Eurotherm®

Performance enhancing precision temperature and power control for the Semiconductor industry

eurotherm.com/semiconductor

WATLOW®
Powered by Possibility

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Key trends

Key trends of the industry

9.2%

Strong growth

Global semiconductor market CAGR forecast

The global semiconductor market is projected to grow from $500 billion in 2022 to $900 billion by 2029, at a CAGR of 9.2%. This growth can be attributed to increasing consumption of consumer electronic devices worldwide, plus AI, IIoT and machine learning technologies.

Source: Fortune Business Insights

>80%

Capacity utilization

Front end fabs are running above 80% capacity utilization

To meet increased demand during the current global chip shortage, the semiconductor industry is substantially increasing its fab capacity utilization. Front-end semiconductor fabrication facilities, or fabs, will typically run above 80 percent capacity utilization, with some individual fabs running as high as between 90-100 percent. Mostly this is for deposition, lithography, and etching.

Source: semiconductors.org

250k

Talent shortfall

... of design and manufacturing Semiconductor professionals in China. The US is also facing a shortfall and competition from other techs aggressively expanding in high-growth areas such as AI, robotics, smart devices, intensifying the ongoing battle for semiconductor talent.

Source: Deloitte.com

9

Sustainable companies

65 companies were assessed in the Semiconductors and Semiconductor Equipment Industry Group and 9 made the cut on the 2021 DJSI World. Semiconductor companies have taken their role in improving sustainability seriously.

Source: eetasia.com

Eurotherm market focus

Eurotherm semiconductor application expertise

Eurotherm specializes primarily on the wafer fabrication front end process for manufacturing fabs.

Silicon Wafer Production

- Single crystal growth
- Truncation
- Diameter rolling
- Slicing
- Chamfering

- Surface grinding
- Edge polishing
- Double-sided polishing (CMP)
- Single-sided polishing (CMP)
- Final cleaning
- Annealing
- Packaging

Wafer Front End

Wafer Fabrication

Deposition

- PVD
- CVD
- Oxidation furnace

Diffusion & Ion Implant

- Ion implantation
- Furnace tube
- Annealing
- Cleaning
- CMP

Lithograpy

- Lithography
- Gumming/Developing

Etch

- Wet Etch
- Plasma

Eurotherm focus on power and temperature control

Wafer Back End

Water Probe

- Probe testing
- Grinding disc
- Wafer lamination/cutting

Packaging

- Wire bonding
- Heat treatment
- Cutting rib/forming

Test

Why is power and temperature control so critical in Semiconductor fabrication?

1 Significant part of OpEx

5~30%

energy costs

Large semiconductor fabs use as much as 100 megawatt-hours of power each hour, this can account for up to 30 percent of fab operating costs.

source: mckinsey.com

2 Power quality and reliability

Up to **3.6M** loss

per voltage sag event

Power quality and reliability of Semiconductor fabs is so critical, as one voltage sag event could constitute up to $3.6M losses for the fab owner, due to the added value of the final product.

source: mdpi.com

3 Increasing sustainability

9

commit to 100% renewable

In the latest DJSI index, representing the top 10% of the largest 2,500 companies in the S&P global Broad Market Index, a total of 65 companies were assessed in the Semiconductors Industry group and 9 of them made the cut.

source: eetasia.com

Time to market - *on average, every 18-24 months new process technologies emerge with more transistor density*

Needs of the industry

Needs of the industry

There are three critical needs within the semiconductor fabrication industry.

1 Efficiency

Improve time to market, reduce cost of ownership

- Improve time from design to build
- Optimize energy usage
- Reduce OpEx by improving overall facility performance

2 Resiliency

Minimize downtime, safeguard operations

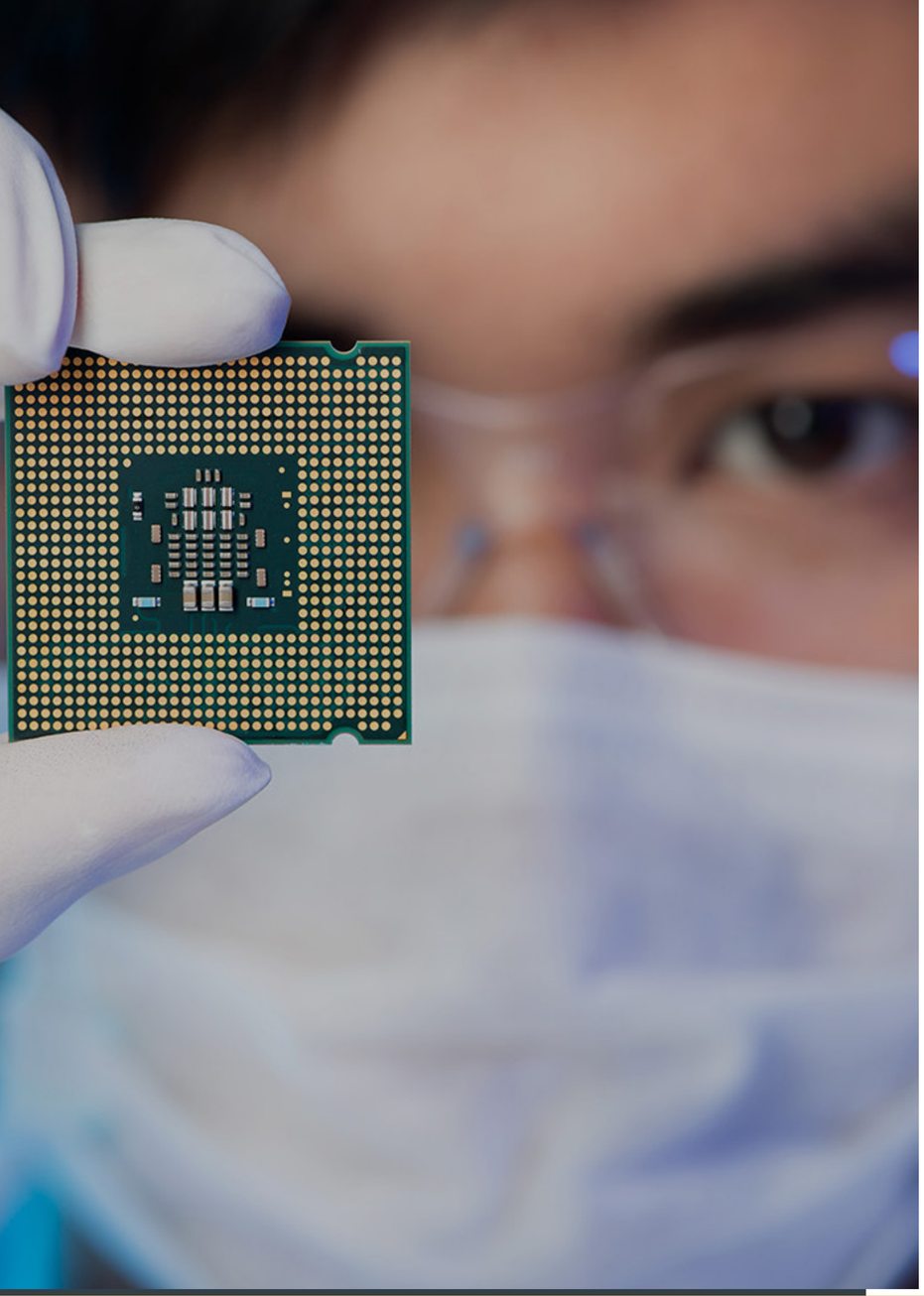
- Ensure power availability and good power quality
- Improve asset reliability and ease of maintenance
- Minimize cybersecurity risks

3 Sustainability

Meet corporate governance, minimize environmental impact

- Help meet climate goals and reduce environmental impact
- Efficient use of energy and resources
- Scalable and future ready

Facing industry challenges



Our value proposition

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

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

Eurotherm®

How Eurotherm helps face industry challenges

- *New process technologies are emerging all the time*
- *Chipmakers need to make wafers that are more complex, smaller, and make them faster*
- *To stay competitive, tool manufacturers must react quickly to changing demand*

1 Efficiency

Time to market and cost of ownership

Shorten time to market with EtherCAT® communication standardization

Optimize machine utilization rates with precision temperature control

Minimize energy bill and OpEx with improved power control

2 Resiliency

Downtime and other interruptions to operations

Maximize power availability, help reduce maintenance and improve yield with robust, reliable control

