



Residential Wiring Lab

Program: Electrician Technician

Course: EL140 Residential Applications

Objectives: Under the supervision of your instructor, you should be able to do the following:

- Layout and wire a basic room in a residential environment

Lab Equipment:

- Residential Lab Bays

Required Tools:

- 1-Pencil or keel
- 1-Tape Measure
- 1-Hammer
- 1-Flat screwdriver
- 1-Phillips screwdriver
- 1-Pair of strippers
- 1-Pair of dikes
- 1-Box cutter

Materials:

- 1-4/0 light on a hanger bar
- 1-4/0 side nail light
- 4-Single gang side nail boxes
- 1-2 gang side nail box
- 15-Romex staples
- 15-wire nuts
- 30'-14/3 Romex
- 50'-14/2 Romex
- 2-3-way switches
- 1-single pole switches
- 3-duplex receptacles
- 2-keyless light fixtures
- 2-bulbs

Safety (PPE):

- Safety glasses/goggles
- Hard hat

Resources:

- N/A

Required Time: One Day

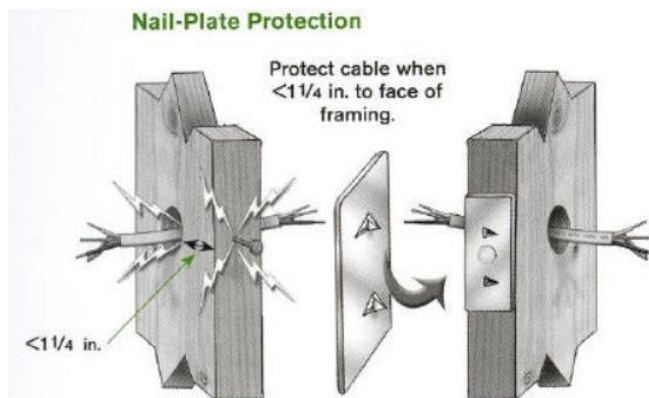


Shop Maintenance:

- All work will cease 20 minutes prior to the end of class.
- All work areas must be cleaned.
- Tools and equipment must be cleaned and returned to the designated areas (cage, tool room, cabinets etc.)
- Any broken or missing tools must be reported immediately.
- Tools and equipment are students' responsibility

Procedures: *(Eye protection must be always worn)*

1. Using Diagram "A", students will mark, with a pencil, all the appropriate places on the wood framed room for placing the boxes.
2. Layout the room using diagram A.
3. Drill, if necessary, holes for Romex.
 - a. Part of the electrical rough-in is running all your electrical cabling, usually Romex. To run cables, you first need to drill holes in your walls to run the wire.
 - b. Drill or notch the framing to allow for the cable/wiring to run between boxes, down into the under-floor crawl spaces, up into the ceiling, as through studs. (Most rooms have either an attic above or a basement/crawlspace below). Drill holes so cable runs horizontally through joists.
 - c. A heavy-duty right-angle drill with a 5/8" bit is the tool for this job. Wall holes drilled at about knee-height will be a good height in relation to the outlets.
 - d. Use metal reinforcing plates (nailing plates) at all points where the drilled hole is less than 1 1/4" from either outside edge of a stud or joist. Nailing plates are required over all notches.



4. Rough-In Electrical Boxes
 - a. Each box should stick out a 1/2" past the framing so its front will be flush with the drywall.
 - b. The boxes will have a pre-formed 1/2" reference line for quick installation.
 - c. Receptacles should be mounted 16" high from floor to the top of the electrical box., or hammer height. for hammer height, set the head of the hammer on the ground next to the stud, place the box so it is resting on the hammer and then nail in the box.
 - d. Mounting heights for light switches should be mounted 45" from floor to the top of the electrical box.
 - e. Be sure to account for trim around the doors when you rough-in electrical boxes if you plan to put a light switch just inside the door. You can easily nail an extra piece of 2x4 to pick up a few more inches as shown below.



