



PDHonline Course E292 (2 PDH)

Duplex Convenience Receptacles

Instructor: David A. Snyder, PE

2020

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5272 Meadow Estates Drive
Fairfax, VA 22030-6658
Phone: 703-988-0088
www.PDHonline.com

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Duplex Convenience Receptacles

David A. Snyder, PE

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Introduction:

Most of us plug something into a receptacle at least once a week, and many of us do so on a daily basis. Receptacles are so commonplace that they are often beneath our notice. The topic of duplex convenience receptacles might seem like an easy one, and it is, but there are many questions and misconceptions about these ubiquitous devices that will be addressed in this course. Some of those questions include:

The following topics will not be covered in this document:
Locking (twist-lock) receptacles.
Receptacles rated 30A and more.
Receptacles rated more than 125V.
Simplex (1-plug) receptacles.
Quadrplex (4-plug) receptacles.
Receptacles other than NEMA 5.
Class B GFCI for equipment protection.

- May a 15A receptacle be installed on a 20A branch circuit?
- May a 20A receptacle be installed on a 15A branch circuit?
- How many receptacles may be powered by a 20A branch circuit?
- How does a GFI receptacle work?

An outlet is any point on the electrical system where power is intentionally made available (see [Glossary](#)). One example is lighting outlets, which are the boxes in the ceiling from which lighting fixtures are powered. Another example is receptacle outlets, which contain one or more receptacles. A convenience receptacle, also known as a convenience outlet, is the type of straight-blade receptacle that we use every day to plug in our toasters, computers, vacuum cleaners, et cetera. A duplex convenience receptacle has two such receptacles, as opposed to a single or simplex receptacle, which has only one receptacle. There are other types of receptacles that are not considered to be convenience receptacles, such as dryer receptacles in residential laundry rooms and welding receptacles at commercial and industrial facilities, but they are not included in the topic of this course, which is duplex convenience receptacles.

The faces of receptacles can be completely flat and smooth for a clean look, or they can have small bevels or indentations at their openings to help guide the blades of the plugs into the slots. The faces of receptacles can be the rectangular Decora or decorator type, such as the isolated ground receptacle in Figure 11 and Figure 14, or the familiar jack-o'-lantern shape shown as the 'regular' receptacle in Figure 11 and Figure 13.

National Electrical Code (NEC):
References to the NEC in this document are from the 2008 edition, unless otherwise indicated. The requirements stated in this document are for new construction or renovation.

Non-grounding receptacles will not be discussed in any detail in this course, since they can only be installed to replace an existing non-grounding receptacle [see NEC 406.3(D)(3)(a)], such as found in older homes, and only if there is not an equipment grounding conductor present at the outlet [see NEC 406.3(D)(1)].

NEMA Classification of Receptacles:

NEMA Standards Publication ANSI/NEMA WD 6-2002 (R2008) *Wiring Devices—Dimensional Specifications* defines the physical dimensions, voltage ratings, amperage ratings, and other parameters for plugs and receptacles used in the United States. The receptacle types discussed in this course will be the everyday 15A and 20A, 120-volt, duplex convenience receptacles that we use in our homes and at work for straight-blade, non-locking plugs. These receptacles are defined as NEMA 5-15R and 5-20R, as shown in Figure 1. There are other types of NEMA designations for other types of receptacles, but they won't be discussed in this course.

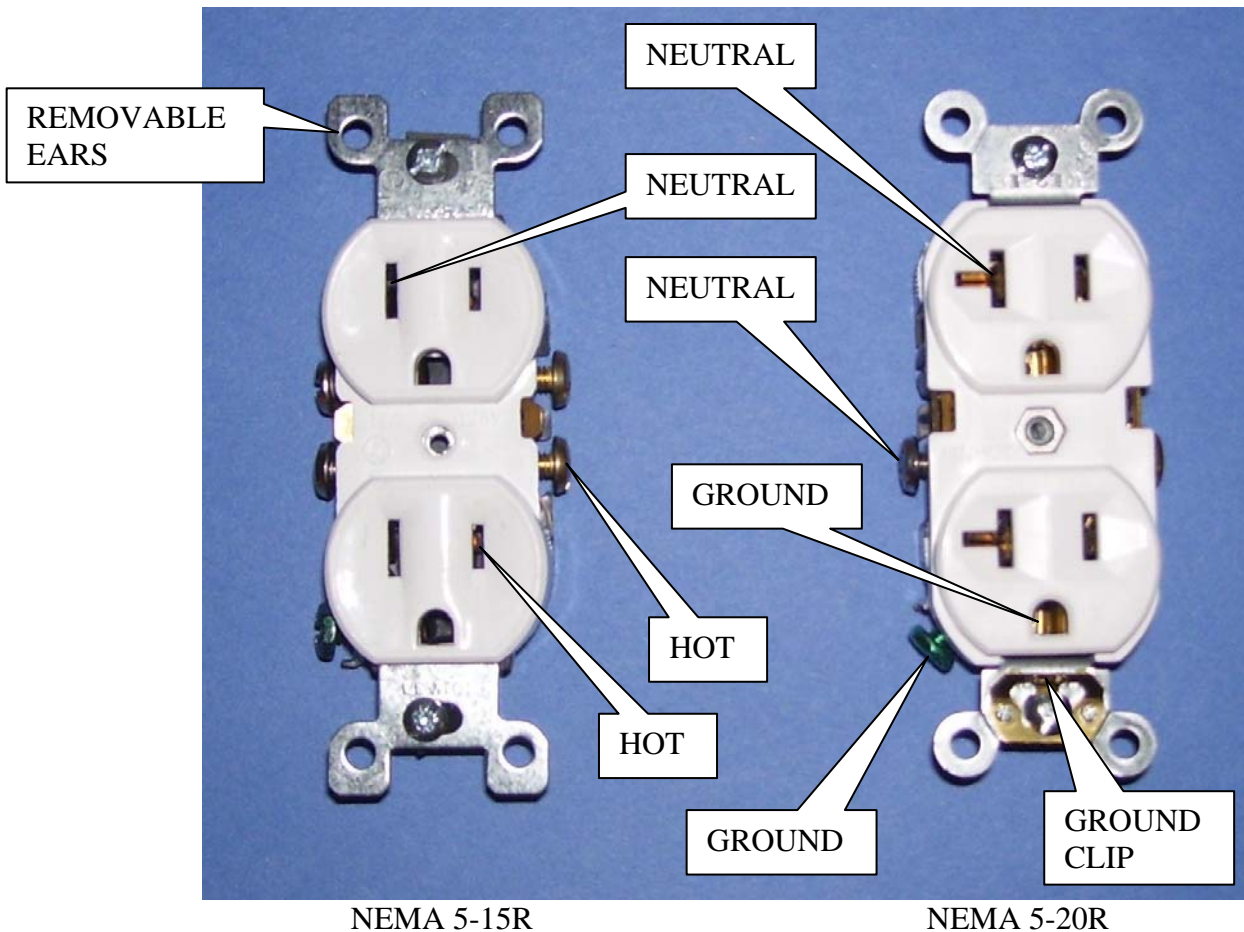


Figure 1

Let's consider the NEMA 5-15R and 5-20R designations. The 5 prefix defines the arrangement, physical size, and orientation of the receptacle connections that we are all familiar with. The -15 and -20 indicate the amperage rating of the plug connections, but the feed-through amperage rating (see [Glossary](#)) for a receptacle is typically 20A for both 15A and 20A receptacles (always confirm with the specific product information). The R suffix means it is a receptacle (female), whereas a P suffix would indicate a plug (male). In other words, a NEMA 5-15P plug would fit a NEMA 5-15R receptacle. As we will see later, a 5-15P plug will also fit a 5-20R receptacle, but a 5-20P plug will not fit a 5-15R receptacle.

