

ARTICLE 625

ELECTRIC VEHICLE POWER TRANSFER SYSTEM

Introduction to Article 625—Electric Vehicle Power Transfer System

Electric vehicles have been around for a long time. Anyone who has worked in a factory or warehouse, or visited a big box store, has probably encountered an electric lift truck. And, of course, we are all familiar with golf carts. These and other off-road vehicles have charging requirements that are easily accommodated by small charging systems.

But today, a new challenge has emerged and is becoming increasingly common. That challenge is the electrically powered passenger vehicle, bus, truck, and motorcycle. Such vehicles, especially an electric car or bus, can weigh considerably more than a golf cart and just moving one takes a proportionately larger motor. In fact, many designs use multiple drive motors.

Those motors are powered by batteries. Adding to the battery sizing requirement are other demands. For example:

- ▶ These vehicles must be able to travel at highway speeds over distances roughly comparable to those traveled by their internal combustion engine counterparts.
- ▶ These vehicles have powered accessories that you typically will not find on a golf cart, such as air-conditioning, electric windows, stereo systems, windshield wipers, security systems, and window defrosters.
- ▶ These vehicles are expected to start in summer heat and in brutal winter cold.

The battery system for an electrically powered passenger vehicle is therefore considerably larger than that for a golf cart or other typical off-road electric vehicle. Consequently, the charging system must have the capability of delivering far more power than the one needed for a typical off-road electric vehicle.

An electrically powered passenger vehicle needs a dedicated charging circuit. Article 625 defines the requirements for the installation of the electrical equipment needed to charge automotive-type electric and hybrid vehicles including cars, motorcycles, and buses.

Part I. General

625.1 Scope

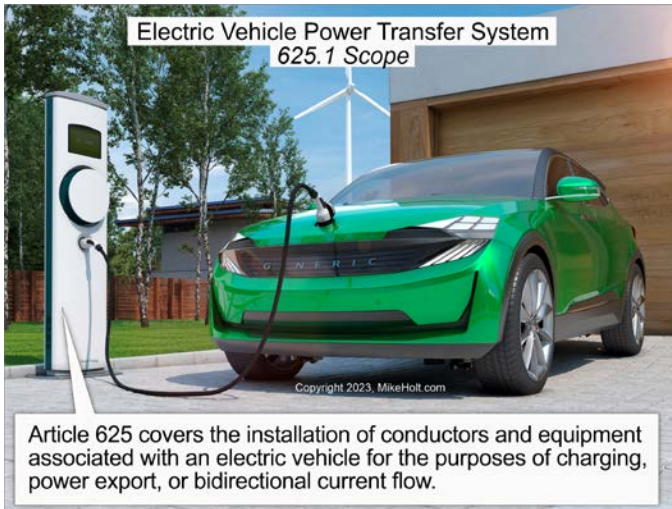
Article 625 covers the installation of conductors and equipment associated with an electric vehicle for the purposes of charging, power export, or bidirectional current flow. ▶[Figure 625-1](#) and ▶[Figure 625-2](#)

According to Article 100, “Electric Vehicle” is an on-road use automobile, bus, truck, van, neighborhood electric vehicle and motorcycle primarily powered by an electric motor. ▶[Figure 625-3](#)

Note: Off-road, self-propelled electric industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, and boats are not electric vehicles for the purpose of the *NEC*. ▶[Figure 625-4](#)

