

Status sensing stabilizes quality for the future of sustainable manufacturing



Improve quality through digitization of equipment status

Digitization of equipment status and environmental changes sometimes does not lead to quality improvement when the optimal equipment and environmental status cannot be determined due to insufficient data acquisition.

Omron offers three types of sensing-sensory, synchronous, and periodic-to raise quality standards through digitization of equipment status.

Intuition of experienced operators cannot be quantified

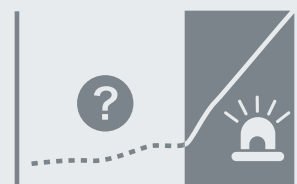


Common problems with digitization

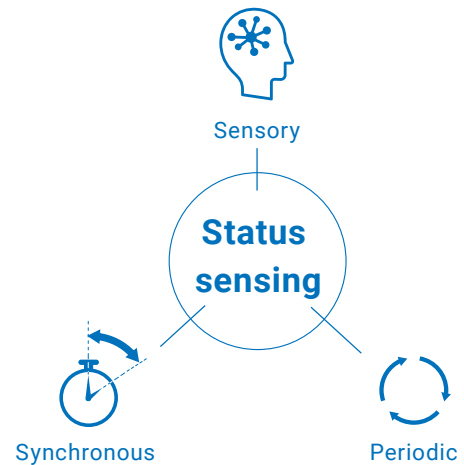
Causality of quality defects cannot be analyzed because data acquisition timings vary



Lots and items produced during equipment malfunction cannot be identified because those data are not linked to the production cycle



Omron's solution using three types of status sensing



"Sensory" status sensing of multiple quantities

Digitize intuition of experienced operators

Multiple physical quantities, which can be used as an alternative to human senses, can be sensed simultaneously at the same position. High-level decisions equivalent to those of experienced operators can be made by digitizing multiple parameters.

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"Synchronous" status sensing with high concurrency

Analyze causality of quality defects

By digitizing equipment status parameters with the same timing, causality can be analyzed when quality defects occur.

Page 6

"Periodic" status sensing of production cycles

Identify lots and items produced during equipment malfunction

Time-series data on changes in status of equipment and environment can be collected and linked to the production cycle such as lots and items. This enables possible defective production lots and items to be identified.

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“Sensory” status sensing of multiple quantities

Digitize intuition of experienced operators

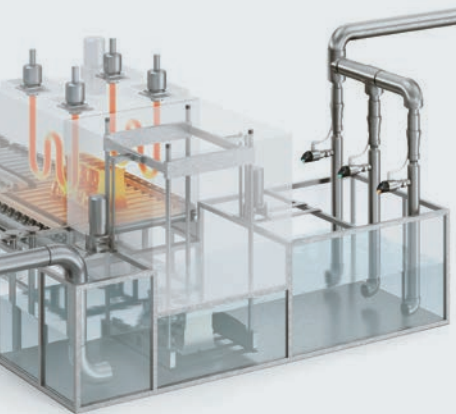
Process sensors measure parameters (e.g., temperature, flow rate, and pressure) at the same position and digitize them. This allows you to raise quality standards without relying on the intuition and skills of experienced operators.

Case example

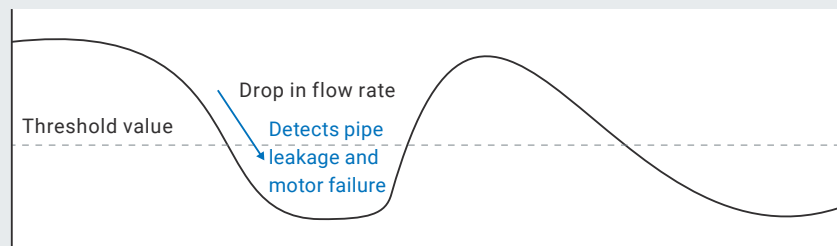
Steel cooling water management for carburizing furnace

Flow rate and temperature are the key parameters for management of cooling water.

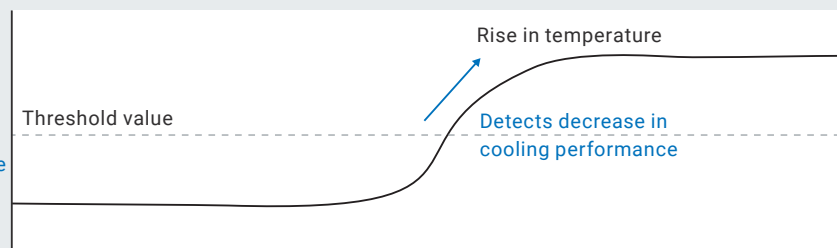
Experienced operators have traditionally checked temperature by touching. The temperature and flow rate can now be measured at the same position and digitized, leading to quality improvement.