Looking at Figure 1, a question that might come to mind is, why are the neutral slots longer than the hot slots? This is known as a polarized connection, since a polarized plug can be inserted in only one orientation (see the NEMA 1-15P plug in Figure 2 or look at the plugs on your lamps and other two-wire appliances at home – see sidebar). The neutral blade on a polarized plug is larger than the hot blade on the plug in order to ensure that the neutral conductor in the plug is connected to the neutral conductor of the incoming power to the receptacle. Plugs and receptacles from the earlier half of the 20th century were 2-wire devices and were not polarized, meaning that the hot and neutral slots were the same size, so the 2-prong, non-grounding type plug could be inserted either way into the non-polarized receptacle. Nowadays, appliances are typically provided with either polarized 2-prong plugs or 3-prong, grounding type plugs in order to ground the appliance through the equipment grounding conductor.

Non-Polarized Plugs:

Some appliances and other electric devices, such as cell phone chargers, come with two-wire non-polarized 1-15P plugs. These devices with two-wire non-polarized plugs are usually designed with double insulation or with switches that break both the hot and the neutral.

Notice in Figure 2 that the 2-wire, non-grounding NEMA 1-15P plug has a larger neutral blade for proper alignment of the polarized connection while the 3-wire, NEMA 5-15P grounding-type plug has a neutral blade and hot blade of the same size. This is because the ground pin of the 3-wire plug will assure proper alignment, which is another reason to never cut off the ground pin of a 3-wire grounding-type plug. With the ground pin removed, most 3-wire plugs would be left with a non-polarized arrangement that could be inserted in either orientation.

Consider the shape of the neutral and hot openings for the 15A and 20A receptacles in Figure 1. Notice that the 15A hot and neutral openings are both straight, but the neutral opening for the 20A receptacle has a different shape that makes the opening look like a sideways T. This T shape will admit a 5-20P plug, as well as a 5-15P plug. See Figure 2 for the arrangement of a NEMA 5-20P plug. You would use a 5-20P plug if you had an appliance or piece of equipment that required a circuit that was more than 15A, but for which a 20A circuit was acceptable. In other words, you would not be able to plug the appliance into a 15A circuit (assuming the circuit had only 5-15R receptacles installed on it, [as is proper](#)) because the 20A plug will not fit into the 15A receptacle. The shape of the neutral opening of a 5-20R receptacle, however, will accept a 15A plug or a 20A plug, which makes sense, since this type of receptacle should only be installed on a 20A circuit, not a 15A circuit.



2-Wire NEMA 1-15P

3-Wire NEMA 5-15P

3-Wire NEMA 5-20P

Figure 2



2-Wire NEMA 1-15P

3-Wire NEMA 5-15P

3-Wire NEMA 5-20P

Figure 3

Notice the ground clip shown on the 5-20R receptacle in Figure 1. The purpose of this ground clip is to ensure a good electrical connection between the yoke of the receptacle and the metallic box, if a metallic box is used instead of a non-metallic box. This type of receptacle is called self-grounding or automatic-grounding. Using this type of receptacle means you don't have to install a jumper between the receptacle and the metallic outlet box [see upper half of Figure 12 and NEC 250.146(B)], if a metallic box is used instead of a non-metallic box.

2-wire versus 3-wire systems:
Older 120VAC electrical systems were 2-pole (hot pole and neutral pole), 2-wire (no ground) systems. Modern 120VAC electrical systems are 2-pole (hot pole and neutral pole), 3-wire (hot, neutral, ground) systems.

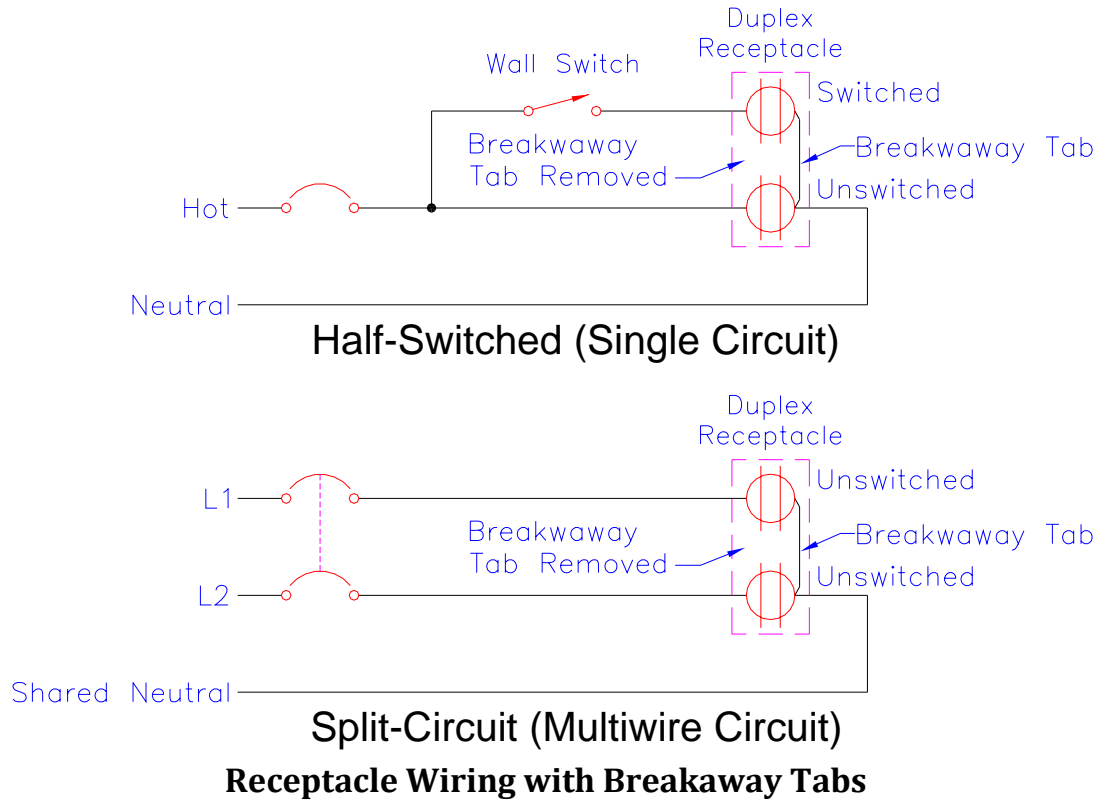


Figure 5

Notice in Figure 6 that the NEMA 5-20R receptacle has a one-piece metallic mounting strap. This type of strap is also known as a wrap-around yoke, for obvious reasons. This type of yoke is a function of the grade or quality of the receptacle, not the NEMA 5-20R classification. The yoke on the left-hand receptacle of Figure 6 does not have a wrap-around yoke, just a regular yoke.

Removable ears (sometimes called “plaster ears”) are shown in Figure 1 and Figure 6. These tabs or ears are used to align the front of the receptacle flush with the face of sheet rock or gyp board walls. These ears can be removed if they are not required.

