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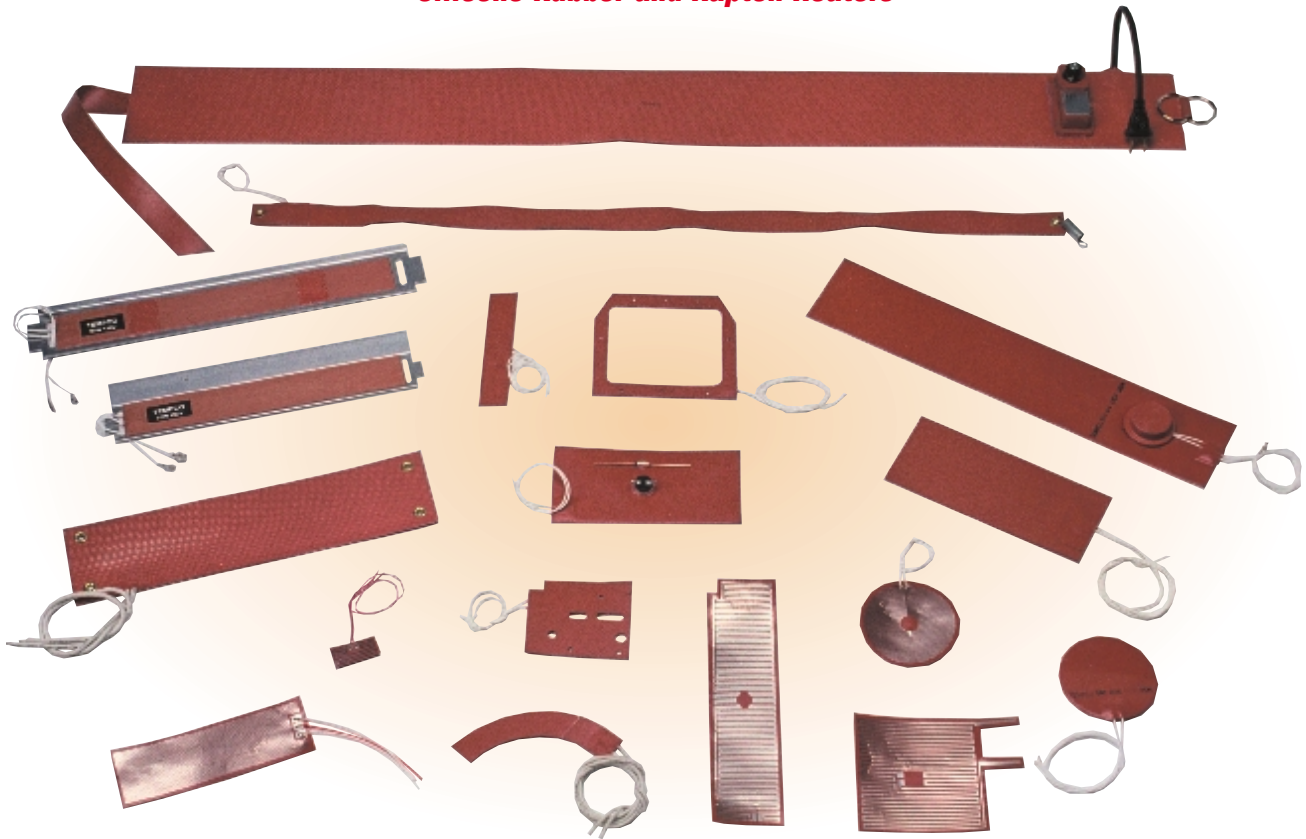


**SECTION**

# **SURFACE HEATERS**



## Silicone Rubber and Kapton Heaters



### The Answer To Hundreds of Unique Heating Applications...

**Flexible Heaters** made with Silicone Rubber or Kapton insulation provide an answer to many of the difficult heating applications in today's industry. The unique construction of Tempco's Flexible Heaters provides you with the flexibility to apply heat where you need it, without hot spotting. They can be fabricated to fit any size or shape, with holes and cutouts located in nearly any position required.

Tempco's Flexible Heaters are capable of operating with excellent performance under many adverse conditions, including: moisture, outdoor exposure or ambient temperatures, radiation, ozone, compression set, vacuum, fungus, oils, solvents, and many other chemicals.

Flexible Silicone Rubber and Kapton Heaters also have very good mechanical properties. They are of low mass construction and provide rapid heat-up due to direct bonding to the part. Flexible Heaters are not affected by mechanical shock, vibration or repeated flexing and will not stretch or tear over a temperature range of  $-392^{\circ}\text{F}$  to  $+500^{\circ}\text{F}$  ( $236^{\circ}\text{C}$  to  $+260^{\circ}\text{C}$ ).

### Choose a Flexible Heater for your specific need...

The uses of flexible heaters typically fall into the following areas: process heat, freeze protection, and condensation protection.

Tempco's engineering staff, with many years of experience in heat processing and temperature control, can assist you in designing the right Silicone Rubber or Kapton Flexible Heater for your application.

#### Typical Applications For Flexible Heaters:

- Optical Equipment
- Gyroscopes
- Copy Machines
- Vending Machines
- Medical Equipment
- Aerospace
- De-Icing
- Food Transportation
- Liquid Reservoirs
- Computer Memory Planes
- Autoclaves
- Laboratory Equipment
- Animal Feeders
- Battery Heaters/Warmers
- Drum Heaters
- Guidance Systems
- Photo Processing
- X-Ray Processing
- Food Service Equipment
- Aircraft Comfort Heaters
- Aircraft Food Service
- Graphic Arts Equipment
- Shoe Machinery
- Packaging Machinery
- Laminators
- Heated Presses
- Mirror Heaters
- Refrigeration Equipment
- Vacuum Chamber



### TECHNICAL SPECIFICATIONS

	Silicone Rubber	Kapton®
<b>Maximum Size:</b>	35" × 72" (88.9 × 183 cm)	10" × 22" (25.4 × 56.9 cm)
<b>Dimensional Tolerance:</b>		
Less than 6":	±.030" (.76 mm)	±.030" (.76 mm)
6" to 12":	±.060" (1.52 mm)	±.060" (1.52 mm)
Over 12":	±.125" (3.17 mm)	±.125" (3.17 mm)
<b>Nominal Thickness:</b>	.056" wire (1.42 mm) .030" foil (.76 mm)	.006" (.15 mm)
<b>Weight:</b>	7 oz./ft. <sup>2</sup> (.21g/cm <sup>2</sup> )	2 oz./ft. <sup>2</sup> (.06g/cm <sup>2</sup> )
<b>Maximum Operating Temperature:</b>	500°F inter. (260°C) 450°F cont. (232°C)	392°F cont. (200°C)
<b>Minimum Operating Temperature:</b>	-80°F (-62.2°C)	-320°F (-195°C)
<b>Resistance:</b>	Wire: +10%, -5% Foil: +10%, -10%	
<b>Maximum Operating Voltage:</b>	480 VAC	
<b>Dielectric Strength:</b>	1000 VAC	
<b>Standard Leads:</b>	10" Teflon® Insulated Stranded Wire	
<b>Agency Approvals:</b>	UL File #E65652 (silicone rubber only)	

### Maximum Watt Density

Use the following chart to determine the Maximum Recommended Watt Density. The graph illustrates the Maximum Recommended Watt Density at various ambient air or metal part temperatures.



The chart does not indicate the watt density required to attain a given part temperature.

### Watt Density Recommendations

<b>Soft Start Heat-Up</b>	2.5 W/in <sup>2</sup> (.388 W/cm <sup>2</sup> )
<b>General Purpose Heat-Up</b>	5 W/in <sup>2</sup> (.776 W/cm <sup>2</sup> )
<b>Rapid Purpose Heat-Up</b>	10 W/in <sup>2</sup> (2.25 W/cm <sup>2</sup> )
<b>Absolute Maximum</b>	Refer to chart

To determine the maximum recommended W/in<sup>2</sup>, divide the total watts required by the area of the heater. Refer to the chart below.

