Modular EV Power LLC
Pompano Beach Florida USA

Installation and Construction Notes for EVSE4

You need to read and understand this if you want to build an EVSE that will be safe and need to pass a building inspectors review.

Before beginning this process please accept you are responsible for whatever you do, the ultimate safety, and your personal safety installing and using this equipment. Electricity is dangerous it could cause death or fires while installing or using this equipment if done improperly. You are accepting any and all responsibility for whatever you do or have done, personal, properly or consequential. We are providing these guide lines to help an educated a user implement a J1772 EVSE system. We are not the experts for your application. We provide a low voltage control board that provides the pilot signal and controls your relay. We may also provide some or all of the UL listed electrical parts but YOU will be building the EVSE. Your implementation and specific needs are out of our control.

The NEC requires that whatever you purchase and connect to the power lines needs to be UL listed. If you build something you need to use UL listed parts, and use them as they were intended to be used. If I build and sell a complete EVSE unit and sell it to you it needs to be UL listed. If you build your own, all that is required is all the parts are UL listed and you follow all the NEC rules. The control board we provide, EVSE4, provides the pilot signal, controls the power contactor (relay), and provides some human interface operates on safe low voltage, 24VAC-CT and has DC voltages under 20 volts, that are all bonded to equipment ground and is not directly connected to the power lines.

We believe this design is suitable for home use and possibly business use. We do not believe it is suitable for general public use. EVSE for general public use need the full safety approval of someone like UL. This determination of is this suitable is your responsibility.

If you are going to build and be inspected, we would recommend selecting all your parts and discussing the project with your local building department before beginning. For people who do not feel qualified to do this themselves or live in a place where a licensed electrician must do the work, discuss this with your electrician. Some of the wiring is in your main circuit breaker box and a qualified person is a good idea for this work since there will be power on in the breaker box. It is up to you to decide how to do this safely and properly for any special requirements you have.

If you are confused by the descriptions here or the terms used you need an electricians help. This is a big job and must be done correctly.

Let's get started:

A **GFI Circuit breaker** is needed in your circuit breaker panel. You need to have space to add the breaker in your panel and, you need to have electrical service capacity to you home for the new breaker. The breaker needs to be a 2 pole GFI (ground fault interrupting) breaker for 240 Volt use. The GFI brakes have a white wire coming out the side that must be connected the neutral buss in the breaker box. This will provide the charging current.

GFI is a protection circuit that ensures all the electricity makes the expected round trip from the breaker box and back with none leaking out of the circuit. If there is a short or an electrical leakage path the GFI detects it and turns the power off. It is just like the ones used for outdoor receptacles or ones in the bathroom. This is essential and could save a life if a fault ever occurs. The down side is if your vehicle is older or home built may have ground faults and they are difficult to track down.

One common one is with flooded lead acid batteries, the acid on the outsides of the cases is a leakage path to the cars chassis.

Another common fault is caused by brush dust from a series wound DC motor. Leaning the comutator and the brush area often corrects this problem.

What GFI breaker rating should you use? First the NEC only allows you to use 80% of the breakers rated amperage. So a 30 amp breaker allows you to use 24 Amps. At least one of those Amps will go the control circuit so you are left with 31 Amps. The newest J1772 standard recommends a maximum of 32 amps for home use, I recommend the smallest standard size your car allows. Standard values are 15, 20, 30, 40, 50Amps. Make sure you have enough current to meet the cars charging requirements.

If you want more current there is a way to use an external GFI sensor but it is more involved than these instructions we may have higher current versions available in the near future.

Wire and Conduit is needed to connect the EVSE you are building to the breaker panel. The NEC Article 625 requires all 240 volt units be hard wired and no plug in connections. This is to ensure a good ground. Wire sizes vary with the current rating of the GFI breaker selected and can be found in the NEC. Conduit or cable is determined by the location, so refer to the NEC again.

An **Enclosure** is needed for the EVSE. We recommend a polycarbonate box with a clear cover that is UL listed and NEMA 4X rated for water resistance. The clear top allows the LCD or LED to be observed while giving good protection. The box will also be substantial enough to support the cable when it is not in use. There is a requirement for storing the cable when it is not in use and a simple tab and the top of the box will do it.

