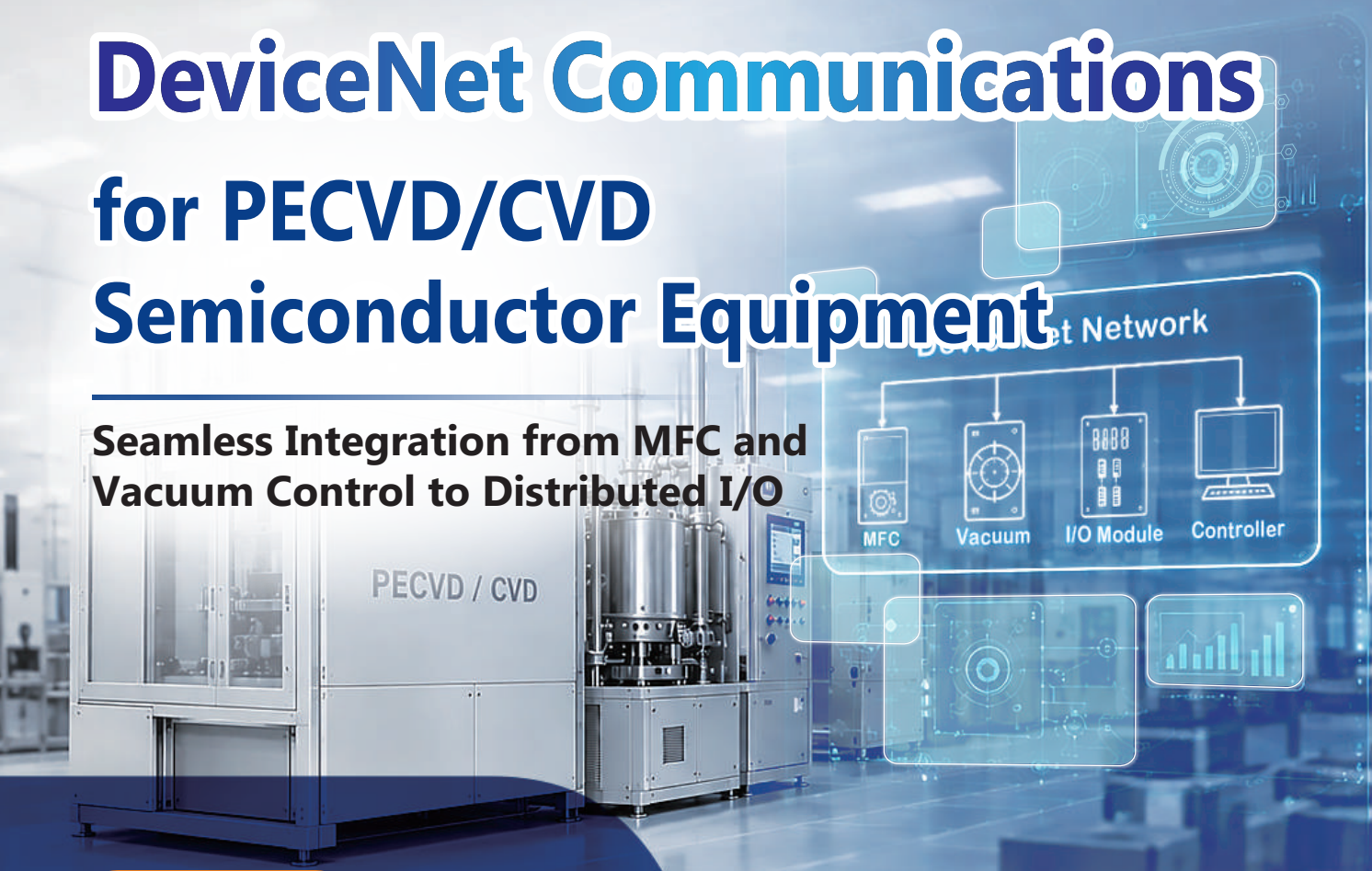
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Automation & Technology Life Vol.87

DeviceNet Communications for PECVD/CVD Semiconductor Equipment

Seamless Integration from MFC and Vacuum Control to Distributed I/O



Application Story

- **RPAC-2858M Enables Automatic Failover for Highly Reliable Coastal Surveillance**

Products Column

- **Securing ICS for Smart Manufacturing: GW-2500iM Series**

Technology Forum

- **Predictive Motor Maintenance via Vibration Analysis**

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High-Speed Measurement & Reliable Transmission

Fault-Tolerant Redundancy



RPAC-2658M
RPAC Redundant Controller

RPS-4M
RPS Redundant Power Supply

EtherCAT

RIO-9840
RIO Redundant I/O System

- Controller Redundant 200ms
- Pwr. Redundancy Instant Switchover
- I/O Redundancy 1ms

Multi-Channel Temperature Measurement

DAS-8421 / DAS-8821
4/8-Slot Ethernet High-Speed Data Acquisition System

Supports Multiple Software Development Tools



- 64/128 CHs Thermocouple
- RTD 48/96 CHs
- 85-100Hz Per Channel Sampling Rate
- ±0.1% FSR

Ethernet Remote Modules



ET / PET-2217H Series
ET / PET-2215H Series
ET / PET-2218H Series

Expansion Modules



I-8015W Series
I-8018W Series

Long-Distance Communication



Standard Ethernet
← 100 m →

T1L Cable
1,000 m

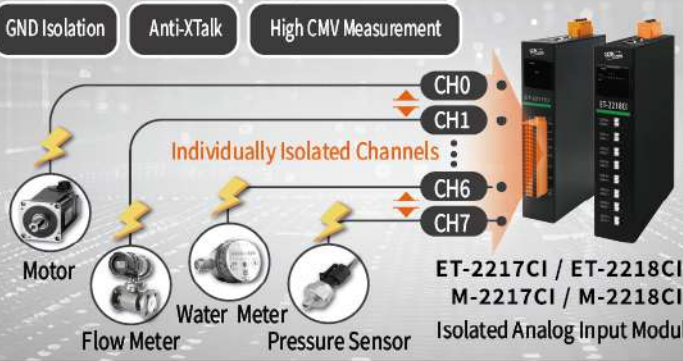
NSM-2402-T1L
Single Pair Ethernet Switch

T1L Ethernet I/O Module (Modbus TCP)

ETL-2255

Channel-to-Channel Isolation

- GND Isolation
- Anti-XTalk
- High CMV Measurement



ET-2217CI / ET-2218CI
M-2217CI / M-2218CI
Isolated Analog Input Module

E-Catalog
遠端 I/O擴充模組

E-Catalog
Remote I/O

ICP DAS 泓格科技 ICP DAS CO., LTD.

AI Predictive Maintenance Accelerates Industrial Adoption

ICP DAS PET-AR401 Integrates ITRI PMS Technology for Smarter Equipment Maintenance

By Editorial Team (Translated by Lynn Tang)

As AI adoption accelerates in manufacturing, equipment maintenance is shifting from scheduled servicing and post-failure repairs to data-driven **Predictive Maintenance**. Developed by ITRI, the **Prognosis Monitoring System (PMS)** for rotating machinery won the **2026 Edison Awards Gold Award**, highlighting Taiwan's advances in AI-based equipment diagnostics and smart maintenance.

ICP DAS integrates ITRI's PMS vibration diagnostic technology into the **PET-AR401 Vibration Data Acquisition and Analysis Module** with the **iMotor Utility** visualization



▲ **Figure 1** | The **PET-AR401 Vibration Data Acquisition and Analysis Module** integrates ITRI's vibration PHM technology for AI-based vibration monitoring and Predictive Maintenance in manufacturing.

interface. The solution combines vibration measurement, anomaly analysis, and health monitoring in one platform. Real-time edge computing and AI diagnostics quickly identify abnormalities in bearings, spindles, gears, and motors, reducing reliance on experienced vibration analysts.

The **PET-AR401** supports four-channel IEPE vibration sensors and **Ethernet/Modbus TCP** for integration with existing machines and monitoring systems. Its AI-powered vibration analysis, overall health index, and **17 fault indicators** help detect bearing wear, imbalance, looseness, and misalignment at an early stage.

In semiconductor, machine tool, high-tech manufacturing, and energy industries, unexpected downtime can disrupt production, cause product loss, and delay deliveries. **Predictive Maintenance** continuously collects operating data and provides early warnings before failures, enabling maintenance based on actual equipment health.

ITRI's PMS combines over 30 years of vibration and maintenance expertise with AI for equipment diagnostics. It provides real-time monitoring, automated fault diagnosis, and **Remaining Useful Life (RUL)** prediction, achieving over **90% accuracy** and reducing the risk of unexpected failures and downtime.

ITRI has deployed the technology in semiconductor, machine tool, and wind power applications. As AI, edge computing, and Industrial IoT converge, equipment health management is evolving from vibration monitoring to an integrated smart maintenance architecture covering **sensing, analysis, diagnosis, and prediction.**

The **PET-AR401**, combined with ITRI's PHM technology, brings AI-based prognosis diagnostics to industrial applications. It enables device-level health monitoring and anomaly detection, shifting from **"repair after failure" to "decision-making before failure"** while reducing downtime and improving equipment availability and resilience.



▲ **Figure 2** | The **Prognosis Monitoring System (PMS)** showcased at the 2026 Edison Awards press event, demonstrating AI-based prognosis diagnostics for smart equipment maintenance.



▲ **Figure 3** | ITRI's **Prognosis Monitoring System (PMS)** won the **2026 Edison Awards Gold Award**, highlighting Taiwan's competitiveness in AI-based equipment diagnostics and smart manufacturing.

SEMICON Taiwan: ICP DAS Focuses on Smart Semiconductor Facility Management to Strengthen Energy, Environmental, and Equipment Risk Management

By Editorial Team (Translated by Eva Lee)

As semiconductor manufacturing advances towards high precision and automation, facility stability is crucial for capacity, quality, and resilience. Managing distributed equipment and environment data—from power, cleanrooms, and chillers to chemical pipelines—for rapid fault detection and energy analysis is now a key smart facility challenge.

