

# Flexible Heaters



Flexible Heaters	Sheath Materials	Max. Operating Temperatures		Typical Max. Watt Densities		Page
		°F	°C	W/in <sup>2</sup>	W/cm <sup>2</sup>	
<b>Polyimide</b>	Polyimide	392	200	50.0	7.75	<b>111</b>
<b>Silicone Rubber</b>	Silicone rubber	500	260	80.0	12.50	<b>113</b>
<b>Line Heating</b>	Silicone rubber/cloth	392/482	200/250	2.5	0.39	<b>123</b>
<b>SERIES EHG<sup>®</sup> Controller</b>	N/A	158*	70*	N/A		<b>135</b>
<b>SERIES EHG SL10 Controller with Limit</b>	N/A	158*	70*	N/A		<b>137</b>

\* Ambient environment, not maximum controlling temperature.



Flexible Heaters



# Flexible Heaters



## Flexible Shapes and Geometries

Flexible heaters are thin, bendable and shaped to fit almost any type of equipment. Heat can be applied to complex shapes and geometries without sacrificing efficiency or dependability.

Excellent heat transfer results from the heater's thin design and direct bonding to an application. Flexible heaters provide fast heat-up and cool-down rates, uniform heat distribution and high watt densities.

### Features and Benefits

#### Flat geometry

- Permits holes, notches and unusual shapes

#### Option of two material types and two element styles

- Allow wider flexibility

#### Lightweight construction and low thermal mass

- Permit use in applications with limited space or weight requirements

#### Heating elements as close as 0.003 in. (0.08 mm)

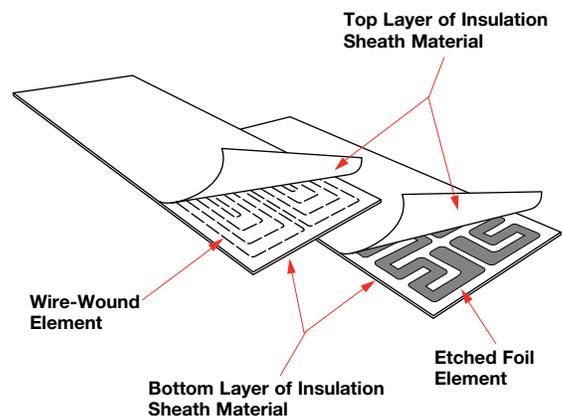
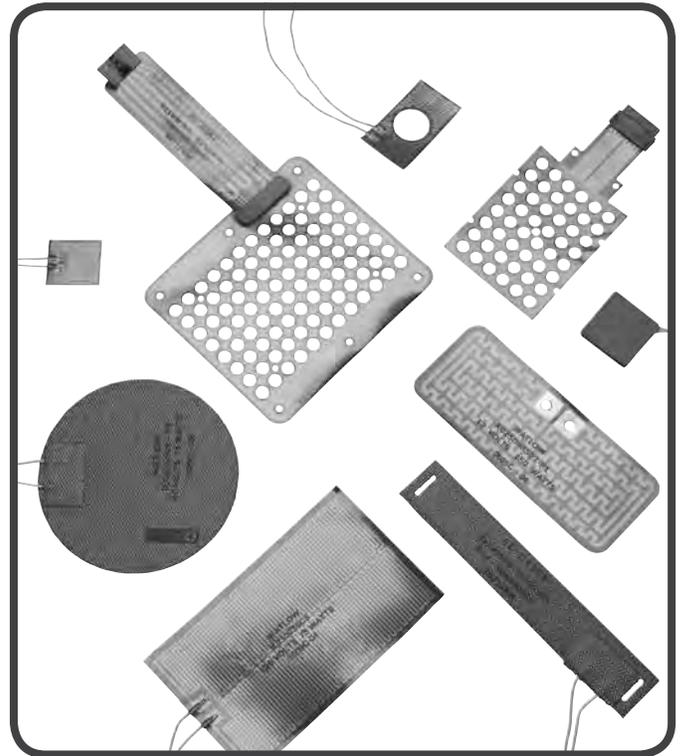
- Creates faster heat-up and cool-down time

#### Uniformly spaced element paths

- Distributes heat more evenly

### Typical Applications

- Medical equipment including blood analyzers, respiratory therapy units and hydrotherapy baths
- Semiconductor equipment, including vacuum and gas delivery lines and wafer processing equipment
- Foodservice equipment, including food holding and warming cabinets
- Battery heating
- Satellite and communication equipment
- Freeze protection for military hardware, aircraft instrumentation, hydraulic equipment, etc.
- Any application requiring a flexible shape or design





## Flexible Shapes and Geometries

### Applications and Technical Data

#### Two Material Types

##### Silicone Rubber

Rugged, moisture- and chemical-resistant material easily can be bonded to parts for effective heat transfer. Watlow silicone rubber heaters handle temperatures up to 500°F (260°C). Many heater styles are available with UR®, cUR®, VDE and CE recognition.

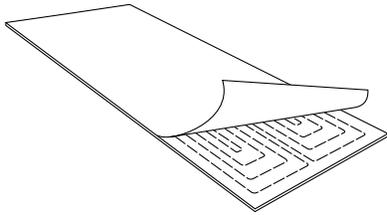
##### Polyimide

Polyimide is a thin, lightweight transparent material designed for precise heating requirements ranging from -319 to 392°F (-195 to 200°C). It is ideal for applications requiring low outgassing in a vacuum or resistance to radiation, fungus and chemicals. Many custom heaters can be UR® and cUR® recognized.

#### Two Element Types

Watlow offers wire-wound and etched foil resistance elements for silicone rubber heaters. Watlow can recommend the type best suited to your application.

##### Wire-Wound Elements

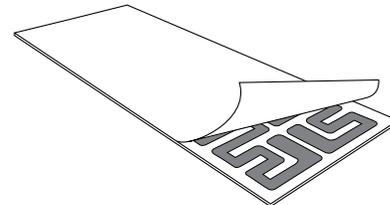


This element style is created by spiraling fine resistance wires around a fiberglass cord. The element is laid out in a pattern designed for a specific application. The benefits of wire-wound elements include:

- Excellent physical strength and flexibility. Repeated heater flexing has no harmful effects on its performance
- The ability to conform easily to curved surfaces, including small radius bends

Semiconductor pump line heaters are typical examples of applications that use the wire-wound method. These heaters are flexed repeatedly during removal and installation, but due to their wiring, no internal damage occurs.

##### Etched Foil Elements



This element type is created by acid etching a circuit in nickel alloy resistance foil. It is available in silicone rubber and polyimide heater types. The etched foil element is known for its excellent circuit pattern repeatability and superior heat transfer, which results from greater coverage of the element. Other benefits include:

- Delivery of more heat and up to twice the watt density of a wire-wound element provides longer heater life
- Complex heat distribution patterns

The etched foil element style is usually recommended for applications requiring high temperatures, watt densities, or multiple zoning.

# Flexible Heaters



## Polyimide Heaters

Polyimide is a thin, lightweight organic polymer film that provides excellent tensile strength, tear and solvent resistance and dimensional stability. The polyimide heater is ideal for applications requiring low outgassing in a vacuum or resistance to radiation, fungus and chemicals.

### Performance Capabilities

- For operating environments as low as -319°F (-195°C), heater temperature as high as 392°F (200°C)
- Watt densities up to 50 W/in<sup>2</sup> (7.75 W/cm<sup>2</sup>)<sup>①</sup>
- UR<sup>®</sup> and C-UR<sup>®</sup> recognitions

### Features and Benefits

#### Excellent physical and electrical properties

- Results in thermal stability over a wide temperature range

#### Transparent polyimide material

- Allows inspection of internal details

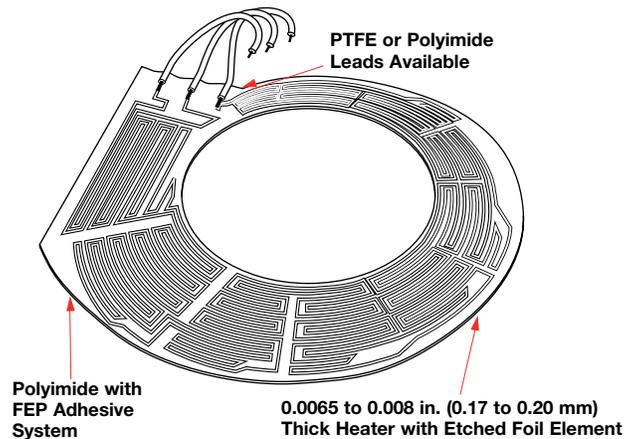
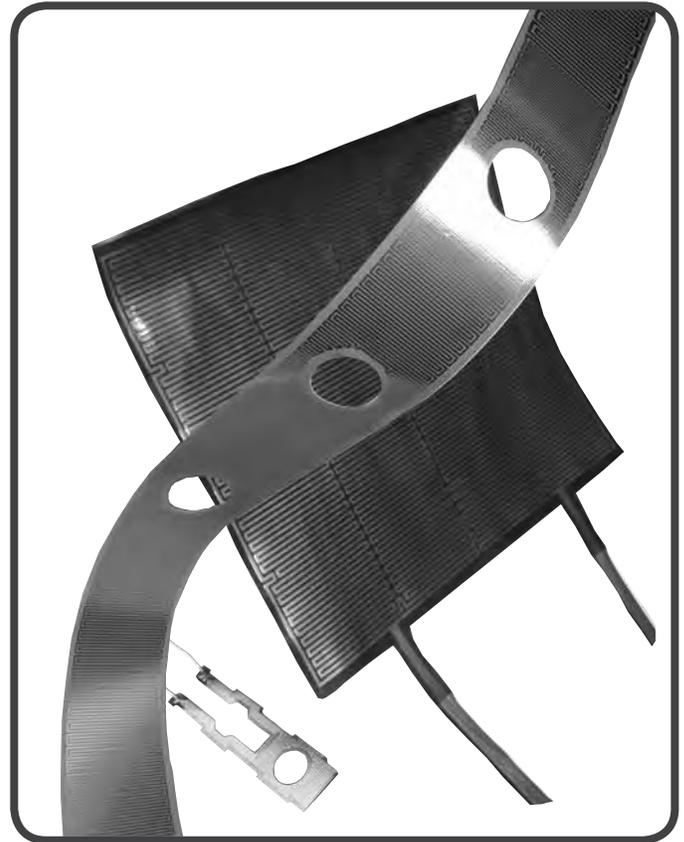
#### Resistance to radiation and fungus

- Allows it to be used in a wide range of applications

### Typical Applications

- Medical applications that require a clean, sterile environment
- Laboratory research
- Semiconductor processing equipment
- Optical equipment
- LCD displays
- Computer equipment
- Photographic equipment
- Aerospace/defense, where low outgassing properties are required

① Watt density limits are application dependent (operating temperatures, bonding method and heat sink).





## Polyimide Heaters

### Technical Data

#### Specifications

##### Thickness

- 0.007 in. (0.2 mm)

##### Flexibility (min. radius)

- 1/32 in. (0.8 mm)

##### Weight

- 1.5 oz/ft<sup>2</sup> (0.05 g/cm<sup>2</sup>)

##### Operating temperature

- Max.: 392°F (200°C)
- Min.: -319°F (-195°C)

##### Watt density rating on stock units

- 5 W/in<sup>2</sup> (0.8 W/cm<sup>2</sup>)

##### Dielectric strength

- Min. VAC: 1000

##### Flammability rating

- Self-extinguishing

##### Heater size limitations

- 18 x 26 in. (457 mm x 660 mm)

##### Weight loss (outgassing)

- 0.51%

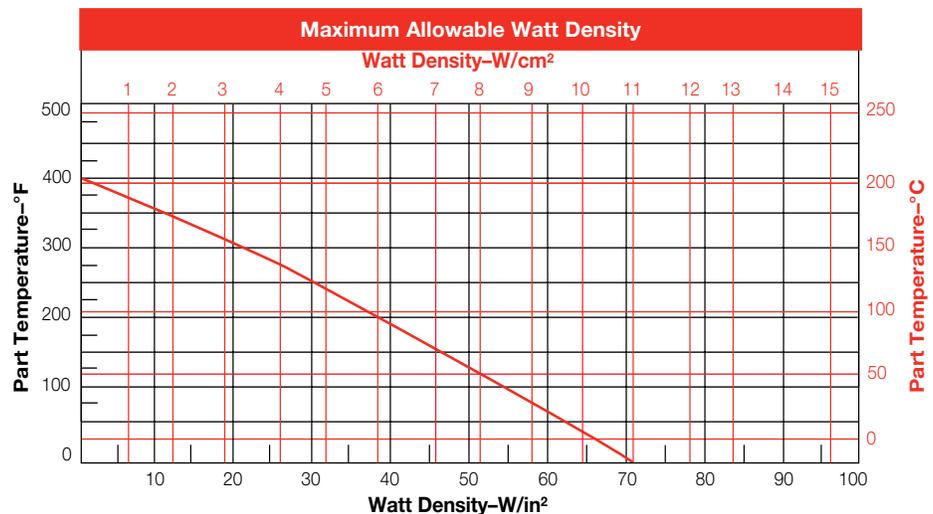
##### Lead length

- 12 in. (305 mm) PTFE E

### Maximum Allowable Watt Density Versus Temperature

To achieve optimum performance with your Watlow polyimide heater, use a proper watt density on the surface of the heater.