Minimize cybersecurity risks with cybersecurity enhancements and services

3 Sustainability

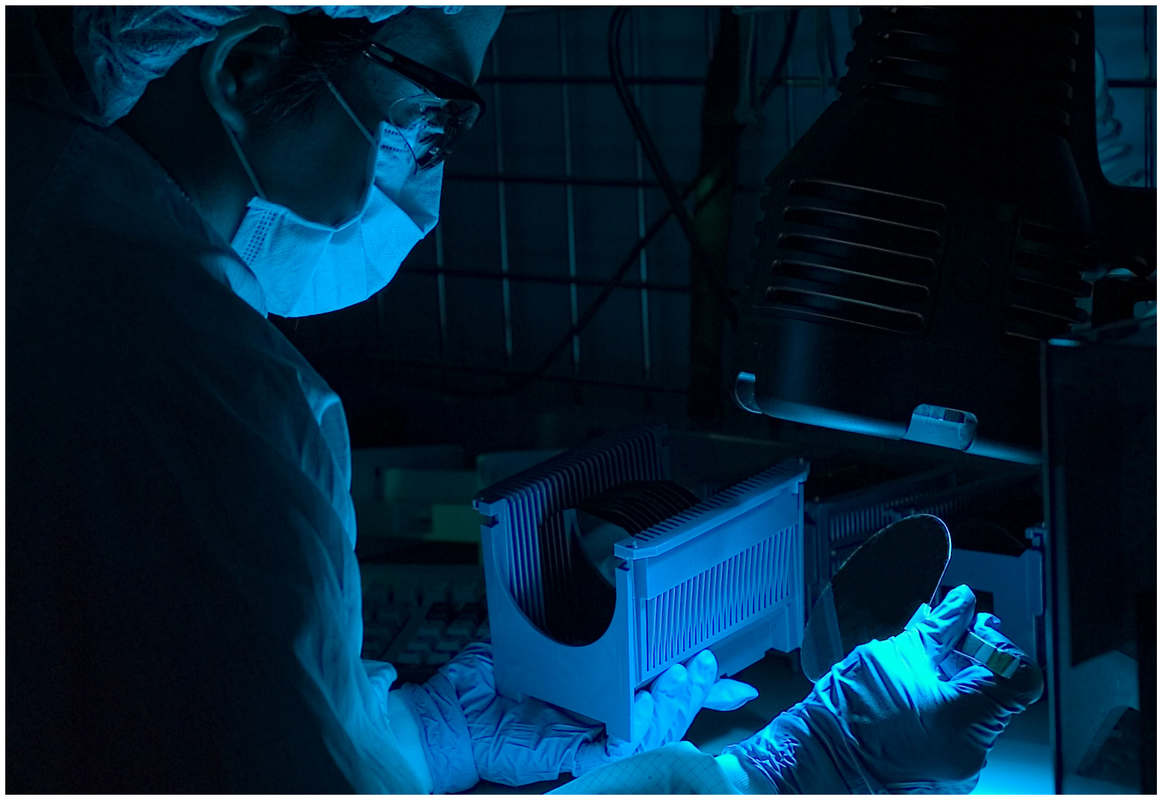
Corporate governance and environmental impact

Optimize resources and meet climate goals

- Our commitment to sustainable performance, by design
- Products designed to help reduce energy usage

Be future-ready, be scalable

We offer specific expertise



Efficiency

The time to market and total cost of ownership is highly important for fabs. Eurotherm focuses on OEM machine builders and tool manufacturers, bringing specific areas of expertise in precision process and power control with leading edge communication options. Scalable, robust offerings can help minimize CapEx; products designed to optimize machine utilization, reduce energy usage, and improve process performance, help reduce OpEx.

Resiliency

A resilient fab results in reduced unplanned downtime, helped by consistently maintaining power quality and reliability. Eurotherm offers are designed to minimize downtime and help safeguard operations through advanced process and power control and cybersecurity enhancements.

Sustainability

Eurotherm products enhance and support customers' sustainability goals with features that minimize energy and manufacturing costs.

Customizable products designed by engineers for engineers

Cost-effective flexible software

- Adaptable to changing customer demands
- Scalable digital upgrades

Enhance and guard your brand

- Unique tamper-resistant option helps guard OEM knowledge and intellectual property (IP)
- Private labelling

Customizable configuration

- Clone files download: Pre-configured at factory for immediate use
- Custom linearization: Flexibility to support less common sensor types
- Fixed firmware: Supporting Copy Exact requirement

Eurotherm superior precision temperature control

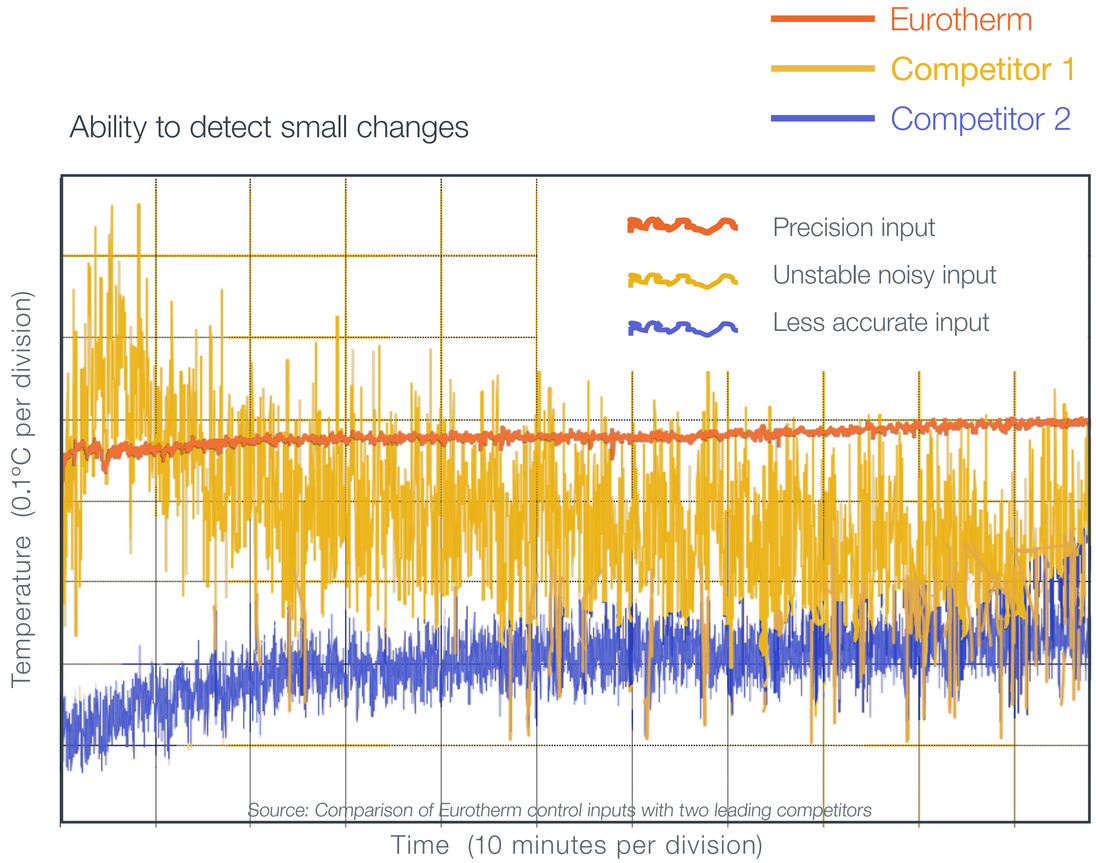
- Stable, repeatable, high precision measurements
- **0.1% CJC accuracy** of reading (over full operating range)
- High noise rejection and fast acting CJ compensation
- Accurate linearization for thermocouples, RTDs and other sensors
- Reduced noise decreases control oscillation

Eurotherm has a valued reputation for excellence in industrial precision control. This level of precision requires the ability to detect small changes and manage stable and repeatable high precision measurements.

For example, the Mini8® loop controller provides better than ±0.1% accuracy of reading with CJC rejection greater than 30:1 for standard 4 and 8 channel thermocouple input boards (TC4/TC8), and greater than 100:1 for enhanced 8 channel input boards (ET8).

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

Better noise rejection decreases control oscillation and low drift characteristics reduce the need for frequent recalibration.



Optimize energy use with Eurotherm power control

Owners need visibility into how energy is used throughout the fab plant if they are going to accomplish their energy reduction goals.

'Within the fab community... with fierce competition... ratcheting up efficiency efforts and taking a 20% to 30% bite out of annual energy costs can offer competitive advantage and improve profit margins'.

Source: Mckinsey–Bringing energy efficiency to the fab

Eurotherm contributes through improved power control performance, helping tool manufacturers, fabs and foundries to meet these demands.

Energy performance

- Accurate, repeatable, multi zone temperature control aids energy optimization
- Heat cycle optimization reduces processing time
- Specialized control algorithms and EtherCAT communication enable fast response to temperature disturbances with minimal overshoot

Power factor optimization

- Advanced control and firing modes allow harmonic noise reduction and power factor optimization
- Lower or eliminate power factor penalties on the energy bill

Energy usage diagnostics

- EPack™ compact SCR power controllers offer monitoring and diagnostics for improving energy efficiency and up-time

EPack compact SCR power controller

Optimize production output

Digital control rather than analog control, aids precision and repeatability which allows the EPack controller to achieve greater thermal uniformity of wafers during heat/cool processing, for sustainable performance and durability.

Helping maximize efficiency

Helping maximize efficiency

The semiconductor fab today, faces an ever-increasing pressure to reduce time to market and minimize costs.

Industry standardization combined with process control excellence can increase market agility and optimize cost of ownership.

Open connectivity with EtherCAT supports industry standardization and helps reduce time in design and build with common connectivity across devices.

Eurotherm has a global reputation for precision control that optimizes machine utilization and yield.

Built-in features help optimize energy usage.

EtherCAT Technology Group (ETG)

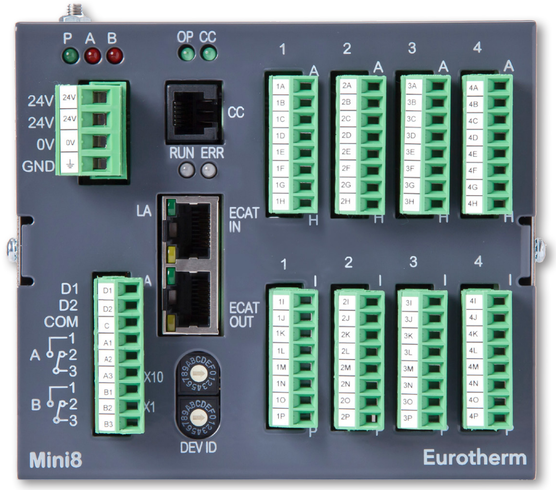
EtherCAT is an industrial Ethernet technology

- Available to everyone
- Cost effective – faster and simpler connection of machines/systems
- International IEC standard and SEMI standard
- Combines the advantages of Ethernet with the simplicity of classic fieldbus systems

EtherCAT-ready products meet ETG profile specifications

- EPack™ compact SCR power controller
- Mini8® loop controller

EPack compact SCR power controller



Mini8 loop controller

EtherCAT is an industrial Ethernet technology

The Eurotherm EPack power controller and Mini8 temperature controller are EtherCAT-ready and meet the ETG power profile and temperature profile specifications. This pre-validation can shorten deployment time and mean faster build time.

