

Lighting: Fixtures, Recessed Cans, Fans, and LED Retrofits

YES Electric • NEC 2026 with NEC 2023 numbers in parentheses

Draft 1 (October 2026). This chapter is under review. Code numbers are NEC 2026. Your local inspector may use an earlier edition, so ask your journeyman which one applies. Boxes marked "Picture coming" will get drawings and photos in a later version.

Course: YES Electric Residential Electrical Course, Phase 1 (Install) **Read first:** R1.1 (Safety, Tools, and the Service Truck), R1.2 (How a House Is Wired), R1.3 (Cable Wiring Methods and Boxes), R1.4 (Receptacles, Switches, and Branch Circuits). **Read after:** R2.6 (Switches, Dimmers, and Lighting Faults) for troubleshooting the things you install here. **Code edition:** This module cites NEC 2026. Where a section moved, the NEC 2023 number is in parentheses. The local inspector (the AHJ, "authority having jurisdiction") may enforce an earlier edition, so ask your journeyman which one applies before your first inspection.

1. Learning Objectives

When you finish this module you will be able to:

1. Swap a ceiling fixture safely, using the YES eight-step flush-mount LED swap from our Fixture Swap Field Guide.
 2. Install recessed lights in a new ceiling (joists open) and in an existing ceiling (drywall up), and tell IC from non-IC and airtight from non-airtight.
 3. Install a canless wafer light and its remote junction box.
 4. Replace a light-only ceiling box with a fan-rated brace box from below, hang a fan, and wire the fan and light on separate switches with 14-3 cable.
 5. Pick a dimmer that matches the LED driver, set its low-end trim, and know when a smart dimmer needs a neutral.
 6. Lay out a light in a clothes closet using the 410.16 storage-space rules and clearances.
 7. Keep fixtures out of the bathtub and shower zone that 410.10(D) protects.
 8. Install low-voltage under-cabinet and landscape lighting, including burial depth and voltage drop on a 12-volt run.
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2. Background in Plain Language

2.1 What the code calls a light

The NEC calls a light fixture a **luminaire**. A luminaire is the whole unit: the housing, the light source, the driver or ballast, and the parts that hold it to the ceiling. A **lampholder** is just a socket. A **lamp** is the bulb. On a work order you will see "fixture," and in the code book you will see "luminaire." They mean the same thing.

Every ceiling or wall light has three jobs you control as the installer:

1. **Support.** The box or the framing has to carry the weight, and for a fan, the shaking.
2. **Connection.** Hot to hot, neutral to neutral, ground to ground, inside a box you can reach later.
3. **Heat.** The light cannot cook the wood, the insulation, or the wires in the box.

Most callbacks on lighting jobs come from one of those three. A fixture that falls is a support failure. A fixture that flickers or goes dark is usually a connection failure. A can light that cycles off and on every 20 minutes is a heat failure: its thermal cutout is opening.

2.2 Lamps, drivers, and "integrated" LEDs

An old incandescent bulb is a hot wire in a glass ball. It runs straight off 120 volts. A fluorescent tube needs a **ballast** to start and run it. An LED needs a **driver**, which is a small power supply that turns 120 volts AC into the low-voltage DC the LED chips want.

There are two kinds of LED lights on the service truck:

Type	What it is	When the light source dies
LED lamp (bulb)	Screws into a standard Edison socket. The driver is inside the bulb base.	Change the bulb.
Integrated LED fixture	The LED board and driver are built into the fixture. No bulb to change.	Replace the whole fixture, or the driver if the maker sells one.

Our Fixture Swap Field Guide notes that installers report integrated-fixture driver life from about 2 years on bad units to 7 or 8 years with no failures on good ones. The bigger problem is that a model often gets discontinued within a few years. If one fixture in a row of eight dies, you may not be able to match it. Tell the customer this before you install a row of integrated fixtures.

2.3 Why dimmers and LEDs fight

A standard dimmer works by chopping off part of each AC wave. Old incandescent bulbs did not care how the wave was chopped. An LED driver does care. If the dimmer and driver are not a match, you get flicker, buzz, a light that will not turn fully off, or a light that pops on at 40 percent instead of fading up.

The two main chopping styles are:

Dimmer style	Also called	Usually matches
Leading edge	Forward phase, incandescent dimmer, TRIAC, ELV-incompatible	Incandescent, magnetic low-voltage transformers, some LEDs
Trailing edge	Reverse phase, ELV (electronic low voltage)	Most LED drivers, electronic low-voltage transformers

A third kind, **0-10 volt** dimming, uses two extra low-voltage wires to send a control signal to the driver. It is common in commercial work and on some high-end residential fixtures. See the commercial LIGHTING masterclass for 0-10 V wiring.

The Halo LT-DM canless downlight instructions say the fixture dims with "most 120V phase control dimmers (LE/TE - Leading Edge / Trailing Edge)," that dimming "may be enhanced with dimmers that feature low-end trim adjustment," and that "some dimmers require a neutral wire in the wall box." That is typical. Always check the fixture maker's dimmer compatibility list before you pick the dimmer.

2.4 IC, non-IC, and airtight

A recessed light sits up inside the ceiling. If attic insulation is packed against it, the heat has nowhere to go.

- A **Type IC** housing is rated for insulation contact. Insulation can touch it.
- A **non-IC** housing must be kept away from insulation and from wood. The NEC numbers are in the table below.
- An **airtight** housing (Halo calls theirs AIR-TITE) has a gasket that stops attic air from leaking through the can into the room. Halo says its airtight housings are certified under ASTM E283. Energy codes often require airtight cans in an insulated ceiling. Ask your journeyman what the local energy code says.

Rule	Non-IC housing	Type IC housing	NEC 2026
Distance from wood and other combustibles	At least ½ in. from all recessed parts. Trim and support points may touch.	May touch combustibles.	410.116(A)(1), (A)(2)
Insulation above the fixture	Not allowed.	Allowed.	410.116(B)
Insulation beside the fixture	Keep 3 in. away from the enclosure, wiring compartment, driver, ballast, or transformer.	Allowed.	410.116(B)
Combustible material temperature	Not over 90°C (194°F).	Same.	410.115(A)

Kuhlman, in *Residential Electrical Troubleshooting* ("Lighting: Recess lights," p. 48), tells why this matters on old houses. Before LED, there were no IC-rated 4-inch old-work cans, so electricians put in non-IC cans and pulled the insulation back the 3-inch minimum. A later homeowner would see the gap and push the insulation back against the can. The thermal cutout should then shut the light off, but you cannot count on a safety device as your only protection. When you find non-IC cans in an insulated attic, tell the customer and recommend IC-rated replacements or LED retrofit trims listed for that housing.

2.5 What a ceiling box can hold

A light box and a fan box look alike from below. They are not alike.

Load on the box	What the box must be	NEC 2026
Wall light, 6 lb or less	Any box, with the fixture held by at least two No. 6 or larger screws.	314.27(A)(1)(a)
Wall light, over 6 lb	A box marked inside with the weight it can carry, if other than 50 lb.	314.27(A)(1)(b)
Ceiling light, up to 50 lb	Any box at a lighting outlet must be able to carry 50 lb.	314.27(A)(2)(a)
Ceiling light, over 50 lb	Supported independently of the box, unless the box is listed and marked for the weight.	314.27(A)(2)(b)
Ceiling fan	A box listed and marked inside "for fan support." Marked with the max weight if over 35 lb. Never more than 32 kg (70 lb).	314.27(B)(1), 422.18(A)

The fan rule exists because a fan does not just hang. It wobbles, and every wobble works the screws loose a little. A fan-rated box is built and tested to take that.

