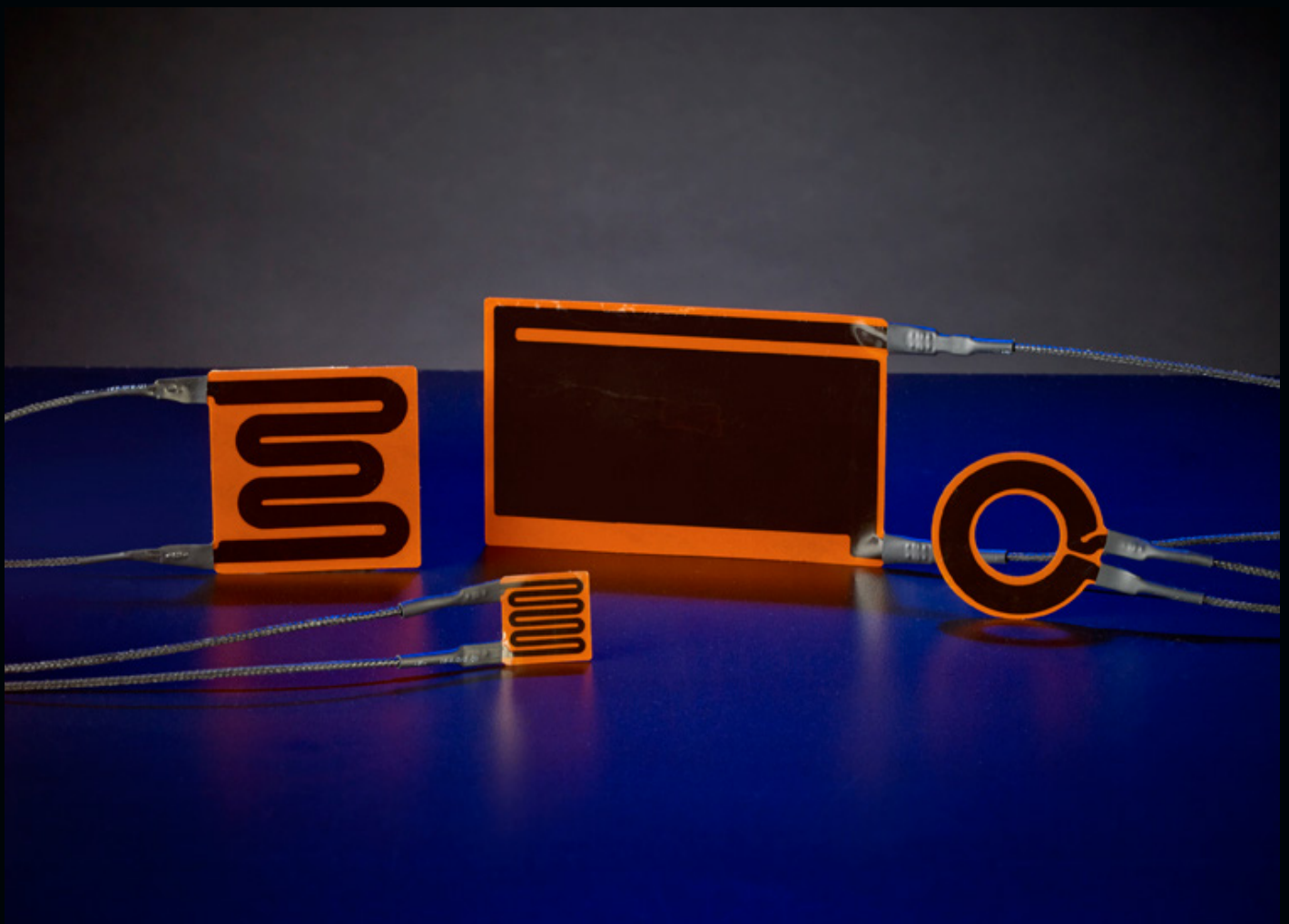