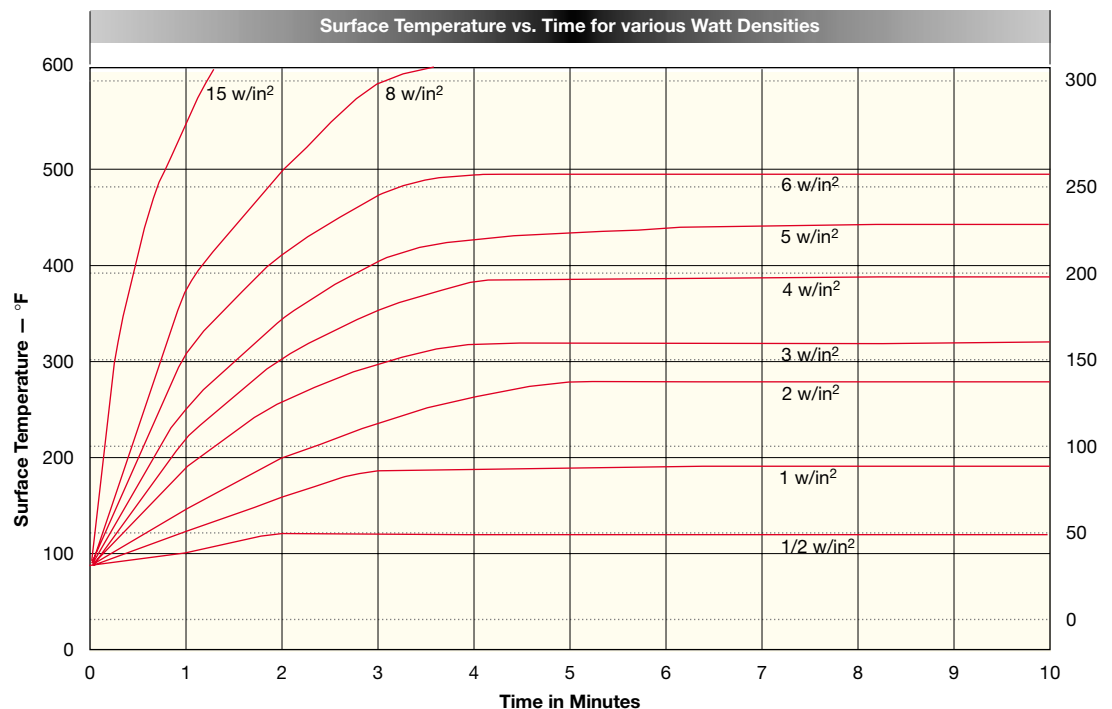
If the calculated watt density required exceeds the chart recommendations: Allow more heated surface area or reduce the total wattage.

On/off controls are generally bi-metal or bulb type thermostats. Non-cycling controls refer to electronic temperature controls. Refer to Section 13.

.....  
If you should encounter any problems in the design of a Flexible Surface Heater, contact Tempco. Our engineering staff will be glad to assist you.  
.....

Graph shows the relationship between the maximum surface temperature and the watt density of standard silicone rubber heaters.

The heater was energized in still air without insulation or a load. Using this graph the designer can estimate the maximum temperature the heater can reach compared to the watt density of the heater.





## Insulation Materials

Standard Insulating materials for Tempco's flexible heaters are Silicone Rubber and Kapton. Their application features are listed below.

### Silicone Rubber

<b>Resistant to:</b>	Moisture Ozone Fungus Radiation
<b>Temperature Range:</b>	
continuous—	-60°F to +450°F (-51.1°C to +232.2°C)
intermittent—	-80°F to +500°F (-62.22°C to +260°C)
<i>Continuously flexible over temperature range.</i>	
<b>Thickness:</b>	.018" to .070" (.46 mm to 1.78 mm)
<i>Dependent upon application</i>	

### Kapton

<b>Resistant to:</b>	Moisture Chemicals Fungus
<b>Temperature Range:</b>	
continuous—	-320°F to 392°F (-195.6°C to +200°C)
<i>Excellent dielectric strength, low outgassing in a vacuum.</i>	
<b>Ultra thin:</b>	.006" (.15 mm)



Other materials are available, such as neoprene rubber or vinyl plastic. Consult Tempco for more information.

## Element Types



**Resistance Wire Flexible Heaters** are made by first preparing the nichrome element by winding resistance wire around a fiberglass core for added strength and flexibility. The silicone rubber substrate is mounted to the pinboard with pins extending through the rubber in the desired resistance pattern. The nichrome element is then wound around the pins by hand.

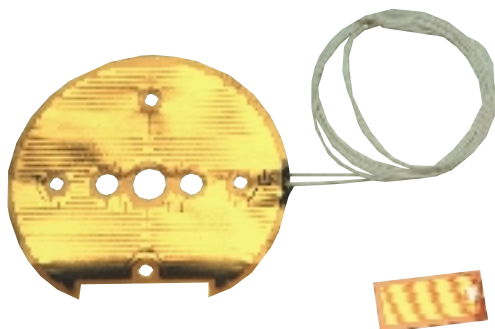
Through a vulcanization process, the assembly is cured into a homogeneous assembly of insulation material encapsulating the resistance wire. This process is used for all types of heaters except Kapton heaters.



**Etched Foil Flexible Heaters** are made with a foil material as the heating element. A thin foil element (.001") is acid etched in a pattern that will produce the required resistance.

The etched foil is then encapsulated between two layers of insulation material that is then cured under heat and pressure.

The etched foil heater has exceptional heat transfer due to its large surface area. It can also be zoned with distributed wattage to compensate for load variations.



**Wire Wound and Etched Foil Heaters** have their own specific features and selection should be based on the actual application.

Etched foil circuits can be mass produced economically and complex heating circuits can be exactly reproduced. However, there are limits in the resistances available in foils and as circuits become larger, the economies versus wire wound become less.

Small quantities are more economical in wire wound since etched foil elements require artwork in the manufacturing process. Prototypes are sometimes made first in wire before production quantities are done with foil.



### Installation Methods/Options

#### Pressure Sensitive Adhesive

For ease of installation specify PSA. PSA comes with a simple removable protective backing. It will adhere to most clean smooth surfaces.

Pressure Sensitive Adhesive is recommended for temperatures up to 350°F (177°C) and watt densities under 5 W/in<sup>2</sup> (.78 W/cm<sup>2</sup>). Care must be taken when installing to attain a smooth, consistent, uniform bond to achieve maximum ratings.

It is not recommended if heaters are to be in storage for long periods of time. Factory Applied.



#### Field Applied Adhesive

For a field applied permanent bond, a room temperature and ambient humidity curing silicone rubber adhesive is recommended. Tempco offers two types:

**RTV106** — a red paste consistency, high temperature resistant adhesive sealant.

**RTV116** — a red, pourable, high temperature resistant adhesive sealant that will flow or self level on a surface.

*Both RTV106 and RTV116 will retain physical and electrical properties up to 500°F (260°C).*

Type	Part Number	Tube Size
RTV106	SEA-102-105	9.5 ounces
RTV116	SEA-102-102	2.8 ounces



#### Factory Vulcanizing

Flexible heaters can be factory vulcanized to metal surfaces for permanent attachment and excellent heat transfer.

The uncured silicone rubber heater is placed on the customer's metal part and placed in the vacuum oven where the heater vulcanizes and adheres to the part in one operation.

This procedure forms an extremely strong permanent bond.



