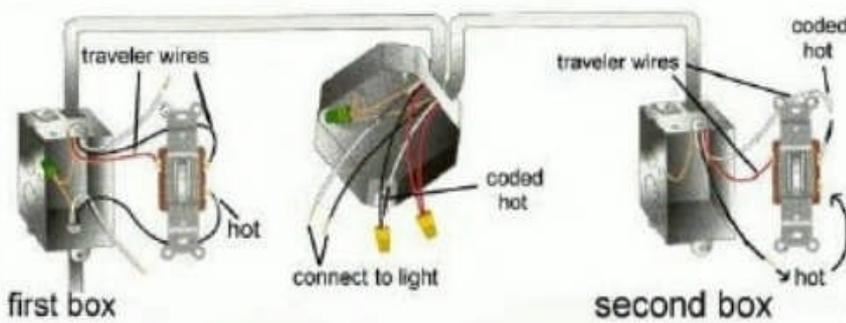


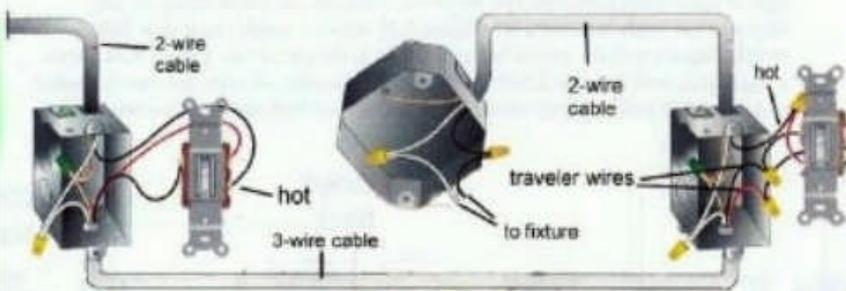
Quick guide

Residential Wiring Diagrams, Codes, And Symbols

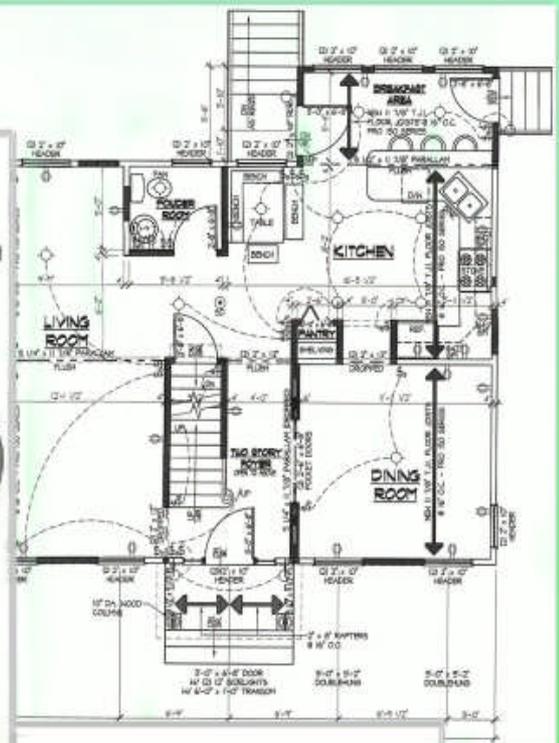
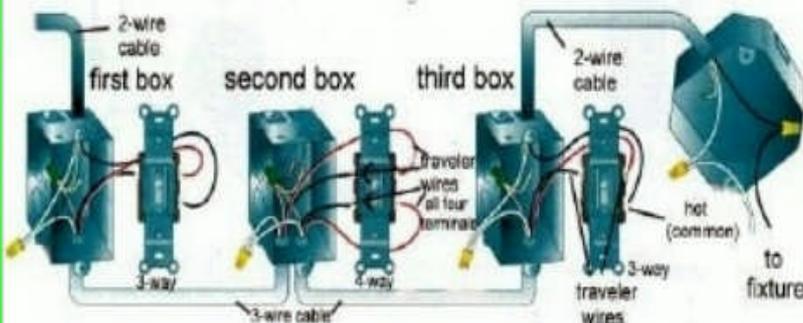
3-way switch with light in center



3-way switch with light at end



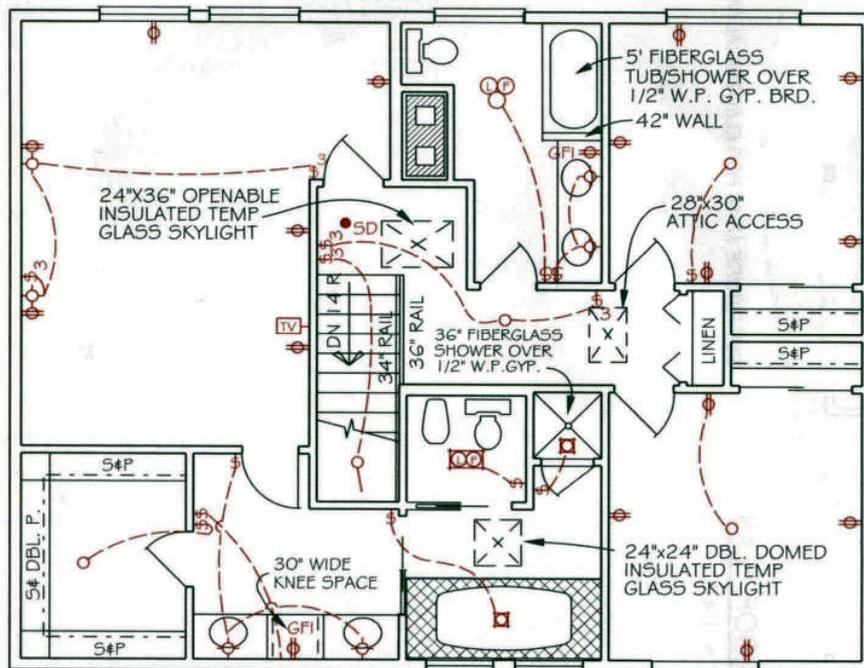
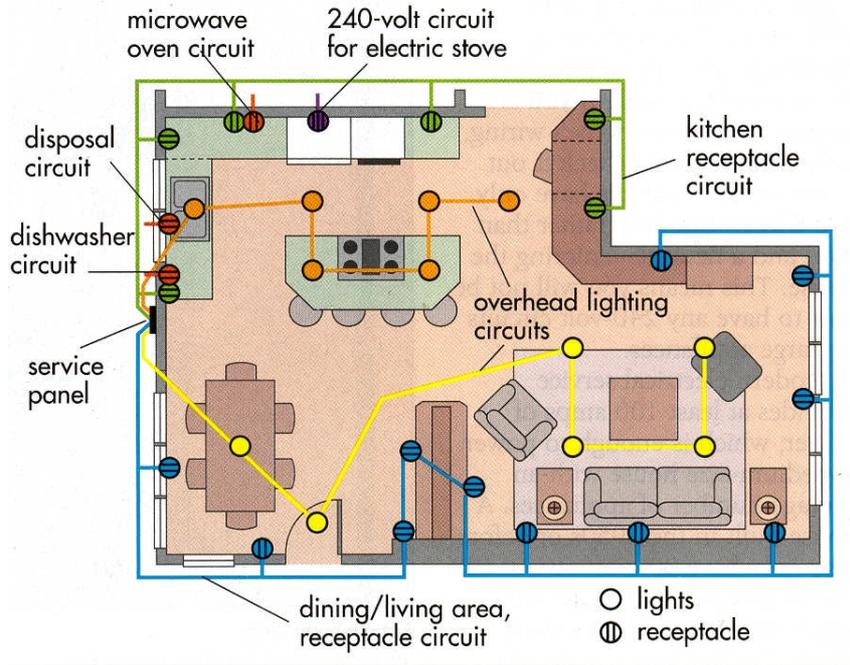
4-way switch



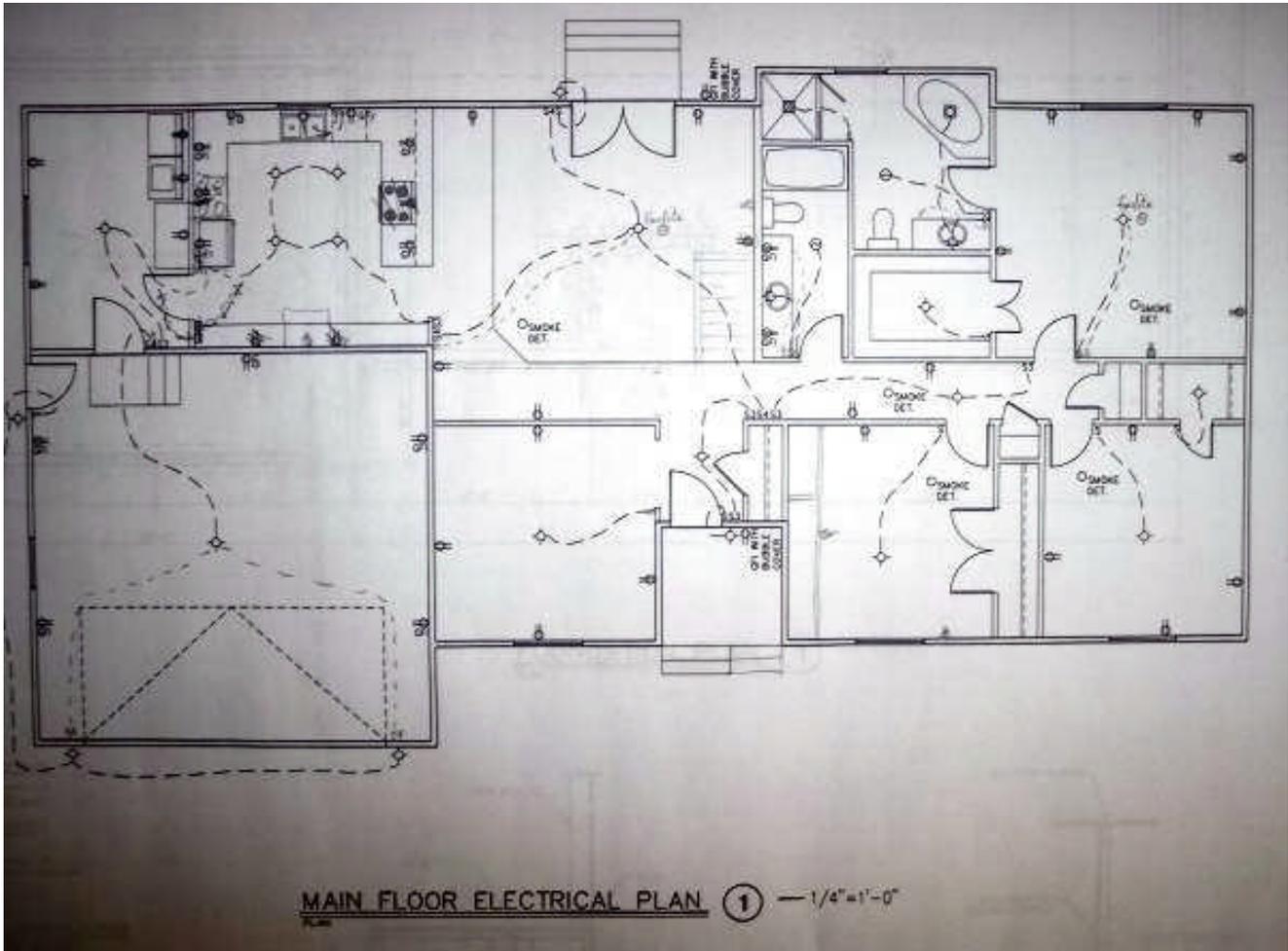
Outlet symbols

-  Duplex receptacle outlet with GFI or GFCI device, wall mounted
-  Duplex receptacle outlet, isolated ground, wall mounted
-  Duplex receptacle outlet, split wired, wall mounted
-  Duplex special purpose outlet
-  Emergency outlet, wall mounted
-  Garbage disposal outlet, wall mounted
-  General outlet, ceiling mounted
-  General outlet, wall mounted
-  Junction box, ceiling mounted
- Junction box

Electrical circuits



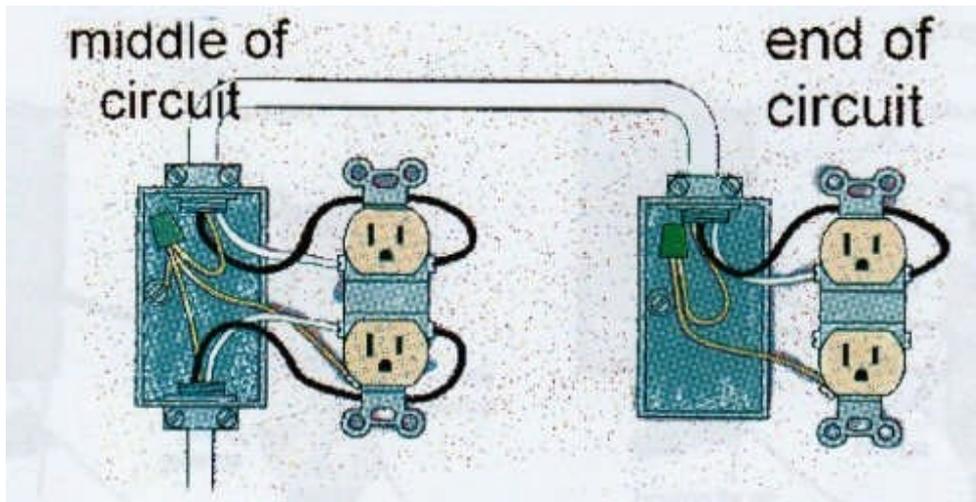
Electrical blueprints



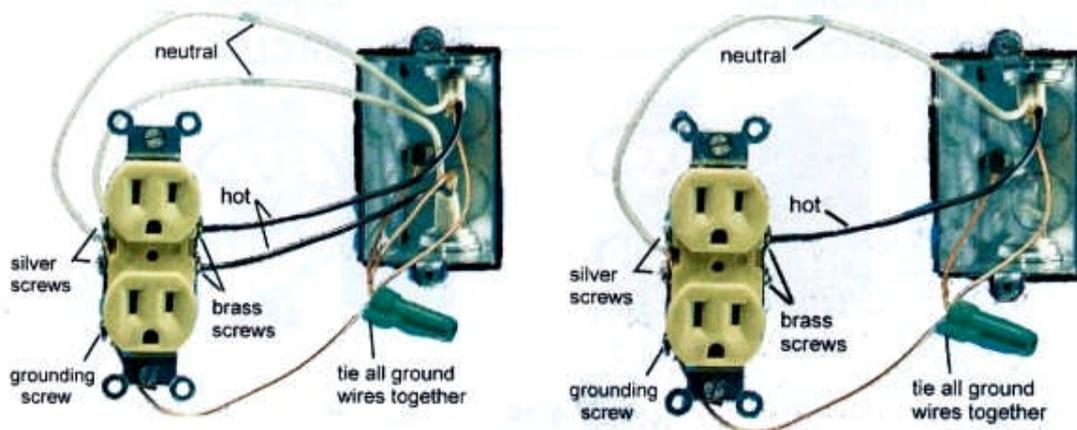
WALL	CEILING	SWITCH OUTLETS			
			S		
			S ₂		
			S ₃		
			S ₄		
			S _D		
			S _E		
			S _P		
			S _K		
			S _{CB}		