The graph recommends watt densities for temperatures using a temperature controller. It does not indicate the watt density needed to achieve a given part temperature.



**Note:** The maximum watt density (W/in<sup>2</sup>) in open air is 5 W/in<sup>2</sup>. The chart above assumes bonding the polyimide heater to a part.

# Flexible Heaters



## Silicone Rubber Heaters

Rugged, yet thin, lightweight and flexible — use of Watlow® silicone rubber heaters is limited only by the imagination. Heat can be put exactly where it is needed to improve heat transfer, speed warm ups and decrease wattage requirements in an application process.

Fiberglass-reinforced silicone rubber provides dimensional stability without sacrificing flexibility. Because very little material separates the element from the part, heat transfer is rapid and efficient. Heaters are constructed with a wire-wound element or with an etched foil element. Its thin construction allows it to fit into applications where space is limited.

### Performance Capabilities

- Operating temperatures up to 500°F (260°C)
- Watt densities up to 80 W/in<sup>2</sup> (12.5 W/cm<sup>2</sup>), dependent upon application temperature
- Wire-wound element thickness — 0.055 in. (1.4 mm)
- Etched foil element — 0.022 in. (0.56 mm)
- UR®, cUR®, VDE and CE recognitions are available on many designs up to 428°F (220°C)

### Features and Benefits

#### Designed to the exact shape and size needed

- Conforms to component and/or equipment

#### More than 80 designs available immediately from stock

- Reduces downtime

#### Constructed with wire-wound or etched foil elements

- Enables a thin, lightweight heater
- Provides the desired flexibility for many dynamic applications
- Delivers low mass and easily repeatable distributed watt densities

#### Moisture and chemical-resistant silicone rubber material

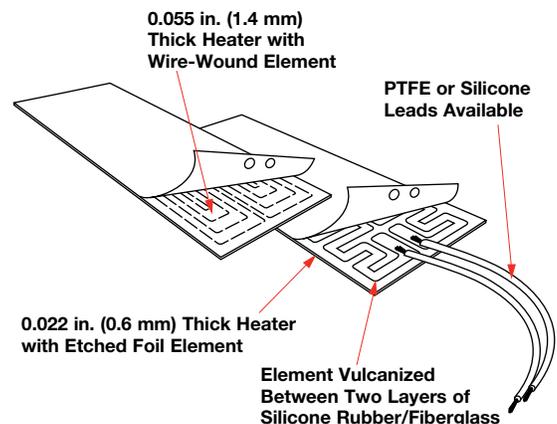
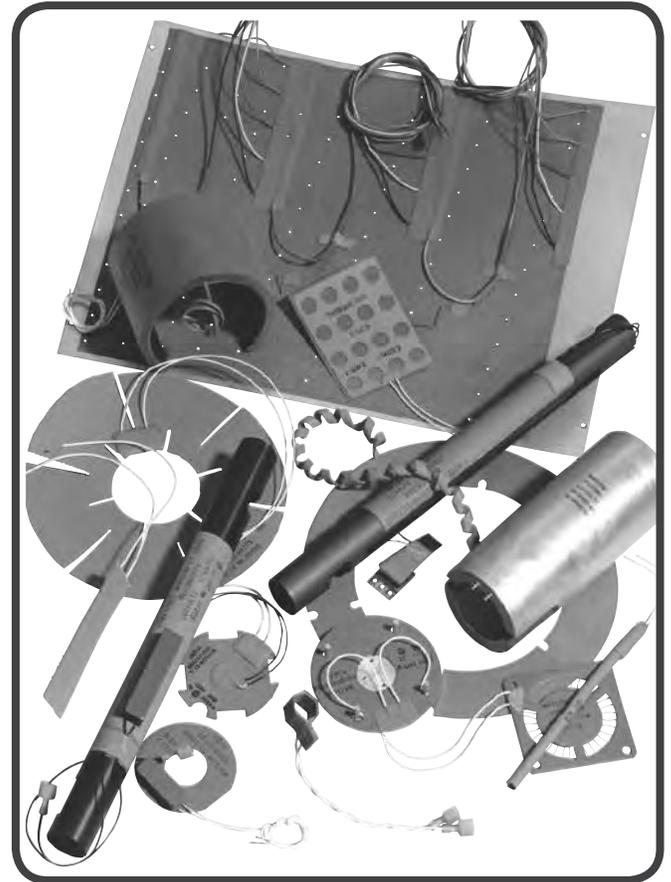
- Provides longer heater life

#### Vulcanizing adhesives or fasteners

- Allows heaters to be easily bonded to parts

### Typical Applications

- Semiconductor processing equipment
- Freeze protection and condensation prevention for many types of instrumentation and equipment
- Medical equipment such as blood analyzers and test tube heaters
- Computer peripherals such as laser printers
- Curing of plastic laminates
- Photo processing equipment





## Silicone Rubber Heaters

### Applications and Technical Data

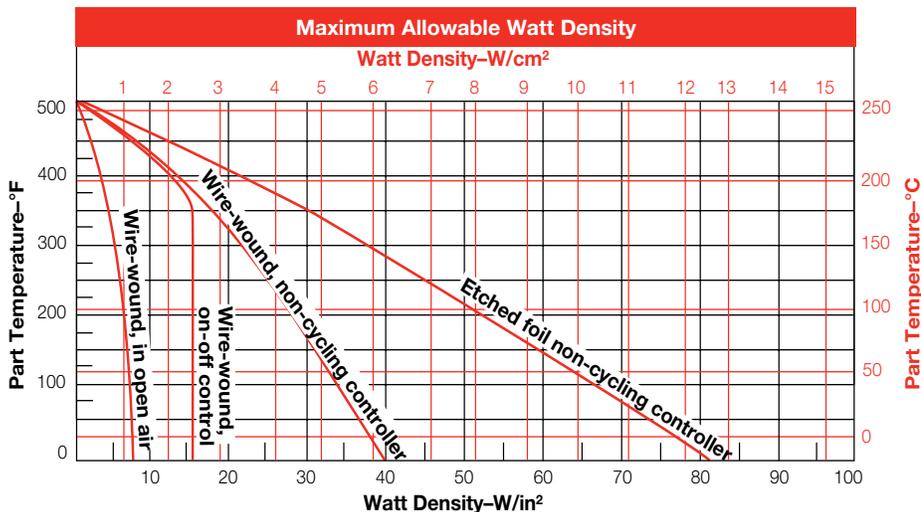
#### Determining Watt Density

The *Maximum Allowable Watt Density* graph illustrates the maximum recommended heater watt density at various metal parts or ambient air temperatures. However, it does not indicate the watt density necessary to achieve a given part temperature. See the *Surface Temperature vs. Time* graph on the next page for assistance with these calculations. When using this graph, consider:

- Part temperature is measured at the point where the heater contacts the metal part.
- Thermostats and on-off controllers are typically bimetal or capillary bulb.
- Non-cycling controllers are typically solid state, time-proportioning or silicone controlled rectifier (SCR) temperature controllers.

- Watt density values should be de-rated by one third if insulation is used.
- UL<sup>®</sup> recognition temperature limits are not detailed.
- Contact your Watlow representative prior to selecting high watt density etched-foil elements, or operating heaters with back side insulation or non-metallic parts, which are poor thermal conductors.

**Example:** A wire-wound heater with a non-cycling controller at a part temperature of 250°F (120°C) can be rated at 24 W/in<sup>2</sup> (3.7 W/cm<sup>2</sup>) maximum. An etched foil heater operating under the same conditions can be rated at 45 W/in<sup>2</sup> (7 W/cm<sup>2</sup>) maximum.



#### Silicone Rubber Specifications

##### Max. width x max. length

- Wire wound: 36 x 95 in. (914 mm x 2413 mm)
- Etched foil: 18 x 34 in. (457 mm x 863 mm)

##### Thickness

- Wire wound: 0.055 in. (1.4 mm)
- Etched foil: 0.022 in. (0.6 mm)

##### Weight

- Wire wound: 8 oz/ft<sup>2</sup> (0.24 g/cm<sup>2</sup>)
- Etched foil: 3 oz/ft<sup>2</sup> (0.09 g/cm<sup>2</sup>)

**Max. operating temperature:** 500°F (260°C)

**Max. temperature for UL<sup>®</sup> recognition:** 428°F (220°C)

**Min. ambient temperature:** -80°F (-62°C)

**Max. voltage:** 600V

**Max. wattage:** see watt density graph

**Lead size:** sized to load

**Lead length:** 12 +1<sup>1</sup>/<sub>2</sub> -1<sup>1</sup>/<sub>2</sub> in. (305 mm +38 mm -13 mm)

##### Wattage tolerance

- Wire: ±5%
- Foil: +5% -10%

##### Dimensional tolerances

- 0 to 6 in. (0 to 152 mm): ±<sup>1</sup>/<sub>16</sub> in. (1.59 mm)
- 6 to 18 in. (152 to 457 mm): ±<sup>1</sup>/<sub>8</sub> in. (3.18 mm)
- 18 to 36 in. (457 mm to 914 mm): ±<sup>3</sup>/<sub>16</sub> in. (4.76 mm)
- Over 36 in. (914 mm): ±1%

# Flexible Heaters



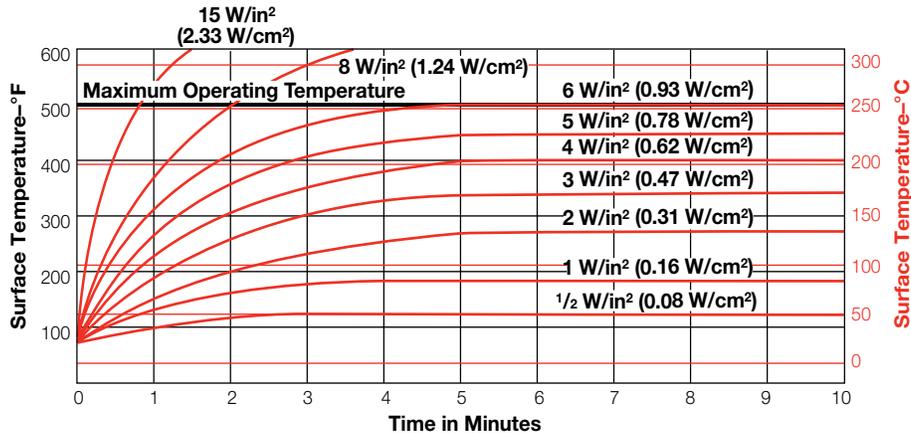
## Silicone Rubber Heaters

### Applications and Technical Data (Continued)

#### Surface Temperature vs. Time

This graph illustrates the surface temperature a silicone rubber heater will reach when uninsulated and suspended vertically in 70°F (20°C) still air.

Data is based on 0.055 in. (1.4 mm) thick construction and is offered as a reference tool.



#### UR®, cUR®, VDE and CE Recognition for Silicone Rubber Heaters

Watlow frequently works with customers requiring agency approvals such as UR®, cUR®, VDE and CE. Many silicone rubber heaters are available with one or more certifications.



**UL® Component Recognition (UR®)** of factory-bonded heaters is available up to 392°F (200°C) and for customer installed heaters up to 428°F (220°C) (UL® File No. E52951).

For Canadian recognition, Watlow offers **cUR® Recognized** silicone rubber heaters under UL® File #E52951. Several constructions are available with ratings to 600V and 428°F (220°C) maximum surface temperature. Contact your Watlow representative for further information.

**VDE Approval** is available on several constructions of both wire-wound (File No. 62533) and etched foil (File No. 62535) silicone rubber heaters. Maximum ratings are 440V and 428°F (220°C) surface temperature. Under VDE guidelines, minimum installed bend radius is 1/8 in. (3.2 mm) for etched foil and 1/4 in. (6 mm) for wire wound. VDE states that the user is responsible for the safe application, installation and wiring of heaters. Maximum working temperature must be maintained by an appropriate temperature controller.

The **CE mark** is available on UR® and/or VDE recognized heaters.

#### Options

Watlow offers options including attachment techniques, integrated controls, thermostats, special leads, holes and cutouts and three-dimensional shapes as described in the introduction to flexible heaters section.

