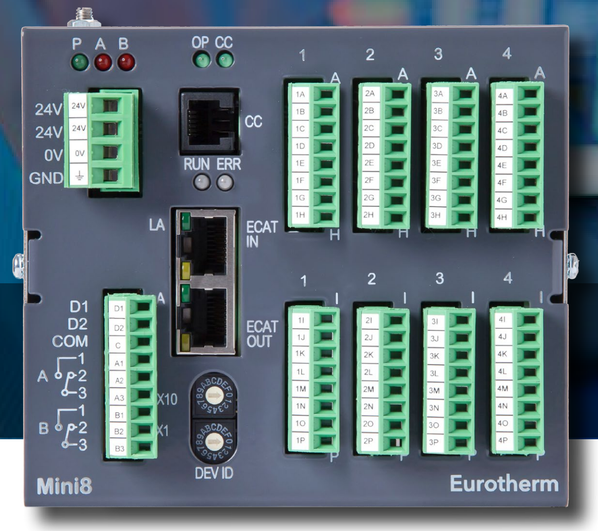
# Compact, repeatable precision temperature control

**Eurotherm®**




## Mini8® loop controller, high performance in a space-saving format

eurotherm.com/mini8

WATLOW®
*Powered by Possibility*

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# Our value proposition

*Eurotherm's knowledge in temperature and power control, combined with expertise in process engineering, enables the continual development of temperature measurement and control enhancements: All designed to help machine manufacturers to increase their efficiency and resiliency for a more sustainable processing future.*

*The Mini8 loop controller provides precision control and versatility with clear, user friendly, configuration tools. Designed to integrate seamlessly with programmable logic controllers (PLCs), and other supervisory control and monitoring systems, the Eurotherm Mini8 controller offers a compact high-performance solution at an affordable cost.*

Your **strategic partner** for performance enhancing **precision temperature** and **power control,** to help increase **efficiency** and resiliency towards a **sustainable** future.

Eurotherm® *a **Watlow** brand*

# Compact, adaptable, capable

# Compact

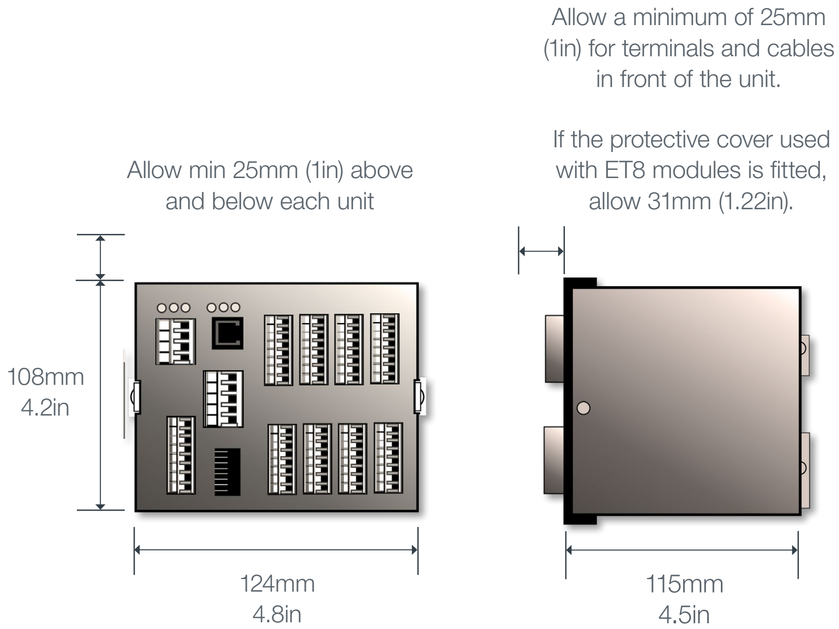
**The Mini8 loop controller packs enough I/O for up to 16 control loops into a robust, compact unit, saving enclosure space when it counts.**

Despite the small size, there are no compromises on specification, with channel-to-channel functional isolation between analog inputs and outputs, and 0.1% full scale precision.

The modular build allows I/O to be added as required, buying only what is needed for an application, while allowing future upgrades.

Connect additional I/O devices using Ethernet communications where needed, with up to 8 remote loops possible using external I/O in addition to the 16 supported by internal I/O.

