



HOMEOWNER’S WIRING GUIDELINE 2020

THIS IS GENERAL INFORMATION ONLY

Effective March 1, 2021

In order to wire the home you own and reside in as your primary residence, you must comply with the requirements of the 2020 Edition of the National Electrical Code (NEC). The NEC is NOT intended as a design specification or an instruction manual for untrained persons. Its purpose is the practical safeguarding of persons and property from hazards arising from the use of electricity. This guideline is written to help the layperson comply with the NEC requirements for family dwelling units, and NOT inclusive of all requirements for every installation. Call your inspector if you have any questions.

Along with meeting NEC requirements, the permit and inspection's process defined in Colorado Revised Statutes must be followed. If your work does not meet the latest edition of the NEC or any other applicable code and is turned down by our electrical inspector, a re-inspection fee may be issued and must be paid to this office prior to your receiving the re-inspection.

RE-INSPECTION FEE POLICY

The following number of trips will be allowed before charging a re-inspection-fee:

Inspection	Number of Trips Allowed Before Re-inspection Fee is Charged
Rough-In	Two (2) Trips
Temporary Pole	One (1) Trip Only
Temporary Sticker	One (1) Trip Only
Final	Two (2) Trips
Manufactured Home	Two (2) Trips

Re-Inspection Fees:

\$50.⁰⁰ for the first Re-Inspection

\$100.⁰⁰ for each additional Re-Inspection on the same violation

GUIDELINES FOR WIRING SINGLE FAMILY DWELLING UNITS

I. SERVICE

The service equipment must be large enough to supply the connected load which is calculated using Article 220 of the NEC. The most common sizes of residential service equipment are 100, 125, 150, 175 and 200 amps. The minimum size wires for service entrance conductors are listed below:

THREE WIRE, SINGLE PHASE DWELLING SERVICES
Conductor Types and Sizes
RH-RHH-RHW-THHW-THW-THWN-THHN-XHHW-USE

COPPER AWG	ALUMINUM AND COPPER CLAD AL-AWG	SERVICE RATING IN AMPS
4	2	100
3	1	110
2	1/0	125
1	2/0	150
1/0	3/0	175
2/0	4/0	200
3/0	250 kcmil	225
4/0	300 kcmil	250
250 kcmil	350 kcmil	300
350 kcmil	500 kcmil	350
400 kcmil	600 kcmil	400

Use an aluminum anti-oxidant on all aluminum connections.

Wire that is to be buried must be suitable for underground, example U.S.E.

The service equipment must be grounded in accordance with Article 250 of the NEC, which in general, says that the neutral must be marked white or gray and must be bonded to the service enclosure and the grounding electrode system defined in 250.1 NEC. The nipple between the meter and the panel, if metal, must be grounded or bonded to the neutral and ground bar that are tied together. All dwelling units require an exterior emergency disconnect. Surge protection is required for new or replaced services for dwellings.

All service equipment and electrical panels must have a clear area thirty (30) inches wide, and thirty-six (36) inches deep in front. This clear area must extend from floor to ceiling with no intrusions from other equipment cabinets, counters, appliances, etc. The bond screw must be green in color. The main service equipment, the neutral and equipment grounding conductors are bonded together. In sub panels, the neutral is isolated from the ground. A water bond and service raceway nipple, if metal, must be bonded also and should be #6 copper for 100 amp and #4 copper for 200 amp. Intersystem Bond Terminals shall be listed for communication systems.

NOTE: The neutral shall be bonded only at the first point of service and an equipment grounding conductor shall be installed on all branch circuits and feeders.

New construction will require a concrete encased electrode consisting of not less than twenty (20) feet of ½ inch rebar or #4 or larger bare copper wire. This electrode must be encased in at least two (2) inches of concrete located within and near the bottom of the footer or foundation whichever is lower. In addition to this, Mesa County will still require the ground rod and all new construction requires gas piping to be bonded.

II. INTERSYSTEM BOND- BONDING FOR OTHER SYSTEMS

A ground bar or set of terminals that has space for three (3) or more wires shall be mounted on or at each building service and shall be external to the enclosure.