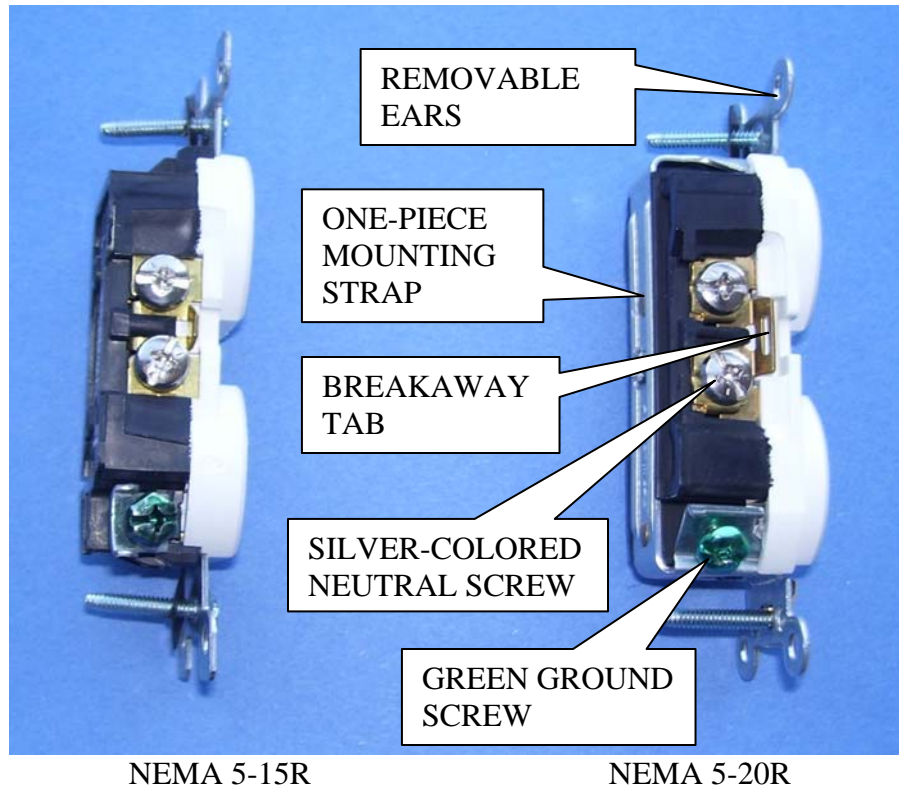


Figure 6

Grades of Receptacles:

In most receptacle catalogs, there will appear several different grades (levels of quality) of receptacles, namely:

- [Hospital Grade](#)
- [Industrial Grade](#)
- [Commercial Grade](#)
- [Specification Grade](#)
- [Residential Grade](#)
- [Other Grades](#)

The only grade listed above which has a specific definition is hospital grade, which means the receptacle model has been tested to the standard described in the next section. A hospital grade receptacle from one manufacturer has passed the same tests as a hospital grade receptacle from a different manufacturer. The rest of the grades listed above represent the different levels of

quality or robustness available from that particular manufacturer. An industrial grade receptacle from one manufacturer is not necessarily the same as an industrial grade receptacle from a different manufacturer. Other than hospital grade, the other grades are not specifically defined as industry standards.

Hospital Grade:

A hospital grade receptacle has met the Hospital Grade requirements of UL 498. Such receptacles are tested to provide better performance in high-use and high-abuse applications found in hospitals. Hospital grade receptacles can also be used in non-hospital applications.

Locations requiring hospital grade receptacles are listed in NEC 517.18(B), 517.19(B)(2), and 517.61(C)(2). Hospital grade receptacles are easily recognized by the green dot on the face of the receptacle. Hospital grade receptacles can be provided with other features, such as isolated ground, tamper-resistant, ground-fault circuit-interrupter (GFCI), and transient voltage surge suppressor (TVSS) functions.

Industrial Grade:

Industrial grade is usually intended to represent a level of quality that is higher than that of commercial grade.

Commercial Grade:

Commercial grade is usually intended to represent a level of quality that is higher than that of residential grade.

Specification Grade:

Specification grade is more of a marketing term than a definable grade. It is up to each manufacturer to decide which of their receptacles will be called specification grade. The term 'specification grade' normally indicates a better quality than residential grade, but 'specification grade' is rather nebulous and can be used in descriptions such as 'heavy duty specification grade', 'specification grade commercial', 'industrial extra heavy-duty specification grade', and 'specification grade TVSS'.

Residential Grade:

Residential grade is typically the lowest grade that is available from a receptacle manufacturer, since the receptacles in houses (residences) are assumed to receive less abuse than commercial, industrial, or hospital areas.

Other Grades:

Some additional grades that manufacturers might use are 'commercial specification grade', 'hard use specification grade', 'construction specification grade', 'extra heavy-duty hospital grade', 'preferred grade', and others, depending on the manufacturer. These terms are used by manufacturers to distinguish their own product lines from each other, but other manufacturers

might not use the same terms. The specifier or engineer must determine which features each receptacle requires during the design.

Federal Specification W-C-596 (also known as Fed Spec WC-596 and other similar appellations) was not mentioned as a grade in this section because it is not usually listed as a grade in manufacturer's literature. There are only two grades listed in W-C-596: general grade and hospital grade. Federal Specification W-C-596 makes reference to UL 498 and includes the requirements of that standard. Fed Spec WC-596 was created to assist the government to purchase receptacles of a certain quality standard and is available in most of the grades mentioned above, but each particular model number must be confirmed by researching the manufacturer's catalogs.

Special Types of Receptacles:

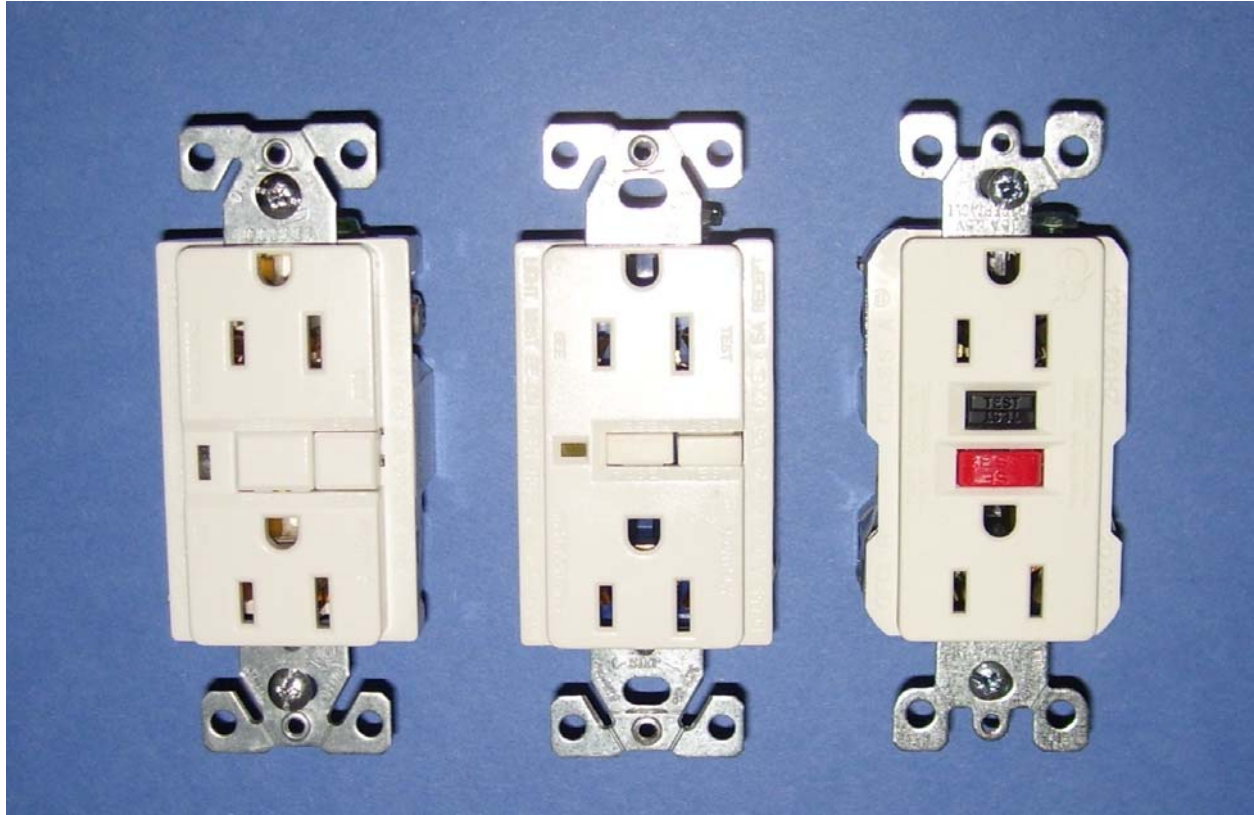
Duplex receptacles can have one or more types of special functions or features built in. Some examples include:

- [Ground-Fault Circuit-Interrupter \(GFI or GFCI\)](#)
- [Isolated Ground](#)
- [Tamper-Resistant](#)
- [Weather-Resistant](#)

GFI or GFCI Receptacles:

The type of GFI receptacle discussed in this document is for personnel protection (Class A), which trips at 5ma (+/- 1mA). There are some GFI circuit breakers which trip at or around 30mA to provide GFI protection for equipment (not personnel), but that type of GFI protection (Class B) won't be discussed in this course.

