

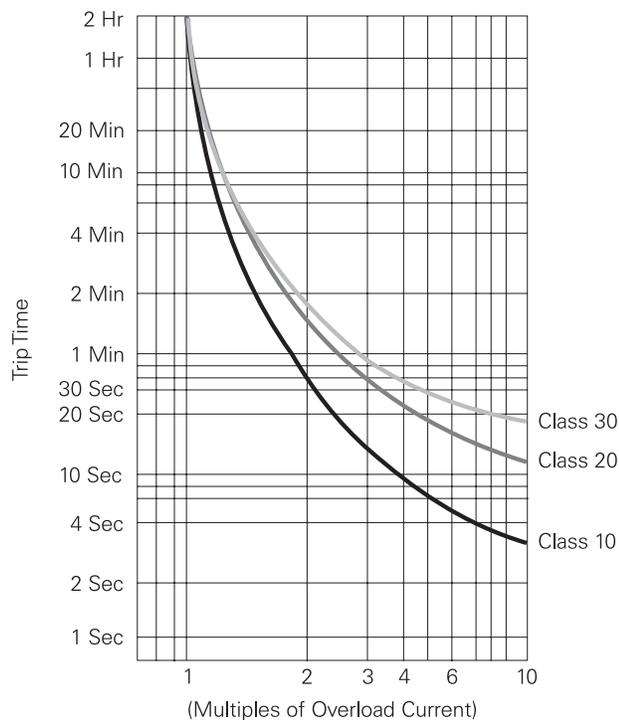
Overload Relays

Overload relays are designed to meet the special protective needs of motor control circuits. Overload relays:

- allow harmless temporary overloads (such as motor starting) without disrupting the circuit
- will trip and open a circuit if current is high enough to cause motor damage over a period of time
- can be reset once the overload is removed

Trip Class

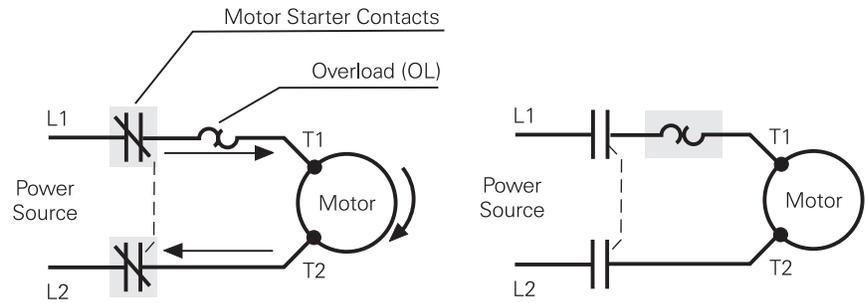
Overload relays are rated by a trip class which defines the length of time it will take for the relay to trip in an overload condition. The most common trip classes are Class 10, Class 20, and Class 30. A Class 10 overload relay, for example, has to trip the motor off line in 10 seconds or less at 600% of the full load amps (which is usually sufficient time for the motor to reach full speed). Many industrial loads, particularly high inertia loads, require Class 30. Siemens offers overload relays in all three trip classes.



Overload Relay in a Motor Circuit

The following illustration shows a motor circuit with a manual starter and an overload relay.

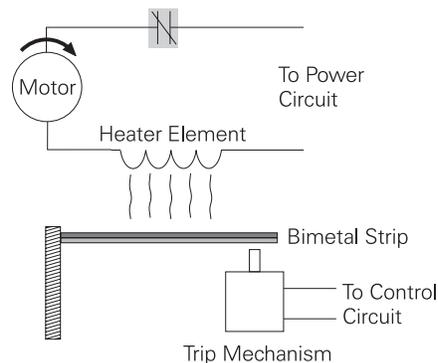
Current flows through the overload relay while the motor is running. Excess current will cause the overload relay to trip at a predetermined level, opening the circuit between the power source and the motor. After a predetermined amount of time, the overload relay can be reset. When the cause of the overload has been identified and corrected, the motor can be restarted.



Bimetal Overload Relays

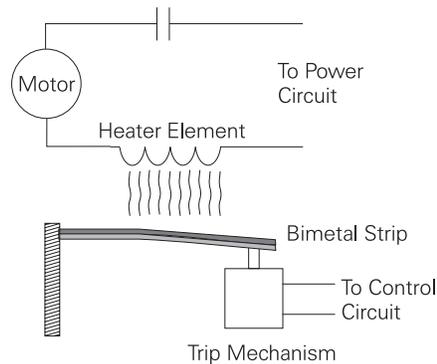
Overload protection can be accomplished with the use of a bimetal overload relay. This component consists of a small heater element wired in series with the motor and a bimetal strip that can be used as a trip lever. The bimetal strip is made of two dissimilar metals bonded together. The two metals have different thermal expansion characteristics, so the bimetal strip bends at a given rate when heated.

Under normal operating conditions, the heat generated by the heater element will be insufficient to cause the bimetal strip to bend enough to trip the overload relay.



Normal Current Flow

As current rises, heat also rises. The hotter the bimetal strip becomes, the more it bends. In an overload condition, the heat generated from the heater will cause the bimetal strip to bend until the mechanism is tripped, stopping the motor.



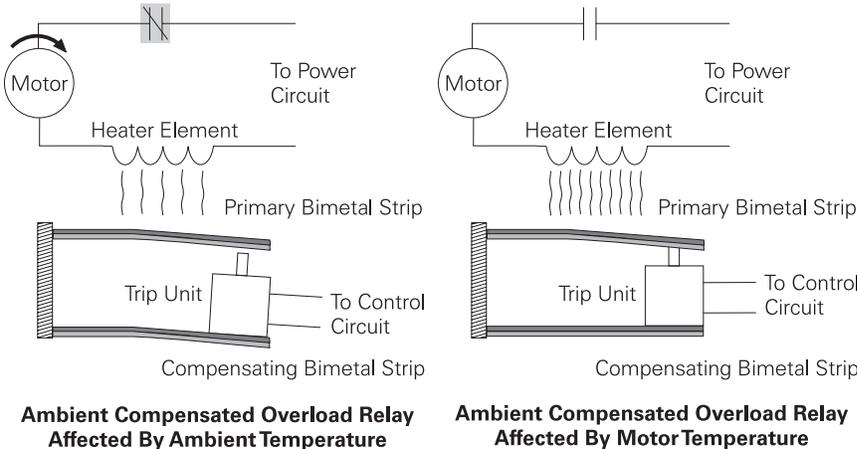
Overload Condition

Some overload relays equipped with a bimetal strip are designed to reset the circuit automatically when the bimetal strip has cooled and reshaped itself, restarting the motor. If the cause of the overload still exists, the relay will trip again and reset at given intervals. Care must be exercised in the selection of this type of overload relay, since repeated cycling will eventually damage the motor.