Flow rate



Temperature



Operating time

Case example

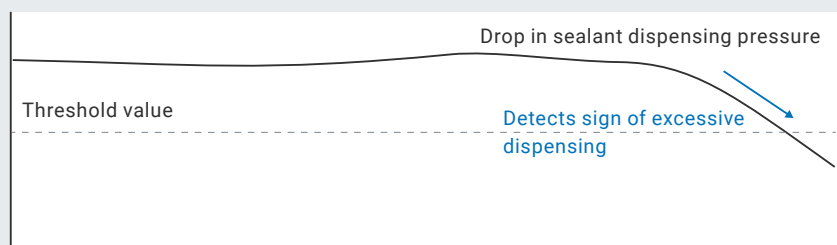
Dispensed amount management for sealant dispenser

Both dispensing pressure and temperature are the key parameters for stable dispensing.

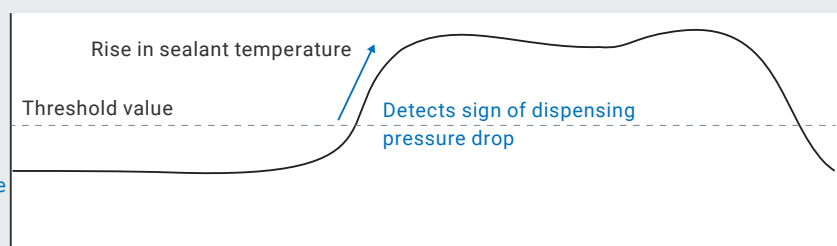
Adjustment of their optimum ranges, which previously relied on skills of experienced operators, can be digitized by simultaneously measuring dispensing pressure and temperature. This translates into improving quality.



Pressure



Temperature



Operating time

Products for “Sensory” status sensing
 Additional "temperature monitoring" feature for quick detection of cooling and hydraulic pressure abnormalities

IoT Flow Sensor E8FC

Flow rate + Temperature

IoT Pressure Sensor E8PC

Pressure + Temperature



Technology to measure flow rate and temperature for cooling abnormality detection

Flow rate The thermal flow rate measurement algorithm detects the flow velocity of the fluid by measuring how fast heat is taken from the pulse heated Ta (heated temperature measurement area), and calculates the flow rate based on the pipe diameter.

Temperature The platinum element in Tb (liquid temperature measurement area) directly measures the liquid temperature.

Technology to measure pressure and temperature for hydraulic pressure abnormality detection

Pressure The piezoelectric element withstands high pressure because its sensing surface is made of a high-hard ceramics. It detects pressure values from changes in resistance of the strain gauge.

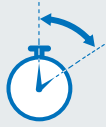
Temperature The platinum temperature measuring element mounted to the back of the piezoelectric element measures temperature.

Multi-sensing display showing cause of abnormality



Adjustable angle and reversible display





“Synchronous” status sensing with high concurrency

Analyze causality of quality defects

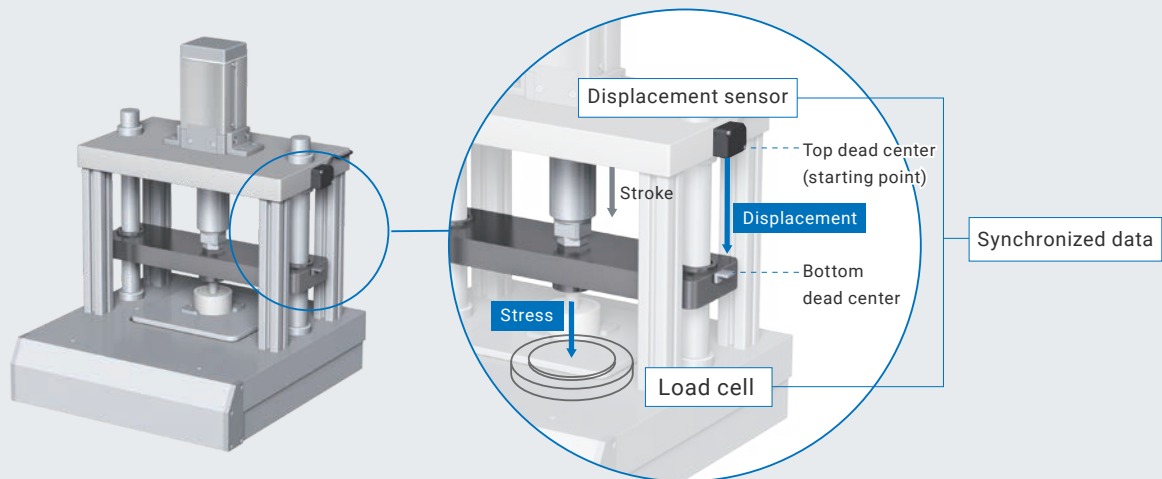
Synchronized measuring data acquisition enables the causes of defective products to be identified, raising quality standards.

Case example

Identification of causes of defective riveting

Stress and displacement are the key parameters for improving riveting quality.