Electrical Wiring Diagrams

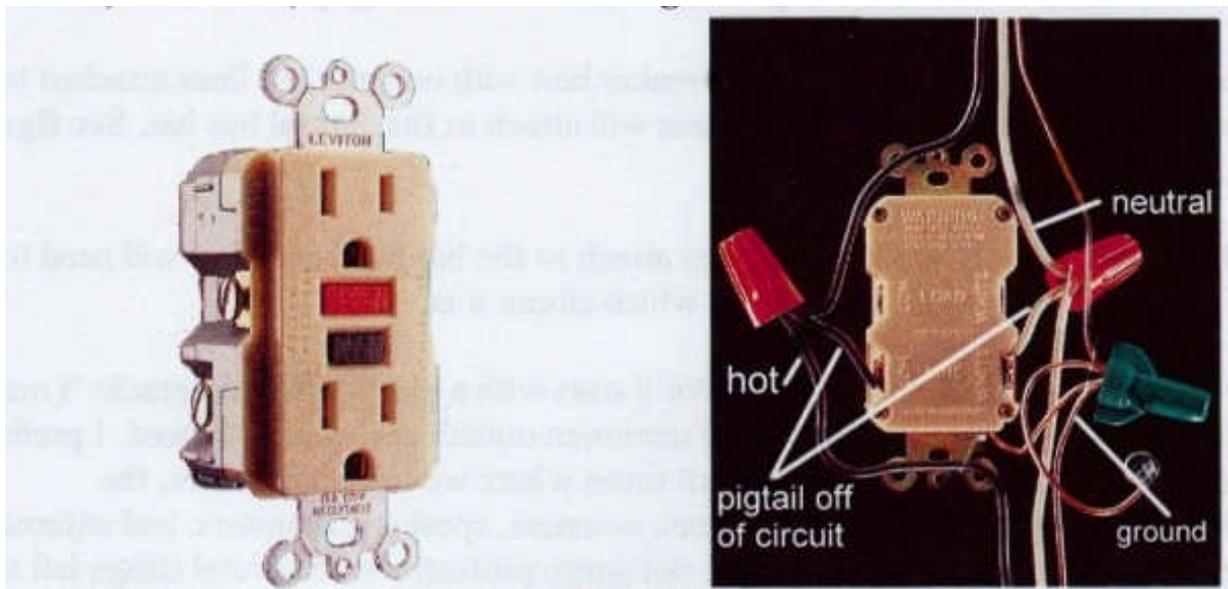
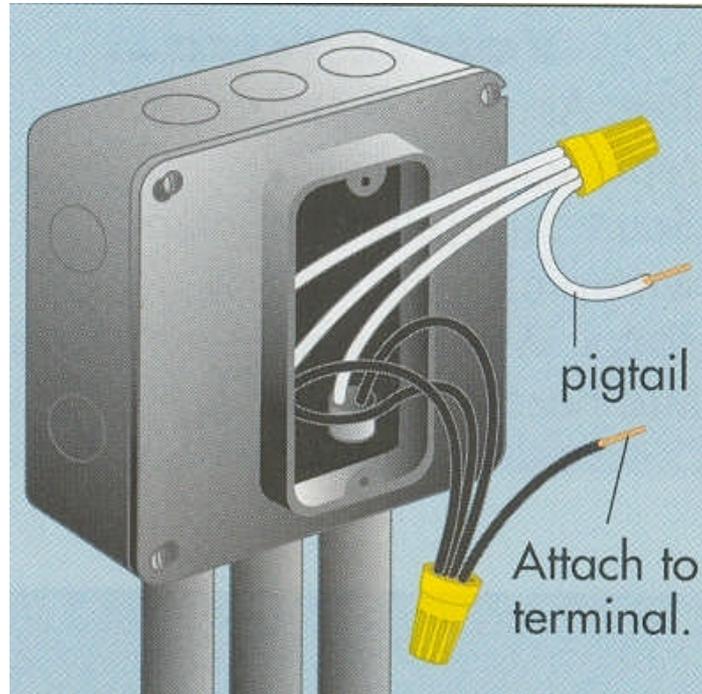
Simple outlet circuit



