

# Service Section

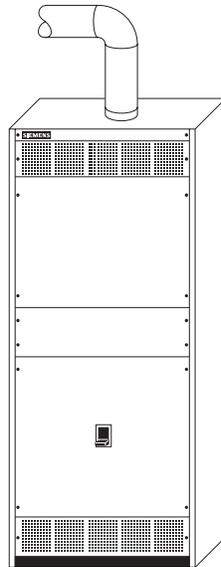
Typical switchboards consist of a service section, also referred to as the main section, and one or more distribution sections. The service section can be fed directly from the utility transformer. In addition to the main disconnect, the service section usually contains utility or customer metering provisions.



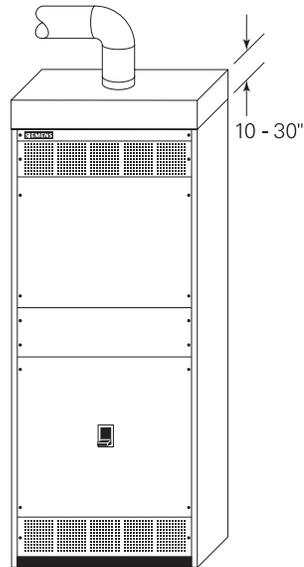
## Service Entrance Methods

Several options are available to bring power into the switchboard service section. Cable can be brought into the switchboard from the top or the bottom.

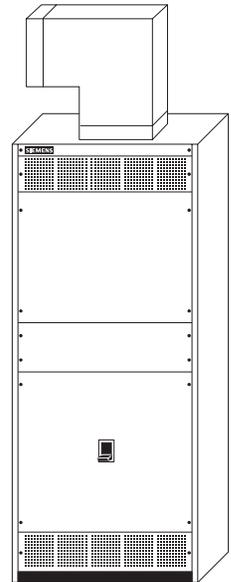
Cable can be brought into the top of the switchboard through conduit. If the cable is a large diameter and more room is needed a pull box, available in 10" to 30" heights, can be added. A bus duct entrance can be used when metal bus is used instead of cables.



Cable And  
Conduit Entrance

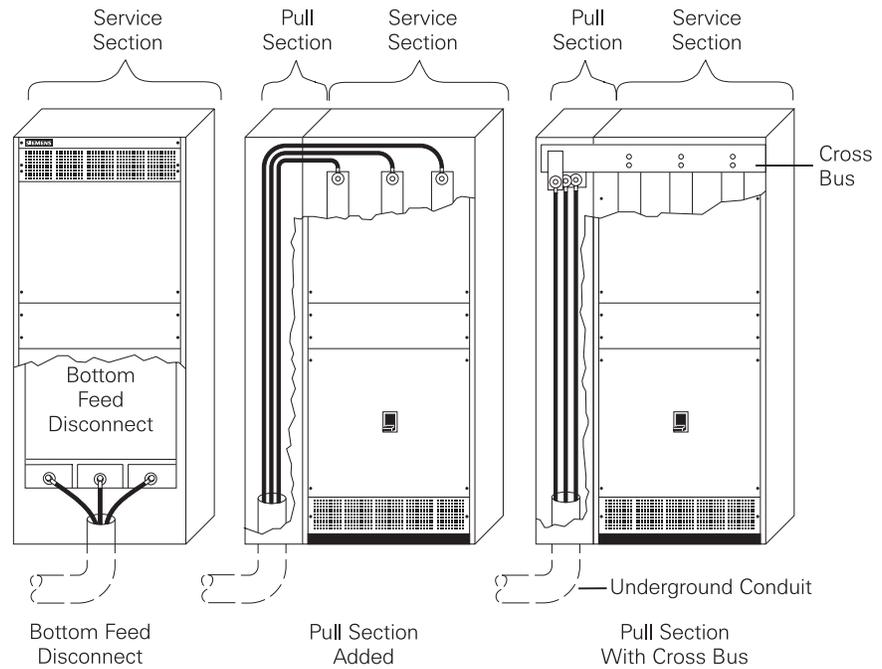


Pull Box  
Added



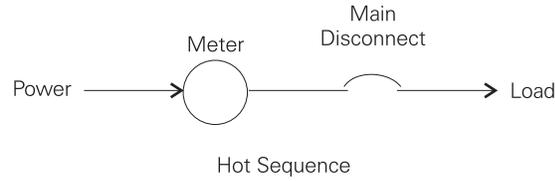
Bus Duct  
Entrance

Cable may enter through a conduit to a disconnect that is fed from the bottom. A pull section can be added to the side of the service section to pass cable to the top of the switchboard. Depending on the cable bending space, cable can be connected directly to the lugs or to a cross bus. A cross bus brings the bus connections to the pull section eliminating the need to bend cables.



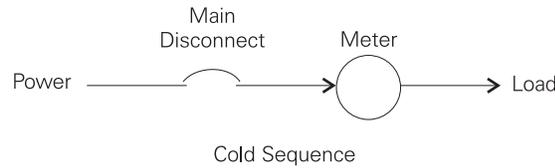
## Hot Sequence

Metering can either be hot sequence or cold sequence. This refers to whether or not power is still applied to the utility meter when the main disconnect is switched off. The following drawing illustrates hot sequence. When the main disconnect is open, power is removed from the load. Power is still applied to the utility meter.