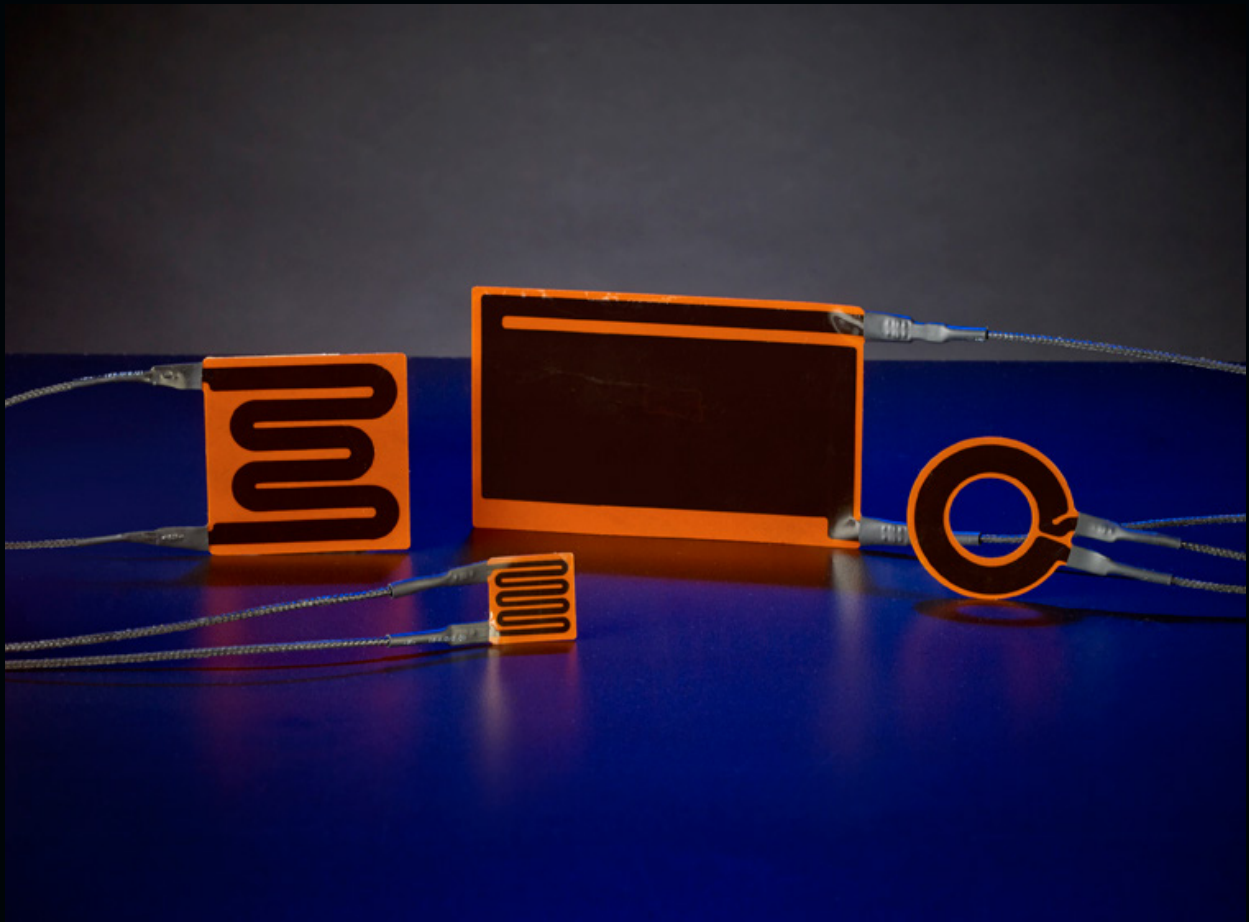