III. BRANCH CIRCUIT WIRING

Type NM cable (a.k.a. romex) is the most widely used wiring method in residential dwellings. NM cable must have a ninety (90) degree conductor insulation rating, which is designated on the cable sheath by the letter "B," Type N.M. - B. #12 and #14 is used for lighting and receptacle circuits, while #10/2 is used for electric water heaters, #10/3 for electric dryers, cook-tops need #8/3 and #6/3 for ranges and mounted wall ovens. Ranges and clothes dryers must be wired with four (4) wires. Four (4) conductor cables and receptacles must be used. These cables must be protected by over-current devices (circuit breakers) which do not exceed the rated amp capacities for cable types as listed below: (all cables must include an equipment grounding conductor)].

<u>COPPER NM CABLE</u>	<u>TYPE S.E.R. ALUMINUM CABLE</u>
15 amps for #14	30 amps for #8
20 amps for # I 2	40 amps for #6
30 amps for #10	60 amps for #4
40 amps for #8	70 amps for #3
60 amps for #6	80 amps for #2
70 amps for #4 copper	Use aluminum anti-oxidant on all aluminum connections.

It is important to note that if you begin a circuit with #12, you must use this same wire size throughout, you CANNOT mix different wire sizes on the same branch circuit.

Type NM cable must be stapled within twelve (12) inches of metal boxes, eight (8) inches of plastic boxes and every 4 ½ feet thereafter. Proper connectors must be used where NM cable enters metal cabinets, boxes or panel boards.

When Type NM cable is installed to framing members, it shall be located at least 1 ¼ inches from the nearest edge of the framing member where nails or screws may penetrate the cable. If this distance cannot be maintained, the cable shall be protected by a steel plate or sleeve at least 1/16 inch thick.

All ceiling mounted lighting outlet boxes shall be fan rated.

IV. REQUIRED BRANCH CIRCUITS

- A. Small Appliance Branch Circuits - The NEC requires a minimum of two (2), 20 amp branch circuits to feed receptacle outlets for small appliance loads, including refrigeration equipment in the kitchen, pantry, breakfast room, and dining room. These circuits, whether two or more shall NOT feed anything other than receptacles in these areas. Only six (6) outlets are allowed on each circuit. Lighting outlets and built-in appliances such as garbage disposal, range hoods, microwave, dishwashers, and trash compactors are NOT permitted on these circuits. Counter top receptacles shall not be used for general wall space requirements.
- B. Laundry Branch Circuit – One (1), 20 amp branch circuit must be provided for the laundry. This circuit is limited to receptacles within the laundry room. No other outlets or lights are permitted on this circuit.
- C. General lighting branch circuits may be wired in # 14 on a 15 amp breaker with ten (10) devices per circuit, 20 amp branch circuit using #12 wire are allowed twelve (12) devices. These lights and receptacle outlets, are other than those covered in A and B above.
- D. Heating system shall have a separate circuit.

V. REQUIRED RECEPTACLE OUTLETS

- A. One (1) bathroom receptacle adjacent and within three (3) feet of each basin. All bathroom receptacles shall meet the requirements of #1 or #2 below.
 - 1. The basin receptacle is required to be a 20 amp branch circuit with no other plugs, except other bathroom receptacles.
 - 2. A bathroom may be all on a single circuit by itself lights, exhaust fan, and receptacles provided that everything in that bathroom is on the required 20 amp branch circuit. Receptacle shall not be installed within three (3) feet horizontally or eight (8) feet vertically from the top of the tub rim or shower threshold.
- B. At least one (1) receptacle in every attached or detached garage and accessory building with electric power. Install one receptacle for each car space, in addition to the number of branch circuits required at least one 120-volt, 20 amp branch circuit shall be installed to supply receptacles outlets in the garage. This circuit shall have no other outlets except to supply readily accessible outdoor receptacle outlets.
- C. One receptacle installed outdoors at the back and front of dwellings. Both receptacles shall be accessible at grade level and not more than 6 ½ feet above grade.
- D. At least one receptacle shall be installed within the perimeter of a balcony, porch, or deck that is accessible from inside the dwelling.