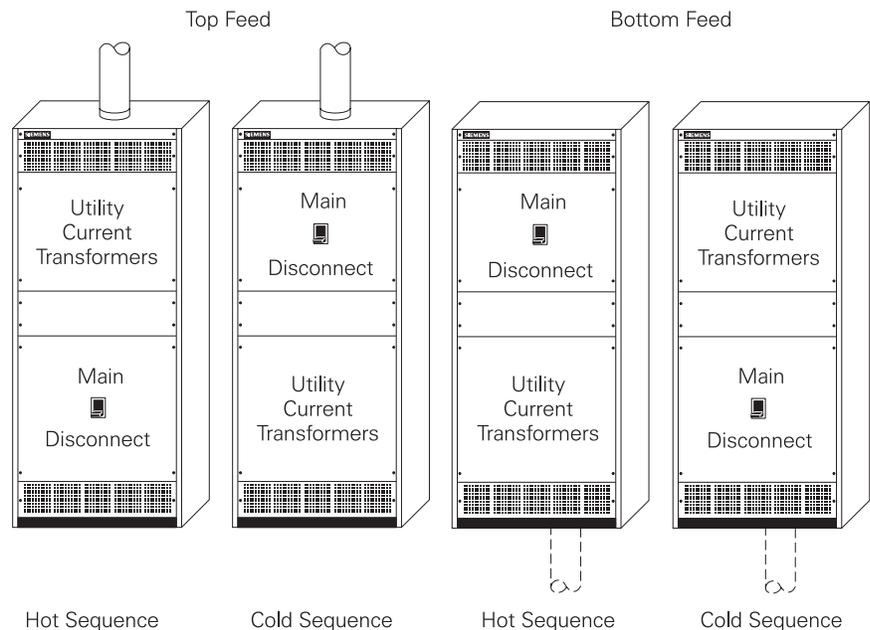


## Cold Sequence

The following drawing illustrates cold sequence. When the main disconnect is open, power is removed from the load and the utility meter.



Hot sequence metering on the line side of the main disconnect is normal, but cold sequence metering on the load side of the main disconnect can also be provided.

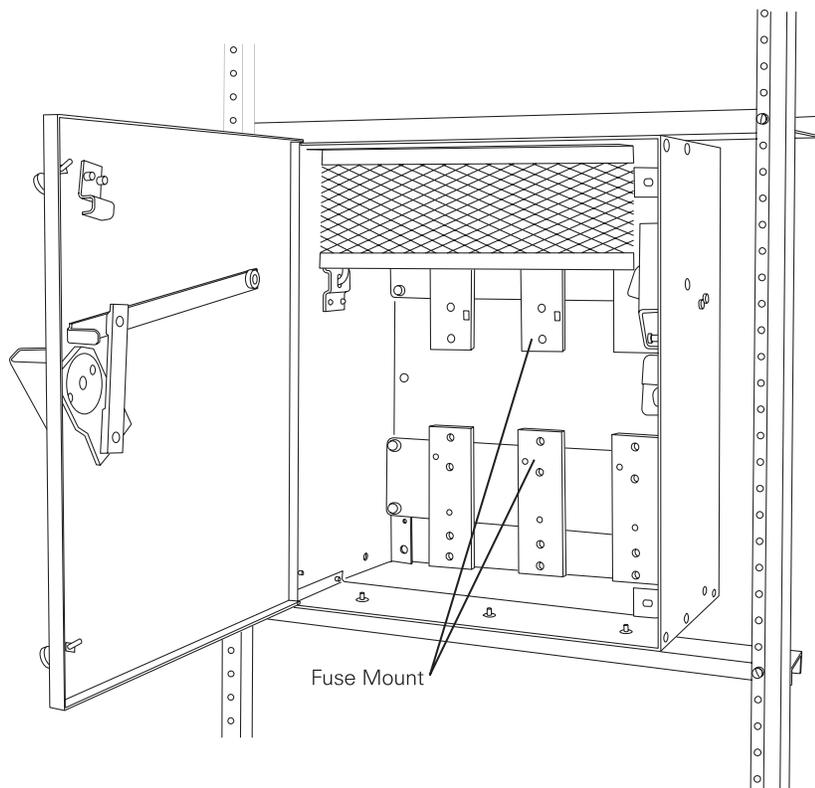


# Service Section Main Disconnect Devices

The service section of Siemens switchboards will accommodate a variety of main protective devices. Selection depends on the characteristics of the electrical system and the needs of the customer.

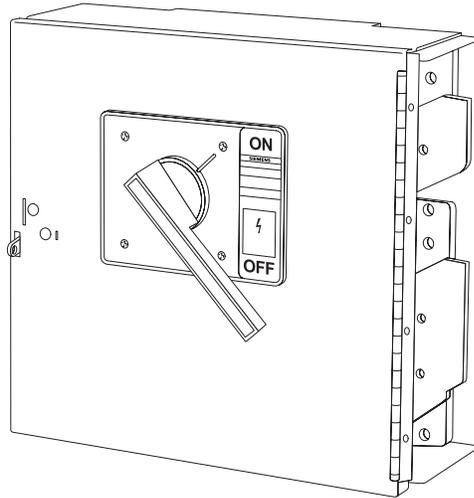
## Fusible Switches

One type of protective device is the Siemens Vacu-Break<sup>®</sup> fusible switch. Fusible switches are available in ampere ratings up to 1200 amps at 600 VAC.



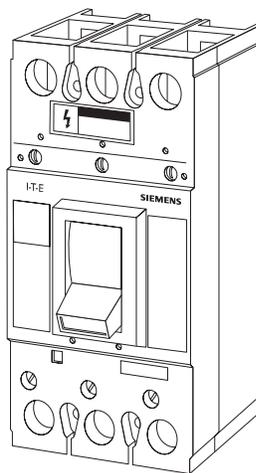
## HCP Fusible Switch

The HCP type fusible switch is another device that can be used in the service section as a disconnect device. Visible contacts provide a visual indication concerning the state of the switch before servicing. HCP fusible switches are available with ampere ratings from 400 to 1200 amps. HCP fusible switches are suitable for use on systems with up to 200,000 amps of available fault current with used with Class J or Class L fuses.

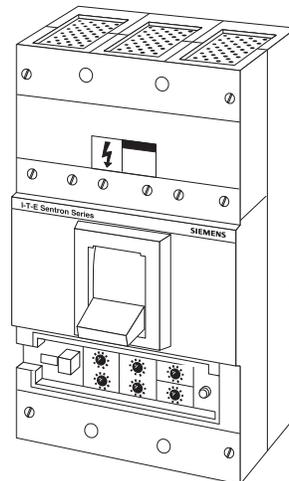


## MCCBs

The Sentron™ Series molded case circuit breakers (MCCB) can also be used as main service section protective devices. Sentron Series circuit breakers are available with ampere ratings from 400 to 2000 amps, and interrupting ratings from 10,000 to 200,000 amps. The Sentron Series circuit breaker is also available with solid state protection, referred to as Sensitrip® III. Sensitrip III breakers are available with ampere ratings from 400 to 3200 amps, and interrupting ratings up to 200,000 amps.



