

SIEMENS

STEP 2000

Busway

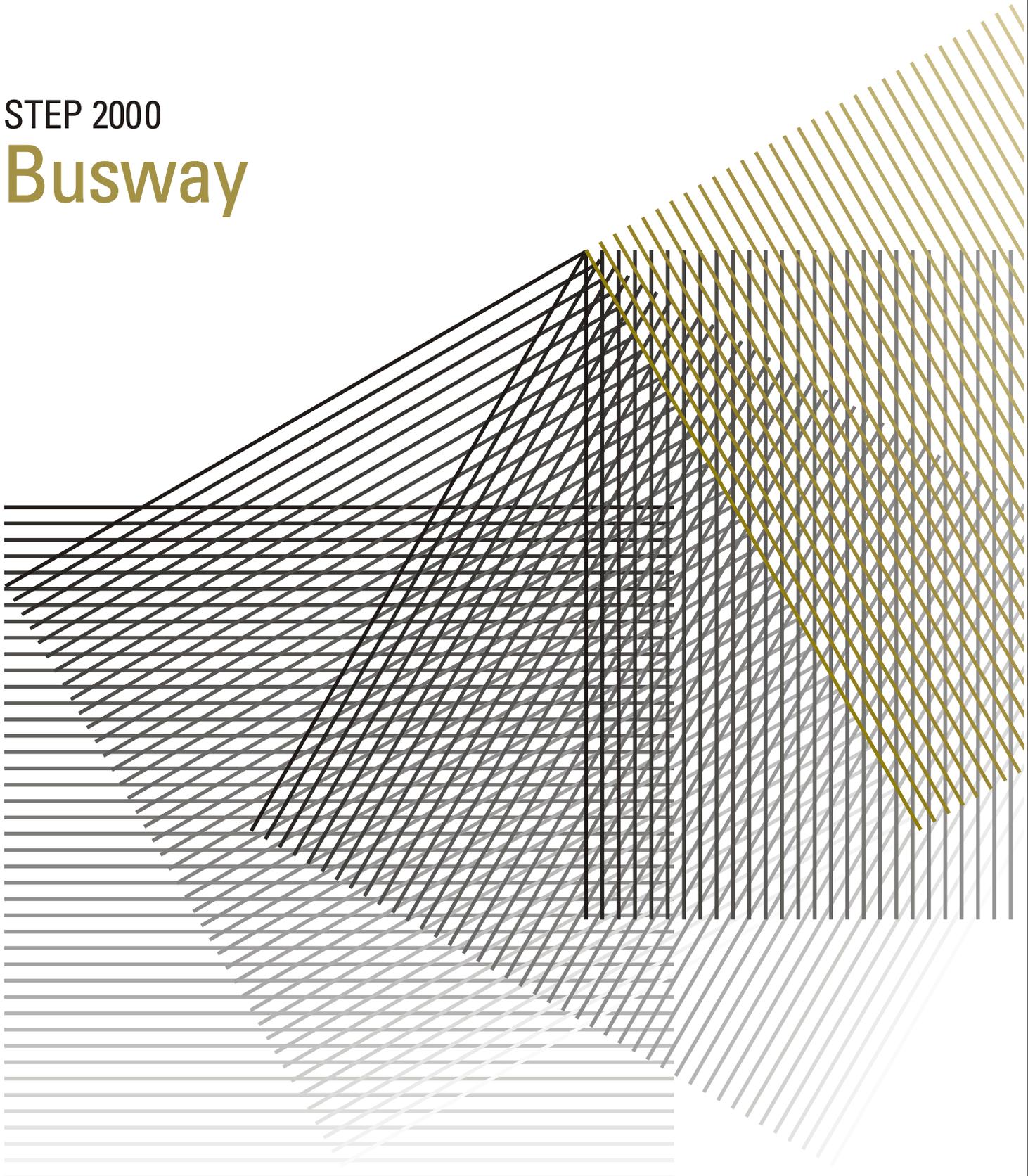


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Introduction

Welcome to another course in the STEP 2000 series, **Siemens Technical Education Program**, designed to prepare our distributors to sell Siemens Energy & Automation products more effectively. This course covers **Busway** and related products.

Upon completion of **Busway** you should be able to:

- Identify the major components of several Siemens busway systems and describe their functions
- Identify the role of busway in a distribution system
- Explain the need for circuit protection
- Identify feeder and plug-in busway and explain the use of each
- Identify various organizations involved with busway design standards
- Describe selected sections of the National Electrical Code[®] (NEC[®]) as it applies to busway
- Measure and layout a basic busway system
- Identify various ratings of Siemens busway
- Describe how a cost savings is realized when busway is selected over cable and conduit

This knowledge will help you better understand customer applications. In addition, you will be better able to describe products to customers and determine important differences between products. You should complete **Basics of Electricity** before attempting **Busway**. An understanding of many of the concepts covered in **Basics of Electricity** is required for **Busway**.

If you are an employee of a Siemens Energy & Automation authorized distributor, fill out the final exam tear-out card and mail in the card. We will mail you a certificate of completion if you score a passing grade. Good luck with your efforts.