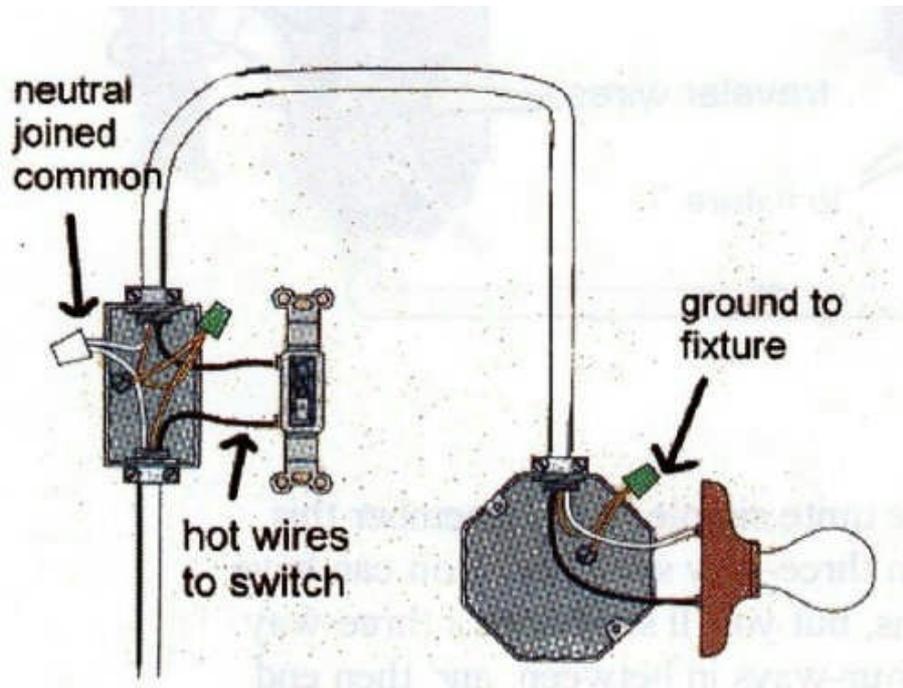
To end of circuit



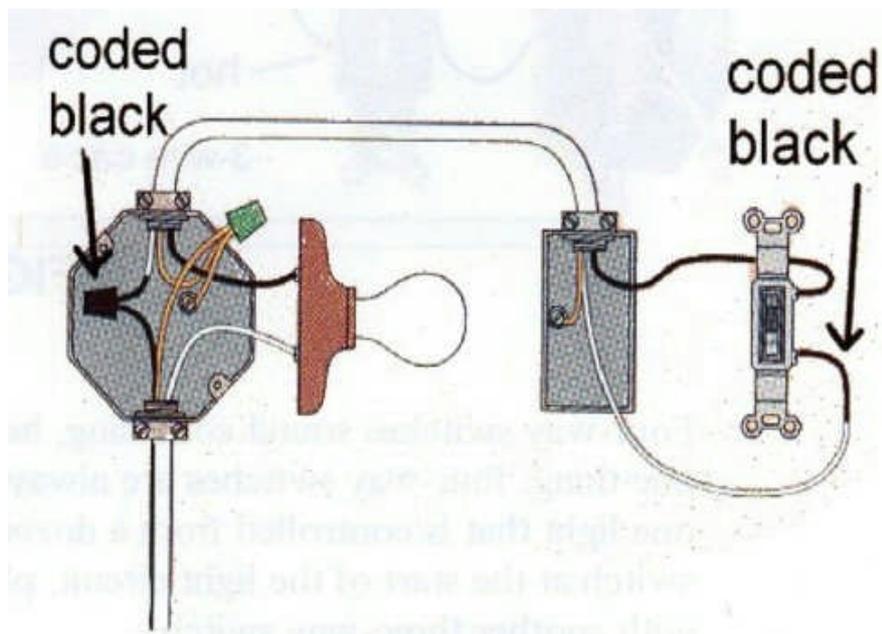
Pigtail GFCI Outlets



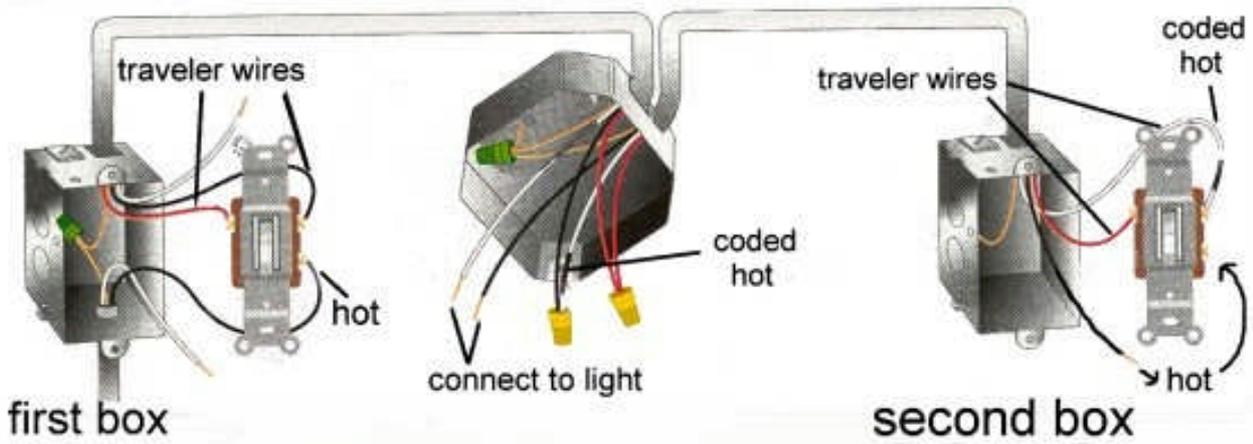
Single switch before light



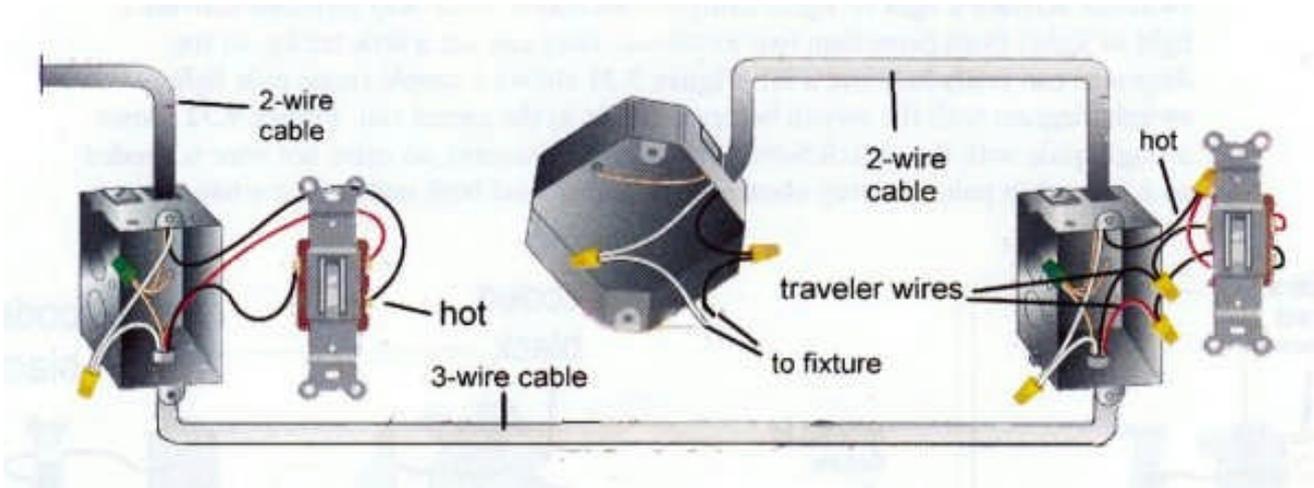
Single switch after light



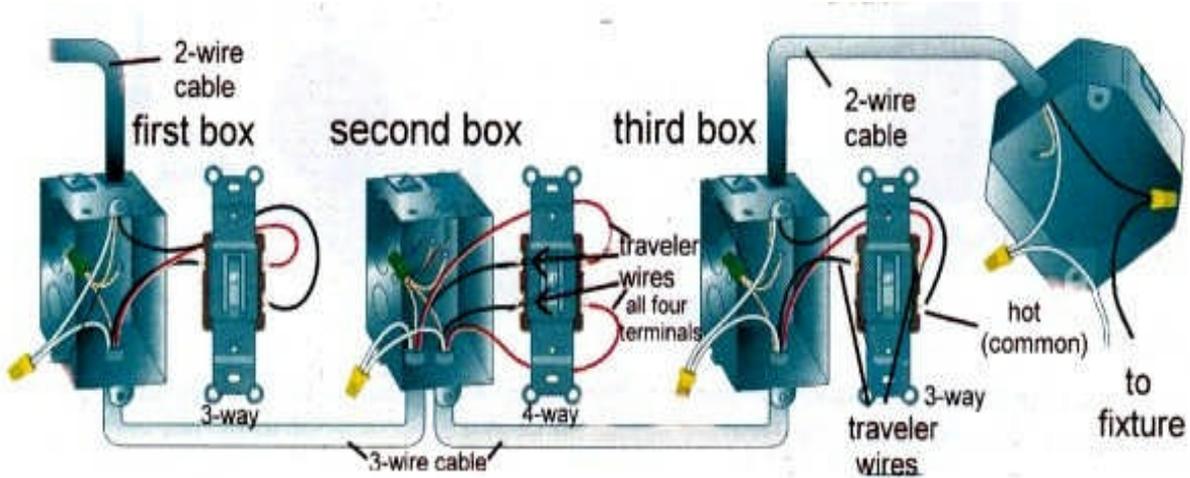
3-way switch with light in center



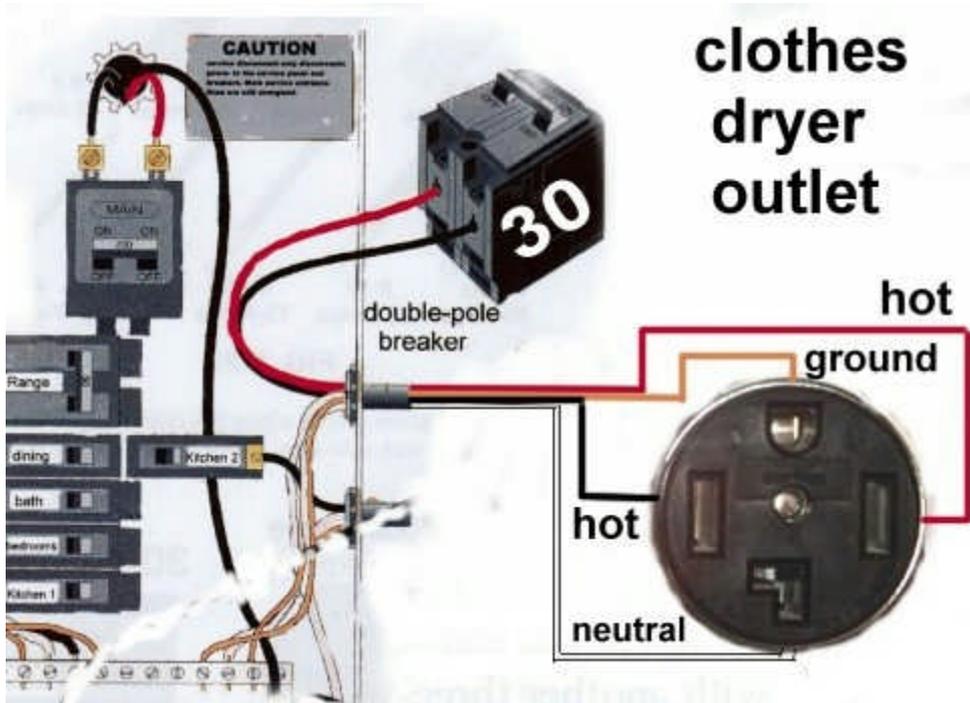
3-way switch with light at end



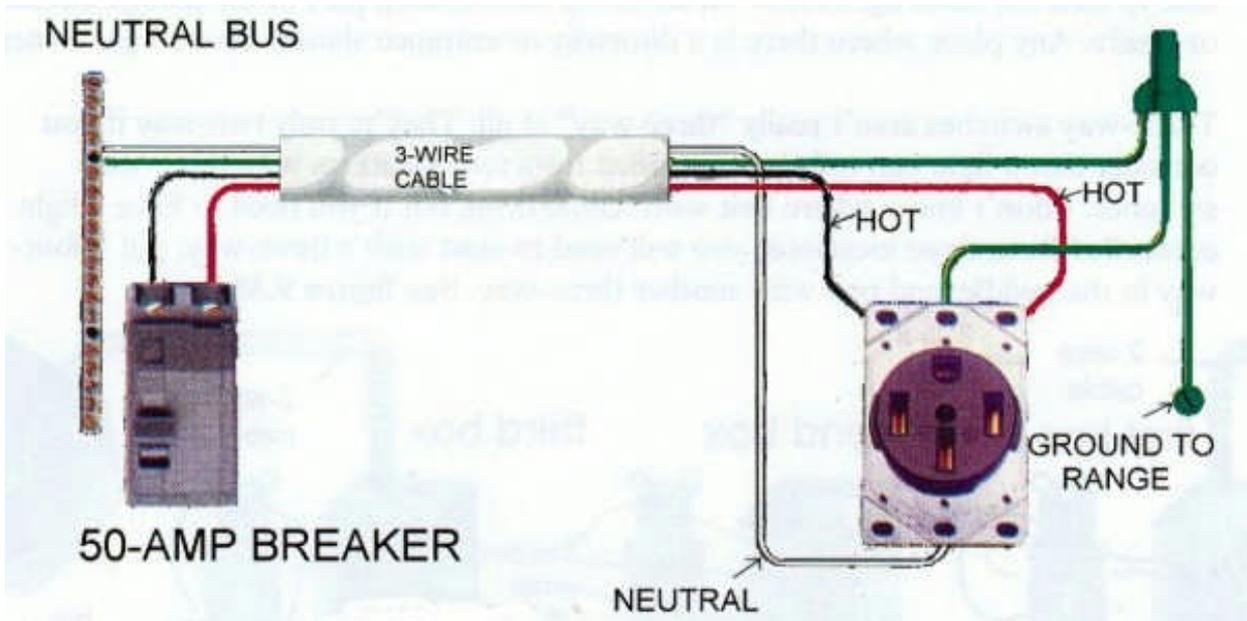
4-way switch



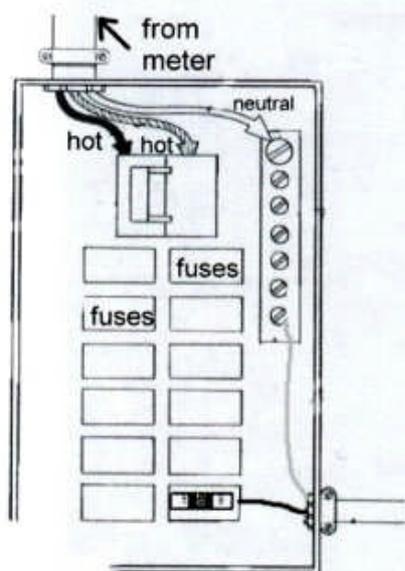
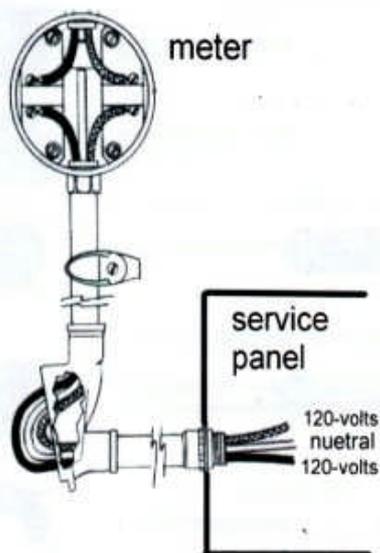
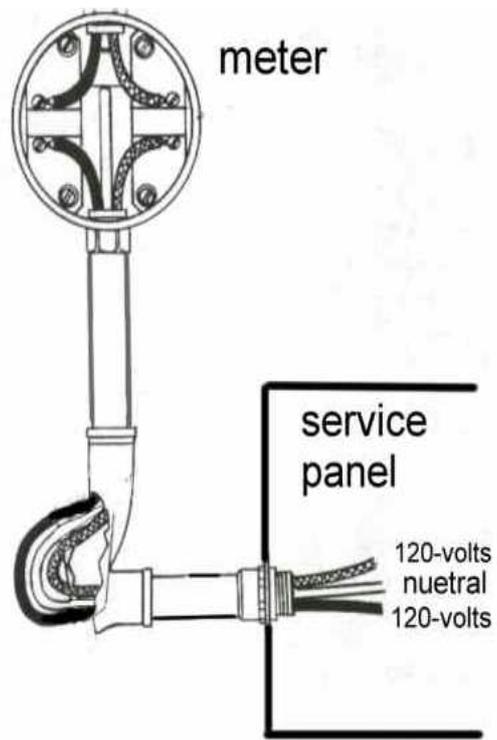
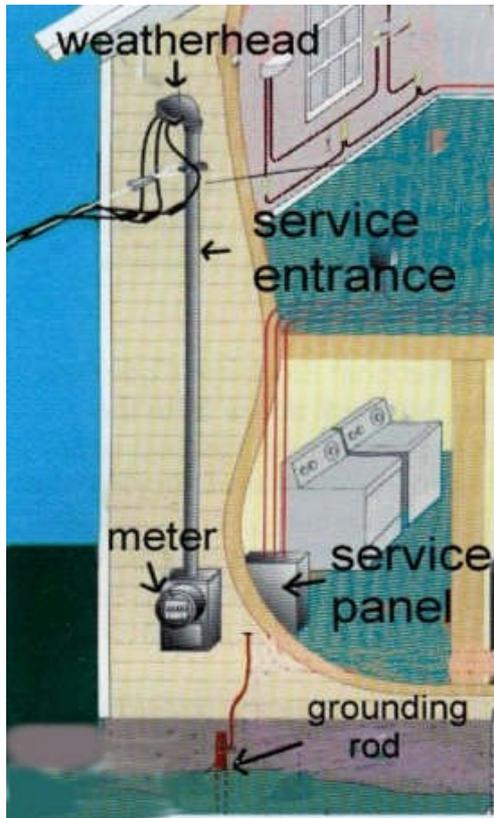
Dedicated circuits



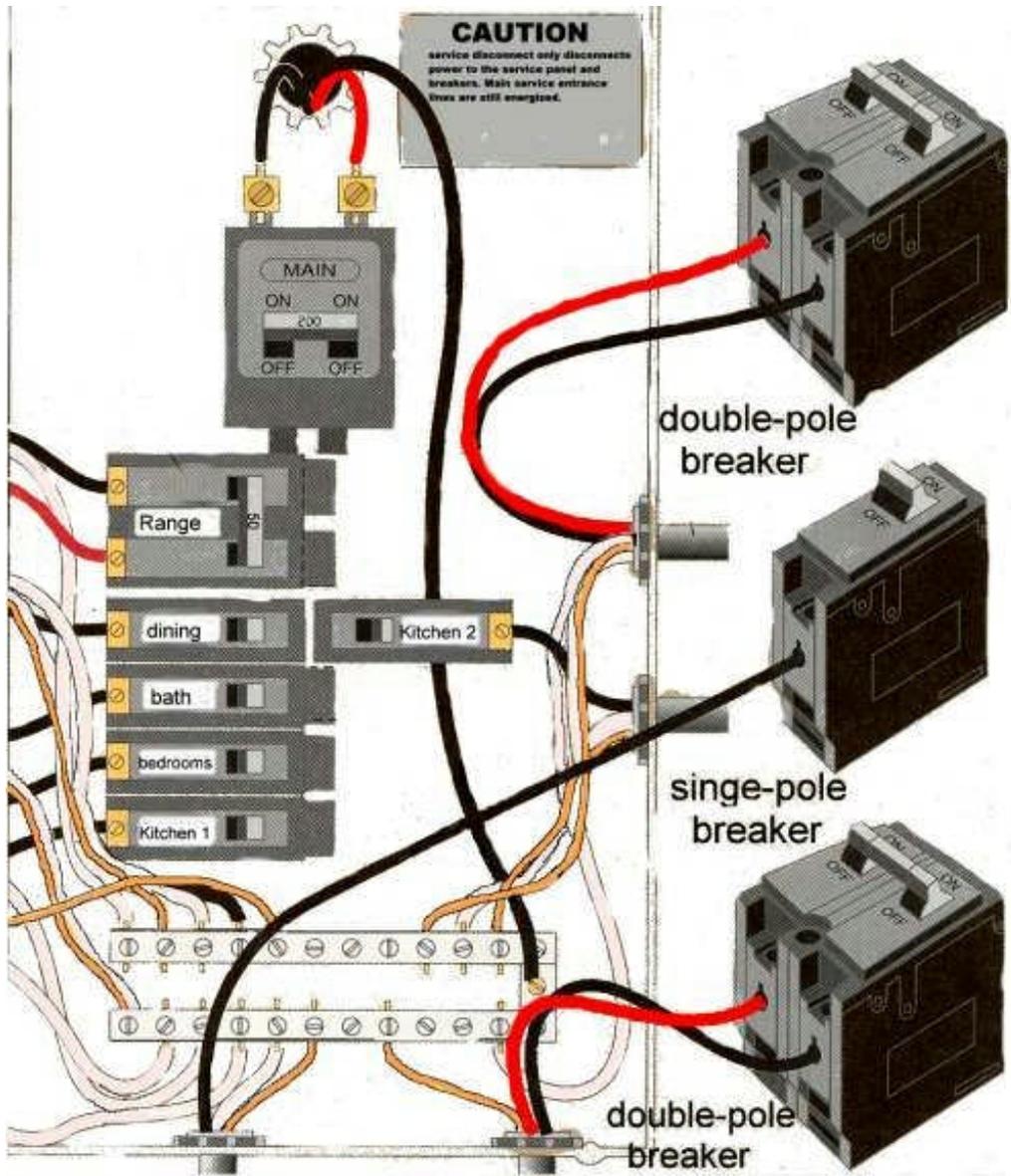
Oven/range



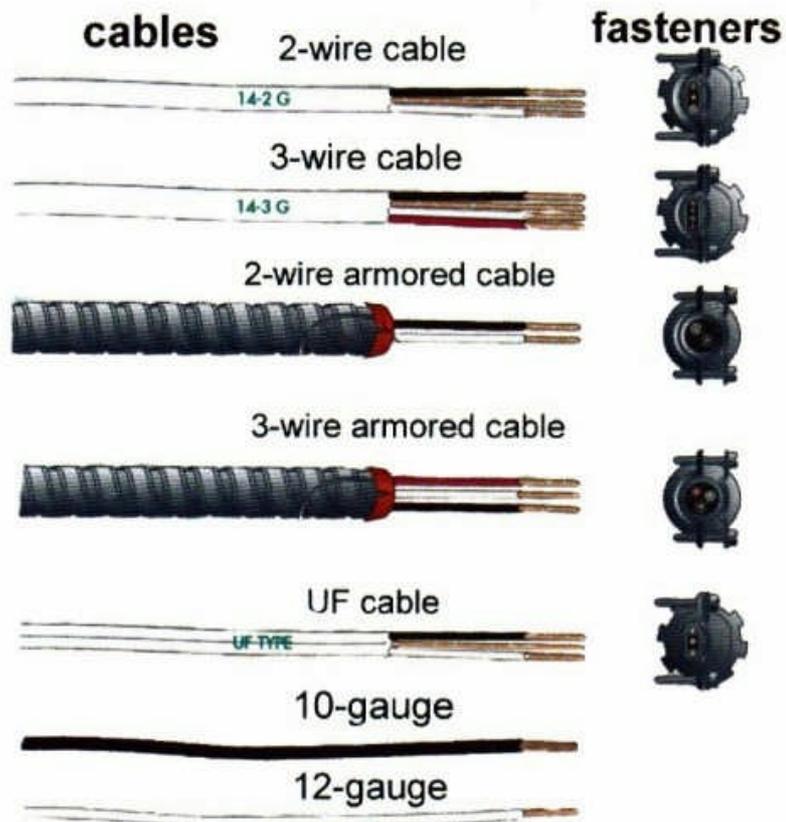
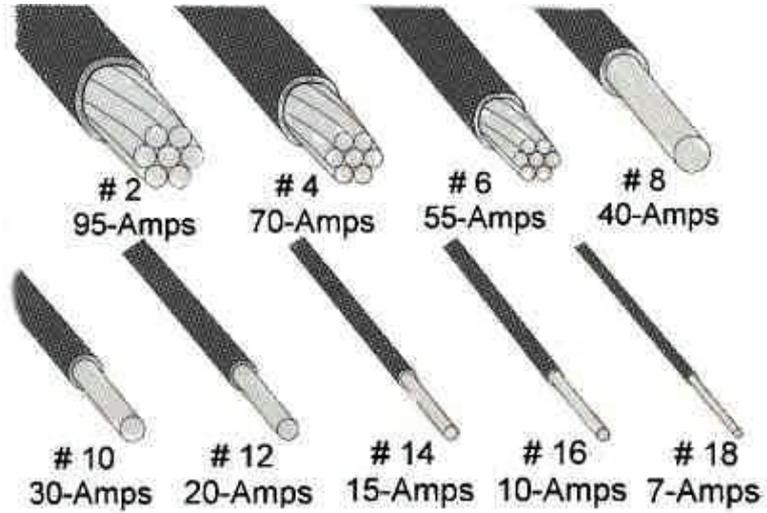
Service entrance to breaker box



Breaker box



Cable Sizes



Outlet Receptacles

Appliance	Voltage	Wire size	Receptacle
Electric dryer	120/240V 20 to 30 amps	#10	 30-Amp 120/240V
Electric water heater	240V 20 to 30 amps	#10	 or  30-Amp 120/240V 30-Amp 240V
Electric range	120/240V 50 amps	Two #6 hot wires and a #8 neutral wire	 or  30-Amp 120/240V 50-Amp 120/240V
Separate oven and cooktop	120/240V 30 amps separate 50 amps together	seperate 30-Amp circuits use #10 wire	 or  50-Amp 120/240V 30-Amp 120/240V
Refrigerator	120V 20 amps	#12	 20-Amp 120V

GFCI Residential Location Requirements 06 IRC 08 NEC

The following rules apply to 15A & 20A receptacles on 120V circuits. They do not apply to 240V receptacles or to 30A 120V receptacles.

