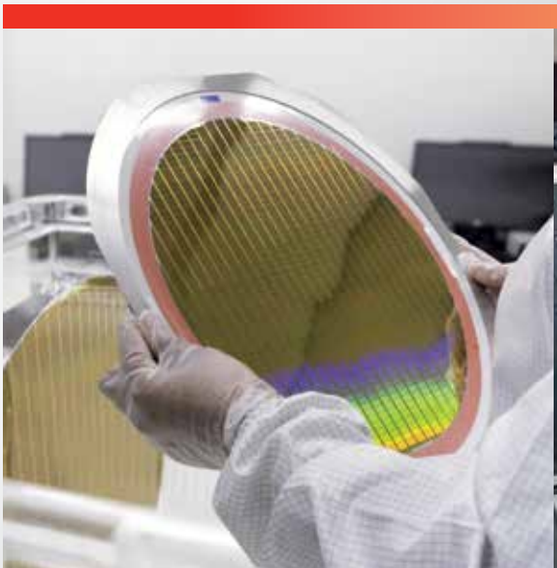
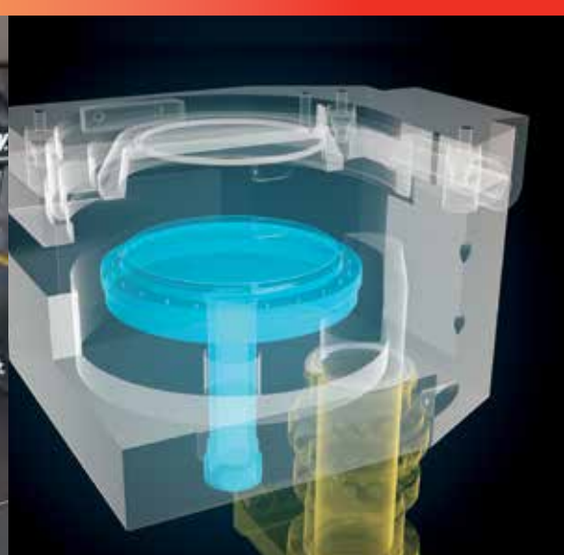
WATLOW®

Powered by Possibility

SEMICONDUCTOR





Thermal Solutions

For the Semiconductor Equipment Industry

Distributed by Valin Corporation | www.valin.com | (800) 774-5630 | customerservice@valin.com

Watlow's Innovative Thermal Solutions

Enhance the Thermal Performance of Our Customer's Critical Tools and Processes to Improve Wafer and Chip Throughput

We offer:

- Adaptive Thermal Systems (ATS™)
- Engineering collaboration at your pace
- Deep domain knowledge
- Computational engineering
- Rapid prototyping
- Technology-leading products
- High-performance solutions
- Global support
- Onsite commissioning

Watlow's Smart Technologies

Connect the Entire Thermal System Ensuring System Simplification, Performance Optimization and Real-Time Diagnostics

Watlow's Adaptive Thermal Systems (ATS™) Technology

Connects All the Systems in a Tool For a Full-System View of All Processes From the Chamber to the Abatement System

Benefits of ATS include:

- Reduce system complexity
- Improve thermal performance
- Obtain real-time system data
- Create high-zone configurations previously unavailable

Watlow's State-of-the-Art Solutions

Help Our Customers Improve Thermal Uniformity, Tuneability, Speed and Diagnostics

Watlow capabilities include:

Design

- Finite element analysis (FEA) and computational fluid dynamics (CFD)
- Rapid prototyping
- Lean product development

Manufacturing

- Over 12,000 square feet of cleanrooms from Class 10k to 100
- Global manufacturing
- Statistical process control

Verification and validation

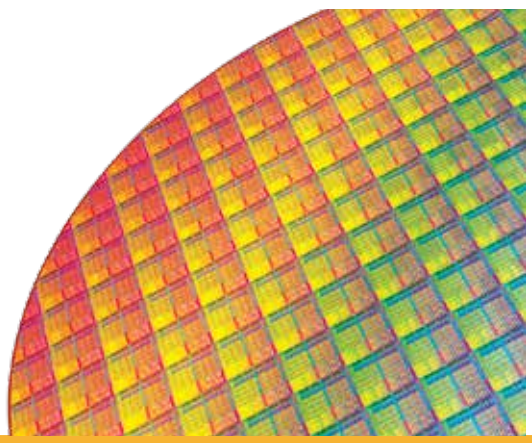
- Infrared thermography
- Acoustic microscopy
- Interferometry
- Vacuum and plasma test chambers

Yarbrough™
A WATLOW COMPANY

With Yarbrough, Watlow now services the entire semiconductor fabrication process, from the tool to the scrubber, to ensure thermal optimization of the complete system.