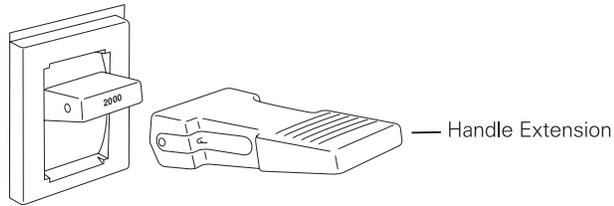
Sentron Series MCCB



Sentron Series Sensitrip III MCCB

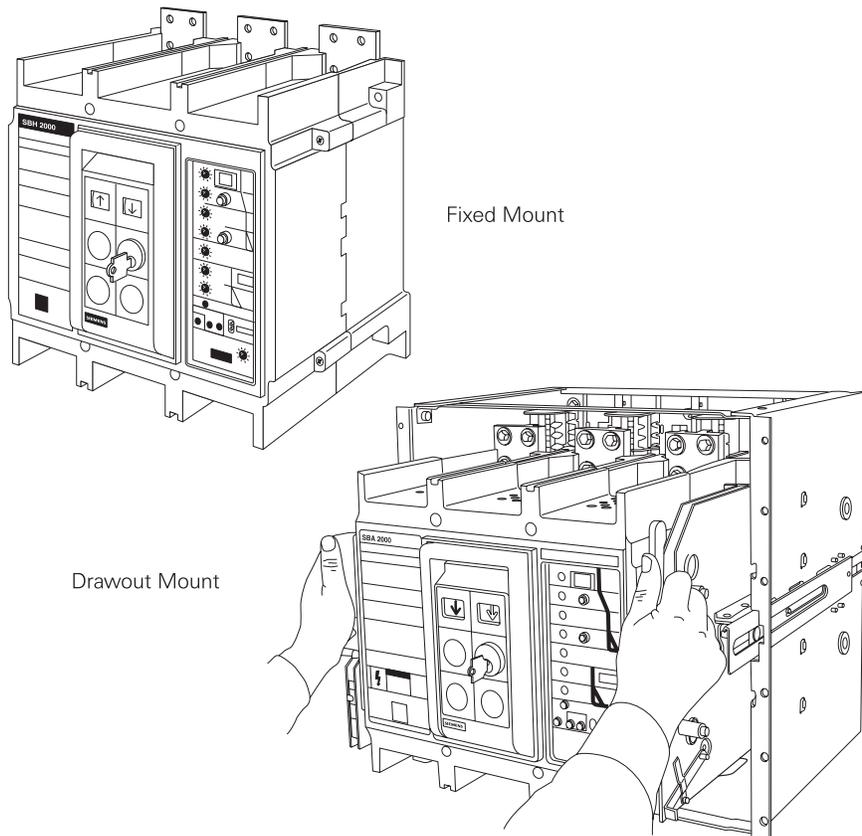
## Handle Extension

It can be difficult to operate some of the handles on the larger circuit breakers. A handle extension is available which allows more leverage to be applied to the circuit breaker handle. This makes opening and closing the circuit breaker easier.



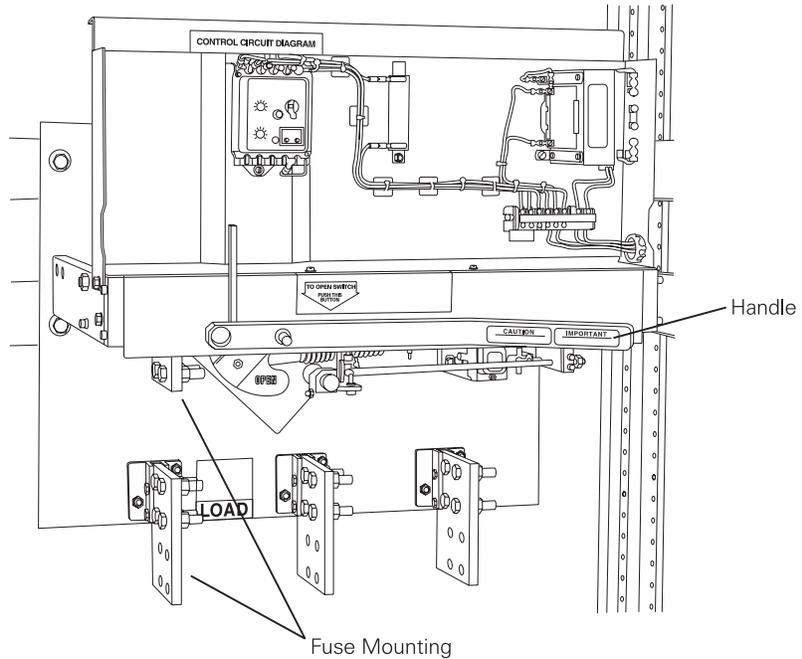
## ICCBs

Insulated case circuit breakers (ICCB) can be applied in applications from 100 to 5000 amps through 600 VAC. There are four ICCB frames: 1200, 2000, 3200, and 5000 amps. Interchangeable rating plugs and a continuous current adjustment are provided with each trip unit. The frame ampere rating is determined by the current sensors in the breaker. Interrupting ratings are available in ratings up to 200,000 amps. ICCBs can be fixed mounted or drawout mounted.