#### Mechanical Fasteners

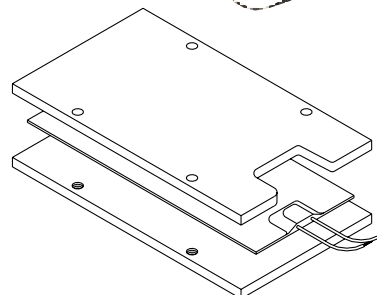
When flexible heaters must be detachable on cylindrical parts, various methods are used. Various techniques routinely used with leather goods can be used on flexible surface heaters. These would include:

- Boot Hooks
- Grommets
- Boot Hooks and Springs
- Boot Hooks and Lacing Cord
- D-Rings and Straps
- Snap Fasteners
- Velcro—hooks and loops



#### Clamping

Flexible heaters may be applied by clamping or compression between two rigid materials. Care must be taken not to damage the heater or pierce the insulation with electrically conductive objects.





## Termination Styles



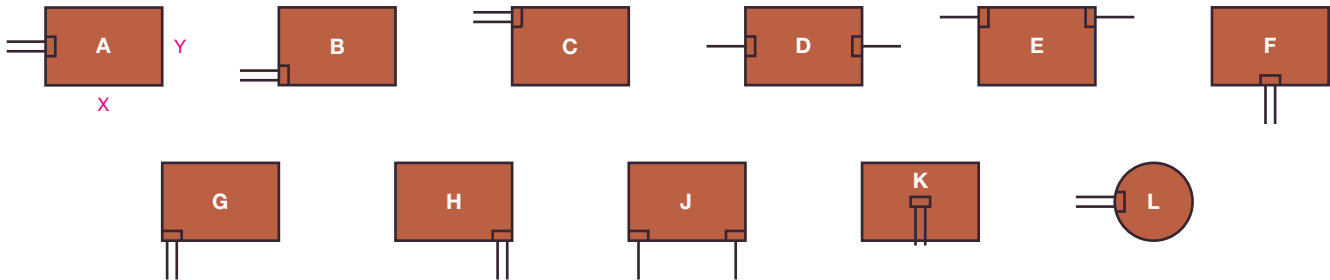
### Standard Leads

Standard leads are 10" long, Teflon® insulated, UL 1180, type EE, flexible, stranded, plated copper wire rated for 392°F (200°C) and 300 volts.

On silicone rubber heaters, the lead connections are insulated with vulcanized silicone rubber, which also acts as a strain relief.

## Lead Location Options

Standard 10" Teflon® Insulated Stranded Wire. ➤ Dimension X > Y ➤ Shows lead location only.



## Termination Options



### Silicone Rubber Leads

Insures a moisture seal on the heater. Due to the similarity in material, the heater will fuse to the leads during the vulcanization process. Silicone rubber leads are not as abrasion resistant as Teflon® leads are.

### HPN Cord and Plug Set

For portable heaters, a 6 ft. (1.83 M) neoprene cordset can be vulcanized to the heater. 18 ga./2-wire (similar to lamp cord).

### SJO Power Cord

For industrial applications, SJO heavy duty power cords can be attached to the heaters in any desired length.

### Special Leads

Special lead types and lengths in many configurations can be done by the expert designers and experienced manufacturers at **Tempco**.



### Sensors

Flexible surface heaters can be manufactured to include temperature sensors of various types internal to their construction. Sensor types include thermocouples, RTD's, thermistors, and thermal cutoffs. The sensors can be positioned on the heater to sense the part being heated or the heater temperature itself.

#### TEMPCO Custom Crafted

##### Thermocouples

Tempco can incorporate type J or K thermocouples virtually anywhere in the heater. Standard thermocouple temperature ranges apply.

##### RTD's

Tempco can also build flexible surface heaters with built-in standard platinum RTD's. The RTD's used are the DIN43760 (European) standard curve (Alpha = 0.00385) Pt 100 ohm at 0°C. The RTD's resistance increases with a rise in temperature and is considered the most accurate and stable sensor.

##### Thermistors

Tempco can include thermistor temperature sensors in flexible surface heaters. The customer will have to provide exact type, style and specifications so expected results can be produced.



##### Thermal cutoff

Also known as thermal fuses, can be used in Silicon Rubber or Kapton heaters. Thermal cutoffs are used as high limit protection devices to guard the object being heated from dangerous temperatures in the event of a primary control device failure.

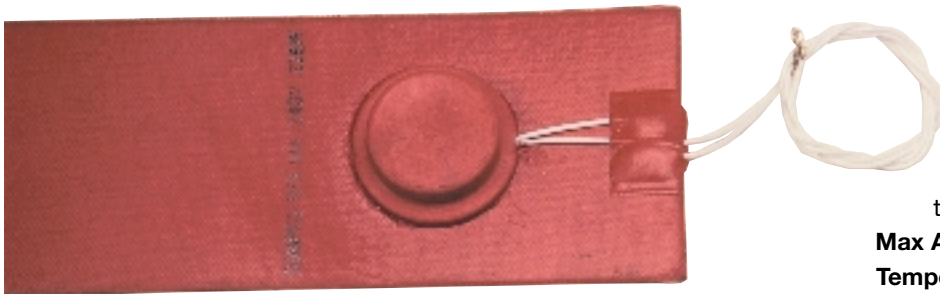
The thermal cutoff is a one-shot, non-resettable component.

**Maximum Amperage:** 20 amps

**Temperature Range:** 140° to 464°F (60° to 240°C)

*Pre-set by manufacturer at a specific temperature point*

### Thermostats



##### Pre-set

Snap action pre-set thermostats can be built in and wired directly into the silicone rubber heater. The thermostat is encapsulated in a silicone rubber overmold and vulcanized to the heater during the curing process.

**Max Amps:** 15A @ 125V 10A @ 250V

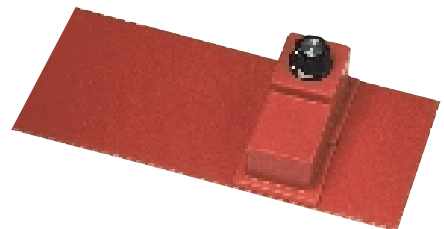
**Temperature Range:** 35° to 450°F (2° to 232°C)

##### Adjustable

Adjustable thermostats allow the user to set a specific temperature and attain a desired result. The thermostat is encapsulated in a silicon rubber overmold. The adjustment shaft extends through a pre-formed hole in the overmold. A high temperature knob is included.

**Amps:** 12.5A @ 125V 6.5 A @ 250V

**Adjustment Range:** 75° to 550°F (24° to 288°C)



# More Options for Flexible Heaters

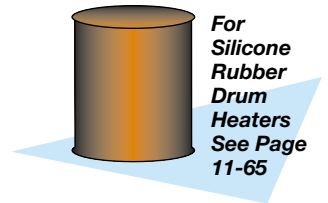


## Holes and Cutouts

Can generally be placed anywhere in the heater assembly. Holes and cut-outs can be used to allow space for bolts, nuts, temperature sensors, brackets, etc. For most holes and cutouts, a detailed drawing will be required for quoting or ordering.

## Ground Plane

For specific applications, it is mandatory that the heater is grounded. Due to the fact that the heater sheath is non-conductive, this can only be done artificially. A second layer of insulating material and a conductive grid can be added to the heater. A ground wire will be attached to the grid.



For Silicone Rubber Drum Heaters See Page 11-65

## Distributed Wattage

In order to compensate for heating losses around the edges or mounting holes, the heating circuit can be designed in a distributed wattage pattern. More wattage can be added to the high loss areas to compensate for the higher losses.