5. Guidelines for Running Cable

- a. Electrical cabling must be roughed in and supported properly. It must be protected from physical and electrical damage.
- b. Bends in Romex must not be made too sharply. Bending cable incorrectly can weaken the outer sheathing as well as the insulation on the individual conductors. The radius of the curve of the inner edge of any bend must not be less than five times the diameter of the cable. A correct installation will result in a "jug handle."
- c. Cable must be fastened to the framing every 4-1/2ft, using staples, cable ties, straps, hangers, or similar fittings. Going through a hole in framing will count towards support of the cable in lieu of a staple, but not for a termination staple into a device box.
- d. Flat cable (i.e., 14/2 Romex) must not be stapled on edge
- e. Flat cables may be installed on top of one another and fastened with one staple, so long as one flat side of one cable is against the framing member and the other flat side is against the flat side of the next cable. (Two cables should not be placed side-by-side and fastened with one staple; this can damage the cable insulation.)
- f. Check that staples or fasteners do not cut through a cable's insulation
- g. Cables cannot run closer than 1-1/4" to the nearest edge of the framing member (See nailing plates above)
- h. Opening around penetrations through walls, floors, and ceilings must be filled with an approved fire-stopping material.
- i. Cabling must be secured within 12" of where the cable enters a box
- j. Cabling for recessed lights should be fastened to the nearest framing, providing a jug handle.
- k. All cables that run into metal or plastic boxes must be protected from abrasion. This can be accomplished by using connectors that have smooth openings for the cabling to go through or by simply making sure a short section of the cable sheathing extends past the clamping mechanism of a cable clamp.
- l. All cables that run into metal or plastic boxes, 2 gang or bigger, must be secured to the boxes. This is typically done using internal or external clamps.
- m. Separate runs of cable are required for bedroom outlets (so they can be provided with Arc-fault Circuit Interrupter (AFCI) protection. The same is true for any other circuits requiring AFCI or GFCI breakers.
- n. As you rough-in your electrical and reach each box or service panel with your cable, pull a few extra feet of cable through for making connections later.



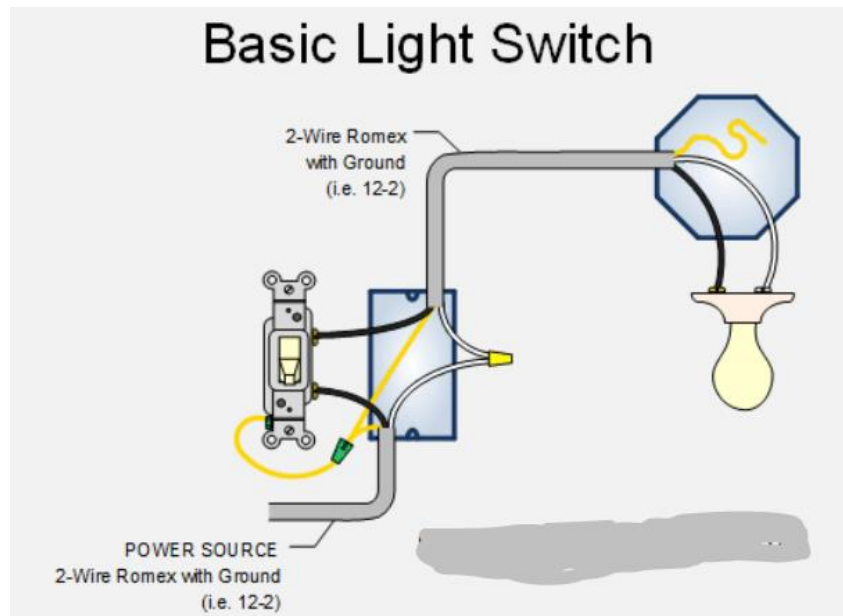
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- ## Wall Outlets
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- The diagram illustrates a parallel wiring system for two wall outlets. A horizontal grey line at the bottom represents the main power bus. From this bus, two vertical grey lines branch out to the left and right. Each vertical line connects to a blue rectangular box representing a wall outlet. The left outlet is shown with its internal wiring: a black wire (line) and a white wire (neutral) are connected to the top terminals, and a yellow wire (ground) is connected to the bottom terminal. A yellow wire also connects the ground terminal of the left outlet to the ground terminal of the right outlet. The right outlet is shown with its internal wiring: a black wire (line) and a white wire (neutral) are connected to the top terminals, and a yellow wire (ground) is connected to the bottom terminal. A yellow wire also connects the ground terminal of the right outlet to the ground terminal of the left outlet. A yellow wire also connects the ground terminal of the right outlet to the ground terminal of the left outlet. A yellow wire also connects the ground terminal of the right outlet to the ground terminal of the left outlet.
- POWER SOURCE
2-Wire Romex with Ground
(i.e. 12-2)
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(i.e. 12-2)

