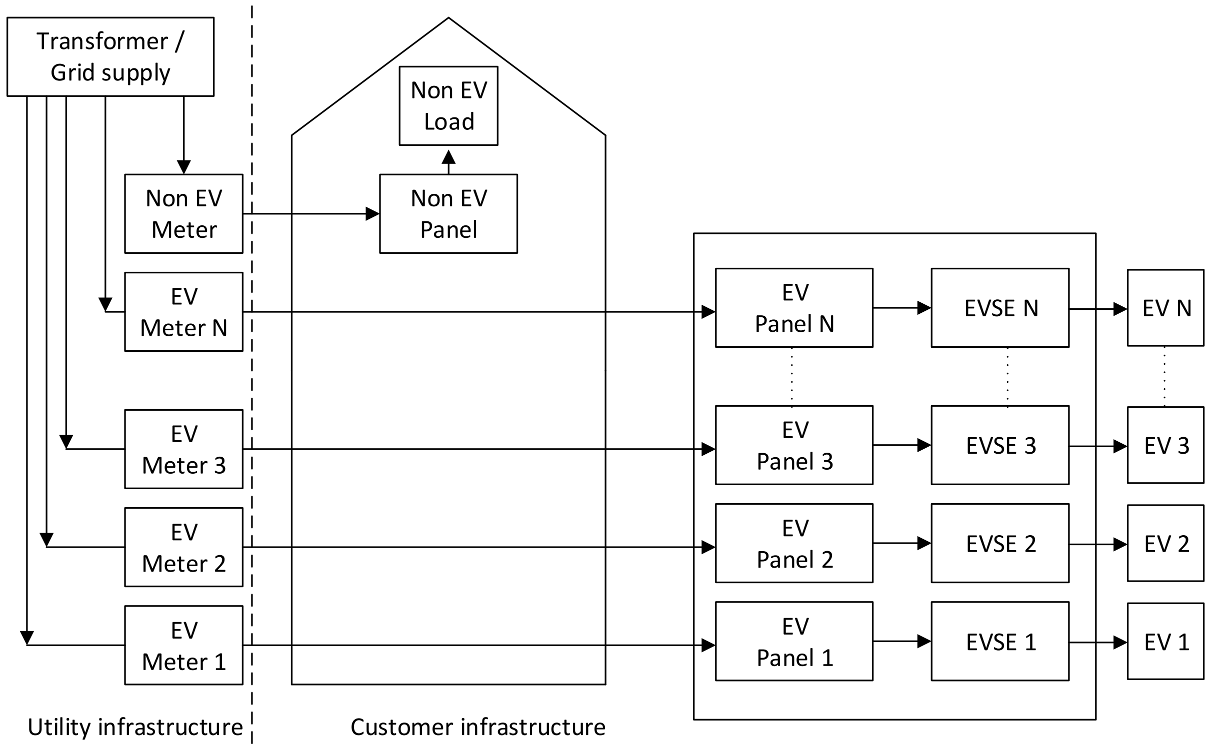


Figure 9 Separate metering for MDU EVCS with Non-EV load at the customer premises

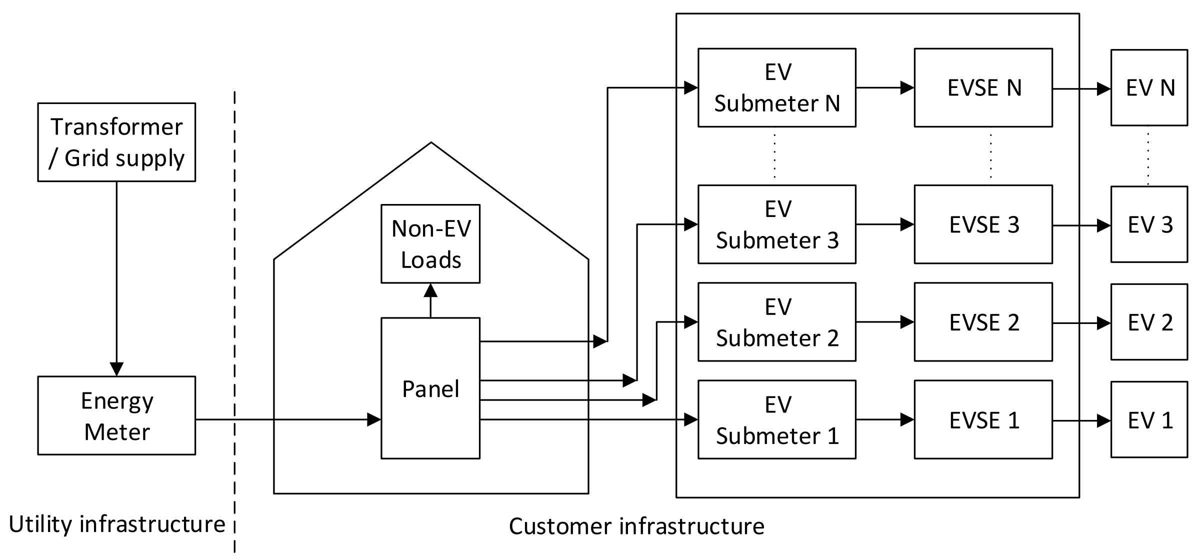


Figure 10 Submetering for MDU EVCS and Non-EV load at the customer premises

However, if the Mode 2 EV charging station with MDUs is not opened to the public, but dedicated to a predefined users such as the employees of the owner organization, the Single metering may be preferred as shown in Figure 11.

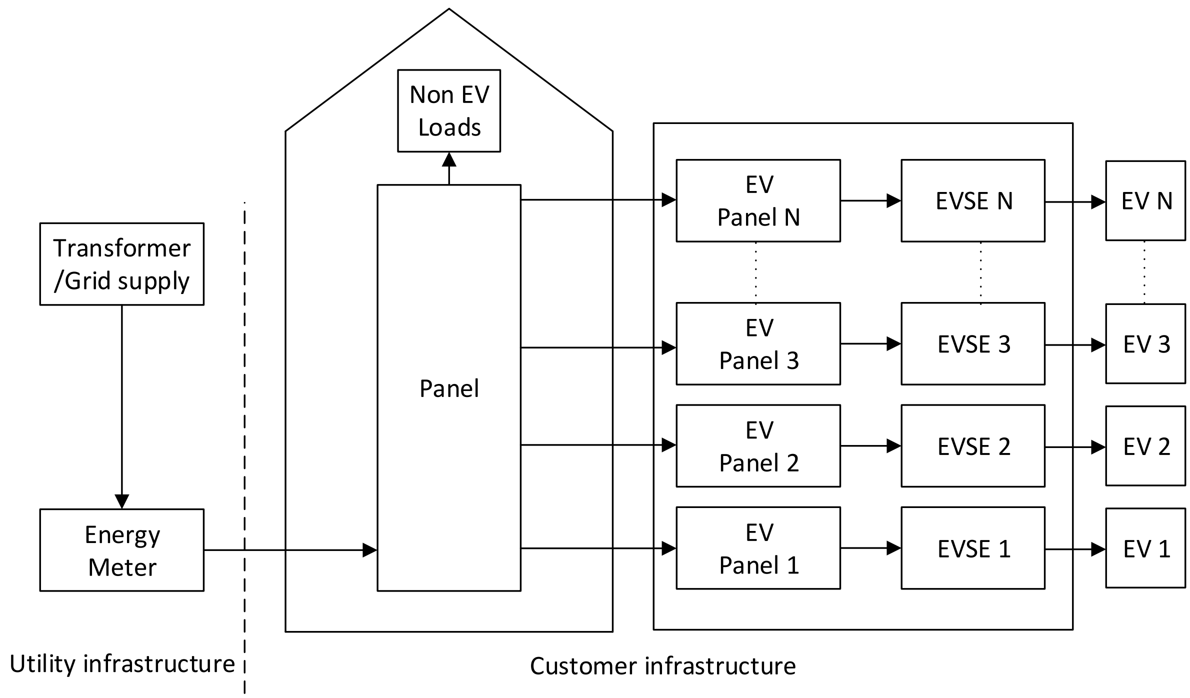


Figure 11 Single metering in Mode 2 EVCS

Safety codes and standards for chargers

In general the following are the key safety and operation requirements of Mode 2 charger:

- Electromagnetic compatibility (EMC) emission and immunity European standard EN 55011, EN 55022 and IEC 61000-4.
- Efficiency more than or equal to 96%.
- Harmonics current total harmonic distortion (iTHD) <7% complying with the Institute of Electrical and Electronics Engineers (IEEE) 519 requirements.
- Minimum enclosure protection of IP54.
- Safety in terms of breaking capacities, cables and connectors, phase fault and earth fault conditions in compliance with IEC 62196, IEC 61851 and Conformité Européene (CE) marking.

Standards for interfaces and cables

IEC 62893-1:2017(E) specifies construction, dimensions and test requirements for cables with extruded insulation and sheath having a voltage rating of up to and including 1000V ac for Modes 2 of IEC 61851-1 for flexible applications under harsh conditions for the power supply between the electricity supply point of the EVCS and the EV. The particular types of cables should be in compliance with the cable as specified in IEC 62893-3. Hence Mode 2 charging cables have to be in compliance with IEC 62893. The maximum conductor temperature for the cables in this part of IEC 62893 is 90 ºC.