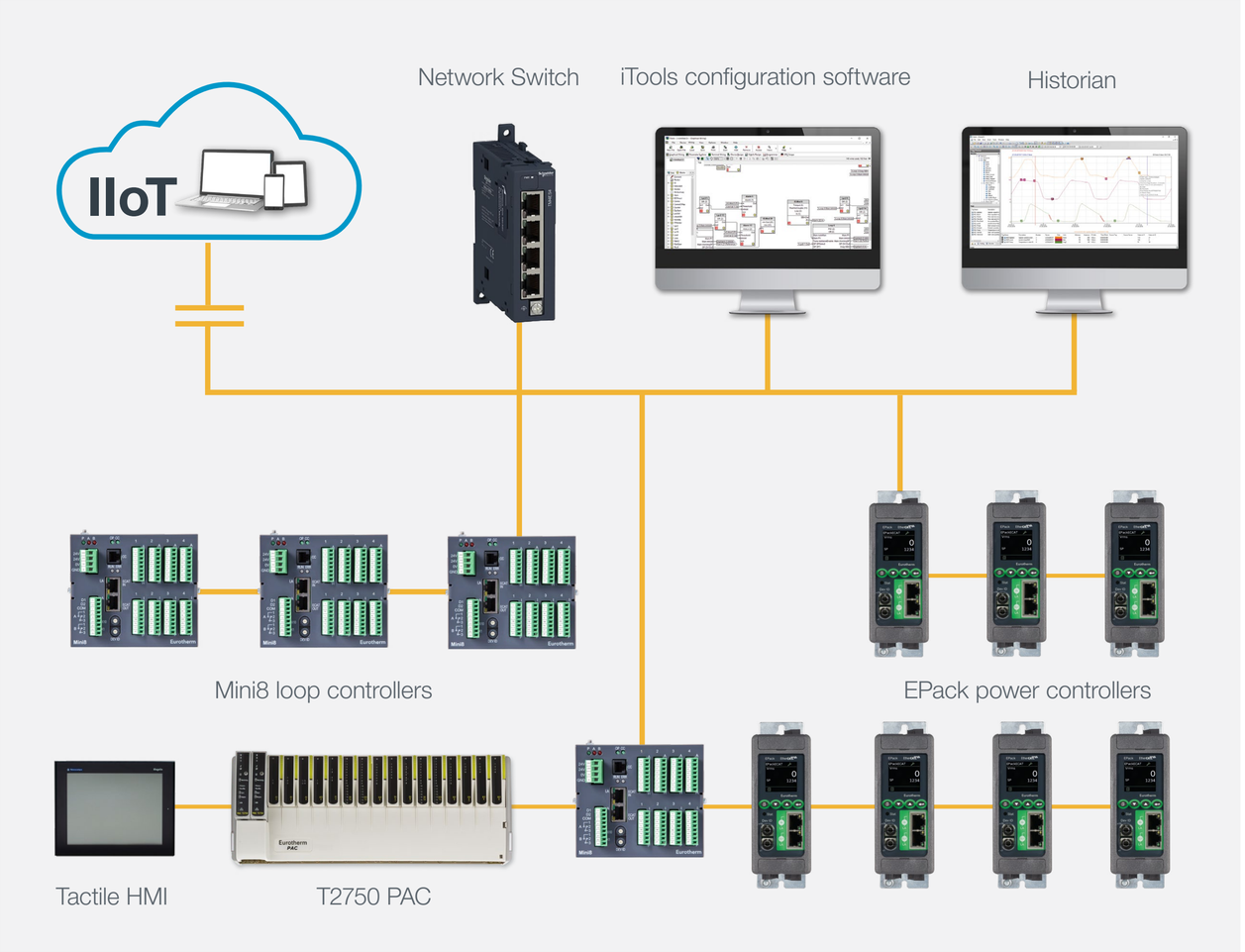
## Mechanical details



# Adaptable

**As demand changes, equipment integrators need to be resilient. The Mini8 controller has multiple communications protocols including EtherCAT™. This, plus other features, help improve market agility to meet increasing demands:**

- Simplified connection to PLCs, devices and Industry 4.0 using standard Ethernet fieldbus technologies
- Fewer I/O devices save cost and time installing and wiring equipment
- Simplified design reduces stock and spares holding
- Compact DIN rail mounting form factor to meet current and future demands for decreasing machine footprint



# Capable

## More processor power

- Enables newer and enhanced control methods, including integrated cascade control using proprietary new SuperLoop technology. With more loops, autotune and better disturbance response

## Direct Ethernet designed for cybersecurity robustness

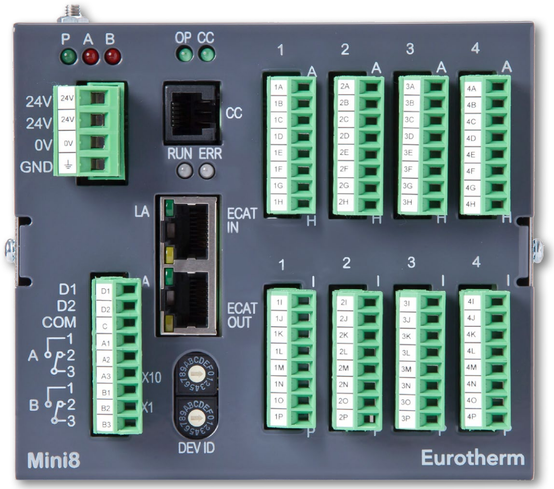
- Built using best practices and current cybersecurity standards: IEC62443-4-1

## Battery-free design

- Removes the need for periodic battery replacement, and reduces environmental impact