The ETG's EtherCAT power profile sets the boundaries by which an EtherCAT power or temperature solution should be selected. It supports the industry’s move from analog to digital devices for increased connectivity, allowing for scheduled and proactive maintenance.

Founded in November 2003, the ETG group is comprised of key user companies and automation suppliers including Eurotherm, who have joined forces to support, promote and advance EtherCAT technology.

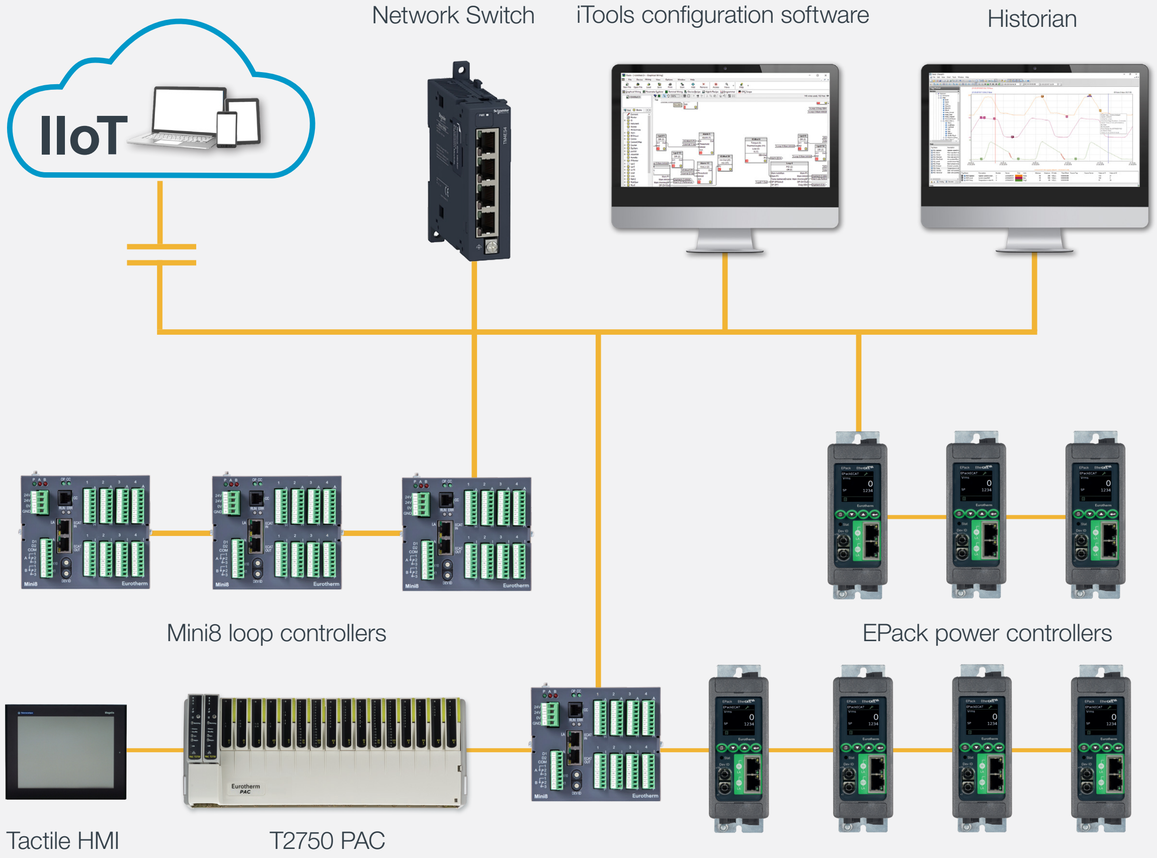
Native communications, ready for IIoT and Industry 4.0

'One of the most widely discussed industry phenomenon has been the slowdown of Moore's Law… which posits that the number of transistors doubles every 18-24 months… Chips are now smaller, denser, and more powerful than ever before. Relative to other industries, Moore's Law has propelled the semiconductor industry to achieve an unparalleled pace of innovation.'

Source: Harnessing the power of the semiconductor value chain

Semiconductor fabs still need to be resilient and adaptable for these changes. EtherCAT helps improve market agility to meet increasing demands:

- Easier connection to PLCs, devices and IIoT technologies
- Daisy-chained communications simplify the architecture for integration into an enterprise management system
- Fewer I/O devices help save cost and installation time of equipment and wiring
- Simplified design reduces stock and spares holding
- Remote software upgrade of I/O

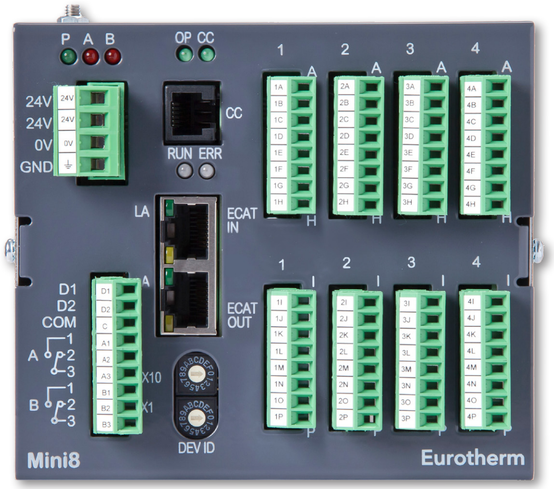


Mini8 loop temperature controller

Read more

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

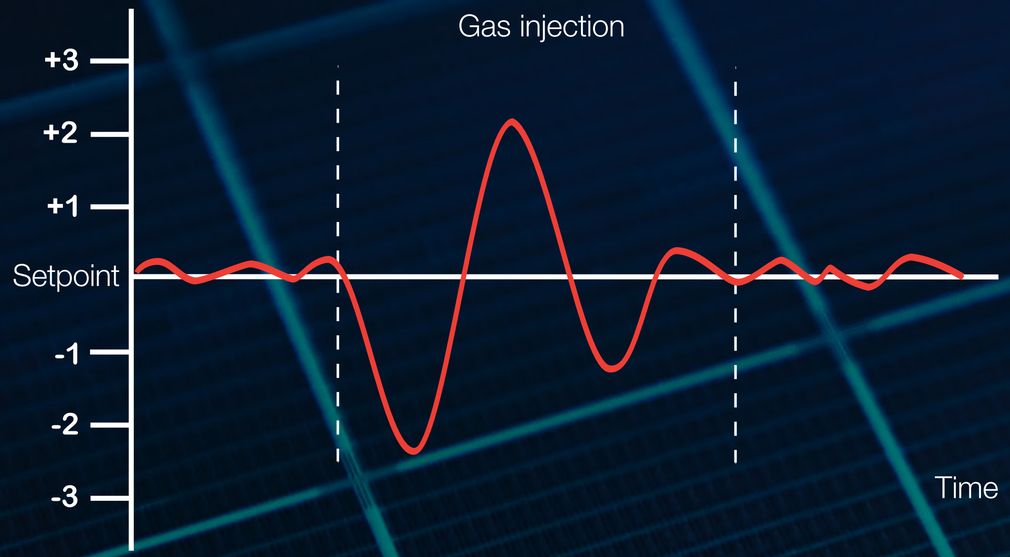


Mini8 loop controller

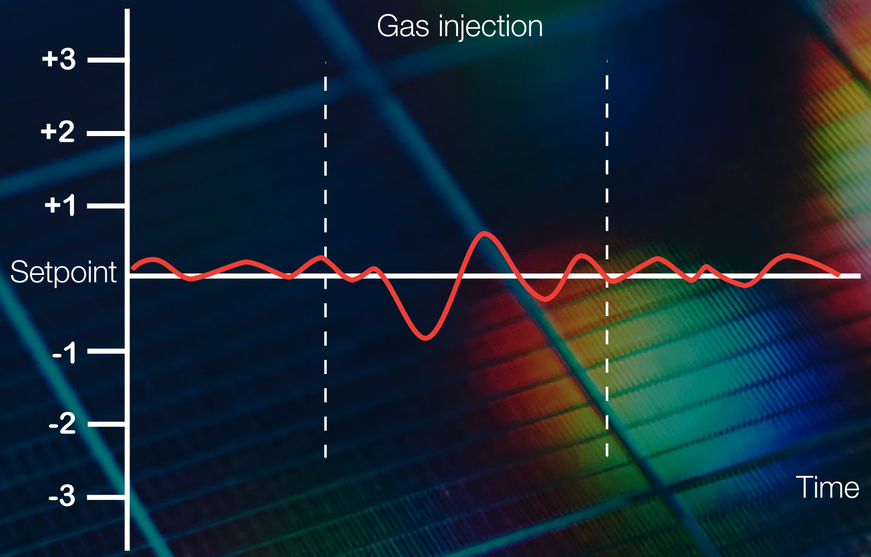
Mini8 loop temperature controller for compact, precision temperature control EtherCAT – fast acting response and common connectivity

Fast response to process disturbances helps maximize production throughput

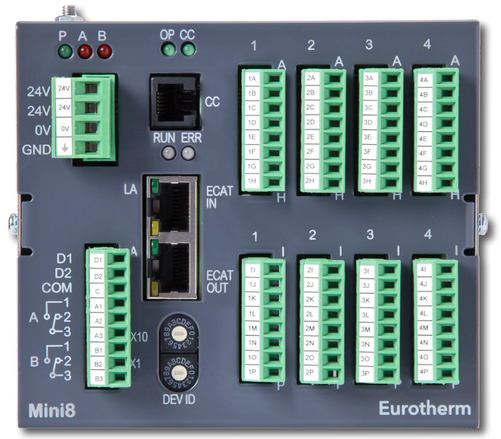
Typical controller



Eurotherm Mini8 loop controller



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.

