Siemens STEP 2000 Course

Safety Switches

It's easy to get in STEP!

1. Download any course.
   Hint: Make sure you download all parts for each course and the test answer form.
2. Complete each chapter and its review section
3. Print the test answer form, take the final exam and fill in the form.
   Hint: The final exam is always at the end of the last part.
4. Send your test answer form to EandM for grading. If you achieve a score of 70% or better, we'll send you a certificate of completion! If you have any questions, contact EandM Training at 866.693.2636 or fax 707.473.3190 or training@eandm.com.

Need more information? Contact **EandM** at
866.693.2636
or fax 707.473.3190
or sales@eandm.com
for product information, quotes,
classroom training courses and more.

STEP 2000 Courses distributed by
www.eandm.com

Table of Contents

Introduction

Welcome to another course in the STEP (**S**iemens **T**echnical **E**ducation **P**rogram) series, designed to prepare our distributors to sell Siemens Energy & Automation products more effectively. This course covers **Safety Switches** and related products.

Upon completion of **Safety Switches** you should be able to:

- Explain the need for circuit protection
- Identify fuse types and classes
- Explain the basic construction and operation of a Siemens safety switch
- Explain the operation and benefit of Siemens VBII Safety Switches and visible blade designs
- Identify various types of Siemens safety switches
- Explain the difference between fusible and non-fusible safety switches
- Identify circuit protection ratings for various types of Siemens safety switches
- Identify safety switch accessories

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 Safety Switches. An understanding of many of the concepts covered in Basics of Electricity is required for Safety Switches.

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.

Speedfax is a registered trademark of Siemens Energy & Automation, Inc.

National Electrical Code ® and NEC ® are registered trademarks of the National Fire Protection Association, Quincy, MA 02269. Portions of the National Electrical Code are reprinted with permission from NFPA 70-2005, National Electrical Code Copyright ©, 2004, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association on the referenced subject which is represented by the standard in its entirety.

Underwriters Laboratories Inc. and UL are registered trademarks of Underwriters Laboratories Inc., Northbrook, IL 60062.

Other trademarks are the property of their respective owners.

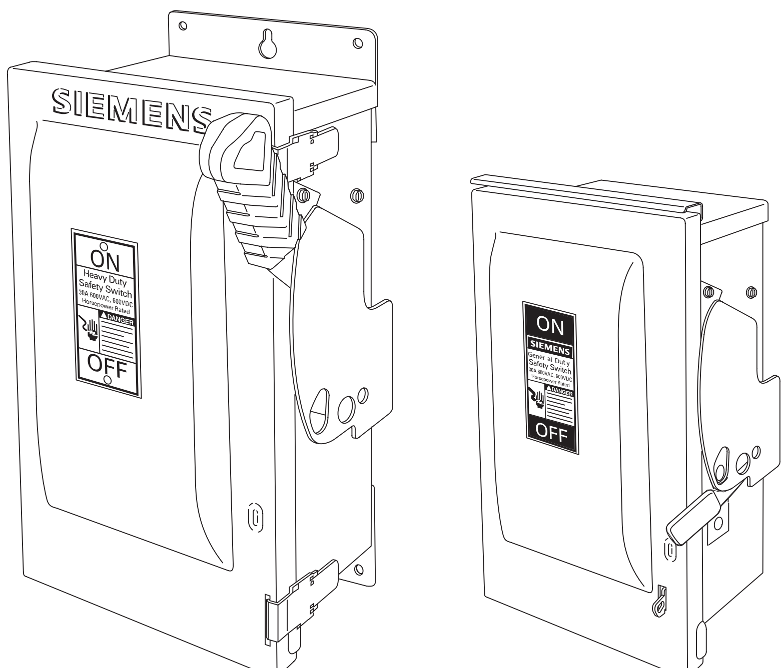
National Electrical Manufacturers Association is located at 2101 L. Street, N.W., Washington, D.C. 20037. The abbreviation “NEMA” is understood to mean National Electrical Manufacturers Association.

Siemens Safety Switches

A switch is generally used for two purposes:

1) A disconnecting means for a service entrance
2) A disconnecting means and fault protection for motors

A safety switch is simply a switch located in its own enclosure. The enclosure provides a degree of protection to personnel against incidental contact with live electrical equipment. It also provides protection to the enclosed equipment against specific environmental conditions. Safety switches may consist of a switch only, or may consist of a switch and fuses. There are two families of Siemens safety switches: general duty and heavy duty.

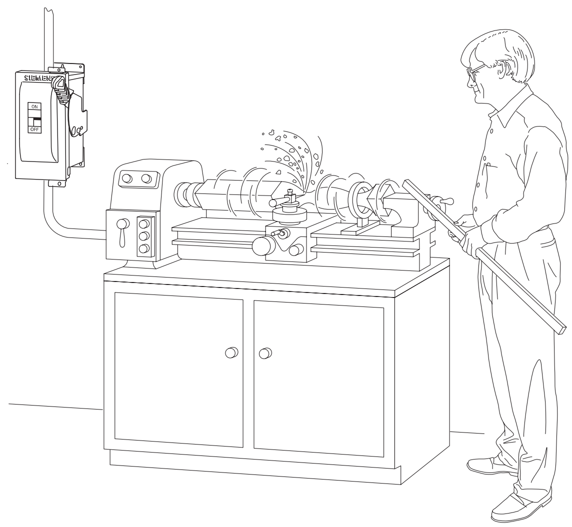


Heavy Duty

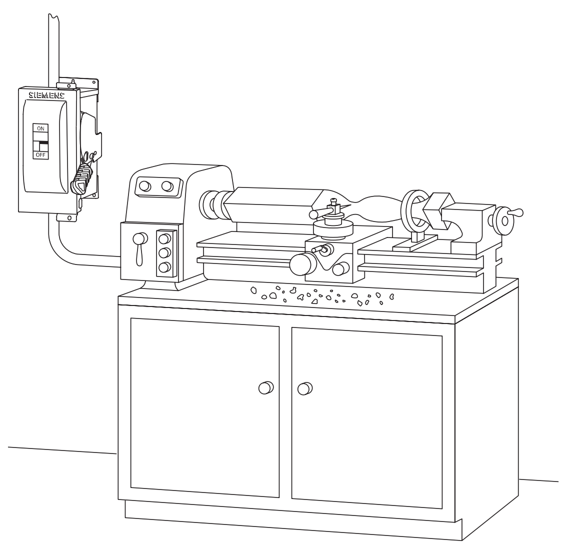
General Duty

Application

Safety switches can be used in any number of applications. The *National Electrical Code®* (*NEC®*), for example, requires that a disconnecting means shall be located in sight from the motor location and the driven machinery location (Article 430.102(B)). The *NEC®* defines "in sight" as visible and not more than 50 feet (15.24 m) distant (Article 100 - definitions). Regardless of where the safety switch is used, the function is to provide a means to connect and disconnect the load from its source of electrical power.



With power removed the operator can safely service the machinery without coming into contact with live electrical components or having the motor accidently start.



NEC® and the *National Electrical Code®* are registered trademarks of the National Fire Protection Association. Reprinted with permission from NFPA 70-2005, the *National Electrical Code®*, Copyright© 2004, National Fire Protection Association, Quincy, MA 02269.

Additional Information

This book offers an introduction to Safety Switches, but more information is available from your local Siemens sales representative.

Among the booklets available are the Safety Switch Application and Selection Guide, the Safety Switch Cross-Reference Guide, and the Safety Switch Replacement Parts Guide.

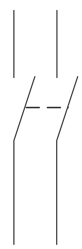
World Wide Web

Information is also available by visiting the Siemenes Energy & Automation web site, at www.sea.siemens.com/dpd.

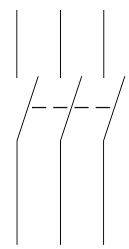
Switch Symbols

Switch Symbols

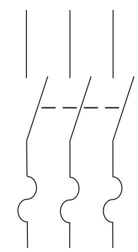
Symbols are used in a diagram to represent components. The symbol commonly used for a disconnect switch is shown below. The switch is normally shown in its "Off," or "Open" state.