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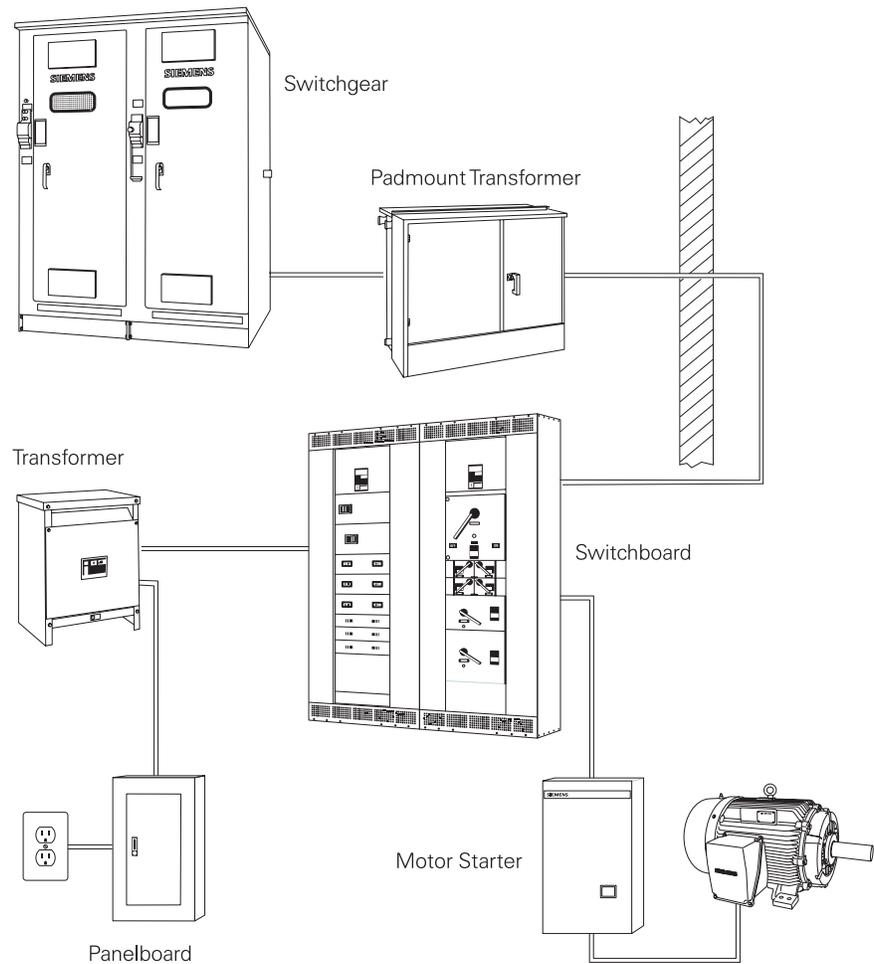
National Electrical Manufacturers Association is located at 2101 L. Street, N.W., Washington, D.C. 20037. The abbreviation "NEMA" is understood to mean National Electrical Manufacturers Association.

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Distribution Systems

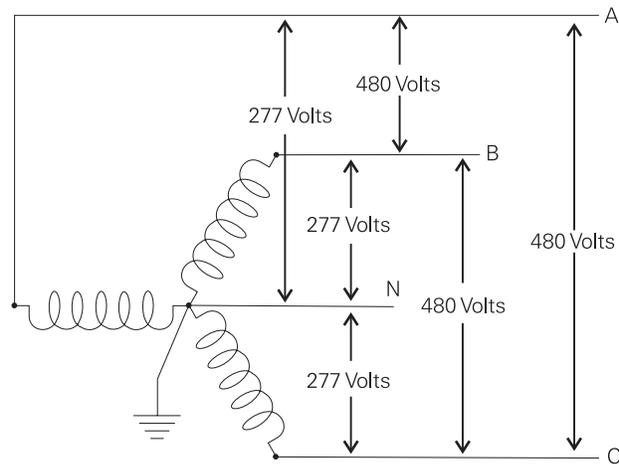
A distribution system is a system that distributes electrical power throughout a building. Distribution systems are used in every residential, commercial, and industrial building.

Distribution systems used in commercial and industrial locations are complex. A distribution system consists of metering devices to measure power consumption, main and branch disconnects, protective devices, switching devices to start and stop power flow, conductors, and transformers. Power may be distributed through various switchboards, transformers, and panelboards. Good distribution systems don't just happen. Careful engineering is required so that the distribution system safely and efficiently supplies adequate electric service to both present and possible future loads.



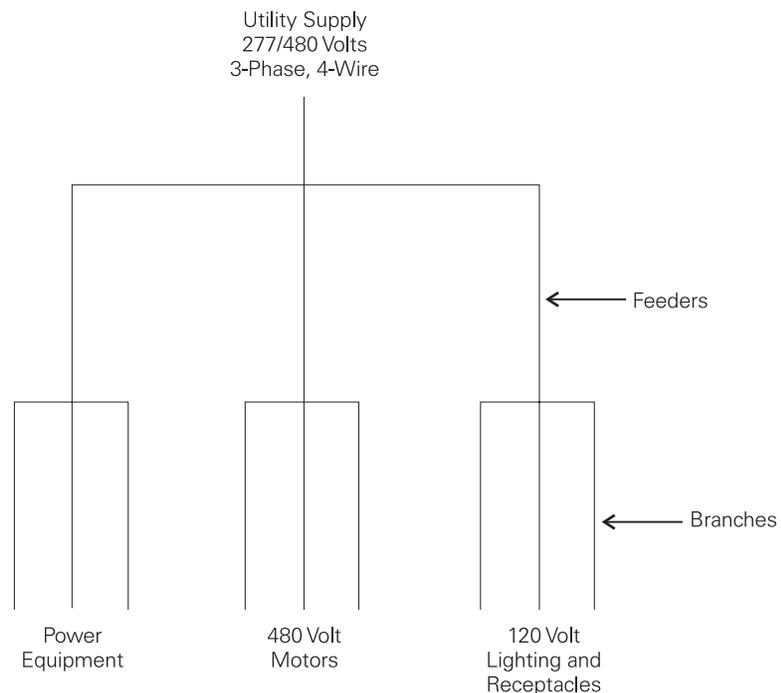
Distribution Example

In this example of a distribution system the incoming power is 277/480 volts, three-phase, four-wire. The utility company supplies power from a transformer. The secondary winding of the transformer produces 277/480 VAC.



Feeders

A feeder is a set of conductors that originate at a main distribution center and supplies one or more secondary, or one or more branch circuit distribution centers. Three feeders are used in this example. The first feeder is used for various types of power equipment. The second feeder supplies a group of 480 VAC motors. The third feeder is used for 120 volt lighting and receptacles.

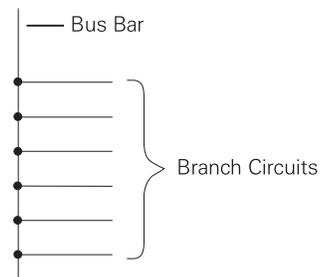


Busway Purpose and Definition

Commercial and industrial distribution systems use several methods to transport electrical energy. These methods may include heavy conductors run in trays or conduit. Once installed, cable and conduit assemblies are difficult to change. Power may also be distributed using bus bars in an enclosure. This is referred to as busway.