Solution – Mini8 loop controller

- 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

EPack compact SCR power controller

Read more

Measurement accuracy and control precision offer temperature stability, uniformity and repeatability for a more consistent yield and improved throughput.

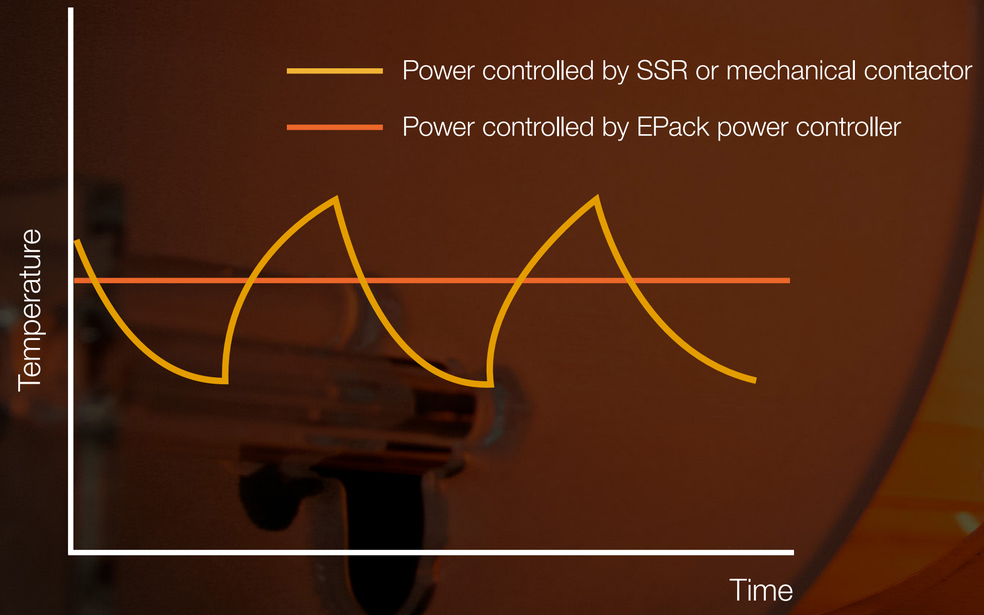
- Minimize impact of temperature disturbances with fast-acting power control response
- Consistent high-quality yield with accurate repeatable temperature control
- Improve energy efficiency and up-time through monitoring and diagnostics
- Help protect valuable IP, limiting access to confidential configurations/recipe information with ‘OEM Security’ option
- Control modes to suit different heater types and load configurations
- V^2, I^2 or true power control
- Advanced control modes allow harmonic noise reduction for optimizing energy use and power factor
- Load failure detection

EPack compact SCR power controller, for improved electrical power efficiency
EtherCAT – fast acting response and common connectivity

Stable and accurate power control response to demand, optimizes energy use

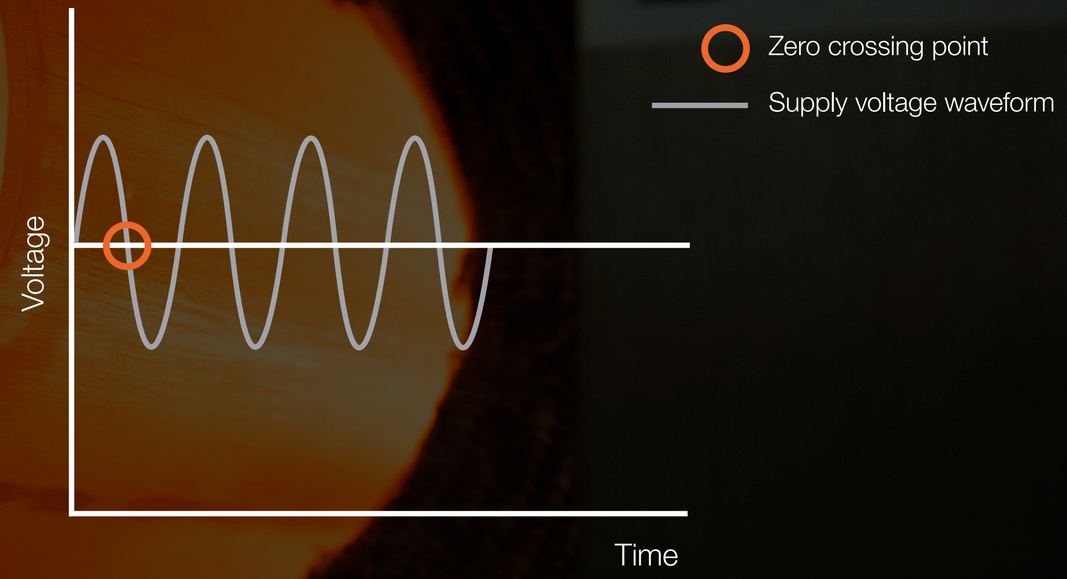
Heating temperature stability

Adjusts energy delivered to the heating element, helping

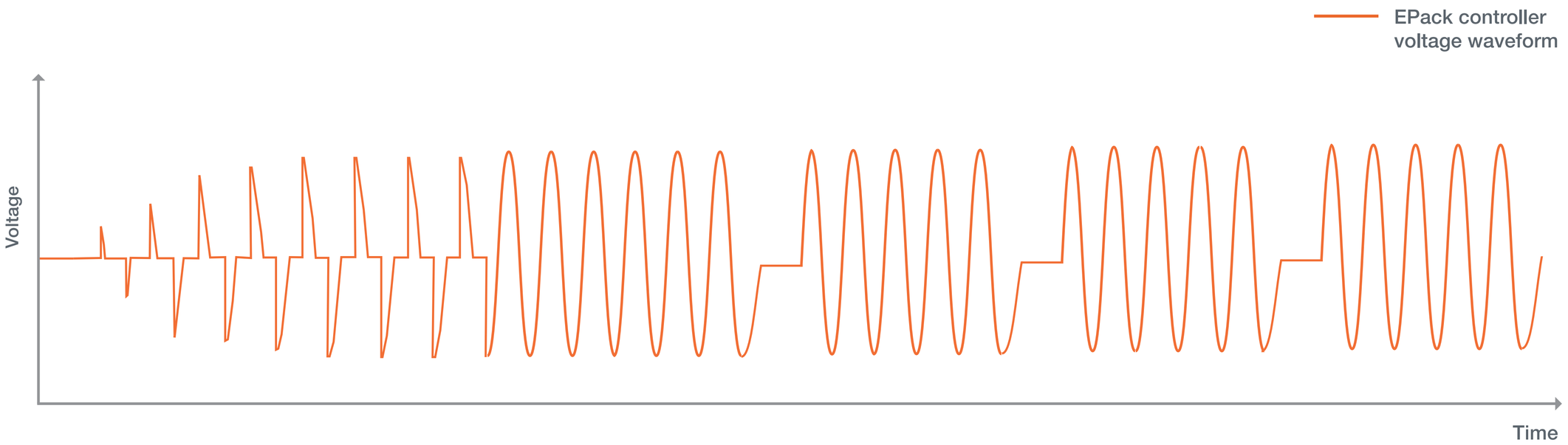


Accuracy of synchronization and firing

Accurately detects zero crossing on the voltage waveform. Results in less harmonic distortion and more accurate response to power demand.



Optimization of firing mode and energy consumption



The EPack power controller will automatically switch firing mode depending upon the ohmic value of the load, for example, during the period of stress when the load is cold. The advanced start-up feature allows smooth start-up with less stress on the load.

The ability to use the most suitable firing mode at the right moment helps to improve the load lifetime and improves energy consumption with less harmonic disturbances and better power factor.

Case study: Precision temperature control for UV laser annealing

An OEM customer designing and manufacturing high energy UV laser equipment for the Semiconductor industry required a three-zone temperature control solution with precise PID control for the end-user.

Customer challenge

Their equipment is used for fast and thin annealing of semiconductor materials such as Silicon, Germanium and Silicon Carbide (SiC). The materials are used to manufacture components such as digital memory devices, power transistors, and CMOS image sensors for digital cameras. The temperature of the wafers is maintained using three PID control loops in the E+PLC combination PLC, and the EPack power controller with Ethernet communications. The electrical parameters and diagnostics are provided through Ethernet Modbus TCP.

Solution: EPack power controller and E+PLC

- Precision PID loops and accurate power control
- Real-time measurement display with setpoint entry capability
- Recording necessary parameters for production quality control

Customer benefits

- E+PLC uses standard IEC 61131-3 programming languages, reducing the learning curve
- Native Ethernet communications in the E+PLC and EPack devices
- Fast integration through simplified wiring
- Straightforward duplication of control strategies
- Accurate repeatable temperature control for the end-user
- Simplified engineering helps minimize overall cost of the solution

E+PLC400 combination programmable logic controller

Read more

- Configuration using CODESYS® development platform
- Minimal learning curve – standard IEC 61131-3 programming
- Eurotherm proprietary auto-tuning PID control algorithms in easy-to-use function blocks
- Accurate measurement enables better process performance
- Precision control and setpoint programmer both enable efficiency optimization:
  - Reduces processing time
  - Contributes to energy saving and cost reduction
  - Minimizes process waste
- Tamper-resistant recording aids compliance to industrial regulations and quality standards
- Faster device integration:
  - Minimizes engineering time
  - Reduces equipment and wiring costs
  - With pre-engineered connection to other Eurotherm products

Case study: Multi-zone etch system machine control

Etch systems are core equipment for ultra-shallow semiconductor production and are challenging to develop. Our customer succeeded in developing their system with independent technologies, realizing mass production.

This manufacturer of etch processing equipment chose Eurotherm E+PLC400 with EPack power control for the development of their control systems. In the previous system the four zone heater was controlled by four single loop heater controllers and PC software managed the interaction between zones. The company preferred Eurotherm PID control due to its fast-acting precision control loops.