Ambient Compensated Bimetal Overload Relay

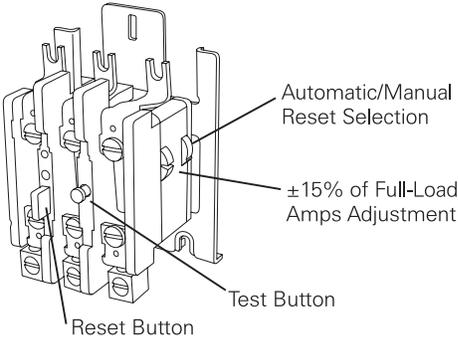
In certain applications (such as a submersible pump), the motor may be installed in a location having a constant ambient temperature. However, the motor control and overload relay may be installed in a location with a varying ambient temperature. In such cases, the trip point of the overload relay will vary with the temperature of the surrounding air as well as current flowing through the motor, which can lead to premature and nuisance tripping.

Ambient compensated bimetal overload relays are designed to overcome this problem. A compensated bimetal strip is used along with a primary bimetal strip. As the ambient temperature changes, both bimetal strips will bend equally and the overload relay will not trip the motor. However, current flow through the motor and the heater element will affect only the primary bimetal strip. In the event of an overload condition, the primary bimetal strip will engage the trip unit.



Class 48 Ambient Compensated Bimetal Overload Relay

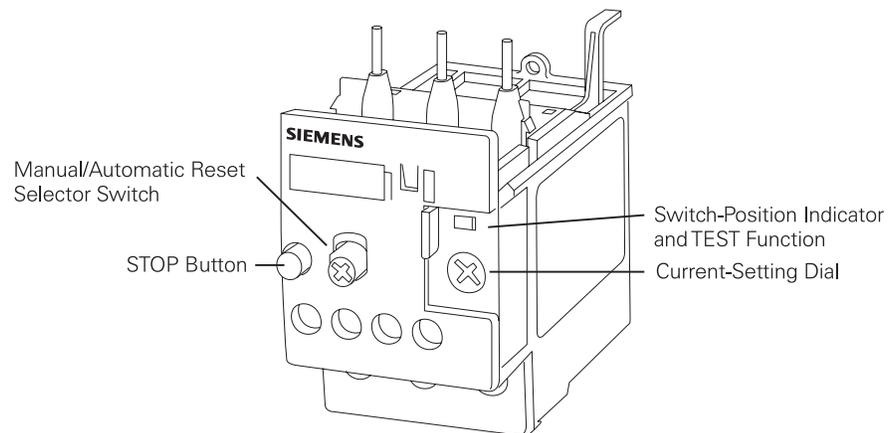
Siemens Class 48 ambient compensated bimetal overload relays are available in single-pole or three-pole designs and can be set for manual or self-resetting operation. An adjustment dial located on the unit allows the ampere trip setting to be adjusted by $\pm 15\%$. A manual test button is provided to test the operation of the overload relay control contacts. The ambient compensated bimetal overload relay heater elements are available in Class 20 or Class 10 ratings. A normally open or normally closed auxiliary contact is available as an option.



SIRIUS 3RU11 Bimetal Overload Relay

The Siemens SIRIUS 3RU11 is a bimetal overload relay with the heater elements as an integral part of the design. The unit comes with a Class 10 trip as standard. SIRIUS 3RU11 overload relays feature manual or automatic reset, adjustable current settings, ambient compensation, and a differential trip bar that causes the unit to trip faster in the event of a phase loss.

The 3RU11 includes a normally closed auxiliary contact for de-energizing the contactor, and a normally open auxiliary contact for signaling an overload trip. Pressing the STOP button momentarily opens the normally closed contact without affecting the normally open contact. The switch-position indicator incorporates a TEST function which, when activated, simulates a tripped overload relay by actuating both auxiliary contacts and displaying the switch position.



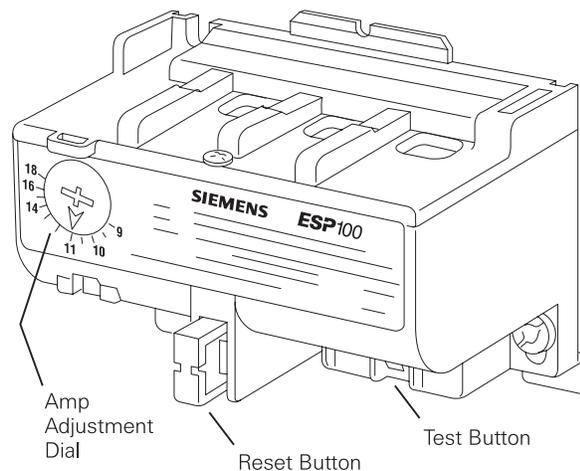
Electronic Overload Relays

Electronic overload relays are another option for motor protection. The features and benefits of electronic overload relays vary, but there are a few common traits. One advantage offered by electronic overload relays is a heaterless design, reducing installation cost and the need to stock a variety of heaters to match motor ratings. Heaterless design also allows the electronic relay to be insensitive to the ambient temperature, minimizing nuisance tripping.

Electronic relays also offer phase loss protection. If a power phase is lost, motor windings can burn out very quickly. Electronic overload relays can detect a phase loss and disconnect the motor from the power source. Phase loss protection is not available on mechanical types of overload relays.