The locations that require GFI receptacles for personnel protection are defined in NEC 210.8. These locations include, but are not limited to, bathrooms, garages, unfinished basements, kitchens, and boat houses. There are certain types of appliances that require GFI receptacles, such as those defined in 422.51 and 422.52, including electric drinking fountains and some types of vending machines.



NEMA 5-15R GFCI RECEPTACLES

Figure 7

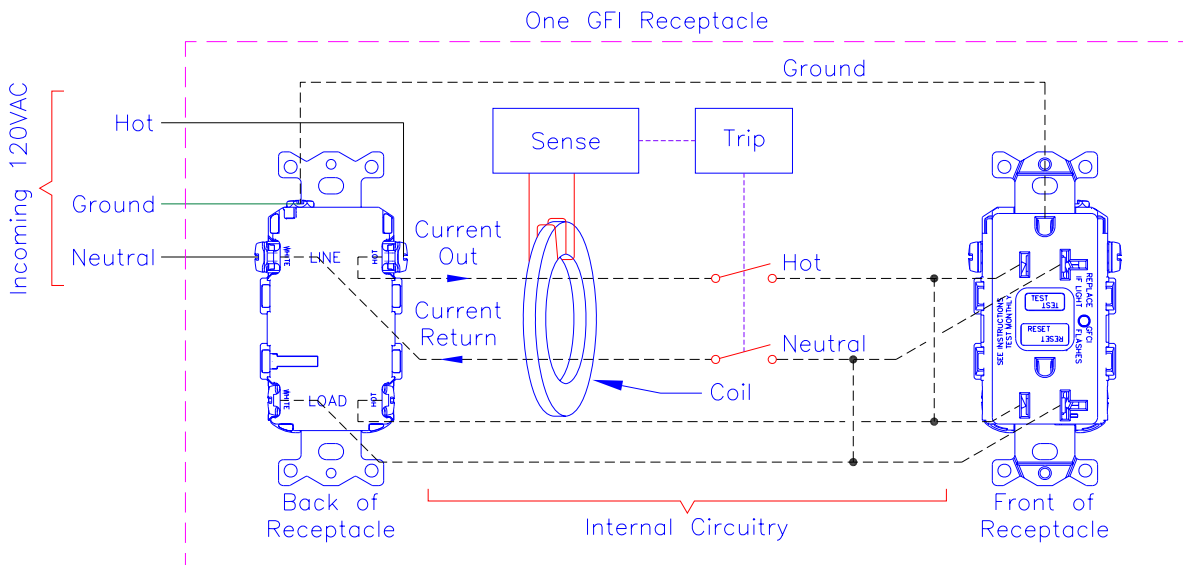
It is important to connect the incoming power to the line terminals, not the load terminals, of a GFI receptacle. If the incoming power is mistakenly connected to the load terminals of the GFI receptacle (a condition known as line/load reversal), that particular receptacle might still provide power to plugs inserted into it, even if the GFI function opens the internal switch and shuts off power to the downstream receptacles. It is common for GFI receptacles to have caution tape covering the load terminals to help identify which terminals the incoming power should be connected to (see Figure 8). Modern GFI receptacles will provide an indication in the event of line/load reversal, and some won't provide power to plugs connected directly to them or to downstream receptacles.



NEMA 5-15R GFCI RECEPTACLES – REAR VIEW

Figure 8

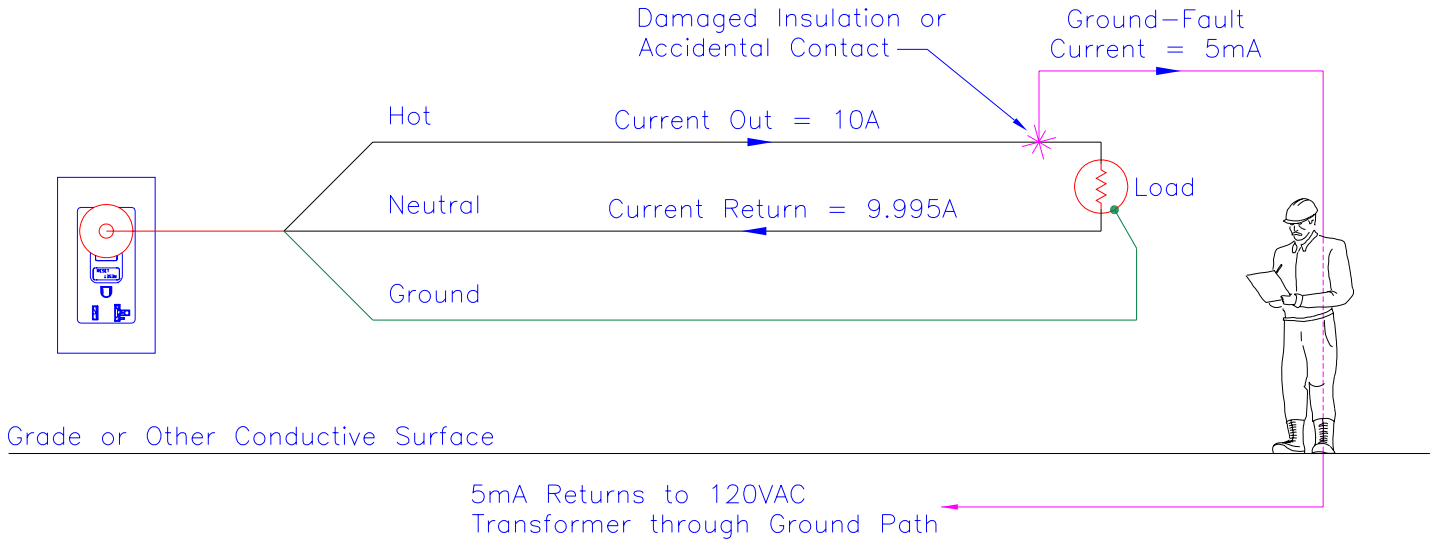
Besides line/load reversal, another possible wiring error with GFI (and non-GFI) receptacles is reversed polarity, in which the hot of the incoming power is connected to the neutral of the receptacle and the neutral of the incoming power is connected to the hot of the receptacle. Figure 9 shows the internal workings of a typical GFI receptacle.



Internal Workings of GFI Receptacle

Figure 9

Figure 10 shows a ground-fault event. If there is an inadvertent contact with the hot conductor that causes ground-fault current to flow, the GFI receptacle's internal circuitry illustrated in Figure 9 will open the circuit when the ground-fault current reaches 5mA, +/- 1mA (see the bottom of Figure 10). If the GFI protection were not present, the ground-fault event might have passed through the person and could easily have exceeded a current of 5mA, possibly resulting in physical harm or death.

