SCR Power Controllers

heaters | sensors | controllers

WATLOW®
Powered by Possibility

Watlow® Silicon Controlled Rectifiers (SCRs): Make Your Thermal System All That It Can Be

SCR: Controlling Thermal Excursions Through Reduced Time Base

Minimizing temperature extremes results in less expansion and contraction of the heater element and extends heater life. By reducing the time base, on-to-on cycle time, the resistance heater can provide a smooth, even output.

The power controlling device you use in your thermal system determines the severity of thermal excursion. For example, the electromechanical contactor (EMC) and mercury displacement relay are limited in their capability to control thermal excursions.

The EMC normally operates on a 30-second or longer time base, allowing the temperature excursion between the overshoot and droop points to increase.

Although longer time-base settings will result in longer life for the contactor, heater life will be reduced significantly. Any shorter time-base settings will shorten the life of the contactor.

The mercury displacement relay (MDR) with shorter cycle times of 3 to 15 seconds still produces a significant temperature excursion, again leading to reduced heater life.

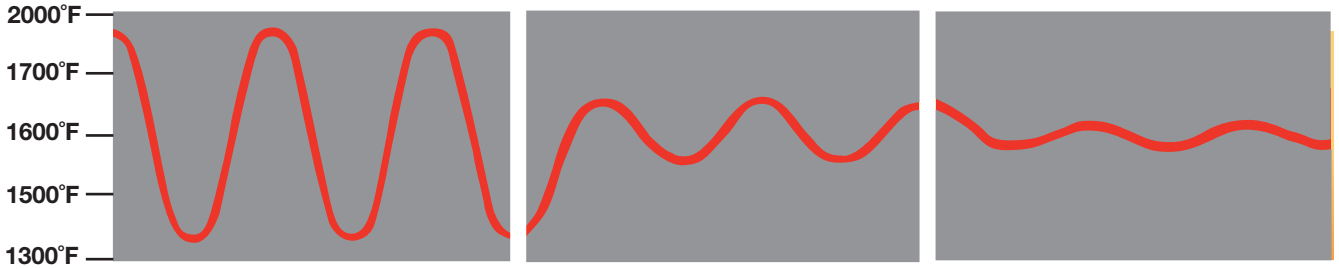
By comparison, solid state relays (SSRs) are able to operate on a one-second time base. This reduces the temperature difference between the overshoot and droop points and increases the life of the heater.

A SCR power controller with burst firing capability and operating on a variable time base of less than one second effectively eliminates temperature excursion.

An SCR power controller with phase-angle firing, regulating power by turning the SCR on within each half cycle, operates on a 8.3 millisecond time base and also effectively eliminates temperature excursion.

Because phase-angle firing can cause undesirable electrical interference, Watlow® recommends the variable time base—burst firing—for all Watlow heaters. Performance and heater life have been tested to be equal.

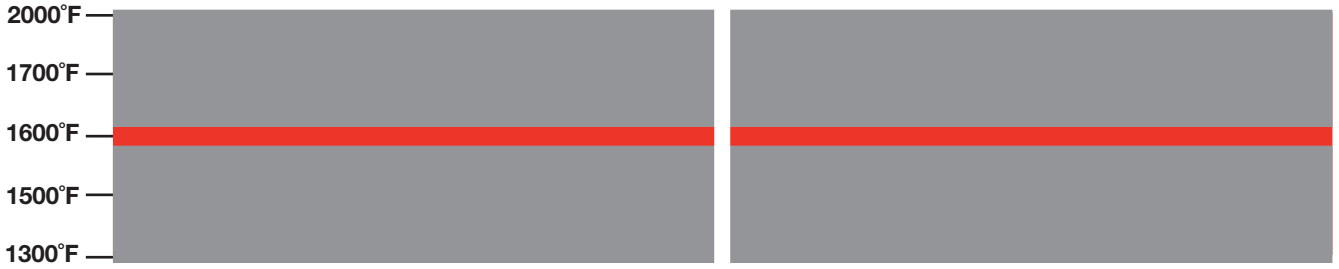
Effect of Various Power Switching Time Bases on Temperature Excursion