Ultra-Thin Flexible Heaters

Innovation in Motion





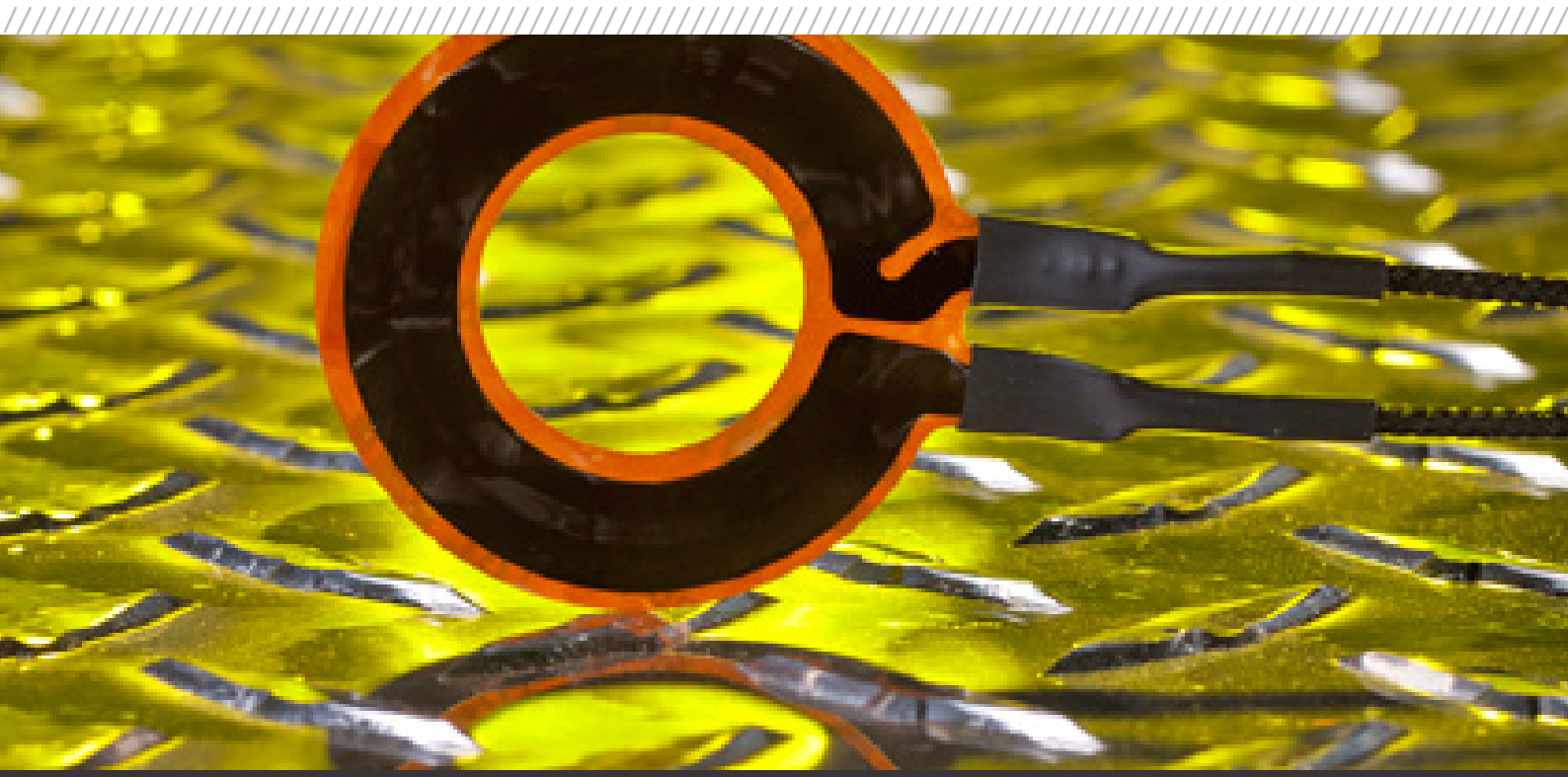
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OVERVIEW

Pelonis Technologies' innovative Ultra-Thin Flexible Heaters outperform conventional heating elements and feature excellent physical and electrical properties that result in thermal stability over a wide temperature range.

UNIFORM HEATING WITH SUPERIOR THERMAL PROPERTIES

Ultra-Thin Flexible Heaters' thin construction and low mass designs allow heat to transfer more efficiently than foil imprinted heaters. Uniform part temperatures are assured by matching power.

QUICK HEAT-UP

Ultra-Thin Flexible Heaters' built-in nano technology heating elements create strong bonding, making them more flexible than typical flexible heaters. This allows heat to transfer more efficiently and evenly than foil imprinted heaters. Ultra-Thin Flexible Heaters' high temperature capability allows higher wattage for faster heat-up and warm-up time.

LOWER EMF

Unlike heaters with printed or wired circuits, Ultra-Thin Flexible Heaters DO NOT produce high EMF or cause cracks and breakages of the internal heater conductor when bent which is the main cause of most heater failures.

GREAT PERFORMANCE & RELIABILITY

Ultra-Thin Flexible Heaters offer excellent performance even under critical operating temperatures from as low as -200°C and can safely operate up to 210°C (higher temperatures depend on the application). For applications below -40°C , a clamping plate should be installed over the heater so that its structure will not be affected by the change in adhesive properties under cold conditions.

