Electrical Tech Note — 251

Biosystems & Agricultural Engineering Department
Michigan State University

READING WIRING DIAGRAMS AND BLUEPRINTS

Electrical plans, blueprints, specifications, and wiring diagrams are required whenever directions must be communicated to other personnel. It is assumed the installer is familiar with installation procedures. Therefore, a system of symbols and abbreviations are used to communicate directions with a minimum of confusion. Standard symbols have been adopted and are used universally. Manufacturers use standard symbols when supplying wiring diagrams with equipment.

Architectural Symbols: Standard architectural symbols have been developed to communicate construction details to the various construction trades that will be at a site. A key will be provided to indicate the type of construction that will be used in a building. *Figure 251.1* is a typical key used to indicate the common architectural symbols that will be shown on blueprints or plans. It is necessary to know the type of wall, ceiling, and floor construction in order to plan the installation of the wiring. Window, door, fireplace, and appliance placement must be known to insure the proper placement and routing of electrical, plumbing and HVAC equipment.

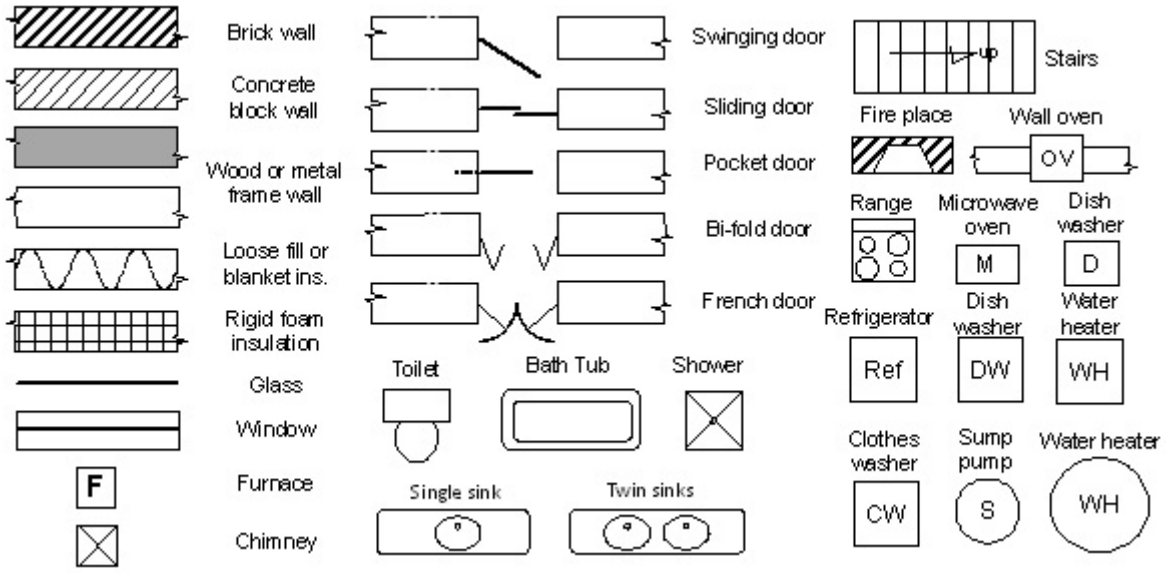

Figure 251.1 *Typical architectural wall construction symbols.*

Electrical Symbols: Electrical construction plans or blueprints use standard electrical symbols to represent lighting luminaires, receptacle outlets, switches, communication devices and similar equipment and materials. The symbols most commonly used are shown in *Table 251.1.* and *Table 251.2.* These symbols are not necessarily standardized, some variations can occur between different sets of plans. The plans or prints may contain a minimum amount of detail, showing only the type and location of electrical luminaires and outlets, the actual circuits and wiring may not even be shown. Notes may be added to a set of plans or prints to provide more detailed information on lighting luminaires and other outlets.

The wiring paths may be drawn on a plan as shown in *Figure 251.2.* This type of plan indicates which outlets are on each circuit. The path of the circuit wiring is also shown. The actual installation is left up to the installer. The installer would use correct wiring methods, cable or raceway based on the installation requirements, specifications, and electrical code. The installer determines the most appropriate route to take to get from one outlet to the next. The plans may specify if the circuit conductors are to be concealed in walls or ceiling, under floors, buried, or exposed on a building surface. Many plans do not make this distinction and the choice is left up to the installer.