Meter accuracy standards

Meter accuracy standards shall be in accordance with the standards specified below or later editions and/or amendments thereof,

- General requirements, tests and test conditions – IEC 62052-21:2003
- Power consumption, voltage requirements, accuracy and local interface - IEC 62053-21:2003
- Data exchange for meter reading, tariff and load control - IEC 62056-21:2002
- Acceptance inspection - IEC 62058-11: 2010 and IEC 62058-31:2010
- Degree of protection - IP 51
- Data communication – IEC 61334 & IEC/ISO 14908-4:2012
- Case – IP53 & IEC 60529
- Certifications - CE and RoHS in addition to the above IEC standards

Chapter 4

Minimum Standards for

EV Charging Station

Mode 3

Power interfaces

In Mode 3, there can be two arrangements of interfaces as

- With Socket-outlet and Plug at EVCS end
- Without Socket-outlet and Plug at EVCS end

The former is often referred to as CASE B and the latter is CASE C in EV standards. Figure 12 shows the conductor arrangement in the Socket-outlet and the Figure 13 shows the pin configuration of the plug. The vehicle socket and the vehicle inlet, which typically support both ac and dc charging are shown in Figures 14 and 15 respectively.

For mode 3 charging, the ac EVCS shall monitor the electrical continuity of the protective conductor to the electric vehicle. If the ac EVCS detects a loss of electrical continuity of the protective conductor, the electrical supply circuit to the vehicle shall be opened.

Figure 12 Type II EVSC socket-outlet for Mode 3;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Figure 13 Type II Plug in Mode 3;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Figure 14 Type II Vehicle connector in Mode 3;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Figure 15 Vehicle inlet supporting Mode 3;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3)

Installation standards

For mode 3 charging, the ac electric vehicle charging station should provide part of the control functions listed in 6.4 of part 1 of IEC61851.

In the installation of the system, an emergency disconnection device shall be installed to isolate the ac supply network from the ac electric vehicle charging station in case of risk of electric shock, fire or explosion. The disconnection device shall be provided with a means to prevent accidental operation.

The maximum permissible surface temperature of parts of the ac electric vehicle charging station which are hand grasped, at the maximum rated current and at an ambient temperature of 40 °C, shall be

– 50 °C for metal parts;

– 60 °C for non-metallic parts.

For parts which may be touched but not grasped, maximum permissible surface temperature under the same conditions shall be

– 60 °C for metal parts;

– 85 °C for non-metallic parts.

When energized or not, and with the socket-outlet access trap door closed, shall provide a minimum degree of protection of IP44. Compliance is checked by test in accordance with IEC 60529.

A storage means shall be provided for the cable assembly and vehicle connector when not in use. The ac electric vehicle charging station should be provided with a means to indicate whether or not the cable assembly/vehicle connector has been stored as intended after disconnection from the vehicle.

The lowest part of the socket-outlet or the storage means provided for the vehicle connector shall be located at a height between 0.4 m and 1.5 m above ground level.

The use of an extension cord for the connection of the EV to the ac EVCS should be prohibited in order to avoid any direct contact or the dangerous use of unsafe components (risk of overload, absence of protective conductor, etc.).

All exposed conductive parts which could be connected to the supply voltage source, under fault conditions, shall be connected together in such a manner that they conduct electricity properly, so as to conduct potential fault currents to the earthed point of the ac supply network.

Compliance shall be checked by testing the electrical continuity between exposed conductive parts and the earth circuit. A current of 16 A, derived from a dc source having a no-load voltage not exceeding 12 V, is passed between any exposed conductive part and the earthing terminal of the charging station. For each exposed conductive part, the voltage drop is measured between these two points. The resistance calculated from the current and measured voltage drop, between any exposed conductive part and the earth-circuit connection, shall not exceed 0.1 Ω. For a class II charging station, there shall be a lead-through protective conductor.

The insulation resistance with a 500 V dc voltage applied between all inputs/outputs connected together (power source included) and the accessible parts shall be

- for a class I station: R > 1 MΩ;
- for a class II station: R > 7 MΩ.

The measurement of insulation resistance shall be carried out after applying the test voltage for 1 min and immediately after the damp heat test.

The choice of circuit components should match the ratings of the EV charging station as given in IEC61851, i.e. 32 A, 400 V three phase or 32 A, 230 V, per charger unit. The station must be supplied from a separate supply or a dedicated branch circuit for charger(s); this may require adding a circuit breaker and a Type A RCD with appropriate rating to the distribution panel. Since this type of apparatus is considered a continuous load, if the existing service line is used, it must be able to support the additional load. Otherwise, it may be necessary to get a new electricity supply connection and a service line. Conductor gauges must be selected so as to limit voltage drops in compliance with IET Wiring Regulations 18th Edition (BS7671).

The installation shall be carried out under the supervision of a chartered engineer by an electrician who has qualifications and experience at the level of Sri Lanka Qualifications Framework Level 4.

The electrician may follow the guidelines given below:

- Read the manufacturer's installation instructions.
- Consult the nameplate in order to make sure the apparatus is approved with the recognized certification marking and determine the ratings, e.g., 400 V, 32 A per dwelling station.
- Ensure that the distribution panel is capable of supplying the additional load, according to the prescriptions of IET Wiring Regulations 18th Edition (BS7671) as each station in the case of multiple dwelling units (MDU) is considered as a separate continuous load.
- Install the wiring between the panel and the EVSC using the appropriate method as specified in BS7671.
- Install a circuit breaker with the appropriate rating in the distribution panel (40 A per dwelling station in this example).
- Anchor the socket-outlet solidly to the wall (IEC62196 case B) or connect the cable permanently where separate plug and socket is not applicable (IEC62196 case C).
- Make the connections and energize the EVSC.
- Check whether the station operates correctly.

Energy metering

Metering equipment provided to measure the use of electricity shall comply with IEC 62052.

Three general approaches have been identified that can be used for metering EV load in Mode 3 as well; single metering, submetering, and separate metering. Similar to Mode 2, Mode 3 charging may be adopted in industrial and commercial EV charging stations. In such industrial and commercial applications, it is natural to use MDUs, where separate branch circuits will be required to each dwelling unit. Hence, the most sensible metering approach will be either separate metering or submetering, where the meter readings will be used to charge the customers who use the facility. The two cases are shown in Figures 16 and 17 respectively. Depending on the capacity of the grid supply, and the demand of the EVSC, the utility will have to decide on the need of a separate transformer.

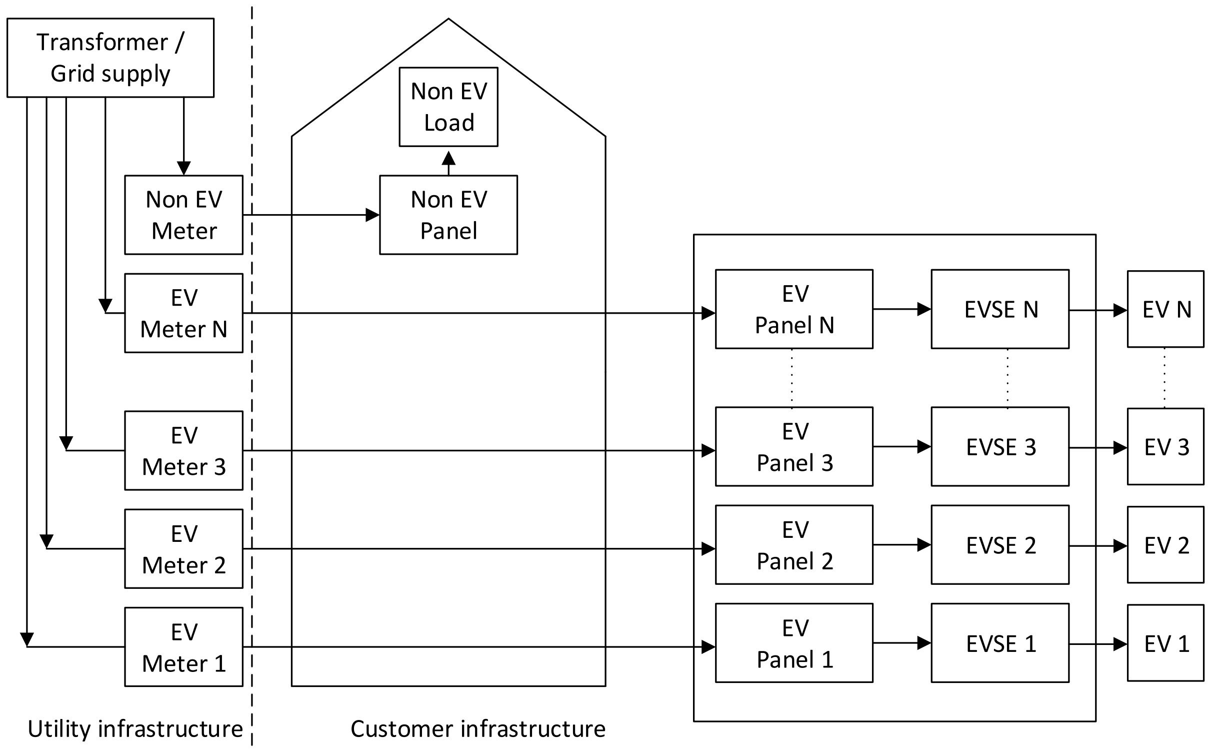


Figure 16 Separate metering for MDU EVCS with Non-EV load at the customer premises