ICP DAS exhibited smart facility monitoring and energy-saving solutions at SEMICON Taiwan 2026 (Sept 2-4, TaiNEX 2, Booth Q5238). Highlights included energy management, thermal imaging alerts, cleanroom monitoring, AI-driven HVAC energy savings, and liquid leak detection.

Energy Management and Power Visualization for High-Energy Equipment

ICP DAS integrates smart meters and concentrators to collect power data from switchboards, process tools, and utilities. Utilizing IoTstar, SCADA, or third-party systems, it provides real-time monitoring, demand management, energy analysis, and alerts to identify high-consumption equipment and optimize energy efficiency.

Thermal Alerts and Environmental Monitoring to Reduce Risks

For high-heat equipment like power panels, server racks, pumps, and motors, infrared temperature modules with edge controllers continuously monitor hotspots and help detect overheating, connection faults, and poor heat dissipation early, reducing the load for manual inspections.

For cleanroom and facility monitoring, sensors measure temperature, humidity, CO_2, PM2.5, TVOC, and weather parameters. Data is transmitted via Modbus TCP/RTU, Wi-Fi, or MQTT for real-time monitoring, trends, and event tracking.

AI HVAC Energy Savings to Enhance Chiller Efficiency

For energy-intensive HVAC and chiller systems, ICP DAS uses ECO-2105 and UA-7231M to integrate data from chillers, pumps,

towers, meters, temperature, flow, and pressure. Complex data is visualized via 3D flowcharts and dynamic trends to build energy models and identify inefficiencies.

The system supports communication redundancy and offline data recovering, minimizing risks of monitoring interruptions and data loss to ensure reliable equipment tuning and energy management.

Real-time Leak Alerts to Mitigate Facility and Pipeline Risks

The iSN series provides flexible leak detection for cleanrooms, chiller rooms, equipment rooms, and piping zones, with detection distances up to 500 m. Leak alerts can be sent via relays, audiovisual devices, monitoring platforms, or mobile communications for rapid response and reduced downtime.

Open Communication for Facility Integration

ICP DAS solutions support Modbus RTU/TCP, MQTT, HTTP, RESTful, and Wi-Fi for integration with SCADA, EMS, BMS, MES, and third-party systems. Deployment can start from individual devices or areas and expand as needed.

At SEMICON Taiwan, ICP DAS presented a smart facility architecture covering sensing, edge control, data communication, and platform management to improve equipment visibility, response efficiency, and energy management.

Exhibition Information

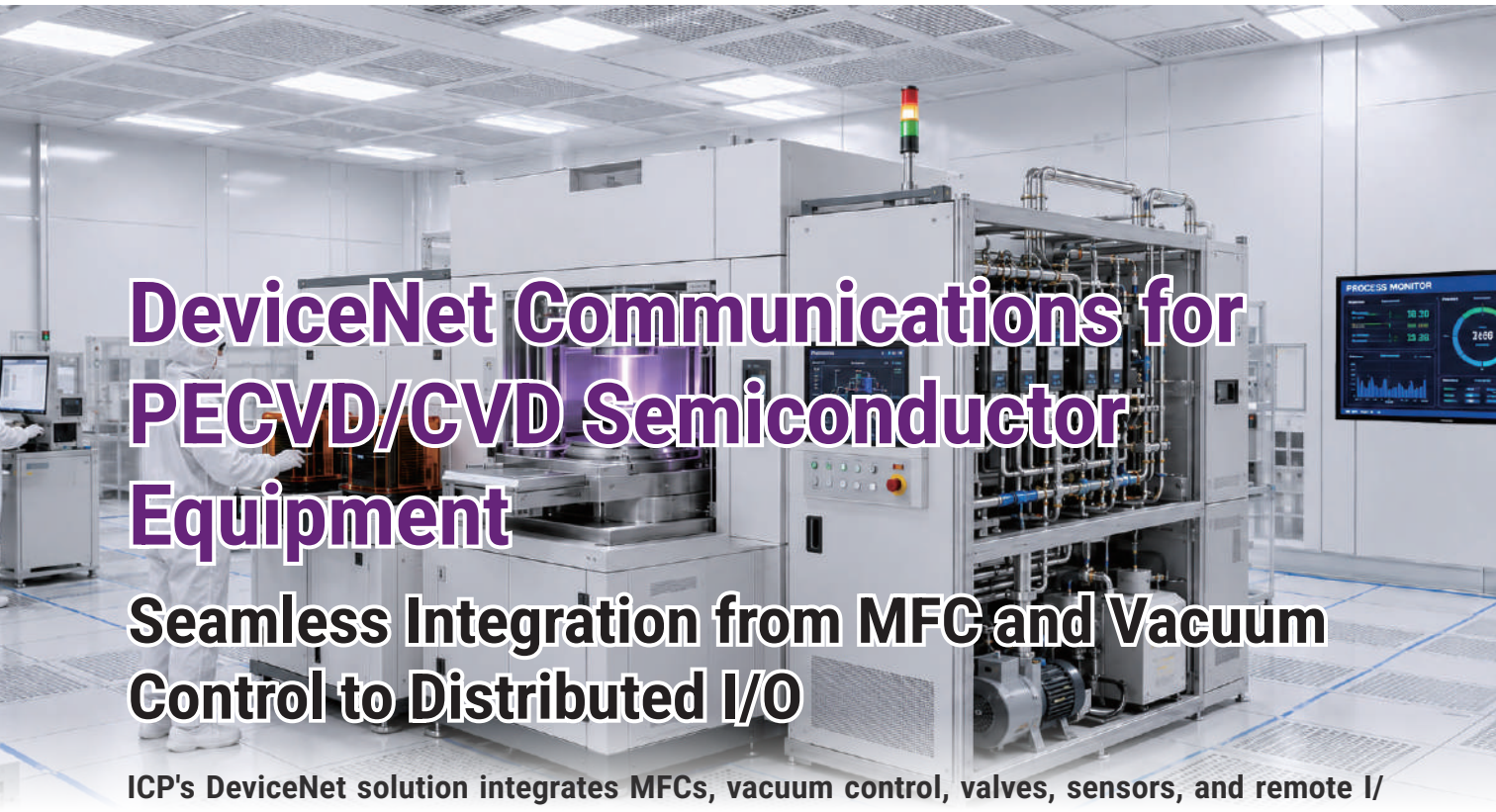
SEMICON Taiwan 2026

Date：2026/9/2 (Wed) – 9/4 (Fri)

Venue：TaiNEX 2, Taipei

Booth：Q5238





DeviceNet Communications for PECVD/CVD Semiconductor Equipment

Seamless Integration from MFC and Vacuum Control to Distributed I/O

ICP's DeviceNet solution integrates MFCs, vacuum control, valves, sensors, and remote I/O in PECVD/CVD equipment. By combining master and slave modules, gateways, and DNM Utility, the solution simplifies multi-vendor device integration and wiring while improving communication stability, diagnostics, and long-term reliability.

By Terry Lai (Translated by Carol Hsu)

As artificial intelligence (AI) and high-performance computing (HPC) drive the demand for greater precision and automation in semiconductor equipment, manufacturers must solve design challenges associated with integrating various multi-brand sensors, I/O modules, and field devices while ensuring stable operation.

Taking PECVD/CVD equipment as an example, a single tool integrates multi-brand components like gas supplies, vacuum controls, sensors, and remote I/O distributed across various areas. Therefore, its control architecture must ensure stable data transmission while supporting real-time response, fault diagnosis, and future expansion.

Based on the CAN bus protocol, DeviceNet features real-time communication, high interference resistance, and simplified wiring. In PECVD/CVD equipment, it uses a master-slave architecture to connect gas/vacuum controls, valves, remote I/O, and other field devices on a common network.

ICP DAS provides DeviceNet Master/Slave modules, Gateways, and DNM_Utility software, helping equipment manufacturers build a seamless integration architecture—from field signals and protocol conversion to commissioning and maintenance.

A communication network that integrates key PECVD/CVD process equipment

PECVD/CVD processes involve gas flow control, chamber pressure regulation, vacuum pumping, valve switching, and peripheral signal monitoring. All subsystems must work in coordination according to the process sequence.

Taking the deposition process as an example, the control system must continuously monitor signals from MFCs, throttle valves, vacuum pressure, valve manifolds, and various I/Os. If status or alarms from any component fail to transmit in real-time, it can compromise process control and prolong troubleshooting and maintenance.

Since components like MFCs, valves, and distributed I/Os are dispersed, using independent wiring or separate coommunication methods requires the control system to handle extensive cabling, multiple interfaces, and different data-exchange methods.

Through the DeviceNet protocol, field devices are unified onto a single industrial network. This allows the main control system to seamlessly gather gas flow, chamber pressure, valve status, and alarm data while executing control commands—eliminating the complexity of standalone integrations and centralizing process management.

Centralizing Multi-brand Management: DeviceNet Master Connects the Process Field

In the PECVD/CVD equipment architecture, the host control platform typically manages process flow, recipe management, the operation interface, equipment status monitoring, and data logging. Meanwhile, the DeviceNet Master handles data exchange with the field DeviceNet slave devices.

Using the DeviceNet Master, the control platform centrally manages field devices and synchronizes data and commands, eliminating the complexity of handling multiple communication protocols.

Actual equipment often integrates multi-brand modules from MKS, SMC, or OMRON. As long as the devices feature a compatible DeviceNet interface, they can be unified and managed on a single network via the DeviceNet Master.

For example, the main control system can read MFC flow, throttle valve status, and I/O data, as well as issue valve commands via the DeviceNet Master, allowing multi-brand devices to exchange data over a single network.

ICP DAS offers various DeviceNet Masters with interfaces like USB, PCI, PCI Express, and PAC modules, helping equipment manufacturers flexibly integrate them into existing control architectures.

From Sensors to Alarm Contacts: Unified Management of Distributed I/O

Beyond DeviceNet-enabled MFCs, throttle valves, and valve manifolds, PECVD/CVD tools also rely on numerous conventional digital and analog signals.

Common signals include pressure/vacuum switches, door statuses, temperatures, pump

statuses, and alarm contacts. Wiring these signals point-to-point back to the central panel not only increases cabling volume but also complicates machine assembly, troubleshooting, and maintenance.

