

Materials Masterclass — Commercial

Materials & the NEC Chapter 3 Wiring-Methods Catalog

A visual, accurate-color field reference anchored to NEC Chapter 3: how to identify, select, install and inspect every cable, conduit, raceway, box, wire, breaker, panel, device, fixture, connector and fastener.

Why this masterclass. Half of being fast in the field is knowing the material on sight: the right wire, the right method, the right device and the right fitting, called by its real name and its NEC article. This masterclass is a visual catalog of commercial electrical materials in accurate color, anchored to NEC Chapter 3 (Articles 320 to 399), the code's master list of wiring methods. For each family it tells you how to identify it, how to pick the right one, how to install it step by step, the mistakes inspectors catch, and what to check before you call it done. All NEC numbers are the 2026 edition; where a section moved, the 2023 number is in parentheses.

0 — How NEC Chapter 3 Is Organized (read this once)

Every wiring method (every cable, conduit, raceway, busway and tray) gets its own article in NEC Chapter 3, and every article follows the same numbering pattern. The number after the decimal point tells you the topic. Learn the pattern and you can find the answer in any of them:

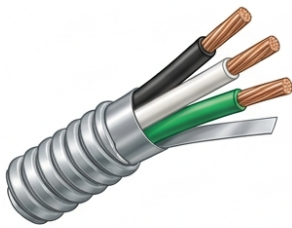
Section	What it tells you	Example
.10 Uses Permitted	Where you are allowed to use it	358.10 EMT
.12 Uses Not Permitted	Where you may not (wet, hazardous, exposed to damage and so on)	334.12 NM
.20 Size / .22 Number of Conductors	Minimum and maximum trade size; fill (Chapter 9, Table 1)	376.22 wireway
.24(A) Bend radius, .24(B) 360° rule	Minimum bend radius, and no more than 360° of bends between pull points	358.24(B) (358.26 in 2023)
.28 Reaming and threading	How to finish cut ends	358.28
.30 Securing & Supporting	How often to strap or support it	358.30
.42 / .44 / .46 Fittings	Couplings, connectors, expansion fittings, bushings	352.44 PVC expansion

Article 300 holds the general rules that apply to every method. The ones you will use every day are 300.13 Securing and Supporting (300.11 in 2023), 300.20 raceways installed as a complete system (300.18 in 2023), and 300.24 Bends, which is new in 2026: "The total degree of bends in any combination of conduit or tubing wiring methods used for a single run shall not exceed 360 degrees between pull points." That means an EMT run that turns into flex still counts all its bends together. When you meet an unfamiliar method, open its article and go to the subsection number you need.

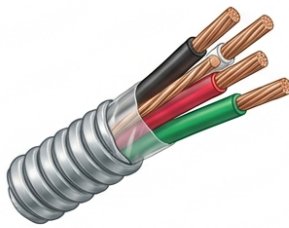
Article 300 topic	NEC 2026	NEC 2023
Physical damage; bushings for 4 AWG and larger	300.6, 300.6(G)	300.4, 300.4(G)
Raceways in wet locations above grade	300.11	300.9
Electrical continuity of metal raceways	300.12	300.10
Securing and supporting	300.13	300.11
Mechanical continuity	300.14	300.12
Free conductor length (6 in.)	300.16	300.14
Raceway installed as a complete system	300.20	300.18
Induced currents (all conductors of a circuit together)	300.22	300.20
Firestop (spread of fire)	300.23	300.21
Plenums and ducts	300.25	300.22

1 — Cable Wiring Methods (factory-assembled)

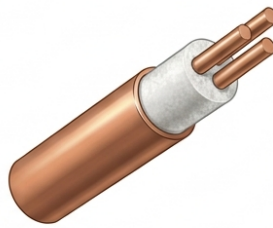
CABLE WIRING METHODS (NEC Chapter 3)



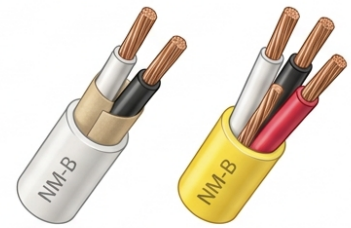
AC armored cable (Art. 320)
— spiral steel armor



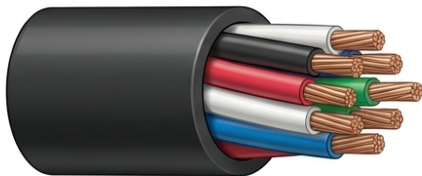
MC metal-clad cable (Art. 330)
— spiral armor, colored
conductors + bare bond



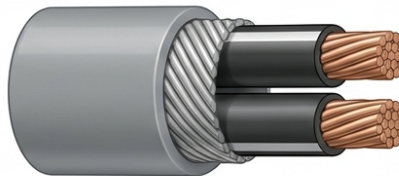
MI mineral-insulated
(Art. 332) — copper sheath



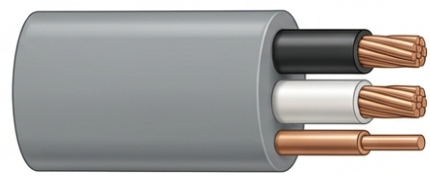
NM nonmetallic (Art. 334) —
white/yellow Romex jacket



TC tray cable (Art. 336) —
black jacketed multi-conductor



SE service-entrance
(Art. 338) — gray



UF underground feeder
(Art. 340) — gray flat

Cable methods come pre-assembled — conductors inside a sheath or armor. The article number tells you the rules.

Method	Art.	What it is & key facts
AC ("BX")	320	Flexible steel armor with an internal bonding strip ; dry locations; the armor plus strip serve as the EGC.
MC	330	Metal-clad: like AC but with a separate green EGC inside (the armor is NOT the ground). The common commercial branch cable; broad uses, some wet with rated conductors.
MI	332	Mineral-insulated, copper-sheathed; fire-resistant and high-temperature; emergency, fire-rated and high-heat circuits.
NM ("Romex")	334	Nonmetallic sheath; one/two-family and multifamily. Not permitted in many commercial occupancies (334.12). Commercial jobs run MC or raceway.
TC	336	Power and control tray cable, for cable tray, raceway, or supported runs.
SE / USE	338	Service-entrance (SE) and underground (USE); SER is the common interior feeder cable.
UF	340	Underground feeder, rated for direct burial.

Identifying MC and AC

- MC is printed "MC" on its tag or jacket. Interlocked aluminum armor is standard. Peel back the armor and you see a green insulated EGC with the circuit conductors. MC-HL (for hazardous locations) has an impervious corrugated sheath with an overall jacket.

- AC has a thin bare aluminum bonding strip running under the armor and no green wire. The strip and armor together are the ground path.
- Everything used with MC must be listed: 330.2 lists the cable, the "cable ties, staples, straps, and hangers," and the fittings.

Step by step: running and terminating MC

1. Check the route. In a return-air ceiling (plenum), only MC "without an overall nonmetallic covering" is allowed (300.25(C)(1)). PVC-jacketed MC is not.
2. Hang it from the structure or from independent support wires. Never tie it to the ceiling grid or the grid's hanger wires. 300.13(B)(1): "Wiring shall not be secured to or supported by the ceiling grid system, including the ceiling support wires." Independent support wires are allowed if they are added to the grid wires and are "distinguishable by color, tagging, or other means" (300.13(B)(2)).
3. Strap it at the code interval. Southwire's MC guide, quoting 330.30, gives every 6 ft and within 12 in. of every box for cable with four or fewer conductors no larger than 10 AWG; vertical runs of 250 kcmil and larger may go 10 ft (confirm against the printed 330.30(B)(C); the local code copy is unreadable there).
4. Bend no tighter than 330.24(B) allows for interlocked armor: "Seven times the external diameter of the metallic sheath."
5. Use a fitting listed for MC. Southwire: "Fittings that are only listed for Flexible Conduits are not permitted to be used on MC cables." With listed MC fittings, "Anti-short bushings are not required by the NEC for MC cables."
6. Land the green EGC on the box ground screw or the device.

MC may be left unsupported in three cases (330.30(D)): (1) when fished through finished walls; (2) "not more than 1.8 m (6 ft)" from the last support to a luminaire or equipment in an accessible ceiling; (3) interlocked MC "not exceeding 900 mm (3 ft)" where flexibility is needed for vibration or movement.