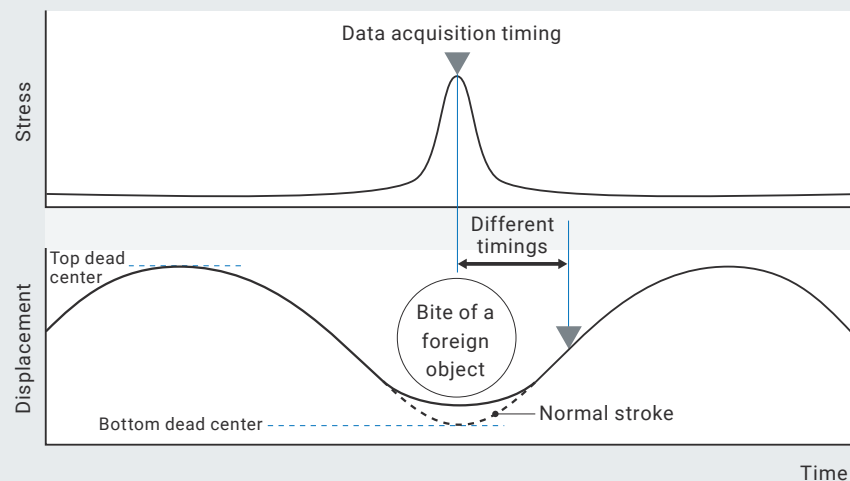
Synchronized data collection allows you to identify the causes of defects and easily take action.



Example of waveforms when riveting once

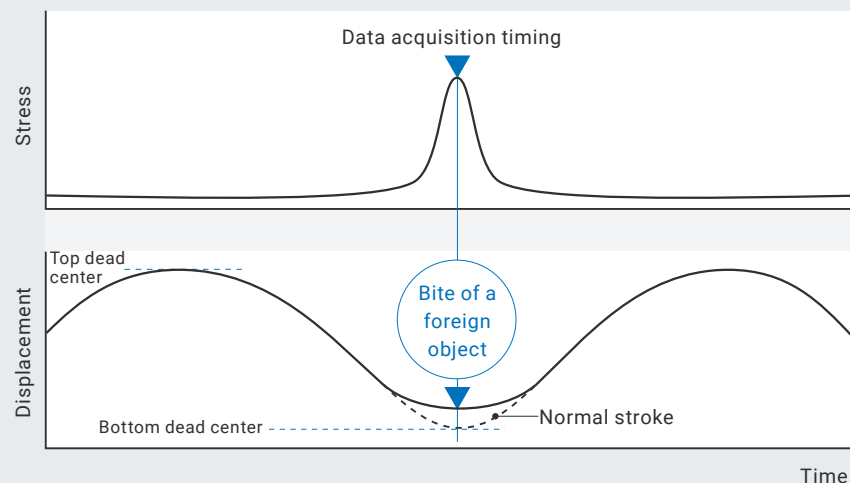
FROM

The defect cause cannot be identified because the exact status of a stroke cannot be obtained from data acquired at different times