- E. At least one receptacle must be installed in each unfinished area of a basement. This receptacle is in addition to any that may be installed for laundry and finished areas or other specific purposes.
- F. In every family room, dining room, living room, parlor, library, den, sun room, bedroom, recreation room, or similar room or area of dwelling units, receptacle outlets shall be installed so that no point along the floor line in any wall space is more than six (6) feet measured from an outlet in that space, including any wall space, two (2) feet or more in width, and excluding only that space afforded by fixed dividers, such as freestanding bar-type counters, shall be included in the six (6) foot measurement. No outlet may be installed over an electric baseboard heater.
- G. In kitchens and dining rooms, a receptacle outlet shall be installed to serve each counter space wider than twelve (12) inches. Receptacles shall be installed so that no point along the wall line is more than twenty-four (24) inches measured horizontally from a receptacle outlet in that space. Islands twelve (12) inches or wider shall have at least one receptacle for the first nine (9) square feet of counter top work surface. An additional receptacle will be required for every additional eighteen (18) square feet. Required receptacles shall not be inside of an appliance garage. Counter top receptacles do not count as required wall space receptacles. Peninsulas will require one receptacle within the outer two (2) feet of counter top. Required receptacles shall not be inside of an appliance garage.
- H. Receptacles installed in the floor must be a box/ receptacle combination designed specifically for that purpose. Receptacles installed in the floor within eighteen (18) inches of the walls may be used in place of the wall mounted receptacles.
- I. A receptacle outlet is required in any dwelling unit hallway that is ten (10) feet or more in length.
- J. Garbage disposal, dishwashers, trash compactors and large microwaves need to be on a separate circuit. Built in dishwasher shall be permitted to be cord & plug connected with a flexible cord not longer than 6 ¼ feet, to an accessible receptacle located in a location adjacent to the dishwasher.

VI. TAMPER-RESISTANT RECEPTACLES

All 15 amp and 20 amp receptacles located 5 ½ foot or lower in a dwelling unit and associated buildings shall be listed tamper-resistant.

VII. REQUIRED LIGHTING OUTLETS

- A. At least one wall switch-controlled lighting outlet or light shall be installed in every habitable room: bathroom, hallways, stairways, attached garages, detached garages with electric power, and at outdoor entrances and exits. The lighting outlet for interior stairways shall have a wall switch at each floor level where the difference between floor levels is six

(6) steps or more.

- B. At least one wall switch controlled light shall be installed in an attic, under floor space, utility room and basement, where these spaces are used for storage or contain equipment requiring servicing. The switch shall be located at the point of entry to these areas and provide illumination to all equipment.
- C. All light fixtures and lamps must be (UL) approved for their location and use.
- D. A grounded (neutral) conductor shall be installed in the switch location providing power to a lighting load.

VIII. GROUND FAULT PROTECTION

All 120 volt through 250 volt receptacles listed below must be protected by a ground fault circuit interrupter. All ground fault circuit interrupter devices must be located in a readily accessible location.

- A. Basements.
- B. Sheds.
- C. Garage and accessory buildings.
- D. All receptacles in a crawl space at or below grade. Crawl space lighting outlets not exceeding 120 volt shall be GFI protected.
- E. Bathroom receptacles.
- F. All outdoor receptacles.
- G. Kitchen receptacles that serve counter tops.
- H. All temporary construction power.
- I. Laundry areas.
- J. Where the receptacles are within six (6) feet of the outside edge of a sink, bathtub, or shower stall.
- K. Kitchen dishwasher.

NOTE: 15 amp and 20 amp, 125 and 250 volt receptacles in wet locations shall have in- use covers and damp or wet location receptacles shall be listed weather resistant.

IX. ARC FAULT CIRCUIT INTERRUPTER

All 120-volt, single phase, 15 amp and 20 amp branch circuits supplying outlets installed in dwelling units except bathrooms and garages shall be protected by a listed arc-fault circuit interrupter combination type. When an existing branch circuit is modified, replaced, or expanded AFCI's shall be installed. All AFCI devices shall be located in a readily accessible location.

X. CONDUCTOR FILL

Outlet and junction boxes shall be of sufficient size to provide free space for all conductors and devices enclosed in the box. All outlet boxes have a specific volume, measured in cubic inches. (See Table 314.16 (A) and 314.16 (B)).