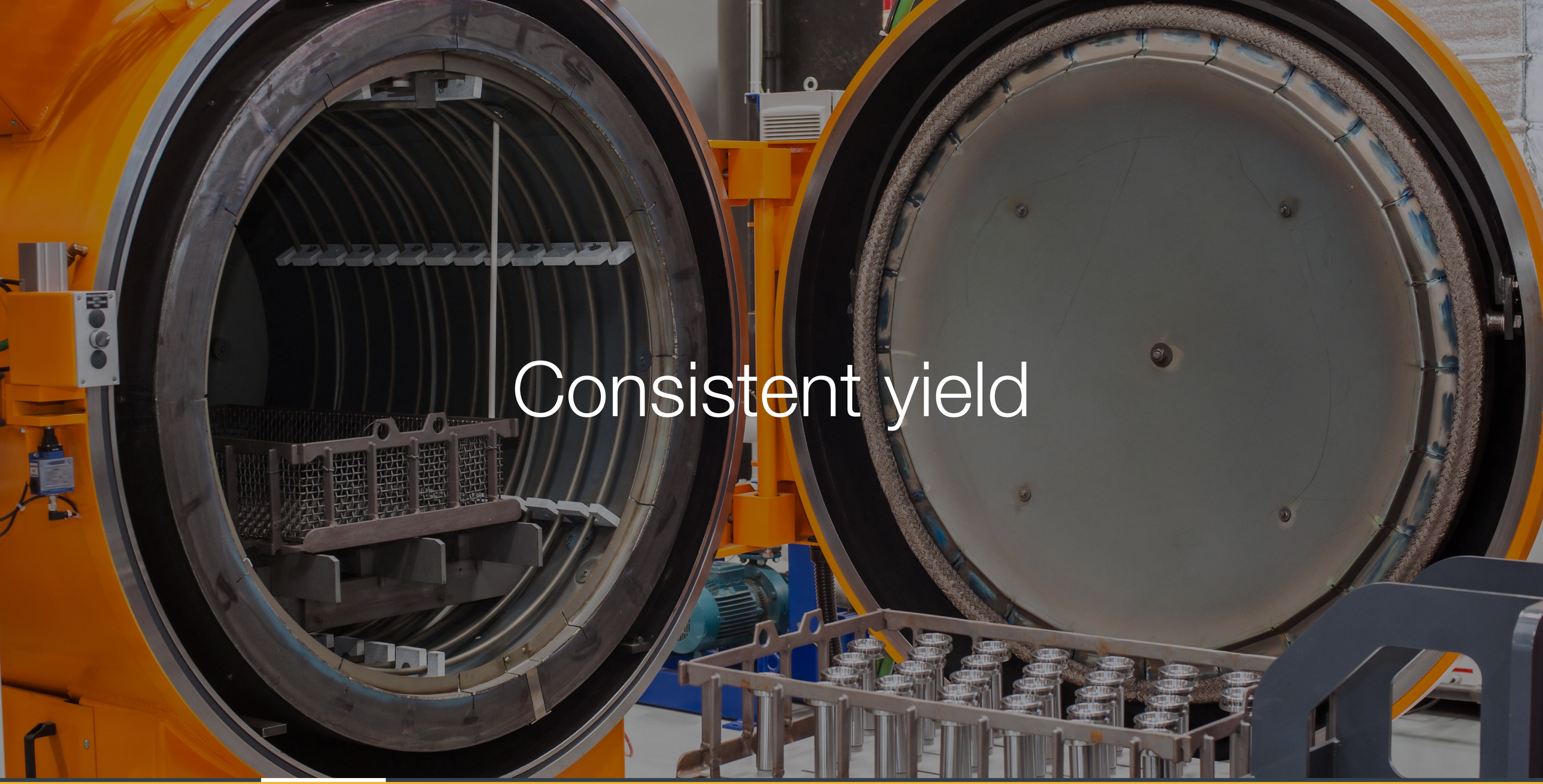
# Improves machine utilization rates with a faster rise to operating setpoint and tighter process tolerances for demanding applications

- Tight process tolerances for demanding processes
- A fast-responding control algorithm is ideal for frequent process disturbances
- Measurements are very stable and repeatable
- Overheating protection features
- Native EtherCAT meets ETG.5003.2060
- Overshoot inhibition cutback function minimizes temperature overshoot, without overdamping the process
- Dual PID (e.g. heat/cool) enables a different gain for each output
- Multiple PID sets allow optimum performance at different setpoints and with varying loads
- Feedforward provides predictive compensation for interactive loops
- Integrated cascade control for high accuracy control of heater load and compensation for process lags
- High level of noise rejection and exceptionally fast-acting cold junction compensation




Mini8 loop controller

## Mini8 loop temperature controller for compact, precision temperature control EtherCAT – fast acting response and common connectivity



# Consistent yield

# Superior precision temperature control

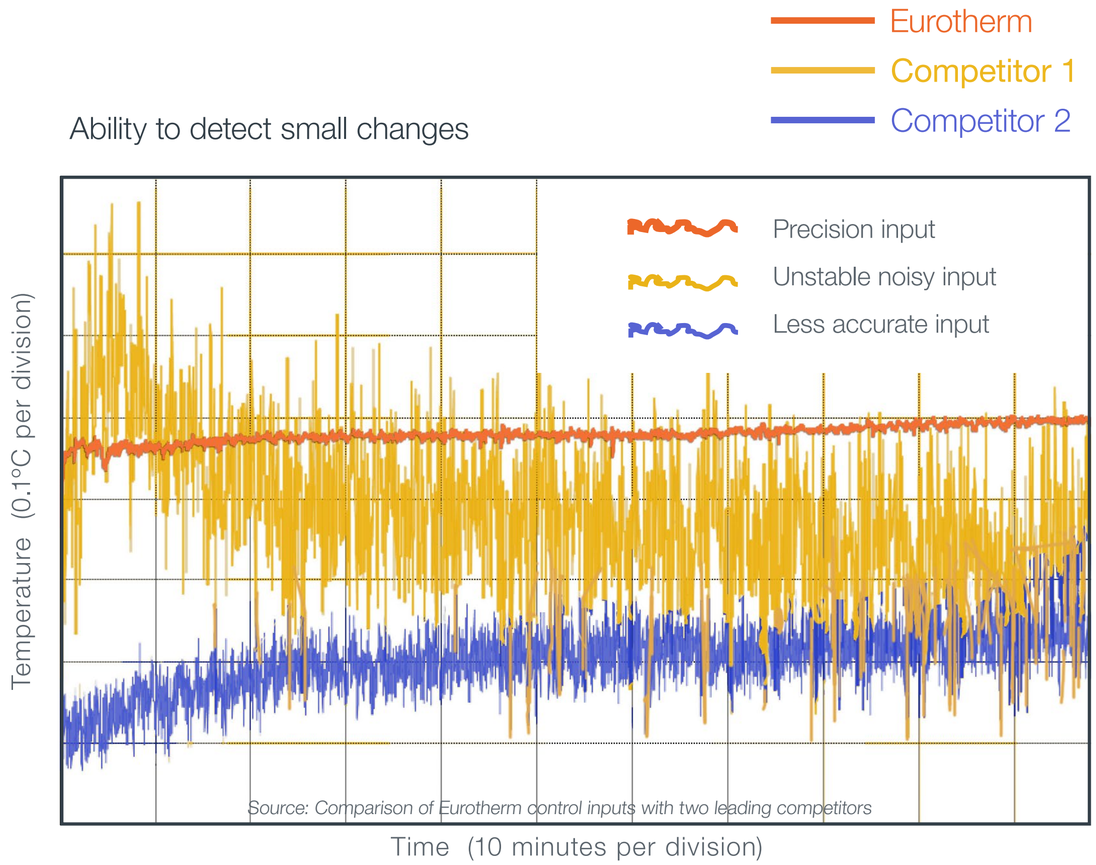
- Stable, repeatable, high-precision measurements
- Accurate linearization for thermocouples, RTDs and other sensors
- High noise rejection and fast acting CJ compensation
- Reduced noise decreases control oscillation

Our customers seek excellence in precise, industrial control to maintain high throughput and optimal yield. The ability to measure small signal variations, free of noise, accurately, aids control stability and repeatability, enabling maximum time at working setpoint and helps minimize under or overshoot.