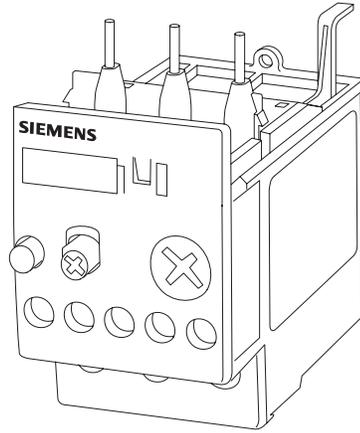
Class 48 ESP100 Electronic Overload Relay

A single ESP100 electronic overload relay replaces at least six size ranges of heaters. Instead of installing heaters, the full-load amperes (FLA) rating of the motor is set with a dial. The ESP100 overload relay illustrated below, for example, is adjustable from 9 to 18 amperes. NEMA Class 10, 20, and 30 trip curves are available for a variety of applications, in either manual or self-resetting versions. A manual test button is provided to test the operation of the overload relay contacts. One normally closed auxiliary contact is included as a standard feature.



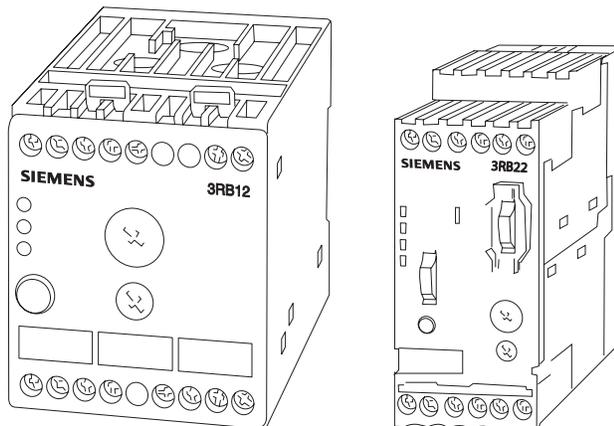
**Siemens 3RB10/20
Electronic Overload Relay**

SIRIUS 3RB10/20 electronic overload relays come with a Class 10 or Class 20 trip and feature manual or automatic reset, adjustable current settings, and ambient compensation. A normally closed auxiliary contact for de-energizing the contactor and a normally open auxiliary contact for signaling an overload trip are included. Pressing the STOP button momentarily opens the normally closed contact without affecting the normally open contact. The switch-position indicator incorporates a test function which, when activated, simulates a tripped overload relay by actuating both auxiliary contacts and displaying the switch position.



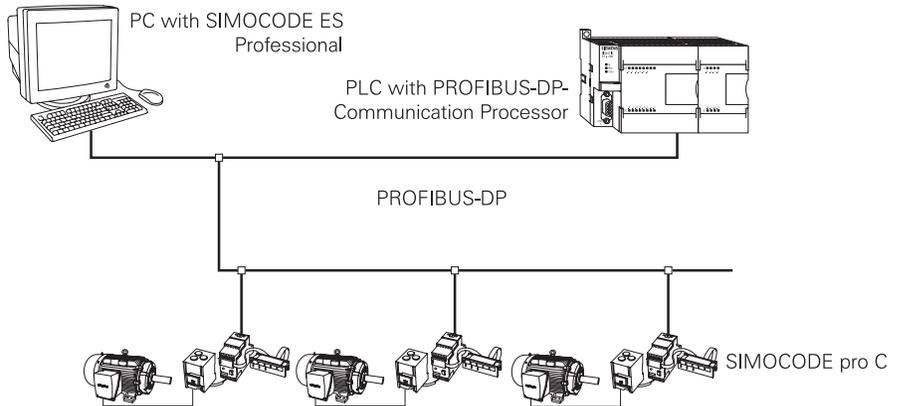
**Siemens 3RB12/22
Electronic Overload Relay**

SIRIUS 3RB12/22 electronic overload relays provide trip class adjustments from Class 5 to Class 30 and ground fault, phase imbalance, and phase loss protection. Motor current is continuously monitored in each phase. Two auxiliary contacts, one normally open and one normally closed, are switched in the event of an overload, phase imbalance, or phase loss. One additional set of auxiliary contacts, one normally open and one normally closed, are switched without time delay in the event of a ground fault. In addition to sensing current, SIRIUS 3RB22 overload relays directly sense motor winding temperature via a thermistor sensor.



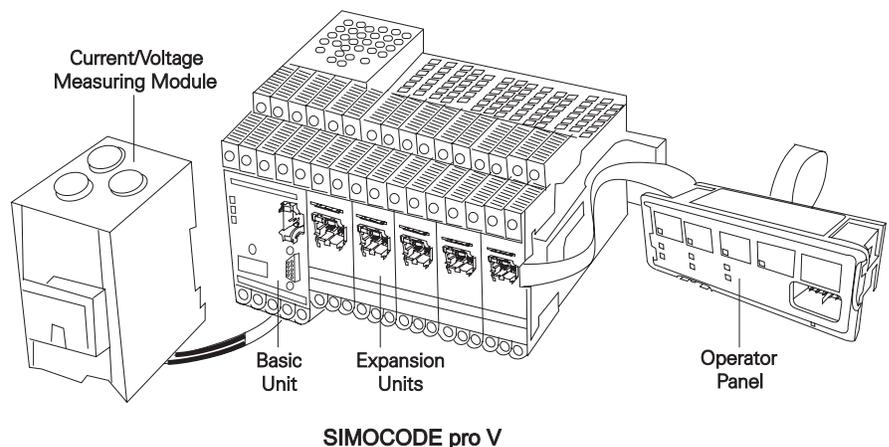
PROFIBUS DP

In any complex process, the need for rapid communication is critical. PROFIBUS DP is an open communication system based upon international standards developed through industry associations. PROFIBUS DP allows multiple field devices, including SIMOCODE pro Basic Units, to communicate with a PLC or computer.