An arrow indicates that a circuit will continue to a panelboard. This is commonly referred to in the electrical trade as a *homerun*. When multiple panelboards are installed in a building, they may be marked with letters such as A, B, or C. They could also be marked with any other letter/number combination to ensure that each is unique from the others. Examine *Figure 251.2 A & B*. On the left the wire runs are not marked with number of wires in each run between outlets. The electrician must be able to figure out the number of circuit wires between outlets such as shown for the diagram on the right. A method for marking wires in a run between outlets is shown in *Figure 251.3.*

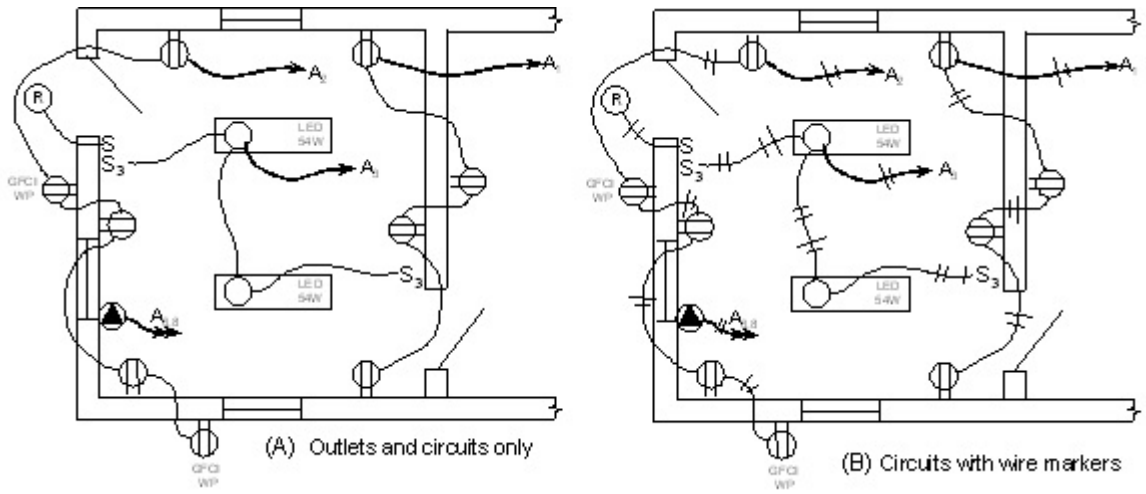

Figure 251.2 *Wiring plan showing outlets, circuits, and wiring details. The trades person must be able to determine the number of wires in each run and the color insulation on those wires.*

Different methods of specifying how wiring is to be run in a building are shown in *Figure 251.3.* The number and type of wires may be indicated with cross marks on the wiring path. This is one of several wire coding systems. A long cross mark is often used to indicate a grounded (neutral) conductor, while short cross lines indicate ungrounded (hot) wires. Conductors that are live at all times, traveler conductors, and the switch portion of a hot conductor are all classified as ungrounded conductors. Cross marks are not generally shown for the equipment grounding conductor. It is assumed that grounding will be properly installed for all circuits.