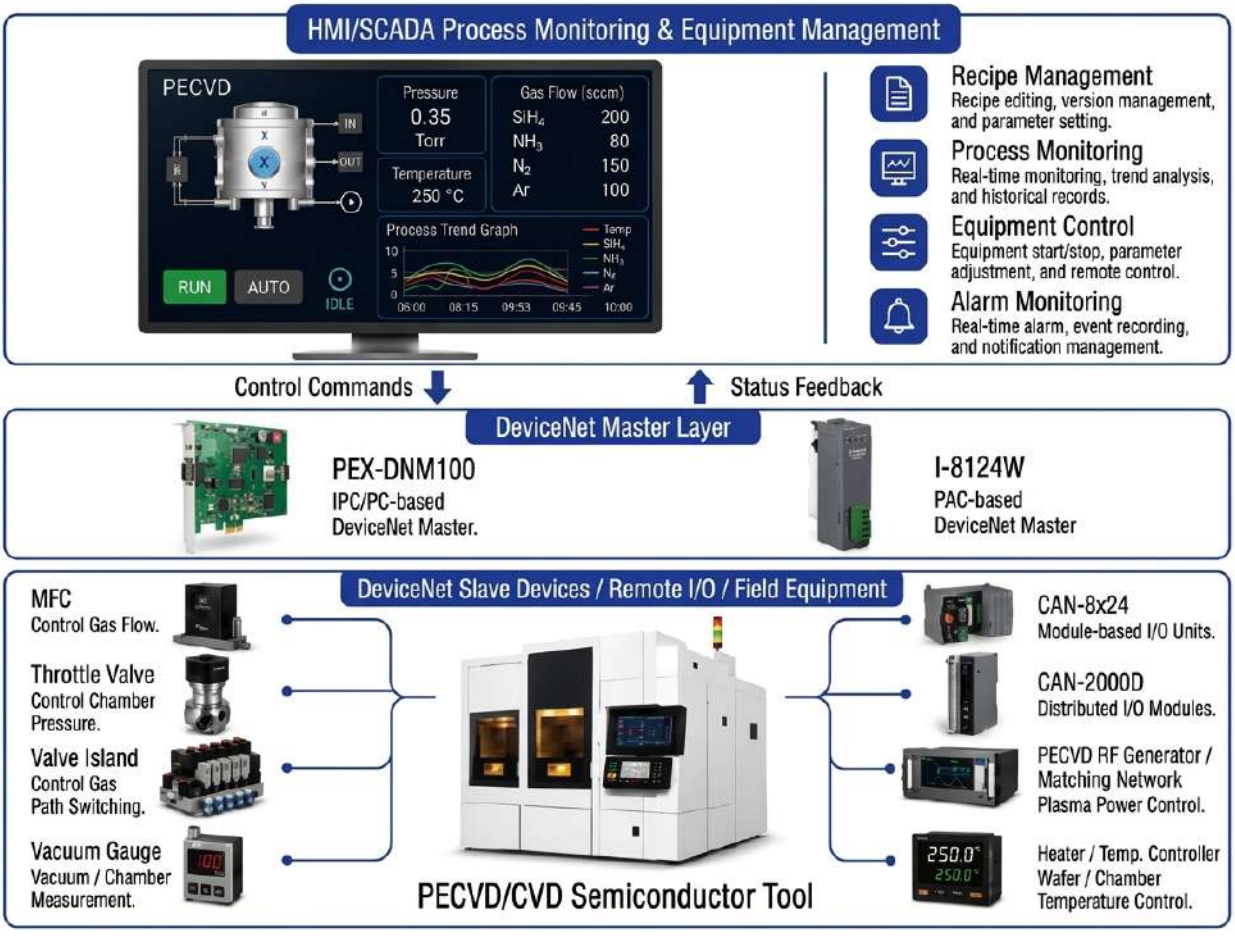
ICP DAS CAN-20xxD and CAN-8x24 slave I/Os connect distributed analog and digital signals across the machine to the DeviceNet network, enabling the host system to centrally acquire statuses and control outputs via the DeviceNet Master.

The distributed I/O architecture minimizes massive wiring to the main control panel and promotes modular equipment design. When adding sensors or expanding the machine, I/O modules can be added on demand, greatly enhancing flexibility for expansion and maintenance.

Connecting DeviceNet and Ethernet: Seamless Equipment Integration

Due to the long lifecycles of semiconductor equipment, a single tool often integrates multiple generations of control technologies simultaneously.

When upgrading to a new Modbus TCP/RTU system, existing DeviceNet equipment does not need replacing; a Gateway can be used to bridge data exchange between the protocols.



The ICP DAS GW-7243D-G (DeviceNet Slave) and GW-7434D-G (DeviceNet Master) can exchange data with Modbus TCP systems while supporting RS-232, RS-485, and Modbus ASCII/RTU communication.

For example, if a new host requires Ethernet, a Gateway converts existing DeviceNet data to Modbus TCP. This allows manufacturers to retain field devices, minimizing rewiring and hardware replacements during upgrades.

Beyond Communication: Faster Commissioning & Verification

Beyond hardware setup, tasks like slave discovery, parameter configuration, and I/O testing truly dictate development efficiency.

PECVD/CVD tools typically have multiple DeviceNet slaves, requiring engineers to individually verify connectivity, data, and controls. Relying on custom programs for this significantly delays development and commissioning.

DNM_Utility provides network configuration, slave discovery, I/O access, and status verification to accelerate equipment development, commissioning, and troubleshooting.



▲ Figure: ICP DAS DNM_Utility Feature Overview

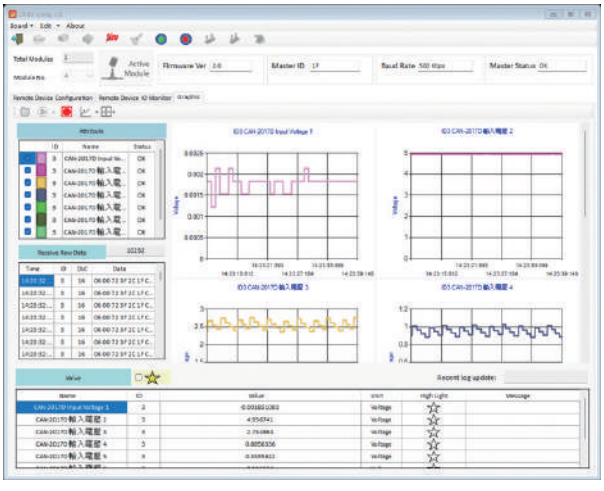
DNM_Utility supports DeviceNet Masters like the PISO-DNM100U, PEX-DNM100, and I-7565-DNM, enabling engineers to verify the network and slave devices before the main control program is completed.

Graphic: Converting Raw Data into an Intuitive Process Trend

During PECVD/CVD commissioning, engineers frequently need to observe analog pressure, MFC flow feedback, valve position signals, or other continuous data.

Viewing only real-time values provides only a snapshot of the data at a given moment, making it difficult to verify whether changes in the signal correspond to the device's operation.

The Graphic feature translates raw values into engineering units and plots trend charts, enabling engineers to visually verify whether signal variations (like pressure and flow) match actual equipment responses.



▲ Figure: Graphic Visualizing Data Changes of CAN-2017D Analog Inputs

Ideal for tool commissioning, sensor verification, and troubleshooting, this feature helps engineers rapidly identify if problems stem from field devices, physical signals, or communication data.

Batch Access Object: Bulk Parameter Processing

DeviceNet slaves contain multiple parameters and status data.

For example, MFCs hold setpoints, flow rates, status, and alarms; throttle valves store control modes, positions, and diagnostics; and I/O modules provide channel settings and parameters.

Individual read/write operations are time-consuming and increase repetitive tasks across multiple devices.

The Batch Access Object feature centralizes multi-parameter access. This eliminates time-consuming individual operations during tool deployment, validation, and troubleshooting, ensuring highly consistent parameter checks.

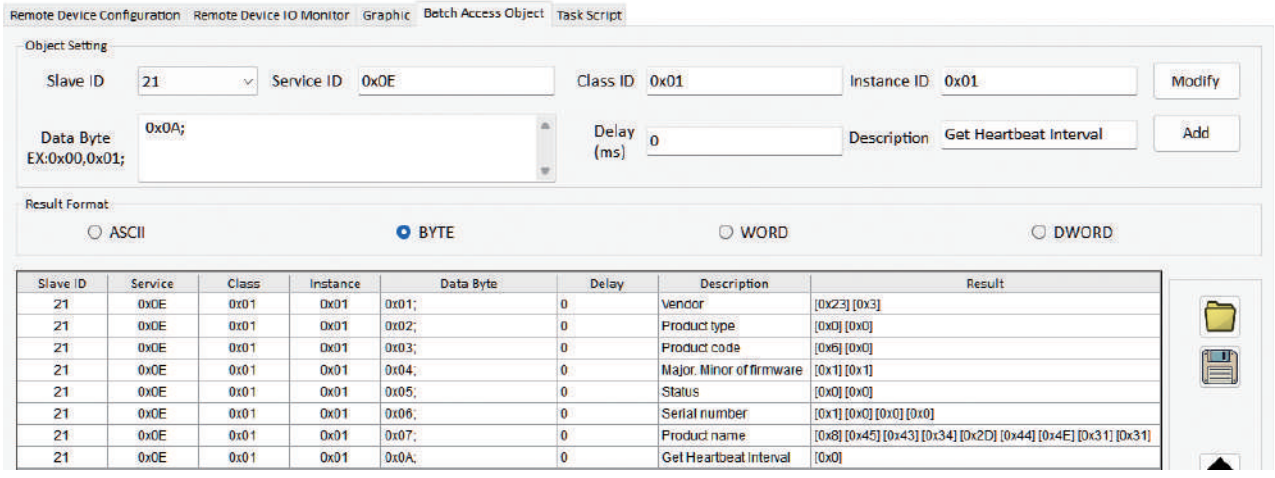
Task Helper: Converting Repetitive Testing into Continuous Verification

During commissioning, maintenance, and extended testing, engineers repeatedly execute actions like controlling outputs, reading inputs, sending Explicit Messages, and verifying tool responses.

Fully manual repetitive operations are time-consuming and hinder long-term stability verification.

