

ELECTRICAL GUIDELINES FOR RESIDENTIAL USE

IMPORTANT:

Before beginning any construction, contact your energy provider to make an application for electric service. There may be utility requirements such as meter location, distance from existing utility lines, and other requirements that will impact your construction.

The Present electrical code for 1 & 2 Family dwellings is the 2015 Michigan Residential Code (MRC).

Residential services are to be 100 amp Minimum.

All residential installations such as stand-by generators, outdoor wood boilers or any installation not covered by the 2015 MRC will be subject to the 2023 Michigan Electrical Code Part 8.

Emergency Disconnects will be required for residential services.

The disconnect must be mounted either on the outside of the home or within 50 feet of the home. This disconnect must be labeled as the "emergency disconnect" with a label or plaque that is weather-resistant. The Letters on this label are to be a minimum of ½ in. in height.

All services are required to have a Surge protective Device. The Surge protective Device can be installed in a downstream sub-panel.

Service Equipment.

The "**Service Disconnect**" is the main breaker or fuse in the Emergency Disconnect.

The neutral in the Emergency Disconnect must be bonded to the service enclosure and the grounding electrode system with the manufacturers supplied **Green** Bonding screw or jumper.

All other panels fed from the emergency panel are sub-panels and are fed with a 4-wire feeder. In most cases a ground buss must be installed in a sub-panel and **ALL** ground wires are to be terminated in this buss. The neutral in sub-panels is NOT bonded to the enclosure in a sub-panel.

The Service Mast is to be minimum 2in. rigid conduit or 2in. intermediate rigid conduit. EMT is not approved as a mast.

Service Conductor size for overhead services and feeders to separate buildings.

#4 AWG copper or #2 AWG Aluminum for 100 Amp services.

#2/0 AWG copper or # 4/0 Aluminum for 200 AMP services.

Conductors used for feeders in underground or wet locations, such as buildings like pole barns, detached garages or other outbuildings, are to be listed for direct burial in earth.

Some of the most common conductor and cable types allowed to be buried are: **UF** (underground Feeder), **USE** (underground service entrance), and **URD** (underground residential distribution). All underground Service cables are required to be buried at least 24 inches below grade. Underground installations are to be inspected prior to being covered. **Type SE (service entrance) cable is Not allowed to be buried.**

Underground Feeders to detached buildings are to be 4-wire, 2- ungrounded (HOT), 1 neutral and 1 Equipment ground.

When installing underground feeders to accessory buildings, such as, pole buildings or detached garages, be aware that **when the cables are in PVC conduit for their entire length**, an EXPANSION fitting will be required where the PVC conduit exits the ground to compensate for frost heave or structure movement.

All service equipment and electrical panels shall have a clear area 30" wide and 36" deep in front. This clear area must extend from floor to finished ceiling with no intrusions from other equipment, cabinets, counters, appliances, pipes, sump pump pits, etc. Electrical Panels are **NOT** allowed in clothes closets, bathrooms or over stairs.

Illumination around the service panel is required and may **not** be controlled by automatic means such as a photoelectric switch or timer.

Service Grounding Electrode.

2 – 8 ft ground rods, located at least 6 ft apart, are required for most services and detached outbuildings, such as pole barns with electrical panels.

Ground rods are to be driven to below grade.

Grounding rod clamps must be listed for DIRECT BURIAL.

One Example of a listed ground rod clamp:



Size # 8 AWG grounding electrode conductors are to be protected with a raceway. The grounding electrode conductor is not to be spliced.

Metallic water piping is to be bonded to the grounding system in the service panel.

A "Concrete encased electrode" (Ufer Ground) does not require an additional electrode. 20 ft of connected re-bar in footing is a Ufer ground. **Must** be inspected before concrete is poured.

The grounding electrode system should not be confused with the Equipment Ground, which serves a different purpose. The equipment ground (example: the bare wire found in NM cable along with the insulated conductors) carries the short circuit current and facilitates opening of the overcurrent device in the event of a short circuit.

An Intersystem Bonding Termination Device is required.

Typical intersystem bonding device



This is for grounding other utility equipment such as cable and telephone. Usually installed on the grounding electrode conductor before the ground rod.

CSST bonding clamp location

CSST Corrugated Stainless steel tubing used for gas piping shall be bonded to the ground buss in the service panel with a #6 AWG copper wire no longer than 75 feet long. **The CSST manufacturer's installation instructions provide instructions for bonding.**

This bond helps protect against damage from external electrical sources such as lightning strikes. CSST has a history of lightning causing holes in the exposed metal tubing and allowing gas to escape. Proper installation of CSST is very important and each manufacturer has instructions for installing CSST.