## Molded Heaters

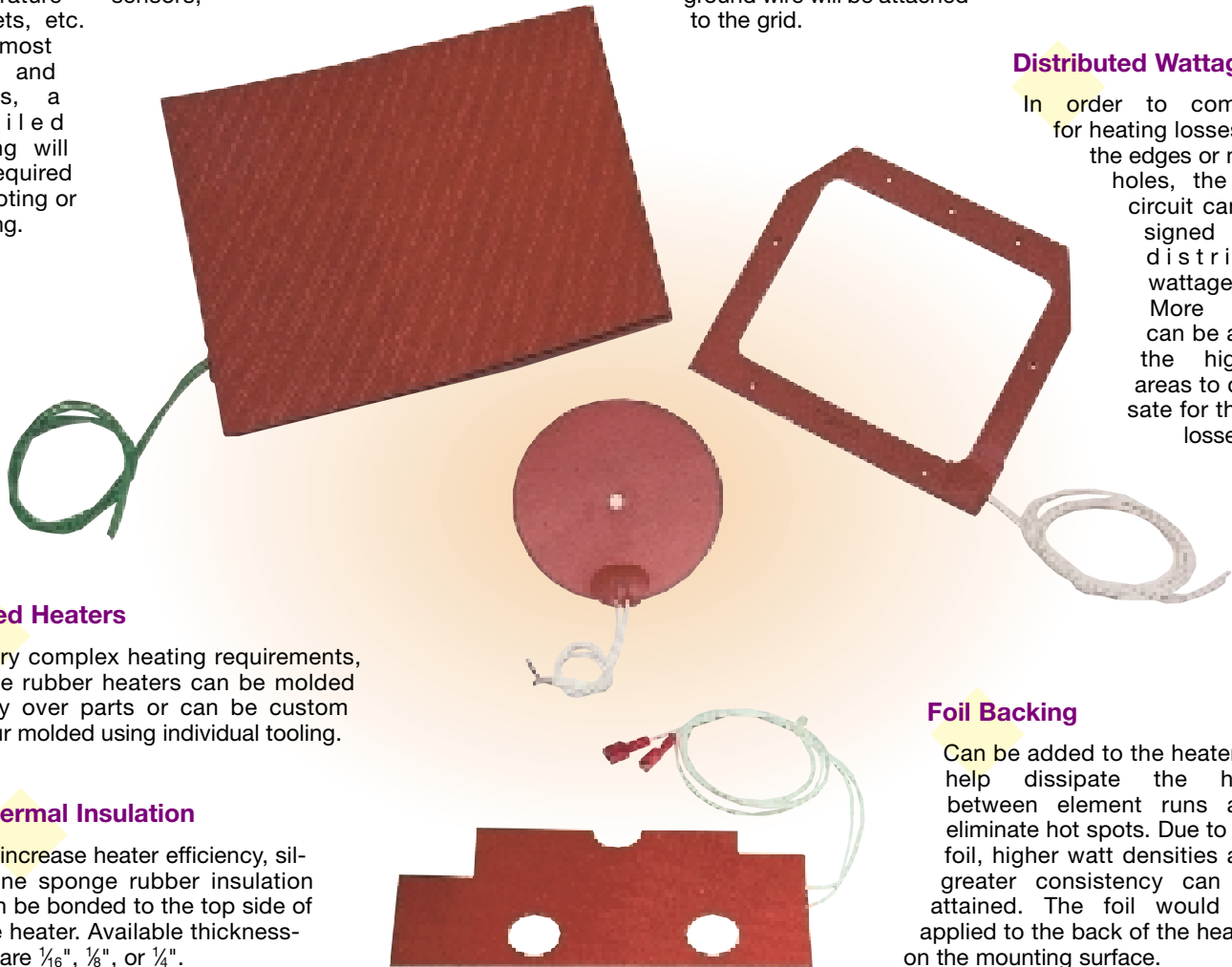
For very complex heating requirements, silicone rubber heaters can be molded directly over parts or can be custom contour molded using individual tooling.

## Thermal Insulation

To increase heater efficiency, silicone sponge rubber insulation can be bonded to the top side of the heater. Available thicknesses are  $\frac{1}{16}$ ",  $\frac{1}{8}$ ", or  $\frac{1}{4}$ ".

## Foil Backing

Can be added to the heater to help dissipate the heat between element runs and eliminate hot spots. Due to the foil, higher watt densities and greater consistency can be attained. The foil would be applied to the back of the heater, on the mounting surface.