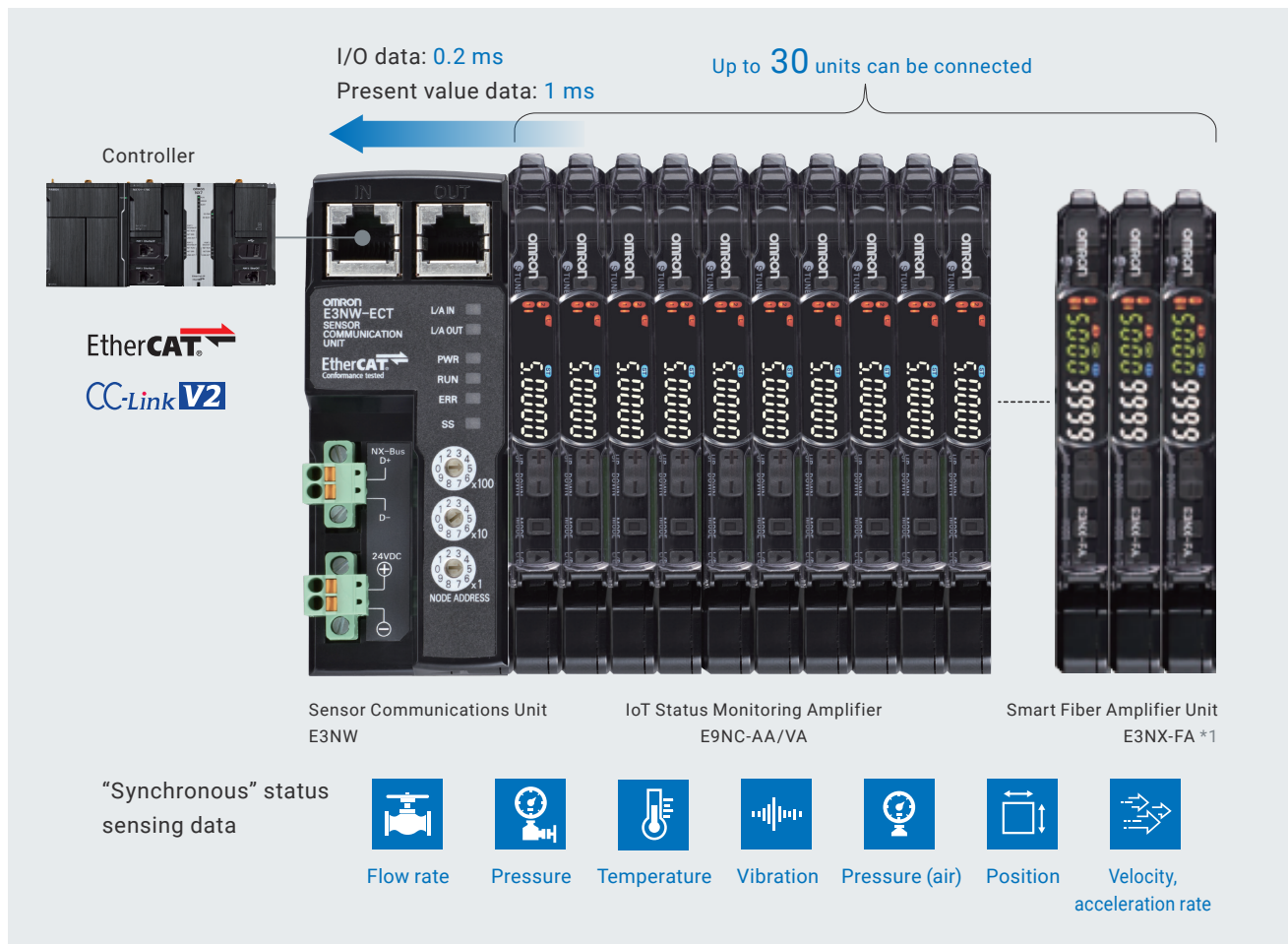
TO

The defect cause can be identified because the exact status of a stroke can be obtained from data acquired at the same time



One platform synchronizes data between sensors and integrates monitoring

Just connect the sensors installed in your machine to the E9NC IoT Status Monitoring Amplifier to centralize data collection from your machine.



*1. See page 13 for connectable sensor amplifier units.

Sensor Communications Unit E3NW

High synchronization with 1 ms jitter

Up to 30 sensor amplifier units can be connected to the E3NW Sensor Communications Unit ^{*2}.

Data synchronized at ultra-high speeds can be updated at 0.2 ms for I/O data and 1 ms for present value data between the IoT status monitoring amplifier and sensor communications unit.

*2. EtherCAT communications.

IoT Status Monitoring Amplifier

E9NC-AA/VA

No need to program PLC

Sensor heads with analog outputs between 1 to 5 VDC (voltage) or 4 to 20 mA DC (current) for measurements can be connected.

Analog inputs can be digitized by setting on the amplifier without a PLC program, enabling easy retrofitting of existing machines with the amplifier.

Connect to PLC on various networks

The EtherCAT model and CC-Link model are available. Your familiar host PLC can be connected.

Check values on 7-segment display

The 7-segment display allows you to check sensor data near the detection position. You can easily check the status at the site, without going for checking PLC data, when you set up the IoT system or failure occurs.



“Periodic” status sensing of production cycles

Identify lots and items produced during equipment malfunction

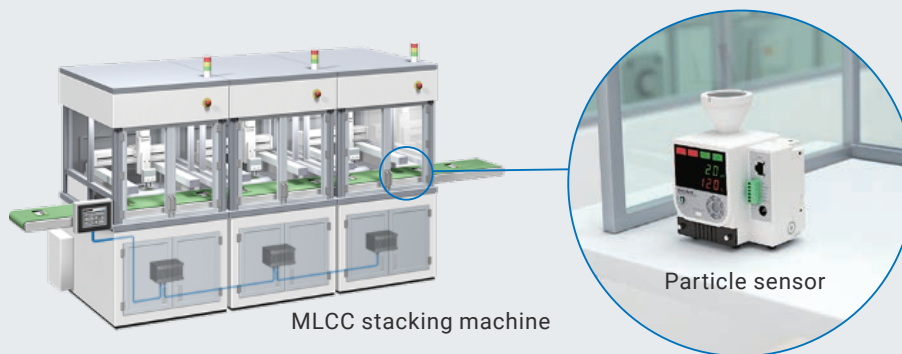
Time-series data on physical changes in equipment mechanisms and environmental changes can be collected and linked to production cycles such as lots and items. This helps you identify the production lots and items during equipment malfunction and take action to prevent defective products from entering the market and to improve quality.

Case example

Continuous monitoring of particles

It is crucial for the stacking process in MLCC manufacturing to continuously monitor the volume of particles that compromise production quality. When the timing of an abnormality exceeding the threshold value is not linked to the production cycle, possible defective lots cannot be identified.

The visualization and analysis software and PLC programs enable you to identify the lots by observing changes in particles over time linked to the production cycle.