SIMOCODE pro

SIMOCODE pro is a flexible, modular motor management system that provides multifunctional, solid-state protection for constant speed motors. SIMOCODE pro implements all motor protection and control functions; provides for tracking of operational, diagnostic, and statistical data; and communicates with the automation system via PROFIBUS DP. SIMOCODE pro C includes a Basic Unit a Current Measuring Module, and an Operator Panel. SIMOCODE pro V includes a Basic Unit, a Current/Voltage Measuring Module, and Operator Panel, but can accommodate up to five expansion modules. Expansion modules are available for digital inputs, analog inputs, ground fault detection, and temperature sensing.

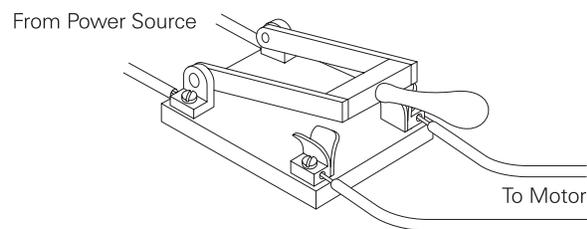


Review 3

1. With an increase in current, heat will _____ .
 - a. increase
 - b. decrease
 - c. remain the same
2. Excessive current is referred to as _____.
3. An _____ occurs when electrical equipment is required to work harder than it is rated.
4. A Class _____ overload relay will trip an overloaded motor offline within 10 seconds at six times full-load amps.
 - a. 10
 - b. 20
 - c. 30
5. A _____ strip uses two dissimilar metals bonded together.
6. An overload relay can be _____ once the overload is removed.
7. Advantages common to most electronic overload relays include:
 1. They do not require the use of _____.
 2. In addition to overload protection, they also provide _____ protection.
 3. They are _____ to the ambient temperature.

Manual Control

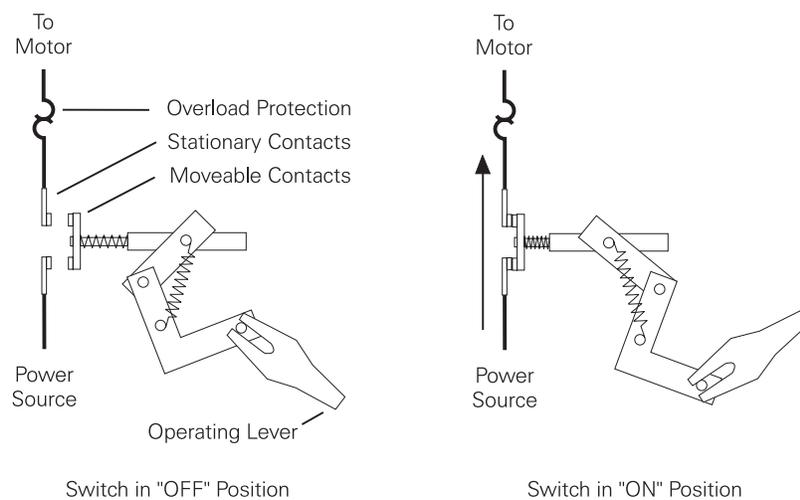
As the name implies, **manual controls** are devices operated by hand. A simple knife switch, like the one shown in the following illustration, was the first manual-control device used to start and stop motors. The knife switch was eventually replaced with improved control designs such as manual and magnetic starters.



Basic Operation

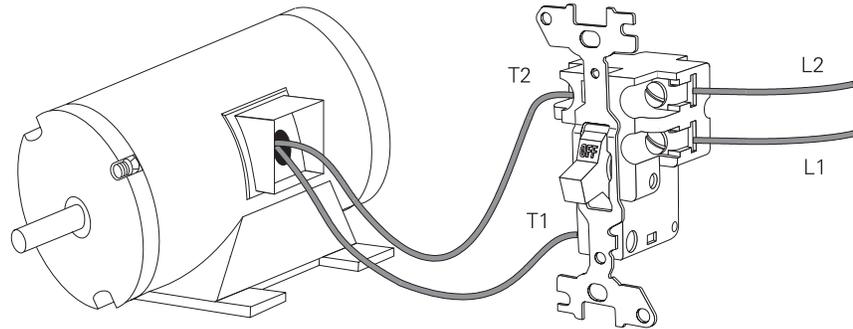
A motor control device must protect the motor from destroying itself under overload conditions. To accomplish this, manual starters consist of a manual contactor (such as a simple switch mechanism) and a device for overload protection.

The following diagram illustrates a single-pole manual motor starter. Each set of contacts is called a **pole**. A starter with two sets of contacts would be called a two-pole starter.

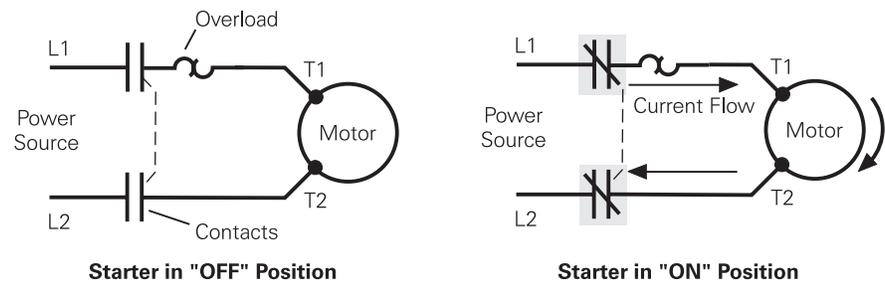


Two-Pole Manual Starter

Starters are connected between the power source and the load. In the following example, a two-pole or single-phase motor starter is connected to a motor. When the switch is in the "OFF" position, the contacts are open, preventing current flow to the motor from the power source. When the switch is in the "ON" position, the contacts are closed, and current flows from the power source (L1), through the motor, then returning to the power source (L2).



This is represented with a line drawing and symbols as illustrated in the following drawing.