2.6 What the code requires for lighting outlets

You will usually be swapping or adding lights the customer asked for. You still need to know the minimum, because a remodel inspection checks it.

Per 210.70(A)(1), every habitable room, kitchen, laundry area, and bathroom needs at least one lighting outlet controlled by a wall switch or listed wall-mounted control near an entrance to the room. Per 210.70(A)(2), you also need a switched lighting outlet in hallways, stairways, attached garages, and detached garages and accessory buildings that have power, plus a switched exterior light at each outdoor entrance or exit with grade-level access. A garage vehicle door does not count as an entrance. Interior stairs with six or more risers need a switch at each floor level and each landing that has a stair entry.

Per 210.70(C), attics, crawl spaces (underfloor spaces), utility rooms, and basements used for storage or holding equipment that needs servicing need a light with a switch at each entry point.

2.7 Neutral at the switch

Smart switches, timers, occupancy sensors, and many LED dimmers need a neutral at the switch box to power their own electronics. NEC 2026 406.30(C) (2023: 404.2(C)) requires the grounded conductor (neutral) to be installed at switch locations that control lighting in bathrooms, hallways, stairways, habitable rooms, and occupiable spaces, with a few exceptions such as switches that control a receptacle. In plain terms: when you run new switch legs, bring the neutral into the switch box even if the switch you are installing today does not use it. On a replacement in an old house where the neutral is not in the box and you cannot get one there without opening walls, the exception lets you install the electronic switch anyway, with limits on how many per circuit.

3. Step-by-Step Procedures

Procedure 3.1: Before any lighting job

Do these every time, in this order.

1. **Ask what the customer wants and what they have.** Get the new fixture's box or spec sheet. Write down its weight, its width, whether it is IC rated (for recessed), and whether it is dimmable.
2. **Find the circuit.** Turn the light on. Flip breakers until it goes off. Label that breaker with tape.

WARNING: A wall switch is not a disconnect. It opens only the hot to the light. The neutral and any other circuits in the box can still be live. Kill the breaker. Then check every wire in the box, because a ceiling box can hold two circuits.

1. **Verify dead at the box.** Use the non-contact tester on every conductor in the box. Then prove it with your meter: hot to neutral, hot to ground, neutral to ground. Test your meter on a known live receptacle before and after. See R1.1 for the full three-way dead check.
2. **Look at the box before you buy or open anything.** Is it plastic, metal, or a pancake? Is it fastened to framing, or hanging from drywall? Is it marked for fan support? Is there a ground wire or a grounded metal box?
3. **Check the wire insulation.** In houses built before about 1985, the wires in a ceiling box above an old incandescent fixture are often baked brittle. If the insulation cracks when you bend it, stop and talk to your journeyman. The fix may be a new splice to fresh conductor, heat-shrink, or a new cable run.
4. **Read the new fixture's instructions.** NEC 110.3(B) says listed equipment "shall be installed and used in accordance with any instructions included in the listing, labeling, or identification." The instruction sheet is enforceable. If it says use 90°C supply conductors, you must.

Procedure 3.2: The YES eight-step flush-mount LED swap

This comes from our Fixture Swap Field Guide. The job it was written for was a laundry room: take out a recessed 2-lamp fluorescent fixture and put in a like-for-like LED flush mount with the same footprint, same junction box, and same mounting points. The order matters as much as the wiring does.

Wire color key

Conductor	Color
Hot	Black
Neutral	White
Ground	Bare copper

Before you climb the ladder, have:

- A non-contact voltage tester.
- Phillips and flathead screwdrivers, and wire strippers.
- The new LED flush mount, sized to the existing recess. Measure the recess first.
- Three wire nuts matched to the new fixture's leads, if the fixture did not come with them.
- A ladder tall enough to work at the ceiling without stretching. See R1.1 for ladder setup.

Step 1: Power off and verify. Kill the breaker feeding this fixture, not just the wall switch. At the fixture, hold a non-contact tester up to the wiring before you touch anything. No glow and no beep means dead. Do not skip this because you are confident which breaker it is. Verify at the box every time. (YES practice adds the meter check from Procedure 3.1, Step 3, once the box is open.)

Step 2: Know what is up there. Before you take anything apart, name the parts: the diffuser lens, two tubes, a ballast, the tombstones (lamp holders), and up inside the recess, the junction box feeding it three conductors: hot, neutral, and ground.

Step 3: Remove the old fixture. Do three moves in order. (A) Unclip the diffuser lens and set it aside. (B) Twist and pull the tubes. (C) Back out the mounting screws and take off the wire nuts to free the housing. The ballast and housing leave together. Nothing here gets reused.

WARNING: Old fluorescent tubes contain mercury. Do not break them. Bag them and bring them back to the shop for recycling. Older magnetic ballasts made before 1979 may contain PCBs; if a ballast is leaking a tar-like fluid, do not touch it bare-handed. Bag it and tell your journeyman.

Step 4: What is left is the junction box. With the old housing gone, you are looking at the bare box screwed to the joist, with three conductors hanging out (hot, neutral, ground) and the

mounting ears the new bracket will use. This is your clean starting point. Check the box is tight to the joist. If it moves, fix it now.

Step 5: Mount the new bracket. The new fixture's mounting plate screws into the same joist and box ears you just exposed. Snug the screws. This plate carries the whole fixture's weight once it is hung. Note the small ground screw on the bracket. That screw bonds the metal bracket to the grounding system before the fixture's own ground lead comes into play.

Step 6: Make the connections. This is the most important step. Make three pairs, matched like to like, each in its own wire nut:

1. House hot (black) to fixture hot (black).
2. House neutral (white) to fixture neutral (white).
3. House ground (bare) to fixture ground (green or bare).

The fixture's ground lead also gets a short pigtail over to the bracket's ground screw from Step 5. The bracket must be bonded too, not just the fixture body. Twist each pair clockwise before capping, and give each nut a gentle tug once it is on.

Before the next step, fold the connections up into the box neatly. Three wire nuts and the slack wire must tuck behind the fixture body without pinching. If they do not, you will be fighting this fixture again in six months.

Step 7: Close it up. Tuck the wiring, lift the fixture body to the bracket, and twist the built-in tabs to lock it in place. Once it is secure and flush, snap the lens or diffuser panel over the light engine. If the recess and the fixture footprint were measured right, it sits flush with no gap around the edge.

Step 8: Power on and test. Turn the breaker back on. Confirm the fixture lights evenly across its full length with no flicker and no dark end. If it is an adjustable color-temperature (CCT) model, set the color now, while the selector switch is still easy to reach.

Field notes from the guide

- These steps show a generic like-for-like install. Your bracket, box style, and lens latch will vary by model. Read the fixture's own sheet for its tab or clip before Step 7.
- Confirm the new fixture's footprint against the measured recess before you buy. This sequence assumes a true drop-in, not a job that needs new blocking or a bridge.
- If the ground pigtail is not pre-attached to the fixture, add a short jumper from the fixture ground terminal to the bracket screw yourself.

Picture coming: An eight-panel horizontal strip, one panel per step of the flush-mount swap: (1) hand holding a non-contact tester to a ceiling fixture, breaker panel inset with one breaker marked OFF; (2) exploded view of a 2-lamp recessed fluorescent fixture labeled diffuser lens, tube, ballast, tombstone, junction box with black, white, and bare wires; (3) the lens unclipped (A), a tube being twisted out (B), the housing coming down with the ballast (C); (4) a bare metal box on a joist with three conductors hanging and two mounting ears; (5) a round LED mounting plate screwed to the ears, green ground screw circled; (6) three wire nuts joining black-black, white-white, bare-green, plus a short green pigtail to the bracket screw, labeled "MOST IMPORTANT STEP"; (7) the fixture twisted onto the bracket tabs and the lens snapped on; (8) the fixture lit evenly with a hand moving a CCT slide switch.