Conductor, Device or Type of Fitting	
Each conductor originating outside and terminating or spliced inside box	1
Each conductor passing through unbroken	1
Conductors that do not leave box	0
Not more than four (4), #16 or smaller fixture wires plus ground from a canopy	0
Internal cable clamps (per type)	1
Support Fittings (fixture studs or hickey (per type))	1
A device or equipment yoke (e.g. switch, receptacles)	2
Equipment grounding conductors (4)	1
Additional Equipment Grounding Conductors	¹ / ₄

No allowance is required for small fittings like locknuts and bushings.

Refer to following charts for sizing boxes.

Volume Required per Conductor	
Size of a Conductor	Free Space within Box for Each Conductor
No. 18	1.5 Cubic Inches
No. 16	1.75 Cubic Inches
No. 14	2.0 Cubic Inches
No. 12	2.25 Cubic Inches
No. 10	2.5 Cubic Inches
No. 8	3.0 Cubic Inches
No. 6	5.0 Cubic Inches

XI. SMOKE ALARMS AND CARBON MONOXIDE ALARMS

A. Smoke Alarms

1. Where Required

- a. Smoke alarms shall be provided in all new dwelling units.
- b. Where alterations, repairs or additions requiring a permit occur, the individual dwelling unit shall be equipped with smoke alarms located as required for new dwellings.
 - i. Exception: Work involving exterior surfaces of dwellings, such as the replacement of roofing or siding, the addition or replacement of windows or doors, or the addition of a porch or deck.
 - ii. Exception: Installation, alteration or repairs of plumbing or mechanical systems.

2. Smoke Alarms shall be installed in the following locations:

- a. In each sleeping rooms.

- b. Outside of each separate sleeping area in the immediate vicinity of the bedrooms.
 - c. On each additional *story* of the *dwelling*, including *basements* and *habitable attics* and not including crawl spaces and uninhabitable *attics*. In *dwelling*s or *dwelling*s units with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full *story* below the upper level.
 - d. Smoke alarms shall be installed not less than three (3) feet horizontally from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by this section.
 - e. Smoke alarms shall not be installed in the following locations unless this would prevent placement of a smoke alarm in a location identified above:
 - i. Ionization smoke alarms shall not be installed less than twenty (20) feet from a horizontally from a permanent installed cooking appliance.
 - ii. Ionization smoke alarms with an alarm-silencing switch shall not be installed less than ten (10) feet from a horizontally from a permanent installed cooking appliance.
 - iii. Photoelectric smoke alarms shall not be installed less than six (6) feet horizontally from a permanent installed cooking appliance.
3. Interconnection. When more than one smoke alarm is required to be installed within an individual *dwelling unit* the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the *dwelling* unit. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and alarms sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.
 4. Combination Alarms. Combination smoke and carbon monoxide alarms shall be permitted to be used in lieu of smoke alarms.
 5. Power Source. Smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and, where primary power is interrupted shall receive power from a battery. Wiring shall be permanent and without disconnecting switch other than those required for overcurrent protection.
 6. Fire Alarm Systems. Fire alarm systems shall be permitted in lieu of smoke alarms and shall comply with section R314.7.1 through R314.7.4.

All smoke alarms shall be listed and installed in accordance with the provisions of this code and the household fire warning equipment provisions of NFPA 72.

B. CARBON MONOXIDE ALARMS. Colorado State Law and the 2018 IRC requires carbon monoxide alarms.

1. Where Required

- a. Carbon monoxide alarms shall be provided in all new dwelling units where either a dwelling unit contains a fire-fueled appliance and/or the dwelling unit has an attached garage with an opening that communicates with the dwelling unit.
- b. Where alterations, repairs or additions requiring a permit occur, the individual dwelling unit shall be equipped with carbon monoxide alarms located as required for new dwellings.
 - i. Exception: Work involving exterior surfaces of dwellings, such as the replacement of roofing or siding, the addition or replacement of windows or doors, or the addition of a porch or deck.
 - ii. Exception: Installation, alteration or repairs of non-fuel fired plumbing or mechanical systems.

2. Carbon monoxide alarms shall be installed in the following locations:

- a. Outside of each separate sleeping area in the immediate vicinity of the bedrooms not to exceed fifteen (15) feet.
- b. Where a fuel-burning appliance is located within a bedroom or its attached bathroom, a carbon monoxide alarm shall be installed within the bedroom.

3. Combination Alarms. Combination smoke and carbon monoxide alarms shall be permitted to be used in lieu of carbon monoxide alarms.