EMC	30 second time base
Process Set Point:	1600˚F (871˚C)
Overshoot:	300˚F (149˚C)
Droop:	254˚F (123˚C)
Internal Temperature:	2100˚F (1149˚C)

MDR	Five second time base
Process Set Point:	1600˚F (871˚C)
Overshoot:	50˚F (10˚C)
Droop:	30˚F (-1˚C)
Internal Temperature:	1830˚F (999˚C)

SSR	One second time base
Process Set Point:	1600˚F (871˚C)
Overshoot:	4˚F (-15.58˚C)
Droop:	5˚F (-15˚C)
Internal Temperature:	1730˚F (943˚C)



SCR (with burst firing)	16.6 millisecond time base
Process Set Point:	1600˚F (871˚C)
Overshoot:	0
Droop:	0
Internal Temperature:	1720˚F (934˚C)

SCR (with phase-angle)	less than 8.3 millisecond time base
Process Set Point:	1600˚F (871˚C)
Overshoot:	0
Droop:	0
Internal Temperature:	1680˚F (915˚C)

Thermal Excursion: The Deadliest Disease for Electric Heating Elements

A temperature controller with an on-off control mode has a characteristic over- and undershoot as it oscillates about set point.

The greater the thermal excursion between the over- and undershoot temperatures, the greater the thermal expansion and contraction of the element wire in the electric heater. This makes the wire more brittle and causes it to breathe and oxidize. The work hardening of the element causes breakage and heater failure.

Using SCR controllers in your process eliminates overshoot and droop to ensure long heater life and better performance of your system.

Heater Life Test

Heater:
Watlow FIREROD®

Watt Density:
110 W/in²

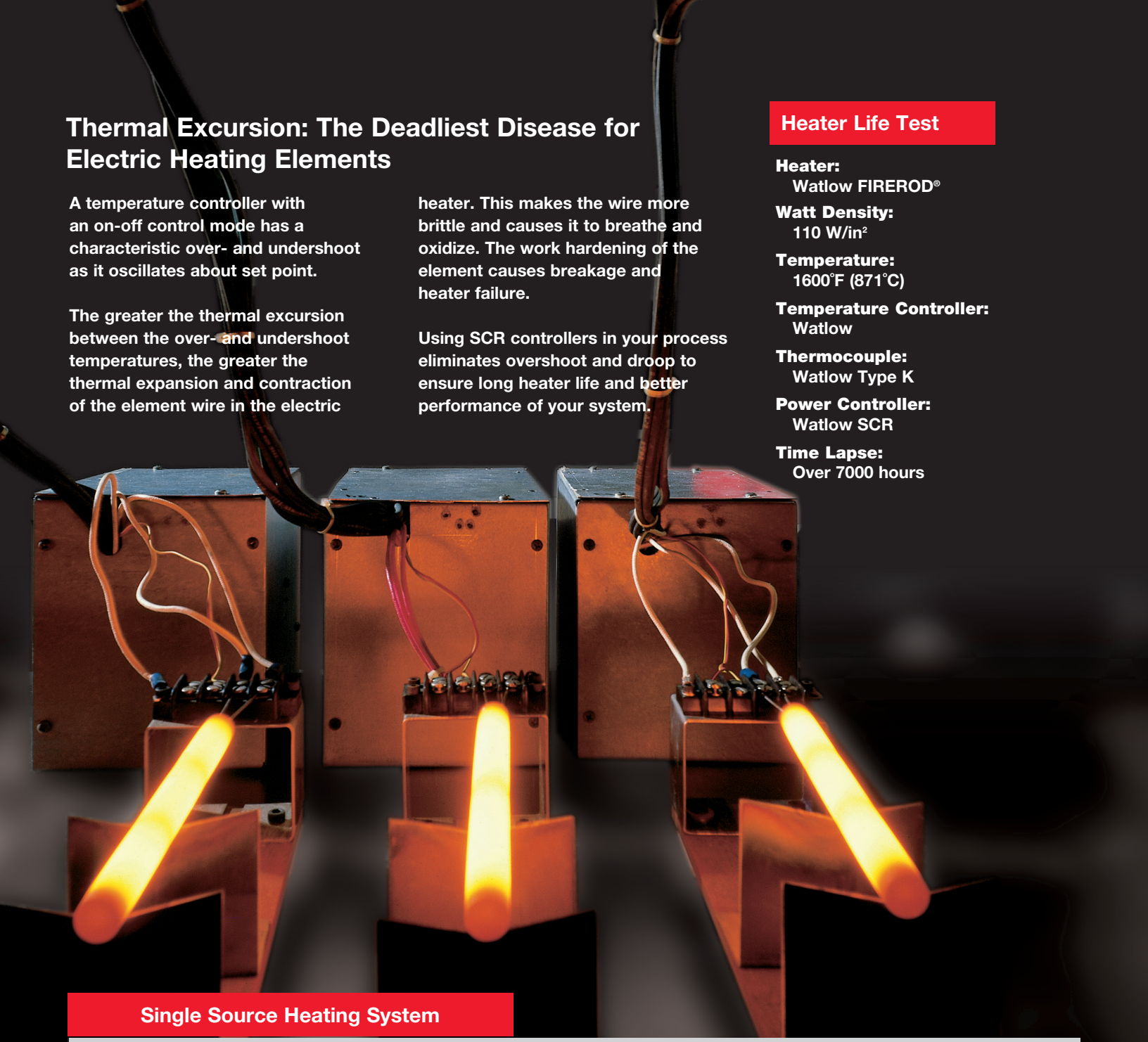
Temperature:
1600°F (871°C)