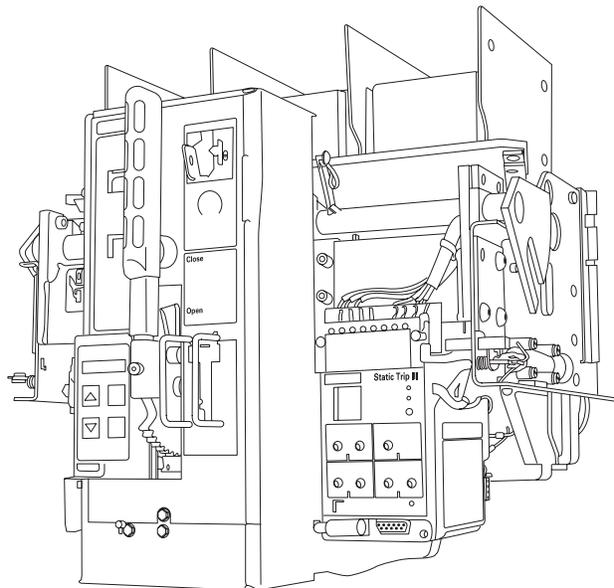
## Bolted Pressure Switch

Bolted pressure switches can also be used as a main disconnect. Bolted pressure switches are available in 800, 1200, 1600, 2000, 2500, 3000, and 4000 amp frames. The maximum short circuit current withstandability is 200,000 amps. Bolted pressure switches are rated for 240 VAC, 480 VAC, and 600 VAC.



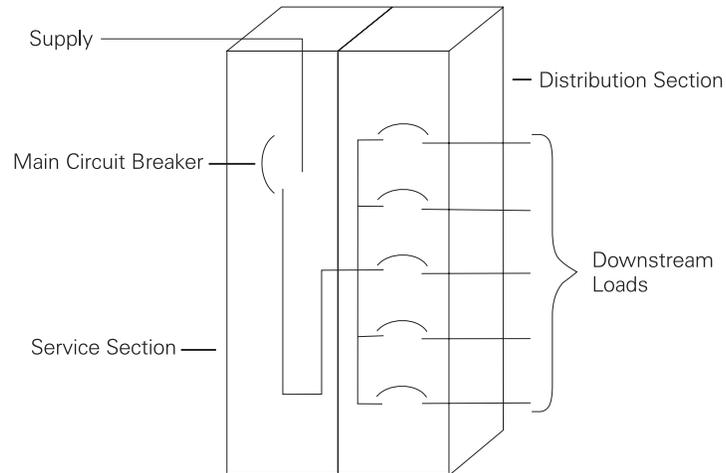
## RL Power Circuit Breakers

RL power circuit breakers can also be used in switchboards. These circuit breakers are available in 800 to 5000 amp frames at 600 VAC. RL power circuit breakers are drawout mount.



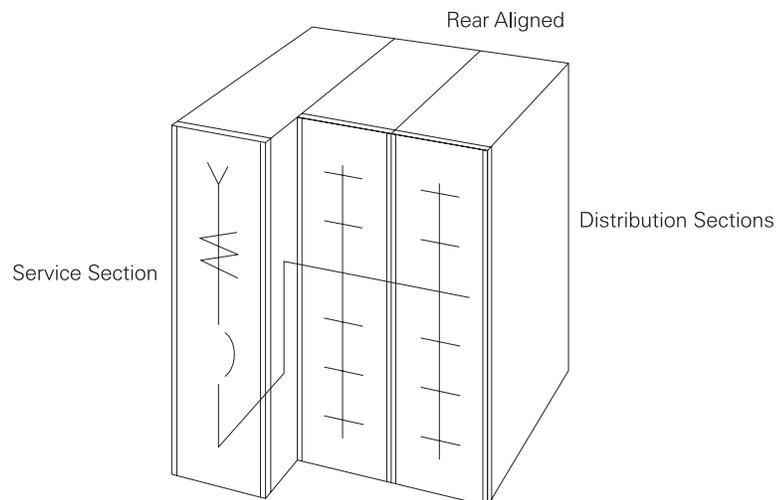
# Distribution Section

The distribution section receives power from the service section and distributes it to various downstream loads.



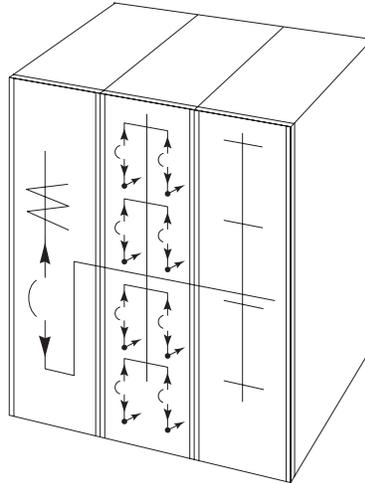
## Rear Alignment

Depending on the design of a specific switchboard, the service section cabinet may be deeper than the distribution section. This is due to the size of the main disconnect device and associated bus requirements. The rear of all sections align so the switchboard may be installed against a wall. This is referred to as rear alignment.



## Front and Rear Aligned

Switchboards can also be front and rear aligned, if the depth of the service section and distribution section are the same. In some switchboards the circuit protection devices and bus may require a deeper cabinet. In other switchboards extra depth may be added as an option.



## Protective Devices

Like the service section, the distribution section will accommodate a variety of protective devices. Selection depends on the characteristics of the electrical system. In addition, motor control starters can also be used in switchboards.

| Device                                   | Current Rating |
|--|----------------|
| Vacu-Break <sup>®</sup> Fusible Switches | 30-1200 amps   |
| Bolted Pressure Switches                 | 800-4000 amps  |
| HCP Switches                             | 400-1200 amps  |
| Molded Case Circuit Breakers             | 15-3200 amps   |
| Insulated Case Circuit Breakers          | 100-5000 amps  |
| LV Power Circuit Breakers                | 800-4000 amps  |