Watlow® provides semiconductor development teams with innovative thermal systems that give equipment manufacturers a competitive advantage. With the acquisition of Yarbrough Solutions Worldwide, Watlow now services end-user customers as well, offering:

- Superior thermal system performance
- Energy savings
- Maintenance cost reductions



Find out more about Watlow and how we can provide thermal solutions for your company:

Phone: 1-800-WATLOW2 (1-800-928-5692)

Email: inquiry@watlow.com

Website: www.watlow.com

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Watlow Products and Technical Support Delivered Worldwide

North American Technical Support & Sales Offices

United States & Canada	1-800-WATLOW2 (1-800-928-5692)

Asian Technical Support & Sales Offices

China	+86 21 3532 8532
India	+91 40 6661 2700
Japan	+81 3 3518 6630
Korea	+82 2 2169 2600
Singapore	+65 6773 9488
Taiwan	+886 7 288 5168

European Technical Support & Sales Offices

Austria	+43 6244 20129 0
France	+33 1 41 32 79 70
Germany	+49 7253 9400 0
Italy	+39 02 458 8841
Spain	+34 91 675 1292
United Kingdom	+44 115 964 0777

Latin American Technical Support & Sales Office

Mexico	+52 442 256 2200

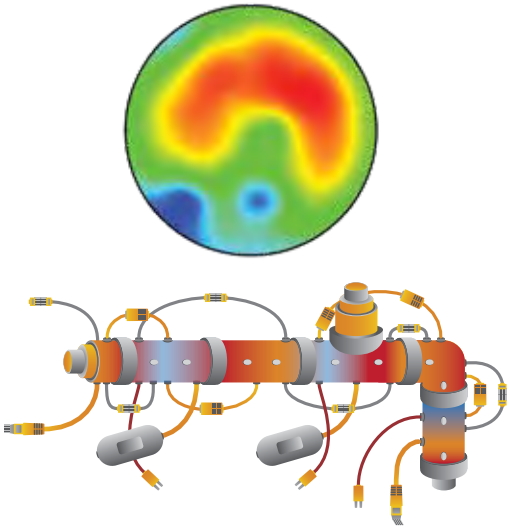
SEMI-CAP-1219
(WP_500)

Watlow's ATS™ Technology Optimizes Thermal System Performance to Meet Your Precise Application Needs

Watlow's Adaptive Thermal Systems (ATS™) are a suite of technologies that combine sensing, heating and controlling in innovative ways to improve the thermal performance of a customer's application. ATS technology integrates foundational technology platforms including power conversion, multi-loop control and sensing, integrated TCH junction temperature control and high TCR materials based temperature control to optimize performance that is specific to the problem being solved.

ATS connects all the systems in a tool for a full-system view of all processes from the chamber to the abatement system.

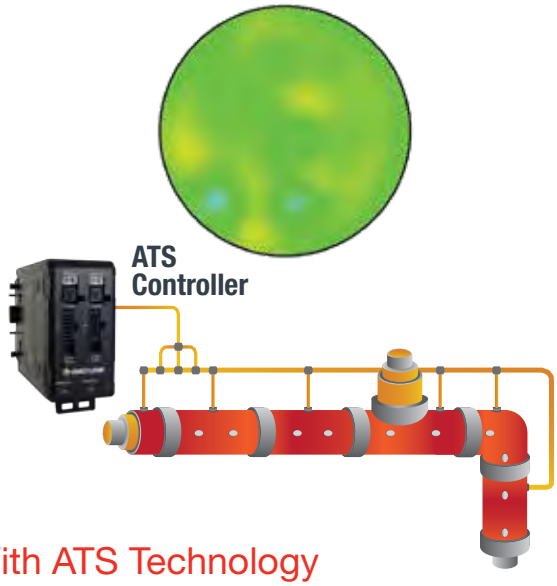
Before ATS



Without ATS Technology

- Extensive and confusing wiring system
- Large zones of control with one sensing point
- Difficult troubleshooting with generic alarms

After ATS



With ATS Technology

- Fewer wires / less complexity
- Better uniformity with closed loop control on every heater
- Advanced fault detection for over temp, low temp and mis-wiring on every heater

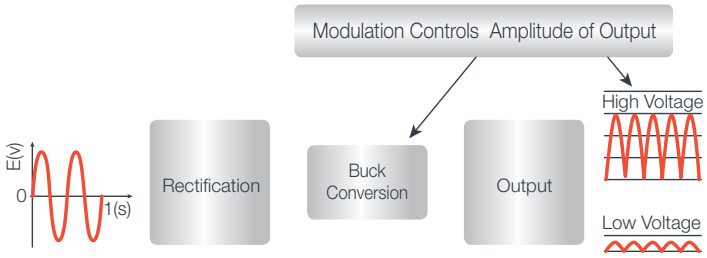
ATS Technology Platforms

Watlow's ATS technology platforms deliver breakthrough performance in wafer processing applications by equipping systems to:

- Protect ceramics from breakage
- Lower sensor and integration costs
- Provide real-time feedback
- Improve thermal performance
- Create high zone configurations previously unavailable
- Obtain real-time system data
- Enable closed loop control for better performance
- Reduce complexity with fewer wires
- Ensure immunity to power quality issues

