

### Standard Flexible Heater Specifications

#### SHS Silicone Rubber Heater Specifications

##### Physical Size and Construction Limitations

<b>Maximum Size:</b>	<i>Wire:</i> 36" × 144" (91.4 × 366 cm) <i>Foil:</i> 10" × 22" (25.4 × 56.9 cm)
<b>Dimensional Tolerance:</b>	
<b>Less than 6":</b>	±0.030" (0.76 mm)
<b>6" to 12":</b>	±0.060" (1.52 mm)
<b>12" to 18":</b>	±0.125" (3.17 mm)
<b>18" to 36":</b>	±0.250" (6.35 mm)
<b>36" to 72":</b>	±0.500" (12.7 mm)
<b>Every 36" after 72":</b>	Additional ±0.250" (6.35 mm)
<b>Nominal Thickness:</b>	<i>Wire:</i> 0.056" (1.42 mm) <i>Foil:</i> 0.030" (0.76 mm)
<b>Available Thickness:</b>	0.018" to 0.112" (0.46 mm to 2.85 mm)
<b>Weight:</b>	7 oz./ft <sup>2</sup> (0.21g/cm <sup>2</sup> )

##### Performance Ratings

<b>Maximum Operating Temperature:</b>	500°F / 260°C Intermittent 392°F / 200°C Continuous
<b>Minimum Operating Temperature:</b>	-70°F / -56.6°C
<b>Physically Resistant To:</b>	Moisture, Ozone, Fungus, Radiation
<b>Agency Approvals:</b>	UL File #E65652 (wire-wound only)

##### Electrical Ratings

<b>Resistance Tolerance:</b>	<i>Wire:</i> +10%, -5%, <i>Foil:</i> +10%, -10%
<b>Maximum Operating Voltage:</b>	<i>Wire:</i> 600 VAC, <i>Foil:</i> 480 VAC
<b>Dielectric Strength:</b>	1000 VAC
<b>Standard Leads:</b>	10" Teflon® Insulated Stranded Wire

#### SHK Kapton® Heater Specifications

##### Physical Size and Construction Limitations

<b>Maximum Size:</b>	10" × 22" (25.4 × 56.9 cm)
<b>Dimensional Tolerance:</b>	
<b>Less than 6":</b>	±0.030" (0.76 mm)
<b>6" to 12":</b>	±0.060" (1.52 mm)
<b>Over 12":</b>	±0.125" (3.17 mm)
<b>Nominal Thickness:</b>	0.008" (0.20 mm)
<b>Weight:</b>	1.5 oz./ft <sup>2</sup> (0.05g/cm <sup>2</sup> )

##### Performance Ratings

<b>Maximum Operating Temperature:</b>	392°F / 200°C Continuous
<b>Minimum Operating Temperature:</b>	-320°F / -195°C
<b>Physically Resistant To:</b>	Moisture, Ozone, Fungus

##### Electrical Ratings

<b>Resistance Tolerance:</b>	+10%, -10%
<b>Maximum Operating Voltage:</b>	480 Vac
<b>Dielectric Strength:</b>	1000 Vac
<b>Standard Leads:</b>	10" Teflon® Insulated Stranded Wire

##### Maximum Resistance Density for Heaters with Etched Foil Element:

125 Ω/in<sup>2</sup>



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

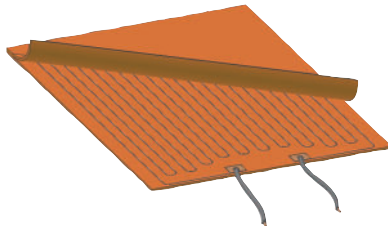
#### Wire-Wound Element Construction ●●●●●●●●●●

Tempco Silicone Rubber heaters with wire-wound elements provide excellent physical strength capable of withstanding repeated flexing without compromising the life and performance of the heater. They are also very effective for manufacturing geometrically challenged shapes, including three dimensional ones.