### Review 3

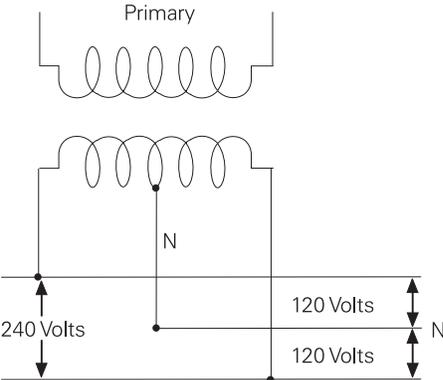
1. Typical switchboards consist of a \_\_\_\_\_ section and usually one or more \_\_\_\_\_ section.
2. A \_\_\_\_\_ \_\_\_\_\_, available in 10" to 30" heights, can be added to the top of a switchboard to allow room for large diameter cable.
3. A \_\_\_\_\_ \_\_\_\_\_ is added to accommodate cable entering the bottom of a switchboard and connected to the bus at the top of a switchboard.
4. \_\_\_\_\_ \_\_\_\_\_ means that power is still applied to the utility meter when the main disconnect is open.
5. \_\_\_\_\_ \_\_\_\_\_ means that power is removed from the utility meter when the main disconnect is open.
6. Which of the following is suitable for use as a main disconnect in the service section?
  - a. fusible switch
  - b. molded case circuit breaker
  - c. insulated case circuit breaker
  - d. bolted pressure switch
  - e. RL power circuit breaker
  - f. all the above
7. The \_\_\_\_\_ section receives power from the service section and distributes it to various downstream loads.
8. \_\_\_\_\_ \_\_\_\_\_ refers to a switchboard where the service section may be deeper than the distribution section, and the rear of all sections are aligned.

# Power Supply Systems

Switchboards receive power from a variety of sources. Downstream switchboards may receive power from upstream switchboards or disconnect switches, however, power for the distribution system originates from a utility power company. Voltage from the power company is stepped down through transformers for distribution systems. The following are some examples of systems in use. The amount of voltage on the secondary depends on how much voltage is on the primary and the ratio between the primary and secondary. The following examples are representative of some voltages commonly found in distribution systems.

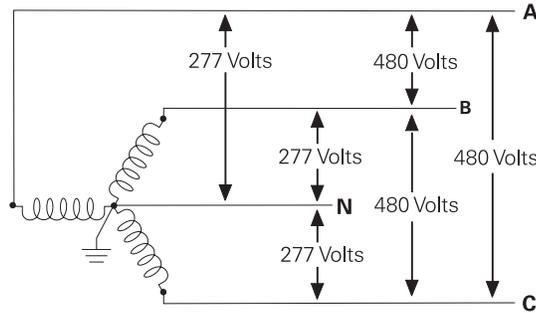
## 1Ø3W

The following diagram illustrates one of the most common single-phase, three-wire (1Ø3W) distribution systems in use today. There are 240 volts across the full secondary of the transformer and 120 volts between the neutral and either end of the transformer. The neutral is the third wire.



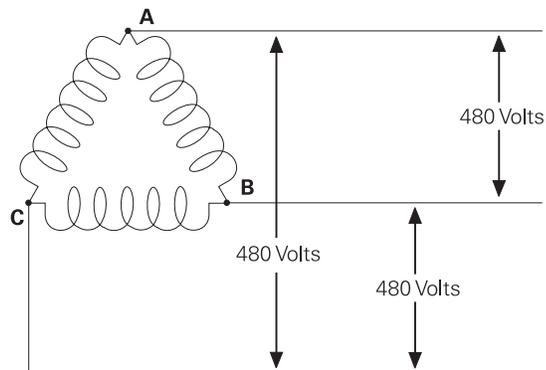
### 3Ø4W, Wye-Connected

The following illustration shows the secondary of a 480Y/277 V three-phase, four-wire (3Ø4W), wye-connected transformer. The "480Y" indicates the transformer is wye-connected and has 480 volts between any two phases. The "277 V" indicates there are 277 volts between any phase and neutral (N). Phase-to-phase voltage is 1.732 times phase-to-neutral voltage ( $277 \times 1.732 = 480$ ). Neutral is the fourth wire.



### 3Ø3W, Delta-Connected

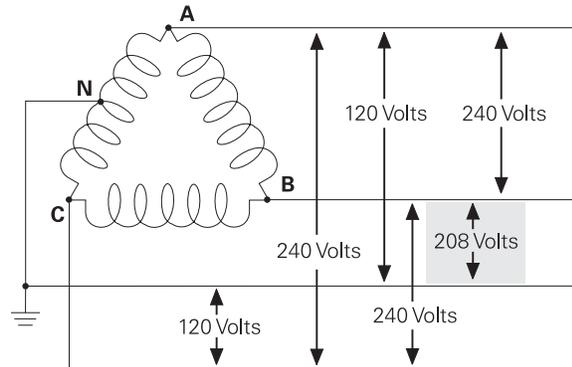
Another method used in connecting transformers is a delta secondary. In this example 480 volts is available phase-to-phase.



### 3Ø4W, Delta-Connected

A three-phase, four-wire, delta-connected secondary works a little differently. The following illustration shows a delta-connected secondary with 240 volts phase-to-phase. The midpoint of one phase winding is grounded to provide 120 volts between phase A and neutral and 120 volts between phase C and neutral. Between phase B and neutral, however, the voltage is 208 volts. This is referred to as the high leg.

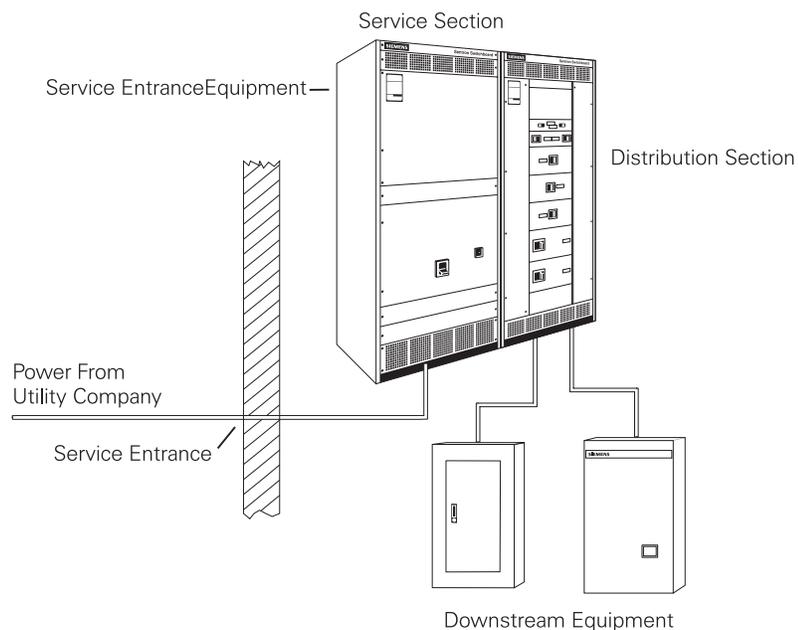
The high leg can be calculated by multiplying the phase A to neutral voltage times 1.732 ( $120 \times 1.732 = 208$ ). Single-pole breakers should not be connected to the high leg. *NEC*<sup>®</sup> Article 215-8 requires that the high leg bus bar or conductor be permanently marked with a finish that is orange in color. This will help prevent electricians from connecting 120 volt single-phase loads to the 208 volt high leg. Four-wire, delta-connected transformers should always be wired so that the B phase to neutral is the high leg.