Required Circuits

Each house is different with respect to the electrical requirements. Some of the Residential electrical systems circuits that will be required to be installed in most houses are:

- 1. General purpose lighting and outlets circuit – depends on size of the home.*
- 2. Kitchen countertop outlets circuit- 2 @ 20 amps ea.*
- 3. Laundry circuit- 1 @ 20amps ea.*
- 4. Bathroom circuit- 1 @ 20amps ea.*
- 5. Garage circuit- 1 @ 15amp or 20amps. For inside garage only.*
- 6. Heating (gas Furnace)- 1 @ 15 or 20 amps*
- 7. Air conditioning- 1 @ 30 amps*
- 8. Electric stove/ovens- 1@ 40 or 50 amps*
- 9. Dishwasher/ garbage disposal. - 1 @ 20 amps*

Each of these circuits has voltage and current requirements along with Ground fault protection for some.

(At present, AFCI protection is not required for 1 & 2 family homes.)

Use # 14AWG NM cable for 15-amp circuits and # 12AWG NM cable for 20-amp circuits. **Do not mix wire sizes in a circuit.**

General purpose lighting and outlets circuit

Tamper-resistant receptacles, including GFI receptacles, are required in most areas in the home including the attached garage. Garage receptacles are to be GFCI protected

To determine the number of general lighting and outlet circuits that would be required, multiply the total square footage of the home by 3 and divide by 120.

*Example: 1500 sq. ft X 3W = 4500W, 4500/120V=38A, resulting in 3-**15amp** or 2-**20amp** circuits for **general lighting and outlets**. This is a **minimum** requirement.*

There is no restriction as to the number of outlets on a circuit in 1-family dwellings.

For most areas of a house, receptacles must be no more than 12 feet apart and no more than 6 feet from a door or entryway - IE, every point on almost all walls should be no farther than 6 horizontal feet, measured along the wall, from a receptacle. The wall spaces formed by fixed room dividers, such as freestanding counters, or railings, are included in the six-foot measurement. Receptacles installed in the floor within 18" of the walls may be used in place of wall-mounted receptacles. Receptacles installed in the floor must use a box-receptacle combination designed specifically for that purpose. Every hallway over 10 feet long must have at least one receptacle.

Kitchen countertop outlets circuit

Kitchen counter top receptacles must be supplied by at least **two 20-amp** small appliance branch circuits. The **two 20-ampere** branch circuits feed only receptacle outlets for small appliance loads, including refrigeration equipment and outlets in the kitchen, pantry, breakfast room, and dining room. Additional circuits may be installed if desired.

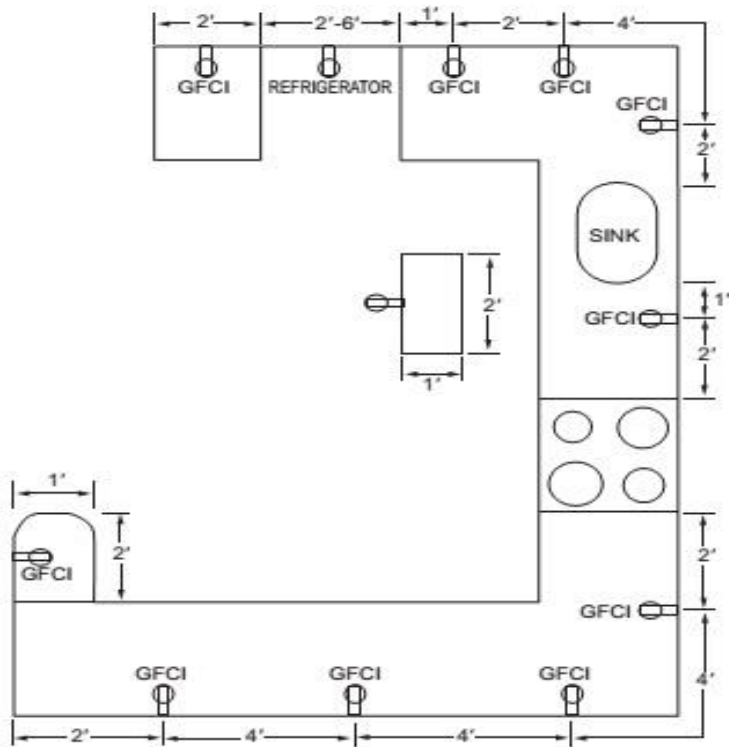
all **kitchen counter top outlets** are to be **GFI** protected. These circuits, whether two or more are used, shall NOT supply anything other than receptacles in these areas. Lighting outlets and built-in appliances such as garbage disposals, hood fans, dishwashers, and trash compactors are NOT permitted on these circuits.

