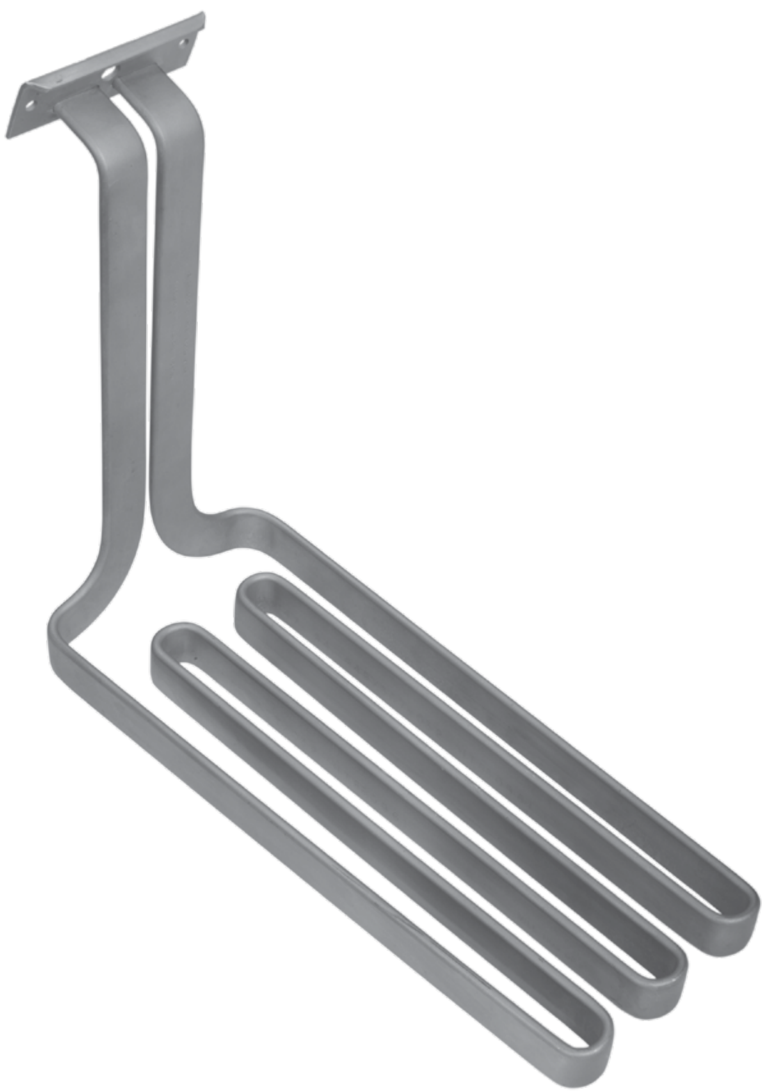
Tubular Heaters

Tubular Heaters	Sheath Materials	Max. Operating Temperatures °F	°C	Typical Max. Watt Densities W/in²	W/cm²	Page
WATROD™ Single-Ended Double-Ended	Alloy 800/840	1600	870	45	6.9	**57**
	Stainless steel	1200	650	60	9.3	
	Steel	750	400	45	6.9	
	Alloy 600	1800	982	45	6.9	
High-Temperature	Alloy 600	1800	982	45	6.9	**80**
MULTICOIL™	Alloy 800	1400	760	45	6.9	**82**
	304 stainless steel	1200	650	45	6.9	
	316 stainless steel	1200	650	45	6.9	
FIREBAR® Single-Ended Double-Ended	Alloy 800/840	1400	760	60	9.3	**84**
	304 stainless steel	1200	650	60	9.3	
FINBAR™ Single-Ended	304 stainless steel	1200	650	50	7.7	**103**



WATROD™ Single/Double-Ended Heaters

Available in single- or double-ended termination styles, the versatile and economical WATROD™ tubular heating element from Watlow® lends itself to virtually the entire range of immersion and air heating applications.

The single-ended WATROD tubular design has both terminals at one end. The opposite end is sealed. Flexible lead wires are 12 in. (305 mm) crimp connected to the terminal pin and have silicone-impregnated fiberglass oversleeves.

The double-ended WATROD, with its round cross-sectional geometry, is highly adaptable for bending—especially when bending is performed in the field. Watlow's double-ended MULTICOIL™ tubular elements offer various combinations of resistor coils and thermocouples inside one sheath. They have the ability to sense the heater's internal temperature accurately every time, or offer three-phase capability in one element.

Both single- and double-ended WATRODs share many construction features delivering long life—the resistance wire is centered in the heater sheath and electrically insulated with compacted, high-grade magnesium oxide for superior heating performance.

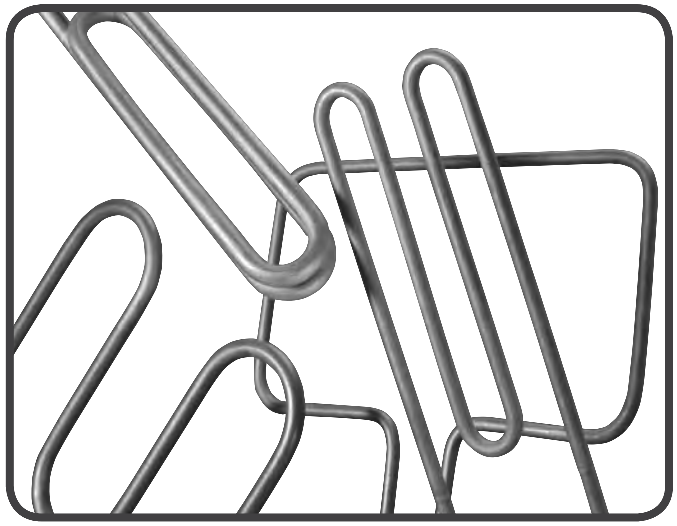
WATROD heating elements have a variety of mounting and termination options making them highly popular among industrial customers.

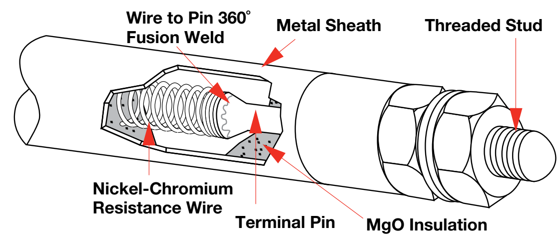
Single-Ended WATROD Performance Capabilities

- Watt densities up to 45 W/in^2 (6.9 W/cm^2)
- UL® and CSA component recognition up to 240VAC
- Alloy 800/840 and stainless steel sheath temperatures up to 1200°F (650°C)

Double-Ended WATROD Performance Capabilities

- Watt densities up to 120 W/in^2 (18.6 W/cm^2)
- UL® and CSA component recognition up to 600VAC
- Alloy 800/840 sheath temperatures up to 1600°F (870°C)
- Stainless steel sheath temperatures up to 1200°F (650°C)
- Steel sheath temperatures up to 750°F (400°C)
- Alloy 800 sheath temperatures up to 1800°F (982°C)





Features and Benefits

Precision wound nickel-chromium resistance wire
- Distributes heat evenly to the sheath for optimum heater performance

Silicone resin seals
- Protects against moisture contamination and is rated to 221°F (105°C)

MgO insulation filled sheath
- Maximizes dielectric strength, heat transfer and life

Standard sheath materials
- Steel, 304 and 316 stainless steel, alloy 800/840 and alloy 600

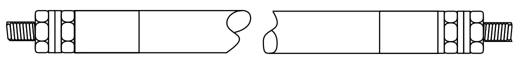
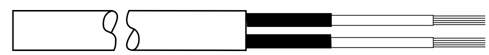
53 standard bend formations
- Allows forming the heating element to the application. Spirals, compound bends and multi-axis and multi-plane configurations

Stainless steel studs
- Fusion welded to terminal pins for mechanical strength

Popular termination, mounting and moisture seal options available

WATROD Single/Double-Ended Heaters

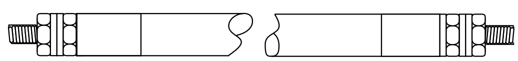
Specifications

	Double-Ended				**Single-Ended**			
								
Applications	Direct immersion		Vacuums		Platens			
	Hot runner mold (manifold)		Semiconductor		Forced air			
	Forced air				Deicing antennas			
	Ovens				Plastic wrap cutting			
	Radiant				Seal bars			
	Clamp-on							
Watt Density	Catalog P/N:		up to 60	(9.3)	Catalog P/N:		up to 20	(3.1)
W/in² (W/cm²)	Standard:		up to 120	(18.6)	Standard:		up to 45	(6.9)
Element Diameters	**Dia.**	**in²**	**Dia. (mm)**	**cm²**	**Dia.**	**in²**	**Dia. (mm)**	**cm²**
in. (mm)	0.210	0.660	(5.33)	(4.26)	0.375	1.178	(9.53)	(7.600)
and Surface Area per Linear	0.260	0.817	(6.60)	(5.27)	0.430	1.351	(10.92)	(8.717)
in² (cm²)	0.315	0.990	(8.00)	(6.38)	0.475	1.492	(12.07)	(9.626)
Diameter Tolerance	0.375	1.178	(9.53)	(7.60)				
± 0.005 in. (0.13 mm)	0.430	1.351	(10.92)	(8.72)				
	0.475	1.492	(12.07)	(9.63)				
Sheath Materials	Standard:	Alloy 800/840	1600°F	(870°C)	Standard:	Alloy 800/840	1200°F	(650°C)
Max. Operating		316 SS	1200°F	(650°C)		316 SS	1200°F	(650°C)
Temperature		Steel	750°F	(400°C)		304 SS	1200°F	(650°C)
		304 SS	1200°F	(650°C)				
		Alloy 600	1800°F	(980°C)				
Sheath Length By Diameter		**Sheath**		**Sheath**		**Sheath**		**Sheath**
in. (mm)	**Dia.**	**Length (in.)**	**Dia. (mm)**	**Length (mm)**	**Dia.**	**Length (in.)**	**Dia. (mm)**	**Length (mm)**
	Standard:				Standard:			
	0.210	9 to 130	(5.33)	(230 to 3300)	0.375	11 to 125	(9.53)	(280 to 3175)
	0.260	9 to 270	(6.60)	(230 to 6858)	0.430	11 to 106	(10.92)	(280 to 2690)
	0.315	9 to 270	(8.00)	(230 to 6858)	0.475	11 to 125	(12.07)	(280 to 3175)
	0.375	11 to 360	(9.53)	(280 to 9144)				
	0.430	11 to 360	(10.92)	(280 to 9144)				
	0.475	11 to 275	(12.07)	(280 to 6985)				
Min. No-Heat Length	**Sheath**	**No-Heat**	**Sheath**	**No-Heat**	**Sheath**	**No-Heat**	**Sheath**	**No-Heat**
in. (mm)	**Length**	**Length**	**Length**	**Length**	**Length**	**Length**	**Length**	**Length**
	11 to 20	1	(280 to 510)	(25)	11 to 20	1 1/2	(280 to 5100)	(38)
	21 to 50	1 1/4	(535 to 1270)	(32)	21 to 50	1 3/4	(533 to 1270)	(44)
	51 to 80	1 1/2	(1295 to 2030)	(38)	51 to 80	2 1/8	(1295 to 2030)	(54)
	81 to 110	1 5/8	(2055 to 2795)	(42)	81 to 110	2 3/8	(2055 to 2795)	(60)
	111 to 140	1 3/4	(2820 to 3555)	(44)	111 to 125	2 5/8	(2820 to 3175)	(67)
	141 to 170	2	(3580 to 4320)	(51)				
	171 to 200	2 1/4	(4345 to 5080)	(57)				
	201 & up	2 1/2	(5105 & up)	(64)	**½ in. (13 mm) No-heat length on all blunt ends**			
Max. Voltage/Amperage	**Dia.**		**Volts**	**Amperes**	**Dia.**		**Volts**	**Ampere**
By Dia.	0.260	(6.6)	250VAC	15	0.375	(9.53)	480VAC	30
in. (mm)	0.315	(8.0)	480VAC	30	0.430	(10.92)	480VAC	30
	0.375	(9.53)	480VAC	30	0.475	(12.07)	480VAC	30
	0.430	(10.92)	600VAC	40				
	0.475	(12.07)	600VAC	40				

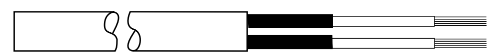
WATROD Single/Double-Ended Heaters

Specifications *(Continued)*

Double-Ended



Single-Ended



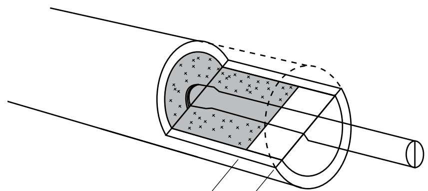
	Double-Ended	Single-Ended
Ohms Per Heated Inch By Dia. in.	**Dia.** **Min.** **Max.** 0.210 0.130Ω 14Ω 0.260 0.080Ω 16Ω 0.315 0.050Ω 25Ω 0.375 0.030Ω 20Ω 0.430 0.030Ω 25Ω 0.475 0.035Ω 25Ω	**Dia.** **Min.** **Max.** 0.375 0.150Ω 25Ω 0.430 0.150Ω 24Ω 0.475 0.150Ω 22Ω
Terminations	Standard: Threaded stud Screw lug (plate) Quick connect (spade) Flexible lead wires	Standard: Flexible lead wires
Seals	Standard: Silicone resin 221°F (105°C) Ceramic base 2800°F (1535°C) Ceramic-to-metal 482°F (250°C) Silicone rubber (RTV) 392°F (200°C) Silicone resin 392°F (200°C) Epoxy resin 194/356°F (90/180°C)	Standard: Silicone resin 221°F (105°C) Silicone rubber (RTV) 500°F (260°C) Epoxy resin 194/356°F (90/180°C)
Mounting Options	Threaded bulkheads Mounting brackets Locator washers	Threaded bulkhead Locator washers Single leg bracket
Surface Finish Options	Oxide anneal Bright anneal Passivation	Oxide anneal Bright anneal Passivation
Agency Recognition	UL® component to 480VAC (File # E52951/E56488) CSA component to 600VAC (File # 31388)	UL® component to 240VAC (File # E52951) CSA component to 240VAC (File # 31388) ①

① Not applicable to 0.375 inch diameter single-ended WATROD.

WATROD Single/Double-Ended Heaters

Options

Moisture Resistant Seals



WATROD's MgO insulating material is hygroscopic. To control the rate of moisture entering the heater, an appropriate moisture seal must be used. Choosing the correct seal is important to the life and performance of the heater. All materials have varying rates of gas vapor transmission. Be sure the maximum continuous use temperature is not exceeded at the seal location. Most end seals are applied with a small cavity in the end of the heater. The seal will also help prevent arcing at the terminal ends.

External Finishes

Bright Annealing

Bright annealing is a process that produces a smooth, metallic finish. It is a special annealed finish created in a non-oxidizing atmosphere. This finish is popular in the pharmaceutical and food and beverage markets.

To order, specify **bright annealing**.

Passivation

During the manufacturing process, particles of iron or tool steel may become embedded in the stainless steel or alloy sheath. If not removed, these particles may corrode, produce rust spots and/or contaminate the process. For critical sheath applications, passivation will remove free iron from the sheath.

To order, specify **passivation**.

Zoned Heaters

Single zone heaters are only available.

End-Seal Options

End-Seal	Color	UL® Recognition	Max. Cont. Use Temperature	Typical or General Usage/Application
Standard Epoxy	Cream	Yes	194°F (90°C)	Long term stable insulation resistance
Intermediate Epoxy	Gray	Yes	356°F (180°C)	Long term stable insulation resistance
High-Temp. Epoxy	Amber	No	450°F (232°C)	Long term stable insulation resistance
Silicone Resin	Clear	Yes	221°F (105°C)	General usage on tubular products - porous
Silicone Fluid	Clear	Yes	392°F (200°C)	Moisture resistance of the MgO, or high temperature ceramic seal (storage only) - porous
Lavacone	Dark Brown	Yes	221°F (105°C)	Porous seal for the FIREBAR
Silicone Rubber RTV	Red-Orange	Yes	392°F (200°C)	General usage on FIREBAR applications - porous
High-Temperature Ceramic	White	Yes	2800°F (1538°C)	Very high-temperature applications - for extremely low vapor transmission rate

WATROD Single/Double-Ended Heaters

Terminations

Double-ended WATROD elements are available with a variety of terminations. Single-ended WATROD elements are available with only flexible lead wires.

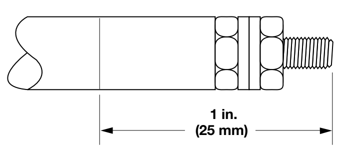
The following table and illustrations detail the terminations available with double- or single-ended WATRODs—for each available sheath diameter.

Flexible lead wires are 12 in. (305 mm), Sil-A-Blend® 390°F (200°C) unless otherwise specified. Insulation options include TGGT 480°F (250°C) plus other temperature ratings. Contact your Watlow representative.

WATROD Element	Sheath Diameter in.	(mm)	Threaded Stud ① A	Screw Lug (Plate) B	C	D	Quick Connect (Spade) E	F	G	Flexible Lead Wires H
Double-Ended	0.260	(6.6)	#6-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.315	(8.0)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.375	(9.5)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.430	(10.9)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.475	(12.1)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-Ended	0.375	(9.53)	No	No	No	No	No	No	No	Yes
	0.430	(10.9)	No	No	No	No	No	No	No	Yes
	0.475	(12.1)	No	No	No	No	No	No	No	Yes

Threaded Stud

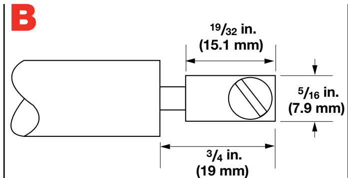
A



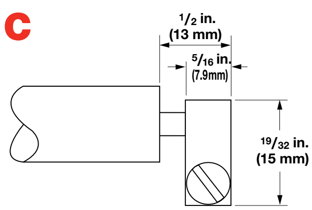
① Optional #8-32, ¼ in. and 4 or 5 mm studs available. Contact factory for details.

Screw Lug (Plate)

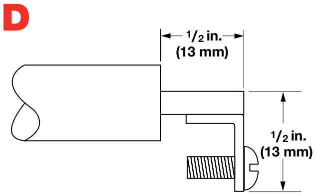
B



C

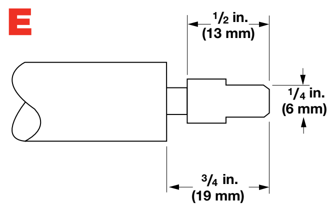


D

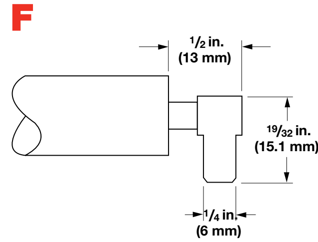


Quick Connect (Spade)

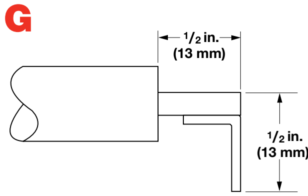
E



F

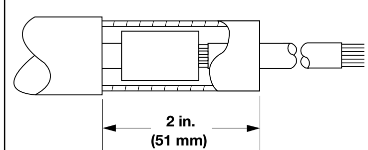


G



Flexible Lead Wires

H



WATROD Single/Double-Ended Heaters

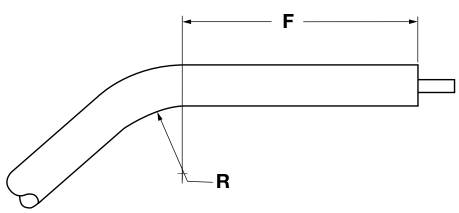
Bend Formations

Double-Ended WATROD Bend Formations

Double-ended WATROD heating elements can be formed into spirals, compounds, multi-axis and multi-planes from 36 common bend configurations. Custom bending with tighter tolerances can be made to meet specific application needs.

Formation is limited by the minimum bend radius (R) and the straight length (F) required beyond the bend. In order to locate the end of a heated length within a bend, the radius must be 3 in. (76 mm) or larger. Additionally, overall length tolerance (T) must be included in one or more of the straight lengths.

Minimum radius for various sheath diameters and lengths are shown in the *Bend Formations* chart below. Illustrated on pages 62 to 71 are the 56 common bend configurations available on both standard and made-to-order WATROD heating elements.



WATROD Length Tolerance (T)			
Sheath Length		Length Tolerance	
in.	(mm)	in.	(mm)
11-50	(280-1270)	±1/8	(±3)
51-110	(1295-2795)	±3/16	(±5)
111-170	(2820-4320)	±1/4	(±6)
171-200	(4345-5080)	±3/8	(±10)
201 & up	(5105 & up)	±1/2	(±13)

Single-Ended WATROD Bend Formations

Watlow does not recommend field bending single-ended WATROD elements. Formation is limited by the minimum radius of a bend (R) and the straight length (F) beyond the bend. The radius must be 3 in. (75 mm) or more for the heated length's end to be inside a bend.

Additionally, the overall length tolerance (T) must be provided for in one or more of the specified lengths.

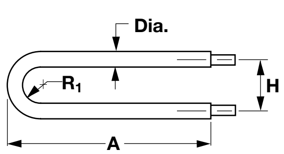
The four common bend configurations available for standard and made-to-order single-ended WATROD elements are Figures 1, 6, 22 and 28.

To order a common bend formation, specify the **bend figure number**, dimensions and critical tolerances.

WATROD Minimum Radius							
Sheath Diameter		Field Bend R①		Factory R①		F② Dimension	
in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
0.260	(6.6)	3/4	(19.0)	3/8	(9.5)	1/2	(13.0)
0.315	(8.0)	3/4	(19.0)	1/2	(13.0)	1/2	(13.0)
0.375	(9.52)	1	(25.0)	1/2	(13.0)	1/2	(13.0)
0.430	(10.92)	1	(25.0)	1/2	(13.0)	3/4	(19.0)
0.475	(12.07)	1	(25.0)	5/8	(15.9)	1	(25.0)

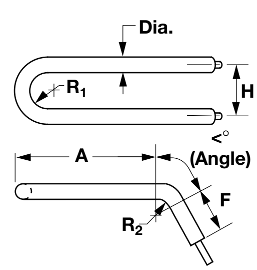
① R is the inside radius of a bend.
② F is the distance from the sheath's end to the start of the first bend.

Figure 1



$SL = 2A + 1.14R_1 - 0.43$ Dia.

Figure 2

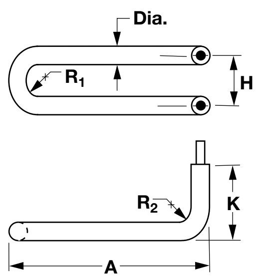


$SL = 2A + 2F + 1.14R_1 + 0.0175\,(<°)$
$(2R_2 + \text{Dia.}) - 0.43$ Dia.