For example, the Mini8 loop controller provides better than ±1°C ±0.1% of reading total accuracy with CJC rejection greater than 30:1 for standard 4 and 8 channel thermocouple input boards (TC4/TC8), and ±0.25°C ±0.05% of reading total accuracy with greater than 100:1 for enhanced 8 channel input boards (ET8), easily meeting the stringent accuracy requirements of AMS2750 and CQI-9.

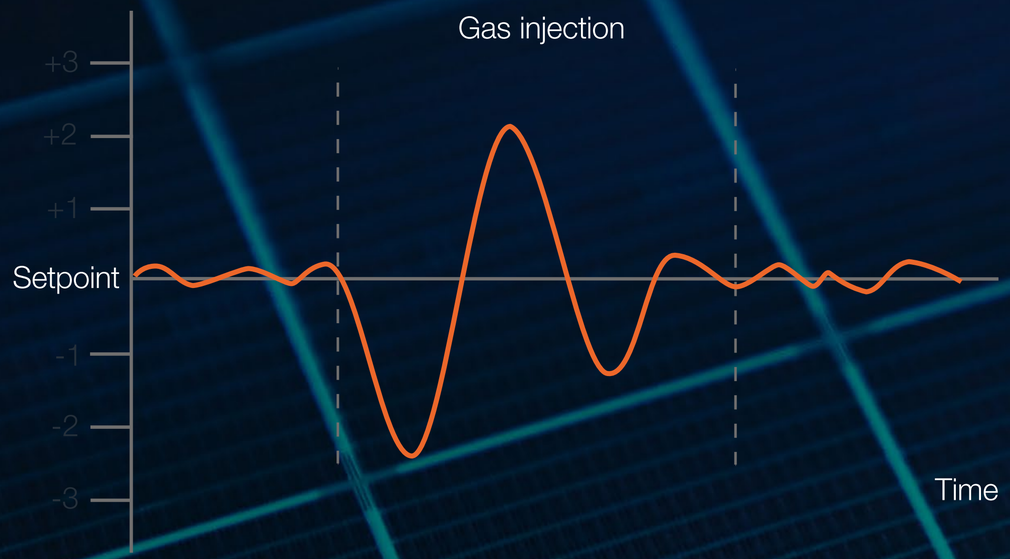
Universal inputs support all commonly used process sensors with accurate linearization for thermocouples, RTDs and other sensors.

Better noise rejection decreases control oscillation and drift.