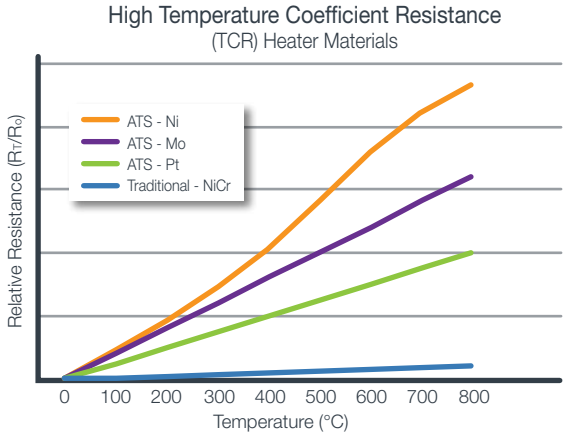
Power Conversion

Regulate power up and down rather than on and off



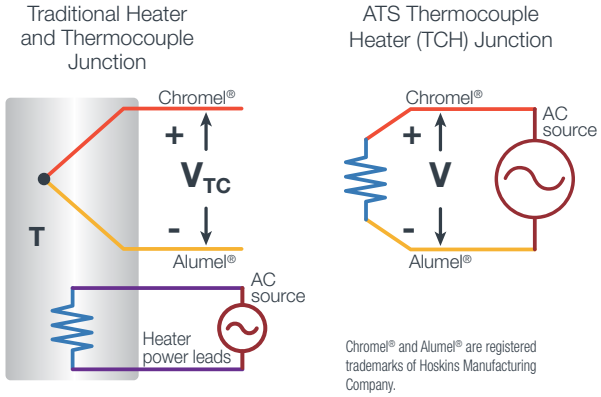
High TCR Materials Based Temperature Control

Measure change in resistance to convert every heater into a sensor



Integrated TCH Junction Temperature Control

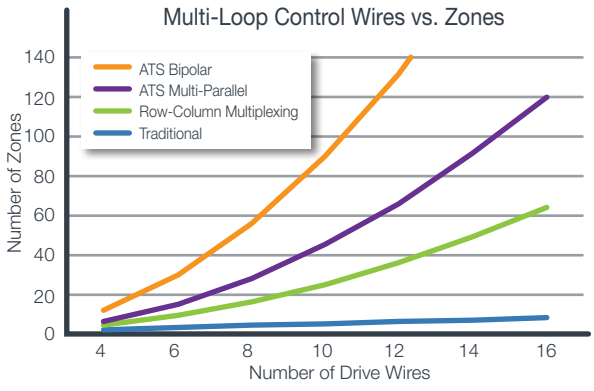
Converts heater power leads into a thermocouple junction



Chromel® and Alumel® are registered trademarks of Hoskins Manufacturing Company.

Multi-Loop Control and Sensing

Increase heater zones while reducing wires



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Contact us at www.watlow.com

Watlow Provides Precise and Flexible Solutions for Wafer Processing Tools

Watlow's layered heaters provide the precision and flexibility needed to ensure the highest level of thermal performance in wafer processing applications. These planar heating circuits can be manufactured using various technologies including thermal spray, thick film and thin film deposition, wet etching and laser ablation. They are designed with distributed power circuitry and can accommodate multiple zones and multiple layers. Watlow has a wide range of integration capabilities that are compatible with various metal and ceramic substrates depending on the application needs.

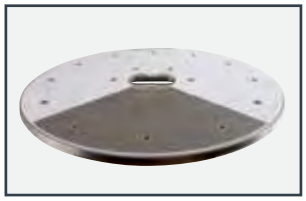
Watlow provides precision elastomeric bonding and assembly integration capabilities for critical components in wafer processing tools. Specialized tooling and innovative bond methods enable superior control over dimensional characteristics and material properties. Watlow also applies elastomeric material expertise to custom molding solutions, both for assembly integration and as stand-alone coatings, seals and gaskets.

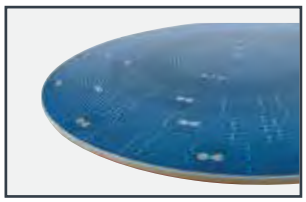
Layered heaters:

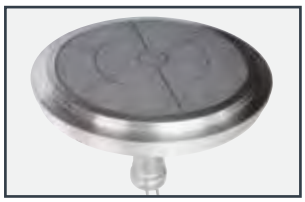
- Accommodate multiple zones and multiple layers
- Enable customized resistance patterns designed with FEA/CFD
- Provide high power densities (typ. 50 – 150 W/in^2)
- Offer low profile (microns to 0.5 mm)

Precision bonded assemblies:

- Ensure flexibility with multiple substrate materials
- Enable elastomer temperatures to 250°C
- Provide custom thermal and mechanical properties (thermal conductivity 0.1 to 3.0 W/m-K)







Substrate Material	Maximum Temperature
Austenitic stainless steel	250°C
Ferritic stainless steel	450°C
Titanium / molybdenum	500°C
Aluminum	250°C
Aluminum oxide	500°C
Aluminum nitride	600°C
Quartz / sapphire	350°C

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High Performance, Metal-Sheathed Heaters for Front End Wafer Processing

WATROD™ tubular heaters

Single-ended spiral cable heater

Aluminum WATROD™ tubular heater

FIREROD® cartridge heater

Watlow's metal-sheathed heaters provide design engineers the ability to precisely apply heat to a variety of applications. From inside the chamber to the gas delivery and abatement systems, metal-sheathed heaters provide temperature capability, power density and modularity making them an effective and economical solution for your thermal systems.