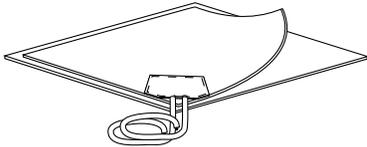


## Silicone Rubber Heaters

### Mounting Methods

Watlow offers various attachment techniques designed for fast installation.

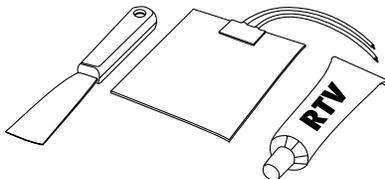
#### Pressure Sensitive Adhesive Surface (PSAS)



For speed, convenience and economy of installation, specify PSAS. Simply peel off the protective backing and roll the heater in place for an even bond to a clean, smooth surface. PSAS is not recommended for curved surfaces or for heaters rated above 10 W/in<sup>2</sup> (1.5 W/cm<sup>2</sup>). It should not be used for applications exceeding 400°F (205°C) on silicone rubber and 300°F (150°C) on polyimide.

**Note:** PSAS has a maximum six-month storage life at or below 86°F (30°C) before heater installation.

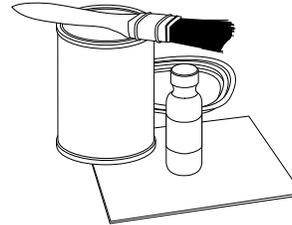
#### Field Applied Adhesive



For a stronger bond or when long storage is probable, room temperature vulcanizing (RTV) silicone adhesive works well. Watlow offers red RTV for temperatures up to 500°F (260°C). White RTV is available from adhesive suppliers for temperatures up to 400°F (205°C). Watlow's one-part RTV is self-priming and can be ordered in either 3 oz (90 ml) or 12 oz (355 ml) tubes. For larger heaters requiring longer adhesive working time, two-part RTV kits can be purchased from adhesive suppliers. These kits require primer on the surface prior to adhesive application.

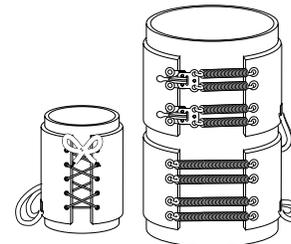
**Note:** Not recommended for polyimide heaters.

#### Silicone Contact Cement Kit



This two-part adhesive consists of a resin and catalyst that are easily mixed together and applied with a paintbrush. Recommended usage is for field cementing of silicone rubber heaters to customer parts. Available for immediate delivery, the cement kit handles temperatures up to 350°F (175°C). The resin is available in pint or quart containers. To order, specify **silicone contact cement** and the container size.

#### Mechanical Fasteners



When a wire-wound flexible heater must be detachable, any type of fastener normally used with fabrics can usually be built into the flexible heater's sheath material. The most common types are latch fasteners, boot hooks and grommets. Other styles include snap fasteners, springs and lacing cord. (Hook and loop style fastener strips are only available as part of the extended capabilities offering.) Grommets and boot hooks are commonly used with tension springs to compensate for slight variations in part size.

# Flexible Heaters

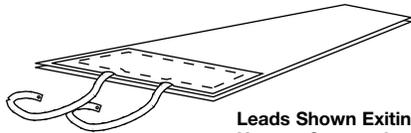


## Silicone Rubber Heaters

### Termination Styles

Watlow offers many types of leads and terminations. Leads can project from any position along the perimeter of the unit. **They are centered on the short side width of rectangular heaters unless specified.**

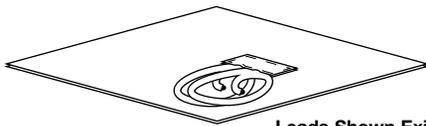
#### PTFE UL® 1180 CSA



Leads Shown Exiting End of Heater, Centered on Short Side

Watlow's leads are 12 in. (305 mm) long, white, PTFE insulated, flexible, plated copper UL® 1180 CSA wire. Leads are rated for 392°F (200°C)/300V. Lead connections on or at the heater are insulated with a cap of sheath material vulcanized to the heater body.

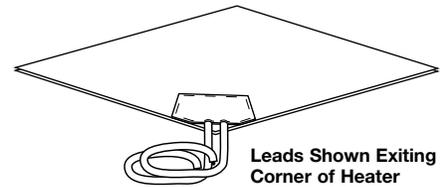
#### PTFE Leads



Leads Shown Exiting Middle of Heater.

PTFE Type E (MIL-W-16878) and PTFE UL® 1199 leads rated for 392°F (200°C)/600V are also available.

#### Silicone Insulated Leads

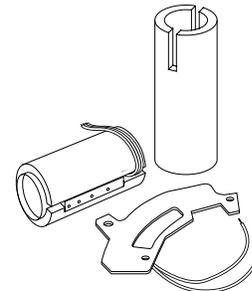


Leads Shown Exiting Corner of Heater

For a better moisture seal, specify UL® silicone insulated lead wires. This lead type is rated for 302°F (150°C)/600V. Any lead length is available. **Note:** Silicone rubber heaters are not designed to be waterproof. Excess exposure to moisture may facilitate premature heater failure.

### Option

#### Thermal Insulation



To increase heating efficiency of your application, silicone rubber heaters can be thermally insulated with silicone sponge rubber bonded to one side in the following thicknesses: 1/16, 1/8, 1/4, 3/8 or 1/2 in. (1.6, 3.2, 6, 9.5 or 13 mm).

An aluminized surface can be added to the back side of the heater to reduce radiated heat losses. This aluminized surface, called "low loss treatment," adds very little to the unit thickness or mass and maintains a very clean appearance.

# Flexible Heaters

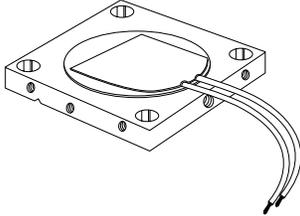
**EXTENDED  
CAPABILITY**



## Extended Capabilities for Silicone Rubber Heaters

### Mounting Methods

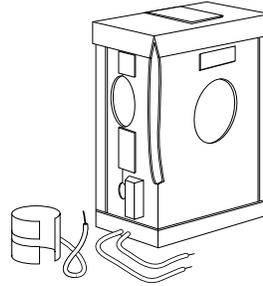
#### Factory Bonding



This attachment technique provides a strong, void-free bond for excellent heat transfer and extended heater life that has proven to be successful. Bonding is recommended for applications that reach maximum temperatures of 500°F (260°C) on silicone rubber and 300°F (150°C) on polyimide.

### Construction

#### Formed Heaters



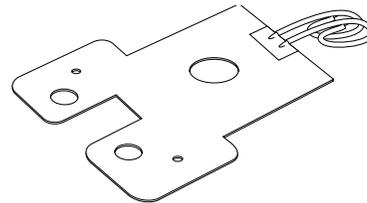
Many three-dimensional shapes, such as cylinders, cones and boxes, can be factory formed. Semi-rigid shapes can self-grip to the part. Special tooling may be required for some designs.

### Integrated Control



The SERIES EHG® is an integrated multi-function controller that is a key component in a powerful system that integrates a heater, an adjustable set point temperature controller, a high/low temperature alert, a power switching device and a high temperature safety limit. The agency recognized controller/safety limit meets UL® and CE requirements.

### Holes, Cutouts and Notches



Watlow provides flexible heaters with special holes, cutouts and notches in nearly any position required for your design. The resistance element can be brought to within 1/8 in. (3.2 mm) of all edges. Standard spacing is 1/4 in. (6 mm) from all edges.

# Flexible Heaters



## Silicone Rubber Heaters

### Wire-Wound Elements

Width		Length		Watts	120VAC Part Number	120/240VAC Part Number
in.	(mm)	in.	(mm)			
1	(25)	2	(51)	10	010020C1*	
		3	(76)	15	010030C1*	
		4	(102)	20	010040C1*	
		5	(127)	25	010050C1*	
		5	(127)	6.25/25		010050C2*
		10	(254)	50	010100C1	
		10	(254)	12.50/50		010100C2*
		15	(381)	75	010150C1	
		15	(381)	18.75/75		010150C2
		20	(508)	100	010200C1	
		20	(508)	25/100		010200C2
		25	(635)	125	010250C1	
		30	(762)	150	010300C1	
		35	(889)	175	010350C1	
		40	(1016)	200	010400C1	
		2	(51)	80	(2032)	400
120	(3048)			600	010F10C1	
2	(51)			20	020020C1*	
5	(127)			50	020050C1	
5	(127)			12.50/50		020050C2*
10	(254)			100	020100C1	
10	(254)			25/100		020100C2
15	(381)			150	020150C1	
15	(381)			37.50/150		020150C2
20	(508)			200	020200C1	
20	(508)			50/200		020200C2
25	(635)			250	020250C1	
30	(762)			300	020300C1	
35	(889)			350	020350C1	
40	(1016)			400	020400C1	
3	(76)			3	(76)	45
		5	(127)	75	030050C1	
		5	(127)	18.75/75		030050C2
		10	(254)	150	030100C1	
		10	(254)	37.50/150		030100C2
		15	(381)	225	030150C1	
		15	(381)	56.25/225		030150C2
		20	(508)	300	030200C1	
		20	(508)	75/300		030200C2
		25	(635)	375	030250C1	
		30	(762)	450	030300C1	
		35	(889)	525	030350C1	
		40	(1016)	600	030400C1	

CONTINUED

\* Due to their high resistance, these heaters are not recommended for curved or flexing applications.

**Notes:**

- Thickness 0.055 in. (1.4 mm)
- UL® component recognition available
- Silicone rubber wire-wound elements rated at 5 W/in<sup>2</sup> (0.78 W/cm<sup>2</sup>)

# Flexible Heaters



## Silicone Rubber Heaters

### Wire-Wound Elements (Continued)

Width		Length		Watts	120VAC Part Number	120/240VAC Part Number
in.	(mm)	in.	(mm)			
4	(102)	4	(102)	80	<b>040040C1</b>	
		5	(127)	100	<b>040050C1</b>	
		5	(127)	25/100		<b>040050C2</b>
		10	(254)	200	<b>040100C1</b>	
		10	(254)	50/200		<b>040100C2</b>
		15	(381)	300	<b>040150C1</b>	
		15	(381)	75/300		<b>040150C2</b>
		20	(508)	400	<b>040200C1</b>	
		20	(508)	100/400		<b>040200C2</b>
		25	(635)	500	<b>040250C1</b>	
		30	(762)	600	<b>040300C1</b>	
		35	(889)	700	<b>040350C1</b>	
		40	(1016)	800	<b>040400C1</b>	
5	(127)	5	(127)	125	<b>050050C1</b>	
		5	(127)	31.25/125		<b>050050C2</b>
		10	(254)	250	<b>050100C1</b>	
		10	(254)	62.50/250		<b>050100C2</b>
		15	(381)	375	<b>050150C1</b>	
		15	(381)	9.38/375		<b>050150C2</b>
		20	(508)	500	<b>050200C1</b>	
		20	(508)	125/500		<b>050200C2</b>
		25	(635)	625	<b>050250C1</b>	
		30	(762)	750	<b>050300C1</b>	
		35	(889)	875	<b>050350C1</b>	
40	(1016)	1000	<b>050400C1</b>			
6	(152)	5	(127)	150	<b>060050C1</b>	
		5	(127)	37.50/150		<b>060050C2</b>
		10	(254)	300	<b>060100C1</b>	
		10	(254)	75/300		<b>060100C2</b>
		15	(381)	450	<b>060150C1</b>	
		15	(381)	112.50/450		<b>060150C2</b>
		20	(508)	600	<b>060200C1</b>	
		20	(508)	150/600		<b>060200C2</b>
		25	(635)	750	<b>060250C1</b>	
		30	(762)	900	<b>060300C1</b>	
		35	(889)	1050	<b>060350C1</b>	
		40	(1016)	1200	<b>060400C1</b>	





# Flexible Heaters

## Silicone Rubber Heaters

### Wire-Wound Elements Configured Options

To order, complete the part number with the information below: →

Wire Wound  
0 60150C1-

#### Modification Options

- 0 = None
- A = PSAS bottom
- B = PSAS top
- E = With plate, heater on side opposite flange
- F = With plate, heater on flange side
- G = Flaps + grommets
- H = Flaps + boot hooks
- J = Flaps + latch fasteners
- K = PSAS and low loss
- L = Low loss
- M = Low loss + flaps + grommets
- N = Low loss + flaps + boot hooks
- P = Low loss + flaps + latch fasteners
- R = 1/16 in. sponge
- S = 1/8 in. sponge
- T = 1/4 in. sponge
- U = 3/8 in. sponge
- V = 1/2 in. sponge
- W = PSAS + 1/16 in. sponge
- Y = PSAS + 1/8 in. sponge
- 1 = PSAS + 1/4 in. sponge
- 2 = PSAS + 3/8 in. sponge
- 3 = PSAS + 1/2 in. sponge

#### Sensors

Type	LOC	WIR
0 = None		
L = T10	STD	STD
M = T10	STD	ALT
N = T10	ALT	STD
P = T10	ALT	ALT
R = T207	STD	STD
S = T207	STD	ALT
T = T207	ALT	STD
U = T207	ALT	ALT
V = T207E	On heater	STD
W = T207E	Remote	STD
4 = JSTD	STD	STD
6 = JALT	STD	STD
7 = KSTD	STD	STD

- For thermostats, standard location is as shown in catalog; standard wiring is integral or in series with the heater, alternate location is rotated parallel with heater width, alternate wiring is separate leads for pilot control.

