

NEUTRAL & GROUNDED CONDUCTORS (NEC Article 90; Article 200; Article 300)

OHM'S LAW & POWER FORMULAS

Ohm's law and the power formula are limited to circuits in which electrical resistance is the only significant opposition to current flow, including all DC circuits and AC circuits that do not contain a significant amount of inductance and/or capacitance.



OHM'S LAW DIAGRAM & FORMULAS

Voltage = Current x Resistance

$$E = I \times R$$

Current = Voltage ÷ Resistance

$$I = E \div R$$

Resistance = Voltage ÷ Current

$$R = E \div I$$



OHM'S LAW & IMPEDANCE

Voltage = Current x Impedance

$$E = I \times Z$$

Current = Voltage ÷ Impedance

$$I = E \div Z$$

Impedance = Voltage ÷ Current

$$Z = E \div I$$

E = Voltage (in volts) **I** = Current (in amps)

Z = Impedance (in Ohms)



POWER DIAGRAM & FORMULAS

Power = Current x Voltage

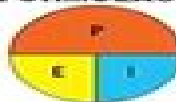
$$P = I \times E$$

Voltage = Power ÷ Current

$$E = P \div I$$

Current = Power ÷ Voltage

$$I = P \div E$$



NUMBER OF CONDUCTORS — BOX FILL CALCULATIONS (Based on 314.16)

- Boxes and conduit bodies must be of an approved size to provide free space for all enclosed conductors.
- In no case must the volume of the box, as calculated in 314.16(A), be less than the fill calculation.
- Each conductor that originates outside the box and terminates or is spliced within the box must be counted once.
- Each conductor that passes through the box without splice or termination must be counted as one.
- Each loop or coil of unbroken conductor not less than twice the minimum length required for free conductors in 300.34 must be counted as twice.

NEUTRAL CONDUCTORS (Based on 200.4(A)(3))

Neutral conductors must be installed in accordance to:

- Neutral conductors must not be used for more than one branch circuit, for more than one multiwire branch circuit, or for more than one set of ungrounded feeder conductors.
- Where more than one neutral conductor associated with different circuits is in an enclosure, grounded circuit conductors of each circuit must be identified or grouped to correspond with the ungrounded circuit conductor(s) by wire markers, cable ties or similar means in at least one location within the enclosure.

GROUNDED CONDUCTOR IDENTIFICATION (Based on 200.6(A)(2))

Grounded Conductors Size 6 AWG or Smaller must be identified by their insulation through one of the following means:

- A continuous white outer finish
- A continuous gray outer finish
- 3 continuous white or gray stripes along its whole length on other than green insulation
- Insulated conductors with their outer covering showing a white or gray color but with colored tracer threads in the braid to identify the source are acceptable for identification
- The grounded conductor of a mineral insulated, metal-sheathed cable (Type MI) must be identified at the time of installation by distinctive marking at its terminations
- A single-conductor, sunlight-resistant, outdoor rated cable used as a grounded conductor in photovoltaic power systems, identified as indicated above at all terminations
- Fixture wire must comply with the requirements for grounded conductor identification as specified in 402.8
- For aerial cable, the identification must be as above, or by means of a ridge located on the exterior of the cable so as to identify it.

Grounded Conductors Size 4 AWG or Larger must be identified in one of the following ways:

- A continuous white outer finish
- A continuous gray outer finish
- 3 continuous white or gray stripes along the entire length of the conductor on any but green insulation
- At installation, by a distinctive white or gray marking at its terminations. Marking must encircle the conductor or insulation.