Two-Pole Non-Fused Switch



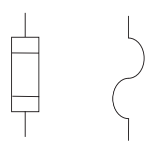
Three-Pole Non-Fused Switch



Three-Pole Fused Switch

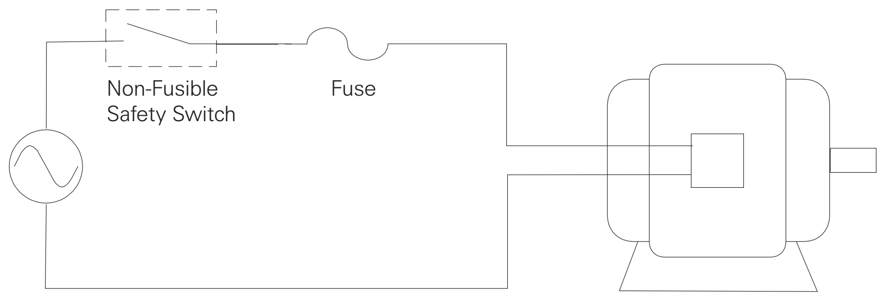
Fuse Symbols

Fuses are represented in an electrical circuit by either of the following symbols:



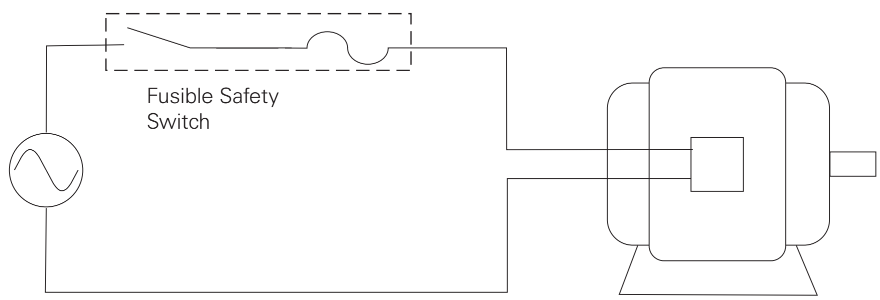
Non-Fusible Safety Switch

A switch with no associated fuses is referred to as a non-fusible safety switch. A non-fusible safety switch has no circuit protection capability. It simply provides a convenient means to open and close a circuit. Opening the circuit disconnects the load from its source of electrical power, while closing the circuit connects the load. Circuit protection must be provided by external overcurrent devices such as circuit breakers or fuses. In the following illustration, power is supplied to a motor through a non-fusible safety switch and a separate fuse.



Fusible Safety Switch

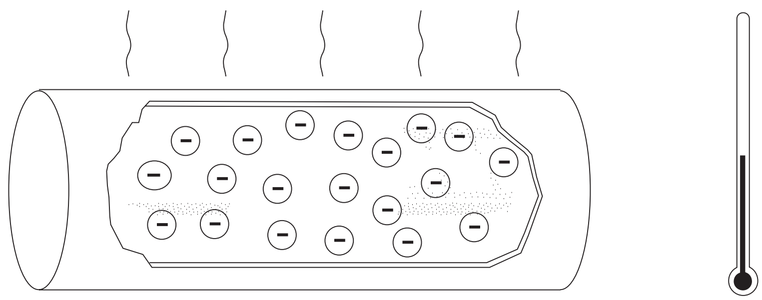
A safety switch can be combined with fuses in a single enclosure. This is referred to as a fusible safety switch. The switch provides a convenient means to manually open and close the circuit, while the fuse provides overcurrent protection.



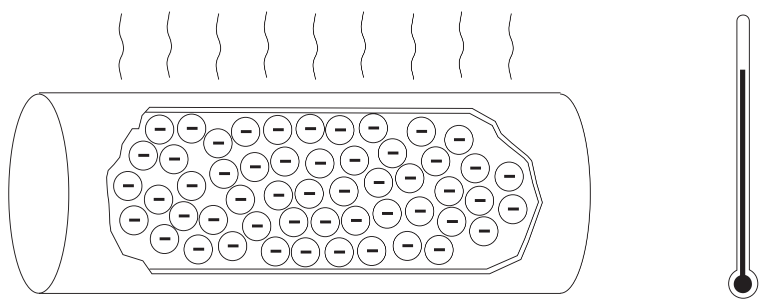
Need For Circuit Protection

Current and Temperature

Current flow in a conductor always generates heat. The greater the current flow in a given size conductor, the hotter the conductor. Excess heat is damaging to electrical components and conductor insulation. For this reason conductors have a rated continuous current carrying capacity, or ampacity. Overcurrent protection devices, such as fuses, are used to protect conductors from excessive current flow. Fuses are designed to keep the flow of current in a circuit at a safe level to prevent the circuit conductors from overheating.



Normal Current Flow



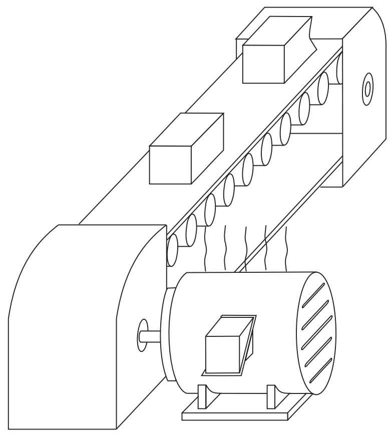
Excessive Current Flow

Excessive current is referred to as overcurrent. 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).

Reprinted with permission from NFPA 70-2005, the *National Electrical Code®*, Copyright© 2004, National Fire Protection Association, Quincy, MA 02269.

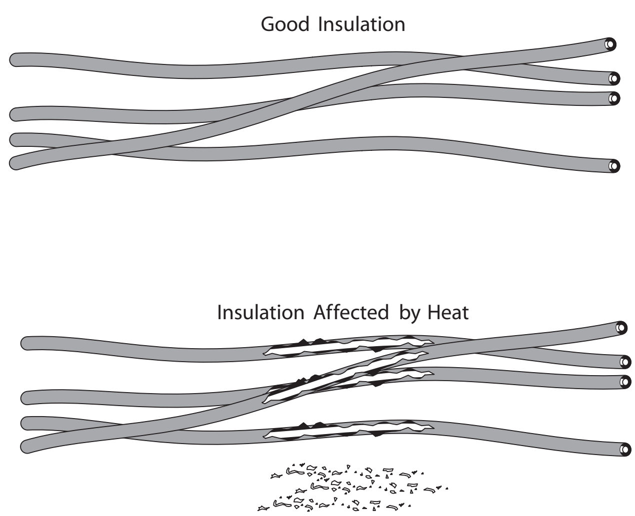
Overloads

An overload occurs when too many devices are operated on a single circuit, or if a piece of electrical equipment is made to work harder than it is designed to work. For example, a motor rated for 10 amperes may draw 20, 30, or more amperes in an overload condition. In the following illustration, a package has become jammed on a conveyor, causing the motor to work harder and draw more current. Because the motor is drawing more current, it heats up. Damage will occur to the motor in a short time if the problem is not corrected, or if the circuit is not shut down by the overcurrent protector.



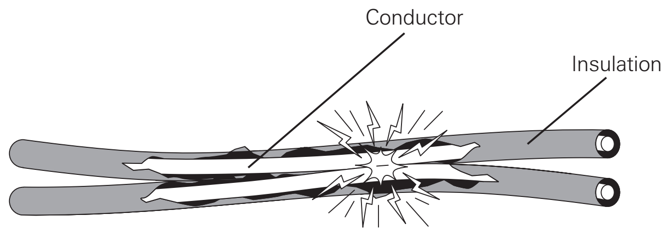
Conductor Insulation

Motors, of course, are not the only devices that require circuit protection for an overload condition. Every circuit requires some form of protection against overcurrent and the heat it produces. For example, high levels of heat to insulated wire can cause the insulation to break down and flake off, exposing the conductors.



Short Circuits

When exposed conductors touch, a short circuit occurs, and the circuit resistance drops to nearly zero. Because of this very low resistance, short circuit current can be thousands of times higher than normal operating current.



Ohm's Law shows the relationship of current, voltage, and resistance. For example, a 240 volt motor with 24 Ω(ohms) of resistance would normally draw 10 amperes of current.

$$I = \frac{E}{R}$$

$$I = \frac{240}{24}$$

$$I = 10\ A$$

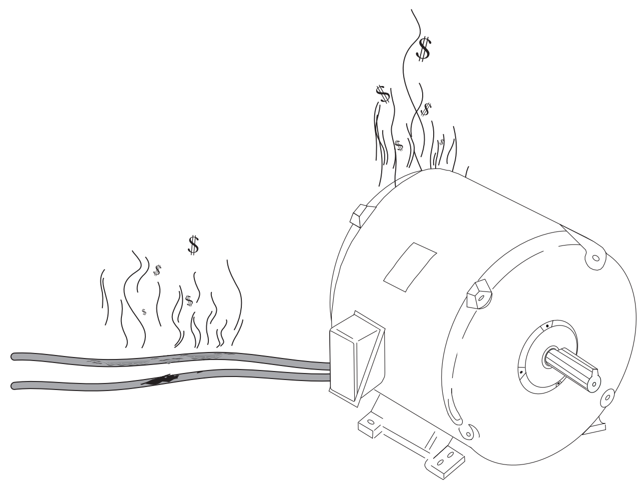
When a short circuit occurs, resistance drops dramatically. For example, if the above resistance dropped to 24 milliohms due to a short circuit, the current would increase to 10,000 amperes.