4. Interconnectivity. When more than one carbon monoxide alarm is required to be installed within an individual *dwelling unit* in accordance with R315.3 the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the *dwelling unit*. Physical interconnection of carbon monoxide alarms shall not be required where *listed* wireless alarms are installed and alarms sound upon activation of one alarm.

- a. Exception: Interconnection of carbon monoxide alarms in existing areas shall not be required where alterations or finishes exposing the structure, unless there is an attic, crawl space or basement available that could provide access for interconnection without the removal of interior finishes.

5. Power Source. Carbon monoxide alarms shall receive their primary power from the

building wiring where such wiring is served from a commercial source and, where primary power is interrupted shall receive power from a battery. Wiring shall be permanent and without disconnecting switch other than those required for overcurrent protection.

- a. Exception: Carbon monoxide alarms shall be permitted to be battery operated where installed in buildings without commercial power.
- b. Exception: Carbon monoxide alarms installed in accordance with Section R315.2.2 shall be permitted to be battery powered.

- 6. Carbon Monoxide Detection Systems. Carbon monoxide detections systems shall be permitted in lieu of carbon monoxide alarms and shall comply with section R315.7.1 through R315.7.4.

XII. EQUIPMENT GROUNDING CONDUCTOR MAKE UP

All equipment grounding conductors must be connected together with solderless pressure connectors such as wire nuts or crimp sleeves, leaving sufficient extra conductor for attachment to the metal box and/or devices. Please note that ALL metal junction and outlet boxes must be grounded by attaching the equipment grounding conductor out of the NM cable to the metal box using an approved green screw or grounding clip. Sheet metal screws are not allowed.

XIII. ELECTRIC HEAT CIRCUITRY

Electric heat may be installed on 15 amp, 20 amp, or 30 amp branch circuits. Listed below is the maximum wattage that may be installed on each size branch circuit. All circuits are figured at 240 volts.

Maximum	15A - 2,880 Watts
Maximum	20A - 3,840 Watts
Maximum	30A - 5,760 Watts

XIV. DETACHED GARAGES OR OUT BUILDINGS

If there is only one circuit, a snap switch may be used as a disconnect. For out buildings that are not a garage, one circuit installation is permitted with a snap switch for a disconnect.

A garage requires two (2) circuits minimum. For two or more circuits, a panel is needed with a minimum of a 60 amp service. For more than six (6) breakers a main will be required. A breaker of the same amperage will go in the "house" panel- two (2) hot wires, a neutral and ground are run to the out building where a panel with main breaker and ground rod are placed. The circuits for the garage will come out of this panel.

The garage must have a light inside and a light outside of each "walk" door and a 110 volt, 20 amp receptacle for each parking space.

XV. AG BUILDINGS

Housing livestock will require equipotential bonding. Please pay attention to Article National Electrical Code #547 for electrical requirements, before building or pouring any concrete.

XVI. ROUGH-IN INSPECTION

At the time you call for your rough-in inspection, you must have all wire pulled, stapled and all splices made up and ready to accept devices and fixtures. Please DO NOT install any devices or fixtures or cover wiring with insulation or wall cover, i.e., drywall or paneling. All wires must extend at least six (6) inches past the front of the box.

XVII. TEMPORARY SERVICE

You may call for a temporary service inspection when the following items are complete: Your panel and meter housing are installed and wired, the ground rod is driven in place and hooked up, a GFCI receptacle is installed and a 20 amp breaker installed on the laundry circuit. The department will inspect the service, if approved a green tag will be issued. After approval is given the power supplier may be called and service will be allowed prior to your final electrical inspection. Conductors and cables exposed to direct rays of the sun shall be listed or marked "Sunlight Resistant".

XVIII. UNDERGROUND

Wire that is to be installed underground must be inspected before it is covered.

XIX. UNDERGROUND SERVICE LATERALS

All service laterals must be inspected before they are covered.

- A. When conductors are in bottom of a twenty-four (24) inch minimum trench.
- B. With warning ribbon to be installed twelve (12) inches over the cable.

XX. FINAL INSPECTIONS

The electrical installation should be complete at the time of request. All devices and fixtures installed service equipment complete and labeled properly. All wiring shall be free from shorts, ground faults and open circuits. All light fixtures are required to be grounded along with light switches and receptacles.