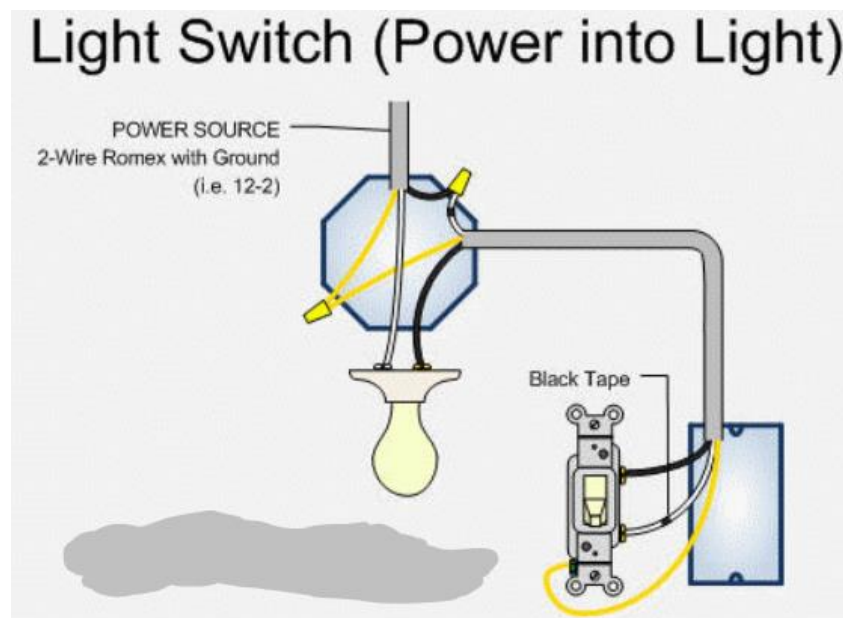
Page 4 of 8



- a. Two-wire Romex is run into the light switch box where the black wires are run through the switch to close or open the electrical circuit to the light bulb.
- b. The white or "neutral" lines are tied together with a wing nut as shown in the diagram.



- c. The following diagram shows how to wire a light switch when the power source runs into the light fixture before it goes to the switch.