- All bathroom receptacles _____ [3802.1] {210.8A1}
- All garage & accessory building receptacles _____ [3802.2] {210.8A2}²¹
- All receptacles in unfinished basements EXC _____ [3802.5] {210.8A5}²¹
- Permanently installed fire or burglar alarm system __ [3802.5X3] {210.8A5X}

The 2005 NEC and the 2006 IRC have exceptions for receptacles in garages and unfinished basements that are not readily accessible or that serve appliances not easily moved from one place to another, such as freezers. A receptacle for a single appliance under that exception must be a single receptacle, and for two such appliances a duplex receptacle can be used.

- All outdoor receptacles EXC _____ [3802.3] {210.8A3}
- Receptacles for snow melting & deicing equipment on dedicated branch circuit if located so they are not readily accessible ___ [3802.3X] {210.8A3X}
- Equipment plugged into receptacles installed under above exception req's GFPE protection in plug cap _____ [4001.7] {426.28}
- All receptacles in crawlspaces at or below grade level _ [3802.4] {210.8A4}
- All receptacles serving kitchen counters **F30** _____ [3802.6] {210.8A6}
- Receptacles within 6ft of outside edge of laundry, utility, or wet bar sinks _____ [3802.7]²² {210.8A7}
- Receptacles in boathouses _____ [3802.8] {210.8A8}

Residential Electrical Guidelines

GENERAL RESIDENTIAL GUIDELINES			
Here are a few typical guidelines that apply to residential work. These are NOT legal interpretations of any one code, so check with your local authority before starting work.			240-volt outlet, wall mounted
			240-volt outlet, clothes dryer, wall mounted
			240-volt outlet, range, wall mounted
Kitchens			Clothes washer outlet, wall mounted
All kitchen, breakfast room, pantry, and dining room outlets must be supplied by at least two 20-amp small appliance circuits.			Dishwasher outlet, wall mounted
Outlets above the kitchen counter (used by countertop appliances) normally are fed by both circuits -- they all cannot be wired to just one circuit. The circuits should not supply any lights or other outlets in the house.			Duplex receptacle outlet, ceiling mounted
Appliances			Duplex receptacle outlet, floor mounted
Separate circuits are needed for built-in appliances (i.e. oven, range, disposer, dishwasher, central air conditioner, furnace).			Duplex receptacle outlet, wall mounted
One 20-amp circuit is needed for the laundry outlet within 6' of the machines. An electric dryer requires an additional 240-volt circuit.			Duplex receptacle outlet with GFI/GFCI device, wall mounted
Outlets			Duplex special purpose outlet, key letter or abbrev., or indicate NEMA config.
One lighting/convenience outlet circuit should be provided for every 575 square feet of floor space in a house.			Emergency outlet, wall mounted
Any bathroom or garage outlet within 6' of a sink must be Ground-Fault Circuit Interrupter (GFCI) protected. All kitchen outlets for countertop must be GFCI protected. Bedroom outlets should be Arc-Fault Circuit Interrupter (AFCI) protected.			Garbage disposal outlet, wall mounted
At least one GFCI outlet is required in an unfinished basement, as well as most outdoor outlets. Exceptions include inaccessible outlets like those in a garage ceiling or behind a refrigerator.			General outlet, ceiling mounted
Any point along the bottom of a wall (which is 2' or wider) must be within 6' of an outlet. The 6' distance cannot be measured across a doorway or fireplace. And the outlet must be within 5 1/2' of the floor. (This cuts down on extension cord use, especially across doorways, fireplaces and similar openings.)			General outlet, wall mounted
Switches			Junction box, ceiling mounted
Every habitable room, hallway, stairway or garage must have a light switch that controls lighting in that area. In kitchens and bathrooms, the light switch must control a permanently installed light fixture. In other rooms, the switch can control either a light fixture (in the ceiling, for example) or a receptacle into which a lamp may be plugged.			Junction box, wall mounted

Rough-in Electrical	
In a new house, addition or major remodeling project, cable and boxes are "roughed-in" before the walls are insulated and drywalled.	
NOTE: Insulation can be put up then removed for an inspection, but inspection must be done before the walls are sealed by a vapor barrier and wallboard.	
Locate/place/attach all device and junction boxes for outlets, lights and switches.	
Make sure wall switches are located with proper respect to door swing, and wall outlets will not conflict with tile, cabinets, lockers, casework, or baseboard heating.	
Each box should stick out a little past the framing so its front will be flush with – or set back just a fraction from – the drywall.	
You can use a scrap piece of drywall to set boxes out the right distance. Some boxes even have a pre-formed 1/2" reference line for quick installation.	
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 well as through studs. (Most rooms have either an attic above or a basement/crawlspace below. Drill holes so cable runs horizontally through joists.)	
A heavy-duty right-angle drill with a 1" bit is the tool for this job. Wall holes drilled at about knee-height will be just right for outlets. Holes through ceiling joists and wall plates will be a bit harder; that's where the right-angle drill comes in really handy.	
Run wire/cable/conduit from the service panel to each box and between boxes. (See "Pulling Cable," inside.)	
Pull wire/cable into each box; clip, clamp and cap.	
Use metal reinforcing plates (nailing plates) at all points where the drilled hole is less than 1 1/2" from either outside edge of a stud or joist. Nailing plates are required over all notches.	

Notching walls and drilling holes					
Nominal Dimensions	Actual Dimensions	STUDS			
		NOTCHED		DRILLED	
		25%	40%	40%	60%
2 x 4	1 1/2 x 3 1/2	7/8"	1 25/64	1 25/64	2 3/32
2 x 6	1 1/2 x 5 1/2	1 3/8	2 13/64	2 13/64	3 19/64
STUDS					
Load-Bearing Walls		Holes should represent less than 40% of the joist depth (see Drilled / 40% above)			
		Notches should represent less than 25% of the joist depth (see Notched / 25% above)			
Non-Load-Bearing Walls		Holes should represent less than 60% of the joist depth (see Drilled / 60% above)			
		Notches should represent less than 40% of the joist depth (see Notched / 40% above)			
JOISTS					
Notches must represent less than 1/6th of the depth of the joist					
Notches are not allowed in the middle third of the joist length (only allowed toward the ends)					
Drilled holes in joists must not be within 2 inches of an outside edge of the joist					
Drilled holes must represent less than 1/3rd of the overall depth of the joist					

Cable Checklist

Cabling must be installed and supported properly. It also must be protected from physical damage and from electrical damage.
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."
Cable must be fastened to the framing every 4-1/2 feet, using staples, cable ties, straps, hangers, or similar fittings.
Flat cables (e.g., 14/2 Romex or 12/2 Romex) must not be stapled on edge.
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.)
Check that staples or fasteners do not cut through a cable's insulation.
Where cable runs through wood framing members, it must be no closer than 1-1/4 inches to the nearest edge of the framing member. When this clearance cannot be maintained, a nailing plate must be added for protection. In cases where a framing member is notched to accommodate electrical cabling, a nailing plate is always required.
Where cable runs through metal studs, plastic grommets must be inserted in all holes, whether those holes are manufactured or field-drilled. The plastic grommet must cover all metal edges of the hole, to provide physical protection as the cables are pulled through the metal studs.
Openings around penetrations through walls, floors, and ceilings must be filled with an approved fire-stopping material. (Some locales require fire-stopping measures in both non-fire-rated and fire-rated building components.)
Check for draft-stopping measures where cabling penetrates framing members.
Cabling must be secured within 8" of every nonmetallic box that's smaller than 2 1/4" x 4".
Cabling must be secured within 12" of every nonmetallic box that's larger than 2 1/4" x 4".
Cabling for recessed lights should be fastened to the nearest framing, providing a jug handle.
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.
All cables that run into metal or plastic boxes must be secured to the boxes. Commonly, this is done using internal or external clamps.
Account for the voltage drop that can be caused by long runs of cable. Try to limit drop to less than 3%. (See Voltage Drop table.)
Separate runs of cable/wire are required for bedroom outlets (so they can be provided with Arc-Failure Circuit Interrupter (AFCI) protection. The same is true for any other circuits requiring AFCI or GFCI protection.

PULLING CABLE

"Running cable" or "pulling cable" is a bit more involved than it sounds. Getting cable to cooperate can be frustrating and time consuming. So it helps to be patient... and a bit creative.

Double-check your circuit diagrams before running any cable. Also make a note where you can double-up runs anywhere by pulling two cables at once.

When pulling wire through conduit, or even when pulling nonmetallic-sheathed cable through holes in studs, joists, etc., "fish tape" can be fed through holes, hooked to the cable or wire, and pulled back to retrieve it.

A typical way to pull cable is to start at the last fixture in the run, pull cable to each fixture in the circuit, and continue all the way back to the service panel:

- Leave the box/spool of cable at the fixture you are cabling, unwind enough cable to complete the run, and then start pulling it through the holes. On long runs, you may need to return to the box or spool a few times to feed more cable through. Two people can really save time: one feeding cable and one pulling cable.
- Nonmetallic-sheathed cable can tangle or bind. If you feel resistance while pulling, the cable is probably kinked somewhere along the run and should be straightened out.
- Each time you reach a junction box, pull a few extra feet of cable through for making connections later.
- Once the cable reaches the service panel, leave a foot or so of extra length on both the service end and the box/spool end for connecting.
- After the cable is in place, fasten it to framing with staples every 4'-6", at turns, and within 12" of where cable enters a box. At turns, provide a jug handle.
- Label each cable at the panel end with a felt pen or piece of tape to keep them organized.

Next Steps: Attach the cable to the framing (see diagrams on following pages for maximum distances between fasteners) and securing the cable to junction/device boxes with clamps provided within the boxes.

WIRE COLOR

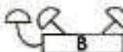
CIRCUIT TYPE

BLACK	"Hot" wire. In an outlet, it is always wired to the narrow spade or brass-colored terminal.
GREEN	"Ground" or "grounding" wire. In an outlet, it is always wired to the green terminal.
RED	"Second hot" wire in a 3-way outlet. Often called the "traveler."
WHITE OR GRAY	"Neutral" wire. In an outlet, it is always wired to the wide spade or silver-colored terminal.

Electrical Switch Symbols

	Fused switch, wall mounted		Single pole switch, wall mounted
	Fused safety switch xxAF= frame size xxAT= trip size		Switch with locator lamp glow, wall mounted
	Key controlled switch, wall mounted		Thermal rated motor switch
	Low voltage switch, wall mounted		Thermostat
	Low voltage master switch, wall mounted		Three-way switch, wall mounted
	Manual motor switch, wall mounted		Timer or motor switch with thermal overload wall mounted
	Manual motor switch, with thermal overloads wall mounted		Time clock switch
	Momentary contact Intermittent switch, wall mounted		Variable speed or volume control switch, wall mounted
	Motion detector sensor		Wall bracket pull switch
	Photoelectric switch		Weather proof circuit breaker, wall mounted
	Pilot/remote light switch load off, wall mounted		Weather proof switch, wall mounted
	Pilot/remote light switch load on, wall mounted		Cable tray
	Remote control switch receiver, wall mounted		Conduit turning up
	Ceiling pull switch ceiling mounted		Conduit turning down
	Chain pull switch		Conduit with capped end
	Circuit breaker switch, wall mounted		Emergency circuit
	Contractor control switch, wall mounted		Exposed circuit
	Dedicated/specialized switch, wall mounted		Homerun to panel letters indicate panel numbers indicate circuits
	Dimmer switch, wall mounted		Plug in or feeder bus
	Disconnect safety switch		Pull box
	Door, closet, or jamb switch		Wire in conduit (solid line indicates conduit in wall or ceiling) #8 phase and neutral size # 10
	Double pole switch, wall mounted		Wireway
	Electric eye, relay		
	Electric eye, source		
	Enclosed circuit breaker xxAF= frame size xxAT= trip size		
	Evaporative cooler switch 3-switches, fan, pump, speed controller, wall mounted		
	Explosion proof switch wall mounted		
	Fluorescent light dimmer switch, wall mounted		
	Four-way switch, wall mounted		

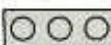
Fixture Symbols

	Emergency exit light combo, battery powered, wall mount		Flourescent lighting fixture, wall mounted
	Emergency exit light combo, battery powered, ceiling mount		Flourescent lighting fixture, channel mount, ceiling mounted
	Emergency exit light remote, battery powered, ceiling mount		Flourescent lighting fixture, number of tubes, ceiling mount
	Emergency exit light remote, battery powered, with 3 sealed beams, wall mount		Flourescent lighting fixture, number of tubes, wall mount
	Emergency lighting on critical power circuit		Flourescent lighting fixture, mod wired in series wall mount
	Emergency lighting on emergency life safety branch		Flourescent lighting fixture, pendant style, ceiling mount
	Exit light, wall mounted arrow indicates exit		Same as above, wall mount
	Exit light, recessed wall mounted		Flourescent lighting fixture recessed style ceiling mount
	Exit light, shaded area indicates number of faces shown, arrow indicates exit no arrow when directly over an exit door		Flourescent lighting fixture surface mount with outlet box, ceiling mount
	Flourescent fixture, ceiling mounted		Flourescent lighting fixture on critical branch circuit
	Flourescent fixture, ceiling mounted		Flourescent lighting fixture on emergency circuit