$$I = \frac{240}{.024}$$

$$I = 10{,}000\ A$$

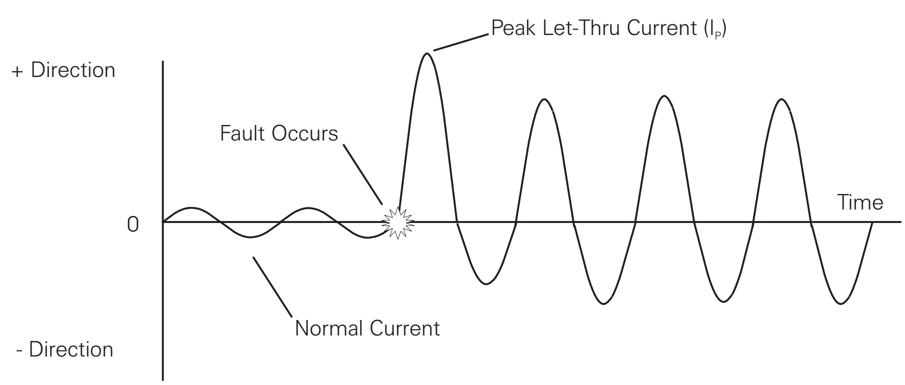
Preventing Damage

The heat generated by short-circuit current can rise to dangerous levels quickly, causing extensive damage to conductors and connected equipment. This heat-generating current must be interrupted as soon as possible after a short circuit occurs. Slight overcurrents can be allowed to continue for some period of time, but as the overcurrent magnitude increases, the protection device must act more quickly. In order to minimize costly damage, outright short circuits must be interrupted almost instantaneously.

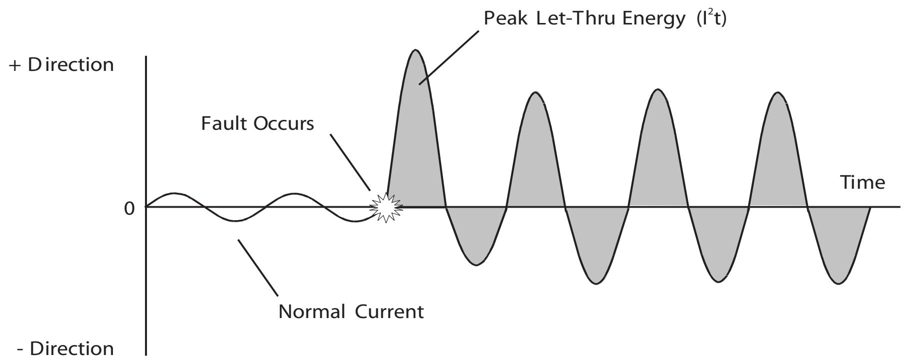


Short-Circuit Current in Unprotected Electrical Circuits

When a short circuit occurs in an unprotected circuit, current will continue to flow until the circuit is damaged, or until the power is removed manually. The peak short-circuit current of the first cycle is the greatest, and is referred to as peak let-through current (I_P). The electromagnetic force associated with this current can cause mechanical damage to electrical components.

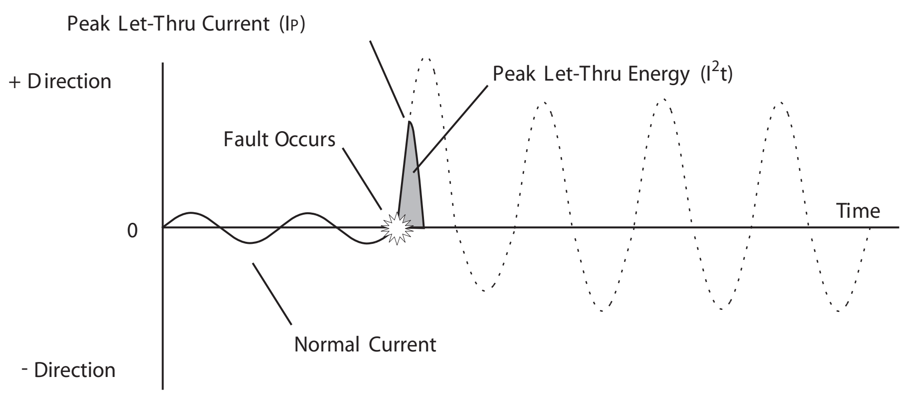


The maximum destructive energy let-through, I^2t, is a measure of the energy associated with this current. It is capable of producing enough heat to melt conductors.



Short-Circuit Current in Protected Electrical Circuits

A properly used overcurrent protecting device will open the circuit quickly, limiting peak let-through current (I_P) and energy (I^2t).



Article 240

Article 240 of the *NEC*® covers overcurrent protection. You are encouraged to become familiar with this material. Article 240.1 (FPN) states that overcurrent protection for conductors and equipment is provided to open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation.

Reprinted with permission from NFPA 70-2005, the *National Electrical Code*®, Copyright© 2004, National Fire Protection Association, Quincy, MA 02269.

Ampacities of Insulated Conductors

How hot an insulated conductor can get before it sustains damage needs to be known. Conductors are rated by how much current they can carry on a continuous basis, known as ampacity. The following illustration is from NEC® Table 310.16. For example, a #8 American Wire Gauge (AWG) copper conductor with Type THW insulation is rated for 50 amperes at 75° C. A #1 AWG copper conductor with Type THW insulation rated at 75° C can carry 130 amperes. To avoid overloads and prevent insulation damage, it is necessary to keep the current from exceeding the conductor's continuous current rating.

Table 310.16 (partial). Allowable Ampacities of Insulated Conductors Rated 0 through 2000 Volts, 60ºC through 90ºC (140ºF through 194ºF) Not More than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30ºC (86ºF)

Size	Temperature Rating of Conductor		
AWG or kcmil	60ºC (140ºF)	75ºC (167ºF)	90ºC (194ºF)
	Types TW, UF	Types FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2
	COPPER		
18	—	—	14
16	—	—	18
14	20	20	25
12	25	25	30
10	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95
3	85	100	110
2	95	115	130
1	110	130	150
1/0	125	150	170
2/0	145	175	195
3/0	165	200	225
4/0	195	230	260

NEC® Table 1 of Table 310.16 gives ampacities under two conditions: the raceway contains not more than three conductors, plus neutral, and the ambient temperature is not more than 30° C (86° F). If either of these two conditions is exceeded, the values shown must be reduced using derating values provided by *NEC*® (not shown here).

Sizing Conductors and Overcurrent Devices

According to the *NEC*®, a continuous load is *a load where the maximum current is expected to continue for three hours or more* (Article 100 - Definitions). The *National Electrical Code*® provides an example of conductor sizing and the rating of overcurrent protective devices in Article 210.20(A), which has to do with branch circuits. The rating of a branch-circuit overcurrent device serving continuous loads, such as store lighting, shall be not less than the noncontinuous load plus 125% of the continuous load.

Exception: Circuits supplied by an assembly and overcurrent devices that are listed for continuous operation at 100% of their ratings. In this case, the continuous and noncontinuous loads are simply added.

In general, an electrical conductor must be capable of carrying 125% of the full-load current. In a branch circuit, continuous loads such as mercantile lighting must not exceed 80% of the circuit rating. If an electric lighting circuit, for example, had a continuous current rating of 100 amperes, then the conductor would be sized to carry at least 125 amperes. In this example 100 amperes (lighting circuit load) is 80% of 125 amperes (conductor ampacity).

Electric Lighting Circuit Rating = 100 amperes

Conductor Ampacity = 125 amperes (100 amperes x 125%)

There are exceptions and the *NEC*® must be consulted for each application. The exception given in the previous paragraph, for example, provides for 100% rating of a circuit if it is supplied by an overcurrent device and assembly rated for continuous operation. (This rating must be done by a qualified testing laboratory.)

For more information on conductor sizing, see *NEC*® Articles 210.19(A), 210.20(A), and 384.16(D) in the 2005 code book.

Reprinted with permission from NFPA 70-2005, the *National Electrical Code*®, Copyright© 2004, National Fire Protection Association, Quincy, MA 02269.

Review 1

1. A safety switch with fuses in a single enclosure is referred to as a ____________ safety switch.

2. *NEC*® defines "in sight" as visible and not more than ____________ feet distant.

