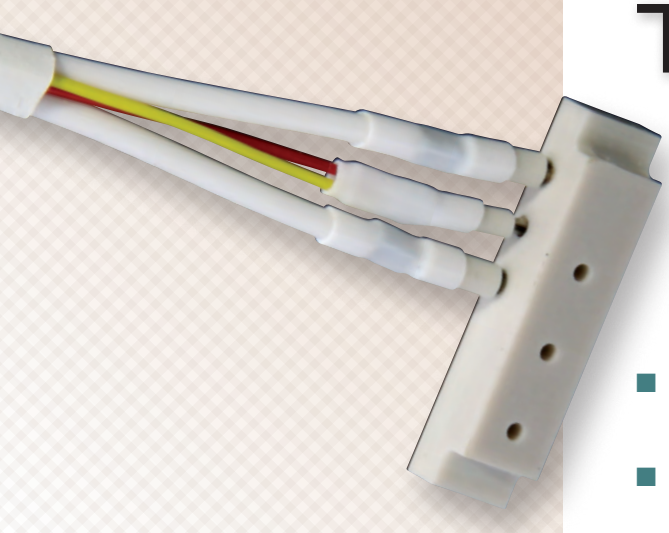
Watlow®
ULTRAMIC® Advanced Ceramic Heaters

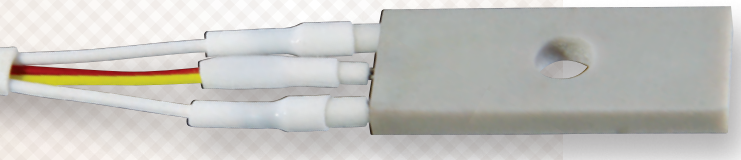
heaters | sensors | controllers

WATLOW®
Powered by Possibility



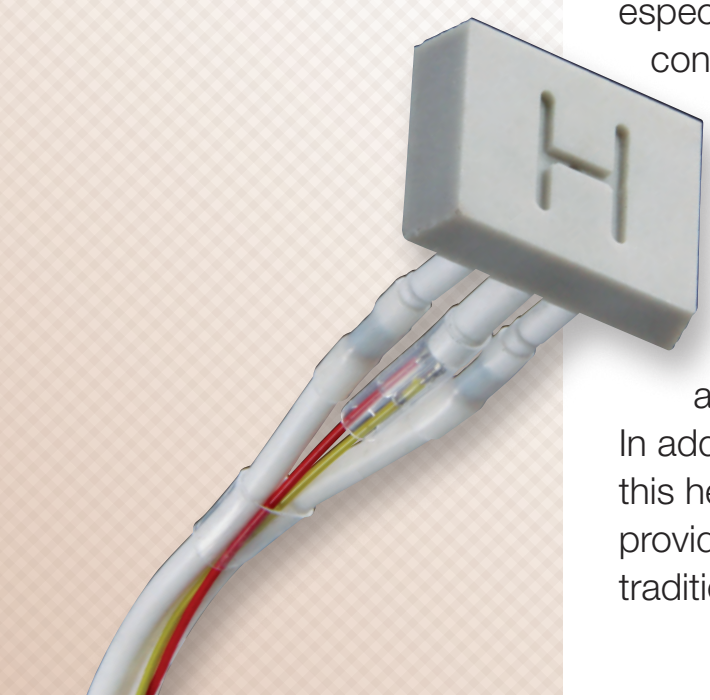
The Revolutionary ULTRAMIC®

- **Ultra-Fast Ramp Rates**
- **High Watt Densities**
- **Low Leakage Current**



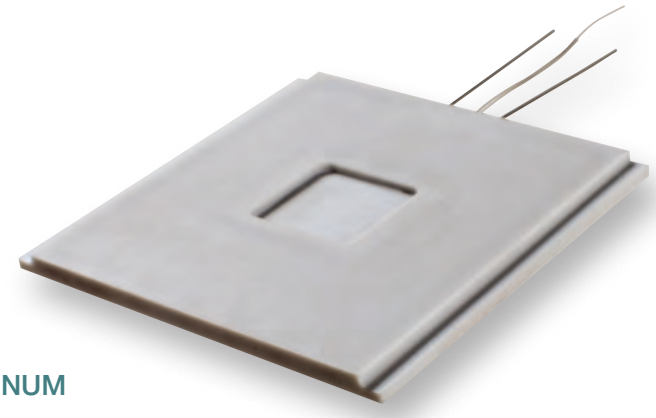
Watlow® ULTRAMIC® heaters are designed for thermal applications where the high performance of an advanced ceramic heater is required to ensure optimal effectiveness of the equipment or process.