Fixture Symbols



Flourescent fixtures continuous row

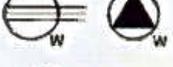
-  Illuminated house number, wall mount
-  Incandescent lighting fixture, ceiling mounted
-  Incandescent lighting fixture, blank, unused ceiling mounted
-  Incandescent lighting fixture, blank, unused wall mounted
-  Incandescent lighting fixture, chandelier, ceiling mounted
-  Incandescent lighting fixture, controlled by low voltage switch relay in box, wall mounted
-  Incandescent lighting fixture, letter in triangle is reference to key, ceiling mounted
-  Incandescent lighting fixture, mirror lights, ceiling mounted
-  Incandescent lighting fixture, mirror/vanity lights, wall mounted
-  Incandescent lighting fixture, multiple flood lights, wall mounted
-  Incandescent lighting fixture, recessed, ceiling mounted
-  Incandescent lighting fixture, recessed directional light fixture, ceiling mounted
-  Incandescent lighting fixture, recessed directional light fixture, ceiling mounted

-  Incandescent lighting fixture, rough-in only, ceiling mounted
-  Incandescent lighting fixture, spot light, ceiling mounted
-  Incandescent lighting fixture, heat lamp, ceiling mounted

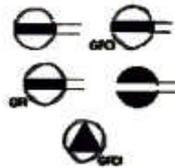
-  Incandescent lighting standard uppercase = key, number = circuit number, switch control

-  Incandescent lighting fixture surface directional light wall mounted
-  Incandescent lighting fixture, track lighting
-  Incandescent lighting fixture underwater recessed, bottom fixture
-  Incandescent lighting fixture underwater recessed, wall mounted
-  Incandescent lighting fixture underwater up beam bottom mounted
-  Incandescent lighting fixture fan ceiling mounted
-  Wall fan
-  Incandescent lighting with pull switch, wall mounted

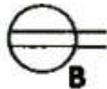
Outlet Symbols

	220-volt outlet, wall mounted
	220-volt outlet, clothes dryer wall mounted
	220-volt outlet, range, wall mounted
	Blanked (unused) duplex outlet, wall mounted
	Blanked (unused) outlet, ceiling mounted
	Blanked (unused) outlet, wall mounted
	Blanked (unused) quad outlet, wall mounted
	Clothes washer outlet, wall mounted
	Combination switch and double outlet, receptacle, wall mounted
	Combination switch and single outlet receptacle, wall mounted
	Dishwasher outlet wall mounted
	Drop cord ceiling mounted
	Duplex receptacle outlet, ceiling mounted
	Duplex receptacle outlet, floor mounted
	Duplex receptacle outlet, wall mounted

Outlet symbols



**Duplex receptacle outlet
with GFI or GFCI device,
wall mounted**



**Duplex receptacle outlet,
isolated ground, wall mounted**



**Duplex receptacle outlet,
split wired, wall mounted**



Duplex special purpose outlet



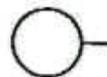
**Emergency outlet,
wall mounted**



**Garbage disposal outlet,
wall mounted**



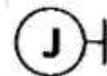
**General outlet,
ceiling mounted**



**General outlet,
wall mounted**



**Junction box,
ceiling mounted**



**Junction box,
wall mounted**



**Lamp holder,
ceiling mounted**

Outlet Symbols



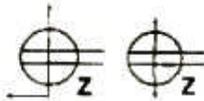
Lampholder, wall mounted



Lampholder, with pull switch,
ceiling mounted



Lampholder, with pull switch,
wall mounted



Multi-outlet assembly
or power strip



Outlet for exit lamp,
ceiling mounted



Outlet for exit lamp,
wall mounted



Poke-through with electrical
outlets, floor mounted



Poke-through (abandoned)



Polarized plug receptacle
outlet, wall mounted



Pull switch, ceiling mounted



Pull switch, wall mounted



Quadraplex (double duplex)
receptacle outlet, ceiling mounted

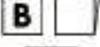
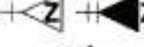
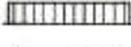


Quadraplex (double duplex)
receptacle outlet, floor mounted

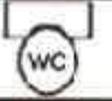
Outlet Symbols

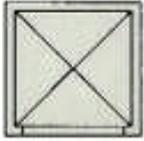
	Quadruplex (double duplex) receptacle outlet, ceiling mounted
	Quadruplex (double duplex) receptacle outlet, floor mounted
	Quadruplex (double duplex) receptacle outlet, wall mounted
	Quadruplex (double duplex) receptacle outlet, isolated ground, wall mounted
	Single grounding receptacle outlet, wall mounted
	Single receptacle outlet, ceiling mounted
	Single receptacle outlet, floor mounted
	Single receptacle outlet, wall mounted
	Single special purpose outlet
	Single special purpose outlet, wall mounted
	Special purpose outlet, key indicates purpose, floor mounted
	Special purpose duplex outlet
	Triplex receptacle outlet, wall mounted
	Triplex receptacle outlet, split wired, wall mounted
	Vapor discharge lamp outlet, ceiling mounted
	Vapor discharge lamp outlet, wall mounted
	Water heater outlet, wall mounted
	Waterproof duplex receptacle outlet

Communication Symbols

	bell		Public telephone, wall mount
	bell & buzzer combo		Push button switch
	buzzer		Signal central station device
	card reader, wall mounted		Signal system device
	chime		Sound system devices, wall mount
	clock		Sound system devices, general symbol
	clock, electrical clock system, wall mounted		Sound system speaker recessed
	closed circuit TV camera		Sound system speaker wall mounted
	Data/phone outlet floor mounted		Sound system volume control, wall mounted
	Data/phone outlet wall mounted		Special auxilliary outlets letter refers to key
	Computer outlet (general)		Telephone public general symbol, letter=key
	Data outlet, floor mount		Telephone outlet
	Data outlet, wall mounted		Telephone outlet, Private, floor mounted
	Microphone, wall receptacle		Telephone outlet, Public, floor mounted
	Paging system device, wall mounted		Telephone terminal cabinet
	Poke through, floor mount		Telephone terminal cabinet, wall mounted
	Poke through, with telephone outlets, floor mounted		TV (CATV) outlet
	Poke through, with various devices, floor mounted		TV antenna devices wall mounted
	Poke through, abandoned, floor mounted		Volume control
	Pole, various devices		Watchman system devices wall mounted
	Private telephone devices wall mounted		Yard bell or chime

Plumbing Symbols

	Water Meter		Cold Water
	Hot Water		Vent Line
	Sanitary Waste		Gas Pipe
	Gate Valve		Water Heater Shut Off
	Water Closet		Lavatory
	Water Heater		Dishwasher
	Clothes Washer		Floor Drain
	Clean Out		Vent Thru Roof
	90 degree Elbow		Pipe Turns Up
	Pipe turns Down		Tee
	Union		Cap

	WC	Toilet, floor outlet		LAV	Lavatory
	WC	Toilet, wall hung			Bathtub, recessed type
	WC	Toilet, tank type		DF	Drinking fountain, floor mounted
		Bidet			Drinking fountain, wall hung
	UR	Urinal, wall hung		SHWR	Shower, stall type
	S	Sink, general			Shower, handicapped
	FS	Sink, floor		HWT	Hot Water Tank
	KS	Sink, kitchen		WH	Water Heater
	MS	Sink, mop			
	SS	Sink, utility			

	Equipment, insulation (indicate thickness)
	Equipment, pipe hanger, alignment guide
	Equipment, pipe hanger, clevis type
	CSH Equipment, pipe hanger, constant support type
	RH Equipment, pipe hanger, roller type
	SS Equipment, pipe hanger, sliding support type
	SCH Equipment, pipe hanger, spring cushion type
	SH Equipment, pipe hanger, spring type
	TH Equipment, pipe hanger, trapeze type
	PS Equipment, pipe stand (floor supported)
	Equipment, pump (arrowhead shows flow)
	RC Equipment, riser clamp

	Equipment, sediment strainer
	Equipment, strainer basket type
	Equipment, strainer blow off type (with valve)
	Equipment, strainer, cone type
	Equipment, strainer, continuous type
	Equipment, strainer, T type
	Equipment, strainer, temporary
	Equipment, trap, generic
	Equipment, trap, float
	Equipment, trap, running
	Equipment, trap, vacuum
	WB Equipment, wall

	Fitting, bell & spigot
	Fitting, bulkhead flange
	Fitting, bull plug, bell and spigot
	Fitting, bull plug, flanged
	Fitting, bull plug, screwed
	Fitting, bushing
	Fitting, choke nipple
	FCO Fitting, clean out, floor
	CO Fitting, clean out, exposed
	Fitting, elbow, 45-degree
	Fitting, elbow, 45-degree dropping
	Fitting, elbow, 45-degree rising
	Fitting, elbow, 90-degree
	Fitting, elbow, 90-degree turned down
	Fitting, elbow, 90-degree turned down
	Fitting, elbow, 90-degree turned up
	Fitting, elbow outlets: side and down
	Fitting, elbow outlets: side and up
	Fitting, elbow, reducing
	Fitting, expansion joint, bellows
	Fitting, expansion joint, sliding
	Fitting, flanged
	Fitting, flexible connection
	FD Fitting, floor drain
	Fitting, flow straightener (flanged fitting shown)
	Fitting, hose connector, quick-couple



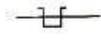
Fitting, joint, double plane swing type



Fitting, joint, swing type or ball joint



Fitting, overflow



Fitting, Pete's plug



Fitting, pipe or cleanout plug, bell & spigot



Fitting, pipe or cleanout plug, screwed



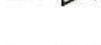
Fitting, reducer, concentric



Fitting, reducer, concentric, rising or descending



Fitting, reducer, eccentric, straight crown



Fitting, reducer, eccentric, straight invert



Fitting, reducing cross



RD Fitting, roof drain



Fitting, screwed



Fitting, sewer, 90-degree base elbow



Fitting, sewer, blank flange



Fitting, sewer, double branch elbow



Fitting, sewer, lateral connection



Fitting, sewer, lateral connection: dropping



Fitting, sewer, lateral connection: rising



Fitting, sewer, long radius elbow



Fitting, sewer, return bend



Fitting, sewer, double sweep



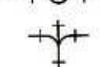
Fitting, sewer, single sweep



Fitting, sewer, street elbow



Fitting, sewer, tee (side outlet/outlet up)



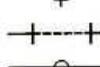
Fitting, sewer, through double T-Y



Fitting, sewer, through double Y



WYE Fitting, sewer, true Y



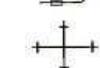
Fitting, sleeve



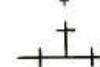
Fitting, soldered



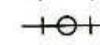
Fitting, solvent cement



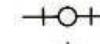
Fitting, straight size cross



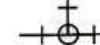
Fitting, straight size tee



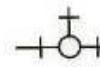
Fitting, tee down



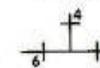
Fitting, tee up



Fitting, tee, outlets: side and down



Fitting, tee, outlets: side and up



Fitting, tee, reducing



Fitting, union, flanged



Fitting, union, screwed



W.H. Fitting, wall hydrant (2 connections shown)



Fitting, welded



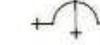
Piping, crossover (no junction)



Piping, pipe



Piping, point of connection (old to new work)



Piping, sloped pipe, drop (indicated e.g. 1:24)



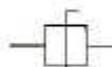
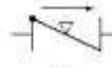
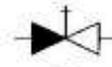
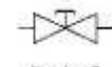
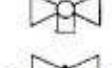
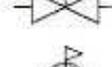
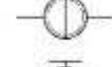
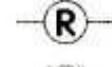
Piping, sloped pipe, rise (indicated e.g. 2:12)

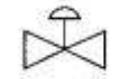
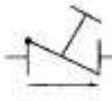
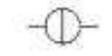
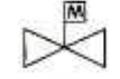
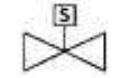


D 3:12



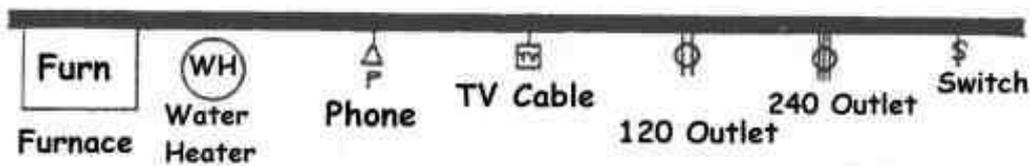
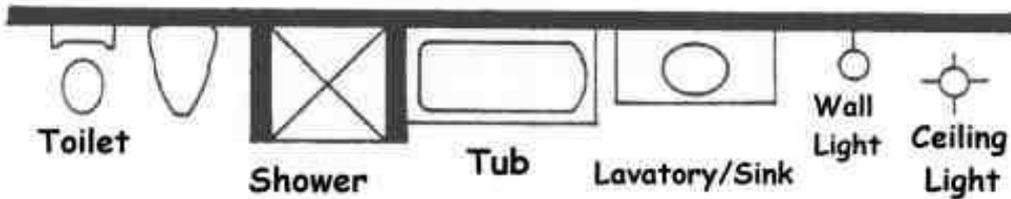
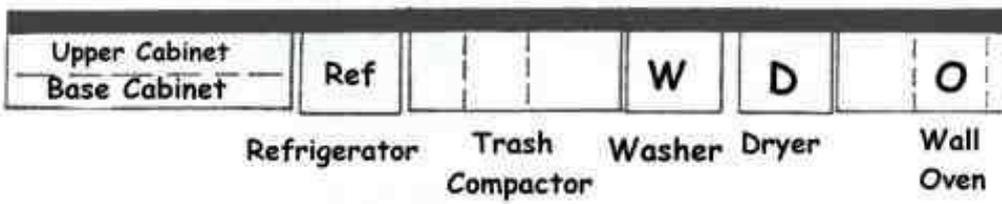
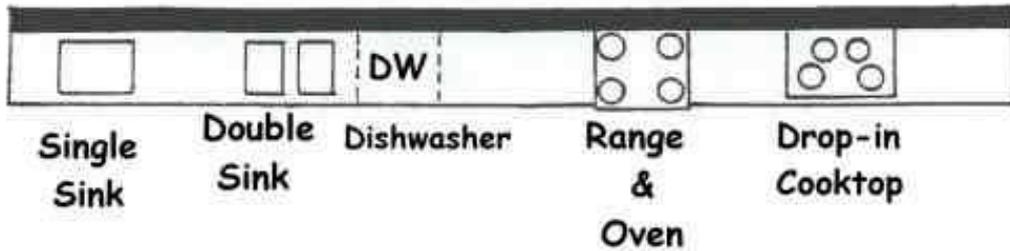
R 3:12