LIGHT AND SPACE SAVING

The thickness of Ultra-Thin Flexible Heaters is less than 0.22mm (0.0087 inches) and each typically weighs only 0.04 g/cm^2 (0.009oz/in^2). They are ideal heaters for applications with limited space such as defense electronics, aircraft, portable medical instruments, laboratory research, optical & photographic equipment, LCD displays, computer equipment, high density electronic devices, automotive applications, and many more.

EASY INSTALLATION

Ultra-Thin Flexible Heaters are easy to install. Simply remove the back adhesive and apply to the surface of the item to be heated. For high wattage density, use a pressure plate to fix the heater in place. Ultra-Thin Flexible Heaters do not have abrupt protruding lead-out areas, hence they allow the pressure plates to fully cover the heaters without having to cut or trim the clamping metal to incorporate the lead-out area.

SAFE WIRE CONNECTIONS

Ultra-Thin Flexible Heaters have more than 18,000 cUL[®] recognized standard rectangular and circular shaped heaters to choose from and more than 28,000 CE recognized standard heaters for selection. In order to achieve higher safety and reliability standards, lead wire connection points are securely fastened and are extended outside the heating area.

Ultra-Thin Flexible Heaters do not have the downside of poor soldering connections as soldered points may become loose and can lead to high resistance or unreliable electrical connections when heat is not released quickly during operation.

WIDE RESISTANCE RANGES

Wide resistance ranges are available from 0.1~19,800 ohms and are suitable for 1.5V~240V applications without requiring additional adaptors for voltage conversions.

GREATER FLEXIBILITY

Unlike heaters with printed or wired circuits, Ultra-Thin Flexible Heaters' unique structure makes them most suitable for applications that require heaters to be bent around a small radius of curvature or across two joining sections.

PRECISE TEMPERATURE CONTROL

Ultra-Thin Flexible Heaters can be utilized with temperature sensors, thermostats, and temperature control products for accurate control. With the patented Micro Temperature Controller, Ultra-Thin Flexible Heaters can even be controlled at precise temperatures within $\pm 0.1^{\circ}\text{C}$ making them ideal for medical and lab use. Additional Temperature Control products include Digital and 4-phase Time Controllers that provide enhanced control for a variety of applications.

TROUBLE-FREE HEATER SELECTION

Ultra-Thin Flexible Heaters include a wide range of standard products from 10mm x 10mm up to 300mm x 300mm in both rectangular and round shapes. Selection is made easy with optional voltages from 1.5V up to 240V. Each heater comes with four temperature rises to select from. Complex customized geometries, voltages, and wattages can also be designed to meet exact application requirements.

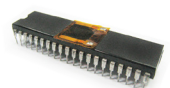
DYNAMIC DESIGNS

Ultra-Thin Flexible Heaters can be made with complex shapes and geometries. Cut-out holes and notches can also be designed in to meet exact application specifications. A single Ultra-Thin Flexible Heater can also be designed with multiple heating areas or multiple watt densities.

APPLICATIONS

- Protection from freezing of outdoor devices
- Condensation prevention of equipment
- Dehumidification of Motors and Control Devices
- Aircraft Equipment
- Battery Heating
- Lab simulation and testing
- Outdoor ATM or camera enclosure heating
- Small, compact home appliances
- LCD displays
- Optical/Photographic equipment
- Computer equipment (IC chips/PC Boards)
- Satellite and communication equipment
- Seat heater/pet warmer/heating pads
- Food trays and food display shelving
- Lab simulation and testing
- Medical and Laboratory equipment and Instruments (eg. blood analyzer combined with our high precision temperature controller to control the temperature at $\pm 0.1^{\circ}\text{C}$)

and many more...



DESIGN CONSIDERATIONS



HOW TO SELECT THE RIGHT HEATER

1. Select the Heater Type

Select the type of flexible heater that is the most suitable for your application. Refer to table below for different characteristics of each type of heater.