Lighting outlets in the kitchen, dining room and other areas associated with the kitchen may not be connected to the small appliance circuits.

Some microwave ovens require a dedicated circuit. Consult the microwave manufacturer's installation instructions for electrical requirements.

In the kitchen and eating areas every counter space wider than **12"** must have a **GFI** protected outlet. Peninsular bars and islands 12" or wider shall have at least one receptacle. Countertop receptacles shall be installed so that no point along the wall is more than 24" measured horizontally from a receptacle outlet in that space.

All outlets within 6 feet from the outside edge of a sink shall be **GFI** protected. This includes outlets under the sink.



Branch Circuits

As a general rule all 240-volt appliances such as ranges, electric dryers, and electric water heaters must be on their own Branch circuit. Most electric water heaters and electric dryers require a 30amp/240 Volt circuit. Electric ranges usually require either a 40- or 50-amp/240-volt circuit. The circuit requirements are in the manufacturer's installation instructions. Ranges and electric dryers must have a 4-wire supply.

Dishwasher outlets may not be in the space behind the dishwasher as the outlet must be readily accessible. Generally, this outlet is in the under-sink cabinet. GFI protection is required for outlets supplying power to dishwashers. In some cases, the dishwasher and garbage disposal are allowed on the same circuit. **The manufacturer's installation instructions are to be available for the inspector.**

Garbage disposal- The circuit requirements are in the manufacturer's installation instructions. A separate 15 or 20-amp circuit is usually required. In some cases, the dishwasher and garbage disposal are allowed on the same circuit. **The manufacturer's instructions are to be available for the inspector.**

Furnace- The circuit requirements are in the manufacturer's installation instructions. A separate 15 or 20-amp circuit is usually required. **The manufacturer's instructions are to be available to the inspector.**

Laundry circuit

One 20-amp branch circuit must be provided for the laundry. This circuit is limited to receptacles within the laundry room. No other outlets are permitted on this circuit. Receptacles in the laundry room be **GFI** protected.

Bathroom circuit

At least one 20-amp circuit for bathroom receptacles. This circuit may supply **receptacles** in other bathrooms but no other equipment such as fans, heaters and lighting outlets in other bathrooms. Where a 20-ampere circuit supplies a single bathroom, outlets for other equipment, such as an exhaust fan/heater unit, within the same bathroom shall be permitted to be supplied by this circuit. The **GFI** protected outlet is to be within 36 inches of the outside edge of the lavatory basin. This circuit shall NOT be used to supply a major fixture such as a whirlpool or hot tub. See the tub manufacturer's installation instructions for electrical requirements.

Outlets located within 6 feet of a bathtub or shower stall are to be **GFI** protected. At least one 15 or 20-amp, 120-volt GFCI protected receptacle must be installed at an indoor spa or hot tub location - not closer than five feet from the inside wall of the unit and not more than ten feet away from it. Light fixtures, outlets and ceiling fans over spas and hot tubs shall be a minimum of 7'6" above the maximum water level.

Attached Garage circuit

The branch circuit supplying the receptacles in the attached garage shall be a 20amp circuit. Not less than one outlet shall be installed for **each** motor vehicle space. Most outlets in the garage are to be **GFI** protected. An outlet on the outside of the garage is permitted to be on the garage circuit.

Basements

Unfinished basements must have at least one receptacle, and all outlets must be **GFI** protected. At least one receptacle must be installed in **each unfinished portion of a basement**. This receptacle is in addition to any receptacles that may be installed for laundry or other specific purposes. Finished areas of basements, with floor coverings are do not require GFI protection.

Detached Garages, Accessory buildings and pole buildings

Detached garages, accessory buildings and pole buildings with electric power are required to have at least one GFI protected outlet, a switched light on the outside near the personal entrance door and a switched light that illuminates the service panel. Generally, all outlets below 8 ft from floor are to be GFI protected.