625.6 Listed

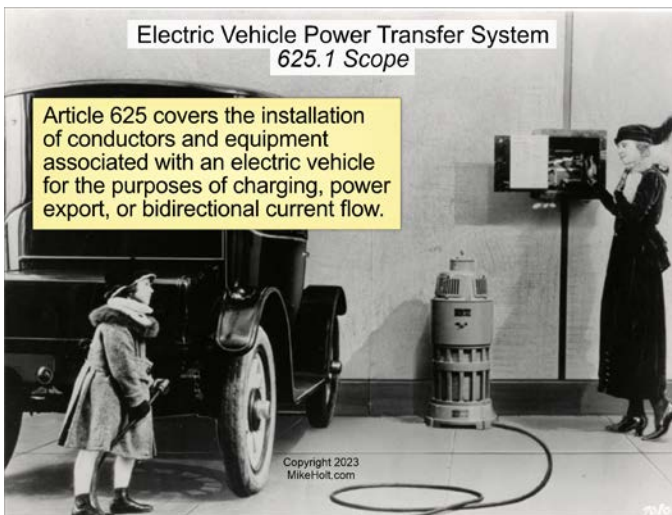
Electric vehicle power transfer system equipment for the purposes of charging, power export, or bidirectional current flow must be listed. ▶[Figure 625-5](#)