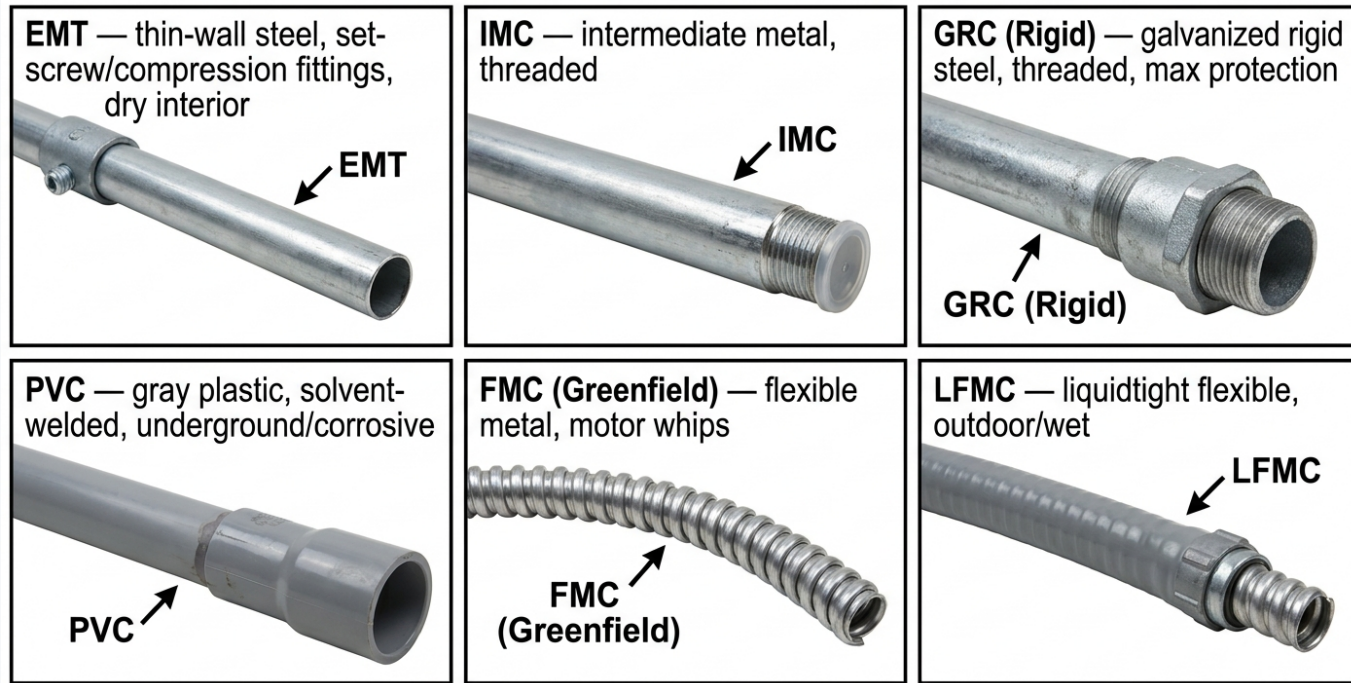
AC cable rules that differ

AC is secured "within 300 mm (12 in.) of every outlet box ... and at intervals not exceeding 1.4 m (4½ ft)" (320.30(B)). At every termination an insulating bushing (the red head) goes between the armor and the conductors, and it must be "visible for inspection" (320.40). The inspector looks for the red head showing in the connector. AC cable is on the plenum list (300.25(C)(1), item 9).

Wet locations: the conductor insulations permitted wet include "THHW, THWN, THWN-2, XHHW, XHHW-2" (310.10(C)).

2 — Conduit & Tubing

COMMON COMMERCIAL CONDUIT & TUBING



The six everyday raceways: EMT, IMC, GRC, PVC, FMC, LFMC — chosen by location and protection.

Method	Art.	What it is & key facts
EMT	358	Thin-wall steel; set-screw or compression fittings; the interior workhorse (dry and damp).
IMC	342	Intermediate metal conduit, threaded, lighter than RMC, same broad uses.
RMC/GRC	344	Rigid metal, threaded, heaviest wall; most protection; all locations, risers, hazardous.
PVC	352	Rigid plastic (Schedule 40/80); glued; underground, wet, corrosive; needs expansion fittings (352.44).
HDPE / RTRC	353 / 355	HDPE coailable duct (underground); RTRC fiberglass (corrosive/underground).
ENT	362	Electrical nonmetallic tubing ("smurf tube"), blue corrugated; concealed/ embedded, bends by hand.
FMC / LFMC	348 / 350	Flexible metal (whips, vibration) / liquidtight flexible metal (wet or outdoor flexible).
LFNC / FMT	356 / 360	Liquidtight flexible nonmetallic / flexible metallic tubing.

Support intervals (NEC 2026)

Method	Maximum between supports	Within this distance of a box or fitting	Section
EMT	10 ft	3 ft (5 ft where framing does not allow 3 ft)	358.30(A)
RMC	10 ft, or Table 344.30(B) for threaded straight runs	3 ft	344.30
IMC	Same pattern as RMC	3 ft	342.30
PVC	½–1 in.: 3 ft; 1¼–2 in.: 5 ft; 2½–3 in.: 6 ft; 3½–5 in.: 7 ft; 6 in.: 8 ft	3 ft	Table 352.30(B)

Step by step: EMT

1. Cut square with a band saw or hacksaw. "All cut ends of EMT shall be reamed" (358.28(A)); a sharp burr strips insulation on the pull. "EMT shall not be threaded" (358.28(B)).
2. Pick the fitting for the location (358.42): fittings must be made up tight, concrete-tight where buried in concrete, and listed for wet locations where wet. Use set-screw fittings in dry locations and raintight compression fittings in wet or outdoor locations. The American Fittings cut sheet lists set-screw connectors as "UL rated concrete tight when taped" and compression raintight connectors "For use in wet locations." Bridgeport marks its raintight compression fittings with a blue gland nut.
3. Count bends as you go. No more than 360° between pull points (358.24(B), and 300.24 for the whole run including flex).
4. Strap within 3 ft of every box and every 10 ft.
5. Tighten the locknut so its teeth point toward the box and bite into the metal (NAVEDTRA 14026: "Install the locknut so that it points inward to dig firmly into the metal box").
6. Over 250 V to ground (277/480 V circuits), check the knockout. If concentric or eccentric rings are left in place, a plain connector does not bond. The 250.97 exception allows "Two locknuts, on rigid metal conduit or intermediate metal conduit, one inside and one outside" or shouldered EMT connectors "with one locknut on the inside" only where those rings are not encountered. Where the rings are present, use a bonding bushing or bonding wedge.