	TSA - Etched Foil	TSC - Nano Carbon (non-printed)	Silicon
Radius of Curvature	>1mm	>0.5mm	>10mm
Dielectric Strength	1000V rms	1500V rms	1000V
Insulation Material	0.025 (0.05)PI	0.05 (0.075)PI	0.5 (0.8)Silicon
Shapes	Rectangular / Circular / Rigid Geometries	Rectangular / Circular / Rigid Geometries	Rectangular / Circular / Stripe
Resistance Range	0.01Ω~60Ω/cm ²	3Ω~150,000Ω/cm ²	0.01Ω~60Ω/cm ²
Resistance Tolerance	±10%	±10% or 0.5 (whichever is greater)	±10%
Max. Voltage	100V	600V	600V
Min. Dimension	5mm x 5mm	10mm x 10mm	10mm x 10mm
Max. Dimension	63mm x 63mm	520mm x 2200mm	520mm x 2200mm
Compressive Strength	50kg/cm ²	50kg/cm ²	5kg/cm ²
Operating Temperature clamped without adhesive clamped with silicon adhesive with silicon adhesive only clamped with acrylic adhesive with acrylic adhesive only	-200°C~ 250 °C -60°C~ 230°C -60°C~ 180°C -40°C~ 150°C -40°C~ 90°C	-200°C~ 230°C -60°C~ 230°C -60°C~ 180°C -40°C~ 150°C -40°C~ 90°C	-200°C~ 230°C -60°C~ 230°C -60°C~ 180°C -40°C~ 150°C -40°C~ 90°C
Weight (standard) with adhesive without adhesive		0.05g/cm ² 0.04g/cm ²	
Thickness with adhesive without adhesive	0.25mm 0.20mm	0.30mm 0.25mm	>2.0mm >2.0mm
Wattage Range	0.15W~1440W		
Lead Wire (standard)	size to load		
Lead Wire Length	210mm (standard); other lengths can be customized		
Dimension Tolerance 0 to 150mm 151 to 300mm over 301mm	± 0.80mm ± 0.15mm ± 3.00mm		

DESIGN CONSIDERATIONS

2. Select from Standard or Custom Sizes

It is usually more cost effective to select from our standard heater ranges for application testing. We have more than 28,000 standard Ultra-Thin Flexible Heaters to select from and more than 18,000 are cUL and CE certified. It is recommended that you select the heater that is closest to your specification for proof-of-concept testing first before working on a customized solution.

When defining the specifications, consider the followings: **1. Dimensions**, **2. Voltage** and **3. Temperature Rise**, then select the most suitable Ultra-Thin Flexible Heater from our Standard Product Specifications tables for your application.

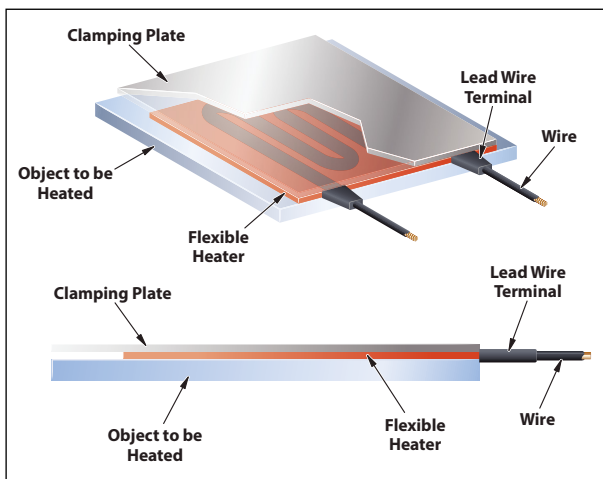
In order to increase the heating efficiency of your application, select the Ultra-Thin Flexible Heater with a higher temperature rise and use a temperature controller to ensure that the heater power is cut off when the desired temperature is reached. Please note that our temperature specifications are based on our lab conditions and are offered as reference only. For a more accurate estimation of the power required, heat loss factors through conduction, convection, and radiation should be considered.

3. Choose an Installation Option

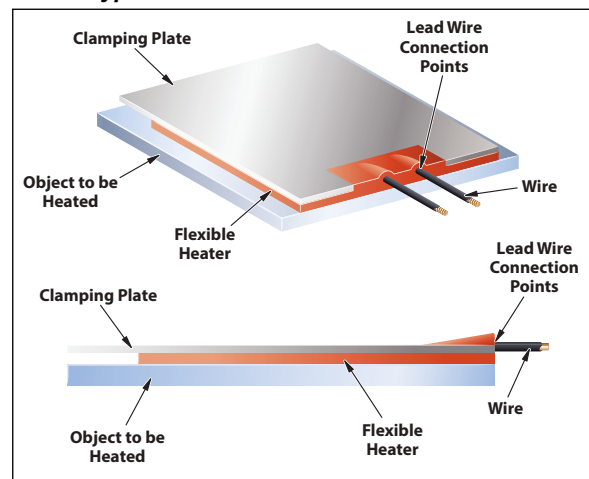
Select from **Clamping** or **Adhesive** backing options. It is crucial to ensure that the Ultra-Thin Flexible Heater is properly installed with no gaps or air pocket between the heater and the contact surface beneath. These gaps will cause hot spots and may result in premature heater failure. If the selected Ultra-Thin Flexible Heater has a watt density greater than $0.8\text{W}/\text{cm}^2$ or if the surface temperature of the item to be heated will reach above 90°C , a clamping method is preferred to ensure optimal heater performance.