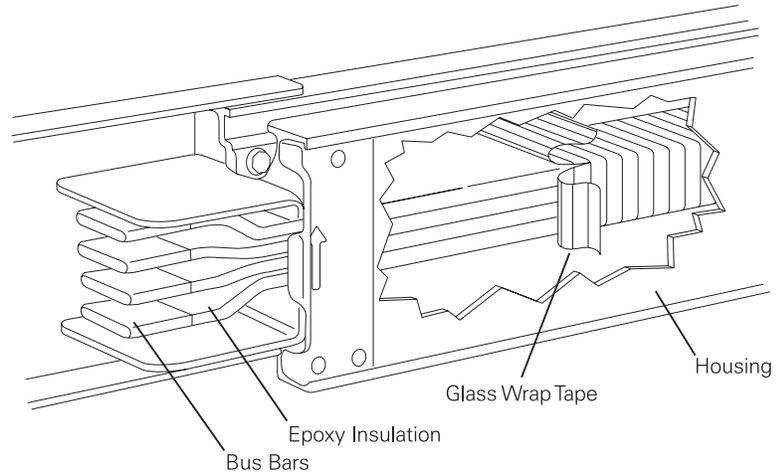
Bus Bars

A bus bar is a conductor that serves as a common connection for two or more circuits. It is represented schematically by a straight line with a number of connections made to it. Standard bus bars in Siemens busway are made of aluminum or copper.



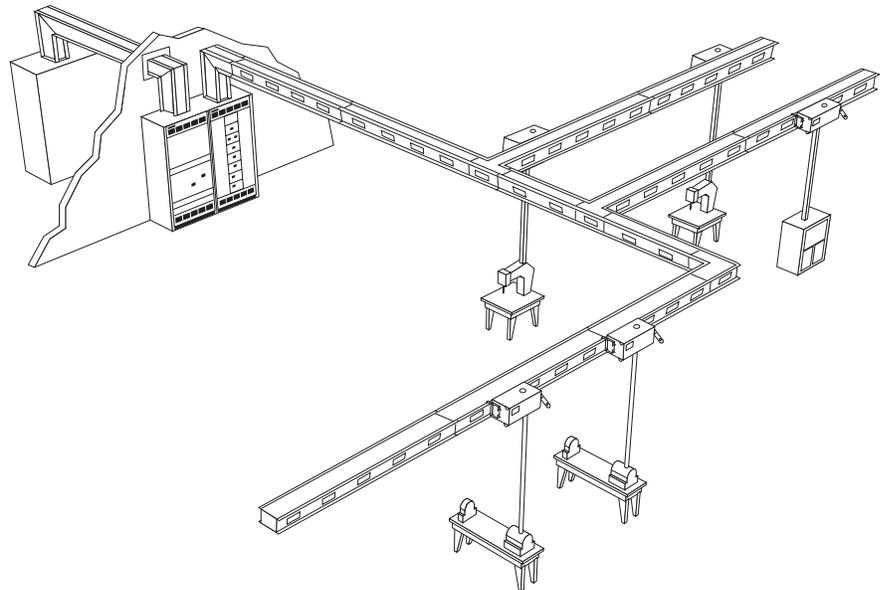
NEMA Definition

Busway is defined by the National Electrical Manufacturers Association (NEMA) as *a prefabricated electrical distribution system consisting of bus bars in a protective enclosure, including straight lengths, fittings, devices, and accessories.* Busway includes bus bars, an insulating and/or support material, and a housing.

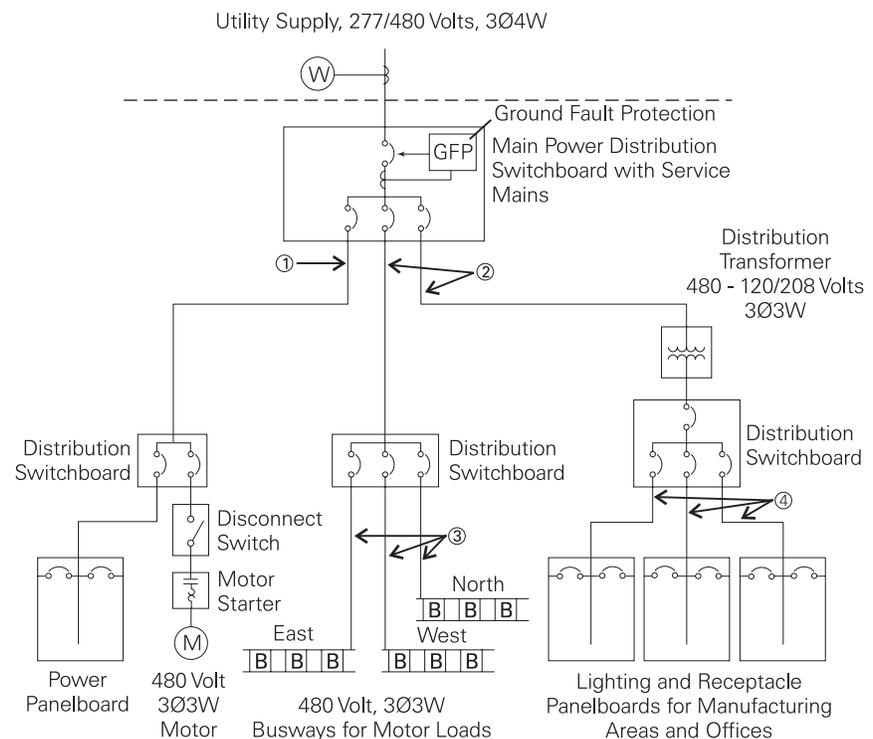


Busway Used in a Distribution System

A major advantage of busway is the ease in which busway sections are connected together. Electrical power can be supplied to any area of a building by connecting standard lengths of busway. It typically takes fewer man-hours to install or change a busway system than cable and conduit assemblies.