Procedure 3.3: Method B, the ballast-bypass LED tube retrofit (reference)

The field guide includes a second method for a different job. Use it when the fluorescent housing and lens are in good shape and only the ballast or tubes failed, or when replacing the whole fixture is not in the budget. It does nothing for a fixture that looks bad or fits poorly.

1. **Kill and verify** as in Step 1 above.
2. **Pull the tubes and the shroud** (reflector cover) to expose the ballast.
3. **Find the ballast leads** that run to each tombstone at both ends of the fixture. Cut them, leaving a few inches of slack in case anyone ever wants to convert back. The ground wire is not part of this job. It stays bonded to the housing as it was.
4. **Look at the tombstones before you cut.** Some have a single jumper between the two wires on one tombstone, so only one wire needs a splice. Others wire both leads on each tombstone separately, so both wires need their own connection to house power.
5. **Wire direct.** House hot goes to the wire or wires on one tombstone. House neutral goes to the wire or wires on the other. For most single-ended, non-polarized bypass tubes it does not matter which side gets which, but that is product-specific. Read the sheet that ships with the tube you are installing.
6. **Splice stranded to solid correctly.** When you splice stranded fixture wire to solid house wire, let the stranded wire sit slightly past the end of the solid wire before twisting, so it seats in the nut. Tug-test every connection.
7. **Reassemble and label.** Twist the LED tubes into the tombstones. The twist also closes the tombstone's rotary contact, so the tube will not light until it is fully seated. Reinstall the shroud. Stick the warning label that ships with the tubes on the outside of the fixture. It tells the next person this fixture is rewired for LED and cannot take fluorescent tubes.
8. **Test.** If the tubes flicker, the ballast is still in the circuit. Go back and verify every ballast lead is fully disconnected, not just cut short.

WARNING: Once bypassed, the tombstones carry line voltage. A person who later puts a fluorescent tube in, or touches a tombstone with the power on, is exposed to 120 volts. That is why the label is required by the tube maker. Never skip it.

Procedure 3.4: Replacing a fixture when the box is wrong

Many swaps are not like for like. Here is what to do with the common problems.

What you find	What to do	Why
Box loose, held only by drywall	Remove it. Install an old-work box rated for the fixture weight, or a brace box (Procedure 3.7).	314.23 requires boxes to be securely supported.
Pancake box (½ in. deep) on a joist	Count box fill (R1.3). If the new fixture's leads and three wire nuts do not fit, you need a deeper box or a canopy that adds space. 410.20 lets the canopy and box together count.	Overstuffed boxes crack wire nuts and pinch insulation.
No ground wire, no grounded metal box	410.44 Exception No. 2 lets a replacement luminaire go in without a ground where it is GFCI protected or has no exposed conductive parts. Otherwise run a ground (R1.6).	Metal fixture bodies must be bonded so a fault trips the breaker.
Two cables in the box, one always hot	The always-hot is feeding through to the next outlet. Keep its splice intact. Only the switched leg goes to the fixture.	Breaking the through-splice kills the rest of the circuit.
Old cloth or rubber insulation, brittle	Stop. Talk to your journeyman about the repair before connecting.	300.4(C) requires replacing conductors damaged by overheating.
Gap between canopy and box edge with exposed wood or drywall paper	Cover any combustible finish exposed between the canopy edge and the box if that area is 180 sq in. or more.	410.23

Picture coming: Four ceiling boxes viewed from below, each with a red X or green check: (1) a plastic box hanging from drywall with no fasteners into framing, red X, label "loose, not supported"; (2) a ½-inch pancake box screwed to a joist with too many wire nuts bulging out, red X, label "overfilled"; (3) a metal box with a bare ground wire under a green screw, green check; (4) a box with two cables where one pair of blacks is spliced together with a pigtail and a separate red switched leg goes to the fixture, green check, label "keep the through-splice."

Procedure 3.5: New-construction recessed housings (framing open)

Use this when the joists are open from below. This is common on remodels where the ceiling drywall is off.

- 1. Lay out the lights on the floor first.** Mark the centers with tape on the floor, then plumb them up to the joists with a laser or plumb bob. A common rule of thumb for 6-inch downlights in an 8-foot room is to space them about 4 to 6 feet apart and about half that distance from the walls. Confirm with the fixture's spacing chart if the customer cares about even light.

2. **Check what is above.** Look for ducts, pipes, and joists in the way. A housing has to sit between joists.
3. **Extend the bar hangers to fit between joists.** Halo's H750TCP instructions say to position the fixture by screwing or nailing the bar hangers into the joists, with the hangers level with the bottom of the joists. That puts the bottom of the housing flush with the bottom of the drywall once it is hung.
4. **Slide the housing along the bars** to where you want it, then lock it in place with the set screws or tabs on the hanger.
5. **Wire the junction box on the housing.** Remove the box cover. Bring the cable in through a clamp or approved connector. Halo's sheet says supply wire insulation must be rated at least 90°C. NM-B cable has 90°C conductors, so it meets this. Strip ½ inch for push-in connectors if the box uses them.
6. **Daisy-chain in and out** of each housing box, or run each to a junction box, per the housing's through-wiring rating. 410.21 says you may not pass branch-circuit wiring through a box that is part of a luminaire unless the luminaire is identified for through-wiring. Most recessed housing boxes are marked for a set number of conductors in and out. Read the label.
7. **Secure the cable** within 12 inches of the housing box and every 4½ feet, per 334.30. See R1.3.
8. **Keep insulation clear if non-IC.** For a non-IC housing, mark the 3-inch clearance and tell the insulation installer. For IC, no clearance is needed.

Picture coming: Cutaway of an open ceiling with three joists on 16-inch centers. A new-construction recessed housing hangs between two joists on extended bar hangers nailed into the joist sides, hanger bottoms flush with the joist bottoms. NM cable enters the attached junction box through a clamp and leaves for the next housing. Labels: "bar hanger level with bottom of joist," "junction box, wire 90°C min," "staple within 12 in.," and a dashed 3-inch circle around a non-IC version labeled "non-IC: insulation kept 3 in. away, none on top."

Procedure 3.6: Remodel recessed housings (drywall up)

Use this when the ceiling is finished and you are working from below. These steps follow Halo's H750RICAT 6-inch remodel IC airtight housing instructions. Other brands are similar.

1. **Find the joists.** Use a stud finder, then confirm by drilling a ⅛-inch test hole in the center of each planned light. Bend a coat-hanger wire into an L, push it in, and spin it. If it hits wood within 3 inches, move the hole.

WARNING: Check the attic first if you can. Look for wires, pipes, and ducts above each planned hole. A hole saw will cut through NM cable just as easily as drywall.

1. **Scribe the hole.** The H750RICAT uses a 6¼-inch circle. Use the template that comes in the box.