Required Ground Fault Protection

A ground fault circuit interrupter must protect ALL receptacles listed below:

- Bathroom receptacles.
- Outdoor receptacles.
- Garage receptacles.
- Kitchen receptacles that serve counter top surfaces
- Counter top receptacles within 6 feet of a wet bar sink.
- All receptacles in an unfinished basement.
- Sump pumps.
- Crawl spaces at or below grade.
- Spas, Hydro massage, Hot tubs and associated electrical components.
- Dishwasher circuits.
- Laundry circuits.

There must be at least two General purpose **GFI** outlets on the outside of the house located on the front and the back of the house. An outlet also must be within 25 feet of air conditioning equipment on the outside. All exterior plugs must be **GFI** protected. Outdoor outlets installed in wet locations shall be listed as "weather resistant". Outlet box hoods are to be listed and identified as "Extra Duty".

An accessible 15 or 20-amp **GFI** protected outlet must be within 25 feet of all HVAC equipment.

Hot tubs, garden tubs, Jacuzzis and the like must be **GFI** protected and wired as required for the particular model. The circuit requirements are in the manufacturer's installation instructions. **The manufacturer's instructions are to be available to the inspector.** The equipment, such as the pump motor and outlet under a hot tub or garden tub must be accessible after the final finish is complete. Accessible means without removing any of the finished surface. Removable panels or access from below or from a removable panel in an adjacent wall are some of the ways to access the equipment. The outlet must be located so there is easy and unobstructed access to the outlet.

Disconnects are required in **sight** of the following equipment:

- Electric water heaters
- Well pump controllers
- HVAC equipment
- Spas and hot tubs
- Hydro massage bathtubs
- Appliances

Disconnects can include a circuit breaker in the main breaker panel, a sub panel circuit breaker, a cord that can be unplugged, dedicated switches that are current and voltage rated for the load, and other disconnect devices.

Required Light Fixtures

Every room, hallway, stair way, attached garage, and outdoor entrance must have at least one light fixture controlled by a wall switch. However, in most rooms other than kitchens and bathrooms, the wall switch may control one or more plugs into which lamps may be plugged instead of a ceiling or wall mounted fixture.

There must be at least one wall switch-controlled light in a utility room, attic, basement or under floor space used for storage or which contains equipment such as heat and air, water heaters, sump pumps, etc. which may ever require service. The switch must be located at the entry point to these areas.

Hallways and stairs with more than six steps require the lights to be controlled by a switch at each end.

In closets, fluorescent fixtures must have at least 6 inches of clearance away from shelves or storables. In a typical two-foot-deep (approx.) closet, the fixture will be mounted on the wall just over the door.

In summary, put a light in every room or large closet, outside of every exterior door, and under the floor and in the attic if there is electrical equipment in these spaces or if they are suitable for storage.

Switch the room lights at every door entering the room, switch a hall or stairway at both ends, and switch exterior lights at the doors which they service.

The number of luminaires on a single circuit is dependent on the calculated load of the circuit. The actual rule for this is to not exceed 80% of the calculated wattage capacity of the circuit. Wattage capacity of the circuit equals the amp rating of the breaker times the voltage (120). Example: a 15amp circuit X 120V = 1800 Watts, 20amp circuit X 120V = 2400Watts

For a typical 15-amp light circuit, add up all the maximum wattage of each fixture on a circuit and make sure that the total wattage is less than 80% of $15 \times 120 = 1800$. $1800 \times .8 = 1440$ watts max.

For a 20-amp circuit, $20 \times 120 = 2400$. $2400 \times .8 = 1920$ watts

Smoke Detectors

There must be a 120-volt with battery backup smoke detector on the ceiling, or on the wall close to the ceiling in the area outside of every bedroom, and inside of each bedroom. All smoke detectors must be tied together so that if one goes off, they all do.

When you are roughing in for smoke detectors daisy-chain them with 14-3 WG and the extra (red) wire will interconnect the system. Connect to a 15-amp circuit only when using 14-gauge wire.

Ceiling mounted paddle fans

weighing 35 pounds or less may be supported by outlet boxes identified for such use. Fans weighing more than 35 pounds must be supported independently of the box. Follow the manufacturer's installation instructions.