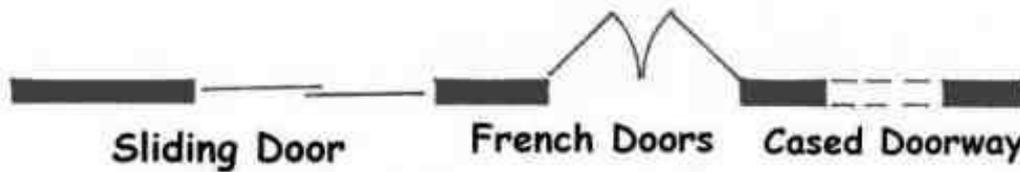
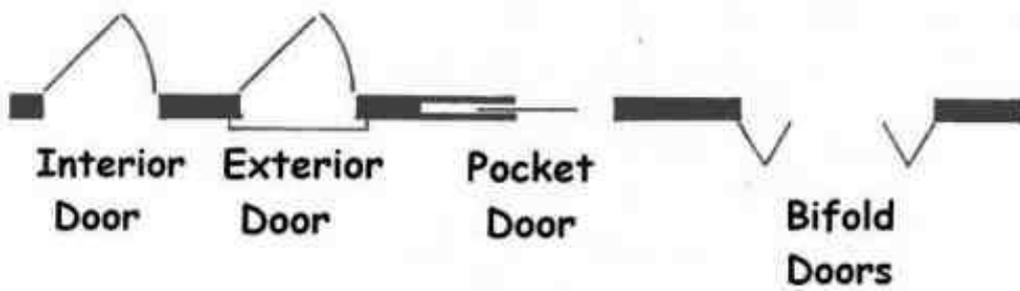
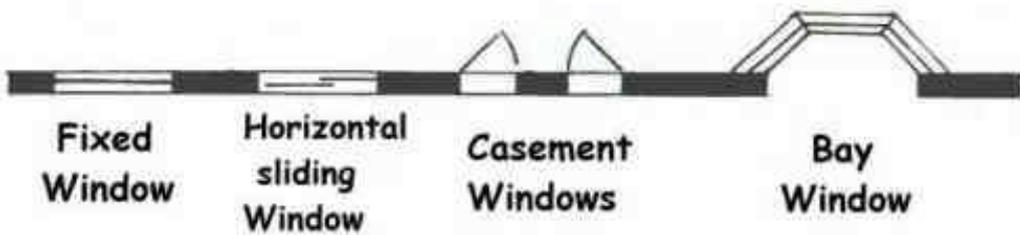
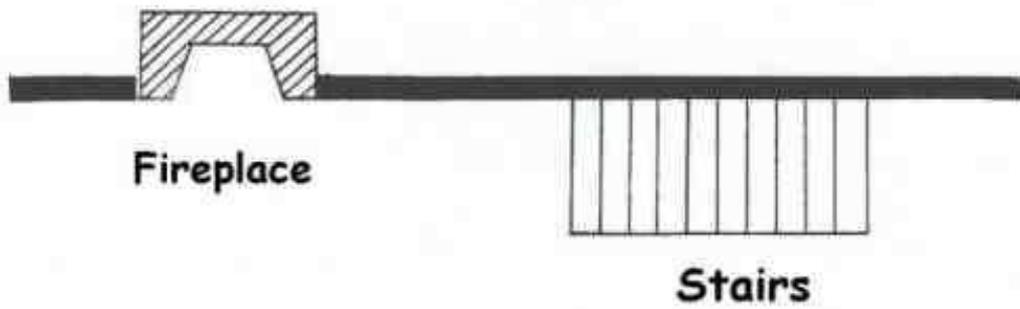
	VTR Piping, vent through roof		HB Valve, hose bibb
	Valve (designated by key or abbreviations)		Valve, hot water balance
	Valve in pit or valve box		Valve, lift check type
	Valve in riser		Valve, listed indicating
	Valve in wall box		Valve, lockable
	Valve, 3-way (shading indicates closed side)		Valve, needle type
	Valve, 4-way		Valve, petcock or cock
	Valve, air- or gas-line		Valve, pig ball type
	Valve, angled gate type		Valve, plug type
	Valve, angled globe type		PIV Valve, post-indicator
	Valve, ball type		Valve, pressure reducing
	Valve, butterfly		Valve, pressure relief
			Valve, rotary plug type
			Valve, safety type

	BFP	Valve, check (also called swing check or backflow preventer)		Valve, spring check type
		Valve, control, diaphragm actuator		Valve, stop check type
		Valve, control, hand actuator		Valve, stop cock plug or cylinder type, 2-way
		Valve, control, motor operated		Valve, stop cock plug or cylinder type, 3-way/2-port
		Valve, control, rotary actuated		Valve, stop cock plug or cylinder type, 3-way/3-port
		Valve, control, solenoid operated		Valve, stop cock plug or cylinder type, 4-way/4-port
		Valve, diaphragm type		Valve, triple duty (flow, flow balance, backflow prevention)
		Valve, faucet		Valve, V-ball type
		Valve, float type		
		Valve, flush valve		
	GV	Valve, gate type, normally closed		
	GV	Valve, gate type, normally opened (abbrev. or letter refers to key)		
		Valve, globe type		

Architectural symbols

Architectural Blueprint Symbols





Electrical boxes

BOXES

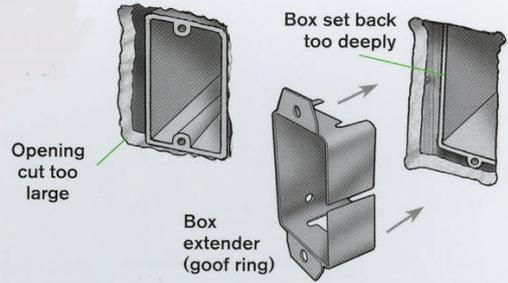
Boxes are necessary to safely enclose and protect wiring splices and to support devices and luminaires (fixtures). In raceways, they provide a pull point for the wiring. Boxes must be large enough to contain all the conductors and devices inside them, and sufficient wire must be brought into the box to safely make up connections. Luminaires that are supported from boxes are generally designed so their connections will be made inside the box, rather than inside the fixture canopy. Device boxes with 6/32 threaded holes are designed to mount switches and receptacles and are not generally used to mount luminaires.

General	06 IRC	08 NEC
<input type="checkbox"/> Metal boxes must be grounded _____ [3805.2]		{314.4}
<input type="checkbox"/> Box & conduit body covers must remain accessible [3805.10]		{314.29}
<input type="checkbox"/> Max 1/4in setback from noncombustible surface F19 [3806.5]		{314.20}
<input type="checkbox"/> Box extenders OK to correct excess setback _____ [3806.5]		{314.20}
<input type="checkbox"/> Boxes flush w/ combustible surface F19 [3806.5]		{314.20}
<input type="checkbox"/> Plaster gap max 1/8in for flush cover boxes F19 [3806.6]		{314.21}
<input type="checkbox"/> Min 6in free conductor & 3in past box face _____ [3306.10.3]		{300.14}
<input type="checkbox"/> Ceiling lighting boxes rated min 50lb _____ [3805.6]		{314.27A} ²⁰
<input type="checkbox"/> Wall boxes marked w/ max weight if not 50lb EXC _____ [n/a]		{314.27A} ²⁰
Wall sconces ≤6lb OK mounted on device boxes _____ [3805.6X]		{314.27AX}
<input type="checkbox"/> Smoke alarms OK mounted to device boxes _____ [n/a]		{314.27EX}
<input type="checkbox"/> Boxes must be rigidly supported _____ [3806.8]		{314.23}
<input type="checkbox"/> PVC & EMT not OK for box support _____ [3806.8.5]		{314.23E&F}
<input type="checkbox"/> PVC & EMT OK for conduit body support _____ [3806.8.5]		{314.23E&F}

Also see NEC sections 352.12B & 358.12.

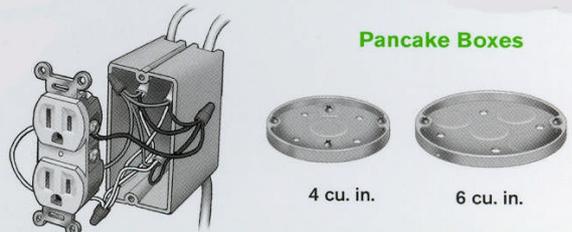
<input type="checkbox"/> Wet location boxes & conduit bodies listed for wet _____ [3805.11]		{314.15}
<input type="checkbox"/> Damp or wet location boxes must keep out water _____ [3805.11]		{314.15}

Box Fill	06 IRC	08 NEC
<input type="checkbox"/> Size sufficient to provide free space for conductors [3805.12]		{314.16}
<input type="checkbox"/> Standard metal boxes per code tables _____ [3805.12.1.1]		{314.16A1}
<input type="checkbox"/> Include volume of marked mud rings & extensions [3805.12.1]		{314.16A}
<input type="checkbox"/> Plastic boxes have volume marking _____ [3805.12.1.2]		{314.16A2}
<input type="checkbox"/> No splices in pancake boxes EXC F21 _____ [3805.12.2]		{314.16B}
4in (6cu in) pancake OK at end of 14/2 run F21 _____ [3805.12.2]		{314.16B}
<input type="checkbox"/> 18cu in box too small for 3 12/2 Romex T8,F20 _____ [3805.12.2]		{314.16B}



Box Fill Factors T7,T8

	06 IRC	08 NEC
<input type="checkbox"/> Count each conductor exiting box EXC _____ [3805.12.2.1]		{314.16B1}
EGCs from luminaires or up to 4 conductors <14AWG from luminaires w/ domed canopies _____ [3805.12.2.1X]		{314.16B1X}
<input type="checkbox"/> Unbroken conductors passing through box count as only 1 conductor EXC _____ [3805.12.2.1]		{314.16B1}
Looped unbroken conductors >12in count as 2 [3805.12.2.1]		{314.16B1}
<input type="checkbox"/> Do not count pigtailed conductors to devices _____ [3805.12.2.1]		{314.16B1}
<input type="checkbox"/> All internal clamps count as 1, based on largest conductor in box _____ [3805.12.2.2]		{314.16B2}
<input type="checkbox"/> Support fittings count as 1 conductor for each fitting type based on largest conductor in box _____ [3805.12.2.3]		{314.16B3}
<input type="checkbox"/> Count devices as 2 conductors based on the connected wire size _____ [3805.12.2.4]		{314.16B4}
<input type="checkbox"/> All EGCs count as only 1 based on largest _____ [3805.12.2.5]		{314.16B5}



2x4 with front nailer



2x4 with 16d nails



4x4 with angled nails



Branch circuits and outlets

BRANCH CIRCUITS & OUTLETS ♦ KITCHENS

17

Receptacle Outlets—General Purpose **F27&28** 06 IRC 08 NEC

- Walls ≥ 2 ft wide req receptacle _____ [3801.2.2] {210.52A2}
- Partitions & bar-type counters count as walls **F30** _____ [3801.2.2] {210.52A2}
- Doorways & fireplaces not counted as walls _____ [3801.2.2] {210.52A2}
- Receptacle req'd within 6ft horizontally of any point along wall _____ [3801.2.1] {210.52A1}
- Receptacle req'd for hallways ≥ 10 ft in length **F28** _____ [3801.10] {210.52H}
- Receptacles that are part of electric baseboard heaters OK as req'd outlets _____ [3801.1] {210.52}
- Receptacles $> 5\frac{1}{2}$ ft high not OK as req'd outlets _____ [3801.1] {210.52}
- Floor receptacles > 18 in from wall not OK as req'd outlets _____ [3801.2.3] {210.52A3}
- Switched receptacles installed as req'd lighting do not count as part of req'd receptacle outlets unless "half hot" _____ [n/a] {210.52} ²⁵

Garages & Unfinished Basements 06 IRC 08 NEC

- Min 1 wall-switched lighting outlet in garage _____ [3803.3] {210.70A2a}
- Min 1 receptacle not dedicated to fixed equipment _____ [3801.9] {210.52G} ²⁶

Bathrooms 06 IRC 08 NEC

- Receptacle req'd on wall within 3ft of each basin OR _____ [3801.6] {210.52D}
- May be in cabinet side or face ≤ 12 in below countertop [3801.6X] {210.52D}
- No face-up outlets on vanity countertop _____ [3801.6] {406.4E}
- No receptacles within or directly over tub or shower [3902.11] {406.8C}
- Separate 20A circuit for bath receptacles only OR _____ [3603.4] {210.11C3}
- Dedicated 20A circuit to each bathroom _____ [3603.4X] {210.11C3X}
- Max rating of fixed space heater on general lighting circuit
15A circuit: 900W; 20A circuit: 1,200W _____ [3602.5] {210.23A2}

Laundry 06 IRC 08 NEC

- Min 1 20A circuit to laundry receptacles _____ [3603.3] {210.11C2}
- No other outlets on laundry receptacle circuit _____ [3603.3] {210.11C2}
- Receptacle within 6ft of intended appliance location _____ [3801.5] {210.50C}
- Electric dryer min 30A circuit (10AWG Cu, 8AWG Al) _____ [T3604.2(1)] {220.54}
- Electric dryer req's 4-conductor branch circuit EXC _____ [3808.7] {250.140}
- Existing 3-wire circuits allowed to remain in use _____ [n/a] {250.140X}

Outdoors 06 IRC 08 NEC

- Receptacle accessible from grade req'd at front & rear of dwelling max 6 $\frac{1}{2}$ ft above grade _____ [3801.7] {210.52E1}
- Receptacle req'd for balconies w/ interior access & ≥ 20 sq ft _____ [n/a] {210.52E3} ²⁷
- Receptacles in damp or wet locations req'd to be listed weather-resistant type _____ [n/a] {406.8A&B} ²⁸
- Outdoor damp location receptacle (e.g., protected porch) req's weatherproof cover **F29** _____ [3902.8] {406.8A}
- Wet location 15A & 20A receptacles req in-use covers **F29** _____ [3902.9] {406.8B1}

FIG. 27

6 ft. & 12 ft. Rule

FIG. 28

6 ft. & 12 ft. Rule Explained

Wall receptacles serve the spaces for 6 ft. on each side of the receptacle. Therefore, the maximum spacing between wall receptacles is 12 ft.