2. **Cut the hole cleanly.** Halo says the ceiling material supports the fixture, so the hole "needs to be cut cleanly and accurately. Jagged edges or an oversize hole may prevent the fixture from seating properly." Use a hole saw with a dust cup, or a drywall saw with a steady hand.
3. **Fish the cable to the hole.** Bring your cable from the switch or from the previous light. See R1.12 for fishing across a finished ceiling.
4. **Wire the housing junction box** at the hole, on the floor or on the ladder, before it goes up. Use 90°C rated supply conductors. Close the box cover.
5. **Put the housing in.** With the remodel clips seated in the can, push the housing up into the hole junction box first.
6. **Set the clips.** Hold the fixture against the ceiling and push each remodel clip through its housing slot. Push the flat part of the clip against the side of the can to lock it. Then push the clip up with a screwdriver until it snaps over the drywall. Halo's four clips fit ½-inch and ⅝-inch ceilings.
7. **Lock the clips if the ceiling vibrates.** Halo suggests a ¼-14 × ½-inch pan head sheet metal screw through the hole in each spring clip into the housing slot where vibration is a problem, such as under a bonus room floor.
8. **Install the trim** or LED retrofit module.

Procedure 3.7: Canless wafer lights

A canless light (also called a wafer or slim light) is a thin LED disc that clips into a round ceiling hole. Its driver sits in a small remote junction box that rides up into the ceiling beside it. There is no can. These steps follow the GE (Cync) Wafer Downlight guide. Halo's LT-DM canless sheet is similar.

1. **Pick the spot.** The GE guide says the maximum distance from the junction box to the downlight is 16 inches. The remote box has to fit beside the light in the joist bay.
2. **Cut the hole.** The GE guide calls for a 4¼-inch hole for a 4-inch wafer and a 6¼-inch hole for a 6-inch wafer. Halo's LT-DM sheet gives a cutout range of 4 to 4½ inches for its 4-inch model and 6 to 6½ inches for its 6-inch model. Use the template from the box you are installing.
3. **Open the remote box and remove a knockout** with a hammer and screwdriver.
4. **Install a cable clamp (strain relief) in the knockout.** It is not included. Route the house cable through it.
5. **Connect black to black, white to white, and green to green or bare copper.** Secure with the provided wire nuts. Close the box cover.
6. **Push the remote box up through the hole** and lay it on the back of the drywall.
7. **Connect the light to the box** with the barrel connector. Screw it together until it is tight.
8. **Set the color temperature** if the model has a selector. Halo LT-DM models offer up to five settings (2700K, 3000K, 3500K, 4000K, 5000K) depending on the model.
9. **Fold the spring clips up** against the fixture and guide it into the hole until the clips snap over the drywall.

Wafer lights are IC rated on most models (the GE guide says so for its unit). Some are rated for damp or wet locations, which matters in a shower (Procedure 3.11). Check the label.

WARNING: Some smart wafers are "not for use with dimmer switches." The GE Cync wafer is one. It dims only with its own app or the maker's smart dimmer. A standard dimmer on that light will make it flicker or fail. Read the sheet before you put a dimmer on any LED.

Picture coming: Three-step drawing of a canless wafer install from below: (1) a 6¼-inch hole cut in drywall between two joists, with "max 16 in." measured to where the remote box will sit; (2) the remote junction box with its cover open, a cable clamp in the knockout, black-black, white-white, bare-green wire nuts; (3) the remote box pushed up into the bay lying on the drywall, the barrel connector joined, and the wafer's two spring clips folded up as it goes into the hole.

Procedure 3.8: Installing a fan-rated brace box from below

Use this when the customer wants a fan where a light was and the box is not marked for fan support. These steps follow Westinghouse's Saf-T-Brace Model 01100 instructions. Westinghouse says this brace is UL listed for fan support and installs through a 4-inch hole. It rates the brace for fans up to 70 lb, for light fixtures up to 150 lb on 16-inch joist spacing, and for light fixtures up to 50 lb on 24-inch joist spacing.

1. **Kill and verify.** Remove the old fixture and the old box. If the old box was nailed to a joist, pry it off carefully. If it was on a light-duty bar hanger, remove that too.
2. **Clear the area.** Move insulation and wiring out of the way. Remove any wire stapled to the side of the joist where the brace will bite.
3. **Insert the brace through the hole** and lay it on top of the drywall, centering the square tube over the hole. Both feet rest on the back of the drywall.
4. **Turn the tube by hand** until its teeth lock into the joists on both sides. A 7/8-inch wrench may be needed for the last turn to bring a flat side of the tube parallel to the drywall. Do not use the wrench to spin it in. The flat side must face down so the box bracket hangs straight.
5. **Snap the bracket over the tube** and center it over the hole, with the bracket's screws pointing down toward the hole.
6. **Remove one knockout** from the box and install a cable connector. Pull the cable down through the hole and into the connector.
7. **Push the box up onto the bracket bolts** and secure it with the two nylon locknuts provided. Tighten securely, but do not overtighten.
8. **Hang the fan from the threaded inserts.** Westinghouse says to install the fan using the 10-24 × ¾-inch bolts into the threaded inserts, "NOT THE ELECTRICAL BOX EARS!" The ears are for lightweight fixtures and cover plates only.

Confirm the new box is marked inside as acceptable for fan support. NEC 314.27(B)(1) requires a box used as the sole support of a fan to be listed, marked by the maker on the inside for that purpose, and marked with the maximum weight if it is over 35 lb.

WARNING: A fan hung on a light-only box will work loose. When it lets go, a spinning fan falls on whoever is under it. If you are not sure the box is fan rated, it is not. Replace it.

Picture coming: Cutaway from the side of a ceiling with two joists. A Saf-T-Brace style expandable bar spans between the joists resting on top of the drywall, its toothed ends biting into each joist. A U-bracket hangs from the square tube with two bolts down through a 4-inch round box. Nylon locknuts on the bolts inside the box. A fan mounting bracket below is screwed into the box's threaded inserts, with an arrow and red text "not the box ears."

Procedure 3.9: Hanging a fan and wiring fan and light on separate switches

This procedure assumes a fan-rated box is in place.

Pick the cable. To switch the fan and the light separately from the wall, you need a cable from the switch box to the fan with two switched hots plus a neutral plus a ground. On a 15-amp circuit that is 14-3 NM-B with ground (black, red, white, bare). On a 20-amp circuit it is 12-3. Per 240.4(D), 14 AWG copper is limited to 15 amps of protection and 12 AWG to 20 amps.

Wiring at the switch box (power coming into the switch box):

1. Bring the incoming 14-2 (or 12-2) from the panel into a 2-gang box.
2. Splice all grounds together with a pigtail to each switch's green screw.
3. Splice the incoming white to the white of the 14-3 going up to the fan. If you are installing a smart control, add a pigtail for its neutral.
4. Splice the incoming black to two pigtails: one to the fan switch, one to the light switch.
5. Fan switch's other terminal goes to the **black** of the 14-3. Light switch's other terminal goes to the **red** of the 14-3.

Wiring at the fan:

1. Hang the fan's mounting bracket on the box's threaded inserts.
2. Feed the fan wires through the downrod, then hang the motor's ball in the bracket socket. Arc Workforce's Residential Electrical Field Guide (Job 6) notes that this lets the fan hang plumb while you work.
3. Connect house black to the fan's black (motor). Connect house red to the fan's blue (light kit). Connect house white to the fan's white. Connect house bare to the fan's green and to the bracket's green screw.
4. Tuck the wires. Slide the canopy up and fasten it.
5. Attach the blades. Install the light kit per the fan's sheet.
6. Restore power and test. Each switch should run its own load.

Single switch: If there is only one switch leg (14-2), connect the house black to both the fan black and the fan blue, and control the fan speed and light with the pull chains or a remote.

Remote receiver: Many fans come with a receiver that sits in the canopy. Wire it per the fan's diagram. The receiver usually takes a constant hot, a neutral, and a ground from the house and has its own outputs to the motor and light.