WATROD Single/Double-Ended Heaters

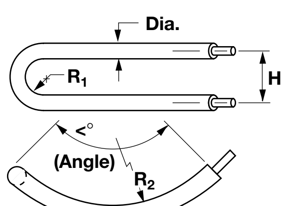
Bend Formations *(Continued)*

Figure 3



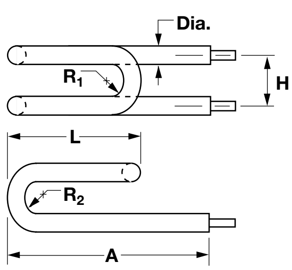
$SL = 2K - 0.86R_2 - 2.86\text{ Dia.} + 2A + 1.14R_1$

Figure 5



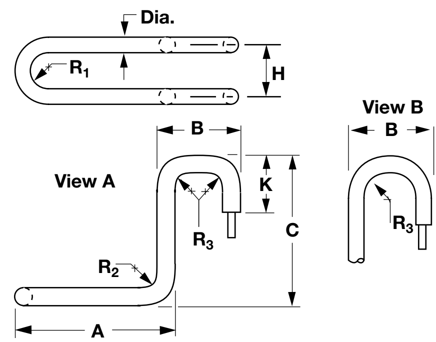
$SL = 0.0175(<°)(2R_2 + \text{Dia.})$
$+1.14R_1 + 0.43\text{ Dia.}$

Figure 7



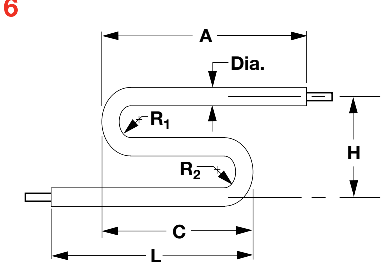
$SL = 2A + 2.28R_2 - 1.29\text{ Dia.} + 2L + 1.14R_1$

Figure 4



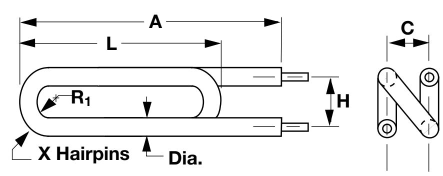
View A: $SL = 2K - 1.72R_3 - 7.72\text{ Dia.} + 2C$
$- 0.86R_2 + 2A + 1.14R_1$
View B: $SL = 2K - 2.28R_3 - 3.72\text{ Dia.} + 2C$
$- 0.86R_2 + 2A + 1.14R_1$

Figure 6



$SL = L + 1.14R_2 - 0.86\text{ Dia.} + C + 1.14R_1 + A$

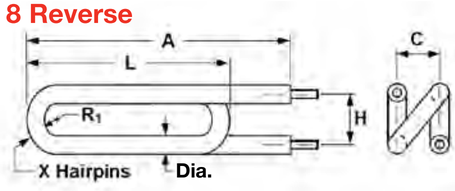
Figure 8



X = number of outside hairpins

$SL = 2A + 3.42R_1 - 1.29\text{ Dia.} + 2L$

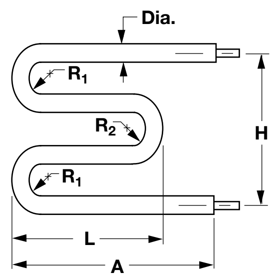
Figure 8 Reverse



WATROD Single/Double-Ended Heaters

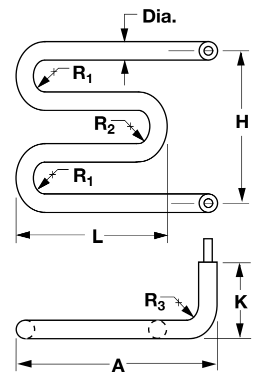
Bend Formations *(Continued)*

Figure 9



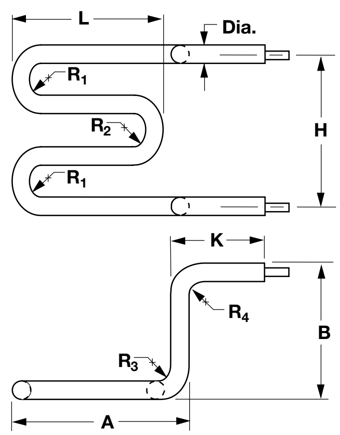
$SL = 2A + 2.28R_1 - 1.29\ Dia. + 2L + 1.14R_2$

Figure 10



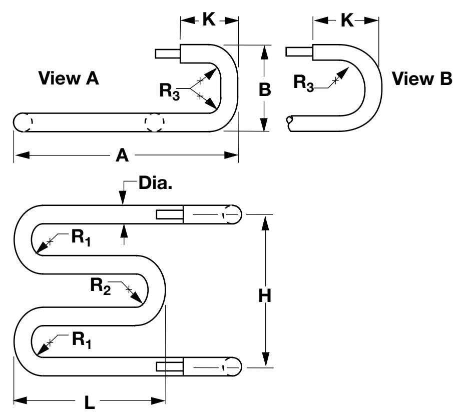
$SL = 2K - 0.86R_3 - 3.72\ Dia. + 2A + 2L$
$+ 2.28R_1 + 1.14R_2$

Figure 11



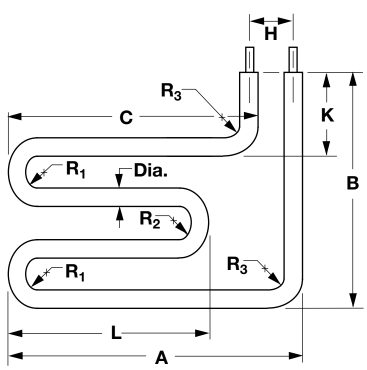
$SL = 2K - 086R_3 - 0.86R_4 - 6.15\ Dia. + 2B + 2A$
$+ 2L + 2.28R_1 + 1.14R_2$

Figure 12



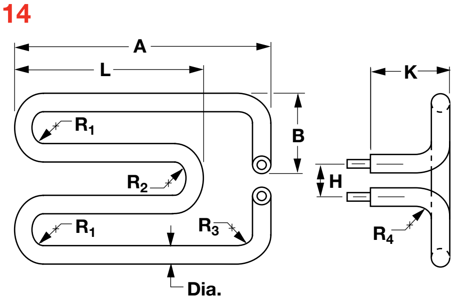
View A: $SL = 2K + 2B + 2A + 2L + 2.28R_1$
$+ 1.14R_2 - 1.72R_3 - 6.15\ Dia.$
View B: $SL = 2K + 2A + 2L + 2.28R_1 + 1.14R_2$
$- 2.28R_3 - 2.15\ Dia.$

Figure 13



$SL = 2B + 2A + 2L - 6.717\ Dia. - 1.717R_1$
$- H - 0.858R_2 - 0.858R_3$

Figure 14

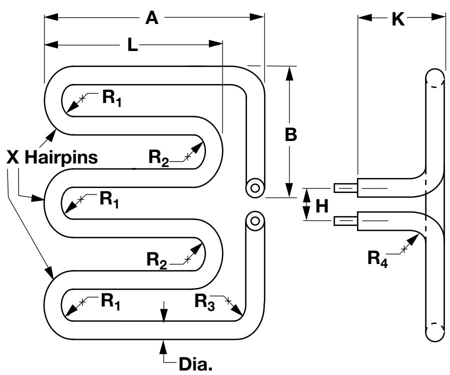


$SL+2K+2A+2L+2.28R_1+1.14R_2+2B$
$-6.15\ Dia. -0.86R_3+0.86R_4$

WATROD Single/Double-Ended Heaters

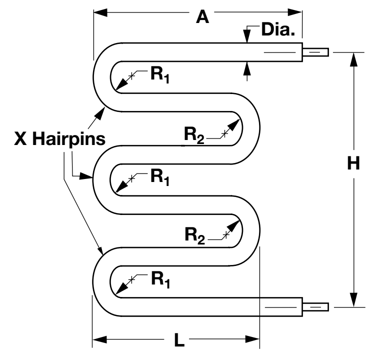
Bend Formations *(Continued)*

Figure 15



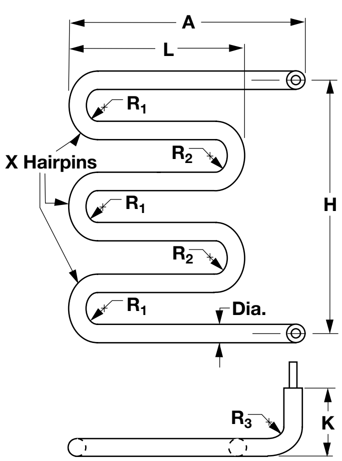
X = number of outside hairpins
SL = 2K + 2A + 2K(X - 1) + 2B - 0.86R_3 - 0.86R_4 + 1.14R_1 (X) + 1.14R_2 (X - 1) - 4.86 Dia. - (2X - 1) 0.43 Dia.

Figure 16



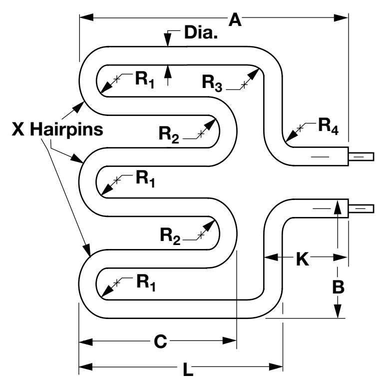
X = number of outside hairpins
SL = 2A + 0.43 Dia. (1 - 2X) + 2L (X - 1) + 1.14R_1 + 1.14R_2 (X - 1)

Figure 17



X = number of outside hairpins
SL = 1.14R_2 X - 0.88 Dia. X - 1.14R_2 - 2 Dia. + 1.14R_1 X -0.86R_3 + 2L X - 2L + 2A + 2K

Figure 18

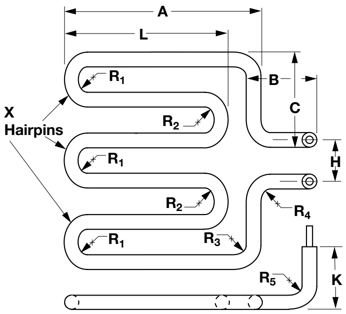


X = number of outside hairpins
SL = 2L + 2K + 2B + 2C (X - 1) - 0.86R_3 - 0.86R_4 - 4.86 Dia. + 1.14R_1 (X) + 1.14R_2 (X - 1) - (2X - 1) 0.43 Dia.

WATROD Single/Double-Ended Heaters

Bend Formations *(Continued)*

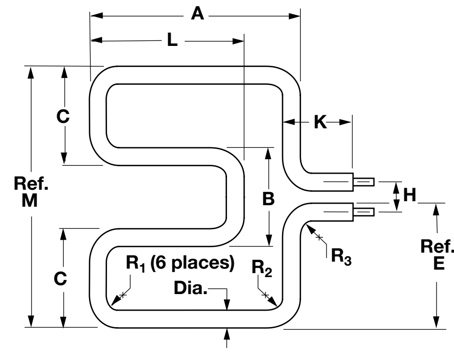
Figure 19



X = number of outside hairpins

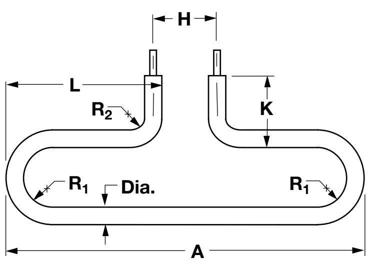
$SL = 2K + 2A + 2B + 2C + 2L\ (X - 1) + 1.14R_1\ (X) + 1.14R_2\ (X - 1) - 0.86R_3 - 0.86R_4 - 0.86R_5 - 7.29\ Dia. - (2X - 1)\ 0.43\ Dia.$

Figure 20



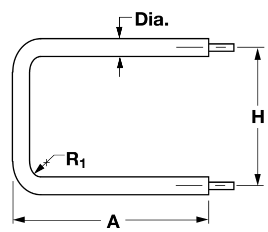
$SL = 2K + 2C + B + 2A + 2L - 2.58R_1 - 0.86R_2 - 0.86R_3 - 12.15\ Dia.$

Figure 21



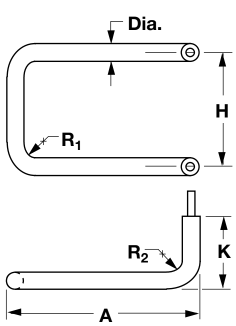
$SL = 2A + 2K - H - 2.28R_1 - 0.86R_2 - 3.29\ Dia.$

Figure 22



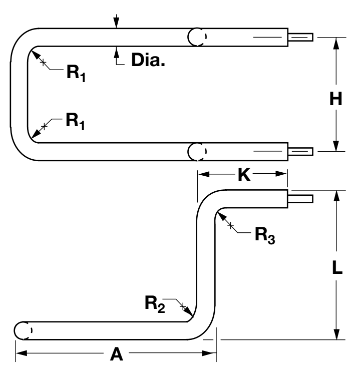
$SL = 2A - 0.86R_1 - 1.43\ Dia. + H$

Figure 23



$SL = 2K - 0.86R_2 - 3.86\ Dia. + 2A - 0.86R_1 + H$

Figure 24

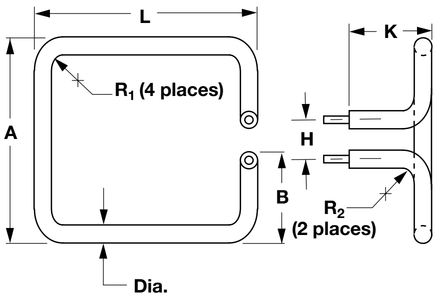


$SL = 2K + 2L + H - 0.86R_1 - 0.86R_2 - 0.86R_3 - 7.29\ Dia.$

WATROD Single/Double-Ended Heaters

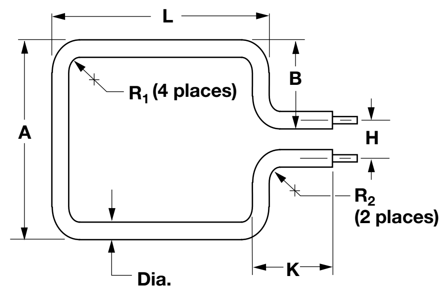
Bend Formations *(Continued)*

Figure 25



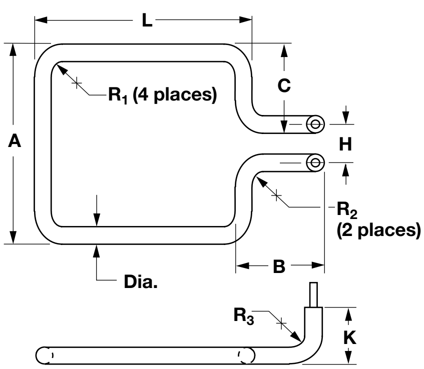
$SL = 2K + 2A + 2L - H - 1.72R_1 - 0.86R_2$
$- 6.92$ Dia.

Figure 26



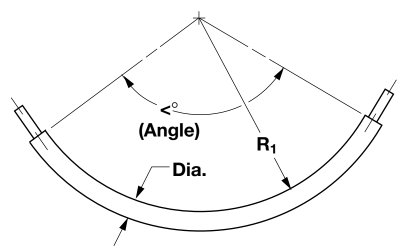
$SL = 2K + 2A + 2L - H - 1.72R_1 - 0.86R_2$
$- 6.29$ Dia.

Figure 27



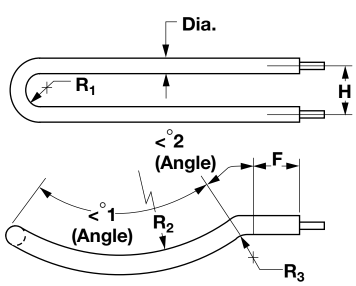
$SL = 2K + 2A + 2L + 2B - H - 1.72R_1$
$- 1.72R_2 - 8.72$ Dia.

Figure 28



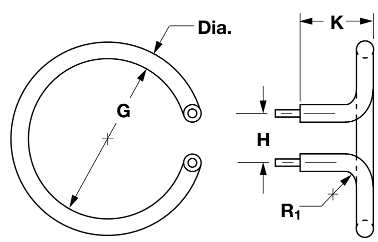
$SL = 0.0175 <° (R_1 + 0.5$ Dia.)

Figure 29



$SL = 0.0175 <°1 (2R_2 +$ Dia.) $+ 2F + 1.14R_1$
$+ 0.0175 <°2 (2R_3 +$ Dia.) $- 0.43$ Dia.

Figure 30

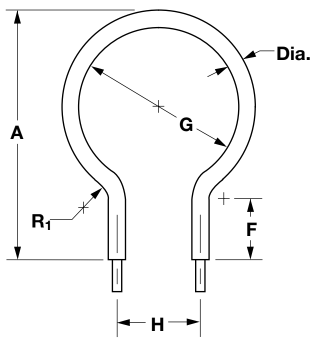


$SL = (G +$ Dia.) $3.14 + 1.14R_1 + 2K$
$+ 3.28$ Dia. $- H$

WATROD Single/Double-Ended Heaters

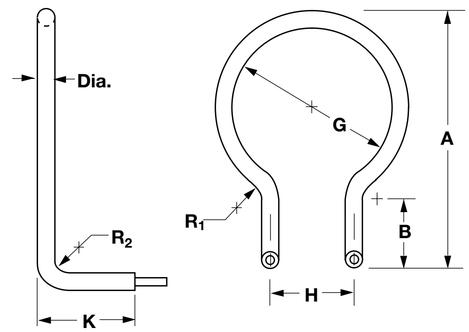
Bend Formations *(Continued)*

Figure 31



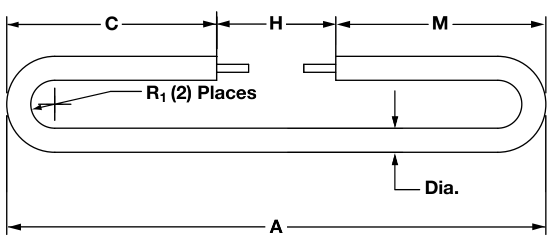
SL = (G + Dia.) 3.14 + 1.14R_1 + 2F + 3.71 Dia. - H

Figure 32



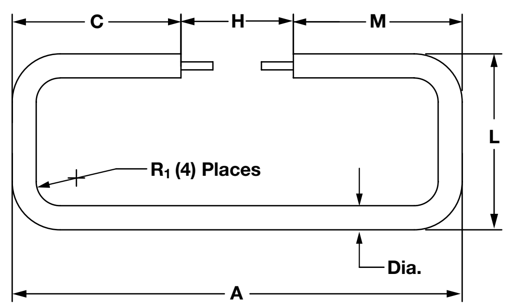
SL = (G + Dia.) 3.14 + 1.14R_1 + 2B + 1.14R_2 + 2K + 3.28 Dia. - H

Figure 37



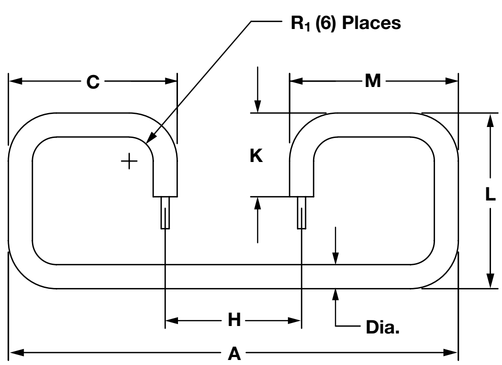
SL = (2A - H) + 2πR_1 - 2R_1

Figure 38



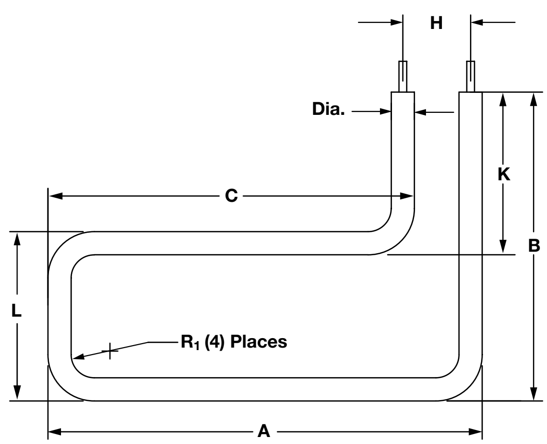
SL = (2A - H) + 2L + 2πR_1 - 4R_1

Figure 39



SL = (2A - H) + 2L + 2K + 3πR_1 - 6R_1

Figure 40

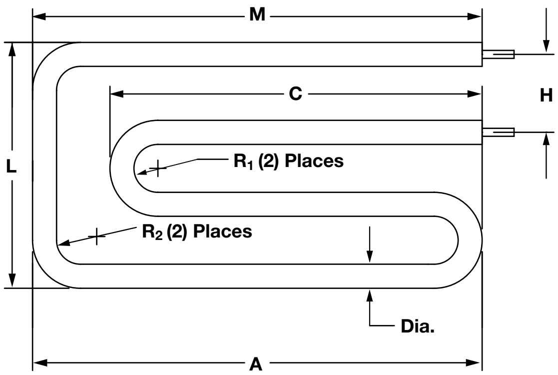


SL = (2A - H) + 2B + 2πR_1 - 4R_1

WATROD Single/Double-Ended Heaters

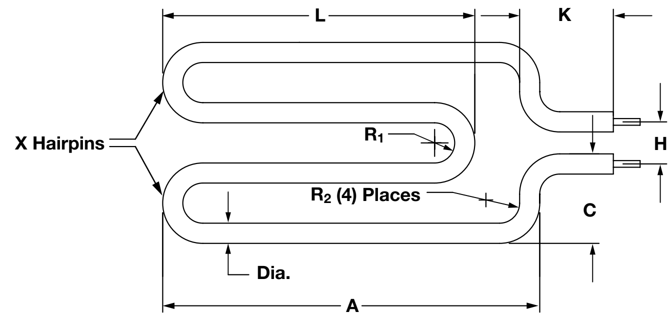
Bend Formations *(Continued)*

Figure 41



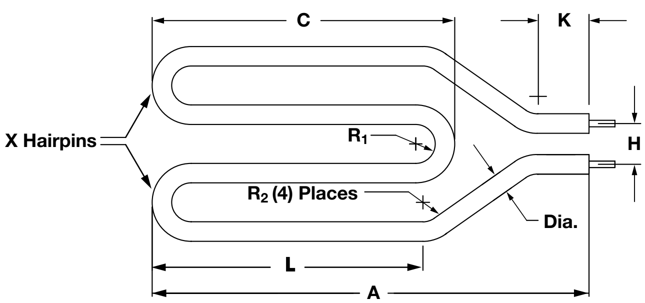
$SL = 2A + 2C + L - H + 2\pi R_1 + \pi R_2 - 2R_1 - 2R_2$