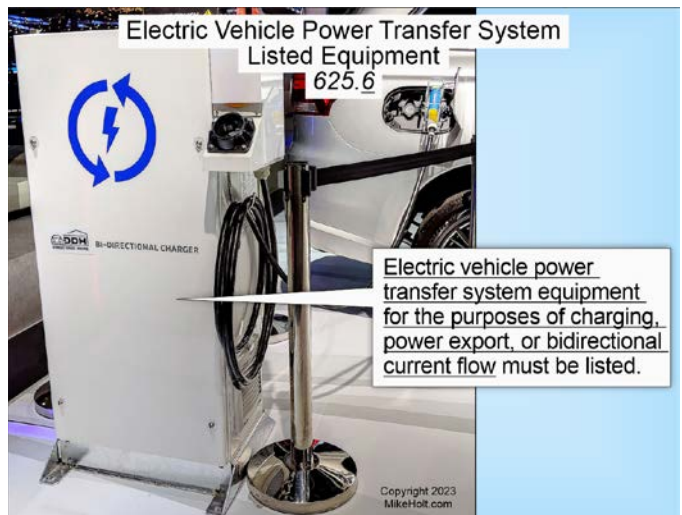
▶Figure 625-1



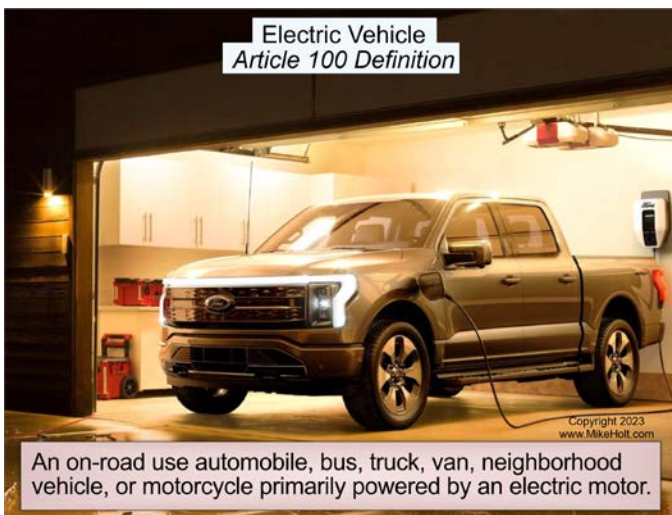
▶Figure 625-4



▶Figure 625-2



▶Figure 625-5



▶Figure 625-3

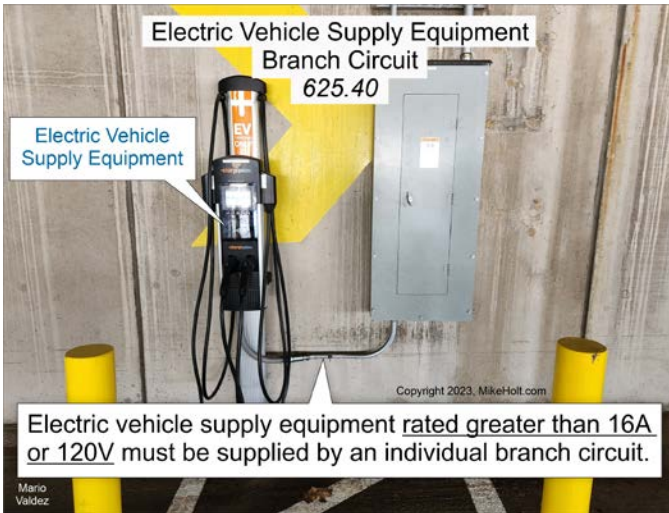
Part III. Installation

625.40 Electric Vehicle Branch Circuit

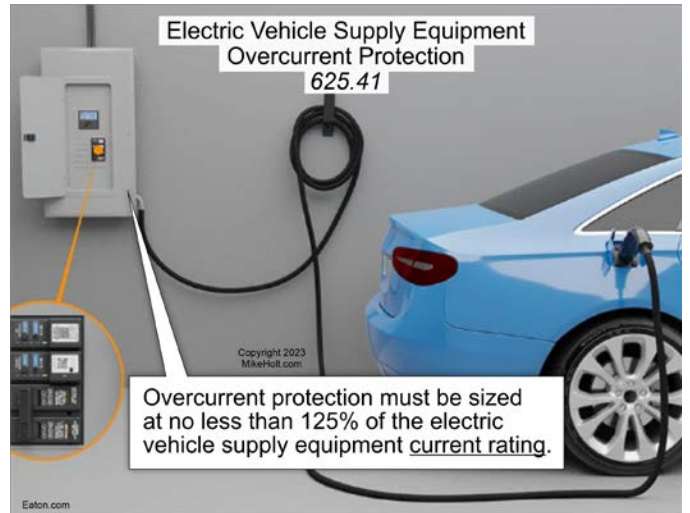
The branch circuit for electric vehicle supply equipment rated greater than 16A or 120V must be supplied by an individual branch circuit.

▶Figure 625-6

According to Article 100, “Electric Vehicle Supply Equipment (EVSE)” includes the conductors, electric vehicle connectors, attachment plugs, personnel protection system, devices, and power outlets installed for the purpose of transferring energy between the premises wiring and the electric vehicle. ▶Figure 625-7



▶ Figure 625-6



▶ Figure 625-8



▶ Figure 625-7

According to Article 100, “Individual Branch Circuit” is a branch circuit that supplies only one utilization equipment.

Ex: A single branch circuit is permitted to supply more than one electric vehicle supply equipment when the loads are managed by an energy management system in accordance with 625.42(A) or (B).

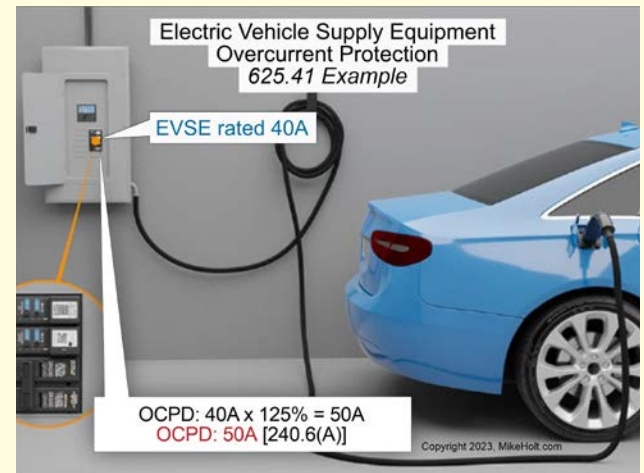
625.41 Overcurrent Protection

Overcurrent protection must be sized at no less than 125 percent of the electric vehicle supply equipment current rating. ▶ Figure 625-8

▶ Example

Question: What size overcurrent protection device is required for EVSE (EV Charger) rated 40A? ▶ Figure 625-9

- (a) 40A
- (b) 50A
- (c) 60A
- (d) 70A



▶ Figure 625-9

Solution:

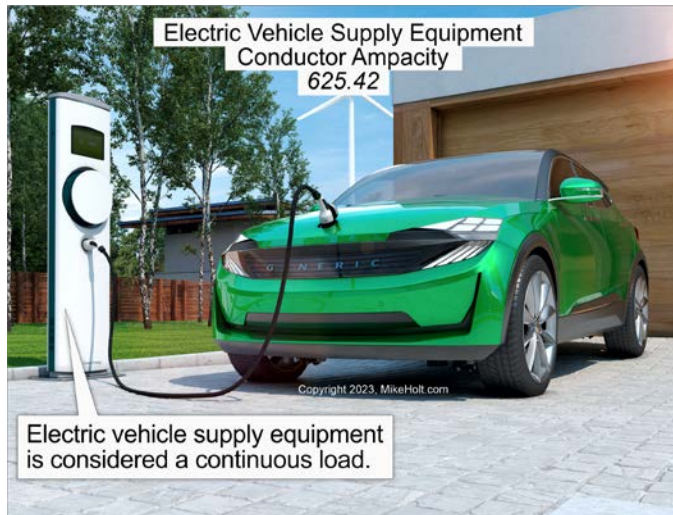
The OCPD must have an ampere rating of not less than 50A (40A × 125%).

Answer: (b) 50A

625.42 Load

Electric vehicle supply equipment is considered a continuous load.

▶ Figure 625-10



▶ Figure 625-10

▶ Conductor Ampacity Example

Question: What's the minimum conductor ampacity size for an EVSE (EV Charger) rated 40A? ▶ Figure 625-11

- (a) 10 AWG (b) 8 AWG (c) 6 AWG (d) 4 AWG



▶ Figure 625-11

Solution:

The conductor must have an ampacity of not less than 50A ($40A \times 125\%$).

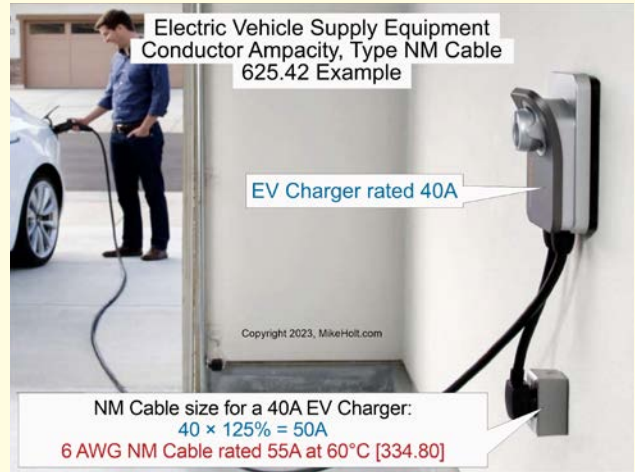
8 AWG rated 50A at 75°C [Table 310.16]

Answer: (b) 8 AWG

▶ Type NM Cable Example

Question: What's the minimum type NM cable ampacity size required for an EVSE (EV Charger) rated 40A? ▶ Figure 625-12

- (a) 10 AWG (b) 8 AWG (c) 6 AWG (d) 4 AWG



▶ Figure 625-12

Solution:

The type NM cable must have an ampacity of not less than 50A ($40A \times 125\%$) at 60°C in accordance with 334.80.