The wire-wound element process consists of resistance wire wound on a fiberglass cord for added support and flexibility. The wire-wound element is laid out in a special designed pattern to ensure uniform heat profile and to conform to the size and shape of the silicone rubber heater, avoiding holes and cutouts, or to concentrate the heat profile in a specific section(s) of the heater as the application dictates.

Power lead wires or cord sets are attached to the heater windings with solder and firmly secured in place through a vulcanizing process, ensuring that the assembly becomes homogenous.

The wire-wound process is recommended and preferred for small to medium size quantities, medium to large size heaters, and to produce prototypes to prove out the design parameters prior to entering into large volume production runs when using etched foil.

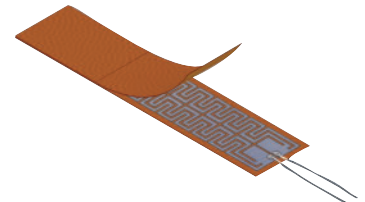


#### Etched Foil Element Construction ●●●●●●●●●●

Etched Foil Silicone Rubber or Kapton flexible heaters are made with a thin metal foil (.001"), usually a nickel base alloy, as the resistance element. The resistance pattern to be etched is designed in CAD and transferred to the foil, which is laminated to the insulating substrate. The element/substrate is then processed through an acid spray to produce the desired resistance pattern.

The top layer is then added and vulcanized for silicone rubber or laminated for Kapton heaters. For silicone rubber heaters, lead wires are then attached to the heater and insulated with additional silicone rubber to complete the heater. For Kapton® heaters, lead wires are attached to the heater and insulated with epoxy cement to complete the heater.

The etched foil heater has exceptional heat transfer compared to wire wound elements, due to its large flat surface area. It can deliver more uniform heat profiles with higher watt densities, providing longer operating heater life. It can also be zoned with distributed wattage or separate heating circuits to compensate for load variations. The etched foil process is recommended for small size heaters in large quantities.



### Flexible Heater Wattage Recommendations

#### Step 1 Determine the Required Wattage

Every process has a unique wattage requirement to heat that particular load up to temperature or to maintain a particular temperature.

If the required heater wattage is not known, estimate the required wattage using the thermodynamic formulas listed in chapter 16, Engineering. A safety factor of 25% additional wattage is recommended to compensate for unknown variables.

#### Example

To raise the temperature of an aluminum plate 6" x 12" x 0.5" (3.53 lb.) 200°F (from 70° to 270°F) in 0.5 hours:

$$\text{Watts} = \frac{3.53 \text{ lbs.} \times (0.24 \text{ Btu/lb.}^\circ\text{F}) \times 200^\circ\text{F}}{3.412 \text{ btu/watt hr.} \times 0.5 \text{ hrs.}} = 99 \text{ watts}$$

Add safety margin: 99 W + 25% = 124 watts

#### Step 2 Determine the Heater Size and Watt Density

A flexible heater should use the maximum space available for mounting and heating the process. Factors that affect heater size include the mounting method and watt density.

$$\text{Watt Density} = \frac{\text{Heater Wattage}}{\text{Area of the Heater}}$$

As a general rule, the following can be applied for silicone rubber heaters:

**Low Heat-Up:** 2.5 w/in<sup>2</sup>

**Average Heat-Up:** 5 w/in<sup>2</sup>

**High Heat-Up:** 7.5 w/in<sup>2</sup> and greater

Continuing the aluminum plate example, determine what size the heater should be:

**Silicone Rubber Heater:** 5" x 10" = 50 in<sup>2</sup>

**Watt Density** = 135 watts ÷ 50 in<sup>2</sup> = 2.7 watts/in<sup>2</sup>

Since the watt density falls between 2.5 and 5 w/in<sup>2</sup>, the silicone rubber heater selected should work satisfactorily.