WARNING: Never put a standard light dimmer on a fan motor. Arc Guide Symptom 8 says this "will overheat the motor and potentially cause a fire." A fan needs a fan speed control. 406.46(D) says dimmers may control only permanently connected loads such as luminaires "unless listed for the control of other loads." A fan motor is another load.

Balance and direction. Run the fan on each speed. If it wobbles, check that every blade is fully seated and the blade brackets are not bent, then use the balancing kit from the box. Arc Guide Job 6 says the fan should turn counterclockwise (seen from below) in summer to push air down, and clockwise on low in winter.

Bathroom fans and lights. No part of a ceiling-suspended (paddle) fan may be in the zone 3 feet horizontally and 8 feet vertically from the top of the tub rim or shower threshold, including the space directly over the tub or shower (422.18(B)).

Picture coming: Wiring diagram for a ceiling fan with light kit on two switches. Left: a 2-gang switch box, incoming 14-2 from the panel (black, white, bare), two single-pole switches, black pigtails from the incoming hot to each switch, grounds pigtailed to both switches. Middle: 14-3 cable (black, red, white, bare) running up to the ceiling box. Right: fan canopy wiring with house black to fan black (labeled "fan motor"), house red to fan blue (labeled "light kit"), white to white, bare to green and bracket screw. Colors as named.

Procedure 3.10: Picking and installing a dimmer for LEDs

1. **Find out what is on the circuit.** Count the fixtures and add their watts. Write down whether they are LED lamps, integrated LED fixtures, low-voltage with a magnetic transformer, or low-voltage with an electronic transformer.
2. **Check every fixture's spec sheet for "dimmable."** If any fixture on the switch leg is not dimmable, do not put a dimmer on it. A non-dimmable LED on a dimmer flickers and its driver fails early.
3. **Pick the dimmer type** from the fixture maker's compatibility list. If there is no list, use the table in Section 2.3 and lean toward a trailing-edge (ELV) LED dimmer for LED loads.
4. **Check the dimmer's LED rating, not just its incandescent rating.** A dimmer marked "600 W incandescent" may be rated for only 150 W of LED. LED ratings are lower because drivers draw a rush of current at turn-on.
5. **Check derating for ganged dimmers.** Arc Guide Symptom 8 notes that many dimmers have breakaway fins (tabs) on the sides. Breaking tabs off to fit dimmers side by side in a

multi-gang box lowers the dimmer's rating by the amount printed on it. Do the math before you snap tabs.

6. **Check whether it needs a neutral.** Many smart and LED dimmers do. If there is no neutral in the box, pick a no-neutral model or bring one in (Section 2.7).
7. **Install.** Kill and verify. Connect ground to the green screw first. Then line and load per the dimmer's markings. For 3-way, follow the dimmer maker's diagram; many smart 3-ways use a companion switch with a traveler instead of a second dimmer.
8. **Set the low-end trim.** Turn the light to its lowest setting. If it flickers, shuts off, or glows when off, adjust the trim (a small dial behind the faceplate or a setting in the app) until the low end is steady.
9. **Test the full range** from off to full and back. Listen for buzz.

Kuhlman ("LED Lighting," p. 50) says most LEDs buzz a little and some louder than others, especially when dimmed, and that pairing the LED with the maker's approved dimmer gives the widest dimming range. He tells of one customer who could hear trims no one else could; the crew brought 20 spare trims and swapped them one at a time until the customer was satisfied. When a customer complains of buzz, swap one trim or bulb first to see if the noise moves with it.

Picture coming: A chart titled "Dimmer to load compatibility" with rows for incandescent/halogen, magnetic low-voltage transformer, electronic low-voltage transformer, LED lamps, integrated LED fixtures, 0-10 V LED drivers, and fan motors; columns for leading-edge (TRIAC), trailing-edge (ELV), 0-10 V, and fan speed control. Cells show a green check for typical match, yellow "check maker's list" for LED lamps and integrated LED under both phase types, red X for any dimmer on a fan motor.

Procedure 3.11: Lights in bathrooms

NEC 410.10(D) controls lights near a tub or shower.

1. **Measure the zone.** The zone is 3 feet horizontally and 8 feet vertically from the top of the bathtub rim or the shower threshold, and includes the space directly over the tub or shower.
2. **Keep hanging lights out of the zone.** No cord-connected luminaires, chain-, cable-, or cord-hung luminaires, lighting track, pendants, or fans with light kits may have any parts in that zone.
3. **Use damp or wet rated lights over the tub or shower.** A luminaire within the outside edges of the tub or shower up to 8 feet above the rim or threshold must be marked for damp or wet locations. If it is where shower spray hits it, it must be marked for wet locations.
4. **Recessed lights over a shower** are common. Use a housing and trim (or a wafer) marked suitable for wet locations, and say so on the work order.

Procedure 3.12: Lights in clothes closets

Closet lights cause fires when a hot bulb touches clothes or boxes on the shelf. NEC 410.16 controls them. The rules are about a space called the **clothes closet storage space**.

Step 1: Draw the storage space. Per 410.16(A), the storage space is:

- From the closet floor up to 6 feet, or up to the highest clothes rod if that is higher, it is everything within 24 inches of the side walls and back wall.
- Above that, up to the closet ceiling, it is everything within 12 inches of the side and back walls, or the shelf width if the shelf is wider than 12 inches.
- For a closet where you can reach both sides of a hanging rod, it also includes 12 inches on either side of the rod, below the highest rod, for the full length of the rod.

Step 2: Pick a fixture type that is allowed. Per 410.16(B), only these may go in a clothes closet:

1. Surface-mounted or recessed incandescent or LED luminaires with completely enclosed light sources.
2. Surface-mounted or recessed fluorescent luminaires.
3. Surface-mounted fluorescent or LED luminaires identified as suitable for installation within the storage space.

Per 410.16(C), open or partly enclosed lamps (a bare bulb in a porcelain keyless) and pendants are not allowed.

Step 3: Keep the clearance. Per 410.16(D), measure from the fixture to the nearest point of the storage space:

Fixture	Mounting	Minimum clearance
Incandescent or LED, completely enclosed	Surface, on the wall above the door or on the ceiling	12 in.
Fluorescent	Surface, on the wall above the door or on the ceiling	6 in.
Incandescent or LED, completely enclosed	Recessed in wall or ceiling	6 in.
Fluorescent	Recessed in wall or ceiling	6 in.
Fluorescent or LED identified for use in the storage space	Surface	May be inside the storage space (exception to 410.16(D))

Step 4: Switch it. A closet light is usually on a wall switch outside the door or on a door-jamb switch. Closets are on the AFCI list in 210.12(B), so the closet light circuit needs AFCI protection.

The worked example in Section 4.1 walks through a real closet.

Picture coming: Side section and plan view of a reach-in clothes closet 24 inches deep with one rod at 66 inches and a 12-inch shelf above it. Shaded volume shows the storage space: 24 inches from back and side walls from floor to 6 ft, then 12 inches (or shelf width) from walls to the ceiling. A completely enclosed LED surface fixture on the ceiling is shown with a dimension line of 12 in. to the shaded zone, a recessed LED with 6 in., and a red-X porcelain keyless bare-bulb fixture labeled "not permitted."

Procedure 3.13: Low-voltage under-cabinet and landscape lighting

Low-voltage lighting runs at 12 or 24 volts from a transformer (power supply). Kuhlman ("Low voltage lighting," p. 49) lists under-cabinet tape light, pucks, and outdoor yard lights as typical. NEC Article 411 covers it.