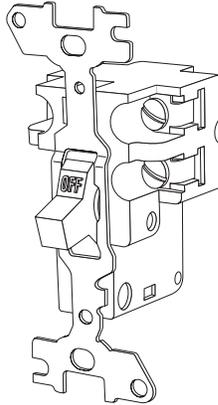
Low Voltage Protection

Some manual motor starters offer low-voltage protection (LVP) as an option. LVP will automatically remove power from the motor when incoming power drops or is interrupted.

An LVP starter must be manually reset when power is restored. This protects personnel from potential injury caused by machinery that would otherwise automatically restart when power is restored.

SMF Fractional-Horsepower Manual Starters

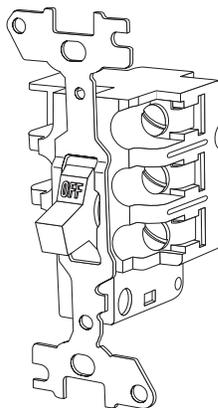
Siemens SMF fractional-horsepower starters provide overload protection and manual “ON/OFF” control for small motors. SMF starters are available in one- or two-pole versions suitable for AC motors up to 1 HP and 277 VAC. The two-pole version is suitable for DC motors up to 3/4 HP and 230 VDC. A melting-alloy type overload relay is used for overload protection. SMF manual starters are available in a variety of enclosures. A two-speed version is also available.



Two-Pole Manual Starter

MMS and MRS Manual Switches

Siemens MMS and MRS manual switches are similar to SMF starters but do not provide overload protection. MMS and MRS switches only provide manual “ON/OFF” control of DC and single- or three-phase AC motors where overload protection is provided separately. These devices are suitable for use with three-phase AC motors up to 10 HP and 600 VAC and up to 1-1/2 HP and 230 VDC. The MMS and MRS manual switches are available in various enclosures. Two-speed and reversing versions are also available.

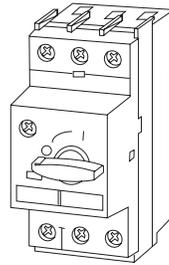


Three-Pole Manual Switch

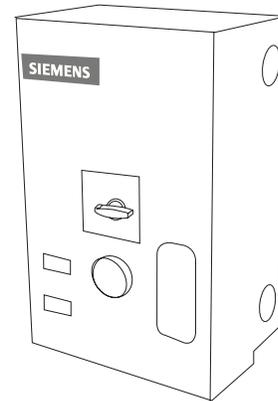
Class 11 - 3RV Manual Starters and Switches

Class 11 - 3RV manual starters and switches provide control for machinery that does not require remote start-stop control. Class 11 - 3RV switches provide control for motors where overload protection is not required or is provided separately. Class 11 - 3RV manual starters are used for single and three-phase motors up to 15HP at 460 VAC. These starters have bimetal heater elements to provide Class 10 overcurrent protection. These manual controllers are available with low-voltage protection which will automatically open the power poles when the voltage drops or the power is interrupted.

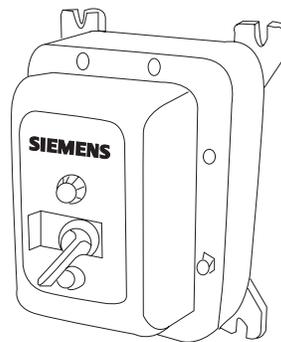
Class 11 - 3RV manual controllers are available in an open style (without enclosure), in NEMA 1 general purpose enclosures, and in NEMA 7 & 9 or NEMA 3 & 4/NEMA 7 & 9 enclosures (for hazardous locations).



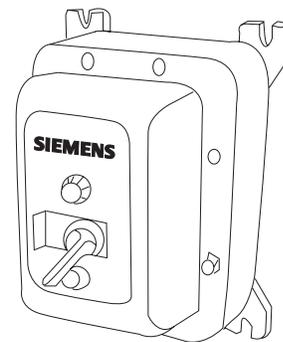
OPEN TYPE
Starter



NEMA 1
General Purpose



NEMA 7 & 9
Class I Group C & D
Class II Group E, F & G



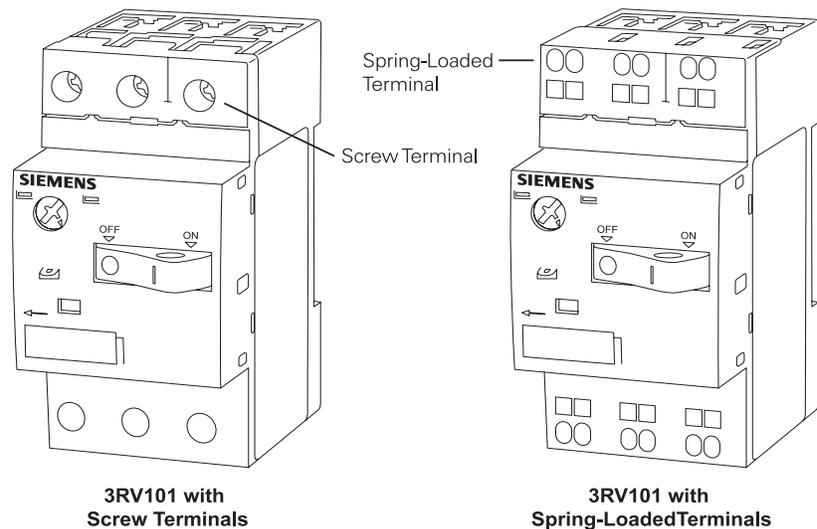
NEMA 3 & 4, NEMA 7 & 9
Class I Group C & D
Class II Group E, F & G

3RV10 Motor Starter Protectors

3RV10 motor starter protectors (MSPs) are part of the Siemens SIRIUS 3R motor control product line. A thermal overload with a bimetal strip is used to provide overload protection with the 3RV10 motor starter protector. 3RV10 MSPs come in four frame sizes: 3RV101, 3RV102, 3RV103, and 3RV104.

Frame	Max Current at 460 VAC	Max HP at 460 VAC
3RV101	12 Amps	7.5
3RV102	25 Amps	20
3RV103	50 Amps	40
3RV104	100 Amps	75

The 3RV101 is available in both screw-terminal and spring-loaded terminal versions. The 3RV102, 3RV103, and 3RV104 are available with screw terminals.