Temperature Controller:
Watlow

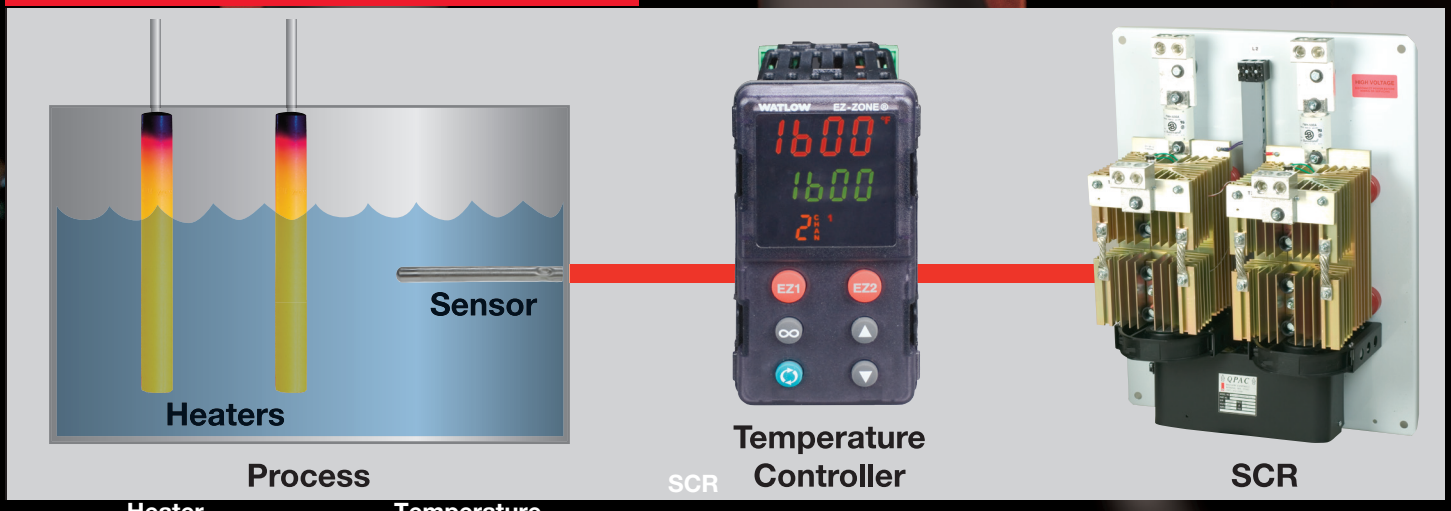
Thermocouple:
Watlow Type K

Power Controller:
Watlow SCR

Time Lapse:
Over 7000 hours



Single Source Heating System

