An Essential Guide to Power Controllers

By: Watlow - March 16, 2020

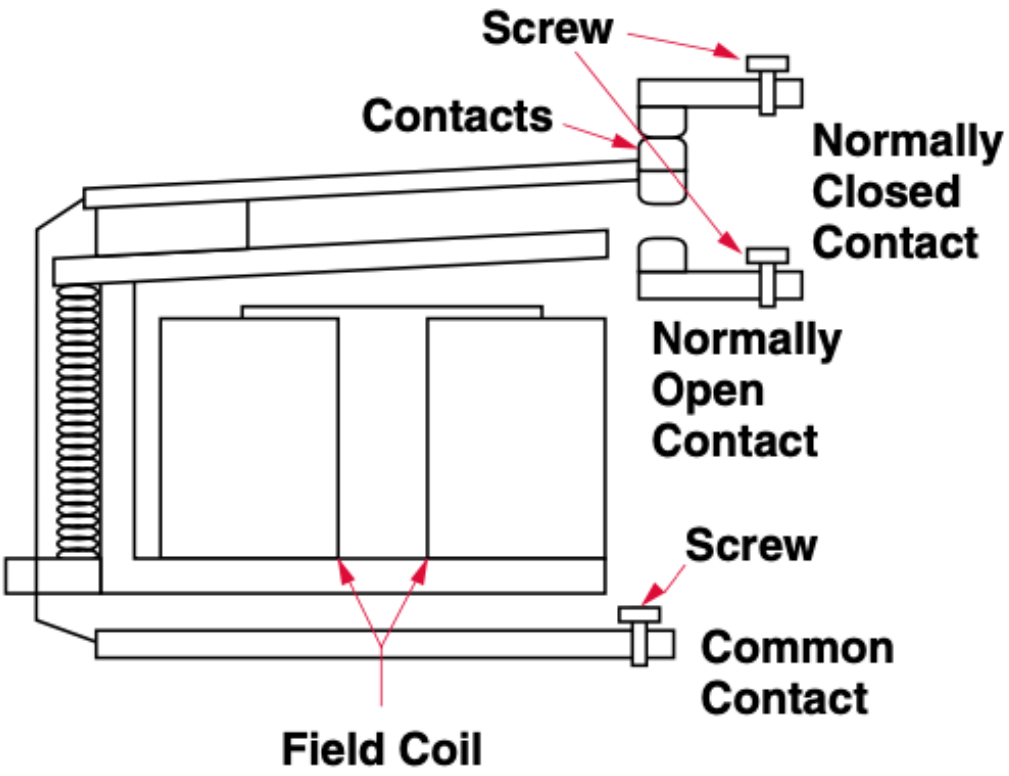
The power controller is a discrete output device that regulates your system with guidance from the temperature controller. There are three common power controllers: electromechanical relays, solid-state relays and silicon-controlled rectifiers (SCRs).

The first uses magnetic devices to actuate power switching. The latter two use solid-state electronics to affect the switching function. There are also hybrid systems and variations of SCRs.

The selection of a specific power controller type depends on the method of control being used. It can also be dependent on system power demands, the degree of temperature control, the heater type, and life requirements. Below is a brief description of each main type along with its uses.

Electromechanical Relay

This contactor, or relay, is an electrical and mechanical device with moving parts. When power is applied to the relay field coil, contact closure is created through the movement of the relay's "common" contact.



(abcimg://electro-mechanical%20relay)

Because this contactor has moving parts, it is susceptible to vibration or mechanical failure. The closure of the contacts when powered results in contact failure. Additionally, due to arcing across the metal contacts as they come together, material transfer will eventually result in the contacts welding

together.

The projected life of a high-quality mechanical relay is around 100,000 cycles, for a full rated load. For a one-third rated load, it is as much as 1,000,000 cycles. Using contactors to control heaters decreases the life of the heater compared to other switching technologies such as SCRs due to thermal cycling.