Multi zone temperature control

- Off-the-shelf single platform solution
- PLC functionality for interlocks
- Precise temperature control: E+PLC400 compensates for interactive zones
- Libraries with pre-defined communications to EPack power controllers, significantly reduce engineering effort

Customer benefits

- Enabling continuous thermal process monitoring with EPack monitoring and diagnostics
- Multizone control with E+PLC400
- Cost savings achieved by reduced footprint and reduced engineering requirements

Designed for operational resilience

Designed for operational resilience

To stay competitive requires resiliency designed into manufacturing fabs. This helps customers increase operational intelligence and aim for zero downtime and minimized outages. In turn this helps to maintain operations 24/7.

Three key drivers aid maintenance excellence and protection of personnel, assets and data.

Precision control

Maximize power availability and quality through precision control.

Asset reliability and maintenance

Features designed to help reduce unplanned downtime.

Designed with cybersecurity in mind

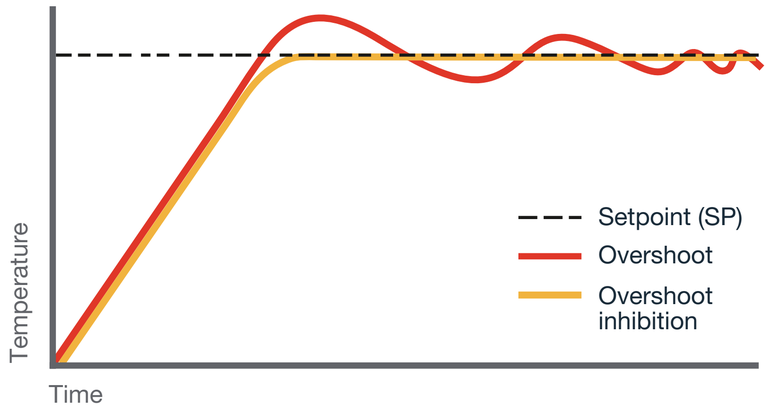
Managing ever increasing threats to operations with products and control systems designed to help reduce the risk of cyberattacks.

Advanced autotune and algorithms aid efficiency and repeatability

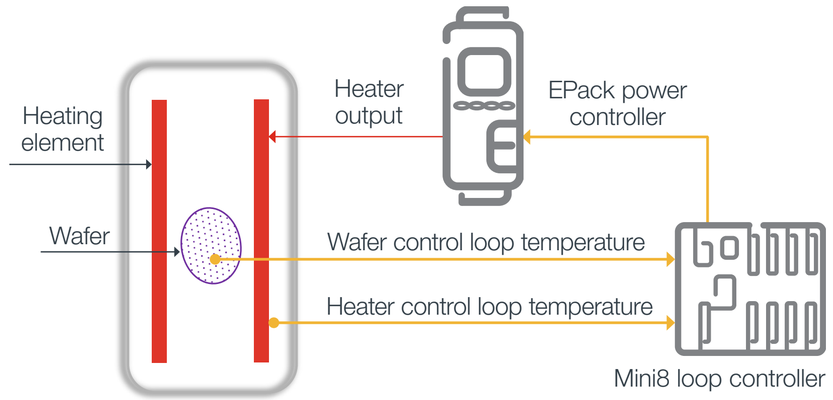
Precision PID control has embedded algorithms to tightly control temperature, so setpoints are reached with minimal overshoot during ramps and the process variable stabilizes faster. When operating temperatures are outside the desired setpoint, the result is wasted time and energy, defects from under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

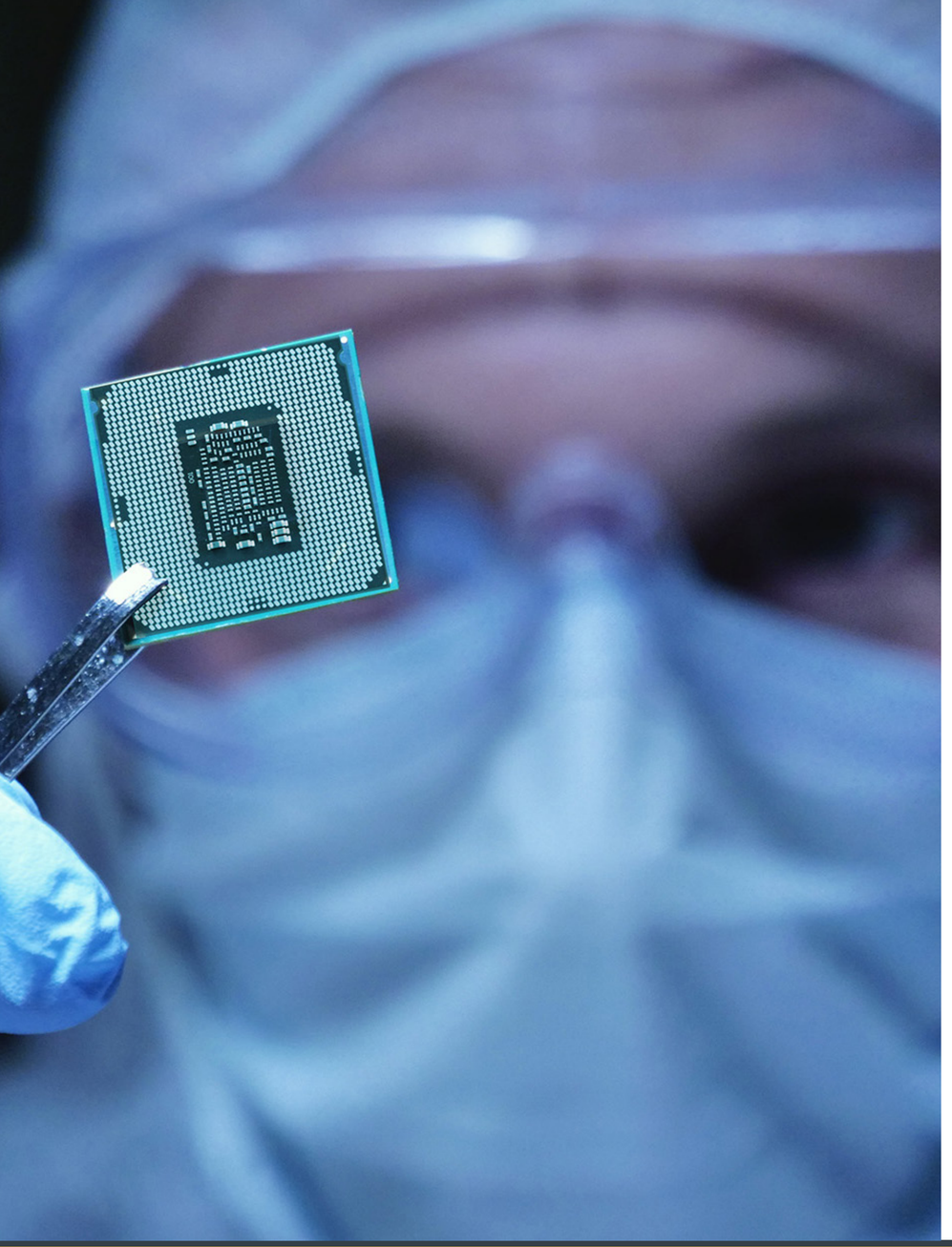
Eurotherm has spent over 50 years perfecting these kinds of algorithms, along with advanced autotune features that automatically set desired parameters in the PID control loops to suit the application. Taking care of this often, manual task, achieves automatic efficiency and repeatability, even compared 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





Proactive, accurate power control and precision temperature control help maximize availability and increase overall reliability of the process:

- Eurotherm thermal heating control increases overall reliability, throughput and yield
- Closed loop power feedback improves temperature control and maximizes heater life
- Provides continuity of process and power conditioning, thus avoiding power quality disturbances
- Contributes to carbon footprint reduction

Managing lower temperature processing is critical in many complex semiconductor processes:

- Eurotherm advanced multi loop control is designed for optimized temperature performance at precise rates
- Mini8 loop controller offers tight control and decisive response to disturbances between temperature zones for optimal performance
- Eurotherm cutback technology provides overshoot and over-ramp suppression
- Setpoint programming enables straight forward configuration which can help reduce engineering time

These features are ideal in applications for diffusion and photolithography processes:

- CMP, wet bench and implant, and the temperature control element of PVD, CVD process stages, increasing process reliability, availability and efficiencies
- Compact solutions that encapsulate the typical control features required for Diffusion and PECVD horizontal tube furnaces

We listen, and we understand the specific needs of our customers

“

— *I need to move from analog to digital power control for increased connectivity, allowing for scheduled and proactive maintenance.*

— *I need a compact alternative for power control with straightforward connectivity via standard protocols for faster data transfer.*

— *I need power control that allows optimization of the process to improve operational efficiency and productivity.*

— *I need to support my existing Mini8 based applications with minimal change costs (drawings and application refactoring, validation).*

— *I need reliable, repeatable control performance, with fast response to process disturbances.*

— *I need a compact alternative to PLC control for demanding applications with straightforward connectivity via standard protocols for faster data transfer.*

”

Robust, easy to install and maintain

A 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, setpoint programming, recipes