Figure 42



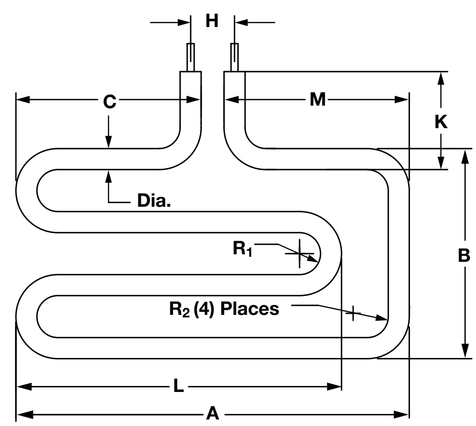
$SL = 2A + (\#)L + 2K + 2C + 2\pi R_2 + (\# \text{ of } R_1)\, \pi R_1 - (\# \text{ of } R_1)\, R_1$

Figure 43



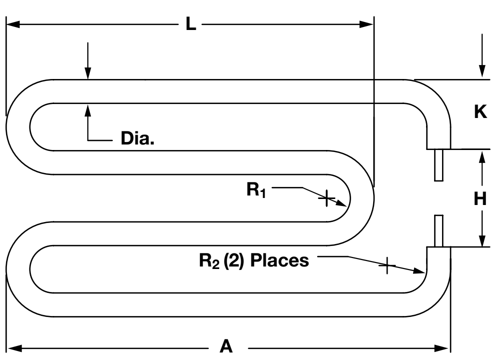
$SL = 2A + (\#)C + (\# \text{ of } R_1)\, \pi + 2\pi R_2 - (\# \text{ of } R_1)\, R_1 - 4R_2$

Figure 44



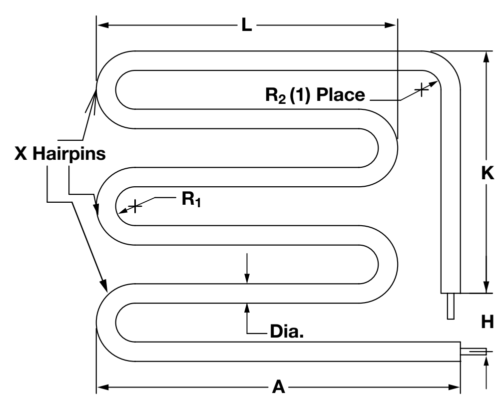
$SL = 2A + 2L + B + 2K + 2\pi R_2 + 3\pi R_1 - 4R_2 - 3R_1$

Figure 45



$SL = 2A + 2L + 2K + 3\pi R_1 + \pi R_2 - 3R_1 - 2R_2$

Figure 46

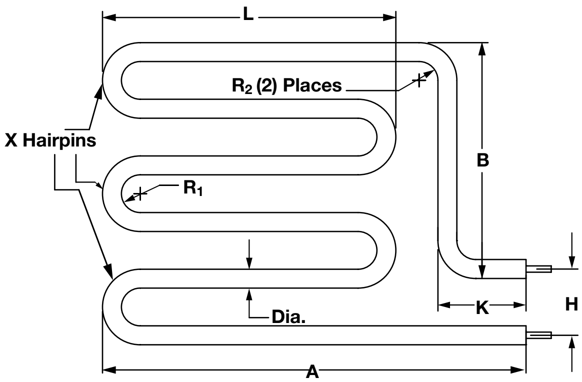


$SL = 2A + (\#)L + K + (\# \text{ of } R_1)\, \pi + \frac{\pi R_2}{2} - (\# \text{ of } R_1)\, R_1 - R_2$

WATROD Single/Double-Ended Heaters

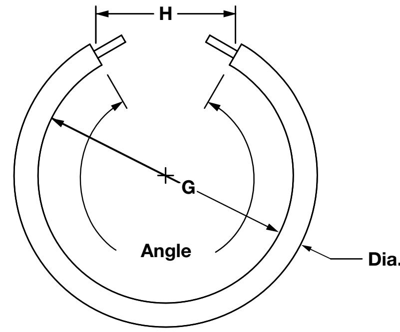
Bend Formations *(Continued)*

Figure 47



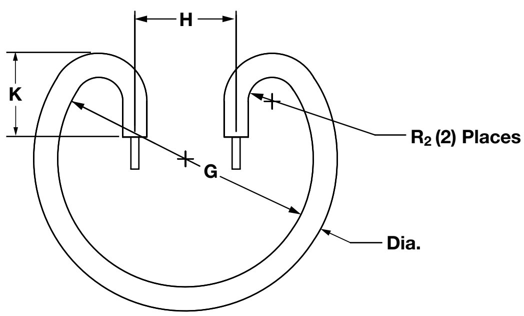
$SL = 2A + (\#)L + B + K + (\#\text{ of }R_1)\ \pi + \pi R_2 - (\#\text{ of }R_1)\ R_1 - 2R_2$

Figure 48



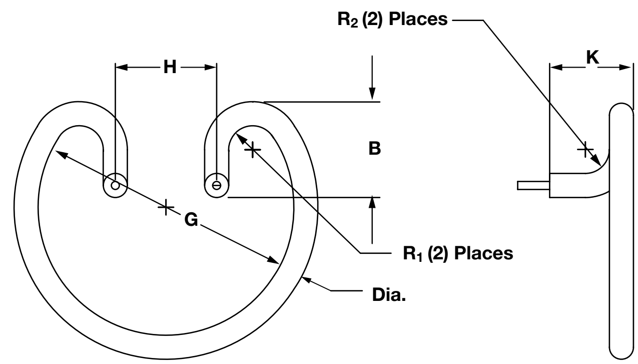
$SL = \pi G - H$

Figure 49



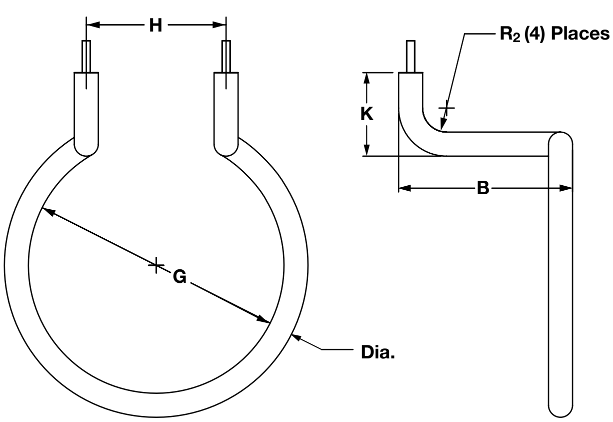
$SL = \pi G - H + 2K + 2\pi R_2 - 2R_2$

Figure 50



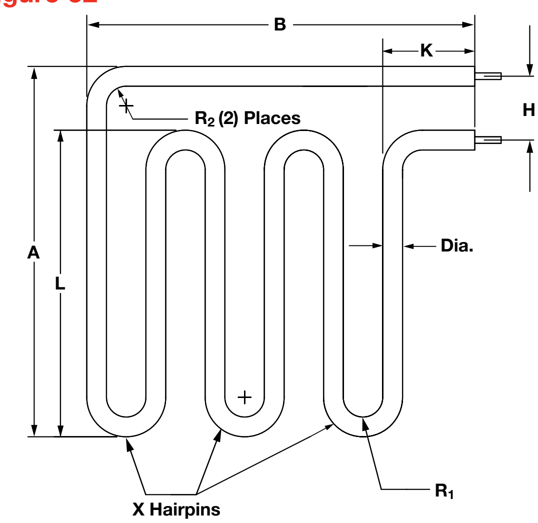
$SL = \pi G - H + 2B + 2K + \pi R_2 + 2\pi R_1 - 2R_1 - 2R_2$

Figure 51



$SL = \pi G - H + 2B + 2K + 2\pi R_2 - 4R_2$

Figure 52

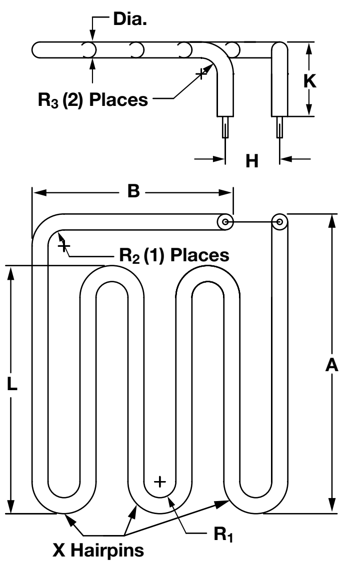


$SL = 2A + B + (\#)L - H + (\#\text{ of }R_1)\ \pi + \pi R_2 - (\#\text{ of }R_1)\ R_1 - 2R_2$

WATROD Single/Double-Ended Heaters

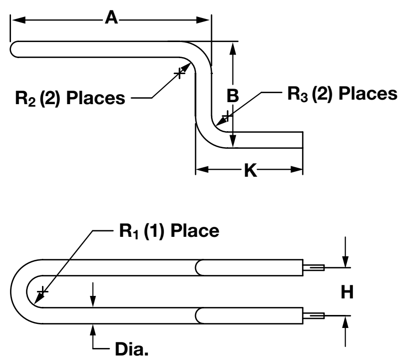
Bend Formations (Continued)

Figure 53



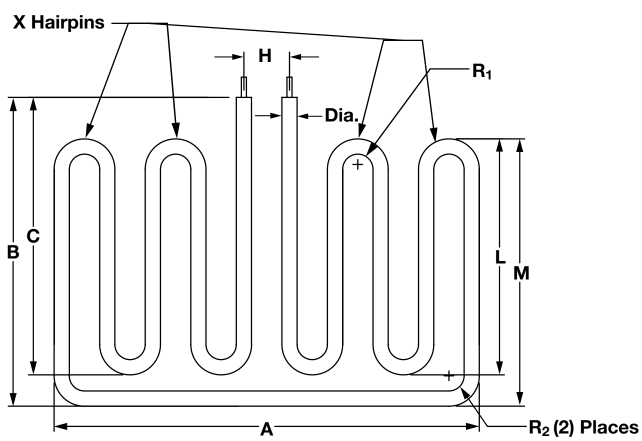
$SL = 2A + (\#)L + B + 2K + (\#\text{ of }R_1)\,\pi + 2\,\frac{(\pi R_3)}{2} - (\#\text{ of }R_1)\,R_1 - 2R_3 - R_2$

Figure 54



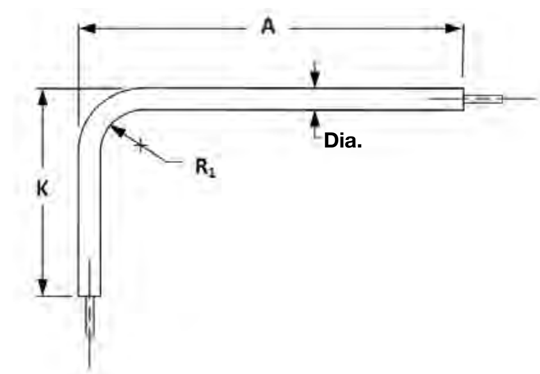
$SL = 2A + 2B + 2K + \pi R_1 + 2\pi R_2 - R_1 - 4R_2$

Figure 55



$SL = A + 2C + 2M + (\#)L + (\#\text{ of }R_1)\pi + \pi R_2 - (\#\text{ of }R_1)\,R_1 - 2R_2$

Figure 56

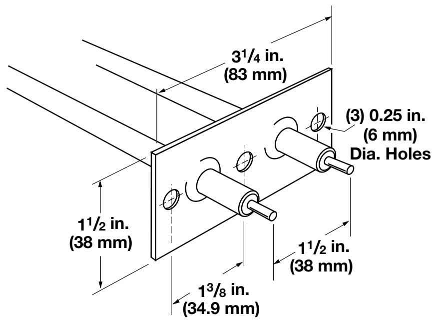


$SL = A + K - 0.86R_1$

WATROD Single/Double-Ended Heaters

Mounting Methods

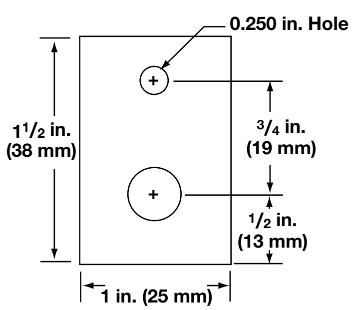
Brackets



A 0.065 in. (1.7 mm) thick stainless steel bracket provides element mounting in non-pressurized applications. Attached to the heater sheath, these brackets are not suited for liquid-tight mountings. The bracket is located 1/2 in. (13 mm) from the sheath's end, unless otherwise specified.

To order, specify **mounting bracket**.

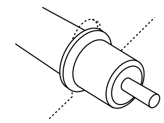
Single Leg Bracket



A 1 1/2 in. (38 mm) x 1 in. (25 mm) wide x 16 gauge stainless steel bracket with one element hole and one mounting hole 1/2 in. (13 mm) from end.

To order, specify **single leg bracket**.

Locator Washers



Stainless steel locator washers retain the heated area of the sheath in the work zone, while allowing for expansion and contraction during cycling.

To order, specify **locator washer**, along with dimension from the heater's end.

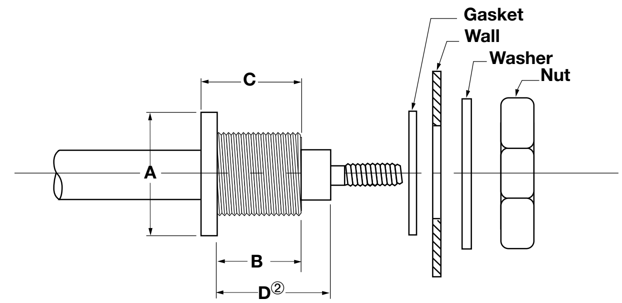
WATROD Single/Double-Ended Heaters

Mounting Methods *(Continued)*

Threaded Bulkheads

A threaded bushing with flange on the heater sheath provides rigid, leak-proof mounting through the walls of tanks. A gasket, plated steel washer and hex nut are included. The threaded end of the bushing is flush with the sheath's end unless otherwise specified. Threaded bulkheads are available in brass, steel or stainless steel as indicated in the table.

To order, specify **threaded bulkheads** and the specifications from the table.



Threaded Bulkhead Specifications

Element Diameter in.	(mm)	Material	Thread Size	A ① Flange Size/Style in.	(mm)	B Threaded Length in.	(mm)	C Overall Length in.	(mm)
0.260	(6.6)	Brass	1/2 - 20 UNF	3/4 Round	(19.0)	5/8	(15.9)	3/4	(19.0)
0.260	(6.6)	Steel ③	1/2 - 20 UNF	3/4 Hex	(19.0)	5/8	(15.9)	3/4	(19.0)
0.260	(6.6)	SS	1/2 - 20 UNF	3/4 Round	(19.0)	5/8	(15.9)	3/4	(19.0)
0.315	(8.0)	Brass	1/2 - 20 UNF	3/4 Round	(19.0)	5/8	(15.9)	3/4	(19.0)
0.315	(8.0)	Steel	1/2 - 20 UNF	3/4 Hex	(19.0)	3/4	(19.0)	15/16	(23.8)
0.315	(8.0)	SS	1/2 - 20 UNF	3/4 Round	(19.0)	3/4	(19.0)	27/32	(21.4)
0.375	(9.5)	Brass	1/2 - 20 UNF	3/4 Round	(19.0)	5/8	(15.9)	3/4	(19.0)
0.375	(9.5)	Steel	1/2 - 20 UNF	3/4 Hex	(19.0)	3/4	(19.0)	15/16	(23.8)
0.375	(9.5)	SS	1/2 - 20 UNF	3/4 Round	(19.0)	3/4	(19.0)	27/32	(21.4)
0.430	(10.9)	Brass	5/8 - 18 UNF	7/8 Hex	(22.2)	3/4	(19.0)	15/16	(23.8)
0.430	(10.9)	Steel	5/8 - 18 UNF	7/8 Round	(22.2)	3/4	(19.0)	15/16	(23.8)
0.430	(10.9)	SS	5/8 - 18 UNF	1 Round	(25.0)	3/4	(19.0)	15/16	(23.8)
0.475	(12.1)	Brass	5/8 - 18 UNF	7/8 Round	(22.2)	3/4	(19.0)	15/16	(23.8)
0.475	(12.1)	Steel	5/8 - 18 UNF	1 Round	(25.0)	1	(25.0)	1 1/8	(28.6)
0.475	(12.1)	SS	5/8 - 18 UNF	1 Round	(25.0)	3/4	(19.0)	15/16	(23.8)

① Designates the dimension across flats for hex flange style and outside diameter for round flange style.
② Equal to "B" dimension unless otherwise specified.
③ Extended capability only.

WATROD Single/Double-Ended Heaters

EXTENDED CAPABILITY

Extended Capabilities/Options

Zoned Heaters

Multiple zone heaters with up to (5) zones are available.

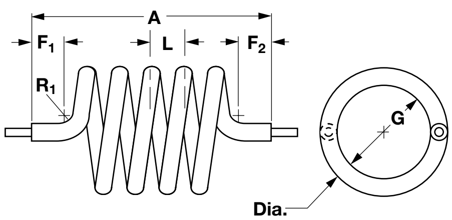
Features and Benefits

Standard sheath materials

- Optional materials available which include 304 SS, 316 SS, Alloy 600, Alloy 800, Alloy 840, copper clad steel, Inconel®/steel, and titanium

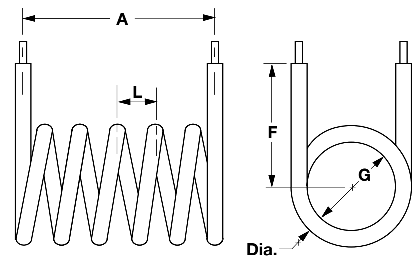
Extended Capabilities/Bend Formations

Figure 33



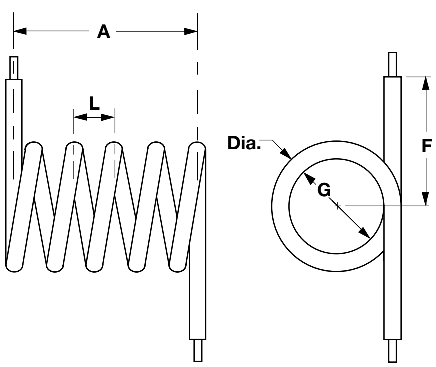
SL = [(G + Dia.) (3.14) (Number of 360°'s)] + F1 + F2

Figure 34



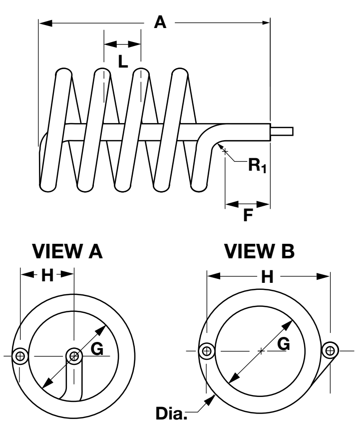
SL = [(G + Dia.) (3.14) (Number of 360°'s)] + 2F

Figure 35



SL = [(G + Dia.) (3.14) (Number of 360°'s)] + 2F

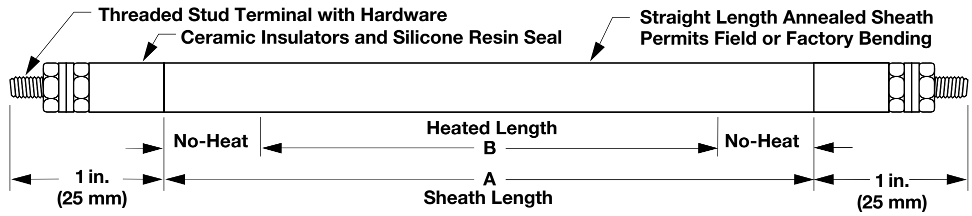
Figure 36



SL = [(G + Dia.) (3.14) (Number of 360°'s)] + (G ÷ 2) + A + F

WATROD Single/Double-Ended Heaters

Double-Ended WATROD



WATROD Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 120VAC	240VAC	480VAC	Est. Net Wt. lbs	(kg)
Applications: Medium-Weight, Non-Circulating Oil, Heat-Transfer Oil										
15 W/in²	29 7/8	(758.8)	22 3/8	(568.4)	500		**RGSS29R10S**		1.0	(0.5)
0.475 in. Dia.	38 3/8	(974.7)	29 7/8	(758.8)	667		**RGSS38G10S**	**RGSS38G11S**	1.3	(0.6)
Steel	44 3/4	(1137.0)	37 1/4	(946.0)	833		**RGSS44G10S**	**RGSS44G11S**	1.7	(0.8)
(2.3 W/cm²)	53 3/8	(1355.7)	44 3/4	(1137.0)	1000		**RGSS53G10S**	**RGSS53G11S**	1.9	(0.9)
(12 mm)	68 3/8	(1736.7)	59 5/8	(1514.4)	1333		**RGSS68G10S**	**RGSS68G11S**	2.1	(1.0)
	83 3/8	(2117.7)	74 1/2	(1892.0)	1667		**RGSS83G10S**	**RGSS83G11S**	2.5	(1.1)
	98 3/8	(2498.7)	89 1/2	(2273.0)	2000		**RGSS98G10S**	**RGSS98G11S**	3.0	(1.4)
	120 3/8	(3057.5)	111 7/8	(2841.6)	2500		**RGSS120G10S**	**RGSS120G11S**	3.9	(1.8)
	142 7/8	(3629.1)	134 1/4	(3410.0)	3000		**RGSS142R10S**	**RGSS142R11S**	4.1	(1.9)
Application: Air Heating										
20 W/in²	48 3/4	(1238.0)	38 3/4	(984.0)	1000		**RCN48N10S**	**RCN48N11S**	1.0	(0.5)
0.430 in. Dia.	58 3/4	(1492.0)	48 3/4	(1238.0)	1250		**RCN58N10S**	**RCN58N11S**	1.1	(0.5)
Alloy 840	73 3/4	(1873.0)	63 3/4	(1619.0)	1667			**RCN73N11S**	1.4	(0.7)
(3.1 W/cm²)	91 3/4	(2330.0)	81 3/4	(2076.0)	2083			**RCN91N11S**	1.7	(0.8)
(10.9 mm)										
Applications: Caustic Solutions, Air Heating										
23 W/in²	29	(737.0)	22	(559.0)	500	**RBN291S**			0.4	(0.2)
0.315 in. Dia.	40	(1016.0)	33	(839.0)	750	**RBN401S**			0.5	(0.3)
Alloy 800	51	(1296.0)	44	(1118.0)	1000	**RBN511S**			0.7	(0.4)
(3.6 W/cm²)										
(8 mm)										
23 W/in²	39	(991.0)	27	(686.0)	1000	**RGNA391S**	**RGNA3910S**	**RGNA3911S**	1.2	(0.6)
0.475 in. Dia.	54	(1372.0)	42	(1067.0)	1500		**RGNA5410S**	**RGNA5411S**	1.6	(0.8)
Alloy 800	69	(1753.0)	57	(1448.0)	2000		**RGNA6910S**	**RGNA6911S**	2.1	(1.0)
(3.6 W/cm²)	84	(2134.0)	72	(1829.0)	2500		**RGNA8410S**	**RGNA8411S**	2.5	(1.2)
(12 mm)	99	(2515.0)	87	(2210.0)	3000		**RGNA9910S**	**RGNA9911S**	3.0	(1.4)
	106	(2692.0)	94	(2388.0)	2778			**RGNA10611S**	3.2	(1.5)
	132	(3353.0)	120	(3048.0)	4167		**RGNA13210S**	**RGNA13211S**	4.0	(1.8)
	157	(3988.0)	145	(3683.0)	5000		**RGNA15710S**	**RGNA15711S**	4.7	(2.2)
Applications: Light Oils, Greases, Heat-Transfer Oils										
23 W/in²	16	(406.0)	12	(305.0)	250	**RBS161S**	**RBS1610S**		0.2	(0.1)
0.315 in. Dia.	18	(457.0)	14	(356.0)	250	**RBS181S**			0.3	(0.2)
Steel	21	(533.0)	17	(432.0)	350	**RBS211S**	**RBS2110S**		0.3	(0.2)
(3.6 W/cm²)	23 3/8	(593.7)	19 3/8	(492.1)	375	**RBS23G1S**			0.3	(0.2)
(8 mm)	28 7/8	(733.4)	24 7/8	(631.8)	500	**RBS28R1S**			0.4	(0.2)
	29	(737.0)	24	(610.0)	500	**RBS291S**	**RBS2910S**		0.4	(0.2)
	42	(1067.0)	37	(940.0)	750	**RBS421S**	**RBS4210S**		0.6	(0.3)
	54	(1372.0)	49	(1245.0)	1000	**RBS541S**	**RBS5410S**		0.7	(0.4)
	77	(1956.0)	72	(1829.0)	1500	**RBS771S**	**RBS7710S**		1.0	(0.5)