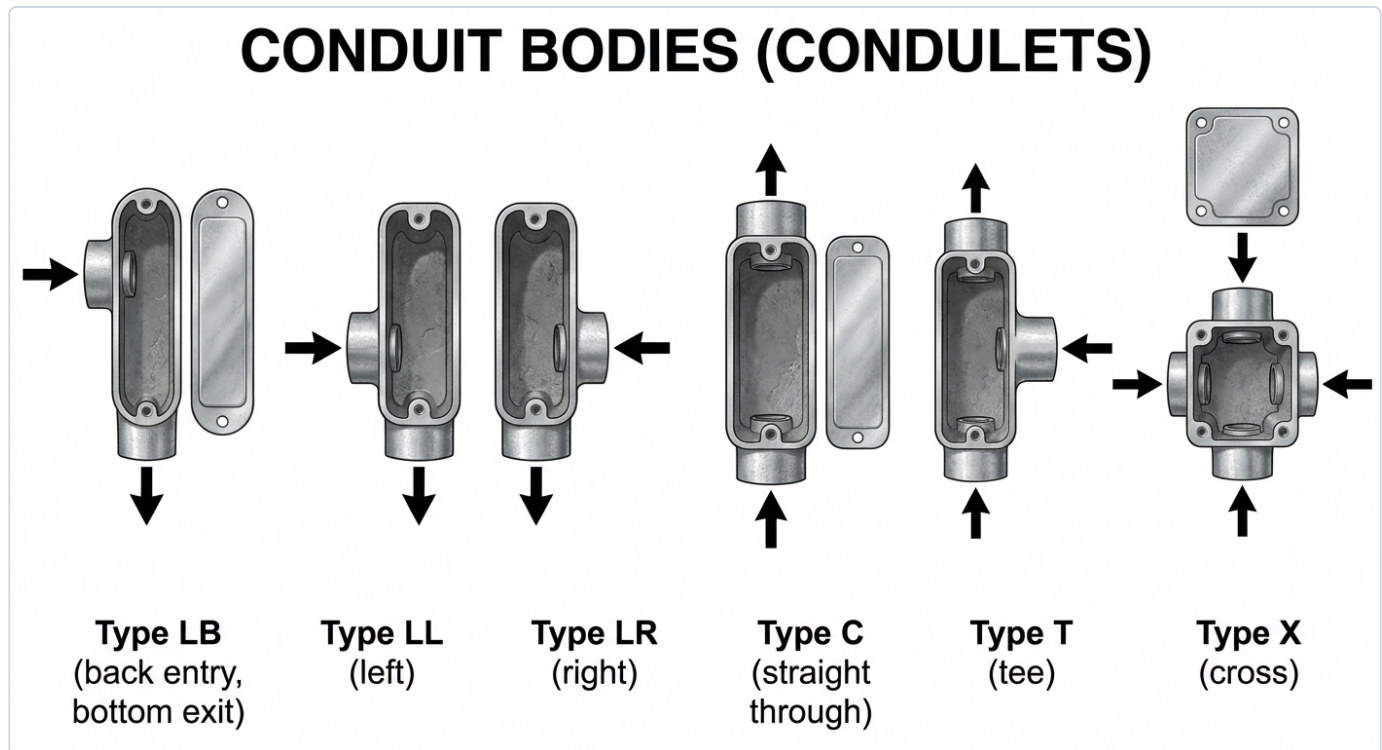
Step by step: gluing PVC (Carlon cement instructions)

1. Make a square cut.
2. Deburr the end inside and out.
3. Clean the socket and the spigot (the pipe end).
4. Coat the spigot with cement, push it to the bottom of the socket, and rotate ¼ turn.
5. Hold it and let it set. Set times run from 2 minutes for ½ to 1¼ in. at 60–100°F to 12 hours for 2½ to 4 in. at 0–40°F. The cement meets ASTM D2564.

PVC grows and shrinks with temperature. 352.44 requires expansion fittings where the computed length change "is expected to be 6 mm (¼ in.) or greater in a straight run." Use Table 352.44 for the coefficient, and see NEMA FB 2.40 (referenced at 300.13) for how to set the piston. Support PVC so it can slide (352.30).

Bushings and wet raceways

- Conductors 4 AWG and larger entering an enclosure need a "smoothly rounded insulating surface," which means an insulating or grounding bushing (300.6(G); 300.4(G) in 2023). A threaded hub with an insulated throat (a Myers hub) meets this.
- A raceway in a wet location above grade (outdoors on a roof, for example) is wet inside: its interior "shall be considered to be a wet location," so pull THWN-2 or XHHW-2, and the raceway "shall be arranged to drain" (300.11; 300.9 in 2023).



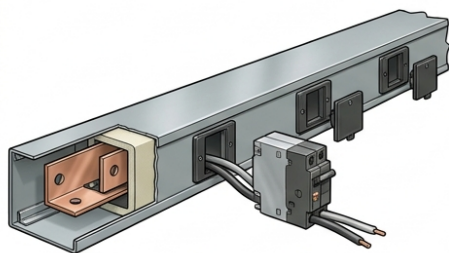
Conduit bodies (condulets) — LB/LL/LR/C/T/X — for turns, pulls, and access on rigid runs (boxes & bodies, Art. 314).

Conduit bodies (314.16(C))

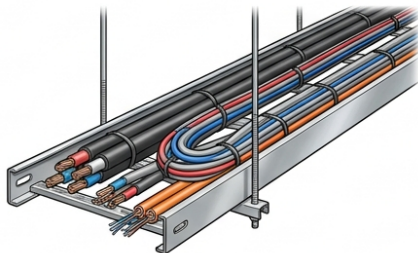
- A body holding 6 AWG or smaller conductors needs a cross-section "not less than twice the cross-sectional area of the largest conduit" it connects to.
- Splices are allowed only in bodies "durably and legibly marked by the manufacturer with their volume." No cubic-inch marking, no splice. Splicing in an unmarked LB is one of the most common writeups.
- Short-radius bodies (capped elbows, service-entrance elbows) "shall not contain splices, taps, or wiring devices" (314.16(C)(3)).

3 — Raceways, Wireways, Busways & Cable Tray

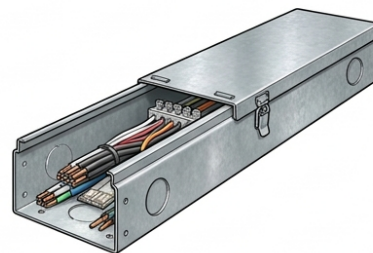
RACEWAYS & WIRING CHANNELS (NEC Chapter 3)



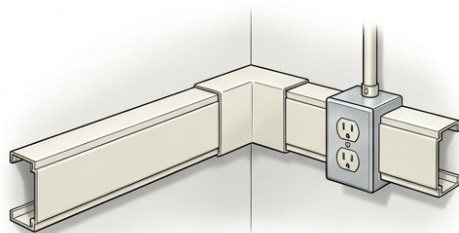
Busway / bus duct (Art. 368) — long metal housing with bus bars and plug-in openings



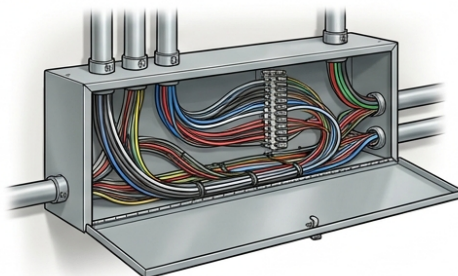
Cable tray (Art. 392) — ladder-style aluminum tray full of cables



Metal wireway / gutter (Art. 376) — square trough with hinged cover



Surface metal raceway (Art. 386) — Wiremold-style surface channel



Auxiliary gutter (Art. 366)



ENT (Art. 362) — blue corrugated nonmetallic tubing

The larger wiring channels — for big feeders, lots of cables, or surface work.

Method	Art.	What it is & key facts
Auxiliary gutter	366	Extra wiring space at gear. Fill no more than 20% (366.22). Derate only when more than 30 current-carrying conductors are at one cross section (366.23(A)(1)).
Busway / bus duct	368	Bus bars in a metal housing with plug-in tap-offs , for big feeders and flexible distribution.
Cablebus	370	Field-assembled insulated conductors in a ventilated housing.
Metal wireway	376	Square sheet-metal trough with hinged or removable cover. Fill no more than 20% (376.22(A)). Derate when more than 30 current-carrying conductors (376.22(B)).
Surface metal raceway	386	"Wiremold" surface channel for finished, dry interior spaces.
Strut-type channel raceway	384	Strut used as an enclosed raceway.
Multioutlet assembly	380	"Plugmold": surface strip with built-in receptacles.
Cable tray	392	A support system (not a raceway) carrying cables: ladder, trough or solid-bottom; common in industrial and data work.

The wireway "30 conductors" rule, read correctly

Two different limits apply to a metal wireway. The fill limit is 376.22(A): conductors "shall not exceed 20 percent of the interior cross-sectional area." The 30-conductor number is in 376.22(B), and it is a derating trigger: the adjustment factors of 310.15(C)(1) apply "only where the number of current-carrying conductors ... exceeds 30" at any cross section. So 30 current-carrying conductors is allowed with no derating, 31 is allowed but must be derated, and the real ceiling is the 20 percent fill. Signal and starting-duty motor control conductors do not count as current-carrying here. Auxiliary gutters work the same way (366.22 and 366.23(A)(1)).

Supporting wireway (376.30). Horizontal runs: support at each end and at intervals not over 5 ft, or at each end or joint for single lengths longer than 5 ft, unless listed for other intervals, and never more than 10 ft between supports. Vertical runs: supports no more than 15 ft apart, with no more than one joint between supports.