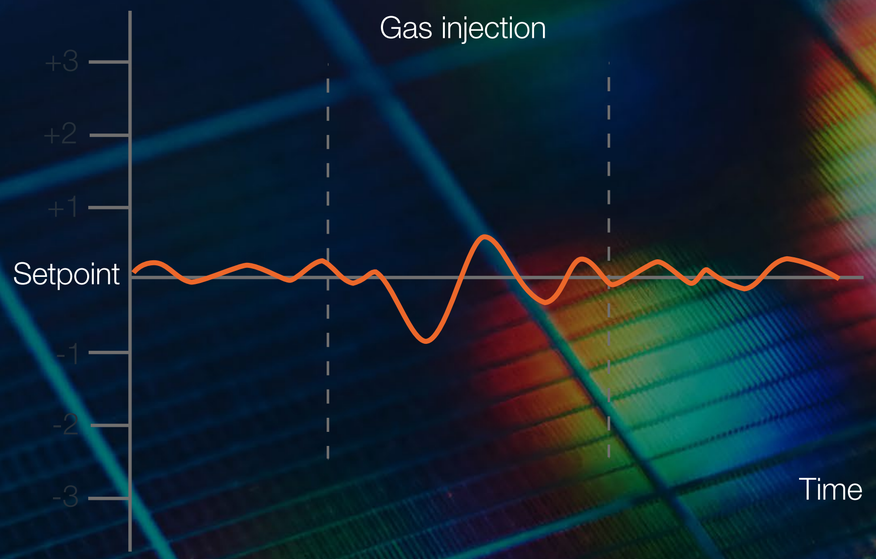


# Fast response to process disturbances helps maximize production throughput

## Typical controller



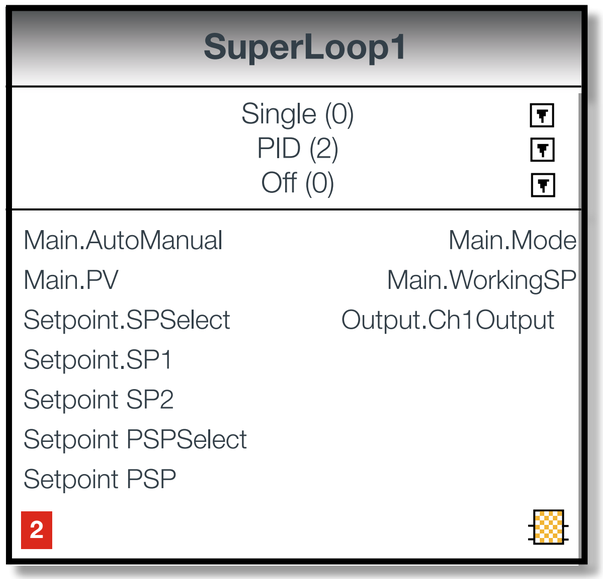

## Eurotherm Mini8 loop controller



# Introducing Eurotherm SuperLoop PID control blocks

**SuperLoop technology provides a simple, consistent interface to Eurotherm enhanced PID functions.**

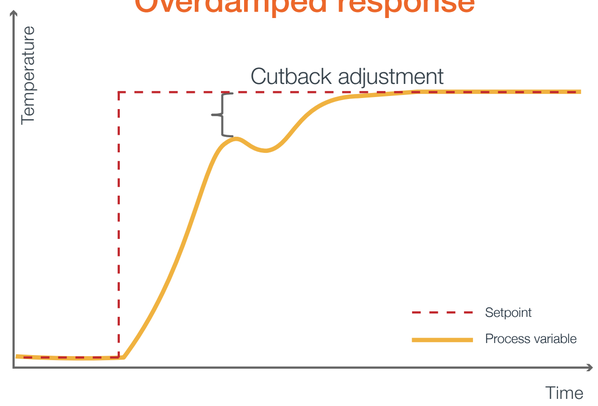
- Encapsulating both single and cascade control modes in a single function block, with autotune
- In single loop mode, the SuperLoop provides state-of-the art PID control performance, with over and undershoot inhibition and full auto-tuning
- Each SuperLoop may be used in cascade mode with auto-tune, when the option is purchased. Use of cascade can simplify applications where there are lags or disturbances
- Option to add 8 additional SuperLoop blocks with external I/O hardware support via Ethernet or EtherCAT



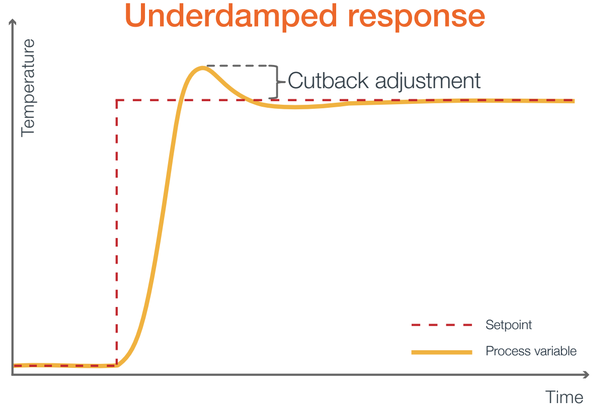

24 SuperLoop blocks - 16 using Mini8 I/O boards plus 8 using comms.

# SuperLoop technology optimizes time to working temperature

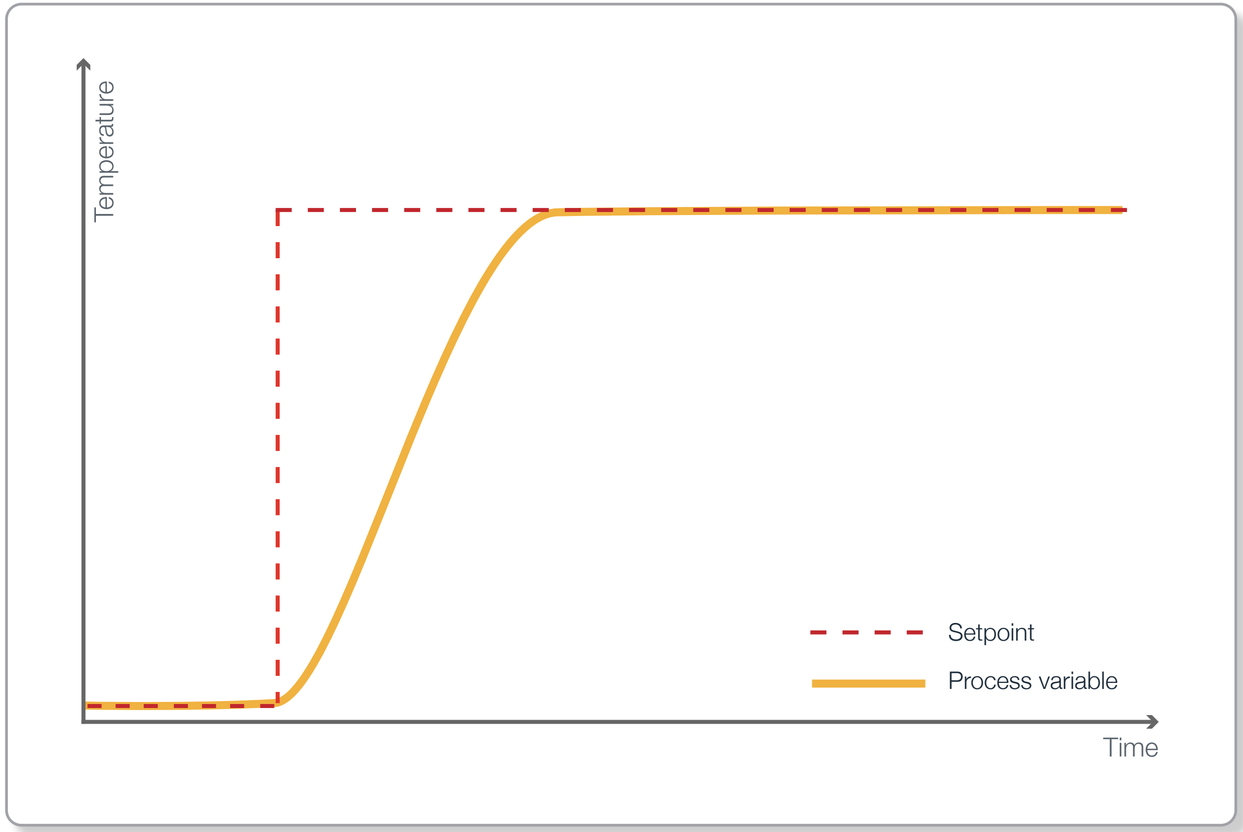
## Overdamped response




## Underdamped response




**SuperLoop technology** provides fast rise to setpoint with minimal oscillation and overshoot. This reduces the time that the process is not operating at the optimal temperature, increasing utilization of expensive furnaces by achieving working temperature as quickly as possible.