Features and Benefits

Ease of Integration

- Several diameter options allow heating of small and large parts
- Cable and tubular heaters offer formability enabling more uniform temperature
- Several termination options allow for wire protection and ease of installation
- Various mounting options available
- Wire harness assemblies of multiple heaters and sensors available

Higher Temperature and Power Capabilities

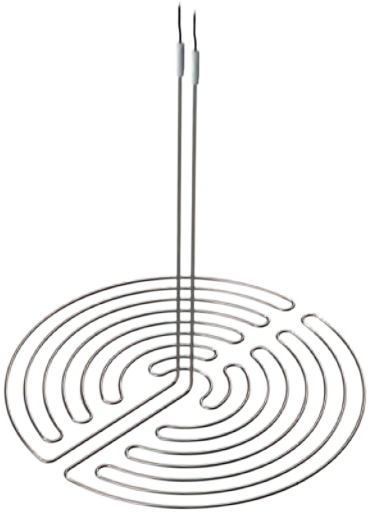
- Sheath temperatures of up to 1600°F / 870°C
- High power densities due to compacted constructions

Engineering Expertise

- Significant history and success with helping semiconductor OEMs effectively solve thermal problems
- Quick turn prototyping, FEA, CFD and application assistance available

FIREROD® Cartridge Heaters

Semiconductor OEMs have consistently turned to Watlow's FIREROD® for applications in chamber heating, gas delivery heating, ampoule heating and novel applications for various wafer processing steps. The FIREROD's ease of application makes it ideal for solving a host of thermal issues in the semiconductor market.



Drawn cable heaters enable maximum element coverage in your part

Parallel coil heaters in an inner and outer zone configuration

Cable Heaters

The cable heater's low mass, small diameter and durable construction make it an ideal choice for higher temperature applications where uniformity is critical. The cable heater can be precision formed to fit a variety of different geometries to address specific thermal problems.

WATROD™ Tubular Heaters

For applications in and around the chamber, Watlow's WATROD™ tubular heaters offer a rugged and flexible solution that can provide contoured heat to a variety of applications including showerhead heating, pedestal heating, radiant wafer heating and baffle heating, to name a few.

WATROD Tubular Heater

WATROD Tubular Heaters: Aluminum

Features and Benefits

- Coefficient of thermal expansion match:
  - Simplifies design, prototype and delivery timeline by removing CTE mismatch
  - Less time spent designing and experimenting with groove patterns
  - Less exposure to potential warping of the parts
  - Aluminum elements in an aluminum substrate prevents heater breaks from CTE mismatch
- Formability
  - Aluminum can conform to tight radius bends thus achieving maximum coverage of the area being heated
- Superior heat transfer
- Excellent corrosion resistance with aggressive etch chemistries

Examples of 3003 aluminum formations within a 300 mm envelope based on diameter of heating element and minimum bend radius. Our team can design a formation that meets the needs of your application.

0.260 inch diameter, maximum heated length 118 inches based on minimum bend radius and cold end location

0.315 inch diameter, maximum heated length 102 inches based on minimum bend radius and cold end location

0.375 inch diameter, maximum heated length 102 inches based on minimum bend radius and cold end location

Ideal applications include:

- Pedestals
- Showerheads
- Chamber lids
- Chamber baffles
- Edge rings

Specifications

	FIREROD Cartridge		WATROD Tubular			Cable Heater	
Common Applications	Heating of chamber walls, ampoules, gas blocks, manifolds, valves, immersion heating, novel metal parts		Heating of pedestals, showerheads, chamber lids, liners, baffles, radiant wafer heating, immersion heating			Pedestals, showerheads, high temperature gas line heating, novel metal parts	
Sheath Alloys	304SS, 316SS	Alloy 800 Alloy 600	3003 Aluminum	304SS 316SS	Alloy 800	304SS	Alloy 800
Maximum Sheath Temperature	650°C	760°C	450°C	650°C	870°C	650°C	760°C
Watt Densities	400 W/in^2		60 W/in^2			60 W/in^2	
Diameters	0.125 in., 0.250 in., 0.375 in., 0.500 in., 0.625 in., 0.750 in., 1 in.		0.260 in., 0.315 in., 0.375 in., 0.430 in.			0.062 in., 0.094 in., 0.125 in., 0.128 in. square, 0.157 in., 0.188 in.	
Formability	Straight length with basic bending capabilities in non-heated sections. Ideal for insertion heating, common for chamber walls and metal parts		Extensive bending and forming capabilities common in metal pedestal and showerhead applications			Best bending and forming capability - tight bend radii enable best uniformity, commonly used in pedestal and showerhead applications	
Mounting	Flanges and metal fittings available for heater retention		Bulkheads, flanges, welded or brazed into grooves			Welded or brazed into grooves, coiled and clamped into place, staked into grooves	
Termination Options	Flexible lead wires with stainless steel hose and braid protection and industry standard connectors. Various seal options available, including hermetic end seals.		Double ended, terminal studs, flexible lead wire, industry standard connectors. Various seal options available, including hermetic end seals.			Flexible lead wires with stainless steel hose and braid connection and industry standard connectors. Various seal options available, including hermetic end seals.	