Continuous White or Gray Finish



Three White or Gray Stripes on Anything but Green



Outer Coloring White or Gray With Colored Threads in Braid

200 AMPS

Service Entrance - From Utility Pole to Energy Meter

150 AMPS

Service Entrance & Feeder Wire - to Panel Box

100 AMPS

Service Entrance & Feeder Wire - to Panel Box

55 AMPS

Feeder & Large Appliance Wire

40 AMPS

Feeder & Large Appliance Wire

30 AMPS

Appliances such as Dryer, Air Conditioning, Water Heater

20 AMPS

Appliances such as Laundry, Bathroom & Kitchen Circuits

15 AMPS

General Lighting, Fans & Outlet / Receptacle Circuits

VOLUME ALLOWANCE REQUIRED PER CONDUCTOR (Based on NEC Table 314.16(B)(1))

| SIZE OF CONDUCTOR (AWG) | FREE SPACE WITHIN BOX FOR EACH CONDUCTOR | |
|-------------------------|--|------------------|
| | cm ³ | in. ³ |
| 18 | 24.6 | 1.50 |
| 16 | 28.7 | 1.75 |
| 14 | 32.8 | 2.00 |
| 12 | 36.9 | 2.25 |
| 10 | 41.0 | 2.50 |
| 8 | 49.2 | 3.00 |
| 6 | 81.9 | 5.00 |

TERMINAL IDENTIFICATION (Based on 200.10(B))

Receptacles, polarized attachment plugs, and cord connectors for plugs and polarized plugs must have the terminal intended for connection to the grounded conductor identified as:

- Identification must be by a metal or metal coating that is substantially white or silver in color or by the word white or the letter W located adjacent to the identified terminal.
- If the terminal is not visible, the conductor entrance hole for the connection shall be colored white or marked with the word white or the letter W.

SINGLE-PHASE DWELLING SERVICES & FEEDERS (Based on 210.10)

- For a service rated 100 through 400 amperes, the service conductors supplying the entire load associated with a one-family dwelling, or the service conductors supplying the entire load associated with an individual dwelling unit in a two-family or multifamily dwelling, must be permitted to have an ampacity not less than 83% of the service rating. **Note:** This also applies to feeders.
- In no case must a feeder for an individual dwelling unit be required to have an ampacity greater than that specified above.
- Grounded conductors must be permitted to be sized smaller than the ungrounded conductors, if the requirements of 220.61 and 220.42 for service conductors or the requirements of 215.2 and 220.61 for feeder conductors are met.

GROUNDED CONDUCTORS OF DIFFERENT SYSTEMS — IDENTIFICATION (Based on 200.6(D))

- Where grounded conductors of different nominal voltage systems are installed in the same raceway, cable, box or auxiliary gutter or other type of enclosure, each grounded conductor must be identified by nominal voltage system.
- Identification that distinguishes each system grounded conductor must be permitted by one of the following means:
 - One nominal voltage system grounded conductor must have an outer covering conforming to 200.6 (A) or (B).
 - The grounded conductor of other systems must have different outer coverings conforming to 200.6 (A) or 200.6 (B) or by an outer covering of white or gray with a readily distinguishable colored stripe other than green running along the insulation.

ALTERNATING-CURRENT SYSTEMS (Based on NEC 250.26)

| TYPE OF SYSTEM | CONDUCTOR TO BE GROUNDED |
|---|--------------------------|
| Single Phase, 2 Wire | one conductor |
| Single Phase, 3 Wire | the neutral conductor |
| Multiphase systems having a common wire to all phases | the neutral conductor |
| Multiphase system where one phase is grounded | that phase conductor |
| Multiphase systems in which one phase is used as a single phase, 3-wire | the neutral conductor |

National Electric Code Residential Wiring

Wolfgang Guggemos



National Electric Code Residential Wiring:

National Electric Code Residential Wiring: Bestsellers in 2023 The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous compelling novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the fascinating narratives that have enthralled audiences this year. The Must-Read : Colleen Hoover's "It Ends with Us" This touching tale of love, loss, and resilience has gripped readers with its raw and emotional exploration of domestic abuse. Hoover skillfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can prevail. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This spellbinding historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Discover the Magic : Delia Owens "Where the Crawdads Sing" This evocative coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These top-selling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of compelling stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and suspenseful novel that will keep you wondering until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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