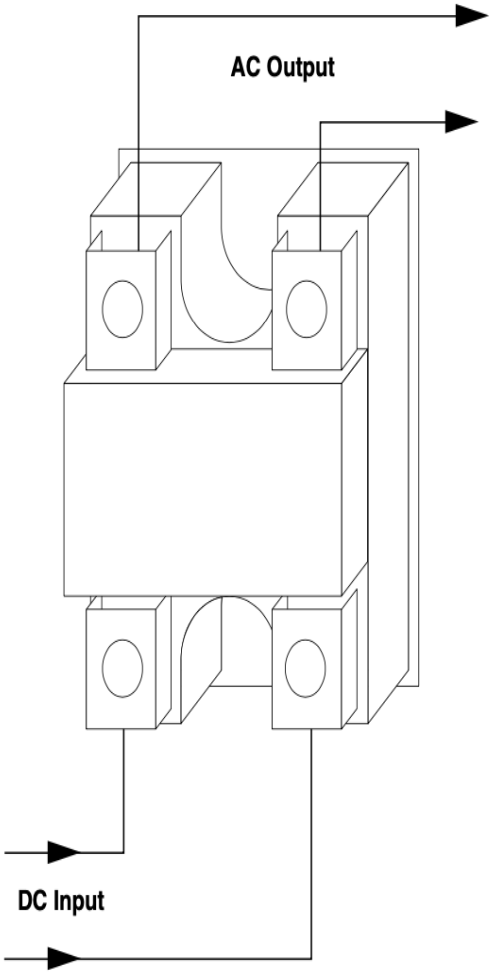
Electromechanical contactors provide a positive circuit break. This is important in many circuits. All safety limit controllers are required to enable a physical break in the flow of energy to the system uses an electromechanical contactor. This contrasts with solid-state devices, which almost always have a small amount of leakage current flow.

Most Watlow controllers can be ordered with mechanical relays.

Solid State Relays

Solid-state switching devices have no moving parts and, consequently, no mechanical failures. Solid-state switches are resistant to shock and vibration. The absence of moving parts also makes them noise-free (they produce no audible sound).

The most important factor affecting service life is its ambient operating temperature. Solid-state devices are very durable if they are operated within tolerable ambient temperatures. Failure to dissipate the heat generated by any solid-state component will quickly destroy it. Location and heat-sinking must be adequate.



(abcimg://solid%20state%20relay%20diagram)

Watlow solid state relays accept a time proportioned or on-off signal from a controller. It changes state near zero volts, in a process known as burst firing.

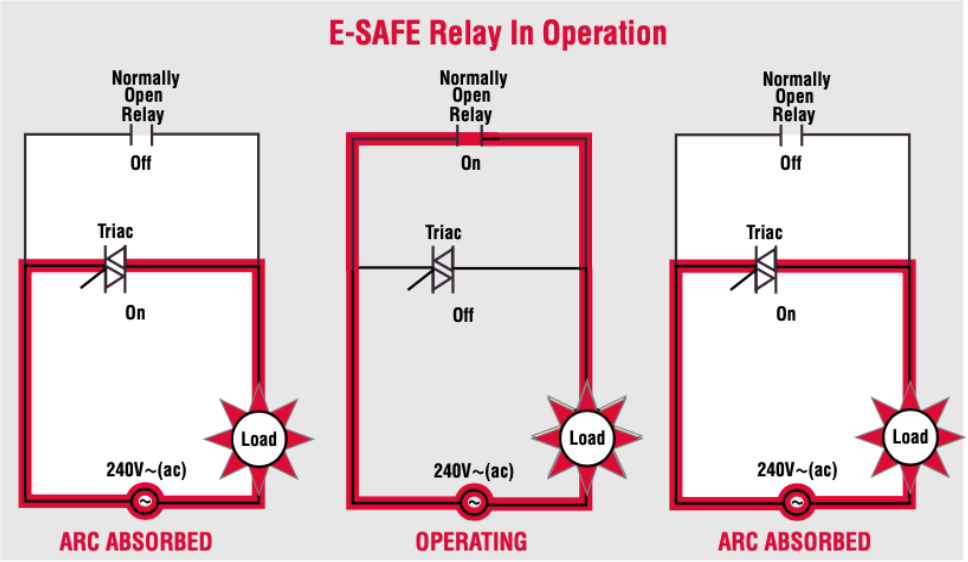
The units are also optically isolated, which means the output circuitry is energized by infrared light striking a photosensitive device. This minimizes electrically generated noise, plus output to input electrical isolation. Solid-state relays can operate at much faster cycle times than electromechanical relays. Consequently, they can be employed where extremely tight process control is required.