# Service Entrance Equipment

Switchboards are often used as service entrance equipment for a building. The service section of a switchboard refers to the section of a switchboard which receives incoming power. This power can be fed directly from utility power. Power can also be fed to the section from another source, such as switchboard or disconnect switch somewhere upstream.

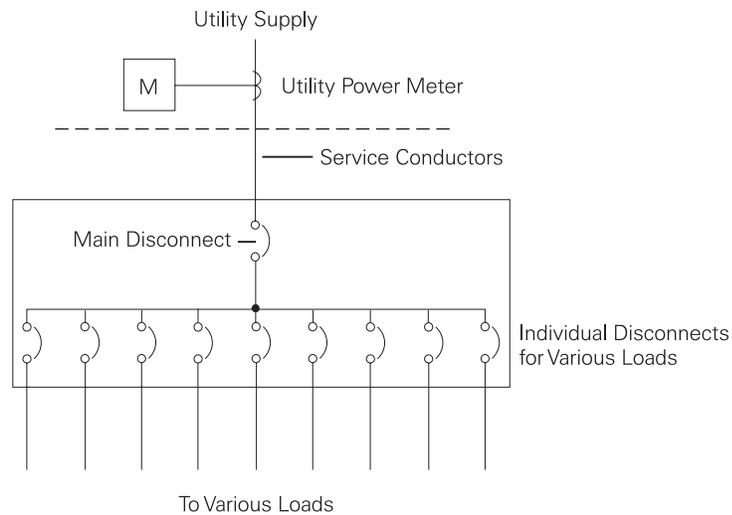
Service entrance equipment refers to the equipment through which the power supply enters the building. The switchboard in the following drawing is considered service entrance equipment because it is where power enters the building. The incoming power supply is connected to this equipment which provides a means to control and cut off the supply. The *National Electrical Code*<sup>®</sup> discusses service entrance equipment in Article 230. Switchboards used as service entrance equipment must be approved and labeled as such. All Siemens Sentron<sup>™</sup> Series switchboards are factory labeled as suitable for service entrance equipment when specified for service entrance.



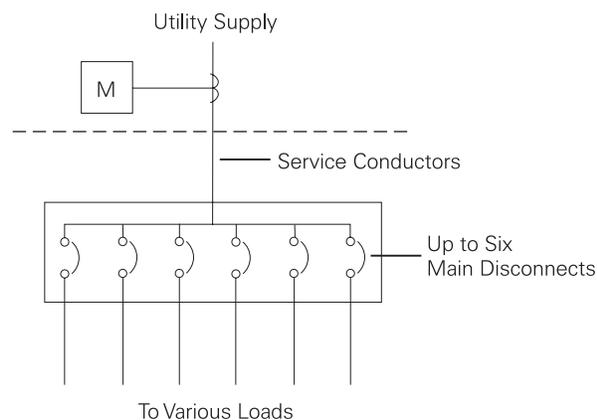
*NEC*<sup>®</sup> and *National Electrical Code*<sup>®</sup> are registered trademarks of the National Fire Protection Association.

## Six Disconnect Rule

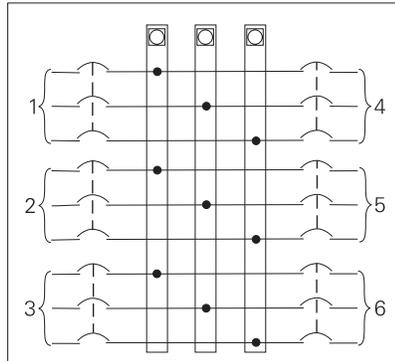
Service entrance conductors must have a readily accessible means of being disconnected from the power supply. *NEC*<sup>®</sup> Article 230.71 specifies that for each set of service entrance conductors no more than six switches or circuit breakers shall be used to disconnect and isolate the service from all other equipment. In the following example, a single main circuit breaker will disconnect power to all equipment being supplied by the service. There can be as many feeder and branch disconnect devices as needed.



In another example, a switchboard may be equipped with up to six circuit breakers to disconnect power to all equipment being supplied by the service. In any case, the circuit breaker must be clearly labeled for the load it supplies.



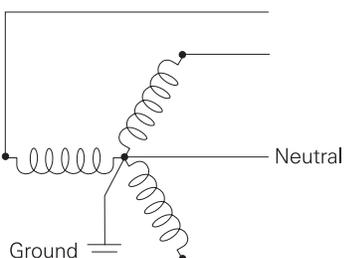
It is important to note that the “six disconnect rule” refers to the number of disconnects and not the number of poles. For example, in the illustration shown below there are 18 poles but only six circuit breakers. Three poles are mechanically linked together to form one disconnect device. In the illustrated configuration the service can be disconnected with no more than six operations of the hand. This arrangement meets the “six disconnect rule.”



# Switchboard Grounding

Grounding is an important aspect of any electrical system and must be considered carefully. Article 250 of the *National Electrical Code*<sup>®</sup> defines ground as *a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.*

The following illustration, for example, shows the neutral (N) conductor of a wye-connected transformer connected to ground.