CONTINUED

WATROD Single/Double-Ended Heaters

Double-Ended WATROD *(Continued)*

WATROD Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 120VAC	240VAC	480VAC	Est. Net Wt. lbs	(kg)
Applications: Light Oils, Greases, Heat-Transfer Oils										
23 W/in²	23	(584)	14	(356)	500	**RGS231S**	**RGS2310S**		0.7	(0.4)
0.475 in. Dia.	31	(787)	22	(559)	750	**RGS311S**	**RGS3110S**		1.0	(0.5)
Steel	39	(991)	27	(686)	1000	**RGS391S**	**RGS3910S**	**RGS3911S**	1.2	(0.6)
(3.6 W/cm²)	45	(1143)	36	(914)	1250	**RGS451S**	**RGS4510S**		1.4	(0.7)
(12 mm)	54	(1372)	42	(1067)	1500	**RGS541S**	**RGS5410S**	**RGS5411S**	1.6	(0.8)
	69	(1753)	57	(1448)	2000	**RGS691S**	**RGS6910S**	**RGS6911S**	2.1	(1.0)
	84	(2134)	72	(1829)	2500	**RGS841S**	**RGS8410S**	**RGS8411S**	2.5	(1.2)
	99	(2515)	87	(2210)	3000		**RGS9910S**	**RGS9911S**	3.0	(1.4)
	106	(2692)	90	(2286)	2778			**RGS10611S**	3.2	(1.5)
	132	(3353)	120	(3048)	4167		**RGS13210S**	**RGS13211S**	4.0	(1.8)
	144	(3658)	128	(3251)	3889			**RGS14411S**	4.3	(2.0)
	157	(3988)	145	(3683)	5000		**RGS15710S**	**RGS15711S**	4.7	(2.2)
Application: Air Heating										
30 W/in²	20	(508)	15	(381)	400		**RAN2010S**		0.2	(0.1)
0.260 in. Dia.	25	(635)	20	(508)	500		**RAN2510S**		0.3	(0.2)
Alloy 840	30	(762)	25	(635)	600		**RAN3010S**		0.3	(0.2)
(4.7 W/cm²)	35	(889)	30	(762)	800		**RAN3510S**		0.4	(0.2)
(6.6 mm)	40	(1016)	35	(889)	900		**RAN4010S**		0.4	(0.2)
	45	(1143)	40	(1016)	1000		**RAN4510S**		0.5	(0.3)
	50	(1270)	45	(1143)	1200		**RAN5010S**		0.5	(0.3)
	55	(1397)	50	(1270)	1200		**RAN5510S**		0.6	(0.3)
	60	(1524)	55	(1397)	1400		**RAN6010S**		0.6	(0.3)
	65	(1651)	60	(1524)	1600		**RAN6510S**		0.7	(0.4)
	70	(1778)	65	(1651)	1800		**RAN7010S**		0.7	(0.4)
	75	(1905)	70	(1778)	1800		**RAN7510S**		0.8	(0.4)
	80	(2032)	75	(1905)	2000		**RAN8010S**		0.8	(0.4)
30 W/in²	15	(381)	10	(254)	300		**RBN1510S**		0.2	(0.1)
0.315 in. Dia.	20	(508)	15	(381)	400		**RBN2010S**		0.3	(0.2)
Alloy 840	25	(635)	20	(508)	600		**RBN2510S**		0.4	(0.2)
(4.7 W/cm²)	30	(762)	25	(635)	800		**RBN3010S**		0.4	(0.2)
(8 mm)	35	(889)	30	(762)	900		**RBN3510S**		0.5	(0.3)
	40	(1016)	35	(889)	1000		**RBN4010S**		0.5	(0.3)
	45	(1143)	40	(1016)	1200		**RBN4510S**		0.6	(0.3)
	50	(1270)	45	(1143)	1400		**RBN5010S**		0.7	(0.4)
	55	(1397)	50	(1270)	1600		**RBN5510S**		0.7	(0.4)
	60	(1524)	55	(1397)	1800		**RBN6010S**		0.8	(0.4)
	65	(1651)	60	(1524)	1800		**RBN6510S**		0.8	(0.4)
	70	(1778)	65	(1651)	2000		**RBN7010S**		0.9	(0.5)
	75	(1905)	70	(1778)	2200		**RBN7510S**		1.0	(0.5)
	80	(2032)	75	(1905)	2400		**RBN8010S**		1.0	(0.5)
	90	(2286)	85	(2159)	2600		**RBN9010S**		1.2	(0.6)
	100	(2540)	95	(2413)	3000		**RBN10010S**		1.3	(0.6)

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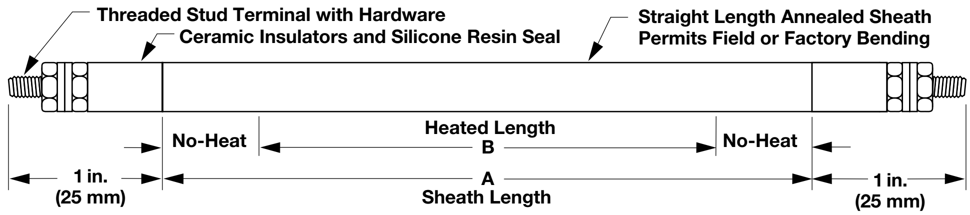
WATROD Single/Double-Ended Heaters

Double-Ended WATROD (Continued)



WATROD Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 120VAC	240VAC	480VAC	Est. Net Wt. lbs	(kg)
Application: Air Heating										
30 W/in^2	15	(381.0)	10	(254.0)	400		**RCN1510S**		0.3	(0.2)
0.430 in. Dia.	20	(508.0)	15	(381.0)	600		**RCN2010S**		0.4	(0.2)
Alloy 840	25	(635.0)	20	(508.0)	800		**RCN2510S**		0.5	(0.3)
(4.7 W/cm^2)	30	(762.0)	25	(635.0)	1000		**RCN3010S**		0.6	(0.3)
(10.9 mm)	35	(889.0)	30	(762.0)	1200		**RCN3510S**		0.7	(0.4)
	40	(1016.0)	35	(889.0)	1400		**RCN4010S**		0.8	(0.4)
	48 3/4	(1238.0)	38 3/4	(984.0)	1500		**RCNX48N10S**	**RCNX48N11S**	1.0	(0.5)
	45	(1143.0)	40	(1016.0)	1600		**RCN4510S**		0.9	(0.5)
	50	(1270.0)	45	(1143.0)	1800		**RCN5010S**		1.0	(0.5)
	58 3/4	(1492.0)	48 3/4	(1238.0)	1917		**RCNX58N10S**	**RCNX58N11S**	1.1	(0.5)
	55	(1397.0)	50	(1270.0)	2000		**RCN5510S**		1.0	(0.5)
	60	(1524.0)	55	(1397.0)	2200		**RCN6010S**		1.1	(0.5)
	65	(1651.0)	60	(1524.0)	2400		**RCN6510S**		1.2	(0.6)
	73 3/4	(1873.0)	63 3/4	(1619.0)	2500			**RCNX73N11S**	1.4	(0.7)
	70	(1778.0)	65	(1651.0)	2600		**RCN7010S**		1.3	(0.6)
	75	(1905.0)	70	(1778.0)	2800		**RCN7510S**		1.4	(0.7)
	80	(2032.0)	75	(1905.0)	3000		**RCN8010S**		1.5	(0.7)
	91 3/4	(2331.0)	81 3/4	(2077.0)	3167			**RCNX91N11S**	1.7	(0.8)
	90	(2286.0)	85	(2159.0)	3500		**RCN9010S**		1.7	(0.8)
	100	(2540.0)	95	(2413.0)	4000		**RCN10010S**		1.9	(0.9)
	110	(2794.0)	105	(2667.0)	4500		**RCN11010S**		2.1	(1.0)
	120	(3048.0)	115	(2921.0)	5000		**RCN12010S**		2.3	(1.1)
Application: Radiant Heating										
40 W/in^2	10 1/4	(260.0)	7 1/4	(184.0)	400	**RDN10E1S**			0.2	(0.1)
0.375 in. Dia.	16 5/8	(422.1)	13 5/8	(346.1)	650	**RDN16L1S**			0.3	(0.2)
Alloy 800	21 1/16	(535.0)	16 13/16	(427.0)	800	**RDN21B1S**	**RDN21B10S**		0.4	(0.2)
(6.2 W/cm^2)	27 1/8	(689.0)	22 7/8	(581.0)	1100	**RDN27C1S**	**RDN27C10S**		0.5	(0.3)
(9.5 mm)	32 1/8	(816.0)	27 7/8	(708.0)	1300		**RDN32C10S**	**RDN32C11S**	0.6	(0.3)
	42 7/8	(1089.0)	38 5/8	(981.1)	1800		**RDN42R10S**	**RDN42R11S**	0.8	(0.4)
	57 1/2	(1461.0)	53 1/4	(1353.0)	2500		**RDN57J10S**	**RDN57J11S**	1.1	(0.5)
	69 1/4	(1759.0)	65	(1651.0)	3000		**RDN69E10S**	**RDN69E11S**	1.3	(0.6)
	81 1/4	(2064.0)	77	(1956.0)	3600		**RDN81E10S**	**RDN81E11S**	1.6	(0.8)
	109 1/4	(2775.0)	105	(2667.0)	4000		**RDN109E10S**		2.1	(1.0)
	134 1/2	(3416.0)	127 3/4	(3245.0)	5000		**RDN134J10S**		2.6	(1.2)
	153 3/8	(3895.7)	145 7/8	(3705.2)	5500		**RDN153R10S**		2.9	(1.4)
	179 1/4	(4553.0)	171 1/4	(4350.0)	6500		**RDN179E10S**		3.4	(1.6)

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WATROD Single/Double-Ended Heaters

Double-Ended WATROD *(Continued)*

Special 208VAC and 277VAC Voltages

WATROD Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 208VAC	277VAC	Est. Net Wt. lbs	(kg)
Application: Radiant Heating									
40 W/in²	21 1/16	(535)	16 13/16	(427)	800	**RDN21B2S**	**RDN21B4S**	0.4	(0.2)
0.375 in. Dia.	27 1/8	(689)	22 7/8	(581)	1100	**RDN27C2S**	**RDN27C4S**	0.5	(0.3)
Alloy 800	42 7/8	(1089)	38 5/8	(981)	1800	**RDN42R2S**	**RDN42R4S**	0.8	(0.4)
(6.2 W/cm²)	57 1/2	(1461)	53 1/4	(1353)	2500	**RDN57J2S**	**RDN57J4S**	1.1	(0.5)
(9.5 mm)	69 1/4	(1759)	65	(1651)	3000	**RDN69E2S**	**RDN69E4S**	1.3	(0.6)
	81 1/4	(2064)	77	(1956)	3600	**RDN81E2S**	**RDN81E4S**	1.6	(0.8)

WATROD Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 120VAC	240VAC	480VAC	Est. Net Wt. lbs	(kg)
Application: Process Water										
48 W/in²	23	(584)	14	(356)	1000	**RGN231S**	**RGN2310S**	**RGN2311S**	0.7	(0.4)
0.475 in. Dia.	30	(762)	21	(533)	1500	**RGN301S**	**RGN3010S**	**RGN3011S**	0.9	(0.5)
Alloy 800	39	(991)	27	(686)	2000	**RGN391S**	**RGN3910S**	**RGN3911S**	1.2	(0.6)
(7.4 W/cm²)	44	(1118)	35	(889)	2500	**RGN441S**	**RGN4410S**	**RGN4411S**	1.3	(0.6)
(12 mm)	54	(1372)	42	(1067)	3000		**RGN5410S**	**RGN5411S**	1.6	(0.8)
	69	(1753)	57	(1448)	4000		**RGN6910S**	**RGN6911S**	2.1	(1.0)
	84	(2134)	72	(1829)	5000		**RGN8410S**	**RGN8411S**	2.5	(1.2)
	92	(2337)	76	(1930)	5556			**RGN9211S**	2.8	(1.3)
	99	(2515)	87	(2210)	6000		**RGN9910S**	**RGN9911S**	3.0	(1.4)
	149	(3785)	133	(3378)	9722			**RGN14911S**	4.5	(2.1)
Application: Hot Runner Molds (Manifolds)										
60 W/in²	35	(889)	25	(635)	1500		**RBR3510S**		0.2	(0.1)
0.315 in. Dia.	44	(1118)	34	(864)	2000		**RBR4410S**		0.3	(0.2)
316 SS	52	(1321)	42	(1067)	2500		**RBR5210S**		0.3	(0.2)
(9.3 W/cm²)	60	(1524)	50	(1270)	3000		**RBR6010S**		0.4	(0.2)
(8 mm)	69	(1753)	59	(1499)	3500		**RBR6910S**		0.4	(0.2)
	77	(1956)	67	(1702)	4000		**RBR7710S**		0.5	(0.3)
	85	(2159)	75	(1905)	4500		**RBR8510S**		0.6	(0.3)
Applications: Deionized Water, Demineralized Water										
60 W/in²	20	(508)	11	(279)	1000	**RGR201S**	**RGR2010S**	**RGR2011S**	0.6	(0.3)
0.475 in. Dia.	26	(660)	17	(432)	1500	**RGR261S**	**RGR2610S**	**RGR2611S**	0.8	(0.4)
316 SS	34	(864)	22	(559)	2000		**RGR3410S**	**RGR3411S**	1.0	(0.5)
(9.3 W/cm²)	40	(1016)	28	(711)	2500		**RGR4010S**	**RGR4011S**	1.2	(0.6)
(12 mm)	47	(1194)	31	(787)	2778			**RGR4711S**	1.4	(0.7)
	46	(1168)	34	(864)	3000		**RGR4610S**	**RGR4611S**	1.4	(0.7)
	57	(1448)	45	(1143)	4000		**RGR5710S**	**RGR5711S**	1.7	(0.8)
	68	(1727)	56	(1422)	5000		**RGR6810S**	**RGR6811S**	2.1	(1.0)
	79	(2007)	67	(1702)	6000		**RGR7910S**	**RGR7911S**	2.4	(1.1)
	105	(2667)	93	(2362)	8333			**RGR10511S**	3.2	(1.5)

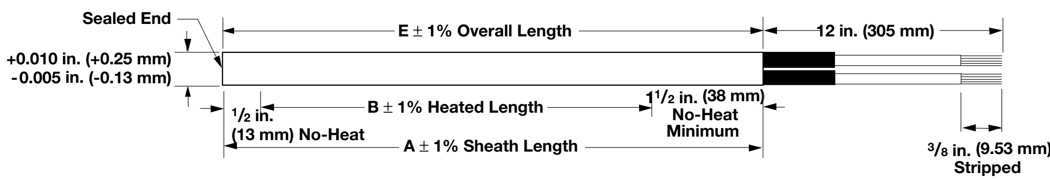
WATROD Single/Double-Ended Heaters

Single-Ended WATROD

Application Hints

The single-ended WATROD heater's construction limits its usefulness in some applications. The following are some guides to follow when considering a single-ended WATROD.

- When single-ended termination simplifies application wiring.
- The application requires lower wattage or a smaller package.
- Do not locate the end of the heated length within a bend, unless the radius is 3 in. (75 mm) or more. Field bending is not recommended.
- Bending is limited to bend Figures 1, 6, 22 and 28 (see pages 62 to 67 for details).
- Ensure termination temperatures do not exceed 390°F (200°C) or the seal's maximum rating.
- Keep terminations clean, dry and tight.



EXTENDED CAPABILITY

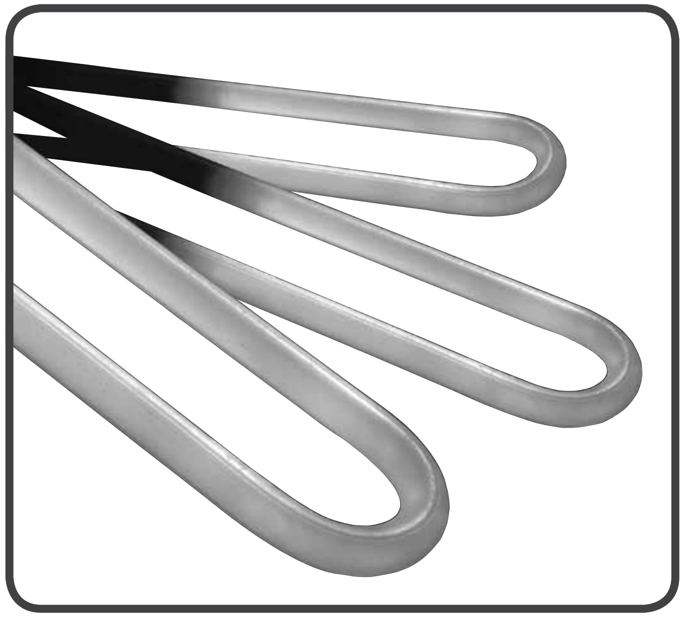
WATROD Double-Ended Heaters

Extended Capabilities for High-Temperature Tubular Heaters

Watlow manufactures high-temperature tubular heaters to bridge the gap between standard tubular heaters and Watlow MULTICELL™ heaters. This tubular is well suited for process air heating applications in excess of 1300°F (704°C), resulting in a maximum sheath temperature of 1800°F (983°C). Controlled lab testing between the new design and current tubular designs show an increase in life of approximately 50 percent.

The high-temperature tubular consists of an engineered tubing with an alloy 600 outer sheath and a special internal construction. The outer sheath offers high temperature capabilities, reduced oxidation as well as corrosion resistance.

The tubular offering is available in 0.430 and 0.375 inch diameters that are configurable either as formed tubulars or process heaters. The heaters can also be welded to flanges and plates for mounting purposes. Maximum sheath length available is 275 inches for the 0.430 inch and 0.375 inch diameters. A Watlow sales representative should be contacted for longer sheath lengths.



Features and Benefits

Alloy 600 sheath material and a special internal construction

- Assures high temperature performance and corrosion protection in tough applications

0.430 inch diameters*

- Allows heater to be configured to existing tubular designs that may be experiencing short life

***Note: 0.375 diameters are available in Watlow's extended capabilities, contact your Watlow representative for details.**

Dual-ended termination

- Installs into flanges and screw plugs similarly to standard product configurations

Bendable in standard formations

- Makes the heater easy to apply in a wide variety of applications

Typical Applications

- High temperature ovens and furnaces
- Radiant heating
- Drying
- Environmental—VOC abatement
- Process air heating: duct heaters, circulation heaters
- Vacuum applications
- Flue gas cleaning (desulphurization)
- Fluidized beds

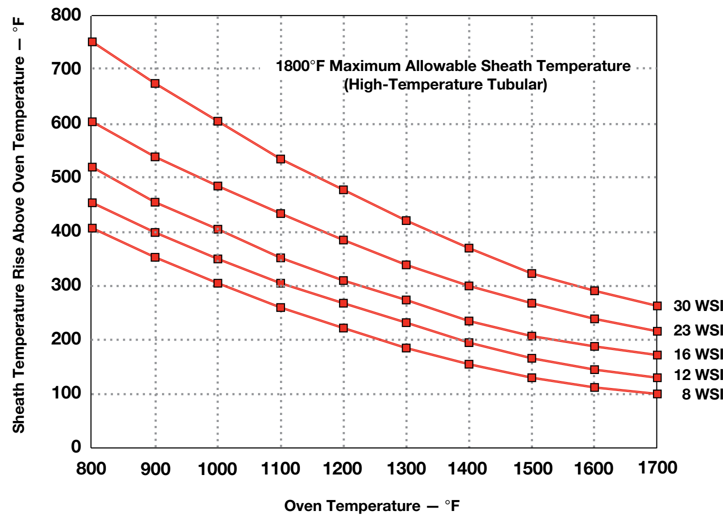
EXTENDED CAPABILITY

WATROD Double-Ended Heaters

Extended Capabilities for High-Temperature Tubular Heaters

Sheath Temperature Versus Oven Temperature at Various Watt Densities

This chart is used to verify the correct watt density for an oven application assuming no air flow. To use the chart, first select the oven process temperature on the X axis, using the chosen watt density read the sheath temperature rise above oven temperature from the Y axis. This number should then be added to oven temperature. If this number is greater than 1800°F (982°C), a lower watt density should be chosen.

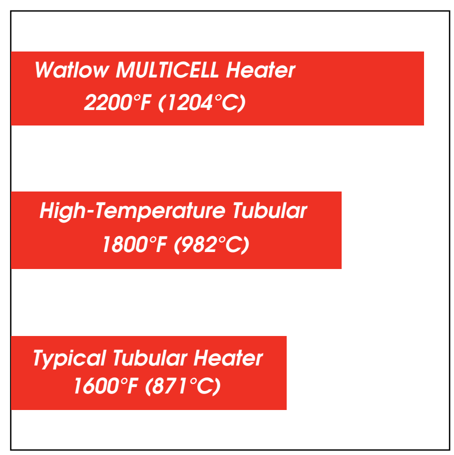


Heater Life Estimate Service

Watlow now provides an industry first service with the offering of the high-temperature tubular. By providing operating parameters, Watlow provides customers with the estimated life of the heater. To get this information, the following information should be provided:

- Heater voltage
- Heater wattage
- Heater diameter 0.430 or 0.375 in. (10.9 or 9.5 mm)
- Heated length
- Bend configuration and dimensions (number of bends and radius)
- Application including process temperature
- Power switching device and cycle time (SCR, etc.)