ULTRAMIC heaters are constructed of aluminum nitride (AIN) and incorporate a thermally matched, proprietary heating element that provides maximum performance in challenging applications. AIN is especially suited for applications requiring a clean, non-contaminating heat source. Additionally, the excellent geometric stability ensures consistent part-to-part thermal contact during heating cycles.



Watlow ULTRAMIC heaters can operate up to 600°C (1112°F) with an ultra-fast ramp rate of up to 150°C (270°F) per second depending on the application, heater design and process parameters. In addition to delivering excellent thermal characteristics, this heater has high electrical isolation and typically provides superior chemical resistance as compared to traditional metal heaters.

Advanced Ceramic Heater Construction



Constructing a Ceramic Heater

ULTRAMIC ceramic heaters are manufactured using a proprietary, sintering process. During sintering, ceramic powders are heated at a high temperature in a controlled environment, which facilitates densification and grain growth. A uniform grain size is created with no open porosity to ensure high mechanical strength and optimal thermal conductivity.

The green AlN matrix is constructed of two parts. The heating element is deposited on one of the AlN parts. Then, the parts are sintered together, making them one homogeneous assembly. The high thermal conductivity of AlN and an optimized circuit layout combine to produce superb temperature uniformity across the heater surface.

Benefits of Aluminum Nitride (AlN)

Advanced ceramics are synthetic, inorganic compounds of exceptional purity. Ceramic compounds include alumina (Al_2O_3), silicon nitride (Si_3N_4) and AlN.

AlN is an excellent choice for a ceramic heater platform as it allows for a homogeneous assembly for atmospheric or vacuum applications. The material also provides the durable heater construction and thermal transfer necessary for high temperature, fast cycling and long heater life. Additional features and benefits received by using AlN construction include:

- **High thermal conductivity:** Exhibiting thermal conductivity similar to aluminum provides rapid heat dissipation, enables the heater to be constructed with a high watt density and gives it the ability to thermally ramp at a rate of 150°C (270°F) per second.
- **Clean, non-contaminating material:** Using a carefully controlled microstructure, high temperature sintering produces a heater that is very hard (1100 Kg/mm^2) and dense (> 99% theoretical density) with virtually no porosity. AlN is an ideal choice for applications requiring a “clean” heater.
- **Moisture resistance:** AlN is impervious to moisture unlike many hygroscopic dielectric materials used in conventional heater construction.
- **High dielectric strength and high insulation resistance:** AlN is an electrical insulator that features very low leakage current (< 10µA @ 500VAC), a highly preferred characteristic for many applications.

The following tables illustrate AlN’s unmatched capability due to its high thermal conductivity and low thermal expansion coefficient.

Table 1 *Material Properties at 25°C (77°F).*

Material	Thermal conductivity (W/K·m)	Thermal expansion coefficient (x10^{-6}/°C)	Heat capacity (J/g·K)	Density (g/cm^3)
AlN	**150**	**4.5**	**0.78**	**3.26**
Al_2O_3	30	7.2	0.88	3.96
Si_3N_4	40	3.2	0.71	3.25
Al	180	23.6	0.90	2.70
304 SS	16	17.2	0.50	8.00

Table 2 ***ULTRAMIC*** *Thermal and Physical Properties*

Thermal Properties		Physical Properties	
Temperature Coefficient of Resistance (TCR)	1.5 x 10^{-3}/°C	Hardness	1050 Hv@500g
Surface Temperature	600°C (1112°F)	Flexural Strength	>250 MPa
Terminal Temperature	400°C (752°F)*		