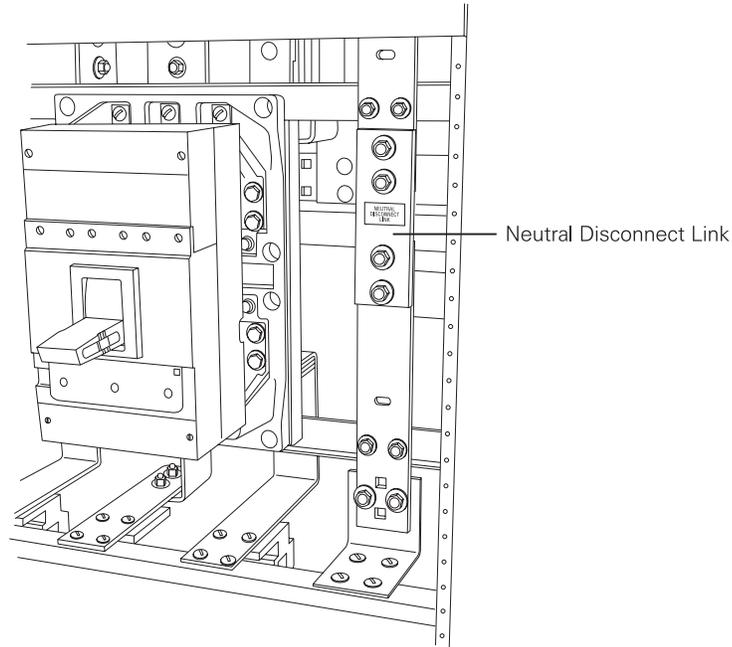
There are two objectives to the intentional grounding of electrical equipment:

- Keep potential voltage differentials between different parts of a system at a minimum which reduces shock hazard.
- Keep impedance of the ground path to a minimum. The lower the impedance the greater the current is in the event of a fault. The greater the current the faster an overcurrent device will open.

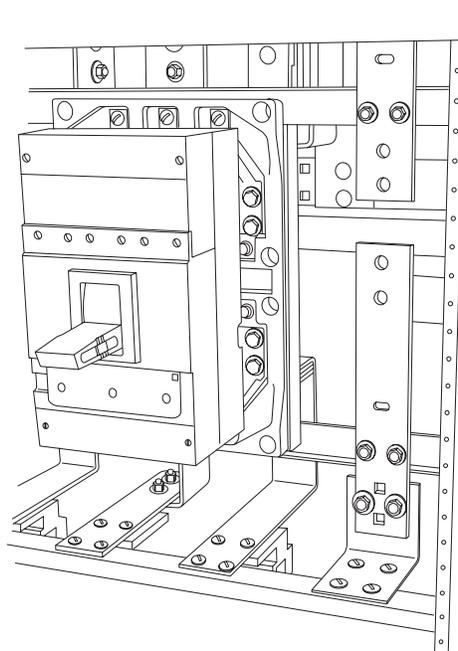
*NEC*<sup>®</sup> and *National Electrical Code*<sup>®</sup> are registered trademarks of the National Fire Protection Association. Reprinted with permission from NFPA 70-2002, the *National Electrical Code*<sup>®</sup>, Copyright© 2001, National Fire Protection Association, Quincy, MA 02269.

## Neutral Disconnect Link

If a switchboard service section is intended to be used as service entrance equipment, provision must be included to isolate the neutral bus from the grounded neutral bus. A neutral disconnect link is provided for this purpose. The following drawing shows the disconnect link in place.

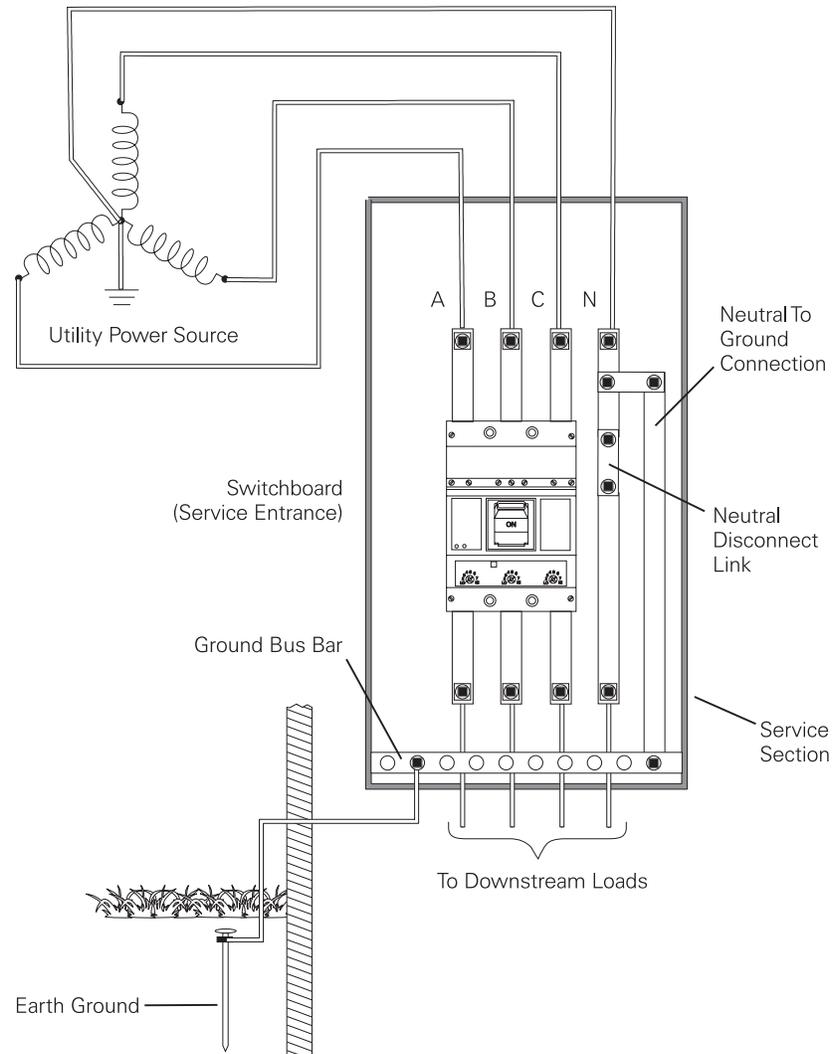


This removable link allows the branch neutral to be checked for continuity on the load side of the main disconnect. The following drawing shows the disconnect link removed.