6 AWG NM Cable rated 55A at 60°C [Table 310.16]

Answer: (c) 6 AWG NM Cable

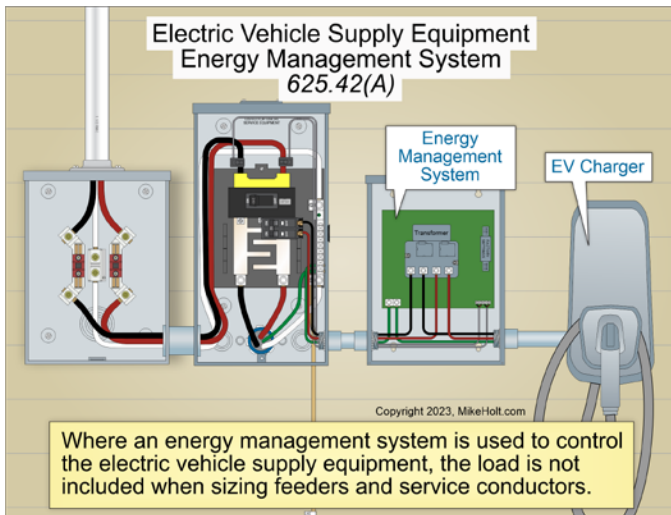
(A) Energy Management System. Where an energy management system is used to control the electric vehicle supply equipment, the load is not included when sizing feeders and service conductors in accordance with 750.30(C)(1)(1). ▶ Figure 625-13

Author's Comment:

- ▶ An EV energy management system prevents the need for a service upgrade to an existing electrical system and EVSE is installed.

(B) Electric Vehicle Supply Equipment with Adjustable Settings.

The adjustable ampere setting in accordance with manufacturers of electric vehicle supply equipment must appear on the rating label with sufficient durability to withstand the environment involved.



▶Figure 625-13

625.43 Disconnecting Means

Electric vehicle supply equipment (EVSE) rated more than 60A must have a disconnect installed at a readily accessible location. ▶Figure 625-14



▶Figure 625-14

If the disconnect for the electric vehicle equipment is remote from the electric vehicle supply equipment or wireless power transfer equipment, a plaque must be placed on the equipment denoting the location of the disconnect.

The remote disconnect must be capable of being locked in the open position with provisions for locking to remain in place whether the lock is installed or not in accordance with 110.25.

625.48 Interactive Equipment

Electric vehicle supply equipment that incorporates a power export function as an interactive (grid tied) optional standby system or a bidirectional power feed must be listed and marked as suitable for that purpose. ▶Figure 625-15



▶Figure 625-15

When an electric vehicle is used as an optional standby system, the interconnection to premises wiring must be in accordance with Parts I and II of Article 705 apply.

Note 1: See UL 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, for further information on supply equipment.

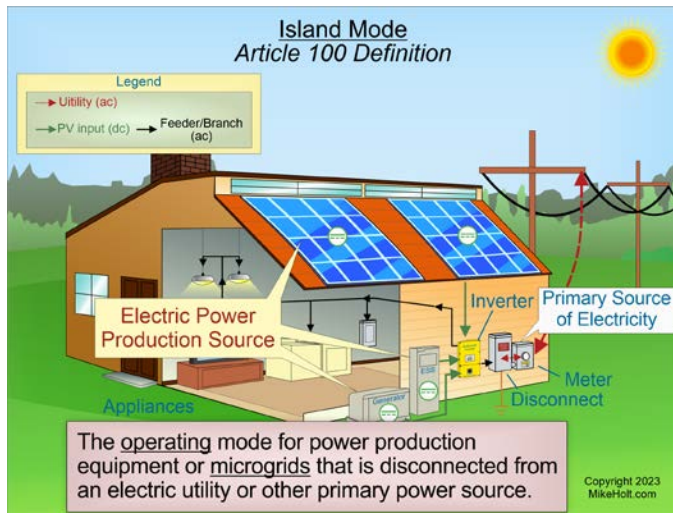
Note 2: See UL 9741, *Bidirectional Electric Vehicle (EV) Charging System Equipment*, for vehicle interactive (grid tied) systems.

Note 3: See SAE J3072, *Standard for Interconnection Requirements for Onboard, Utility-Interactive Inverter Systems*, for further information.

625.49 Island Mode

Electric vehicle power export equipment and bidirectional electric vehicle supply equipment that incorporate a power export function are permitted to be a part of an interconnected power system operating in island mode.

