Application Guide

Power Controllers

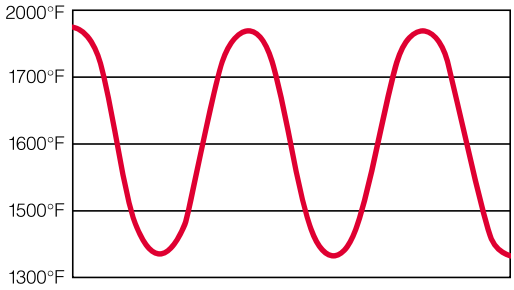
Heater Life and Selection of Power Handling Device

Heater Construction

Nichrome wire of computer-calculated gauge, length and spacing is wound on a supporting core. The resistance is precisely centered in the unit-equidistant to the sheath of all points. If the heater temperature cycles between two values in a means to maintain the process temperature, this repeated excursion causes expansion and contraction of the resistance wire. This stress on the element will reduce heater life. The higher the excursion, the shorter the life.

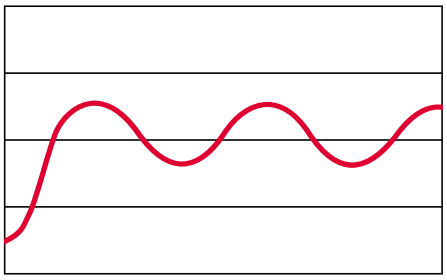
Effect of Time Base on Temperature Excursion

Ref. 111



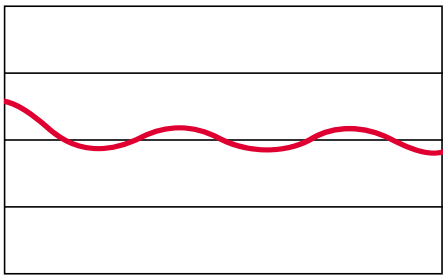
Electromechanical	30 Second Cycle Time
Process Set Point:	1600°F
Overshoot:	300°F (1900°F)
Droop:	254°F (1346°F)
Internal Temperature	2100°F

Ref. 112



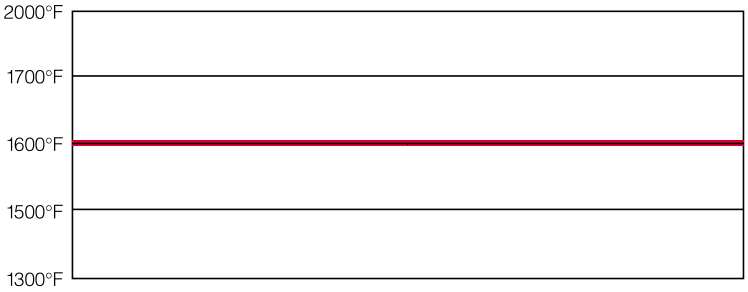
MDR	5 Second Cycle Time
Process Set Point:	1600°F
Overshoot:	50°F
Droop:	30°F
Internal Temperature	1830°F

Ref. 113



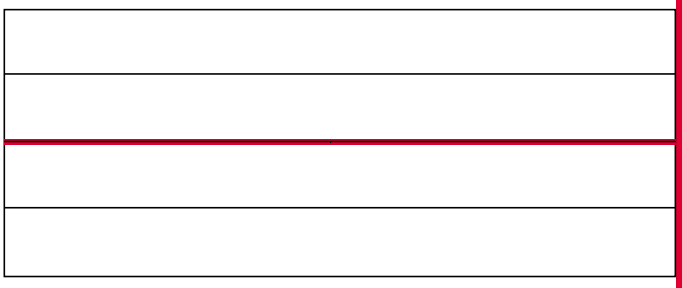
Solid State Relay	1 Second Time Base
Process Set Point:	1600°F
Overshoot:	4°F
Droop:	5°F
Internal Temperature	1730°F

Ref. 114



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

Ref. 115



SCR (with phase angle)	Less than 8.3 millisecond time base
Process Set Point:	1600°F
Overshoot:	0
Droop:	0
Internal Temperature	1680°F

Power Controllers

SCR Protective Devices

1. Semiconductor Fuses

Semiconductor fuses are a specialty fuse that is intended for SCR protection only. They are very fast clearing and will open a short circuit in less than two milliseconds. The clearing time and clearing current are designated by I^2t. Current squared times time. This rating must be at or below the I^2t rating of the SCR to insure protection. Semiconductor fuses need to be in all controlled legs. They are only intended to protect the SCR's and are not legal for cable or load (branch circuit) protection.

2. Current Limiting

A means of sensing current through a current transformer. Some heater elements change resistance during their operation, (i.e., silicon carbide). In order to control at a slow ramp, it is often advantageous to limit the current.

3. High Limit Control

The most common failure mode of an SCR is in the shorted state. If this happens, the temperature controller can no longer control the SCR and a runaway condition exists. An independent high limit controller must be used that will sense unsafe temperature and disengage the power.

4. Heat Sink Thermostat

Removes signal from an SCR in case of fan failure, filter blockage, or excess heat in the enclosure. SCRs that incorporate a fan for forced cooling can reach unsafe temperatures if the fan fails. All Watlow SCRs with fan cooling incorporate a heat sink thermostat.

Power Controller Comparisons

The following chart is an abbreviated comparison of power controllers along with their suitability for use.

Power Switching Device Comparison Chart—Ref. 116

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.

*Includes heater replacement and lost production.