What may go in a plenum ceiling (300.25(C)(1); 300.22(C) in 2023)

A plenum is a ceiling or other space used for return or supply air. The allowed wiring list includes non-plug-in busway; RMC, IMC and EMT "without an overall nonmetallic covering"; FMT and FMC; MI cable; MC cable without a jacket; Type AC cable; and listed plenum cables. Surface metal raceway or metal wireway "with metal covers" is allowed where accessible. Nonmetallic cable ties in a plenum must be listed "as having low smoke and heat release properties" (300.25(C)(1)(c)). PVC conduit, jacketed MC and ordinary nylon ties do not belong there.

Legacy methods (recognize, don't install): Concealed **knob-and-tube (394)**, **messenger-supported (396)**, and **open wiring on insulators (398)** are still in Chapter 3 and still energized in old buildings. See the Legacy Systems Masterclass.

4 — Boxes & Enclosures (Art. 314 / 312)

COMMERCIAL ELECTRICAL BOXES



4-inch square (1900) box



4-11/16 inch square box



octagon ceiling box



handy (utility) box



masonry box



FS cast box



FD cast box



screw-cover pull/junction box

Steel and cast boxes — match the box to the device, the wall, and the environment. Sizing & fill: Art. 314.

Identify boxes by trade name and volume (Table 314.16(A))

Box	Volume (in ³)	Max #12	Max #14
4 in. square × 1½ in. deep ("4S," "1900" box)	21.0	9	10
4 in. square × 2⅞ in.	30.3	13	15
4-11/16 in. square × 1½ in.	29.5	13	14
4-11/16 in. square × 2⅞ in.	42.0	18	21
3 × 2 × 3½ in. device box	18.0	8	9
Masonry box, 1 gang, 3½ in. deep	21.0	9	10
FS single gang (cast, threaded hubs)	13.5	6	6
FD single gang (deeper cast)	18.0	8	9

Step by step: box fill (314.16(B))

1. Count each conductor that enters and ends or splices in the box as one. Use the volume per conductor from Table 314.16(B)(4): 14 AWG 2.00, 12 AWG 2.25, 10 AWG 2.50, 8 AWG 3.00, 6 AWG 5.00 in³.
2. Add two allowances (of the largest conductor on it) for each device yoke (a switch or receptacle).

3. Add one allowance for up to four EGCs, plus $\frac{1}{4}$ allowance for each EGC beyond four (2026 wording).
4. Add one allowance if the box has internal cable clamps, one for each luminaire stud or hickey, and one for a terminal block.
5. Add the box volume plus any mud ring or extension ring that is marked with its volume. An unmarked ring adds nothing (314.16(A)).
6. Compare. The total required must not exceed the total available.

Worked example 1. A $4S \times 1\frac{1}{2}$ box (21.0 in^3) holds four 12 AWG current-carrying conductors, two 12 AWG EGCs and one duplex receptacle. Conductors: $4 \times 2.25 = 9.00$. EGCs (up to four count once): $1 \times 2.25 = 2.25$. Device yoke: $2 \times 2.25 = 4.50$. Total 15.75 in^3 , which fits in 21.0 in^3 . Adding a second duplex on a two-device ring adds another 4.50 for 20.25 in^3 , still within 21.0 but with no room for another splice unless the ring is marked with added volume.

Pull and junction boxes for 4 AWG and larger (314.28(A))

- Straight pull: the box length must be at least "eight times the metric designator (trade size) of the largest raceway."
- Angle or U pull: "six times" the largest raceway, plus the sum of the other raceways entering the same wall in the same row.
- Boxes with any dimension over 6 ft need the conductors "secured in an approved manner" (314.28(B)).

Worked example 2. A straight pull with 3 in. conduit needs a box at least $8 \times 3 = 24$ in. long. An angle pull with one 3 in. and one 2 in. entering the same wall needs $6 \times 3 + 2 = 20$ in. on that wall.

Support and setback

- Screws through a box into framing must be "within 6 mm ($\frac{1}{4}$ in.) of the back or ends" so they do not hit the wiring space; metal braces must be at least 0.020 in. thick (314.23).
- A box fastened to suspended-ceiling framing may be no larger than 100 in^3 (314.23(D)).
- In gypsum, plaster, tile or concrete, the front edge of the box or ring may not be set back more than $\frac{1}{4}$ in. from the finished surface (314.20(A)).

Enclosure types (Table 110.28)

110.28 requires every enclosure to be "marked with an enclosure-type number." Read it on the label inside the door.

Type	Where	Protects against
1	Indoor	General purpose
12	Indoor	Dripping liquid and dust
3R	Outdoor	Rain and sleet; no hosedown
3	Outdoor	Rain, sleet and windblown dust
4 / 4X	Indoor or outdoor	Hosedown; 4X adds corrosion resistance
6P	Indoor or outdoor	Prolonged submersion

Box inspection points

- Box fill calculated, and any ring volume used in the calculation is marked on the ring.
- All unused knockouts closed: "Openings ... shall be closed using listed means" (314.17(A)). Use KO seals, not tape.
- Covers on every pull and junction box (314.28(C)), and every box accessible without removing part of the building (314.29).
- Box flush within ¼ in. in noncombustible walls; screws within ¼ in. of the back.

5 — Conductors & the Color Code (Art. 310 / 200 / 250)

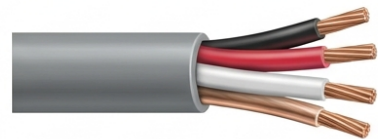
COMMERCIAL WIRE & CABLE



**THHN/THWN-2
building wire**



MC cable



SER service cable



flexible cord SOOW



Cat6 data cable



bare copper ground

Building wire and cable. THHN/THWN-2 is the everyday raceway conductor.

COMMERCIAL CONDUCTOR COLOR CODE

(U.S. common practice — verify your local AHJ/POCO requirements)

Phase A / B / C

Neutral Ground

**120/208V
(3-phase Wye)**

A BLACK	B RED	C BLUE	NEUTRAL WHITE	GND GREEN
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**277/480V
(3-phase Wye)**

A BROWN	B ORANGE	C YELLOW	NEUTRAL GRAY	GND GREEN
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High-leg (Δ) note: on a 120/240V high-leg delta, the high (stinger) leg = ORANGE (Phase B), NEC 110.15 / 230.56.

The conductor color code — different for 120/208V and 277/480V. (200.7 neutral (200.6 in 2023), 250.119 ground, 110.15 high-leg.)

Reading the wire

The insulation is printed every couple of feet with the type, size (AWG), voltage, copper or aluminum, and the maker. Read it before you pull.

Type	How to spot it	Rating	Where used
THHN/ THWN-2	Thin PVC with a nylon outer jacket; slick	90°C dry and wet (Table 310.4(1))	Everyday raceway branch circuits and feeders
XHHW-2	Cross-linked insulation, no nylon jacket	90°C dry and wet	Common on aluminum feeders and underground

Identification rules

- **Neutral (grounded conductor), 200.7 (200.6 in 2023).** For 6 AWG and smaller: "A continuous white outer finish," "A continuous gray outer finish," or "Three continuous white or gray stripes" on other than green insulation. For 4 AWG and larger you may also mark it at installation with a white or gray marking that encircles the insulation at each termination (200.7(B)(4)). Taping a black 8 or 10 AWG wire white to make it a neutral is not allowed.
- **Grouping neutrals (200.6(B), new heading "Neutral Conductors").** Where more than one neutral is in an enclosure, group each neutral with its circuit "by wire markers, cable ties, or similar means."
- **Equipment grounding conductor, 250.119(A):** "green or green with one or more yellow stripes," or bare.
- **High leg, 110.15:** on a 4-wire delta, the high leg must be "durably and permanently marked orange."

- **Hot conductors with two voltage systems, 210.5(C)(2):** identify "by phase or line and by nominal voltage system at all termination, connection, and splice points," and the method must be documented or "permanently posted at each branch-circuit panelboard."

Black-red-blue and brown-orange-yellow are convention, not code. The NEC does not name hot-conductor colors. Black/red/blue for 120/208 V and brown/orange/yellow for 277/480 V are the industry habit. What the code requires is that the building's method be consistent and posted at each panel. Always match the posted legend.