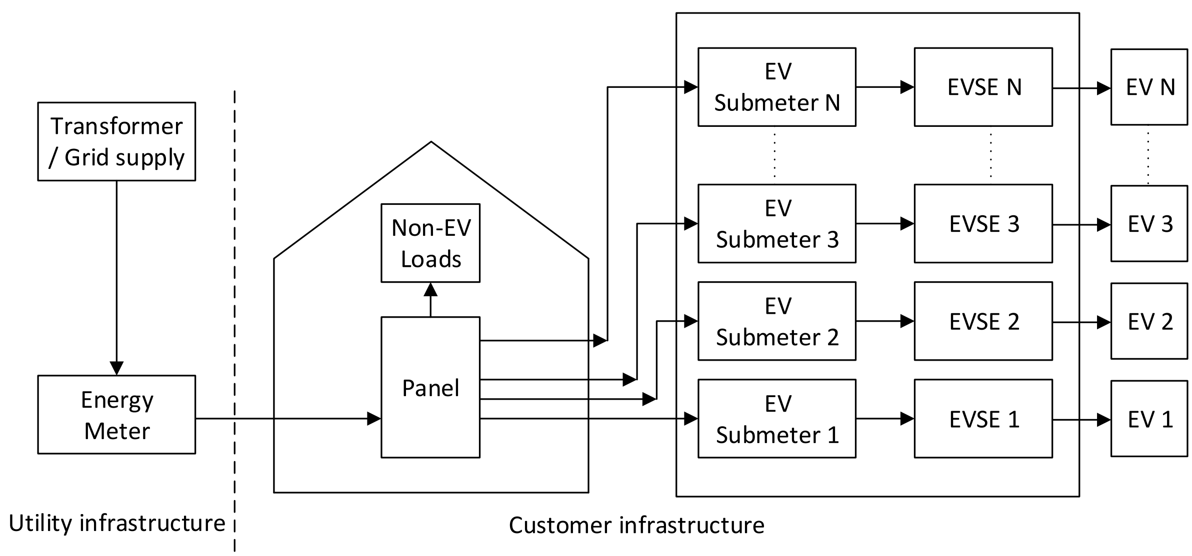


Figure 17 Submetering for MDU EVCS and Non-EV load at the customer premises

However, if the Mode 3 EV charging station with MDUs is not opened to the public, but dedicated to a predefined users such as the employees of the owner organization, the Single metering may be preferred as shown in Figure 18.

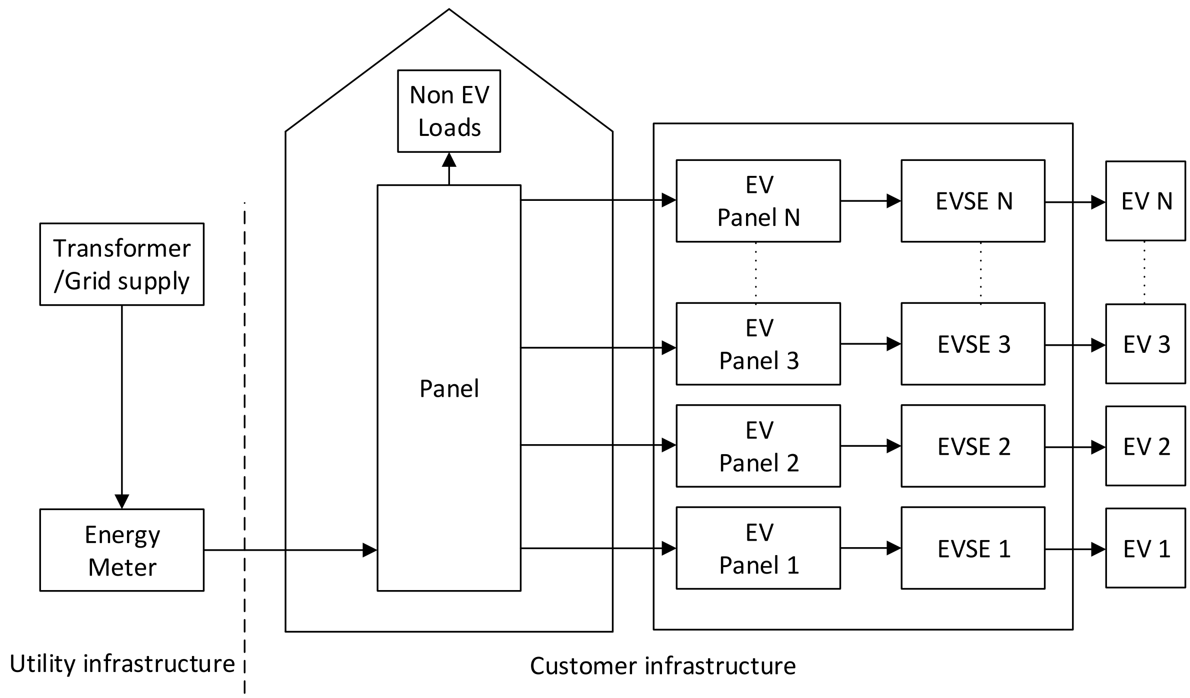


Figure 18 Single metering in Mode 3 EVCS

Safety codes and standards for chargers

In general the following are the key safety and operation requirements for Mode 3 Charger:

- Electromagnetic compatibility (EMC) emission and immunity - European standard EN 55011, EN 55022 and IEC 61000-4.
- Efficiency more than or equal to 96%.
- Harmonics current total harmonic distortion (iTHD) <7% complying with Institute of Electrical and Electronics Engineers (IEEE) 519.
- Minimum enclosure protection of IP54.
- Safety in terms of breaking capacities, cables and connectors, phase fault and earth fault conditions in compliance with IEC 62196, IEC 61851 and Conformité Européene (CE) marking.

Standards for interfaces and cables

IEC 62893-1:2017(E) specifies construction, dimensions and test requirements for cables with extruded insulation and sheath having a voltage rating of up to and including 1000V ac for Mode 3 charging of IEC 61851-1 for flexible applications under harsh conditions for the power supply between the electricity supply point of the EVCS and the EV.

Maximum conductor temperature for the cables in this part of IEC 62893 is 90 ºC. The particular types of cables are specified in IEC 62893-3 for Mode 3 charging. Hence Mode 3 charging cables have to be in compliance with IEC 62893.

Meter accuracy standards

Meter accuracy standards shall be in accordance with the standards specified below or later editions and/or amendments thereof,

- General requirements, tests and test conditions – IEC 62052-21:2003
- Power consumption, voltage requirements, accuracy and local interface - IEC 62053-21:2003
- Data exchange for meter reading, tariff and load control - IEC 62056-21:2002
- Acceptance inspection - IEC 62058-11: 2010 and IEC 62058-31:2010
- Degree of protection - IP 51
- Data communication – IEC 61334 & IEC/ISO 14908-4:2012
- Case – IP53 & IEC 60529
- Certifications - CE and RoHS in addition to the above IEC standards

Chapter 5

Minimum Standards for

EV Charging Station

Mode 4

Mode 4 charging means the connection of the EV to the supply network utilizing a dc EVCS (e.g. off-board charger) where the control pilot function extends to the dc EVCS. Pluggable dc EV charging stations, which are intended to be connected to the ac supply network using standard plugs and socket outlets, shall be compatible with residual current device with characteristics of type A. The pluggable dc EV charging station shall be provided with an RCD, and may be equipped with an overcurrent protection device.

Essentially, dc charging differs from ac charging in that it uses a charger built into the charging station instead of the on-board vehicle charger and offers higher charging power. Since the charging station delivers power directly to the vehicle battery, it must be able to adjust the charging voltage and current to the EV's characteristics.

There are three power levels in practice as

- DC Level 1: 200-450V dc, up to 20 kW (80A)
- DC Level 2: 200-450V dc, up to 80 kW (200A)
- DC Level 3: 200-600V dc, up to 200 kW (400A).

The connection of EVs using cables shall be carried out in case of C connection as specified in IEC61851-1. The mandatory dc charging functions of the charger as per the IEC61851-23 are

1. verification that the vehicle is properly connected
2. protective conductor continuity checking
3. energization of the system
4. de-energization of the system
5. dc supply for EV
6. measuring current and voltage
7. retaining / releasing coupler
8. locking of the coupler
9. compatibility assessment
10. insulation test before charging
11. protection against overvoltage at the battery
12. verification of vehicle connector voltage
13. control circuit supply integrity
14. short circuit test before charging
15. user initiated shutdown
16. protection against temporary over voltage

17. emergency shutdown

Power interfaces

DC fast charging is governed by the North American SAE J1772 Combo standard and the Japanese JEVS G105-1993 standard. DC fast-charge stations shall support both these standards. All carmakers adhere to one of these standards, except Tesla, which has developed a higher performance charging station, but offers a CHAdeMO adapter as an option. The maximum charging power specified by the CHAdeMO standard is 62 kW (125 A at 500 V DC), while the J1772 Combo standard sets the maximum power at 100 kW (200 A at 500 V DC). In practice, very few batteries support 500 V, and charging stations are commonly equipped with both standard connectors and limit the rated power to 50 kW. In contrast, Tesla Supercharger stations are rated 120 kW, and the automaker has announced even higher output levels in the near future.

The pin configurations and the communication protocol between the EV charging station and the EV can differ between the standards, but the basic functionalities should be the same. For example, both have two power pins (positive and negative), one ground pin, one pin to detect the presence of the connector in the socket and one pin for communication.