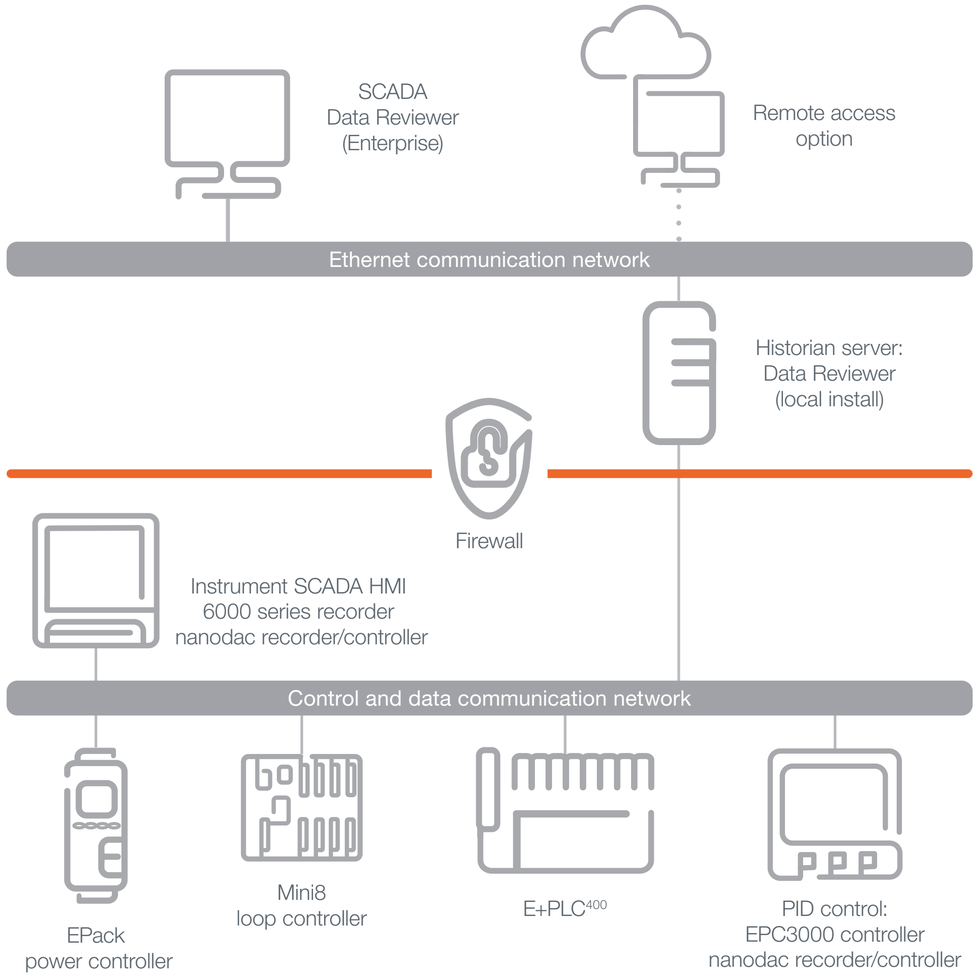
Simplified integration

- Multi-protocol and 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 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

Robust control designed with cybersecurity in mind

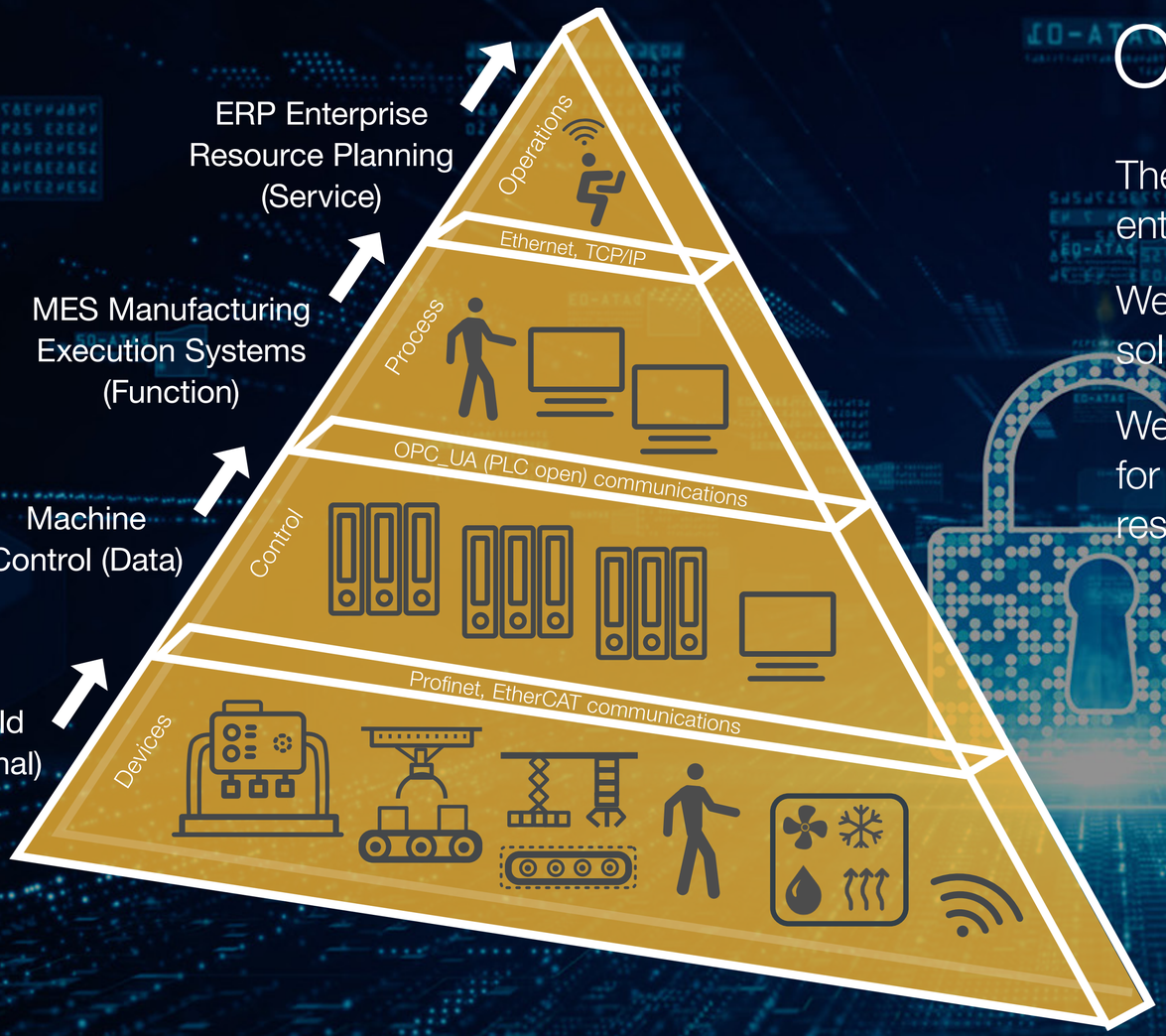


Managing cybersecurity is about managing risk. Eurotherm provides technical capabilities and professional industrial cybersecurity services to support customers with this.

Looking at this example of a typical architecture, Eurotherm controller and data acquisition products normally reside in the process control level behind a firewall. Our product ranges include communication robustness and user access features, helping to protect production processes from being compromised by cyber attacks as part of a ‘defense in depth’ strategy.

Eurotherm products across control and communications networks include features such as the previously mentioned ‘OEM Security’ option, designed to minimize unauthorized access to confidential configuration information, so helping to guard your intellectual property.

Eurotherm control and data acquisition products with Achilles certification have communication robustness features, for example, algorithms that can detect excessive network activity and help to ensure that a device’s resources are prioritized on the essential functions of the control and/or recording strategy.



Our cybersecurity capabilities

The triangle represents a typical architecture from shop floor to enterprise level.

We can help you assess your risk, implement cyber-specific IIoT solutions, and maintain your defenses over time, at your location.

We will help you to empower staff to carry out secure operations for your process and reduce the chance of cybersecurity incidents resulting from human error.

A more sustainable future

A more sustainable future

We are here to help semiconductor manufacturing fabs in their sustainability journey across the full value chain to build the most sustainable fabs of the future. We are invested in optimizing resources, and helping the industry meet its climate goals as well as helping customers to meet corporate governance and minimize environmental impact.

Accelerate the carbon roadmap towards zero impact semiconductor fabs and help build long-term business resiliency

Optimize resources

Efficient management of energy through precision thermal processing control.

+

Helping meet climate goals

Products designed to deliver sustainable performance. Commitment to more facilities meeting net zero carbon emissions.

Meeting OEM challenges to optimize resources, be scalable, be resilient and ready for the fabs of the future

18~24

- New process technologies emerge ≈ every 18–24 months
- Chipmakers must increase capacity to meet demand

Source: semiengineering.com

We can help determine where operational improvements can deliver measurable value, now and in the future

Industry 4.0

- OEMs need to react quickly to customer needs
- End users need continual process improvements

We offer:
- **Customizable solutions**
- **Development support for future demands**
- **Infrastructure readiness for Industry 4.0**

9x

Nine times more data was generated in last 6 months of 2020 vs. last 15 years so the need for new technologies is now

Source: semiengineering.com

We have experience of complex and regulated industries that require data integrity. Good data practices (GxP) lead to trustable data and analytical insights

Modernization of equipment and infrastructure enables production line power supply agility to meet the demands of the future.

Eurotherm is helping customers minimize their impact on the environment in a growing and rapidly changing industry

In the semiconductor industry, as demand changes, we see surges over 18–24-month periods.

Scalability and being future-ready is critical: Eurotherm can help fabs be ready and resilient to meet these changes. Our wide range of control and firing modes to cover different heating applications offer OEMs customizable solutions to react quickly to customer requirements while reducing integration time and on-costs.

Eurotherm offers products and solutions ready for semiconductor equipment in Industry 4.0 smart factories and fabs:

- Scalability for growth as fabs evolve
- Compact products help to meet future demand for smaller devices, and minimize factory footprint
- Cloud technology for large amounts of data
- Support for future development – highly skilled R&D team plus global support/ service teams
- Eurotherm helps OEMs to help end users, by developing products and features that aid compliance with evolving industry standards/legislation
- Eurotherm power and temperature profiles are designed, tested and validated for fast and easy integration into existing installations, enabling leverage of connected digital technology for operational efficiency, while helping reduce environmental impact.