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www.watlow.com

Watlow's EZ-ZONE® RM Fiber Optic Temperature Measurement System

A Complete Temperature Measurement and Control System for Plasma Chambers

Temperature sensors that transmit electrical signals (such as thermocouples and RTDs) are often compromised when exposed to the electromagnetic environments found in plasma chambers where the RF noise couples onto the sensor and distorts the signal.

Fiber optic temperature sensing, using the principles of fluorescence, enables operation in plasma environments providing stability, repeatability and cost effectiveness.

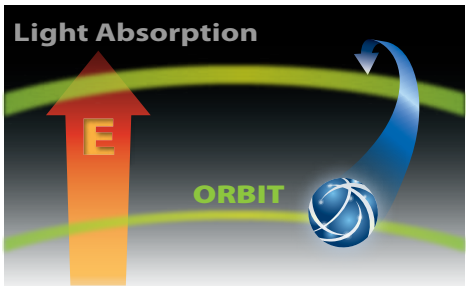
The Watlow® system surpasses conventional offerings by integrating fluorescent fiber optic sensing with Watlow's proven EZ-ZONE® temperature control product family, thereby providing tighter temperature control and faster response times in RF environments.

Ideal applications include:

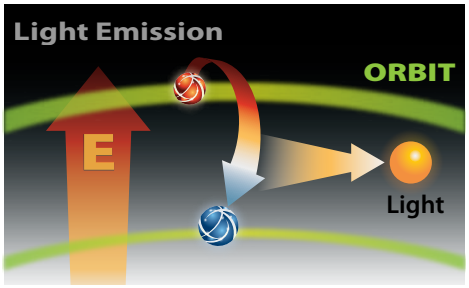
- Chamber lids
- Chamber baffles
- Electrostatic chucks
- Edge rings
- Showerheads

How Fluorescent Temperature Sensing Works

Fluorescence is the slow release of energy, in the form of light, by a material following its exposure to shorter, higher energy wavelengths. Fluorescent temperature sensing is based on the principle that the rate of energy released is dependent on the temperature of the fluorescing material. This time-dependent behavior, when properly measured, calibrated and controlled, can be used to accurately and repeatably measure temperature.

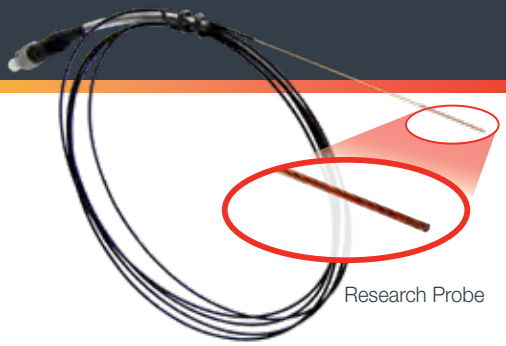


Energy/light absorbed by a molecule causes electrons to move to a higher energy level



"Fluorescence" occurs when electrons cascade back to a lower energy level releasing their energy in the form of light

The Fluorescent Temperature System


Research Probe

By combining advances in fluorescent sensing with the power of proven EZ-ZONE multi-loop controllers, the Watlow system is unsurpassed in offering temperature measurement and control in a flexible configuration ideal for integration into the latest semiconductor processing tools. Two versions make the system adaptable to all system requirements.


EZ-ZONE RMZ Module

The EZ-ZONE RMZ is specifically targeted at the most advanced implementations of measurement and control by integrating fiber optics, PID temperature control and EtherCAT® communications in a single package. It features multi-channel control, hosting up to four channels of fiber optic inputs as well as supporting up to 44 additional control loops from other EZ-ZONE RM modules. These modules support a wide array of capabilities including I/O, logic, current measurement, power switching and more.

The EZ-ZONE RMF module is a dedicated fiber optic input module integrating the advanced control technology of the EZ-ZONE system with one to eight channels of fiber optic temperature sensing.


EZ-ZONE RMF Module

The EZ-ZONE RMF can also serve as additional inputs to the EZ-ZONE RMZ enabling extensive expansion opportunities for future system needs. All EZ-ZONE RM modules are self-identifying making expansion and integration easy. The EZ-ZONE RMF is ideal either as an expansion module or configured with built-in temperature control loops. The EZ-ZONE RMF can be used independently when only sensing is required.

Probes

Integration of the probe (sensing head) is a critical element of the total sensing system and must be designed to ensure consistent contact of the fluorescent material with the target surface throughout the temperature range. Probes are typically custom configured with the construction determined by many factors including application environment, temperature regime, size constraints and material compatibilities.