When the vehicle connector is inserted into the EV vehicle inlet, the connection shall be detected by the charging station, which in turn should signal the EV that the dc charging circuit has been established. The charging station and the vehicle shall exchange data throughout the charging process. Charging shall be managed by the external charger based on the data communicated by the EV.

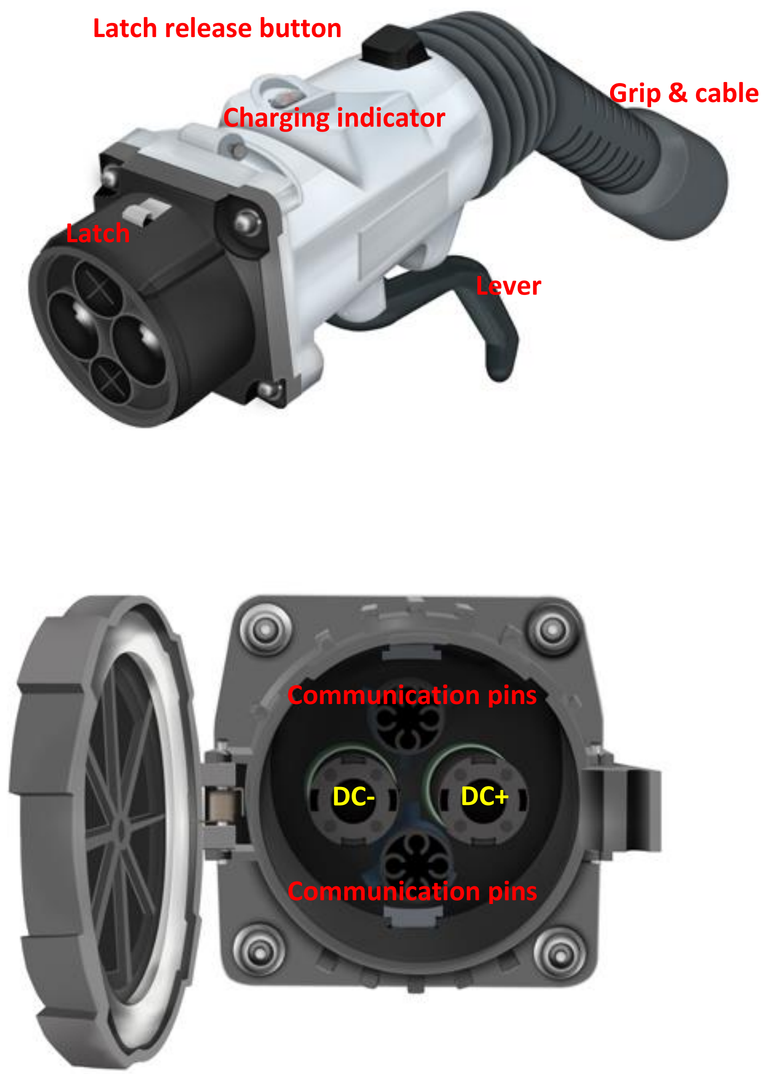


Figure 19 CHAdeMO Vehicle connector (upper) and CHAdeMO vehicle inlet

SAE J1772 Combo dc fast-charge stations (Combined Charging System, i.e., CCS) are equipped with a combination plug that uses pins from the standard J1772 (ac) connector, plus two additional power pins for 200 A current. When the Combo plug is inserted into the EV socket, the connection is detected by the charging station, which in turn signals to the EV that the dc charging circuit has been established over the high-power pins. The EV responds with its charge level and battery voltage, as well as the current its battery can accept. After this handshake, the connector and the cable are energized and charging begins. Charging is managed by the external charger based on the data communicated by the EV.

There are two variants of the CCS. One is based on SAEJ1772 socket interface (equivalent to IEC Type 1 socket) and the other based on IEC Type 2 socket interface. They are called Combo 1 and Combo 2 respectively. The former is more commonly used in EVs from the U.S. while the latter is more so among EVs from European countries.

A CCS vehicle inlet is shown in Figure 20.

Figure 20 Combine Charging System (CCS) supporting Mode 4;

Proximity Pilot (PP), Control Pilot (CP): Protective Earth (PE), Neutral (N) and Phases (L1, L2, and L3),

DC+ positive terminal, DC- negative terminal

The distinguishing feature of Tesla connectors is that they automatically support both ac and dc charging. Like in the other cases, Tesla EVCS starts the current flow only when the vehicle connector is plugged into the vehicle inlet and communication has been established between the charging station and the vehicle. A typical Tesla supercharger vehicle socket design is shown in Figure 21 and the corresponding supercharger vehicle inlet is shown in Figure 22.

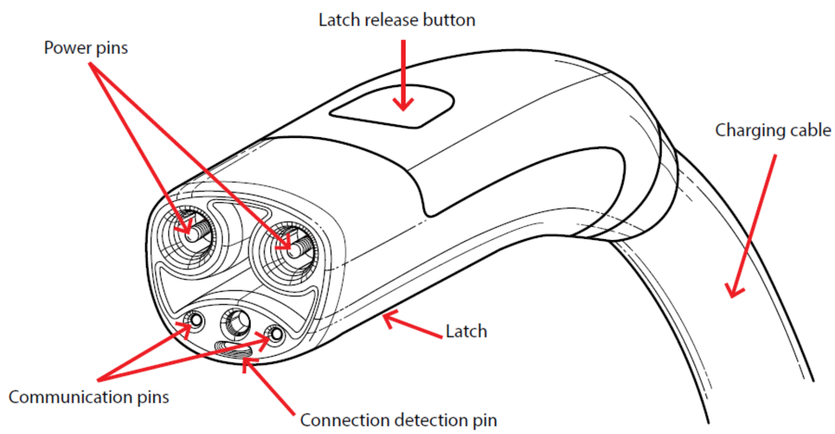


Figure 21 Tesla supercharger vehicle socket design

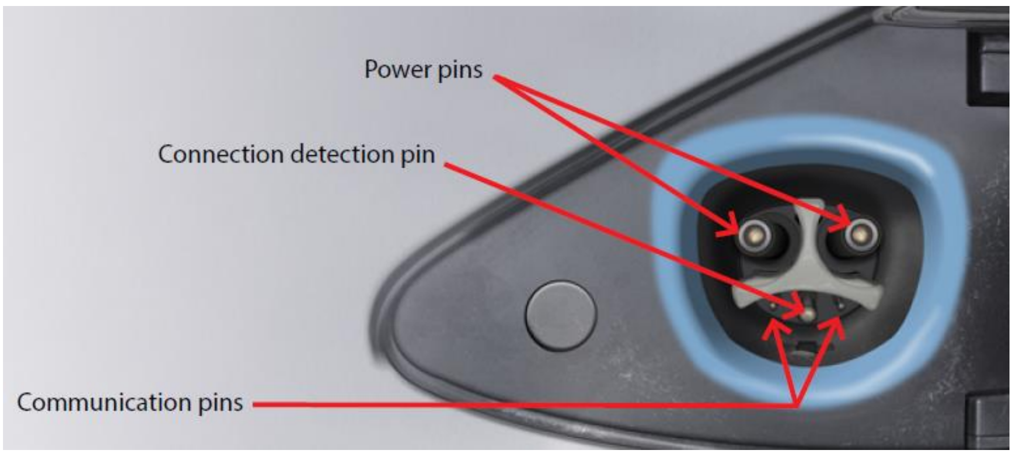


Figure 22 Tesla supercharger vehicle inlet

Installation standards

For mode 4 charging, the ac electric vehicle charging station should provide part of the control functions applicable to dc charging, which are listed in 6.4 of part 1 of IEC61851.

In the installation of the system, an emergency disconnection device shall be installed to isolate the ac supply network from the dc electric vehicle charging station in case of risk of electric shock, fire or explosion. The disconnection device shall be provided with a means to prevent accidental operation and should use Type A RCD and appropriate over current protection measures.

The maximum permissible surface temperature of parts of the ac electric vehicle charging station which are hand grasped, at the maximum rated current and at an ambient temperature of 40 °C, shall be

– 50 °C for metal parts;

– 60 °C for non-metallic parts.

For parts which may be touched but not grasped, maximum permissible surface temperature under the same conditions shall be

– 60 °C for metal parts;

– 85 °C for non-metallic parts.

When energized or not, and with the socket-outlet access trap door closed, shall provide a minimum degree of protection of IP44. Compliance is checked by test in accordance with IEC 60529.

A storage means shall be provided for the cable assembly and vehicle connector when not in use. The dc electric vehicle charging station should be provided with a means to indicate whether or not the cable assembly/vehicle connector has been stored as intended after disconnection from the vehicle.

The lowest part of the socket-outlet or the storage means provided for the vehicle connector shall be located at a height between 0.4 m and 1.5 m above ground level.

The use of an extension cord for the connection of the EV to the dc EVCS should be prohibited in order to avoid any direct contact or the dangerous use of unsafe components (risk of overload, absence of protective conductor, etc.).

Compliance shall be checked by testing the electrical continuity between exposed conductive parts and the earth circuit. A current of 16 A, derived from a dc source having a no-load voltage not exceeding 12 V, is passed between any exposed conductive part and the earthing terminal of the charging station. For each exposed conductive part, the voltage drop is measured between these two points. The resistance calculated from the current and measured voltage drop, between any exposed conductive part and the earth-circuit connection, shall not exceed 0.1 Ω. For a class II charging station, there shall be a lead-through protective conductor.