** 600°C (1112°F) extended capability offering available.*

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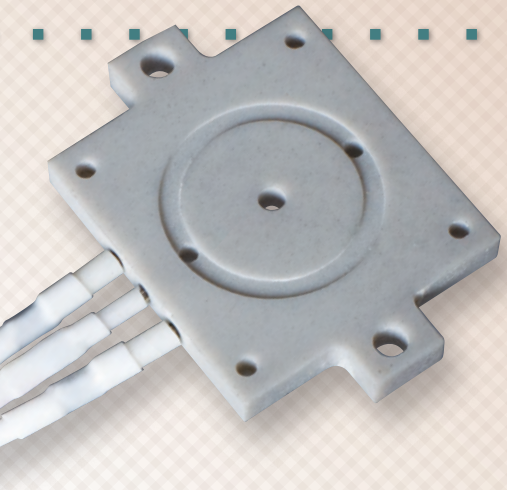


Ultra-Fast Ramp Rates

With the ongoing push for equipment productivity, improving heat/cool cycle times is one way to optimize system performance. The high thermal conductivity of AlN allows the ULTRAMIC heater to heat and cool quickly, and to be constructed with extremely high watt densities of up to 1000 W/in^2. These high watt densities enable ramp rates as high as 150°C (270°F) per second, resulting in higher productivity in applications such as semiconductor chip testing and eutectic die bonding.

Semiconductor Equipment Application

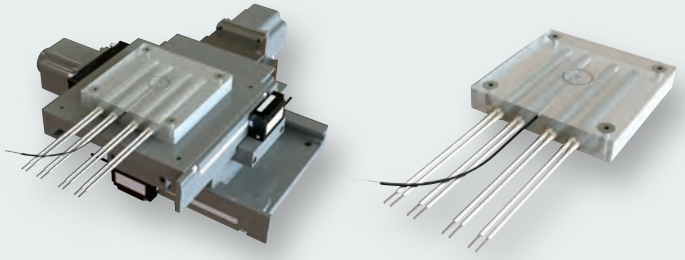
Eutectic die bonding equipment is used in the attachment of lead wires to the die before packaging of the integrated circuit (IC). Optimal bonding is achieved by ramping the solder and lead temperature through the eutectic state. Watlow's ULTRAMIC heater is ideal for this application because a temperature ramp of up to 150°C (270°F) per second can be achieved while also achieving a fast cool down in preparation for processing the next device.

Benefits of using ULTRAMIC heaters in semiconductor applications include:

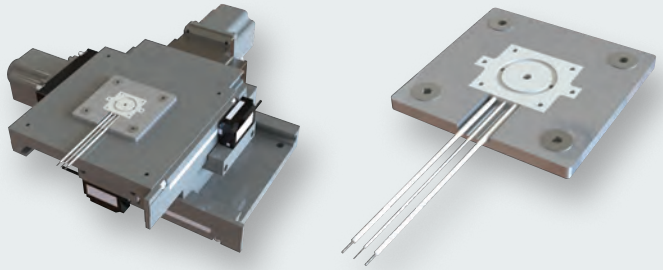
- Vacuum holes and grooves
- Surface flatness of 0.05 mm (0.002 in.)
- Surface finish <1.5 µm (64 µ-in.)

Maximum and minimum power densities can vary with voltage, surface area and application parameters. Contact factory to determine optimum voltage and power for your application.