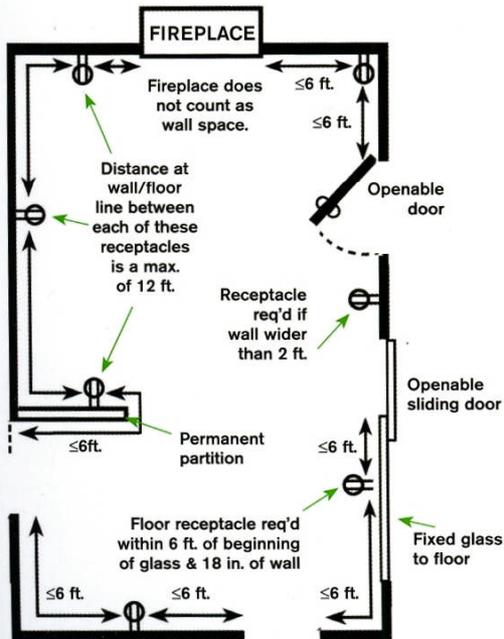
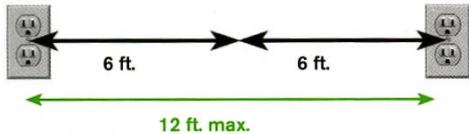


FIG. 29

Outdoor Receptacle Covers

Weatherproof cover

In-use cover

Lighting Outlets (also see p.19) 06 IRC 08 NEC

- Wall-switch controlled lighting outlets req'd in all habitable rooms & bathrooms _____ [3803.2] {210.70A1}
- Habitable room lighting outlets may be switched receptacle except in kitchen & bathroom _____ [3803.2X1] {210.70A1X1}
- Occupancy-sensor wall switches OK _____ [3803.2X2] {210.70A1X2}
- Wall-switch controlled lighting outlets req'd in hallways, stairways, attached garages, & detached garages w/ power _____ [3803.3] {210.70A2}
- Interior stair req's switch at each entrance if ≥ 6 risers [3803.3] {210.70A2c}
- Lighting outlet req'd on exterior side grade-level doors [3803.3] {210.70A2b}
- Lighting outlet req'd at garage egress doors _____ [3803.3] {210.70A2b}
- Lighting outlet not req'd at garage vehicle doors _____ [3803.3] {210.70A2b}

KITCHENS

A minimum of two small-appliance branch circuits are required for portable appliances that are used in kitchens and dining areas. These circuits are in addition to those that supply lighting or permanently installed appliances. Portable kitchen appliances have short cords so they are not as likely to be run across cooktops or sinks or to hang down in the reach of children. A receptacle is needed to serve every countertop 1 ft. or more in width.

Branch Circuits

- | | 06 IRC | 08 NEC |
|--|--------------|--------|
| <input type="checkbox"/> Min 2 20A small-appliance circuits req'd _____ [3603.2] | (210.11C) | |
| <input type="checkbox"/> Small-appliance circuits must serve refrigerator & all countertop & exposed wall receptacles in kitchen, dining room, & pantry EXC [3603.2] | (210.52B1) | |
| <input type="checkbox"/> Refrigerator OK on individual branch circuit $\geq 15A$ [3603.2X] (210.52B1X2) | | |
| <input type="checkbox"/> Switched receptacle for dining room light OK on non-small-appliance circuit _____ [n/a] | (210.52B1X1) | |
| <input type="checkbox"/> No other outlets (including lights) on small appliance branch circuits EXC _____ [3801.3.1] | (210.52B2) | |
| <input type="checkbox"/> Receptacles for clock or gas range ignition OK _____ [3801.3.1X] | (210.52B2X) | |
| <input type="checkbox"/> Dishwasher & disposer req separate circuits if combined rating exceeds branch circuit rating _____ [3601.2] | (210.19A1) | |
| <input type="checkbox"/> Circuits for ranges $\geq 8.75kW$ min 40A 240V _____ [3602.9.1] | (210.19A3) | |

Receptacles for Countertop Spaces

- | | 06 IRC | 08 NEC |
|--|--------------|--------|
| <input type="checkbox"/> Receptacles req'd for wall counter spaces $\geq 12in$ wide _____ [3801.4.1] | (210.52C1) | |
| <input type="checkbox"/> Countertop spaces separated by sinks or ranges considered separate countertop spaces F30 _____ [3801.4.4] | (210.52C4) | |
| <input type="checkbox"/> Spacing so no point $>24in$ from receptacle F31 _____ [3801.4.1] | (210.52C1) | |
| <input type="checkbox"/> Area behind sink or range not considered countertop space if $<12in$ for straight wall F32 or $<18in$ for corner appliance F33 _____ [3801.4.1X] ²⁹ | (210.52C1X) | |
| <input type="checkbox"/> Max 20in above countertop _____ [3801.4.5] | (210.52C5) | |
| <input type="checkbox"/> Peninsula countertop spaces req receptacle if long dimension $>24in$ & short dimension $>12in$, measured from connecting edge F30 _____ [3801.4.3] | (210.52C3) | |
| <input type="checkbox"/> Island & peninsula countertop spaces min 1 receptacle per space—no 24in rule F30 _____ [3801.4.2&3] | (210.52C2&3) | |
| <input type="checkbox"/> Island & peninsula receptacles may be mounted no more than 12in below counter if max 6in counter overhang & no backsplash or means of installing receptacle in an overhead cabinet F30 _____ [3801.4.5X] | (210.52C5X) | |
| <input type="checkbox"/> No face-up countertop receptacles _____ [3801.4.5] | (406.4E) | |
| <input type="checkbox"/> GFCI protection for all receptacles serving countertops [3802.6] | (210.8A6) | |

FIG. 30

Kitchen Receptacles

Cord-plug connected range-hood allowed if supplied by individual branch circuit.

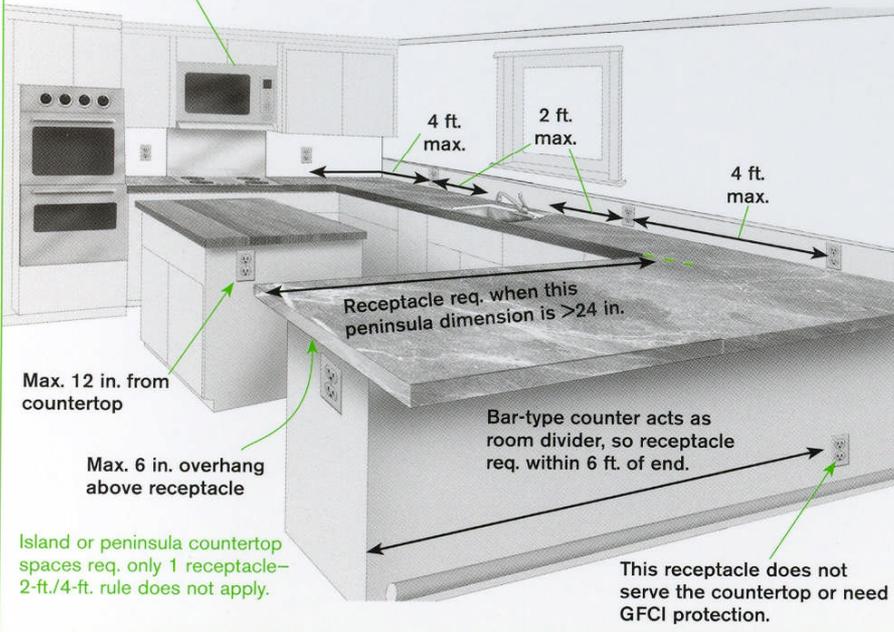


FIG. 31

2-ft./4-ft. Rule

Wall countertop receptacles serve the spaces for 2 ft. on each side of the receptacle. Therefore, the maximum spacing between receptacles on the same countertop space is 4 ft.



FIG. 32

Extended Range or Sink

If $X \geq 12$ in., countertops not considered separate spaces & the 2-ft./4-ft. rule applies to the entire countertop.

$X < 12$ in.: measure from here

$X < 12$ in.: measure from here

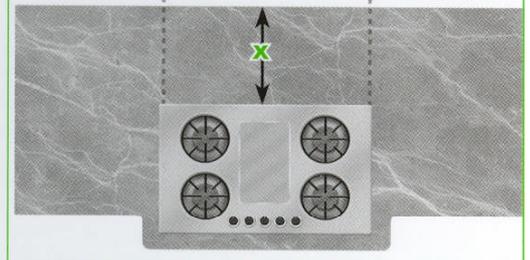


FIG. 33

Corner Range or Sink

$X < 18$ in.: outlet not required here

$X < 18$ in.: measure from here



If $X \geq 18$ in., countertops not considered separate spaces & the 2-ft./4-ft. rule applies to the entire countertop.

SWITCHES

Switch installations must ensure that an equal load is going in and out on each wiring method. Some modern occupancy sensors require a neutral conductor, and old-style switch loops are not sufficient for these sensors.

Switches

- | | 06 IRC | 08 NEC |
|---|--------|-------------|
| <input type="checkbox"/> All switching in ungrounded conductors F34,35 [3901.8&9] | | {404.2A&B} |
| <input type="checkbox"/> Snap switches & dimmers req grounding EXC [3901.11.1] | | {404.9B} |
| Replacement switches OK w/ GFCI or plastic faceplate [3901.11.1X] | | {404.9BX} |
| <input type="checkbox"/> Grounding OK by screws to grounded metal box [3901.11.1] | | {404.9B1} |
| <input type="checkbox"/> Metal faceplates must be grounded to switch [3901.11.1] | | {404.9B} |
| <input type="checkbox"/> Faceplate must completely cover wall opening [3901.11] | | {404.9A} |
| <input type="checkbox"/> 3-way switches req'd at stairs w/ 6 or more risers [3803.3] | | {210.70A2c} |
| <input type="checkbox"/> Dimmers OK for incandescent lights not receptacles [3901.12] | | {404.14E} |
| <input type="checkbox"/> Current-carrying conductors of circuit grouped F34 [3306.7] | | {300.3B} |
| <input type="checkbox"/> Re-identify ungrounded white or gray wires F34 [3307.3X] | | {200.7C} |
| <input type="checkbox"/> "CO/ALR" switch req'd if direct AL wire connection [3901.2] | | {404.14C} |

FIG. 34

3-Way Switch

3-way switching takes place from a common terminal to one or the other traveler terminals.

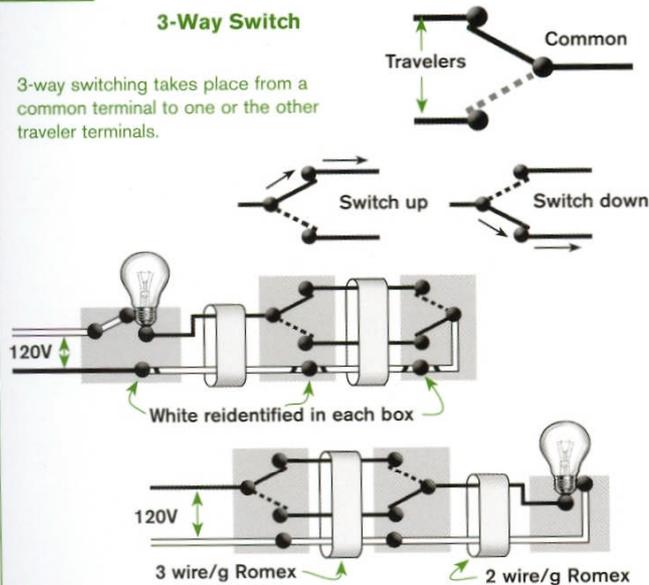
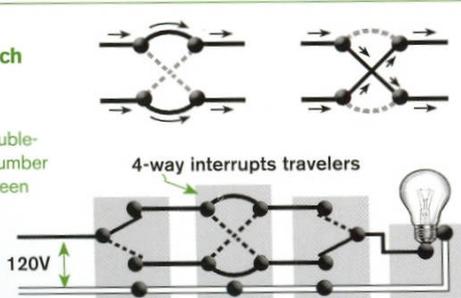


FIG. 35

4-Way Switch

A 4-way switch is a double-pole, double-throw switch. Any number can be placed between the two 3-ways.



LIGHTING

Lighting outlets and luminaires must be installed with no exposed live parts that could pose a shock hazard. The heating effect of luminaires must be considered, especially around thermal insulation. Lights rated "type IC" are suitable for insulated ceilings. See p.17 for required locations.

General

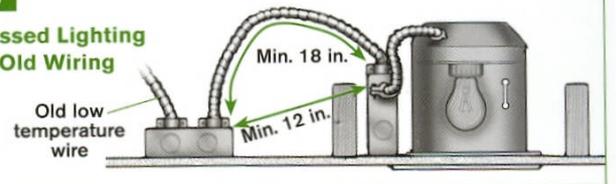
- | | 06 IRC | 08 NEC |
|---|--------|-----------|
| <input type="checkbox"/> All luminaires & lampholders listed [3303.3] | | {410.6}30 |
| <input type="checkbox"/> Exposed metal parts grounded EXC [3903.3] | | {410.42A} |
| Incidental metal parts such as mounting screws [3903.3] | | {410.42A} |
| <input type="checkbox"/> Wet location luminaires L&L for wet location [3903.8] | | {410.10A} |
| <input type="checkbox"/> Damp location luminaires L&L for damp or wet location [3903.8] | | {410.10A} |
| <input type="checkbox"/> Screw shells for lampholders only—no adapters [3903.4] | | {410.90} |

Recessed Lights

- | | 06 IRC | 08 NEC |
|--|--------|-------------|
| <input type="checkbox"/> Non-Type IC min 1/2in from combustibles [3904.8] | | {410.116A1} |
| <input type="checkbox"/> Non-Type IC min 3in from insulation [3904.9] | | {410.116B} |
| <input type="checkbox"/> Type IC OK in contact w/ combustible material [3904.8] | | {410.116A2} |
| <input type="checkbox"/> Type IC OK in contact w/ insulation [3904.9] | | {410.116B} |
| <input type="checkbox"/> Luminaires that req >60°C wire must be marked [n/a] | | {410.74} |
| <input type="checkbox"/> Connect proper temp-rated wire to luminaire [n/a] | | {410.117A} |
| <input type="checkbox"/> Tap conductors to 60°C wire min 18in max 6ft F36 [n/a] | | {410.117C} |

FIG. 36

Recessed Lighting with Old Wiring

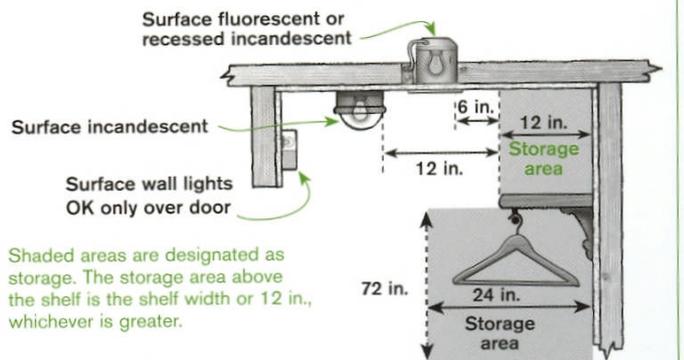


Closet Lights **F37**

- | | 06 IRC | 08 NEC |
|--|--------|--------------|
| <input type="checkbox"/> Incandescent bulbs req'd to be fully enclosed [3903.11] | | {410.16A1} |
| <input type="checkbox"/> Partially enclosed incandescent bulbs prohibited [3903.11] | | {410.16B} |
| <input type="checkbox"/> Surface-mounted only on ceiling or wall above door [3903.11]{410.16C1&2} | | |
| <input type="checkbox"/> Surface incandescents min 12in from storage [3903.11] | | {410.16C1} |
| <input type="checkbox"/> Surface fluorescents min 6in from storage [3903.11] | | {410.16C2} |
| <input type="checkbox"/> Recessed (wall or ceiling) min 6in from storage [3903.11]{410.16C3&4} | | |
| <input type="checkbox"/> Surface fluorescent or LED (light-emitting diode) OK in storage area if listed for same [n/a] | | {410.16C5}31 |

FIG. 37

Closet Lights



CABLE SYSTEMS

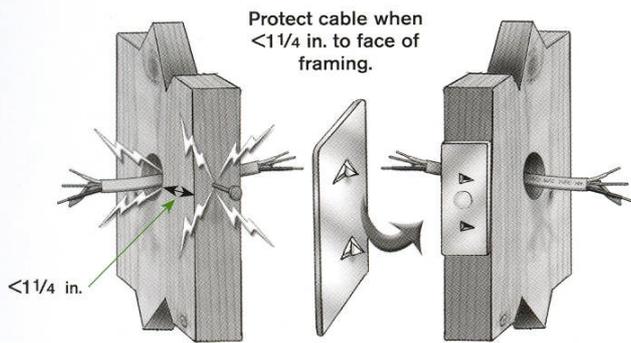
Cable systems are the most common residential wiring methods. Cables contain all conductors of the circuit inside a protective outer sheath of metal or plastic. Starting with the 2005 edition, the NEC uses a parallel numbering system for rules pertaining to cables and raceways. See the common numbering system table (T23) on the inside back cover.