Ultra-Thin Flexible Heaters allow the pressure plate to fully cover the heater object without having to cut or trim the clamping metal to incorporate the lead-out area.

Ultra-Thin Flexible Heaters



Other Types of Flexible Heaters



4. Choose the Wire Length

Our standard Ultra-Thin Flexible Heaters are supplied with 210mm standard lead wires. Customized lead wire lengths and/or connecting terminals are also available upon request.

5. Choose Optional Accessories

Thermostats, high precision temperature controllers, and heat sinks are also available for selection.

6. Test and Prototype

Test and evaluate the heater's performance and discuss with our professional engineers. We will work with you to meet your application requirements.

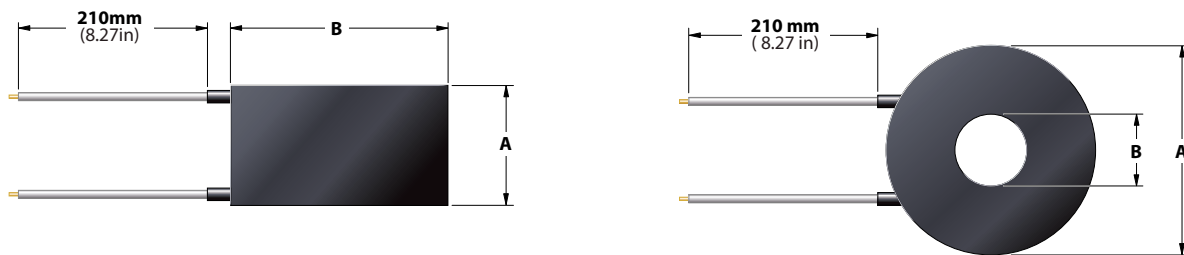
DESIGN CONSIDERATIONS

HOW TO ORDER

To order, please provide the following:

1. Heater application
2. Shape of heater
3. Heater dimensions (select from the list below or from our Product Specifications Guide)
4. Estimated temperature rise (select from the list below or from our Product Specifications Guide)
5. Voltage (select from the list below or from our Product Specifications Guide)
6. Installation method (Clamping or Adhesive)

* We will calculate the wattage, resistance, and lead wire size based on your selection and application.



STANDARD ULTRA-THIN FLEXIBLE HEATER SPECIFICATIONS

Heater Material	:	TSA - Etched Foil	TSC - Nano Carbon	Silicon																
Shapes	:	Rectangular or Round																		
Dimension Range (mm)																				
Standard widths/Outer Diameter (A)	:	10	13	16	20	25	32	40	50	63	80	100	125	160	200	250	300	mm		
Standard lengths (B of rectangular)	:	10	13	16	20	25	32	40	50	63	80	100	125	160	200	250	300	mm		
Standard inner diameter (B of round)	:	0	5	6	8	10	13	16	20	25	32	40	50	63	80	100	125	160	mm (must be smaller than A)	
Temp Rise Reference (°C)	:	30	60	90	120	150	180	210	°C											
Voltage Range(V)	:	1.5	3	3.7	4.2	5	9	12	24	48	56	72	100	110	120	200	220	230	240	VAC/DC

Notes:

* The length of the lead wires will be 210mm unless otherwise specified.

** Please note that the Temperature Rise value is for reference only. The actual temperature rise is dependent on the ambient environment and the application of the flexible heater.

*** If the heater requires a higher heat-up rate or higher power density ($>0.8W/cm^2$), make sure a temperature sensor or thermostat is installed to prevent overheating causing damage to products.