**TEMPCO**  
Custom Crafted

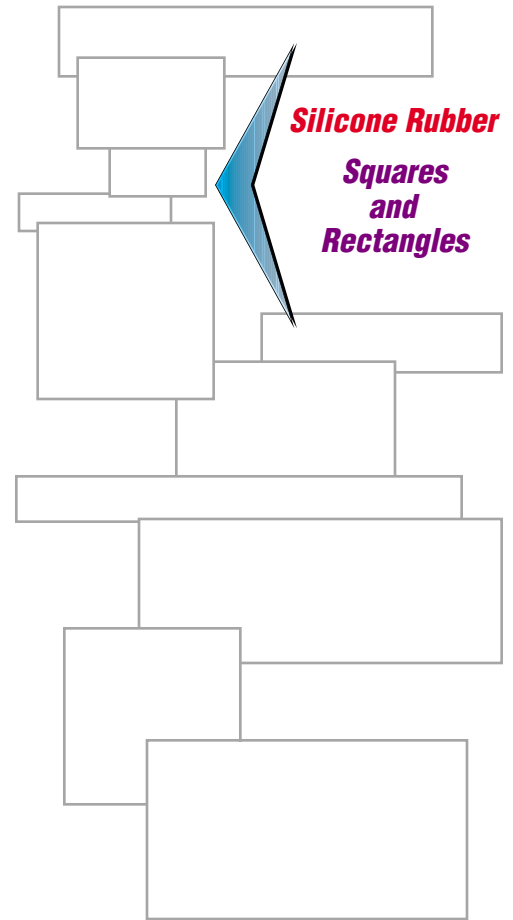
**CALL TEMPCO AND GET EXPERT ASSISTANCE FOR ALL YOUR HEATING NEEDS!**



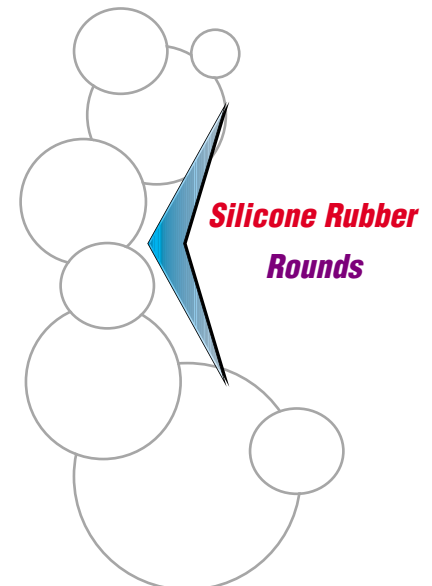


## Silicone Rubber – Common Sizes

Width		Length		Watts	Wire Construction		Foil Construction	
in.	mm	in.	mm		120V	240V	120V	240V
1	25	8	203	40	SHS00001	—	SHS00080	—
1	25	12	305	60	SHS00002	SHS00041	SHS00081	SHS00101
1	25	24	610	120	SHS00003	SHS00042	—	—
1	25	48	1219	240	SHS00004	SHS00043	—	—
2	51	2	51	20	SHS00005	SHS00044	SHS00082	SHS00102
2	51	4	102	40	SHS00006	SHS00045	SHS00083	SHS00103
2	51	8	203	80	SHS00007	SHS00046	SHS00084	SHS00104
2	51	12	305	120	SHS00008	SHS00047	SHS00085	SHS00105
2	51	24	610	240	SHS00009	SHS00048	—	—
2	51	48	1219	480	SHS00010	SHS00049	—	—
3	76	4	102	60	SHS00011	SHS00050	SHS00086	SHS00106
3	76	8	203	120	SHS00012	SHS00051	SHS00087	SHS00107
3	76	12	305	180	SHS00013	SHS00052	SHS00088	SHS00108
3	76	24	610	360	SHS00014	SHS00053	—	—
3	76	48	1219	720	SHS00015	SHS00054	—	—
4	102	4	102	80	SHS00016	SHS00055	SHS00089	SHS00109
4	102	8	203	160	SHS00017	SHS00056	SHS00090	SHS00110
4	102	12	305	240	SHS00018	SHS00057	SHS00091	SHS00111
4	102	24	610	480	SHS00019	SHS00058	—	—
4	102	48	1219	960	SHS00020	SHS00059	—	—
5	127	6	152	150	SHS00021	SHS00060	SHS00092	SHS00112
5	127	10	254	250	SHS00022	SHS00061	SHS00093	SHS00113
5	127	12	305	300	SHS00023	SHS00062	SHS00094	SHS00114
5	127	24	610	600	SHS00024	SHS00063	—	—
5	127	48	1219	1200	SHS00025	SHS00064	—	—
6	152	6	152	180	SHS00026	SHS00065	SHS00095	SHS00115
6	152	10	254	300	SHS00027	SHS00066	SHS00096	SHS00116
6	152	12	305	360	SHS00028	SHS00067	SHS00097	SHS00117
6	152	24	610	720	SHS00029	SHS00068	—	—
6	152	48	1219	1440	SHS00030	SHS00069	—	—
8	203	8	203	320	SHS00031	SHS00070	SHS00098	SHS00118
8	203	12	305	480	SHS00032	SHS00071	SHS00099	SHS00119
8	203	24	610	960	SHS00033	SHS00072	—	—
8	203	48	1219	1920	SHS00034	SHS00073	—	—
10	254	10	254	500	SHS00035	SHS00074	SHS00100	SHS00120
10	254	24	610	1200	SHS00036	SHS00075	—	—
10	254	48	1219	2400	SHS00037	SHS00076	—	—
12	305	12	305	720	SHS00038	SHS00077	—	—
12	305	24	610	1440	SHS00039	SHS00078	—	—
12	305	48	1219	2880	SHS00040	SHS00079	—	—



Diameter		Area		Watts	Wire Construction		Foil Construction	
in.	mm	in <sup>2</sup>	cm <sup>2</sup>		120V	240V	120V	240V
3.0	76	7.07	45.6	35	SHS00201	—	—	—
3.5	89	9.62	62.1	48	SHS00202	—	SHS00241	—
4.0	102	12.57	81.1	63	SHS00203	SHS00222	SHS00242	—
4.5	114	15.90	102.6	80	SHS00204	SHS00223	SHS00243	SHS00261
5.0	127	19.63	126.6	98	SHS00205	SHS00224	SHS00244	SHS00262
5.5	140	23.76	153.3	119	SHS00206	SHS00225	SHS00245	SHS00263
6.0	152	28.27	182.4	141	SHS00207	SHS00226	SHS00246	SHS00264
6.5	165	33.18	214.1	166	SHS00208	SHS00227	SHS00247	SHS00265
7.0	178	38.48	248.3	192	SHS00209	SHS00228	SHS00248	SHS00266
7.5	191	44.18	285.0	221	SHS00210	SHS00229	SHS00249	SHS00267
8.0	203	50.26	324.3	250	SHS00211	SHS00230	SHS00250	SHS00268
8.5	216	56.74	366.1	284	SHS00212	SHS00231	SHS00251	SHS00269
9.0	229	63.62	410.4	318	SHS00213	SHS00232	SHS00252	SHS00270
9.5	241	70.88	457.3	354	SHS00214	SHS00233	SHS00253	SHS00271
10.0	254	78.54	506.7	393	SHS00215	SHS00234	SHS00254	SHS00272
10.5	267	86.59	558.7	430	SHS00216	SHS00235	SHS00255	SHS00273
11.0	279	95.03	613.2	480	SHS00217	SHS00236	SHS00256	SHS00274
11.5	292	103.87	670.2	520	SHS00218	SHS00237	SHS00257	SHS00275
12.0	305	113.10	729.7	570	SHS00219	SHS00238	SHS00258	SHS00276
15.0	381	176.72	1140.2	880	SHS00220	SHS00239	SHS00259	SHS00277
20.0	508	314.16	2027.0	1570	SHS00221	SHS00240	SHS00260	SHS00278





# Kapton® – Common Sizes

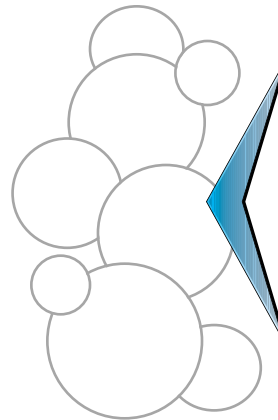
Width		Length		Watts	Part Number	
in.	mm	in.	mm		120V	240V
1	25	8	203	40	SHK00001	—
1	25	12	305	60	SHK00002	SHK00022
2	51	2	51	20	SHK00003	SHK00023
2	51	4	102	40	SHK00004	SHK00024
2	51	8	203	80	SHK00005	SHK00025
2	51	12	305	120	SHK00006	SHK00026
3	76	4	102	60	SHK00007	SHK00027
3	76	8	203	120	SHK00008	SHK00028
3	76	12	305	180	SHK00009	SHK00029
4	102	4	102	80	SHK00010	SHK00030
4	102	8	203	160	SHK00011	SHK00031
4	102	12	305	240	SHK00012	SHK00032
5	127	6	152	150	SHK00013	SHK00033
5	127	10	254	250	SHK00014	SHK00034
5	127	12	305	300	SHK00015	SHK00035
6	152	6	152	180	SHK00016	SHK00036
6	152	10	254	300	SHK00017	SHK00037
6	152	12	305	360	SHK00018	SHK00038
8	203	8	203	320	SHK00019	SHK00039
8	203	12	305	480	SHK00020	SHK00040
10	254	10	254	500	SHK00021	SHK00041



**Kapton®**  
**Squares**  
**and**  
**Rectangles**

## KAPTON FLEXIBLE HEATERS

Diameter		Watts	Part number	
in.	mm		120V	240V
3.0	76	35	SHK00101	—
3.5	89	48	SHK00102	—
4.0	102	63	SHK00103	—
4.5	114	80	SHK00104	SHK00116
5.0	127	98	SHK00105	SHK00117
5.5	140	119	SHK00106	SHK00118
6.0	152	141	SHK00107	SHK00119
6.5	165	166	SHK00108	SHK00120
7.0	178	192	SHK00109	SHK00121
7.5	190	221	SHK00110	SHK00122
8.0	203	250	SHK00111	SHK00123
8.5	216	284	SHK00112	SHK00124
9.0	229	318	SHK00113	SHK00125
9.5	241	354	SHK00114	SHK00126
10.0	254	393	SHK00115	SHK00127



**Kapton®**  
**Rounds**

### How to Order

#### Catalog Heaters

Chose from the tables of common sizes of Silicone Rubber and Kapton® in round or rectangular shapes.

The heaters listed are 5 W/in<sup>2</sup>. Standard configuration includes 10" Teflon® leads, exit style A or L (see page 9-6) and no mounting option.

#### Custom Engineered/Manufactured Heaters

Understanding that an electric heater can be very application specific, for sizes and ratings not listed, **TEMPCO** will design and manufacture a Flexible Surface Heater to meet your requirements. **Standard lead time is 4-5 weeks.**

**Please Specify** the following:

- Diameter
- Wattage and Voltage
- Lead Type
- Sensors or Thermostats
- Special features or Cutouts
- Lead Location





## Electrical Resistance Heating Tape— Adhesive Backed

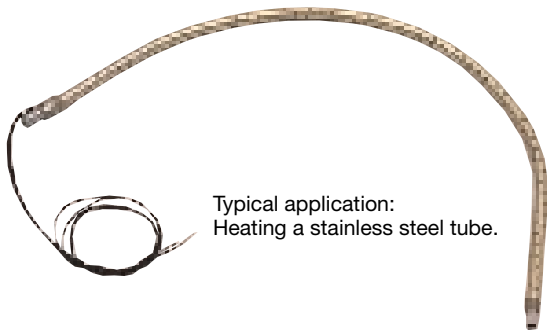
### Designed For High Heat Transfer

All electrical resistance elements create heat, but some systems are better at transferring this energy. The secret to this heating tape is in its thermally conductive adhesive and its outer reflective sheath.