Task Helper consolidates multiple steps into repeatable workflows, enabling engineers to execute automated testing and cyclic verification script-free.

Ultimately, DNM_Utility is more than just a network setup tool; it supports the entire lifecycle from deployment and commissioning



▲ Figure: Using the Batch Access Object to Access DeviceNet Slave Data in Batches

to maintenance and verification. Its Graphic, Batch Access Object, and Task Helper features significantly minimize the manual effort required for signal checks, parameter setup, and repetitive testing.

Building a Stable, Integrable, and Maintainable PECVD/CVD Communication Framework

PECVD/CVD tools require continuous stable operation and integrate complex gas, vacuum, and I/O systems. Handling diverse brands and extensive field signals means that a highly integrable and maintainable communication architecture is key to efficient development, commissioning, and ongoing support.

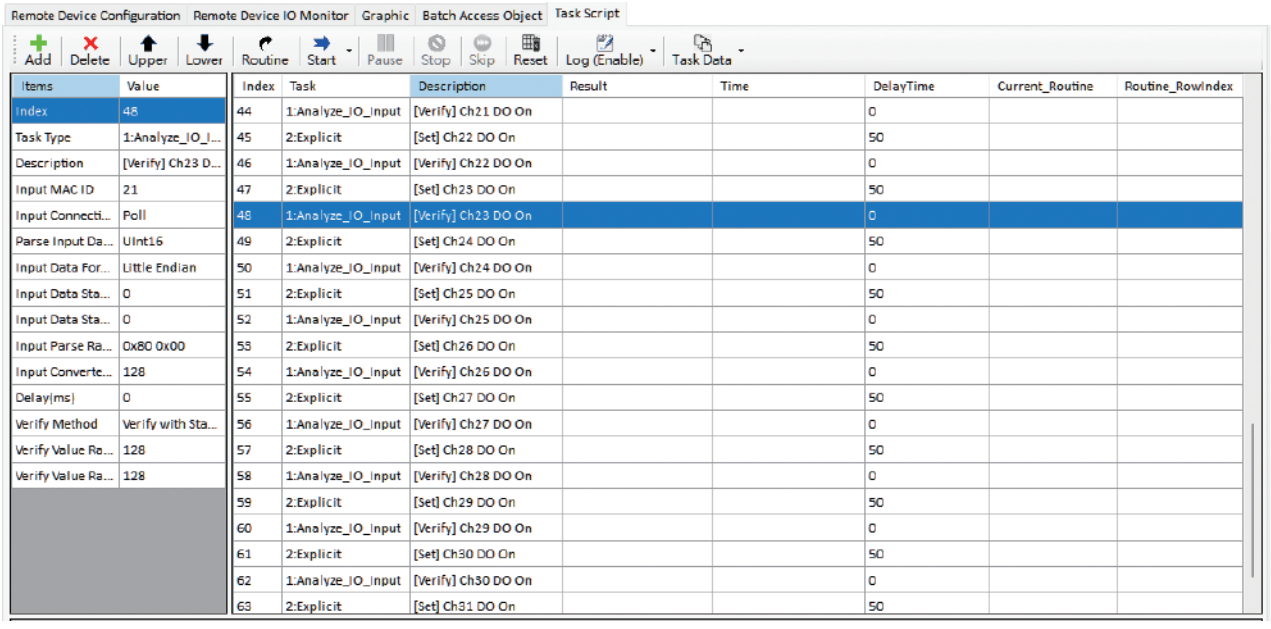
The DeviceNet Master centralizes control of MFCs, throttle valves, and valve manifolds. Adding DeviceNet Slave I/Os unifies distributed signals into one network, while gateways enable smooth cross-protocol data exchange for tools running Ethernet or Modbus systems.

With DNM_Utility, engineers easily perform slave discovery, signal monitoring, and cyclic verification. This elevates DeviceNet from a mere interface to a fully integrated framework linking field devices, control platforms, and engineering support.

For manufacturers relying on DeviceNet, a comprehensive hardware and software suite minimizes integration complexity without major architectural changes, accelerating PECVD/CVD tool development, commissioning, and maintenance.

Product Selection Guide

ICP DAS offers DeviceNet Masters across diverse platforms and interfaces, including USB (I-7565-DNM for PCs/IPCs), PCI (PISO-DNM100U), and PCI Express (PEX-DNM100). For PAC systems, the I-8124W, I-87124, and I-9124 support various expansion setups. This



▲ Figure: Automated Testing of Digital Outputs and Inputs for CAN-2057D-32 and CAN-2053D

extensive lineup ensures manufacturers can easily match a master module to their host controller.

For field I/O, the distributed CAN-20xxD offers versatile I/O functions, while the slot-based CAN-8x24 enables custom module configurations.

For multi-protocol integration, the GW-7243D-G operates as a DeviceNet Slave and exchanges data with Modbus systems. The GW-7434D-G provides DeviceNet Master functionality, connecting DeviceNet slave devices withh Modbus TCP and Modbus ASCII/RTU systems.

By combining Masters, Slave I/Os, Gateways, and DNM_Utility, engineers can build tailored DeviceNet solutions based on the PECVD/CVD tool's existing platforms, field devices, and communication architectures.

DeviceNet Master

Model	Interface ／ Platform	CAN Connector
I-7565-DNM	USB	9-pin D-Sub
PISO-DNM100U	PCI (5 V ／ 3.3 V)	5-pin Terminal Block or 9-pin D-Sub, depending on the model
PEX-DNM100	PCI Express	5-pin Terminal Block or 9-pin D-Sub, depending on the model
I-8124W	I-8K Slot (XPAC、WinPAC、ViewPAC)	5-pin Terminal Block
I-87124	I-87K Slot (XPAC、WinPAC、ViewPAC)	5-pin Terminal Block
I-9124	I-9K Slot (WinPAC)	5-pin Terminal Block

DeviceNet Slave

Model	Form Factor	Main I/O
CAN-20xxD	Distributed I/O	AI, AO, DI, DO, Counter, Frequency Input, PWM Output
CAN-8x24	Slot-type I/O	AI, AO, DI, DO, Counter, Frequency Input

Note: xx represents the actual function model; x represents the number of slots.

DeviceNet Gateway

Model	DeviceNet Role	Ethernet	Serial Interface	Serial Protocol
GW-7243D-G	Slave	Modbus TCP	1 × RS-232、1 × RS-485	Modbus ASCII / RTU
GW-7434D-G	Master	Modbus TCP	1 × RS-232、1 × RS-485	Modbus ASCII / RTU



RPAC-2858M Enables Automatic Failover for Highly Reliable Coastal Surveillance

The RPAC-2858M provides dual-controller redundancy for coastal surveillance, integrating I/O, power monitoring, HMI, VPN, and SCADA to enhance reliability and remote management.

By Raiden Lan (Translated by Lynn Tang)

Along rugged coastlines, every lighthouse and monitoring station safeguards maritime safety. For system integrators and automation engineers, a controller failure in remote, high-temperature, salt-spray environments can disrupt an entire navigation route—not just sensor data. While IIoT often focuses on cloud computing and big data, **high reliability** is the foundation of resilient hardware. **The RPAC-2858M** is designed to provide a final layer of system resilience for mission-critical applications where downtime is not an option.

Over 130 Lighthouse Sites Face Three Key System Integration Challenges

This application originated from a coastal lighthouse surveillance upgrade project in a South Asian country, covering over **130 sites** and deployed by a multinational maritime systems integrator.

Exposed to high humidity and salt spray, the remote sites required three key capabilities:

1. **High availability:** Rapid failover to a backup controller while in a failure.
2. **Versatile-data acquisition:** Integration of

power meters, environmental sensors, and analog/digital signals.

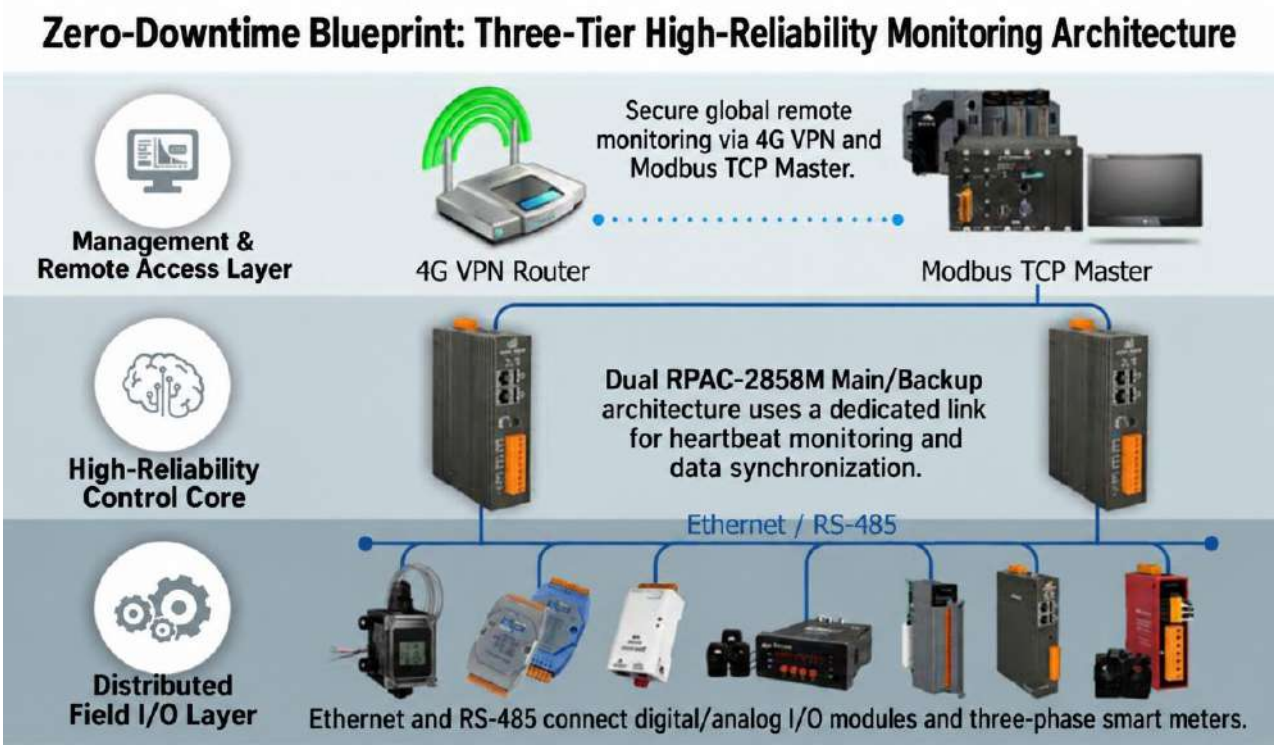
3. **Remote management:** VPN connectivity to a central **SCADA** system for centralized monitoring across sites.