Termination temperature (110.14(C)(1))

A wire is only as hot-rated as the lug it lands on. For circuits of 100 A or less, or 14 through 1 AWG conductors, use the 60°C ampacity column unless the equipment is listed for 75°C. Over 100 A, use 75°C. That is why 90°C THHN still gets sized from the 60°C or 75°C column; the 90°C column is only for derating math.

Handling wire

- Leave at least 6 in. of free conductor at every box, and at least 3 in. outside the box opening if the opening is smaller than 8 in. (300.16(A); 300.14 in 2023).
- Cold-weather pulls (Southwire Power Cable Installation Guide): keep cable in heated storage "for at least 24 hours" before pulling in the cold. Minimum installation temperature is 14°F (−10°C) for PVC-insulated cable and −40°F for XLPE/EPR.

6 — Circuit Breakers (Art. 240 / 408)

CIRCUIT BREAKER TYPES



single-pole



two-pole



three-pole



GFCI breaker



AFCI breaker



dual-function
AFCI/GFCI



molded-case breaker
(MCCB)



main breaker

Single-pole to 3-pole, GFCI/AFCI/dual-function, molded-case (MCCB), and mains. Match the breaker to the panel accepted-type label.

Step by step: reading a breaker before you install it

1. Read the handle: that number is the ampere rating.
2. Read the side label: voltage, interrupting rating (AIC, for example 10k, 22k, 65k), HACR or SWD marks if present, and Cu/Al terminal ratings. 240.83(C) requires every breaker other than a 5,000 A one to have "its interrupting rating shown on the circuit breaker."
3. Read the panel label: find the breaker's catalog number on the accepted-type list. A breaker that only fits is not enough.
4. Compare the AIC to the available fault current marked on the panel. 110.9 requires an "interrupting rating ... at least equal to the available fault current."
5. If the panel is series rated, it carries a label reading "CAUTION — SERIES COMBINATION SYSTEM RATED ___ AMPERES. IDENTIFIED REPLACEMENT COMPONENTS REQUIRED" (240.86, 110.22(C)). Only the breakers in that tested combination may go in.
6. Torque the breaker terminal to the value on the breaker or panel label (110.14(D)).

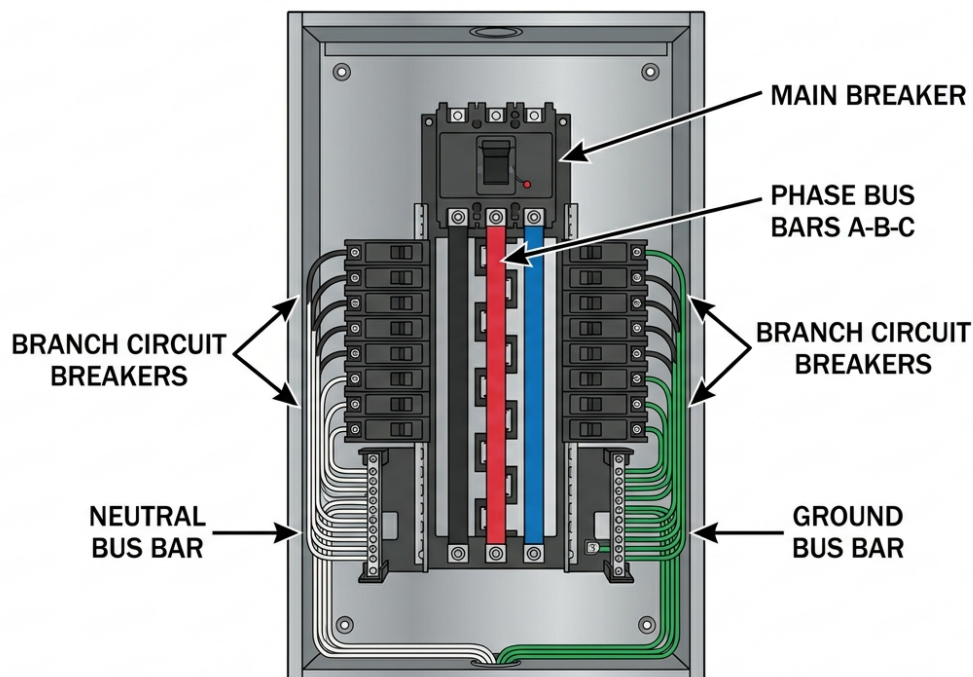
Fuses: classes you will see (Bussmann SPD handbook, pub. 3002)

Class	Volts	Amps	Interrupting rating	Example	Field tell
CC	600	½–30	200 kA	LP-CC, KTK-R, FNQ-R	13/32 × 1½ in., rejection button on one end
J	600	1–600	200 kA (LPJ 300 kA)	LPJ-SP	Smaller than R; "only Class J fuses can be installed" in J clips
RK1	250/600	0–600	300 kA	LPN-RK, LPS-RK	Ferrule or blade with a rejection groove
RK5	250/600	0–600	200 kA	FRN-R, FRS-R	Same body as RK1, less current-limiting
T	300/600	Up to 1200	200 kA	JJN, JJS	Very compact

Never swap fuse classes because they fit. RK1 and RK5 fit the same clip, but the engineer may have counted on the RK1's current limiting for a series rating or an equipment short-circuit rating. Putting an RK5 in that spot can leave the downstream gear under-rated for the fault current. Replace with the class and type on the label or the schedule. The rejection feature in Class J, CC and R clips "prevents installing other fuse types."

7 — Panels & Distribution (Art. 408)

COMMERCIAL PANELBOARD



The commercial panelboard — main, A-B-C phase bus, branch breakers, neutral (white) and ground (green) buses.

Where the 2026 rules are

Rule	NEC 2026	Note
Reconditioned equipment	408.3	New heading. "Reconditioned panelboards shall not be permitted" (408.3(B)).
Bus arrangement, phase order, high-leg position	408.10(E)/(F)	408.3(E)/(F) in 2023
Circuit directory	408.4(A)	"Every circuit and circuit modification shall be provided with a legible and permanent description"; "Clear, evident, and specific"; spares with a breaker described
Source label	408.4(B)	In other than one- and two-family dwellings, "the identification and physical location of where the power originates," permanent and "not handwritten"
Short-circuit rating and available fault current marking	408.6	"available fault current at the line terminals and the date the calculation was performed shall be field marked"
Torque	110.14(D)	Marked torque applied with "torque tools or devices such as shear bolts"

Step by step: setting a panelboard interior (Square D NQ example, bulletin 80043-712-06)

1. Mount the can at the location and height on the drawings.
2. Bring raceways in, bush 4 AWG and larger (300.6(G)), and bond any concentric knockouts on 277/480 V work (250.97).
3. Install the interior. If this is service equipment or the drawings call for it, install the main bonding strap. Square D's torques: 10-32 bonding strap screws 10–12 lb-in, ¼-20 screws 25–30 lb-in; bonding cable binding screws 45–50 lb-in.
4. Land the feeder. Tighten each lug "to the torque values shown on the interior wiring and torque diagram" with a calibrated torque tool.
5. Install branch breakers from the accepted-type list, land and torque branch wires, and group neutrals with their circuits.
6. Fill in the directory with specific descriptions ("Room 104 receptacles," not "plugs").
7. Apply the source label (408.4(B)) and the available fault current marking (408.6), printed, not handwritten.
8. Install all filler plates. No open breaker spaces.

Torque once, correctly. Use the label value and a calibrated tool at installation. Do not plan to re-torque on a schedule; Schneider treats bolted bus joints as maintenance-free and NEMA guidance says not to re-torque. Check connections in service with an infrared scan instead.

8 — Wiring Devices: Receptacles & Switches (Art. 406)

COMMERCIAL RECEPTACLES



15A & 20A duplex
(spec grade, ivory)



GFCI receptacle
(white, with test/reset buttons)



isolated-ground
(ORANGE)



USB receptacle



hospital-grade
(with green dot)



twist-lock / locking
receptacle



single 20A



weather-resistant
in-use cover

Receptacle tells: ivory spec-grade, white GFCI, ORANGE isolated-ground, green-dot hospital-grade, 20A T-slot, locking, USB, weather-resistant.