Contact Probe

Benefits of Watlow's high performance fluorescence based temperature measurement system include:

- Compact integrated fiber optic sensing with temperature control
- Easily expands to increase number of zones as your system needs increase
- Integrates seamlessly with the temperature control system avoiding additional analog signal processing
- Faster temperature sampling rates with high resolution
- Minimizes installed footprint due to the small form factor and DIN-rail mounting
- Highly accurate fluorescent signal processing electronics
- Offers highly reliable LED light source, designed to run at low currents for maximum life
- Up to 48 loops of input and control with all EZ-ZONE RM temperature control features
    a. Temperature/limit loops
    b. Power switching
    c. Current measurement
    d. Logic

Specifications

	EZ-ZONE RMZ	EZ-ZONE RMF
Optical Inputs	1 to 4	1 to 8
Communication	EtherCAT®, Standard Bus, EtherNet/IP™, DeviceNet™, PROFIBUS DP, Modbus® TCP, Modbus® RTU	
Short Term Stability	3 σ ±0.03°C	
Operating Ambient Temperature	-18°C to 65°C	
Unit to Unit Accuracy (electronics)	±0.05°C	
Module Dimensions (mm)	51.6 (H) x 44.5 (W) x 148 (D)	
Measurement Ranges**	-70°C to 450°C	
Probe Materials (typical)	Polyimide/PEEK/Polyamide-imide	
System Accuracy (calibrated)	±0.05°C	
System Accuracy (uncalibrated)	±0.5°C	
Maximum Drift	0.5°C/yr	
Analog Output*	0-10V, 0-20mA	

* Outputs via EZ-ZONE RME module
** Consult engineering center for measurement ranges outside of these values

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Contact us at www.watlow.com

Achieve Maximum Performance with Intelligently Designed Thermal Systems

Features and Benefits

- Moisture and chemical-resistant heating materials
  - Provides longer heater life
  - Ensures cleanroom compatibility
- Flexible heater designs
  - Allows thermal profile to be customized to meet specific needs
  - Reduces system costs
- Maximize thermal coverage
  - Eliminates cold spots
  - Provides uniform heating
- Integrated control systems
  - Provides multiple zones of control
  - Eliminates the need for over-temperature protection
- Agency approvals: UL®, SEMI-S2 and CE
  - Meets necessary safety and industry regulations

Watlow's

Thermal Solutions Provide Reliability and Temperature Uniformity in Complex Applications

Watlow's Gas Delivery/Exhaust Heating Solutions

The solution to achieving the optimum performance on the lines in a semiconductor tool is through an intelligently designed heating system.

Watlow® has the knowledge, experience and expertise to partner with you during the design phase of the system. Working in parallel, Watlow can customize the right solution for the lines during the design phase by recommending the correct heaters, sensors and control system to achieve optimal performance.

Watlow's vast product offering ensures the right product for your process.

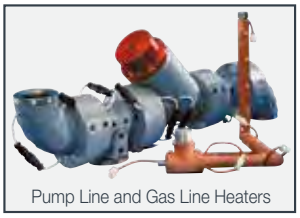
STRETCH-TO-LENGTH®

- Easy-to-install, two-part system
- Silicone sponge insulation materials
- Adaptable to various geometries

STRETCH-TO-LENGTH® Heater

Silicone Rubber

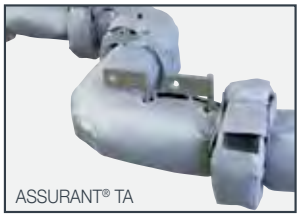
- Designed to specific part geometry
- Rugged, yet thin, lightweight and flexible
- Uniform heating



Pump Line and Gas Line Heaters

ASSURANT® TA

- Uniform heating for applications up to 180°C
- Flexible, silicone-coated fiberglass construction allows for quick prototyping



ASSURANT® TA

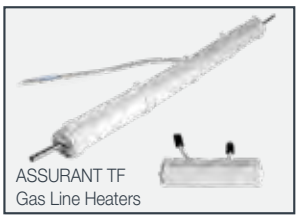
ASSURANT TC

- PTFE coated fiberglass
- Uniform heating for applications up to 250°C

ASSURANT TC

ASSURANT TF

- PTFE cloth
- Uniform heating for applications up to 250°C
- Low outgassing



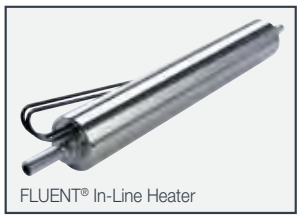
ASSURANT TF Gas Line Heaters

SERIES EHG® SL10

- Process controller and safety limit in one package
- Easy to install, compact design

FLUENT® In-Line Heater

- Small, lightweight yet robust
- High watt density, ultra-fast response



FLUENT® In-Line Heater

EZ-ZONE® RM Rail Mount Controller

- Precise thermal control
- Integrated functions
- Flexible and scalable allowing mixing and matching of inputs and outputs

EZ-ZONE® RM

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Find the thermal solution for your application, contact Watlow today.

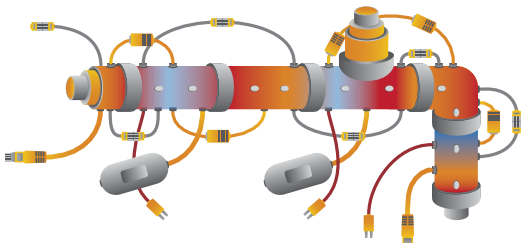
Contact us at www.watlow.com

Watlow's New Line Heating Control System with ATS™ Technology Delivers Precise Temperature Control and Improves Thermal Uniformity

Watlow's Adaptive Thermal Systems (ATS™) are a suite of cutting-edge technologies for semiconductor heating applications. ATS technology is unparalleled in the industry, providing performance that is more efficient and precise for our customers.