Dual RPAC-2858M Controllers Enable Automatic Failover

To minimize monitoring interruptions caused by controller failure, two **RPAC-2858M** controllers form a Main/Backup redundant architecture. The controllers use **RS-422 Heartbeat** monitoring to verify each other's status and a dedicated Ethernet link for data synchronization, keeping variable states consistent. If the Main controller fails, the Backup takes over within **0.2 seconds,** minimizing system downtime. This design is ideal for remote lighthouse sites where on-site maintenance is difficult, enhancing system availability through controller-level redundancy.

Distributed I/O Integrates Field Monitoring Signals

For field data acquisition, Ethernet-based Remote I/O provides a distributed architecture for integrating various sensor and device signals. **ET-7217** collects analog signals such as voltage and current, while **ET-7244** provides digital I/O for equipment status monitoring and control. Power consumption is monitored via **Modbus RTU** and three-phase power meters. This distributed I/O architecture consolidates field signals into the control platform for further processing and transmission.



▲ Figure 1 | High-Reliability Coastal Surveillance System Architecture

Remote Monitoring from Field HMI to Central SCADA

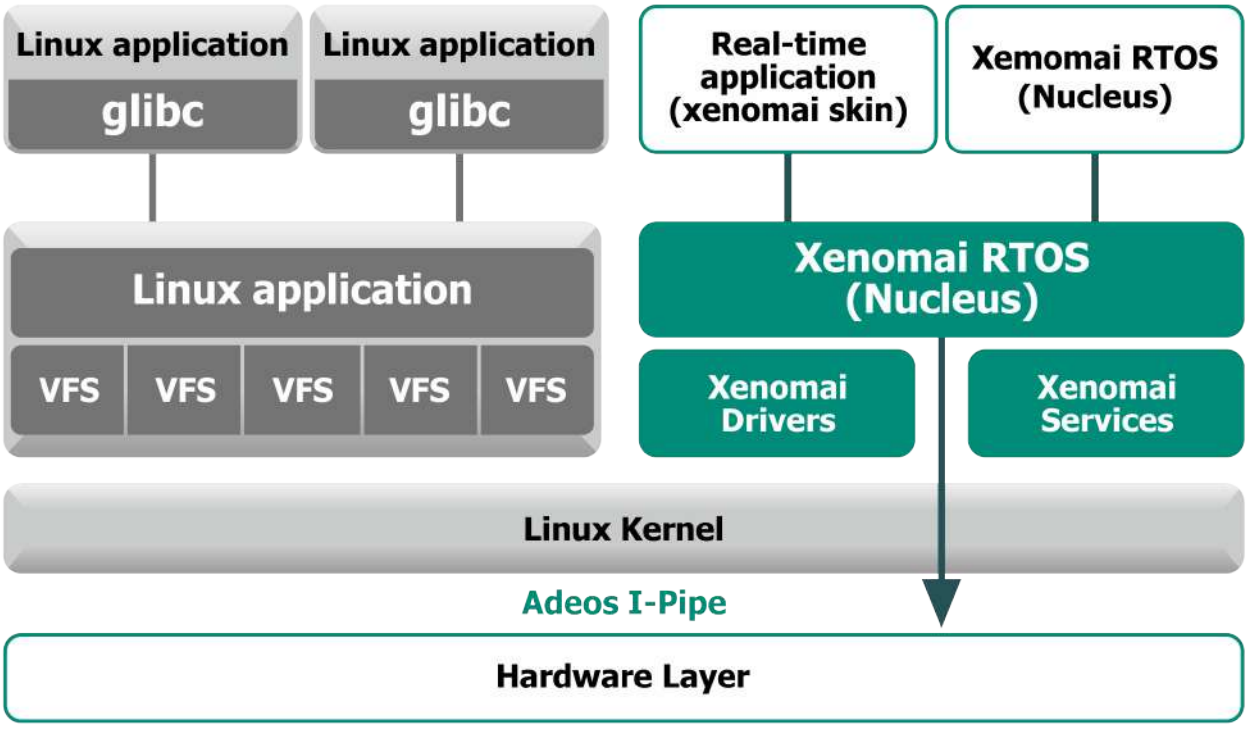
Each lighthouse site is equipped with a touchscreen HMI for local monitoring and operation. A 4G VPN router connects each site to the central SCADA system, enabling centralized monitoring of lighthouse operations across regions. Even at remote coastal sites, operators can monitor equipment status remotely, reducing reliance on manual inspections.

RPAC-2858M Meets Real-Time Control and Communication Needs

Coastal surveillance systems must handle control logic, I/O data, remote communications, and monitoring simultaneously, making real-time performance and multitasking essential.

The **RPAC-2858M** features a **1.6 GHz quad-core Cortex-A53** processor running **Linux Kernel 4.14.78** with the **Xenomai Real-time Framework.** Xenomai maintains stable control cycles with a **1–15 ms scan time,** minimizing the impact of non-real-time tasks such as 4G VPN transmission and Web Server operations.

For control development, the RPAC-2858M includes **Win-GRAF,** an **IEC 61131-3**-compliant soft logic development environment supporting **LD** and **ST**. Its **On-line Change** function allows control logic and parameters to be modified while the system remains in operation, providing greater flexibility for remote coastal sites where on-site maintenance is difficult.



▲ Figure 2 | Xenomai Dual-Core Architecture



▲ Figure 3 | Win-GRAF Workbench (Soft Logic)

Multiple Industrial Protocols Enhance Device Integration Flexibility

Lighthouse sites may contain devices from different generations and with different communication interfaces, requiring flexible protocol integration alongside real-time processing. The **RPAC-2858M** supports **OPC UA Server, Modbus TCP/RTU, DCON,** and user-defined protocols for diverse data exchange needs. **OPC UA** enables cross-platform communication, **Modbus** integrates Ethernet and serial devices, **DCON** connects ICP DAS I/O modules, and user-defined protocols support specialized devices. Its **COM1, COM2, and COM3** ports also provide **2500 VDC isolation** for enhanced communication protection in industrial environments.

From Single-Device Redundancy to Complete Remote Monitoring

By integrating dual RPAC-2858M redundancy, distributed I/O, power monitoring, and 4G VPN, the system combines reliable control, data acquisition, and centralized management. If the Main controller fails, the Backup takes over within 0.2 seconds, while central SCADA enables remote site monitoring. Win-GRAF and multiple industrial interfaces provide flexibility for logic updates, I/O expansion, and third-party integration.

For remote, distributed applications such as lighthouse and coastal monitoring systems, continuous operation is critical. With automatic failover, real-time control, and remote management, the RPAC-2858M provides a reliable platform linking field control with centralized monitoring.

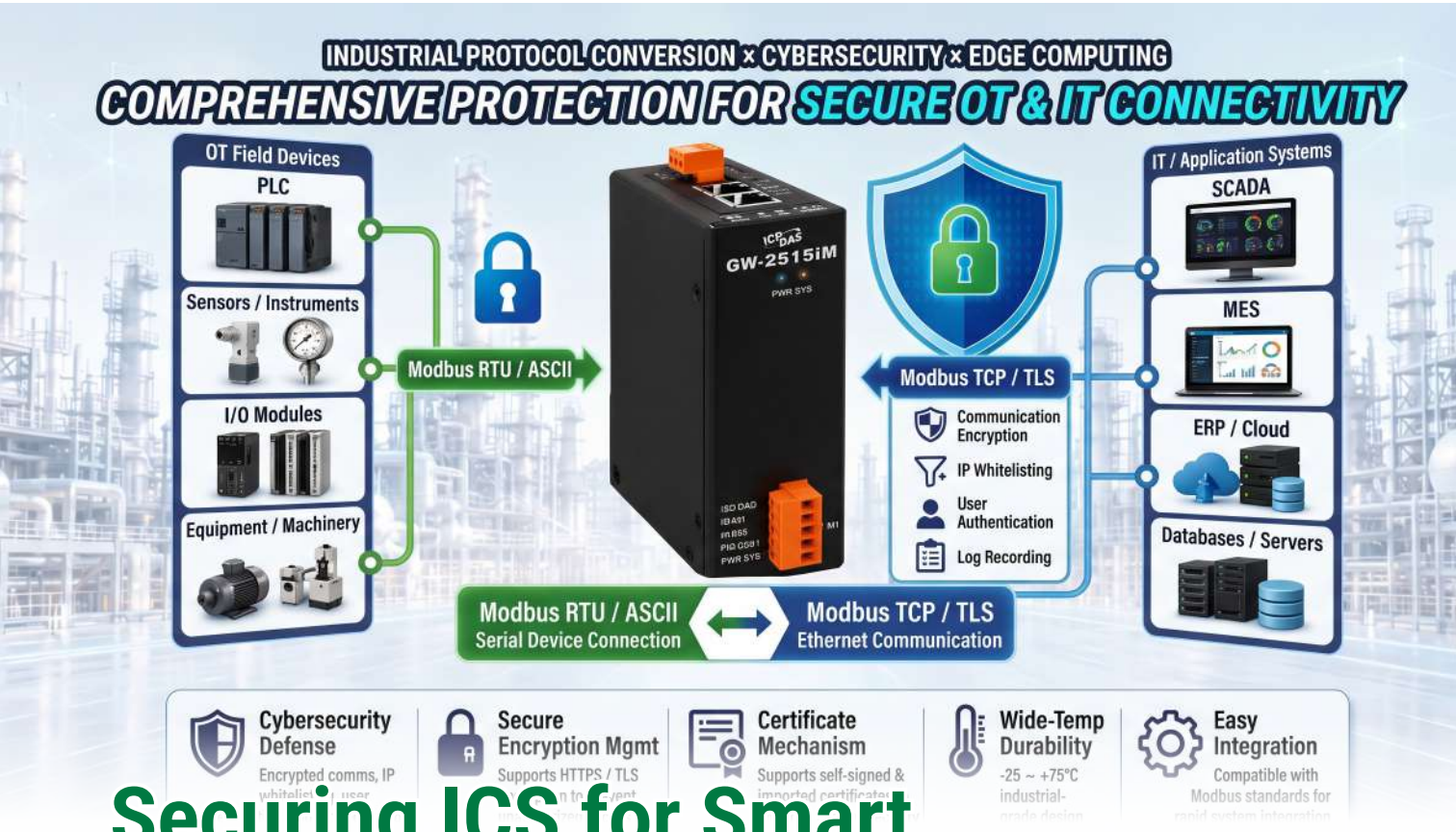
Product Information

RPAC-2858M	Win-GRAF based PAC built-in Linux OS
ET-7217	Built-in Web Server I/O module, 8-ch AI, 4-ch DO
ET-7244	Built-in Web Server I/O module, 8-ch DI, 8-ch DO
PM-5133	3.5" Touchscreen, 3-phase Smart Power Meter, Modbus RTU