- For thermocouples, Type J standard is PFA insulation, Type J alternate is fiberglass insulation, Type K standard is fiberglass insulation.

#### T10 Set °F\*

- 0 = None
- A = 125
- B = 150
- E = 175
- F = 200
- G = 225
- H = 250
- J = 275
- K = 300

#### T207 Set °F\*

- 0 = None
- 1 = 40/55
- 2 = 60/75
- 3 = 95/110
- 4 = 145/160

#### T/C Length

- 0 = None
- A = 8 in.
- B = 12 in.
- E = 18 in.
- F = 24 in.
- G = 30 in.
- H = 36 in.
- J = 40 in.
- K = 4 ft
- L = 5 ft
- M = 6 ft
- N = 7 ft
- P = 8 ft
- R = 9 ft
- S = 10 ft
- T = 12 ft
- U = 15 ft
- V = 18 ft
- W = 20 ft
- Y = 22 ft
- 1 = 25 ft
- 2 = 30 ft

\* For all thermostats the heater must be a 2 in. (51 mm) min. width and 5 in. (127 mm) min. length.

#### Lead Insulation

- 0 = None
- 1 = 1180 UL® R/C
- 2 = 1180 C-UL® R/C
- 3 = 3133 22 Ga.
- 6 = 1199 CSA
- 7 = HPN
- 8 = 6 ft HPN set
- 9 = Type E PTFE
- A = 1180VDE\*
- B = 1199VDE\*
- C = Silicone leads w/waterproof cap
- E = SJO cord
- F = 6 ft SJO set

\* 1180VDE denotes a C-UL® heater plus a VDE stamp.

#### Lead Length\*

- A = 8 in.
- B = 12 in.
- E = 18 in.
- F = 24 in.
- G = 30 in.
- H = 36 in.
- J = 40 in.
- K = 4 ft
- L = 5 ft
- M = 6 ft
- N = 7 ft
- P = 8 ft
- R = 9 ft
- S = 10 ft
- T = 12 ft
- U = 15 ft
- V = 18 ft
- W = 20 ft
- Y = 22 ft
- 1 = 25 ft
- 2 = 30 ft

\* Customer specified length must be noted in inches when ordering.

# Flexible Heaters



## Gas Delivery and Exhaust Thermal Solutions

Watlow has the knowledge, experience and product breadth to optimize the thermal performance of your gas delivery and exhaust systems. Watlow designs and manufactures all of the thermal components to work together to enhance the performance of our customers' wafer processing products. Incorporating thermal design of the gas systems early in the process will ensure maximum temperature uniformity, a reduction in particle buildup and minimal amount of tool downtime. We understand your system needs and can offer a customized solution to help improve tool yields.

Watlow works at your pace to help you remain competitive.

Watlow provides:

- Cleanroom compatible heaters that cover the entire line
- Heaters that fit tightly to line components, eliminating cold spots
- Heaters that can be customized for uniform heating
- Electronic temperature controllers and integral sensors to provide stable temperature control
- Communications and software that can network with the tool or plant-wide system
- ATSTM technology to simplify complex applications and reduce design iterations

Watlow offers:

- ASSURANT® cloth-type heaters
- Silicone rubber heaters
- Molded silicone foam rubber heaters
- FLUENT® in-line heaters
- Integrated sensing and control systems



### Features and Benefits

#### Moisture and chemical-resistant semiconductor-grade materials

- Provides longer heater life
- Ensures cleanroom compatibility

#### Flexible heater designs

- Allows thermal profile to be customized to meet specific needs
- Reduces system costs

#### Heaters fit tightly to line components

- Eliminates cold spots
- Provides uniform heating

#### Integrated control systems

- Provides multiple zones of control
- Eliminates the need for over-temperature protection

#### Agency approvals: UL®, SEMI-S2 and CE

- Meets necessary safety and industry regulations

# Flexible Heaters



## Line Heating

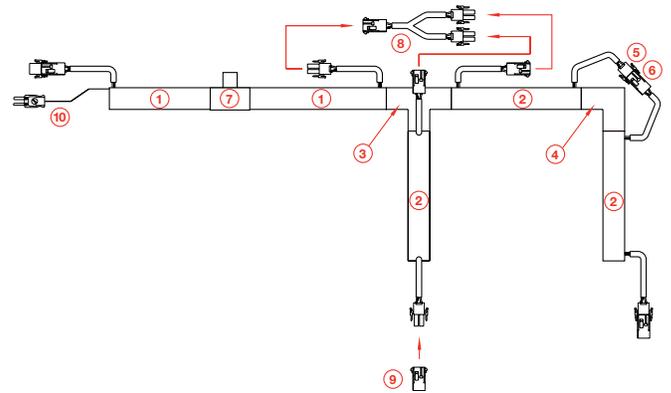
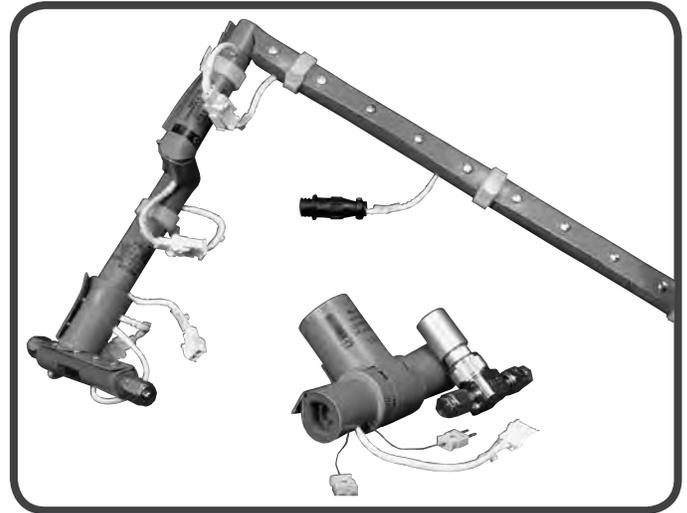
### Silicone Gas Line Heaters

#### Gas Delivery

Tetraethyl orthosilicate (TEOS), boron trichloride ( $\text{BCl}_3$ ), aluminum chloride ( $\text{AlCl}_3$ ), chlorine trifluoride ( $\text{ClF}_3$ ) and dichlorosilane (DCS) are gases that condense or liquefy due to a phase shift at low temperatures. In semiconductor processes, condensation occurs in the gas line and puddles in the shower head before being injected into the vacuum chamber. A substantial number of wafer defects will occur if liquefied gases are injected into the vacuum chamber. Uniform heating of the lines will prevent condensation. TEOS lines are typically heated above 194°F (90°C) and  $\text{BCl}_3$  above 86°F (30°C), depending on pressure and flow rate. The optimum line temperature will vary depending on the process parameters.

#### Specifications

- Watt density of 2.5 W/in<sup>2</sup> (0.4 W/cm<sup>2</sup>) on gas line O.D.
- UL<sup>®</sup> recognized for U.S. and Canadian safety standards
- Heaters and insulators meet UL<sup>®</sup> 94-HB flammability requirements
- Insulated straight fillers for 100 percent line coverage; elbows and tees are trim-to-fit to proper length
- I.D. available: 1/4, 3/8, 1/2, 3/4 in. (6, 9.5, 13, 19 mm)
- 120V standard, other voltages available
- Small metal snaps
- Heaters are insulated with a 3/8 in. (9.5 mm) wall, silicone rubber, closed cell sponge



#### Upstream Gas Line Heater Assembly (Example)

- ① 9 in. (229 mm) heater with thermocouple. Heater leads have a male plug on one end and a female cap on the other end. Heater materials are UL<sup>®</sup> rated to 392°F (200°C)
- ② 6 in. (152 mm) heater, heater leads, see 1
- ③ Union tee insulator
- ④ 90° union elbow insulator
- ⑤ Male plug, AMP MATE-N-LOK<sup>™</sup> connector part number 1-480698-0; with sockets AMP MATE-N-LOK<sup>™</sup> connector part number 350689-1
- ⑥ Female cap, AMP MATE-N-LOK<sup>™</sup> connector part number 1-480699-0; with pins AMP MATE-N-LOK<sup>™</sup> connector part number 350690-1
- ⑦ Valve or regulator
- ⑧ Y connector: one female cap on one end, two male plugs on the other end
- ⑨ Dead plug (sealed)
- ⑩ Type J thermocouple w/ male mini-plug (optional)



## Line Heating

### ASSURANT® SERIES TF Gas Line Heaters

Watlow's cloth heater jackets provide flexibility in designing optimum heating systems for gas lines. ASSURANT® TF heater jackets are ideal for high temperature / low outgassing for cleanroom applications.

Watlow's ASSURANT SERIES TF heater jackets maximize thermal uniformity and coverage by providing an efficient, easy-to-install heating solution for upstream gas line applications. The ASSURANT heater jackets optimize process tool uptime and chip yield by providing full coverage to the line eliminating cold spots that result in particle buildup.

ASSURANT heater jackets can be customized with distributed watt densities, so lighter and heavier component parts are heated uniformly.

This heater jacket can be supplied with integrated temperature sensors and controllers to assure accuracy and equipment longevity.

### Features and Benefits

#### Even heating for uniform temperature profiles over the entire heated line

- Eliminates cold spots that result in sublimation and solid particle buildup in the line

#### High operating temperatures up to 482°F (250°C)

- Prevents particle buildup in high-temperature applications such as certain atomic layer deposition (ALD) applications

#### PTFE construction

- Exhibits low outgassing and little to no particle generation
- Appropriate solution for cleanroom applications

#### UL®, SEMI S2 and CE agency approval

- Assures safety standard compliance

#### Environmental safety

- Reducing particle buildup decreases potential of exposure to hazardous materials during normal cleaning cycles

#### Easy-to-install system

- Conveniently fits on most gas line configurations
- Provides full line coverage for uniform heating
- Interconnection between heaters is easily accomplished using the mating electrical connectors



#### Integrated sensors and controllers

- Enables flexible control solutions using PID temperature algorithms to deliver accurate and precise temperature control

#### Flexible heater design

- Allows for heating typical vacuum line components and fittings including pipes, valves, clamps and elbows in the line
- Allows complex geometries to be combined, which reduces the number of components needed

#### Fiberglass insulation

- Provides high efficiency
- Lowers power consumption and the cost of ownership
- Yields low backside temperatures

### Typical Applications

Gas delivery lines

- Boron trichloride, BCl<sub>3</sub>
- Chlorine trifluoride, ClF<sub>3</sub>
- Dichlorosilane, (DCS), SiH<sub>2</sub>Cl<sub>2</sub>
- Tetra ethyl orthosilicate, TEOS
- Tungsten hexafluoride, WF<sub>6</sub>
- Process gas line qualification



## Line Heating

### **ASSURANT SERIES TF Gas Line Heaters** *(Continued)*

#### **Specifications**

##### **Operating temperature**

- Standard operating temperature up to 392°F (200°C) (recommended)
- Maximum operating temperature up to 482°F (250°C)
- Other options available (contact your Watlow representative)

##### **Agency approvals**

- UL® 499, File # E52951
- RoHS compliant
- CE
- SEMI S2

##### **Standard connectors**

- AMP MATE-N-LOK™
- 4-pin AMP CPC
- Other options available (contact your Watlow representative)

##### **Integrated sensor (optional)**

- Type K thermocouple
- Over-temperature mechanical thermostat 482°F (250°C) max.

##### **Voltage**

- 120, 208 or 240V standard, other voltages available

##### **Fastener**

- Hook and loop

##### **Inner jacket material options**

- 100% PTFE cloth

##### **Outer jacket material options**

- 100% PTFE cloth

##### **Dimensions**

- Available for pipe sizes 1/4 to 1 in. (6 to 25 mm) diameter.

For other sizes contact your Watlow representative.



## Line Heating

### **STRETCH-TO-LENGTH® Heaters**

During semiconductor processes, condensation of many critical gases occurs due to a phase shift at low temperatures. Burning of gases occurs if the delivery line is too hot. High or low temperature conditions may result in undesirable particulates, costly device defects and tool maintenance.

The Watlow STRETCH-TO-LENGTH® (S-T-L) gas line heater system is an easy-to-assemble temperature solution that delivers superior performance compared to heat tape. The heater's preformed construction allows an engineer to easily wrap it around the delivery line. It provides consistent heater/gas line contact to improve temperature uniformity. Due to its flexibility, the S-T-L gas line heater can compensate for variable component sizes to reduce the potential for hot and cold spots.