We like the **control board** to be located in the top of the box away from the power components mounted in the bottom. Parts need to be securely mounted to the metal panel that comes with the box. The panel and all metal parts must be connected to equipment ground. If you have some industrial component mounting rail (DIN 35) it may simplify the mounting but screws are fine. Don't select a box until you have all the parts and have checked they will all fit. Remember boxes are only to be filled to 40% and wires need space for bends.

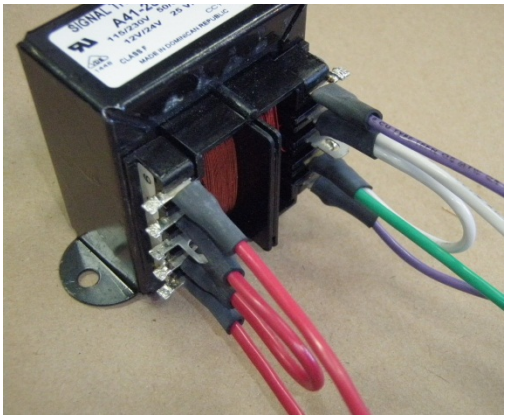
Wires should be THHN or THWN 90°C stranded wire. Use 18 or 16 gage for low voltage signals and the appropriate gage for power signals. If you have our kit we have provided various colors for different signal types but the color code is not essential.

Selecting the **contactor** (relay) involves picking one with two or more poles, a 24 volt AC coil and contact rated at over 240 volts (typically 600 volts) and with a current rating greater or equal to your breaker rating. Most of these contactors will be 3 pole and you just don't use one. 24 volts AC is a very common industrial voltage for the coil and should provide many available contactors. For systems at lower current levels 24VAC is the contactor coil voltage for most air conditioning parts. There are basically 3 types, definite purpose which are exposed low cost units, NEMA heavy duty large exposed terminals, and IEC which are smaller, touch safe, but a little more expensive.

It is also possible to use two relays, one small signal relay with a 24 Volt AC coil connected to the board and its contacts controlling the contactor with a 240 volt AC coil. The small relay would switch the 240 VAC and drive the larger contactor coil. Remember to fuse the coil circuit or use the same fuse that protects the power supply.

While there is no specification about the relay type we believe this is a safety circuit and a contactor switching both power leads provides true separation from the power source. Solid State Relays rely on a triac or back to back SCR's and include snubbers that always conduct. The SSR do not provide true isolation. We do not recommend the use of solid state relays. There is a requirement that both hot power leads be switched.

Our control board needs AC power 24 volts center tapped. This can be obtained with a center tapped

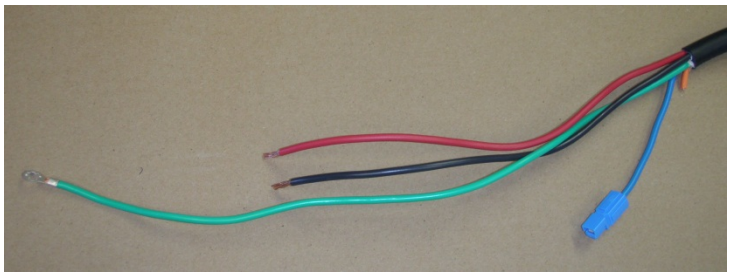


transformer or a transformer that has two 12 volt secondarys that you connect in series. The transformer must be able to power the contactor coil as well. Typically this will be 25 VA (volt-amps). The contactor catalog may specify the current or the volt-amps (VA) of the coil. The transformer needs to be able to provide about 10 VA for the control board, the coil power, another 10 VA and 10% for a safety factor. Any type UL listed fully isolated transformer can be used. The transformers primary must operate on the voltage you will be charging at, probably 240 Volts. The transformer should be fused. You can use a Class II transformer and then it is energy limited and the fuse is not needed.

The transformer may have wire leads or it may have solder tabs. Some solder tabs can accept crimp on quick disconnect lugs. Solder is the most reliable. If you solder put the wire(s) through the hole in the tab band for a secure mechanical hold. Solder with rosin core solder, no extra flux should be needed. Cover the tab with heat shrink tubing for extra protection.

Most transformers need a **fuse**. We recommend a slow blow fuse rated 3 times the transformers VA rating. So if you have a 25VA transformer and are operating on 240 volts (25 X 3) /240 = 0.3Amp, so use a 3/8 Amp or 1/2Amp fuse. You may use a fuse or circuit breaker. They must be UL listed and rated for the power line voltage.