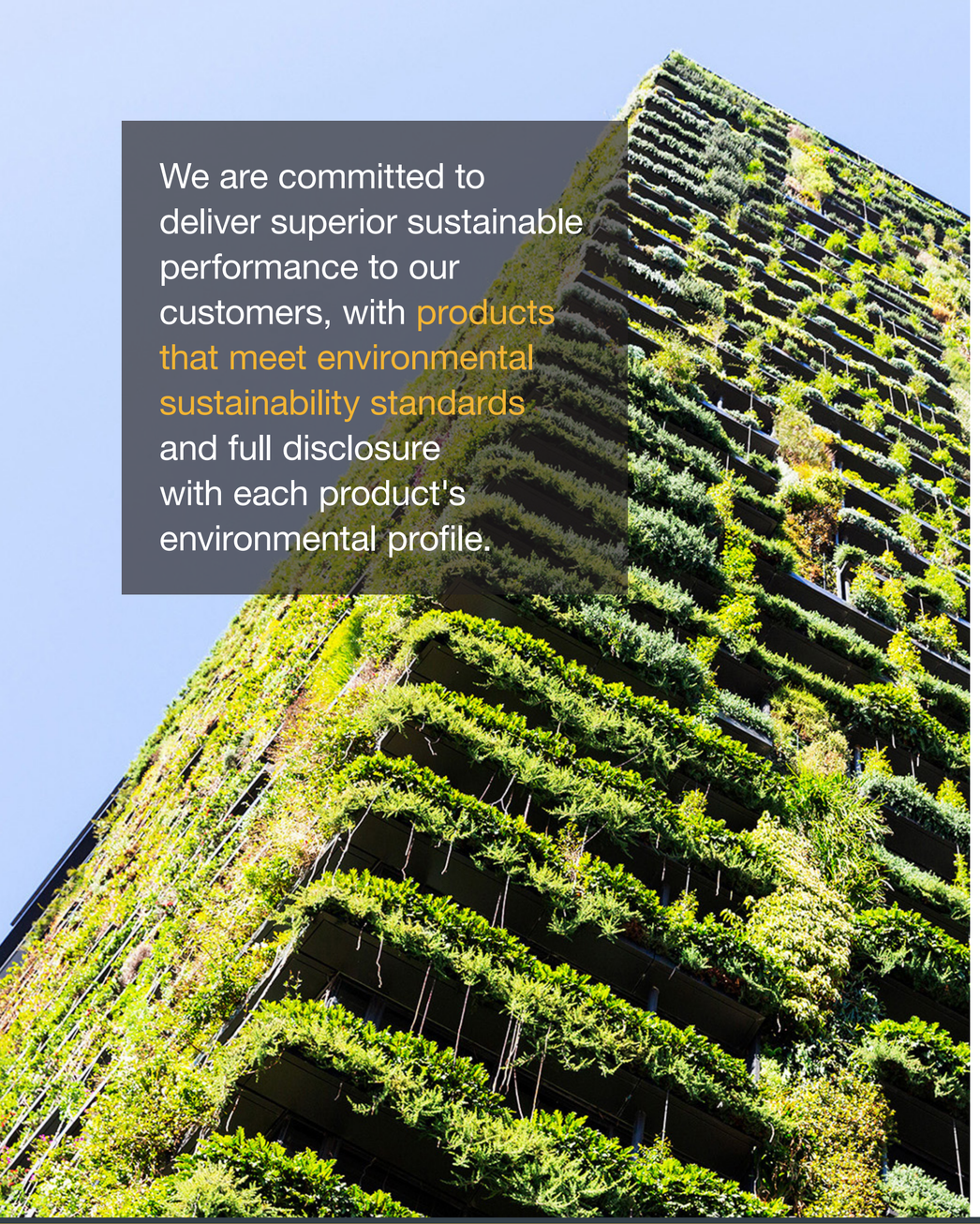
The need for new technologies is gaining momentum

> ***We are seeing more data generated for the last 6 months than over the past 15 years.***
>
> *We believe the coming three years, starting 2022, will see an intense increase in formal verification adoption. This drive for formal methods will be necessary for all kinds of designs.*
>
> Source: semiengineering.com

Rapid world growth, globalization, advanced technologies for Industry 4.0 automation and data analysis trends, are emphasizing the need for high standards of data quality and integrity.

Good data practices (GxP) will enrich the quality of data, enabling semiconductor companies to make strategic decisions based on trustable data and analytical insights.

Eurotherm has experienced teams that have successfully implemented validated solutions around the world. Our solutions and services can help to efficiently manage the quality of manufactured goods, through machine and process automation efficiency.



We are committed to deliver superior sustainable performance to our customers, with products that meet environmental sustainability standards and full disclosure with each product's environmental profile.

Climate goals – we all have a part to play

Lets talk about the future and how we all have a part to play in reversing climate change.

We strive to help customers to optimize their resources with thoughtful, sustainability-focussed design and build.

- **Power control performance**, helping machine builders, fabs and foundries to meet their energy reduction goals
- Compact products for a **reduced footprint**
- **Meeting environmental standards** across multiple offers, including the EPack power controller and Mini8 loop controller

Note: Refer to the semiconductor product information page on the Eurotherm website www.eurotherm.com for details.

Eurotherm facilities and zero carbon target

We continuously strive to minimize our own environmental impact.

Our production facility meets sustainability criteria confirmed by BREEAM certification.

The Eurotherm production facility in Lędziny, Poland meets sustainability criteria confirmed by BREEAM certification – the world leading sustainability assessment method for master planning projects, infrastructure and buildings.

Source: BREEAM.com

Source: PR Eurotherm, Poland

Eurotherm Italy zero carbon building:

Eurotherm Italy site was the first Italian zero carbon building of the group, joined shortly after by the Eurotherm France site.

Source: PR Eurotherm Italy

UK HQ facility is on target for zero carbon with a committed biodiversity team working towards a bio-diverse landscape for outside areas.

Eurotherm global headquarters in the UK is the base for many functions including Eurotherm Research and Development. A major refit of the Worthing UK HQ will meet net zero carbon by completion.

The project includes not only the buildings but surrounding land: removing lawns and replanting with native plant species, providing wildlife corridors and connection between green spaces, using organic maintenance methods and providing natural shelter for insects and wildlife.

Eurotherm®

Semiconductor application expertise

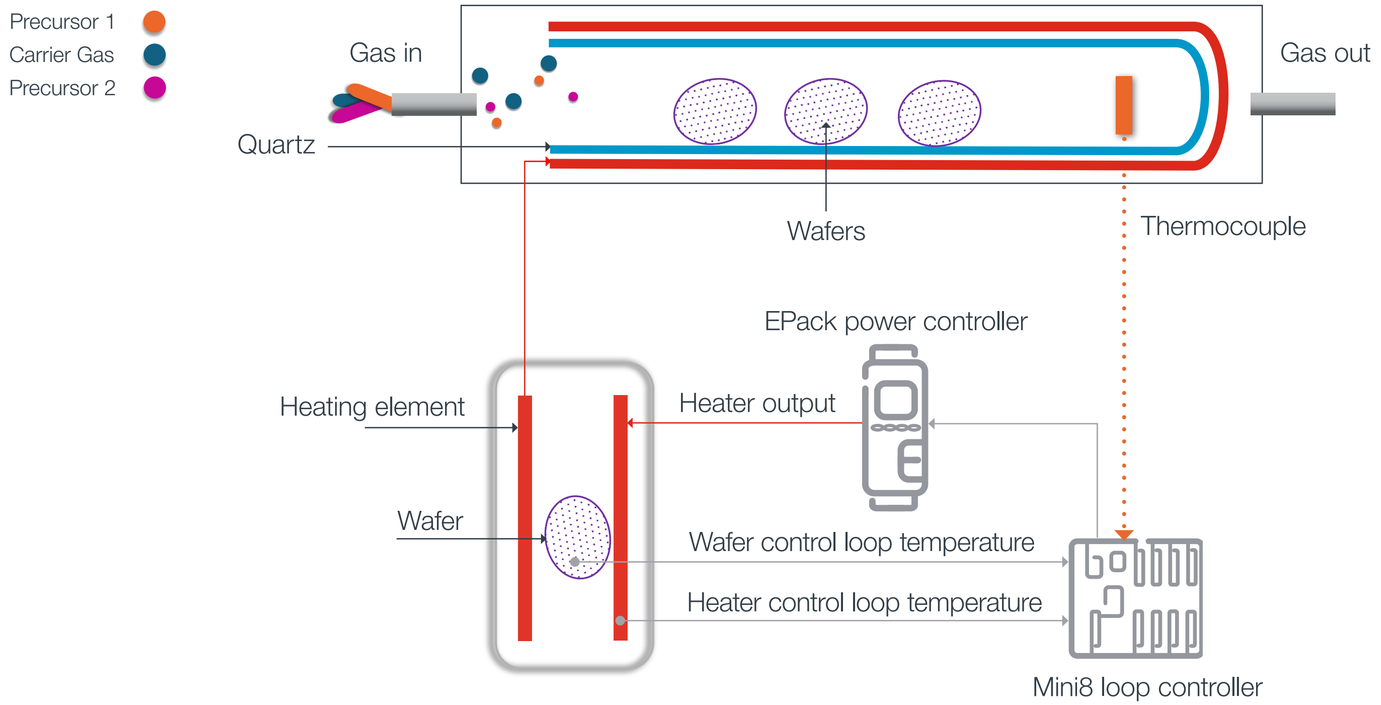
Helping meet semiconductor processing challenges