SWITCHES & CONTROLS



single-pole toggle



3-way



4-way



decora paddle



dimmer (slide)



occupancy/vacancy
sensor switch



timer switch



pilot-light switch

Single-pole, 3-way, 4-way, decora, dimmer, occupancy sensor, timer, and pilot-light switches.

In NEC 2026 the general-use snap switch rules moved into Article 406 Part III: mounting at 406.42, grounding of switch enclosures at 406.44, and rating and use at 406.46 (404.14 in 2023). Article 404 still covers listing, enclosures, breakers used as switches and knife switches.

Identifying receptacles

Tell	What it means	Rule
Orange triangle on the face	Isolated-ground receptacle; use only where an isolated EGC is actually run. In a nonmetallic box, use a nonmetallic plate.	406.11(C), 250.146(D)
Green dot on the face, "Hospital Grade" on the back	Hospital grade (patient care areas)	517.18(B), 517.19(B)(2)
"WR" on the face	Weather-resistant; required in wet and damp locations	406.9(B)(1)(d)
"TR" on the face	Tamper-resistant; required in listed occupancies	406.26 (406.12 in 2023)
T-shaped neutral slot	20 A receptacle	Table 210.21(B)(2)
"Controlled" and the power symbol	Receptacle switched by an automatic control (energy code)	406.11(D)

About "grades." UL 498 recognizes only general use, hospital grade, federal specification (W-C-596, marked with "F" and "S" next to the UL mark), and hospital/fed spec. "Spec grade," "commercial grade" and "residential grade" are marketing terms (IAEI). Buy what the project specification names.

Selecting receptacles and switches

- Cord-and-plug loads on a multi-outlet circuit (Table 210.21(B)(2)): a 15 A receptacle on a 15 or 20 A circuit may carry 12 A; a 20 A receptacle 16 A; a 30 A receptacle 24 A.
- Commercial GFCI (210.8(B)): receptacles up to 150 V to ground, 50 A single-phase or 100 A three-phase, in 16 listed locations including "Rooftops," "Outdoors," "Indoor damp locations," "Laundry areas," and within 6 ft of a sink.
- Tamper-resistant (406.26): commercial triggers include dwelling common areas, hotel guest rooms, child care, preschools and education facilities, business offices accessible to the public, and lobbies and waiting spaces.
- Switch rating (406.46(A)): a general-use snap switch may control "Motor loads not exceeding 80 percent of the ampere rating of the switch," and LED drivers and electronic ballasts "not exceeding 20 amperes and not exceeding the ampere rating of the switch."

No backstabs on 20 A circuits (new in NEC 2026). 406.10(3): push-in terminals "shall be installed on not greater than 15-ampere branch circuits and be connected with 14 AWG solid copper conductors only." Commercial branch circuits are 20 A with 12 AWG, so use the side screws or the back-wire clamp plate. Lever-clamp and back-wire clamp terminals are a different construction and are not push-in terminals under UL 498.

Step by step: installing a receptacle

1. Verify the circuit is off and test for absence of voltage.
2. Check the device: rating (15 or 20 A), WR or TR if required, isolated ground only if an isolated EGC is run.
3. Strip to the strip gauge on the back. Land hot on brass, neutral on silver, ground on the green screw (clockwise loop under a screw, or straight under a clamp plate).
4. Connect the grounding contact to the EGC (406.12(B)). In a metal box, also bond the box.
5. Torque the terminal screws to the value printed on the device if one is given.
6. Fold the conductors back, mount the device straight and flush, and install the plate.
7. Outdoors or wet: use an in-use cover that is "weatherproof whether or not the attachment plug cap is inserted," "listed and identified as extra-duty," with a hinged lid that opens at least 90° (406.9(B)(1)).
8. Test with a receptacle tester; press TEST and RESET on every GFCI.

9 — Lighting Fixtures (Art. 410) — see also the Lighting Masterclass

COMMERCIAL LIGHTING FIXTURES



2x4 lay-in
LED troffer



2x2 troffer



LED high-bay



wraparound



strip light



recessed
downlight (can)



track lighting



exterior
wall pack



EXIT sign
(red)

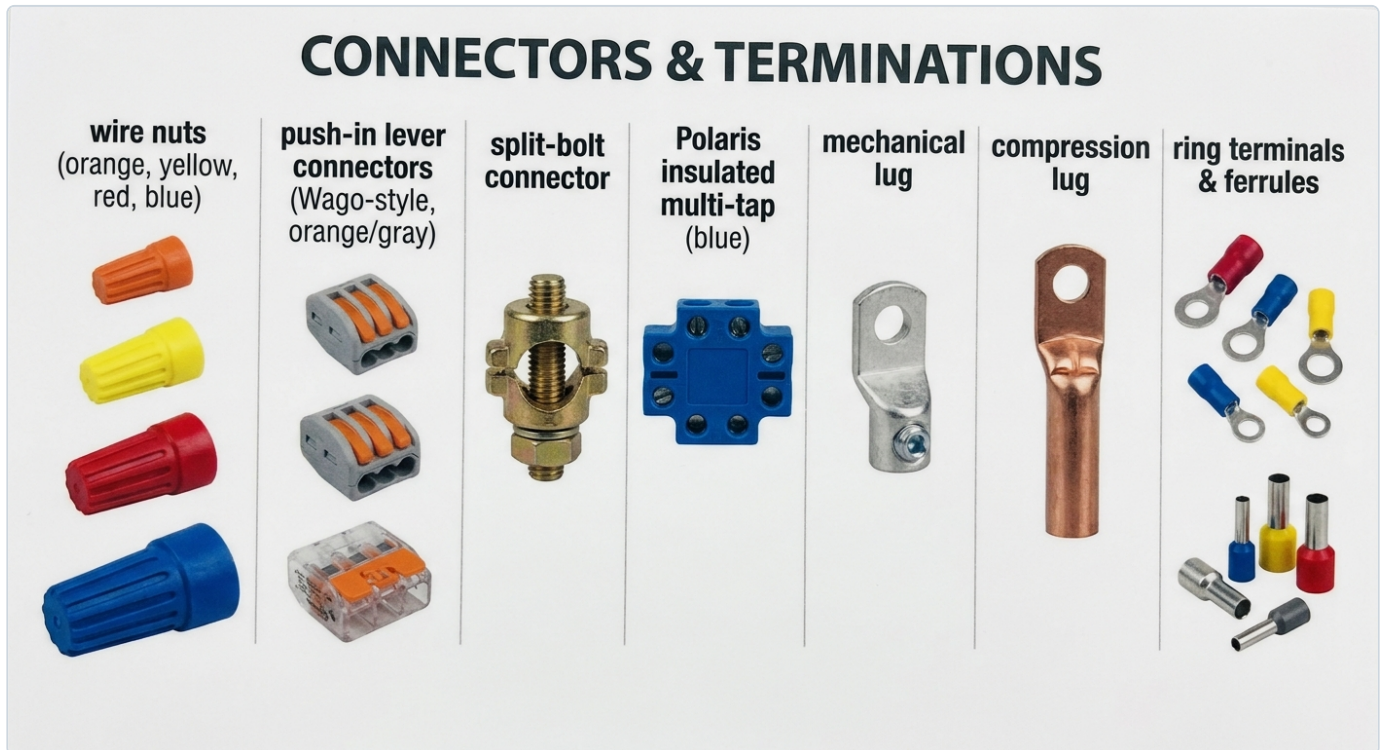


emergency
bug-eye light

Troffers, high-bay, wraparound, strip, downlight, track, wall pack, exit sign, and emergency bug-eye.

- **Lay-in fixtures in a grid ceiling (410.36(B)).** The luminaire must be "securely fastened to the ceiling framing member by mechanical means such as bolts, screws, or rivets. Listed clips ... shall also be permitted." Extra tie wires from the fixture to the structure come from the manufacturer's instructions, seismic requirements or the local inspector, not from 410.36(B) itself.
- **Fixture whips.** MC may run unsupported up to 6 ft from the last support to a luminaire in an accessible ceiling (330.30(D)(2)).
- **Disconnect for linear LED and fluorescent fixtures (410.71).** Indoors in other than dwellings, luminaires with drivers or ballasts that are serviced in place "shall have a disconnecting means either internal or external to each luminaire," and "The line side terminals of the disconnecting means shall be guarded." The same applies when you replace a driver.
- **Grounding.** Bond the fixture to the EGC (410.40, 410.42).