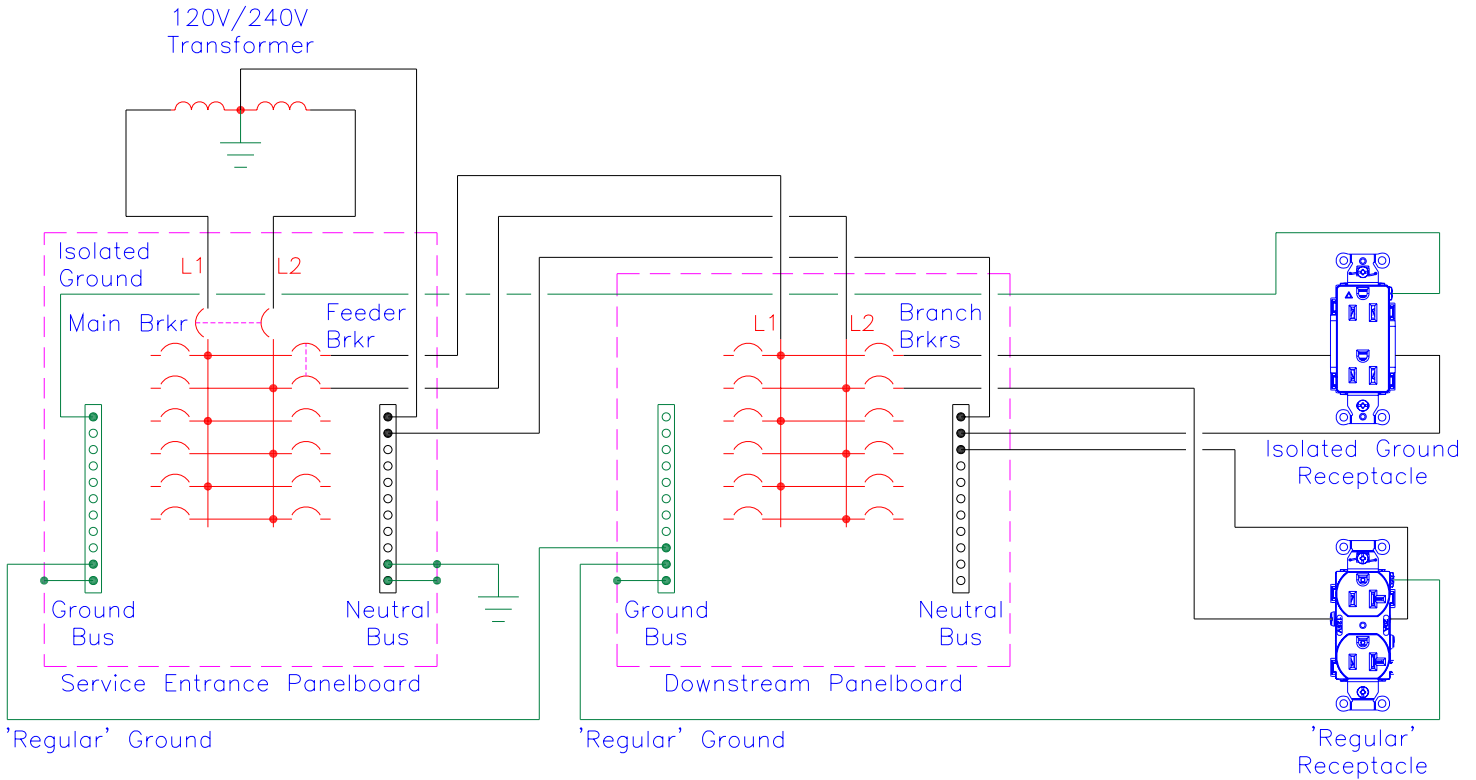


Ground-Fault Event

Figure 10

Isolated Ground Receptacles:

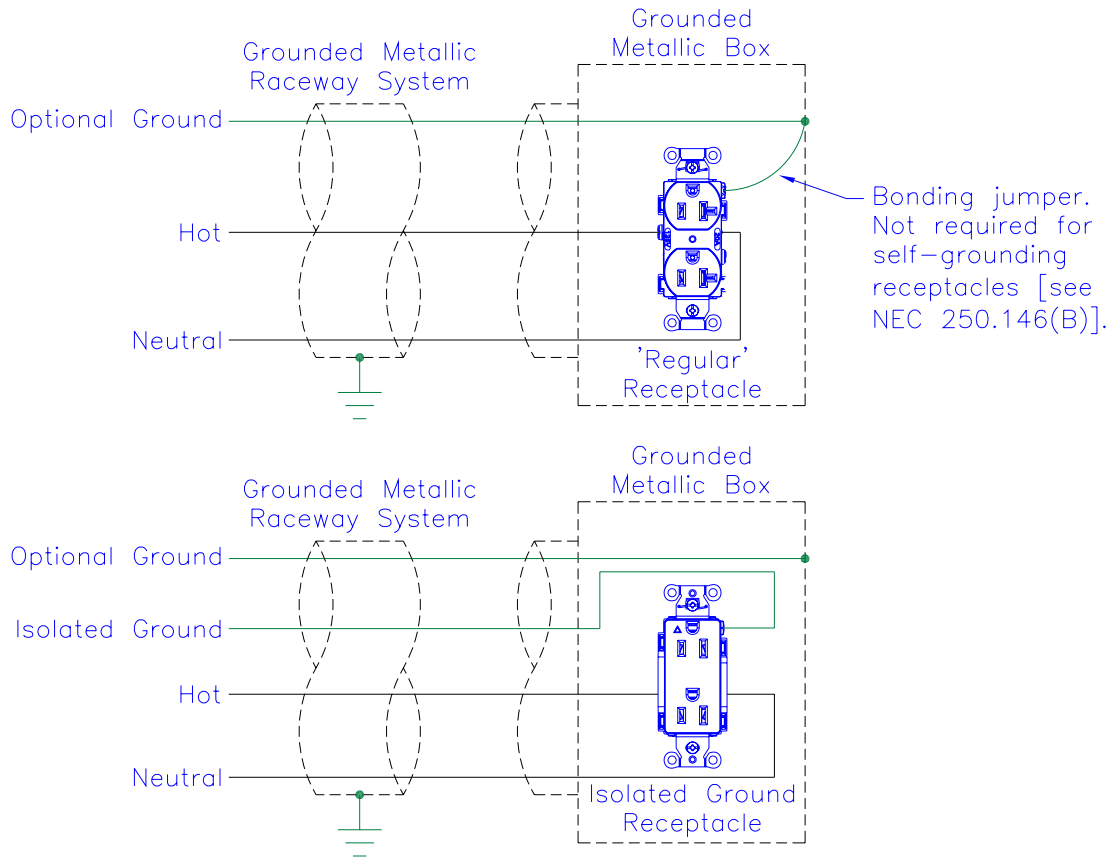
Isolated ground receptacles are discussed in NEC 250.146(D). The grounding terminal (green screw) of an isolated ground receptacle is electrically isolated from the metallic yoke / mounting strap of the receptacle. Some people have the misconception that the grounding system of an isolated ground receptacle installation is totally isolated from the 'regular' grounding system, but such is not the case. The isolated ground is only isolated from the 'regular' grounding system starting at the isolated ground receptacle and ending at the service disconnecting means or the upstream 120VAC transformer in the same building or structure. The isolated ground conductor is connected to the 'regular' grounding system at this point (see left side of Figure 11). The isolated ground conductor is allowed to pass through panelboards without any connections until it reaches its final destination (see Exception to 408.40).