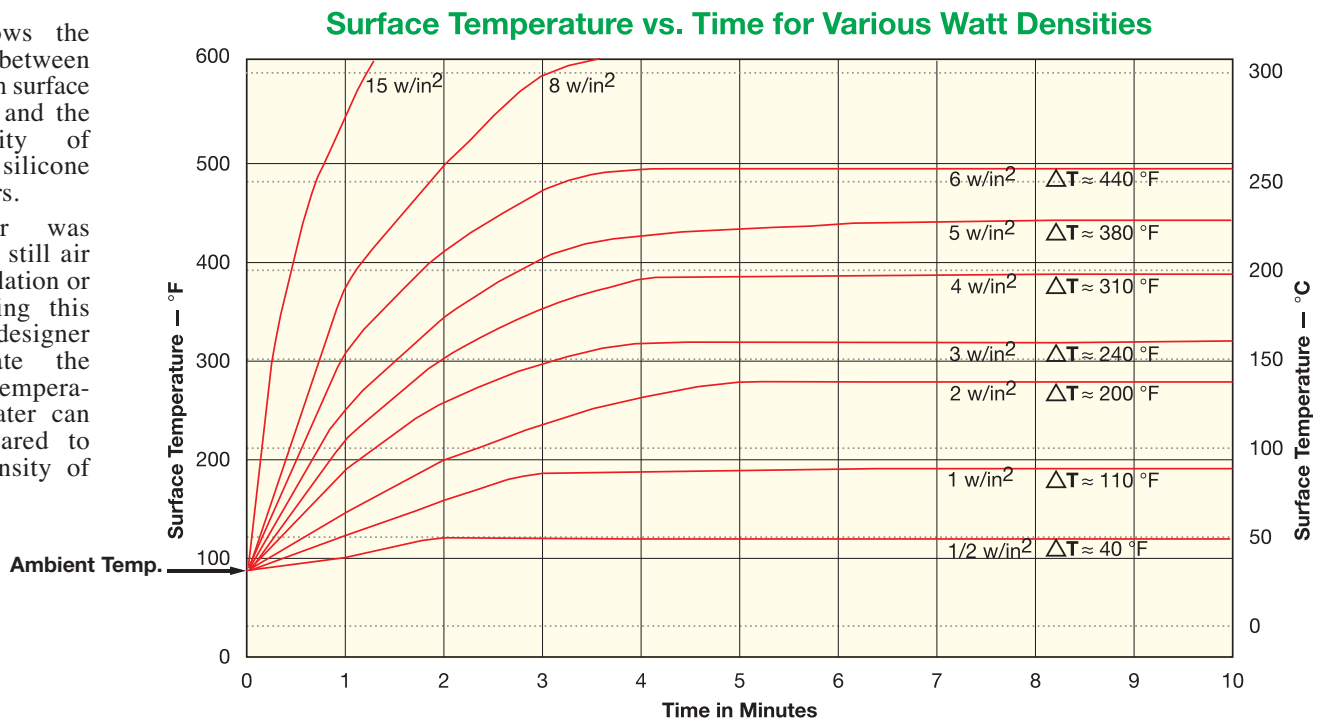
Referring to the chart below for a wire wound silicone rubber heater, pressure sensitive adhesive mounting should work well for this application at the required temperature.

If the calculated watt density is too high, a larger heater will lower the required watt density and still produce the same wattage.

### Silicone Rubber Heater Surface Temperature vs. Watt Density

**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.



ΔT = Temperature Rise From Ambient at Specified Watt Densities

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### Flexible Heater Wattage Recommendations

Continued from previous page...