# Maximize your PLC solution

# Enhance your PLC solution with Eurotherm PID Features

The Mini8 loop controller is an ideal partner for a PLC in multi-loop PID applications, such as plastics extrusion and multi-zone furnaces. By devolving loop control to the Mini8 controller the PLC can concentrate on providing fast and effective logic control without the burden of running complex control algorithms.

The Mini8 controller is a very cost-effective alternative to implementing control loops in a PLC. Providing not only better control performance and easy configuration, but it also offers the same deterministic response and autotune features as Eurotherm panel mount controllers. The Eurotherm open approach to communication, supporting serial, Fieldbus and Ethernet protocols, makes it easy to interface with intelligent clients such as PLCs.

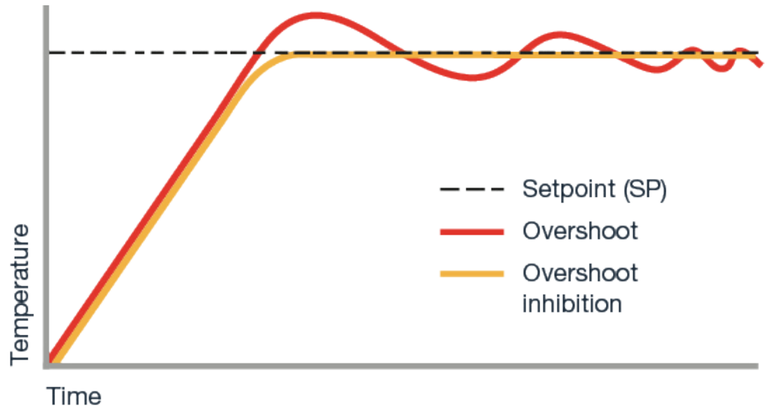
- Reduce PLC hardware
- Easy and quick set-up
- Improve control performance
- Minimize signal conditioning hardware
- Up to 24 PID control loops
- Flexible and standard configurations
- 110 ms process value sampling
- Math and logic functions
- Process alarms
- Heater failure detection
- Help protect OEM knowledge and IP with "configuration lock"

# Advanced autotune and algorithms aid efficiency and repeatability

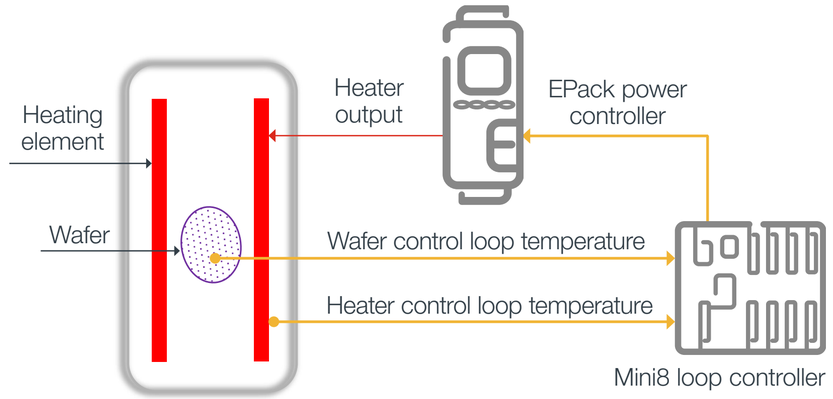
Precision PID control has embedded algorithms to tightly control temperature, so setpoints are reached with minimal overshoot during ramps and the process variable stabilizes faster. When operating temperatures are outside the desired setpoint, the result is wasted time and energy, defects from under or over-heated material and possible scrap product. In Eurotherm products the ‘cutback’ algorithm helps prevent overshoot.

Eurotherm has spent over 50 years perfecting these kinds of algorithms, along with advanced autotune features that automatically set desired parameters in the PID control loops to suit the application. Taking care of this often, manual task, achieves automatic efficiency and repeatability, even compared to the most sophisticated model-based control strategies, which are not able to compensate for a badly tuned process.

## Eurotherm 'cutback' algorithm helps prevent overshoot




## Ideal in applications for diffusion and photolithography processes



# Customization capabilities designed by engineers for engineers

## Cost-effective flexible software

- Adaptable to changing customer demands
- Scalable digital feature upgrades

## Enhance and guard your brand

- "Configuration lock" option helps guard OEM knowledge and intellectual property (IP)
- Private labelling

## Customizable configuration

### Clone file download:

- Pre-configured at factory for immediate use

### Custom linearization:

- Flexibility to support less common sensor types

### Fixed firmware:

- Supporting Copy Exact requirement

# Robust, easy to install and maintain

**Engineering time can be greatly reduced, and up-time maximized by choosing devices that support operational resilience by design with easy-to-use configuration methods. Eurotherm control products come with pre-configuration at point of order, quick-code start-up, and free iTools configuration software for easy control setup using function block style programming and graphical wiring editor**

## Resilient products

- Fast easy panel installation and commissioning/ integration into wider systems lowers equipment costs for OEMs and their customers
- Market leading control algorithm for accurate, repeatable temperature precision
- Function blocks for simplified setup of PID loops, recipes

## Simplified integration

- Multiple protocols including EtherCAT-ready devices for simplified integration into machine architecture
- Many competitor products cannot be configured without a licence, but proprietary iTools configuration software comes free to download with Eurotherm products
- Products designed to comply with international standards help to simplify global supply chains

## Faster maintenance

- Expert support where needed
- Extended support outside normal office hours from technical experts
- Remote access diagnostics
- Speedy expedition for time-sensitive issues
- Web-based support
- Service Level Agreements
- PID loop and process control expertise to help diagnose complex temperature control challenges