The adhesive surrounds the resistance wire and transfers the thermal energy directly to the surface of the load. The resistance wire itself has a back and forth kink that acts as a spring to absorb expansion and contraction.

The outer aluminum sheath spreads heat evenly over the entire surface of the tape and also reflects heat back onto the load.

The end result is a highly efficient heating source with maximum heat being transferred to the desired material.



Typical application:  
Heating a stainless steel tube.

### Typical Applications

- \* Cylinder wrap tube, pipe, vessels.
- \* Placed directly on PVC, PTFE plastic pipe without the need for other material.
- \* Excellent for prototype engineering, placing heat exactly where it is needed.
- \* Even heating throughout the length of a heated hose for hot wax handling, food processing, hot melt and other plastic processing.
- \* De-fogging, de-icing, fuel line warming.
- \* Acrylic product approved by NASA for space flight.
- \* Acrylic low outgassing perfect for vacuum applications.

### Product Types

**4 Conductor Tape** ½" (12.7 mm) wide has the highest watt density and the most variety of resistances. It can have leads at one end in the case of a series connection or a series/parallel connection, or leads at either end in a parallel connection.

The tightest wrap this tape can achieve is on a ¼" (6.3 mm) O.D. surface. A smaller tube should be wrapped with ¼" (6.3 mm) or ⅙" (4.2 mm) tape.

**2 Conductor Tape** ¼" (6.3 mm) wide has leads on one end in the series connection, and leads at both ends for parallel connections. This tape will wrap down to ⅙" (3.17 mm) O.D.

**1 Conductor Tape** ⅙" (4.2 mm) wide can wrap down to .060" (1.52 mm) O.D. A lead will be present at both ends.



Typical finished assembly with leads.

### ADHESIVE SPECIFICATIONS

	Silicone	Acrylic
<b>Operating Temperature Range</b>	-100°C to 250°C -148°F to 482°F	-100°C to 180°C -148°F to 356°F
<b>Outgassing... TML/VCM</b>	1.047%/.322%	.264%/.000%
<b>Adhesion to Etched Aluminum (oz/inch width)</b>	28 @ +125°C 450 @ -100°C	29 @ +125°C 50 @ -100°C
<b>Overall Thickness Applied</b>	.025" (.63 mm)	.028" (.71 mm)
<b>Dielectric Strength</b>	600 vdc	600 vdc

### General Purpose Wattage Calculations for Tube and Pipe Heating

$$T_p = P \times L \times \Delta T$$

**T<sub>p</sub>** = Total Watts Required

**P** = Watts per lineal foot of tube per °F temp. rise (see chart below)

**L** = Length of tube in feet

**ΔT** = Temperature rise, °F above ambient

**To Find P:** Look at the intersection of Tube O.D. and Insulation thickness.

Insulation Thickness	Tube Outside Diameter			
	¼"	½"	1"	2"
Bare	.10	.13	.21	.40
½"	.07	.09	.13	.20
1"	—	.05	.08	.11



This is for estimating power requirements only. Confirmation by prototype testing is recommended.

- \* If the temperature rise is over 100 degrees, increase the wattage by 10%.
- \* For rapid start-up and to allow for colder material entering the hose, increase the wattage by 25% and use a thermocoupled temperature controller.



### Engineering Example

A 10 ft. stainless steel braided hose— $\frac{1}{2}$ " O.D., needs to be heated to 400°F from 70°F. Insulation:  $\frac{1}{2}$ ". The voltage is 220V.

- Determine the Length.** To cover the hose completely would take  $\pi \times \frac{1}{2} \times 120 = 188$  sq.in. A 12" length of  $\frac{1}{2}$ " tape would cover 6 sq.in. of hose; therefore, 31 ft. of  $\frac{1}{2}$ " tape would completely cover the hose, spiral wrapped edge to edge.
- Determine the Watts.** Total Power ( $T_p$ ) =  $P \times L \times \Delta T$   
From the chart,  $P = .09$  for a  $\frac{1}{2}$ " hose with  $\frac{1}{2}$ " insulation, therefore  $T_p = .09 \times 10 \text{ ft.} \times (400-70) = 297$  Watts. For rapid start-up and to compensate for colder material flowing through the hose, increase the wattage by 25% to 400W.
- Calculate the Ohms per Foot.** The ohms/ft. =  $E^2 \div (T_p \times L)$   
Therefore ohms/ft. =  $220^2 \div (400W \times 31 \text{ ft.}) = 3.9$  ohms per ft.
- Calculate the Watts per Foot.** The Watts per ft. =  $T_p \div L$   
Therefore the watts/ft. =  $400 \text{ watts} \div 31 \text{ ft.} = 12.9$  watts/ft.
- Choose Heat Tape Material from the Table.** From the table, the FTP00035,  $\frac{1}{2}$ " tape with four conductors and silicone adhesive in the parallel/series connection at 4.0 ohm/ft. would fill the requirements. The required 12.9 watts/ft. is well under the maximum rating of 62 watts/ft.



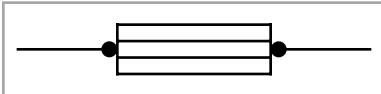
Bulk roll of Heat Tape

### Heating Tape Resistance Table

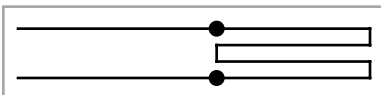
Width		$\frac{1}{8}$ " (4.2 mm)	$\frac{1}{4}$ " (6.3 mm)	$\frac{1}{2}$ " (12.7 mm)		
Number of Conductors		1	2	4		
Part Number		Ohms/ft. Max. Watts/ft.		Ohms/ft. Max. Watts/ft.		
50 ft. roll	100 ft. roll	Ohms/ft.	Max. Watts/ft.	see notes (1) (2)	see notes (1) (2) (3)	Max. Watts/ft.
FTP0001 <input type="checkbox"/>	FTP1001 <input type="checkbox"/>	1.9	25	.9 3.8	40	.5 1.9 7.6 70
FTP0002 <input type="checkbox"/>	FTP1002 <input type="checkbox"/>	3.2	25	1.6 6.4	40	.8 3.2 12.8 70
FTP0003 <input type="checkbox"/>	FTP1003 <input type="checkbox"/>	4.0	23	2.0 8.0	35	1.0 4.0 16.0 62
FTP0004 <input type="checkbox"/>	FTP1004 <input type="checkbox"/>	4.9	20	2.4 9.8	30	1.2 4.9 19.6 52
FTP0005 <input type="checkbox"/>	FTP1005 <input type="checkbox"/>	7.0	25	3.5 14.0	40	1.7 7.0 28.0 70
FTP0006 <input type="checkbox"/>	FTP1006 <input type="checkbox"/>	8.8	23	4.4 17.6	35	2.2 8.8 35.2 62
FTP0007 <input type="checkbox"/>	FTP1007 <input type="checkbox"/>	10.8	20	5.4 21.6	30	2.7 10.8 43.2 52
FTP0008 <input type="checkbox"/>	FTP1008 <input type="checkbox"/>	13.2	20	6.6 26.4	30	3.3 13.2 52.8 52
FTP0009 <input type="checkbox"/>	FTP1009 <input type="checkbox"/>	21.3	13	10.6 42.6	20	5.3 21.3 85.2 32
FTP0010 <input type="checkbox"/>	FTP1010 <input type="checkbox"/>	26.8	10	13.4 53.6	16	6.7 26.8 107.2 25

### NOTES

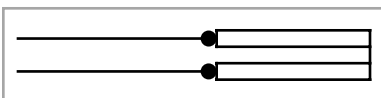
- Ohms per foot with all conductors in a parallel connection.