The ATS enabled line heating system is Watlow's latest innovation for semiconductor gas delivery and exhaust applications. While current competing systems require complicated assemblies and struggle to provide thermal uniformity, ATS technology simplifies the entire process and responds to process conditions, enabling it to deliver better temperature control and thermal uniformity.

Watlow's new ATS enabled line heating system intelligently combines heaters and electronics to simplify design and installation while enhancing tool performance.



Without ATS Technology

- Extensive and confusing wiring system
- Large zones of control with one sensing point
- Difficult troubleshooting with generic alarms

With ATS Technology

- Fewer wires / less complexity
- Better uniformity with closed loop control on every heater
- Advanced fault detection for over temp, low temp and mis-wiring on every heater

Watlow's New EZ-ZONE® RMT Controller Offers Closed Loop Control for Each Heater Preventing System Issues

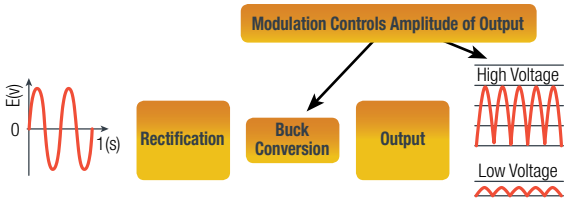
A critical part of Watlow's new line heating control system with ATS technology is the new EZ-ZONE® RMT controller. While other line heating systems require a maze of wires and controllers, the ATS enabled line heating system streamlines the solution by offering closed loop control for each heater, managed entirely by one EZ-ZONE RMT controller. The efficiency helps prevent system issues our customers would otherwise experience. The need to integrate fewer controls makes installation quicker and easier by cutting the required heater connections in half. It also reduces costs and provides a more spatially efficient system.

Features and Benefits:

- Removes complications and nuisance components by migrating functions from the heater to the controller
  - Creates a clean, aesthetic loop with just two wires
- Incorporates an improved fault detection system
  - Provides connectivity to all zones to locate and fix system issues as quickly as possible
- Intelligent design
  - Allows for better diagnostics, reliability and product life expectancy
  - Lowers total cost of ownership
- Reduces the number of design iterations needed
  - Provides a complete thermal system with significantly reduced lead times

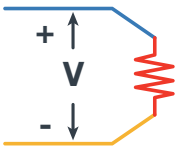
ATS Power Conversion:

- Delivers voltage level required, rather than power on and off
- Achieves the proper temperature for each heater by delivering proper voltage to each circuit
- Allows for tuning of each heater



ATS Integrated TCH Junction Temperature Control:

- Thermocouple integrated into heater
- Measure temperature without a separate sensor



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SEMI-ATS/LH-1218

Powerful Gas Line Controller with ATS™ Technology Features Built-In Diagnostics and Multiple Input and Output Capabilities for Maximum Flexibility and Control

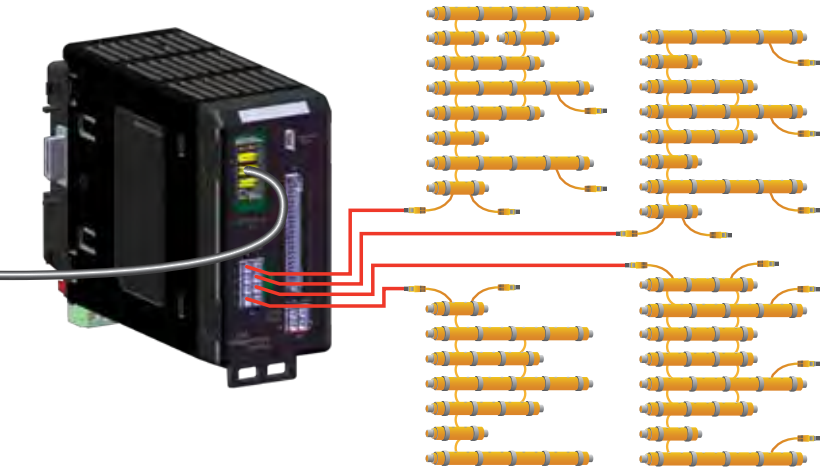
The EZ-ZONE® RMG gas line controller with Adaptive Thermal Systems (ATS™) technology is Watlow's new controller for gas delivery applications. The rail-mounted controller is versatile in regards to mounting within the gas chamber and provides distributed control up to 12 amps from four outputs (up to three amps per output).

Watlow's ATS technology provides detection of mis-wired heaters by offering a "ping" feature test system allowing users to obtain immediate feedback from soft power prior to turning on the main power. A small amount of power is applied and the system is tested against the input data from the free software tool. If any data does not match, including ground fault detection, a fault condition occurs signaling the built in global relay to shut down the system. This feedback prevents catastrophic conditions associated with overheated or cold spots within the gas line system.