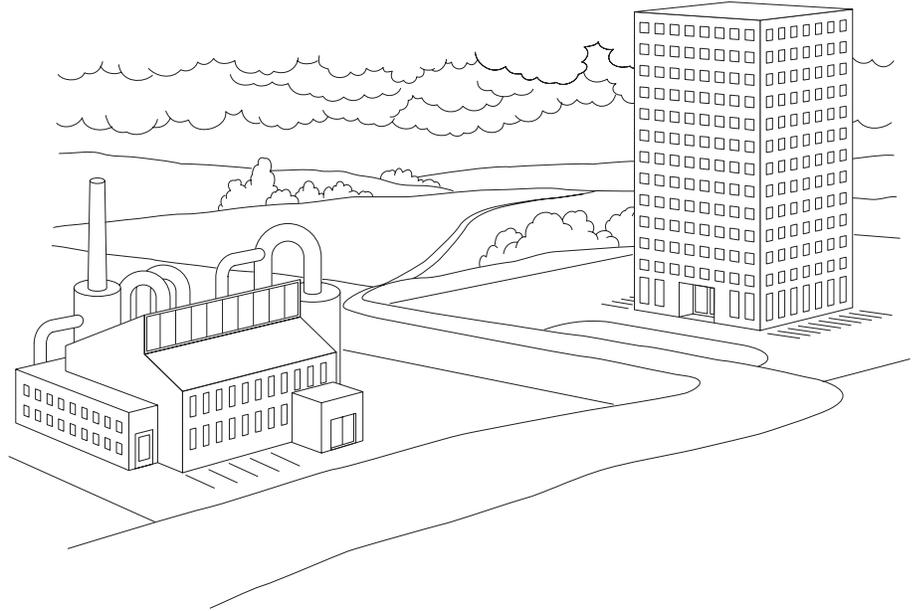
The total distribution system frequently consists of a combination of busway and cable and conduit. In this example power from the utility company is metered and enters the plant through a distribution switchboard. The switchboard serves as the main disconnecting means. The feeder on the left feeds a distribution switchboard, which in turn feeds a panelboard and a 480 volt, three-phase, three-wire (3Ø3W) motor. The middle feeder feeds another switchboard, which divides the power into three, three-phase, three-wire circuits. Each circuit feeds a busway run to 480 volt motors. The feeder on the right supplies 120/208 volt power, through a step-down transformer, to lighting and receptacle panelboards. Branch circuits from the lighting and receptacle panelboards supply power for lighting and outlets throughout the plant. In many cases busway can be used in lieu of the cable/conduit feeders at a lower cost.



Symbols			
	Circuit Breaker		Transformer
	Switch		Current Transformer
	Motor		Busway
	Motor Starter		Watt Hour Meter

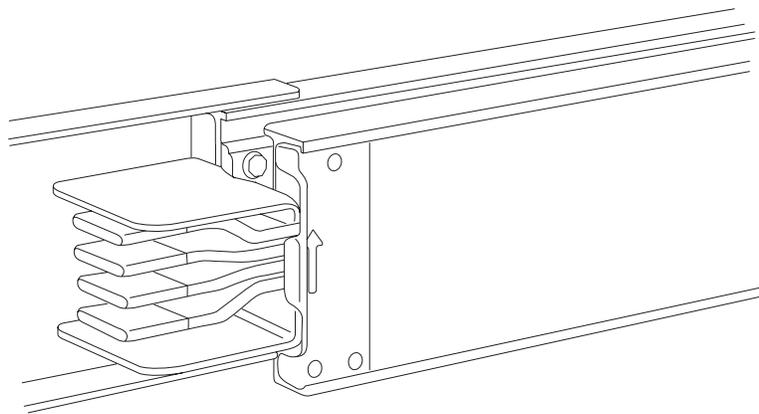
- ① 277/480 Volt 3Ø4W Feeder
- ② 480 Volt 3Ø3W Feeders
- ③ 480 Volt 3Ø3W Circuits
- ④ 120/208 Volt 3Ø4W Circuits

Busway is used in various applications and can be found in industrial installations as well as high-rise buildings. Busway used in industrial locations can supply power to heavy equipment, lighting, and air conditioning. Busway risers (vertical busway) can be installed economically in a high-rise building where it can be used to distribute lighting and air conditioning loads.



Sentron Busway

Throughout this course Siemens Sentron™ busway will be used to explain and illustrate principles and requirements of busway. Sentron busway will meet the needs of most busway systems with current ratings from 800 amperes to 5000 amperes. Siemens manufactures several types of busway. There are a number of reasons why different types of busway are manufactured. An existing pre-Sentron busway system, for example, may need to be expanded. Other types of Siemens busway, including significant features, and ratings will be discussed later in the course.

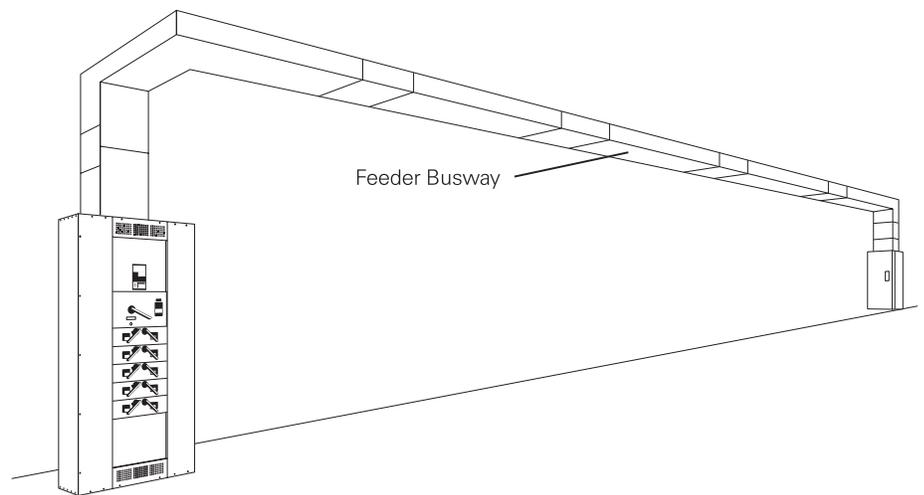


Sentron Busway

Types and Application

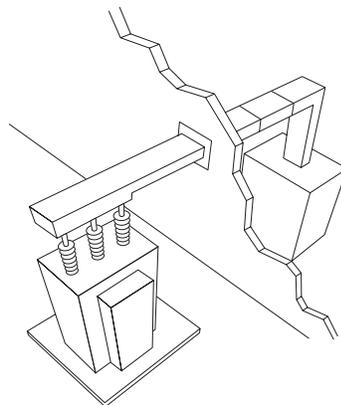
Feeder Busway

There are two types of busway, feeder and plug-in. Feeder busway is used to distribute power to loads that are concentrated in one physical area. Industrial applications frequently involve long runs from the power source to a single load. This load may be a large machine, motor control center, panelboard, or switchboard.