High-Temperature Heater Comparisons



*Assuming normal design practices.

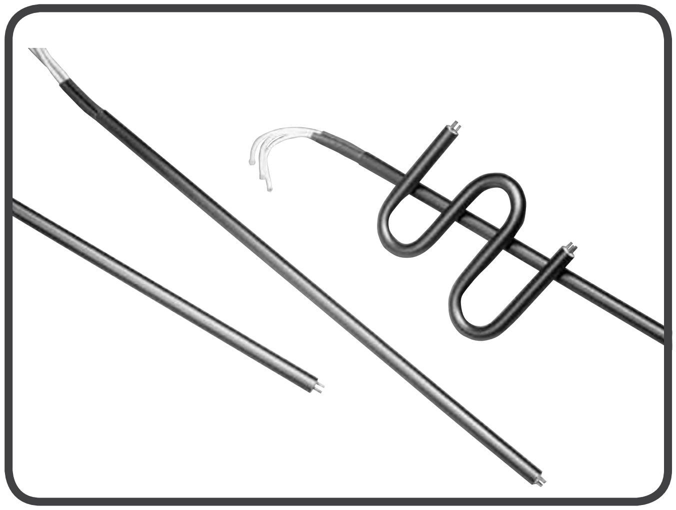
EXTENDED CAPABILITY

WATROD Single/Double-Ended Heaters

Extended Capabilities for MULTICOIL™ Tubular Heaters

The tubular element with multiple coils and/or thermocouples inside one sheath from Watlow answers the need for a versatile, innovative tubular heater. Watlow's patented method of packaging a thermocouple inside of a heater with one or more resistance coils, gives the ability to sense a heaters' internal temperature accurately, every time.

Moreover, this is the first tubular heater in the industry with three-phase capability. The three coil, three-phase heater will offer a compact package solution while delivering the full power required in a compact heater package. Previously three separate heaters would have been required to do the same job; therefore Watlow's MULTICOIL™ heater capabilities save money.



Performance Capabilities

- Watt densities up to 60 W/in^2 (9.3 W/cm^2)
- Sheath temperatures up to 1600°F (870°C)
- 304 and 316 stainless steel sheath temperatures up to 1200°F (650°C)

Features and Benefits

Three-phase capability
- Results in one element versus three, lower amperage, reduced installation time and lower overall cost

Multiple coil operations
- Reduces inventory by allowing dual voltage capability

Versatile forming capabilities
- Forms into many configurations

Internal construction with sensor
- Allows space savings because drilling and tapping of flange is unnecessary; plus, the interior thermocouple eliminates contamination buildup around the external sensing tip, reducing the possibility of false readings

Typical Applications

- Foodservice equipment
- Process
- Medical
- Milled groove
- Plastics
- Plating
- Oven heating
- Semiconductor

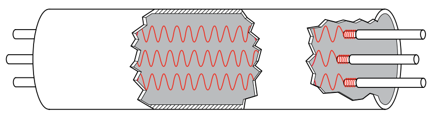
EXTENDED CAPABILITY

WATROD Single/Double-Ended Heaters

Extended Capabilities for MULTICOIL Tubular Heaters

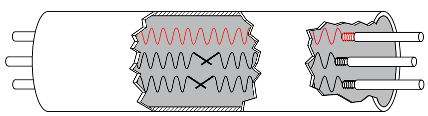
Options

Option A



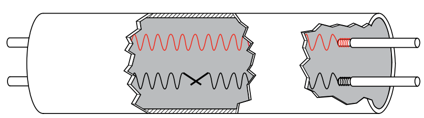
3-phase tubular, 0.475 inch diameter.

Option C



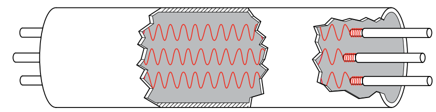
1-phase tubular with one resistance wire and two thermocouples, 0.475 inch diameter.

Option D



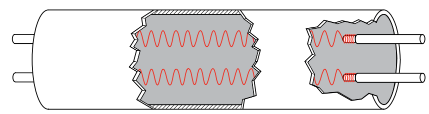
1-phase tubular with one resistance coil and one thermocouple, 0.375, 0.430 and 0.475 inch diameter.

Option E



1-phase tubular with three different one phase circuits, 0.475 inch diameter.

Option F



1-phase tubular with two resistance coils, 0.375, 0.430 and 0.475 inch diameter.

Specifications

Termination styles
- Lead wires 392°F (200°C) Sil-A-Blend® or 482°F (250°C) GGS.

Moisture seals
Moisture seals are required, options include:
- Epoxy with temperature rating to 356°F (180°C). Typical applications include water/oil immersion.
- Lavacone with temperature rating to 221°F (105°C). Typical application includes air heating.
- High-temperature ceramic rated to 2800°F (1538°C).
- Contact your Watlow representative for other moisture seal options.

Mounting options
- Mounting brackets
- Locator washers
- Water-tight bulkheads

Maximum trim length
- 237 in. (6020 mm), heater designs with trim length greater than 120 in. (3048 mm) must be reviewed with your Watlow representative.

Sheath materials
- Alloy 600, 800, 840, 304 and 316 stainless steel, contact your Watlow representative for other sheath material options.

Internal thermocouple options
- Type K is used, contact your Watlow representative for Type J thermocouple options.

FIREBAR® Single/Double-Ended Heaters

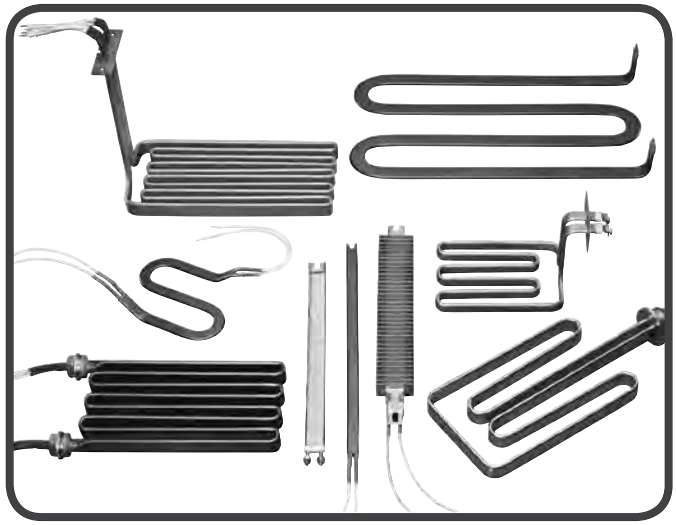
FIREBAR® heating elements provide added heating performance over standard round tubular heating elements—especially for immersion applications in petroleum based liquids requiring high kilowatts.

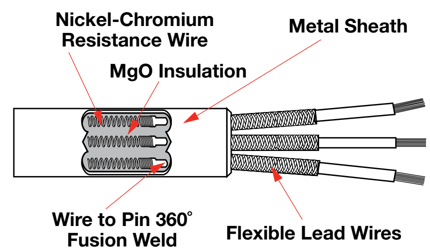
The FIREBAR's unique flat surface geometry packs more power in shorter elements and assemblies, along with a host of other performance improvements. These include:

- Minimizing coking and fluid degrading
- Enhancing the flow of fluid past the element's surface to carry heat from the sheath
- Improving heat transfer with a significantly larger boundary layer allowing much more liquid to flow up and across the sheath's surface

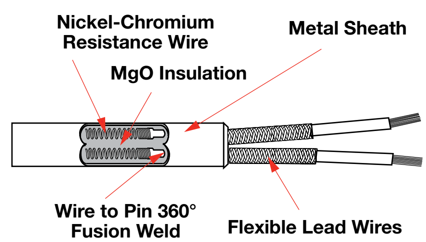
FIREBAR elements are available in single- and double-ended constructions with one inch or 5/8 inch heights. These two configuration variables make it possible to use FIREBAR elements instead of round tubular elements in virtually all applications.

FINBAR™ is a special version of the one inch, single-ended FIREBAR. FINBAR is specially modified with fins to further increase surface area for air and gas heating applications. Details are contained in the *FINBAR* section, starting on page 103.





One Inch Double-Ended FIREBAR Element and Lead Configurations



5/8 Inch Double-Ended FIREBAR Element and Lead Configurations

Double-Ended Performance Capabilities

One Inch

- Watt densities up to 120 W/in^2 (18.6 W/cm^2)
- Alloy 800 sheath temperatures up to 1400°F (760°C)
- 304 stainless steel sheath temperatures up to 1200°F (650°C)
- Voltages up to 240VAC
- Amperages up to 48 amperes per heater or 16 amperes per coil

5/8 Inch

- Watt densities up to 90 W/in^2 (13.9 W/cm^2)
- Alloy 840 sheath temperatures up to 1400°F (760°C)
- Voltages up to 240VAC
- Amperages up to 32 amperes per heater or 16 amperes per coil

Single-Ended Performance Capabilities

One Inch

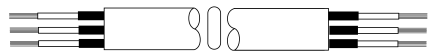
- Watt densities up to 60 W/in^2 (9.3 W/cm^2)
- Alloy 800 sheath temperatures up to 1400°F (760°C)
- 304 stainless steel sheath temperatures up to 1200°F (650°C)
- Voltages up to 240VAC
- Amperages up to 48 amperes per heater or 16 amperes per coil

5/8 Inch

- Watt densities up to 80 W/in^2 (12.4 W/cm^2)
- Alloy 840 sheath temperatures up to 1400°F (760°C)
- Voltages up to 240VAC
- Amperages up to 16 amperes per heater

FIREBAR Double-Ended Heaters

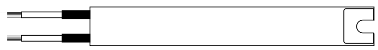
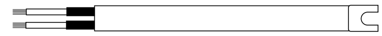
Specifications

	One Inch FIREBAR 	⅝ Inch FIREBAR 
Applications	Direct immersion; water, oils, etc. Clamp-on; hoppers, griddles Forced air heating (Also see FINBAR, page 103) Radiant heating	Direct immersion; water, oils, etc. Clamp-on; hoppers, griddles Forced air heating Radiant heating
Watt Density W/in² (W/cm²)	Standard: up to 90 (13.9) Made-to-Order (M-t-O): up to 120 (18.6)	Standard: up to 90 (13.9) Made-to-Order (M-t-O) up to 90 (13.9)
Surface Area Per Linear In. (cm)	2.3 in² (14.8 cm²)	1.52 in² (9.80 cm²)
Cross Section Height ± 0.015/0.010 in. (0.381/0.254 mm) Thickness ± 0.005/0.001 in. (0.127/0.025 mm)	 1.010 (25.7) 0.235 (5.9)	 0.650 (16.5) 0.235 (5.9)
Sheath Material—Max. Operating temperature	Standard: Alloy 800 1400°F (760°C) M-t-O: Alloy 800 1400°F (760°C) 304 SS 1200°F (650°C)	Standard: Alloy 840 1400°F (760°C) M-t-O: Alloy 840 1400°F (760°C) 304 SS 1200°F (650°C)
Sheath Length in. (mm)	Standard: 15 to 114 (381 to 2896) M-t-O: 11 to 180 (280 to 4572)	Standard: 15 to 51 (381 to 1295) M-t-O: 11 to 115 (280 to 2920)
Straightness Tolerance Major axis in./ft (cm/m): Minor axis in./ft (cm/m):	 0.062 (0.52) 0.062 (0.52)	 0.062 (0.52) 0.062 (0.52)
No-Heat Length	1 in. min., 12 in. max. (25/305 mm)	1 in. min., 12 in. max. (25/305 mm)
Max. Voltage—Amperage **Max. Hipotential** **Max. Current Leakage Per Coil (cold)** **Max. Amperage Per Coil** **Phase(s)** **Resistance Coils**	240VAC—48A 1480VAC 3mA 16A 1-ph parallel/series, 3-ph delta/wye 3 or 2	240VAC—32A 1480VAC 3mA 16A 1-ph parallel/series 2
Ohms/In./Unit① **Ohms/In./Coil①**	0.270Ω min.—2.833Ω max. 0.080Ω min.—8.500Ω max. per coil	0.040Ω min.—4.250Ω max. 0.080Ω min.—8.500Ω max. per coil
Terminations	Flexible lead wires Quick connect (spade) Screw lug (plate) Threaded stud	Flexible lead wires Quick connect (spade) Screw lug (plate) Threaded stud
Seals	Standard: Lavacone 221°F (105°C) M-t-O: Ceramic base 2800°F (1535°C) Silicone rubber 392°F (200°C) Lavacone 221°F (105°C) Epoxy resin 266/356°F (130/180°C)	Standard: Lavacone 221°F (105°C) M-t-O: Ceramic base 2800°F (1535°C) Silicone rubber 392°F (200°C) Lavacone 221°F (105°C) Epoxy resin 266/356°F (130/180°C)
Min. Axis Bending Radius in. (mm) (Do not field bend)	Major: 1 (25) Minor: ½ (13) 90° bend Minor: 5/32 (4) 180° bend	Major: ¾ (19) Minor: ½ (13) 90° bend Minor: 5/32 (4) 180° bend
Mounting Options	Brackets (Type 1, 2 and 3) Threaded bulkhead or fitting	Brackets (Type 1, 2 and 3) Threaded bulkhead or fitting
Surface Finish Options	Bright anneal, passivation	Bright anneal, passivation
Agency Recognition	UL® component recognition to 240VAC (File # E52951) CSA component recognition to 240VAC (File # 31388)	UL® component recognition to 240VAC (File # E52951) CSA component recognition to 240VAC (File # 31388)

① Resistance values valid for three coil 1 in. (25 mm) FIREBAR only.

FIREBAR Single-Ended Heaters

Specifications *(Continued)*

	One Inch Single-Ended FIREBAR 	⅝ Inch Single-Ended FIREBAR 
Applications	Clamp-on; hoppers, griddles Forced or convection air heating (Also see FINBAR, page 103)	Clamp-on; hoppers, griddles Forced or convection air heating
Watt Density W/in² (W/cm²)	Standard: up to 40 (6.2) M-t-O: up to 60 (9.3)	Standard: up to 20 (3.1) M-t-O: up to 60 (12.4)
Surface Area Per Linear In. (cm)	2.3 in² (14.8 cm²)	1.52 in² (9.80 cm²)
Cross Section Height ± 0.015/0.010 in. (0.381/0.254 mm) Thickness ± 0.005/0.001 in. (0.127/0.025 mm)	 1.010 (25.7) 0.235 (5.9)	 0.650 (16.5) 0.235 (5.9)
Sheath Material—Max. Operating temperature	Standard: 304 SS 1200°F (650°C) M-t-O: Alloy 800 1400°F (760°C) 304 SS 1200°F (650°C)	Standard: Alloy 840 1400°F (760°C) M-t-O: Alloy 840 1400°F (760°C) 304 SS 1200°F (650°C)
Sheath Length in. (mm)	Standard: 11 to 46¼ (280 to 1175) M-t-O: 11 to 120 (280 to 3048)	Standard: 11½ to 52 (280 to 1321) M-t-O: 11 to 116 (280 to 2946)
Straightness Tolerance Major axis in./foot (cm/m): Minor axis in./foot (cm/m):	 0.062 (0.52) 0.062 (0.52)	 0.062 (0.52) 0.062 (0.52)
No-Heat Length Top cold end Bottom (blunt end) cold end	 1 in. min., 12 in. max. (25/305 mm) 1 ph- 0.5 min., 2 in. max. (13/51 mm) 3 ph- 0.75 min., 2 in. max. (19/51 mm)	 1 in. min., 12 in. max. (25/305 mm) Only available at 1.25 in. N/A
Max. Voltage—Amperage **Max. Hipotential** **Max. Current Leakage (cold)** **Max. Amperage Per Coil** **Phase(s)** **Resistance Coils**	240VAC—48A 1480VAC 3mA 16A 1-ph, 3-ph wye 3 or 1	240VAC—16A 1480VAC 3mA 16A 1-ph 1
Ohms/In./Unit	0.200Ω min.—14.00Ω max. ①	0.200Ω min.—14.00Ω max. ①
Terminations	Flexible lead wires Threaded stud Quick connect (spade) Screw lug (plate)	Flexible lead wires Quick connect (spade) Screw lug (plate)
Seals	Standard: Lavacone 221°F (105°C) M-t-O: Ceramic base 2800°F (1535°C) Silicone rubber 392°F (200°C) Lavacone 221°F (105°C) Epoxy resin 266/356°F (130/180°C)	Standard: Lavacone 221°F (105°C) M-t-O: Ceramic base 2800°F (1535°C) Silicone rubber 392°F (200°C) Lavacone 221°F (105°C) Epoxy resin 266/356°F (130/180°C)
Min. Axis Bending Radius in. (mm) (Do not field bend)	Major: 1 (25) Minor: ½ (13) 90° bend Minor: 5/32 (4) 180° bend	Major: ¾ (19) Minor: ½ (13) 90° bend Minor: 5/32 (4) 180° bend
Mounting Options	Bracket (Type 2) Threaded bulkhead	Bracket (Type 2) Threaded bulkhead
Surface Finish Options	Bright anneal	Bright anneal
Optional Internal Thermocouple	—	—
Single-end Configuration	Standard: Slotted M-t-O: Slotted, sealed or welded	Standard: Slotted M-t-O: Slotted, sealed or welded
Agency Recognition	UL® component recognition to 240VAC (File # E52951) CSA component recognition to 240VAC (File # 31388)	UL® component recognition to 240VAC (File # E52951) CSA component recognition to 240VAC (File # 31388)

① Based on 1-phase, single voltage heater.

FIREBAR Single/Double-Ended Heaters

Features and Benefits

One Inch Features and Benefits

Double-Ended

Streamline, 0.235 x 1.010 in. (5.9 x 25.6 mm) normal to flow dimension
- Reduces drag

70 percent greater surface area per linear inch compared to a 0.430 in. (11 mm) diameter round tubular heater
- Reduces watt density or packs more kilowatts in smaller bundles

Compacted MgO insulation
- Maximizes thermal conductivity and dielectric strength

Nickel-chromium resistance wires
- Precision wound

0.040 in. (1 mm) thick MgO walls
- Transfers heat more efficiently away from the resistance wire to the sheath and media—conducts heat out of the element faster

Three resistance coil design
- Configurable to either one- or three-phase power, readily adapts to a variety of electrical sources and wattage outputs

Lavacone seals
- Provides protection against humid storage conditions, moisture retardant to 221°F (105°C)

Single-Ended

Single-ended termination
- Simplifies wiring and installation

Streamline, 0.235 x 1.010 in. (5.9 x 25.6 mm) normal to flow dimension
- Reduces drag

70 percent greater surface area per linear inch
- Reduces watt density from that of the 0.430 in. (11 mm) diameter round tubular

Slotted end
- Provides installation ease in clamp-on applications

Lavacone seals
- Provides protection against humid storage conditions, moisture retardant to 221°F (105°C)

5/8 inch Features and Benefits

Double-Ended

Special sheath dimensions, 0.235 x 0.650 in. (5.9 x 16.5 mm)
- Results in a lower profile heater

10 percent greater surface area per linear inch
- Reduces watt density from that of the 0.430 in. (11 mm) diameter round tubular heater

0.040 in. (1 mm) thick MgO walls
- Transfers heat efficiently away from the resistance wire to the heated media—conducts heat out of the element faster

Lavacone seals
- Provides protection against humid storage conditions, moisture retardant to 221°F (105°C)

Single-Ended

Single-ended termination
- Simplifies wiring and installation

Special sheath dimensions, 0.235 x 0.650 in. (5.9 x 16.5 mm)
- Results in a lower profile heater for more wattage in a smaller package

Slotted end
- Provides installation ease in clamp-on applications

Lavacone seals
- Provides protection against humid storage conditions, moisture retardant to 221°F (105°C)

FIREBAR Single/Double-Ended Heaters

Performance Features

FIREBAR's flat tubular element geometry produces performance features and benefits not possible with traditional round tubular technology. The following describes how and why the FIREBAR is functionally superior for many applications—especially those requiring large wattage with low watt density.

By using the FIREBAR element it will:

- Lower the element's watt density
- Reduce element size and keep the same watt density
- Increase element life by reducing sheath temperature

Flat Shape Produces Lower Sheath Temperature

The FIREBAR element operates at a lower sheath temperature than a round tubular element of equal watt density because of three factors.

1. Flat Surface Geometry

FIREBAR's flat, vertical geometry is streamline. The liquid's flow past the heating element's surface is not impaired by back eddies inherent in the round tubular shape. The FIREBAR's streamline shape results in fluids flowing more freely with more heat carried away from the sheath.

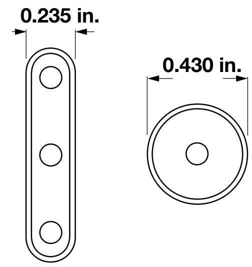
2. Normal to the Flow

The element's width (thickness) of both 1 inch and 5/8 inch FIREBAR elements is just 0.235 in. (5.9 mm). Compared to a 0.430 in. (11 mm) round tubular element, this relative thinness further reduces drag on liquids or gases flowing past the heater.

3. Buoyancy Force

The FIREBAR element's boundary layer, or vertical side, is greater than virtually all round tubular elements. This is 1.010 and 0.650 in. (25.6 and 16.5 mm) for the one inch and 5/8 in. FIREBARs respectively, compared to a 0.430 in. (11 mm) diameter on a round tubular element. The FIREBAR element's increased height, relative to flow, increases the buoyancy force in viscous liquids. This buoyancy force can be as much as 10 times greater depending on the FIREBAR element and liquid used.

Comparative Widths



Watt Density and Surface Area Advantages

The surface area per linear inch of a 1 in. FIREBAR is 70 percent greater than the 0.430 in. (11 mm) diameter round tubular element. The 5/8 in. FIREBAR is nearly 10 percent greater.