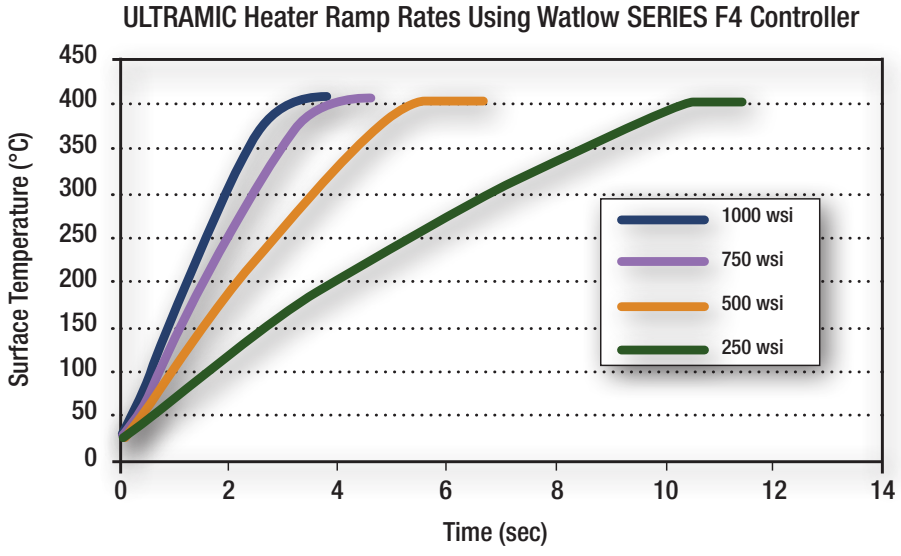
Traditional Heater Solution



ULTRAMIC Advanced Ceramic Heater Solution



These models depict how an ULTRAMIC heater could replace traditional heaters, resulting in a smaller, higher performance, and more easily integrated system solution.



ULTRAMIC temperature ramp rate as a function of watt density. Test completed using Watlow's SERIES F4 temperature controller.

Low Leakage Current

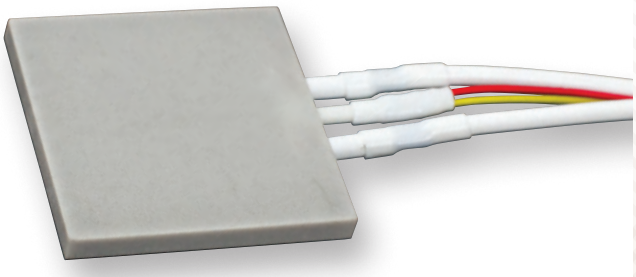
For many applications, such as medical devices, extremely low leakage current is critical for patient safety or system performance. To meet agency regulations, many device manufacturers resort to using step down isolation transformers and low voltage power supplies to enable the use of traditional heating technologies. These transformers add size, weight and cost to the system. In many cases, an ULTRAMIC heater can eliminate the need for these transformers by providing the required electrical performance, even at standard line voltages, in a small, clean package.