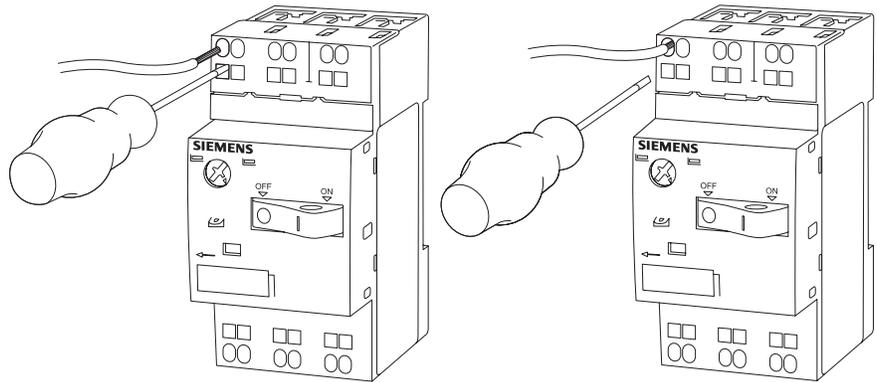


SIRIUS 3RV10 MSPs are UL listed as Manual Motor Controllers per UL508, making them appropriate for manual starting and stopping applications if upstream short-circuit protection is provided in the form of an appropriately-sized circuit breaker or fuses.

SIRIUS 3RV10 MSPs can also be used as a component in group installation where one MSP is used to provide group short circuit protection for multiple motor controllers.

Spring-Loaded Terminals

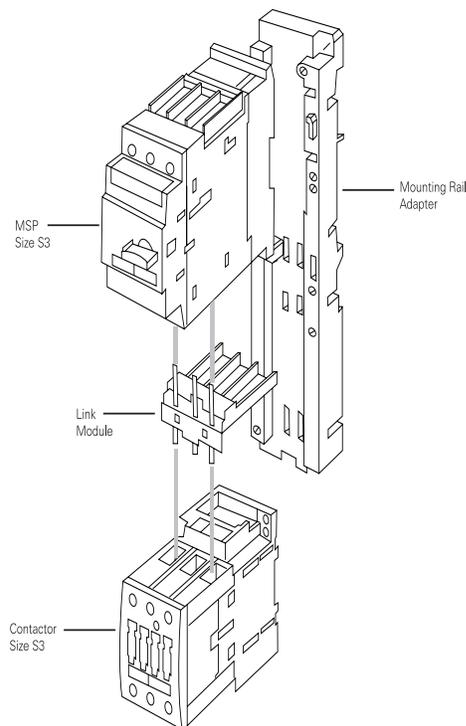
Spring-loaded terminals are available on many Siemens SIRIUS 3R products including the MSPs. To connect a wire simply push an electrician's blade screwdriver into the appropriate portal, and insert the stripped end of the wire into the portal directly above the blade. Remove the screwdriver, and the wire is securely connected. Devices equipped with spring-loaded terminals are especially beneficial in installations that are subject to vibration.



Enclosures and Options

Siemens 3RV10 MSPs are available in a variety of enclosures. Several options, such as indicator lights, are also available.

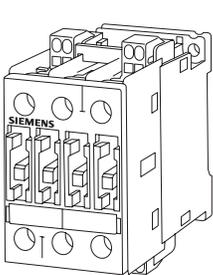
Additionally, most 3RV10 MSPs have been listed as UL508 Type E, Self-protected Manual Combination Starters. This UL listing allows the MSP to be operated in a machine without having to add separate short-circuit protection upstream.



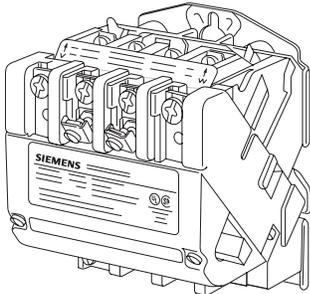
Size S3 Combination Starter

Magnetic Contactors and Starters

Most motor applications require the use of remote control devices to start and stop the motor. **Magnetic contactors** (similar to the ones shown below) are commonly used to provide this function. Contactors are also used to control distribution of power in lighting and heating circuits.