- Ohms per foot with all conductors in a series connection.



- Ohms per foot with all conductors in a parallel pair-series connection.



### Accessories

Terminal Kit for 1-wire  
2-wire

Additional solderless crimps

Aluminum/Silicone  
Heat Transfer Tape

16-20 Ga.

FTP00911

FTP00912

FTP00920

$\frac{3}{4}$ " x 10 ft.

FTP00930

22-26 Ga.

FTP00913

FTP00914

FTP00921

$1\frac{1}{4}$ " x 10 ft.

FTP00931

### How to Order

#### Bulk Heat Tape

Heat Tape can be ordered in **bulk in 50 or 100 ft. rolls** or in custom assemblies. The part number for each item is completed by filling in the  from the following table to detail adhesive type and tape width:

- |                                            |                                           |
|--------------------------------------------|-------------------------------------------|
| 1-silicone, $\frac{1}{8}$ " wide (1 cond.) | 2-acrylic, $\frac{1}{8}$ " wide (1 cond.) |
| 3-silicone, $\frac{1}{4}$ " wide (2 cond.) | 4-acrylic, $\frac{1}{4}$ " wide (2 cond.) |
| 5-silicone, $\frac{1}{2}$ " wide (4 cond.) | 6-acrylic, $\frac{1}{2}$ " wide (4 cond.) |

#### Custom Engineered/Manufactured Heaters

Understanding that an electric heater can be very application specific, for sizes and ratings not listed, **TEMPCO** will design and manufacture custom Heating Tape assemblies to meet your requirements— ready to install. **Standard lead time is 4-5 weeks.**

For a quote, **Please Specify** the following:

- Application Information
- Wattage Requirements
- Lead Information



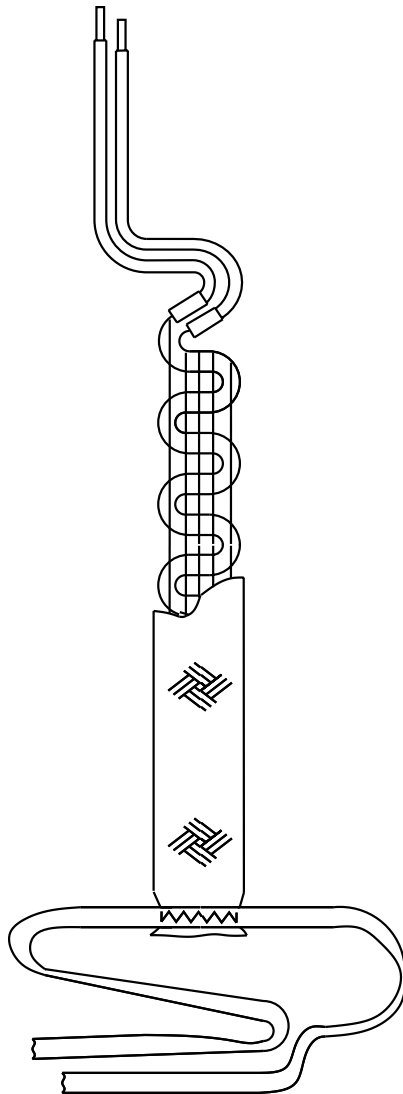
## Flexible Heating Tape — Duo-Tape®

### Features:

- \* 1400°F (760°C) temperature rating
- \* 2 ft. (61 cm) high temperature lead wires on one end
- \* Highly flexible & rugged, knitted design
- \* High, medium and low watt density designs
- \* Constant wattage (min. ohm change cold to hot)

### Typical Applications:

- Laboratory, general application
- Research and Development
- Pilot plant research heaters
- High temperature hose heating
- Industrial applications, anywhere high temperature and flexibility are required (Non-hazardous and dry locations only)



### Tempco Heating Tapes

We provide high temperature, flexible electric heating elements. They were developed to offer the unique convenience of wrap-on heat for tubing, laboratory apparatus or any dry environment application, where flexible surface spot heat is required.

Heating tapes are offered in many standard sizes, having watt densities from 3.25 to 13 watts per square inch, and temperature ratings to 1400°F (760°C).

#### CONSTRUCTION

The construction begins with bundled, fine strand resistance wire, 37 to 40 gauge, covered with a minimum of 2 layers of high temperature braided AMOX yarn. The insulated resistance wire is then knitted into a serpentine configuration, forming a flat tape. Once the lead wires are attached, most tapes have an additional braided, dielectric protection layer of AMOX yarn for use on conductive (metal) surfaces.

#### DURABILITY FEATURE

Unlike other straight element heating wires and tapes, knitting allows for cushioning during heating and cooling. The element expands in all directions rather than one, virtually eliminating “thermal growth”. In addition, knitting prevents the tape from tensile stress when stretched (a typical problem of elements applied to flexible hoses).

#### LOW WATT DENSITY, WELL DISTRIBUTED HEAT FEATURE

Knitting allows dense distribution of wire per unit length of tape. This feature provides longer life resulting from lower watts per inch of wire. (A typical 1-inch-wide tape may contain 10 inches (25.4 cm) of wire element.)

#### DUO-TAPE®

Duo-Tape® is a breakthrough design innovation that allows two wires to be knitted side by side. The advantage is that the lead wires may be attached on the same end rather than opposite ends. The balance of the tape is constructed the same as the other single wire tapes.

### OPTIONS

- 1. Plug** A 120V plug can be ordered on indicated heaters only as a custom assembly. Since the leads of the Duo-Tape® are on one end, the plug is a single molded unit.
- 2. Lead Wire** Standard lead wire length is 2 ft. (61 cm)



**Note:** When a plug is requested, lead wire length may be 2 ft. or shorter.

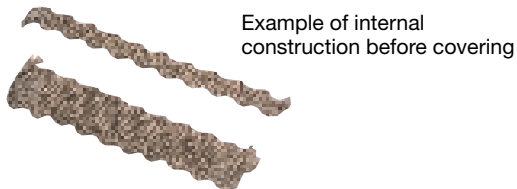
Optional lengths may be ordered to 8 ft. For special length, width, watts or volts—contact **Tempco**.



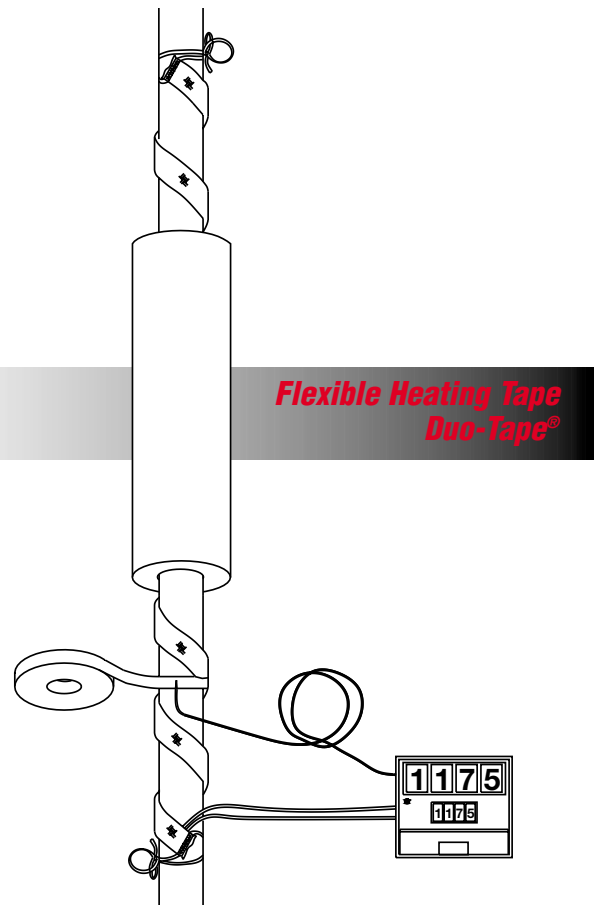
### Duo-Tape® Standard Sizes and Ratings