The S-T-L system includes a 2 W/in<sup>2</sup> S-T-L heater and silicone foam rubber insulation.

### **Features and Benefits**

#### **Easy to install two-part system**

- Conveniently fits most gas line configurations

#### **Flexible heater design**

- Easily customize the thermal profile for each gas line application
- Allows quick prototyping to determine energy distribution requirements for process improvements

#### **Flexible standard system components**

- Eliminates unnecessary lead times for custom designs

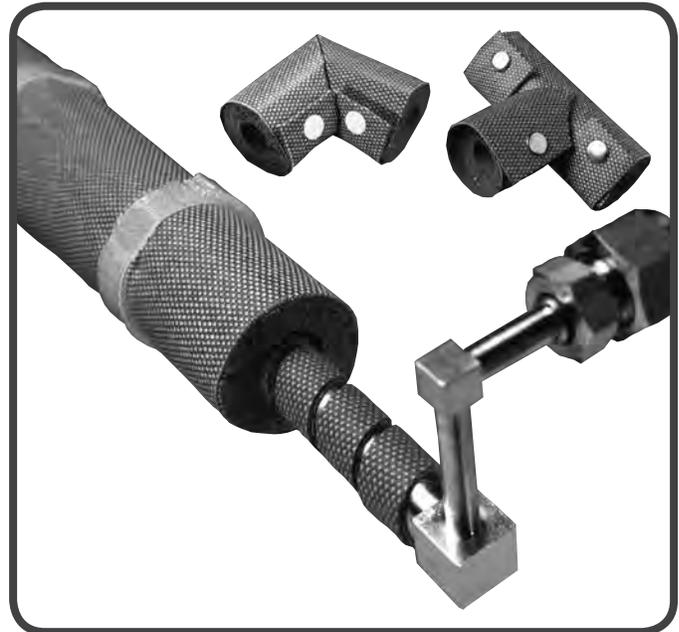
#### **Agency Certification, Recognition Compliance and Approvals**

- Semi S2-93 compatible with a high-limit thermocouple and controller
- UL® recognized for U.S. safety standards

### **Typical Applications**

#### **Gas delivery lines**

- Boron trichloride, BCl<sub>3</sub>
- Chlorine trifluoride, ClF<sub>3</sub>
- Dichlorosilane, (DCS), SiH<sub>2</sub>Cl<sub>2</sub>
- Tetra ethyl orthosilicate, TEOS
- Tungsten hexafluoride, WF<sub>6</sub>
- Process gas line qualification



### **Specifications**

- Heater material is reinforced silicone rubber fabric
  - Color:
    - Insulation and outer jacket – orange
    - Heater – orange
- Cleanroom strap fasteners
- Voltage: 120 and 240VAC
- Max. operating temperature: 392°F (200°C)
- Heater watt density: 2 W/in<sup>2</sup> (0.31 W/cm<sup>2</sup>) – Watlow recommends 80% line wrap for optimum performance
- Power lead wires: 12 in. (305 mm); #18 AWG UL® 1180 CSA, rated 10A, lead wire pair encapsulated in reinforced silicone rubber sleeving
- Heater interconnectable up to a 10A circuit
- Material rated UL® 94-HB
- Heater materials are UL® rated to 392°F (200°C)
- Insulation:
  - 3/8 in. (9.5 mm) wall, silicone rubber, closed cell sponge
  - Jacket material is reinforced silicone rubber fabric

# Flexible Heaters



## Line Heating

### STRETCH-TO-LENGTH Heaters (Continued)

S-T-L heaters are specified by their straight length. For actual applications, an engineer can wrap the heaters to achieve an optimum temperature profile. Coverage lengths of approximately 60 and 80 percent on ¼ in. (6 mm) and ½ in. (13 mm) diameter tubes are provided

as a guide to select heater lengths for actual gas line dimensions. A gas line with 100 percent coverage is approximately 2 W/in<sup>2</sup>, 80 percent coverage 1.6 W/in<sup>2</sup> or 60 percent coverage 1.2 W/in<sup>2</sup>.

### S-T-L Heater Ranges - ¼ in. (6 mm) O.D. Tubing

0.25 60% Coverage	0.25 80% Coverage	120V Version Part Number	Amperes	240V Version Part Number	Amperes
10.20	8.04	005120500	0.10	N/A	N/A
14.45	11.39	005170500	0.14	N/A	N/A
18.70	14.74	005220500	0.18	005220501	0.09
23.80	18.76	005280500	0.23	005280501	0.12
30.60	24.12	005360500	0.30	005360501	0.15
39.95	31.49	005470500	0.39	005470501	0.20
51.00	40.20	005600502	0.50	005600503	0.25
63.75	50.25	005750500	0.63	005750501	0.31
76.50	60.30	005900500	0.75	005900501	0.38

### S-T-L Heater Ranges - ½ in. (13 mm) O.D. Tubing

0.50 60% Coverage	0.50 80% Coverage	120V Version Part Number	Amperes	240V Version Part Number	Amperes
10.20	6.63	005170501	0.14	N/A	N/A
15.00	9.75	005250501	0.21	N/A	N/A
21.00	13.65	005350502	0.29	005350503	0.15
29.40	19.11	005490502	0.41	005490503	0.20
38.40	24.96	005640502	0.53	005640503	0.27
47.40	30.81	005790502	0.66	005790503	0.33
59.40	38.61	005990502	0.82	005990503	0.41
73.80	49.97	005F103502	1.02	005F103503	0.51
92.40	60.06	005F128502	1.28	005F128503	0.64

### ¼ in. (6 mm) O.D. Tubing Insulators

¼ in. (6 mm) Heater I.D. x Length	Description	Part Number
18 in. (457 mm)	Straight insulator	012180500
36 in. (914 mm)	Straight insulator	012360500
Elbow	90° union elbow insulator	012020500
Tee	Union tee insulator	012030500
VCR	VCR fitting	015030500

### ½ in. (13 mm) O.D. Tubing Insulators

½ in. (13 mm) Heater I.D. x Length	Description	Part Number
18 in. (457 mm)	Straight insulator	024180500
36 in. (914 mm)	Straight insulator	024360500
Elbow	90° union elbow insulator	020024500
Tee	Union tee insulator	024030500
VCR	VCR fitting	015042500

### ¾ in. (9.5 mm) O.D. Tubing Insulators

¾ in. (9.5 mm) Heater I.D. x Length	Description	Part Number
18 in. (457 mm)	Straight insulator	016180500
36 in. (914 mm)	Straight insulator	016360500
Elbow	90° union elbow insulator	016020500
Tee	Union tee insulator	016030501
VCR	VCR fitting	015042500

# Flexible Heaters



## Line Heating

### *STRETCH-TO-LENGTH Heaters (Continued)*

#### Power Extensions

Description	Part Number
3 ft (914 mm)	<b>A000136</b>
6 ft (1829 mm)	<b>A000137</b>
10 ft (3048 mm)	<b>A000138</b>

#### Accessories

Description	Part Number
Power cord 6 ft 18-2 SJ	<b>Z5302-2</b>
Wiring Y connector – 1F-2M	<b>Z5303-2</b>
Wiring Y connector – 1M-2F	<b>Z6333</b>
Female termination plug	<b>Z5309-2</b>
Male termination plug	<b>Z6332</b>
12 in. 24 Ga. Type J T/C w/mini plug	<b>Z5786</b>
12 in. 24 Ga. Type K T/C w/mini plug	<b>Z5639</b>
Gender changer – M-F	<b>Z6334</b>
Gender changer – F-M	<b>Z6335</b>
6 in. power extension	<b>Z6374</b>
10 ft Type J T/C extension	<b>Z6271</b>

**Note:** All power connectors use AMP MATE-N-LOK™

# Flexible Heaters



## Line Heating

### Silicone Pump Line Heaters

The tight contact fit of Watlow's pump line heaters provide superior, uniform heating of transfer lines.

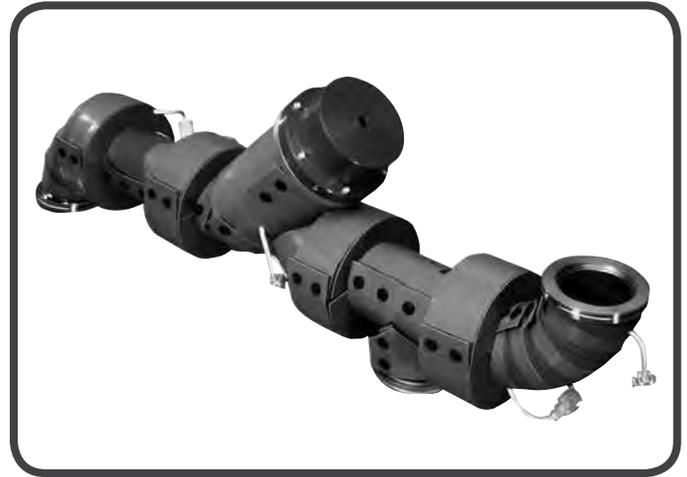
### Agency Certification, Recognition Compliance and Approvals

- Complies with SEMI S2-93 standards
- UL® recognized for U.S. and Canadian safety standards
- CE, VDE
- National Electrical Code (NEC), Article #427-23
- UL® Listed available

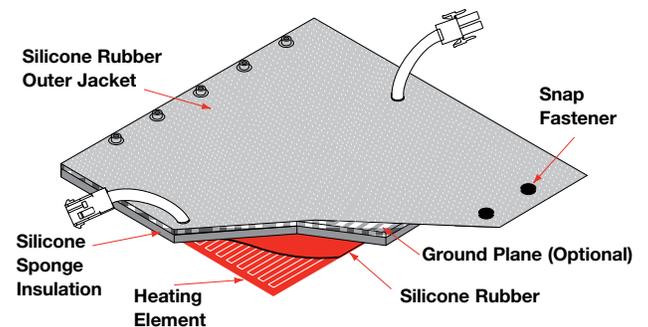
Contact your Watlow representative for specific applications and approvals.

### General Specifications

- The heater and jacket material are constructed using reinforced silicone rubber fabric.
- Insulation and outer jacket are gray. The heater is red-orange in color.



**Sensor Pocket Built-in to all Straight Length Heaters 3 in. (76 mm) Long and Greater; One Per Heater**



- Snap type fasteners are ½ in. (13 mm) with a nominal diameter metal construction and a nylon cover. The maximum operating temperature is 392°F (200°C).
- Hook and latch fasteners are available.
- 120 and 208VAC are standard. Contact your Watlow representative for other voltages.
- Power lead wires are 3 in. (76 mm) #18 AWG UL® 1180/CSA PTFE insulated and rated 10A. The lead wire pair is encapsulated in reinforced silicone rubber sleeving.
- Heaters are interconnectable up to a 10A circuit.
- Low watt density:
  - 1.5-2 in. (38-51 mm) diameter, 1.5 W/in<sup>2</sup> (0.23 W/cm<sup>2</sup>)
  - 3-4 in. (76-102 mm) diameter, 1.25 W/in<sup>2</sup> (0.19 W/cm<sup>2</sup>)



## Line Heating

### Molded Silicone Rubber Line Heaters

Watlow's molded silicone rubber pump line heaters are designed to provide improved temperature uniformity and increased heater performance, while working to decrease system downtime. Silicone foam insulation is bonded to the outside of a reinforced silicone heater mat. The unique molded design conforms to the exhaust line tubing, minimizing gaps and the resulting heat loss. The molded silicone not only ensures consistent and uniform heating, but it maintains a safe-to-touch temperature on the outside. Snap-on flange insulators keep the flanges hot, which eliminates cold spots due to exposure to the surrounding environment.

### Features and Benefits

#### Even heating for uniform temperature profiles over the entire heated line

- Eliminates cold spots that result in sublimation and solid particle buildup in the line

#### Easy-to-install system

- Conveniently fits on most pump line configurations
- Provides full line coverage for uniform heating
- Interconnection between heaters is easily accomplished using the mating electrical connectors

#### Integrated sensors and controllers

- Enables flexible control solutions using PID temperature algorithms to deliver accurate and precise temperature control

#### UL®, SEMI S2 and CE agency approval

- Assures safety standard compliance

#### Flexible heater design

- Allows for heating typical vacuum line components and fittings including pipes, valves, clamps and elbows in the line

### Typical Applications

- Semiconductor, PV, FPD and LED
- Fore lines, pump lines, exhaust lines and bypass lines
- Etch
- PECVD
- Nitride
- TEOS
- OEM tools
- Vacuum bake-out
- Abatement tools



### Specifications

**Pre-set temperature set points:** 302°F (150°C); or 221°F (105°C)

**Exterior range temperature:** Ambient to 185°F (85°C) dependent on set point

**Interior range temperature:** Ambient to 365°F (185°C)

**Foam thickness:** 0.5 in. (12.7 mm)

**Materials:** Molded silicone foam, fiberglass reinforced silicone, PTFE insulated wire

**Connectors:** Molex® Mini-fit Jr.

**Weight Range:** 0.5 to 6.2 lb (0.73 to 2.8 kg)

**Product Safety:** UL®/C-UL® listed, CE, Semi S2

# Flexible Heaters



## Line Heating

### ASSURANT SERIES TC Pump Line Heaters

Watlow's heater jackets provide flexibility in designing optimum heating systems for pump lines, fore lines and exhaust lines. ASSURANT TC heater jackets are ideal for high temperature/low outgassing for cleanroom applications.