Users can find detailed product information, including specifications and user manuals, on the website. Please refer to the link below:

https://www.icpdas.com/en/product/p02.php?root=481

https://www.icpdas.com/en/product/RPAC-2858M



Securing ICS for Smart Manufacturing: GW-2500iM Series

To address IIoT cybersecurity challenges, the ICP DAS GW-2500iM gateway features built-in Modbus conversion, TLS encryption, and access control. It seamlessly upgrades existing infrastructure, comprehensively enhancing industrial control communication security device management, and deployment flexibility.

By Cindy Huang (Translated by Carol Hsu)

As smart manufacturing and industrial automation advance, the high interconnectivity between factory devices and IT/SCADA systems presents industrial networks with critical cybersecurity demands in data transmission, authentication, and access control.

ICP DAS introduces the new-generation GW-2500iM Cybersecurity Gateway. Beyond traditional protocol conversion, it integrates advanced secure communication and network management mechanisms. It enables enterprises to enhance communication security within their existing infrastructure while maintaining device integration and deployment flexibility, establishing a secure connectivity foundation for smart manufacturing.

Advancing ICS Security: First Line of Defense

As smart manufacturing and IIoT drive the rapid integration of IT and OT systems, interconnected factory devices face escalating cybersecurity threats, including unauthorized access and network attacks. Balancing uninterrupted production with robust communication and device security has become a critical priority in building smart factories.

Designed specifically for industrial control environments, the ICP DAS GW-2500iM goes beyond traditional Modbus gateways by integrating protocol conversion and cybersecurity into a single device. Supporting Modbus TCP and RTU/ASCII, it seamlessly connects with existing PLCs, SCADA systems, and other industrial devices. This empowers enterprises to upgrade their Modbus communication security without major modifications to their existing infrastructure.

The GW-2500iM features multi-layered security, integrating HTTPS, TLS encryption, AES-128/256, SHA-256, IEEE 802.1X authentication, and IP filtering to fully secure device access and data transmission. Additionally, it supports advanced industrial networking functions such as IPv4/IPv6 Dual Stack, VLAN, QoS, LAN Bypass, and PoE, ensuring high network reliability and deployment flexibility.

Ideal for smart manufacturing, semiconductors, energy management, and water treatment, the GW-2500iM bridges existing Modbus devices and Ethernet networks. As a critical OT communication node, it helps enterprises build a secure, stable, and easily managed data transmission environment.

GW-2500iM Cybersecurity Gateway vs. Traditional Modbus Gateways

Specs \ Type	GW-2500iM Series	Traditional Modbus Gateways
Modbus Protocol	Modbus TCP/UDP/TLS	Modbus TCP/UDP
Web	HTTP/HTTPS	HTTP
Transmission Encryption	AES-128, AES-256, SHA-256	-
IEEE 802.1X	EAP, PEAP	-
User Authentication	User Account Authentication	None / Basic Account
PoE Power Supply	IEEE 802.3af, Class 2	Mostly Unsupported
Access Control	HTTPS + IP Filter + Authentication	-
IPv6	IPv4 / IPv6 Dual Stack	Mostly Unsupported
SNMPv3	Secure Network Management	-

▲ Table 1: Feature Comparison: GW-2500iM Cybersecurity Gateway vs. Traditional Modbus Gateways

Traditional Modbus gateways focus solely on Ethernet-to-Serial protocol conversion. As industrial devices increasingly connect to enterprise networks and SCADA systems, the gateway's role has expanded from simple conversion to securing device access and communications.

Beyond standard Modbus TCP/UDP, the GW-2500iM incorporates advanced security features such as Modbus TLS, HTTPS, IEEE 802.1X, user authentication, IP filtering, and SNMPv3. Supported by AES-128/256, SHA-256, IPv4/IPv6 Dual Stack, and IEEE 802.3af PoE, it centralizes device integration, network management, and secure communications into a single platform.

Product Features

Multiple Cybersecurity Protection Mechanisms for ICS Communications

As industrial devices increasingly connect to enterprise networks and remote systems, securing device logins, network connections, and data exchanges becomes just as critical as ensuring stable transmission.

The GW-2500iM features HTTPS management and Modbus TLS encryption with SSL/TLS, AES-128/256, SHA-256, and IEEE 802.1X support. Additionally, users can configure IP whitelists/blacklists for access control and use Netstat for real-time monitoring to ensure secure communications.

The GW-2500iM secures Modbus environments through comprehensive device, network, and data protection, allowing existing infrastructure to meet modern OT cybersecurity standards seamlessly.

Industrial Protocol Conversion: Extending the Value of Existing Equipment

Many factories still rely heavily on RS-232/422/485 devices. Completely replacing existing PLCs, RTUs, and instruments for network upgrades incurs high equipment costs and increases the risks of system modification, testing, and downtime.

The GW-2500iM provides Modbus TCP and RTU/ASCII protocol conversion, seamlessly connecting serial devices to Ethernet networks. Enterprises can integrate cross-generation equipment under a single architecture without replacing existing devices, significantly reducing



▲ Figure 1| GW-2500iM OT/IT Secure Communication & Protocol Integration

network upgrade and system integration costs.

By allowing users to manage devices directly through a web interface, the GW-2500iM goes beyond protocol conversion to serve as a critical bridge connecting existing OT to Ethernet.

Traffic Anomaly Protection for Stable Device Communications

Industrial devices require continuous connectivity. Sudden surges of abnormal packets can exhaust system resources and disrupt normal communications.

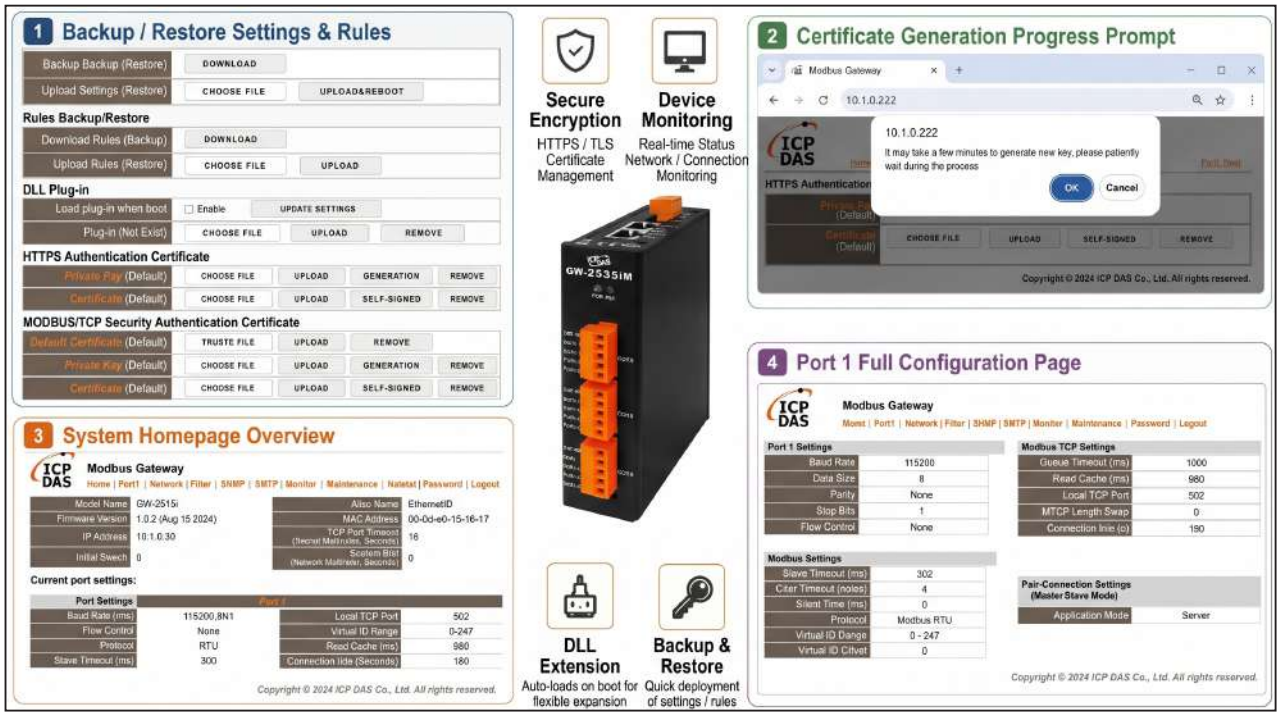
The GW-2500iM features built-in DoS/DDoS protection mechanisms to manage abnormal network traffic. These mechanisms help reduce the impact of massive packet surges, ensuring the stability of Ethernet communications and continuous device operation.

IPv4/IPv6 Dual Stack for Flexible Industrial Network Management

Featuring a Dual Stack design, the GW-2500iM simultaneously supports IPv4 and IPv6, seamlessly integrating with existing architectures while ensuring future scalability. Built-in support for SLAAC and IPv6 Plug-and-Play significantly reduces configuration complexity in mixed network environments.