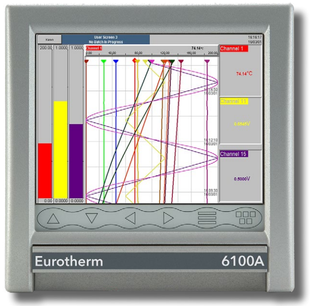
# Seamless data acquisition

# The Mini8 controller can connect to a 6000 series recorder in a control system

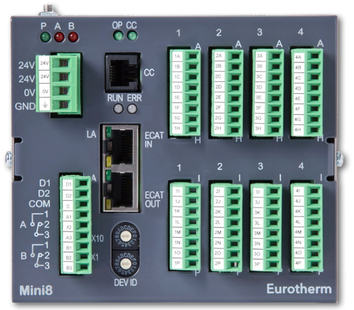
**The Mini8 controller can be installed as a control or data acquisition component of larger installations providing up to 32 input channels per unit. Eurotherm can provide solutions from “simple” SCADA using Eurotherm iTools to more demanding applications using SCADA, MES, and IIoT system platform and operations management solutions. The open communications nature of the Mini8 loop controller makes communication with third party equipment easy to achieve.**

## Powerful features of the 6000 series recorder

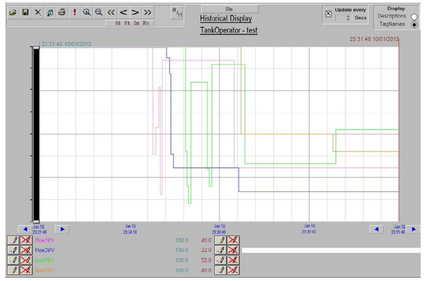
- Modbus client/server communications
- Ethernet and serial connectivity
- User defined screens
- Remote access
- Auditor
- Tamper-resistant data recording from other devices
- Centralized HMI
- View and modify control loop parameters within the Mini8 controller



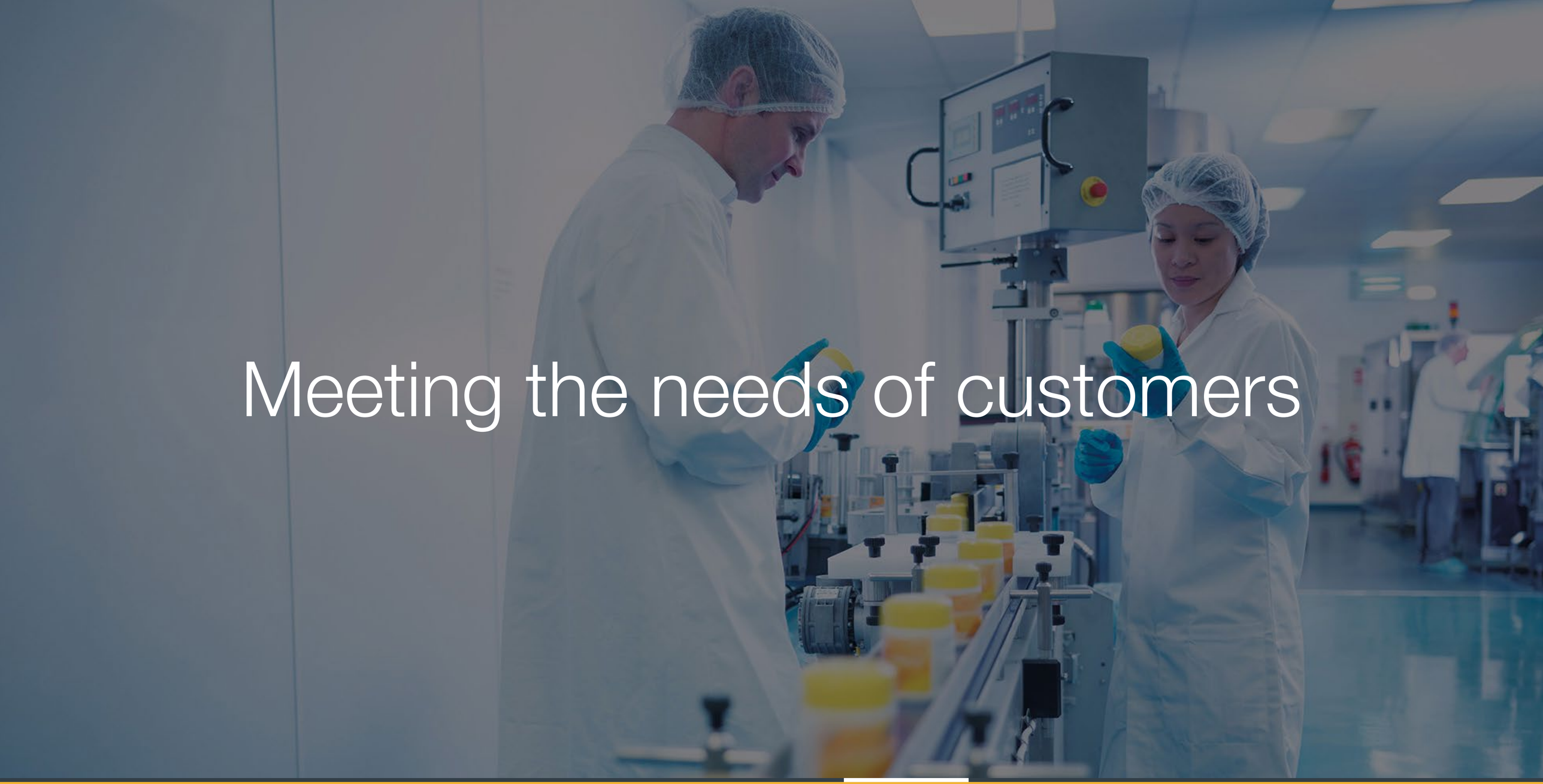

6000 Series Paperless Graphic Recorders




Mini8 loop controller




EurothermSuite™ Visualization software



# Meeting the needs of customers

# **Case study:** High quality PECVD processing

**During the PECVD (Plasma-Enhanced Chemical Vapor Deposition) process, it is essential for high quality and maximum throughput, that all control zones are kept within strict process limits, creating a uniform temperature profile within the furnace.**

## Customer challenge

Typically, a PECVD furnace has multiple control zones, all of which have significant process lags making temperature control challenging. Additionally, it is not possible during production to measure the actual surface temperature of the wafer and the process is often affected by disturbances such as pressure cycling, and gas being admitted to the chamber. The challenge is therefore to optimize production time by helping to ensure uniformity between all zones and recovering as quickly as possible from process disturbances.