Watlow's ASSURANT SERIES TC heater jackets maximize thermal uniformity and coverage by providing an efficient, easy-to-install heating solution for downstream exhaust line applications. The ASSURANT heater jackets optimize process tool uptime and chip yield by providing full coverage to the line eliminating cold spots that result in particle buildup.

ASSURANT heater jackets can be customized with distributed watt densities, so lighter and heavier component parts are heated uniformly.

This heater jacket can be supplied with integrated temperature sensors and controllers to assure accuracy and equipment longevity.

### Features and Benefits

#### Even heating for uniform temperature profiles over the entire heated line

- Eliminates cold spots that result in sublimation and solid particle buildup in the line

#### High operating temperatures up to 482°F (250°C)

- Prevents particle buildup in high-temperature applications such as certain atomic layer deposition (ALD) applications

#### PTFE construction

- Exhibits low out-gassing and little to no particle generation
- Appropriate solution for cleanroom applications

#### UL®, SEMI S2 and CE agency approval

- Assures safety standard compliance

#### Environmental safety

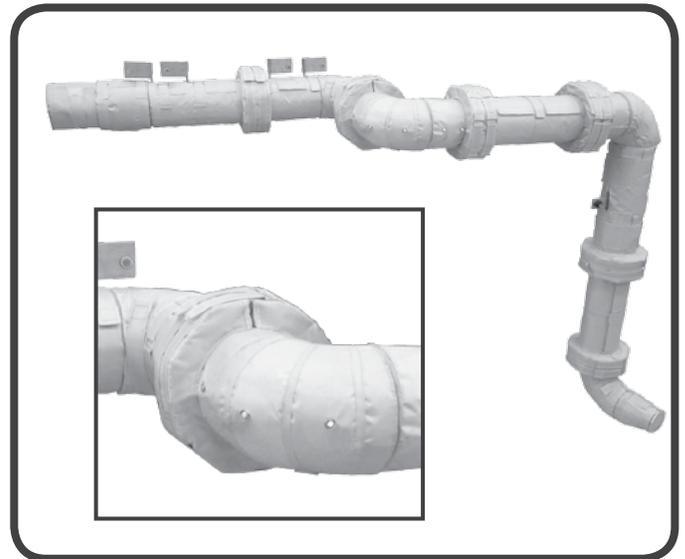
- Reducing particle buildup decreases potential of exposure to hazardous materials during normal cleaning cycles

#### Easy-to-install system

- Conveniently fits on most pump line configurations
- Provides full line coverage for uniform heating
- Interconnection between heaters is easily accomplished using the mating electrical connectors

#### Integrated sensors and controllers

- Enables flexible control solutions using PID temperature algorithms to deliver accurate and precise temperature control



#### Flexible heater design

- Allows for heating typical vacuum line components and fittings including pipes, valves, clamps and elbows in the line
- Allows quick prototyping to determine energy distribution requirements for process improvements

#### Fiberglass insulation

- Provides high efficiency
- Lowers power consumption and the cost of ownership
- Yields low backside temperatures

#### Typical Applications

- Semiconductor, PV, FPD and LED
- Fore lines, pump lines, exhaust lines and bypass lines
- Etch
- PECVD
- Nitride
- TEOS
- OEM tools
- Vacuum bake-out
- Abatement tools

# Flexible Heaters



## Line Heating

### ASSURANT SERIES TC Pump Line Heaters (Continued)

#### Specifications

##### Operating temperature

- Standard operating temperature up to 356°F (180°C) (recommended)
- Maximum operating temperature up to 482°F (250°C)
- Other options available (contact your Watlow representative)

##### Agency approvals

- UL® 499, File # E52951
- RoHS compliant
- CE
- SEMI S2

##### Standard connectors

- AMP MATE-N-LOK™
- 4-pin AMP CPC
- Other options available (contact your Watlow representative)

##### Integrated sensor (optional)

- Type K thermocouple
- Over-temperature mechanical thermostat 392°F (200°C) max.

##### Voltage

- 120, 208 or 240V standard, other voltages available

##### Fastener

- Hook and loop

##### Inner jacket material options

- PTFE coated fiberglass

##### Outer jacket material options

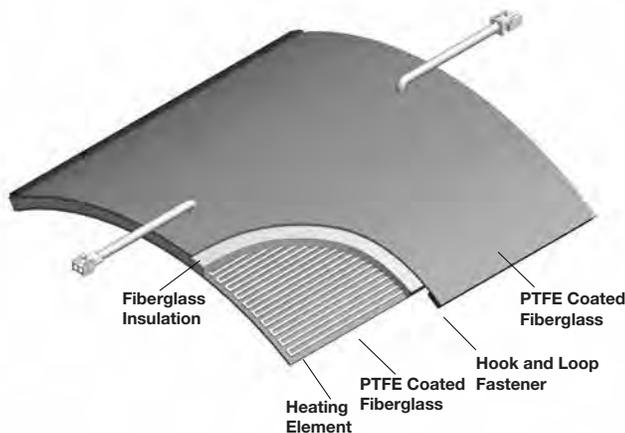
- PTFE coated fiberglass

##### Dimensions

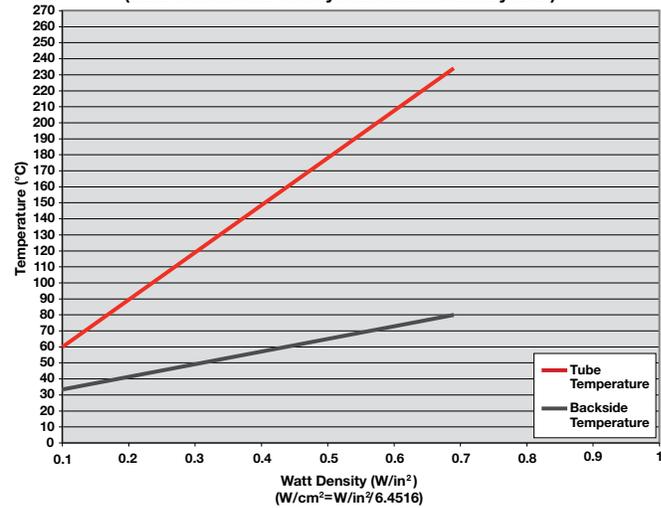
- Available for pipe sizes 1 to 6 in. (25 to 152 mm) diameter.

For other sizes contact your Watlow representative.

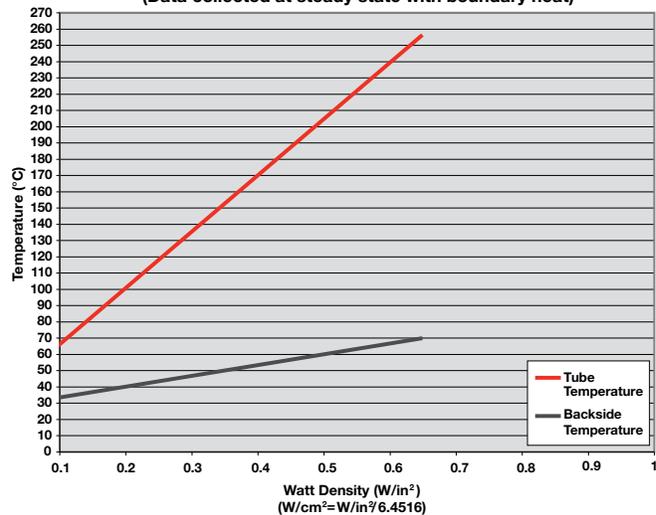
#### Heater Construction



Watt Density vs. Tube Temperature vs. Jacket Backside Temperature  
ASSURANT SERIES TC - 10 mm Insulation  
(Data collected at steady state with boundary heat)



Watt Density vs. Tube Temperature vs. Jacket Backside Temperature  
ASSURANT SERIES TC - 15 mm Insulation  
(Data collected at steady state with boundary heat)



**Note:** The data in the charts above represent nominal values derived from a test environment. Please consult a Watlow sales engineer to discuss your particular application.

# Flexible Heaters



## Line Heating

### ASSURANT SERIES TA Pump Line Heaters

Watlow's heater jackets provide flexibility in designing the optimum heating systems for pump lines, fore lines and exhaust lines. ASSURANT heater jackets solve the thermal challenges caused by varying mass and constricted spaces.

Watlow's ASSURANT SERIES TA heater jacket maximizes thermal uniformity and coverage by providing an efficient, easy-to-install heating solution for downstream exhaust line applications. The ASSURANT heater jackets optimize process tool uptime and chip yield by providing full coverage to the line eliminating cold spots that result in particle buildup.

ASSURANT heater jackets can be customized with distributed watt densities, so lighter and heavier component parts are heated uniformly.

This heater jacket can be supplied with integrated temperature sensors and controllers to assure accuracy and equipment longevity.

#### Features and Benefits

##### Even heating to 356°F (180°C) for uniform temperature profiles over the entire heated line

- Eliminates cold spots that result in sublimation and solid particle buildup in the line

##### Silicone coated fiberglass construction

- Provides economical solution for critical semiconductor processes

##### UL®, SEMI S2 and CE agency approval

- Assures safety standard compliance

##### Environmental safety

- Reducing particle buildup decreases potential of employee exposure to hazardous materials during normal cleaning cycles

##### Easy-to-install system

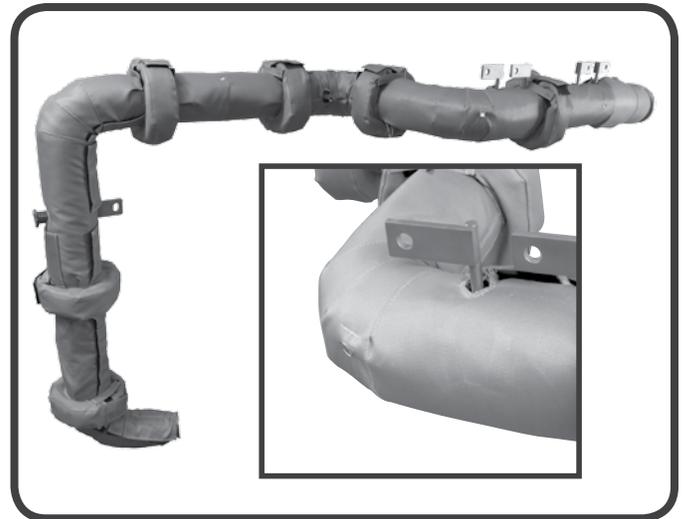
- Conveniently fits on most pump line configurations
- Provides full line coverage for uniform heating
- Interconnection between heaters is easily accomplished using the mating electrical connectors

##### Integrated sensors and controllers

- Enables flexible control solutions using PID temperature algorithms to deliver accurate and precise temperature control

##### Flexible heater design

- Allows for heating typical vacuum line components and fittings including pipes, valves, clamps and elbows in the line
- Allows quick prototyping to determine energy distribution requirements for process improvements



#### Fiberglass insulation

- Provides high efficiency
- Lowers power consumption and the cost of ownership
- Yields low backside temperatures

#### Typical Applications

- Semiconductor, PV, FPD and LED
- Fore lines, pump lines and exhaust lines
- Etch
- PECVD
- Nitride
- TEOS
- OEM tools
- Vacuum bake-out
- Abatement tools

# Flexible Heaters



## Line Heating

### ASSURANT SERIES TA Pump Line Heaters

#### Specifications

##### Operating temperature

- Standard operating temperature up to 302°F (150°C) (recommended)
- Maximum operating temperature up to 356°F (180°C)

##### Agency approvals

- UL® 499, File # E52951
- RoHS compliant
- CE
- SEMI S2

##### Standard connectors

- AMP MATE-N-LOK™
- 4-pin AMP CPC
- Other options available (contact your Watlow representative)