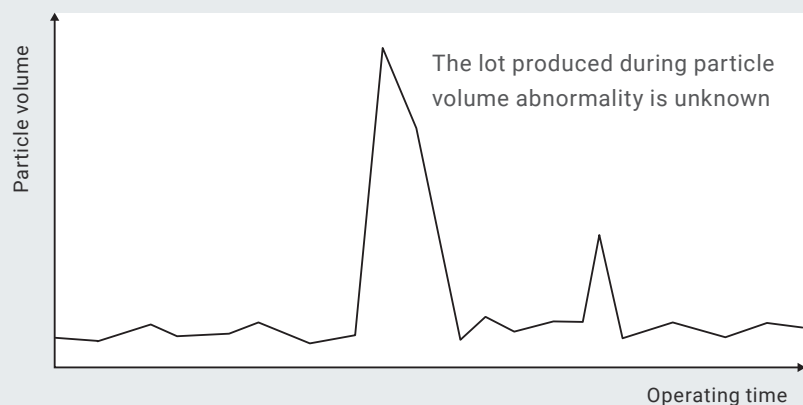


MLCC stacking machine

Particle sensor

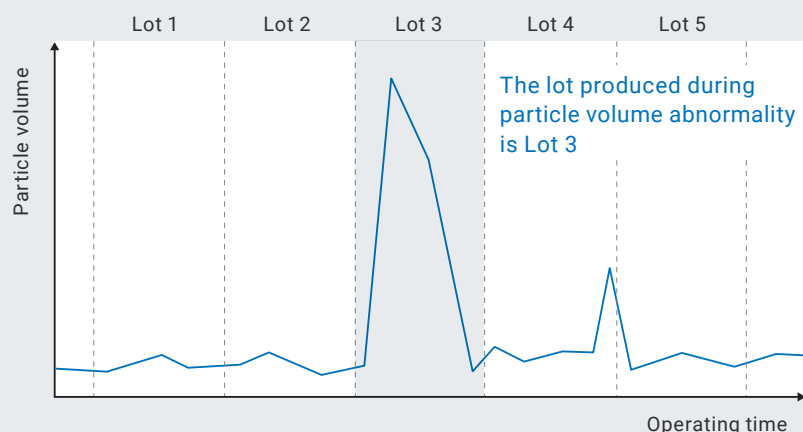
FROM

The lot produced when there are excessive particles cannot be identified because data linked to the production cycle cannot be obtained



TO

The lot produced when there are excessive particles can be identified because time-series changes linked to the production cycle can be observed



* Monitoring of particle volumes when five lots are produced per day

Products for “periodic” status sensing

Management of particle volumes linked with production lots

Air Particle Sensor ZN-PD-S

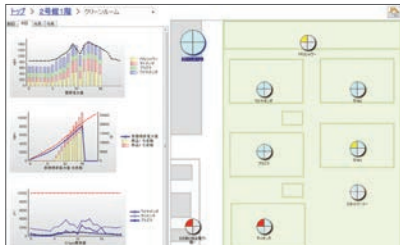
This sensor measures airborne particles (0.3 to 1 μm) at manufacturing sites and dust fallout generated by people and machines (5 to 50 μm). Continuous monitoring of the manufacturing process enables you to capture signs of deteriorating quality.



Visualization and Analysis Software F-Scape

F-Scape is software ideal for small start of IoT through production data collection and visualization, highlighting on-site issues. Hierarchical display (e.g., machines, lines, and floors) is the most outstanding feature. This software also offers customization, time-series graphing, and easy-to-use simplified analysis.