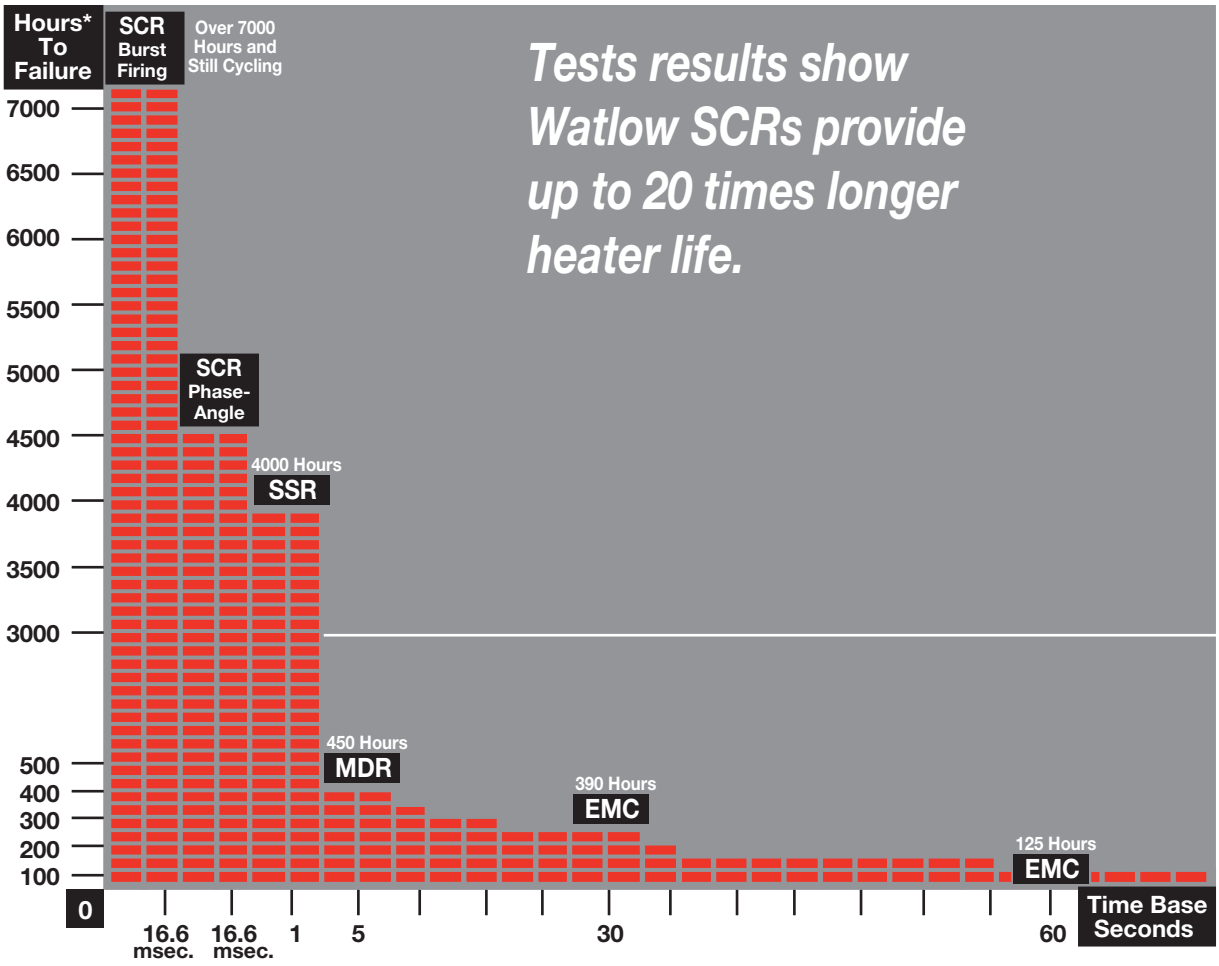


Heater
Process
Sensor

Temperature Controller

Single source heating system design assures you of Watlow quality in each system component.