3. With an increase in current, heat will

   a. increase
   b. decrease
   c. remain the same

4. Two causes of overcurrent are ____________ and ____________ ____________ .

5. A ____________ ____________ occurs when two bare conductors touch.

6. An ____________ occurs when electrical equipment is required to work harder than it is rated.

7. The peak short circuit current of the first cycle is known as ____________ ____________ - ____________.

8. Peak let-thru ____________ is a destructive thermal force.

9. Article ____________ of the *NEC*® covers overcurrent protection.

10. Table ____________ of the *NEC*® gives ampacities of insulated conductors.

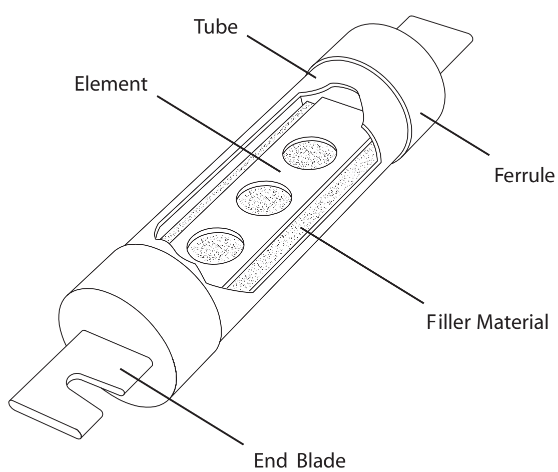
11. In general, the electrical conductor must be capable of carrying ____________ % of the full-load current.

Fuses

Circuit protection would be unnecessary if overloads and short circuits could be eliminated. Unfortunately, they do occur. To protect a circuit against these destructive currents, a protective device must determine when a fault condition develops and automatically disconnect the electrical equipment from the power source. A fuse is the simplest device for interrupting a circuit experiencing an overload or a short circuit.

Fuse Construction

A typical fuse, like the one shown below, consists of an element electrically connected to ferrules. These ferrules may also have attached end blades. The element provides a current path through the fuse. It is enclosed in a tube, and surrounded by a filler material.

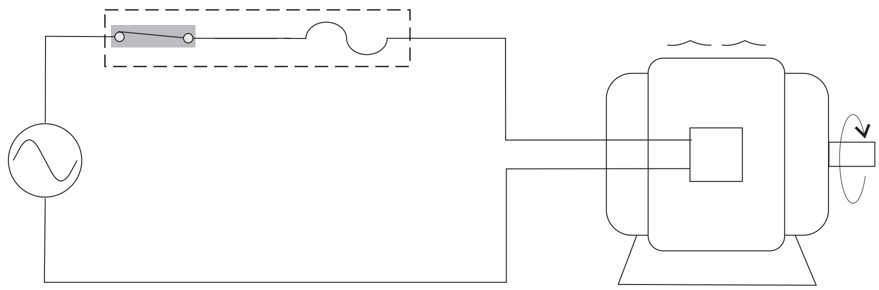


Closed Switch Symbol

As mentioned earlier, switches are normally shown in their "Off" or "Open" position. For the purpose of illustration, the following symbol can be used to show a switch closed, connecting the load to the power source. This is not a legitimate symbol. It is used here for illustrative purposes only.

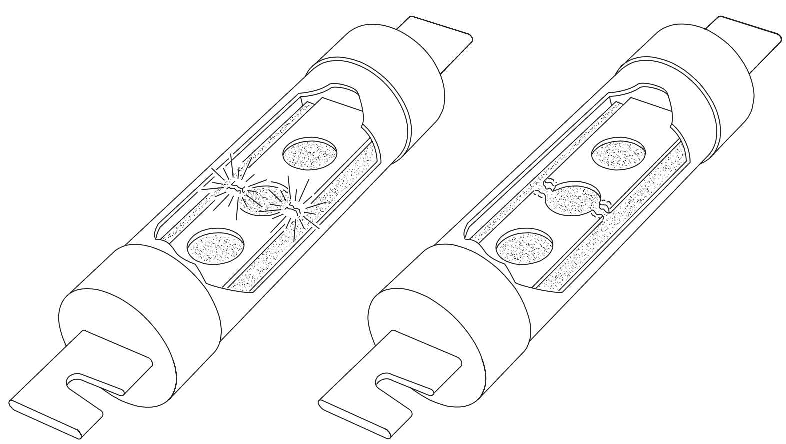
Using a Fuse in a Circuit

In the following example a motor is connected to a voltage source through a fusible safety switch. The switch and fuse function as part of the conductor supplying power to the motor.



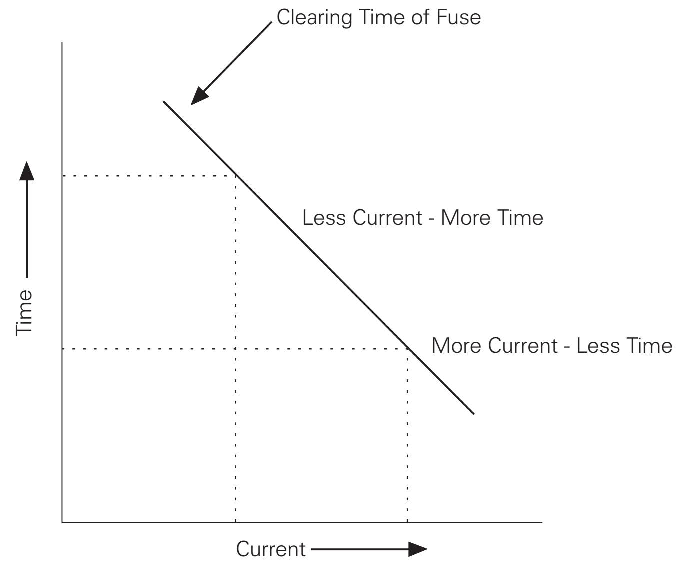
Fuse Subject to Overcurrent

Current flowing through the fuse element generates heat, which is absorbed and dissipated by the filler material. When an overcurrent occurs, temperature in the element rises. In the event of a transient overload condition the excess heat is absorbed by the filler material. However, if a sustained overload occurs, the heat will eventually melt open an element segment. This will stop the flow of current.



Fuse Clearing Time

Fuses have an inverse time-current characteristic. The greater the overcurrent, the less time it takes for the fuse to open. This is referred to as the clearing time of the fuse.

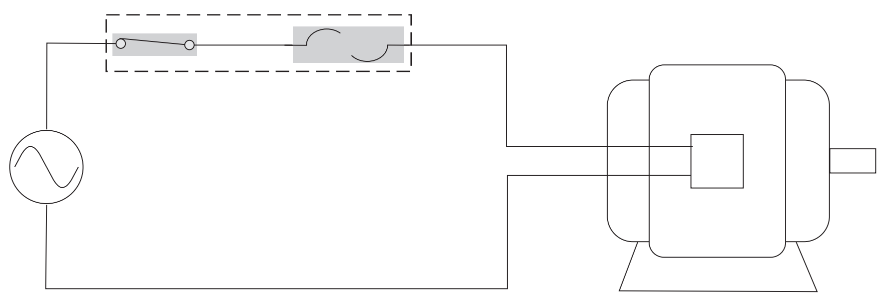


Open Fuse Symbol

For the purpose of explanation the following symbol is used to show an open fuse. This is not a legitimate symbol. It is used here for illustrative purposes only.

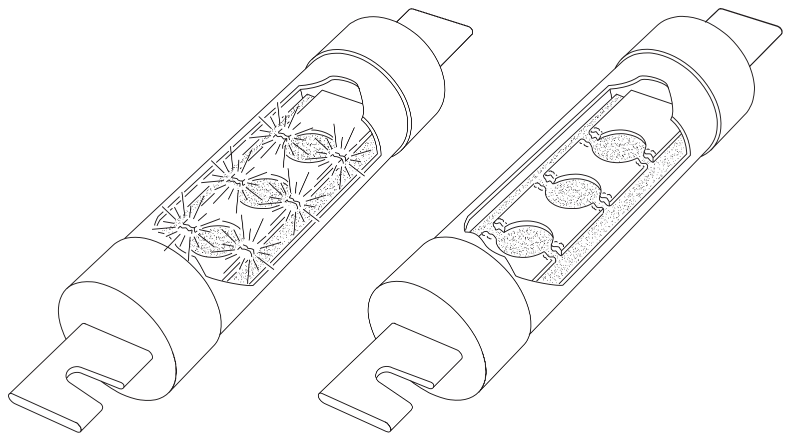
Overload Current

Returning to the example of a motor circuit, if an overload occurs, temperature will rise in the fuse, eventually causing it to open. Power will be removed from the motor, which will coast to a stop.



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 power source 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. However, short-term overloads, such as motor starting current, may cause nuisance openings of nontime-delay fuses. For this reason, 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 of a second, after which the current-carrying element melts. This means that these fuses should not be used in motor circuits, which often have starting currents greater than 500%.

Time-Delay Fuses

Time-delay fuses provide both 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. However, if an overload condition occurs and persists, the fuse will open.

Fuse Ratings And Classifications

Ampere Rating

Each fuse has a specific ampere rating, which is its continuous current-carrying capability. The ampere rating of the fuse chosen for a circuit usually should not exceed the current-carrying capacity of the circuit. For example, if a circuit's conductors are rated for 10 amperes, the largest fuse that should be selected is 10 amperes.