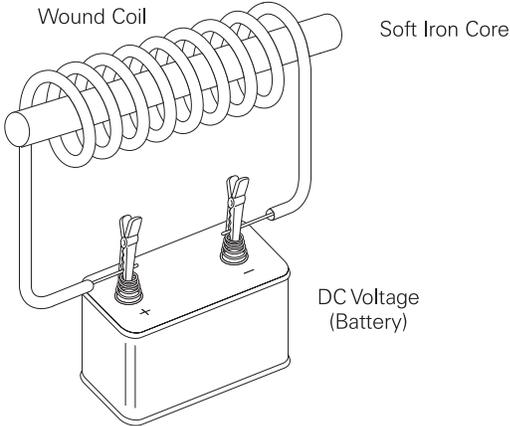
SIRIUS 3R IEC Contactor



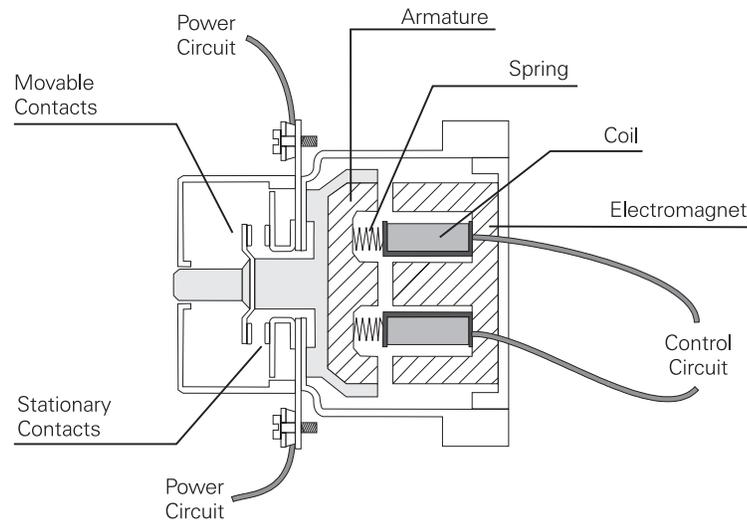
Class 40 NEMA Contactor

Basic Contactor Operation

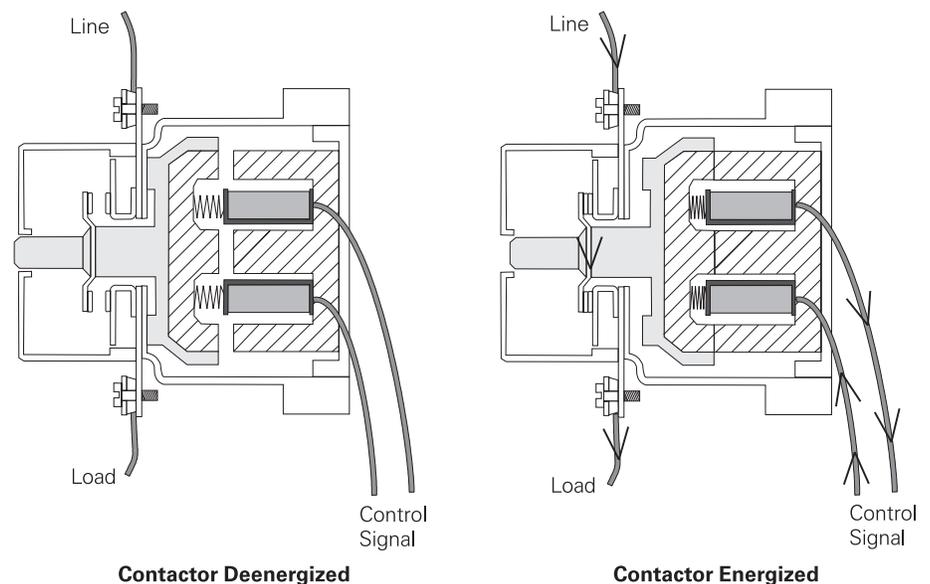
Magnetic contactors operate by utilizing electromagnetic principles. A simple electromagnet can be fashioned by winding a wire around a soft iron core. When a DC voltage is applied to the wire, the iron becomes magnetic. When the DC voltage is removed from the wire, the iron returns to its nonmagnetic state.



The following illustration shows the interior of a basic contactor. There are two circuits involved in the operation of a contactor: the control circuit and the power circuit. The control circuit is connected to the coil of an electromagnet, and the power circuit is connected to the stationary contacts.

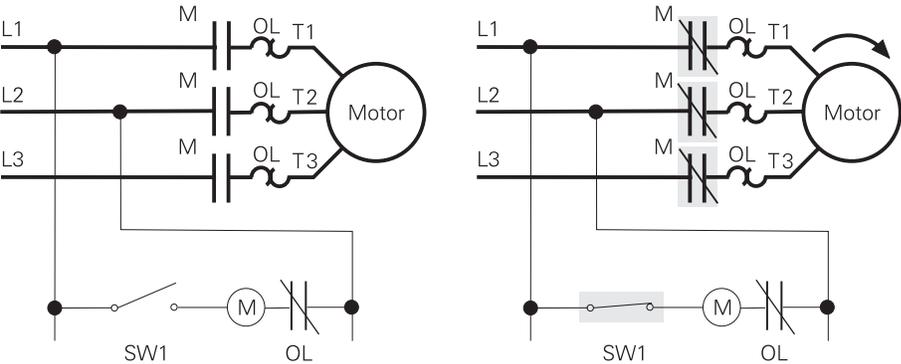


The operation of this electromagnet is similar to the operation of the electromagnet we made by wrapping wire around a soft iron core. When power is supplied to the coil from the control circuit, a magnetic field is produced, magnetizing the electromagnet. The magnetic field attracts the armature to the magnet, which in turn closes the contacts. With the contacts closed, current flows through the power circuit from the line to the load. When current no longer flows through the power circuit, the electromagnet's coil is de-energized, the magnetic field collapses and the movable contacts open under spring pressure.



The following schematic shows the electromagnetic coil of a contactor connected to the control circuit through a switch (SW1). The contacts of the contactor are connected in the power circuit to the AC line and a three-phase motor.

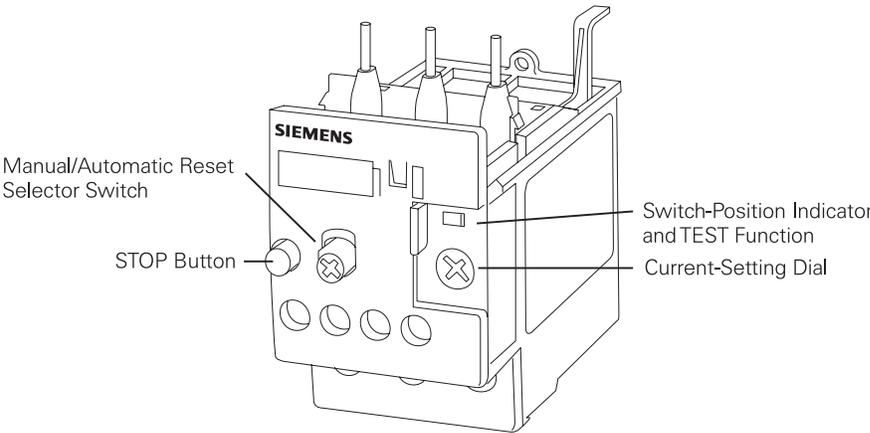
When SW1 is closed the electromagnetic coil is energized, closing the “M” contacts and applying power to the motor. Opening SW1 de-energizes the coil, opening the “M” contacts and removing power from the motor.