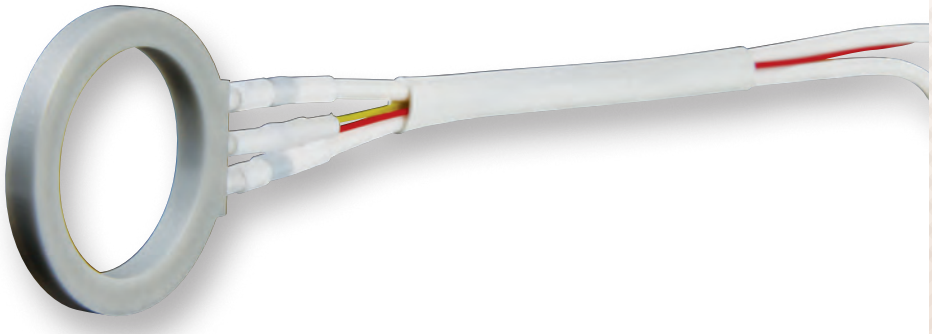
Superior Electrical Performance

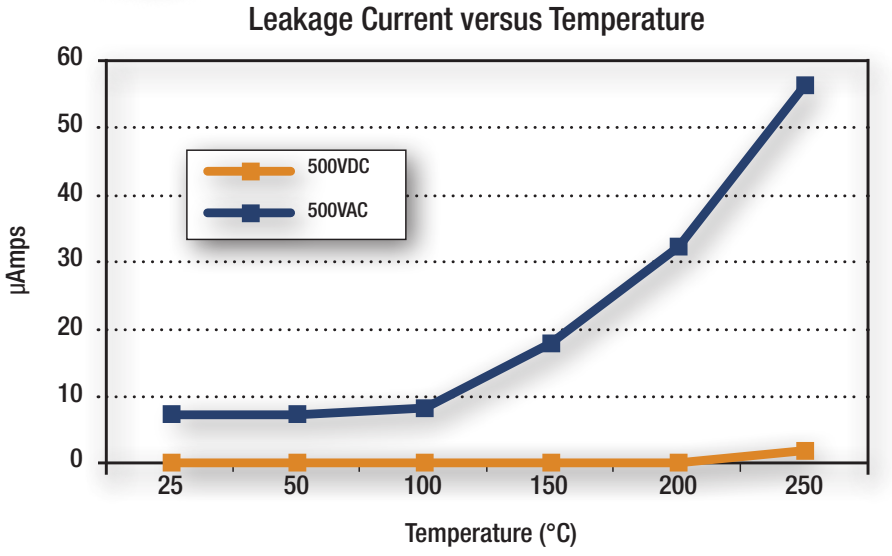
- Low leakage current; <10 µA at 100°C

UL® and CE Agency Compliance

- Designed to meet global safety standards
- RoHS compliant





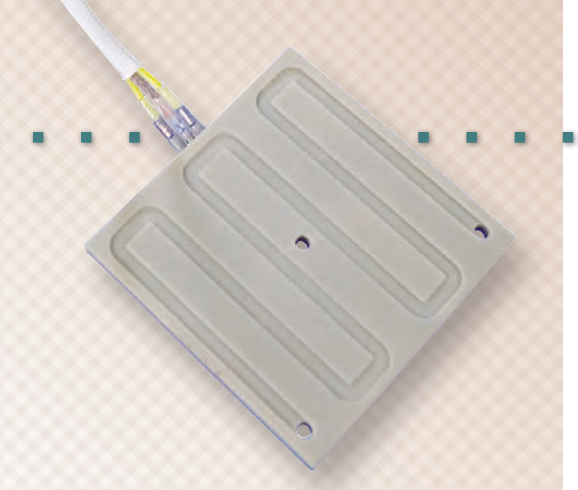


Medical Application

High flow respiratory therapy equipment adds warmth and moisture to breathing gases through the nasal cannula of patients. This equipment must provide the perfect mix of temperature, humidity and oxygen without discomfort to the patient. The ULTRAMIC heater is able to deliver the heat needed to generate proper humidity and temperature to maximize patient comfort. Because the equipment needs to be portable, the small size and light weight ULTRAMIC heater is a great fit. The extremely low leakage current and integrated thermocouple of the heater ensures safety for the patient and operator.

Benefits of using the ULTRAMIC heaters in medical applications include:

- Low leakage current of <1 µA at 120V
- Integrated thermocouple
- Small size and light weight



Analytical Instrumentation Application

Mass spectrometers are used to determine the presence of trace chemicals in industrial, environmental and clinical applications. With detection capabilities into the part-per-trillion levels, cleanliness is of paramount concern. For use with ion sources, the chemical compatibility, low porosity and fine surface finish make the ULTRAMIC heater an excellent choice where contamination of the sample is of concern.

Benefits of using ULTRAMIC heaters in analytical applications include:

- Process temperatures up to 600°C (1112°F)
- Chemical compatibility
- High dielectric strength
- Easy system integration

Product Design Capability

Application Miniaturization

Miniaturization, or reducing the size of products and components, is an ongoing effort in virtually all industries. Parallel with reducing size is the need for increased precision and reduced system cost. With sizes as small as 8 mm (0.31 in.) and green state CNC machining capability, ULTRAMIC heaters help meet these needs and can often replace multiple components in a system.

Integrated Thermocouple

Watlow's ULTRAMIC heater with integrated Type K thermocouple provides a convenient way of controlling temperature with a high watt density heater without going through the trouble of installing a separate temperature sensor. The benefits of using an integrated sensor include:

- Ensures reliability of heater/sensor interface with the bonded assembly process
- Improves accuracy with optimized temperature sensing
- Provides high response rate in ramping applications

In addition to, or in place of the standard bonded thermocouple, a drilled hole or slot can be provided for installing an externally mounted sensor.