Element Type	Surface Area Per Linear Inch (cm) in^2	(cm^2)
1 in. FIREBAR	2.30 in^2	(5.84 cm^2)
5/8 in. FIREBAR	1.52 in^2	(3.86 cm^2)
0.430 in. Round	1.35 in^2	(3.43 cm^2)

Flat vs. Round Geometry Comparisons

The unique flat surface geometry of the FIREBAR element offers more versatility in solving heater problems than the conventional round tubular element. The following comparisons show how the FIREBAR element consistently outperforms round tubular heaters. FIREBAR elements can:

- Reduce coking and fluid degrading
- Increase heater power within application space parameters
- Provide superior heat transfer in clamp-on applications resulting from greater surface area contact
- Lower watt density

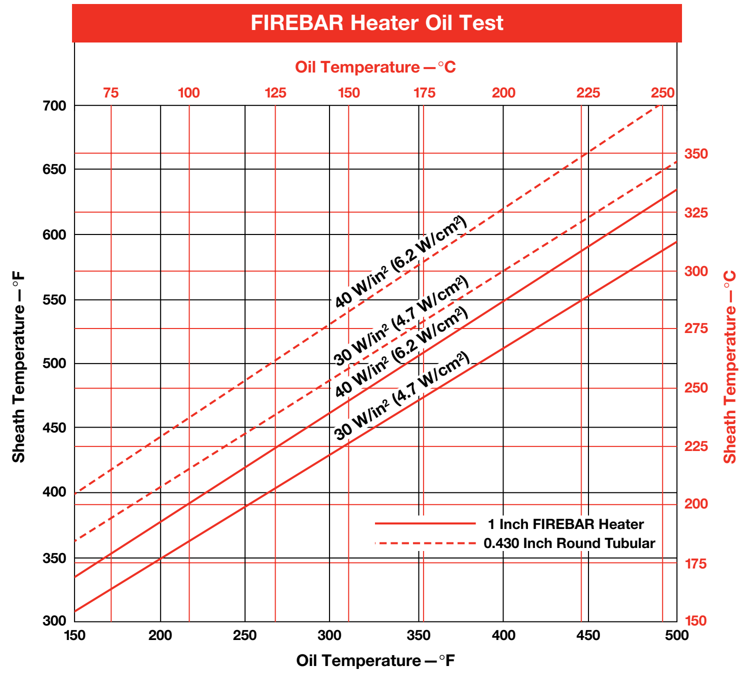
Reducing watt density or sheath temperature extends life. The FIREBAR element allows you to do either, without sacrificing equipment performance … as is proven by the accompanying *Heater Oil Test, Air Flow and Watt Density vs. Sheath Temperature* graphs.

FIREBAR Single/Double-Ended Heaters

Technical Data

The *FIREBAR Heater Oil Test* graph compares sheath temperatures of 40 W/in^2 (6.7 W/cm^2) flat and round tubular elements. The FIREBAR element consistently operates at a lower sheath temperature than the round tubular element, even when light oils are tested at different temperatures. This reduces the chance that coking and fluid degradation will occur.

In fact, the FIREBAR element's sheath temperature at 40 W/in^2 (6.7 W/cm^2) is lower than a 30 W/in^2 (4.6 W/cm^2) round tubular element.



Heater Size and Power

The *Heater Size Comparison* chart shows, at the same wattage and watt density, the FIREBAR element is 38 percent shorter than a 0.430 in. (11 mm) round tubular element. The FIREBAR element requires less space in application and equipment designs.

Heater Size Comparison

Element	Heated Length in.	(mm)	Wattage	W/in^2	(W/cm^2)
1 in. FIREBAR Element	19$^7/_8$	(504.8)	1000	23	(3.6)
0.430 in. Round Tubular Element	32$^1/_4$	(819.0)	1000	23	(3.6)

The *Heater Power Comparison* chart demonstrates equal watt density, element length and increased total wattage for the FIREBAR element. The power in the FIREBAR element is 70 percent greater.

Heater Power Comparison

Element	Heated Length in.	(mm)	Wattage	W/in^2	(W/cm^2)
1 in. FIREBAR Element	32$^1/_4$	(819.0)	1700	23	(3.6)
0.430 in. Round Tubular Element	32$^1/_4$	(819.0)	1000	23	(3.6)

FIREBAR Single/Double-Ended Heaters

Technical Data (Continued)

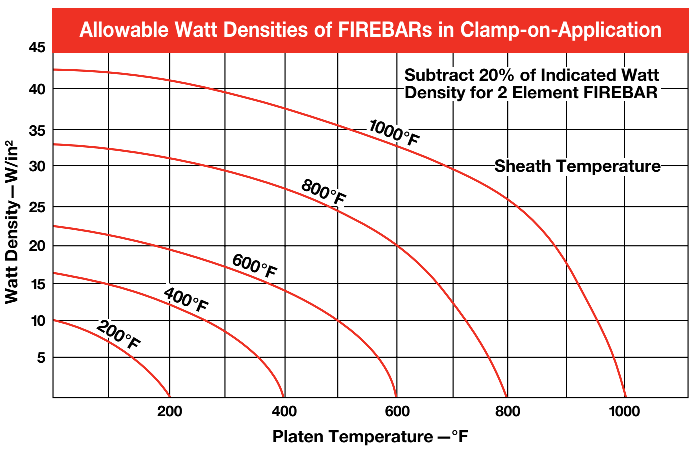
Clamp-On Applications

Direct immersion in the liquid may not always be practical. In these instances the FIREBAR element can be clamped to a tank wall. Heat from the FIREBAR is conducted to the tank wall and into the media.

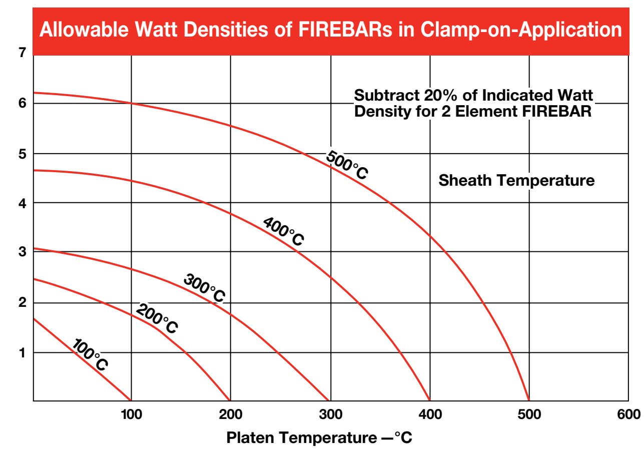
FIREBAR elements are also economical platen heaters. The *Platen Heating* graph shows FIREBAR's large, flat surface area allowing it to operate at twice the watt density of round tubular elements … without sacrificing heater life.

Clamps should be placed approximately 6 in. (150 mm) apart and torqued down with 60 in.-lbs (6.8 Newton meters).

Platen Heating (°F)

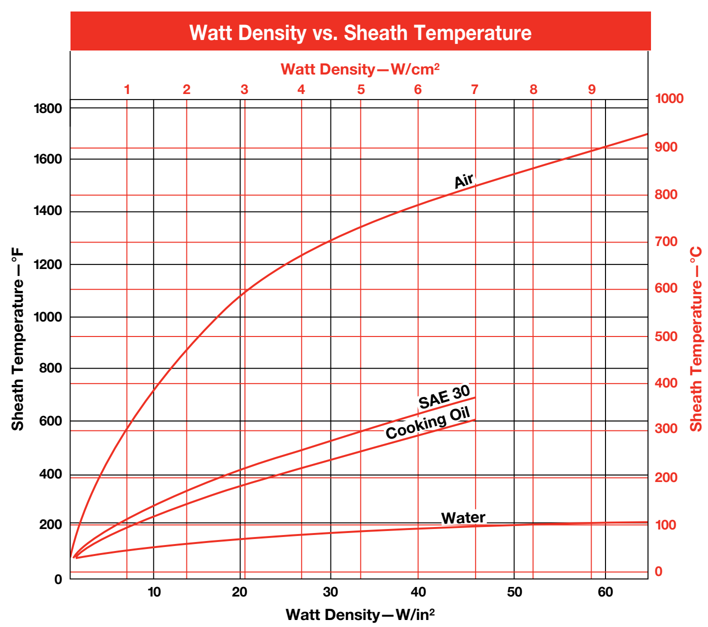


Platen Heating (°C)



Watt Density vs. Sheath Temperature

The *Watt Density vs. Sheath Temperature* graph features sheath temperature curves for commonly heated substances. A FIREBAR element's watt density will result in the sheath temperature shown at the intersecting point of its vertical watt density line and substance curve.



FIREBAR Single/Double-Ended Heaters

Technical Data (Continued)

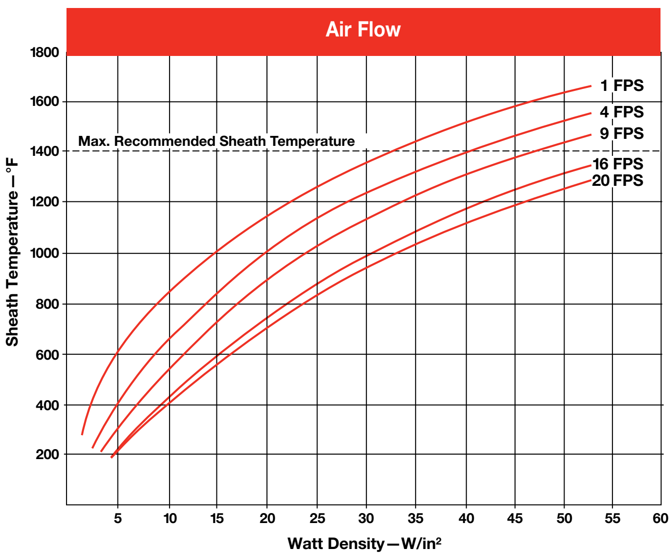
Air Heating

The Air *Flow/Watt Density/Sheath Temperature* graph shows the relationship between air flow, watt density and sheath temperature. Keep in mind that lower sheath temperature yields longer heater life.

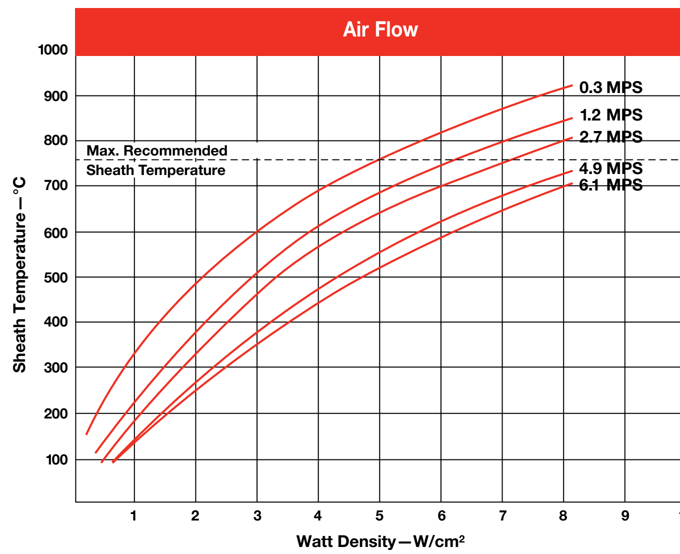
To use the *Air Flow* graph, determine the air flow in feet per second (or meters per second). Then follow the curve to find the recommended sheath temperature and watt density.

Air Flow Normal to Sheath Geometry

Air Flow/Watt Density/Sheath Temperature (°F)



Air Flow/Watt Density/Sheath Temperature (°C)



Moisture Resistant Seals

A lavacone seal is provided to prevent moisture and contaminants from entering the heater. Upon request, optional silicone rubber (RTV) and epoxy resin seals may be ordered.

Silicone Rubber (RTV) Seal

Silicone rubber RTV seals are $^1/_8$ in. (3.2 mm) moisture barriers surrounding the terminal pins at the end of the sheath. Silicone rubber is effective to 392°F (200°C).

Epoxy Resin Seal

Epoxy resin seals are $^1/_8$ in. (3.2 mm) moisture barriers surrounding the terminal pins at the end of the sheath. Epoxy resin is effective to 194°F (90°C) or 356°F (180°C), and recommended for water heating applications.

Application Hints

- Choose a FIREBAR heating element instead of an assembly when the application requires lower wattages or smaller system packages.
- Keep terminations clean, dry and tight.
- Extend the heated section completely into the media being heated at all times to maximize heat transfer and heater life.
- Do not locate the end of the heated length within a bend, unless the radius is 3 in. (76 mm) or larger.
- Ensure termination temperatures do not exceed 392°F (200°C) or the maximum temperature rating of the end seal, whichever is lower.

FIREBAR Single/Double-Ended Heaters

Technical Data *(Continued)*

All FIREBAR heaters are available with a variety of termination options. Contact your Watlow representative for availability.

Terminations

Part Number*	Termination	Phase	Wiring	1 in. FIREBAR		5/8 in. FIREBAR	
				Dual-Ended	S. End/FINBAR	Dual-Ended	Single-Ended
A1	Sil-A-Blend® 200°C lead wire	1	Parallel	Yes	Yes	Yes	Yes
A2	Sil-A-Blend® 200°C lead wire	1	Series	Yes	No	Yes	No
A3	Sil-A-Blend® 200°C lead wire	3	Delta	Yes	No	No	No
A4	Sil-A-Blend® 200°C lead wire	3	Wye	Yes	Yes	No	No
B1	TGGT 250°C lead wire	1	Parallel	Yes	Yes	Yes	Yes
B2	TGGT 250°C lead wire	1	Series	Yes	No	Yes	No
B3	TGGT 250°C lead wire	3	Delta	Yes	No	No	No
B4	TGGT 250°C lead wire	3	Wye	Yes	Yes	No	No
C1	¼ in. quick connect (spade)	1	Parallel	Yes	Yes	Yes	Yes
C2	¼ in. quick connect (spade)	1	Series	Yes	No	No	No
D1	Screw lug (plate) terminal	1	Parallel	Yes	Yes	Yes	Yes
D2	Screw lug (plate) terminal	1	Series	Yes	No	No	No
D3	Screw lug (plate) terminal	3	Delta	Yes	No	No	No
E1	#10-32 stud terminal	1	Parallel	Yes	Yes	Yes	Yes
E2	#10-32 stud terminal	1	Series	Yes	No	No	No
E3	#10-32 stud terminal	3	Delta	Yes	No	No	No

Termination Code Number Legend*

A = Silicone rubber insulation (Sil-A-Blend®) with fiberglass oversleeves Rated to 392°F (200°C)

B = High-temperature TGGT insulation with fiberglass oversleeves Rated to 480°F (250°C)

C = Nickel-plated steel quick connect

D = Nickel-plated steel screw lug with ceramic insulator and plated steel screw

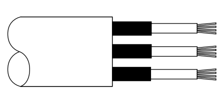
E = #10-32 nickel-plated steel threaded stud with plated steel nuts and washers

Electrical Configuration

1 = 1-phase parallel, 2 = 1-phase series, 3 = 3-phase delta, 4 = 3-phase wye

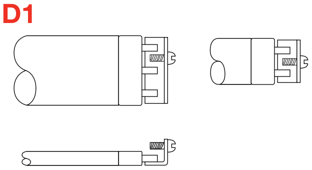
Double-End/Single-End 1 in. FIREBAR

Flexible Lead Wire①
A, B



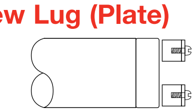
- Double-End 1 in. FIREBAR
- Single-End 1 in. FIREBAR
- FINBAR

Screw Lug (Plate)
D1



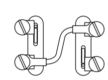
- Double-End 1 & 5/8 in. FIREBAR

Screw Lug (Plate)
D3

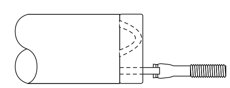


- Double-End 1 in. FIREBAR

3-phase delta wiring example

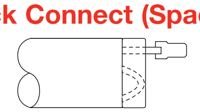


Threaded Stud
E2



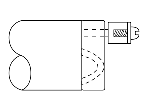
- Double-End 1 in. FIREBAR

Quick Connect (Spade)
C2



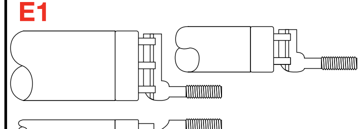
- Double-End 1 in. FIREBAR

Screw Lug (Plate)
D2



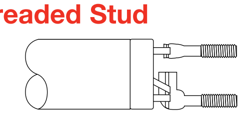
- Double-End 1 in. FIREBAR

Threaded Stud
E1



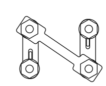
- Double-End 1 & 5/8 in. FIREBAR

Threaded Stud
E3



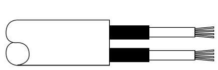
- Double-End 1 in. FIREBAR

3-phase delta wiring example



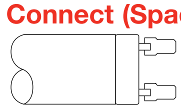
Single-End FIREBAR, Double-End/Single-End FINBAR

Flexible Lead Wire①
A, B



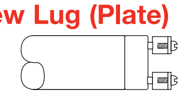
- Single-End 1 in. FIREBAR
- Double-End 5/8 in. FIREBAR
- Single-End 5/8 in. FIREBAR
- FINBAR

Quick Connect (Spade)
C1

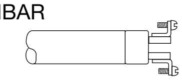


- Single-End 1 FIREBAR
- FINBAR
- Double-End 5/8 in. FIREBAR
- Single-End 5/8 in. FIREBAR

Screw Lug (Plate)
D1

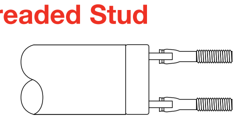


- Single-End 1 in. FIREBAR
- FINBAR



- Double-End 5/8 in. FIREBAR
- Single-End 5/8 in. FIREBAR

Threaded Stud
E1



- Single-End 1 in. FIREBAR
- FINBAR

①Flexible lead wires are 12 in. (305 mm) long unless otherwise specified.

FIREBAR Single/Double-Ended Heaters

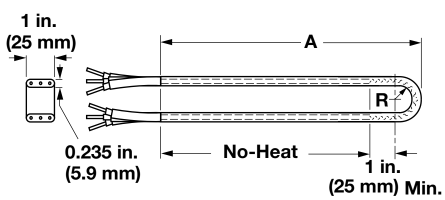
Bending

Major and Minor Axis Bending Parameters

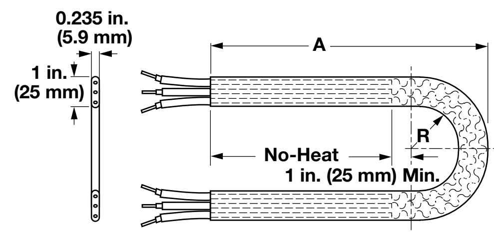
The following illustrations detail the recommended major and minor axis bend parameters for FIREBAR elements. These illustrations show the relationship between the type of bend and the location of heat and no-heat sections. See the next two pages for the 15 common bend formations.

Note: Watlow does not recommend field bending FIREBAR elements. If the element must be bent in the field, please contact your Watlow representative for assistance.

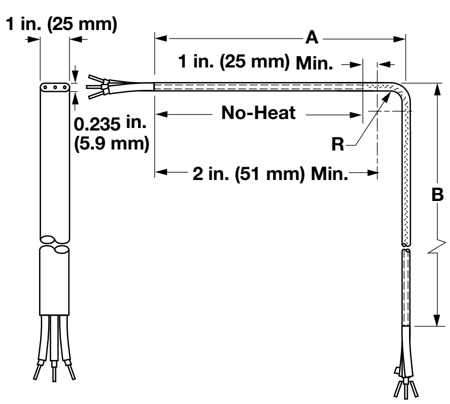
180° Minor Axis Heated Bend



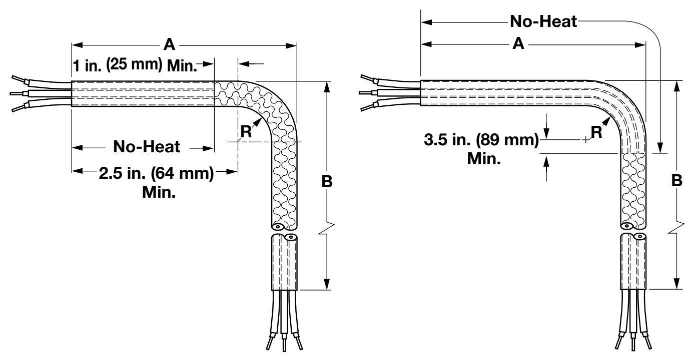
180° Major Axis Heated Bend



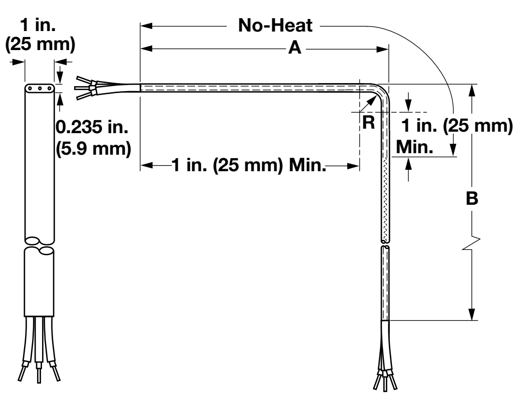
90° Minor Axis Heated Bend



90° Major Axis Heated Bend



90° Minor Axis Un-Heated Bend



180° Major Axis Bends

FIREBAR Size in.	(mm)	Radius in.	(mm)	Arc Length
5/8	(15.9)	3/4	(19.0)	3.125
5/8	(15.9)	1	(25.0)	3.900
5/8	(15.9)	1 1/4	(32.0)	4.620
5/8	(15.9)	1 1/2	(38.0)	5.600
1	(25.0)	1	(25.0)	4.335
1	(25.0)	1 1/4	(32.0)	5.121
1	(25.0)	1 1/2	(38.0)	5.906

FIREBAR Single/Double-Ended Heaters

Bend Formations

FIREBAR elements can be formed into compounds, multi-axis and multi-plane configurations from 15 common bends. Custom bending with tighter tolerances can be made to meet specific application needs.

Formation is limited by bending parameters specified in the illustrations of major and minor axis bends on the previous page. On these illustrations, please note the no-heat end location.

The no-heat end junction must be located a minimum of 1 in. (25 mm) from any bend. If these parameters are not followed, the heater may fail prematurely. Field bending not recommended.

Illustrated below are the common bends that can be ordered for all FIREBAR heating elements.

To order a common bend, specify the **figure number** and **critical dimensions**.

Note: The alpha characters and symbols are used to designate specific dimensions within each illustration.