Watt Density	Size	Watts	Plug	Part Number	
				120V	240V
13.00 W/in <sup>2</sup>	1/2" x 2'	156	Avail	FTF00101	FTF00107
	1/2" x 4'	312	Avail	FTF00102	FTF00108
	1/2" x 6'	468	Avail	FTF00103	FTF00109
	1/2" x 8'	624	Avail	FTF00104	FTF00110
	1/2" x 10'	780	None	—	FTF00111
	1/2" x 12'	936	None	—	FTF00112
	1/2" x 16'	1248	None	—	FTF00113
	1" x 2'	312	Avail	FTF00105	FTF00114
	1" x 4'	624	Avail	FTF00106	FTF00115
	1" x 6'	936	None	—	FTF00116
8.67 W/in <sup>2</sup>	1/2" x 2'	104	Avail	FTF00118	—
	1/2" x 4'	208	Avail	FTF00119	FTF00125
	1/2" x 6'	312	Avail	FTF00120	FTF00126
	1/2" x 8'	416	Avail	FTF00121	FTF00127
	1/2" x 10'	520	Avail	FTF00122	FTF00128
	1/2" x 12'	624	None	—	FTF00129
	1/2" x 16'	832	None	—	FTF00130
	1" x 2'	208	Avail	FTF00123	FTF00131
	1" x 4'	416	Avail	FTF00124	FTF00132
	1" x 6'	624	None	—	FTF00133
1.3 W/cm <sup>2</sup>	1" x 8'	832	None	—	FTF00134
	1" x 10'	986	None	—	FTF00135
	1/2" x 2'	39	Avail	FTF00136	—
	1/2" x 4'	78	Avail	FTF00137	FTF00147
	1/2" x 6'	117	Avail	FTF00138	FTF00148
	1/2" x 8'	156	Avail	FTF00139	FTF00149
	1/2" x 10'	195	Avail	FTF00140	FTF00150
	1/2" x 12'	234	Avail	FTF00141	FTF00151
	1/2" x 16'	312	Avail	FTF00142	FTF00152
	1" x 2'	78	Avail	FTF00143	FTF00153
3.25 W/in <sup>2</sup>	1" x 4'	156	Avail	FTF00144	FTF00154
	1" x 6'	234	Avail	FTF00145	FTF00155
	1" x 8'	312	Avail	FTF00146	FTF00156
	1" x 10'	385	None	—	FTF00157
	1" x 12'	468	None	—	FTF00158
	1" x 16'	624	None	—	FTF00159

Part Numbers in table are for heaters without plugs



Example of internal construction before covering



Flexible Heating Tape Duo-Tape®



Typical Duo-Tape® Assembly including ties

### How to Order

#### Standard Heaters

Choose the Duo-Tape® Heater from the above table that meets your needs. Specify Part Number.

#### Custom Engineered/Manufactured Heaters

Understanding that an electric heater can be very application specific, for sizes and ratings not listed, **TEMPCO** will design and manufacture a Duo-Tape® Heater to meet your requirements. **Standard lead time is 2-3 weeks.**

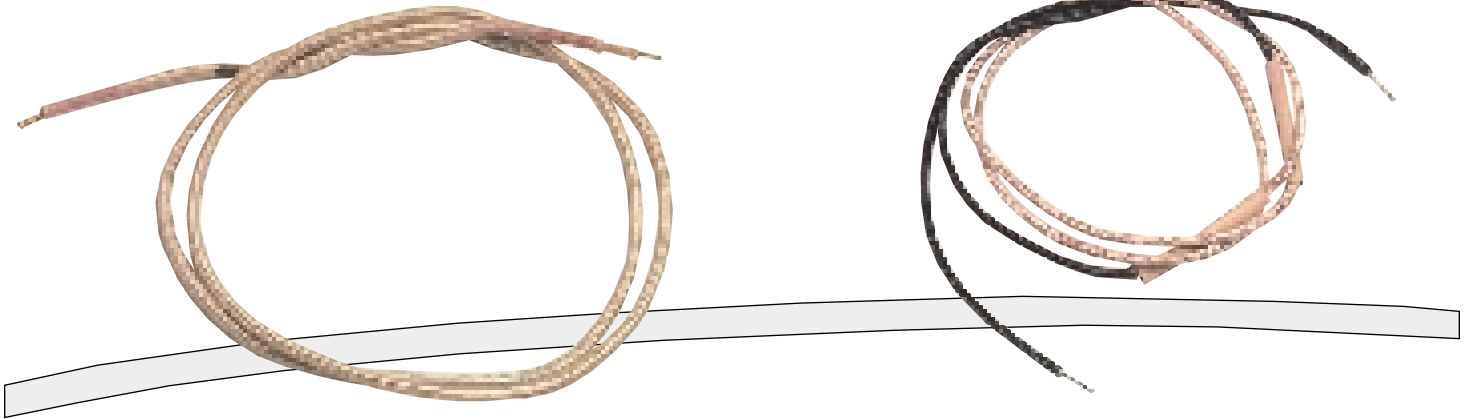
**Please Specify** the following:

- Application
- Length
- Wattage
- Voltage
- Termination
- Leads
- Crimp Connectors

# Rope Heaters Std. Sizes & Ratings



## Rope Heaters



### Construction

A resistive alloy element is helically wound around a fiberglass core and covered with a .040" layer of braided fiberglass. The leads are 18 ga. and covered with .030" silicone and a layer of glass braid. The connections are insulated with silicone glass sleeves.

**Maximum Temperature:** 600°F (315°C)

**Nominal Diameter:** .150" to .200" (3.8 to 5.1 mm) depending on design.

### Typical Applications

- Laboratory Equipment
- Valves and Piping
- Appliances
- Blueprint Machines
- Incubators
- Tracers
- Any Application Where Spot Heat is Needed

Length	Volts	Watts	Watt Density W/in <sup>2</sup>	Part Number
36"	120	60	1.67	RHR00101
	240	60	1.67	RHR00102
	120	90	2.50	RHR00103
	240	90	2.50	RHR00104
	120	120	3.33	RHR00105
	240	120	3.33	RHR00106
72"	120	120	1.67	RHR00107
	240	120	1.67	RHR00108
	120	180	2.50	RHR00109
	240	180	2.50	RHR00110
	120	240	3.33	RHR00111
	240	240	3.33	RHR00112
108"	120	180	1.67	RHR00113
	240	180	1.67	RHR00114
	120	270	2.50	RHR00115
	240	270	2.50	RHR00116
	120	360	3.33	RHR00117
	240	360	3.33	RHR00118
144"	120	240	1.67	RHR00119
	240	240	1.67	RHR00120
	120	360	2.50	RHR00121
	240	360	2.50	RHR00122
	120	480	3.33	RHR00123
	240	480	3.33	RHR00124



**Note:** All above heaters include 12" leads stripped 1/2".

## How to Order

### Catalog Heaters

Choose the Rope Heater from the table that fits your needs. Specify Part Number.

Minimum order: 5 pieces

### Custom Engineered/Manufactured Heaters

Understanding that an electric heater can be very application specific, for sizes and ratings not listed, **TEMPCO** will design and manufacture a Rope Heater to meet your requirements. **Standard lead time is 3-4 weeks.**

**Please Specify** the following:

- |                                               |                                           |
|-----------------------------------------------|-------------------------------------------|
| <input type="checkbox"/> Application          | <input type="checkbox"/> Termination      |
| <input type="checkbox"/> Length               | <input type="checkbox"/> Leads            |
| <input type="checkbox"/> Wattage and Voltage  | <input type="checkbox"/> Crimp Connectors |
| <input type="checkbox"/> Element Watt Density |                                           |