#### Suggested Maximum Watt Density by Heater Type and Mounting Method

Watt Density w/in <sup>2</sup>	Silicone Rubber – Wire Element		Silicone Rubber – Foil Element		Kapton® – Foil Element	
	Vulcanized	PSA	Vulcanized	PSA	Acrylic PSA	Acrylic PSA with 3 mil Aluminum Foil
5	420 to 356°F (216 to 180°C)	350 to 335°F (177 to 168°C)	455 to 419°F (235 to 215°C)	350 to 320°F (177 to 160°C)	212 to 189°F (100 to 87°C)	302 to 275°F (150 to 135°C)
10	356 to 266°F (180 to 130°C)	335 to 248°F (168 to 120°C)	419 to 383°F (215 to 195°C)	320 to 293°F (160 to 145°C)	189 to 163°F (87 to 73°C)	275 to 257°F (135 to 125°C)
15	266 to 158°F (130 to 70°C)	248 to 140°F (120 to 60°C)	383 to 347°F (195 to 175°C)	293 to 266°F (145 to 130°C)	163 to 131°F (73 to 55°C)	257 to 230°F (125 to 110°C)
20	158 to 68°F (70 to 20°C)	140 to 32°F (60 to 0°C)	347 to 311°F (175 to 155°C)	266 to 239°F (130 to 115°C)	131 to -25°F (55 to -32°C)	230 to 194°F (110 to 90°C)
25	68 to -40°F (20 to -40°C)	32 to -49°F (0 to -45°C)	— —	— —	— —	194 to 167°F (90 to 75°C)
30	— —	— —	311 to 257°F (155 to 125°C)	239 to 185°F (115 to 85°C)	— —	167 to 125°F (75 to 52°C)
35	— —	— —	— —	— —	— —	125 to 86°F (52 to 30°C)
40	— —	— —	257 to 185°F (125 to 85°C)	185 to 104°F (85 to 40°C)	— —	86 to -25°F (30 to -32°C)
50	— —	— —	185 to 50°F (85 to 10°C)	104 to -40°F (40 to -40°C)	— —	— —
60	— —	— —	50 to -49°F (10 to -45°C)	-40 to -49°F (-40 to -45°C)	— —	— —



**Note:** Use an appropriate Temperature Controller for the application.

### Silicone Rubber Standard (Non-Stock) Sizes and Ratings

Silicone Rubber Heaters listed have 10" Teflon® Insulated Stranded Lead Wires exiting at Location L (see page 9-9).

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

**Silicone Rubber  
Rounds**



# Flexible Heaters



## Standard Sizings and Ratings

### Kapton® Standard (Non-Stock) Sizes and Ratings



**Kapton  
Rounds**

Diameter		Area		Watts	Part Number	
in.	mm	in <sup>2</sup>	cm <sup>2</sup>		120V	240V
3.0	76	7.07	45.6	35	SHK00101	—
3.5	89	9.62	62.1	48	SHK00102	—
4.0	102	12.57	81.1	63	SHK00103	—
4.5	114	15.90	102.6	80	SHK00104	SHK00116
5.0	127	19.63	126.6	98	SHK00105	SHK00117
5.5	140	23.76	153.3	119	SHK00106	SHK00118
6.0	152	28.27	182.4	141	SHK00107	SHK00119
6.5	165	33.18	214.1	166	SHK00108	SHK00120
7.0	178	38.48	248.3	192	SHK00109	SHK00121
7.5	190	44.18	285.0	221	SHK00110	SHK00122
8.0	203	50.26	324.3	250	SHK00111	SHK00123
8.5	216	56.74	366.1	284	SHK00112	SHK00124
9.0	229	63.62	410.4	318	SHK00113	SHK00125
9.5	241	70.88	457.3	354	SHK00114	SHK00126
10.0	254	48.54	506.7	393	SHK00115	SHK00127

## KAPTON FLEXIBLE HEATERS



**Kapton  
Squares  
and  
Rectangle**

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	—	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

### Ordering Information

#### 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 9-9) and no mounting option.

#### Custom Engineered/Manufactured Heaters

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 to 5 weeks.**

**Please Specify** the following:

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

**⚠ WARNING:** Cancer and Reproductive Harm - [www.P65Warnings.ca.gov](http://www.P65Warnings.ca.gov).

**View Product Inventory @ [www.tempco.com](http://www.tempco.com)**