The EZ-ZONE RMG also offers a combination of thermocouple inputs (up to 18 per printed circuit board assembly) and field effect transistor outputs (four three-amp outputs). The module can be ordered in multiple arrangements; with inputs and outputs, inputs only or outputs only. This ability to mix and match inputs and outputs allows for maximum system flexibility.

Multiple EZ-ZONE RMG modules can be used together to make up multiple loops of control. Alternating switching technology is built in to provide for maximum ambient conditions whereby all four outputs are not full-on at the same time. The EZ-ZONE RMG can also be used in conjunction with any other EZ-ZONE RM series controller. For example, additional thermocouple inputs from the gas line module can be mapped to outputs within the EZ-ZONE RME module.

Multiple gas line control



Features include

- ATS capabilities
- Built-in diagnostics
- Multiple inputs and outputs
- Free software
- Plug and play; adapts directly with EZ-ZONE RMZ EtherCAT® module

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Watlow's New POWERGLIDE™ Enables Superior Performance of Multiple Zone Aluminum Nitride Ceramic Pedestals

POWERGLIDE™ is a unique embodiment of Watlow's Adaptive Thermal Systems (ATS™) technology and combines temperature and power control into one ATS-enabled device ideal for semiconductor processing applications.

The process activities in a semiconductor chamber can cause the inner and outer zones of a two-zone aluminum nitride ceramic pedestal to change temperature, sometimes in different directions. Open loop or power ratio control is the current method of determining how much power to deliver to the outer zone based on the power of the inner zone, since there is typically no sensor in the hard-to-access outer zone. This causes the outer zone to react in the same manner as the inner zone when the boundary conditions change due to gas introduction, pedestal repositioning, plasma application or wafer placement. This parallel action might be opposite of what is needed to maintain proper temperature uniformity. This can cause significant temperature difference in the inner and outer zones resulting in poor thermal uniformity and reduction in yield. In addition, when the temperature delta between the zones becomes too large cracked pedestals and broken wafers are typical non-desired results.

Watlow's solution… POWERGLIDE, enabled with ATS technology, a next generation controller.

Watlow's new POWERGLIDE enables certain two-zone aluminum nitride ceramic pedestals to perform more efficiently. It runs closed loop and monitors temperature from both zones to improve uniformity, help prevent ceramic breakage, achieve higher temperatures and provide visibility to changing conditions.

With POWERGLIDE, users will gain total control of power quality. POWERGLIDE features Watlow's innovative ATS technology and incorporates power conversion, a technology platform that regulates power up and down rather than on and off. In addition, POWERGLIDE incorporates an algorithm that uses temperature co-efficient of resistance (TCR) to measure temperature and provide control, which is a technology platform that converts every heater zone into a sensor, as well as ceramic protection algorithms.

POWERGLIDE offers several communication protocols including EtherCAT®, which is optimized for the semiconductor manufacturing industry.

Features and Benefits

- **Built-in automatic calibration algorithm**
  - Eliminates downtime associated with calibration
- **High TCR heater materials based temperature control**
  - Allows closed loop control for all zones
- **Incorporates ceramic control algorithms**
  - Maintains the limitations of the materials to protect the pedestal
  - Provides programmable, state-based PID control
- **EtherCAT® communications protocol**
  - Ensures adherence to industry standard protocols

Specifications

Environmental
- Operating temperature: 0 to 50°C
- Humidity: 5% to 95% RH non-condensing

Physical
- Dimensions: 9.0 in. L x 5.5 in. W x 4.0 in. T
- Weight: 6.15 lbs including heat sink
- Mounting: can be paired with a second unit to share heat sink fan, 4 #8 screws to a back plate

Power Outputs
- Quantity: two, 1 per zone pedestal
- Output voltage: 0-208V rectified AC
- Output current: 30A (peak), 25A steady state max.
- Interlock relay: one, form A - 5A, 24V

Power Input
- Quantity: 2, 1 per zone, each zone isolated from the other
- Input voltage: 85 to 264VAC/DC

Electronics (Logic) Power
- 24VDC on DB9

Communications
- RS-485 on pair of DB9 with pass-through, Watlow standard bus protocol
- EtherCAT® supporting ETG.5003.2060
- USB device 2.0, Watlow standard bus protocol

Sensing Inputs
- 2 zones of thermocouple Type K for reference sensing
- Heater resistance 1 to 20 ohms via delivered I and V resolution 0.001Ω

Algorithms
- Model based PID and rate control with 8 programmable control states
  - Power-up
  - Soft start
  - Rate control
  - PID control
  - Manual power
  - Remote power
  - Off
- 2 programmable transition conditions per state
- 1 state entry integral manipulation per state

Pedestal Protection Algorithms
- Zone to zone temperature difference reduction and safety shutdown
- Zone to reference temperature difference reduction and safety shutdown
- Over-temp shutdown
- Drives interlock relay
- Over-current shutdown

Resistance to Temperature Methods
- Programmable base resistance and TCR
- 16 point offset table
- Auto-calibration to reference TC

Agency Directive
- UL®/EN 61010-1 Safety Requirements for measurement, control and laboratory equipment

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