Minor Axis	Major Axis	Minor Axis	Major Axis

Figure 1A

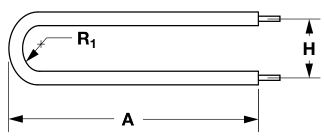


Figure 1B

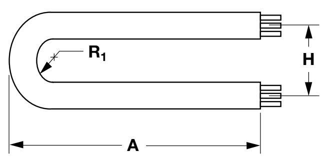


Figure 2A

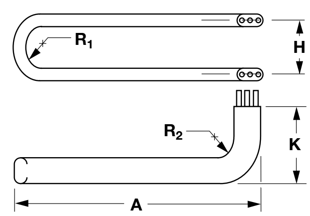


Figure 2B

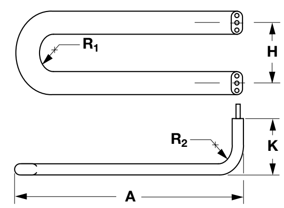


Figure 3A

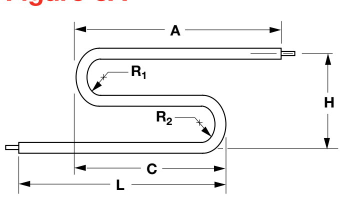


Figure 3B

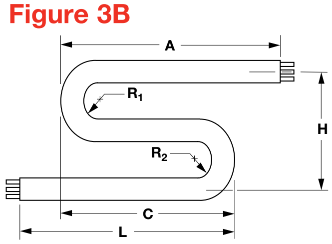


Figure 4A

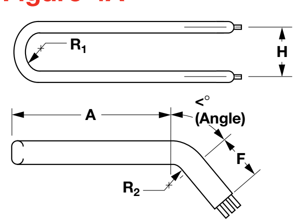


Figure 4B

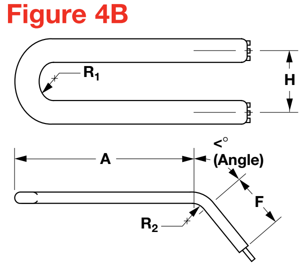


Figure 5A

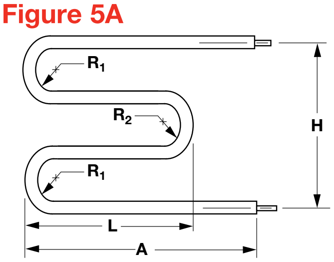


Figure 5B

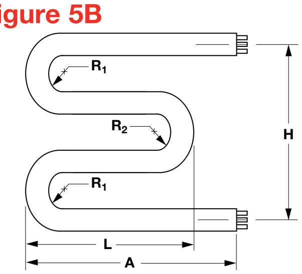


Figure 6A

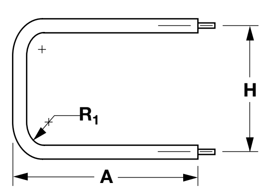


Figure 6B

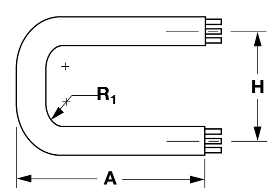


Figure 7A

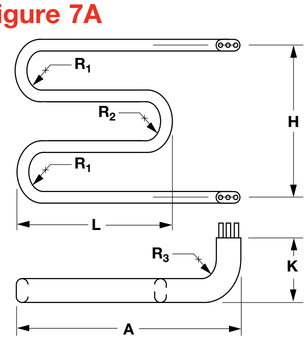


Figure 7B

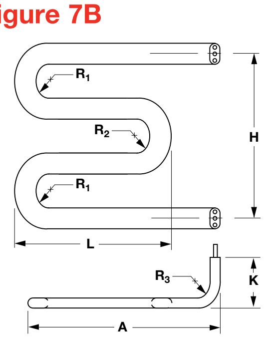


Figure 8A

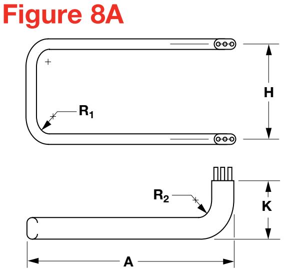
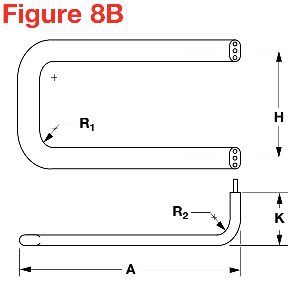


Figure 8B



FIREBAR Single/Double-Ended Heaters

Bend Formation (Continued)

Minor Axis	Major Axis	Minor Axis	Major Axis

Figure 9A (Minor Axis)

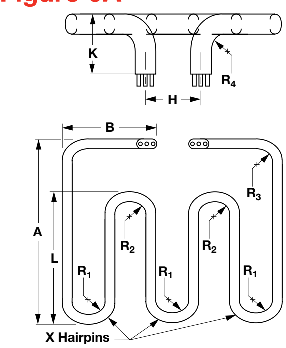


Figure 9B (Major Axis)

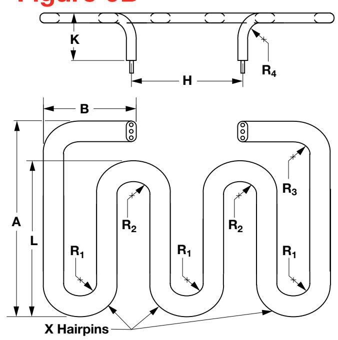
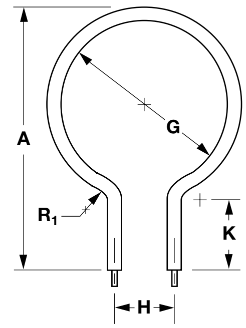
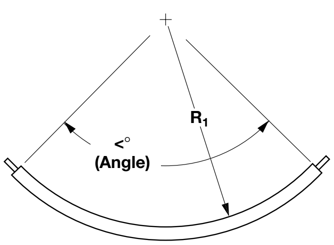


Figure 10A (Minor Axis)



Bend Figure 10B Not Available On Major Axis

Figure 11A (Minor Axis)



Bend Figure 11B Not Available On Major Axis

Figure 12A (Minor Axis)

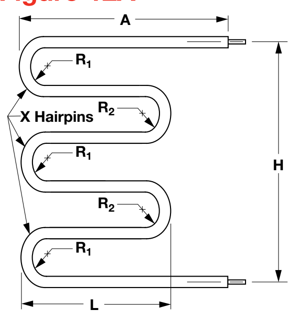


Figure 12B (Major Axis)

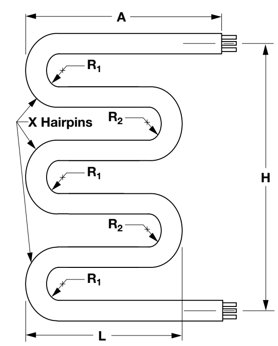


Figure 13A (Minor Axis)

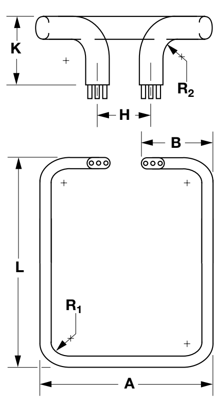


Figure 13B (Major Axis)

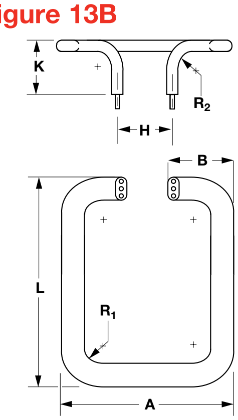


Figure 14A (Minor Axis)

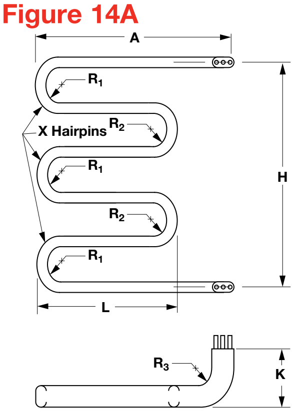


Figure 14B (Major Axis)

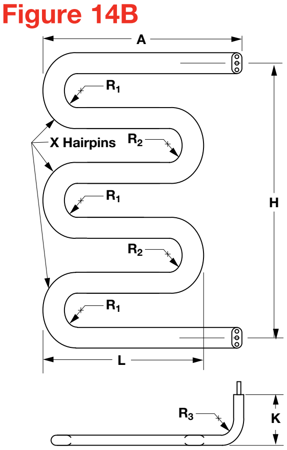


Figure 15A (Minor Axis)

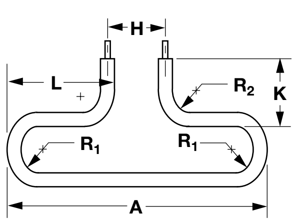
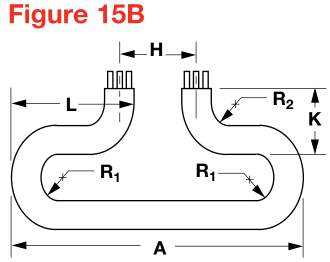


Figure 15B (Major Axis)



FIREBAR Single/Double-Ended Heaters

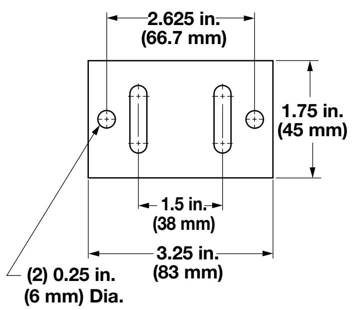
Mounting Brackets

Steel brackets provide element mounting in non-pressurized applications. In air heating applications, an 18-gauge aluminized steel bracket is tack welded to the element. A $^{1}/_{4}$ in. (6 mm) thick steel bracket is brazed or welded liquid-tight to the element for liquid heating. Upon request, stainless steel brackets can be provided. Special sizes also available.

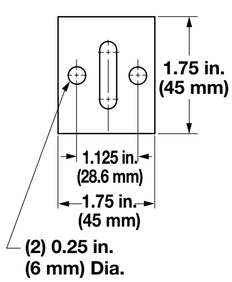
The bracket is located $^{1}/_{2}$ in. (13 mm) from the sheath's end, $^{1}/_{16}$ in. (1.6 mm) if welded. Available on $^{5}/_{8}$ in. (15.9 mm) FIREBAR as **made-to-order** only.

To order, specify **mounting bracket** as well as type, location, material and size.

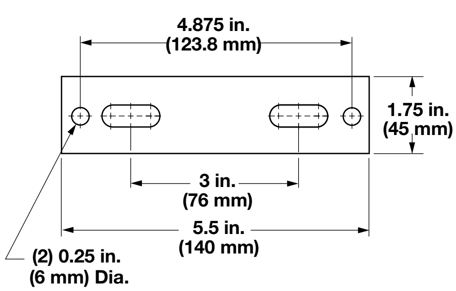
Type 1



Type 2



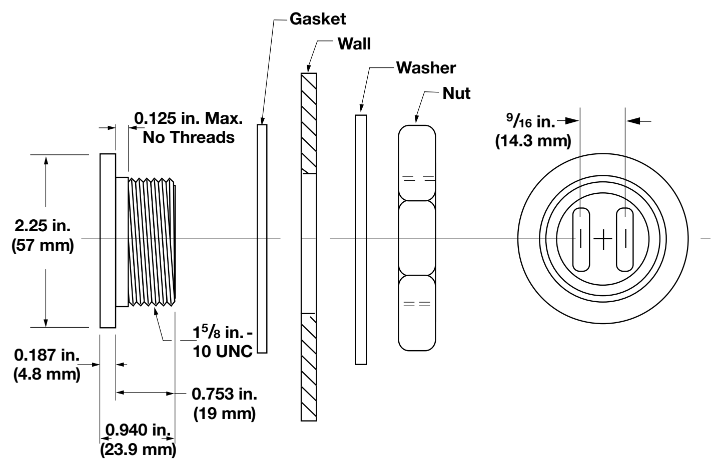
Type 3



Water-Tight Double-Leg Threaded Fitting

A threaded $1^{5}/_{8}$ in.-10 UNC stainless steel fitting with flange on the heater sheath provides rigid, leak-proof mounting through tank walls. This fitting allows both legs of the heater to pass through the same opening. A gasket, plated steel washer and hex nut are included. The threaded end of the bulkhead is mounted flush with the sheath's end, unless otherwise specified. Available on **1 inch FIREBAR only (brazed only, available)**.

To order, specify **water-tight double-leg threaded fitting**.



Surface Finish

Bright Annealing

Bright annealing is a process that produces a smooth, metallic finish. It is a special annealed finish created in a non-oxidizing atmosphere. This finish is popular in the pharmaceutical and foodservice/beverage markets.

To order, specify **bright annealing**.

Passivation

During manufacturing, particles of iron or tool steel may be embedded in the stainless steel or alloy sheath. If not removed, these particles may corrode and produce rust spots. For critical sheath applications, passivation will remove free iron from the sheath.

To order, specify **passivation**.

Extended Capabilities for FIREBAR Single/Double-Ended Heaters

EXTENDED CAPABILITY

Single Leg Threaded Bulkhead

A threaded stainless steel bushing with flange on the heater sheath provides rigid, leak-proof mounting through tank walls. A gasket, plated steel washer and hex nut are included (brazed only, available).

To order, specify **single leg threaded bulkhead**.

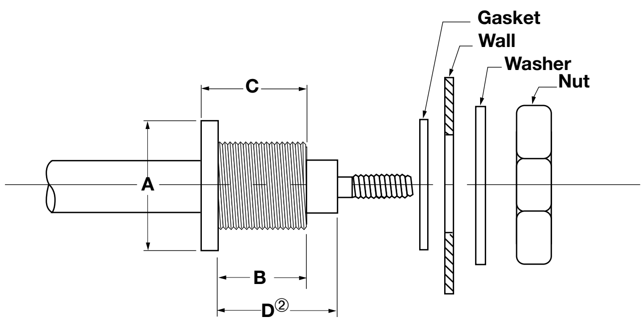


Illustration for 1-inch FIREBAR

Illustration for 5/8-inch FIREBAR

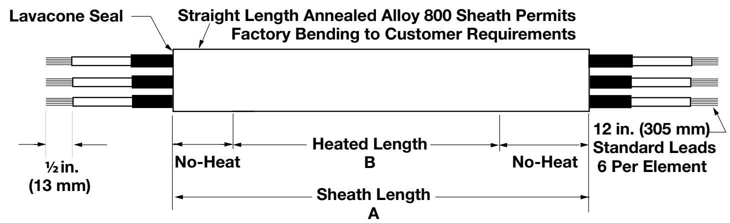
Heater Size in.	(mm)	Thread Size
5/8	(15.9)	7/8-14 UNF-2A
1	(25.0)	3/4-16 UNF-2A

Options for One-Inch and 5/8-Inch FIREBAR

- Electropolished finish
- Bulkhead, single leg
- Custom formations
- Terminal enclosures (general purpose, moisture resistant, and moisture/corrosion resistant)
- Custom wattage tolerance (±5%)

FIREBAR Single/Double-Ended Heaters

One-Inch, Double-Ended FIREBAR

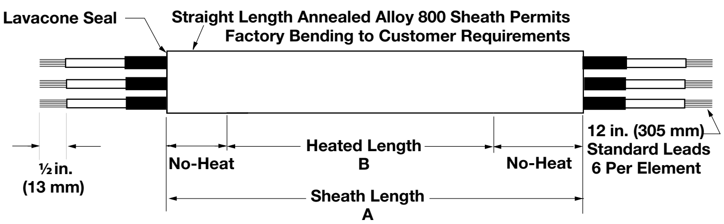


FIREBAR Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 120VAC	240VAC	Est. Net Wt. lbs	(kg)
Applications: Asphalt, Paraffin (Solid), Bunker Oil, Clamp-On									
6 W/in^2 Alloy 800 (1 W/cm^2)	35	(889)	25	(635)	310	**FBN351WD**		1.3	(0.6)
	41	(1041)	31	(787)	410	**FBN411WD**		1.5	(0.7)
	51	(1295)	41	(1041)	530	**FBN511WD**	**FBN5110WD**	1.9	(0.9)
	62	(1574)	52	(1320)	650	**FBN621WD**	**FBN6210WD**	2.3	(1.1)
	72	(1828)	62	(1574)	800	**FBN721WD**	**FBN7210WD**	2.6	(1.2)
	93	(2362)	83	(2108)	1,060	**FBN931WD**	**FBN9310WD**	3.4	(1.6)
	114	(2895)	104	(2641)	1,350	**FBN1141WD**	**FBN11410WD**	4.2	(1.9)
Applications: Griddles, Fuel Oil, Clamp-On									
10 W/in^2 Alloy 800 (1.6 W/cm^2)	25	(635)	22	(558)	500	**FBN251WL**		0.9	(0.4)
	35	(889)	32	(812)	750	**FBN351WL**	**FBN3510WL**	1.3	(0.6)
	47	(1193)	43	(1092)	1,000	**FBN471WL**	**FBN4710WL**	1.7	(0.8)
	69	(1752)	65	(1651)	1,500	**FBN691WL**	**FBN6910WL**	2.5	(1.2)
	90	(2286)	86	(2184)	2,000	**FBN901WL**	**FBN9010WL**	3.3	(1.5)
Applications: Clamp-On, Medium Weight Oils, Liquid Paraffin, Low-Temperature Ovens 400°F (205°C)									
15 W/in^2 ① Alloy 800 (2.3 W/cm^2)	29	(736)	19	(482)	670		**FBN2910WE**	1.1	(0.5)
	34	(863)	24	(609)	830		**FBN3410WE**	1.3	(0.6)
	39	(990)	29	(736)	1,000		**FBN3910WE**	1.4	(0.7)
	48	(1219)	38	(965)	1,330		**FBN4810WE**	1.8	(0.9)
	58	(1473)	48	(1219)	1,670		**FBN5810WE**	2.1	(1.0)
	68	(1727)	58	(1473)	2,000		**FBN6810WE**	2.5	(1.2)
	87	(2209)	77	(1955)	2,670		**FBN8710WE**	3.2	(1.5)
	106	(2692)	96	(2438)	3,330		**FBN10610WE**	3.9	(1.8)
Applications: Radiant, Platens, Dies, Low-Temperature Ovens 300°F (150°C)									
20 W/in^2 Alloy 800 (3.1 W/cm^2)	15	(381)	11	(279)	500	**FBN151WM**		0.6	(0.3)
	20	(508)	16	(406)	750	**FBN201WM**		0.8	(0.4)
	26	(660)	22	(558)	1,000	**FBN261WM**	**FBN2610WM**	1.0	(0.5)
	36	(914)	32	(812)	1,500	**FBN361WM**	**FBN3610WM**	1.3	(0.6)
	48	(1219)	43	(1092)	2,000	**FBN481WM**	**FBN4810WM**	1.8	(0.9)
	70	(1778)	65	(1651)	3,000		**FBN7010WM**	2.6	(1.2)
	91	(2311)	85	(2159)	4,000		**FBN9110WM**	3.3	(1.5)
Applications: Degreasing Solutions, Heat Transfer Oils									
23 W/in^2 Alloy 800 (3.6 W/cm^2)	35	(889)	25	(635)	1,250	**FBN351WT**	**FBN3510WT**	1.3	(0.6)
	41	(1041)	31	(787)	1,625	**FBN411WT**	**FBN4110WT**	1.5	(0.7)
	51	(1295)	41	(1041)	2,125	**FBN511WT**	**FBN5110WT**	1.9	(0.9)
	62	(1574)	52	(1320)	2,625	**FBN621WT**	**FBN6210WT**	2.3	(1.1)
	72	(1828)	62	(1574)	3,200	**FBN721WT**	**FBN7210WT**	2.6	(1.2)
	93	(2362)	83	(2108)	4,250	**FBN931WT**	**FBN9310WT**	3.4	(1.6)
	114	(2895)	104	(2641)	5,400	**FBN1141WT**	**FBN11410WT**	4.2	(1.9)

CONTINUED

FIREBAR Single/Double-Ended Heaters

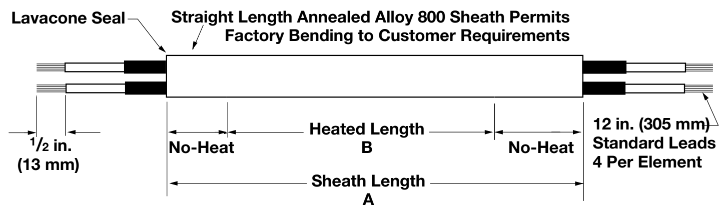
One-Inch, Double-Ended FIREBAR (Continued)



FIREBAR Description	Sheath A Dimension		Heated B Dimension		Watts	Part Number		Est. Net Wt.	
	in.	(mm)	in.	(mm)		120VAC	240VAC	lbs	(kg)
Applications: Cooking Oils, Mild Caustic Solution, Ethylene Glycol (100%)									
30 W/in^2 Alloy 800 (4.7 W/cm^2)	16	(406)	10	(254)	750	**FBN161WH**		0.6	(0.3)
	20	(508)	14	(355)	1000	**FBN201WH**		0.8	(0.4)
	27	(685)	21	(533)	1500	**FBN271WH**	**FBN2710WH**	1.0	(0.5)
	34	(863)	28	(711)	2000	**FBN341WH**	**FBN3410WH**	1.3	(0.6)
	50	(1270)	43	(1092)	3000		**FBN5010WH**	1.8	(0.9)
	64	(1625)	57	(1447)	4000		**FBN6410WH**	2.4	(1.1)
	80	(2032)	72	(1828)	5000		**FBN8010WH**	2.9	(1.4)
Applications: Process Water, Ethylene Glycol (50%)									
40 W/in^2 Alloy 800 (6.2 W/cm^2)	25	(635)	22	(558)	2000		**FBN2510WK**	0.9	(0.4)
	35	(889)	32	(812)	3000		**FBN3510WK**	1.3	(0.6)
	47	(1193)	43	(1092)	4000		**FBN4710WK**	1.7	(0.8)
	69	(1752)	65	(1651)	6000		**FBN6910WK**	2.5	(1.2)
	90	(2286)	86	(2184)	8000		**FBN9010WK**	3.3	(1.5)
45 W/in^2 Alloy 800 (7 W/cm^2)	29	(736)	19	(482)	2000		**FBN2910WP**	1.1	(0.5)
	34	(863)	24	(609)	2500		**FBN3410WP**	1.3	(0.6)
	39	(990)	29	(736)	3000		**FBN3910WP**	1.4	(0.7)
	48	(1219)	38	(965)	4000		**FBN4810WP**	1.8	(0.9)
	58	(1473)	48	(1219)	5000		**FBN5810WP**	2.1	(1.0)
	68	(1727)	58	(1473)	6000		**FBN6810WP**	2.5	(1.2)
	87	(2209)	77	(1955)	8000		**FBN8710WP**	3.2	(1.5)
	106	(2692)	96	(2438)	10,000		**FBN10610WP**	3.9	(1.8)
Applications: Clean and Potable Water									
80 W/in^2 Alloy 800 (12.4 W/cm^2)	15	(381)	11	(279)	2000		**FBN1510WJ**	0.6	(0.3)
	20	(508)	16	(406)	3000		**FBN2010WJ**	0.8	(0.4)
	26	(660)	22	(558)	4000		**FBN2610WJ**	1.0	(0.5)
	36	(914)	32	(812)	6000		**FBN3610WJ**	1.3	(0.6)
	48	(1219)	43	(1092)	8000		**FBN4810WJ**	1.8	(0.9)
	70	(1778)	65	(1651)	12,000			2.6	(1.2)
	91	(2311)	85	(2159)	16,000			3.3	(1.5)
90 W/in^2 Alloy 800 (14 W/cm^2)	35	(889)	25	(635)	5000	**FBN351WG**	**FBN3510WG**	1.3	(0.6)
	41	(1041)	31	(787)	6500	**FBN411WG**	**FBN4110WG**	1.5	(0.7)
	51	(1295)	41	(1041)	8500		**FBN5110WG**	1.9	(0.9)
	62	(1574)	52	(1320)	10,500		**FBN6210WG**	2.3	(1.1)
	72	(1828)	62	(1574)	12,750		**FBN7210WG**	2.6	(1.2)
	93	(2362)	83	(2108)	17,000			3.4	(1.6)
	114	(2895)	104	(2641)	21,500			3.4	(1.6)