Relationship: Heater Life vs. Time Base



(The hours represented on this chart are the result of an accelerated life test and are for comparison purposes only.)

Watlow SCRs: Dramatically Increase Heater Life

As time-base cycling rates increase past one second, they become more damaging to the heater element. Faster cycling does not cause as much expansion or contraction of the element wire. SCRs, cycling at less than one second, stabilize element temperature and increase heater life.

To illustrate this, Watlow conducted a heater life test of the effects of time-base cycling on resistance heater element life. Test models used identical cartridge heaters, thermocouples and temperature controllers. The only variable was the power controller type: EMC, MDR and SCR and their minimum time-base cycling rates.

The heaters were operated in open air and at high temperatures to accelerate failure. Test results showed any cycling over one second shortened the life of the heater significantly. Using SCRs extended heater life up to 20 times and more in some instances.

Watlow SCRs: Higher Allowable Watt Densities

SCRs improve heater life regardless of watt density. However, heater life is of greatest concern when using higher temperature and higher watt density heaters. Because these heaters produce a greater temperature differential between the element and sheath than lower watt density heaters, they will have a shorter life.

However, if operated with a proportional temperature controller and an SCR power controller, this difference is reduced as temperature excursions are stabilized through faster cycling. Because the SCR does not allow the element temperature to rise to a destructive level during the cycle's on-time, the higher watt density heater will survive.

Watlow SCRs: Provide Years of Reliable Service

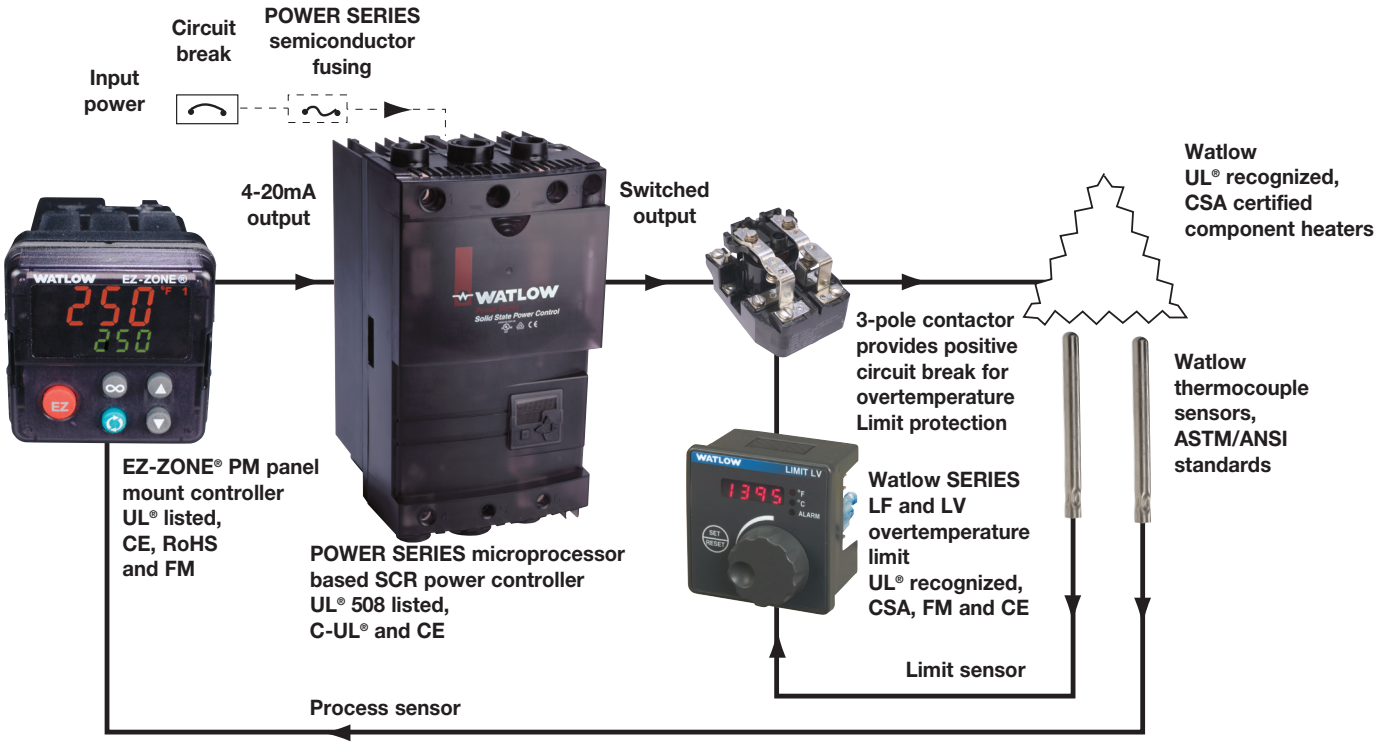
Because the SCR power controller is a solid-state device, there are no inherent wear-out modes, no moving parts to replace. The SCR is capable of many years of service while operating at the fastest time base.