##### Integrated sensor (optional)

- Type K thermocouple
- Over-temperature mechanical thermostat

##### Voltage

- 120, 208 or 240V standard, other voltages available

##### Fastener

- Hook and loop

##### Inner jacket material options

- Silicone rubber coated fiberglass

##### Outer jacket material options

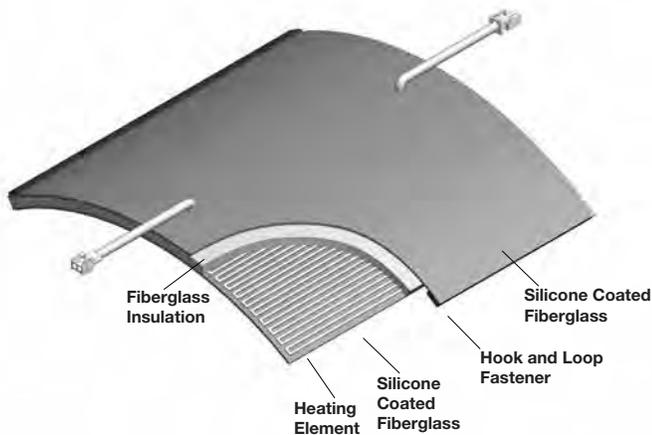
- Silicone rubber coated fiberglass

##### Dimensions

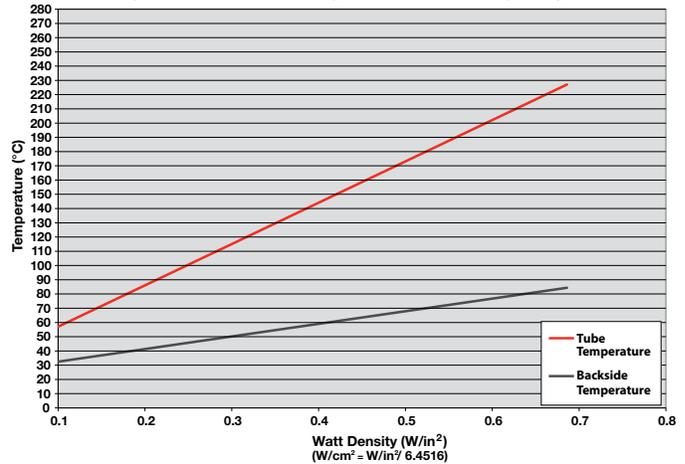
- Available for pipe sizes 1 to 6 in. (25 to 152 mm) diameter.

For other sizes contact your Watlow representative.

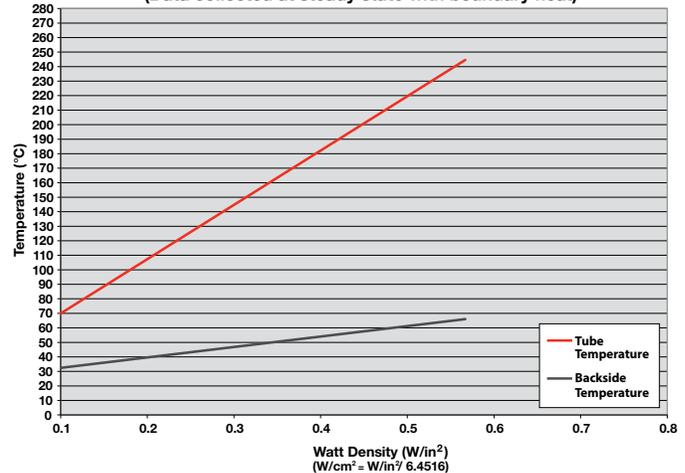
#### Heater Construction



Watt Density vs. Tube Temperature vs. Jacket Backside Temperature  
ASSURANT SERIES TA - 8 mm Insulation  
(Data collected at steady state with boundary heat)



Watt Density vs. Tube Temperature vs. Jacket Backside Temperature  
ASSURANT SERIES TA - 16 mm Insulation  
(Data collected at steady state with boundary heat)



**Note:** The data in the charts above represent nominal values derived from a test environment. Please consult a Watlow sales engineer to discuss your particular application.

# Flexible Heaters



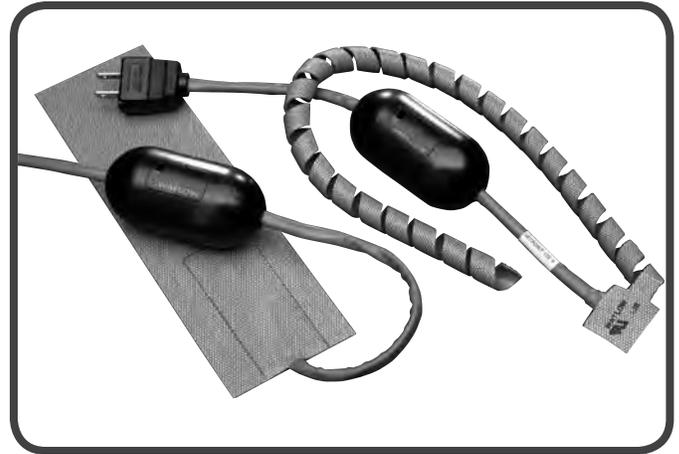
## SERIES EHG®

Many applications requiring a fixed temperature set point rely on a mechanical thermostat for thermal control. Thermostats have proven, however, to be inadequate for many applications due to long-term reliability issues, such as 100,000 cycle rating and poor temperature control.

The SERIES EHG® thermal solution includes a compact temperature controller, thermocouple sensor and power switching device integrated into the heater's power cord. The SERIES EHG reduces system costs and lasts substantially longer than a conventional thermostat solution.

The evolution of miniature microprocessor technology and Watlow switching technology fostered development of a small, versatile temperature controller and thermocouple sensor that is integrated with Watlow silicone rubber heater products. This device senses the temperature via input from a thermocouple strategically placed on the heater mat. The microprocessor is programmed prior to shipment with an application specific set point. This results in quick delivery of a custom, integrated system.

The small thermocouple mass provides superior response to changes in process temperature enabling higher watt density silicone rubber heater designs. These features offer an integrated custom set point temperature controller with superior life span, faster heat-up rates and improved accuracy. The SERIES EHG system has been tested to over four million cycles at rated amperage. Depending on the application, Watlow's power switching design can last up to 40 times longer than a conventional thermostat.



### Features and Benefits

#### Long operational life

- Improves system reliability

#### Tight temperature control

- Ensures process accuracy

#### Small sensor footprint

- Fits with almost any heater
- Responds quickly to temperature changes
- Controls high watt densities in low mass applications

#### A single EHG controller can be configured with multiple heaters

- Reduces system cost

#### Pre-wired, in-line control

- Simplifies installation
- Offers two-wire power connection

#### Durable housing with built-in strain relief

- Protects electronics
- Provides low risk of mechanical damage

#### Manufactured with proven Watlow components

- Assures reliable system performance

### Typical Applications

- Semiconductor processing
- Aerospace composite repair
- Foodservice equipment
- Freeze protection
- Life sciences
- Telecommunications



## SERIES EHG

### Technical Information

#### Specifications

##### Operational

- SERIES EHG silicone rubber heater UL<sup>®</sup> recognized to 428°F (220°C) operating temperature
- Factory programmed fixed set point
- On-off control with 6°F (3°C) switching hysteresis
- Temperature band LED indicator ON between ±36°F (±2°C) of set point

##### Electrical

- Voltage rating: 120 or 240VAC – 30/+10%, 50/60Hz
- Silicone rubber heater watt densities up to 80 W/in<sup>2</sup> (12.5 W/cm<sup>2</sup>) dependent on application temperature
- SERIES EHG system UL<sup>®</sup> recognized to 10A max.

##### Sensor

- Type K thermocouple

##### Mechanical

- Control dimensions 3.75 in. (95 mm) long by 1.75 in. (45 mm) diameter
- Heater per silicone rubber heater specifications

##### Agencies

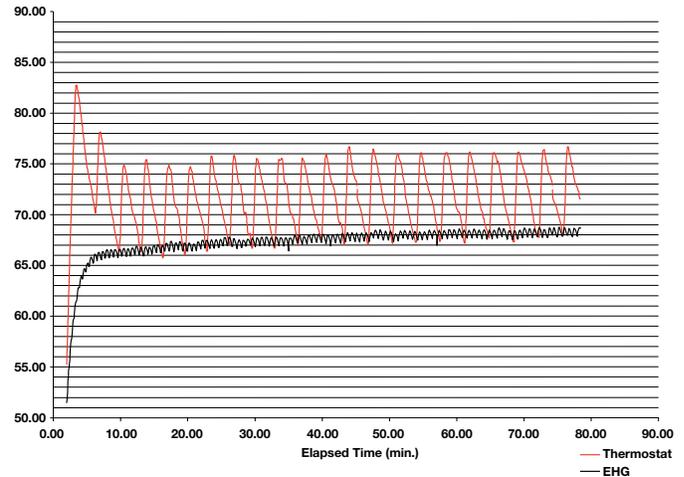
- Silicone rubber heater: UL<sup>®</sup> recognized File #E52951
- SERIES EHG control: TUV File DE 3-3068 to EN 61010-1:2001, UL<sup>®</sup> File E43684 to UL<sup>®</sup> 873 temperature indicating and regulating equipment

##### Environmental

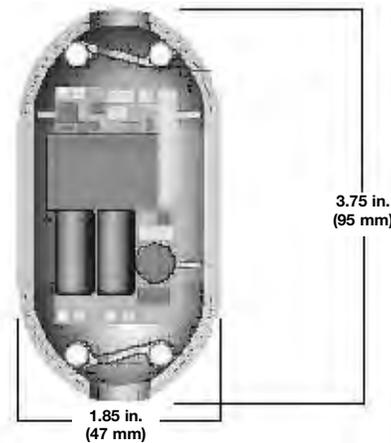
- Control operating temperature range 32 to 158°F (0 to 70°C)
- Control storage temperature range -40 to 158°F (-40 to 70°C)

Contact your Watlow representative for custom configurations.

**SERIES EHG Versus Thermostat (typical application)**



#### Dimensions



### Integrated SERIES EHG System Versus Integrated Thermostat System

	Integrated EHG System	Integrated Thermostat System	SERIES EHG Benefit
Life comparison at rated amperage	Tested to greater than 4,000,000 cycles with 10A load	Rated 100,000 cycles	Longer product life of SERIES EHG system and high application reliability
Switch hysteresis	6°F (3°C)	15°F (8°C)	Provides superior process control
Improved response time reduces overshoot on start-up	6°F (3°C) typical	25°F (14°C) typical	Responds to temperature changes faster than a thermostat
Warranty	2 years for material and workmanship	1 year on material and workmanship	Warranty can be extended due to longer life cycle
Zero cross switching	SERIES EHG has zero cross switching	Random switching during sign wave cycle	Reduces the possibility of electrical mechanical interference (EMI)

# Flexible Heaters



## SERIES EHG SL10

The SERIES EHG SL10 integrated, multi-function controller is a key component to a powerful system that integrates a heater, an adjustable set point temperature controller, a high/low temperature alert, a power switching device and a high temperature safety limit. Its agency recognized controller/safety limit meets UL® 1998 and CE 60730 requirements.

An optional display/communications module can be easily added in the field to provide a digital display indication, an adjustment of set point, RS485 Modbus® communications and other Human Machine Interface (HMI) features. As a scalable system, only what is needed can be purchased.

The EHG SL10 controllers' easy to install, compact design, inherent reliability and integrated limit functions offer unmatched value. It is designed for easy integration with Watlow heaters to simplify engineering, reduce component count for new equipment and decrease ownership cost. For original equipment manufacturers, (OEMs), CE, Semi-S2 compliance and UL® recognition, the EHG controller reduces time and costs associated with global agency testing and validation.