Lead Wire and Terminations

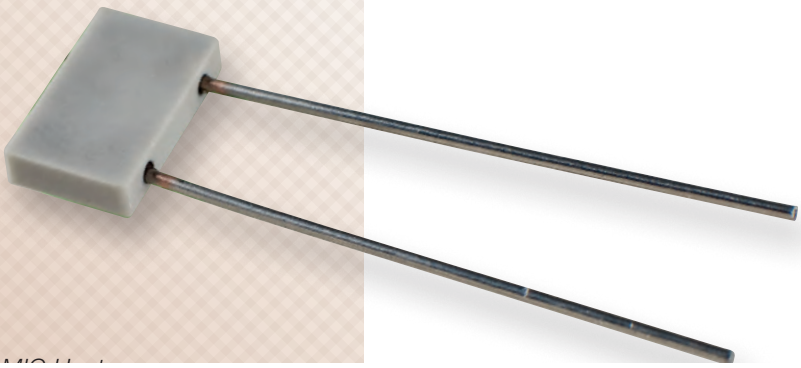
Various lead wire and termination options are available to meet specific application needs. Some of these options include:

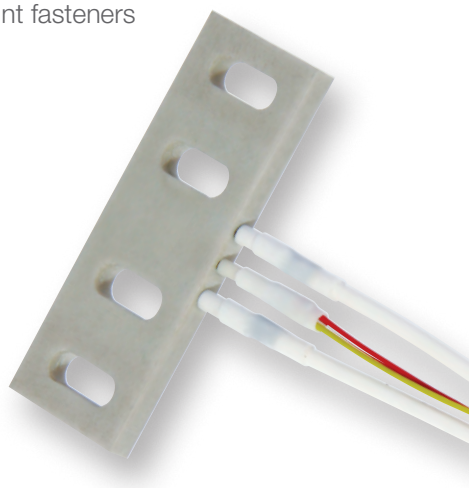
- Power terminals exit locations — extended from the side/edge or from the face of the heater
- Teflon® insulated silver-plated copper lead extension
- Lead extension length — standard length 305 mm (12 in.)
- Ceramic beads

Mounting Guidelines

This product can be mounted within a system in numerous ways. The mounting guidelines depend on the temperature and the application. Below are general rules for mounting and a detailed mounting guide can be found at www.watlow.com/ultramic:

- Temperature <200°C (392°F): bond with high-temperature epoxy adhesive
- Temperature >200°C (392°F): screw hole can be provided (recommend insulation buffer such as mica spacer)
- Clamp using single or multiple-point fasteners





Watlow's Service and Support

Delivery

A development engineer can quickly and easily acquire a standard heater to determine its suitability in an application. These standard heaters are available for shipment in one to three business days. Custom configurations are routinely manufactured to meet specific application requirements. Delivery of these orders is dependent on the complexity of the design.

Rapid Prototyping

If our standard units do not meet your application needs, Watlow can rapidly accommodate more complex designs that have specific shapes and features such as holes and vacuum grooves.

Optimized Performance

Using a finite element analysis (FEA) technique, the heater circuit is optimized and the thermal performance simulated prior to manufacturing. With FEA, custom prototypes can be delivered in weeks rather than months.

Configurations and Dimensions

Maximum Area 4032 mm² (6.25 in²)				
	Length	**Width**	**Thickness**	**Aspect Ratio**
Flat Square	Min: 10 mm (0.393 in.) Max: 63.5 mm (2.5 in.)		Min: 2.5 mm (0.098 in.) Max: 5 mm (0.196 in.)	1
Rectangular	Max: 100 mm (3.94 in.)	Min: 8 mm (0.315 in.)	Min: 2.5 mm (0.098 in.) Max: 5 mm (0.196 in.)	<10
	Inside Diameter I.D.	**Outside Diameter O.D.**	**Thickness**	**Ring Wall Thickness**
Ring	Min: 0	Max: O.D. 77.5 mm (3.05 in.)	Min: 2.5 mm (0.098 in.) Max: 5 mm (0.196 in.)	Min wall thickness: 3 mm (0.118 in.)
Machined Features				
Straight Groove Custom Feature			**Hole Size Round Diameter**	
Depth: 0.5 mm min. (0.019 in.) Width: 1 to 2 mm (0.039 to 0.078 in.)			Min: 1 mm (0.039 in.)	
Electrical Properties				
Voltage				
12 to 480V				