However, there are circumstances where the ampere rating is permitted to be greater than the current-carrying capacity of the circuit. For example, motor and welder circuits' fuse ratings can exceed conductor ampacity to allow for inrush currents and duty cycles within limits established by the NEC®.

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, could be used in a 480 volt circuit, but 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). A fuse for a specific application should be selected so that it can sustain the largest potential short circuit current that could occur in the application. Otherwise, the fuse could rupture, causing extensive damage, if the fault current exceeded the interrupting ability of the fuse.

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 in developing its safety test procedures. These specifications have resulted in distinct classes of low voltage fuses (600 volts or less). The following chart lists various UL fuse classes.

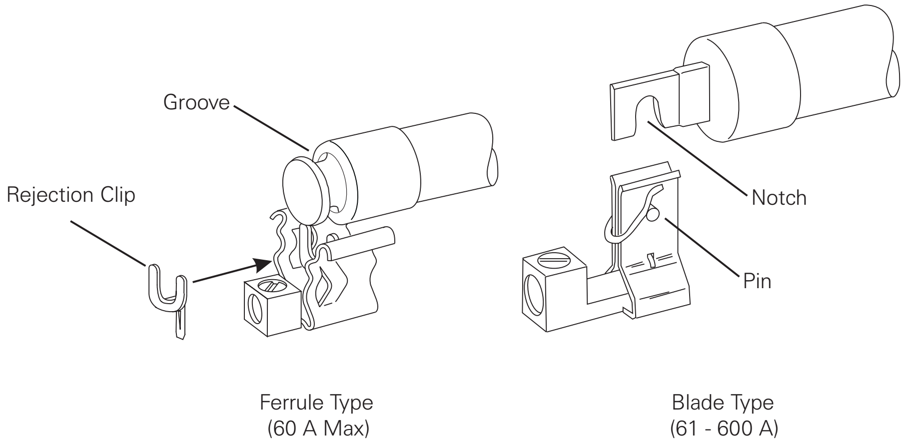
Fuse Ratings

Class	Amps	Volts	Dimensions	Int. Ratings	I^2t, I_p	Circuits
H	1-600A	250 and 600V	NEC standards	10,000A —	Less than 10,000A	General purpose circuits
K5*	1-600A	250 and 600V or less AC	Class H without rejection	100,000A	I^2t - RK5 up to 100A I_p - RK5 up to 100A	Feeder circuits
J	1-600A	600V or less	Diff. From Class H	200,000A	I^2t - Low I_p - Low	Main & feeder circuits
RK1	1/10-600A	600V or less 250 V or less	Class H with rejection feature	200,000A	I^2t - Slightly>J I_p - Slightly>J	Main & feeder circuits (motor load small percent)
RK5 (time delay)	1/10-600A	600V or less 250 V or less	Class H with rejection feature	200,000A	I^2t ->RK-1 I_p -RK-1	Motor starting currents
T	1-1200A	300V AC	Diff. From Class H	200,000A	I^2t - <J I_p - <J	Main & feeder circuits
T	1-800A	600V AC	Diff. From Class H	200,000A	I^2t - =J I_p - =J	Main & feeder circuits
L	601-6000A	600V or less	Bolt type	200,000A	I^2t - Low I_p - Low	Main & feeder circuits

* Class K5 fuses do not prohibit the use of Class H type fuses in a switch.

Class R Current Limiting Fuses

The following illustration shows Class R type fuse holders, which feature rejection clips or pins that permit only Class R fuses to be installed. This prevents installation of a fuse with a lower AIC rating, such as a Class H or K.



Review 2

1. Fuses have an ____________ time-current characteristic.
2. A fuse can usually interrupt short-circuit current in less than ____________ a cycle.
3. Nontime-delay fuses provide excellent ____________ circuit protection.
4. ____________ - ____________ fuses provide overload and short circuit protection.
5. The continuous current carrying capability of a fuse is known as its ____________ rating.
6. The voltage rating of a fuse can be ____________ than the circuit voltage, but never ____________ .
7. The interrupting rating of a Class R fuse is ____________ amperes.

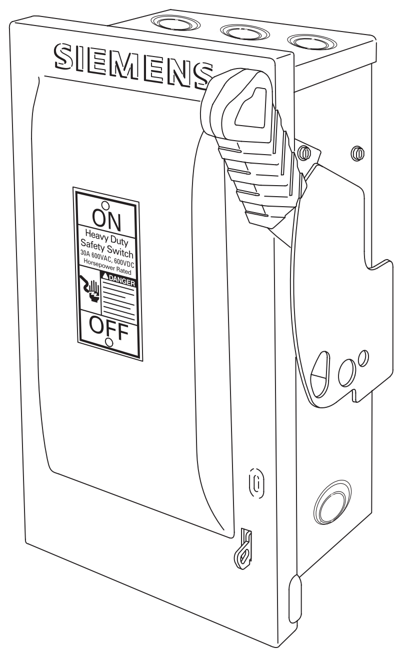
Enclosures

The *National Electrical Code®* defines an enclosure as *the case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts, or to protect the equipment from physical damage* (Article 100 - definitions). The *NEC®* definition references ANSI/NEMA standard 250.

The standard for enclosures of electrical equipment is UL 50, published by Underwriters Laboratories (UL). The standard provides enclosure descriptions, features, and test criteria for hazardous (classified) and nonhazardous locations. The following brief descriptions cover enclosures available for Siemens safety switches.

Type 1 Enclosures

Type 1 enclosures are intended for indoor use primarily to provide protection against limited amounts of falling dirt and contact with the enclosed equipment in locations where unusual service conditions do not exist.

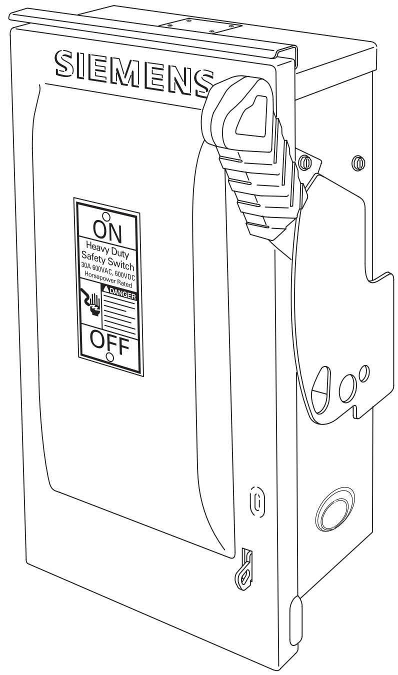


Type 1 Enclosure

Reprinted with permission from NFPA 70-2005, the *National Electrical Code®*, Copyright© 2004, National Fire Protection Association, Quincy, MA 02269.

Type 3R Enclosures

Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain and sleet and protection from contact with the enclosed equipment. They are not intended to provide protection against conditions such as dust, internal condensation, or internal icing.

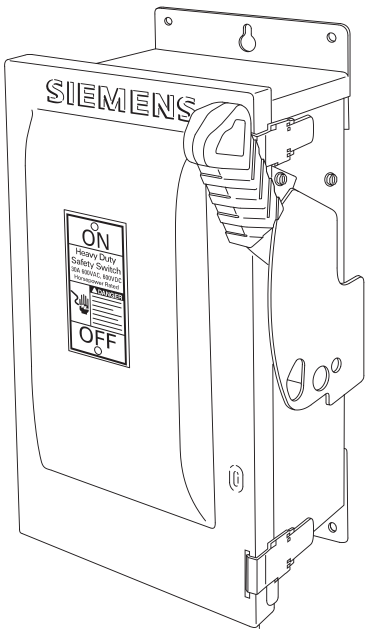


Type 3R Enclosure

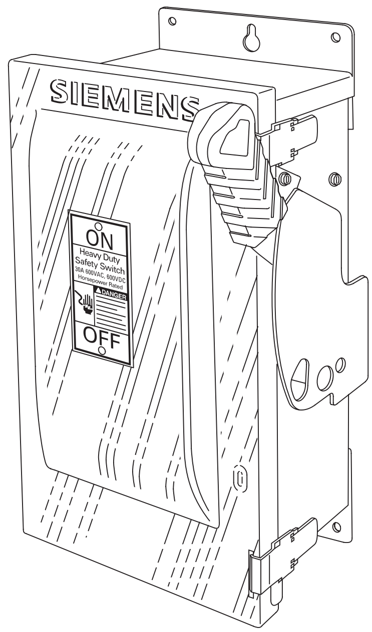
Type 4 and 4X Enclosures

Type 4 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust, rain, splashing water, hose-directed water, and damage from external ice formations. They are not intended to provide protection against conditions such as internal condensation or internal icing. Type 4X enclosures are made of a material such as stainless steel and provide a high degree of protection against corrosion.