The insulation resistance with a 500 V dc voltage applied between all inputs/outputs connected together (power source included) and the accessible parts shall be

- for a class I station: R > 1 MΩ;
- for a class II station: R > 7 MΩ.

The measurement of insulation resistance shall be carried out after applying the test voltage for 1 min and immediately after the damp heat test.

The choice of circuit components should match the ratings of the EV charging station as given in IEC61851, i.e. 32 A, 400 V three phase or 32 A, 230 V, per charger unit. The station must be supplied from a separate supply or a dedicated branch circuit for charger(s); this may require adding a circuit breaker and a Type A RCD with appropriate rating to the distribution panel. Since this type of apparatus is considered a continuous load, if the the existing service line is used, it must be able to support the additional load. Otherwise, it may be necessary to get a new electricity supply connection and a service line. Conductor gauges must be selected so as to limit voltage drops in compliance with IET Wiring Regulations 18^{th} Edition (BS7671).

The installation shall be carried out under the supervision of a chartered engineer by an electrician who has qualifications and experience at the level of Sri Lanka Qualifications Framework Level 4.

The electrician may follow the guidelines given below:

- Read the manufacturer's installation instructions.
- Consult the nameplate in order to make sure the apparatus is approved with the recognized certification marking and determine the ratings, e.g., 400 V, 32 A per dwelling station.
- Ensure that the distribution panel is capable of supplying the additional load, according to the prescriptions of IET Wiring Regulations 18th Edition (BS7671) as each station in the case of multiple dwelling units (MDU) is considered as a separate continuous load.
- Install the wiring between the panel and the EVSC using the appropriate method as specified in BS7671.
- Install a circuit breaker with the appropriate rating in the distribution panel (40 A per dwelling station in this example).
- Make the connections and energize the EVSC.
- Check whether the station operates correctly.

Communication between EV and dc EV charging station have been defined in IEC61851-23 as System A, System B and System C. Different protocols (such as CCS, CHAdeMO, Tesla, GB/T) may follow one of these Systems and the manufacturers should specify the System they have adopted.

System A

System A is a regulated dc charging system using a dedicated Control Area Network (CAN) communication circuit for digital communication between a dc EVCS and an EV for control of dc charging. The vehicle connector of configuration AA as specified in IEC 62196-3 is applicable to system A. The specific requirements for digital communication and details of the communication actions and parameters of system A are defined in Annex A of IEC 61851-24. The rated voltage of dc output for system A station is limited to 500 V dc. This system is recommended for the passenger vehicles and light trucks. The schematic block diagram of system A is given in Figure 23 as defined in IEC61851-23.

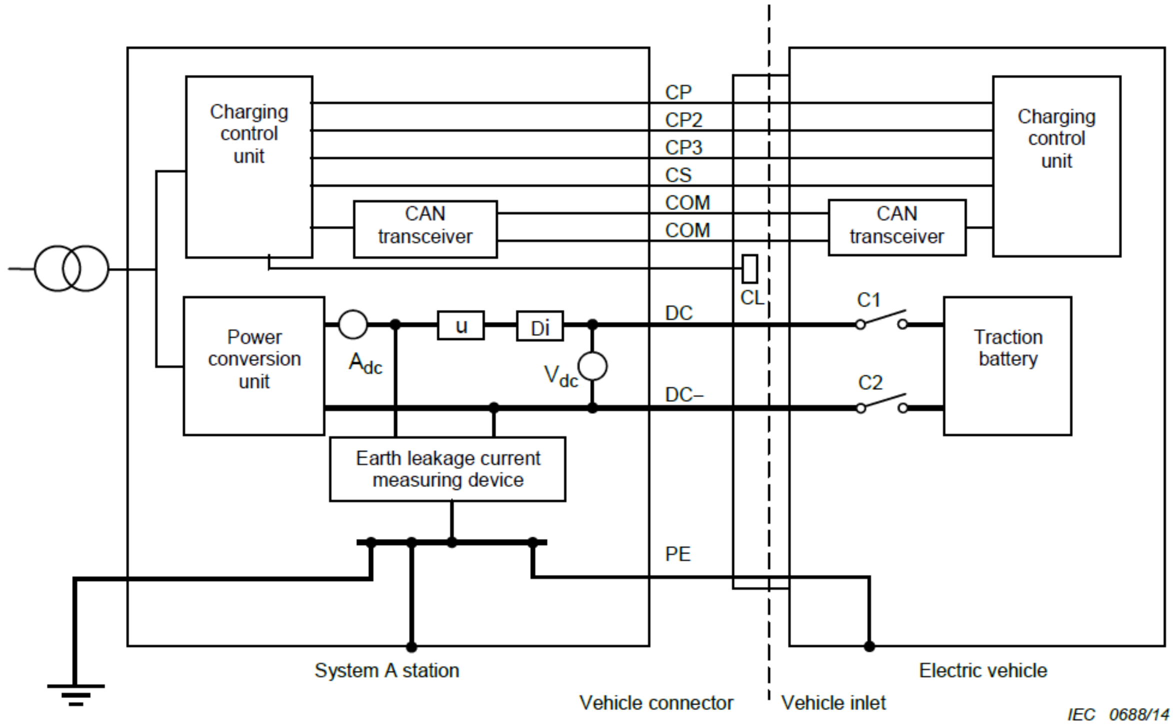


Figure 23 System A schematic diagram

System B

Figure 24 shows the System B basic solution of dc charging system for charging mode 4, including DC charger control unit resistors R1, R2, R3, R4 and R5, switch S, ac supply circuit contactor K0, isolating transformer T, ac/dc inverter, dc supply circuit contactors K1 and K2, low voltage auxiliary supply circuit contactors K3 and K4, charging circuit contactors K5 and K6, reverse-current-prevention device including diode K7 and R6, electrical interlock, and vehicle control unit. Vehicle control unit can be integrated in the BMS (battery management system). Resistors R2 and R3 are installed on the vehicle connector, and resistance R4 is installed in the vehicle inlet. Switch S is the inner switch of vehicle connector, and it will close when the vehicle connector and vehicle inlet are properly connected. During the whole charging process, dc charger control unit should detect and control the states of K1, K2, K3 and K4, while the vehicle control unit detects and controls K5 and K6. During the charging procedure, if the insulation monitoring device (IMD) detects that the insulation resistance drops below the setting value, the setting value shall be no less than a value calculated by 100 Ω/V multiplied by the maximum output voltage rating of the dc EV charging station.

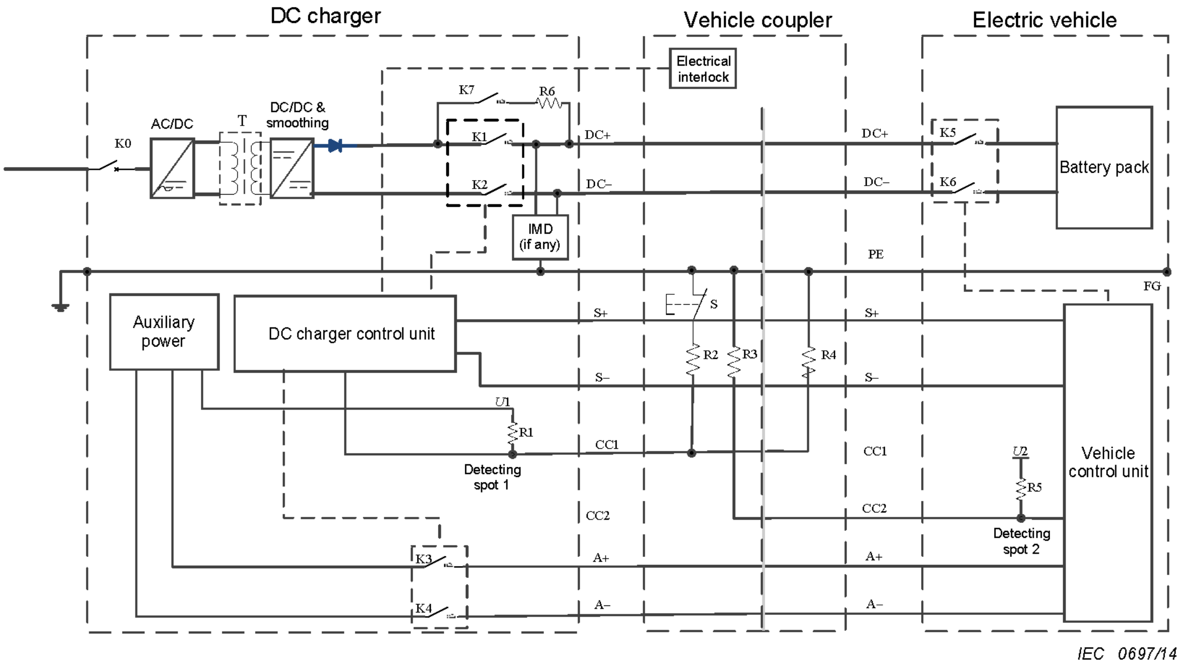


Figure 24 System B schematic diagram

System C

System C provides specific requirements for dc EV charging stations for use with the combined charging system. The combined charging system is a mode 4 charging system with rated dc output voltage limited to 1000 V. Schematics of combined charging system for dc supply is given in Figure 25.