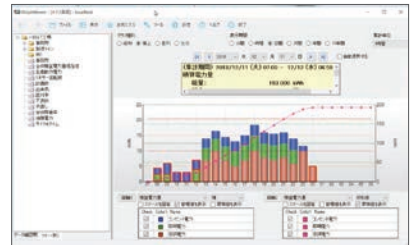
Example of floor status display



Example of machine status display



Simplified analysis screen



Video recording before and after problems

Factory Drive Recorder

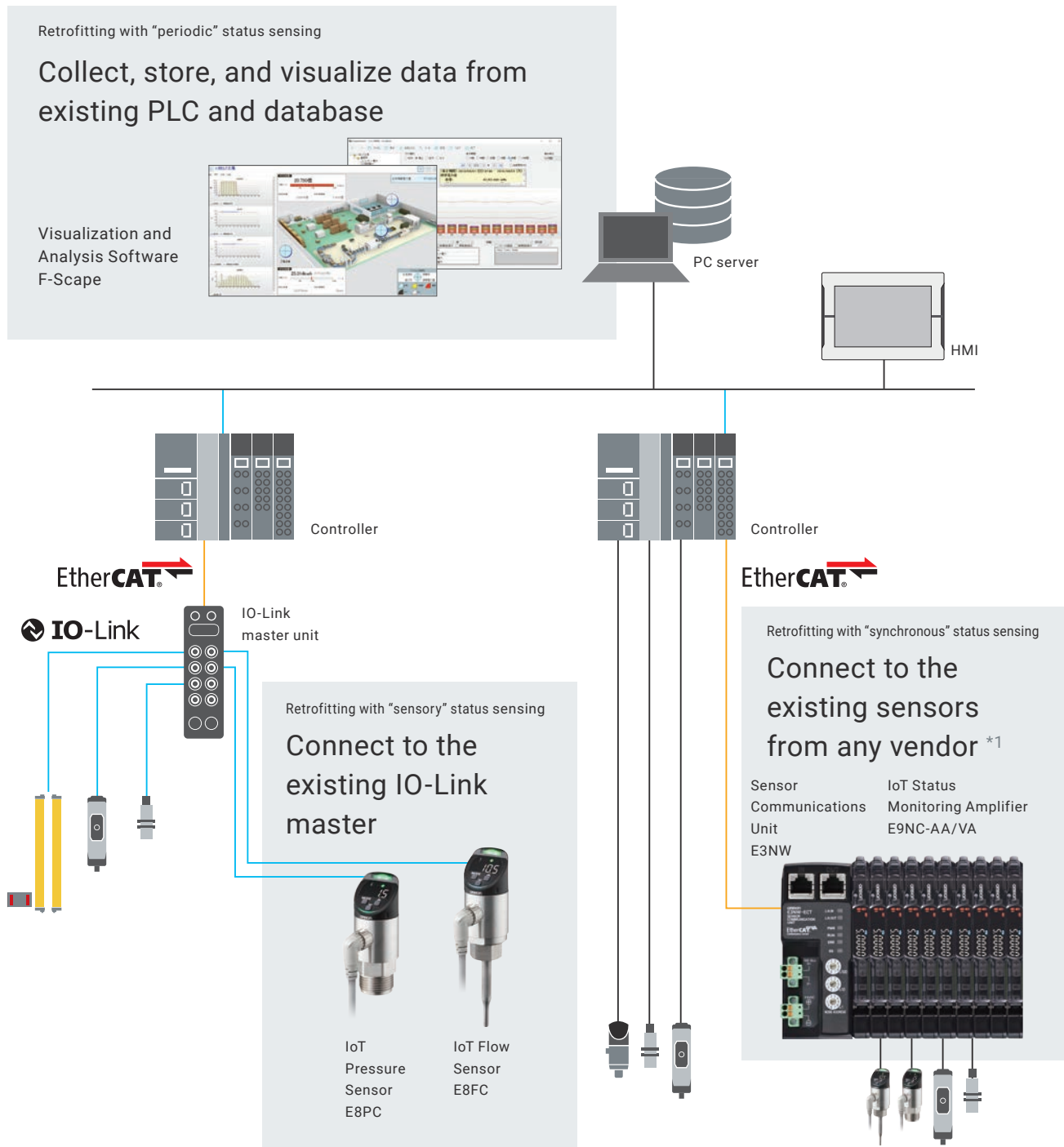
When a problem is detected, the cameras record videos showing five minutes before and after the problem. You can accurately understand the event and quickly troubleshoot. The simple configuration consists of cameras, lenses, a PC, and software, facilitating retrofit. You can choose from more than 100 cameras, from compact remote head cameras to 20 Mpix high-resolution cameras, to suit your environment.



Integrate into your existing equipment without building a complex system

Adding new functions to existing equipment to digitize the equipment status requires large-scale modification and construction, which incurs considerable time and cost. Although manufacturers pursue production that does not lose opportunities, such major modification can compromise the conventional functions. In some cases, this may hinder the digitization of equipment status. One of the concepts of Omron's status sensing devices is retrofit. They can be installed in existing equipment without much effort or expense.