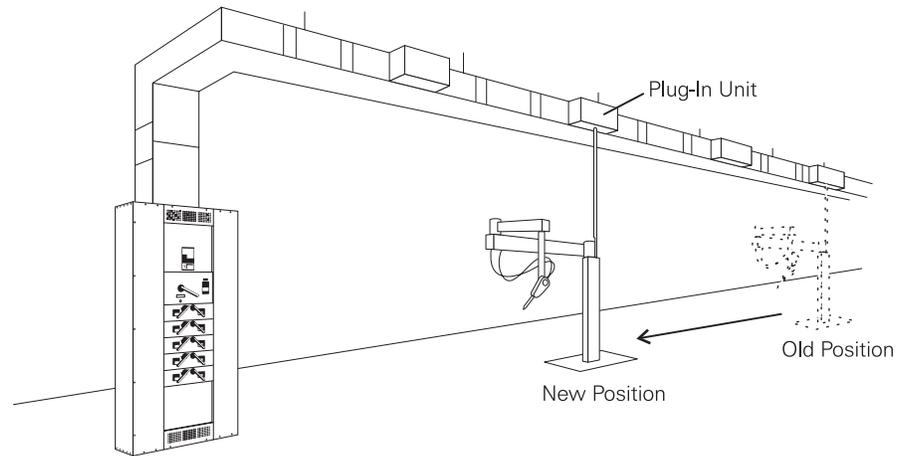
Service Entrance

The service entrance is the point of entrance of supply conductors to a building or other structure. Feeder busway, which can be purchased for indoor or outdoor use, can be used as service entrance conductors to bring power from a utility transformer to a main disconnect inside the building.



Plug-in Busway

Plug-in busway is used in applications where power requirements are distributed over a large area. Using plug-in units, load connections can be added or relocated easily. Plug-in busway is for indoor use only.



Review 1

1. A _____ _____ distributes electrical power throughout a building.
2. A _____ is a set of conductors that originate at a main distribution center and supply one or more secondary, or one or more branch circuit distribution centers.
3. _____ is a type of power distribution device that is made up of heavy bus bars in an enclosure.
4. It typically takes fewer man-hours to install or change a _____ system than cable and conduit assemblies.
5. The two types of busway are _____ and _____.
6. _____ busway can be purchased for use indoors or outdoors, _____ busway is for indoor use only.

Design Standards and Ratings

Several organizations maintain standards of design, construction, installation, and performance of busway. The following list includes some of these organizations:

Underwriters Laboratories, Inc. (UL)

The National Electrical Manufacturers Association (NEMA)

International Electrotechnical Commission (IEC)

The National Electrical Code® (NEC®)

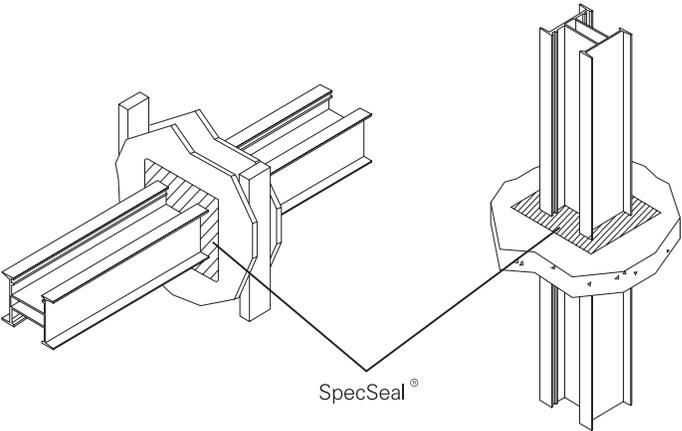
Organizations responsible for state and local electrical codes

Sentron™ busway meets the worldwide standards of UL 857, IEC 439-1, and IEC 439-2.

Underwriters Laboratories

Busway bearing the Underwriters Laboratories listing mark must pass a series of performance tests based on UL publication UL 857. These tests and standards relate to the strength and integrity of a busway system when subjected to specific operating and environmental conditions.

UL 1479 provides guidelines for a fire rating. Sentron busway has been tested in accordance with UL 1479 and offers a certified two hour fire rating for gypsum wallboard and a three hour fire rating for concrete slab or cement block. These ratings are achieved by using standard Sentron busway installed with SpecSeal® sealant from Specified Technologies, Inc.



Two Hour Fire Rating
Gypsum Wallboard

Three Hour Fire Rating
Concrete Slab

NEMA

NEMA standards for busway are listed in NEMA publication number BU 1.1-2000. NEMA is primarily associated with equipment used in North America. It is important to note that NEMA short-circuit ratings require a 3 cycle short-circuit rating. This means that the busway was tested and rated on the basis of successfully experiencing 3 cycles of peak current (I_P). NEMA recommends the following minimum short-circuit current ratings for busway.

Continuous Current Rating of Busway (Amperes)	Short-Circuit Ratings (Symmetrical Amperes)	
	Plug-In Busway	Feeder Busway
100	10,000	
225	14,000	
400	22,000	
600	22,000	42,000
800	22,000	42,000
1000	42,000	75,000
1200	42,000	75,000
1350	42,000	75,000
1600	65,000	100,000
2000	65,000	100,000
2500	65,000	150,000
3000	85,000	150,000
4000	85,000	200,000
5000		200,000

IEC

The International Electrotechnical Commission is associated with equipment sold in many countries, including the United States. IEC standards are found in IEC publications 439 and 529.

IEC also recommends short-circuit ratings for busway. Siemens manufacturers Sentron busway with continuous current ratings from 800 amperes to 5000 amperes. The following table shows the short-circuit ratings for Sentron busway. These ratings meet IEC specifications.