Electric Heat

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

15A - 2,880 watts maximum **15 X 240 = 3600watts** - (.80 X 3600 = **2880**)

20A - 3,840 watts maximum **20 X 240 = 4800 watts** - (.80 X 4800 = **3840**)

30A - 5,760 watts maximum **30 X 240 = 7200 watts** - (.80 x 7200 = **5760**)

For example, if you are installing baseboard heaters which are rated 250 watts a linear foot, you could install 15 feet on a 20-amp, 240-volt circuit. $250W \times 15 = 3,750$ watts.

Outlets may be installed over an electric baseboard heater provided the baseboard **manufacturer's installation instructions** allow for installation under electric outlets. The inspector may request that you provide these instructions.

Boxes in walls and ceilings

In noncombustible materials, such as sheetrock or concrete, tile or stone finishes, all switch, device and junction boxes may not be set back from the finished surface **not more than** $\frac{1}{4}$ in. Gaps around the edge of boxes are to be no more than $\frac{1}{8}$ in.

When installing switch and device boxes in kitchen and bathrooms where tile or other water-resistant surfaces is to be installed, determine what the thickness of the tile or other surface will be and mount the device or switch box so the front edge of the box is flush with the finished surface. There are adjustable device boxes made for this purpose.

Box Fill

Non-metallic 2in. X 4in. device and switch boxes generally are 3 sizes, 18 cu. in, 20.5 cu. in, and 22.5 cu. in. The cubic in. capacity is embossed or marked on the inside of each box. The procedure to calculate the needed box size: Determine how many cables are to be terminated in the box. (Each 2 wire NM cable, contains 3 conductors, a black, a white, and a bare ground). 2.25 cu. in. is required for each # 12 conductor and 2.00 cu.in. is required for #14AWG conductor.

There is also a volume requirement for the device that would be installed in the box such as an outlet or switch. This would equal the volume of 2 conductors of the largest size conductor in the box. All grounds count as only 1 conductor. **Metallic** boxes have similar requirements for box fill.

Example 1: 3- #12 NM cables in a 2in. X 4in. plastic outlet box.

- 6- #12 conductors (3 black, 3 white) = $2.25 \times 6 = 13.5$ cu. in.
- 1- # 12 ground = $2.25 \times 1 = 2.25$ cu. in.
- 1- Device @ 2 conductors = $2.25 \times 2 = 4.50$ cu. in.
- **Total** = **20.25 cu. In. box volume required**

Example 2: 3-#14-3 wire NM cables with ground to a 3-gang switch box, plus 3-#14-2 NM cables.

- 15-# 14 conductors = $2.00 \times 15 = 30$ cu. in.
- 1- #14 ground = $2.00 \times 1 = 2.00$ cu.in.
- 3 device @ 2 conductors = $2.00 \times 6 = 12.00$ cu.in.
- **Total** = **44.00 cu. In. box volume required**

A typical plastic 3-gang box is approximately 44 cu in.

Type NM cable must be secured within 12" of metal boxes, 8" of plastic boxes and every 4½ feet thereafter. Listed cable connectors must be used where NM cable enters metal cabinets, boxes or panel boards.

When Type NM cable is installed parallel to framing members, or in bored holes, it shall be located at **least 1¼"** from the nearest edge of the framing member, where nails or screws may penetrate the cables. If this distance cannot be maintained, the cable shall be protected by a steel plate or sleeve at least 1/16" thick.

NM Cable or non-metallic raceway-type wiring methods installed in a groove, to be covered by wallboard, siding, paneling, carpeting, or similar finish, shall be protected by 1/16-inch steel plate, sleeve, or equivalent, or must be recessed in the groove 1 1/4-inch for the full length of the groove in which the cable or raceway is installed.

Ground Conductor Make Up for Rough Electrical Inspection.

All equipment grounding conductors must be connected with listed solderless pressure connectors such as wire nuts or crimp sleeves, leaving sufficient extra conductor for attachment to the metal box and/or device.

When crimp type connectors are used, they must be crimped using the tool recommended by the manufacturer of the crimp device.

Please note that ALL metal junction and outlet boxes must be grounded by attaching the equipment grounding conductor in the NM cable to the metal box using an approved screw or grounding clip. When circuit conductors are made up, six inches of free conductor must be left for use in make-up and for the attachment of devices.

Inspections.

Rough-in: At the time you call for your rough-in inspection, you should have all wires pulled, stapled properly, installed in ditches, and splices made up and ready to accept devices and fixtures. **Ground wires are to be terminated or connected together with approved connectors in all device boxes. DO NOT cover any wires with insulation / wall coverings, install any devices / fixtures, or cover any wiring which is to be buried underground.**