The GW-2500iM supports mDNS hostname resolution, allowing device access via a fixed .local hostname. Even if the DHCP-assigned IP address changes, users can seamlessly connect using the fixed name, eliminating the administrative burden of tracking IP updates.

For traffic management, the GW-2500iM supports IEEE 802.1Q VLAN for logical network segmentation. Combined with IEEE 802.1p and QoS mechanisms, it assigns higher transmission



▲ Figure 2| GW-2500iM Web-Based Management Interface

priority to critical control packets, ensuring essential industrial data is delivered first even during network congestion.

Streamline Wiring and Management to Accelerate Field Deployment

Beyond connectivity and security, field conditions such as installation space, wiring, and power supply directly impact deployment efficiency and setup costs.

The GW-2500iM features a built-in two-port Ethernet switch that supports daisy-chain configuration. Multiple devices can be connected in series directly, eliminating the need for additional switches and cabling, which significantly simplifies installation and enhances future scalability.

Supporting IEEE 802.3af PoE, DC, and AC power options, the GW-2500iM offers highly flexible power configurations. This flexibility enables engineers easily meet specific site requirements while minimizing extra power wiring.

The GW-2500iM features a web-based management interface, allowing users to configure the device directly via standard browsers without installing dedicated software. With HTTP/HTTPS support, it enables secure, cross-platform remote management, effectively reducing overall maintenance costs.

Conclusion

Driven by smart manufacturing and IIoT, industrial communications demand more than basic connectivity. Encryption, authentication, access control, and traffic management are now essential elements of modern system deployment.

GW-2500iM Series Selection

Modbus TCP ↔ RTU/ASCII Cybersecurity Gateway, supporting PoE and Terminal Block Power Input

Model	Serial Ports	Serial Interface	Ethernet
GW-2515iM	1 Port	RS-422 / RS-485	2-Port 10/100 Mbps
GW-2525iM	2 Ports	RS-422 / RS-485	2-Port 10/100 Mbps
GW-2535iM	3 Ports	RS-422 / RS-485	2-Port 10/100 Mbps
GW-2518iM	1 Port	RS-232 / RS-422 / RS-485	2-Port 10/100 Mbps
GW-2528iM	2 Ports	RS-232 / RS-422 / RS-485	2-Port 10/100 Mbps

※Note: RS-232 uses 3-wire, RS-422 uses 4-wire, and RS-485 uses 2-wire communication configurations.

▲ Table 2: GW-2500iM Series Communication Interface & Model Selection

Replacing existing PLCs, RTUs, and field instruments is costly and risks downtime. Upgrading OT security without altering current infrastructure is a major challenge. As the optimal Modbus TCP to RTU/ASCII secure gateway, the GW-2500iM seamlessly integrates protocol conversion, secure communications, and access control. Deploying it between legacy equipment and Ethernet extends device lifespan while significantly enhancing connectivity and management security.

Transitioning from simple connectivity to secure industrial communication, the GW-2500iM combines Modbus protocol conversion and cybersecurity in one gateway. It delivers a secure and stable environment for Modbus applications, allowing enterprises to upgrade OT security seamlessly without sacrificing investments.





Predictive Motor Maintenance via Vibration Analysis

PET-AR401 uses edge computing to analyze vibration, detect anomalies, and identify faults in real time. With iMotor Utility for centralized management, it helps track degradation, reduce unplanned downtime and over-maintenance, and enable data-driven maintenance decisions.

By Mac Cho (Translated by Eva Lee)

ITRI has long been dedicated to motor health diagnostics research, combining vibration analysis with health assessment models to detect anomalies early, track degradation trends, and plan maintenance before failure occurs—effectively minimizing unplanned downtime risks.

Through technology transfer with ITRI, ICP DAS integrated this proven vibration diagnostic technology into the PET-AR401 AI Edge vibration monitor. By analyzing vibration signals locally, it enables distributed motor health monitoring, delivering health indices, real-time alerts, and diagnostic insights for an efficient, low-latency, and scalable Predictive Maintenance solution. PET-AR401 supports 17 fault-factor models and provides ISO 20816-compliant health ratings.

From Reactive Maintenance to AI Predictive Maintenance: Building Motor Health Monitoring Systems for Smart Factories

Motors are the critical heartbeat of modern factories, powering pumps, fans, compressors,

conveyors, CNC machines, and other key equipment. When a motor fails, it involves far more than simple component replacement—it can trigger production line shutdowns, schedule delays, and cascading operational losses.

Therefore, understanding equipment health before failure occurs has become an essential priority in smart manufacturing.

Limits of Traditional Maintenance

Historically, equipment maintenance uses two main approaches.

Reactive Maintenance

In this approach, maintenance takes place only after equipment fails—making it the most traditional yet passive strategy.

Although it incurs no upfront monitoring costs, failures often halt machinery and lead to production shutdowns, delays, and compounding operational losses.

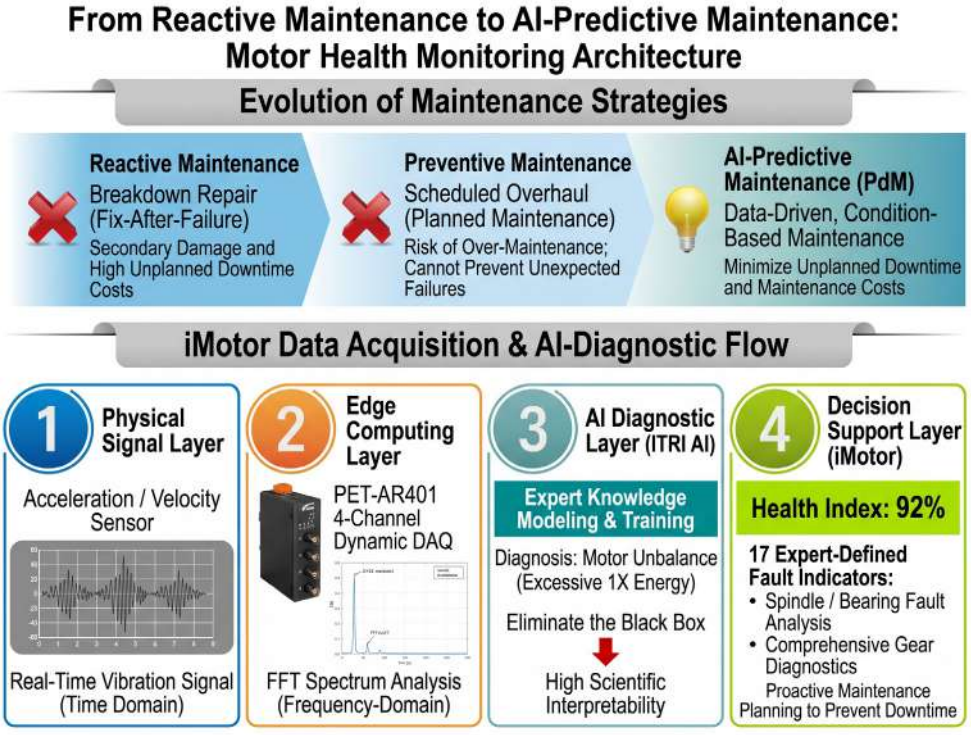
For manufacturers, the primary challenge is rarely the cost of parts and labor, but rather the severe capacity and delivery risks caused by unplanned downtime.

Preventive Maintenance

Another common approach schedules maintenance based on fixed time intervals or operating hours, such as routine bearing, belt, or lubricant replacements.

While this mitigates certain unexpected failure risks, rigid maintenance schedules do not necessarily match the actual health condition of each machine.

Usable parts may be replaced prematurely, driving up unnecessary maintenance costs; conversely, anomalies can still emerge between scheduled service intervals, creating blind spots.



Consequently, shifting from calendar-based maintenance toward condition-based maintenance has become a critical objective for smart manufacturing.

From Scheduled to Predictive Maintenance

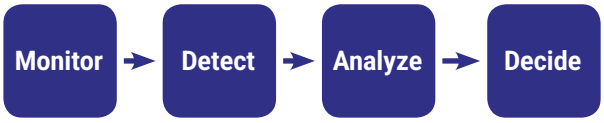
Scheduled maintenance can reduce failures but also cause over-maintenance. Usable parts may be replaced early, increasing costs without preventing faults between service intervals.

With recent advances in the Industrial IoT (IIoT), sensing technology, and artificial intelligence, equipment maintenance is rapidly evolving toward intelligent Predictive Maintenance. Instead of adhering strictly to predetermined intervals, maintenance can be scheduled according to actual equipment health, substantially improving maintenance efficiency while driving down downtime risks.

The maintenance model shifts from:



to:



Using status data aids decisions, cutting downtime risks and unnecessary early upkeep.

Why Does Vibration Reflect Motor Health?

For rotating machinery, vibration acts as a heartbeat. Properly operating equipment exhibits stable, predictable vibration signatures. When components experience wear, looseness, or misalignment, vibration signals change first—typically well before temperatures climb or the machine shuts down.

Vibration spectral analysis can identify common mechanical anomalies, including:

- Unbalance
- Misalignment
- Mechanical Looseness
- Bearing Fault
- Gear Fault
- Resonance

Consequently, vibration analysis has become one of the most critical methodologies for monitoring rotating equipment health.

AI Edge: Enabling On-Device Diagnostics

ITRI has spent years developing rotating machinery diagnostic technologies, pairing vibration analysis with health evaluation models to help operators detect anomalies and track degradation trends early.

Through technology transfer, ICP DAS integrated these diagnostic algorithms into the PET-AR401 AI Edge smart vibration monitoring device.

Rather than simply streaming raw vibration data back to a central host for post-processing, the PET-AR401 integrates data acquisition, feature analysis, and diagnostic logic directly at the edge, outputting real-time asset health and fault diagnosis on-site.

The PET-AR401 supports 4-channel IEPE external accelerometers with 24-bit resolution and up to 128 kS/s sampling rate. It also provides Ethernet connectivity supporting both Modbus TCP and raw data transmission for seamless integration with SCADA, PLC, or IT systems.

Deploying analysis at the edge eliminates the network bottlenecks of centralized raw data streaming. As enterprises scale up their monitoring points, distributed deployment keeps diagnostics right where the physical assets operate.