Code limits you must know (NEC 2026 Art. 411):

Rule	Limit	Section
System parts	Isolating power supply, low-voltage luminaires, and associated equipment all identified for the use, or a listed system	411.2, 411.4
Power supply output	25 amps maximum under all load conditions	411.4(A)
Operating voltage	Not over 30 volts AC or 60 volts DC; if wet contact is likely, not over 15 volts AC or 30 volts DC	411.4(B)
Reconditioned systems	Not permitted	411.3(B)
Bare conductors	Indoors only, at least 7 ft above the floor unless listed lower	411.4
Concealed wiring through walls, floors, ceilings	Chapter 3 wiring method, or wiring supplied by a listed Class 2 power source installed per 722.140	411.6(A)
Near pools, spas, fountains	At least 10 ft horizontally from the water edge unless permitted elsewhere	411.6(B)
Supply circuit for non-Class 2 power supplies	20 amps maximum	411.8(B)
Burial depth, landscape circuits 30 V or less in UF or identified cable	6 in. (lesser depth where the listed system's instructions allow)	Table 300.7(A), Column 5 (2023: Table 300.5)

Under-cabinet tape light

1. Plan the run. Measure each cabinet run. Total the watts per foot from the tape spec sheet times the feet.
2. Size the power supply. Pick a driver whose rating is above the total watts. Leaving headroom keeps it cooler; many makers suggest loading to about 80 percent, but check the driver sheet.

3. Mount the driver where it can be reached and kept cool, such as in an upper cabinet, above a cabinet, or in an accessible box. Feed it from a switched 120-volt circuit or a dimmer matched to the driver type (Kuhlman notes magnetic and electronic transformers each need the matching dimmer type).
4. Check polarity. Kuhlman warns that some low-voltage products need correct + and – polarity and some do not, and that one tape product his crew used for years changed to polarity-sensitive without notice. Read the sheet for each product, every time.
5. Run the low-voltage leads. If they go inside the wall, use a Chapter 3 method or Class 2 wiring from a listed Class 2 power supply (411.6(A)).
6. Stick the tape on clean, dry cabinet bottoms. Use the aluminum channel if the maker calls for it to shed heat.
7. Test each run end to end. A dim far end means voltage drop. Feed long runs from the middle or from both ends.

Landscape lighting

1. Mount the transformer on the house near a GFCI-protected outdoor receptacle, at least 12 inches above grade or as the maker says. Outdoor receptacles need GFCI protection per 210.8(A) and 210.8(F).
2. Lay out the fixtures. Total the watts.
3. Size the transformer above the total watts.
4. Run the cable. Bury it at least 6 inches (Table 300.7(A), Column 5), or shallower only if the listed system's instructions allow.
5. Do the voltage-drop math (Section 4.5). On long runs, use heavier cable, split into multiple home runs, or use a transformer with higher-voltage taps if the maker provides them.
6. Test each fixture with your meter at the lamp. Most 12-volt landscape lamps want roughly 10.5 to 12 volts; check the lamp maker's range.

Picture coming: Two side-by-side drawings. Left: kitchen elevation with upper cabinets, LED tape on the cabinet bottoms, a plug-in or hardwired driver in an upper cabinet labeled "120 V in, 12 V or 24 V out," low-voltage leads drilled through cabinet sides. Right: a house wall with a landscape transformer mounted 12 inches above grade next to a GFCI receptacle with an in-use cover, 12/2 landscape cable running in a trench labeled "6 in. cover," and three path lights tapped along it with a meter reading "11.2 V" at the last one.

4. Worked Examples

4.1 Closet light layout

A walk-in closet is 5 feet wide and 6 feet deep. It has a single rod and a 12-inch shelf along the back wall only, with the rod at 66 inches. The side walls have no rods or shelves. The ceiling is 8

feet. The customer wants a surface-mounted LED with a fully enclosed lens in the center of the ceiling.

1. The storage space follows the side and back walls whether or not they have rods (410.16(A) bounds it by "the sides and back closet walls"). Below 6 feet, it is 24 inches from the back wall and 24 inches from each side wall.
2. Above 6 feet, it is 12 inches (or the shelf width, which is 12 inches) from the walls.
3. The ceiling center is 30 inches from each side wall ($60 \div 2$) and 36 inches from the back wall ($72 \div 2$).
4. The nearest point of the storage space up at the ceiling is the 12-inch band. Distance from the fixture center to that band toward a side wall is $30 - 12 = 18$ inches. Toward the back wall it is $36 - 12 = 24$ inches.
5. The fixture is 11 inches in diameter, so its edge is $5\frac{1}{2}$ inches from its center. The edge-to-band distance toward the side wall is $18 - 5\frac{1}{2} = 12\frac{1}{2}$ inches.
6. 410.16(D)(1) requires 12 inches for a surface-mounted, completely enclosed LED. $12\frac{1}{2}$ inches passes.

If the customer picks a 14-inch fixture instead, the edge-to-band distance is $18 - 7 = 11$ inches, which fails. Pick a smaller fixture, a recessed LED (6 inches required), or an LED fixture identified for use inside the storage space.

4.2 Recessed light count and circuit load

A 14×16 foot living room gets 6-inch canless wafers rated 12 watts each, in a 2×3 grid. The circuit is 15 amps on 14 AWG.

1. Count: $2 \times 3 = 6$ wafers.
2. Load: $6 \times 12 \text{ W} = 72 \text{ W}$.
3. Current at 120 V: $72 \div 120 = 0.6$ amps.
4. A 15-amp circuit can carry $15 \times 120 = 1,800 \text{ W}$. The lights use $72 \div 1,800 = 4$ percent of it.

Lighting load is rarely what limits a circuit now. Check what else is on that circuit before you add to it, and remember the living room circuit needs AFCI protection (210.12(B)).

4.3 Dimmer rating check

The customer wants those six wafers and four more in the dining room on one 2-gang box with two dimmers side by side. The dimmer is marked "600 W incandescent, 150 W LED," with a note that each side fin removed drops the rating. Its sheet says that in a 2-gang installation with the inner fin removed, the LED rating drops to 125 W.

1. Living room dimmer: $6 \times 12 \text{ W} = 72 \text{ W LED}$. 72 is less than 125. OK.
2. Dining room dimmer: $4 \times 12 \text{ W} = 48 \text{ W LED}$. OK.

If the living room had 12 wafers, 144 W would exceed the 125 W derated rating. You would need a dimmer with a higher LED rating or split the lights onto two dimmers. The fin numbers in this

example are made up for practice. Always use the numbers printed on the dimmer you are holding.

4.4 Fan box weight

A customer bought a 58-inch fan with a light kit. The box says the fan weighs 24 lb, and the light kit adds 3 lb.

1. Total: $24 + 3 = 27$ lb.
2. 314.27(B)(1) requires a box listed and marked for fan support. A weight marking is required on the box only if it supports more than 35 lb. Any listed fan box is fine for 27 lb.
3. The box can never support more than 32 kg (70 lb) as the sole support.

If the customer instead chose a 75 lb fan, a box cannot be its sole support. Hang it from framing per the fan's instructions, independent of the box (422.18(A)).

4.5 Voltage drop on a 12-volt landscape run

A homeowner wants six path lights at 10 watts each at the far end of a 100-foot run of 12 AWG stranded copper landscape cable, on a 12-volt transformer.