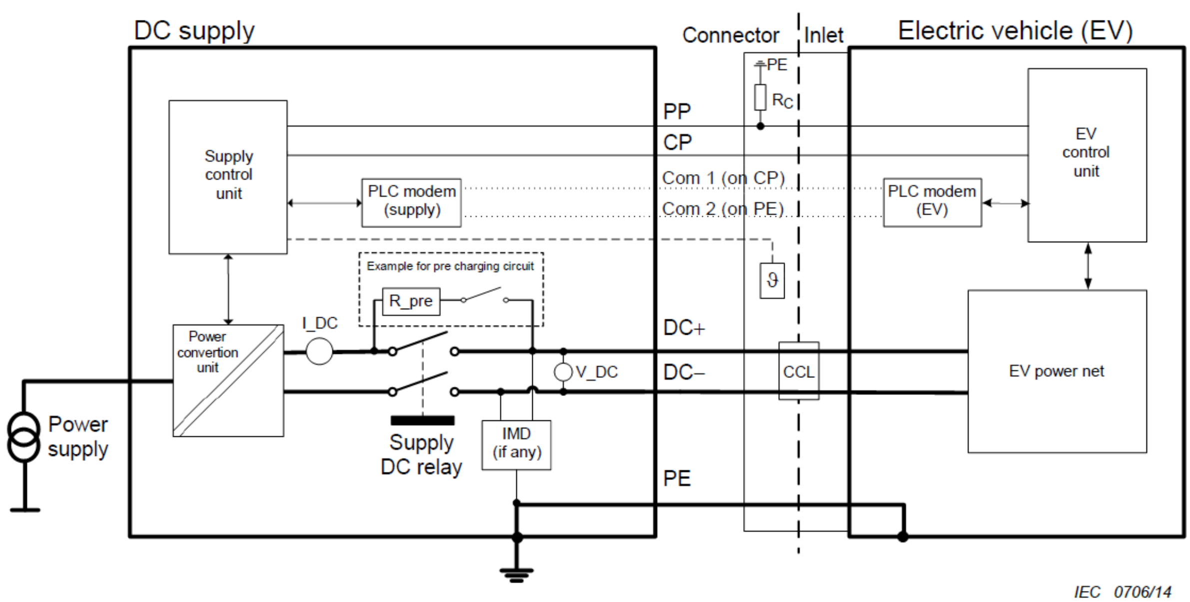


Figure 25 System C schematic diagram

Energy metering

The ac side metering is as same as in Mode 3. The metering equipment provided to measure the use of electricity shall comply with IEC 62052. Three general approaches have been identified that can be used for ac side metering of EV load in the Mode 4 as well; single metering, submetering, and separate metering. Similar to Mode 2 and 3, Mode 4 charging may be adopted in industrial and commercial EV charging stations. In such industrial and commercial applications, it is natural to use MDUs, where separate branch circuits will be required to each dwelling unit. Hence, the most sensible metering approach will be either separate metering or submetering, where the meter readings will be used to charge the customers who use the facility. The two cases are shown in Figures 26 and 27 respectively. Depending on the capacity of the grid supply, and the demand of the EVSC, the utility will have to decide on the need of a separate transformer.

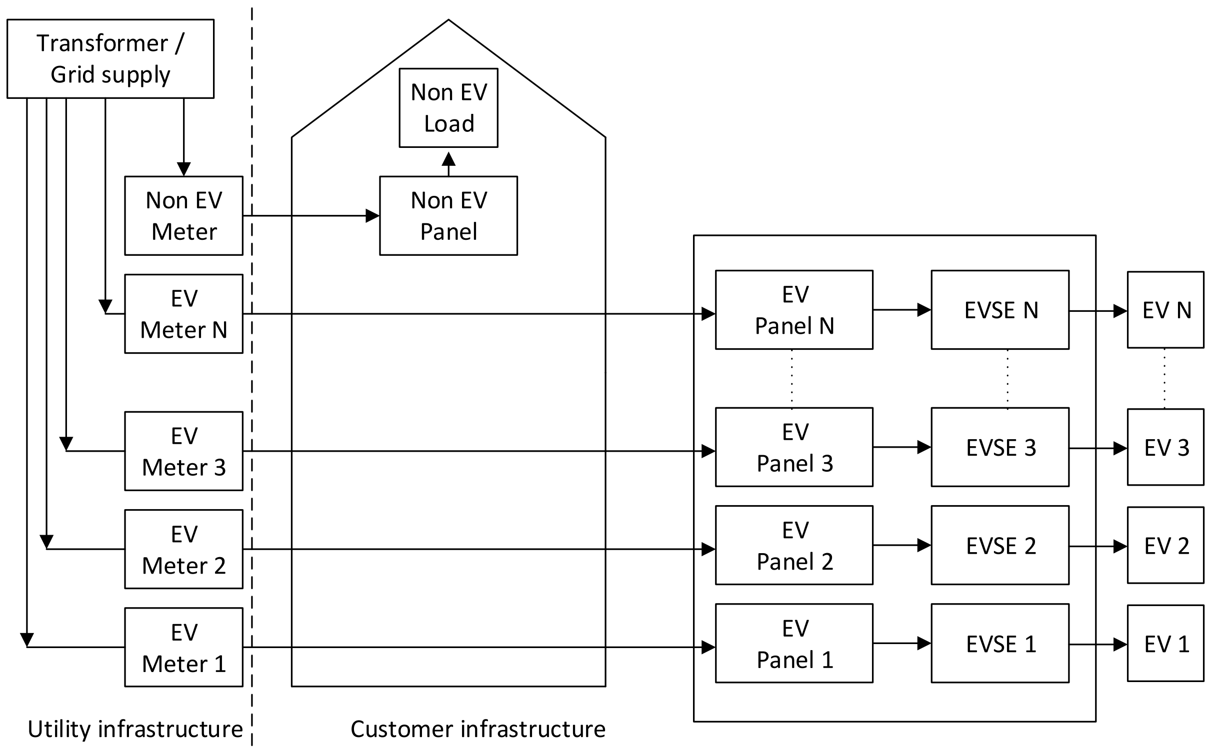


Figure 26 Separate metering for MDU EVCS with Non-EV load at the customer premises

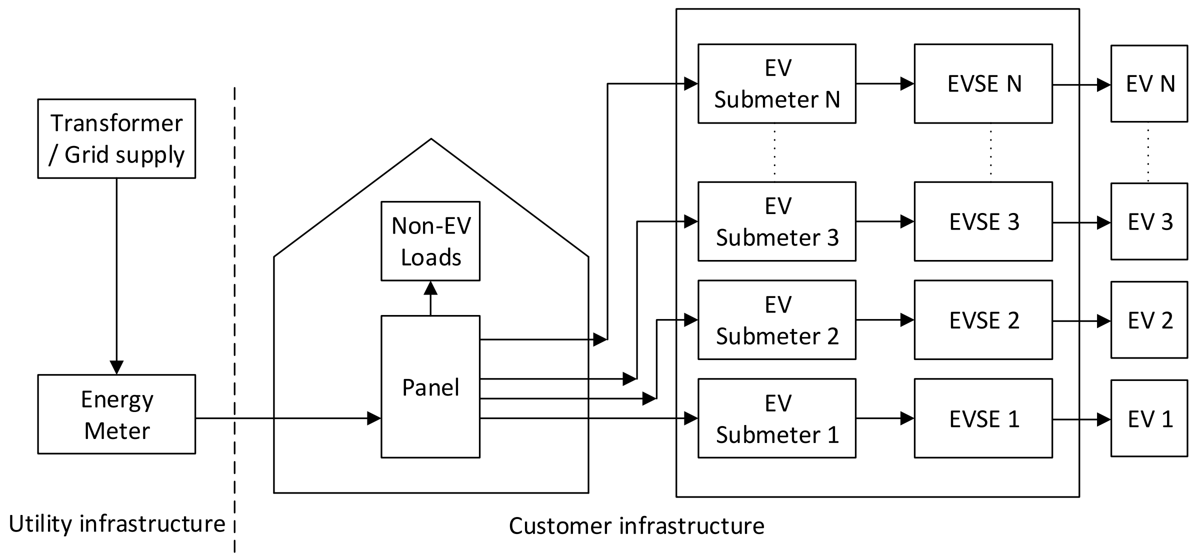


Figure 27 Submetering for MDU EVCS and Non-EV load at the customer premises

However, if the Mode 3 EV charging station with MDUs is not opened to the public, but dedicated to a predefined users such as the employees of the owner organization, the Single metering may be preferred as shown in Figure 28.