10 — Connectors & Terminations (Art. 110.14)



Wire nuts, push-in lever connectors, split-bolt, Polaris multi-tap, mechanical and compression lugs, ring terminals and ferrules.

The rules (110.14)

- Connectors must be "identified ... for the material of the conductor." Copper and aluminum may not touch in a connector unless it is identified for that use. Any inhibitor or joint compound must be "identified for the use."
- Fine-stranded conductors (finer than ordinary Class B/C building wire, such as welding or flexible cable) need connectors "identified for the specific conductor class."
- Splices (110.14(B)) use "splicing devices identified for the use," get insulation equal to the conductor's, and must be listed for direct burial when buried.
- Torque (110.14(D)): use the marked torque and a torque tool. Where the equipment gives no value, Informational Note 2 points to the UL 486A-486B annex tables.

Twist-on connectors (Ideal wire range chart)

Connector	Color	Range
71B	Gray	Min 2 #22 stranded, max 2 #16 (300 V)
72B	Blue	Max 3 #16 (300 V)
76B	Red	Min 2 #14, max 4 #12
452 Wing-Nut	Red	Min 2 #18, max 4 #10
454 Wing-Nut	Blue	Up to 1 #6 with 2 #8

Colors are not standardized across brands. Read the chart on the box for the connector in your hand.

Lever nuts (WAGO 221 datasheet)

The 221 series takes 24 to 12 AWG solid, stranded or fine-strand, rated 20 A and 600 V; a 10 AWG family is rated 30 A. Strip 11 mm (0.43 in.) using the gauge on the side, open the lever, push the wire to the stop, close the lever, and look through the clear housing to confirm the conductor is fully inserted.

Step by step: Polaris insulated multi-tap (NSi instructions)

1. Pick the connector for the run and tap sizes.
2. Strip each conductor to the length on the chart.
3. Wire-brush any oxidation off aluminum. The connector is "prefilled with antioxidant."
4. Insert one conductor per port. The insulation must sit "no less than 3/8"" inside the port.
5. Torque the set screw to the chart value with a hex bit. Maximum torques: #4 connector 35 lb-in (1/8 in. hex); 1/0 80 lb-in; 3/0 250 lb-in; 250 kcmil 360 lb-in; 500 kcmil 450 lb-in; 600/750 kcmil 550 lb-in.
6. Replace the port caps on unused ports. Sizes 2/0 to 750 may be used on the line side of service equipment.

Mechanical vs. compression lugs

A mechanical lug clamps the wire with a set screw torqued to the label value. A compression lug is crimped with the die whose index is stamped on the lug; after crimping, check the die code embossed in the barrel to prove the right die was used. Put antioxidant on aluminum only if the lug maker calls for it, and then only a compound identified for the use.

FASTENERS & SUPPORTS



wedge anchor



drop-in anchor



sleeve anchor



toggle bolt



beam clamp (gold)



strut channel



all-thread rod



one-hole & two-hole
conduit straps



J-hook



powder-actuated pin

Concrete anchors (wedge/drop-in/sleeve), toggle bolt, beam clamp, strut + spring nut, all-thread, conduit straps, J-hook, and powder-actuated pins.

300.13 (300.11 in 2023) requires raceways, cables, boxes and fittings to be "securely fastened in place," bans support from the ceiling grid and its wires, and limits using one raceway to support another. Pick the fastener by what you are fastening to.

Base material	Fastener	Key number
Concrete, heavy load	Wedge anchor (Simpson Strong-Bolt 2)	Torque $\frac{3}{8}$ in. 30 ft-lbf; $\frac{1}{2}$ in. 60–65 ft-lbf
Concrete, overhead rod hanger	Drop-in anchor (Simpson)	Drill embedment + $\frac{1}{8}$ in.; set until the tool shoulder touches
Concrete or block, light load	Tapcon screw	Hole $\frac{1}{4}$ in. deeper than embedment; minimum 1 in. embedment
Steel beam flange	Beam clamp or flange clip (CADDY 812M24)	$\frac{1}{2}$ – $\frac{3}{4}$ in. EMT on $\frac{1}{8}$ – $\frac{1}{4}$ in. flange, 75 lb static
Strut	P1000 channel ($1\frac{5}{8} \times 1\frac{5}{8}$ in., 12 ga) with spring nuts	$\frac{3}{8}$ -16 bolt 19 ft-lb recommended (25 max); $\frac{1}{2}$ -13 bolt 50 ft-lb (70 max)

Step by step: wedge anchor (Simpson Strong-Bolt 2)

1. Drill with a carbide bit of the anchor's nominal diameter to the required depth. An oversized hole reduces capacity.

2. Blow the hole clean.
3. Set the nut flush with the top of the anchor and hammer the anchor through the fixture into the hole.
4. Torque the nut: $\frac{3}{8}$ in. 30 ft-lbf, $\frac{1}{2}$ in. 60–65 ft-lbf. "Do not use an impact wrench to set or tighten."

Step by step: drop-in anchor for all-thread (Simpson)

1. Drill to the embedment depth plus $\frac{1}{8}$ in. for flush mounting.
2. Blow the hole clean.
3. Tap the anchor in flush with the surface.
4. Drive the internal plug with the setting tool until the tool's shoulder contacts the anchor top. On the DIAB, "four indentations will be visible."
5. Thread in the rod with engagement at least equal to the rod diameter.

Step by step: Tapcon (ITW Red Head)

1. Drill with the matched Tapcon bit ($\frac{5}{32}$ in. bit for $\frac{3}{16}$ in. screws, $\frac{3}{16}$ in. bit for $\frac{1}{4}$ in. screws), "at least $\frac{1}{4}$ " deeper than anchor embedment."
2. Clean the hole.
3. Drive the screw through the fixture with at least 1 in. embedment.

Strut and clips

- Unistrut's bolt torques assume "a properly calibrated torque wrench with a clean dry (non-lubricated)" fitting.
- CADDY lists static loads with 3:1 or 3.5:1 safety factors. The 812M24 flange clip "Requires only a hammer to install." Do not use the SM (sprinkler/seismic) variant for conduit; it is rated 25 lb.

12 — Firestop (300.23; 300.21 in 2023)

Every hole you make through a fire-rated wall or floor must be sealed so the wall keeps its rating: openings "shall be firestopped using approved methods to maintain the fire resistance rating." The informational note points to the 24 in. horizontal separation between boxes on opposite sides of a rated wall.

1. Find the UL system number for the penetration on the drawings or the firestop submittal.
2. Check that your penetrant (EMT, MC, cable bundle), its size, the wall type and the annular space (the gap around the pipe) all match that system.
3. Install backing and sealant to the depth the system requires.
4. Label the penetration as the project requires.

Example: Hilti system W-L-5025. Up to 4 in. EMT through a gypsum wall needs "MINIMUM 5/8" DEPTH OF SEALANT FOR A 1-HR" wall and 1¼ in. for a 2-hour wall. Using a sealant or system that does not match the listed penetrant or wall is the common failure.

13 — Labels & Hazard Markings

- Field-applied hazard labels (110.21(B)) must warn with "effective words, colors, and/or symbols," be "permanently affixed," and "not be handwritten."
- Every disconnect must be marked with its purpose (110.22(A)) and, in other than one- or two-family dwellings, the "identification and location of the circuit source."
- Panelboards need the directory (408.4(A)), the source label (408.4(B)) and the available fault current marking with its date (408.6).
- Series-rated panels need the series combination caution label (110.22(C)).
- Markings must have "sufficient durability" for the environment (110.21(A)(1)). Use printed labels that survive heat, sun and washdown.