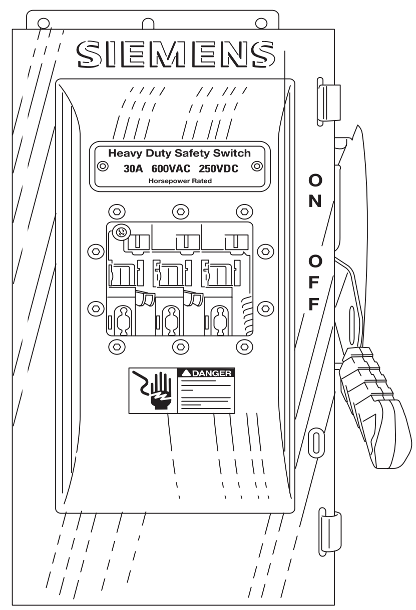
Type 4X stainless steel enclosures are also available with a window to allow viewing of the visible blade position for switches with 30 - 400A ratings. The window also allows viewing of indicating fuses in 30 - 200A fusible switches.



Type 4



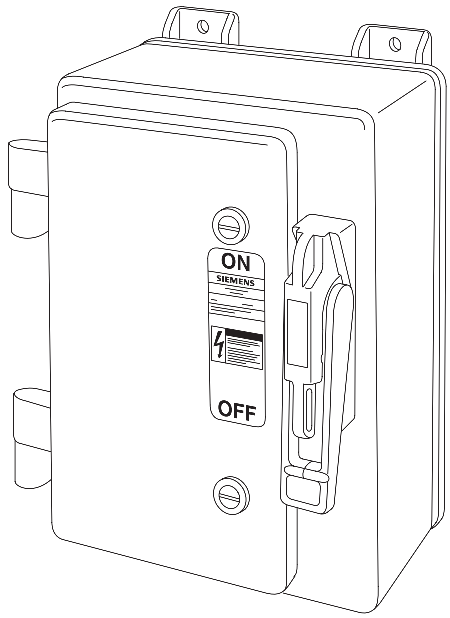
Type 4X Stainless



Type 4X Stainless
with Viewing Window

Non-Metallic 4X Enclosure

A fiberglass-reinforced polyester version of the 4X enclosure is also available. This Non-Metallic 4X enclosure has no external metal parts. It also features external mounting, a cover interlock, and a removable door for easier wiring.



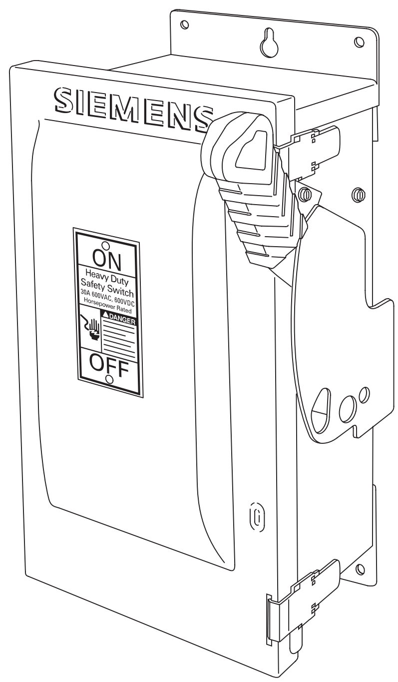
Type 4X Non-Metallic

Type 3S and 12 Enclosures

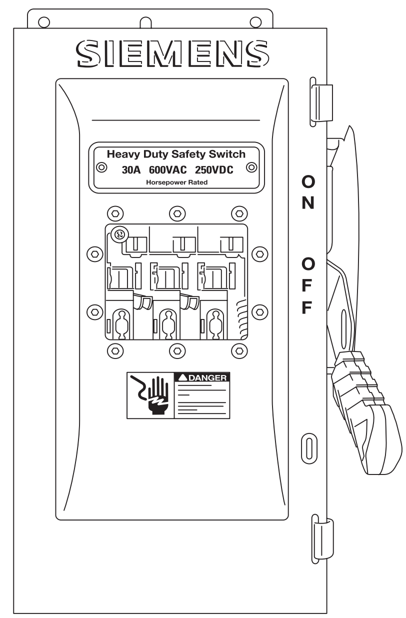
Type 3S enclosures are suitable for use in outdoor locations which require a degree of protection against windblown dust. They are intended to allow operation when ice laden, but are not intended to protect against condensation or internal icing.

Type 12 enclosures provide a degree of protection against dust, falling dirt, and dripping water in indoor locations, but are not intended to protect against conditions such as internal condensation.

Type 12 enclosures are also available with a window to allow viewing of the visible blade position for switches with 30 - 600A ratings and viewing of indicating fuses in 30 - 200A fusible switches.



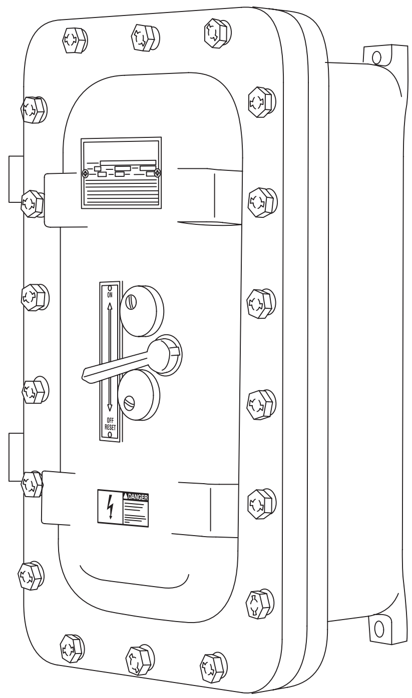
Type 3S / 12 Enclosure



Type 3S / 12 Enclosure
with Viewing Window

Type 7 and 9 Enclosures

Type 7 and 9 enclosures. Type 7 enclosures are intended for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the *NEC®*. Type 9 enclosures are intended for indoor use in locations classified as Class II, Groups E, F, or G, as defined in the *NEC®*.



Type 7 and 9 Enclosure

Hazardous Environments

Articles 500 through 504 of the *National Electrical Code®* cover the use of electrical equipment in locations where fire or explosions due to gas, flammable liquids, combustible dust, or ignitible fibers may be possible. While you should never specify a hazardous location, it is important to understand the regulations that apply. It is the user's responsibility to contact local regulatory agencies to define the location as Division I or II and to comply with all applicable codes.

Divisions

Division I refers to a situation where hazardous materials are normally present in the atmosphere. Division II identifies conditions where the atmosphere may become hazardous as a result of abnormal conditions. For example, if a pipe carrying a hazardous material developed a leak, the surrounding atmosphere could become hazardous.

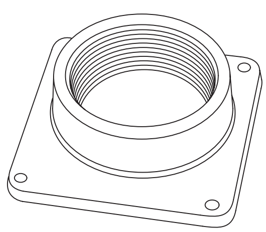
Classes and Groups

Hazardous locations are further identified by class and group. Class I, Groups A, B, C, and D are chemical gases or liquids. Class II, Groups E, F, and G include flammable dust. Class III includes all ignitible fibers and lints such as clothing fiber in textile mills. Class III is not divided into groups.

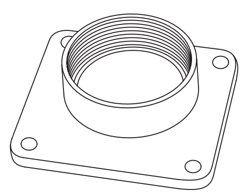
Group	Class I	Group	Class II	Group	Class III
	Groups A-D Gases and Liquids		Groups E-G Flammable Dust		Ignitable Fibers
A	Acetylene	E	Metallic Dust	na	Rayon
B	Hydrogen	F	Carbon Dust	na	Jute
C	Acetaldehyde Ethylene Methyl Ether	G	Grain Dust		
D	Acetone Gasoline Methanol Propane				

Hubs

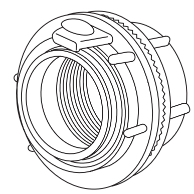
Various hubs are available for attaching cable conduit to the enclosures.