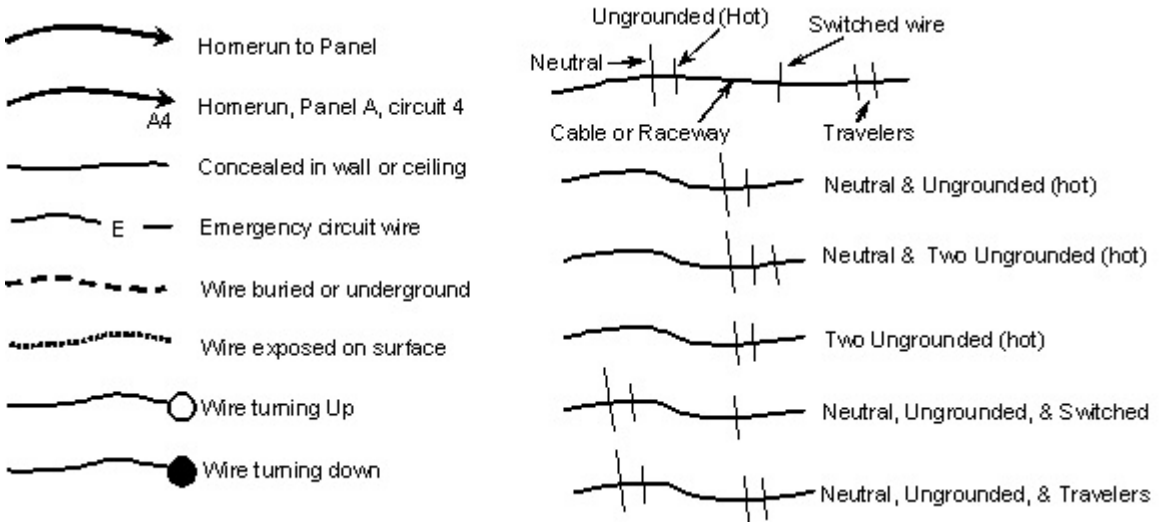

Figure 251.3 *Symbols used to represent circuit wires on a plan. On some plans the number of wires is identified by cross lines.*

Specifications: Project *specifications* spell out the details of the wiring installation. The specifications describe the wiring materials and methods to be used. The specifications explain details that are usually not contained on the plans. A completion schedule, billing and payment procedures, insurance requirements, and liabilities are usually contained in the specifications.

Even if a set of prints or plans seems to be drawn in great detail be sure to check the specifications. A minimum circuit wiring size and type is frequently provided in the specifications and only exceptions are indicated on the plans. Lighting luminaire, lamp types and wattage, and circuit voltage are also provided in the specifications in a lighting schedule. Switch and receptacle mounting heights are generally given in the specifications. It will be specified if the mounting height is to the center or the bottom of the box. The measurement will be made from the finished floor line. If the floor is not in place at the time the box is installed, it will be necessary to determine the floor line. Specifications may also state that an equipment grounding conductor for an installation must be installed in a raceway even if the raceway is recognized in the electrical code as permitted to be an equipment grounding conductor. Read the specifications carefully before starting the installation. Specifications are permitted to exceed the minimum requirements of the electrical code.

Riser Diagrams: A *riser diagram* is a sketch of the main service equipment and the feeder wiring and panelboards. The riser diagram in *Figure 251.4* shows at a glance the complete electrical distribution system in an installation. The diagram is generally not drawn to scale and the different panels and equipment may actually be in different rooms or areas. It is necessary to examine the plans in order to determine the exact location of the equipment shown on the riser diagram.

The feeder wires from the service disconnect to the various subpanels in a building may not actually be shown on the plans. The plans may show only the locations of the equipment. It is the responsibility of the installer to run the feeder wires in the most appropriate manner. The conductor material, insulation type and size and type are shown on the riser diagram. Fuse and circuit breaker ratings are also indicated on the riser diagram.

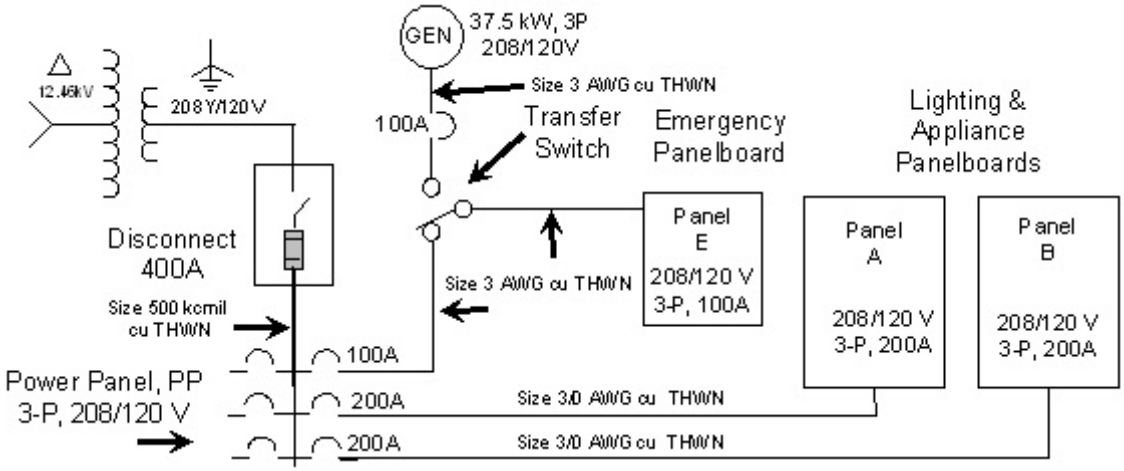

Figure 251.4 *Riser diagram for the service entrance and the feeders and sub-panels of a building.*