Explainable Motor Health Increases Diagnostic Trust

AI has advanced rapidly, but many models remain black boxes, providing results without explaining the basis for diagnosis.

For example, a system may show only:

Health: 73%

users cannot identify the issue or plan maintenance.

True value lies not just in health scores, but in revealing potential anomaly sources.

PET-AR401 combines AI vibration analysis and edge diagnostics to generate a composite health index with 17 fault-factor models.

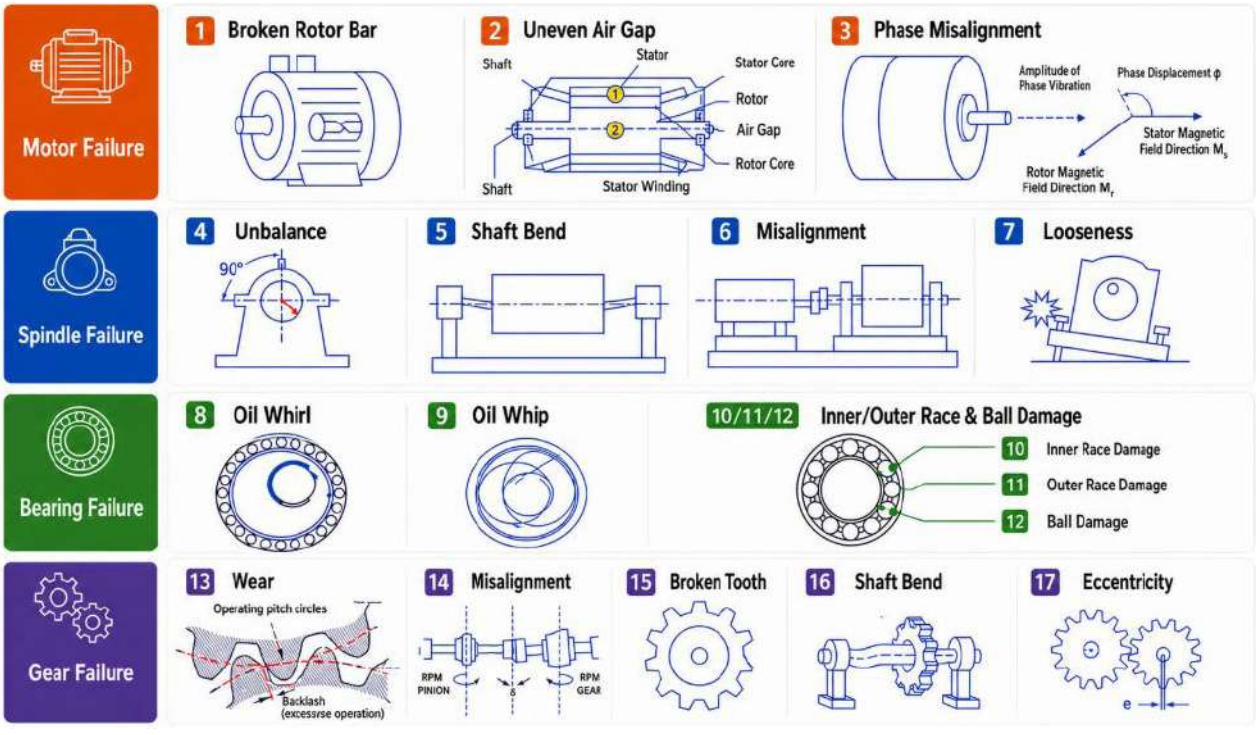
Covering common motor, spindle, bearing, and gear faults, these models convert complex vibration signals into actionable diagnostic information.

Examples:

- 1× RPM Anomaly → Possible Unbalance
- 2× RPM Rise → Possible Misalignment
- Bearing Frequency → Possible Fault

Explainable diagnostics help maintenance teams identify 17 potential fault causes faster and make more confident decisions. Compared with raw vibration data alone, this approach provides clearer fault directions for inspection and maintenance.

iMotor Utility: Equipment Health at a Glance



Beyond edge AI analysis, a complete health monitoring system must also make diagnostic results easy to understand.

iMotor Utility visualizes monitoring and diagnostic data, allowing users to view health status, alerts, trends, and fault results at a glance.

Compared with complex waveforms and spectra, visualized health data helps operators quickly identify equipment needing attention.

As monitored assets grow, maintenance teams need to identify condition changes first, then investigate possible causes—not review every vibration record.

Managers can quickly view:

- Equipment health
- Anomaly alerts
- Historical trends
- Fault diagnostics
- Maintenance recommendations

Even across hundreds of assets, health ranking and status indicators help identify equipment requiring priority attention.

With 17 built-in fault-factor models covering motors, spindles, bearings, and gears, the PET-AR401 significantly shortens the turnaround time between anomaly detection and root-cause identification.

Building Data-Driven Maintenance Decisions

The key value of AI motor health monitoring is not just health scores, but a data-driven maintenance workflow.

Continuous health monitoring enables earlier maintenance, less unplanned downtime and over-maintenance, and longer equipment life with greater efficiency.

Maintenance decisions can shift from:

Fixed schedules and human experience

to:



This reduces unplanned downtime and unnecessary early maintenance while improving troubleshooting and maintenance efficiency.

Shifting from passive waiting to active tracking, and from experience to AI/data-aided decisions, predictive maintenance is essential for smart manufacturing.

When equipment starts to “speak,” the key is not just receiving alerts, but understanding what they indicate.

PET-AR401 integrates vibration, AI analysis, health indices, and 17 fault-factor diagnostics at the edge, turning complex vibration data into actionable health information. Ethernet, Modbus TCP, and Raw Data interfaces also simplify system integration.

True predictive maintenance is about more than just knowing a failure might happen—it empowers enterprises to interpret machine health, isolate root causes, and execute optimal maintenance decisions well before unplanned downtime.

Product Information

https://www.icpdas.com/en/product/PET-AR401

I-8018W-G/S1

I-8018W-G/S1 8-Channel High Speed Thermocouple Input Module



100 Hz High-speed Sampling Enhances Multichannel Temperature Acquisition

The ICP DAS I-8018W-G/S1 8-channel high-speed thermocouple input module, used with the CN-1825 daughter board, provides 8 thermocouple inputs with sampling rates up to 100 Hz per channel for multichannel measurements requiring fast data updates.

Supporting J, K, T, E, R, S, B, N, C, L, M, and L DIN 43710 thermocouples, the module allows independent channel configuration for flexible, multi-point measurements. Its 16-bit resolution and 100 Hz sampling per channel provide faster updates than the I-87018W-G's 10 Hz rate.

The I-8018W-G/S1 suits systems that monitor multiple temperature points and track rapid changes, including process monitoring, heating and heat-treatment equipment, and test systems. Its eight independently configurable inputs accommodate different thermocouple types, while 100 Hz sampling captures temperature changes in greater detail.

For measurement and input protection, each channel features automatic cold-junction compensation, thermocouple open-wire detection, and 30 VDC overvoltage protection to help identify input faults.

In communication, I-8018W-G/S1 supports Modbus RTU and UART speeds up to 921.6 kbps, using one COM port per module. COM port drivers are available for PACs running Windows 10 IoT, WES7, Windows CE 6.0/7.0, and Linux.

With 8 thermocouple inputs, 100 Hz sampling per channel, broad sensor support, and built-in compensation and protection, the I-8018W-G/S1 is a practical I/O solution for high-speed, multi-point temperature monitoring and acquisition.

Learn more information: https://www.icpdas.com/en/product/I-8018W-G_S1



iNS-3224-SFP

24-port 10/100 Mbps + 2 SFP Combo PoE(PSE) IoT Switch

Flexible Network Management with Remote PoE Control, Power Scheduling, and LAN Bypass

The ICP DAS iNS-3224-SFP 24-port PoE(PSE) IoT Switch provides 24 10/100 Mbps Ethernet ports and two 100/1000 Mbps SFP/RJ45 combo ports. All 24 ports support IEEE 802.3af/at PoE, delivering up to 30 W per port for integrated network connectivity and device power.

The iNS-3224-SFP supports auto-negotiation, flow control, and Auto MDI/MDI-X, the switch features individual PoE status LEDs for easy monitoring. Its two 100/1000 Mbps SFP/RJ45 combo ports offer flexible copper or fiber connectivity for network expansion.

In device management, the iNS-3224-SFP built-in Web GUI enables remote port monitoring and PoE management. Scheduled power control automatically switches devices on or off to reduce energy use. SNMP v2c and Modbus support simplifies integration with existing network and monitoring systems.

In addition, the iNS-3224-SFP supports LAN Bypass, which maintains communication between Ports 1 and 2 during a switch power failure, helping prevent network interruptions. The 1U rack-mount design fits standard equipment cabinets.

With multi-port PoE, remote power control, scheduling, combo-port expansion, and LAN Bypass, the iNS-3224-SFP simplifies centralized device management and enables flexible IoT network deployment.

For more information: https://www.icpdas.com/en/product/iNS-3224-SFP

Vibration Predictive Diagnostics Solution

Automated Analysis Engine

One-Click Health Indicator

17 Fault Factor Models

17 Fault Types

Motor Fault



Spindle Fault



Bearing Fault



Gear Fault



Vibration Signal Acquisition | Fault Diagnostic Analysis



Overall Health Index



- Integrates ITRI PMS Technology
- 128ks/s High-Speed Sampling
- 24-bit ADC
- 4-Channel IEPE Input

iSN Vibration Sensor Series



iSN-701X-mA iSN-701X	iSN-711-MRTU iSN-713-MRTU	iSN-701-F15-L030 iSN-701-F15-L060

iWSN Wireless Vibration Sensor Series



iWSN-100X-CLE iWSN-101X-CLE	iXN-2VB1 iXN-2VB3

Ethernet High-Speed Data Acquisition Module + SG Series



PET-7H16N PET-7H24N	SG-3227 SG-3037	iSN-701-F15-L030 iSN-703-F1-L01S

AR Series High-Soeed Vibration Data Logger



AR-200/300-T/400	iSN-701-F15-L030 iSN-701-F15-L060

E-Catalog

Vibration Measurement Solution

E-Catalog

振動量測解決方案