### Features and Benefits

#### Process controller and safety limit in one package

- Meets UL® 1998 and CE 60730 requirements
- Eliminates the need for a thermal fuse on a heater
- Eliminates replacement of heater when fuse fails

#### Optional display/communications module

- Allows easy upgrade to base device
- Offers low cost field upgrade
- Provides easy, snap-on installation

#### Accurate and flexible temperature process controller

- Replaces problematic bi-metal thermostats with accurate electronic temperature process controller
- Allows easy change of process parameters

#### Ambient operating temperature range 32 to 158°F (0 to 70°C)

- Increases reliability when mounting in harsh temperature environments or in close proximity to heaters

#### Integrated high/low temperature alert signal relay

- Provides dry contact output to activate external alarm or process function
- Signals control status with three integrated LEDs
- Allows a signal of up to two amperes 30VAC/MDC, Form A to alert if process temperature is out of range limits



#### Health check diagnostics

- Monitors maximum heater process temperature, maximum ambient temperature and thermocouple operation
- Provides health check signal to inform operator that the process is working correctly

#### Universal power supply

- Allows an input of 85 to 264VAC, 50/60Hz
- Provides safe control of up to 2400 watts with 10 amperes switching in both controller and safety limit

#### Can be switched from on-off and PID algorithm

- Increases product life (on-off control is default)
- Offers selectable PID control algorithm for tighter temperature control

#### Universal 1/8 turn mounting bracket

- Allows mounting to most surfaces
- Provides flexible mounting—either horizontally or vertically

### Typical Applications

#### Foodservice equipment

- Warming and serving equipment
- Food holding cabinets

#### Life sciences

- Laboratory equipment
- Medical equipment

#### Packaging

- Heat sealing bars
- Hot glue application equipment

#### Semiconductor processing

- Gas delivery lines
- Exhaust lines



## SERIES EHG SL10

### Technical Information

#### Specifications

##### Operational

- Two, Type K thermocouple inputs - process temperature control and safety limit
- Process temperature output - 10A NO-ARC relay
- Safety limit alarm - 10A relay
- High/low temperature alert - 2A 30VAC/VDC, Form A (single pole, normally open contact)
- On-off temperature controller algorithm, upgraded via communications to PID algorithm (min. cycle time 30 seconds)

##### Standard Molex® connectors

- Controllers are integral to the heater and are supplied by Watlow

##### Power

- Isolated universal power supply 85 to 264VAC, 50/60Hz
- Up to 2400 W with 10A switching capability

##### NO-ARC Relay

- 10A switching
- 4.5 million cycles

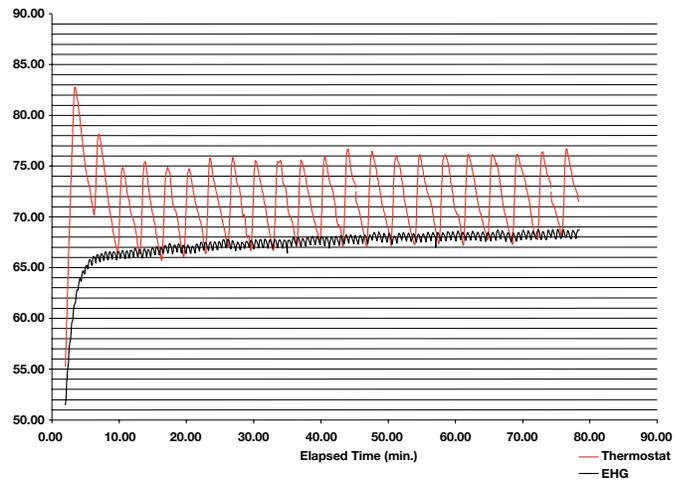
##### Environmental

- Ambient operating temperature range 32 to 158°F (0 to 70°C)

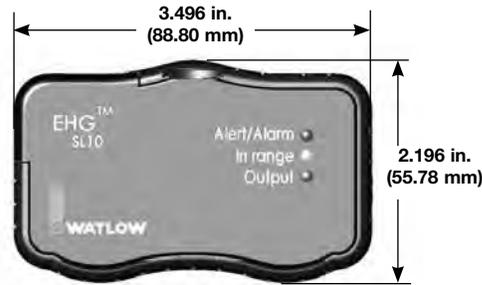
##### Agency Approvals

- UL® 1998/ C-UL®
- CE 60730
- Semi-S2

### SERIES EHG Versus Thermostat (typical application)



### Dimensions



Base Unit



Without Optional Module



With Optional Module

### Switching Device Comparison Chart

	T-Stat	Solid State Relay	Watlow NO-ARC Relay
Amperage at 77°F (25°C)	10A	10A	10A
Amperage at 158°F (70°C)	10A	De-rate significantly and add heat sink and air cooling	10A
Output device life at 10A	Rated 100,000 at 158°F (70°C)	Greater than 10 million cycles at 77°F (25°C)	Greater than 4.5 million cycles at 158°F (70°C)

# Flexible Heaters



## SERIES EHG SL10

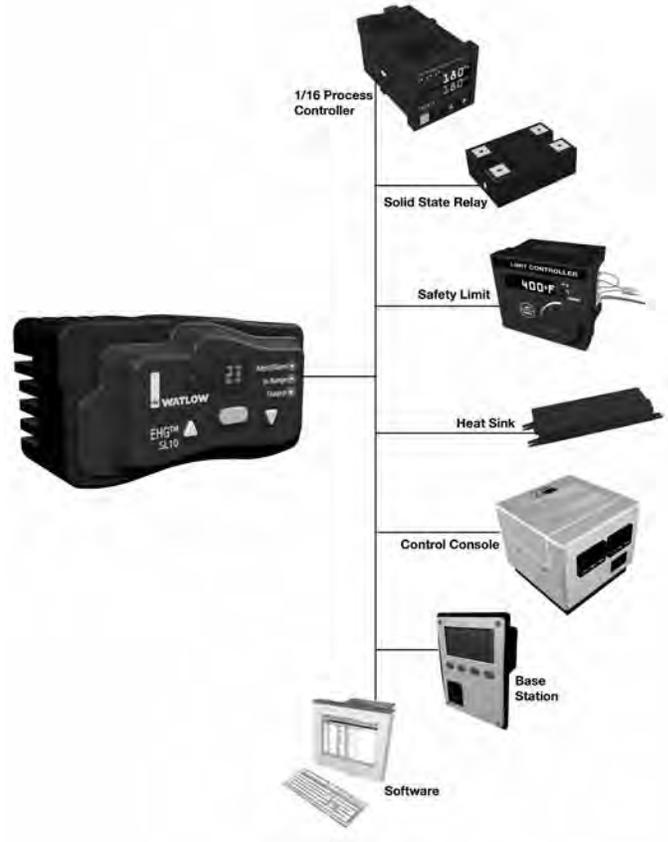
### Technical Information (Continued)

#### EHG SL10 Software

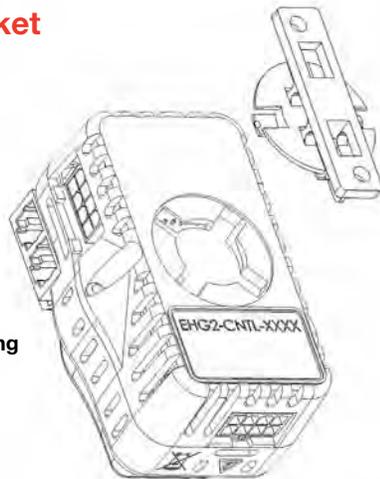
With the addition of an optional communication module, the EHG SL10 can be managed, monitored and manipulated via software. Change set points, label devices, change tuning parameters, check health status and much more all with the click of a key.



#### Reduces System Complexity and Cost



#### Mounting Bracket



The EHG SL10 mounting enables the controller to be mounted in four angles.



The EHG SL10 can be "daisy-chained" for gas line and other assemblies.



## SERIES EHG SL10

### Technical Information (Continued)

#### Using an SL10 with Flexible Heaters (Non Stretch-To-Length (S-T-L))

The EHG SL10 controller is designed to work with Watlow flexible heaters. It was originally designed to be added to custom designs only. Now, with the right accessories, it can be used with many of our flexible catalog heaters, which have the standard Mate-N-Lok™ plug for power.

This controller requires a dual Type K T/C to operate. The key to successful operation is that the two Type K T/Cs must be in the same location. A differential of greater than 20°C while the control is calling for heat will shut off the output. In order to allow its use with our standard catalog product, Watlow has created P/N A005867. This dual T/C assembly is a flexible pad with 18 inch leads, which will connect to a special “Y” adapter (P/N 265-000-911), which then connects to the SL10. The “Y” adapter also has a Mate-N-Lok™ receptacle to connect to our standard Mate-N-Lok™ power plug.

This configuration can be used in many applications where our standard flexible product is used. It is not suitable for gasoline applications where the .ID. of the heater is less than 1.5 inches due to the size of the pad on P/N A005867. For these applications you should consider using our stretch-to-length (S-T-L) product which can now also be used with the SL10.

#### Using an SL10 with S-T-L Heaters

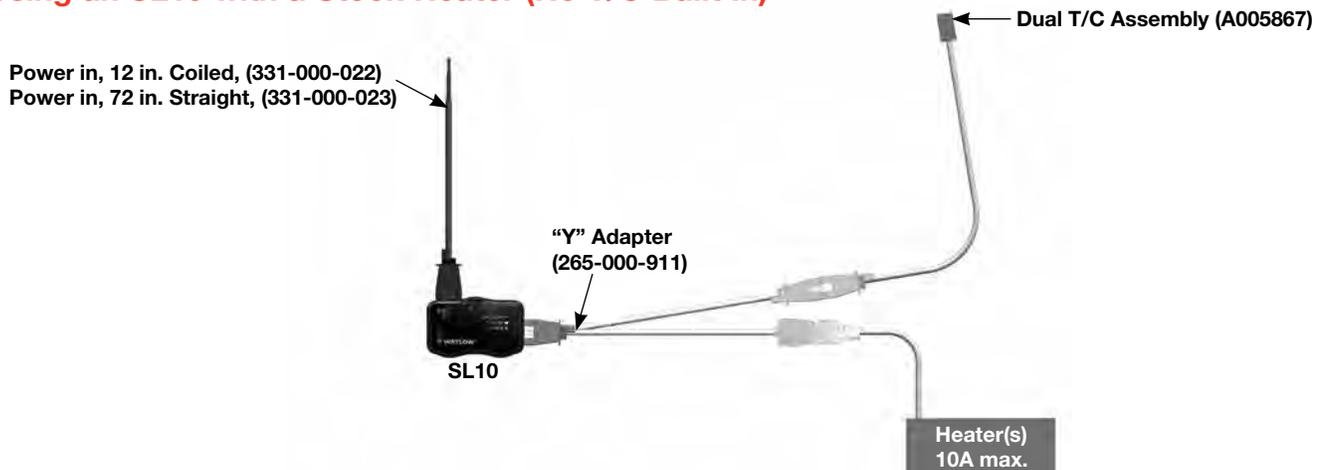
The EHG SL10 controller is designed to work with Watlow flexible heaters. It was originally designed to be added to custom designs only. Now, with the right accessories, it can be used with many of our flexible catalog heaters, which have the standard Mate-N-Lok™ plug for power.

This controller requires a dual Type K T/C to operate. The key to successful operation is that the two Type K T/Cs must be in the same location. A differential of greater than 20°C while the control is calling for heat will shut off the output. Watlow now offers a selection of S-T-L heaters, which have dual T/Cs built into them for use with our EHG SL10 controllers.

When you find the S-T-L heater for your needs in the catalog you can use the table below to select the appropriate heater shaded in gray from the table below. This new heater will include the necessary dual T/Cs built in and will have the necessary Molex® plug to connect directly to the SL10. If you need additional coverage, S-T-L heaters can be daisy chained in parallel as each includes parallel in and out connections on 12 inch leads. Only one of the new, dual T/C heaters is needed for each control zone.

New Part Number with Dual K T/C	Stock S-T-L in Catalog Part Numbers
005120523	005120500
005280525	005280500
005600535	005600502
005280526	005280501
005600536	005600503
005170522	005170501
005490524	005490502
005990515	005990502
005490525	005490503
005990516	005990503

#### Using an SL10 with a Stock Heater (No T/C Built In)



# Flexible Heaters



## SERIES EHG SL10

### Technical Information (Continued)

#### Optional Upgrade Modules

These upgrade modules are easy to install. There is no need to reconfigure, rewire or reorder the base unit. A technician is not needed for the installation, resulting in a seamless, cost-efficient system that can be upgraded.

		Diagnostics Memory Control Parameters	Ability to Change Temperature Parameters	Field Adjustable Set Point	3-Digit 7-Segment LED Display Illuminated	Diagnostic LEDs	User Interface Software	Modbus® RTU Communication	RS 485
Base Unit		✓	✓			✓			
Optional Display Module		✓	✓	✓	✓	✓			
Optional Communication Module		✓	✓	✓		✓	✓	✓	✓
Optional Display and Communication Module		✓	✓	✓	✓	✓	✓	✓	✓

### Ordering Information

#### Part Number

1 2 3 4 5 6	7 8 9
265 EG2	Modules

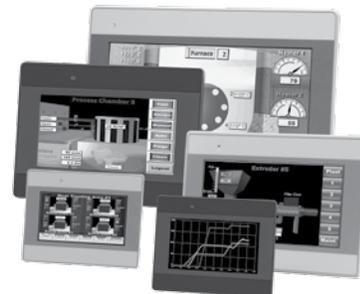
7	8	9	Modules
001	=		Base unit
007	=		Display module
008	=		Communications module
002	=		Display and communications module

#### Additional cables for wiring parallel heater circuits (daisy-chaining) in gas line and other assemblies

- 4800-0012 - Long cable
- 4800-0022 - Long terminating cable
- 4800-0011 - Short cable
- 4800-0021 - Short terminating cable

### Compatible Accessories

#### Operator Interface Terminals (OIT)



Silver Series EM touchscreen operator interface terminals provide a customizable user interface, email event notifications and log and graph data for Watlow controllers and other devices. A Silver Series EM operator interface terminal paired with Watlow controllers is the perfect solution for industrial processes or machine control applications.