HV300
3″ Conduit Hub
Type 3R Enclosure



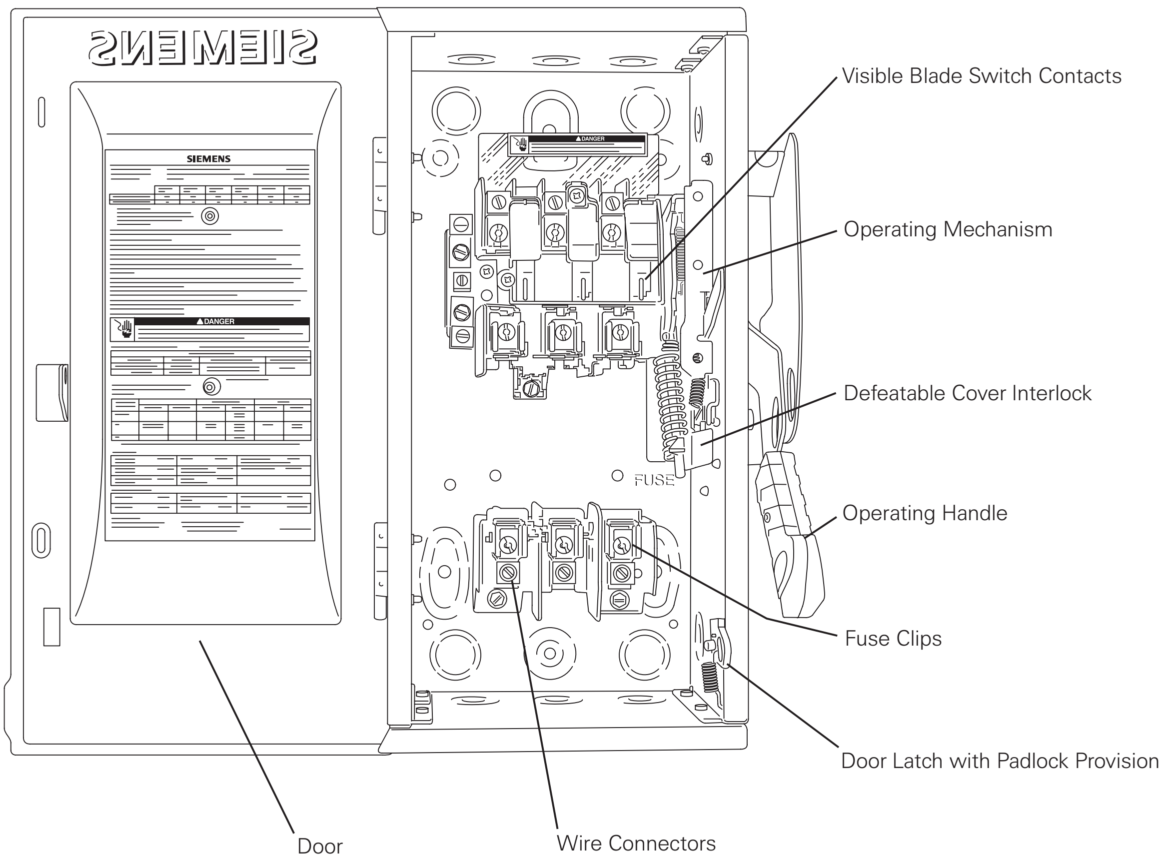
HS200
2″ Conduit Hub
Type 3R Enclosure



SSH 150
1-1/2″ Conduit Hub
Type 4 / 4X Enclosure

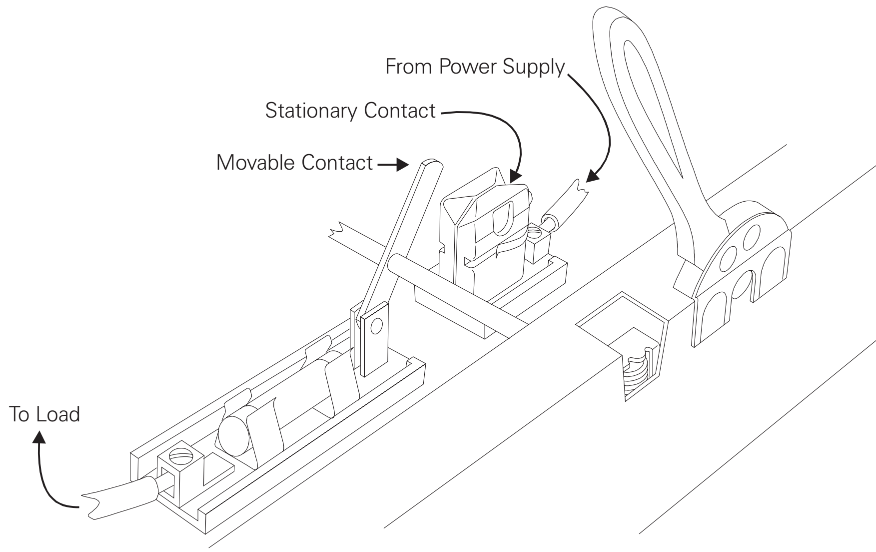
Switch Design

The enclosure houses the switch mechanism, wire connectors, and an operating mechanism. A handle, connected to the operating mechanism, opens and closes the visible blade contacts. If the switch is fusible the enclosure also houses the fuse clips. Provisions have been made for locking the door and/ or switch handle.

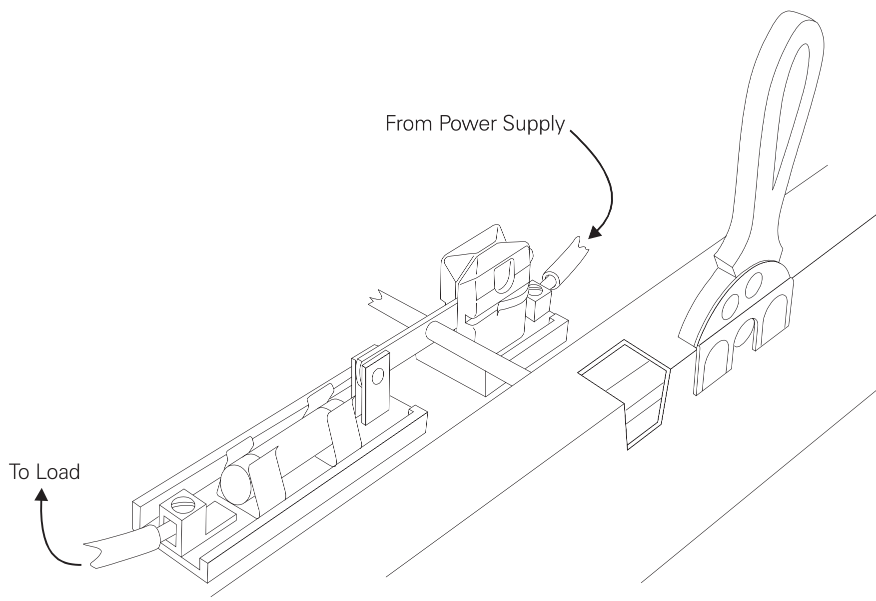


Knife Blade Switch Principle

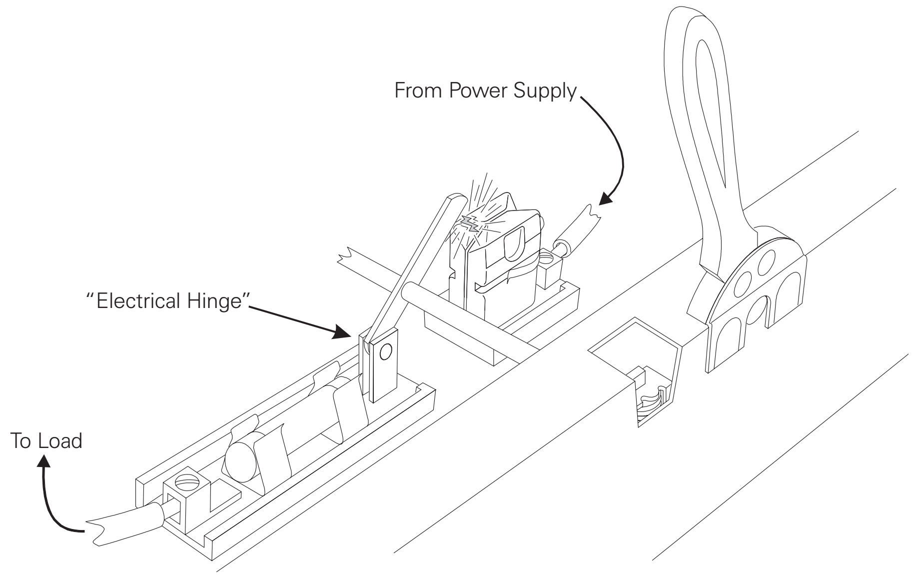
Switches use contacts to break the circuit and stop the flow of current. A typical switch assembly consists of a stationary contact, a hinged movable contact, and an operating handle. The hinged movable contact may also be referred to as a knife blade. If the movable contact is not touching the stationary contact, no current flows.