System configuration example

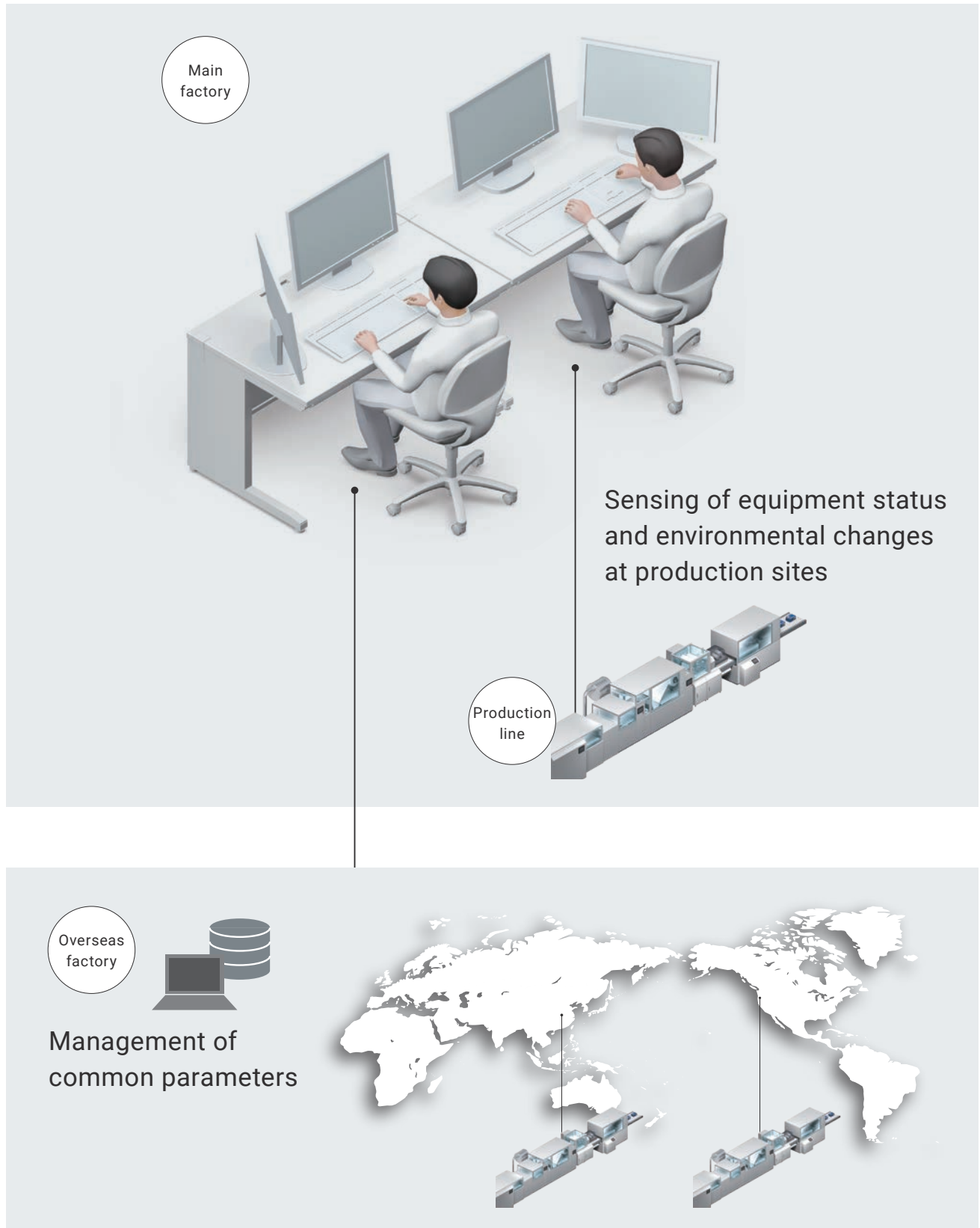


*1. Sensor heads with analog outputs between 1 to 5 VDC (voltage) or 4 to 20 mA DC (current) for measurements.

Digitization of equipment status helps enable remote commissioning and operation

Operating status of domestic and overseas factories can be monitored remotely by uploading acquired key parameters of machine status to a cloud server via host communication. You can build a system to support remote commissioning and operation.

Remote commissioning and operation of equipment



Products for status sensing

Process sensor

IoT Flow Sensor

E8FC

Detect signs of abnormalities in cooling water by simultaneous measurement of “flow rate + temperature”

- Multi-sensing of “flow rate + temperature” prevents sudden stops and manufacturing defects
- A wide variety of replacement adapters facilitate replacement of your current pressure gauges and flow meters
- IO-Link communications function for self-diagnostics of sensor abnormalities and analog current output function



Applicable fluid *1	Rated flow rate range (pipe diameter)	Connection method	IO-Link baud rate	Model
Liquid	0.6 to 14 l/min (10 A) 1 to 30 l/min (15 A) 1.5 to 60 l/min (20 A) 2 to 100 l/min (25 A)	M12 (4-pin) connector	COM2 (38.4 kbps) COM3 (230.4 kbps)	E8FC-25□

*1. The liquid must not corrode the material of the wetted part (e.g., water and fluid whose conductivity is equivalent to that of water).

Refer to the *E8FC/E8PC Series Catalog* (Cat. No. E472) for details.

IoT Pressure Sensor

E8PC

Detect signs of abnormalities in cooling water and hydraulic oil by simultaneous measurement of “pressure + temperature”

- Multi-sensing of “pressure + temperature” prevents sudden stops and manufacturing defects
- A wide variety of replacement adapters facilitate replacement of your current pressure gauges and flow meters
- IO-Link communications function for self-diagnostics of sensor abnormalities and analog current output function



Applicable fluid *2	Rated pressure range	Connection method	IO-Link baud rate	Model
Liquid and gas	-0.1 to 1 MPa	M12 (4-pin) connector	COM2 (38.4 kbps) COM3 (230.4 kbps)	E8PC-010□-E
Liquid	0 to 10 MPa			E8PC-100□-E
	0 to 40 MPa			E8PC-400□-E

*2. The gas and liquid must not corrode the material of the wetted part (e.g., water, glycol solution, and oil).

Refer to the *E8FC/E8PC Series Catalog* (Cat. No. E472) for details.