The **J1772 cable and connector set** need to be UL listed and rated at or above the breakers current rating. There are a few details about attaching the cable to the EVSE box. It needs to be done in such a way that it will break away from the box if the car drives away while plugged in. Additionally the wires



need to be arranged and secured so they disconnect in an orderly fashion. First use an Anderson (plastic blue connector) connector or ¼ inch QD on the pilot wire. Have as little slack as possible, possibly 3 inches so this will pull apart first removing the pilot signal and removing power. Next the two power leads to the J1772

cable need to have about twice that much slack. The power leads will connect directly to the bottom of the contactor. With this extra slack they will pull out next. Finally the ground wire needs still twice as much slack as the power wires so it absolutely pulls out last. This orderly shutdown maximizes safety and is required. The wires need to be arranged so that if they pull out they will not touch any terminals as they exit the box.

The **cable needs to be secured to the box** with a strain relief to resist normal pulls and use but not one of the extra high force ones used for overhead cables so the cable can break away before the box pulls away from its mounting. The strain relief needs to be plastic if it is used with a plastic box.

There needs to be a **main grounding point** in the control box. The power in ground and the J1772 cable join at this point. Also the transformer center tap and a ground for the control board come from this point. If this is a brass screw use ring lugs on all wires. If it is a terminal strip, terminate the wires as required.

Remember to have a way to **store the cable when not in use** so the plug is 24 to 48 inches above the ground. This can be as simple as a tab on the box top and winding it around the box.

Wire it up per the drawings, double check it all and it is ready for use or inspection.

Good luck and happy charging.

If you have questions recommendations, improvements, please write.

7/20/2012 First Version from EVSE 3
10/21/2012 Version for EVSE 4.1

NEC 625 2011 Compliance Notes.

6/27/2011 Rev 1.0

When it comes to what is acceptable or not, it is up to the inspector and possibly a local professional engineer. These notes explain why we believe this design meets the requirements.

We recommend you pick your components, plan your project and discuss it with your local inspectors or an electrician before you buy parts to avoid after construction changes and unforeseen requirements.

625.1 Scope: Explains this is for charging electric vehicles is.

625.2 Definitions: explains the terminology to be used.

625.3 Some numbers are not used and this is one.

625.4 Voltages: voltages 120, 120/240, 208Y/120, and 120 are all this design is intended to be used with.

625.5 Listed: All Electrical materials, devices, fittings and equipment that connects to the power line are listed or labeled.

625.9 Wiring Methods

625.9.A Polarization: The J1772 connectors are polarized.

625.9.B Noniterchanability: The J1772 connectors are not compatible with anything else.

625.9.C Construction and Installation: The J1772 connectors are off when not connected, touch safe and everything is in a listed box.

625.9.D Unintentional Disconnection: The J1772 connectors have a latch.

625.9.E Grounding Pole: The J1772 connectors have a ground pin.

625.9.F Grounding Pole Requirements: The J1772 connectors ground pin mates first and separates last.

625.13 Supply Equipment: only 120 volt units may get power via a plug, all others must be hard wired.

625.14 Rating: the circuit breaker, wires, relay must be rated for 125% of the maximum load (use 80% rule).

625.15 Markings: Must be labeled “for use with electric Vehicles” and “Ventilation not required”.

625.16 Means of coupling: are conductive via J1772.

625.17 Cable: the J1772 UL listed cable and connector set use approve EV type cable.

625.18 Interlock: The J1772 Pilot signal must be controlled to enable power out of the EVSE control box.

625.19 Automatic Denerization of Cable: The differing lengths of service loop on the cable in the EVSE along with the quick disconnect on the Pilot signal make sure power is off and ground breaks last.

625.21 Overcurrent: This being a home based design the GFI circuit breaker prevents overcurrent.

625.22 Personal Protection System: The GFI breaker provides this protection.

625.21 Overcurrent: This being a home based design the GFI circuit breaker is the disconnect.

625.25 Loss of Primary Source: The EVSE is powered by the line and the relay would drop out. This is not intended for Interactive use.

625.26 Interactive Systems: This is not intended for interactive use, but if so, see articles 702 and 705.

625.28 Hazardous locations: This is not suitable for a hazardous location.

625.29 Indoor Sites: Location. Cable storage height or 18-48 inches above floor. Only for applications where no ventilation is needed.

625.30 Outdoor Sites: Location. Cable storage height or 24-48 inches above parking surface. Enclosure must be suitable for location.