

To: Electrical Engineering Students
From: Nick Viera
Date: 10/31/07
Subject: Replacing an electrical receptacle outlet

This guide details the replacement of standard 15 and 20-Amp, 120-Volt electrical receptacle outlets. This guide is intended for use by those with basic knowledge about electricity and electrical wiring devices, and who have knowledge of standard electrical safety practices.



Warning Working with electricity can be hazardous and deadly if standard electrical safety practices are not adhered to. This guide involves working with line-voltage circuitry, which is tied to a relatively unlimited power source. To avoid injury to equipment and/or personnel, it is important that only those familiar with basic electrical safety practices use this guide, and that this guide and the NEC are strictly adhered to.

Conventions

This guide follows standard conventions used for AC wiring: Grounding conductors (“Ground” wires) are assumed to be bare copper/aluminum, or covered with green insulation. Grounded conductors (“Neutral” wires) are assumed to be covered with white insulation. Ungrounded conductors (“hot” or “live” wires) are assumed to be covered with an insulation color *other than* white or green, where black, red, and blue are the most common colors used. The receptacle types in figure 1 are referenced in this guide:

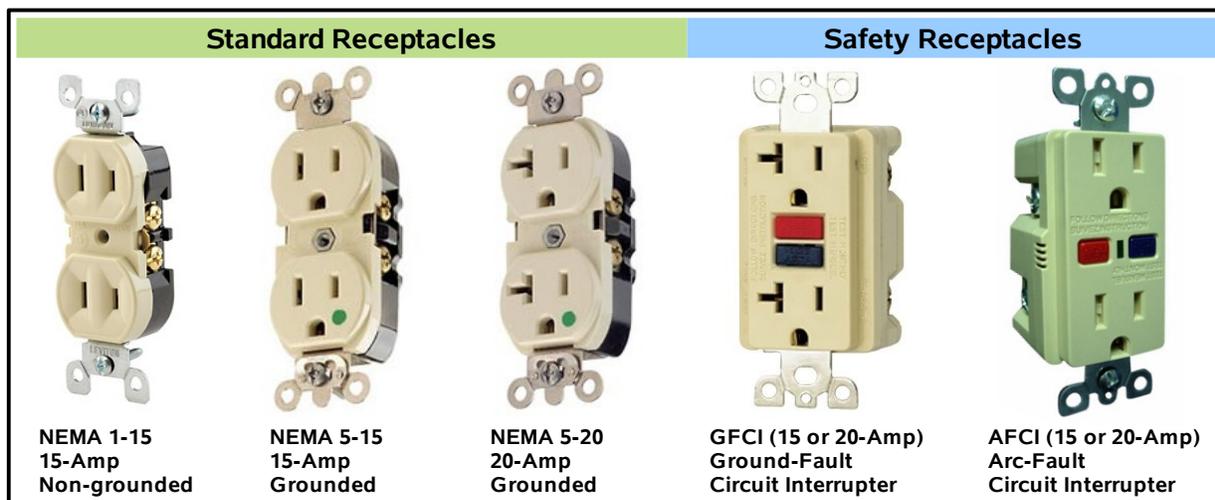


Figure 1: Standard NEMA receptacle types for residential / commercial use.

List of Equipment

- Multimeter or other voltage tester
- Flathead screwdriver
- Needle nose or Lineman's pliers
- Wire cutters
- Wire strippers
- NEMA 5-15 or 5-20 receptacle

Removing the Old Receptacle

R1. Use a voltage tester or multimeter set to the “AC Voltage” scale to check if the receptacle you plan to replace has power. A powered receptacle will illuminate the lamp(s) on a voltage tester, or present a reading in the 105 to 130-Volt AC range on a multimeter.



Caution When working on a duplex receptacle, or on a receptacle which shares an electrical box with other wiring devices always test every device in the box for power, in case the different receptacles/devices are wired to different branch circuits. Never assume the power state of the entire box unit until all devices have been tested!

R2. If the receptacle is powered, turn off the branch circuit breaker or remove the fuse which powers the receptacle. After turning off the breaker or removing the fuse, retest the receptacle for power the same way you did in step R1.



Warning Be sure the power to the receptacle is off before proceeding! If you cannot verify if the power is off, or cannot turn off the power, **STOP WORK** and call a qualified electrician. This guide does not cover nor condone the practice of working on live electrical equipment!

R3. Using a flathead screwdriver, remove the wallplate screw(s) and remove the old wallplate from the wall. Gentle prying around the wallplate with the screwdriver may be necessary if the wall plate has been painted in place.

R4. Remove the two screws holding the receptacle to the electrical box.

R5. Grabbing the top and bottom of the metal mounting bracket of the receptacle, pull it straight out and away from the wall box, to gain access the side/rear terminals.



Note If the wiring doesn't have enough slack in it to allow you to pull the receptacle out, you may have to “lean” the receptacle out of the electrical box at an angle to gain access to the wiring connections. In multi-gang electrical boxes, un-mounting and pulling the other wiring devices away from the electrical box (per steps 4 and 5) can make it much easier to work on the device(s).