One-Line Diagrams: *One-line diagrams* provide a means of representing a complete wiring system in a simple sketch. Only one line is drawn, and it can represent two, three, or four wires, depending upon the type of electrical system. One-line diagram symbols that are frequently used are shown in *Table 251.2* and *Figure 251.5.* These symbols are often used in riser diagrams.

One-line diagrams are useful for calculating and specifying sizes and types of materials to be used in an electrical system. A sketch can be made and notes added to specify materials and installation methods. This sketch with notes can convey a clear idea to the installer. A typical one-line diagram of a 3-phase, 4-wire service to a circuit breaker panel is shown in *Figure 251.5.* There is a transfer switch and a standby generator installed ahead of the main service panel. A motor circuit with symbols is also shown.

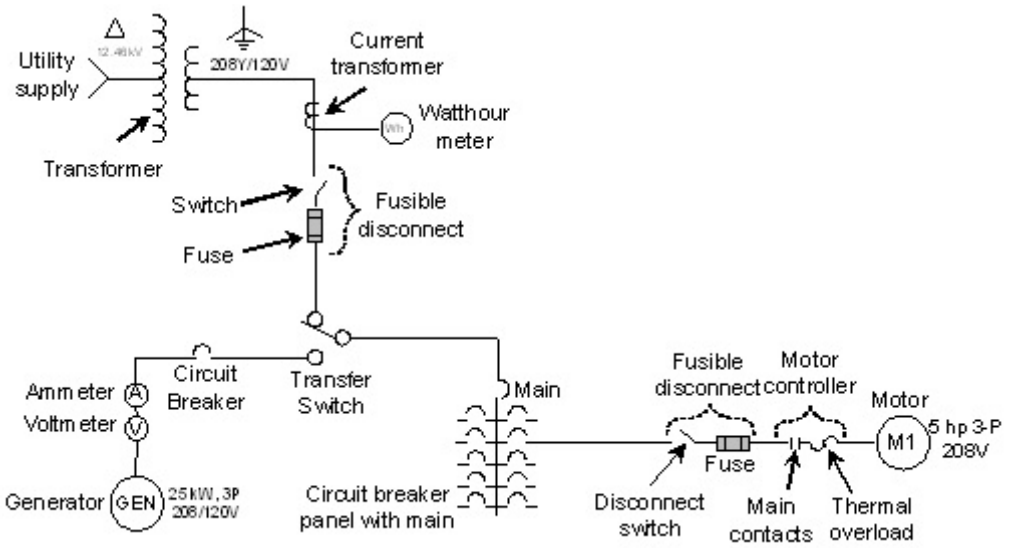

Figure 251.5 *One-line diagram of a building service and a motor circuit in the building with a standby generator and transfer switch on the line side of the main service.*

Table 251.1 Electrical wiring plan and blueprint symbols, switches, receptacles & lighting..

S	Single-pole switch
S_2	Double-pole switch
S_3	Three-way switch
S_4	Four-way switch
S_D	Dimmer or Door switch
S_T	Timer switch
S_O	Occupancy sensor switch
S_K	Key opened switch
S_P	Pilot switch
S_V	Speed control switch
S_{WP}	Weather-proof switch

	Single receptacle
	Duplex receptacle
	Split duplex receptacle
GFCI	GFCI receptacle
WP	Weatherproof receptacle
IG	Isolated ground receptacle
R	Range receptacle
	Special purpose receptacle
	Floor receptacle

	Lighting outlet, ceiling or wall
R	Recessed lighting outlet
PS	Pull switch lighting outlet
O	Occupancy sencor outlet
PE	Photoelectric sensor outlet
X	Exit light
F	Exhaust fan
	Paddle fan
H	Infrared heat lamp

Table 251.2 Lighting symbols and electrical system types.