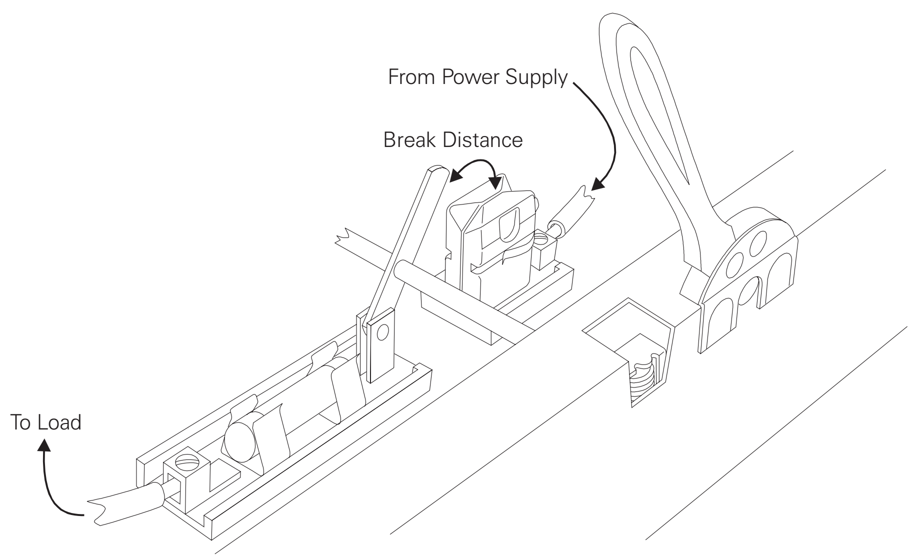
Moving the handle to the "On" position closes the contacts and provides a complete path for current to flow from the power supply to the load.



Moving the handle to the “Off” position opens the contacts, interrupting the flow of electricity. As the contacts start to open, current continues to flow across the air gap between the two contacts in the form of an arc. Current continues to flow until the physical distance between the contacts is great enough to interrupt the flow of current.

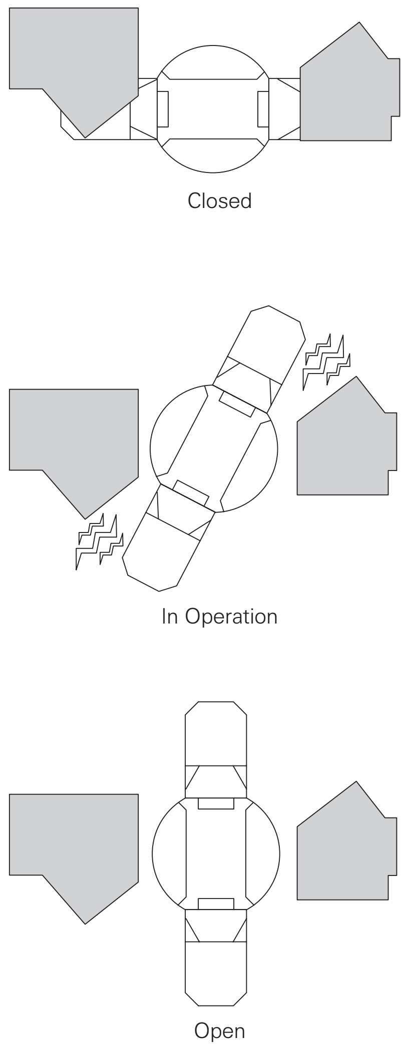


The point at which the arc is extinguished is called the break distance.



VBII Safety Switch Design

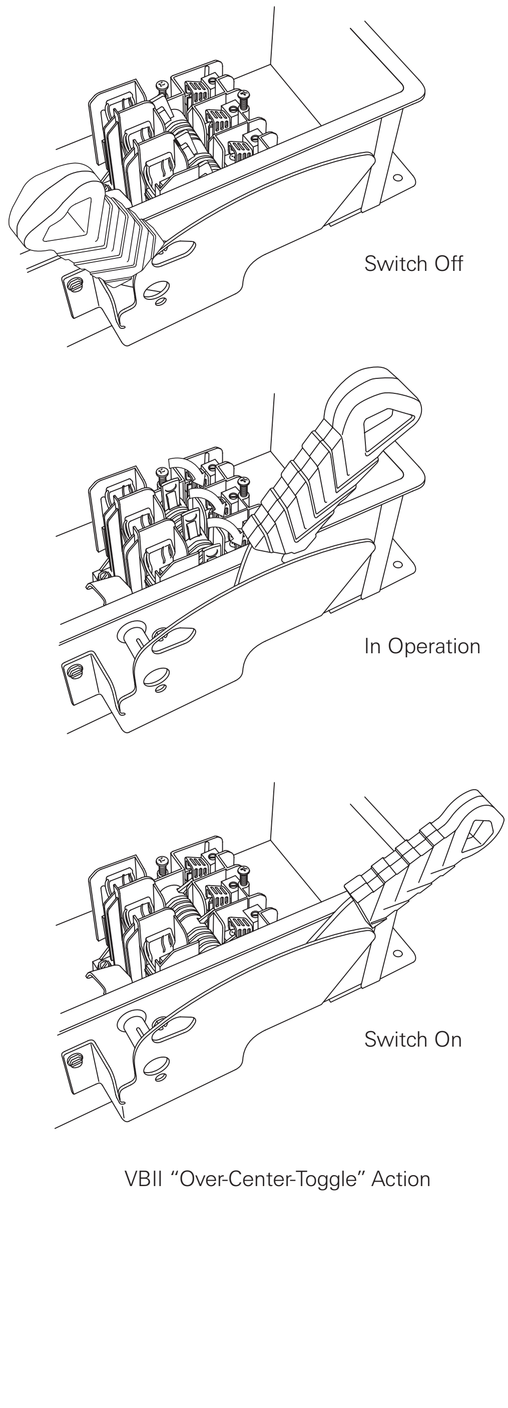
Unlike the knife-blade switch, the switching action of the Siemens 30-200A VBII Safety Switch breaks the arc in two places. As a result, two smaller arcs are created, and heat generation is reduced. The switching speed is also increased, since the breaking distance is effectively doubled. The overall result is enhanced performance and increased longevity. Also, in contrast to the knife blade switch, the VBII Safety Switch blades are self-aligning, ensuring positive contact. Furthermore, the "electrical hinge," a wear and friction point, has been eliminated. The result is a fast, positive, and reliable switching action.



VBII Switch Action

“Over-Center-Toggle” Switch Action

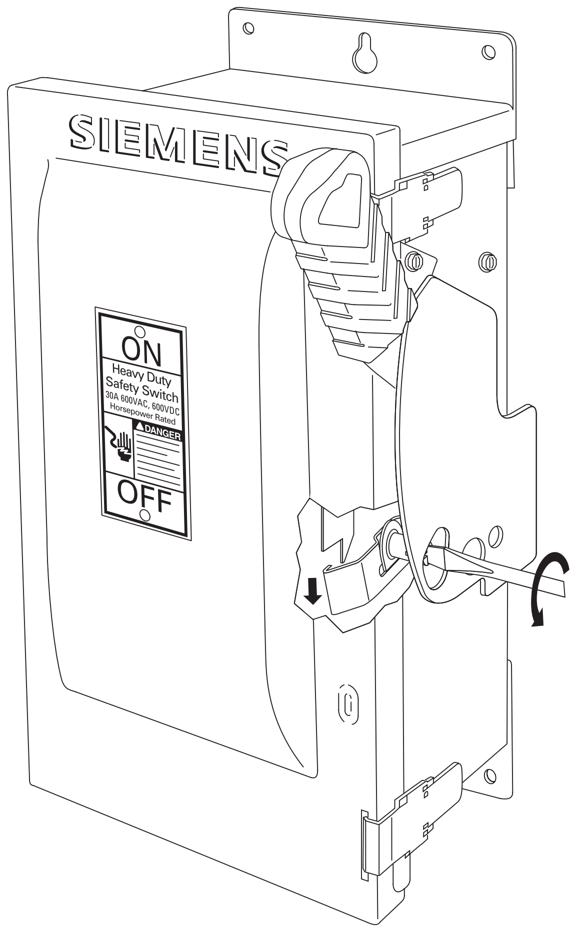
Another feature which enhances the speed of switching is the “over-center-toggle” design. During operation of the switch, for example, from the “Off” position to the “On,” as the handle is moved up the switching action does not occur gradually. As the handle is moved past the midpoint, the switch suddenly and rapidly moves from “Off” to “On.” Besides enhancing the switching speed, this also gives a positive feel to the switch operation.



VBII “Over-Center-Toggle” Action

Defeatable Cover Interlock

The VBII cover interlock prevents opening the door while the switch is in the "On" position. Normally, it also prevents turning the switch "On" with the door open. However for the purposes of testing or servicing, the door interlock is defeatable. As in the following illustration, this can be done with an ordinary screwdriver.



Review 3

1. Type ____________ enclosures are intended for indoor use primarily to provide protection against contact with the enclosed equipment in locations where unusual service conditions do not exist.

2. Type ____________ enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain and sleet.

3. Switches use ____________ to break the circuit and stop the flow of energy.

4. The VBII 30-200 A switch design breaks the arc in ____ ________ places, thereby reducing heat and switching time.