R6. Take note of the color of the wires attached to the receptacle, and identify the receptacle using figure 1. The neutral wire should be attached to the side of the receptacle closest to the longer vertical slot (for NEMA 1-15 or 5-15), or the “T” shaped slot (for NEMA 5-20). The hot wire should be connected to the opposite side (closest to the shorter vertical slot), and the ground wire should be connected to the grounding screw located on the lower side or bottom of the receptacle (not applicable for NEMA 1-15).

If the wiring colors do not match the conventions as listed in this guide, then you should write down the color and position of each wire to the receptacle, for reference when installing the new receptacle. For cases other than the swapping of the locations of the neutral and hot wires, you are strongly encouraged to seek the help of a qualified electrician before proceeding.



Note Most receptacles use silver colored screws for the neutral wire connection(s), gold/brass or black colored screws for the hot wire connection(s) and a green screw for the ground wire connection.

- R7. Remove the wires from the old receptacle. If the wires are connected using the screw terminals, they can be released by loosening and/or removing the screws then gently unwrapping the wire from the screws (or for some receptacles pulling the wire away from the unit and out of the screw-clamps). Needle nose or lineman's pliers are helpful for removal of the wire from around the screws.

In addition, some receptacles use pressure-clamps for holding the wires into holes in the rear of the receptacle (called back-wiring.) In this case, the wires can be removed by sticking a flathead screwdriver into the slots which are adjacent to the back-wire holes, and pressing inward to the receptacle with the screwdriver while gently pulling the wires out from the rear of the receptacle.

Installing the New Receptacle

11. Briefly inspect the existing wiring. If any of the wire ends appear darkened, bent, scratched, or otherwise fatigued, and if there is sufficient slack in the wiring, use wire cutters or lineman's pliers to cut off the ends of the wires just to the point where the insulation begins (typically about $\frac{1}{2}$ " back). Then using lineman's pliers or wire strippers, remove about $\frac{1}{2}$ " of insulation from the wires, to expose new, clean ends.
12. Using needle nose or lineman's pliers, bend the exposed ends of the wires around to form a "U" shape which is large enough to fit over the receptacle's screw terminals. If you plan to back-wire the new receptacle, skip this step.



Caution Aluminum wire must never be back-wired to a receptacle. In addition, back-wiring is considered an inferior wiring connection method to using the screw terminals, and thus its use is highly discouraged on receptacles which feed power to other receptacles or wiring devices.

13. If the old receptacle was duplex and the two halves of it were on different circuits or switches, then the new receptacle must be configured for such use. This is accomplished by removing the piece of copper which bridges across the two hot screw terminals of the receptacle. Use needle nose pliers to grasp this bridge connection, and bend it back and forth until it breaks off, separating the receptacle's two hot screw terminals.

14. Wire up the new receptacle. The wiring should match that of the old receptacle, which, if correct, will also match the description in step R6 of this guide.
 - A. If using the screw terminals, wrap each “U” shaped wire end around the appropriate screw, with the wire wrapping clockwise around the screw. The wire should reach around at least $\frac{2}{3}$ of the screw. This means that the very end of the wire will sit to the right of the screw. Firmly tighten the screw. Tighten any unused screws.
 - B. If the receptacle is to be back-wired, make sure about $\frac{1}{2}$ ” of bare wire is exposed, then firmly push the wire into the appropriate back-wire hole on the rear of the receptacle. Tighten any unused screws.



Caution It is important that the correct receptacle be installed per the NEC to prevent equipment damage or worse! In most cases, the old receptacle type was correct, and the new receptacle should be of the same type. NEMA 1-15 and 5-15 receptacles should *only* be installed on 15-Amp branch circuits or on 20-Amp branch circuits which feed multiple outlets. NEMA 5-20 receptacles must *only* be installed on 20-Amp branch circuits. Aluminum wiring may *only* be connected to receptacles rated for such use! If you are in doubt, consult a qualified electrician.



Caution GFCI receptacles **MUST** only be replaced with GFCI receptacles, and AFCI receptacles **MUST** only be replaced with AFCI receptacles. The use of any other type of receptacle in these applications is a NEC violation and puts equipment and personnel at risk.



Note If the old receptacle was a NEMA 1-15 receptacle it must be replaced only with another NEMA 1-15 or with a GFCI receptacle. The NEC prohibits the installation of *any other receptacle* type in place of a non-grounded receptacle.

15. After all wires are securely fastened to the receptacle, gently push the receptacle into the wall box. You may have to work the wires into the box as you push on the receptacle, to ensure that they don't catch on anything and bend smoothly. The wires should not be allowed to bend sharply or to protrude past the face of the receptacle once it is fully mounted in the wall box.
16. Mount the receptacle to the wall box with the two screws provided. If the new screws aren't long enough, chances are the old ones were; use those instead. The “ears” on the top and bottom of the receptacle should sit firmly against the wall/flooring/ceiling material. If necessary, the ears can be removed or washers can be used behind them to get the receptacle mounted correctly in unusually shallow or deep applications.
17. Reinstall a wall plate and fasten it to the receptacle. Be careful not to over-tighten the wallplate screw, as this could crack or bend the wallplate.
18. Restore power and check for proper operation of the receptacle per step R1.