According to Article 100, "Island Mode" is the operating mode for power production equipment that is disconnected from an electric utility. ▶Figure 625-16



▶Figure 625-16



▶Figure 625-17

625.52 Ventilation

The ventilation requirement for charging an electric vehicle in an indoor enclosed space is determined by any of the following:

(A) Ventilation Not Required. Mechanical ventilation is not required where the electric vehicle supply equipment is listed for charging electric vehicles indoors without ventilation.

(B) Ventilation Required. Mechanical ventilation is required where the electric vehicle supply equipment is listed for charging electric vehicles with ventilation for indoor charging. The ventilation must include both supply and exhaust equipment permanently installed and located to intake and vent directly to the outdoors.

625.54 GFCI

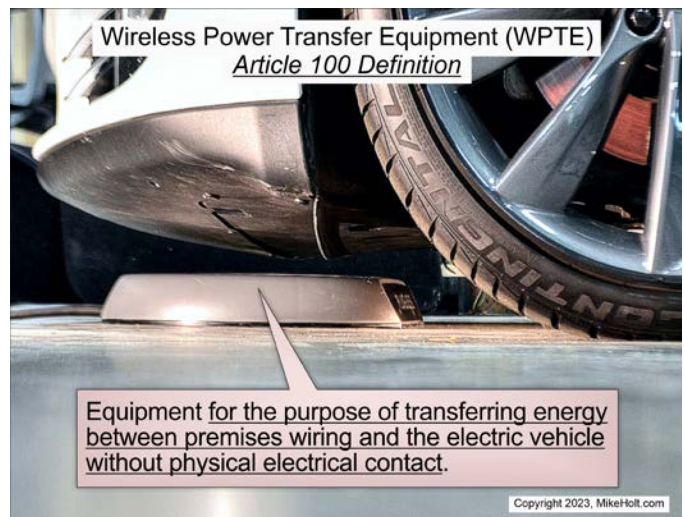
Receptacles for the connection of electric vehicle supply equipment must be GFCI protected. ▶Figure 625-17

Author's Comment:

- ▶ GFCI breakers or receptacles typically used in dwelling units are not suitable for back feeding. That prohibits their use for a bidirectional EVSE. This GFCI requirement only applies to cord-and-plug-connected EVSE, making hard-wired EVSE the only type suitable for bidirectional use.

Part IV. Wireless Power Transfer Equipment

According to Article 100, “Wireless Power Transfer Equipment (WPTE)” is used to transferring energy between premises wiring and an electric vehicle without physical electrical contact. ▶Figure 625-18



▶Figure 625-18

625.101 Grounding

The primary pad base plate must be of a nonferrous metal and connected to the circuit equipment grounding conductor unless double-insulated.

625.102 Installation

(A) General. The control pad must comply with 625.102(B), and the primary pad must comply with 625.102(C).

(B) Control Box. The control box enclosure must be suitable for the environment and mounted not less than 18 in. above the floor level for indoor locations or 24 in. above grade level for outdoor locations.

The control box must be mounted in:

- (1) Pedestal
- (2) Wall or pole
- (3) Building or structure
- (4) Raised concrete pad

(C) Primary Pad. The primary pad must be secured to the surface or embedded in the surface with its top flush with or below the surface and:

▶[Figure 625-19](#)

- (1) Where located in an area requiring snow removal, it must not be located on or above the surface.

Ex: Where installed on private property where snow removal is done manually, the primary pad is permitted to be installed on or above the surface.



▶[Figure 625-19](#)

- (2) The primary pad enclosure must be suitable for the environment; if located in an area subject to severe climatic conditions (e.g. flooding), the enclosure must be suitably for those conditions.

(D) Protection of Cords and Cables to the Primary Pad. The output cable to the primary pad must be secured in place over its entire length for the purpose of restricting its movement and to prevent strain at the connection points. If installed in conditions where drive-over could occur, the cable must be provided with supplemental protection.

(E) Other Wiring Systems. Other wiring systems and fittings specifically listed for use on the WPTE are permitted.