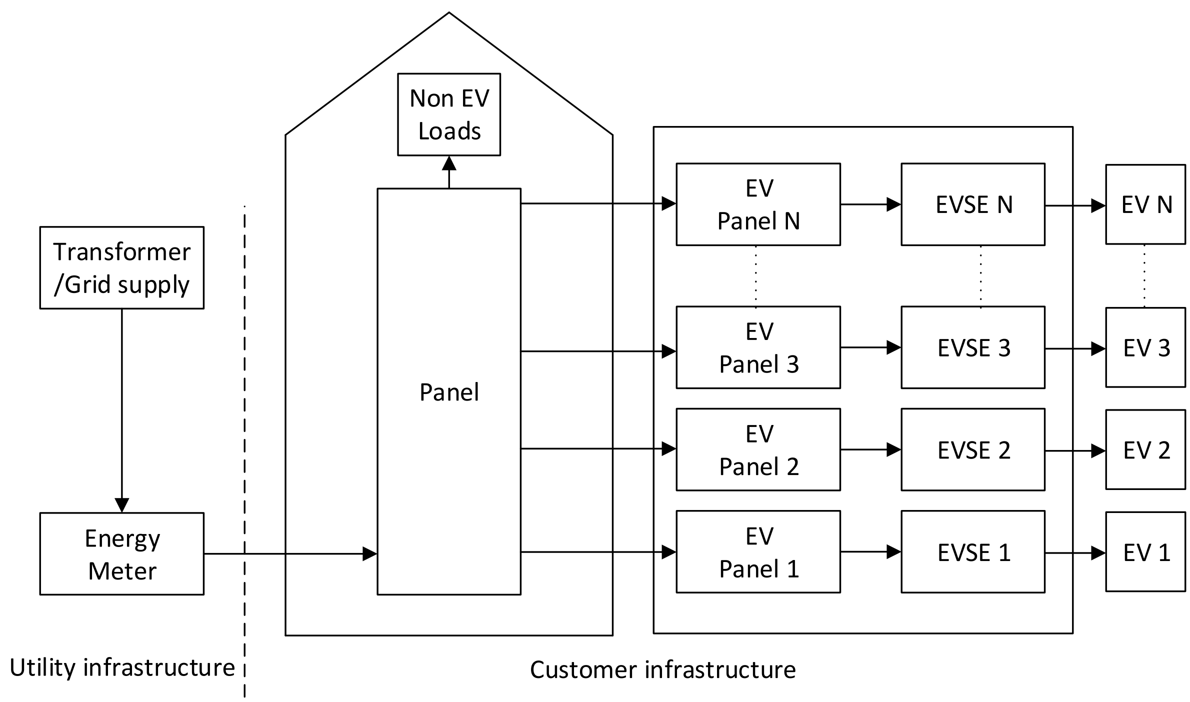


Figure 28 Single metering in Mode 3 EVCS

Since the current utility practices do not allow installing more than one energy meter to one premises, single metering is the only possible metering scheme in Sri Lanka as of now. However, for Mode 4 charging, the energy measurements are acquired using the backend software provided by the charger manufacturer. The same will be displaced to the users of the EV chargers. Typically such communications follow the Open Charge Point Protocol (OCPP). All such acquired charging information should be made accessible to the PUCSL online, who will determine the charging fees either on the charging time or the consumed energy units (kWh). Since the charging fees for a customer at a dwelling unit will be calculated based on the energy dispatched at the dc side, it is the responsibility of the EVCS management to deploy the off-board chargers of highest conversion efficiency.

Meter accuracy standards

Meter accuracy standards shall be in accordance with the standards specified below or later editions and/or amendments thereof,

- General requirements, tests and test conditions – IEC 62052-21:2003
- Power consumption, voltage requirements, accuracy and local interface - IEC 62053-21:2003
- Data exchange for meter reading, tariff and load control - IEC 62056-21:2002
- Acceptance inspection - IEC 62058-11: 2010 and IEC 62058-31:2010
- Degree of protection - IP 51
- Data communication – IEC 61334 & IEC/ISO 14908-4:2012
- Case – IP53 & IEC 60529
- Certifications - CE and RoHS in addition to the above IEC standards

Standards for interfaces and cables

IEC 62893-1:2017(E) specifies construction, dimensions and test requirements for cables with extruded insulation and sheath having a voltage rating of up to and including 1500 V dc for Mode 4 charging of IEC 61851-1 for flexible applications under harsh conditions for the power supply between the electricity supply point of the EVCS and the EV.

The EV charging cable is intended to supply power and, communication (detailed in IEC 62196 series and IEC 61851-1) to an EV. Maximum conductor temperature for the cables in this part of IEC 62893 is 90 ºC. The particular types of cables are specified in IEC 62893-4 for mode 4 for dc charging. Hence Mode 4 charging cables have to be in compliance with IEC 62893.

Safety codes and standards for chargers

In general the following are the key safety and operation requirements of off-board Mode 4 dc chargers:

- Electromagnetic compatibility (EMC) emission and immunity - European standard EN 55011, EN 55022 and IEC 61000-4.
- Minimum efficiency 96%.

- Harmonics current total harmonic distortion (iTHD) <7% complying with Institute of Electrical and Electronics Engineers (IEEE) 519.
- Minimum enclosure protection of IP54.
- Safety compliance with IEC 62196, IEC 61851 and Conformité Européene (CE) marking.

Chapter 6

Technical Guidelines for EV Charging Stations in Sri Lanka

Introduction

This set of technical guidelines sets out the statutory requirements and general guidelines for installation of Electric Vehicle Charging Stations in Sri Lanka.

This set of technical guidelines supersedes all previous technical guidelines on charging facilities for electric vehicles and shall apply to new charging facilities. Existing charging facilities conforming to previous technical guidelines may continue to be used unless such facilities are being altered, added or improved in which case this set of technical guidelines shall apply.

The terms and definitions used in this set of technical guidelines are listed in Appendix A

Statutory Requirements

Electric vehicle charging stations are fixed electrical installations and shall comply with the relevant requirements of the Sri Lanka Electricity Act, No. 20 of 2009 and its subsidiary Regulations, including Electricity Safety, Quality and Continuity Regulations (ESQCR), Distribution Code, and Guidelines for Electricity Meters.

Electrical work on EV charging facilities including design, installation, commissioning, inspection, testing, maintenance, modification and repairing shall be carried out under the supervision of chartered engineers by workers who have qualifications and experience at the level of Sri Lanka Qualifications Framework Level 4.

General Guidelines on Electric Vehicle Charging Stations

Final Circuit

a) Each final circuit of EV charging facility shall be installed as a separate radial circuit of the fixed electrical installation.

b) Electric cable for the final circuit shall be protected by means of metal sheath or armour, or installed in steel/plastic/PVC conduits for Modes 3 and 4.

c) The copper conductor size of electric cable for each final circuit shall be selected based on the design current of the EVSE and taking into account the constraint of voltage drop in the circuit in accordance with the relevant requirements of the latest Code of Practice for the Electricity (Wiring) Regulations. A larger size electric cable may be used to facilitate future upgrade. In connection with this, a conductor size suitable for carrying a minimum rated current of 32A is recommended.

Protective Device

a) Each final circuit shall be individually protected by a high breaking capacity (HBC) fuse or miniature circuit breaker (MCB) of suitable rating.
b) An earth leakage protective device shall be provided for each final circuit. A residual current device (RCD) with characteristics of type A and residual operating current not exceeding 30mA is acceptable.
c) A current breaking device (an ON/OFF switch or others) shall be provided at the upstream of the socket outlet at the charging facility for switching on after plugging and switching off before unplugging the charging cable assembly.

Socket Outlet and Plug

a) For Mode 1 charging, the standard socket outlet for EV charging facility used in Sri Lanka shall be a 13A socket outlet complying with BS 1363 and the associated plug used shall be a 13A non-rewirable plug also complying with BS 1363.
b) For Mode 2 charging, socket outlet and the associated plug used complying with IEC 60309 may be employed.
c) For Mode 3 charging, the type of socket outlet or vehicle connector required shall conform to the charging system protocol designed for the EV. At present, dedicated socket outlets conforming to IEC 62196 and SAE J1772 are becoming more common while socket outlets conforming to GB 20234 are also available.

In recent market development, EV charger manufacturers have launched multi-standard products to enhance the versatility of EV chargers. There are various configurations of the multi-standard systems. The more common one incorporates two dc charging standards in one charger, e.g. CHAdeMO plus CCS or other combinations. Some chargers may also incorporate both ac and dc charging in a single charger, e.g. IEC plus CCS or IEC plus CCS and CHAdeMO etc.

DC fast chargers typically of 50 kW capacity in compliance with the Japanese CHAdeMO protocol (Mode 4 off-board charging).

Combined Charging System (CCS) integrates one-phase ac charging, three-phase ac charging and dc charging into a single vehicle inlet. This universal charging system will allow EV owners to recharge at most existing charging stations regardless of power source.

d) EVSE or socket outlet shall, in general, be installed at a height of about 1.2 m above finished floor level for easy access but the actual level may vary to suit EV user's need and site condition.

e) EVSE and socket outlet and associated electrical equipment shall be suitably protected from ingress of dust and water to an index of protection of IPX3 for use at indoor car park. An index of protection of IPX4 or higher is required for both plugged and no-plug conditions if the EV charging facility is installed and used in an outdoor environment. The use of a weatherproof enclosure to house both socket outlet and associated electrical equipment is acceptable.

Extension Unit

No extension unit other than charging cable assembly designed for EV charging shall be used.

Type Test Certificate

All EVSE and their accessories shall be type tested for compliance with the relevant IEC, SAE, GB or CHAdeMO standard(s). In addition, if an EVSE is designed for outdoor use, test certificate for ingress protection rating in accordance with IEC 60529, e.g. IP 54 or above shall be available. EVSE suppliers shall be obliged to provide such test certificates.