DESIGN CONSIDERATIONS



Dimension Selection

An Ultra-Thin Flexible Heater's selected dimension should be smaller than or equal to the contact surface of the item to be heated. If the contact surface is uneven or has puncture holes, the heater should be designed with a hollow center or with cutouts where uneven surfaces are located to ensure intimate contact over the entire surface area. Ultra-Thin Flexible heaters can also be designed with special holes, cutouts and notches required for your application. Any width, length or diameter not selected within our Standard product list will be customized.

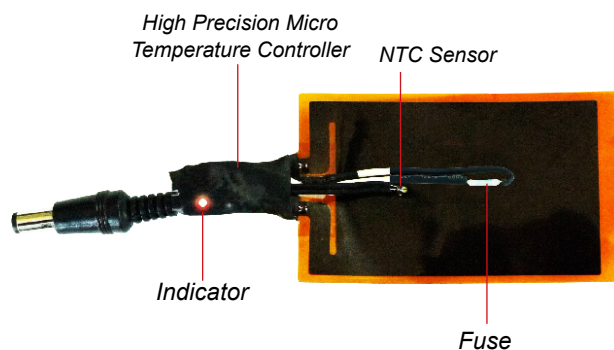
Voltage Selection

Ultra-Thin Flexible Heaters can be designed from 1V to 600V with AC and DC. When multiple power supply is available, it is recommended that a heater with a higher voltage is selected or that one is installed with a thermal controller. This is to prevent the heater from overheating when the input voltage is higher than the heater's specifications.

**Please contact our Sales Team with the required voltage if the desired voltage is not listed in our Standard Product Specifications Guide.*

Simplified Power Selection

Power selection is made easy by knowing the desired temperature rise of your application and by referring to the "Temperature Rise Reference" columns in our Product Specifications Guide for the corresponding Power (W). Based on the Power (W), you can then adjust the Power (W) level up or down to suit your needs (e.g. Raise the Power (W) for a quicker heat-up rate). You can also consider our high precision micro temperature/time controller with precise temperature settings which has a tolerance of $\pm 1^{\circ}\text{C}$ or range settings. It will ensure that your system will not be affected by the change in environmental temperature.



**Please note that the "Temperature Rise Reference" was generated under a laboratory environment and is provided only as a reference.*

Precise Power Selection

For a more precise estimation of the total amount of power required for an application, the following will need to be considered:

Warm-up power: Watts required to bring an object to a set temperature in a given period of time.

Heat loss: All systems lose heat through convection (air or liquid movement), conduction through support structures, and thermal radiation.

Material to be heated: Depending on the state of the material to be heated, several factors will need to be considered to determine the appropriate power (W) required for thermal heating. They are listed in the following table for reference:

DESIGN CONSIDERATIONS

	Solid	Liquid	Stationary Gas	Air Flow
Dimension of object to be heated (mm ²)	✓	✓		
Density of object to be heated (g/cm ³)	✓	✓		
Volume of gaseous substance to be heated			✓	
Cross-section area of airflow (m ²)				✓
Airflow rate (m/S)				✓
Specific Heat of heating object (cal/g°C)	✓	✓	✓	✓
Original Temperature (°C)	✓	✓	✓	✓
Final Temperature (°C)	✓	✓	✓	✓
Expected time to reach final temperature (sec.)	✓	✓	✓	
Efficiency* (η)	✓	✓	✓	✓

* Suitable value for Efficiency (η) is generally between 0.2 ~ 0.5. It is difficult to calculate this value precisely because efficiency changes depending on heat retention, insulation, heater arrangement, ambient temperature, etc.

If the heater requires a higher heat-up rate with higher power density (>0.8W/cm²), or if the operating temperature will reach higher than 90°C, make sure the heater is clamped to the object to be heated and that a temperature sensor or thermostat is installed to prevent overheating which can cause damage to products.

Conducting Experiments

Heat transfer theory is complex. It is usually best to prototype your system with actual heaters to observe the behavior and fine tune the design.

For detailed product information, refer to our "Product Specifications and Installation Guide".



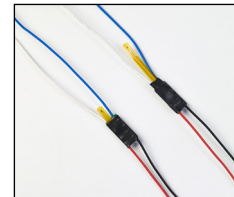
Temperature Controllers

Temperature Controllers can be utilized with Ultra-Thin Flexible heater products for lab testing, room heating, or end product temperature control.

Micro Temperature/Time Controller

The Micro Temperature Controller's small, compact patented design provides a quick solution for implementing heating features into your existing applications without reorganizing circuit layouts. Its robust feature allows customized ON/OFF temperature as well as time interval settings with more than 10,000 available specifications. It can be utilized with Ultra-Thin Flexible Heaters or with any products with limited space.