## Customer solution

- Multi-zone cascade control compensating for process lags
- Custom linearization blocks for thermocouple profile characterization
- Custom math block algorithm to help optimize temperature uniformity
- EtherCAT communications to PC/PLC host system

## Customer benefits

- Improved quality by accurate temperature control of wafer and uniform temperature profile across all zones
- Fast response to process disturbances to help maximize production throughput
- Integrates easily with PECVD control system

# **Case study:** Consistency is essential in glass-to-metal seals manufacture

**A compression hermetic seal is produced when the metal housing material thermal expansion rate is much higher than that of the glass. Upon solidification of the seal during the manufacturing process, the housing will contract around the glass, applying a desirable compression stress on the glass bead. The consistency of glass produced depends on the accuracy of the temperature control. The strength of the glass-to-metal seal is reinforced mechanically as well as chemically, creating a stronger, more durable part.**

## Customer challenge

This customer sought Eurotherm's expertise as they were having problems with the manufacture of their glass-to- metal compression seals.

They needed precise temperature control to provide improvements in product quality, consistency and repeatability.

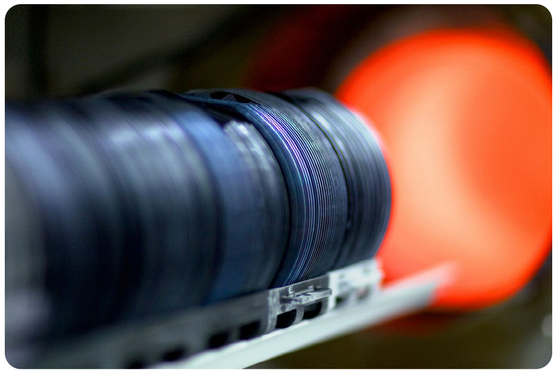
## Customer solution

- Multi-zone cascade control compensating for process lags
- Custom math block algorithm to help optimizetemperature uniformity
- 6000 series data acquisition designed to meet industrial requirements for data integrity:
  - Capacity extendable recording
  - Data can be encrypted during transmission to archive/backup servers

## Customer benefits

- Very accurate temperature control of the company's multi-zone furnaces.
- The Mini8 controller helps provide high stability operation, reduced wastage and maximizes production
- 6000 series data recorders are cost effective, self contained, trusted by customers and auditors alike

# **Limited head control** helps reducing overshoot during a critical process stage



**Managing tight control of temperature across zones is critical during photovoltaic manufacturing for production of silicon wafers, to retain uniformity and quality. Temperature control performance can be affected by many factors such as the high thermal insulation of the photovoltaic manufacturing tubes. The challenge is managing a fast setpoint step response, whilst minimizing overshoot.**

## How limited head works as a solution

Limited head is a strategy to reduce overshoot in cascade control which can be used if further performance enhancement is required after PID tuning. Ideal in applications that require tight control and rapid response to step changes of setpoint. It controls the power injected into the process during a transient phase (e.g., a step change of primary setpoint) by limiting the peak secondary setpoint in a cascade loop.

Limited head requires only one parameter to be set, and then adapts automatically to any operational point. This enhances full-scale cascade where the units of primary and secondary loop control are the same, e.g. temperature of load and temperature of heaters.

## The benefits of limited head control

Ideal for diffusion and photolithography in photovoltaic manufacturing processes where thermal insulation and tendency to overshoot are very high. Optimal cascade control simultaneously manages tube profile and heater temperatures. Limited head enhances cascade control features by increasing process reliability, availability and efficiencies in CMP, wet bench, and implant, and the temperature control element of PVD and CVD process stages.

# **Heater failure detection** minimizes risk of production disruption


**Utilizing a unique cycling algorithm and current transformer input module, the Mini8 controller can automatically scan electrical heaters connected to its logic or relay control outputs and indicate partial heater failure. Heater current readings are also available within the controller to calculate power delivered to the load and make this information available to a supervisory system. Heater failure detection is compatible with both single or three phase load installations.**

A typical furnace control process consists of 16 heater loads wired in parallel to produce both the required heating rate and maximum temperature. A common recurring problem is when one or more heaters fail, it isn't noticed until the process is under way. Typically, this results in the furnace being out-of-service until the faulty heater is replaced.

## Solution

The Mini8 controller can detect three modes of failure of any one of 16 heaters, which can then be repaired before a run is started.

## Solid State Relay (SSR) Fault

If current is detected flowing through a heater when the controller is requesting it to be off, then this typically indicates that an SSR has a short circuit. If current is not detected when the controller is requesting the heater to be on, then this typically indicates that the SSR has an open circuit.

## Partial Load Fault (PLF)

If less current is detected flowing through a heater than the PLF threshold, which has been set for that channel, then this typically indicates that the heater may have a fault. In applications that use multiple heater elements in parallel, it could indicate that one or more of the elements may have an open circuit.

## Over Current Fault (OCF)

If more current is detected flowing through a heater than the OCF threshold, then this indicates that the heater has an issue. In applications that use multiple heater elements in parallel then this indicates that one or more of the elements has lower than expected resistance value.

## Benefits of early heater failure detection

Early detection across multiple heater loads is a significant advantage in order to better manage maintenance before a run has started. This can result in:

- Minimized downtime
- Less scrap and rework
- Maximized production yield and quality

To learn more about the Mini8 loop controller visit:
eurotherm.com/mini8

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