Communications unit and status monitoring amplifier

Sensor Communications Unit

E3NW

Next-generation sensor networking units revolutionize manufacturing sites from installation to commissioning and operation

- Distributed placement of sensor communications unit and distributed sensor units at low initial cost (PATENTED) *1
- Transmission of ON/OFF signals and detected quantities to host PLC without programing
- Reading and writing threshold values and function settings and tuning
- Reduced wiring: simply connect communications cable and power cable and slide amplifier unit



*1. "PATENT PENDING" means that we applied for a patent in Japan, and "PATENTED" means that we obtained a patent in Japan. (As of March 2021)

Host communication	Connectable sensor amplifier unit	Max. no. of connectable sensor amplifier units	Model
EtherCAT *2	N-Smart Smart Fiber Amplifier Unit : E3NX-FA0 Smart Fiber Amplifier Unit (infrared model): E3NX-FAH0 Smart Fiber Amplifier Unit (2-channel model): E3NX-MA0 Color Fiber Amplifier Unit : E3NX-CA0 *3 Smart Laser Amplifier Unit: E3NC-LA0 Smart Laser Amplifier Unit (CMOS model): E3NC-SA0 Smart Proximity Amplifier Unit: E2NC-EA0/EA10/EA40 Contact-Type Smart Amplifier Unit: E9NC-TA0 *4 IoT Status Monitoring Amplifier: E9NC-AA/VA	30 *5	E3NW-ECT

*2. The CC-Link model (E3NW-CCL) is also available.

*3. The E3NX-CA0 is supported for firmware version 1.06 or higher (sensor communications units manufactured in June 2016 or later).

*4. The E9NC-TA0 is supported for firmware version 1.03 or higher (sensor communications units manufactured in July 2014 or later).

*5. The maximum total number of sensors that can be connected to a sensor communications unit and distributed sensor units when the sensor communications unit is connected to Omron's NJ Controller. Up to 16 E2NC-EA10/EA40 Smart Proximity Amplifier Units can be connected.

Refer to the E3NW Catalog (Cat. No. E428) for details.

IoT Status Monitoring Amplifier

E9NC-AA/VA

Connects to various sensors with general-purpose analog outputs

- General-purpose input: Connects to sensor heads with analog outputs between 1 to 5 VDC (voltage) or 4 to 20 mA DC (current) for measurements
- Scaling: Converts analog input values to desired values for display (Upper limit setting: -1999.9999 to 9999.9999)
- Connects up to 30 units *6



*6. The maximum number of connectable units varies depending on conditions such as the current consumption of the sensor head.

Input type Input range	Supply current for sensor and max. no. of connectable units	Connection method	Control output	Model	
				NPN output	PNP output
Current input 4 - 20 mA DC	Sensor consumption current 40 mA max.: 30 *7	Connector for sensor communications unit	None	E9NC-AA0	
		Connector for sensor communications unit Pre-wired (2 m)	1 output	E9NC-AA10 2M	E9NC-AA40 2M
Voltage input 1 - 5 VDC	Sensor consumption current 100 mA max.: 12	Connector for sensor communications unit	None	E9NC-VA0	
		Connector for sensor communications unit Pre-wired (2 m)	1 output	E9NC-VA10 2M	E9NC-VA40 2M

*7. Only E9NC-VA0/AA0 can connect to 17 or more units (up to 30 units).

Refer to the E9NC-AA/VA Datasheet (Cat. No. E474) for details.

Products for status sensing

Air particle sensor and industrial camera + factory drive recorder

Air Particle Sensor

ZN-PD-S

Continuous monitoring of particles to identify dust sources and control dust



- Easy measurement of particles and dust
 - Much smaller size than particle counters. Fits in narrow spaces
 - Remote monitoring via Ethernet
 - Continuous operation of more than two years.
- Ideal for quality control by continuous monitoring



Item	Measured particle diameter	Sample flow rate	Communications interface	Model
Particle measurement type	0.3 µm, 0.5 µm, or 1.0 µm min.	2.8 liters/min min.	Ethernet (10BASE-T, 100BASE-TX)	ZN-PD03-S
Dust measurement type	5 µm (10 µm), 20 µm (30 µm), or 50 µm min. *1	6.0 liters/min min.		ZN-PD50-S

*1. () is selectable. The maximum particle diameter that can be measured is approximately 200 µm. (When the pre-filter is attached.)
Refer to the ZN-PD-S/THX21-S/DPX21-S Catalog (Cat. No. E411) for details.

Industrial Camera + Factory Drive Recorder

STC-FDR-SW01

Records videos before and after problems for accurate grasp of events



- Simple configuration facilitates retrofit
- High-speed video capture never overlooks events
- A selection of more than 100 cameras, from compact remote head cameras to 20 Mpix high-resolution cameras, to suit site environment



Item	Connectable camera	Max. no. of connectable cameras	Model
Factory Drive Recorder	STC Camera Series • USB3 Vision Model • GigE Vision Model	8 per PC	STC-FDR-SW01

Software

Visualization and Analysis Software

F-Scape

Small start of IoT through production data collection and visualization

- Easy collection and visualization of production data
- Highlights on-site issues through data utilization
- Helps solve issues as an organizational communication tool



Item	Supported device and data source	No. of channels to register	Collecting interval	Model
F-Scape	PLC (NX/NJ/CJ2) *1 EQ100 Edgecross compatible PLC *2 External DB (automatic collection) CSV file (manual input)	5,000 max.	1 s, 5 s, 10 s, 15 s, 30 s, 1 min, 5 min, 10 min, 30 min, 60 min	IBS-VP10

*1. FA Communications Software CX-Compolet/Sysmac Gateway is required.

*2. Edgecross basic software and data collector for connected devices are required.

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