Other Considerations

a) An operation instruction for the charging facility including essential information of the rated voltage (V), frequency (Hz), current (A), and number of phase shall be displayed at a prominent location at each of the parking space with EVCS.

b) For Mode 2 charging, a bracket or hanging device for supporting the weight of in-cable control box of the EV charging cable shall be provided as far as practicable to avoid excessive loading on the EV charging cable and plug.

c) Other advanced features for charging facility such as system energization, charging rate selection, vehicle connection verification, and circuit protective conductor integrity detection may be considered.

d) Directional signage inside and outside car park is recommended to direct EV drivers to designated parking spaces within the EVCS.

e) Occupancy sensors are useful devices giving indication to drivers on availability EVCS in a public car park and may be considered by the owner of a public car park.

f) Means of preventing unauthorized usage of the charging facilities such as housing the socket outlet in a padlocked box or using an access card for energizing charging facility etc., may be provided as necessary.

g) The provision of an indicator light at the charging facility to indicate charging in progress may be provided.

h) For EVCS with multiple charging facilities, provision of wired communication for group control of the charging facilities may be considered.

i) CCTV surveillance may be considered to improve security.

j) The installation of charging facilities at a petrol station requires specific precautions to avoid hazardous areas such as the fuel pumps and fuel tank vents. It is recommended to install the chargers outside the Zone 2 of Figure 29 and 30 [12].

k) In addition to the general sign boards for parking, no parking, electrical shock risks, under CCTV surveillance, keep children away, the EVCS must use the symbol similar to Figure 31 to signify its existence in the public.

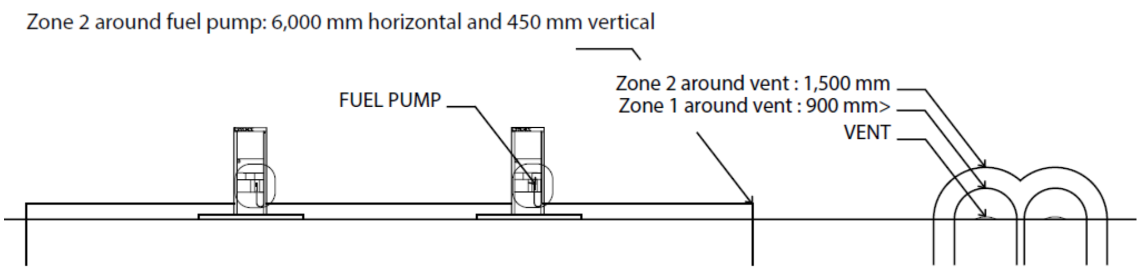


Figure 29 Side elevation of the hazardous areas

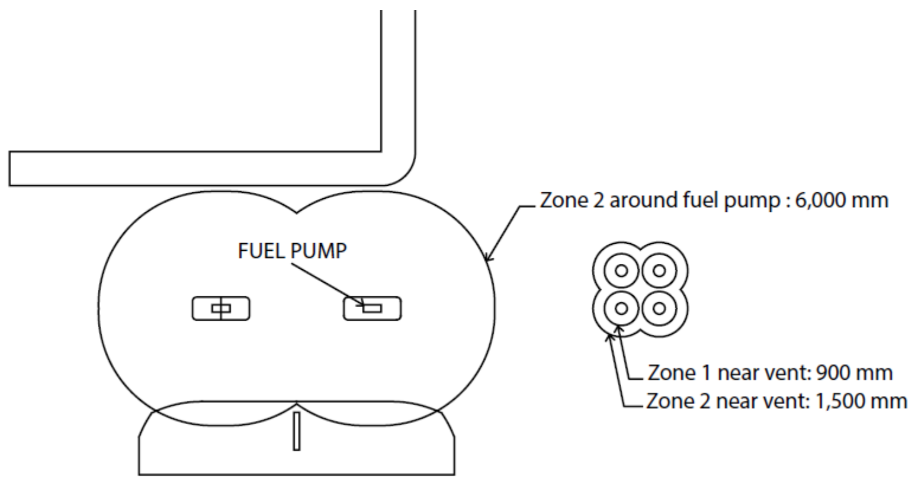


Figure 30 Plan view of the hazardous areas

Figure 31 Sign of the EVCS

Inspection and Maintenance

Regular inspection of the charging facilities shall be carried out. If repair or maintenance is required, any electrical work shall be carried out under the supervision of chartered engineers by workers who have qualifications and experience at the level of Sri Lanka Qualifications Framework Level 4.

APPENDIX A

For the purposes of this document, the following terms and definitions as per IEC61851 apply.

A.1 basic insulation - insulation of hazardous-live-parts which provides basic protection.

A.2 cable assembly - piece of equipment used to establish the connection between the EV and socket-outlet.

A.3 charger - power converter that performs the necessary functions for charging a battery.

A.3.1 class I charger - charger with basic insulation as provision for basic protection and protective bonding as provision for fault protection.

NOTE Protective bonding consists of connection of all exposed conductive parts to the charger earth terminal.

A.3.2 class II charger - charger with

– basic insulation as provision for basic protection, and

– supplementary insulation as provision for fault protection, or in which

– basic and fault protection are provided by reinforced insulation.

A.3.3 off-board charger - charger connected to the premises wiring of the ac supply network (mains) and designed to operate entirely off the vehicle. In this case, direct current electrical power is delivered to the vehicle.

A.3.4 dedicated off-board charger - off-board charger designed to be used only by a specific type of EV, which may have control charging functions and/or communication.

A.3.5 on-board charger - charger mounted on the vehicle and designed to operate only on the vehicle.

A.4 charging - all functions necessary to condition standard voltage and frequency ac supply current to a regulated voltage/current level to assure proper charging of the EV traction battery and/or supply of energy to the EV traction battery bus, for operating on-board electrical equipment in a controlled manner to assure proper energy transfer.

A.5 connection - single conductive path.

A.6 control pilot - the control conductor in the cable assembly connecting the in-cable control box or the fixed part of the EVSE, and the EV earth through the control circuitry on the vehicle. It may be used to perform several functions.

A.7 earth terminal - accessible connection point for all exposed conductive parts electrically bound together.

A.8 electric vehicle (EV) - any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electric service), which is manufactured primarily for use on public streets, roads or highways.

A.8.1 class I EV - an EV with basic insulation as provision for basic protection and protective bonding as provision for fault protection. This consists of connection of all exposed conductive parts to the EV earth terminal.

A.8.2 class II EV - EV in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions, such as double insulation or reinforced insulation, are provided, there being no provision for protective earthing or reliance upon installation conditions.

A.9 EV supply equipment (EVSE) - conductors, including the phase, neutral and protective earth conductors, the EV couplers, attachment plugs, and all other accessories, devices, power outlets or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the EV and allowing communication between them if required.

A.9.1 ac EV charging station - all equipment for delivering ac current to EVs, installed in an enclosure(s) and with special control functions.

A.9.2 dc EV charging station - all equipment for delivering dc current to EVs, installed in an enclosure(s), with special control functions and communication and located off the vehicle.

NOTE DC charging includes pulse mode charging.

A.9.3 exposed conductive part - conductive part of equipment, which can be touched and which is not normally live, but which can become live when basic insulation fails.

A.9.4 direct contact - contact of persons with live parts.

A.9.5 indirect contact - contact of persons with exposed conductive parts made live by an insulation failure.

A.10 live part - any conductor or conductive part intended to be electrically energized in normal use.

A.10.1 hazardous live part - live part, which under certain conditions, can result in an electric shock.

A.11 in-cable control box - a device incorporated in the cable assembly, which performs control functions and safety functions. The in-cable control box is located in a detachable cable assembly or plug that is not part of the fixed installation.

A.12 plug and socket-outlet - means of enabling the manual connection of a flexible cable to fixed wiring. It consists of two parts: a socket-outlet and a plug.

A.12.1 plug - part of a plug and socket-outlet integral with or intended to be attached to the flexible cable connected to the socket-outlet.

A.12.2 socket-outlet - part of a plug and socket-outlet intended to be installed with the fixed wiring.

A.13 power indicator - resistor value identifying supply rating recognition by the vehicle.

A.14 retaining device - mechanical arrangement which holds a plug or connector in position when it is in proper engagement, and prevents unintentional withdrawal of the plug or connector.

A.15 vehicle coupler - means of enabling the manual connection of a flexible cable to an EV for the purpose of charging the traction batteries. It consists of two parts: a vehicle connector and a vehicle inlet.

A.15.1 vehicle connector - part of a vehicle coupler integral with, or intended to be attached to, the flexible cable connected to the ac supply network (mains).

A.15.2 vehicle inlet - part of a vehicle coupler incorporated in, or fixed to, the EV or intended to be fixed to it.

A.16 function - any means, electronic or mechanical, that insure that the conditions related to the safety or the transmission of data required for the mode of operation are respected.

A.17 pilot function - any means, electronic or mechanical, that insures the conditions related to the safety or the transmission of data required for the mode of operation.

A.18 proximity function - a means, electrical or mechanical, in a coupler to indicate the presence of the vehicle connector to the vehicle.

A.19 standardized socket-outlet - socket-outlet which meets the requirements of any IEC and/or national standard.

A.20 residual current device (RCD) - mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions.

A.21 pulse mode charging - charging of storage batteries using modulated direct current.

A.22 plug in hybrid electric road vehicle (PHEV) - any electrical vehicle that can charge the rechargeable electrical energy storage device from an external electric source and also derives part of its energy from another source.

A.23 cord extension set - assembly consisting of a flexible cable or cord fitted with both a plug and a connector of a standard interface type.

NOTE A mode 2 or a mode 1 cable assembly is not considered as a cord extension set.

A.24 adaptor - a portable accessory constructed as an integral unit incorporating both a plug portion and one socket-outlet. The socket-outlet may accept different configurations and ratings.

A.25 indoor use - equipment designed to be exclusively used in a weather protected locations.

A.26 outdoor use - equipment designed to be allowed to be used in non-weather protected locations.

REFERENCES

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