Contactors vs. Overload Relays

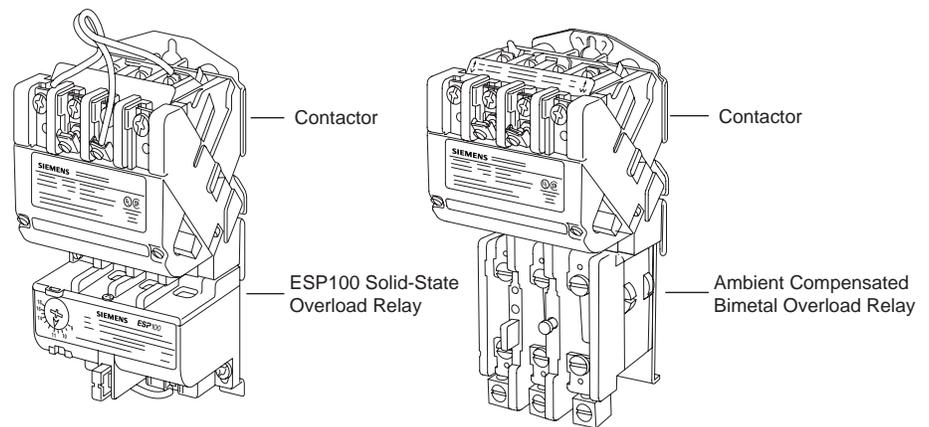
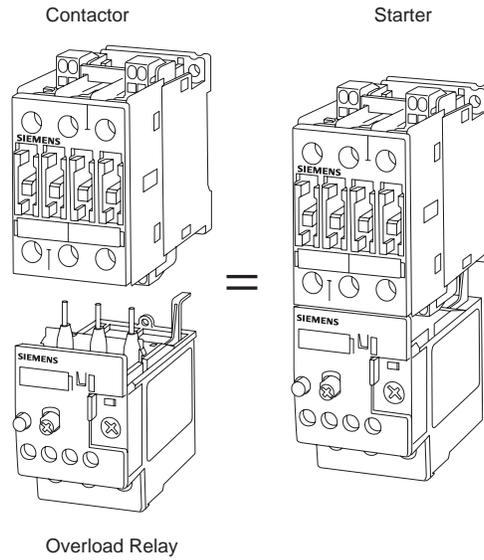
Contactors are used to control power in a variety of applications. When used in motor-control applications, contactors can only start and stop motors. Contactors cannot sense when the motor is being loaded beyond its rated conditions, and provide no overload protection.

Most motor applications require overload protection, although some smaller-rated motors (such as household garbage disposals) have overload protection built into the motor. Where overload protection is required, overload relays (discussed previously, similar to the one shown below) provide such protection.



Motor Starter

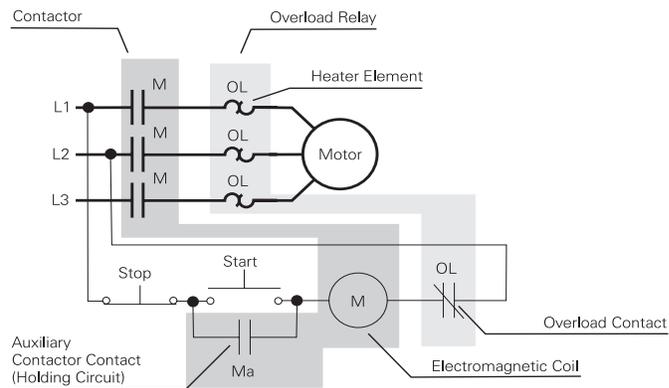
Contactors and overload relays are separate control devices. When a contactor is combined with an overload relay, it is called a **motor starter**.



Motor Starter in a Control Circuit

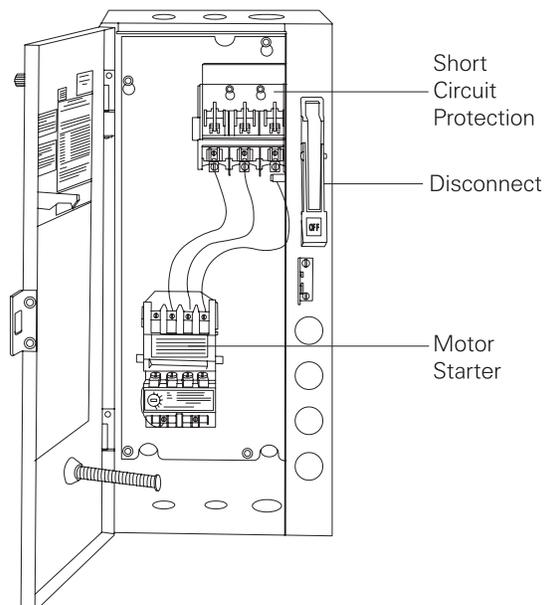
The following diagram shows the electrical relationship of the contactor and overload relay. The contactor (highlighted with the darker grey) includes the electromagnetic coil, the main motor contacts, and the auxiliary contacts. The overload relay, highlighted by the lighter grey, includes the “OL” heaters and overload contacts. The contactor and the overload relay have additional contacts (known as **auxiliary contacts**) for use in the control circuit.

In this circuit, a normally closed “OL” contact has been placed in series with the “M” contactor coil and L2. A normally open “M” auxiliary contact (“Ma”) has been placed in parallel with the “Start” pushbutton.



Combination Starters

Combination starters are devices that incorporate a motor starter, short circuit protection, and a means of safely disconnecting power. In addition to combination starters formed using IEC components as described earlier, Siemens offers a full selection of combination starters incorporating NEMA components.



Review 4

1. A starter with two sets of contacts would be called a _____ -pole starter.
2. _____ will automatically disconnect power from the motor when incoming power drops or is interrupted.
3. The Class 11 - 3RV manual starter protects motors up to _____ HP at 460 VAC.
4. The 3RV102 motor starter protector protects motors up to _____ HP at 460 VAC.
5. When a contactor is combined with an overload relay, it is called a _____ .
6. A _____ incorporates a motor starter, short circuit, and a means of safely disconnecting power.