

Precision Thermal Stability for Semiconductor Excellence

Wireless Temperature Monitoring

Maintain sub-degree temperature control, eliminate thermal drift, and protect yield at advanced nodes—while minimizing HVAC energy waste.

Yokogawa digitizes cleanroom microclimates with secure, high-integrity, real-time sensing.

Introduction

As fabs push into 3 nm, 2 nm, and advanced packaging, temperature stability becomes a yield limiter—not just a facilities KPI. Sub-degree drift can drive dimensional changes, overlay error, and tool-to-tool variability that snowball into rework or scrap. At the same time, fabs face tightening expectations around energy efficiency and greenhouse gas reduction, with industry initiatives accelerating toward net-zero targets across Scopes 1 and 2.



Example of workers in a semiconductor fabrication plant, with cleanroom suits and high-tech equipment

Operationally, the cleanroom is also governed by globally recognized cleanroom standards that define classification and the need for ongoing monitoring evidence. ISO 14644-1 defines cleanroom air cleanliness classification, while ISO 14644-2 specifies minimum requirements for a monitoring plan that provides evidence of performance over time.

Yokogawa helps fabs balance thermal precision, compliance, and sustainability by building a secure, scalable sensing and data layer that turns localized thermal behavior into actionable intelligence—without adding operator burden or compromising cleanroom discipline.

The Challenge

Why traditional thermal monitoring falls short

Cleanroom temperature monitoring often misses the operational reality of “micro-climates” created by high-density tools, localized airflow patterns, and frequent recipe changes:

- **Thermal Layering & Micro-Climates:** Standard HVAC sensors often overlook localized heat pockets generated by high-performance machinery, leading to undetected “hot spots.”
- **Data Latency:** Legacy systems lack the sampling speed to capture rapid heat spikes, preventing real-time corrective actions.
- **Calibration Integrity:** Maintaining traceable, high-accuracy thermal data is difficult in a 24/7 operating environment is labor-intensive and prone to human error.
- **Alarm fatigue** from nuisance events (e.g., brief access cycles) that desensitize operators
- **Limited remote visibility** that increases unnecessary gowning and response time
- **Disconnected data** that prevents correlation across zones, shifts, tools, and maintenance events.
- **The Energy Paradox:** To ensure stability, many facilities “over-cool,” leading to excessive energy waste and increased carbon emissions.

The Solution

Yokogawa SMARTDAC+ & Wireless Edge Sensing

Yokogawa’s thermal monitoring architecture creates a comprehensive “digital twin” of your clean room’s climate, integrating edge sensing with advanced data management. Scalable from point monitoring to facility-wide thermal intelligence—supporting modernization, revamps, and expansion:

- **SMARTDAC+ GX/GP Series:
The Thermal Core**

The SMARTDAC+ GX20/GP20 serves as the high-precision data hub. It supports up to 100 channels of direct thermocouple or RTD inputs with industry-leading accuracy. With its modular I/O, it captures the high-fidelity data required for sub-degree stability.



SMARTDAC+ GX Series

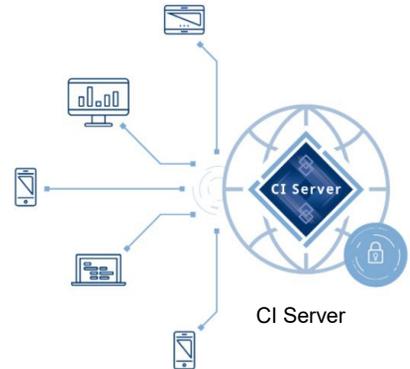
- **Advanced Analytics & Math Functions:**

Beyond simple logging, the GX series utilizes AI-driven math functions to calculate real-time Mean Kinetic Temperature (MKT) and thermal stability trends. This allows for predictive HVAC adjustments, neutralizing thermal drifts before they breach tolerance limits.

- Sushi Sensor (Wireless IIoT): Total Visibility**
 For facility revamps and hard-to-reach areas, Yokogawa's **Sushi Sensor (Wireless Temperature)** utilizes **LoRaWAN®** technology. These sensors allow operators to monitor temperature near motors or inside tight equipment enclosures without the cost of new cabling, facilitating a rapid digital rollout.



- Collaborative Information Server (CI Server) Integration**
 All thermal data can be unified into the **CI Server**, Yokogawa's cross-platform data orchestrator. This enables remote, secure web access to real-time thermal maps, ensuring the clean room remains sealed, sterile, and monitored from any location.



Key Benefits

- Enhanced Yield & Zero-Drift Reliability:** Yokogawa's world-class input modules ensure long-term stability, significantly reducing wafer scrap and the frequency of costly recalibrations.
- Sustainability through Thermal Efficiency:** By identifying areas of "over-cooling," plant managers can optimize HVAC setpoints to reduce energy consumption by up to **15%** while maintaining safety margins.
- Intelligent Smart Alarming:** Customizable "Delay Alarms" ignore transient temperature spikes caused by brief equipment access, focusing operator attention on genuine thermal runaway risks.
- Audit-Ready Compliance:** Automatically generates encrypted, electronic thermal reports that comply with global quality standards (such as ISO 14644-1), eliminating paper-based errors and dust contamination.

OpreX™ Yokogawa achieves operational excellence by providing products, services, and solutions based on the OpreX comprehensive brand that cover everything from business management to operations.

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