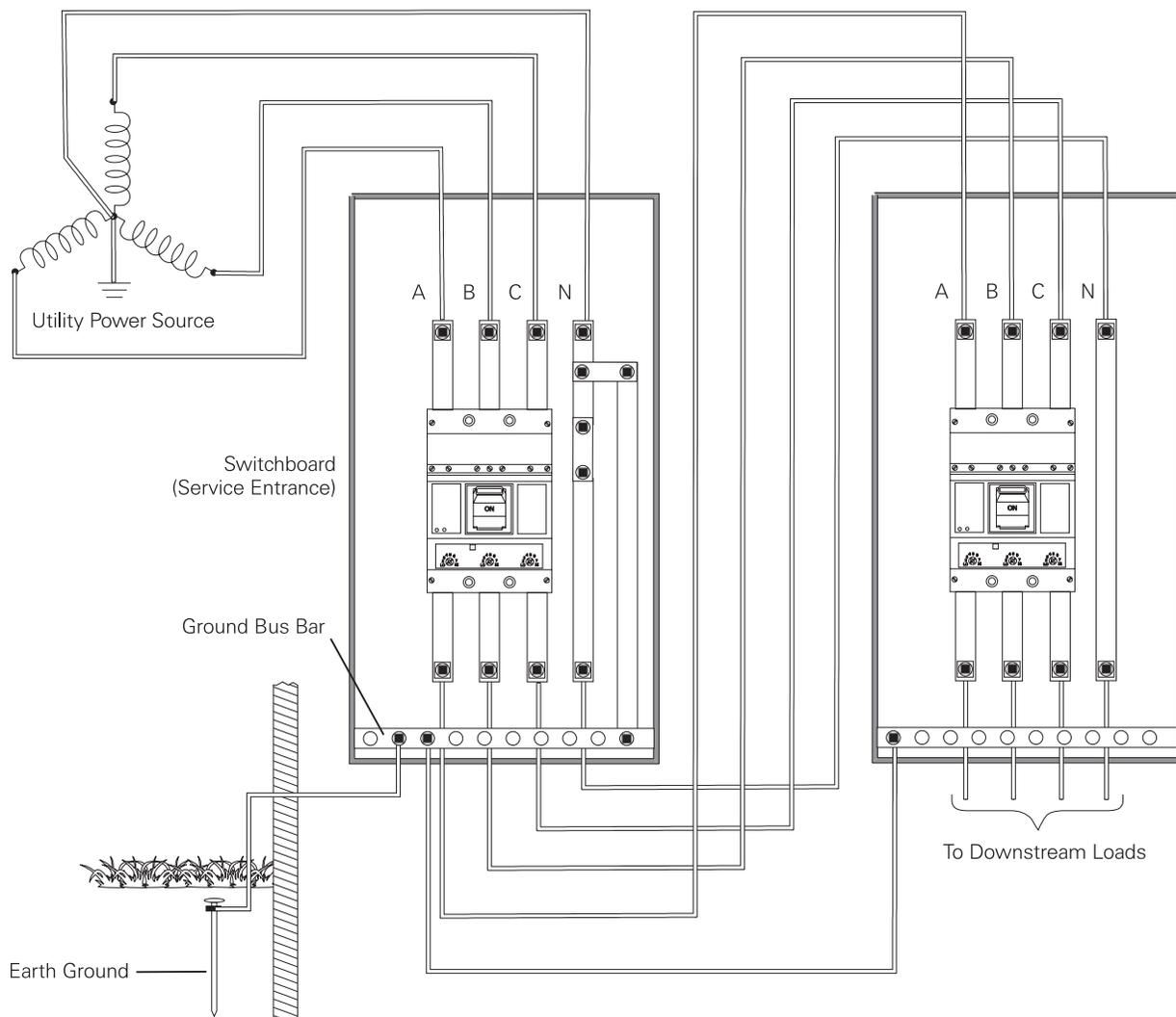
## Service Entrance Grounding

In the following drawing a switchboard is used as service entrance equipment. Power to the service section is received from a 3Ø4W service. The neutral is always grounded in service entrance equipment. The neutral is connected to ground through a neutral to ground connection and ground bus bar. The ground bus bar is connected to the frame of the switchboard, which is connected to the system or earth ground. The neutral disconnect link is left in place to supply downstream loads. Three-phase, four-wire power is then supplied to downstream loads.



## Downstream Equipment

The neutral is only connected to ground at the service entrance. When downstream equipment is used the neutral is isolated in that equipment. As shown in the following illustration, the neutral is connected to earth ground through the ground bus bar of the service entrance switchboard. In this example a second switchboard is used downstream of the service entrance switchboard. The enclosure of the downstream switchboard is connected to ground through a grounding conductor back to the service equipment. The neutral is not connected to ground in the downstream switchboard. Notice also that the second (downstream) switchboard does not have a neutral disconnect link. Neutral disconnect links are not required in switchboards used as non-service entrance equipment. Similarly the second switchboard will feed additional downstream loads.



## Review 4

1. If the secondary of a four-wire, wye-connected transformer is 480 volts phase-to-phase, the phase to neutral voltage is \_\_\_\_\_ volts.
2. If the secondary of a four-wire, B phase high leg, delta connected transformer is 240 volts phase-to-phase, the phase-to-neutral voltage is  
\_\_\_\_\_ volts A to neutral  
\_\_\_\_\_ volts B to neutral  
\_\_\_\_\_ volts C to neutral
3. The term service section refers to the section of a switchboard which receives incoming power. The term \_\_\_\_\_ equipment refers to equipment through which the power supply enters the building.
4. According to *NEC*<sup>®</sup> Article 230.71, the maximum number of circuit breakers that can be used to disconnect and isolate the service from all other equipment is \_\_\_\_\_ .
5. A neutral \_\_\_\_\_ is supplied in switchboards used as service entrance equipment to allow the branch neutral to be checked for continuity on the load side of the main disconnect.