FIREBAR Single/Double-Ended Heaters

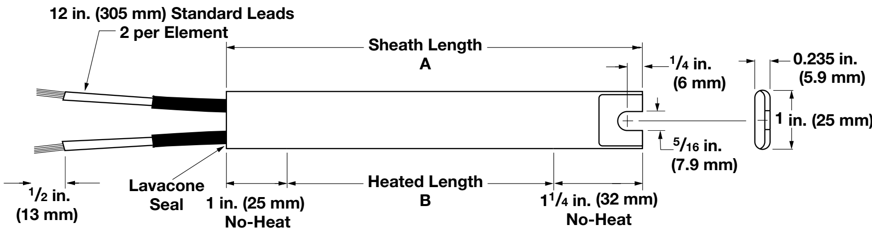
5/8-Inch Double-Ended FIREBAR



FIREBAR Description	Sheath A Dimension		Heated B Dimension		Watts	Part Number		Est. Net Wt.	
	in.	(mm)	in.	(mm)		120VAC	240VAC	lbs	(kg)
Applications: Degreasing Fluids, Heat Transfer Oils									
23 W/in^2 ①	19	(483)	11	(279)	375	**FAN191WT**		0.5	(0.3)
Alloy 840	22	(559)	14	(356)	500	**FAN221WT**	**FAN2210WT**	0.5	(0.3)
(3.6 W/cm^2)	26	(660)	18	(457)	625	**FAN261WT**	**FAN2610WT**	0.6	(0.3)
	30	(762)	22	(559)	750	**FAN301WT**	**FAN3010WT**	0.7	(0.4)
	37	(940)	29	(737)	1000	**FAN371WT**	**FAN3710WT**	0.9	(0.5)
	44	(1118)	36	(914)	1250	**FAN441WT**	**FAN4410WT**	1.0	(0.5)
	51	(1295)	43	(1092)	1500	**FAN511WT**	**FAN5110WT**	1.2	(0.6)
Applications: Clean and Potable Water									
90 W/in^2	15	(381)	7	(178)	1000	**FAN151WG**	**FAN1510WG**	0.4	(0.2)
Alloy 840	19	(483)	11	(279)	1500	**FAN191WG**	**FAN1910WG**	0.5	(0.3)
(14 W/cm^2)	22	(559)	14	(356)	2000	**FAN221WG**	**FAN2210WG**	0.5	(0.3)
	26	(660)	18	(457)	2500	**FAN261WG**	**FAN2610WG**	0.6	(0.3)
	30	(762)	22	(559)	3000	**FAN301WG**	**FAN3010WG**	0.7	(0.4)
	37	(940)	29	(737)	4000		**FAN3710WG**	0.9	(0.5)
	44	(1118)	36	(914)	5000		**FAN4410WG**	1.0	(0.5)
	51	(1295)	43	(1092)	6000		**FAN5110WG**	1.2	(0.6)

FIREBAR Single/Double-Ended Heaters

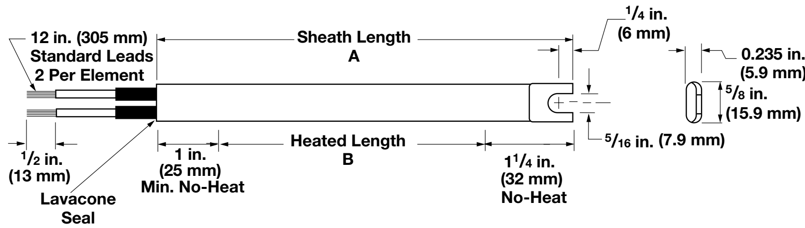
One-Inch, Single-Ended FIREBAR



FIREBAR Description	Sheath A Dimension in.	(mm)	Heated B Dimension in.	(mm)	Watts	Part Number 120VAC	Part Number 240VAC	Est. Net Wt. lbs	(kg)
Applications: Radiant, Platens, Dies, Low-Temperature Ovens 300°F (150°C)									
20 W/in^2	8 3/4	(222.0)	6 1/2	(165.0)	300	**FSP91WM**		0.4	(0.2)
304 SS	10 1/4	(260.0)	7 1/2	(203.0)	375	**FSP101WM**		0.4	(0.2)
(3.1 W/cm^2)	12 1/4	(311.0)	10	(254.0)	450	**FSP121WM**		0.5	(0.3)
	13 1/2	(343.0)	11 1/4	(286.0)	500	**FSP141WM**		0.5	(0.3)
	16 1/8	(408.6)	13 7/8	(352.4)	650	**FSP161WM**	**FSP1610WM**	0.6	(0.3)
	17 3/4	(451.0)	15 1/2	(393.0)	725	**FSP181WM**	**FSP1810WM**	0.7	(0.4)
	19 1/4	(489.0)	17	(431.0)	800	**FSP191WM**	**FSP1910WM**	0.7	(0.4)
	22	(558.0)	19 3/4	(502.0)	900	**FSP221WM**	**FSP2210WM**	0.8	(0.4)
	23 3/4	(603.0)	21 1/2	(546.0)	1,000	**FSP241WM**	**FSP2410WM**	0.9	(0.4)
	25	(635.0)	22 3/4	(578.0)	1,050	**FSP251WM**	**FSP2510WM**	0.9	(0.4)
	28 5/8	(727.1)	26 3/8	(670.0)	1,250	**FSP291WM**	**FSP2910WM**	1.1	(0.5)
	31 5/8	(803.3)	29 3/8	(746.1)	1,350	**FSP321WM**	**FSP3210WM**	1.2	(0.6)
	34 1/8	(866.8)	31 7/8	(809.6)	1,500		**FSP3410WM**	1.3	(0.6)
	36 7/8	(936.6)	34 5/8	(879.5)	1,600		**FSP3710WM**	1.4	(0.7)
	40 5/8	(1031.9)	38 3/8	(974.7)	1,800		**FSP4110WM**	1.5	(0.7)
	46 1/4	(1175.0)	44	(1117.0)	2,000		**FSP4610WM**	1.7	(0.8)
Applications: Air Heating									
40 W/in^2	8 3/4	(222.0)	6 1/2	(165.0)	600	**FSP91WK**		0.4	(0.2)
304 SS	10 1/4	(260.0)	7 1/2	(203.0)	750	**FSP101WK**		0.4	(0.2)
(6.2 W/cm^2)	12 1/4	(311.0)	10	(254.0)	900	**FSP121WK**	**FSP1210WK**	0.5	(0.3)
	13 1/2	(343.0)	11 1/4	(286.0)	1,000	**FSP131WK**	**FSP1310WK**	0.5	(0.3)
	16 1/4	(413.0)	13 7/8	(352.4)	1,300	**FSP161WK**	**FSP1610WK**	0.6	(0.3)
	17 3/4	(451.0)	15 1/2	(393.0)	1,450	**FSP181WK**	**FSP1810WK**	0.7	(0.4)
	19 1/4	(489.0)	17	(431.0)	1,600		**FSP1910WK**	0.7	(0.4)
	22	(558.0)	19 3/4	(502.0)	1,800		**FSP2210WK**	0.8	(0.4)
	23 3/4	(603.0)	21 1/2	(546.0)	2,000		**FSP2410WK**	0.9	(0.4)
	25	(635.0)	22 3/4	(578.0)	2,100		**FSP2510WK**	0.9	(0.4)
	28 5/8	(727.1)	26 3/8	(669.9)	2,500		**FSP2910WK**	1.1	(0.5)
	31 5/8	(803.2)	29 3/8	(746.1)	2,700		**FSP3210WK**	1.2	(0.6)
	34 1/8	(866.8)	31 7/8	(809.6)	3,000		**FSP3410WK**	1.3	(0.6)
	36 7/8	(936.6)	34 5/8	(879.5)	3,200		**FSP3710WK**	1.4	(0.7)
	40 5/8	(1031.9)	38 3/8	(974.7)	3,600		**FSP4110WK**	1.5	(0.7)
	46 1/4	(1175.0)	44	(1117.0)	4,000		**FSP4610WK**	1.7	(0.8)

FIREBAR Single/Double-Ended Heaters

5/8-Inch Single-Ended FIREBAR

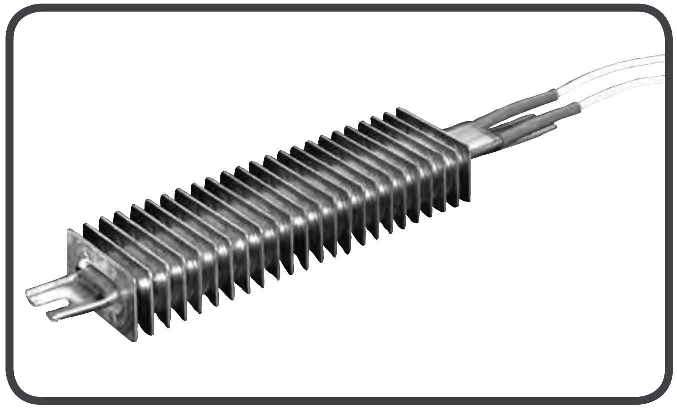


FIREBAR Description	Sheath A Dimension		Heated B Dimension		Watts	Part Number		Est. Net Weight	
	in.	(mm)	in.	(mm)		120VAC	240VAC	lbs	(kg)
Applications: Radiant, Platens, Dies, Low-Temperature Ovens 300°F (150°C)									
20 W/in^2	11 1/2	(292)	8	(203)	250	**FSA121WM**		0.3	(0.2)
Alloy 840	15 1/2	(394)	12	(304)	375	**FSA161WM**	**FSA1610WM**	0.4	(0.2)
(3.1 W/cm^2)	19 1/2	(495)	16	(406)	500	**FSA201WM**	**FSA2010WM**	0.5	(0.3)
	28	(711)	24	(609)	750	**FSA281WM**	**FSA2810WM**	0.6	(0.3)
	36	(914)	32	(812)	1,000	**FSA361WM**	**FSA3610WM**	0.8	(0.4)
	52	(1321)	48	(1219)	1,500	**FSA521WM**	**FSA5210WM**	1.2	(0.6)

FINBAR™ Single-Ended Heaters

Composed of aluminized steel fins press fitted to a one-inch single-ended FIREBAR element. The FINBAR™ is designed to improve heat transfer to the air and permits putting more power in tighter spaces—like forced air ducts, dryers, ovens and load bank resistors.

Heat transfer, lower sheath temperature and element life are all maximized by its finned construction. Installation is simplified by terminations exiting at one end and mounting accommodations on both ends.



Performance Capabilities

- Watt densities up to 50 W/in^2 (7.7 W/cm^2)
- 304 stainless steel sheath temperatures up to 1200°F (650°C)
- Voltages up to 480VAC
- Amperages up to 48 amperes per heater or 16 amperes per coil

Features and Benefits

Rugged aluminized steel fins
- Provides an increase in surface area to approximately 16 square inches for every linear inch of element length. Fins press fitted to the heating element improve heat transfer to the air

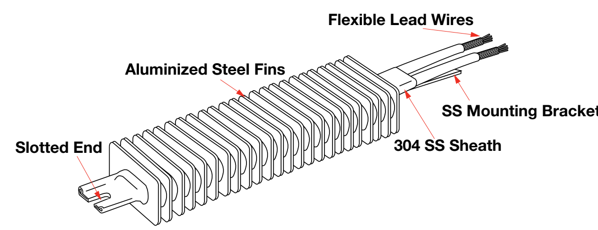
Single-ended termination
- Simplifies wiring and installation

Stainless steel mounting bracket, welded to the terminal end, supplied with a slotted end
- Allows ease of installation

Lavacone seals
- Provides protection against humid storage conditions, moisture retardant to 221°F (105°C)

Typical Applications

- Forced air heating for dryers, ovens, ducts
- Still air heating for ovens, comfort heating
- Incubators
- Ink drying
- Load bank resistors



Construction Features

Watt Density: Up to 40 W/in^2 (6.2 W/cm^2)

Fin Surface Area: 16 in^2/linear in. (40.5 cm^2/linear cm)

Fin Cross Section: 2 x 1 in. (50 x 25 mm)

Maximum Operating Temperature: Sheath material: 304 SS, 1200°F (650°C), fin material; aluminized steel; 1100°F (600°C)

Heater Length: 11 to 120 in. (280 to 3050 mm)

No-Heat Length: 1 in. (25 mm) min., 12 in. (305 mm) max.

Voltages: Up to 240VAC

Phase: 1-phase parallel or 3-phase wye

Resistance Coils: 1 or 3

Terminations: Flexible lead wires, quick connect (spade), screw lug (plate) and threaded stud

Seal Material: Lavacone, rated to 221°F (105°C)

Single-End Configuration: Slotted

FINBAR Single-Ended Heaters

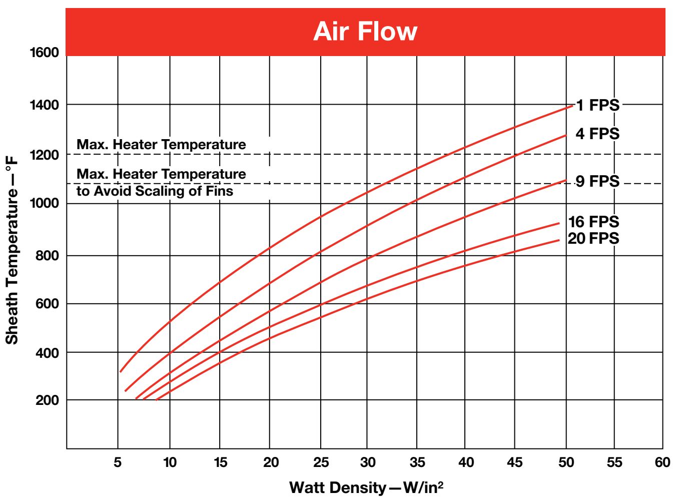
Air Heating

The *Watt Density, Air Flow and Sheath Temperature* graph shows the relationship between watt density, air flow velocity and sheath temperature, along with a recommended temperature to avoid deteriorating the fins. Be aware that **lower sheath temperature yields longer heater life**.

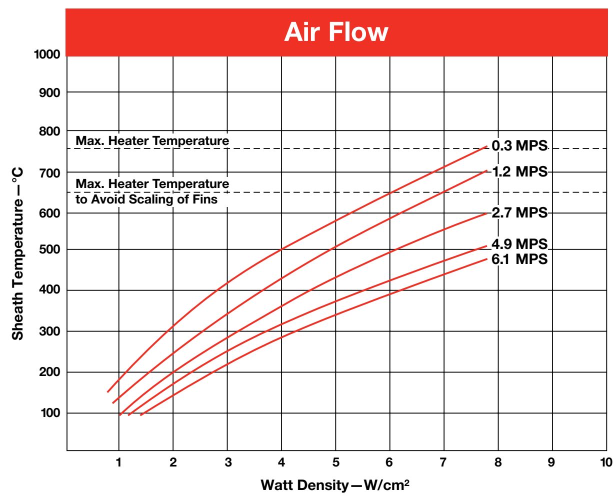
The graphic representation is based on a single-ended FINBAR, various air velocities (at 68°F/20°C inlet temperature) and different watt densities.

To determine, from the graph, the operating temperature of the FINBAR's sheath, identify the air velocity curve that approximates your application in feet per second (meters per second). Then, look at the vertical line that most closely approximates the FINBAR's watt density. From the intersecting point, read over to the temperature column to determine the sheath's operating temperature.

Watt Density, Air Flow and Sheath Temperature (°F)



Watt Density, Air Flow and Sheath Temperature (°C)



Dual Ended FINBAR

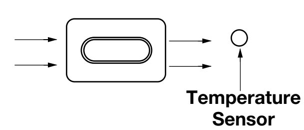
FINBAR elements are typically terminated at one end. Upon request, however, dual-ended FINBAR heaters can be ordered. To order, specify **dual-ended FINBAR** and lead length.

Application Hints

- Avoid deteriorating the fins by not exceeding the recommended maximum fin temperature of 1100°F (600°C).
- Ensure proper air flow to prevent premature heater failure.
- Locate the temperature sensor downstream from heater(s) for process temperature sensing.

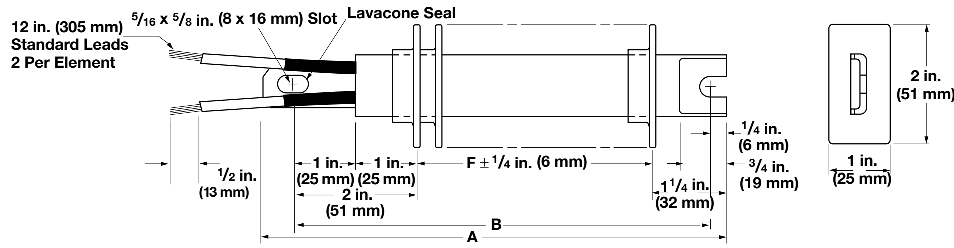
The following mounting parameters are recommended:

- Air flow over element must be parallel with the flat side.
- Element center line to element center line spacing must be a minimum of $1^1/2$ in. (38 mm).



Proper air flow relative to the heater's sheath is parallel with the longer cross sectional axis.

FINBAR Single-Ended Heaters



FINBAR Description	Overall A Dimension		Overall F Dimension		Mounting B Dimension		Watts	Part Number		Est. Net Wt.	
	in.	(mm)	in.	(mm)	in.	(mm)		120VAC	240VAC	lbs	(kg)
Application: Forced Air											
20 W/in² 304 SS (3.1 W/cm²)	10 1/4	(260.0)	6 1/2	(158.0)	9 1/2	(241.0)	300	**FSP91WMF**		1.4	(0.7)
	11 3/4	(298.0)	8	(203.0)	11	(279.0)	375	**FSP101WMF**		1.4	(0.7)
	13 3/4	(349.0)	10	(254.0)	13	(330.0)	450	**FSP121WMF**		1.5	(0.7)
	15	(381.0)	11 1/4	(285.0)	14 1/4	(362.0)	500	**FSP141WMF**		1.5	(0.7)
	17 5/8	(447.7)	13 7/8	(352.4)	16 7/8	(428.6)	650	**FSP161WMF**	**FSP1610WMF**	1.6	(0.8)
	19 1/4	(489.0)	15 1/2	(393.0)	18 1/2	(469.0)	725	**FSP181WMF**	**FSP1810WMF**	1.7	(0.8)
	20 3/4	(527.0)	17	(431.0)	20	(508.0)	800	**FSP191WMF**	**FSP1910WMF**	1.7	(0.8)
	23 1/2	(597.0)	19 3/4	(501.0)	22 3/4	(577.0)	900	**FSP221WMF**	**FSP2210WMF**	1.8	(0.9)
	25 1/4	(641.0)	21 1/2	(546.0)	24 1/2	(622.0)	1000	**FSP241WMF**	**FSP2410WMF**	1.9	(0.9)
	26 1/2	(673.0)	22 3/4	(577.0)	25 3/4	(654.0)	1050	**FSP251WMF**	**FSP2510WMF**	1.9	(0.9)
	30 1/8	(765.2)	26 3/8	(669.9)	29 3/8	(746.1)	1250	**FSP291WMF**	**FSP2910WMF**	2.1	(1.0)
	33 1/8	(841.4)	29 3/8	(746.1)	32 3/8	(822.3)	1350	**FSP321WMF**	**FSP3210WMF**	2.2	(1.0)
	35 5/8	(904.9)	31 7/8	(809.6)	34 7/8	(885.8)	1500		**FSP3410WMF**	2.3	(1.1)
	38 3/8	(974.7)	34 5/8	(879.5)	37 5/8	(955.7)	1600		**FSP3710WMF**	2.4	(1.1)
	42 1/8	(1070.0)	38 3/8	(974.7)	41 3/8	(1051.0)	1800		**FSP4110WMF**	2.5	(1.2)
	47 3/4	(1213.0)	44	(1117.0)	47	(1193.0)	2000		**FSP4610WMF**	2.7	(1.3)
40 W/in² 304 SS (6.2 W/cm²)	10 1/4	(260.0)	6 1/2	(158.0)	9 1/2	(241.0)	600	**FSP91WKF**		1.4	(0.7)
	11 3/4	(298.0)	8	(203.0)	11	(279.0)	750	**FSP101WKF**		1.4	(0.7)
	13 3/4	(349.0)	10	(254.0)	13	(330.0)	900	**FSP121WKF**	**FSP1210WKF**	1.5	(0.7)
	15	(381.0)	11 1/4	(285.0)	14 1/4	(362.0)	1000	**FSP131WKF**	**FSP1310WKF**	1.5	(0.7)
	17 5/8	(447.7)	13 7/8	(352.4)	16 7/8	(428.6)	1300	**FSP161WKF**	**FSP1610WKF**	1.6	(0.8)
	19 1/4	(489.0)	15 1/2	(393.0)	18 1/2	(469.0)	1450	**FSP181WKF**	**FSP1810WKF**	1.7	(0.8)
	20 3/4	(527.0)	17	(431.0)	20	(508.0)	1600		**FSP1910WKF**	1.7	(0.8)
	23 1/2	(597.0)	19 3/4	(501.0)	22 3/4	(577.0)	1800		**FSP2210WKF**	1.8	(0.9)
	25 1/4	(641.0)	21 1/2	(546.0)	24 1/2	(622.0)	2000		**FSP2410WKF**	1.9	(0.9)
	26 1/2	(673.0)	22 3/4	(577.0)	25 3/4	(654.0)	2100		**FSP2510WKF**	1.9	(0.9)
	30 1/8	(765.2)	26 3/8	(669.9)	29 3/8	(746.1)	2500		**FSP2910WKF**	2.1	(1.0)
	33 1/8	(841.4)	29 3/8	(746.1)	32 3/8	(822.3)	2700		**FSP3210WKF**	2.2	(1.0)
	35 5/8	(904.9)	31 7/8	(809.6)	34 7/8	(885.8)	3000		**FSP3410WKF**	2.3	(1.1)
	38 3/8	(974.7)	34 5/8	(879.4)	37 5/8	(955.7)	3200		**FSP3710WKF**	2.4	(1.1)
	42 1/8	(1070.0)	38 3/8	(974.7)	41 3/8	(1050.9)	3600		**FSP4110WKF**	2.5	(1.2)
	47 3/4	(1213.0)	44	(1117.0)	47	(1193.0)	4000		**FSP4610WKF**	2.7	(1.3)