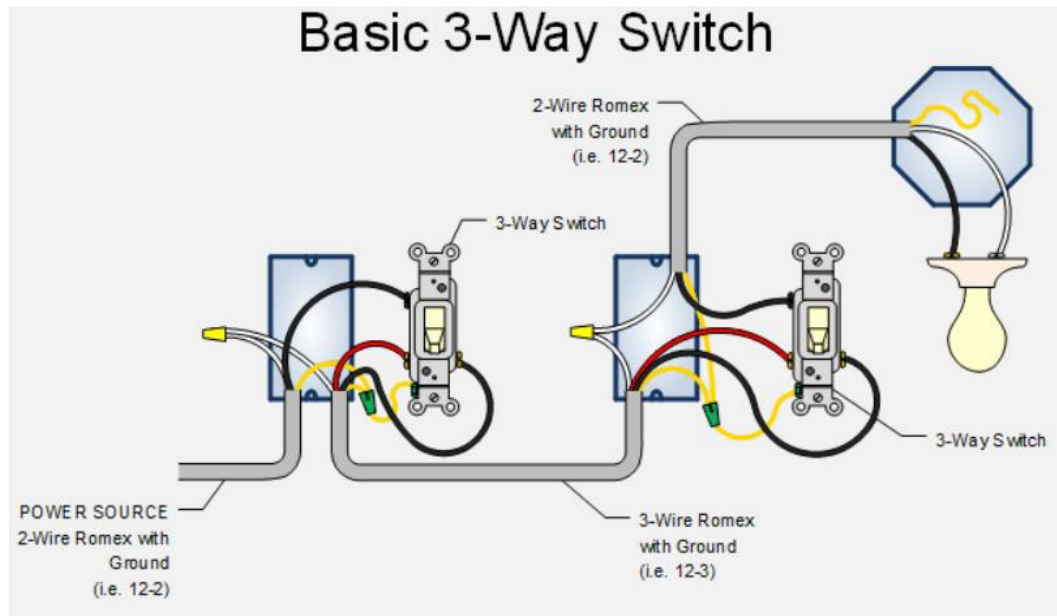


3-way switches

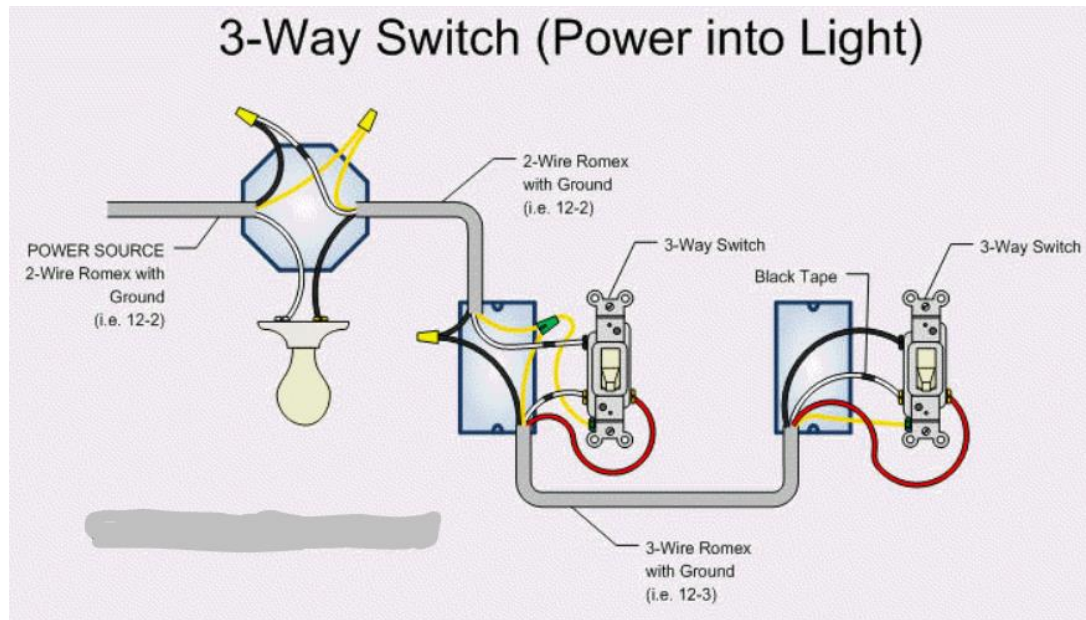
- a. Three-way switches are used to control power to a light from two different locations. 3-way switches can be quickly identified by the 3 screw terminals (in addition to the green/ground screw terminal).
- b. When wiring a three-way switch, you will need a 3-wire cable coming from the power source and then a 4-wire cable going between the two switches. This extra wire between the switches is needed for



- the "traveler" wires. Wiring from the second switch to your light fixture or fixtures can be regular 3-wire cable. Here are the definitions of each wire color:
- c. 3-Wire Cable/ROMEX
Black wire = HOT or power
White wire = Neutral
Bare copper = Ground
 - d. 4-Wire Cable/ROMEX
Black wire = HOT or power
Red wire = HOT or power
White wire = Neutral
Bare copper = Ground
 - e. When learning how to wire a 3 way switch you must understand all you are doing is controlling the hot wire going to the light. The neutral will be passed through each junction box all the way to the light. The black colored screw or terminal on each 3-way switch is called the common terminal. The black "hot" wire from the power source goes to the common as does the black "hot" wire that leaves the last switch and goes to the light. The other two terminals on the 3-way switch are used to connect the "travelers" between the two switches.



- f. When your electrical layout requires power to run into the light fixture before going to the switches you can use this wiring diagram. If power needs to go through more than one light before you reach the switches you can duplicate the wiring shown on the one bulb below for each of the lights.



7. Power room from breaker in sub panel and verify all is working correctly.
8. Troubleshoot any problems that arise.