Cable Protection Indoors (NM, AC, MC, UF, SE) 06 IRC 08 NEC

- Bored holes & standoff clamps 1/4in setback **F56** [3702.1] {300.4A&D}
- Protect cables w/ 1/16in steel plate (or L&L plate) if closer than 1/4in to framing surfaces **F45** [3702.1] {300.4A&D}
- Provide guard strips within 6ft of attic scuttle **F46** [3702.2.1] {334.23}
- Provide guard strips up to 7ft high in attic w/ ladder or permanent stairs **F46** [3702.2.1] {334.23}

FIG. 45

Nail-Plate Protection



NM–Nonmetallic Sheathed Cable (Romex) F48 06 IRC 08 NEC

- OK in dry locations only [3701.4] {334.12B4}
- Protect exposed cable from damage where necessary [3702.3.2] {334.15B}
- Listed grommets for holes through metal framing [3702.1] {300.4B1}
- OCPD selection based on 60° column **T11** [3605.4.4] {334.80}
- Derating & temp correction based on 90° rating [3605.4.4] {334.80}
- Derate >2 NM cables in same caulked (fireblocked) hole [3605.4.4]³⁶ {334.80}
- Derate >2 NM cables installed w/o spacing in contact w/ thermal insulation [n/a] {334.80}³⁷
- Secure to box w/ approved NM clamp EXC **F49** [3805.3.2] {314.17B&C}
 - Single-gang (2 1/4×4in) plastic box stapled within 8in [3805.3.2] {314.17CX}
- Min 1/4in sheathing into plastic boxes [3805.3.1] {314.17C}
- Secure within 12in of box & max 4 1/4ft intervals [3702.1] {334.30}
- Do not overdrive staples or staple flat cable on edge [3702.1] {334.30}
- Bends gradual (min 5× cable diameter) [3702.5] {334.24}
- Running board for small cable under joists **F47** [3702.4] {334.15C}

FIG. 48

NM (Romex)–Nonmetallic–Sheathed Cable



GLOSSARY OF ELECTRICAL TERMS

Accessible: Not permanently concealed or enclosed by building construction.

Accessible, as applied to equipment: Capable of being removed or exposed without damaging the building finish or structure. A piece of equipment can be considered accessible even if tools must be used or other equipment must be removed to gain access to it.

Accessible, readily: Capable of being reached quickly for operation or inspection without the necessity of using tools to remove covers, resorting to ladders, or removing other obstacles.

Alternating current (AC): Current that flows in one direction and then in the other in regular cycles; referred to as frequency or Hertz.

Apparent power: See *power*.

Approved: Acceptable to the AHJ. The AHJ will usually approve materials that are listed and labeled.

Arc fault: An electric current propagated through air.

AFCI, Arc-Fault Circuit Interrupter: Device intended to provide protection from the effects of arc faults by recognizing certain characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

AFCI, branch/feeder type: An AFCI meeting the standard for interrupting parallel arcs if 75A of current are available at the device.

AFCI, combination type: An AFCI meeting the standard for interrupting both series and parallel arcs, and requiring <math>< 75\text{A}</math> available current to facilitate operation.

Authority Having Jurisdiction (AHJ): The building official or person(s) authorized to act on his or her behalf.

Bonded, bonding: Connected to establish continuity and conductivity.

Branch circuit: The circuit conductors between the final OCPD (breaker or fuse) protecting the circuit and the outlet or outlets.

Branch circuit, general purpose: Branch circuit that supplies two or more receptacles or outlets for lighting and appliances.

Branch circuit, individual: Branch circuit supplying only one piece of equipment.

Branch circuit, multiwire, residential: Branch circuit consisting of two hot conductors having a 240V potential between them and a grounded neutral having a 120V difference between it and each hot conductor **F17**.

Branch circuit, small appliance: Branch circuit supplying portable household appliances in kitchens and related rooms and that has no permanently installed equipment connected to it (see **p. 18** for exceptions).

Clothes closet: A non-habitable room or space intended primarily for storage of garments and apparel **F37**.

Controller: A device to directly open and close power to a load.

Derating: A reduction in the allowable ampacity of conductors because of ambient temperatures >86°F or more than three current-carrying conductors in the same raceway, or cables without spacing between them.

Device: A piece of equipment that carries or controls electrical energy as its primary function, such as a switch, receptacle, or circuit breaker.

Equipment: A general term including materials, fittings, devices, appliances, luminaires (fixtures), apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation.

Equipment Grounding Conductor (EGC): A wire or conductive path that limits voltage on metal surfaces and provides a path for fault currents **F16**.

Flexibility after installation: Anticipated movement after initial installation, such as that caused by motor vibration or equipment repositioning.

Feeders: Conductors supplying panelboards other than service panels.

Gooseneck: A curve at the top of a service entrance cable designed to prevent water from entering the open end of the cable.

Ground: The Earth.

Grounded conductor: A current-carrying conductor that is intentionally connected to earth (a neutral).

- Grounding electrode conductor (GEC):** A conductor used to connect the service neutral or the equipment to a grounding electrode or to a point on the grounding electrode system **F6**.
- Ground fault:** An unintentional connection of a current-carrying conductor to equipment or conductors that are not normally intended to carry current.
- GFCI:** A device to protect against shock hazards by interrupting current when an imbalance of 6 milliamps or more is detected.
- GFPE:** A device to protect equipment from ground faults and allowing higher levels of leakage current than a GFCI.
- Hertz:** A measure of the frequency of AC. In North America, the standard frequency is 60 Hertz.
- Individual branch circuit:** A circuit supplying only one piece of utilization equipment.
- In sight:** See *within sight*.
- Load:** The electrical demand of a piece of electrical equipment measured in amps or watts.
- Lighting outlet:** An outlet intended for the direct connection of a lampholder or a luminaire.
- Location, damp:** An area protected from weather, yet subject to moderate degrees of moisture, such as a covered porch.
- Location, dry:** A location not normally subject to dampness or wetness.
- Location, wet:** All installations underground or in concrete or masonry in direct contact with the earth and areas subject to direct saturation with rain water or other liquids.
- Luminaire:** (formerly lighting fixture) A complete lighting unit, including parts to connect it to the power supply and possibly parts to protect or distribute the light source. A lampholder, such as a porcelain socket, is not itself a luminaire.
- Neutral conductor:** The conductor connected to the neutral point of a system that is intended to carry current under normal conditions **F17**.
- Open conductors:** Individual conductors not contained within a raceway or cable sheathing, such as a typical service drop.
- Outlet:** The point on a wiring system at which current is taken to supply equipment. A receptacle or a box for a lighting fixture is an outlet; a switch is not an outlet.
- Overcurrent:** Any current in excess of the rating of equipment or conductor insulation. Overcurrents are produced by overloads, ground faults, or short circuits.
- Overfusing:** A fuse or breaker that has an overload rating greater than allowed for the conductor it is protecting.
- Overload:** Equipment drawing current in excess of the equipment or conductor rating and in such a manner that damage would occur if it continued for a sufficient length of time. Short circuits and ground faults are not overloads.
- Panelboards:** The "guts" of an electrical panel; the assembly of bus bars, terminal bars, etc., designed to be placed in a "cabinet." What is commonly called an electrical panel or load center is, by NEC terms, a panelboard mounted in a cabinet **F16**.
- Power:** Electrical power is the product of volts times amps and can be expressed as either watts (true power) or VA (apparent power).
- Service:** The conductors and equipment providing a connection to the utility **F2**.
- Service drop:** The overhead conductors supplied by the utility **F2**.
- Service entrance conductors:** The conductors on the customer's premises that convey power to the service equipment.
- Service equipment:** The equipment at which the power conductors entering the building can be switched off to disconnect the premises' wiring from the utility power source. A meter can be a part of or separate from the service equipment.
- Service lateral:** Underground service entrance conductors.
- Service point:** The connection or splice point at which the service drop and service entrance meet—it is the handoff between the utility and the customer.
- Short circuit:** A direct connection of current-carrying conductors without the interposition of a load, resulting in high levels of current.
- Short circuit rating (SCR):** The amount of current that a piece of equipment (such as a breaker or switch) is rated to sustain without damage.
- Snap switch:** A typical wall switch, including 3-way and 4-way switches.
- Ufer:** A concrete-encased grounding electrode, named after the developer of the system, Herbert Ufer **F6**.
- Unit switch:** A switch that is an integral part of an appliance.
- Within sight:** (also written as "in sight") Visible, unobstructed, and not more than 50 ft. away.

OHM'S LAW

The rate of the flow of the current is equal to electromotive force divided by resistance.

I = Intensity of Current = Amperes

E = Electromotive Force = Volts

R = Resistance = Ohms

P = Power = Watts

The three basic Ohm's law formulas are:

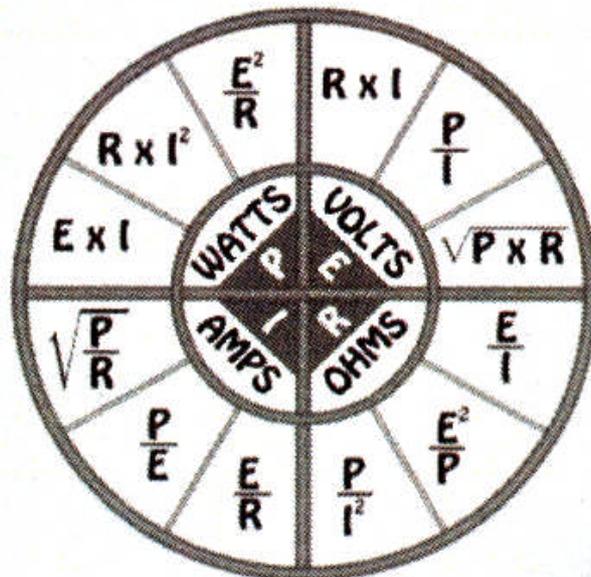
$$I = \frac{E}{R}$$

$$R = \frac{E}{I}$$

$$E = I \times R$$

Below is a chart containing the formulas related to Ohm's law.

To use the chart, from the center circle, select the value you need to find, I (Amps), R (Ohms), E (Volts) or P (Watts). Then select the formula containing the values you know from the corresponding chart quadrant.



Example:

An electric appliance is rated at 1200 Watts, and is connected to 120 Volts. How much current will it draw?

$$\text{Amperes} = \frac{\text{Watts}}{\text{Volts}} \quad I = \frac{P}{E} \quad I = \frac{1200}{120} = 10 \text{ A}$$

What is the Resistance of the same appliance?

$$\text{Ohms} = \frac{\text{Volts}}{\text{Amperes}} \quad R = \frac{E}{I} \quad R = \frac{120}{10} = 12 \Omega$$

OHM'S LAW

In the preceding example, we know the following values:

$$I = \text{amps} = 10$$

$$R = \text{ohms} = 12\Omega$$

$$E = \text{volts} = 120$$

$$P = \text{watts} = 1200$$

We can now see how the twelve formulas in the Ohm's Law chart can be applied.

$$\text{AMPS} = \sqrt{\frac{\text{WATTS}}{\text{OHMS}}}$$

$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{1200}{12}} = \sqrt{100} = 10A$$

$$\text{AMPS} = \frac{\text{WATTS}}{\text{VOLTS}}$$

$$I = \frac{P}{E} = \frac{1200}{120} = 10A$$

$$\text{AMPS} = \frac{\text{VOLTS}}{\text{OHMS}}$$

$$I = \frac{E}{R} = \frac{120}{12} = 10A$$

$$\text{WATTS} = \frac{\text{VOLTS}^2}{\text{OHMS}}$$

$$P = \frac{E^2}{R} = \frac{120^2}{12} = \frac{14,400}{12} = 1200W$$

$$\text{WATTS} = \text{VOLTS} \times \text{AMPS} \quad P = E \times I = 120 \times 10 = 1200W$$

$$\text{WATTS} = \text{AMPS}^2 \times \text{OHMS} \quad P = I^2 \times R = 100 \times 12 = 1200W$$

$$\text{VOLTS} = \sqrt{\text{WATTS} \times \text{OHMS}} \quad E = \sqrt{P \times R} = \sqrt{1200 \times 12} = \sqrt{14,400} = 120V$$

$$\text{VOLTS} = \text{AMPS} \times \text{OHMS} \quad E = I \times R = 10 \times 12 = 120V$$

$$\text{VOLTS} = \frac{\text{WATTS}}{\text{AMPS}}$$

$$E = \frac{P}{I} = \frac{1200}{10} = 120V$$

$$\text{OHMS} = \frac{\text{VOLTS}^2}{\text{WATTS}}$$

$$R = \frac{E^2}{P} = \frac{120^2}{1,200} = \frac{14,400}{1,200} = 12\Omega$$

$$\text{OHMS} = \frac{\text{WATTS}}{\text{AMPS}^2}$$

$$R = \frac{P}{I^2} = \frac{1200}{100} = 12\Omega$$

$$\text{OHMS} = \frac{\text{VOLTS}}{\text{AMPS}}$$

$$R = \frac{E}{I} = \frac{120}{10} = 12\Omega$$