Continuous Current Rating of Sentron Busway (Amperes)	6 Cycle (0.1 sec.) Short-Circuit Ratings (Symmetrical Amperes)		60 Cycle (1 sec.) Short-Circuit Ratings (Symmetrical Amperes)	
	Aluminum	Copper	Aluminum	Copper
800	100,000	85,000	47,000	40,000
1000			50,000	50,000
1200	125,000	100,000	60,000	65,000
1350	150,000		75,000	80,000
1600		125,000	90,000	95,000
2000		150,000	110,000	115,000
2500	200,000	150,000	130,000	130,000
3000			160,000	175,000
4000		200,000	200,000	200,000
5000				

The following chart lists IEC and UL specifications for enclosure protection of busway.

IEC 529 - Degrees of Protection Provided by Enclosures		Approved for Sentron Busway		
Code	Description	Feeder	Plug-In	Plug-In Units
IP2X	Plug-in outlet protects against access to live parts by 12 mm (.472") test probe, even with cover opened. <u>Finger Safe.</u>	Yes	Yes	Yes
IP40	Enclosure protects against entry of 1.0 mm (.039") test probe. <u>Indoor</u> (typical UL designation).	Yes	Yes	Yes
IP54	Enclosure protects against entry of dust and splashing water. <u>Spray Proof.</u>	Yes	Yes	Yes
IP55	Enclosure protects against the entry of dust and jetted water.	Yes	No	No

UL 50 - Enclosures for Electrical Equipment		Approved for Sentron Busway		
Code	Description	Feeder	Plug-In	Plug-In Units
NEMA 3R	Outdoor use, protection against rain, sleet and damage due to ice formation.	Yes	No	No

Feeder or Plug-In

Indoor IP 40
 Spray Proof IP 54 & IP55

Feeder Only

Outdoor NEMA 3R

National Electrical Code[®]

The *National Electrical Code*[®] (sponsored by the National Fire Protection Association), once adopted by the authority having jurisdiction, stipulates installation requirements which are necessary for the safe application of electrical equipment. Article 368 of the *NEC*[®] specifically applies to busway, although other articles in the *NEC*[®] are applicable in certain situations. Thorough familiarization of the *NEC*[®] requirements for busway is recommended.

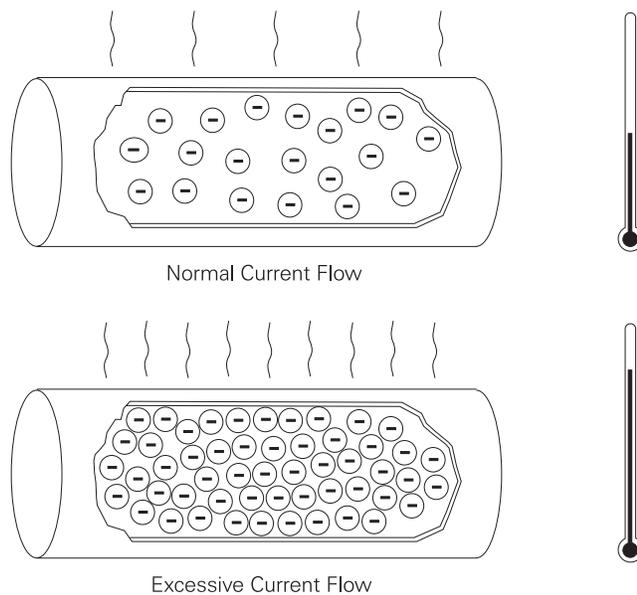
- 368.1 Scope
- 368.2 Definition
- 368.4 Use
- 368.5 Support
- 368.6 Through Walls and Floors
- 368.7 Dead Ends
- 368.8 Branches from Busways
- 368.9 Overcurrent Protection
- 368.10 Rating of Overcurrent Protection - Feeders
- 368.11 Reduction in Ampacity Size of Busway
- 368.12 Feeder of Branch Circuits
- 368.13 Rating of Overcurrent Protection - Branch Circuits
- 368.15 Marking

State and Local Codes

State and local authorities have electrical codes which are often more stringent than other organizations. You are encouraged to become familiar with this material in your local area. In addition, busway is frequently used for the main electrical service of a building, in which case the busway is connected to one or more distribution transformers owned by local electric power companies. Electrical power companies throughout the United States prefer different methods of connecting to busway. It is recommended that the local power company be contacted before applying or installing a service entrance busway run.

Circuit Protection

Circuit protection must be taken into consideration with any electrical circuit, including busway. Current flow in a conductor always generates a watts loss in the form of heat. As current flow increases, the conductor must be sized appropriately in order to compensate for higher watt losses. Excess heat is damaging to electrical components. For that reason, conductors have a rated continuous current carrying capacity or ampacity. Overcurrent protection devices are used to protect conductors from excessive current flow. Two devices used to protect circuits from overcurrent are fuses and circuit breakers. These protective devices are designed to limit the flow of current in a circuit to a safe level, preventing the circuit conductors from overheating.



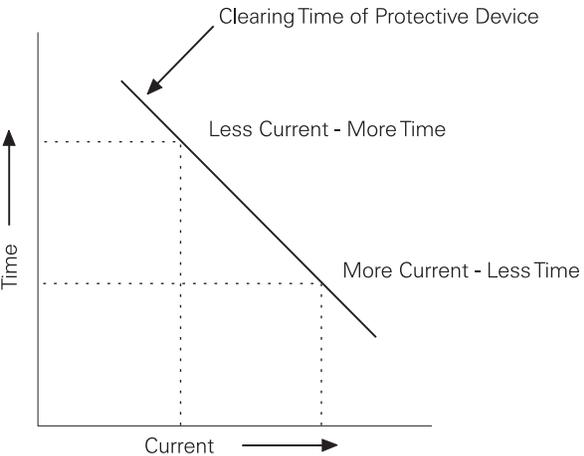
The *National Electrical Code*[®] defines overcurrent as *any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault* (Article 100-definitions).

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Circuit protection would be unnecessary if overloads and short circuits could be eliminated. Unfortunately, overloads and short circuits do occur. To protect a circuit against these currents, a protective device must determine when a fault condition develops and automatically disconnect the electrical equipment from the voltage source.