Isolated Ground Receptacle Installation

Figure 11

What is the advantage of an isolated ground installation? Metallic objects, such as metal boxes and metal conduit, act as antennas to pick up the electrical noise that permeates most of our world. When metal conduits and boxes are used as the sole equipment grounding conductor, electrical noise could be introduced into the ground pin of the plug – a situation that is not suitable for sensitive electronic devices, such as computers. This problem is partially alleviated when a dedicated equipment grounding conductor (see upper half of Figure 12) is used for grounding the receptacle, rather than only the metallic raceway system, but electrical noise from other loads, such as HVAC motors and electronic fluorescent lighting ballasts, might also be present in the ‘regular’ grounding system. An even better solution for sensitive electronic loads is to keep the equipment grounding conductor isolated from the other grounding connections until the last possible moment, at the service entrance or upstream 120VAC transformer. Any metallic conduits and metallic boxes used for an isolated ground receptacle must still be grounded, but independently of the isolated ground terminal on the receptacle. Some people go so far as to bring a separate wire for grounding the box, in addition to the isolated ground conductor (see bottom half of Figure 12).



Grounding of Receptacles in Metallic Boxes

Figure 12

Both illustrations in Figure 12 show an ‘Optional Ground’ conductor, labeled at the left side of the illustrations. The metallic raceway system (conduits, fittings, boxes) should already be grounded, and this grounded metallic raceway system is allowed to serve as the equipment grounding conductor (see NEC 250.118), so it is not necessary to bring an equipment grounding conductor to a ‘regular’ grounding receptacle, but many commercial and industrial projects bring an equipment grounding conductor to the receptacles anyway. Residential applications don’t usually have a metallic raceway system, so it is necessary to bring an equipment grounding conductor to the receptacles. The equipment grounding conductor is connected to the box, then jumpered to the receptacle, not the other way around, because the grounding system must not be interrupted by the removal of a receptacle. Imagine that there is another downstream receptacle from that shown in the top half of Figure 12. If the equipment grounding conductor were connected directly to the receptacle, then jumpered to the box, the grounding connection to downstream receptacles would be lost if this receptacle were removed, thereby disconnecting the wiring.

Non-Metallic Boxes:

If a receptacle is mounted in a non-metallic box, the equipment grounding conductor would be connected directly to the ground pin on the receptacle.

The receptacles shown in Figure 12 are at the end of a branch circuit. If those receptacles were at the beginning or middle of a run of branch circuit wiring, then wire nuts would be used to connect the equipment grounding conductor to a jumper to the metallic box and a jumper to the receptacle.

As mentioned earlier, the grounding terminal of an isolated ground receptacle is electrically isolated from the device yoke or strap, so if the isolated ground receptacle were installed in a non-metallic box, a metallic faceplate would not be grounded through the yoke of the receptacle. Therefore, faceplates for isolated ground receptacles installed in non-metallic boxes must be non-metallic, unless the non-metallic box has provisions for effective grounding of the metallic faceplate [see NEC 406.2(D)(2)].

Modern isolated ground receptacles are easily identified by the orange triangle on the face of the receptacle [see NEC 406.2(D)]. Older models might feature an orange receptacle with a green triangle on its face.

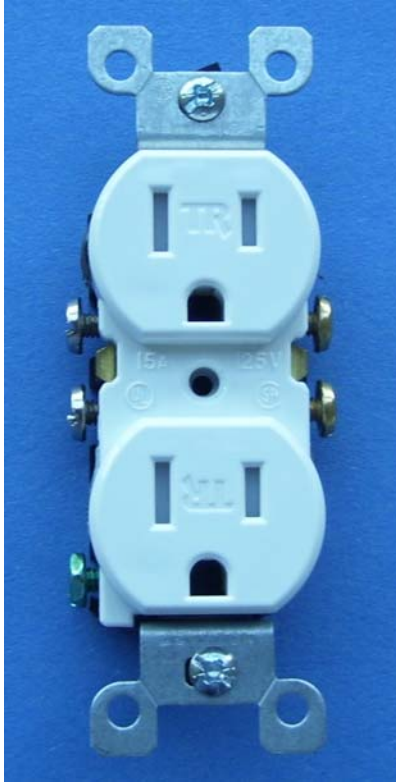
Tamper-Resistant Receptacles:

The new requirements in NEC 406.11 call for tamper-resistant receptacles for all of the receptacles required by NEC 210.52. These locations include, but are not limited to, bedrooms, basements, bathrooms, garages, hallways, kitchens, and living rooms. Also, NEC 517.18(C) requires tamper-resistant receptacles or covers in pediatric wards.

A tamper-resistant receptacle has sliding shutters across the neutral and hot slots in the receptacle, while the ground connection is not shuttered at all. These shutters will only move out of the way if something is poked into both the hot and neutral slots at the same time. If you try to put a screwdriver or similar object into just one of the slots, the shutters will not slide out of the way and access will not be granted to the energized hot terminal. This design is intended to prevent curious children from being injured by poking hairpins, paper clips, keys, or other foreign objects into a receptacle. Tamper-resistant receptacles look the same as 'regular' receptacles, except that you can see the plastic shutters covering the terminals if you look into the slots, as shown Figure 13 (unless the shutters are black, which makes them harder to see).

Note:

Even though NEC 210.52 is titled "Dwelling Unit Receptacle Outlets", the requirements listed therein are generally applied to many types of non-dwelling functions, such as offices, break rooms, schools, and many others.



Tamper-Resistant NEMA 5-15R Receptacle

Figure 13

Tamper-resistant receptacles will usually have the words “Tamper-Resistant” or the letters “TR” on the face of the device, faintly visible in Figure 13.

Weather-Resistant Receptacles:

The updated text in NEC 406.8(A) Damp Locations and 406.8(B) Wet Locations now requires weather-resistant receptacles in damp locations and wet locations. See Article 100 of the NEC for the definitions of damp locations and wet locations, which can be paraphrased respectively as protected from the weather but subject to moderate degrees of moisture (damp) and locations subject to saturation with water and other liquids or unprotected from the weather (wet).

Some GFI receptacles are also weather-resistant, but not all of them are, so you have to confirm this for each receptacle model number. See Figure 14 for an over-achieving receptacle – a 20A, tamper-resistant, weather-resistant, GFI receptacle.



20A, Tamper-Resistant, Weather-Resistant GFI Receptacle

Figure 14

Weather-resistant receptacles will usually have the words “Weather-Resistant” or “WR” on the face of the device, barely discernible on the lower right-hand corner of the receptacle in Figure 14.

Common Questions:

The following are some common questions about duplex convenience receptacles:

1. May a 15A receptacle be installed on a 20A branch circuit?

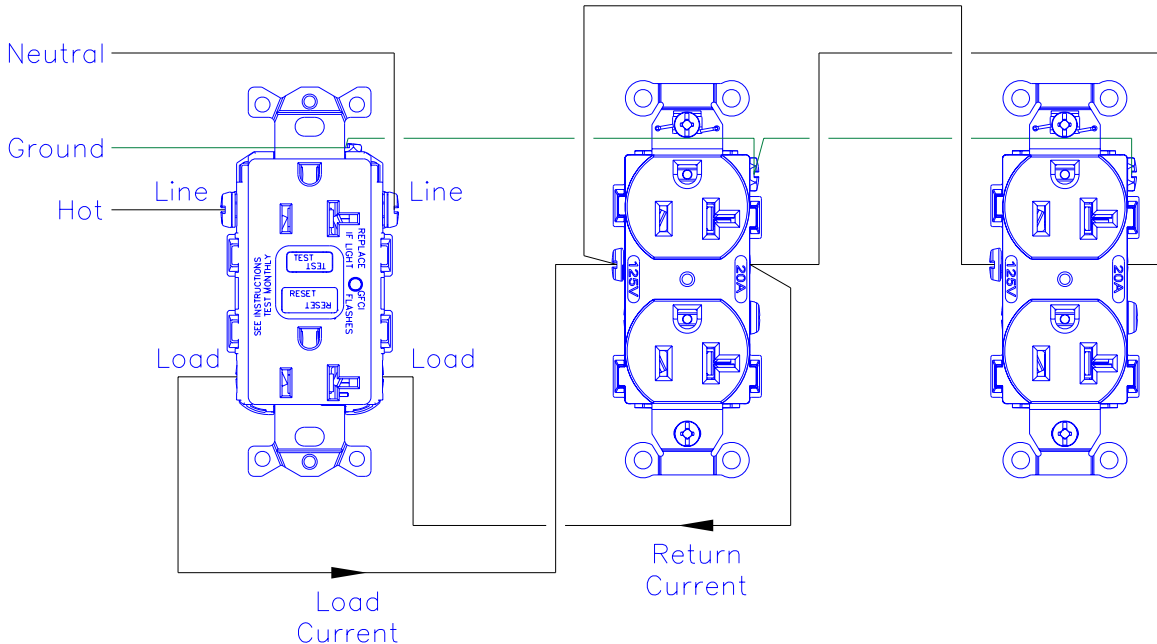
Yes, a 15A receptacle may be installed on a 20A branch circuit. See NEC 210.21(B)(3) and the table of the same name. A 15A receptacle will accept a 15A plug, but it will not accept a 20A plug. Ignoring the fact that there may be other loads plugged in to this branch circuit, it is unlikely that the load on a 15A plug will trip the 20A branch circuit breaker (see [Maximum Loads on Receptacles](#) below).

2. May a 20A receptacle be installed on a 15A branch circuit?

No, a 20A receptacle may not be installed on a 15A branch circuit. See NEC 210.21(B)(3) and the table of the same name. A 20A receptacle will accept a 15A plug and a 20A plug, but a 15A branch circuit cannot provide 20 amps. Plugging in a load requiring a 20A branch circuit could lead to an overload condition that might trip a 15A branch breaker. Therefore, a 20A receptacle must be installed on a 20A branch circuit.

3. Does a GFI receptacle protect downstream receptacles on the same branch circuit?

Yes, but only if the downstream receptacles are powered through the load connections of the GFI receptacle. See Figure 15. As long as the current going to the load (load current) is equal to the current returning from the load (return current), with a difference of 5mA or less, the GFI receptacle will not trip. If, however, the return current is less than the load current by 5mA or more, indicating that 5mA is going to ground somewhere downstream of the GFI receptacle, the GFI receptacle will trip. See Figure 10.



'Regular' Receptacles Downstream of a GFI Receptacle's Load Connections

Figure 15

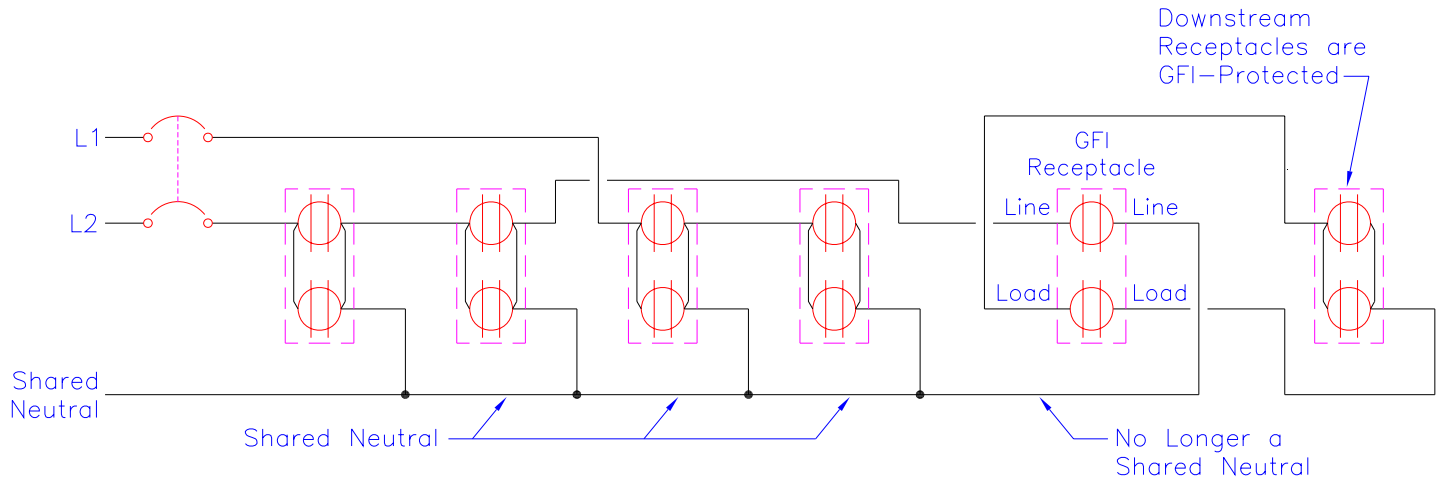
If the downstream receptacles were wired to the line side connections of the GFI receptacle instead of the load side connections, they would not be protected by the GFI receptacle.

4. Will a GFI receptacle work on a non-grounded system?

Yes, since the GFI receptacle looks at the difference between the current on the hot conductor and the neutral conductor, and does not look at the ground conductor, a GFI receptacle will work on a system without a ground conductor. If a GFI receptacle is installed on a non-grounded system, however, it must be marked "No Equipment Ground", and any downstream grounding (3-wire) receptacles must be marked "GFCI-Protected. No Equipment Ground." This marking is required because it might be assumed that an equipment grounding conductor is present when one sees that a grounding (3-wire) receptacle has been installed.

5. Will a GFI receptacle work on a multi-wire (shared neutral) circuit?

No. A multi-wire circuit has two or three hot conductors with a shared neutral. Since the GFI receptacle can only compare one hot conductor to the neutral conductor, it will not see an accurate representation of the total current going out to the loads when it compares the current in one hot conductor to the current coming back on the shared neutral. A GFI receptacle will work properly only if it installed at or downstream of a point on a multi-wire circuit where the neutral is no longer shared, where it ceases to be a multi-wire circuit (see Figure 16).



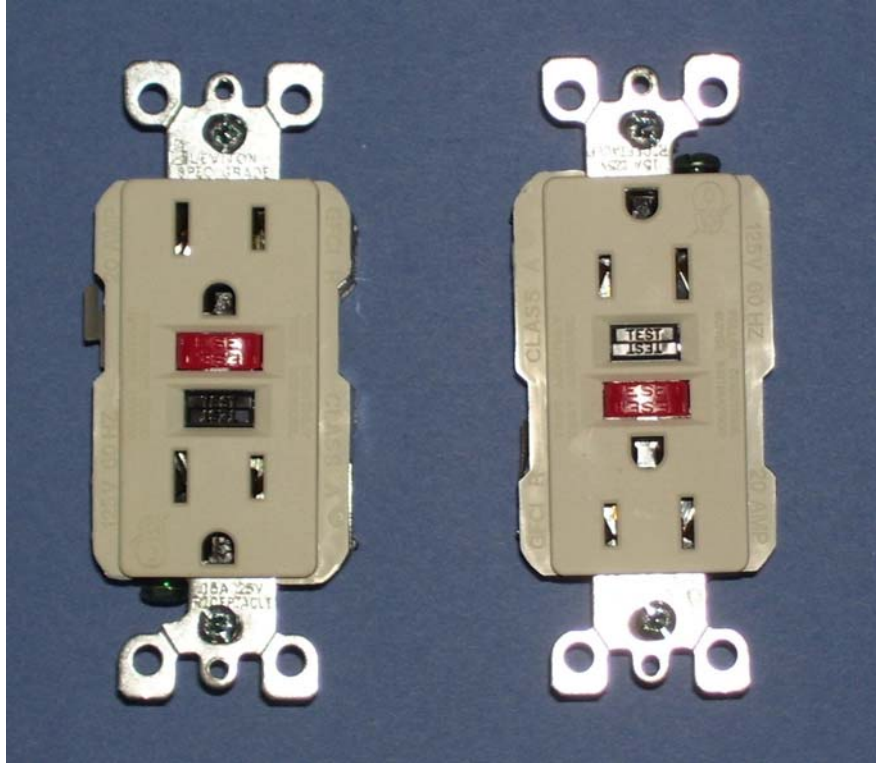
GFI Receptacle and Multiwire Circuit

Figure 16

Grounding is not shown on Figure 16.