1. Load: $6 \times 10 \text{ W} = 60 \text{ W}$.
2. Current: $60 \text{ W} \div 12 \text{ V} = 5 \text{ amps}$.
3. Wire length: current goes out and back, so $2 \times 100 \text{ ft} = 200 \text{ ft}$.
4. Resistance: NEC Chapter 9, Table 8 gives 1.98 ohms per 1,000 ft for 12 AWG stranded uncoated copper at 75°C. $200 \text{ ft} \times 1.98 \div 1,000 = 0.396 \text{ ohms}$.
5. Voltage drop: $5 \text{ A} \times 0.396 \Omega = 1.98 \text{ volts}$.
6. Voltage at the lights: $12 - 1.98 = \text{about } 10 \text{ volts}$. That is a 16.5 percent drop ($1.98 \div 12$).

The lights will look dim. Fixes, in order of cost:

- Split the six lights into two runs of three. Each run carries 2.5 A, so the drop is cut in half to about 1 volt.
- Use 10 AWG cable. Table 8 gives 1.24 ohms per 1,000 ft for 10 AWG stranded. $200 \times 1.24 \div 1,000 = 0.248 \Omega$. $5 \times 0.248 = 1.24 \text{ V drop}$.
- Use the transformer's 13-, 14-, or 15-volt tap if it has one, and measure at the lights until they read in the lamp maker's range.

4.6 Non-IC can in an insulated attic

You find four old 6-inch non-IC cans, each with a 65-watt incandescent flood, in a ceiling with blown insulation packed against them. The customer says the lights "go off by themselves."

1. Non-IC housings need 3 inches clear of insulation on the sides and none on top (410.116(B)). These fail.

2. The lights going off is the thermal protector opening (Kuhlman, "Recess lights," p. 48, describes this cutout).
 3. Options: (a) build listed insulation covers or dams that hold insulation 3 inches away, if the housing maker allows it; (b) replace with IC-rated remodel housings (Procedure 3.6); (c) install LED retrofit trims listed for use in that brand and size of housing, which cuts heat. Check the retrofit trim's label for which housings it is listed for.
 4. Write up all three options with photos for the office to price. Do not leave insulation packed on a non-IC can after you have seen it.
-

5. Common Mistakes

Mistake	What happens	How to avoid it
Turning off the wall switch instead of the breaker	Shock from the always-hot or neutral in the box	Kill the breaker, verify at the box every time (Step 1)
Hanging a fan on a light-only box	The fan works loose and falls	Look for "acceptable for fan support" inside the box; install a brace box (Procedure 3.8)
Hanging a fan from the box ears instead of the threaded inserts	Ears bend or strip	Use the inserts with 10-24 bolts (Saf-T-Brace step 5)
Standard dimmer on a fan motor	Motor overheats, fire risk	Use a fan speed control (406.46(D))
Non-dimmable LED on a dimmer	Flicker, early driver failure	Read "dimmable" on every fixture before installing a dimmer
Insulation packed on a non-IC can	Thermal cutout cycling, fire risk	Use IC housings in insulated ceilings; keep 3 in. on non-IC
Jagged or oversize remodel can hole	Can will not seat; clips do not grab	Use the template and a hole saw; cut clean
Bare-bulb keyless light in a closet	Hot bulb ignites clothing	Only enclosed or listed fixture types (410.16)
Fixture over a tub not marked damp or wet	Water in the fixture, shock	Check the label; wet rated where shower spray hits (410.10(D))
Cutting a ballast lead short but leaving it connected	Tubes flicker; ballast still in circuit	Disconnect every ballast lead fully (Method B, Step 8)
No warning label on a bypassed fluorescent fixture	Next person installs a fluorescent tube on line voltage	Always apply the tube maker's label
Breaking the always-hot splice in a ceiling box	Downstream outlets go dead	Identify through-feeds before taking splices apart
Ignoring low-voltage polarity	Tape section stays dark	Read each product's sheet; test each section
Long 12 V landscape runs on light cable	Lights at the end are dim	Do the voltage-drop math (Section 4.5)
Snapping dimmer fins without derating	Dimmer overheats	Check the derated rating for ganged installs

6. Field Exercise

Do this on the training ceiling with a journeyman watching. It comes straight from the course outline.

Part A: Eight-step flush-mount swap

1. On the training ceiling, a recessed 2-lamp fluorescent fixture is installed and wired to a breaker.
2. Do all eight steps of Procedure 3.2, saying each step out loud before you do it.
3. Your journeyman checks: dead verified with tester and meter, bracket bonded with a pigtail, each wire nut tug-tested, wires folded neatly, fixture flush, lights evenly, CCT set.
4. Bag the old tubes for recycling.

Part B: Remodel recessed housing and canless wafer

1. In a drywall section of the training ceiling, find the joists and drill test holes.
2. Cut in one remodel IC housing (Procedure 3.6) and one canless wafer (Procedure 3.7) on the same switch leg.
3. Wire both, with the cable fished to each hole.
4. Your journeyman checks: clean holes, clips snapped, wafer box within the maker's distance, all connections in closed boxes, both lights work on the switch.

Part C: Fan-rated brace box, fan, and separate switching

1. A standard light-only round box is in the training ceiling.
2. Remove it from below. Install a fan-rated brace box from below (Procedure 3.8).
3. Run 14-3 from a 2-gang switch box to the fan box.
4. Hang a fan with a light kit and wire fan and light on separate switches (Procedure 3.9).
5. Your journeyman checks: brace teeth locked, flat side down, box marked for fan support, fan on threaded inserts, black to motor, red to light, grounds bonded to box and bracket, each switch runs its load, fan does not wobble.

Part D: The dimmer lesson

1. Put a non-dimmable LED lamp in a fixture on a standard dimmer. Run it from high to low. Write down what you see and hear.
2. Swap in a dimmable LED lamp from the maker's list and a dimmer listed as compatible.
3. Set the low-end trim until the low end is steady.
4. Write two sentences you would say to a customer about why the first setup flickered.

Sign-off

The journeyman signs when all four parts pass with no safety misses.

7. NEC 2026 Cross-References

Read each section in the code book. Know the reason for each rule.

Section	What it covers	Why it exists
110.3(B)	Install listed equipment per its instructions	The listing tested the product only as the instructions describe
210.8(A), 210.8(C), 210.8(F)	GFCI for dwelling receptacles, crawl space lighting outlets, outdoor outlets	Wet and grounded locations raise shock risk
210.12(B)	AFCI for dwelling circuits in listed rooms, including closets	Arcing faults in damaged cords and wiring start fires
210.70(A), 210.70(C)	Required lighting outlets and switch locations	So no one walks into a dark room, stair, or attic
240.4(D)	15 A max on 14 AWG, 20 A on 12 AWG	Small wire overheats on larger breakers
300.4(C)	Replace damaged conductors	Heat-damaged insulation fails
Table 300.7(A), Col. 5 (2023: Table 300.5)	6 in. cover for landscape circuits ≤ 30 V	Shovels and edgers
314.16, 410.20, 422.19	Box fill; canopy plus box space	Overstuffed boxes damage insulation
314.23	Box support	Boxes must not move
314.27(A), 314.27(B), 314.27(E)	Light boxes, fan boxes, weight-supporting ceiling receptacles	Weight and vibration
406.30(C) (2023: 404.2(C))	Neutral at switch locations	Electronic controls need a neutral to run
406.46(A)(5), 406.46(D)	Switch ratings for LED loads; dimmers only for permanently connected loads unless listed	Wrong control on a load overheats it
410.10(D)	Bathtub and shower zone	Water plus hanging fixtures equals shock
410.16	Clothes closets	Hot lamps ignite stored clothes
410.21	Through-wiring luminaire boxes only if identified	Heat in the luminaire box
410.23	Cover combustible finish at canopies over 180 sq in.	Heat and arcs reaching wood or paper
410.36	Luminaire support by boxes per 314.27	Weight
410.42, 410.44	Grounding luminaires; replacement exception	Metal parts must trip the breaker on a fault
410.115, 410.116	Recessed temperature, IC and non-IC clearances	Heat in insulated ceilings
410.117(C)		

Section	What it covers	Why it exists
	Tap conductors (whips) 18 in. to 6 ft to a box at least 1 ft away	Keeps the splice away from the hot housing
411.2 through 411.8	Low-voltage lighting	Limits current and voltage so the secondary is safe
422.18	Ceiling fan support and bathroom zone	Weight, vibration, water

8. End-of-Chapter Checklist

Check every box before you leave a lighting job.