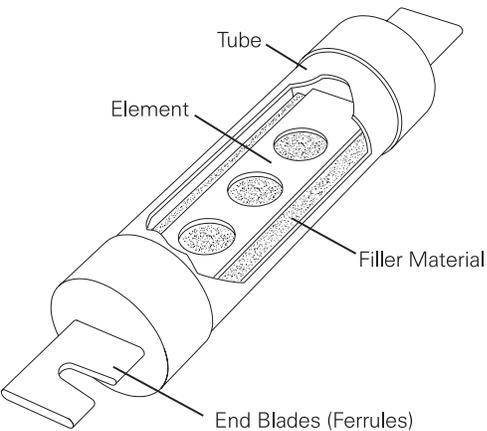
Inverse Time-Current Characteristic

An overcurrent protection device must be able to recognize the difference between overcurrents and short circuits and respond in the proper way. Protection devices use an inverse time-current characteristic. Slight overcurrents can be allowed to continue for some period of time, but as the current magnitude increases, the protection device must open faster. Short circuits must be interrupted instantly.



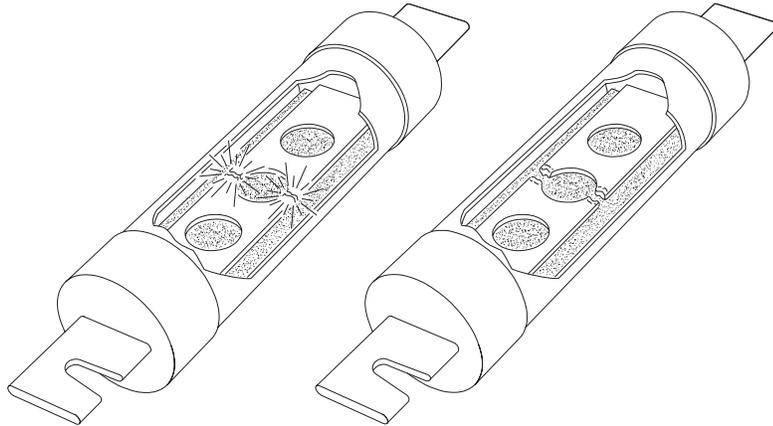
Fuse Construction

A fuse is the simplest device for interrupting a circuit experiencing an overload or a short circuit. A typical fuse, like the one shown below, consists of an element electrically connected to end blades or ferrules. The element provides a current path through the fuse. The element is enclosed in a tube and surrounded by a filler material.



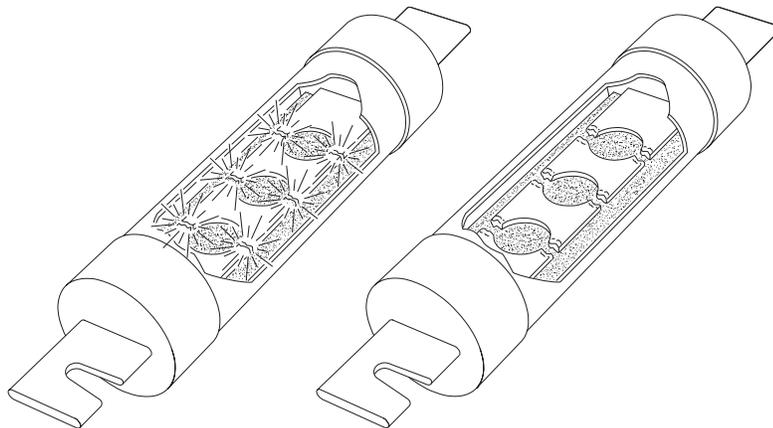
Overcurrent

Current flowing through the element generates heat, which is absorbed by the filler material. When an overcurrent occurs temperature in the element rises. In the event of a harmless transient overload condition the excess heat is absorbed by the filler material. If a sustained overload occurs the heat will eventually melt open an element segment forming a gap; thus stopping the flow of current.



Short-Circuit Current

Short-circuit current can be several thousand amperes and generates extreme heat. When a short circuit occurs several element segments can melt simultaneously, which helps remove the load from the source voltage quickly. Short-circuit current is typically cut off in less than half a cycle, before it can reach its full value.



Nontime-Delay Fuses

Nontime-delay fuses provide excellent short circuit protection. Short-term overloads, such as motor starting current, may cause nuisance openings of nontime-delay fuses. They are best used in circuits not subject to large transient surge currents. Nontime-delay fuses usually hold 500% of their rating for approximately one-fourth second, after which the current carrying element melts. This means that these fuses should not be used in motor circuits which often have inrush (starting) currents greater than 500%.

Time-Delay Fuses

Time-delay fuses provide overload and short circuit protection. Time-delay fuses usually allow five times the rated current for up to ten seconds. This is normally sufficient time to allow a motor to start without nuisance opening of the fuse unless an overload persists.

Ampere Rating

Fuses have a specific ampere rating, which is the continuous current carrying capability of a fuse. The ampere rating of a fuse, in general, should not exceed the current carrying capacity of the circuit. For example, if a conductor is rated for 10 amperes, the largest fuse that would be selected is 10 amperes.

There are some specific circumstances when the ampere rating is permitted to be greater than the current carrying capacity of the circuit. For example, motor and welder circuits can exceed conductor ampacity to allow for inrush currents and duty cycles within limits established by the *NEC*[®].

Sentron Fusible Switches

Plug-in fusible switches are available on Siemens busway. Sentron[™] fusible switches, for example, are rated from 30 - 600 amperes.

Voltage Rating

The voltage rating of a fuse must be at least equal to the circuit voltage. The voltage rating of a fuse can be higher than the circuit voltage, but never lower. A 600 volt fuse, for example, can be used in a 480 volt circuit. A 250 volt fuse could not be used in a 480 volt circuit.

Ampere Interrupting Capacity (AIC)

Fuses are also rated according to the level of fault current they can interrupt. This is referred to as ampere interrupting capacity (AIC). When applying a fuse, one must be selected which can sustain the largest potential short circuit current which can occur in the selected application. The fuse could rupture, causing extensive damage, if the fault current exceeds the fuse interrupting rating.

UL Fuse Classification

Fuses are grouped into current limiting and non-current limiting classes based on their operating and construction characteristics. Fuses that incorporate features or dimensions for the rejection of another fuse of the same ampere rating but with a lower interruption rating are considered current limiting fuses. Underwriters Laboratories (UL) establishes and standardizes basic performance and physical specifications to develop its safety test procedures. These standards have resulted in distinct classes of low voltage fuses rated at 600 volts or less. The following chart lists various UL fuse classes.