The SCR's virtually limitless life eliminates the maintenance time and cost in replacing mechanical contactors.

SCR Power Controller Products Quick Selection Chart

Product	Firing Mode	Current	Type of Heater Application	Feartues	Agency Approvals
POWER SERIES	Burst firing • Contactor • Variable time base Phase-angle	65 to 250A See rating curve	Resistance element, Nichrome®-Watlow Special elements	Microprocessor design with heater diagnostics and communications. Quick delivery.	UL® 508 listed and C-UL® 200KA SCCR CE with the appropriate filter
QPAC	Burst firing • Contactor • Variable time base	150 to 1000A	Resistance element, Nichrome®-Watlow	Modular design incorporating plug-in cards for burst firing; contactor, variable time base, or phase-angle firing options. Quick delivery.	UL® 508 listed and C-UL® up to 1000A and 200KA SCCR on select models
DIN-A-MITE®	Burst firing • Contactor • Variable time base Phase-angle	18 to 100A See rating curve	Resistance element, Nichrome®-Watlow Special elements	Burst firing on 1- and 3-phase. Shorted SCR and open heater detector alarm on some zero-cross models. Quick delivery. Phase-angle on single-phase models. DIN-rail mount SCR power controller in a finger and palm safe package.	UL® 508 listed and C-UL® CE with the appropriate filter 200KA SCCR with specified fusing
SSR	VAC or VDC Burst firing Contactor input	10 to 75A	Resistance element, Nichrome®-Watlow	Low cost, requires heat sink. Heat sink and overtemperature protection recommended. Stocked for same day delivery.	UL® 873 recognized CSA certified VDE CE

A Watlow System Solution for Temperature Control



Find out more about Watlow and how we can provide thermal solutions for your company:

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About Watlow

Watlow provides best-in-class engineering expertise and leading thermal products that enable customers to thrive. Our world-class technology is offered in industrial heaters, temperature sensors and electronics and communications. Watlow engineers solutions that give our customers a competitive advantage in their respective markets.

Watlow brings its experience to numerous industries, including semiconductor processing, diesel emissions, energy and environmental technologies, foodservice equipment and medical and analytical equipment to name a few

Since 1922, Watlow has grown in product capability, market experience and global reach. The company holds more than 980 patents and employs 2,000 people working globally through nine manufacturing facilities and three advanced technology centers. Headquartered in St. Louis, Missouri with sales offices in 50 countries around the world, Watlow continues to grow. Our pride and confidence stems from thrilling our customers with our products and the Watlow experience.

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