Atomic Layer Deposition (ALD) processing

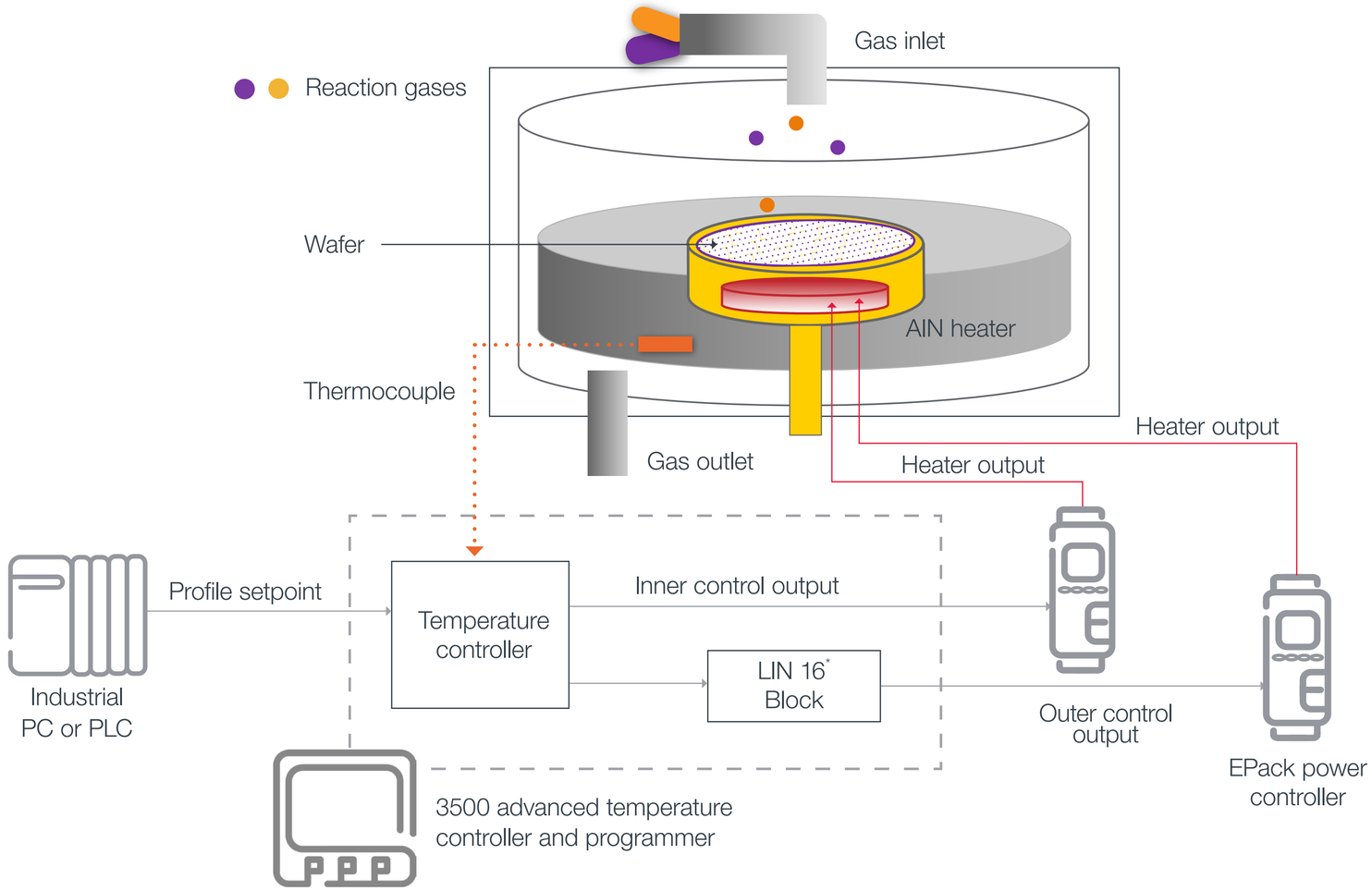
Manufacturing challenges	Eurotherm precision temperature and power control solutions
• Atmospheric contamination in the chamber • Low process temperature can lead to low reactivity in chamber • Condensation – reduces effective purging • Decomposition – adds undesirable components • Desorption of the film or precursor	• Precise, uniform and stable temperature control reduces risk of these common and detrimental process effects • Improves yield and quality

ALD batch chambers with Eurotherm cascade control

The wafer temperature is controlled using a cascade configuration where the wafer temperature uses the inner loop and the heating element temperature uses the outer loop.



Plasma-enhanced chemical vapor deposition (PECVD)



*16 point Linearization block (output characterization)

Manufacturing challenges	Eurotherm precision temperature and power control solutions
1. Managing complex cycle stages at low and high temperatures 2. Temperature disturbances – detrimental to quality and uniformity of wafer 3. Managing process lags and temperature uniformity between zones 4. Need fast rise to setpoint and precise tracking of desired ramp rates without overshoot	1. High accuracy control maintains varying temperature ranges 2. Decisive and fast response to process disturbances 3. Cascade control regulates spike temperature and profile temperature across zones 4. Precision PID control maintains process variables close to setpoint, even during ramps

- Typically two or up to four vacuum chambers per machine
- Eurotherm true power control
- Two control outputs with different gain
- Control of up to four AlN heaters

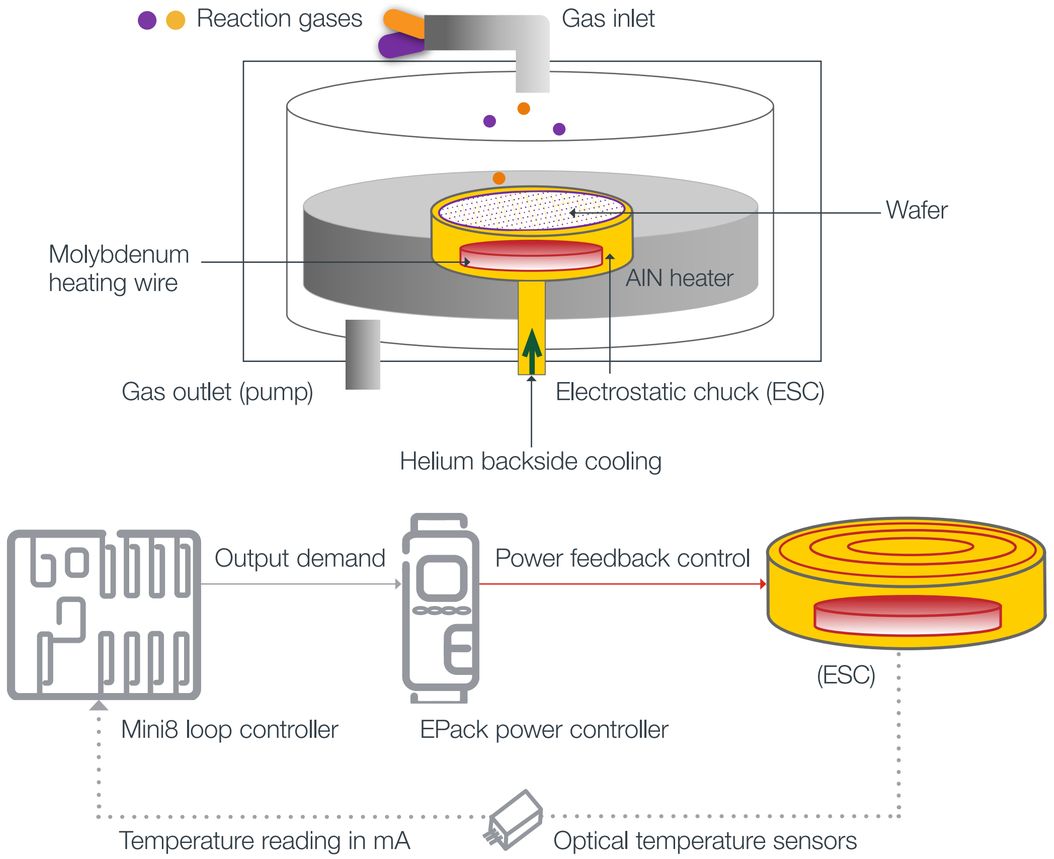
Dry Etch processing

Manufacturing challenges	Eurotherm precision temperature and power control solutions
Complex recipes and short processing times require: 1. Fast response to process disturbances 2. Substrate temperature is critical to the process recipe 3. Often high temperature processing 4. Constant demand for smaller wafers and smaller machines	1. Cascade control offers fast response to process disturbances which helps maximize production throughput 2. Precise, uniform substrate temperature control 3. EPack power feedback (V^2) helps minimize energy use 4. Reduced footprint using compact products and flexible control solutions

Eurotherm precision temperature measurement and heater control

During the process, gas entry causes temperature disturbances. Eurotherm offers accurate temperature measurement, precise heater control and fast response to temperature disturbances.

With Eurotherm support, customers can manage **±1°C precision temperature control** during the Helium cooling process stage, and **±0.5°C for other stages.**



Summary

Front	Eurotherm precision temperature and power control offers:
• Accurate temperature measurement • Often high temperature processing • Low thermal/time-related drift	• Accurate, stable industrial temperature measurement • Excellent CJC accuracy and rejection ratio
• Stable repeatable temperature control within fine limits • High degree of interaction between zones	• Eurotherm algorithm and overshoot inhibition parameters offer fast response to process disturbances • Interactive algorithms compensate for closely coupled zones • Power controllers accurately regulate power delivered to the load
• Easy integration into PLC and PC-based control systems	• Flexible open communication protocols • True power control configuration in the field with native EtherCAT communication
• Small footprint for semiconductor machines	• Mini8 loop controller 8-16 loops in a compact footprint — 124mm/4.88in(w) x 108mm/4.25in(h) x 115mm/4.53in(d) • EPack SCR power controller — compact, modular design • EtherCAT connection saves cabling costs, reduces footprint
• Tool manufacturers need differentiation from competitors	• Customizable configurations for specialized recipes • OEM security and private labelling

To learn more about Eurotherm semiconductor solutions, visit

eurotherm.com/semiconductor

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