14 — Reading a Material List or Submittal

A submittal is the package of cut sheets the contractor sends the engineer to approve before buying. Before you order or install, check every line:

1. Match each line item to its specification section.
2. Check the listing and marking: the UL mark, the type (for example THHN/THWN-2), and the voltage.
3. Check the environment rating: wet or raintight, NEMA type (Table 110.28), WR and TR, plenum.
4. Check the electrical ratings: amps, AIC against the available fault current (110.9), short-circuit current rating, the series-rating table, the fuse class.
5. Check compatibility: breaker on the panel's accepted list, connector rated for Cu or Al (110.14), MC fitting listed for MC.
6. Check quantities against the takeoff. YES Electric practice adds about 10% extra stock; that is company practice, not code.
7. Flag every "or equal" substitution for engineer approval before ordering.

15 — Handling, Storage & Consumables

From the Southwire Power Cable Installation Guide, "Handling and Storage Guidelines":

- Lift reels with a forklift "by contacting both flanges," never by the cable.
- Store reels on a hard surface.
- "Cable ends must always be sealed to prevent the entrance of moisture."
- Have a person feed cable straight into the conduit during the pull.

- Use a pulling lubricant compatible with the cable jacket (see the guide's "Cable Lubrication Selection").

Company practice (not a cited standard): keep PVC flat and shaded, keep devices boxed until trim-out, cap EMT and keep it off the ground, stage fittings by type, and check PVC cement dates (Carlon gives 24 months unopened below 80°F). Phase tape colors follow the posted 210.5(C)(2) legend. Use plenum-rated ties in return-air ceilings.

16 — Safety for Material Work

- Working near energized parts: OSHA 1926.416. Lockout and tagging: OSHA 1926.417. Test for absence of voltage before touching any conductor.
- Wear eye protection when drilling concrete and setting anchors.
- Use a calibrated torque wrench or screwdriver for every lug and breaker terminal (110.14(D)).
- Ream every cut end; burrs cut hands as well as insulation.

Common Mistakes

Mistake	Why it fails
MC or flex tied to the ceiling grid wires	300.13(B)(1)
Jacketed MC, PVC or nylon ties in a plenum ceiling	300.25(C)(1)
Flex-only fitting on MC	Not listed for MC (330.2)
No red head on AC cable, or not visible	320.40
Unreamed EMT, set-screw fittings outdoors	358.28(A), 358.42
More than 360° of bends between pull points	358.24(B), 300.24
No expansion fitting on a long sunny PVC run	352.44
Splice in an LB with no volume marking	314.16(C)
No bushing on 4 AWG and larger	300.6(G)
Concentric KO rings on a 480 V run with no bonding bushing	250.97
Box overfilled, or an unmarked mud ring counted	314.16
Open knockouts left in boxes and panels	314.17(A)
Black 10 AWG taped white as a neutral	200.7
Wireway derated for 30 conductors or treated as capped at 30	376.22: 20% fill is the limit; derate only above 30
RK5 swapped for RK1	Loses the series or equipment short-circuit rating
Non-listed breaker that "fits" the panel	Panel accepted-type label
Backstabbed receptacles on 20 A circuits	406.10(3)
Orange IG receptacle with no isolated EGC	406.11(C)
Handwritten directory or source label	408.4
Wedge anchor set with an impact wrench	Simpson instructions
Firestop that does not match the UL system	300.23

Inspection Checklist Before You Call It Done

1. Every raceway and cable supported at its article's interval and within the distance of each box; nothing on the ceiling grid.
2. Fittings right for the location (raintight outdoors) and tight; locknuts biting; bushings on 4 AWG and larger.
3. Bends counted: 360° or less between pull points.

4. Boxes: fill OK, rings marked, KOs closed, covers on, flush within $\frac{1}{4}$ in., accessible.
5. Conductors: insulation type matches the location, neutrals identified per 200.7, EGC green or bare, high leg orange, legend posted.
6. Breakers on the accepted list, AIC at least the available fault current, series labels in place.
7. Every lug torqued with a calibrated tool and marked.
8. Devices: right rating, WR/TR where required, extra-duty in-use covers outdoors, no push-ins on 20 A, GFCIs tested.
9. Panel directory specific and typed; source label and fault current marking in place.
10. Penetrations firestopped to the UL system; labels permanent and not handwritten.

NEC 2026 Checkpoints (2023 number in parentheses where it moved)

- **300.6(G)** (300.4(G)) bushings • **300.11** (300.9) wet raceways • **300.13** (300.11) support
- **300.16** (300.14) 6 in. free conductor • **300.20** (300.18) complete system • **300.23** (300.21) firestop • **300.24** bends (new) • **300.25(C)** (300.22(C)) plenums.
- **358.24(B)** (358.26) and **352.24(B)** (352.26) 360° rule • **358.28, 358.30, 358.42** EMT • **352.30, 352.44** PVC • **320.30, 320.40** AC • **330.2, 330.24(B), 330.30(D)** MC.
- **366.22, 366.23** gutters • **376.22, 376.30** wireways (20% fill; derate above 30).
- **314.16, 314.17, 314.20, 314.23, 314.28** boxes • **Table 110.28** enclosure types.
- **200.7** (200.6) neutral ID • **200.6(B)** neutral grouping • **250.119** EGC • **110.15** high leg
- **210.5(C)(2)** voltage-system ID • **110.14(C)** termination temperature • **110.14(D)** torque.
- **110.9** interrupting rating • **240.83(C), 240.86** breakers and series ratings • **408.3** reconditioned • **408.4, 408.6** directory, source, fault current • **408.10(E)/(F)** (408.3(E)/(F)) bus arrangement.
- **406.10(3)** push-in terminals (new) • **406.9** wet locations • **406.11(C)** isolated ground • **406.26** (406.12) tamper-resistant • **406.46** (404.14) switch ratings • **210.8(B)** GFCI.
- **410.36(B)** lay-in support • **410.71** fixture disconnect • **110.21(B), 110.22** labels.

Hands-On Field Exercise

- From the shop stock, identify by sight and name the article for: AC, MC, EMT, IMC, RMC, PVC, ENT, FMC and LFMC. Show where MC's EGC is and where AC's bonding strip is.
- Calculate box fill for a 4S × 1½ box with two 12 AWG circuits, their EGCs and two devices on a marked ring.
- Size the straight-pull and angle-pull box for a 3 in. and 2 in. run.
- Cut, ream and make up an EMT run with one set-screw and one raintight compression connector; bond a concentric knockout with a bonding bushing.
- Glue a PVC joint following the five Carlon steps.
- Read three breakers and one panel label; say whether each breaker may go in that panel and why.
- Terminate a 20 A receptacle on the side screws, then a Polaris tap, torquing both to the chart.
- Set a $\frac{3}{8}$ in. wedge anchor and a drop-in anchor in a concrete block and torque them.

Sources used in this module (public documents)

- NFPA 70, National Electrical Code 2026 (free read-only access at nfpa.org): Articles 110, 200, 210, 240, 250, 300, 310, 314, 320, 330, 344, 352, 358, 366, 376, 406, 408, 410, 517.
- Eaton Bussmann, Selecting Protective Devices handbook, publication 3002: eaton.com
- Schneider Electric / Square D, NQ/NQM Panelboards Instruction Bulletin 80043-712-06: se.com
- Southwire, Power Cable Installation Guide and MC Cable Installation Guide: southwire.com
- Unistrut General Engineering Catalog No. 17: unistrutstore.com
- nVent CADDY Fixing, Fastening and Support catalog: nvent.com
- Simpson Strong-Tie, Strong-Bolt 2 product data and Drop-In installation instructions: strongtie.com
- ITW Red Head Tapcon installation instructions: itwredhead.com, tapcon.ca
- Ideal Wire Range Chart: idealind.com. WAGO 221 Series Lever-Nuts datasheet: wago.com
- NSi Polaris insulated connector installation instructions: nsiindustries.com
- Carlon PVC cement instructions and "Cements, Primers and Sealers": carlonsales.com
- American Fittings EMT fittings and Bridgeport wet-location fittings cut sheets.
- IAEI Magazine, "Receptacle Grades: What Do They Mean?" (January 2005): iaeimagazine.org. Leviton receptacle grades: leviton.com
- Hilti firestop system W-L-5025 detail: hilti.com
- OSHA 29 CFR 1926.416 and 1926.417: osha.gov
- NAVEDTRA 14026 Construction Electrician Basic, Chapter 5.

Next: Lighting Masterclass — Commercial Lighting.