6. Should a receptacle be installed with the ground pin(s) up or down?

Yes or no. Refer to Figure 17. This question has been known to create heated discussions, since there is no clearly-defined, absolutely correct answer. Although there is no preference stated in the NEC or ANSI/NEMA WD 6-2002 (R2008), there are some manufacturers and many people who have a very strong preference – some say ground pin up and some say ground pin down. Many of today's receptacle catalogs have illustrations which show the orientation of ground pin up.



Ground Pin Up or Down?

Figure 17

Ground Pin Up Preference: One argument in favor of ground pin up is the unlikely but possible scenario in which the metallic coverplate (if a metallic coverplate is installed instead of a non-metallic coverplate) becomes detached and slides down onto a plug that is partially pulled out of the receptacle. The metallic coverplate would become a short across the exposed hot and neutral blades of the plug, which would present a danger until the circuit breaker trips. A similar scenario can be imagined if a coin or a strand of metallic Christmas tinsel, rather than a detached metallic nameplate, fell in just the right orientation upon the exposed blades of a partially inserted plug in the ground pin down receptacle.

Ground Pin Down Preference: Some people might argue that it is more likely for the plug's ground pin to become disconnected from the receptacle's ground terminal if the plug is hanging somewhat loosely from the ground pin up receptacle, but that is unlikely because the ground pin on a typical plug is 1/8" longer than the other two pins [refer to NEC 406.9(D) or measure the blades of a 3-prong plug]. Therefore, the alleged possible disconnection of the ground pin is not a reason reject the ground pin up orientation.

Another Ground Pin Down Preference: One compelling reason to go with the ground pin down orientation, especially in residential applications, is that many night lights, CO monitors, and other plug-in devices will be upside-down if they are plugged in to a ground-pin-up receptacle.

This document does not express or imply a preference for either orientation. Notice that GFI receptacles, like those shown in Figure 9 and Figure 17, have the Test and Reset text arranged such that they can be read in either orientation. Another example of this bidirectional text is the TR on the tamper-resistant receptacle in Figure 13. Refer to the construction specifications or other installation requirements to see if there is a stated orientation for that particular project.

If you are replacing an existing receptacle, it would make sense to orient the ground pin to match the rest of the existing receptacles in that room or area.

If you want to prolong the above arguments in an attempt to avoid another 15 minutes of productive work, suggest to someone that the only proper orientation for receptacles is horizontally mounted with the neutral pin up.

Another orientation consideration:

Receptacles are not allowed to be installed face-up on a horizontal work surface, such as a countertop [see NEC 406.4(E)]. The reason for this is that spilled water or other material could fall into the receptacle and cause a dangerous situation. On the other hand, horizontally-mounted receptacles are installed in floor boxes that have covers and gaskets to keep out water and cleaning compounds that might be present during floor cleaning operations.

7. How many receptacles may be powered from a 20A branch circuit?

Thirteen receptacles. Since receptacles are not continuous loads, (NEC Article 100 defines a continuous load as a load where the maximum current is expected to continue for three hours or more, such as a lighting circuit), the 125% rating of NEC 210.20(A) does not apply to them. Receptacles have an NEC-defined load of 180VA (though much more power can be provided through them) per yoke (one duplex receptacle, in this course write-up). This 180VA load is the same for 15A- and 20A-rated receptacles. A 20A branch circuit can provide $120V \times 20A = 2,400VA$. Dividing 2,400VA by 180VA gives us 13.333, which rounds down to 13 receptacles per 20A branch circuit. This is true for simplex and duplex receptacles, or any combination of the two types, since a simplex receptacle is counted as 180VA and a duplex receptacle is counted as 180VA [see NEC 220.14(I)].

8. How many receptacles may be powered from a 15A branch circuit?

Ten receptacles. Using the same procedure as in the 20A branch circuit question above, we find that a 15A branch circuit can provide $120V \times 15A = 1,800VA$. Dividing 1,800VA by 180VA gives us 10 receptacles per 15A branch circuit.

Maximum Load on Receptacles:

It is interesting to note that, although receptacles aren't considered to be continuous loads, the maximum load that one receptacle is permitted to power is 80% of the receptacle rating. See NEC 210.21(B)(2) and the table of the same name. Notice that the maximum load for a single 15A receptacle is 80% of 15A, which is 12A. Likewise, the maximum load for a single 20A receptacle is 16A. This means that if you have a load that will require more than 12 amps, it must have a 20A plug on it, not a 15A plug.

An everyday contradiction to the maximum load of a receptacle stated above is the common hand-held hair dryer that most of us have in our homes. These hair dryers are available with ratings as high as 1,875W. This same hair dryer, however, will be manufactured with a 15A plug, in contradiction to the NEC. Why is this? There doesn't seem to be a simple answer, but there is further discussion of this topic under the heading The Other Side of the Coin at this web site: www.iaei.org/magazine/?p=2612 and also the Permissible loads paragraph of the article on this web site: www.ecmweb.com/nec/electric_branch_circuits_part/

Terminations on Receptacles

There is a color code associated with the termination of wires to a receptacle. Looking at Figure 6, the green screw on the receptacle is for the equipment grounding conductor (typically a green or bare wire). The brass-, copper-, or gold-colored screw on the receptacle is for the hot conductor (typically a black wire). The chrome- or silver-colored screw is for the neutral (typically a white or gray wire).

In Closing:

Duplex convenience receptacles are one of the many life-changing modern conveniences that we take for granted. Although this is a simple topic, there are many subtleties of which many people are not aware. For example, this course pointed out that it is easy to determine if a receptacle is rated at 15 amps or 20 amps, simply by looking at it. If a 20A receptacle is installed, then it is possible to infer that it is on a 20A branch circuit, if it is installed according to code.

Glossary:

ANSI – American National Standards Institute

A – Amperes or amps.

Feed-Through Current Rating – the amount of current (120VAC) that can be passed on to a downstream receptacle is typically 20A for receptacles rated 15A and 20A, but always confirm this for each receptacle.

GFCI – Ground-Fault Circuit-Interrupter.

GFI – A less-proper abbreviation for GFCI, but used commonly.

NEC – NFPA 70: *National Electrical Code*, 2008 Edition, unless otherwise indicated.

NEMA – National Electrical Manufacturers Association

NFPA – National Fire Protection Association

Outlet – A point on the wiring system at which current is taken to supply utilization equipment.
[NEC Article 100]

Raceway – A system of conduits, boxes, wireways, and other means of holding or containing wires, cables, or busbars.

Receptacle – A contact device installed at an outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke. [NEC Article 100]

Receptacle Outlet – An outlet where one or more receptacles are installed. [NEC Article 100]

TVSS – Transient Voltage Surge Suppressor.

UL 498 – *Standard for Attachment Plugs and Receptacles* (for all grades of receptacles).

UL 544 – *Standard for Medical and Dental Equipment* (for Hospital Grade receptacles).

V – Volts.

VA – Volt-Amps

W-C-596 – *Federal Specification Connector, Electrical, Power, General Specification for* (fed spec for receptacles).

WD 6 – *Wiring Devices—Dimensional Specifications* (NEMA)