- ☐ I killed the breaker, not just the switch, and verified dead with a tester and a meter.
- ☐ I read the new fixture's instructions and followed them.
- ☐ The box is secure to framing and rated for the weight. Any fan is on a box marked for fan support.
- ☐ Box fill is within limits, counting the canopy if it adds space.
- ☐ Hot to hot, neutral to neutral, ground to ground, each nut tug-tested.
- ☐ Metal brackets and fixture bodies are bonded to the equipment grounding conductor.
- ☐ Through-feed splices are intact and every downstream outlet still works.
- ☐ Recessed housings in insulated ceilings are IC rated, or non-IC clearances are kept.
- ☐ Closet fixtures are an allowed type and meet the 410.16(D) clearance.
- ☐ Bathroom fixtures in the tub/shower zone are damp or wet rated; no pendants or fans in the zone.
- ☐ Every LED on a dimmer is dimmable, the dimmer is on the maker's list, and the low-end trim is set.
- ☐ No light dimmer controls a fan motor.
- ☐ Any bypassed fluorescent fixture has the tube maker's label on it.
- ☐ Low-voltage runs are within the power supply rating, polarity is right, and voltage at the far light is in range.
- ☐ Old tubes and ballasts are bagged for recycling.
- ☐ I took before and after photos and wrote up anything else I saw (non-IC cans in insulation, brittle wires, loose boxes).

10. Sources

- YES Electric, Flush-Mount LED Fixture Swap — Field Guide, (9 pages). Steps 1–8, Method B, and field notes are from this guide.
- Jesse Kuhlman, Residential Electrical Troubleshooting (2019). "Lighting" section: "Recess lights," "Edison Screw Sockets," "Low voltage lighting," and "LED Lighting." Pages 48 (recess

lights, Edison sockets), 49 (low voltage), and 50 (LED), checked against the full-page text in. Paraphrased.

- Arc Workforce, Residential Electrical Field Guide, Part 4 Job 6 (ceiling fan) and Part 1 Symptom 8 (dimmer issues). Its code cites are NEC 2020; the NEC numbers in this module are from NEC 2026.
 - Cooper Lighting (Halo), H750RICAT remodel housing installation sheet: <https://s1.img-b.com/build.com/mediabase/specifications/halo/1476812/halo-h750ricat-installation-sheet.pdf>
 - Cooper Lighting (Halo), H750TCP new-construction housing installation instructions: <https://www.cooperlighting.com/api/assets/v1/file/CLS/content/ad24a2b3bae84495b261ad4000726e6e/HALO-704624-H750TCP-Installation-Instructions.pdf>
 - Cooper Lighting (Halo), LT-DM canless LED downlight installation instructions: <https://www.cooperlighting.com/api/assets/v1/file/CLS/content/halo-ltc-canless-ins/HALO-LT-Canless-LED-Downlight-instruction-sheet.pdf>
 - GE Lighting (Cync), Wafer Downlight Installation Guide, 4-in and 6-in: <https://www.gelighting.com/sites/default/files/products/c2d165b3-fbc8-4c56-a79d-81269c5dbd2c.pdf>
 - Westinghouse Lighting, Saf-T-Brace Model 01100 Ceiling Fan and Fixture Support instructions: https://assets.usesi.com/product-media/installation-instructions/USESI_15020_installation_instructions.pdf
 - NFPA 70, National Electrical Code, 2026 edition.
 - Commercial course: LIGHTING masterclass (drivers, color temperature, 0-10 V).
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Videos to watch

These videos are made by other electricians and companies, not YES Electric. Watch each one after you read the section it goes with. Where a video does something differently from this module, the caution line says so. Follow this module and your journeyman, not the video. Click a title to open it on YouTube.

Section	Video
Procedure 3.2 Flush-mount fixture swap; Procedure 3.4 Replacing a fixture when the box is wrong	How to Safely Replace a Ceiling Light Ask This Old House This Old House • 8:18 A master electrician opens a 1960 ceiling box, finds 60 °C cloth-jacketed cable that the new fixture's label does not allow, moves the splice to a junction box in the attic, runs new 90 °C cable to a new box, grounds the box and the fixture strap, and hangs the fixture. Caution: Power is turned off off-camera; YES verifies dead at the box with the NCV and meter every time (R1.7 Step 1 and Procedure 3.1). The new attic junction boxes must stay accessible.
Procedure 3.8 Installing a fan-rated brace box from below	RACO Retro-Brace® Ceiling Brace & Box Kit Hubbell Commercial Construction • 5:20 The manufacturer removes an old light box and its hanger bar, expands a Retro-Brace between joists through the 4 in. hole, mounts the steel box to it, and snaps in the cable connector. Gives the weight ratings: 70 lb fan / 110 lb fixture at 16 in. joists, 35 lb / 50 lb at 24 in. Caution: Product video for RACO 936/937/939 kits; other brands' braces differ, so read the box label for the fan weight it is listed for.
Procedure 3.9 Hanging a fan and wiring fan and light on separate switches	The Easy Way to Put Light and Fan on Separate Switches (With Some Luck) Sparky Channel • 15:47 Proves the tester on a live wire, kills the breaker, finds an existing 3-conductor cable (black and red) between switch and fixture, removes the jumper tying them together, and lands the light and fan on a double switch. Caution: His example is a bathroom exhaust fan/light combo, not a ceiling paddle fan; the switching method with 14-3 is the same as R1.7 Procedure 3.9. Uses 12 AWG and Wago lever nuts.
Procedure 3.7 Canless wafer lights	LED Wafer light Warning! Electrical Code Coach • 4:43 Shows a wafer light and its remote junction box, then reads one maker's instructions that require 3 in. of clear space above and no contact with joists, pipes, or cables, which is why you must read each wafer's sheet before cutting. Caution: Talk only; the install itself is not shown. Follow the clearance and insulation rules printed for the exact wafer model you install (R1.7 Procedure 3.7).

Procedure 3.6 Remodel recessed housings (drywall up)	All About Lights How to Install Recessed Lights This Old House This Old House • 4:31 Checks the attic for joists and pipes, cuts holes with a 6 in. hole saw, fishes 14-2 between holes, makes up each housing's junction box with wire nuts, and clips remodel housings to the ceiling. Caution: Old video with screw-in lamps. It never mentions IC or airtight ratings; in an insulated ceiling YES uses IC-rated, airtight housings (R1.7 §2.4). Remodel housings with integrated LED or a wafer are more common now.
Procedure 3.3 Method B, ballast-bypass LED tube retrofit	How to Install Type B Linear LED Lamps Feit Electric • 3:07 The lamp maker shows removing a fluorescent ballast, connecting one end's lampholder wires to the hot and the other end's to the neutral for double-ended Type B tubes, and applying the retrofit label. Caution: Wiring is for double-ended tubes only; single-ended tubes wire differently. Follow the label on the exact tube (R1.7 Procedure 3.3 is a reference method).