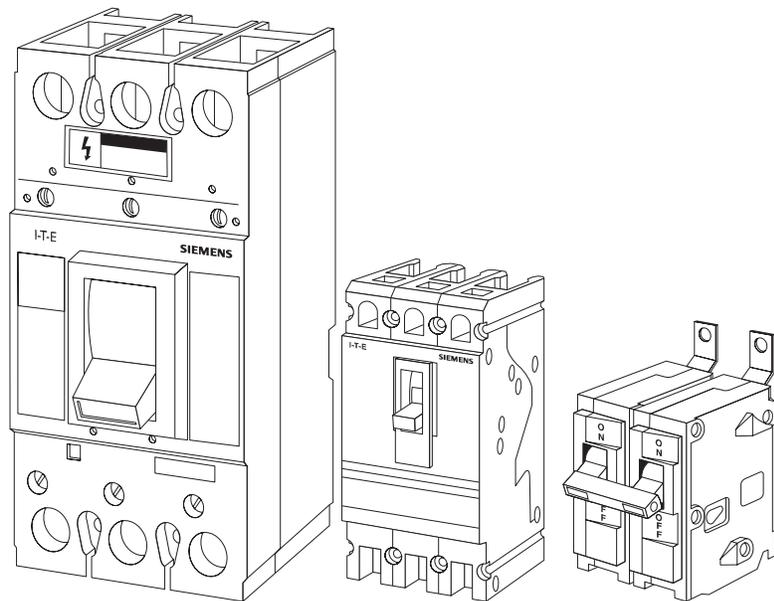
Class	Voltage Rating	Ampere Rating	Interrupting Rating (Amps)	Sub Classes	UL Standard
G*	300	0-60	100,000		UL 198 C
H	250, 600	0-600	10,000	Renewable Non renewable	UL 198 B
J*	600	0-600	200,000		UL 248 B
K	250, 600	0-600	50,000 or 100,000, or 200,000	K1 and K5	UL 198 D
L*	600	601-6000	200,000		UL 248 10
R*	250, 600	0-600	200,000	RK1 and RK5	UL 248 12
T*	300	0-1200	200,000		UL 248 15
T*	600	0-800	200,000		UL 248 15
CC*	600	0-30	200,000		UL 248 4
Plug	125	0-30	10,000	Edison Base and Type S	UL 198 F

*Current Limiting Fuses

Circuit Breakers

Another device used for overcurrent protection is a circuit breaker. The *National Electrical Code*® defines a circuit breaker as *a device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating* (Article 100 - definitions).

Circuit breakers provide a manual means of energizing and deenergizing a circuit. In addition, circuit breakers provide automatic overcurrent protection of a circuit. A circuit breaker allows a circuit to be reactivated quickly after a short circuit or overload is cleared. Unlike fuses which must be replaced when they open, a simple flip of the breaker's handle restores the circuit.



Ampere Rating

Like fuses, every circuit breaker has a specific ampere, voltage, and fault current interruption rating. The ampere rating is the maximum continuous current a circuit breaker can carry without exceeding its rating. As a general rule, the circuit breaker ampere rating should match the conductor ampere rating. For example, if the conductor is rated for 20 amperes, the circuit breaker should be rated for 20 amperes. Siemens I-T-E® breakers are rated on the basis of using 60° C or 75° C conductors. This means that even if a conductor with a higher temperature rating were used, the ampacity of the conductor must be figured on its 60° C or 75° C rating.

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There are some specific circumstances when the ampere rating is permitted to be greater than the current carrying capacity of the circuit. For example, motor and welder circuits can exceed conductor ampacity to allow for inrush currents and duty cycles within limits established by *NEC*[®].

Generally the ampere rating of a circuit breaker is selected at 125% of the continuous load current. This usually corresponds to the conductor ampacity which is also selected at 125% of continuous load current. For example, a 125 ampere circuit breaker would be selected for a load of 100 amperes.

Sentron MCCB Plug-In Units

Plug-in devices with molded case circuit breakers (MCCB) are available on Sentron busway with circuit breaker ratings from 125 - 800 amperes.

Voltage Rating

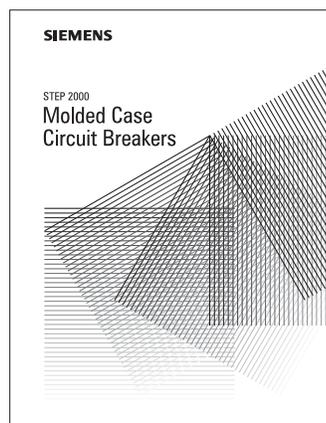
The voltage rating of the circuit breaker must be at least equal to the circuit voltage. The voltage rating of a circuit breaker can be higher than the circuit voltage, but never lower. For example, a 480 VAC circuit breaker could be used on a 240 VAC circuit. A 240 VAC circuit breaker could not be used on a 480 VAC circuit. The voltage rating is a function of the circuit breakers ability to suppress the internal arc that occurs when the circuit breaker's contacts open.

Fault Current Interrupting Rating

Circuit breakers are also rated according to the level of fault current they can interrupt. When applying a circuit breaker, one must be selected which can sustain the largest potential short circuit current which can occur in the selected application. Siemens circuit breakers have interrupting ratings from 10,000 to 200,000 amperes. To find the interrupting rating of a specific circuit breaker refer to the Speedfax[®] catalog.

Additional Information

For additional information on circuit breakers refer to the STEP 2000 course, **Molded Case Circuit Breakers**.



Review 2

1. In accordance with UL 1479, Sentron busway offers a _____ hour fire rating for gypsum wallboard, and a _____ hour fire rating for concrete slab when used with SpecSeal® sealant.
2. Sentron busway, with a continuous current rating of 800 amperes and aluminum bus bars, has a 60 cycle short-circuit rating of _____ amperes.
3. The highest level of enclosure protection of Sentron feeder busway is IP _____ and the highest level of enclosure protection of Sentron plug-in busway is IP _____ .
4. Article _____ in the *National Electrical Code*® specifically applies to busway.
5. A Class R has an ampere interrupting capacity of _____ amperes.
6. Siemens circuit breakers have a fault current interrupting capacity of _____ to _____ amperes.