- Small, lightweight, space saving patented design.
- Easy to use; does not require additional controls or circuit design.
- Sampling rate <0.1seconds.
- Customized ON/OFF temperature.
- Customized ON/OFF time interval and temperature rotation.
- More than 10,000 available specifications.
- Can be utilized with various heater products.



Digital Temperature/Time Controller

Digital Temperature/Time Controllers are designed for more precise heating. The temperature can be controlled within 1°C of the set temperature with a sampling rate at 100ms. It can be used with Ultra-Thin Flexible Heaters for lab testing, room heating, or end product temperature control.

- Easy to use
- Automatically memorizes previous setting.
- Timer setting available from 30min intervals to continuous operation.
- Precise temperature control within 1°C.
- Can be utilized with various heater products.
- Both pre-wired device and connector (self-connected) device available.



4-Phase Temperature/Time Controller

The 4-Phase Temperature Controller uses Pulse Width Modulation (PWM) to control power input, providing four settings - 25%, 50%, 75% and 100%. The output temperature varies depending on the heater device. It is small, lightweight, and easy to control.

- Easy to use
- Automatically memorizes previous settings.
- 4-Phase power settings: 25%, 50%, 75% and 100% power input.
- Suitable for both AC (110V/220V) and DC (12V~24V).
- Can be utilized with various heater products.



For detailed specifications of all Temperature Control Devices, refer to the "Temperature Controllers" Product Guide.

Frequently Asked Questions

Q1. Do I need a Temperature Controller?

If you require Ultra-Thin Flexible Heaters with a higher heat-up rate or higher power density ($>0.8\text{W}/\text{cm}^2$), make sure a temperature sensor or thermostat is installed to prevent overheating which can cause damage to products. Place the temperature sensor close enough to the heater to sense the heater temperature.

Q2. What is the correct voltage for this heater?

Standard heaters are specified by resistance, not voltage. This lets you operate them at different power levels. In selecting a heater model, you should consider the size, resistance, operating temperature, total wattage and watt density (watts/in² or watts/cm²) for your application. The watt density rather than the total wattage determines the maximum applied voltage.

Q3. Can an Ultra-Thin Flexible Heater be used suspended in air?

Because the mass of an Ultra-Thin Flexible Heater is very small, it is generally not suitable for heating free-standing in air. Ultra-Thin Flexible Heaters operate best when mounted to an object that can be heated by conduction rather than convection or radiation. For heating free-standing in air, we recommend using PTC Heaters for various heating options.

Q4. What are the differences between Ultra-Thin Flexible Heaters and PTC Heaters?

There are several major differences between the two types of heaters as shown in the table below:

	PTC Heaters	Ultra-Thin Flexible Heaters
Inrush Current	Yes	No
Power (W)	High Power applications	Low Power applications
Ohm's Law	No	Yes
Heating	Air heating & Conductive heating	Conductive heating
Constant Temperature	Voltage change will have little effect on heater temperature and power (W).	Voltage change will affect both heater temperature and power (W). However, if low power is maintained ($<150^\circ\text{C}$), the temperature will remain consistent.
Defining Wattage	Exact heater wattage cannot be defined; wattage will change according to the ambient temperature and heat dissipation rate.	Constant heater wattage will not change with ambient environment.
Advantages	Stable temperature; safe to use; have wide applications.	Light, small and flexible; have wide applications.

Q5. Which attachment method should I use?

To ensure longer heater life, proper attachment to the contact surface is critical. With the exception of heaters with a lower power density ($<0.4\text{W}/\text{cm}^2$), Ultra-Thin Flexible Heaters must make intimate contact over the entire contact surface. For heaters with a higher power density ($>0.8\text{W}/\text{cm}^2$) or a surface temperature $>90^\circ\text{C}$, flexible heaters should be attached by clamping to the object to be heated and making sure that the thermostat is connected to prevent overheating. Alternatively, lower temperature heaters can use either a self-adhesive or a clamping method for mounting.

Q6. Can I trim a Flexible Heater to the size and shape I need after I've received it?

No. Ultra-Thin Flexible Heaters cannot be cut or trimmed. The element conductor covers the entire area to maximize the heat spreading effect. Cutting into this would create an electrically open circuit and expose the electrically live element.