A disadvantage of solid-state relays is that they do not provide a positive circuit break. They also have a relatively high initial cost and can enter a failure mode when misapplied or subjected to overrated conditions. If the system heater shorts out it can cause burnout of the switch. Other failure modes include a reduction in switching capabilities and failure caused by line transients and inductive loads.

E-SAFE Relay®

The E-SAFE® relay (DISCONTINUED) (/en/products/controllers/power-switching-devices/e-safe-hybrid-power-controller)is a long-life hybrid relay. It uses a mechanical relay, with a triac (a three terminal electronic component that conducts current in either direction when triggered) in parallel to turn on and off the load at the zero-cross point in the sine wave.

Once the triac has been on for one cycle, the mechanical relay is energized to pass the current until the turn off sequence. At this point, the triac again turns on for one cycle and then turns off at zero cross. This eliminates the contacts from arcing and greatly increases the life of the mechanical relay.



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Silicon Controlled Rectifier (SCR)

The silicon controlled rectifier (SCR) is a solid-state switching device that can switch up to a 1200 amp load. A correctly chosen SCR can reduce system costs by improving heater life and process controllability.

Watlow SCR power controllers can accept time proportioned (on-off) and process (4-20mA or 1-10 VDC) input signals from any temperature control. SCRs accepting time proportioned signals are generally called “power contactors.” SCRs accepting process signals are generally called “power controllers.” They control the power by two methods of firing, phase angle and variable time-based burst firing.

The advantage of SCR power controllers is their flexible input options and lack of moving parts. They also offer long life, improved controllability, and tremendous current handling capability.

A Watlow SCR can improve system performance with increased heater life through the rapid switching an SCR provides. All SCRs, including Watlow’s, require a proper heat sink. Heat is the inevitable by-product of solid-state power switching.

Power Controller Comparison

Device	Initial Cost	3 Year Cost*	Controller Life	Heater Life	EMI Generation	Control-lability	Response Rate	Options	Comments
Electro-mechanical Relay and Contactor	Low for low current	Highest	Limited (elec. and mech.)	Shortest	Yes, coil and contacts	Poor	Slowest	None	To extend contactor life the cycle time is normally extended to 30 seconds or more. This shortens heater life.
Mercury Displace-ment Relay	Low	Medium	High	Good	Yes, coil and contact	Medium to Good	Medium to Fast	None	Silent Operation. Mercury may not be desirable. Minimum cycle time is two seconds. Position sensitive.
Solid State Relay	Medium	Medium	Extended	Extended	Minimal with burst firing	Good	Fast	None	Excellent control with one second cycle time. Requires heat sink. May require snubber.
SCR Solid State Contactor	Medium	Low	Extended	Extended	Minimal	Good	Fast	None	Excellent control with one second cycle time.
SCR Burst Firing	High	Low	Extended Longest	Longest	Minimal	Very Excellent	Very Fast	None	one second time base or variable time base unit.
SCR Phase Angle	High	Lowest	Extended	Longest	High	Excellent	Fastest	Current Limit	Required for tungsten elements, transformers, or for current limiting.
Saturable Core Reactor	Highest	Low	Extended	Longest	Minimal	Very Good	Fast	Current Limit	Cannot be turned full ON or OFF, inefficient.

(abcimg://power%20control%20comparison%20chart)

Watlow manufactures a wide range of solid-state relays and SCR power controllers to meet almost all power switching needs. Each is manufactured to the highest standards of reliability and performance.

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